



The Challenge for Future Power Generation

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Senior Executive Vice President

October, 2014



MITSUBISHI HITACHI POWER SYSTEMS, LTD.



1. What is required by Energy & Environment

2. Establishment of MHPS

3. High Efficiency Gas Turbines

4. IGCC - Most Advanced Technology in the World

5. Air Quality Control Systems



1. What is required by Energy & Environment

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3. High Efficiency Gas Turbines

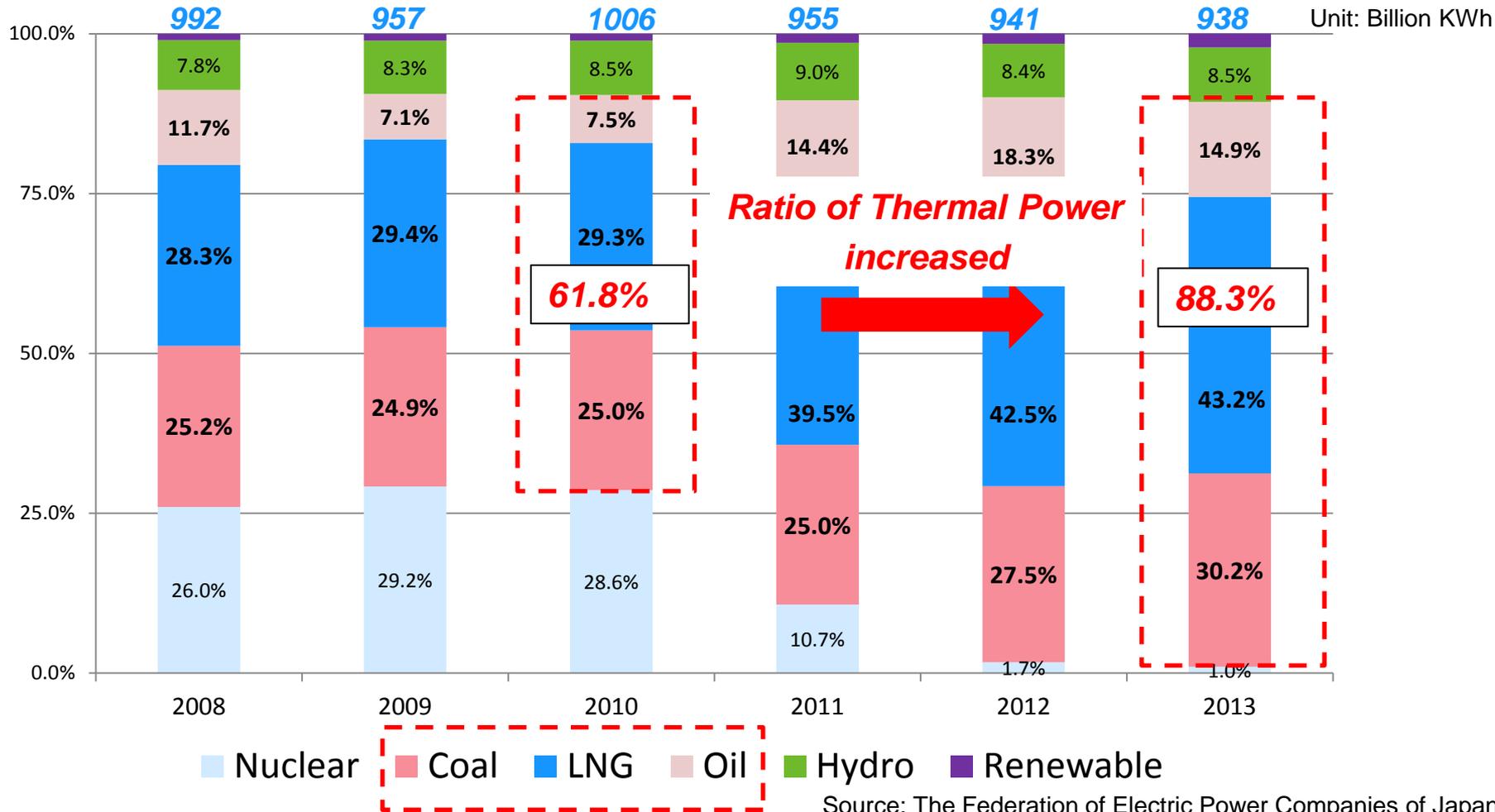
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5. Air Quality Control Systems

1-1. Power Generation in Japan



Ratio Change of Power Generation in Japan(2008-2013)



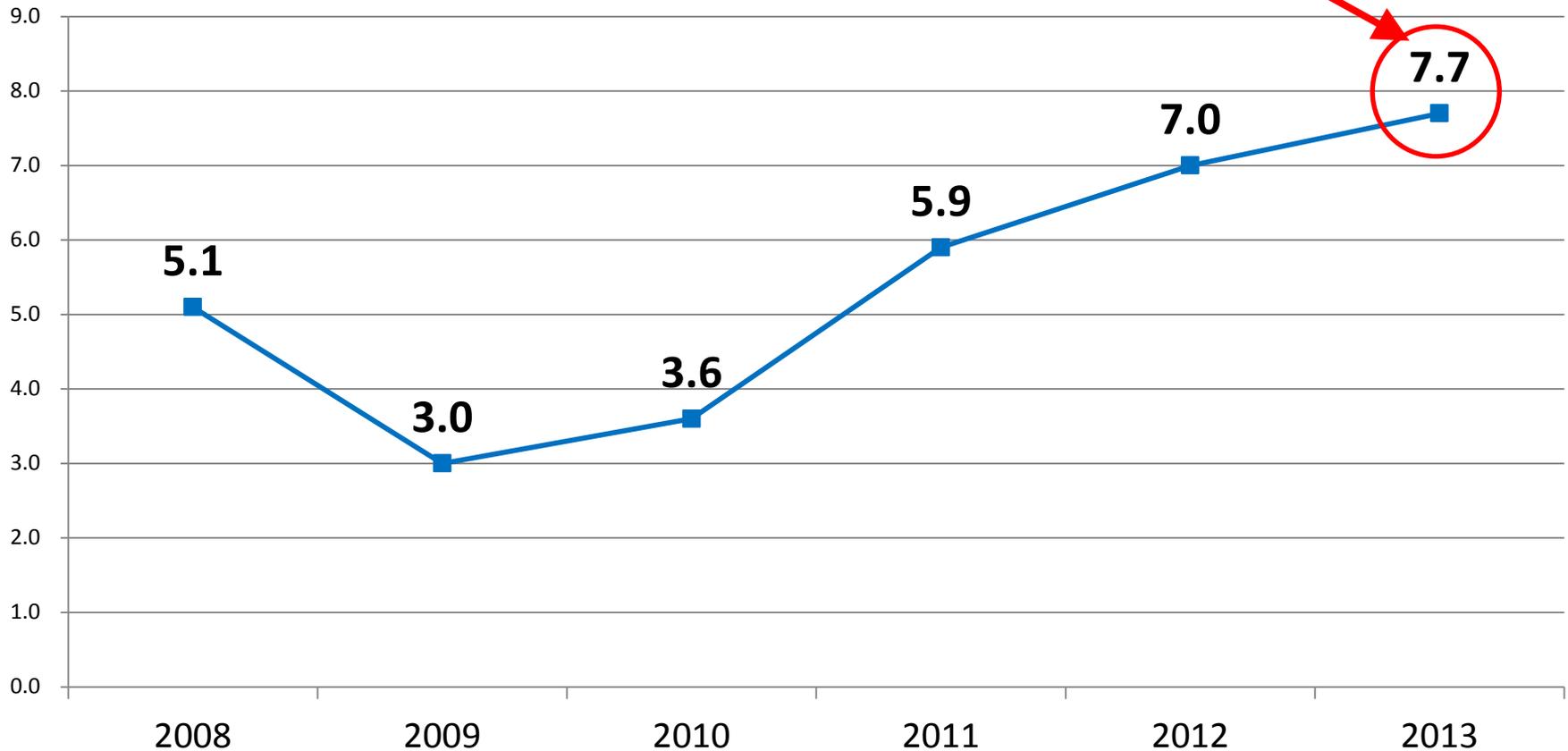
Source: The Federation of Electric Power Companies of Japan

1-2. Energy Cost for Power Generation in Japan



The highest energy cost for power generation in Japan

Unit: Trillion JPY

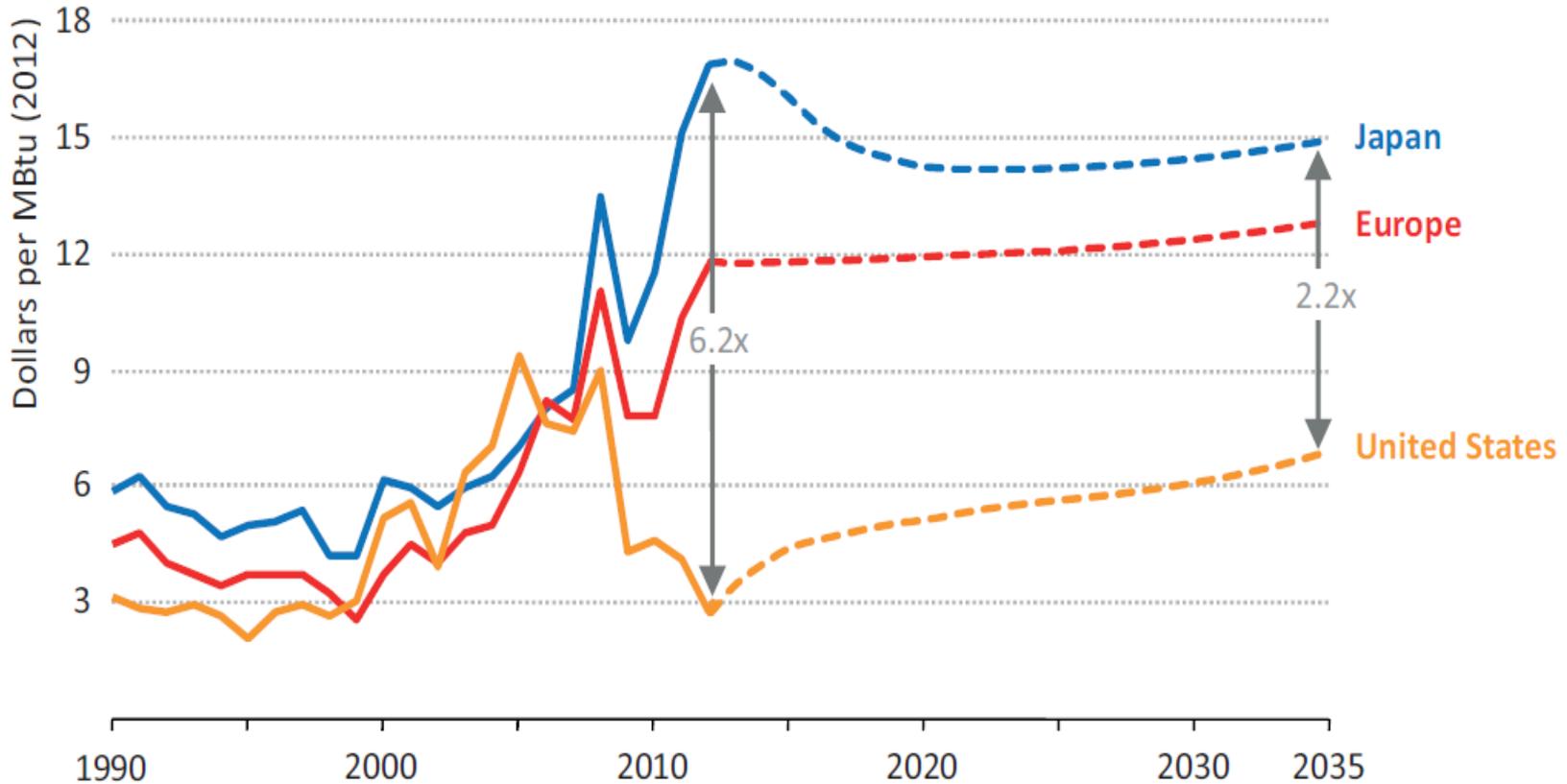


Source: The Federation of Electric Power Companies of Japan, total of 10 major electric companies

1-3. Forecast of Natural Gas(LNG) Price



Source: International Energy Agency, World Energy Outlook 2013



Increasing fuel price requests *high efficient equipment*



1. What is required by Energy & Environment

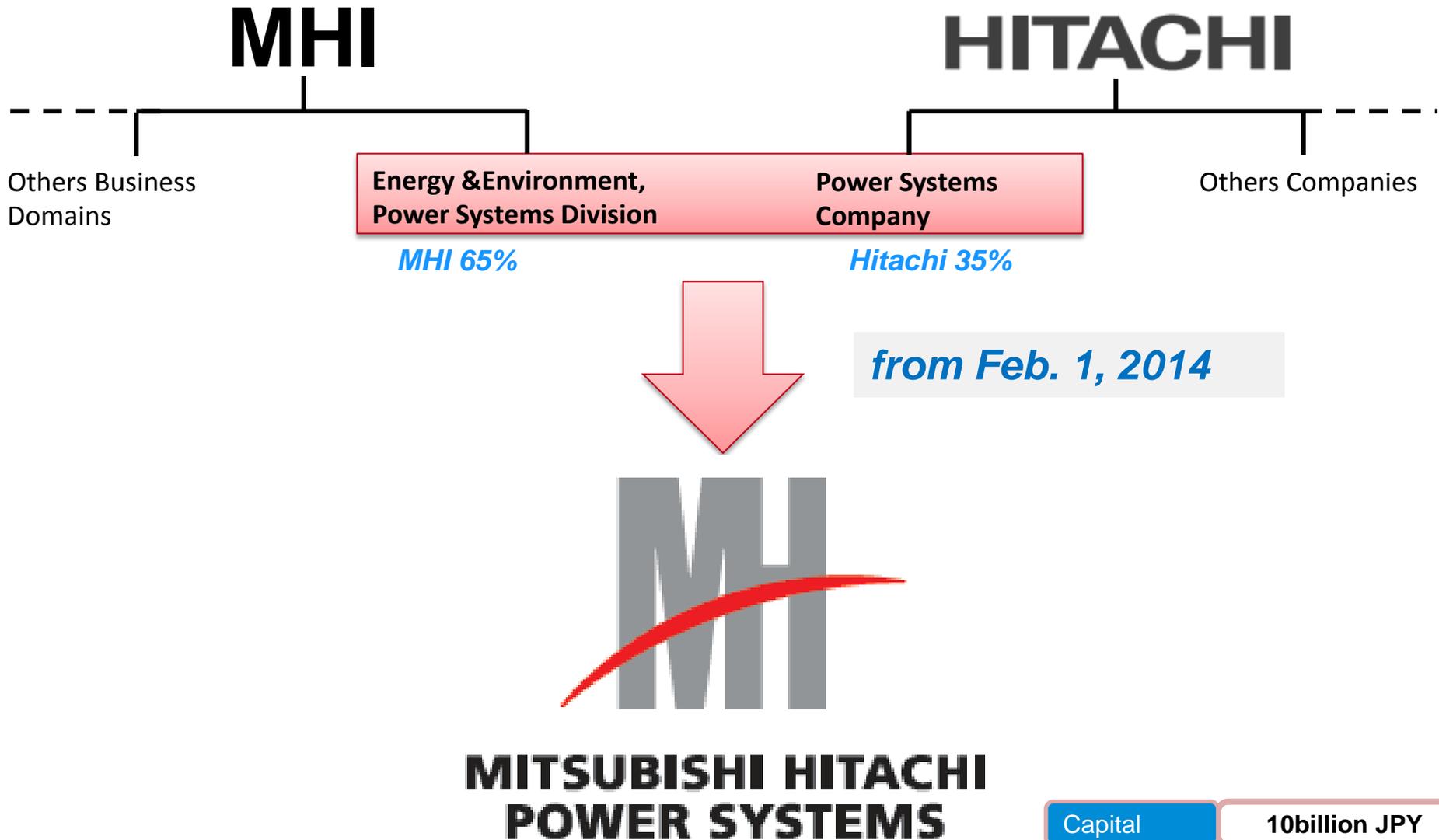
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2-1. Establishment of MHPS



Capital	10billion JPY
Employee	23,000

As of Oct.1, 2014

2-2. Head office and Factories



2-3. Global Network



54(*) Subsidiary Companies Oversea

(*) More than 50% shares owned by MHPS



2-4. Our Products



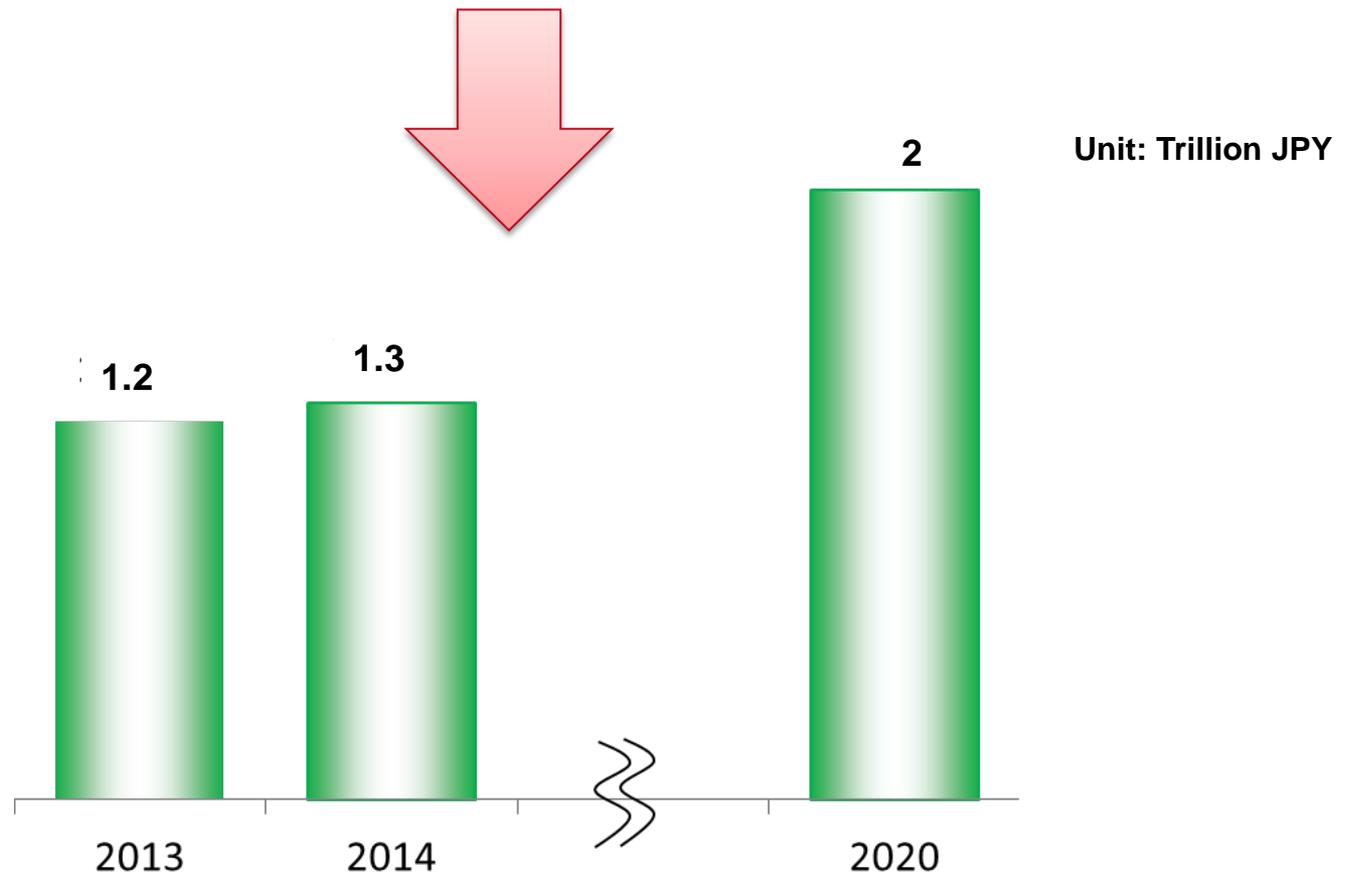


One + One = Infinite Potential

Customer Focus and Long-Term Support

Solving Energy and Environmental Issues on a Global Scale

Business Scale





1. What is required by Energy & Environment

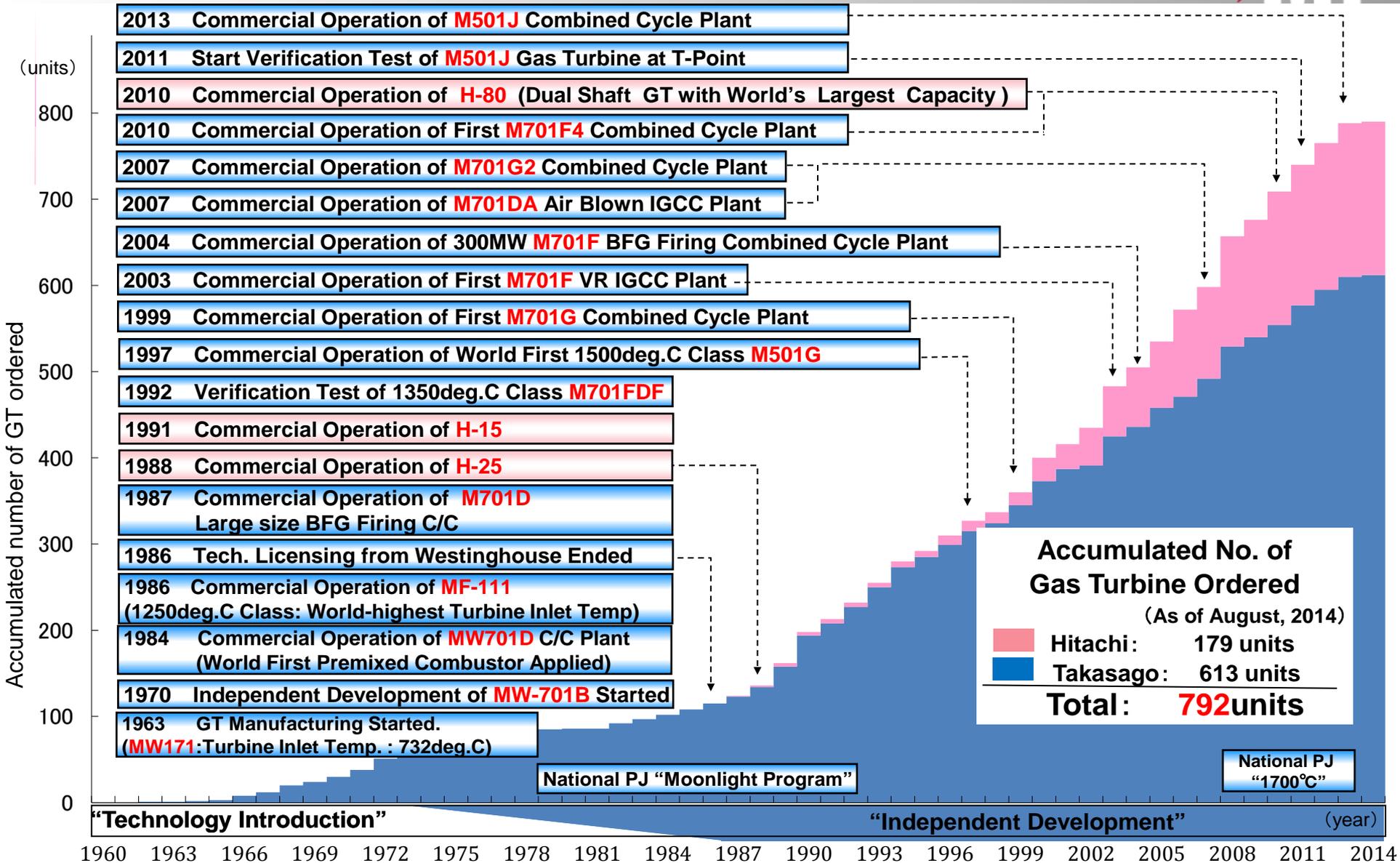
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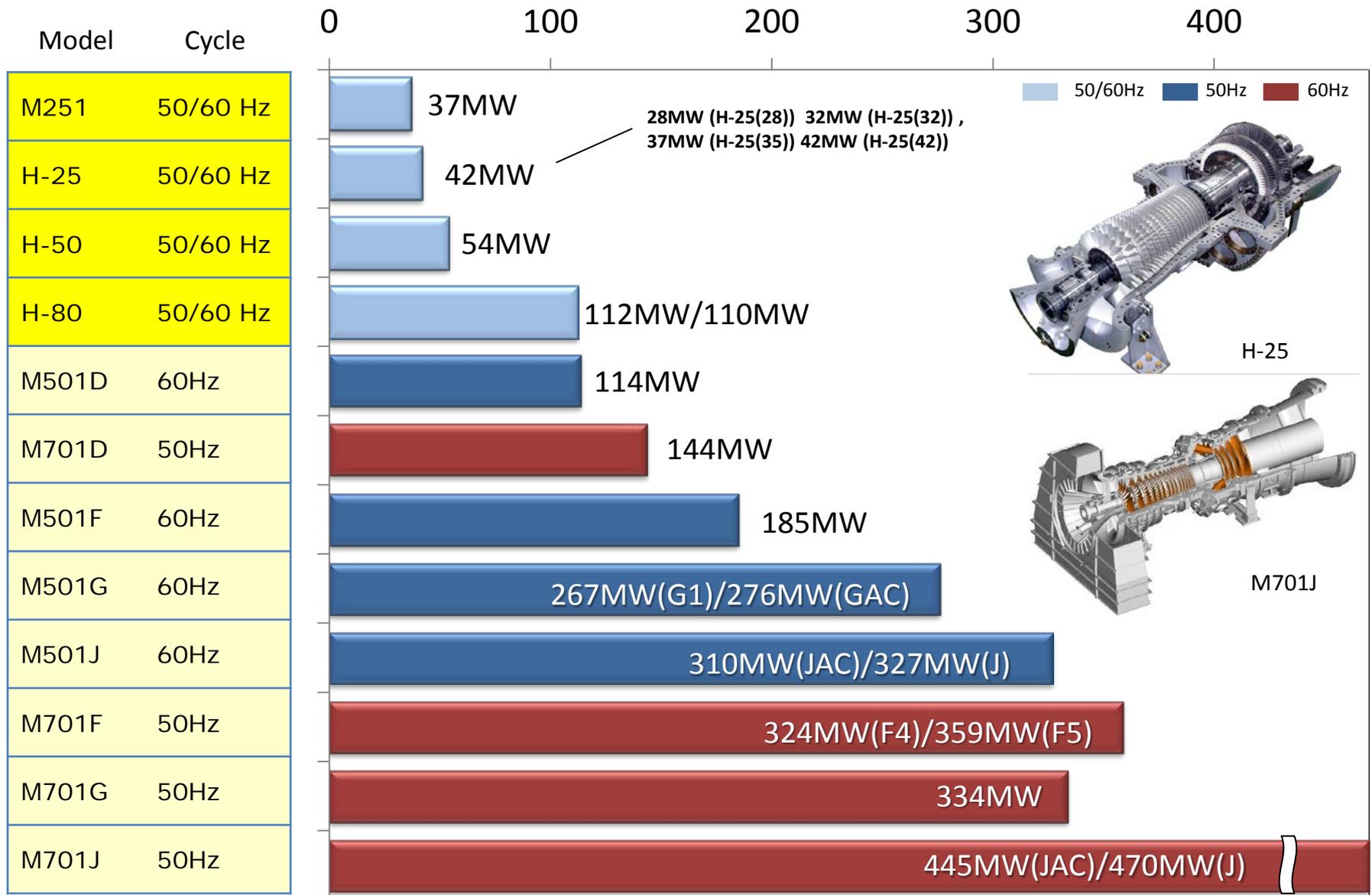
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3-1. History of Gas Turbines



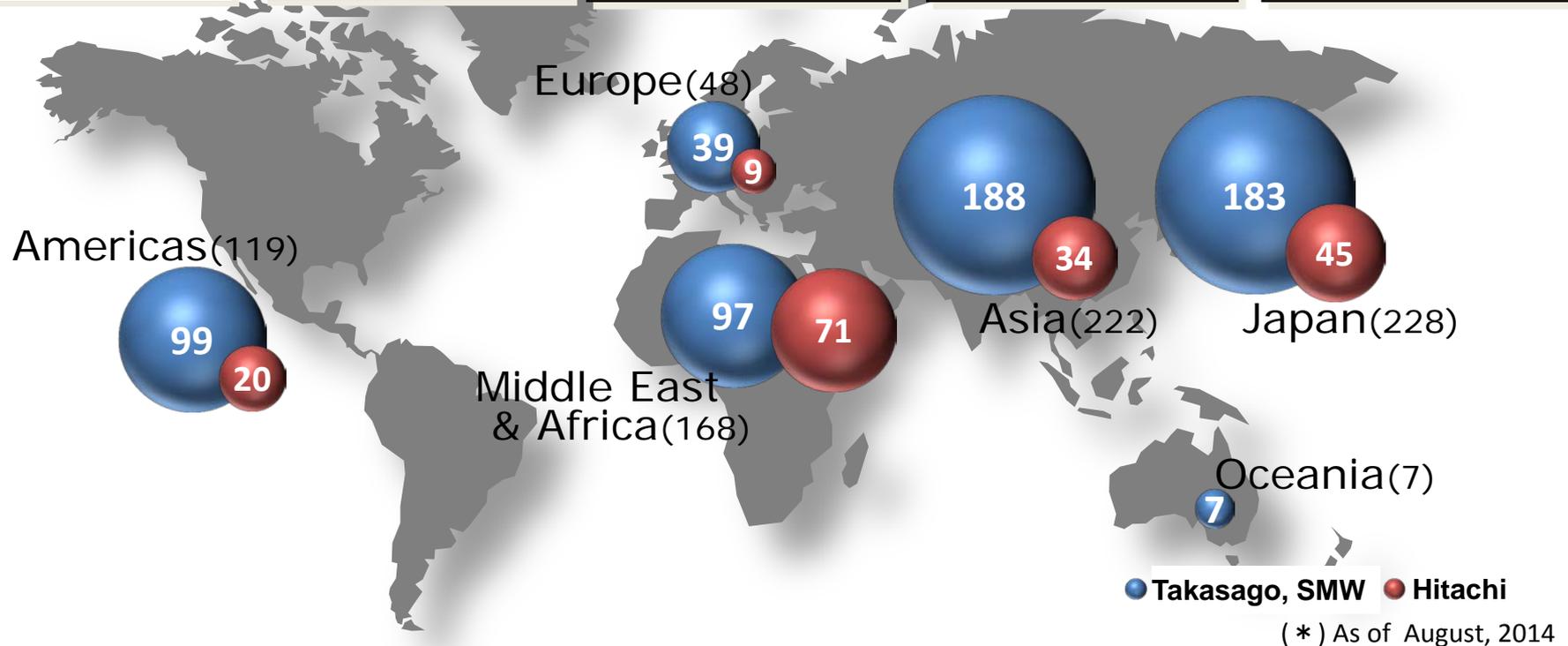
3-2. Gas Turbine Line up



3-3. MHPS Gas Turbine Global Experience



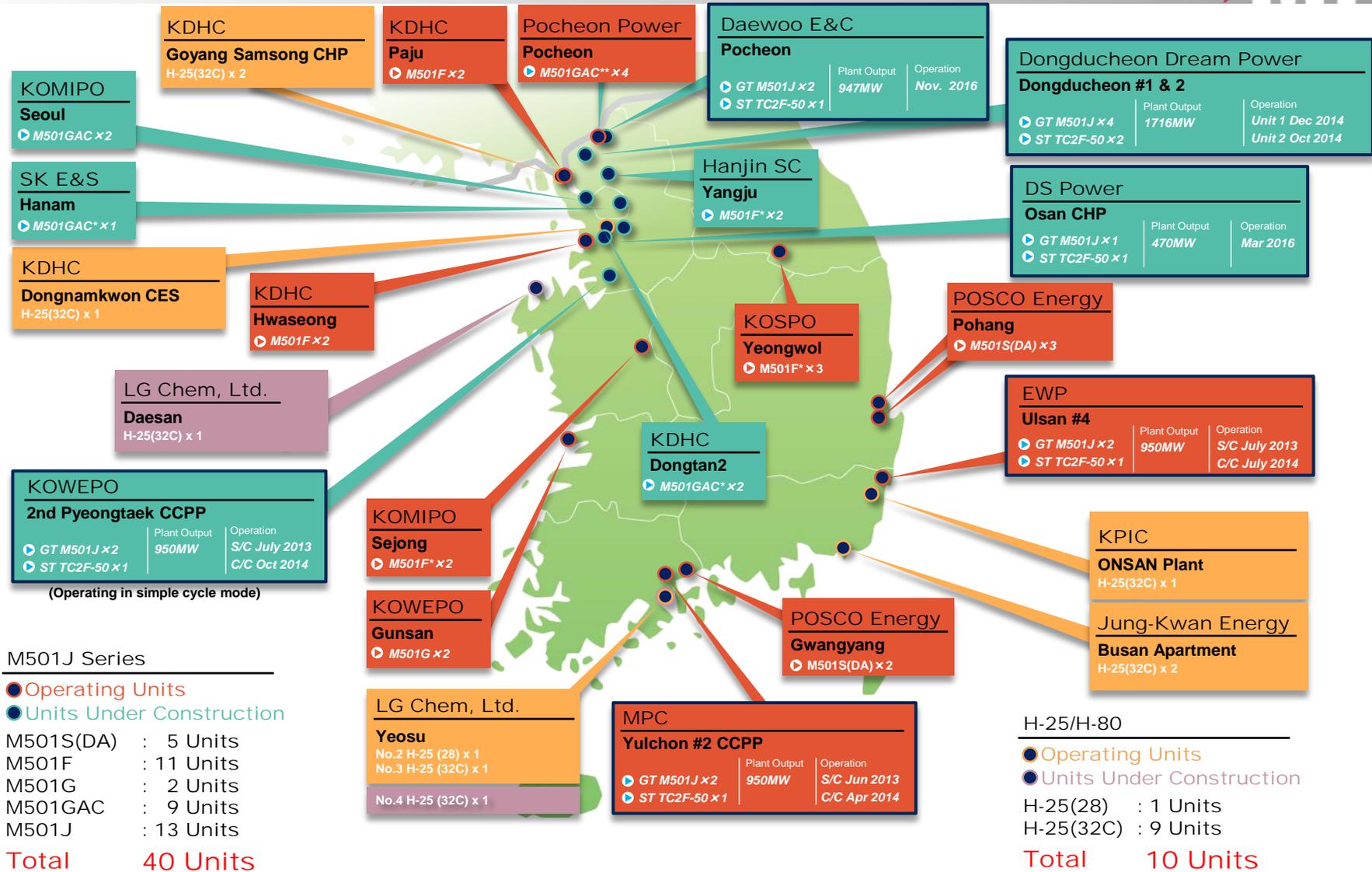
M501J × 26 M701J × 2 Total: 28 units	M501G × 70 M701G × 11 Total: 81 units	M501F × 73 M701F × 125 Total: 198 units	M501D × 25 M701D × 92 Total: 117 units	H-15 × 6 H-25 × 160 H-80 × 13 Total: 179 units
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All Units – 792 units

(including 189 units of Takasago Mfd. Mid&Small Class GTs)

3-4. MHPS Gas Turbine Award Record in Republic of Korea



* :Supplied by Doosan Under MHI's License
 ** :Last Unit Supplied by Doosan Under MHI s License

As of Aug. 2014

3-5. J Series Gas Turbine Features



- C/C efficiency > 61%
- High Pressure Ratio Compressor Experience from H Engine
- Steam Cooled Combustor Experience from G Engine
- Turbine Technologies from National Project

Compressor

Validated H Compressor

- 23:1 pressure ratio
- 3D profile
- Improved inlet duct

Combustor

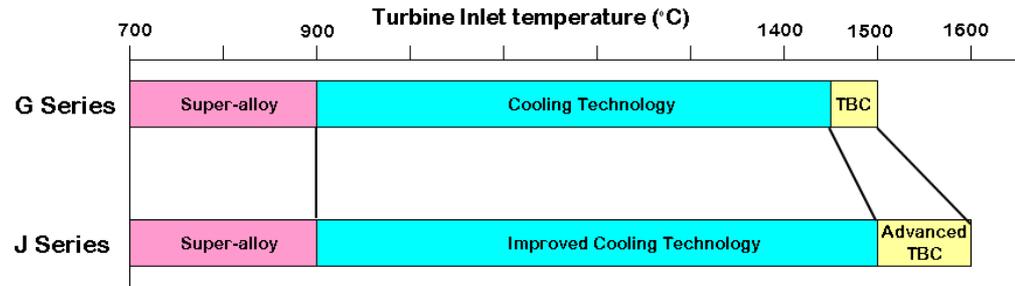
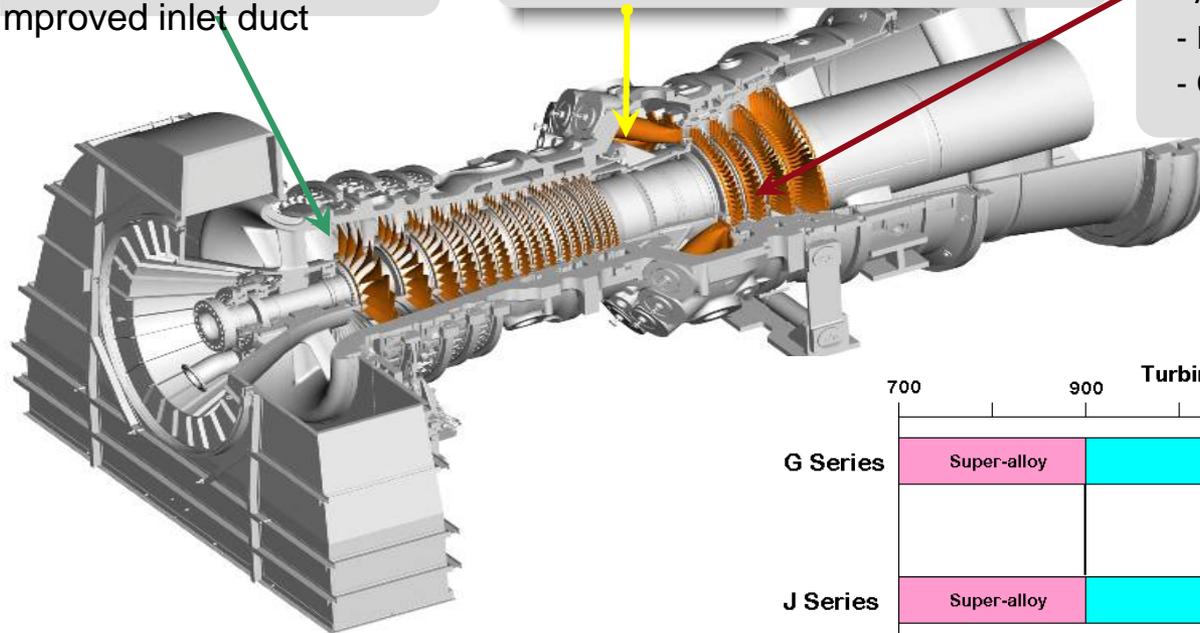
Proven G Combustor

- Well experienced DLN combustor
- Steam cooled liner

Turbine

National Project Technologies

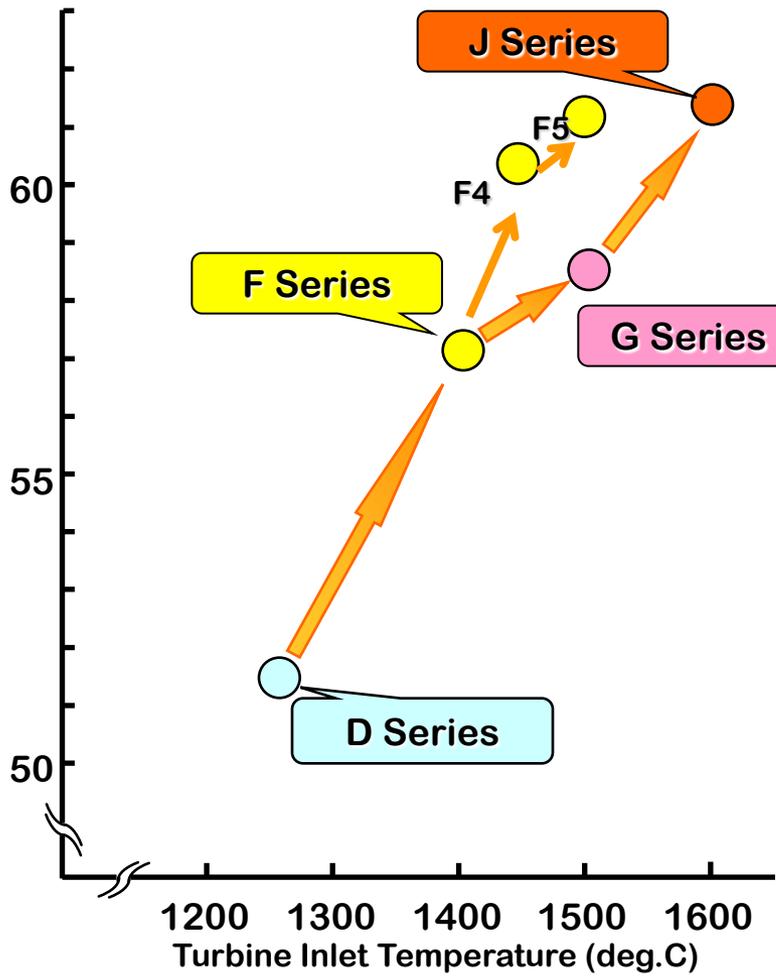
- Advanced TBC + Cooling
- High efficient aerodynamic technology
- Cooled row4 blade



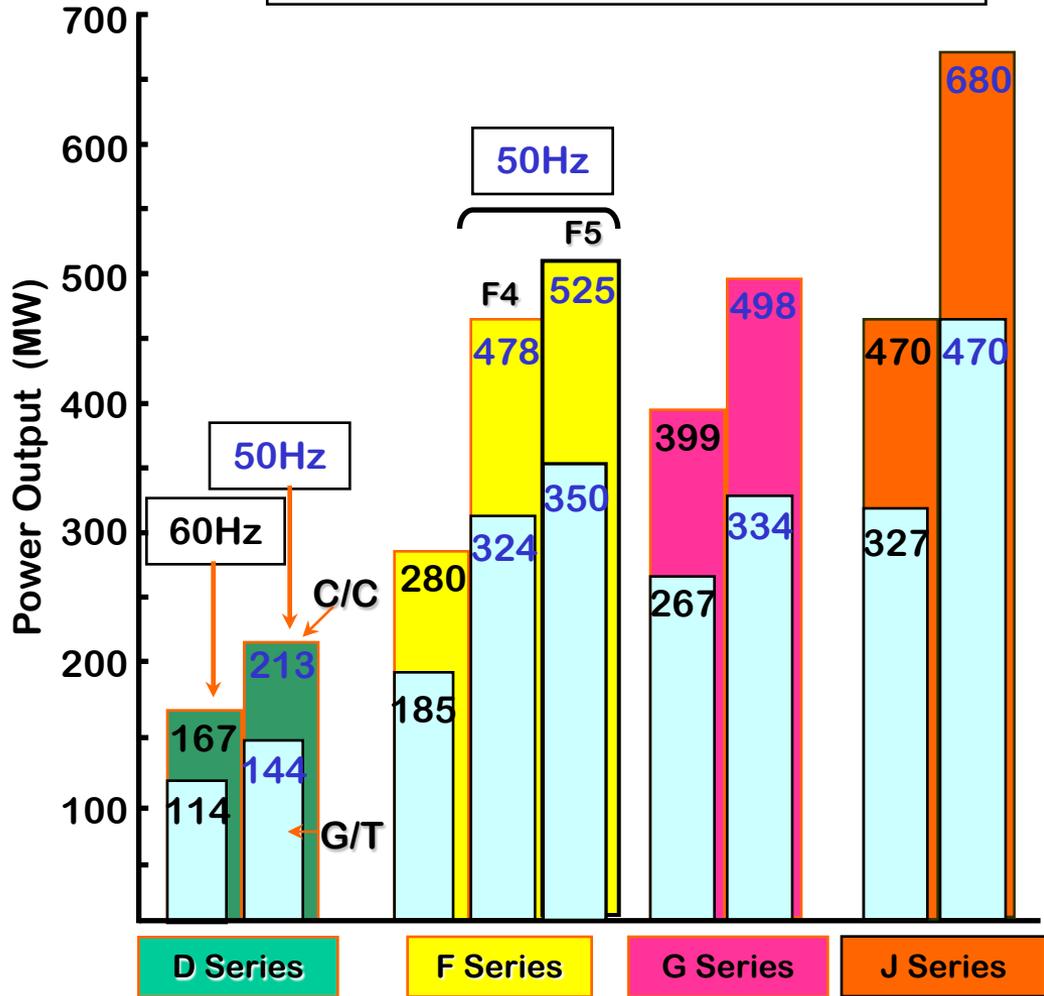
3-6. Performance Enhancement



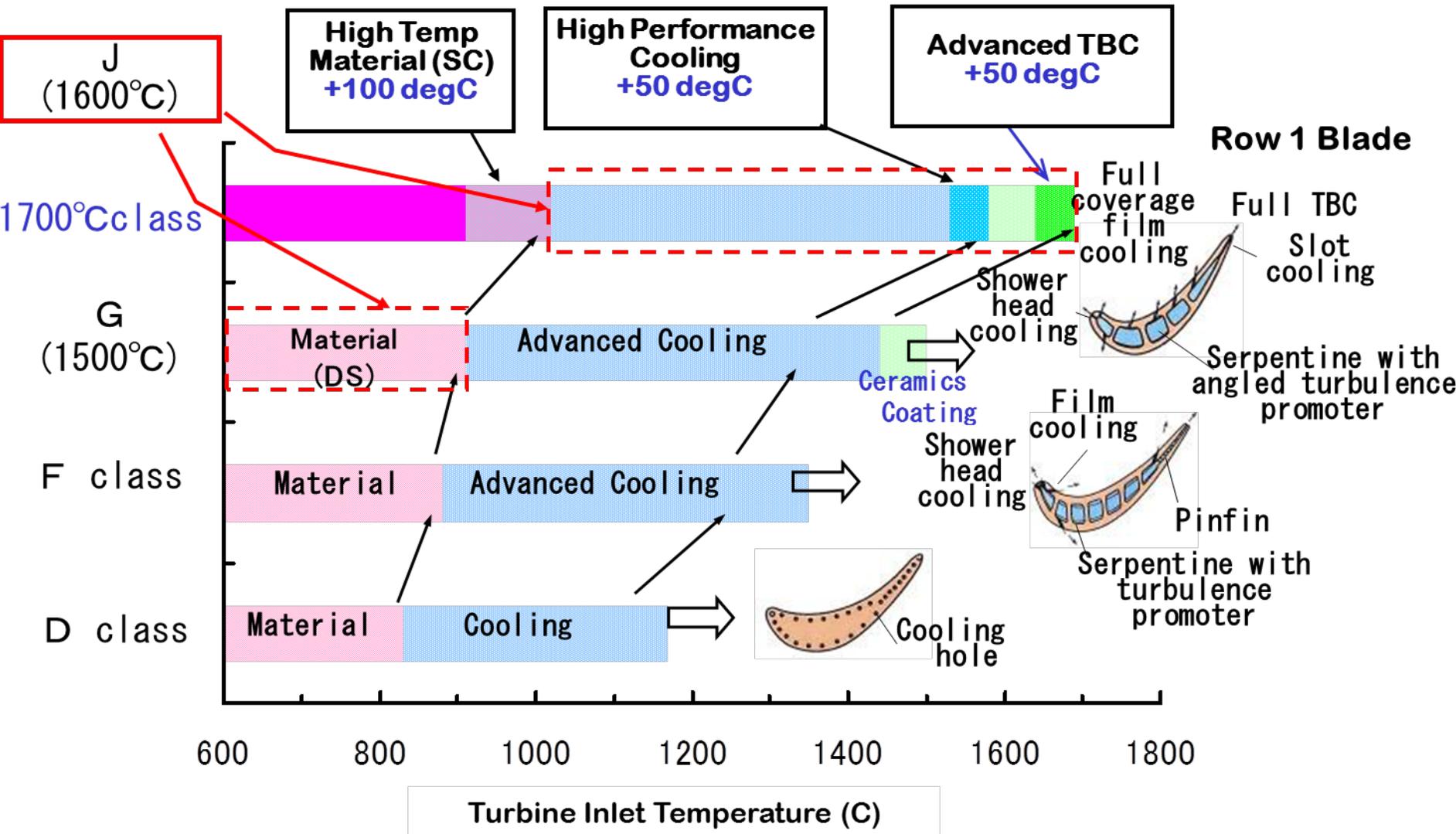
C/C Efficiency



C/C Power Output (1on1)



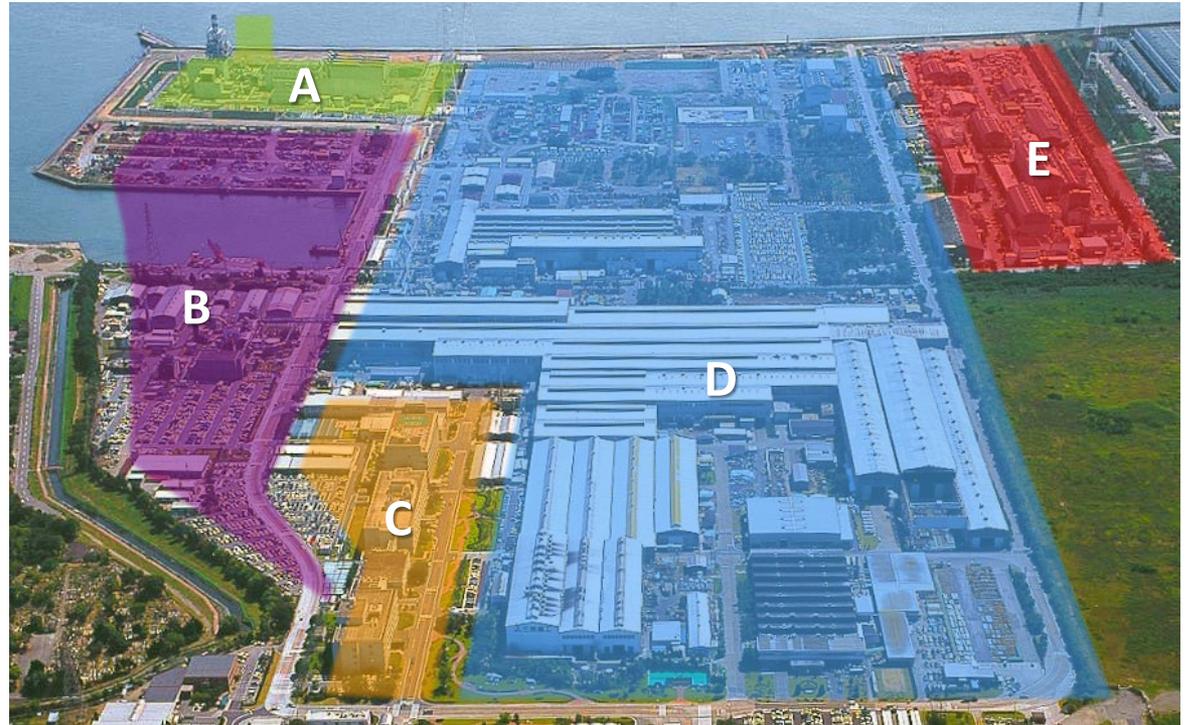
3-7. The role of each technology for 1600C J-series GT



3-8. Development and Verification in Takasago

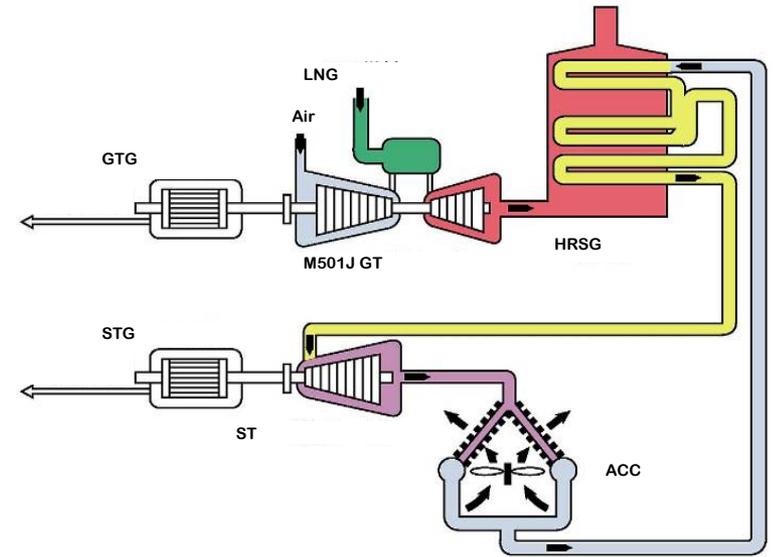


- A** • T-Point Verification Plant
- B** • Education Center & Shipping
- C** • Administration & Engineering/Service
- D** • Manufacturing
- E** • Research & Development



	Takasago Machinery Works	R&D Center
Site Area	216 acres	35.4 acres
Building Area	2,677,974 ft ²	657,018 ft ²
Employees	4,027	406

3-9. T-Point Verification Plant at Takasago



18,466AOH / 175starts (by end of Sep. 2014)



M501J Gas Turbine

	2010			2011								
	10	11	12	1	2	3	4	5	6	7	8	9
Manufacturing	█											
Installation	█											
Commissioning					█							
Demand Operation											█ →	



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4-1. IGCC - Most Advanced Technology in the World



Features of MHPS IGCC

- Highest Plant Efficiency by Air-Blown IGCC
- Flexibility for Variety of Coal Including Brown Coal
- Higher Reliability & Easier Maintainability with Membrane Waterwall Configuration
- High Plant Efficiency by High Temp. GT and High Reliability from Abundant “Low BTU Gas Firing” GT

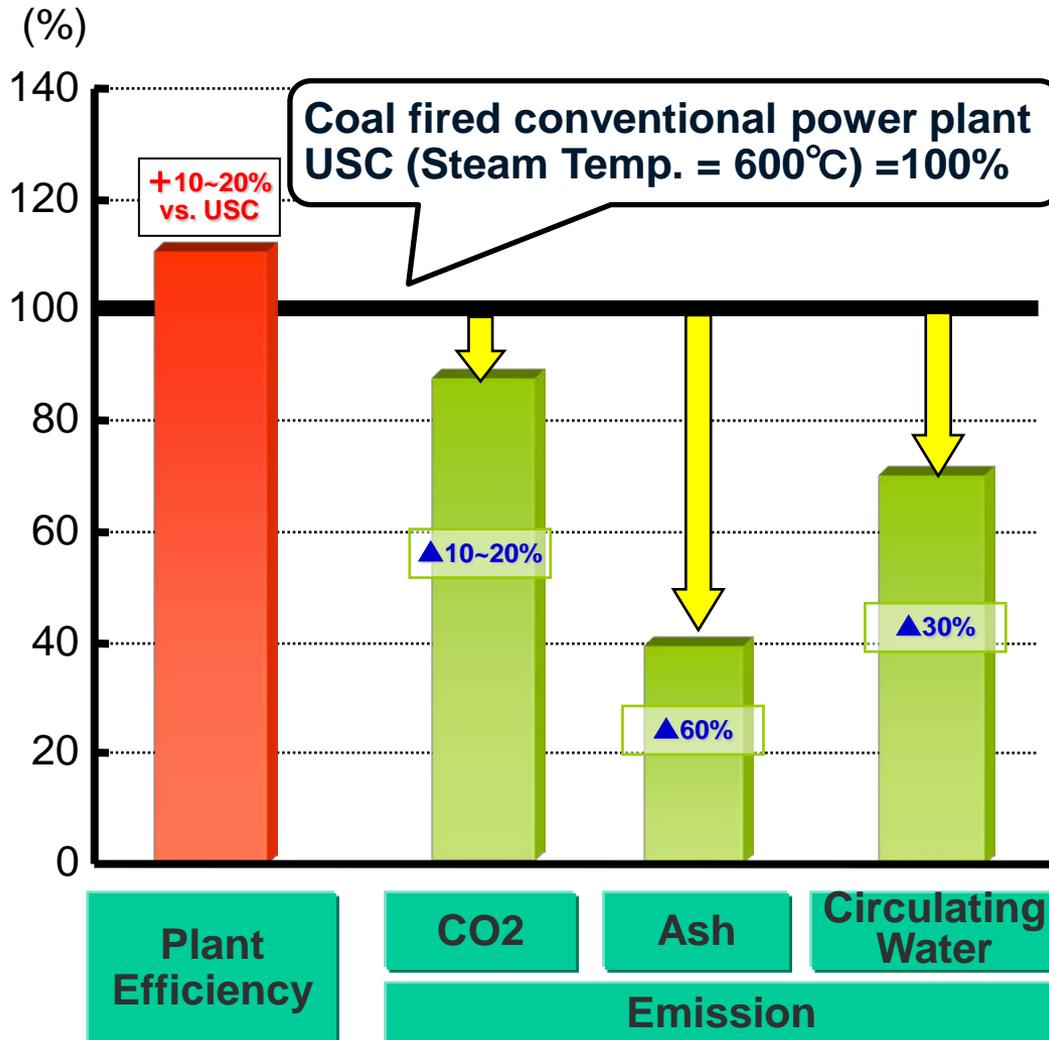
250MW-IGCC Plant (Joban Joint Power.Co., Ltd. Nakoso #10)



4-2. IGCC – World Highest Efficiency & Lowest Emission



The World Highest Efficiency and Lowest Emission for coal can be achieved by MHPS Air-blown IGCC.



Flyash (Conventional Boiler) Grassy Molten Slag (IGCC)

Approx. 60% decrease in volume



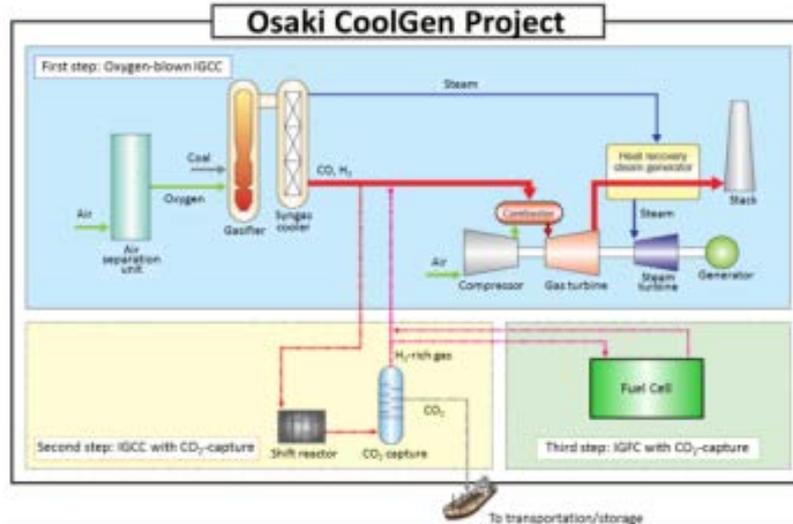
Utilization as a pavement material Utilization as a concrete aggregate are possible.

4-3. Oxygen-Blown Gasification Technology



Oxygen Blown IGCC Demonstration (Osaki CoolGen Project)

- J-Power and The Chugoku Electric Power Co., Inc. jointly established Osaki Cool Gen Corporation on July 2009.
- Osaki CoolGen constructs a 170-MW-class IGCC demonstration plant supported by Ministry of Economy, Trade and Industry and then plans to conduct trials utilizing the latest CO₂ separation and capture technology and fuel cell technologies.



(Under construction)

Output	166 MW
Gasifier	O₂ blown, single-chamber two-stage spiral-flow entrained type
Gas Cleanup	Methyldiethanolamine (MDEA)
Gas Turbine	H-80 (1,300°C Class)
Operation Start(Scheduled)	March 2017

4-4. IGCC - TEPCO Develops IGCC Commercial Plants (500MW Class) in Japan

Tokyo Electric Power Company -New Comprehensive Special Business Plan-

- **Creating industry and employment through the construction of the world's most advanced high-efficiency coal-fired power plant**

In Fukushima, the large-scale IGCC facility, employing Japanese clean coal technology, leads the world in proving the technology and attracts global acclaim as a source of clean coal technology and as a symbol of Fukushima's revitalization

- **Generating employment through ongoing infrastructure repairs to small and medium-sized aging hydroelectric power stations**

Over the next 10 years, small and medium-sized hydroelectric power stations in Fukushima's Inwashiro catchment area will be progressively refurbished, contributing to local employment and the economy

- **Transfer of part of TEPCO's operations to the Hamadori region**

Part of TEPCO's business operations (the salary accounting and customer materials mailout businesses) will be relocated to the Hamadori region

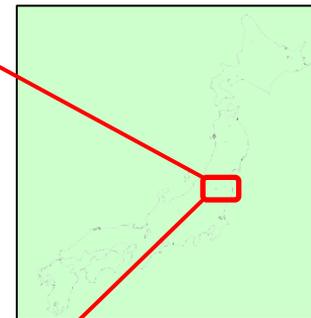
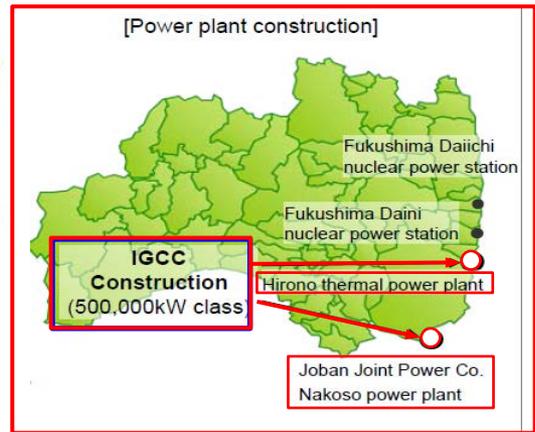


- On the premises of the Hirono thermal power plant (Futaba-gun) and the Nakoso power plant run by the Joban Joint Thermal Power Co. (Iwaki City), a 500,000 kW-class trial project involving the construction and operation of a coal-fired thermal power plant using world-leading high-efficiency technology (IGCC)

- As far as possible, the construction equipment and materials used to refurbish the small and medium-sized aging hydroelectric power stations will be purchased from businesses in Fukushima prefecture.

- Relocation of part of the personnel-related operations, such as salary accounting, in the first half of FY2014, and part of the sales-related operations, such as the customer materials mailout business, during FY2013

*IGCC (Integrated coal Gasification Combined Cycle)



Source: Tokyo Electric Power Company HP Press Release on 15 Jan.2014
Detailed Report of the New Comprehensive Special Business Plan

Project Schedule

- Environmental Impact Assessment 2014.5~ (officially started already)
- Start of Construction 2016 (scheduled)
- Start of Operation 2020 (scheduled)



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5-1. Air Quality Control Systems

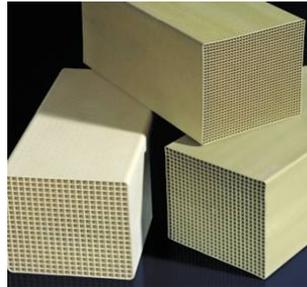
Environmental Systems

MHPS expands its product lineup to offer systems that match the needs of customers.



Flue Gas Denitrification System

Systems can now operate with both honeycomb catalysts and plate catalysts to serve a wide range of customers.



Honeycomb Catalyst

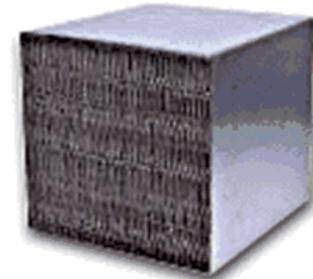


Plate Catalyst



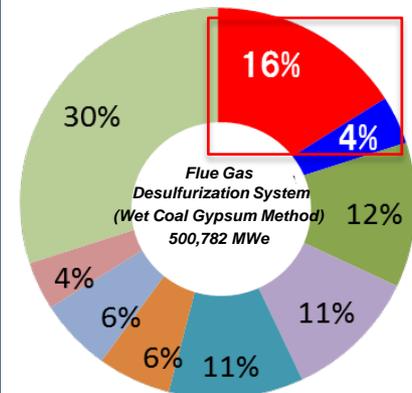
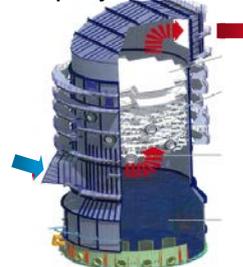
Flue Gas Desulfurization System

The two companies' strong technologies complement each other to meet a broader spectrum of customer needs.

Liquid Column Tower



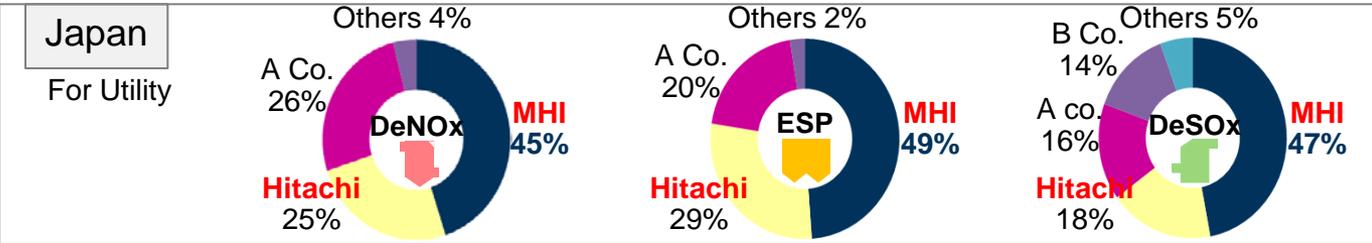
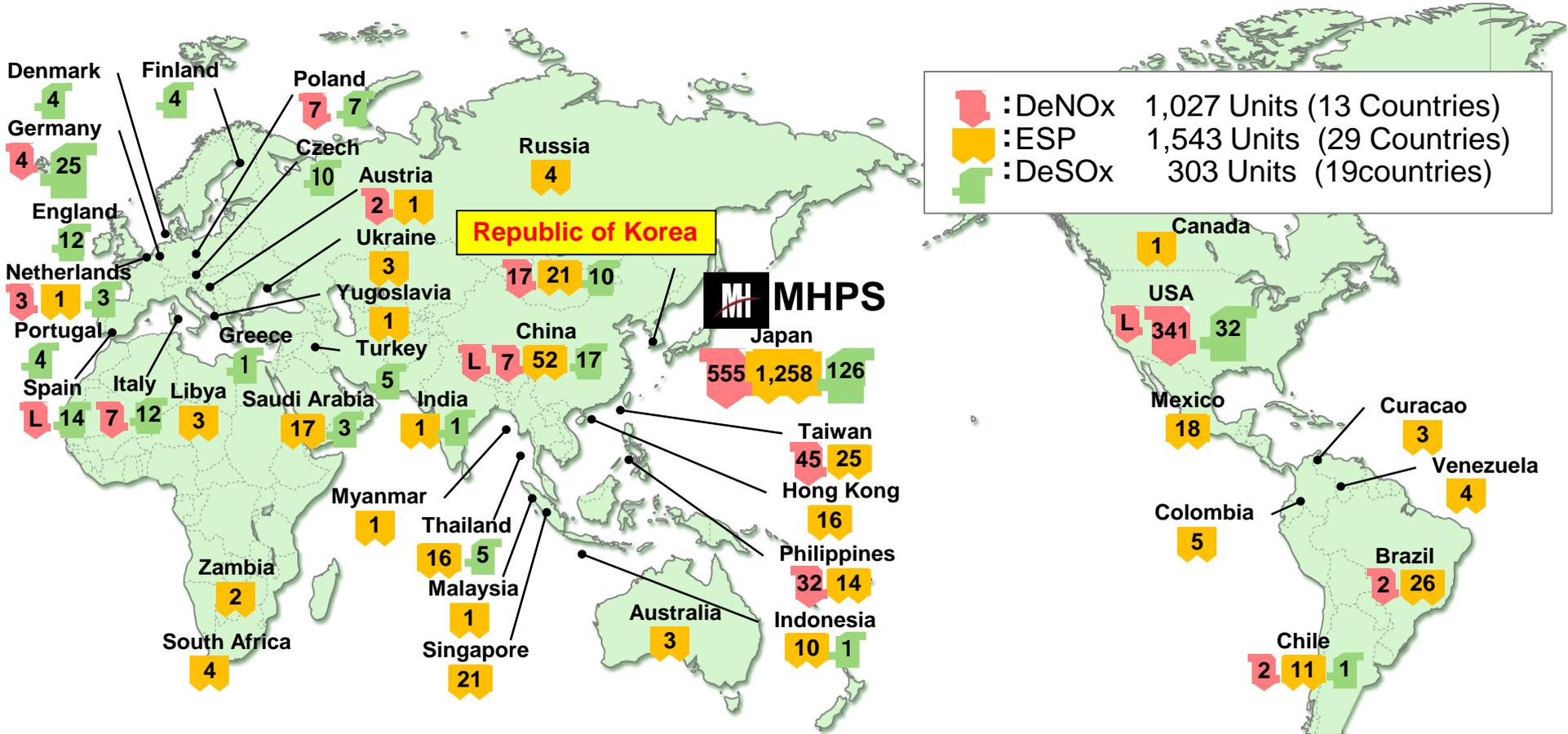
Spray Tower



Overseas Market Share in Wet Coal Gypsum Method (as of Apr. 2013, excl. China) (Database: McCoy Power Company)

- MHI
- Hitachi
- F company
- A company
- B company
- M company
- D company
- E company
- Others

5-2. Air Quality Control Systems Delivery Record



As of 2013

Number : References
L : License

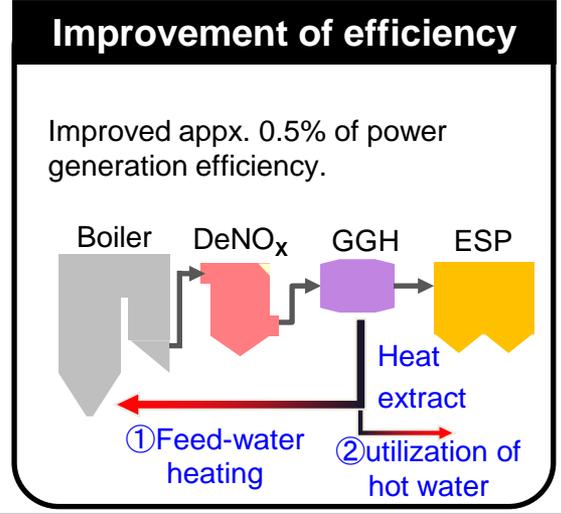
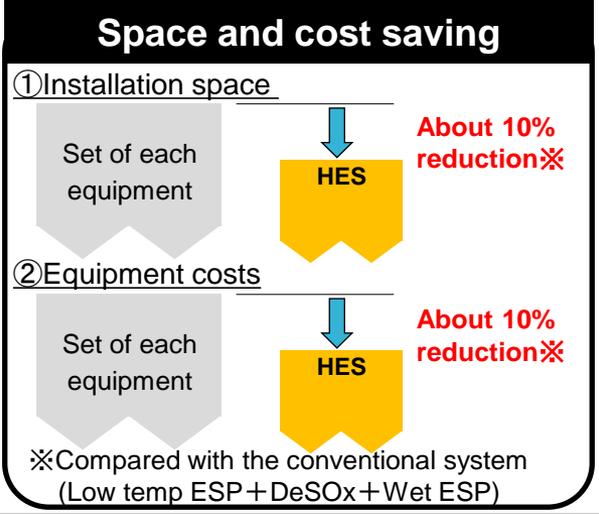
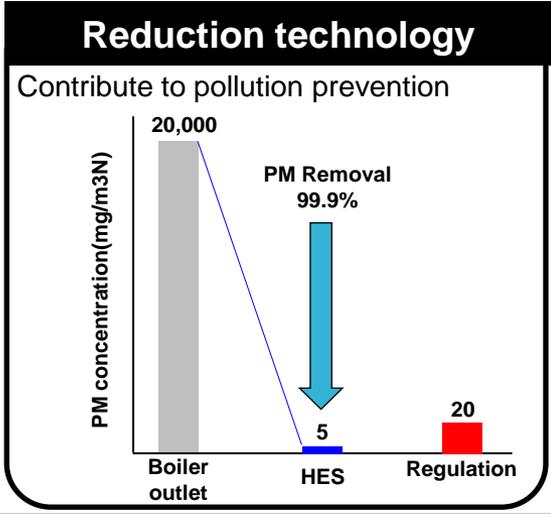
5-3. High Efficiency PM Removal System



High Efficiency PM Removal System (consist of GGH, Low-Low Temp. ESP and FGD) reduces PM (Particle Matter) emissions less than 5mg/m³N and improve power generation efficiency as well.



Advantages of High Efficiency PM Removal System(HES)





Elektrownia “Kozienice” S.A. (Poland) / Kozienice P.S. / Unit No.4-8

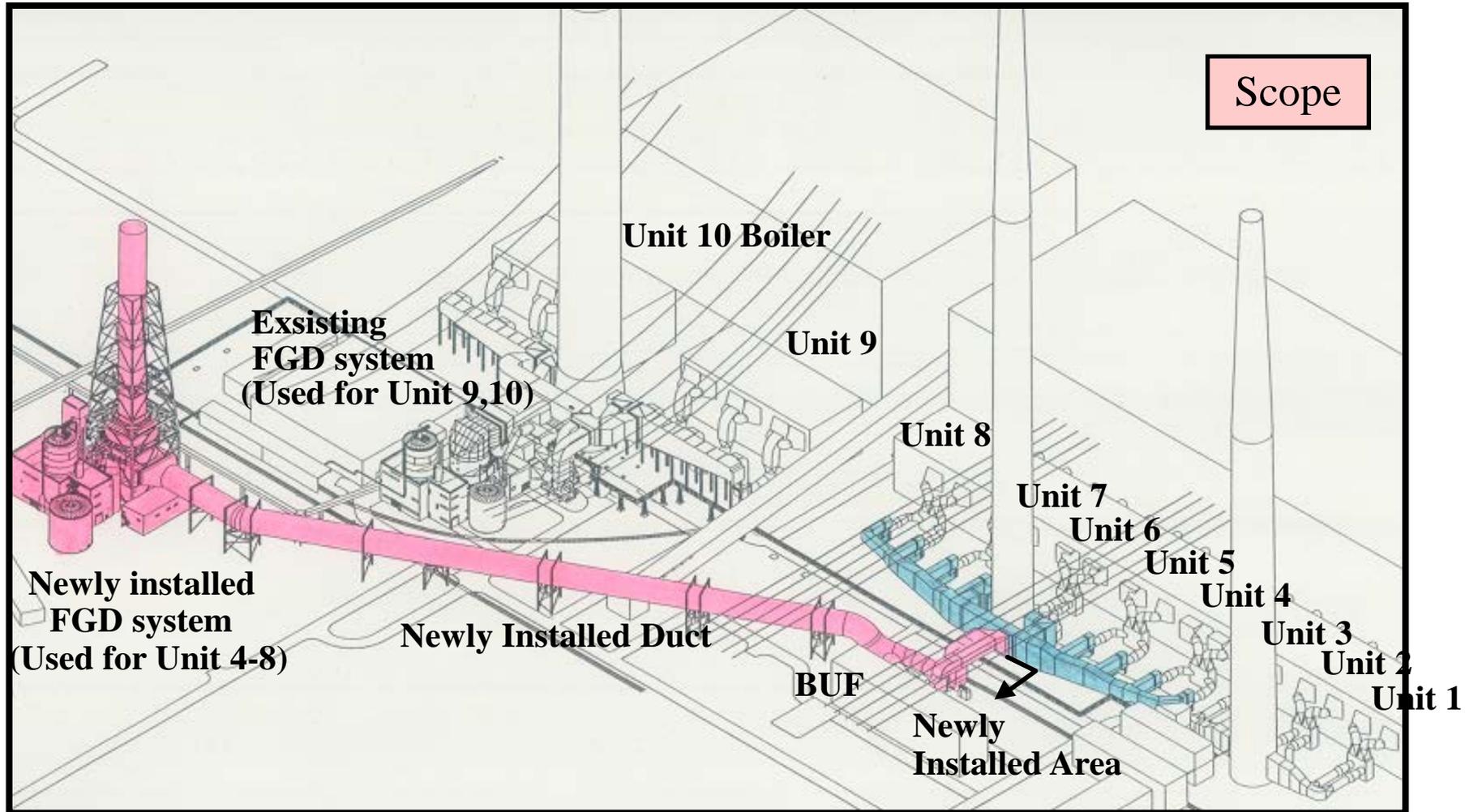


FGD KOZ II FGD (800MW equiv.)

MAJOR SPECIFICATION

<i>Boiler Fuel:</i>	<i>Hard Coal</i>
<i>FGD Process:</i>	<i>Wet Limestone-gypsum</i>
<i>Gas Flow Rate:</i>	<i>3 480 000 m³N/h</i>
<i>(Single Common Absorber For 5 boilers, 200MW each)</i>	
<i>Inlet SO₂ Concentration:</i>	<i>3 200 mg/ m³N</i>
	<i>(1 120 ppmd)</i>
<i>SO₂ Removal Efficiency:</i>	<i>93,75 %</i>
<i>Absorber Type:</i>	<i>Single-Loop</i>
	<i>In-Situ Oxidation Process</i>
<i>Operation:</i>	<i>Dec., 2006</i>

5-4. FGD Retrofit to existing units : Reference in Poland (2/2)



5-5. Sea Water FGD for Asian Market : Reference in Indonesia



Client : PT. Paiton Energy

Plant : Paiton #3, Indonesia

Fuel : Coal

Generating Power : 856MW

Gas Flow Rate : 2,859,500 Nm³/h(w)

Desulfurization : 92.0 %

Efficiency

Start up : April 2012

Absorber Type : DCFS

Absorbent Type : Sea water



Flue gas for 856MW is treated by single module absorber



**MITSUBISHI HITACHI
POWER SYSTEMS**