

# Wyoming / JCOAL Workshop 2017

## Advanced Coal Fired Power Generation Technologies

**IHI**

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**IHI INC. Power Plant Engineering Division**

**I H I Corporation**

# Contents

**1. Introduction of IHI Group Business**

**2. Overview of IHI Boiler Business**

**3. Advanced Coal Fired Power Generation Technologies**

**4. Summary**

# 1. Introduction of IHI Group Business





IHI Head Office, Tokyo



The First Steamship Built by Japanese Private Company – “Tsu-un maru”.

- **Founded** : 1853
- **Head Office** : Tokyo, JAPAN
- **Capital** : JPY 107.165 mil  
(USD 975 mil)
- **Net Sales** : JPY 1,486,332 mil  
(USD 13,512mil)
- **Employees** : 29,659
- **Works in Japan** : 7
- **Branches / Sales offices in Japan** : 16
- **Overseas offices** : 14
- **URL** : [www.ihico.jp](http://www.ihico.jp)  
(IHI Corporation)

Information is on consolidated basis as of March 2017.

# 1-2. Business Areas

**Boiler, Gas Turbine/Gas Engine, LNG Terminal, Process Plant, etc.**



**Bridge, Transportation System, Security, etc.**



**Resources,  
Energy & Environment**

**Social Infrastructure &  
Offshore Facilities**

**Aero Engines,  
Space & Defense**

**Industrial Systems &  
General-Purpose Machinery**



**Jet Engine, Rocket**

**Industrial Systems**



**Steel Manufacturing Furnaces, Heat/Surface Treatment Equipment, Logistics Systems, Material Handling Equipment, etc.**

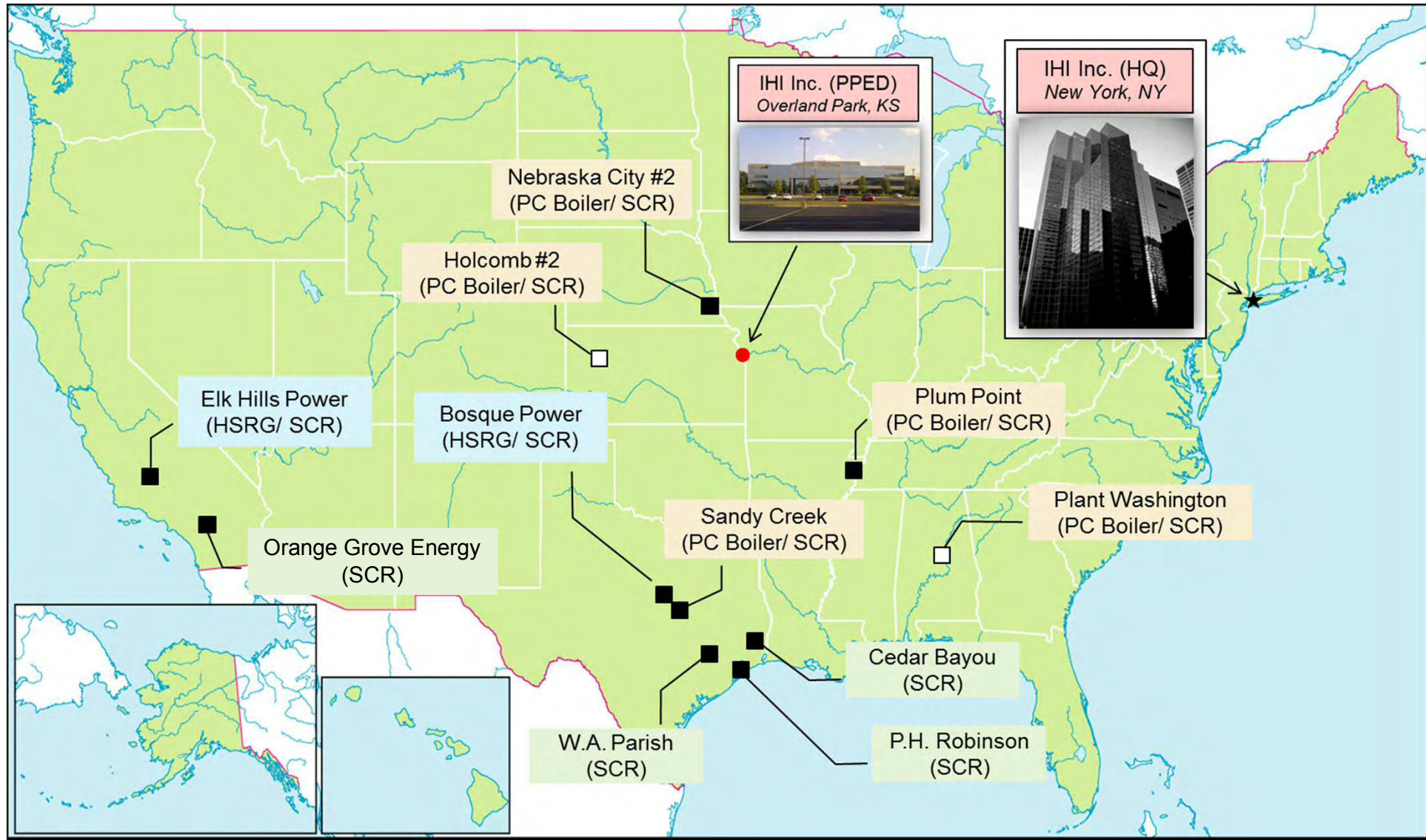
**General-Purpose Machinery**



**Compressor, Separator, Turbo charger, etc.**

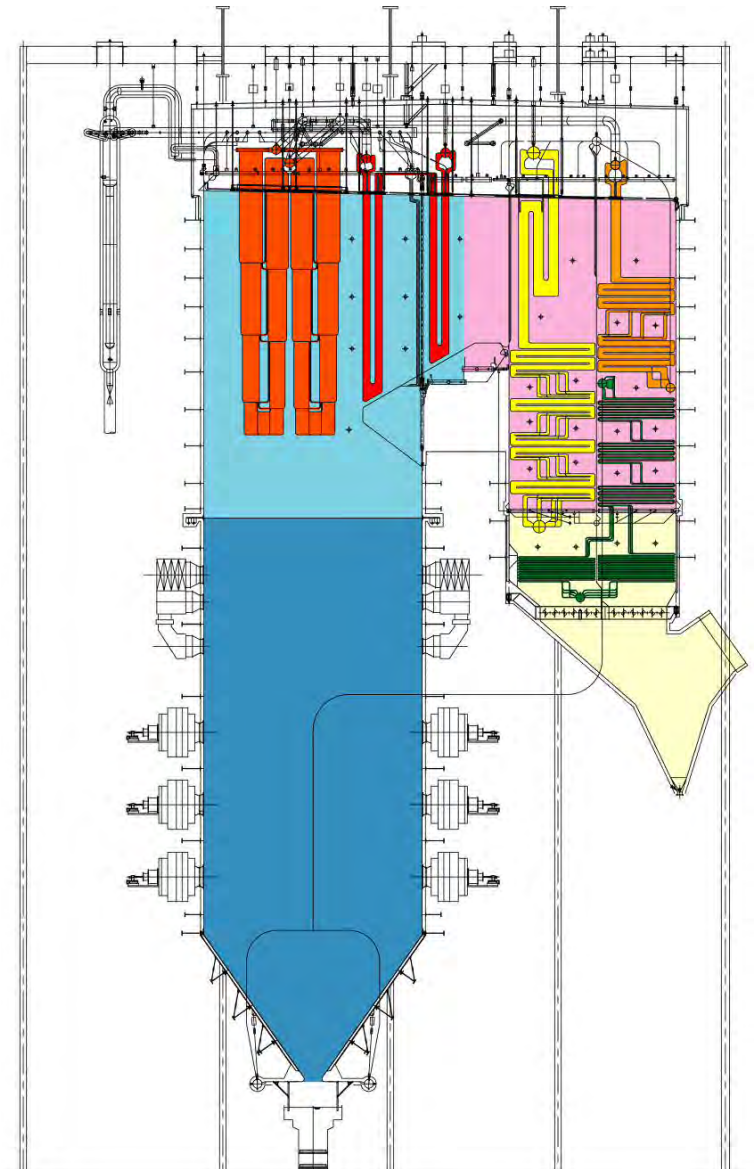
## 2. Overview of IHI Boiler Business

# 2-1. Project Sites in USA



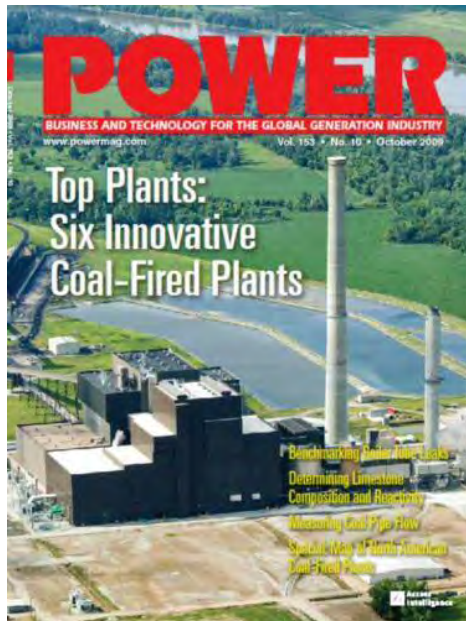
## 2-2. IHI Reference in USA

Client	Sandy Creek Energy Associates, L.P.
Unit	Sandy Creek
Turbine Output	998.5MW (net)
Boiler Capacity	6,295 klb/h (2,852 t/h)
Steam Conditions	3,908psia, 1086/1082F (26.9MPa, 585/583°C)
Fuel	Pulverized coal 100% Sub-bituminous Coal (PRB Coal)
Commercial Operation	2013



## 2-2. IHI Reference in USA

Client	Nebraska City Power Partners
Unit	OPPD Nebraska City No.2
Turbine Output	660MW (net)
Boiler Capacity	4,750 klb/h (2,155 t/h)
Steam Conditions	2,612psia, 1056/1052F (18.0MPa, 569/567°C)
Fuel	Pulverized coal 100% Sub-bituminous Coal (PRB Coal)
Commercial Operation	2009

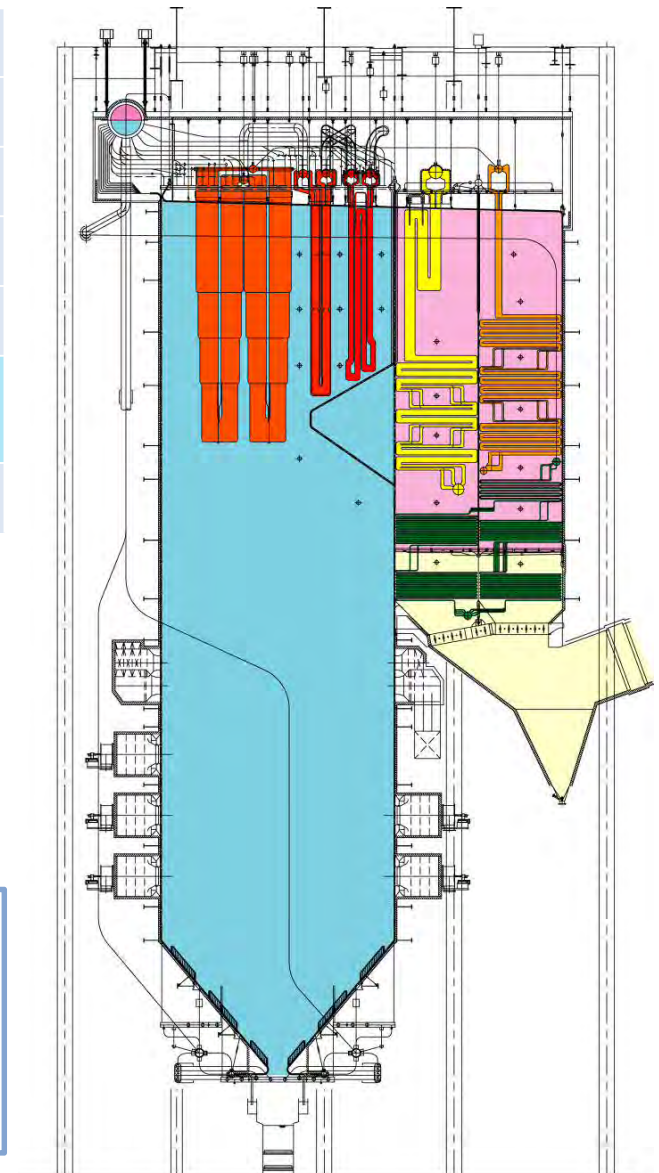


### - BEST of the BEST -

IHI's steam generator was praised as one of the six innovative top coal fired plants by "POWER" and was featured on the October 2009 cover.

### Actual Operating Situation

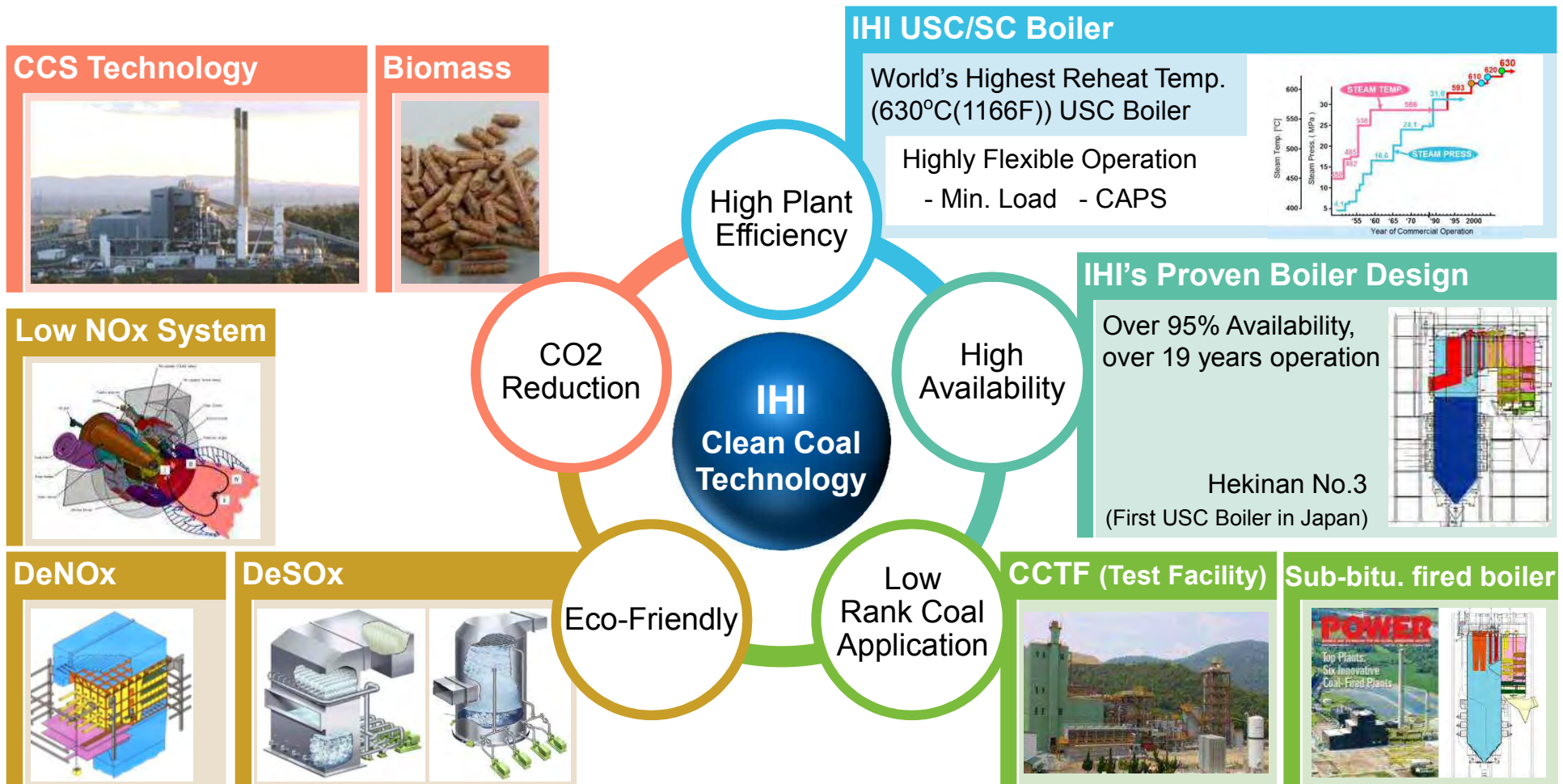
• **Successful Operation over 97% Availability with Full Load in 2011. (Actual Result)**



# **3. Advanced Coal Fired Power Generation Technologies**

# 3-1. IHI Clean Coal Technology

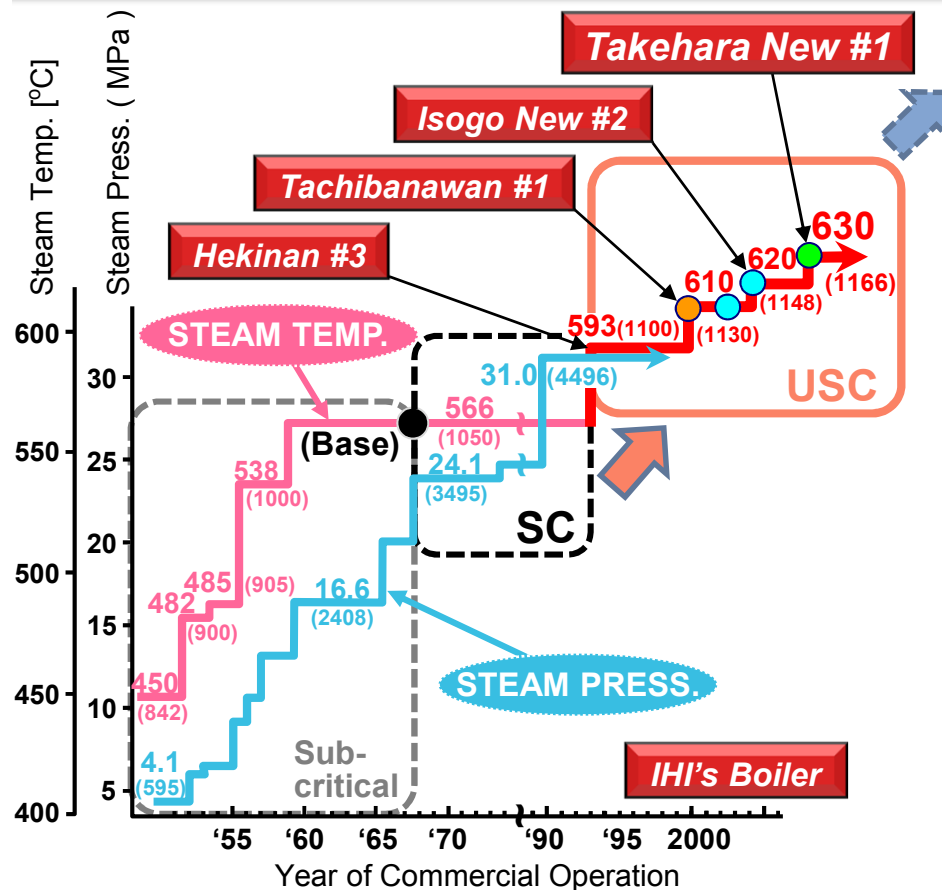
IHI supplies the world with state-of-the-art coal-fired boilers, utilizing Clean Coal Technology (CCT), which we developed through years of extensive research.



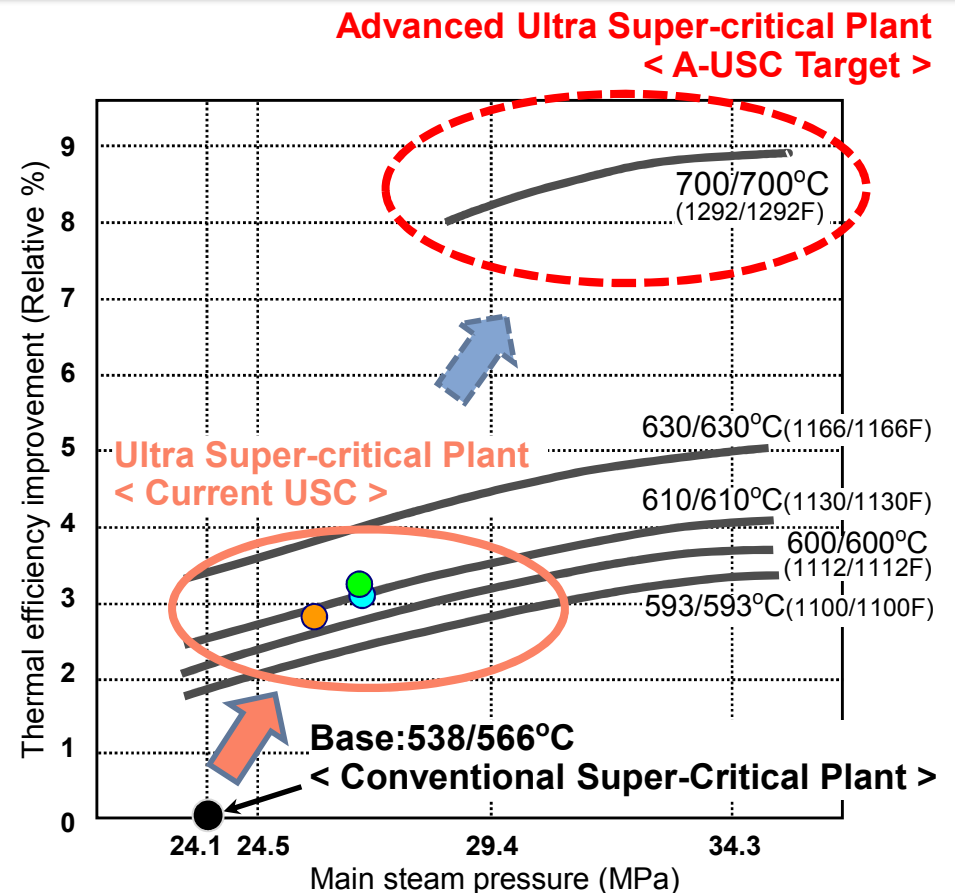
### 3-2. High Plant Efficiency - USC

As a leading company in this field, and a pioneer in Ultra Supercritical (USC) coal-fired boilers, we have achieved the world's highest pressure and temperature steam conditions, and we continue to look for ways to improve plant efficiency.

History Record of Boiler Steam Condition in Japan



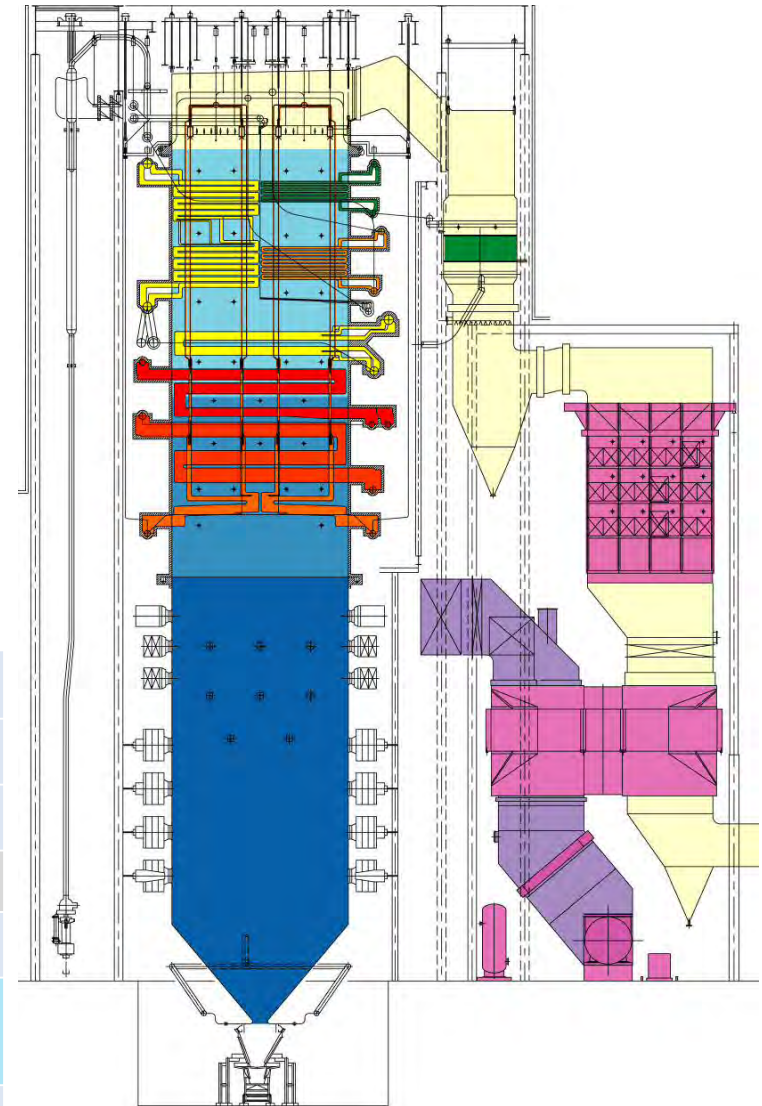
Improvement of Plant Efficiency by Higher Steam Condition



# 3-3. IHI USC Boiler Reference



Photo is provided by J-POWER(EPDC)



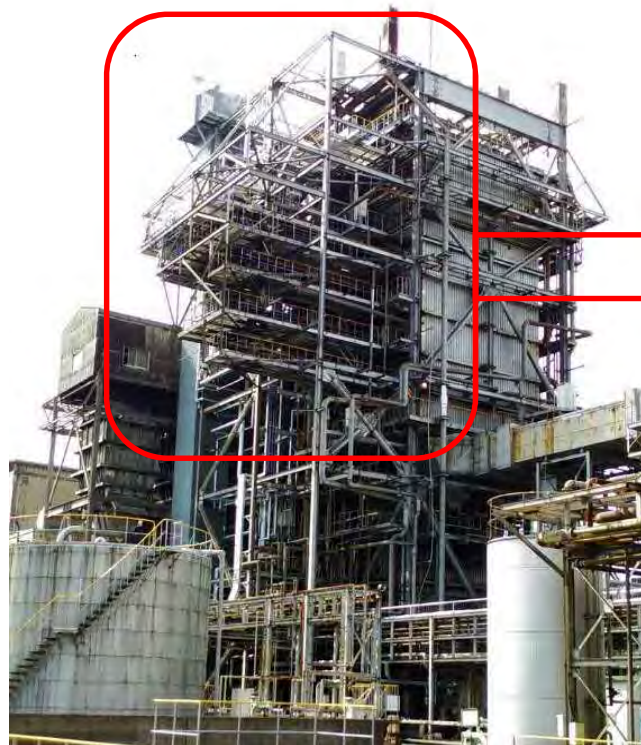
Client	Electric Power Development Co., Ltd. / J-POWER, Japan	
Unit	Isogo New No.1 and 2	
Turbine Output	2 x 600MW (Gross)	
	No.1	No.2
Boiler Capacity	1,710 t/h (3,770 klb/h)	1,670 t/h (3,682 klb/h)
Steam Conditions	27.5MPa, 605/613°C (3,987psi, 1121/1135F)	27.2MPa, 605/ <b>623°C</b> (3,945psi, 1121/1153F)
Commercial Operation	2002	2009

### Development of A-USC Technology

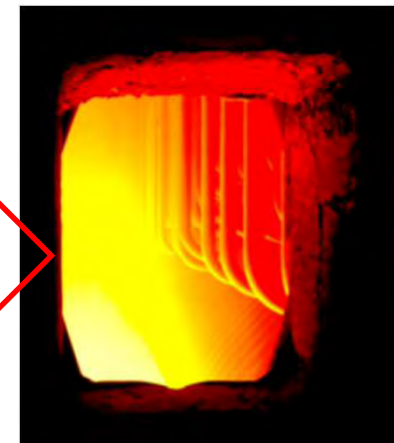
We are currently participating in the joint development of the Advanced USC (A-USC) 700degC-class boiler in order to achieve a plant efficiency of 46% (net HHV) and further reduce CO2 emissions.



Mock-up model of SH header



Boiler component test facility



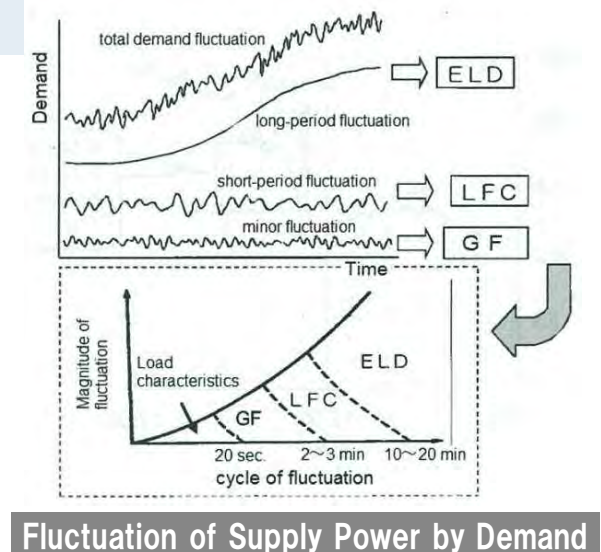
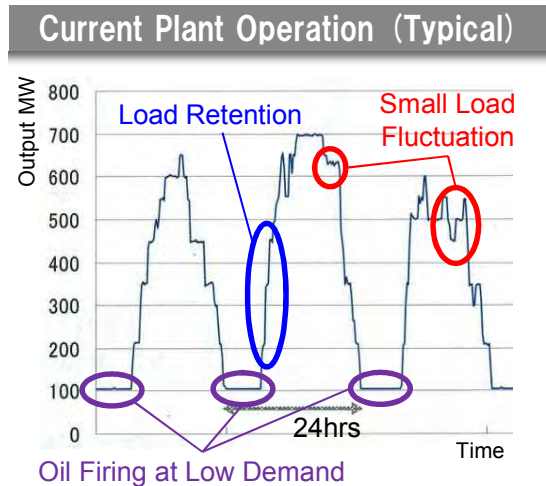
Heating element during testing

# 3-5. Highly Flexible Operation

## Customers Needs on Current Plant Operation

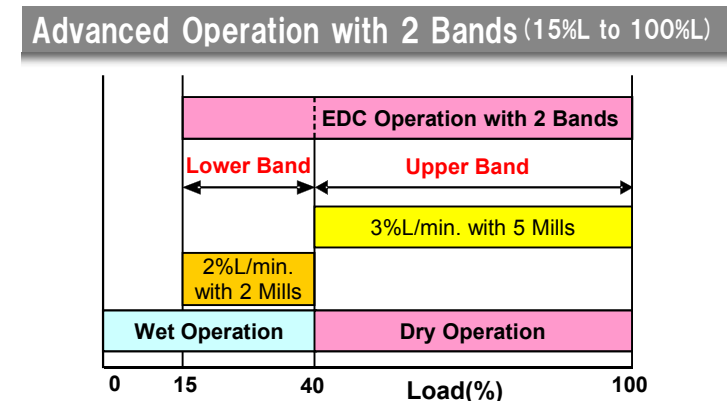
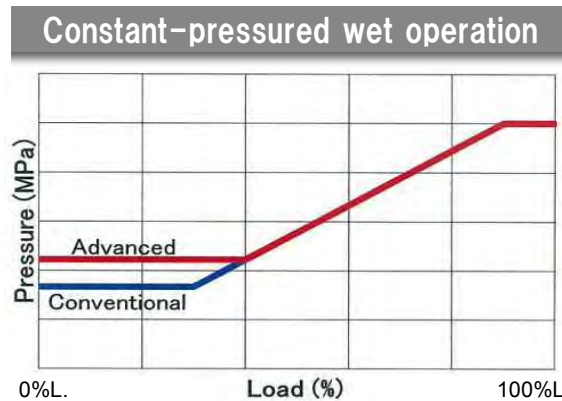
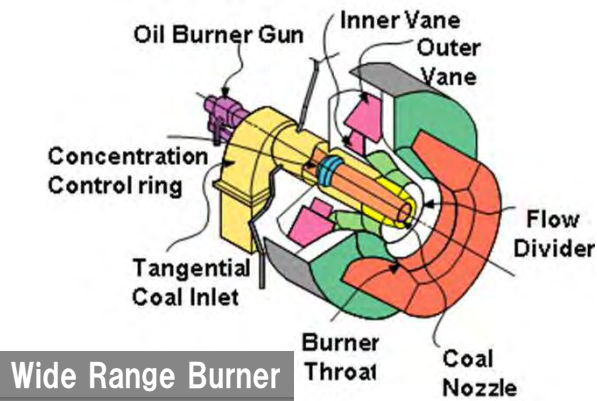
- Minimization of Load Retention for Mill Start/Stop Operation
- Minimization of Time Lag for Load Change Demand
- EDC/ELD(\*) Operation at Minimum Load by Coal Firing

(\*) EDC/ELD: Economic Load Dispatching Control



## IHI Advance Technology respond to Customers Needs

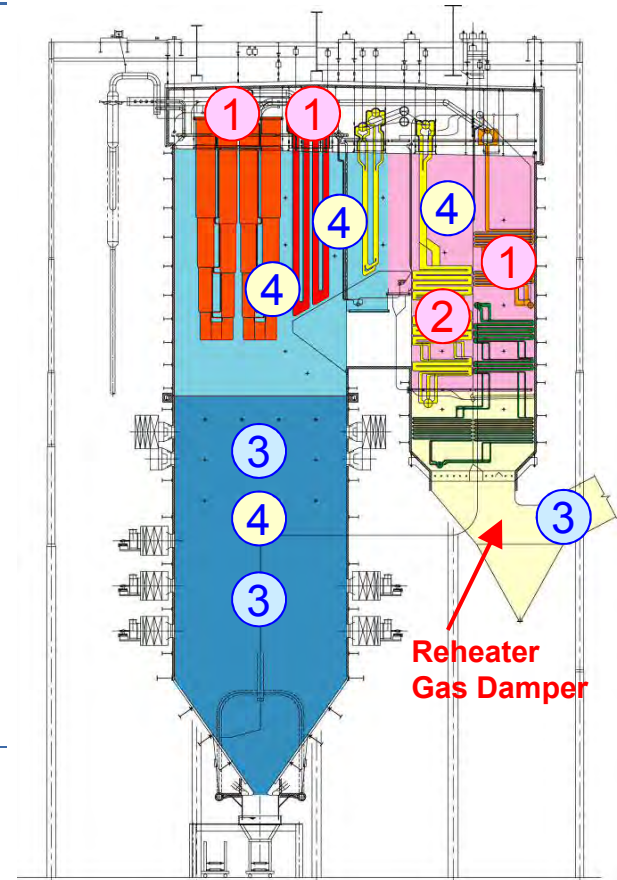
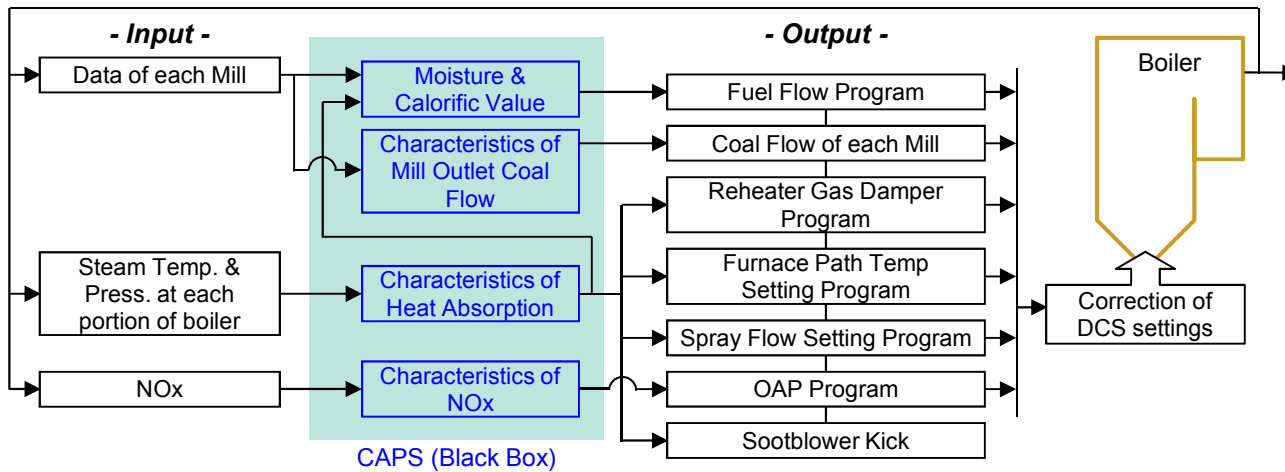
- Application of Wide Range Burner
- Expansion of Recirculation Operation Range (Wet Mode)
- Constant-pressured Wet Operation
- Optimized Boiler Control System



# 3-6. Highly Flexible Operation - CAPS

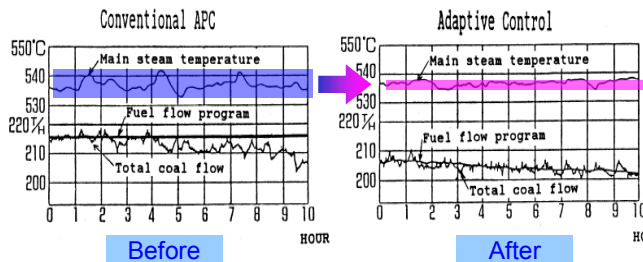
## Coal Adaptive control system for Power Stations

- Adjust the control parameters automatically depend on the difference of heat absorption and combustion characteristics in case of coal brand change.
- Keep the optimum plant performance without any additional adjustments by long-term commissioning.

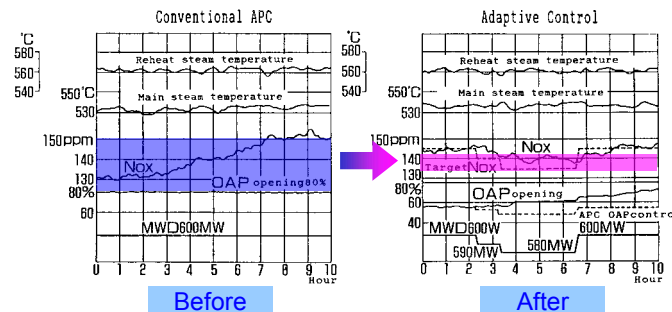


## Example of CAPS effect

- MST (Main Steam Temp.) / RST (Reheat Steam Temp.) optimum control

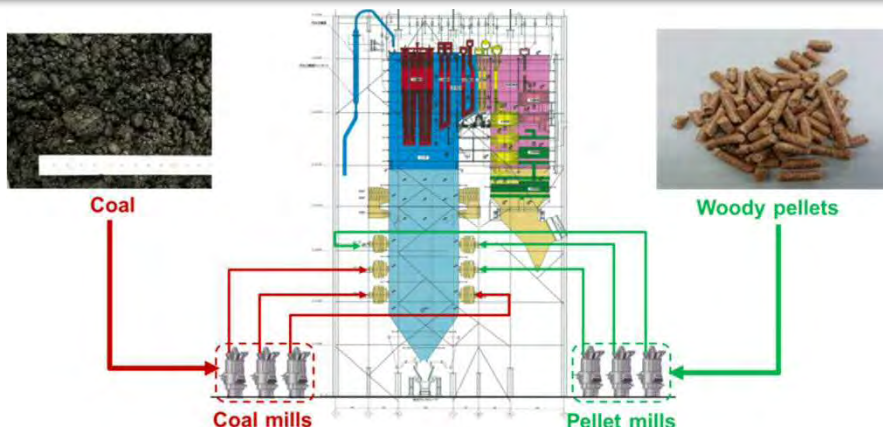


- NOx Control coped with various coal kinds



No.	Functions
1	Superior SH spray control
2	RH temperature control
3	Emission (NOx) control
4	Optimized sootblower control

## Woody Pellet High Ratio Co-firing

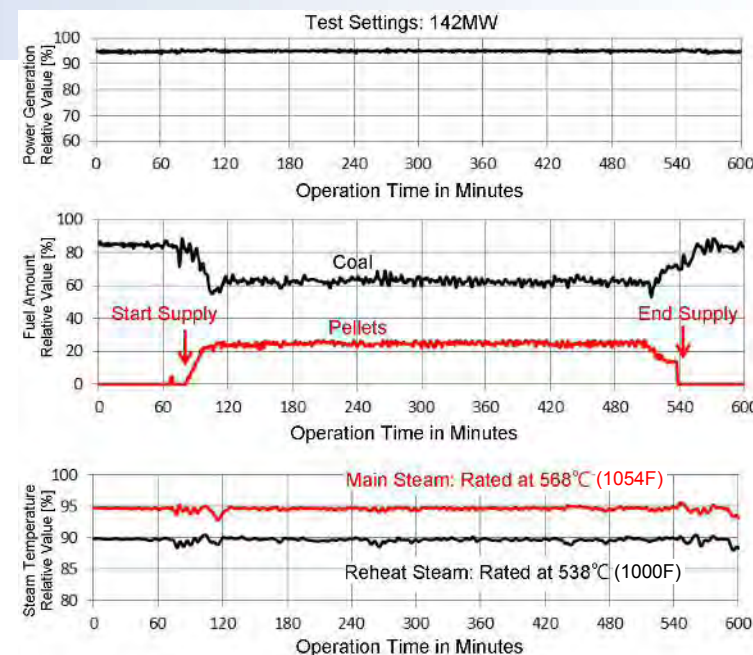


## Features

- CO2 reduction according to number of pellet mill can be achieved
- Achievable of CO2 negative with CO2 capture technologies such as Oxyfuel and PCC
- Possible utilization of both coal and woody pellet with minor modification

## Verification with 149MW Power Plant in Japan (2015)

- One coal mill (total 4 mills) was retrofitted to a pellet mill equipped with a “flow acceleration ring”.

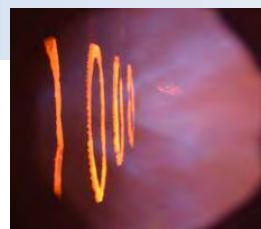


# 3-8. Boiler Fuel Conversion

## Deference between Coal /Oil and Gas Fuel

Heat absorption at furnace will be reduced due to flame brightness.

- Coal / Oil : Brighter Flame
- Gas : Blue colored flame



Gas Flame



Coal Flame



Oil Flame

## Item to be modified

Mandatory Items	Depend on Existing System
<ul style="list-style-type: none"> <li>■ Burner Replacement</li> <li>■ Flame Detector Replacement (UV to IR)</li> <li>■ Fire Fighting System (Gas Detection System)</li> </ul>	<ul style="list-style-type: none"> <li>■ Heating Surface Modification</li> <li>■ Spray System Modification</li> <li>■ SCR Re-Tuning (if available)</li> <li>■ BOP (fuel oil system, SCAH etc.) Preservation</li> </ul>
<ul style="list-style-type: none"> <li>■ Gas Supply System</li> <li>■ Logic Change</li> <li>■ Commissioning</li> </ul>	

## Rich Experiences

IHI has rich experiences of boiler fuel conversion; oil to gas, coal to gas.

### Oil to Gas Fuel Conversion Project in Japan

- Boiler OEM : IHI
- Fuel : Fuel Oil → Natural Gas
- Capacity : 350MW

#### Scope of Modification

- 1) Burner System Modification
- 2) Pressure Parts Modification
- 3) Control System Modification
- 4) Additional SH Spray and Upgrade of Primary & Secondary SH Spray
- 5) Replace or Modification of each Fan System

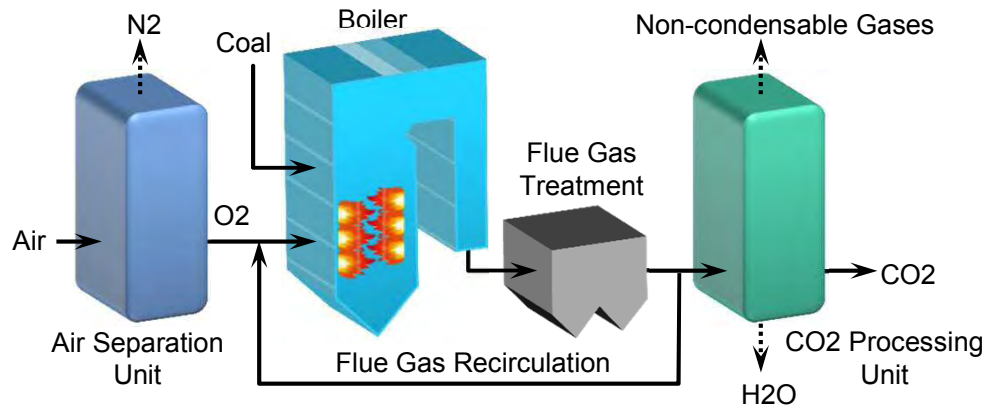


Before Modification



After Modification

## Oxyfuel Combustion



## Features

- Lower CO2 capture cost for full capture
- Byproduct reuse such as N2 resulting from air separation for O2
- Achievable of CO2 capture rate up to 98%
- Applicable to both existing and new power plants

## Callide Demonstration Project in Australia (2012 - 2015)

- The world's only one oxyfuel power plant for CO2 capture from coal fired power plants.
- Achieved over 10,000 hours oxyfuel operation without serious technical barrier
- Ready for large scale commercial plant



Callide A Power Station  
Owned by CS Energy  
4 x 30 MWe

Steam :136 t/h at 4.1MPa, 465°C  
(300 klb/h at 595psi, 869F)

Commissioned :1965 – 69  
Refurbished :1997/98  
Placed in storage in 2002



## 4. Summary



**We are confident that IHI's coal fired power generation technologies will fit to the best-mix for the world wide energy requirements and also will be the best solution to promote effective utilization of existing assets related coal.**

**IHI**

**Realize your dreams**