We Care for a Better Future.

Success with H2 CHP technology in NRW & abroad

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2G. Cogeneration.

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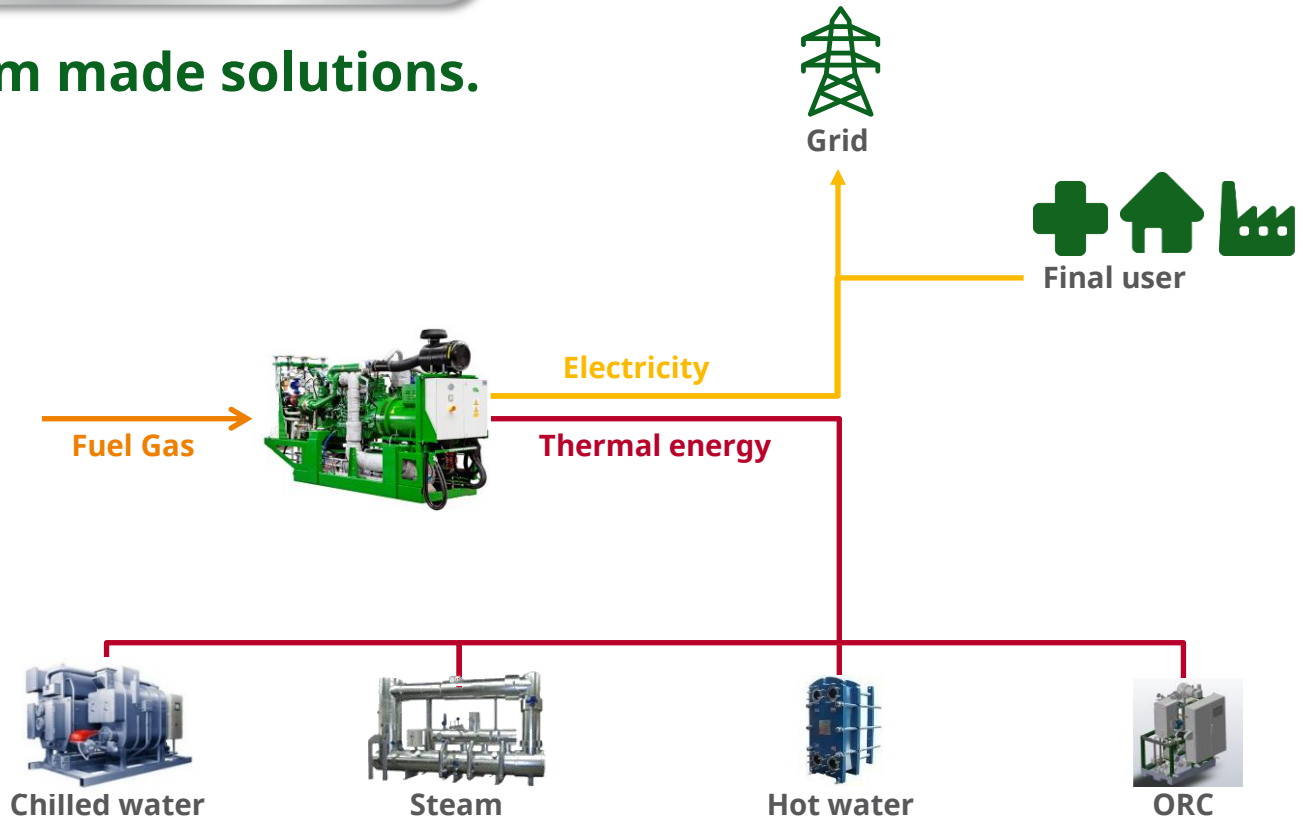
Introduction.

- Founded 1995 - Headquarters in Heek, Germany
- One-stop shop for Gas engine & CHP solutions
- CHP systems for biogas and natural gas applications 60 – 2,500 kW electrical power
- CHP systems for Hydrogen applications 115 – 750 kW electrical power
- 10 international subsidiaries
- Since 2007 listed on the German stock exchange
- 750 employees
- +7,500 CHP plants in more than +50 countries worldwide

Custom made solutions.



Fields of application.

Schools and universities

Food

Industrial companies

Sewage plants

Hospitals

Retirement homes

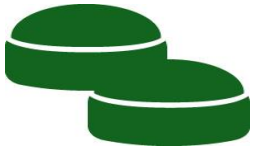
Hotels

Landfills

Residental buildings

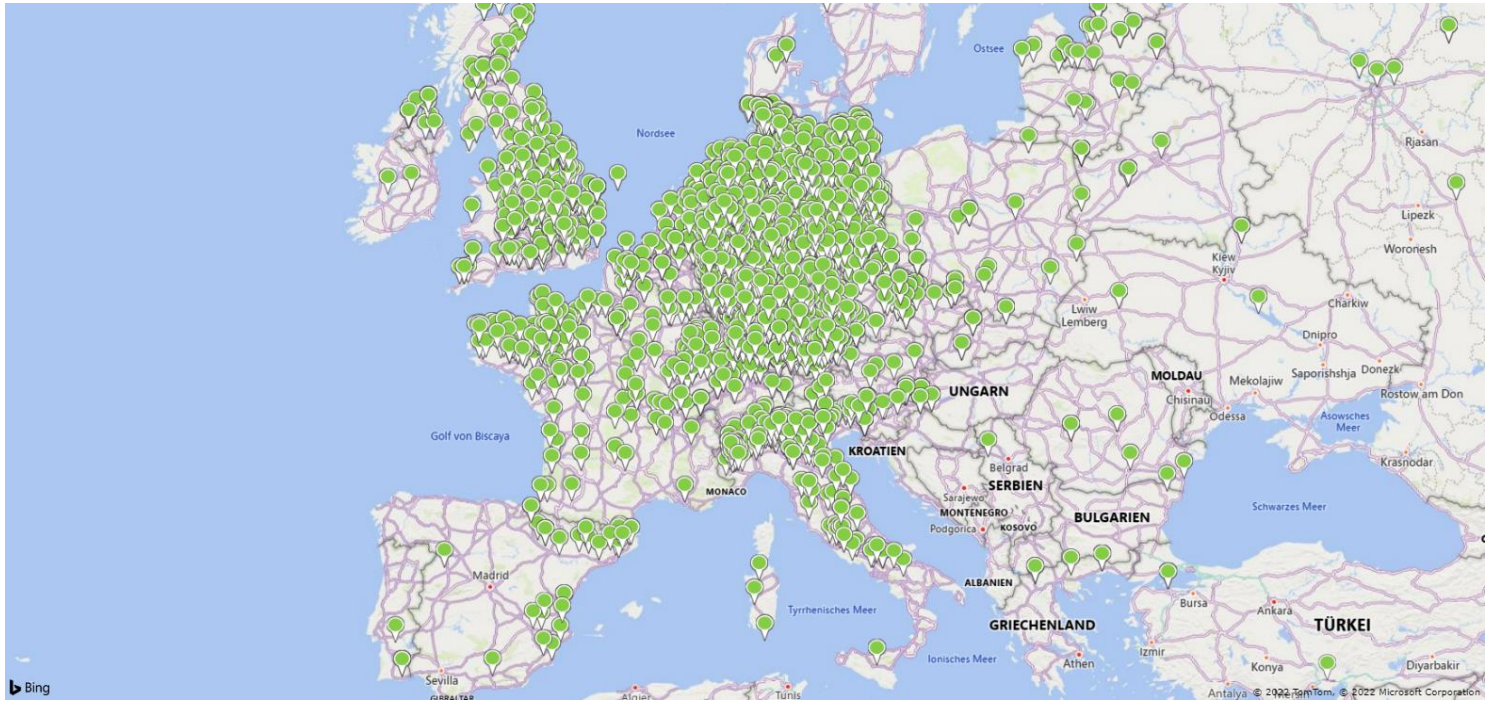
Swimming pools

Heating grids



Biogas plants

Global Footprint

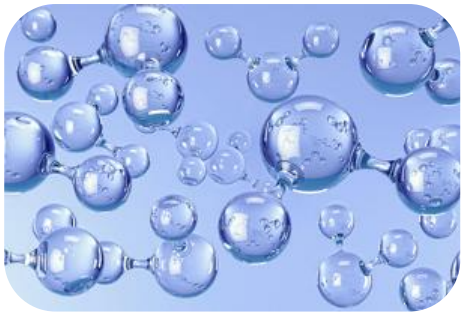


Global Footprint

A multitude of fuels.

Biogas

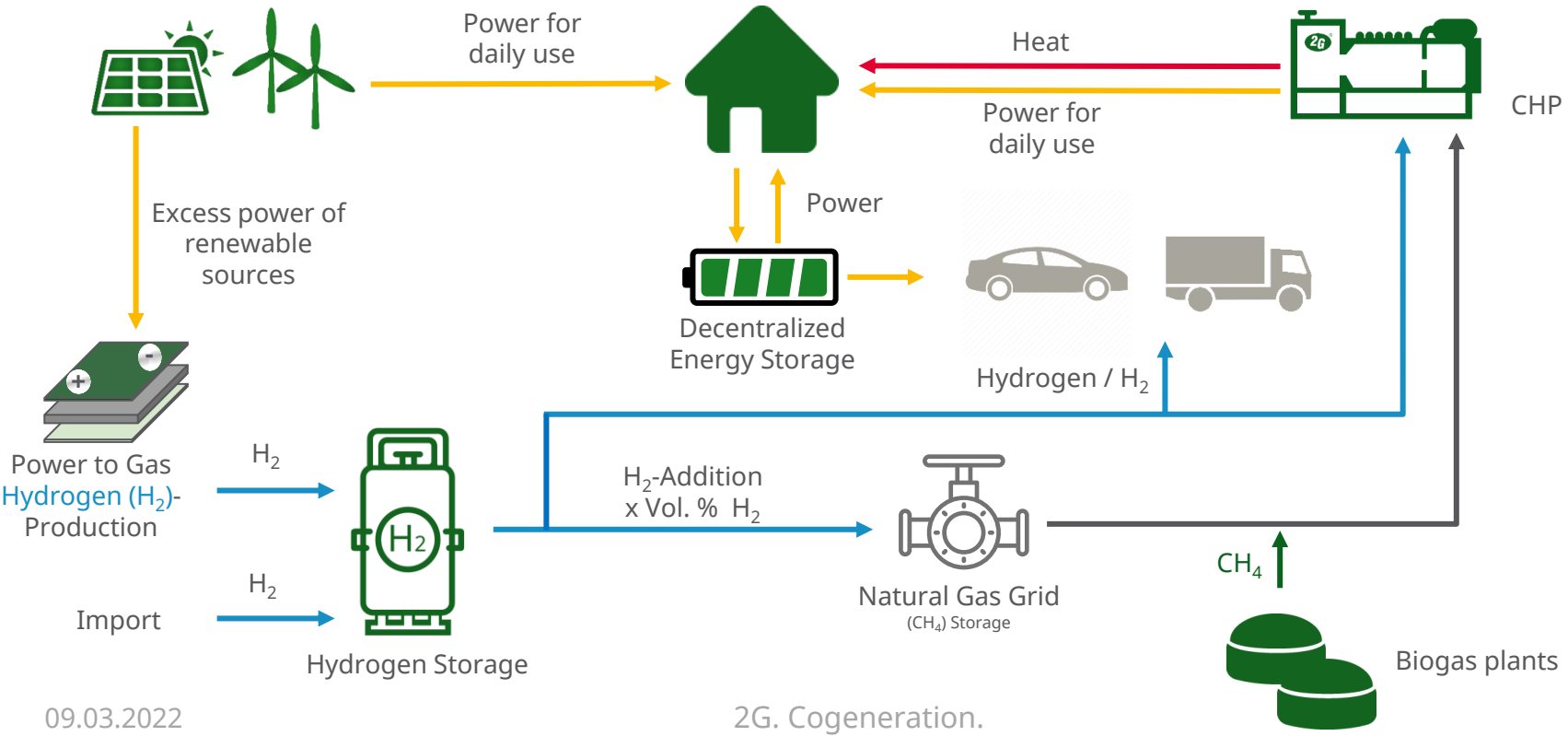
Natural Gas (LNG)



Hydrogen

Propane (LPG)

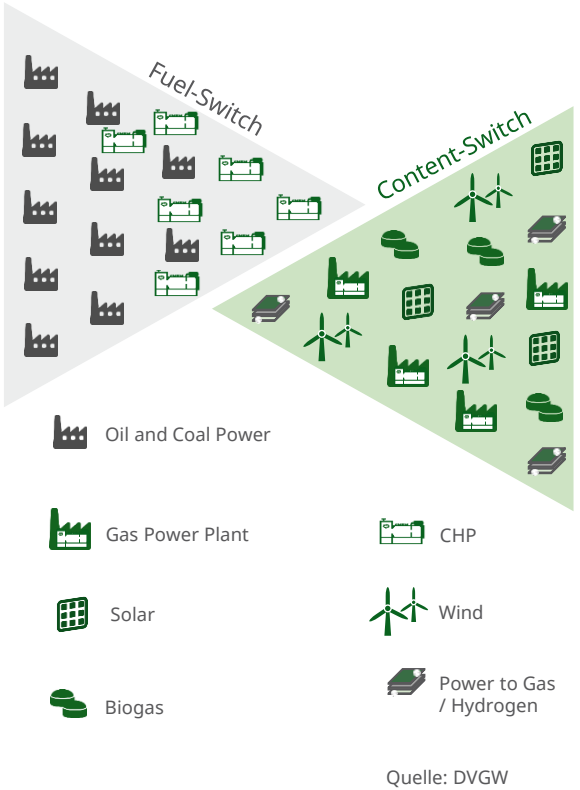
Power to Gas.


Power for daily use
Heat
Power for daily use
CHP
Power
Excess power of renewable sources
Decentralized Energy Storage
Hydrogen / H_2
Power to Gas
Hydrogen (H_2)-Production
H_2
H_2
Import
Hydrogen Storage
H_2-Addition
x Vol. % H_2
Natural Gas Grid
(CH_4) Storage
CH_4
Biogas plants

Fuel-Switch und Content-Switch.

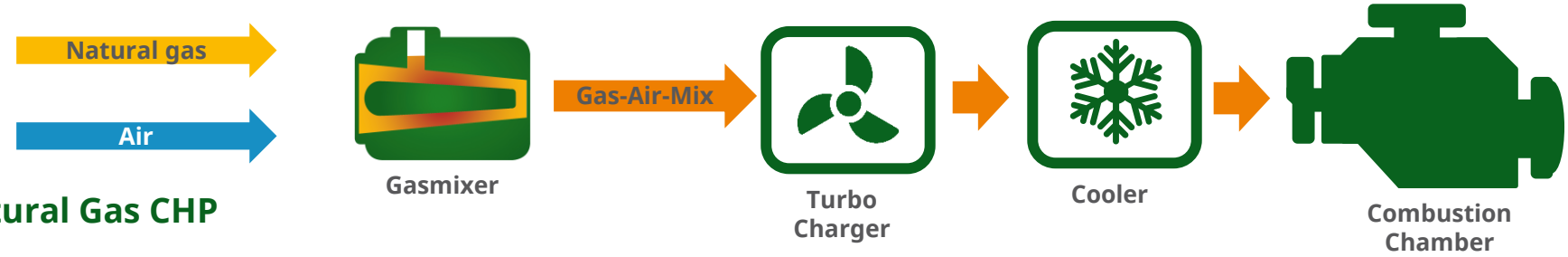
Fuel-Switch:
The switch from fossil fuels towards renewable fuels

Content-Switch:
The switch towards utilization of „green“ gases and renewable energy



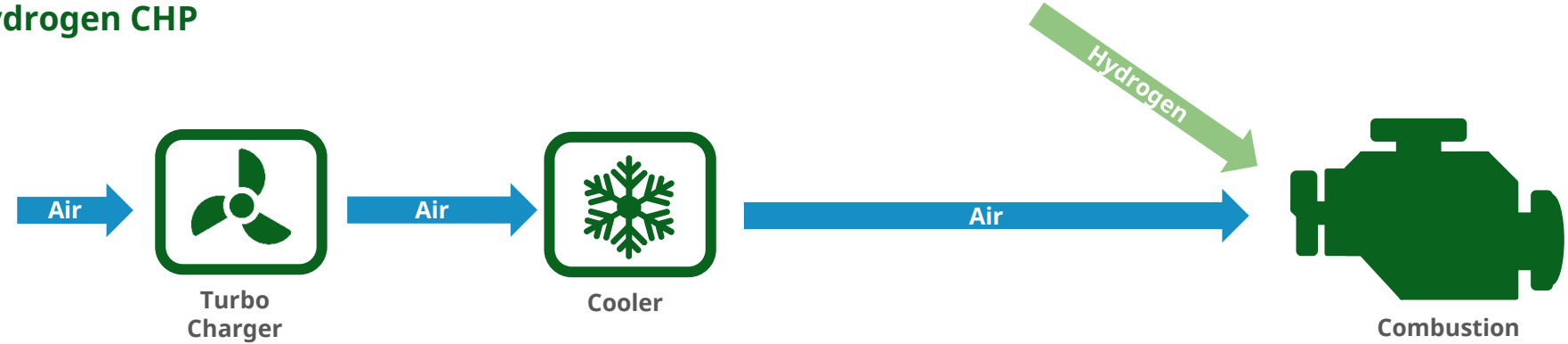
Quelle: DVGW

Comparison: Natural Gas CHP vs. Hydrogen CHP

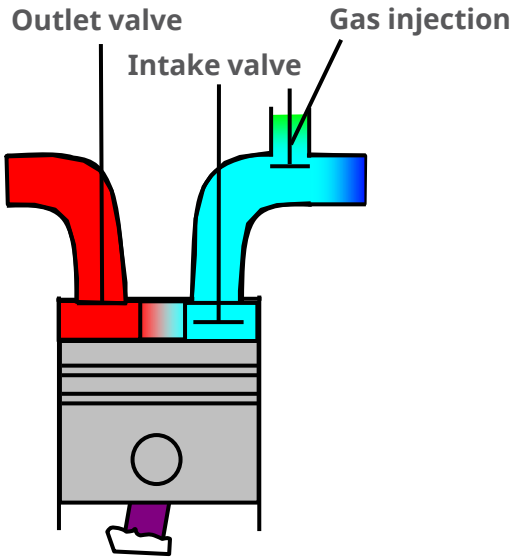


Natural Gas CHP

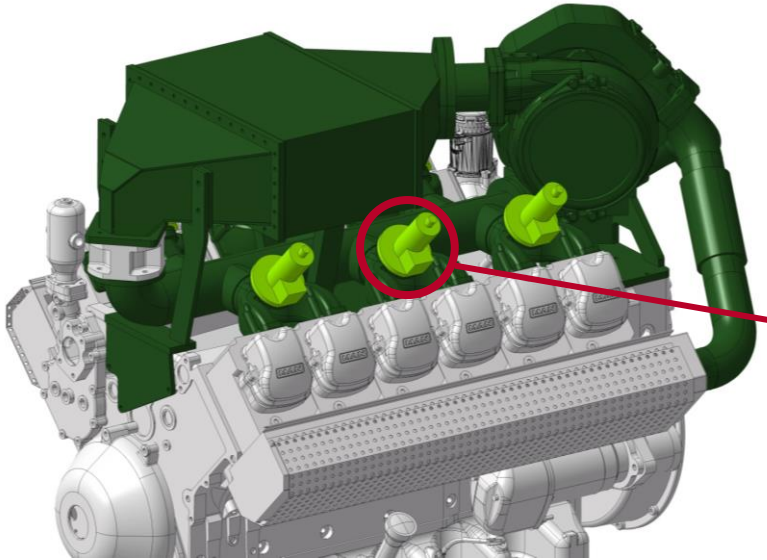
Hydrogen CHP

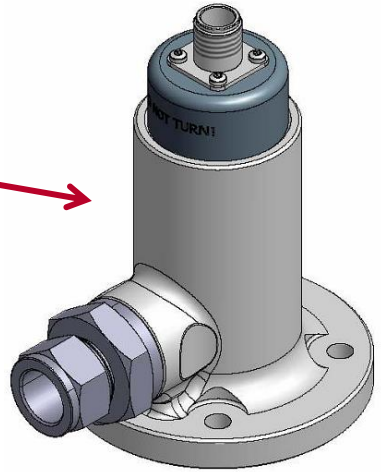


Mixture with Port Injection: Gases with low Methane Number.



Port Injection:
Mixture just before the combustion chamber





Gas injection valve

Hydrogen CHP by 2G

- Gas train for Hydrogen
- Gas injection at each cylinder (multipoint injection)
- Special 2G spark plug & pistons
- Partial load capability from 50 – 100 % nom. load
- Island operation with large loads is possible
- Gas Blending is possible (e.g. NG / H2)
- “Waste” Hydrogen containing impurities can be utilized
- 2G engines can be retrofitted to H2 in the future

2G Hydrogen Portfolio.

Type	Output		Efficiency Rate		
	Electrical	Thermal	Electrical	Thermal	Total
agenitor 404c H_2	115 kW	129 kW	37.7 %	42.3 %	80.0 %
agenitor 406 H_2	170 kW	183 kW	39.0 %	41.9 %	80.9 %
agenitor 408 H_2	240 kW	250 kW	40.2 %	41.9 %	82.1 %
agenitor 412 H_2	360 kW	371 kW	40.5 %	41.7 %	82.2 %
agenitor 420 H_2	750 kW	747 kW	41.2 %	41.0 %	82.2 %

Latest H2 References.

TOTAL hydrogen service station at BER airport / Germany
agenitor 306 SG with 110 kWel

Haßfurt municipal works / Germany
agenitor 406 SG with 140 kWel

Siemens project in Dubai / UAE
agenitor 412 SG with 360 kWel

APEX in Rostock / Germany
agenitor 404c with 115 kWel

Green hydrogen Esslingen GmbH / Germany
agenitor406 with 170 kWel

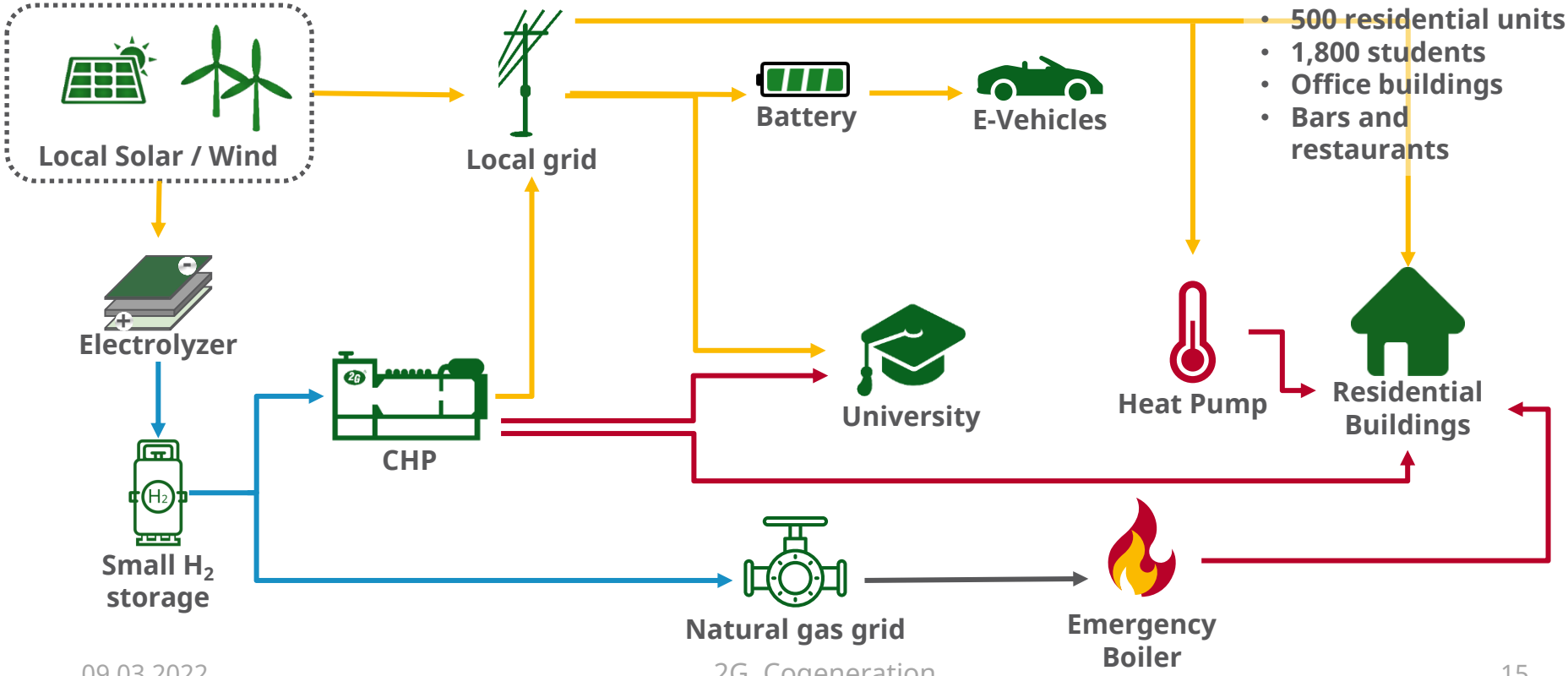
Toyota project / Japan
Agenitor412 with 360kWel

Kirkwall Airport / Orkney / UK
agenitor 404c with 115kWel

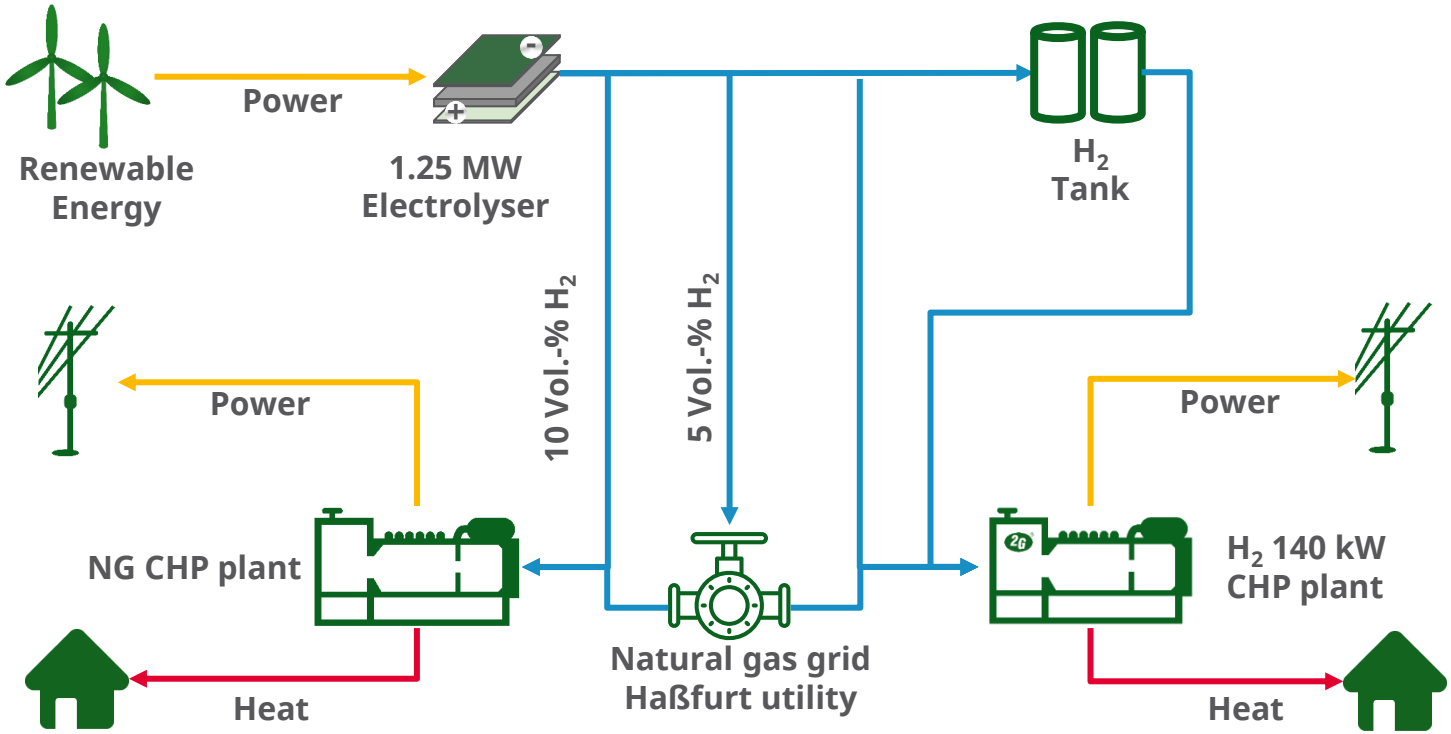
Not yet disclosed project / Japan – 1st commercially operated H2 Unit in Japan
agenitor 412 with 360kWel

Not yet disclosed project / Japan
2x agenitor 404c with 115kWel each

Case Study: City of Esslingen (Germany)



Power to Gas - Case Study Utility Haßfurt.



Source: Stadtwerk Haßfurt

Hydrogen project in Japan.

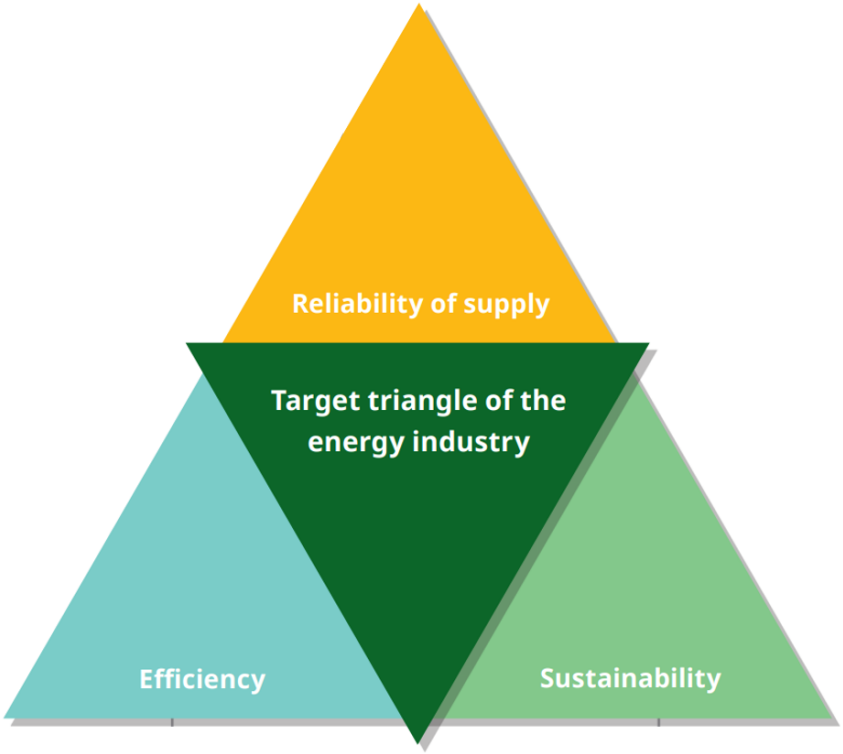
2G and their Japanese partners Technis Co. Ltd. and Fuji Electric have proudly installed an H2 CHP at Toyota Honsha plant (Head office plant) in Toyota City. With it´s goal of achieving zero CO2 emissions until 2050 in all Toyota facilities around the globe, CHP technology is seen as one of the core technologies for the path over the next decades. Initially the CHP (Type: agenitor 412) will be operated on 40% hydrogen and can be upgraded to 100% hydrogen depending on it´s local availability. Moreover, this project may serve as kind of blueprint for further Toyota production sites around the globe. For Andre Banken, 2G´s Director of International Business Development, the solution demonstrates the huge potential of CHP technology for the global energy transition: „Customers are seeking for low energy costs, a stable supply of energy and the pathway to zero CO2 emissions. CHP technology can meet these requirements from the very first day of installation onwards.“

Summary – CHP systems are….

1. …part of the renewable energy storage solution in order to re-electrify the wind and solar energy stored in the gas system in a highly efficient manner

2. …the natural partner technology for PV systems due to the complementary mode of operation

3. …system-relevant and can cover the residual load highly efficient as required



Thank you very much for your attention!

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