Project: BiG>East
(EIE/07/214)

Biogas Show Cases in the target region of Romania

Deliverable D 6.4

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Executive summary

Both selected sites for the show cases are located in one of the reaches areas in Romania in terms of overall biomass production.

Description of the selected regions for potential Biogas Sites

All of the sites selected for the case studies are coming from the reaches biomass regions of Romania. Site 1 (Sahateni) and 2 (Dulbanu) are located also in areas of high density of energetic crops but also with good potential in agricultural primary production wastes and wastes from secondary production.

Site selection was done starting with the selection of the interested developers, based on the biomass potential of proposed location. The peculiarities of those sites were compared against results from 2.3 and 2.4 Tasks Reports and integrated with the data about site vicinity and infrastructure as well as with the potential for energy utilization (both as heat and electricity).

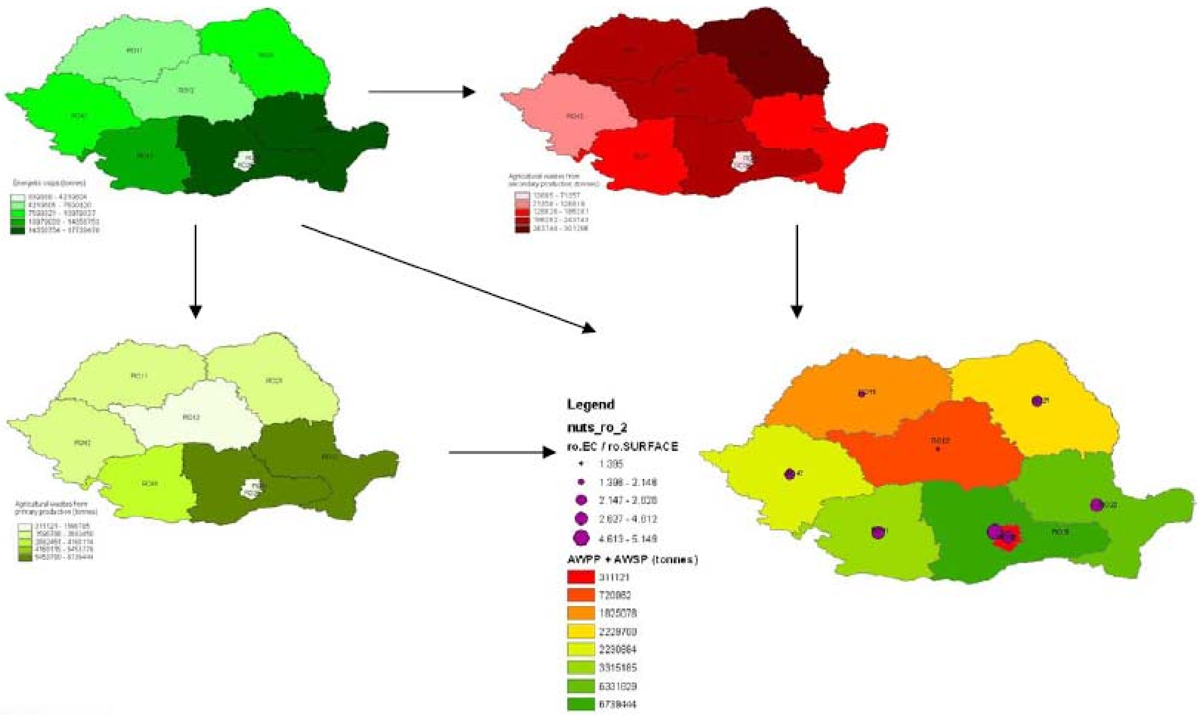

Figure 1 – Site selection considering biomass potential in the areas.

Show case 1 - Sahateni (~ 0,64 million m^3 biogas/year)

Site 1:

This site is located in the Buzau district, 110 Km North-East from Bucharest, in an area predominately agricultural. The biogas plant will be integrated with a biodiesel plant (oleaginous seeds pressing, extraction, and oil filtering as well as biodiesel production equipment). The biodiesel production is estimated at about 2000 l/day. The total surface for the facility is estimated at about 8000 m^3. Main feedstock will be rapeseed and sunflower cakes from pressing facility, glycerol, maize straw and other vegetal agricultural waste matter. D 6.1 methodology was used to asses the potential of the agricultural area in terms of distance from the plant and also to asses the heat/electricity consume in the area. Nearby village is a good opportunity to sell the heat in the winters and power on regularly basis (offering in this respect possibilities to develop a local district heat network, eventually based on regional development programs and structural funds). In the same time the capacity of the plant could be increased accordingly if proven economical in order to increase the heat and electrical energy capacity. It is expected that the total capacity of the plant to be upgraded up to 5 times the estimated capacity (0,7 mil*m^{-3}*year^{-1}). Technology used:

1. Co-digestion of feedstock in 2 stages i) thermophilic digestion at 50-52 C ii) lower temperature digestion at 40-45 C;
2. The estimated capacity is estimated at 199kWh/h (50%) and a heat production of about 163 kWh/h/year (40%). The heat will be used mainly for the process and about 40-50 % will be sold to the local community for heating.

The table below summarises the basic data and financial assumptions applied for the needs of the assessment and calculation of the economic forecast and the main results. Using the template provided in Big East project the following data have been generated:

Investment Cost: Sahateni	**Euro**
Total Financial Demand	-448.857 €
Profit and Loss: Sahateni	
Economic Yield from Plant Operation	
Yield from electricity sale	162.806€
Yield from heat sale	41.799 €
Total economic value	**204605**
Plant working costs	
General Busines Cost	- 72.457 €
Biomass purchase	-12.799 €
Purchase of electric energy	-3.799 €
Discharge of sludge	0 €

Earnings before Interest	119.349 €
Internal Return Rate (IRR)	10.00 %
Capital Cost	-59.825 €
Total Earnings	59.524 €

Show case 2: Dulbanu (~ 0,50 millions m^3 biogas/year)

The second site identified site is located close to the first one, in the district of Buzau, being an agricultural research and production facility of Romanian Agricultural Sciences Academy. The farm has a 600 ha property and a cow farm (80 heads and growing) situated in a 3 ha agricultural complex. The facility has research laboratories and staff and is developing a program for integrated farm production, being the perfect location for a small biogas pilot plant for research and demonstration purposes. The raw material (cow manure) will be supplemented with maize and cereal straw. Cow farm, the greenhouse and plans to have chicken/turn-key farm with incubator, assure the use of the heat during winter and requires that a significant part of the heat generated during wither to be use for the own purposes. The same is with the generated power. For this site it is expected that the electricity to be around 123 kwh/h and generated heat around 148 kwh/h. Exceeding heat will not be used in the first step during the hot season, and the electricity could be sold to national grid. The same technology will be used for this site as well as for the previous one due especially to their capacity and raw materials requirements. The table 2 summarises the basic data as well as the financial assumptions applied for the economic forecast. Using the template provided in Big East project the following data have been generated:

Investment Cost *: Dulbanu	**Euro**
Total Financial Demand	-350.000 €
Profit and Loss: Dulbanu	
Economic Yield from Plant Operation	
Yield from electricity sale	126.081€
Yield from heat sale	32.370 €
Total economic value	**158451**
Plant working costs	
General Busines Cost	- 67.563 €
Biomass purchase	-15.442 €
Purchase of electric energy	-2.942 €
Discharge of sludge	0 €
Earnings before Interest	75.446 €
Internal Return Rate (IRR)	11.47 %
Capital Cost	-49.221 €
Total Earnings	26.225 €

1. Biogas Show Case: Sahateni

1.1. Basic plant design

Site 1 was chosen as potential location for a biogas plant based on the agricultural wastes and rapeseed/sunflower cakes a biodiesel plant developed on the same location. It is in fact a well developed farm site integrating energy sources at local scale. It is a step ahead on the integration of different technologies from integrated farm production and energy production. With a biodiesel facility of 2000 l/day biodiesel, counting on a feedstock for biogas of approximately 1350 t/year rapeseed cakes from the biodiesel plant and a minimum of 1800 t/year maize silage as well as 150 t/year oil residues and other vegetal agricultural waste matter. Supplementary raw material is to be considered as being the technical glycerol from the biodiesel factory.

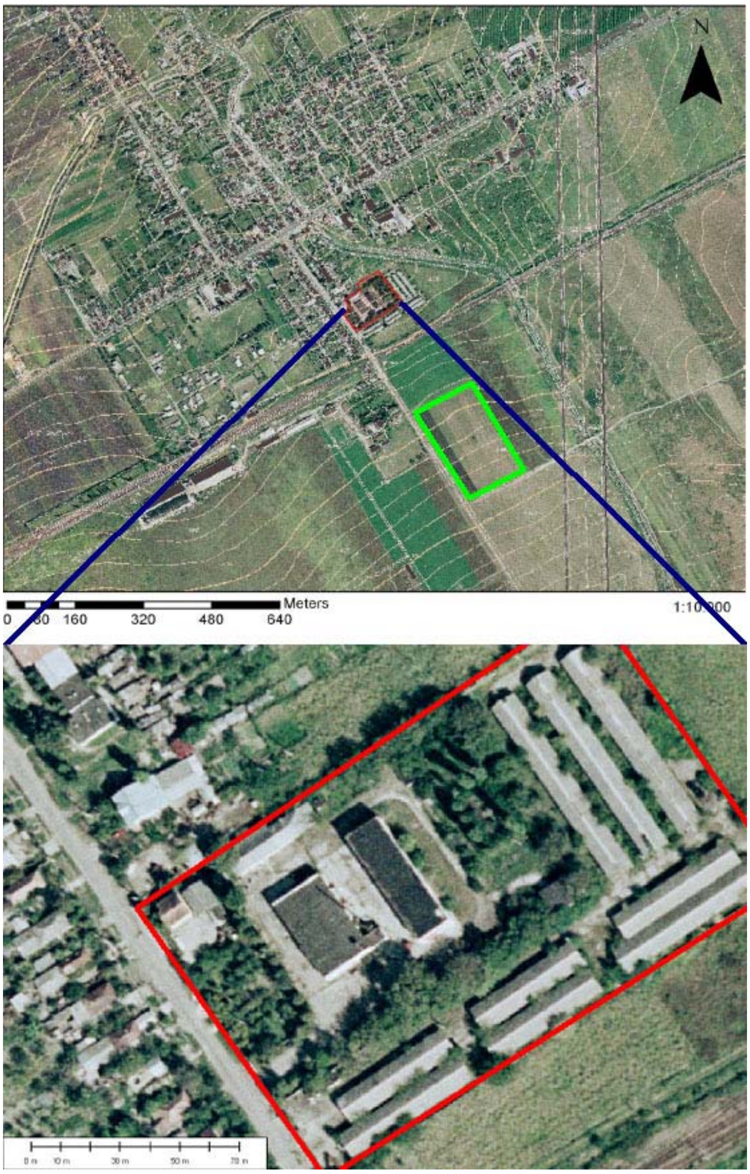

Figure 2 Geographical location of site 1 – Sahateni

Biogas Site 1: *Sahateni*

Situated in the Sub-Carpathian plane of Buzau, close to Buzau river, Sahateni is an agricultural area proper for maize and cereals. The main spaces for the development of the biodiesel and biogas facility are presented in figure . The biodiesel facility (red), the available area for the biogas plant (light green), as well as the details for the biodiesel facility are presented in the same figure.

The facility has access to a national road and is 200 m far from a main railroad with station 2 km to East.

Biogas, compost and liquid fertilizer generation and use

The facility has an estimated capacity of 645000 m3/year. Half of this is utilized for the electricity production using a gas engine and the electricity is then sold (as green energy) to the market. The heat generated in the process is used in the farm (heating different facilities) as well as for the local community purposes.

An electricity production of approx. 1719 MWh e per year can be expected. The heat generation is expected as being 1408 MWh.

Besides heat and power generation the biogas facility is also producing 2 tones/day of compost (almost 730t/year) as well as 1825 t/year liquid fertilizer. This poses no problem for the total farm surface of 600 hectares in relation with Nitrogen retention. The fertilizer was not taken into consideration when the cost analysis was done. With a cost of about 10-15 euro/tone of liquid fertilizer the total earnings of the facility could increase by almost 30000 euro/year.

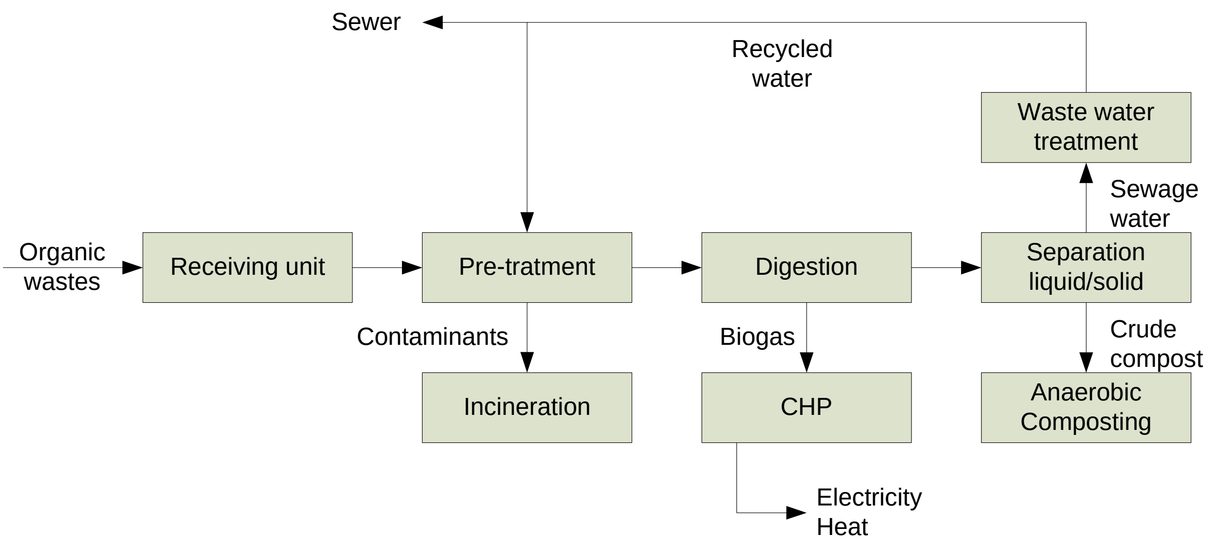

Figure 2. Block diagram showing the overall production process at Sahateni site

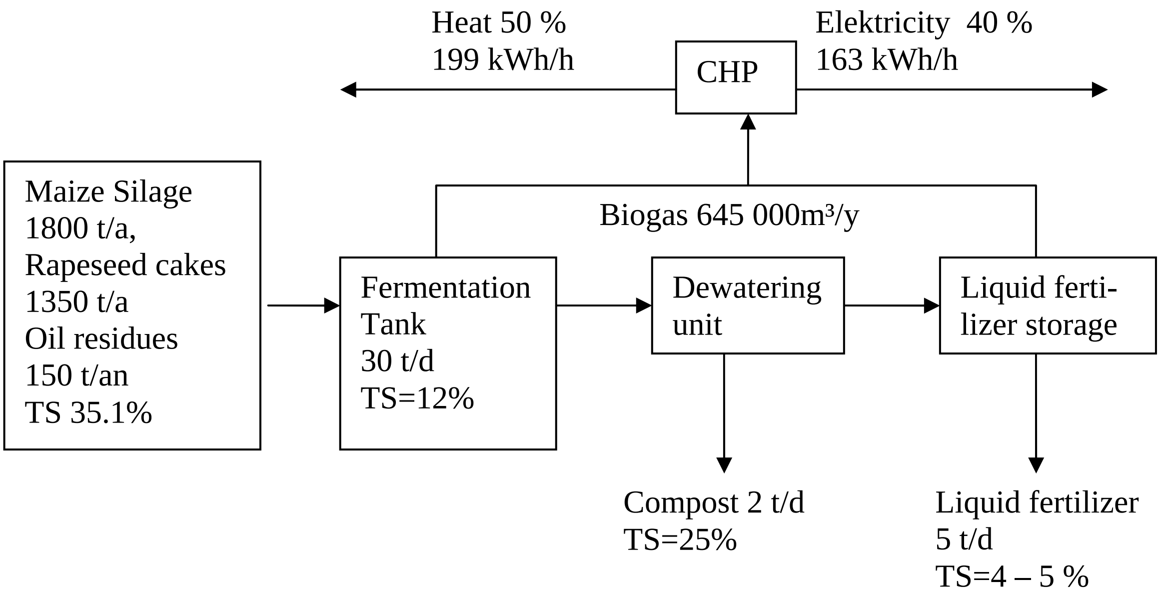

Figure 3. Block diagram showing the mass balance for the biogas plant - Sahateni

1.2. Technology Specifications

We assumed that mainly maize silage and rapeseed cakes as well as very high methane content of oil residues will be used for methane generation. The wet technology will be used for generation of biogas and we will use (but this is still subject of discussions) a cylindrical plug-flow digester (concrete) for high solid content digestion and a second digester with tarpaulin for the second phase.

Overall plant set up

The maize silage is transported to the biogas facility. This will be done by using the farm transporters.

By an estimated retention time of approx. 20 days in the primary digesters the volume of the primary digesters will be approx. 600 m3. This first digester will have a concrete structure.
The secondary digesters will be made also from concrete with a tarpaulin membrane. The retention time will be even greater than in the primary digester. Because the digested liquid will be used as fertilizer is a storage tank of about 300t will be also constructed.

1.3. Economical specifications

Based on the previous assumptions and the technological solution presented above we have estimated both the investment costs as well as the profit and loss for the facility. The tool used for the economic specification is the one made available by the BIG East project (http://www.big-east.eu). We have to mention that not all cost has been taken into consideration as well as not all the benefits (like the benefits coming from selling the liquid fertilizer, estimated at about 27000 euro.

Being a small facility the investment cost is not very high.

Investment Cost: Sahateni	**Euro**	*Comments*
Construction / Buldings / Earth works	-148.000 €	*Incl. VAT and delivery*
Machinery	-96.000 €	*Incl. VAT and delivery*
Electrical equipment	-45.000 €	*Incl. VAT and delivery*
Planning and site supervision	-25.000 €	
CHP and grid access	-102.857 €	*Incl. VAT and delivery*
Others	-32.000 €	*7 %, being 3 E/t = control of the biological parameters (considering that the substrate is not appropriate for self-sustainability of the anaerobical fermentation process).*
Liquid assets	-50.000 €	
Total Financial Demand	-448.857 €	

We have being using only one single scenario, based on the biogas utilisation for heat and power generation.

Profit and Loss: Sahateni	**Euro**	*Comments*
Economic Yield from Plant Operation		
Yield from electricity sale	162.806€	
Yield from heat sale	41.799 €	
Plant working costs		
General Busines Cost	- 72.457 €	
Biomass purchase	-12.799 €	*Maize silage was calculated at 5 E/t, being the costs for cultivation, crop and transport (the shareholder owns the land for crop).*
Purchase of electric energy	-3.799 €	
Discharge of sludge	0 €	*Used on the owner land or taken by the farmers*
Earnings before Interest	119.349 €	
Internal Return Rate (IRR)	10.00 %	
Capital Cost	-59.825 €	

Total Earnings	59.524 €	

1.4. Organizational structure

The owner of the plant is private investor (Navigal Impex SRL) but also other investors could be attracted for this. Also a Public Private Partnership (PPPs) could be taken into consideration. In order to take full advantage on the Romanian legal framework as well as on the financial one we are confident that a private investor (including all the financial schemes) is the best solution for this period. The use of financial support through structural (EU) funds is also highly recommended.

Project definition, accessing the financial resources and construction

Due to the fact the concept as well as the pre-feasibility study was realized (this document) it is a need for the following steps: i) feasibility study, ii) project development for structural funds, iii) technical project and detailed technical project (this phase is requiring also all the permits including the environmental ones), and vi) construction phase. For the construction phase it is assumed that either local or EU expertise to be used. For this a tender will nevertheless be organized in full agreement with the EU regulations.

1.5. Risk management

On all of the above phase’s different risk are involved from changes in the private investor intentions up to not obtaining the environmental permits. We do not foresee any problems with the biomass used for fermentation.

2. Biogas Show Case: Dulbanu

The second site identified site is located close to the first one, in the district of Buzau, being an agricultural research and production facility of Romanian Agricultural Sciences Academy. The farm has a 600 ha property and a cow farm (80 heads and growing) situated in a 3 ha agricultural complex. The facility has research laboratories and staff and is developing a program for integrated farm production, being the perfect location for a small biogas pilot plant for research and demonstration purposes. The raw material (cow manure) will be supplemented with maize and cereal straw. Cow farm, the greenhouse and plans to have chicken/turn-key farm with incubator, assure the use of the heat during winter and requires that a significant part of the heat generated during wither to be use for the own purposes. The same is with the generated power. Exceeding heat will not be used in the first step during the hot season, and the electricity could be sold to national grid. The same technology will be used for this site as well as for the previous one due especially to their capacity and raw materials requirements. The table 2 summarises the basic data as well as the financial assumptions applied for the economic forecast. Using the template provided in Big East project the following data have been generated:

BIG>East Biogas Calculation	**Dulbanu project**	
Farm based biogas plant, turn key project		
1. Investment costs		
Total of Investment	-350.000,00	€
Liquid assets	-50.000,00	€
2. Feedstock data (Year 1):		
Quantity of maize silage TS=32%	2.500	t/year
Quantity of grass silage TS= 40%	0	t/year
Quantity of cattle/pig manure TS=10%	1.200	t/year
Quantity of grease trap residues	0	t/year
Quantity of packed grocery store waste	0	t/year
Quantity of source separated organics (bio-waste)	0	t/year
Removed contaminates	0	t/year
Added water	3.700	t/year
Feedstock in biogas plant total	**7.400**	t/year
Average costs/income of feedstock per year	-15.441,89	€/year
3. Plant data		
Average biogas yield	505.000	m³/year
Average energy yield	2.697.500	kW/year
estimated electrical power output	126	kWh/h
estimated electrical power consumption	6	kWh/h
produced amount of compost TS=25%	733	t/year

produced amount of liquid digestate TS= 5%	2.386	t/year
4. Revenues on energy		
Revenues from selling electricity	126.081,15	€/year
Revenues from selling heat	32.370,00	€/year
5. Plant working costs		
General Business Costs	-67.563,33	€/year
Costs for electrical energy	-2.941,89	€/year
Costs for contaminats removal	0,00	€/year
6. Earnings before Interests	75.445,93	
7. Internal Return Rate of Project (IRR)	**11,47%**	
8. Capital costs:	-49.221,15	€/year
9. Total earnings	**26.224,77**	**€/year**

2.1. Basic plant design

Dulbanu village is situated close to second site, in an agricultural intensive area with many animal farms.
Dulbanu is a research-orientated unit under the Romanian Academy of Agricultural Sciences and it was one of the stakeholders manifesting interest in Big_East project even before acceptance (issuing a letter of interest in that respect).

It has good infrastructure – concrete access road with national road network intercommunion. Electrical grid has a transformer on place.

The biogas plant could be partially built on the farmland (in red) and the silage could be stored on the red perimeter.

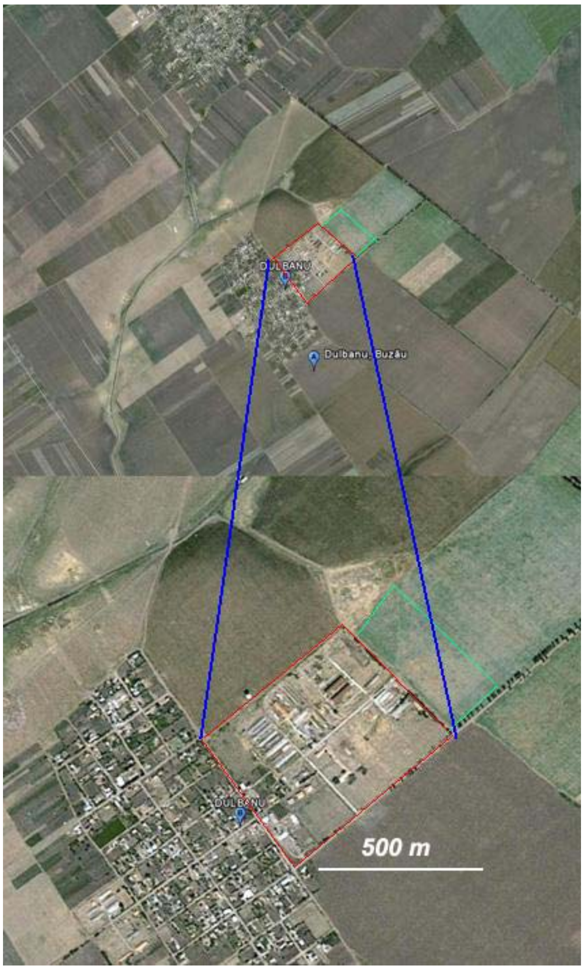

Figure 4 - Geographical location site 2 Dulbanu farm

The overall production process and a diagram showing mass balance for Dulbanu biogas facility are presented in figure 5 and 6.

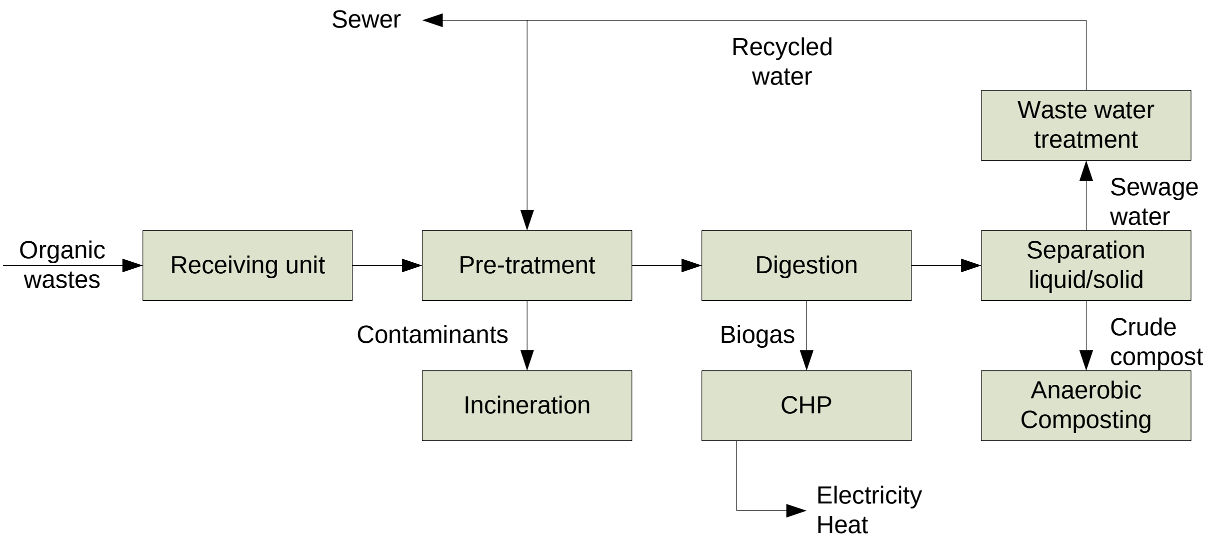

Figure 5 - Block diagram showing the overall production process at Dulbanu site

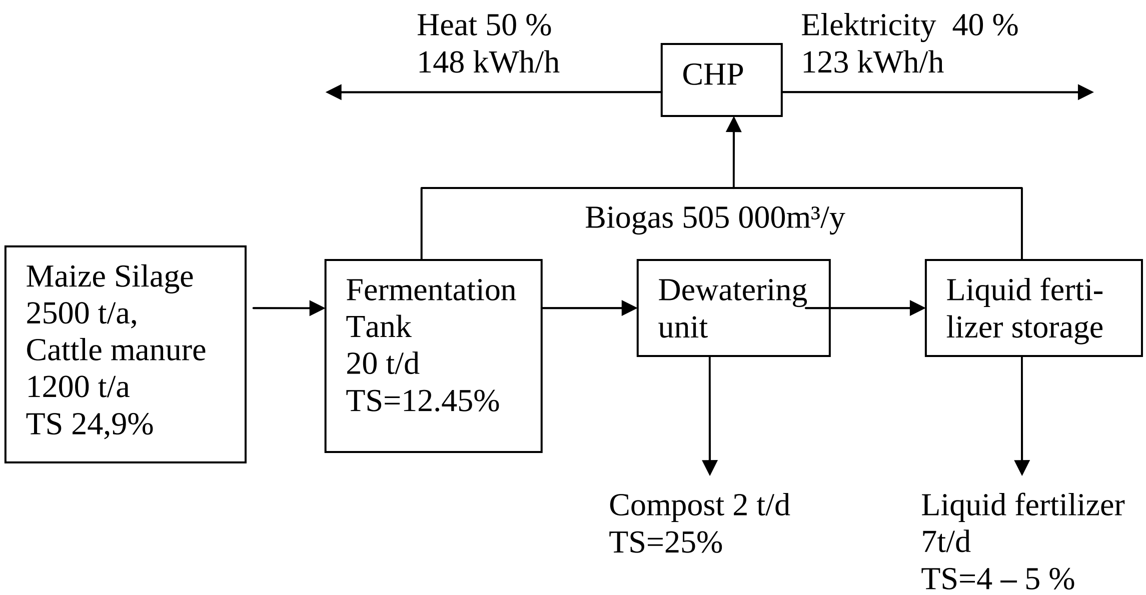

Figure 6 Block diagram showing the mass balance for the biogas plant - Dulbanu

2.2. Technology Specifications

The biomass is composed mainly by maize silage and manure and so we considered suitable for thermophilic digestion at 50-52^{o}C with a retention time in the primary digester of about 17-20 days.

Estimating the retention time in the first digester at approx. 20 days then the volume of the tank should be at least 250-300 m^{3}.

The secondary digesters can be made as concrete tanks provided with a double membrane. The retention time will be higher than in the first digestion tank. It is assumed that the digested liquid fertilizer is supplied to farms where it can be utilized.

2.3. Economical specifications

Based on the previous assumptions and the technological solution presented above we have estimated both the investment costs as well as the profit and loss for the facility. The tool used for the economic specification is the one made available by the BIG East project (http://www.big-east.eu). We have to mention that not all cost has been taken into consideration as well as not all the benefits (like the benefits coming from selling the liquid fertilizer, estimated at about 27000 euro.

Investment Cost *: Dulbanu	**Euro**	*Comments*
Construction / Buldings / Earth works	-115.000 €	*Incl. VAT and delivery*
Machinery	-75.000 €	*Incl. VAT and delivery*
Electrical equipment	-35.000 €	*Incl. VAT and delivery*
Planning and site supervision	-20.000 €	
CHP and grid access	-80.000 €	*Incl. VAT and delivery*
Others	-25.000 €	*7 %, being 3 E/t = control of the biological parameters (considering that the substrate is not appropriate for self-sustainability of the anaerobical fermentation process).*
Liquid assets	-25.000 €	
Total Financial Demand	-350.000 €	

Profit and Loss: Dulbanu	**Euro**	*Comments*
Economic Yield from Plant Operation		
Yield from electricity sale	126.081€	
Yield from heat sale	32.370 €	
Plant working costs		
General Busines Cost	- 67.563 €	
Biomass purchase	-15.442 €	*Maize silage was calculated at 5 E/t, being the costs for cultivation, crop and transport (the shareholder owns the land for crop).*
Purchase of electric energy	-2.942 €	
Discharge of sludge	0 €	*Used on the owner land - taken by the farmers*
Earnings before Interest	75.446 €	
Internal Return Rate (IRR)	11.47 %	
Capital Cost	-49.221 €	
Total Earnings	26.225 €	

** Estimated media over 15 years*

2.4. Organizational structure

The owner of the plant is public investor (belonging to the National Agronomical Academy of Science) but also other investors could be attracted for this. A Public Private Partnership (PPPs) is most likely to foreseen. This will also increase the capability of the investor to attract other financial resources such as those from the structural funds.

Project definition, accessing the financial resources and construction

The same steps as for the Sahateni project are required.

Due to the fact the concept as well as the pre-feasibility study was realized (this document) it is a need for the following steps: i) feasibility study, ii) project development for structural funds, iii) technical project and detailed technical project (this phase is requiring also all the permits including the environmental ones), and vi) construction phase. For the construction phase it is assumed that either local or EU expertise to be used. For this a tender will nevertheless be organized in full agreement with the EU regulations.

2.5. Risk management

On all of the above phase’s different risk are involved from changes in the private investor intentions up to not obtaining the environmental permits. We do not foresee any problems with the biomass used for fermentation.