Annex I
ERPA

Project Design
Document

Saaremaa Animal Waste Management Project

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Saaremaa Animal Waste Management Project

Commissioned by the Nordic Environmental Finance Corporation (NEFCO)

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Table of Contents:

1 General description of project activity

1.1 Introduction to project activity

1.1.1 Title of the project activity

Saaremaa Animal Waste Management Project, Estonia

1.1.2 Description of the project activity

The project seeks to improve animal waste management practices through the utilization of the waste as a resource by processing manure and other organic wastes into biogas for energy use using anaerobic digestion technology and producing a mineral enriched natural fertilizer. The project will also aim

- To end the land spread of ca 99 % pig manure on farmland at Saaremaa causing odours nuisances to local community and tourism
- To cease the substandard treatment of waste water sediment in the territory of Kuressaare city waste water treatment plant;
- To minimize/end the burying of animal waste in Saaremaa and appr. 1000 t/y treatment of animal waste in the new utilization equipment
- To minimize the amount of animal waste transported from Saaremaa to Väike-Maarja and minimize the risk for associated environmental pollution
- To effectively manage pig manure, bio sludge and slaughterhouse wastes utilization in Saaremaa, which is environmentally sustainable and in accordance with environmental requirements
- To produce and market "green" energy from biogas, which will occur while processing pig manure and
- To produce and market mineral-enriched natural fertilizer

The Business-As-Usual is believed to represent the baseline scenario, however, taken into known regulatory/legal changes that will occur and have and impact on the GHG emissions. The requirement for come in force in 2008 is to secure manure storage capacity sufficient to cover 10 months manure generation does thus impact baseline emissions.

The emission reductions from this project are being procured by the Baltic Sea Region Testing Ground Facility (TGF). The Baltic Sea Region Testing Ground Facility is a regional carbon purchase fund, which is managed by NEFCO. The TGF invest in projects with a potential for delivering cost-effective ERUs (according to Article 6 of the Kyoto Protocol) and AAUs (according to Article 17 of the Kyoto Protocol for projects delivering emissions reductions prior to 2008) for the account of the investors, which provide good examples of JI thereby helping to further clarify central issues of the project mechanism, develop the procedures and promote common understanding the countries of the Baltic Sea Region. The Estonian counterparty under the Testing Ground Agreement is the Ministry of Economy and Communication.

1.1.3 Project participants

Applicant	
Name	OÜ Saare Economics
Type of organization	Private company. OÜ Saare Economics is a special purpose company established on 21.11.2003.
Other functions of the Applicant within the project	The company will act as overall project manager, undertake the civil engineering works (foundations) and be the operator of the plant.
Main activities, knowledge and experience	Project management
Name of contact person	Raul Maripuu
Address	OÜ Saare Economics Valjala 94302, Estonia. Reg. nr. 10969593. Share capital of 50,000 EEK.
Phone/fax	Tel: +372 45 49 596 Fax: +372 45 49 485 GSM: +372 50 34 249
E-mail	feedmill@tt.ee

Contractor	
Name	N.V. Ecomac
Type of organization	Private company, registered in Belgium. http://www.groupmachiels.com/en/framesets_fiches/ecomac.html
Other functions of the project developer within the project	Turnkey contractor (supply, assembly and commissioning) and equipment supplier of the Ecomac technology.
Main activities, knowledge and experience	Treatment of organic residue streams into secondary raw materials namely green electricity and soil improver. The company is part of the contracting, industrial services and environmental company Group Machiels.
Name of contact person	Louis Machiels
Address	3500 Hasselt, Ekkelgaarden, Belgium
Phone/fax	
E-mail	

Other project participants	
Name	Baltic Sea Region Testing Ground Facility
Type of organization	Fund managed by the Nordic Environment Finance Corporation (NEFCO)
Function within the project	Carbon Purchaser
Name of contact person	Ash Sharma
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E-mail	Ash.sharma@nefco.fi

Other project participants	
Name of the project participant	ECON Analysis a.s. Is retained as a technical advisor to the project, and is not formally a project participant.
Type of organization	Private enterprise
Function within the project	Technical consultant (environmental finance advisor)
Name of contact person	Marianne Ramlau
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1.1.4 Duration of the project activity and crediting period

Expected operational lifetime of the project activity: 15 years. The crediting period is 7 years starting from 2006 (2006-2012 included). Early credits (AAUs) are claimed for 2006-2007. ERUs are claimed for 2008-2012.

1.1.5 Public funding

At the time of writing no public funding of the project exists. However, the owner has applied grant from the following sources in order to make the project viable for the owners to undertake:

- Estonian Environmental Investment Centre
- EU LIFE Programme

1.2 Technical description of the project activity

1.2.1 Sector in which the project will be operating

The Estonian pig industry is considered a viable economic sector, with growth prospects within the enlarged EU. This is evidenced by the planned extension of pig farming on the island. The farms involved in this project houses approximately 25-26000 pigs on average and is expected to remain at least at this level. This accounts for approximately 7.2% of the Estonian total (Estonian Inventory).

The farms belong to the four big pork producers in Saaremaa: OÜ Oss, OÜ Saare Peekon, OÜ Ääre Pig Husbandry and Valjala Pig Husbandry OÜ. These enterprises produce 99% of pork in Saaremaa.

The pig manure volume generated at the farms equals 99% of the pig manure generated in Saaremaa and which is managed in open storage tanks before disposed of on farmland. The manure volume is beyond the demand for fertilization of arable land belonging to the involved farms themselves. In consequence, spreading on other land takes place today according to contracts made with the respective landowners. However, landowners prefer other manure types over pig manure for fertilization of farmland and it is difficult to enter contracts with landowner for manure disposal in spring and summer due to odours causing nuisance to local community and tourism. From 1st November to end of March there are restrictions by law for disposing manure due risk of N-polluting surface and ground water. From 2008 farmers have to comply with requirements of manure storage capacity equaling 10 months of manure generation which is not complied with currently at the involved farms.

The Saaremaa Animal Waste Management Project introduces an advanced manure treatment expected to resolve the issues of current pig manure management practises.

In addition the project introduces more environmentally preferred treatment of biosludge and slaugtherhouse wastes compared to current treatment practises of open air composting of biosludge at the Kuressaare city wastwater treatment plant and treatment of slaugtherhouse waste by heating.. The project is considered to be consistent with the Estonian Ministry of Agriculture's interpretation of Best Available Technology (BAT) for pig farming which, however, does not stipulate any recommendations to consider biogas treatment as Best Available Technique (BAT) to be implemented at farms covered by the IPCC[1] regulation.

1.2.2 Planned Activity

For the implementation of the project, following main activities are expected:

- Construction of digester plant in the territory of Jööri pig farm with following list of main equipment: one reception buffer tank for pig manure, one reception buffer tank for biosludge, one reception tank for mixing biosludge and manure, one heat exchanger, one digester (tank, where heating takes place), one biogas compressor, one biogas blower, one biogas motor with integrated generator, one boiler, one centrifuge, once pre-filter, one Advanced Oxidation Process equipment, one micro filter, one reversed osmosis equipment, one dryer.
- The construction of well system and sewage pipe work to discharge the wastewater to Lõve River.
- Construction of closed manure storage tanks with appr. 150m^3 of capacity in the territories of OÜ Oss Koikla pig farm, OÜ Saare Peekon Pähkla pig farm, OÜ Ääre Pig Husbandry Kärla pig farm and Kaali pig farm, Valjala Husbandry OÜ Aru pig farm, Jööri pig farm and Tagavere pig farm;
- Connection of the electricity generator to the grid

Plant installation expected to commence Q3 2005, with plant fully operational by 1st January 2006 and expected final commissioning by Q1 2006, hence would be generating emission reductions by 1st January 2006.

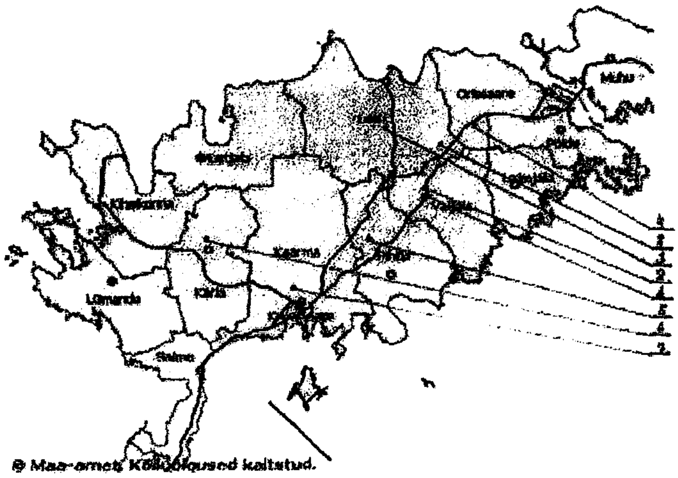
[1] Integrated Pollution Prevention Control.

1.3 Location of the project activity

Location of project activity	
Host Country	Estonia
Region/State etc.	Saaremaa (Saare County)
City/Town etc.	Jööri village (land register 85801:001:0001) Valjala Municipality
Brief description of the project location	The plant will be located at Valjala, 25km north east of the main settlement on the island of Saaremaa, Kuressaare. 

The map below shows the location of the 8 pig farms to provide manure at the biogas plant. The biogas plant is located at Jööri pig farm (No. 2)

Figure 1.1 Map of Saaremaa



1. Söödatehas- AS Valjala Söödatehas
2. Jööri sigala- Valjala SeakasvatuseOÜ
3. Aru sigala- Valjala Seakasvatuse OÜ
4. Tagavere sigala- Valjala Seakasvatuse OÜ
5. Kaali sigala- OÜ Äare Seakasvatus
6. Kärla sigala- OÜ Äare Seakasvatus
7. Pähkla sigala- OÜ Saare Peekon
8. Koikla sigala- OÜ Oss

1.4 Technology to be employed by the project activity

The project activity introduces advanced treatment of pig manure and other raw material (biosludge and slaughterhouse waste) in a digestion plant (or biogas plant) where the generated biogas is utilized for energy purposes (electricity and power generation) and digester effluent undergo further treatment where the output is organic material applicable for soil improvements/fertilization purposes and effluent water to be discharged.

The biomass treatment technology comprises: an anaerobic digester, a biogas engine including electricity generator and effluent treatment equipment.

The capacity for biomass treatment is 40,000 m^3 per year expected to be broken down on pig manure (36,000m^3), biosludge from waste water treatment (3,000m^3) and waste from slaughterhouse (1,000m^3). The latter includes also dead animals but is referred to hereon as simply "slaughterhouse wastes".

The biomass supply is delivered by tank trucks able to provide their own charging and discharging. They discharge into two dedicated reception buffer tanks (one for manure and one for biosludge) having a capacity of maximum 2 days storage. Mechanical stirrers shall avoid phase breaks and solids sedimentation during storage. Mixing of biosludge and manure take place in an underground 240 m^3 mixing tank.

From themixing tank, the digester is charged through a counter current pipe heat exchanger allowing heating up the biomass to the required process temperature.

In the digester, organic matter in the manure is fermented by into biogas under controlled anaerobic conditions. Biogas consists mainly of CH_4 (60-70%) and CO_2 (30-40%). In the steel coated and isolated tank mesophilic fermentation takes place (30-38°C). The tank volume allows a hydraulic retention time of up to 30 days.

The biogas is combusted in a gas engine and used for generation of heat and electricity. The entire heat production and most of the electricity (approx. 75%) is used to cover the digestion plants own demand for heat and power. Capacity for heat and power generation equals 55-57 kWh electricity and 90-120 kWh per m^3 of processed biomass.

After treatment in the mesophilic tank, the digester effluent is directed to a centrifuge, separating the flow in a solid and liquid fraction. The liquid fraction runs through a coarse pre-filter and is fed into an oxidation process conditioning it to be ideally treatable by micro filtration and reversed osmosis. The concentrate of the reversed osmosis is mixed with the solid fraction of the centrifuge. The output is firm and stable in shape. This output is expected being applied for soils improvements/fertilisation purposes.

Effluent water is expected being discharged to Lõve River as expected being permitted by relevant authorities.

The principal turnkey contract is awarded to Ecomac N.V., which is part of the large diversified Belgian contractor Group Machiels. The company has already implemented a similar project in Belgium, which has been operating successfully for some years. The technology is proven at an installation for pig manure treatment in Peer, Belgium.

At the pig farms supplying the biogas plant with manure, underground manure tanks of approx. 140 m^3 will be built of concrete with a cast iron cover.

1.5 Emissions reductions

1.5.1 Nature of emission reductions

Due to the project activity, baseline emissions reductions will occur from:

Methane emissions

- Avoided baseline methane emissions from slurry channels and open manure storage tanks at the pig farms since implementation of the advanced treatment technology imply that any generated methane gases are captured and combusted for energy purpose. In addition, baseline methane emissions, if any, from disposal of manure on agricultural soil will be avoided;
- Avoided baseline methane emissions from fuel consumptions for transportation of manure from open storage tanks to farmland where the manure is disposed of to fertilize the agricultural soil; and
- Avoided baseline methane emissions from biosludge treatment in piles and from applying waste from slaughterhouses in soil

The sources of baseline methane emissions are in compliance with legal requirements or common practice and are believed to continue in the absence of the project activity. In fact baseline CH_4 emissions from manure storing may even increase due to law enforcement of storage capacity equaling 10 months manure production. This may likely imply that the manure generated at the involved farms on average would be stored for at longer period than in the current situation, where storage capacity on average for the involved farms equals 6 months.

Nitrous Oxides emissions

- Avoided baseline N_2O emissions from pig manure storage tanks and from agricultural soil where the stored manure is disposed of.
- Avoided baseline N_2O emissions from fuel combustion for transportation of manure from storage tanks to farmland and from spreading manure on farmland; and

- Avoided baseline N_2O emissions from biosludge composting treatment and disposal on soil and from burying of animal wastes.

The sources of baseline N_2O emissions are not against any legal requirements or common practice and are expected to continue in the absence of the project activity. This includes also nitrogen-fertilization of agricultural soil as source for N_2O emissions. Though baseline nitrogen-fertilization may exceed demand from agricultural crops (an environmentally undesirable outcome) they do not exceed the norms for N-disposal on soil derived from the implementation of the EU water and nitrate directives.

Carbon Dioxide emissions

- Avoided baseline CO_2 emission associated with grid-supplied electricity; and

- Avoided baseline CO_2 emissions occurring from fuel combustion for transportation of manure including spreading manure on farmland

The sources of baseline CO_2 emissions associated with grid-supplied electricity are expected to continue in the absence of the project activity, as it is not against any legal requirement or energy sector policies. This applies also to CO_2 emissions derived from fuel combustion for transportation of manure to farmland.

The above listed baseline emissions are all included in the project boundary. However, in the interest of conservativeness and as uncertainty in estimations would be high, some are taken to be zero in the baseline emissions. This applies to methane emissions from agricultural soil and emissions from treatment of biosludge and organic animal waste (both methane and N_2O emissions).

1.5.2 Estimated amount of emission reductions

Emission reductions are estimated at 88,516 tCO_2e over 7 years from 2006 to 2012. These can be disaggregated as follows:

- Assigned amount units (AAU) for 2006-2007: 24,805 tCO2e

- Emission reduction units (ERUs) for 2008-12: 63,711 tCO2e

2 Application of a baseline methodology

2.1 Methodology Applied

Two approved CDM methodologies appear relevant to consider for the baseline methodology proposed for this project activity viz. AM0006 "GHG emission reduction from manure management system" and AM0016 "Greenhouse gas mitigation from improved Animal Waste Management Systems in confined animal feeding operations".

The CDM methodologies do, however, not fully meet the operational requirements relevant to this project activity though similarities are found as indicated below and a third methodology is therefore proposed for the purpose of this project activity

Table 2-1 Applicability of methodologies

	AM0006 & AM0016	Proposed methodology
Project boundary	Animal barns Subsequent manure treatment	Animal barns Subsequent manure treatment Agricultural soil Transportation of manure to farmland including transportation work associated with spreading of manure
Baseline emissions	CH_4 & N_2O from above sources	CH_4 and N_2O from above sources CO_2 from grid connected electricity generation and transportation of manure

N_2O emissions from disposal of manure on agricultural soil are not included in the boundaries of the CDM methodologies apparently as baselines emissions and net reductions are considered insignificant compared to the baseline methane emissions reductions.

The Saaremaa Animal Waste Management Project is different to the cases in the CDM methodologies above since treated manure will no longer be applied to farmland and N_2O emissions should therefore be set to be zero. Accordingly, all

N_2O baseline emissions from manure disposal on farmland can be attributed the project activity as avoided emissions.

In summary, the here proposed methodology deals with baseline CH_4 and N_2O emissions from the AWMS including from excretion in animal barns to final disposal on agricultural soils.

The proposed methodology relies significantly on IPCC methodologies for estimating CH_4 and N_2O emissions and on IPCC default values unless alternative parameters and values can be justified to reflect more accurately the specific conditions and practices implemented in Estonia. The proposed methodology draws on IPCC methodologies like the CDM methodologies do, but equations, parameters and (default) values are not necessarily similar to the ones suggested in the CDM methodologies.

For estimation of baseline CO_2 emissions from grid supplied electricity, the latest validated emissions baseline undertaken for Estonia (March 2005[2]) is applied, which use the recommended combined margin methodology for grid connected renewable energy.

Estimations of baseline CO_2, CH_4 and N_2O emissions occurring from fuel combustion for transportation of manure are based on measured and calculated diesel oil consumptions (activity data) and fromemissions factors for diesel oil suggested by the revised 1996 guidelines of IPCC.

2.2 Description of Emission Reductions

Methane and nitrous oxides emissions from agricultural soil

Current AWMS[3]s at the involved farms comprises open storage tanks where pig manure (dung and urine) is stored between 1-12 months to finally be disposed of on arable land. Via slurry channels, the storage tanks are supplied with manure from the pig housings on a daily basis. Storing manure in open tanks and subsequent disposal for fertilization of farmland is an AWMS widely practiced in Estonia as well as in many other European countries with large scale pig farming. The AWMS falls under the IPCC-category: "liqued/slurry systems".

Emissions of methane may (depending on e.g. temperature, time and anaerobic conditions) take place during the manure staying in the slurry channels in the pig housings and during the staying in the open manure tanks. Methane emissions may also continue after disposal of manure at arable land for fertilizing agricultural soil depending amongst other on the applied disposal technology. In the interests of conservativeness these baseline methane emissions from the agricultural soil are, however, assumed to be zero and further in the interests of conservativeness, the methane generation potential estimated from the open

[2] Esivere and Virtsu II Wind Power Development, Baseline Study, undertaken by ECON Analysis, March 2005. Validated by TÜV SÜD and available at http://www.netinform.de/KE/startE.asp?Ziel=aktuell_listingE.aspx

[3] Animal Waste Management Systems

storage tanks are reduced with the methane potential estimated from the slurry channels.

In the absence of the project activity, methane emissions from handling of manure in slurry channels and storage tanks would continue as there is no legal, regulatory or other requirements or common practice for avoiding methane emissions from manure handling. Reducing methane emissions is not an issue to pig farming, while protection of surface and groundwater from nutrient disposal and other pollutants are due to national and EU requirements. Minimum requirements to manure storage capacity to prevent pollution with nutrients will also have an impact on methane emissions and are therefore taken into account when considering baseline emissions being avoided by the project activity. From 2008, Estonian pig farmers have to comply with these requirements for storage capacity equaling 10 months manure production. The likely result of complying with this demand is that current storage capacity and in consequence of this the average storage time is increased. Increase in storage time will increase generation of methane gases.

To the extend that nitrification and de-nitrification processes of the nitrogen in the manure takes place in slurry channels, manure storage tanks and on agricultural soil, N_2O may be generated and emitted from all three steps in the manure handling and treatment cycle. Absent the project activity the current degree of nitrogen-fertilization of agricultural land at Saaremaa would be expected to continue as long as it does not exceeds limit values for nitrogen disposal derived from EU Water and N-directives and from Estonian law and regulations. The current fertilization with nitrogen is not beyond those limits though it may exceed the demand of agricultural crops for fertilization.

Table 2-2 GHG-emissions by sources in the AWMS

Sources	Baseline emissions of AWMS	Project activity emissions of AWMS
Slurry channels at pig barns	CH_4 and N_2O.	CH_4 zero. N_2O.
Manure storage tanks	CH_4	Not arising
Controlled digestion & combustion of CH_4	Not arising	CH_4 expected to be zero. CO_2 emissions from biogas combustion assumed to be CO_2 neutral.
Manure disposal on agricultural soil	CH_4 but assumed to be zero. N_2O.	Not arising
Disposal of effluent water and mineralized fertilizers	Not arising	Arising outside project boundary. CH_4 and N_2O assumed to be zero.

Baseline methane emissions from slurry channels (if any) and open storage tanks will be avoided by the project activity as the project introduces a new AWMS, where the manure is removed from the slurry channels to underground manure storage tanks at the farms before methane gases are generated. The underground manure storage tanks are built of concrete with a cast iron cover and are believed to be airtight. Low temperature and short stay (discharging of tanks twice a week) is likely to be insufficient to allow for generation of methane of any significant amount. Discharging is done through a whole in the cast iron cover of the tanks covered by a lit. At discharging the lit is opened and the suction device of the truck tanks is placed over the whole. Once transported to the biogas plant, the tank truck will automatically discharge and the manure is pumped to a reception tank for manure, further to the mixing tank and from here to the digestion tank where the heating takes place. All tanks are hermetically closed and no leaks are believed to occur. Methane gases generated under the digestion process are captured and combusted in the project activity. Combusting of methane gases emits CO_2 gases due to the oxidation of methane to CO_2. It is expected that no methane gases will remain non-combusted and released as non-combusted gases[4].

Manure disposal on agricultural soil will not continue in the project activity. The effluent water from the digestion will be discharged to a water recipient (Lõve River) and soil improvement/fertilizer product that is manufactured from the digester is expected being applied outside project boundaries and for other purposes than fertilization of agricultural soil. Emissions, if any, from effluent water and final application of soil improvement/fertilizer product manufactured in the project activity will not take place within the project boundary. They are treated as leakages not directly under the influence of the project and assumed to be zero.

Methane and nitrous oxide emissions from treatment of biosludge

The project activity will reduce baseline methane and N_2O emissions derived from the treatment of biosludge at the Kuresaamee wastewater treatment plant (WWTP). The current WWT practice implies open air composting of biosludge in 2-3 meter high piles. This may allow for some anaerobic digestion and for generation and emission of methane gases. It may also emit N_2O gases. Emissions from the composting treatment of approx. 3,000 tonnes biosludge per year at the WWT plant are included in the project boundary, but in the interests of conservativeness they are assumed to be zero.

When composting treatment is finalized, the biosludge is used for fertilization and soil improvements on farmland and elsewhere and N_2O emissions may continue also after disposal of the composted material on soil. Emissions from final disposal of on soil are not within the project boundary. No indications prevail to suggest that demands for composted biosludge for soil improvement will increase as a result of displacement of biosludge to the digestion plant and no leakage effect is therefore expected.

Current practice of wastewater treatment and composting of biosludge are not against legal and regulatory requirement and no such regimes are foreseen that would directly or indirectly regulate emissions of methane and N_2O. Accordingly, CH_4 and N_2O emissions are expected to would have continued unchanged in the absence of the project activity. In the interests of conservativeness, these emissions from the biosludge treatment are, however, assumed to be zero.

[4] Personal communications, equipment suppliers, 21th May 2005.

Methane and nitrous oxide emissions from treatment of animal waste

The biogas plant supply is expected to include also 1,000 tonnes of slaughterhouse waste per year. The waste originates primarily from the slaughterhouse, but include also dead animals. Current treatment implies heating of the waste and subsequent burying in soil. It is believed that this practice hardly will continue to be accepted by relevant Estonian authorities due to i.a health risks. Baseline emissions (CH_4, N_2O and possible CO_2) stemming from treatment of about 1000 tonnes per year at the current treatment facility is found to be within the project boundary. In the interests of conservativeness they are set to be zero. No leakage such as increased demand for current treatment practice is expected as a result of the project activity.

Emissions of carbon dioxide, methane and nitrous oxides from diesel oil consumption for transportation and disposal of manure

GHG- baseline emissions associated with manure disposal at agricultural soil will be avoided by the project activity since this manure management practice will cease. The baseline emissions derive from the fuel consumption associated with transportation work necessary to transport the manure from the open storage tanks to the farmland and to spreading the manure on the soil. The manure is transported in manure tanks placed at tractor-trailers. External service providers undertake the transportation and spreading of manure. The tractors are fuelled with diesel oil and the consumption of diesel causes emissions of CO_2, CH_4 and N_2O. These baseline emissions are considered being within the project boundary and are all assessed in the proposed baseline emission methodology.

Carbon dioxide emissions from displacement of grid supplied electricity

CO_2 baseline emissions for electricity supplied to the Estonian grid are avoided by the project activity since electricity generated at the biogas plant will either feed into the grid or be delivered directly to customers (pig farms) who absent the project activity would be supplied from the grid. These CO_2 emissions baselines are considered to be within the project boundary. CO_2 project emissions from the heat and power generation in the project activity are considered to be zero (CO_2-neutral) as they are entirely fuelled by biogas produced at the digestion plant. Replacement of conventionally produced electricity with electricity generated from biogas is considered not to would have occurred in the absence of the project activity, as the biogas technology is not build margin electricity generation technology.

The entire heat produced in the project activity will be used for the digestion process and will therefore not avoid any baseline emissions.

The electricity demand of the AWMSs to be introduced at the pig farms in the project activity is expected to be lower or at least not to exceed electricity consumptions in the baseline scenario as new and considerable more efficient equipment for pumping manure will be installed in the project activity and because of higher pumping demand (distance from slurry channels to open storage tanks) in the baseline scenario. In the interests of conservativeness, CO_2 emissions derived from electricity savings from decreased pumping demand at the farms is set to zero.

2.3 Project Boundary

The project boundary consists of the physical location of the biogas plant and the manure management systems (pig housings/slurry channels and manure storage tanks) at the farms expected to supply manure to the digestion plant. Arable land fertilized with manure from the involved farms is also included in the project boundary. In total 8 farms are expected to supply the biogas plant with pig manure. Most of the farms are located in the range of 8-15 km away from the biogas plant with one at 34 km and another at 45 km (see map in section 1.5).

Furthermore, the project boundary is given by the physical location of the wastewater treatment plant (Kuressaare city WWTP) and the treatment facility for slaughterhouse waste, both of which are supposed to supply organic waste to the biogas plant. The WWT is located 28 km away from the biogas plant and the animal waste treatment facility is located in 31 km away. Though included in the boundary, baseline emissions from these two sources are considered to be zero in the interest of conservativeness.

Not included in the project boundary are: soil subject to soil improvement/fertilization by the product manufactured from the digestion of manure, the water recipient to which the effluent water is discharged (Lõve River) and soil subject to improvement with treated biosludge from the biosludge plant.

3 Estimation of GHG emissions by sources

3.1 Estimate of GHG emissions by sources

3.1.1 Methane emissions reductions

Baseline methane emissions occur from the manure digestion under anaerobic conditions prevailing in the AWMS. Generation of methane gases is highly dependent on the Volatile Solids (VS) content and the temperature. It is taken to occur a few days after excretion, which means that methane, may be generated while the manure stays in the slurry channels (in the pig housings) and – to a larger extend - during the stay in the open manure storage tanks. The manure is stored for a period between 1-12 months at the farms involved in the project.

Methane emissions can be calculated by use of the equation below:

$$EF_{CH4} = VS \times B_o \times MCF$$

Where EF_{CH4} is methane emissions (kg/year)

VS is amount of Volatile Solids (in kg VS/year)

B_o is maximum methane producing capacity and

MCF is the Methane Conversion Factor suggesting how much of the maximum methane producing capacity (B_o) that is released.

The IPCC methodologies for estimating CH4 emissions suggest IPCC default values to determine the parameters unless country specific values are available. In the case of the project activity, actual country and project specific parameters are available and used here. Parameters applied for estimation of baseline methane emissions are the following:

VS	VS rate of manure volume based on 4 samples[5] of the manure. The average measured VS rate is 11.2% of volume (manure).
B_o x MCF	0.11419 kg CH_4/kgVS

B_o x MCF refers to a model developed by the Danish Institute of Agricultural Science (Danish Institute of Agricultural Science, 2001). The model was developed to adjust the IPCC methodology to Danish practice and conditions for manure handling. As country specific parameters for Estonia appears to be lacking, these Danish research results are considered to reflect better the actual conditions for baseline emissions than the default values of the IPCC for cool climate. Still, the values have been further adjusted for the purpose of this PDD to account for differences in Danish and Estonian practice.

CH_4 generation is highly dependent on the temperature and increases exponentially at temperatures above 10°C. During the months with temperatures at minimum 10°C, the utilization degree of storage capacity is little in Denmark since the Danish emptying cycle implies a complete emptying in April. Compared to this, the Estonian emptying cycle imply maximum utilization of storage capacity in May, June, July, August and September where ambient average temperatures reach 10°Celsius or more[6]. This argues for a higher MCF for the average unit of manure compared to the Danish research results.

The Estonian emptying cycle is a result of restrictions on manure spreading from 1st November to end of March and the risk of odours from manure spreading on farmland affecting local communities and tourist activities.

Another point of difference is use of surface layer[7] in storage tanks. The model assumes natural floating coverage in accordance with Danish practice where such surface layer is used to reduce ammonia evaporation and odours. Measurements carried out in Denmark show that natural floating coverage reduces CH_4 emissions. This is explained by the biological oxidation of CH_4 to CO_2 as the methane gas passes through the porous surface layer. Natural floating coverage is not used in Estonia and methane emissions will thus be higher than the Danish figures. Measurements suggest the effect of natural floating coverage to be in the range of 12-38% (Danish Institute of Agricultural Science, 2001 and JTI, 2003). To adjust to Estonian practice the emissions factor is conservatively increased to 12%.

Adjustments to Estonian practices as described above, result in an emission factor at 0.11419 kg CH_4/kgVS. Relying on the IPCC default Bo value for pig manure (0.293 kg CH_4/kg VS), MCF for determines baseline emissions from the AWMS are estimated to be 39%. This is equivalent to IPCCs default value (IPCCa) suggesting the MCF for cool climate to be 39%.

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[5] The samples were made by the accredited analytical laboratory Lisec N.V, Netherlandes on behalf of the biogas plant supplier, ECOMAC N.V. Samples were taken in October 2004 (Ref.Lisec, Analyserapport, 28-10-04).

[6] According to 30 years measurements 1961-1990. Ref:Estonian Meteorological and Hydrological Institute, www.emhi.ee

[7] Consisting of eg. straw, leca pellets, rape oil or other organic material.

When converting this emission factor (0.11419 $kgCH_4/kgVS$) to an activity parameter for manure that is handled, the measured average VS rate is applied (0.112kgVS/kg manure). The resulting activity parameter for manure handled is 0.01279 tCH_4/t manure that is stored.

For converting from CH_4 emissions to CO_{2e} emissions a Global Warming Potential (GWP) at 21 CO_{2e} for CH_4 is applied. As a result, the activity parameter at 0.26857 tCO2e/t manure.

Baseline methane emission may also arise from agricultural soil as the manure may continue to digest under anaerobic conditions after disposal. However, these baselines emissions are likely insignificant and determination, if any, will imply great uncertainties. In the interest of conservativeness, they are therefore assumed to be zero.

3.1.2 Nitrous oxides emissions reductions

Baseline N_2O emissions occur from agricultural soil due to nitrogen fertilizing of farmland by pig manure from the involved farms. According to the IPCC methodology, direct emissions of N_2O-N from organic fertilizer can be calculated by use of following equation:

$$N_2O \text{ direct} = F_{aw} \times EF$$

Where N_2O direct is the direct emissions

F_{aw} is the nitrogen amount disposed of on the agricultural soil (kg N_2O-N year) and

EF is the emissions factor.

In the absence of country specific EF, the IPCC default value at 1.25% is used.

A factor 44/28 is used for conversion of N_2O-N (the F_{aw} unit) to N_2O according to the IPCC Good Practice Guidance for Inventories and Uncertainty Management (IPCCa).

To compensate for N-losses calculated as indirect emissions, the resulting amount of nitrogen disposed of from the manure (F_{aw}) is reduced by a factor 0.8 according to the IPCC methodology.

The resulting formulae to calculate emissions are the following:

$$N_2O \text{ direct} = (F_{aw} \times 0.8 \times 44/28) \times 0.0125$$

Baseline estimations of amount of nitrogen disposed of are based on dry matter (in kg/year) in the manure and nitrogen concentration (Kjeldahl-N). Annual amount of dry matter (DM) disposed of is calculated from DM vol.% measured in manure samples from October 2004 and the nitrogen concentration refers to measured Kjeldahl N- concentrations. Average values of 4 samples are used:

DM vol.% is 15.25

Nitrogen concentration (Kjeldahl N) is 0.057425 kg N per kg DM

From this, F_{aw} can be determined as:

F_{aw} = Manure volume (tonne/year) x 15.25 x 0.057425 (kg N per kg DM)

For converting from N_2O emissions to CO_{2e} emissions a GWP at 310 CO_{2e} for N_2O is applied.

3.1.3 Carbon dioxide emissions reductions associated with electricity generation

Baseline CO_2emissions occur from the generation of electricity delivered to the grid or directly to end-users otherwise being supplied from the grid.

EF_{CO2} = Net electricity delivery x Margin C

Where EF_{CO2} is CO_2 emissions (in tonne per year)

Margin C is the combined margin baseline emission factor and net electricity delivered to the grid (in MWh/year) constitute electricity produced by the biogas plant minus own consumption. With reference to the emissions baseline for grid connected renewable energy in Estonia[8] the combined margin applied for estimating baseline emissions is 1.05 tCO_2/MWh. According to the validated emissions baseline, the emissions factor does not change during the period relevant in this project activity viz. 2006-12.

3.1.4 Emissions reductions associated with fuel consumption for transport

Baseline emissions of CO_2, CH_4 and N_2O occur from diesel oil consumption used for transportation and spreading of manure on the farmland.

To establish the baseline emissions from the transport work required a series of samples were made in August and September 2005, measuring diesel oil consumption during transport and spreading of manure. Totally, 180 tonnes of manure were transported and spread on three different fields located in a distance between 1.6- 6.5 km from the manure tank. Total hours of operation were 76 and total consumption of diesel oil was 1864 litres. On average one tonnes of manure required 10.35 litres of diesel for the transport work (spread in results between the different locations is insignificant (from 10.2 – 10.6 litres/tonne manure). For the further estimation of baseline emissions a value of 10 litres diesel per tonne manure is applied.

CO_2 emissions

CO_2 emissions can be determined from following equation:

[8] Esivere and Virtsu II Wind Power Development, Baseline Study, undertaken by ECON Analysis, March 2005. Validated by TÜV SÜD and available at http://www.netinform.de/KE/startE.asp?Ziel=aktuell_listingE.aspx

TF_{CO2} = Diesel oil consumption (in TJ/year) x CO_2 emissions factor

Where TF_{CO2} is CO_2 emissions (in tonne CO_2 per year) from consumption of transport fuels and the CO_2 emissions factor for diesel oil is 73 tonne CO_2/TJ for non-road mobile sources in agricultural sector according to the CORINAIR values referred to in the 1996 revised guidelines of IPCC (IPCCb, Reference Manual, table 1-49).

To convert from fuel consumption in volume (litre) to fuel consumption in weight (tonne), a density rate at 0.84 tonne/m^3 is assumed[9] for diesel oil. To convert to energy content of diesel oil a Net Calorific Value at 43.33 GJ/tonne diesel oil is applied. This is a default value suggested by IPCC (IPCCb, 1996 revised guidelines).

CH_4 emissions

CH_4 emissions can be determined from following equation:

TF_{CH4} = Diesel oil consumption (in TJ/year) x CH_4 emissions factor

Where TF $_{CH4}$ is CH_4 emissions (in tonne CH_4 per year) from consumption of transport fuels and the CH_4 emissions factor for diesel oil is 0.004 tonne CH_4/TJ for non-road mobile sources in agricultural sector according to the CORINAIR values referred to in the 1996 revised guidelines of IPCC (IPCCb, Reference Manual, table 1-49).

Values for density and Net Calorific Value are the same as the ones applied in calculations of CO_2 emissions from diesel oil combustion.

For converting from CH_4 emissions to CO_{2e} emissions a GWP at 21 CO_{2e} for CH_4 is applied.

N_2O emissions

N_2O emissions can be determined from following equation:

$TF_{N2O\,t}$= Diesel oil consumption (in TJ/year) x N_2O emissions factor

Where TF $_{N2O}$ is N_2O emissions (in tonne N_2O per year) from consumption of transport fuels and the N_2O emissions factor for diesel oil is 0.03 tonne N_2O/TJ for non-road mobile sources in agricultural sector according to the CORINAIR values referred to in the 1996 revised guidelines of IPCC (IPCCb, Reference Manual, table 1-49).

Values for density and Net Calorific Value are the same as the ones applied in calculations of CO_2 emissions from diesel oil combustion.

For converting from N_2O emissions to CO_{2e} emissions a GWP at 310 CO_{2e} for N_2O is applied.

[9] Refers to Energy Statistics of the Danish Energy Agency (DEA, 2004)

3.2 Estimated leakage

Potential sources of CH_4 and N_2O emissions outside the project boundary and potentially attributable to the project have been identified as:

- Potential emissions from the water recipient (Lõve River) of the discharge effluent are not included in the project boundary. The discharge water is to comply with the limits set by Estonian authorities, which includes also nitrogen concentration. It is assumed, however, that there will be only insignificant losses of nitrogen through the effluent water (the far greatest loss will be in the soil improvement/fertilizer product) and potential N_2O emissions, if any, is assumed to be zero.

- Soil subject to improvement with treated biosludge from the biosludge plant is outside the boundary, but is not considered a leakage as displacement of treated biosludge in the project activity can hardly be taken to increase consumption of treated biosludge.

- Potential emissions from alternative fertilization practice on farmland currently fertilized from manure from the involved farms.

- Soil subject to improvement with fertilizer manufactured from the organic material after final treatment at the biogas plant. This fertilizer/soil improvement will be applied outside the boundary of this project. It is however not considered to increase demand for such products and it is more likely that it will substitute chemical fertilizers or other organic products, which would imply a "positive" leakage viz. decreasing GHG-emissions outside the boundary of this project. Such are, however, not considered further.

In summary, no leakages have been identified that should be subject to monitoring plans.

3.3 Baseline emissions

3.3.1 Methane emissions from AWMS

The CH_4 baseline emissions per tonne of manure are assessed to be 0.11419 kg CH_4/kgVS based on a combination of IPPC-default values (IPPCb), a model describing the manure management practice occurring in Denmark (Danish Institute of Agricultural Science, 2001) and country specific parameters assessed for the purpose of this PDD.

For the annual treatment of 36,000 tonnes pig manure – which corresponds to the maximum annual volume digested in the project activity – the CH_4 baseline emissions will be 460 tonnes. The first year of operation only 34,000 tonnes pig manure is expected being treated at the biogas plant corresponding to 435 tonnes CH_4. The baseline emissions during 2006-12 – the crediting period – amount to 3,197 tonnes CH_4 or 67,142 tCO_2e.

3.3.2 Nitrous Oxides emissions from agricultural soil

The N_2O baseline emissions factor from disposal of manure on agricultural soil has been calculated to 0.138 kg/tonne manure from the IPCC methodology (IPCCa).

Assuming baseline disposal of 36,000 tonnes manure per year, baseline N_2O emissions are calculated to be 4.95 tonne N_2O and 4.68 tonne N_2O assuming disposal of 34,000 tonnes (refer to year 2006 which is first year of operation of the biogas plant). Resulting baseline emissions during the 7-years period 2006-12 are the following:

Table 3-1 Baseline N_2O emissions, 2006-12

	In tonnes N_2O	In tCO_2 e
N_2O emissions	34.40	10,665.2

3.3.3 Carbon dioxide emissions from electricity generation

In accordance with the validated emissions baseline (TÜV SÜD, 2005), CO_2 emissions factor for renewable sourced electricity supplied to the Estonian grid has been set to 1.05 tonne CO_2/MWh delivered Assuming net electricity deliverance to the grid/directly to consumers supplied from the grid of 487.5 MWh/year, the baseline CO_2 emissions is calculated to 512 tonnes CO_2/year or 3,584 tonnes CO_2 during the period of 2006-12.

The biogas plant is expected to generate more electricity than what covers its own demand. The net electricity delivery to the grid/to consumers supplied from the grid is expected to equal 75% of total electricity generation or about 488 MWh per year.

3.3.4 GHG emissions from transport fuel consumption

Based on samples made in August and September 2005 on diesel oil consumption for spreading manure on farmland, the average diesel oil consumption per tonne manure handled is 10 litres of diesel oil corresponding to 8.4 kg diesel oil per tonne manure handled. With a net calorific value at 43.33 GJ/tonne fuel, energy content of diesel oil per tonne manure handled is calculated to be 0.364 GJ per tonne manure.

For the annual transportation and spreading of 36,000 tonnes manure in the baseline, the diesel oil demand would be 302 tonnes with an energy content at 13,103 GJ. Due to less amount of manure transported (34,000 tonnes), diesel oil consumption during the first year of operation is expected to equal 12,375 GJ. Based on the emissions factors suggested by the IPCC, baseline GHG-emissions during the 7-years period 2006-12 is the following:

Tabel 3-2 Baseline GHG-emissions from use of transport fuels, in 2006-12

	In tonnes	In tonne CO_2e
CO_2 emissions	6,642.5	6,642.5
CH_4 emissions	0.4	7.6
N_2O emissions	2.7	846.2
Total	-	7,496.4

3.4 The emissions reductions of the project activity

3.4.1 Methane emissions reductions

Project activity methane emissions from the AWMS are believed to be zero. As the slurry channels will be emptied on a daily basis and manure removed to underground storage tanks where temperature is low and where the manure stays for maximum 4 days, generation of methane gases, if any, are believed to be immaterial. Further to this, methane gasses, if any, will likely not leak from the airtight underground storage tanks, from discharging of storage tanks nor from truck tanks transporting the manure to the reception tanks at the biogasplant.

During digestion and combustion at the biogasplant, no leakage of methane is expected[10]during normal operation and planned stops of gasengine. Overall methane emissions of the project activity are therefore believed to be zero and emissions reductions to equal baseline emissions.

Table 3-3 CH_4 emissions reduction in tonnes CO_2e

	7 years period from 2006-12
Baseline emissions	67,145
Project emissions	0
Emissions reductions	67,145

Only in emergency situations methane may vented to prevent accidents. This will be monitored in the monitoring plan and emissions, if any, will be estimated as accurate and conservative as necessary.

3.4.2 Nitrous oxides emissions reductions

Project activity N_2O emissions from agricultural soil are considered to be zero. The far largest potential loss of N_2O is to the soil improvement/fertilizer product to be manufactured, but it is in a stable form and is not considered to cause any N_2O emissions within the project boundary. Project emissions are therefore believed to be zero and emissions reductions to equal baseline emissions.

[10] Personal communications, equipment suppliers, 21th May, 29th June and 17th August, 2005.

Table 3-4 N_2O emissions reductions from agricultural soil, in tonnes CO_2e

	7 years period from 2006-12
Baseline emissions	16,620
Project emissions	0
Emissions reductions	16,620

3.4.3 Carbon dioxide emissions reductions associated with electricity generation

Project activity CO_2 emissions are expected to be CO_2 neutral. Combustion of methane cases in the CHP unit emits CO_2 gases, which however will not be counted against baseline emissions as the CO_2 emissions of the project activity are to be considered as CO_2 neutral. Emissions reduction are therefore considered to equal baseline emissions.

Table 3-5 CO_2 emissions reductions electricity generation, in tonnes CO_2e

	7 years period from 2006-12
Baseline emissions	3,583
Project emissions	0
Emissions reductions	3,583

3.4.4 GHG emissions from transport fuel consumption

While the project activity will avoid fuel consumption for transportation of manure from storage tanks to farmland it will on the other hand create a new demand for transportation of manure from the involved farms to the biogas plant. It is expected that to cover this demand 17,000 litres of diesel oil will be needed. The calculations are based on fuel economy of the truck at 2.4 km/litres of diesel and transport work of 40,776 km. Another approx. 3,000 litres are added in the interests of conservativeness to total 20,000 litres of diesel for transport of 36,000 tonnes manure corresponding to 0.56 litres diesel oil per tonnes manure or 0.47 kg diesel oil per tonnes manure (assuming density at 0.84 kg/litre diesel oil). The corresponding energy demand is calculated to 0.020 GJ per tonnes manure (assuming Net Calorific Value at 43.33 GJ/tonne fuel according to the IPCCb, Reference manual).

Emissions factors for estimating project activity emissions of CO_2, CH_4 and N_2O are found in the IPCC 1996 revised guidelines[11] referring to the CORINAIR factors for European diesel heavy duty vehicles, as presented in the table below:

[11] IPCCb, Reference manual, table 1-39

Tabel 3-6 Emissions factors for European diesel heavy duty vehicles

	Emissions factor in tonnes per TJ	Emissions factor in tCO_2e per TJ
CO_2 emissions	73 tCO_2/TJ	73 tCO_2e /TJ
CH_4 emissions	0.006 tCH_4/TJ	0.126 tCO_2e /TJ
N_2O emissions	0.003 tN_2O/TJ	0.9300 tCO_2e /TJ
Total		74,056 tCO_2e /TJ

Emissions reductions associated with savings in transport fuels are the following:

Tabel 3-7 GHG emissions reductions from fuels in transport, in tonnes CO_2e

	7 years period from 2006-12
Baseline emissions	7,496.37
-CO_2	6,642.49
-CH_4	7.64
-N_2O	846.43
Emissions of project activity	374.36
-CO_2	369.02
-CH_4	0.64
-N_2O	4.70
Net baseline emissions	7,122.01
-CO_2	6,273.47
-CH_4	7.01
-N_2O	841.53

3.4.5 Resulting emissions reductions

Overall emissions reductions are summarized in the table below.

Tabel 3-8 Resulting emissions in tonnes CO_2e

	7 years period from 2006-12
Baseline emissions	88,890
-CO_2	10,226
-CH_4	67,153
-N_2O	11,511
Emissions of project activity	374.36
-CO_2	369.02
-CH_4	0.64
-N_2O	4.70
Net baseline emissions	88,516
-CO_2	9,857
-CH_4	67,152
-N_2O	11,507

4 Application of monitoring methodology and plan

4.1 Monitoring Report

At the beginning of each year until 2012, the Monitoring Report will be compiled. The monitoring report will include the following information:

- Project key information
- Short description of operation of the installation during the past year with special emphasis on abnormalities and accidents encountered with potential impact on GHG-emissions (if any). Emergency situations where biogas has been vented for security or other reasons will in particular be described and amounts of methane emitted will be estimated as accurate and conservative as required.
- Short description of service, maintenance incl. preventive maintenance carried out during the past year according to Operation and Maintenance Manual and Preventive Maintenance Plan elaborated. Operation and Maintenance Manual and Preventive Maintenance will be enclosed the Monitoring Report including documentation of service and maintenance carried out by the operational staff of Saare Economics and by external service providers.
- Description of problems encountered during monitoring (if any)
- Information on calibration of meter equipments including manure flow meter, gas flow meters and electricity meters
- Results of samples taken from the manure (if any) to revise values for Volatile Solids, Dry Matter and Nitrogen content. This is only valid if fodder composition to the knowledge of Saaremaa Economics is changed. All documents regarding purchased fodder is archived at Saaremaa Economics and from this changes in fodder composition can be tracked.
- "Monitoring Protocol on Electricity Supplies"

- "Monitoring Protocol on Transport Fuels"
- "Monitoring Protocol on Biogasplant"
- Signature and name of the responsible person.

The Monitoring Report will be presented to the purchaser of emission reductions, to the Estonian JI Focal Point and to an Independent Entity for verification by the deadlines as specified in the Emission Reduction Purchase Agreement.

Mr Maasik, Saare Economics is responsible for the Monitoring Report including for archiving documentation that supports the Monitoring Report and Monitoring Protocols. All records will be maintained in paper and electronic format until the end of 2014 for verification purposes. Supporting documentations including electricity sales and purchase invoices, manure purchase invoices, service and maintenance invoices etc. will be archived in Saare Economics office at Saareema, Estonia.

In the below, methodology, procedures and plan for monitoring are further described for the Monitoring Protocols to be included in the Monitoring Report.

4.2 Monitoring Protocol on Electricity supplies

4.2.1 Activity data

As there are no project emissions and no leakage, the net amount of electrical output from the biogas plant is defined as the only key activity to monitor. The baseline emission factor at 1.05 tCO_{2e}/MWh for electricity supplied to the grid as well as directly to customers will not be changed during the crediting period. Therefore emissions reductions achieved in the project can be calculated as:

$$EF_{CO2} = \text{Net electricity delivery x } 1.05\ t/CO_{2e}/MWh$$

Where EF_{CO2} is CO_2 emissions (in tonnes per year) reductions achieved by the project activity.

Net electricity delivered by the biogas plant is derived from electricity amounts generated and delivered to grid or directly to customers, minus the plants own electricity consumption. The activity data to be collected is therefore electricity amounts delivered and electricity amounts consumed by the biogas plants. The relevant electricity amounts will be subject to measurements by electricity meters.

4.2.2 Data collection and quality

Data on electricity supplies will be collected from monthly and annual operational statistics, i.e. from the activities related to sales of electricity. The operational staff of OÜ Saare Economics will undertake the data collection, calculation and data record keeping and trend analyses, while the Managing Director Mr. Margus Maasik has the overall responsibility. The manager has been trained in the aforementioned issues and will in turn train the procedure to other involved staff.

The data will be booked on a Monitoring Protocol (MS Excel sheet, see Annex A) on a monthly basis for verification purposes. Execution of Quality Control of data entries is the responsibility of Mr Maasik who will appoint a second staff member to double check the data entries.

The monthly billing meter reports from the purchaser of electrical power (national utility Eesti Energia) and sales invoices will serve as backup documents to the form. Also internal electronic metering systems of the power generation equipment at the biogas plant will serve as back up.

The measurement of net electrical energy will be taken care of with the measurement equipment of Eesti Energia, which will be installed in accordance with the company standard EE10421629 ST 8:2001.

Sales of electricity will be carried out in accordance with the Network Agreement and Power Purchase Agreement to be signed between the project companies and Eesti Energia and in accordance with valid legislation – a.o. Electricity Market Act and Grid Code. Details regarding quality, accuracy and calibration are set out in detail in the mentioned agreements and in legislation.

4.3 Monitoring Protocol on Transport Fuels

4.3.1 Activity data

The key project activity to monitor is the transport fuel consumption per tonne manure transported. This is derived from data on diesel oil consumption and on manure amounts treated in the digester.

Baseline diesel oil consumption per tonne of manure transported as determined according to samples made in August and September 2005 will not be changed during the crediting period. Emissions factors of CO_2, CH_4 and N_2O, density and Net calorific values will also remain as determined in the here proposed methodology for non-road mobile sources in agriculture in Europe as described in the previous chapter.

Like for baseline emissions, project activity emissions factors suggested by the here proposed methodology will not be changed during the crediting period. These factors relate to diesel heavy duty vehicles in Europe as described in the previous chapter.

Tabel 4-1 Emissions factor for monitoring of GHG emissions from transport fuels

Item	Baseline emissions factor	Project activity emissions factor
CO_2 in tCO_{2e}/TJ	73	73
CH_4 in tCO_{2e}/TJ	0.084	0.126
N_2O in tCO_{2e}/TJ	9.3	0.93
Total in tCO_{2e}/TJ	82.384	74.056
Density kg/liter fuel	0.84	0.84
Net Calorific Value in GJ/tonne fuel	43.33	43.33

Net emissions from transport fuel consumption is calculated as:

Net TF emissions = TF baseline emissions – TF project activity emissions

Where Net TF emissions corresponds to annual emissions reductions of the project activity associated with transport fuel consumption; TF baseline emissions are annual baseline emissions and; TF project activity emissions are the annual emissions of the project activity.

Baseline emissions

TF baselines emissions are calculated as:

TF baseline emissions = (MT x RFC x D/1000) x NCF x (BEF/1000)

Where TF baseline emissions refer to annual emissions (in tCO_{2e});

MT is the annual volume of manure (in tonne per year) treated in the biogas plant;

RCF is the relative fuel consumption per tonne manure treated. RCF is set to 10 litres/tonne manure in accordance with samples made in August and September 2005;

D is density for diesel oil at 0.84 x kg/l fuel;

NCF is Net Calorific Value at 43.33 GJ/t fuel; and

BEF is the baseline emissions factor at 82.384 tCO_2e/TJ for the total of CO_2, N_2O and CH_4.

The annual volume of manure (MT) treated in the biogas plant will be monitored for determination of baseline emissions.

Project activity emissions

TF project activity emissions are calculated as:

TF project activity emissions = (MT x RCF x D/1000) x NCF x (BEF/1000)

Where TF project activity emissions refer to annual emissions (in tCO_{2e});

MT is the annual volume of manure (in tonne per year) treated in the biogas plant;

D is density for diesel oil at 0.84 x kg/l fuel;

NCF is Net Calorific Value at 43.33 GJ/t fuel;

BEF is the project activity emissions factor at 74.056 tCO_2e/TJ for the total of CO_2, N_2O and CH_4; and

RCF is transport fuel consumption (in litres/tonne manure).

The MT and the RCF will be subject to monitoring.

4.3.2 Data collection and quality

Data to be collected for "Monitoring Protocol on Transport Fuels" is quantities of diesel oil used for collecting manure at the farms and for transportation to the biogas plant and the volume of manure treated. External service providers carry out the service and information on diesel oil consumptions will be collected from the invoiced sales from the service providers to Saare Economics.

Data will be collected from monthly and annual operational statistics form activities related to transport of manure. The operational staff of OÛ Saare Economics will undertake the data collection, calculation and data record keeping and trend analyses, while the Managing Director Mr. Margus Maasik has the overall responsibility. The manager has been trained in the aforementioned issues and will in turn train the procedure to other involved staff.

A member of the operational staff will mannually book the data on Monitoring Protocol (MS Excel, see enclosure) on a monthly basis for verification purposes. Execution of Quality Control of data entries is the responsibility of the Managing Director Mr. Margus Maasik who will appoint a second staff member to double check the data entries. The monthly billing reports from the suppliers of manure and sales invoices will serve as backup documents.

4.4 Monitoring Protocol on Biogas Plant

4.4.1 Activity data for CH_4emissions

As there are no project emissions during normal operation and no leakage providing adequate preventive maintenance of the digestion tanks, the amount of manure treated in the digester plant is defined as the only key activity to monitor. The baseline emission factor will not be changed during the crediting period. Therefore emissions reductions achieved in the project can be calculated as:

$$EF_{CH4} = \text{tonne of manure} \times 0.01279\ tCH_4 \times 21\ (GWP)$$

Where EF_{CH4} is CH_4 emissions (in tonne/year) and GWP is the global warming potential of CH_4.

The emission factor at 0.01279 tCH_4 is calculated as described in the previous chapter and with reference to samples taken as regard rate of volatile solids (VS) of the manure. If composition of fodder used at the pig farms changes during the monitoring period, the emission factor will be re-calculated according to the new VS-rate that can then be determined. The revised emission factor will likely be subject to verification by an independent verifier.

4.4.2 Activity data for N_2O emissions

As there are no project emissions and no leakage, the amount of manure treated in the digester plant is defined as the only key activity to monitor to determine N_2O emissions from spreading manure on agricultural soil in absence of the project activity. The baseline emission factor will not be changed during the crediting period providing that fodder composition as per October 2004 is not changed. N_2O emissions reductions achieved in the project can be calculated as:

N_2O direct = tonne of manure x 0.042662 tonne CO_2e

Where N_2O direct is emissions of N_2O (in tonne CO_2e/year).

The emission factor at 0.042662 tCO_2e has been calculated according to the methodology and the IPCC default values described in the previous chapter and from the dry matter rate and nitrogen content determined through manure samples from October, 2004. Changes in fodder composition may change the values applied for dry matter rate and nitrogen content and the emission factor will have to be re-calculated in such events from revised values for dry matter and nitrogen content likely to be determined from samples taken from the manure. The revised emission factor will likely be subject to verification by an independent verifier.

4.4.3 Data collection and quality

Data to be collected for the "Monitoring Protocol on Biogas Plant" is amounts of manure supplied to the digester during the monitoring period. The manure volume will be measured by an electronic metering system measuring manure amoumts delivered to the reception buffer tank.

Data on manure amounts will be collected from monthly and annual operational statistics from activities related to purchase of manure. The operational staff of OÜ Saare Economics will undertake the data collection, calculation and data record keeping and trend analyses, while the Managing Director Mr. Margus Maasik has the overall responsibility. The manager has been trained in the aforementioned issues and will in turn train the procedure to other involved staff.

A member of the operational staff will manually book the data on Monitoring Protocol (MS Excel, see enclosure) on a monthly basis for verification purposes. Execution of Quality Control of data entries is the responsibility of Mr Maasik who will appoint a second staff member to double check the data entries. The monthly billing reports from the suppliers of manure will serve as backup documents

4.4.4 Documentation of Preventive Maintenance

To maintain the equipment airtight and prevent leaks of gasses (in particular from storage tanks, reception tanks and digestion tanks), a Preventive Maintenance Plan will be elaborated by Saare Economics to satisfy any maintenance requirements according to the equipment suppliers and any legal and regulatory requirements. The Preventive Maintenance Plan will describe maintenance procedures and responsibilities. Preventive maintenance will be documented by service sheets signed by the external service providers or by the Saare Economics staff who carry out the service and maintenance.

Mr Margus Maasik will be responsible for following up the Preventive Maintenance Plan and for ensuring documentation on preventive maintenance carried out.

For verification purposes, the documentation on requirements from suppliers to maintenance and preventive maintenance will be archived during the monitoring period – so will the Preventive Maintenance Plan and the documentation that maintenance has been carried out in accordance with the Plan.

During periods of planned service/maintenance or for other reasons planned stop of gas engine, the biogas will be combusted by the boiler to produce heating for the digestion tank and/or biogas production will gradually be reduced for prepare for stop of engine without.

4.4.5 Recording accidents and emergency situations

Safety and Work Safety procedures will be established and implemented according to requirements of equipment suppliers and other requirements according to relevant legislation and regulation. Such events of abnormalities, emergency situations and accidents will automatically be monitored and recorded electronically.

The "Monitoring Report on Biogas Plant" will include data on any venting of biogas that encounter. From the data, amounts of biogas will be estimated as accurate and conservatively as needed.

If risks of overpressure occurs, the supply of manure from reception tanks will immediately be stopped or controlled and thereby the generation of biogas. The maximum amount of biogas that could be vented in an emergency situation is $1m^3$, but it will be measured automatically.

5 Environmental and Socio-economic Impacts

5.1 Environmental Impacts

5.1.1 Legislative Basis

According to the national Act (passed 14.06.2000) "Environmental Impact Assessment and Environmental Auditing Act" paragraph 1 and 2 and regulation by Ministry of Environment from 10.05.2001 "List and amplitude of activities that carry high environmental risk", the environmental impacts associated with the construction and implementation of the pig manure utilization facility do not require an EIA as it does not constitute a high environmental risk. However, it was considered important and required by the local authority, Valjala Municipality, based on the above Act § 6 subsection 3.

In respect of the Integrated Pollution Prevention and Control Act According to the Government of Estonian Republic Regulation No. 150 from 7 May, 2002 "Determination of the sub-activities and threshold capacity of the activities that need integrated environmental permit and determination of application deadlines for already existing installations" the OÜ Saare Economics pig manure utilization equipment does not exceed the threshold capacity and therefore an integrated environmental permit is not needed.

5.1.2 Summary of the EIA

The developer, in cooperation with the equipment supplier, has designed premises, roads, sites and their location, by taking into consideration technical and all other necessary requirements for planning industrial premises, as well as, economic considerations and the need to fit the new premises into the current pig farm complex.

An EIA was undertaken by the licensed firm, OÜ Vetepere and completed during January – April 2005 in accordance with all Estonian and EU legislation on EIAs. The Saaremaa Environmental Authority on 22.04.05 approved the EIA and on 27.04.05 Valjala Municipality issued a permit for construction for the organic waste utilization plant.

The consultants concluded that the utilization equipment for treating pig manure, wastewater sediment and other organic wastes in this manner does not have any significant adverse impacts on the environment. The consultants judged that overall, construction of the plant will result in considerable pollution reductions in surface and ground water and in ambient air pollution in large parts of Saaremaa.

[illegible]	
Expected global/local environmental effects (positive and negative) of the project	The project will offer the following benefits ▪ GHGs : reduction in the volume of methane and nitrous oxide as compared to those that would otherwise occur in the current scenario of traditional manure treatment systems. ▪ Improved ambient air quality ▪ Reduced odours from treatment of the manure as opposed to traditional methods ▪ Reduced risks of surface and groundwater pollution ▪ Production of natural fertilizer ▪ Production of water for indirect potable consumption

The conclusions of the EIA are summarized below

- No adverse impact on air quality. Diffusive calculations shows that biogas combustion in the plant does not exceed the allowed levels of NO_x, CO, VOCs in combusting materials that would cause the ambient air pollution.
- No adverse impact on water quality after mitigation measures is taken into account. Discharging the wastewater into Lõve River by using the described alleviation methods (it has been recommended to build a long ditch into Lõve river that helps to discharge the waste water) is not dangerous for the quality of the water in the river.
- No direct environmental impacts from construction of the plant
- Some minor negative impacts during operation due to logistics and traffic noise
- The EIA calls for environmental monitoring including measurement of air pollutants in coordination with the Saaremaa Environmental Authority, waste water discharges to the Lõve River in accordance with the Water Act, recommendations for waste transportation and operational practices.

5.2 Socio-Economic and Development Impacts

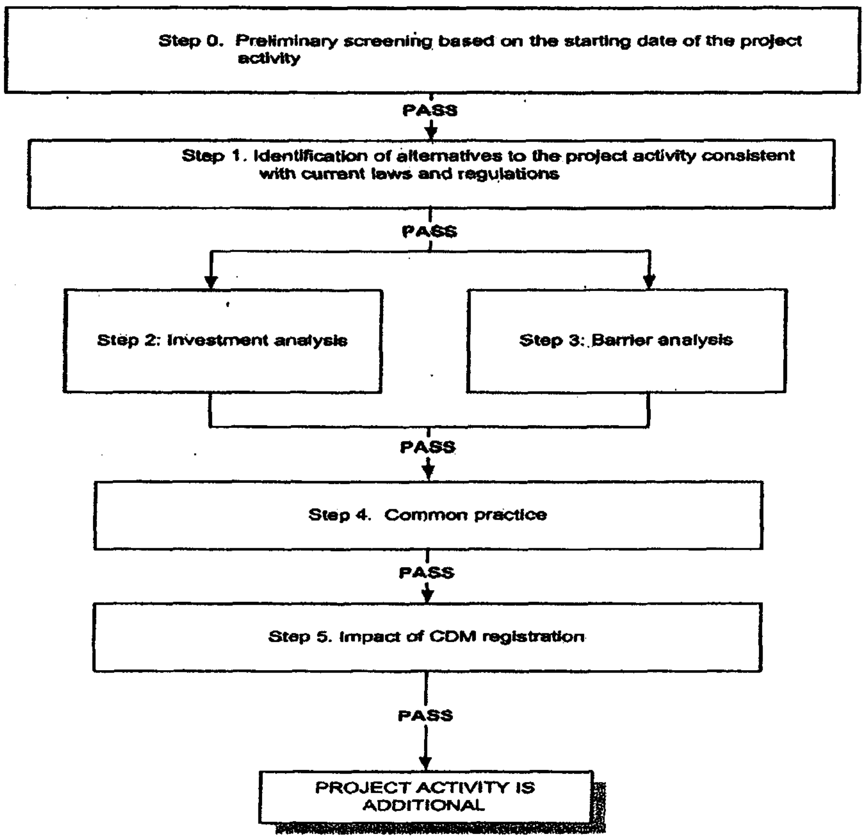
Socio-economic and development aspects	
Expected social and economic effects of the project	The project will offer the following benefits ▪ The technology will be the first of its kind in Estonia, and therefore has an important demonstration effect for advanced waste management and good agricultural practices ▪ In economic terms, the project brings capital investment, tax income and technology transfer to a rural location of Estonia ▪ The project improves animal waste management practices to the highest levels currently observed in other parts of the EU ▪ As the project will be 100% locally owned it will be demonstration of Estonian entrepreneurship in the environmental technology field ▪ In social terms, the project offers less nuisance (odours) and reduced risks to human health ▪ No adverse socioeconomic impacts in terms of tourism and public amenity
Project-related employment structure	Together with the operating manager four new jobs will be created (operators). Transport of manure and possible value-added to organic fertilizer (packaging, marketing) creates further employment.

6 Additionality

6.1 Consolidated Additionality Tool

The "Tool for the demonstration and assessment of additionality" agreed by the Executive Board or CDM Additionality Tool[12] is used here. Although it does not apply to a JI activity it is used here in the interests of conservativeness.

Flowchart: Additionality scheme



[12] For full description visit http://cdm.unfccc.int/EB/Meetings/016/eb16repan1.pdf

Step 0 - Preliminary screening based on the starting date of the project activity

The project activity had not started construction at the time of the initial application for JI financing. JI was considered early in the financing and the JI project idea note was submitted March 2005 and accepted by purchaser for further consideration for funding April 2005.

Further the proposed project activity will not apply for crediting before registration and this screen is therefore not applicable.

Result: Pass

Step 1 – Identification of alternatives to the project activity consistent with current laws and regulation

Sub-step 1a. Define alternatives to the project activity

Alternative management practices for pig manure are identified in this section. It subsequently considered whether the options are realistic and credible alternatives to the project activity.

There are a number of ways manure from pig farming can be treated and disposed of.

Option 1: Continuation of current practices with tank storage and land spreading of pig manure

Tank capacity is under this option increased in order to have sufficient capacity 1. January 2008 to comply with Estonian and EU. By 2008 a storage capacity of 10 months will be required. Current capacity averages 6 months for the farms involved in this project.

Option 2: Treatment of manure in open-air lagoons for longer time periods

As an alternative pig manure can be treated in larger open-air lagoons for longer time periods.

This option is a technique usually applied under warmer climate in southern Europe (e.g. Portugal and Greece). Due to the colder climate this option is not technically suitable in Estonia and is not considered to be a realistic and credible option.

Option 3: Anaerobic digestion and land spreading of digested manure

In this option manure is treated in a biogas reactor in the absence of oxygen. The final products of digestion are biogas for heat and electricity generation and stabilized treated slurry that is applied to land. Organic dry matter is reduced in the process and subsequently less is applied to land through land spreading.

Option 4: Separation of manure in liquid and solid fractions and land spreading liquid parts

In this option separating solid fractions of manure reduces land spreading to liquid parts. Solid fractions are marketed as organic fertilizer either unprocessed or processed by composting, drying or incineration. Liquid parts are applied to land with no prior treatment or alternatively treated by aerobic digestion beforehand to reduce nitrogen content.

Option 5: Anaerobic digestion and manufacturing of organic fertilizer without any JI contribution

This option includes establishing facilities equivalent to the project activity but without the benefits of JI accruing to the project. Both liquid and solid parts are treated so land spreading locally is no necessity. This is an advanced treatment option and even more so than option 3 and 4.

Assessment

Generally using manure as a fertilizer by land spreading on agricultural soils is the preferred technique. Different treatment techniques are usually only considered in circumstances where suitable land areas are not available or due to regulatory requirements.

In particular the EU Nitrates Directive (91/676/EEC) lays down minimum provision on the application of manure to land with the aim of providing all waters a general level of protection against pollution from nitrogen compounds, and additional provisions for applying manure in designated vulnerable zones. In circumstances where manure generation locally exceeds soil capacity and crop requirements, treatment options have to be applied to reduce the amount of manure applied to land or the content of nitrogen compounds. This is in particular the case in areas with high concentration of intensive livestock production and where land is identified as nitrate vulnerable zones under the Nitrates Directive.

It is generally acknowledged that applying different treatment techniques involves additional costs for farmers. Analysis of treatment options in conjunction with assessment of Best Available Techniques underlines this. Pig manure treatment options have in particular been analyzed in the region of Flanders in Belgium due to significant concentration of livestock production and deficit of land for manure spreading[13]. It has been estimated that applying more advanced treatment options increases the cost to farmers by 20%-300%, see figure 1.

Best Available Techniques (BAT) are techniques that are proven in practice, that have the best overall environmental result and are not too costly. Due to the excessive costs of the techniques no BAT have been determined for pig manure processing in Flanders.

[13] The highest densities of pig production in the EU are reported in the Netherlands, Denmark and Belgium.

Table 6.1 *Estimate of the costs of treatment in Belgium*

Treatment option	Costs of treatment €/tonne
Land spreading (option 1)	12,5
Anaerobic digestion and land spreading of digested manure (option 3)	19
Separation of manure in liquid and solid fractions and land spreading liquid parts (option 4)	15-32
Anaerobic digestion and manufacturing of organic fertilizer without any JI contribution (option 5)	>25-37

Source: Feyaerts, Huybrechts and Dijkmans (2002)

The project activity is not situated in an area with nutrient surplus. There is sufficient land in the vicinity of farms to spread the manure and no immediate need to process manure.

On this background it is not realistic that pig farmers would incur additional costs by applying option 3-5. It can be concluded that the only credible option is option 2.

Sub step 1b. Enforcement of applicable laws and regulations

Estonian law requires the adequate management of animal wastes. However, it does not specify the technology to be used.

Continuation of current practices with storage and land spreading of manure are compliant with current legislation. The only requirement is that farmers to have storage capacity for manure equivalent to 10 months production.

More advanced treatment options would also be compliant with Estonian requirements. In particular deployment of anaerobic digestion technology clearly goes beyond legal requirements in terms of technical and environmental benefits.

Result: Pass

Step 2 – Investment Analysis

Investment comparison analysis has been carried out to assess the attractiveness of the project activity without carbon revenue compared to the baseline situation with continuation of existing practices for pig manure handling.

The costs per tonne of pig manure handled (unit costs) have been estimated and show that unit costs under the project activity is 70% higher than continued land spreading. Estimates are based on calculations of the net present value of cash flows over an eight-year period using a discount factor of 8%.

Calculations for the baseline situation include:

- Investments in tank capacity to comply with Estonian regulation (see table below)

- Unit costs of land spreading based on current paid rates (45 EEK/m3) and 3% annual inflation

Calculations for the project activity are based on information in the business plan and include:

- Investments in the biogas plant net of grant funding
- Annual operating costs with 3% annual increase
- Income from sale of electricity, processing of waste water residue, processing of slaughterhouse waste and the sales of organic fertilizer

Table 6.2 *Construction and costs of establishing required tank capacity in the baseline scenario*

Pig farm	No.	Capacity / m^3	Year	Cost mil EEK
Jööri	1	4000	2005	2
Tagavere	2	8000	2005	4
Aru	1	4000	2006	2
Sakla	2	8000	2005	4
Kärla	2	2000 (reconstruction of old tank) + 4000	2006	0,5+2
Kaali	1	4000	2005	2
Koikla	2	8000	2006	4
Pähkla	2	8000	2006	4
In total	13	50 000		24,5

It can thus be concluded that the project activity clearly involves additional costs of manure management compared to continuation of current practices (option 2). The higher capital costs and low financial rates of return for the project activity further support the less economic and financial attractiveness of the project.

Result: Pass

Step 3 – Barrier Analysis

An assessment of the investment reveals that there are a number of barriers to the development of the Saare Animal Waste Management Project, including

- Higher capital costs than current methods, with low financial rates of return as demonstrated in the Business Plan (a commercially confidential document, only available to the validator). Carbon revenue adds 2,1 percentage points to IRR and without carbon revenue the debt-service coverage ratio falls significantly below factor 1.

- Technological barriers arising from the implementation of an environmental technology which is not widely used in the former Soviet Union
- Management barriers relating to a lack of experience with the operational and maintenance of such technology

Result: Pass

Step 4 - Common Practice

The project is understood to be the first of its kind in Estonia, and hence cannot be considered to be common practice. Other similar technologies include the methane tanks of the Tallinn city waste management plant and pig manure treatment methane tanks in Linnamäe and Pärnu meat production plants. No other facility with the integrated process of anaerobic digestion and manufacturing of organic fertilizer is currently in operation in Estonia. The project will be the first of its kind.

Result: Pass

Step 5 – Impact of JI Registration

The expectation of income from the sale of ERUs has a positive impact on the economics of the project, and assists the project owner in overcoming many of the investment barriers and risks as previously highlighted. Carbon revenue adds 2,1 percentage points to IRR. As the project has a low rate of return, the additional income from the sale of ERUs/AAUs makes an important contribution to the financing of the project

Result: Pass

6.2 Assessment

The project is judged to be additional since

- Continuation of the current practice (the baseline) is legal, and there are no imperatives to investment in digestion technology
- The baseline is clearly the least cost option, and the project activity is a higher cost option
- There are technical and management (aversion to new technology where established practices suffice) barriers to implementation as this is the first project of its kind in Estonia
- The project is financially not viable without grant funding and other interventions

Following the above logic (using a stringent set criteria as proposed by the CDM-EB), the proposed project activity is not the baseline, and hence is additional.

7 Stakeholders' comments

The following public meetings in connection with the Environmental Impact Assessment have been held to solicit and take into account the comments of interested stakeholders:

- On 14.02.05 to present the programmed for the EIA, with participation of 12 people representing the local municipality, Saaremaa Environmental Service, project developer and partners, EIA expert, NGOs and local people, and
- On 12.04.05 to present the findings of the EIA, with participation of 9 people from the same above mentioned organizations.

At the latter meeting the EIA report was in detail presented and the following questions were discussed: quarantine related to equipment, EIA monitoring, price of compost, removal of N & P in the process, wastewater outflow from the plant, noise of the biogas engine, transport of manure, biosludge and animal by-products, future of the existing tanks at pig farms. The EIA expert and developer provided adequate answers to all raised questions and no unsolved problems remained. According to local municipality, no complaints or proposals had been received in connection with the EIA.

In addition, consultations have been held with the following authorities an organization during the development of the project, all of whom have provide their support and encouragement for the project:

- Valjala municipality and the other municipalities on whose territories the pig farms are located
- The local environmental NGO, Clean Environment of the Islands (Saarte Puhas Keskkond)
- Neighbouring farms

References

Environmental Impact Assessment Report of Construction And Implementation Of Manure Utilization Facility In Valjala Pig Husbandry (Unofficial Translation), Undertaken by OÜ Vetepere, January 2005

Feyaerts, Huybrechts and Dijkmans (2002), Beste Beschikbare Technieken (BBT) voor mestverwerking (tweede éditie), VITO, 2002

CDM Executive Board, Approved baseline methodology AM006, Available at http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

CDM Executive Board, Approved baseline methodology AM0016, Available at http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

European Commission, Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques for Intensive Rearing of Poultry and Pigs, July 2003

Danish Institute of Agricultural Science, Reduction of GHGs from manure and organic waste by biogas treatment (Reduktion af drivhusgasemission fra gylle og organisk affald ved biogasbehandling) DJF report no. 31, 2001

Andrew Dustan, Review of methane and nitrous oxide emission factors for manure management in cold climates, JTI Institutet för jordbruks- och miljöteknik, 2002

IPCCa, Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories

IPCCb, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories

TÜV SÜD, validation of Esivere and Virtsu II Wind Power Development, Baseline Study undertaken by ECON Analysis, March 2005, available at http://www.netinform.de/KE/startE.asp?Ziel=aktuell_listingE.aspx

Lisec, Analyserapport, 28-10-04 (not published).

Appendix A Proposed Monitoring Protocols

Proposed monitoring protocol on electricity supplies **Year** **2012**

Baseline emissions factor
Methane emission factor [illegible]
Nitrous oxides emission factor [illegible]
[illegible] new emissions factors should
[illegible] verification

[illegible]
If venting occurs, emissions factors per m^3 vented gas is to be determined as conservative as neccessary and subject to independent verification

Pig manure treated	Unit	Remarks	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Manure input recetion tanks	*tonnes*	*Monitored*	*0*												
Change in fodder composition	yes/no	Monitored													
Vented biogas	m^3	Monitored													
Date of monthly entry	yr-mm-dd														
Reponsible person	initials														
Date of quality control (qc)	yr-mm-dd														
Reponsible person for cc	initials														
Responsible person for cc	Signature														
Baseline emissions	tCO_2e	Calculated													0
Project emissions from venting of biogas	tCO_2e	Calculated													
Net project emissions	tCO_2e	tCO_2e													0

Proposed monitoring protocol on fuels for manure transport Year 2006

[illegible]

[illegible]

Transport fuel consumption	Units	Remarks	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Diesel oil	Litre l0	Monitored													
Others if any, specify)	Litre l0	Monitored													
Total consumption	*Litres l_j*	*Monitored*	0	0	0	0	0	0	0	0	0	0	0	0	
Total fuel consumption	*tonnes t_j*	*Calculated*	0	0	0	0	0	0	0	0	0	0	0	0	
Total energy consumption	*GJ**	*Calculated*	0	0	0	0	0	0	0	0	0	0	0	0	
Manure transported	*tonnes t_j*	*Monitored*	0												
Date of monthly entry	yr-mm-dd														
Reponsible person	initials														
Date of quality control*	yr-mm-dd														
Responsible for qc	initials														
Responsible for qc	Signature														
Project emissions	tCO_2e	Calculated													0,0
Baseline emissions	tCO_2e	Calculated													0,0
Net project emissions	tCO_2e	Calculated													0,0