MONITORING REPORT

Houbensteyn Ysselsteyn Methane Recovery Project

Crediting Period: 01 May 2006 – 31 December 2007

ARA Carbon Finance GmbH

19 March 2008; Version 02

KEY DATA

Project Name	*Houbensteyn Ysselsteyn Methane Recovery Project*
Project Location	Ysselsteyn, The Netherlands
Project Operator	Houbensteyn milieu BV
VER Owner	ARA Carbon Finance GmbH
Baseline (Approach I)	Uncontrolled methane emissions during storage of manure
Baseline (Approach II)	Heating of manure through fossil energy sources
Project Activity (Module I)	Control digestion of manure, Methane capture and combustion in Combined Heat and Power (CHP) Electricity Generation
Project Activity (Module II)	Heat from combusting biogas in CHP for hygienization of manure
GHG Reduction (Approach I)	Mitigation of uncontrolled methane emissions through digestion
GHG Reduction (Approach II)	Substitution of fossil fuel through renewable heat production
Validation	August 27, 2007
Validator	TÜV Rheinland Group
Start Crediting Life Time	May 01, 2006
Verification Period II	May 01, 2006 to Dec 31, 2007

CONTENT

1 Introduction

The *Houbensteyn Methane Recovery Project* was validated by TÜV Rheinland Group on August 27th, 2007 as domestic GHG offset project according to JI standards. The reduction approaches were demonstrated by the mitigation of uncontrolled methane emission out of manure and organic wastes, as well as the generation of captive renewable thermal energy used to substitute fossil sources. The crediting life time of the project started on May 01, 2006. The Houbensteyn *Methane Recovery Project* should be verified for its first operation period during May 01, 2006 – Dec 31, 2007, in order to certify the correspondingly reduced GHG emissions by this project activity within this period.

This monitoring report on hand directly refers to the monitoring concept of the PDD submitted in its version 04 by ARA Carbon Finance GmbH on Febuary 7th, 2007 to the TÜV Rheinland Group.

2 Project Status

Since May 2006 the *Houbensteyn Methane Recovery Project* was set into operation. Biogas was produced from the digestion of swine manure. During project operation, other co-substrates such as turnip, potatoes, vegetables, grains, food residues, glycerine and vegetable oil were also fed into the digester.

The first 346 kWel CHP engine was commissioned shortly before the start of the crediting period, the second and third engines where commissioned in December 2006. Since the beginning of the crediting period, the heat of the CHPs has been used for space and water heating of the adjacent pig stalls and office building as well as for pre-heating of piglet food substituting natural gas. Furthermore since January 2007 heat has been used for the hygienization of the digestate.

3 Data Analysis

All data have been designated to be recorded according to the monitoring plan as stated at Section D.3 of the PDD. Table 1 lists the monitoring parameters.

Table 1 Monitoring Parameters of the *Houbensteyn Methane Recovery Project*

ID	Parameter	Unit	Device	Recorded	Remark
1. BGP	Biogas produced	m³	Flow meter	n/a	Not available, due to occurring technical problems. *Auxiliary determination through parameter 5. EEP*
2. MC	Methane content	Vol%	Gas analyser	Yes	
3. FT	Fraction of time	h	Runtime counter	Yes	
4. ETP	Thermal energy produced for external utilisation	MWh	Heat meter	n/a	Since Feb 07 heat meter have be installed measuring the total amount of heat used. *Will be calculated as per section D.2 in PDD.*
5. EEP	Electrical energy produced	MWh	Power meter	Yes	
6. EEI	Electrical energy imported	MWh	Power meter	Yes	
7. $MCOF_i$	Mass of co-ferment i fed into digester	t	Scales recording	Yes	
8. MANURE	Mass of manure fed into digester	t	Scales recording	n/a	Not available. *Will be calculated with help of digestate sold and co-ferment input*.
9. OIL	Diesel consumed in emergency generator	m³	Volume scale and/or delivery receipt	Yes	

3.1 Digester Input Materials and Gas Production Ratios

The digester of the biogas module was constantly fed with swine manure as primary ferment, as well as with several secondary-/ co-ferments. The co-ferment input materials have been weighed and subsequently fed into the digester. The operator has not measured the amount of manure input, as it comes from own farm. Hence, the manure input figures are determined through a calculative method, with help of digestate sold (measured and recorded for 2007) as well as co-fermente input as follows. The amount of co-fermente input is subtracted from the amount of digestate sold. For year 2006 the ration of electricity production compared to electricity production in 2007 is applied. This method is considered to be very conservative, as it dose not take in consideration the weight lost due to dissolved biogas. The input curves are presented in figure 1 as deviation from the arithmetic mean of their monthly input mass.

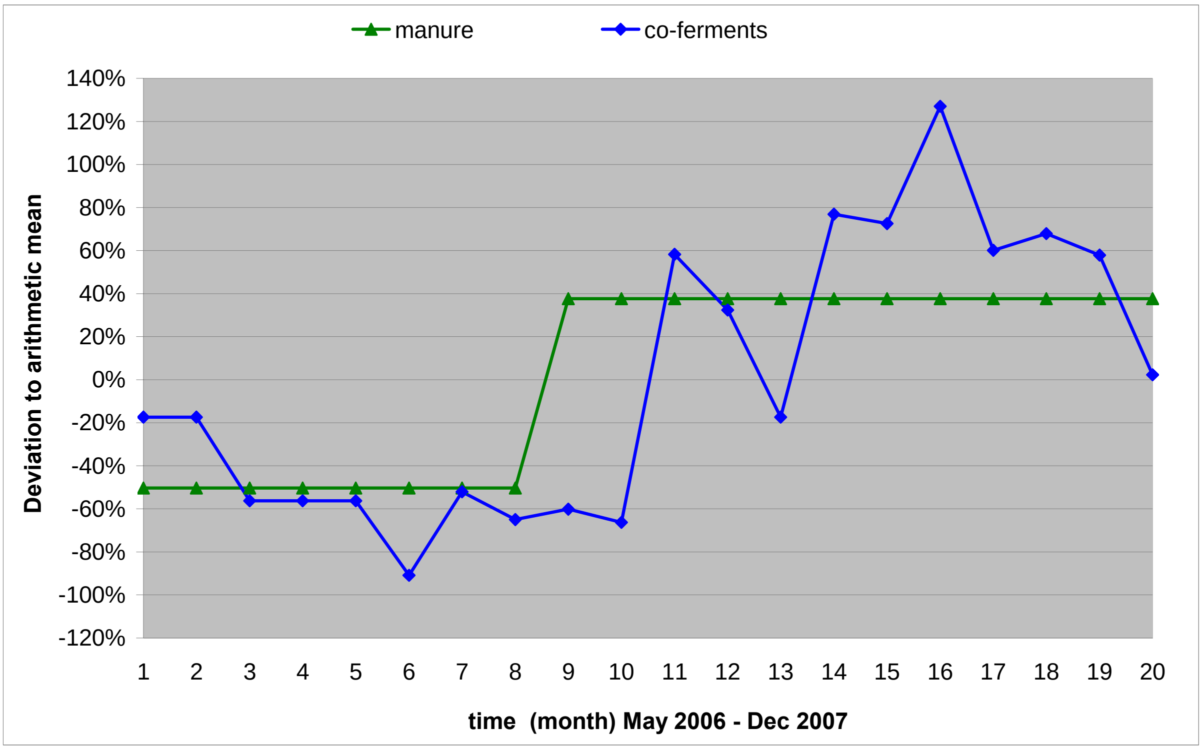

Figure 1 Digestate mass input curves

During the operation period the total mass input was measured to be 44.022 ton with the contribution of 31.583 tons of manure and 5.990 tons of waste co-ferment. The amount of input material was significantly lower during 2006 when only one engine was running than in 2007. The monthly input amount of manure into the biogas installation was 2006 50 % below the average manure input. Conversely during the year 2007 the manure input was 38 %

higher than the average. The input amounts of co-ferments followed the same trend. However, the monthly input amounts of co-ferments varied much more from month to month. The table 2 below presents the input substrates and the monthly input amounts.

Since only the manure and waste digestion is of relevance for the reduction of uncontrolled methane emissions occurring during the storage of untreated manure and waste decay in the baseline scenario, the ratio of the biogas produced in the digestion process caused by the non-waste co-ferments has to be deducted from the total biogas produced within the project activity. Table 3 reflects the derivation. From the total input mass of each single ferment applied as raw material to the project activity, the CO_2e gas ratio produced by technical digestion was determined by using the specific literature data of dry matter content (dmc), dry organic matter (dom) and CH_4 capacity.

Applying this approach, during the monitoring period May 1, 2006 to December 31, 2007 the gas production ratio caused by manure and waste co-ferment input through technical digestion could be determined to 72,56 vol-% (volume percent) of the entire gas produced. This value will be applied in section 4.1 when calculating the methane mitigation from the biogas volume flow produced.

Table 2 Digester Input Materials

Digester Input	swine manure [t]	glycerine [t]	food residues [t]	vegetable oil [t]	rape [t]	potato [t]	vegetable [t]	corn residues [t]
Mai 06	784	-	-	-	211	220	47	36
Jun 06	784	-	-	-	211	220	47	36
Jul 06	784	-	-	-	175	13	73	11
Aug 06	784	-	-	-	175	13	73	11
Sep 06	784	-	-	-	175	13	73	11
Oct 06	784	-	-	-	29	-	-	28
Nov 06	784	-	-	-	237	-	-	61
Dec 06	784	-	-	-	123	-	35	60
Jan 07	2.174	-	-	-	203	-	-	45
Feb 07	2.174	-	-	-	137	-	-	73
Mar 07	2.174	-	198	-	757	-	-	29
Apr 07	2.174	143	169	175	71	-	-	265
Mai 07	2.174	10	209	164	101	-	-	30
Jun 07	2.174	147	362	65	-	-	-	526
Jul 07	2.174	-	345	591	30	-	-	107
Aug 07	2.174	129	347	273	-	-	-	663
Sep 07	2.174	34	404	107	-	-	-	451
Oct 07	2.174	352	293	215	-	-	-	184
Nov 07	2.174	148	382	205	-	-	-	247
Dec 07	2.174	76	301	146	-	-	-	113
total digester input	**31.583**	**1.039**	**3.010**	**1.941**	**2.635**	**479**	**348**	**2.987**

Table 3 Derivation of gas production ratio manure/total input amount

Digestate	manure	waste co-ferments			non-waste co-ferments			
	swine manure	**glycerine**	**food residues**	**vegetable oil**	**rape**	**potato**	**vegetable**	**corn residues**
total digester input [t]	31.583	963	2.709	1.795	2.635	479	348	**2.987**
dmc; %	7,00	47,00	37,00	99,00	12,00	22,00	15,00	87,00
dom; %	86,00	69,00	98,00	99,00	85,00	18,00	76,00	98,00
VS; t	1.901,28	312,30	982,28	1.759,28	268,77	18,97	39,67	2.546,72
CH4 capacity; m³/t	450,00	412,50	275,00	833,00	467,50	385,00	280,00	371,00
	Ref: IPCC	Ref: Suppliers data sheets & Several scientific sources						
CH4 density; t/m³	0,0007168	0,0007168	0,0007168	0,0007168	0,0007168	0,0007168	0,0007168	
CH4 potential; t	613,28	92,34	193,63	1.050,46	90,07	5,23	7,96	677,26
GWP	21,00	21,00	21,00	21,00	21,00	21,00	21,00	21,00
CO2e potential; t	12.878,82	1.939,16	4.066,18	22.059,57	1.891,38	109,93	167,21	14.222,36
CO2e potential from manure; t	**16.825,02**							
CO2e potential from co-ferments; t		**28.064,92**			**15.852,84**			
gas production ratio single feed / total	21,56%	3,50%	7,56%	39,93%	3,17%	0,18%	0,28%	23,81%
gas production ratio manure & waste/ total	**72,56%**							

Sources: For manure: IPCC 2006. For co-ferments: Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz , 2006, Studie Einspeisung von Biogas in das Erdgasnetz, Table 4-1 p.103Forschungsanstalt für Agrarwirtschaft und Landtechnik 2006, FAT Bericht Nr. 546 p. 2, Universität für Bodenkultur Wien 2004, Untersuchungen zur Wirkung von Rohglycerin aus der Biodieselerzeugung als leistungssteigerndes Zusatzmittel zur Biogaserzeugung aus Silomais, Körnermais, Rapspresskuchen und Schweinegülle p. 4 and 10, Webistes of Bavarian State Research Center for Agriculture [http://www.lfl.bayern.de/ilb/technik/10225/?sel_list=24%2Cb&strsearch=&pos=left] and from KTBL data bank: http://daten.ktbl.de/biogas/navigation.do;jsessionid=742193133B0BADD6BABAA2DFD2397AD4?selectedAction=Startseite#start

3.2 Power Production of CHP Engines

The electricity production from the installed CHP has been continuously recorded. Table 4 shows the electricity generation on a monthly basis.

Table 4 Power production of the CHP engines attached to the biogas module

Months	Days	Electricity Production	Power Output	Installed Power	Load factor	Full load runtime
		kWh/ month	kW	kW	%	h/mp
Mai 06	31	213.073	346	346	83%	12.118
Jun 06	30	215.388	346	346	86%	12.658
Jul 06	31	237.200	319	346	92%	13.490
Aug 06	31	251.590	338	346	98%	14.308
Sep 06	30	231.780	322	346	93%	13.621
Oct 06	31	251.644	338	346	98%	14.311
Nov 06	30	227.068	315	346	91%	13.344
Dec 06	31	249.240	335	346	97%	14.175
Jan 07	31	558.318	750	1.038	72%	10.584
Feb 07	28	575.603	857	1.038	83%	12.081
Mar 07	31	672.626	904	1.038	87%	12.751
Apr 07	30	665.322	924	1.038	89%	13.033
Mai 07	31	677.248	910	1.038	88%	12.839
Jun 07	30	662.937	921	1.038	89%	12.986
Jul 07	31	730.971	982	1.038	95%	13.857
Aug 07	31	690.535	928	1.038	89%	13.091
Sep 07	30	589.202	818	1.038	79%	11.542
Oct 07	31	661.800	890	1.038	86%	12.546
Nov 07	30	703.034	976	1.038	94%	13.772
Dec 07	31	615.535	827	1.038	80%	11.669
Total	**610**	**9.680.114**			**90%**	**12.939**
Mean 06		**234.623**				
Mean 07		**650.261**				

In the beginning of the monitoring period on engine with the installed capacity of 346 kWel was running. In January 2007, when two new motors where installed, the capacity increased to 1.048 kWel. During the monitoring period 9.680.114 kWh electricity was produced and fed into the gird. The monthly load factor of the CHP ranged from 72 % to 100 %. Figure 2 illustrates the electricity production of the CHP versus their installation capacity.

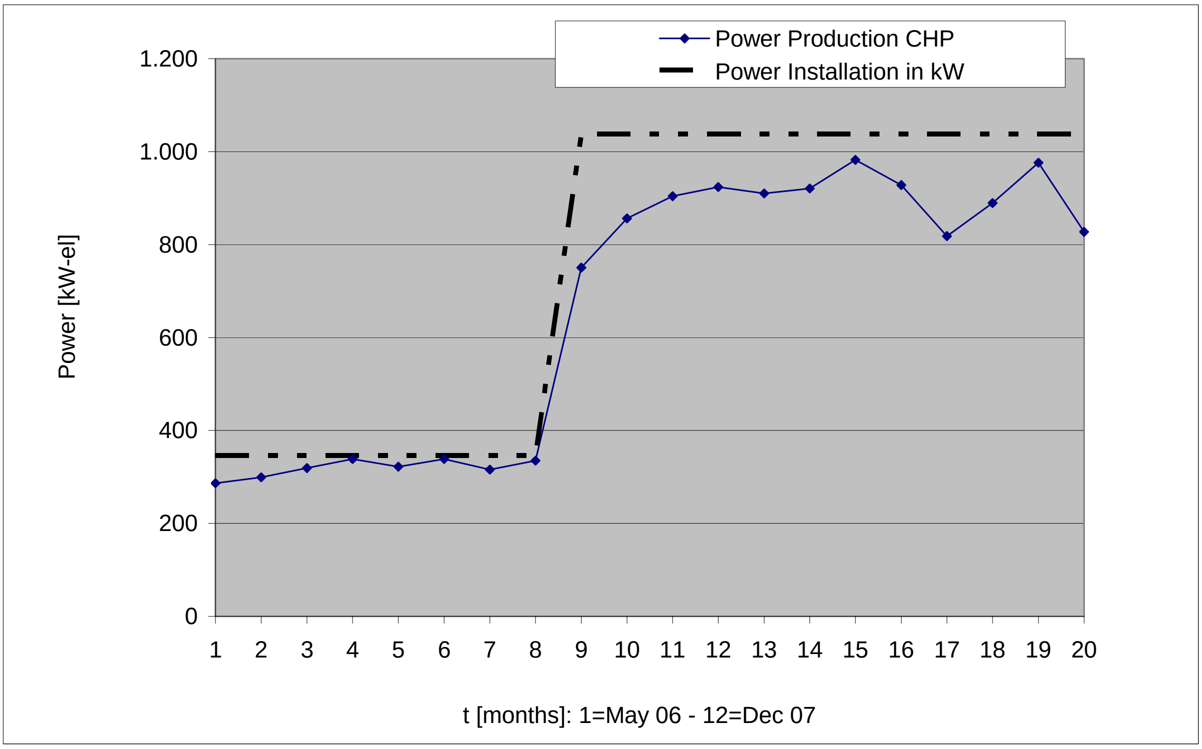

Figure 2 Electricity Generation of the CHP vs. installed capacity

As the figure 2 shows, the production of electricity increased significantly in 2007 due to commissioning of the second and third CHP engines. However, there was a small drop in September 2007 due to minor technical and biological problems. Maximum production was reached in July 2007 with 730.971 kWh. The minimum electricity production took place in November 2006 with 227.068 kWh. The average mean electricity production in 2006 was 244.383 kWh/month and in 2007 650.261 kWh/month.

3.3 Biogas Production with help of power production

The monthly biogas production has been measured uncontinuously with a flow meter. As the gas flow meter broke down several times during the monitoring period it is impossible to provide consistent biogas data with help of the flow meter. Hence, the biogas flow is calculated with help of electricity production. The monthly biogas flow rates into the CHP engines installed with their corresponding CH_4 volume contents are shown in table 5. The biogas has been derived according equation 1 as follows[1]:

[1] In accordance with the CCX Agricultural Methane Gas Project Guidelines

$$BGP = \frac{EEP}{(ETA_{CHP-el}) * HV_{Biogas}} \qquad (1)$$

with:

- *BGP* Biogas produced [m³]
- *EEP* Electricity energy produced [MWh]
- ETA_{CHP-el} Electric efficiency of the CHP engines = 0,374 (Ref.: MAN data sheet)
- HV_{Biogas} Caloric value biogas [MWh/m³],

$$HV_{Biogas} = 0{,}01 \frac{MWh}{m^3} * x_{CH4}$$

with:
x_{CH4}: = CH_4 volume content of biogas flow

The CH_4 volume content has been measured continuously with a gas analyser.

Table 5 Biogas flow into CHP engines

Months		CHP		
		Electricity production	CH4 content	Biogas Flow
		kWh	vol %	m³
May 06	1	213.073	58	98.227
Jun 06	2	215.388	58	99.294
Jul 06	3	237.200	58	109.349
Aug 06	4	251.590	58	115.983
Sep 06	5	231.780	58	106.850
Oct 06	6	251.644	58	116.008
Nov 06	7	227.068	58	104.678
Dec 06	8	249.240	58	114.900
Jan 07	9	558.318	58	257.384
Feb 07	10	575.603	58	265.353
May 07	11	672.626	58	310.080
Apr 07	12	665.322	58	306.713
May 07	13	677.248	58	312.211
Jun 07	14	662.937	58	305.614
Jul 07	15	730.971	58	336.977
Aug 07	16	690.535	58	318.336
Sep 07	17	589.202	58	271.622
Oct 07	18	661.800	58	305.089
Nov 07	19	703.034	58	324.098
Dec 07	20	615.535	58	283.761
Total		**9.680.114**	**58**	**4.462.527**

3.4 Runtime Hours

ICHP's runtimes were recorded continuously, but logged only quarterly. The runtime hours are shown in table 6. Furthermore the table 7 presents the estimated monthly runtime hours, which are calculated bases on the quarterly figures and derived average monthly figures. The monthly runtime hours are need for cross-check purposes.

Table 6 Runtime Hours (recorded)

	Q2 06	Q3 06	Q4 06	Q1 07	Q2 07	Q3 07	Q4 07	**Total**
CHP 1	2.045	2.149	2.137	2.133	2.162	2.111	2.188	14.925
CHP 2				1.872	2.143	2.107	2.020	8.142
CHP 3				2.111	2.154	2.091	2.172	8.528
Total	2.045	2.149	2.137	6.116	6.459	6.309	6.380	31.595

Table 7 Monthly runtime hours (calculated)

Runtime CHP (recorded) hours	**Runtime per record (calculated) hours**
	720
2.045	720
	716
	716
2.149	716
	712
	712
2.137	712
	2.039
	2.039
6.116	2.039
	2.153
	2.153
6.459	2.153
	2.103
	2.103
6.309	2.103
	2.127
	2.127
6.380	2.127
	30.990

3.5 Cross-Check biogas parameters

Due to the process characteristic the primary parameters electricity production, standardized input amounts (to specific gas production parameters), CHP runtime and biogas flow are supposed to be proportional. To prove this proportionality, and thus to prove the data plausibility, the parameter data during the monitoring period was standardized to its arithmetic mean and mapped as deviation of this mean value (fig. 3).

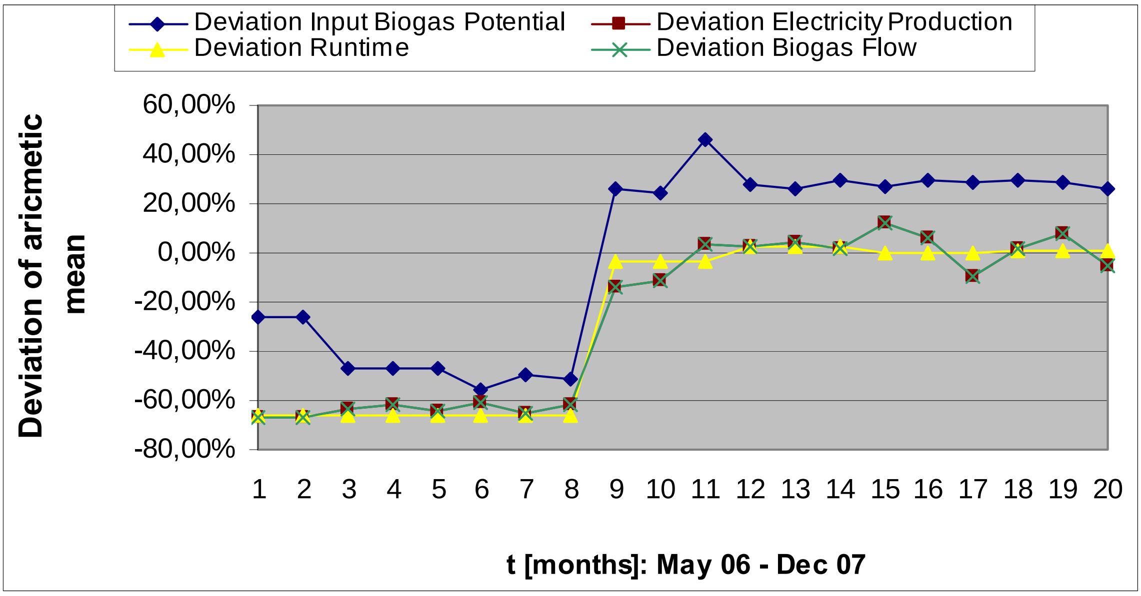

Figure 3 Cross-check of biogas figures

Due to the parallel courses of the curves biogas production calculated through methane production potentials and calculated through electricity production in the first phase, it is clearly proved that the reported parameters are consistent and hence the data is postulated to be plausible.

3.6 Thermal Energy

The heat produced by the CHP was used for hygienization, space heating and food preheating for piglets displacing natural gas. In February 2007 a heat meter was installed measuring the total heat delivered from the CHPs to the several heating and hygienization units. As the amount of heat used before February 2007 has not be measured, calculative methods needs to be applied. Furthermore the hygienization conditions of the fermenter output (37°C) do not correspond to the baseline conditions (10°C). Hence, the amount of the fossil fuels displaces through hygienization is calculated as per equation 2 (given in section D.2 of the PDD):

$$Fuel_{Hyg} = Manure \bullet Cap_{Heat} \bullet (T_{Hyg} - T_{Inlet}) \bullet 1 / Eff_{Hex} \quad (2)$$

Where:

$Fuel_{Hyg}$	average annual consumption of propane in the hygienization system, in Nm^3
Manure	annual manure excreted from the animals in kg
T_{Hyg}	needed hygienization temperature, set to 71 °C
Cap_{Heat}	heat capacity of the manure to be pre-heated, set to the capacity of water 4,18 kJ/kg K
T_{Inlet}	manure inlet temperature to the hygienization system, set to the average ambient temperature 10 °C
Eff_{HEx}	heat exchanger efficiency, set to 88 %

As stated before the hygienization of the digestate started in January 2007. Table 8 shows the calculation of thermal energy required for hygienization.

Table 8 Amount of heat required for hygienization of manure in digestate

Month	Total Digestate [kg]	c [KJ/kgK]	T_{in} [°C]	T_{out} [°C]	ΔT °C	$Q_{digestate}$ TJ
Jan 07	2.174.333	4,18	10	71	61	0,554
Feb 07	2.174.333	4,18	10	71	61	0,554
Mar 07	2.174.333	4,18	10	71	61	0,554
Apr 07	2.174.333	4,18	10	71	61	0,554
Mai 07	2.174.333	4,18	10	71	61	0,554
Jun 07	2.174.333	4,18	10	71	61	0,554
Jul 07	2.174.333	4,18	10	71	61	0,554
Aug 07	2.174.333	4,18	10	71	61	0,554
Sep 07	2.174.333	4,18	10	71	61	0,554
Oct 07	2.174.333	4,18	10	71	61	0,554
Nov 07	2.174.333	4,18	10	71	61	0,554
Dec 07	2.174.333	4,18	10	71	61	0,554
Total	**26.092.000**					**6,65**

With 26.092 tons of manure input, from the heat produced by the biogas plant 6,65 TJ has been required for hygienization.

The amount of fossil fuels displaced through space heating and food pre-heating are calculated according the equation 3, section D.2. of the PDD (please see section 4.2. equation 5). The calculation bases on the amount of fossil fuels substituted. The operator of the biogas plant has kept record of the historic fuel use and the amount of fuel substituted by the biogas produced. The calculation is shown in table 9.

Table 9 Fossil fuels displaced through space heating and food pre-heating

Parameter	Symbol	Unit	Value	Reference
Fuel consumption	$Fuel_{CON}$	Nm³		Baseline setup
2005: for piglets			*10.969*	
Jan –Apr 2006: for piglets			*14.356*	
May 2006 – Dec 2007: for piglets			*1.000*	
Monthly average historic			1.583	
Monthly average project			50	
Monthly difference			1.533	
Natural Gas substituted	Fuel	Nm³	30.656	Project setup
Heating Value	HU_{NGas}	kWh/m^3	9,5	Supplier fuel data sheet
Thermal energy displaced	ETP	TJ	1,05	Calculated

3.7 Cross-Checking Thermal Energy Figures

In February 2007 a heat meter was installed measuring the total heat delivered from the CHPs to the several heating and hygienization units. For the year 2007, a total amount of 1.460.927 kWh heat has been delivered from the CHPs, which is 561.852 kWh less than the calculative method gives for 2007 (2.022.779 kWh). Considering that the digestate in practice just had to be warmed from fermenter exit temperature (about 37°C) to 71°C instead of 10°C to 71°C in the baseline, which requires 817.984 kWh (2,94 TJ) less thermal energy. Adding this difference, to the amount of heat measured (2.278.911 kWh), the calculative method can be considered to be very conservative; as it gives 256.132 kWh less than the measurement heat requirement would give in baseline. Furthermore, it should be noted that the heat meter was installed one cold winter month later than the calculated figures for Jan – Dec 07. Hence, the calculative method is considered to be plausible.

3.8 Electric Energy imported

During the monitoring period, 17.538 kWh of electricity has been imported from the public grid. On the other hand, the project activity has produced 9.680.114 kWh of electricity (table 4), from which 8.057.771 kWh has been fed into the grid during the period from May 1, 2006 to December 31, 2007. Thus, the project activity provides a positive green energy balance. Hence, no GHG emission in terms of electricity needs to be considered.

3.9 Oil Consumption

An oil-fired boiler exists for the purpose of a breakdown of the GHPs. It has not been used during the period from May 1, 2006 to December 31, 2007.

4 Emission Reductions

The emission reductions of the project activity are determined by the two mitigation approaches (1) reduction of uncontrolled methane emissions which occur during storage of untreated manure, and (2) substitution of fossil fuels from manure hygienization, stall heating and food pre-heating through thermal energy from CHPs in the project activity.

4.1 Methane Mitigation

The methane emission reductions through the project activity *Houbensteyn Methane Recovery Project* are to be derived according to the PDD, section D.3, by the following equation:

$$GHG_{red,\ IIID} = AF * (BGP * MC - \Sigma\ BGCO_i * MCCO_i) * D * GWP \qquad (3)$$

With:

$$AF = 1 - dm_{nw,\ l} / (dm_{manure} + \Sigma\ dm_{nw,\ l} + \Sigma\ dm_{w,\ j}) \bullet 0,1$$

Where:

$GHG_{red,IIID}$	annual emission reduction through methane recovery, in t CO2e
BGP	total annual biogas produced by the project activity BGP, in m³

BGCOi	annual biogas portion of the total biogas amount produced, caused by a digested co-ferment i if applied, to be determined by the appropriate input amount (MCOFi) and the specific gas productivity of the co-ferment i, in m^3
MC	average annual methane content in the biogas, in m^3 methane / m^3 biogas
MCCOi	average methane content arising in the biogas through digesting a co-ferment i, in m^3 methane / m^3 biogas
D	density of methane, set to 0,0007168 t CH4 / m^3 CH4 according to ACM0001
GWP	Global Warming Potential of methane, set to 21 t CO2e / t CH4 according to UNFCCC
$dm_{nw, I}$	dry matter of the proceeded quantity of non-waste co-ferment i
dm_{manure}	dry matter of the proceeded quantity of manure
$dm_{w, j}$	dry matter of the proceeded quantity of waste co-ferment j

Referring to the derived gas production ratio of manure and waste co-ferments of 72,56 -vol % related to the total input amount and to the mean methane content 58 %, the methane reduction equation reduces to (please see table 3 and 5):

$$GHG_{red, IIID} = AF \bullet 0,7256 * BGP * 0,58 * D * GWP \quad (4)$$

Table 10 Data applied to calculate the GHG reductions through methane mitigation

	Emission reduction trough manure and waste co-ferments				
Month	**CH4 (m^3)**		**CH4 (t)**		**CO2 (t)**
May 06	41.338		30		622
Jun 06	41.788		30		629
Jul 06	46.019		33		693
Aug 06	48.811		35		735
Sep 06	44.968	**Density**	32	**GWP_{CH4}**	677
Oct 06	48.822	0,0007168	35	21	735
Nov 06	44.054	t/m³	32		663
Dec 06	48.355		35		728
Jan 07	108.320		78		1.631
Feb 07	111.673		80		1.681
May 07	130.497		94		1.964
Apr 07	129.080		93		1.943
Mai 07	131.394		94		1.978
Jun 07	128.617		92		1.936
Jul 07	141.816		102		2.135
Aug 07	133.971		96		2.017
Sep 07	114.312		82		1.721
Oct 07	128.396		92		1.933
Nov 07	136.396		98		2.053
Dec 07	119.421		86		1.798
Total	**1.878.048**		**1.346**		**28.270**
dry matter of the proceeded quantity of non-waste co-ferment i					2.874
dry matter of the proceeded quantity of manure					1.901
dry matter of the proceeded quantity of waste co-ferment j					3.331
Adjustment Factor					0,9645
CO_2 emission reduction / m.p.					**27.268**

The CO_2 reduction achieved during the period from May 2006 to Dec 2007 by the project activity *Houbensteyn ethane Recovery Project* calculates to be:

27.268 tons of CO_2e.

4.2 Thermal Energy for the User

The emission reductions gained through thermal energy delivered to hygienization of the digestate and to the heating facilities to displace fossil fuels are calculated based on the equation presented in PDD, section D.2:

$$GHG = Fuel \bullet Hu_{NA} \bullet D_{NA} \bullet CEF \bullet FCO \bullet 44/12\ t\ CO_2 / t\ C_{ox} \qquad (5)$$

Where:

GHG annual emission from the theoretical combustion of propane in the hygienization system, in t CO_2 = t CO_2e

Fuel theoretical average annual consumption of natural gas, in TJ

Hu_{PNA} the heating value of natural gas, 9,5 $kWhm^3$

CEF carbon emission factor of natural gas, 15, 53t C/TJ

FCO fraction of carbon oxidized, 1 t C_{ox} / t C

The table 11 show the data applied from this equation.

Table 11 Data applied to calculate the GHG reductions through thermal energy

Parameter	Symbol	Unit	Value	Reference
Thermal energy substituted [pace heating]		TJ	1,05	Project setup
Thermal energy substituted [hy-gienization]		TJ	6,65	Project setup
Carbon Emission Factor (NG)	CEF	t C/ TJ	15,3	IPCC, Vol 2, p.1.24
Fraction of Carbon oxidized	FCO	t C_{ox} / t C	1	IPCC, Vol 2, p.1.24
Conversion Factor		t $C0_2$ / t C_{ox}	3,67	(44 g/mol / 12 g/mol)
CO2e reduced by natural gas displacement (piglet stalls)		**t/mp**	**432**	**Calculated**

The methane emissions reductions achieved by fossil fuel substitution during the period of May 2006 – Dec 2007 through the project activity *Houbensteyn Methane Recovery Project* calculates to:

432 tons of CO_2e.

4.3 Emissions by Sources

As the oil-fired emergency generator has not been used during the period from May 1, 2006 to December 31, 2007, and the own production was enough to cover the hat and electricity demand, no emission by the source of the project activity occurred.

4.4 Compilation

The project activity *Houbensteyn Methane Recovery Project* causes GHG emission reductions due to both approaches methane reduction occurring during storage from manure and waste decay as well as substitution of fossil sources by thermal energy produced. Since the project owner has to deal with a lot of organic waste streams of different type, in order to be extremely conservative when determine the final GHG reductions for verification an additional security factor of 0,5 to the reduction calculations made above shall be applied. However, the project owner shall reserve the right to later enhance this GHG reduction figure of 27.700 t CO2e retroactively by specified proof of every single waste stream and its associated parameter applications to the baseline. The net balance of the GHG reductions achieved is shown in table 12.

Table 12 Summarized data of the GHG emissions and reductions through the project activity *Houbensteyn Methane Recovery Project*

Reduction Approach	**tCO_2e**
Methane Reduction	27.268
Heat Production (fuel switch)	432
Emission by Sources (oil consumption)	0
Electricity	0
Total GHG Reductions	27.700
GHG Reductions claimed	**13.850**

The total CO_2 net reductions claimed by the project activity Houbensteyn Methane Recovery Project calculate for the operation period during the period of May 01, 2006 – Dec 31, 2007 to be:

13.850 tons of CO_2e.

5 References

- ARA Carbon Finance GmbH; PDD – Project Design Document, *Methane Recovery Project Houbensteyn Ysselsteyn, Limburg, The Netherlands, Final Version 04, July 02, 2007*;
- Tüv Rheinland Group; *Determination Report and Determination Protocol; Final Version, August 27, 2007*
- Operators Data Recordings for the operation period May 2006- Dec 2007
- Chigago Climate Exchange; CCX Agricultural Methane Gas Project Guidelines

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