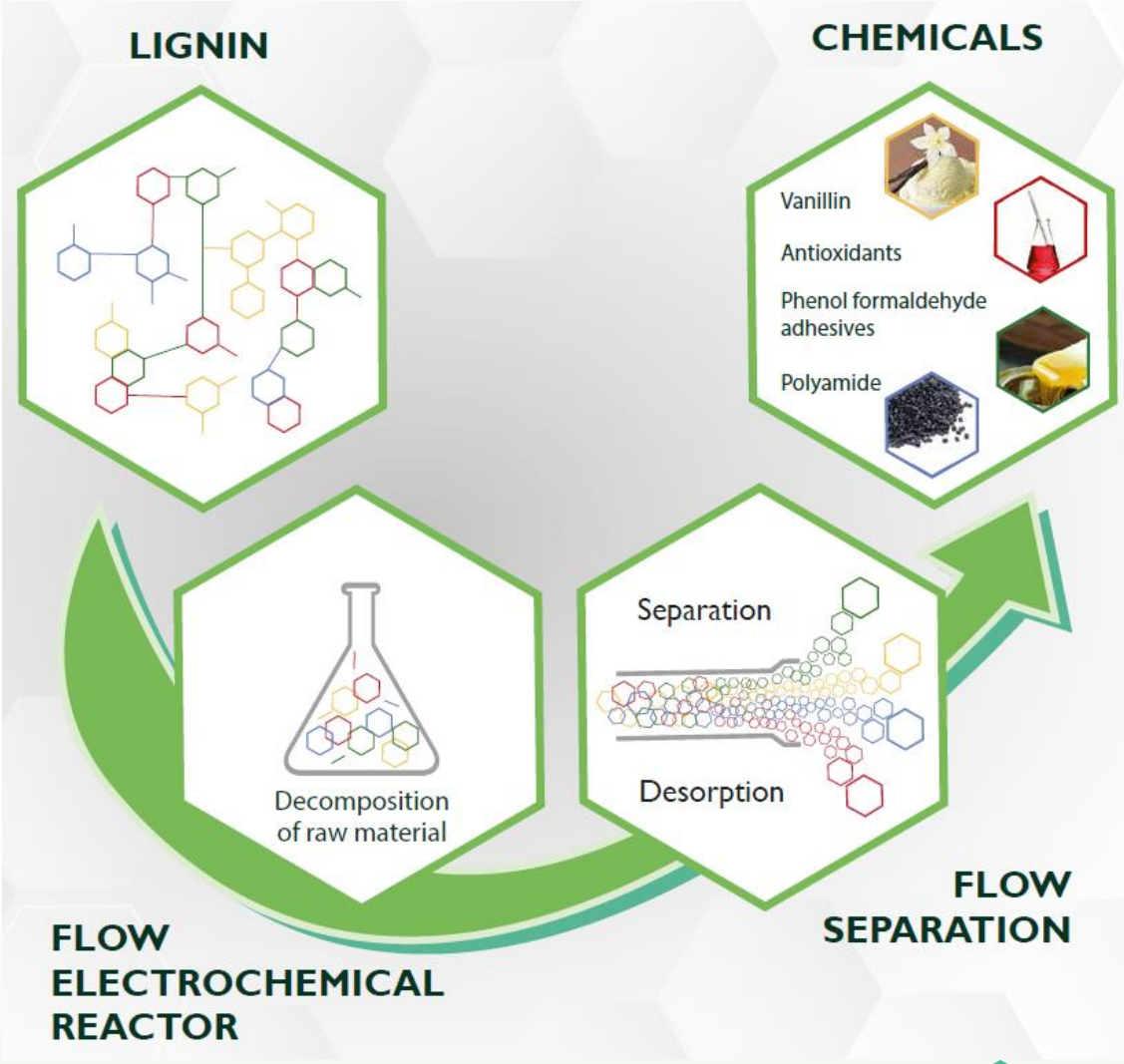
Liberate

Lignin Biorefinery Approach using Electrochemical Flow

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 820735.

Concept

LIBERATE will deliver a pilot scale electrochemical plant to demonstrate the commercial opportunities of converting low cost lignin feedstock in high value biosustainable chemicals.



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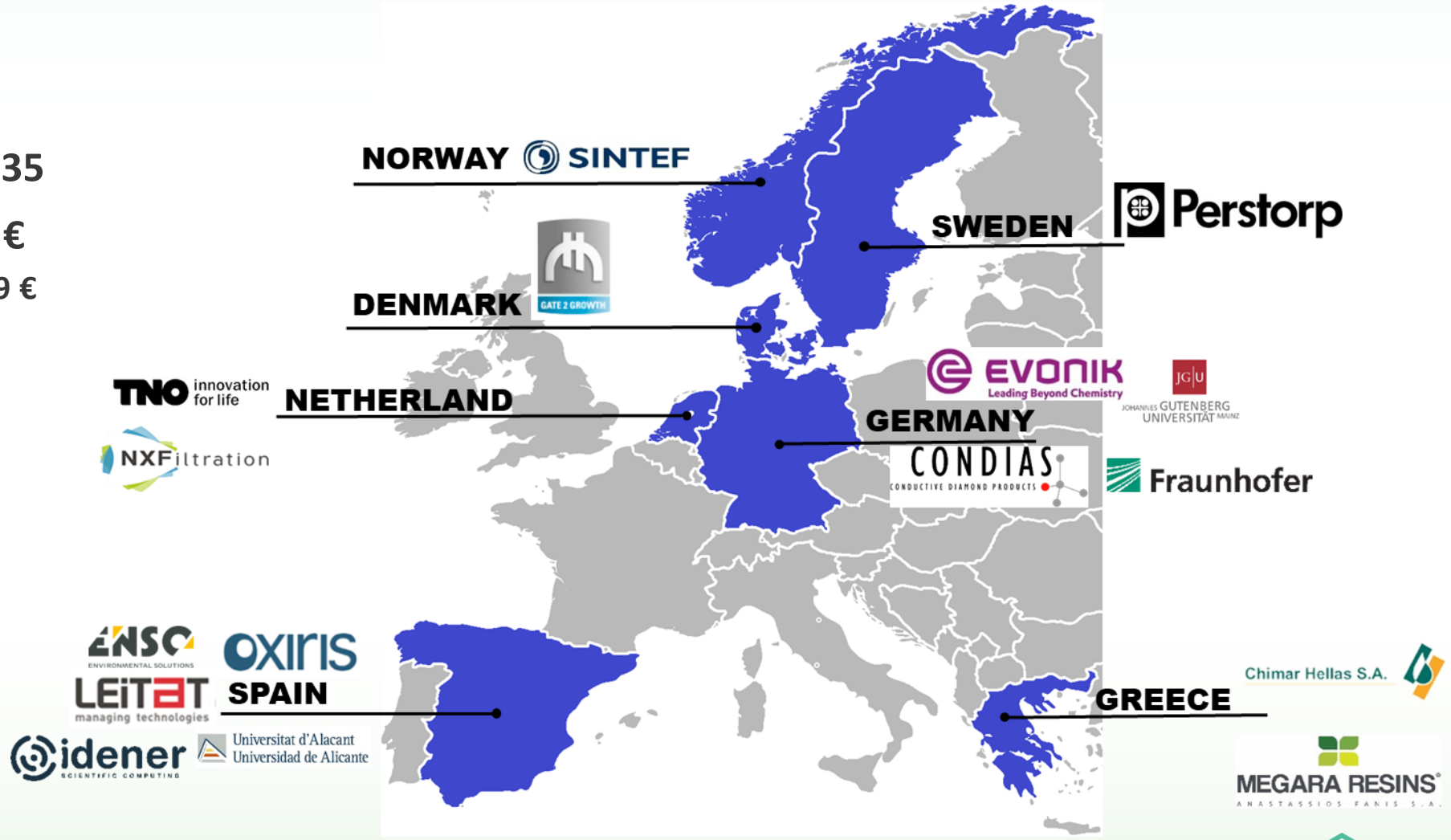
Overview LIBERATE

- **H2020-CE-SPIRE-02-2018**
- Grant agreement **n° 820735**
- Total Budget: **10.047.735 €**
  - EU contribution: **8.763.489 €**
- Duration: **09/2022**
- Coordinator: **LEITAT**



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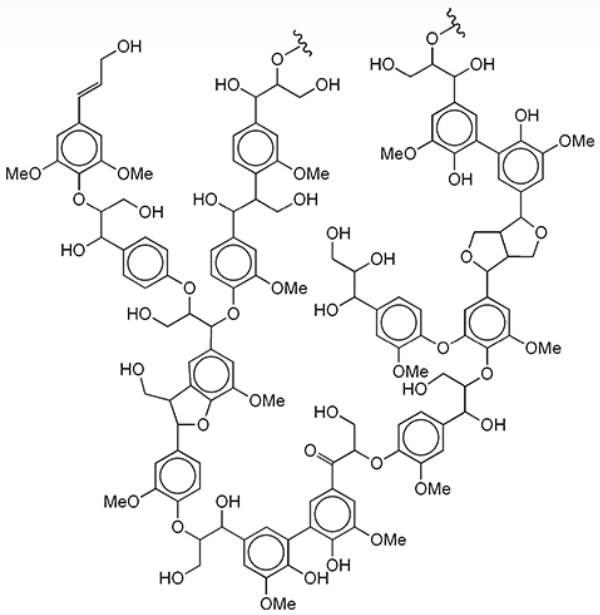
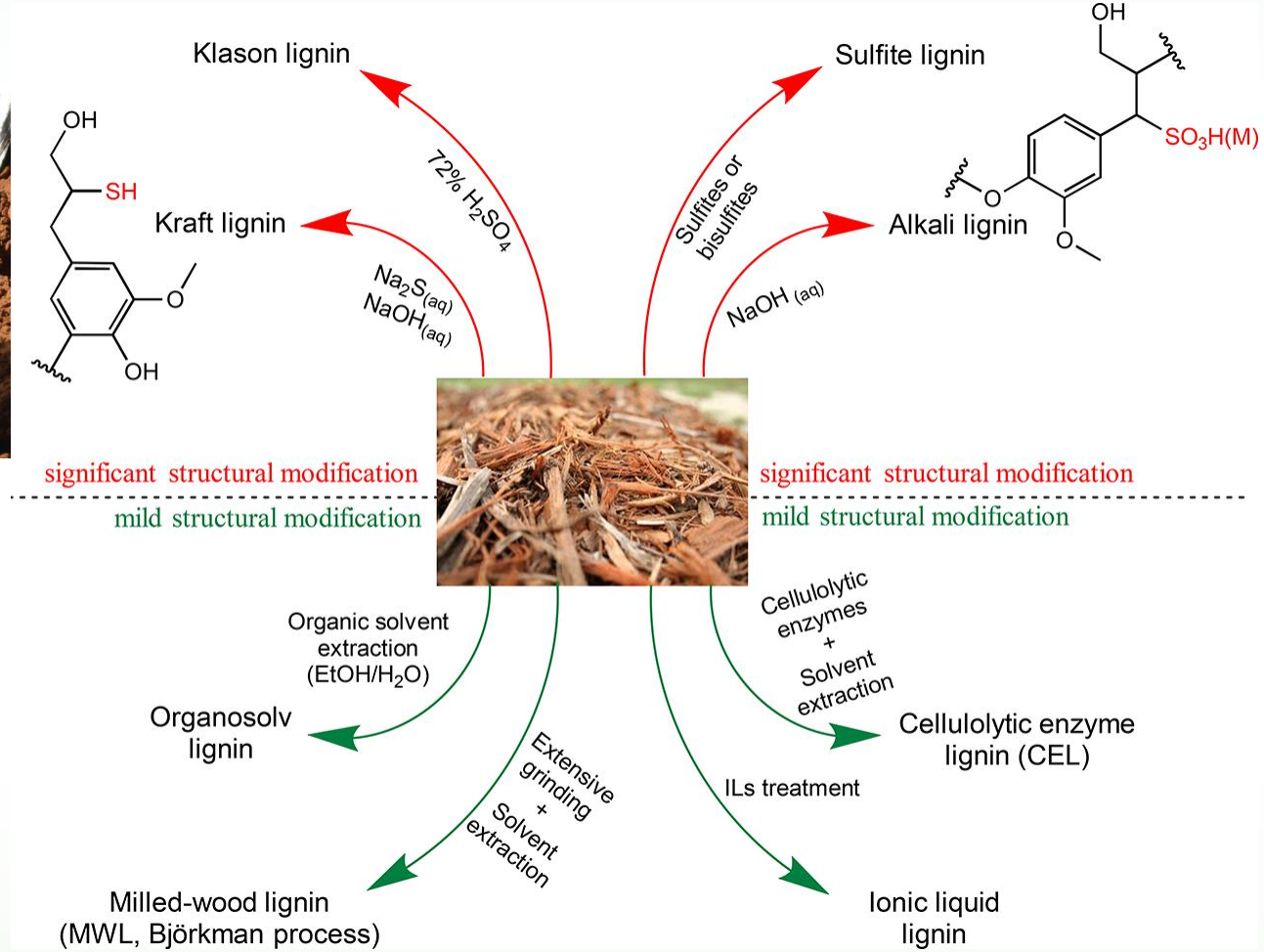
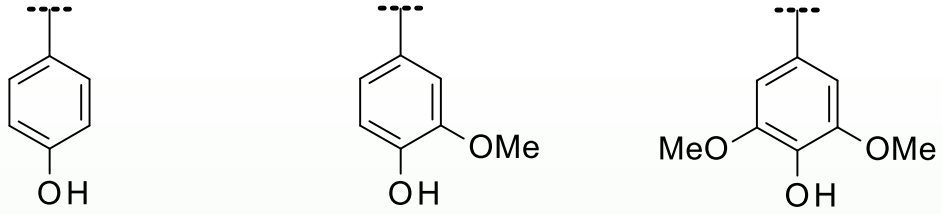
State of the art





H:G:S Ratio



Hydroxyphenyl Guaiacyl Syringyl

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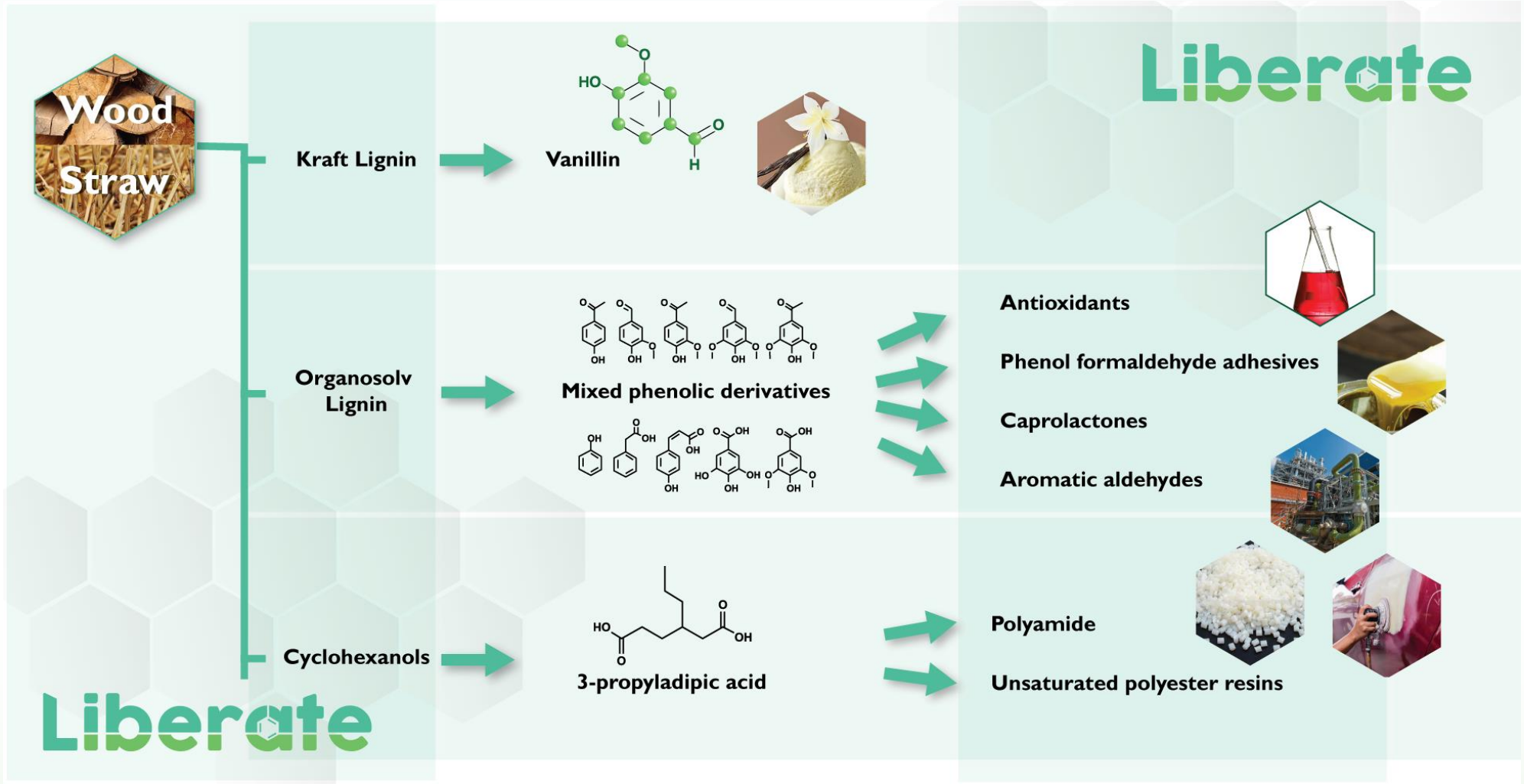
LIBERATE processes



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Main Objectives

1. Kraft lignin → 7% yield of Vanillin
2. Organosolv lignin → > 35% yield of Phenolic derivate
3. Cyclohexanol → up to 80% of propyl adipic acid
4. A biorefinery process:
   - Renewable energy fluctuations without loss in efficiency
   - Better energy efficiency (95% improvement) and Resource efficiency (350% improvement)
   - 29 times less CO_2 than the conventional petrochemical alternatives.

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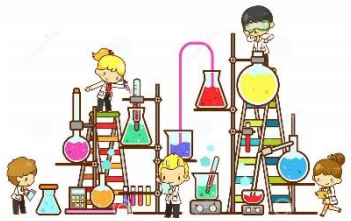
Time Line

KOM

Specifications signed off
Lignin precursor chemistry defined



Process chemistry confirmed

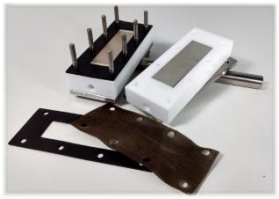
Perstorp
EVONIK POWER TO CREATE
MEGARA RESINS ANASTASSIOS FANIS S.A.
OXIRIS
Chimar Hellas S.A.

Demonstration of pilot line achieves project objectives

10/18 — 09/19 — 03/20 — 09/20 — 09/21 — 03/22 — 09/22

2018

2022



Reactor design freeze

Pilot line commissioned

Life cycle assessment

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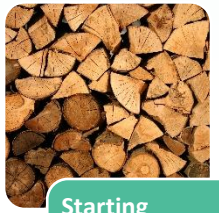
Value Chain



Starting Material

- Kraft Lignin
- Organosolv Lignin
- Cyclohexanol

TNO innovation for life

Fraunhofer CBP

Electrochemical process

- Reaction
- Electrodes
- Reactors
- RES fluctuation

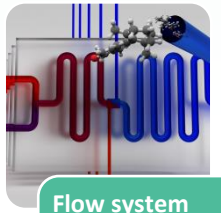
JG|U Johannes Gutenberg Universität Mainz

Fraunhofer IGB

CONDIAS Conductive Diamond Products

Universitat d'Alacant Universidad de Alicante

LEITAT managing technologies



Flow system

- Electrochemical
- Downstream

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Fraunhofer IGB

LEITAT managing technologies

SINTEF

NXFiltration

System demonstrator

- Design
- Construction

SINTEF

NXFiltration

Validation

- Energetic
- Business
- LCA

idener Scientific Computing

Universitat d'Alacant Universidad de Alicante

GATE 2 GROWTH

ENSC Environmental Solutions

Market

- Antioxidant
- Phenol-formaldehyde
- Caprolactones
- Aromatic aldehydes
- Polyamide
- Polyester

OXIRIS

Chimar Hellas S.A.

Perstorp

EVONIK Leading Beyond Chemistry

MEGARA RESINS Anastassios Fanis S.A.

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What we have achieved?

Organosolv Lignins

- Production of different organosolv lignins from softwood, hardwood and herbaceous biomass under various fractionation conditions and staged lignin precipitation for improved electrochemical depolymerisation efficiency.
- Validation of fractionation conditions on the electrochemical lignin depolymerisation behaviour revealed differences in depolymerisation rates.

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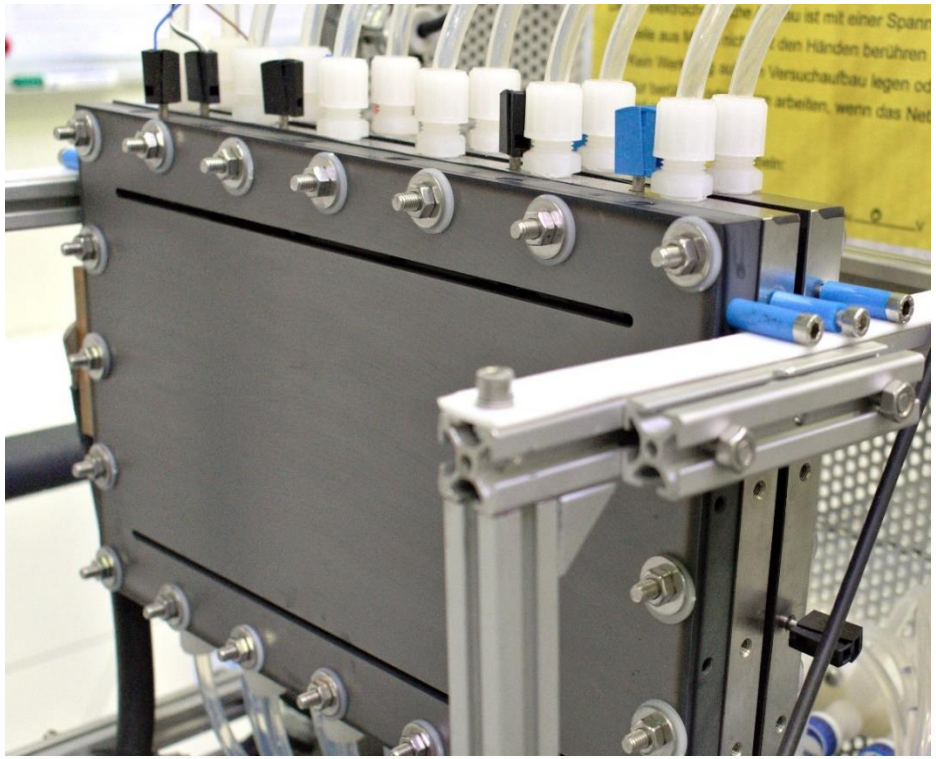
What we have achieved?

Electrochemical Reactors



- Filter-press reactor and tubular reactors designed.
- Electrode materials and shapes were performed using different techniques, such as additive manufacturing or chemical vapor deposition.
- The electrodes surviving more than 15 days working in the reaction media at currents up to 240 mA/cm^2 without micro- or macroscopic corrosion or significant loss of efficiency.
- Reactors are in progress to be tested with the corresponding procedures to validate and select the best options for the implementation.

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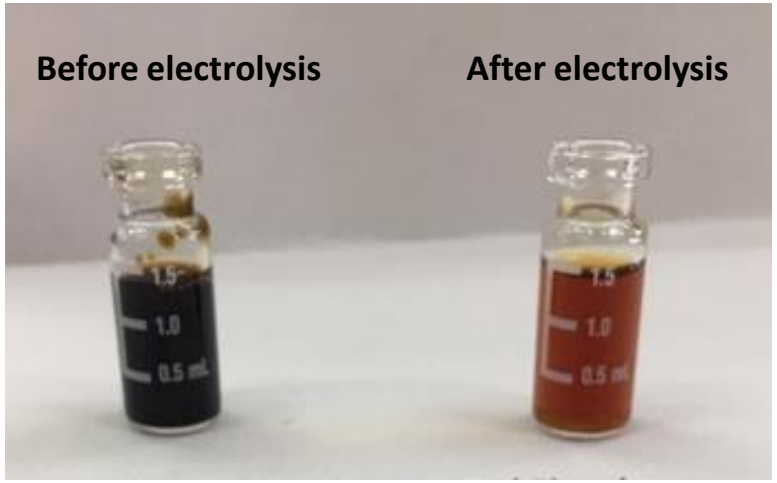
What we have achieved?

Electrochemical process and downstream

- Production:
  - Vanillin from commercial kraft lignin up to 6 %wt of yield (three times higher than the actual commercial process and 91% effectiveness, comparing with the theoretical highest yield calculated).
  - Propyl adipic acid production: 60% of yield.
  - Both reactions to larger electrode surface and consequently a larger area was established without significant changes regarding yield or selectivity.
- Downstream: lab tests were done using different single module filtration:
  - Single module filtration: Selectivities around 85% for lignin and up to 75% for different phenolic compounds
  - Coupling with ion exchange resins: tuning the solvent condition, nearly 100% of the mono aromatic phenols could be recovered.



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Thank you for the attention

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