
Gasification Technology Conference 2010
Technical Update of
the MHI Air Blown and Oxygen Blown
Gasifier
November 1, 2010
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Gasification
MITSUBISHI
HEAVY INDUSTRIES, LTD.

# Business Portfolio

MITSUBISHI HEAVY INDUSTRIES, LTD.

***Contribute to Both the Power Generation and the Chemical Industries through MHI Coal Gasification Technology***

- **Air-Blown Gasifier with High Temperature GT for IGCC (i.e. for Power) with the Highest Plant Efficiency and Economical Merits**

  ⇨ ***•Update of Australian ZeroGen Project***

  ***•IGCC Combination with Latest J-type GT technology***

- **Oxygen-Blown Gasifier for Chemical Products (i.e. SNG, CTL, NH3, etc.) with Minimum Utility Consumption Including Auxiliary Power**

  ⇨ ***•Development of Low Rank Coal Utilization***

# Outline of MHI Air-Blown IGCC System

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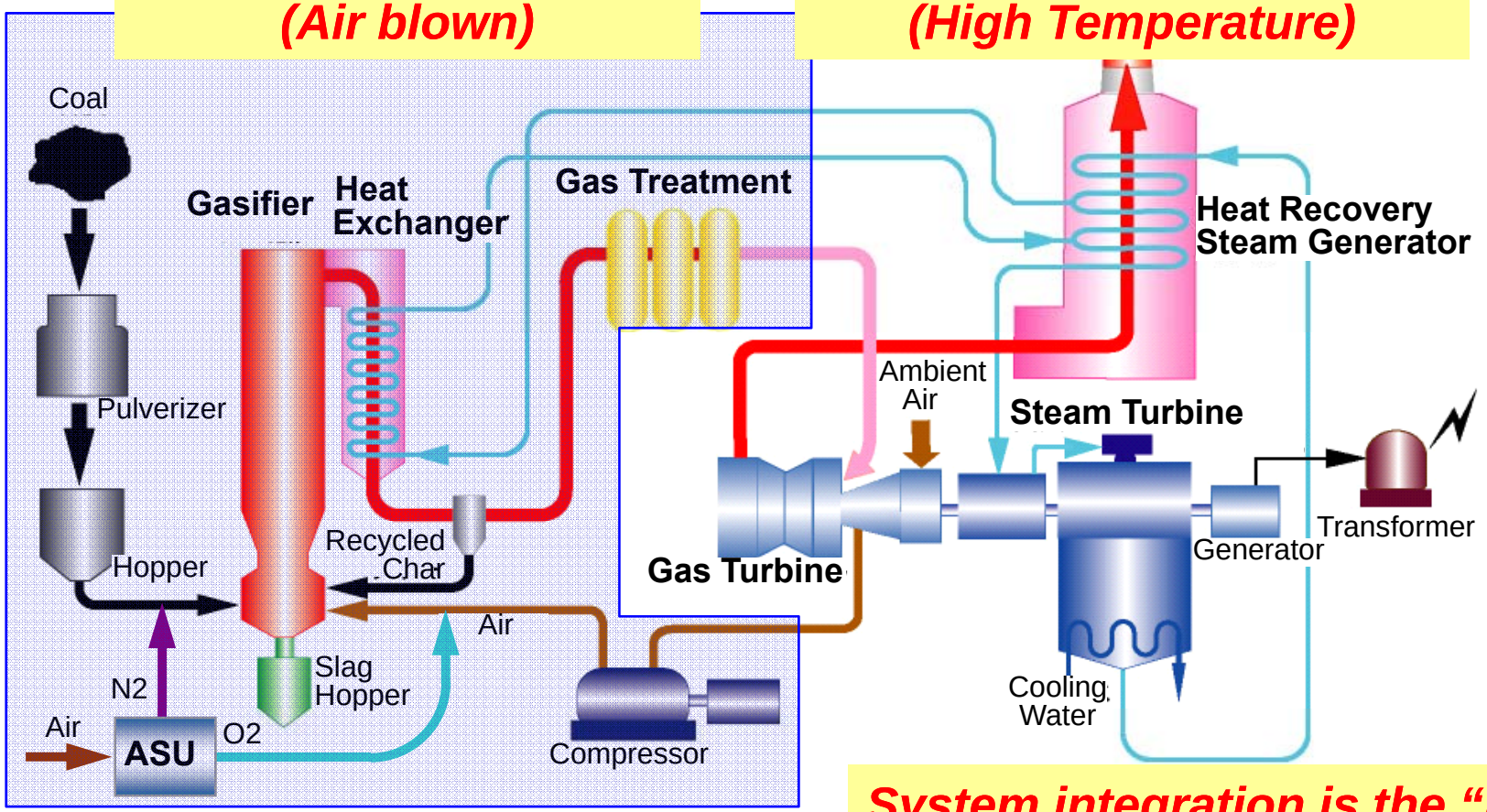
**Gasifier / Gas Treatment Island**

**Power Block**
**(Equivalent to typical NGCC Plant)**

***Highly Efficient Gasifier (Air blown)***

***Highly Efficient Gas turbine (High Temperature)***




***System integration is the "Key."***

# Scenario of Clean Coal Technology Innovation

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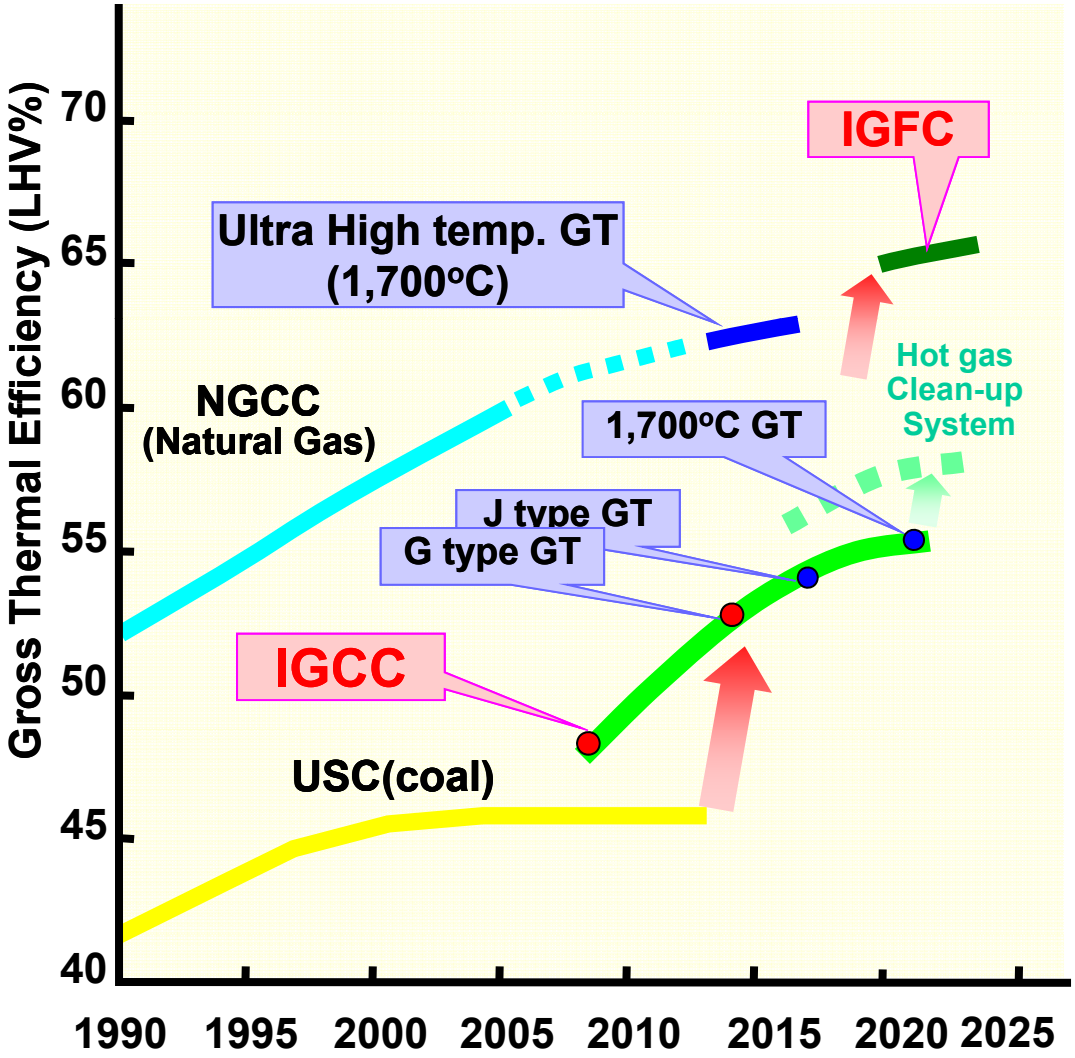
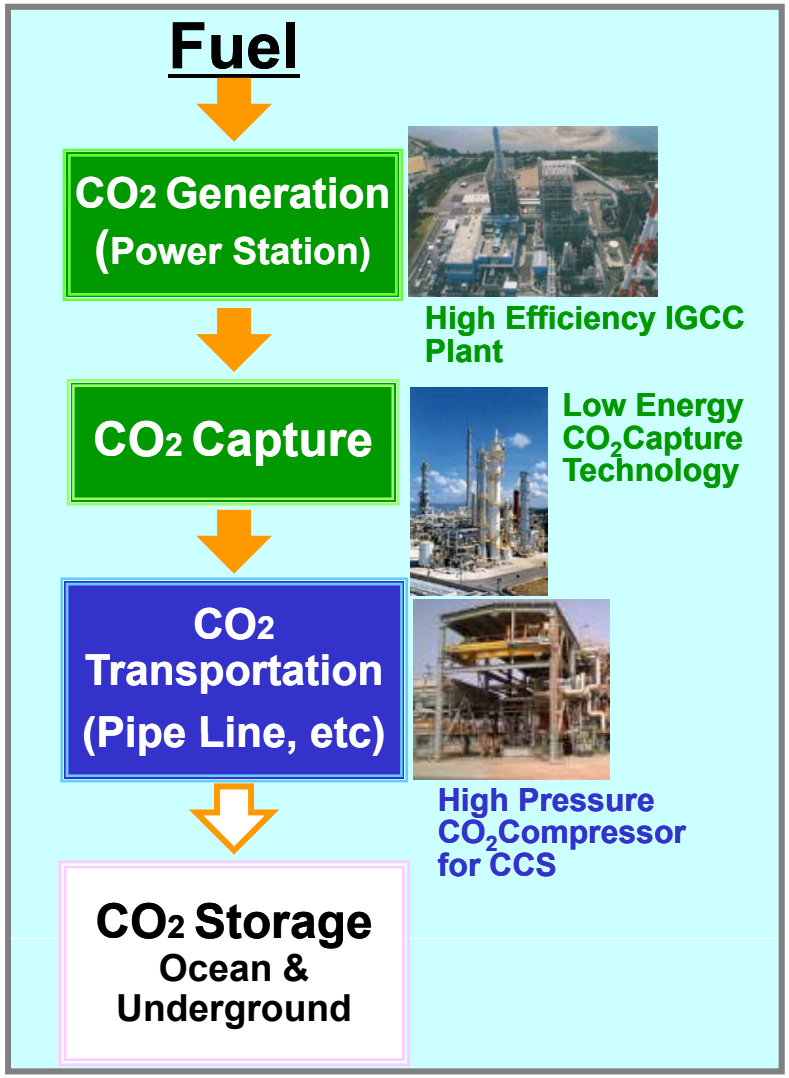
## 1. Improvement of Thermal Efficiency




## 2. CO2 Capture and Storage



# *ZeroGen in Australia IGCC + CCS Commercial Project*



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- **ZeroGen Pty Ltd., owned by the Queensland State Government of Australia decided to develop their world-first IGCC+CCS flagship project with MHI.**

- **CCC (Clean Coal Council), Queensland State Government, provided official approval to start the commercial scale project (530MW) together with MHI, by highly recognizing the successful results of the 250MW Nakoso IGCC demonstration project.**

# ZeroGen in Australia - Battery Limits -



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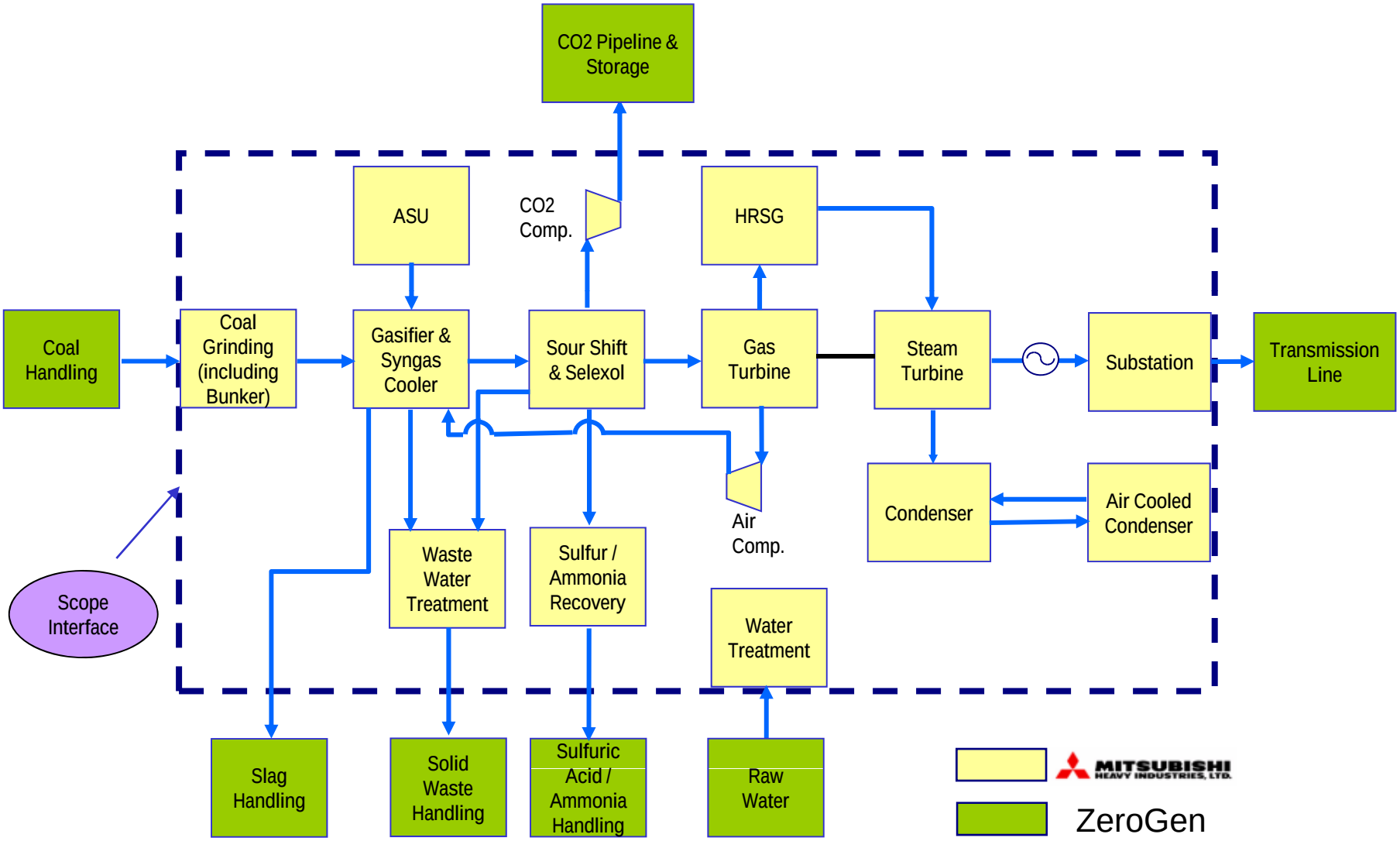

# ZeroGen in Australia
# IGCC + CCS Commercial Project



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***Feasibility Study was successfully completed and further optimization study has started.***

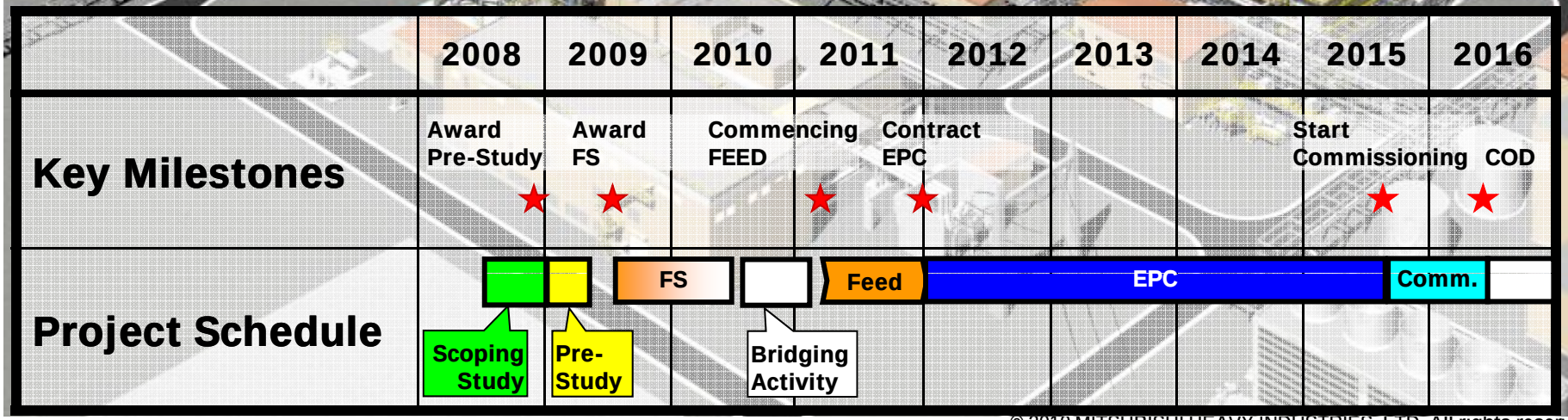
## Principal Specifications

| | |
|---|---|
| Coal | Australian Hard Coal |
| Output | 530 MW gross |
| Gasifier | Air Blown. Dry Feed |
| Gas Turbine | M701G2 GT (1 on 1) |
| Carbon Capture | 65-90% |
| CO2 Storage | 2-3 Mil.ton/yr |

## Major Events

- Coal gasification test using MHI's Pilot Plant was successfully completed. :April 2010
- FS Report was issued and submitted to the Federal Government. :June 2010
- Third Party Review to the Report was finished to highly evaluated results. :July 2010

## Key Milestones



# Gasification / Coal Testing

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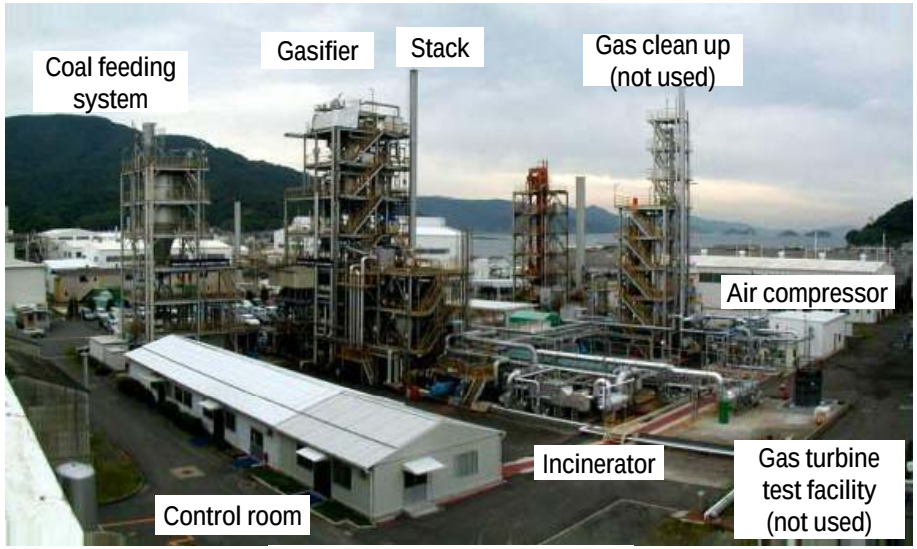
- Sample test of four (4) candidate coals completed
  - *Initial analysis for coal properties*
  - *Suitability to MHI's air-blown gasifier evaluated*
- 24t/d Pilot Plant Scale Gasification Test using Design coal
  - *Stable slag discharge confirmed*
  - *No significant slag deposits in the gasifier*
  - *Suitability of MHI's air-blown gasifier confirmed*

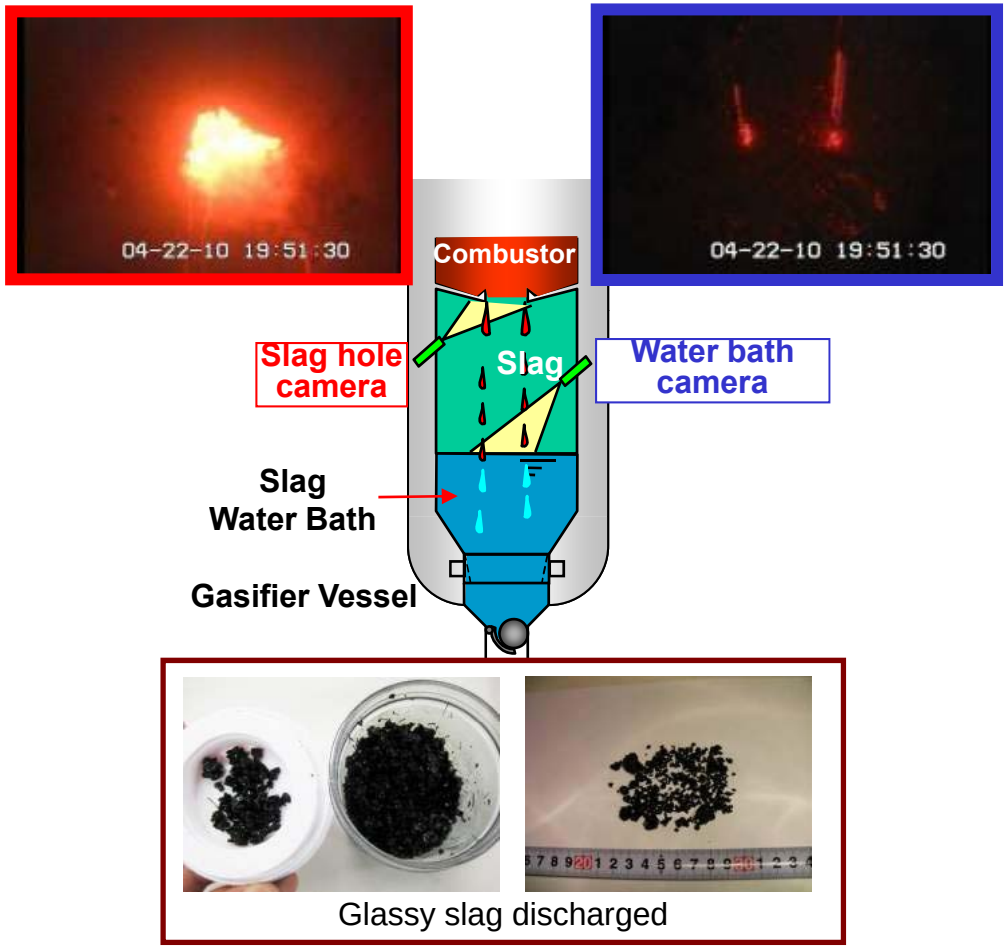



**MHI Test facility**

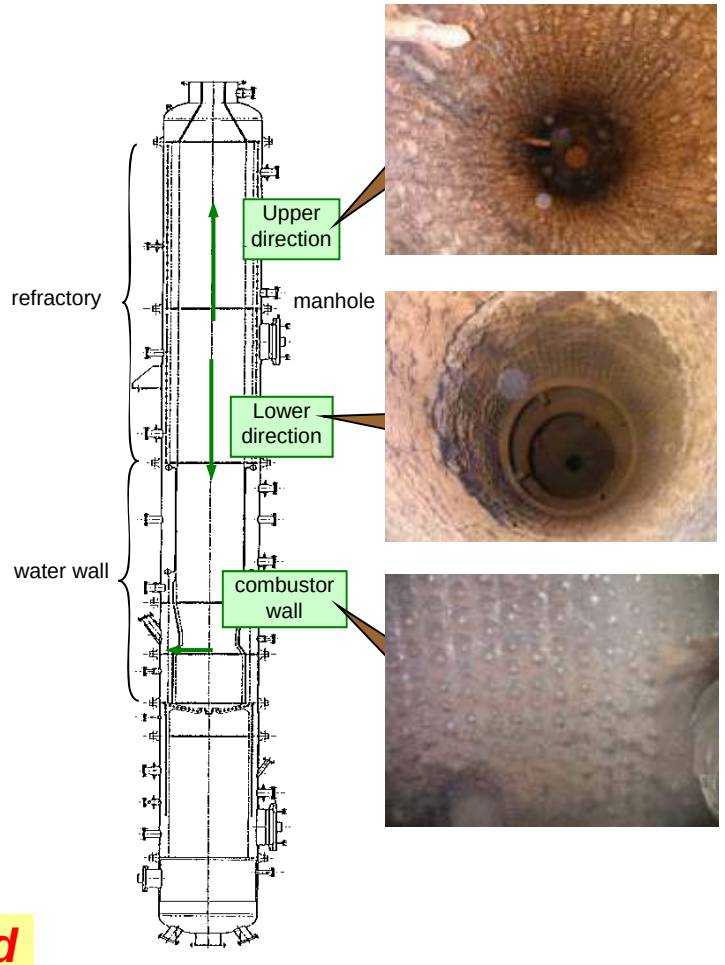
# Gasification / Coal Testing

MITSUBISHI HEAVY INDUSTRIES, LTD.

- *Stable Slag Discharge*




- *No significant slag deposits in the gasifier*




***Confirmed that the Design Coal is well suited for MHI's air-blown gasifier***

# IGCC Commercial Plant is Ready
## - Typical Expected Performance -



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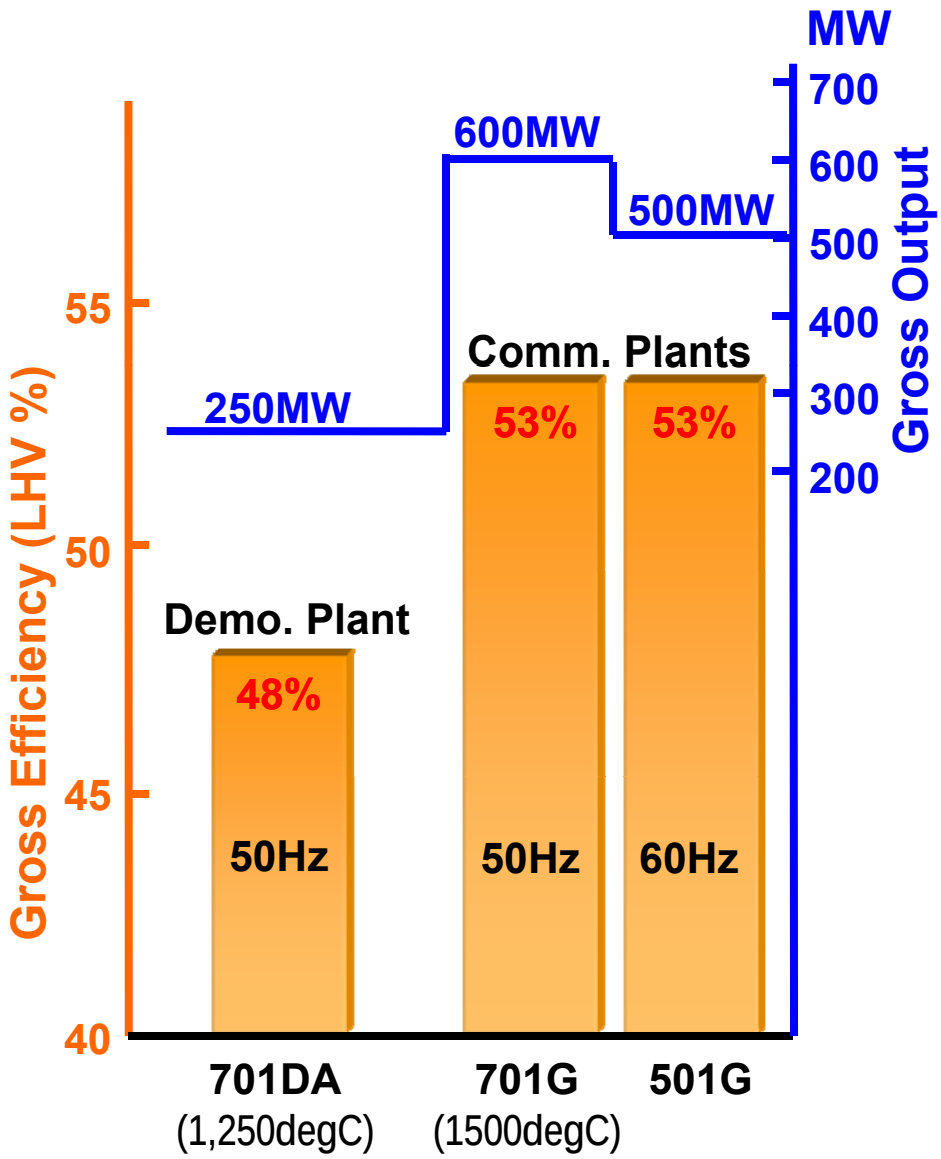


| Item | Specification | |
|---|---|---|
| Coal | Bituminous Coal | |
| Frequency | 50Hz | 60Hz |
| Output Gross | 600MW | 500MW |
| Net | 540MW | 450MW |
| Gasifier Oxidizer | Air | |
| Coal Feed | Dry | |
| Acid Gas Clean-up | Wet MDEA w/o CO2 Cap. | |
| Gas Turbine | M701G x1 (1 on 1) | M501G x1 (1 on 1) |
| Gross Efficiency (LHV) | 53% w/o CO2 Cap. | |

***Note: Plant efficiency depends on site conditions including coal properties.***
***Emission and acid gas clean-up process depends on regional regulations.***

# *Further Improvement of Efficiency*
## *- J Class Gas Turbine Market Introduction -*

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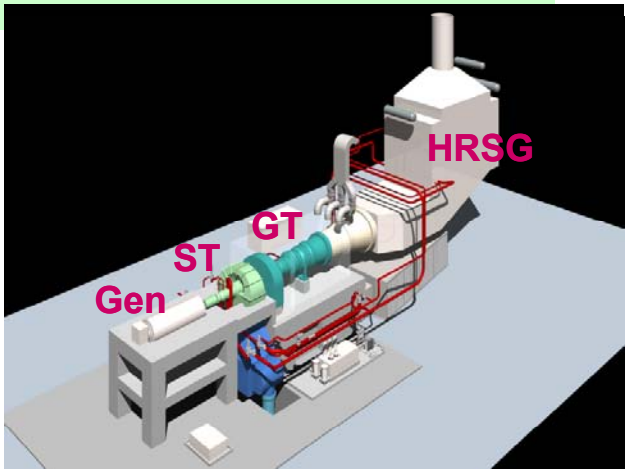
***Delivery of Commercial Units to Begin in 2011. (60Hz)***
***First Commercial operation Unit in 2013 for 2,900MW (M501J×6)***
***Kansai Electric Power Company.***




**[T-Point Verification]**

Strategic Planning → R&D / Design → Design Implementation → Verification Test

2011

**[60Hz] Commercial Plant**

Strategic Planning → R&D / Design → Design Implementation → Ready for FOB → Commercial Operation

2009 2011 2013

**IGCC Application**

G type IGCC Commercialization → Development of J type IGCC

# *Oxygen-Blown Gasifier Development - Functions Required for the Gasifier -*



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- **Requirements**

| For Power Generation | For Chemical Production |
|---|---|
| (1) Gasifier Operation<br>: Stable Slag Discharge<br>(2) Gas Turbine Operation<br>: Calorific Value of Syngas (HHV) >1,100kcal/m3N<br>(3) Higher Plant Efficiency<br>: Less Auxiliary Power | (1) Gasifier Operation<br>: Stable Slag Discharge<br>(2) Higher Production Rate<br>: High yield of Usable Gas ( H2 + CO )<br>Less interfering materials and impurities<br>(3) Higher Cold Gas Efficiency |

- **Measures**

| | |
|---|---|
| 1. Air-Blown | 1. Oxygen-Blown |
| 2. 2-Stage configuration | 2. 2-Stage configuration |
| | 3. Fuel transportation using CO2/N2 gas |

# MHI Gasifier Applicable to Chemical Products (Oxygen-Blown)



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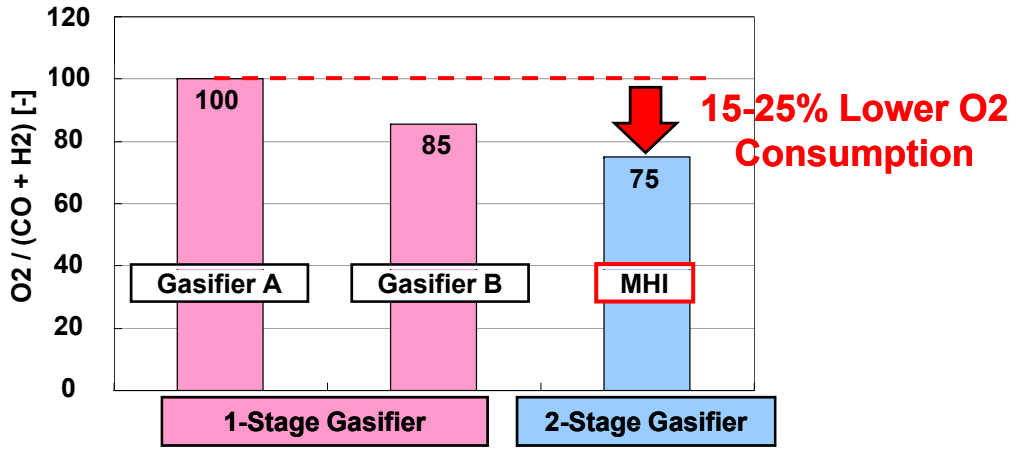
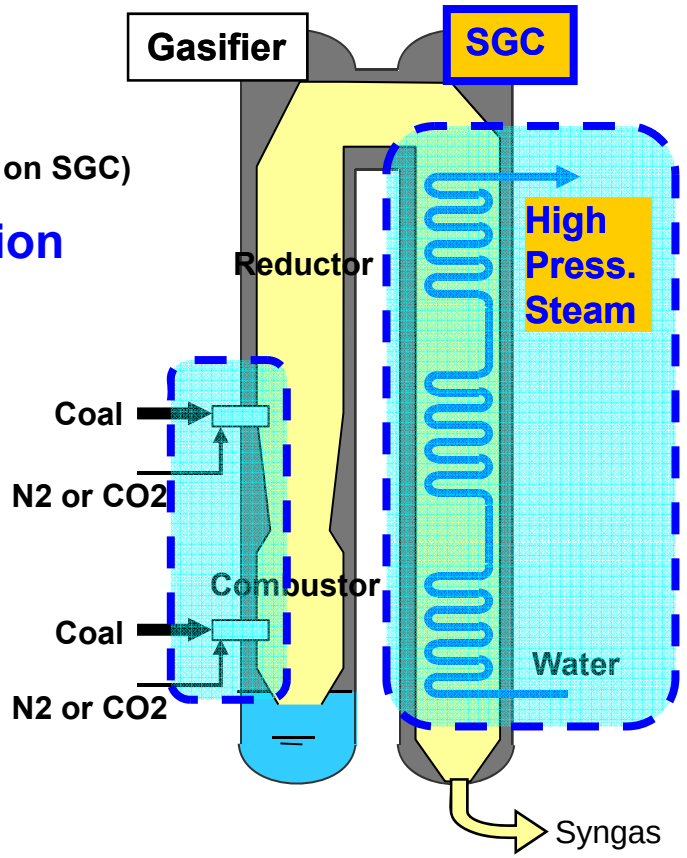
## MHI Can Design and Supply Gasifiers Both for Air-Blown and Oxygen-Blown

- **Same "MHI 2-Stage Entrained Flow Gasifier" as Air-Blown Nakoso Project Applied to Oxygen-Blown**
  - Can be easily modified to Oxygen-Blown
  - Without changing the basic design of the existing gasifier in operation
  - Important factors duly considered

  (ex. increased heat flux, change in burner, change of carrier gas, impact on SGC)
- **2-Stage Gasification Reduces Oxygen Consumption**
- **SGC, as Monolithic Structure with Gasifier, Produces Steam and Supplies Auxiliary Power Needed in the Plant**



# DME Production from Coal

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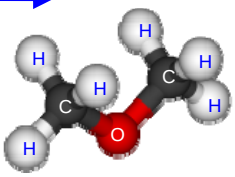
**DME Process has an additional step of DME synthesis (Dehydration) compared with MeOH Process**

**Methanol and DME synthesis are proven technology adopted in many plants with natural gas**

**Coal** → **Gasification** → **Methanol Synthesis** → **DME Synthesis** → **DME**




**Coal is converted to Syngas by gasification**

**Syngas is converted to Methanol**

**CO + 2H2 → CH3OH**

**CO2 + 3H2 → CH3OH + H2O**

**Methanol is dehydrated to DME.**

**2CH3OH → CH3OCH3 + H2O**

Coal

Synthesis Gas

H2

CO

$CO_2$

**Saudi Arabia Methanol Plant**
**AR-RAZI Plant**

***DME: dimethyl ether***

# Scenario of High Moisture Coal Utilization



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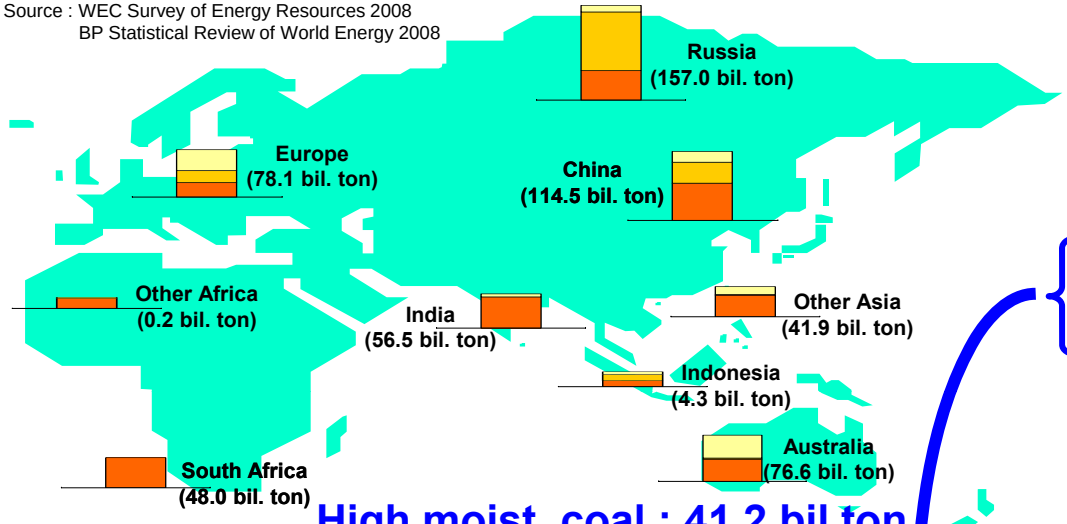
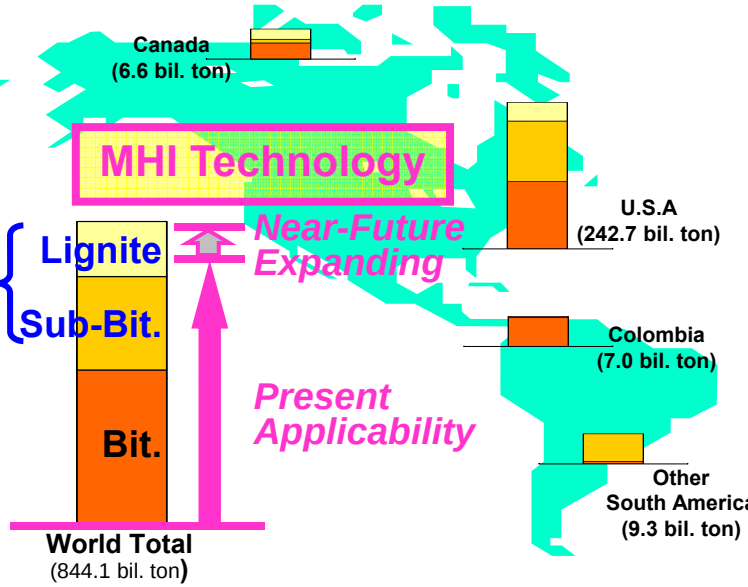
Source : WEC Survey of Energy Resources 2008
BP Statistical Review of World Energy 2008




**High moist. coal : 41.2 bil.ton**
**- Scenario of utilization -**




## Mine-mouth IGCC

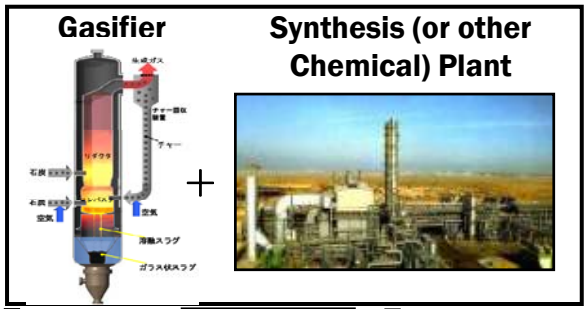
**Pre-Drying***

+

## Mine-mouth Synfuel/Chemical Production

**Pre-Drying***

+




Synfuel

GTCC
Diesel Engine

NH3, etc.

*Pre-Drying may be applied in the future when high moisture lignite is used.

# Commercial Plant with Brown Coal Drying

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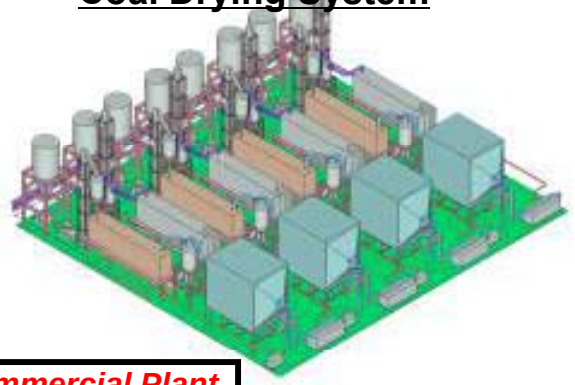
**Coal Drying System**



**Brown Coal Fired Power Station**

*Elemental test*

**Demo Plant (~200 t/d)**

Design/Manufacture

Test

**PDU test (Approx. 6-10 t/d)**

***National Project of METI***

**Commercial Plant IGCC or DME (11,000 t/d class)**

FS

FEED

Design/Manufacture

Test

2009 2010 2011 2012 2013 2014 2015 2016

MITSUBISHI HEAVY INDUSTRIES, LTD.

Our Technologies, Your Tomorrow

# *"Mitsubishi's Contribution for Energy and Environment Solutions"*

*Thank you!!*