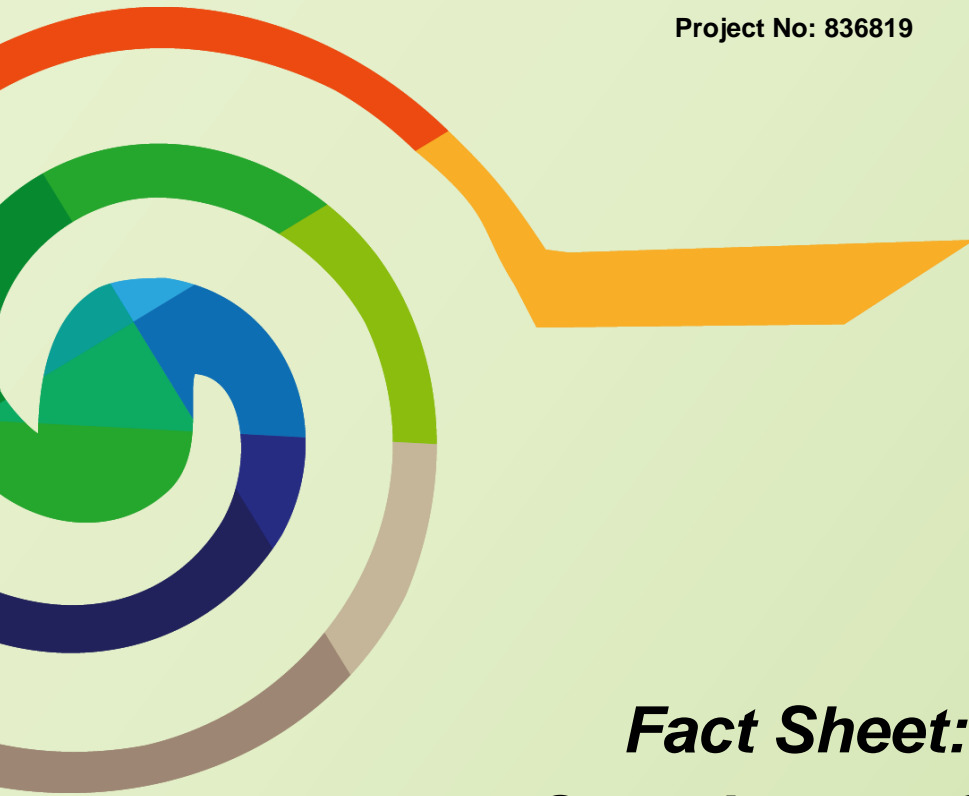


Smart strategies for the transition in coal intensive regions

Project No: 836819



Fact Sheet: Greening the Gas

September 2019



GET

Description

With the "**greening the gas**" strategy, the gas industry offers the opportunity to rapidly integrate and distribute large quantities of renewable energy into the space heating market and make it available to the end consumers. The greening of the gas strategy will enable natural gas demand in district heating to be fully covered by green gas (bio-methane from residues and synthetic gas from power-to-gas and hydrogen). (Fernwärme)

First of all, what is Biogas and Biomethan?

Biogas: is produced after organic materials (plant and animal products) are broken down by bacteria in an oxygen-free environment, a process called anaerobic digestion. Biogas systems use anaerobic digestion to recycle these organic materials, turning them into biogas, which contains both energy (gas), and valuable soil products (liquids and solids).

Important technologies in the biogas industry:

- Power to gas
- Membrane technology
- Dry fermentation technology (Tanigawa, 2017)

Biomethane: Biomethane can be either upgraded biogas from anaerobic digestion or cleaned syngas from gasification of biomass, being **100% renewable**. Also the methane of the Power-to-Gas process is included if the applied electric power is generated from renewable sources and the hydrogen is biologically converted to methane with the CO₂ in the digester. (European Biogas Association)

Upgrading technologies remove impurities from biogas and convert it into biomethane, which can be used as a **fuel** for vehicles or injected into the **natural gas grid**. The operating pressure in distribution grids is usually **below 4 bar**, so no additional compression is needed after the gas upgrading. However, the biomethane gas has to be compressed to **200 bar** to supply it to the vehicles. Compressed Biomethane Gas (CBG) can be supplied at existing **CNG filling station**.

Number of compressed natural gas (**CNG**) filling stations:

- Austria 177
- Italy 1046
- Germany 921
- Great Britain 16 etc. (Neven Duic, 2016, p. 86)

A large number of technologies for biogas cleaning and upgrading have been developed. Continuous research on biogas upgrading, attempts to further improve the overall efficiency and reduce investment, operation and maintenance costs. (Neven Duic, 2016, p. 53)

Conventional biogas **upgrading methods** can be categorised as follows:

- Membrane separation;
- Scrubbing technologies (absorption methods);
 - Water scrubbing;
 - Physical scrubbing;
 - Chemical scrubbing;
- Pressure swing adsorption (PSA);
- Cryogenic treatment. (David Wilken, 2017)

Biomethane offers many **advantages**. Here are some of them:

- More efficient use of the gas
- Minimal intervention into nature
- Security of energy supply
- Sustainability

- Socio-economic benefits (Neven Duic, 2016, pp. 77-78)

A great variety of organic material can be used in anaerobic digesters as a feedstock for generating biogas. (Dana M Kirk, 2019)

Biogas Feedstocks can be for example:

- Food Waste
- Landfill Gas
- Livestock Waste
- Wastewater Treatment etc.

(Tanigawa, 2017)

Biogas is known as an **environmentally friendly** energy source because it **alleviates two major** environmental problems simultaneously:

- The global waste epidemic that releases dangerous levels of methane gas every day
- The reliance on fossil fuel energy to meet global energy demand (Homebiogas, n.d.)

Further **advantages** would be:

- Well-established, proven technology
- A storable form of renewable energy, capable of being transported and utilised 24 hours a day, 7 days a week
- Reduces air pollution and acid rain
- Releases biogenic carbon dioxide emissions and therefore is a carbon neutral technology (Bio2Watt, n.d.)

Achievements

In Europe, the biomethane market is developing rapidly, with double-digit growth every year: the number of European biomethane plants has gone from **187 to 459** in just **five years**, with the market expected to continue growing in the years to come.

Germany represents the largest share of this growth, with an increase from **87 to 185** plants within the same timeframe. Between **43% and 55%** of all European biomethane, plants are located in Germany – the exact percentage varies from year to year.

15 countries use up-grading techniques to produce biomethane (AT, CH, DE, DK, ES, FI, FR, HU, IC, IT, LU, NL, NO, SE, UK).

(David Wilken, 2017, p. 6)

For example

Brazil: Biogas has been **successfully** processed into biomethane and today serves as fuel for an in-house vehicle fleet. Here, in a project funded by the International Climate Initiative (IKI) of the Federal Ministry for the Environment, a plant was built to treat the biogas from the wastewater treatment plant in the Brazilian Franca to natural gas quality. (Fraunhofer IGB)

Vienna: In the biogas plant, **biogenic waste** from Vienna, which is suitable for fermentation, is converted into energy. Annually there are processed about **22,000 tons** of biogenic waste. After quality control, the biomethane is compressed to a pressure of up to 70 bar and then **fed into the local natural gas grid**. The upgrading of biogas to biomethane to feed it subsequently into the natural gas grid has gained so much relevance.

More than **900 households** in Vienna are supplied with biomethane from the biogas plant in Simmering. In this sense, Wien Energie, the power supply company of Vienna, included biomethane also into their tariffs. (Prof.dr.sc. Neven Duic, 2016, pp. 16-17)



Figure 2: Upgrading and grid injection of biomethane in Vienna

(Prof.dr.sc. Neven Duic, 2016, p. 17)

Zürich: In **Switzerland**, sewage sludge must be incinerated. This circumstance is exploited to create symbioses effect in the city of Zürich, where the Biogas Zürich AG's new biogas digester started operation in July 2013. In order to introduce the environmentally friendly biowaste management which includes renewable energy recovery and production of a high quality fertiliser, new biogas plant for AD treatment of biowaste was built in 2012/2013. Source separated biowaste from households is used as the feedstock.

The biomethane produced from **both streams** (biowaste to biogas and sewage sludge to biogas) is injected into the national gas grid. (Prof.dr.sc. Neven Duic, 2016, pp. 23,25)

Challenges

In general, the most economic risk is the fluctuating price of the input material, security of supply and the higher production costs for upgrading to biomethane.

Economic risks

- **Construction costs** (direct construction material price, land rent, transportation, loss maintenance etc.)
- **Operating costs** (raw materials, regular inspection and maintenance for the equipment, environmental protection etc.)

(Tanigawa, 2017)

In addition, currently there are no **new technologies** to simplify and improve the process of biogas generation, meaning that it is not a completely efficient system.

Large-scale production for a wider population is not possible yet, and **investment** into the sector is not particularly popular with governments, which are instead putting money into the more developed alternatives of wind and solar. (Power Technology, 2018)

For example, in Austria studies showed, that present quality requirements for gas feed-in are due to historical reasons oriented at the quality of natural gas. The specialities of fermentation gas, in particular the lower energy content of fermentation gas, are not taken into account. As a result, fermentation gas has to be **upgraded** on the quality of natural gas before it can be fed-in into the gas grid. The required upgrading process is very **cost expensive**. (Hornbachner, n.d.)

A challenge might also be to calculate the **economic feasibility** of an upgrading project. There is a very useful **Excel-tool** available to get some fast economic outcomes for biogas upgrading and grid injection:

http://www.bin2grid.eu/documents/73603/136995/D6.2_biomethane+tool+for+economic+analysis+of+biogas+production%2C+gas+upgrading+and+utilization+of+biomethane.xlsx/46d92c3a-e49a-4f2f-a7e4-a904b124aaca

For example, in that tool the costs for upgrading and grid injection were about 30 €/MWh biomethane, plus the costs for the raw biogas.

Enabling conditions

Enabling conditions consist of **national regulations, policies, subsidies and incentives**, as well as **international market and legal infrastructure, trade and technical assistance**.

Currently, enabling conditions encourage the prevailing economy, which depends excessively on fossil fuels, resource depletion and environmental degradation.

In addition to these policies, creating the right conditions for investment in the **green economy** requires a combination of capacity building, information sharing, dissemination of good policy practice, social assistance, skill development, general education and awareness to make sure that green measures are well designed, implemented, enforced and understood. (un-page, p. 29)

Biogas plants create **economic opportunities** in markets where energy costs and/or waste disposal costs are relatively high. Since the organic fraction of municipal solid waste can represent approximately 50% of MSW mass, it becomes economically interesting to divert the organic fraction from conventional disposal towards anaerobic digestion.

Processing of organic waste in a biogas plant can help reduce waste disposal cost. Production of biogas from organic waste can help generate an affordable renewable energy.

For example, small island countries can benefit greatly from biogas plant since they often generate expensive and dirty electricity with diesel (\$0.50+/kWh) and are confronted with significant challenges regarding disposal of their waste. (Eric Camirand, n.d.)

There exist several **critical steps** in the realization of a **successful biogas project**.

Biogas plants are large expensive finicky biological systems that require careful planning. In fact, most biogas plant failures are due to poor planning and/or not paying close enough attention to project fundamentals such as **feedstock, energy utilization, digestate management, and financing**.

- Establishing expected **feedstock** collection methods (trucks, bins, routes, etc.), quantity, quality and overall logistics (collection contracts, transfer stations, hours of reception, etc.) often require significant studies and planning.
- Finding a **proper site** for a biogas plant also requires significant effort. The site needs to meet proper zoning, and environmental regulations (proximity to houses, rivers, wells, etc.). The site must also be easily accessible by road for the feedstock to come in, and the digestate to come out without causing too much traffic nuisance to the neighborhood. Finally, the site must be close an energy grid (gas or electrical) in order for the biogas energy to be exported efficiently.
- **Digestate management** must be studied carefully since the disposal of digestate is often the largest operational cost of a biogas plant. All possible avenues of disposal, transformation or treatment must be taken into consideration to ensure that the final strategy for digestate management is the most efficient. Otherwise, the biogas plant economics will be less than optimal. (Eric Camirand, n.d.)

References and further links

Further examples:

The Bionerval anaerobic digestion plant in Étampes, France (food and beverage waste, expired products as input material):

https://www.youtube.com/watch?v=RI05gv9_0f0&feature=youtu.be

Bin2Grid Good Praxis Example: Biogas Plant in Hartberg, Austria (organic waste as input material)

<https://www.youtube.com/watch?v=6yJ2qBcM-n4&feature=youtu.be>

Factsheets on good practice of biogas upgrade:

http://www.bin2grid.eu/documents/73603/136970/Eng_Bin2Grid_revision.pdf/2dbe8c8b-1656-4336-8438-a15fcd632331

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