

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

Assessment Studies for Specific Biogas Sites in the target region of Bulgaria

Deliverable D 6.3



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ANNEX: EXPERT COMMENTS BY HEINZ PRABL

Summary

Summary data about potential biogas plant sites are provided in the table below. Locations of the sites are marked on the map (fig. 1).



Figure 1. Selected sites on the map of Bulgaria

Table 1. Summary data for the selected sites

Site	Kalchevo	Stara Zagora	Mekom
Planning region	South East	South Central	North East
Location	South-East, Yambol	South-Central	North-East, Silistra
Primary biomass feedstock	Liquid pig manure	Chicken dung	Liquid pig manure
Quantities	36500 m ³ /year, 3÷6%	2900 t/year, as exerted	43800 t/year, as exerted
Other biomass	Sun flower	Bedding	Slaughter wastes
Quantities	200 ha	600 t/year	5000 t/year
Biogas, m ³ /day	2560	712	4500
Biogas use	cogeneration	cogeneration	cogeneration

Site selection process follows the BIG East Methodology (D6.1). In Step 1 “Selection of the Region” the main conclusions from BIG East Tasks 2.3&2.4 are used. The most promising planning regions are North-East and South Central, according to the results of BiG>East task 2.3. There is a serious concentration of lands and live-stock (BiG>East 2.4). Therefore each potential site should be considered on its own.

Of special importance for region and site selection is willingness for cooperation of the stakeholders.

Results within Step 1: Selection of the Region

Description of the selected regions for potential Biogas Sites

Biogas Site 1: PIGS REPRODUCTION FARM – JSC Kalchevo



Figure 2. Map of Yambol and region



Figure 3. Sun-flower field

Tundzha Municipality is located in the southeastern part of the Thracian Valley, South East region of Bulgaria. The agriculture is the main branch in the Municipality. Agricultural lands take 76.9% of the whole district territory, and the forests 15.5% of it. The region has established as one of the biggest agricultural producers in the country.

The landscape in Yambol region is predominantly plain and hilly. The average annual temperatures are between 12 and 12.5°C. The average January temperatures are 0,6 - 1,2 °C, the average July temperatures are 22,6 - 22,8 °C. The mild winter and the long vegetation period create favorable conditions for second crops cultivating. The average annual precipitations are

between 530 - 540 l/m². The largest river in the region is Tundzha, the fourth of its size within the country.

Plant-growing and stock-breeding are the main occupations of a large part of the population. The favorable nature: fertile humus, humus-resin type and alluvial soils along the Tundzha River valley, as well as the relatively mild climate are suitable for growing various grain and bean crops, vegetables, industrial and essential oils crops, fruit orchards and vineyards; the above-mentioned factors are conducive to agriculture development. Grain crops have the biggest share in plant-growing - 54%, followed by industrial crops - 15%, and essential oils crops - 10%. Cattle- and sheep-breeding, both for milk and meat yielding, goat-, pig-, rabbit-breeding, poultry farming and bee-keeping are developed.

The industrial sector of the region includes construction; electrical engineering; metal and wood – working industries; tailoring, textile and furrier industries; food and drink production; glass and ceramic industries etc.

Kalchevo village is located in South East region, near Yambol (10 km). Arable lands are 1600 ha. They are leased to 6 farms. The population is 688 peoples. There are good conditions for cultivation of wheat, barley, maize and sunflower. Animal breeding and bee-keeping are well developed. On the territory of the village, the following major companies are situated: Mila-nov Popov OOD roll mill and grain-store, poultry slaughter-house and Pigs Reproduction farm.

Villages in the region are Veselinovo, Roza, Tenevo, Kalchevo and Botevo. In village Roza and Botevo there is cow farm with main herd of 1500 heads and heifers and calves. Roza is located 20 km from Kalchevo and Botevo is about 30 km.

References: <http://yambol.government.bg/pics/tundzhaen.htm>,
http://selo.bg/regional_catalogue/bg/27/yambol

Biogas Site 2: PCG Ltd., layers, Stara Zagora



Figure 4. Map of Stara Zagora and region

Stara Zagora is located in South Central region. According to the results of BiG>East Task 2.3, South Central region (BG22) is one of the regions with biggest potential for primary and secondary agricultural wastes in Bulgaria. The district includes parts of the Thracian Plane, parts of Sredna Gora Mountain, the Southern slopes of Stara Planina and the Kazanlak Valley. Stara Zagora is an important industrial, cultural and education center. It is one of Bulgaria's

fastest growing Municipalities. Regional industries include textiles, chemicals, fertilizers, power generation, agricultural implements, machine tools, and cigarettes as well as brewing and canning. The climate is moderately continental with strong Mediterranean influences along the valley of the Maritsa river. Yearly average temperature is 13°C (average for January - +1,0° and average for July +24,0°C) and average annual precipitation is 650 mm. The PCG Ltd farm is located in the mountain area north east of the town.

Biogas Site 3: *Mekom JSC, Silistra, Sitovo*



Figure 5. Map of Sitovo, Silistra and region

Silistra is located in the North-East part of Bulgaria in the rich agricultural region Dobrudza that is especially noted for livestock, grains, beans, sugar beets, and viticulture. North-East region (BG13) has the biggest potential for primary and secondary agricultural wastes in Bulgaria, according to the results in BiG>East Task 2.3 report. Agriculture is of special importance for the economy of the region - about 80% of the population in the area make a living from agriculture. Other important branches of the economy are food and textile industry as well as production of furniture, brick, and tile, as well as matting, packaging materials. The level of unemployment is higher than average for the country.

Mekom pig farm is situated in Sitovo village. There is water purification station in Vetren village (5 km from Sitovo, near Danube river). The main business of Mekom is meat processing. In addition the company has its own agricultural lands, a fodder factory, a modern pig farm, fattening farms for sheep, lamb, cattle and water buffaloes. At the present moment there are 1100 employees in the company and its branches.

Biomass supply

Biogas Site 1: PIG REPRODUCTION FARM – JSC Kalchevo

The main biogas source is considered to be pig manure. The average number of pigs is 12000 per year. The average weight is 50 kg. They produce 36500 m³ liquid manure per year with total solids content of 3÷6%.

Another raw material in own production is sunflower – harvested area ~200 ha, yield ~1,5÷2 t/ha, total production 300÷400 t/year. Additional quantities of sunflower and rape could be bought. The farm rents arable lands in the area. The main crops for this region are wheat, barley, sunflower and in recent years - rape.

There is a sunflower mill "Papas-oil" near Yambol - about 10 km from Kalchevo, on the crossroad Yambol-Sliven-Bezmer. Special technology is used so the residues from the production do not have good nourishing qualities and can be used for biogas.

In Kalchevo village there is a private mill for grain so residues from wheat processing (bran) could be bought. The same company prepares fodder also. Pig Farm JSC Kalchevo also has fodder plant for own needs.

The logistic infrastructure is well developed due to the current operations of the farm.

Expected biogas yield could be calculated as follows (based on excel calculation tool enclosed in the Guidelines from BiG>East, Task 6.1, see table 2 below also)

- biogas from manure – 2560 m³/day (930000 m³/year)
- other (residues from sunflowers) – see the Appendix

Table 2. Calculation of biogas production

Feedstock type	Quantity, t/year	Biogas yeild, m ³ /t	Biogas per year =col.1*col.2	Biogas per day = col.3/365	Biogas per hour = col.4/24
Liquid pig manure	36500	25	912500 m ³ /year	2500 m ³ /day	104 m ³ /h

References: questionnaire filled by the stakeholder.

Biogas Site 2: PCG Ltd., layers, Stara Zagora

The main business of PCG Ltd is laying hens. The average annual number of layers is 65000. Therefore the primary biomass feedstock is chicken dung. There is a stable generation of 8000 kg fresh manure per day (2900 t per year). Manure collection is without dilution.

In addition there are 600 t/year bedding.

Lands around the farm are uncultivated. There are agricultural cooperatives 15 km away.

Expected biogas production (see table 3):

Table 3. Calculation of biogas production

Feedstock type	Quantity, t/year	Biogas yeild, m ³ /t	Biogas per year =col.1*col.2	Biogas per day = col.3/365	Biogas per hour = col.4/24
chicken dung, case 1	2900	66	191400 m ³ /year	525 m ³ /day	22 m ³ /h
chicken dung, case 2	2900	80	232000 m ³ /year	635 m ³ /day	26,5 m ³ /h
chicken dung+ bedding	2900 600	66 112	191400 + + 67200 = 260000 m ³ /y	709 m ³ /day	29,5 m ³ /h

References: visit on the site, discussions

Biogas Site 3: Mekom JSC, Silistra, Sitovo

The number of animals is summarized in table 4 below:

Table 4. Number and type of animals in Sitovo pig farm

Animal type	Average annual number	Average weight
Breeding sows	2850	200 kg
Piglets <20 kg	5400	6 kg
Piglets 20-50 kg	8250	30 kg
Other pigs	10375	90 kg

The primary biomass feedstock is 120 t fresh pig manure per day

Other biomass feedstocks that could be used are:

- up to 15 t slaughter wastes per day
- agricultural wastes and energy crops

Biogas from primary feedstock is calculated as follows:

$$\text{biogas yield} = 37,5 \text{ m}^3/\text{t}$$

$$\text{manure per year} = \text{manure per day} * 365 = 120 * 365 = 43800$$

$$\begin{aligned} \text{biogas} &= \text{manure per year} * \text{biogas yield} = 43800 * 37,5 = 1642500 \text{ m}^3/\text{year} = \\ &= 4500 \text{ m}^3/\text{day} = 188 \text{ m}^3/\text{h} \end{aligned}$$

References: questionnaire filled by the stakeholder

Biogas digestate utilisation

Biogas Site 1: PIG REPRODUCTION FARM – JSC Kalchevo

The biomass digestate is about 36500 m³/year. It could be used for application on agricultural lands. There are 150 ha own lands and 450 ha lands in third party for fertilizing. For storage of the digestate during the winter season there are five lagoons available.

Biogas Site 2: PCG Ltd., layers, Stara Zagora

The digestate (about 10000 m³/year) could be a problem – the nearest agricultural lands are 15 km away. There is enough place for storage on the site - ~3000 m² pits for solids settle down.

Biogas Site 3: Mekom JSC, Silistra, Sitovo

The biomass digestate is about 41900 m³/year with TS=5,9%. It could be used for application on agricultural lands.

Results within Step 2: Selection of the biogas neighbourhood

Sale of energy in the neighbourhood of the biogas plant

Biogas Site 1: PIG REPRODUCTION FARM – JSC Kalchevo

Based on the biomass considered above, the following estimation for energy production could be made:

- from liquid pig manure – 240 kW_{el} and 290 kW_{th} (200 kW_{th} in the winter)

Current thermal energy requirements of „Pig-breeding farm” JSC Kalchevo are 120 t heavy fuel oil per year for stable heating, buildings and premises. The distance between the biogas plant and heat consumers would be of the order of 50 ÷ 500 m.

Current electrical energy needs are presented in table 5.

Table 5. *Electrical energy, own needs, Pig Reproduction - Kalchevo*

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
kWh	110000	90000	80000	70000	60000	65000	82000	85000	82000	95000	105000	115000

It can be calculated, that electrical energy needs are roughly 110 kW_{el} in winter and 80 kW_{el} in summer. Thermal energy needs equivalent to 120 t heavy fuel oil are on average 175kW (250 kW in winter, 100 kW in summer)

Biogas could be used for electricity production or for biomethane, both options are considered interesting by the stakeholder.

In the summer there is excess of thermal energy, so further investigation of possible heat applications should be performed (e.g. additional drying facilities).

Biogas Site 2: PCG Ltd., layers, Stara Zagora

Energy production could be calculated as follows using BiG>East Biogas Calculation tool:

- chicken litter
 - Electrical power – (53 ÷ 64) kW (biogas yield 66÷80 m³/t)
 - Thermal power – (63 ÷ 77) kW (biogas yield 66÷80 m³/t)
- with additional substrates (e.g. bedding)
 - Electrical power – 70 kW (biogas yield from manure 66 m³/t, from bedding 112 m³/t)
 - Thermal power – 84 kW

Sale and Purchase of Electricity:

The opportunities for sale and purchase of electricity are summarysie in table 6.

Table 6. *Infrastructure for electricity distribution*

Site name: PCG Ltd., layers, Stara Zagora	Figure	Comments
Distance to the general electric grid in meters:	50 m	On the site
Voltage of the general electric grid nearby in kV:	20 kV	
Space for transformation station on-site in m ² :	yes	Own transformer available

Current electrical energy needs (mainly for ventilation) are as follows:

- 25000kWh/month in the winter (35 kW_{el})
- 40000kWh/month in the summer (55 kW_{el})

Biogas could be used for satisfying own needs for electrical energy. Sale of electricity is possible due to readily available equipment and infrastructure.

Use of Heat:

The farm consumes about 10 t propane-butane per year for heating the poultry. Premises are heated ten months in the year using jet burners.

$$\text{LPG heating value} = 10997 \text{ kcal/kg} = 12,8 \text{ kWh/kg} = 25775 \text{ kcal/m}^3 = 30 \text{ kWh/m}^3$$

Therefore, current thermal consumption is:

$$10 \text{ t LPG per year} = 12,8 * 10000 = 128000 \text{ kWh/year} = 12800 \text{ kWh/month}$$

$$18 \text{ kW}_{\text{th}} \text{ most of the year (e.g. } 10 \text{ kW}_{\text{th}} \text{ in summer and } 26 \text{ kW}_{\text{th}} \text{ in winter)}$$

Table 7. Use of heat

	kW	Brief description of heat use	Distance to heat customer in meters
Plant size in kW _{el}	70		
Heat Supply Total in kW _{th}	87.5		
Heat Supply Summer	87.5		
Heat Supply Winter	57.75		
Heat Demand 1 in Summer	10	Heating the poultry	on the site, less than 200 m
Heat Demand 1 in Winter	26	Heating the poultry	on the site, less than 200 m
Heat Demand 2 in Summer		potential drying facilities	
Heat Demand 2 in Winter			
Heat Demand 3 in Summer			
Heat Demand 3 in Winter		potential greenhouse heating	
Remaining Heat Load Summer	77.5		
Remaining Heat Load Winter	31.75		

Thermal energy produced exceeds own needs for heating. Therefore an alternative utilization of heat should be looked for. Construction of greenhouses and drying facilities for compost or pellets could be considered.

Biogas Site 3: Mekom JSC, Silistra, Sitovo

Based on the biomass considered above, the following estimation for energy production from liquid pig manure could be made:

- possible electrical power - 450 kW_{el}
- possible heat extraction - 540 kW_{th} (370 kW_{th} in the winter)

Current electrical energy needs are as follows:

Table 8. Electrical energy, own needs, Sitovo pig farm

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
kWh	305000	285000	273000	256000	204000	230000	236000	234000	195000	213000	257000	272000

It can be seen, that electrical energy needs are roughly 280 kW_{el} in winter and 240 kW_{el} in summer.

In addition, there are two villages 2,5 km away from the farm.

Results within Step 3: Selection of the Biogas Site itself

Requirements towards the biogas plant site

Biogas plant site description and analysis follow the directions of BiG>East D6.1 Site Selection Guidelines.

Biogas Site 1: PIG-REPRODUCTION FARM – JSC Kalchevo



Figure 6. Pig reproduction farm Kalchevo neighbourhood



Figure 7. Pig reproduction farm Kalchevo site

Available space

In the table below the existing land use for manure management is considered. Additional areas could be used if needed.

Site name:	Figure	Comments
Space for Biogas Plant (in m2)	yes	Not estimated
Space for the storage of biomass on-site:	3x900 m ³	Three siloes for manure compost are available
Space for the storage of biomass at the producer	-	Not applicable
Space for the sludge storage	yes	Five lagoons are available

Sufficient Road Access

There is good road access to the farm

Site name:	Figure	Comments
Distance to intersectorial road (in km)	1	

Additional site requirements

Site name:	Yes	No	Comments
Site access for trucks possible	√		
Soil contamination is unlikely	√		
Soil is suitable for industrial construction	√		
Planning instrument prohibits biogas plant on – site		√	
Planning instruments foresees residential, cultural or nature protected areas nearby		√	
Residential, cultural or nature areas do exist in the proximity		√	

Ownership structure

Site name:	PIG-BREEDING FARM JSC Kalchevo
Who is the owner of the selected site:	PIG-BREEDING FARM JSC Kalchevo
Will the owner also be the operator of the biogas plant	YES
Is there a basic possibility to buy the land	Own lands

Biogas Site 2: PCG Ltd., layers, Stara Zagora



Figure 8. PCG Ltd., layers, Stara Zagora site

Available space

At the farm there is more than enough place for the biogas installation and support infrastructure.

In the table below the existing land use for manure management is considered.

Site name:	Figure	Comments
Space for Biogas Plant (in m2)	yes	There is a big unused building
Space for the storage of biomass on-site:	~1 dca	Ground for temporary storage
Space for the storage of biomass at the producer	-	Not applicable
Space for the sludge storage	~3 dca	Settle pits in operation

On the picture below, ground for temporary storage and truck loading is presented. Manure could be loaded directly on the truck from the conveyor-belt (coming from the hen-houses) or could be stored until the truck is available.



Figure 9. PCG Ltd., layers, Stara Zagora, temporary storage area

Sufficient Road Access

In general the road infrastructure in the area is not well developed.

Site name:	Figure	Comments
Distance to intersectorial road (in km)	~3	See the map below

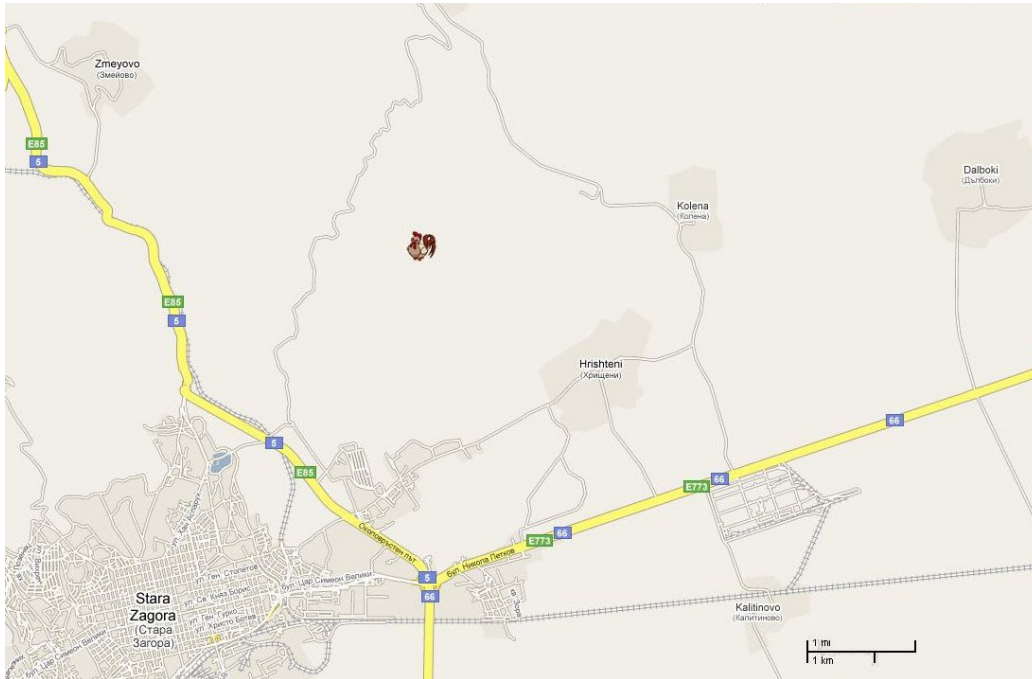


Figure 10. PCG Ltd., layers, Stara Zagora, road infrastructure

Additional site requirements

Site name:	Yes	No	Comments
Site access for trucks possible	√		One asphalt and one dirt road are available
Soil contamination is unlikely	√		
Soil is suitable for industrial construction	√		
Planning instrument prohibits biogas plant on – site		√	
Planning instruments foresees residential, cultural or nature protected areas nearby		√	
Residential, cultural or nature areas do exist in the proximity		√	

Ownership structure

Site name:	PCG Ltd., layers, Stara Zagora
Who is the owner of the selected site:	PCG Ltd., private company owned by two partners
Will the owner also be the operator of the biogas plant	YES
Is there a basic possibility to buy the land	Own lands

Biogas Site 3: Mekom, Silistra



Figure 11. Sitovo pig farm site

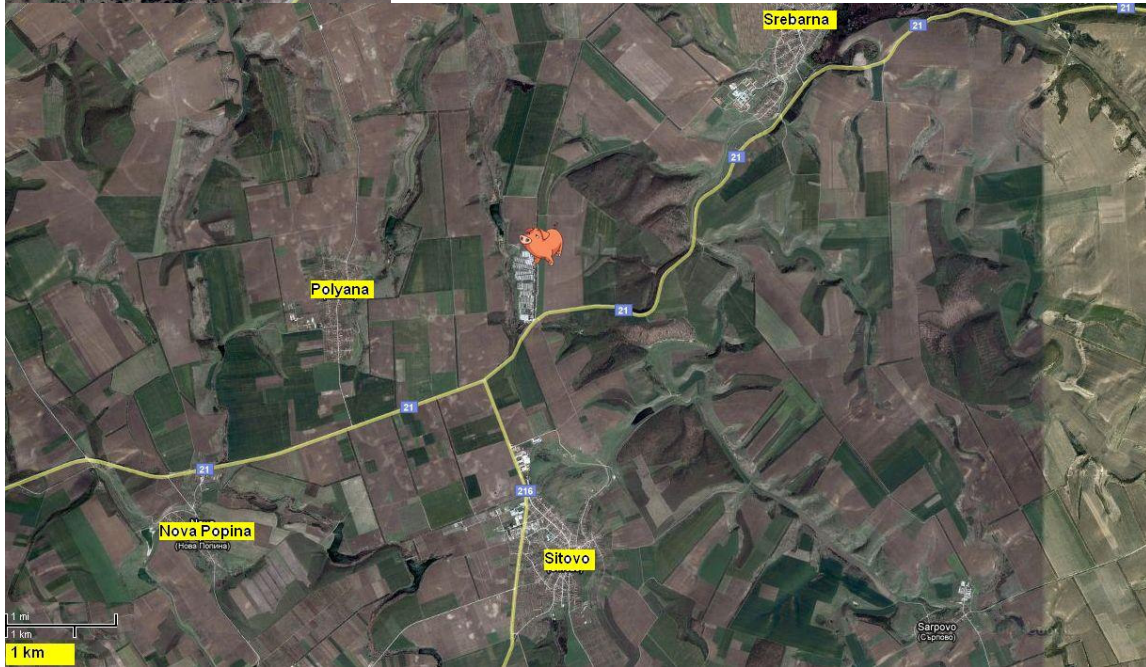


Figure 12. Sitovo pig farm neighbourhood

Available space

There are large spaces available around the farm.

Site name:	Figure	Comments
Space for Biogas Plant (in m2)	yes	Not estimated
Space for the storage of biomass on-site:	yes	Not estimated
Space for the storage of biomass at the producer	yes	Not estimated
Space for the sludge storage		Not estimated

Sufficient Road Access

There is good road access to the farm.

Site name:	Figure	Comments
Distance to intersectorial road (in km)	0,5	Close proximity

Additional site requirements

No problems with the site were found.

Site name:	Yes	No	Comments
Site access for trucks possible	√		
Soil contamination is unlikely	√		
Soil is suitable for industrial construction	√		
Planning instrument prohibits biogas plant on – site		√	
Planning instruments foresees residential, cultural or nature protected areas nearby		√	
Residential, cultural or nature areas do exist in the proximity		√	

Ownership structure

Site name:	Mekom, Silistra
Who is the owner of the selected site:	Mekom JSC
Will the owner also be the operator of the biogas plant	YES
Is there a basic possibility to buy the land	Own lands

Results within Step 4: Optimising the soft requirements for selected sites

In general know-how for biogas operation is not available in Bulgaria because there are no operating biogas plants. Nevertheless, person with the adequate technical background could be found and trained.

Project development could be organized with local engineering companies with interests in biogas technologies.

Public acceptance and support at municipal and regional level should be wanted in all cases.

Biogas Site 1: „*PIG-BREEDING FARM*” – *JSC Kalchevo*

Political support on municipal level could be found.

Biogas Site 2: *PCG Ltd., layers, Stara Zagora*

Significant advantage of the site is availability of well educated management which could be trained to arrange and organize optimal biogas plant operation and performance.

Biogas Site 3: *Mekom, Silistra*

New facilities for manure management are envisaged for design and construction at the farm. Therefore biogas plant could be integrated into the project.