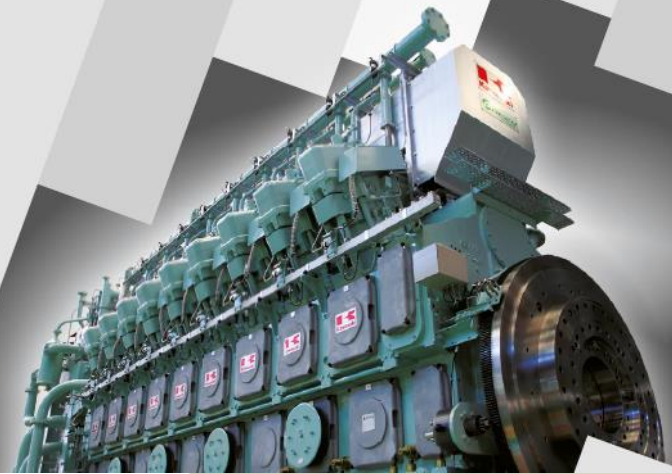
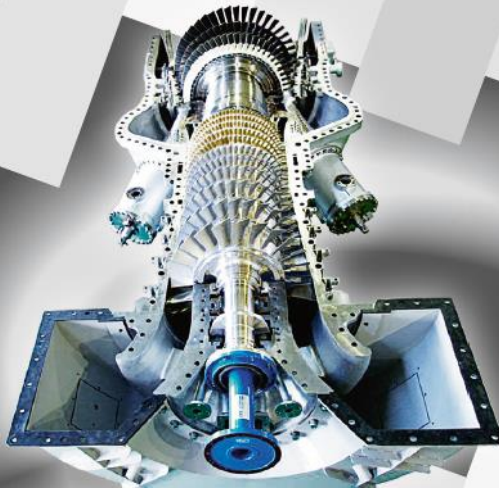


Two Specialists

No Compromise



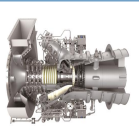
KAWASAKI Gas Turbine Europe GmbH

CHP and Combined Cycle-Plants

General Company Presentation

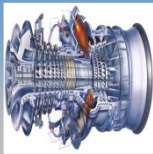
 **Kawasaki**
Powering your potential

Agenda



1

Kawasaki Heavy Industries (KHI)



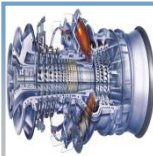
2

Kawasaki Gas Turbine Europe (KGE)



3

Kawasaki Products & Services



4

Developments for Hydrogen Gas Turbines @ KHI

Kawasaki Heavy Industries – Sections

Kawasaki Heavy Industries, Ltd.

**Ships & Offshore
Structure Company**



**Rolling Stock
Company**



**Aerospace
Company**



**Energy System & Plant
Engineering Company**

**Motorcycle &
Engine Company**



**Precision Machinery
Company**



Kawasaki Gas Turbine Europe GmbH

- Germany – Europe headquarter
- Romania – Representative office responsible for South – East Europe

**Kawasaki Gas Turbine Asia Sdn. Bhd.
(Malaysia)**

**Kawasaki Gas Turbine Asia Sdn. Bhd.
- Jakarta Representative Office**

**Kawasaki Heavy Industries, LTD
- Bangkok Office**

Kawasaki Gas Turbine Europe (KGE) – History

1975 License Agreement with Deutz AG

- *Deutz, Cologne starts the Sales and Service of the M1A Gas Turbine*
- *MWM Diesel & Gastechnik, Mannheim takes over the business from Deutz*

1998 Establishment of KAWASAKI Gas Turbine Europe GmbH

- *Headquarter for the entire European Market*
- *Sales, Packaging and Service of Gas Turbine Generator Sets*
- *10 Employees*

2003 Expansion of Production Facilities

- *Relocation to Bad Homburg (close to Frankfurt City)*
- *Establishment of the Production Site and Service Centre Europe*
- *Start of in-house packaging of GPB17D*
- *25 Employees*

2013 Introduction of the Gas Engines into the product portfolio

- *Start of Promotion and Sales of KG-12/V and KG-18/V*
- *40 Employees*

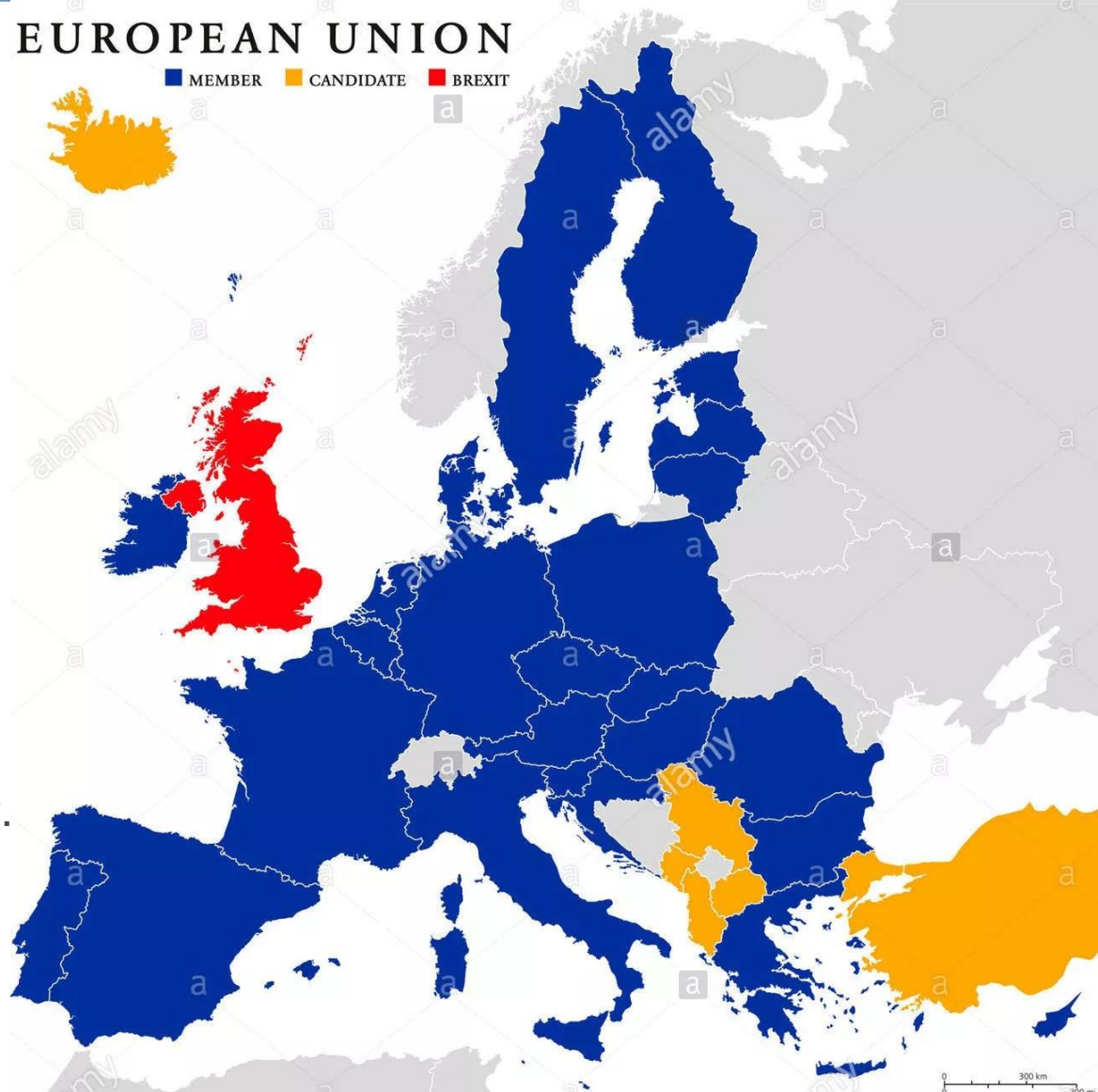
2018 Establishment of Romanian Office in Bucharest

- *Promotion & Sales Activities started, responsible for South-East Europe*
- *Currently: 67 Employees*



European Union context for KGE business

- EU-ETS – reduction of CO₂ emissions 2021 - 2030;
- 2015 Paris Agreement – greenhouses gas emissions reduction 2020 – 2030, limit global warming to no more than 2 deg. C;
- EU Directive 27/2012 – Energy Efficiency
- Decision 1442/2017 – En. Eff. levels and Emiss. Levels associated with BAT;



Kawasaki's challenge

**How can Kawasaki,
Japanese/German company,
contribute to
such European
environmental policy ?**

EUROPEAN UNION

MEMBER CANDIDATE BREXIT



Working as one for the good of the planet!

Highly Focusing on Environmental Protection and Energy Savings



- **Reduction of emissions**
Global warming gas CO₂
Harmful gas NO_x, SO_x
- **Energy Saving**



- **Renewable energy**



Distributed Generator System

- **Provide highly efficient energy use**
 - **Flexible and reliable**
- to complement unstable renewable energy**

Planning of cogeneration power plants

Potential clients of cogeneration

➤ Industry

Pulp and paper



Medicines and cosmetics



Refinery / Chemistry



Food and beverages industry



Automotive and tyres



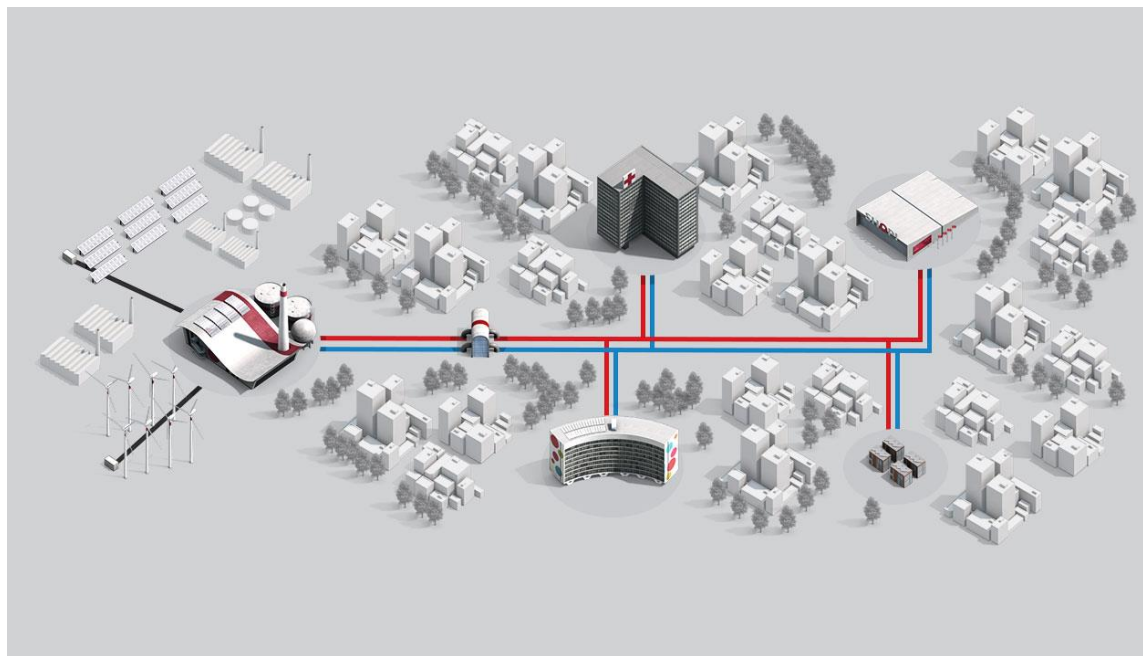
Ceramics



Planning of cogeneration power plants

Potential clients of cogeneration

➤ District Heating



➤ Services with own small cogeneration unit:

Universitary campus

Hospitals

Hotels

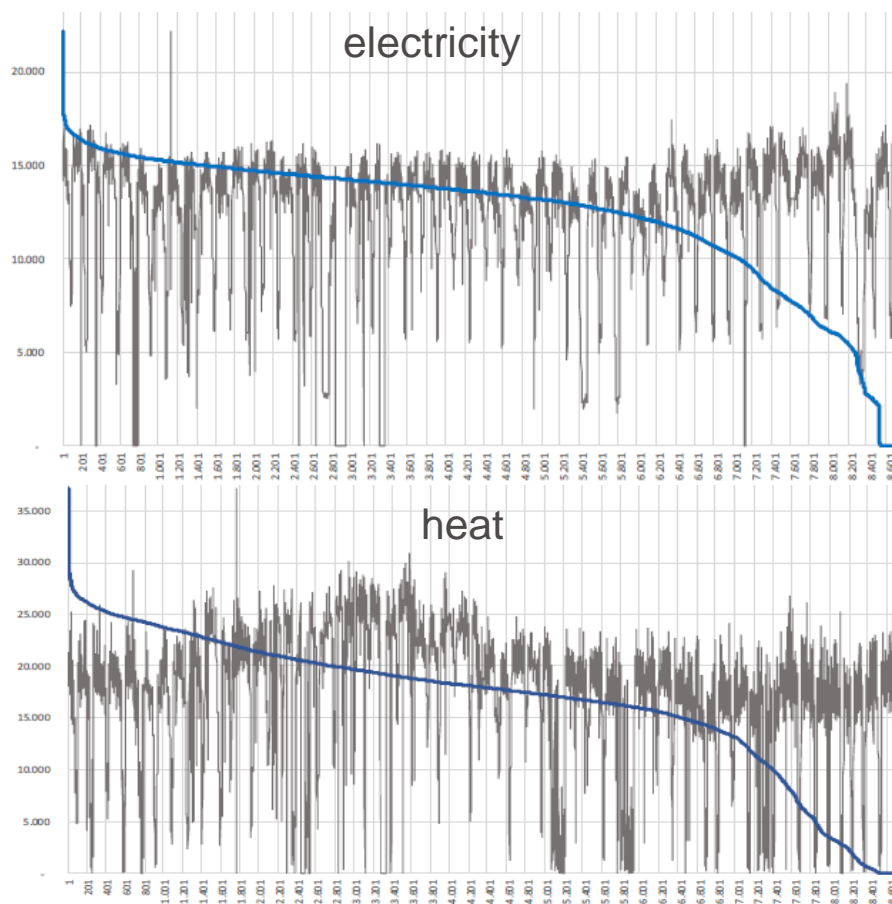
Airports

Planning of cogeneration power plants

Main steps to size a cogeneration unit

- Calculating heat and electricity demand
- Analysis of consumption profile and simultaneity electricity and heat consumption

example



Planning of cogeneration power plants

Main steps to size a cogeneration unit

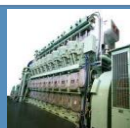
- Sizing criteria
 - Heat demand: heat demand is main criteria and electricity is a result
 - Electricity demand: electricity is main criteria and heat is a result
- Cogeneration technology
- Sizing of cogeneration unit
- Investment (CAPEX)
- Technic and economic calculation
 - Yearly operation data
 - Criteria of high efficiency cogeneration – CE Directive no. 27/2012
 - OPEX
- Financing solution
 - Own funds and / or loans
 - BOOT
 - EU funds – POIM / 6.4 (extended till 31 December 2020), Mechanisms 10C (Derogation) and 10 D (Modernization unit)
 - Grants

Kawasaki Products & Services

Kawasaki Gas Turbine Europe · Kawasaki Heavy Industries



Products



Services

Gas Turbines

M1A-17D
1,816 kWel
 $\eta = 28.1 \%$

M5A-01D
4,720 kWel
 $\eta = 32.6 \%$

M7A-03D
7,810 kWel
 $\eta = 33.6 \%$

L20A-01D
18,500 kWel
 $\eta = 34.3 \%$

L30A-01D
34,300 kWel
 $\eta = 40.3 \%$

Gas Engines

KG12
5,200 kWel
 $\eta = 49.0 \%$

KG12-V
5,200 kWel
 $\eta = 49.5 \%$

KG18
7,800 kWel
 $\eta = 49.0 \%$

KG18-V
7,800 kWel
 $\eta = 49.5 \%$

Engineering

Concept Engineering

Detailed Engineering

Implementation

Project Planning

Customized Packaging

Erection Commissioning

Maintenance

Spare Parts Consumables

Full Maintenance

Remote Monitoring

Other Services

**Low-interest loans
(i.e. governmental loans)**

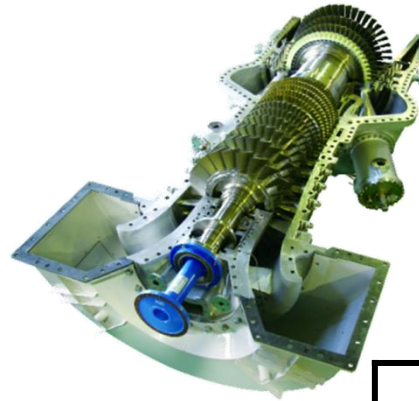
Kawasaki Gas Turbine Engine Models

M1A-17D



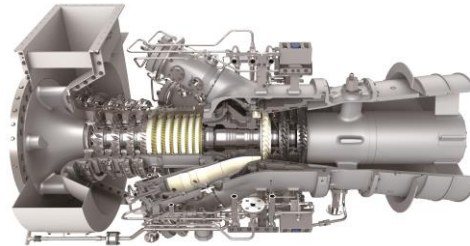
	M1A-17D
Power Output[kWe]	1,816
Ele. Efficiency[%]	28.1
Exhaust Gas Temperature[degC]	522
NOx [ppm]	< 9
CO [ppm]	50

M7A-03D



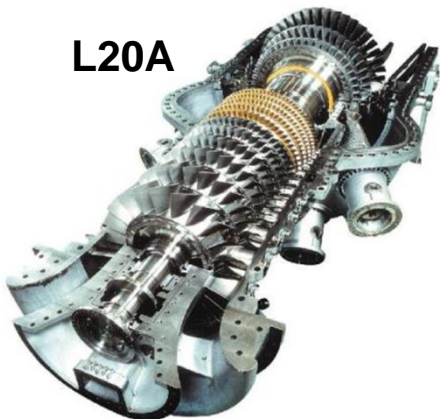
	M7A-03D
Power Output[kWe]	7,810
Ele. Efficiency[%]	33.6
Exhaust Gas Temperature[degC]	523
NOx [ppm]	< 9
CO [ppm]	10

M5A-01D



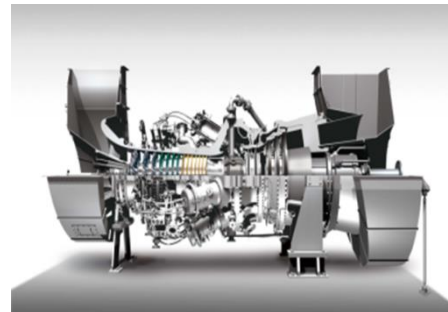
	M5A-01D
Power Output[kWe]	4,720
Ele. Efficiency[%]	32.6
Exhaust Gas Temperature[degC]	511
NOx [ppm]	15
CO [ppm]	15

L20A



	L20A
Power Output[kWe]	18,500
Ele. Efficiency[%]	34.3
Exhaust Gas Temperature[degC]	542
NOx [ppm]	15
CO [ppm]	25

L30A



	L30A
Power Output[kWe]	34,380
Ele. Efficiency[%]	40.3
Exhaust Gas Temperature[degC]	502
NOx [ppm]	15 / 9
CO [ppm]	25

Gas Turbine Generator Sets – Main Features

Main Features



- **High Exhaust Temperature >500°C**

- **Less amount of Low Temperature Heat**

- **Low Level Sound Enclosures**

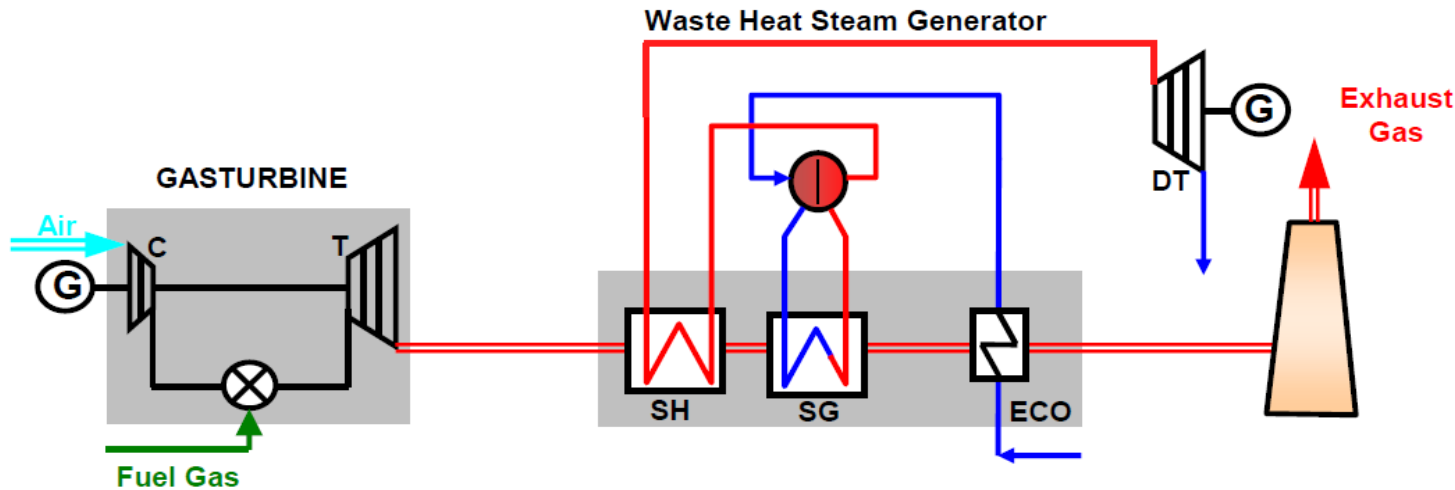
- **Low Exhaust Gas Emissions**

- **Less Interfaces**

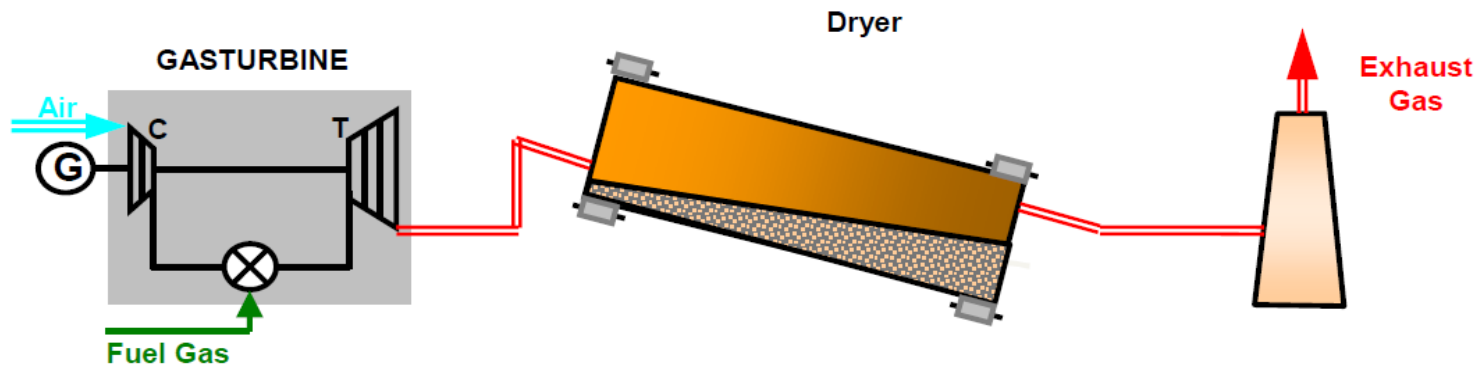
- **Long Maintenance Intervals**

Possible Applications in Cogeneration – 1/3

Combined Cycle Power Production

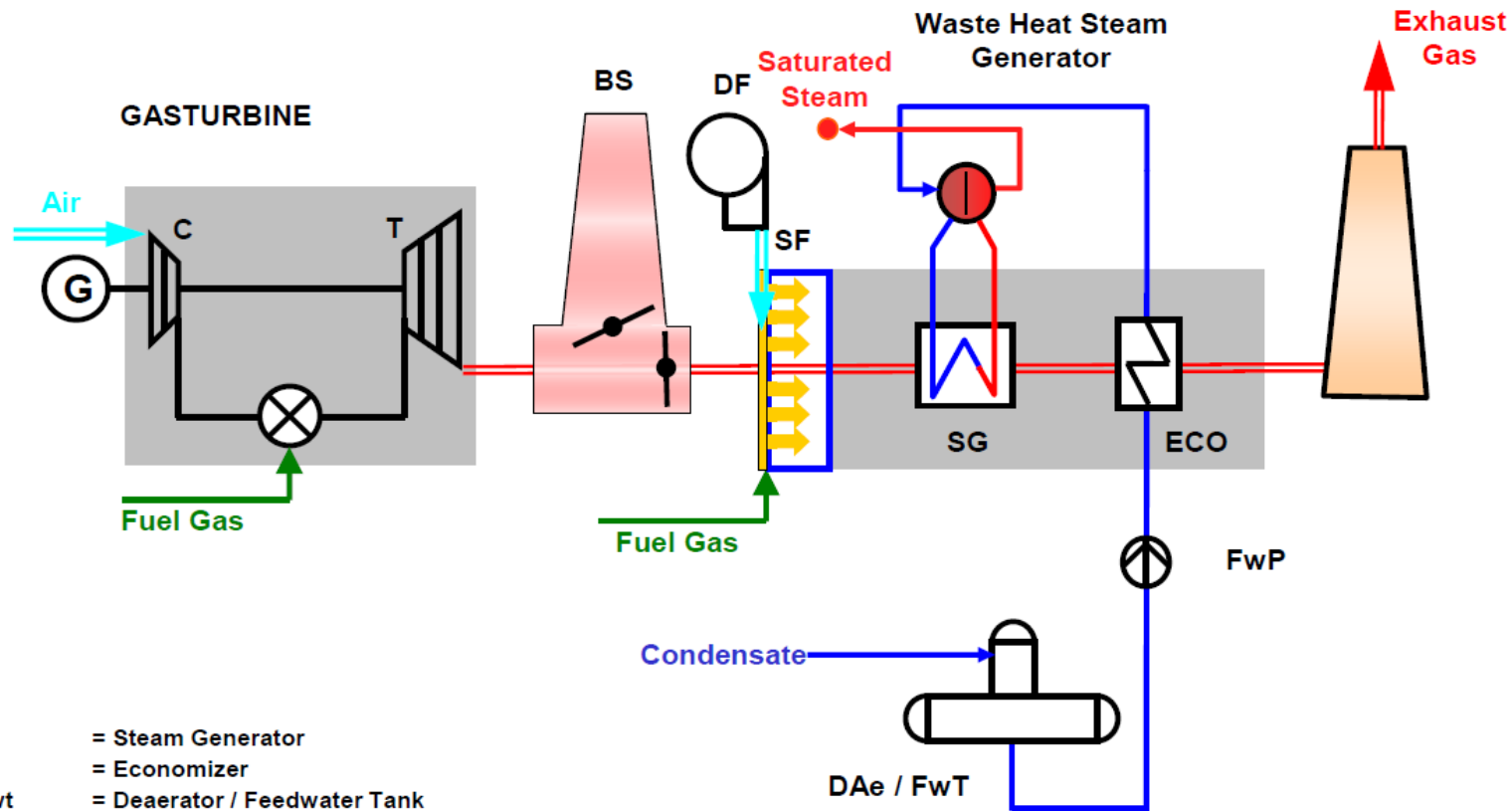


Direct Exhaust Gas Utilization



Possible Applications in Cogeneration – 2/3

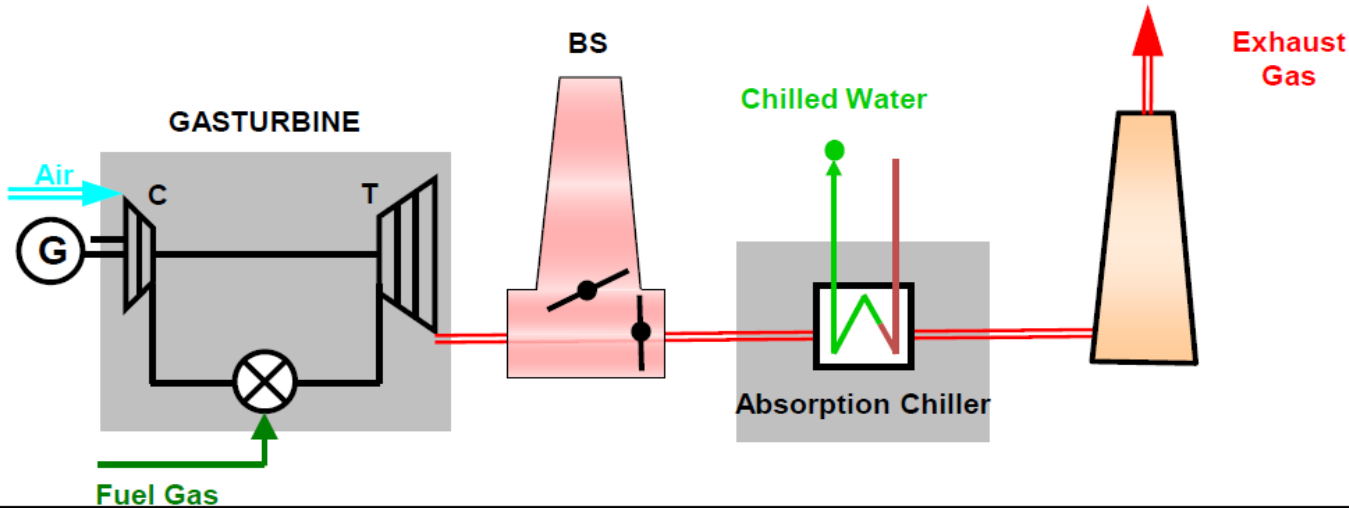
Gasturbine with WHSG, SF, Bypass Stack (BS) and Draft Fan (DF)



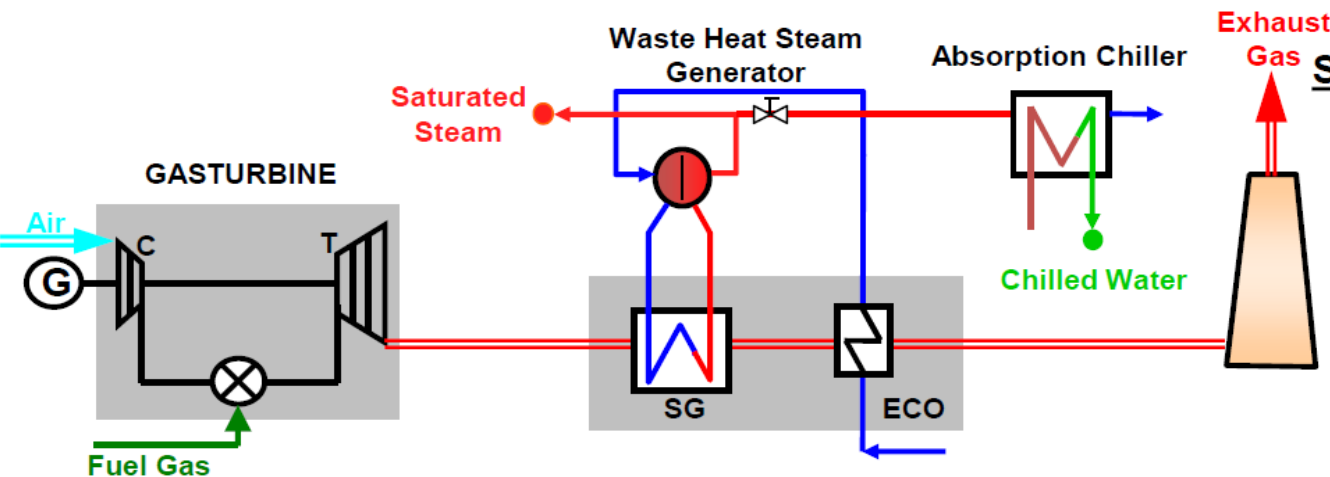
- SG = Steam Generator
- ECO = Economizer
- Dae + Fwt = Deaerator / Feedwater Tank
- SF = Supplemental Firing
- BS = Bypass Stack
- DF = Draft Fan
- FwP = Feed-water Pump

Possible Applications in Cogeneration – 3/3

Direct Fired Absorption Chiller



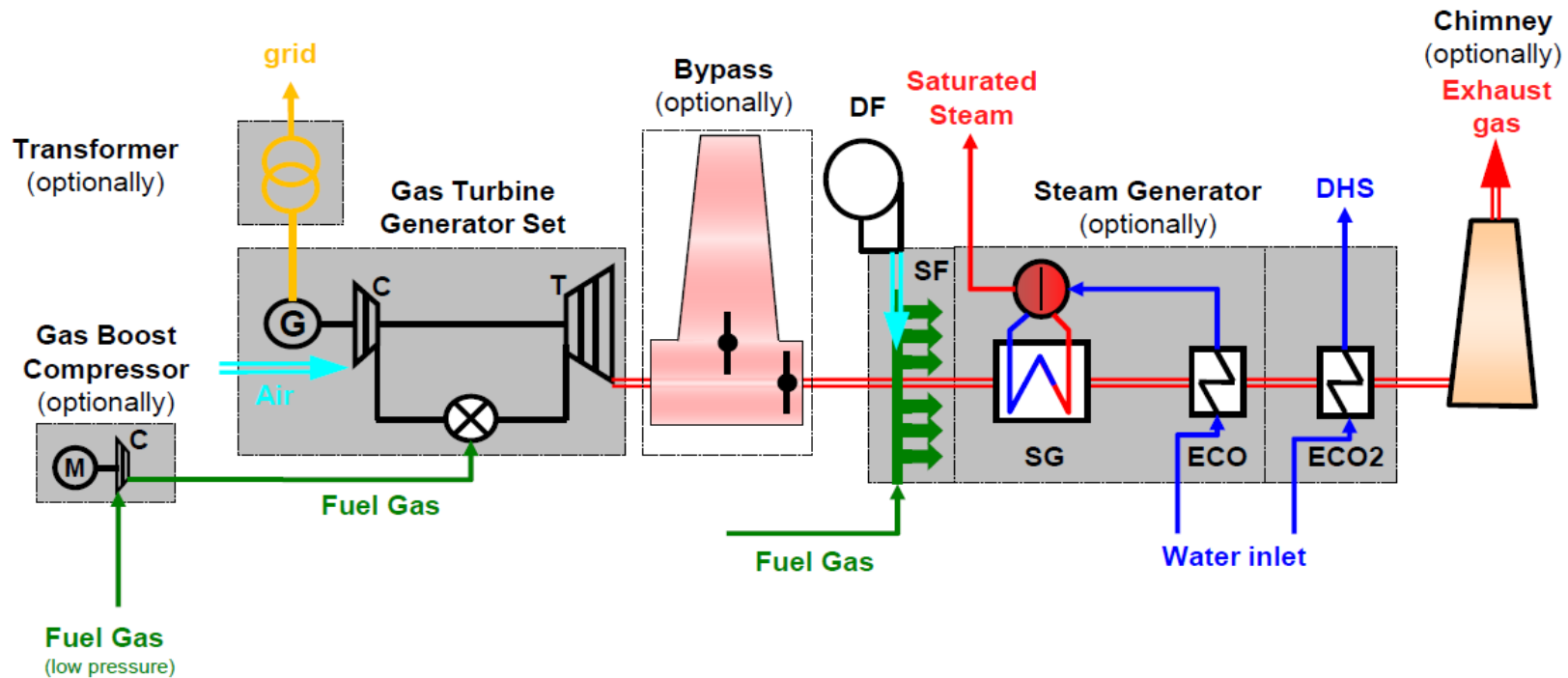
Steam Fired Absorption Chiller



Steam fired Absorption Chiller

e.g. for part time usage in summer

Kawasaki Gas Turbine Europe (KGE) – Scope of Supply



Gas Engine Generator Sets – Main Features

Main Features



- **Highest Electrical Efficiency 49.5%**

- **Excellent Partial Load Performance**

- **Wide Continuous Operating Range**

- **Less Impact by Ambient Conditions**

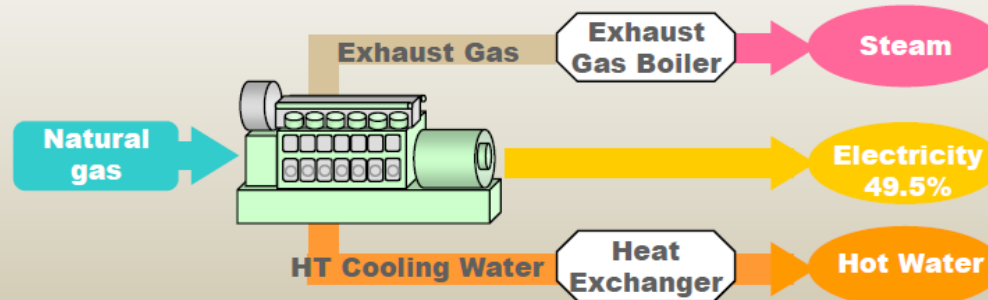
- **Quick Start-Up** (In 10 minutes to 100% Load)

Possible Applications in Cogeneration of KG 18V, KG 12V

Typical Application for Steam/Hot Water/Chilled Water Demand

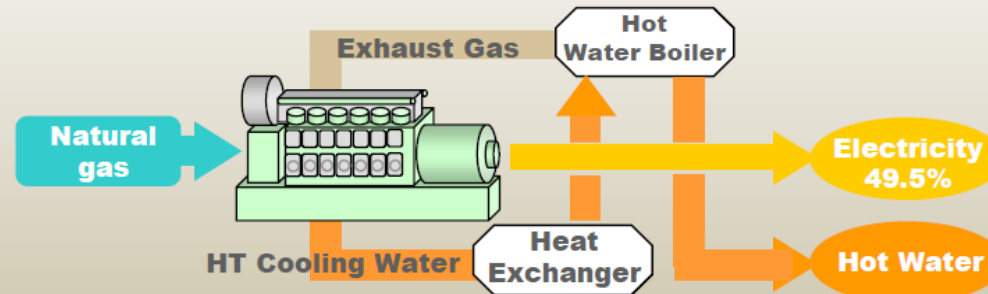
Example1

Electricity + Steam + Hot Water



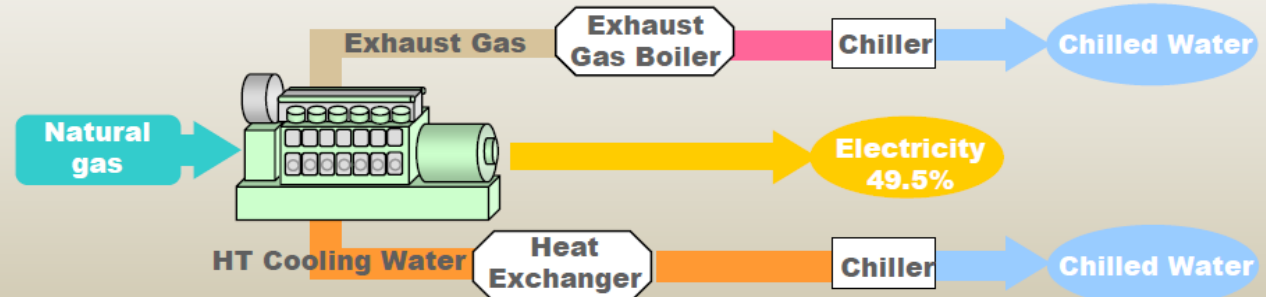
Example2

Electricity + Hot Water

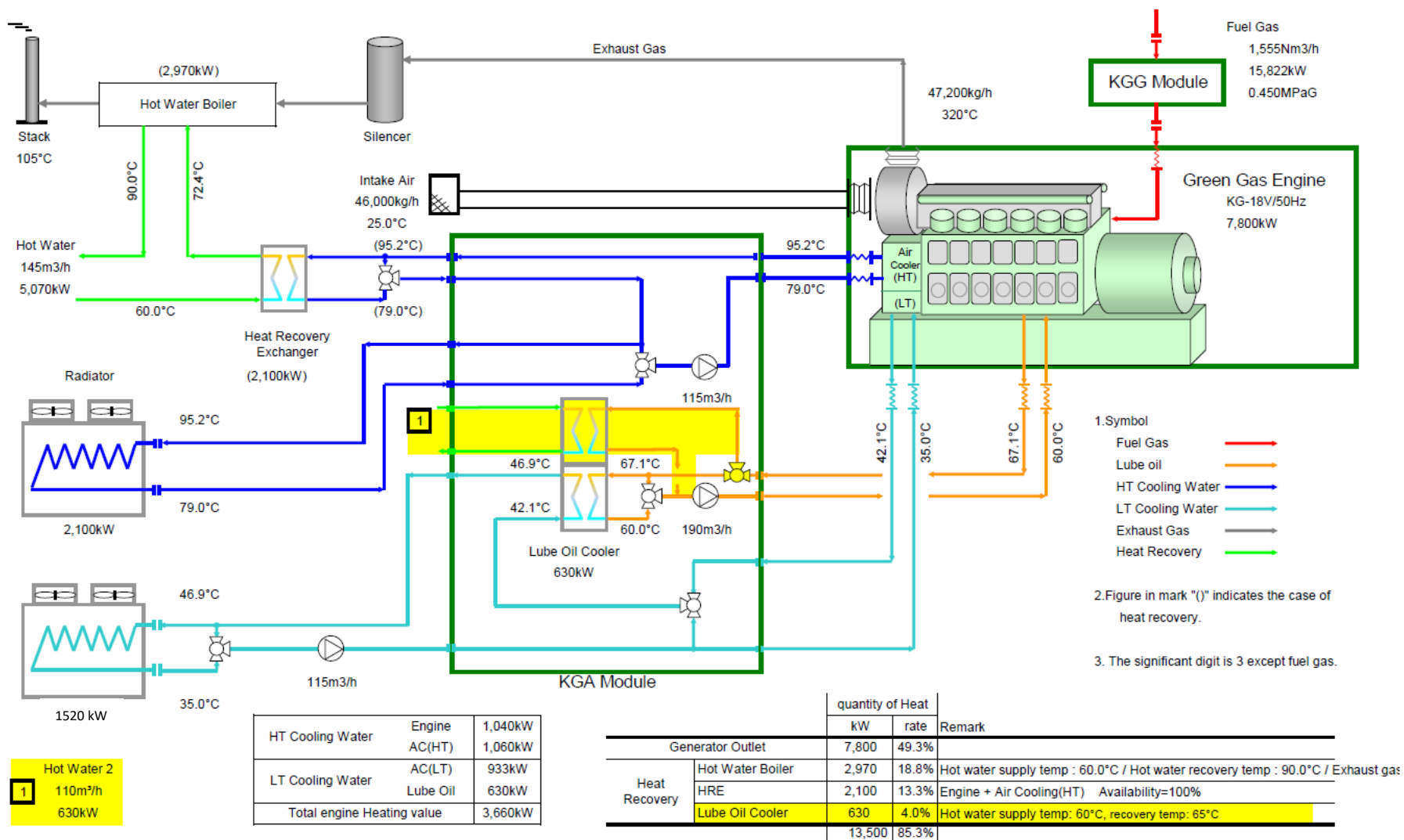


Example3

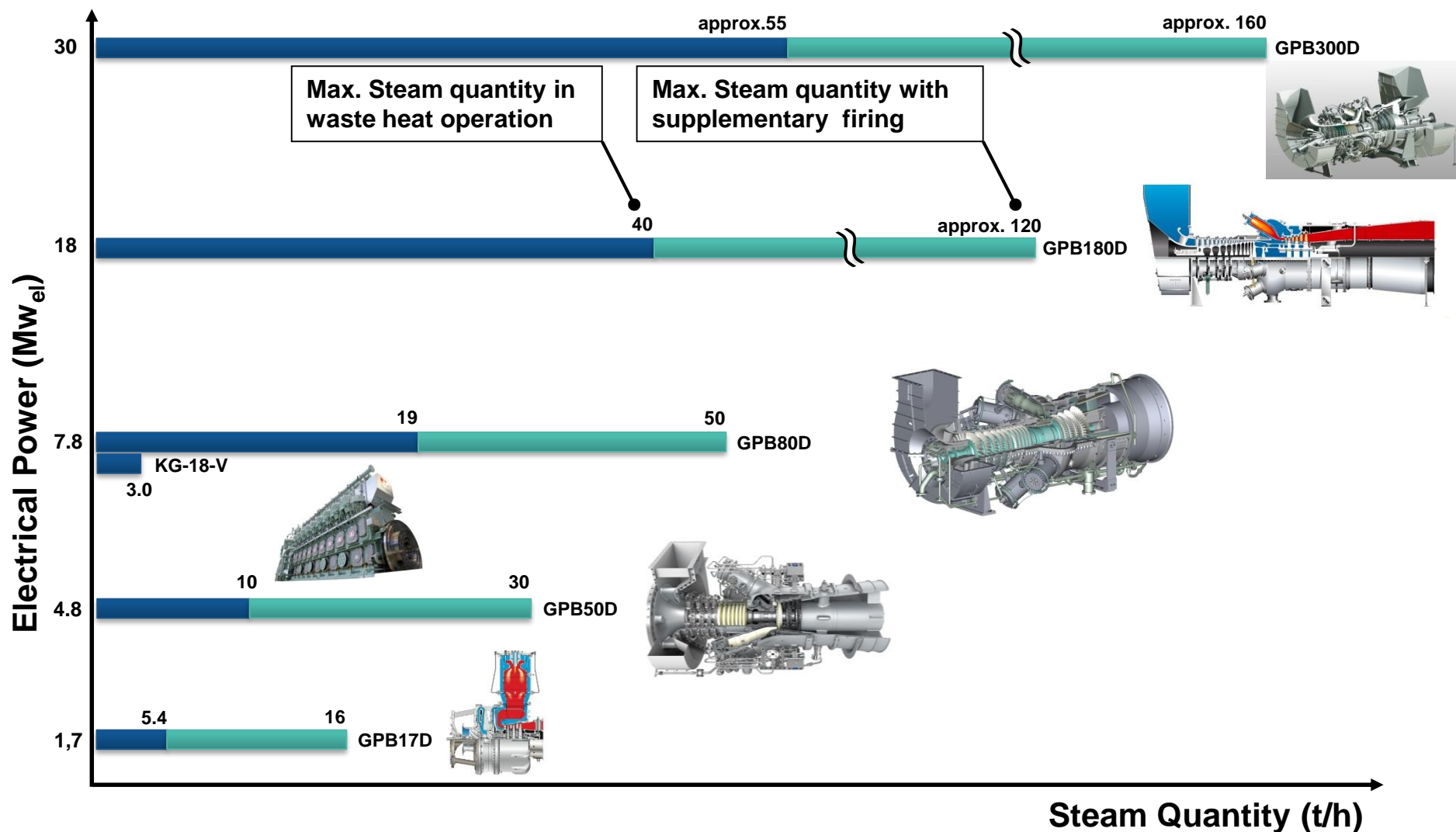
Electricity + Chilled Water



Gas Engine integration - sample



Performances in CHP



GPB17 example of installation /P Kelco Großenbrode (D)

Project background

- Supplementation to existing conventional boilers with Steam turbine

Challenges

- Maritime climate
- First GPB17 with 9 ppm NOx-System in Europe
- Low sound level of 65dB(A) because of tourist region
- Extended scope of supply:
 - gas boost compressor
 - Re-cooling system

Project key data

- Commissioning: September 2014
- Output (electrical): 1,735 kW at 10° C
- Efficiency (Electrical, terminal, LHV): 26.7 %



GPB80 example of installation / AGFA (B)

Project background

- Supplementation of steam generation by one GTGS, boilers with supplementary firing

Challenges

- Limited space
- Low noise level for all aggregates
- Combustion air cooler
- Electrical cabinets separate
- Extended scope of supply:
 - Gas Boost Compressor
 - Water tube boiler with ECO2
 - Supplementary firing up to 40 t/h
 - Stainless steel chimney



Project key data

- | | |
|--|----------|
| ■ Commissioning: | 08/2011 |
| ■ Output (electrical, at 11° C): | 7,480 kW |
| ■ Efficiency _{(Electrical, terminal, LHV):} | 34.4 % |

GPB80 + GPB180 example of installation EDP (P)

Project background

- Build up new and full flexible power plant based on Kawasaki GPB80 and GPB180 each with Bypass Stack, Supplementary Firing and Draft Fan.

Challenges

- Maritime climate
- Adiabatic inlet cooling
- First GPB180 GTGS in Europe

Project key data

- Commissioning: December 2009
- Output (electrical): 7,290 kW at 15° C
18,000 kW at 15° C
- Efficiency (Electrical, terminal, LHV): GPB80: 32.7 %
GPB180: 32.8 %



Joetsu Green Power Project for Nihon Techno / J



Model	KG-18-V
Unit Output	7,800kW
No. of Unit	14
Total Output	109.2MW



110MW Nihon Techno Sodegaura Green Power (JPN)

Gas Engine Features

49.5% Electrical Efficiency - The World Best Performance

Achieved excellent electrical efficiency by optimized design of combustion chambers and individual cylinder control

Environmental Friendly

NOx emission : Less than 200 ppm (@O₂ = 0%)

High Partial Load Performance and Wide Continuous Operating Range

Operating range is 30% ~ 100% / Keep high efficiency at partial load

*suitable for peak operation

Quick Start Up

Within 10 minutes to 100% load from start order

*suitable for peak operation

Less Impact by Ambient Conditions

Stable output in hot climates / at high altitude

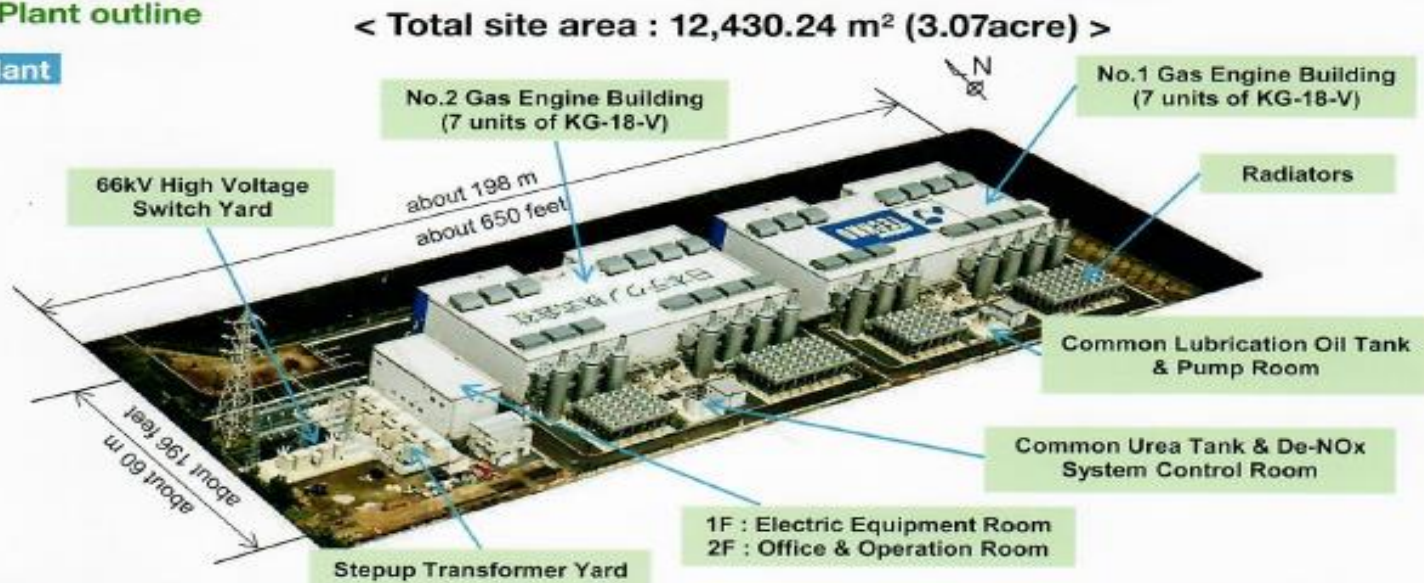
Construction Period: December 19, 2011 - August 15, 2012

Works	Oct./2011	Nov.	Dec.	Jan./2012	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Planning & Designing											
Civil & Architecture Work											
Machine Installation											
Pipework											
Electrical Work											
Commissioning											

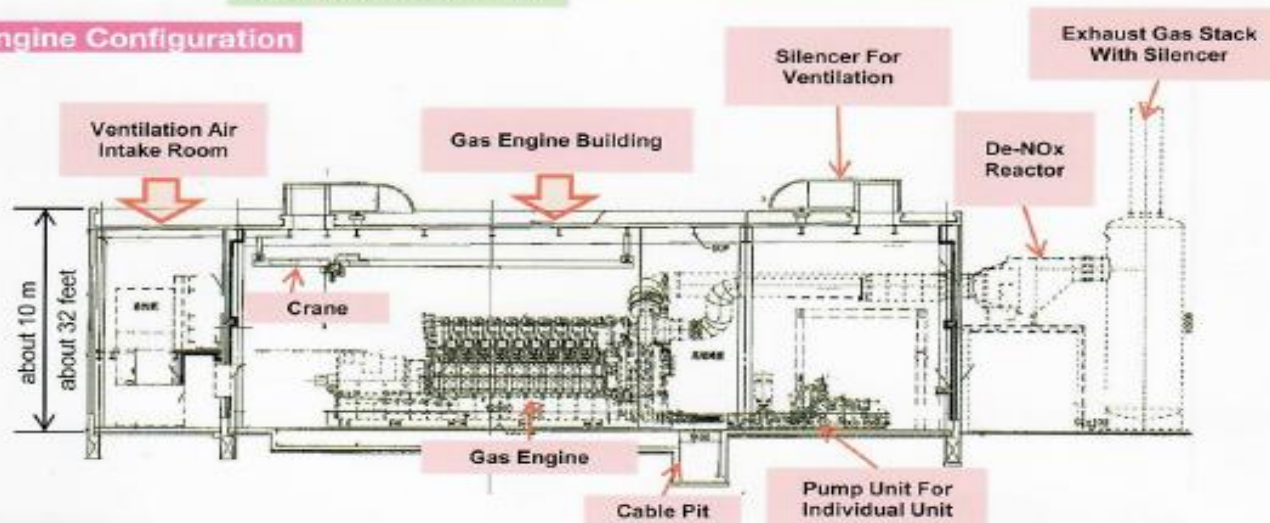
110MW Nihon Techno Sodegaura Green Power (JPN)

Plant outline

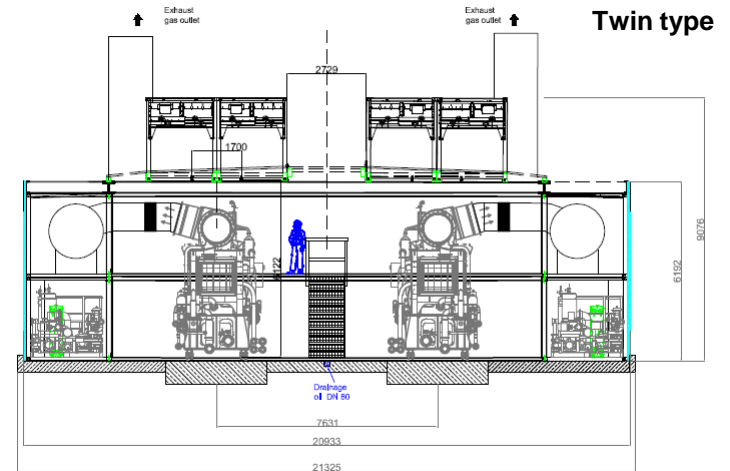
Plant



Each Engine Configuration



Under Development

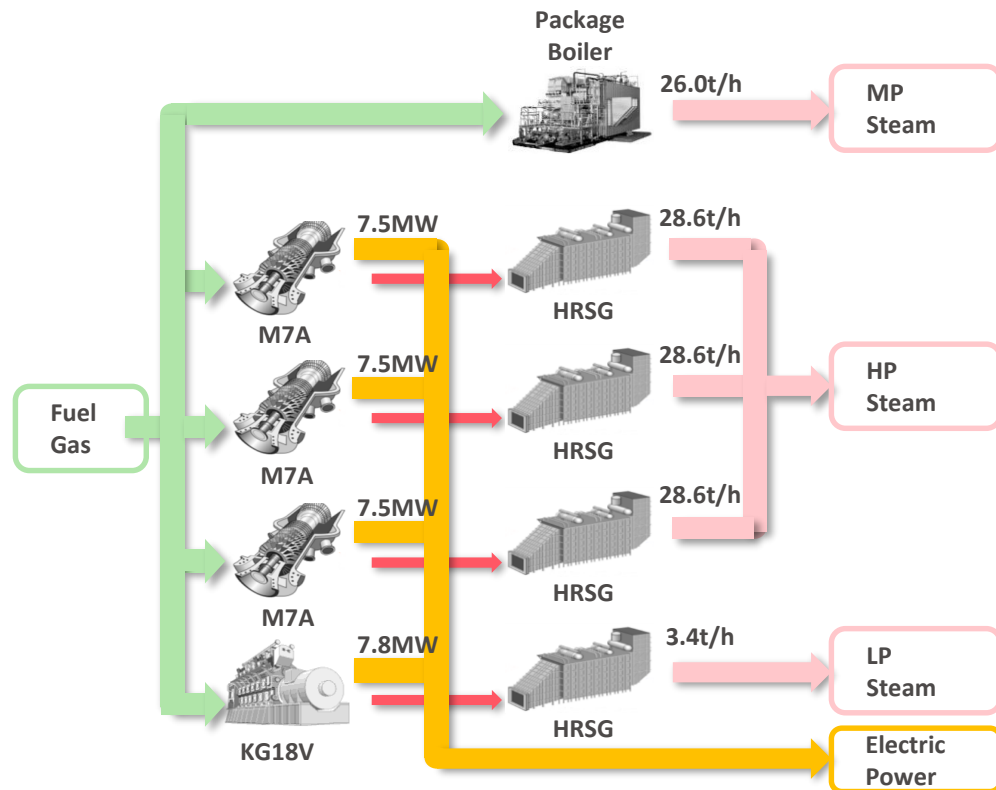


Hybrid CHP for Chemical Industries (JPN)

Example of installation

GPB80 GT and KG-18 GGE, Japan

CHP Package	GPB80D + Gas Engine
Output	M7A (7.5MW) x 3 units KG-18-V (7.8MW) x 1 unit 26t/h Package Boiler

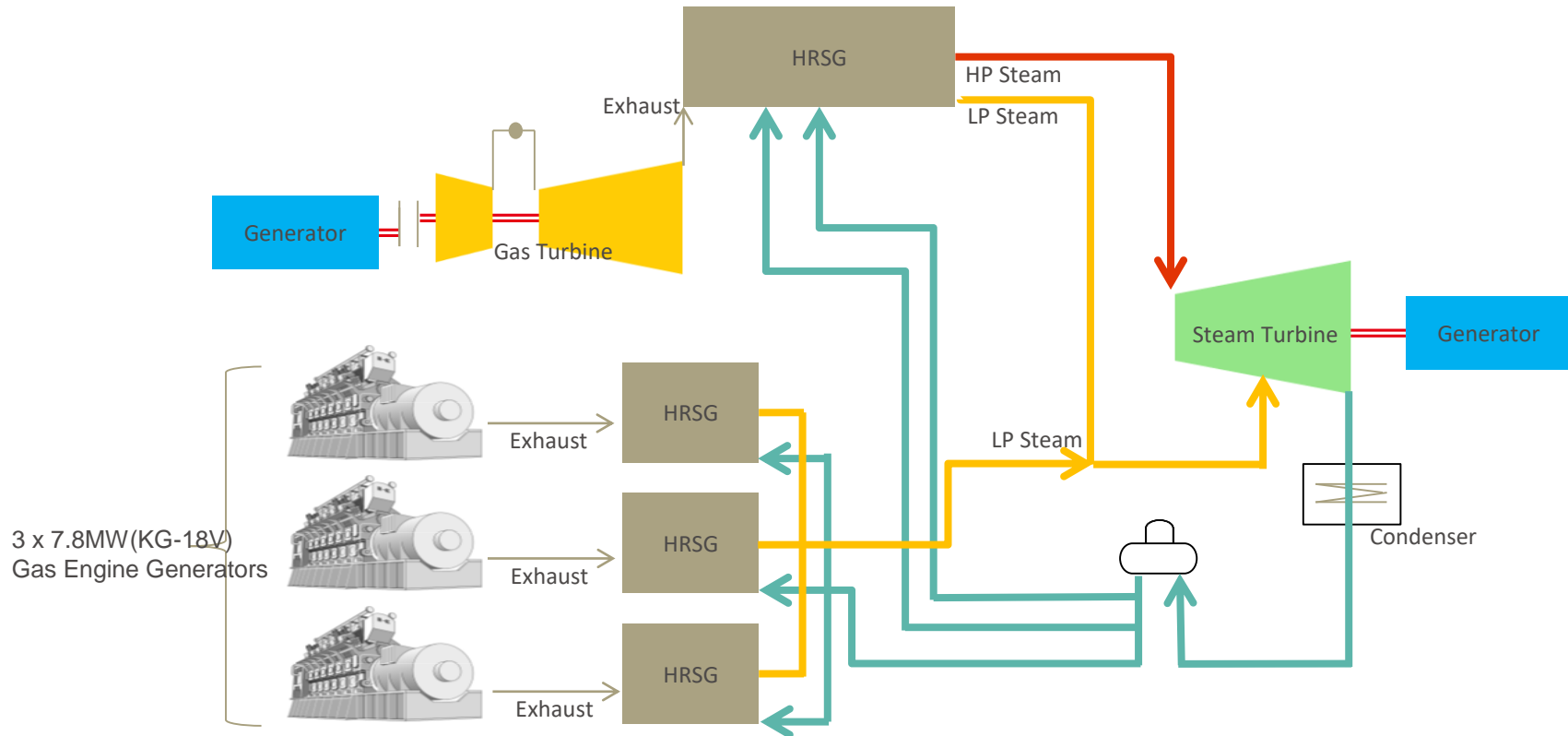


LP : Low Pressure
MP : Medium Pressure

Hybrid CHP for Industrial Park (THA)

Optimal Configuration for load alteration (Peak/Off-peak) By Hybrid Combined Cycle (Gas Turbine & Gas Engines + Steam Turbine)

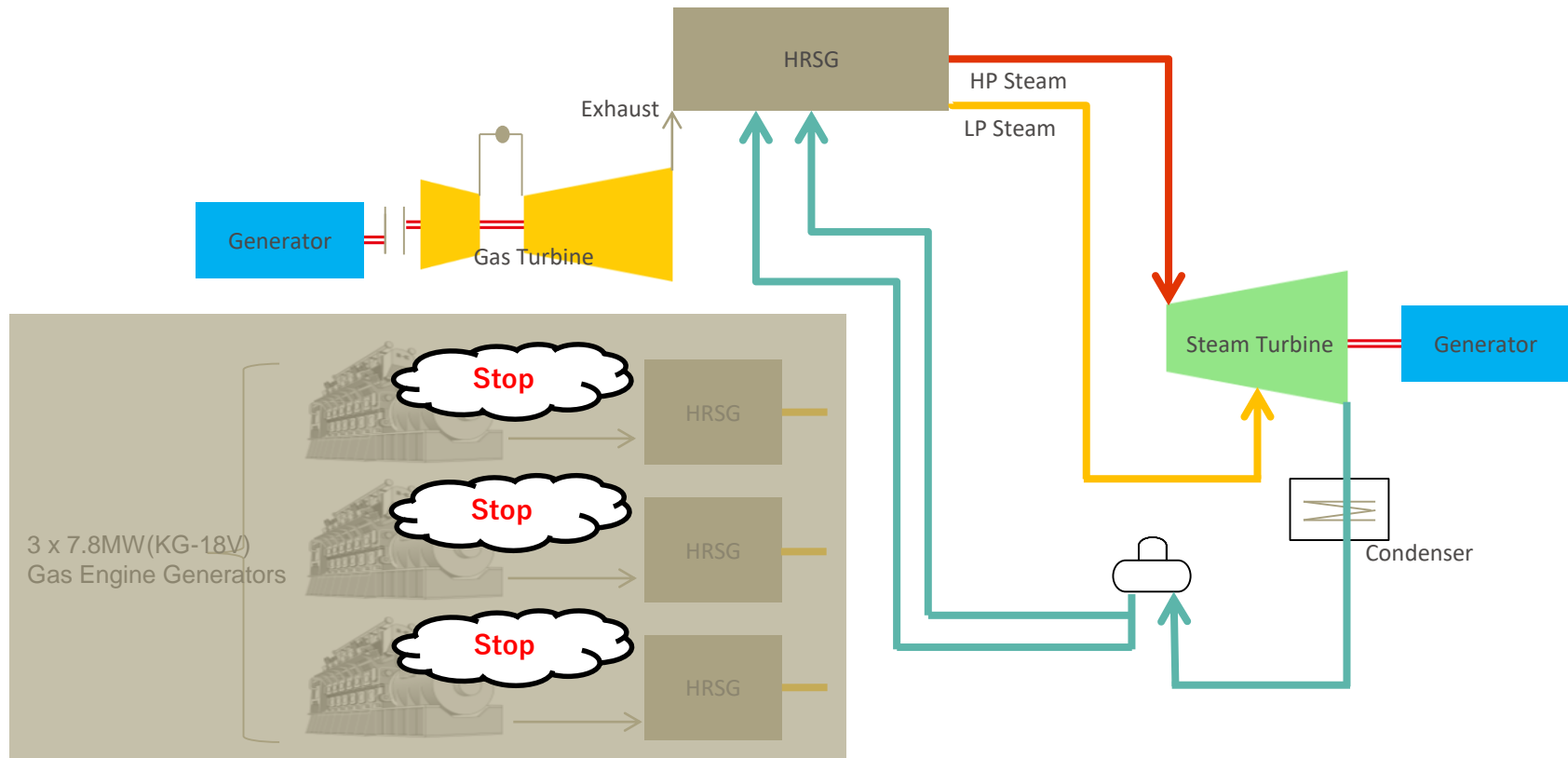
~Peak (Day) Time~



Hybrid CHP Reference for Industrial Park (THA)

Optimal Configuration for load alteration (Peak/Off-peak)
By Hybrid Combined Cycle (Gas Turbine & Gas Engines + Steam Turbine)

~Off-Peak (Night) Time~



How KGE Team Works

- KGE provides individual consultancy from early beginning of CHP project – ***The customer will never walk alone;***
- KGE provides the optimal solution according with the customer energy and economical requirements – ***Maximum profit and flexibility in Operation;***
- KGE, for each project, simulates the performances of running machines according with customer energy consumption – ***Guaranteed Performance;***
- KGE designs them solutions according with site conditions – ***Customized Solution;***
- KGE, together with them partners, can provide ***Financial Solutions;***

How KGE Team Works

- KGE can offer extended scope of supply – ***Engineering, Procurement,***
- KGE provides project management, as well as detailed engineering – ***Partnership with Customer,***
- KGE provides all the activities for project implementation – ***Erection, Commissioning and Start-up;***
- KGE provides full maintenance for long term, spare parts and remote monitoring – ***Sustainable Cooperation with Our Customer is Warranted.***

Kawasaki Hydrogen Road Map

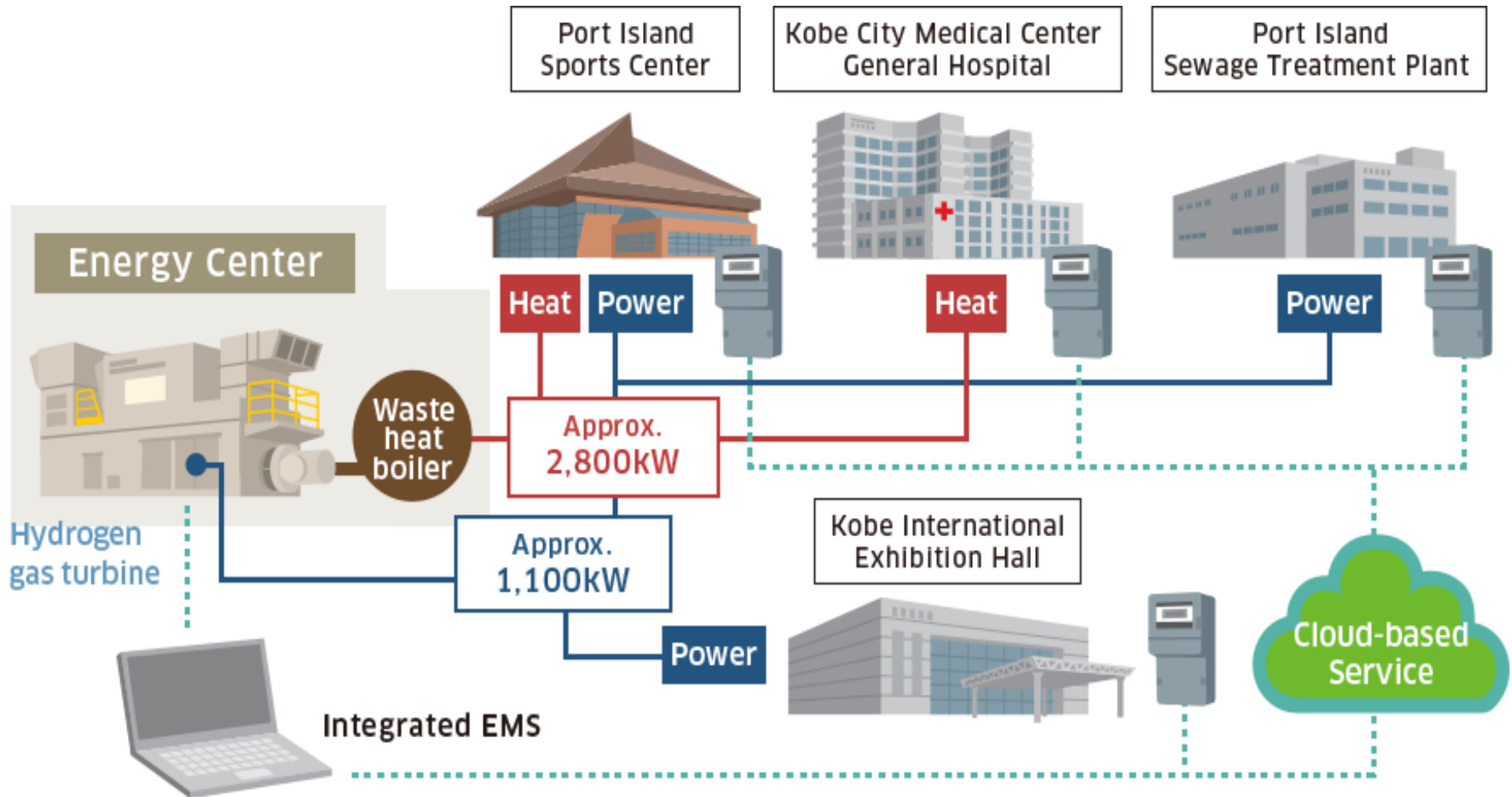
KOBE city



Development of Smart Community Technology by Utilization of Cogeneration System with Hydrogen Gas Turbine

Kawasaki Hydrogen Road Map

The first attempt in the world to supply electric power and heat generated from hydrogen gas turbine to an actual urban area



Kawasaki Hydrogen Road Map

**Gas Turbine CHP Plant using
100% Hydrogen as a fuel**

Power Generation: 1.7 MWe



Partners:

- Obayashi
- Kawasaki
- Kobe City
- KEPCO
- Iwatani
- Osaka University

Supported by NEDO

Kawasaki will pursue "manufacturing that makes the Earth smile."

“Global Kawasaki”