



**We Care for a Better Future.**



# **2G - Hydrogen CHP**

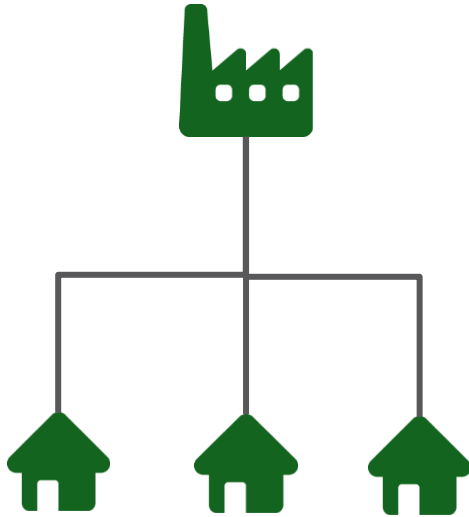
CHP-Technology for green hydrogen as fuel

## Key Data

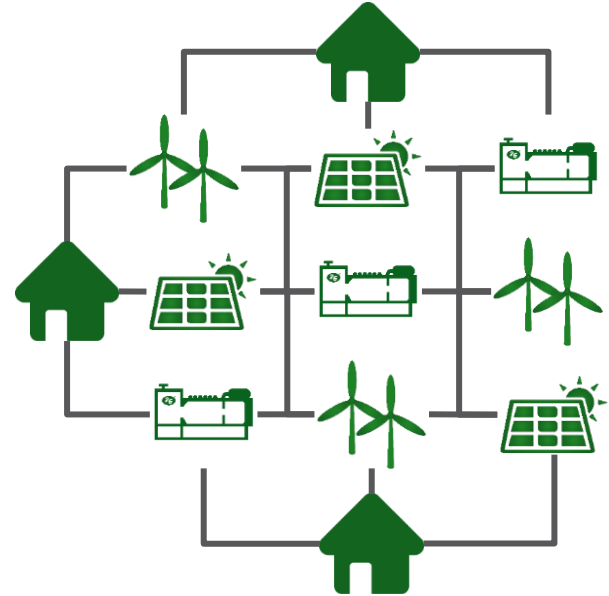
- Founded in 1995 - Headquarters in Heek, Germany
- Solution provider for the whole life-cycle
- Plants for biogas and natural gas (20 – 4,500 kW), hydrogen, syngas, propane
- Listed in the German stock market since 2007
- 900+ employees
- 50+ countries
- 8,500+ CHP plants
- 10 international subsidiaries



# Paradigm shift



central + fossil



decentralized + renewable



## 4 D's of Energy Transition

**D**ecarbonization

**D**ecrease of use

**D**eregulation

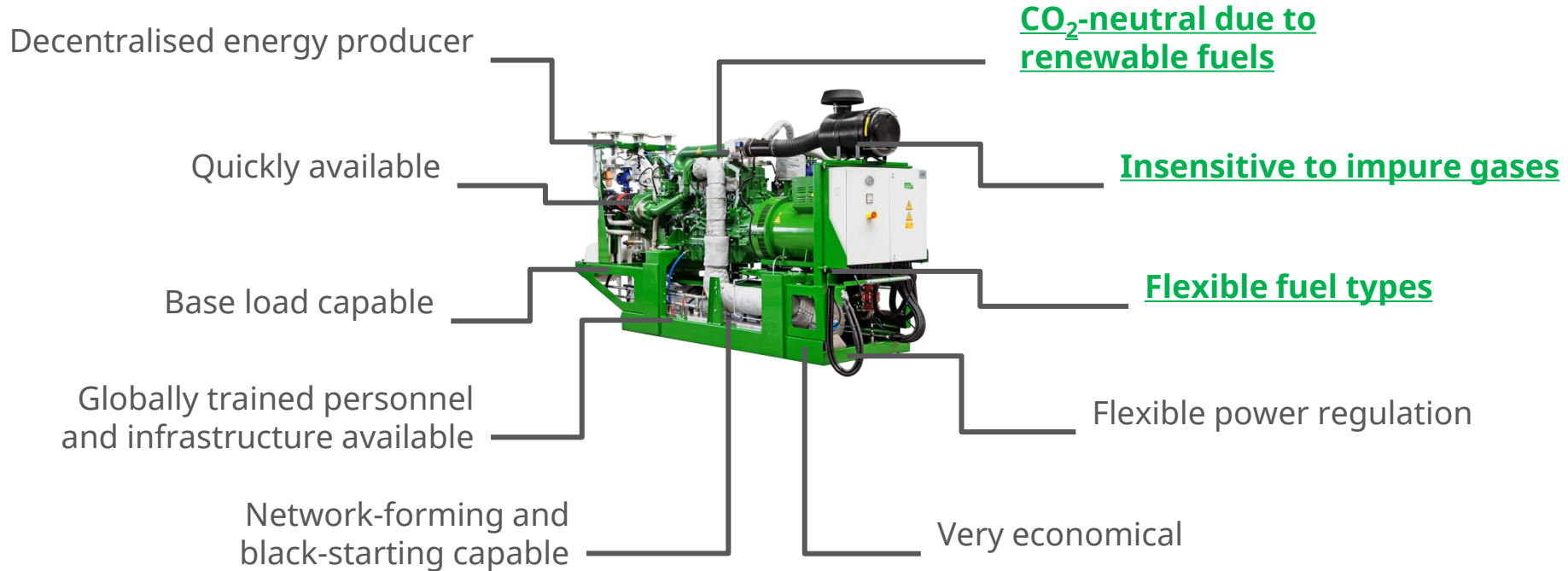
**D**ecentralization

**D**igitalization

**D**emocratization

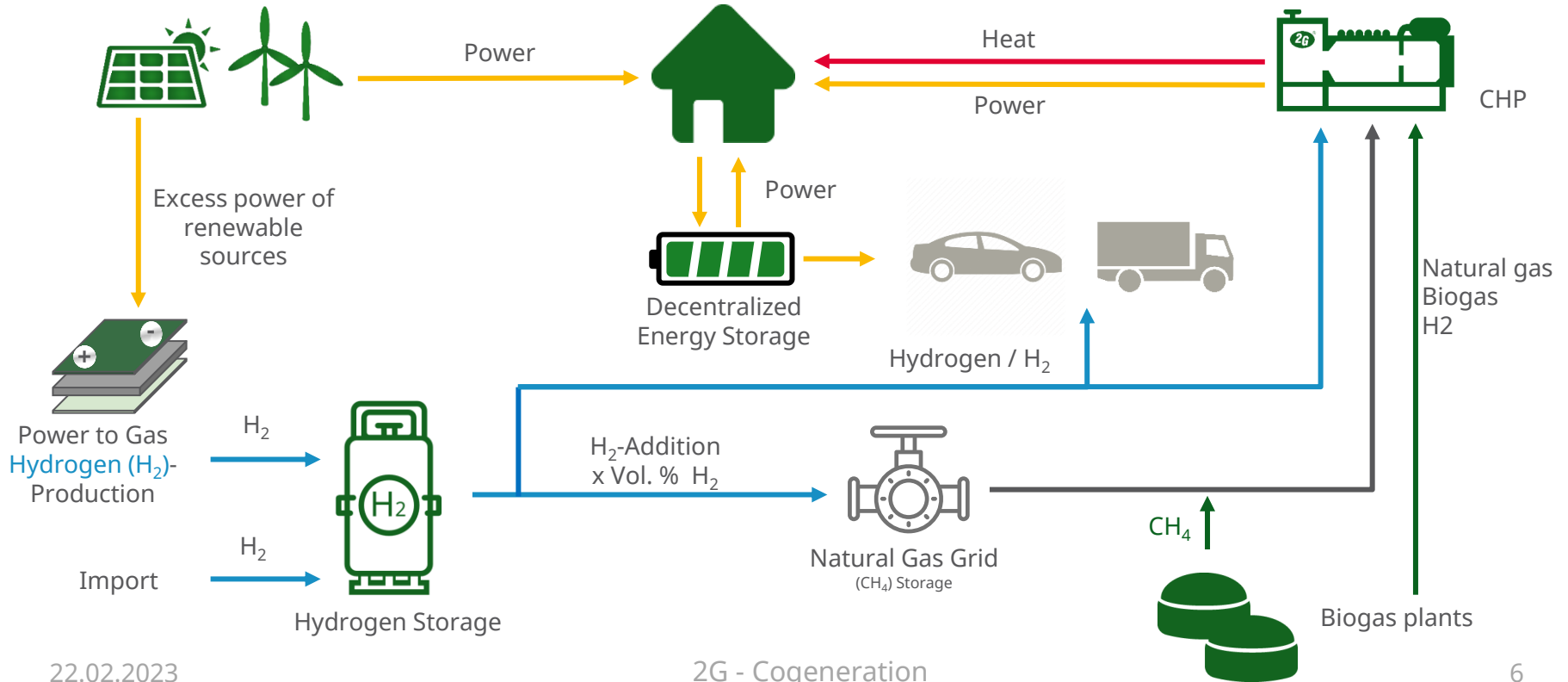


# CHP - the backbone of the energy transition

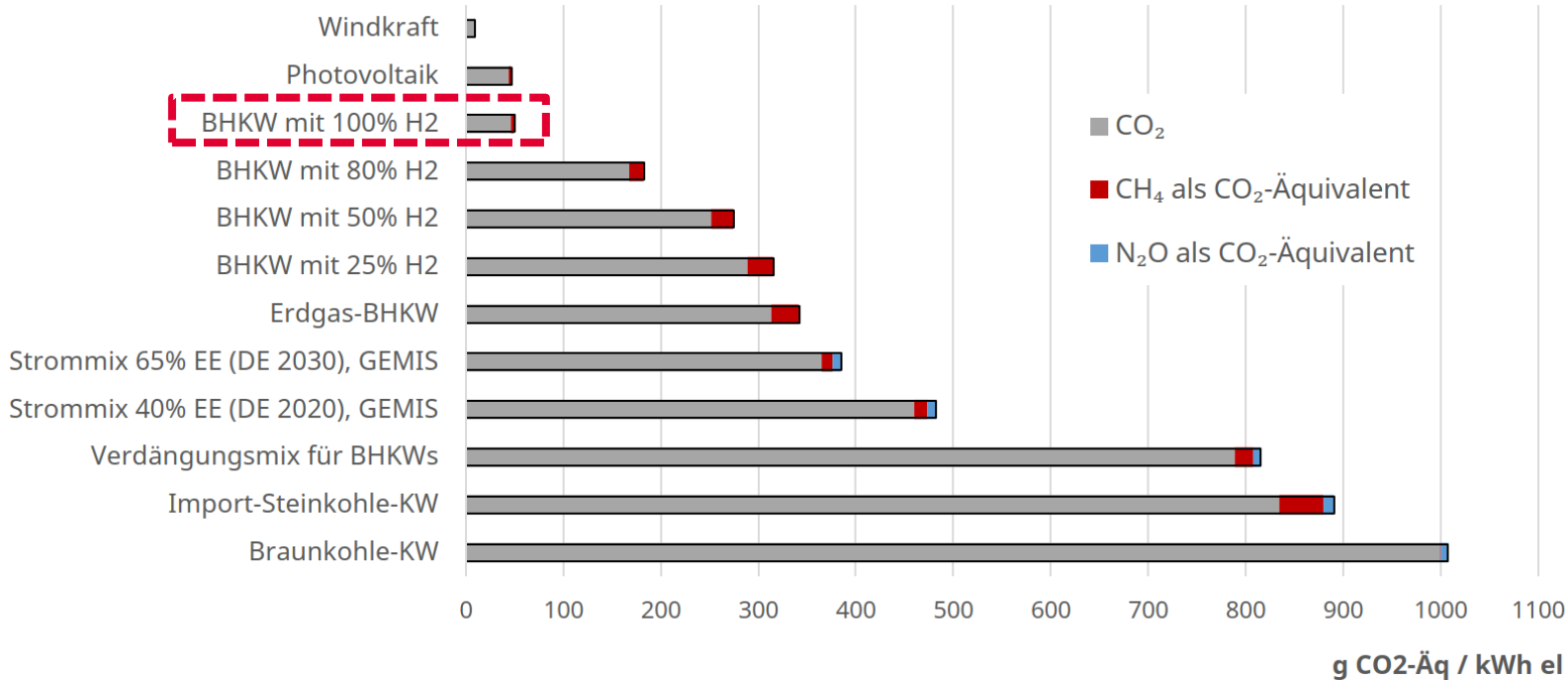




# Sectoral Coupling



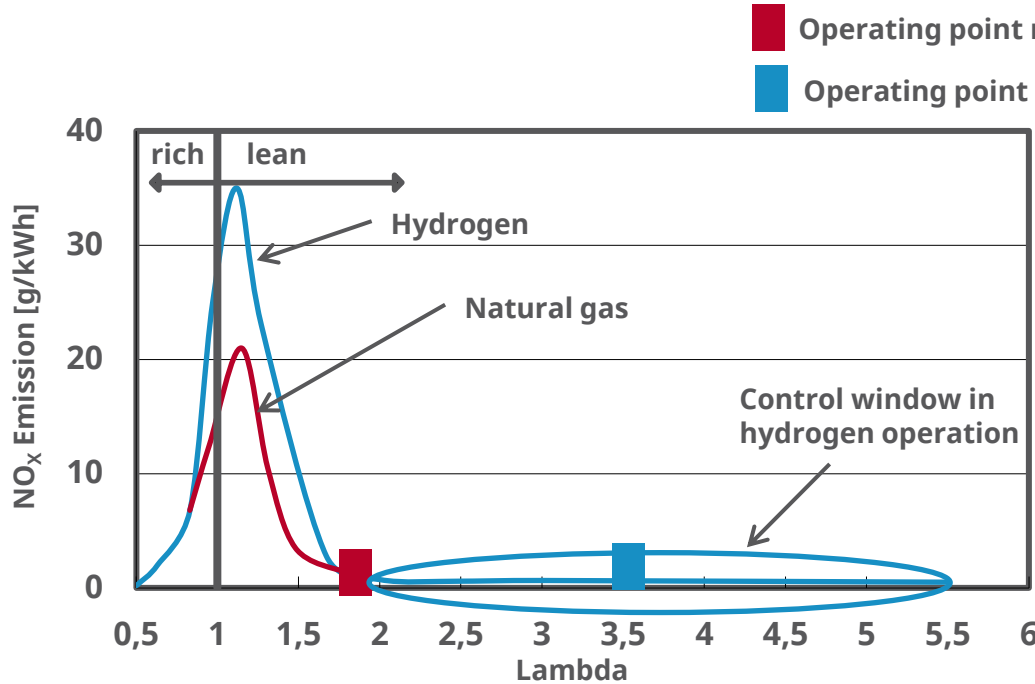
# Fuel-switch und content-switch



Quellen: GEMIS, 2017 und eigene Berechnungen



# Control windows and emissions w/H2 operation

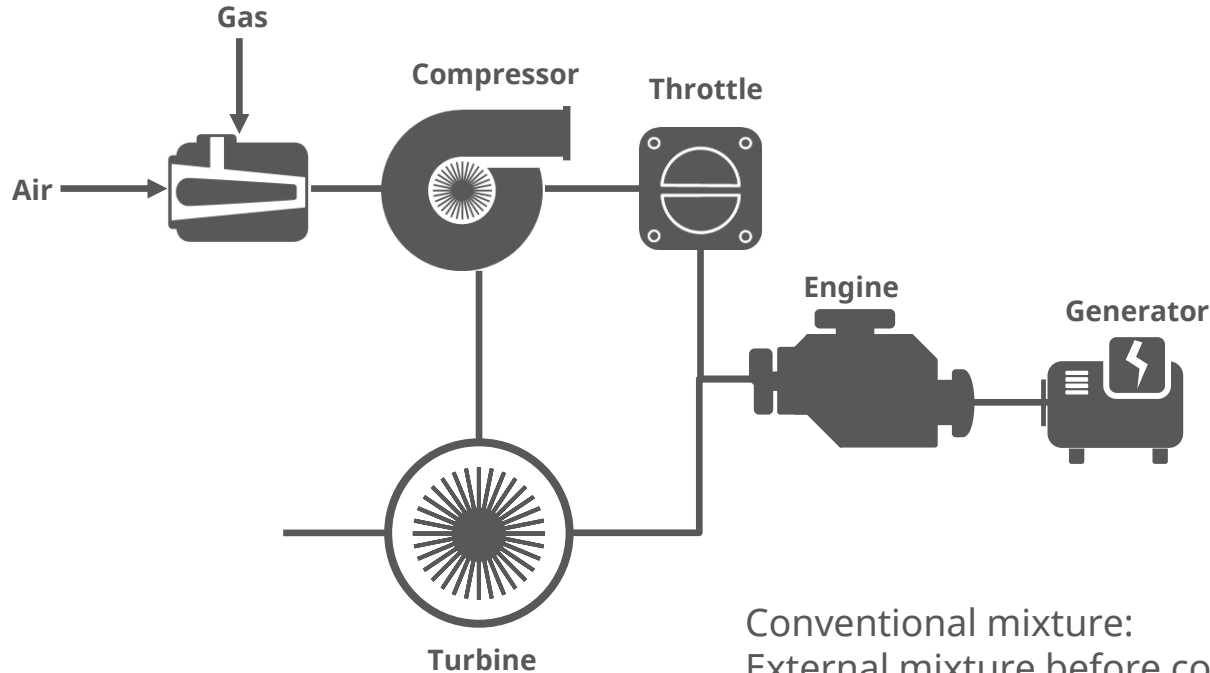


**Below 36 mg/Nm<sup>3</sup> @5% O<sub>2</sub>**

**In addition, there are no CO<sub>2</sub> emissions = carbon neutrality!**



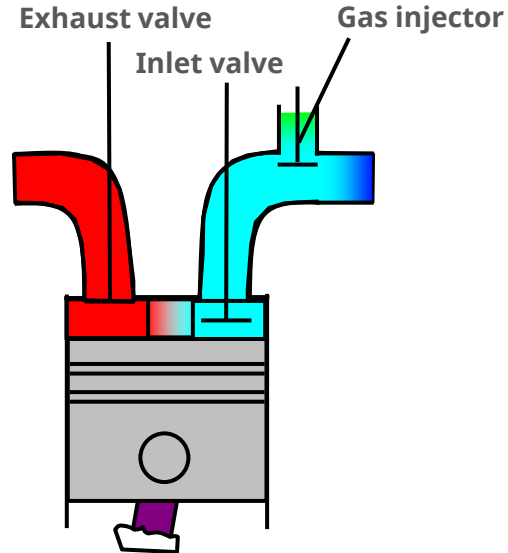
# Comparison of mixture formation - Conventional



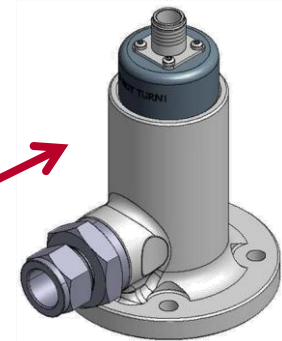
Gas mixer:  
Flowmix 65

Conventional mixture:  
External mixture before compression in the turbocharger  
by means of a controllable Venturi gas mixer

# Mixture formation - Hydrogen



**Port Injection:**  
External mixture formation just before  
the combustion chamber



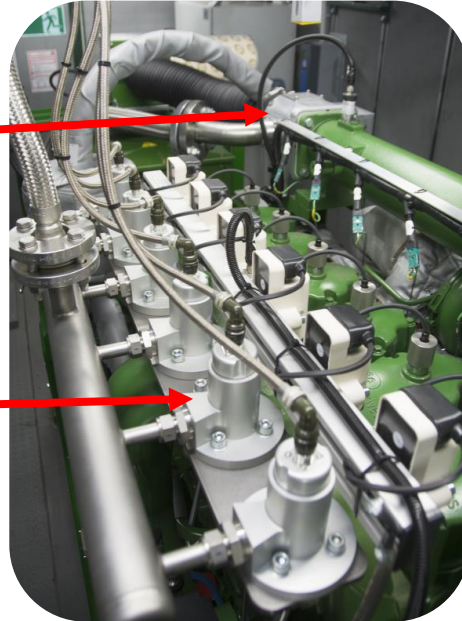
Gas injector



## 2G Hydrogen Engines

Conventional  
gas mixer

Gas injector  
for hydrogen  
operation



Existing units running on natural gas, biogas or LPG could be **retrofitted on site for H<sub>2</sub> operation**

Can be operated with **100% hydrogen as well as mixed** with other fuels.



## Product portfolio for hydrogen usage

Module – 50Hz	agenitor 404c hydrogen	agenitor 406 hydrogen	agenitor 408 hydrogen	agenitor 412 Hydrogen	avus 1000plus H2
Electrical Output	115 kW	170 kW	240 kW	360 kW	750 kW
Electrical Efficiency	37.8 %	39.1 %	40.2 %	40.4 %	41.2 %
Thermal Output	128 kW	182 kW	250 kW	372 kW	747 kW
Thermal Efficiency	42.1 %	42.0 %	41.9 %	41.7 %	41.0 %



Same service interval, minor and major overhaul as natural gas units.



## H<sub>2</sub> references

**TOTAL hydrogen service station at BER airport**  
agenitor 306 SG with 2G hydrogen technology (110 kWel)

**Haßfurt municipal works**  
agenitor 406 SG with 2G hydrogen technology (140 kWel)

**Siemens project in Dubai**  
agenitor 412 SG with 2G hydrogen technology (360 kWel)

**APEX in Rostock**  
agenitor 404c with 2G hydrogen technology (115 kWel)

**Green hydrogen Esslingen GmbH**  
agenitor 406 with hydrogen technology (170 kWel)

**Kirkwall Airport in Orkney**  
agenitor 404c with hydrogen technology (115 kWel)

**Erex, Japan**  
Agenitor 412 with hydrogen technology (360 kW)

**Toyota, Japan**  
Agenitor 412 with hydrogen technology (360 kW)

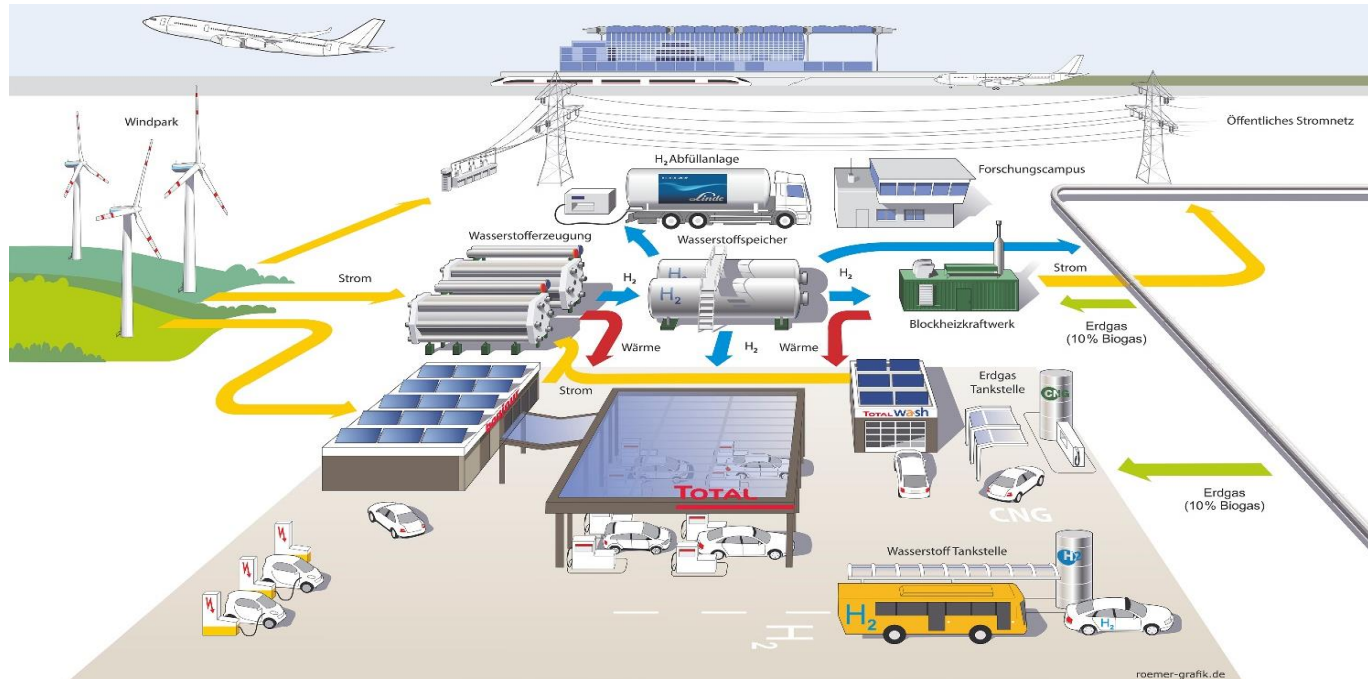


22.02.2023



2G - Cogeneration

# Berlin airport



# Utility Haßfurt

A stylized illustration of a landscape featuring a row of wind turbines on a horizon under a blue sky with white clouds. In the foreground, there are green fields and a dirt road on the right side.

**AUS WIND WIRD WASSERSTOFF!**  
pro Windgas, unser Speicher  
für erneuerbare Energie

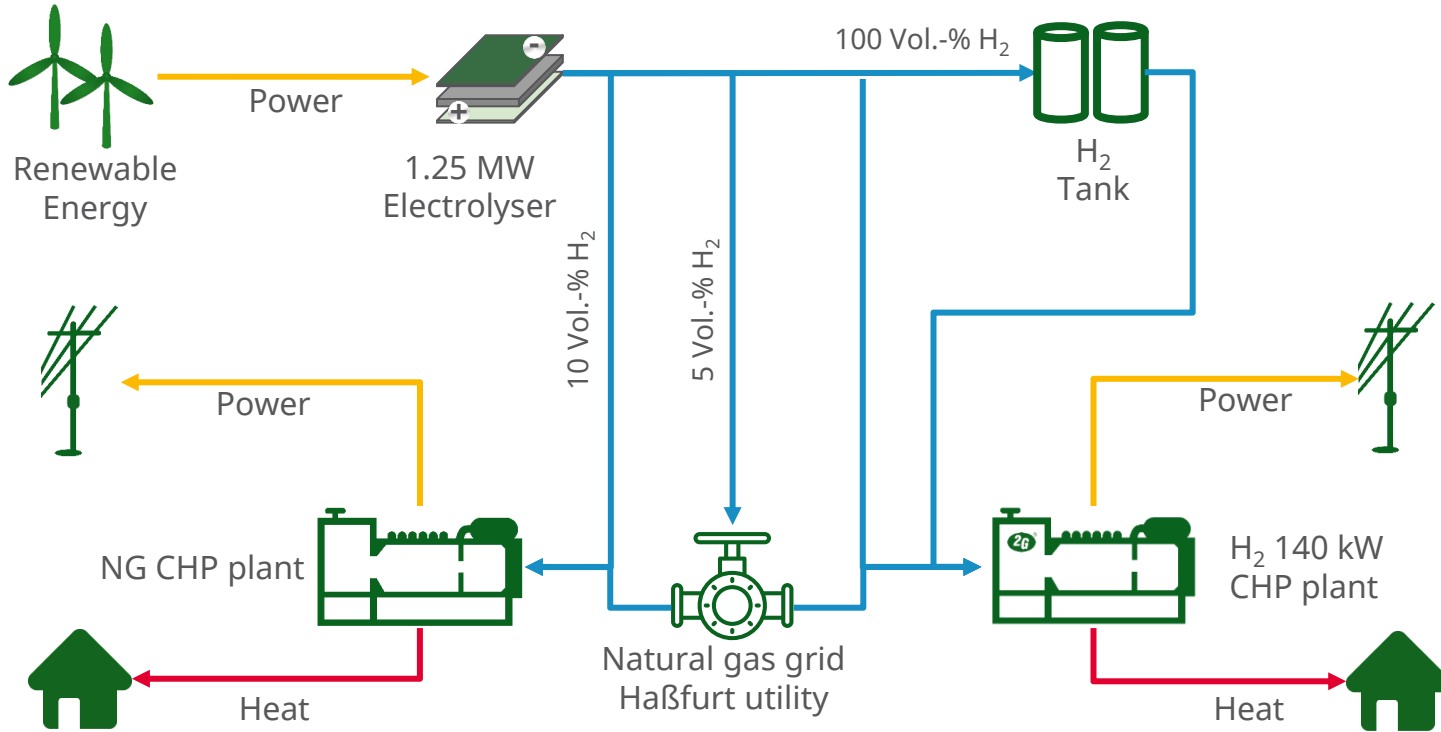
A circular icon with a dark red background, containing a white silhouette of a wind turbine.

**städtischebetriebe**  
haßfurt

**windgas**  
haßfurt

The Greenpeace Energy logo, featuring the word 'GREENPEACE' in a smaller font above the word 'ENERGY' in a larger, bold font, both enclosed in a white rectangular border.

# Utility Haßfurt

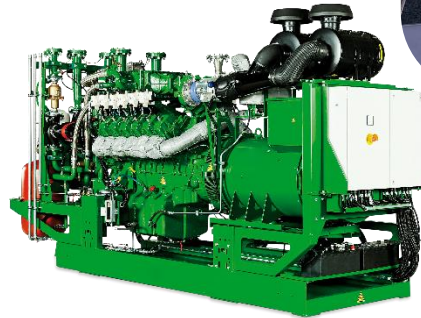




## Hydrogen project in Dubai

Worlds largest solar park (1,000 MW in 2020 / 5,000 MW in 2030) - Mohammed bin Rashid Al Maktoum (MBR) in Dubai.

Siemens and the DEWA are building up the hydrogen economy in 2020 and beyond.



## APEX - Rostock

APEX's own hydrogen power plant.  
Grid-connected hydrogen plant in North Germany (Rostock).

- Electrolysis: 2 MW + Hydrogen storage
- CHP: 2G agenitor 404c 115 kWe
- Fuel cell: 100 kW
- Electricity storage: 1 MW battery
- Public filling station: up to 40 buses and 200 cars



# Green hydrogen Esslingen



agentor 406 H2 in a container



Project: Green Hydrogen Esslingen

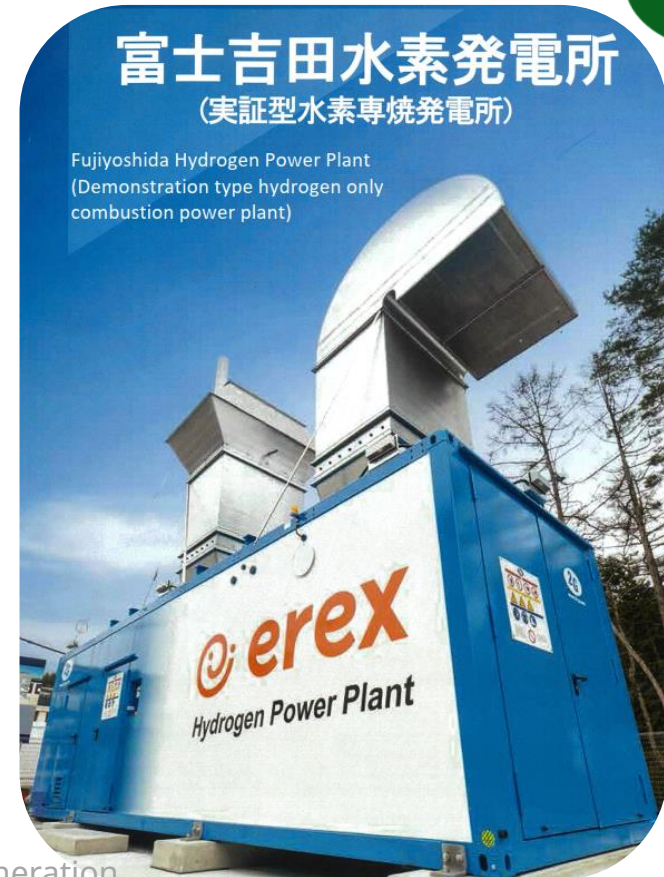
## Kirkwall airport

- agenitor 404c hydrogen technology (115 kWel)
- In cooperation with Doosan
- Delivered 2021
- Hydrogen supplied by European Marine Energy Centre (EMEC)



## Fujiyoshida H<sub>2</sub> Power Plant

- agenitor 412 hydrogen technology (360 kWel)
- Construction March 2022.
- Hydrogen supplied produced by Hydrogen Technology Co. Ltd.
  - Catalyst process
- H<sub>2</sub> storage 1,410 m<sup>3</sup>





## Conclusions

- 2G hydrogen engines **do not need pure hydrogen**, they can operate successfully with impurities in the gas flow.
- **Blended gas** operation **is possible** (e.g. natural gas / biogas / landfill gas)
- **Requirements** for ensuring **network stability are met** – decentralized approach!!!
- **Partial load** capability from **50 – 100 %** nominal load
- **Island operation** with large load increases **is possible**
- **Retrofit** of existing natural gas engines **to hydrogen is possible**

**2G Power Plants are part of the energy transition for a carbon-neutral future!**



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