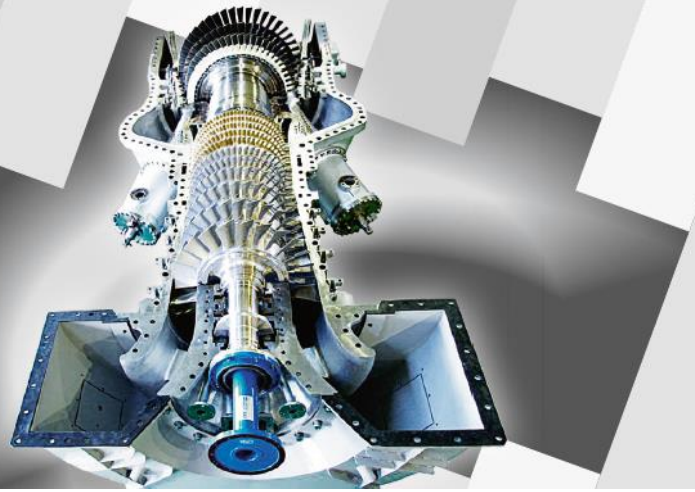
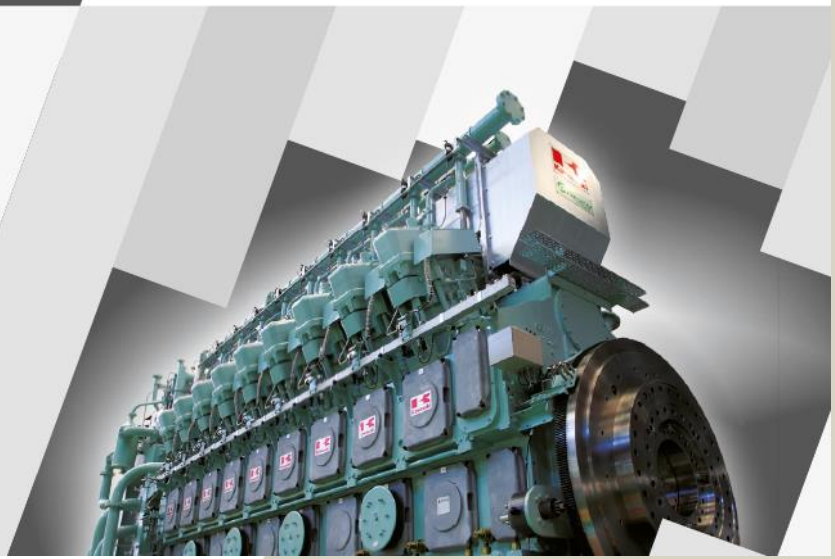
Two Specialists

No Compromise





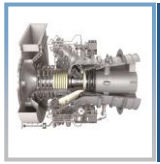
KAWASAKI Gas Turbine Europe GmbH

CHP and Combined Cycle-Plants

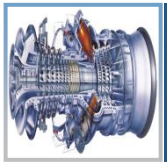
General Company Presentation

Kawasaki
Powering your potential

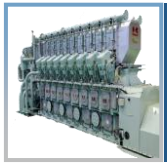
Agenda



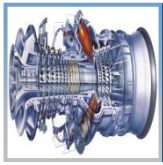
1 Kawasaki Heavy Industries (KHI)



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*

Bundesverband Kraft-Wärme-Kopplung e.V.

KGE's Take

Working as one for the good of the planet!

Highly Focusing on Environmental Protection and Energy Savings

- **Reduction of emissions**
  - Global warming gas CO_2
  - 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

KGE cogeneration market

- **Industry**

Pulp and paper

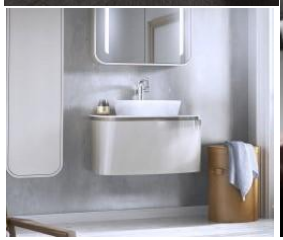
Medicines and cosmetics

Refinery / Chemistry

Food and beverages industry

Automotive and tyres

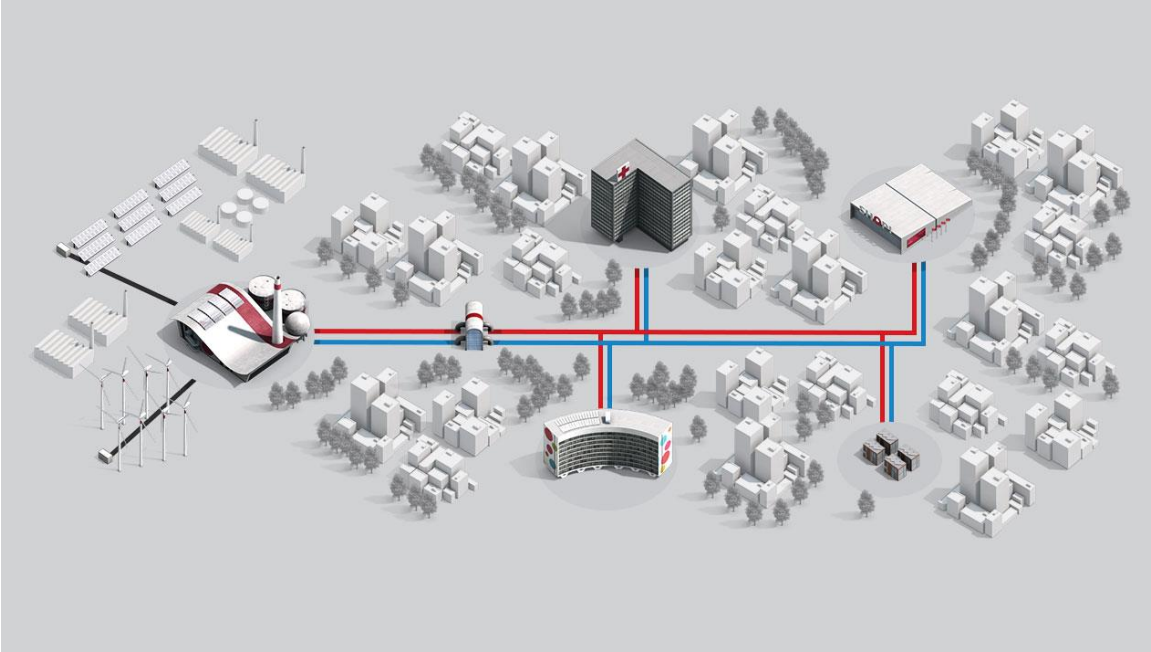
Ceramics



KGE cogeneration market

Potential clients of cogeneration

- **District Heating**

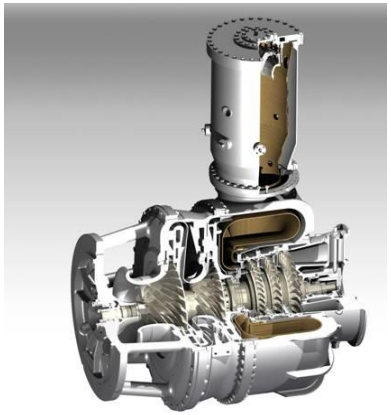


- **Services with own small cogeneration unit:**

Universitary campus **Hospitals** **Hotels** **Airports**

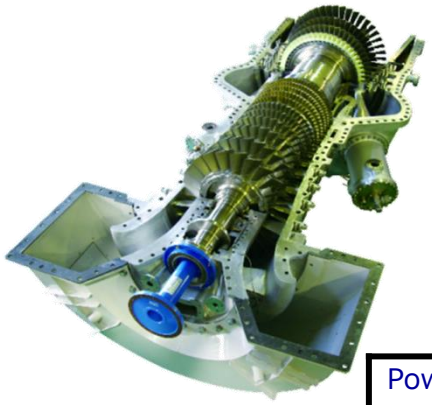
Kawasaki Gas Turbine Engine Models

M1A-17D



Power Output [kWe]	1,816
Ele. Efficiency [%]	28.1
Sat. steam 8 barg [t/h]	5
Exhaust Gas Temperature [°C]	522
NO_x @ O_2 = 15% [ppm] CO @ O_2 = 15% [ppm]	< 9 50

M7A-03D

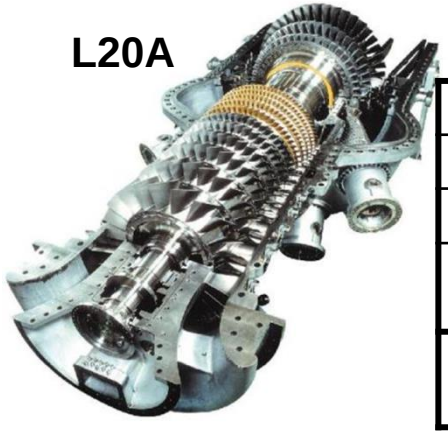


Power Output [kWe]	7,810
Ele. Efficiency [%]	33.6
Sat. steam 8 barg [t/h]	16.4
Exhaust Gas Temperature [°C]	523
NO_x @ O_2 = 15% [ppm] CO @ O_2 = 15% [ppm]	< 9 10

M5A-01D

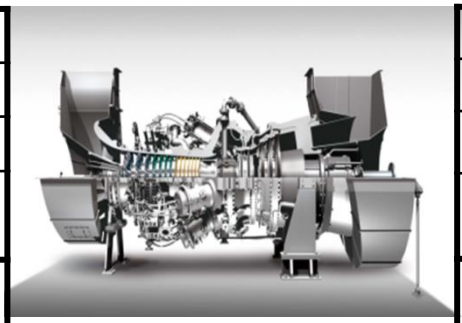
Power Output [kWe]	4,720
Ele. Efficiency [%]	32.6
Sat. steam 8 barg [t/h]	11
Exhaust Gas Temperature [°C]	511
NO_x @ O_2 = 15% [ppm] CO @ O_2 = 15% [ppm]	15 15

L20A



Power Output [kWe]	18,500
Ele. Efficiency [%]	34.3
Sat. steam 8 barg [t/h]	37
Exhaust Gas Temperature [°C]	542
NO_x @ O_2 = 15% [ppm] CO @ O_2 = 15% [ppm]	15 25

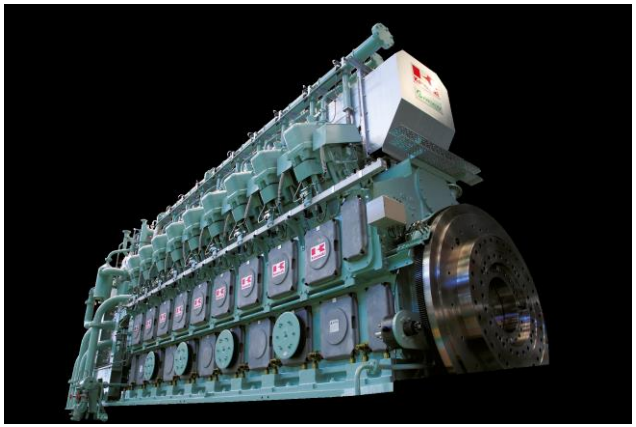
L30A



Power Output [kWe]	34,380
Ele. Efficiency [%]	40.3
Sat. steam 8 barg [t/h]	55
Exhaust Gas Temperature [°C]	502
NO_x @ O_2 = 15% [ppm] CO @ O_2 = 15% [ppm]	15 / 9 25

Kawasaki Gas Engine Models

KG 18V



Power Output [kWe]	7,800
Ele. Efficiency [%]	49.5
Exhaust Heat [kWth]	4,000
Exhaust Gas Temperature [°C]	320
NOx @ O_2 = 0% [ppm] CO @ O_2 = 0% [ppm]	200 50
Methane number	> 65

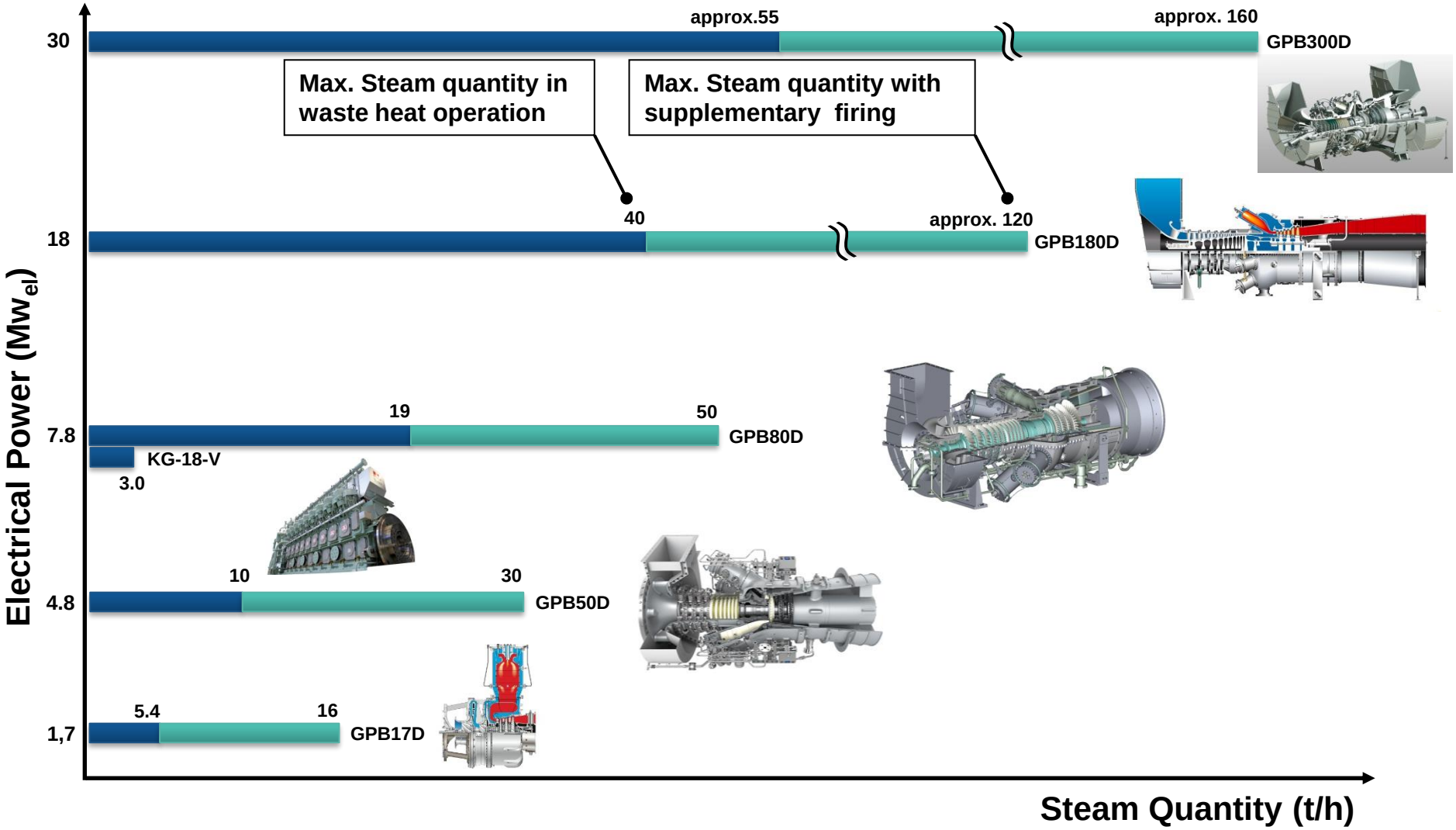
KG 12V

Power Output [kWe]	5,200
Ele. Efficiency [%]	49.5
Exhaust Heat [kWth]	2,700
Exhaust Gas Temperature [°C]	320
NOx @ O_2 = 0% [ppm] CO @ O_2 = 0% [ppm]	200 50
Methane number	> 65

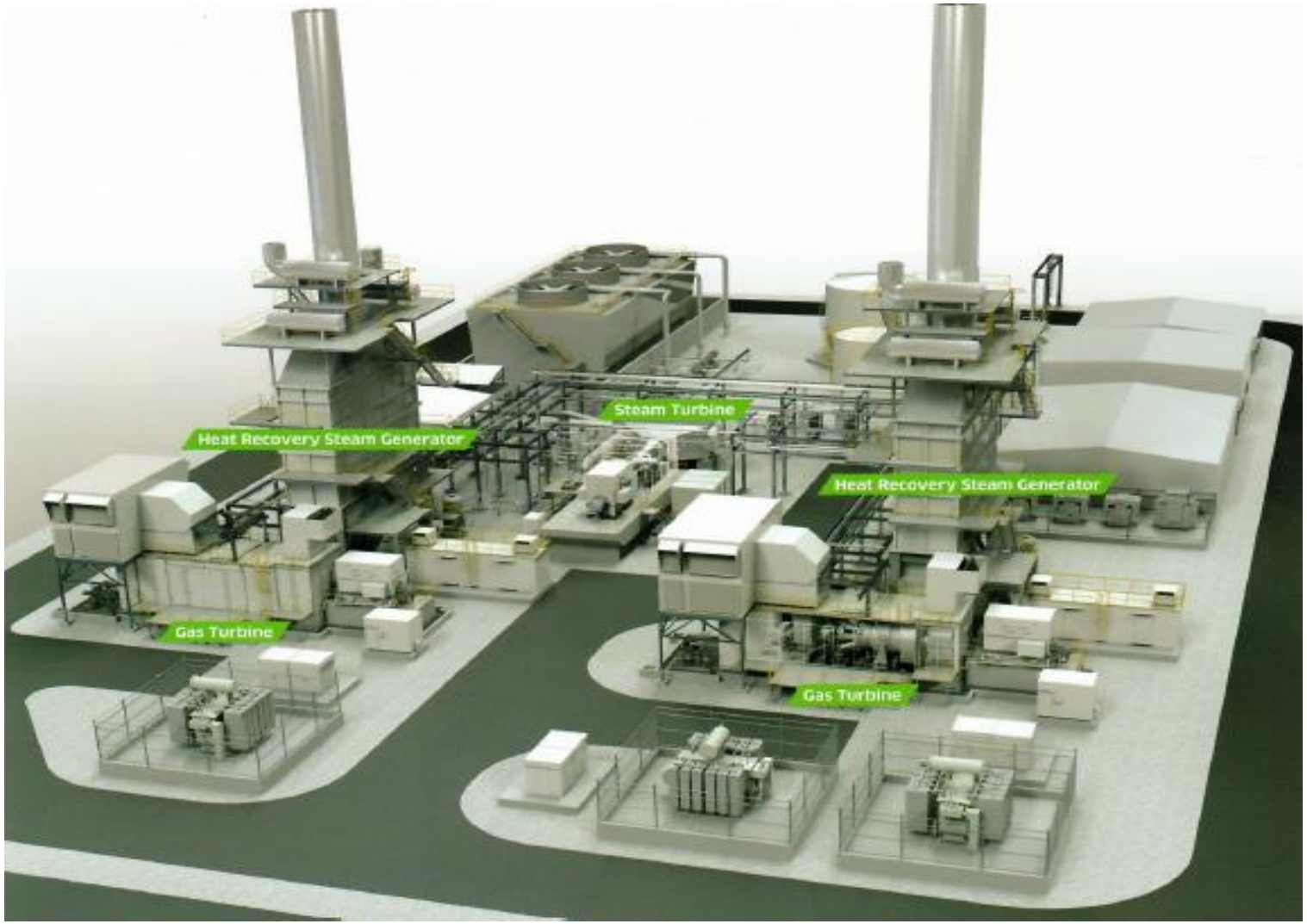
KG 18T

Power Output [kWe]	7,800
Ele. Efficiency [%]	51
Exhaust Heat [kWth]	
Exhaust Gas Temperature [°C]	
NOx @ O_2 = 0% [ppm] CO @ O_2 = 0% [ppm]	250
Methane number	> 65

Performances in CHP



Kawasaki Gas Turbine (KHI) – 100 MW CCPP (combined cycle power plant)



Kawasaki Gas Turbine (KHI) – 100 MW CCPP (combined cycle power plant) - performances

Combined Cycle Performance Data (Reference)

	1 on 1	2 on 1	2 on 1 (Reheat)
CC Electric Output [MWe]	44.7	89.9	101.5
CC Heat Rate [kJ/kW-hr]	6,650	6,620	6,520
CC Electrical Efficiency [%]	54.1	54.4	55.2
Number of Gas Turbines	1	2	2
Bottoming Cycle Type	2PNRH	2PNRH	3PRH

Condition
Inlet Air Temperature : 15 deg-C
Atmospheric Pressure : 101.3 kPa
Fuel Type : Natural Gas (100% CH_4)
LHV of Fuel : 35.9 MJ/Nm^3

2PNRH : Two Pressure Non-reheat
3PRH : Three Pressure Reheat

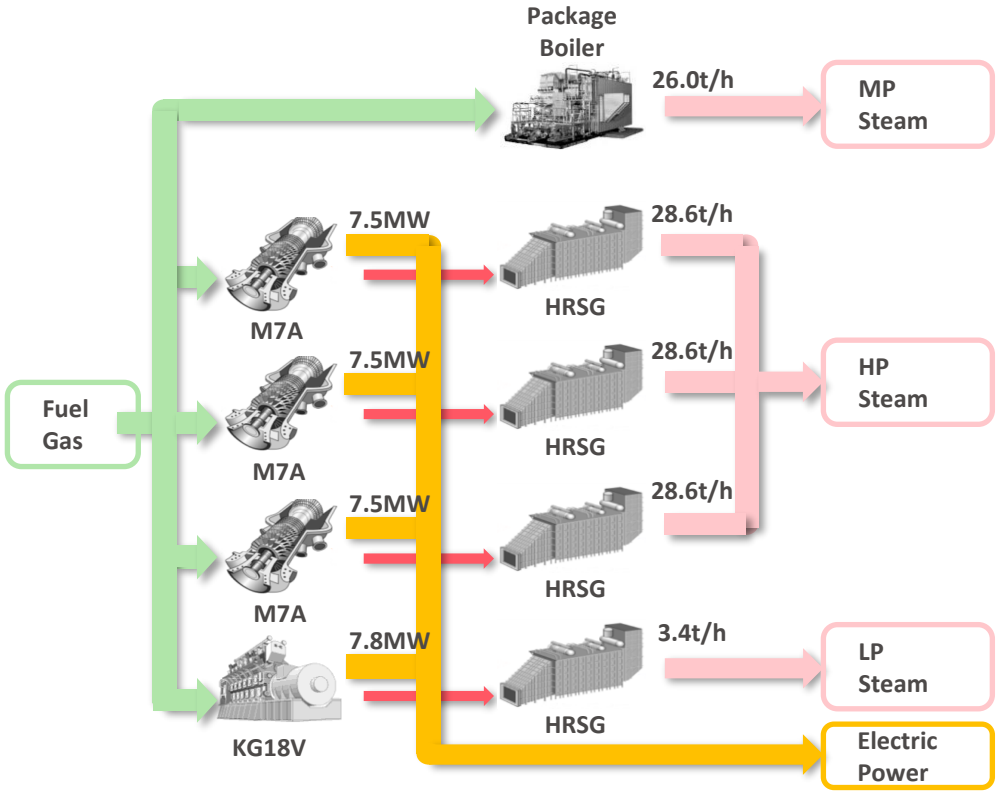
Joetsu Green Power Project for Nihon Techno / J

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

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



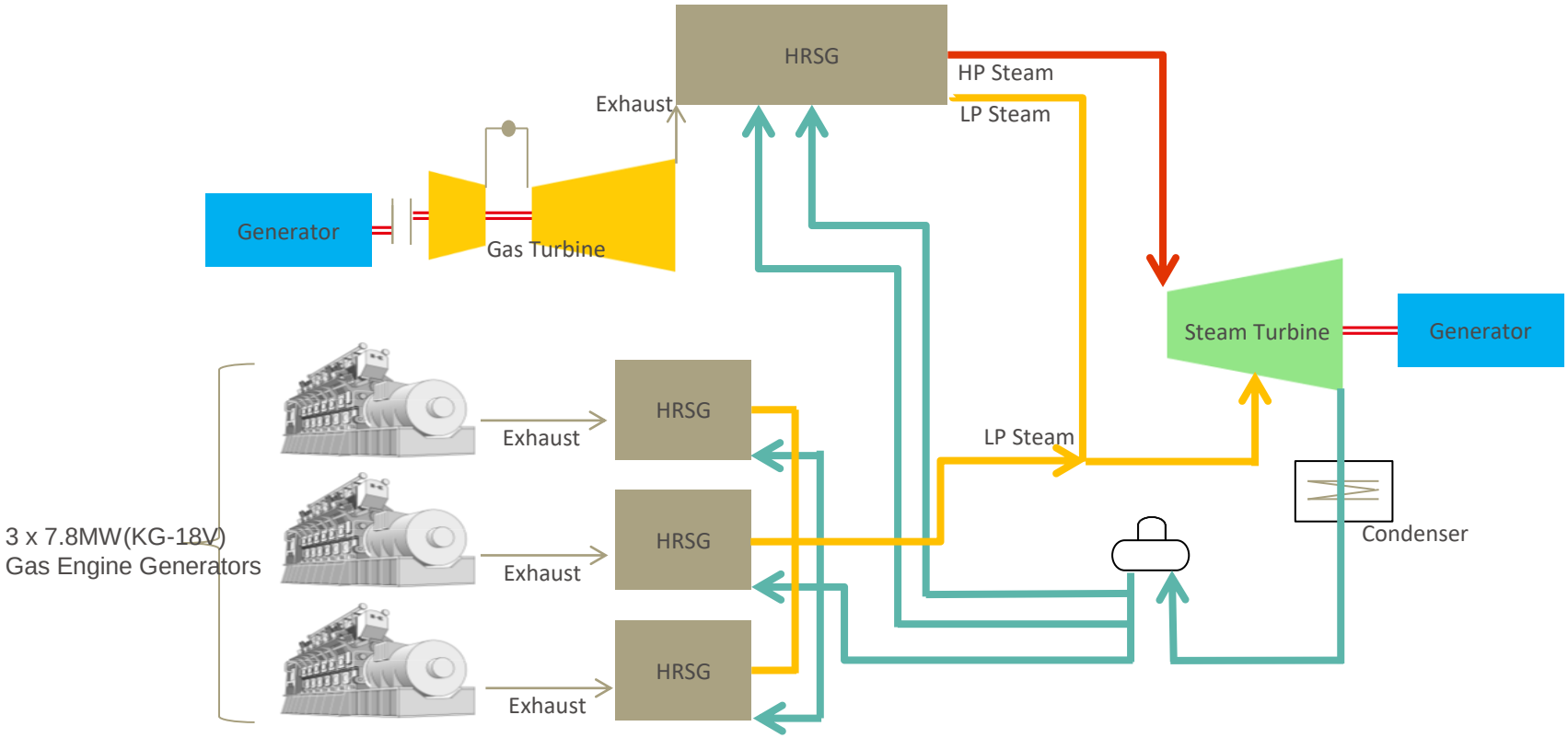
LP : Low Pressure
MP : Medium Pressure

Kawasaki Powering your potential

Hybrid CHP for Industrial Park (THA)

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

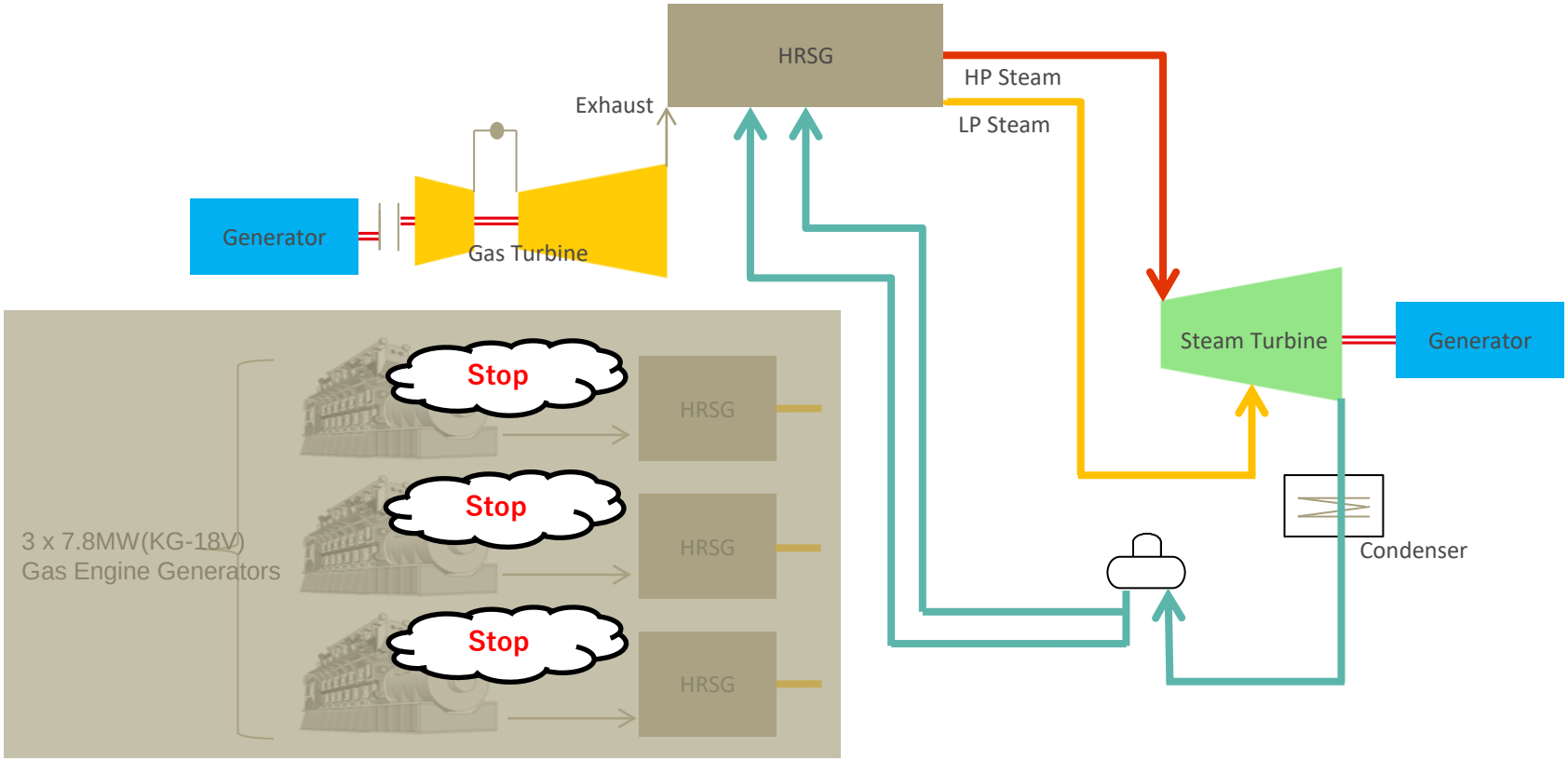
~Peak (Day) Time~



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~



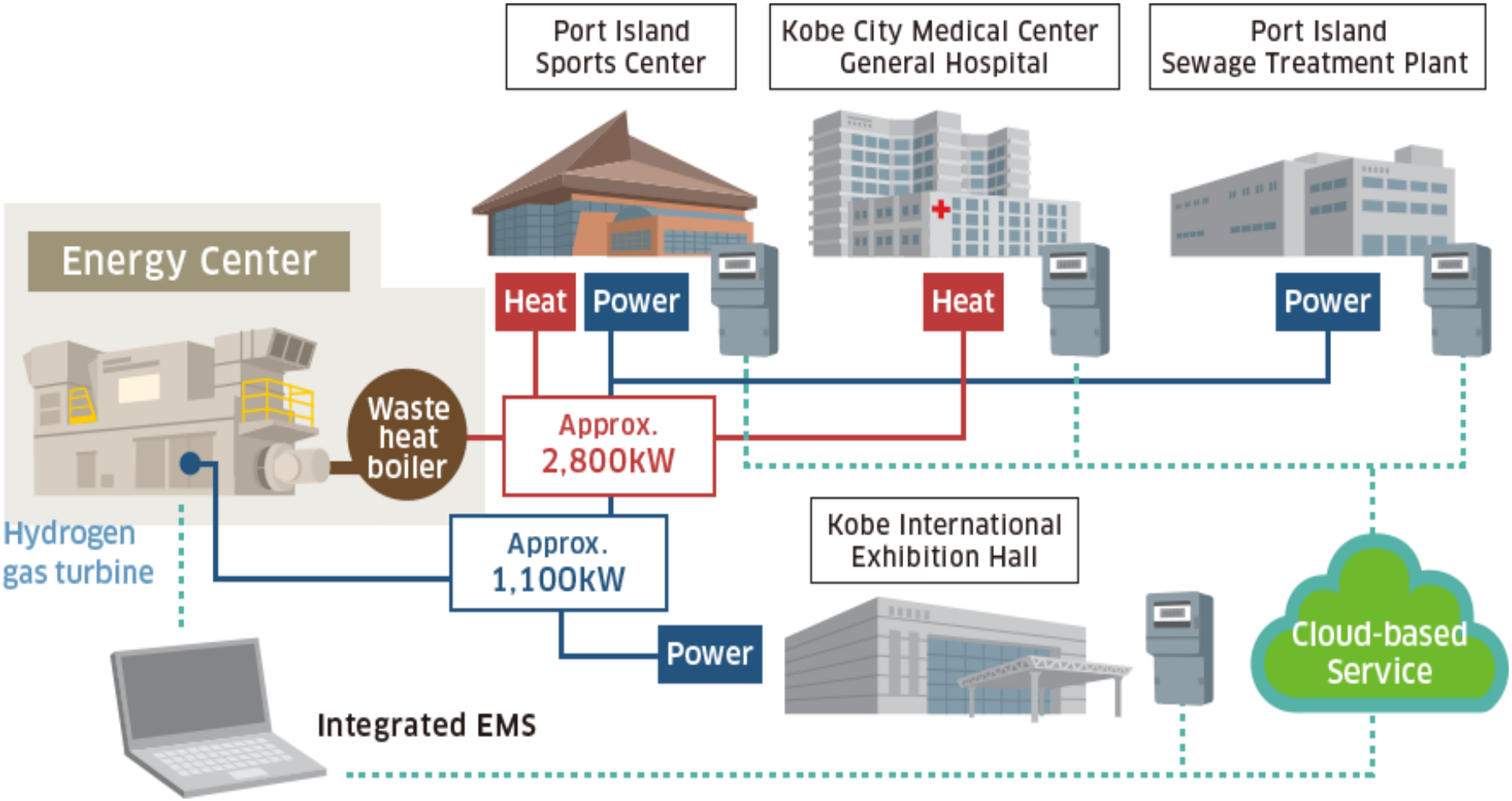
Kawasaki Hydrogen Road Map

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”

Kawasaki
Powering your potential