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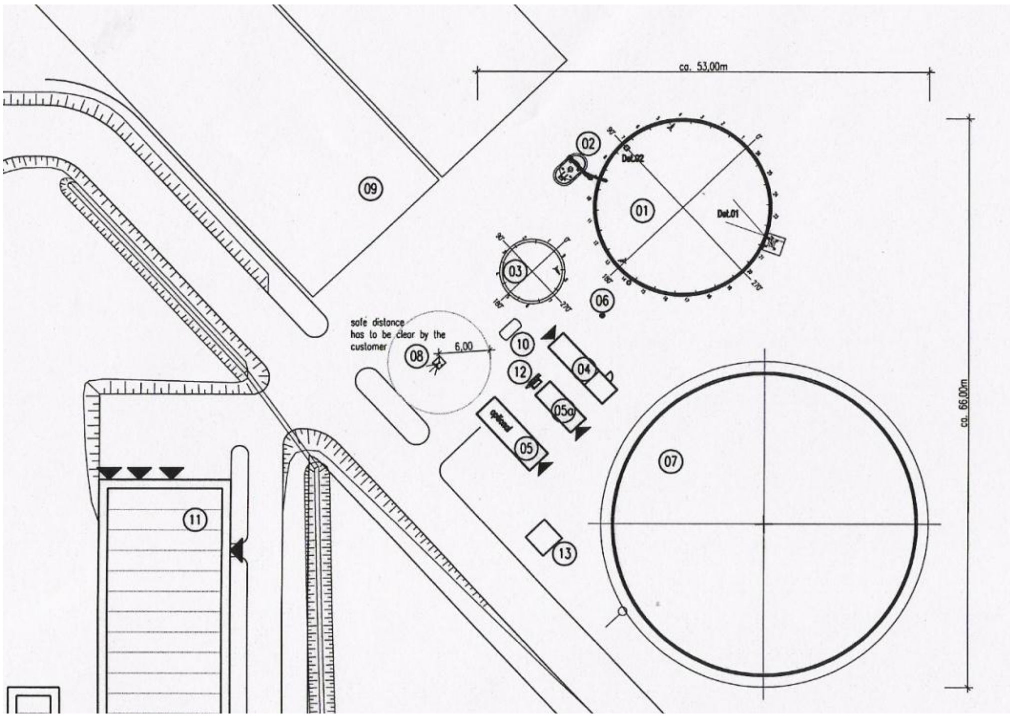

Vecauce Biogas Plant, Latvia

Improvement and enlargement of Vecauce Biogas Plant, Latvia

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Prepared by

BALTIC COMPASS

PlanAction

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1 Introduction

This assessment of possible improvement and expansion of the biogas plant at Vecauce, Latvia is made under the EU Baltic Compass program by PlanAction Aps, Denmark. The study is based on a site visit and interview made on the site in November 2011 and all data used to describe the present situation have been given from Vecauce.

2 Summery

Vecauce constructed in 2008 a biogas plant for the digestion of manure from their dairy farm and energy crops as grass and maize. The plant was designed to provide heat for the farm and electricity to be sold to the grid in accordance to the quota given to Vecauce. The plant was constructed as a simple one-step mesophilic plant.

The plant has operated for three years in full operation but has not been profitable mainly because the production of gas that does not enable full utilisation of their electricity production quota.

On this background the plant set-up and operation have be assessed to provide solutions for a development towards a profitable operation.

The present situation for the operation of the biogas plant is:

- The engine operates often in part load meaning that there is a potential for a higher electricity production and income if more gas can be produced
- The digester seems overloaded and the production is therefore limited and it is not possible to enlarge production by adding more biomass
- The part load operation of the engine cause relative high operation costs
- The digestate is very high in dry matter causing handling problems

Besides the biogas plant Vecauce also operates a district heating system in Auce only approx. 5-600 m from the biogas plant. This system supplies the university and dwellings in the town. The operation is costly mainly because of high cost for LPG used as a middle/peak load fuel.

The operation of the biogas plant and the district heating plant can be optimised by an enlargement of the biogas plant and utilisation of biogas as the main fuel on the district heating plant.

This enlargement will enable utilisation of manure produced on the farm (solid manure) and from a neighbouring pig farm – as resource not utilised today. The enlargement will be a feasible investment.

Besides the enlargement to enable economic feasible operation of the plant it is regarded necessary to optimise the handling of the digestate and the operation of the engine.

An enlargement and rebuilding of the plant will provide a greenhouse gas impact of approx. 4,700 t CO_2 equivalents

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3 The present situation

The biogas plant at Vecauce was constructed in 2008 and commissioned for the operation on manure. In 2009 maize silage was added to the plant. Since then the plant has been operating using a mix of mainly manure and silage (maize and grass). Besides this other products as whole crop silage and flour have been used for the production of biogas.

The biogas is utilised in a 260 kW electric CHP plant installed in a container on site. The electricity is sold to the grid in accordance with an agreed quota. The quota means the following conditions:

- 7,000 full load hours equal to up to 1,820 MWh electricity/year: 149 LVL/MWh
- Electricity sales above 1,820 MWh/year: 30 LVL/MWh

To maintain the quota the sales must be at least 80% of the agreed quota equal to 1,456 MWh electricity per year (5,600 full load hours).

The production of electricity has been kept inside the slot between minimum delivery and max delivery, i.e. inside the quota.

The heat is utilized partly on the farm and partly for process heating of the biogas plant.

3.1 Biomass

The biomass digested is:

- Approx. 15,000 t of dairy manure in average approx. 7% TS
- Approx. 2,700 t of maize silage at approx. 33% TS
- Approx. 2,200 t grass silage at approx. 25% TS
- Approx. 150 t flour at approx. 90% TS
- In total approx. 20,050 t biomass per year

The manure is added to the plant relative constant over the year where the maize silage is used in winter (together with some flour) and the grass silage is used in the summer and raised in winter to correspond the variations in the heat demand.

The maize silage is cut during harvest to a max length of approx. 2 cm. The grass is during harvest cut to approx. 5 cm. The silage will be further chopped in a feed mixer before entering the digester. The silage is partly stored in a concrete plate and partly in stacks made on the adjacent field.

Besides this smaller amounts of grain as well as other types of silage (full crop silage) have been added. It has been tested to use solid manure from the dairy herd (young cows and dry cows). This biomass has been difficult to handle in the plant as well as it gave some problems in relation to creation of foam in the digester and it is therefore not used at the moment.

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The digester is fed with the best biomasses in winter to optimize the production. The general input winter and summer is:

Winter	t/day	% TS	t TS	VS/TS	t VS
Manure	36,0	8%	2,9	80%	2,3
Maize	15,0	33%	5,0	95%	4,7
Grass silage	-	25%	-	95%	-
Flour	0,8	90%	0,7	95%	0,7
In total	51,8	17%	8,6	90%	7,7

Summer	t/day	% TS	t TS	VS/TS	t VS
Manure	40,0	6%	2,4	80%	1,9
Maize	-	33%	-	95%	-
Grass silage	12,0	25%	3,0	95%	2,9
Flour	-	90%	-	95%	-
In total	52,0	10%	5,4	88%	4,8

After digestion the digestate is stored in a 4,000 m^3 storage open tank next to the digester and from here it is spread on the farm land using traditional slurry spreaders (own equipment or contractors).

3.2 Gas production

The plant is not provided with a gas meter and the amount of gas produced can therefore only be estimated from the production of electricity from the engine. This is regarded as a relative safe way of estimating the gas production and can therefore be used in this assessment. During service time, power break on the grid, and other stops on the engine the biogas is burned in the boiler but this is a limited amount that only has a minor impact on the calculations.

The gas production is varied over the year. By adjusting the amount and quality of silage for the plant the production in the winter is higher than in the summer.

The production of gas estimated in winter and summer operation is:

	Load	kW	Efficiency	Input kW gas	m3 CH4/day
Winter	100%	260	35,9%	724	1.749
Summer	60%	156	33,0%	473	1.141
Full load		260			

3.2.1 Gas production calculated from the input biomass

Using Danish standard figures for a one-step digestion as the one in the Vecauce plant - the following production should be possible to make winter/summer (theoretical gas production):

Winter	t VS/day	GVS	m3 CH4/d
Manure	2,3	210	484
Maize	4,7	350	1.646
Grass silage	-	320	-
Flour	0,7	370	253
In total	7,7		**2.383**

Summer	t VS/day	GVS	m3 CH4/d
Manure	1,9	210	403
Maize	-	350	-
Grass silage	2,9	320	912
Flour	-	370	-
In total	4,8		1.315

In relation to the estimated production from the operation of the engine this is lower:

Gas production	Estimated m3 CH4/d	Theoretical m3 CH4/d	Lower gas prod m3 CH4/d	Lower gas prod %
Winter	1.749	2.383	634	36%
Summer	1.141	1.315	174	15%

It can be seen that the estimated gas production is 15-36% lower than the theoretical calculated production. It must be marked that the estimated production is uncertain. Anyway the trend is regarded as safe so it can be concluded that the production of biogas is lower than it ought to be, in particular in winter.

The process has been assessed in relation to the pH in the digester. Data given from the plants shows a pH level in average on 7.5 in the situation where maize and manure is fed to the digester. The pH is a little higher when only manure is fed to the digeste r. This is relative low in relation to the conditions in well-functioning Danish digesters and normally indicates an overloading of the digester caused by a relative high organic load of the digester which will cause a lower gas production than what can be expected.

3.3 Plant set up

The plant is supplied by the German company Veltec BioPower as a standard plant as common in Germany.

The plant is a one-step mesophilic operated biogas plant.

Main parameters are:

- 144 m^3 reception tank/mixing tank/preheating tank for manure
- Approx. 12 m^3 feed in device for solid biomass/silage, direct feed into the digester
- 2,000 m^3 digester, full mixed stainless steel tank provided with double membrane. The tank is heated and provided with 80 mm insulation on the walls
- Gas storage approx. 540 m^3 under the double membrane cover on the digester
- 4,000 m^3 non covered steel storage tank for digestate
- Pumping system utilizing one pump for all pumping routines (Seepex snail pump)

- Gas handling system including biological purification in digester, FeCl addition, active coal filter and cooling system (cooling in ground as well as active cooling)
- Gas engine 260 kW electric (Liebherr mounted in a container)
- 100 kW dual fuel boiler (heating oil and biogas)
- Flare

The manure is pumped from the stables into the reception tank where it is heated to approx. 25°C to avoid frozen manure to be pumped into the digester.

The maize silage is supplied by a front loader into the feeding device and from here with no further treatment fed into the digester.

3.4 Operational parameters

3.4.1 Digester

The main parameters for the assessment of the plant set up in relation to the operation of the digester are:

- Process: One step
- Retention time in digester: Approx. 35 days
- Organic load of the digester: Approx. 2.7-4.3 kg VS/m^3 digester per day
- Temperature in the digester: Approx. 38°C (mesophilic)

The one step process used is quit uncommon because the storage tank for digestate normally is used as a secondary digester. The storage tank at this plant is not covered and is therefore not used. Besides this the very low winter temperatures in the area means that the tank beside the cover should have been equipped with insulation.

The retention time is normal for mesophilic digestion but the organic load is rather high. The process has been tested in relation to the German FOS/TAC method. This shows low load when the organic acid content of the digester is related to the alkaline buffer capacity. This show a process that is under-loaded. The reason for this can be an inhibited creation of acid which also is indicated by the relative low pH in the digester.

3.4.2 Biogas engine

The plant is equipped with a 260 kW Liebherr biogas engine mounted in a container.

In the winter the engine is operated 24h all days. In summer the engines operates on low load often close to minimum load equal to 60% of max load. The efficiency at low load is relative low.

The engine cannot run on loads below 60% of max load equal to 156 kW electric.

3.5 Economic conditions

3.5.1 Investment

The plant was installed in 2008 for a total price of 780,000 LVL This investment is amortised inside 10 years with a yearly cost of approx. 100,000 LVL.

3.5.2 *Operational costs*

Operational costs are mainly purchase of silage and other biomasses. This is estimated for 2011 based on the first 9 month production. The estimated cost is approx. 87,000 LVLL per year. Other costs corresponds approx. 65,000 LVL per year. In total operational costs is 152,000 LVL for 9 month equal to 200,000 LVL per year.

3.5.3 *Income*

The income is limited by the quota for production and sales of electricity to the grid. The income corresponds to the production of electricity that corresponds to the production of gas. The production is expected to be just enough for fulfilling the quota. Total income 2011 will then be approx. 220,000 LVL.

3.5.4 *Balance*

If the electricity production of this level is reached the plant will show a deficit of approx. 10,000 LVL in 2011. This is not regarded as satisfactory.

3.6 Handling of the digestate

The digestate is utilised as fertiliser on the approx. 2,000 ha arable land operated by Vecauce.

Storage of the digestate is partly in the 4,000 m^3 storage tank adjacent to the biogas plant and partly in older lagoons. The storage tank at the biogas plant is a simple not covered steel storage tank and it is not provided with any mixing system. Before spreading the tank is mixed using tractor mounted mixers.

The digestate is spread using partly own small tankers, a larger tanker provided with hoses that is borrowed from a neighbouring farm and partly by using contractors.

The digested biomass is because of the very high dry matter input and insufficient digestion very difficult to mix, to pump to the tankers as well as to spread.

4 Assessment of the plant

4.1 Technical set up of the plant

The plant is made as a simple “German-type” maize/manure plant. The simplicity of the plant is advantageous because it limits the moving parts and therefore investment and operational costs.

In general the individual parts of the plant are functioning and can all be used in the future.

Because of the simplicity of the plant some parts that are not well functioning and can cause operational disadvantages.

These are:

- Insufficient insulation of the primary digester (walls only 80 mm insulation and no insulation in the double membrane on the top of the digester where digesters for the climate as in Latvia is recommended to be provided with 200 mm insulation and a fixed and insulated roof)
- Non-covered storage tank without possibility of collection of gas
- No chopping of the biomass, in particular grass silage before feeding into the digester
- Pumping system from the intake tank and the digester that can cause a risk of sedimentation of sand and smaller stones in these tanks
- Relative low conversion of organic material to gas in particular in winter because of limited size reduction of the biomass, relative small digester/limited retention time and a one-step process
- Insufficient gas purification in the biological purification probably because of limited surface in the digester and non-optimal conditions for the sulphur eating bacteria in the digester (the full mixed digester do not create best possible conditions for these bacteria)
- No heat accumulation tank meaning that there must be a correspondence between production and utilisation of heat
- Relative low heat efficiency on the engine because it is not provided with a low temperature heat exchanger for cooling the exhaust gas to approx. 70°C (the present cooling is to approx. 170°C)

4.2 Plant operation

4.2.1 Production of gas

As can be seen above the production of gas is 13-34% lower than the theoretical production of a one-step plant. Even though there are uncertainties in the way of - in particular - calculating the actual production the tendency is clear.

The main reason for this is consider being the relative high organic load of the digester. The organic load is highest in winter where the lowest relative production of biogas is observed.

The retention time and the organic load are estimated from the given input winter/summer:

	Retention Days	Org load kg VS/m3
Winter	34,7	4,3
Summer	34,6	2,7

As can be seen the retention time is relative equal over the year where as the organic load is much higher in winter than in summer due to the higher amount of organic dry matter (VS) in maize and particular in flour than in grass silage.

The retention time is short in a mesophilic one-step plant but is not regarded as critical short. The main difference between summer and winter operation is therefore the organic load of the digester. As it was seen above, the theoretical gas yield in relation to the calculated production shows that the conversion of organic material in the winter situation is lower in winter than in summer. We will explained the lower winter production to be caused by the higher organic load even if the load is not above critical limit of 4.5 kg VS/m3 digester that have been given from the German supplier.

Inhibition can be in the acid creation process and/or in the methane creation process. From the plant it is informed that the organic acid content in the digester is relatively low which indicated that the acid creation process is inhibited.

5 Specific problems

5.1 Located operational problems

During the plant visit and the meetings with the operational staff, the following was observed:

- Difficulty in handling other solid biomasses than silage in the intake system
- Foam problems when solid manure is added
- High heat demand in winter
- Huge problems in handling the digested biomass
- Difficulties in reaching gas production to operate the engine at full load/limitation in relation to retention time in digester
- Problems in keeping acceptable sulphur level in the gas when glycerine was used to raise gas production

5.1.1 Solid biomass handling

The solid biomass – the silage – that is used today can be handled in the system. The gas yield is too low which can be related to the short retention time/high organic load in relation to the mesophilic process and to the missing chopping of the biomass.

The process cannot handle more solid biomass in winter (e.g. solid manure) mainly because of overloading.

5.1.2 Foam problems when solid manure is added

It has been tried to add solid manure to the digester. This caused foam properly because of the high organic load in the digester and mechanical problem in relation to the mixing of the digester because the straw was not cut. Because of this the gas yield from the solid manure was limited. The solid manure is therefore not used today even if this is a “free of cost” biomass.

5.1.3 High heat demand in winter

The digester has a limited insulation causing a high demand for heat in particular in winter and hereby less heat available for the farm.

5.1.4 *Handling of digested biomass*

The digestate is very difficult to handle mainly because of high fibre content but also because the storage tank for digestate is not mixed. The digestate creates therefore a huge layer of fibre that have to be grabbed out of the tank and that is difficult to spread.

The main reason for the high amount of fibre is the high load of dry matter mainly in winter. Here is the input TS approx. 17%. Because of the relative bad digestion rate in winter only parts of the organic dry matter (VS) is broken down into biogas and therefore is the remaining dry matter in the digestate too high.

Besides the problems of handling high organic load there are problems related to the evaporation of nitrogen and inlet of rain water in a non-covered tank.

5.1.5 *Produce enough gas for full load operation of the engine*

The gas production is not high enough to operate the engine at maximum of the quota for sales of electricity. The main reason is that the digester gets overloaded if biomass for full gas production is added. In relation to operating the digester mesophilic as planned the digester volume is too small. Besides this there is no secondary digestion that could add biogas.

5.1.6 *Sulphur purification*

The gas is purified in the digester in a biological process where air is added to enable aerobic bacteria to take up H_2S. Besides this the gas is purified by adding iron chloride (FeCl) to the process. The iron binds the sulphur. As a last "polishing" of the gas an active carbon filter are used. The gas contains in normal operation using the input biomasses mentioned above approx. 500 – 600 ppm H_2S after purification which is relative high and can cause operational problems for the engine as well as demand for change of oil in the engine quit often causing operation costs. The reason for the high sulphur content must be an insufficient biological purification because of a relative small surface for the bacteria to operate on, and insufficient amount of FeCl added and that the active carbon filter have reached its capability to purify because it is saturated with sulphur.

It has been tried to add glycerine to the process to bust the gas production. Glycerine contains a relative high amount of sulphur and the present purification system has not been sufficient to treat the higher sulphur level in the gas.

Utilisation of FeCl for the purification is efficient but is regarded as a relative expensive method where the biological purification is low/no cost. The active carbon filter is fine for the end "polishing" of the gas but must not be used for purification of gas with relative high sulphur level.

The gas purification is therefore regarded as insufficient in relation to minimising the cost and to enable utilisation of sulphur-containing biomasses such as glycerine.

5.2 Possible problems not located visually but anticipated

The biomass contains non organic parts as sand and stones the can be fed into the digester.

Stones are located in the silage. Some of these are sorted out in the feeding systems but smaller stones can pass though. The main reason for stones in the silage is that a part of the silage is stored in field stacks in the bare ground.

The dairy manure normally contains sand and soil from the feedstuff eaten by the cows. The cows at the farm are normally indoors which means that the normal problem of cows taken soil into the stable when they are in loose housing systems is not present here.

The sand and stones is not taken out of the digester in the normal pumping routines from the digester to the storage tank because the out take pipe do not go to the bottom as well as it goes vertical up over the top of the tank and then down on the outer side of the tank. The present pumps do not have the capability to soak stones and sand this way.

There is a possibility to soak out from approx. 30-50 cm from the bottom using a vacuum tanker. This is done regularly but it is anticipated that there still will be some sedimentation. This is not a problem intrinsically but will reduce active volume and thereby shorten the retention time.

5.3 Located financial problems

The plant is at the present operating conditions not feasible for the owner.

The main reason is the located operational problems as seen above. Besides this the silage is a relative expensive biomass in relation to the rather low degree of utilisation.

The income from electricity is also too low because of limited amount of gas.

The operational costs of the engine are too high because it is operated in part-load mainly in the summer period. The operational costs are normally per operation hour independent on the production.

6 Optimisation of the plant

6.1 Possible improvements in relation to overcome the identified problems

In accordance with the list of located and anticipated problems on the plant the following action can be taken:

Optimising the production on the existing biogas plant:

- Coverage for gas extraction with integrated gas storage and insulation of the storage tank
- Improved H_2S purification

Optimising the handling of the digestate:

- Post treatment (separation) of digestate to ease handling
- Enlargement of storage capacity for the digestate

Enlargement of production of gas and supply of gas to the district heating:

- Biogas supply to the district heating plant
- Utilisation of alternative biomasses (pig manure, solid manure and possible waste products from the food industry)
- Installation of equipment for cutting straw etc. before entering
- Sanitation equipment that enables treatment of Cat. 3 waste to enable intake of this biomass
- Enlargement of the digester volume to improve digestion and enable additional biomass feedstock.
- Optimising of the intake system to ensure capacity and chopping of the biomass

Optimising of heat production

- If more heat demanded on the farm the heat production from the engine can be optimised by adding a low temperature heat exchanger (required H_2S content in the gas below 70 ppm).
- Installation of a heat accumulation tank to equalise the production and utilisation of the heat

6.1.1 *Optimising of operation on the existing plant*

Coverage and insulation of the storage tank

The biomass in the storage tank is at the moment has a high dry matter content. This is partly because of a low gas production as seen above due to short retention time in the digester in relation to type of biomass. It is therefore recommended to improve digestion by adding a secondary step of digestion in the storage tank. This can be made by providing the existing storage tank with a cover and insulation.

The cover can be made as a standard double membrane fixed to the edge of the tank. This will besides enabling collection of gas also enable enlarged storage and used of the tank for H_2S purification of the biogas. To use it for storage and purification all biogas produced must pass over the storage tank.

To keep temperature in the tank it is recommended to insulate it as well. This can be made as a traditional outside insulation covered with steel plates or as insulation with foam that are sprayed on the inside of the tank. The insulation will secure a temperature in the tank where the biogas process is still active as well as the H_2S purifying bacteria can function.

Besides the improved gas production and purification there will be no rain water coming into the tank and no evaporation of nitrogen go out of the tank.

Improved H_2S purification

It can be advantageous to improve the gas purification so that the engines can be operated with a low temperature heat exchanger. To do this the sulphur content must be below 70-80 ppm H_2S. The present purification is efficient but is partly based on adding FeCl which is rather costly. It is therefore recommended to add a biological purification in the existing storage tank when this is rebuilt to be a secondary digester as mentioned above. The purification will take place as today in the digester where atmospheric air is injected to enable aerobic bacteria to function on the surface of the digestate.

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If this cannot provide sufficient purification of the gas an external biological biogas purification filter can be added.

6.1.2 Optimising of handling of the digestate

Post treatment (separation) to ease handling of digestate

The digestate will be easier to handle by installing a separator that can divide fibre from the liquid before storage. The separation can be made either after the storage or before the storage. This will depend on the degree of digestion and the herby following handling of the digestate in the storage tank. It can be tested if the fibre contains residual gas which then can be recycled into the biogas plant.

When lagoons are used for storage it can be advantageous to separate the digestate to avoid mixing problems in the lagoons.

Enlarged storage capacity for digestate

To utilise the digestate as fertiliser in the optimal way it is recommended to enlarge the storage capacity for digestate by installing covered lagoons that can contain approx. 6-9 month production of digestate.

6.1.3 Enlargement of the biogas production and supply of gas to district heating

Enlarging the biogas production on the plant enables to continue the production of electricity and heat on the farm in accordance to the electricity production quota as well as transmission of biogas to a new engine installed on the district heating plant.

To enlarge the production more biomass as well as capacity is needed.

Alternative biomasses for the biogas production

The biogas production can be raised at the same time as costs for feedstock can be lowered by adding alternative biomasses to the plant. It has been the objective to locate biomasses which can be supplied for free to the plant.

Solid manure from the dairy farm

The Vecauce farm has a production of solid dairy manure from the heifers and the dry cows. This is not utilised in the biogas plant because the utilisation causes creation of foam and a very limited gas production.

It has from the farm been informed that the production of solid manure is 5-10 per day in summer and 10-12 t in winter. Here an average production of 9 t per day has been used for the estimate below.

The resource can be utilised in an enlarged plant where the necessary retention time as well as organic load can be achieved.

The production of solid manure and potential gas production in a two-step thermophilic plant is estimated to be:

	t/year	TS	%VS/TS	GVS	m3 CH4/y
Solid dairy manure	3.285	26%	80%	231	157.838

The gas production equals an average of 175 kW biogas that can produce approx. 63 kW electricity.

The digestion of the biomass will in a thermophilic digester with a retention time of 20 days require approx. 600 m^3 digester volume.

The handling of the solid manure requires feeding and chopping equipment. The existing feeder can be used for solid manure but have to be followed by a chopper.

Pig manure
Pig manure can be supplied from "PF Vecauce SIA Pig" stable located in approx. 2 km from the biogas plant. They produce approx. 10,000 – 12,000 t of pig manure per year with a dry matter on 3-7% TS.

The pig farm operates no land and the manure is taken for free by a local farmer.

The main challenge in relation to take this manure into the biogas plant is the transport. To minimise these costs and to make the transport as smooth and environmental friendly as possible it is recommended to pump the manure from the farm into the biogas plant. Because the pig farm does not operate any land this transport will be a one-way transport and can be made in one-string string simple pumping system that pumps the manure from a pumping well at the farm and into the reception tank at the biogas plant.

The pig manure has the following gas potential in a two-step biogas process:

	t/year	% TS	%VS/TS	GVS	m3 CH4/y
Pig manure	11.000	6%	80%	330	174.240

The production equal to an average of approx. 200 kW biogas that can produce approx. 71 kW electricity.

The digestion of the biomass will in a thermophilic digester with a retention time of 20 days require approx. 600 m^3 digester volumes.

Industrial residuals
The plant does not take in industrial residual at the moment but there are potential suppliers inside an acceptable distance from the biogas plant.

Potential suppliers can be:

Slaughterhouses:	Stomach content, intestines and other soft parts, blood, fat trap waste, flotation sludge etc.
Fish processing:	Heads, intestines, cuttings, flotation sludge etc.
Vegetable processing:	Residual vegetables, peels etc.
Biodiesel:	Glycerine

General food processing: Flotation sludge, fat trap waste, residual raw material, failure and over dated products

The animal based products except of stomach content must be sanitised at 70°C/1h in accordance to EU regulations.
Fish and vegetable residuals can be treated with no sanitation. Sanitation can be made in standard batch tanks. The heat required for the sanitation is fully reused when hot sanitised waste is mixed with cold incoming manure or other cold biomasses in the input system for the digesters.

There are at the moment no agreements with industrial suppliers of residuals but it is recommended to make such agreement as well as to rebuild the intake system at the biogas plant so that it is possible to handle these products.

The existing 144 m^3 reception tank for manure will be suitable for handling liquid residuals e.g. fat sludge. This tank can be heated and the products can therefore be kept liquid even if they have high dry matter/fat content. It can be necessary to add a feed in module for feeding in possible solid waste products into the tank.

Waste water treatment sludge
Waste water treatment sludge from municipal sewage can be treated in biogas plants. Normally most sludge is secondary sludge with a limited gas yield. This product is only of interest for the plant if it can be followed by a gate fee. If primary sludge and flotation/fat trap fat can be supplied this is of interest but requires sanitation.

Waste water treatment sludge including flotation sludge/fat trap fat is not included in the proposal below.

Enlargement of the digester volume
The digester volume is a limiting factor because it means a high organic load in particular in winter and herby following a relative low gas production. The possible organic load can be raised by raising the temperature in the digester.

The present digester insulation is insufficient (8 cm) and therefore it is not recommended to raise the process temperature to thermophilic level (50-54°C) because it will cause an increased heat loss.

The digester volume can be raised by transforming the storage tank into a digester that could be operated serial after the present digester. The rebuild of the tank into a digester requires insulation, mixing and cover. If the tank is not provided with heat a limited production in particular in winter can be anticipated because of a low temperature in the tank. The relative high dry matter that comes from the existing primary tank can also jeopardise the process because it requires substantial mixing capacity.

It can be seen that the primary digester is the limiting factor and it is therefore recommended to set up a new primary digester. This can be made as a thermophilic full mixed digester. The biomasses are suitable for thermophilic digestion and the faster and more efficient process means that the digester can be smaller than a mesophilic digester and hereby cheaper.

By installing a new thermophilic primary digester the existing digester can serve as a secondary digester that will operate on approx. 40-45°C.

The more efficient digestion and thus increased gas production mean a lower dry matter content in the digestate which will ease the handling.

Intake system
The growth of the amount of input manure (pig manure and solid dairy manure) will require an enlarged intake tank for manure.

For the intake of solid biomass it is recommended to add a system for chopping the biomass, which will provide an increased gas production as well as easier handling.

6.1.4 Optimising of heat production

The heat production can be extended by adding a low temperature heat exchanger that utilise the cooling of the exhaust gas from approx. 180°C to approx. 70°C. There will be no risk in relation to corrosion in operating this heat exchanger because the biogas has a very low content of sulphur.

The heat exchanger can add approx. 16-18% more heat.

The operation can possible be optimised by installing a heat accumulation tank that enables the engine to operate 100% load and start/stop without any impact on the supply of heat for the farm and the biogas plant.

A heat accumulation tank on approx. 50 m^3 will be sufficient. This can be made in a second hand tank that must be vertical mounted and insulated. Such a tank can store approx. 2.300 MWh equal to approx. 7 hours full load production on the engine.

7 Utilisation of heat or gas at the district heating plant in Auce

Vecauce operates a district heating scheme in the town supplying the castle owned by the university as well as the dwellings former belonging to the university now privatized.

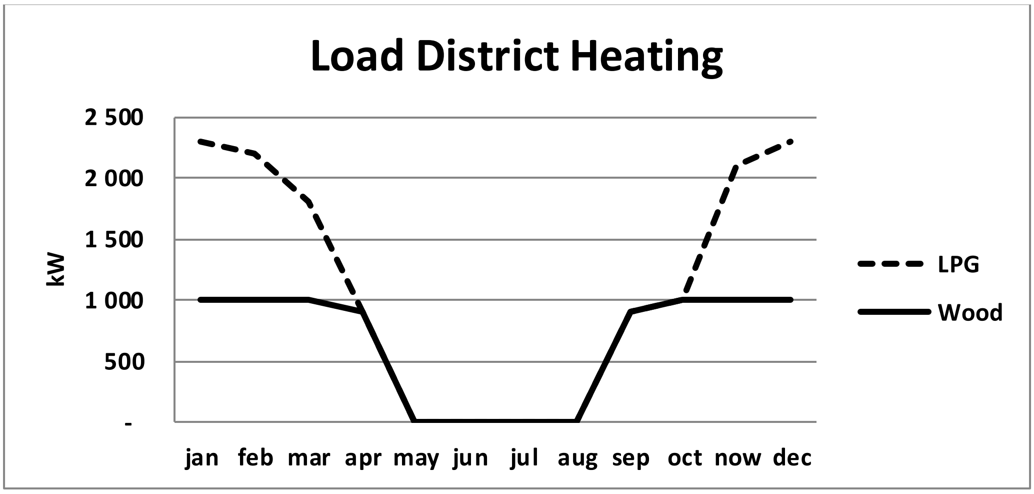
The district heating is heating approx. 25,000 m^2 and has a max winter peak supply of 2,3 – 2,5 MW and a summer load of 0 MW because it is chosen to cut supply in the four summer month due to difficulties in getting payment.

The boiler house is equipped with:

- Wood (wood stove Orion 1.3 MW)
- LPG gas (gas stove Buderus 1.6 MW)

The wood stove normally supply up to 1 MW. At higher demand the LPG gas burner tops up.

The yearly contribution of the heat production is shown in the figure below:



This contribution of the heat production means that approx. 60% of the heat is produced on wood and the rest – approx. 40% - is produced on LPG gas.

The fuel is purchased for:

Wood:	17 LVL/m^3 equal to approx. 0.008 LVLL/kWh at 2.08 MWh per m^3 wood
LPG (propane):	0.337 LVL/l equal to approx. 0.053 LVLL/kWh at 6.4 kWh per l

The yearly cost for fuel can be estimated to be approx.

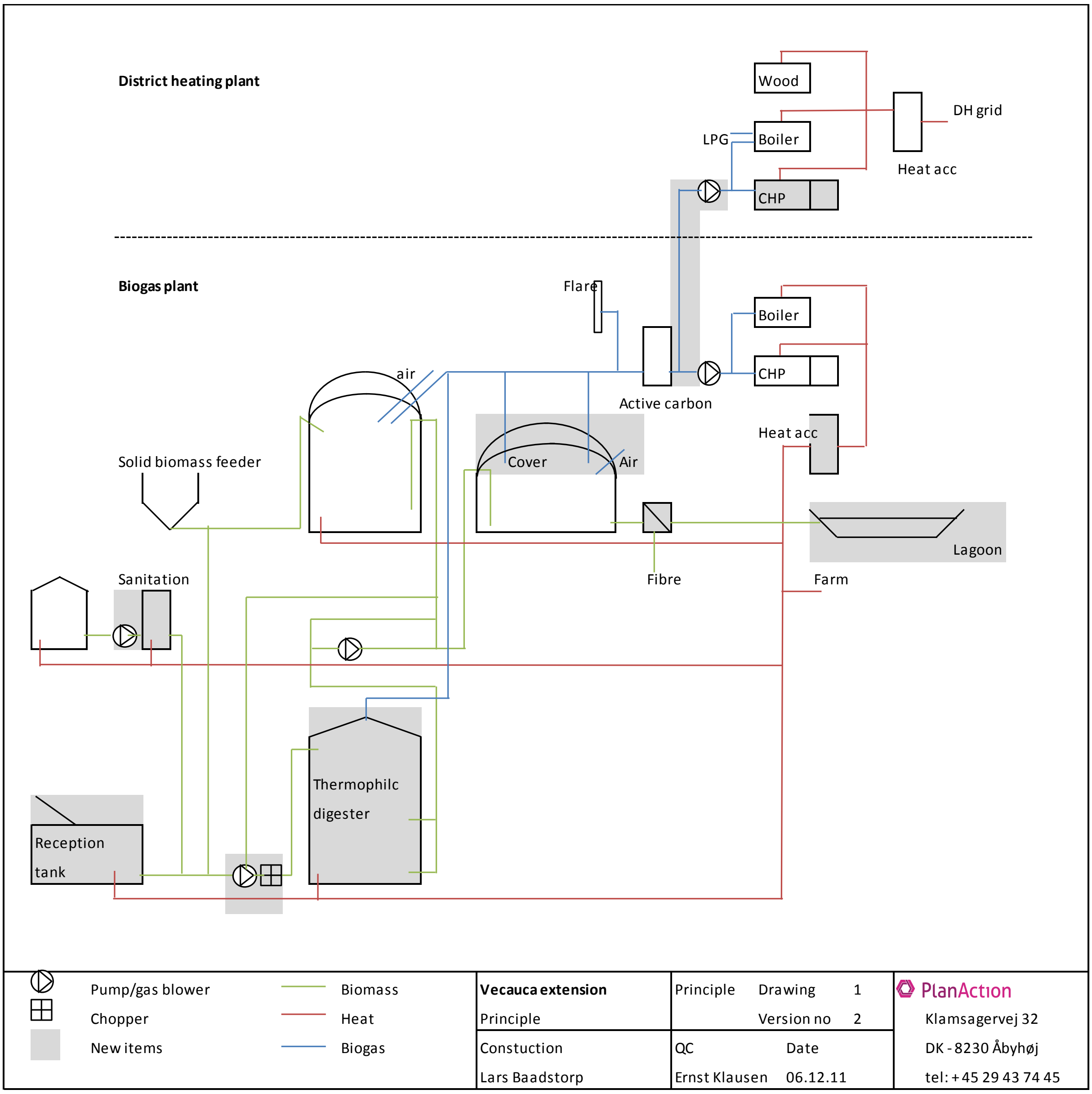
Fuel	Produced kWh	Efficiency in %	Input energy kWh	Price LVL/kWh	Fuel cost LVL/year
Wood	5.664.000	85%	6.663.529	0,008	53.308
LPG	3.302.400	95%	3.476.211	0,053	184.239
In total	8.966.400		10.139.740		237.547

8 The enlarged biogas plant

In accordance with the proposed changes above a full developed plant for treatment of all manure from the university farm (including the solid manure), the pig manure from the neighbouring farm as well as possible Cat 3 waste and the same amount for energy crops as today and supply heat for the farm and the district heating system an updated plant set up can be:

The proposal for the enlarged plant is shown is the drawing below where new parts are marked with light grey. Please mark that it is a principle drawing and that the existing plant is not drawn precisely as build as well as the drawing do not show all parts, valves etc.

The separator can be installed before the construction of the enlarged plant and be placed up front of the storage tank to solve the problems of mixing the storage tank.



The new primary digester is recommended to be constructed as a thermophilic digester. This enlarge the capability to handle an enlarged amount of organic dry matter so that the production can be enlarge and that the foam problems located when solid biomass was added to the present digester will not be present.

A new input system added on the existing system must contain a chopping devise (Vogelsang Rotocut, Muncher or similar). In the setup recommended all biomass will pass though this chopping devise.

The present digester will function as a secondary digester. It is not expected that it will be needed to add heat here but the possibility will be present.

The existing storage tank will after it is covered and possible insulated have more functions. There will still be a small gas production that can be extracted. Under the double membrane there will be a significant gas storage that will supplement the existing storage on top of the digester. Besides this adding a small quantity of air to the tank enables gas purification for H_2S.

8.1 Operation of the biogas plant after the enlargement

The manure will be supplied into the new reception tank from the farm as liquid and solid manure and by piping from the adjacent pig farm.

Possible waste products will be supplied from tankers into the existing reception tank. Silage will as today be fed into the dry feeing equipment.

The manure will be pumped through a chopper into the new thermophilic digester where it is heated to process temperature.

Waste will be pumped from the reception tank into the sanitising unit. Here is estimated an approx. 5 m^3 tank that can heat the material in 1½-2 hours and then the material is retained for 1 hour at 70^oC before it is pumped hot into the digester.

The maize is dosed though a new feeding equipment where it is mixed with hot digestate and then through a chopper into the thermophilic digester.

The primary digester is operated thermophilic (50-52^oC). The biomass is suitable for this digestion as well as the retention time and the organic load is not stressed so that a stable process can be expected (the retention time will be 25 – 35 days and the organic load 2.6 – 5.5 kg VS per m^3 digester)

From the thermophilic digester the biomass is pumped by the existing pumps to the existing digester that is used as a secondary digester. It is not expected to heat this digester because the input biomass is warm.

From the secondary digester the biomass is pumped into the storage now covered and mixed so it will function as a third step digestion as well as it can be used for gas purification and gas storage.

The gas is lead from the top of the primary and secondary digesters into the storage tank where there will be buffer storage of approx. 2,000 m^3 of biogas. Air will be added to provide purification.

From here the gas passes the active carbon filter and goes either for utilisation on site or is pumped into the district heating plant for utilisation.

The digestate can be pumped from the storage tank into the covered storage lagoons. It is anticipated that these are located between the biogas plant and the pig farm.

8.2 Biogas production after enlargement

The biogas production will after the enlargement of the plant, be based on manure, waste products and energy crops. The following average monthly input of biomass is assumed:

t/month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Manure (8% TS)	1.116	1.008	1.116	-	-	-	-	-	-	1.116	1.080	1.116	6.552
Manure (6% TS)	-	-	-	1.200	1.240	1.200	1.240	1.240	1.200	-	-	-	7.320
Solid manure	341	308	341	225	233	225	233	233	225	341	330	341	3.375
Pig manure	934	844	934	904	934	904	934	934	904	934	904	934	11.000
Maize silage	620	560	310	-	-	-	-	-	-	-	600	620	2.710
Grass silage	186	168	434	120	-	-	-	-	390	558	180	186	2.222
Organic waste	465	420	465	450	465	450	465	465	450	465	450	465	5.475
Flour	-	-	-	-	-	-	-	-	-	-	-	-	-
Total t/month	3.662	3.308	3.600	2.899	2.872	2.779	2.872	2.872	3.169	3.414	3.544	3.662	38.654

This will provide the following production:

Input biomass	t/year	% TS	VS/TS	t VS	GVS	m3 CH4/y
Manure (8% TS)	6.552	8%	80%	419	210	88.059
Manure (6% TS)	7.320	6%	80%	351	210	73.786
Solid manure	3.375	25%	80%	675	210	141.729
Pig manure	11.000	6%	80%	528	300	158.400
Maize silage	2.710	33%	95%	850	350	297.355
Grass silage	2.222	25%	90%	500	320	159.984
Organic waste	5.475	22%	90%	1.084	380	411.939
Flour	-	95%	100%	0	400	-
In total primary digester	38.654			4.407		1.331.251
Added in secondary digester	10%					133.125
Total production						1.464.376

This production will be slightly over the production needed to supply the CHP on the farm as well as a new CHP at the district heating.

It must be marked that there is no specific agreements on the supply of organic waste products. Here it is assumed that this is mixed slaughterhouse waste but other Cat 3 wastes or waste outside category (vegetable waste) can be utilised.

It is recommended to continue the process started by the University in locating the waste products and closing agreements on these possible waste supplies. If more waste can be supplied the input of maize and other energy crops can be reduced.

8.2.1 Production of digestate

From the input biomasses mentioned above there will be produced approx. 35,000 t of digestate. It is estimated that the digestate will have TS content on approx. 5.1%.

If the digestate is separated in a simple mechanical separator it can be separated into:

Digestate	t/y	TS	t TS
Input	35.364	5,1%	1.812
Fibre fraction	3.374	30,0%	1.012
Liquid fertiliser	31.990	2,5%	800

The liquid fraction can be stored in lagoons while the fibre fraction can mature as compost in building.

To utilise the digestate optimally it is necessary to store it so it can be utilised when the crops can take up the nutrients. This is mainly in the spring and in the beginning of the growth period but some crops also need fertiliser in the autumn. It is therefore recommended to install lagoons for storage for at a minimum 6 month (to enable storage of digestate from September to March. This requires approx. 16,000 m^3 storage facilities e.g. made as covered lagoon. Besides this there will be some storage capacity in the storage tank on site.

The composition of the digestate will depend on the actual composition of the input biomass. Based on Danish standard figures for the input biomasses following content of the digestate can be estimated:

Nutrient content digestate (kg/t)		
kg N/t	kg P/t	kg K/t
5,9	1,0	4,1
NH4-n		
5,0		
Total amount of nutrients (t/y)		
N	P	K
209	36	146

Compared with the present figures these differ mainly in relation to:

- Total nitrogen: Measured to be 2.7 kg/t biomass
- NH4-n: Measured to be 1.0 kg/t biomass

The reason for the lower content in the existing digestate can be a low content of nitrogen in the input maize. The low ratio of ammonia can be because of relative poor digestion as it has been discussed above.

The total amount of digestate after enlargement will contain approx. 209 t N. This can full fertilise approx. 1.250 ha equal to approx. 70% of the entire farm land operated by Vecauce.

8.3 Development of the district heating plant

It is assumed that part of the biogas production is piped into the district heating plant where an additional CHP unit approx. 500 kW electric/665 kW heat is installed. It is assumed that this engine as well as the engine on the biogas plant operates full speed in the winter, spring and autumn periods but on lower speed in the summer. To enable this operation strategy it is necessary that the maize silage is mainly used in the summer period. This operation strategy still enables the engine on the biogas plant to fulfil the electricity production quota.

The new engine on the district heating plant will supply the base load for the heat supply. Because heat is available all year it is assumed that the district heating supply is maintained in summer. If heat exchangers for the production of hot water in the houses is installed all heat demand can then be covered by district heating.

The existing wood boiler is assumed utilised for middle load.

For the peak load it is assumed that biogas is used in the existing boiler/new burner instead of LPG so that all LPG can be subsidised by biogas based heating.

9 Economic impacts

9.1 Investment

The investment in the improvements and enlargement mentioned above has been budgeted. For the main items offers have been taken in from potential suppliers. For mounting, piping etc. estimated have been used. The expenditures for consultancy are an estimated cost. It is assumed that the parts is purchased individual and combines in accordance to specifications from the consultant and that the plant management at Vecauce themselves takes care of supervision during the construction period. For unforeseeable expenditures 7.5% of the estimated cost has been added. Please mark that possible expenditures for approvals etc. are not included.

All figures are in LVL.

Optimisation and extension of the Vecauce Biogas plant	
Optimising the production on the existing biogas plant:	LVL
Cover/gas storage on storage tank	96.000
Insulation of storage tank	64.000
Mixers for storage tank	15.000
Consultancy	4.000
In total	179.000
Optimising the handling of the digestate:	LVL
Lagoon	202.000
Manure pumping pipe incl pump	32.000
Separator	25.000
Consultancy	4.000
In total	263.000
Enlargement of production/supply of gas to the district heating:	LVL
Basc desing extended plant	20.000
Reception tank (manure)	49.000
Manure piping from pig farm	32.000
Sanitation tank (Cat 3 waste)	44.000
Intake system solid biomass/chopper	17.000
New thermophilic 3000 m3 digester	306.000
Expansion of control system /metering equipment	20.000
Mounting	15.000
Piping	15.000
Manure piping from pig farm	32.000
Gas piping biogas to district heating	27.000
Gas blower	5.000
Biogas burner existing boiler district heating	5.000
Gas engine for district heating plant	264.000
Piping, control systeme etc on district heating	25.000
Consulting detailed design, purchase, supervision	50.000
Unforseenable	79.000
In total	1.005.000
Optimising of heat production	LVL
Low temeprature heat exchanger on biogas plant	30.000
Heat accumulation tank on farm	15.000
Consultancy	4.000
In total	49.000

Total investment rebuilding/expansion	**1.496.000**

It is recommended to split the investment in two phases:

Phase 1: The optimisation of the production on the existing plant and the optimisation of the handling of the digestate. These are relative simple investments that will raise gas production, provide a cleaner gas as well as solve the problem in the handling of the digestate and improve the utilisation of the digestate as fertiliser and the environmental impact of the project. It is recommended to include basic design for the extended plant in this first phase.

Phase 2: Enlargement of the plant and installation of the biogas CHP and boiler on the district heating plant

Budget for the two phases:

Phase	LVL
Phase 1	462.000
Phase 2	1.034.000
In total	1.496.000

It has been the aim of this feasibility study to assess and optimise the biogas installation. Anyway there is potential for saving and environmentally improve the district heating by optimising the system and the heat supply for the university castle in Auce. It is recommended to make a feasibility study for the district heating system for locating the potential savings, necessary investments and the impact on the heat supply.

9.2 Financing

The investments can be financed by a mix of grant and loan.

The loans can e.g. be made by:

- Traditional loans in local banks based on the feasibility of the project
- Nordic Investment Bank
- Nordic Project Export Fund (Nopef)
- Local banks based on Danish export guarantees

Possible grants can be from EU such as next phase Baltic Compass (2013) or national grants. Please mark that the feasibility calculation below is based on 100% loan finance.

To reduce direct investment and hereby the demand for bank loan it is recommended to investigate the possibilities of leasing of the CHP unit for the district heating.

9.3 Economic impact

The economic impact of the investment above has been estimated.

The main additional income will be provided based on the enlargement of the biogas plant and the use of biogas on the district heating plant. The first phase is necessary because it solves the present digestate handling problems as well as creates the basis for the enlargement.

It has been assumed that the district heating system has the same sales prices as today as well as the “summer heat” is not charged.

The total income from the expanded plant and expenditures has been estimated based on the given figures for electricity sales, heat sales etc. and for operation expenditures. Please mark that this is a marginal approach and that the existing income from production of electricity and heat is not included and will still continue as usual.

There is no cost for manure included in the budget besides the costs for pumping the pig manure because it is assumed that the pig manure is supplied for free as well as the handling of the solid manure do not add significant costs in relation to the present handling.

The scheme only includes operation costs and income and no financial costs and depreciation.

Income after extension of the plant/CHP on district heating	**LVL/year**
Electricty production District Heaing Plant	407.000
Expanded electricy production on the farm	31.000
Saved LPG on District Heaing	184.000
Saved wood on District Heating	18.000
Value of the fertiliser minus spreading costs	57.000
Total income	696.000
Expanded operation costs:	
Electricity on the biogas plant	12.000
O&M cost on extended biogas plant	12.000
O&M CHP on district heating plant	29.000
Other costs	10.000
Total estimated costs	**63.000**
Net result	**634.000**
Total investment	1.496.000
Simple payback period	**2,4**

As it can be seen the estimated surplus after the extension of the plant is approx. LVL 636,000 per year. This equals a simple payback of the entire investment exclusive possible grants on approx. 2.4 years.

The investment in the optimised digestate handling is not a direct investment in improved energy production but is regarded necessary for the further improvement as well as this will provide savings in the handling of the digestate (mixing the digester tank as well as taking solid material out of the tank), lower spreading costs and possible a higher utilisation of the nitrogen in the digestate.

If the investment is financed by a 10 year serial loan, 7% pa in interest rate.

A simple 10 year business plan for the extension under these conditions is:

BALTIC COMPASS Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument) Baltic Sea Region Programme 2007-2013

Business plan In 1000 LVL	Marginal impact for extension of				2% inflation 8% interest rate and cost of loan 10 year serial loan					
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Income	696	710	724	739	753	768	784	799	815	832
Expenditures	63	64	66	67	68	70	71	72	74	75
Primary result	633	646	659	672	685	699	713	727	742	756
Finance costs										
Pay back	150	150	150	150	150	150	150	150	150	150
Interest rate	120	108	96	84	72	60	48	36	24	12
Total finance cost	269	257	245	233	221	209	197	186	174	162
Yearly marginal result	**364**	**388**	**413**	**438**	**464**	**489**	**515**	**542**	**568**	**595**

As can be seen there will be a yearly surplus on 360 – 600,000 LVL per year. Even if part of this surplus will be used for a reduction of the heat price but even then there will be a substantial benefit in the extension of the plant.

When the investment is paid back a higher income will be created as well as there will be a possibility for lowering the heat costs for the university as well as for the other consumers connected to the grid.

Besides this there is potential income/savings from:

- Reduced consumption of FeCl for purification of gas
- Possible heat sales in the summer period
- Gate fee from waste treated on the plant

The investment is therefore very feasible and it is recommended to realise the extension.

9.4 Priorities

The main problem on the plant is that the biogas production is too low and that the digestate is too difficult to handle.

- It is therefore recommended as first priority to provide the storage tank with a double gas dense membrane, insulation and mixer so it can be made into a secondary digester. The tanks can still be used partly as storage but it will be advantageous to install new lagoons for storage and a separator for easing the handling of the digestate. It is recommended to coordinate the installation of the lagoon with the demand for storage in relation to the field operation on the farm. This is all known technology that can be purchased as standard products and can be made relative cheap as well as construction time will be relative short.

- Second priority must be to install the enlarged plant by installing a new digester including intake system for more manure as described above. Until the rebuilding of the district heating plant is made the extended digester volume can be used to enlarge the amount of manure and adjust the use of silage to a level that ensures 100% utilisation of the electricity production quota. This will extend the income from electricity as well as reduce costs for maize. The digestate will contain less dry matter and easy handling.

- Hereafter the improvement in the heating system on the biogas plant can be made as third priority

The priorities investment plan will then be:

Priority	Item	LVL
1	Optimised production on existing plant	179.000
2	Optimised handling of digestate	263.000
3	Enlargement/rebuilding district heaing	1.005.000
4	Optimised heat production	49.000
		1.496.000

10 Environmental impacts

10.1 Nutrients

The digestion and the separation enable a higher utilisation of the N in the manure as well as nutrients in the waste as high quality fertiliser.

The enlarged biogas plant will treat solid manure and pig manure not treated today. Assuming an utilisation of the N in this manure on 30% in the solid biomass and 50% utilisation of the N in the digestate the utilisation now and after extension of the plant will be:

Utilisation of N i manure				
Now	t N/year	Utilisation	Utilised t N/y	Lost t N/y
Solid manure	21,6	30%	6,5	15,1
Pig manure	74,8	50%	37,4	37,4
In total now	96,4	46%	43,9	52,5
After digestion	t N/year	Utilisation	Utilised t N/y	Lost t N/y
Solid manure	21,6	80%	17,3	4,3
Pig manure	74,8	80%	59,8	15,0
In total after digestion	96,4	80%	77,1	19,3
Saved leakage to enviroment				**33,2**

The digestion of the manure will save the environment for a leakage of nitrogen from the manure on approx. 33.2 t per year.

If possible waste products today are spread on farmland the digestion will provide a similar better utilisation of the nutrients in the waste.

10.2 Greenhouse gasses

The enlarged biogas plant will reduce the greenhouse gas emission from:

- Reduced CO_2 from substituting LPG
- Reduced CO_2 from substituting electricity produced from fossil fuel (natural gas)
- Reducing methane outlet from the solid manure and pig manure storage
- Reduced production of chemical fertiliser

These have been estimated to provide a yearly reduction of near to 4,800 CO_2 equivalents as calculated below:

CO2 reduction						
Electricity production	3.615	MWh/y	0,159 t CO2/MWh		575	t CO2/y
Supsidising LPG	3.476	MWh/y	0,24 t CO2/MWh		834	t CO2/y
Reduced CH4 emission	154	t CH4	20 times CO2		3.085	t CO2/y
Reduced CO2 from fertiliser	109.000	kg nutrients	2,6 kg CO2/kg nutrients		283	t CO2/y
Total reduced CO2 emission					**4.777**	**t CO2/y**
Reduced CH4 emission is estimated to be 30% of the methane production from biomass not digested today						

This equals approx. 1,440 citizens in Latvia becomes CO_2 neutral assuming a CO_2 outlet on 3.32 kg CO_2 per year per citizen of Latvia.

Please mark that the calculation of the CO_2 impact on the fertiliser saving can vary in accordance with the baseline emission on the production of the nutrients. Here figures from Kongshaug (1998)[1] assuming that the CO_2 emission from production of NP and K is 2.6 kg CO_2/kg nutrient is used.
Beside this there will be a saving of nitrogenous gasses from spreading of raw manure and possible industrial waste on the farm land.

11 Recommendations and action plan

It is recommended to implement the changes as mentioned above.

The enlargement of the plant is very feasible. It is therefore recommended to start this by installing the new digester and intake system and then hereafter install the CHP on the district heating plant (2012)

The improvement of the digestate handling can be made in 2013.

Because the project involve more parties, that there is a substantial knowhow on biogas build up by the operational staff on site as well as the extension has to be built into an existing plant it is recommended that Vecauce cooperates with a consultant and then purchase the parts themselves from individual contractors that sets up the parts.

To design and organise the purchase, implementation and commissioning of the parts/the extended plant it is recommended that Vecauce hire a consultant to provide this job.

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[1] Kongshaug, G. 1998. Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. IFA Technical Conference, Marrakech, Morocco, 28,September-1 October, 1998, 18pp.

11.1 Action plan

Start 2012:	Decision to start the development process in accordance to this study
	Agreement with consultant to provide project, purchase etc. for the implementation of optimisation, the new digester and intake as well as rebuilding on the district heating plant
	Explorations of finance for the first phase (loan, loan guarantees)
	Application for permission for the new digester and intake
	Application for permission for new CHP on the district heating plant
	Close finance optimisation, enlargement of digester and intake as well as rebuilding on the district heating plant
Mid 2012:	Implementation of the membrane and the insulation on the storage tank
	Implementation of the separator and lagoon
	Tender on the digester, intake system etc. for the enlargement of the bi ogas plant
	Tender on the rebuilding/engine on the district heating plant
	Implementation of the new digester and intake
End 2012:	Operation on the enlarged biogas plant
Start 2013:	Start operation on the CHP on the district heating plant
	Financing of the lagoons
Mid 2013:	Installation of the improved digestate handling
End 2013:	Improvement on the CHP at the biogas plant

The extended plant can be in commercial operation from end 2012/start 2013 if the permissions, finance etc. makes it possible to start construction at the latest May 2012. The improved digestate handling will be in place end 2013.

Baltic Compass

Baltic COMPASS promotes sustainable agriculture in the Baltic Sea region. The region's 90 million inhabitants anticipate both high quality food produced in the region and a healthy environment, including a cleaner Baltic Sea. Baltic Compass looks for innovative solutions needed for the future of the region and its agriculture, environment and business.

Baltic Compass has a wide approach to the agri-environmental challenges, covering agricultural best practices, investment support and technologies, water assessment and scenarios, and policy and governance issues.

Baltic Compass is financed by the European Union as a strategic project for its support to investments and policy adaptation. The 22 partners represent national authorities, interest organizations, scientific institutes and innovation centres from the Baltic Sea Region countries. Baltic Compass is a three year project running until December 2012.

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