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The Achievement of Environmental Impact Controls And The Study on the IGCC Project in Mae Moh Coal-Fired Power Plant

ASEAN ++ 2013 : Moving Forward : The 11th International Conference on Mining, Materials and Petroleum Engineering, The 7th International Conference on Earth Resources Technology and ASEAN Forum on Clean Coal Technology

November 11 – 13, 2013,

Centara Duangtawan Hotel, Chiang Mai, Thailand

By Thitiporn Supasri[1], Thanawan Sumonsart[2], Nat Suwannathep[3]

Engineer from Mae Moh Power Plant

Electricity Generating Authority of Thailand, THAILAND

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Contents

- Overview of Mae Moh Power Plant
- Power Plant Emission Control (SO_2 , NO_2 , TSP)
  - Process
  - Management measures
- Study of The IGCC Project 500 MW at Mae Moh

  [MHI + IEEJ + JCOAL + METI]

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Overview Mae Moh Power Plant

Satellite Image Above Mae Moh Power Plant and Mining Area

: Mae Moh mining process

Source: Mae Moh Mine, EGAT

Unit	Construction (Year)		Operating (Year)	Generating Capacity (MW)
	Started	COD		
4	1981	1984	27	150
5	1981	1984		150
6	1982	1985		150
7	1982	1985		150
8	1986	1989	22	300
9	1987	1990		300
10	1989	1991	20	300
11	1989	1992		300
12	1991	1995	17	300
13	1991	1995		300
			Total :	**2,400**

*Remark : Unit 1-3 (3*75MW) were decommissioned since 1st October 2003*

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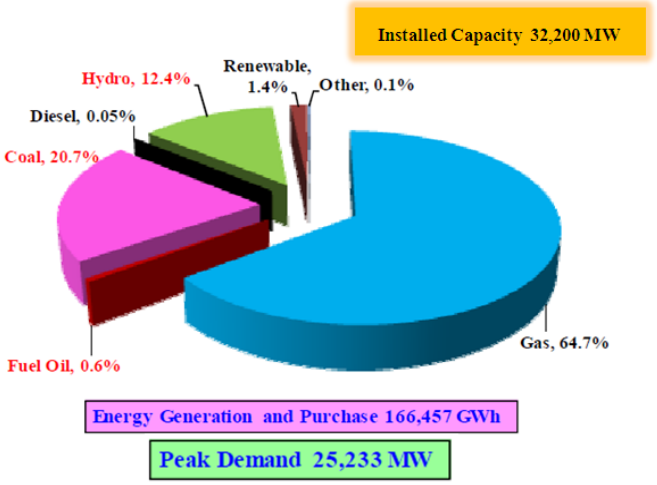
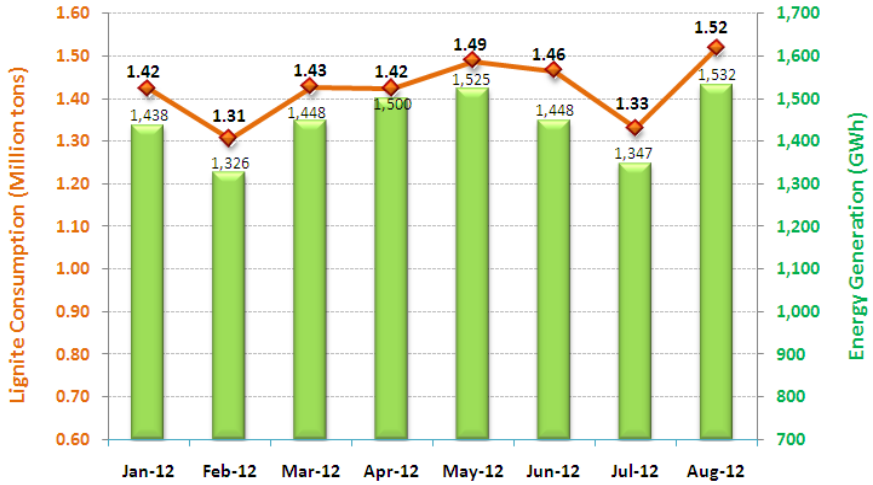
Overview Mae Moh Power Plant

: EGAT Generation Plan Y2012

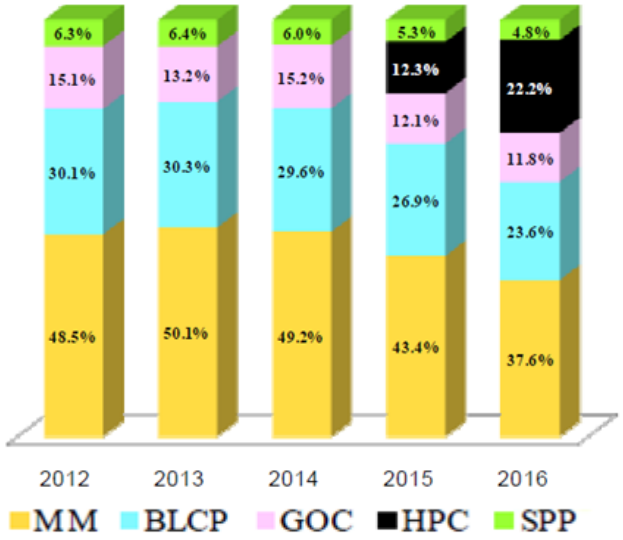


Source: System Control Operation Division, EGAT



Source: Mae Moh Production Division, EGAT

: Coal Energy Generation Plan



Source: System Control Operation Division, EGAT

Y2012 (8 months) :

Total Lignite Consumption = 11.38 Million tons

Total Net Energy Generation = 11,565 GWh

Availability Factor = 93.14%

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Overview Mae Moh Power Plant

: MAE MOH LIGNITE

PROXIMATE ANALYSIS

MOISTURE		% BY WT.	30 - 32
ASH		% BY WT.	20 - 26
VOLATILE MATTER		% BY WT.	22 - 32
FIXED CARBON		% BY WT.	15 - 23
AVG. SULPHUR		% BY WT.	2.4 - 3.5
HEATING VALUE	LHV :	Kcal/Kg	2,450
	HHV :	Kcal/Kg	2,750

SULPHUR/LOW.HEAT	= 11.2	mg/Kcal
SULPHURDIOXIDE CONCENTRATION	= 4,536	ppm.

Source: Mae Moh Production Division, EGAT

- The existing units using domestic lignite at Mae Moh (Open Pit Mining: Area of 30 square kilometers)
- Consumption :
  - Lignite 45,000 ton/day (16 million ton/year)
  - Water 133,000 m^3/day (50 million m^3/year)
  - Limestone 3,600 ton/day (1.3 million ton/year)
- By Products and Emission :
  - Ash 4.4 million ton/year
  - Gypsum 2.4 million ton/year
  - SO_2, NO_2, TSP
  - Waste water 9.1 million m^3/year

PART I : EMISSION CONTROL

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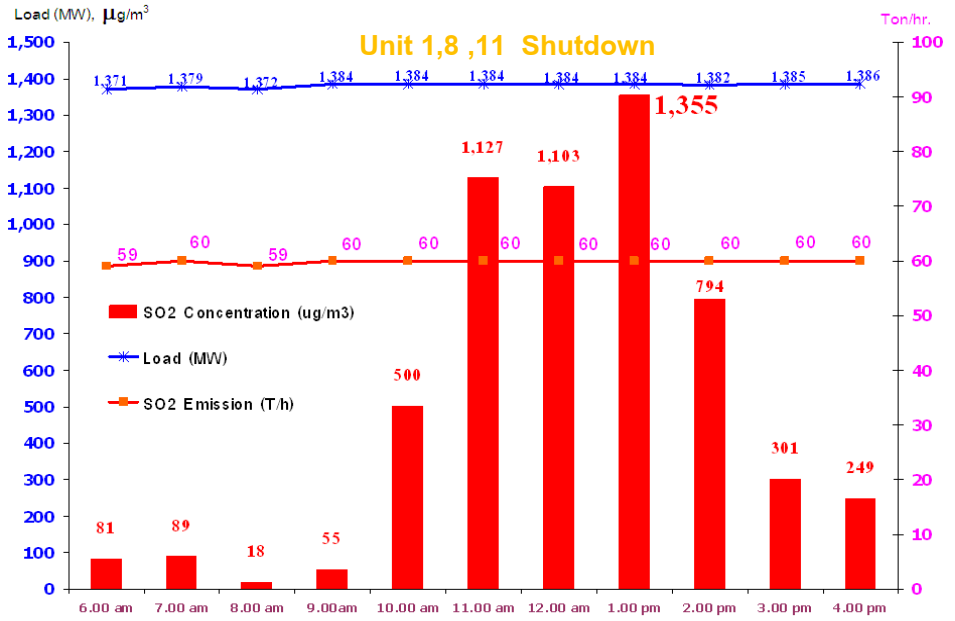
Air pollution occurred in the past

: Data 3rd October 1992



Source: Flue Gas Desulfurization Department, Mae Moh Power Plant of EGAT

Pollution Control Department (PCD)

Ministry of Natural Resources and Environment, Thailand

Y1998 Issued New Standard: Mae Moh Power Plant Emission

- SO_2 Emission <780 µg/Nm^3 in one hour.
  And Total of all units <11 ton/hr.
- SO_2 Concentration <320 ppm.

- During 1992, in early October
  - Weather(season) : rainy => winter
  - High pressure atmosphere => the air around the plant to engross in the phenomenon
- Ground level ambient SO_2 concentration was observed.
- Environmental impact => people living in several villages located downwind from the power plant sought medical attention for symptoms which included stinging nose and throat and shortness of breath. The plants and animals have been affected.
- Afterwards, EGAT realize to eliminate the problem completely.

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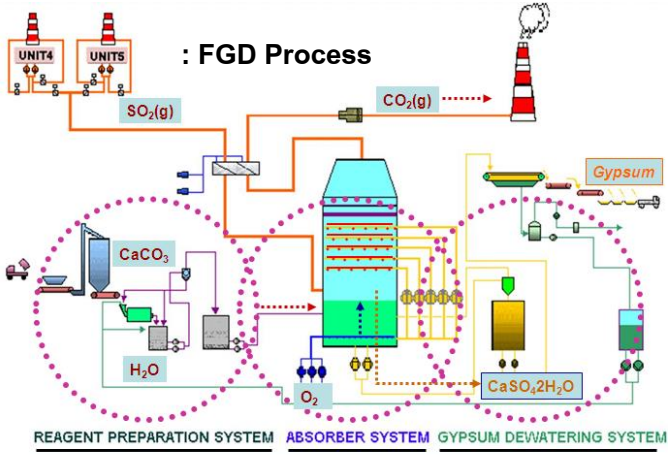
FLUE GAS DESULFURIZATION SYSTEM (FGD)

: FGD Mae Moh Power Plant

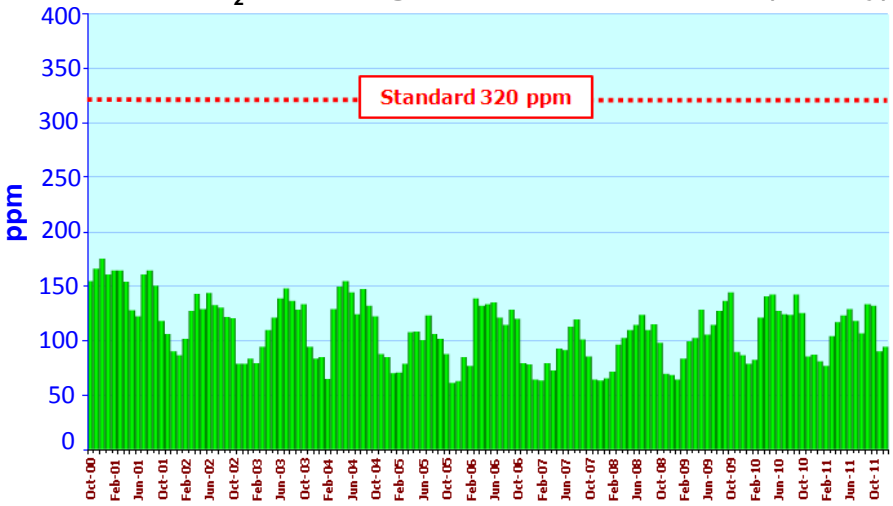
Unit	Efficiency (%)	Commissioning (Year)	Construction Cost (Million Baht)
4-5	97	2000	2,321
6-7	97	1999	
8	95	1997	2,624
9	95	1997	
10	95	1998	
11	95	1998	
12	92	1995	2,160
13	92	1995	
Total :			**7,105**

: FGD Process



Reaction $CaCO_3 + SO_2(g) + (1/2)O_2 + 2H_2O \Rightarrow CaSO_42H_2O(s) + CO_2(g)$
(Limestone) (Oxidation air) (Gypsum)

: Actual SO_2 Emission @Stack Point Y2001 - Y2011 (Monthly)



Source: Mae Moh Production Division, EGAT

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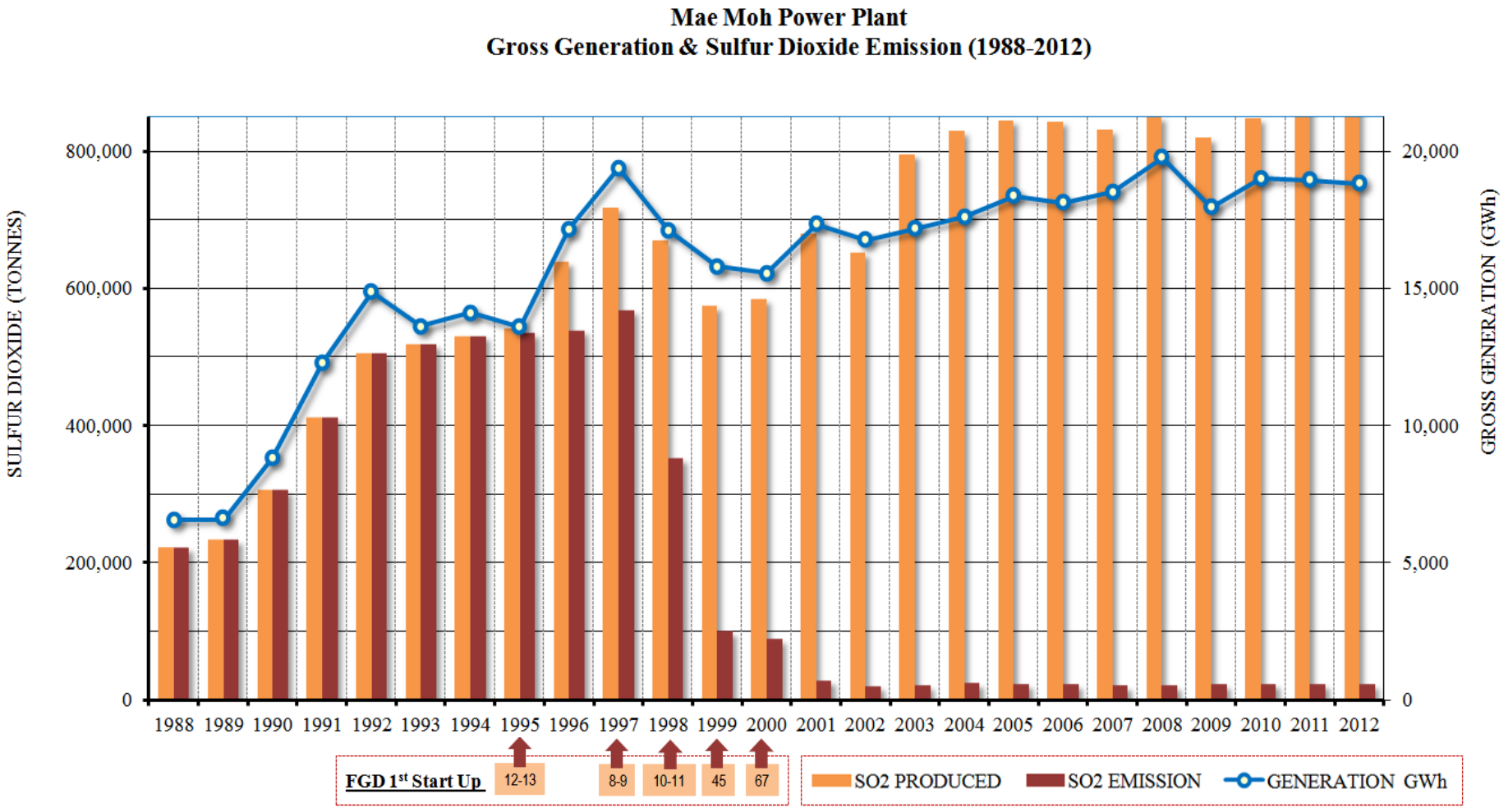
SO_2 Emission control



Source: Mae Moh Production Division, EGAT

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SO_2 Emission Control Procedures

Normal controls at power plant :

SO_2 Emission @stack sum of all units

✓Mar-Oct < 4.8 ton/hr.

✓Nov-Feb < 2.0 ton/hr. (06:00-12:00 am)

< 3.0 ton/hr. (other times)

SO_2 concentrate at stations monitoring ⬆ :

" Solution is Decrease Load to control "

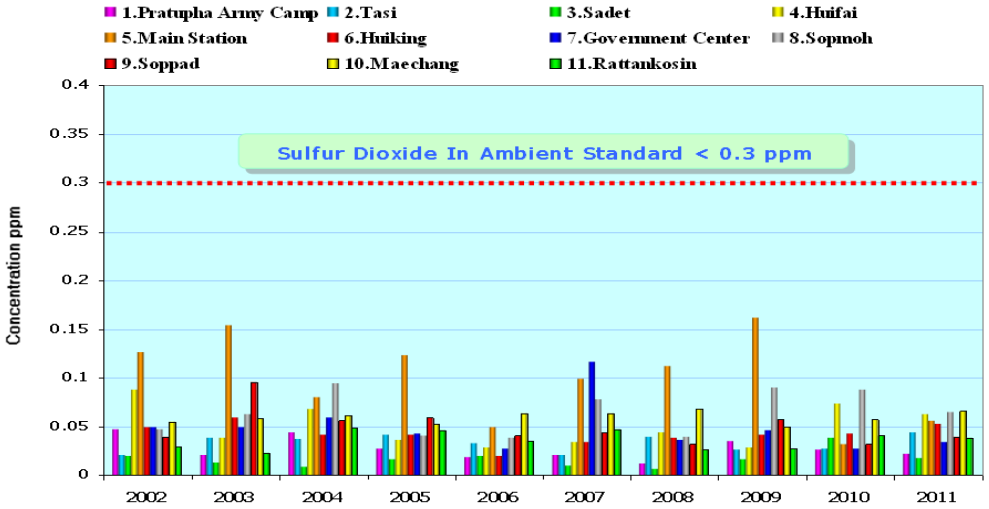
Emergency Case : FGD Outage(unavailable)

- Reduce lignite consumption
- 30 mins. later if FGD still unavailable

=> use only diesel fuel. And then if FGD still unavailable within 2 hrs. must shutdown plant.

- Nov-Feb 06:00-11:00 am

=> Trip plant immediately



Sources: Mae Moh Production Division, EGAT

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NO_2 Emission control

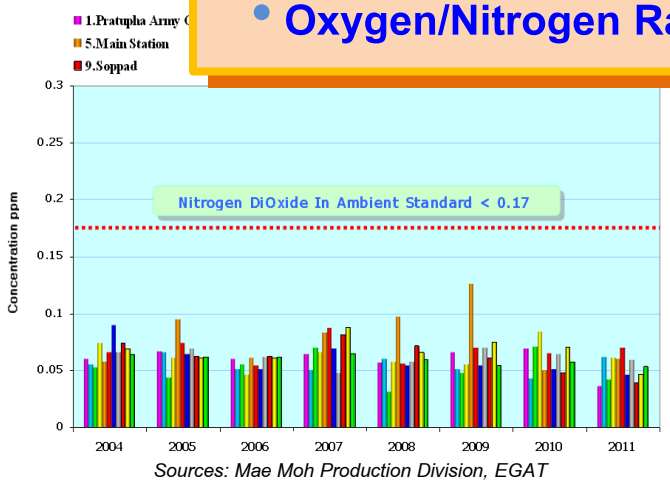
: Actual NO_2 Emission @Stack Point Y2001 - Y2011 (Monthly)

Source: Mae

Successful NO_x Removal !

No_x Emission : The factors

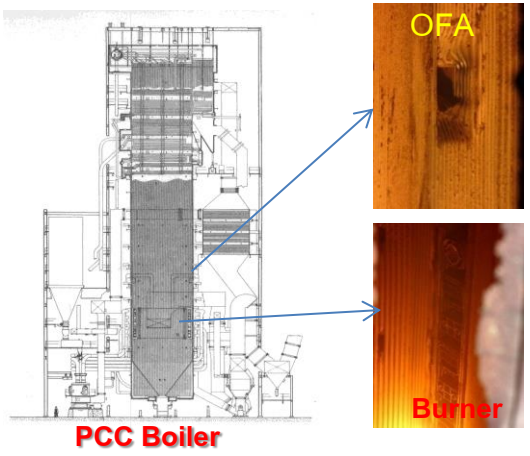
- Oxidation **with Nitrogen in fuel**
- **Oxygen/Nitrogen Ratio** control



Sources: Mae Moh Production Division, EGAT

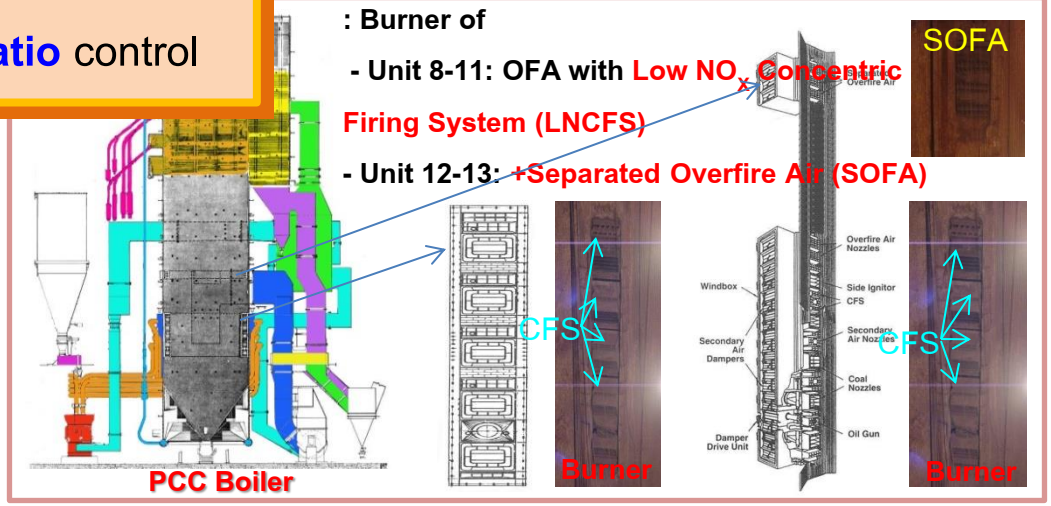
All Units : Low NO_x Burner

: Burner of Unit 4-7 with Overfire air (OFA)



: Burner of

- Unit 8-11: OFA with Low NO_x Concentric Firing System (LNCFS)
- Unit 12-13: +Separated Overfire Air (SOFA)



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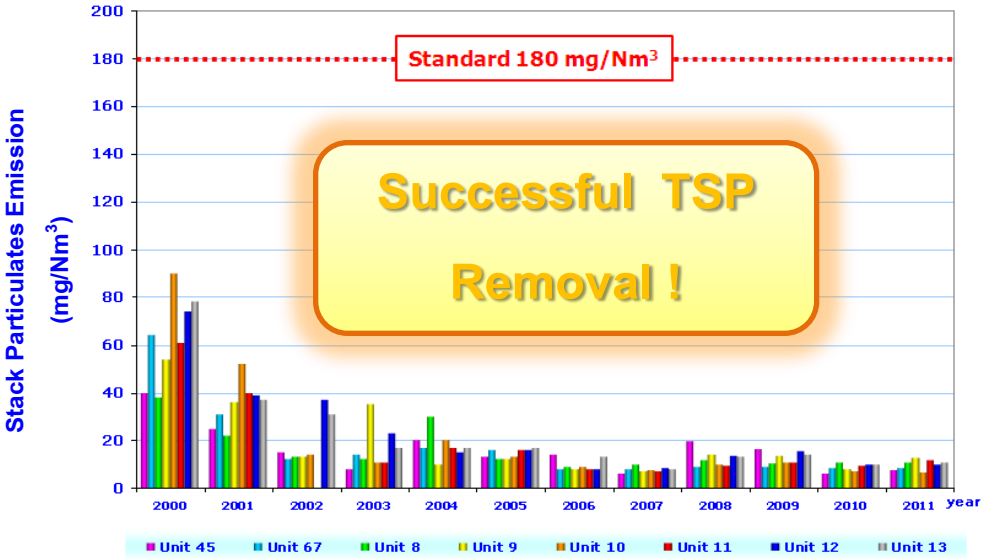
TSP Emission control

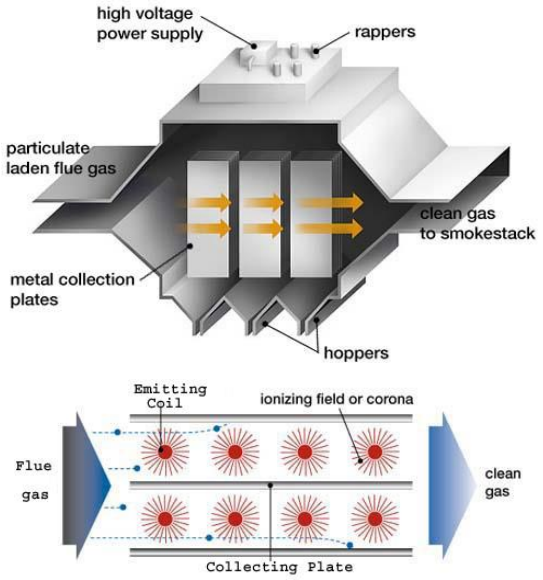
: Actual Dust Emission @Stack Point Y2000 - Y2011 (Monthly)



Source: Mae Moh Production Division, EGAT

Electro Static Precipitator (ESP)

Collecting Plate + Emitting Coil



All Units : ESP Efficiency

more than design value (99.5-99.75%)

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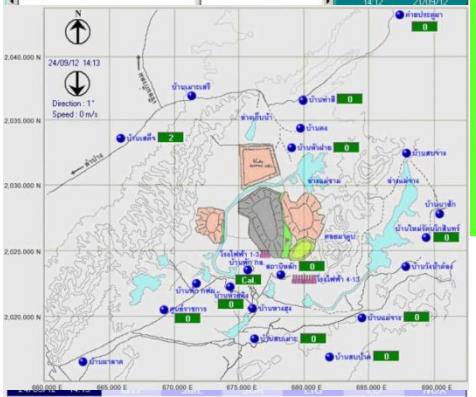
Continuous Emission Monitoring



	SO2	MS	KO	HK	HF	TS	KP
	จากสถานีวัด	0	Cal.	0	0	0	0
	(ug/Nm3)	GC	SM	SP	MC	RS	SD
		0	0	0	0	0	2

Cal. = Calibrate
N/A = Not Available
A/C = AC Line Down
* = SOR and NOX are average value

Message : Welcome to the SO2 Emission Online 2009

11 stations + **1 point@Stack for each unit**

- Mae Moh District Office
- Baan Sop Paad

→ Government Pollution Control Department Monitoring Station

- Pratu Pha Camp
- Baan Ta See
- Baan Sadej
- Baan Hua Faii
- Main Station
- Baan Sop Paad
- Baan Sop Moh
- Baan Mae Jang
- Rattanagisint
- Huai King
- Mae Moh District Office

→ EGAT Ambient Air Quality Monitoring Station

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Summary Part I

- The pollution problems in the past as a key to improve the manufacturing process. More environmentally conscious.
- We search for devices which high performance technology to capture particles that pollute the environment around Mae Moh Power Plant.
- Process & Continuous Measuring Controls are very important.
- ISO 14001 Certification : 1st time Y2001 (Cont. until now)

" Therefore, The Mae Moh Power Plant which is the largest coal-fired power plant in Thailand can control pollution emitted than the law requires. "

PART II : STUDY OF THE IGCC PROJECT

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Study of The IGCC Project at Mae Moh

IEEJ+MHI+JCOAL+METI

Coordination with

- **May 2011 : EGAT and IEEJ => coordinated => To Applying Clean Coal Technology by study for Coal Gasification and Generation at Mae Moh**
- **Jul. 2011 : Feasibility Study → Start!**
- **Aug. 2012 : Summary Report of the Study to EGAT**

No. EGAT 940000/ 26064

May 24, 2011

Mr. Koji Morita
THE INSTITUTE OF ENERGY ECONOMICS, JAPAN
Inui Bldg., Kachidoki, 13-1, Kachidoki 1 Chome, Chuo-ku
Tokyo 104-0054, Japan

Attention : Mr. Koji Morita
Senior Research Fellow
Director, Strategy and Industry Research Unit

Subject : Advanced Clean Coal Technology
Energy Diversification by Coal Gasification at Mae Moh

Referring to you letter dated May 24, 2011 regarding the above subject, we, Electricity Generating Authority of Thailand ("EGAT"), have interest in Clean Coal Technology including IGCC, as well as renewable energy, in terms of Greenhouse Gas Emission Reduction and diversified sources of electricity generation, as specified in Thailand Power Development Plan 2010-2030 (PDP2010).

In fact, EGAT has been operating 2,400 MW sub-critical thermal power plants for two to three decades using domestic lignite at Mae Moh and deterioration and decrepitude of the plants are gradually observed. Therefore, the existing units may be replaced with more efficient and clean coal power plant in due course.

In order to execute necessary feasibility study for the introduction of advanced clean coal power plant at Mae Moh, including IGCC, we would be highly appreciated if you could coordinate with Ministry of Economy Trade and Industry of the Japanese Government and obtain technical and financial assistance for your execution of such feasibility study.

Yours sincerely,

(Mr. Somboon Arayaskul)
Deputy Governor-Development
Acting on behalf of Governor

Deputy Governor-Development
Tel. 0 2436 1000
Fax. 0 2436 1090

31 MAY 2011

MITSUBISHI HEAVY INDUSTRIES, LTD. ENGINEERING HEADQUARTERS
Power Systems Project Engineering Department/ IGCC Engineering Group

REF. No. MHISPPIE120010	ENGINEERING SHEET	DATE August 1, 2012
PLANT : IGCC Commercial Plant in Thailand		ORDER No.
SUBJECT : Mitsubishi Air-Blown IGCC Technology Information		

This document is issued in accordance with "Questions for Mitsubishi IGCC Technology" requested by Electricity Generating Authority of Thailand (EGAT) in May 2012.

Approved by
Checked by
Drawn by

COPY | CUSTOMER | TOTAL

IEE JAPAN
THE INSTITUTE OF ENERGY ECONOMICS, JAPAN
Electric Power & Coal Unit
Inui Bldg. Kachidoki, 13-1 Kachidoki 1-chome, Chuo-ku, Tokyo, 104-0054, JAPAN
Phone:+81-3-5547-0214 Facsimile:+81-3-5547-0223

August 1, 2011

ELECTRICITY GENERATING AUTHORITY OF THAILAND
53 Moo 2 Charansanitwong Road.,
Bang Kruai, Nonthaburi 11130

Attention: Mr. Somboon Arayaskul
Deputy Governor-Development

Subject: Study for Coal Gasification and Generation at Mae Moh by Applying Clean Coal Technology

Dear Sir,

Reference is made to our letter dated July 15, 2011, addressed to you.

First of all, we would be very grateful for your kindness and kind support.

We are pleased to inform you the outline of the captioned study and our requirements for conducting the study as the attached papers. It would be greatly appreciated if you could understand the contents of this study and arrange the project team for this study.

Your kind cooperation would be highly appreciated.

Yours faithfully,

森田浩仁

Mr. Koji Morita
Board member, Director
Electric Power & Coal Unit
THE INSTITUTE OF ENERGY ECONOMICS, JAPAN

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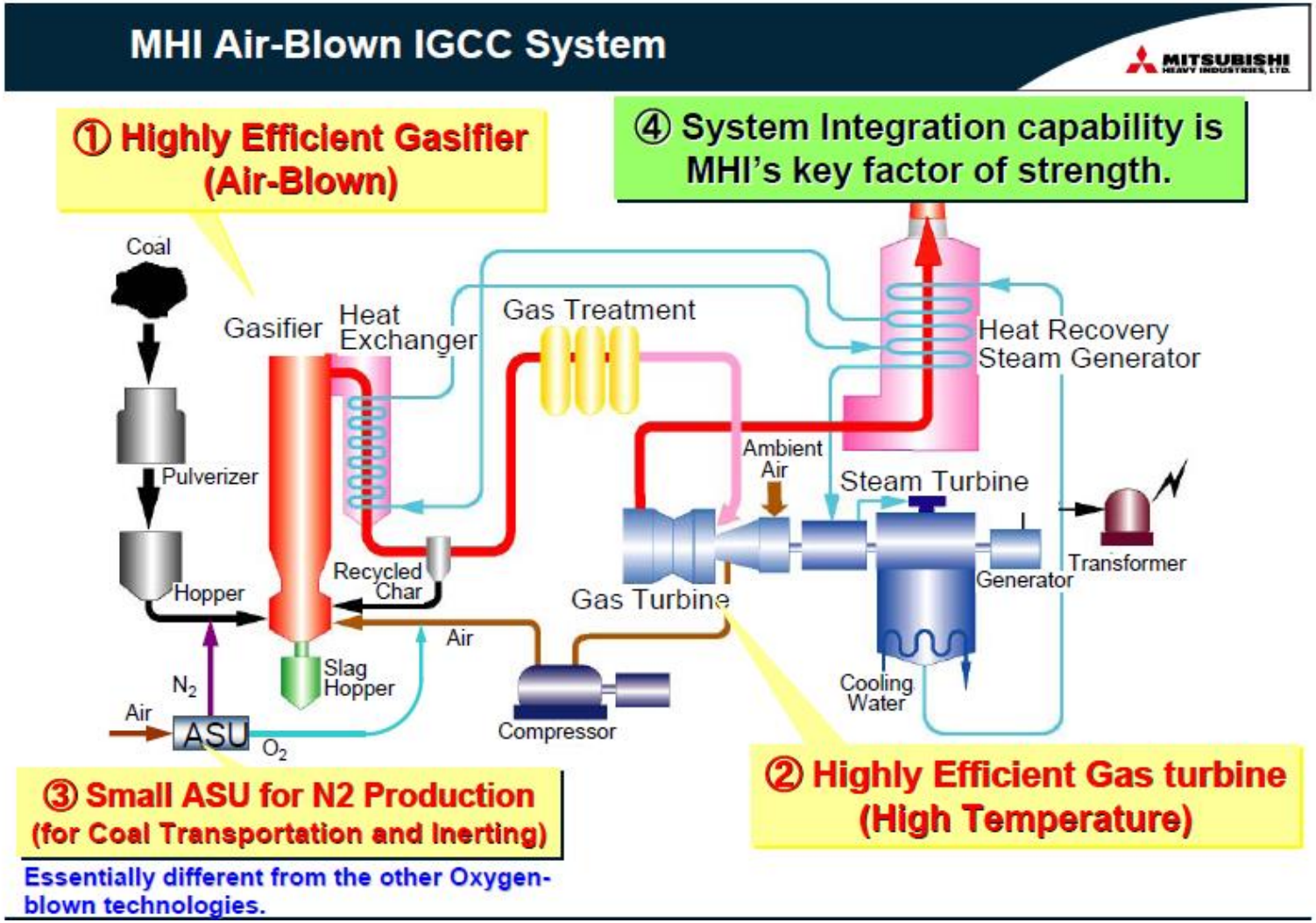
Study of The IGCC Project at Mae Moh



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Study of The IGCC Project at Mae Moh

Variety of Coal Experience

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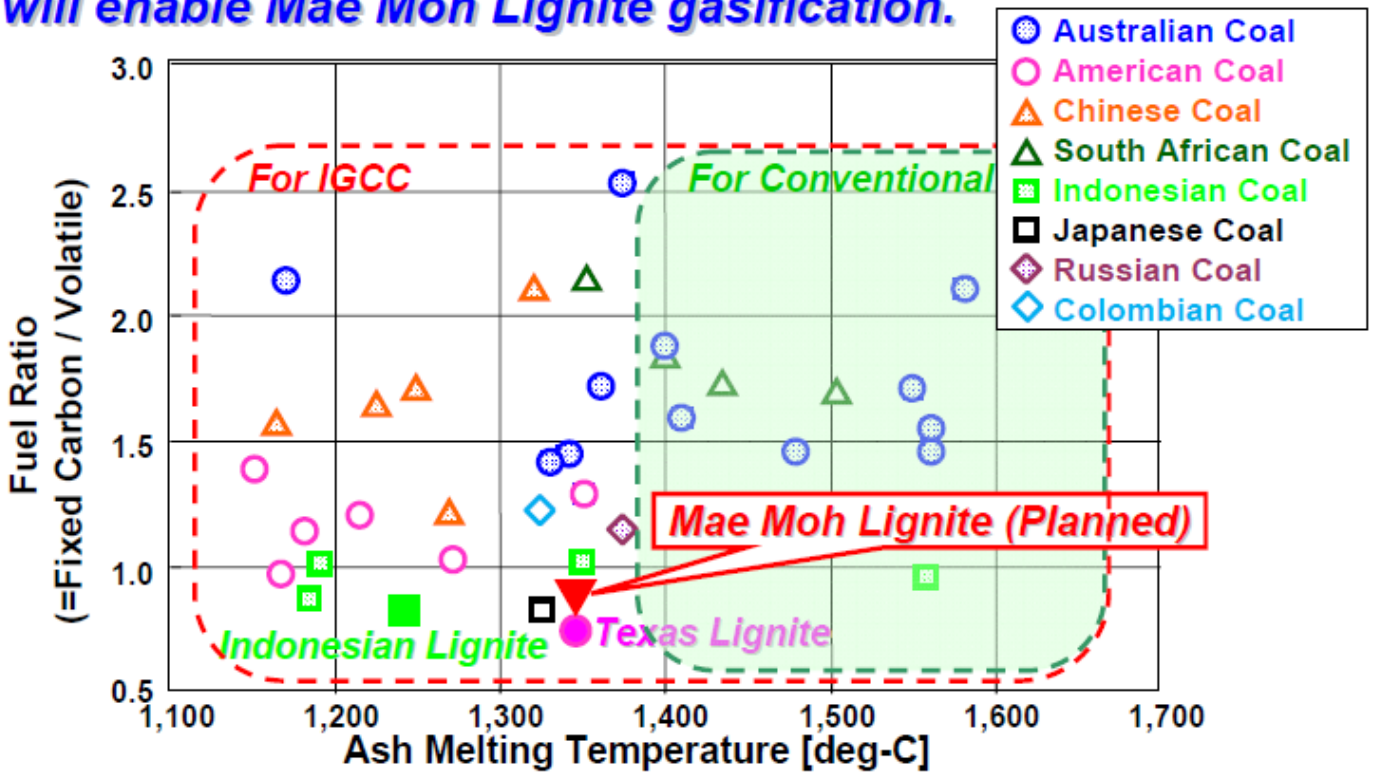
Experience of various coals including Lignite MHI Gasifier successfully gasified, will enable Mae Moh Lignite gasification.



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Study of The IGCC Project at Mae Moh

Features of MHI Air-Blown IGCC

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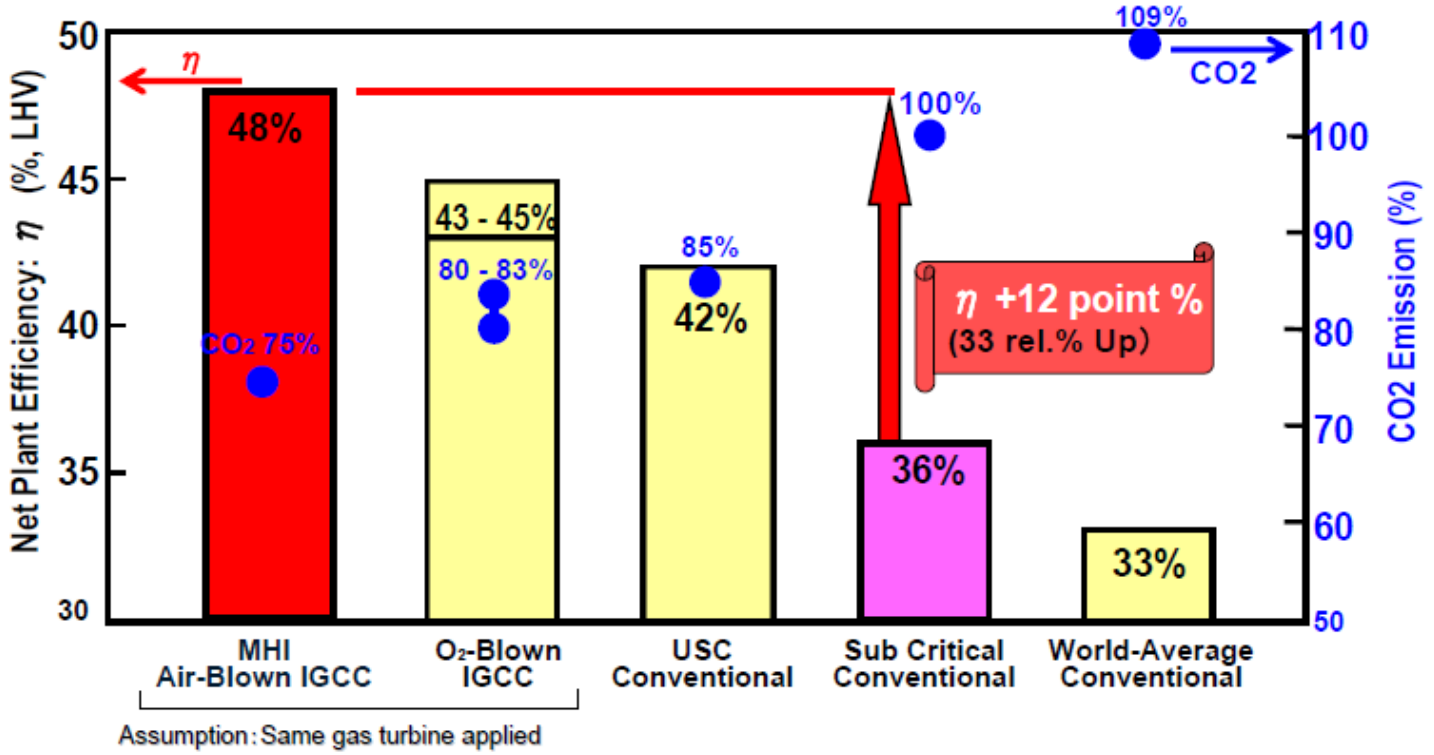
- CO2 is extremely reduced by high efficiency.
- The Air-Blown IGCC is MHI's original technology.



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Study of The IGCC Project at Mae Moh

Present Status of 250MW IGCC Demonstration Project (Nakoso)

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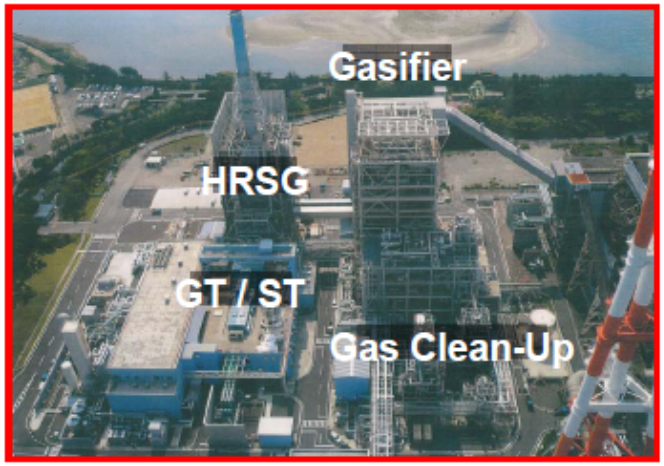

METI Ministry of Economy, Trade and Industry

30% Subsidy

Joint Project Agreement

70% Contribution

Hokkaido EPCo.
Tohoku EPCo.
Tokyo EPCo.
Chubu EPCo.
Hokuriku EPCo.
Kansai EPCo.
Chugoku EPCo.
Shikoku EPCo.
Kyushu EPCo.
J-Power
CRIEPI

Clean Coal Power R&D Co., Ltd.

Researchers

MHI Single Point Responsibility (EPC Turn-Key Contract)

- Project is going on Schedule.
- Operation started Sep. 2007
  - 100% Load
  - 2,000hrs. Continuous Operation finished
  - Coal Change / Load Swing / Efficiency Improvement, etc.
  - 5,000hrs. Durability Test finished
  - ⇒Subsidy from METI ended

2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
			Engineering			Construction			Operation			

All of the demonstration targets have been achieved.

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Study of The IGCC Project at Mae Moh

Typical Major Specification of 500MW Plant
-Typical Plot Plan-

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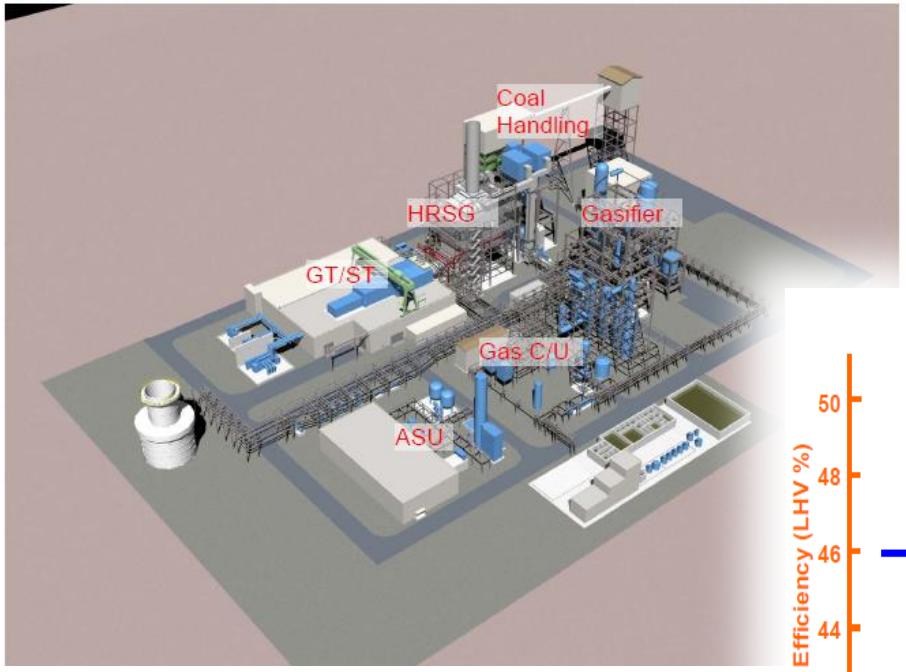

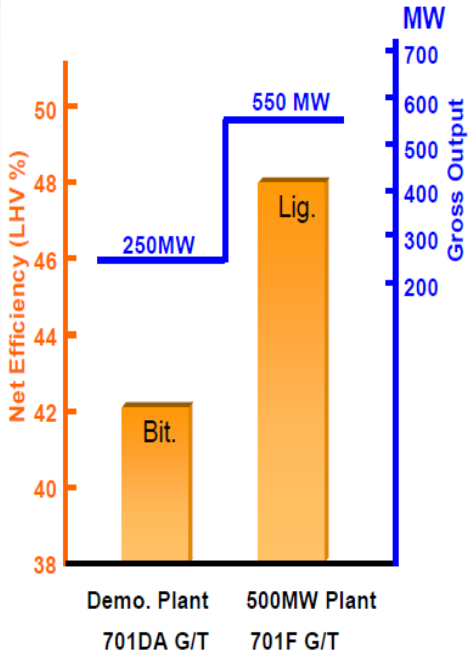

Item	Specification
Coal	Mae Moh Coal (expected)
Output Gross	550 MW
Net	500 MW
Gasifier Oxidizer	Air
Coal Feed	Dry
Acid Gas Clean-up	Wet MDEA
Gas Turbine	M701F ×1 (1 on 1)
Net Efficiency (LHV)	Approx. 48 % w/o CO_2 Capture

Note: Plant performance like output and efficiency depends on site conditions including coal properties.
Emission performance like SOx, NOx and PM can be discussed, depending on the regional regulation.

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Study of The IGCC Project at Mae Moh

Typical Major Specification of 500MW Plant
-Utilities & Emissions-

MITSUBISHI HEAVY INDUSTRIES, LTD.

Items	Utilities	Note
Coal consumption	285.4 metric-ton/hour	As received basis
Oxygen consumption	40.3 metric-ton/hour	O2 purity: 95vol%
Slag discharge	38.5 metric-ton/hour	Dry basis
Elemental Sulfur production	5.0 metric-ton/hour	Elemental "S"
Cooling Water consumption	11,800 m3/hour	
Demineralized water	34 metric-ton/hour 17 metric-ton/hour	(max.) (ave.)
Industrial water	1260 metric-ton/hour 1,250 metric-ton/hour	(max.) (ave.)

Items	Emissions	Note
Exhaust Gas Flow Rate	2,013,000 m3N/hour	dry basis
SOx	9.6 ppmV	@15%O2-dry = 23 ppmV @7%O2-dry
NOx	6.0 ppmV	@15%O2-dry = 14 ppmV @7%O2-dry
Dust	4.8 mg/m3N	@15%O2-dry

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Summary Part II

- We are very interested in IGCC technology. Executive Committee was appointed to feasibility study this technology.
- Although, in foreign countries such as USA, this technology has occurred for a long time. But that is a new technology for the electric power industry in Thailand. So it should be study the advantages - and disadvantages in more details.
- Present status of IGCC, demonstration project(Nakoso) only 250 MW.

“ Therefore, The chief executive of EGAT remain under consideration to apply IGCC for Replacement Project (600 MW) at Mae Moh Power Plant. ”

Mae Moh Power Plant

" Energy and Environmental awareness always "

Thank you for your kind attention!