



BIOGRID

BIOGAS SUPPLY THROUGH A SPECIAL DISTRIBUTION GRID AND ADJUSTMENT OF RESIDENTIAL APPLIANCES



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ABSTRACT

The energy and gas transition is beginning in earnest. Where Gasunie has held the monopoly for decades, now new gas suppliers are making their entrance onto the regional grids. Green gas, upgraded and produced from biomass, can be injected into the Netherlands' natural gas grid. The changes will affect gas supply, techniques and institutional and operational aspects.

The BioGrid project takes a major step forward, as we consider the gas supply chain in all its aspects. In the BioGrid project, modifications to accommodate biogas in the gas chain are not carried out within the gas production and distribution itself, but on the equipment of the end-user. The pilot project will apply development and practice towards building a dedicated biogas grid and modifying the relevant household appliances. The project will experiment with a mix of natural gas and biogas.

This paper on the BioGrid considers the changes in market service, the technical aspects and the pilot project.

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INTRODUCTION

The Netherlands' main gas supply has come from the Groningen gas fields since the 1960s. Smaller North Sea fields and other conventional resources were later added to supply Dutch customers and for export. Gas has traditionally been sold and supplied by Gasunie. Precise gas quality has been properly attuned to gas users' installations in our national and regional networks. Today gas distribution in the Netherlands transports 963PJ gas over 121,000 km of pipeline to supply 6.5 million customer connections.

A new biogas market has recently begun to develop. The quest for new renewable energy resources, the realisation of geopolitical independence and new ways of dealing with residual and waste material gas from biomass are all playing a role. The political environment (from the European Commission and the Dutch government through to regional districts) provides a better climate for investment than it did a decade ago. Research, installations for fermentation and production and new concepts all receive financial support. For example a special SDE (Support for Renewable Energy) supports the financial risks of exploitation for 12 years. New initiatives, investments and innovations are launched and explored.

The gas market is changing rapidly. Gas is no longer delivered exclusively from Groningen, but also from other initiatives and locations in the Netherlands, such as waste treatment facilities, sewage treatment plants and farms across the country. New opportunities are perceived in the fermentation of their products. Previously this was virtually a monopoly of the Dutch Gasunie. These days farmer Giles has an interest in producing gas from his cattle manure.

And we can go even further. In the Netherlands biogas for injection into the natural gas grid needs to meet the green gas specifications. These quality specifications are secured in Dutch legislation. The underlying idea is that the gas quality must meet the specifications of the installations and equipment of the gas consumers connected to this grid. Customers should receive the high-quality gas required, for example, to power a household's high-efficiency boiler.

But some customers only use gas for heating. Here a high natural gas standard is not necessary for every installation, and is therefore a significant waste of effort and energy. If you just burn the gas why should you upgrade it so precisely and sharply to exactly two decimal places to meet the specs? Upgrading to an unnecessarily high gas quality standard is therefore not economic, and is inefficient in terms of both energy and the ecology. One solution is the BioGrid design by Alliander. In this new concept, the new gas is not adapted to the conventional gas but instead, installations, equipment and devices will be adapted to the new gas. This creates new prospects for expanding and servicing the gas market.

A pilot project has been launched to research and build a dedicated biogas grid and to design and develop residential appliances.

Gas market in the Netherlands

The Netherlands has ambitious goals for the transition towards renewable energy. Some 45% of Dutch primary energy consumption (1466 PJ in 2009) is based on natural gas. Over the short term between 8% and 12% is to be substituted by renewable gases. The Dutch government is adopting the European target of using 14% renewable energy by 2020. The calculations for this objective are based on renewable energy production. By 2050 up to 50% is to be substituted.

Some 963 PJ of gas is distributed in the Netherlands over 121,000 km of pipeline supplying 6.5 million connections. The turnover of gas distribution is one billion euros.

Alliander is the largest regional grid operator in the Netherlands, owning over 35,000 kilometres of gas distribution grid, with around 5,800 million cubic metres distributed to more than 2,114,000 customer connections. Alliander, in cooperation with other Dutch grid operators, plays a pivotal role in facilitating

the transition towards renewable gases. Based on experiences from several pilot projects, biomethane injection into the gas grid is almost common practice. Biomethane injection into the natural gas grid requires strict quality standards.

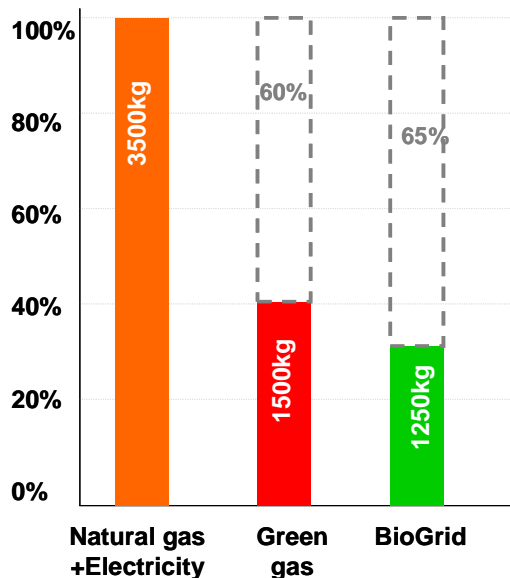
Sewage treatment plants (STP), and organic waste and manure digesters have been in the Netherlands for some time. The biogas is currently burned in combined heat and power cogeneration. If CHPs are depreciated or the MEP subsidy period expires, investors will be looking for new opportunities, and the production of biogas is under serious consideration.

BioGrid as a high performer in CO₂ emission reduction

Manure is an important source of biomass in the Netherlands. There is plenty of it, and other renewable opportunities such as wind energy or solar power are often not feasible because of regional restrictions, for example because of wooded areas. Milk quota legislation is also to be changed, so that the affected farmers will seek new income streams. Manure fermentation performance is exceptionally good: high methane content can be achieved and a significant reduction of CO₂. Taking CH₄ conducted emission in the calculations of CO₂ emissions significantly. See Figuur 1

Figuur 1

Manure digestion 2020 Option	Ton CO ₂ /ha/annual reduction	CO ₂ reduction percentage	Euro/ ton CO ₂
Co digestion for electricity only	>100	430%	0-60
Co digestion co generation CHP	>100	360%	0-30
Biogas sales in region for industry	>100	435%	16-70
Bio digester next to industry	>100	435%	11-60
Green gas injection into natural gas grid	>100	430%	20-70
LBG (Liquid Biogas) (transportation)	>100	400%	auto's en pompen)
Bio-CHP with wood		68-90%	40-150
Co-firing with in addition to coal		90%	apr-40
Biochemistry		92%	60-300



In the BioGrid, the direct distribution in public networks using an HR-technology heating boiler achieves high energy efficiency. Upgrading energy and costs are saved.

Figure 2: impact of biogas on CO₂ emission of a new home per chain. (Figures based on 1,000 new homes and 1 gas producer (270Nm³/h)

BioGrid turns the gas market upside down

Supplying gas has been a conventional affair for half a century. But now the gas market is changing thanks to the increasing supply of biogas, turning the market upside down in a number of ways.

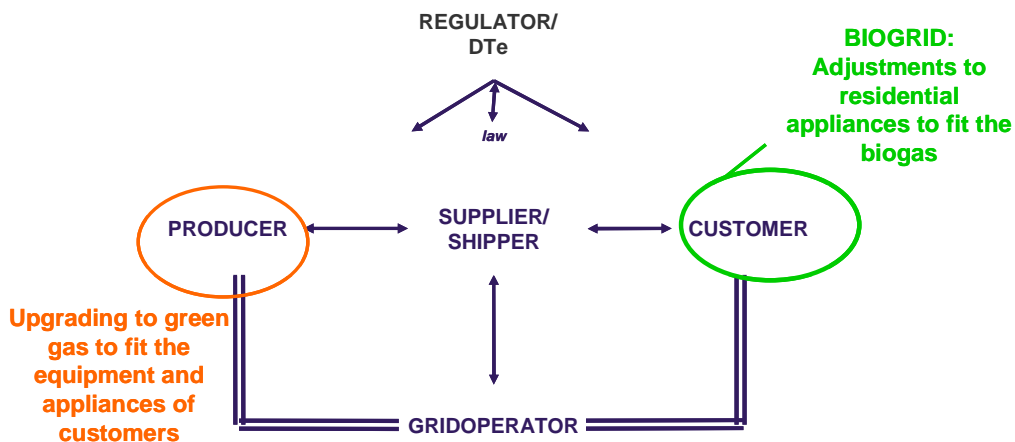
The first effect is changing the gas market from a monopoly of Gasunie (a public-private partnership of Shell (25%), ExxonMobil (25%) and the Netherlands (50%)) towards an oligopoly, a market dominated by a small number of sellers.

Secondly, the gas flow will not be delivered by Gasunie to the regional grids exclusively. Gas has been distributed from the large gas field in Groningen, small fields in the North Sea or from imports of conventional gas resources. The physical gas flow has been distributed from Groningen and the entry points over the high-pressure grid (67 bar – 40 bar) to the regional distribution grids (8 bar – 100 mbar) to supply industrial and household customers. Gas flows from high pressure towards the low-pressure grids. Because of the gas injection in the lower-pressure grids, the gas distribution station (GasOntvangstStation, GOS) is no longer the only entry point for gas in the regional grids. Now decentralised injection points are connected to the grid as new entry points. This could result in so-called decentralised standalone self-supplied regions or areas within the regional grid.

Thirdly, if gas usage is less than the gas produced within the same grid section, gas needs to be transferred to a higher-pressure level. An overflow to the higher-pressure grid might be needed, changing the one-way direction of the gas flow.

Finally, for decades Gasunie was responsible for gas quality. Now new parties will refine and upgrade their own gas.

In the current gas transition, we consider the market from various angles and perspectives. The BioGrid ignores the conventional model, where gas should meet the specifications of the existing gas. Now the focus is on the customer and his application: it could be more efficient to adjust the end-user's equipment for the biogas than to adjust the biogas to the traditional natural gas specifications. From the producer and customer perspective, the BioGrid must be optimised financially, with higher energy efficiency. Only the minimum of upgrading steps are needed: unnecessary steps to upgrade the biogas fall away, while safety and reliability remain the basic principles. Approaching gas supply from a different angle changes the conceptual framework, from technical innovation and optimisation towards the chain approach putting the customer's appliances at the core. In this chain approach, adjustments are made to the customer's technical equipment and installations, instead of those of the producer. For years innovation has been implemented on the gas industry side.



Figuur 3 pivot role of the gridoperator

BIOGRID DESIGN AND TECHNIQUES

BioGrid concept

Figure 4 shows a schematic representation of the BioGrid concept. A biogas production facility will supply biogas suitable for pipeline transportation. The biogas is free of harmful contaminations and is suitable for safe operation in residential central-heating boilers. No upgrading to biomethane quality is needed. A dedicated distribution station will supply the biogas to the distribution grid. The distribution grid connects the distribution station to all residential buildings in the BioGrid area. All residential heating boilers will be equipped with a modified burner capable of dealing with variable gas quality. The BioGrid will include both gas quality (Q) and volumetric (V) measurements.

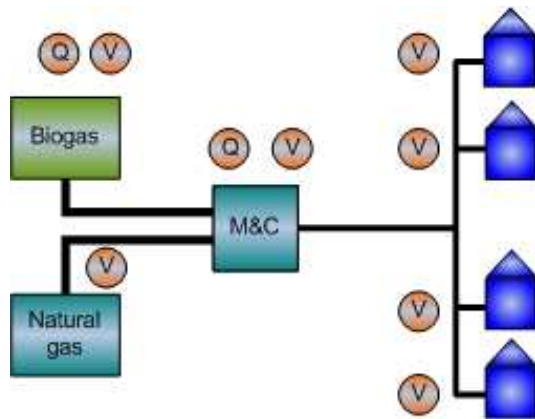


Figure 4: Schematic representation of the BioGrid

BioGrid financial aspects

Direct use of biogas overcomes the need for a gas upgrading facility. Direct use of biogas can therefore reduce production costs by € 0.10 – 0.15, to approximately € 0.60 – 0.70 per m³ natural gas equivalent. Relative to natural gas delivery, the direct use of biogas can reduce CO₂ emissions by 65% compared to 60% for biomethane delivery. See Figure 2.

Research and development

The BioGrid pilot project is the first in the Netherlands for the supply to, and direct use of biogas by, residential end-users. All aspects of the project are new and require substantial research and development. For implementation of the BioGrid, the following research and development issues will be taken into account:

- Development of an adapted residential central-heating boiler
- Development of a dedicated distribution station
- Development of an accounting method
- Research on gas quality variations within the BioGrid
- Research into the influence of biogas on various pipeline materials

Adapted residential central heating boiler

Residential central-heating boilers in the Netherlands operate on Groningen natural gas. The upper heating value operating range is 31.6 to 38.7 MJ/nm³. These traditional boilers cannot operate on variable-quality biomethane at lower heating values. A boiler appliance company has developed a boiler capable of dealing with low and variable heating values. The exact operating range still has to be determined. These modified central heating boilers will be applied in the BioGrid pilot as a field test.

Dedicated distribution station

A dedicated biogas distribution station will be developed. The primary function of the distribution station is the safe and undisturbed supply of gas to end-user locations. Biogas quality can vary. Depending on the source and operating conditions, biogas methane concentrations can be as low as 40 vol%. The minimum required quality level for the BioGrid concept is set by the modified residential central-heating boilers. It is expected that the minimum required methane concentrations are 50 – 60 vol%. The minimum biogas quality level has to be maintained for safe and undisturbed operation. The dedicated distribution station will therefore include a biogas quality measurement and control system. Natural gas will be mixed in when the biogas heating value drops below the required level. The natural gas also serves as a backup. When biogas supply capacity drops below the energy demand, natural gas will ensure a continuous and adequate gas supply. It is expected that over 80% of the annual energy requirement can be met by biogas. The dedicated distribution station will include smart functionalities as presented in the paper “District station, design of a future-proof district station” (I.M. Smits et al, IGRC 2011)

Accounting method

Energy consumption by residential end-users is generally accounted for by a volumetric measurement at the end-user location. The biogas heating value, energy content or so-called calorific value can vary substantially within the BioGrid concept. The heating value will be monitored continuously at the distribution station (see Figure 4). A new method for allocation is needed because of the fluctuations in energy content. Allocation is the administrative calculation and division across the energy suppliers who delivered the gas. A method of calculation will be needed for cases where there are multiple suppliers. The BioGrid project will use the opportunity to find a simple accounting method allocation which is mutually satisfactory.

Biogas quality

Groningen natural gas quality is the standard by which the infrastructure and end-user appliances operate in the Netherlands. Gas composition and quality is maintained within strict and narrow margins. Biogas composition and quality can however vary. The gas quality will be monitored at several locations within the BioGrid to determine the extent and influence of these variations.

Biogas influence on pipeline materials

Biogas distribution is not yet common practice. The BioGrid offers the opportunity to study the influence of biogas on pipelines. The BioGrid pilot project will include several pipeline materials in order to determine the influence of biogas on pipeline materials.

BioGrid opportunity for European regulations for buildings

The BioGrid may provide a new opportunity to target energy-saving aspects and to meet national government legislation implementing the Directive on the energy performance of buildings (2002/91/EC). Buildings are responsible for 40% of energy consumption and 36% of EU CO₂ emissions. The energy performance of buildings is the key to achieving the EU Climate & Energy objectives, namely reducing greenhouse gas emissions by 20% by 2020, and 20% in energy savings by 2020. Improving the energy performance of buildings is a cost-effective way of combating climate change and improving energy security.

BIOGRID PILOT PROJECT

The economic and environmental saving potential of the direct use of biogas will be demonstrated in the BioGrid pilot project.

Objective

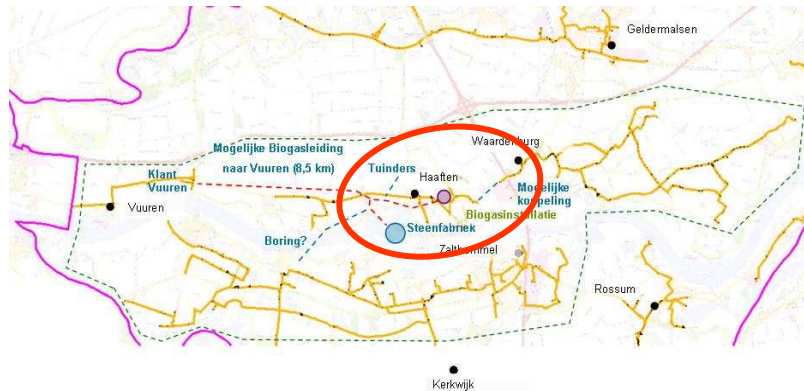
The objective is to investigate and demonstrate a dedicated biogas distribution grid with natural gas backup for direct use in residential central-heating boilers. The pilot project includes the technical development, implementation, testing and operation of the BioGrid concept. All required stakeholder communication and institutional aspects for implementation and operation of the BioGrid will be taken into account.

It is expected that the BioGrid pilot project will demonstrate the possibility of safe and undisturbed supply and the economic and ecological advantages of the direct use of biogas in residential appliances.

The BioGrid pilot project will also provide design criteria for dedicated biogas distribution stations and grids. It will generate valuable operational data on gas quality variations, control responses, control margins and material and equipment suitability for these conditions and appliances.

Test location

A group of individual houses, isolated from the natural gas grid, will be adapted and connected to the BioGrid for testing and implementation. The BioGrid will be developed and implemented within a new housing estate. The general requirement is a new housing estate of at least 200 houses. An additional requirement is that an existing or planned biogas production plant must be available within a range of no more than 5 km.



Project status

The Alliander executive leadership team decided to implement the BioGrid concept in a pilot project. A modified residential central-heating boiler has been developed in close collaboration with a residential central-heating boiler company. The functional demands and the basic design of the dedicated distribution station have been drawn up. The required quality and volumetric measurements within the BioGrid are being selected. Research into possible locations for the pilot project implementation has resulted in two possible locations. Implementation negotiations are now underway with the municipalities. The BioGrid pilot project is scheduled for implementation in 2012.

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