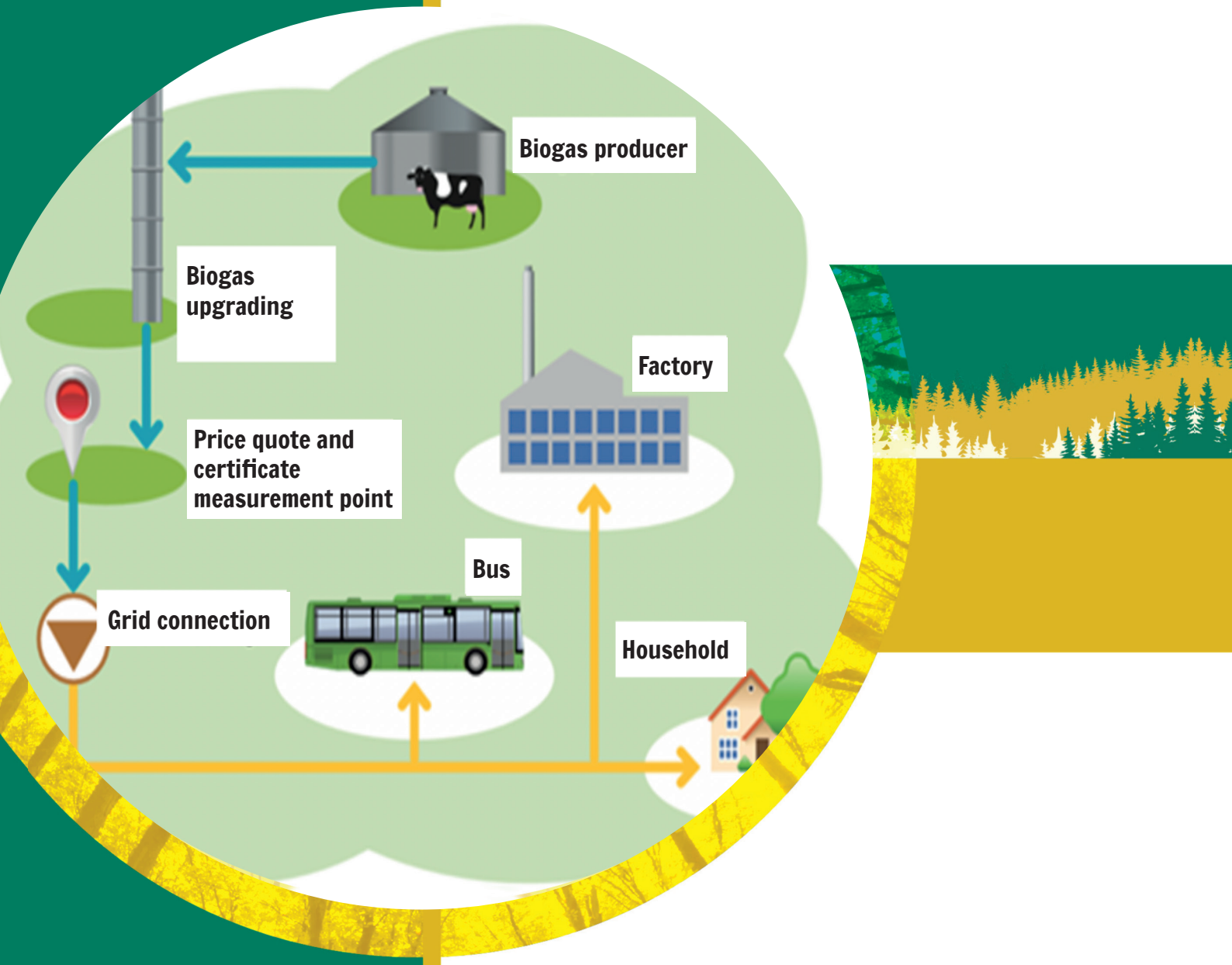
BIOGAS IN SOCIETY
A Case Story

GREENING THE GAS GRID IN DENMARK



IEA Bioenergy Task 37

IEA Bioenergy: Task 37: February 2019

POTENTIAL DISPLACEMENT OF NATURAL GAS WITH GREEN GAS

Denmark is the country in Europe with the highest share of green (decarbonized) gas in the gas grid and could be the first European country to become independent of fossil natural gas by satisfying all of gas consumption through green gas produced from food waste, industrial organic waste and agricultural by-products. As of 2019, more than 10 % of the gas in the Danish gas grid is green throughout the year. In the summertime the decarbonized share is 25 %. It is estimated that 100 % of the expected gas consumption could be green by 2035 (this equates to 72PJ) according to assessments from Aarhus University and Green Gas Denmark (Figure 1). The assessment is based on an increased use of manure and digestible wastes as well as 50 % of the straw resources as anaerobic digestion (AD) feedstock, along with an increased production efficiency. Aarhus University points out that utilisation of the gas grid for electricity storage (whereby electricity is converted to hydrogen and the hydrogen is reacted with CO_2 to produce methane) could boost the energy potential to 100 PJ. This development could also create up to 20,000 new jobs in Denmark by 2035.

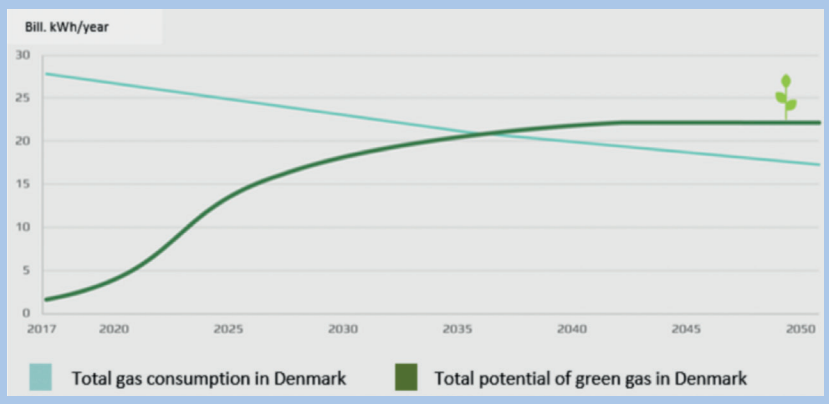


Figure 1: Gas consumption and potential of green gas in Denmark (from Green Gas Denmark)

Green gas is a common term for several renewable gases, which are produced from renewable sources through specific processes. One of these green gases is upgraded biogas, also known as biomethane. The production of green gas for the gas grid began in Denmark with the Energy Agreement from 2012, supported by a large political majority. Since then, an industrialization process of the sector has taken place, and many large-scale biogas plants, equipped with biogas upgrading units, were built. About half of the produced biogas was upgraded in 2018. Currently, 32 green gas plants are connected to the gas grid (Figure 2). The share of biogas upgraded and supplied to the natural gas network is increasing sharply and the interest in biogas for transport is growing.

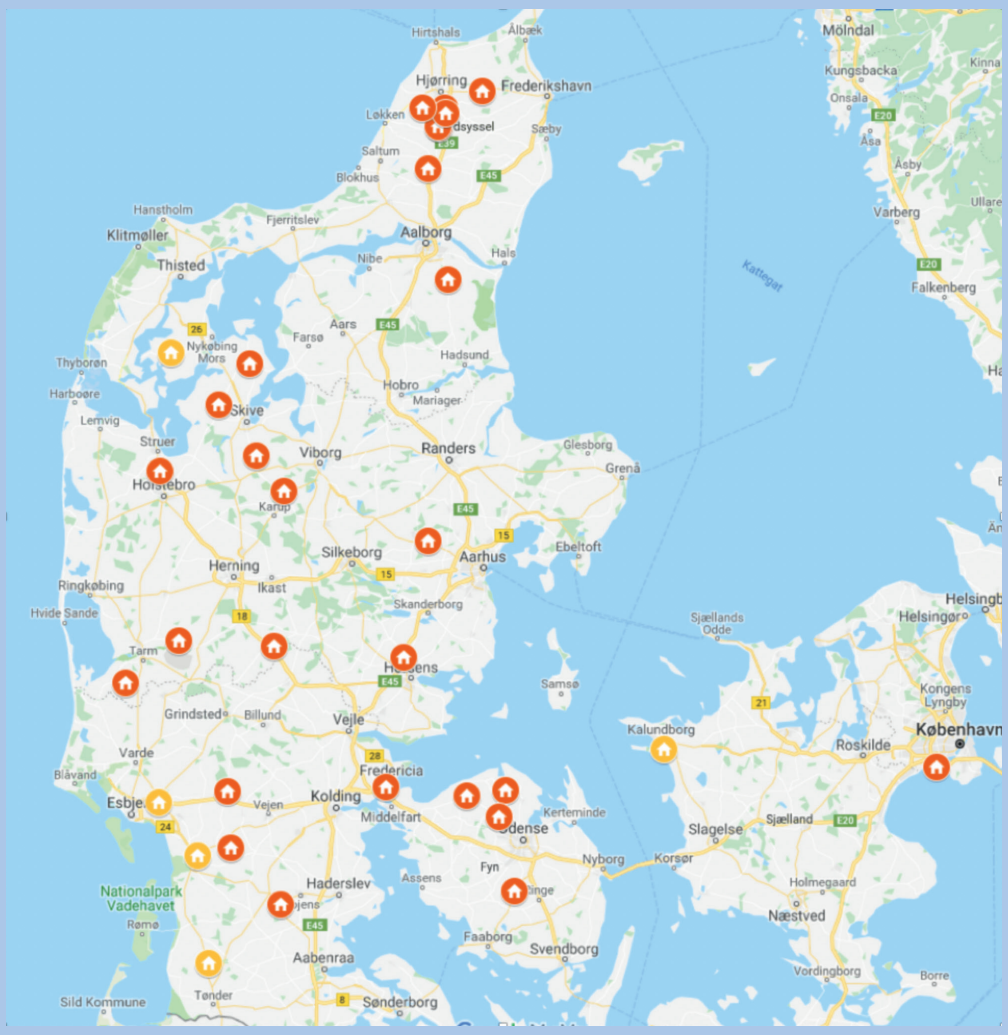


Figure 2: Grid connections for green gas in Denmark (yellow marks indicate connections established in 2017)

THE ROLE OF GREEN GAS IN DECARBONIZING ENERGY

Denmark plans to reduce greenhouse gas (GHG) emissions from transport, housing and agriculture by 39% by 2030. One fifth of this targeted reduction could be achieved through use of green gas as a vehicle fuel for buses and trucks. This is an ideal use of biomethane as transport is the least decarbonized energy sector and electrification is not seen as a likely solution for haulage and intercity long distance buses. Thus greening of heavy transport through a shift to green gas use in natural gas vehicles together with electricification of the private transport fleet is essential for reaching the above target. A new report from Sydtrafik indicates that biogas for transport is 1.43 DKK/km cheaper than electricity.

In 2014, the year green gas first entered the gas grid in Denmark, it reduced CO_2 emissions by 675,000 tons, equivalent to the annual emissions from more than 300,000 cars. For 2018 alone biomethane is estimated to have reduced the country's CO_2 emissions by 800,000 tons. According to Green Gas Denmark, the complete conversion to green gas would bring about important benefits for society, including:

- Displacement of 4.6 million tons of CO_2 by 2035;
- An optimal use of the state-owned gas system – a social investment of DKK 55 billion;
- The development of a strong vibrant Danish green gas industry with potentially up to 20,000 new jobs and $16 billion DKK in exports by 2035;
- Conversion of the heavy transport fleet to green gas reducing CO_2 and NO_X emissions;
- Circular economy benefits including lower emissions in agriculture;
- Decentralised, CO_2 neutral indigenous gas production.

The Danish gas system is relatively modern, installed in the 1980s. It is efficient and widely deployed, suitable for distribution and storage of many different forms of green gas. The gas network has a storage capacity for green gas equivalent to one third of Denmark's annual electricity consumption. This allows the gas system to operate as the optimum safety net for the green transition. In the future, the gas system will also play an even more important role, as a storage system for surplus (or curtailed or constrained) electricity. When intermittent renewable electricity from wind turbines and PV systems is produced at a time when the demand is low, the electricity may be converted to hydrogen via electrolysis, and subsequently methane via a methanization process, and can be injected to the gas grid for storage.

NATURE ENERGY LEADING THE GREEN GAS TRANSITION

One of the companies that are exploiting the new green gas market is Nature Energy A/S, the largest producer of biogas in Denmark and a European leader in the emerging green gas to grid sector. Nature Energy A/S operates in the cross field of green energy production, circular economy in waste management, and sustainable farming. As one of the main actors of the green transition in Denmark, the company considers biogas to be one of the important pillars, in building the fossil free society, along with wind and solar. "Our goal is to help our customers choose future-proof energy solutions that create value for themselves and for society. We do this by offering tailor-made energy solutions, advising on and subsidising energy efficiency projects and, of course, selling gas at the market price. At the same time, we are turning the gas sector green by being the largest biogas producer in Denmark"– says Ole Hvelplund, Managing Director of Nature Energy A/S.

The four large AD plants, built By Nature Energy A/S in recent years (Holsted (Figure 3), Korskro/Esbjerg, Videbæk and Månsson (the largest organic green gas plant in Europe)) have the capacity to convert 1,000,000 tons of digestible wastes and manure into

Figure 3: Holsted Biogas Plant, producing 20.7 million m^3 gas / year. Source: Nature Energy

biogas every year. Some of the upgraded biogas is used as an advanced renewable gaseous transport biofuel, dispensed at numerous filling stations around the country. CO_2 is in short supply throughout Europe. In partnership with Strandmøllen A/S, Nature Energy captures CO_2 from biogas from the Esbjerg facility (one of the world's largest biogas facilities) and uses the purified CO_2 as "gas bubbles" in beverages and beer. This further reduces CO_2 emissions from the biogas plant improving sustainability and again highlights that biogas is an exemplar of the circular economy in practice.

FUTURE ENERGY SYSTEMS INCLUDE RELIABLE GREEN GAS SYSTEMS

Decentralised production of green gas at 32 gas to grid facilities is underway in Denmark. Similar amounts of biogas are not upgraded and are used locally. In essence green gas production can readily be doubled. The Danish gas system is progressively changing to a decentralized green gas production system, based on a connected network of many plants (Figure 2). Increasing supply (Figure 1) leads to increasing security of gas supply leads to energy self-sufficiency and decarbonisation of heavy transport.

The Danish system employs large-scale plants taking advantage of economies of scale. Technological advances are anticipated in the coming years; the level of professionalism among biogas actors such as Nature Energy A/S leads to efficiencies in processes and increased biogas production. Upgrading biogas to biomethane and injection to the natural gas network is expected to be the primary outlet for biogas. Most of the proposed facilities expect to sell upgraded biogas, and some of the plants in operation today, that sell gas for electricity production, are expected to switch to gas to grid systems. The major challenge for the industry is to simultaneously reduce production costs and increase sustainability.

Nature Energy A/S has a dynamic approach to new market opportunities, including new feedstock types such as poultry farming residues, expansion into new markets in Europe and North America, while continuing to supply more AD plants in Denmark. This should lead to a doubling of Naure Energy's biogas production, to around 200 million m^3 biomethane per year.

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"Energy from Biogas"
http://task 37.ieabioenergy.com

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IEA BIOENERGY

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