Kawasaki Gas Turbine Europe GmbH

CHP and Combined Cycle-Plants

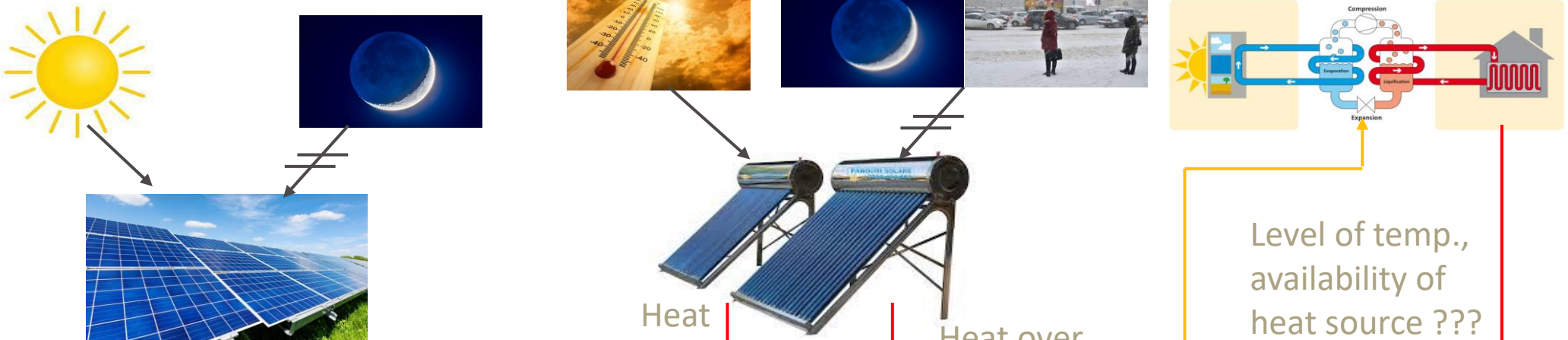
Two Specialists
No Compromise

Kawasaki

Energynomics 14th Sepetember
General Company Presentation

Cogeneration solution = energy efficiency solution = support for renewable energy sources

Renewable sources ≠ Energy efficiency solutions ≠ Energy Independence



Electricity for:
- Industrial process;
- Heat pumps;
- Electrolysers;
- DHS - Thermal substations.

Heat for:
- Industrial process;
- DHS.

Heat for:
- DHS;
- Industrial process.

CHP = COGENERATION = support for renewable sources

Fuel: NG, H2, Biomass, Biogas, Municipal Waste

Kawasaki Powering your potential

European Union - Energy Approach based on 4D

Energy approach based on 4 pillars = 4D:

- 1st D = Decarbonization;
- 2nd D = Decentralization;
- 3rd D = Digitalization;
- 4th D = Distributed energy generation

Kawasaki Heavy Industries (KHI)

Kawasaki Heavy Industries, Ltd.

- Ships & Offshore Structure Company

- Rolling Stock Company

- Aerospace Company

- **Energy System & Plant Engineering Company**
- Motorcycle & Engine Company

- Precision Machinery & Robots Company

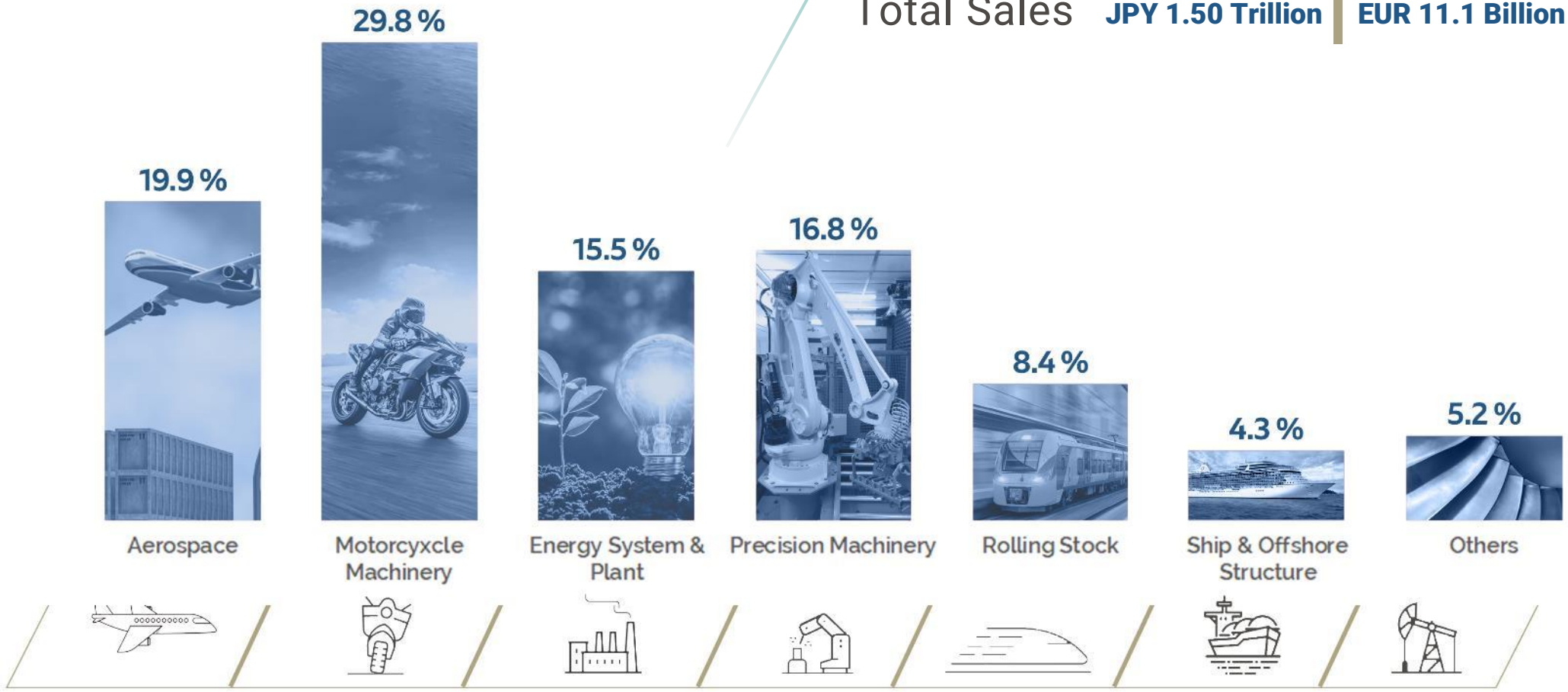
- **Kawasaki Gas Turbine Europe GmbH**
  - Germany – Europe headquarter
  - Romania – Representative office responsible for South – East Europe
- **Kawasaki Gas Turbine Asia Sdn. Bhd. (Malaysia)**
- **Kawasaki Gas Turbine Asia Sdn. Bhd. - Jakarta Representative Office**
- **Kawasaki Heavy Industries, LTD - Bangkok Office**

Kawasaki Heavy Industries (KHI)

FY2021

Business year starts from April 1, 2021 and ends on March 31, 2022

Total Sales **JPY 1.50 Trillion** | **EUR 11.1 Billion**



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 NOx, SOx
- Energy Saving

→ Hydrogen – future fuel for energy production

Distributed Generator System

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

Products

Gas Turbine Generator Sets

GPB17D	GPB50D	GPB80D	GPB180D	GPB300D
1,816 kWel	4,960 kWel	7,8!0 kWel	18,500 kWel	34,300 kWel
η = 28.1 %	η = 32.6 %	η = 33.6 %	η = 34.3 %	η = 40.3 %

Gas Engines

KG12	KG18	KG18-V	KG18-T
5,200 kWel	7,800 kWel	7,800 kWel	7,800 kWel
η = 49.0 %	η = 49.0 %	η = 49.5 %	η = 51 %

@ ISO-conditions

Services

Engineering
Preliminary Engineering
Detailed Engineering

Implementation
Project Planning
Customized Packaging
Erection Commissioning

Maintenance
Scheduled Maintenance
Trouble Shooting
Spare Parts, Consumables
General Overhaul
Remote Monitoring

Gas Turbine Generator Sets

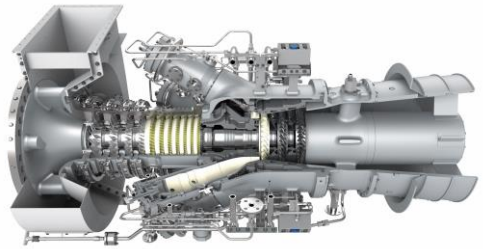
M1A-17D

Power Output [kWe]	1,816
Ele. Efficiency [%]	28.1
Sat. steam 8 barg [t/h] / Heat recovered [kWth]	5 / 3.646
Exhaust Gas Temperature [°C]	522
NO_x @ O_2 = 15% [ppm]	< 9
CO @ O_2 = 15% [ppm]	50

M7A-03D

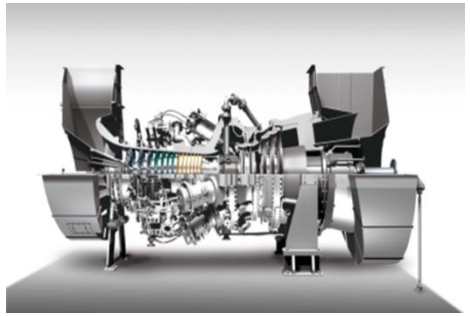
Power Output [kWe]	7,810
Ele. Efficiency [%]	33.6
Sat. steam 8 barg [t/h] / Heat recovered [kWth]	16.4 / 12.471
Exhaust Gas Temperature [°C]	523
NO_x @ O_2 = 15% [ppm]	< 9
CO @ O_2 = 15% [ppm]	10

M5A-01D



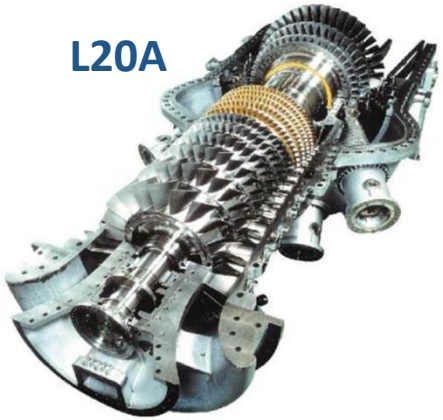
Power Output [kWe]	4,720
Ele. Efficiency [%]	32.6
Sat. steam 8 barg [t/h] / Heat recovered [kWth]	11 / 7.723
Exhaust Gas Temperature [°C]	511
NO_x @ O_2 = 15% [ppm]	15
CO @ O_2 = 15% [ppm]	15

L30A



Power Output [kWe]	34,380
Ele. Efficiency [%]	40.3
Sat. steam 8 barg [t/h] / Heat recovered [kWth]	55 / 39.943
Exhaust Gas Temperature [°C]	502
NO_x @ O_2 = 15% [ppm]	15 / 9
CO @ O_2 = 15% [ppm]	25

L20A



Power Output [kWe]	18,500
Ele. Efficiency [%]	34.3
Sat. steam 8 barg [t/h] / Heat recovered [kWth]	37 / 28.550
Exhaust Gas Temperature [°C]	542
NO_x @ O_2 = 15% [ppm]	15
CO @ O_2 = 15% [ppm]	25

Gas Engine Models

KG 18V

Power Output [kWe]	7,800
Ele. Efficiency [%]	49.5
Total Engine Heat [kWth]	5,000
Exhaust Gas Temperature [°C]	320
NOx @ O_2 = 0% [ppm]	200
CO @ O_2 = 0% [ppm]	50
Methane number	> 65

KG 12

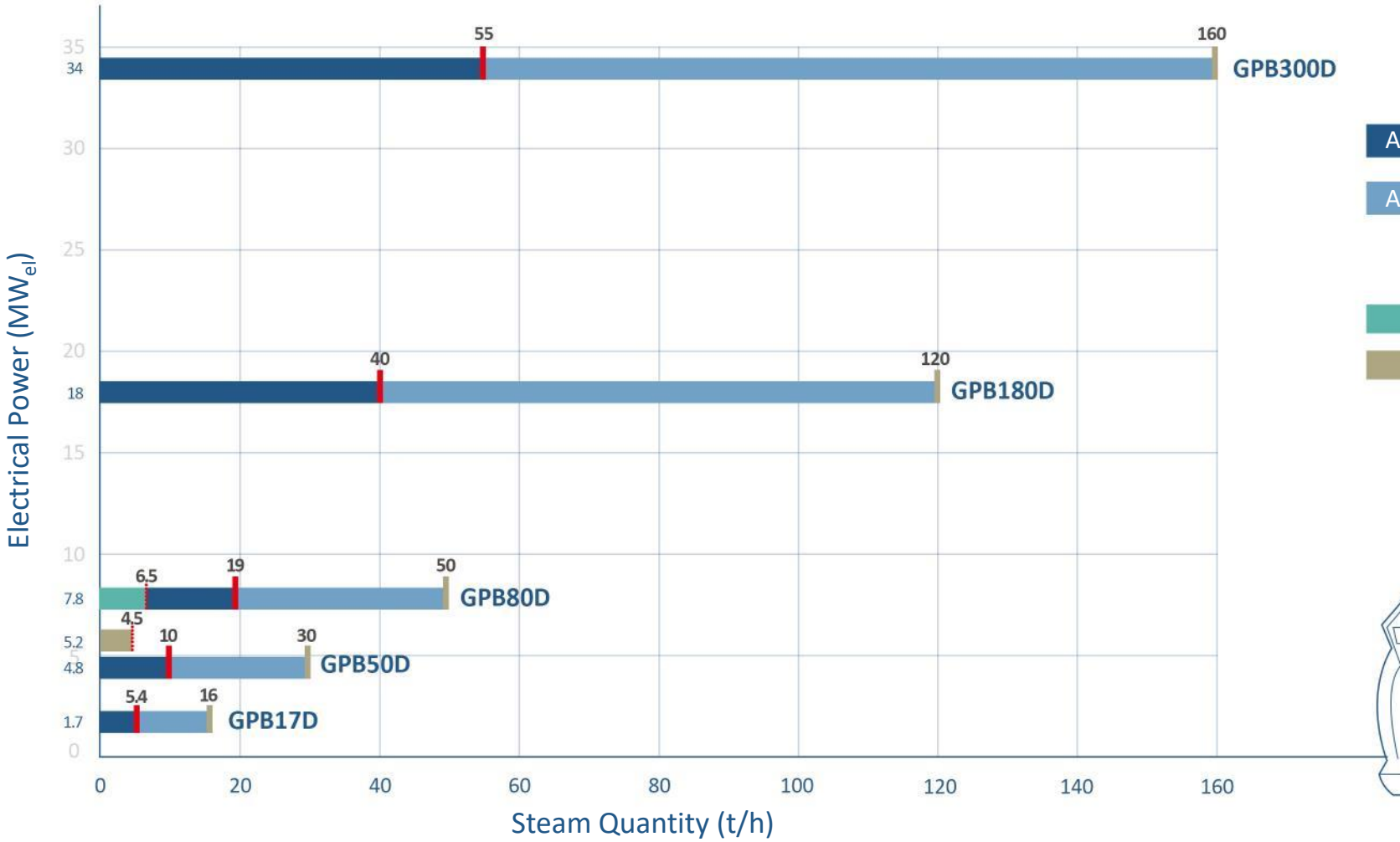
Power Output [kWe]	5,200
Ele. Efficiency [%]	49
Total Engine Heat [kWth]	3,000
Exhaust Gas Temperature [°C]	320
NOx @ O_2 = 0% [ppm]	200
CO @ O_2 = 0% [ppm]	50
Methane number	> 65

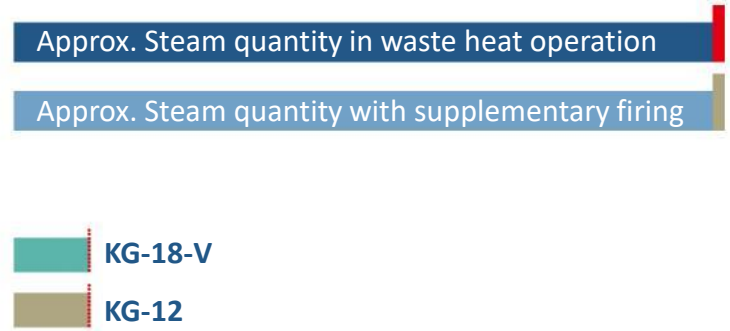
KG 18T

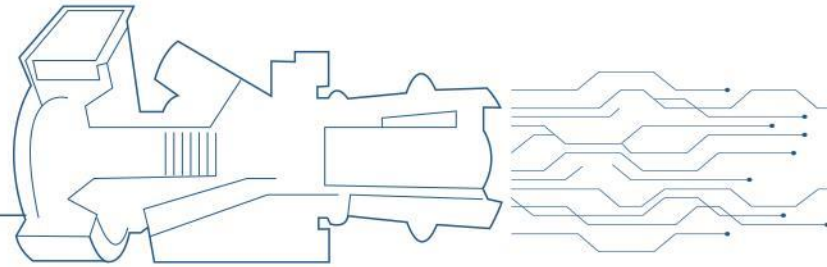
Power Output [kWe]	7,800
Ele. Efficiency [%]	51
Total Engine Heat [kWth]	3,500
Exhaust Gas Temperature [°C]	285
NOx @ O_2 = 0% [ppm]	250
CO @ O_2 = 0% [ppm]	
Methane number	> 65

Kawasaki
Powering your potential

Performance in CHP







Kawasaki
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KGE market – request of electricity and steam / hot water / child water / CO_2

Pulp and paper

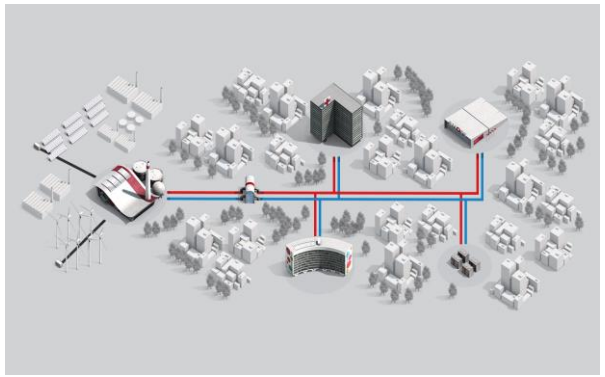
Medicines / cosmetics

Refinery / Chemistry

Automotive / Tires

Food and Beverage

District Heating



Universities

Hospitals

Hotels

Airports

Ceramics

Fertilizers

Hydrogen Road

H2-Production and Liquefaction

H2-Storage Tanks

H2-Oversea Transportation

H2-Land Transportation

H2-Gas Turbines
H2-Compressors

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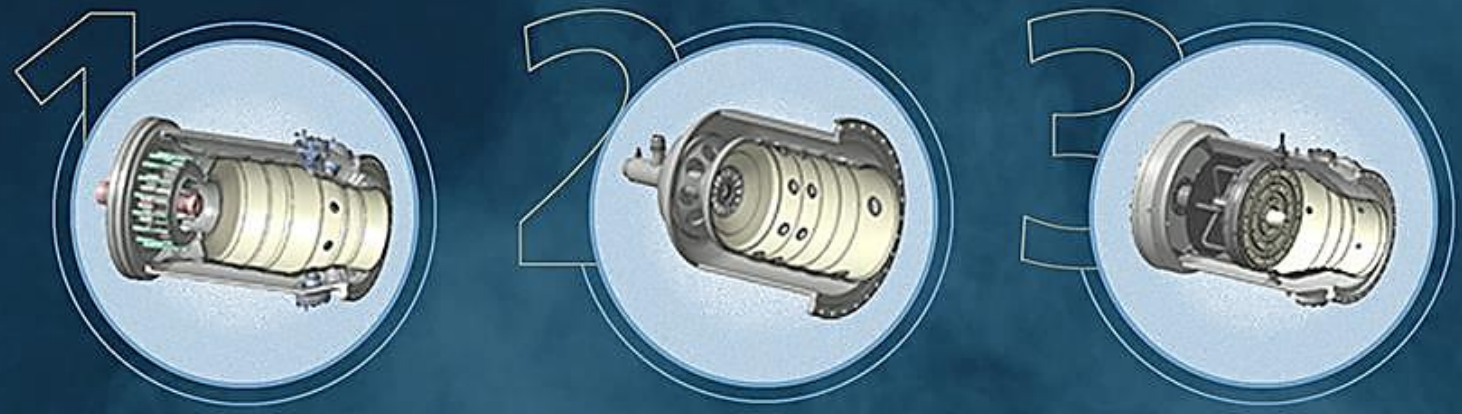
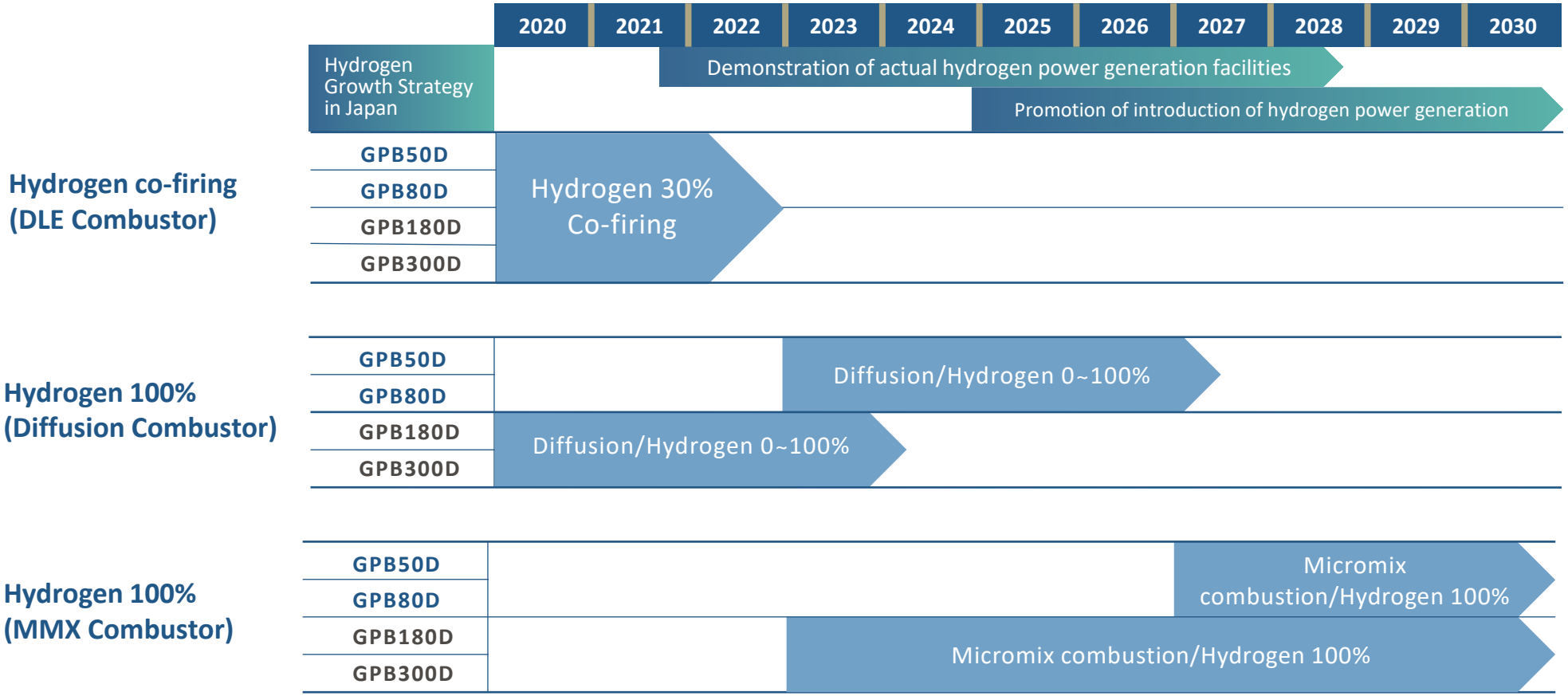
Overview of Combustor Developments



Combustor Configuration:	DLE for Natural Gas	Diffusion Flame	DLE Micro-Mix
NOx Reduction	"Dry"	"Wet" Water/Steam	"Dry"
H2 Content	0 … 30 vol%	0 … 100 vol%	90 … 100 vol%
Status	Demonstration at Akashi Works, 2014	Applied to KOBE Demonstration Plant, 2018	Applied to KOBE Demonstration Plant, 2020

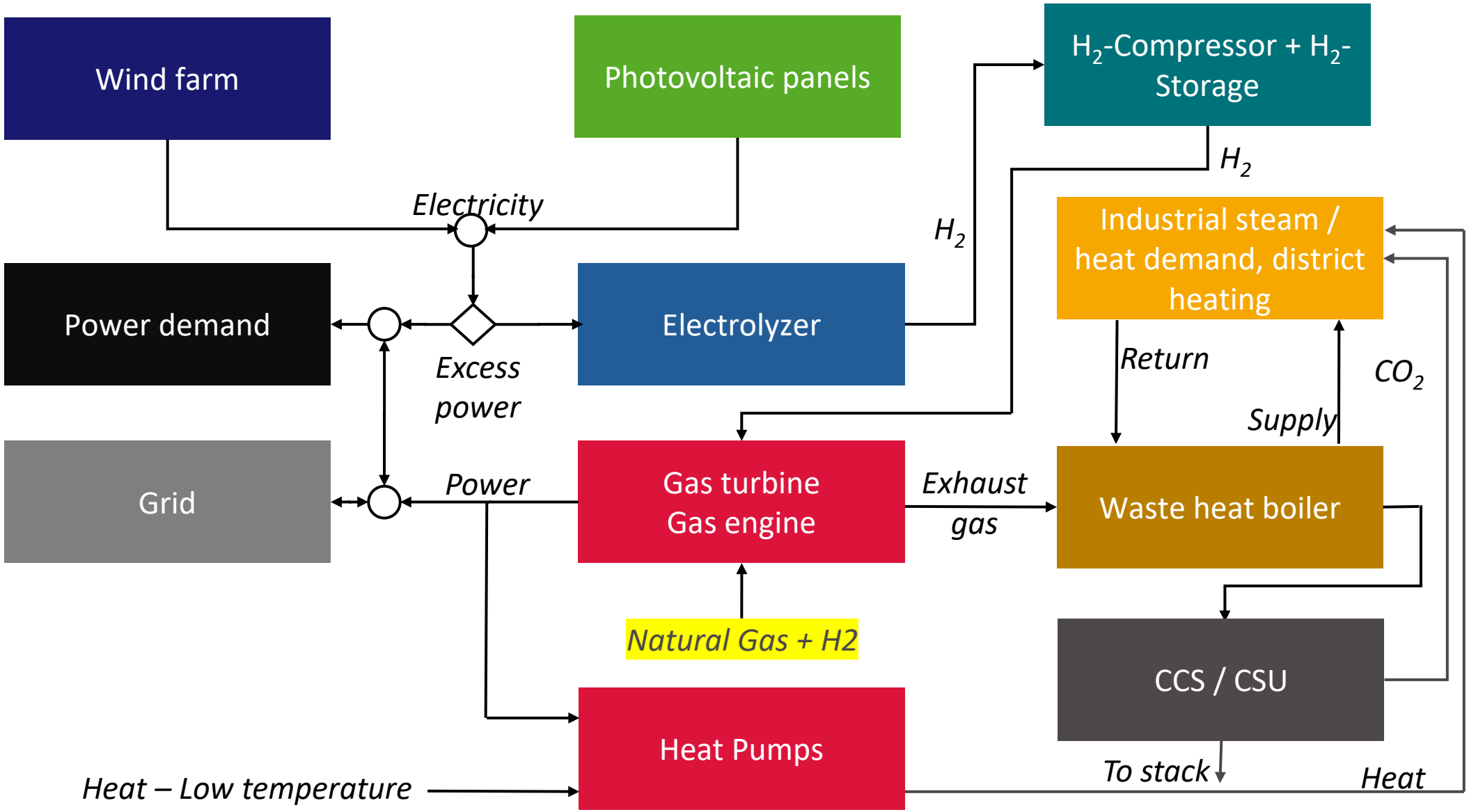
Road Map of Hydrogen Gas Turbine Development (KHI)



GT‘s fuel consumption for 30% Hydrogen

GT Type	Gen. Output	Fuel Consumption		Fuel Consumption 1		Fuel Consumption 2		
				NG		30% H2		
	kWe	kW	m3/h	kW	m3/h	kW	m3/h	kg/h
GPB 17D	1820	6478	803.76	5765	566.65	713	237.11	21.34
GPB 50D	4890	13040	1675.53	11360	1116.506	1680	559.02	50.31
GPB 80D	7820	23320	2893.44	20755	2039.86	2565	853.57	76.82
GPB 180D	18340	53080	6585.92	47241	4643.05	5839	1942.87	174.86
GPB 300D	33700	83020	10300.74	73888	7261.99	9132	3038.75	273.49

Hybrid Plants – Common Concept based on RES



Green H2 production solutions

1. “Classic solution” – water electrolysis

   For 1 kg H2 are necessary:

   60 kWh electricity from PV / Wind farm

   +

   9 kg water

2. Methane Plasmalyser – methane electrolysis

   For 1 kg H2 are necessary:

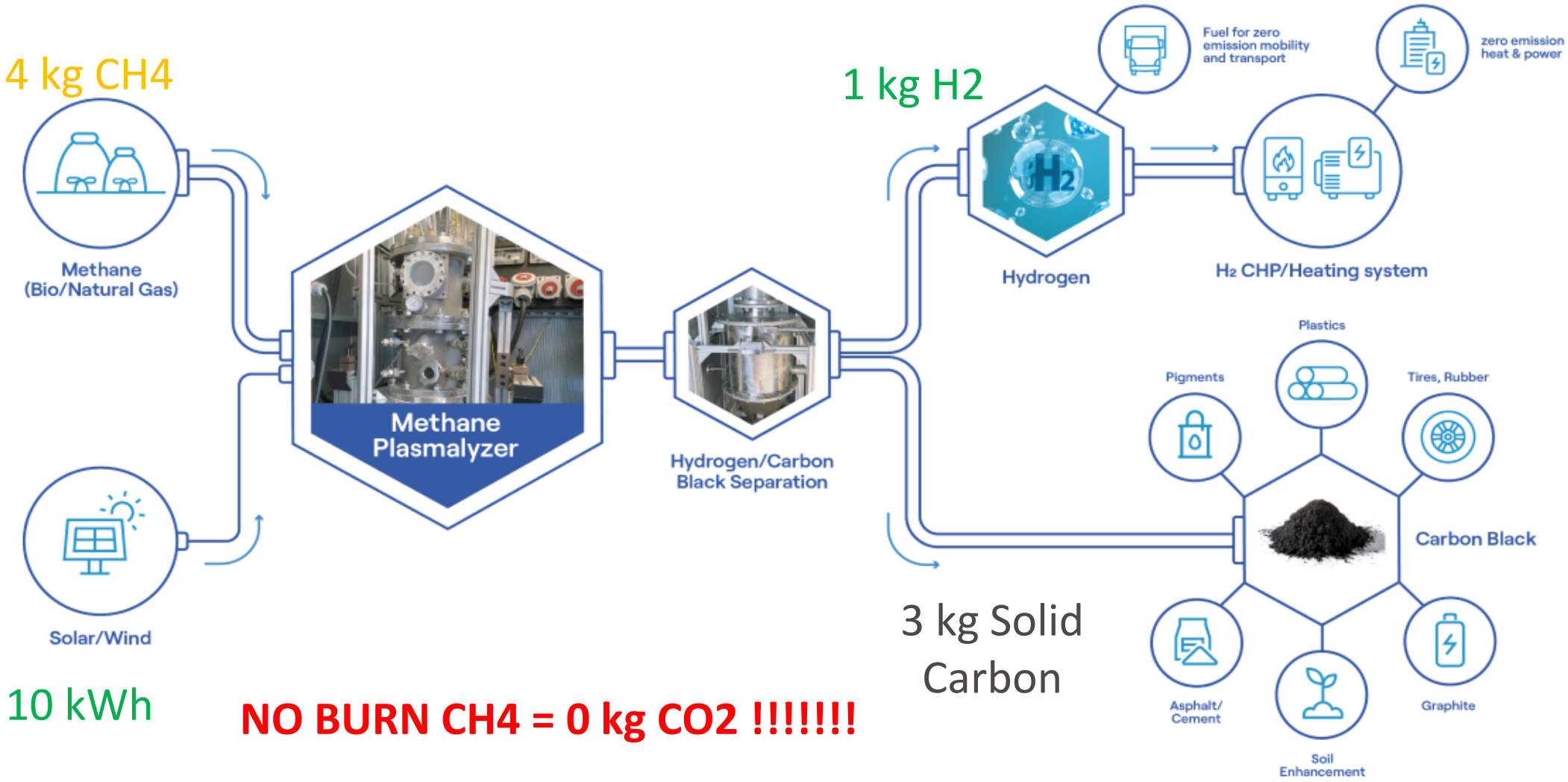
   10 kWh electricity from PV / Wind farm

   +

   4 kg CH4

How is running: high frequency voltage field generated from PV / wind farm split into its molecular H2 and C.

Methane Electrolysis concept



NO BURN CH4 = 0 kg CO2 !!!!!!!

NO WATER NEEDED + LOW ELECTRICITY CONSUMPTION THAN CLASSIC SOLUTION !!!!!!!

Methane Plasmalyser + Kawasaki Gas Turbines =

Business case which can be realised already today!?

“Global Kawasaki”

Kawasaki
Powering your potential