

# BIO4 FUELS

## Norwegian Centre for Sustainable Bio-based Fuels and Energy

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# Nordic Bio-resources

## Technologies

- Biochemical
- Thermochemical
- Chemical

## Stakeholders

- Resource owners
- R&D institutes
- Industry
- Authorities
- NGOs

Bio-resource ,  
Environment, Climate

Primary Biomass  
Conversion

Secondary Conversion and  
upgrading

Process design and  
End Use

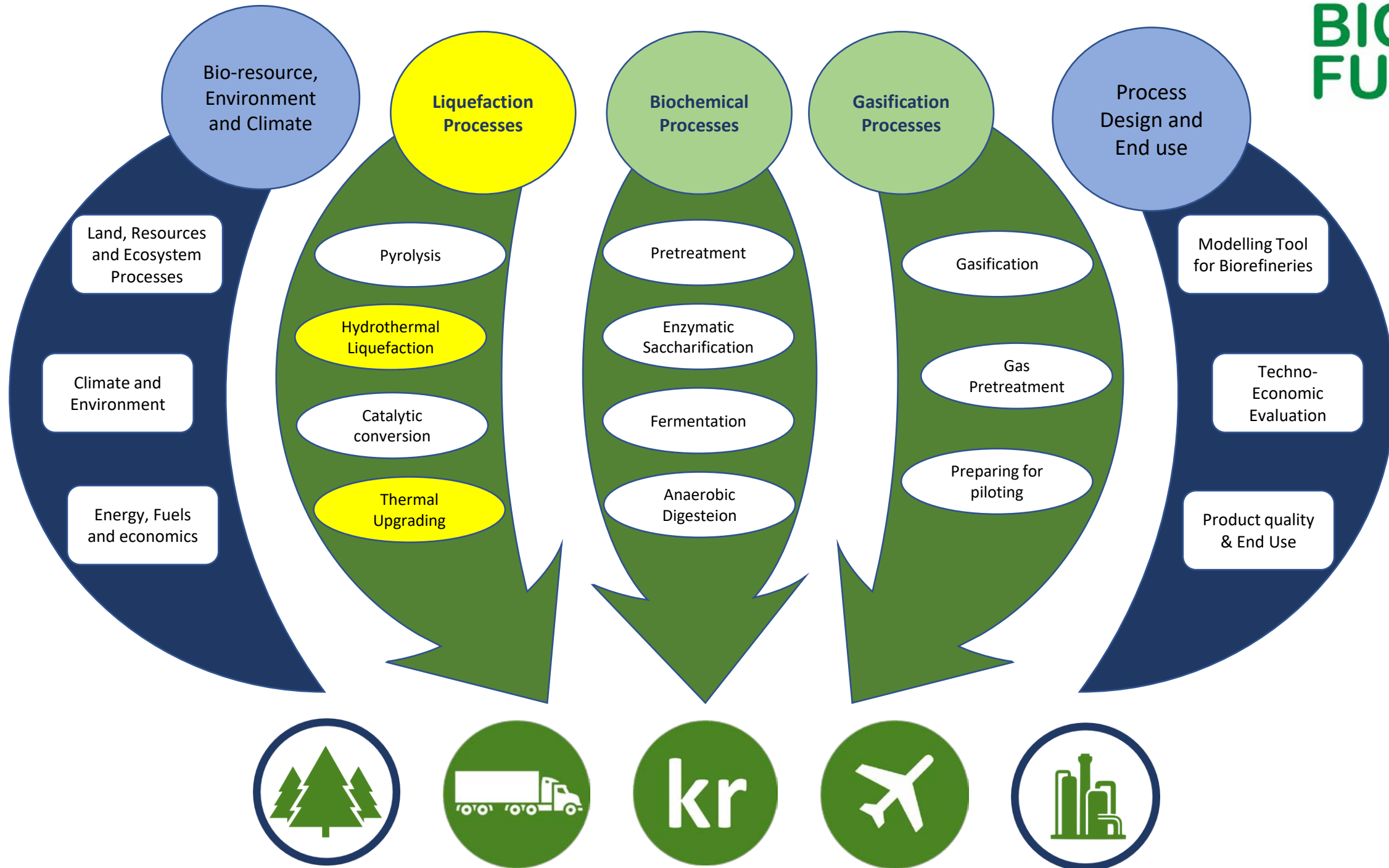
SUSTAINABILITY

*Enabling sustainable  
biofuels production  
in Norway*

## Markets

Aviation fuel • Heavy Diesel • Biogas • Valorised Side Streams







# Overall objectives of the HTL work in Bio4Fuels

## Liquefaction Processes

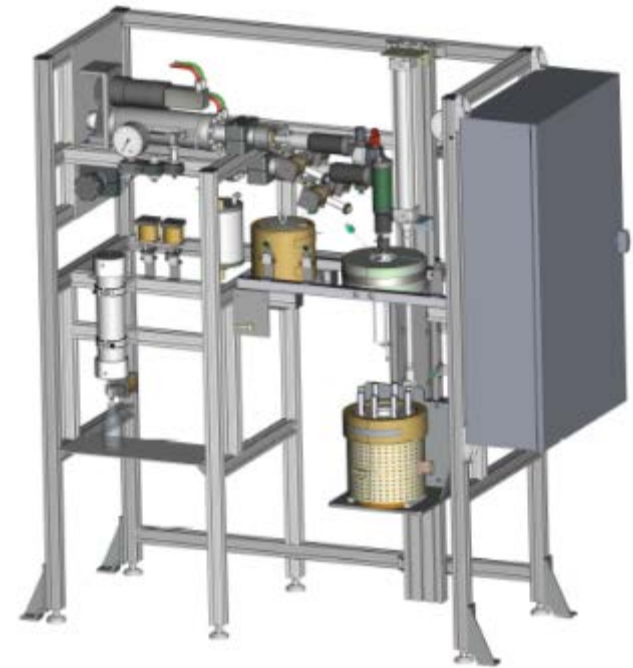
Pyrolysis

Hydrothermal  
Liquefaction

Catalytic  
conversion

Thermal  
Upgrading

- Establish a simple and easy-to-operate continuous research reactor
- Focus on the feedstock and inorganic chemistry – modelling and experimental
- Upgrading
  - HDO catalyst preparation and testing
- Other activities
  - International cooperation





## Modeling Process



### Biomass

- Known elemental composition (C, H, O, N, S and inorganics)



### HTL reaction

- No measurement data of compounds
- Modeled by Matlab-based thermodynamic equilibrium model



### Cooling & Decompression

- Modeled by OLI Studio Stream Analyzer



### Products

- Determine elemental composition
- Phase distribution



### Compare to experimental data

- Validation







## Continuous HTL processing reactor

Reactor type: Continuous CSTR reactor

- internal volume 1000 ml
- internal diameter 80 mm
- internal height 200 mm
- up to 6 corrosion samples per experiment

Feed capacity: 0.5-2 L/h, slurry feeding with dual pumps

State-of-the-art operating conditions

- 500 °C
- 350 bar

Products: Biocrude for upgrading



**BIO4  
FUELS**



# Bio4Fuels HTL - Highlights

Feedstock

- The HTL reactor is operative – milestone is achieved
- First successful experiment and first exp. campaign is performed
  - Steady state with no operator input needed
  - Tiny tubing – some challenges
- Experiments
  - Exchange student from Aalborg university
  - Wood powder, lignin and microalgae as feedstock
  - Analyses are ongoing
  - Publication planned Q2/Q3 2021

Product



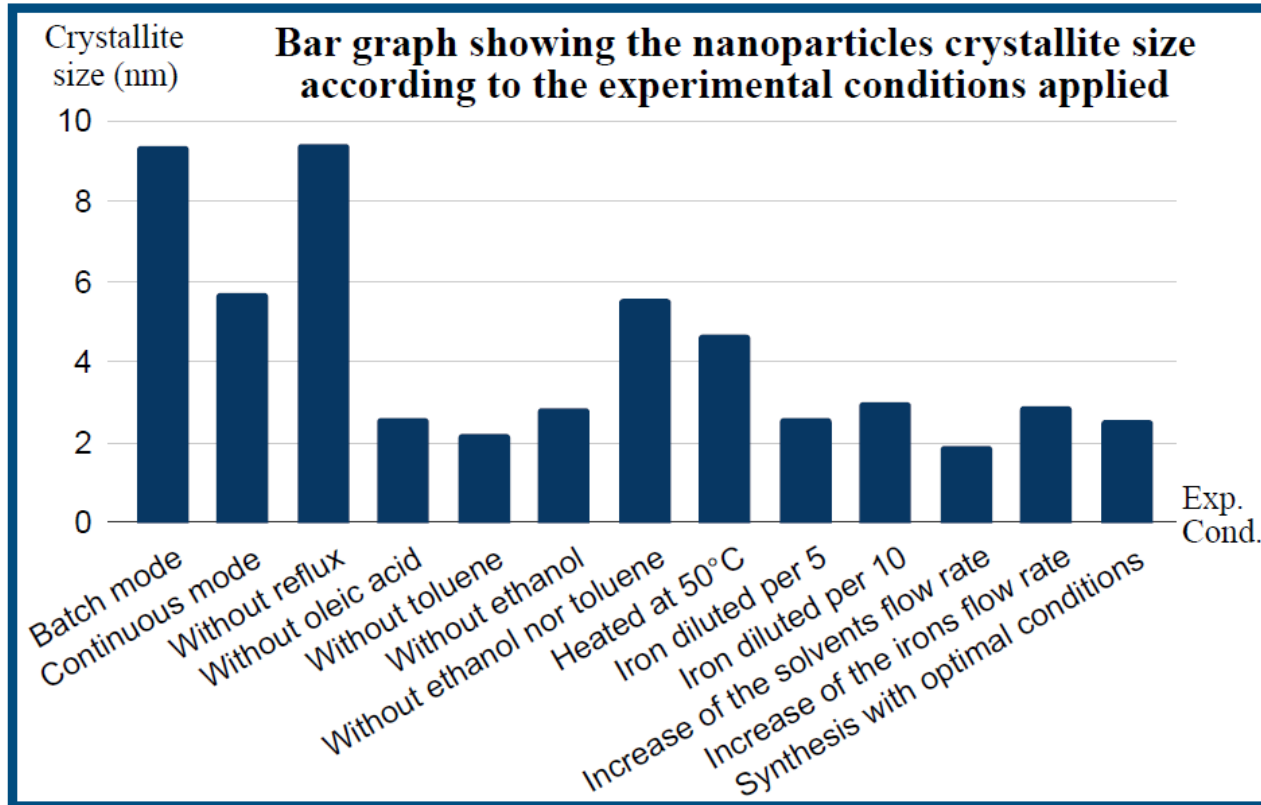


# NanoCat4Fuels – A satellite project of Bio4Fuels

- Norway-India collaborative research project
- Partners: Anna University (Chennai) & SINTEF (Oslo)
- Objective:  
Development of catalyst systems for upgrading of crude bio oil fractions
- Experimental focus:
  - Lab-scale preparation and characterization of slurry catalysts
  - Testing hydrotreatment activity for HTL oils



# Catalyst preparation and testing for crude bio liquid hydrotreatment



Optimisation of FeS catalyst preparation based on flow chemistry principles

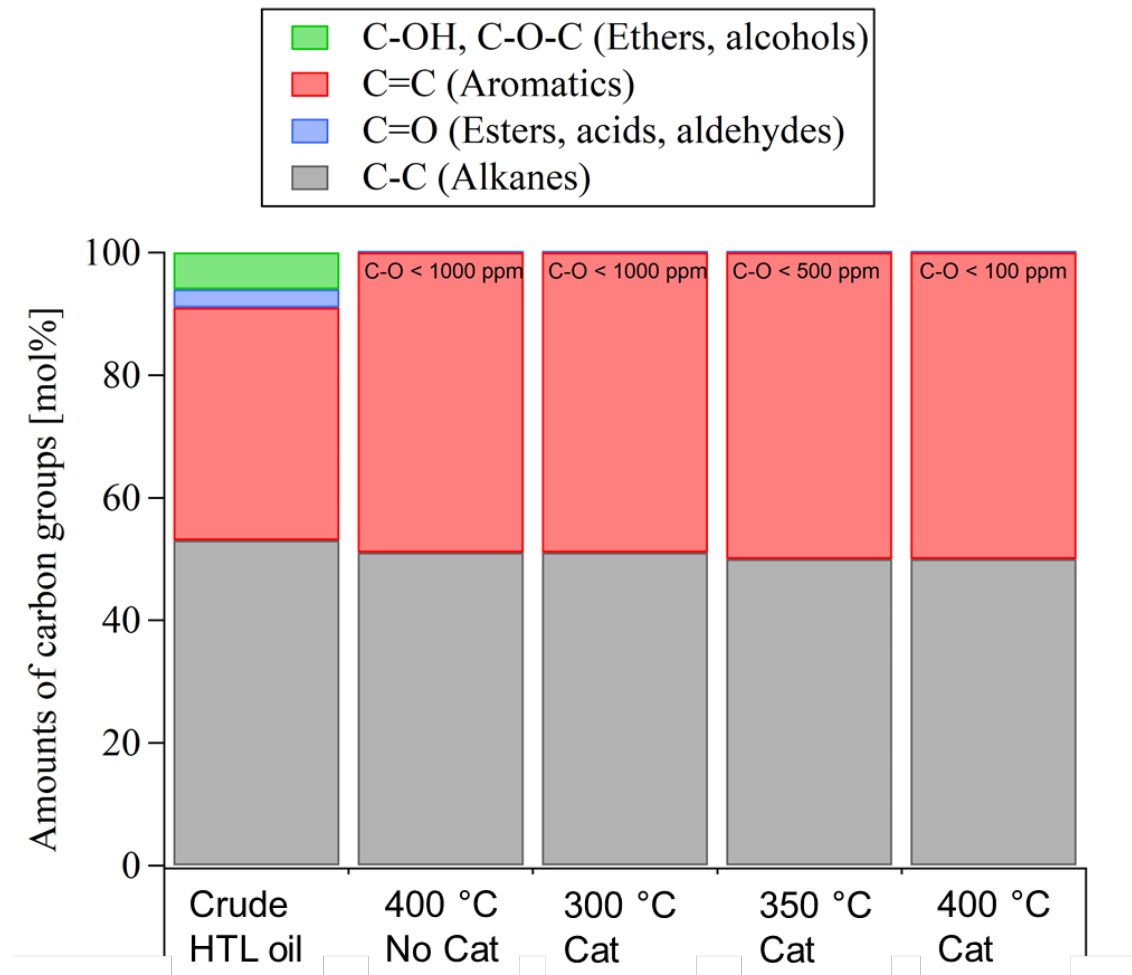


Catalyst testing in high pressure batch reactor and product analysis by NMR



# Catalytic hydrotreatment results

- Process conditions based on modern liquefaction technologies do work
- Degree of HDO is controlled by temperature (assuming sufficient H<sub>2</sub>-availability)
- Significant HDO is achieved without addition of catalyst
- Still, the catalytic system provides deep hydrogenation and some cracking activity





# Bio4Fuels Stakeholders

## Bioresources



## Norwegian Technology



## International



## End Users



## Government and State





# Thank you for your attention!



**[www.nmbu.no/bio4fuels](http://www.nmbu.no/bio4fuels)**



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