Fraunhofer UMSICHT

Fraunhofer-Institut für Umwelt-, Sicherheits- und Energietechnik UMSICHT

2. Forum Grüner Wasserstoff Bayern | 12. September 2024

Wasserstoff aus Abfällen und landwirtschaftlichen Reststoffen

Prof. Dr.-Ing. Matthias Franke

Fraunhofer UMSICHT

Institute branch Sulzbach-Rosenberg

Advanced Carbon Conversion Technologies

Clean Combustion and Process Heat

Secondary Resources and Assessment

Facts

100 staff members

2100 m^2 Technical labs

10 Mio. EUR Turnover

SERVICES

Process- and plant development

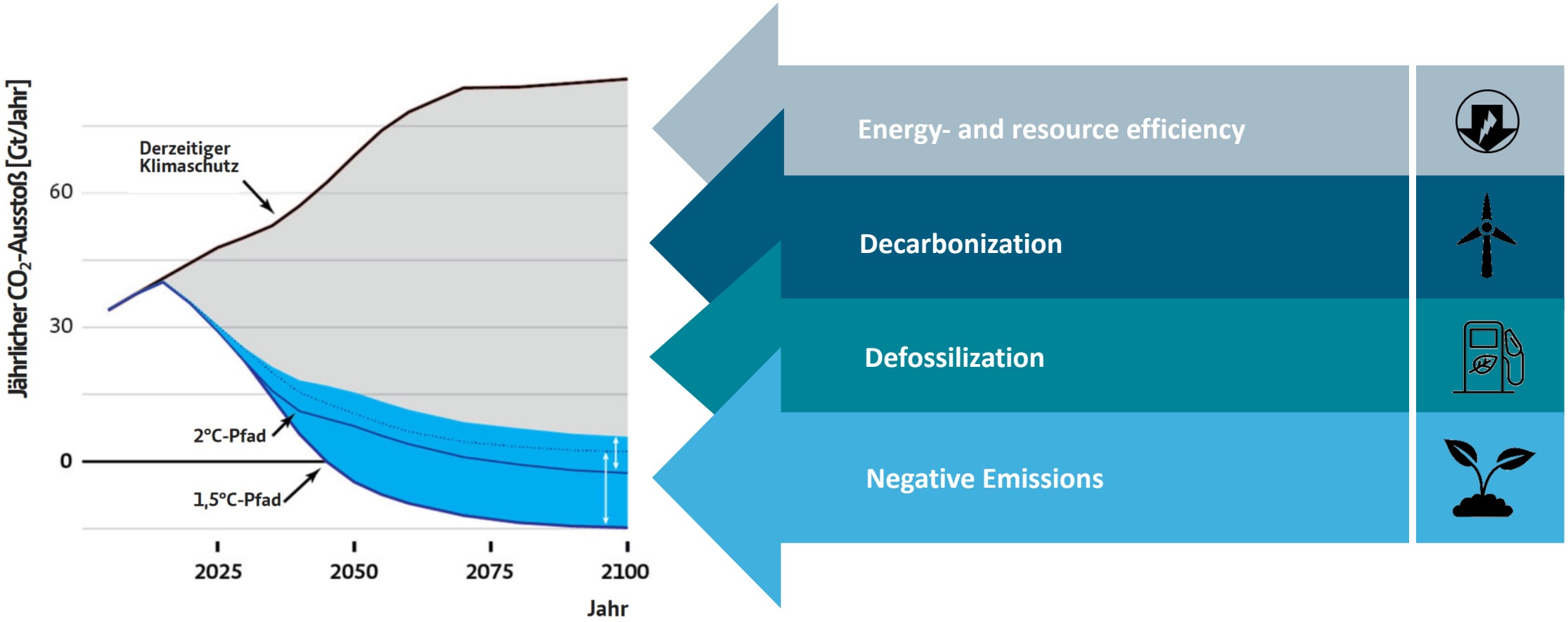
Laboratory uad analytics

Waste- and ressource strategies

Technology assessment and LCA

Background: Reduction of global CO_2-Emissions

Meeting the 1.5 degree target requires fast action and a mix of measures



Szenarien zur Erreichung des 1,5 bzw. 2 Grad-Ziels.

Quelle: Mercator Research Institute on Global Commons and Climate Change (MCC) gGmbH | Berlin

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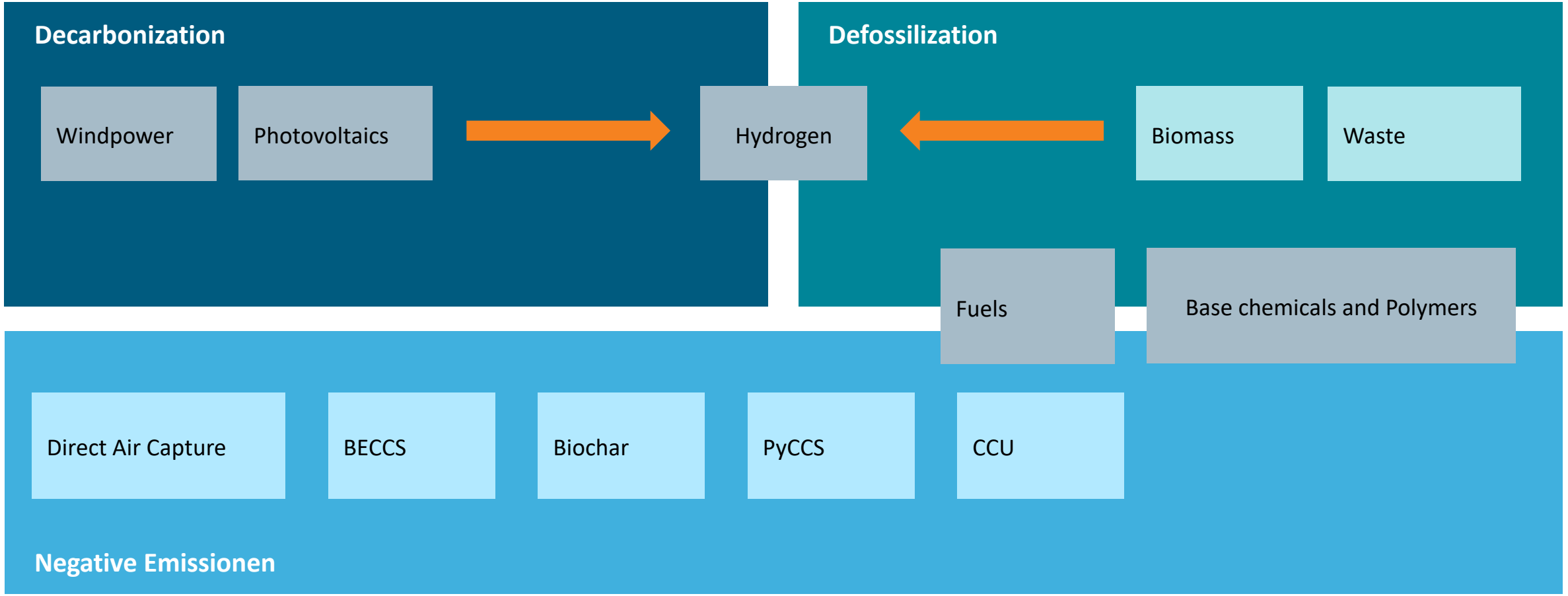
Background

Decarbonization, defossilization and negative Eeissions



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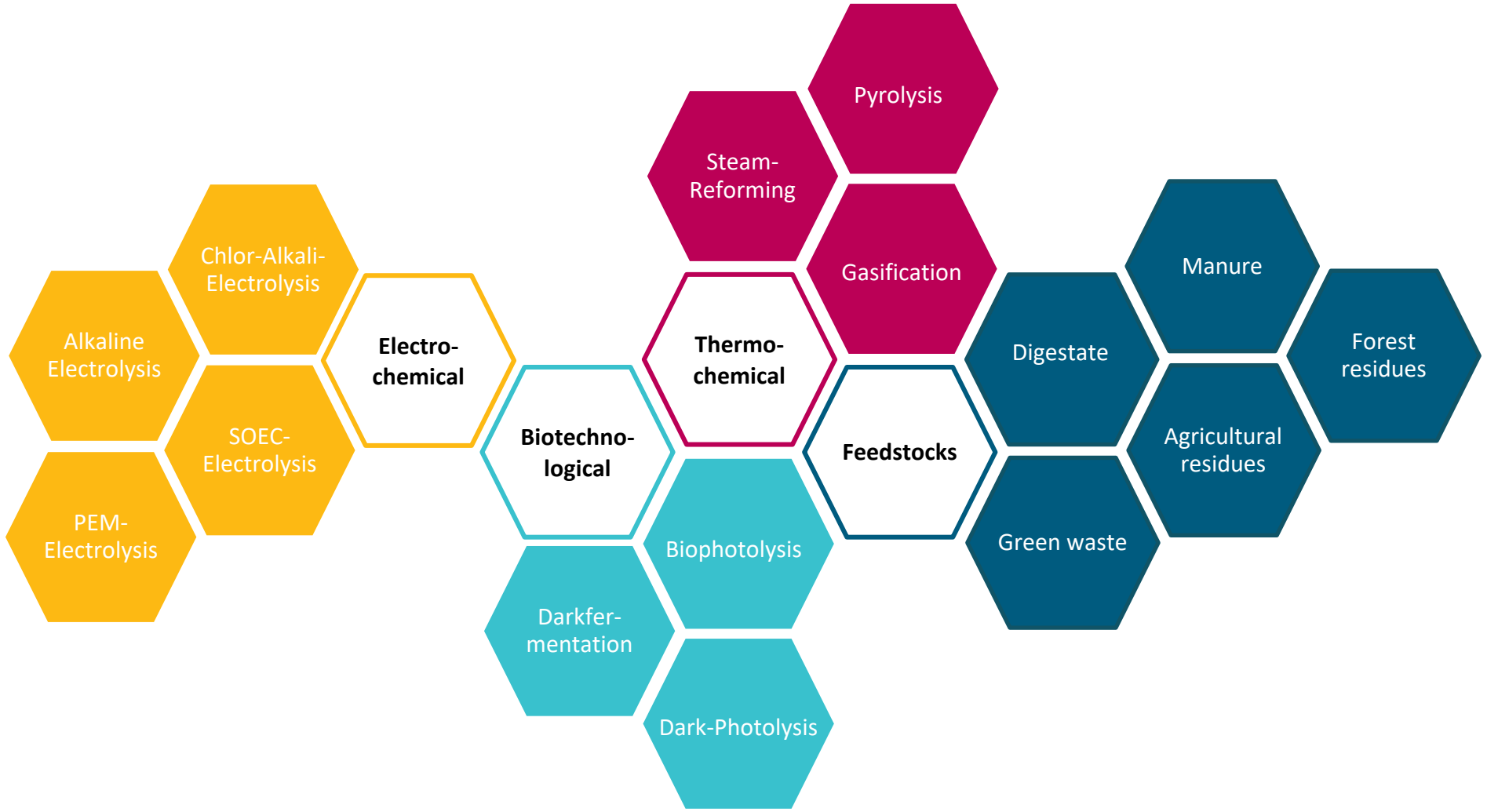
Selected processes and feedstocks for hydrogen production



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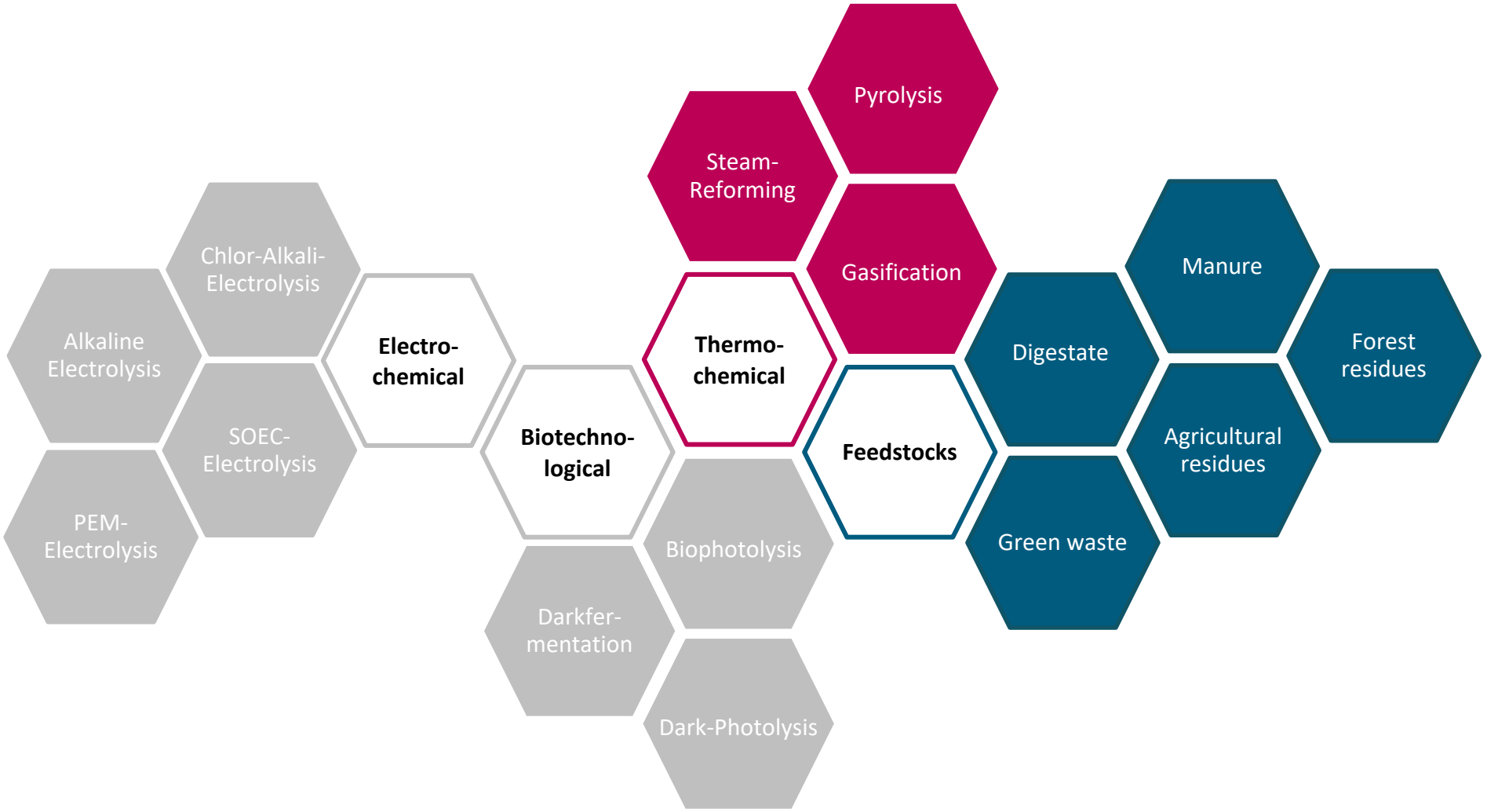

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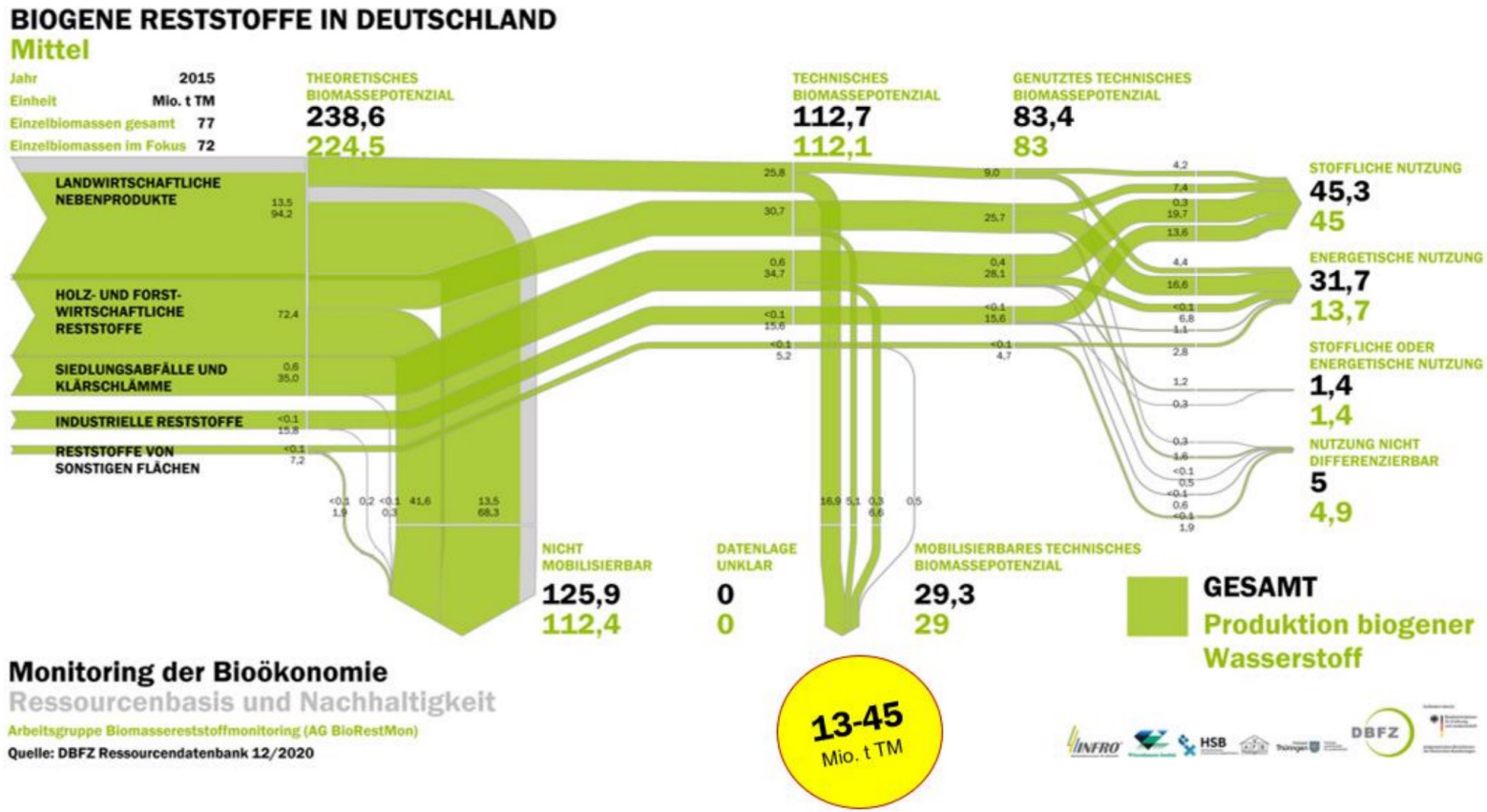
Potential for production of H_2 from biogenic residues



Quelle: DBFZ Report Nr. 46 | BIO2HY | Wasserstoff aus Biomasse, Leipzig: DBFZ, 2022

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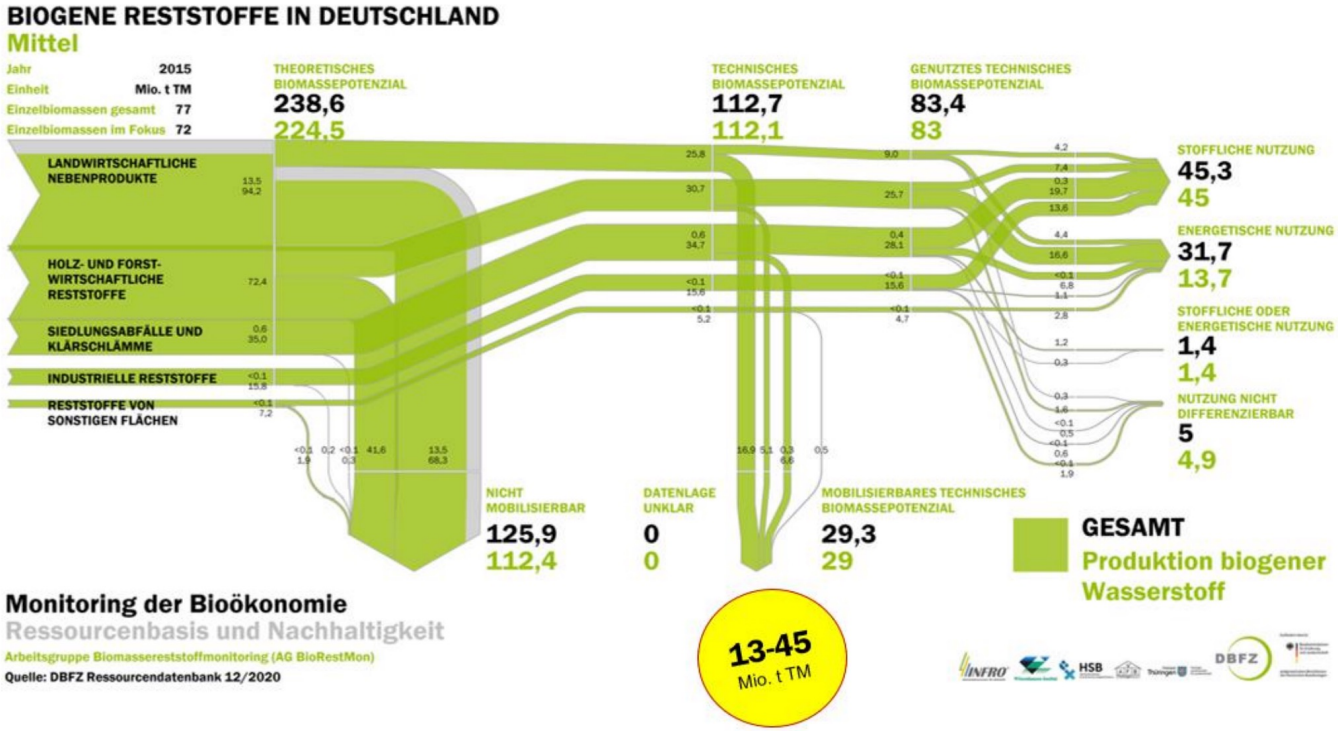

Quelle: DBFZ Report Nr. 46 | BIO2HY | Wasserstoff aus Biomasse, Leipzig: DBFZ, 2022

*) Quelle: BMWK: Fortschreibung der Nationalen Wasserstoffstrategie, Berlin, Juli 2023

Total demand H_2 in D
95 - 130 TWh / 2030*)

28 TWh*)

Targeted domestic production Green H_2

H_2 from biogenic residues (10% of mobilizable technical potential)

11 TWh

6 TWh

1 TWh

H_2 from biogenic residues (1% of mobilizable technic potential)

0,6 TWh

H_2-potential from share of biogenic residues in biogas plants excluded (7-10 TWh, DBFZ 2022)

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Processes and maturity of different technologies for H_2-production

Process	Feedstock	Technology Readiness Level								
		1	2	3	4	5	6	7	8	9
Steam reforming	Biomethane								X	
Steam reforming	Biogas						X	X	X	
Methane pyrolysis	Bio-methane			X	X					
Gasification* (O_2)	Biomass	X	X							
Gasification (H_2O)	Biomass								X	
Pyrolysis	Biomass					X	X	X		

*) < 1 MW_{FWL})

Plankenbühler et al. 2021

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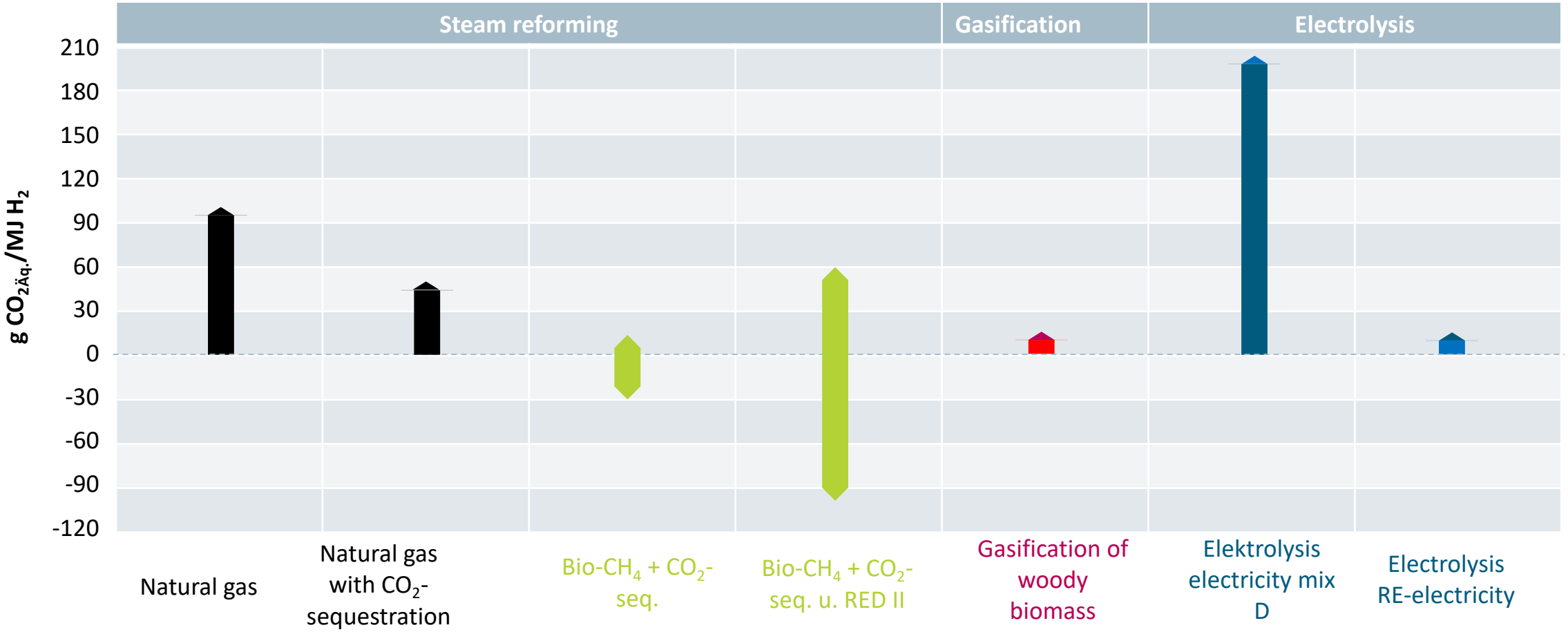
THG-Emissions of different production paths for H_2



Wolf et al. 2022; Antonini et al. 2020

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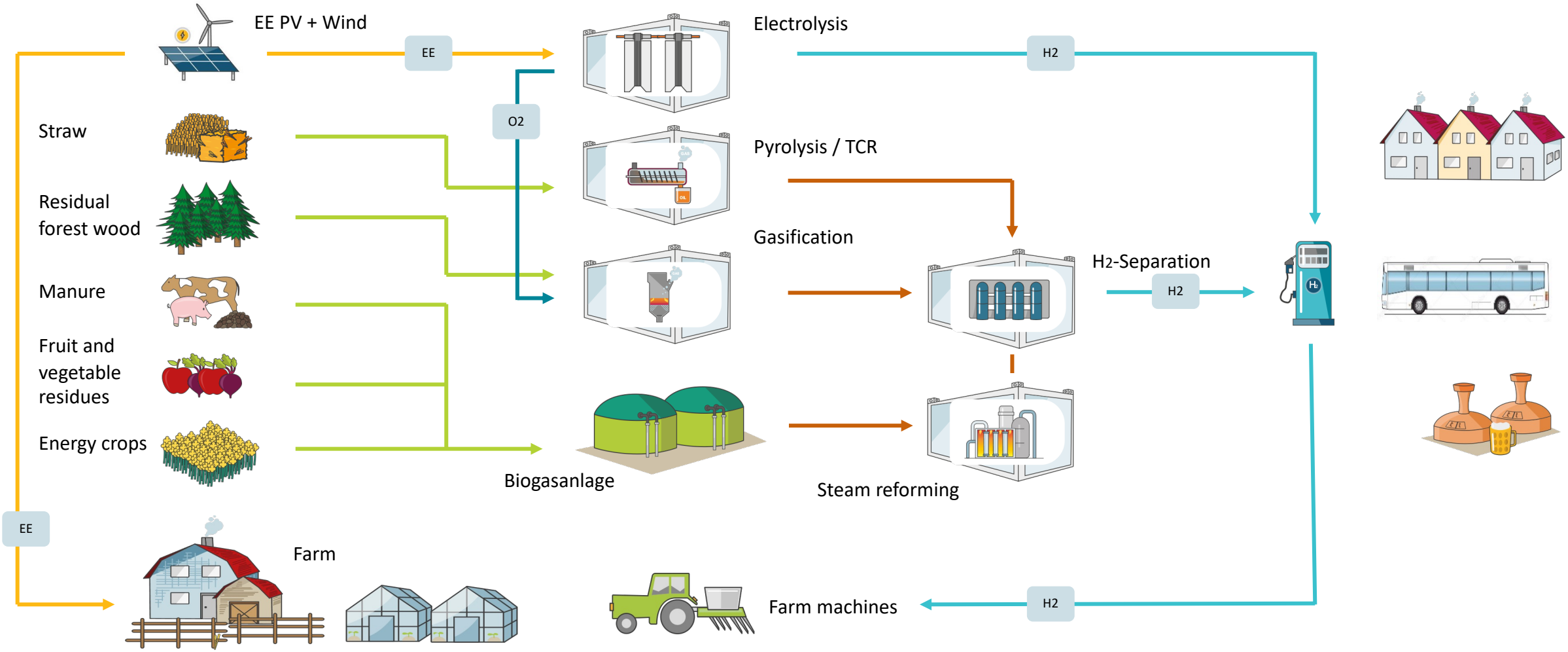
H_2 – Production and utilization options in agriculture



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The **TCR-Technology**

The Thermo Catalytic Reforming Technology (TCR)

Patented Conversion of biogenic residues into sustainable products

Use cases and outcome

- Utilization of biogenic residues (no food vs. fuel discussion)
- Decentralised application possible (regional added value)
- Products with near-zero carbon footprint possible

Products

- Syngas with up to 50 % green hydrogen
- Oil with high thermal stability for processing into standard fuels
- Coal for soil application / storage / energetic use

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- Informationsklassifizierung -

TCR - Functional principle

Intermediate pyrolysis with integrated catalytic reforming step

Use cases and outcome

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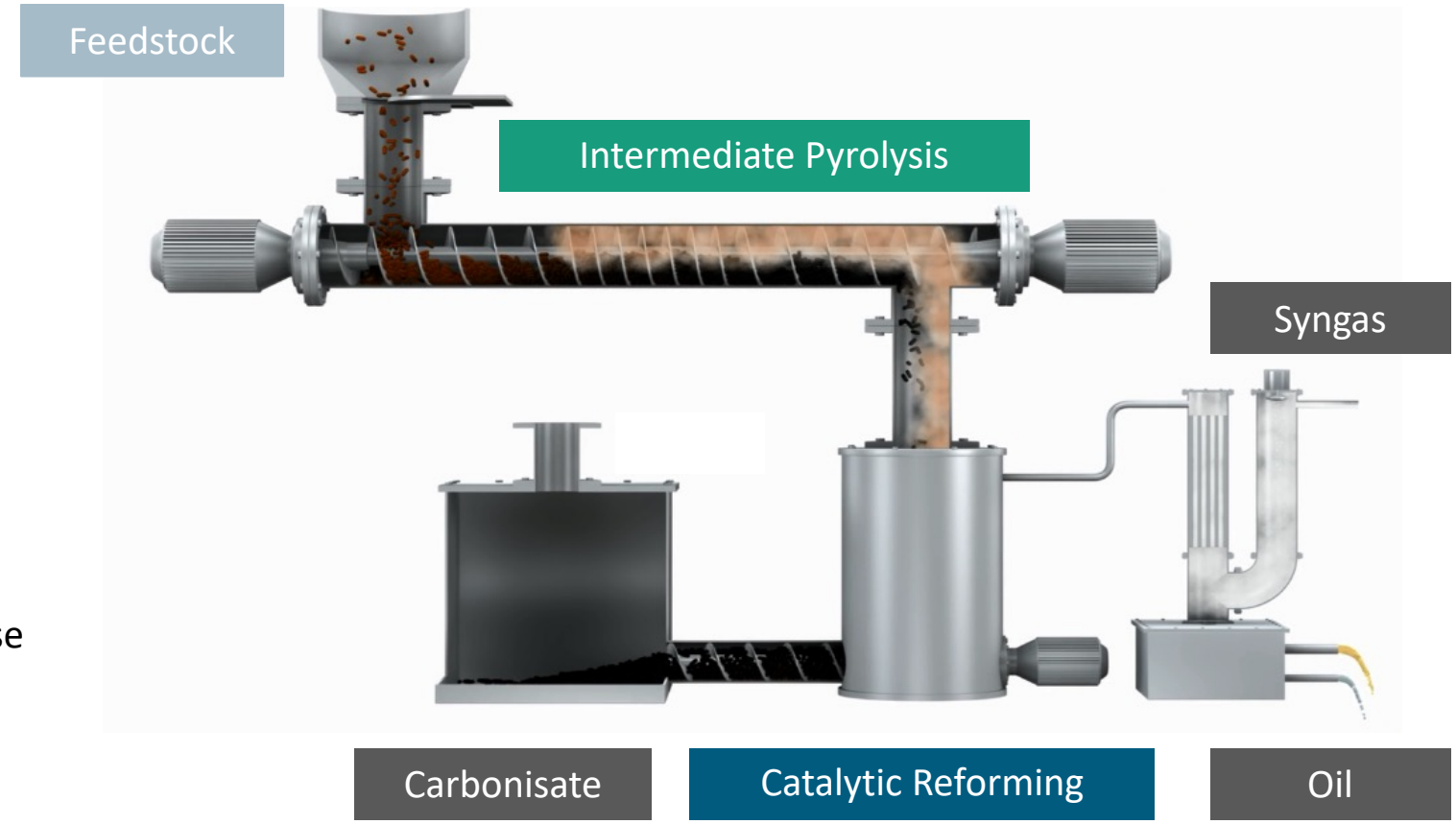

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TCR - Feedstocks

High potential of input materials

- Variable biomass, biogenic residues, bio-waste and mixtures (>70% DM) can be used as feedstock
- More than **90 biogenic waste materials** already tested
- **Examples**:
  - Agricultural residues
  - Digestate
  - Sewage sludge
  - Spent grains
  - Paper residues
  - Leaves
  - Biowaste
  - …

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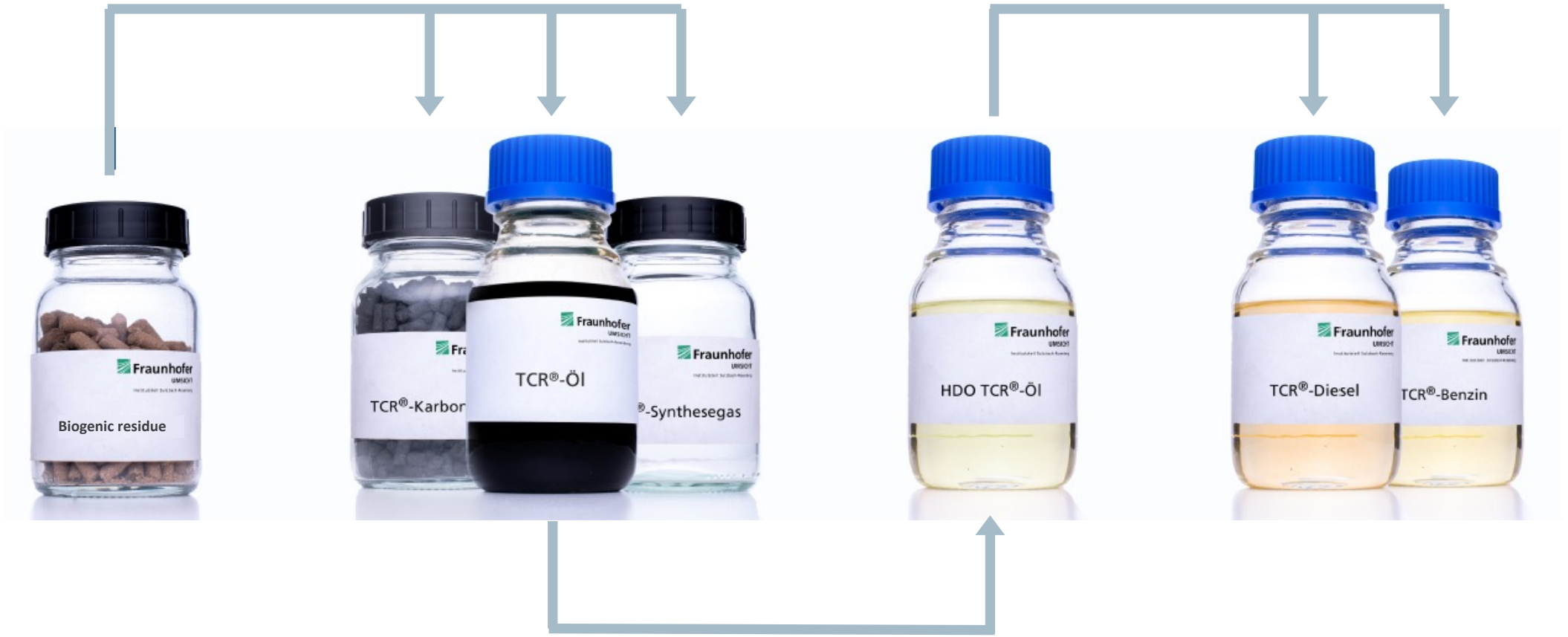
TCR - Products

From biogenic residue to standard fuels



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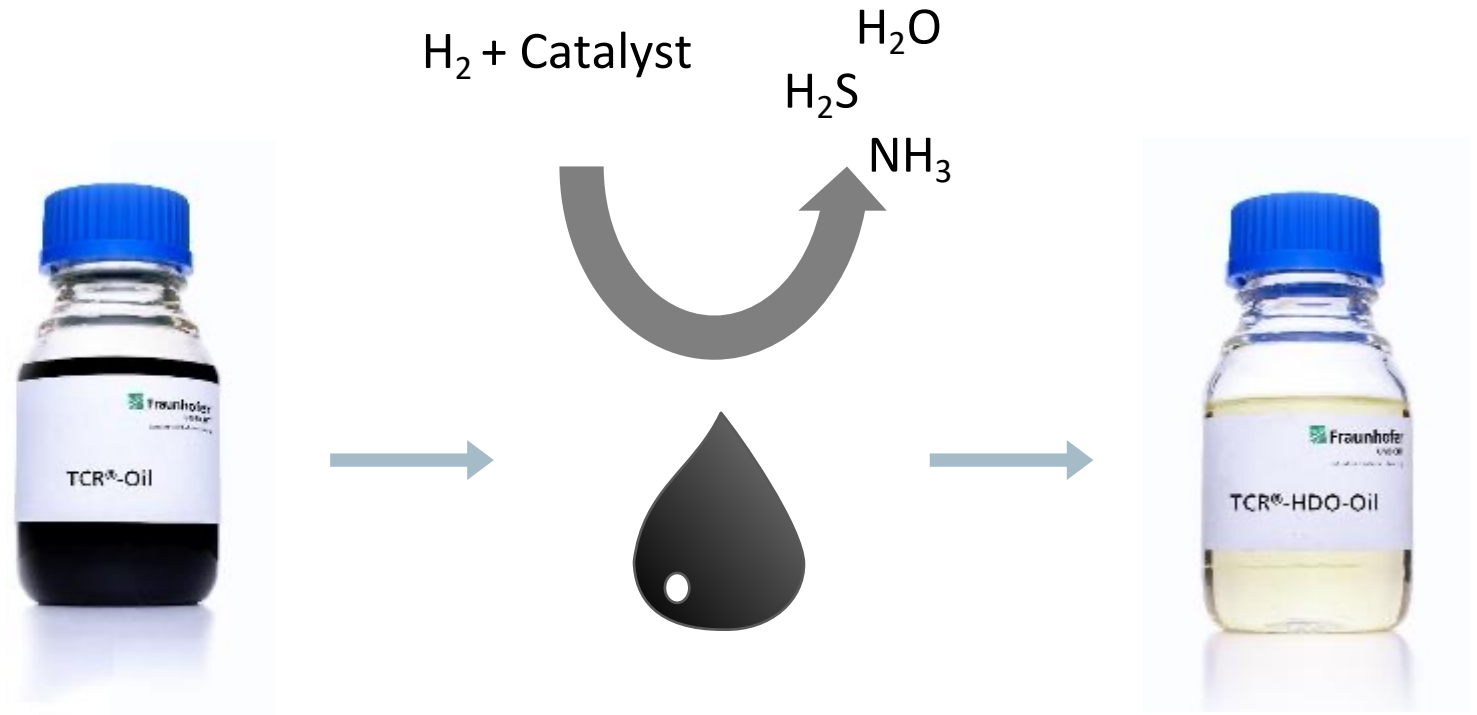
TCR - Products

Thermal stability of TCR-Oil opens the path for hydrotreatment



TCR® Oil

upgraded
TCR® Bio-Oil (HBO)

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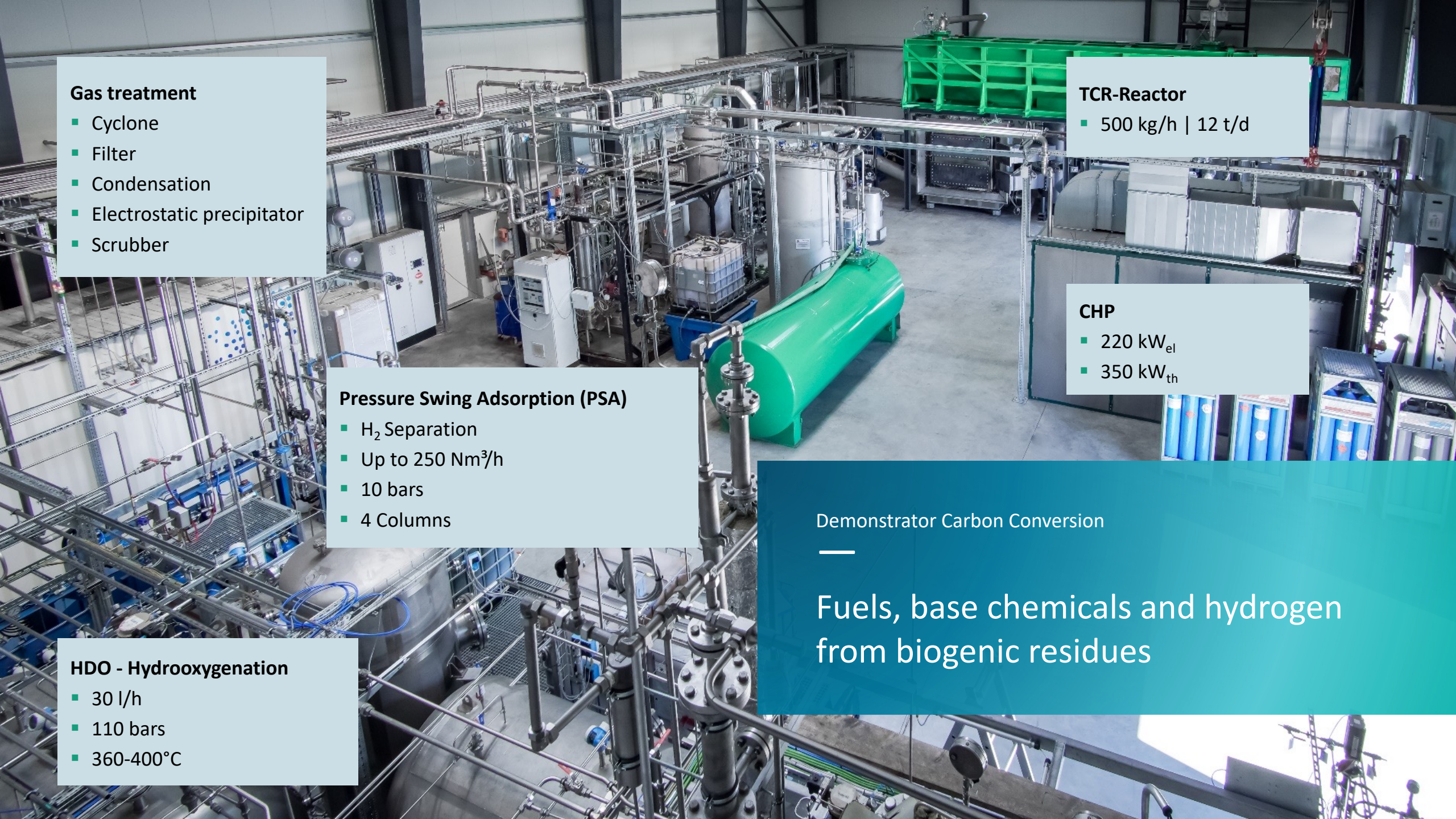


Gas treatment
- Cyclone
- Filter
- Condensation
- Electrostatic precipitator
- Scrubber

TCR-Reactor
- 500 kg/h | 12 t/d

CHP
- 220 kW_{el}
- 350 kW_{th}

Pressure Swing Adsorption (PSA)
- H_2 Separation
- Up to 250 Nm^3/h
- 10 bars
- 4 Columns

HDO - Hydrooxygenation
- 30 l/h
- 110 bars
- 360-400°C

Demonstrator Carbon Conversion

Fuels, base chemicals and hydrogen from biogenic residues

Car tour through europe

50,000 Liters of climate neutral crude oil from sewage sludge

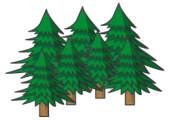
Outlook – current development

Sustainable aviation fuel from biogenic residues at refinery scale

Examplary scenario TCR

Straw

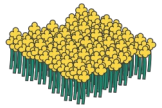
Residual forest wood



Manure

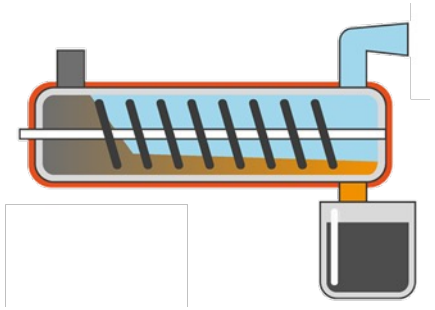
Fruit and vegetable residues

Energy crops

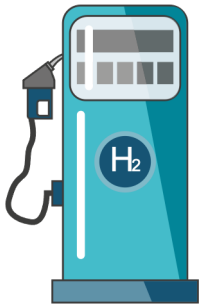


1,950 t digestate

1,950 t straw



1,750 t biochar



190,000 l Diesel

35,000 kg H_2

190,000 l Gasoline

60 houses à 22,000 kWh/y

9 tractors à 1,000 h/y

5 trucks á 80,000 km/y

35,000 Hl

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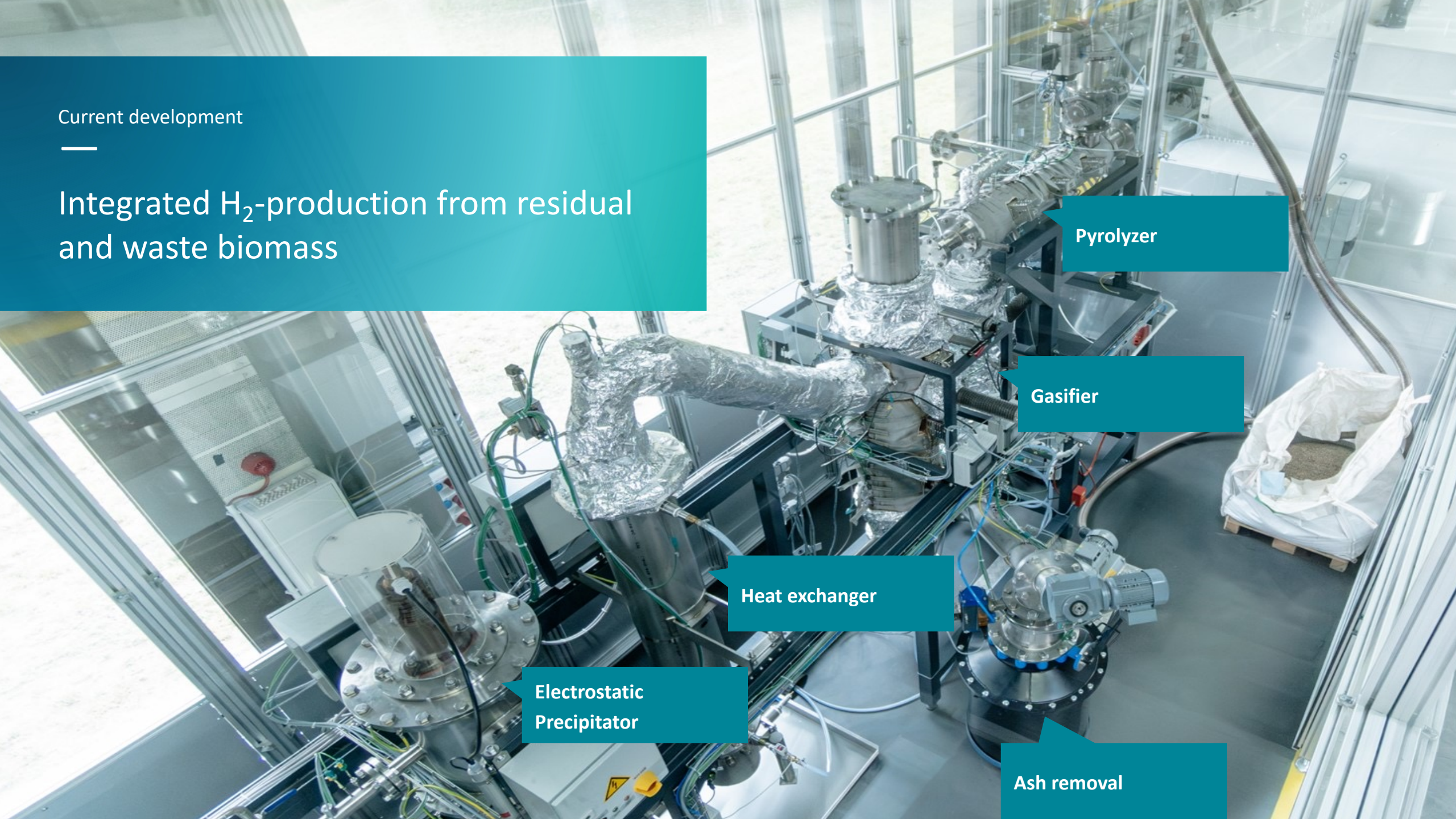
Current development

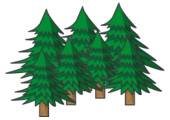
Integrated H_2-production from residual and waste biomass



Examplary scenario TCR + Gasification

Straw

Residual forest wood



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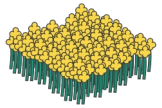

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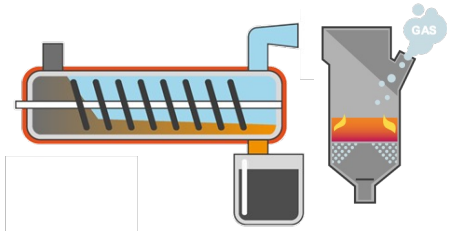

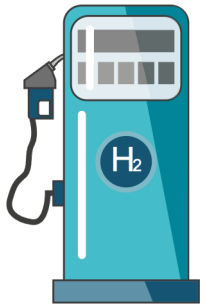

156,000 kg H_2

260 houses à 22,000 kWh/y

43 tractors à 1,000 Bh/y

21 Trucks á 80,000 km/y

156,000 Hl

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Many thanks for your kind attention!

Contact

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