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NET-Fuels – Integrating negative emission technologies in biofuels production

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Abstract

The EU-funded NET-Fuels project develops a novel, integrated approach to renewable syngas and hydrogen production, while simultaneously enabling negative emissions through advanced carbon management strategies. By combining biomass pyrolysis (TCR), Biochar Carbon Removal (BCR), and Bioenergy with Carbon Capture and Storage or Utilization (BECCS, BECCU) via oxyfuel combustion, the project addresses both energy transition and climate mitigation goals.

Within this framework, Fraunhofer UMSICHT focuses on the development and optimization of the pyrolysis and oxyfuel subsystems. Biogenic residues are thermochemically converted via Thermocatalytic Reforming (TCR) into a volatile gas phase, solid biochar and TCR-oil. The biochar, containing stable carbon, is either sequestered or valorized in long-term applications, contributing to certified carbon removal (BCR). The volatile fraction is upgraded to high-quality syngas, from which hydrogen is extracted using Pressure Swing Adsorption (PSA). The remaining tail gas is utilized in the oxyfuel process, ensuring efficient energy recovery and CO_2 capture. The thermally stable oil is used in refineries.

A central innovation of NET-Fuels is the integration of oxyfuel combustion to treat process residues and generate a concentrated CO_2 stream suitable for capture and storage. The oxygen required for this process is provided by LEITAT's Bioelectric Methanation (BEM) system, which produces oxygen as a by-product while converting captured CO_2 into synthetic methane. This coupling not only enhances overall system efficiency but also creates a circular carbon economy by linking carbon capture with utilization.

The modular and decentralized design of the NET-Fuels system allows for flexible deployment in rural and industrial regions, particularly where biomass and CO_2 storage infrastructure are available. The project thus contributes to the development of regional value chains and supports the implementation of the European Green Deal and hydrogen strategy.

This presentation will showcase UMSICHT's contributions to system integration, process development, and environmental assessment, while highlighting the broader impact of NET-Fuels as a platform technology for a climate-positive energy future.