

COMSYN

NEXT GENERATION BIO-FUEL TECHNOLOGY

COMSYN

Compact Gasification and Synthesis process for Transport Fuels

Newsletter

September 2020



COMSYN project has received funding from the European Union's Horizon 2020 research and innovation Programme under Grant Agreement No 727476

COMSYN

COMSYN is an EU funded international project with partners from Finland, Germany, Czech Republic and Italy.

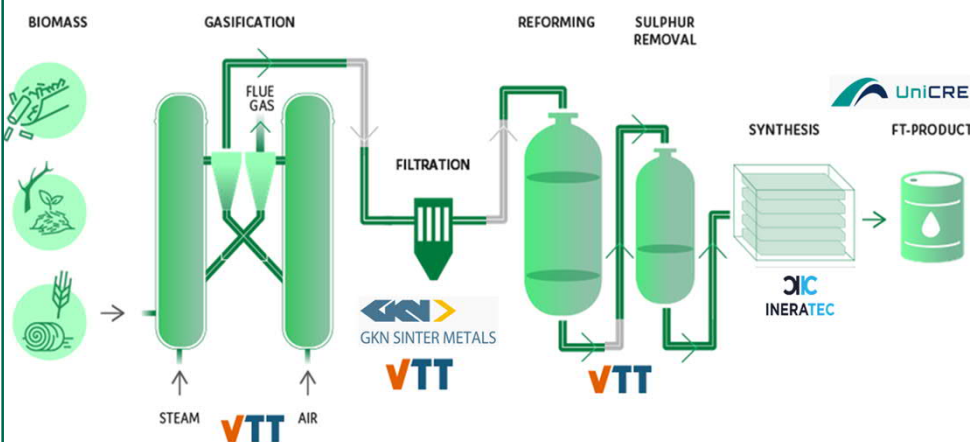
COMSYN project develops modern, intensified reactors, which have high production rate compared to equipment size. Gasification is a process of choice for the initial biomass transformation to a gas stream. Synthesis is used to convert the gas stream to hydrocarbons, which we upgrade in an oil refinery to Transport Fuels.

OBJECTIVES

Diversify biomass raw materials base
Increase filtration temperature
Improve technology for oxygen feed
Improve synthesis gas cleaning
Intensify Fischer-Tropsch technology
Upgrade biocrude in an oil refinery.
Screen the most advantageous possibilities for commercial plant.

IMPACT

Cuts down raw material costs.
Improves process thermal efficiency.
Oxygen plant is not needed.
Chemical processing is not needed.
Decreased investment costs.
Decreased production costs.
Concept ready for commercialization.



TECHNOLOGY DEVELOPMENT

Reduction of biofuel
production cost down
to 0.80 €/L

COMSYN PROJECT

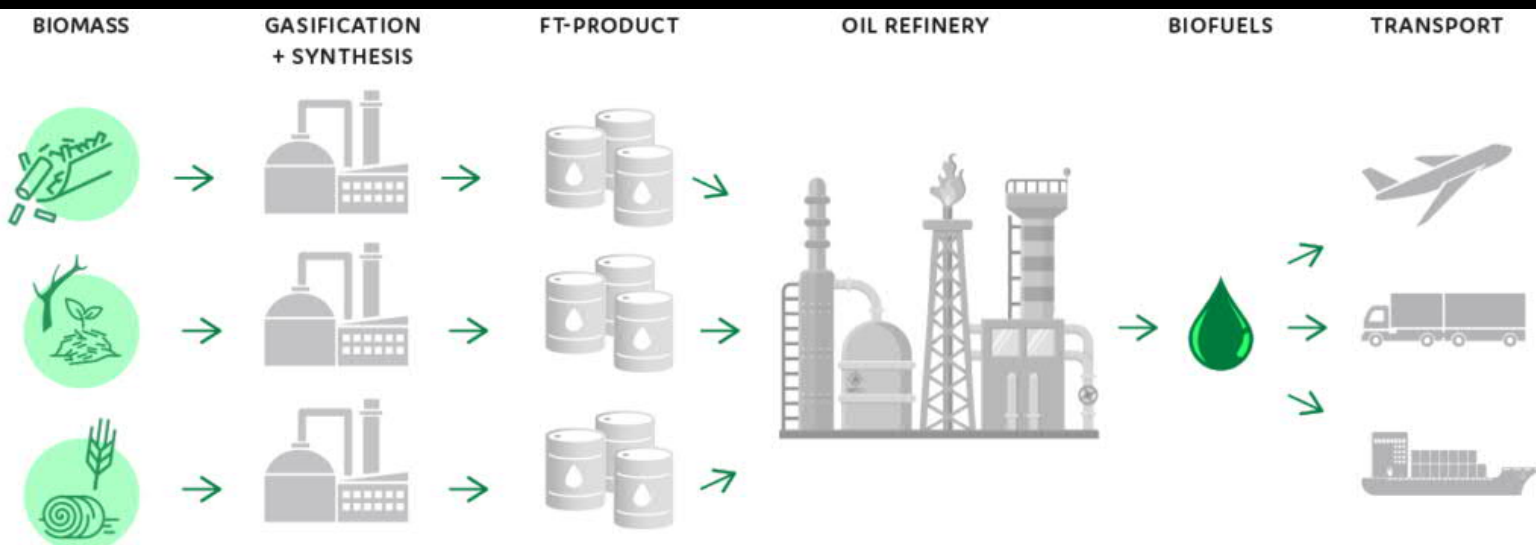
- Duration: May 2017 - April 2021, 4 years
- Funding of EUR 5.1 million from EU Horizon 2020 Competitive Low-Carbon Energy call 08-2016
- Coordinator: Johanna Kihlman, VTT, Finland

CONSORTIUM , 7 PARTNERS



COMSYN

COMSYN technology is the next step towards competitive low carbon energy solutions for the sustainable future!



Compact Gasification and Synthesis process
Decentralized primary conversion of biomass in 30 – 150 MW units

COMSYN Technical Work Packages

WP₁ Coordination and management (VTT)

WP₂ Gasification process (VTT)

WP₃ Synthesis (Ineratec)

WP₄ Product upgrading (UniCRE)

WP₅ Validation of the complete production concept (VTT)

WP₆ Techno-economic, environmental assessment of the process concepts (DLR)

WP₇ Exploitation and business models for the technical concepts (AFRY)

WP₈ Dissemination and exploitation (VTT)



WP2 Gasification process (VTT)

WP2 provides the necessary laboratory and bench scale studies for the design and improvement of the pilot scale process and validation of the complete production concept

Partners involved: VTT, GKN, Wood, Ineratec

GASIFICATION GAS FILTRATION

Hot gas filtration development by GKN and VTT

Increasing filtration temperature, decomposition of tars & Development of catalytic coating for filters

- GKN has developed and provided the filters for laboratory and pilot-scale studies. VTT has modified the filters with catalytic layers and tests them first at laboratory scale, and also in bench scale tests.



PILOT
SCALE
FILTER
CANDLE

REFORMING OF GASIFICATION GAS

Lab scale studies for the options of improved steam reforming of hydrocarbons in the biomass gasification gas :

- Oxygen feed in to the reformer through a membrane
- Modification of the reformer feed and catalyst

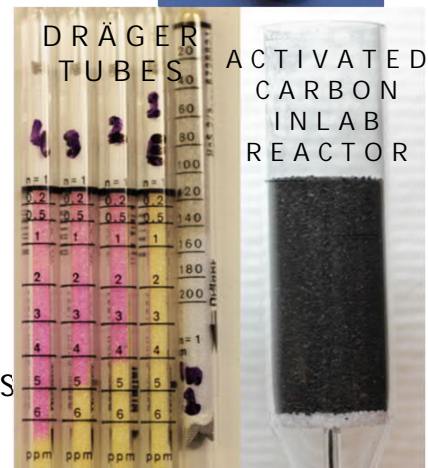
SULFUR REMOVAL

To produce gasification gas suitable for FT-synthesis

- Lab-scale experiments on activated carbon and ammonia catalyzed H₂S removal tests performed
- Basic design data provided for the pilot-scale gas clean-up line.
- Achieved results have direct impact on the investment and operation cost of the final gas clean-up solution

BENCH SCALE GASIFICATION & GAS CLEANING TESTS

- Experiments before validation test focused on the ultracleaning process steps, i.e. removal of minor impurities and CO₂ downstream reforming



GASIFICATION PROCESS DESIGN

- Validation of the COMSYN ultra cleaning process concept through high-level techno-economic comparison with the more "traditional" approach based on solvent washing for wet Sulphur removal
Case 1: No CO₂ removal, Base Case & Case 2: Partial CO₂ removal, Alternative Case
- Input for designing the plant modifications to the PDU tests of WP5.

WP3 Synthesis (INERATEC)

Partners involved: INERATEC, VTT, UniCRE

INERATEC has developed the FT synthesis process which is one of the fundamental steps in the COMSYN process as the FT product distribution and carbon conversion are among critical parameters that determine the feasibility of the entire process.

IMPURITIES INFLUENCE

- Long-term experiments were carried out at INERATEC's lab-scale test rig to study FT catalyst deactivation first in the absence of impurities – 1000 h test run performed with different operating conditions.
- The influence of the two catalyst poisons, Sulphur (in the form of H₂S) and Toluene, on the performance of the FT synthesis was successfully tested at INERATEC.

PROCESS VARIATION FOR TESTING OF FUEL WORKUP

- Design and construction of a two-stage lab and bench scale FT synthesis in 2017/2018
- The operation point of FT synthesis was optimized to maximize product output and minimize costs.
- The product properties of the FT wax were optimized in a cooperation with UniCRE.

INSTALLATION of FT SYNTHESIS at VTT SITE

- The first version of the pilot scale FT reactor, filled with commercial catalyst, was delivered to VTT in 2016 for installation in MOBSU 1.0
- In 2018, a catalyst exchange was performed with this FT reactor; MOBSU FT reactor V1.1 provided with commercial FT catalyst for MOBSU 2.0
- MOBSU, a FT pilot plant using INERATEC's FT technology, was operated successfully in conjunction with VTT's biomass gasifier in several 100 h long campaigns



REACTOR SCALE UP FOR PILOT SCALE APPLICATION

- To approach the final application size targeted in COMSYN, INERATEC is developing the design, construction and manufacturing of a next generation reactor module size with a capacity of 0,5 – 2,5 MW synthesis gas input.



WP4 Product upgrading (UniCRE)

WP4 focuses on the upgrading of FT products into biofuel components, mainly diesel and gasoline. The target is to utilize all liquid and solid fractions from the FT synthesis in various oil refinery processes.

BIO FT-PRODUCT UPGRADING CONCEPT DEVELOPMENT

- FT product upgrading concept, assessing the pretreatment steps required for the bio-based FT wax as well as determining and optimising the process conditions in the upgrading steps have been defined
- VTT and Ineratec have provided FT product samples to UniCRE for characterization

Partners involved: UniCRE, VTT, Ineratec



FT-biocrude has been proven to be suitable for conventional fractionation used in refineries. Further experimental work on FT-crude upgrading is ongoing with novel hydroisomerisation catalysts. The FT-crude is exceptionally pure - novel approaches on this refining step are possible.

Light and heavy naphtha FT-fractions distilled at UniCRE have been delivered to VTT. Hydroisomerization and reforming laboratory reactors are ready and first experiments started during summer 2020 at VTT. The target for these experiments is to show FT-crude suitability for high quality gasoline fuel and additives

DEVELOPMENT OF THE REFINERY-SCALE UPGRADING TECHNOLOGY

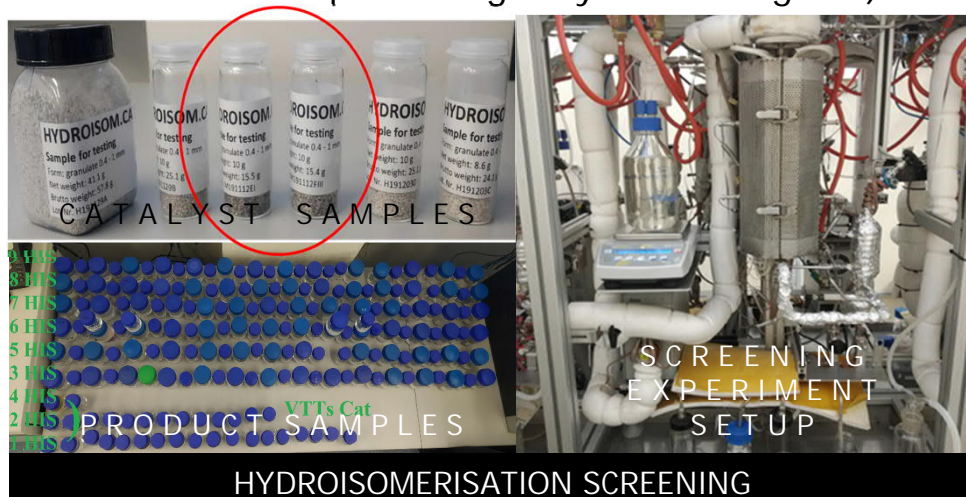
- Technological conditions and requirements enabling provision of stand alone/co-processing defined (UniCRE cooperation with Unipetrol)
- Development of hydroisomerisation non-sulphurized catalyst for middle distillates is ongoing

INDUSTRIAL-SCALE SIMULATION, PROOF OF CONCEPT

- Process integration in refinery's installation and scale-up from bench to industrial size will be simulated using a refinery planning model (based on the results obtained from trials on co-processing in hydrocracking unit)

The main product in FT synthesis are waxes with more than 20 carbon atoms which can be sold to the chemical industry, or converted to diesel and kerosene via hydroprocessing.

In this concept of BTL the aim is to convert the waxes together with fossil resources in existing refineries.



WP5 Validation of the complete production concept (VTT)

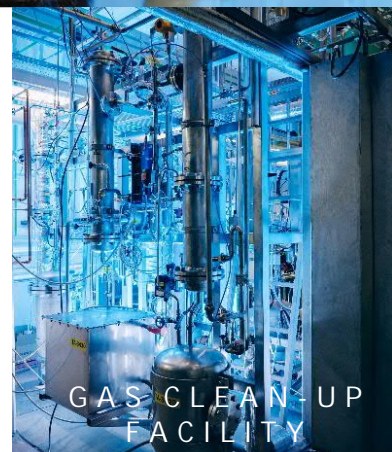
In WP5, the whole production chain from various biomass sources to the FT-wax product have been designed and validated - with biocrude product supplied to the upgrading experiments of WP4. Based on validation test data, process design of industrial scale production units was performed.



Partners involved: VTT, Ineratec, GKN, UniCRE, Wood

Modifications, assembly of the new unit processes at the PDU of VTT:

- Design & construction of the new gas clean-up train, ultracleaning
- Modifications to the existing gasification facility
- Installation of Ineratec's FT-synthesis reactor at VTT's site



Technology validation at PDU scale in 2018 - 2019

- Three successful week-long test campaigns in 2018- 2019
→ Successful validation of the entire process chain
- Gasification, gas clean-up, auxiliary units, sampling, analysis operated by VTT; MOBSU operated by INERATEC
- The once-through FT-unit, utilizing INERATEC's novel reactor, was successfully validated with real biomass-based syngas
- ~170 kg of FT liquids (oils & waxes) produced during the test campaigns were shipped to UniCRE for upgrading tests
- Results presented in e-EUBCE July 2020:
"Compact Gasification and Synthesis process
for Transport Fuels: PDU-scale validation of complete BtL process"



Design and evaluation of an industrial production unit

for the whole production chain from biomass gasification to the production of FT-wax:

- Wood has in close collaboration with other project partners prepared a preliminary design package for an industrial COMSYN plant with 100 MW feedstock capacity. As a result of this work a general economic model for the process has been made and this will strengthen the basis of detailed case studies of WP6.

MOBSU 2.0

- Improved operability & safety features
- Integration with VTT's gasification test facility
- Site Acceptance Test (SAT) in May-June 2019

Design & construction of MOBSU 2.0 in Dec 2018 – May 2019



WP6 Techno-economic & environmental assessment of the process concepts (DLR)

WP6 delivers a techno-economic and environmental assessment of the COMSYN process and identifies its potential in comparison to competing technologies.

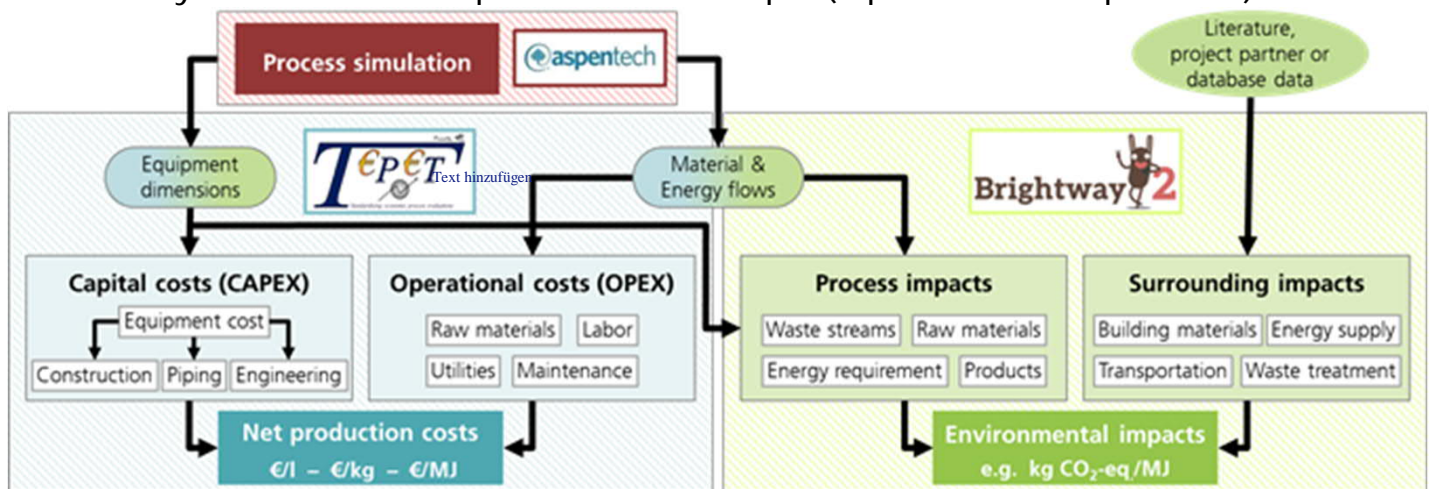
Objectives

Partners involved: DLR, VTT, Ineratec, GKN, UniCRE, wood

- Identification of bottle-necks and critical process steps for proposed concept
- Determination of optimized process setup in terms of feasibility, efficiency and cost
- Determination of most promising local alternative fuels production chains comparing alternative technologies and process routes
- Determination of ecological footprint of process concepts.

Setup of basic flowsheet model for the production concepts

- Aspen Plus process simulation model was used in assessing the techno-economic feasibility of the COMSYN production concepts (input data from partners)



DLR's economic & ecological assessment methodology

Supporting technical feasibility studies

- DLR has carried out supporting feasibility studies on substantial production steps of overall FT production process but are not topics of the technical WPs of COMSYN

General performance evaluation

- Techno-economic studies are carried out for the three specified COMSYN process configurations by the earlier developed flowsheet model the in-house tool of DLR (TEPET = Techno economic process evaluation tool)

LCA for proposed process concept

- DLR will perform LCA for the COMSYN production concept according to the ISO standards with the developed TEPET extension based on Brightway2

Case studies

- Detailed case studies will be performed for Nordic and Central European markets

WP7 Exploitation and business models for the technical concepts (AFRY)

In WP7, the market potential of the products in future transportation systems and the potential in energy and chemical sectors will be assessed.

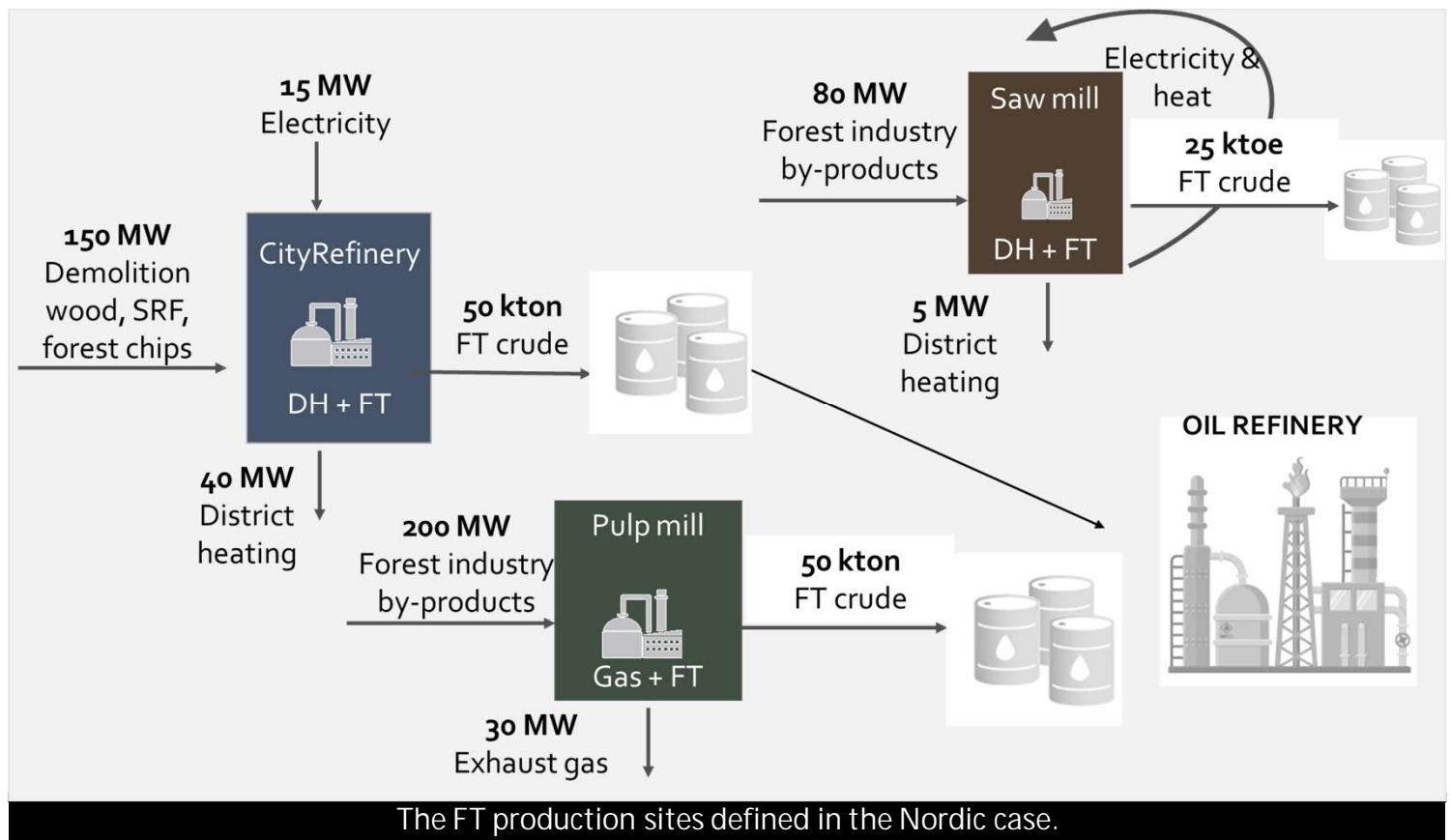
Partners involved: AFRY, VTT, Ineratec, GKN, UniCRE, DLR, Wood

Bioproduct market potential assessment

- AFRY has conducted market studies and collected information on biofuels and bioproducts from various sources and interviewed potential biofuel producers. According to the interviews, most petrochemical companies are not aware of small-scale FT solutions and the FT-process is seen as a huge investment.
- Dissemination of market opportunities: Suitable Conference for presentation is pending at the moment.

Business concepts for the for the developed technology concepts

- Business concepts for North and Central European cases have been developed: Selection and supply chain of raw materials, site location and FT transport and integration to the refinery have been defined.
- Finnish case already established and Central European case to be defined.



WP8 Dissemination and exploitation (VTT)

SCIENTIFIC PUBLICATIONS

- Experimental Bench-Scale Study of Residual Biomass Syngas Desulfurization Using ZnO-Based Adsorbents
C. Frilund et al., Energy & Fuels 2020 34 (3), 3326-3335,
<https://doi.org/10.1021/acs.energyfuels.9b04277>
- Desulfurization of Biomass Syngas Using ZnO-Based Adsorbents: Long-Term Hydrogen Sulfide Breakthrough Experiments
C. Frilund et al., Energy & Fuels 2020 34 (3), 3316-3325
 - <https://doi.org/10.1021/acs.energyfuels.9b04276>





MASTER THESES

- Kivelä, V., Filtration of biomass-based gasification gas at elevated temperatures – VTT, 2018
- Baudner, J., Intensified, Two-Stage Fischer-Tropsch Synthesis of Gasification Product – IT, 2018
- Yim, J., Preparation of oxygen permeable gastight disk-type perovskite membranes by dry pressing – VTT, 2018
- Viertö, T., Atomic layer deposition coatings for catalytic high-temperature filtration of gasification gas – VTT, 2019
- Prokopová, E., Hydrocracking of petroleum feedstocks with the addition of Fischer-Tropsch synthesis products – UniCRE, 2019
- Rozhon, J., Experimental study of Fischer-Tropsch synthesis products cracking – UniCRE, 2019
- Jenčík, J., Liquid biofuels based on Fischer-Tropsch synthesis – UniCRE, 2020
PhD 2019
- Lukáš Filip, Mathematical modeling of biomass gasification and subsequent Fischer Tropsch process – UniCRE

CONFERENCES - WORKSHOPS

COMSYN project was presented at EUBCE Conferences 2018 – 2020:



COMSYN presentations in several Conferences & Seminars, latest events:

- FILTECH 2019
- EUROPACAT 2019
- 2nd German Doctoral Colloquium Bioenergy, 2019
- 13th Concawe Symposium, 2019
- Fuels of the Future, 2019
- 18th Nordic Symposium on Catalysis, 2018
- 9th International Freiberg Conference on IGCC & xTL Technologies, 2018

Two workshops organized by COMSYN


- ITW1: April 2018, Germany (DLR & IT)
Topic: 2nd Generation Biofuels
- ITW2: May 2019, Czech Republic (UniCRE)
Topic: Future of BTL Products in Europe

Proceedings of workshops:

<https://www.comsynproject.eu/news-articles/>



UPCOMING EVENTS



COMSYN
NEXT GENERATION
BIO-FUEL TECHNOLOGY


EUROPEAN
SPRING SCHOOL

2ND GENERATION BIOFUELS

Stuttgart, Germany
March 17 – 19, 2021

School on 2nd Generation Biofuels:
17-19 March 2021, Stuttgart, Germany

In co-operation with H2020 project ABC-salt and DLR



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You are a PhD student and you want to learn how to maximize the output of your research project?
 At our Spring School you will learn how researchers from different disciplines can improve their scientific outcome by combining their strengths and setting up successful projects.

More information: <https://dlr.expert/spring-school-biofuels/front/index.php>

Registration will open on September 15th, 2020 at 10am UTC. If you wish to be reminded a day before, please write an e-mail to spring-school-biofuels@dlr.de.

Next upcoming Webinar
 Workshop ITW3: January 19 -20, 2021
 Techno-economics, once-through plants with
 CHP integration, plans for follow-on projects
 In co-operation with EU FLEXCHX-project



COMSYN -See the YOUTUBE VIDEOS

- COMSYN – Introduction by Pekka Simell: Video explains the background and targets of the COMSYN project
- COMSYN – Biofuel production process explained by Niko Heikkinen: Video explains the production process at the VTT pilot in Bioruukki.
- COMSYN – Have we done enough?: Short promotional video about the background of the project.



Magazines



EERA Bioenergy Newsletter, Winter 2019
www.eera-bioenergy.eu/wp-content/uploads/pdf/EERABioenergyNewsletterIssue12.pdf

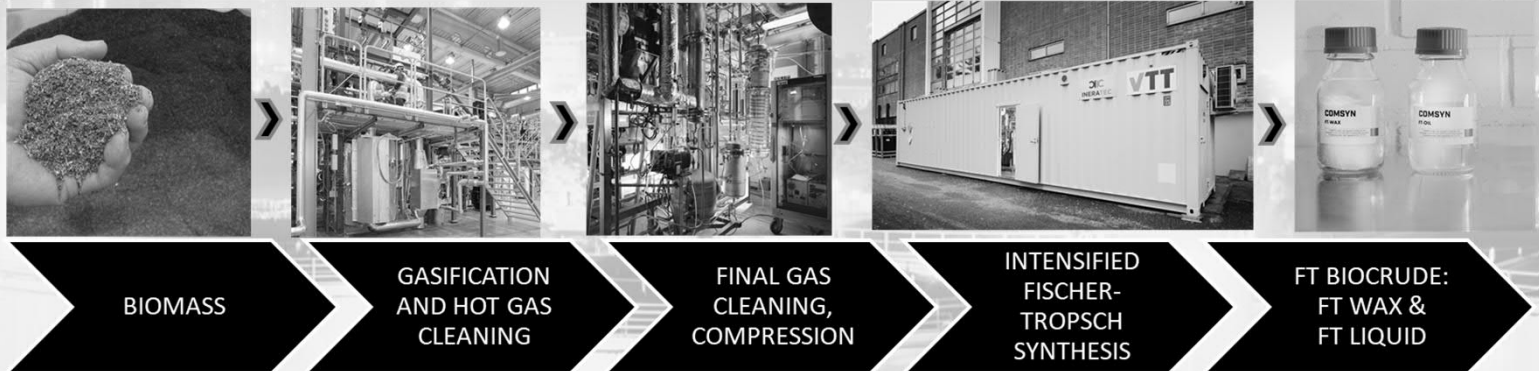


EUREC “Myths and realities of renewable energies”, Dec. 2019
<https://eurec.be/myths-and-realities-of-renewable-energy/>

COMSYN

Compact Gasification and Synthesis process for Transport Fuels

TECHNOLOGY VALIDATION AT PDU SCALE



COMSYN Meeting on January 2020 at VTT BIORUUKKI, FINLAND

Next generation biofuels have a significant role to play in the decarbonization of our economy. COMSYN project aims to bring the biofuel production costs down with intensified process technologies.



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