Financial Performance of Organic Biogas Production

SUSTAINGAS Report D3.1

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Financial Performance of Organic Biogas Production

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Preface

This report is a part of a joint project of nine partners in EU-countries: SUSTAINGAS. Organic biogas is still not very wide spread in the EU, so most of the present experience is coming from research and empirical data from Germany and partly from Austria and Denmark.

The concept is therefore quiet new to most organic communities, politicians and other stakeholders. It is the opportunity and the hope of this project, that the concept of organic biogas can be multiplied in more EU-countries on the basis of recommendations developed in this task.

To see biogas as a multifunctional servant for organic production of food and feed can contribute to more sustainable biogas.
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1 Introduction

Biogas production from agricultural biomass takes place in interaction with the farm supplying the biomass. For organic farming, there are some special conditions that make the interaction with biogas production particularly interesting. The hypothesis of SUSTAINGAS is that there is an economic synergy between biogas production in organic farming and the production of organic food. That is why the aim of this task is to analyze the economic performance of organic biogas plants and develop strategies to improve the economic performance.

Figure 1: Illustration of the interaction between organic farm and the biogas plant.

Organic farming can deliver energy-dense biomass, like solid manure, green manure and cover crops, straw and residues into the biogas plant. The biogas plant in turn delivers manure of good quality to the fields of organic agriculture. By using material which is usually used as green manure to produce biogas it will be economically more advantageous for farmers to grow these plants, and it contributes to a more sustainable and productive crop rotation with higher yields and fewer weeds. In addition, better performance in relation to the environment, soil condition and the climate is achieved.
1. Introduction

The study of SUSTAINGAS is based on interviews with 40 organic farmers with biogas plants or planning to have a biogas plant. Moreover a workshop was held with two invited German specialists. Finally, the results are discussed in the light of the results from the literature.

The possibility of getting a higher price for organic biogas energy is investigated by interviewing political and commercial stakeholders in the participating partner countries. This investigation will be reported separately.

The study results in recommendations of strategies for improving economic performance of organic biogas plants for organic farmers who produce biogas or plan to do so.

In addition to this report a tool to calculate the economic interaction between biogas production and organic food production was developed. For description of the tool see report D3.2.

2 Interview survey with 40 farmers

2.1 Design of the action

Organic farmers who may contribute to a definition of sustainable organic biogas have been contacted to get their knowledge. For selecting farmers a specific procedure has been followed: Only farmers having a potential for organic biogas production or that already produce biogas have been contacted.

Criteria for selection of organic farmers without biogas plants but with potential (being in a planning phase) were

- the farm is operated organic, AND
- the farmer is interested in biogas, AND
- one of the following conditions applies:
  - the farmer’s animal livestock is larger than 75 livestock units (LU), OR
  - the farmer’s arable land is larger than 80 ha, OR
livestock or arable land is half as large, but the farmer is willing to cooperate in order to ensure a sufficient amount of input material.

These criteria distinguish farmers with potential, disregarding farmers with low production or very specialized production.

Table 1: Design of the action

<table>
<thead>
<tr>
<th>Action characteristics</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target group</td>
<td>organic farmers with biogas plants OR: in a planning phase</td>
</tr>
<tr>
<td>Number of interviews</td>
<td>planned: 40 received: 40</td>
</tr>
<tr>
<td>Split received:</td>
<td>AT 5, BG 5, DE 15, DK 5, ES 5 and PL 5</td>
</tr>
<tr>
<td>by nation</td>
<td>organic farmers with biogas plants: 21 in a planning phase: 19</td>
</tr>
<tr>
<td>by target group</td>
<td>organic farmers with biogas plants: 21 in a planning phase: 19</td>
</tr>
<tr>
<td>Type of interview</td>
<td>face-to-face OR: by phone</td>
</tr>
<tr>
<td>Date of the interviews</td>
<td>July 2012 to November 2012</td>
</tr>
<tr>
<td>Questionnaire type</td>
<td>half-standardized</td>
</tr>
</tbody>
</table>

Figure 1: Structure of the sample, by running / contributing to a biogas plant

Do you run or contribute to a biogas plant?

- Yes, I run my own biogas plant on my farm
- Yes, I run a biogas plant on another farm together with other farmers
- Yes, I run a biogas plant together with other farmers on my farm
- No

percentages, n=40
Most of the respondents (52%) run a biogas plant. The organic farmers with biogas plants are located in DE (15), AT (5) and DK (1). In BG, PL and ES there are no biogas plants on organic farms (with 1 exception in Spain, which will be contacted later). Most of the respondents running a biogas plant run it as their own biogas plant and on their own farm. In Austria, there is a higher share of co-operatives, as farm sizes are small: “Yes, I run a biogas plant together with other farmers on my farm”, “Yes, I run a biogas plant on another farm together with other farmers”.

Two thirds of the farms are organic since more than 5 years, one third less than 5 years.

The interviews were analyzed to describe organic biogas as a product and a concept. The results of this and the evaluation of different sustainability factors of organic biogas among the owners of biogas plants is monitored and presented in report D2.1.

In this report the interviews are analysed to understand the important factors for the financial performance of organic biogas production.

The 21 biogas plants in the study range in size from 50 to 700 kW. The average size is 370 kW. They are built from 1996 to 2011. Half of the plants are built after 2005. The Danish plant was built in 2009, the Austrian plants from 2003 to 2006, while the German plants are built over the entire period. 15 of the established biogas plants report, that they use clover, clover grass, alfalfa or permanent grass land material as substrate. 9 farms use maize as supplement to clover grass etc..

First the farmers were asked to express their satisfaction or non-satisfaction to 43 different issues concerning the economy of their biogas plant. These were grouped in plant establishment, operation, biomass operation, sale of slurry, sale of gas, power, heat etc., as well as the effects on different parameters. See all issues in figure 2. Additionally, the farmers had the possibility to add comments.

In the next part the farmers have answered the following questions from the interview questionnaire:

- Describe the economic development for the biogas plant in: relation to the annual profits or losses.
- What factors have had the greatest influence on the economy of the biogas plant?
• How has the biogas plant affected the economic performance of your organic farm?
• Are there planned new investments, please describe what, and expected outcome?
• If you were to repeat the project again, what would you do different?
• What measures would improve the economic performance of your biogas plant?

2.2 Results of the interviews

Answering this part of the questionnaire has mostly been done by farmers with a running biogas plant in Germany, Austria and Denmark, and by 4 farmers in the planning phase in Denmark.

The farmers were asked to express their satisfaction or non-satisfaction to 43 different issues concerning the economy of their biogas plant. In figure 2 the satisfaction of 21 farmers with a biogas plant is displayed.

Plant establishment
With financing and investment cost there is more than ¾ who is satisfied, but with Demands and permissions and Advice and consultancy there is only about half of the farmers who are satisfied. More comments address that the advisers are too inexperienced with organic biogas plants.

Plant operation
In this area there is mainly high satisfaction with most issues. The highest unsatisfactory (40-50 %) is connected with working hours, Repairs and daily operation costs. In the comments some farmers express that they have great difficulties with their plant. In working hours there is a tremendous span between 3 hours per week up to 60 hours per week. It seems like if the plant is running properly, the working hours are less than a half day job, but if there are problems continuously it is a fulltime job.

Biomass operation
Farmers are most satisfied with storage costs and pretreatment benefits, though only half of the farmers answered the latter, probably because they have no pretreatment in operation. The highest non-satisfaction is in the area of transportation costs, harvest costs and prices fluctuations of biomass. Concerning trade agreements, which have almost 2/3 satisfactory, the comments suggest that the ideal
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situation is that the biomass is ‘borrowed’ from the supplier, if not coming from the plant owners own land, and delivered back to the supplier after biogas production.

This area has the highest share of missing answers probably because they don’t sell slurry. The comments state several times, that the slurry is returned to the biomass supplier, or is used on the plant owners own land. Generally the issues is satisfactory for the farmers, but the highest non-satisfactory is the Opportunity for sale of slurry.

Most satisfactory (100%) is the price fluctuations since there are none. It is the fluctuating prices of biomass which is the problem. Only two farmers have answered about gas prices, indicating, that almost none of them sell biogas as gas. The highest dissatisfaction is about Connection costs, with almost 50%.

This is the area with the highest satisfaction (between about 85 and 100%, disregarding none-answers). None have answered not satisfied at all. 19 out of 21 farmers are satisfied with the effect on yield of crops. In the comments it is estimated to be between 10-40 % yield increases. Concerning weeds, quality of crops and quality of manure, there are a few comments about a beneficial difference, but most comments say they can’t tell the difference. The effect on animal husbandry has many none-answers, which is assumed to be lack of relevance of the interviewed.

In the following the answers of farmers to the other six questions are described:

13 farmers have indicated that they have achieved positive economic results from 0 to 5 years with an average of 1.5 years among these. The farmers who have answered immediately(positive economic result) are set to 0 years. 6 farmers (4 from Austria, 1 from Denmark, 1 from DE) have indicated that they have not yet had a positive economic result from the biogas plant. 17 farmers indicate that they have had years of both positive and negative results. On average, farmers had 39 % of years with positive results and 51 % with negative results. Considering only looking at the German plants, farmers had 58 % of years with positive results and 28 % of years with negative results. One farmer did not give an answer to the question, and was not counted in the above calculations, but he expected that the plant is paid back after 6-7 years, which can be regarded as a good economic situation.
Figure 2. How satisfied are you with the following issues concerning the economy of your biogas plant.

- Plant establishment
  - Financing
  - Investment cost
  - Demands from authorities, permissions
  - Professional advice, building consultancy

- Plant operation
  - Costs of analyses of bio-process
  - Methane yield
  - Startup of biological processes
  - Electricity produced
  - Maintenance
  - Heat produced
  - Technics failures at startup
  - Working hours
  - Repairs
  - Daily operation costs

- Biomass operation
  - Storage of the biomass costs
  - Pretreatment of biomass benefits
  - Trade agreements: manure/crops
  - Pretreatment of biomass - costs
  - Transportation costs
  - Harvest costs
  - Prices, price fluctuations of biomass

- Sale of slurry
  - Slurry delivery agreements
  - Post treatment benefits
  - Storage fo the biogas slurry
  - Post treatment costs
  - Transportation costs
  - Prices, price fluctuations of sales
  - Opportunities for sales

- Sale of gas, power...
  - Price fluctuations
  - Own use of energy
  - Price heat including subsidy
  - Trade agreements
  - Price electricity including subsidy
  - Price gas including subsidy
  - Connection costs

- Effects on...
  - Yield of the crops
  - The animal husbandry
  - The crop rotation
  - Quality of crops
  - Weed infestation
  - Pest in the crops
  - Amount of manure
  - Quality of manure

- Scale:
  - Very satisfied
  - Fairly well satisfied
  - not too satisfied
  - not satisfied at all
  - no answer
25 farmers have responded, including 4 farmers planning biogas plants in DK. The answers are very diverse and more farmers give several answers. The answers are divided into 17 categories in Table 2. The two most frequent factors are the price of sold electricity (energy price) and the price of biomass input. They are mentioned 8 times each. Next come failures of the biogas plant and related repairs mentioned 6 times. The other factors listed appear 1 to 2 times each.

Table 2: Number of answers within different factors influencing the economy of the biogas plant in a negative way.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Number of answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed in tariff for power</td>
<td>8</td>
</tr>
<tr>
<td>Price of biomass input</td>
<td>8</td>
</tr>
<tr>
<td>Failures and repairs</td>
<td>6</td>
</tr>
<tr>
<td>Running hour of CHP</td>
<td>2</td>
</tr>
<tr>
<td>Investments</td>
<td>2</td>
</tr>
<tr>
<td>Lack of gas production</td>
<td>2</td>
</tr>
<tr>
<td>Management and process understanding</td>
<td>2</td>
</tr>
<tr>
<td>Sale of heat</td>
<td>1</td>
</tr>
<tr>
<td>Starting problems and costs</td>
<td>1</td>
</tr>
<tr>
<td>Technology</td>
<td>1</td>
</tr>
<tr>
<td>Harvest and transport of biomass</td>
<td>1</td>
</tr>
<tr>
<td>Efficiency of CHP</td>
<td>1</td>
</tr>
<tr>
<td>Moderate power purchase</td>
<td>1</td>
</tr>
<tr>
<td>Production of feedstuff</td>
<td>1</td>
</tr>
<tr>
<td>Dry matter in plants</td>
<td>1</td>
</tr>
<tr>
<td>To convert to organic farming</td>
<td>1</td>
</tr>
<tr>
<td>Availability of biomass</td>
<td>1</td>
</tr>
</tbody>
</table>
21 farmers have responded, including a farmer in the planning phase. The answers are sorted in 8 categories and shown in table 3.

**Positive Impact:** Farmers have experienced significant better yield of crops (9 answers) and better economy in the farm (5 answers). They've got a heat supply from the plant (5 answers) and their management of manure and nutrient supply is improved (7 answers). Better crop rotation, a high gas yield and better crop quality is also mentioned in each one answer.

**Negative Impact:** 9 farmers have responded and given quite different answers. A Danish plant has been a major economic burden to the farm. 1 reply mentions the lack of return on equity, 2 answers mention the increased workload, 1 answer mentions the high cost of biomass production, 2 answers mention the high investment requirements, 1 mention that poor planning and construction has been stressful. Lastly 1 answered, that the fibre-rich biomass is not exploited well enough in the biogas plant.

### Table 3: Number of answers in different categories having positive impact on the economic performance of the organic farm.

<table>
<thead>
<tr>
<th>Answer category</th>
<th>Number of answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better crop yields</td>
<td>9</td>
</tr>
<tr>
<td>Better nutrient supply</td>
<td>7</td>
</tr>
<tr>
<td>Improved economic performance</td>
<td>5</td>
</tr>
<tr>
<td>Use of heat</td>
<td>5</td>
</tr>
<tr>
<td>Clover grass as cash crop</td>
<td>4</td>
</tr>
<tr>
<td>Crop rotation</td>
<td>1</td>
</tr>
<tr>
<td>Good gas yields</td>
<td>1</td>
</tr>
<tr>
<td>Better quality in products</td>
<td>1</td>
</tr>
</tbody>
</table>

20 farmers with an operational biogas plant have answered. 4 farmers have answered that they do not plan any investments currently. 16 other farmers have responded very different types of investments. In table 4 the responses are sorted into 18 categories. Investments like larger manure storage, increased utilization of heat, stirring and pretreatment equipment are mentioned 3 times each. Silage silos and feeding systems are each mentioned 2 times and the other 12 items, each mentioned 1 time.
Table 4: Number of answers in different categories of plans for new investments in the biogas plant.

<table>
<thead>
<tr>
<th>Investment</th>
<th>Number of answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slurry storage</td>
<td>3</td>
</tr>
<tr>
<td>Heat utilization</td>
<td>3</td>
</tr>
<tr>
<td>Stirring</td>
<td>3</td>
</tr>
<tr>
<td>Pretreatment of biomass</td>
<td>3</td>
</tr>
<tr>
<td>Clamp silo for silage</td>
<td>2</td>
</tr>
<tr>
<td>Feeding system</td>
<td>2</td>
</tr>
<tr>
<td>Gas storage</td>
<td>1</td>
</tr>
<tr>
<td>Higher CHP performance</td>
<td>1</td>
</tr>
<tr>
<td>Treatment of digestate</td>
<td>1</td>
</tr>
<tr>
<td>Storage for surface water</td>
<td>1</td>
</tr>
<tr>
<td>Dry fermentation</td>
<td>1</td>
</tr>
<tr>
<td>Hydrolysis pretreatment</td>
<td>1</td>
</tr>
<tr>
<td>Solar power</td>
<td>1</td>
</tr>
<tr>
<td>500 kW CHP</td>
<td>1</td>
</tr>
<tr>
<td>Pump systems</td>
<td>1</td>
</tr>
<tr>
<td>Drying facilities</td>
<td>1</td>
</tr>
<tr>
<td>Sale of solid fertilizer</td>
<td>1</td>
</tr>
<tr>
<td>Transition to arable farming</td>
<td>1</td>
</tr>
</tbody>
</table>

19 out of 21 current plant owners have answered. 5 farmers say they would not build again, but for different reasons. Both Danish, German and Austrians farmers corresponded in that way. Most answers addressed that they would use a different technology (6 answers), that they would want a different size of plant (7 answers). As for size, three wishes to have or maintain a small biogas plant. One farmer wants to build the plant together with other farmers. And finally they would use more or better advice in the planning and construction phase (6 answers). Regarding technology 4 farmers answer that they would use another feeding and / or stirring technique.

If you were to repeat the project again, what would you do different?
What measures would improve the financial performance of your biogas plant?

23 farmers have responded and mentioned one measure, including 4 farmers in Denmark, which are in the planning stages. 19 farmers have also mentioned a second measures, while 11 farmers have mentioned a third measure. In total 55 answers are given, and they are divided into 30 categories of measures, as it was not possible to pool more answers in a fair manner. All categories and number of answers are shown in table 5. Biogas plant owners thus have many different views and experiences of what it takes to improve the economy.

Table 5. Number of answers in different categories of measure that would improve the economic performance of the biogas plant.

<table>
<thead>
<tr>
<th>Category of answer</th>
<th>Number of answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher feed-in tariff</td>
<td>8</td>
</tr>
<tr>
<td>Lower price for biomass input</td>
<td>6</td>
</tr>
<tr>
<td>Pretreatment of biomass</td>
<td>5</td>
</tr>
<tr>
<td>Lower power consumption</td>
<td>4</td>
</tr>
<tr>
<td>Improved stirring technology</td>
<td>2</td>
</tr>
<tr>
<td>Local purchase of heat</td>
<td>2</td>
</tr>
<tr>
<td>Index adjustment of feed-in-tariff</td>
<td>2</td>
</tr>
<tr>
<td>Secure operation systems and design</td>
<td>2</td>
</tr>
<tr>
<td>Premium for organic biogas</td>
<td>2</td>
</tr>
<tr>
<td>Research in biogas from inter crops</td>
<td>1</td>
</tr>
<tr>
<td>External investors</td>
<td>1</td>
</tr>
<tr>
<td>Lower running cost</td>
<td>1</td>
</tr>
<tr>
<td>More cash crops</td>
<td>1</td>
</tr>
<tr>
<td>Organic manure gets a slurry premium</td>
<td>1</td>
</tr>
<tr>
<td>Convert to dry fermentation</td>
<td>1</td>
</tr>
<tr>
<td>Higher efficiency on CHP</td>
<td>1</td>
</tr>
<tr>
<td>Production without failures</td>
<td>1</td>
</tr>
<tr>
<td>Establish drying facilities</td>
<td>1</td>
</tr>
<tr>
<td>Improved digestion</td>
<td>1</td>
</tr>
<tr>
<td>Lower transportation costs</td>
<td>1</td>
</tr>
<tr>
<td>Better motor management</td>
<td>1</td>
</tr>
<tr>
<td>God trade agreements</td>
<td>1</td>
</tr>
<tr>
<td>Gas sold for transportation</td>
<td>1</td>
</tr>
<tr>
<td>Improved process with enzymes</td>
<td>1</td>
</tr>
</tbody>
</table>
2.3 Summary of the interviews

The study leaves no doubt that organic farming economy is affected positively by biogas production, if the biogas production at all works. It is a widespread experience reported here, that higher crop yields will occur. The farmers are very well satisfied with the effects of the biogas plant on their organic farm performance.

It is also clearly documented by the interview and very logical that the payment of delivered energy (feed-in tariff) is essential for economic sustainability. This condition is country specific, and impossible for the single farmer to change.

The cost of biomass is the other major influencing factor, primarily the price of purchasing the external silage. This challenge is addressed later in the report.

Another clear experience is that quite a part of the organic biogas plants in the study have to some extend been challenged by unsuitable technology in the plants. It has not been robust and suitable enough to handle solid and fibre-rich biomass, which is more pronounced as biomass for organic biogas plants.

A last point to mention is that besides the above most prevalent experiences, there is a great variety of additional issues, challenges, benefits and so on, which shows, that the farmers operating organic biogas plants have very different individual conditions. This is also very logic as the biogas plants are very different in size and age, and are operating in three countries with different policies and subsidy schemes for energy produced by biogas and different environment concerning knowledge, state of the art etc..
3 Workshop in Berlin

On 17th of October 2013 a workshop was held for the project partners in SUSTAINGAS. The workshop was held in the premises of the project partner RENAC. The workshop was introduced with a presentation by the leader of workpackage 3, Mr Michael Tersbøl titled *Organic Biogas - drivers and perspectives*. It mainly unfolded the Danish context for organic biogas, where the organic industry in Denmark and also the Danish minister of food, fisheries and agriculture wants to promote conversion to organic farming by using biogas.

Subsequently a presentation by Dipl Agr. Bio Mr Michael Köttner from IBBK1 followed. The title of the presentation was *Success Factors for Biogas on Organic Farms*. Finally, there was a presentation by Mr Benjamin Blumenstein, Department of Farm Management, Faculty of Organic Agricultural Sciences University of Kassel. The title of the presentation was *Highlights from research in organic biogas: structures, economics, opportunities and risks*.

After each presentation, there was a round table discussion with the invited experts, facilitated by Mr Michael Tersbøl. It should be noted that the most comprehensive experience with organic biogas is found in Germany, so the content of the workshop necessarily was based much on German knowledge and experience.

3.1 Highlights from the presentations and discussion with Michael Köttner

Biomass dependency is one of the major challenges for biogas. It is the largest economic burden for all biogas plants. Michael Köttner strongly recommends that organic biogas concepts do not base their biogas production on the purchase of energy crops on market conditions.

1 Internationales Biogas & Bioenergie Kompetenzzentrum: http://www.biogas-zentrum.de/
This assessment is consistent with the interview survey, stating that the cost of purchasing biomass is highlighted as the most important factor.

Mr Köttner took us through various examples of alternative technologies for biogas plants in organic farming and adapted techniques suitable to handle the fibre-rich biomass, which is the characteristic input material for organic biogas plants.

Dry fermentation is a robust technology that can handle a high N content. The concept though places great demands on control and operational management. Even if it seems relative simple to construct, it is expensive to establish.

The company Lipp has a hydrolysis module as a biological pretreatment unit for a conventional wet fermentation plant. The benefit is that the bacteria do the pretreatment work.

The company Sauter has developed a lagoon system where feeding and stirring is designed to be a very simple and robust concept. There is no agitator inside the vessel and the feeding is done with a wheel loader.

Finally, he introduced the concept from company Biogasprojekte D&K, which derives from a principle of self-building by farmers with an engineer supervising it. The concept has been developed by farmers in Rosenheim area east of Munich. It takes many hours of work for the farmer, and there is no warranty on the system, only on the components. Even this concept is not cheap anymore due to increased legal requirements.

Price trend for investment in turnkey biogas plants have been studied. Over the years there has been increasing specific costs (€ / kW installed) due to more advanced technology and regulatory requirements. Small installations and large-scale plants have the highest specific investment costs. The price per kW installed is lowest for plants in the interval 250-500 kW installed. In 2003 the cost of a plant of 200 kW was approx. € 2500 per kW, while in 2006, it has doubled. Today the plants cost between 7000 and 9000 € per kW.

It is essential that the farmer choose a simple, robust and proven technology that is adapted to the biomass to be used. In addition, be sure to pay attention on high wear and tear and allocate budget for replacement.
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Organic farming has in Mr Köttners eyes a unique opportunity to produce biogas because they have surplus biomass: manure, green manure and intercropping. In addition, they can exploit the agricultural benefits of biogas plants. Therefore it is crucial also to exploit the degassed manure optimally.

Organic farming with livestock may have difficulty delivering sufficient biomass for biogas plants, since they also produce fodder for their animals. They will typically demand smaller biogas plants that suit their amount of animal manure and biomass left-overs.

Common biogas plants (cooperative plants) can be more economically viable if they are based on a binding community and cooperation. But often farmers do not want to be dependent on others. It is a challenge to get cooperation between farmers in the priority.

The engine power efficiency given by manufactures can often be unrealistically high, so he usually downsizes it with 3 % -units.

Costs for connection to the power grid can be very high.

The costs for the biogas plant can be reduced by building in self-help groups and joint procurement of CHP and other components.

- Low energy density of biomass.
- High ammonia levels in the reactor (can be toxic to the bacteria).
- Accumulation of soil in the reactor due to soil in the biomass.
- Acquired biomass is often not organic.
- High wear in the feeding system, the pumps and the agitator.

3.2 Highlights from the presentations and discussion with Benjamin Blumenstein

The presentation reviewed research of the institute, including surveys of about 108 plants among nearly 160 German organic biogas plants.

Mr Blumenstein introduced by reviewing the arguments pro and against biogas from organic farms. An important argument is that biogas provides better opportunities for organic food production, expressed in the word Ecological Intensification. The arguments against biogas are
the risk contained in a process of *conventionalization* and damage of image of organic products. In addition, the effects of biogas slurry on soil humus have been much discussed. So far there is scientific consensus that there are no effects - positive or negative - on humus. The long-term effects are, however, difficult to document since no long-term experiments exist.

Structurally, research shows that newer organic biogas plants are significantly larger and import more conventional substrate especially maize silage. They do not have the same clear idealistic basis as farmers with the older smaller installations.

On average, organic biogas plants use around 75 % sustainable biomass (manure + clover grass) while the conventional only use around 40 %. Maize takes up 14 % by organic biogas plants and 48 % of conventional biogas plants. At the largest organic plants 44 % maize is used but still 24 % grass and clover is included compared with only 4 % in conventional plants.

The organic farming associations in Germany want to phase out the non-organic inputs in 2020 and do not allow new plants to use it. It puts the established larger installations under pressure. New large plants have difficulty getting established when they cannot use conventional biomass. The reason for the use of conventional biomass is that there is not enough organic biomass available.

An alternative to the conventional biomass can be landscaping material. It is very difficult to handle in an ordinary wet fermentation biogas plants, and therefore nobody wants to use it. An EU-project Pro Grass have shown a method to make grass from natural areas more useful by pressing the juice of the material out before it is used in the biogas plant. See http://www.prograss.eu/.

The Scandinavian Interreg project BIOM was mentioned in the discussion. Here landscaping material was pre-treated in an Extruder from Lehmann Mashinenbau and thus it becomes very useful in wet fermentation plants. http://agrotech.dk/projekter/biom-projektet.

Mr Blumenstein also mentioned research with dual cropping systems where two organic crops are grown and harvested in the same growing season. It provides higher dry matter yields per hectare, but not lowers dry matter costs when harvested several times per season. This can be sustainable crops which can fix nitrogen, provide good soil coverage and permit good control of weeds. One may also choose crops
that have a small N content and thus can relieve the reactors nitrogen stress.

**Crucial economic parameters for organic biogas according to Mr Blumenstein:**
- Organic substrate has higher costs per kg dry matter and is less prevalent.
- Less energy density in the versatile biomass provides lower capacity utilization (compared to maize and beet)
- Capital and operating costs are higher (5 per cent investment) because of fibre-rich biomass.
- Optimization of productivity from the sale of electricity, heat utilization and internal ecological services as use of fertilizer.
- Systematic cultivation of energy crops for use in organic biogas plants is not profitable, since biomass is too expensive.

**Mr Blumenstein concludes**
- Biogas plant must be optimized to local conditions and to farm size and layout.
- Heat utilization should be achieved.
- Costs for purchased substrate is high and unstable, therefore adapt to realistic biomass quantities and availability.
- If necessary you have to find concepts for smaller systems to suit the local biomass volumes.
- For the time being organic biogas energy cannot be sold at a premium price.
- Opportunities for collaboration between organic farmers on biogas should be found and developed.
- Operation of the plant must be optimized.
- The concept of organic biogas must be based on ecological principles and use of residual biomass.
- Ecological associations’ guidelines should be adapted.
4 Recommendations

Based on the survey and the workshop the SUSTAINGAS project suggests the following list of recommendations:

4.1 Strategy for biomass supply

Farmers must work together to use the biogas plant as a fertilizer plant, and they should decouple biomass supply of energy crops (green manure) from the market.

Biogas production also gives better nutrient supply of ‘organic origin’ which organic suppliers of biomass also need. It should therefore be in the interest of organic crop producers to supply affordable biomass to organic biogas plants on a long-term agreement, in exchange for getting supply of fertilizer (degassed biomass). This can contribute to improved economic performance in their other cash crops for organic food supply.

Organic growers have an interest in promoting internal functions and services in their crop rotation. That is why they have advantages of being able to sell green manure to biogas plant.

Focus must be on residual biomass like green manure, intercrops/catch crops, livestock manure, landscaping material and straw. Eventually pre-treatment for better digestibility is needed.

To improve biomass supply from organic farms, conversion to organic farming in the local area can be promoted and facilitated and thereby also increase organic food production. Supply of conventional biomass can to some extent, be a strategy for a short transitional period until a supply of organic biomass can be achieved. Conventional plant biomass may eventually as a compromise consist of crops other than maize, but instead clover grass, alfalfa, intercrops, straw, etc..
4.2 Utilization of internal ecological services

Organic biomass (green manure) for biogas plant can be grown in rotation, so the rotation is versatile and provides maximum support to other crops for feed and food.

Green manure should anyway be grown to prevent spreading of perennial weeds, for example as 2-3 year clover grass or alfalfa. With the appropriate cutting strategy nitrogen fixation will be increased. Dual-cropping systems can be considered, as it also can provide specific crop rotation functions, like weed suppression.

Residual biomass such as feed residues, solid manure, surplus of straw, cover crops, intercropping, waste from fruit and vegetable sorting and processing etc. should be collected and fed to the biogas plant to promote a perfect nutrient cycle internally on the farm, so all nutrients are kept in the circle.

Nitrogen of animal manure can be made more available to crops in biogas plant and also can achieve disinfection, as certain bacteria and parasites occurrence are lowered.

4.3 Utilization of fertilizer from biogas

The digested biomass has great value in organic crop production. Therefore, all steps to ensure optimal use should be taken, including, covering the storage tanks and cooling the slurry from the reactor vessel. Also appropriate applications in the field and in crops with respect to time of year, weather conditions, application technique (injection into the ground), prioritization of crops, crop development etc. are important.

Separation of the digestate in solid and liquid fraction may increase utilization of nitrogen. Separation can thus provide a more targeted use of three types of fertilizers for different purposes (untreated digestate, liquid fraction and fibre fraction). The fibre fraction may be dried, stored and transported over long distances, or it can be composted and is used as a soil conditioner.

Fertilizer should be given to the crops, so they get a high yield but without being attacked by insects and fungi. Possibly the slurry can be appllicated in several turns. The fertilizer can be used to improve the
quality of crops, e.g. wheat for bread. The fertilizer is prioritized to crops that have a less favourable position in the crop rotation.

4.4 Intensive organic production

Improved nutrient supply from the biogas plant can be utilized to develop business opportunities and earnings in organic production. More N-demanding crops with market demand can be bread cereals, oilseeds (canola), grass seed and propagation cereals, certain vegetables, early potatoes and other specialty crops.

Excess biogas organic fertilizer can be sold to growers and nurseries. Fibre fraction can be dried or composted and sold as fertilizer or compost and soil conditioner, possibly for gardeners and small farmers without livestock.

4.5 Robust technology

Biogas plant must be equipped with proven technology. Tank form and concept must be tested and adapted to the current and typical biomass from organic farms.

Feeding technology is the most vulnerable, and must be durable, reliable and energy efficient. Stirring technique should be large paddles and blades that can move the tough biomass and keep the swimming layer moist and under control. Pumping should be done with robust pumps like eccentric worm pump. They must be placed appropriate for their task, which often is near the vessels. The shape of tanks may have important implications. Flat and shallow tanks must be avoided when the dry matter content is high. Covers should be tested for leaks.

Mechanical (or other) pre-treatment is relevant with the use of landscaping material. Hydrolysis can also be an interesting approach.
4.6 Consulting and expert client consultancy

Consultants who have experience with organic biogas and facilities to convert fibrous and dry matter rich biomass should be preferred, but more experts and consultants in this field are needed.

Legal assistance in drafting and confirming the contract with suppliers of biogas plants should be engaged. The contract should contain adequate warrants to ensure the system is functioning in relation to the heating system, stirring, pumping, hydraulic, control of swimming layer etc.

4.7 Utilizing heat from electricity production

Heat generation from a CHP unit must be used for sales to residential areas, institutions or by using the heat in agricultural production or ancillary production. It may be drying, for example of grain, grass, wood chips, fibre fraction, or for cooling of storage facilities or heating of production facilities, for example greenhouses.

4.8 Investment in biogas plant

The possible strategies depend on the starting point for the individual farmer. Is it a small organic farm or larger? Is there a larger herd, and thus feed and slurry production? Is the area allocated to perennial crops such as fruit or wine? Are there other organic farmers around? Possible strategies are shown in Table 6.

As the idea and benefit of organic biogas is the improving effect on agriculture, it is obviously important that the biogas plant is owned and controlled by the organic farmer or group of farmers. Due to the current difficulties in raising capital for investment, it is tempting to use foreign capital from investors. But it should be critical considered, as it can affect the synergy between biogas and organic agriculture.
### Table 6. Possible strategies for investment split by size of biogas plant

<table>
<thead>
<tr>
<th>Biogas plants</th>
<th>Small &lt; 100 kW</th>
<th>Medium 100-500 kW</th>
<th>Big &gt; 500 kW</th>
</tr>
</thead>
</table>
| **Suitable for** | • Small farms  
• Farms with only animal production  
• Farms with mainly perennial cultures like fruit and wine. | • Big farms  
• Farms with more arable crop production (with green manure)  
• Larger horticulture production | • Several bigger organic farms with short distances in between.  
• Potential for a common biogas plant in cooperation. |
| **Disadvantages** | • High specific cost for biogas plant (€ per kW)  
• Management lies on the farmer himself  
• Lower electric efficiency in CHP | • Dependency of external biomass supply  
• Waste heat utilization can be a challenge  
• Transportation cost may occur  
• Appropriate cooperation agreements with biomass suppliers must be foreseen | • Higher cost per kW  
• Transportation costs  
• More costly and time demanding approval process  
• Cooperation agreements must be developed |
| **Advantages** | • Closely integrated with the farm setting  
• Only own biomass (no dependencies)  
• No transportation cost  
• Waste heat allocated locally | • Lower specific cost for biogas plant (€ per kW)  
• Higher electric efficiency in CHP  
• Employed people can take part in the operation. | • More optimal energy sales can be developed, like upgrading for the gas grid.  
• Biomass should be available according to plant size.  
• Specialized operator can be employed. |
| **Strategies** | • Do-it-your selves' concept appropriate or simple turn-key concepts. | • Turn-key plant appropriate  
• Organic biomass must be secured through agreements from suppliers.  
• Import of conventional biomass for a transition period  
• Convert neighboring farms to organic | • Customized biogas plant setting can be afforded.  
• Alternative marketing strategies can be analyzed |
5 Discussion

The findings, that the organic farm is beneficially affected by the operation of a biogas plant are not new. It is documented by several investigations, both as survey among farmers (again in German)\(^2\), and by field trials with different crop rotation systems\(^3\).

This advantage should be utilized to its maximum, as it has the potential to supplement the economy of biogas plant with the sale of fertilizer or legitimize a biogas plant without profit. High utilization of fertilizer for higher yields or qualities and new business opportunities is the key to getting more organic biogas.

The biggest challenge is to get enough organic biomass for an affordable and stable price. This challenge should be solved already in the planning of the biogas plant and before the establishment of the plant, so there are agreements on mutual supply of biomass and organic fertilizer. Suppliers of biomass have an interest in being able to receive organic fertilizer. This also applies for rising food prices, as nutrients in that case also has higher value. It is vital to the economy of organic biogas plants at they can agree with biomass suppliers on mutually binding and mutually beneficial agreements for biomass-and fertilizer exchange.

Small biogas plants, only using the farms own biomass, is relatively expensive to build. But it should be examined whether they with the agricultural benefits in mind though still can be profitable, and very robust and customized solutions must be found.

Dependence on conventional biomass is unfortunate for organic agriculture. Therefore, increased conversion of land to organic operation in the local area is seen as a viable strategy to leverage additional biomass. The organic food market is still developing and therefore the organic production has potential for being expanded. A new study in Denmark showed that lack of access to organic fertilizer plays a vital role for conventional farmers’ choice not to be organic, in particularly in the eastern part of Denmark, where there are generally fewer farm animals and less animal manure than in the west\(^4\). Organic biogas plants can help to improve the

\(^2\)Anspach et al 2011

\(^3\)Møller et al 2006, Gunnarsson & Gertsson, 2004

\(^4\)Epinion, 2012.
supply of organic fertilizer and thus permit more farmers to convert to organic production. This requires, however, that the supply and demand of organic food produce continues to develop in a balanced way.

Conventional biomass may be used during a transitional period, until more organic land is converted in a local area. In the SUSTAINGAS report D2.1, it was surprisingly found that only 66% of the surveyed farmers reflected that the amount of conventional biomass is important in relation to sustainability, while 86% think that the type of biomass in general is important. So is the type of input (manure, crops etc.) more important than if the biomass is organic or conventional? This can lead to a discussion of whether it is acceptable to use residual biomass from conventional agriculture (manure, cover crops, straw, even clover grass) rather than energy maize or other intensive conventional crops.

Apparently many organic biogas owners have experienced technical problems, so there is a big task in order to provide good guidance on technique, so high reliability is achieved. Tear and wear cannot be avoided, but some concepts are less sensitive and should arouse interest and be further documented. This need has been the starting point for a Danish project Competence Centre for Organic Biogas, which has published two reports with German colleagues with knowledge of the industry.5

6 Conclusion

The SUSTAINGAS project has developed a number of recommendations for how organic biogas can improve economic performance. The basis for the recommendations are the collected knowledge and experience from organic biogas plant owners, as well as a workshop with invited experts. We also see in this work that the organic farmers need help to get better solutions in the future. This includes better consultancy, development of good cooperation between biogas plants and biomass suppliers, and help to find the most appropriate technical solutions. Finally, it is important to discuss if the organic sector wants to use biogas as a tool to develop and improve the sustainability of organic farming, and how to work with it within the organic principles.

7 References


