

Gas Engine Power Generation for CMM/VAM

Clean & High Efficiency Gas Engine Power Plant

MACH-30G

***** Stop the Green House Effect *****

Utilization of Coalmine Gas



MITSUBISHI HEAVY INDUSTRIES, LTD.

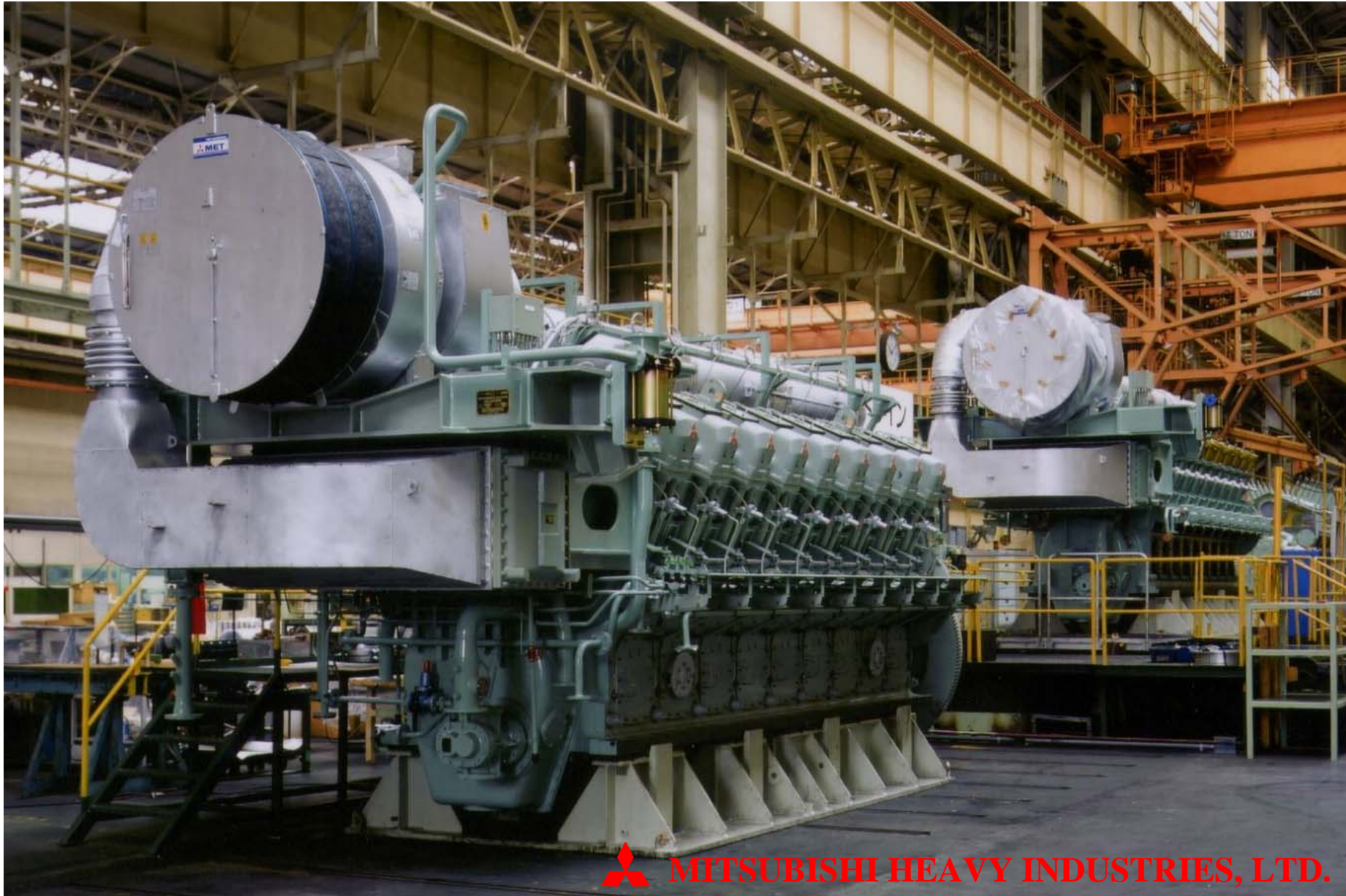
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2007

Road map for the presentation

- **Introduction of
MITSUBISHI MACH30G GAS ENGINE**
- **Utilization of C M M
with MACH30G GAS ENGINE**

MACH-30G (18MACH-30G)



What is MACH ?

M(Mitsubishi)

A(Advanced Engine of)

C(Clean &)

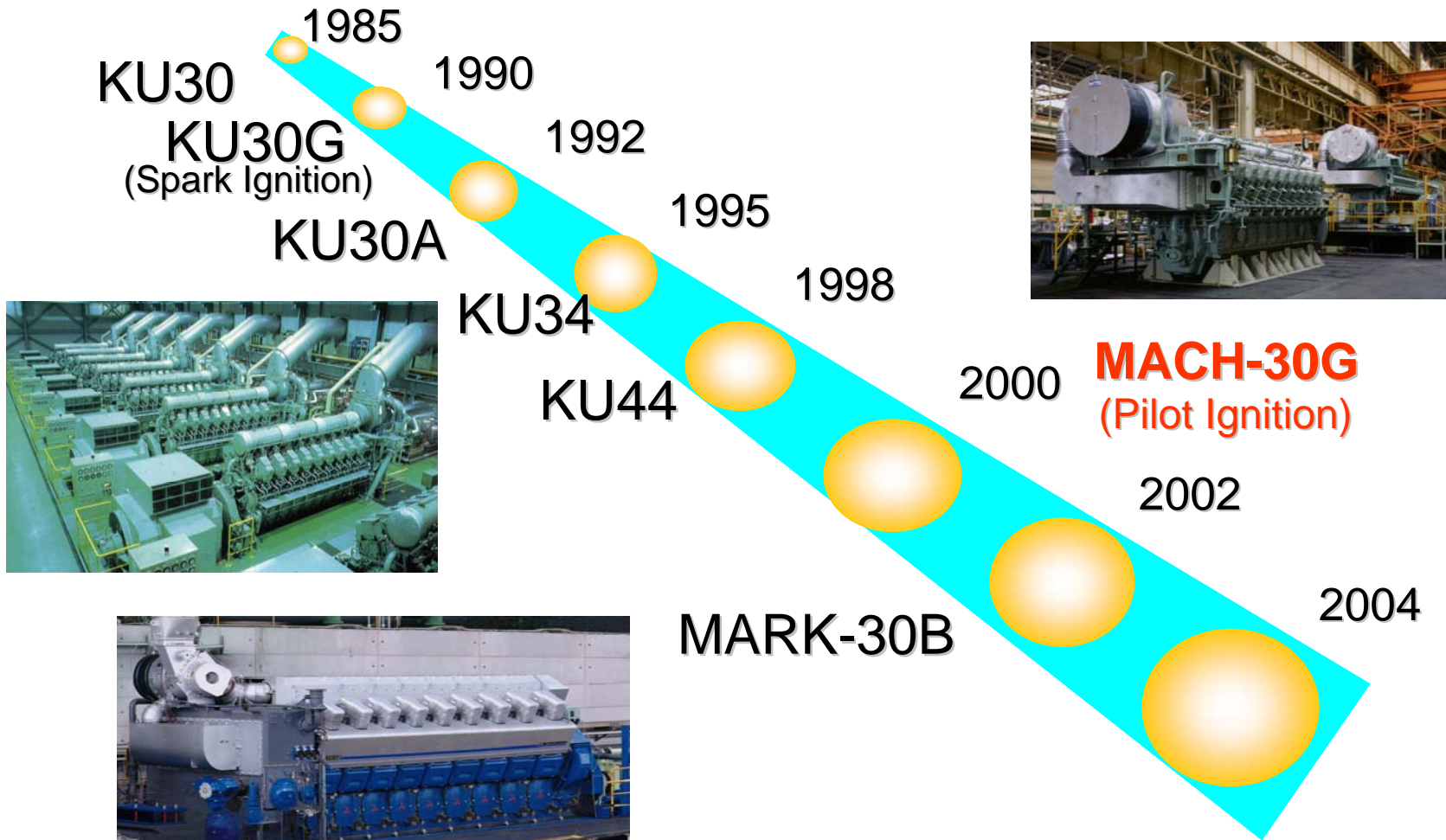
H(High Efficiency)

Principal Particular

Engine Type/		V-type 4cycle Gas Engine (Pilot Ignition with Pre-chamber)			
No. of Cylinder		12	14	16	18
Cylinder Bore	mm	300			
Stroke	mm	380			
Speed	rpm	7 2 0 / 750 (Frequency 6 0 / 50Hz)			
Gen. Output *1	kW	3650 / 3800	4250 / 4450	4900 / 5100	5500 / 5750

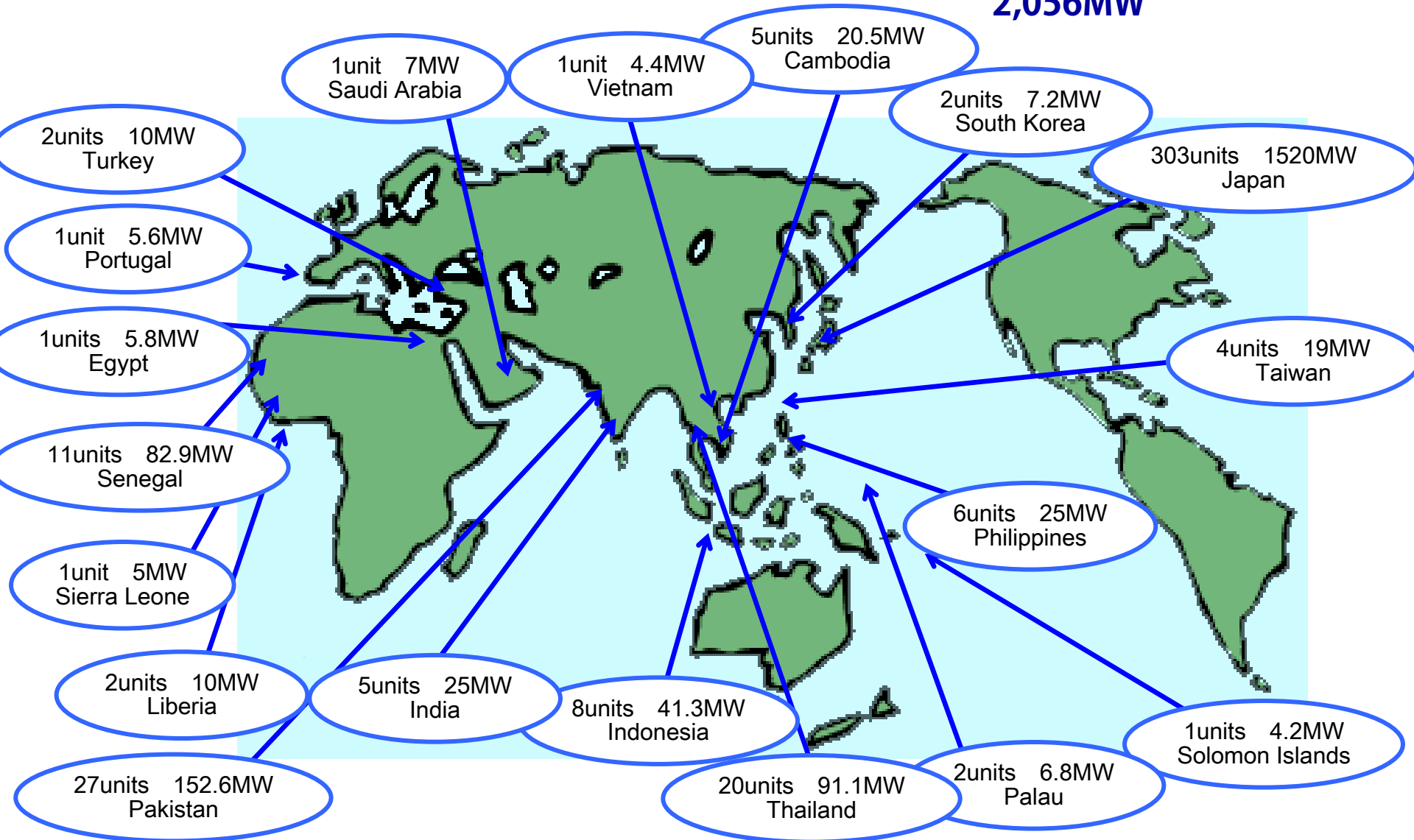
*1 when using Natural Gas or City Gas with Methane Number ≥ 65

Development of KU engine series

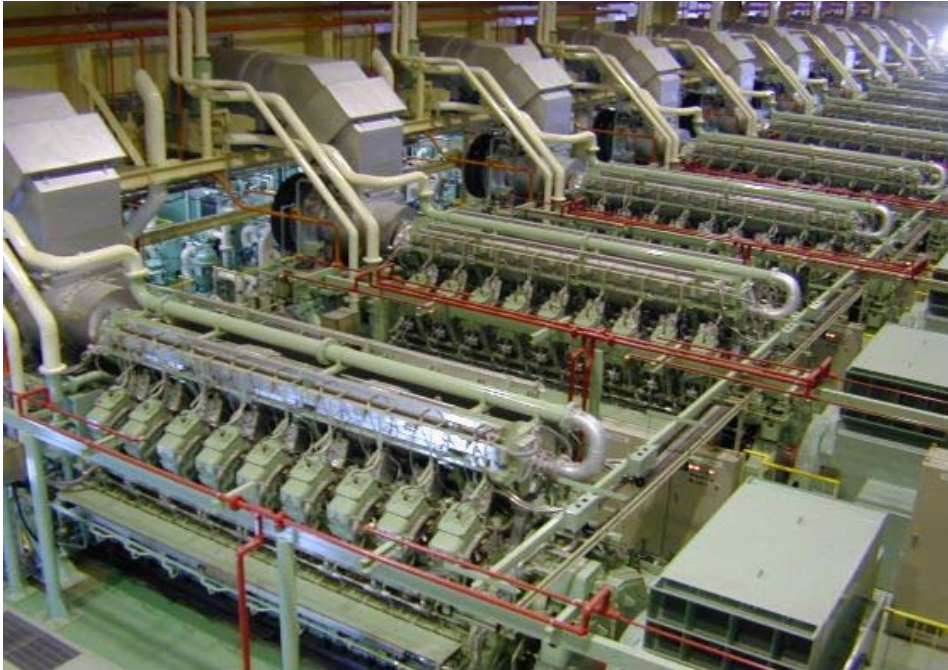


KU SERIES SALES RECORD IN THE WORLD

**Total 404units
2,056MW**



EXAMPLE OF MITSUBISHI GAS ENGINE ①



Client	Nippon Steel Corporation
District	Chiba, Japan
Engine Type	18MACH-30G
Unit	10
Output	57,500kW
Delivery	2003,3

EXAMPLE OF MITSUBISHI GAS ENGINE ②



Client	MHI Energy & Service
District	Kanagawa , Japan
Engine Type	18MACH-30G
Unit	2
Output	11,500kW
Delivery	2002,10

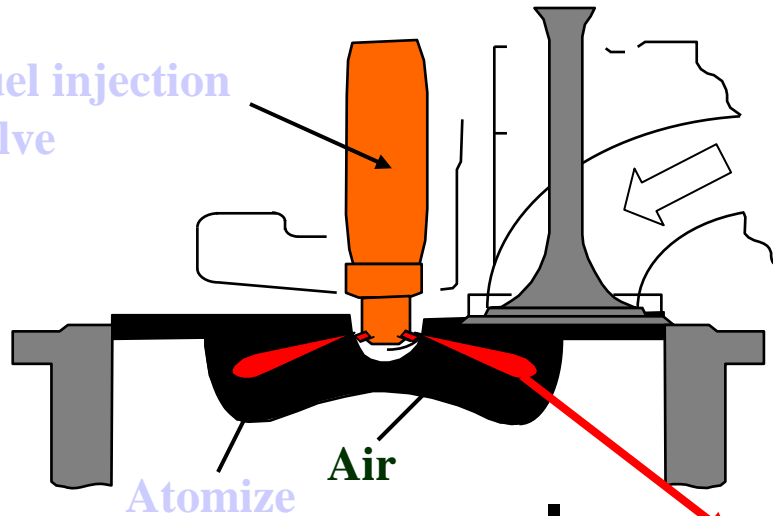
Feature of MACH Gas Engine

- Lean burn (Base technology)
Pre-combustion chamber is equipped to main combustion chamber → **Low NOx emission**
- Pilot ignition
Fuel oil Pilot Ignition Valve is used for ignition source instead of Spark Plug
→ **Make a stable combustion & Low NOx emission**
- Fuel Gas Supply System
Fuel gas is supplied to each cylinder directly through the gas supply valves for them.
→ **Higher response against load change**

Comparison of combustion between diesel engine and gas engine

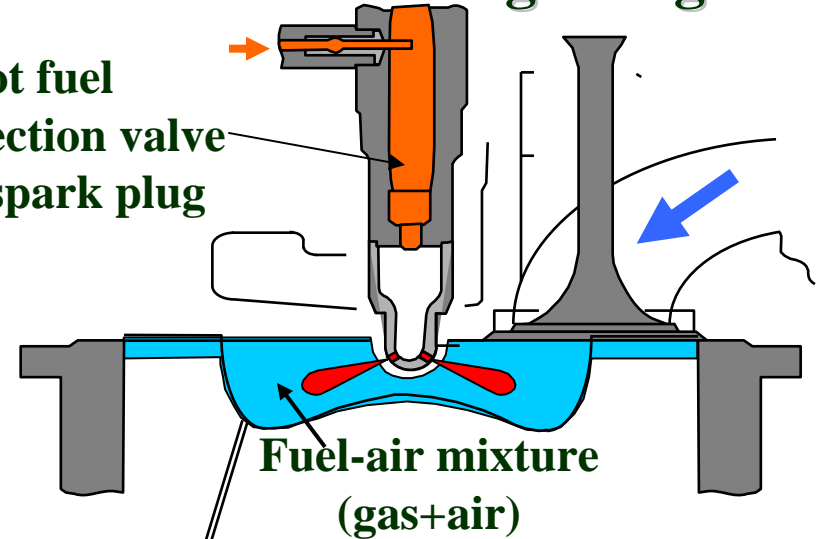
Diesel engine

Fuel injection valve



Lean burn gas engine

Pilot fuel injection valve or spark plug

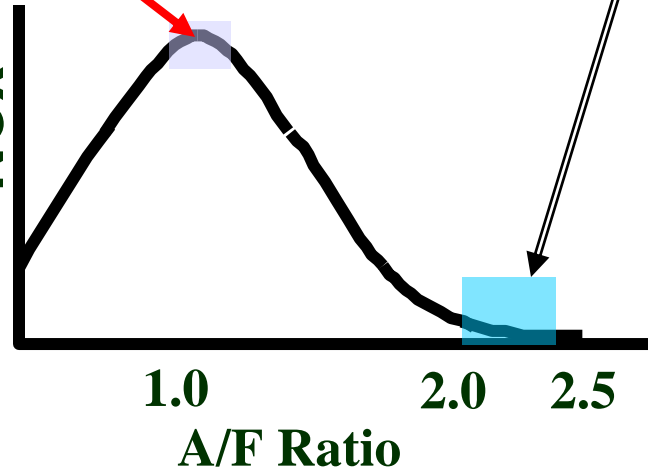


A/F Ratio 1

NOx level is high

Dust emission is high

NOx

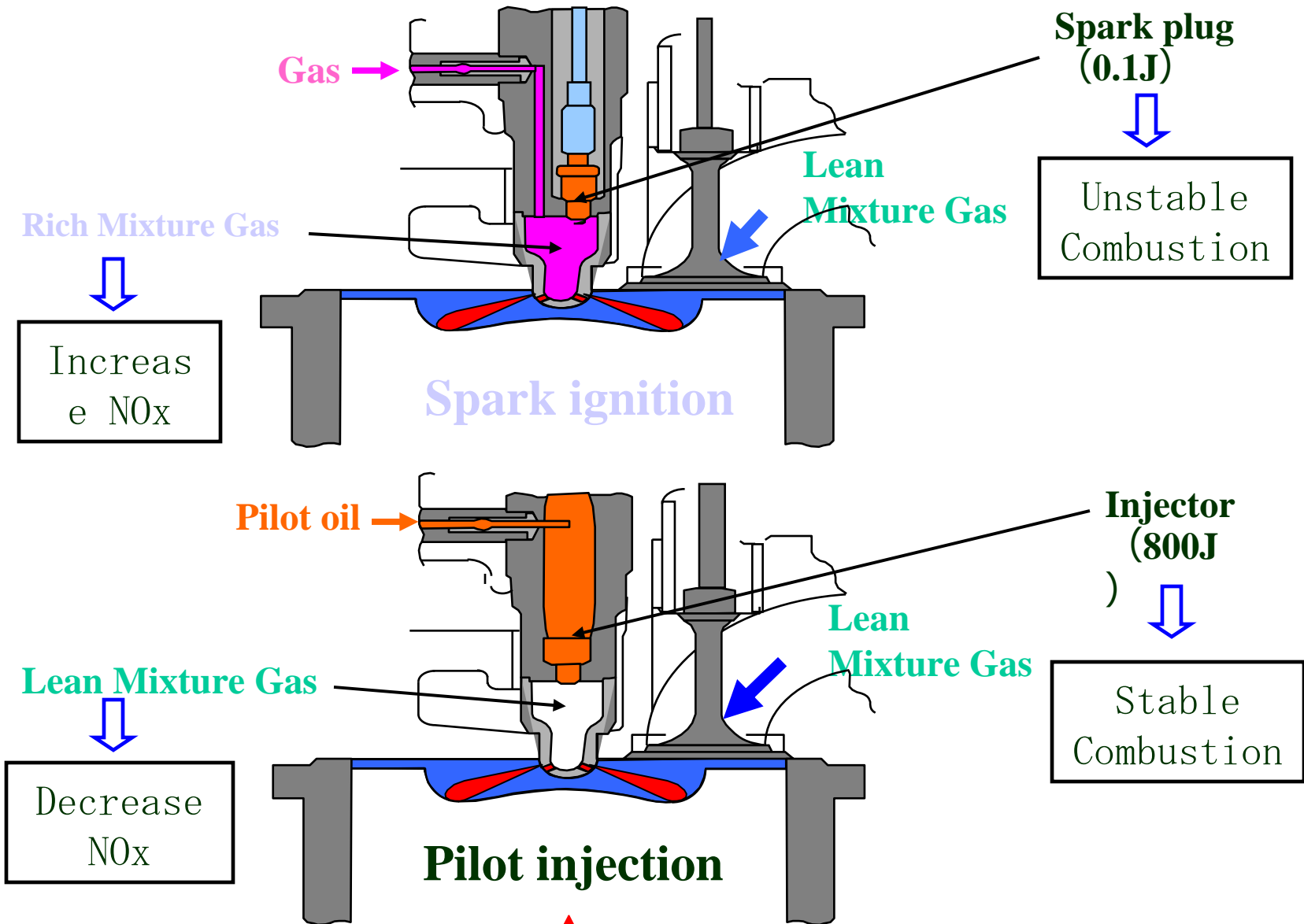


A/F Ratio 2

NOx level is low

Dust emission is low

Comparison between conventional gas engine (spark ignition) and new design (pilot injection)



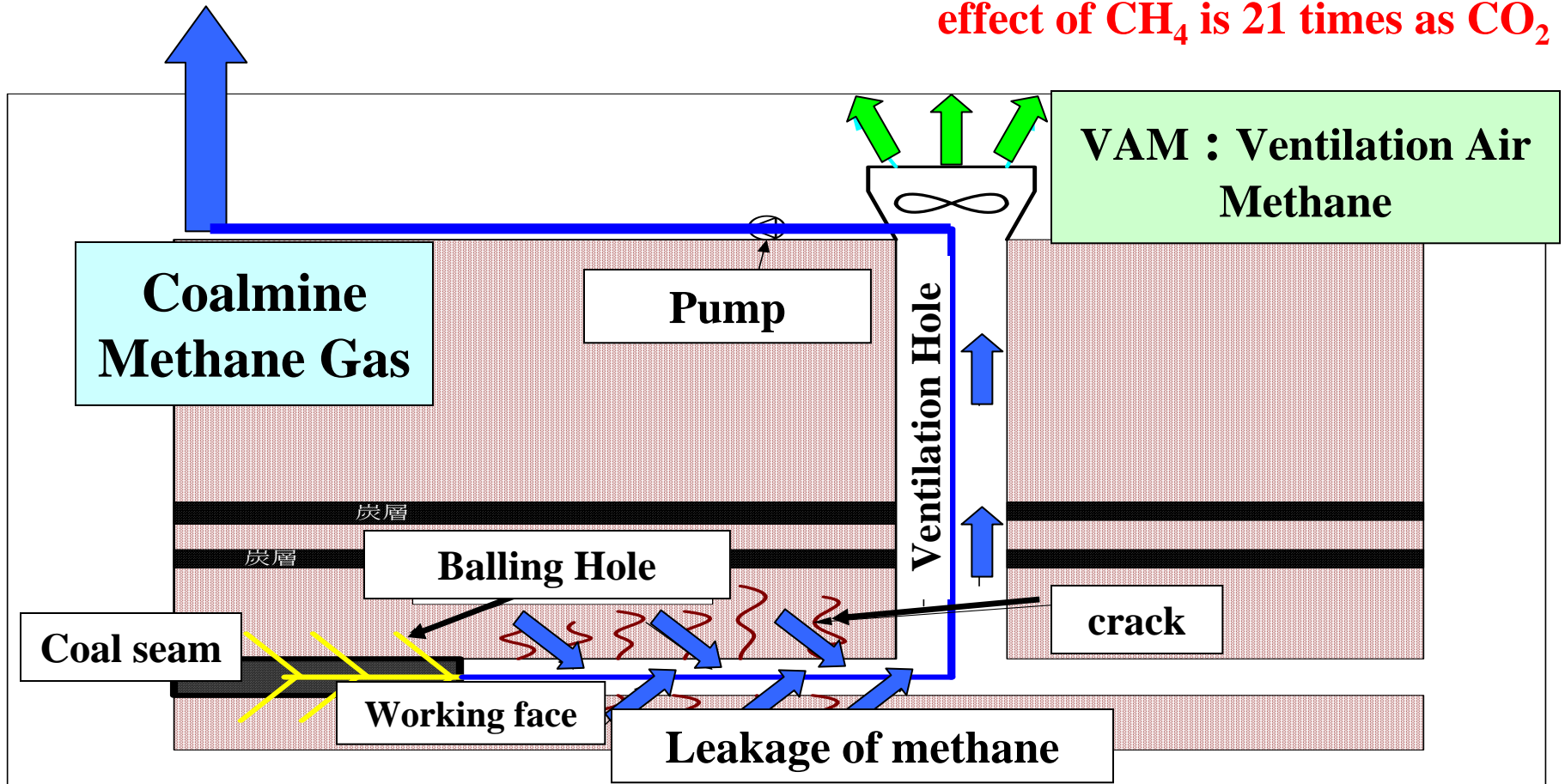
Present Situation of Coalmine Gas

Methane Emission from world Coalmines \doteq **22.4 M ton/yr**

\doteq

Same Green House Effect as **CO₂ of 470 M ton/yr**

effect of CH₄ is 21 times as CO₂



Utilization Plan of CMM in China

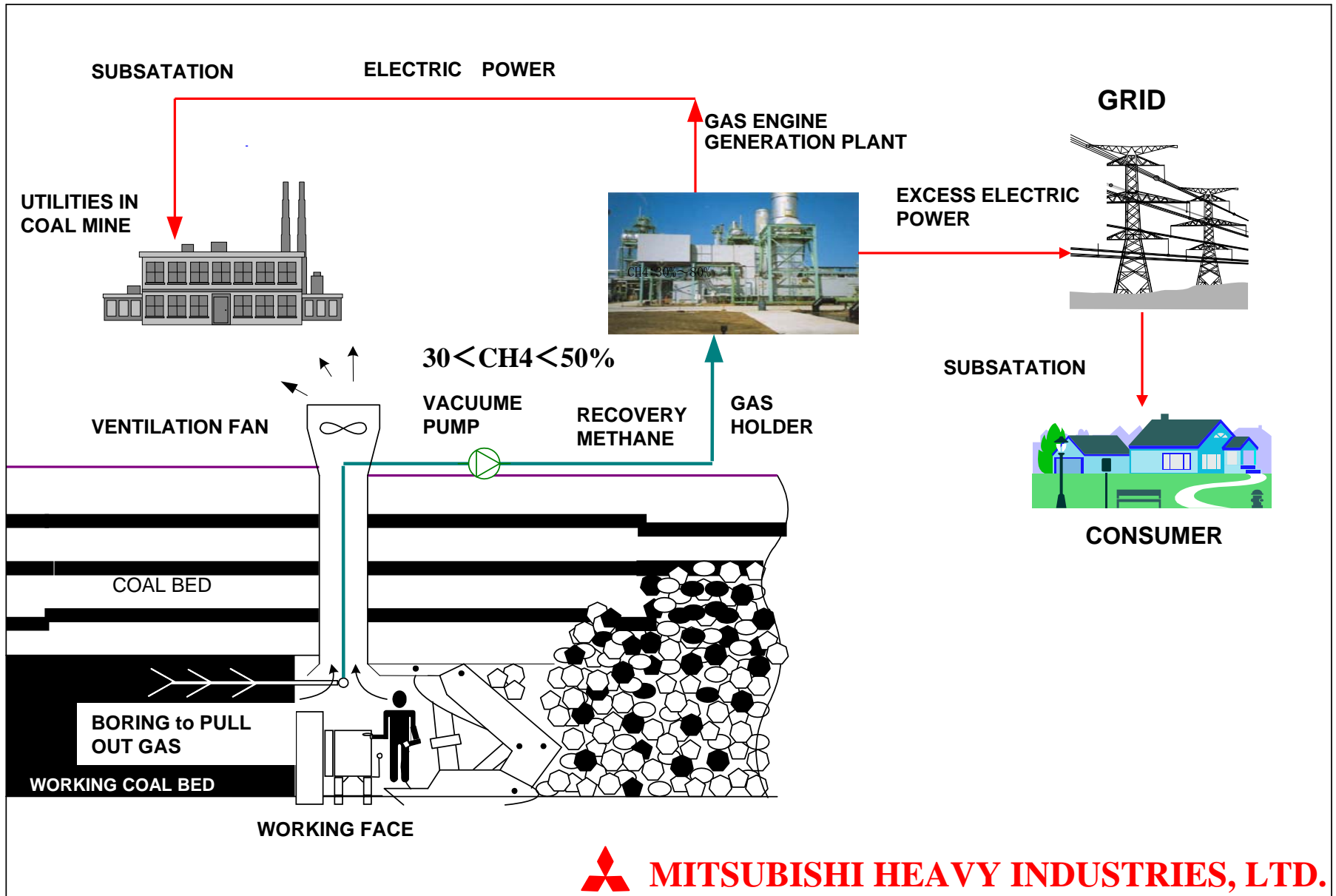
	2005 (Actual result)	2010 (Target)
Production	15 billion m ³	17.7 billion m ³
Recovery	2.3 billion m ³	10 billion m ³
Utilization	1 billion m ³	8.7 billion m ³

The source : The 11th Five-year Plan for Coal Mine Production Safety

**Utilization of CMM will lead good effect of
not only [Reducing the exhaust energy]
but also [Reducing CO₂]**

CH₄ 1ton = CO₂ 21ton

CMM GAS POWER PLANT



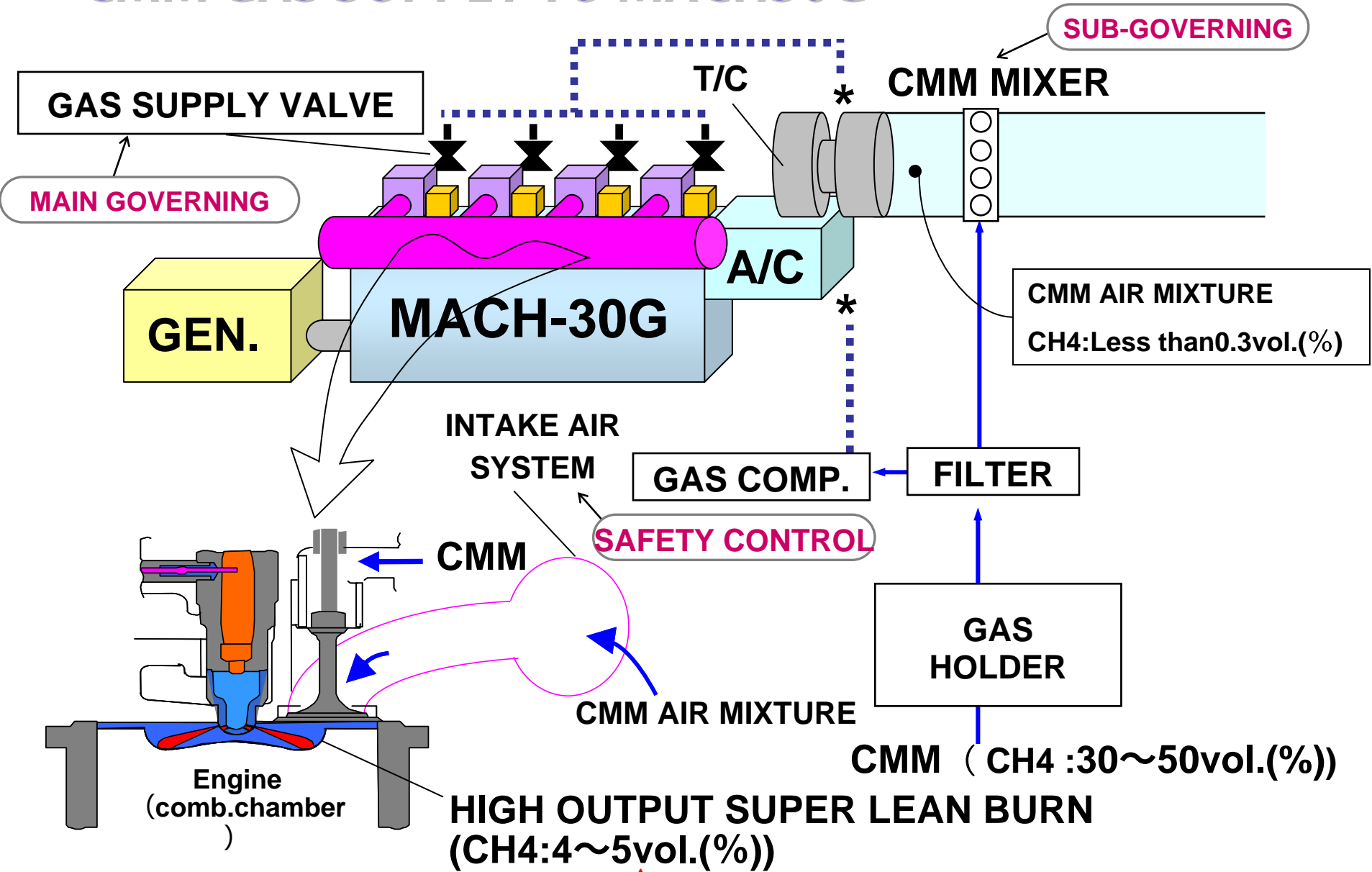
Principal Particular for CMM Gas engine (Design Target)

Engine Type		V-type 4cycle Gas Engine (Pilot Ignition with Pre-chamber)	
No. of Cylinder		12	18
Cylinder Bore	mm	300	
Stroke	mm	380	
Speed	rpm	750 (Frequency50Hz)	
Gen. Output *1	kW	3450	5200

***1: CMM Gas Concentration of CH₄ : More than 30%**

The Gen. output is depend on the Gas condition and site condition

CMM GAS SUPPLY TO MACH30G

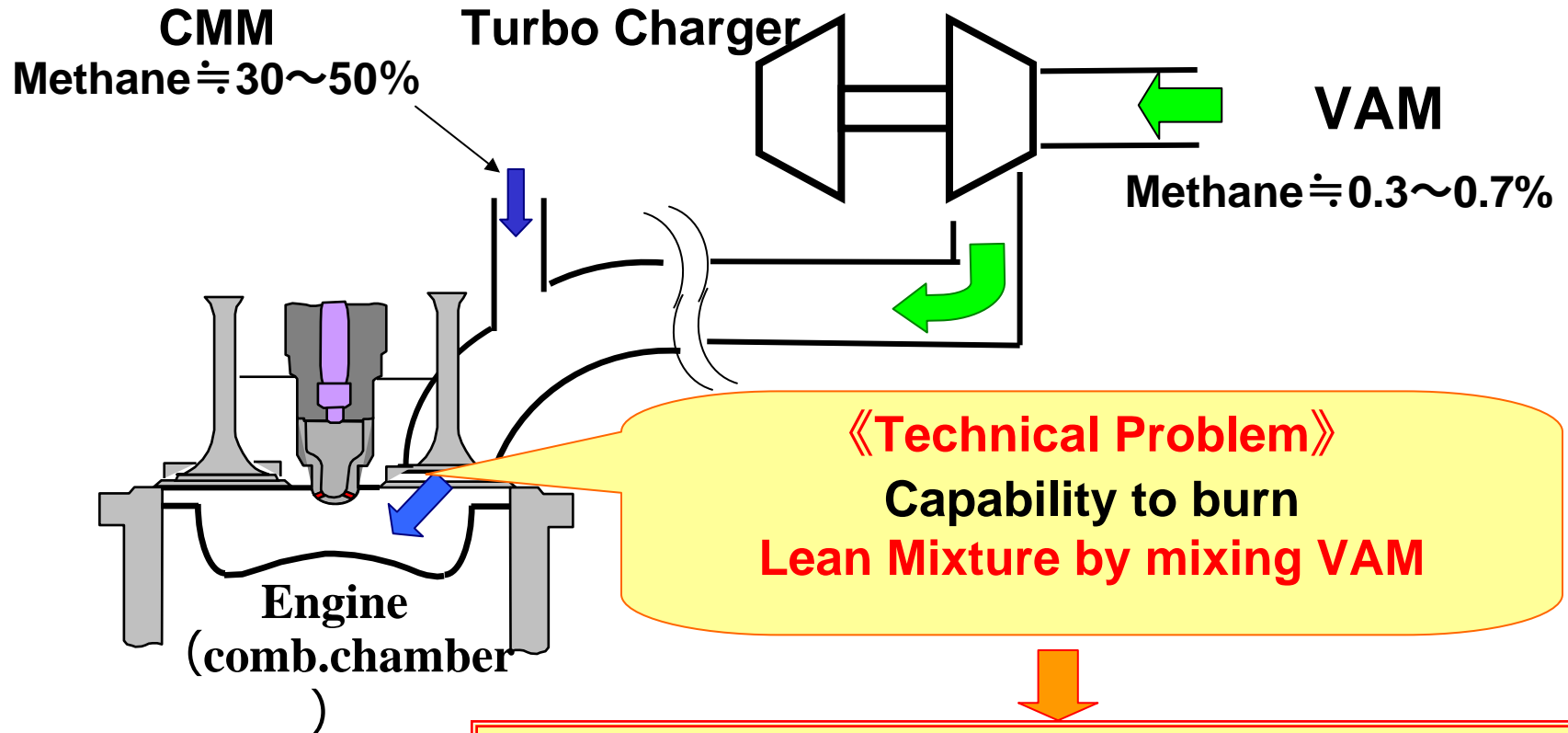


Future Possibility to use VAM

Necessary to reduce Green House Gas further in future



Utilization of VAM
(Ventilation Air Methane)



MACH-30G has high potential because of technical advantage of Lean Burn

MACH-30G Technologies for Coalmine Gas

Problems with Conventional Engine

Solutions of MACH30G

**Low
Calorific
Value**



**Unstable
Ignition due
to Low Ign.
Energy**

***Pilot Ignition
(High Ignition Energy)***

**Large
Variation of
Methane %**



**Combustion
Variation**

**Abnormal
Combustion**

Combustion Control

**Knock with rich
Misfire with Lean**

**When mixing
VAM**



**Leaner
Mixture**

***Lean Burn Technology
&
Fuel Gas Direct Supply
system to cylinder***



Conclusion

We believe

Mitsubishi MACH-30G Gas engine

will contribute to

stop the Green House Effect utilizing Coal Mine Gas

Key Technology

Lean Burn Technology

Pilot Ignition

Combustion Control

Fuel Gas Direct Supply System to Cylinder



Reducing

Exhaust Energy

CO₂



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MACH-30G (18MACH-30G)

Thank you

