EBIO

Biofuels through Electrochemical transformation of intermediate BIO-liquids

Project duration Dec 2020 – Nov 2024

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SUSTAINABLE PLACES 2023
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btg biomass technology group
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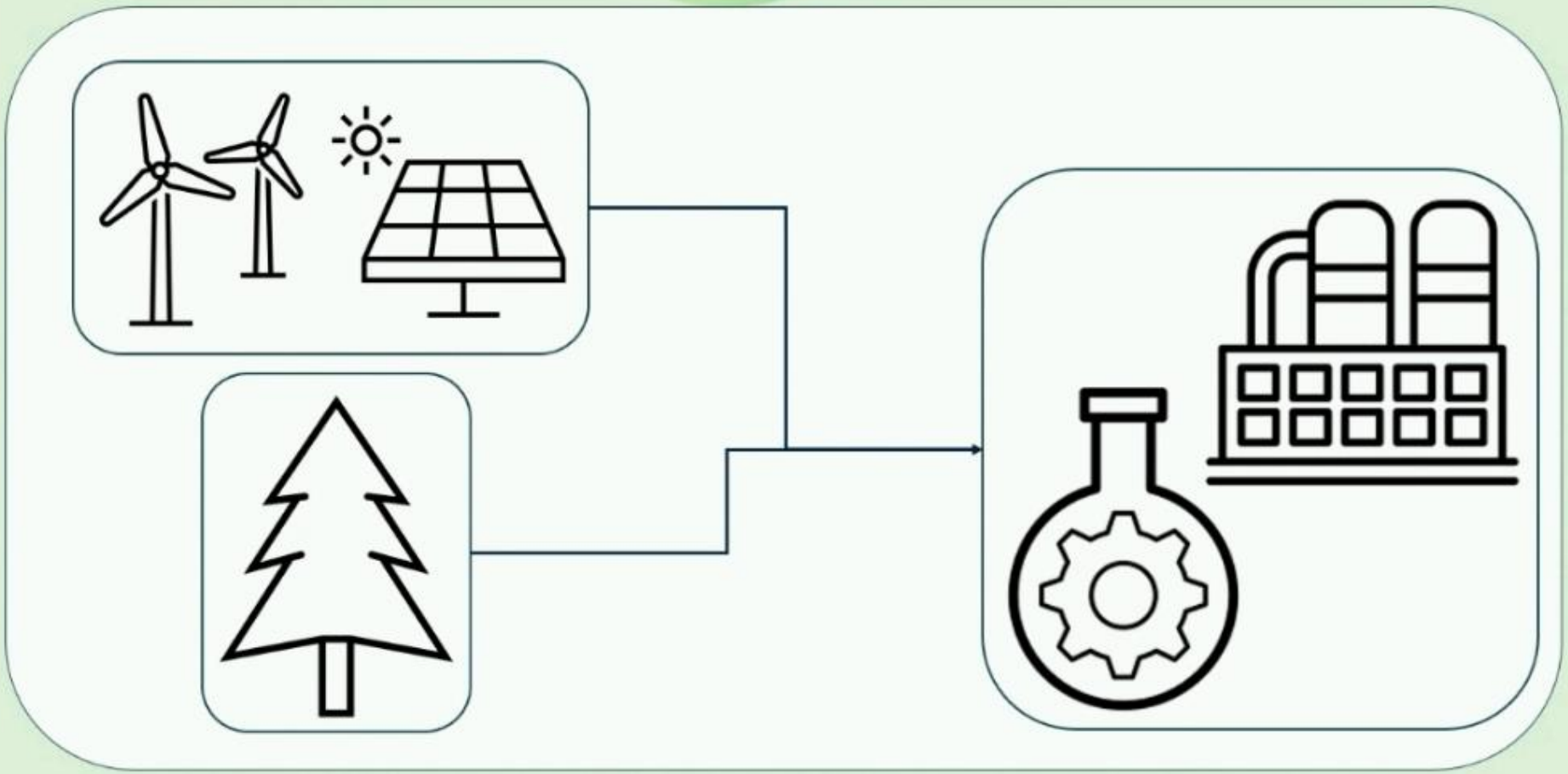
Introduction



Project focus

EBIO

EBIO – Flexible combination of thermochemical and electrochemical upgrading process for lignocellulosic biomass to energy dense hydrocarbon conversion with a carbon yield of 60%, contributing to answer European energy challenges

- European challenge to develop new renewable energy systems for the future
- Current production processes need high temperature and pressure, not optimal for bio-based molecules
- Large demand of biofuels and high-value chemicals

Low-value biogenic oils (pyrolysis oils, black liquor) obtained by thermochemical conversion of stem wood and residues

Full process design and integration

Optimisation of electrochemical upgrading (electrodes, cell design and product separation)

- Oxidative depolymerisation and decarboxylation
- Reductive hydrogenation

Target products

- Biofuels and fuel intermediates

By-products

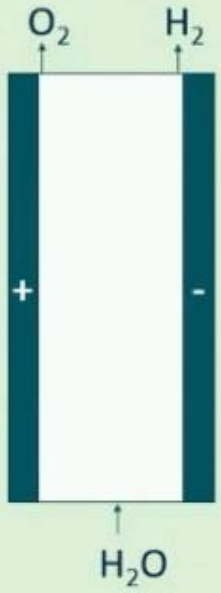
- Platform chemicals
- High-value compounds
- Hydrogen

Easy scale-up and implementation in

- *Pyrolysis plants*
- *Pulp mills*
- *Refineries*

Improved social acceptance

Electrochemical processes



Water electrolysis

Conversion of biobased compounds

Advantages:

→ Operation at mild conditions

→ Additional degrees of freedom

→ Simple operation

Disadvantages:

→ Low specific surface areas

→ Complex reaction mechanisms

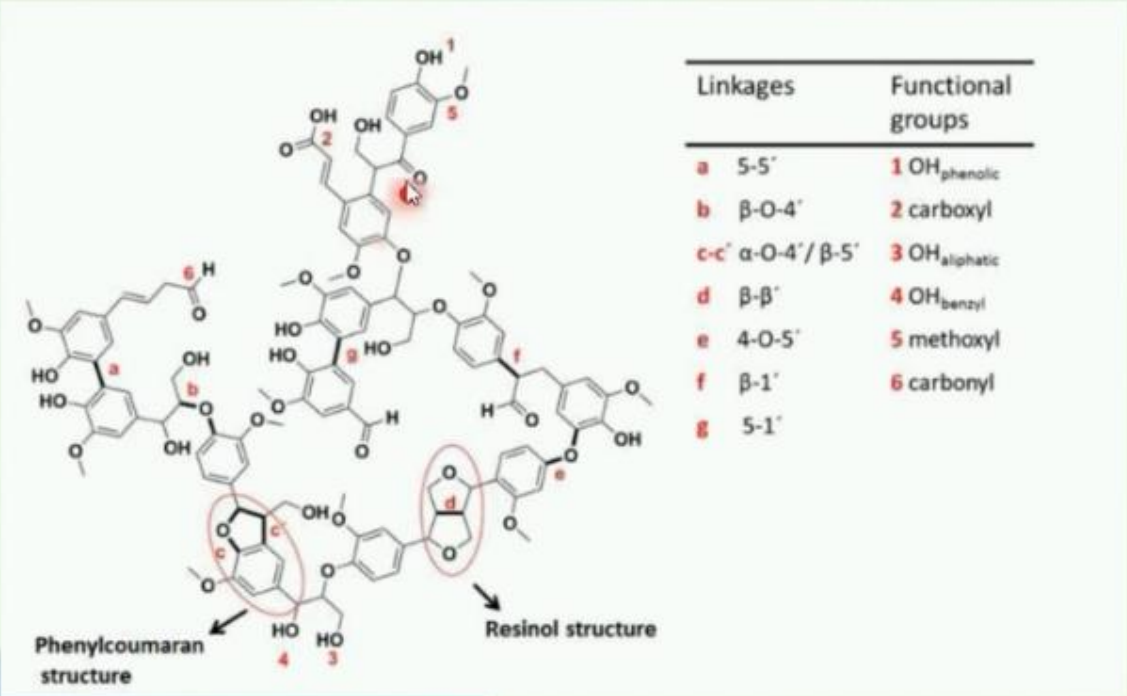
Electrochemistry:

Objective:

- Upgrade bioliquids at mild conditions
- Store electricity in a carbon containing backbone

Target reactions:

1. Anodic depolymerization of lignin fraction



Linkages		Functional groups	
a	5-5´	1	$OH_{phenolic}$
b	β-O-4´	2	carboxyl
c-c´	α-O-4´/β-5´	3	$OH_{aliphatic}$
d	β-β´	4	OH_{benzyl}
e	4-O-5´	5	methoxyl
f	β-1´	6	carbonyl
g	5-1´		

Lignin Structure with the main functional groups, linkages and substructures. Adapted From: Dobado José, G. Calvo Flores Francisco et al.

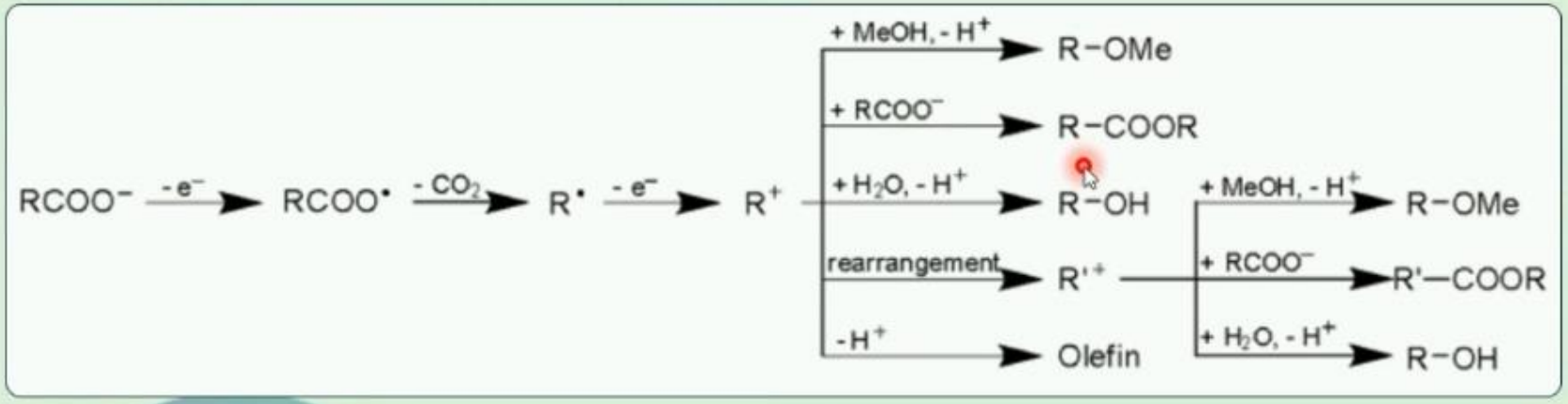
Electrochemistry:

Objective:

- Upgrade bioliquids at mild conditions
- Store electricity in a carbon containing backbone

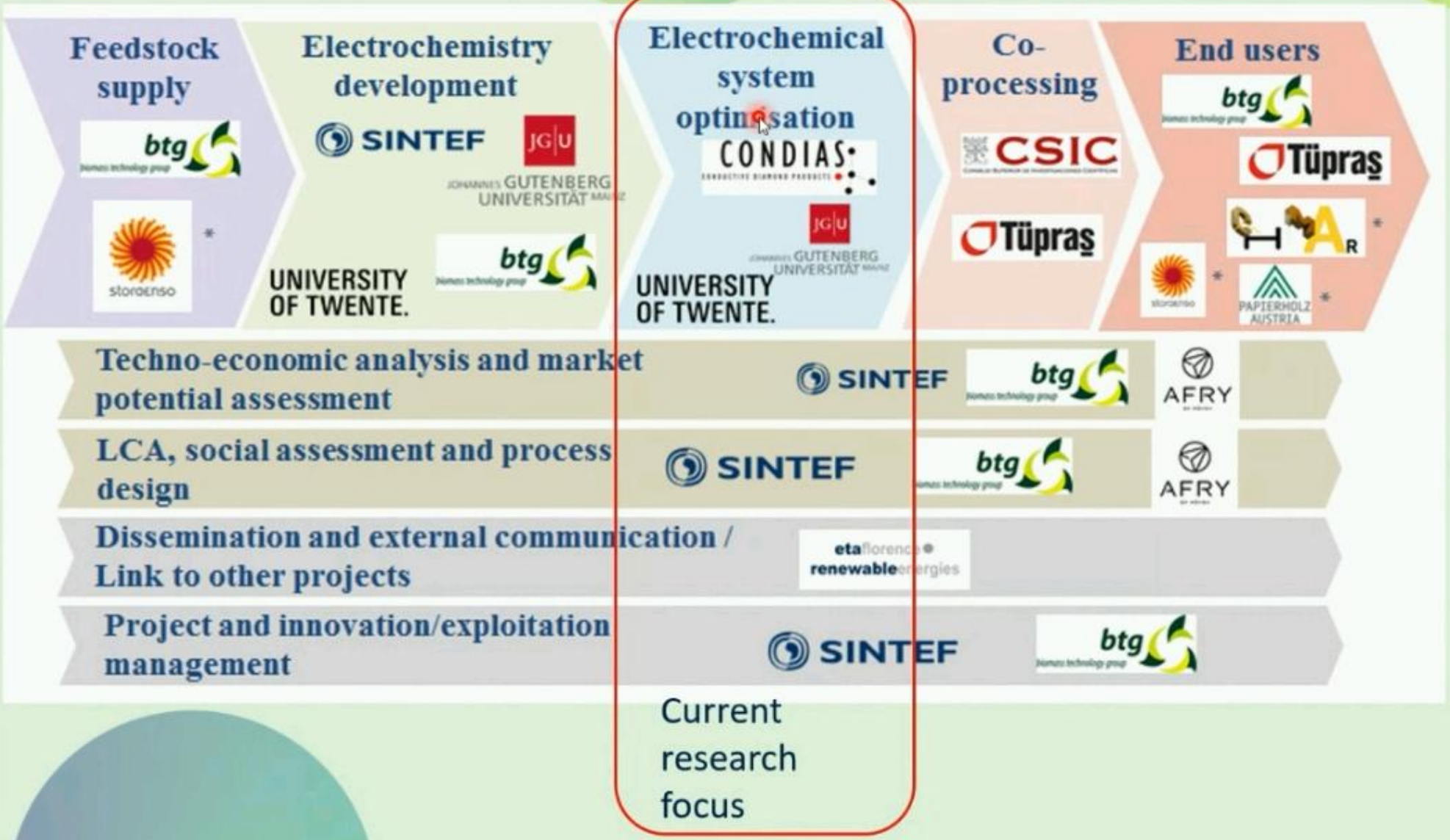
Target reactions:

1. Anodic depolymerization of lignin fraction
2. Anodic decarboxylation of acids



3. Cathodic reduction of carbonyl groups

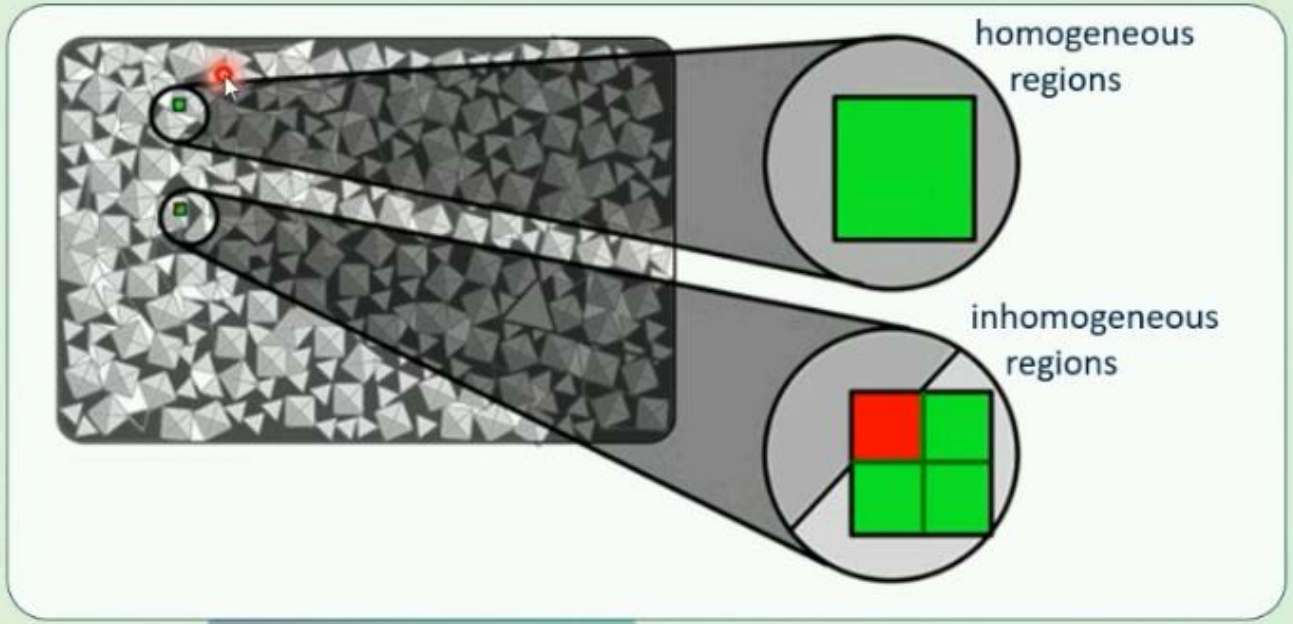
Value chain and partners



Technical research focus

Production, characterization and testing of scalable electrodes and cells

→ Variation of materials properties
→ Implementation of automated characterization methods
→ Development of novel production methods

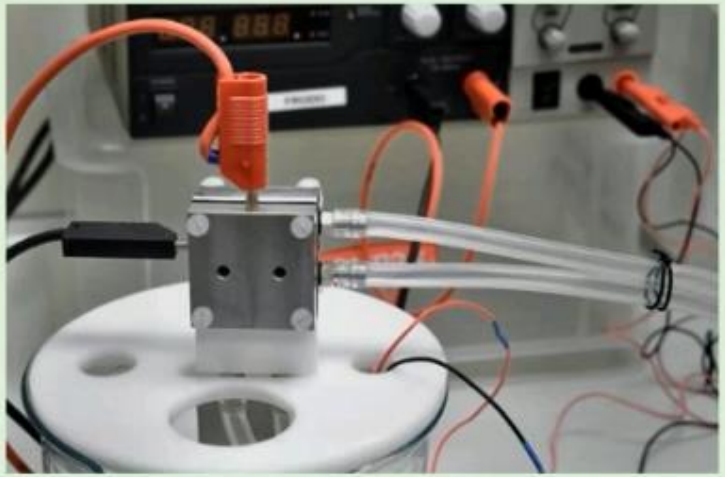


Electrochemical upgrading

→ Lignin depolymerization
→ Decarboxylation of acids
→ Hydrogenation of oxygenates

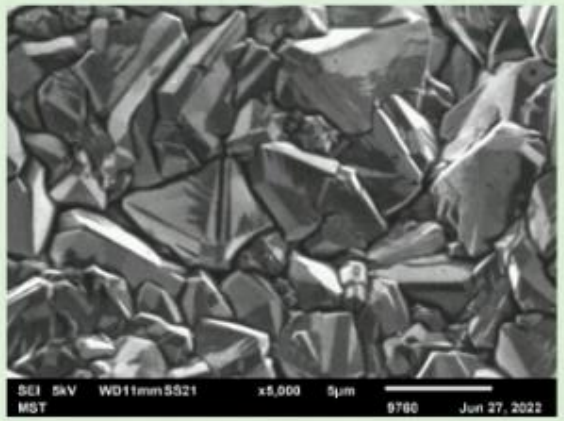
Toolbox

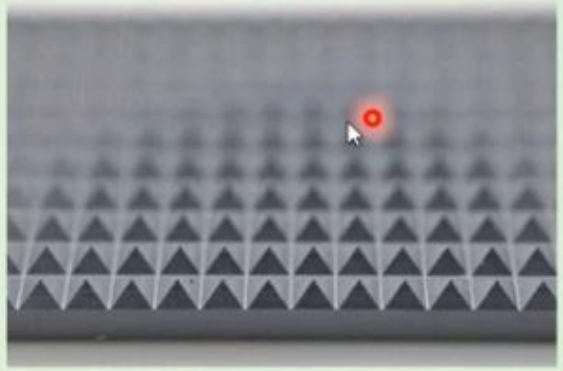
Cells/rigs



Cells in batch and continuous bench and pilot systems

Electrodes



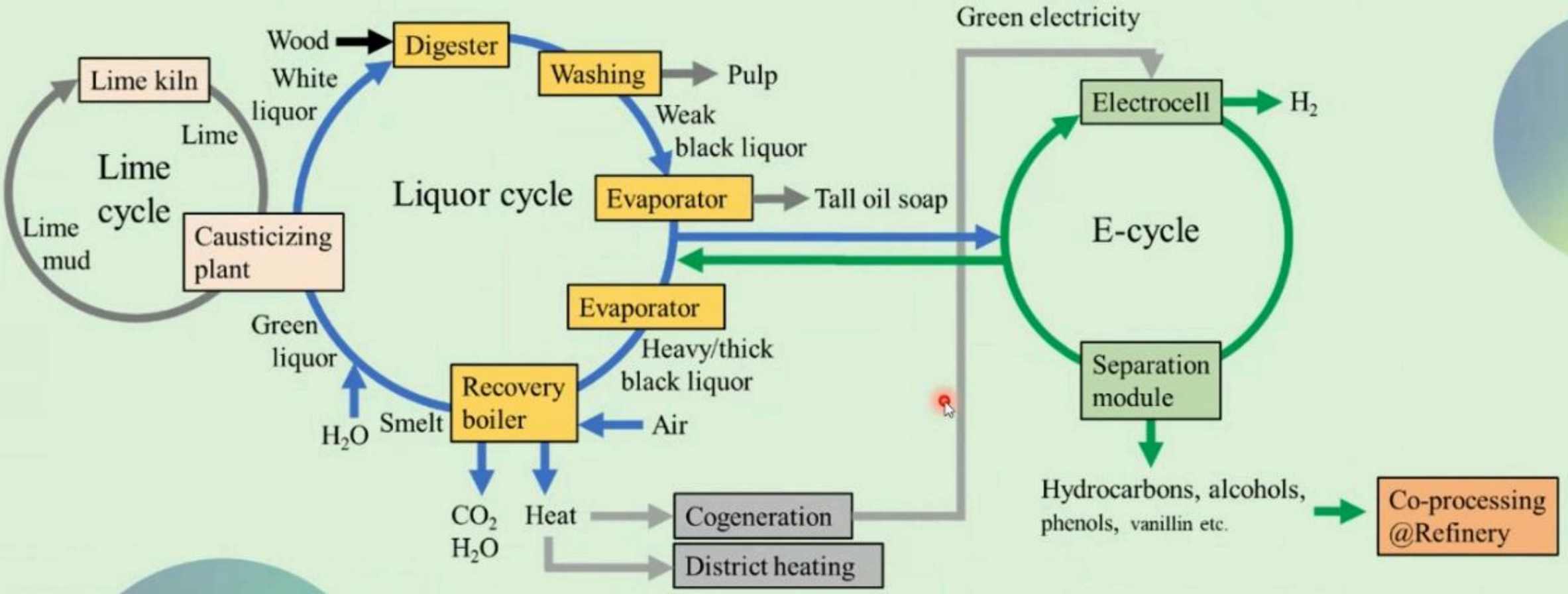


Carbon-based: Graphite, BDD
Metal-based: Ni, Cu, Pt

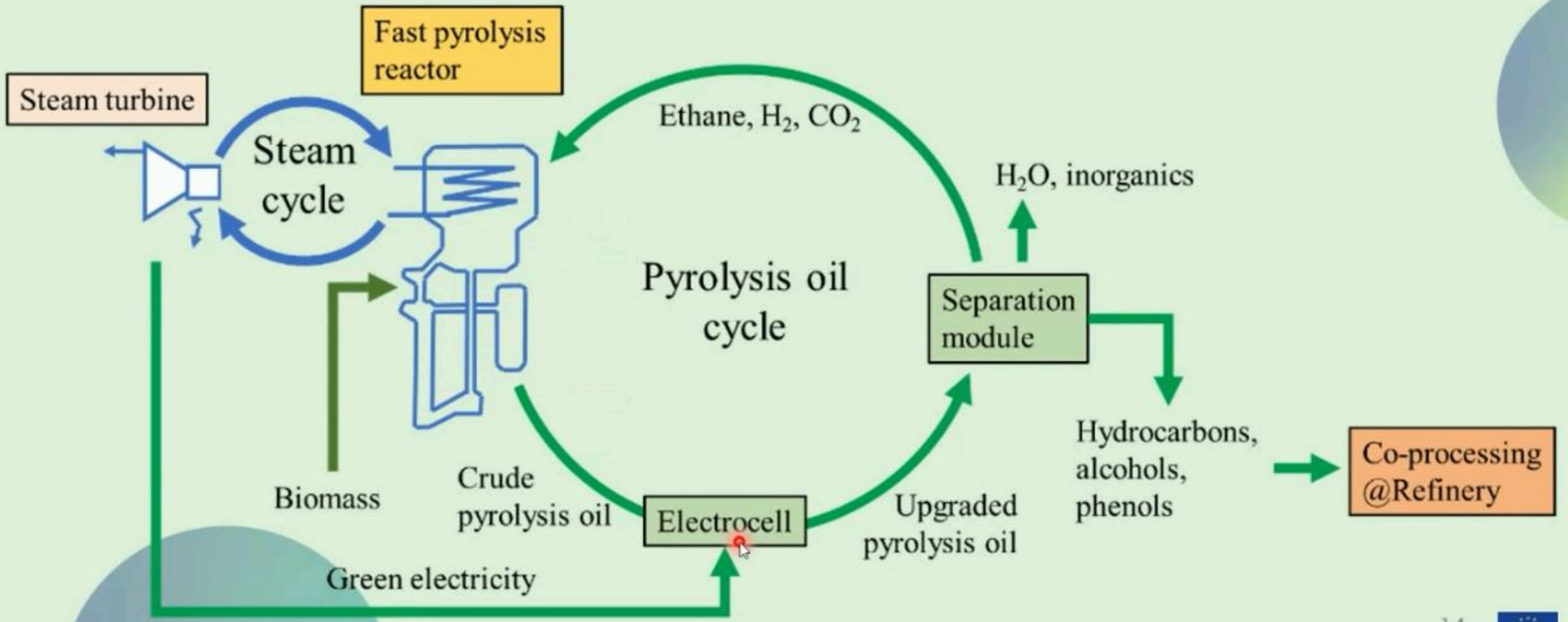
Analysis

Online:
GC, MS
Offline:
NMR, LC-MS, LC-TOF-MS, LC-MS-MS, GC-GC-MS, GPC, SEM, TEM

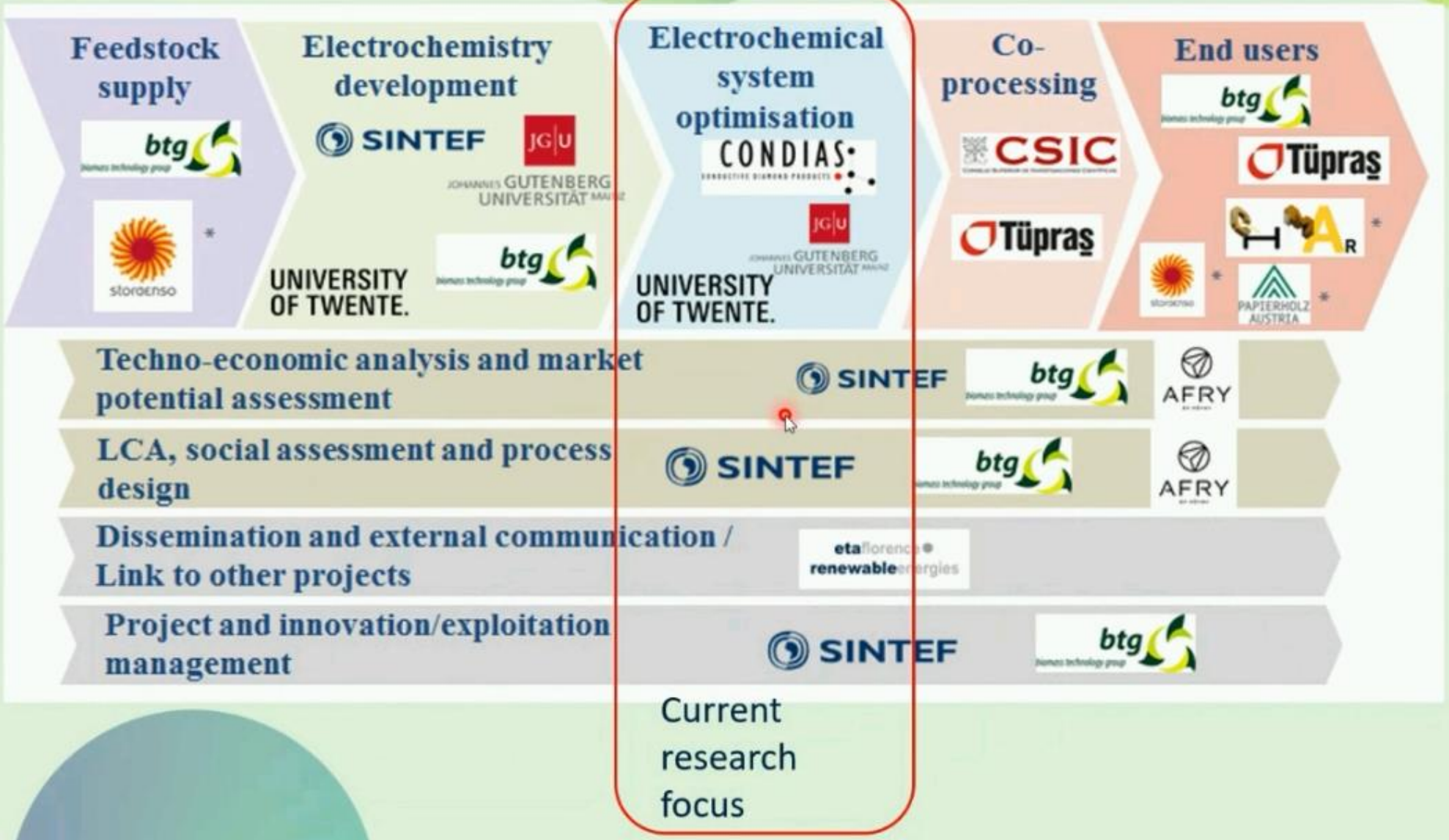
EBIO concept – Development and integration of electrochemical processes for bio crude upgrading



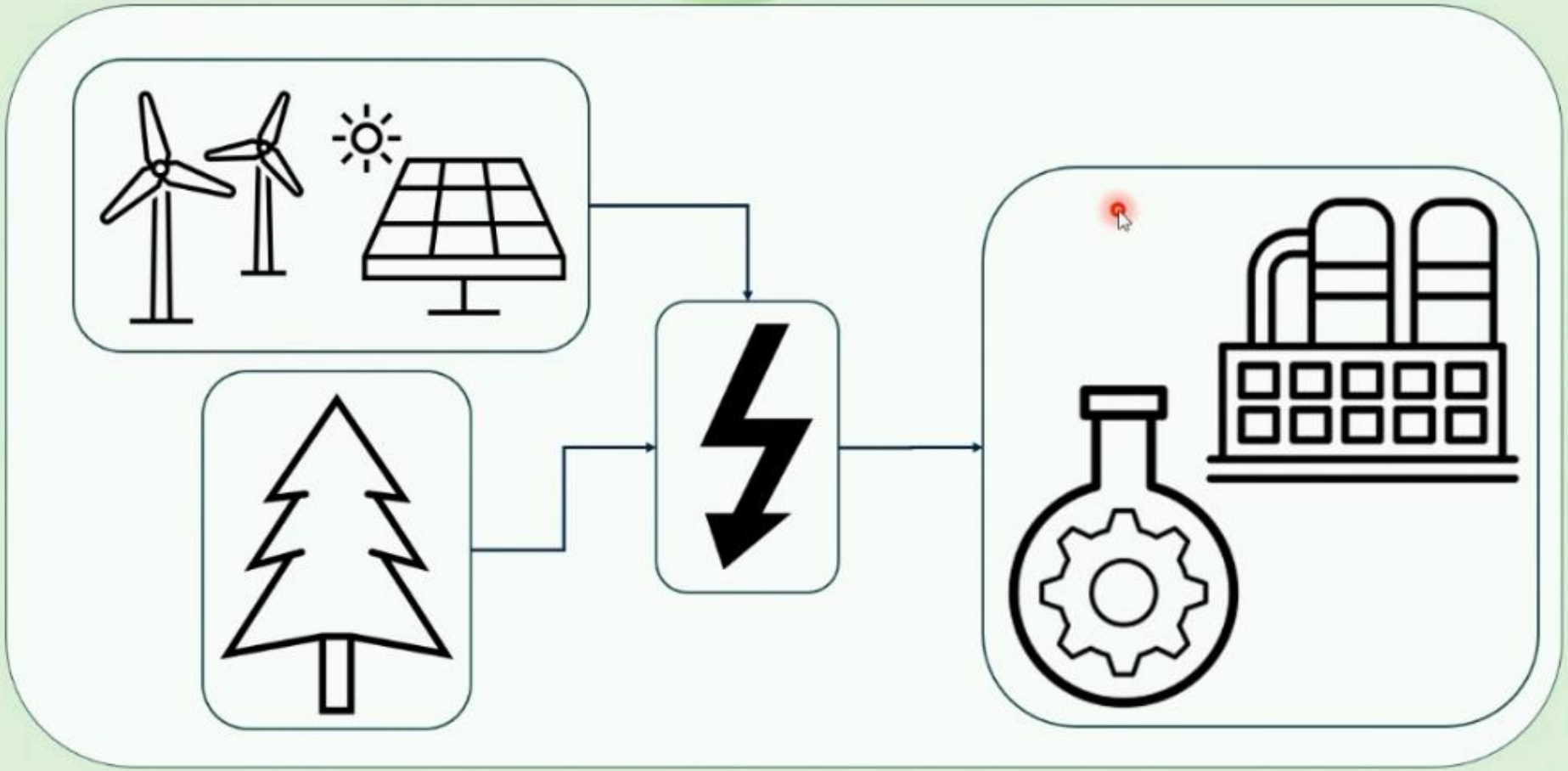
EBIO concept – Development and integration of electrochemical processes for bio crude upgrading



Value chain and partners



Use of intermittent electricity



EBIO case studies – Societal impact of a full-scale process

- Discussions with stakeholders, surveys
- Assessment of societal impact
- Identification of impact categories, criteria and possible indicators
- Description of sectoral economic linkages

EBIO

Thank you!

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