

BIOGAS IN SOCIETY
A Case Story

BIOLOGICAL METHANATION DEMONSTRATION PLANT IN ALLENDORF, GERMANY

AN UPGRADING FACILITY FOR BIOGAS



IEA Bioenergy Task 37

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MISSION AND VISION

The power-to-gas concept is an energy storage solution suitable for long-term and large-scale storage of intermittent renewable electricity. Initially renewable electricity is used to produce hydrogen via electrolysis. Further conversion to renewable methane is conducted by reacting hydrogen with a carbon source ($4\text{H}_2 + \text{CO}_2 = \text{CH}_4 + 2\text{H}_2\text{O}$). The plant concept is based on a biological methanation process using the carbon dioxide in raw biogas as the carbon source. Thus, the technology doubles as a biogas upgrading process ideally suited for small biogas plants and as an energy storage for otherwise curtailed renewable electricity. The generated methane gas serves as an advanced gaseous transport fuel or may be used for renewable heat (Figure 1).

PLANT DESCRIPTION

The first demonstration plant worldwide using the power to gas combination of electrolysis and biological methanation was established in Germany at the Schwandorf wastewater treatment plant. This was a collaboration project between MicrobEnergy GmbH, Schmack Carbotech GmbH (Essen, Germany), Viessmann Werke GmbH & Co. KG and Schmack Biogas GmbH (Schwandorf, Germany). The facility moved to Allendorf (Eder, Germany) in late 2014 (Figure 2). The plant consists of a PEM-electrolyzer (Carbotech) and a methanation unit (BiON technology, MicrobEnergy GmbH). The methanation unit forms the core of the plant and converts either carbon dioxide from the gas processing plant or directly from the raw biogas (Figure 3).

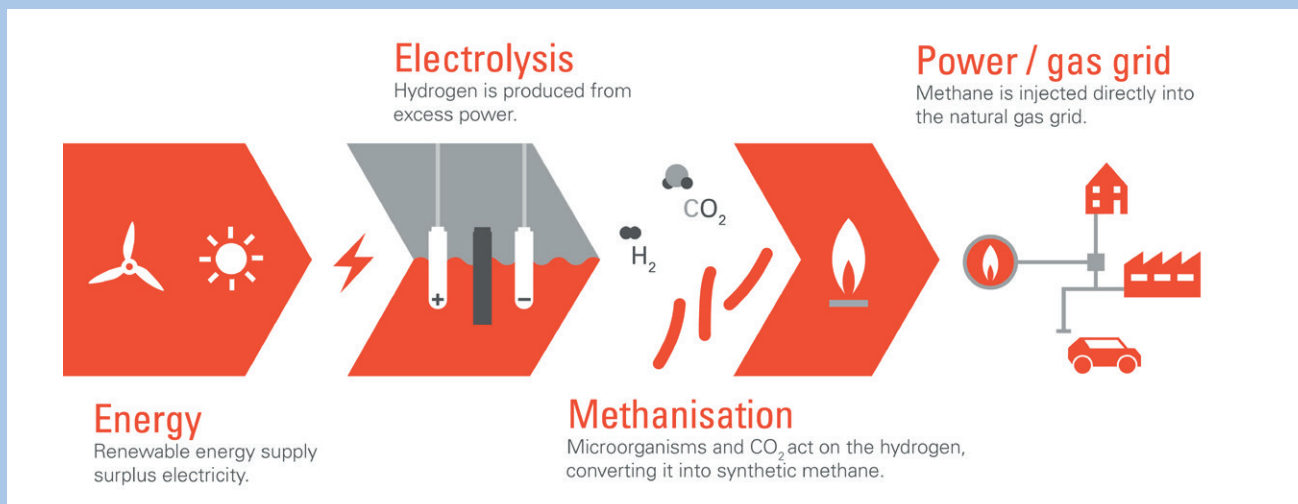
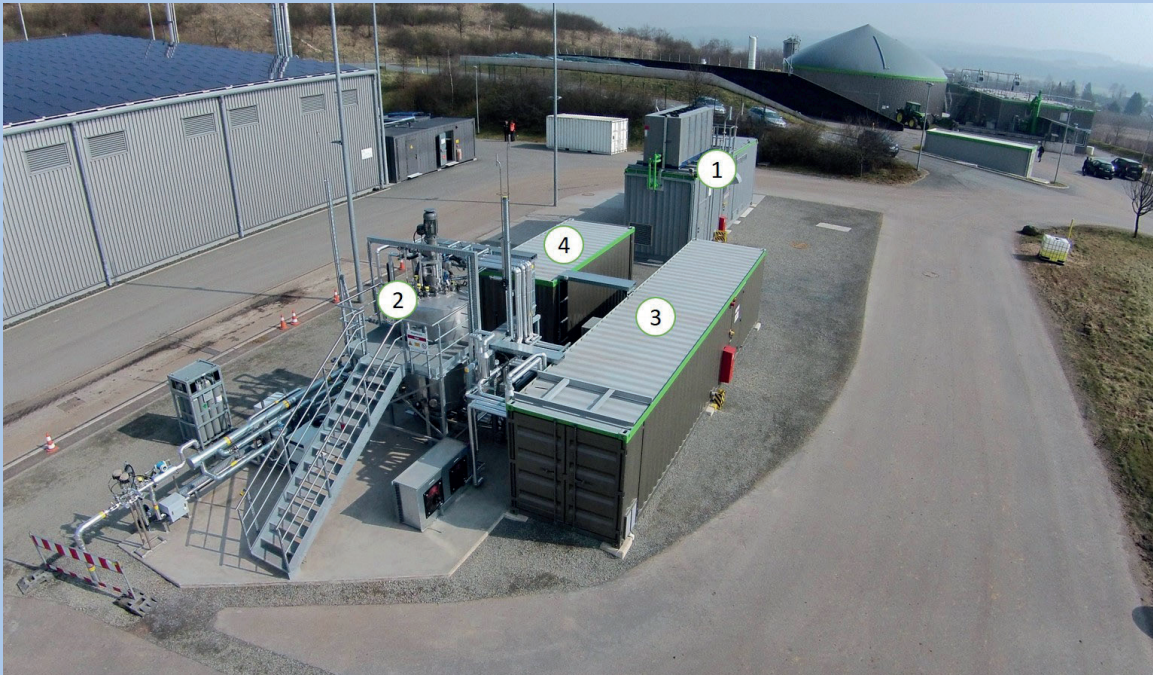


Figure 1: Concept of combined power-to-gas and biological methanation technology



Figure 2: Demonstration plant located in Allendorf (Eder), Germany (© Viessmann Werke GmbH & Co. KG)



- 1: PEM-electrolyzer
- 2: Methanation-reactor
- 3: Measuring and mechanical process technology
- 4: Process and system control

Figure 3: Schematic view of the demonstration plant in Allendorf (Eder), Germany (© Viessmann Werke GmbH & Co. KG)

PROCESS DATA

The methanation plant treats up to 30 m³ of raw biogas per hour at Standard Temperature and Pressure (STP). The product gas has greater than 98 % methane content and less than 1.5 % hydrogen content. The plant has a feed-in capacity of ca. 400,000 kWh per year. The methanation reactor is a continuous stirred tank reactor with a volume of 5 m³ operating at 5 to 15 bar in the temperature range 50 to 80°C. Biological methanation is performed using an aeration stirrer operating at 400 rev/min.

the produced methane contributes to policy linking the electricity, heat and transportation sectors. The potential usage of methane as climate-friendly fuel led to implementation of a cooperation with Audi and marketing as an advanced gaseous biofuel. Biological methanation has the advantage of working at low temperature and pressure utilising BiON technology. The greenhouse gas reduction potential is assessed as 94.7%; this calculation is based on 3000 hours a year of operation using electricity from hydropower with 70% usage of surplus heat. The produced methane can add value to decarbonisation of transport and heating sectors.

Table 1: Input and output of the demonstration plant (Allendorf, Germany) in 2015

	PEM-electrolyzer	Methanation reactor
Input	1 L H ₂ O/m ³ (STP) H ₂ 300 kW	15 m ³ CO ₂ / h
Output	max. 60 m ³ H ₂ / h	15 m ³ (STP) CH ₄ / h ca. 20 L H ₂ O/h
buffer capacity	20 m ³ H ₂	

ECONOMIC AND ECOLOGICAL ASPECTS OF POWER TO GAS

The produced methane is certified and sold in the transport fuel market. Since 2016, the plant participates in the German electricity balancing market. Due to the inherent long-term storage capacity,

OUTLOOK

This power to gas facility is a demonstration plant built within the “BioPower2Gas” research project funded by the program “Energetic Biomass Utilization” (September 2013 to August 2016) of the Federal Ministry for Economic Affairs and Energy. The power-to gas combination of electrolysis and biological methanation technology represents an essential component for future energy systems, combining decentralised solutions for storage of energy with upgrading of raw biogas. Due to present taxes and regulations associated with surplus renewable electricity, the storage of electricity by power to gas in Germany is not yet economically feasible. The vision is that in combination with biogas upgrading business models can be developed. Currently the MicrobEnergy GmbH advise and support companies to develop Power-to-Gas-projects in a range from 2 to 40 MW worldwide.

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“Energy from Biogas”
<http://task37.ieabioenergy.com>

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IEA BIOENERGY

The IEA Bioenergy Technology Collaboration Programme (www.ieabioenergy.com) is a global government-to-government collaboration on research in bioenergy, which functions within a framework created by the International Energy Agency (IEA - www.iea.org). As of the 1st January 2016, 23 parties participated in IEA Bioenergy: Australia, Austria, Belgium, Brazil, Canada, Croatia, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Republic of Korea, the Netherlands, New Zealand, Norway, South Africa, Sweden, Switzerland, the United Kingdom, the USA, and the European Commission.

The mission of IEA Bioenergy is to increase knowledge and understanding of bioenergy systems in order to facilitate the commercialisation and market deployment of environmentally sound, socially acceptable, and cost-competitive bioenergy systems and technologies, and to advise policy and industrial decision makers accordingly. The Agreement provides platforms for international collaboration and information exchange in bioenergy research, technology development, demonstration, and policy analysis with a focus on overcoming the environmental, institutional, technological, social, and market barriers to the near- and long-term deployment of bioenergy technologies.