

# H<sub>2</sub>

## Plasmalysis

*Hydrogen and synthetic raw materials  
made of various feedstocks*

*Kai Dame*

*Marc Dünow*



# HEADQUARTERS AND PRODUCTION FACILITIES

The development and administrative activities take place at the headquarters in Adlershof near Berlin

## Berlin Adlershof (HQ)

Headquarters and R&D



<b>Founded in</b>	2012
<b>Total site size</b>	c. 440 m <sup>2</sup>
<b>Functionality</b>	Office & laboratory
<b>Headcount (2022)</b>	> 20 FTE



## Waltersdorf + Wassmansdorf

Production plants



<b>Total site size</b>	c. 2,100 m <sup>2</sup>
<b>Functionality</b>	Production
<b>Headcount (2022)</b>	> 20 FTE

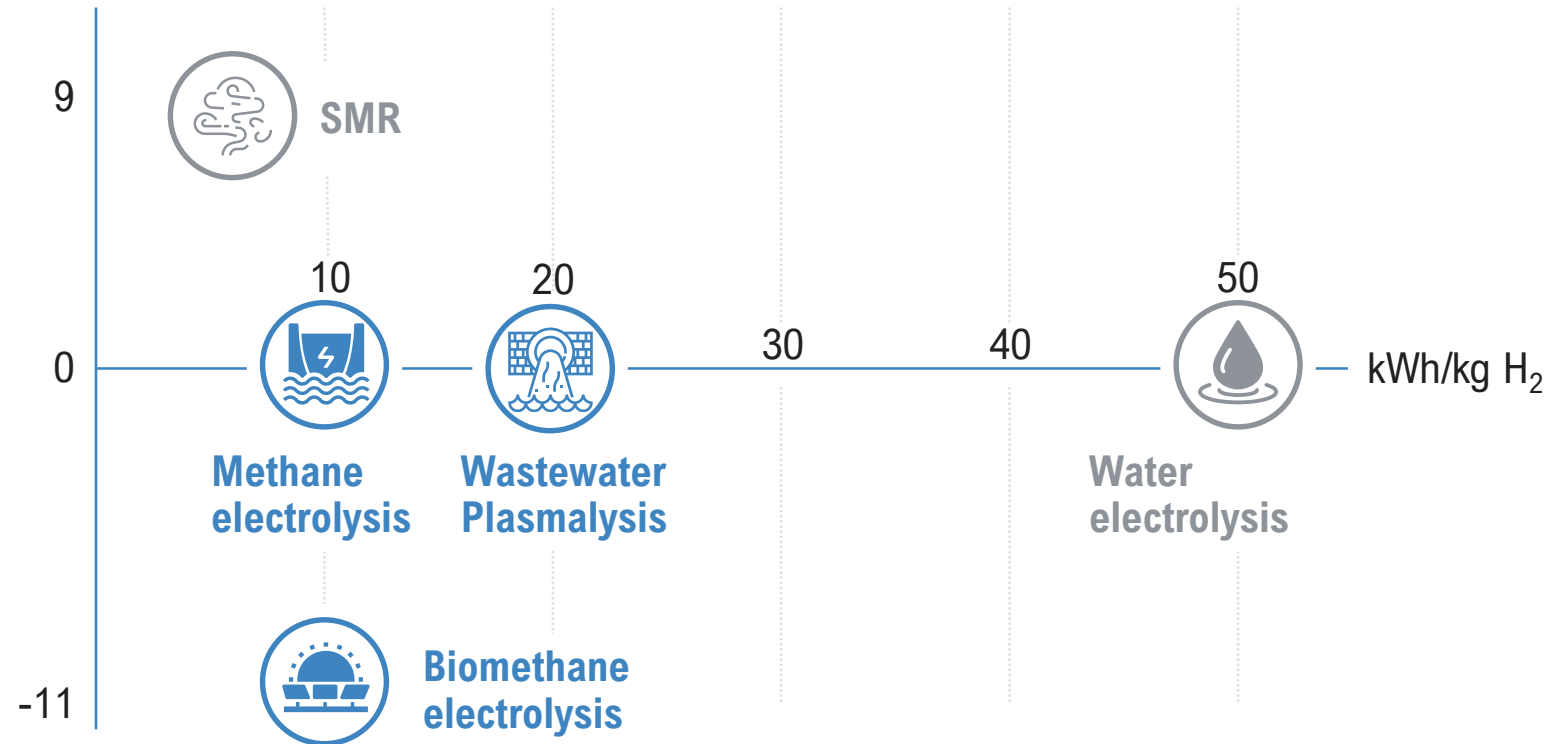


# HYDROGEN PRODUCTION TECHNOLOGIES

Key parameters

## Hydrogen technologies key parameters

kg CO<sub>2</sub>/kg H<sub>2</sub>



**Water electrolysis** needs 50 kWh power and 9 liters clean drinking water for 1 kg hydrogen  
**Zero CO<sub>2</sub> emissions**



**Steam reforming** requires 3 liters drinking water and <10 kWh for 7x more H<sub>2</sub>  
**9 kg CO<sub>2</sub> emissions**



**Methane electrolysis** requires no water and only 10 kWh but yields 5x more H<sub>2</sub> than water electrolysis  
**Zero/negative CO<sub>2</sub> emissions**



**Wastewater Plasmalysis** requires ammonia from wastewater and only 20 kWh but yields 2.5x more H<sub>2</sub> than water electrolysis  
**Zero CO<sub>2</sub> emissions**

# WASTEWATER PLASMALYSIS

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

## BERLIN WASSMANNSDORF PLANT (WWTP)

Gefördert durch:



Waste water throughput *3,000 l/h*

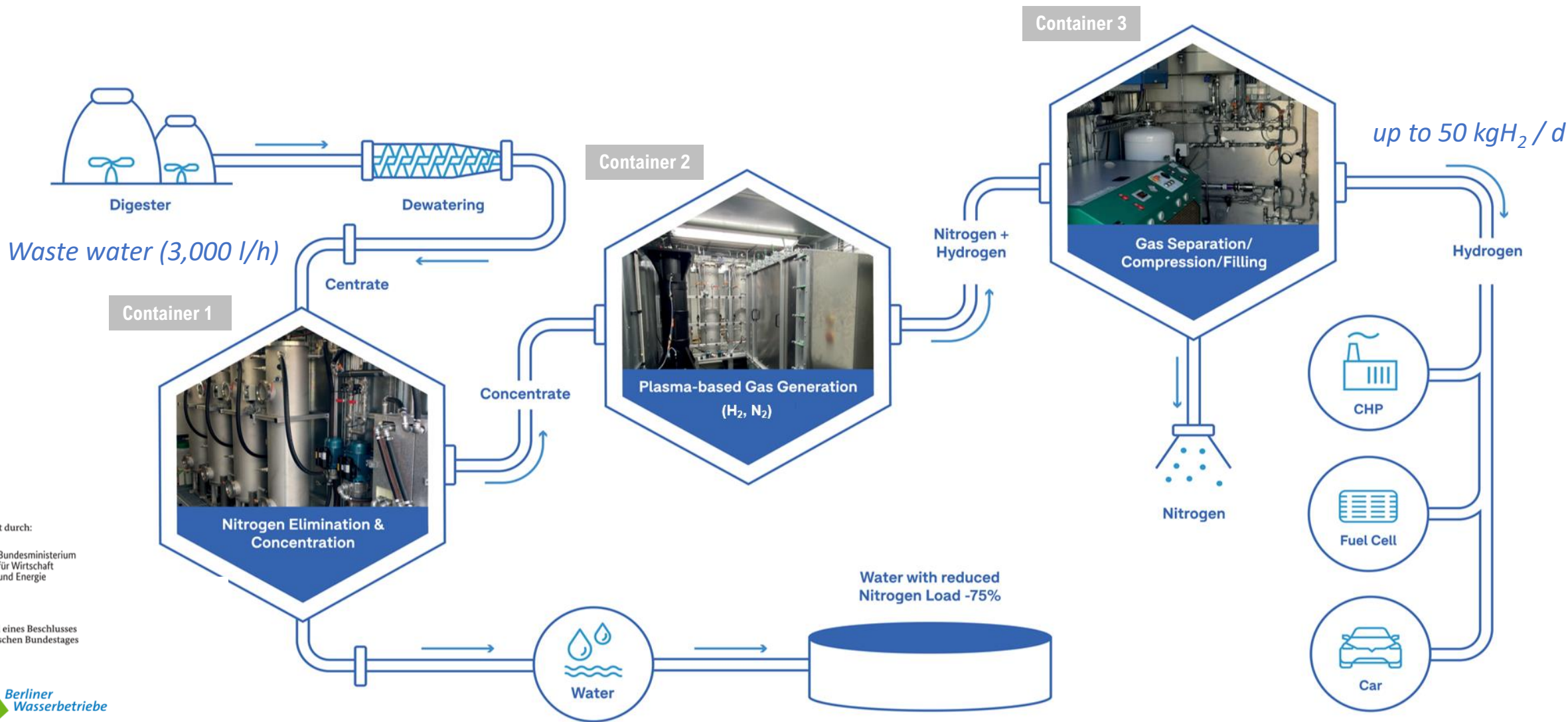
Powered by *renewable electricity*

Production of up to *50 kg hydrogen/day* from NH<sub>4</sub>-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



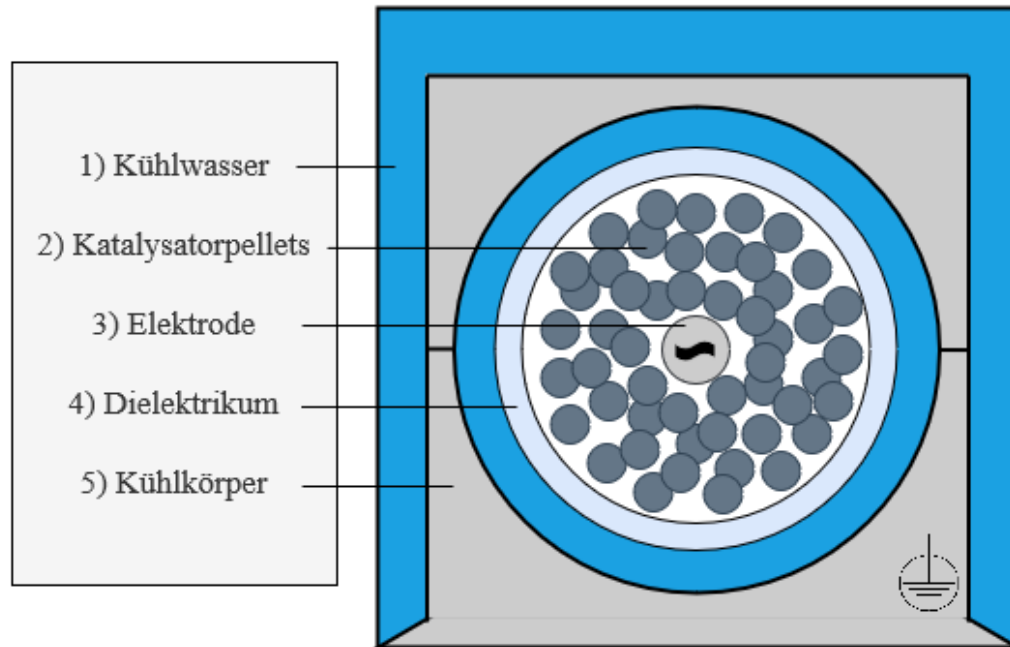


# HYDROGEN AND NITROGEN FROM WASTEWATER (AMMONIA)

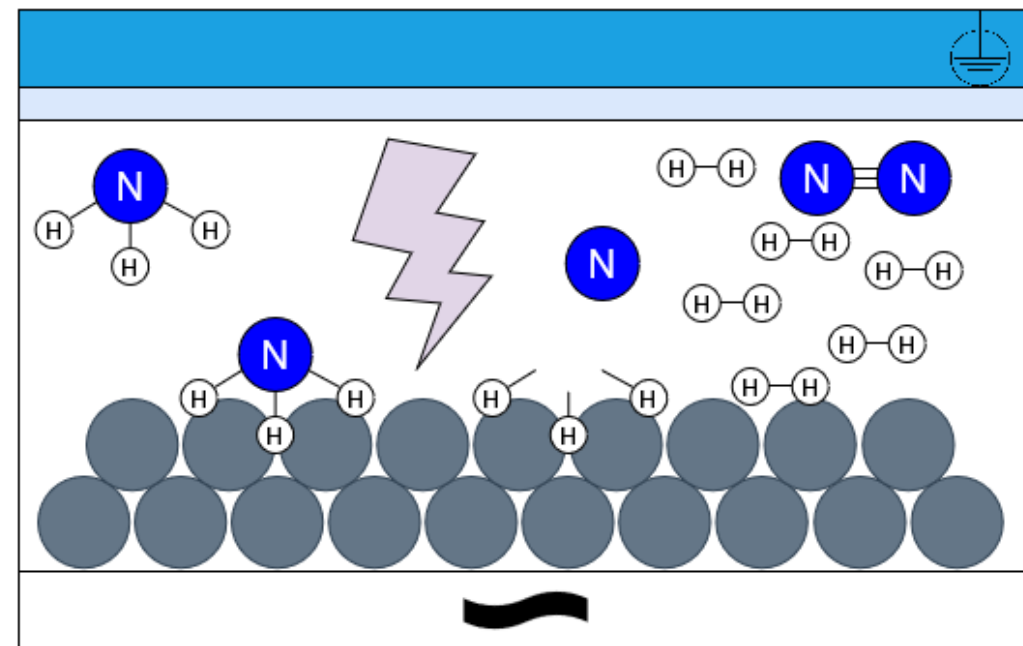


# HYDROGEN AND NITROGEN FROM WASTEWATER (AMMONIA)

Querschnitt der plasmachemokatalytischen Reaktoren

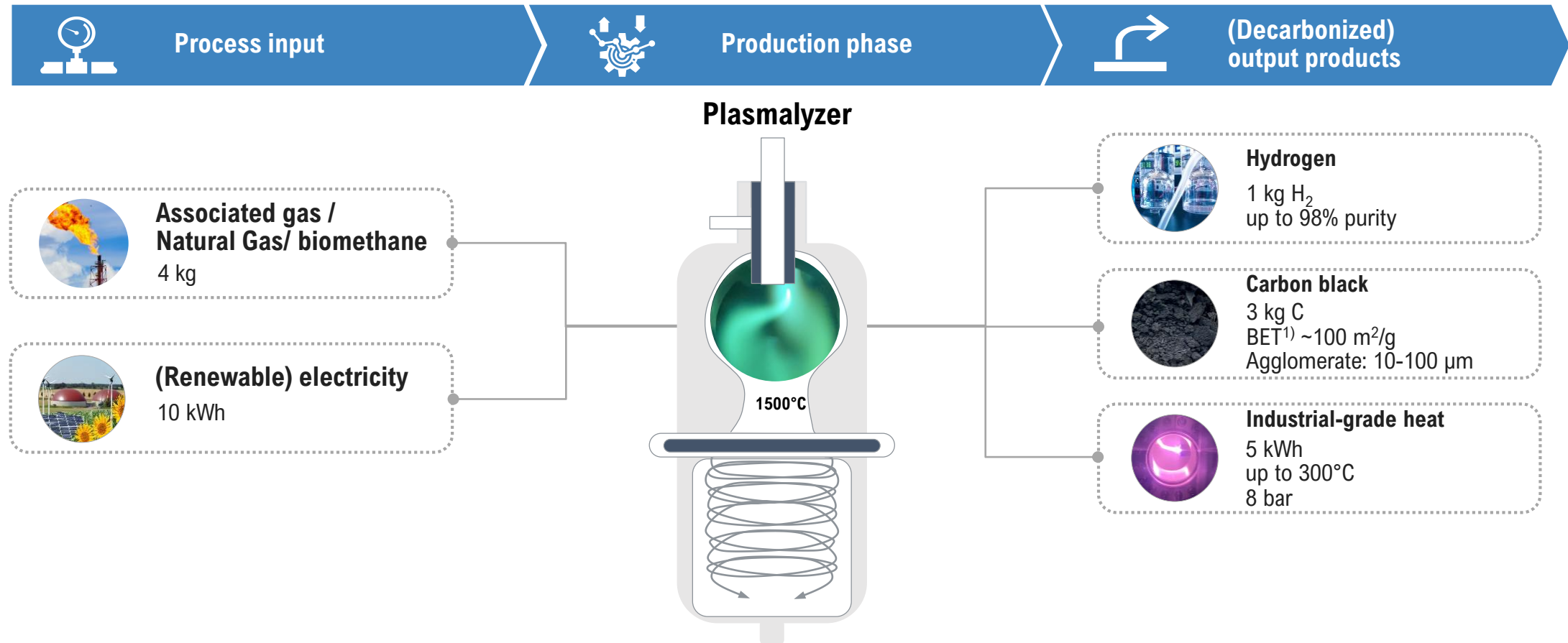


Prinzip der Plasmachemokatalyse



# METHANE PLASMALYSIS TECHNOLOGY

Methane Plasmalysis decarbonizes methane to produce hydrogen (H<sub>2</sub>) and solid carbon (C) and industrial-grade heat

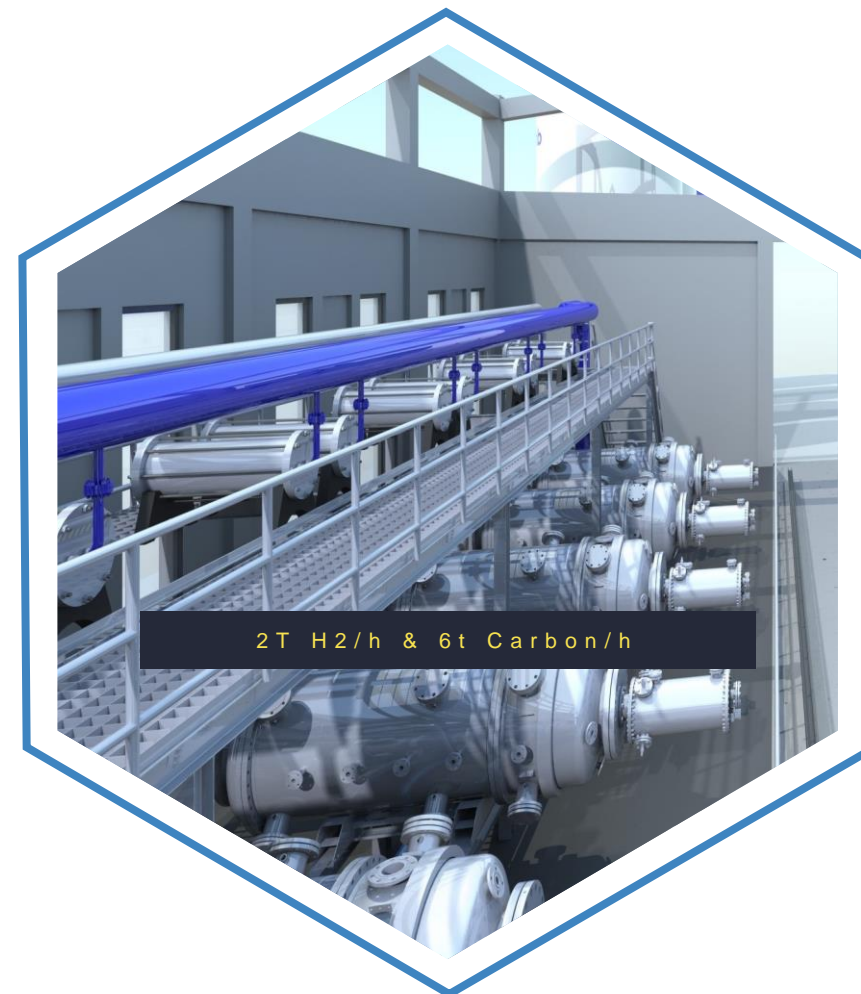
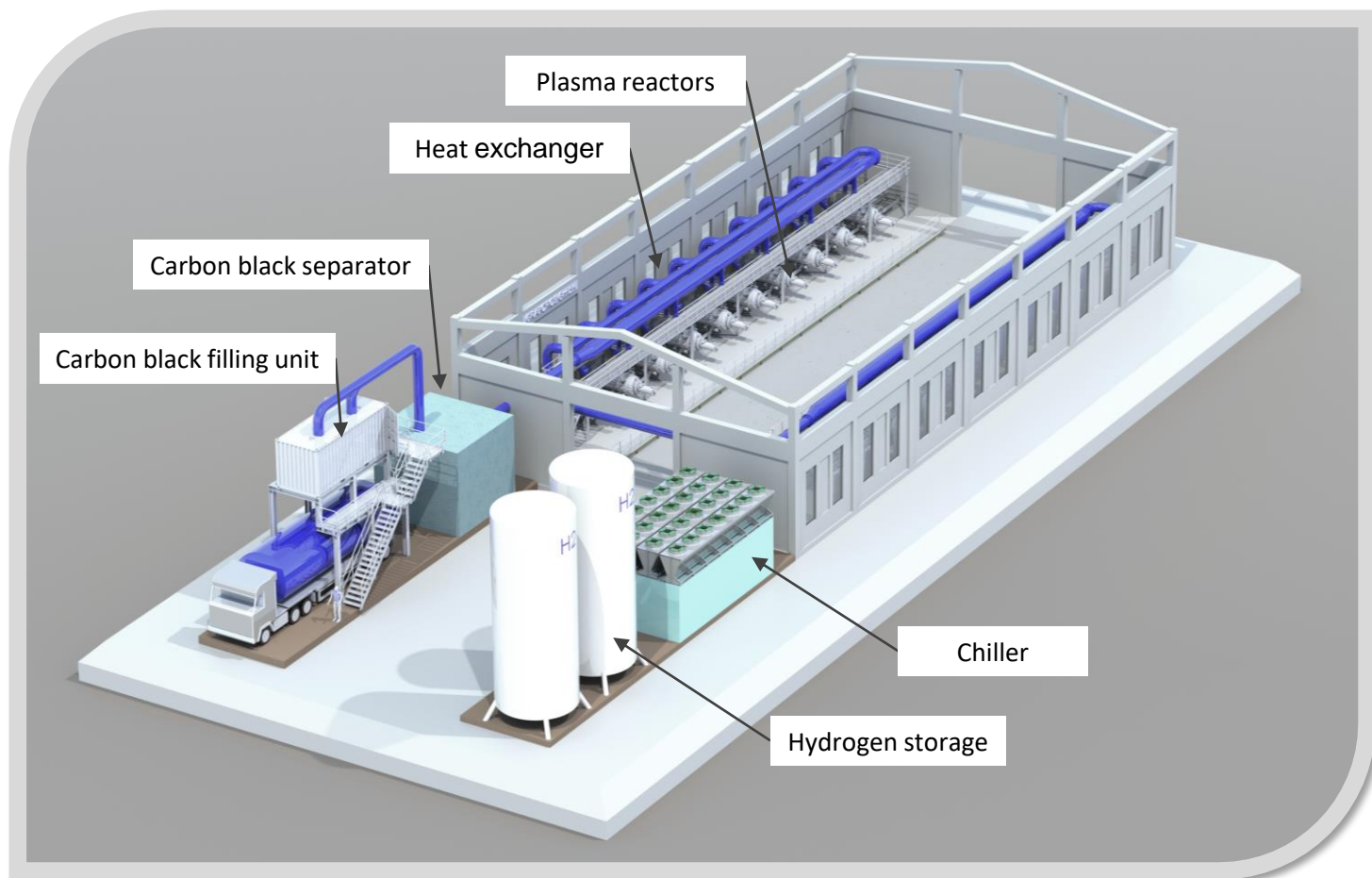


1) Degree of physical adsorption of gas molecules on a solid surface based on the Brunauer–Emmett–Teller (BET) theory. Note: All process units are per hour of production, based on a 0.5 MW plasmalysis system.



# 10 MW SYSTEM WITH MODULAR APPROACH

Example layout of a 10MW hydrogen production plant



# REFERENCE PLANTS

Market-ready products



Hydrogen fuel plant from natural gas feedstock



Hotel MOA H<sub>2</sub>-blending heating boilers for CO<sub>2</sub> reduction



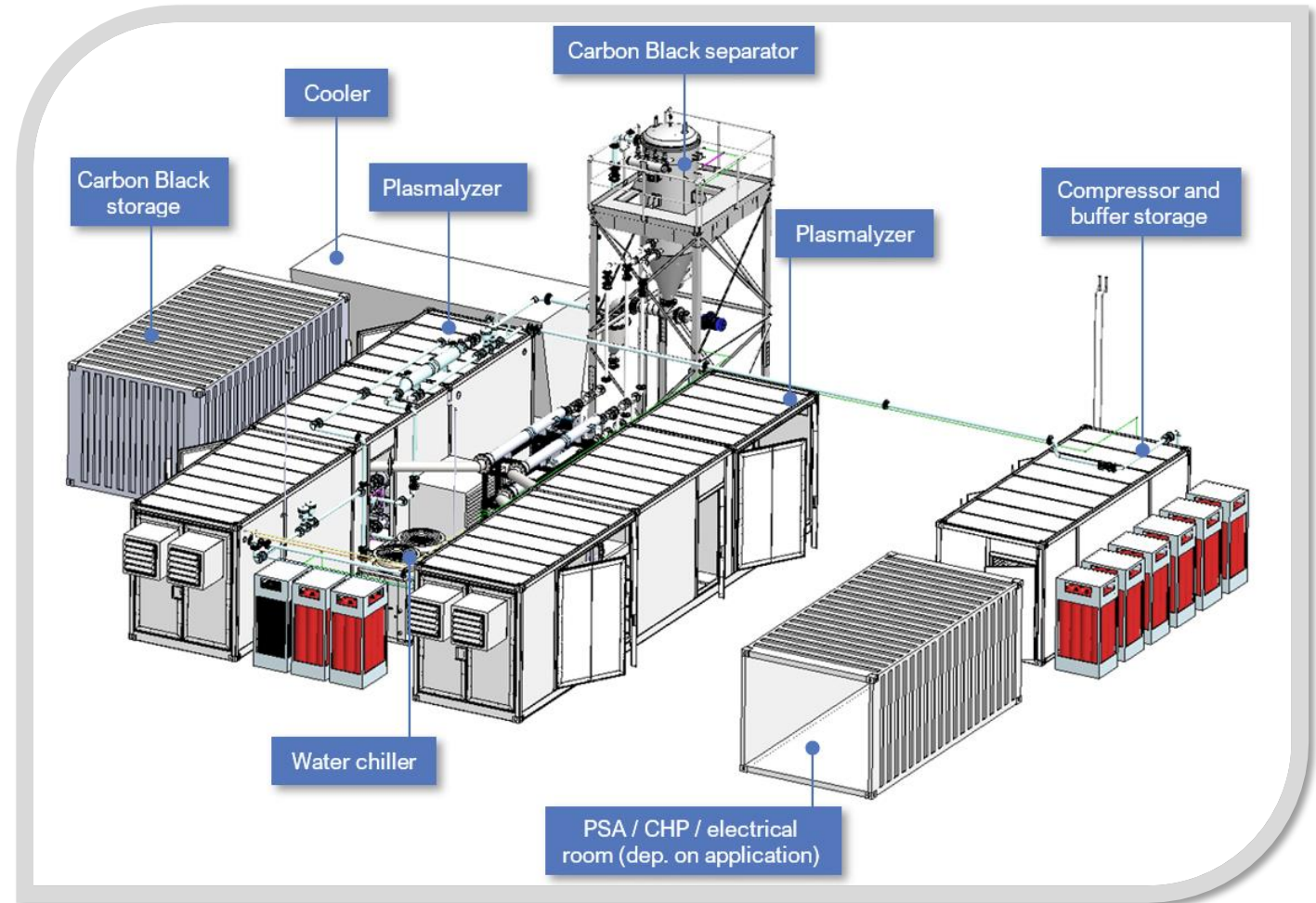
Graforce hydrogen plant from ammonia feedstock



# DECARBONIZATION PROJECT – COMMERCIAL PLANT

Decarbonize natural gas into hydrogen and carbon black

## Commissioning at Refinery Austria (Q2/2023)

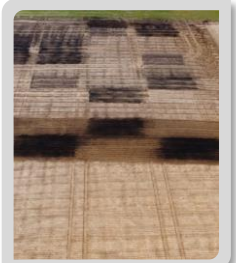


0.5 MW Gas Electrolysis Plant

# CARBON BLACK

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

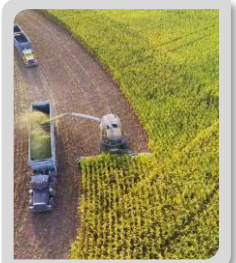
## Agricultural applications



Increased water storage capacity



Increased fertility



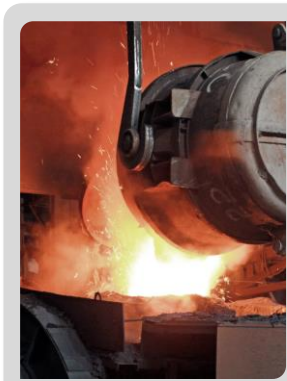
New sales potential

## Concrete



Up to 20% of the concrete can be substituted with CO<sub>2</sub> neutral carbon black

## Steel



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



# GRAFORCE'S TECHNOLOGY USP's



**Carbon neutral process with flexible feedstocks**

**Cost-efficient, CO<sub>2</sub>-neutral production of H<sub>2</sub> 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<sub>2</sub> yield with significantly lower CAPEX compared to electrolysis**



**Market-ready product**

**Market-ready product with a capacity of 50 - 200 kg H<sub>2</sub>/h**



**Strong R&D team**

**Specialized, dedicated and long-standing development team for all essential areas of product development**



H2



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# USE CASES OF GAS ELECTROLYSIS PRODUCTS

## Hydrogen

### Oil & gas



**Oil refining**

### Buildings



**Heat generation with a CHP<sup>1)</sup>**

### Energy



**Gas-powered plants**

### Chemicals & industrial materials



**Methanol & ammonia, fertilizers, steel and concrete production**

### Mobility



**Emission-free fuels**

## Carbon Black

### Agriculture



**Carbon soil enrichment increasing fertilization and water absorption**

### Building materials



**Concrete, roadworks/asphalt, steel manufacturing, etc.**

### Tire manufacturing



**Tire coloring and performance improvements**

### Specialty applications



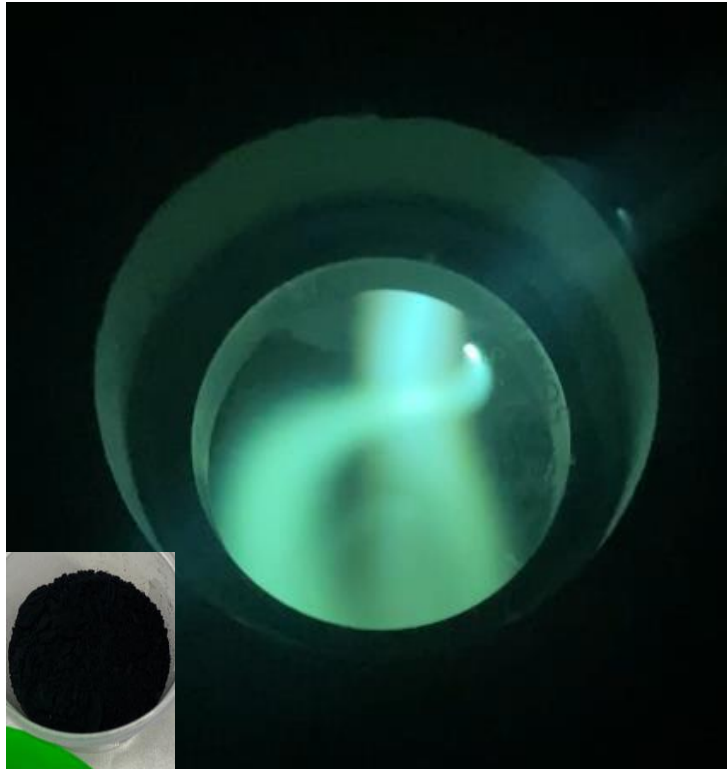
**Colored plastics and improved features such as conductivity**

1) Combined heat and power plant

1  
6  
0  
7  
/  
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2

# METHANE PLASMALYSIS

Kinds of Plasma-Sources with different Hydrogen and Natural Gas Composition



DC Plasma Hydrogen&Natural\_Gas

Plasma travels along the electrodes (green gas)



DC\_Plasma\_Hydrogen&Natural\_Gas

Natural Gas inner channel, hydrogen outer, increase- Carbon structure and Surface (3 $\Omega$ )



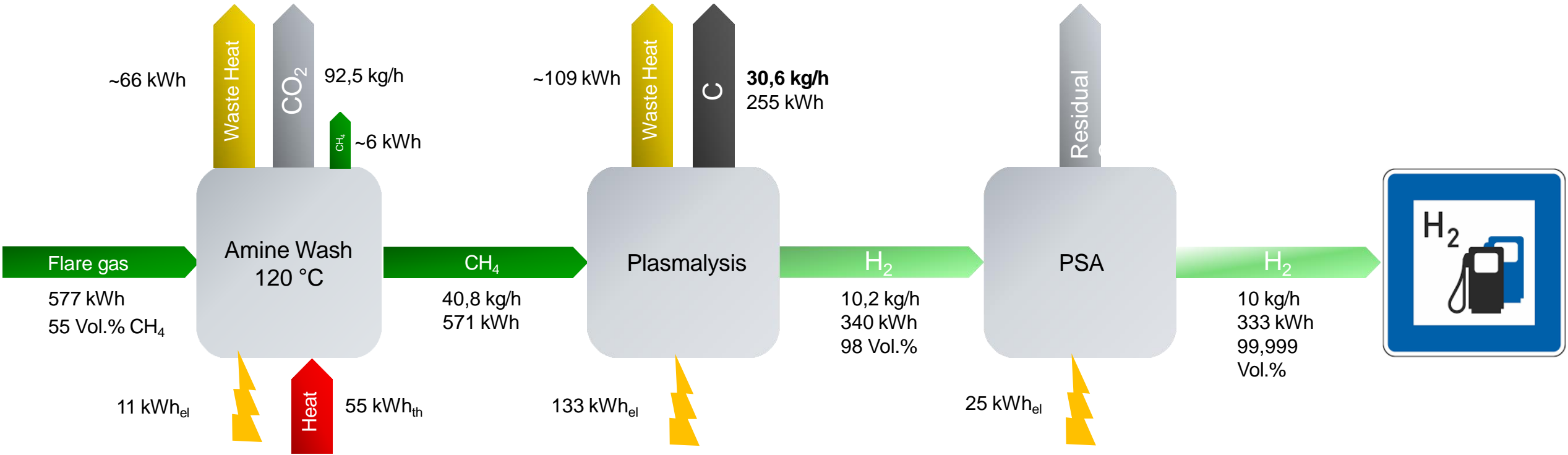
RF\_Plasma with Natural Gas

Plasma complete at the tip of the electrode. Gas between inner electrode and ceramic tube



# MASS AND HEAT BALANCE – BIOGAS TO H<sub>2</sub> (5.0)

ENERGY CONCEPT WITH “NEGATIVE CARBON FOOTPRINT”

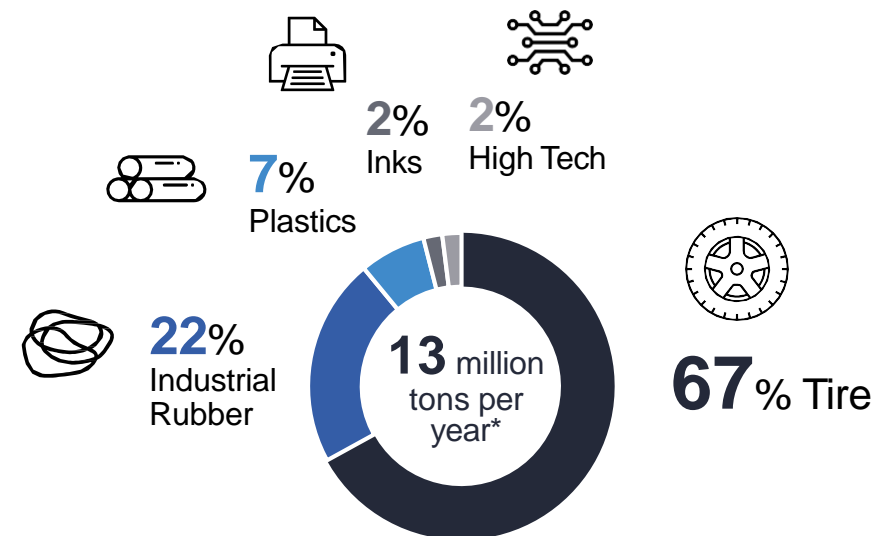


# CARBON BLACK AS SYNTHETIC FEEDSTOCK

## Market Potential

- Out of 4 kg Methane, Plasmaplysis generates 1 kg H<sub>2</sub> and 3 kg Carbon black.
- H<sub>2</sub> used for heat and power with zero emission.
- Carbon Black used as feedstock in several industries.
- Negative CO<sub>2</sub> emissions result from: Biomethane plasmaplysis, and Carbon Black used to replace or supplement plastics, building materials, etc.
- Price: approx. 250-450€/t

## Main applications of carbon black by industry sales

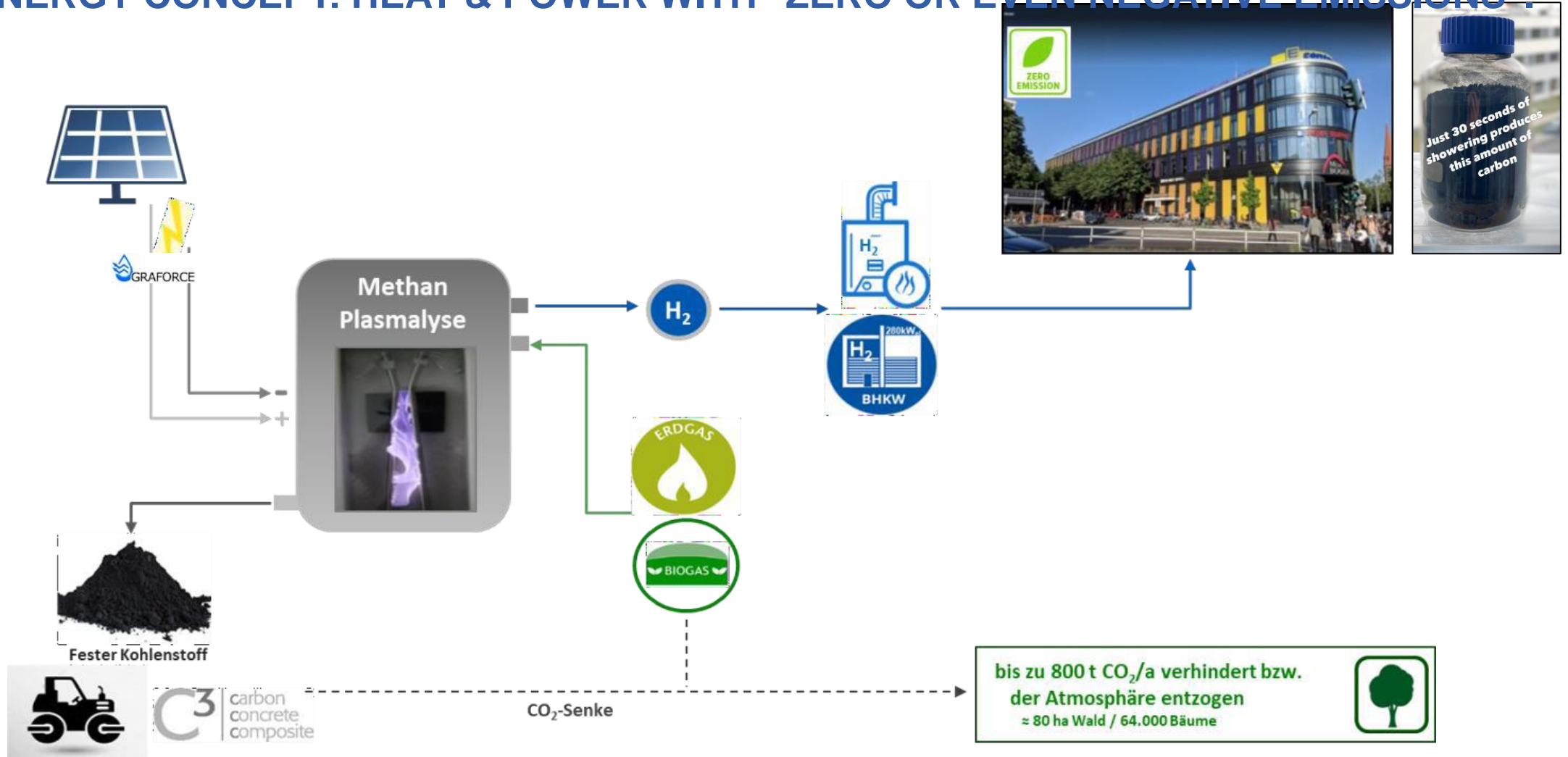


Main applications of carbon black by industry sales –  
**World Production:** 13 million tons per year

Future applications:  
Concrete, asphalt, coffee capsules, soil enhancement, biochar...

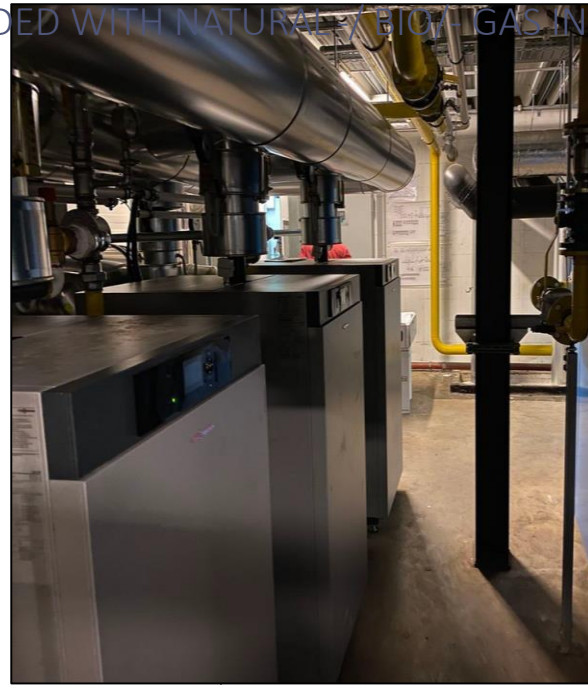
C\* [https://actualites.minesparis.psl.eu/Donnees/data44/4467-2020-07-17\\_Production\\_d\\_hydrogene\\_decarbonel\\_la\\_troisieme\\_voie.pdf](https://actualites.minesparis.psl.eu/Donnees/data44/4467-2020-07-17_Production_d_hydrogene_decarbonel_la_troisieme_voie.pdf)

# ENERGY CONCEPT: HEAT & POWER WITH "ZERO OR EVEN NEGATIVE EMISSIONS".



# CO2 FREE HEAT GENERATION

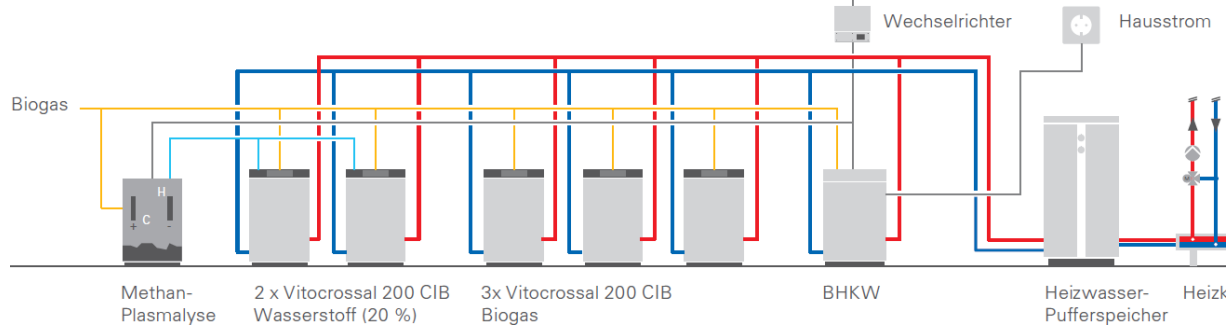
UP TO 40% HYDROGEN BLENDED WITH NATURAL BIOGAS IN BERLIN HOTEL MOA



2 x Boiler  
(a'318kW)

2 x Plasmalyse

1 x CB-Storage



**VIESMANN**

**Mercure**  
HOTELS

MOA BERLIN



# PLASMALYSIS WITH A HCNG-FUEL-STATION IN BERLIN

## Plant Images



# PRODUCTION FACILITY

Plant assembling of standard 0.5 MW system



**Location** Waltersdorf (15min from headquarters)

**Total site size** c. 2,100 m<sup>2</sup>



**Assembly of a 0.5 MW Methane Plasmalysis plant**