

ADDED VALUE ENHANCEMENT FOR 1,000kW-CLASS CHP SYSTEM

19 / Oct /2011

**OSAKA GAS CO., LTD.
&
MITSUBISHI HEAVY INDUSTRIES, LTD.**

CONTENTS

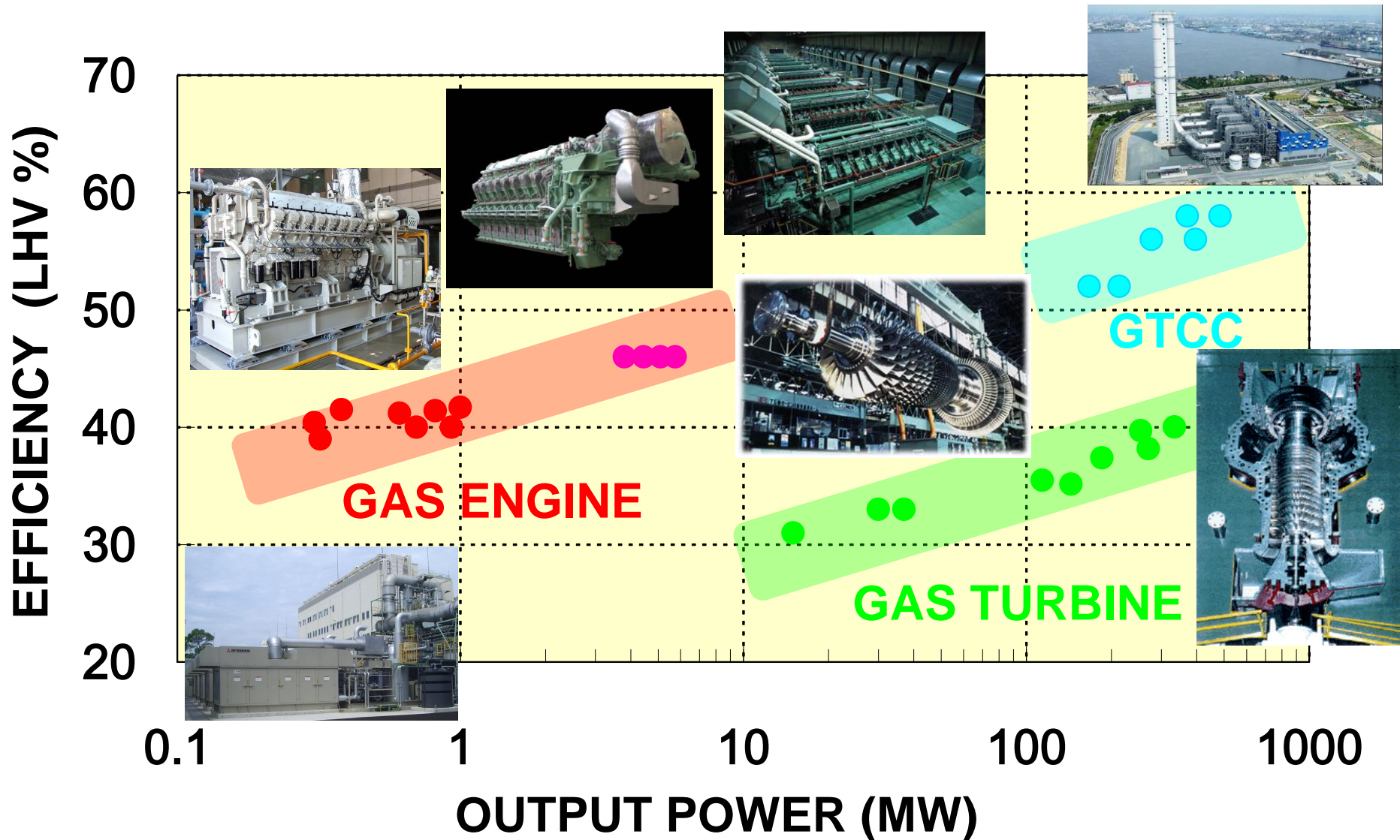
1. MHI GAS ENGINE AND GAS TURBINE

(MHI : MITSUBISHI HEAVY INDUSTRIES, LTD.)

2. Added value enhancement for 1,000kW- Class CHP SYSTEM

- Improvement of
the first step loading ratio**
- Improvement of total efficiency**

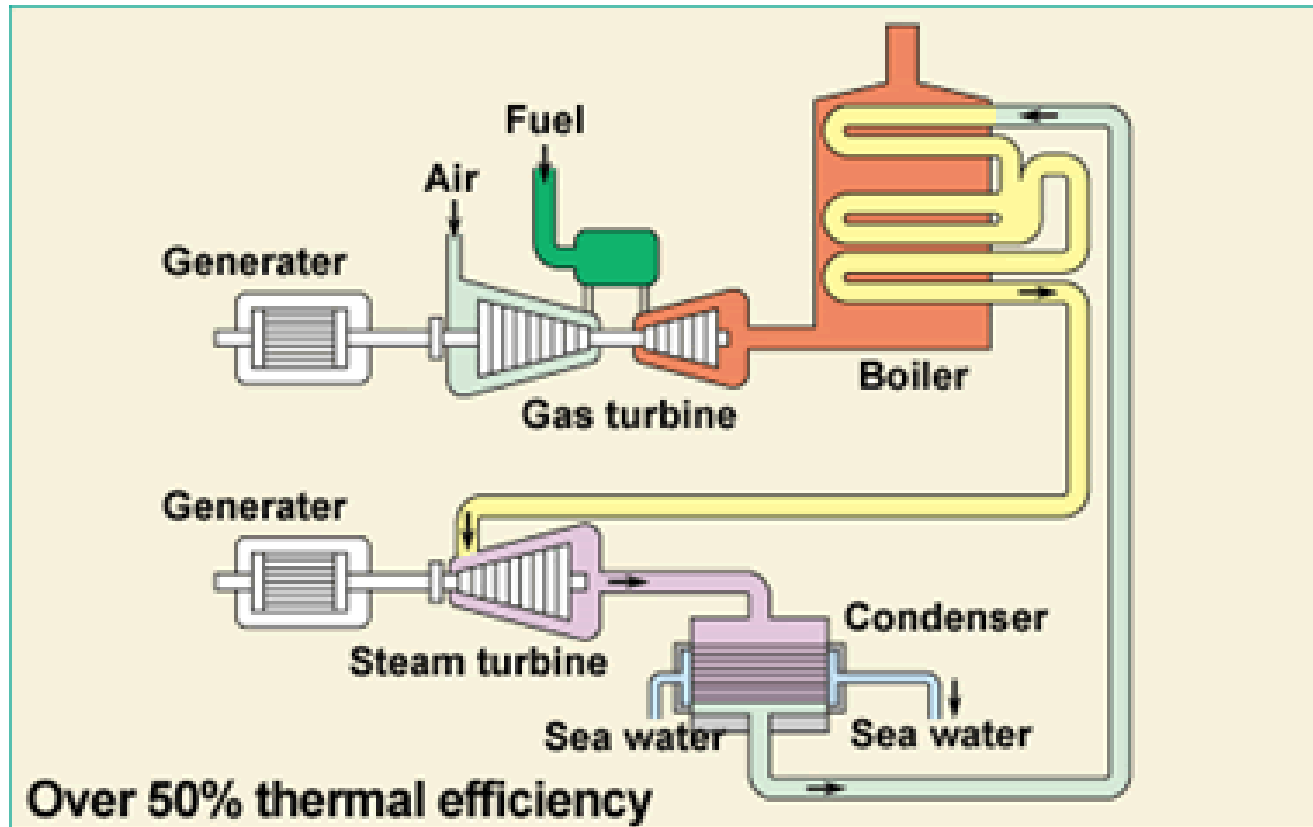
MHI GAS ENGINE & GAS TURBINE SERIES



Development trends

Output Range	Type	Customer	What is required
10- 500MW class	Gas turbine GTCC	Gen. co. Power Plant	High efficiency High reliability
1- 10MW class	Gas engine (low speed)	IPP (Independent Power Producer) Large facility	High total efficiency with heat recovery
100- 1000kW class	Gas engine (high speed)	Factory Commercial facility Hospital etc.	

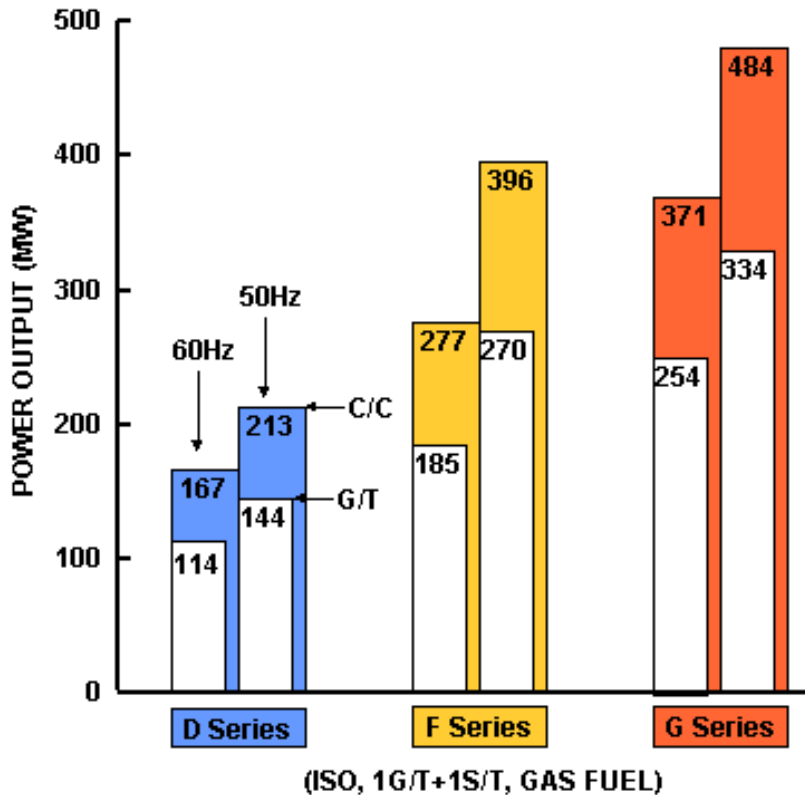
GTCC : GAS TURBINE COMBINED CYCLE



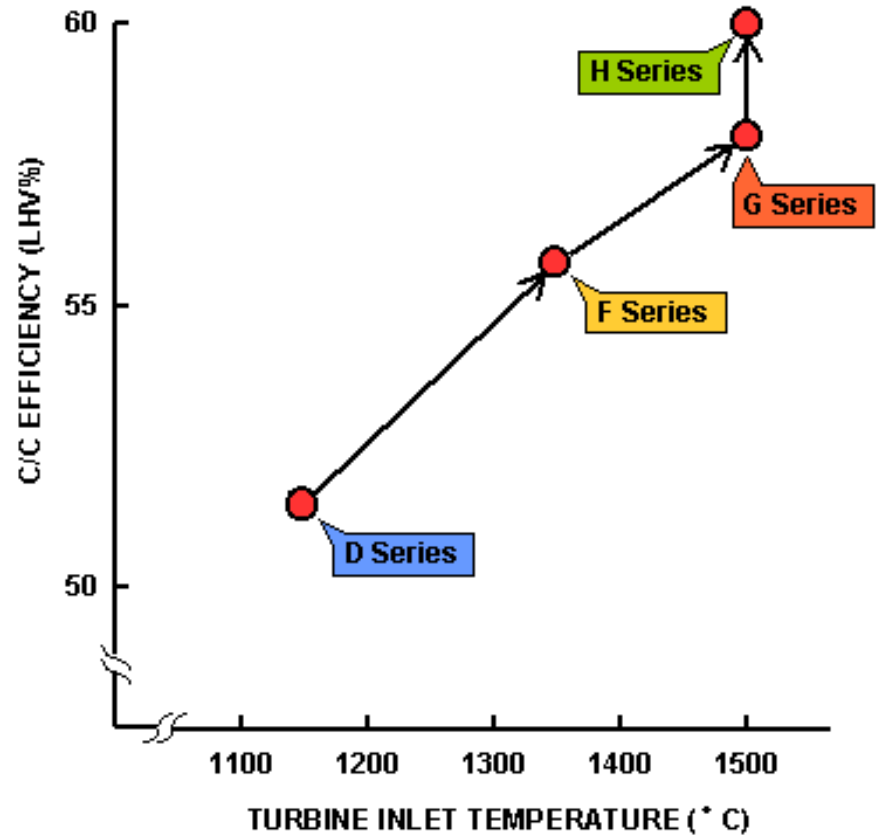
In combined cycle power generation, as shown above, the gas turbine generates electric power, and the steam produced by the exhaust heat of the gas turbine rotates the steam turbine to generate electric power together.

DEVELOPMENT OF MHI GAS TURBINE AND GTCC

POWER OUTPUT

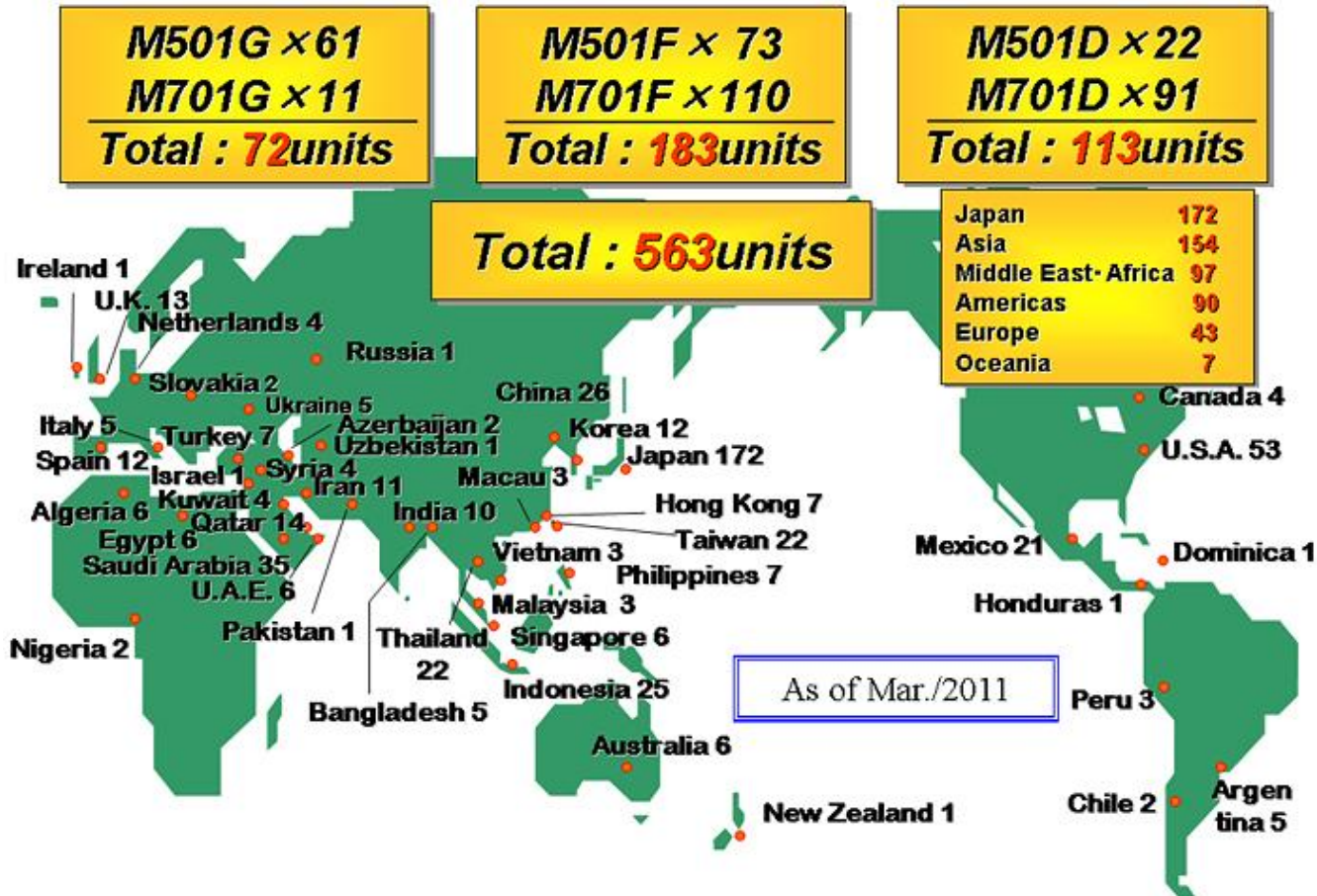


C/C EFFICIENCY



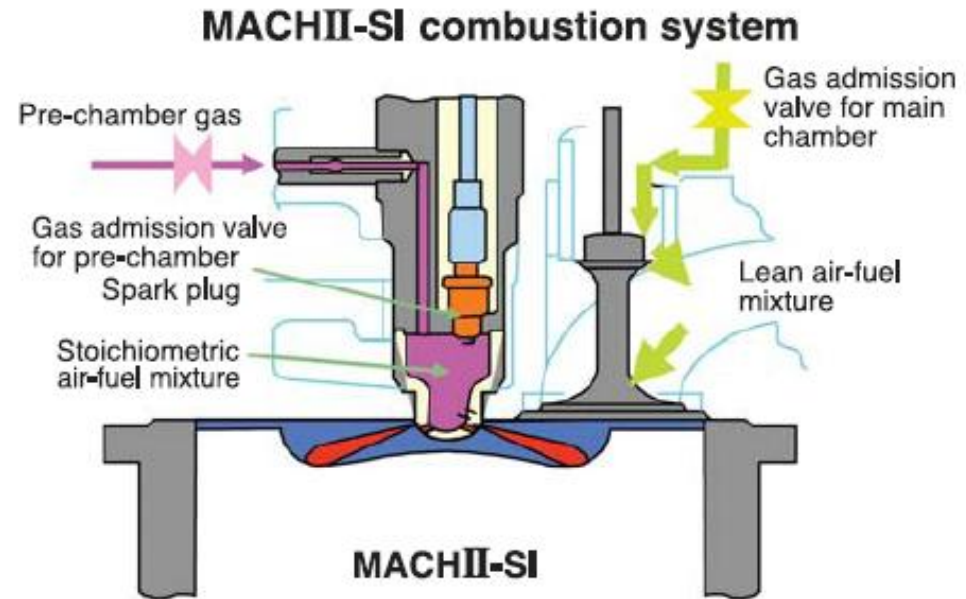
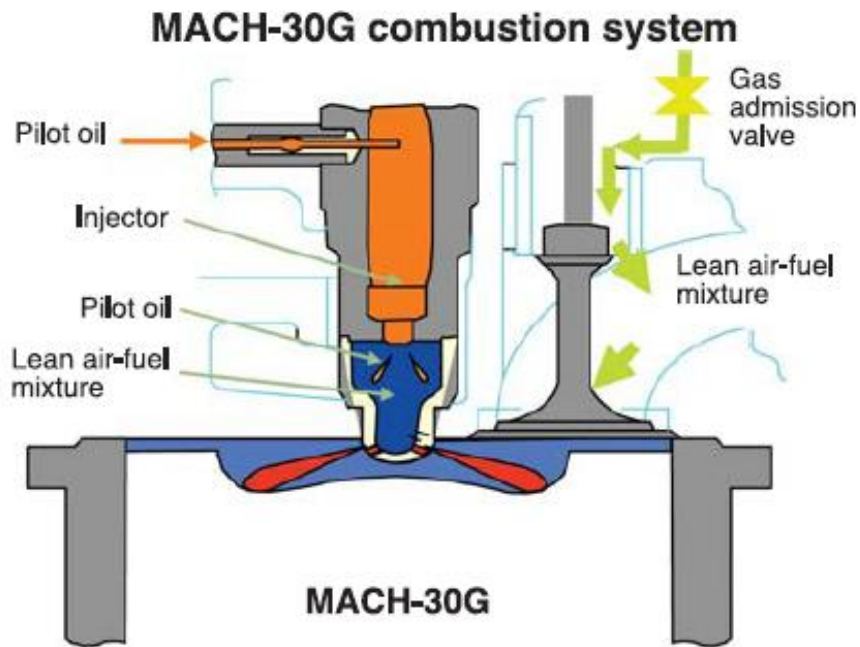
MHI has developed more advanced high-efficiency and high power gas turbines which MHI calls “ D, F and G series gas turbine”, by increasing the turbine inlet temperature from 1,150 to 1,500 degree C.

WORLD WIDE EXPERIENCES OF MHI GAS TURBINE (6 - 300MW)



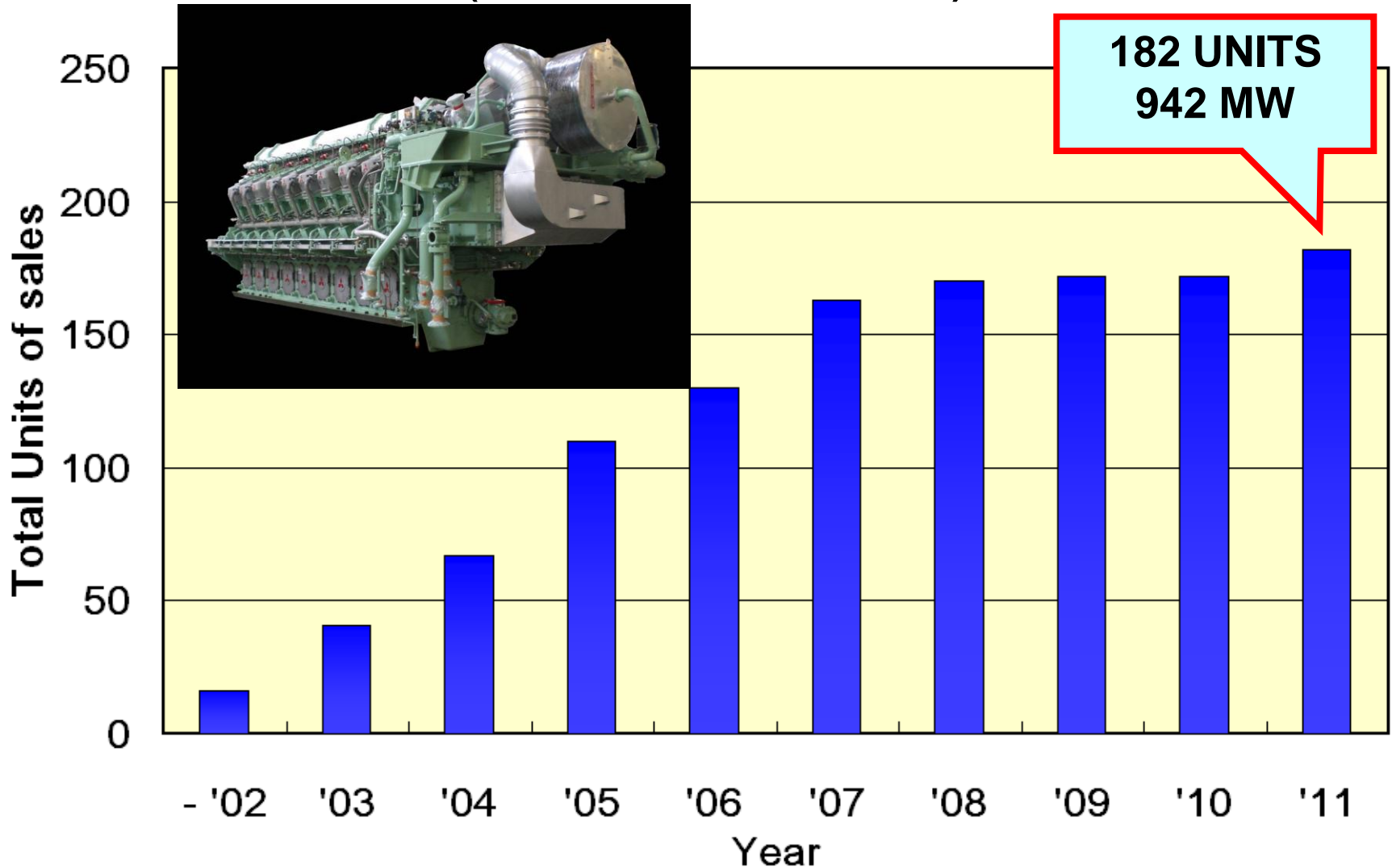
MHI provides a wide range of gas turbines, from 6MW to 300MW class, to meet various requirements from customers all over the world. MHI has manufactured and delivered more than 500 gas turbines.

DEVELOPMENT OF MHI LARGE GAS ENGINE (3 - 6MW class low speed gas engine)



MHI has developed more advanced high-efficiency and high power gas engines, which MHI calls “ MACH”, by optimizing combustion. MACH has 2 types of ignition system of spark and micro pilot.

Sales of MACH Gas engine (3 – 6 MW class)



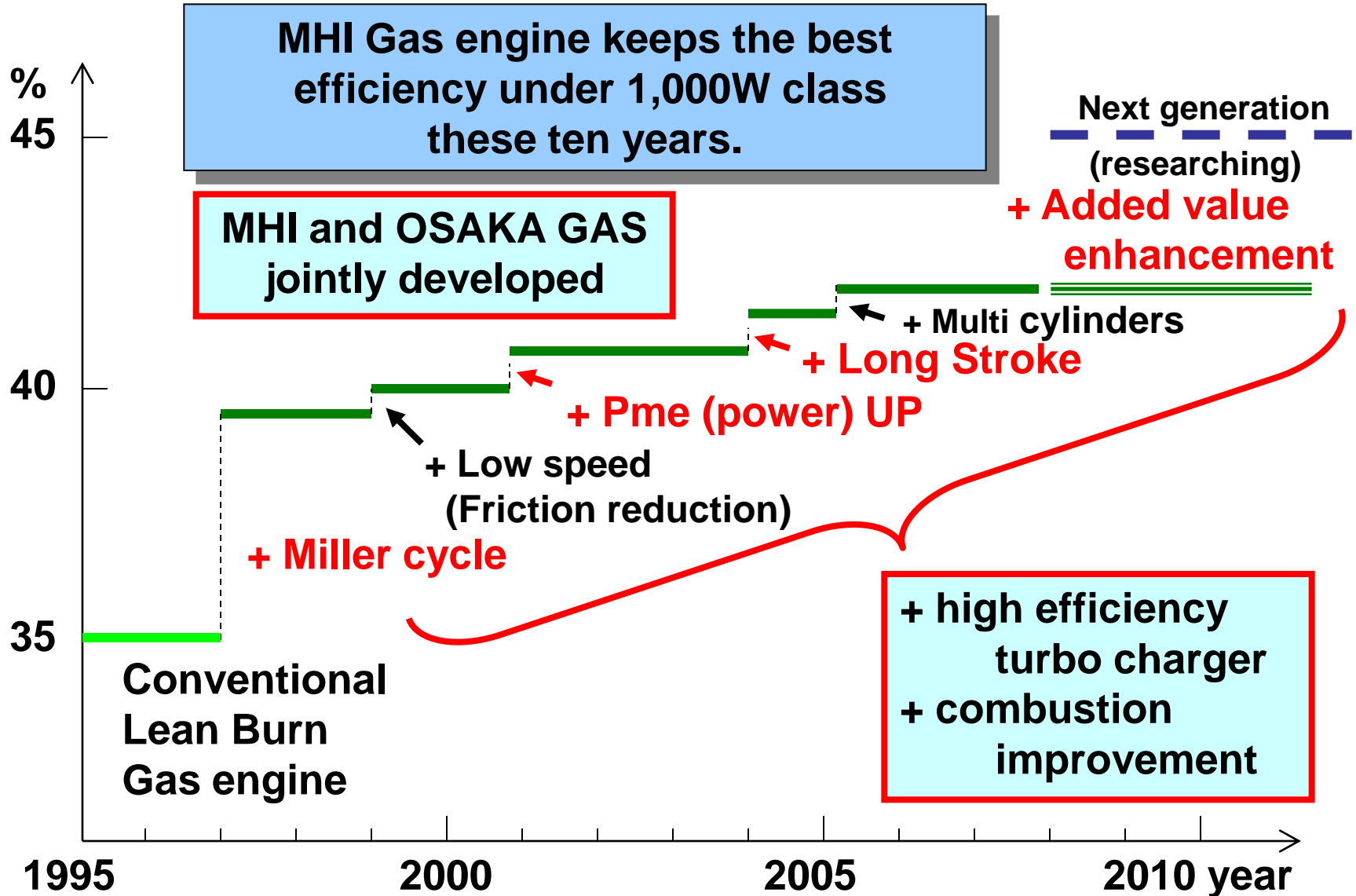
MHI Miller-cycle Gas engine (1,000kW - Class)



Engine model	GS16R2
Output power	1000kW
Engine speed	1200min ⁻¹
No. of cylinder	16-V type
Displacement	79.9L
Cylinder bore	170mm
Cylinder stroke	220mm
Gen. efficiency	41.7%
Total efficiency	74.1%
NO _x (O ₂ =0%) (after de-NO _x catalyst)	< 100ppm

Development of MHI gas engine

Generation Efficiency



MHI 1,000kW class Gas engine

Features and Advantages

- Lean-burn and miller cycle gas engine
with MHI original high efficiency turbo-charger

➔ High efficiency : 41.7% at generator outputs
(The world best level under 1000kW class)

- MHI original integrated control system
and Pre-chamber combustion system

➔ Good performance and High reliability
: Stable start and fast loading
MTBF (mean time between failure) is longer
than 7,000hrs *(The best level in Japan market)*

MHI CHP package

**75% total efficiency
with Heat recovery**

**Boiler with
De-NOx Catalyst**



75dB(A) Enclosure

Heat Exchangers Silencer

Our CUSTOMERS

(Factory, Commercial facility, Hospital, Ship etc.)

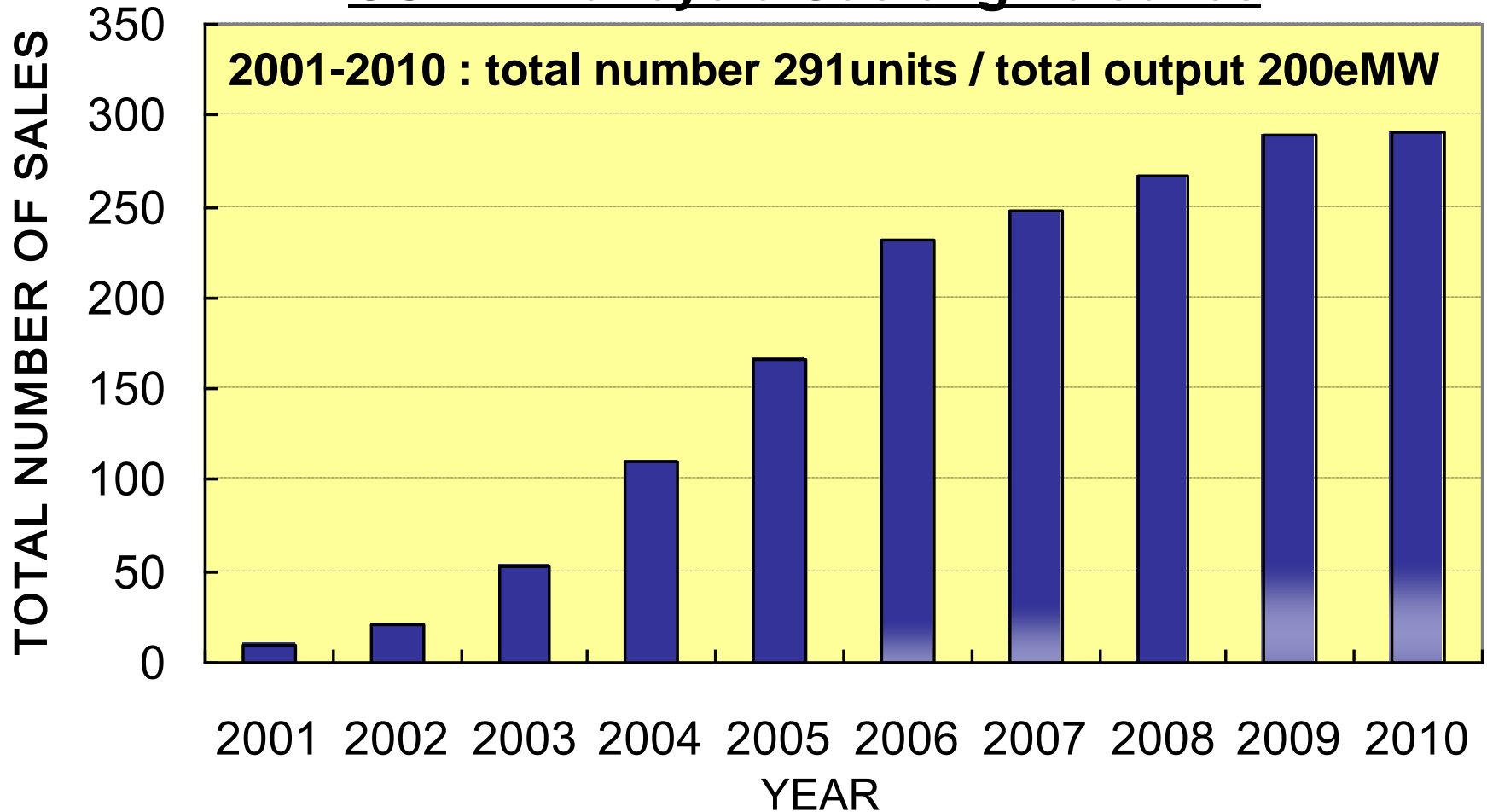


GS12R 675kW x4
Electric propulsion ship

GS16R 815kW x5 CHP package

Sales of MHI Gas engine

GSR miller cycle Gas engine series



CONTENTS

1. MHI GAS ENGINE AND GAS TURBINE

(MHI : MITSUBISHI HEAVY INDUSTRIES, LTD.)

2. Added value enhancement for 1,000kW- Class CHP SYSTEM

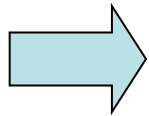
- Improvement of
the first step loading ratio**
- Improvement of total efficiency**

What's added value of CHP ?

CHP : power supply and heat recovery

ADDED VALUE

- **Security of the **emergency** power supply**



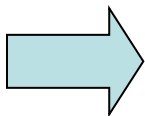
Quick power supply (within 40 sec.)

Increase of acceptable block load

(Gas engine cannot load

the full power immediately.)

- **Eco-friendly (friendly to the environment)**

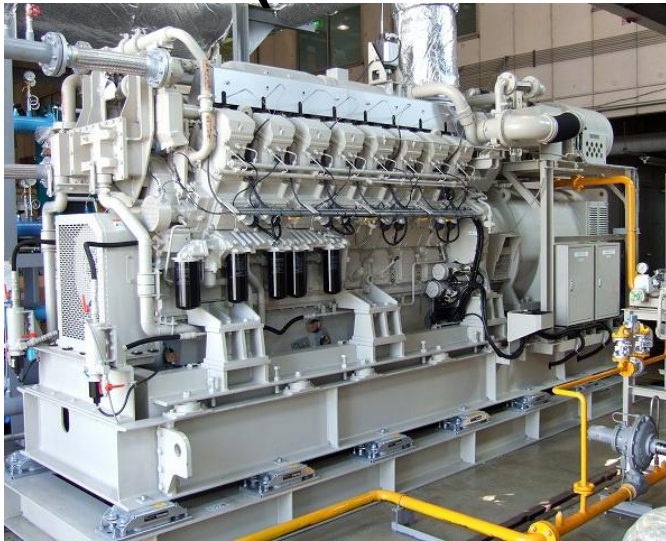


**Reduction of the emission and
waste heat for the environment**

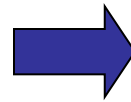
Improvement of the first step loading ratio

**GAS engine generator set can be used
as stand-by engine for emergency generator.
The acceptable block load for emergency
depends on the first step loading ratio.**

(If the first step loading ratio is 20%,)

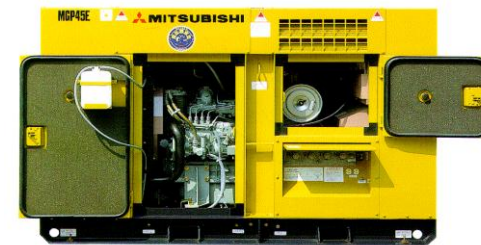


**1000kW-class
GAS engine gen-set**



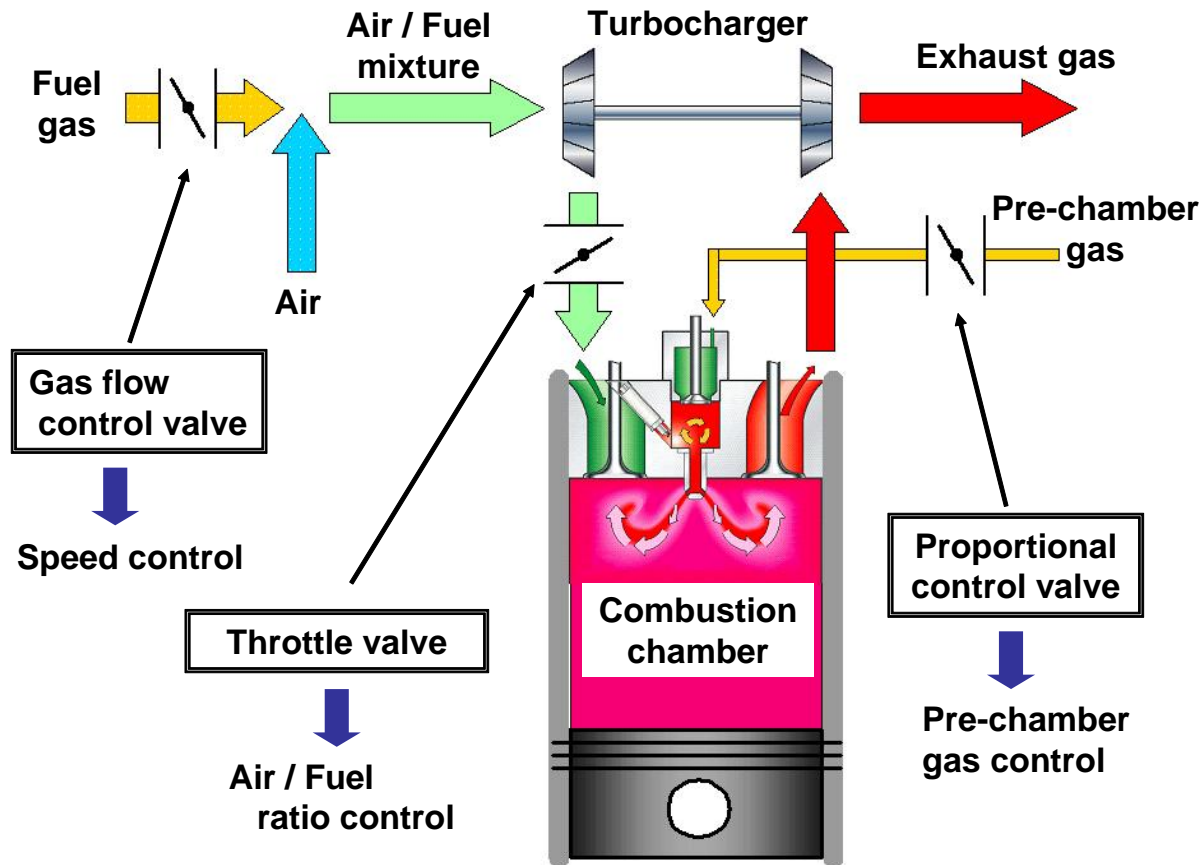
**In emergency
only 200kW output !!**

(within 40 sec)



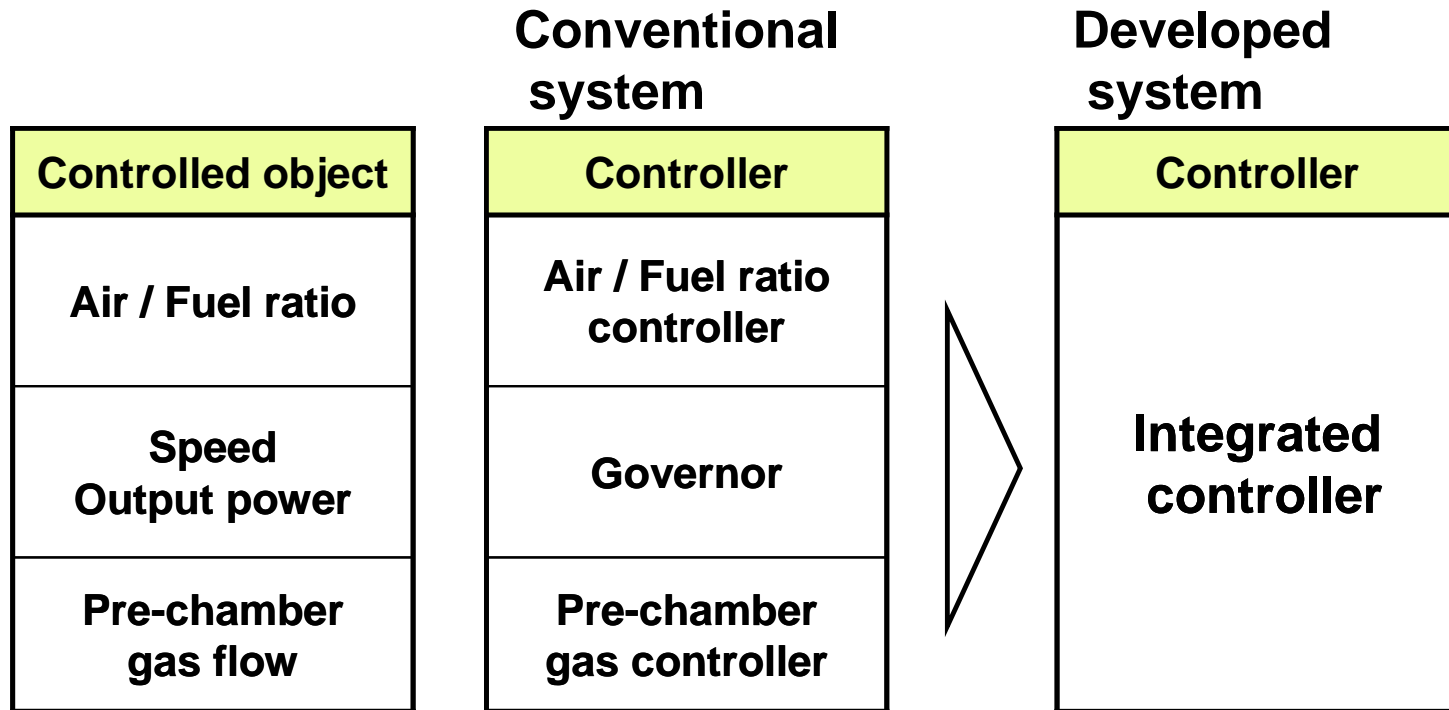
**It is equal to 200kW st-by
diesel engine output.**

Improvement of the first step loading ratio



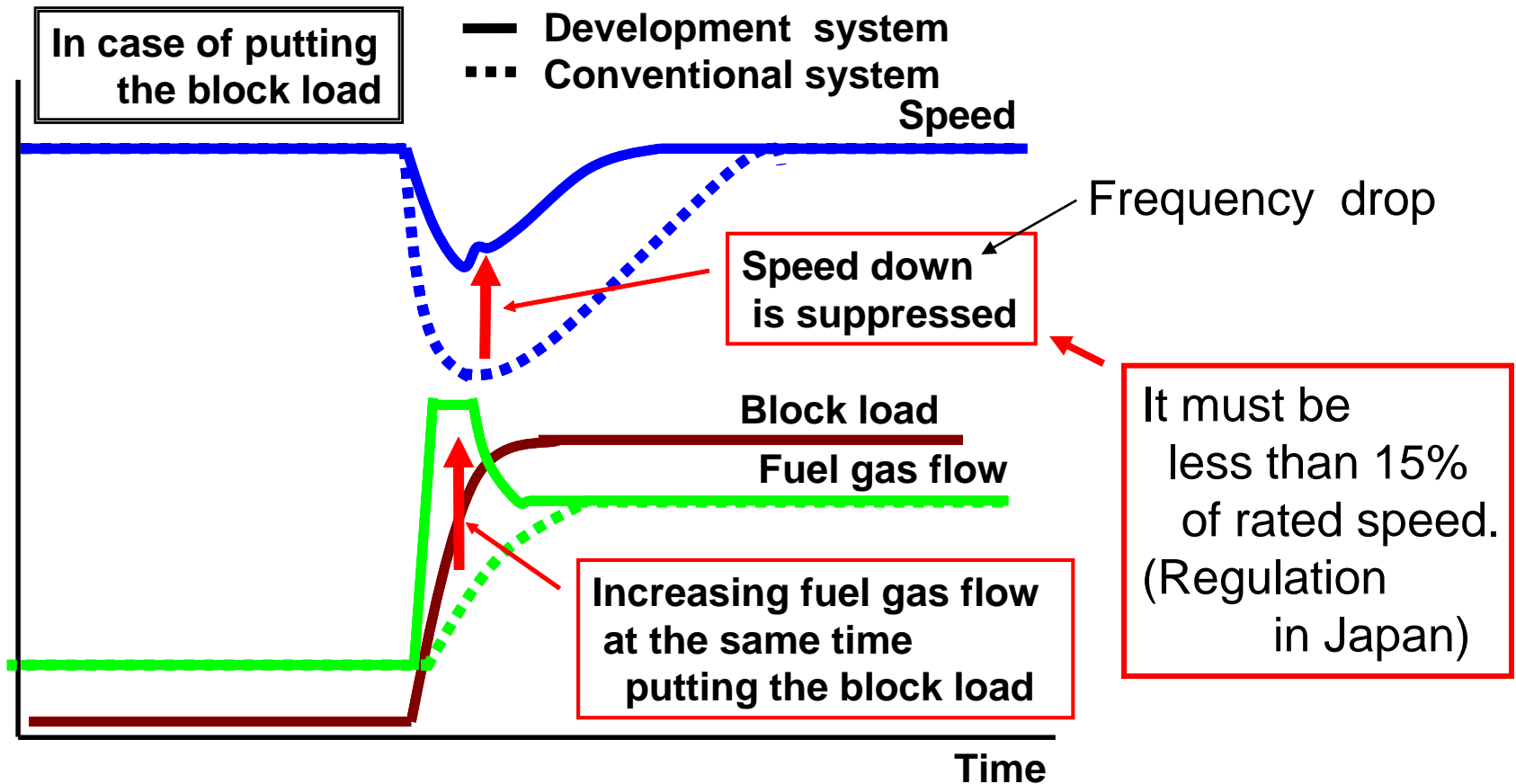
Pre-chamber combustion system of MHI Gas engine achieved quick start and loading within 40 sec for emergency generator. (within 40 sec : Regulation in Japan)

Improvement of the first step loading ratio



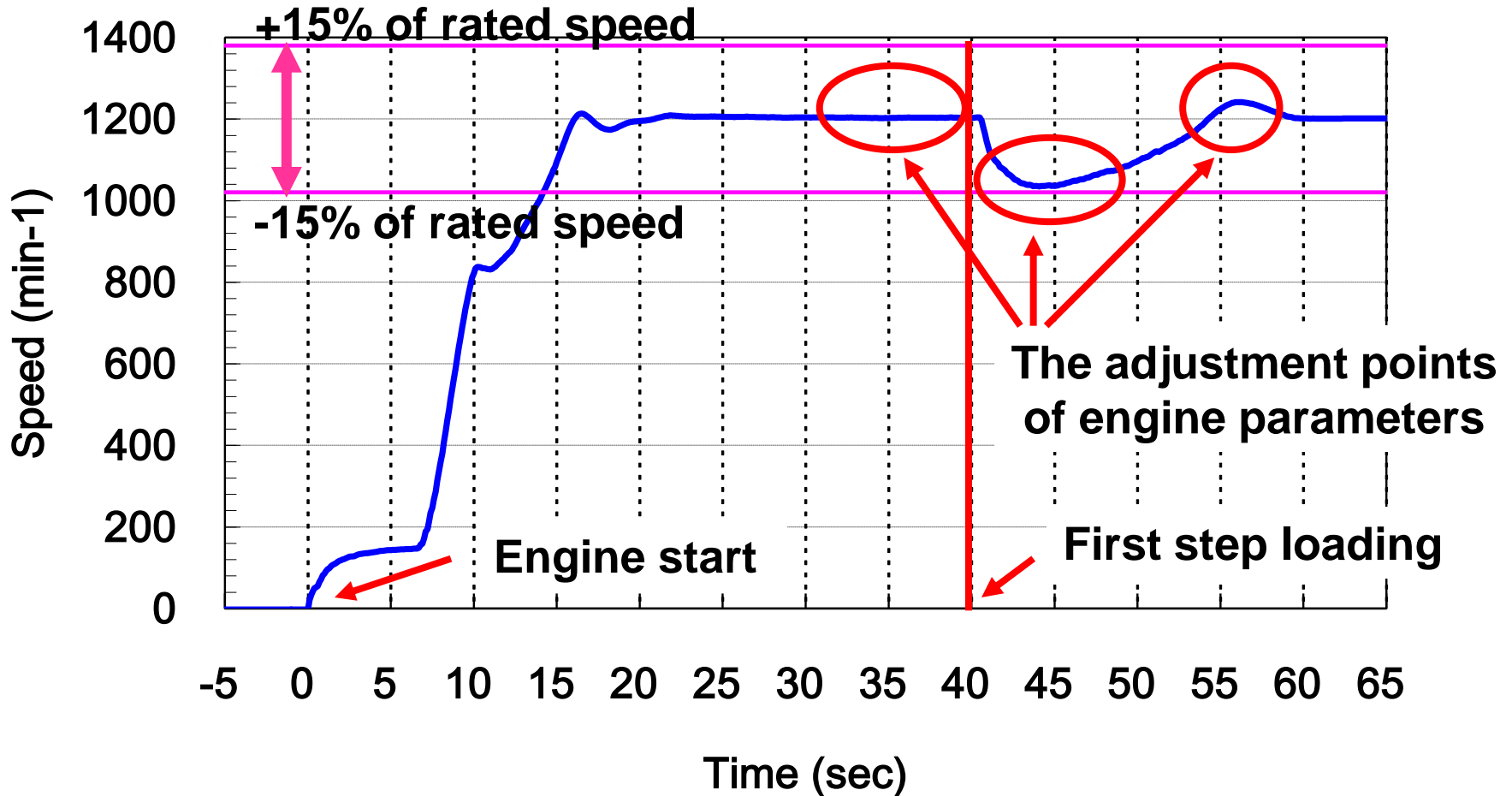
MHI developed new control system and software with original control logic, to improve the engine performance to the load change such as block loading and load release.

Improvement of the first step loading ratio



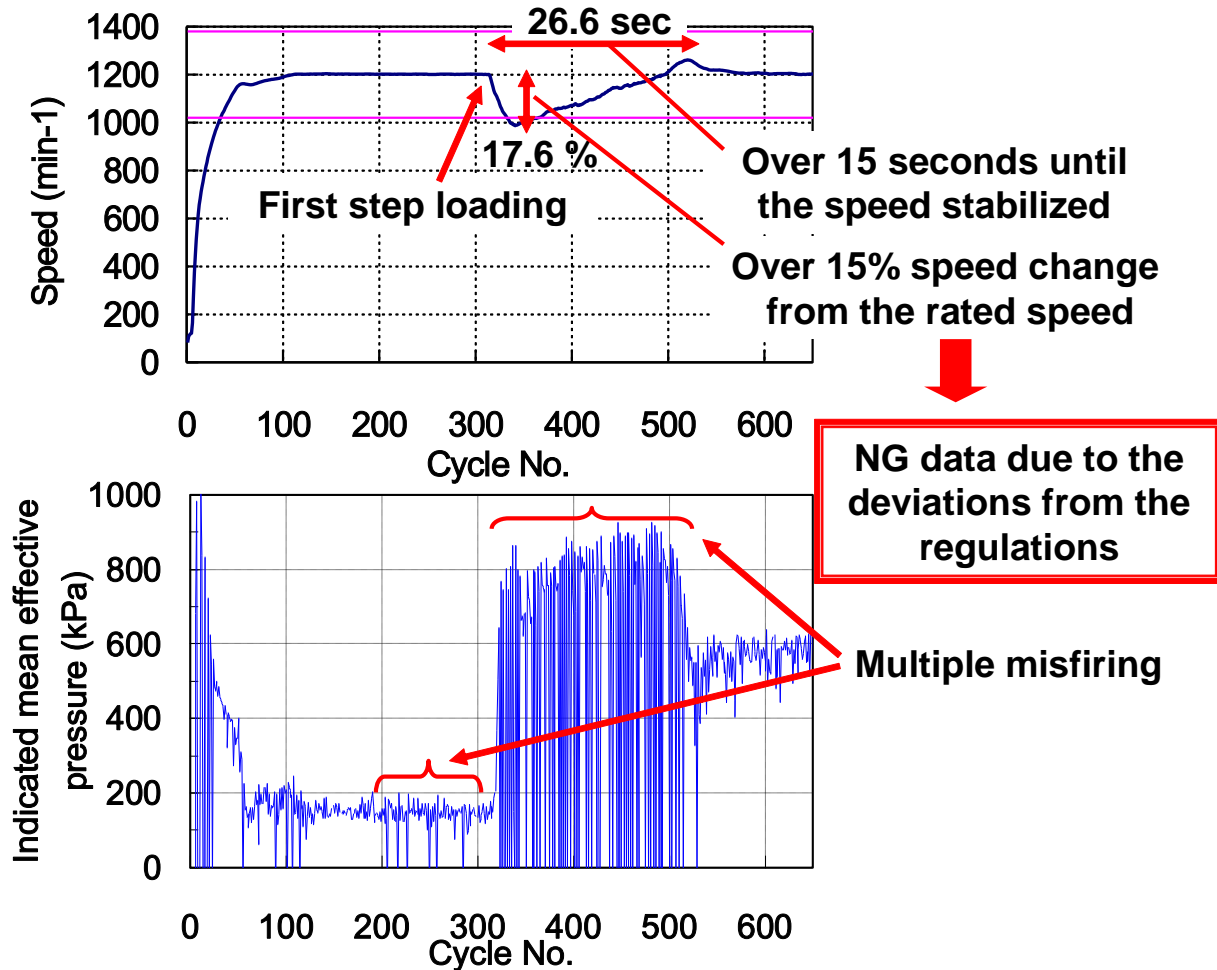
As MHI original control logic achieved to improve the engine performance, the acceptable block load could be increased.

Improvement of the first step loading ratio



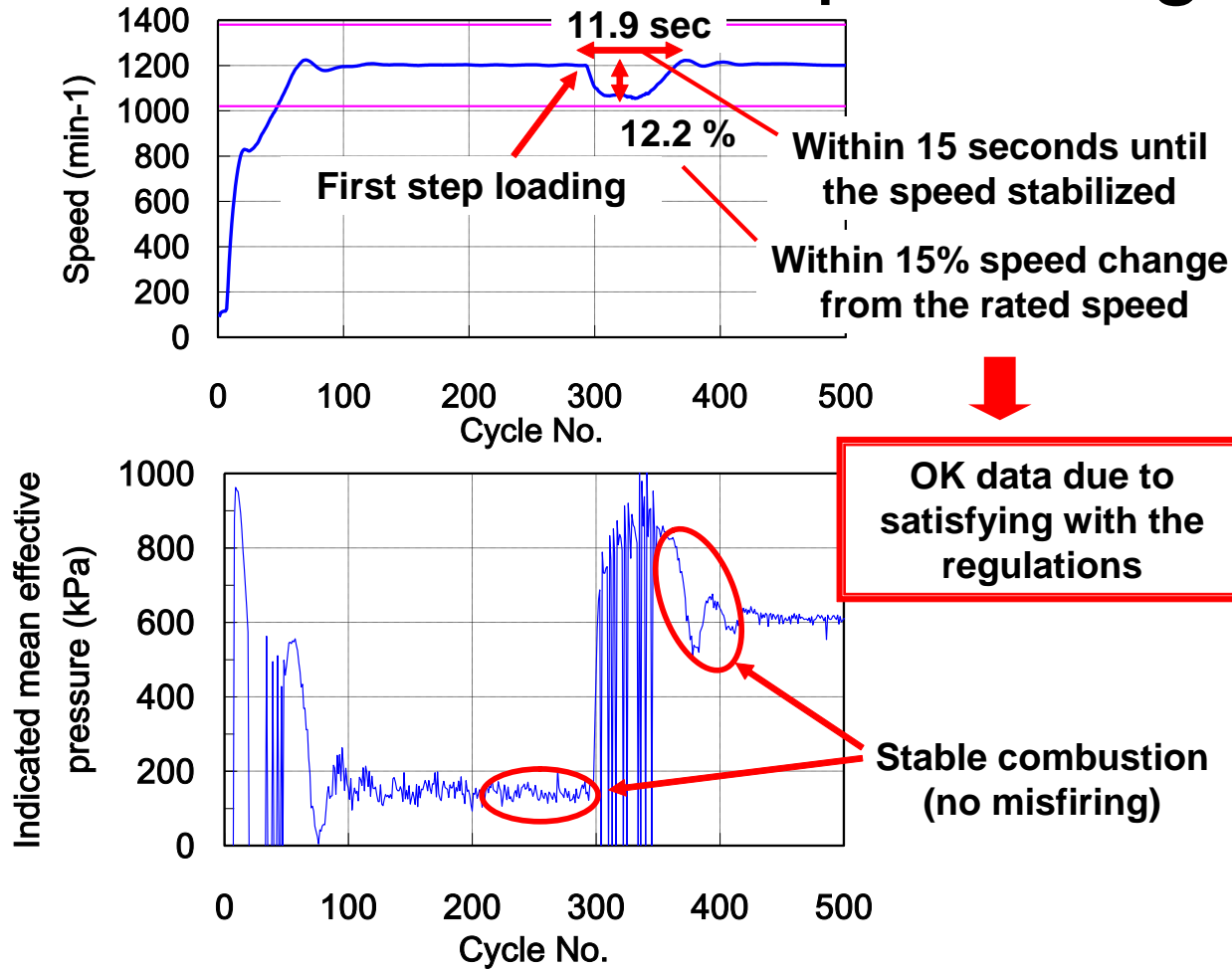
**By the adjustment parameters of engine controller,
the engine performance can be further improved.**

Improvement of the first step loading ratio



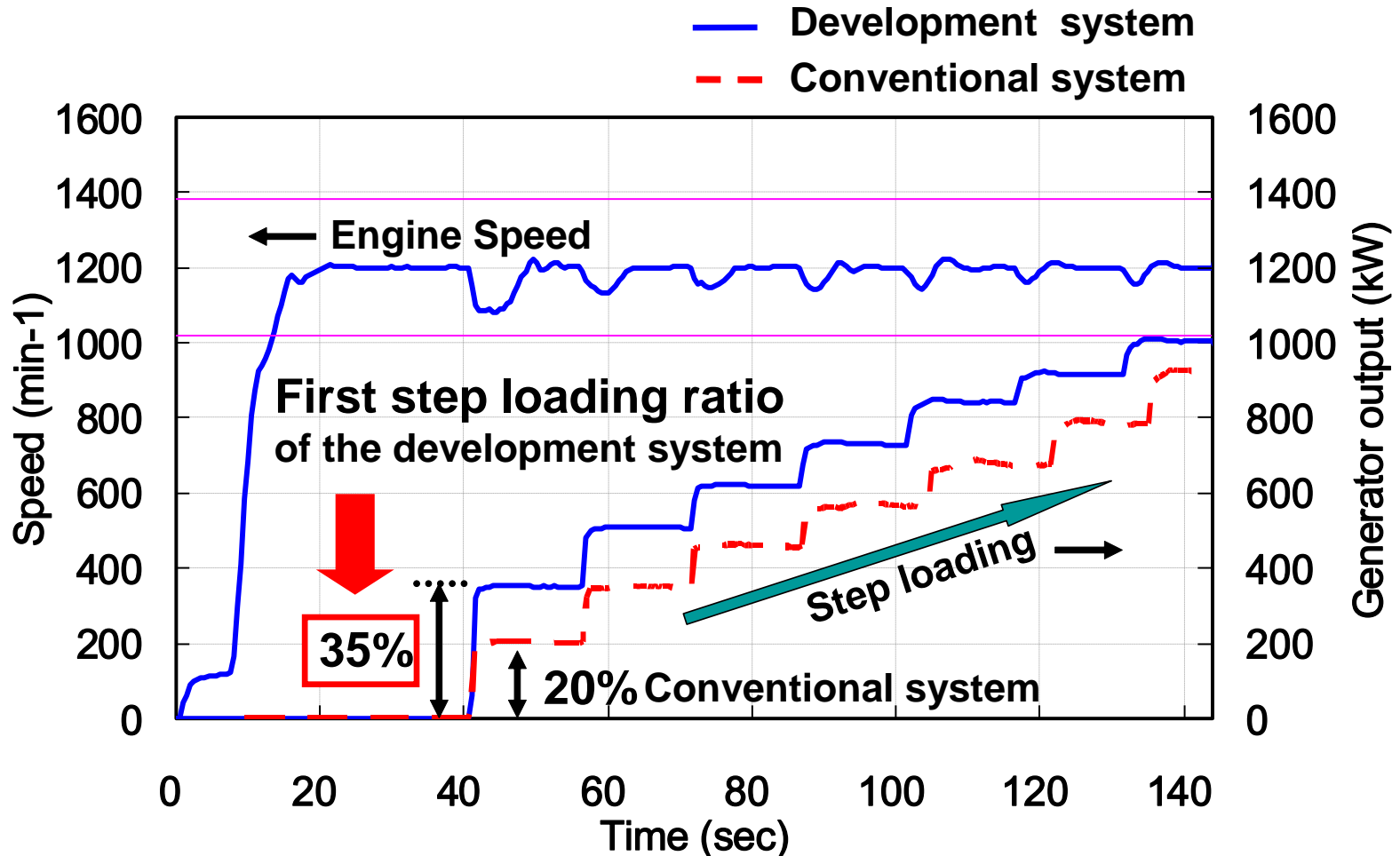
To improve the engine performance, we investigated the combustion state of each cylinder during block loading.

Improvement of the first step loading ratio



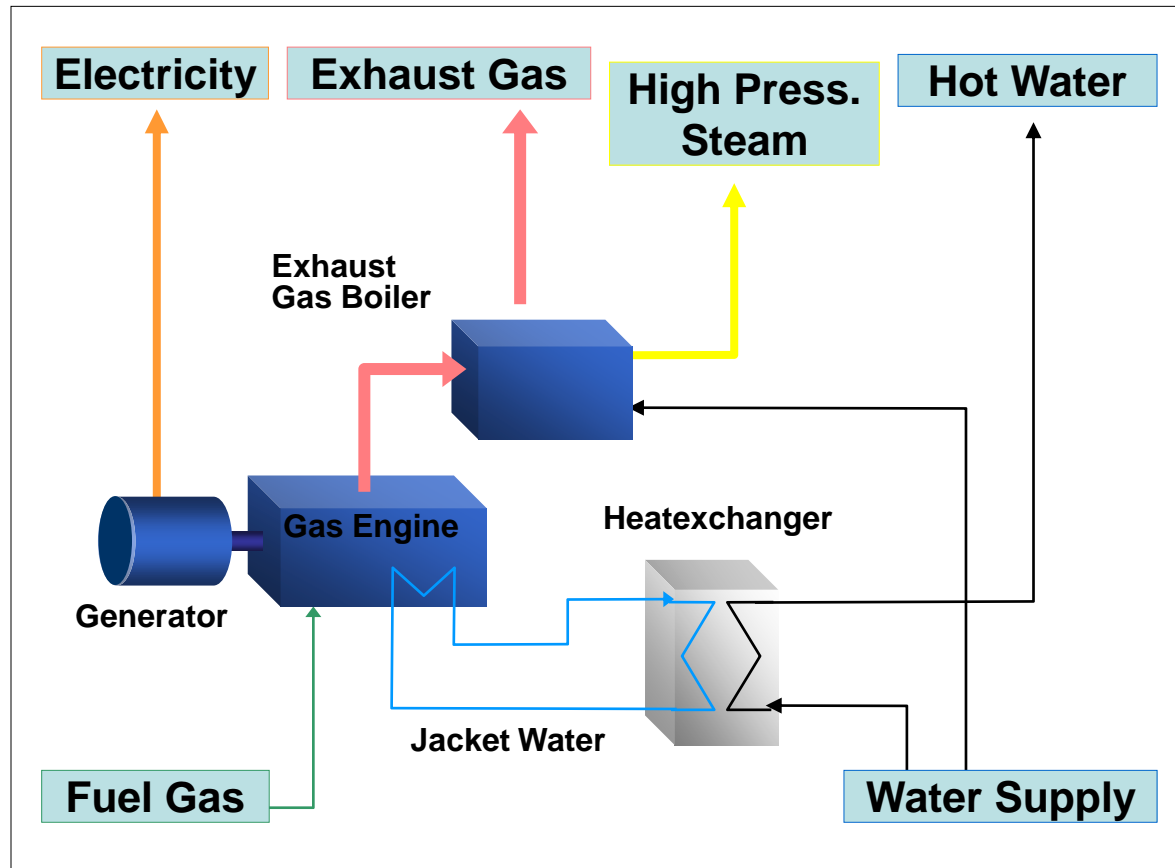
By stabilizing the combustion, it was found that the engine performance also improved .

Improvement of the first step loading ratio



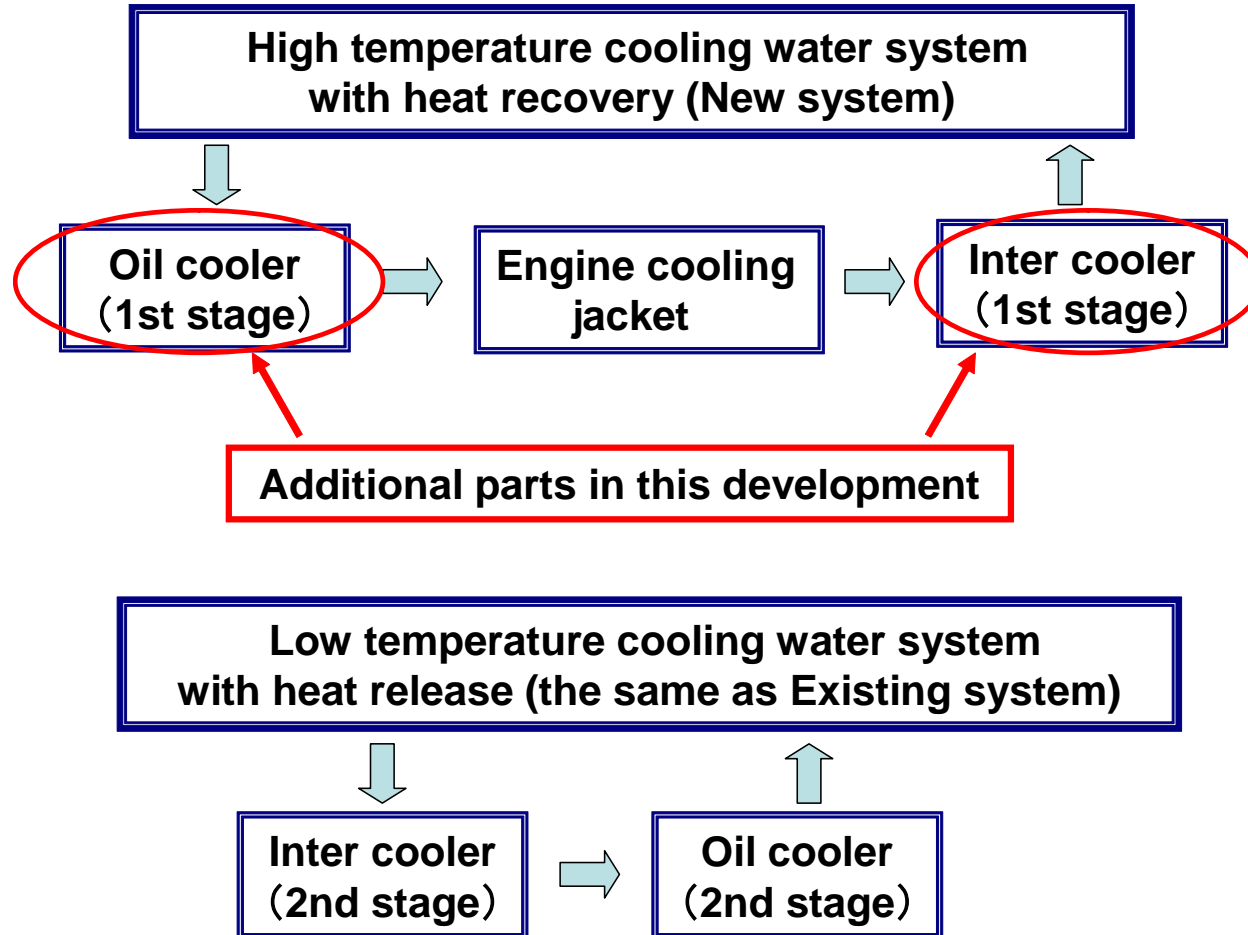
By developing control system and stabilizing combustion, the first step loading ratio is improved from 20% to 35%.

Improvement of total efficiency



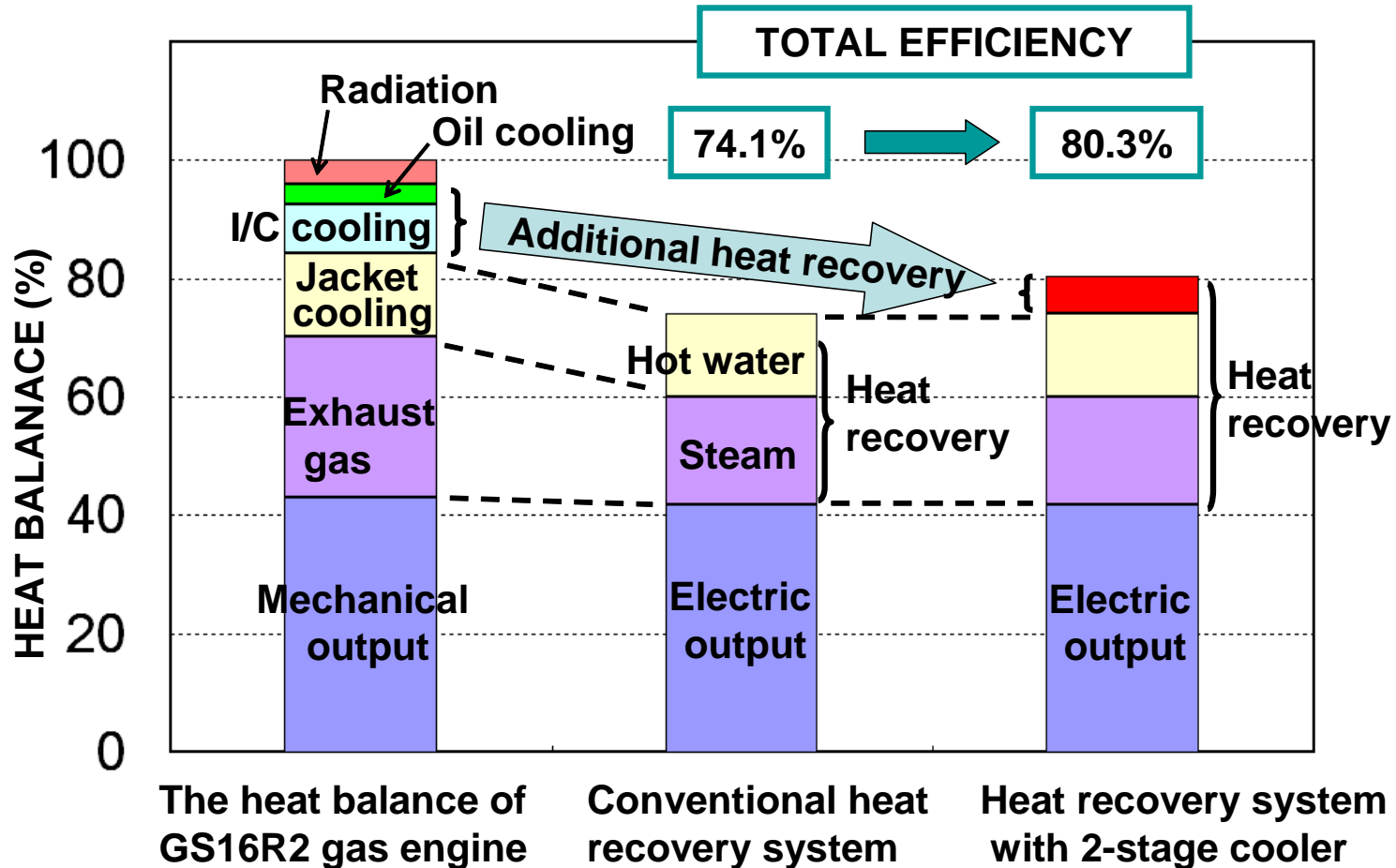
The heat release from GAS engine can be used for boiler, chiller and hot water by heat recovery system. Improving total efficiency contributes to reduction of CO₂ emission as well as economic efficiency.

Improvement of total efficiency



By using 2-stage cooling system, the total efficiency is improved.

Improvement of total efficiency



By using 2-stage cooling system, the total efficiency is improved from 74.1% to 80.3% achieving the world best level for 1000kW class CHP system.

Summary

1. MHI 1,000kW class Miller-cycle Gas engine

(MHI : MITSUBISHI HEAVY INDUSTRIES, LTD.)

High efficiency,

Good performance and High reliability

2. Development of MHI Gas Engine

By developing control system and stabilizing combustion, the first step loading ratio is improved from 20% to 35%, enhanced added value of CHP as the emergency power source.

By using 2-stage cooling system, the total efficiency is improved to 80.3% achieving the world best level for 1000kW class CHP system.

Thank you for your listening !!



When ordering, Please contact our agencies of MHI !!
<http://www.mhi.co.jp/global/>

Presenter : M. Ogawa from MHI Sagamihara in Japan