



FutureGas

WP1

November

2019

WORK IN WP1

# Main activities in WP1

## 1. Work finalized

**Report 1.0. Gases in the scope of the project FUTUREGAS (with WP2). Report delivered end of 2016. Updated early 2017.**

The report defines the gases within the scope of FutureGas. For further info, please refer to the summary of WP2.

- *1.1 Report on upgrading of biogas to biomethane with the addition of hydrogen from electrolysis*
- *1.2 Report on biogas upgrading*
- *1.3 Scientific review article on microbial biogas enrichment*
- *1.4 Biogas introduction in the grid*
- *1.5 Scientific review paper chemical synthesis from Carbon dioxide*
- *1.6 Cost estimation of biogas upgrading*
- *1.7 Scientific research article on Alternative of biogas injection into the Danish gas grid system*
- *1.8 Scientific research article on methane emission from commercially operating biogas plants*

## 2. Ongoing work

- **Lab test**  
*Two-stage methanation approach combining gasification via biomass based fluidized bed gasifier reactor and anaerobic digestion*

The stream at the exit of a gasifier reactor mainly contains CH<sub>4</sub>, CO, CO<sub>2</sub> and H<sub>2</sub> called syngas. In the ongoing experiment, syngas is being produced from wood pellets, has been coupled with methanogen, containing anaerobic digester and then methane enrichment and gas purification will be done using microbes as catalyst. The experiment was performed in 100 mL serum bottle to explore the syngas methanation

- *Conversion of carbon dioxide into methane in bioelectrochemical systems (BES)*

The experimental design for Bioelectrochemical system (BES) for biogas upgrading is under development at Aarhus university. Conversion of CO<sub>2</sub> into CH<sub>4</sub> by electromethanogenesis microbes is one of the most promising emerging technologies. In bioelectrochemical systems microbes called electro-methanogenesis utilize the electric current as a source of energy and carbon dioxide as a source of carbon to produce CH<sub>4</sub>. This application has become an attractive alternative for biological methanation. However, there are still some limitations, such as reactor design, electron transfer mechanism from electrode to microbes and scaling up, which need to be solved to move further towards commercialization. The experiment was performed and data analysis is in progress.

- *Scientific paper on Bioelectrochemical system for biogas upgrading*

The book chapter/ summary report of Bioelectrochemical system for biogas upgrading has been under preparation and deliver to FutureGas Project as emerging technology for biogas upgrading.

## Planned work

The book chapter/ summary report of Bioelectrochemical system for biogas upgrading will be written and deliver to FutureGas Project as emerging technology for biogas upgrading.

## Presentation and scientific publication

### ➔ Workshop on methane emissions

A workshop on methane emissions from gas system was organized. It took place at DTU 22th of oct. 2019. It contained presentations on losses and emissions from biomethane production, the gas grid, gas application, road transport and from the maritime sectors.

- Methane emission from biogas production  
-Torben Kvst, DGC
- Losses related to transport and distribution of gas  
-Per G. Kristensen, DGC
- Emissions from the maritime sector  
-Sergey Ushakov, NTNU
- Emissions from the road transport  
-Jesper Schramm, DTU
- Emissions from stationary applications  
-Jan de Wit, DGC

The presentation can be found on

<https://futuregas.dk/workshop-on-methane-emissions/>

### ➔ Presentation

Invited presentations

- Biogas – production and utilization, Århus University
- 10<sup>th</sup> October 2019
- Biological methanation. Presented on 22-23 May 2019 at Gastekniske Dage, Denmark
- Biogas – production and utilization, DTU Department of Chemical Engineering on 1<sup>st</sup> April 2019
- Biogas upgrading and gas utilization at Aalborg University, Copenhagen on 30<sup>th</sup> May 2018.
- Biogas upgrading technology at DTU Department of Chemical Engineering on 12<sup>th</sup> April 2018
- Power-to-Gas at Aarhus University on 20<sup>th</sup> November 2017.
- Syngas Production from straw gasification and biomethanation presented by Nabin Aryal at DTU Sustain conference on 30<sup>th</sup> November 2018

Poster presentations

- Biological methanation. Presented on 8-9 May 2018 at Gastekniske Dage, Denmark
- Biogas introduction in gas grid. Presented on 8-9 May 2018 at Gastekniske Dage, Denmark

### ➔ Published Scientific paper

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1. **Aryal, N.**, Ammam F., Patil S., Pant D., (2017) Overview of electrode materials used in Carbon dioxide in microbial electrosynthesis Green Chemistry, 2017, **19**, 5748-5760
2. **Aryal, N., & Kvist, T.** (2018). Alternative of biogas injection into the Danish gas grid system—A study from demand perspective. ChemEngineering, 2(3), 43.
3. **Aryal, N., Kvist, T., Ammam, F., Pant, D., & Ottosen, L. D.** (2018). An overview of microbial biogas enrichment. Bioresource technology.
4. **Kvist, T, Aryal, N.,** (2019), Methane loss from commercially operating biogas upgrading plants. Waste management, 87, 295-300
5. N. Rasmussen, **Aryal, N.,** (2019), Syngas production using wood and straw pellet gasification in fluidized bed reactor under different temperature conditions. (Accepted from fuel journal)

6. Bajracharya, S., **Aryal, N.**, De Wever, H., & Pant, D. (2019). Bioelectrochemical Syntheses. In An Economy Based on Carbon Dioxide and Water (pp. 327-358). Springer, Cham.

### ➔ Scientific paper under preparation

7. **Aryal N et al.**, Bioelectrochemical redox flow battery design reactor configuration for continuous methane production utilizing Carbon dioxide
8. **Aryal N et al.**, Syngas methanation in tricking bed reactor configuration for biomethane
9. **Aryal N et al.**, Recent advance in Bioelectrochemical system for biogas upgrading ( Book chapter)

## INFORMATION

Torben Kvst, DGC (tkv@dgc.dk)