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# RENEWABLE GASFIELD – A HOLISTIC POWER-TO-GAS APPROACH WITH PEM ELECTROLYSIS AND CATALYTIC METHANATION

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## 1 SUMMARY

Firstly, natural gas provides around 20% of the total primary energy demand in Austria through a well-established and valuable gas-grid, including also large long-term storage facilities but it is also a necessary primary industrial commodity in numerous chemical processes including fertilizer production. On the other hand, the currently non-renewable natural gas has to be substituted with green gas in order to fight climate change.

In the Styrian research project "Renewable Gasfield" green hydrogen and biomethane are produced as important core components in the process of converting the Austrian gas grid into a carbon dioxide neutral structure. A holistic power-to-gas (P2G) approach is pursued in which green hydrogen is generated through PEM-electrolysis with energy from the on-site photovoltaic modules and certified green energy from the grid. A larger share of the green hydrogen will be trailered to off-site industrial use while a smaller part is used to upgrade the $CO_2$ in raw biogas of a regional agricultural biogas plant into biomethane in a catalytic methanation process.

## 2 INTRODUCTION

Today natural gas is not only used for heating and transportation, but it is also key to numerous industrial processes like fertilizer production or chemical synthesis processes. In Austria about 80% of the gas consumption is accounted for trade and industrial companies, including gas-fired power plants (ÖVGW, 2021a). Natural gas can be stored cheaply, safely and for a long time in large underground storage facilities as the gas grid is well established in urban and rural areas in Austria. (ÖVGW, 2021b).

The Austrian federal government is pursuing the goal of decarbonising the energy sector. Hence, the production of green hydrogen ($H_2$) and biomethane are part of the climate and energy strategy "#mission2030". (BMNT & BMVIT, 2018). In the Styrian research project "Renewable Gasfield" a power-to-gas plant is built in Gabersdorf near Leibnitz. It shows the role of renewable hydrogen and biomethane as important core components in a future energy model region considering sector coupling.

## 3 PROJECT GOALS

The goals of this project are to demonstrate the methanation process on a large scale, to generate green biomethane for storage and distribution in the existing gas network and to produce green hydrogen strictly from renewable energy sources including an on-site photovoltaic plant.

One main focus lies on taking regional conditions into account. The $CO_2$ for methanation is provided from raw biogas from the nearby agricultural biogas plant. The location of the power-to-gas plant in Gabersdorf is also well situated as it is directly adjacent to an existing natural gas transport pipeline connecting southern regions with the Styrian capital Graz.

## 4 DESIGN

The whole plant is designed modularly to allow expandability of the developed infrastructure. Most of the components are installed in standard-ISO-containers.

Green hydrogen generation is performed by a 1 MW PEM electrolysis with a production capacity of 210 $Nm^3$ $H_2$/h. The energy is provided by on-site photovoltaic modules (850 kWp) and certified green electricity (mainly wind power) from the grid. The produced green $H_2$ is stored at 30 and 500 bar and can be filled into distribution trailers in order to be transported to nearby industrial sites.

For the methanation, biogas is delivered from the nearby agricultural biogas plant. Roughly 260 ha of agricultural land is used to renewably grow the processed crops for the generation of 260 $m^3$/h biogas. The biogas contains around 52 v% $CH_4$ and 46 v% $CO_2$, is converted in 500 kW electric power and also roughly 550 kW thermal power in a CHP unit. The thermal power is used in a local heating network.

21 $m^3$/h of the biogas is transported to the new P2G plant. After dehumidification and cleaning with activated carbon, biogas is introduced into a catalytic reactor together with 40 $Nm^3$/h hydrogen from the electrolysis for direct methanation. The catalytic reaction takes place on a specialized catalysator at medium temperature and pressure levels. The produced biomethane (21 $m^3$/h) with a remaining share of hydrogen (< 10 v%) fulfils the requirements of the Austrian gas network (ÖVGW GB 210-2021) and is injected into the local natural gas grid.

With this P2G-plant up to 140 tons/a of hydrogen can be produced from green volatile electricity. This project demonstrates the conversion of non-storable renewable electric energy into extremely valuable and storable green gases (hydrogen and biomethane) what contributes to the decarbonization of the Styrian heavy industry.

## 5 CONCLUSIONS AND OUTLOOK

Even with numerous energy efficiency measures, the gas demand in the industrial sector will remain substantial in the future (Baumann et al., 2021). Hence, the addition of green gas to the natural gas grid is important for decarbonising the energy sector (BMNT & BMVIT, 2018) but also to become more independent from energy carrier imports.

The demonstration of the technical feasibility of the P2G-plant is therefore vital for a successful achievement of the ambitious goals and for the promotion of further research and investments in these technologies. In this particular case the linking of different energy sectors by taking into account the local framework conditions is especially relevant.

## 6 REFERENCES


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## 7 CONFERENCE TOPIC

Coupling of Energy Sectors