APPLIED PLANT RESEARCH
WAGENINGEN UR

FEASIBILITY STUDY ANAEROBIC DIGESTION AS HEATH AND ELECTRICITY PRODUCTION FOR GLASSHOUSE HORTICULTURE

A CASESTUDY

Peter Vermeulen

Applied Plant Research Glasshouse and Horticulture,
P.O. Box 8, NL-2760 AA Naaldwijk, The Netherlands
E-mail: peter.vermeulen@wur.nl

Leon van Boheemen

INHOLLAND School of Agriculture & Technology,
P.O. Box 3190, NL-2601 DD Delft, the Netherlands

Keywords: Anaerobic digestion, Energy costs, Glasshouse Horticulture, Feasibility study

Introduction:

International competition in horticulture continues to increase. The entrepreneur can choose two strategies to maintain profits: specialization in a niche product or reduction of cost price by scaling-up. Table 1 shows the development of the sizes of horticultural companies in The Netherlands.

Table 1: Development of size of Dutch horticultural companies

	Vegetables					Ornamental				
Year	Companies	ha	ha / comp.	Comp. < 1 ha	Comp. > 2 ha	Companies	ha	ha / comp.	Comp. < 1 ha	Comp. > 2 ha
1975	9769	4683	0,48	8746	101	8352	3060	0,37	7854	72
1985	6974	4559	0,65	6481	238	7701	4275	0,56	6889	254
1995	4686	4405	0,94	5498	442	7399	5518	0,75	6454	478
2000	3433	4200	1,22	4030	599	6575	5927	0,90	6335	712
2001	3171	4271	1,35	2971	644	6156	5845	0,94	5471	741
2002	3001	4287	1,43	1920	659	5796	5823	1,00	4431	771
2003	2825	4320	1,53	1688	688	5597	5769	1,03	4049	810
2004	2652	4398	1,66	1541	686	5347	5692	1,06	3718	820
2005	2547	4491	1,76	1425	699	5071	5615	1,11	3531	825

Source: Land- en tuinbouwcijfers 2006. LEI en CBS

Horticultural companies not only become larger in the latter case, but often become more energy intensive. The use of artificial light as grow light and automation of the production processes are become normal to the bigger companies.

In 2006, the horticulture has been faced with a doubling of the price of natural gas. A commodity price of € 0.12 by m3 was in 2005 still normal; in May 2006 that price has already increased to € 0.25 / m3. The cost of energy in horticulture is considerable. The percentage of the various costs in the production of the six most important horticultural products are shown in table 2. Energy contributes 20% to 33% and in all cases is one of the three greatest costs.

Table 2: Contribution of the costs of production for the six most important products in glasshouse horticulture

	Tomato	Sweet Pepper	Cucum-ber	Rose	Chrysant	Gerbera
Plant material	4%	7%	9%	3%	25%	7%
Energy	27%	25%	23%	33%	21%	20%
Delivery	4%	4%	6%	8%	8%	11%
Other production costs	6%	6%	6%	3%	3%	5%
Labour	32%	30%	31%	32%	19%	30%
Equipment costs	22%	25%	22%	18%	21%	24%
Several	3%	4%	3%	2%	3%	3%

Source: Applied Plant Science (PPO Glas)

Glasshouse owners now are looking to ways to keep the energy costs under control and are looking to alternatives for natural gas. Energy saving is in the glasshouse horticulture already far by led and does not offer to much extra possibilities more.
The new developments such as "the closed glasshouse" and "the energy producing glasshouse" have been not yet developed sufficiently on large scale applied. A logical step is look at then to alternative fuels. Some combinations of glasshouse owners have taken the plan to stoke their cogeneration installation with biogas. These growers have together a number of large heat and power cogeneration installations (HPC), with what a large part of the warmth and the electricity need of their companies is produced. From them the question came; select which possibilities offer digestion to biomass for the production of biogas for the HPC.

The following questions for application of biomass digestion in horticulture have been asked:

1. Which techniques are suitable most?
2. Which biomass is as feeding most is suitable?
3. Which key figures belong to this biomass?
4. How much and where this biomass is available?
5. What are the costs and turnovers of digestion?
6. What costs 1 kWh electricity produced with gas of digestion or with the natural gas driven co-generation installation?

To answer questions to these a model has been developed. The presentation gives an overview of the functions of the model and the results of the case study.

Which techniques are suitable most and which biomass is as feeding most is suitable?

For the glasshouse horticulture a number of points are important:

- The digestion process must be constantly and reliable, because the glasshouse cropping is not possible without warmth.
- The most important glasshouse horticulture areas have almost no other agrarian activities more. The organic material for the digestion must be invoked of other areas.
- The smoke gases of the HPC must be safe, to be able dose CO2 in the glasshouse.
- The prices of soil in the Netherlands in the most important glasshouse horticulture areas are between the € 50 – 60 /m2 and in the rural areas between € 10 and € 25 /m2.
- The legislation around the removing of sludge is strict.

Soil use and transport indicate in the direction of a combination of efficient digestion with a feeding with high CH_4 production by m^3 feeding. A constant gas production and legislation around removing of sludge plead for a feeding with a constant composition.
The stability of a mesophilic digestion with energy rich maize or energy beets seems to be for this the best choice.

Which key figures belong to this biomass?
During the research a mount of not similar key figures float above.
For calculations is especially important:

- CH4 production by barrel fresh mass feeding: m3/t fm
- CH4 % biogas
- Volume feeding
- Stoke volume feeding
- Digestion volume digester
- Volume sludge
- Transport movements for supply feeding and remove of sludge

In the model an overview with standardized data has been incorporated for the feeding for the digestion, usual at this moment.

The case study
A glasshouse horticulture entrepreneur wants know what the impact and risk are of the production and use of biogas. Head question is: Under which conditions the production of warmth and electricity with a HPC, biogas from digester is cheaper to use then natural gas.
The entrepreneur has a horticulture company of 3 ha large with a heating requirement of 35.9 m3 natural gas by m2 by year (34 TJ per year). He has a HPC of 1,36 mWe. The HPC runs 7.900 hours per year.
The heating requirement of the glasshouse has been divided unequally over the year. This partitioning has been reflected in figure 1 in combination with the heath production of the HPC on natural gas and the net heath production of the HPC after heating of the digester.

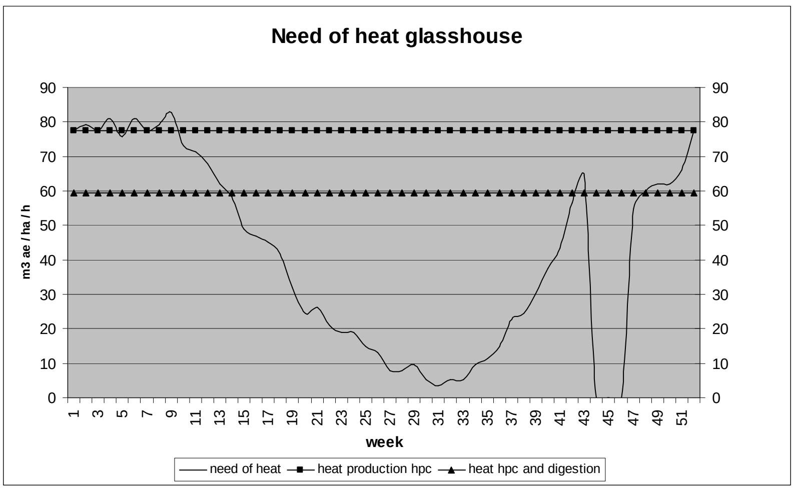

Figure 1: Need of heat for a sweet pepper crop and the heat production of a HPC, one running on natural gas an one running on biogas after heating the digester

In table 2 the most important key figures of the case are showed.

Table 2: Input figures of the case

Digester and HPC:	€ 2.600.000,–
Output HPC:	35 % el., 55 % heat
Price maize:	€ 37,- / 1000 kg
Costs removing sludge	€ 15,- / 1000 kg
Price natural gas	€ 0,25 / m3
Feeding	100 % corn

Results

In this case there are the following results:

- The digestion unit must have a volume of 7.600 m3.
- Input of maize will be 36.000 ton a year, resulting in 23.400 ton sludge a year. If the digester is based on glasshouse plant, the transport gives 1.500 van rides for the supply of corn and 1.000 rides for the removing of sludge.

The yearly costs of the electricity production are showed in table 4:
In this case the electricity production costs are higher when biogas of digestion is used. Without MEP subsidy the costs are 2.4 times the costs of production with natural gas. With MEP subsidy the electricity production cost are 20 % higher.

Table 4: Partitioning yearly electricity production costs

HPC working on biogas of the digestion:			HPC working on natural gas:		
Net electricity production	10.078.906	kWh/year	Net electricity production	10.722.240	kWh/year
	€ / year	€ / kWh		€ / year	€ / kWh
Costs digester	282.250	0,028			
Costs HPC	140.300	0,014	Costs HPC	140.300	0,013
Costs biomass	1.329.500	0,132	Costs natural gas	946.200	0,088
Removing costs sludge	350.300	0,035			
Total costs	2.102.350	0,209	Total costs	1.086.500	0,101
Saving of warmth costs	237.000	0,024	Saving of warmth costs	266.800	0,025
Balance	1.865.350	0,185	Balance	819.700	0,076
MEP[1] subsidy	1.040.100	0,097	MEP subsidy	82.100	0,008
Costs - MEP subsidy	825.250	0,082	Costs - MEP subsidy	737.600	0,069

The next question will be, under which circumstances the use of biogas of digestion will be profitable? In table 5 the break-even prices of several cost factors are showed.

Table 5: Break-even prices of several production costs

	With MEP	Without MEP
Price corn per 1000 kg	€ 33,25	€ 6,50
Removing costs sludge	€ 9,25	
Price natural gas per m3	€ 0,29	€ 0,59

[1] MEP = Milieuvriendelijk elektriciteit productie =Environmental friendly Electricity production

A lower price of corn gives a feasible project in the case of MEP subsidy. Without MEP the price of natural gas must increase till almost € 0,60 / m3 to make the project feasible.

Conclusions

The conclusions of this research are as follows.

- Digestion for greenhouses is technically feasible.
- The most interesting products for digestion are energy corn followed by normal corn.
- Every single situation has to be examined for its economic perspectives. The feasibility depends on several factors. The most important factors are:
    - The high of the MEP-subsidy.
    - The price of the products that will be used for digestion.
    - The costs of removing the sludge.
    - The price of natural gas.

However, there are several risks and uncertainties with the digestion of biomass for greenhouses, which should not be underestimated.

Risks:

- High investments are needed to realize it all (the investments are much higher in comparison with a combined heat and power production plant on fossil gas).
- Dependence on subsidy. It is not economically feasible without the MEP-subsidy on the produced kilo Watt hours.
- A slight increase of the price for energy maize or green maize will have a large impact on the financial feasibility of the installation.
- A slight increase of the costs of removing the sludge will have a large impact on the financial feasibility of the installation.
- A decrease of the fossil gas price will have a large impact on the financial feasibility of the installation.

Uncertainties:

- There is always a chance that the digestion process will come to a stop, due to a human error. When that happens, there will be no biogas available for generating the necessary warmth, electricity and CO2 in the greenhouse. In winter time this will give big problems.
- The sale of sludge is uncertain because of unclear legislation.
- The MEP-subsidy is under discussion.

As a result of this research the following recommendation has been made.

- Look for cooperation between a neighbour farmer and a horticultural company. After the digestion process has taken place at a farm, the produced biogas will be transported through a short gas pipe to the horticultural company.
- This combination offers the agricultural farmer as well as the horticultural farmer a positive result. It ensures optimum use of all out going flows, such as: electricity, warmth, CO2, and the sludge. Moreover, in this way it is possible to steer clear of troublesome legislation.

Biographical details:

Peter Vermeulen; Economics and Management Research in the Glasshouse Horticulture
Subjects: Energy costs, Energy saving, Feasibility studies, Entrepreneurship, Labour, Labour planning, Data collecting and analyzing

Leon van Boheemen; Student Agribusiness, Inholland School of Agriculture & Technology, Delft