TOSHIBA

Japan-Asia CCUS Forum 2020

# Toshiba's Activity in Ministry of the Environment Sustainable CCS Project

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Toshiba Energy Systems & Solutions Corporation

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# Business Domain for Toshiba ESS Corporation






# Products and Systems of Power Systems Division – Thermal & Hydro Power Segment

Conventional Thermal Power

Combined-Cycle Power

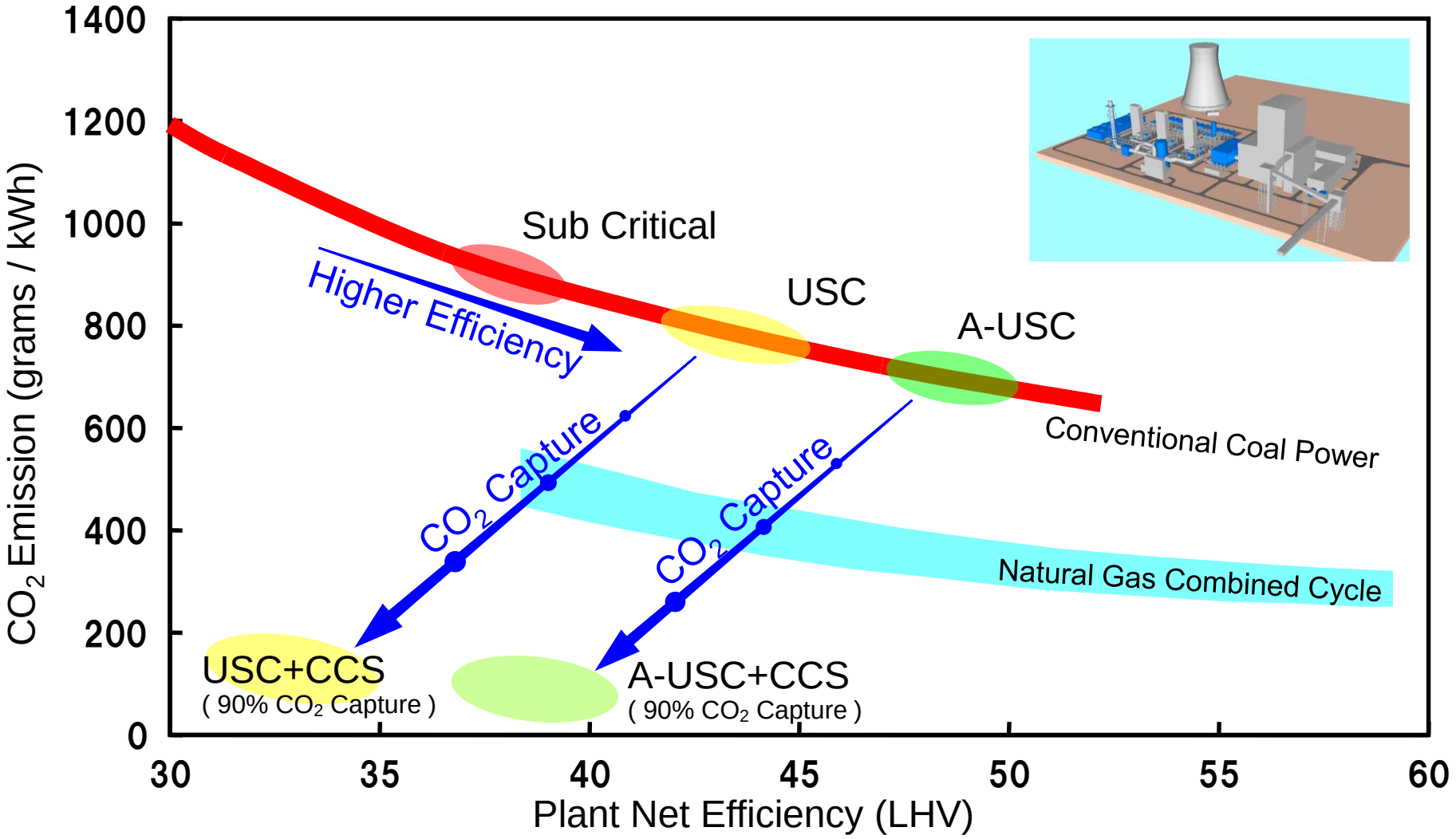
Geothermal Power

$CO_2$ Capture System

Hydro Power

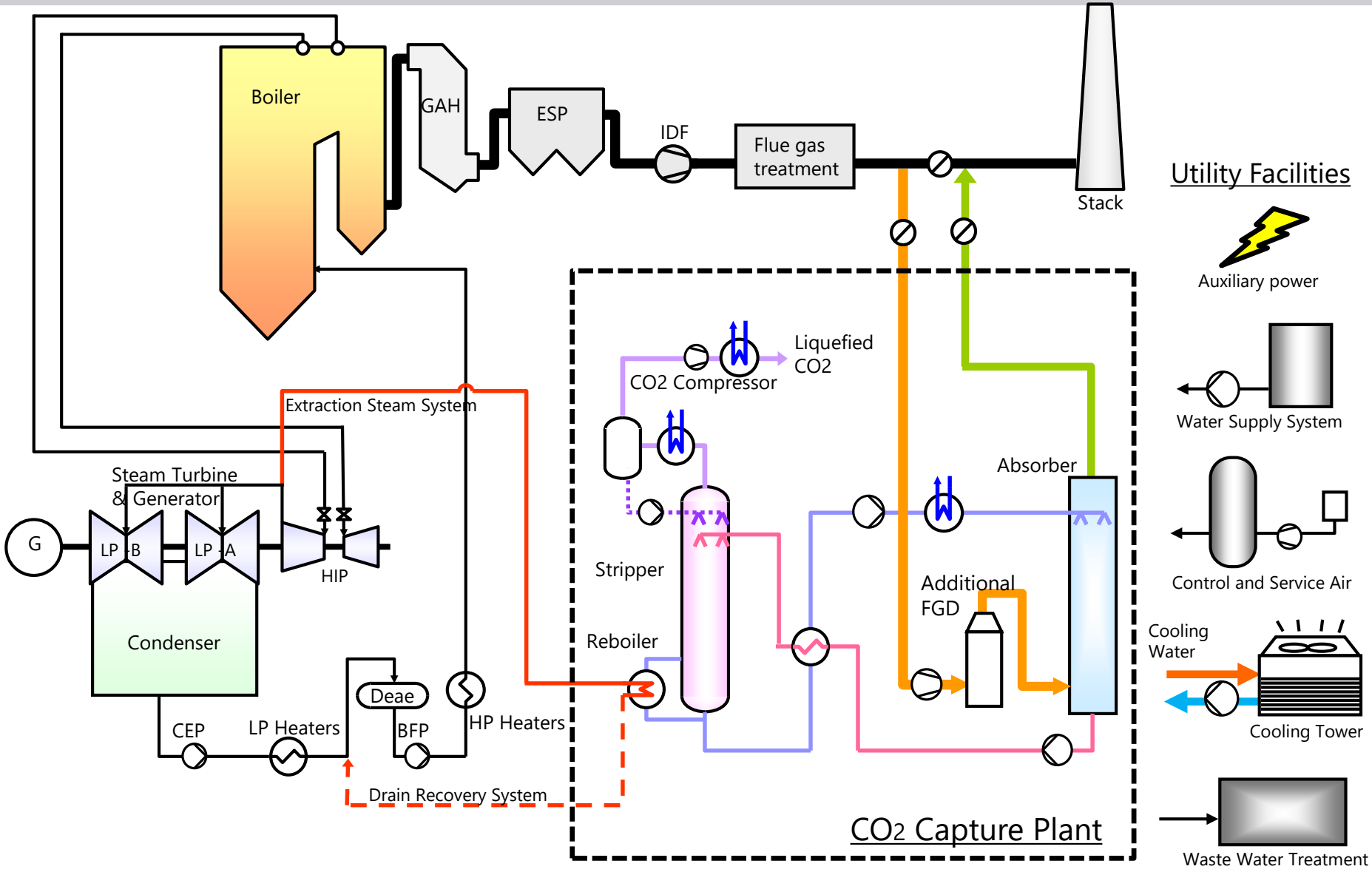
# Contents

# Reducing $CO_2$ Emission from Thermal Power Plants

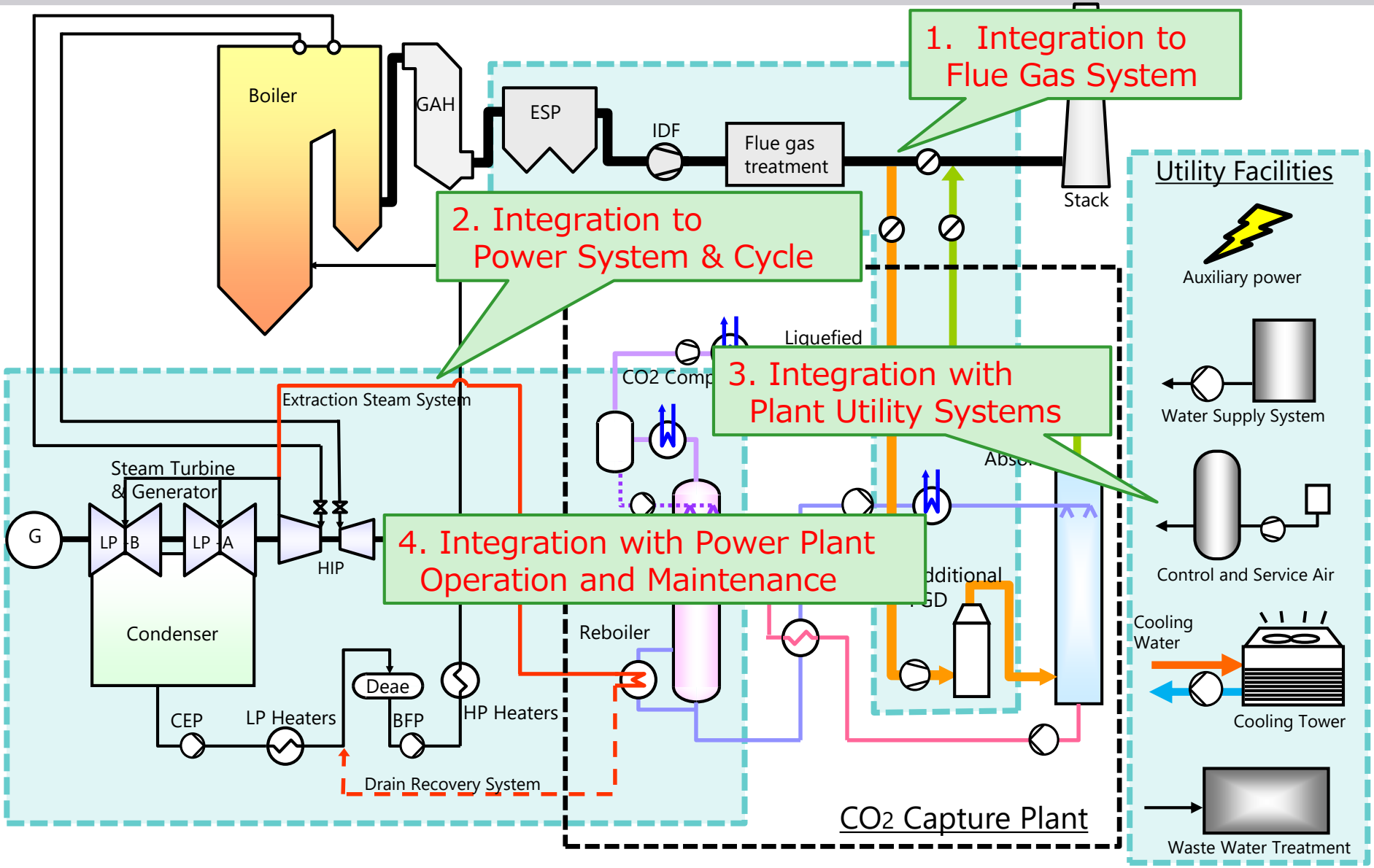



Substantial $CO_2$ reduction is realized by Integration and Optimization of both High efficiency Turbine Cycles and CCS technology

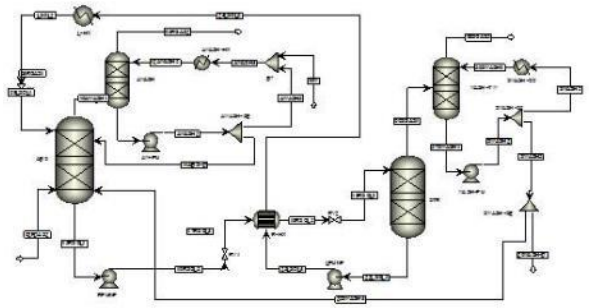
# Thermal Power Plant with $CO_2$ Capture



# Issues Regarding Plant Integration



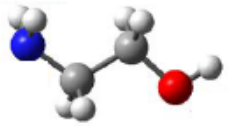
# $CO_2$ Capture Technology Implementation Flow

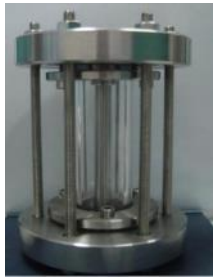


Process Design / Evaluation of System Performance Improvement by Simulation


Overall Demonstration at Mikawa PCC Pilot Plant

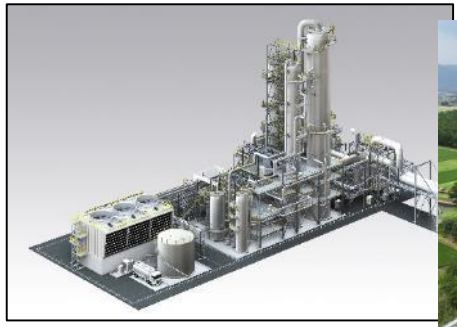
Amine





Design of Amine Solvent / Evaluation of Basic Properties and Absorption Performance

Performance / Degradation Evaluation by Small Loop



Integration to Large Scale Demonstration / Commercial Plant

# Mikawa Thermal Power Plant & Testing Facilities

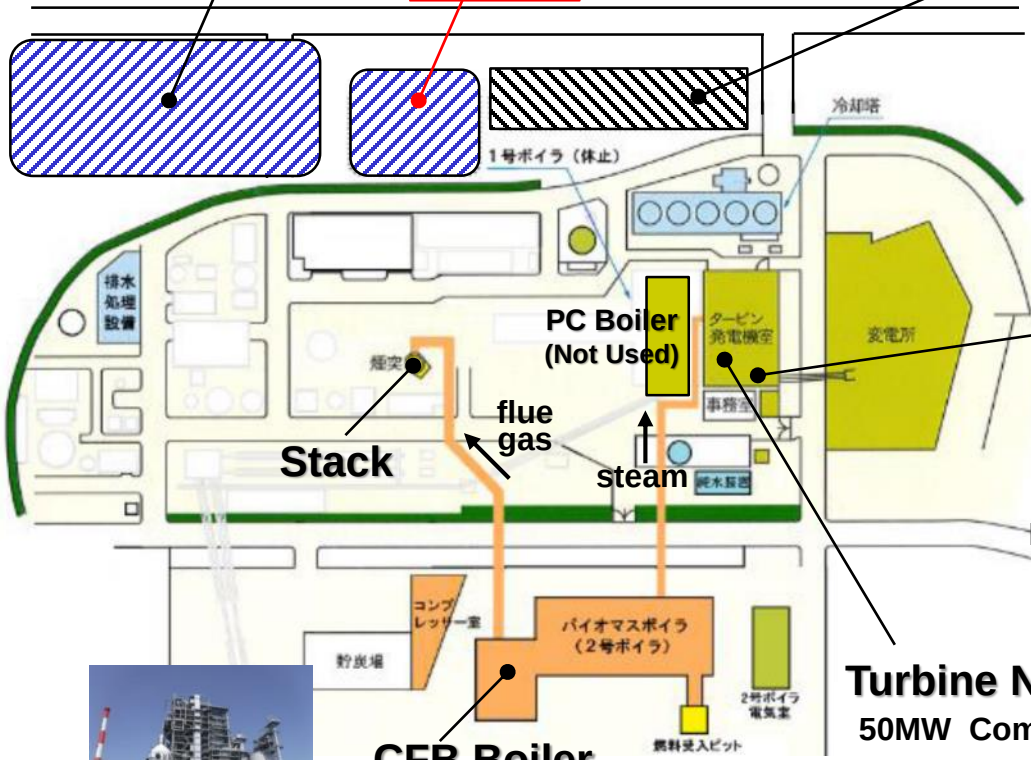
## $CO_2$ Capture Demonstration Plant

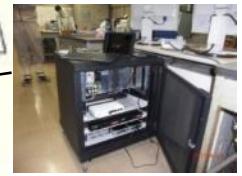
Constructed under the Ministry of the Environment Project


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

**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

# Mikawa PCC Pilot Plant - Overview and Summary

## Plant Outline


| | |
|---|---|
| Location: | Omuta City, Fukuoka<br>Inside Mikawa Thermal Power Plant<br>(Property of SIGMA POWER Ariake Co.Ltd.) |
| Plant Commenced: | September 29, 2009 |
| Carbon Capture Technology: | Post Combustion Capture (PCC)<br>Amine-based Chemical Absorption (Toshiba's Solvent System) |
| Capture Capacity: | 10 ton-$CO_2$ / day |
| Flue Gas Flow: | 2100 $Nm^3$ / hour ( from Mikawa Biomass/Coal Fired Power Plant ) |

* Test flue gas $CO_2$ concentration adjustable from 4%(NGCC) to 30%(Steel works) utilizing absorber and stripper exit gas recirculation and air bypass intake line.

## Summary of Results (as of Oct, 2020)

- Cumulative 12938 hours of operation on a live flue gas of biomass / coal fired thermal power plant
- $CO_2$ Recovery Energy: less than 2.4 GJ/ t-$CO_2$ (@90% $CO_2$ Capture, $CO_2$ Conc. approx. 12%)
- Verified system stability over 2800 hours of continuous operation.


## Reference Website

https://www.toshiba-energy.com/en/thermal/product/zero-emissions.htm

## Contents

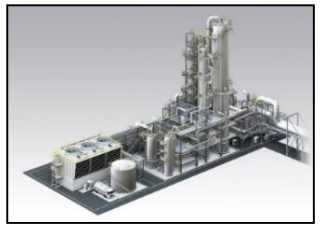
# Japan's Ministry of the Environment CCS Project Summary

The project demonstrates capturing most of the emitted $CO_2$ at an existing thermal power plant.
It also identifies a smooth deployment methodology by taking the demo results into consideration.

## CCS project overview

### Capture

**Toshiba Energy Systems & Solutions**
Mizuho Information & Research Institute



CO2 capture: 500tCO2/day

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

### Transport

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

**Consideration of CO2 transport method suitable for Japanese condition**

*** Officially launched in FY2018**

### Storage (Monitoring etc.)

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**

### Developing a smooth deployment methodology of CCS

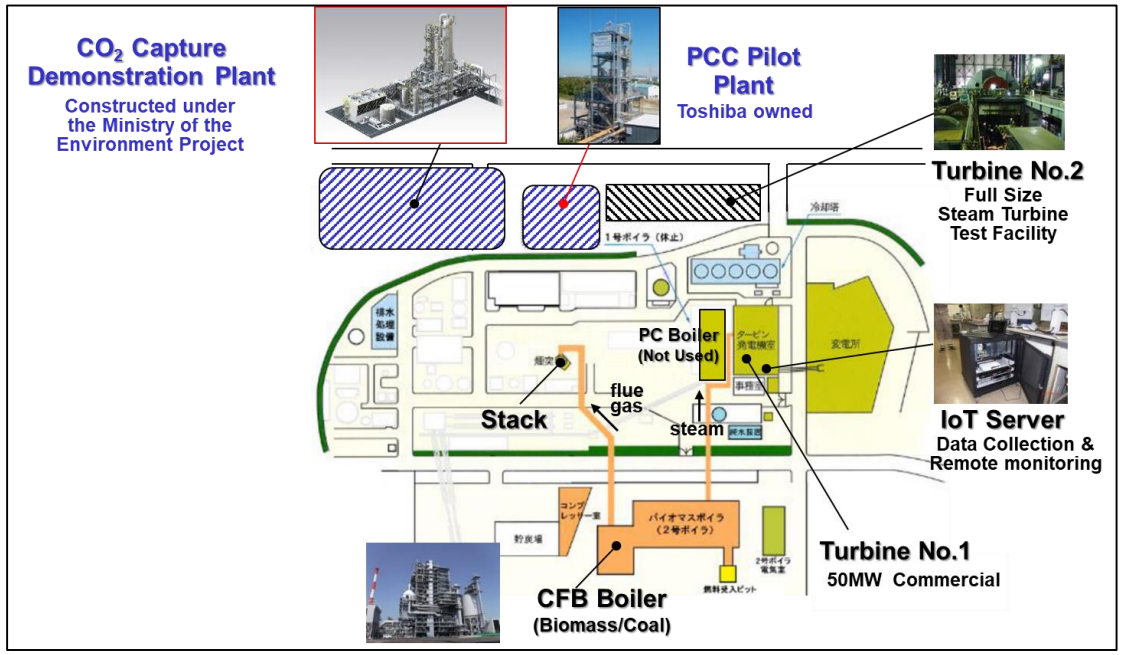
QJ Science
JANUS
Mizuho Information & Research Institute
Kyushu University

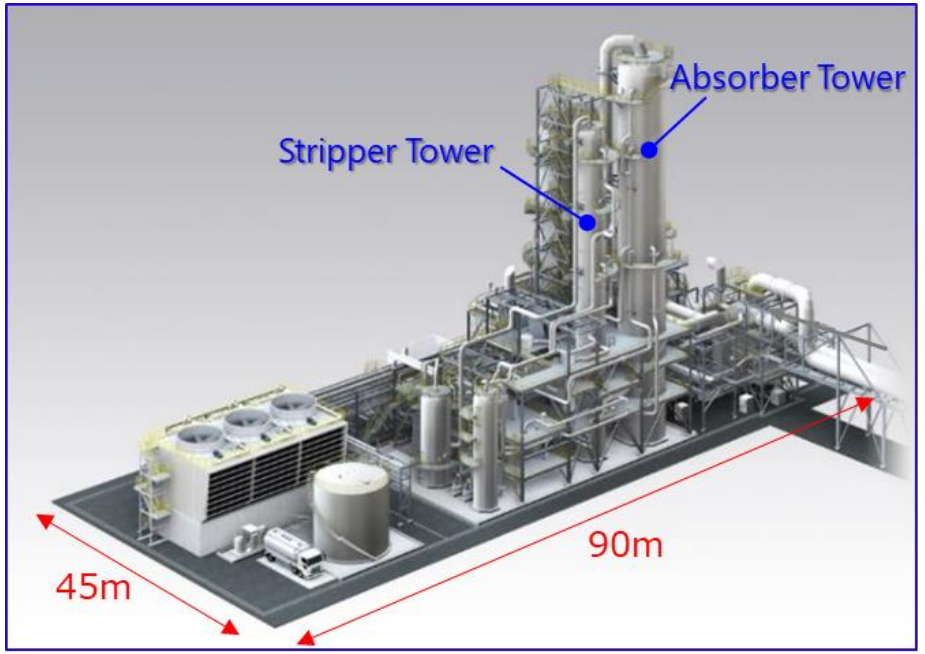
Taiheiyo Cement
JCOAL

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

# $CO_2$ Capture Demonstration Plant – Outline & Features

## Plant Outline

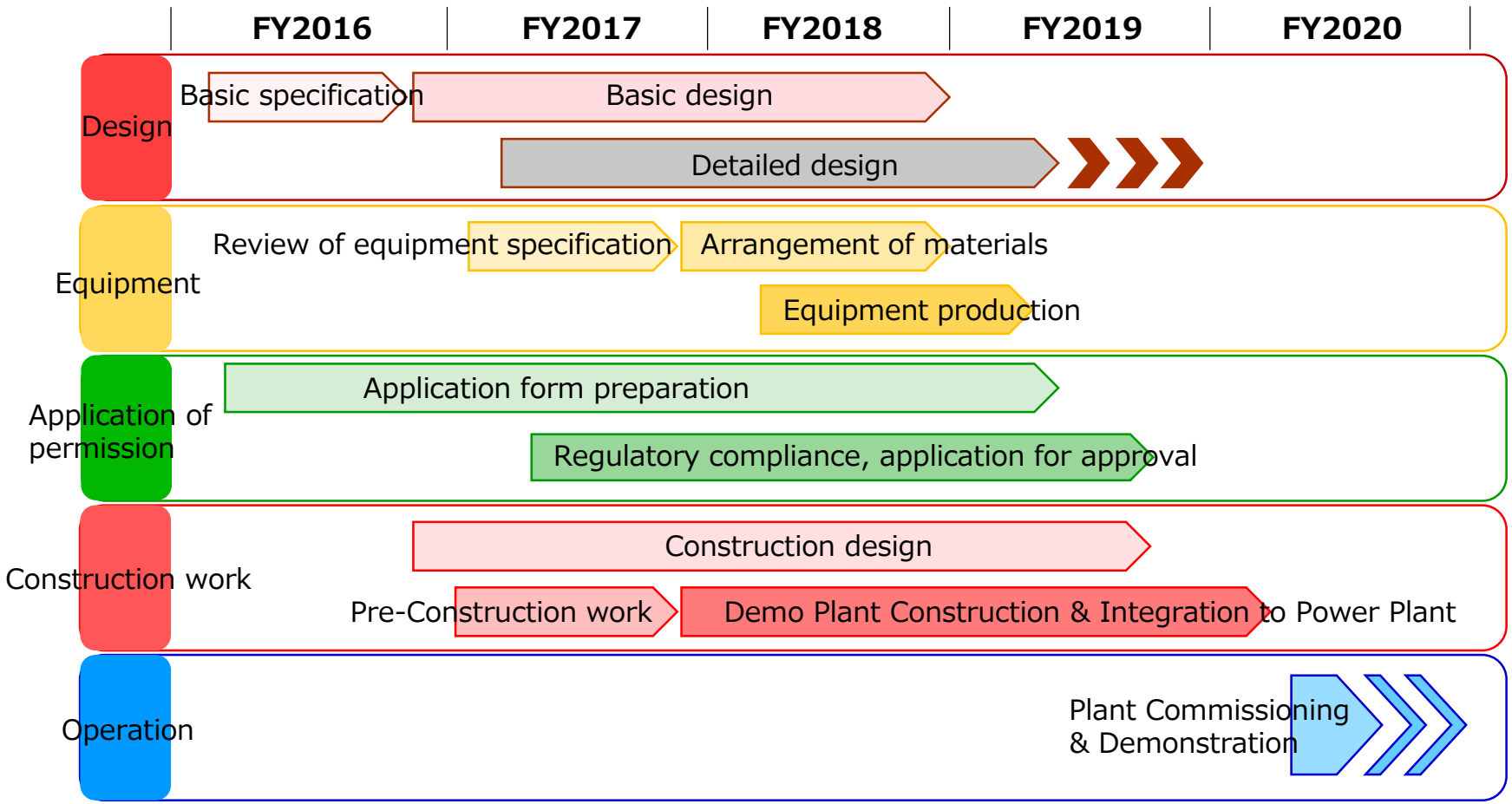


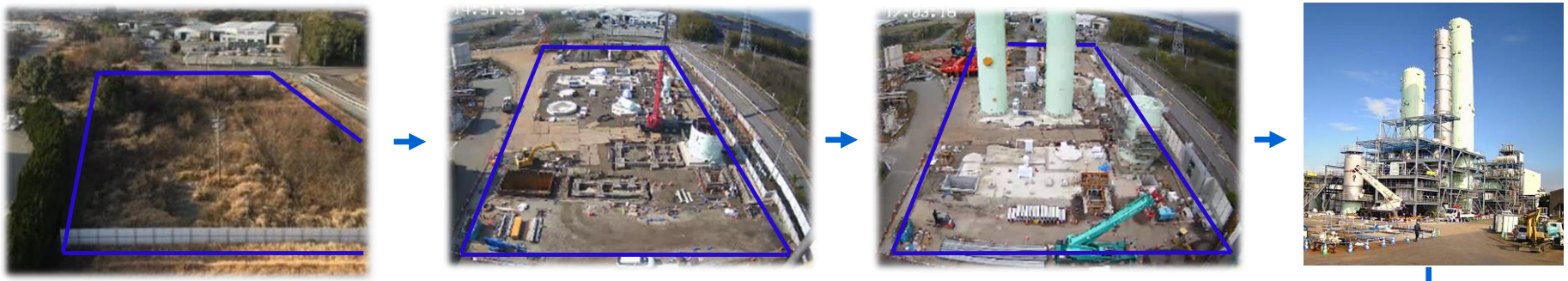

## Plant Features

- As part of the MoE's Sustainable CCS Project, Toshiba has designed and constructed the $CO_2$ Capture Demonstration Plant, which captures more than 500 tons-$CO_2$/day from Mikawa Power Plant (more than 50% of its total emissions)
- The Demonstration Plant has been built and fully integrated with the Power Plant, with turbine extraction steam feeding the energy for desorbing $CO_2$ at the stripper tower.
- The Mikawa Power Plant has a boiler capable of burning 100% biomass. Consequently, the project has the potential to be one of the first **BECCS** project in the world.

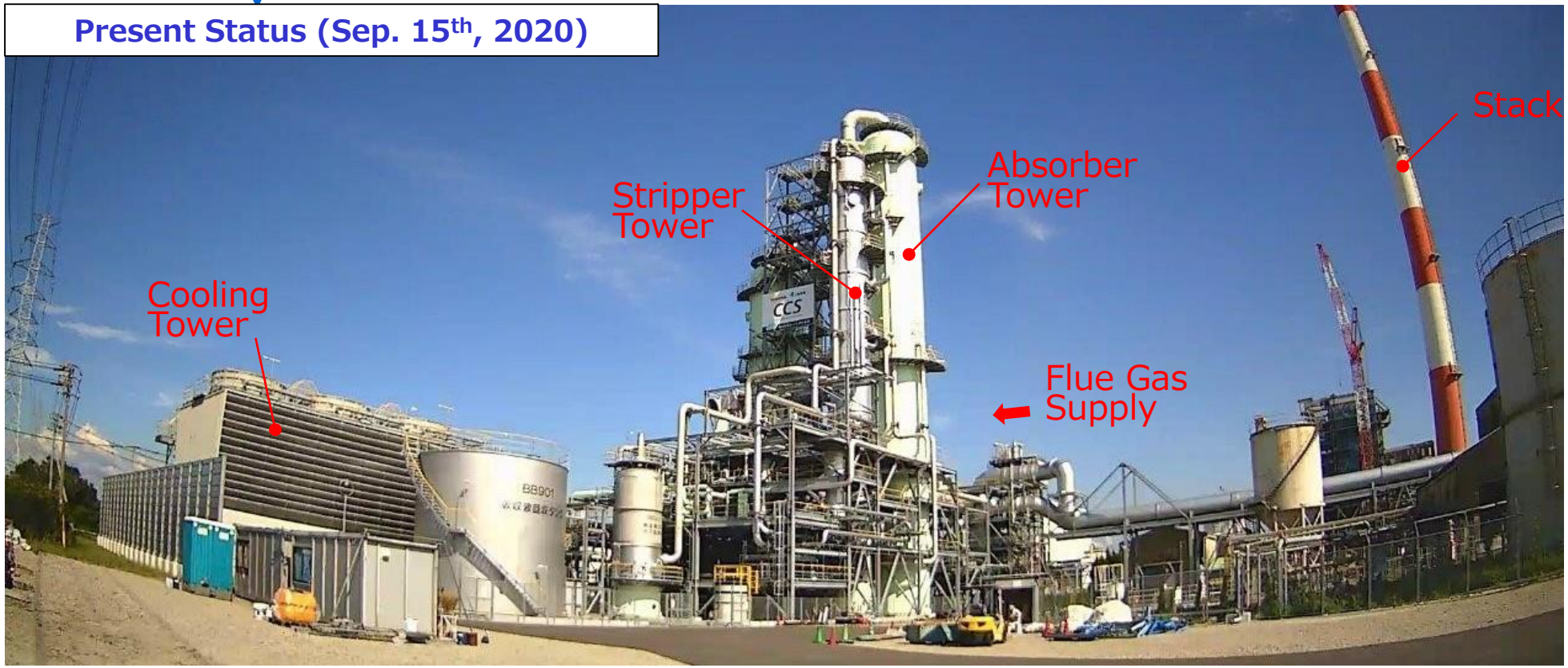
# $CO_2$ Capture Demonstration Plant – Schedule



# $CO_2$ Capture Demonstration Plant – Construction Complete



**Present Status (Sep. 15th, 2020)**



# $CO_2$ Capture Demonstration Plant – Demo Contents

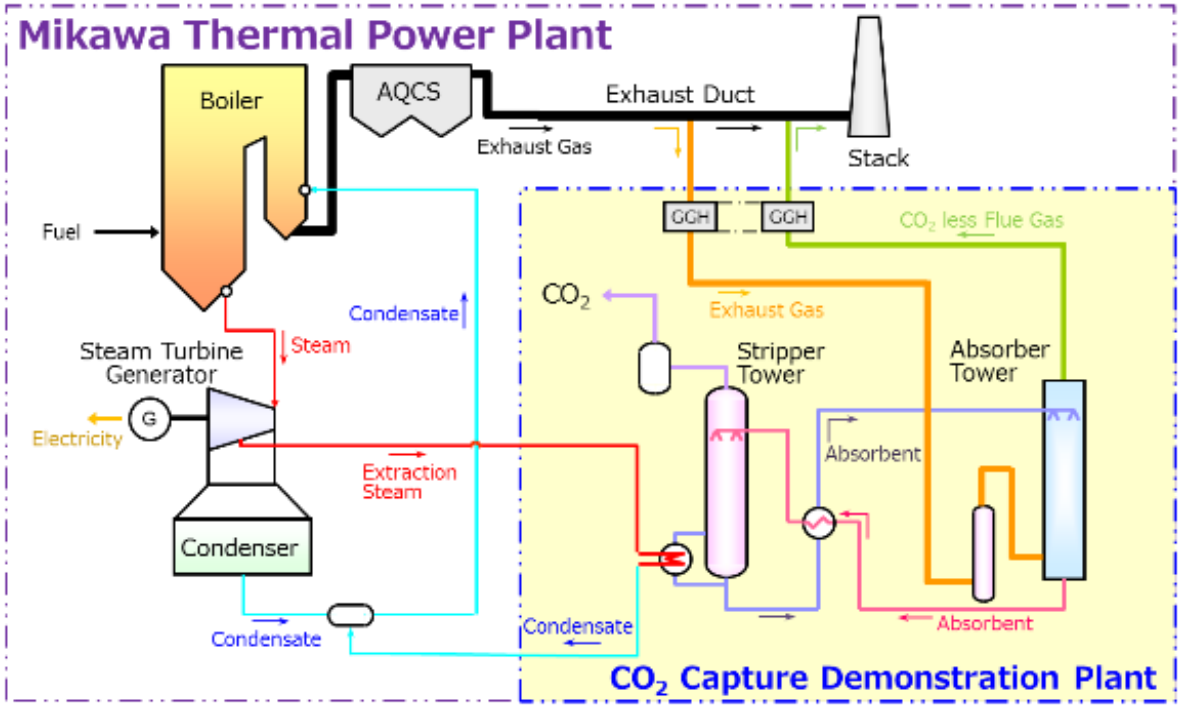
## Planned demonstration issues in 2020

The following are to be demonstrated/verified at the $CO_2$ Capture Demonstration Plant:

◆ Performance Issues
- $CO_2$ Capture mass flow
- $CO_2$ Capture rate
- Energy required to capture $CO_2$ (Recovery Energy)
- Overall effect on performance of the power plant equipped with $CO_2$ capture facility

◆ Operability Issues
- Effects of $CO_2$ capture rate setting
- Effects of heat inputs to $CO_2$ capture
- Start-up, shut-down, transient operations
- Part load, part capture operability

◆ Environmental Issues
- Emissions from $CO_2$ capture facility
- Control methods of emissions



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# Thank you for your attention !