Japanese Air Blown IGCC Project Progress

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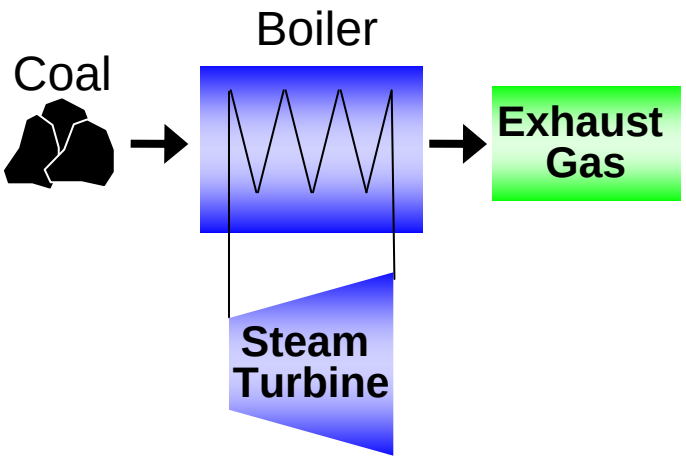
System Feature of IGCC

Conventional PCF

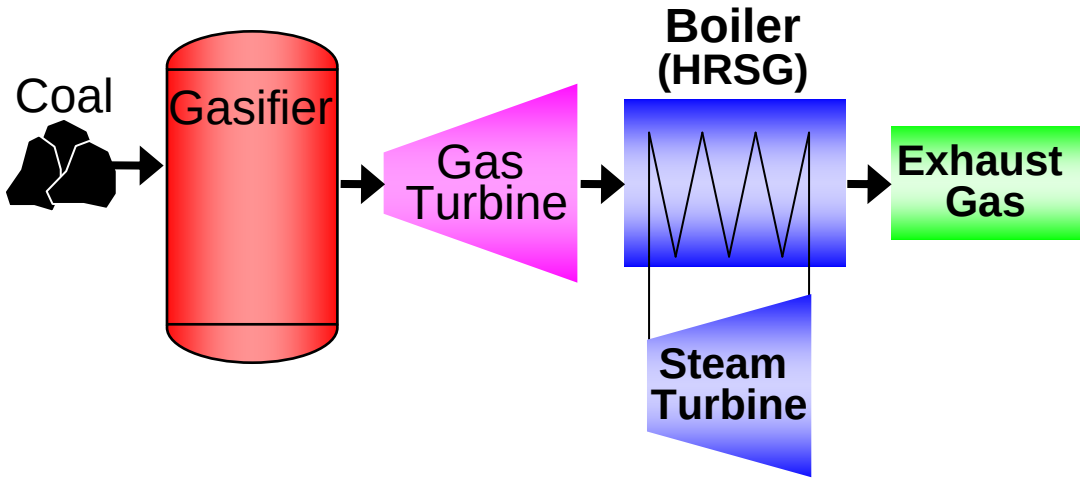
Boiler + Steam Turbine



PCF : Pulverized Coal Firing

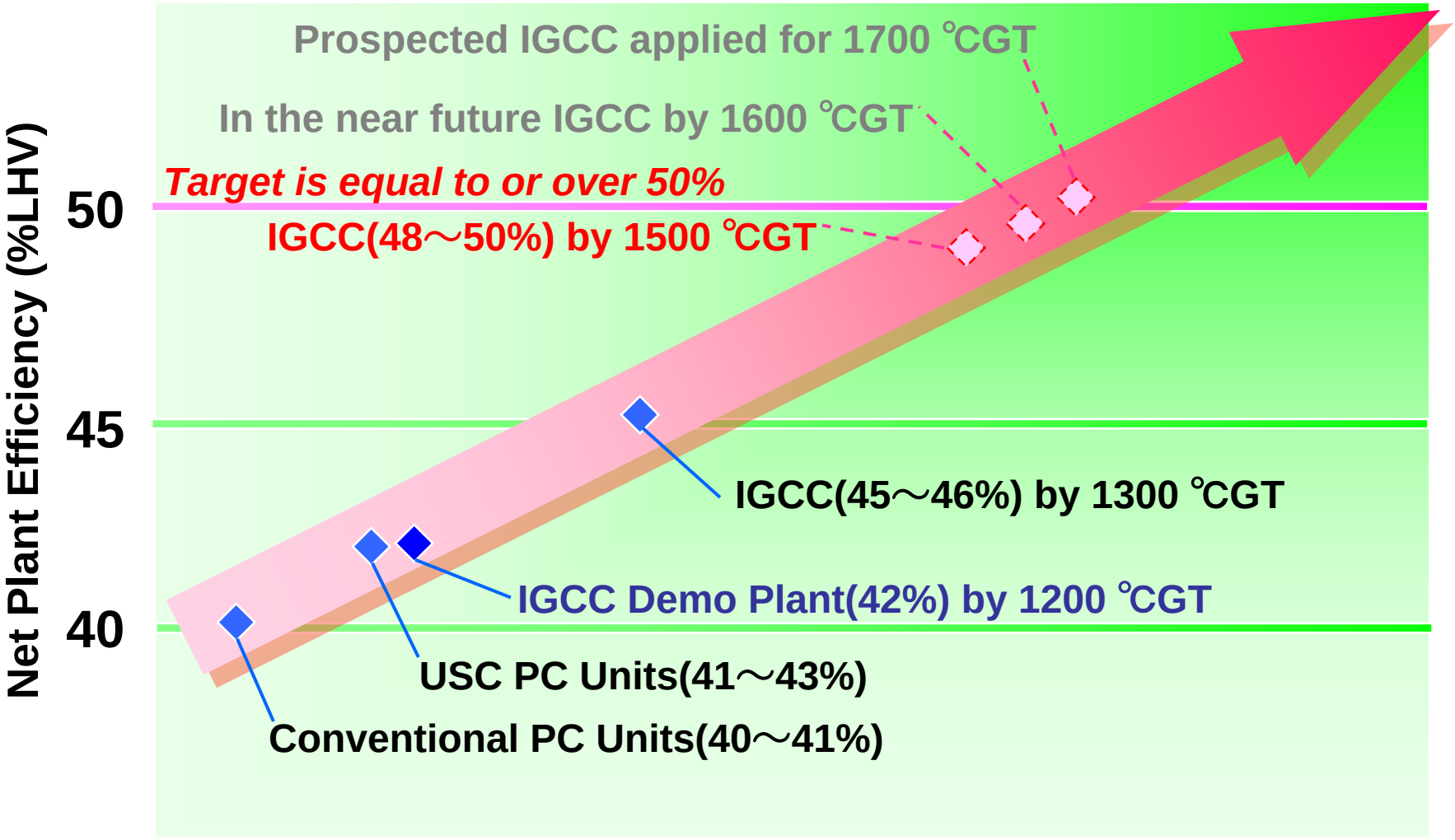
IGCC

Boiler + Steam Turbine
+ Gasifier + Gas Turbine



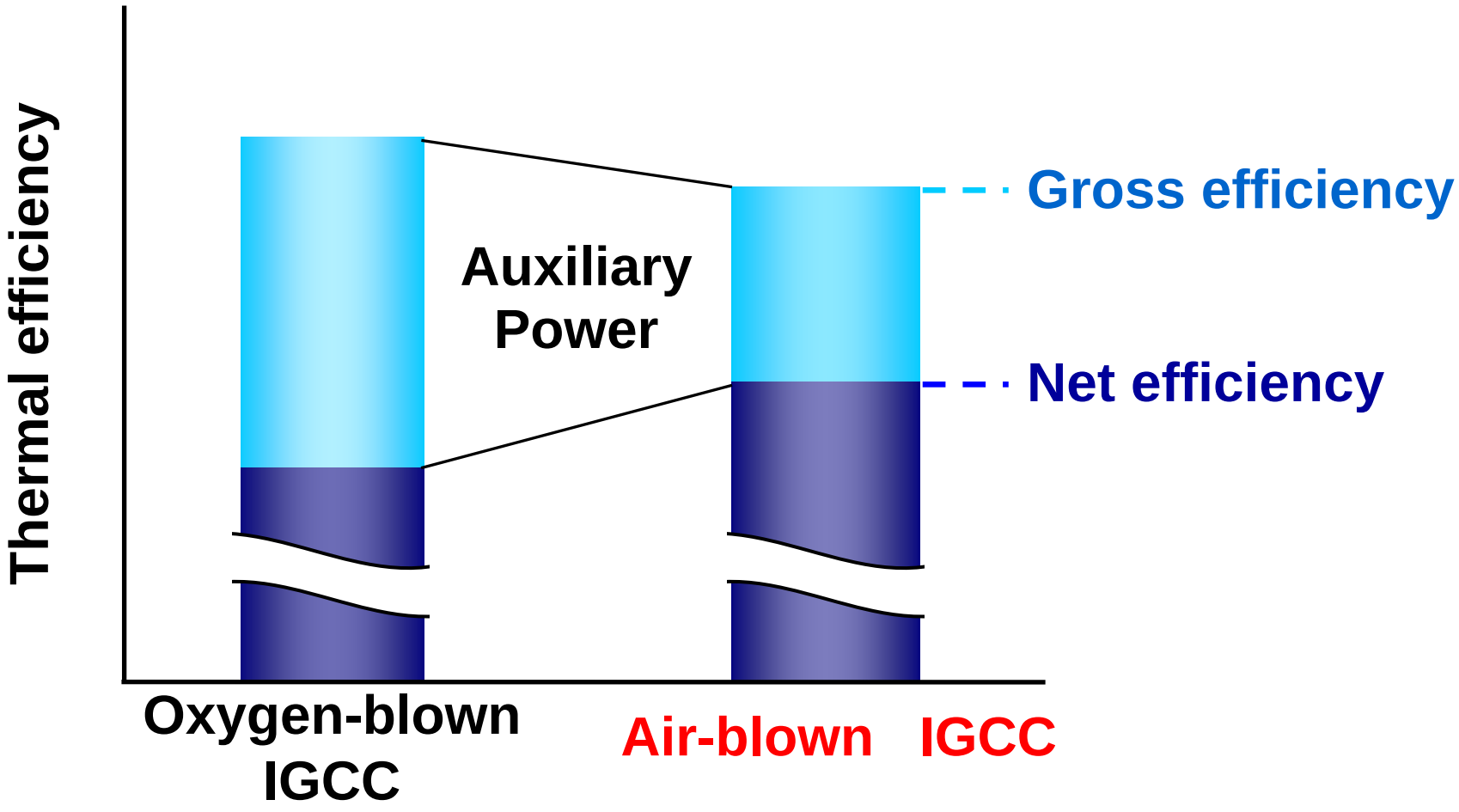
IGCC is a new power generation system aiming at higher efficiency than conventional coal-fired systems by integrated coal gasification with combined cycle power generation technology.

Thermal efficiency Improvement



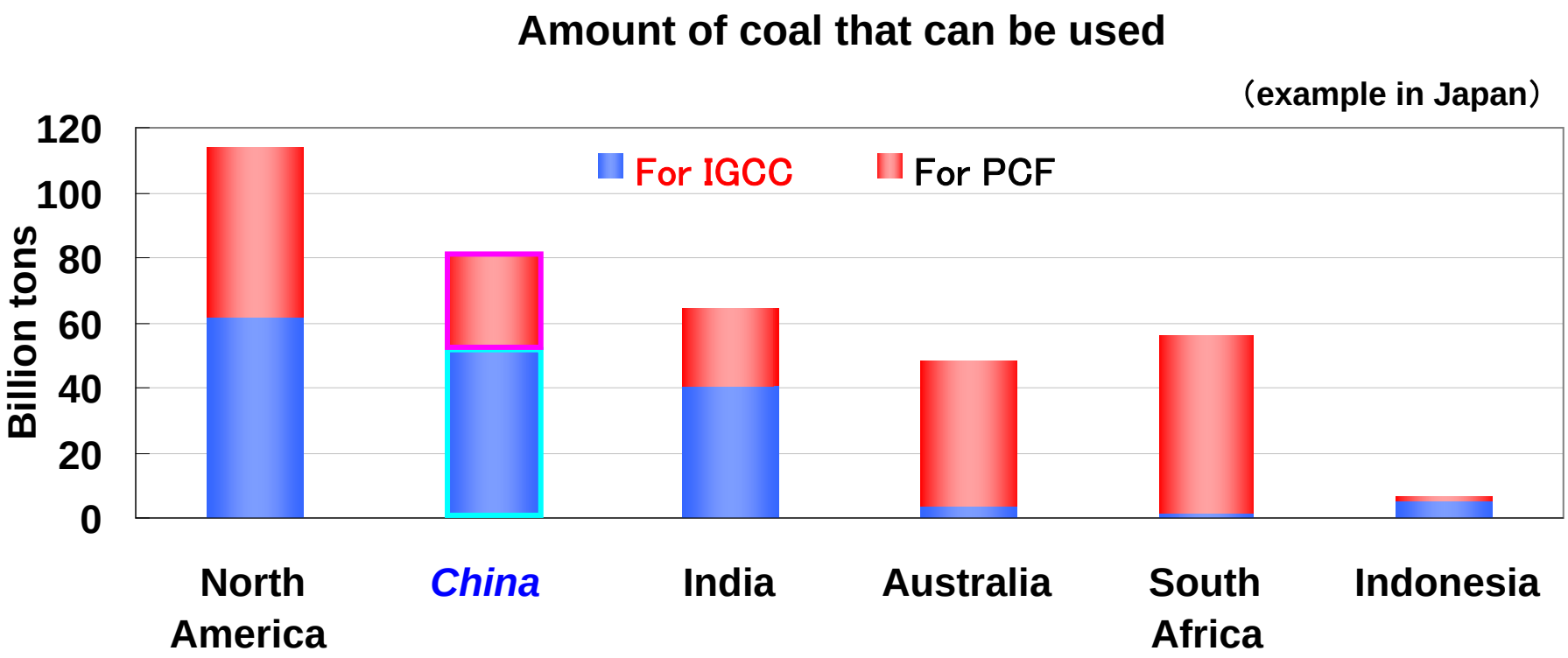
Thermal efficiency improves in cope with high temperature gas turbine combined cycle technology.

Advantage of Air-blown IGCC in Efficiency



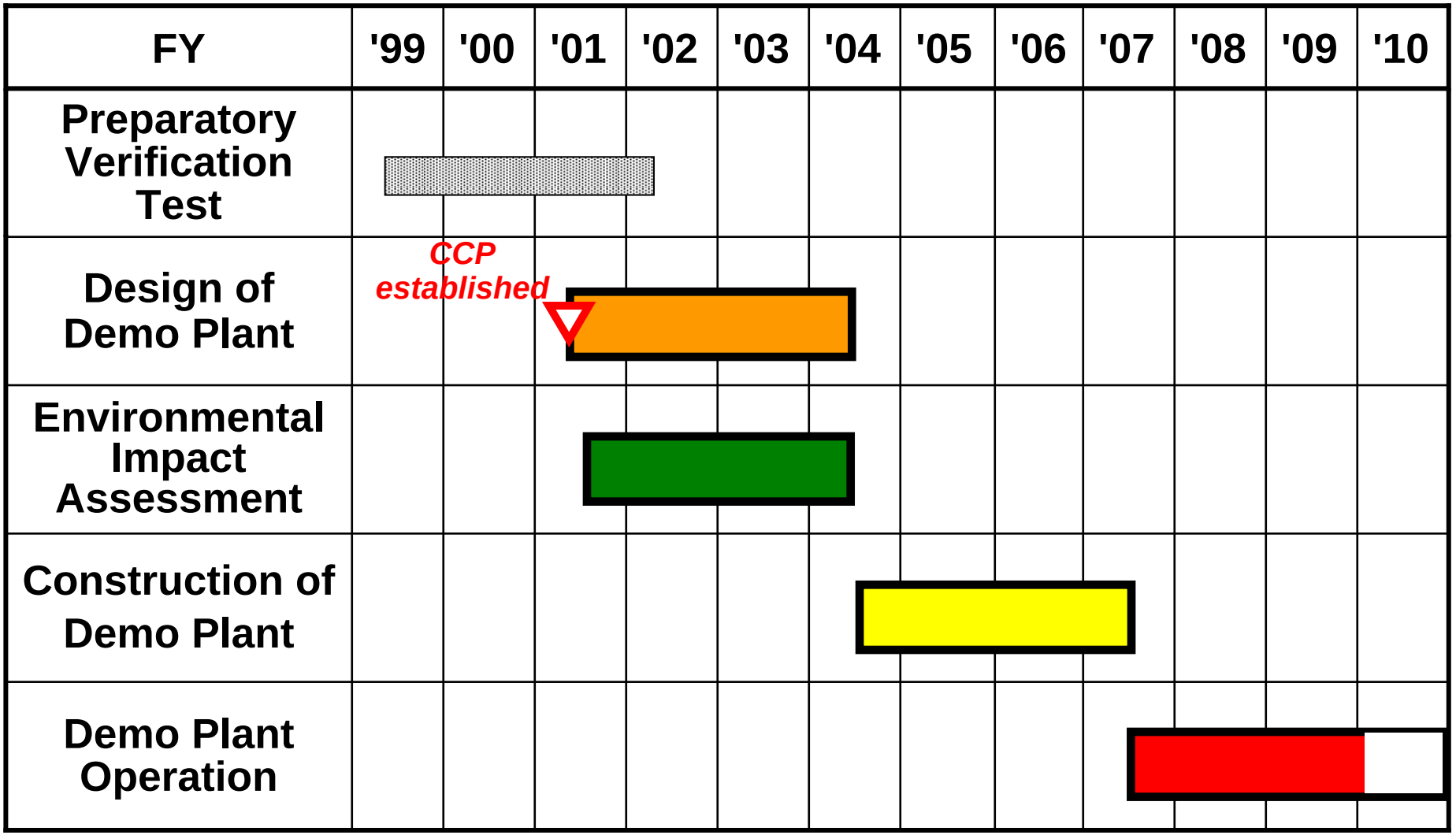
Air-blown IGCC applied in Nakoso is expected to realize high thermal efficiency compared with oxygen-blown IGCC.

Increase in kinds of coal



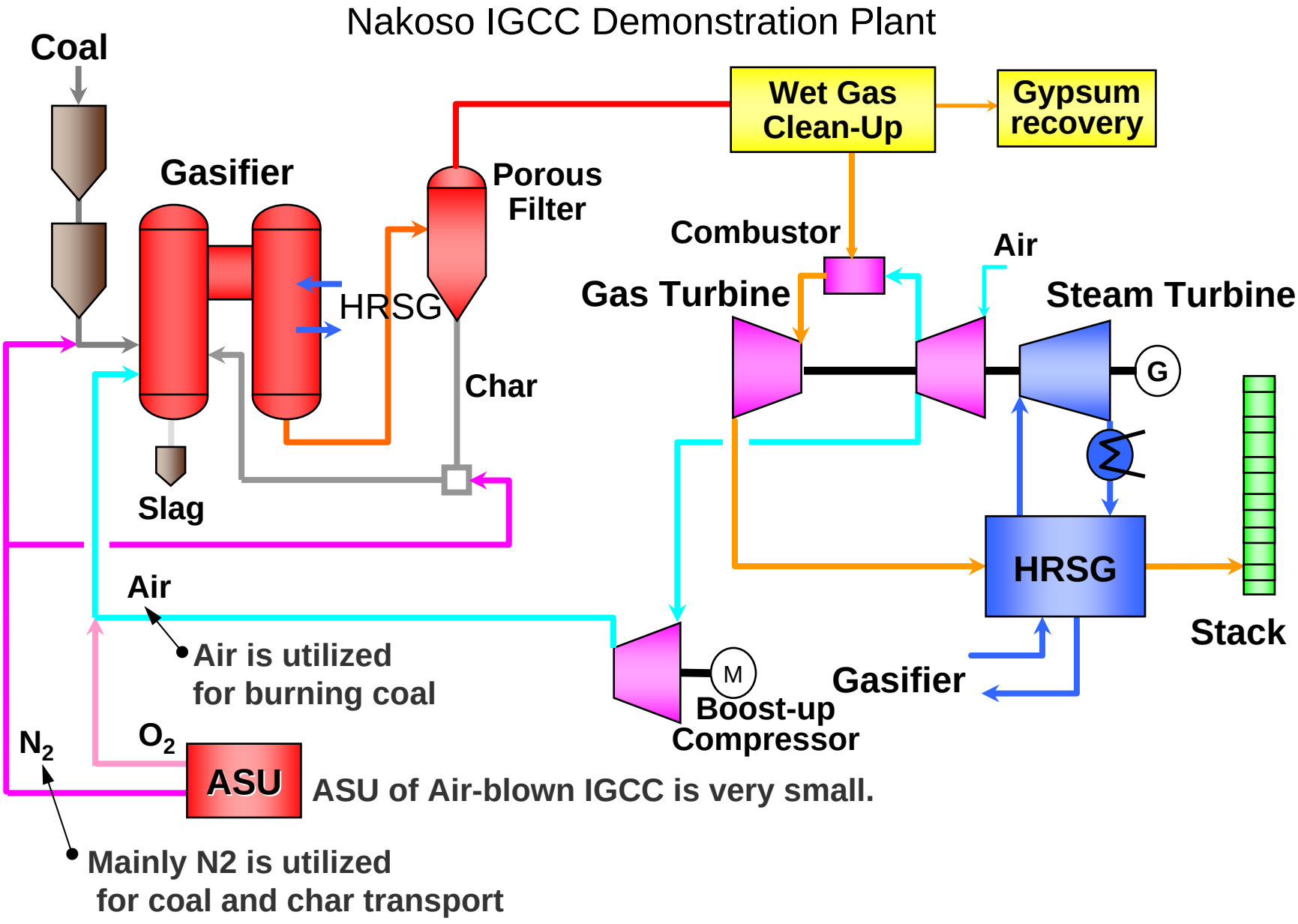
- Low rank coal use could be increased because IGCC utilizes different type of coals.
- Biomass fuel can be also used for IGCC.

Demonstration Project Schedule

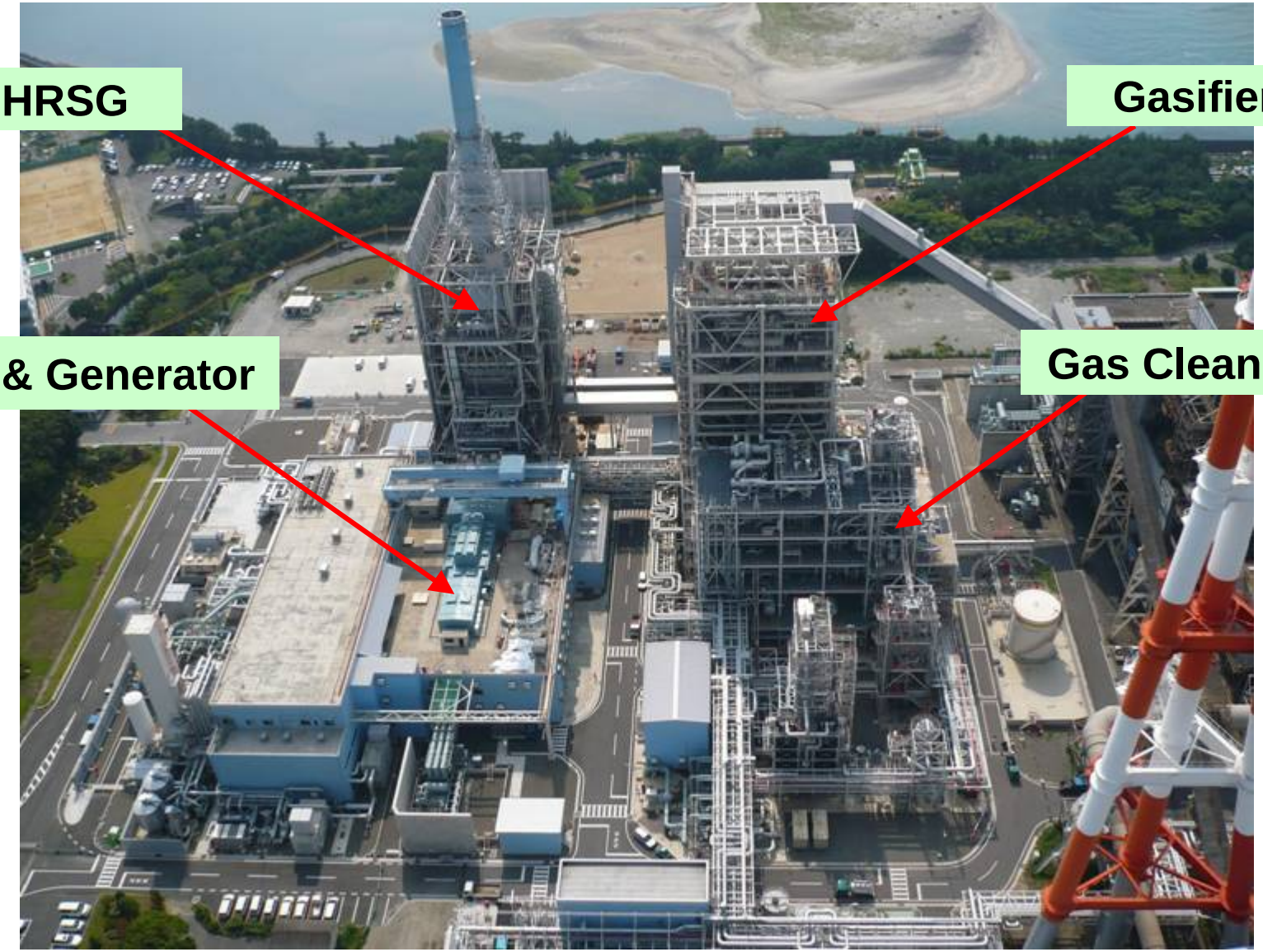


The construction work finished in September 2007, and demonstration operation is executed now.

Schematic diagram of Demonstration Plant



View of IGCC Demonstration Plant



Specification of Nakoso IGCC

Capacity	**250 MW gross**		
Coal Consumption	**approx. 1,700 metric t/day**		
System	**Gasifier**	**Air-blown & Dry Feed**	
	Gas Treatment	**Wet (MDEA) + Gypsum Recovery**	
	Gas Turbine	**1200 degC-class (50Hz)**	
Efficiency (Target Values)	**Gross**	**48% (LHV)**	**46% (HHV)**
	Net	**42% (LHV) ***	**40.5% (HHV)**
Flue Gas Properties (Target Values)	**SOx**	**8 ppm**	**(16%O_2 basis)**
	NOx	**5 ppm**	
	Particulate	**4 mg/m^3N**	

* While target net thermal efficiency is 48～50% in commercial IGCC plant applying 1500 degC class gas turbine, 1200 degC-class gas turbine was adopted to reduce the capacity of plant for economy.

Outline of Demonstration Test Program

No.	Item	Goal
1	System Safety and Stability	Safe and stable operation to be verified during start-up, operation and shutdown
2	Reliability	2,000 hours continuous operation (equivalent to 3 months operation)
3	Fuel Flexibility	Several types of coals to be used for the design of future commercial IGCC
4	High Efficiency	Achievement of target efficiency
5	Durability	Durability of components and auxiliaries to be examined by inspection after long-term operation
6	Economy	Evaluation of economy of commercial IGCC by the results of construction, operation and maintenance of Demonstration Plant

No.1: System Safety and Stability

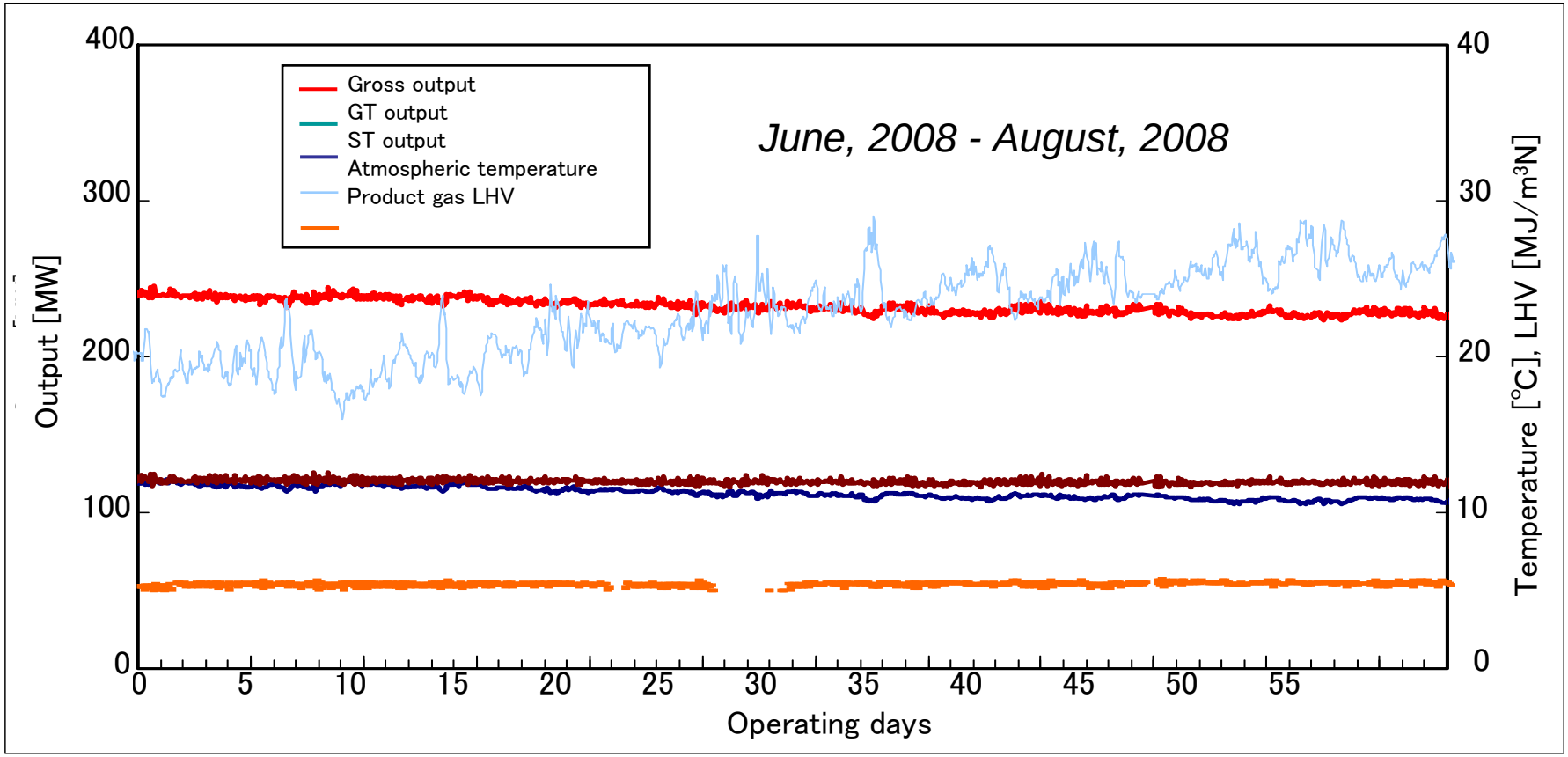
Plant Performance in March 2008

	Design values	Results
Atmospheric Temperature	15degC	13.1degC
Gross Output	250 MW	250.0 MW
Gas Turbine Output	128.9 MW	124.4 MW
Steam Turbine Output	121.1 MW	125.8 MW
Net Efficiency (LHV)	42 %	42.4 %
Syngas LHV	4.8 MJ/m^{3}N	5.2 MJ/m^{3}N
Composition CO	28.0 %	30.5 %
CO2	3.8 %	2.8 %
H2	10.4 %	10.5 %
CH4	0.3 %	0.7 %
N2 & Others	57.5 %	55.5%
Environmental Performance	<Target values>	
(16% O2 Corrected) SOx	8 ppm	1.0ppm
NOx	5 ppm	3.4 ppm
Particulate	4 mg/m^{3}N	<0.1 mg/m^{3}N

- Full load (250MW) operation was achieved in March 2008.
- Stable and continuous full load operation as well as design plant performance was confirmed.

No.2: Reliability

Trend Data of Long Term Reliability Test



- Capability of stable power generation was confirmed.
- 2000hours continuous operation was achieved in the first year.
  >Total operating hours reached 2,039 (1568+471) hours.

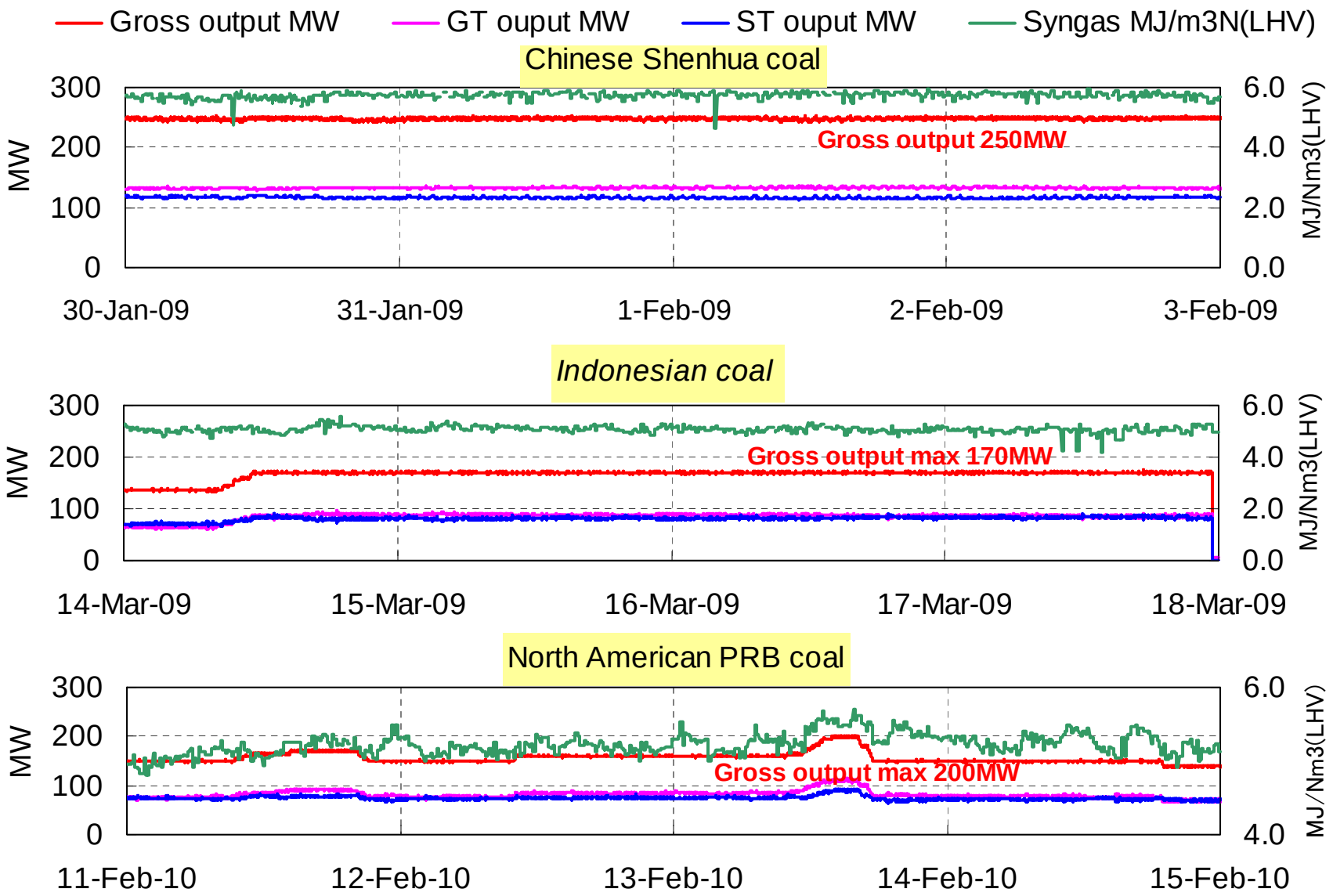
No.3: Fuel Flexibility (1)

Properties of Coal Used

		Chinese Shenhua coal	North American PRB coal	Indonesian coal
Proximate Analysis (Dry)				
Fixed Carbon	wt%	56.2	51.2	49.1
Volatile Matter	wt%	34.3	42.5	47.0
Ash	wt%	9.5	6.3	3.9
Total Sulfur	wt%	0.3	0.4	0.2
Moisture Content	wt%	16.3	29.3	25.3
HHV (Dry Base)	MJ/kg	29.3	28.6	28.8
Ash Fluidization Temp.	degC	<1300	<1200	<1200

Bituminous coal and sub-bituminous coal have been used at the demonstration Plant.

No.3: Fuel Flexibility (2)



Stable power generation using various coals was confirmed.

No.4: High Efficiency

Plant Performance in January 2009

	Design values	Results
Atmospheric Temperature	15degC	9.9degC
Gross Output	250 MW	248.8 MW
Gas Turbine Output	128.9 MW	130.4 MW
Steam Turbine Output	121.1 MW	118.4 MW
Net Efficiency (LHV)	42 %	42.9 %*
Cold Gas Efficiency of Gasifier	73 %	77 %
Carbon Conversion Efficiency	>99.9 %	>99.9 %
Syngas LHV	4.8 MJ/m^{3}N	5.6 MJ/m^{3}N
Composition CO	28.0 %	31.9 %
CO2	3.8 %	2.7 %
H2	10.4 %	10.0 %
CH4	0.3 %	1.4 %
N2 & Others	57.5 %	54.0 %
Environmental Performance	<Target values>	
(16% O2 Corrected) SOx	8 ppm	0.5 ppm
NOx	5 ppm	3.9 ppm
Particulate	4 mg/m^{3}N	<0.1 mg/m^{3}N

*Correction value at 15 degC

Highly efficient operation was achieved.

No.5: Durability

5000 hours durability test is in progress now.
Shut-downs in durability test were principally caused by incidents in auxiliary facilities as shown in the following table.

Item of Incident	System	Root Cause	Cure
1.Leakage from Ground of Rotary Valve below Porous Filter	Char Recycle System	Inadequate tightening of a packing caused the gas leakage from the ground.	Proper control of tightening the packing at the ground
2.Trip of Slag Discharge Conveyor	Slag Treatment System	Scraper of the drag chain conveyor meandered and stuck onto the gutter of the bottom plate, and caused overloading of the conveyor motor.	Improvement of the conveyor structure
3.Leakage of Coal from the Pulverized Coal Collector	Pulverized Coal Supply System	Filter cloth tore and pulverized coal accumulated in the bag filter was oxidized and increased in temperature.	Monitoring device added and operation procedure improved
4.Leakage of No.2 Extraction Air Cooler Tube	Gasifier Air Supply System	Inadequate and irregular tube material selection caused corrosion. Air leaked to the condenser and resolved oxygen concentration in condensate water increased.	Tube material correctly changed
5.Leakage of Char Gasifier Burner Cooling Tube	Gasifier	Inadequate positioning of the burner front edge caused erosion of the burner cooling tube	Proper control of positioning the burner front edge

Every incident could be solved, and know-how has been accumulated so that commercial plants will be realized with high reliability.

No.6: Economy

Economy of commercial IGCC is evaluated by the results of construction, operation and maintenance of demonstration plant.

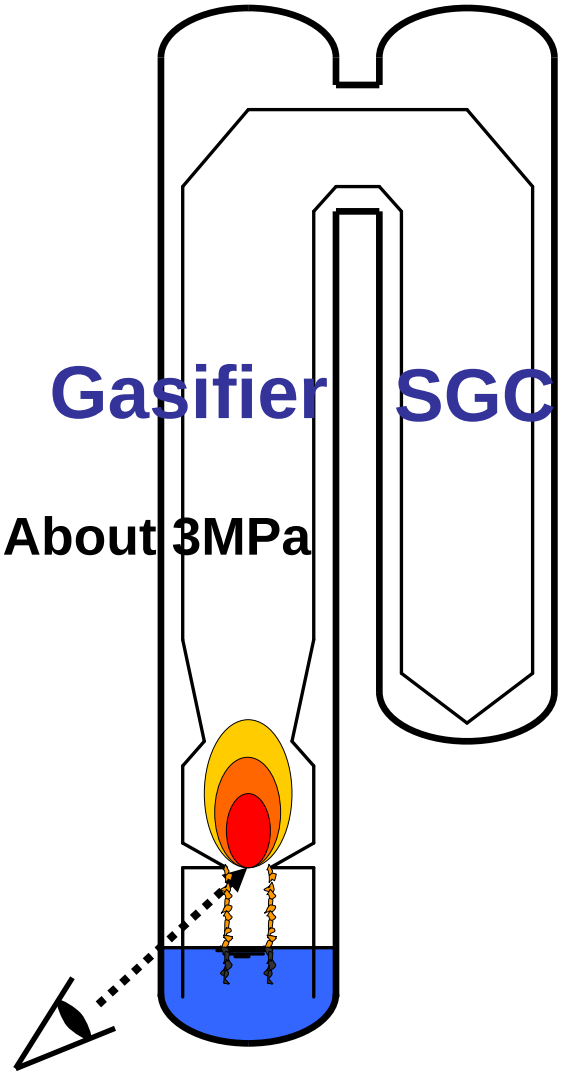
Power generation cost = construction cost + operating cost + maintenance cost

Target cost/kWh of commercial IGCC	≦	Cost/kWh of conventional PFC

Target power generation cost of commercial IGCC is less than or equal to power generation cost of conventional pulverized coal firing plant (USC).

Molten Slag Observation

Slag Hole View from Lower Side

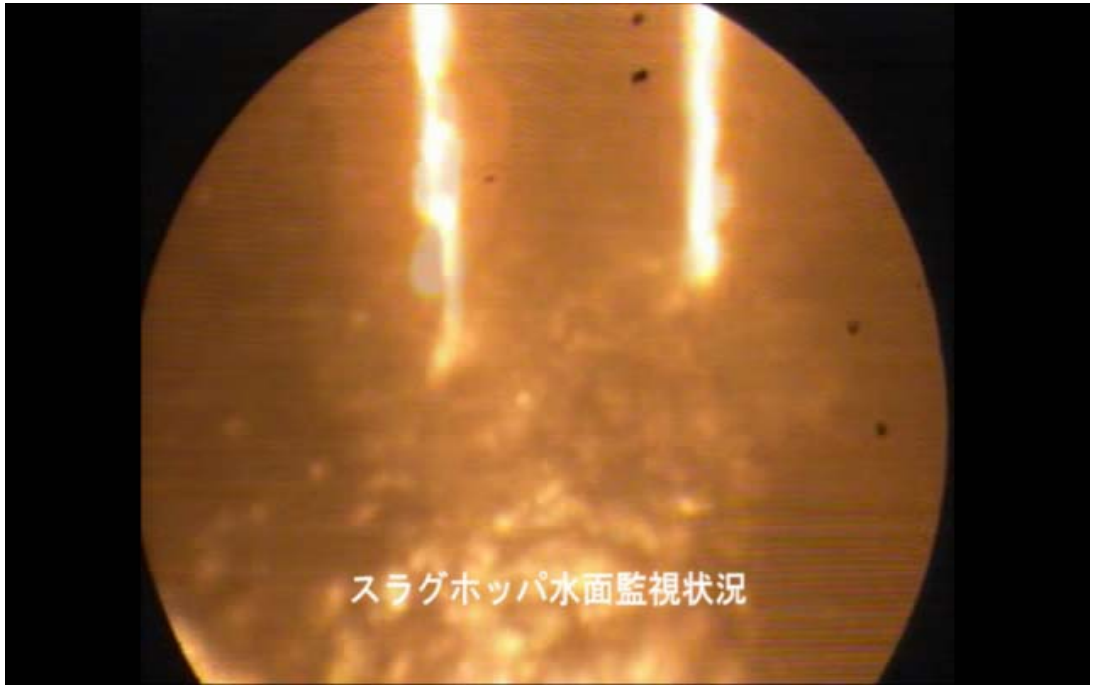


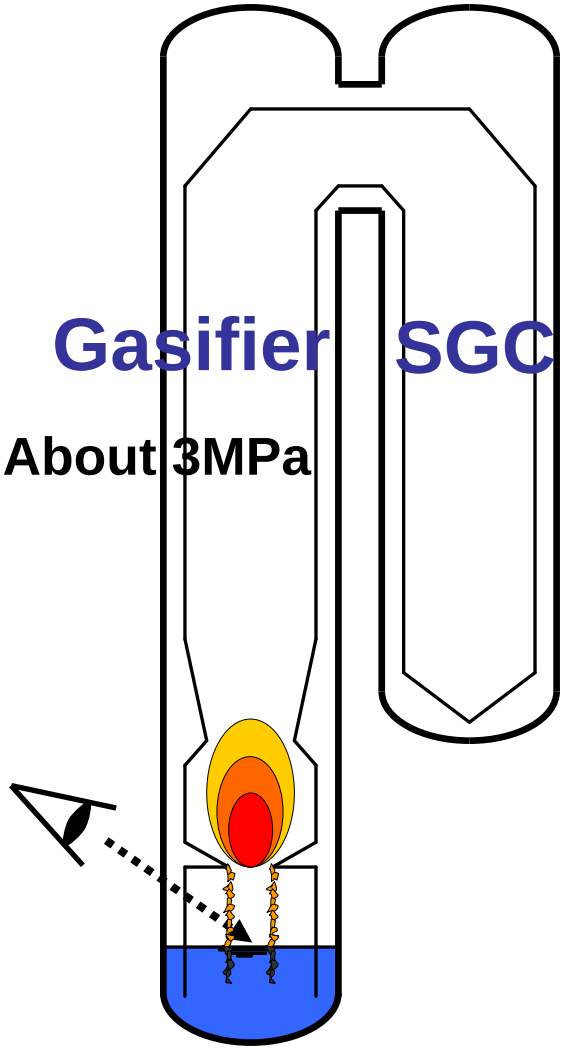
Two stable streams of molten slag flowing from the slag hole.

Combustion in gasifier is very stable.

Molten Slag Observation

Surface of the Water in Slag Hopper



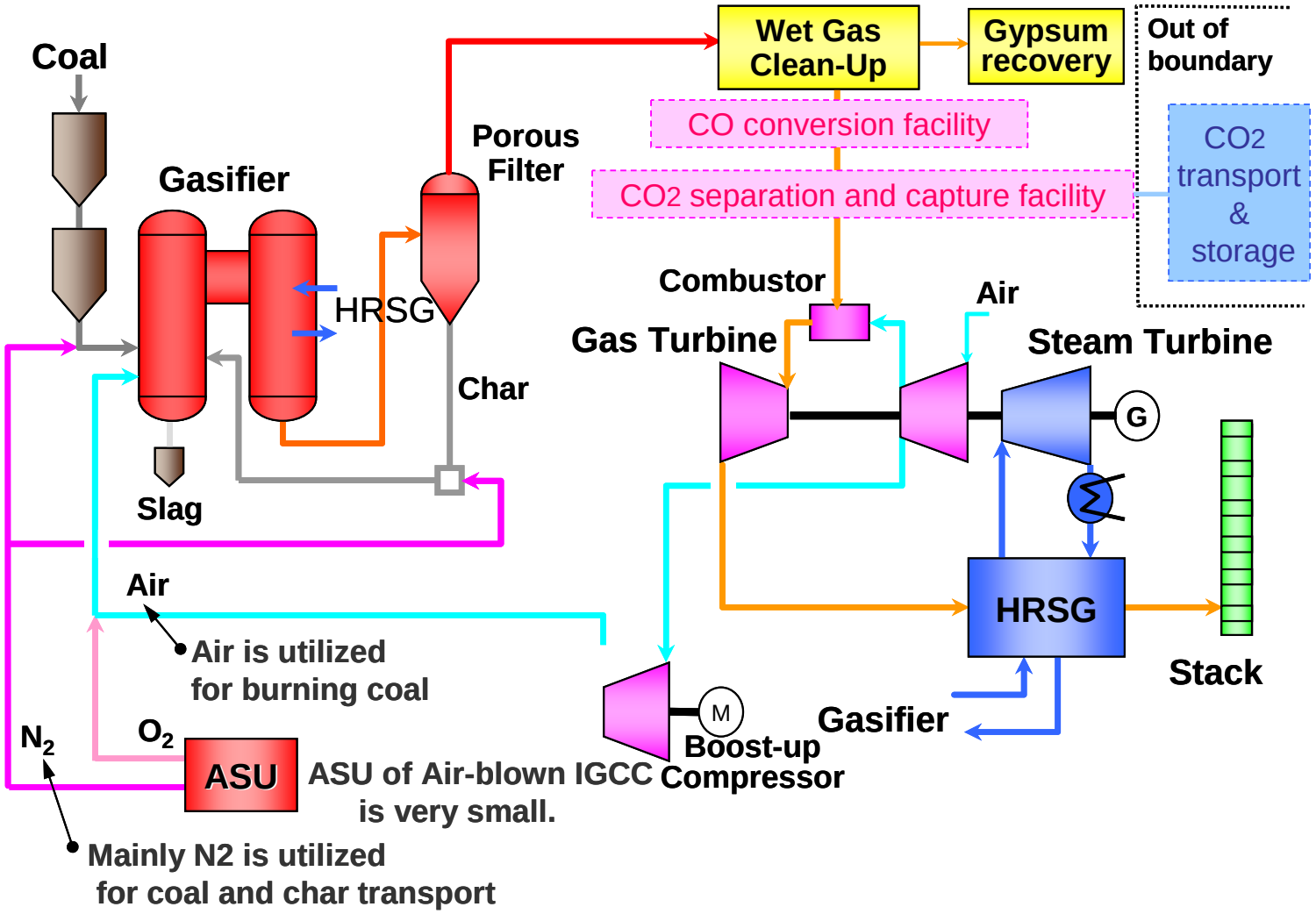


Two streams of molten slag is dropping into the slag water pool.

The flow of slag is constant, which means that the gasifier is operating in a very stable condition.

Subject after the operation test

Japanese government is now conducting feasibility study of CCS application utilizing the Nakoso IGCC plant.



Concluding Remarks

- ***Air-blown IGCC can achieve the highest net thermal efficiency among the coal-fired thermal plant. Japan has continued to develop air-blown IGCC more than 26 years, and now is the final stage of the development.***

- ***Our demonstration test has been proceeded almost on schedule. Net thermal efficiency higher than design value was achieved, and 2000hr continuous operation test was successfully done, and now the 5000hr durability test is being conducted.***

- ***The most important point of utilization of IGCC is reliability and economics. CCP will finalize the air-blown IGCC with high efficiency, high reliability and competitive price. And contribute to the global warming problem as well as the reduction of fuel consumption.***

Thank you!

Attachment 1: Summary of Clean Coal Power R&D Co., Ltd

1. **Date of Establishment : June 15, 2001**
2. **Business Activities :**

   Test and Research of IGCC through Design, Construction and Operation of Demonstration Plant.

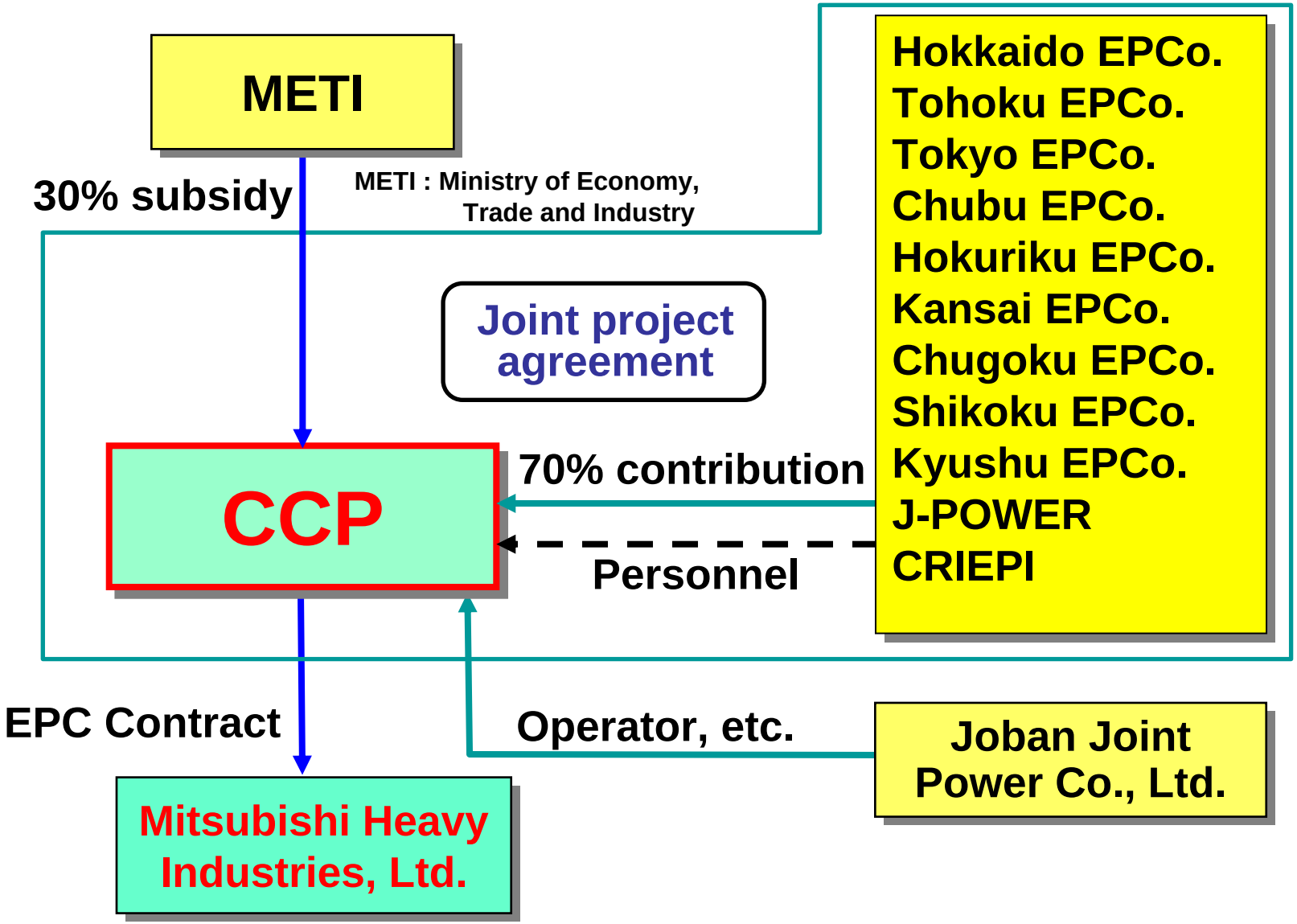
3. **Shareholders :**

Hokkaido EPCo	Kansai EPCo
Tohoku EPCo	Chugoku EPCo
Tokyo EPCo	Shikoku EPCo
Chubu EPCo	Kyushu EPCo
Hokuriku EPCo	Electric Power Development Co.

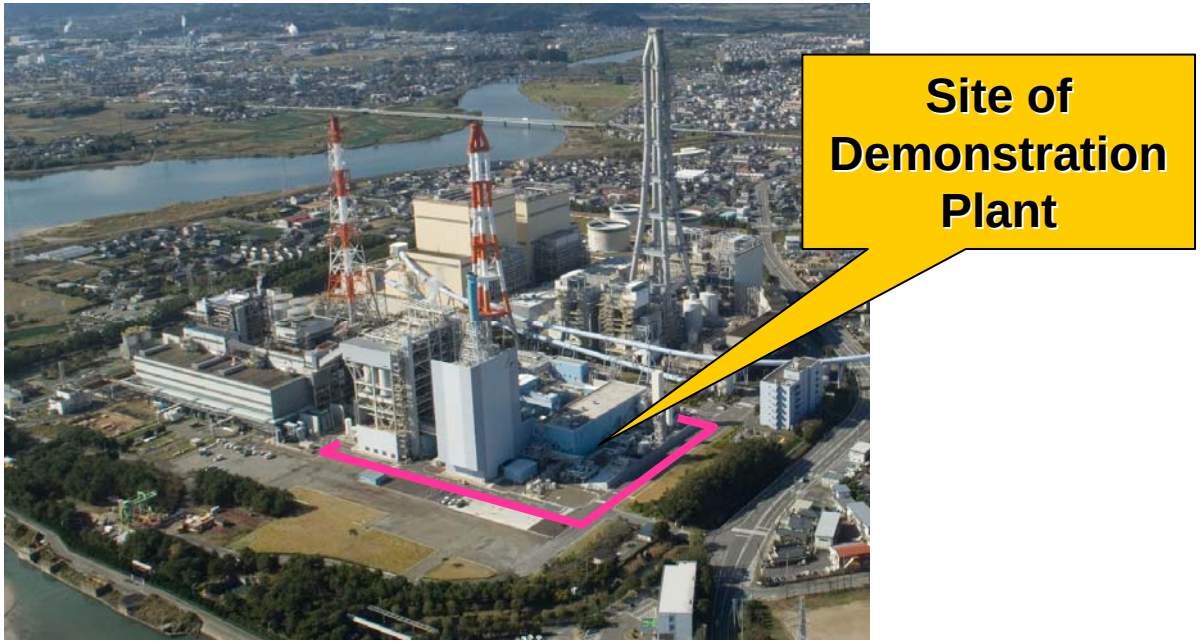
4. **IGCC Development Coalition :**

   Above EPCOs + Central Research Institute of Electric Power Industry (CRIEPI)

Attachment 2: Project Scheme



Attachment 3: Location of demonstration plant



Located within the NAKOSO Power Station of JOBAN JOINT POWER CO.,LTD.

Attachment 4: History of Air-Blown IGCC in Japan

Demonstration plant

CCP R&D Co.,Ltd.
1700t/d 250MW (2007-2010)

Pilot plant

IGC Research Association
200t/d Equivalent to 25MW (1991-1996)

Process development unit

CRIEPI-MHI 2t/d(1983-1995)

Confirmation test plant

MHI Nagasaki 24t/d (1998-2002)

CRIEPI: Central Research Institute of Electric Power Industry