

# High Efficiency Low Emissions Coal Thermal Power Generation Technology ( The Osaki Coolgen Project of Oxygen-blown IGCC Demonstration )

Jan.16, 2017

Osaki CoolGen Corporation

## Company Profile

**Company name** OSAKI COOLGEN CORPORATION

**Founded** July 29, 2009

**Location** Hiroshima Prefecture, Japan



**Investing enterprises** Chugoku Electric Power Co., Inc. (Energia)  
Electric Power Development Co., Ltd (J-POWER)

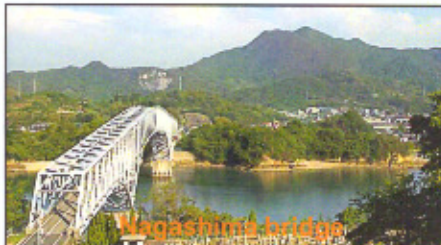
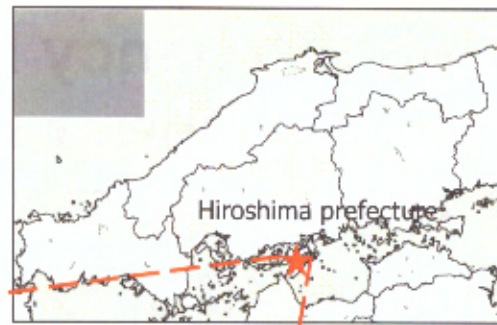
**Line of business** Construction of large-scale demonstration plant for oxygen-blown IGCC technology and carbon dioxide capture technology and conducting of tests using such plant



# Osaki Kamijima



Area About 43km<sup>2</sup>  
population 7,944(Jun. 2016)



Nagashima bridge



Cherry blossom



Canoe Festival



Old houses

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## Outline

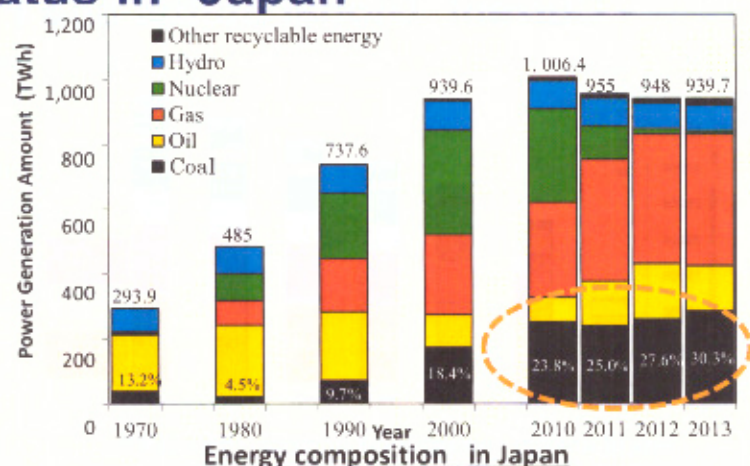
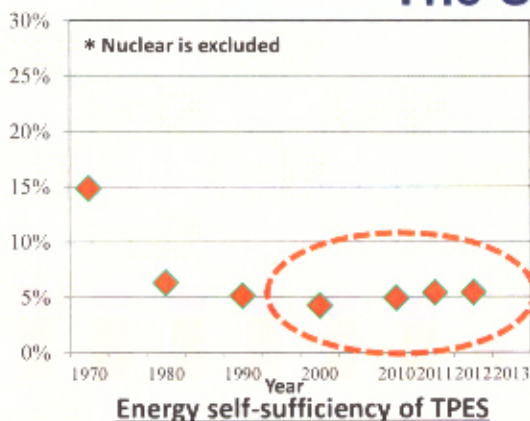


1. Significance of IGCC Development
2. Features of the IGCC Technology and System
3. Overview of the Osaki Coolgen (OCG) Project
4. State of Construction work progress and Manufacturing work progress

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## Coal-fired Power Generation – The Status in Japan –



Source : METI Energy White Paper 2013  
 IEA Energy Balance of OECD countries 2013  
 The data which Federation of Electric Power Companies announced

- **Energy self-sufficiency in Japan = about 5%**
- **Coal-fired generation ⇒ Essential for the best mix of energy**  
 ( Positioned as the Base Load Power Generation in the Basic Energy Plan due to Supply Stability , Economic Efficiency , Safety )



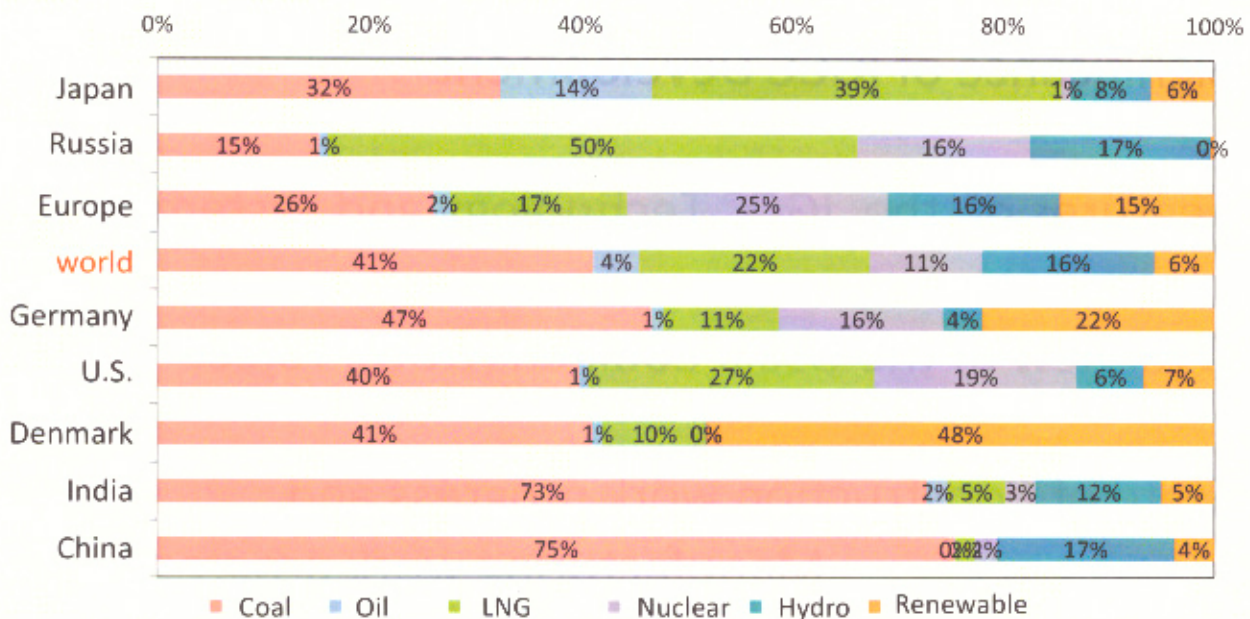
**Replacement Demand of Coal-fired generation in Japan**  
 ⇒ **37 GW (for the 35years after 2020)**



# Coal-fired Power Generation



- Percentage of each generation resource in 2013 -



Source: Energy balances of OECD countries 2015(IEA) / Energy balances of non-OECD countries 2015(IEA)

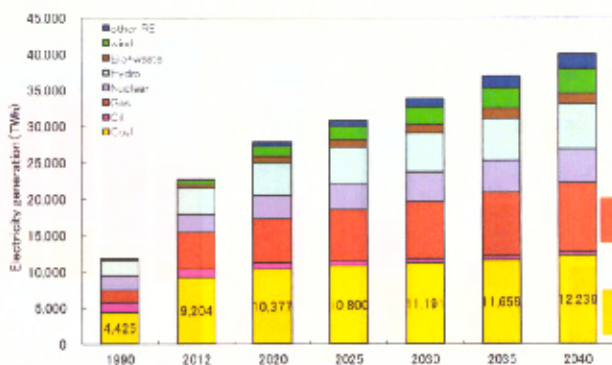
➤ **41% of world generation resource is the Coal**

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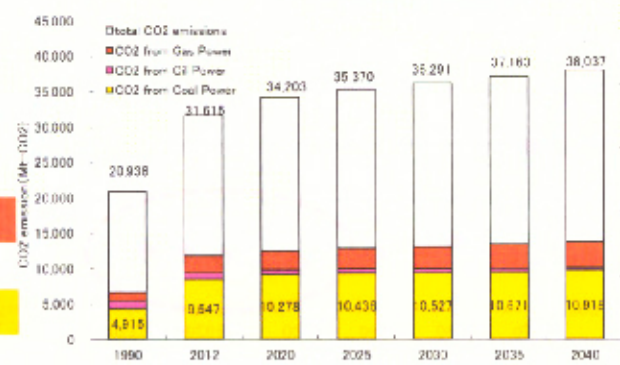
# Coal-fired Power Generation



- Current Global Status and Future Prospects -



World energy composition outlook 1990-2040 (New policies scenario)



World CO2 emission by type outlook 1990-2040 (New policies scenario)

Source: IEA World Energy Outlook 2014

➤ **Coal-fired power generation in the world = 30% or more**  
 ⇒ **Key role in Global Power Demand for Sustainable Development**

➤ **CO2 emission from Coal-fired power generation = about 30%**  
 ⇒ **Key issue of reducing CO2 emissions for Sustainable Development**

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# Significance of Osaki Coolgen project



## Global Sustainable Development

We must:

- Use **low cost coal efficiently** for increased Power Demand
- Drastically **reduce CO2 emissions** against Global Warming

## In Resources Importing Countries (as Japan)

- Coal is indispensable to achieve stable power supply

## Development of Efficient Clean Coal Technology

### Osaki Coolgen Project: A Top-Class IGCC solution

(Step-1) **IGCC: Integrated coal Gasification Combined Cycle**

- High-Efficiency & Environmental Performance & Reliability

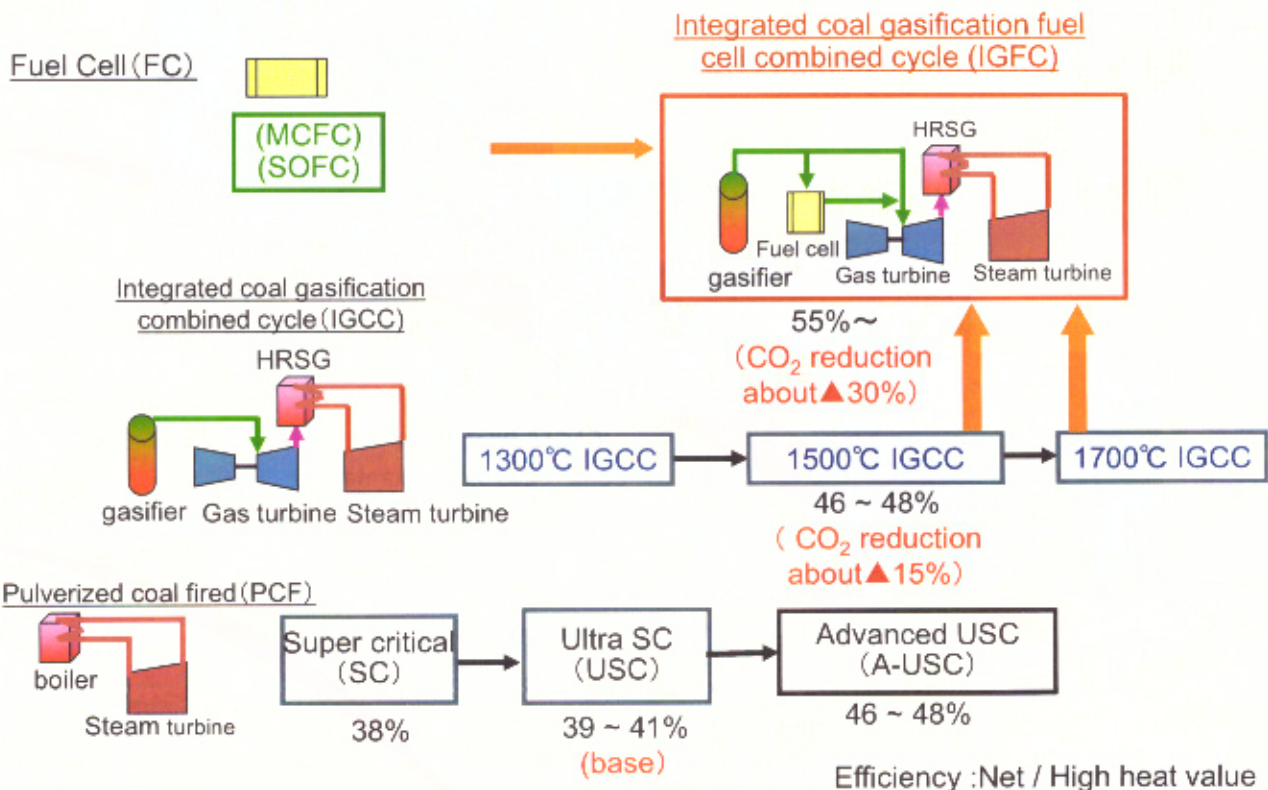
(Step-2)

(Step-3)

**IGCC + CO<sub>2</sub> Capture** → **IGFC + CO<sub>2</sub> Capture**

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# R&D for Future of Coal-fired Power Generation



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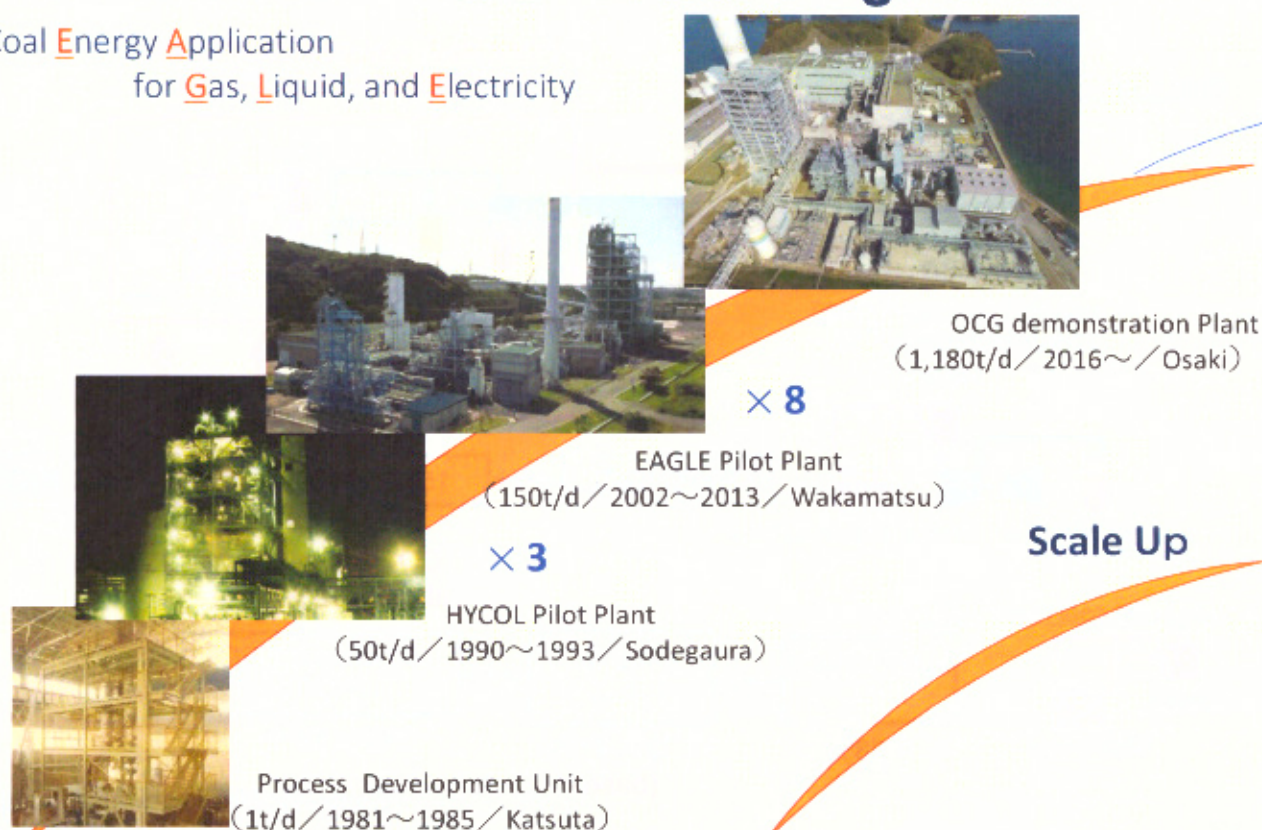
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## Development history of the “EAGLE” gasifier

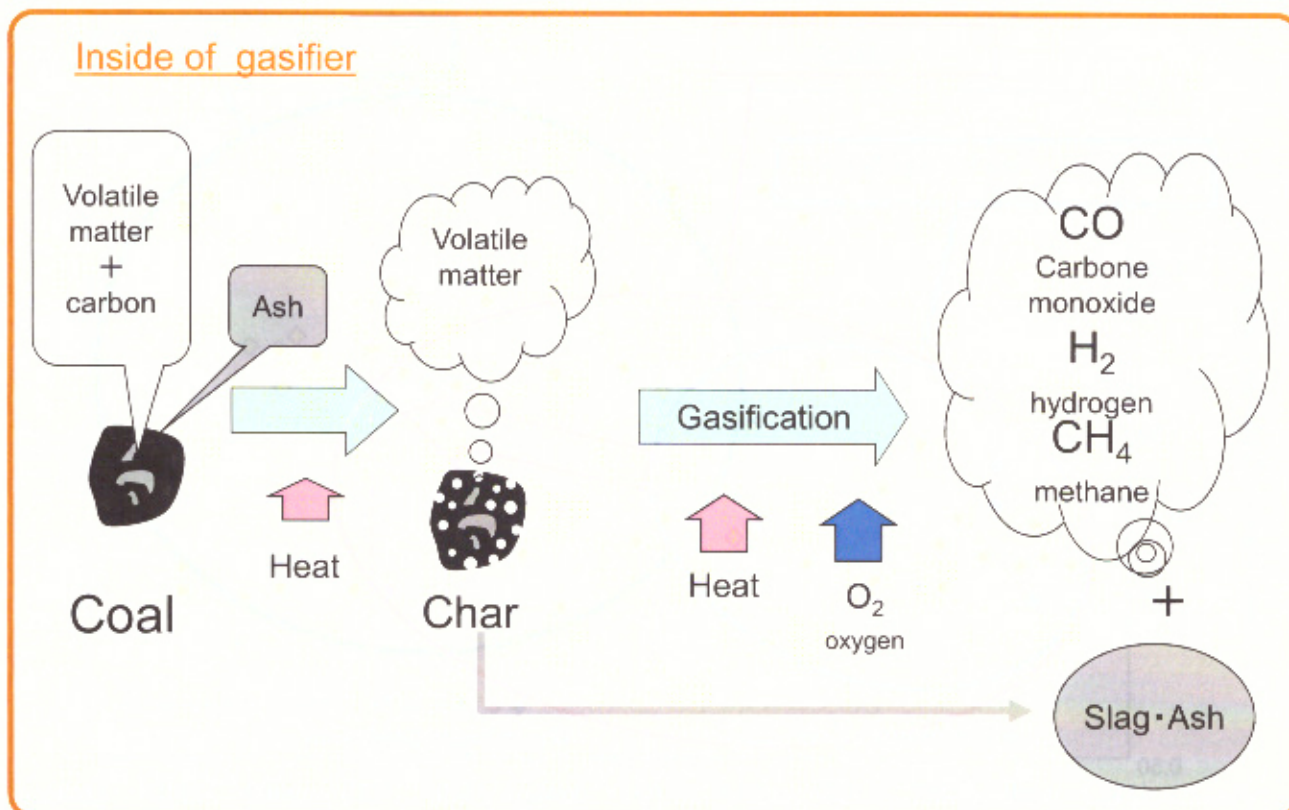


Coal **E**nergy **A**pplication  
for **G**as, **L**iquid, and **E**lectricity



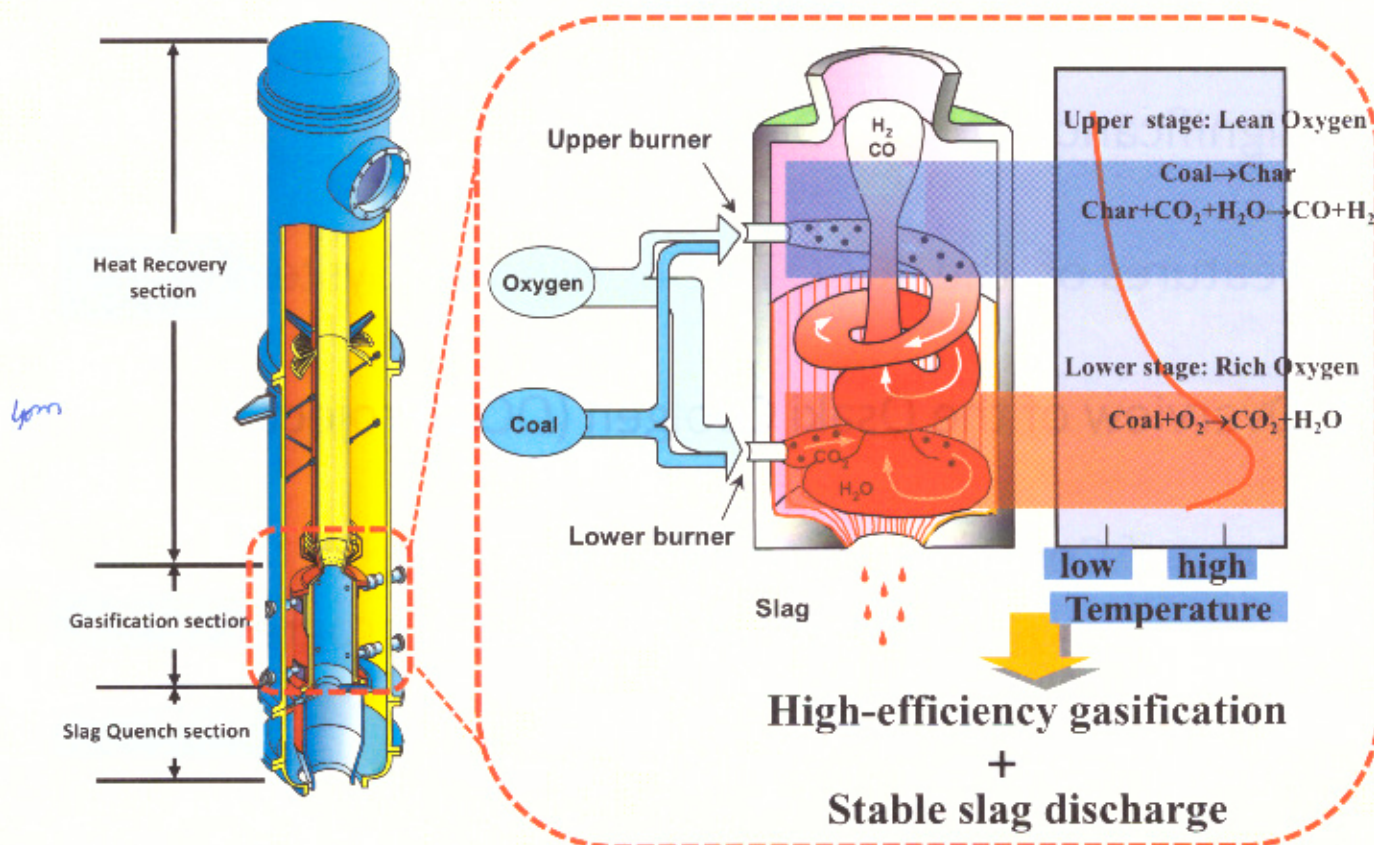


# Coal Gasification Image



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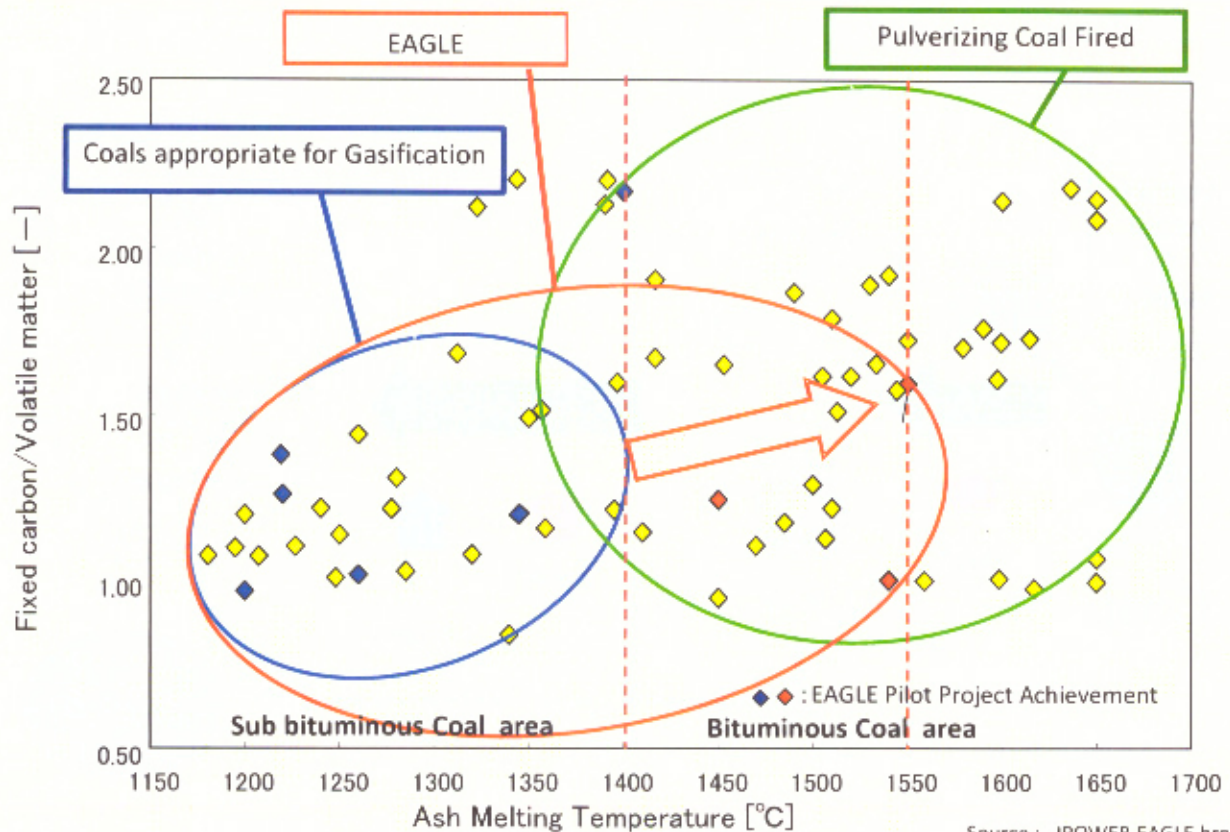
# The "EAGLE" gasifier mechanism



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# Applicable Coal types for the "EAGLE" gasifier



Source : JPOWER EAGLE brochure  
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## Outline

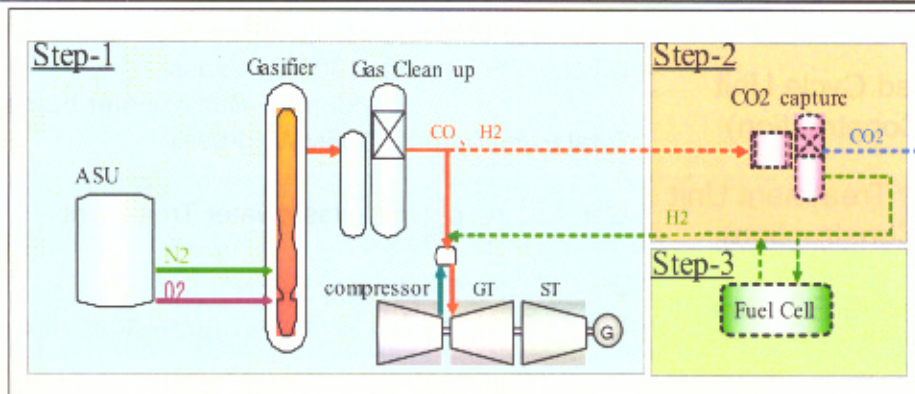
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# Schedule of the Osaki Coolgen Project

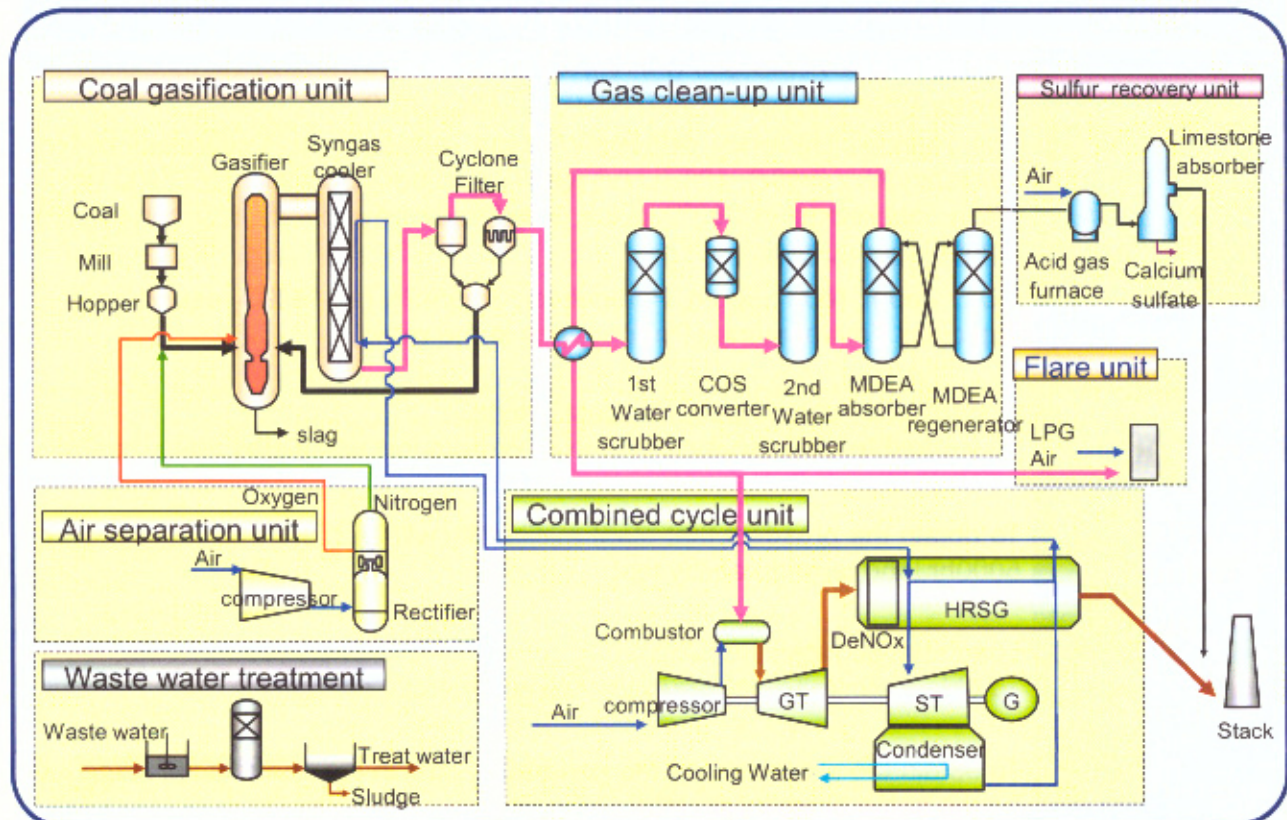


Fiscal Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Environmental Assessment	[Bar]												
NEDO research project		Feasibility study					Feasibility study						
Step-1 Oxygen blown IGCC				IGCC Design, Manufacturing and Construction				Demonstration Operation					
Step-2 IGCC with CO2 Capture		<Primary Research>						CO2 Capture Design, Manufacturing and Construction			Demonstration Operation		
Step-3 IGFC with CO2 Capture			<Primary Research>					Feasibility study	Total system of IGFC with CO2 Capture Design, Manufacturing and Construction			Demonstration Operation	



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## STEP1 System Flow



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# STEP1 Major Specifications



Main Units and Utilized Existing Equipment	Spec
Coal Gasification Unit (New Construction)	Oxygen-Blown Single-chamber Two-staged Spiral-flow Entrained Bed Coal feed : 1,180 t/day
Gas Clean up Unit (New Construction)	Wet Desulfurization Unit : Methyl-diethanol Amine (MDEA) Sulfur Recovery Unit : Limestone Wet Scrubbing
Air Separation Unit (New Construction)	Pressurized Cryogenic Separation Type
Combined Cycle Unit (New Construction)	GT (MHPS : H100 1300°C class, adopted Multi-Cluster burner) Total Plant output : 166MW (gross)
Wastewater Treatment Unit (New Construction)	Gas Clean up Unit Wastewater Treatment
Utilized Existing Equipment	Wastewater Treatment, Stack, Coal Stock and Conveying system, etc.

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# STEP1 Targets



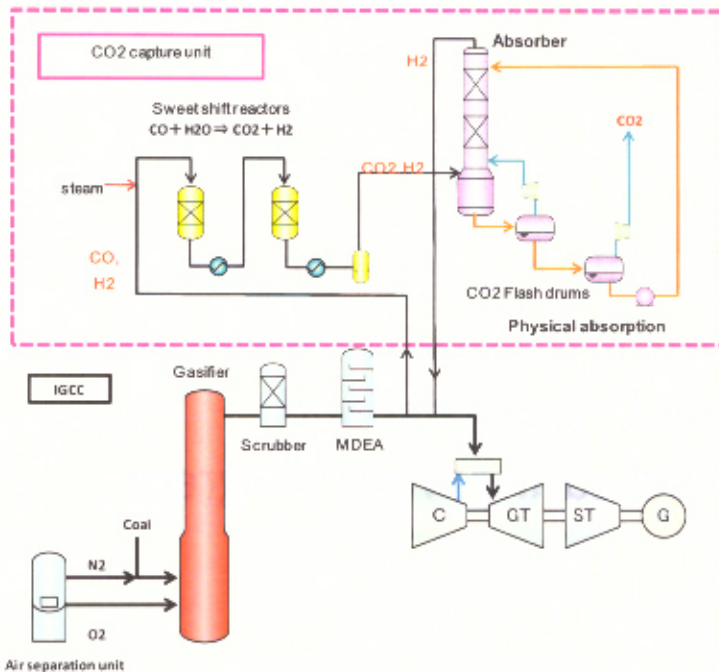
Item	Targets
Efficiency	Net Efficiency : 40.5% (HHV), 42.7%(LHV) Gross Efficiency : 48.0%(HHV), 50.6%(LHV) The Highest Efficiency in 170MW class in the world. Equivalent to Net efficiency 46%(HHV), 48%(LHV) ,Gross efficiency 53%(HHV),56%(LHV) when applied to 1,500°C class GT(already developed) in a commercial plant(higher output)
Emission Level	SOx : 8ppm, NOx : 5ppm, Particulate : 3mg/m <sup>3</sup> N (as 16%O <sub>2</sub> equivalent) <b>Top class Environmental Performance</b> in the world.
Coal Variety Compatibility	Confirmation of coal range for gasification. To expand to high ash fusion temp. coal from low ash fusion temp. coal.
Plant Reliability	To obtain the prospect that plant availability will be <b>more than 70%/year</b> by 5000hr long term durability test.
Plant Controllability & Operability	Load change rate : 1-3%/min. To obtain controllability equivalent to commercial operations.
Economy	To obtain the prospect that the generating cost in the commercial stage will be <b>the same or less than PCF</b> .

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# Plan for STEP2 / CO<sub>2</sub> Capture

To demonstrate IGCC with CO<sub>2</sub> capture to achieve stable generation and high thermal efficiency



Specifications	
CO <sub>2</sub> Capture rate	15%
CO <sub>2</sub> removal rate for CO <sub>2</sub> capture unit	90%
Purity of captured CO <sub>2</sub>	99%

## STEP2 Targets

Item	Targets
Basic Performance	<p>CO<sub>2</sub> Capture rate : 90%</p> <p>CO<sub>2</sub> Purity : 99%</p>
Plant Efficiency	<p>Optimization of operating conditions</p> <ul style="list-style-type: none"> <li>- Steam/CO ratio</li> <li>- Auxiliary power</li> </ul> <p>➔ Targeted to achieve 40%(net, HHV) efficiency while 90% of CO<sub>2</sub> is captured in newly-installed IGCC (with 1500°C class GT)</p>
Operability & Reliability	<p>Establishing O&amp;M procedures for IGCC system combined with CO<sub>2</sub> Capture</p>



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## First step: IGCC Construction Progress

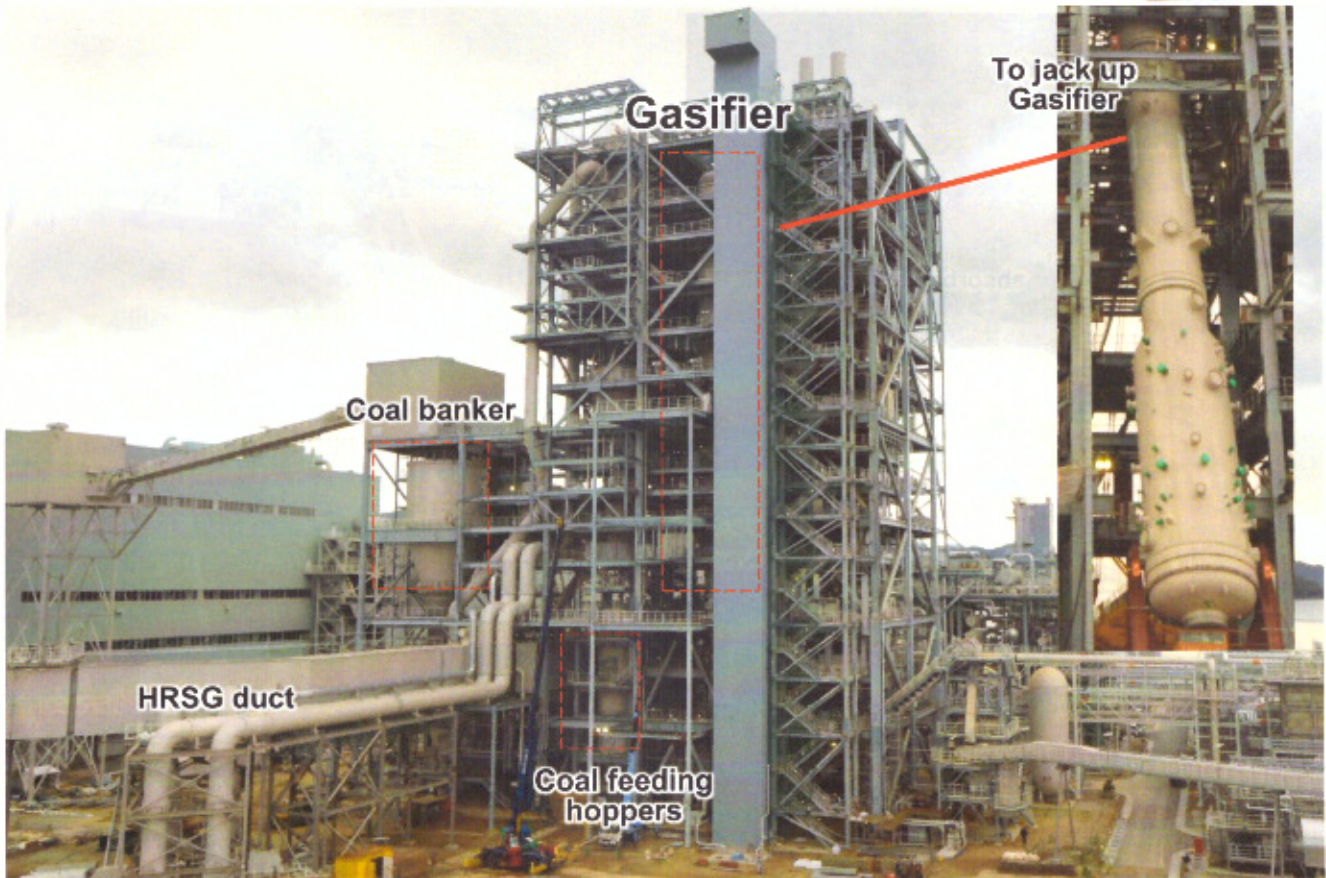
FY	2012	2013	2014	2015	2016	2017	2018
Major Events							
	Mar ▶ Start of Civil work		May ▶ HRSG on site Nov ▶ SGC on site Dec ▶ Gasifier on site Jan ▶ ASU on site	Jul ▶ Pressurization test of piping Nov ▶ Power reception for commissioning	Apr ▶ Gas turbine start-up Jul ▶ Gasifier start-up by coal Aug ▶ Start of generation by coal	Mar ▷ Start of demonstration	



# First step: Mechanical completion



## Gasification Unit

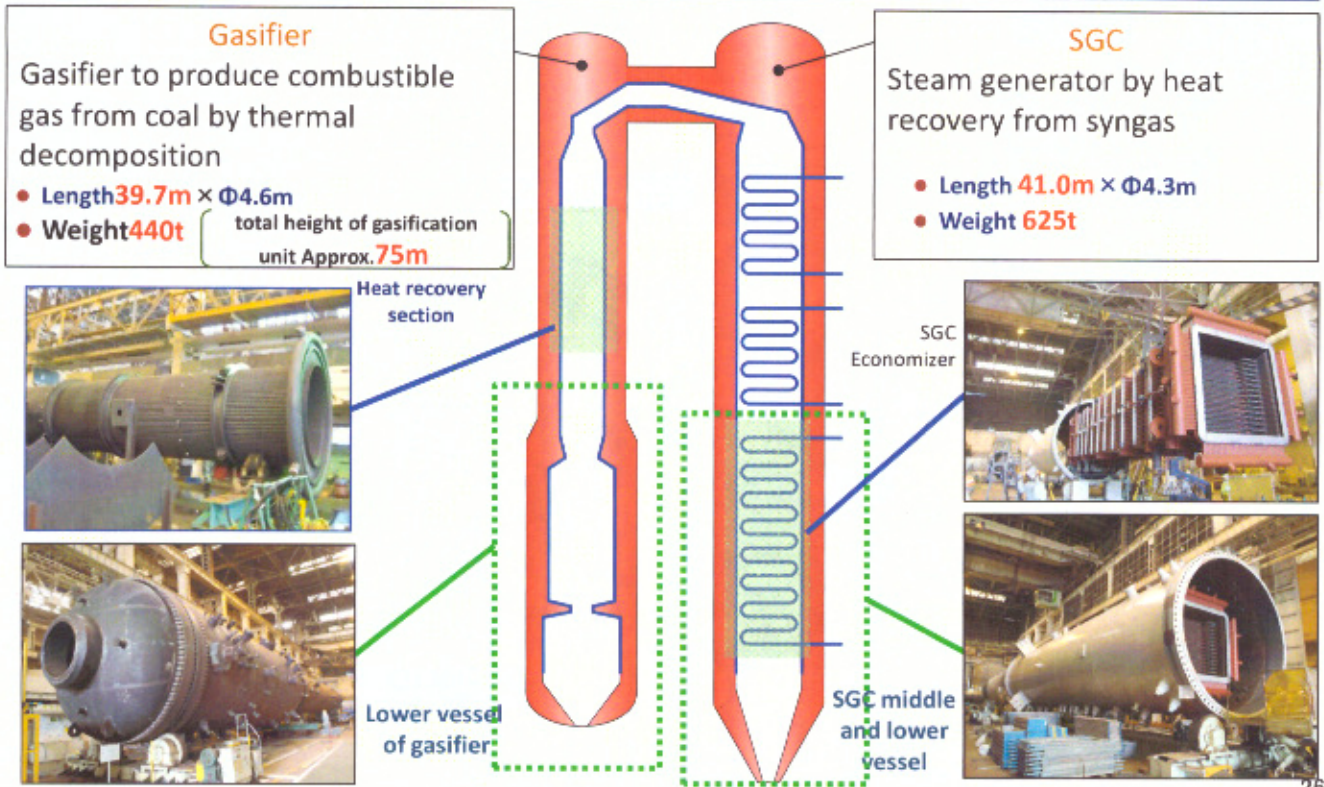




# Coal Gasification Facilities



■ Gasifier and Syngas Cooler were manufactured in MHPs works, and were shipped to the site. (SGC : Nov. 2014, Gasifier : Dec. 2014)

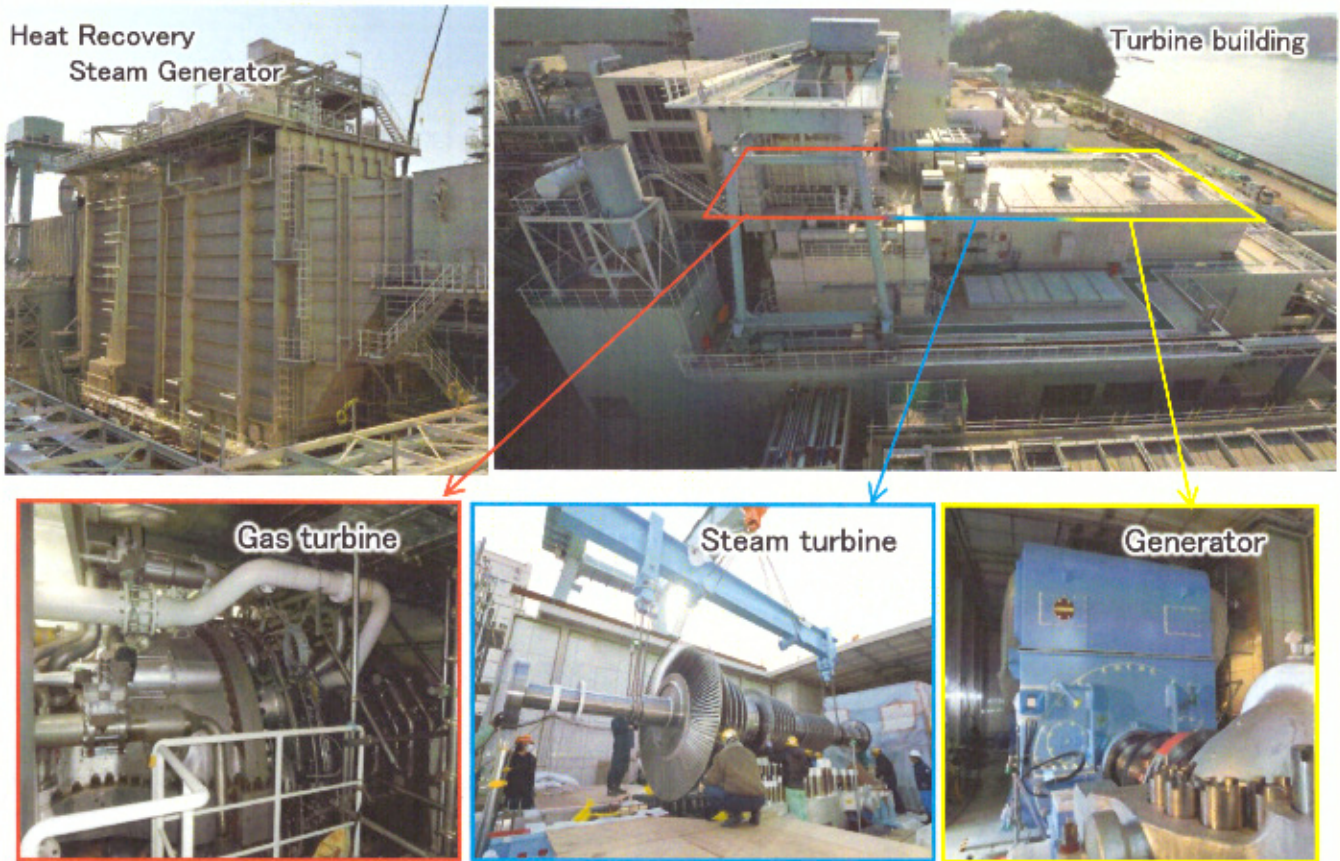


# Gas Clean Up unit, Sulfur Recovery Unit





# Combined cycle unit



# Air separation unit





# Waste water treatment unit / CO<sub>2</sub> capture area



## Commissioning

### ■ Gas turbine start-up



### ■ Gasifier start-up by coal

