

Flexible Production of Synthetic Natural Gas and Biochar via Gasification of Biomass and Waste

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1. FlexSNG at EUBCE 2023

FlexSNG had a big presence at this year's EUBCE with project partners presenting posters, abstracts, chairing session and hosting a successful workshop!

The workshop titled Syngas technologies, value chains, and market potential (6th June 2023) gave a platform to four different EU funded projects all research gasification technologies. The presentations highlighted differences between value chains, technologies, and market potentials for each project. We heard from:

- BIOMETHAVERSE: Demonstrating and Connecting Production Innovations in the Biomethane universe – project overview. (Presenter: Claudio Carbone, ENEA).
- BioSFerA: Biofuels production from Syngas Fermentation for Aviation and maritime use – presenting results and updates from the project. (Presenter: Giorgia Pellegrino, Envipark).
- FlexSNG: Flexible Production of Synthetic Natural Gas and Biochar via Gasification of Biomass and Waste Feedstocks, and its market potential. (Presenters: Minna Kurkela, VTT & Stephan Seidelt, EIFER).
- Carbon Neutral LNG: Carbon Neutral electricity enhanced Synthesis of Liquefied Natural Gas from biomass – an overview of this new research project. (Presenter: Juergen Karl, FAU).

And the day rounded off with an interesting panel discussion: Common ground and contribution of EU projects to the revamping of the SET Plan Action 8, with Ilkka Hiltunen, VTT, representing FlexSNG.

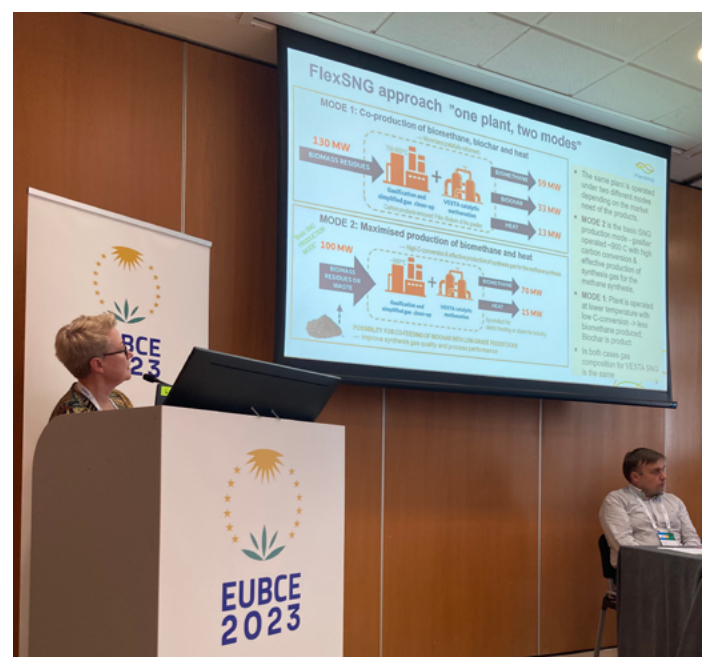


Figure 1. : Minna Kurkela, VTT presenting FlexSNG at EUBCE 2023

2. FlexSNG featured in Cordis information pack: ‘Innovative biomethane for REPowerEU’

Europe’s energy security is under pressure from rising costs, climate change, domestic and international energy policy, and conflict. Biomethane – natural gas produced from renewable sources such as municipal and agricultural waste – offers a reliable, drop-in fuel that can meet the energy needs of citizens.

This Projects Info Pack showcases the research being carried out to grow Europe’s biomethane industry, boosting energy security and helping to deliver on the EU’s ambitions for a competitive, low carbon economy, including

Follow this link to download the full pack: [Innovative biomethane for REPowerEU. A projects info pack by CORDIS](#) A summary of the pack highlights is provided here: [Cordis info pack ‘Innovative biomethane for REPowerEU’](#).



Figure 2.: Innovative biomethane for REPowerEU

3. New Published Paper: Partial oxidation of biomass gasification tar with oxygen transport membranes

FlexSNG published its fourth scientific paper based on results from the project. The paper presents how dual phase oxygen transport membranes were directly integrated into the producer gas stream of a low temperature circulating fluidized bed (LT-CFB) gasifier for partial oxidation of tar. $\text{Ce}_{0.9}\text{Gd}_{0.1}\text{O}_{1.95}\text{-La}_{0.6}\text{Sr}_{0.4}\text{FeO}_{3-d}$ composite membranes were prepared by extrusion and dip-coating, co-sintered and infiltrated with electro-catalysts. These were investigated in two different set-ups: i) a membrane test rig, and ii) a partial oxidation testing unit connected to a biomass gasifier. The stability and performance of the membrane were tested in two different gas-streams; i) H_2 and ii) producer gas. An oxygen flux of $1.5 \text{ Nm}^3\cdot\text{cm}^{-2}\cdot\text{min}^{-1}$ was measured in an air/ H_2 gradient at $850 \text{ }^\circ\text{C}$ through a 10 cm long membrane with a diameter of 10 mm , whereas a lower oxygen flux of $0.5 \text{ Nm}^3\cdot\text{cm}^{-2}\cdot\text{min}^{-1}$ was measured for the air/producer gas case. The producer gas contained ca. 2000 mg Nm^{-3} of primary tar. Analysis of the gas and the tar composition at the output of the membrane unit demonstrated that it contributed to the partial oxidation of the primary

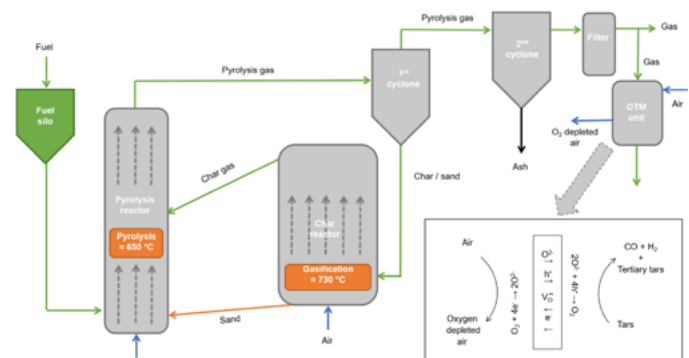


Figure 3.: LT-CFB gasifier flow diagram with the operating principle of a dense ceramic membrane for the partial oxidation of tar.

tar, resulting in a twofold increase of H_2 , CH_4 and CO in the producer gas. This successful integration of oxygen transport membranes demonstrated that these membranes can reduce the tar content in producer gas from biomass gasifiers.

The full article can be downloaded [here](#).

4. OTM module integration tests

In April 2023, DTU shipped the OTM module from DTU in Denmark to VTT in Finland. DTU representatives were present at the FlexSNG test site, Bioruukki, to integrate the OTM module with the pilot gasifier with the support of project coordinator VTT. As well as the assembly and commissioning of the OTM unit DTU were responsible for operating and monitoring the performance of the OTM unit during validation testing and evaluating the test results with regard to oxygen production. More news on the results of these tests will follow in the coming months.



Figure 4.: OTM module (credit: DTU)

5. Tailored supply systems and supply

The integration of forest, agro and waste biomasses can be an important way to cut feedstock cost in the FlexSNG application. The FlexSNG concept has a possibility to help decarbonize both the transport sector and energy production system, where the novel and optimized process design with a flexible value-oriented production is key. As for many other bio-based energy applications, the handling of the logistics will also be crucial for a successful implementation. This project will demonstrate a 20 % reduction in feedstock supply cost.

The cost reduction is the expected result from improving the efficiency of the supply system by two different means. First, current supply systems need to be tailored through added or modified feedstock processing, transport, or storage activities to better fit the FlexSNG requirements. Second, an integrated approach need to be adopted that combines forest/agro/waste biomass supplies and exploit the specific characteristics of each feedstock stream as a basis for establishing a better combined outcome.

The project has identified areas in the FlexSNG supply system with the highest potential to improve its cost-efficiency.

Upcoming steps include the further development of an existing optimization tool (Woodflow) for optimizing and analyzing feedstock supply, with the goal to demonstrate the targeted 20 % cost reduction.

A key factor of the tailored and integrated supply approach is smart use of the fluctuations in seasonal and geographic availability and/or quality. This can be achieved in the following areas:

- Co-handling and transportation of different feedstock origins
- Use of central storage nodes and terminals
- Sharing of machine, equipment and other resources between feedstock origins
- Smart location of the FlexSNG plant to create synergy effects with other systems
- Mixing feedstocks origins to overcome quality challenges
- Using different feedstock recipes depending on the current feedstock stream
- Established channels for information sharing to enable smart coordination

Each of these actions adds a degree of freedom to the supply system that can be exploited when optimizing the feedstock supply.



Figure 5. :FlexSNG supply system

6. FlexSNG presented at BIOMASS DAY 2023

The main topic of the BIOMASS DAY 2023 seminar, held in Athens on 27th Jan 2023, was “the role of bioenergy as an active Bioeconomy sector in dealing with the Energy Crisis”.

As part of the conference Kostis Atsonios, CERTH, presented new gasification technologies for the production of liquid and gaseous biofuels for transport use. To start, he explained why biofuels have an important role in the decarbonization of transport sector and showed the advantages & challenges of gasification technology.

Then, Kostis presented the concepts of three ongoing H2020 projects, that CERTH is participating in, which deal with the development of advanced biofuels, focusing on the enabling gasification technologies. More specifically, FlexSNG's technology was presented, showing the flexible gasification concept that VTT is developing for the production of biomethane, biochar and heat, pointing out the benefit it offers in feedstock flexibility, enabling the development of sustainable case studies for Greece.

The audience showed interest in the FlexSNG concept, especially in regards to its comparison with the traditional biomethane route via biogas upgrading. The full presentation in Greek can be downloaded [here](#).



Figure 6. : Biomass Day 2023



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