METHANE RECOVERY PROJECT

PRINCEPEEL WILBERTOORD

Document Prepared By GES Biogas GmbH

Project Title	Methane Recovery Project Princepeel Wilbertoord
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PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

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 and has on February 2009 published an addendum to also fulfil VCS requirements. The project is technically an agricultural biogas plant that produces electric energy from different organic input materials. The reduction approaches were in the PDD 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* has been verified according to VCS standard 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. During the first Monitoring period, only 4 engines were operational and the biogas process had to be started and the heat utilization was not implemented.

This report monitors emission reductions that have occurred during the Monitoring period January 01 to Dec 31, 2012. During this Monitoring period the biogas plant was in full operation with 5 CHPs and caused calculated emission reductions of 59,882t CO2e

The methodology used 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 and to its Monitoring report of March 2008 in its Version 02 submitted to TÜV Rheinland and verified according to VCS standard on February 24th, 2009.

1.2 Sectoral Scope and Project Type

The VCS sectoral scopes applicable to the project activity are “1. Energy industries”, “13 Waste handling and disposal” and “15. Livestock and manure management”.

1.3 Project Proponent

Organization name	B.V. Landgoed de Principeel
Contact person	Jos van Heugten
Title	
Address	Molenstraat 40 5446 PL Wanroij
Telephone	+31(0)485476230
Email	jos@princepeel.nl

1.4 Other Entities Involved in the Project

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Organization name	GES Biogas GmbH
Role in the project	Carbon Consultant
Contact person	Marius Bossen
Title	Project Manager
Address	Neuer Wall 54
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Email	m.bossen@ges-biogas.de

1.5 Project Start Date

The start of commissioning was the 01 May 2007.

1.6 Project Crediting Period

The starting date of the crediting period and the first monitoring period is set to 1st of June 2007. The project will use a fixed crediting period of 10 years which ends on 1st of June 2017

1.7 Project Location

The project activity will take place on the estate of the project owner B.V. Landgoed de Principeel. The project will be located in Wilbertoord. Approximate geographical coordinates are N51°39'45 E5°44'24''.

1.8 Title and Reference of Methodology

Three small scale methodologies according to the CDM standards of the UNFCCC are used in the project:

Type III, other project activities, AMS III.D, Methane recovery in agricultural and agro industrial activities" (Version 11)
(referring to the capture of methane gases from decomposing manure, actual version is named "Methane recovery in animal manure management systems" (Version 19,0))

Type II, Energy Efficiency Improvement Projects, AMS II.F, "Energy Efficiency and Fuel Switching measures for agricultural
facilities and activities" (Version 08) (referring to the replacement of diesel fuel by biogas for combustion motor driven irrigation pumps)

Type I, Renewable Energies, Category AMS I.C, Thermal energy for the user with or without electricity" (Version 09)
(referring to the utilization of the waste heat to replace fossil energy)

1.9 Other Programs

Project activity does not claim emission reduction from production of electric energy. In this aspect it has no influence on projects that have binding emission limits under the EU ETS. Anaerobic digestion is not considered in the greenhouse gas inventory of the Netherlands so the emission reductions caused by the avoided uncontrolled decay of waste or manure will not be counted towards the greenhouse gas emission inventory of the Netherlands.

The project also receives no other form of incentives for the activities that cause the emission reduction.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

The project activity was set into operation in May 2007. The project operation commenced in several stages; The initial project setup had 4 CHP motors with capacities of 2 x 1,064 kWel, 475 kWel and 550 kWel. The installation of a fifth CHP with 1,416 kWel has been commis-sioned since then, as it was already planned and mentioned in the first Monitoring report. In total 4.568 kWel were installed during the Monitoring period of 2012.

The waste heat produced has been used in a digestate hygienization unit and a so called N-Stripper as it has been announced in the last Monitoring. The N-Stripper reduces the amount of Nitrogen in the digestate. This makes the relation between the nutrients more favorable for fertilization.

During the Monitoring period of 2012 still no heat meters were installed that were able to measure the amount of heat used for external processes. For this reason no emission reductions were claimed here.

Deviant from the first Monitoring the Carbon Manager has been changed from ARA Carbon finance GmbH to GES Biogas GmbH

2.2 Deviations

Deviation in the implementation of the project has been the missing fuel switch in the irrigation pumps from fossil fuels to biogas. Also no heat meters are installed to measure the external heat utilization.

[redacted] Methodology Deviations

Deviant from the Methodology described in the PDD the amount of biogas is not measured but calculated by the amount of electricity produced. Reason is that no flow meter is installed to measure the biogas volume that is utilized in the CHP. The electricity measurement can be considered as very accurate because it also is the basis for the accounting with the utility. No negative influence on the amount of emission reductions can be expected as the calculated value is expected to be very close to the actual value.

[redacted] Project Description Deviations

Deviation in the implementation of the project has been the missing fuel switch in the irrigation pumps from fossil fuels to biogas. But no emission reductions were claimed from this activity during the Monitoring period anyhow.

2.3 Grouped Project

Project activity is not a grouped project.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data / Parameter	D_{CH4}
Data unit	t CH4/m³
Description	Density of Methane
Source of data	IPCC
Value applied:	0.0007168
Justification of choice of data or description of measurement methods and procedures applied	IPCC Methodology ACM0001
Purpose of the data	Calculation of baseline emissions
Comments	None

Data / Parameter	GWP_{CH4}
Data unit	*t CO2e / t CH4*
Description	*Global warming potential of Methane*
Source of data	UNFCCC
Value applied:	*21*
Justification of choice of data or description of measurement methods and procedures applied	*Justify the choice of data source, providing references where applicable. Where values are based on measurement, include a description of the measurement methods and procedures applied (eg, what standards or protocols have been followed), indicate the responsible person/entity that undertook the measurement, the date of the measurement and the measurement results. More detailed information may be provided in an appendix.*
Purpose of the data	*Calculation of baseline emissions*
Comments	None

3.2 Data and Parameters Monitored

Data / Parameter	BGP
Data unit	Nm^3
Description	Biogas produced
Source of data	Calculated
Description of measurement methods and procedures to be applied	Calculated by the amount of electricity produced and the efficiency of the CHP
Frequency of monitoring/recording	Continuously
Value monitored:	16,003,970
Monitoring equipment	N/A
QA/QC procedures to be applied	See Parameter EEP
Purpose of the data	Calculation of baseline emissions
Calculation method	$$BGP = \frac{EEP}{(ETA_{CHP-el}) * HV_{Biogas}}$$ BGP — Biogas produced [m^3] EEP — Electricity energy produced [MWh] ETA_{CHP-el} — Electric efficiency of the CHP engines = 0.395 HV_{Biogas} — Caloric value biogas [MWh/m^3], $HV_{Biogas} = 0.1 \frac{kWh}{m^3} \times \chi_{CH4} H$ 0,1 — Stoichiometric combustion calculation of methane; 802,6 kJ/mol / 0.02241 m^3/mol = 35,81 MJ/m^3 = 0,1 MWh/m^3 χ_{CH_4} — CH_4 volume content of biogas flow
Comments	None

Data / Parameter	MC
Data unit	Vol-%
Description	Methane content of the biogas
Source of data	Gas analyzer
Description of measurement methods and procedures to be applied	Gas analyzers are used to monitor the amount of methane in the biogas. A methane content of above 50% is important to provide the engines with enough calorific value to combust the gas. The values are recorded daily from the operational personnel. Accuracy of Methane measurement devices is usually +-5%
Frequency of monitoring/recording	Continuous measurement, daily recording.
Value monitored:	56.11% (annual average)
Monitoring equipment	Gas analyzer
QA/QC procedures to be applied	Equipment will undergo regular calibration according to manufacturers specification
Purpose of the data	Calculation of baseline emissions
Calculation method	N/A
Comments	Data used for controlling reasons

Data / Parameter	Fraction of time	
Data unit	h	
Description	Runtime of the CHP	
Source of data	Runtime counter in CHP	
Description of measurement methods and procedures to be applied	Runtime counters automatically record the number of hours that a CHP operates. The value increases continuously during lifetime the actual number is recorded daily in the operational manual.	
Frequency of monitoring/recording	Continuously	
Value monitored:	CHP 1	7,972
	CHP 2	8,308
	CHP 3	7,226
	CHP 4	8,009
	CHP5	8,571
Monitoring equipment	Runtime meter	

QA/QC procedures to be applied	Runtime meters will have a inaccuracy of < 1%. Calibration is not neccessary
Purpose of the data	Plausibility of electricity production
Calculation method	N/A
Comments	Data used for controlling reasons

Data / Parameter	EEP
Data unit	kWh
Description	Electrical energy produced
Source of data	Power meter
Description of measurement methods and procedures to be applied	Electric power meter at the CHP measures the produced electric energy.
Frequency of monitoring/recording	Continuously
Value monitored:	35,474,599
Monitoring equipment	Power meter at CHP unit
QA/QC procedures to be applied	Precision is very high (uncertainty < 0,5%). The electric meters are sealed and maintained by the grid operator. Calibration is done by authorized service providers. The documentation of the last calibration by Fudura BV has been handed out to the VVB.
Purpose of the data	Calculation of baseline emissions
Calculation method	N/A
Comments	Data used for controlling reasons. Basis for payment from the grid operator is the feed in at the substation which is ~1% lower.

Data / Parameter	EEI
Data unit	kWh
Description	Electric energy imported
Source of data	Invoices of utility
Description of measurement methods and procedures to be applied	The biogas plant will receive invoices for the own electricity demand from the local utility.
Frequency of monitoring/recording	At invoicing of the utility
Value monitored:	2,462,216

Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of the data	Demonstrate that the net impact of electricity production and consumption is positive.
Calculation method	N/A
Comments	None

Data / Parameter	MCOFi
Data unit	t
Description	Mass of each co-ferment i fed into the digester
Source of data	Scale recording
Description of measurement methods and procedures to be applied	Mass of co ferments will be noted on the delivery receipt. The input of co ferments will be measured with weighing scales At delivery
Frequency of monitoring/recording	At delivery
Value monitored:	

Barley	1,154
Potatoe starch	14
Snijmais	4,002
Grain	1,722
Potatoes	121
Potatoe wastes	89
Beet pulp	742
Cacao waste	2,049
Food waste	102
Solid Fruit waste	1,516
Glycerine	8,552
Gras	302
Vegetable waste	29
Whey waste	42
Maize plant	1,602
Plant fat	59
Suikerwater	544
Vegetable waste	353
processed food waste	10,932
Liquid Fruit waste	2,871

Monitoring equipment	Weighing scales on the installation
QA/QC procedures to be applied	Weighing scales are precise and have a uncertainty level of ~5%. Subject to regular calibration.
Purpose of the data	Calculation of baseline emissions
Calculation method	N/A
Comments	Input into the digester is not measured directly. It can be assumed that the amount delivered and feeded is nearly equal. Inventory data made available to the DOE showed that the annual inventory showed a deviation of 66 t between beginning and end of 2012. Also recorded for the operation manual.

Data / Parameter	OIL
Data unit	m^3
Description	Oil consumed in emergency boiler
Source of data	Volume scale and/or delivery receipt
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	At delivery
Value monitored:	0
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of project emissions
Calculation method	*N/A*.
Comments	Emergency boiler has not been used in 2012

Data / Parameter	DIESEL
Data unit	m^3
Description	Diesel consumed in emergency generator
Source of data	Volume scale and/or delivery receipt
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	At delivery
Value monitored:	0

Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of project emissions
Calculation method	*N/A*.
Comments	Emergency boiler has not been used in 2012

Data / Parameter	MANURE
Data unit	t
Description	Volume of manure fed into digester
Source of data	Scales recording, flow meter recordings
Description of measurement methods and procedures to be applied	Solid manure is weighed like co-ferments during feed in with the solid feeding system. Liquid manure from own farm is measured with flow meters.
Frequency of monitoring/recording	At feeding the digester
Value monitored:	Liquid pig manure: 62,925 Solid pig manure: 1,051 Liquid cow manure: 7,698 Solid cow manure: 1,437 Rumen contents: 6,822
Monitoring equipment	Weighing scales /flow meter
QA/QC procedures to be applied	High mass scales are very robust mechanical instruments being resistant of deviation within the uncertainty level.
Purpose of the data	Calculation of baseline emissions
Calculation method	N/A
Comments	Also recorded for the operation manual

3.3 Monitoring Plan

Generally the relevant data for the calculation of emission reductions is recorded and collected for usual business operation. Data is needed for controlling and accountancy. Another reason for data collection are the requirements for the feed in tariff (amount of manure).

The operation personnel maintains a operational manual which contains the daily feed of the digesters as well as electricity production and the methane content.

The daily feed is recorded by weighing scale in the solid feeding entry and recorded handwritten in the operation manual. The electricity production is continuously recorded at the processing unit of the CHP. The daily production is recorded by a data logger and/or recorded handwritten in the operation manual. The methane content is recorded handwritten in the operation manual.

Data is stored in electronic form in the accountancy and data about the daily operation is stored in the operation manual that can be found on the installation itself.

A specialized employee is responsible for collecting all data that is relevant for the monitoring of emission reductions (see contact person). This person is experienced with greenhouse gas monitoring and has already accompanied monitoring processes for this and other biogas plants.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

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:

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

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 m^3
- $BGCO_i$ 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 m^3
- MC is the average annual methane content in the biogas, in m^3 methane / m^3 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

The monthly biogas flow rates into the CHP engines installed with their corresponding CH_4 volume contents are shown in table 1. 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]:

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

Folge allgemeiner Verbrennungsrechnung, Quelle

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 [kWh/m³],

$$HV_{Biogas} = 0{,}1\frac{kWh}{m^3} * x_{CH4}$$

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

Methane is the component that determines the calorific value of biogas. Following the equation of combustion the calorific value of methane under normal conditions is 50,01 MJ/kg = 9.9968 kWh/m³ ~10 kWh/m³[2].

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

[2] Source: HAHNE: Technische Thermodynamik, (ISBN 348659231-9) page 406

Month	Electricity produced [kWh]	Average Methane content [%]	Calorific value [kWh/m³]	Efficiency	Biogas Flow [m³]
January	3,009,764	56.39	5.64	0.395	1,351,312
February	2,830,133	54.48	5.45	0.395	1,315,075
March	3,147,235	53.65	5.36	0.395	1,485,256
April	2,663,979	54.50	5.45	0.395	1,237,477
May	2,642,825	52.58	5.26	0.395	1,272,560
June	2,809,658	58.19	5.82	0.395	1,222,392
July	3,263,625	57.83	5.78	0.395	1,428,647
August	3,240,142	57.97	5.80	0.395	1,415,079
September	3,076,141	57.47	5.75	0.395	1,355,168
October	2,785,528	55.35	5.54	0.395	1,273,957
November	3,093,374	57.70	5.77	0.395	1,357,249
December	2,912,195	57.16	5.72	0.395	1,289,797
	35,474,599 total	**56.11 mean**			**16,003,970 total**

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Tab. 1 Biogas flow to CHP engines

Measured annual average Methane content in the biogas (MC) is 56.11%

The biogas potential of non-waste material $BGCO_i$ and its Methane content $MCCO_i$ are derived from the monitored types and masses of material input ($MCCO_i$) and their specific biogas and methane building capacities.

Category	Substrate	Amount [t]	biogas production [m³/ t fresh mass]	Biogas potential [m³]	Methane content [%]	Methane potential [m³]	Percentage of Methane potential
non waste	Barley	1,153.52	579.10	668,001	52.7	352,036	12.61%
	Potatoe starch	14.34	605.65	8,685	50	4,342	
	Snijmais	4,001.72	185.29	741,477	52.2	387,051	
	Grain	1,721.57	194.82	335,403	52.3	175,416	
waste	Potatoes	121.14	150.13	18,186	51.5	9,366	70.40%
	Potatoe wastes	88.94	67.68	6,019	51.4	3,094	
	Beet pulp	742.2	514.98	382,220	50.6	193,403	
	Cacao waste	2,048.78	343.40	703,552	55.3	389,064	

	Food waste	102.3	92.05	9,417	60.2	5,669	
	Solid Fruit waste	1,516.05	87.64	132,871	50	66,436	
	Glycerine	8,552.4	845.75	7,233,192	50	3,616,596	
	Gras	302.44	208.30	62,998	54.1	34,082	
	Vegetable waste	29.48	57.00	1,680	56	941	
	Whey waste	41.78	36.91	1,542	55.3	853	
	Maize plant	1,602.08	157.65	252,565	51.5	130,071	
	Plant fat	58.68	874.00	51,286	68	34,875	
	Suikerwater	543.84	15.59	8,477	50	4,239	
	Vegetable waste	353.08	57.00	20,126	56	11,270	
	processed food waste	10,931.5	92.05	1,006,293	60.2	605,788	
	Liquid Fruit waste	2,871.4	15.59	44,758	50	22,379	
manure	Liquid pig manure	62,925	20.40	1,283,670	60	770,202	16.99%
	Solid pig manure	1,051	74.25	78,037	60	46,822	
	Liquid cow manure	7,698	28.90	222,472	55	122,360	
	Solid cow manure	1,437	90.00	129,330	55	71,132	
	Rumen contents	6,822	60.48	412,595	55	226,927	

Tab. 2 Input Materials and their biogas and methane building potential

With the parameters determined above the methane reduction equation reduces to:

(3)

$$GHG_{red,\ IIID} = 0.9869 \bullet (16{,}003{,}970 \bullet 56.11\% - \Sigma\ 1{,}753{,}565 \bullet 52.30\%) \bullet 0{,}0007168 \bullet 21$$

= 119,765 tons of CO_2e.

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.

Uncertainty is given by the many different input types and their gas potential. To deal with those uncertainties the project applies an security factor of 0.5.

Since the external application of the heat of the CHP engines has not been measured in 2012, no emission reduction through substitution of fossil fuels is claimed.

4.2 Project Emissions

As the oil- and diesel-fired emergency generators have not been used during 2012, no emission by the source of the project activity occurred.

4.3 Leakage

According to the PDD no leakage has to be considered.

4.4 Net GHG Emission Reductions and Removals

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
Year 2007 (01 June - 31 December	9,005	0	0	9,005
Year2012 (01 January-31 December)	**59,882**	0	0	**59,882**
Total	68,887	0	0	68,887