ARA Bioenergie Brokenlande GmbH & CO. KG

"Brokenlande Biogas Project"

GHG Project Plan

April 2010

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PROJECT DESCRIPTION

Project title

Brokenlande Biogas Project

The project's purpose(s) and objective(s) are:

The proposed project activity is a Combined Heat and Power Plant that will utilize biogas produced by efficiently managing and upgrading the existing manure system and drastically reducing the open storage dwell time of the manure produced.

Main objective of the project activity is the technical production of biogas using manure from dairy cows that otherwise would emit uncontrolled methane emissions into the atmosphere during their storage. Another objective of the project activity is to mitigate GHG emissions by replacing fossil fuels in the neighboring greenhouse heating system. Instead of the previously used fossil fuel (heating oil) thermal energy from the biogas fired CHP motor will be used for these thermal applications. Additionally, renewable energy is produced to be fed in the local power grid.

Expected lifetime of the project

The expected lifetime of this project is 20 years beginning with the start of operation in May 2009.

Type of greenhouse gas emission reduction or removal project

Carbon dioxide (CO_2)

The project activity reduces CO_2 emission via heat generation by the CHP sourced by biogas. In absence of the project, the heat would be produced with heating oil. The project will also generate clean electricity by the CHP. However, the net CO_2 mitigation from the electricity approach is neutralized in order to avoid conflicts with other legal acts in Germany.

Methane (CH_4)

The project activity collects and combusts the biogas generated from the management system of the manure and co-ferments. In absence of the project the methane would emit into the atmosphere in an uncontrolled manner during its storage.

Legal land description of the project or the unique latitude and longitude

The biogas plant is located in the Northern part of Germany in Brokenlande, district of Großenaspe. The plant site is next to the Hans Gosau garden center and close to the highway exit "Großenaspe".

The geographical coordinates are 53°59'55.18" north 9°55'44.68" east.

The exact address of the project site is:

Street: Brokstedter Straße 1

District: Brokenlande

Community: Großenaspe

Postal Code: D-24623

State: Germany

Figure 1: project location

Conditions prior to project initiation

The biogas plant receives manure from the dairy cow farming operations located in the near vicinity of the project site. Without this project activity the dairy cow manure would continue to be stored in open storage tanks over roundabout 6-9 months before spread on the fields. The manure when kept in open-top basins, tanks or lagoons open to the atmosphere will undergo anaerobic fermentation and release greenhouse gases (methane, CO_2 and N_2O) to the atmosphere and also produce bad smell for the neighborhood. Heat for the greenhouse was generated by another already existing CHP and by an oil heating system. The heat generated by project activity will replace the corresponding amount of heat from the oil heating.

Description of how the project will achieve GHG emission reductions or removal enhancements

The project activity is the technical production of biogas using cattle manure that otherwise would emit uncontrolled methane emissions into the atmosphere during its storage. The collected biogas will be combusted in CHP. This process will reduce the CH_4 emission. The electricity generated from CHP will be fed into the local power grid. The thermal energy from CHP will be used to replace the utilization of heating oil in the nearby greenhouse. This process will reduce the CO_2 emission. However, the net GHG mitigation from the electricity approach is neutralized in order to avoid conflicts with other legal acts in Germany.

Project technologies, products, services and the expected level of activity

The project is an anaerobic digestion setup with a grid connected Combined Heat and Power plant (CHP) attached using primarily cow manure for fermentation, as well as co-ferments such as grass or corn silage.

The biogas production starts with collection of manure in the mixing tank. From there the digesters are continuously fed with manure and co-substrates. In the digesters methane bacteria metabolize the methane at a temperature of 40°C. The process is very complex and includes the sub steps hydrolysis, acidification, acetic acid generation, and methane generation. It is very vulnerable to temperature change and substrate composition. Result of this process is biogas with a methane content of approx. 60%.

The biogas will be collected under a double membrane top and directed from there to the CHP plant. The top can also serve as a gas storage. In the CHP the methane is combusted to produce electrical energy. The digestate will be moved to a post digester and finally to a digestate storage. Finally, it will be spread on the fields as fertilizer.

Co ferment	Volume t/y	Specific gas production Nm³/ t	Biogas production Nm³/t	Methane content [%]	Methane production m³/y	Source
liquid manure	14627,37	34	497331	55,00%	273.532	www.lfl.bayern.de/
solid cattle manure	12,6	108	1361	55,00%	748	www.lfl.bayern.de/
dry chicken manure	220,5	500	110250	58,10%	64.055	www.lfl.bayern.de/
corn silage	2964,9	185,3	549396	52,20%	286.785	www.lfl.bayern.de/
gras silage	347,5	208,3	72384	54,10%	39.160	www.lfl.bayern.de/
whole crop silage	90,8	194,8	17688	52,30%	9.251	www.lfl.bayern.de/
potato	109	150,1	16361	51,50%	8.426	www.lfl.bayern.de

beet pulp	14,2	594,3	8439	50,60%	4.270	/ www.lfl.bayern.de /

Table 1: List of Substrates in 2009

Total GHG emission reductions and removal enhancements, stated in tonnes of CO_2 e, likely to occur from the GHG project (GHG Assertion)

	PFC (tCO_2 e)	HFC (t CO_2 e)	SF_6 (t CO_2 e)	CO_2 (t CO_2 e)	CH_4 (t CO_2 e)	N_20 (t CO_2 e)	Total (t CO_2 e)
2009 ex-post				240	4.448		4.688

Table 2: Reduction of greenhouse gases in 2009

The measured ex-post values for 2009 have been lower than calculated ex-ante but are within a realistic range. Biogas production came very close to the calculated because feeding of the digesters took place before beginning of operation. Thus biogas was produced nearly the whole year. Reduction from substitution of fossil fuels was not as high as expected. This may be explained with a lack of demand at the greenhouse or technical problems.

Identification of risks

There are considerable risks in participating in such a project. Firstly, there is a general operational risk for biogas plants. The fermentation process within the fermenters is depending on several factors. The most important factor is the bacteria which are producing enzymes. These enzymes are starting a fermentation process which starts to break up the manure into its components. In other words, the fermentation in the biogas plant is a biological process which relies on microbiological deposition of the materials used in the process. Manure is commonly used in numerous biogas plants around the world. Therefore the technology and substrates applied in the fermentation process are pretty much standardized which reduces operational risks. Anyhow, there is a certain risk that once the process is running it could be disrupted by failures resulting from fluctuations of the material input (quantity) or the material quality into the digester. The fermentation process could be interrupted by these or other issues. An interruption could cause a complete operation breakdown and would make a complete restart of the process necessary.

Although the legal frame for renewable energy projects can be considered as relatively stable the renewed renewable energy act 2009[1] showed that there is still a considerable risk concerning

[1] EEG 2009 http://bundesrecht.juris.de/bundesrecht/eeg_2009/gesamt.pdf

tariffs for biogas installation. A retroactive modification in the law considering the size of several bundled biogas plants was leading to a series of insolvency of biogas companies who trusted the legal framework[2]. With a minor change in the feed in tariff the risk of insolvency is increasing dramatically. As consequence the new introduced manure bonus is not secured for a life time and it is not 100% secured that the actual tariff is valid for the next 20 years.

The implementation of the biogas plant implemented in a wider network of farmers is not usual in Germany. The bonus for the use of manure has been designed to favor the farms with sufficient amount of manure in order to produce electricity. Mostly this fact is favoring large scale farms which large amount of animals which produce often at an industrial scale. While elsewhere the agro-industries of large scale developed to realize economies of production and scale, Schleswig-Holstein has only few big farms compared to those in other parts of Europe - not to mention the agricultural structure of North America. Instead the region around Großenaspe has numerous small and medium-sized farms, even though there has been a development towards concentration in the agriculture of Schleswig-Holstein for the last 40 years. The transport of manure is although common in regions where the soil can not absorb the nutriments (the amount of N is limited to 170 kg/ha) and the manure has to be "exported" to a region with a demand of fertilizer (e.g. region around Vechta where agriculture is focused on swine pork production). This is not the case in Großenaspe – for farmers the manure represents a high value fertilizer. For the participating farmers there is a risk in giving away the manure even if scientific documentation argues that fertilizing value of the manure is increasing. Participation and cooperation of the farmers is essential for the continuous delivery of manure and co-ferments and the successful operation of the plant.

Roles and Responsibilities

Project Owner and Operator:

Organization:	ARA Bioenergie Brokenlande GmbH & Co. KG
Street /P.O. Box:	Großer Burstah 31
City:	Hamburg
State/Region:	--
Postal code:	20457
Country:	Germany
Contact person:	Christian Saul
Phone:	+ 49 (0)40 809 063 101

[2] http://www.news4press.com/Biogasanlage-in-Penkun-%E2%80%93-Anleger-sollten_473172.html

Direct e-mail:	Christian.saul@greenstream.net

Table 3: information on project owner

ARA Bioenergie Brokenlande GmbH & Co. KG is the project owner, who declaims to have all the title of primary ownership of the emission credits. A technical staff is assigned by ARA Bioenergie Brokenlande GmbH & Co. KG to take charge of the operative execution of the operation and monitoring process.

Report Author and Carbon Manager:

Organization:	Greenstream Network Biogas GmbH
Street /P.O. Box:	Grosser Burstah 31
City:	Hamburg
State/Region:	--
Postal code:	20457
Country:	Germany
Contact person:	Mr. Thomas Eccard
Phone:	+49 (0)331- 581645 – 10 + 49 (0)331- 581645 – 12
Direct e-mail:	Thomas.eccard@greenstream.net

Table 4: information on report author and Carbon Manager

Greenstream Network Biogas GmbH is the responsibility party of the generation and commercialization of emission credits out of the project. It will perform the supervision of the monitoring concept and execute the continuous evaluation of the recorded data and the preparation of the monitoring report.

Any information relevant for the eligibility of the GHG project under a GHG program and quantification of emission reductions

ISO 14064 focuses on GHG projects or project-based activities specifically designed to reduce GHG emissions or increase GHG removal. The proposed biogas power plant is designed to recover the methane emission from the manure management system and utilize it to generate electricity and heat, which is eligible for a GHG project.

The Brokenlande Project has been approved according to the Federal Immission Protection Law of the Federal Republic of Germany. This Act provides the set of rules which regulates the impact assessment of plants - or similar constructions - on the environment.[3] The Federal Immission Protection Law implies public involvement of the projects including the submission of project documents (such as plans, drawings, studies). Public stakeholders have the right to comment on the project. Additionally the publicity has to be informed about the final project decision.

Due to the regulation of EU-ETS the net GHG mitigation from the electricity approach (production amount minus operating demand) is neutralized in order to avoid conflicts with other legal acts in Germany, e.g. the regulation covering the feed in tariff for electricity produced from biogas as per "Gesetz für den Vorrang erneuerbarer Energien" (Erneuerbare Energie Gesetz) EEG. Therefore, this report only involves the emission reduction from methane recovery from manure management and thermal energy generation.

The project applies for registration in the GHG CleanProject Registry.

Summary environmental impact assessment

An environmental impact assessment was not claimed by the authorities. The approval for Federal Immission Protection Law does clearly state that such an assessment is not necessary.

Relevant outcomes from stakeholder consultations and mechanisms for on-going communication.

The Federal Immission Protection Law implies public involvement of the projects including the submission of project documents (such as plans, drawings, studies). Public stakeholders have the right to comment on the project. Additionally the publicity has to be informed about the final project decision. The content of this decision including its reasons is to be made public as well. The Brokenlande Project is matter to the rules of the Federal Immission Protection Law and therefore the project has been made public. The process how to make the project is also ruled by German law. Additionally to these legal aspects, the regional press reported about the project well before it started. Unrestricted information about the Brokenlande project has been published according to the laws. All stakeholders were informed and had the chance to comment on this project and – if desired – litigate against the project at the administrative court.

No such action was taken whatsoever. Whenever stakeholders gave feedback it was very positive due to the advantageous economical and environmental consequences of the project.

Detailed chronological plan

Date	Activity
September 12st 2008	Approval/ building permit

[3] Bundes-Immissionsschutzgesetz (BImSchG) in der Fassung der Bekanntmachung vom 26. Sept. 2002 -BGBI. IS. 3830-, in Verbindung mit Nr. 1.2a, Spalte 2 des Anhangs der Verordnung über genehmigungsbedürftige Anlagen (4. BImSchV)

September 15st 2008	Begin of construction
May 01th 2009	Begin of credit period of the project activity
May 25th 2009	Begin of project operation

SELECTION AND JUSTIFICATION OF THE BASELINE SCENARIO

The baseline represents the most plausible scenario in absence of the project activity and is the base to calculate the emissions that are expected in this scenario. To determine the baseline, the status before and during project activity and alternatives are compared and discussed.

Current practice in Germany is the storage of manure in lagoons, basins and tanks open to the environment, so that all methane, laughing gas and other odorous and hazardous gases are emitted to the atmosphere. It is defined as the baseline scenario. The farms around Brokenlande use such anaerobic lagoons in all its barns since this concept is compliant with German legislation and it represents the state of the art and least cost scenario for manure systems in Germany. From economic point of view, an anaerobic lagoon is much cheaper than a biogas plant with closed fermenters. As an alternative, closed lagoons could be installed. The odor would be reduced but without the utilization of the biogas high investment costs would stand against no revenues.

Oil heating could be replaced by other more environmental friendly systems like natural gas or even CO2 neutral combustion of biomass. Feasibility for this measure alone is very low though. The existing heating system still runs without problems, a new installation with this capacity (4,8 MW) would result in high investment costs.

DESCRIPTION OF HOW THE ANTHROPOGENIC EMISSIONS OF GHG BY SOURCES ARE REDUCED BELOW THOSE THAT WOULD HAVE OCCURRED IN THE ABSENCE OF THE REGISTERED PROJECT.

Application of the benchmark analysis is the chosen method to determine that the project activity is not the most economical feasible alternative.

Apply benchmark analysis

Renewable energy projects are typically financed by equity (appr. 30 %) and loans (appr. 70 %). To evaluate the additionality from the point of view of private investments the IRR (internal rate of return) on equity is the most suitable parameter and accordingly chosen within the investment analysis. For comparison reason with benchmark indicators the NPV (net present value) on equity is also going to be calculated.

In the investment sector, for biogas and wind projects in German (benchmark), the required rate on return on private equity amounts to 8% – 9%. This range is supported by four private equity funds. The first one is named "Biogasfond Sachsen-Anhalt"[4]. It was released in 2005 and aiming for investment capital for three biogas plants. The IRR prognosis for this found calculated to be 8,88%. The second one is named "BEV BioEnergie GmbH & Co."[5]. This private equity fund was released in 2005, collecting investment capital to four biogas plants. The IRR is calculated to be 8,39 %. The two more founds concerned are "Cash Cow II" and "Cash Cow III". The "Cash Cow II" [6] released on 2005, has collected investment capital for six biogas projects in Germany. The IRR prognosis was calculated to be 8,89%. The "Cash Cow III" [7] was released 2006 aiming for investment capital for four biogas plants. The IRR prognosis for this found calculated to be 8,88%. For wind projects several funds are offering participating opportunities, for example Prokon with an return of 8 % on average[8].

As the biogas project Brokenlande is a single project, where the risk concentrates on this single site, the benchmark RRR of 8 % is considered to be conservative and thus applied for this project.

The state of Hungary published a manual for evaluation of additionality which also sets 8% IRR as the benchmark.[9]

Calculation and comparison of financial indicators

The financial model in detail is submitted for validation but remains confidential to the public. The description and explanation of the single approaches of this financial model are given below.

Investment costs

Scenario 1: The investment costs of the biogas plant Brokenlande were calculated according to the project planning to 2.550.000 EUR, including the costs for engineering, official approval and project development.

Financing

As usual when financing renewable energy projects, the capitalization was realized by a mixture of loan and equity capital applied with a split of 76,5 % loan (01.08.2009EUR) and 23,5 % equity (01.01.2009).

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[4] ABO Wind AG, 15.09.2005

[5] Müller & Partner, 31.03.2006

[6] Aufwind Schmack GmbH & Co, 02.11.2005

[7] Aufwind Schmack GmbH & Co, 28.11.2006

[8] Prokon Energiesysteme 4.9.2009 URL: <http://www.prokon-energiesysteme.de/microsite/index3.php>

[9] "Manual for evaluating the additionality of Joint Implementation projects and for calculating the baseline emissions of electric power projects", Hungarian ministry for Environment and Water

Financing conditions are equal for both scenarios. The loan conditions were arranged to 5,3 % annual interest rate for the loan of with a redeeming period over 15 years.

Replacement Investments

For replacement investments, 456.000 EUR were placed in the financial model to be invested 10 years after project start. This approach of 20% of the total investment costs could be considered as conservatively by means of leading to a rather higher IRR than realistically to be expected.

Income Stream

The income stream of the project activity during project realization is determined by both the feed-in tariff of the German EEG [law] (Erneuerbare Energien Gesetz/ Renewable Energy Act) in its version valid as of January 2008, and the delivery of thermal energy to the vicinal greenhouse.

Compensation tariffs according to EEG:

base tariff, emission bonus, NAWARO-bonus (energy crops), Gülle-Bonus (manure bonus) (detailed values in calculation sheet)

Annual Expenses

The total annual expenses during standard operation are added up to EUR based on the following single cost positions:

annual expenses without price increase	
Manpower (Operation&Administration)	-20.000
Operating Costs Wheel Loader	-10.000
Manpower (Administration ans Accountancy)	-8.000
Overhaul and Maintenance except CHP	-22.800
Overhaul and Maintenance CHP	-62.635
Electricity demand	-37.271
Analysis	-1.600
Insurance	-7.650
TOTAL	**-169.955**

Table 5: annual costs

Thermal energy:

Income for thermal heat which is delivered to the greenhouse is arranged to 1 ct/kWh. As manure consists mainly of water internal process energy to heat up the substrates is considerably higher than it is for the use of maize. To simplify the calculation it is assumed that only thermal energy for heating is necessary and transmission losses by the surface are estimated to 30% of the energy to heat the material. This is a conservative approach, as in reality losses by the surface are significantly. As these losses are proportional to the surface, larger digesters, which are necessary for digestion of manure are transmitting effectively more energy. In the model this simplified approach is calculated with specific heat capacity of water (because substrates consist mainly of water) and an average increase of 26 K (from 12°C average temperature to 40°C mesophilic band).

Annual Price Increase

The annual price increase on all annual expenses was estimated to 1,4 % according to statistical data of the last 5 years in Germany[10]. This is a very conservative approach as the increase of electricity costs and diesel prices are significantly higher.

Taxes

Based on the German tax formalities within the profit and loss prognosis, 15,825 % corporate tax and approx 20 % income tax upon loss carry forward or EBT, respectively has been applied.

Benchmark Analysis

As explained above (see apply benchmark analysis) the RRR (bench mark) was conservatively chosen to be at 8 %. The IRR on equity of the project activity is calculated to be 1,97%, which is much lower than the RRR of 8 %. Applying the same 8 % as opportunity costs, the NPV to equity is calculated to be -330.517 EUR conforming the unattractiveness of an investment when referring to benchmark conditions. Hence, both parameters IRR and NPV clearly show that the project activity cannot be considered as financially attractive.

Sensitivity analysis

To prove the robustness of the financial analysis a sensitivity analysis with variations in the critical assumptions was conducted. The three parameters investment costs, annual expenses as well as energy production were chosen for this analysis. The results are shown below.

The analysis was performed on each of the three parameters with a deviance range from – 20 % to + 20 % compared to their reference values in the financial model. The decreasing of all parameters down to 80 % of their reference values leads to an IRR to reach an IRR of 8 %. As

[10] Statistisches Bundesamt Verbraucherpreisindex 2001 bis 2008 http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Content/Statistiken/Zeitreihen/WirtschaftAktuell/Preise/Content100/kpre510bv4.psml

propability for an increase of values is the same as for a decrease the sensivity analysis proves the need of an additional income in order to finance the transports from manure.

	deviance of paramenter / IRR corresponding				
	80%	90%	100%	110%	120%
Investment	8%	5%	2%	-1%	-3%
Annual expenses	17%	10%	2%	-10%	0%
Energy production	0%	0%	2%	11%	19%

Table 6: deviance of parameter

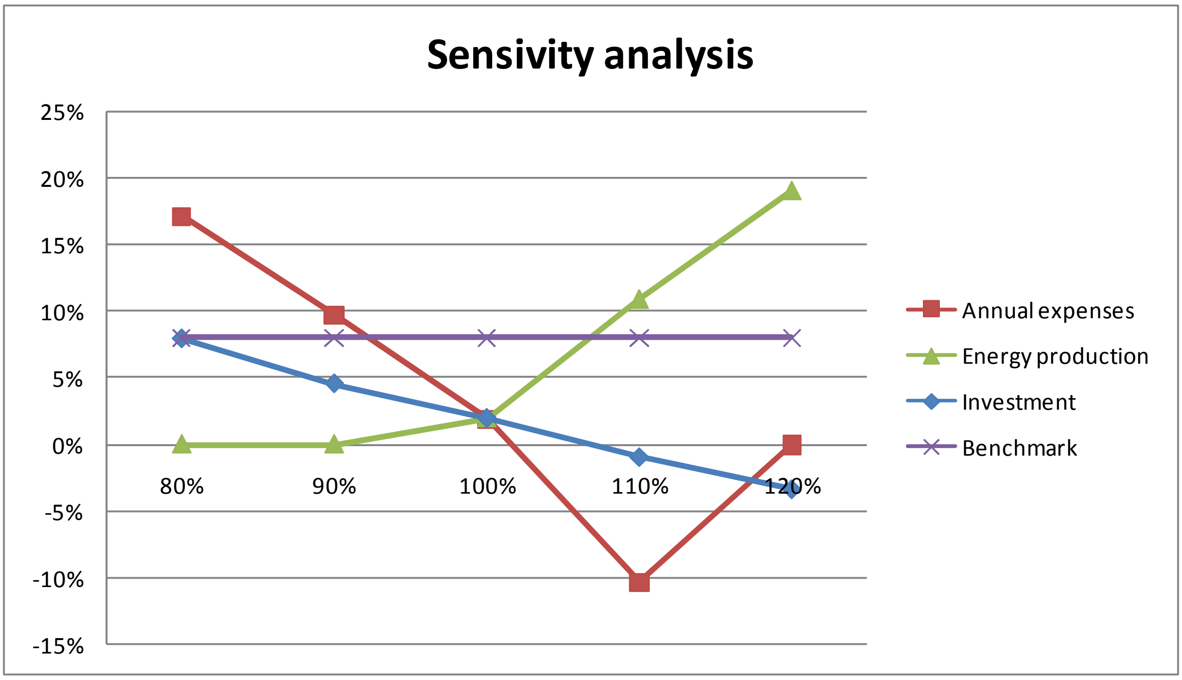

Figure 2: sensivity analysis

Taking into account conservative values already chosen for these parameters in the financial model, the sensitive analysis proves the high unlikeliness of the project to generate IRRs on equity in the range of the benchmark. Much more likely is the scenario of higher costs, which leads to even lover IRR for the project activity. The sensitivity analysis shows clearly that the derived conclusions on the financial unattractiveness is very robust to variations of important costs parameters especially when assuming that the applied cost approaches are reasonably low in a conservative sense.

INVENTORY OF SOURCES, SINKS AND RESERVOIRS (SSRS) FOR THE PROJECT AND BASELINE

	Controlled	Related	Affected	How the GHG SSR change from the baseline scenario to the project?
Baseline				
GHG Source				
1) CO_2 emission from fossil fuel consumption to generate electricity and/or heat in absence of the project	√			The thermal energy generated by the project activity will replace the consumption of nature gas, which will reduce the CO_2 emission.
2) CH_4 emission released during the degradation process of manure	√			The project will collect CH_4 via biogas digester and combust it with CHP. In absence of the project activity the CH_4 will release into atmosphere in an uncontrolled manner.
3) N_2O and CO_2 emission from the production of artificial fertilizer			√	The closed nutrient cycle of project activity will make some of the artificial fertilizer redundant, reducing the demand.
Project activity				
GHG Source				
4) CO_2 emission emitted from the fossil	√			There will probably be some fossil, electricity, heat consumption by the

, electricity, heat consumption by the project activity				project activity, which will emit CO_2.
5) CO_2 emission from burning of diesel fuel by trucks transporting manure and co-ferments	√			More transports than in baseline scenario are likely to appear.
6) CH_4 emissions from leakage or incomplete methane combustion.	√			Several measures were taken to avoid the possibility of methane leakage.
GHG Sink				
7) CO_2 and Nitrogen sink in the co-ferments probable used in the project		√		The project activity is possible to use co-ferment to supplement the nutrient element in the biogas digester. In that case part of CH_4 is generated by the degradation of co-ferment, which is against GHG sink. However, the project monitoring system will record the co-ferment utilization and deduct the emission reduction caused by this element.

Table 7: sources sinks and reservoirs of baseline and project activity

Criterion for relevance of a source, sink or reservoir is an emission (reduction) that counts for at least 1% of the calculated total emission reduction of project activity. SSRs that do not meet this criterion will not be considered. Also only SSRs controlled by project activity will be considered.

Source 2 will, in spite being relevant by definition above, not be considered because no reductions were claimed for the production of renewable electric energy. Project activity has a positive balance regarding emission from electric energy production. Considering the electric energy consumption but not the much higher reduction would mean a disadvantage for such an installation.

Source 5 accounts for less than 1% of total emission reductions. In 2009 emissions from transport were 5,8 t CO2e, 0,12% of total emission reductions of 4.688 t. Experience showed that this is the case for all biogas plants with a rather small radius for obtaining substrates.

Source 6 is estimated as irrelevant because state of the art technique is not supposed to leak a significant amount of methane. Methane combustion is the process that generates energy and therefore the income of the plant. A high loss of methane would make a biogas plant economical unfeasible. Technical measurements to avoid methane leakage here include gastight gas pipes and digesters as well as double membrane roofs for gas storage in times of non operation of the CHP.

During Monitoring the measured biogas production will be cross checked with the energy produced. Energy counters are well developed equipment because production of electric energy is as mentioned essential for the economical operation of such a plant. If there was significantly less energy generated than potentially was possible from the amount of biogas than a method to quantify possible leakage will be developed.

QUANTIFICATION AND CALCULATION OF GHG EMISSIONS/REMOVALS

1. Equations for CH4 emissions from manure management systems and agricultural and food wastes

The IPCC Tier 2 approach[11] was used to estimate the baseline emissions from a group of animals ex-ante:

$$BE_{I,y} = GWP_{CH4} * D_{CH4} * UF_b * \sum_{j,LT} MCFj * B_{0,LT} * N_{LT,y} * VS_{LT,y} * MS\%_{Bl,j}$$

BE_y	Baseline Emissions of part A in the year y (t CO_2e)
GWP_{CH4}	Global Warming Potential of CH4 (21)
D_{CH4}	Density of CH4 (0,0007168 t/m³ at room temperature (20 °C) and 1 atm pressure)
UF_b	Correction factor to equal model uncertainties (0,94)
j	manure management system
MCF_j	annual methane conversion factor (MCF) for manure management system j
LT	Livestock (cattle, swine, breeding pig, poultry)
$B_{0,LT}$	Maximum Methane production potential of organic solids for livestock „LT“ (m³ CH_4/kg dm)
$N_{LT,y}$	Annual average number of animals of livestock „LT“ in the year y
$VS_{LT,y}$	Organic volatile solids of livestock “LT” that is brought in the manure management system in the year y (dry matter, kg dm/head/year)
$MS\%_{Bl,j}$	Fraction of manure in the manure management system j

The calculation delivers the annual **baseline** methane emissions **of** released **4.368 t CO_2e** from stored manure.

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[11] Equation 16, page 4.26; Revisd 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual; Or equation 4.17, page 4.34, IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories

The amount of biogas will be monitored continuously, so that in consequence the calculation will be much more exact than the estimation of emissions via the number of animals. The Methane actually destroyed by project activity is calculated with the measured amount of biogas and its methane content minus the share of methane generated from the co-ferments. The following formulas are used for the *ex-post* calculations:

$$GHG_{red\,I} = \left(BGP_y * MC_y - \sum_n BGCO_{n,y} * MCCO_{n,y} \right) * GWP_{CH4} * D_{CH4}$$

MD_y	Captured and converted methane from project activity in the year y (t CO_2e)
BGP_y	Amount of biogas that is flared or gainfully used in the year y (m³)
MC_y	Average fraction of Methane in the biogas in year y (%)
$BGCO_{n,y}$	Biogas production of Co-ferment n in year y (m³)
$MCCO_{n,y}$	Average fraction of Methane of Biogas from Co- ferment n in year y (%)

Biogas production of Co ferments is determined by the appropriate input volume and the specific gas production of the Co –ferment. Specific gas production and Methane content values are taken from literature.

Co ferment	Volume	Specific gas production	Methane content	Methane production	Source
	t/y	Nm³/ t	[%]	m³/y	
corn silage	2964	185,3	52,20%	286.698	http://www.lfl.bayern.de/ilb/technik/10225/
gras silage	347	208,3	54,10%	39.104	http://www.lfl.bayern.de/ilb/technik/10225/
whole crop silage	90	194,8	52,30%	9.169	http://www.lfl.bayern.de/ilb/technik/10225/
potato	109	150,1	51,50%	8.426	http://www.lfl.bayern.de/ilb/technik/10225/
beet pulp	14,2	594,3	50,60%	4.270	http://www.lfl.bayern.de/ilb/technik/10225/

Table 8: methane production 2009

A total amount of 1.211.244 m³ biogas with a methane content of 51,3 % was combusted in 2009 (see Monitoring report 2009 for details). Of 642.17 m³ methane a fraction of 347.891 m³ was generated from co ferments. The destruction of the methane originated from manure results in an emission reduction of **4.448 t CO2e**.

2. Equations for replacement of fossil fuels for heating

The CO_2 emissions due to the use of fossil fuels to generate heat are determined using formula from approved IPCC methodology AMS-I.C. Thermal energy production with or without electricity. The ex-ante estimation is calculated the following:

$$BE_{II,y} = \frac{EG_{thermal,y}}{\eta_{BL,thermal}} * EF_{FF,CO2}$$

$BE_{B,y}$	Baseline Emissions of fossil heat replaced by project acitvity in the year y[t CO_2e]
$EG_{thermal,y}$	Net heat supplied by project activity in year y. [TJ]
$\eta_{BL,thermal}$	Efficiency of fossil fuel based system in absence of project activity in year y [%]
$EF_{FF,CO2}$	CO_2 Emission factor of fossil fuel in the baseline scenario [t CO_2 / TJ]

For ex-post calculation of the substitution of fossil fuels a possible change of the heating system must be considered. If the heating consumer would change to a system with renewable fuels, the claimable emission reductions would equal zero. This is not expected for the next 10 years of rest lifetime though.

$$GHG_{red\ II} = \sum_{m} TEP_{m,y} * EF_{CO2-m}$$

$TEP_{m,y}$	Thermal energy used by heat consumer to substitute fossil fuel m in the year y (TJ)
$EF_{CO2\text{-}m}$	Emissions factor of fossil fuel m (t CO_2e /TJ)

Thermal energy used is measured as monitoring parameter ETP and converted from kWh to TJ with a factor 0,0000036

4. Total emission reduction

The total GHG reduction caused by the project acitivity is determined *ex-ante* by

$BE_{total} = BE_{I} + BE_{II}$

For the *ex-ante* estimation of GHG emission reduction by the project activity is 5.240 tCO_2e annual.

The total GHG reduction caused by the project acitivity is determined *ex-post* by

$GHG_{red,total} = GHG_{red,I} + GHG_{red, II}$

The *ex-post* calculation of GHG emission reduction by the project activity is 4.688 tCO_2e in 2009. More information is provided in the appended monitoring report of the project during the period of May 1st 2009 – Dec 31st 2009.

DESCRIPTION OF HOW EACH OF THE GUIDING PRINCIPLES HAS BEEN RESPECTED OR ADDRESSED

Relevance

Relevance criterion was adapted from CDM/JI rules. The criterion is a share of at least 1% of the baseline emissions or an amount of 2.000 t CO_2e depending on which value is lower. Because of the small scale the 2.000 t cap is not applicable though.

Only exception from use of this criterion is the consumption of electric energy, which is measured but not added as project emissions. As explained above project activity has a positive balance regarding emission from electric energy production.

Completeness

For Baseline of Methane reduction the physical leakage was not considered. This is because values were seen as to high and unrealistic. A leakage of 10% would make a biogas installation economical unfeasible. The consideration of physical leakage in the baseline would distort the estimation without having any influence on the claimable reductions.

For Monitoring the amount of biogas combusted, methodology uses an adjustment factor, which is not done here. Instead a model correction factor is applied to the total emission reductions for reasons of conservativeness.

Consistency

Formulas are adapted from approved IPCC methodologies.

Accuracy

Accuracy of measurement is supposed to be very high because the instruments are state of the art. Formulas from approved methodologies have undergone several revisions and improvements. Thus results can expected to be accurate.

Transparency

All data used for calculations is described in the appended Excel sheet and sources are also named. Monthly reports 2009 of ARA Bioenergie Brokenlande are appended.

Conservativeness

Conservative assumptions have been made in all key questions like additionality and relevance of SSRs. Furthermore a correction factor of 0,9 was applied to the total emission

reduction in order not to over estimate them.

MONITORING THE DATA INFORMATION MANAGEMENT SYSTEM AND DATA CONTROLS

SSR identifier or name	Data parameter	Estimation, modeling, measurement or calculation approaches	Data Recording (electronic or paper)	Data unit	Sources/ Origin	Monitoring frequency	Description and justification of monitoring method	Uncertainty	QA/QC
Source 2	BGP (Biogas produced)	Monitored	Analysis report, Electronic or paper	m^3	Flow meter	Continuously	The flow meter measures data cumulative and continuously as the biogas flow is occurring.	Low (approx.<1%)	Based on inductive flow measuring, volume flow measuring is standard technique applied in industrial processes for long. Will be cross checked with energy production.
Source 2	MC (Methane content)	Monitored	Analysis report, Electronic or paper	Vol-%	Gas analyzer	Continuously	This parameter determines the actual methane content in the biogas.	Low (approx.<3%)	Determination of methane volume content is a standard analysis method.

Source 6	FT (Fraction of time)	Monitored	Analysis report, Electronic or paper	h	Runtime counter	Monthly	This parameter is used to control that the biogas produced (parameter 1. BGP) is destroyed in the CHP engines.	Low (approx.<1%)	Runtime hour recording is a standard measurement method.
Source 1	ETP (Thermal energy produced for external utilisation)	Monitored	Analysis report, Electronic or paper	kWh or MWh	Heat Counter	Continuously	To determine the displaced fossil fuels of the baseline scenario (only for phase 2).	Low (approx.<1%)	Heat counters are standard installations being highly precise, additionally normally referred to delivery accounting.
Source 1	EEP (Electrical energy produced)	Monitored	Analysis report, Electronic or paper	kWh or MWh	Power meter	Continuously	To cross-check the biogas produced and destroyed by the CHP engines.	Very low (approx.<0.5%)	Power meters are standard installations being highly precise, additionally referred to delivery accounting.
Source 4	EEI (Electrical energy imported)	Monitored	Analysis report, Electronic or paper	kWh or MWh	Power meter	Continuously	To ensure that the amount of EEP of the project activity exceeds the demand for its electrical energy	Very low (approx.<0.5%)	Power meters are standard installations being highly precise, additionally referred to delivery accounting.

Source 2	$MCOF_i$ (Mass of each co-ferment $_i$ fed into digester)	Monitored	Analysis report, Electronic or paper	t	Scales recording	When applicable	To determine the portion of biogas generated by co-ferments within the entire biogas amount. produced.	Low (approx.<3%)	High mass scales are very robust mechanical instruments being resistant of deviation within the uncertainty level.
Source 2	MANURE (Volume of manure fed into digester)	Monitored	Analysis report, Electronic or paper	t	Scales recording	When applicable	To determine the portion of biogas generated by manure self within the entire biogas amount produced.	Low (approx.<3%)	High mass scales are very robust mechanical instruments being resistant of deviation within the uncertainty level.

REPORTING AND VERIFICATION DETAILS

Monitoring Report for first period of operation in 2009 is appended to this document.

This document has been verified by an independent third party:

Name of Verifier:	TÜV Rheinland Immissionsschutz und Energiesysteme GmbH
Contact Name:	Roland Wollenweber
Address:	Am Grauen Stein; 51105 Cologne -Germany
Phone :	++49-221/806-4391
Fax:	++49-221/806-2889
E-mail:	enertest@de.tuv.com
URL:	www.umwelt-tuv.de

Greenstream Network Biogas GmbH assigned TÜV Rheinland Immissionsschutz und Energiesysteme GmbH (TÜV Rheinland) with the verification of the presented GHG project plan on April 13th 2010.

On April 16th 2010 an onsite visit has been conducted by TÜV Rheinland verifier Mr. Roland Wollenweber. Documentary and physical evidences for the data used for calculation of emission reductions has been provided.

The verification report has been issued by TÜV Rheinland to Greenstream Network Biogas GmbH on 26th April 2010.

Verification criterion has been accordance to ISO 14062-2 with a reasonable level of assurance.

The verification Report states that "Project accounting and the data supporting the GHG calculations have sufficient controls and are done in accordance with ISO 14062-2 and recognized methodologies"

TÜV Rheinland also confirms that it is free from conflicts of interest and can be addressed as independent third party.

The Verification statement is appended at the last page.

MONITORING REPORT

Brokenlande

Biogas Project

Crediting Period: 01 May 2009 – 31 December 2009

Greenstream Network Biogas GmbH

17 March 2010; Version 01

CONTENT

ARA Bioenergie Brokenlande GmbH & Co KG

Großer Burstah 31

20457 Hamburg, Germany

INTRODUCTION

Bioenergie Brokenlande was implemented as a climate protection project in 2009. A reduction of greenhouse gas (GHG) emissions is realised by avoiding uncontrolled methane emissions from manure storage and by producing CO2 neutral thermal and electrical energy. The *Brokenlande Biogas project* should be verified for its first operation period during May 2009 25th – Dec 31, 2009, in order to certify the corresponding reduced GHG emissions by this project activity within this period. Crediting Period starts on May 1th 2009. The data recorded and calculations performed follow the GHG project plan according to ISO standard 14064-2.

PROJECT STATUS

Biogas plant "Bioenergie Brokenlande" was taken in operation on 25th of May 2009. Biogas was produced from the digestion of cattle manure small amounts of chicken dry manure and Co-Substrates. Since the beginning of the crediting period, the heat of the CHP has been used for heating the nearby Greenhouse. The original heating system, which is also the baseline of project activity, is run with oil. The whole amount of heat directed from the CHP to the greenhouse decreases the need for a corresponding amount of heat generated from the fossil fuel oil.

DATA ANALYSIS

Following data are used to calculate the emission reduction ex-post, according to the GHG project plan.

ID	Parameter	Unit	Device	Recorded	Remark
1. BGP	Biogas produced	m³	Flow meter	Yes*	Used to calculate Emission reduction from manure
2. MC	Methane content	Vol%	Gas analyser	Yes	Used to calculate Emission reduction from manure
3. FT	Fraction of time	h	Runtime counter	Yes	Used to check for plausibility
4. ETP	Thermal energy	MWh	Heat	Yes	Used to calculate

	produced for external utilisation		meter		Emission reduction from fossil fuel heating
5. EEP	Electrical energy produced	MWh	Power meter	Yes	Used to prove positive GHG balance of electric energy
6. EEI	Electrical energy imported	MWh	Bills from supplier	Yes	Used to prove positive GHG balance of electric energy
7. $MCOF_i$	Mass of co-ferment i fed into digester	t	Scales recording	Yes	Used to calculate Emission reduction from manure
8. MANURE	Mass of manure fed into digester	t	Scales recording	Yes	Used to check Emission reduction from manure

*Recording started in July, missing months were calculated

Actually measured values:

	ID	Parameter	Value	Unit
1.	BGP	Biogas produced*	1.044.045	m³
2.	MC	Methane content	51,3	%
3.	FC	Fraction of time	4.996	h
4.	ETP	Thermal energy used	912.100	kWh
5.	EEP	Electrical energy produced	2.518.512	kWh
6.	EEI	Electrical energy imported	194.992	kWh
7.	MCOF1	corn silage input	2964	t/y
7.	MCOF2	gras silage input	347	t/y
7.	MCOF3	whole crop silage input	90	t/y
7.	MCOF4	Potato input	109	t/y
7.	MCOF5	Beet pulp input	14	t/y

8.	MANURE	Manure input	14627	t/y

* Recording started in July, missing months were calculated

EMISSION REDUCTION

Emission reduction from destruction of methane

The Methane destroyed by project activity is calculated with the measured amount of biogas and its methane content minus the share of biogas and methane generated from the co-ferments.

$$MD_y = \left(BGP_y * MC_y - \sum_n BGCO_{n,y} * MCCO_{n,y} \right) * \; GWP_{CH4} * D_{CH4}$$

MD_y	Captured and converted methane from project activity in the year y (t CO_2e)
BGP_y	Amount of biogas that is flared or gainfully used in the year y (m^3)
MC_y	Average fraction of Methane in the biogas in year y (%)
$BGCO_{n,y}$	Biogas production of Co-ferment n in year y (m^3)
$MCCO_{n,y}$	Average fraction of Methane of Biogas from Co- ferment n in year y (%)

Biogas production of Co ferments is determined by the appropriate input volume and the specific gas production of the Co –ferment. Specific gas production and Methane content values are taken from literature.

Co ferment	Volume t/y	Specific gas production Nm³/ t	Methane content [%]	Methane production m³/y	Source
corn silage	2964	185,3	52,20%	286.698	http://www.lfl.bayern.de/ilb/technik/10225/
gras silage	347	208,3	54,10%	39.104	http://www.lfl.bayern.de/ilb/technik/10225/
whole crop silage	90	194,8	52,30%	9.169	http://www.lfl.bayern.de/ilb/technik/10225/
potato	109	150,1	51,50%	8.426	http://www.lfl.bayern.de/ilb/technik/10225/

beet pulp	14,2	594,3	50,60%	4.270	http://www.lfl.bayern.de/ilb/technik/10225/

Measurement of biogas flow was not performed during the first two month because the flow meter was not in operation. However the CHP began power production in May and the amount of power produced was recorded. With the average m³ biogas per kWh ratio of the other months the amount of biogas in May and June is calculated to be 167.202m³. Actually, biogas production took place even earlier because fermenters were loaded with manure before May. There is no reliable variable to calculate this amount though, so it will not be considered for reasons of accuracy and conservativeness.

A total amount of 1.211.244 m³ biogas with a methane content of 51,3 % was combusted in 2009. Of 642.17 m³ methane a fraction of 347.891 m³ was generated from co ferments. The destruction of the methane originated from manure results in an emission reduction of **4.448 t CO2e**.

Cross check with energy production

Measured volume of biogas will be checked by calculating the theoretical required volume for the production of the measured amount of electric energy.

$$BGP = \frac{\frac{EG_{elec}}{\eta_{CHP}}}{10\ kWh/m^3} * MC$$

$EG_{elec,y}$	Net supplied electricity by project activity in year y
η_{CHP}	Electric efficiency of the CHP (manufacturer specification)

For the production of 2.457.096 kWh with an electric efficiency of 0,38 and a average methane content of 51,3% an amount of biogas of 1.260.437 m³ would be necessary. 1.211.244 m³ have been measured and calculated. It can be expected that the measurement of produced electric energy is more accurate than the biogas flow measurement[12]. This means more biogas could have been burned in the CHP than actually was measured or the methane content of the biogas was higher than measured. For reasons of conservativeness and consistency the measured (and calculated) biogas flow will be used anyway.

Emission reduction from substitution of fossil fuel heating

Heat produced by the CHP is utilized in the nearby greenhouse. In absence of project activity an oil heating system would deliver the heat. The heat delivered from project activity to the greenhouse is measured with a heat meter. This amount of heat replaces the same amount that would be produced by fossil fuels.

$$ER_{B\,y,ex-post} = \sum_{m} TEP_{m,y} * EF_{CO2-m}$$

$TEP_{m,y}$	Thermal energy used by heat consumer to substitute fossil fuel m in the year y (TJ)
$EF_{CO2\text{-}m}$	Emissions factor of fossil fuel m (t CO_2e /TJ)

In the baseline scenario crude oil will be consumed to generate thermal energy for the nearby greenhouse. The CO2 emission factor of crude oil is 73.3 t/TJ[13] and the converted factor from kWh to TJ is 0.0000036. To keep the calculation conservative, the thermal generation efficiency of the engine in baseline scenario is set as 100%.

In 2009 an amount of 912.100 kWh thermal energy was delivered to the greenhouse avoiding emissions from combustion of fossil fuels of **240 t CO2e.**

[12] Production of electric energy and its exact measurement is important for economics of the facility. Measurement of electric energy is state of the art.

[13] Source: 2006 IPCC Guidelines, Volume 2, Table 1.4

Project Emissions

Project activity will not result in any emissions that would not have occurred in its absence or that significantly lower its emission reduction potential.

Transport Emissions count for less than 1% of total emission reductions

Consumption of electric energy has not to be considered. During the monitoring period, 194.992 kWh of electricity has been imported from the public grid. On the other hand, the project activity has produced 2.457.096 kWh of electricity which equals a share of 7,94%. Thus the project activity provides a positive green energy balance. Hence, no GHG emission in terms of electricity needs to be considered. Project activity has a positive balance regarding emission from electric energy production.

Runtime of the flare has been 3,2 hours according to runtime measurement. There are no significant emissions from operation of the flare.

Total Emission reduction

Total emission reduction from project activity in 2009 account for **4.458 t CO2e**. For reasons of conservativeness a model correction factor was chosen to compensate uncertainties and to ensure that the results of the calculations are not too high. As a result, claimed Emissions will only be 90% of calculated emissions.

Reduction Approach	tCO_2e
Methane Reduction from manure management	4.448
Heat Production (fuel switch)	240
Project emissions	0
GHG Reductions total	4.688
Modell correction factor 0,9	-468
GHG Reductions claimed	4.220

The total CO_2 net reductions claimed by the project activity Bioenergie Brokenlande calculate for the operation period during the period of May 01, 2009 – Dec 31, 2009 to be:

4.220 tons of CO_2e.

Industrial Services
Energy and Environment

TÜVRheinland®
Precisely Right.

Verification statement

April 26, 2010

GreenStream Network Biogas GmbH

Grosser Burstah 31

20457 Hamburg

Germany

RE: Verification Statement for GreenStream Network Biogas GmbH – Brokenlande biogas project under CSA CleanPojects, period May 1st 2009 – Dec 31st 2009

Greenstream Network Biogas GmbH as responsible party providing the GHG assertions on behalf of ARA Bioenergie Brokenlande GmbH & Co. KG has engaged TÜV Rheinland Immissionsschutz und Energiesysteme GmbH to review and verify the GHG assertion made covering the period May 1st, 2009 to December 31st 2009. The GHG assertions, indicated through the GHG-report as of April 13th 2010, claim emission reductions of:

4220 tons CO_2e

over the aforementioned period.

We have conducted the verification of the GHG assertion in accordance with the requirements of the program and the standard ISO 14064-3 to a reasonable level of assurance by applying a materiality threshold of 5 %. The GHG information verified includes the GHG report delivered to TÜV Rheinland Immissionsschutz und Energiesysteme GmbH and all relevant information and evidence acquired during the verification process as stated in the verification report as of April 26th 2010.

We have come to the conclusion that based on our review and all available documentation the GHG assertion is made in accordance with the requirements of the program and is material correct and fairly represents the GHG emissions data and information without material discrepancies.

26.04.2010 / [signature]
Date / Signature
Roland Wollenweber
lead verifier

Date 26.4.10 / [signature] Signature
Jürgen Reinhardt
internal peer review