



KAWASAKI VAM Abatement System

Kawasaki Heavy Industries, Ltd.
Gas Turbines & Machinery Company
Gas turbine Division

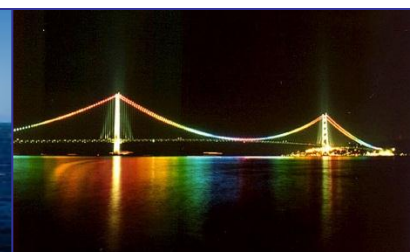
4th September , 2012

InterContinental Hotel, Sydney, Australia





Who is Kawasaki?



Kawasaki Heavy Industries, Ltd. (KHI)

... a leading global manufacturer of transportation & industrial equipment

Sea



Land



Land



Air



Air

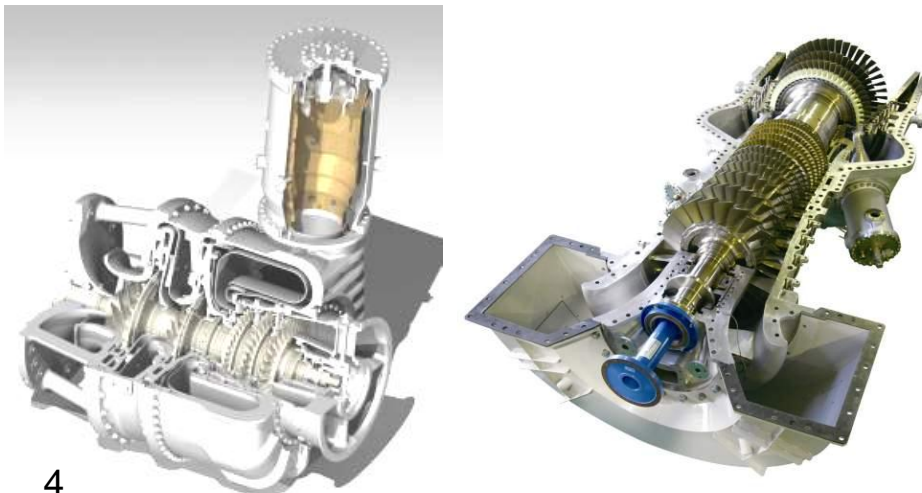


【Kawasaki Gas Turbine】

- ◆ Started development of industrial Gas Turbine in 1972.
- ◆ Accumulated order of over 10,000 engines

【Product Line-up】

- ◆ Base Load Model : 1.5MW - 30MW
- ◆ Stand-by Model : 0.2MW - 4.8MW



【Application】

Cogeneration



Stand-by Gene-set



Pump Drive



Mobile Gene-set



Combined-cycle System

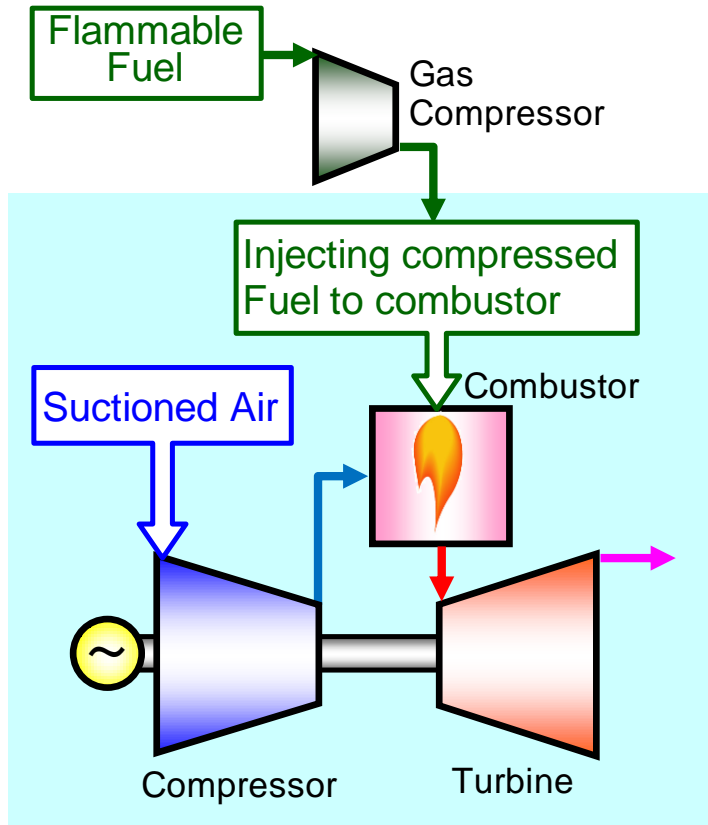


Lean Methane Fueled Gas Turbine

Catalytic Combustion & Re-generative Cycle Gas Turbine

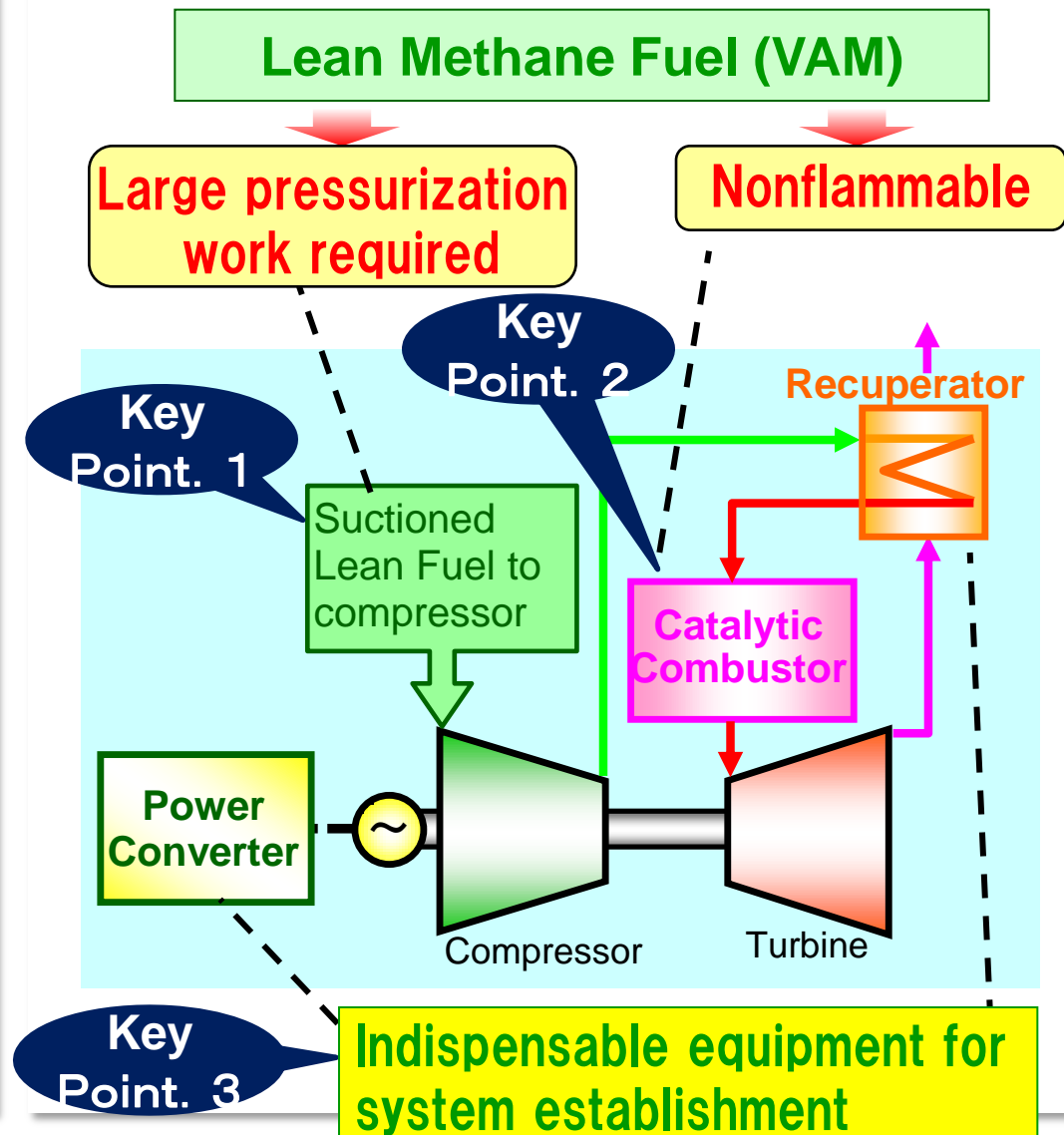
【Simple Cycle GT】

Flammable Fuel (Natural Gas)



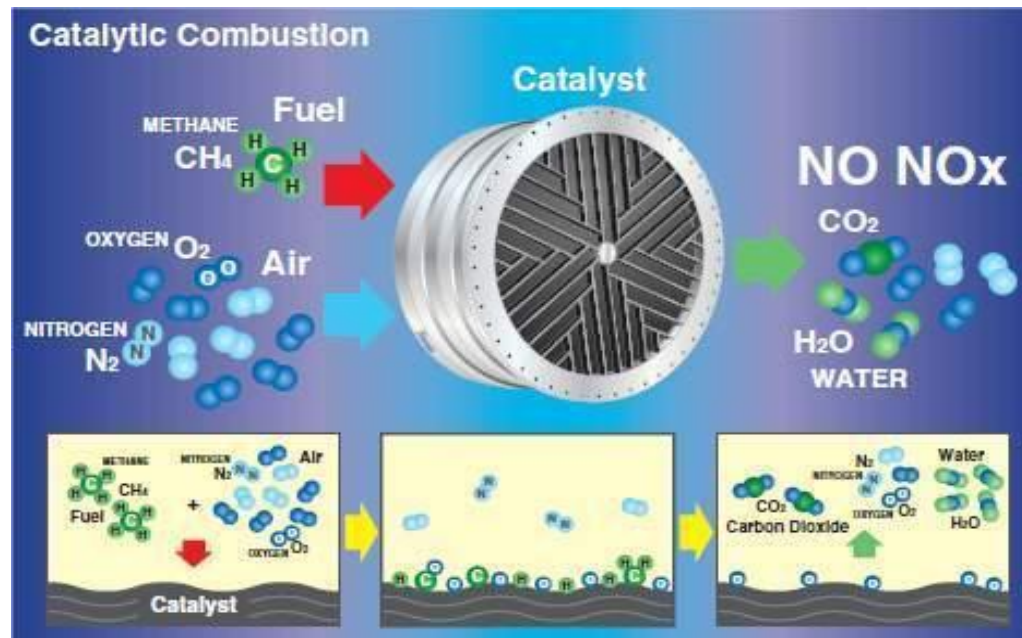
【Lean Methane Fueled GT】

Lean Methane Fuel (VAM)



Feature of Catalytic Combustion:

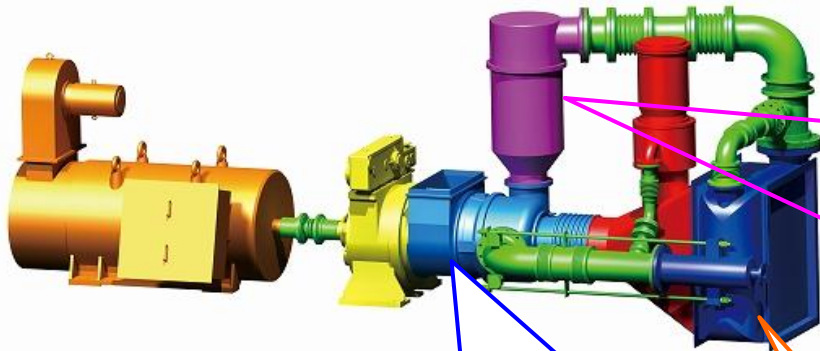
- Can burn (oxidize) lean methane/air mixture (**less than 5% v/v** ; out of flammable range) at low temperature (**lower than 900°C**)
- Resulting in **no NOx emissions** and **no flame** (flameless combustion)



Catalytic Combustion & Re-generative Cycle Gas Turbine

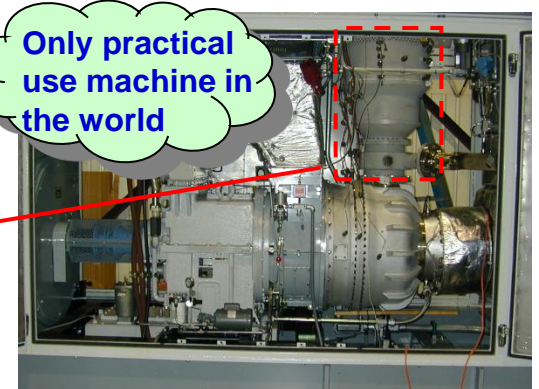
...based on Proven Technologies

Catalytic Combustion & Re-generative Cycle Gas Turbine



Catalytic Combustor

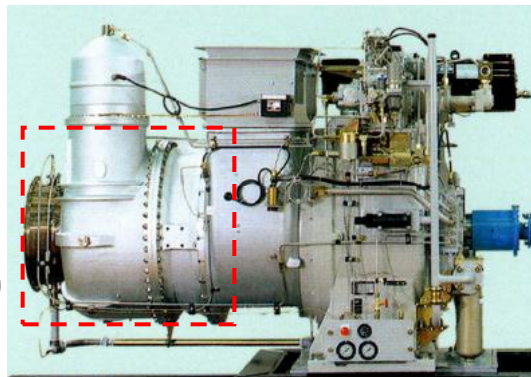
Only practical use machine in the world



1,500kW-class Catalytic Combustion GT : M1A-13X

Gas Turbine

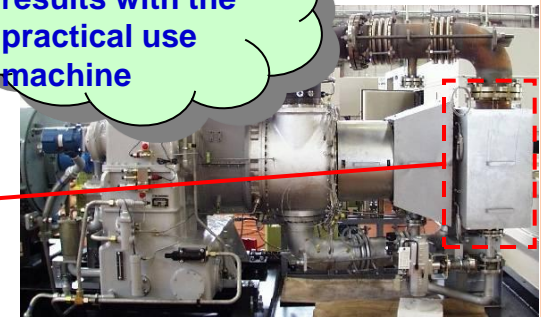
Abundant operative results



1,000kW-class GT : M1A-01

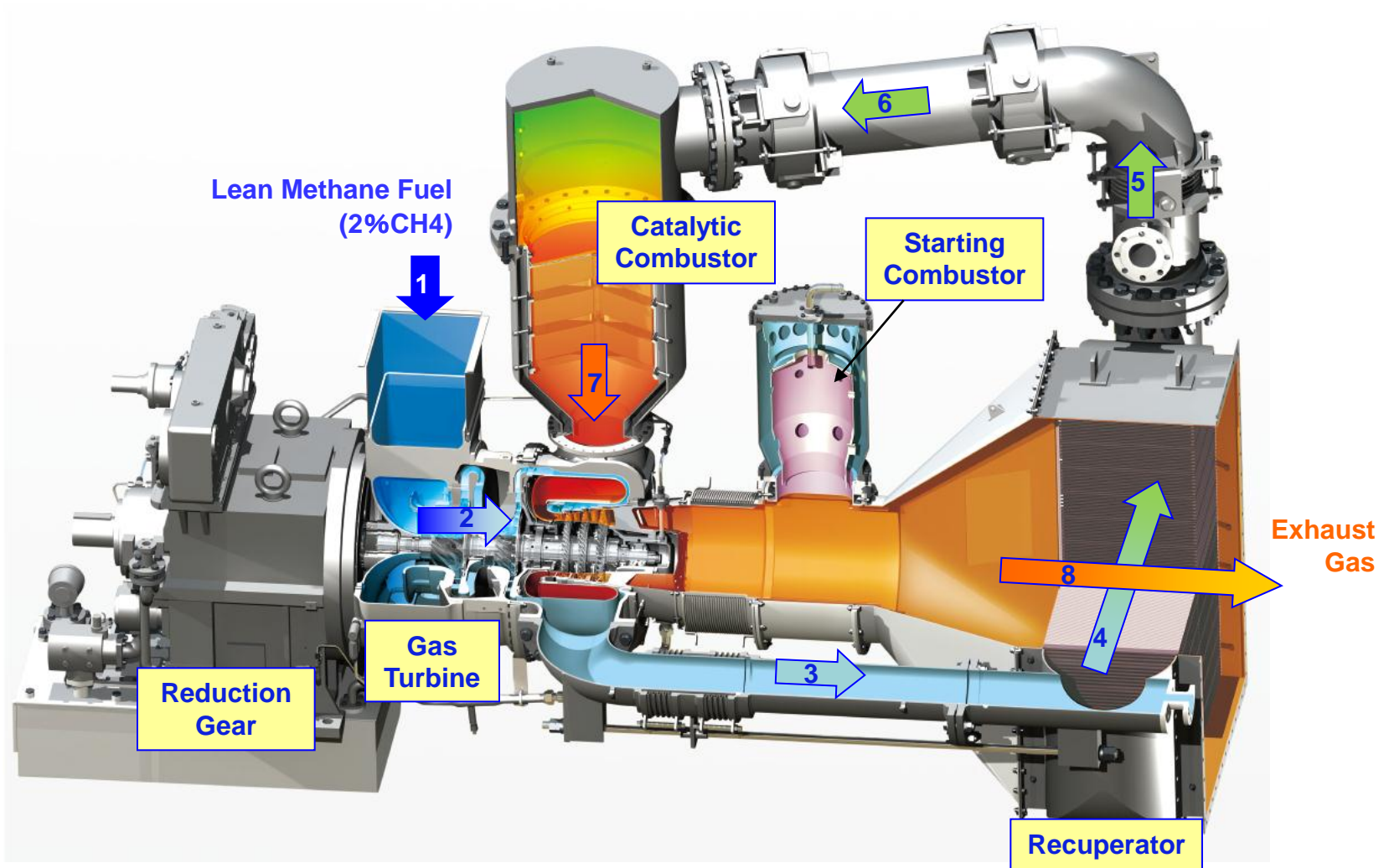
Recuperator

The long time use results with the practical use machine



600kW-class Re-generative cycle GT : S7A

Layout of Lean Methane Fueled Gas Turbine



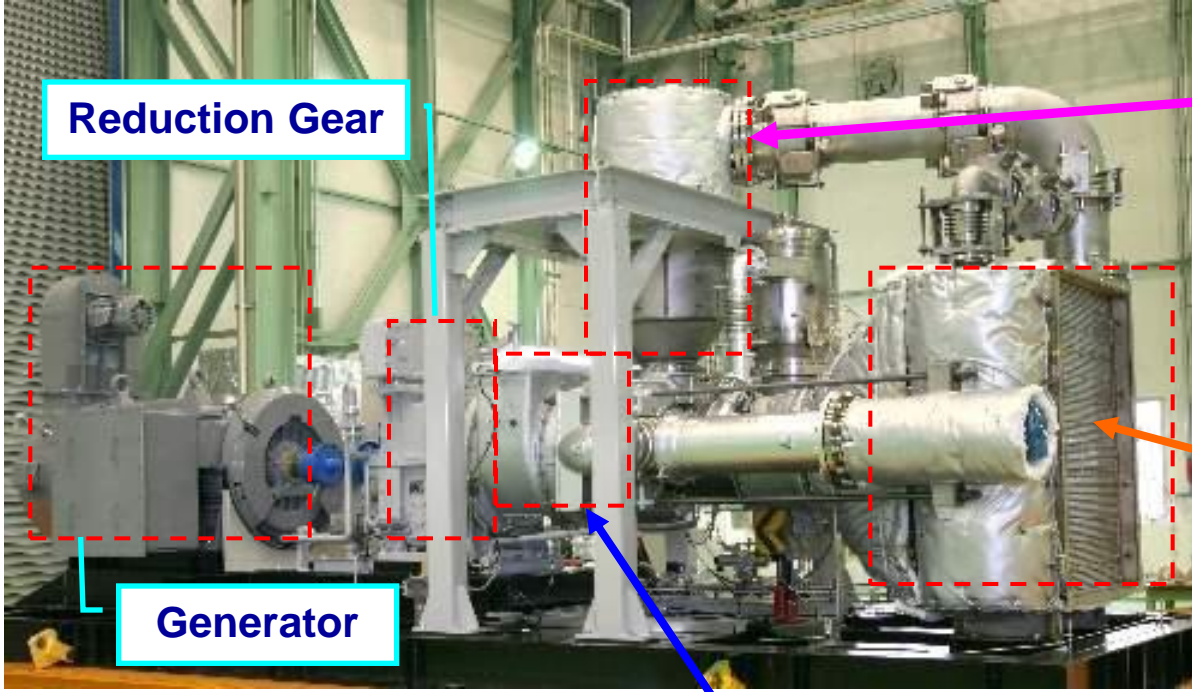
For Reference

Generator Output [1]	800 (kWe)
Utilization of VAM & Drainage Gas	22,000 (mN³/hr)
GHG Reduction [2]	48,000 (tCO₂e/year)

【Note.1】 ISO Condition (15°C、1atm、sea level:0m)

【Note.2】 Availability of operation : 97%.

Assembling of Practical Test Engine



Catalytic combustor

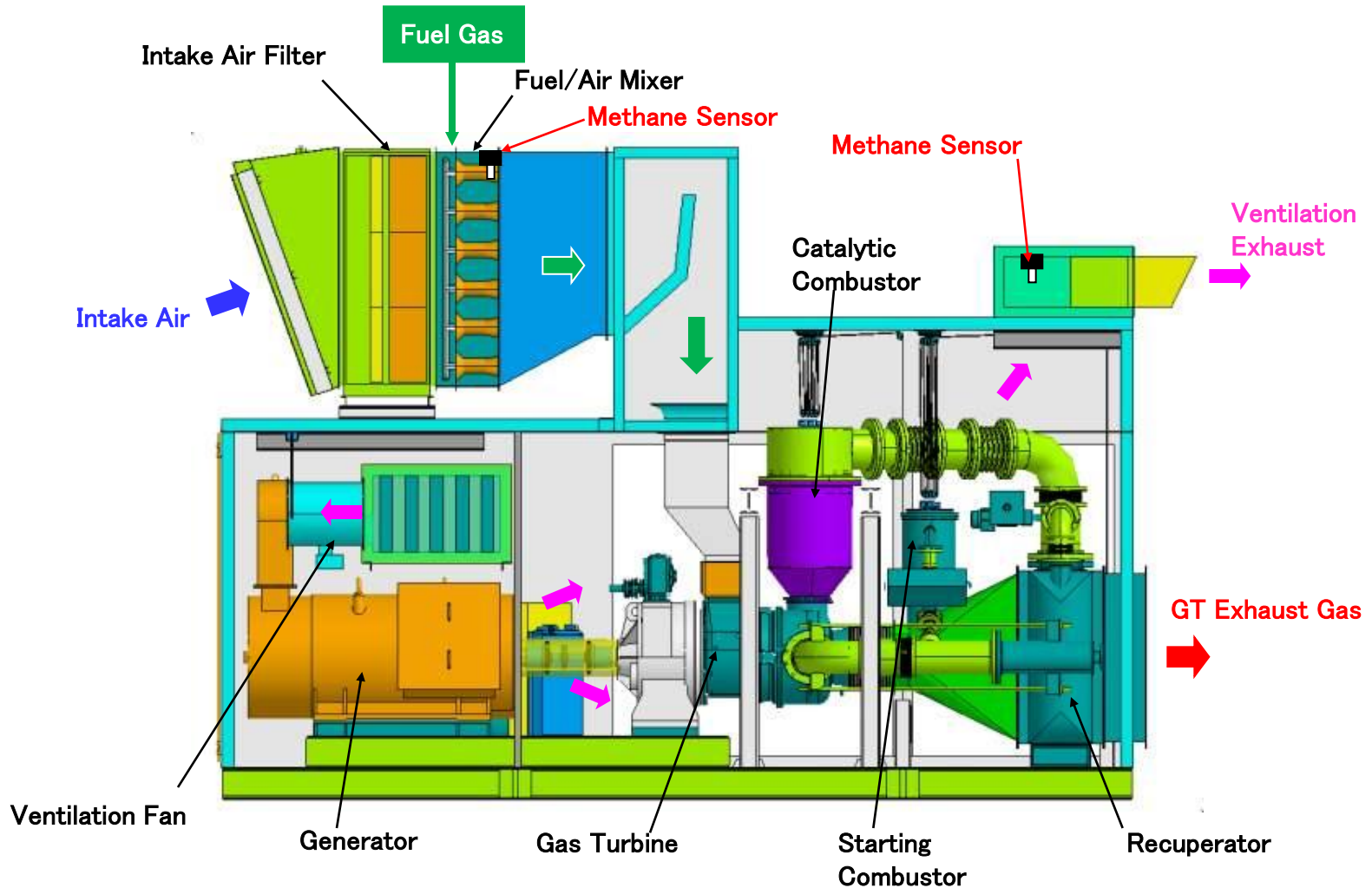


Recuperator

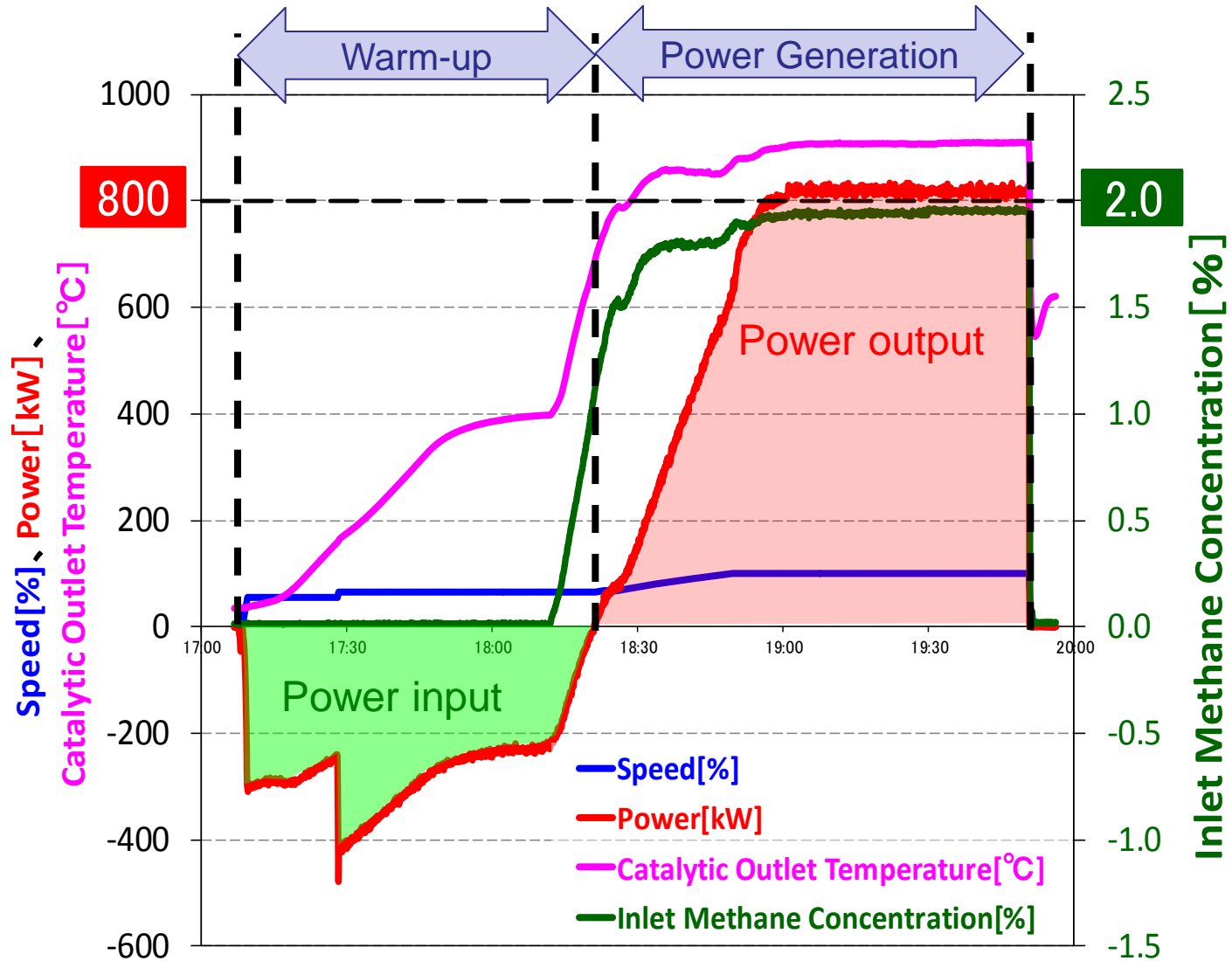




Construction of the Gas Turbine Gene-set



size : 7,700(L) x 2,980(W) x 5,140(H)
weight : 27,000kgf



Kawasaki's Proposed VAM Abatement System

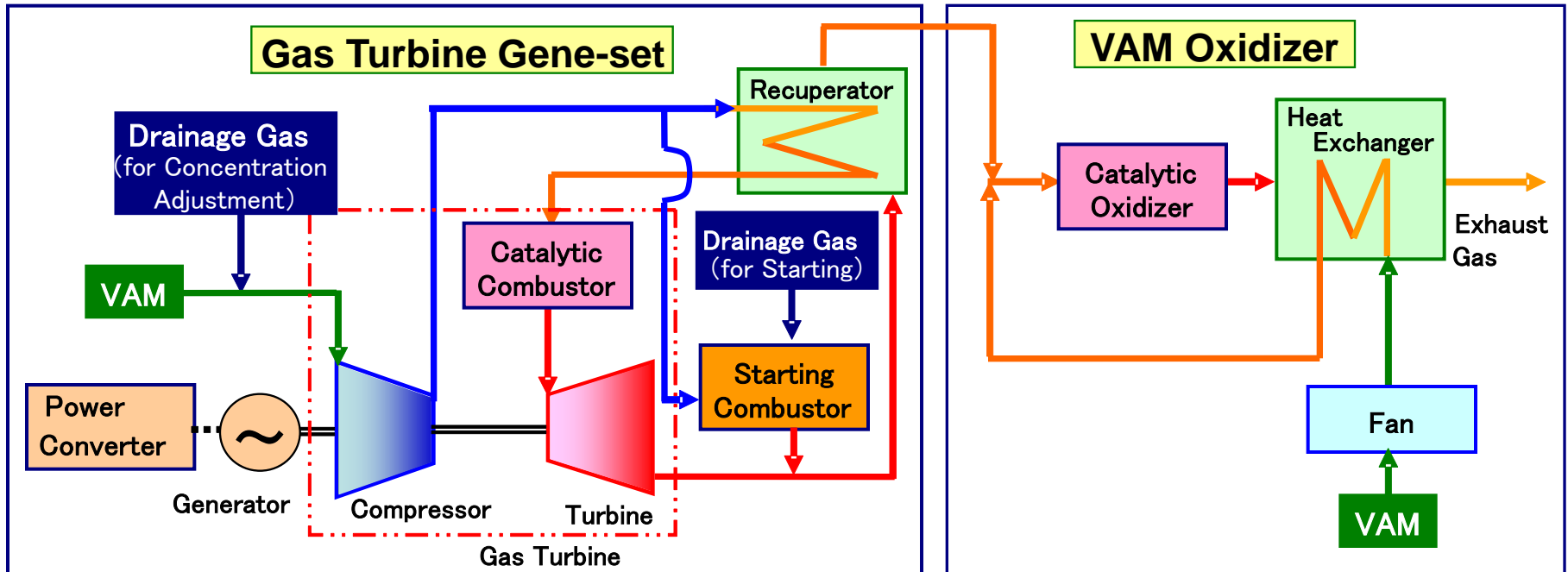
***Combination of the Lean Methane Fueled Gas Turbine
and
Catalytic Oxidizer***

Gas Turbine Gene-set

- Ingest VAM & Drainage Gas mixture as a fuel (methane concentration approx. 2%)
- Generate electricity : 800kW
- VAM mixture abatement : 22000Nm³/Hr

VAM Oxidizer

- Oxidize huge VAM by **Catalytic Oxidizer**
- Preheat VAM through the heat exchanger
- Increase VAM temperature by mixing with GT exhaust gas for starting and assisting



- ◆ No grid electricity required for operation (except startup period)
- ◆ No water required for operation
- ◆ Small foot print
- ◆ Shorter startup- and shutdown-time
- ◆ Quick response for fluctuation in CH₄ concentration
- ◆ Low operation temperature due to catalytic oxidation
 - Gas turbine gene-set : 900 °C max
 - Oxidizers : 600 °C max



RELIABLE PRODUCT CARE **ECO-FRIENDLY** **ENERGY EFFICIENT**

GREEN
Gas Turbines

*Kawasaki Gas Turbine places importance on "Efficient Energy Use", "Eco-friendly" and "Reliable Product Care for Total Life Cycle" as a philosophy of our products.
To enhance this philosophy,
we have introduced a new title for our products..... "GREEN Gas Turbines".*

" Get Reliable Eco-friendly Energy Now "