Project: BiG>East

(EIE/07/214)

Biogas Show Cases in the target region of Latvia

Deliverable D 6.4

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With the support of:

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Executive summary

Biogas Show Cases report was elaborated by national project partner and assisted by expert group of the BiG>East project (Biogas for Eastern Europe) which is supported by the European Commission under the Intelligent Energy for Europe Programme. This report consists of description of two Biogas Show Cases in Latvia, presenting two specific sites suitable for biogas production and utilization. Both sites were selected using Site Selection Guideline (see BiG>East Deliverable 6.1).

Biogas Show Cases are provided to assist local stakeholders in developing their own projects and to motivate decision makers to support new biogas production plants in their areas.

Criteria for site selection were not only the biomass availability, but also the possibility to have political and public support and interest for biogas project development. The summary on two selected sites is provided below.

Show Case 1. Biogas plant in poultry farm "Ķekava"

As first potential biogas site poultry farm "Ķekava" is selected, located in Ķekava parish in Rīga district. The total area of poultry farm is around 100 ha. Main feedstock used for biogas production is poultry manure, slaughterhouse waste and meat processing waste (all of them resulting from farm's production processes) and additionally grass silage is necessary to stabilize the biological process during the digestion.

Biomass available for biogas production:	
Poultry manure	1 300 t/year
Slaughterhouse waste	5 000 t/year
Meat processing waste	390 t/year
Grass silage	5 000 t/year

Unlike traditional agricultural biogas plants, the use of slaughterhouse waste and meat processing residues for biogas production requires additional treatment in order to comply with EU rules on sanitation, digestate quality and safety. Therefore, in addition to equipment used for two stage digestion process, also sanitation unit, conditioning and waste removal equipment has to be installed. Biogas will be used in CHP unit with estimated capacity of 530 kW_{el} (electricity) and 590 kW_{th} (heat).

Output of the biogas plant:	
Biogas production	1,93 million m^3/year
Electricity production	4,072 MWh_{el}/year (for feed-in general grid)
Heat production	4,516 MWh_{th}/year (for farms self consumption)
Amount of digestate	10 200 m^3/year (liquid fertilizer)

For economical analysis the calculation tool developed in BiG>East project were used. For the calculations different assumptions were taken into account therefore the results generated by the calculation tool should be considered as indicative numbers only and subject of change.

Project economy:	
Calculated investment costs	5 million €
Operational costs	294 773 €/year
Revenues	678 699 €
IRR	32 %

JSC "Putnu fabrika "Ķekava"" (poultry farm) will be the owner of project. There is a basic possibility to buy additional land and feedstock if necessary. Liquid manure can be sold based on existing contracts for manure management.

Show Case 2. Biogas plant "RZS Energo"

As second site for biogas production – biogas plant "RZS Energo" near to the animal farm "Rudeņi" is selected. The plant is located in Sesava parish in Jelgava district – at the border to Lithuania. Territory available for biogas production site – digesters, gas storage, CHP unit, auxiliary facilities and territories is 10 000 m^2. Main feedstock used for biogas production will be cattle manure, cattle dung and maize silage.

Biomass available for biogas production:	
Cattle manure	9 000 t/year
Cattle dung	3 600 t/year
Maize silage	8 000 t/year

Biogas plant is intended as typical agricultural biogas plant based on co-digestion of different kind of feedstock. Two steps process will be used, where the first step is thermophilic digestion at temperatures above 50^oC and the second step is post-digestion at lower temperatures (40-45^oC). Biogas will be used in CHP unit with estimated capacity of 540 kW_{el} (electricity) and 600 kW_{th} (heat).

Output of the biogas plant:	
Biogas production	2,05 million m^3/year
Electricity production	4,325 MWh_{el}/year (for feed-in general grid)
Heat production	4,797 MWh_{th}/year
Amount of digestate	17 900 m^3/year (liquid fertilizer)

Concerning the use of heat, there are several alternatives – heat could be used for farm "Rudeņi" self-consumption, for grain drying, for district heating in settlement located near the farm or even the new business possibilities like building of greenhouses are under discussion.

For economical analysis the calculation tool developed in BiG>East project were used. For the calculations different assumptions were taken into account therefore the results generated by the calculation tool should be considered as indicative numbers only and subject of change.

Project economy:	
Calculated investment costs	1,62 million €
Operational costs	240 438 €/year
Revenues	747 965 €
IRR	12 %

Farm "Rudeņi" and one of the managers of farm "Rudeņi" will be the owner. The land is property of farm "Rudeņi". Land rent contract for 20 year period is made.

1. Biogas Show Case: Ķekava parish – poultry farm "Ķekava" biogas plant

1.1. Basic plant design

Poultry farm "Ķekava" is located in Ķekava parish in Rīga district (see Figure 1.1).

The total area of poultry farm is around 100 ha (one million m^2). The annual breeding amount in poultry farm "Ķekava" is more than 11 million chickens per year having a place for 2,03 million chickens at the same time.

The feedstock used for biogas production is poultry manure, slaughterhouse waste and meat processing waste.

The available amount of poultry manure in poultry farm "Ķekava" is 5 t per working day or 1300 t per year. This is pure poultry manure without litter, collected from the sheds of laying hens. Currently manure is sold as fertilizer for vegetable farms.

By the end of 2006 the new slaughterhouse of poultry farm "Ķekava" were built. The maximum slaughterhouse output is 48 000 chickens per working day resulting to 5 000 t of slaughterhouse waste per year. This waste is utilized in bone-meal production unit.

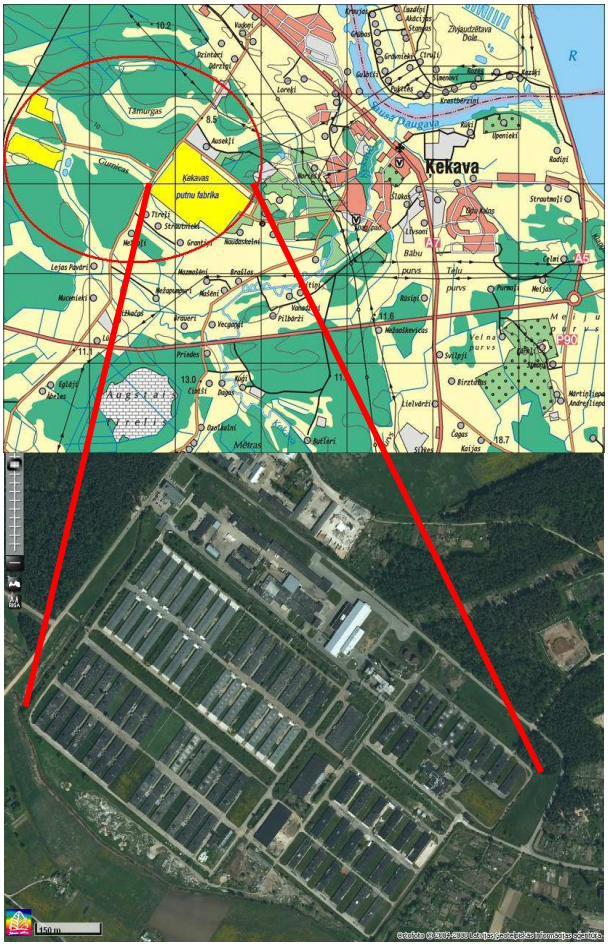

Figure1.1.Location of "Ķekava" poultry farm

Poultry farm "Ķekava" is the biggest poultry meat producer in Latvia. Waste from sausage production and waste fat counts for total of 390 t per year. This waste product is currently delivered to other company for utilization.

To ensure the optimal nitrogen and sulphur content during the digestion process, it is necessary to add about 5000 t/year of grass silage that will be purchased outside the farm.

An overview of biomass amounts and corresponding biogas yields is given in Table 1.1.

Table 1.1.Available feedstock with corresponding biogas yields and methane amounts

Type of biomass	Amount of biomass, t/year	Dry mat-ter	Biogas yield m³/t	Biogas yield, m³	Methane content, %	Methane amount, m³
Poultry manure	1300	min 15%	56	72 800	55	40 040
Slaughterhouse waste	5000	25%	180	900 000	60	540 000
Meat processing waste	390	70%	378	147 420	60	88 452
Energy crops	5000	30%	162	810 000	53	429 300
TOTAL	**11 690**			**1 930 000**		**1 097 792**

As can be seen in Table 1.1, the calculated biogas amount is 1,93 mil.m^3/year. Estimations on expected energy production are given in Table 1.2.

Table 1.2.Initial calculations on energy production

Site name: Ķekava	Amount of biogas, m³	Energy production coefficients kWh	Total produced energy, kWh
Total energy	1 930 000	5,5	10 615 000
Electricity	1 930 000	2,11	4 072 300
Heat	1 930 000	2,34	4 516 200

Based on preliminary calculations it was assumed that "Ķekava" biogas plant could have an output of electrical capacity equal to 530 kW_{el} and heat capacity - 590 kW_{th}. Electricity will be sold to the grid, and heat will be used for farm's production processes.

The calculated amount of digestate is 10 200 m^3/year. Digestate could be utilized as fertilizer. Already now poultry farm "Ķekava" has contracts with other farmers and vegetable farms for selling the poultry manure as fertilizer. At the moment special storages for digestate are not available. They will be constructed during the project implementation.

Block diagrams showing the overall production process and mass balance of "Ķekava" biogas plant are given in Figures 1.2 and 1.3 respectively.

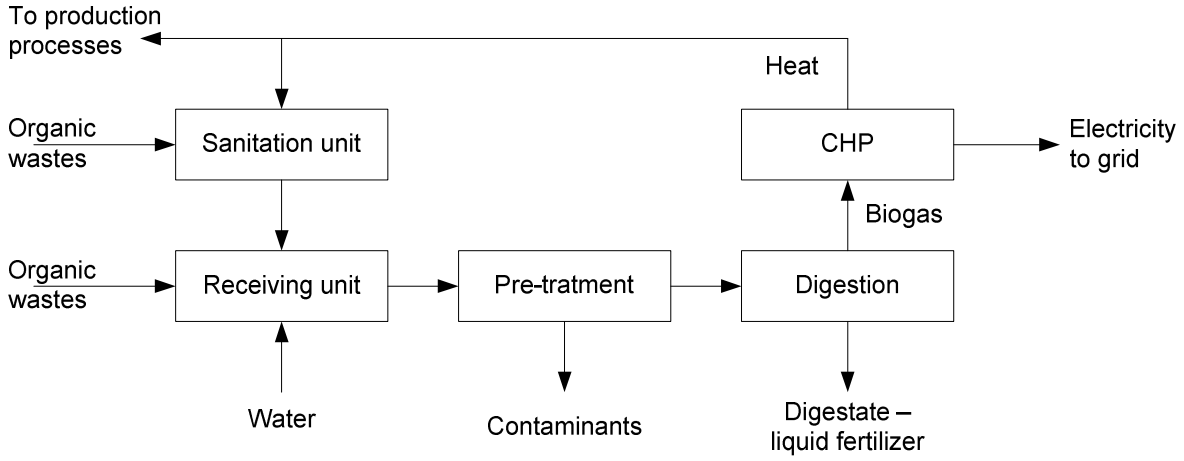

Figure 1.2.Overall production process of „Ķekava" biogas plant

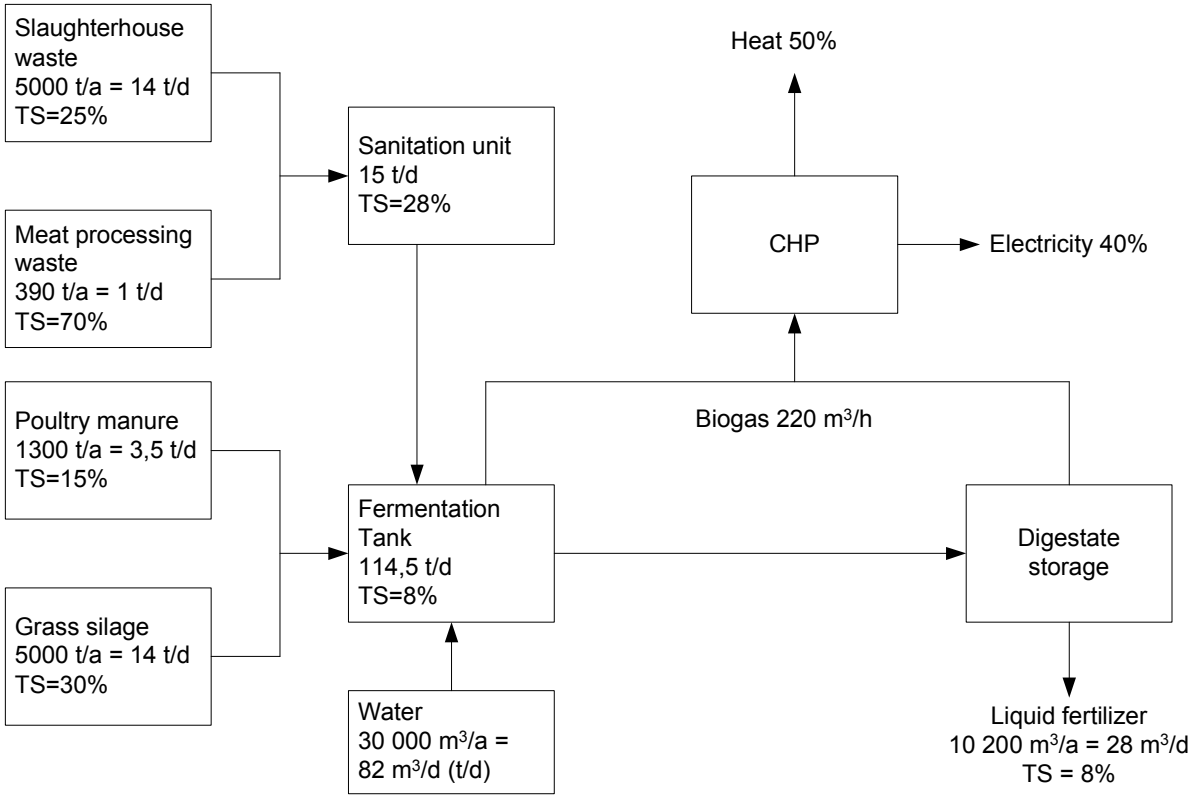

Figure 1.3.Mass and energy balance of "Ķekava" biogas plant

1.2. Technology Specifications

Traditional two steps wet digestion technology will be used. Unlike traditional agricultural biogas plants, the use of slaughterhouse waste and meat processing residues for biogas production requires pre-treatment in order to comply with EU regulations on sanitation, digestate quality and safety. The pre-treatment process includes two steps:

1) Conditioning, where feedstock is homogenized by smashing, mincing, mixing and removing of any non-digestible materials

2) Sanitation, where homogenized feedstock is kept under a certain temperature and pressure for a certain time as stated in the Regulation EC 1774/2002[1].

The Regulation also requires checking the feedstock quality and documentation of hazardous materials is necessary that potentially requires employment of more people for biogas plant operation. It is suggested that pre-treatment part ("dirty" part) should be divided from the biogas production side ("clean" part). An example on division is given in Figure 1.4.

[1] Regulation (EC) No 1774/2002 of the European Parliament and of the Council of 3 October 2002 laying down health rules concerning animal by-products not intended for human consumption

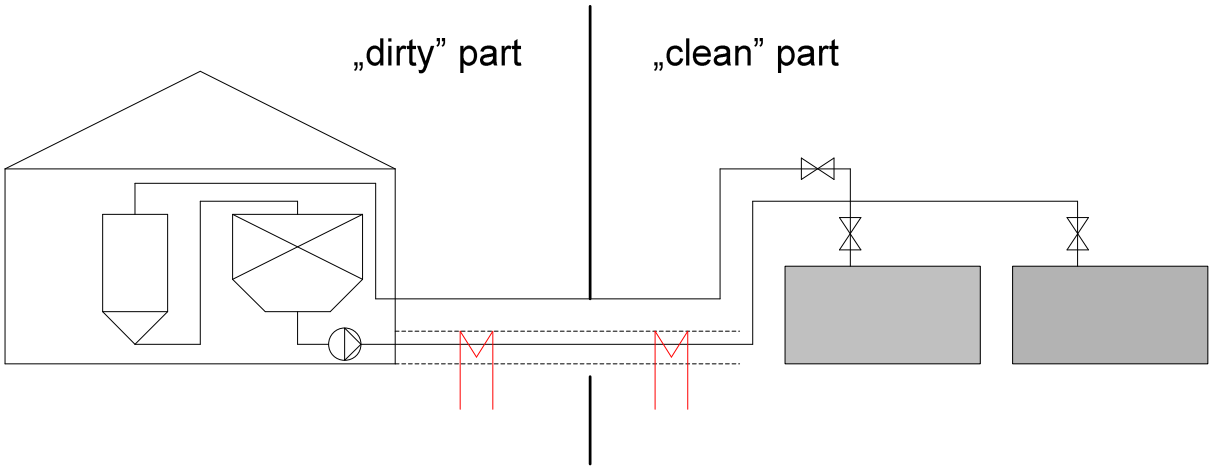

Figure 1.4.Example on dividing the „clean" part from the "dirty" part in biogas plant

1.3. Economical specifications

For economical analysis the calculation tools developed in BiG>East project were used. For the calculations different assumptions were taken into account therefore the results generated by the calculation tool should be considered as indicative numbers only and subject of change.

During the calculation following main assumptions ware made:

- Investment costs in level of very high standard organic waste treatment plant or 10000€/kW resulting in 5 mil. € of total investment costs
- Costs for feedstock:
  - Grass silage 37 €/t
  - Poultry manure 5,7 €/t (the money that farm receives when selling the manure as fertilizer)
- Revenues from waste treatment (savings from using slaughterhouse waste and meat processing waste for biogas production instead of utilizing them in bone-meal) 143 €/t
- Revenues from sales of electricity (feed-in tariff) 0,1617 €/kWh
- Revenues (avoided costs from heat generation by natural gas) from heat use 0,03 €/kWh
- Interest rate 5,5% (however, together with global economic crises, the interest rate in Latvia for commercial lending tends to increase and more likely will be around 7%)
- Credit period 5-15 years

Investment Cost:* **Poultry farm "Ķekava"**	**Euro**
Construction / Buldings / Earth works	2 000 000
Machinery	1 800 000
Electrical equipment	250 000
Planning and site supervision	200 000
CHP and grid access	550 000
Others	200 000
Liquid assets	50 000
Total Financial Demand	**5 000 000**

* VAT and delivery included

Profit and Loss*: Poultry farm "Ķekava"	**Euro**
Economic Yield from Plant Operation	
Yield from electricity sale	568 041,49
Yield from heat sale	110 657,43
Plant working costs	
General Busines Cost	236 810,23
Biomass purchase	-512 061,58
Purchase of electricity	57 963,42
Discharge of sludge	0
Earnings before Interest	953 950,28
Internal Return Rate (IRR)	32,30 %
Capital Cost	619 559,61
Total Earnings	334 390,67

* Value from Year 1 of operation

The calculated IRR (32,30%) is quite high because of the expensive slaughterhouse waste and meat processing waste utilization (now 143 €/t) that will be avoided if wastes will be used for biogas production. However, the IRR could be reduced by the following factors:

- strong rise of biomass prices and transportation costs,
- technology problems and with that reduced production hours,
- high financial expenses through expensive bank loans,
- etc.

1.4. Organizational structure

JSC "Putnu fabrika "Ķekava"" (poultry farm) will be the investor and owner of the project. Since the total financial demand is high, possibilities for attracting external funding are investigated. Funding can be provided from EU Funds in Rural Development Program or Cohesion Funds or external investors can be attracted.

The majority of biomass is available on site and will be supplied using farm trucks and transportation systems. For grass silage supply the contracting of local farmers is necessary. Digestate can be sold based on existing contracts for manure management.

1.5. Risk management

The technological solution of biogas plant is complex and involves technological risks during the plant construction, operation and maintenance. Those risks can be avoided by choosing good quality technology and supplier who is able to provide qualified assistance during the first years of operation.

Another risk would be increase of biomass prices. To minimize that risk, the long-term contracts should be provided.

In this stage of project no other risks are foreseen. Detailed and comprehensive risk analysis will be performed in the following steps of project, e.g., the feasibility analysis.

2. Biogas Show Case: Sesava parish – RZS ENERGO biogas plant

2.1. Basic plant design

As potential site for biogas project development, a location near to the biggest animal farm "Rudeņi" is selected. For biogas project development a company "RZS Energo" was founded, where shareholders and board members are representatives from farm "Rudeņi". Potential biogas plant "RZS Energo" is located in Sesava parish, Southern part of Jelgava district, close to the border to Lithuania. (see Figure 2.1).

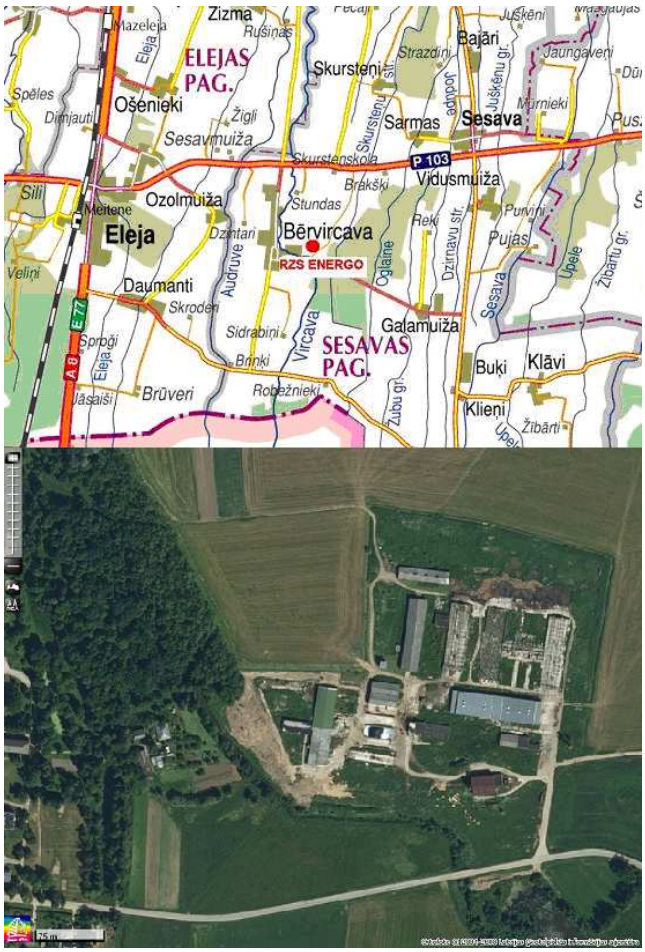

Figure 2.1.Location of "RZS Energo" plant

Farm "Rudeņi" was established in 1995 with specialization in milk production and grain production. Farm is operating more than 500 ha land, organized in rather big fields. Production buildings and fields are located close to good quality access roads. Number of cattle is more than 300, including 120 dairy cows, but it is planned to raise the total number of animals till 600, including dairy cows and younger stock.

For biogas production following types of biomass is available on site:

- Cattle manure from new stable of farm "Rudeņi. The total amount of manure is about 9000 t/year.
- Cattle dung (with straw) – 3600 t/year.
- Maize silage produced on ~ 200 ha with planned amount around 40 t/ha, totally 8000 t/year.

An overview of biomass amounts and corresponding biogas yields is given in Table 2.1.

Table 2.1.Available feedstock with corresponding biogas yields and methane amounts

Type of biomass	Amount of biomass, t/year	Dry matter	Biogas yield m^3/t	Biogas yield, m^3	Methane content, %	Methane amount, m^3
Cattle manure	9000	8%	26	234 000	60	140 400
Cattle dung	3600	Min 15%	60	216 000	60	129 600
Maize silage	8000	33%	200	1 600 000	52	832 000
TOTAL	**20 600**			**2 050 000**		**1 102 000**

As can be seen in Table 2.1, the calculated biogas amount is 2,05 mil.m^3/year. Estimations on expected energy production are given in Table 2.2.

Table 2.2.Initial calculations on energy production

Site name: RZS Energo	Amount of biogas, m^3	Energy production coefficients kWh	Total produced energy, kWh
Total energy	2 050 000	5,5	11 275 000
Electricity	2 050 000	2,11	4 325 500
Heat	2 050 000	2,34	4 797 000

Based on preliminary calculations it was assumed that "RZS Energo" biogas plant could have an output of electrical capacity equal to 540 kW_{el} and heat capacity - 600 kW_{th}. Electricity will be sold to the grid, and several alternatives for heat use are considered:

- Biogas plant could be connected to the district heating system of Bervircava village,
- Part of the heat will be used for farm "Rudeņi" self-consumption,
- Heat could be used for grain draying in farm "Rudeņi",
- Heat could be used for new business possibilities, which could be developed near to the biogas site (e.g. fish production or greenhouses).

The calculated amount of digestate is 17 900 m^3/year. The farm "Rudeņi", which will be the main biomass supplier, currently operates more than 500 ha agriculture land. Operations are organized in radius ~ 15 km around potential biogas site. Therefore digestate will be used for fertilization of farmland. Farm premises are located near to the planned biogas site. The new farm lagoon type manure storage with capacity of 6000 m^3 is constructed. Lagoon will be used for digestate storage.

Block diagrams showing the overall production process and mass balance of "RZS Energo" biogas plant are given in Figures 2.2 and 2.3 respectively.

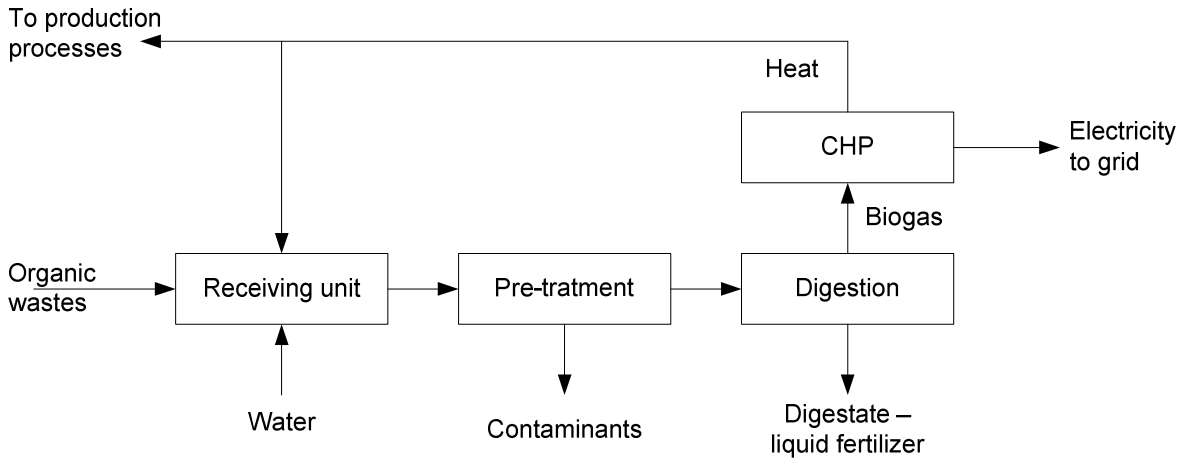

Fig.2.2. Overall production process of „RZS Energo" biogas plant

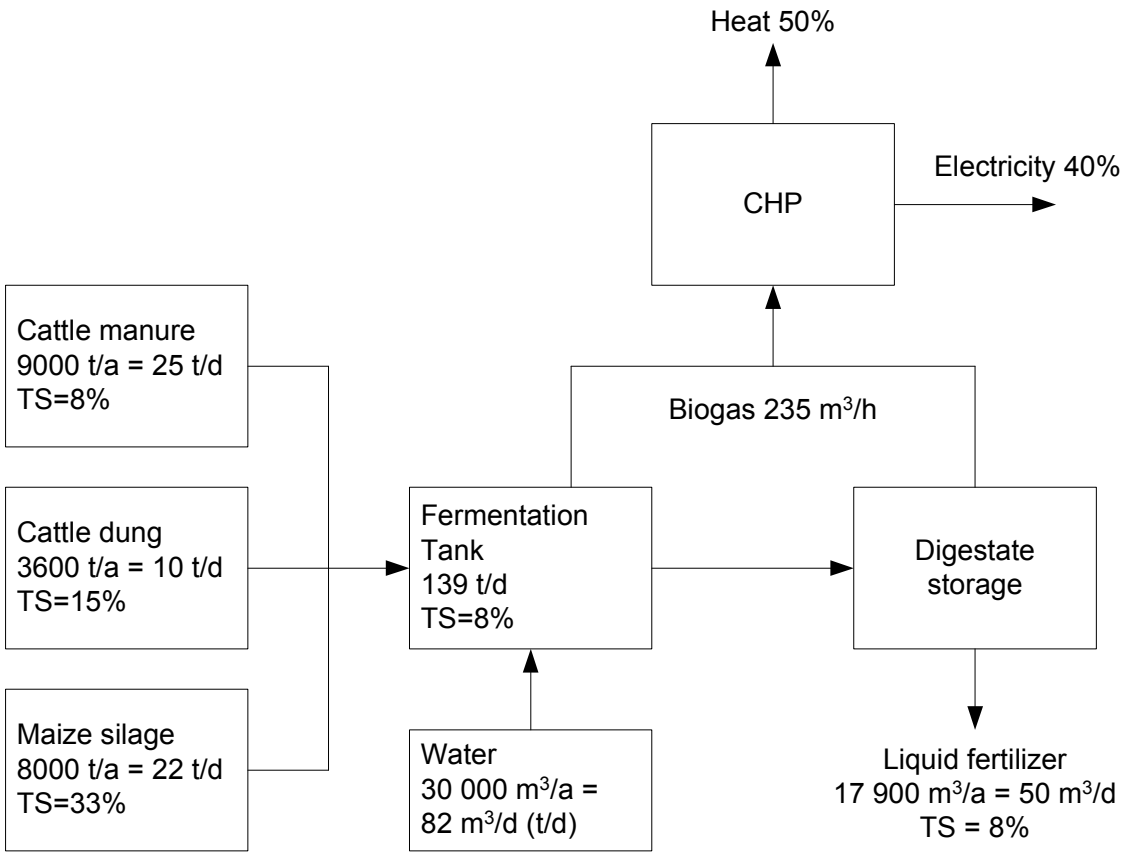

Fig.2.3. Mass and energy balance of „RZS Energo" biogas plant

2.2. Technology Specifications

"RZS Energo" biogas plant is typical manure and maize silage based co-digestion plant. Cattle manure is pumped into pre-treatment tank then into digester. The digester (fermentation tank) will be vertical completely mixed steel or concrete tank with air tight double membrane on the top for collection and storage of biogas. Cattle dung and silage will be fed into the digester using front loader and solid feedstock feeding system.

A wet fermentation process is foreseen, operating at mezophilic conditions i.e. temperature 30-42^{o}C and retention time 30-40 days.

2.3. Economic specifications

For economical analysis the calculation tool developed in BiG>East project were used. For the calculations different assumptions were taken into account therefore the results generated by the calculation tool should be considered as indicative numbers only and subject of change.

During the calculation following main assumptions was maid:

- Investment costs in level of medium standard agricultural biogas plant or 3000€/kW resulting in 1,62 mil. € of total investment costs
- Costs for maize silage 35 €/t
- Revenues from sales of electricity (feed-in tariff) 0,1617 €/kWh

- Revenues from heat use 0,01 €/kWh (since options for the use of heat are different, in this calculation a comparatively low heat tariff is assumed)
- Interest rate 5,5% (however, together with global economic crises, the interest rate in Latvia for commercial lending tends to increase and more likely will be around 7%)
- Credit period 5-15 years

Investment Cost:* **"RZS Energo" biogas plant**	**Euro**
Construction / Buldings / Earth works	490 000
Machinery	400 000
Electrical equipment	100 000
Planning and site supervision	30 000
CHP and grid access	600 000
Liquid assets	50 000
Total Financial Demand	**1 620 000**

* VAT and delivery included

Profit and Loss*: "RZS Energo" biogas plant	**Euro**
Economic Yield from Plant Operation	
Yield from electricity sale	710 938,21
Yield from heat sale	37 027,20
Plant working costs	
General Busines Cost	206 584,16
Biomass purchase	316 654,20
Purchase of electricity	33 854,20
Discharge of sludge	0
Earnings before Interest	224 727,05
Internal Return Rate (IRR)	12,04 %
Capital Cost	192 927,59
Total Earnings	31 799,46

* Value from Year 1 of operation

2.4. Organizational structure

The main supplier of biomass will be farm "Rudeņi", which will be also a co-owner of the biogas plant. There is a good road system for delivery of maize from fields for silage production. Silage will be prepared and stored in piles near to the stable and biogas plant. Farm "Rudeņi" has all necessary machinery for silage production.

Silage storage place is located near to the dairy farm. Silage will be produced and used for both purposes – animal feeding and biogas production. Silage storages are located ~ 150 m from planned digester site. For manure auxiliary storage of 100 m³ is placed near to the stable. This storage will be used also for manure storage before filling in digester. Dung will be stored near to the young stock farm before delivery to the reactor. Concrete storage is available.

For digestate storage lagoon type manure storages will be used. Digestate will be used for fertilization of farmland.

2.5. Risk management

The technological solution of biogas plant is quite common and widely used; therefore significant technological risks during the plant construction, operation and maintenance are not foreseen.

One of the main risks would be the increase of biomass prices, particularly the expenses of maize silage production.

In this stage of project no other risks are foreseen. Detailed and comprehensive risk analysis will be performed in the following steps of project, e.g., the feasibility analysis.