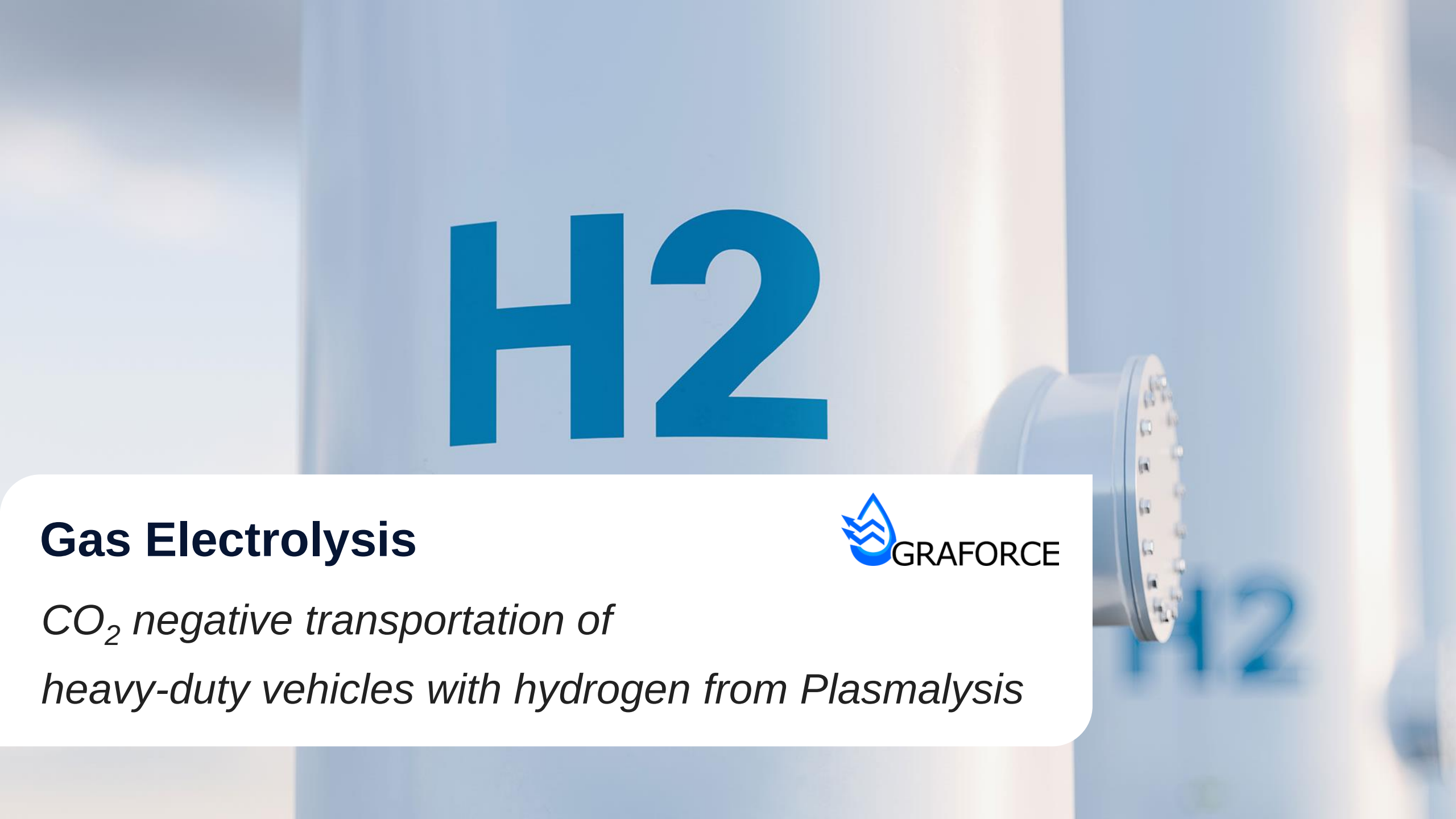


Gas Electrolysis

GRAFORCE

CO_2 negative transportation of

heavy-duty vehicles with hydrogen from Plasmalysis

GRAFORCE

Headquarters and production facilities

Berlin Adlershof (HQ)

Headquarters and R&D

Founded in	2012
Total site size	c. 440 m²
Functionality	Office & laboratory
Headcount (2022)	> 20 FTE

Waltersdorf

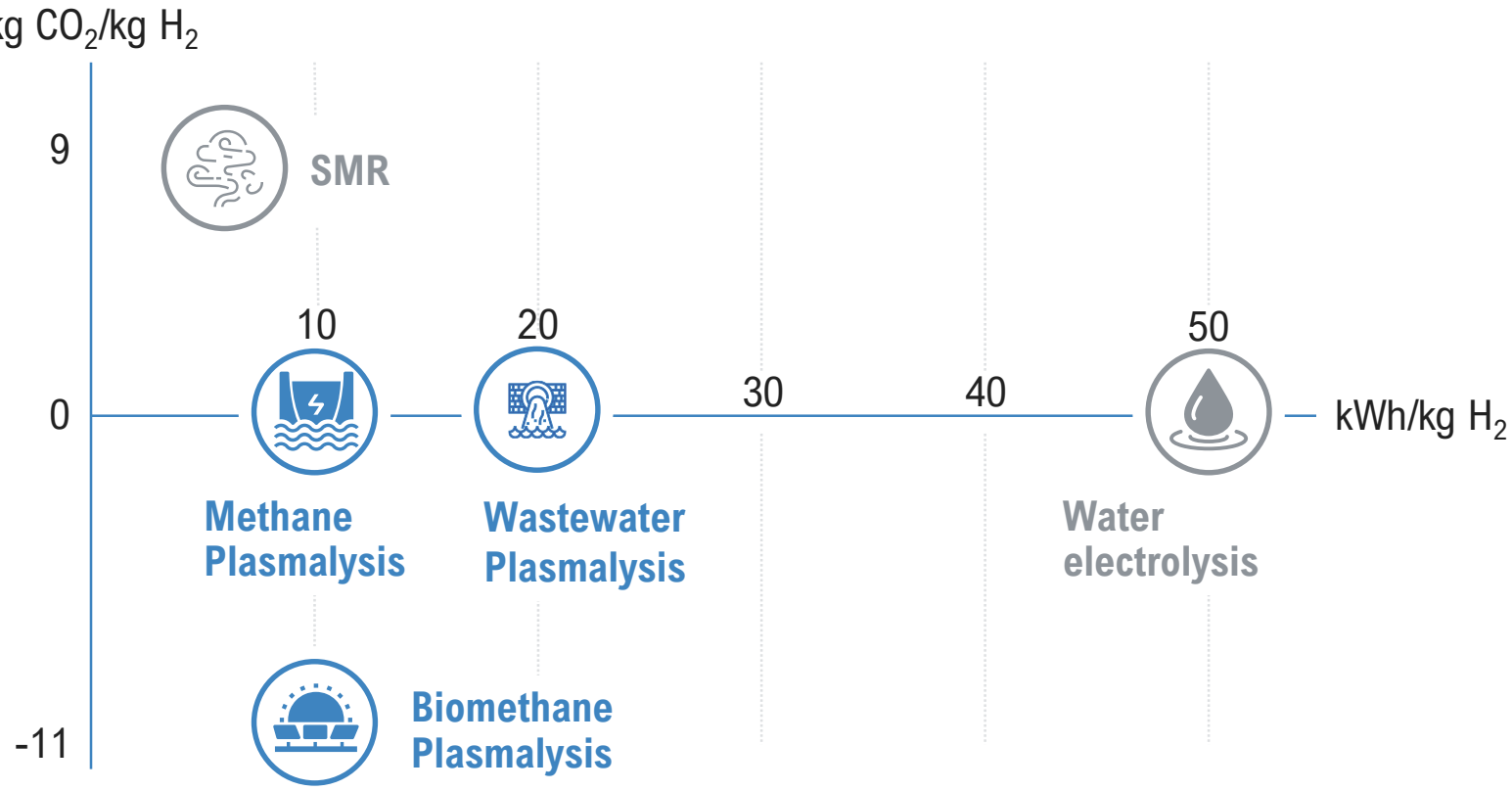
Production plants

Total site size	c. 2,100 m²
Functionality	Production
Headcount (2022)	> 20 FTE

HYDROGEN PRODUCTION TECHNOLOGIES

Energy demand and carbon footprint of hydrogen production technologies

Hydrogen technologies key parameters

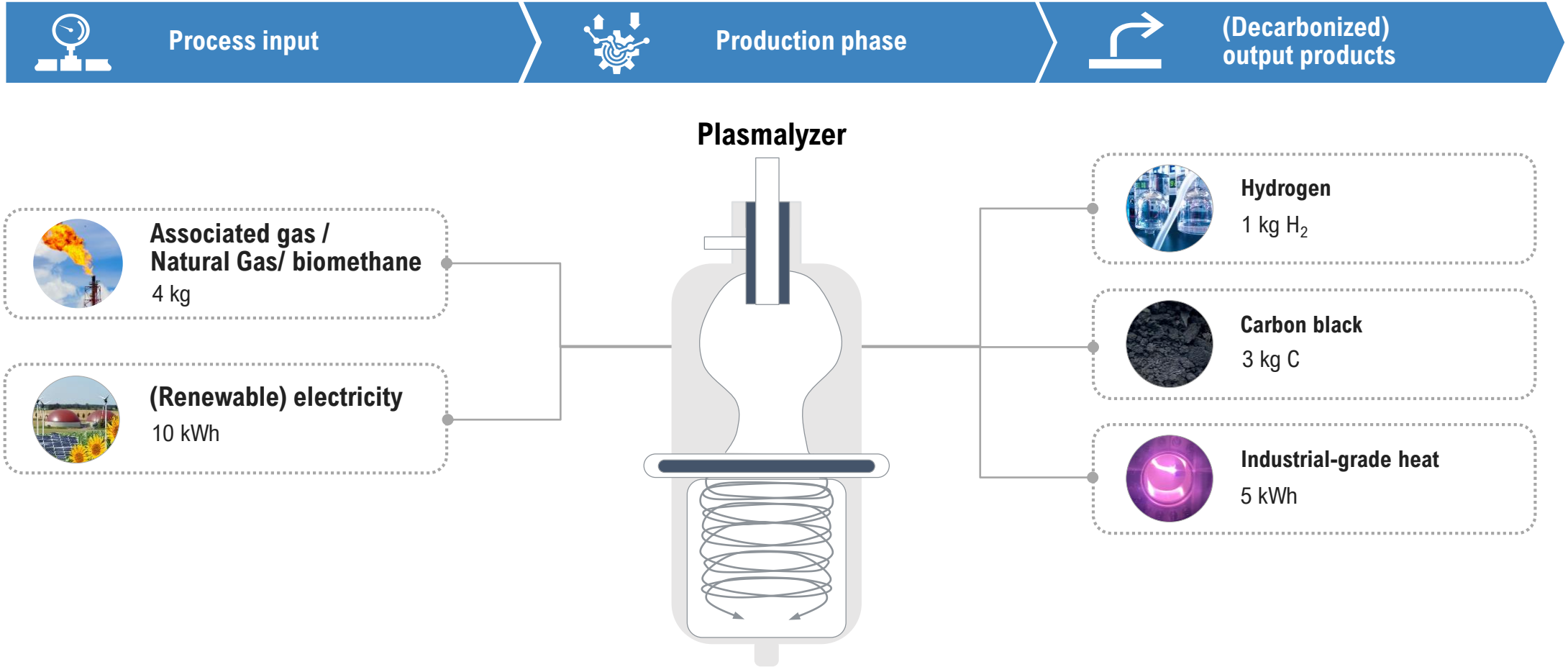


Methane Electrolysis

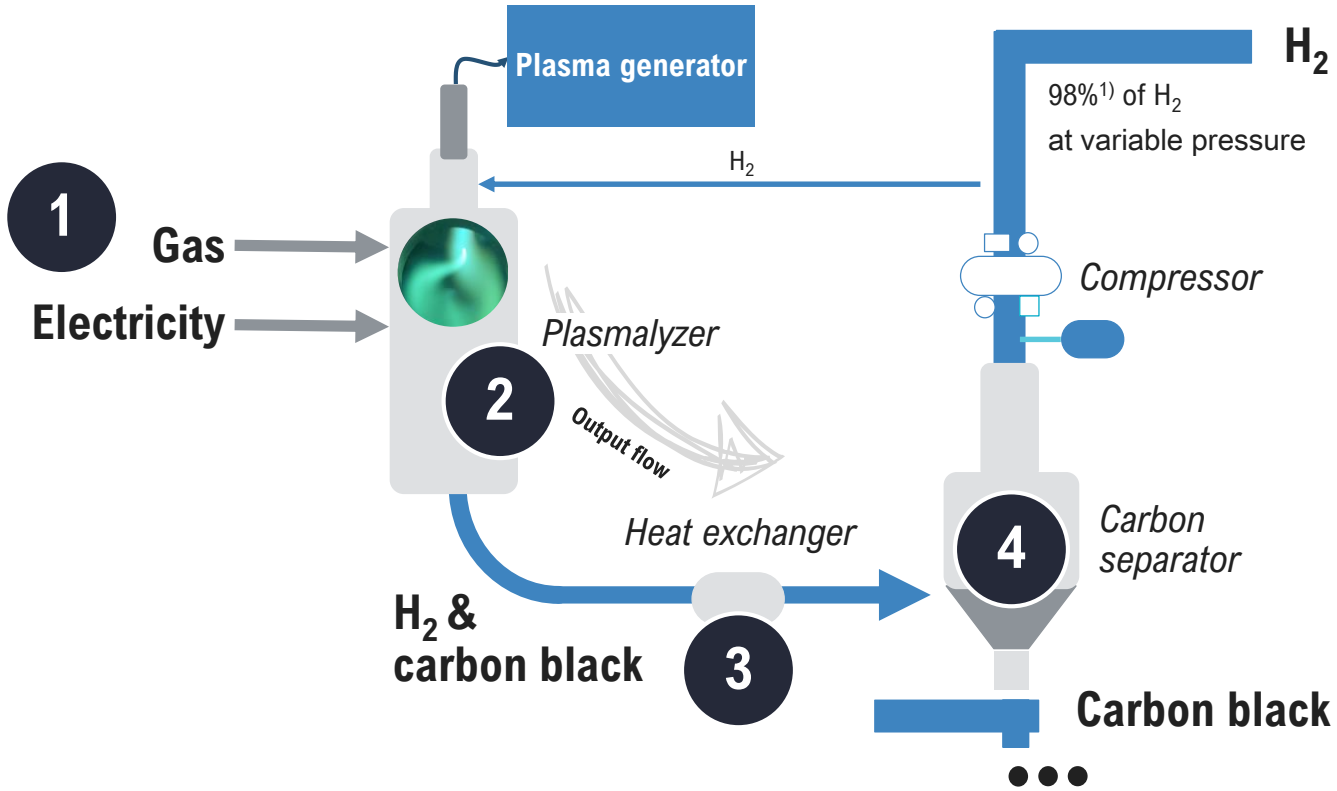
1. Only **20 % of electric energy** consumption compared to water electrolysis
2. **No CO_2 emissions** from the process with natural gas feedstock
3. **Carbon removal** / negative CO2 emissions with biomethane feedstock

METHANE PLASMALYSIS TECHNOLOGY

Gas Electrolysis decarbonizes methane to produce hydrogen (H_2) and solid carbon (C) and industrial grade heat

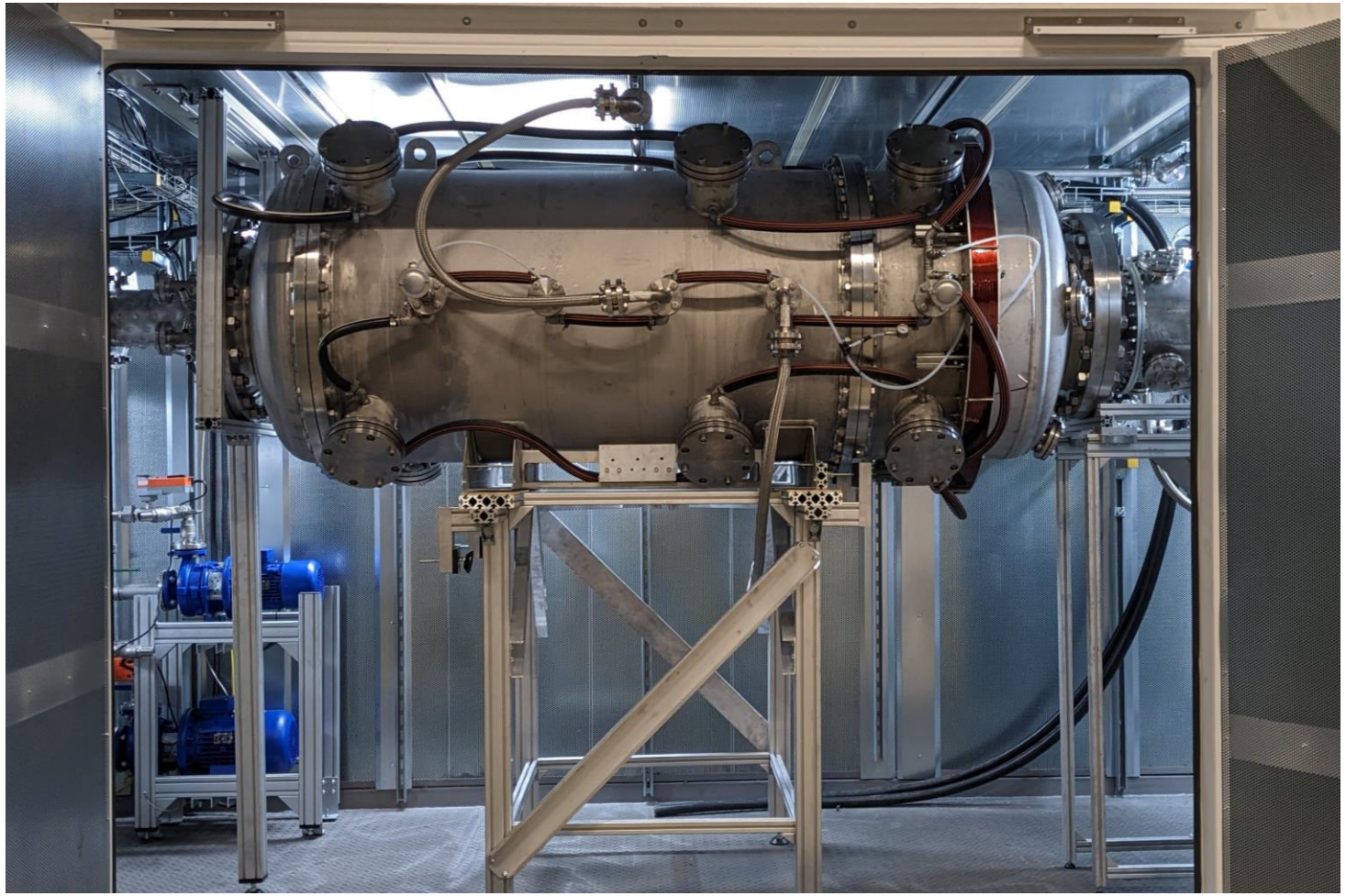


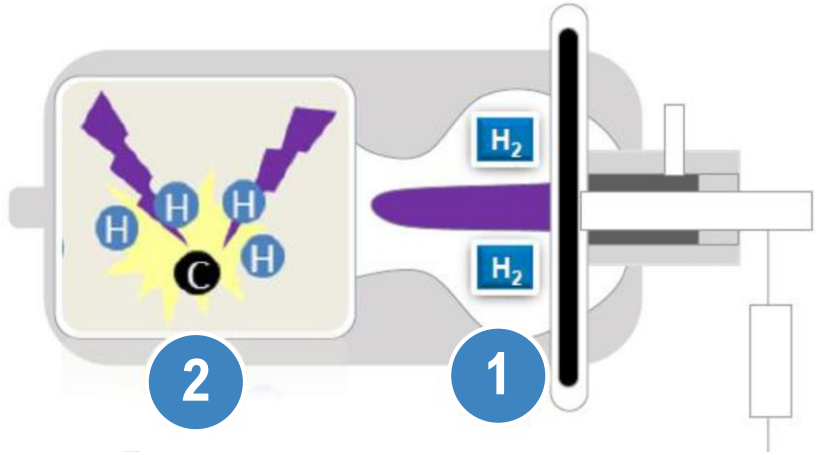
METHANE PLASMALYSIS TECHNOLOGY



1. Natural gas or biogas and electricity as **feedstock**
2. **Dissociation** into hydrogen and carbon black
3. Excess **Heat of up to 300°C**
4. High-purity **hydrogen (up to 98%[1])**, condensed **carbon black**

METHANE PLASMALYSIS 0.5 MW MODULE





1. Plasma is created using two graphite elements. Feedstock used for plasma is either H2, N2 or a mixture of both

2. Hydrocarbons are dissociated into hydrogen and solid carbon through heat and plasma electrochemical processes in a separate chamber

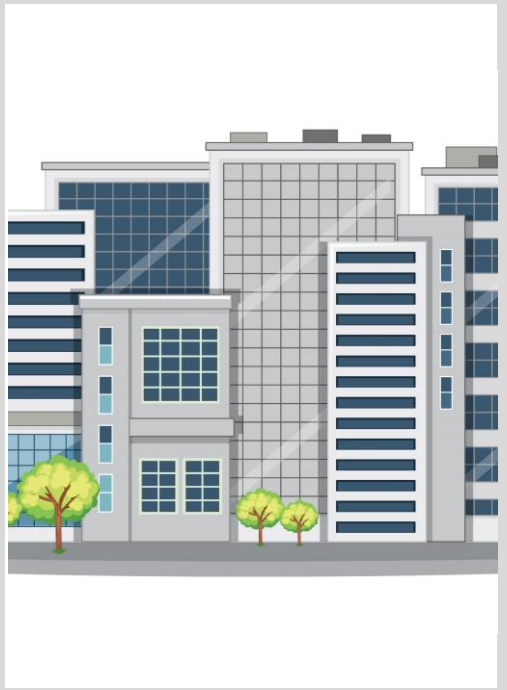
PROJECTS COMMISSIOINGS IN 2023

Customer: Gas company (Austria)

Methane Electrolyzer

- **Decarbonizing natural gas/flare gas** for utilization into **existing pipeline grid** infrastructure
- **H_2 CHP** integrated to produce **CO_2-free electricity**
- **0.5 MW** with **potential to scale** to **> 50 MW**

Customer: Real estate developer (Germany)

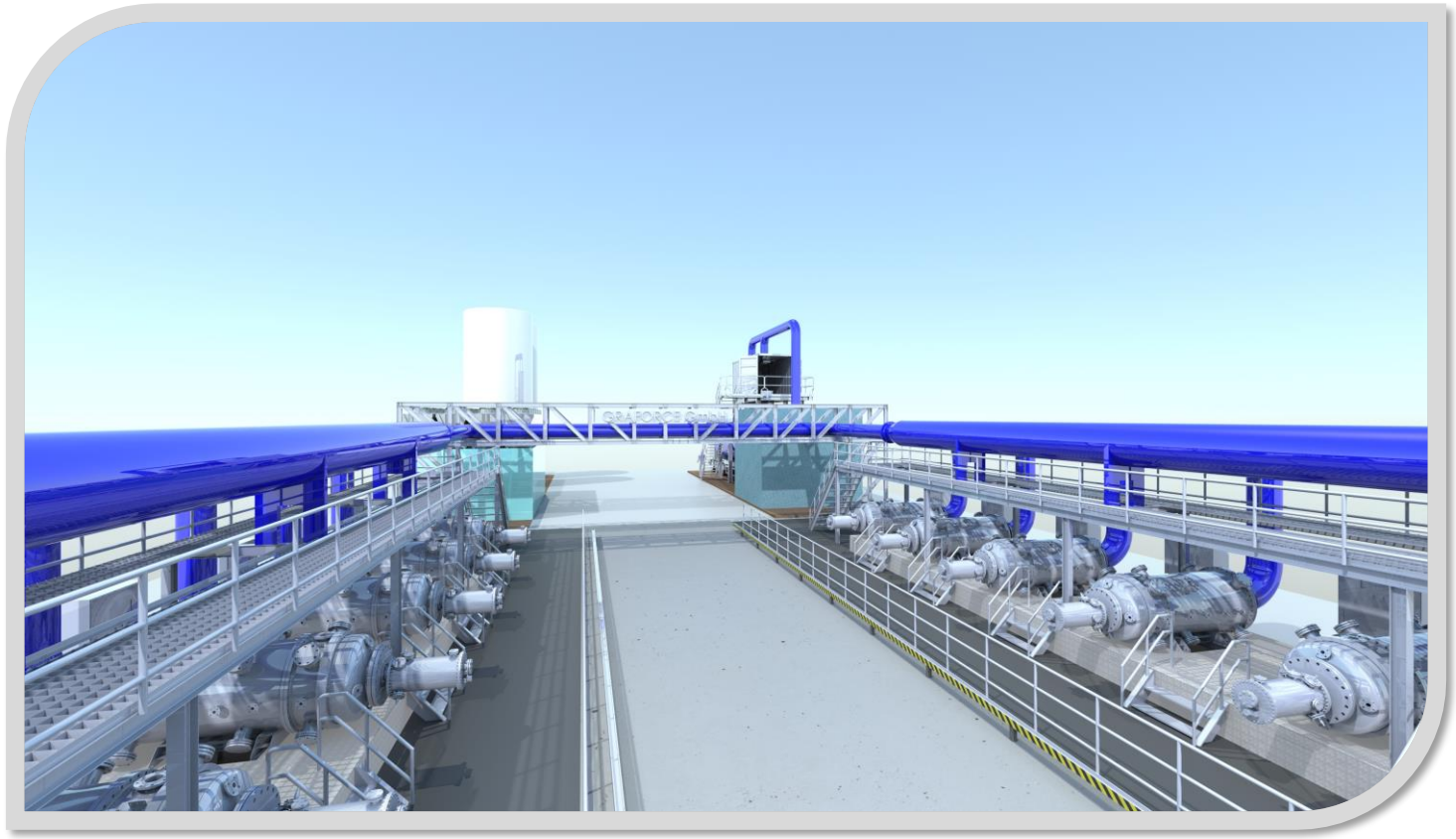


Methane Electrolyzer

- **Decentralized hydrogen production** for a real estate development in Germany
- **H_2 CHP** integrated for **CO_2-free heat and electricity generation**
- 0.25 MW (expansion to **0.5 MW** in 2024)

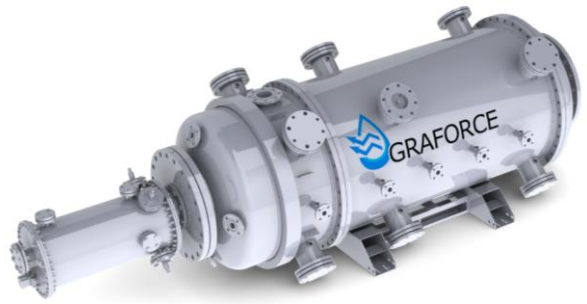
10 MW SYSTEM WITH MODULAR APPROACH

Example layout of a 10MW hydrogen production plant



Methane Electrolysis

Module



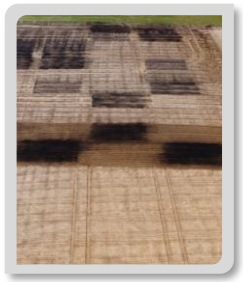
Technical specifications

Feedgas	Natural gas, associated gas, biogas
Feedgas pressure	1.3 – 1.6 bar
Hydrogen production	up to 550 Sm^3/h
Hydrogen purity	approx. 98 %
Carbon production	up to 150 kg/h
Thermal energy	approx. 250 kW (up to 300 °C)

CARBON BLACK APPLICATIONS

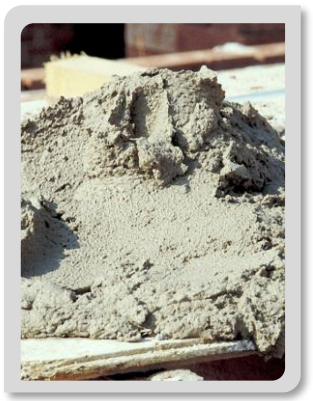
Application in soil and building materials (long-term storage of carbon)

Agricultural applications



- Increased water storage capacity
- Increased fertility
- New sales potential

Concrete



Up to **20% of the concrete can be substituted** with CO_2 neutral carbon black

Steel

Potential to **add up to 15 kg of carbon black** per ton of steel and replace coke

WASTEWATER PLASMALYSIS

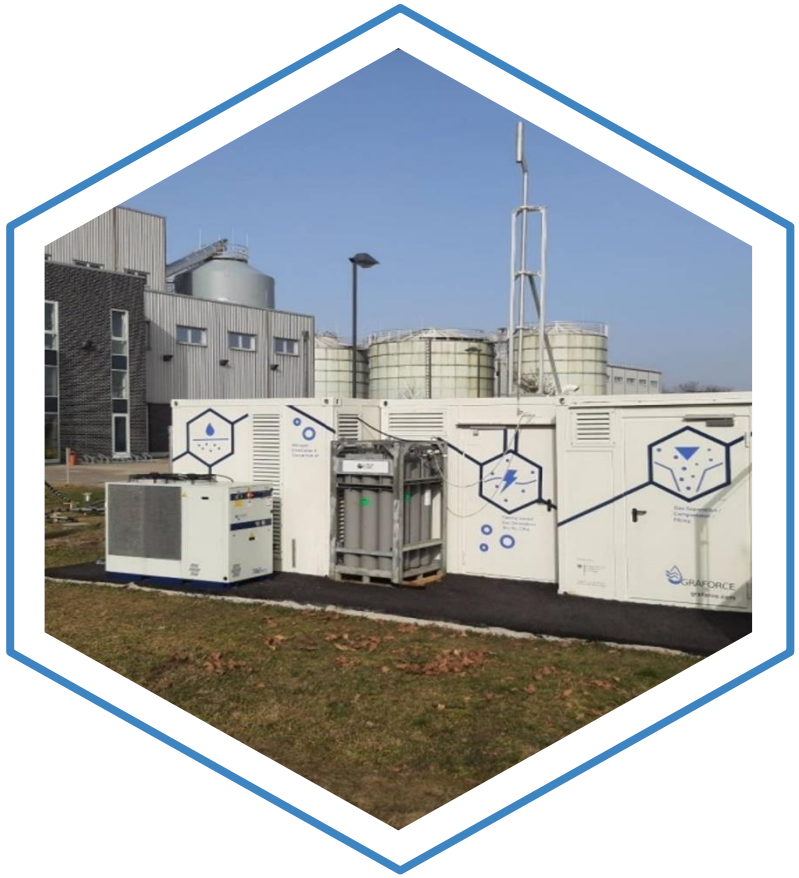
Pilot plant at the WWTP near Berlin, in operation since 2021

BERLIN WASSMANNSDORF PLANT (WWTP)

Gefördert durch:

Bundesministerium für Wirtschaft und Energie

Berliner Wasserbetriebe



Waste water throughput *3,000 l/h*

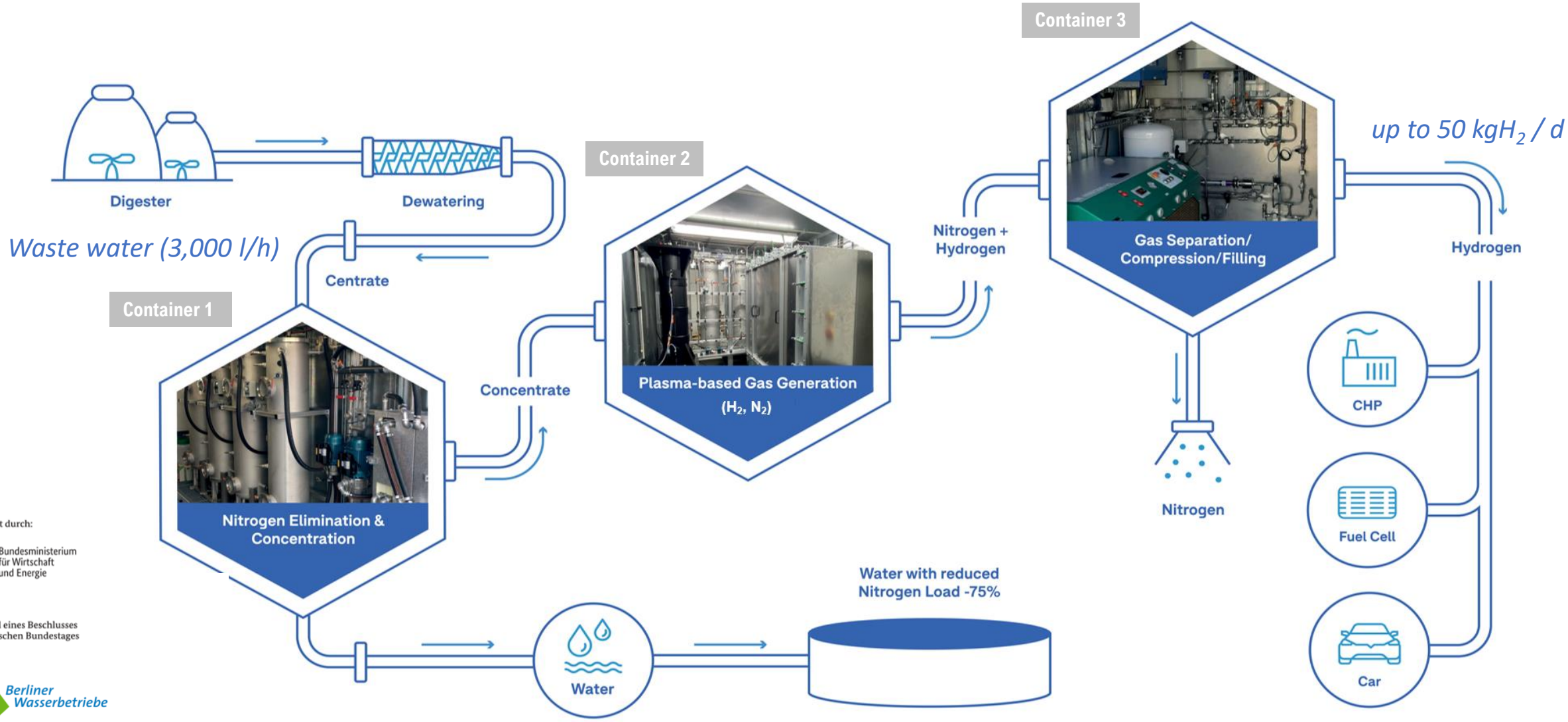
Powered by *renewable electricity*

Production of up to *50 kg hydrogen/day* from NH_4-rich waste water

Industrial reactor concept for *quick upscaling*

Reduction of *nitrogen* load in waste water by 75 %

HYDROGEN AND NITROGEN FROM WASTEWATER (AMMONIA)



Gefördert durch:

Bundesministerium für Wirtschaft und Energie

aufgrund eines Beschlusses des Deutschen Bundestages

Berliner Wasserbetriebe

REFERENCE PLANTS

Market-ready products

Hydrogen fuel plant from natural gas feedstock

Hotel MOA H_2-blending heating boilers for CO_2 reduction

Graforce hydrogen plant from ammonia feedstock

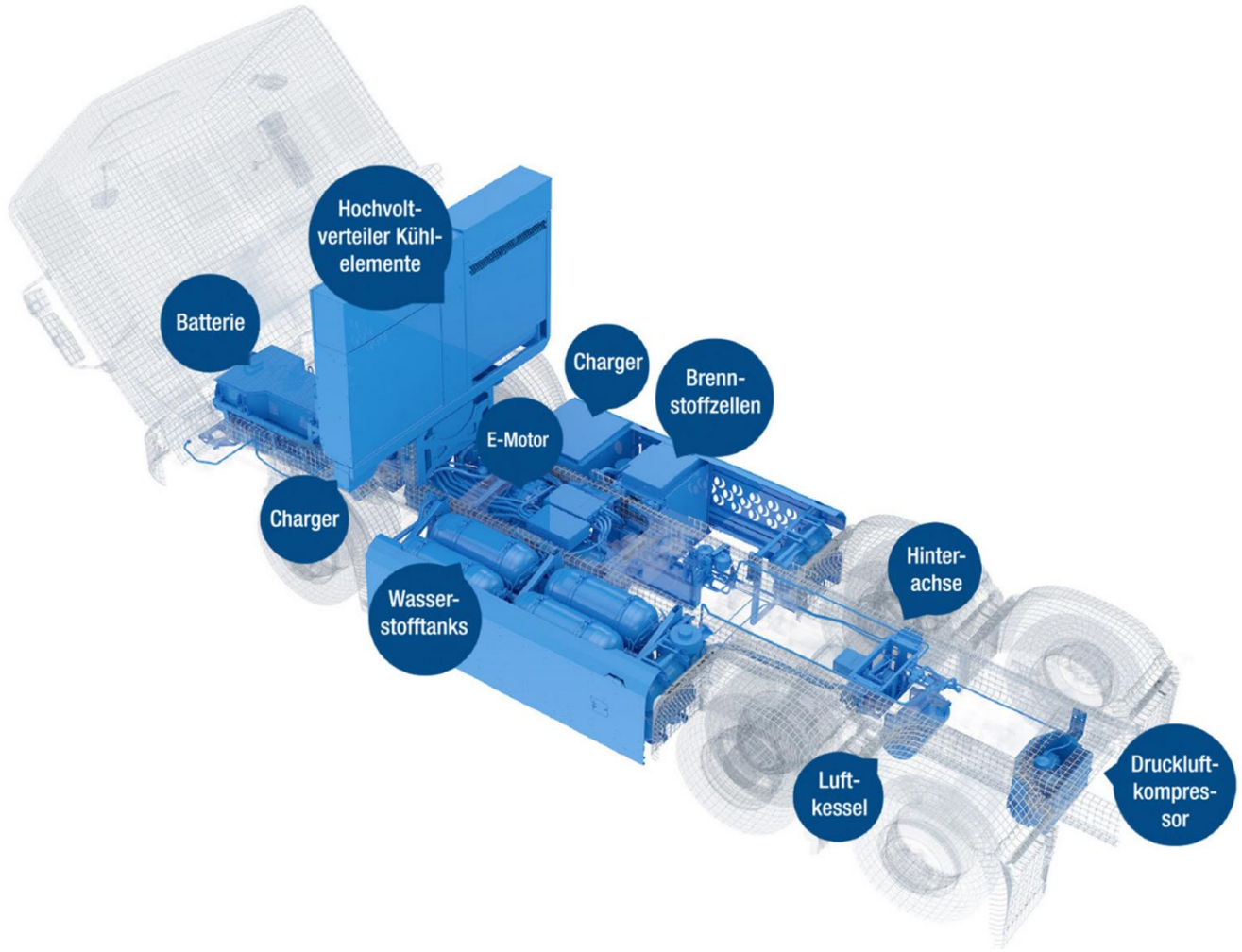
HCNG FILLING STATION AND WASTEWATER PLASMALYSIS BY GRAFORCE

Impressions

HYDROGEN FUELED HEAVY-DUTY VEHICLES

Advantages of hydrogen-powered semi-trucks:

1. **Zero** emissions
2. **high energy density** of hydrogen allows for **fewer batteries** on a truck compared to EV
3. **longer range** and **heavier payloads** than EV
4. **rapid refueling** in minutes



CO2-NEGATIVE FUEL FOR HEAVY-DUTY TRANSPORTATION

GRAFORCE

Every kilogram of Hydrogen creates a **carbon sink** of:

-13 kg_{CO2} / kg_{H2}

Biogas plant

13 kg Biogas (60v% CH4)

Biogas treatment

4,7 kg BIO-CH4

Plasmalysis

1,2 kg H2

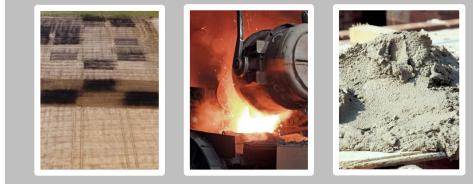
PSA, compressor

1 kg H2

8,6 kg CO2

3,5 kg C (=13 $kg_{CO2,eq}$)

Long-term storage of solid carbon



soil *steel* *concrete*

GRAFORCE'S TECHNOLOGY USP's

Carbon neutral process with flexible feedstocks	**Cost-efficient, CO_2-neutral production** of H_2 and CCUS carbon **from all hydrocarbons**
Modular in size and power	**Modular and easy-to-transport plants** (0.5 MW, 2 MW up to 100 MW)
Energy and resource efficient	**Five times higher H_2 yield** with **significantly lower CAPEX** compared to electrolysis
Market-ready product	**Market-ready product** with a capacity of 50 - 200 kg H_2/h
Strong R&D team	**Specialized, dedicated and long-standing development team** for all essential areas of product development

GRAFORCE

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