Fermentation as possible energy source for the organic greenhouse horticulture

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Abstract

In 2009 the province Flevoland had the idea to start a study to make the horticultural sector in the province more sustainable. The province started the project Agropark Flevoland. One of the issues is to look for the input of organic materials. Will it be possible to use this material as food for a fermentation plant to produce biogas, before it will be used to upgrade the soil? In 2010 a case study is done to find out what the possibilities will be for the use of a fermenting plant to produce biogas to heath a group of greenhouses and produce electricity with a co generator. This article shows the results of this case study.

INTRODUCTION

To grow to a more sustainable agriculture the province Flevoland started in 2009 the project Agropark Flevoland. Issues of this project are among others: sustainable energy, combined logistics and sustainable soil use. The ultimate aim is to have a cradle to cradle closed agricultural production.

A specific region of the province Flevoland is the Noordoostpolder. This 460 km^2 new land area is caused by the construction of dykes in 1942. Important crops of the Noordoostpolder are seed potatoes and flower bulbs. Because most of the soil is sandy loam and the cultivation plan is very intensive, there is a high need of organic material input to keep the soil healthy and a high need of minerals. Therefore there is a continuous import of farmyard manure from other regions outside the province Flevoland. For this situation the province had the idea to make a double use of this manure by using it first in a fermentation plant which makes biogas. This biogas can be used in a co generator to produce heath and electricity. The fermented manure and organic material, the digestaat, can be used as a soil quality upgrade. To find out what the feasibilities will be of this plan, the province has commissioned Wageningen UR a case study. In this case study is worked out what size of fermentation plant will be necessary to produce the heath for a region with three greenhouse growers located near the village Ens. Ens is located in the south east corner of the Noordoostpolder, nearby one of the main entrance ways and nearby a small harbour. The main distribution pipe of the gas grid crosses the village. For these reasons Ens will be a good location for a fermentation plant (see figure 1).

The main questions of the case study are:

- What is the heath demand during the year?
- In what way is this heath demand filled in yet?
- What will be the necessary capacity of a fermentation plant to fill in this heath demand (partly)?

- What are the consequences of the use of this fermentation plant?
- What kind of organisation will be necessary to manage this plant?

MATERIAL AND METHOD

In Ens three growers with a total greenhouse area of 52 ha are situated at the same street. These growers are an organic vegetable grower and two garden plant growers. An open air grower of strawberry seed plants is interested to use the digestaat to upgrade his soil quality. The key figures of these greenhouse growers are shown in table 1. At the moment the garden plant growers have co generators. One of the growers has already and the other has planned to buy a wood boiler to produce the necessary heath for the garden plant production. The vegetable grower has a gas boiler and sells heath from his neighbour when necessary, who is therefore connected at the heath water grid of the garden plant grower.

The heath demand during the year for the garden plants growers is high in the spring and autumn, while the organic grower has a more equal demand during the year. The summed heath demand of these three growers results in a very fluctuating demand with a top heath demand in March of 9.000 MWh and a lowest heath demand of 1.800 MWh in the summer (see figure 1).

The biogas produced by the fermentation units normally will be used in a cogenerator, which produces heath and electricity. The heath will be used in the greenhouses and the electricity will be sold to the national electricity grid. Because of the fluctuation in the heath demand three options were worked out: ‘high capacity’, ‘middle capacity’ and ‘low capacity’ fermentation capacity. The key figures of these options are described in table 2. The size of a fermentation unit for a 1 MW_{el} co generator is based on 22.000 – 25.000 ton input a year. Dutch law requires that this input must contain at least 50 % manure and the other 50 % can be cereals as maize, organic house waste, glycerine or other organic materials, to be able to use the digestaat as manure on the fields. This kind of fermentation unit will produce biogas with 50 -55 % methane. Usually the co generator runs 8.000 hours a year.

To get an exploitation subsidy of the government at the combination fermentation and co generation, a great part of the heath must be used.

During this case study the growers were members of a feedback group. This group gave the input figures, discussed the terms and conditions which had to be filled in, to become a part of the organisation and to have a say in the options that were to be calculated. They mentioned the maximum price for the heath they will buy from the fermentation plant to be equal of lower than the gas price at the moment.

RESULTS AND CONCLUSIONS

Calculations for the three options showed that the option ‘high capacity’ during the whole year gives an overproduction of heath. The options ‘middle capacity’ and ´low capacity’ will give only an overproduction in the summer and fill in a great part of the heath demand of the garden growers and the whole demand of the vegetable grower (see figure 3). Looking for the energy efficiency the option ‘low capacity’ gives the best results (see table 3). Most of the produced heath can be used for the greenhouses; 85 % and the fermentation process; 3 %, this gives a total use of the heath of 88%. The total heath demand of the organic vegetable grower will be produced with the biogas of a fermentation plant of 135 kTon a year and there will be some heath for the other growers.

The global economic calculation also shows that option ‘low capacity’ seems to be the best. Important factors for a positive result are low prices of the menu products, the price of the sold electricity and the grant for the produced electricity, the price of the sold heath, the investments costs and the price to sell the digestaat. The main important factor will be the management of the plant. The process must be controlled so that the gas production will be continued to feed the co generators. The menu management therefore is very important.

The use of fermentation results in an extra soil use of 1 ha a unit. Each fermentation unit gives an extra transport movement of nearby 2.500 trucks a year. Option ‘low capacity’ seems to be the best and has three fermentation units.

The growers don’t want to explore the fermentation plant themselves, because the success depends on a good management. This exploitation will cost a lot of time, 24 hours a day 7 days a week, so it will compete with their main business as grower. They advised to make a separate concern for the exploitation of the fermentation plants. At this moment there are three interested parties to do this exploitation.

DISCUSSION

The question is whether the use of food products for fermentation is ethical allowed for the production of heath and electricity. Maybe the use of organic house waste is a solution, but this depends of what the restrictions of the organic agriculture will be.

The input of 65 kTon maize will have a great influence at the market price of maize in the surrounding of Ens. That will have a negative influence at the profitability of the fermentation.

There will be a competition between the price of the heath that is necessary to explore the fermentation profitable and the price that the growers want to pay to be competing with the actual gas price.

Will the exploitation of the fermentation plant be a governmental task, because of the positive effect at the environment and the low profitability?

Literature Cited

Boheemen, L. M. van, 2006, Haalbaarheidsstudie van biomassavergisting in de glastuinbouw. Praktijkonderzoek Plant & Omgeving B.V. Business Unit Glastuinbouw. 55 pag.

Tables

Table 1. Farm information

Grower		B1	B2	B3
Crop		Garden plants	Organic vegetables	Garden plants
Area greenhouses	ha	24	8	20
Gas boiler	MW	6	8	
Electric power co generators	MW	1.5		2.7
Wood boiler	MW	6		
Natural gas boiler	m^3/m^2/year	4.2	37.5	
Natural gas co generator	m^3/m^2/year	8		13
Electricity	kWh/m^2/year	4	7	4

Table 2. Key figures options case study

		High	Middle	Low
Fermentation units		9	5	3
Total fermentation cap.	kTon/year	405	225	135
Co generation units		18	10	6
Power electric co gen.	MW_{el}	36	20	12

Table 3. Results of options case study

		High	Middle	Low
Methane production	Mm^3/year	64	36	21
Heath production co gen.	TWh	360	200	120
Electr. production co gen.	TWh	288	160	96
Efficiency heath use	%	54	80	88
Saleable heath	%	42	67	85
Soil use fermentation plant	Ha	9	6	3
Transport moves	trucks /year	22.000	12.000	7.500

Figures

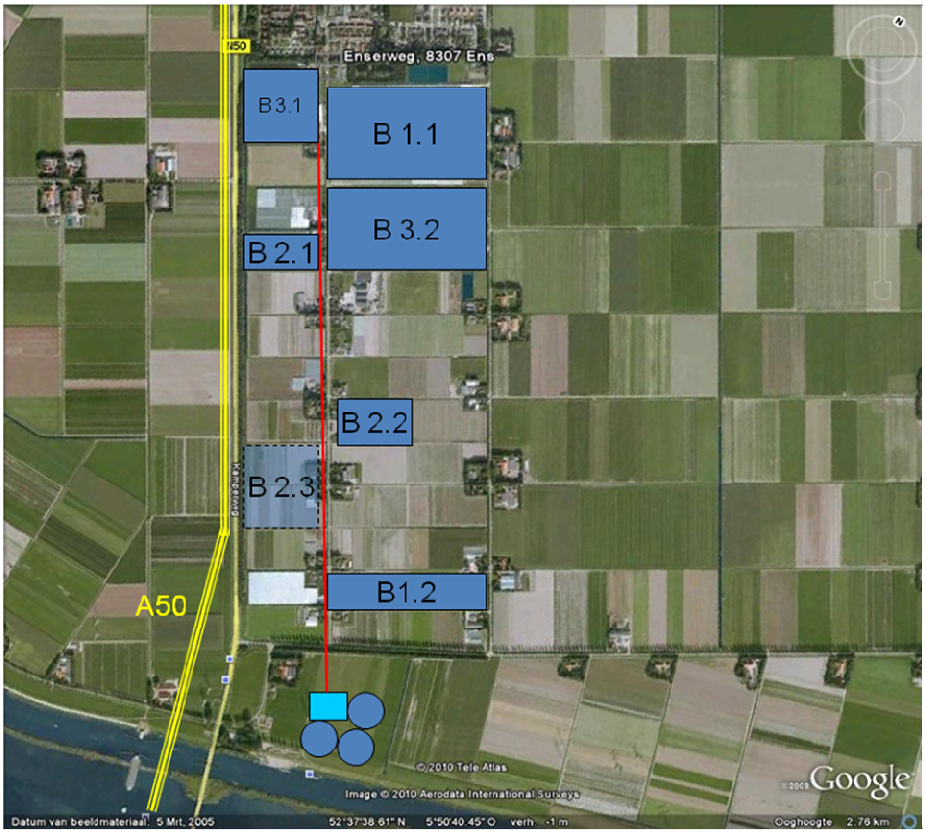

Fig 1. The different locations of the greenhouses of each of the three growers in Ens

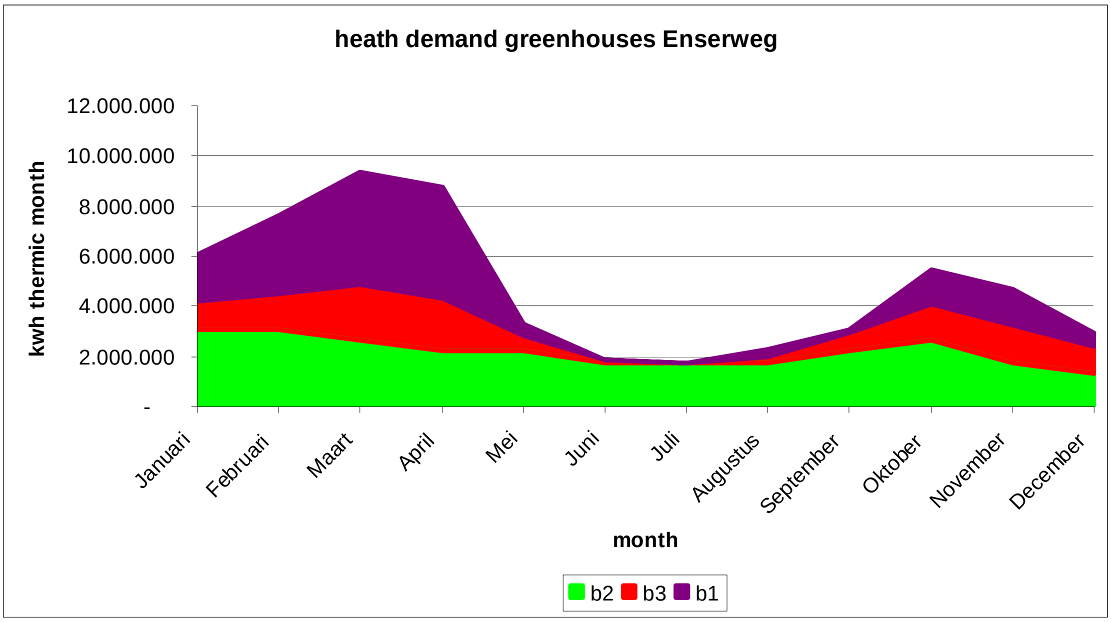

Fig 2. Total heath demand during the year of the greenhouses in Ens.

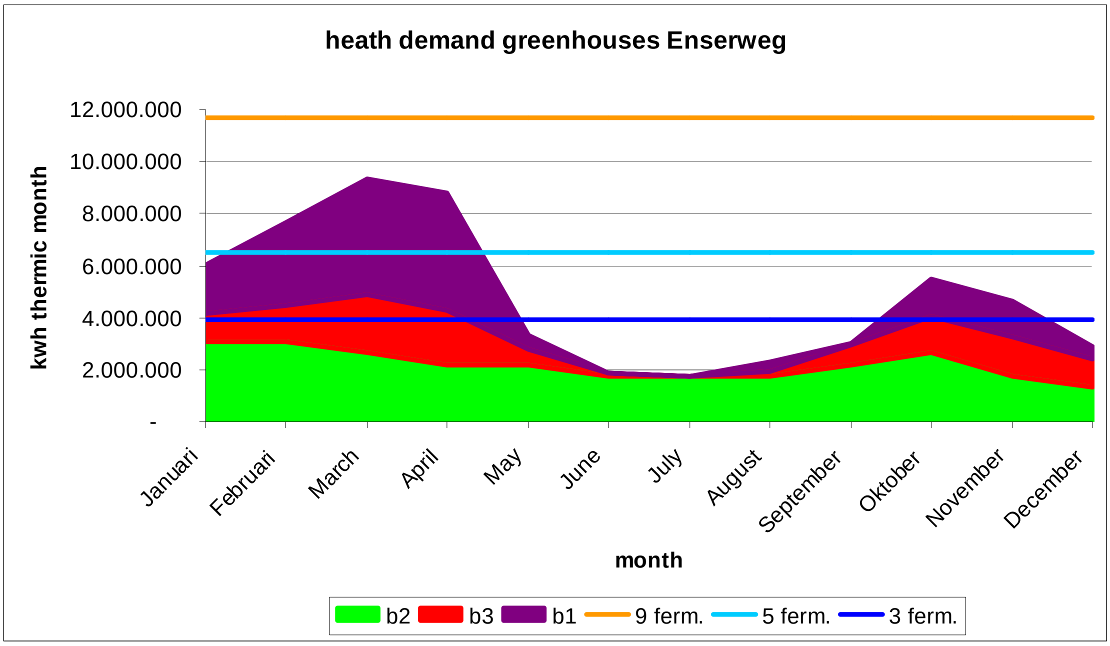

Fig 3. Total heath demand during the year of the greenhouses in Ens and the heath production of three fermentation capacity options.