VALORIZATION OF WASTE AGRICULTURAL RESIDUES FROM NORTH-WESTERN GERMANY

A pathway to biofuels and long-term carbon storage within the UNLOC concept

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DLR

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German Aerospace Center (DLR) in 2023

Research Organisation
8.350 employees

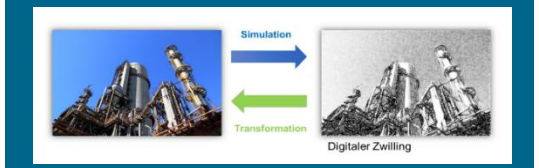
Project Management Center
1.400 employees

Space Administration
250 employees

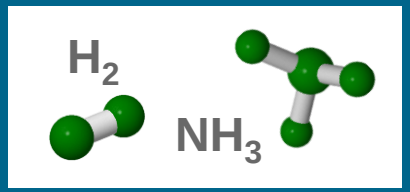
- **10.000 Total number of employees**
- **35 Locations nationwide with 55 institutes and facilities**
- **4 international offices**
- **Turnover 2020 Research facilities: approx 1,2 Mrd. €**

Institute of Low-Carbon Industrial Processes (DLR-DI)

High-Temperature Heat Pumps



Simulation and Virtual Design



Low Carbon Reducing Agents

University Library Cottbus

City Center Zittau

CO_2-reduction options for the Industry

Climate-neutral energy sources/feedstocks

- Electrification
- H_2 / synth. / carbon-free energy sources
- Biomass
- Solar process heat

H_2-utilization Biomass

High-Temperature Heat Pumps

Energy efficiency

CO_2 utilization & capture

- Carbon Capture and Use (CCU)
- Carbon Capture and Storage (CCS)

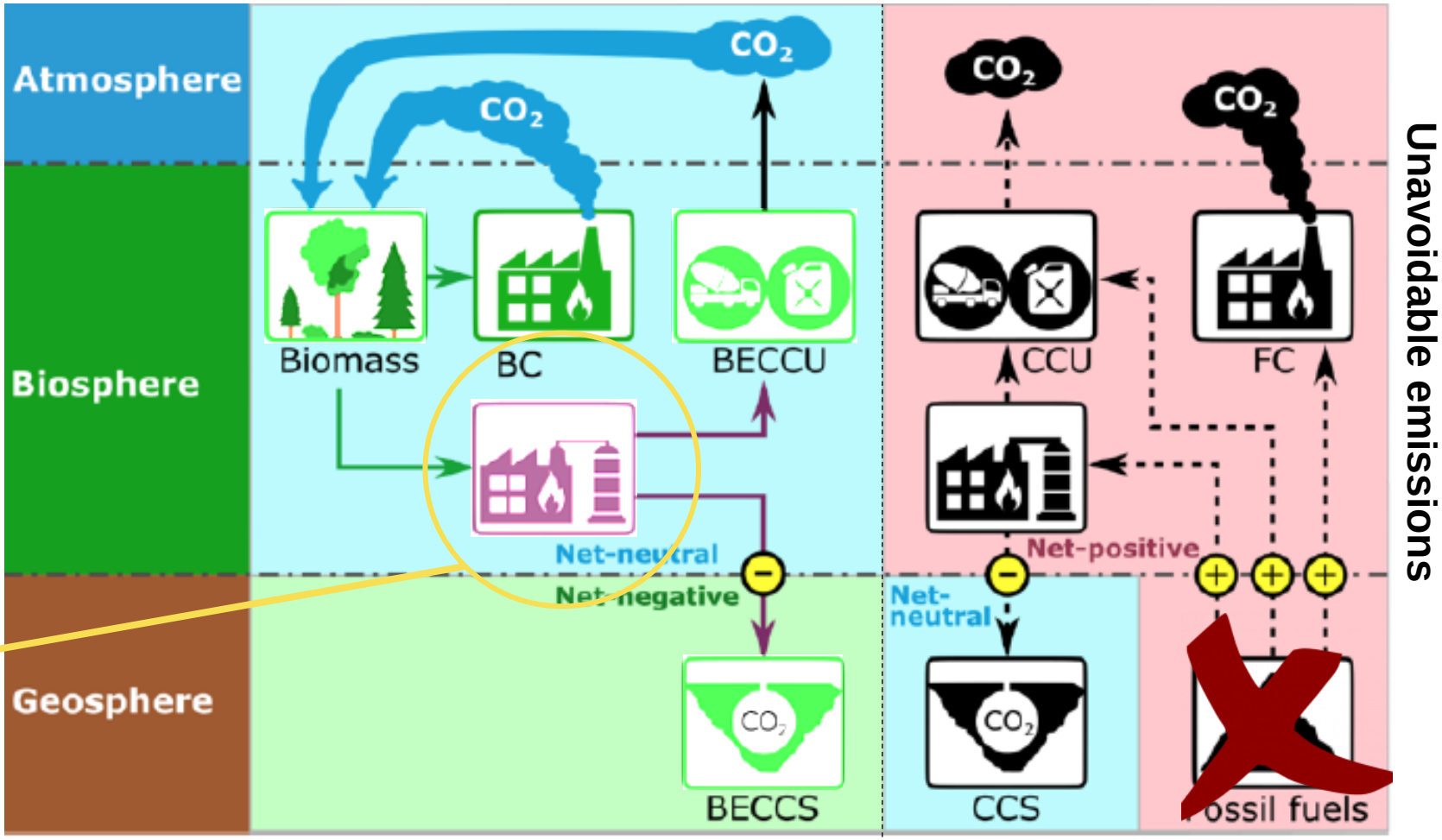
Process Chemistry

Reduction in demand for primary materials

- Reduction of final demand
- Material substitution
- Circular economy
- Material efficiency

Source: Leipprand et al., DLR, FVEE-Tagung 2020

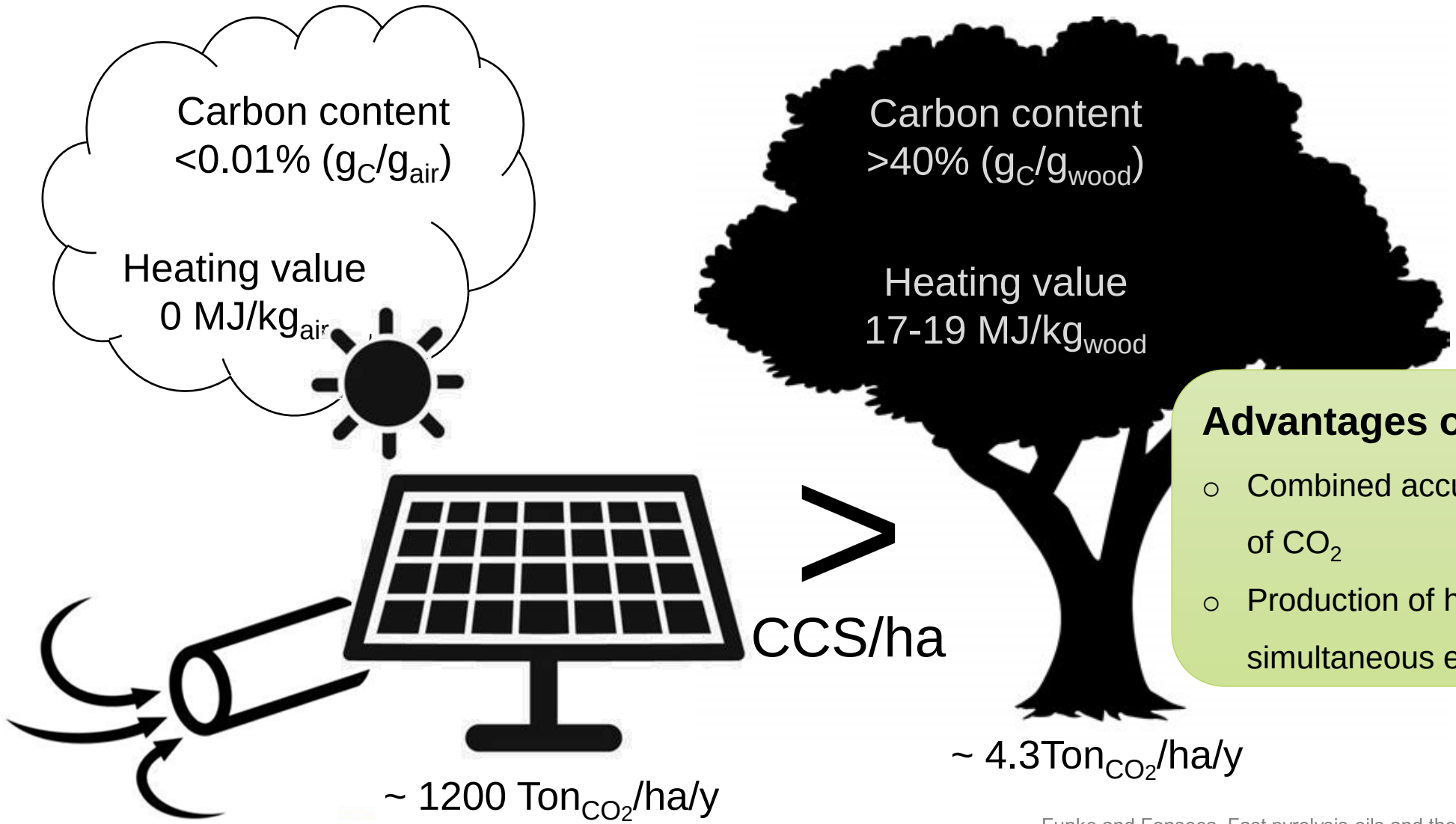
Carbon-capture methods



Pyrolysis, HTL

Schematic diagram of carbon dioxide cycles for CCS and CCU in bioenergy routes (left) and comparison with fossil routes (right). From IEA Bioenergy – BECCUS value chains – from concept to commercialization. Available online (10.09.2024) at https://www.ieabioenergy.com/blog/publications/beccus-value-chains-from-concept-to-commercialization/

Carbon accumulation during biomass growth



Advantages of biomass

- Combined accumulation **and** ‘activation‘ of CO_2
- Production of harvestable carbon **and** simultaneous energy provision

Funke and Fonseca, Fast pyrolysis oils and their application, BL2F Summer School (2023)

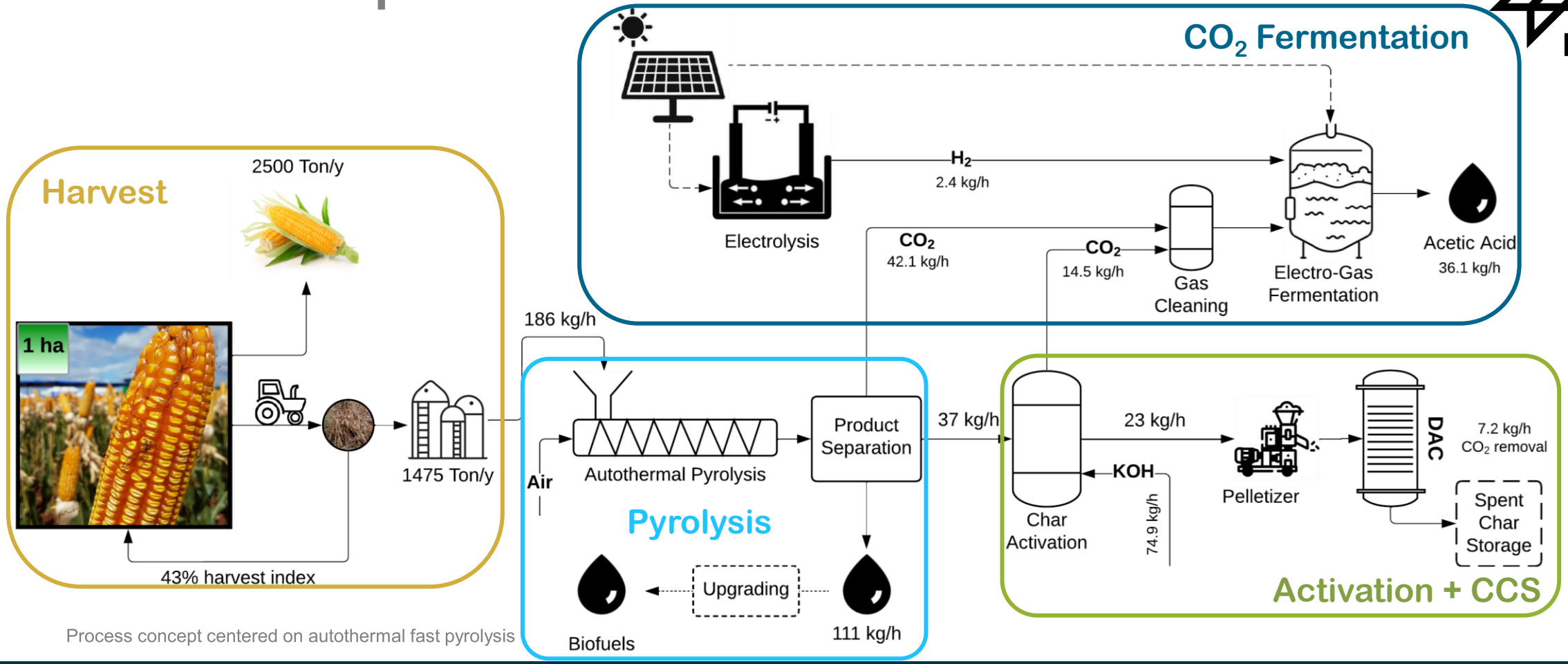
Corn Stover in Niedersachsen, DE

- Mixture of leaves, stalks and cobs of maize (*Zea mays*).
  - 1:1 stover to grain
  - Traditional uses:
    - Animal feed, bedding and local heating
  - Current developments:
    - Bioethanol
- In Germany: 2100 kHa in 2024
  - Niedersachsen: 24% of total DE (potentially 4 MTon/year)
  - Niedersachsen: easy access of sea routes

Corn stover harvest.
Available online (10.09.2024) at https://www.flickr.com/photos/inl/7896779532/

Fraction of the maize production area in German based on squares of area 5 km × 5 km.
Available online (10.09.2024) at https://agraratlas.statistikportal.de/

Process concept: corn stover to biofuels + CCUS



Process concept centered on autothermal fast pyrolysis

- **Base:** 2500 Ton/ha/y of corn stover
- Autothermal pyrolysis avoids energy supply **(*carbon neutral*, CCU)**
- *Activated* bio-char can be used for **Direct Air Capture**
- Alkali activated carbon **binds CO_2 strongly**
- Spent AC *can* be stored or **incorporated into inerts (CCS)**
- CO_2 streams can be valorized using **fermentation (CCU)**

Summary and Outlook

- Maize corn is a staple worldwide
- UNLOC concept adaptable to several regions and crops

- Pyrolysis – central unit: ***easy* product control**
  - Flexibility between production of biofuels vs. gas + char
  - Autothermicity minimizes external emissions

Looking for collaborations to bring this project to life!

- Carbon capture using alkaline solid[s] leads to **strong bonding**
  - Long-term storage of spent solids *hypothetically* feasible
  - Legal framework inexistent

- [M]obial electrosynthesis + electro-fermentation is reaching a **high level of technological maturity**
  - Currently targeting production of C_2 (ethanol, acetic acid), but evolving to C_4 (butanol)

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Impressum

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Thank you for your attention!

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