Clean Coal Technology is ready for Australian Projects

26 June 2009

MITSUBISHI HEAVY INDUSTRIES, LTD.

Diversified Products

MITSUBISHI HEAVY INDUSTRIES, LTD.

MHI'S Diversified Products are Contributing to Every Area of Society;

ENERGY & ENVIRONMENT:	**Power Systems, Pollution Control Equipment,**	
INFRASTRUCTURE :	**Bridges, Gates, Desalination Plants**	
TRANSPORTATION :	**Aircraft, Ships, Land Transportation Systems**	
INDUSTRIAL & CHEMICAL :	**Pulp & Paper Machinery, Chemical Plants Industrial Robots, Machine Tools**	
LIFE STYLE AND LEISURE:	**Air-Conditioners, Refrigeration Units, District Heating, Pleasure Boats, Leisure Facilities**	
OCEAN AND SPACE DEVELOPMENT :	**Ocean Research Ships, Deep Submergence Research Vehicles, Rockets, Space Planes**	
DEFENSE :	**Submarines, Naval Vessels, Jet Fighters, Missiles, Tanks**	

MHI's products for Power Generation and Chemicals

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POWER PLANT & EQUIPMENT


Combined Cycle Power Plant


Steam Turbine


Gas Turbine


Geothermal Power Plant


Boiler


IGCC (Integrated coal Gasification Combined Cycle)


Flue Gas CO_2 Recovery Plants


Compressor for Ethylene Plant


Refuse Incineration Plant


Purified Terephthalic Acid Plant

CHEMICAL PLANT & EQUIPMENT

Mitsubishi's Clean Coal Technology

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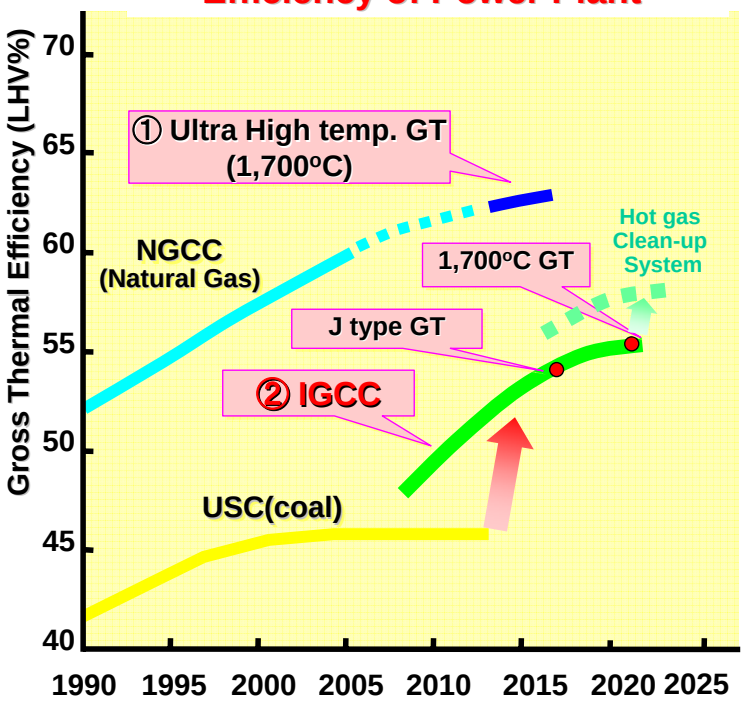
1. Improvement of Thermal Efficiency of Power Plant



IGCC: Integrated Gasification Combined Cycle

2. CO2 Capture and Storage

Fuel

CO_2Generation (Power Station)


MHI High efficiency Power Plant

CO_2Capture


MHI CO_2Capture technology --Low Energy Capture

CO_2 Transportation (Pipe Line,etc)


MHI High Pressure CO_2Compressor for CCS Plant

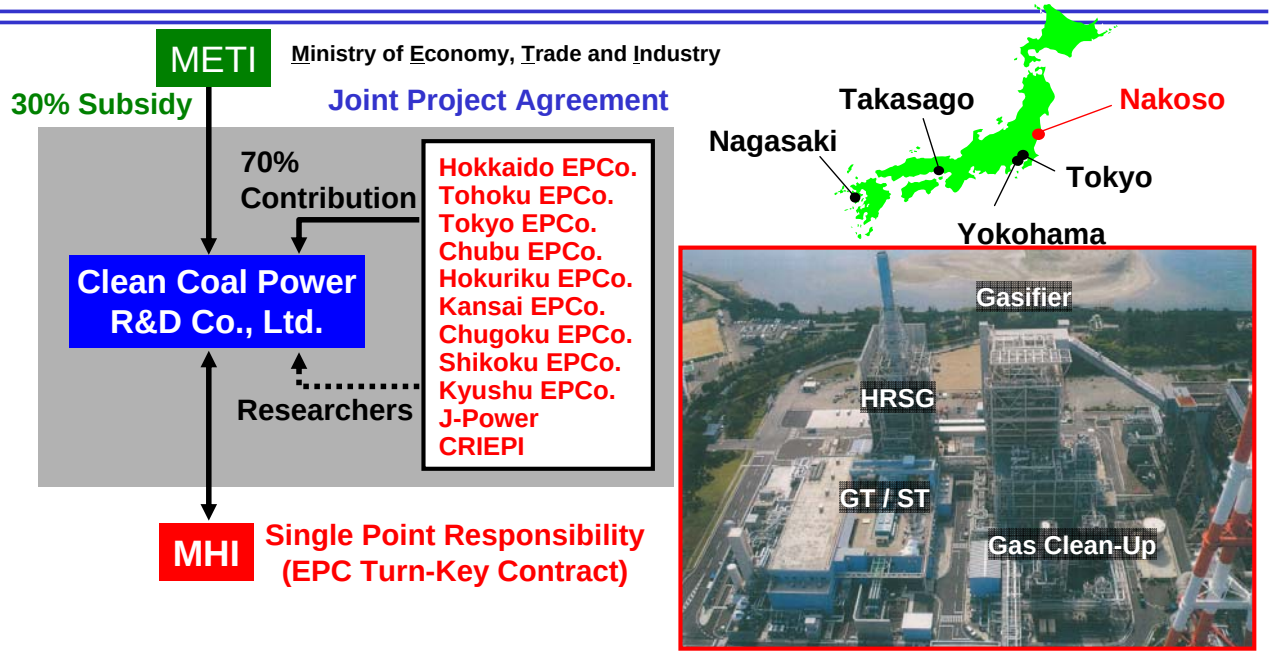
CO_2Storage Ocean & Underground

Contents

MHI propose IGCC and CCS solution in Auatralia

1. IGCC Demonstration Plant
2. IGCC Commercial Plant
3. Carbon Capture Technology
4. Utilization of Australian Brown Coal

250MW IGCC Demonstration Plant



Project is Going on Schedule. Operation Started September, 2007.

2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	Design			Construction (36M)			Operation	● (31M)	

250MW IGCC Demonstration Plant

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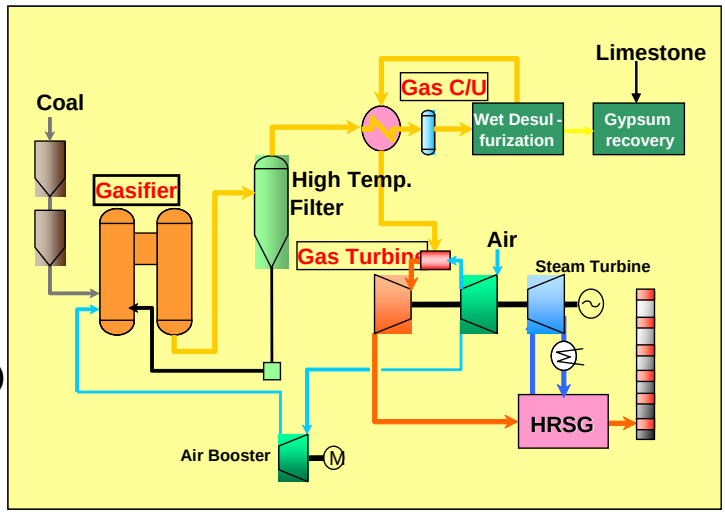
- **Specification**

Gasifier	Dry feed, Air Blown, Two-Staged Entrained Bed
Gas Clean-up	MDEA (Methyl Di-Ethanol Amine)
Gas Turbine	D-class (1,250℃ Class)

- **Coal feed** 1,700t/day
- **Plant Efficiency** 42%(LHV, Net) 40.5%(HHV, Net)
- **Emission (16%O2, dry)** SOx : 8ppmV (actual:1ppm) NOx : 5ppmV(w/SCR) (actual:3ppm) Dust : 4mg/m^{3}N (actual:＜ 0.1mg/m^{3}N)



MHI Supplied All the Key Components under Single Point Responsibility.

Coal IGCC Projects in the World

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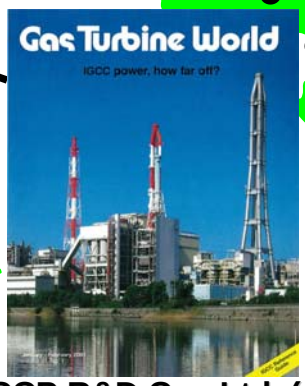
Puertollano (Spain) 318MW 1997

Buggenum (Netherlands) 284MW 1994

Wabash River (U.S.) 296MW 1995

Tampa (U.S.) 315MW 1996

Item	Nuon (Demokolec)	Wabash River	Tampa Electric	ELCOGAS	CCP R&D Co. Ltd
Location	Netherland Buggenum	U.S. Illinois	U.S. Florida	Spain Puertollano	Japan Nakoso
Gasifier	Shell	E-Gas™	Texaco (GE)	Prenflo (shell)	MHI
Oxidant	O2	O2	O2	O2	Air
Coal Feed	Dry	Slurry	Slurry	Dry	Dry
Gas Turbine	Siemens V94.2	GE 7FA	GE 7FA	Siemens V94.3	MHI M701DA
Output (Gross ,MW)	284	296	315	318	250
Start of GT Syngas Firing	Jan. 1994	Aug. 1995	July 1996	Nov. 1997	Dec. 2007



CCP R&D Co., Ltd. (Japan) 250MW 2007

Excellent Operation results in First Year

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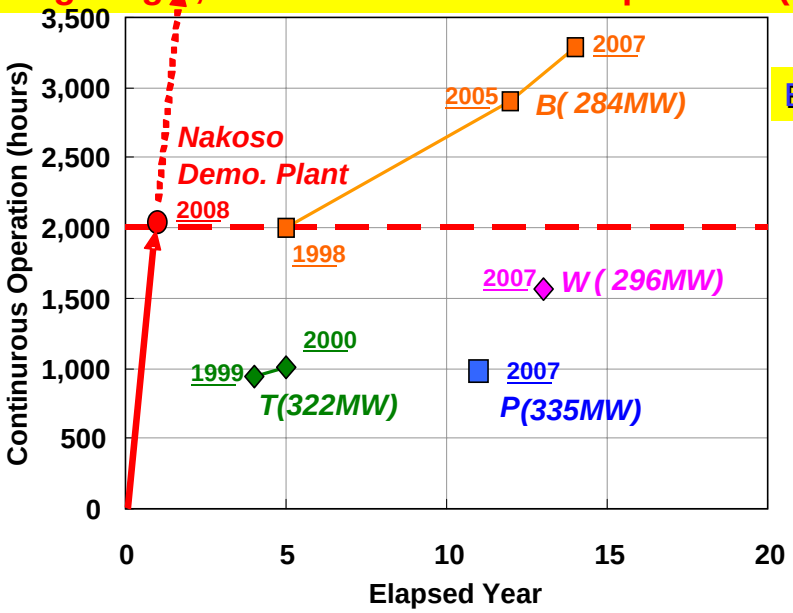
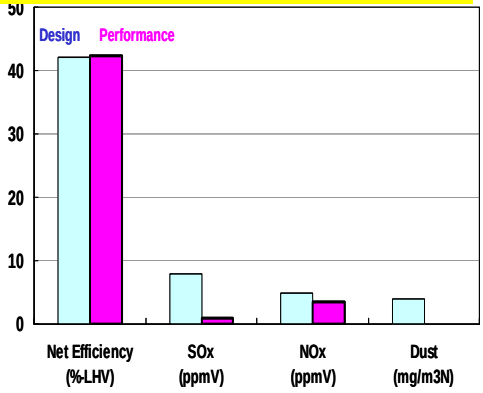
Showed Excellent Reliability and Performance!

Targeting 5,000hours Continuous Operation (2009)



Excellent Performance



Origin of MHI IGCC Commercial Plant

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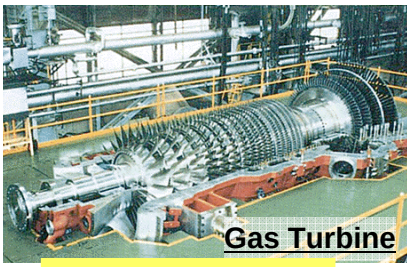
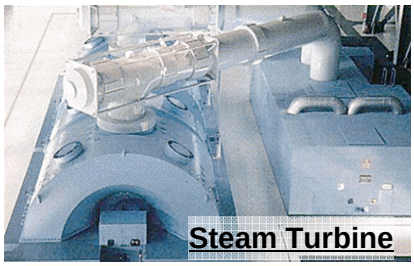




Boiler
625,778t/h
(2,976 units)

Gas Turbine
62,478MW
(486 units)

Steam Turbine
182,939MW
(1,987 units)

Developed to Gasifier

Optimized for IGCC

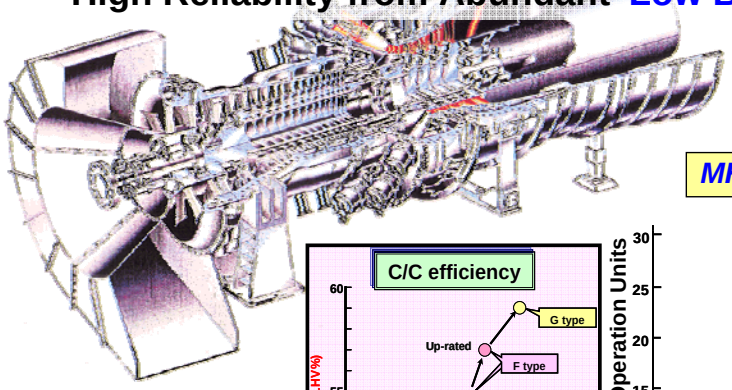
Gas Purification System

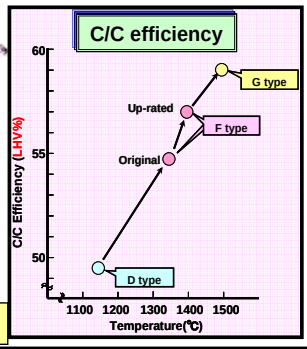
Developed to Gas C/U for IGCC

Features of Mitsubishi Gas Turbine

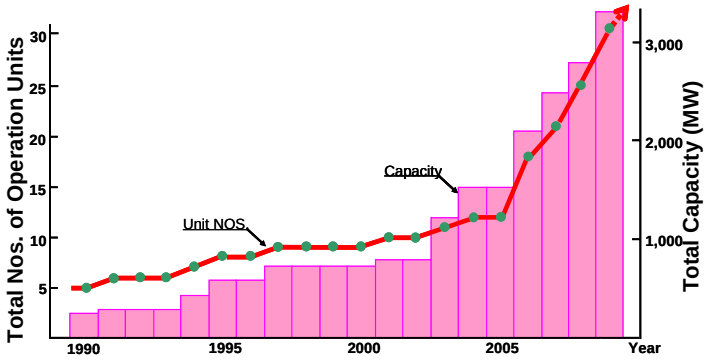
MITSUBISHI HEAVY INDUSTRIES, LTD.

- High Plant Efficiency by High Temp. GT
- High Reliability from Abundant "Low BTU Gas Firing" GT





MHI Experience Low BTU gas GT



Experience of MHI GT

M501G ×51 M701G ×11	M501F × 69 M701F ×102	M501D ×20 M701D ×91
Total : 62units	Total : 171units	Total : 111units

Total : 533units

Item	UnderOperation	Under Construction	Total
No. of Units	23	13	36
Capacity	2,278 MW	2,990 MW	5,268 MW
Operating Hours	> 1,223,000	-	> 1,223,000

Birds Eye View of IGCC plant

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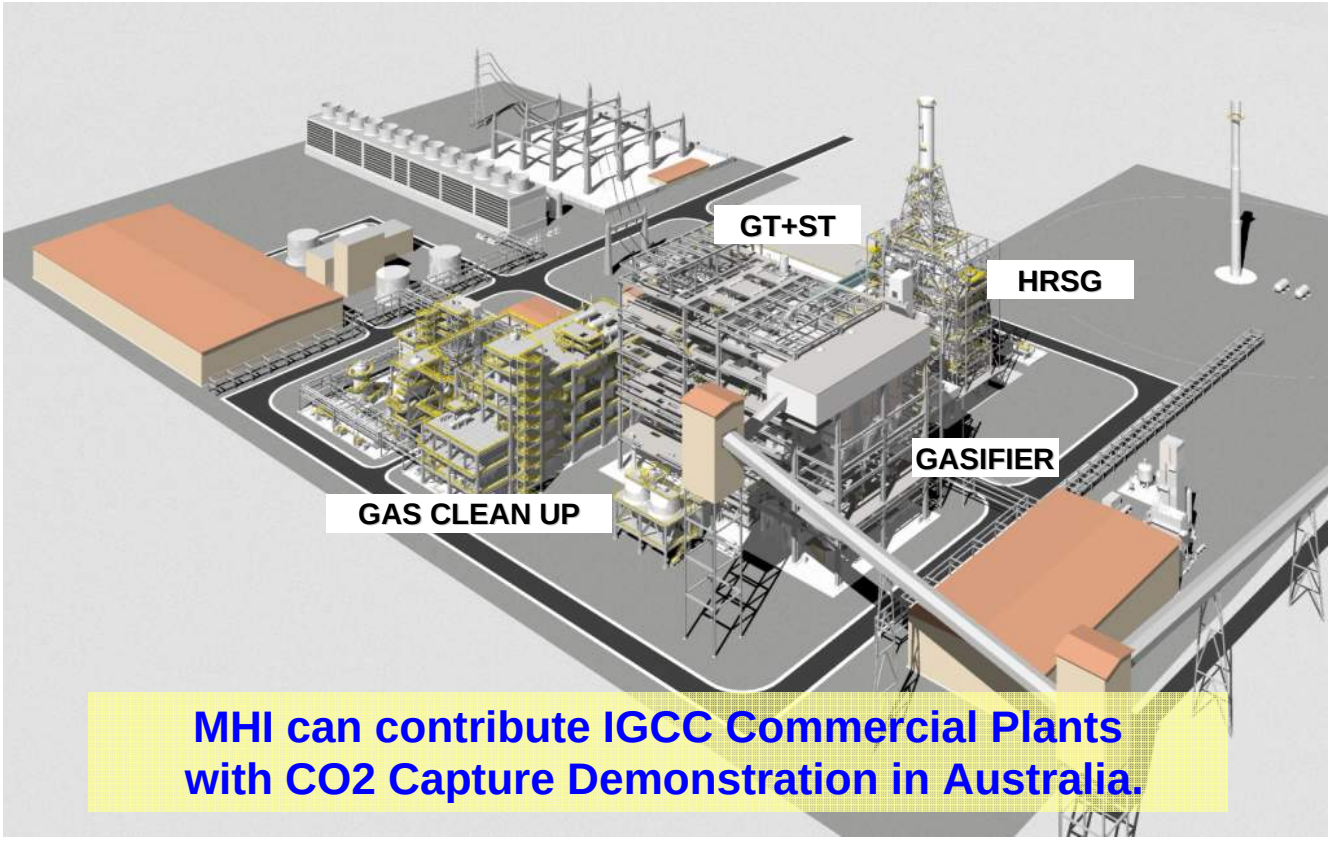

MHI can contribute IGCC Commercial Plants with CO2 Capture Demonstration in Australia.

CO_2 Capture from fossil fuel firing plant

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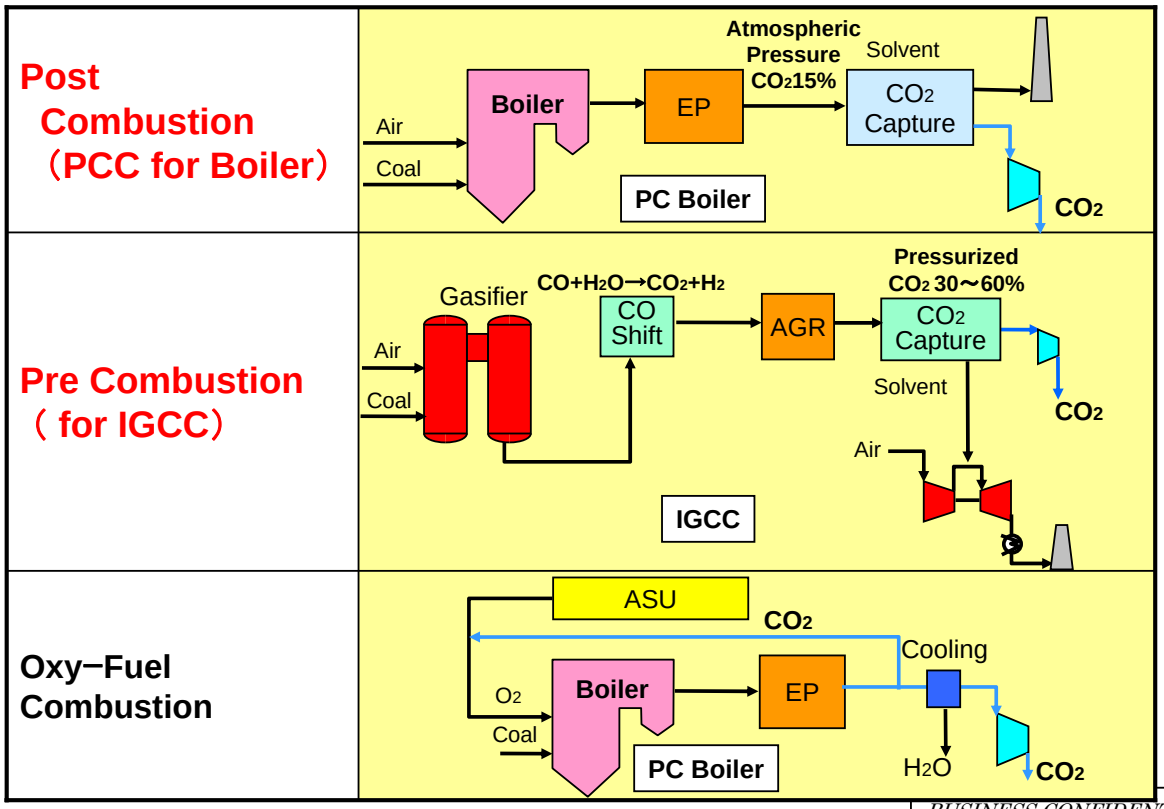

IGCC：Integrated Gasification Combined Cycle

<Post Combustion>

MHI's Operating commercial CO2 Capture Plants

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Malaysia

Client: Petoronas
Start-up: 1999~
CO2 Source:
Nat. Gas Reformer
Capacity: 200 t/d
Product: Urea

India

Client: IFFCO
Location: Aonla
Start-up: Dec 2006~
CO2 Source:
Nat. Gas Reformer
Capacity: 450 t/d
Product: Urea

Japan

Client: Chemical Co.
Start-up: 2005~
CO2 Source:
Nat. Gas Boiler
Capacity: 330 t/d
Product: General use

India

Client: IFFCO
Location: Phulpur
Start-up: Dec 2006~
CO2 Source:
Nat. Gas Reformer
Capacity: 450 t/d
Product: Urea

<Post Combustion>

Coal Fired Long Term Demonstration Plant

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Plant Outline

Solvent : KS-1
Capacity : 10 T/D
Feed Gas : Coal Fired Boiler (14.1 v% CO_2)
Start-up : July 2006
Location : Nagasaki, Japan

Operational experiences

- Increased understanding of the effects of impurities on the system (dust, SOx, NOx, etc.)
- Identifying and incorporating countermeasures for each impurity
- >5,000 hours of operation and experience
- Test results exceeded expectations and will facilitate scale up CO2 capture for coal fired boilers
- Confirms that the MHI CO2 capture process can be applied to coal fired flue gas streams

<Pre Combustion>

IGCC System Configuration with CO_2 Capture

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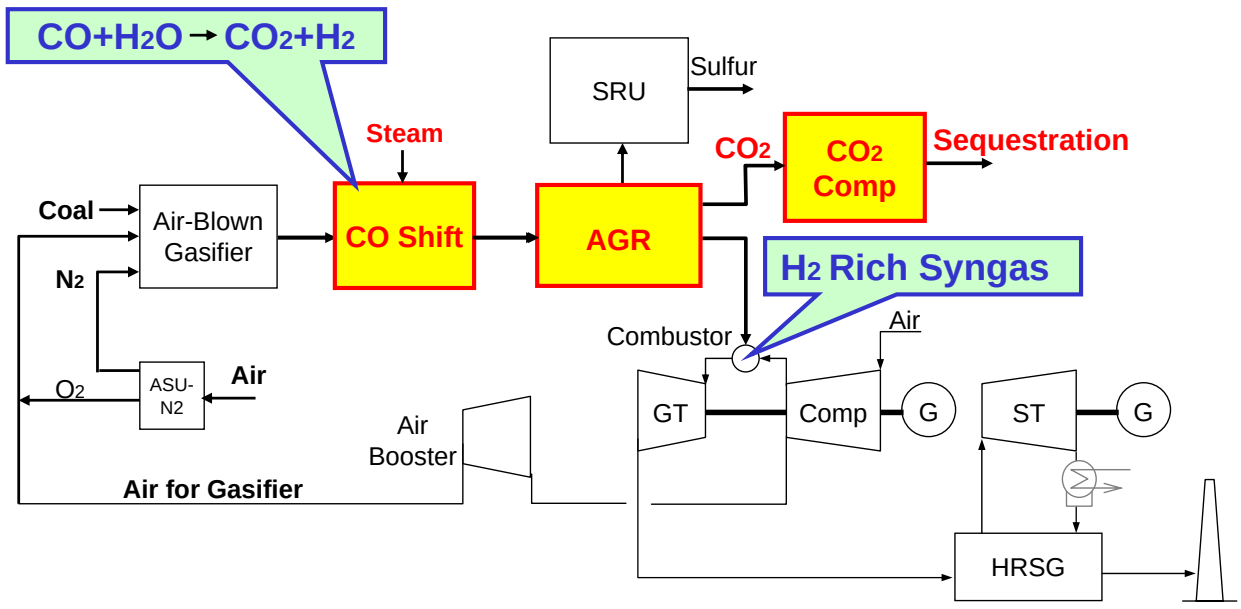

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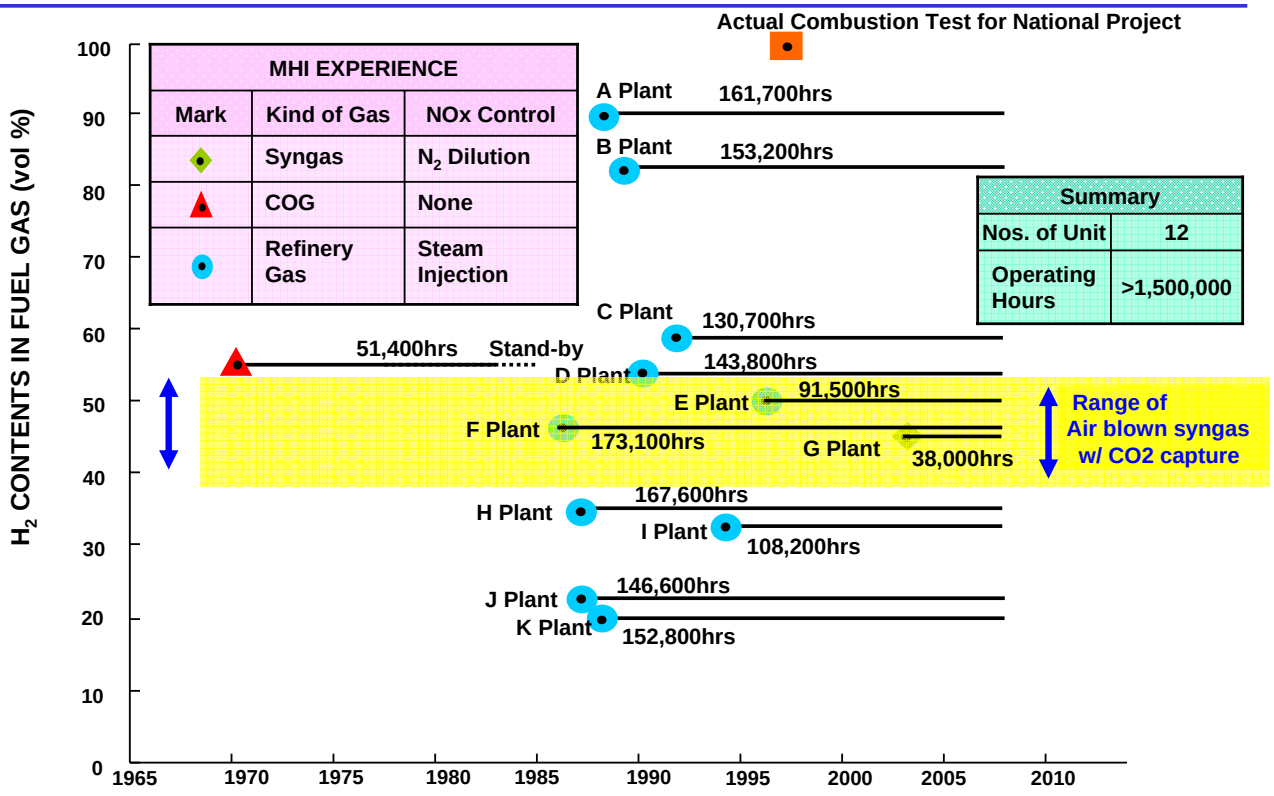
H_2 Rich Gas Experience in MHI Gas Turbine



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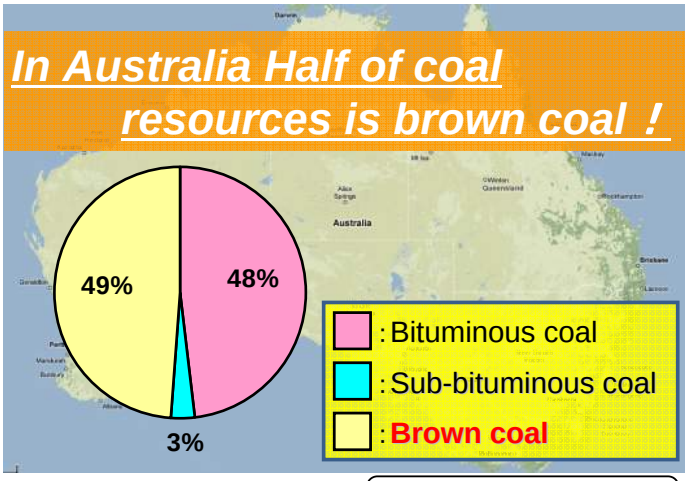
Utilization of Australian Brown Coal

MHI challenges to utilize Australian Brown Coal !!

Approx. 20% of world coal resources is brown coal. However, its utilization is limited due to necessity of specially designed large capacity boiler, difficulty of transportation and low efficiency, etc.

- High efficiency power generation by brown coal IGCC
  ⇒ Reduction in CO_2 emission
- Clean energy (DME supply chain) produced with brown coal
  ⇒ Diversification of Energy Security



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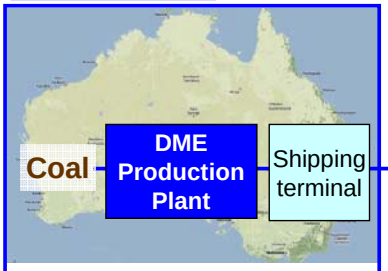
<Clean Energy>

DME Supply Chain Development

Resources



DME Production Plant

Shipping terminal

DME tanker

Receiving terminal

Coastal tanker

Terminal

Tank Lorry

Train

DME Tank

DME Station

Power Plant

Industry

Residential

Automobile

Producing Country

Consuming Country

Security of export products produced with brown coal

Technologies

Security of clean energy (Alternative Liquid Fuel)

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<High Efficiency Power Generation>

Brown Coal IGCC by Innovative Coal Drying Technology

Raw Brown Coal (Moisture: 60-70%)

Pre-Drying
(Development of innovative coal drying technology using plant waste heat)

Dried brown coal (Moisture<30-40%)

Proven Technology

Pulverizer

Air Blown Gasifier

Gas Clean-up

Gas Turbine

HRSG

Moisture 62.8%

Latent heat occupies 15% of calorific value

Fixed Carbon 18.2%

Volatile Matter 18.5%

Ash :0.5%

< Brown Coal Composition >

	Bituminous coal	Brown coal
Boiler 600 MW	15m(base), 52m(base), 17m(base), 251m² (base)	19m(×1.24), 67m(×1.30), 21m(×1.26), 392m² (×1.56)
Gasifier for 701G 600 MW	43m(base), 55m(base), Φ6m (base)	43m(base), 55m(base), Φ6.2m (×1.03)

Conclusion

MITSUBISHI HEAVY INDUSTRIES, LTD.

1. 250MW Demonstration Plant in Successful Operation
   ⇒ Ensuring Quality/Performance of Commercial Plant

2. Commercial Scale IGCC Plant with Carbon Capture
   ⇒ MHI is confident of our capability for successful contribution and realization of ZeroGen Project in Australia.

3. Australian Brown Coal
   ⇒ Offers clean energy produced with coal by supply chain development, and high efficiency power generation by development of innovative coal drying technology

Development History of IGCC in Japan

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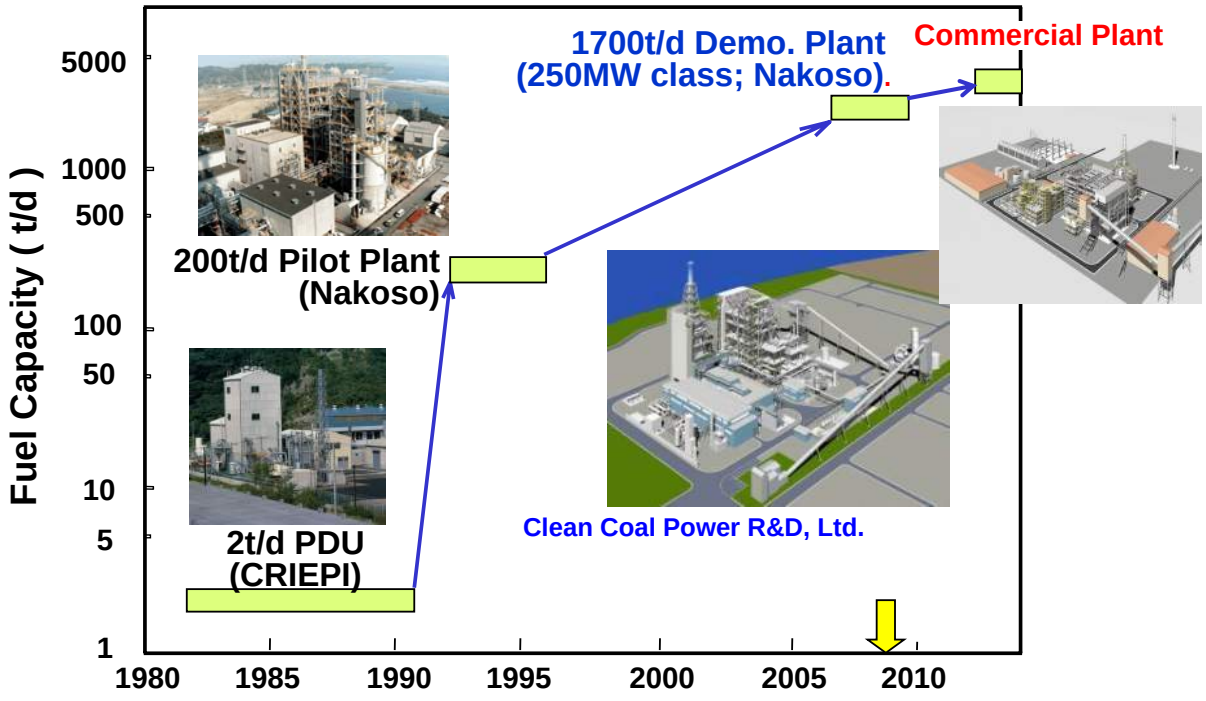
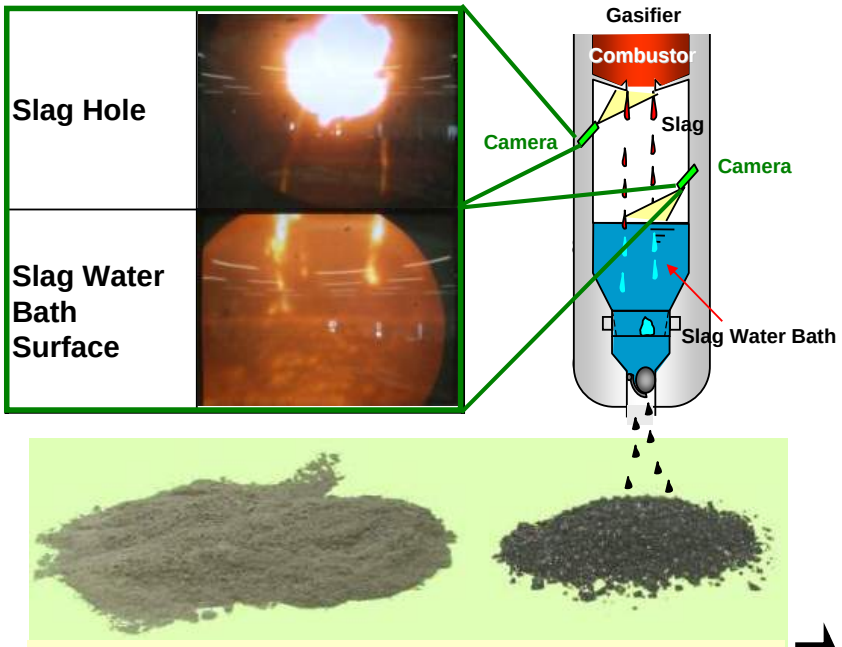
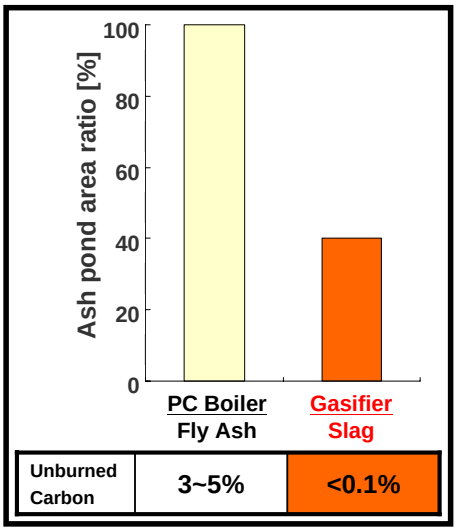


PDU : Process Development Unit
CRIEPI:Central Research Institute of Electric Power Industry

Advantage in Slag Treatment





PC Boiler
Fly Ash
(Powder)
Volume 100%

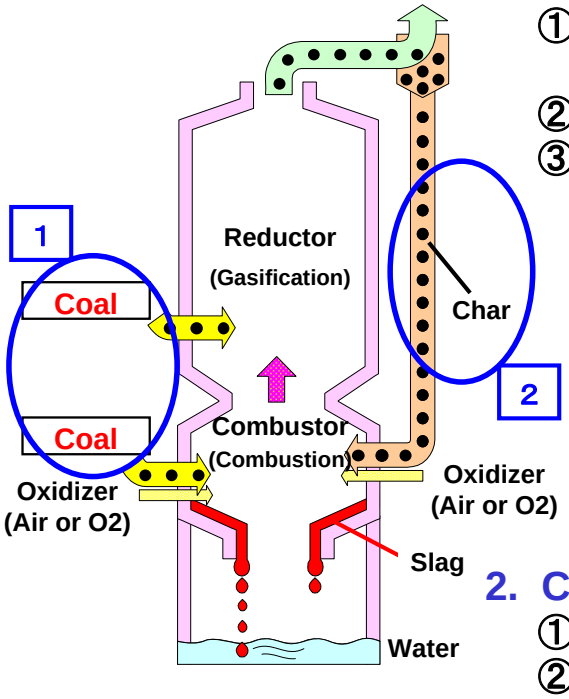
Gasifier
Molten Slag
(Glassy Granular)
Volume 40%

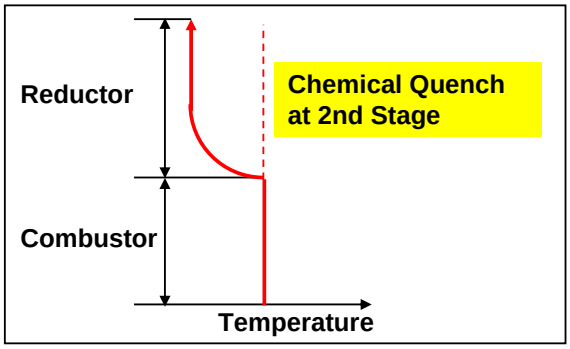
Advantage
- Lower Slag Volume
- No Leaching from Slag
- Lower Unburned Carbon

Principle and Advantage of MHI Air-BlownGasifier

1. 2-Staged Gasification - Combustor / Reductor Configuration

① Stable Syngas Production for Wide Variety of Coal
② Smooth Slag Discharge Capability
③ No Necessity of Chemical Quench Gas





2. Char Recycling System

① Minimize Unburnt Carbon in Slag
② No Black Water from Gasifier

Features of MHI Gasifier

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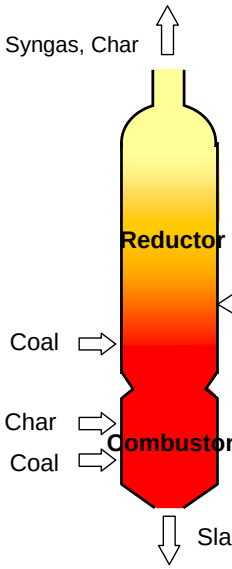
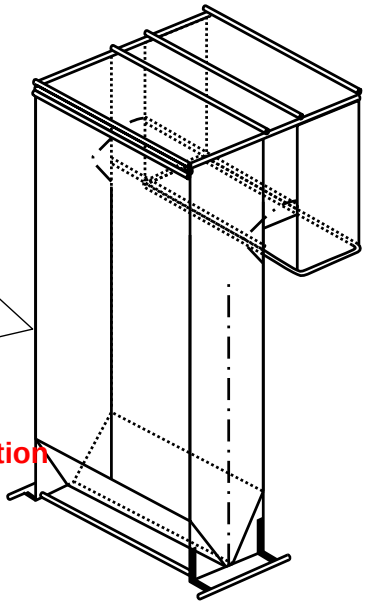
Same WW Structure as MHI's 3,000 Boilers
Offers Best Durability Reducing Maintenance Work



WW of Coal Firing Boiler
More than 10 years Operation



cf.
Refractory Configuration
(by Other Technology)

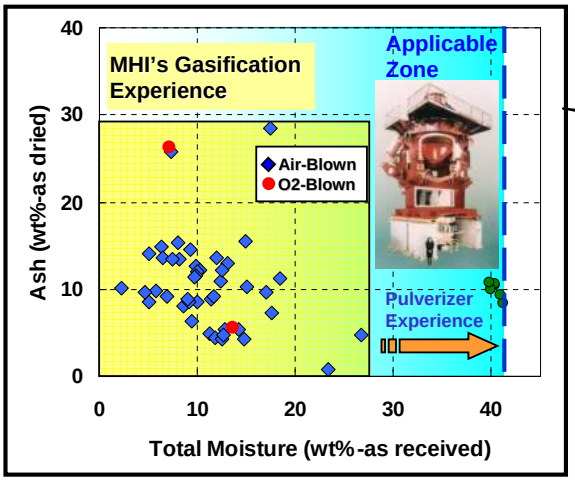
Features of MHI Gasifier

MITSUBISHI HEAVY INDUSTRIES, LTD.

MHI Dry Feed System Brings ;

- **High Efficiency**
  - **Low Heat Loss due to Moisture**
- **Flexibility for Variety of Coal**
  - **No Need to Make Slurry**

Slurry Feed	Dry Feed
	



Same Pulverizer as Conventional Boiler Is Used ;

- **Proven by Much Experience in Variety of Coal**

Commercial Plant Expected Performance

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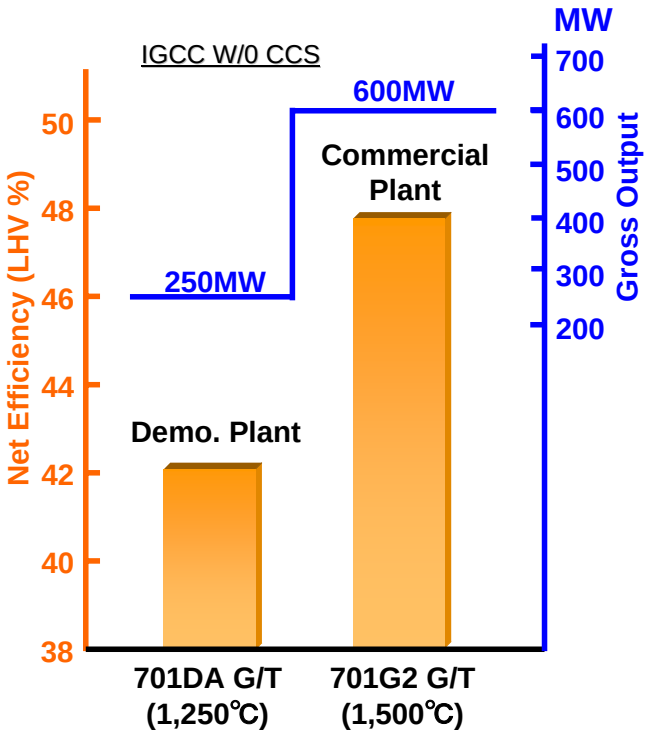

Item		Specification
Coal		Bituminous Coal
Output	Gross	600 MW
	Net	540 MW
Gasifier	Oxidizer	Air
	Coal Feed	Dry
Acid Gas Clean-up		MDEA
Gas Turbine		M701G2 ×1 (1 on 1)
Net Efficiency (HHV)		46%

Note: The above figures are base on the results of feasibility study for a domestic IGCC Plant without CO_2 Capture. Plant performance depends on coal properties. SOx emission and acid gas clean-up process depends on the regional regulation.

<Post Combustion>

MHI's CO_2 Recovery Technology

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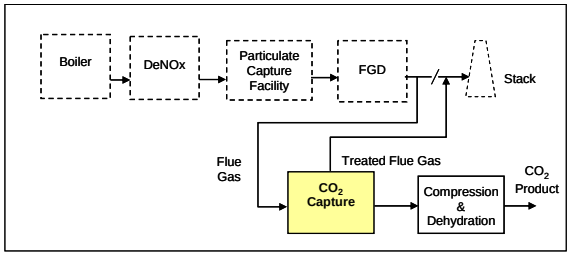
Process Flow for Amine Absorption



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<Clean Energy>

Alternative Liquid Fuel Produced with Coal