

Toshiba's Contribution to Advanced Carbon Capture Solutions

TOSHIBA

Toshiba Energy Systems & Solutions Corporation

September 2, 2024

Contents

- 01 Company Overview**
- 02 New technology development
for Carbon Capture Solutions**
- 03 Advanced Carbon Capture Solutions**
- 04 Delivery records and Business expansion
into Global market**

01

Company Overview



Organization

Toshiba Corporation

Toshiba Infrastructure Systems
& Solutions Corporation

Toshiba Electronic Devices
& Storage Corporation

Toshiba Digital Solutions
Corporation

Toshiba Energy Systems & Solutions Corporation

As of December 22nd, 2023



Taro Shimada
President and CEO
Toshiba Energy Systems &
Solutions Corporation

Power Systems Div.

Isogo Nuclear Engineering Center

Keihin Product Operations

Grid Solution Div.

Hamakawasaki Operations

Fuchu Operations

Energy Aggregation Div.

Digital Transformation Div.

Domestic Marketing & Sales Div.

Global Marketing & Sales Div.

**Energy Systems Research &
Development Center**

Hokkaido Branch Office

Kansai Branch Office

Tohoku Branch Office

Chugoku Branch Office

Chubu Branch Office

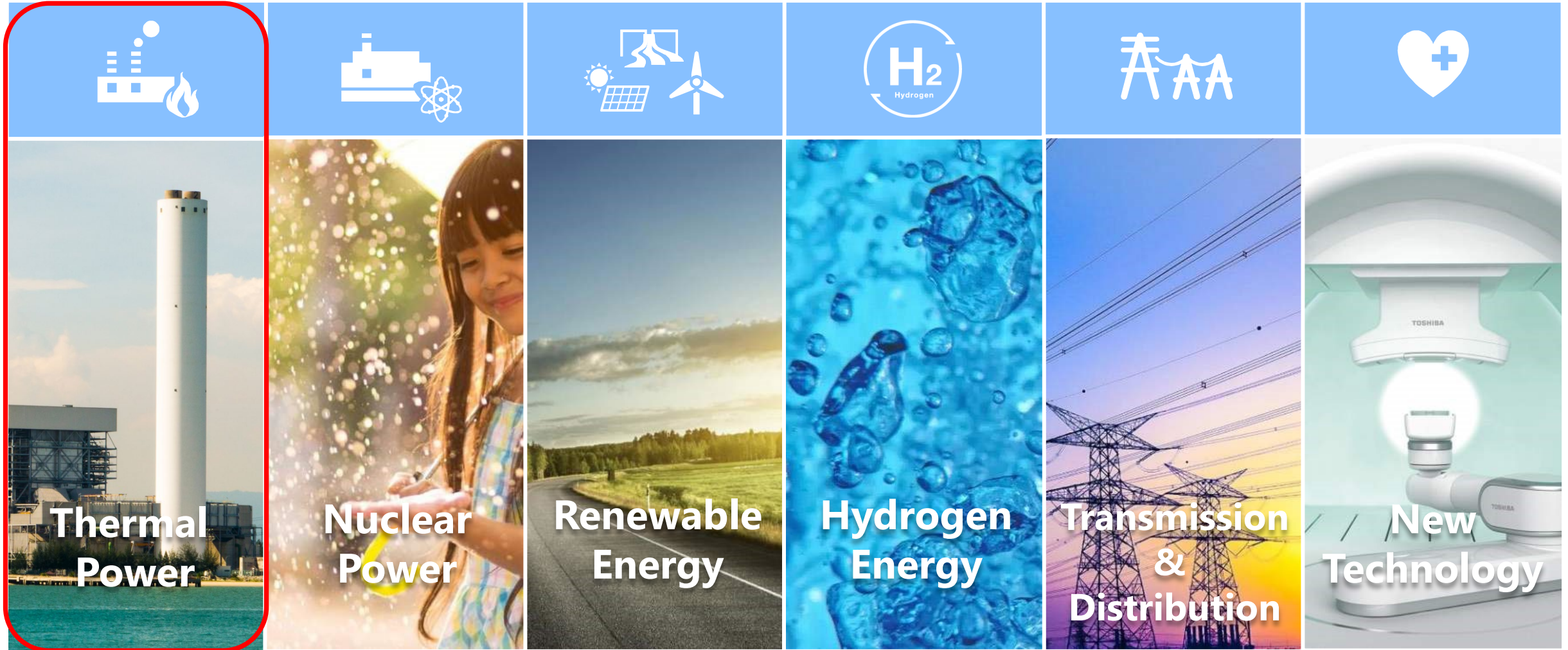
Shikoku Branch Office

Hokuriku Branch Office

Kyushu Branch Office

Business Domains

- Toward the realization of sustainable society

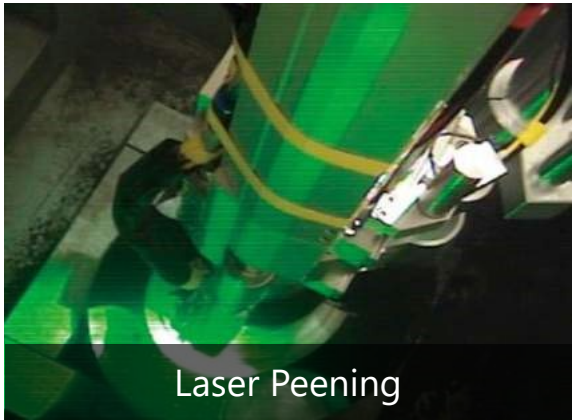
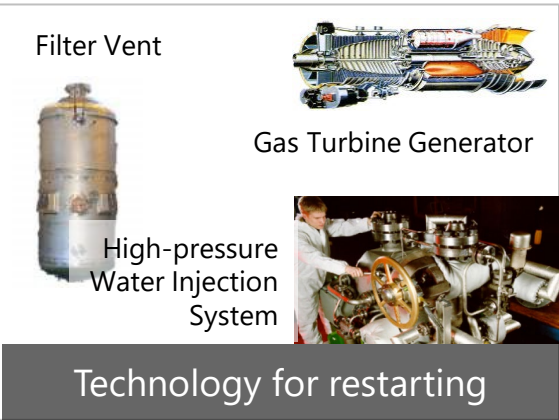


Thermal Power / Nuclear Power

Thermal Power



Nuclear Power



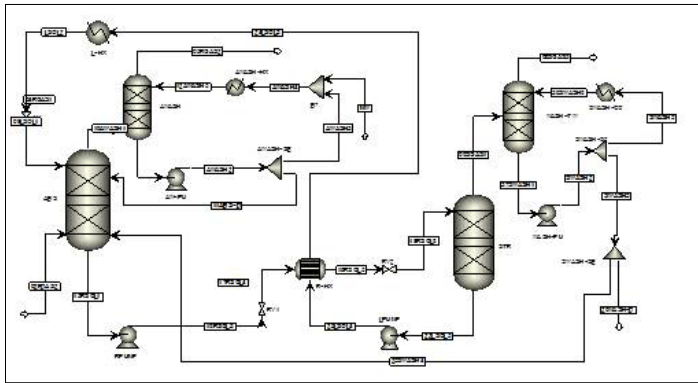
02

New technology development for Carbon Capture Solutions



CO2 Capture Technology Implementation Flow

① Development



Process Design & System Performance improvement evaluation by Simulation



Solvent Development



Performance / Degradation Evaluation by Small Loop

② Field Evaluation



Comprehensive evaluation based on actual exhaust gas

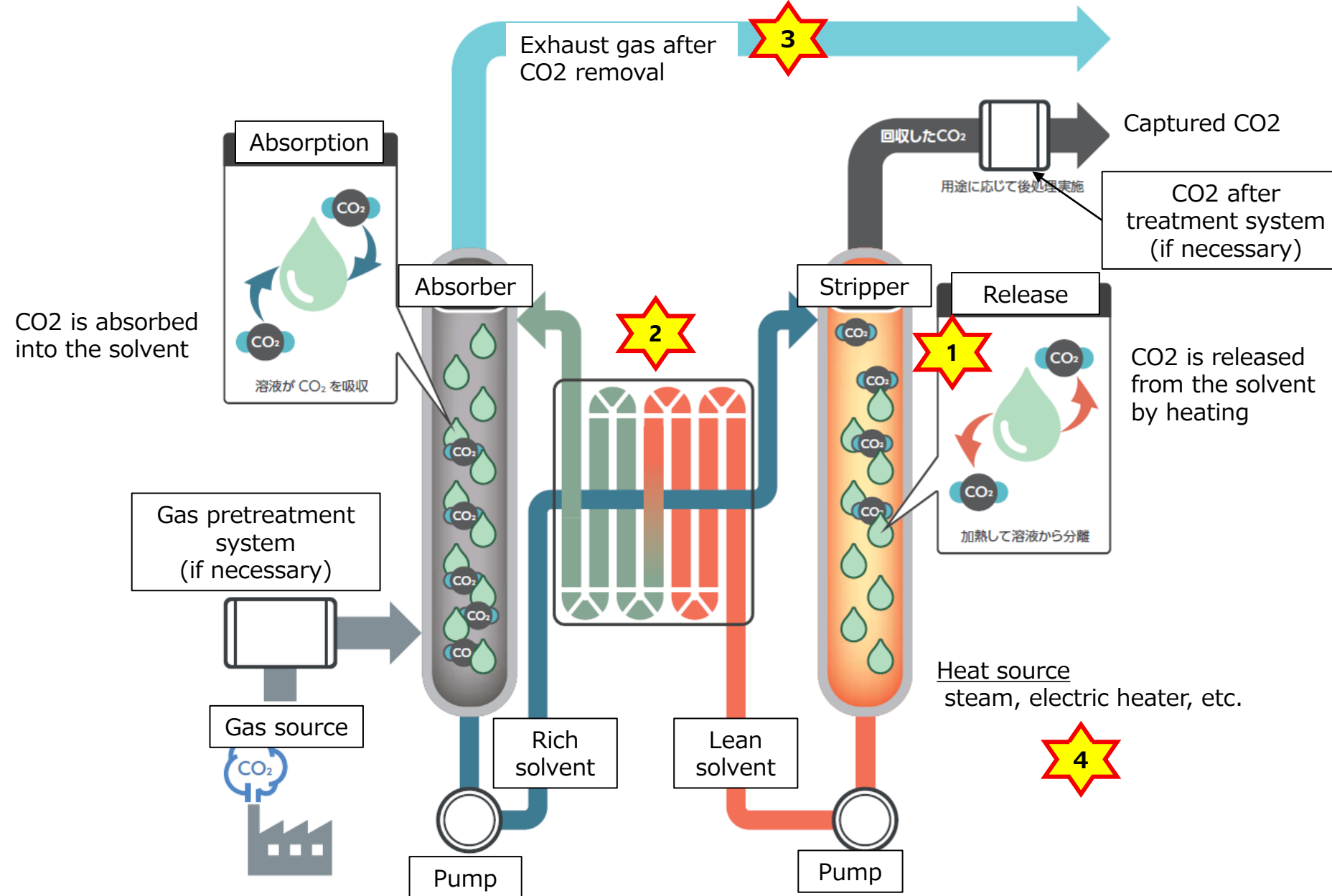


③ Commercial Scale



• Saga City Incineration (L)
• MOE Demonstration PJ (R)

Carbon dioxide capture system using chemical absorption method



Why Toshiba ?

- 1 Reliability/Quality of solvent**
Owner and Operator of its own Pilot Plant
- 2 Less energy consumption**
Licensor of amine solvent, 2.4GJ/ton, Tier 1 position in the world
- 3 Environmental**
Testing of amine emissions and its control methods
- 4 Coordinating steam cycle**
integrate CCUS system with existing steam cycle systems

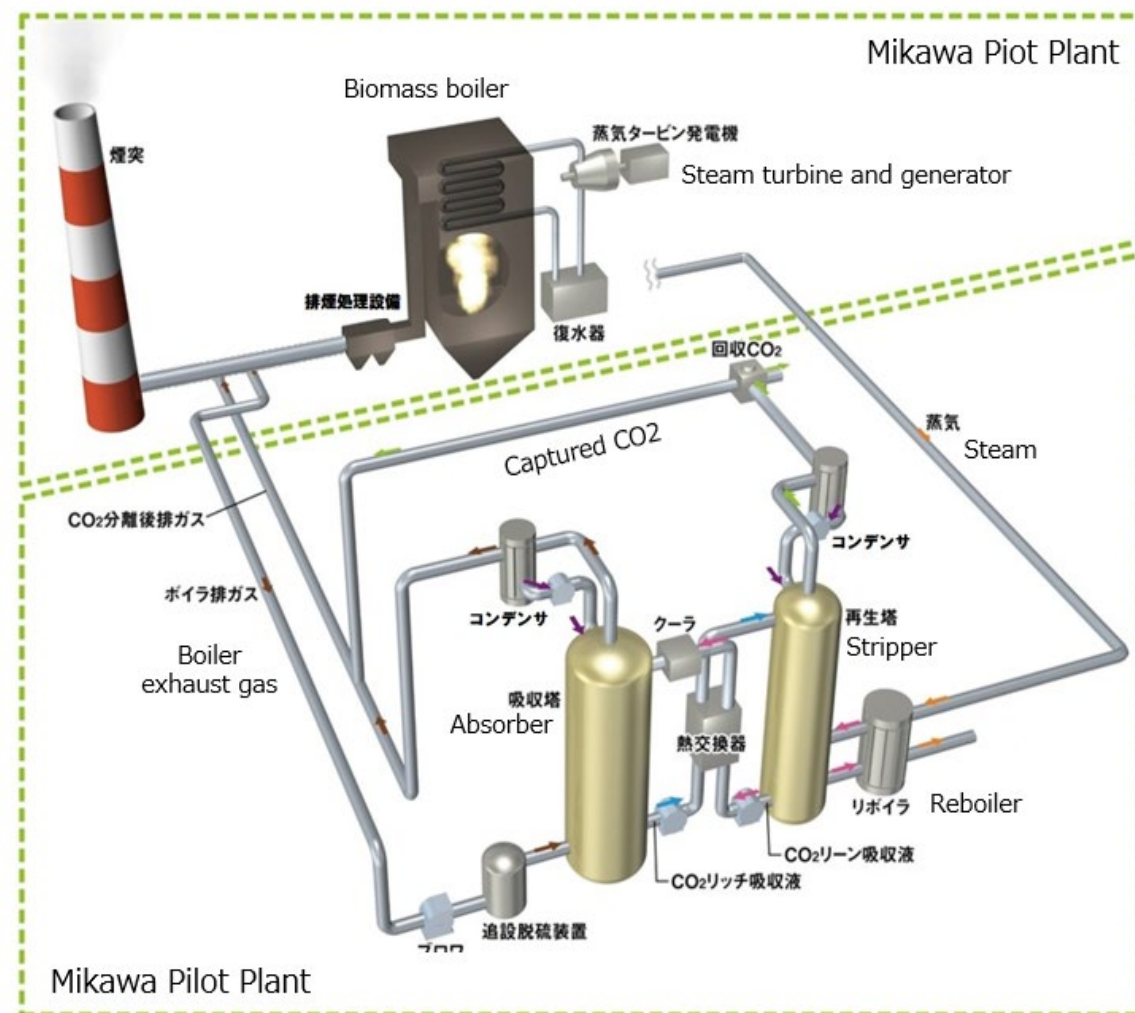
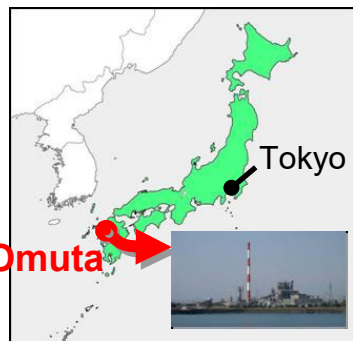
Pilot plant for CO2 Capture



Reliability/Quality of solvent

Plant Overview

- **Location**
Omuta City, Fukuoka
- **Start of Operation**
2009/9
- **Flue Flow Rate**
2,100Nm³/h
- **CO₂ Concentration**
4~30%
- **Capacity**
10ton-CO₂/day



New technology development at commercial-scale facilities using actual flue gas

Pilot plant for CO₂ Capture

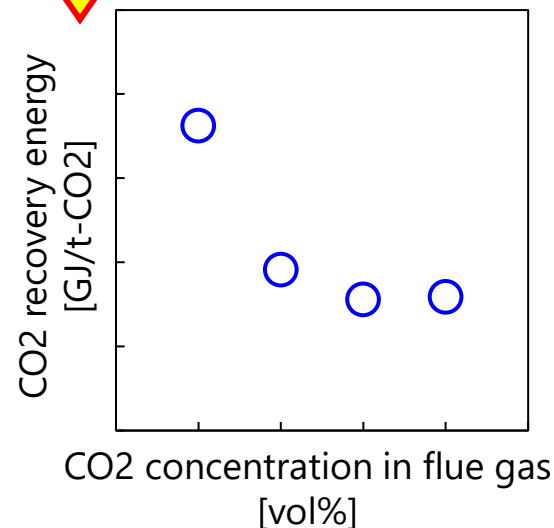
2

Less energy consumption

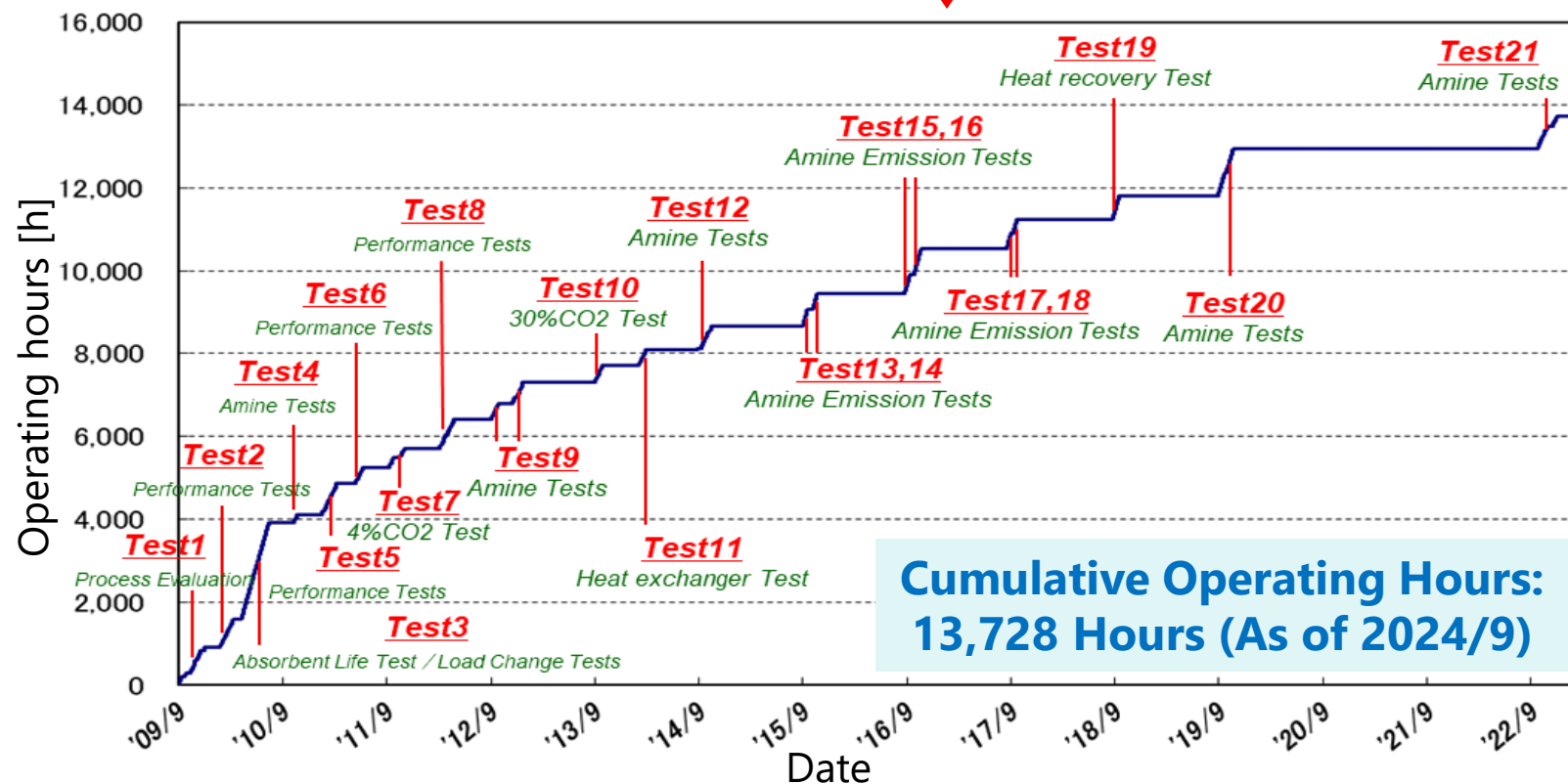
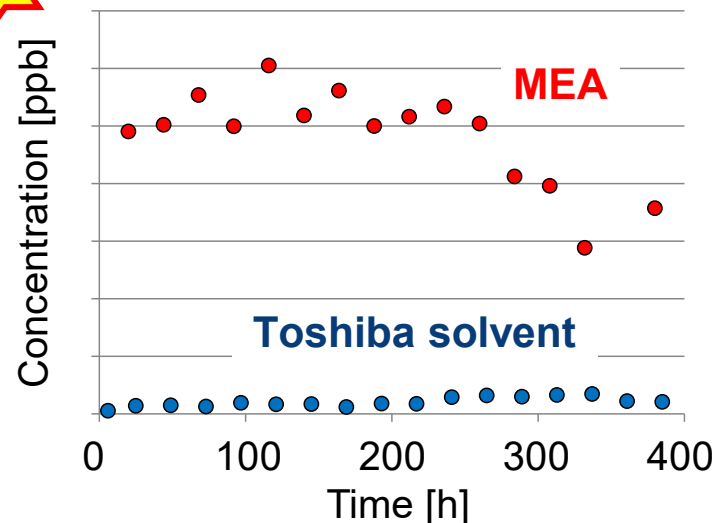
3

Environmental

2 Example of test result



3 Amine concentration at absorber outlet



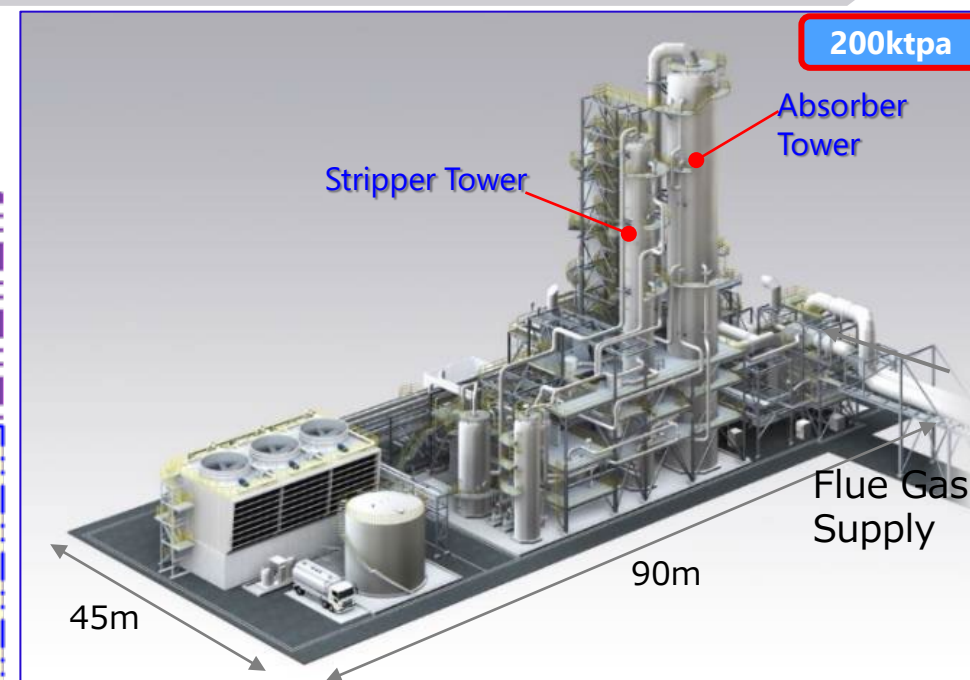
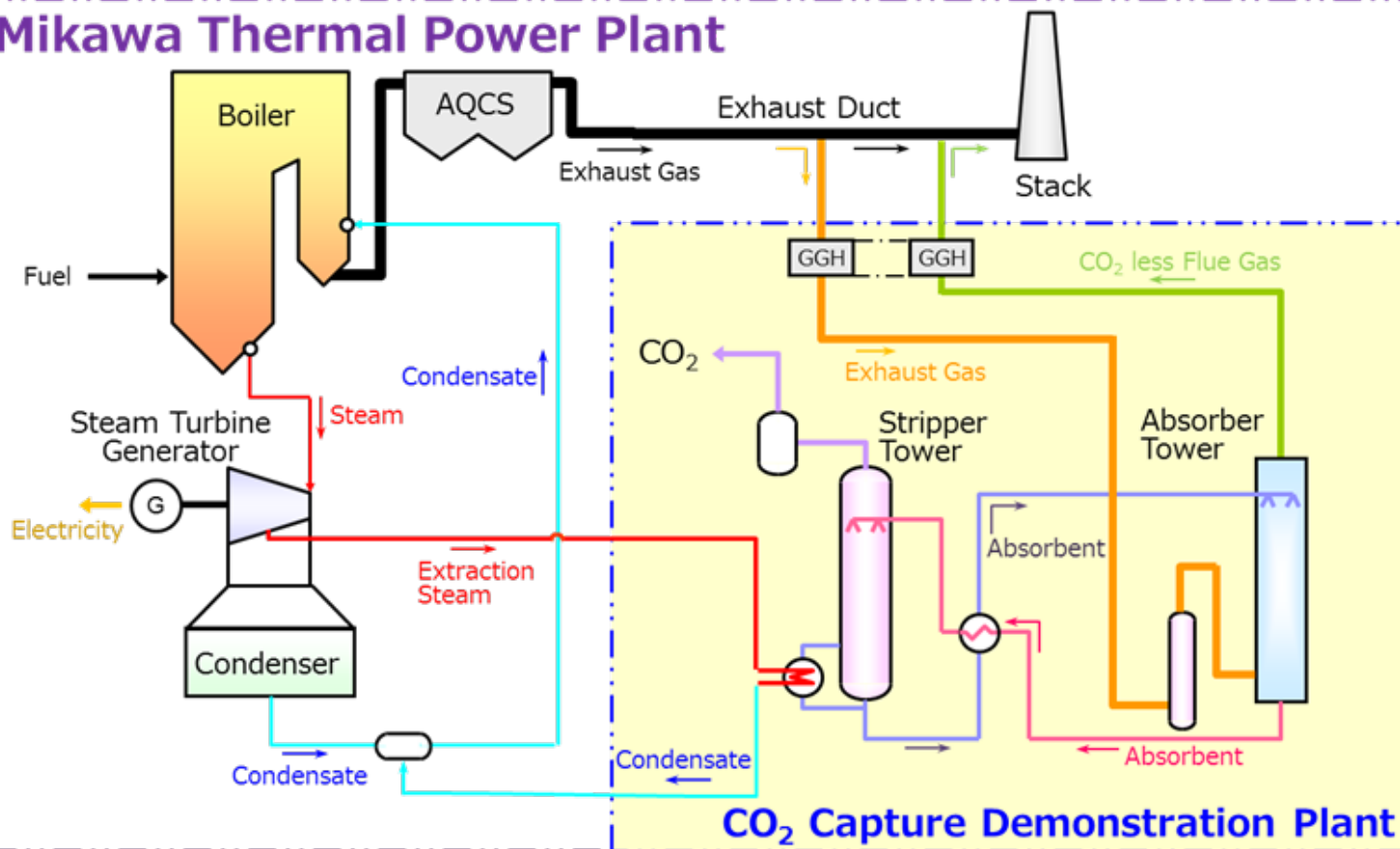
Tests conducted

- ✓ Seeking high performance amine solvents
- ✓ System improvements with various components
- ✓ Effect of CO₂ gas concentration on CO₂ recovery energy
- ✓ New amine emission control system

Deployment to Power Plants (MoE's Sustainable CCS Project)

The world's first large-scale BECCS* ready demonstration facility added to a biomass power plant. One of the largest in Japan, capturing over 50% of emitted CO₂ (over 600t/day)

Mikawa Thermal Power Plant



* BECCS : Bio-Energy with Carbon Capture and Storage

03

Advanced Carbon Capture Solutions

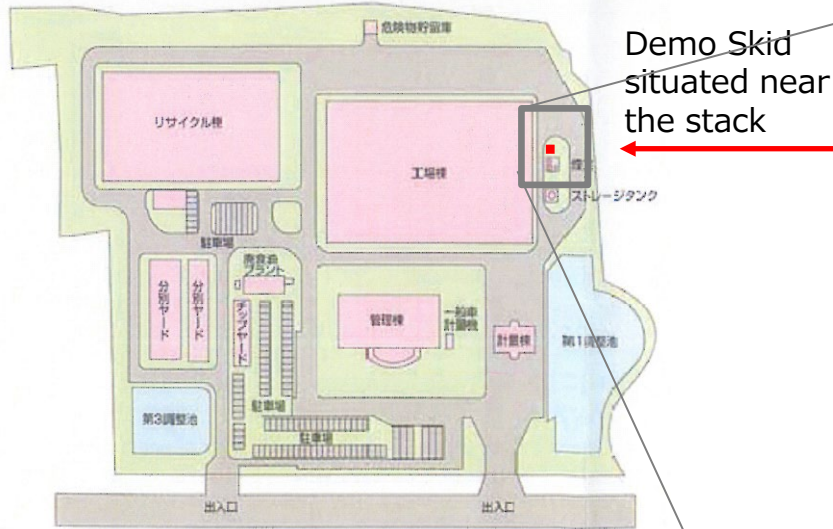


Waste Incineration Plant at Saga City :

Phase 1: CO₂ utilization in agriculture (deployment in small scale)

- ◆ Project promoted by Saga city as part of its Biomass Industrial City Vision. CO₂ is captured from exhaust gas of existing Saga city municipal waste incineration (WtE; Waste to Energy) plant.
- ◆ First phase of the project started in 2013 until 2015. Using the small scale demo skid, the concept of capturing high purity CO₂ from WtE was proven through cumulative 8000 hours of operation.

Saga Waste Incineration (WtE) Plant



Small Scale Demo Skid (10~20 kg/day)



(Salad crop cultivation)
Verification of impurities in CO₂ gas

Waste Incineration Plant at Saga City :

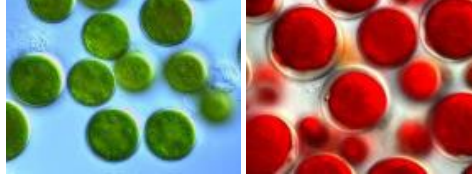
Phase 2: CO2 utilization in agriculture (deployment in commercial scale)

■ Promotion of Environment-friendly **Agriculture & Algae Industry**

- ◆ **World's first** commercial-use CCU system constructed in a municipal waste incineration plant.



JA Zennoh Cucumber



Albita Algae

CO2 Transfer piping to the Algae Cultivation area

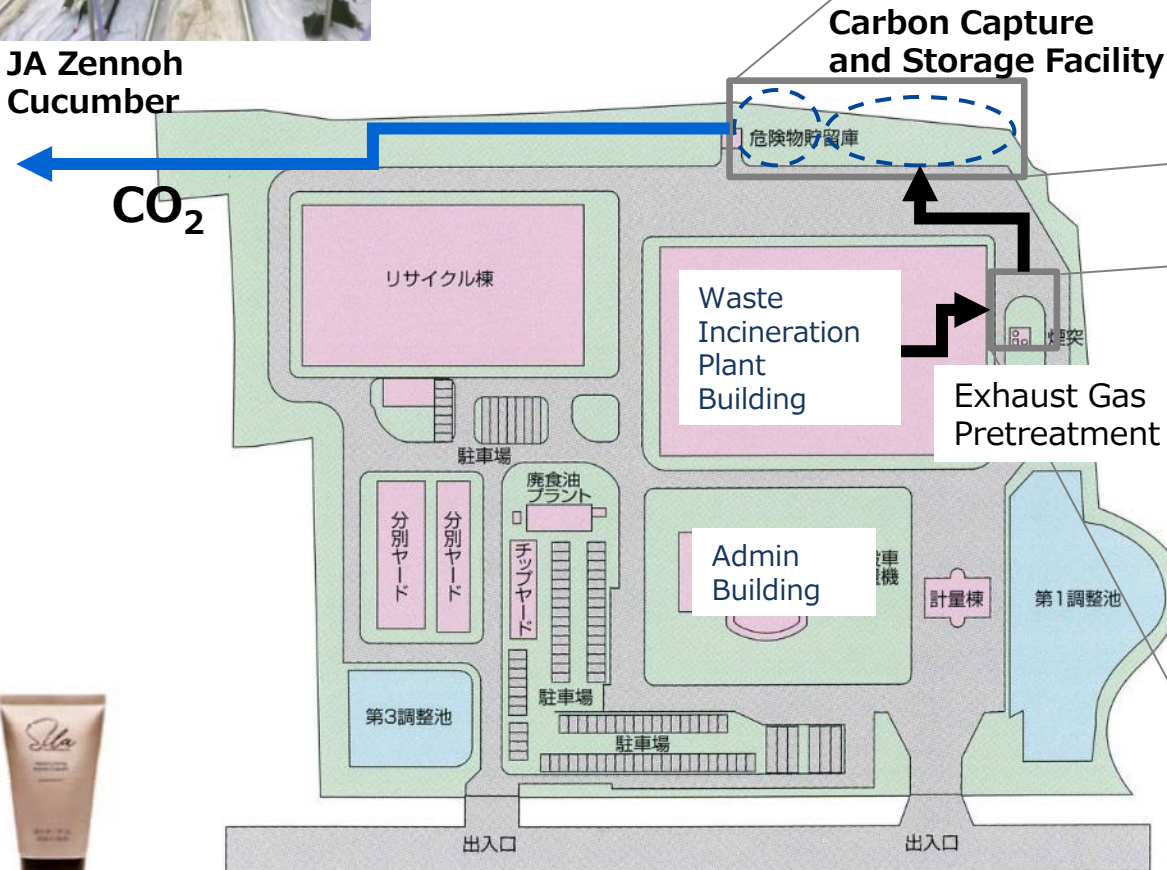


Haematococcus is cultivated and astaxanthin is extracted. It affects an antioxidant action.
(Use : cosmetics etc.)



A **hand cream**, **body cream**, and the **supplement** "Sila*" are on sale.

*Saga Incubates Local Algae



CO2 capture plant
CO2 storage equipment

3ktpa



10 ton/day
Operational since 2016

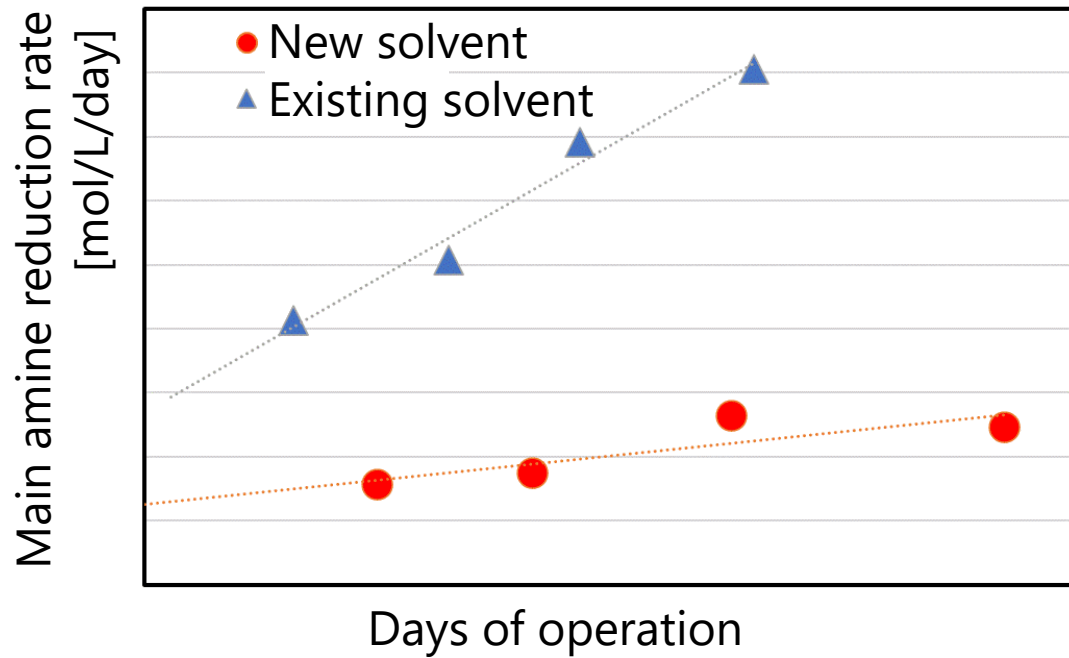


Exhaust gas pretreatment plant
(desalination treatment)

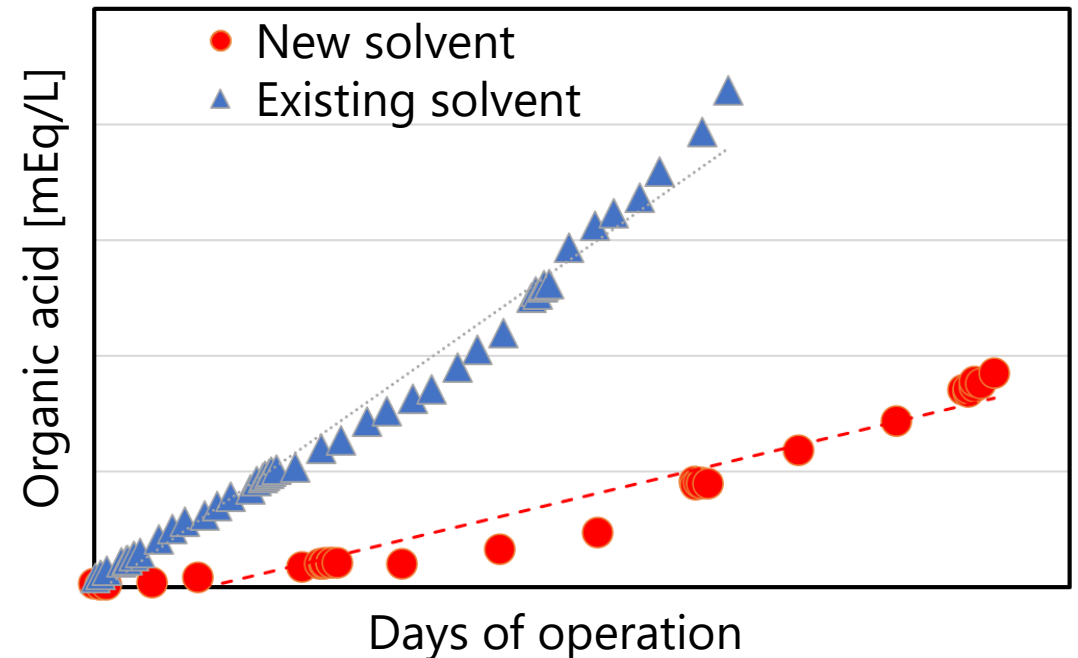
Waste Incineration Plant at Saga City :

Phase 3: CO₂ utilization in agriculture (collaborative research Part I)

- Toshiba conducted **collaborative research with Saga City** beginning in March 2023.
- Toshiba supplied the **new solvent** and verified the performance at Saga city's commercial plant **for a year**.



Comparison of decrease in main amine concentration in new and existing CO₂ solvents



Comparison of organic acid accumulation speed in new and existing CO₂ solvents

Compared to our existing solvent, it enables higher performance operation.

Waste Incineration Plant at Saga City :

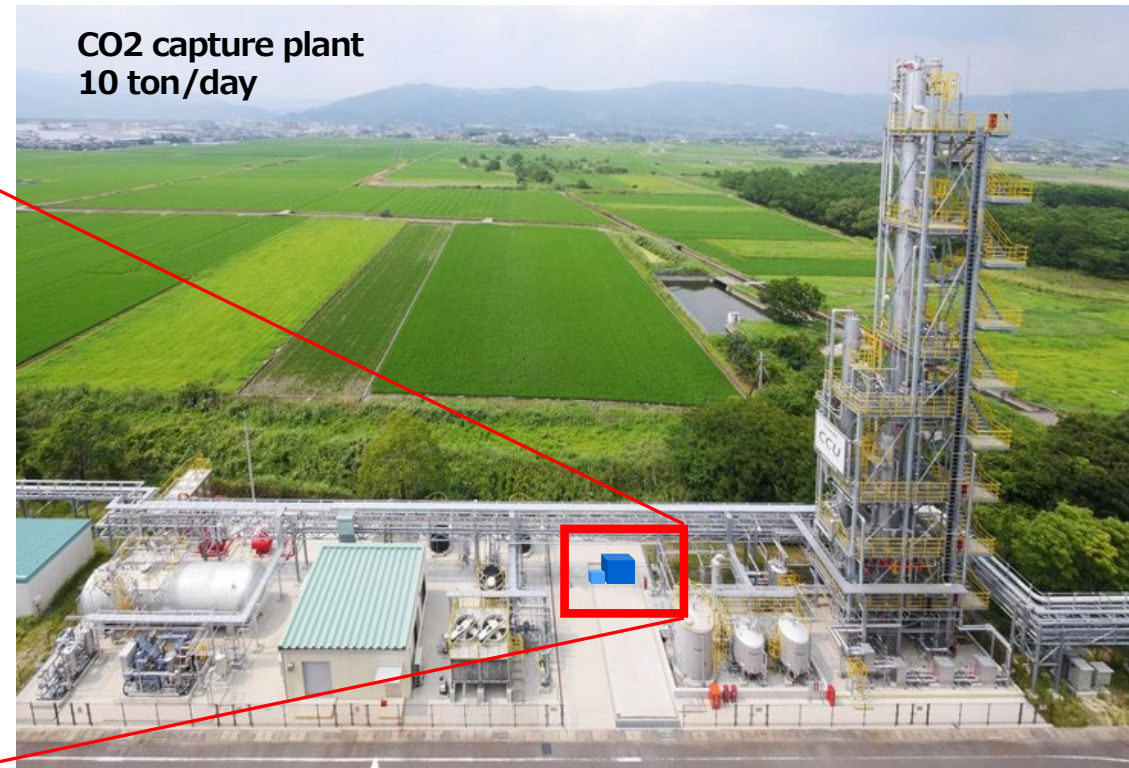
Phase 4: CO2 utilization in agriculture (collaborative research Part II)

- As for the development of solvent reclaiming technology, Toshiba has been conducting **collaborative research with Saga City** since April 2024.
- Toshiba has installed an **electrodialysis test facility**, which is currently under demonstration at Saga city's commercial plant.

Exterior of electrodialysis test facility



Interior of electrodialysis test facility



The demonstration is scheduled to continue until the end of FY 25.

04

Delivery records and Business expansion into Global market



Delivery records for the development of CCUS

I Industrial Sector (demonstration)

Beverage supplier (10kg/day-CO₂) Gas supplier (10kg/day-CO₂)



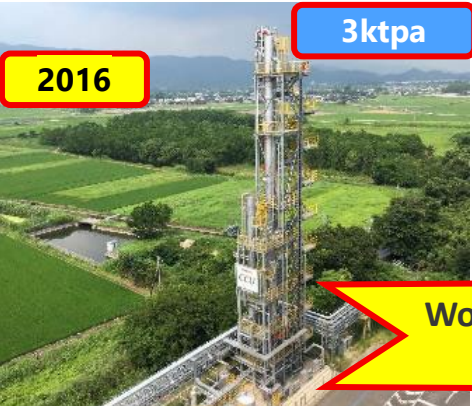
[Toshiba Successfully Delivers Carbon Capture System to Tokyo Gas | News Release | Toshiba Energy Systems & Solutions \(global.toshiba\)](#)

II WtE Plant (CCU)

Pilot plant (PoC) (10kg/day-CO₂)



Commercial plant (10 t /day-CO₂)



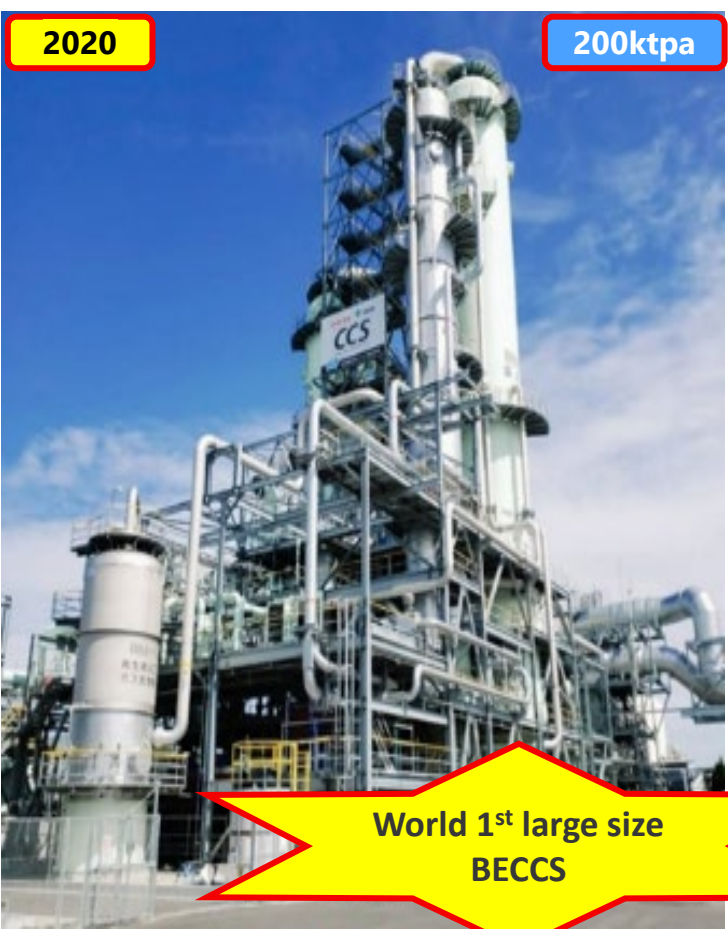
World 1st CCU with WtE plant

III Coal/Biomass power plant (CCS)

Pilot plant (10 t /day-CO₂)



MoE's Sustainable CCS Project (600 t /day-CO₂)



World 1st large size BECCS

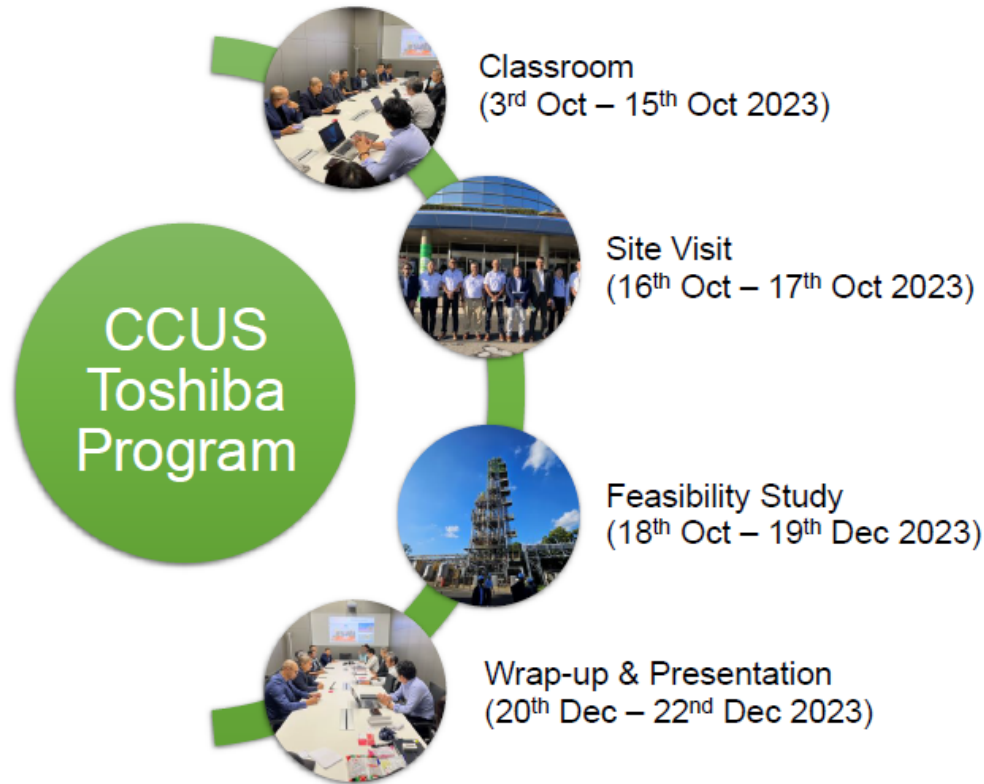
★BECCS : Bio-Energy with CCS

Business expansion into global market

~Application of CO₂ Capture Technology to Large Thermal Power Plants(1)~

Toshiba has agreed with national utility company in Malaysia to further **collaborate on CO₂ capture technology implementation**, and begun **full-scale introduction of CCS technology to thermal power plants in Malaysia**, including the acceptance of national utility company 's engineers to Toshiba ESS facilities.

Overall Activities (82days)



[Toshiba and Tenaga Nasional Berhad, to Accelerate the Application of CO₂ Capture Technology to Thermal Power Plants | News Release | Toshiba Energy Systems & Solutions \(global.toshiba\)](#)

Business expansion into global market

~Application of CO₂ Capture Technology to Large Thermal Power Plants(2)~

Toshiba has established a framework of a **strategic technology partnership with PLN-Nusantara Power** for the future introduction of carbon capture technology.

Both parties will conduct a Feasibility Study under the MOU, including the **implementation of a pilot plant at existing PLN power generation assets in Indonesia.**

Idea of candidate plant (Toshiba OEM)



Paiton Power Station



Carbon Capture Pilot Plant



AZEC Jakarta, Aug.21,2024

Exploring opportunities to introduce CCS Add-ons for Thermal Power Plants in Southeast Asian Countries.

Thank you for your attention !

The information and statements made in this document and during the presentation represent solely the personal views of the individual, and do not represent the views of the organization to which the speaker belongs.



Contact Information :
Kiyohiko Iwasa - Expert
CCUS System Engineering & Development Dept.
Power Systems Div.
E-mail: kiyohiko.iwasa@toshiba.co.jp