



The Challenge for Future Power Generation

Kenji Ando

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

2. Establishment of MHPS

3. High Efficiency Gas Turbines

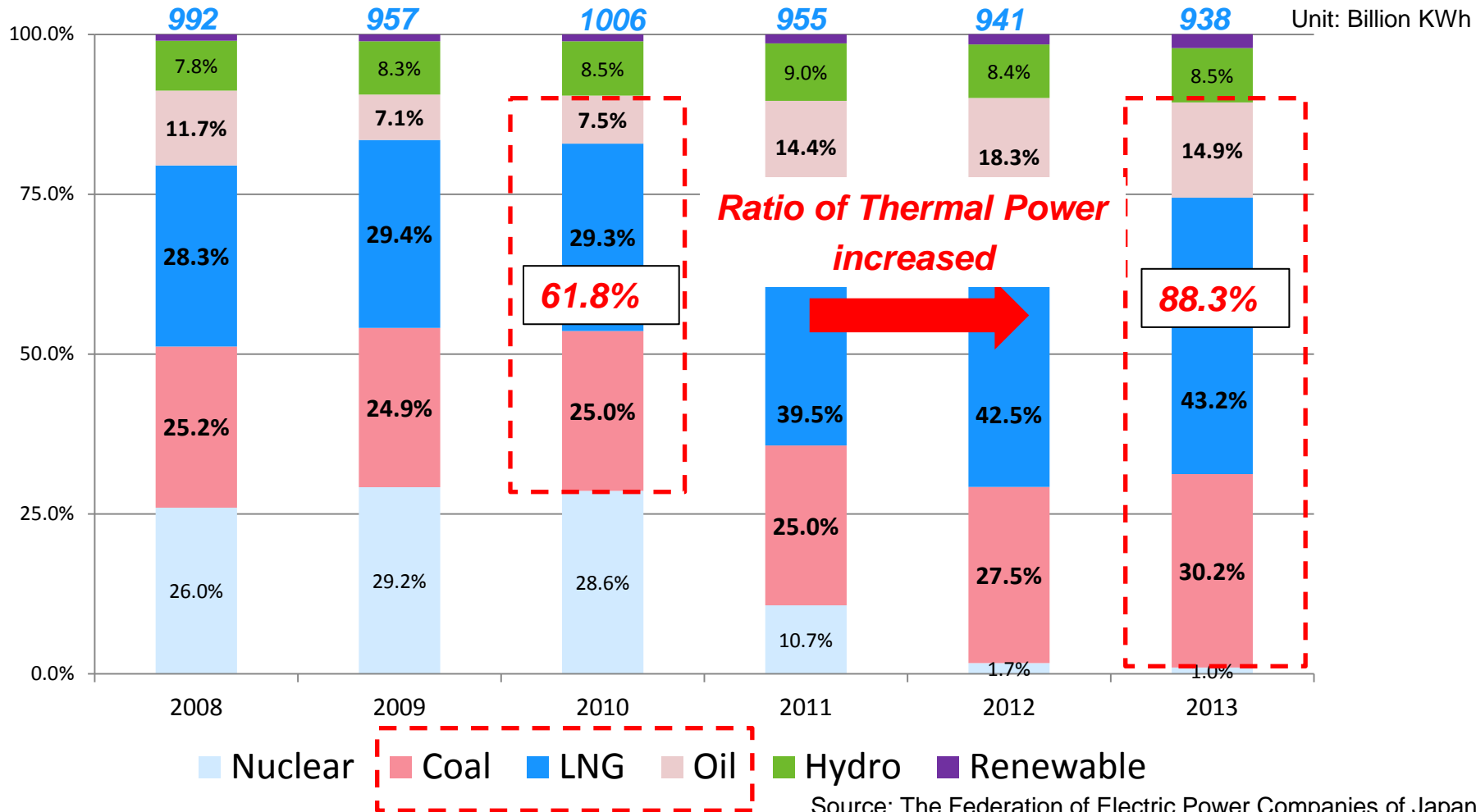
4. IGCC - Most Advanced Technology in the World

5. Air Quality Control Systems

1-1. Power Generation in Japan



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

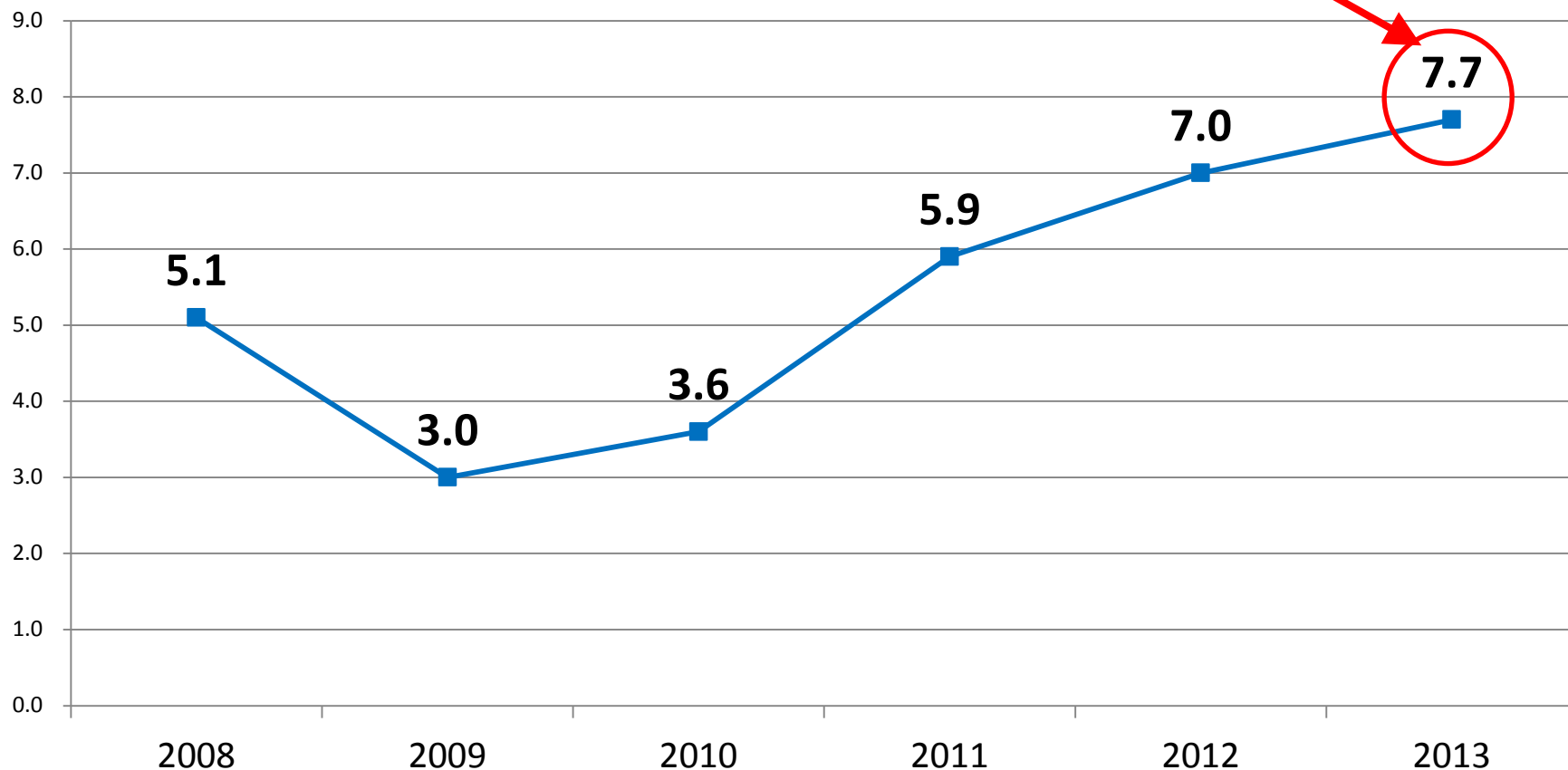


1-2. Energy Cost for Power Generation in Japan



The highest energy cost for power generation in Japan

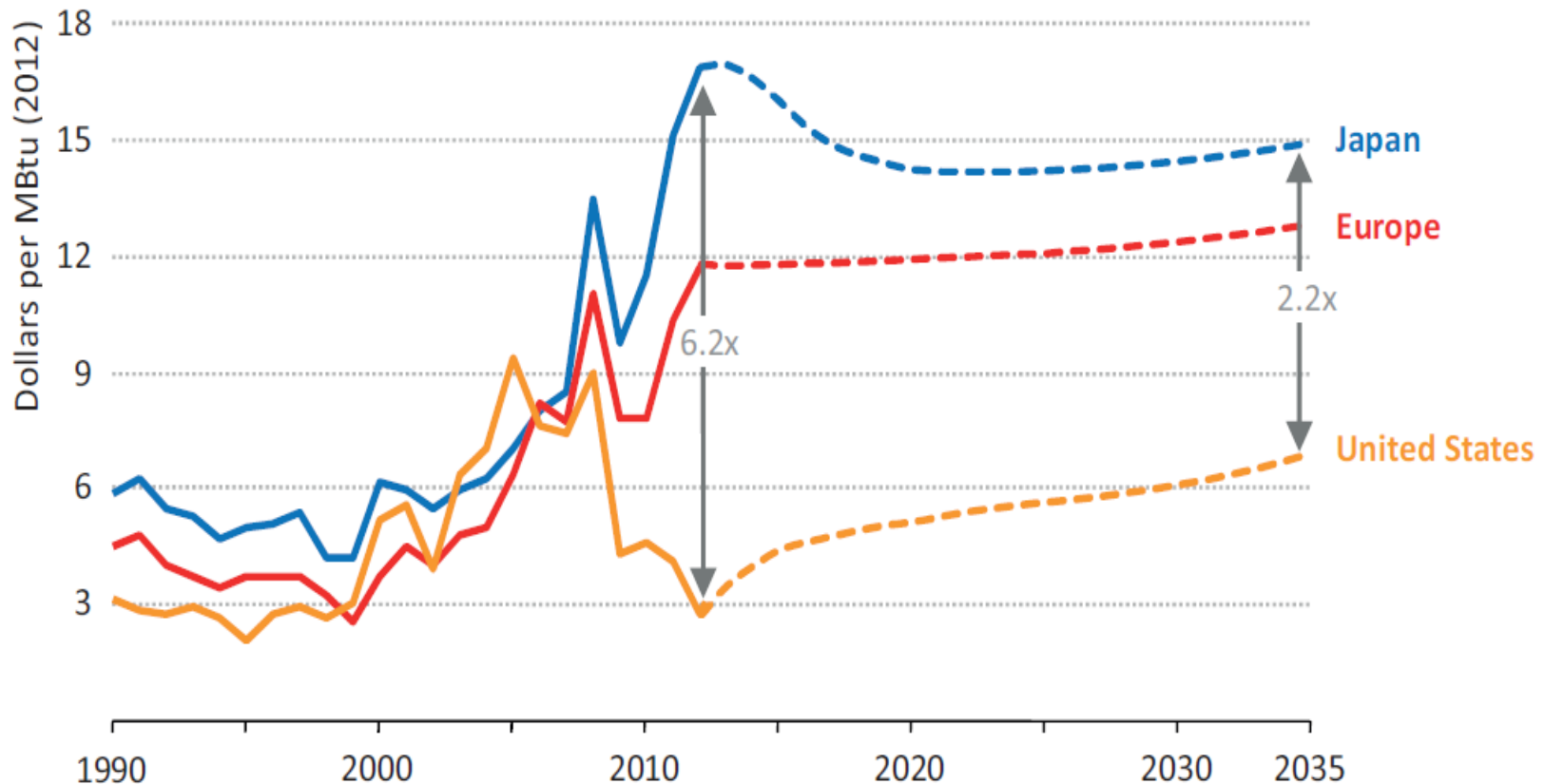
Unit: Trillion JPY



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

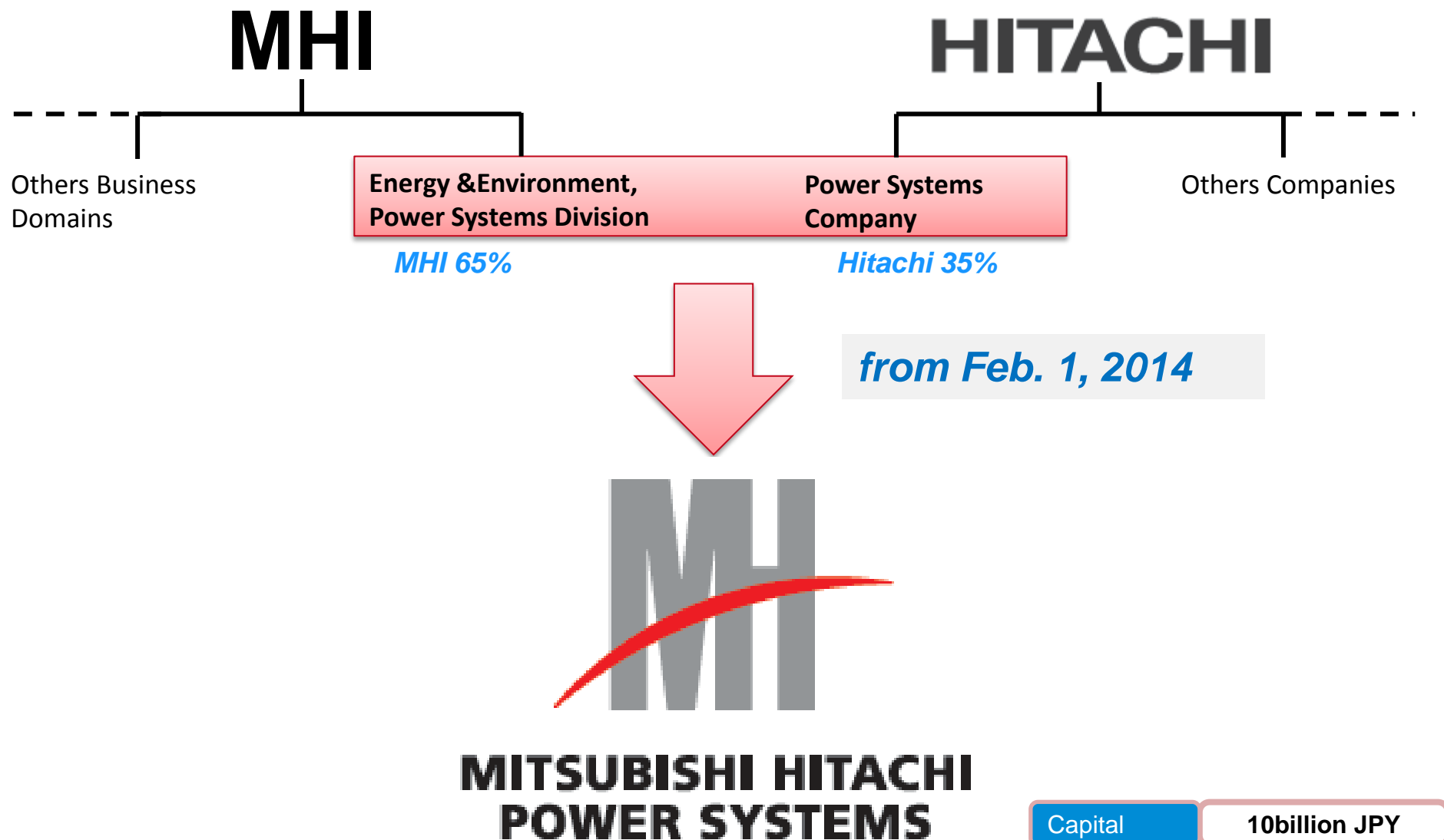
2. Establishment of MHPS

3. High Efficiency Gas Turbines

4. IGCC - Most Advanced Technology in the World

5. Air Quality Control Systems

2-1. Establishment of MHPS



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



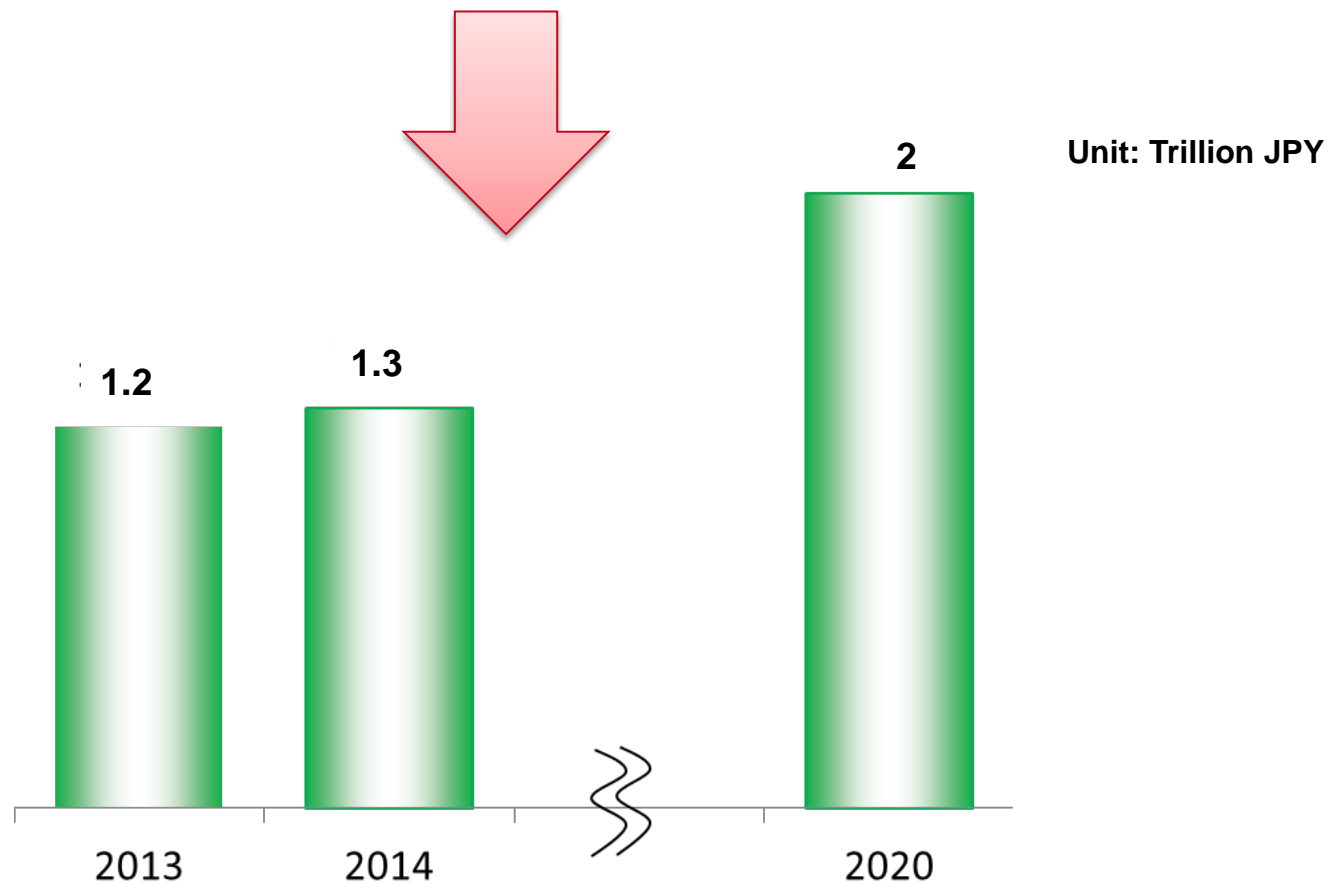


One + One = Infinite Potential

Customer Focus and Long-Term Support

Solving Energy and Environmental Issues on a Global Scale

Business Scale





1. What is required by Energy & Environment

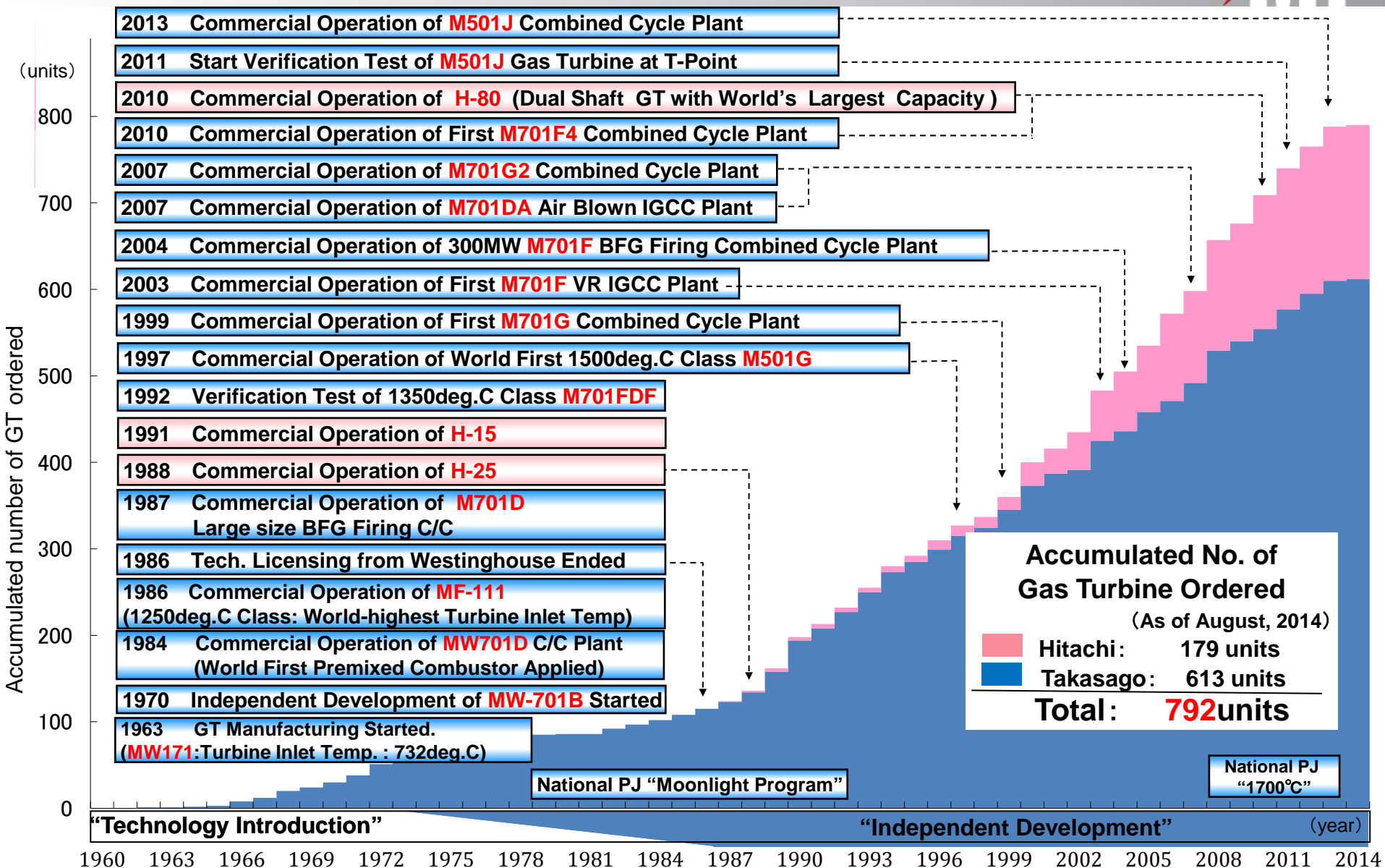
2. Establishment of MHPS

3. High Efficiency Gas Turbines

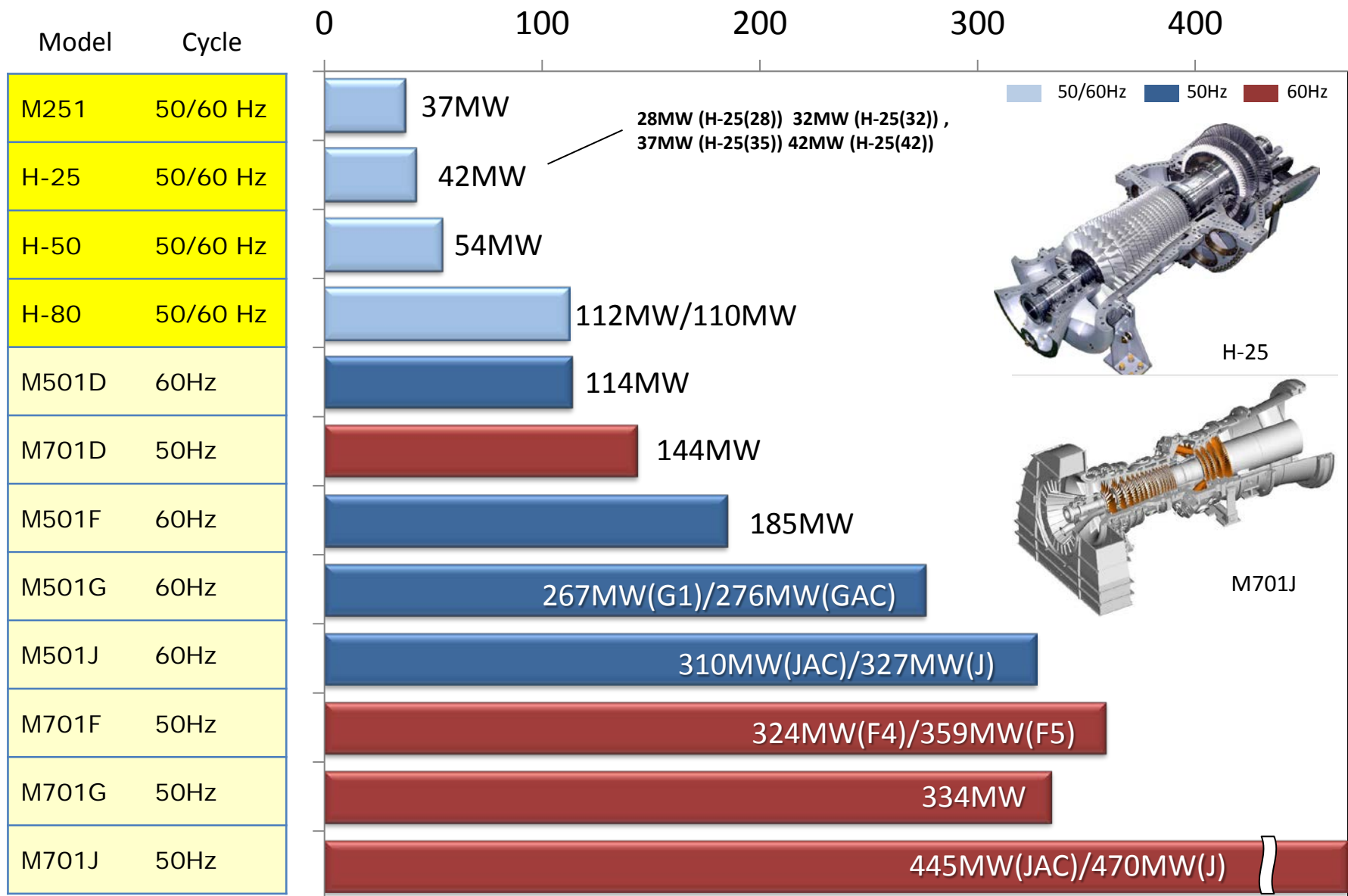
4. IGCC - Most Advanced Technology in the World

5. Air Quality Control Systems

3-1. History of Gas Turbines



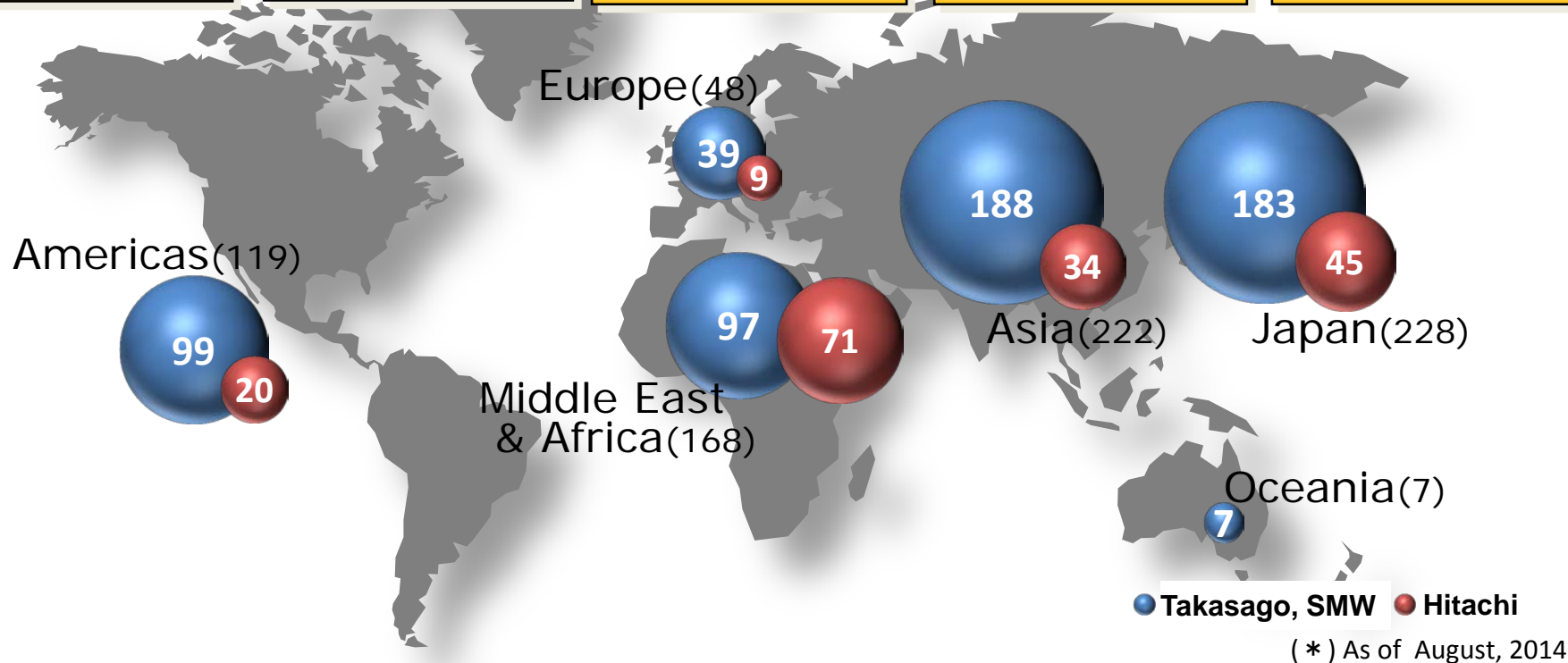
3-2. Gas Turbine Line up



3-3. MHPS Gas Turbine Global Experience



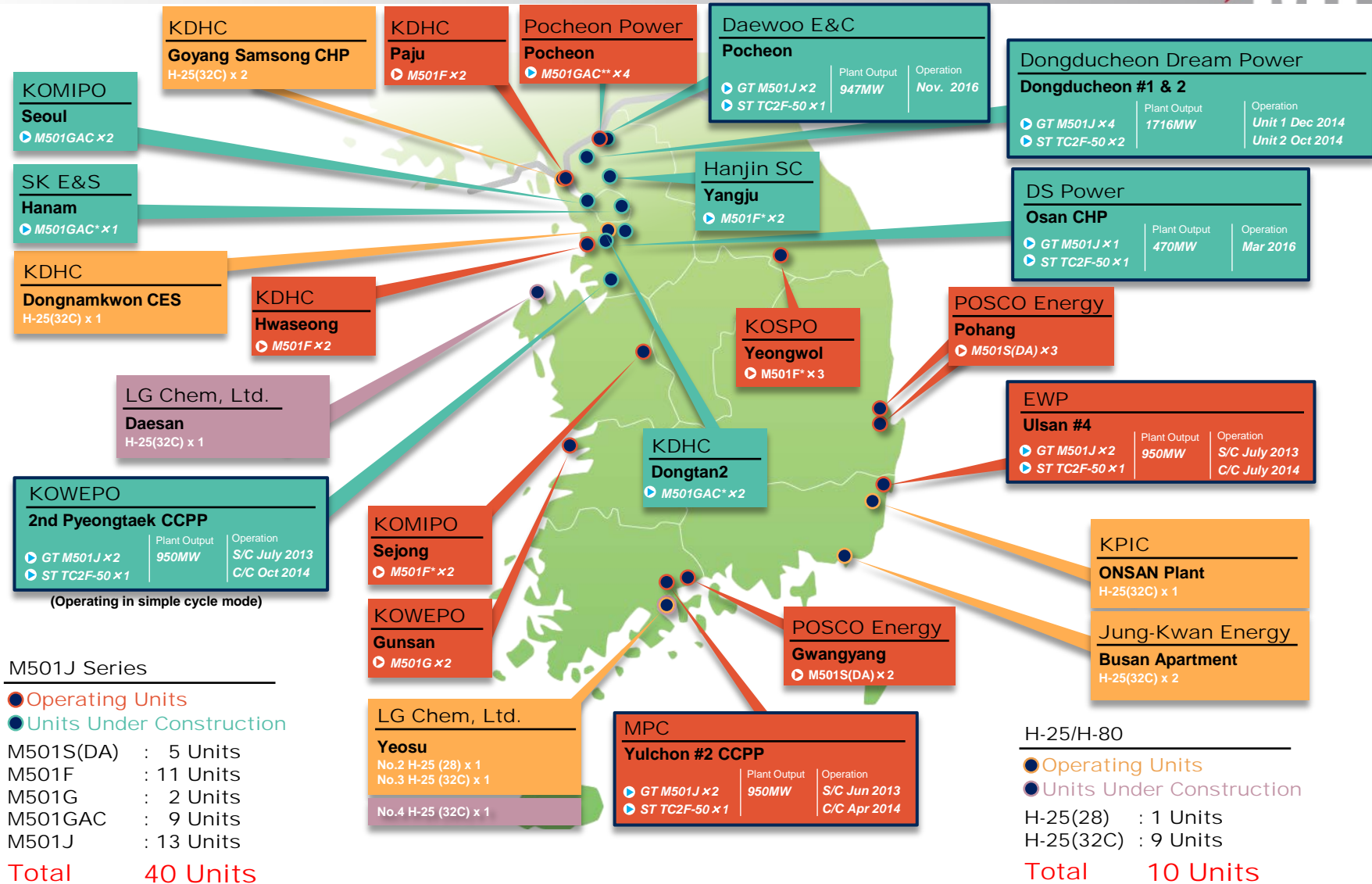
M501J × 26 M701J × 2 Total: 28 units	M501G × 70 M701G × 11 Total: 81 units	M501F × 73 M701F × 125 Total: 198 units	M501D × 25 M701D × 92 Total: 117 units	H-15 × 6 H-25 × 160 H-80 × 13 Total: 179 units
---	--	--	---	---



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

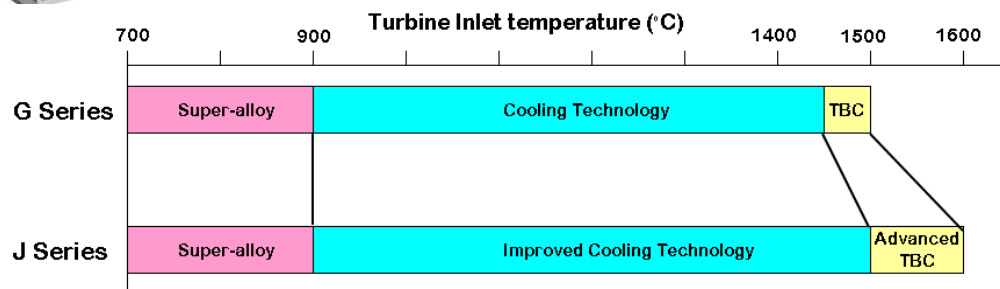
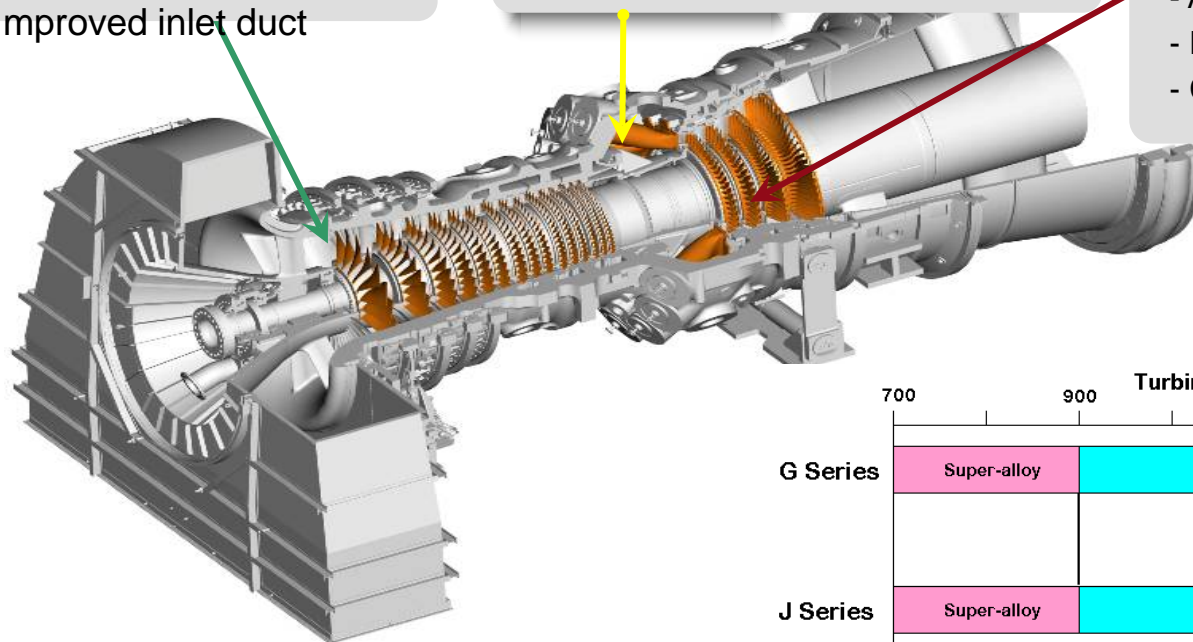
Proven G Combustor

- Well experienced DLN combustor
- Steam cooled liner

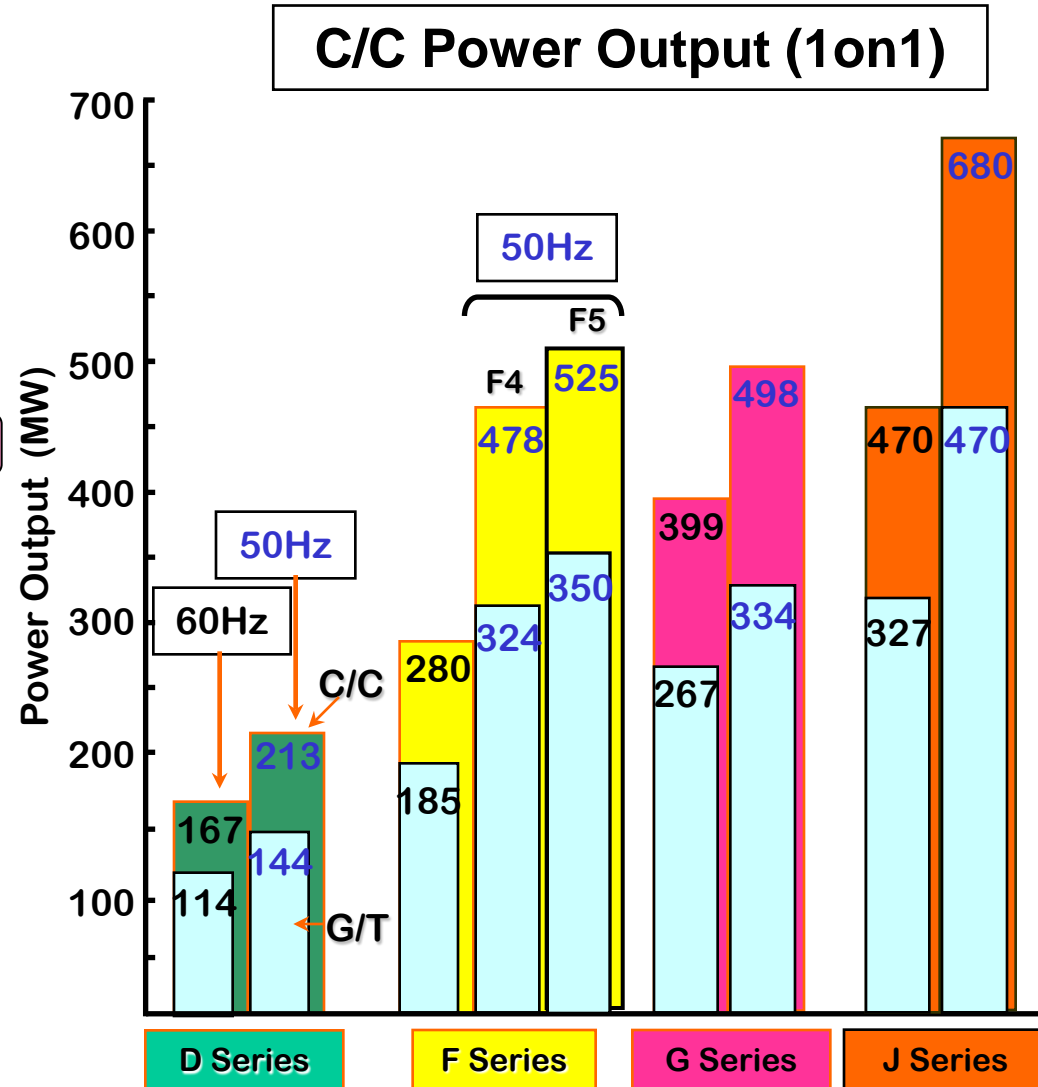
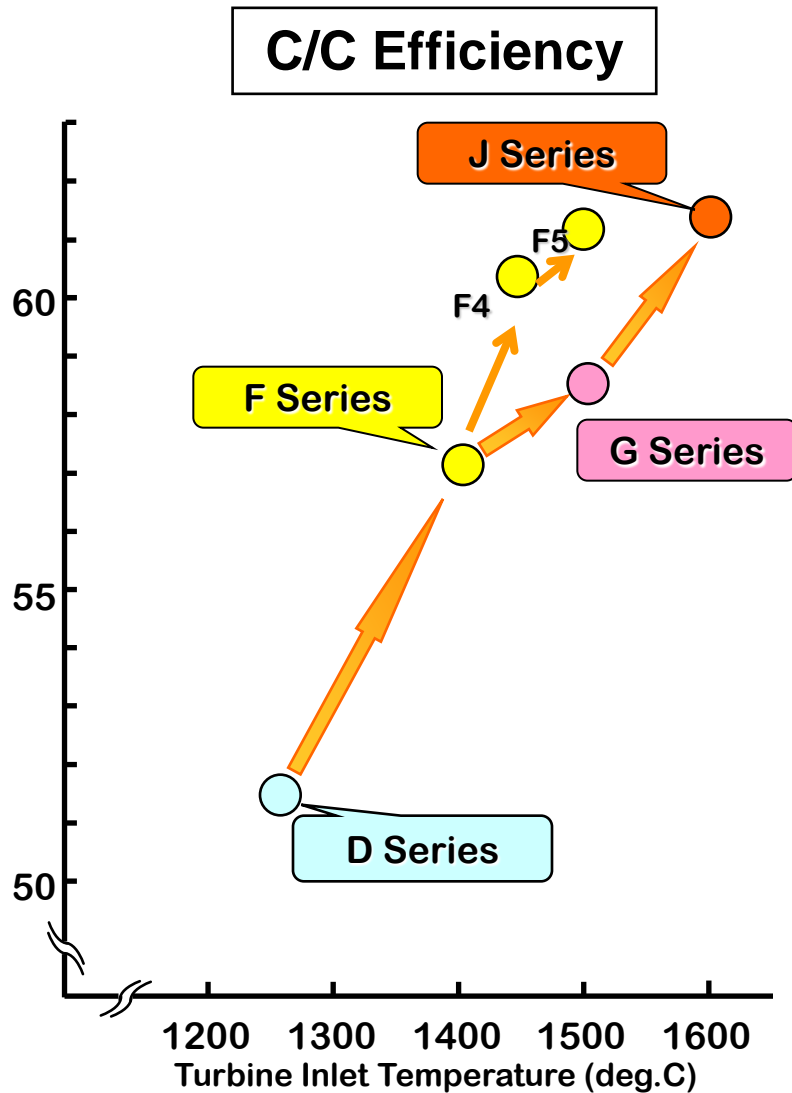
Turbine

National Project Technologies

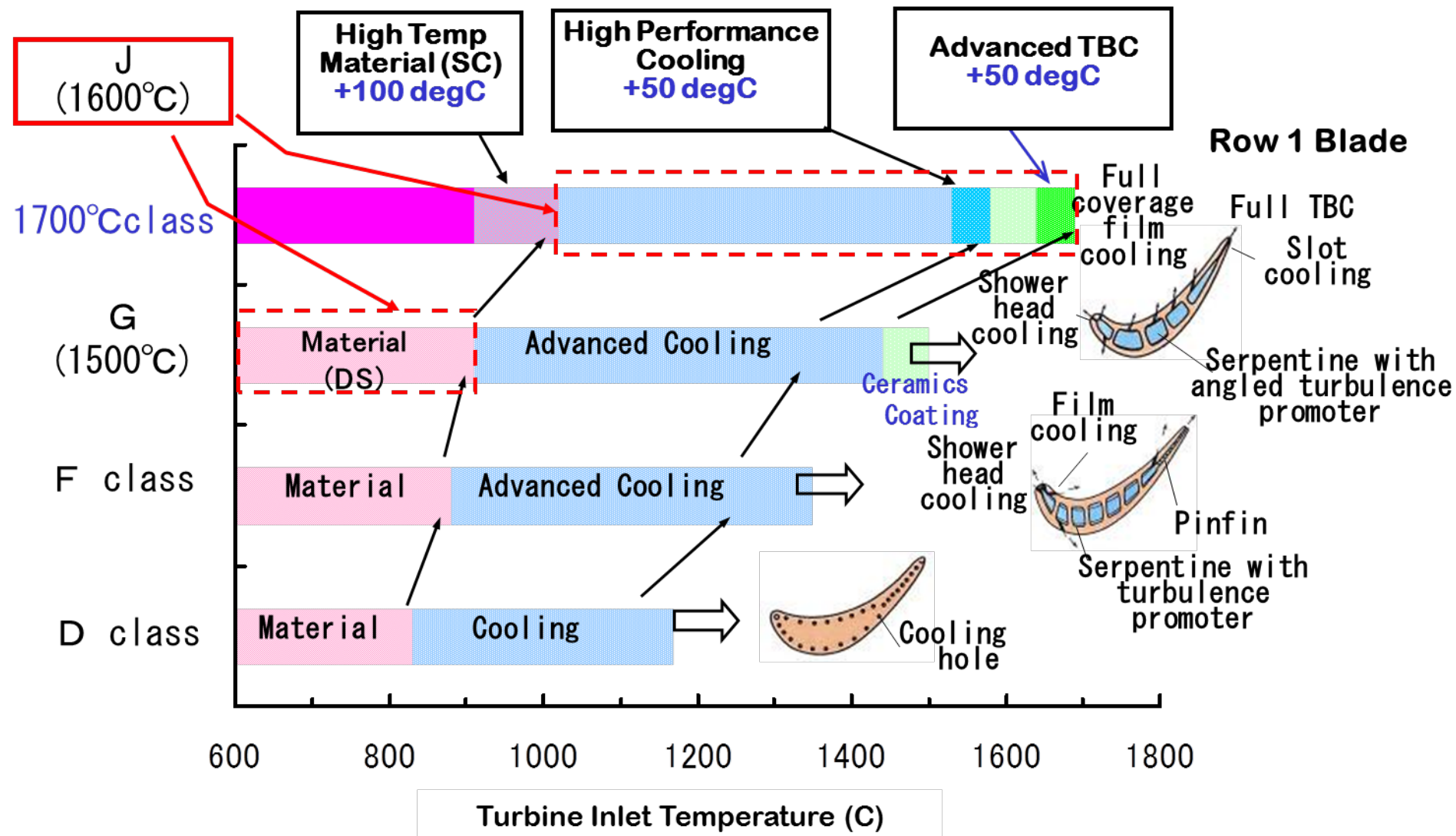
- Advanced TBC + Cooling
- High efficient aerodynamic technology
- Cooled row4 blade



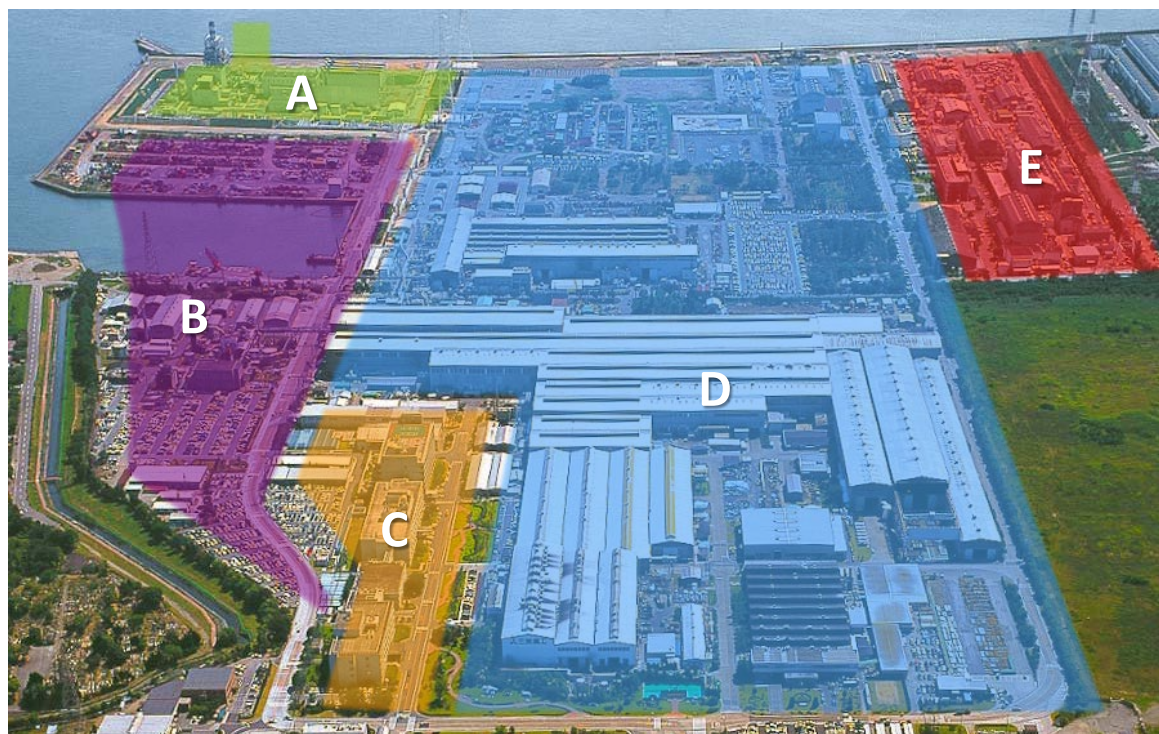
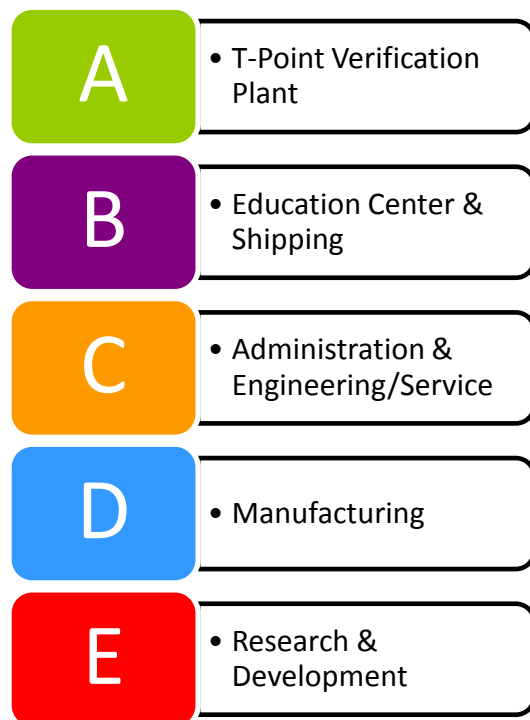
3-6. Performance Enhancement



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

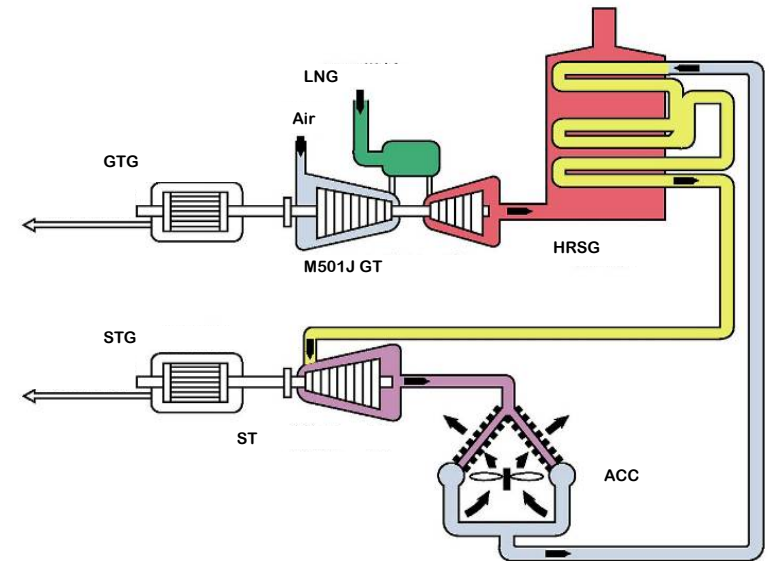


3-8. Development and Verification in Takasago



	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												

- 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**

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

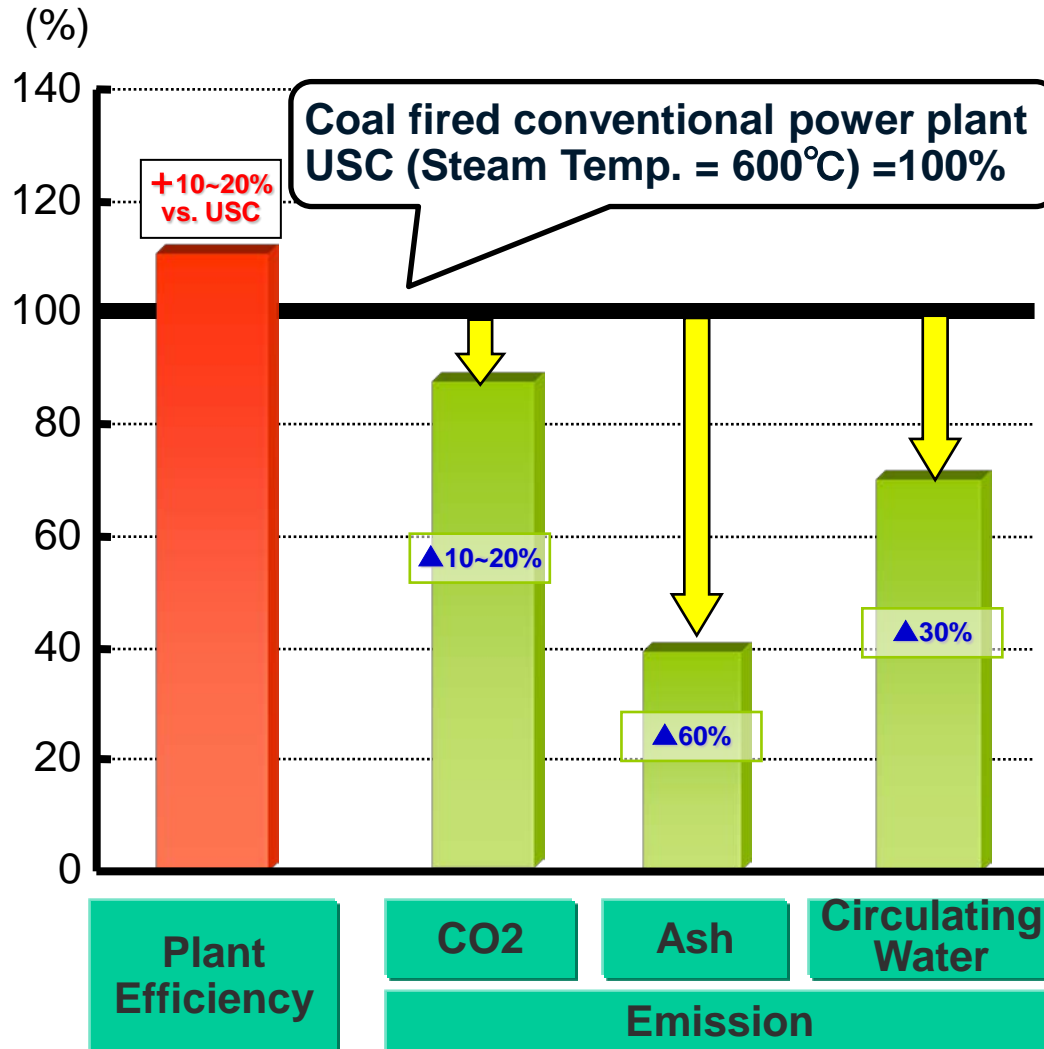
250MW-IGCC Plant (Joban Joint Power.Co., Ltd. Nakoso #10)



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



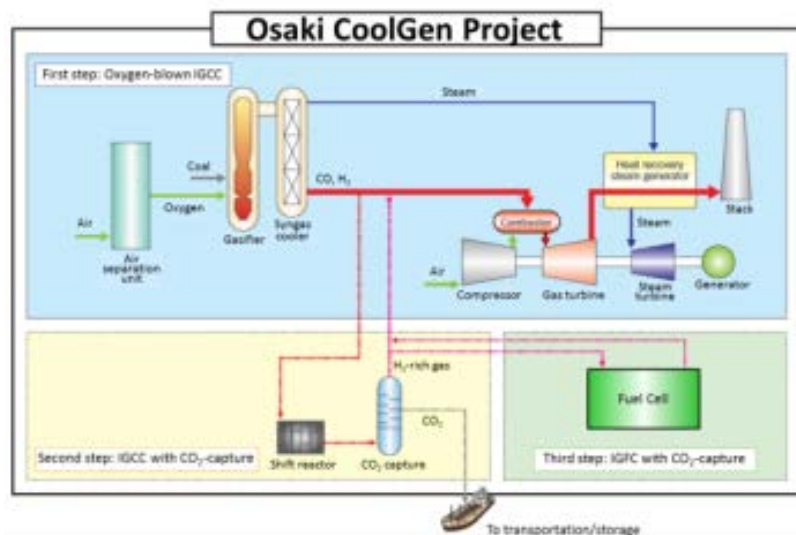
Utilization as a *pavement material* Utilization as a *concrete aggregate*
are possible.

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	O ₂ 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 Inawashiro catchment area will be progressively refurbished, contributing to local employment and the economy

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

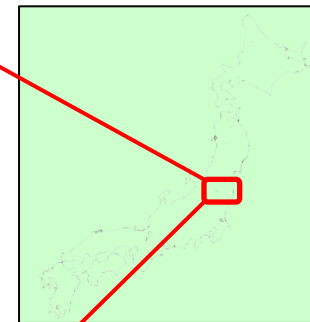
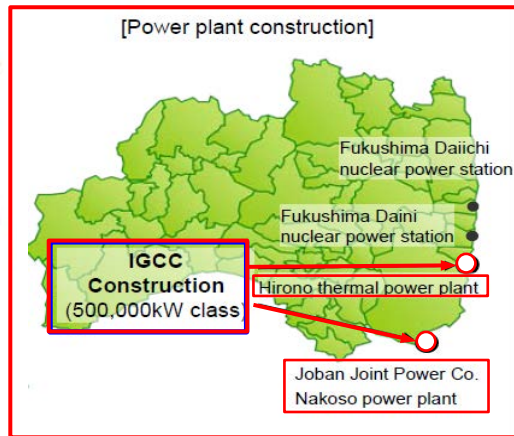
Part of TEPCO's business operations (the salary accounting and customer materials mailout businesses) will be relocated to the Hamadori region

- On the premises of the Hirano 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)

- 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**

5-1. Air Quality Control Systems

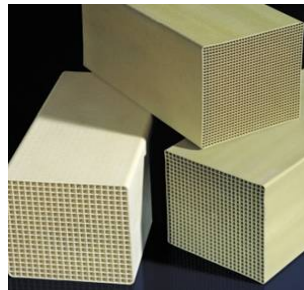
Environmental Systems

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

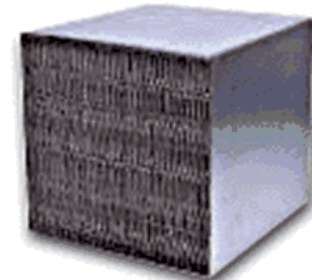


Plate Catalyst



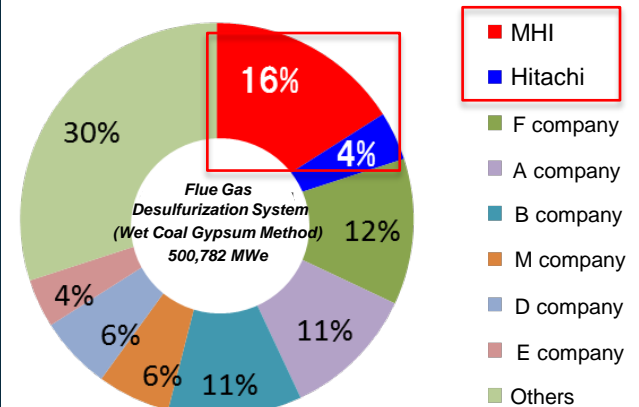
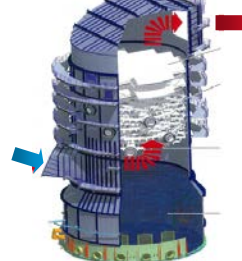
Flue Gas
Desulfurization System

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

Liquid Column Tower

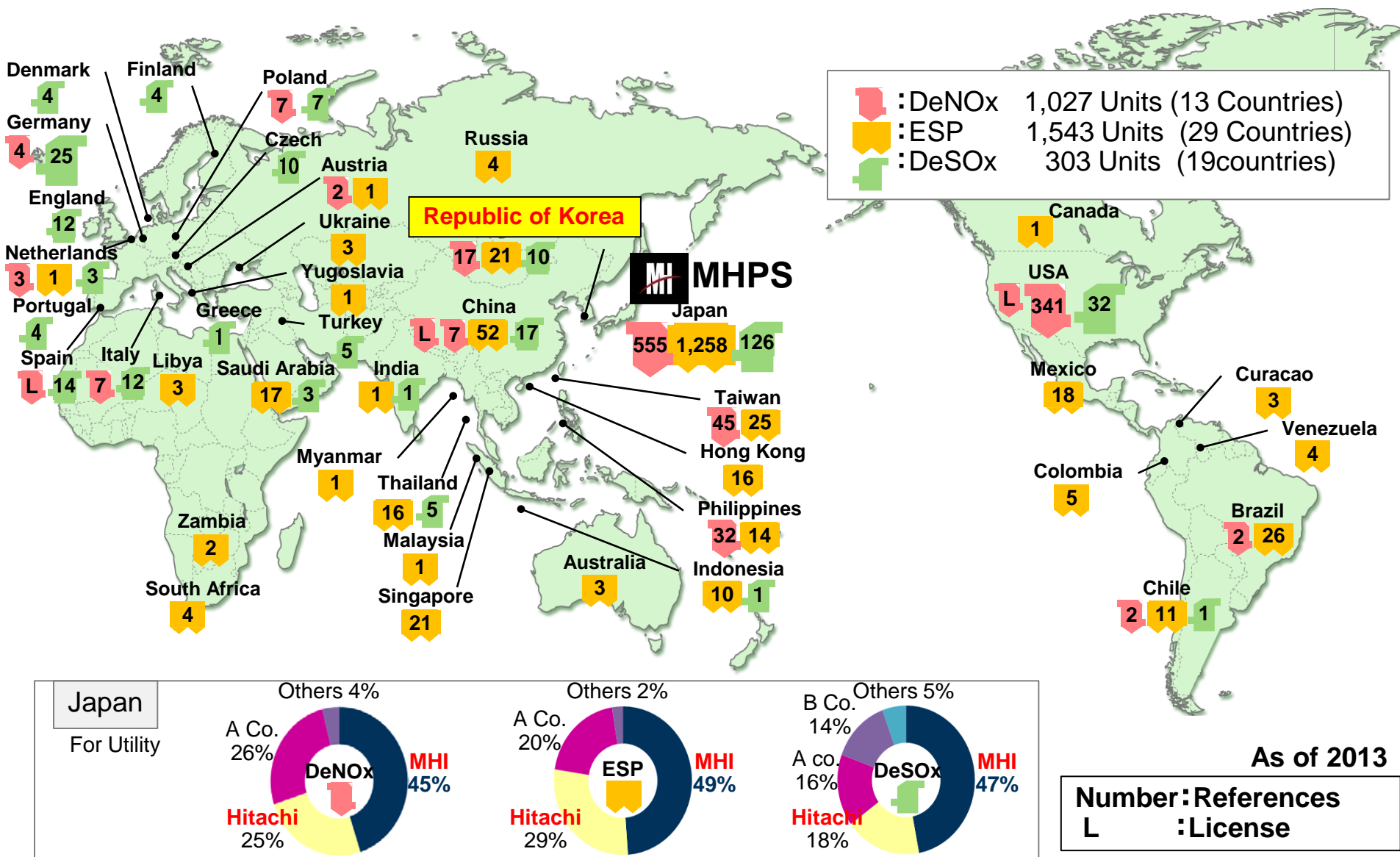


Spray Tower



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

5-2. Air Quality Control Systems Delivery Record



5-3. High Efficiency PM Removal System

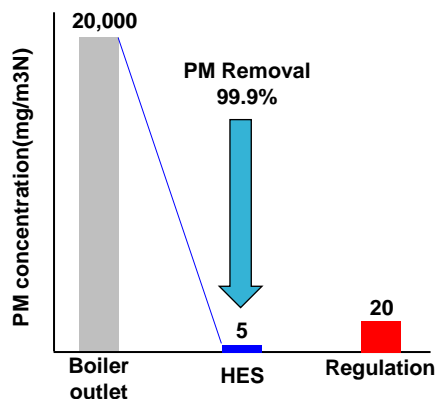


High Efficiency PM Removal System (consist of GGH, Low-Low Temp. ESP and FGD) reduces PM (Particle Matter) emissions less than 5mg/m³N and improve power generation efficiency as well.



Reduction technology

Contribute to pollution prevention



Space and cost saving

① Installation space

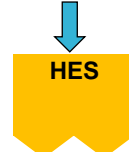
Set of each equipment



About 10% reduction※

② Equipment costs

Set of each equipment

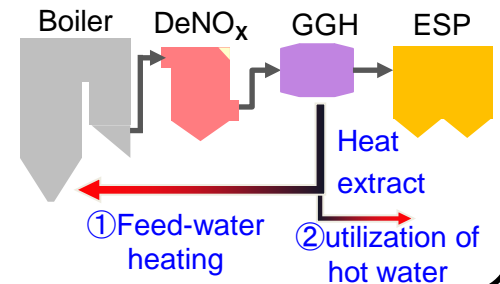


About 10% reduction※

※Compared with the conventional system (Low temp ESP + DeSOx + Wet ESP)

Improvement of efficiency

Improved appx. 0.5% of power generation efficiency.





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



FGD KOZ II FGD (800MW equiv.)

MAJOR SPECIFICATION

Boiler Fuel: Hard Coal

FGD Process: Wet Limestone-gypsum

Gas Flow Rate: 3 480 000 m³N/h

(Single Common Absorber For 5 boilers, 200MW each)

*Inlet SO₂ Concentration: 3 200 mg/ m³N
(1 120 ppmd)*

SO₂ Removal Efficiency: 93,75 %

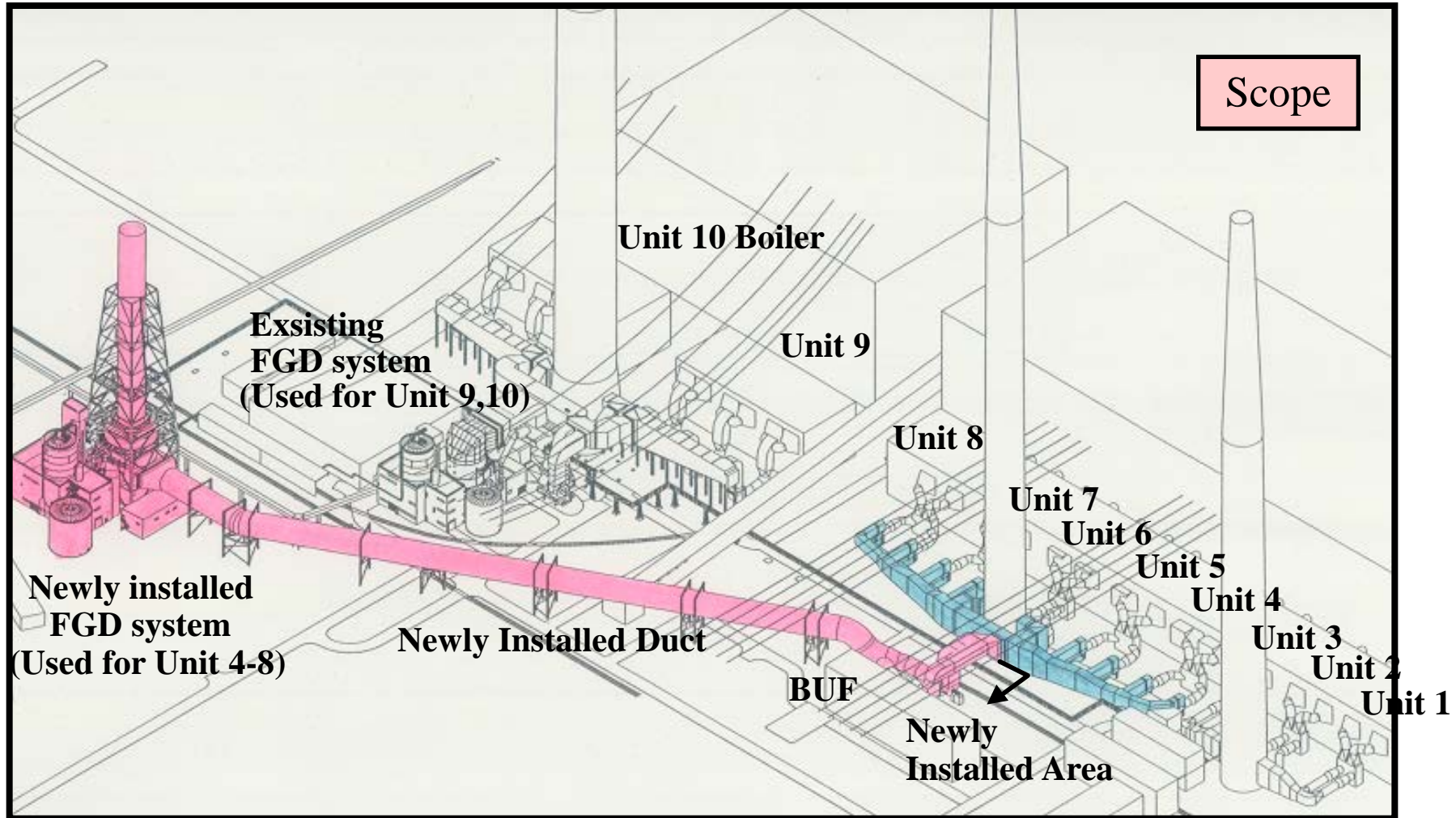
Absorber Type: Single-Loop

In-Situ Oxidation Process

Operation: Dec., 2006

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

Scope



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**