MONITORING REPORT

Methane Recovery Project

Princepeel Wilbertoord

Crediting Period: 01 June – 31 December 2007

ARA Carbon Finance GmbH

17 March 2008; Version 02

KEY DATA

➢ Project Name	*Methane Recovery Project Prince-peel Wilbertoord*
➢ Project Location	Wilbertoord, The Netherlands
➢ Project Operator	B.V. Landgoed de Principeel
➢ VER Owner	ARA Carbon Finance GmbH
➢ Baseline (Approach I)	Uncontrolled methane emissions during storage of manure
➢ Baseline (Approach II)	Heating through fossil energy sources
➢ Project Activity (Module I)	Technical digestion of manure, plus combined heat and power
➢ 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 25, 2007
➢ Validator	TÜV Rheinland Group
➢ Start Crediting Life Time	June 01, 2006
➢ Verification Period I	June 01 to Dec 31, 2007

CONTENT

1 Introduction

The *Methane Recovery Project Princepeel Wilbertoord* was validated by TÜV Rheinland Group on August 25th, 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, by direct substitution of fossil fuels in irrigation pumps and by the generation of renewable thermal energy used to substitute fossil sources. The crediting life time of the project started on June 1st, 2007. The *Methane Recovery Project Princepeel Wilbertoord* should be verified for its first operation period from June 1 to December 31, 2007 in order to certify the correspondingly reduced GHG emissions by this project activity within this period.

This monitoring report on hand refers to the monitoring concept of the PDD submitted in its version 05 by ARA Carbon Finance GmbH on Jun 28th, 2007 to the TÜV Rheinland Group.

2 Project Status

The project activity was set into operation in May 2007. The project operation commenced in several stages; the fermenters slowly being loaded to full capacity and the 4 CHP motors with capacities of 2 x 1.064 kWel, 475 kWel and 550 kWel being commissioned one after another. The installation of one additional 1.416 kWel engine is planned for the near future. The waste heat produced will in the future be used for space heating of several buildings, for digestate hygienization and soil substrate production plant in order to sell the concentrated dry matter as soil substrate. Furthermore, the biogas will be used directly in irrigation pumps to substitute natural gas. The hygienization units are expected be to launch in April 2008. The fuel switch of the irrigation pumps will presumably start in 2009. During the first monitoring period the waste heat from the CHP engines was exclusively used to cover the fermentrers internal heat demand. Currently the project activity is permitted to use 30.000 t of manure per annum.

3 Data Analysis

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

Tab. 1 Monitoring Parameters of the *Methane Recovery Project Princepeel Wilbertoord*

ID	Parameter	Unit	Device	Recorded	Remark
1. BGP	Biogas produced	Nm^3	Flow meter	n/a	Not available. The operator has not installed a flow meter so far. *Auxiliary determination through parameter 6. 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	Not available. So far, no heat has been used for external purposes.
5. ETHY	Thermal energy produced for hygienization.	MWh	Heat meter	n/a	Not available. So far, no heat has been used for hygienization process.
6. EEP	Electrical energy produced	MWh	Power meter	Yes	
7. EEI	Electrical energy imported	MWh	Power meter	Yes	
8. $MCOF_i$	Mass of co-ferment i fed into digester	t	Scales recording	Yes	
9. MANURE	Volume of manure fed into the digester	t	Scales recording	Yes	
10. OIL	Oil consumed in emergency boiler	m^3	Volume scale and/or delivery receipt	Yes	
11. DIESL	Diesel consumption in emergency generator.	m^3	Volume scale and/or delivery receipt	Yes	

[tab. 1 continues]

12. GASPROP	Biogas used in irrigation pumps	Nm^3	Flow meter	n/a	Not available. The pumps will start to operate with biogas in a later stage as stated in the PDD.

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 secondary-/ co-ferments like maize, grain, potato fibres, beans, lactose, drinks, food residues and glycerine. The input materials have been weighed and subsequently fed into the digester. Table 2 shows the monthly mass balances of these feed materials.

Tab. 2 Digester Input Materials

Month	Manure	Waste							Non-waste	
	Swine manure m^3	Potato fibres (t)	Mayonnaise (t)	Drinks (t)	Lactose (t)	Food residues (t)	Glycerine (t)	Beans (t)	Grain (t)	Maize (t)
Jun 07	1.340		506	649	327	216	242		33	
Jul 07	1.520		233	444	297	97	108		46	
Aug 07	1.480		205	305	372	76	259	35	34	
Sep 07	1.550		137	423	376	211	218	31		
Oct 07	1.560		149	246	336	108	377	50	83	90
Nov 07	1.520	129	37	280	359	39		257	61	
Dec 07	1.420	180		246	69	37			42	
total input	**10.390**	**309**	**1.267**	**2.593**	**2.136**	**784**	**1.204**	**373**	**299**	**90**

Figure 1 demonstrates the input curves for manure and co-ferments between June 1 and December 31, 2007 as deviation from the arithmetic mean of their monthly input mass.

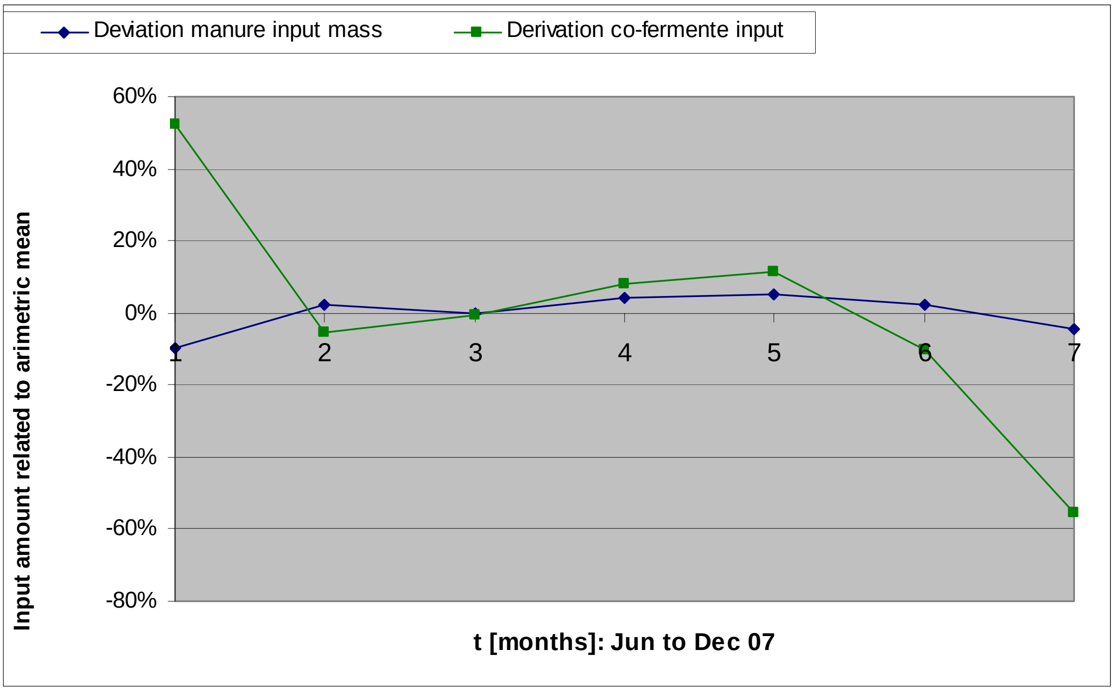

Fig. 1 Digester mass input curves of manure and co-ferments (sum)

The amount of manure input has been fairly steady during the monitoring period, changing between minimum 1.340 tons in June to maximum 1.560 tons in October. Instead the monthly input amount of co-ferments into the biogas installation has varied much more. The most co-ferments were used in the beginning of the period, which is not surprising as the relatively big fermenters had to be filled with substrate. This explains as well, why the co-ferment input amount dropped directly to 5% below average in June. From June on, the amount of co-ferments used increased slowly up to a maximum of 1.439 tons in October, which is 11% above average. From November onwards, the amount of co-ferments fed in to the diggester dropped drastically reaching the lowest amounts in December, with only 574 tons (54 % < average). The reason for this was the explosion of a glycerine silo in November.

Since only the manure and waste co-ferment digestion is of relevance for the reduction of uncontrolled methane emissions occurring during the storage of untreated manure as well as from 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 amount of biogas produced within the project activity. Table 3 reflects the derivation.

Tab. 3 Derivation of gas production ratio manure / total input amount

	manure	**waste**							**non-waste**	
	swine manure	**potato fibres**	**mayon-naise**	**drink**	**lactose**	**food residues**	**glycerine**	**beans**	**grain**	**maize**
total digester input (t)	**10.390**	**309**	**1.267**	**2.593**	**2.136**	**784**	**1.204**	**373**	**299**	**90**
dmc; %	7,00	30,00	99,90	40,00	6,50	37,00	47,00	40,00	35,00	33,00
dom; %	86,00	93,40	99,90	99,00	92,00	98,00	69,00	94,00	91,10	95,80
VS; t	625,48	86,58	1.264,47	1.026,83	127,73	284,28	390,46	1402,48	95,34	28,45
CH4 capacity; m³/t	450,00	737,20	918,75	99,00	495,00	275,00	412,50	523,40	582,10	586,10
Ref:	IPCC			Supplier						
CH4 density; kg/m³	0,7168	0,7168	0,7168	0,7168	0,7168	0,7168	0,7168	0,7168	0,7168	0,7168
CH4 potential; t	201,75	45,75	832,73	72,87	45,32	56,04	115,45	526,17	39,78	11,95
GWP	21,00	21,00	21,00	21,00	21,00	21,00	21,00	21,00	21,00	21,00
CO2e potential; t	4.236,84	961	17.487	1.530	952	1.177	2.424	11.050	835,36	251,02
CO2e potential from manure; t	**4.237**									
CO2e potential from co-ferments; t							**35.581**		**1.086**	
gas production ratio single feed / total	**13,69%**	3,10%	56,48%	4,94%	3,07%	3,80%	7,83%	3,57%	2,70%	0,81%
gas production ratio manure & waste co-ferment / total				**96,49%**						
gas production ratio non-waste co ferment /total									**3,51%**	

Sources: For manure: IPCC 2006, vol 4. For co-ferments: Fachagentur Nachwachsende Rohstoffe e.V 2006. Handreichung p. 95, Forschungsanstalt 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 leistungsstei-gerndes Zusatzmittel zur Biogaserzeugung aus Silomais, Körnermais, Rapspresskuchen und Schweinegülle p. 4 and 10

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 June 1 to December 31, 2007 the gas production ratio caused by manure and waste co-ferment input through technical digestion could be determined to 96,49 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.

3.2 Power Production of CHP Engines

The power production of all 4 CHP engines installed has been continuously recorded. Table 4 shows the results on a monthly basis.

Tab. 4 Power production of the CHP engines attached to the biogas module

		Power production	**Engine power**		**Load factor**	
Project		CHP	output CHP	installed capacity		full load run time
start		kWh/ month	kW	kW (total)	%	h/a
Jun 07	1	485.416	674	3.153	21	1.873
Jul 07	2	830.272	1.153	3.153	37	3.204
Aug 07	3	897.000	1.246	3.153	40	3.461
Sep 07	4	859.739	1.194	3.153	38	3.318
Oct 07	5	867.707	1.205	3.153	38	3.348
Nov 07	6	689.700	958	3.153	30	2.661
Dec 07	7	705.994	981	3.153	31	2.724
Total		**4.850.412**			**34**	**2.941**
					Arithmetic mean	

In total, 4.850.412 kWh of electricity have been produced by the biogas unit for own consumption and to be fed into the grid. The electricity production was achieved through four engines, with electric capacities of 2 X 1.064 kWel, 475 kWel and 550 kWel. The low efficiency values are caused by biological problems. In general, it takes long to run a biogas plant of this scale on maximum gas production. The operator doses not currently have enough biogas to run the motors fuel load. This delay is supported by the complicated situation on the Dutch market for co-ferments, where prices increase.

Figure 2 illustrates the power production of the CHP engines versus their installation capacity.

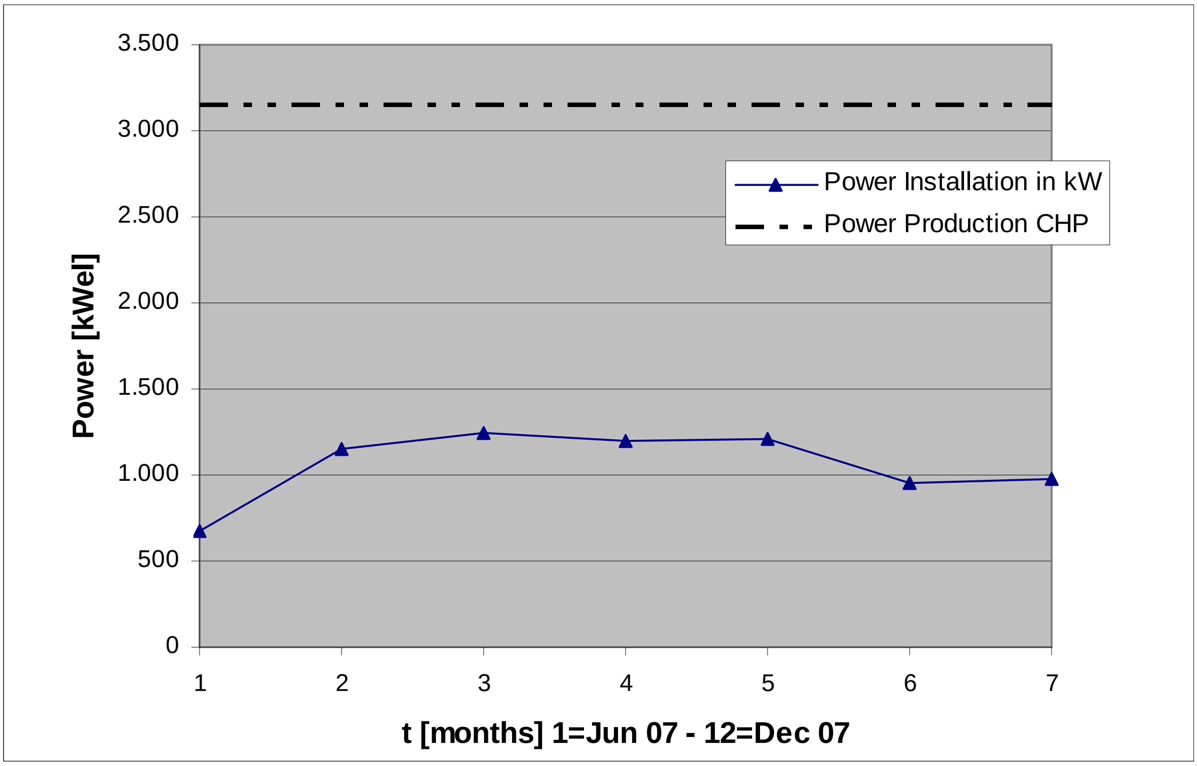

Fig. 2 Power production of the CHP engines vs. the installation capacity

The electricity production rates were poor (< 40 % of the installed capacity) during the period May to December 2007. The average production rate of electricity generated by the CHP engines in the monitoring period was 36 %, which corresponds to 3.119 hours of annual run-time of the CHP engines at full load.

3.3 Biogas Production with help power production of CHP Engines

The monthly biogas flow rates into the CHP engines installed with their corresponding CH_4 volume contents are shown in table 5. Since the biogas flow itself could not be directly recorded, the appropriate monthly data of the produced electricity and methane content where used to calculate the biogas flow as follows[1]:

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

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

with:

- *BGP:* Biogas produced [m³]
- *EEP:* Electricity energy produced [MWh]
- ETA_{CHP-el} Electric efficiency of the CHP engines = 0,39 (Ref.: engine 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

Tab. 5 Biogas flow to CHP engines

Month		CHP Power Production kWh	CHP CH_4 content vol %	CHP Biogas flow m³
Jun 07	1	485.416	55	226.301
Jul 07	2	830.272	56	380.161
Aug 07	3	897.000	57	403.509
Sep 07	4	859.739	58	380.079
Oct 07	5	867.707	58	383.602
Nov 07	6	689.700	58	304.907
Dec 07	7	705.994	58	312.111
		4.850.412 **total**	**57,1** **mean**	**2.164.368** **total**

3.4 Plausibility Check Biogas Parameters

Due to the process characteristic the primary parameters electricity production, standardized input amounts (to specific gas production parameters) and biogas flow are supposed to be proportional. To prove this proportionality, and thus to prove the data plausibility, the parameter data during the year 2007 was standardized to its arithmetic mean and mapped as deviation of this mean value (Fig. 3).

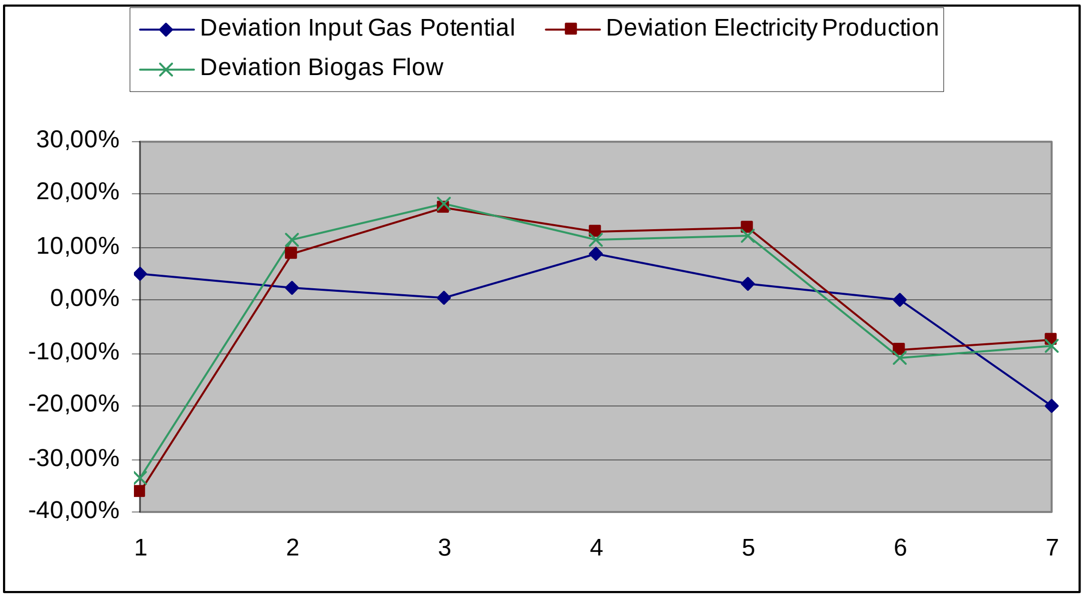

Fig. 3 Plausibility check of parameter data

Due to lack of monthly data for the runtime hours, this parameter could not be added to the plausibility check. However, the courses of the curves biogas amount, power production and input gas vary similar. Hence, the data plausibility could be postulated.

3.5 Runtime Hours

The operator has recorded the runtime hours of the CHP engines only in the end of the year. The recorded figures are given in the table 6 below.

Tab. 6 Runtime hours

Runtime (h)	CHP 1 (Jenbacher 1.064 kWel)	CHP 2 (Jenbacher 1064 kWel)	CHP 3 (Waukesha 475 kWel)	CHP 4 (Waukesha 550 kWel)
1 Jun – 31 Dec 2007	4629	956	2549	110

3.6 Thermal Energy for external Utilisation

No thermal energy has been used for external utilization to displace fossil fuels during the monitoring period.

3.7 Electric Energy imported

During the monitoring period, 640 kWh of electrical energy have been imported for the project activity. The project activity has produced 4.850.412 kWh of electricity (table 4) and from which 4.549.449 kWh has been exported into the grid. Hence, the project activity provides a positive green energy balance and no GHG emission in terms of electricity needs to be considered.

3.8 Oil and Diesel Consumption

The oil- and diesel-fired boilers exist for the purpose of a breakdown of the CHPs. The emergency generators have not been used during the period from June 1 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 for heating purposes in the near vicinity farm through production and delivery of thermal energy by the project activity.

4.1 Methane Mitigation

The methane emission reduction through the project activity *Methane Recovery Project Princepeel Wilbertoord* is to be derived according to the PDD, section D, by the following equation:

$$GHG_{red,\ IIID} \quad = AF \bullet (BGP \bullet MC - \Sigma\ BGCO_i \bullet MCCO_i) \bullet D \bullet GWP_{CH4} \qquad (2)$$

With:

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

Where:

- $GHG_{red,IIID}$ is the annual emission reduction through methane recovery, in t CO_2e
- BGP is the total annual biogas produced by the project activity BGP, in m³
- $BGCO_i$ is the 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 ($MCOF_i$) and the specific gas productivity of the co-ferment i, in m³
- MC is the average annual methane content in the biogas, in m³ methane / m³ biogas
- $MCCO_i$ is the average methane content arising in the biogas through digesting a co-ferment i, in m³ methane / m³ biogas
- D is the density of methane, set to 0,0007168 t CH_4 / m³ CH_4 according to ACM0001
- GWP_{CH4} is the Global Warming Potential of methane, set to 21 t CO_2e / t CH_4 according to UNFCCC
- $dm_{nw,\ I}$ is the dry matter of the proceeded quantity of non-waste co-ferment i
- dm_{manure} is the dry matter of the proceeded quantity of manure
- $dm_{w,\ j}$ is the 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 96,49 % related to the total input amount and to the mean methane content 57,1 %, the methane reduction equation reduces to (please see table 3 and 5):

$$GHG_{red,\ IIID} = AF \bullet 0{,}9649 * BGP * 0{,}571 * D * GWP \qquad (3)$$

Table 7 shows the data applied for this equation.

Tab. 7 Data applied to calculate the GHG reductions through methane mitigation

	Emission reductions from manure and waste				
Month	**CH4 (m^3)**		**CH4 (t)**		**CO2 (t)**
Jun 07	120.098		86		1.808
Jul 07	205.420		147		3.092
Aug 07	221.929	**Density**	159	**GWP_{CH4}**	3.341
Sep 07	212.710	0, 7168	152	21	3.202
Oct 07	214.682	kg/m^3	154		3.232
Nov 07	170.641		122		2.569
Dec 07	174.672		125		2.629
Total	**1.200.054**		**860**		**18.064**
dry matter of the proceeded quantity of non-waste co-ferment					123,8
dry matter of the proceeded quantity of manure					625,5
dry matter of the proceeded quantity of waste co-ferment					3320,6
Adjustment Factor					0,99696
CO_2 emission reduction / m.p.					**18.009**

m.p. refers to monitoring period: Jun 1- Dec 31, 2007

The methane emissions reduction achieved during June 1 and December 31, 2007 through the project activity *Methane Recovery Project Princepeel Wilbertoord* calculates to be:

18.009 tons of CO_2e.

Since the pumping station of irrigation pumps will be modified for the use of biogas only in 2009, the equation 2 of the monitoring plan (PDD, p. 24) will not be applied in this stage.

4.2 Thermal Energy for the User

Since the external application of the heat of the CHP engines has not been applied in 2007, no emission reduction through substitution of fossil fuels is claimed

4.3 Emissions by Sources

As the oil- and diesel-fired emergency generators have not been used during the period from June 1 to December 31, 2007, no emission by the source of the project activity occurred.

4.4 Compilation

The project activity *Methane Recovery Project Princepeel Wilbertoord* 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 18.009 t CO_2e retroactively by specified proof of every single waste stream and its associated parameter applications to the baseline. The emission reduction achieved trough the project activity is shown in table 8.

Tab. 8 Summarized data of the GHG emissions and reductions

Reduction Approach	**t CO_2e**
Methane Reductions	18.009
Heat Production (Fuel Switch)	0
Emission by Sources (Oil combustion)	0
Electricity	0
Total GHG Reductions	18.009
GHG Reductions claimed	**9.005**

The total CO_2 net reductions claimed by the project activity Methane Recovery Project Princepeel Wilbertoord calculate for the operation period June 1 - December 31, 2007 to be:

9.005 tons of CO_2e.

5 References

- ARA Carbon Finance GmbH; PDD – Project Design Document**,** *Methane Recovery Project Princepeel Wilbertoord*, Final Version 05, August 18, 2007
- Tüv Rheinland Group; Determination Report and Determinaiton Protocol; Final Version, 2007-08-25
- Operators Data Recordings for the operation period 2007
- Chicago Climate Exchange; CCX Agricultural Methane Gas Project Guidelines

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