IEA Bioenergy
Technology Collaboration Programme

IEA Task 34 Direct Thermochemical Liquefaction

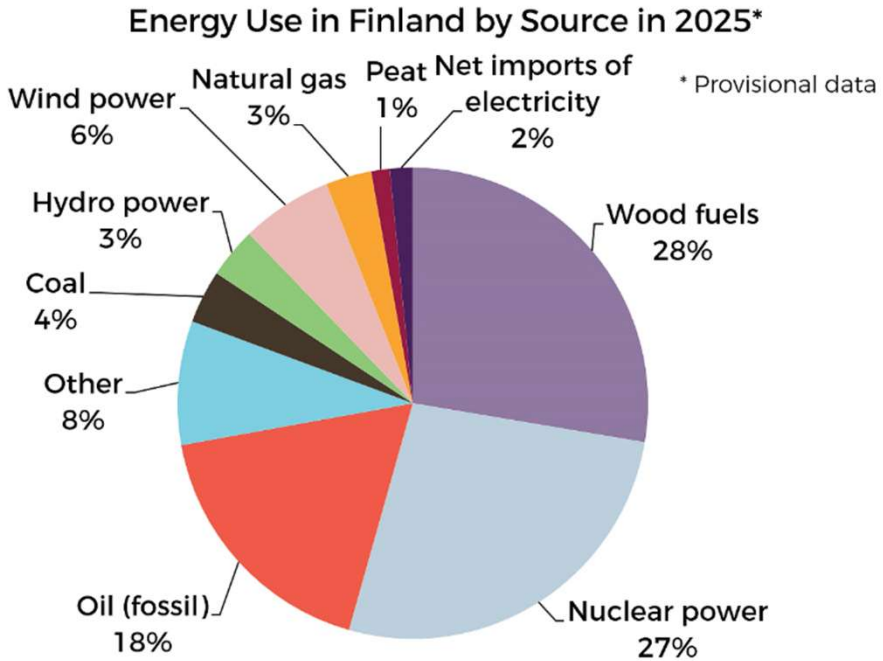
Finland country report 2026

Christian Lindfors

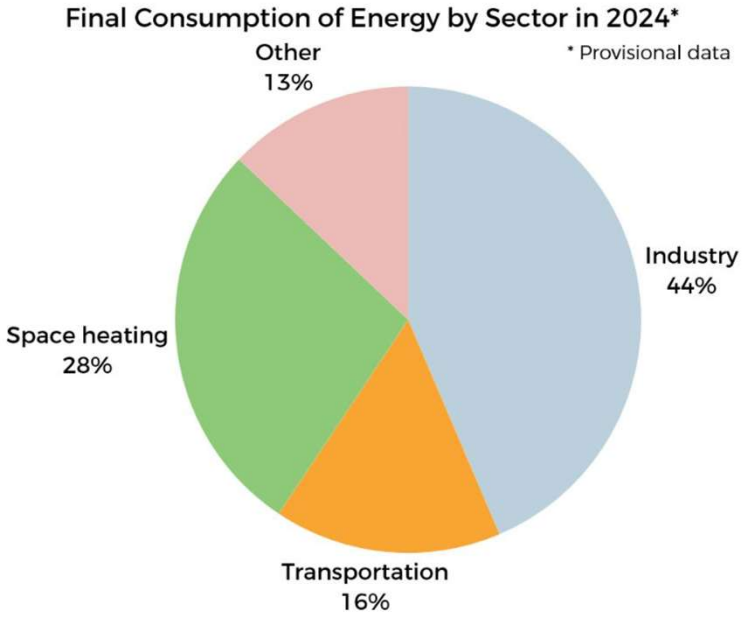
Austria 30.6.2026

Energy consumption in Finland

- Total energy consumption in Finland in 2025 was 1 278 PJ



Picture 1. Energy Use in Finland by Source in 2025.

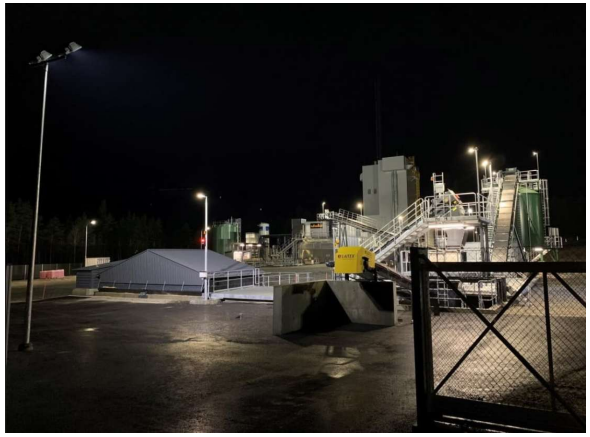


Source: Statistics Finland

Industrial projects

Green Chem, Lieksa

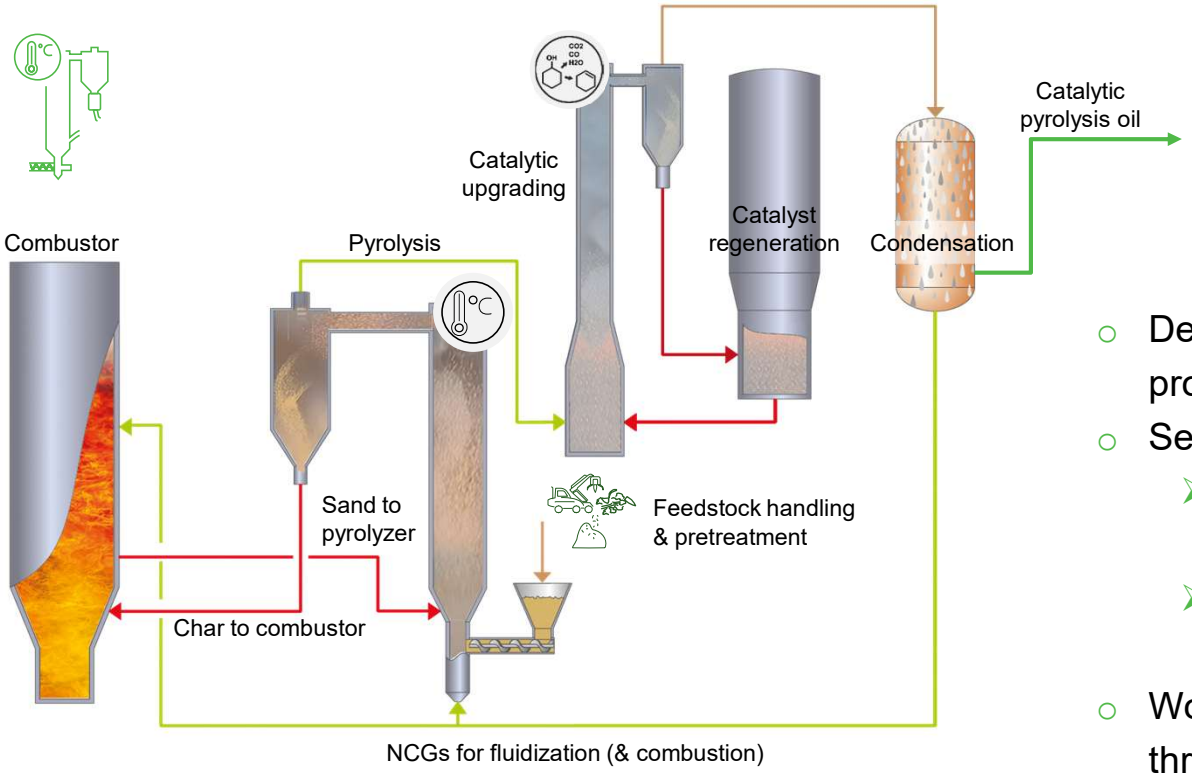
- Reactor technology: rotating cone, BTG-BTL technology
- Location: Kevätniemi, Lieksa
- Capacity: Around 90 000 m3 of raw material is converted into 20 million liters (24 000 t) of bio-oil annually
- Start-up: End of 2020
- Feedstock: Wood
- Investment: 25 M€
- In March 2024 Green Fuel Nordic filed for bankruptcy.
- The primary reason was the increased costs of feedstock and energy due to the war between Russia and Ukraine.
- In 2025 the plant was sold to BTG Bioliquids and further to Green Chem (Timo Saarelainen and Sergei Malkov)
- Target of this two-stage corporate acquisition was to reduce the risks.

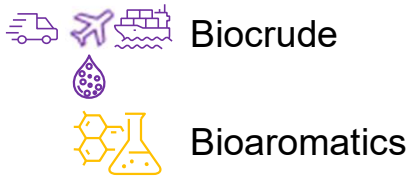


Valmet Energy R&D Center in Tampere, Finland

- Valmet has been developing innovative technologies to produce pyrolysis oil through fast pyrolysis for more than two decades.
- Recognizing the inherent challenges of conventional fast pyrolysis oil, a mission to enhance oil quality through catalytic fast pyrolysis started.
- Initial investigations started first in laboratory scale and were later tested also in bench and pilot.
- The results & findings matched the expectations, which led to the construction and commissioning of the largest pilot plant with a 400 kg/h feeding rate in Tampere, Finland.

Valmet Pyrolyzer with catalytic upgrading, for biomass





- Deoxygenation and aromatization of pyrolysis vapors to produce a condensate with low O and low acidity
- Separate stages for pyrolysis and catalytic upgrading
  - Reduction of catalyst contamination from impurities in the feedstock
  - Process parameters can be controlled independently in pyrolysis and catalytic stages
- Work has continued with post-treatment of the oil through hydrodeoxygenation, performed in
- collaboration with technology partners.
- The goal is to produce upgraded oil similar to hydrocarbons in the range of gasoline and diesel.

VTT research projects

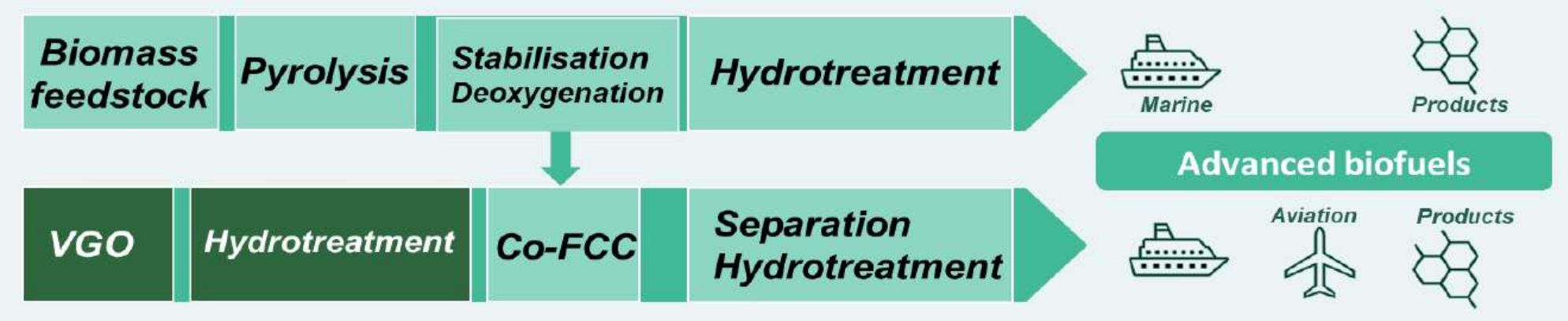
REFOLUTION
Unlocking the potential of biofuels

2023 - 26

VTT

Fast pyrolysis to advanced bio-oils

Refinery integration, scale-up and certification for aviation and marine biofuels production

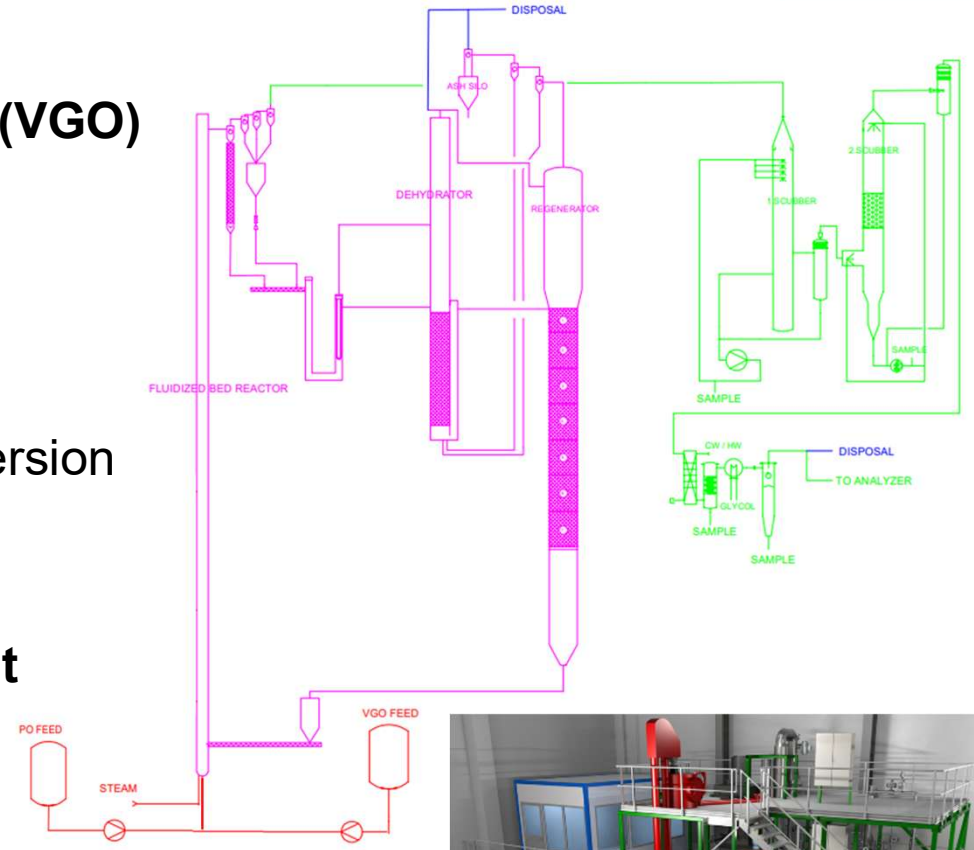


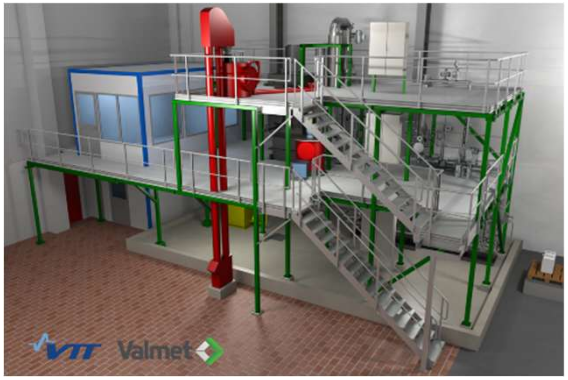
Virtual Special Issue of Recent Advances in Biofuel Production via Co-refining Route. Oasmaa, A., Elliott, D. C. & Prins, W., 18 May 2023, In: Energy and Fuels. 37, 10, p. 6875-6878 4 p. Access to Document: 10.1021/acs.energyfuels.3c01384

Co-processing of Biocrudes in Oil Refineries. Lindfors, C., Elliott, D. C., Prins, W., Oasmaa, A. & Lehtonen, J., 19 Jan 2023, In: Energy and Fuels. 37, 2, p. 799-804 6 p. Access to Document: 10.1021/acs.energyfuels.2c04238

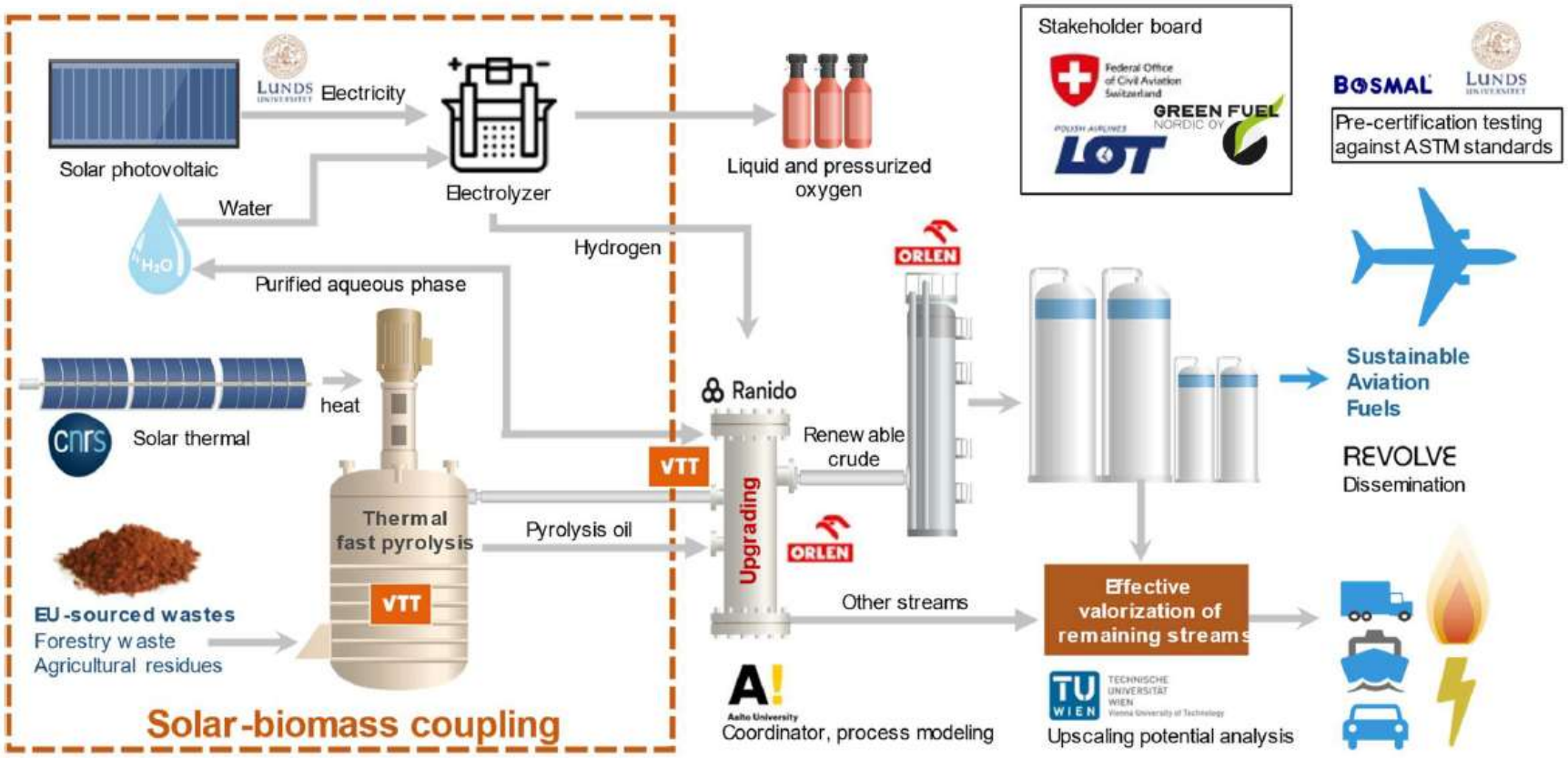
Co-FCC pilot

- Co-FCC unit for **co-processing vacuum gas oil (VGO)** and **bio-oil** as renewable feed
  - Feeding rate 10-15 kg/h
  - Bio-oil feeding rate 1 kg/h
- **Unit facilities include:**
  - **Riser** reactor for catalytic cracking and co-conversion
  - **Cyclones**
  - **Stripper** and **dehydrator**
  - Circulating catalyst loop with continuous **catalyst regeneration**
  - **Sidestream sampling**
  - **Condensation system** for liquid product recovery
  - **Online gas analysis** and **catalyst sampling points**





EU CIRCULAR FUELS 2023 - 26



- The Circular Fuels process concept for the coupling of concentrated solar heat to the fast pyrolysis of EU-sourced waste feedstocks. The resulting bio-oil is then upgraded using solar hydrogen by advanced hydrotreatment processes and distilled to produce sustainable aviation fuels.

BF Bio4all 2024 - 26

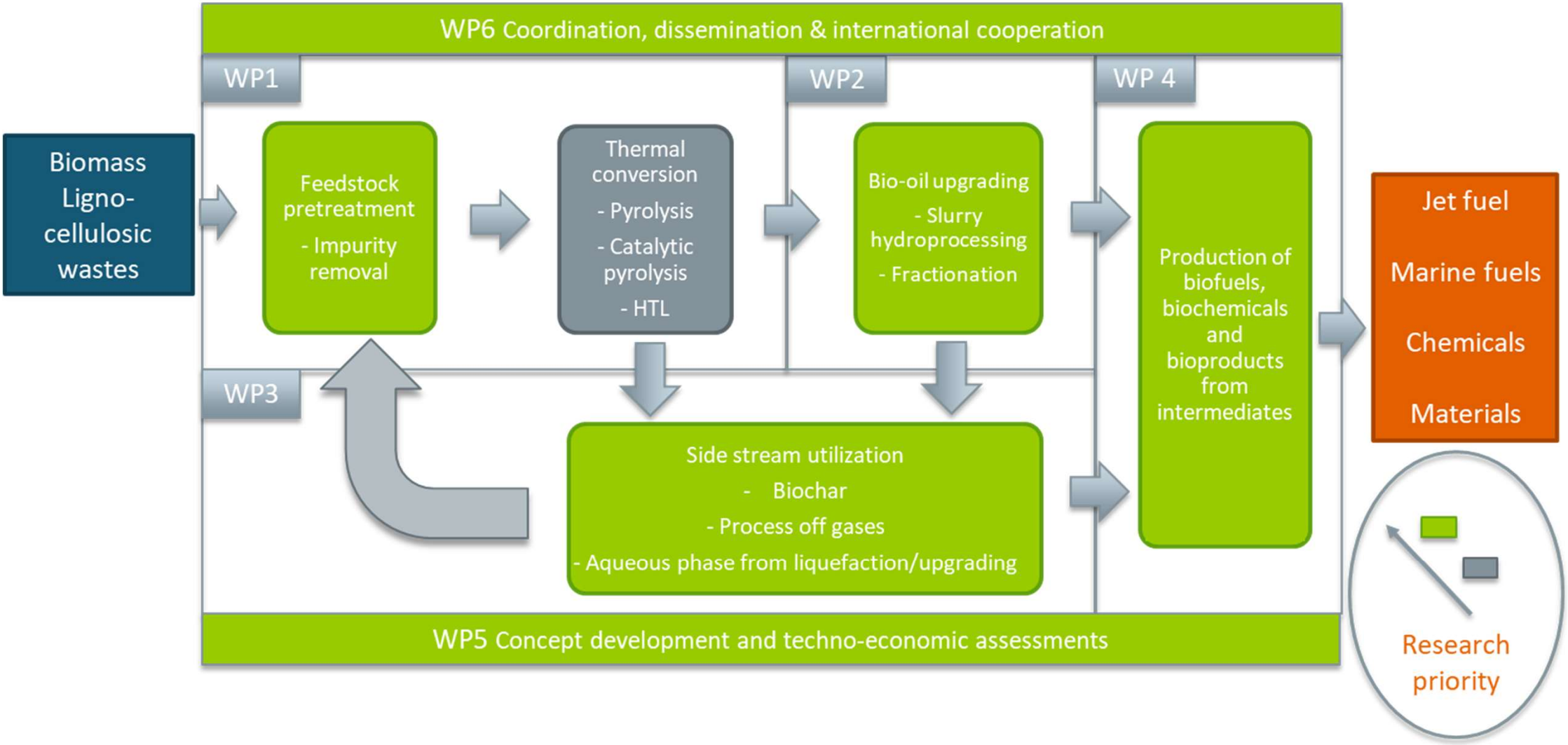
Sustainable chemicals and fuels from biomass residues

Improving carbon efficiency of liquefaction-based values chains. Production of advanced fuels, chemicals and cracker feeds from biomass wastes and residues.

In the core of the Bio4all are the biomass liquefaction technologies with the target to improve the carbon efficiency and side stream utilization of these processes. The produced bio-oil intermediates will be upgraded by catalytic technologies to transportation fuels and petrochemistry feedstock. Studied value chains unlock the route from bio-based waste streams towards cracker feeds.

Elmeri Pienihäkkinen, Research Scientist
Tel. +358 40 631 4199, elmeri.pienihakkinen@vtt.fi
Juha Lehtonen, Research Professor
Tel. +358 50 407 1075, juha.lehtonen@vtt.fi

BF Bio4all – Targeted concept and WP structure



CETP-LowCoBio – Low corrosion biofuel production processes

Analysis of corrosion properties of bio-oils from different origin. Investigating the effect of different pre-treatments to the corrosion properties before and after processing steps.

Coordinator: Linda Sandström, RISE
linda.sandstrom@ri.se
Juha Lehtonen, Research Professor
juha.lehtonen@vtt.fi

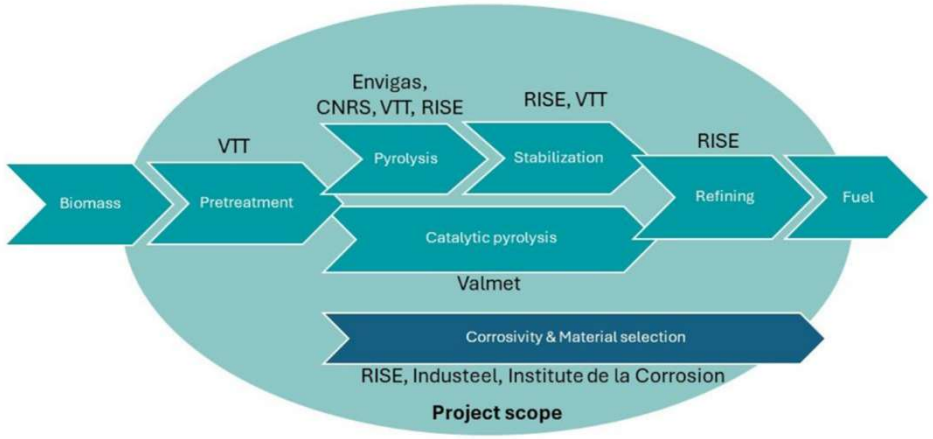


Figure 1. A schematic overview on fuel production from biomass, either via thermal pyrolysis followed by stabilization or by catalytic pyrolysis. Material selection and corrosivity issues are important throughout the production. Project focus is on all conversion steps and all products from the biomass to the finished fuel. The main contributions of each partner are indicated in the figure.

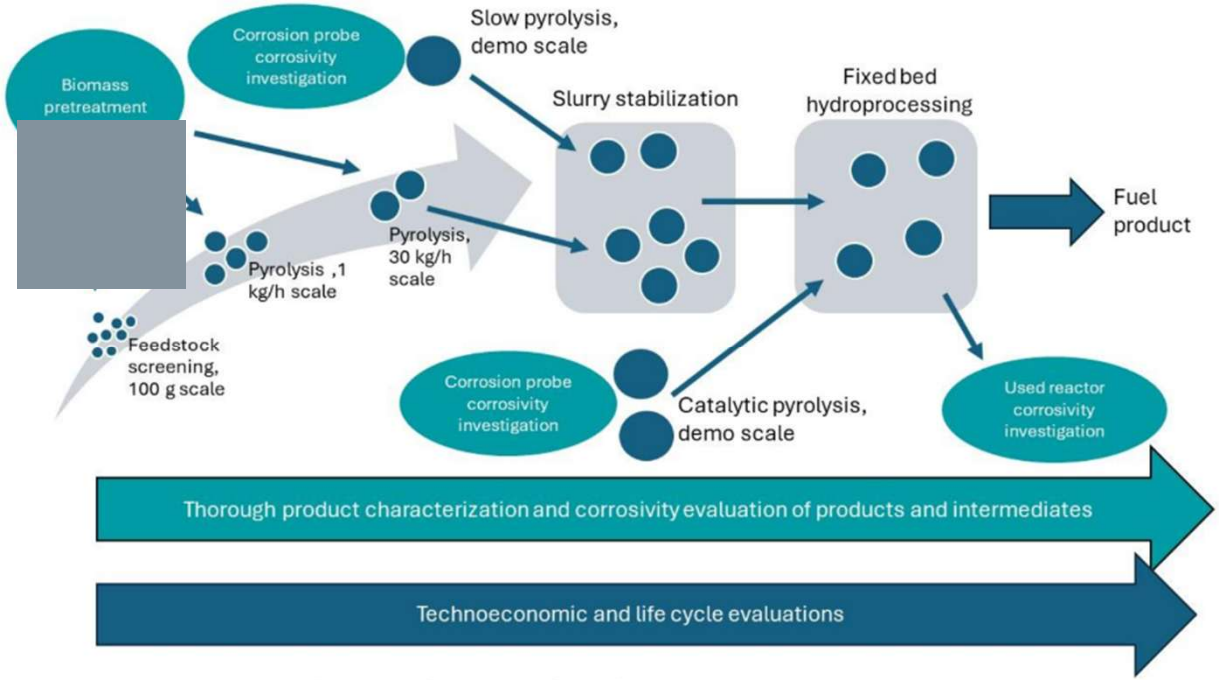
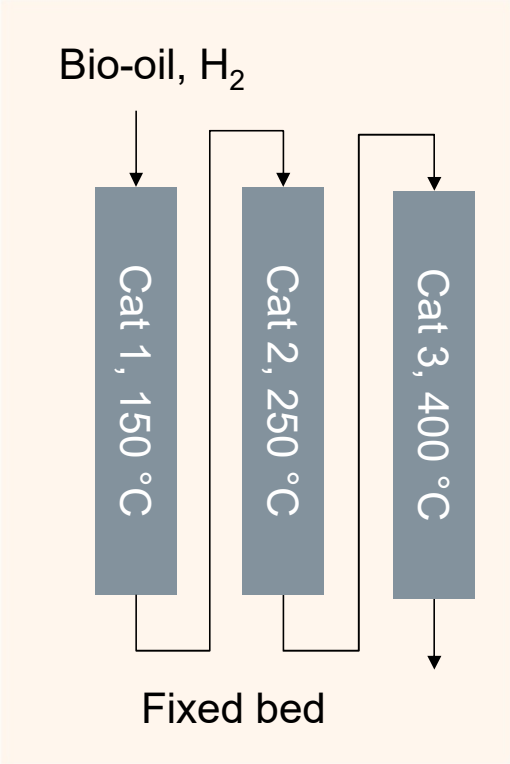


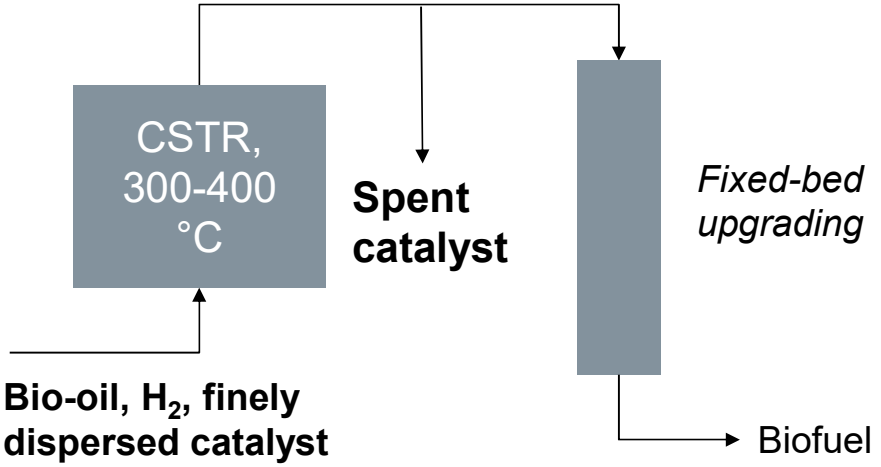
Figure 2. Overview of LowCoBio project methodology.

BUSINESS FINLAND

Slurry hydroprocessing of bio-oil



- Bio-oil stabilization
  - Removal of unstable oxygen compounds
  - Adjustment of physical and chemical properties for further upgrading
- Continuous catalyst removal and replacement
- Recirculation and/or recovery of catalyst



Funded by the European Union

VTT's slurry hydrotreater

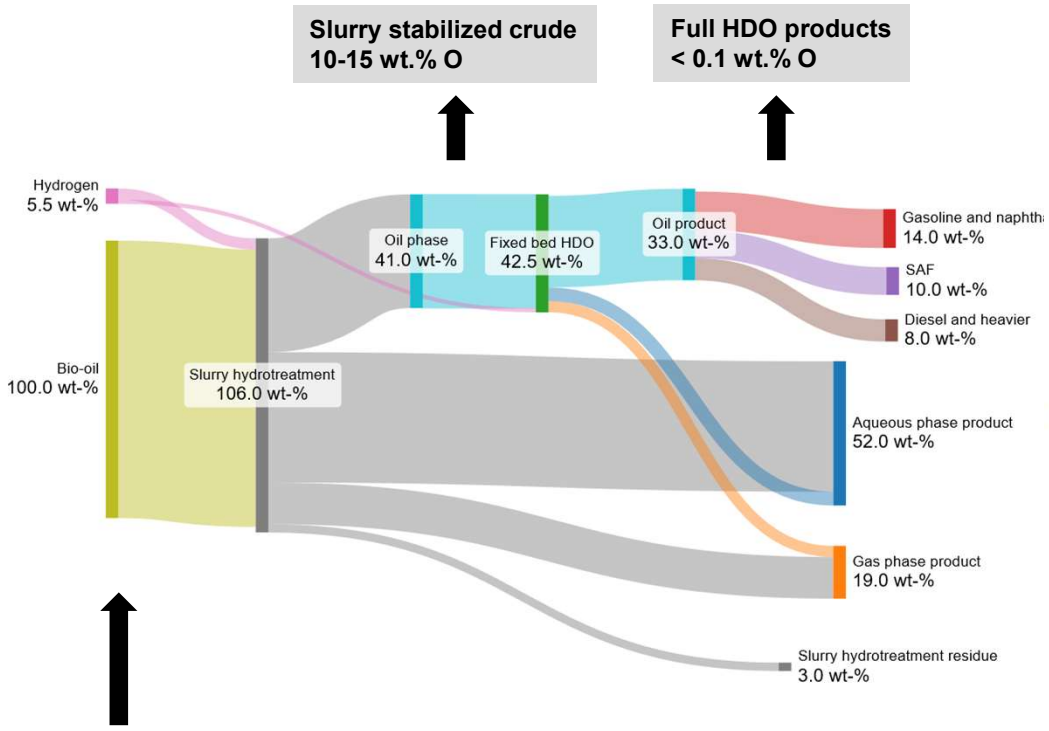
- CSTR miniplant
  - Two 250 ml Hastelloy reactors in series
- Designed for hydroprocessing challenging feedstocks
  - Up to 20% solids in the feed
  - 200 bar, 500 °C
  - Min. ~3 L of feedstock required for representative sample
  - Extensive product separation capabilities

  ➔Slurry hydrotreatment of bio-oil

  ➔Hydroliquefaction of biomass or plastics
- Automated for 24/7 unmanned operation and sampling, online gas-GC
- Feed gases H_2 and N_2
- 0.5-3 kg/day capacity
- Currenly in commissioning, **on-stream Jun 2026**

Mass & carbon balances

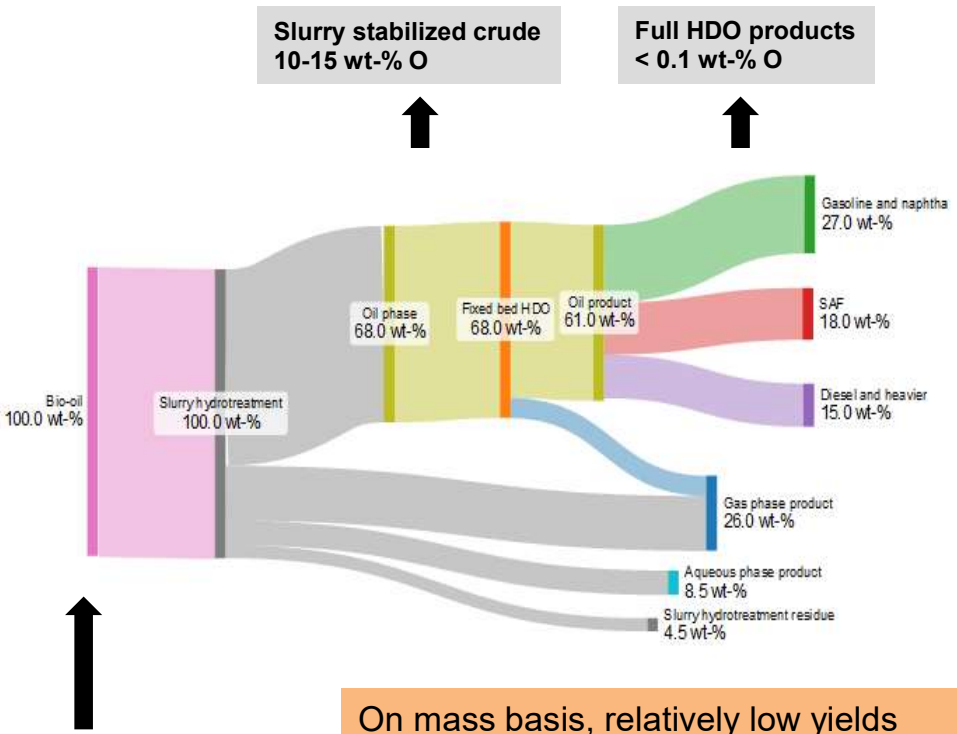
Mass balance



Sawdust-based FPBO
45-49 wt.% O

Mass-based total aqueous phase 52 wt-%

Carbon balance

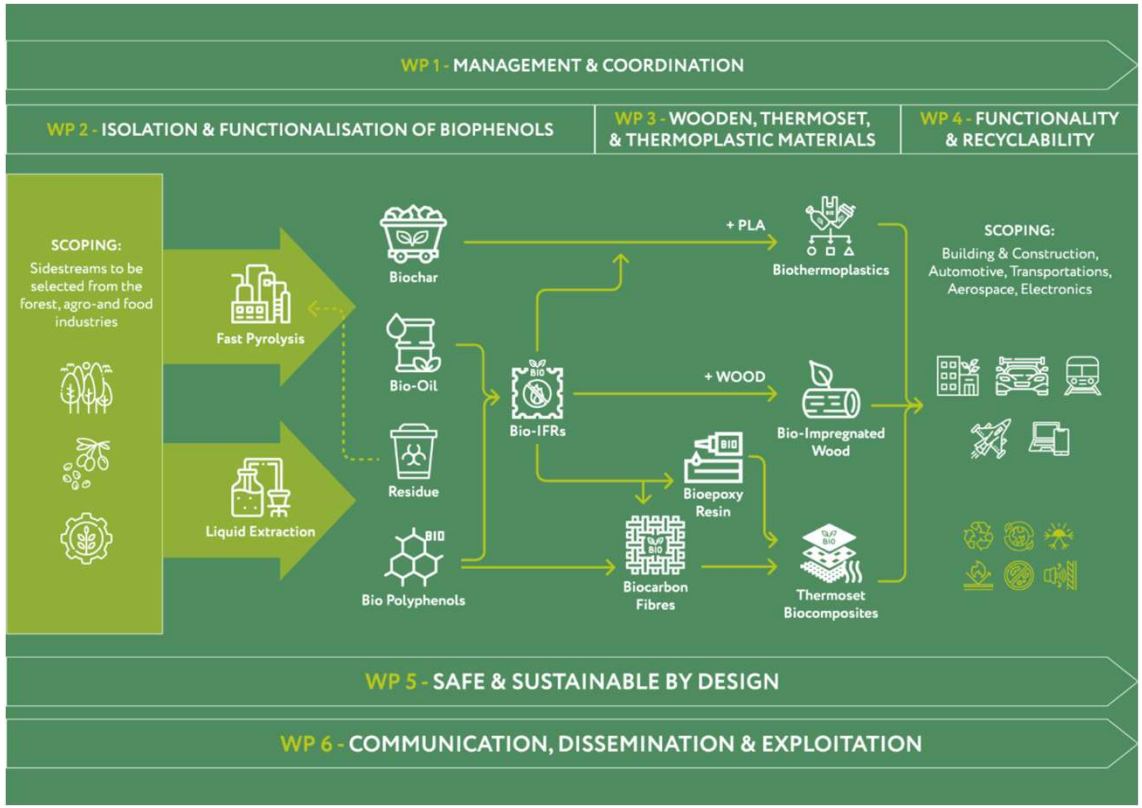


Sawdust-based FPBO
45-49 wt.% O

On mass basis, relatively low yields observed due to high water formation. On carbon basis, 61% yield from bio-oil to liquid range hydrocarbons.

BiPhenom 2024 - 28

- Isolation of biophenols by fast pyrolysis (pyrolytic lignin) and liquid extraction.
- Synthesis of multifunctional bio-based intumescent flame retardants (bio-IFRs) by adding nitrogen into biophenols.
  - Impregantion of wood to improve its biological durability and fire resistance.
  - Use of bio-IFRs in the syntehsis of epoxy resins, biocarbon fibres, and as additive in thermoset and thermoplastics.
- Use of biochar as additional flame retardant agent.



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christian.lindfors@vtt.fi

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