Bio4Fuels

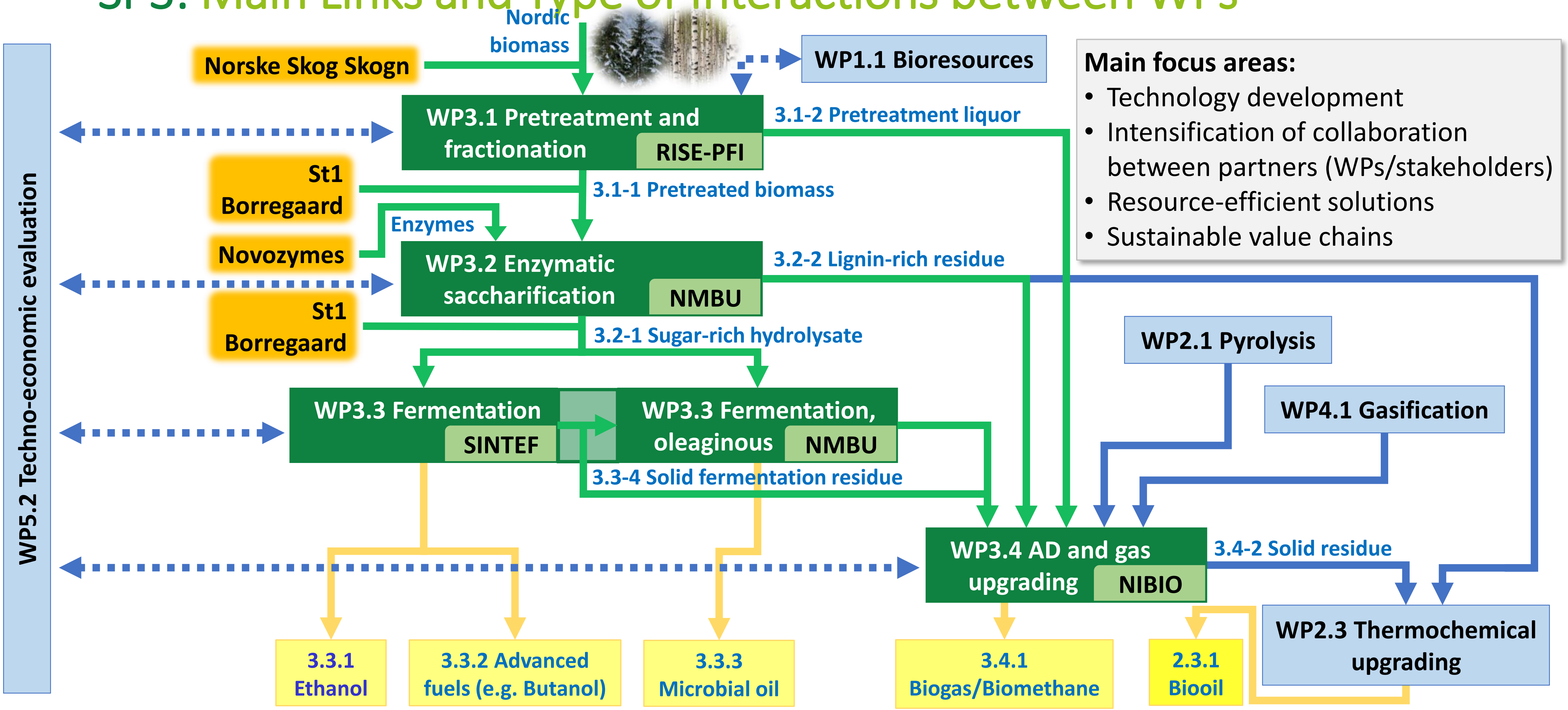
Norwegian Centre for Sustainable Bio-Based Fuel and Energy

SP3 Biochemical processes – Eight years in eight minutes –

Anikó Várnai

Bio4Fuels Days 2024; June 12; Helsinki

SP3: Main Links and Type of Interactions between WPs



Key highlights: Technology development, WP3.1

WP3.1 Pretreatment and fractionation — **RISE-PFI**

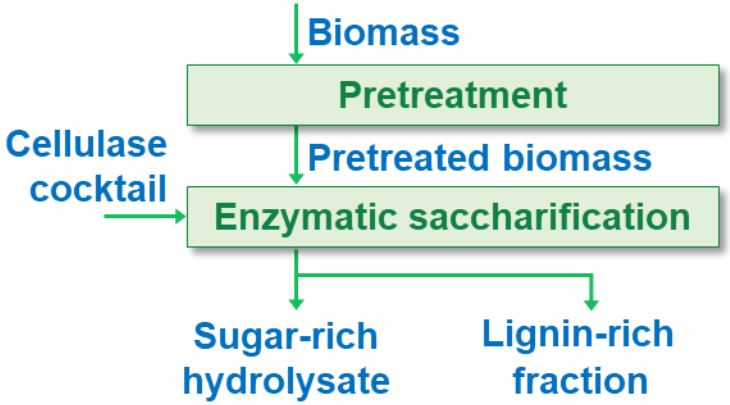
Organosolv pretreatment:

- **State-of-the-art pilot-scale reactor** established for better fractionation pretreatment
- High purity & high quality **organosolv lignin** used **as biopolymer additive** in materials

Completely biomass-derived thermoformed fibre products. Photo by RISE-PFI

Steam explosion pretreatment:

- **2-naphthol impregnation** before steam explosion preserves lignin reactivity and leads to **complete enzymatic saccharification of spruce biomass** and generation of **pure lignin fraction**



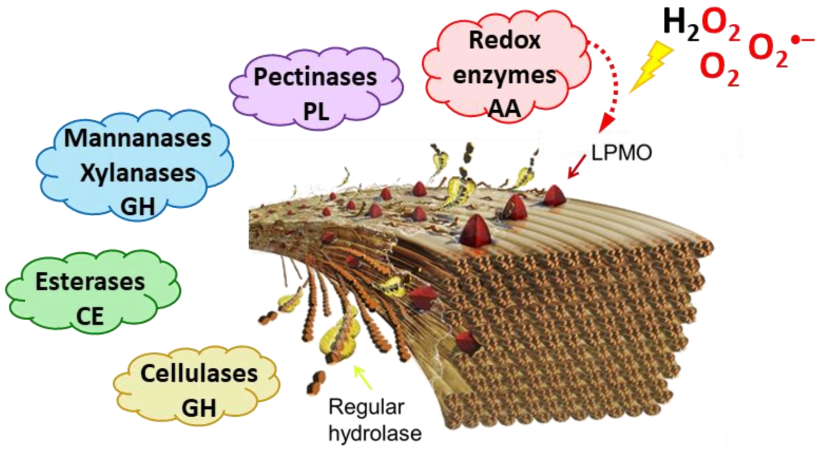
Key highlights: Technology development, WP3.2

WP3.2 Enzymatic saccharification NMBU

Unravelling the **H_2O_2-dependent mechanism of oxidative depolymerization of cellulose by LPMOs**

Discovery that **exposing lignin to visible light facilitates H_2O_2** that fuels cellulose depolymerization by LPMOs

Proof-of-concept study with state-of-the-art process setup on stimulating **oxidative cellulose depolymerization by LPMOs during** simultaneous saccharification and fermentation (**SSF**) under anaerobic conditions **using H_2O_2**

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Bastien Bissaro[1,2*]
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BIOTECHNOLOGY and BIOENGINEERING
ARTICLE | Open Access
H_2O_2 feeding enables LPMO-assisted cellulose saccharification during simultaneous fermentative production of lactic acid
Line D. Hansen, Vincent G. H. Eijsink, Svein J. Horn, Anikó Várnai
First published: 05 December 2022 | https://doi.org/10.1002/bit.28298 | Citations: 1

Key highlights: Collaboration with stakeholders, WP3.2

In the Field

Biofpr
Biofuels Bioproducts & Biorefining

Demonstration-scale enzymatic saccharification of sulfite-pulped spruce with addition of hydrogen peroxide for LPMO activation

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Piotr Chylenski, Anikó Várnai, Faculty of Chemistry, Biotechnology and Food Science, Norwegian University of Life Sciences (NMBU), Aas, Norway
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Vincent G.H. Eijsink, **Svein Jarle Horn**, Faculty of Chemistry, Biotechnology and Food Science, Norwegian University of Life Sciences (NMBU), Aas, Norway

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View online April 25, 2020 at Wiley Online Library (wileyonlinelibrary.com);
DOI: 10.1002/bbb.2103; *Biofuels, Bioprod. Bioref.* 14:734–745 (2020)

Better understanding of how to activate enzymes for efficient biomass processing: Technology demonstrated for Borregaard's feedstock with Cellic CTec3 at 2,000 L working volume scale at Borregaard's Demo Unit.

Borregaard's Demo Unit, Sarpsborg. Photo by Martin Lersch

Key highlights: Technology development, WP3.3

WP3.3 Fermentation

SINTEF | **NMBU**

Fermentation with yeast:

- **Collaboration with St1** to improve their process efficiency **using SSF**

Fermentation with bacteria:

- **Gas fermentation lab** at SINTEF is established
- **Carbon capture / CO_2 utilization realized** during production of (bio)chemicals **with** several **mixotrophic acetogenic strains grown on pure CO_2** and Borregaard's (Excello 90) and Fibenol's wood hydrolysates

Fermentation with oleaginous fungi:

- Raman spectroscopy-based **analytics established for online monitoring** of submerged fermentation of oleaginous microorganisms
- **Proof-of-concept co-production of microbial oil and value-added chemicals** (carotenoids and chitin/chitosan) in SSF using oleaginous fungi

Key highlights: Technology development, WP3.4

WP3.4 Anaerobic digestion and gas upgrading NIBIO

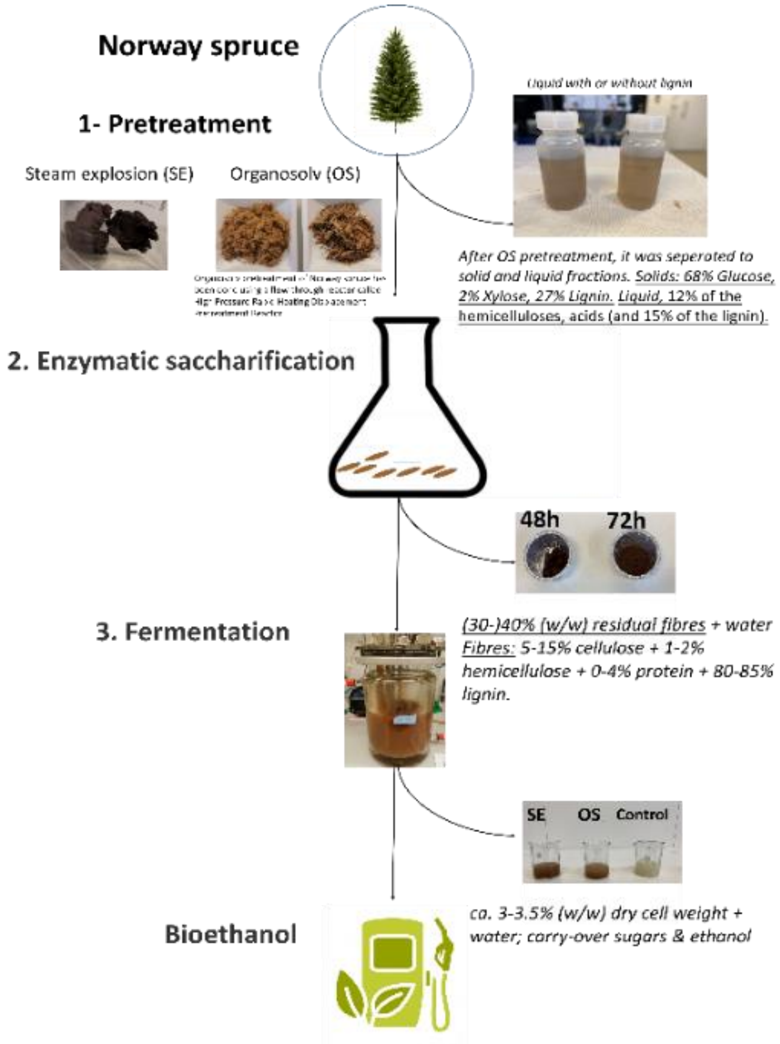
Ex-situ biomethanation:
- **Process and external CO_2 converted into methane (over 98.5%)** with external (green) H_2, thus reducing the CO_2 content of biogas & hence CO_2 emissions

Modified trickle bed reactors for gas upgrading. Photo by NIBIO

Sorption-enhanced methanation:
- **Innovation** (in situ water removal) leads to **further increase in biomethane yield** and **protection of catalyst** from steam-induced deactivation

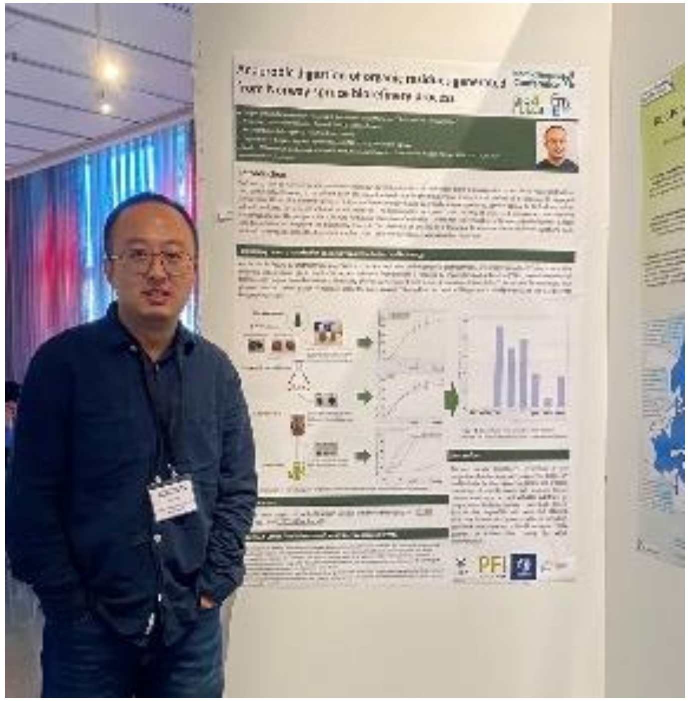
Strong industrial interest & collaboration:
- Cambi AS (cooperation on lignocellulosic residues pretreatment)
- Oslo kommune – Energigjenvinningsetaten (biogas production and CO_2 reuse)
- ZEG Power AS (biogas reforming with integrated CO_2 capture)
- Biokraft AS (biogas production and CO_2 reuse)

Key highlights: Collaboration within SP3



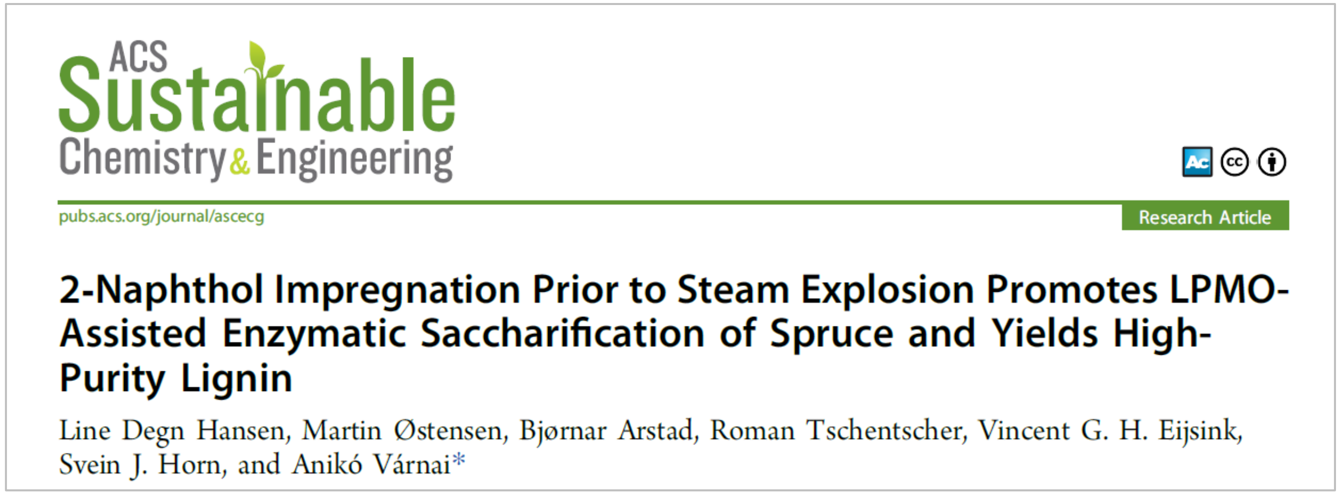
Anaerobic digestion of organic residues generated from Norway spruce biorefinery process.

Aim: to improve resource utilization and bioenergy production in a biochemical lignocellulose biorefinery



Presentation of the work at the Nordic Biogas Conference in October 2022. Photo by Lu Feng

Key highlights: Collaboration across SPs 2-3-5


ACS Sustainable Chemistry & Engineering

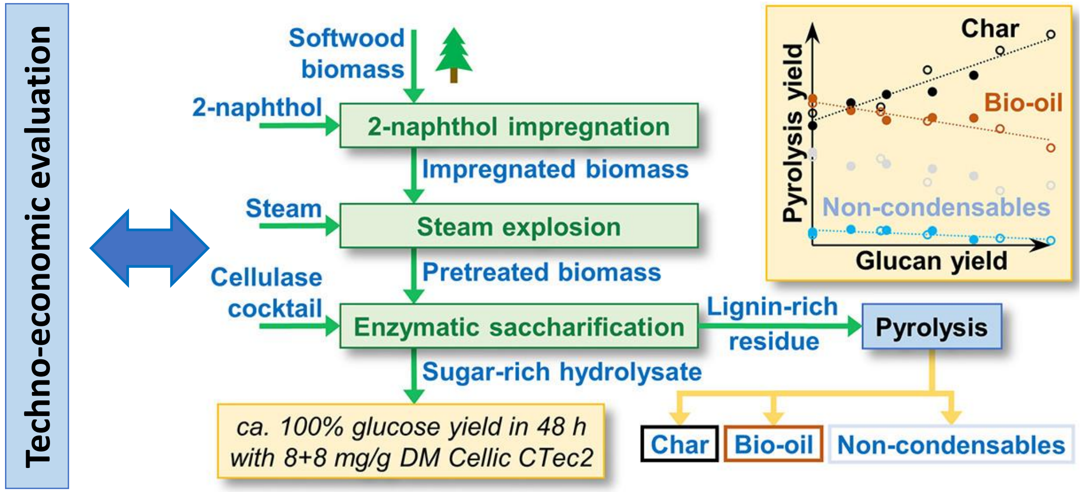
pubs.acs.org/journal/ascecg

Research Article

2-Naphthol Impregnation Prior to Steam Explosion Promotes LPMO-Assisted Enzymatic Saccharification of Spruce and Yields High-Purity Lignin

Line Degn Hansen, Martin Østensen, Bjørnar Arstad, Roman Tschentscher, Vincent G. H. Eijsink, Svein J. Horn, and Anikó Várnai*

Collaboration with SPs 2&5 to conduct a **technoeconomic assessment** of a **spruce biorefinery with combined biochemical and thermochemical processes**, which had been previously established within Bio4Fuels.



Presentation of the work at the ESCAPE Conference in June 2024. Photo by Filippo Bisotti

Session program

15:00	COFFEE BREAK
15:20	**FOCUS: Biochemical Processes.** Chair: Aniko Varnai, NMBU 15:20 – 15:50 Industry: **Q Power**, Anni Alitalo 15:50 – 16:00 *SP Leader introduction*, Aniko Varnai, NMBU 16:00 – 16:25 *Fermentation-based approaches for the production of biofuels and value-added chemicals*, Volha Shapaval, NMBU 16:25 - 16:50 *Anaerobic digestion and biogas upgrading, status and perspective*, Lu Feng, NIBIO
16:50	BREAK

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The Research Council of Norway