

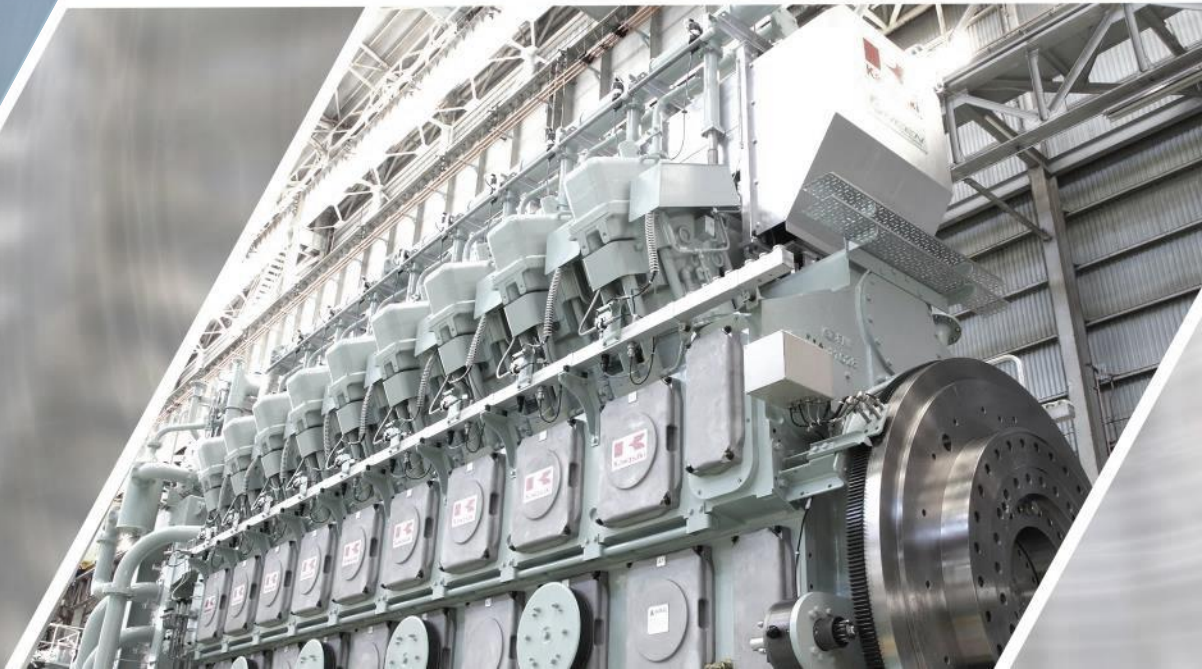
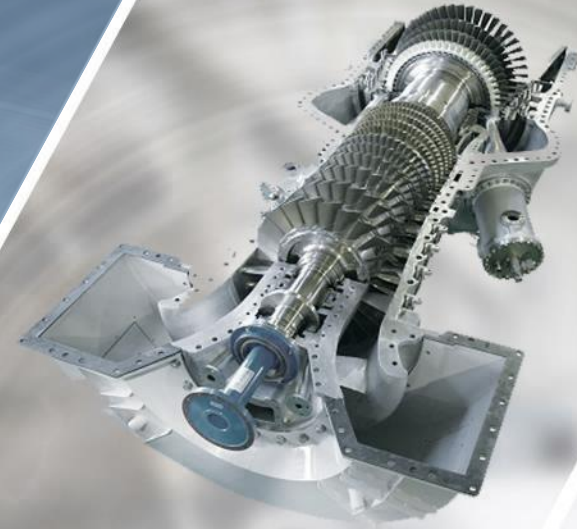
# Kawasaki Gas Turbine Europe GmbH

CHP and Combined Cycle-Plants

Two Specialists  
No Compromise



Energynomics 23<sup>rd</sup> Feb. '24 - Athens  
General Company Presentation



Energy approach based on 4 pillars = 4D:

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

## Cogeneration technologies covered by this Directive

1. Combined cycle gas turbine (CCGT) with heat recovery
2. Steam back pressure turbine
3. Steam condensing extraction turbine
4. Gas turbine with heat recovery
5. Internal combustion engine
6. Microturbines
7. Stirling engines
8. Fuel cells.

## High-efficiency cogeneration criteria

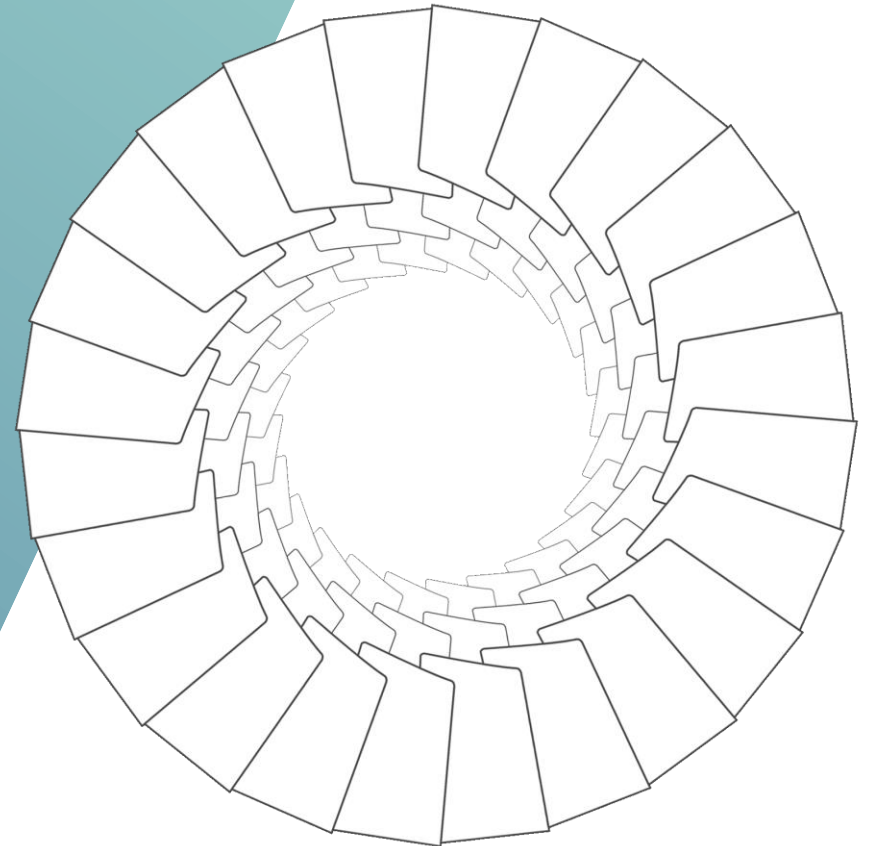
1. **Primary Energy Savings** compared with the references for separate production of heat and electricity = **min 10%**
2. **CO<sub>2</sub> from cogeneration production (fuelled with fossil fuels) < 270 gCO<sub>2</sub> / kWh of total energy output** (incl. steam/heating/cooling, power and mechanical energy)
3. **Overall eff**
  - a) = **min 75%** for cogeneration technologies types (2), (4), (5), (6), (7) and (8) or,
  - b) = **min 80%** for cogeneration technologies types (1) and (3)

### Remark:

- power to heat ratio default values (for statistical purposes) for cogeneration are in Directive 2023/1791 of 13th September 2023, ANNEX II
- references values for separate production of electricity and heat are in Delegated Regulation (EU)2023/2104 of 4<sup>th</sup> July 2023

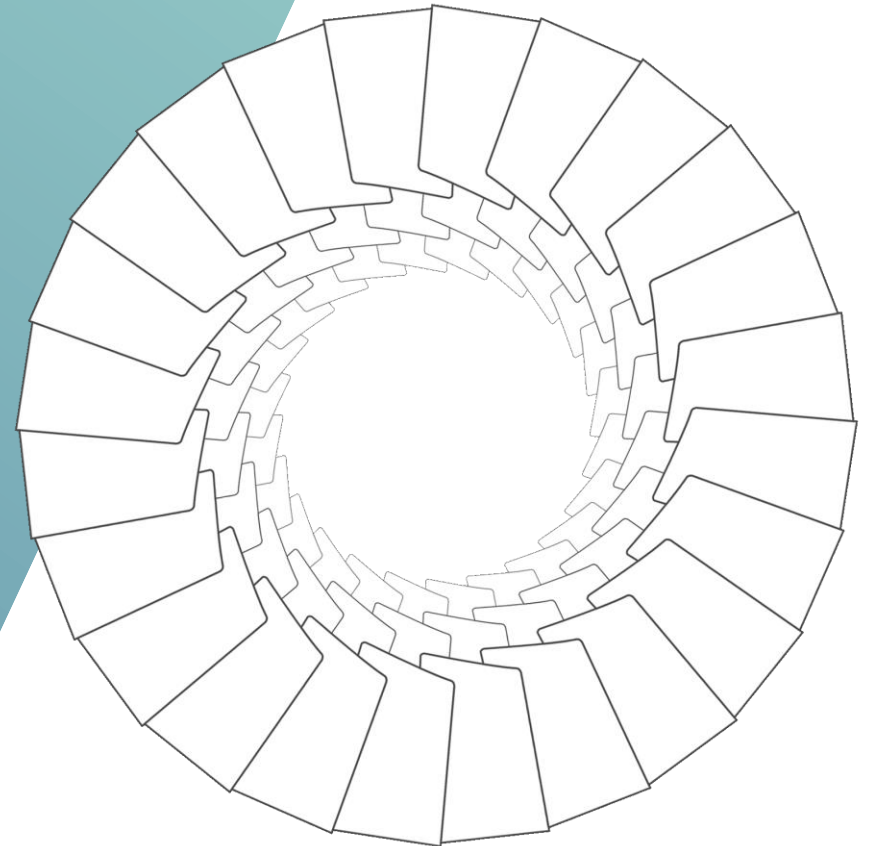
# Agenda

- I Kawasaki Heavy Industries (KHI)
- II Kawasaki Gas Turbine Europe (KGE)
- III Kawasaki Products & Services
- IV Applications of Generator Sets



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# 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

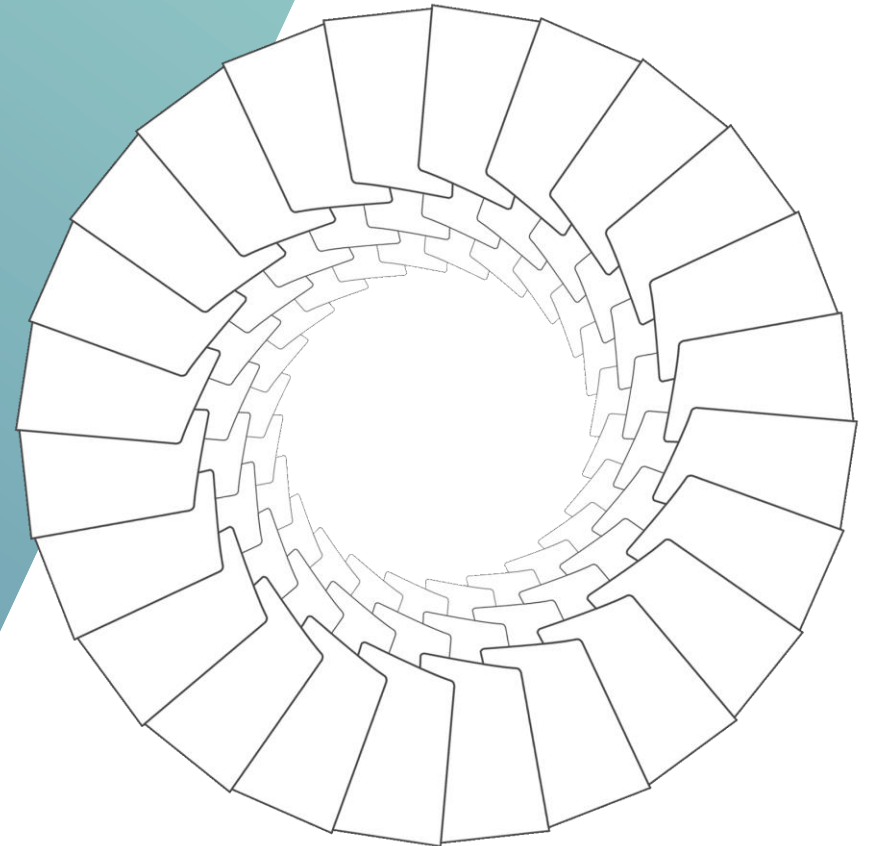
**Kawasaki Gas Turbine Asia Sdn. Bhd. (Malaysia)**

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

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

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# Kawasaki Gas Turbine Europe (KGE) - History

1975	<b>License Agreement with Deutz AG</b> Sales and Service of the M1A Gas Turbine
1998	<b>Establishment of Kawasaki Gas Turbine Europe GmbH</b> Headquarter for the entire European Market Sales, Packaging and Service of Gas Turbine Generator Sets
2003	<b>Expansion of Production Facilities</b> Relocation to Bad Homburg (close to Frankfurt City) Packaging of Gensets in house and at selected partners
2014	<b>Expand product range and Sales Areas</b> Development of additional turbines by KHI (5 MW and 35MW) Development of Hydrogen technology chain by Kawasaki Heavy Industries Market activities all across Europe
2018	<b>Establishment of Romanian Representative Office in Bucharest</b> Development of non-EU Countries Promotion & Sales Activities started
2021	<b>Italian Market</b> Celebrating 100 MW of installation within three years Currently: 70 employees





# Regions of Activity of KGE

● Kawasaki Gas Turbine Europe GmbH (Frankfurt, Germany)

● Sales & Marketing

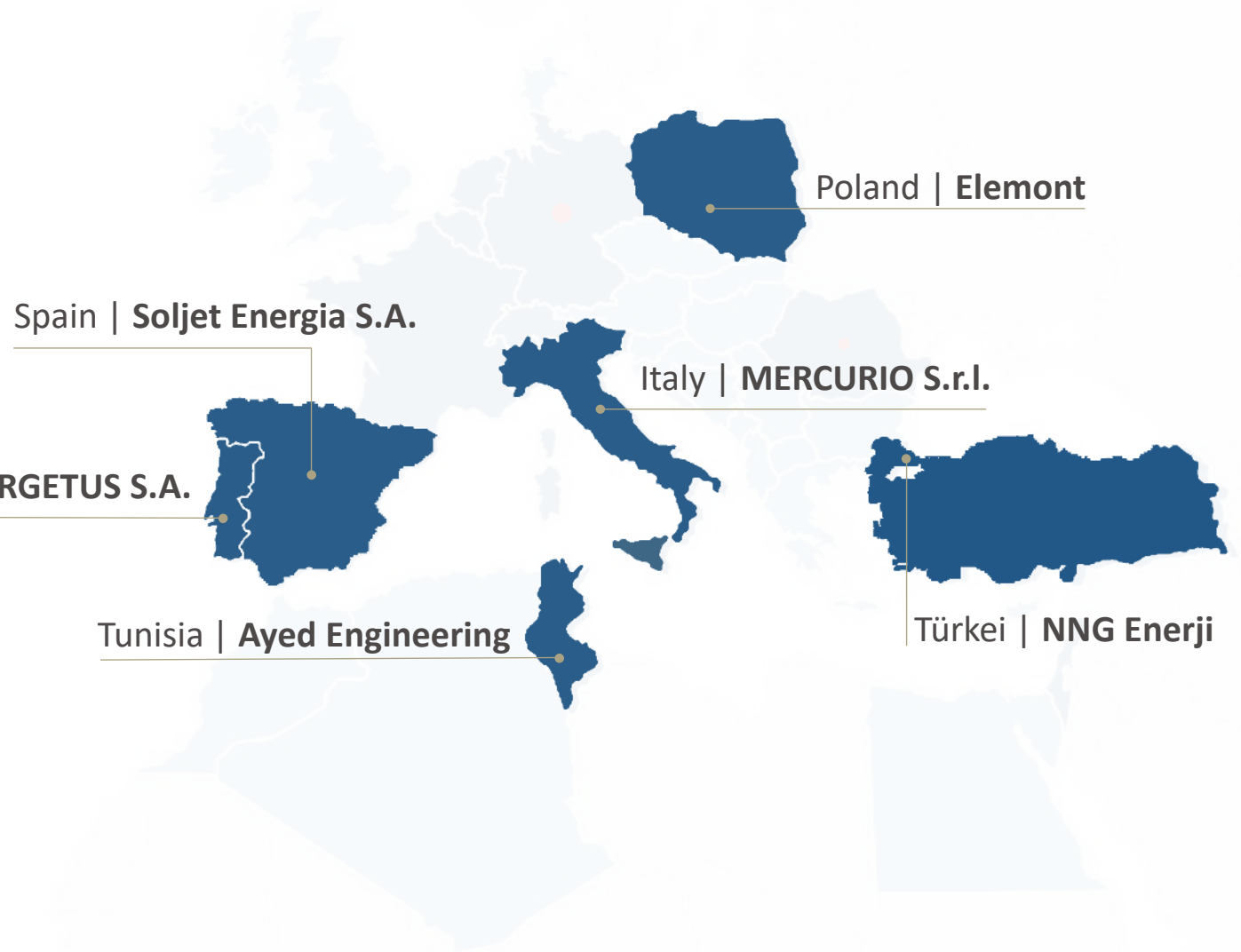
● Packaging

● Service and Maintenance

● Kawasaki Gas Turbine Europe GmbH (Bucharest)

● Sales & Marketing

- KGE agents or installations
- Ongoing / planned



## 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

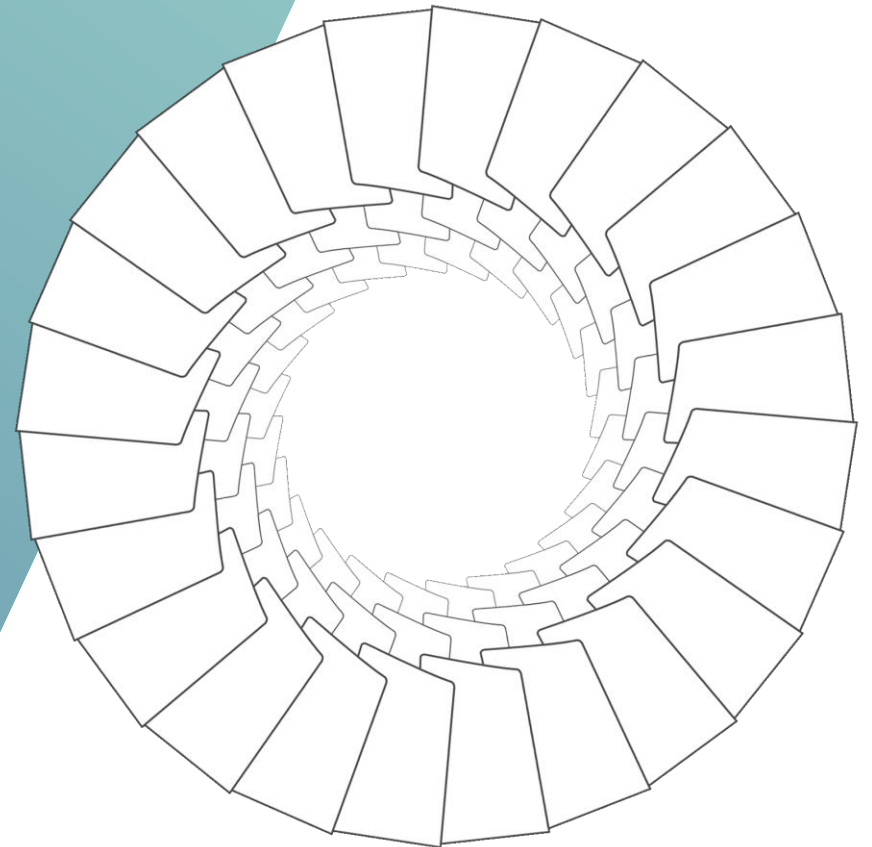


**Distributed Generator System**

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

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## ● Products



### Gas Turbine Generator Sets

<b>GPB17D</b> 1,816 kWel $\eta = 28.1 \%$	<b>GPB50D</b> 4,960 kWel $\eta = 32.6 \%$	<b>GPB80D</b> 7,810 kWel $\eta = 33.6 \%$	<b>GPB180D</b> 18,500 kWel $\eta = 34.3 \%$	<b>GPB300D</b> 34,300 kWel $\eta = 40.3 \%$
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### Gas Engines

<b>KG12</b> 5,200 kWel $\eta = 49.0 \%$	<b>KG18</b> 7,800 kWel $\eta = 49.0 \%$	<b>KG18-V</b> 7,800 kWel $\eta = 49.5 \%$	<b>KG18-T</b> 7,800 kWel $\eta = 51 \%$
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@ ISO-conditions



## Services

### ● Engineering

Preliminary Engineering  
Detailed Engineering

### ● Implementation

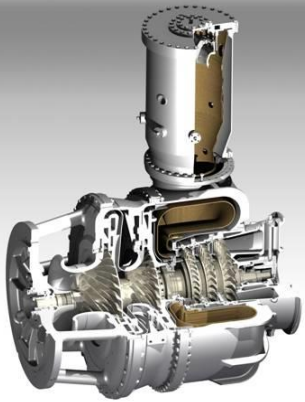
Project Planning  
Customized Packaging  
Erection Commissioning

### ● Maintenance

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

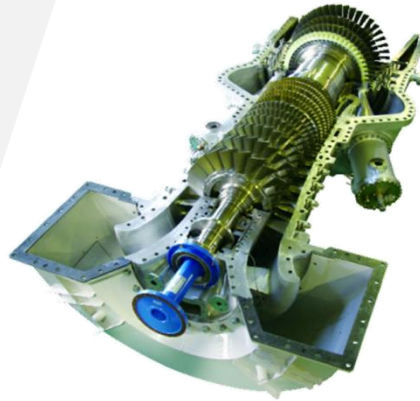
# Gas Turbine Generator Sets

## M1A-17D



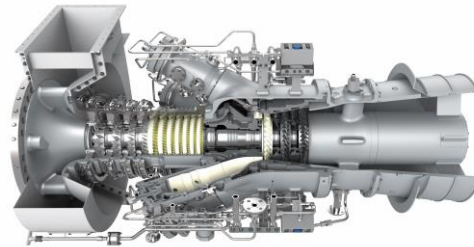
Power Output [kWe]	1,816
Ele. Efficiency [%]	28.1
Sat. steam 8 barg [t/h] / Heat recovered [kWth]	5 / 3.646
Exhaust Gas Temperature [°C]	522
NO <sub>x</sub> @ O <sub>2</sub> = 15% [ppm]	< 9
CO @ O <sub>2</sub> = 15% [ppm]	50

## M7A-03D



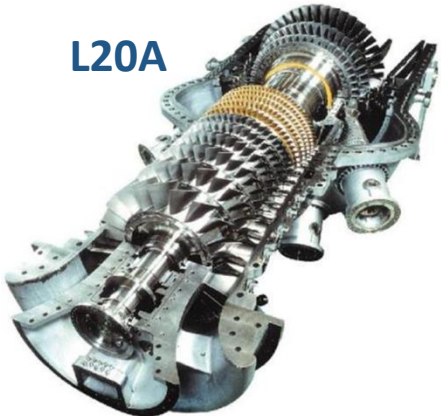
Power Output [kWe]	7,810
Ele. Efficiency [%]	33.6
Sat. steam 8 barg [t/h] / Heat recovered [kWth]	16.4 / 12.471
Exhaust Gas Temperature [°C]	523
NO <sub>x</sub> @ O <sub>2</sub> = 15% [ppm]	< 9
CO @ O <sub>2</sub> = 15% [ppm]	10

## M5A-01D



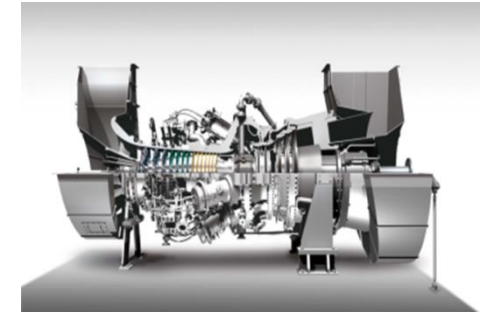
Power Output [kWe]	4,720
Ele. Efficiency [%]	32.6
Sat. steam 8 barg [t/h] / Heat recovered [kWth]	11 / 7.723
Exhaust Gas Temperature [°C]	511
NO <sub>x</sub> @ O <sub>2</sub> = 15% [ppm]	15
CO @ O <sub>2</sub> = 15% [ppm]	15

## 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 <sub>x</sub> @ O <sub>2</sub> = 15% [ppm]	15
CO @ O <sub>2</sub> = 15% [ppm]	25

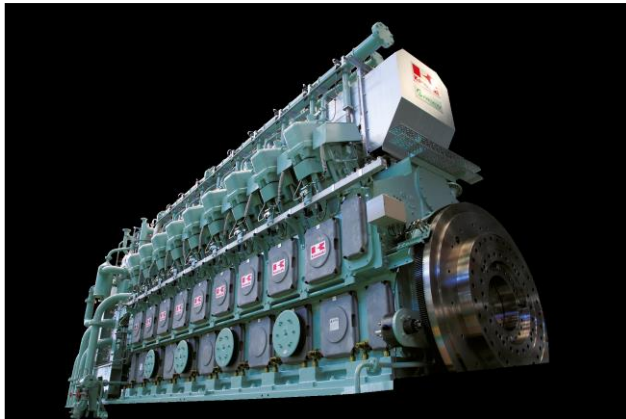
## L30A



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 <sub>x</sub> @ O <sub>2</sub> = 15% [ppm]	15 / 9
CO @ O <sub>2</sub> = 15% [ppm]	25

# Gas Engine Models

**KG 18V**



**KG 12**



**KG 18T**



Power Output [kWe]	7,800
Ele. Efficiency [%]	49.5
Total Engine Heat [kWth]	5,000
Exhaust Gas Temperature [°C]	320
NOx @ O <sub>2</sub> = 0% [ppm]	200
CO @ O <sub>2</sub> = 0% [ppm]	50
Methane number	> 65

Power Output [kWe]	5,200
Ele. Efficiency [%]	49
Total Engine Heat [kWth]	3,000
Exhaust Gas Temperature [°C]	320
NOx @ O <sub>2</sub> = 0% [ppm]	200
CO @ O <sub>2</sub> = 0% [ppm]	50
Methane number	> 65

Power Output [kWe]	7,800
Ele. Efficiency [%]	51
Total Engine Heat [kWth]	3,500
Exhaust Gas Temperature [°C]	285
NOx @ O <sub>2</sub> = 0% [ppm]	250
CO @ O <sub>2</sub> = 0% [ppm]	50
Methane number	> 65

# Hydrogen Road



H2-Production  
and Liquefaction



H2-Storage Tanks



H2-Oversea  
Transportation



H2-Land  
Transportation



H2-Gas Turbines  
H2-Compressors

## Overview of Combustor Developments



### Combustor Configuration:

- NOx Reduction
- H2 Content
- Status

### DLE for Natural Gas

“Dry”  
0 ... 30 vol%

Demonstration at  
Akashi Works, 2014

### Diffusion Flame

“Wet” Water/Steam  
0 ... 100 vol%

Applied to KOBE  
Demonstration Plant, 2018

### DLE Micro-Mix

“Dry”  
90 ... 100 vol%

Applied to KOBE  
Demonstration Plant, 2020



# Development Schedule of Hydrogen Gas Turbines

H2-GT	≤30 %-Vol. H2	≤100 %-Vol. H2	
	Standard DLE	Diffusion	Micro-Mix DLE
M1 - 1.8 MW <sub>el.</sub>	✓	✓	✓
M5 - 4.7 MW <sub>el.</sub>	✓	2025	
M7 - 7.8 MW <sub>el.</sub>	✓	2024	
L20 - 18.5 MW <sub>el.</sub>	✓	2023	
L30 - 34.3 MW <sub>el.</sub>	✓	2026	2027

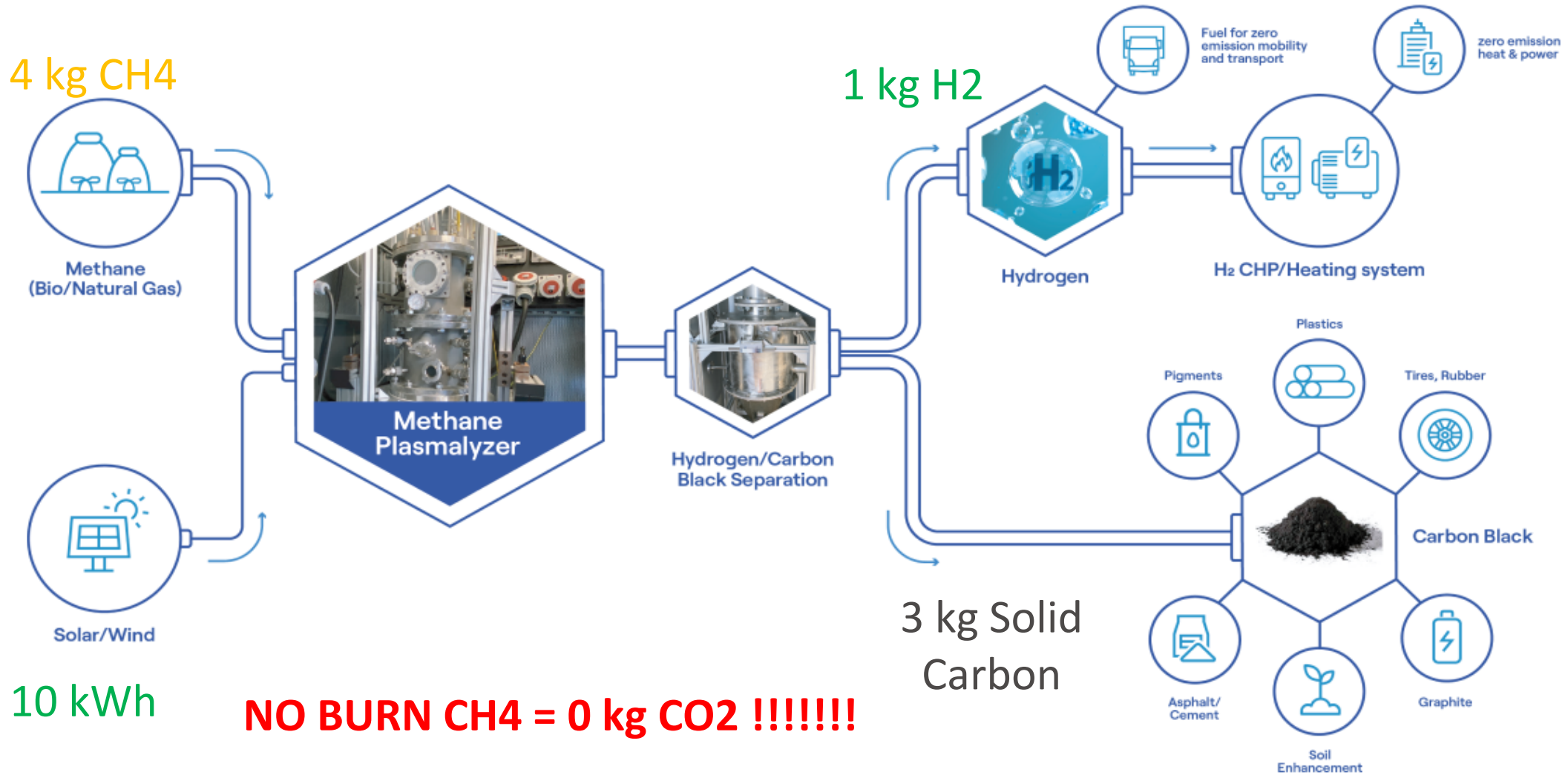
- official sales release
- available soon
- availability not defined yet

## 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 CH<sub>4</sub> = 0 kg CO<sub>2</sub> !!!!!!!**

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

Methane Plasmalyser + Kawasaki Gas Turbines =  
Business case which can be realised already today!?

## Example of Kawasaki Hydrogen Gas Turbine application in Belgium



Chevron Philips Chemical International N.V. (CPChem plant in Tessenderlo) – produce organic sulfur compounds

March 2021 - Kawasaki Gas Turbine Europe installed a standard natural gas fired DLE (Dry Low Emission) Gas Turbine GPB17D.

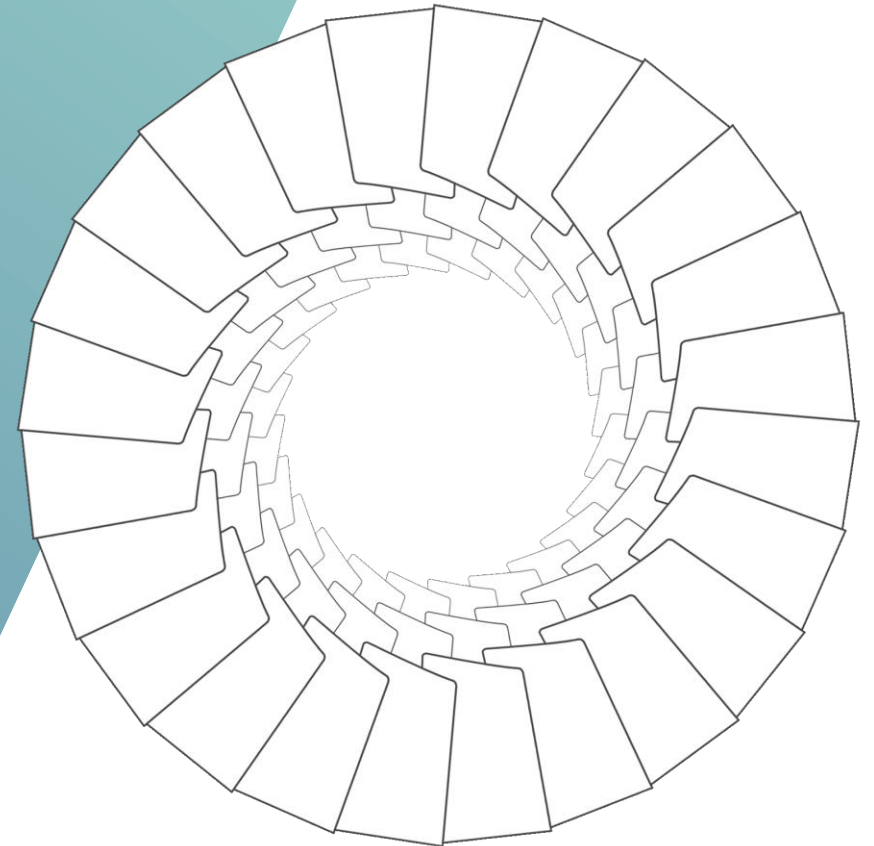
October 2023 - the existing standard DLE System was modified to a 30vol% H<sub>2</sub> DLE that can be fed by the Hydrogen generated as a by-product on site.

NO<sub>x</sub> < 15 ppm@O<sub>2</sub>=15%. Since then, this Gas Turbine has been the world's first Gas Turbine to run fully flexible in the range of 0-30vol% Hydrogen capability.

**Kawasaki Gas Turbine Europe successfully commissioned the world's first commercial 30% DLE Hydrogen Gas Turbine Generator Set.**

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# KGE market – request of electricity and steam / hot water / chilled water / CO<sub>2</sub>

## Pulp and paper



## Medicines / cosmetics



## Refinery / Chemistry



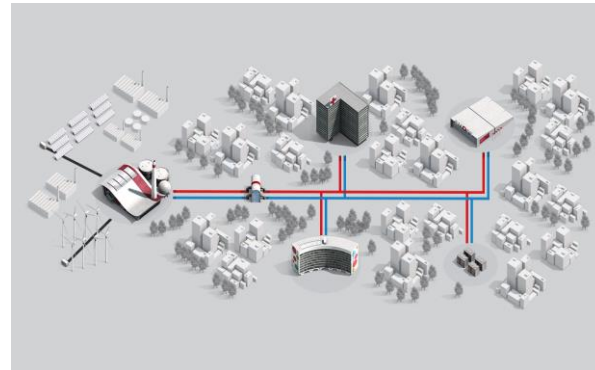
## Automotive / Tires



## Food and Beverage



## District Heating



Universities  
Hotels

Hospitals  
Airports

## Ceramics

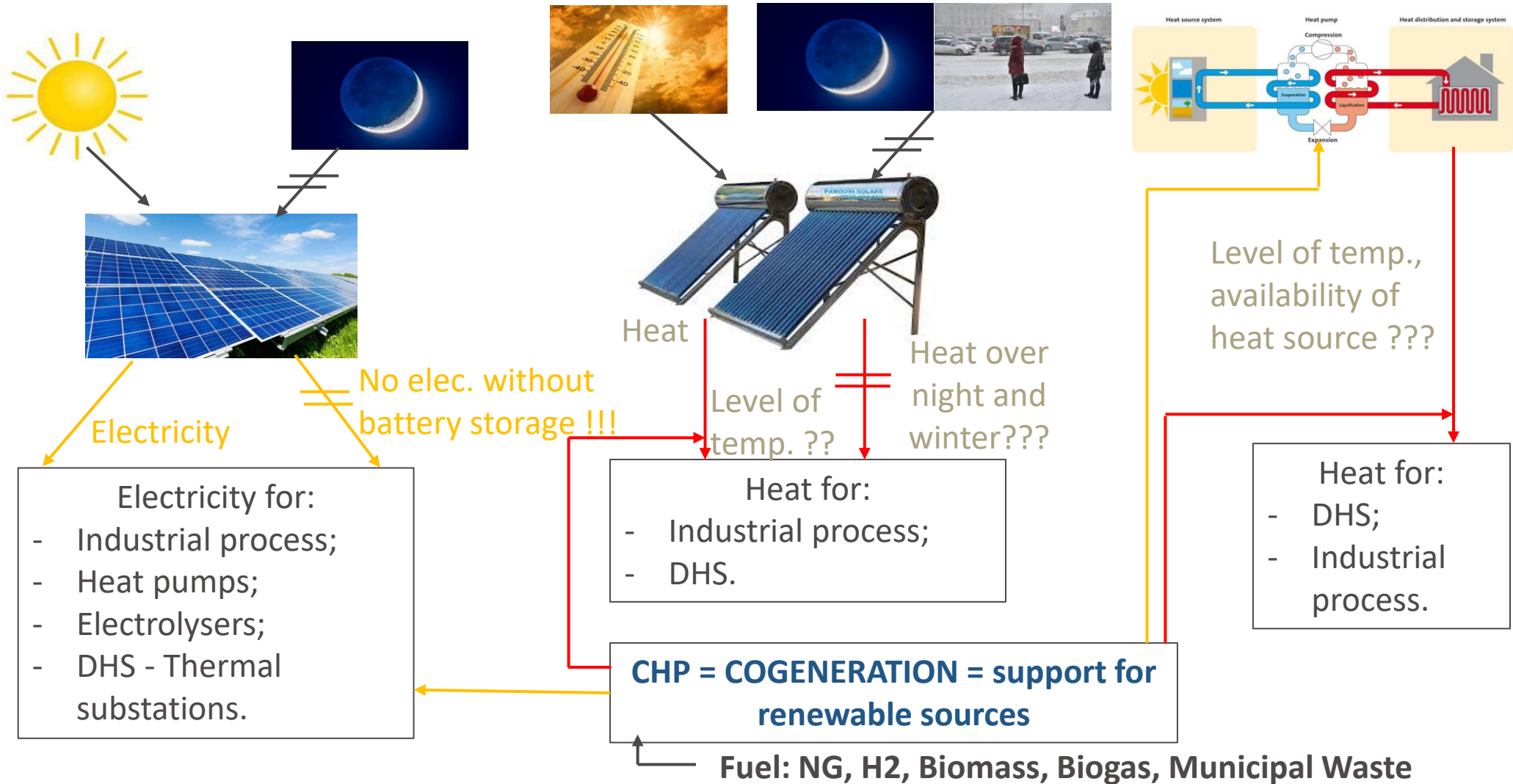


## Fertilizers



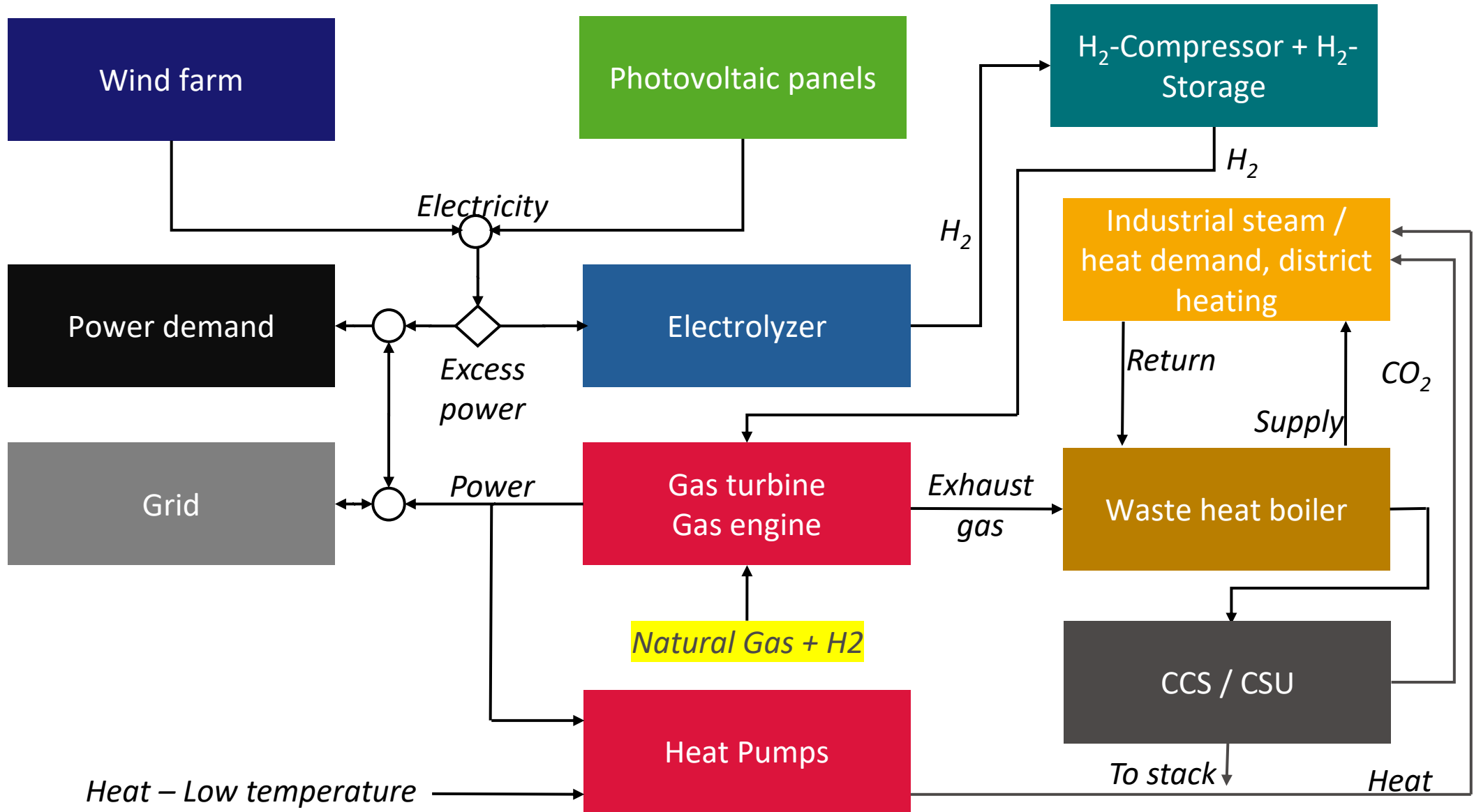
# Cogeneration solution = energy efficiency solution = support for renewable energy sources

## Renewable sources ≠ Energy efficiency solutions ≠ Energy Independence





# Hybrid Plants – Common Concept based on RES



“Global Kawasaki”