Biogrid; an affordable alternative for a sustainable future

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Increase of biomethane production too slow

In the Netherlands and abroad we see an increasing demand of renewable energy. Societies are looking for sustainable futures. Gas supply cannot and should not stay behind. We expect a supply of new gases, gas different from natural gas, and of decentred initiatives resulting in regional opportunities.

Feeding in of biomethane in the natural gas grid has become common practice in several countries. But the increase in production installations and capacity is not as high as was expected. With the current pace, no European country will reach its ambitions in replacing natural gas by biogas or biomethane.
One of the main reasons for this is the high costs involved with both upgrading the produced biogas to biomethane (which is the composition comparable to the local natural gas) and with the costs involved in controlling and monitoring of that upgrading.

But why do we need all that? The only reason is that we once decided on a specific set of parameters for the natural gas that we were producing or distributing at that time. And since then, every appliance that was installed, was optimised for that specific composition only. We created our own lock-in.

Varying gas composition is not a problem, but the solution

We can do it better. It is now time to make another choice in finding the optimal way for using biogas for heating purposes. A choice that is based upon the wider possibilities of biogas and natural gas together. A choice that gives us full flexibility of using gases of different origin, no matter if it is high- or low- calorific, no matter if it is natural gas or biogas. That choice is to use appliances with new available technology that are capable of handling a wide variety of gas compositions. If the appliance can handle automatically both natural gas and biogas, there is no need to upgrade the biogas. Only basic cleaning processes like dehydration and desulphurisation are necessary. This saves a small biogas producer up to a million euro in investment costs, thus improving the feasibility of biogas production. Furthermore it saves the grid operator an expensive control system for safeguarding the gas composition at the feed-in points. This way, the social cost for

production and usage of biogas decrease substantially and the business case for production of biogas is improved.

Biogrid; where biogas and natural gas meet

In a joint research and development program between ATAG Heating and Alliander this concept of distributing and using a wide band of gas compositions is being developed and tested. ATAG Heating developed a multi-fuel high efficiency boiler capable of handling this wide variety of gases automatically. Alliander developed the regulating and mixing stations to feed the biogas in the natural gas grid, thereby safeguarding the composition limits and securing the uninterrupted supply for the end-users independent of the biogas composition. The full system is called Biogrid.

Lessons learned from testing

The technology has been tested on the premises of a water sludge treatment plant in Eerbeek since 2012 and is being tested in a community building in Haaften since the winter of 2013. The first test was mainly focusing on the technical aspects, while the second test was mainly focussing on the issues that arise when applying this concept in a public environment.
At the premises in Eerbeek, waste water of local paper factories is collected and purified. The purified water is discharged at a local river. The remaining sludge can be fermented into biogas. This biogas is normally used as fuel for a gas engine, to produce electricity and heat.
During the test, the office building is heated with biogas directly. The installation consists of two residential size multigas boilers, piping system and a mixing station to mix biogas and natural gas.
The multigas boiler runs on gases with a Wobbe index between 27 and 80 MJ/m^3. The burner adapts automatically if the Wobbe varies in time. The Wobbe index of biogas is typically between 20 and 35 MJ/m^3 depending on the type of biomass. Therefore, if the biogas has a Wobbe index lower than 27, natural gas (Wobbe index 43-45 MJ/m^3) needs to be mixed in. For this a mixing station is designed to maintain a certain minimal Wobbe index.
In case the biogas has always an Wobbe index higher than 27 MJ/m^3 a mixing station isn't needed. If continuous heating of the boilers is needed, natural gas can be used as back-up. For this situation a switching station is designed. In case the biogas production stops, natural gas will be delivered to the boilers.
The installation in Eerbeek has run several thousands of hours, without any significant problems.

After one year of testing in Eerbeek, the complete installation is moved to Haaften in a so-called "Kulturhus". This is a building from and for the local community including a nursery and primary school, a library, a sports hall and rooms for local clubs. This building is open for public and therefore ideal for demonstration purposes.

Just outside the building a mixing station is placed where biogas from a local producer and natural gas should meet. Because the intended biogas producer is not yet producing, synthetic biogas is being trucked to the location. The biogas piping used is yellow PE pipe with a green stripe and the printed text “Biogas” and therefore clearly recognizable. In the building a cascade of wide band appliances produce heat and hot tap water based upon natural gas, biogas and the mixture thereof.

How to handle a heavier gas that smells different?

There are two specific safety issues that arise when distributing biogas instead of natural gas. Biogas is heavier than natural gas, and it may smell different, while odorisation is harder because of the small flows.

In the project of Eerbeek no special technical measures have been taken, because everyone involved is well informed and well aware of the special, temporary, pilot project going on. The employees working at Eerbeek wear H_2S detection devices.
In the Haaften project the installation runs on biogas only when Alliander technical personnel is on site.
For further projects it is advised that personnel wear methane and H_2S detection devices. This is simple equipment, available on the market, and gives additional awareness.
For future projects odorisation will be applied, even though some concerns are raised about possible smell masking components in biogas depending on the biomass used. The main smell masking component is H_2S, which will need to be low enough for distribution purposes.

Dealing with the energy content

The current system of paying for natural gas is based upon the volume of gas used. The caloric value is determined on a central level and considered constant for at least one month. With Biogrid, there is a varying energy content which means that measuring flows only is not sufficient for comptability.
For Biogrid a system is tested that determines both the volume as function of time per household and the caloric value in the mixing station as function of time. With these parameters the amount of delivered energy delivered can be calculated.

To determine the caloric value three instruments are tested based upon methane infra-red measurements, multipurpose infra-red measurements and a gas chromatograph. The methane infra-red sensor only measures the amount of methane in biogas. It is the cheapest and simplest way for biogas only measurements. But if biogas is mixed with natural gas a multipurpose infra-red system is needed to measure also the higher hydrocarbons which influence the measurement significantly. A gas chromatograph can be used in all situations. However, it is the most expensive instrument and also costly during operation and maintenance. Furthermore the instrument is not easy to operate and special expertise is needed.

Business case

The investment level for creating a dedicated biogrid is slightly higher than the level for a natural gas grid. The regulating/mixing station adds 20 k€ to 200 k€, depending upon the quality and quantity of the biogas to be managed and distributed. Other cost for the gas distribution grid, like piping, metering and excavation, are on a comparable level as for a standard natural gas grid.
The cost for a multi-fuel boiler is almost the same price as a standard residential high efficiency boiler.

Whether there is a viable business case in a country for Biogrid depends upon the market value of the biogas compared to the natural gas it substitutes. Depending on the taxation of natural gas, and the subsidy schemes on renewable energy a viable business case can be build. For instance, in the Netherlands natural gas prices for the customer are 33 cent, to which 20 cent is added with energy taxes. When freeing renewable gases from energy taxes the business case for a Biogrid solution is positive and viable without any additional subsidy schemes. Locally this of course depends on de demand of gas and volume produced. Opportunities for this solution lay therefore in EU countries with high taxation (for example Italy, Spain, Sweden, Denmark and Italy) and/or countries with attractive subsidy schemes for renewable heat or gas, in which cases this solution is suitable.

Expected is that the Biogrid as a distribution solution in bringing renewable heat into building will be in many cases a winning solution from a Total Cost of Ownership perspective, compared to routes as:

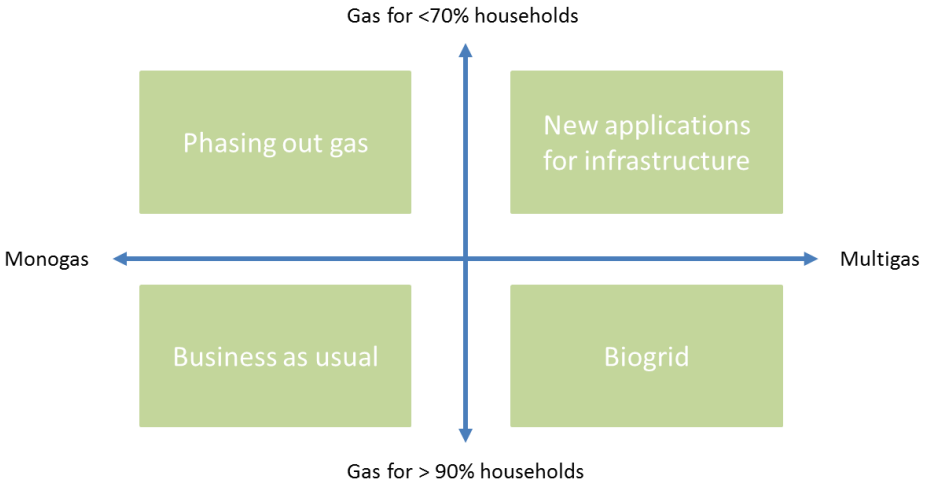
- Biogas to heat - heat distribution network to buildings.
- Biogas to Biomethane – Natural gas/biomethane to buildings

A cost comparison simulation has been performed, based upon costs related to convert 270 m_n^3 biogas to heat a building area which is located 3 km from the biogas production site. Three chains have been evaluated; biogas to biomethane to heat, biogas to CHP to heat and biogas to heat (Biogrid). The total costs of ownership are simulated from these chains showing that the Biogrid solution is 8,5 cent more profitable compared to a biomethane chain and 20,5 cent more profitable compared with a biogas to CHP to heat chain, per m_n^3 biogas distributed.

The Biogrid solution is therefore a highly cost effective building solution and area measure. Energy can be supplied from alternative sources towards 100% for existing and new buildings. The Biogrid is a new renewable option in fulfilling the national ambition on CO_2 reduction and national requirements on EU's Buildings Directive (Directive 2010/31/EU).

Renewable gases; a must for the gas industry

European Directives for greening the energy supply support the trend towards sustainability. Because of the European Building Directive, natural gas will disappear from residential buildings because of increasing insulation and alternative measures of heating by mainly electric heat pumps. The gas industry can either let this happen or develop alternatives that are both sustainable and affordable, thus serving society in a way that the advantages of a stable and existing gas grid can be used.



Biogrid is a solution to reduce the CO_2 level and easily meet Building Directive targets of 2020. Customer involvement and increased security of supply are interesting advantages. Households will be able to keep using gas, renewable gas, in a smooth transition. Bringing renewable energy into the gas grid is the only way to maintain a license to operate. Biogrid is making a smooth transition possible.

Further development of wide band appliances is necessary, not only for residential use, but also for industrial use. To enable the distribution of wide bandwidth gases, comptability for wide band gases should be put down in regulations and the change in safety requirements has to be put down in clear and simple standards.
In the meantime, dedicated local Biogrids can be built, gaining experience and promoting the use of biogas and wide band multi-fuel appliances.