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Ringkoebing-Skjern biogasproject

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Abstract

This paper describes the results from a project dealing with the establishment of approximately 60 small biogas plants as well as 1-2 large biogas plants in connection with a biogas grid in Ringkoebing-Skjern municipality to supply the local heat- and power plants with biogas.

The municipality is a typical rural municipality with a high potential of biogas production. The municipality has initiated a project supported by public funds in order to investigate if the economics in biogas projects can be improved by transporting biogas instead of manure/energy crops. A heavy cost for a biogas plant is the transport costs of slurry and digested slurry between farm and biogas plant. This project concerns decentralization of biogas production combined with establishment of a PE low pressure biogas grid for supply of the municipality`s 10 CHP plants. The goal is to show that decentralized produced biogas systems can compete economically with central production of biogas. To optimize the use of biogas particularly during the summer, the project includes an upgrading plant to transform biogas to natural gas, which can be distributed or stored in the natural gas system.

Additional a “pure” upgrading solution is investigated to obtain if this could give a higher outcome. This solution is based on 100 % delivery of upgraded biogas to the natural gas grid.

As a spin-off to this project a new way to upgrade biogas to natural gas quality using hydrogen is investigated.

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Study case:

Distribution of locally produced biogas in a biogas distribution grid combined with the upgrading of biogas to natural gas quality and methanisation of CO2 with hydrogen produced from wind power.

Scope.

The geographically largest municipality in Denmark is Ringkoebing-Skjern municipality covering an area of 1489 km². The municipality is a typical rural municipality with a high potential of biogas production. The municipality has initiated a project supported by public funds in order to investigate if the economics in biogas projects can be improved by transporting biogas instead of manure/energy crops. A heavy cost for a biogas plant is the transport costs of slurry and digested slurry between farm and biogas plant. This project concerns decentralization of biogas production combined with establishment of a PE-100SDR17 low pressure biogas grid for supply of the municipality`s 10 CHP plants. The goal is to show that decentralized produced biogas systems can compete economically with central production of biogas. To optimize the use of biogas particularly during the summer, the project includes an upgrading plant to transform biogas to natural gas, which can be distributed or stored in the natural gas system.

The biogas potential in Ringkoebing-Skjern municipality is estimated to approx. 30 million Nm³ of methane per year from manure and approx. 30 million Nm³ of methane per year from energy crops. The total biogas potential is thus approx. 60 million Nm³ of methane per year. The natural gas consumption in the municipality is about 100 million Nm³ of methane per year, and the decentralized power plants consume around 60 million Nm³ of methane per year.

Biogas grid solution.

The plan is to establish approximately 60 small biogas plants as well as1- 2 large biogas plants. The small biogas plants will each year produce biogas equivalent to approx. 650.000 Nm³ methane and the 2 larger plants will each produce biogas equivalent to approx. 10 million Nm³ of methane per year. An approx. 150 km long biogas grid will transport the biogas from the biogas plants to the 10 CHP plants in the municipality. To balance the biogas production and biogas consumption it is planned to establish an upgrading plant with a capacity of approx. 2600 Nm³ of methane per hour. Below is the entire biogas project-design illustrated.

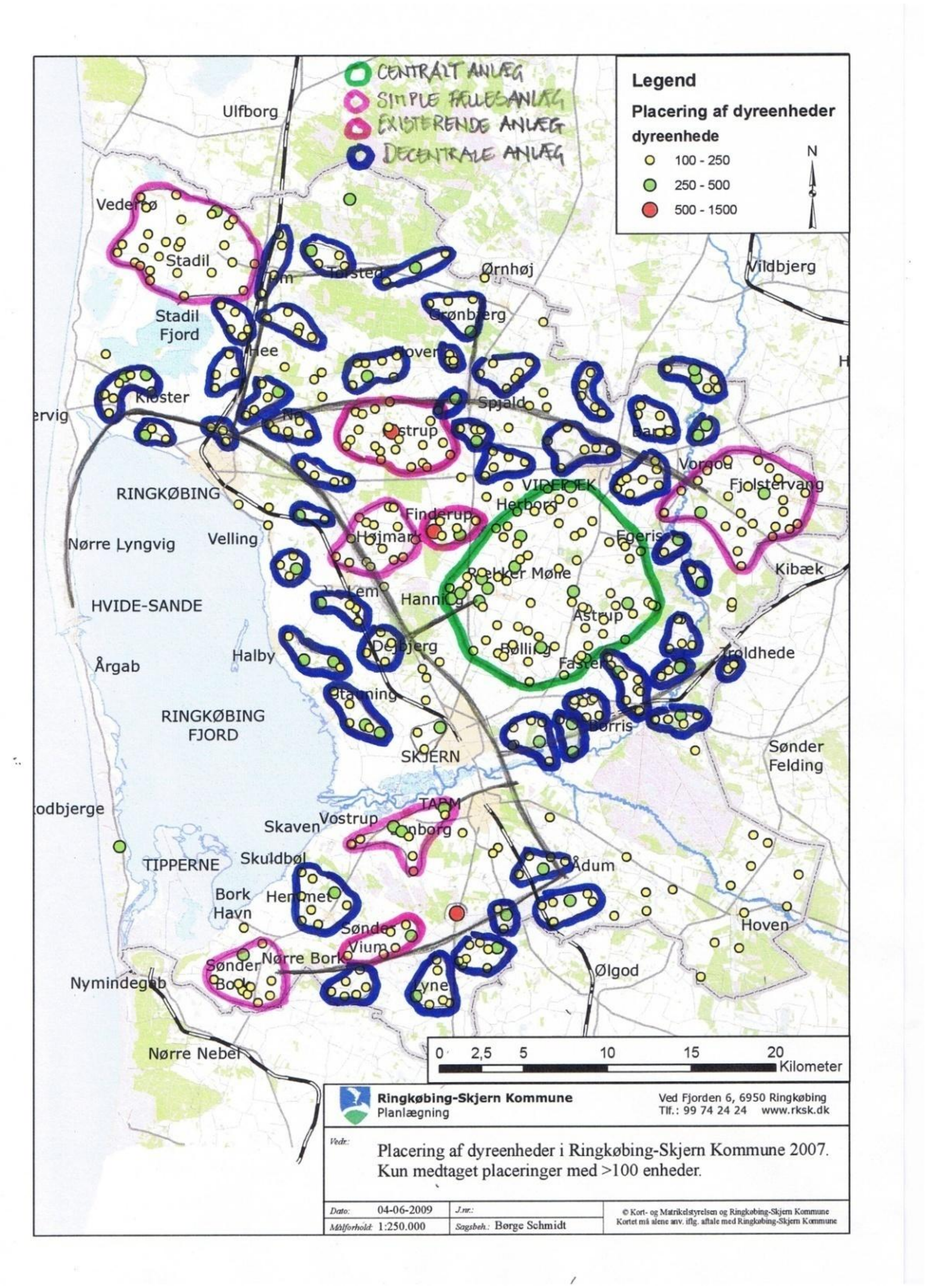

Figure 1 All-over view – location of biogas plants

The map above shows the proposed location of biogas plants with associated agriculture areas and the planned trace for the biogas grid. Each dot represents a farm with animal production. The circles around the dots represents a cluster of farms delivering manure to one biogas plant.

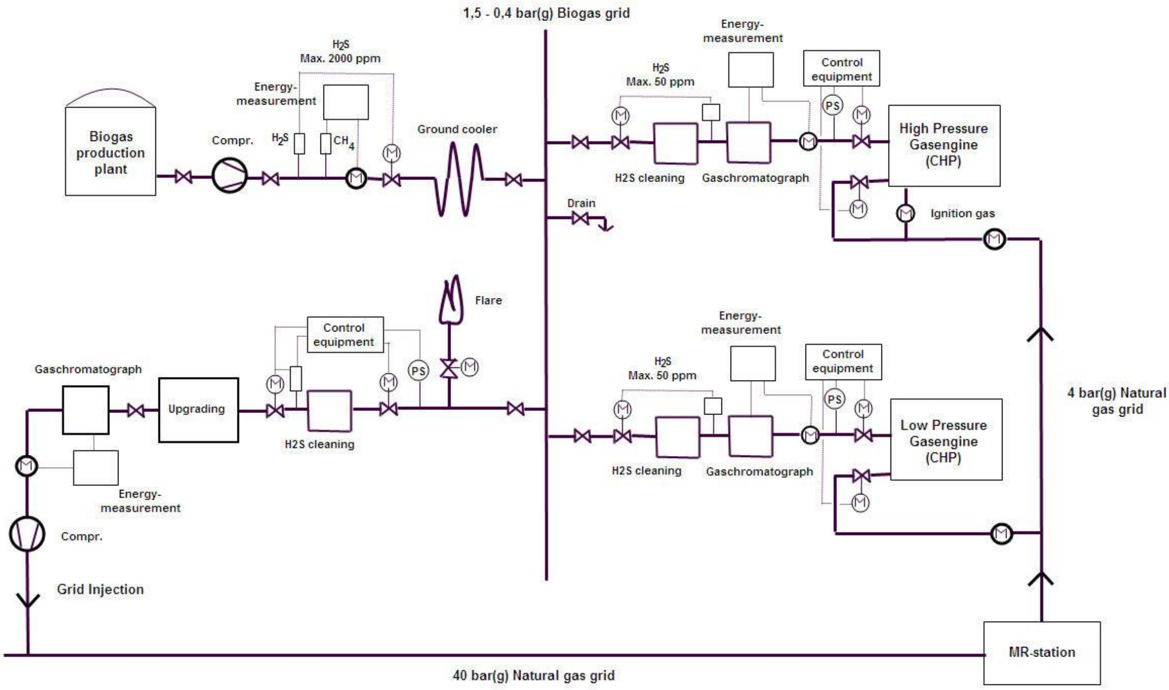

Figure 2- System layout.

It is expected that biogas will cover approx. 75% of the gas demand at the CHP plants and the remaining 25% is covered by natural gas through existing natural gas infrastructure. The natural gas system will act as back-up system for the CHP plants, since biogas engines can run on a mixture of biogas and natural gas and clean natural gas if biogas is missing. Existing boilers installed at the CHP plants will remain natural gas-fired.
Since biogas consumption will vary with heating needs, and when biogas production is virtually constant over the year, there will be a need to smooth the power plant's operation over the day in summer, so the amount of biogas to be upgraded does not exceed the capacity of the upgrading plant. It is anticipated that almost 12 million Nm³ of methane per year must be upgraded and delivered to the natural gas grid in order to balance the biogas production and biogas consumption. The possibility of upgrading the biogas ensures that approx. 98% of biogas production can be transformed to useful energy.

Along this line, biogas network has been designed so that at least the desired biogas volume can be delivered at a pressure of 300 mbar (g) by the consumers. The working pressure at the biogas grid is designed to max. 1.3 bar(g). Biogas grid design and dimensions are shown in Figure 3

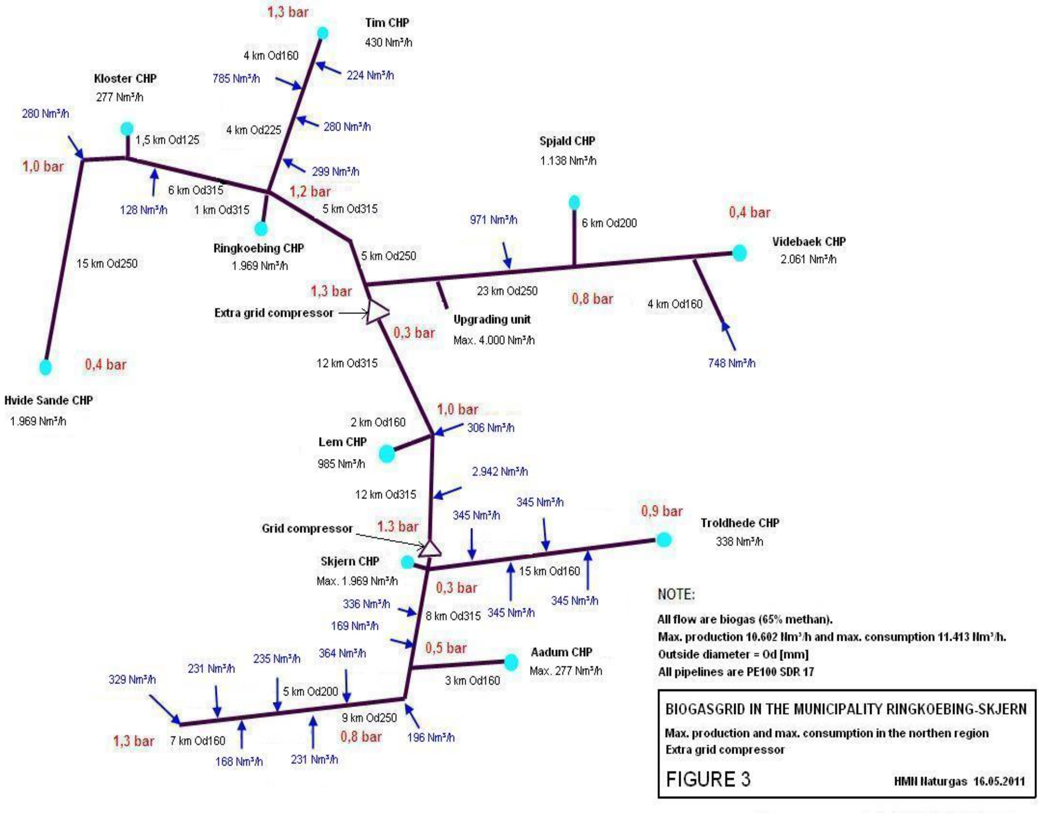

Figure 3 - Biogas grid design

The figure shows that the biogas grid is equipped with 2 grid compressor stations to transport gas from the southern part of the municipality to the north where consumption is highest. It is also proposed to establish an upgrading plant with a capacity of approx. 2600 Nm³ of methane per hour at Ringkoebing. It is expected to upgrade around 20% of the biogas production equivalent to approx.12million Nm³ of methane per year for balancing the biogas grid.

Construction costs.

The project team has calculated the estimated project cost for the following:

Decentralized / centralized biogas plants:	67 million euro
Biogas grid including compressor stations:	25 million euro
Upgrading plant:	7 million euro
Conversion of engines/new biogas engines:	15 million euro.
Total costs excl. VAT:	**114 million euro**

It is estimated that profits from biogas production before interest and depreciation with the current natural gas prices, taxes, etc. will amount to approx. 10 million euro per year, resulting in a simple payback time for the project of approx. 12 years.

Biogas upgrading solution.

As an alternative to use the biogas in the CHP plants it is examined whether upgrading of the entire biogas amount to the natural gas grid is profitable. It is assumed that a fiscal equality for biogas used for CHP and upgraded biogas injected to the natural gas grid with respect to taxes and subsidies are in force. It is planned to establish 2 large central upgrading plants, respectively 4500 Nm³ of methane per hour at Skjern and 2500 Nm³ of methane per hour at Ringkoebing, so the plants can be connected to the 40 bar natural gas transmission grid. In addition the excess heat from the upgrading facilities (20.000 MWh/year) could be used in district heating network in Skjern and Ringkoebing.
A proposal for grid design is shown in Figure 4

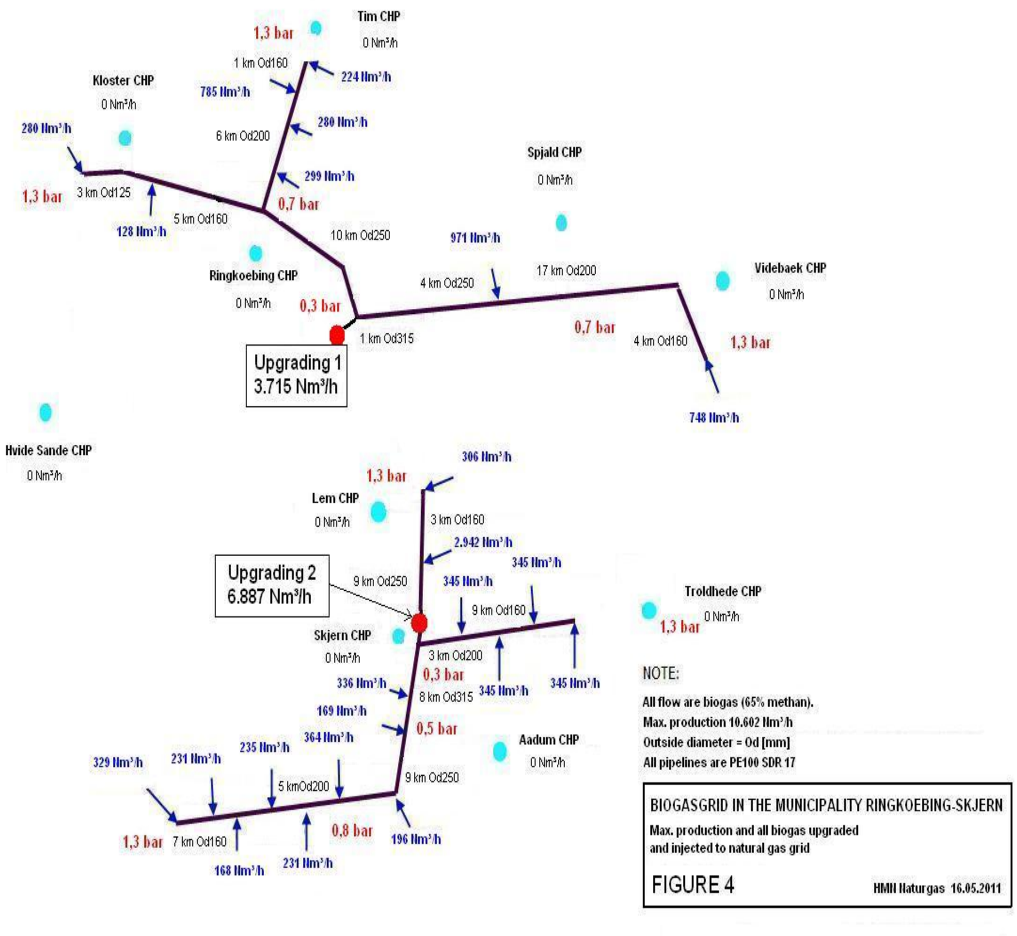

Figure 4 - Biogas grid with 100% opgrading of biogas to natural gas grid

Construction costs.

The project team has calculated the estimated project cost for the following:

Decentralized / centralized biogas plants:	67 million euro
Biogas grid:	20 million euro
Upgrading plants:	15 million euro
Gas compressors 4/40 bar:	2 million euro
Total costs excl. VAT:	**104 million euro**

This solution is thus approx. 10 million euro cheaper than the solution, where biogas is supplied directly to the local CHP plants

It is estimated that this solution will provide an annual operating profit in the same magnitude as the original project, so the simple payback time is about 1 year shorter. One of the great advantages of upgrading option is access to the natural gas market and hence a large customer-mass.

Biogas/Hydrogen solution.

As a spin off to this project it has been decided to investigate whether it would be attractive in the future to exploit the separated CO2 from the upgrading process (or from the CO2 mixed in biogas), so this can be converted to methane by adding hydrogen. It is assumed that electricity consumption for hydrogen production is based on "surplus electricity" from wind power. Utilizing this technology methane production from the biogas plant will increase by almost 70%. A demonstration project is expected to be completed in 2012.

Furthermore the project examines the possibilities of adding hydrogen directly to the biogas without upgrading first, so the mixed gas consisting of methane and CO2 can react directly with hydrogen in a Sabatier reactor. The system is shown in figure 5.

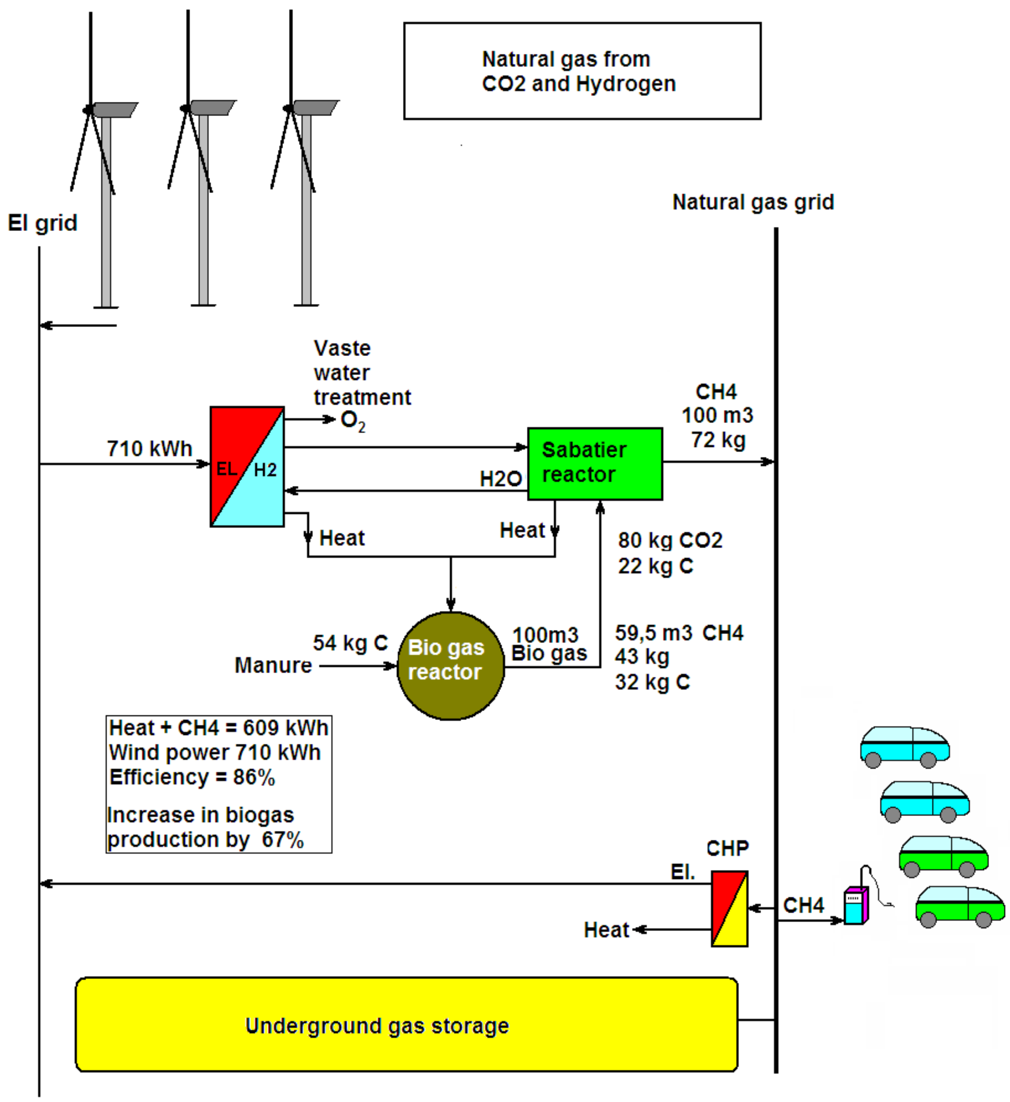

Figure 5 - System producing methane from CO2 and hydrogen.

The combination of 3 different but well known technologies gives the possibility of optimizing the process, so heat produced by the Electrolyser and the Sabatier reactor can be used for heating the biogas reactor and of supplying district heating systems with energy. The water produced by the Sabatier reactor can be used in the Electrolyser and the oxygen produced by the Electrolyser can be used in the biogas plant to remove sulpur from the biogas or it can be sold for other purpose. Additionally it will be possible to use a part of the steam (20 bar) produced by the Sabatier reactor to pre-treat biomass before injection in the biogas reactor which can increase the biogas production. The main purpose of the project is to show the opportunities of storing surplus electricity from e.g. wind power in the natural gas grid in a realistic and competitive way.

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