

Bio4Fuels

Norwegian Centre for Sustainable Bio-Based Fuel and Energy



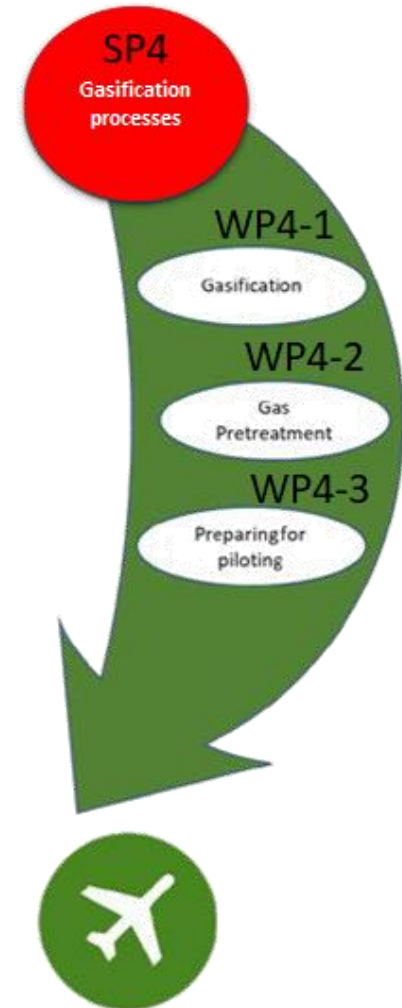
Bio4Fuels Days 2020 - Wed 18 November – Thu 19 November

SP4 – Gasification Processes

Work Plans 2021 – initial draft

Introduction

- Develop gasification technologies which enable operation at high thermodynamic efficiency without significant fuel pre-treatment or with the help of additives
- Develop gasification technologies which are not fuel (ash) sensitive, and thereby enable the use of low-cost fuels in combination with paid side streams
- Develop supplementing gas cleaning technology optimized for the new gasifier, capable of delivering "ready for synthesis" gas quality
- Site specific approach, scale-up, specification and integration of a full-scale gasification plant, 20-100 MW?



Bio-jet fuels/biodiesel at 18-20 NOK per liter

- Regarding the economics of thermal gasification + Fischer Tropsch synthesis, SINTEF recently calculated [1] that if a **450 MW** biorefinery was erected in Norway biofuels could be produced at around 24-29 NOK per liter, based on pure wood.
- Erecting the biorefinery into an existing refinery, and assuming the use of 25% sludge into the biomass mix, the production costs can be further reduced to 19-22 NOK and 18-20 NOK, respectively.
- Since the energy content of the biomass is considered CO₂ neutral when used, the associated GHG reduction will be between 74-77 % compared to the use of conventional diesel.

The calculations are made on the basis of a return of 10%, 25 years of plant life, a borrowing rate / time of 7% / 10 years and 7000-8000 hours of production time per year.

[1] Gonzalo D. A. et al., Decentralized Production of Fischer–Tropsch Biocrude via Coprocessing of Woody Biomass and Wet Organic Waste in Entrained Flow Gasification: Techno-Economic Analysis, Energy Fuels, 2017, 31 (6), pp 6089–6108

Work Plans 2021 – initial draft

In SP4 we have reached the common understanding that to increase the probability of successfully reaching the final goal, a full scale, fully specified and integrated (at a specific site location in Norway) biofuel plant for some future-proof fuels, it will be necessary to interweave the tasks of each WP into a common overall workplan.

This will be achieved by conducting as many common status meetings as possible, seminars, better coordination of PhD work between WPs and keep a bottom-up WP level communication with stakeholders.

Work Plans 2021 – initial draft

Site specific approach and integration for a full-scale gasification plant

- Specific approach towards Herøya Industripark. Other sites of interest? Decision when?
- A seminar with NTNU/SINTEF/USN and Herøya Industripark is in the planning for 2020/2021
- Decision on end products - FT biofuel, methanol (for integration with H₂ production)? Others?
- Expecting better cooperation with SP5 for technoeconomic evaluation and integration on selected site(s).

Work Plans 2021 – initial draft

Experimental campaigns at SINTEF, USN, NTNU

- Which fuels? Building waste, lignin, hazardous waste (paid side streams), plastics, Ecopro sludge -> decision within 2021
- Perform a necessary number of experiments with selected fuel(s) both at USN (Bubbling bed) and at SINTEF (Entrained Flow, Entrained Flow Fixed Bed with/without steam) to pinpoint reactor specific pros and cons.
- FTS synthesis - Catalyst preparation/characterization and experiments on Phosphorus-poisoning of Co FTS catalysts, Gas conditioning - Combined HC reforming and Mixed metal catalyst development and testing.
 - Common papers on experimental results
 - Common papers comparing experiments with simulations

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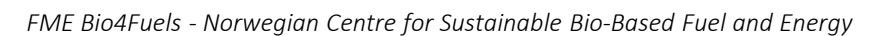
Simulations, specifications and upscaling of selected reactors

- Selection of high potential gasification reactor(s) for selected fuel(s). Possibility of integrating two reactor types for higher fuel flexibility?
- Results from simulations will form the early full-scale reactor specifications and set the specs for the gas cleaning system
- Modelling CFD and systems (NTNU ASPEN simulations (includes FT?). Clarify the possibility of continuing parts of the work performed at NTNU (Magne Hillestad))

Work Plans 2021 – initial draft

PhD contingency and collaboration

- USN: new PhD with startup 2021
 - CFD and system modelling for scale-up
- NTNU: New PhD from august 2020
 - FTS synthesis and gas conditioning



Ambitions in the Bio4Fuels Value Chain

Stakeholders involved

Primary Stakeholders' inputs to the Workplan (including in kind activities)	<ul style="list-style-type: none"> • Herøya Industripark (piloting and up-scale) • Johnson Matthey?
Secondary Stakeholders with potential interest	<ul style="list-style-type: none"> • Ecopro (sludge) • ST1 (lignin) • Biozin (forestry/sawmill waste) • Viken skog (potential source of feedstock) • Cambi AS (potential source of feedstock) • EGE (potential source of feedstock) • Haldor Topsøe (downstream equipment and materials) • Avinor AS (end user) • Volvo Group Trucks (end user) • Statens vegvesen (end user)

New gasification project/proposals

- New gasification project (2020-2022)
 - TeamTec, SINTEF Energy and Innovation Norway (3.5 MNOK),
“Innovative modular energy recovery plant for waste which
complies with the EU emissions directives”

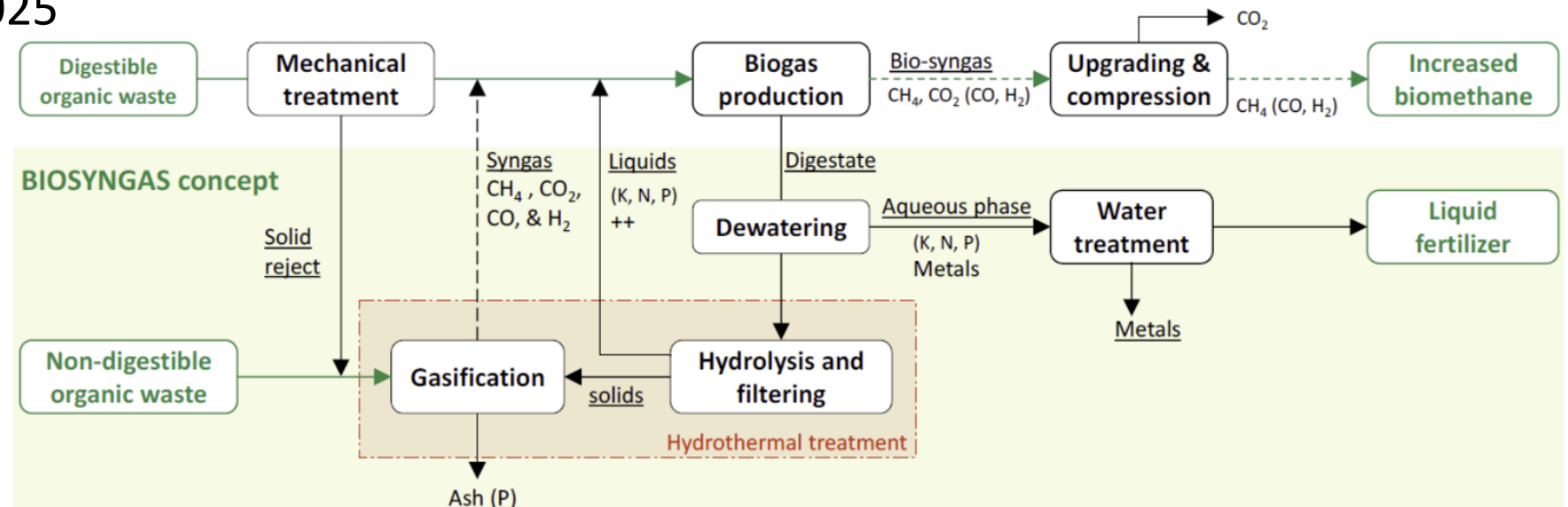
The main goal of the project is to demonstrate a new type of modular small-scale energy recovery plant for environmentally friendly management of municipal waste through successive prototype construction and critical testing for to achieve minimal emissions (EU requirements), optimal efficiency and good mechanical solutions - where the plant will be built on based on TeamTec's existing product portfolio.



New gasification project/proposals

BIOSYNGAS: Next generation **B**iogas production through the **S**ynergetic Integration of **G**asification

- KSP to EnergiX, R&D partners; SINTEF ER, NIBIO, NTNU, NMBU, Zhejiang University of Technology
- Duration: 2021-2025
- Budget: 24 MNOK
- Both wet (HTG) and dry (EF) gasification





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