NL Agency
Ministry of Economic Affairs

Green Gas Symposium 2012: 'Innovative technology for biogas and green gas'

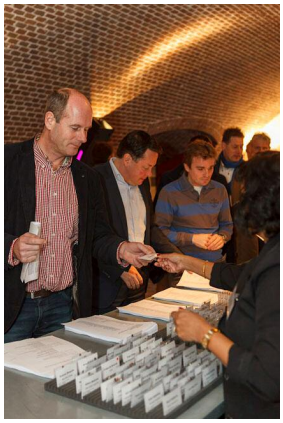
In accordance with its Sustainability theme, the NL Agency programme entitled 'Sustainable Energy in the Netherlands' collaborated with the Green Gas Netherlands Foundation to organise the 'Green Gas Symposium 2012 in Fort Voordorp in Groenekan, on 14 December 2012': 'Innovative technology for biogas and green gas'. This was prompted by a "National Info day" within the Green Gas Grids project: www.greengasgrids.eu. Attracting around 230 visitors, the symposium was a great success and many positive comments have since been heard during networking moments.

The purpose of the symposium was to inform all visitors about the situation concerning innovative technology for the production of biogas and green gas. Part one of the symposium provided an overview of the current-day technology, which is now already available. Part two dealt with the innovations supported by the top sector policy for gas. The plenary part of the afternoon programme paid attention to the role played by the top sector for gas in the innovations for development of green gas. In subsequent parallel sessions, attention was paid to the presentation of new projects which enjoy financial support from the top sector for gas.

Presentations and Workshops

The symposium was kicked off with a presentation by Jeroen Althof 'Could the grass be greener on the other side?' This was followed by a presentation by Ulco Vermeulen on the TKI Gas (Top consortium for Know-how and Innovation) and the innovation contracts, in the hope of stimulating those present to enter into an innovation contract themselves. A variety of interesting workshops were organised throughout the day. The presentation of each workshop was subsequently posted on the Green Gas Netherlands website for anyone interested in reading the information at a later date.

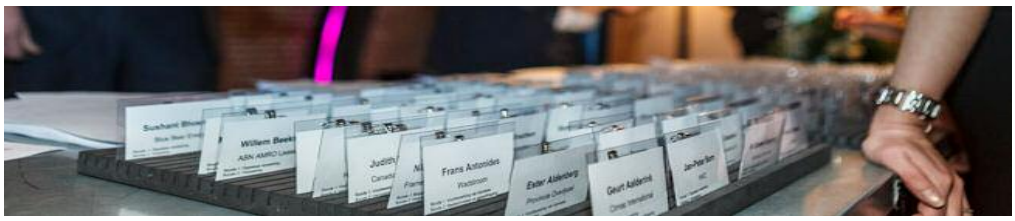
The workshops given were:



<u>Round I: 'Currently Available'</u>
- Pretreatment of biomass
- Biogas upgrading
- Digestate processing

<u>Round II: 'Ready for the Future'</u>
- Fermentation
- Gasification
- Measuring technology and Gas network access

The following pages give a brief impression of the workshops.

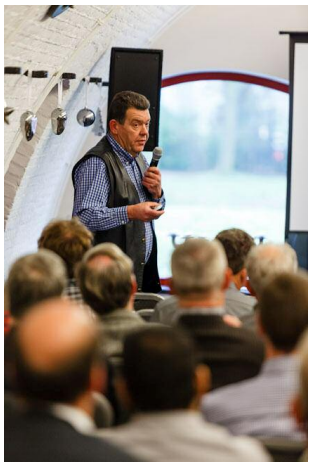


1 Workshop on pretreatment of biomass

1.1 Robert Bakker – WUR – Summary of pretreatment of biomass

Mr. Bakker gave a summary of the various methods for treatment of biomass, prior to fermentation. This preprocessing is also aimed at treating high lignin /lignocellulose biomass in such a manner that the biomass output from the digester is increased and the residence time shortened. Besides treating the digester feedstock, the same techniques can be applied to treat biomass between the fermentation and post-fermentation processes. He discussed:

1. Mechanical preprocessing;
2. Base / alkaline decomposition;
3. Weak acid decomposition;
4. Thermal decomposition;
5. Enzymatic decomposition.



The conclusion was that the alkaline, weak acid and thermal decomposition processes require great heat, which can possibly be provided via the residual heat of CHP plants. Alkaline and thermal decomposition processes seem the most suitable for increasing the biogas output of a digester.

1.2 Lex van Dijk – Sustec BV – Thermal pressure hydrolysis and recycling

Sustec has developed a system called Turbotec, that uses thermal pressure hydrolysis technology. This is intended to increase the biogas output of the digester feedstock. When heat and pressure is applied to biomass (active sludge, for example), it decomposes, thus increasing the contact surface area and speeding up the process by which anaerobic bacteria can produce biogas. In this case, the residence period was reduced from 20 to 12 days. The residual product proved to have a dry matter content of 35%, and to contain 2.5 times as much nitrogen as the active sludge feedstock. The first Turbotec plant was built in Venlo, for the processing of sewage sludge. The payback period of the plant is less than five years. Turbotec is also involved in a project for struvite production at the RWZI Industrial water treatment plant in Apeldoorn. This plant is currently under construction.

1.3 Klaas de Jong – Greenmove – Production of enzymes using Greenstep

Mr. De Jong presented Greenstep, a system for the production of enzymes for the fermentation process. The enzymes are produced by a cocktail of various moulds which compete with each other. Tests have been conducted together with the WUR and E-kwadraat in Goutum (Leeuwarden), which showed the enzymes to increase the biogas output of the digester by 20 to 30%. BioClear from Groningen has validated the system. Greenstep introduced the system on the market at a

biogas plant in Holwerd early in December 2012, and results are expected in two weeks' time.

Benefits mainly lie in the hydrolysis phase of the fermentation process, due to enzymes being required for digestion of cell wall material (cellulose). Consequently, the residence period of the biomass is considerably reduced. The greatest profits can be booked in the fermentation of cattle manure, pig manure, roadside grass and green waste, which have a relatively high cellulose content. The feedstock of such biomass comprises 1 to 2% enzymes.

These enzymes are added automatically, which limits the work to 1 to 2 hours per week. Once the enzymes have been depleted, they are decomposed in the digester and converted into biogas.

The system costs approximately € 120,000 per MW unit annually. On top of this, approximately € 15,000 of nutrients must be purchased annually as a growth medium for the mould.

2 Biogas upgrading

The great interest in the workshop is a sign of the increasing importance of this component of the green gas chain. Three companies presented their solutions for biogas upgrading. They each chose a specific solution, and it was clear that technological developments were still very much underway.

2.1 Coen Meijers – DMT- The biogas upgrading plant in Poundburry

Coen Meijers of DMT-ET provided insight into the pilot plant which is operational in the UK. It is an example of the success enjoyed by Dutch companies abroad. Despite many years of experience, or perhaps precisely for that reason, the plant is still able to improve its efficiency.

2.2 Mathieu de Bas – GTS - Future Energy – flexible products from biogas upgrading plants

Their patented gas freezing system allows GTS and Future Energy to upgrade biogas at a low cost price. The energy consumption of this upgrading technique is around 3%. As far as further development of the plant is concerned, they particularly recognise advantages in greater flexibility of the process. This will provide a solution to variations in the biogas feed, which was originally the case at waste dump sites but nowadays is also increasingly applied at plants which process fluctuating biomass flows.

2.3 Niels den Heijer – Pentair Haffmans- Turning biogas into biomethane and green CO_2

Niels den Heijer of Pentair Haffmans demonstrated how a completely different sector can become involved in the biogas world. The Haffmans company roots lie in the recycling of CO_2 from beer. This sector has developed membrane technology to such an extent that it is now successfully applied in biogas upgrading. CO_2 issues are becoming ever more important from an environmental point of view. A positive side effect is that there is great demand for technical solutions.

The general conclusion of the workshop was that plenty of technological progress is still being booked in the Netherlands. Ongoing technological innovation is essential due to the limited margins in most biogas business cases. In this workshop, three successful companies proved how much perspective lies in biogas upgrading.

3 Digestate processing

3.1 Fridhof De Buisonjé – WUR – Digestate, the pros and cons

De Buisonjé explained one of the main problems to be the requirement expressed by the biogas and cattle sector that "digestate be regarded as a replacement for artificial fertilizer". Regarding digestate as a fertilizer, waste product or compost, regardless of its composition, is seen as being a restriction to its application. Our manure surplus is first and foremost a phosphate surplus, which must be exported.

De Buisonjé provided a summary of the techniques used for digestate separation and drying, and how these can be achieved using the heat from bio CHP or industrial residual heat. A dried fraction rich in phosphate has a monetary value. The CHP from combined fermentation generally only produces enough heat to dry the thick fraction. When industrial residual heat is applied for example, the thin fraction can also be dried. The system of using dried pellets is mainly seen outside of the Netherlands, as arable farmers generally have a free supply of slurry on their land. The increased price for artificial phosphate fertilizers offers opportunities for the sale of phosphate pellets. The price band for these dried pellets varies greatly, depending on their quality. Another option for digestate processing is the export of the complete digestate, following cleaning, with heat from the bio-CHP.

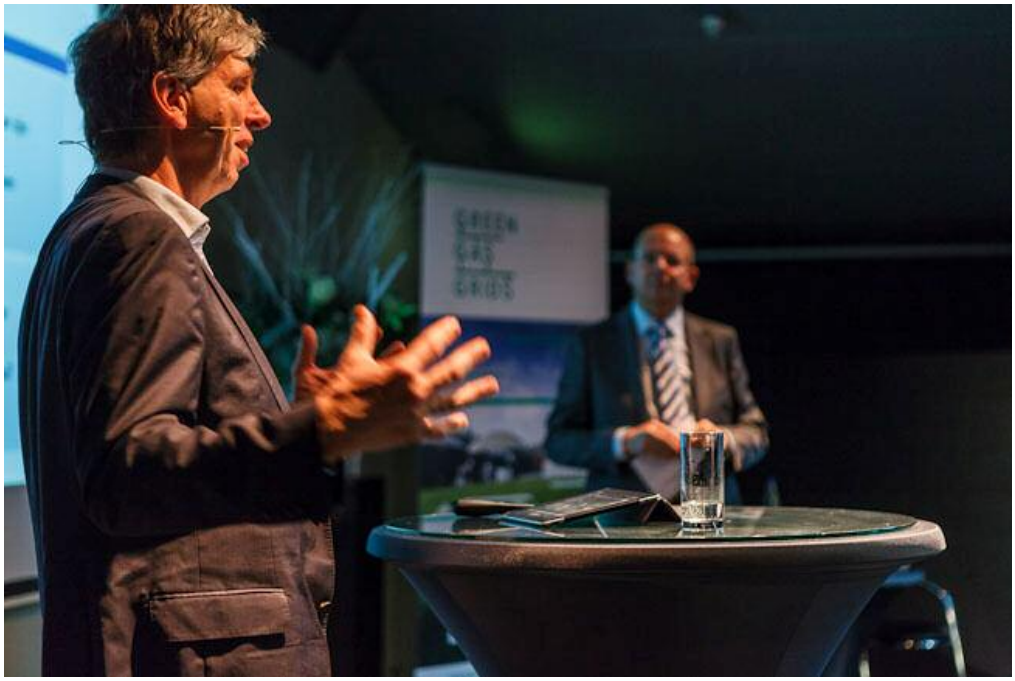
3.2 Gijs van Selm – Waterstromen – Digestate, the situation

Gijs van Selm demonstrated how Waterstromen efficiently processes and increases the economic value of industrial waste water at four production locations. Biogas is converted into electricity and heat in a CHP plant, and part of the biogas is supplied directly back to the industry. Phosphor and a small percentage of the nitrogen is recycled as struvite and exported as a fertilizer. A member of the audience remarked that the Dutch agriculture sector requires 90% water soluble phosphate, for which struvite is not suitable. Waterstromen sales have not been affected by this, as it is a specialty market so far. The company is positive regarding the application in arable farming. Digestate must be pasteurised, according to the European regulations on animal by-products. The digestate may be exported following pasteurisation.

3.3 Wim Kuster – BiogasPlus – Pasteurisation and drying of digestate

Wim Kuster of BiogasPlus gave a summary of the company's modular pasteurisation system, in 15m^3tanks. BiogasPlus also has an innovative solution for evaporation and drying of the digestate. The evaporator works according to a concept of vertical belts picking up a thin layer of digestate, which is subsequently air dried. The evaporator (up to 80-95% dry matter) comprises two stacked horizontal drying belts, the product falls from the first belt onto the second belt. The drying process takes place using hot air. Sensor technology ensures that the product does not leave the belt until it has reached the required degree of dryness.

The conclusion is that there are interesting technical solutions for processing digestate to produce suitable fertilizers. There are restrictions to their use in Dutch arable farming due to legislation, and competition from manure slurry. While there are still plenty of export opportunities, De Buisonjé is quoted as saying: "Digestate is a challenge".



Afternoon programme with an explanation of the role played by the top sectors policy for gas in the development of the green gas market in the Netherlands, by the Chairman of TKI gas (Top consortium for Know-how and Innovation in Gas), Mr. Ulco Vermeulen.

4 Fermentation

4.1 Arjan Prinsen – Groot-Zevert - Increasing the economic value of nutrients

The Groot-Zevert biogas plant supplies 600 kW units (via the former MEP Environmental Energy Production subsidy scheme). The feedstock used is independently sourced. The company works in short, regional cycles and makes use of locally available biomass rather than food products. Groot Zevert operates on 95% manure, which guarantees the sale of digestate to the farming community. The target is to quadruple the current capacity in order to be able to produce for 66ct/Nm3. This is not yet possible, hence the need to increase the economic value of manure and/or nutrients. Fermentation of all manure is essential in order to realise the full potential. This can be achieved using an open ring for gas or an open ring for manure, along with centralized upgrading of biogas to biomethane. Increasing the economic value of nutrients: Protein from duckweed has been improved from 21% to 40%. The mineral-rich thin fraction can be processed into fertilizer. The low-mineral thick fraction can be used for improving soil structure.

4.2 Jan-Evert van Veldhoven – De Dommel water board- RWZI as a logistics centre

The water board has conducted a survey of the manure processing possibilities in the region. One of the conclusions is that there is considerable leaching of minerals to surface waters. Improvements in this nitrogen leaching situation can only be achieved if all manure in the region becomes processed, and this will be unsuccessful if only the surplus manure is treated. The survey also considered how a water board can contribute to processing manure in a region. Until now, there is little added value to be achieved when processing manure at RWZI industrial waste treatment plants. Business cases are being studied however, to determine whether a combined effort is worthwhile. Sewage slurry and other biomass flows could be combined at the front, for example, and the residual flow jointly used in utilities. The Energiefabriek (energy factory) project is already underway at the RWZI plant in Tilburg. A further 2 hectares of land is available there, directly adjacent to the Attero production location, for a manure processing initiative.

4.3 René Cornelissen – CCS - Small-scale biogas production

There is great interest in small-scale fermentation, at the individual farm level. Generally speaking, the generation of electricity (in a CHP plant) is not attractive unless you can utilise the heat. Moreover, small-scale fermentation entails considerable investment. This project looks at ways of reducing these costs. Injection and quality control are relatively expensive, especially for smaller volumes. The main advantage of the small scale is that the manure remains within the farmyard, thus dispensing of the need for disposal (transport). The question in hand is: How to develop a small-scale and economical biogas upgrading installation? The result? A combination of pressure-free H_2S and removal of CO_2. The process therefore requires little energy but part of the gas produced is

necessary for the heating process. All in all, it yields € 50,000 per annum. The payback period will be 7 to 9 years, depending on the use of fiscal instruments.

5 Gasification

5.1 Gerton Smit – Gensos - Super-critical gasification of wet waste flows

Gensos has been working on the development of a super-critical gasifier since 2006, and has concentrated on the gasification of manure right from day one. Minerals which cannot be separated from the manure in a "dry" process, can be reclaimed in this gasifier. The company is now also exploring opportunities for gasification of sewage slurry and algae. The gasification process results in a conversion rate of more than 95%. A pilot plant is currently under construction, and expectations are that the initial results from that plant will be available by early 2013.

5.2 Marten Alkema – Synvalor - Synvator® direct gasification for green gas production

Synvalor introduced an application for gasification of poultry manure in the late 1980s, and has been concentrating on torrefaction of biomass since 2006. Attention has now been turned to a fluidized bed gasifier in order to produce syngas, from which heat and electricity can then be generated via a CHP plant. A Synvator gasifier has been built in Vlissingen (3.5 MW) utilising wood as feedstock. The installation has few problems with large volumes of ash: reeds, straw, manure, slurry and digestate can all be gasified. The pyrolysis gas is recirculated in order to provide the required heat and generate sufficient vortex. Natural gas is therefore only required during the start-up process.

5.3 Herman Klein Teeselink – HoSt - En route to greater efficiency

There is enough grain straw available in Europe to produce biogas equivalent to no less than 350 billion m3 natural gas. Ninety percent of this straw is currently only used for ploughing into the soil. HoSt advocates gasification, as this results in a greater volume of gas than fermentation for this type of feedstock. HoSt is also involved in small-scale upgrading of biogas to form biomethane, through the use of membranes.

The HoSt gasification technology could also be deployed for the production of ethanol, for example. Direct fermentation only gives one-third of the conversion rate which can be achieved using gasification. Less oxygen is added to the gasifier system, resulting is considerably less flue gases, which therefore no longer need to be removed before emission.

In the gasification system, 20-25% of the energy is converted into heat. The main bottleneck lies in the reliability of the system, which is currently around 6000 hours' availability, whereas HoSt plans to improve this to 7800 hours.

Gasification is particularly suitable versus incineration when a fuel cannot be easily placed on the grid, when the emission will be too costly or when an incineration permit cannot be easily obtained.

6 Measuring technology and Gas network access

This popular workshop was opened by Mathieu Dumont of NL Agency, who sketched the importance of the innovation contracts for the themed influences, of which a number of examples were presented in this workshop.

6.1 Arthus Scheffer – Adsensys – Biokeep

The workshop was kicked off by Arthur Scheffer of the Adsensys company, which is working on small-scale biogas applications under the Chempat label. Within the framework of TKI Know-how and Innovation in Gas, the company is working on development of a "cheap" monitoring system for quality control of the green gas feedstock in the network grids. The use of gas chromatographs renders the conventional systems relatively expensive in both purchase and operation for small-scale injection into the grids. Adsensys expects to be able to develop a monitoring system which will cost less than € 50,000, and which is also much less expensive to operate than the conventional systems, thanks to the lack of GC. They believe this can be achieved thanks to a modular system design, with gas analysis based on a hybrid of various measuring techniques and sensors. Monitoring of the odorization level of the gas will also be part of the system, while the use of a PLC and web portal will give the network companies and the suppliers insight into all the necessary information. Another question concerned the OPEX, which have not yet been calculated but are expected to be low. The issue of whether the monitoring process should become the responsibility of the network company remained unanswered, this currently lies with the supplier and there are no signs of this changing. Mr. Scheffer concluded with the comment that the TKI is a nice stimulus for Adsensys to develop the Biokeep system more extensively.

6.2 Leo Brummelkamp and Gideon Blij – Bionet – Central heating on biogas

Leo Brummelkamp of Alliander and Gideon Blij of ATAG gave a combined presentation. They are working jointly on a concept of "BioNet, the next step". As owner of a large regional gas network, Alliander is all too aware of the developments in gas production, the decline of the Slochteren gas field and the establishment of sustainable energy projects. On the one hand, they see more and more producers of biogas/green gas, and on the other hand devices (gas engines, for example) being converted to make them suitable for combustion of alternative gases. Liander wishes to use a BioNet to demonstrate that it is possible to tailor energy consumers to an available source, and that not only Groningen natural gas but also gases with a different Wobbe index and

caloric value can be distributed and calculated. In their planned pilot, a residential neighbourhood will be provided with a biogas/natural gas mixing station, adapted condensing boilers and an alternative system for price calculation. The pilot also includes the basic design for the mixing station and the development of a pricing system. The independently developed technique will be brought together, in order to demonstrate that the entire system can operate as a chain. If this is successful, there are no longer any technical restrictions to the network company offering the BioNet product to newly built residential neighbourhoods. With regard to the question of how to tailor the capacity of the biogas producer to the consumption, a field test was chosen which included a large-scale user as the basis for gas consumption. Hot items are the odorization of the gas and the caloric pricing for customers in the region. Alliander believes that these challenges can be met. The potential of the project is that when applying a Bionet biogas, it is not always necessary to upgrade to the full G-gas quality, and the existing infrastructure can be used.

Atag Heating Corporation was represented by Gideon Blij, who began by describing the background of ATAG as a global player in the field of heating systems such as condensing central heating boilers, heat boilers, solar boilers, heat pumps, etc. They foresee a diversity of gas types being introduced on the basis of supply surety, market effect and increased sustainability. Their contribution in terms of TKI is the development of the ATAG Multi gas boiler. This Multi gas boiler is a condensing boiler which functions well regardless of the available gas composition (from biogas to extremely high calorie gases). The solution was found in the relationship between the burner temperature and the ratio of gas/air to the burner. The company's participation in the BioNet project with a test location in Eerbeek in which the boilers could be installed in the households, resulted in an ideal pilot test which combined the network company's experience of an alternative type of gas with the actual consumption of that gas. One of the reasons for the application of a BioNet is that the use of biogas also contributes positively to the EPC (energy performance certificate) value of the houses in the region.
The conclusion was that this workshop gave effective insight into the field of measuring techniques and gas network access, and that TKI is a good instrument for preparation of the parties involved in the green gas sector for the future situation.

Enclosure: Programme

9.30 – 10.00 hours Reception and registration

10.00 – 10.15 hours Word of welcome by the day's Chairman,
Erik van Engelen, Director of Groen Gas Nederland

10.15 – 10.45 hours Speaker Jeroen Althoff,
Roland Berger Consultancy and forum discussion

10.45 – 11.15 hours Pause and visit to Know-how centre

11.15 – 12.30 hours Workshop round I: 'Currently Available'

- **Pretreatment of biomass**
  Robert Bakker, WUR
  Lex van Dijk, Sustec B.V.
  Klaas de Jong, Green Move Technologies
- **Biogas upgrading**
  Coen Meijers, DMT-ET
  Mathieu de Bas, GTS
  Niels den Heijer, Pentair Haffmans
- **Digestate processing**
  Fritdjof de Buisonje, WUR
  Gijs van Selm, Waterstromen B.V.
  Wim Kuster, Biogas Plus

12.30 – 13.30 hours Lunch & networking at the Know-how centre

13.30 – 14.30 hours 'Opportunities for the future', explanation of the Top sectors policy 2013, *by Ulco Vermeulen, Chairman of TKI Gas, Top sector Energy*

14.30 – 15.00 hours Pause and visit to Know-how centre

15.00 – 16.15 hours Workshop round II: 'Ready for the Future'

- **Fermentation**
  Arjan Prinsen, Groot-Zevert
  Jan-Evert van Veldhoven, WS de Dommel
  René Cornelissen, CCS
- **Gasification**
  Gerton Smit, Gensos
  Jacques Poldervaart, Synvalor
  Herman Klein Teeselink, Host
- **Measuring technology and Gas network access**
  Arthur Scheffer, Adsentech
  Leo Brummelkamp, Alliander
  Gideon Blij, ATAG

16.15 – 17.30 hours Conclusion and networking drinks