Verified Carbon Standard

METHANE RECOVERY PROJECT PRINCEPEEL WILBERTOORD NORTH BRABANT, THE NETHERLANDS

Document prepared by GES Energie GmbH

Project Title	Methane Recovery Project Princepeel Wilbertoord, North Brabant, the Netherlands
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CONTENT

1 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 published an addendum on February 2009 to also fulfil VCS requirements. Technically, the project is an agricultural biogas plant that produces renewable energy (electricity and heat) from different organic input materials. The GHG emission reduction approaches were demonstrated in the PDD by the mitigation of uncontrolled methane emission out of manure and organic wastes as well as the generation of renewable thermal energy decentrally used to substitute fossil fuels. The project activity was set into operation in May 2007. The Methane Recovery Project Princepeel Wilbertoord has been verified for 2 operation periods in order to certify the correspondingly reduced GHG emissions by this project activity within these periods. The first operation period was from June 1st, 2007 to December 31st, 2007 and the second one from January 1st, 2012 to December 31st, 2012.

The objective now is to monitor the remaining years of the crediting period: 01/01/2008 - 31/12/2011 and 01/01/2013 - 31/05/2017, with a quantitative monitoring of emission reductions for only the last 6 years of the project's crediting period (01/06/2010 to 31/05/2017 excl. the already monitored year 2012). The period between 01/01/2008 and 31/05/2010 is subject to a verification by the Verification Body concerning the evidence, that the project has reduced and not emitted GHG emissions in that period of time (see in Appendix E the "Request for exemption from quantitative monitoring for the crediting period from 01/01/2008 to 31/05/2010"). Consequently, no emission reductions are claimed in those years.

According to the VCS requirements, a monitoring period shall not overlap with previous monitoring periods. Hence, the quantitative monitoring of the remaining years of the crediting period is divided into 2 monitoring periods:

1. 01/06/2010 - 31/12/2011
2. 01/01/2013 - 31/05/2017

Hence, the present Report monitors emission reductions that have occurred during the period of time under 2. and refers to the monitoring concept of the PDD submitted in its version 05 by ARA Carbon Finance GmbH on August 18th, 2007 to the TÜV Rheinland Group.

The project activity involves power generation using Combined Heat and Power engines (CHP) to produce electricity and heat: 6 CHPs with a total electric capacity of 6.1 MW has been put into operation till now. The project is under continuous operation since the beginning of the project activity in June 2007.

The heat produced by the biogas plant is used for the own process of the biogas plant, but also to substitute fossil fuels with hygienization of digestate, space heating of the plants buildings and drying the digestate.

The total GHG emission reductions generated under the current monitoring period starting from 01/01/2013 to 31/05/2017 are 241.150 t CO_2e.

1.2 Sectoral Scope and Project Type

The VCS sectoral scopes applicable to the project activity is 13. “Waste handling and disposal”. The project is not a debundled component of a larger project activity.

1.3 Project Proponent

Organization name	B.V. Landgoed de Principeel
Contact person	Pieter Smits
Title	Director
Address	Molenstraat 40 5446 PL Wanroij North Brabant - The Netherlands
Telephone	+31 (0) 48 54 76 230
Email	pieter@princepeel.nl

1.4 Other Entities Involved in the Project

Organization name	GES Energie GmbH
Role in the Project	Carbon Consultant
Contact person	Pauline Kalathas
Title	Project Manager
Address	Domstrasse 11, 20095 Hamburg
Telephone	+49 (0) 40 80 90 63 220
Email	p.kalathas@ges-energie.de

1.5 Project Start Date

The start of commissioning was the 01st of May 2007.

1.6 Project Crediting Period

The starting date of the crediting period and the first monitoring period is set to the 01st of June 2007. The project uses a fixed crediting period of 10 years which ends on 31st of May 2017.

1.7 Project Location

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

1.8 Title and Reference of Methodology

Referring to the PDD, 3 small-scale methodologies according to the CDM standards of the UNFCCC have been planned to be 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. The actual version is named *“Methane recovery in animal manure management systems”* (Version 21).

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. The actual version has the same name (Version 10).

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. The actual version is named *“Thermal energy production with or without electricity”* (Version 21).

1.9 Participation under other GHG Programs

The project is not registered under any other GHG program.

Methane Recovery Project Princepeel Wilberthood has never applied to any other greenhouse gas program outside of the Voluntary Carbon Standard VCS. The Project Proponent confirms that credits generated in the current monitoring period do not form part of any other national or international scheme.

1.10 Other Forms of Credit

The project has been planned for the generation of voluntary emission reductions (VER) in Wanroij, North Brabant, The Netherlands, based on the UNFCCC criteria for JI projects according to Article 6 of the Kyoto Protocol and subsequent decisions of the Joint Implementation Supervisory Committee with regard to JI modalities and procedures and the application of approved methodologies. Even if the project activity investigated being currently treated as a VER-project, approved CDM baseline methodologies as well as the *Tool for the demonstration and assessment of additionality* of the UNFCCC were applied in order to allow a conversion into a JI project at a later stage.

However, the project has never been converted into a JI project and hence, is not listed as a JI project on the UNFCCC website.

Project activity does not claim emission reductions 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 (see Appendix A, *Evidence for no double counting*).

The project is currently not part of any other GHG program, emission trading scheme or environmental credit, that means double counting can be exempted. The project also receives no other form of incentives for the activities that cause the emission reduction.

1.11 Sustainable Development

The project contributes to achieving nationally stated sustainable development priorities written down in the National Environmental Policy Plan and the Future Environmental Policy Agenda.

The project activity contributes to generating electricity and heat from renewable sources, that helps in country energy security, reduces the GHG emissions and encourages clean, renewable and efficient technologies. Furthermore, the project activity contributes to enhancing local employment by providing direct and indirect employment generation during construction and operation phases. Other positive impacts of the project activity are the improved quality of digestated manure compared to manure and the reduction of odor emissions in the vicinity spreading the digestate.

2 SAFEGUARDS

2.1 No Net Harm

The Princepeel project has been formally and finally approved by the responsible regional authorities of the Netherlands in accordance with the Dutch building law “Wet op de Ruimtelijke Ordening”. This act provides the set of rules which regulates the impact assessment of plants or projects on the environment. The approval covers the installation and operation of the biogas power plant including all components such as storage, feeders, fermenters, CHP modules, etc.

The project activity contributes to a significant higher ecological sustainability compared to a reference scenario without manure's treatment by using biogas plants.

Hence, the Princepeel project has no relevant negative environmental and socio-economic impacts and contributes positively by providing environment friendly power generation leading to sustainable development of the region.

2.2 Local Stakeholder Consultation

The Project is already registered with VCS (VCS ID 337). The Local Stakeholder Consultation process was already conducted in line with the requirements during the project registration.

As during the authorization process for the project, public stakeholders have the right during the operation phase of the biogas plant to litigate against the project at the administrative court in case the installation have a negative impact on their well-being. In the same way, public stakeholders have the possibility to contact directly and at any time the company of B.V. Landgoed de Princepeel in case they feel directly or indirectly disturbed by the project activity.

In general, the biogas installation impacts positively the region on an economical, environmental and a social level, so that no complaint or litigation are taking place in the day-to-day business.

However, some complaints about odour during the slaughterhouse transports and about the traffic have occurred from time to time in the past. Because the biogas plant is located on a 500 hectares property, there are no direct neighbours (the first little village next to the plant is 3-4 km far away from it). But the trucks delivering the substrates to the plant are going through inhabited areas, so that some residents complained about their activity. To solve the problem, the company has almost stopped the transportation of slaughterhouse to the biogas plant since 2015 and has changed the routeing for the trucks (only 1 way road through the critical locations to halve the traffic there).

Furthermore, the company has organized an open day event at the biogas plant in 2015 to explain the activities on the biogas site to the neighbourhood. This gave the frame to react on potential complaints of stakeholders and to explain the source of the problems and how the company deals with it. Since then, the complaints have stopped.

2.3 AFOLU-Specific Safeguards

Not applicable to the project activity.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The project activity was put into operation in May 2007. The project operation started with 4 CHP engines with a capacity of 475 kW_{el}, 550 kW_{el} and 2 x 1.067 kW_{el}. Another 2 CHPs with 1.415 kW_{el} and 1.489 kW_{el} has been commissioned in the years 2008 and 2014 and correspond to the extension of the plant's capacity mentioned in the PDD on page 10. During the present monitoring period, a total of 6.063 kW_{el} were installed on the plant's site.

CHP Units		Electric capacity installed	Thermal capacity installed	Electric efficiency [FT]	Start of operation date
		kWel	kWth	%	
CHP 1	Waukesha 475	475	695	35,20	2006
CHP 2	Waukesha 550	550	865	37,60	2006
CHP 3	Jenbacher 320	1.067	1.339	39,30	2006
CHP 4	Jenbacher 320	1.067	1.339	39,30	2006
CHP 5	Jenbacher 420	1.415	1.405	42,00	2008
CHP 6	Jenbacher 420	1.489	1.709	41,80	2014

Table 1: Data of installed CHP units from BV Landgoed de Princepeel

The biogas plant is treating pig manure from the own farm as well as cattle, pig, chicken manure and slaughterhouse waste from other farmers (minimum of 50% of the total biomass fed). Co-ferments from agricultural and food industries are also delivered and fed to the biogas plant.

The heat produced by the biogas plant is used for the own process of the biogas plant, but also to substitute fossil fuels by heating the plant's building, through hygienization or by drying the digestate. During the present monitoring period, no heat meters were installed to measure the amount of heat used for external processes. For this reason, no emission reductions are claimed here.

Likewise, no emissions reductions are claimed for the substitution of diesel fuel by biogas for the operation of irrigation pumps (as planned and described in the PDD), since no biogas was used for this purpose.

During this monitoring period, the biogas plant has been running without any significant event that would have affected the GHG emission reductions and monitoring. The biogas plant is still in operation today.

3.2 Deviations

3.2.1 Methodology Deviations

1. Biogas production

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. This calculation, based on a reference method described by the CCX Agricultural Methane Gas Project Guidelines, has already been assessed in the last monitoring period and estimated as a conservative way to calculate the amount of biogas produced. This calculation is also used in similar climate protection projects with biogas technology. The electricity measurement can be considered as very accurate because it is also 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.

This deviation has already been assessed and verified by the Verification Body TÜV Rheinland for the 2 last monitoring periods in 2007 and 2012 as well as recently by the Verification Body Aenor and Verra under VCS for the monitoring of Methane Recovery Project Aben (which is the same project type and category as the present project) for the period 2010 to 2016.

2. Conservativity factor

Another deviation from the methodology is the application of an overall deduction factor of 0,5 on the emission reductions due to methane recovery. This conservativity factor covers the uncertainties due to the fact, that the project owner has to deal with a lot of organic waste streams of different type and only default values are used instead of local values for waste specific parameter. Furthermore, the project was developed at a time when the methodological approaches and guidelines were not yet mature. Following the conservativeness principle prescribed by the VCS methodology as well as ISO 14064, the application of an additional security factor of 0.5 (conservativity factor) is appropriated to highly compensate the risk of an over-estimation of the emission reductions.

This factor has already been assessed and verified by the Verification Body TÜV Rheinland as well as by Verra under VCS for the monitoring periods in 2007 and 2012 (see in Appendix B the *Project Review Report* of Project Princepeel, pages 5-7).

Through the selection of conservative values for the biogas production of input substrates and the application of an overall deduction factor of 0,5, it is absolutely secured that, in general, no over-estimation of the emission reductions can occur.

3. Methodologies

The methodologies AMS II.F and AMS I.C as described under 1.8 of this report were not applied to the project during the actual monitoring period. This is due to the fact that the irrigation pump system has not been implemented as described in the PDD (AMS II.F) and no emission reductions are considered for the substitution from fossil fuel for the use of renewable heat (AMS I.C).

3.2.2 Project Description Deviations

1. Increase of manure quantities

Deviation in the implementation of the project has been the increase in the manure quantities over the crediting period of the project. Higher amounts of manure generally and of manure with a dry matter content have been treated than initially planned. This development is attributed to the higher manure surpluses that the Netherlands have been experiencing in the last decade and that could not have been anticipated. To address these issues on a national level, dutch policies have been developed to reduce the amounts of manure surplus again. Hence, the biogas plants in the Netherlands had to adapt their plant concepts to the changed biomass market. For the project activity, this has resulted in an increase in emission reductions, even if the plant capacity has stayed the same as described in the initial project documentation.

This deviation has already been worked out, assessed and verified by the Verfication Body TÜV Rheinland as well as by Verra under VCS during the last monitoring for this Methane Recovery Project Princepeel Wilbertoord (see in Appendix B the *Project Review Report* of Project Princepeel, page 7).

2. Amount of emission reductions

The amount of emission reductions is higher than the estimated amounts in the PDD. This is partly due to the larger amounts of manure that are processed in the biogas plant, as described above. But it is also due to the fact, that only the baseline methane emissions released from stored manure are calculated in the PDD and not the one from waste management. Hence, the yearly estimated methane emissions reductions written down in the PDD do not correspond to the entire methane emissions that are reduced through the project activity. Furthermore, the Global Warming Potential of CH4 has been adapted from 21 to 25 according to the Fourth Assessment Report and VCS Requirements, which also leads to higher emission reductions.

3. Carbon Consultant

Deviant from the last Monitoring in 2012, the company of the Carbon Manager has changed from GES Biogas GmbH to GES Energie GmbH, but this company and its employees belong to the same company group as the GES Biogas GmbH. This has no impact on the quality of the Monitoring Report and the resulting emission reductions, since the actual Carbon Consultant has been working in the carbon sector for almost 15 years.

4. Project Proponent

The person responsible for collecting all data relevant for the monitoring of GHG emission reductions was originally Teun Smits, managing director at B.V. Landgoed de Princepeel, as described in the PDD. Since 2012, Pieter Smits, director of the company, has taken over the responsibility for monitoring and recording all data with Jos van Heugten supporting him between 2012 and 2017 as commercial manager of the company. This presents a deviation from the PDD information from 2012 on. Since the data collected for the Monitoring has also to be collected by the company as basis for accountancy and feed-in tariffs, and is verified by external authorities, negative impacts on the quality of the documentation provided for the calculation of emission reductions is excluded.

5. Heat meter

Deviant from the initial PDD, no heat meter has been installed to measure the use of external heat. This deviation has a conservative impact on the emission reductions since these are not claimed for the substitution of fossil fuel.

6. Biogas flow meter

Deviant from the description in the PDD, no biogas flow meter has been running during the present monitoring period. Practice shows that biogas flow meters are usually unable to deliver reliable measurements due to contaminations like moisture (condensation) or Sulfur (H_2S). Since the biogas production is a central parameter to calculate the emission reductions, accurate values are essential.

Hence, the biogas flow has been calculated following a reference method described by the CCX Agricultural Methane Gas Project Guideline, based on the electric energy produced, the efficiency of the CHPs and the calorific value of biogas (please refer to section 5.1.1 of the present Monitoring Report). The calculation of the biogas amount bases on the electricity production measured by an electric meter with an accuracy <1%. Since the accuracy of the electric meter is highly precise and the method described by CCX is considered to be conservative, using the CCX method will have a conservative effect on the quantity of emission reductions.

7. Irrigation pumps

As also described in the last Monitoring, a deviation in the implementation of the project has been the missing fuel switch from fossil fuels to biogas in the irrigation pumps. This deviation has a conservative impact on the emission reductions since these are not claimed for the substitution of diesel fuel.

8. CHP engines

The increase of available manure in the near vicinity of the biogas production project was not foreseeable at the time the project has been planned, as written under section 3.2.1 of the current MR. In order to treat the available manure surplus and the resulting increased biogas quantities, new CHPs had to be installed over the past years. This presents a deviation from the indications in the PDD about the total installed electric capacity and increase the amount of emission reductions, since more manure has been treated. Nevertheless, the project capacities to treat biomass in the plant has been planned to process substrate amounts of 100.000 t/a (see PDD, p. 10), so that the capacity to treat biomass during the monitoring period corresponds to the planned treatment capacities as defined in the PDD. The substrate treatment capacity of the plant determines the projects capacity to capture and destroy methane, which is the basis for the calculation in the Monitoring.

9. Manure from own farm

The amount of liquid manure coming from the own farm is calculated based on the amounts of manure transported by trucks instead of being measured, as required in the PDD. As can be seen from other biogas projects, flow meters are never installed on a biogas plant just to measure the amounts of manure coming from their own farm. Since biogas projects are usually hardly economically viable, investments in technologies that are of no use or not prescribed by law are avoided. As required by law, the amount of manure coming from the own farm is based on animal numbers in case the manure does not have to be transported. Otherwise, it is based on truck transports. For the project Princepeel, each delivery is first listed on a document and then saved electronically. The accuracy of the manure amounts from the company's own farm, that are delivered to the biogas plant, can be specified as very precise, since the transport volume of the trucks is known. In addition, the company is keen to make as few transports as possible in order to save money and time. Therefore, transports without full manure tanks can be excluded. However, the emission reductions are calculated based on the total amount of CH_4 minus the amount of CH_4 from non-waste co-substrates. Therefore, the amount of manure has no significant impact on the amount of emission reductions. Hence, this deviation does not impact the accuracy and quantity of emission reductions.

3.3 Grouped Projects

Project activity is not a grouped project.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	D_{CH4}
Data unit	t CH_4/m^3
Description	Density of Methane
Source of data	UNFCCC
Value applied	0.0007168
Justification of choice of data or description of measurement	Density of methane at standard temperature and pressure. “Methane Recovery Project Princepeel”, PDD p. 24

methods and procedures applied	
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	GWP_{CH4}
Data unit	t CO_2e / t CH_4
Description	Global warming potential of methane
Source of data	UNFCCC
Value applied	25
Justification of choice of data or description of measurement methods and procedures applied	Global Warming Potential value for methane for the second commitment period is 25 t CO_2e/t CH_4
Purpose of Data	Calculation of baseline emissions
Comments	The GWP value set in the PDD has been adapted to the second commitment period with value from the fourth assessment report according to UNFCCC and VCS Requirements

4.2 Data and Parameters Monitored

This Monitoring Report comprises a total of 4,4 years of monitored data. In order to keep the Monitoring Report clear, only the values for the year 2016 are given below for each parameter when displaying the values of all monitored years is not possible. The values of the other monitored years are stated in the annexed spreadsheet with the details of all the calculation steps for every year (see Appendix C).

The following monitored parameter are described in detail in chapter 4.3 with references to sources.

Data / Parameter	BGP
Data unit	Nm^3
Description	Biogas produced
Source of data	Calculated

<table>
<tr><td>Description of measurement methods and procedures to be applied</td><td>Calculated by the amount of electricity produced (EEP), the methane content of the biogas and the efficiency of the CHP engines</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>See parameter EEP</td></tr>
<tr><td>Value monitored</td><td><table><tr><th>Year</th><th>Biogas produced [m³]</th></tr><tr><td>2013</td><td>15.852.797</td></tr><tr><td>2014</td><td>16.288.210</td></tr><tr><td>2015</td><td>16.614.734</td></tr><tr><td>2016</td><td>16.635.677</td></tr><tr><td>2017</td><td>6.521.947</td></tr></table></td></tr>
<tr><td>Monitoring equipment</td><td>N/A</td></tr>
<tr><td>QA/QC procedures to be applied</td><td>See Parameter EEP</td></tr>
<tr><td>Purpose of the data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Calculation method</td><td>$$BGP = \frac{EEP}{(ETA_{CHP-el}) * HV_{Biogas}}$$
Where:
BGP Biogas produced [m³]
EEP Electrical energy produced [MWh]
ETA_{CHP-el} Electric efficiency of the CHP engines
HV_{Biogas} Calorific value of biogas [kWh/m³]
With
$$HV_{Biogas} = 0,01 \frac{MWh}{m^3} \cdot x_{CH4}$$
Where:
0,01 Stoichiometric combustion calculation of CH_4 [MWh/m³]:
802,6 kJ/mol /0,02241 m³/mol = 35.814,37 kJ/m³ = 0,01 MWh/m³
x_{CH4} CH_4 volume content of biogas flow [%]</td></tr>
</table>

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	The gas analyzer is used to measure daily the amount of methane in the biogas. The measured values are recorded by the operations staff and logged electronically.
Frequency of monitoring/recording	Continuous measurement, daily recording.
Value monitored	see table below
Monitoring equipment	Technical specification of gas analyzer: see table below
QA/QC procedures to be applied	The devices are calibrated annually according to manufacturer's instructions. The accuracy of both used gas analyzers is resp. +/- 3 Vol.-% and till +/-1,5 Vol.-% (see Appendix D "Gas analyzer Sewerin_Prüfprotokoll SR2-DO" and "Gas analyzer Geotech_Technical specifications_Photo").
Purpose of the data	Calculation of baseline emissions
Calculation method	N/A
Comments	The Sewerin unit has been replaced by the BIOGAS 5000 gas analyzer in 2014.

Value monitored:

Year	Average methane content [%]
2013	56,13
2014	54,97
2015	53,84
2016	54,34
2017	55,57

Monitoring equipment:

Brand and model type	Serial No	Operation period	Unit	Accuracy
Sewerin Ex-Tec SR2-DO	4701000064	2013-2014	Vol.-%	+/- 3
BIOGAS 5000 Gas Analyser	G502097	2014-2017	Vol.-%	+/- 1,5

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 operation hours have been read back directly on the runtime counter and the annual values sent per Email to the project owner. The annual operation hours of the plant are calculated as difference between the runtime hours of the beginning and of the end of the year.
Frequency of monitoring/recording	Monthly
Value monitored	see table below
Monitoring equipment	Runtime meter
QA/QC procedures to be applied	Runtime meters have an inaccuracy of < 1% (see Appendix D "Runtime counter - Accuracy - Jenbacher")
Purpose of the data	Plausibility of electricity production
Calculation method	N/A
Comments	None

CHP		Electric capacity installed [kW_{el}]	Runtime hours in 2016 [h]
CHP 1	Waukesha 475	475	1.752
CHP 2	Waukesha 550	550	1.343
CHP 3	Jenbacher 320	1.067	7.791
CHP 4	Jenbacher 320	1.067	7.585
CHP 5	Jenbacher 420	1.415	7.861
CHP 6	Jenbacher 420	1.489	8.427

Data / Parameter	ETP
Data unit	kWh
Description	Thermal energy produced for external utilization
Source of data	Heat counter
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Continuously

Value monitored	0
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of the data	To determine the displaced fossil fuels of the baseline scenario
Calculation method	N/A
Comments	No heat meter has been installed on the biogas plant's site to measure the external heat use, so no emission reductions are claimed

Data / Parameter	ETHY
Data unit	kWh
Description	Thermal energy produced for hygienisation unit
Source of data	Heat counter
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Continuously
Value monitored	0
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of the data	To determine the displaced fossil fuels of the baseline scenario
Calculation method	N/A
Comments	No heat meter has been installed on the biogas plant's site to measure the external heat use, so no emission reductions are claimed

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 each CHP measures the produced electric energy.
Frequency of monitoring/recording	Continuously

Value monitored

Year	Electricity produced [kWh]
2013	35.151.462
2014	35.876.009
2015	35.842.927
2016	36.221.393
2017	14.521.875

Monitoring equipment

Technical specifications of the power meter at CHP units (see Appendix D “Meetprotocol elektriciteit en warmte - Princepeel - 2018”, p. 10):

EAN	Seriennr. Gross meter	Brand	Meter Type	Name	Unit	Accuracy class
EAN 915	88502998	Landis+Gyr ZMD410CT44.0457	GEN1	Gross production WKK5	kWh	Class 1
EAN 915	93968706	Landis+Gyr ZMD410CT44.0457	GEN2	Gross production WKK2	kWh	Class 1
EAN 915	94088664	Landis+Gyr ZMD410CT44.0457	GEN3	Gross production WKK4	kWh	Class 1
EAN 915	94088667	Landis+Gyr ZMD410CT44.0457	GEN4	Gross production WKK3	kWh	Class 1
EAN 440	94732952	Landis+Gyr ZMD410CT44.0457	GEN5	Gross production WKK1	kWh	Class 1
EAN 915	93968702	Landis+Gyr ZMD410CT44.0457	GEN6a	Gross production WKK6	kWh	Class 1
EAN 915	38402196	Landis+Gyr ZMD402CT44.0457	GEN6b	Gross production WKK6	kWh	Class 1
EAN 915	38402193	Landis+Gyr ZMD402CT44.0457	GEN6c	Gross production WKK6	kWh	Class 1

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 in compliance with the European CE-Directive (MIT = Measurement Instrument Directive).
Purpose of the data	Calculation of baseline emissions, of biogas produced by the plant and cross-checking the biogas produced and destroyed by the CHP engines
Calculation method	N/A
Comments	None

Data / Parameter	EEI
Data unit	kWh

Description	Electric energy imported
Source of data	Power meter
Description of measurement methods and procedures to be applied	The own electricity consumption for running the biogas plant is not directly measured. The gross and net electricity productions are directly measured, so that the own electricity consumption can be calculate as difference from gross and net electricity (see chapter 4.3).
Frequency of monitoring/recording	Continuously and at invoicing of the utility
Value monitored	see table below

Year	Electricity consumed for own process [kWh]
2013	2.425.191
2014	3.139.824
2015	3.430.699
2016	4.094.420
2017	1.533.905

Monitoring equipment	Technical specification of power meter for gross measurements (please refer to Parameter EEP) and for net measurements in following table (please refer to chapter 4.3):

EAN	Seriennr. Net meter	Brand	Name	Unit	Accuracy class
EAN 915	85240073	Landis+Gyr ZMD405CT44.0007	Main connection	kWh	Class 0,5
EAN 915	85240078	Landis+Gyr ZMD405CT44.0007	Control measurement	kWh	Class 0,5
EAN 440	87743557	Landis+Gyr ZMD405CT44.0007	Main connection	kWh	Class 1
EAN 440	87743547	Landis+Gyr ZMD405CT44.0007	Control measurement	kWh	Class 1

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 in compliance with the European CE-Directive (MIT = Measurement Instrument Directive).
Purpose of the data	To demonstrate that the net impact of electricity production and consumption is positive.
Calculation method	The project's own electricity consumption can be calculated as gross electricity production minus net electricity production = own consumption.
Comments	None

Data / Parameter	MCOFi
Data unit	t
Description	Mass of each co-ferment i fed into the digester
Source of data	Scales recording

<table>
<tr><td>Description of measurement methods and procedures to be applied</td><td>Each co-ferment is weighed at delivery. The mass of the co-ferment is noted on the delivery receipt which is stored as hard copy in folder on the plant’s site. The amounts of co-ferments are also recorded in an electronic database.</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>At delivery</td></tr>
<tr><td>Value monitored</td><td>
<table>
<tr><th>Substrates in 2016</th><th>Amount [t]</th></tr>
<tr><td>Corn silage</td><td>494</td></tr>
<tr><td>Grain</td><td>1.735</td></tr>
<tr><td>Feed residues</td><td>3.352</td></tr>
<tr><td>Cocoa products</td><td>2.033</td></tr>
<tr><td>Coffee grounds</td><td>141</td></tr>
<tr><td>Food waste</td><td>33.143</td></tr>
<tr><td>Glycerine</td><td>8.700</td></tr>
<tr><td>Gras</td><td>325</td></tr>
<tr><td>Maize plant</td><td>31</td></tr>
<tr><td>Plant fat</td><td>314</td></tr>
<tr><td>Sugar water/ Fruit waste liquid</td><td>136</td></tr>
<tr><td>Vegetable waste</td><td>356</td></tr>
<tr><td>Whey waste</td><td>48</td></tr>
<tr><td>Total</td><td>50.808</td></tr>
</table>
</td></tr>
<tr><td>Monitoring equipment</td><td>Specification of the weighing scale on the installation:
<table>
<tr><td>Type/Model, Type/Model:</td><td>VS125 18x3m</td></tr>
<tr><td>Fabrikant, Manufacturer:</td><td>PRECIA MOLEN</td></tr>
<tr><td>Serienummer, Serial number:</td><td>VS125 18x3m</td></tr>
<tr><td>Weegvermogen, Weighing capacity:</td><td>60.000 kg</td></tr>
<tr><td>Indeling, Division:</td><td>20 kg</td></tr>
<tr><td>Nauwkeurigheidsklasse, Accuracy class:</td><td>III</td></tr>
<tr><td>Toelatingsnummer, No of type approval certificate:</td><td>T2177</td></tr>
<tr><td>Bouwjaar, Year of construction:</td><td>2008</td></tr>
</table>
</td></tr>
<tr><td>QA/QC procedures to be applied</td><td>Weighing scales are precise and belong to the accuracy class III (see Appendix D “Weighing scale_Technical specifications”). Calibration occurs when the devices need service or repair.</td></tr>
<tr><td>Purpose of the data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Calculation method</td><td>N/A</td></tr>
<tr><td>Comments</td><td>None</td></tr>
</table>

Data / Parameter	MANURE
Data unit	t
Description	Volume of manure fed into digester
Source of data	Scales recording for external manure
Description of measurement methods and procedures to be applied	Manure from external farms is weighed like co-ferments when delivered with the weighing scale. The delivery notes are stored on the operation site. The manure amounts are logged in the official software of the government under minj.rvo.nl. Manure from the own farm is calculated based on the number of truck transports. The daily amounts of manure are recorded in the electronic database.
Frequency of monitoring/recording	At delivering to the plant
Value monitored	**Manure in 2016** / **Amount [t]**: Liquid - pig 34.920; Liquid - cattle 8.839; Solid - cattle 6.258; Solid - chicken 76; Slaughterhouse waste 420; **Total** **50.514**
Monitoring equipment	Technical specification of the weighing scales (please refer to Parameter MCOFi)
QA/QC procedures to be applied	Weighing scales are precise and belongs to the accuracy class III. Calibration occurs when the devices need service or repair.
Purpose of the data	Calculation of baseline emissions
Calculation method	N/A
Comments	None

Manure in 2016	**Amount [t]**
Liquid - pig	34.920
Liquid - cattle	8.839
Solid - cattle	6.258
Solid - chicken	76
Slaughterhouse waste	420
Total	**50.514**

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 during the monitoring years 2013-2017

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	An emergency generator was installed end of 2015 but not was not used till the end of monitoring period in 2017, so that no significant amounts of diesel was used during that period.

Data / Parameter	GASPROP
Data unit	Nm^3
Description	Biogas used in irrigation pumps
Source of data	Flow meter
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	When applicable
Value monitored	0
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of the data	To calculate the emission reductions from fuel switching measures
Calculation method	N/A
Comments	No fuel switch has been implemented during the monitoring years 2013-2017.

4.3 Monitoring Plan

The person responsible for collecting all data relevant for the monitoring of GHG emission reductions is Pieter Smits, managing director of B.V. Landgoed Princepeel, supported by Jos van Heugten as commercial manager of the company since 2012. The operation and maintenance of the biogas plant is being done by the operating personnel of the company. Generally, all the relevant data needed for the calculation and monitoring of emission reductions are also requested by the government for usual business operation and must be collected and recorded. Data is needed for controlling and accountancy, but also to meet the requirements for the feed-in tariff for energy production. The operation personnel maintain an handwritten operational manual which contains the daily feed of the digesters, the electricity production and the methane content. These data are also logged electronically. The operation manual can be found on the biogas installation itself.

The electricity production is continuously recorded at the processing unit of the CHP (measurements every 15 minutes). The monthly production rates are recorded and evaluated in excel files named (see Appendix D “Overzicht vollasturen Princepeel BV [*year*]”). An overview about the monthly electricity production is also sent per e-mail by CertiQ, a certification body designated by the Dutch government to control the electricity production before part of the subsidies can be paid out (see Appendix D “CQ_BIN_Meetwaarden_per_installatie_2013-2017”). The electric meters are supplied, installed, and operated by a recognized measuring company Fudura B.V. Fudura reads, collects and validates the necessary measurement data and send the data to the grid operator. Fudura also takes care of the control and maintenance of the meter. According to Fudura, the electricity measurements fully comply with the European CE-Directive Measuring Instrument Directive (MID). That means, that the meters are operated, maintained and calibrated according to the manufacturer’s instructions (see E-Mail from a Fudura adviser in Appendix D “Fudura_Electric meters”). The installation and operation of the electrical meter is regulated by law. The operator has not the possibility access or manipulate the meters as they are sealed by officials (Fudura B.V.). This is a common fact in EU countries. Authorities require meters to be initially qualified (DU: “Eichung”) which is similar to a calibration but can only be conducted by a competent authority. Accuracy is provided and safeguarded by law through the competent authority (see Appendix B “Project Review Report” from VCS, Finding 1, p. 3).

The accuracy class of the CHPs’ power meters given in a report named “Meetprotocol elektriciteit en warmte - Princepeel - 2018” on page 10 (see Appendix D). This report contents also the data regarding electricity (and heat) production, their technical description, the monitoring methods as well as calibration reports (for heat). This report has to be submitted to the government and serves as basis for the subsidies.

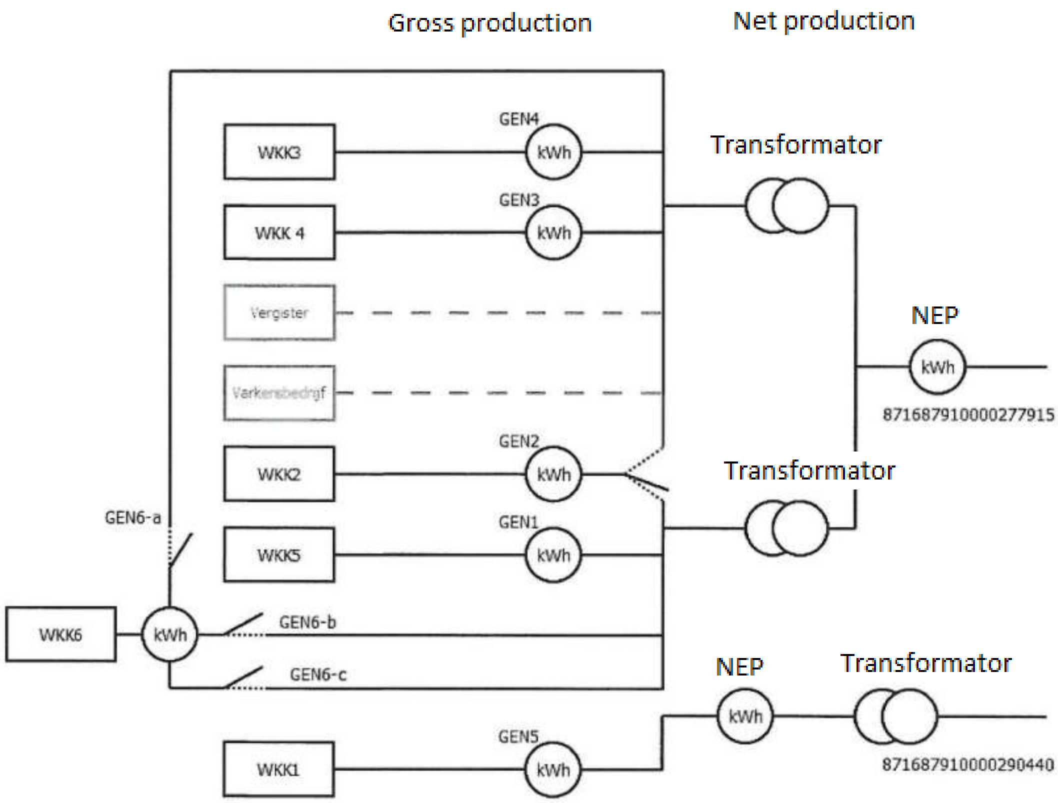

Figure 1 : Schematic representation of electricity flows including system limit and meters (Source: "Meetprotocol elektriciteit en warmte - Princepeel" p. 6)

As can be seen from the schema above, all CHP installations are equipped with their own gross production counter (GEN[no]). The own electricity consumption is directly taken from the electricity produced by the biogas plant. Since the net production is also measured with electricity meters (NEP), the project's own electricity consumption can be calculated as: gross production - net production = own consumption. The monthly records of gross and net electricity production are sent by CertiQ, where the own electricity consumption has been calculated in the same excel file (see Appendix D "CQ_BIN_Meetwaarden_per_installatie_2013-2017"). The monthly records of gross and net electricity production are also recorded and evaluated in the excel files "Overzicht vollasturen Princepeel BV [year]" (see Appendix D).

The runtime counters automatically record the number of hours that a CHP operates. The runtime hours can be read directly on the CHP engine. The annual runtime hours have been collected by Jos van Heugten and sent per e-mail to Teun Smits (see Appendix D "Bedrijfsuren motoren_2012-2016). The calculation of the annual runtime hours for each CHP based on the values of the runtime counters can be seen in the excel file "20210114_VCS_Data Inquiry_Princepeel" (see Appendix D).

The methane content of the biogas has been measured with a gas analyzer during the present monitoring period, as described in the PDD and handled in both previous monitoring. The methane content is daily recorded handwritten in the operation manual and then put into electronic form in excel files (see Appendix D "[year] Controle gasmetingen"). The gas analyzer DR2-DO from Sewerin has been removed and replaced in 2014 by the 5000 BIOGAS gas analyzer from Geotech. The accuracy of methane measurement device from Sewerin is +/-3% (see Appendix D "Gas analyzer Sewerin_Prüfprotokoll SR2-DO"). The accuracy of methane measurement device from Geotec is +/-0,5% (CH_4 range from 0%-70%) and +/- 1,5% (CH_4 range from 70% - 100%), as described in Appendix D "Biogas 5000 - Datasheet". The gas analyzer is annually calibrated according to the manufacturer's instructions (see Appendix D "Gas analyzer - Calibration reports_2010-2017"). The maintenance is carried out by the manufacturer.

The co-ferment substrates entering the biogas plant are weighed at delivery by a weighing scale. The delivery notes of weighed co-ferments are stored in folders on the plant's site. The amounts of co-substrates are logged electronically in the computer-based process visualization system from Siemens named Wincc (Windows Control Center). The data is saved for 1 month in Wincc and then exported to files named "Overzicht productleveringen Princepeel BV [year]" (see Appendix D).

The amounts of manure coming from external farms entering the biogas plant are weighed at delivery by a weighing scale. The delivery notes of weighed co-ferments are stored in folders on the plant's site. Those amounts of manure are recorded online via the official program from the Dutch National Service for Enterprise (Rijksdienst voor Ondernement RVO), that records all the nutrients shifts and flows between farms under minj.rvo.nl and are exported in excel files (see Appendix D "Overzicht aan- en afvoer mest [year]").

The manure coming from the project owner's farm is calculated based on the number of trucks delivering the manure to the biogas plant and their load capacity. The daily amounts of delivered manure are recorded electronically (see Appendix D "Aanvoer mest eigen bedrijven [year]").

No heat meter has been installed to measure the heat used externally during the current monitoring period.

No emergency boiler was installed on the plant's site during the monitoring period 2013-2017, so that no project emissions could occur from this source at that time.

An emergency generator was installed end of 2015 on the site of the biogas plant but was not running during the current monitoring period. The generator is started once a month for some minutes for reasons of security, to be sure that, in case of an emergency, the generator is ready for operation. Hence, no significant project emission occurred from this source at that time.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

5.1.1 Manure management systems and agricultural/ food wastes

The methane emission reduction through the project activity is calculated according to the small-scale Methodology AMS III D, as per the registered PDD Section D with the following equation:

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

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 Nm^3
AF	is an adjustment factor, which ensures a conservative estimation of the realized emission
$dm_{nw,I}$	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
$BGCO_i$	is the annual biogas portion of the total biogas amount produced, caused by a digested non-waste co-ferment i if applied, to be determined by the appropriate input amount (MCOFi) and the specific gas productivity of the non-waste co-ferment i, in m^3
MC	is the average annual methane content in the biogas, in Nm^3 methane / Nm^3 biogas
$MCCO_i$	is the average methane content arising in the biogas through digesting a non-waste co-ferment i, in Nm^3 methane / Nm^3 biogas
D	is the density of methane, set to 0,7168 kg CH_4 / Nm^3 CH_4 according to

ACM0001

GWP_{CH4} is the Global Warming Potential of methane, set to 25 t CO_{2e} / t CH_4 according to UNFCCC

The calculation of the methane emission reductions bases on the total amount of methane produced in the biogas plant, from which the amount of methane produced out of non-waste is deducted, because only the emission reductions caused by manure and waste, that would have otherwise been left to decay, are taken into account.

The co-ferments intended to be fed into the biogas installation are separated into waste and non-waste co-ferments:

- the waste co-ferments have been left to decay on landfills in the baseline scenario
- the non-waste co-ferments are substrates that would not have been landfilled in the baseline scenario since these substrates could be used as animal feed.

Biogas flow (BGP) and Methane content (MC)

Since the biogas flow BGP could not be directly recorded, BGP is calculated following a reference method described by the CCX Agricultural Methane Gas Project Guidelines and used in different similar climate protection projects. The produced electricity and methane content of the biogas are used to calculate the biogas flow as follows:

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

with:

- BGP: Biogas produced [m³]
- EEP: Electricity energy produced [MWh]
- ETACHP-el Electric efficiency of the CHP engines [%] (Ref.: engine data sheet)
- HVBiogas Caloric value biogas [kWh/m³]:

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

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

Methane is the component that determines the calorific value of biogas. The net calorific value of methane has been derived from common stoichiometric combustion calculation of methane under normal conditions: 802,6 kJ/mol / 0.02241 m³/mol = 50,01 MJ/kg = 0,01 MWh/m³ [1]. Hence, the calorific value of biogas is given by the multiplication of 0,01. As described under *4.3. Monitoring Plan* of this Report, the methane content has been measured by a gas analyzer. However, since the biogas production is calculated based on the electricity production and the methane content in the biogas, the biogas production will decrease proportionally with a higher methane content. Hence, the level of methane content in the biogas has no direct impact on the amount of emission reductions.

To calculate the biogas production, the electricity production and the electric efficiency of the CHP is needed. The electricity production from biogas is measured by an electric power meter at the CHP. The electric meters are sealed and maintained by an independent and qualified company, Fudura B.V. As the measurements for the amounts of electricity produced are the base for the feed-in tariff, the value measured can be stated as very accurate.

The efficiency of the CHP engines is taken from the data sheet of the CHPs (see Appendix D "Meetprotocol elektriciteit en warmte - Princepeel - 2018", p. 11 and 30 ff.). An average weighted efficiency has been calculated for each year. The efficiency value of a CHP in the technical data sheet of the CHP manufacturers is the highest the CHP engine will have in practice. Consequently, this value has a conservative impact on the emission reductions because a higher efficiency value leads to less emission reductions.

Using the formula above, the biogas flow in the monitoring years 2013 - 2017 is represented in the following table and detailed below for the year 2016:

BGP = 36.221.393 kWh / (0,40 * 5,43 kWh/m³)

= 16.635.677 m³

Year	Electricity produced [kWh]	Average Methane content [%]	Calorific value [kWh/m³]	Efficiency	Biogas Flow [m³]
	EEP	x_{CH4}	HV_{Biogas}	$ETA_{CHP\text{-}el}$	BGP
2013	35.151.462	56,13	5,61	0,395	15.852.797
2014	35.876.009	54,97	5,50	0,401	16.288.210
2015	35.842.927	53,84	5,38	0,401	16.614.734
2016	36.221.393	54,34	5,43	0,401	16.635.677
2017	14.521.875	55,57	5,56	0,401	6.521.947

Table 2: Calculated biogas flow (BGP) from electricity production per year

<u>Monitored Parameter Biogas flow (BGCO) and Methane content (MCCO) from non-waste substrates</u>

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

The biogas flow and methane content from non-waste substrates are calculated based on the data provided by literature mainly from the “Bayerische Landesanstalt für Landwirtschaft (LfI)”[2]. LfI data and calculation methods are recognized and commonly used as reference values in practice in the biogas field. Two other sources have been used, where the biogas production or methane content of specific substrates could not be found in the LfI: “Gaserträge und Nährstoffgehalte - Abfall (Archea)”[3] and “Ökostrom Schweiz”. Both references base also on officially recognized sources and are also used for GHG emission reduction projects on both the voluntary and the mandatory markets.

To calculate the biogas potential and methane content of the biogas, the values for dry matter, organic matter, biogas production from dry matter and methane content from the non-waste co-ferments (as well as from waste and manure for cross-check reasons) are needed and taken from the described sources above. Where no precise data for specific substrates were available, the co-ferment has been analyzed and the highest values from a substrate with similar specifications has been taken to calculate the biogas potential and the methane content of the biogas, in order to maintain the principle of conservativeness.

The values for BGCO and MCCO from non-waste co-ferments of the year 2016 are presented in the table below (the values for the other monitored years are presented under Appendix C in the attached calculation spreadsheet):

[2] https://www.lfl.bayern.de/iba/energie/049711/

[3] https://www.archea-biogas.de/_mediafiles/9-substrate.pdf

	Substrate	Amount	Dry matter (dm)	Organic dm (odm)	Total dry matter	Biogas production from odm	Biogas production from fresh mass	Methane content	Biogas potential from substrate "i"	Methane potential from substrate [x]
		[t]	[%]	[%]	[t]	[m³/ t odm]	[m³/ t fresh mass]	[%]	[m³]	[m³]
NON-WAS	Corn silage	494	33,00	95,80	163,13	586,10	185,29	52,20	91.596	47.813
	Grain	1.735	87,00	98,10	1.509,37	700,90	598,20	52,80	1.037.818	547.968
	Feed residues	3.352	87,00	98,30	2.916,41	690,20	590,27	52,80	1.978.689	1.044.748
WASTE	Cocoa products	2.033	90,40	92,00	1.837,99	412,90	343,40	55,30	698.195	386.102
	Coffee grounds	141	36,50	81,00	51,46	550,00	162,61	54,00	22.924	12.379
	Food waste	33.143	14,40	81,50	4.772,60	642,60	75,42	59,80	2.499.504	1.494.703
	Glycerine	8.700	100,00	99,50	8.699,62	850,00	845,75	50,00	7.357.704	3.678.852
	Gras	325	40,00	89,20	130,00	583,80	208,30	54,10	67.697	36.624
	Maize plant	31	35,00	92,30	10,77	488,00	157,65	51,50	4.849	2.497
	Plant fat	314	95,00	92,00	298,22	500,00	437,00	56,00	137.183	76.823
	Sugar water/ Fruit waste liquid	136	4,30	72,50	5,85	500,00	15,59	55,00	2.120	1.166
	Vegetable waste	356	15,00	76,00	53,47	500,00	57,00	56,00	20.317	11.378
	Whey waste	48	5,60	88,80	2,66	742,30	36,91	53,50	1.754	938
MANURE	Liquid - pig	34.920	6,00	85,00	2.095,20	400,00	20,40	60,00	712.368	427.421
	Liquid - cattle	8.839	10,00	85,00	883,92	400,00	34,00	55,00	300.532	165.293
	Solid - cattle	6.258	25,00	80,00	1.564,56	450,00	90,00	55,00	563.240	309.782
	Solid - chicken	76	15,00	73,80	11,44	500,00	55,35	55,40	4.221	2.338
	Rumen content	420	15,00	84,00	62,99	480,00	60,48	55,00	25.399	13.970
	Total	**101.322**			**25.070**			**57,75**	**15.526.112**	**8.260.795**

Table 3: Input substrates and their biogas and methane potential in 2016

As described under *3.1.1. Methodology deviation* of this Report, the conservativity factor of 0.5 has been applied on the calculated emission reductions to compensate the risk for an over-estimation of the emission reductions

The application of the formula above and of the factor of conservativity results in emission reductions due to the project activity *Methane Recovery Project Princepeel Wilbertood* in the Monitoring year 2016 of:

$$GHG_{red,\ IIID} = 0{,}9817 * (16.638.931\ m^3 * 54{,}34\ \% - 3.108.104\ m^3 * 52{,}75\ \%) * 0{,}0007168\ t\ CH_4/m^3 * 25 * 0{,}5$$

$$= 65.094\ t\ CO_2e$$

2016			
Parameter ID	**Value**	**Unit**	**Description**
AF	0,9817	#	Adjustment factor
$dm_{nw,\ I}$	4.588,92	t	Dry matter of the proceeded quantity of non-waste co-ferment i
$dm_{w,\ j}$	15.862,64	t	Dry matter of the proceeded quantity of waste co-ferment j
dm_{manure}	4.618,11	t	Dry matter of the proceeded quantity of manure
BGP	16.635.677	m³	total annual biogas produced by the project activity
MC	54,34	%	average annual methane content in the biogas
$BGCO_i$	3.108.104	m³	Portion of biogas from co-ferments
$MCCO_i$	52,75	%	Methane content of co-ferments (weighted average)
D_{CH4}	0,0007168	t CH_4/m³	Density of methane
GWP_{CH4}	25	#	Global Warming Potential of methane
KF	0,5	#	Factor of conservativity
$GHG_{red,\ IIID}$	**65.094**	**t CO_2e**	Annual emission reduction through methane recovery

Table 4: Emission reductions through methane recovery in 2016

The emission reductions through methane recovery for the remaining years of the present Monitoring are presented under Appendix C in the attached calculation spreadsheet (“ER *Year*”).

5.2 Project Emissions

The oil-fired emergency boiler has not been installed on the plant’s site, so that no emissions by this source of the project activity occurred during the actual monitored period from 2013 to 2017.

The diesel-fired emergency generator has first been installed end of 2015 and was not used during the actual monitored period from 2013 to 2017, so that no significant emissions by this source of the project activity occurred.

The project emissions from transport of biomass due to the combustion of fossil fuels is not considered, since the emissions from transportation are below 1 % of total baseline emission by the project and do not exceed the criterion for significance as described in the PDD (p 17). The calculation of the emissions from truck transportation for manure are based on the transport load in tonne kilometre and the respective GHG emissions per tonne kilometre as follows:

MANURE in 2016	**Amount**	**Source**	**Distance from biogas site**	**Transport load**
Livestock	[t/y]	[own or external]	[km]	[t km/y]
Liquid - pig	34.920	own	10	349.200
Liquid - cattle	8.839	external	75	662.939
Solid - cattle	6.258	external	75	469.367
Solid - chicken	76	external	75	5.720
Slaughterhouse waste	420	external	45	18.898
TOTAL	**50.514**			**1.506.123**

Table 5: Transport load for all manure types in 2016

Since the GHG emissions for a 12-24 t lorry using diesel is 204 g CO_2e/t km[4], the project emissions from truck transportation for manure in 2016 are:

$PE_{Transport,2016}$ = 1.506.123 t km * 204 g CO_2e/t km / 1.000.000

= 307 t CO2e

Since the baseline emissions of the year 2016 were 65.159 t CO_2e, the transport emissions make up 0,47 % of those. Hence, no emission by this source of the project activity has to be considered.

CH_4 emissions from physical leakage of biogas in the manure management systems, which includes production, collection and transport of biogas to the point of combustion or gainful use of the anaerobic digester, have to be considered. Those project emissions have not been considered during the last monitoring period. This is due to the fact, that the Carbon Consultant in charge of the Monitoring at that time was not aware of the existence of physical leakage from biogas plant. He has correctly followed the Monitoring Plan defined in the PDD. The current Monitoring Report has been established by a different Carbon Consultant, who has worked for years in the field of biogas as project developer as well as Carbon Manager for similar emission reductions projects from methane recovery. The biogas practice as well as corresponding methodologies regarding methane emissions from manure management systems have been considerably developed over the last 15 years. The practice has shown that few emissions from

[4] Calculating GHG emissions for freight forwarding and logistic services in accordance with EN 16258, European Association for Forwarding, transport, logistics and customs services, p. 11, https://www.dslv.org/dslv/web.nsf/gfx/1090CAF3225E6AF241257BB70077B20E/$file/DSLV-Leitfaden%20engl.%20Berechnung%20von%20THG-Emissionen%20Stand%2003-2013.pdf

physical leakage of biogas on the plant can potentially occur. The CDM Methodology AMS III.AO *"Methane recovery through controlled anaerobic digestion",* Version 01[5], suggests estimating these project emissions using a default factor of 0,05 m³ biogas leaked/m³ biogas produced. Considering experience from practice, this value can be addressed as too high. The system of the biogas plant starting at the input of manure is gastight. The operator has an interest to keep the system gastight for security reasons, but also because biogas is the fuel that runs the engine and creates the income. Severe discrepancies between the biogas potential of the substrates and the produced electric energy would become apparent to the operator. Nevertheless, since no measurements of leaked methane on the plant are available, the proposed calculation for Project Emissions from physical leakage of biogas has been taken over, so that the principle of conservativity can be kept.

The calculation of the Project Emissions from physical leakage for the project Princepeel is shown is the table below with following equation with the year 2016 as example:

$$PE_{\text{phy leakage},2016} = 16.635.677\ \text{m}^3 * 0{,}05 * 54{,}34\% * 0{,}0007168\ \text{t}\ CH_4/\text{m}^3 * 25 = 8.100\ \text{t}\ CO_2\text{e}$$

Year	Biogas Flow [m³]	Default factor [m³ biogas leaked/m³ biogas produced]	Biogas leaked [m³]	Methane content of biogas [%]	Density of methane [t CH4/m³]	Global Warming potential of CH_4	Project emissions [t CO_2e]
2013	15.852.797	0,05	792.640	56,13	0,0007168	25	7.973
2014	16.288.210	0,05	814.410	54,97	0,0007168	25	8.022
2015	16.614.734	0,05	830.737	53,84	0,0007168	25	8.015
2016	16.635.677	0,05	831.784	54,34	0,0007168	25	8.100
2017	6.521.947	0,05	326.097	55,57	0,0007168	25	3.247
Total	**71.913.366**		**3.595.668**				**35.357**

Table 6: Project Emissions from physical leakage during the monitoring period 2013 till 2017

5.3 Leakage

According to the PDD section E.2., no leakage has to be considered.

5.4 Net GHG Emission Reductions and Removals

[5] https://cdm.unfccc.int/filestorage/C/D/M/CDM_AMSU745LJQM81SDJJOJ2S4G7ID9EIKFGD/EB58_repan16_AMS-III.AO.pdf?t=aWx8cWF6bDdlfDC8bL3Q3JMGdSFxjetuSlEX, Page 6

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 2013	64.092	7.973	0	56.120
Year 2014	59.429	8.022	0	51.407
Year 2015	62.539	8.015	0	54.524
Year 2016	65.094	8.100	0	56.994
Year 2017	25.353	3.247	0	22.105
Total	276.507	35.357	0	241.150

APPENDIX A: DOUBLE COUNTING

Verified Carbon Standard

Supporting Documentation:

The following email evidence was provided to Verra by the project proponent to demonstrate that emissions reductions associated with methane emissions from manure digesters are not included within the national inventory.

The original email record is provided at the end of this document.

Email of Nov 21, 2017, from Jos Cozijnsen, on behalf of John Horrevorts in the framework of the Dutch Green Deal to establish a domestic CO2 market [not official translation]:	
Original (Dutch):	Translated (English):
Hallo Peter, "In vervolg op onze eerdere gesprekken wil ik je namens John Horrevorts, die aangesloten is bij onze green deal en met mestvergistingsprojecten bezig is in Brabant vragen om een mededeling dat bevestigt dat de methaanreducties van mestvergisting totnogtoe niet zijn meegenomen in de NIR. Dat kan wellicht via email, of over brief, met verwijzing naar de plek in de NIR. Graag horen we of je daar nog informatie voor nodig hebt of dat je dat zo kunt sturen."	"Hello Peter As a follow-up to our earlier discussions, I would like to ask you on behalf of John Horrevorts, who is involved in our green deal and with manure fermentation projects in Brabant, to submit a statement confirming that the methane reductions of manure digesters have not yet been included in the NIR. This may be possible via email, or letter, with reference to the place in the NIR. We would like to hear if you need information or that you can send it that way."
Email of Nov 27, 2017, from Peter , Dutch official, responsible for drafting the National Inventory Report:	
Original (Dutch):	Translated (English):
"Beste Jos en John Door middel van deze mail bevestig ik dat er in Nederland nog geen sprake van het meerekenen van emissiereducties als gevolg van mestvergisting. Hierbij verwijs ik naar de NIR2017 (http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/nld-2017-nir-14apr17.zip) waar in paragraaf 5.3.6 de volgende tekst staat vermeld: *A technical measure to prevent methane emissions caused by manure management is manure treatment in an anaerobic digester. In 2014, 2% of the total amount of manure in animal housing was treated in an anaerobic digester. The Netherlands is examining future needs and possibilities in this area to include anaerobic treatment in the methodology and to extend calculations. Results of initial research (Hoeksma et al., 2012) make it clear that further investigation is needed.* Op dit moment is het RIVM samen met de WUR een methode te ontwikkelen, waarmee de effecten van mestvergisting kunnen worden verrekend in de emissies. Het blijkt een complex onderwerp (met plussen en minnen), dat waarschijnlijk in de NIR 2019 zal worden doorgevoerd."	"Dear Jos and John, By means of this e-mail I confirm that there is no inclusion in the Netherlands of the emission reductions as a result of manure digesters. I refer to the NIR2017 (http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/nld-2017-nir-14apr17.zip where the following text is mentioned in section 5.3.6: A technical measure to prevent methane emissions caused by manure management is manure treatment in an anaerobic digester. In 2014, 2% of the total amount of manure in animal housing was treated in an anaerobic digester. The Netherlands is examining future needs and possibilities in this area to include anaerobic treatment in the methodology and to extend calculations. Results of initial research (Hoeksma et al., 2012) make it clear that further investigation is needed. At the moment, the RIVM, together with the WUR, is developing a method with which the effects of manure fermentation can be calculated in the emissions. It turns out to be a complex topic (with pluses and minuses) that will probably be implemented in the NIR 2019."

APPENDIX B: PROJECT REVIEW REPORT

For further information about the increase of manure amounts during the project activity and the accuracy of electric meters, please refer to the "Project Review Report of the Methane Recovery Project Princepeel Wilbertoord" under Finding 3, page 7 and Finding 1, page 3.

APPENDIX C: SPREADSHEET WITH CALCULATION OF EMISSION REDUCTIONS

APPENDIX D: MONITORING PLAN - DOCUMENTATION

1. Accuracy of methane measurement device from Sewerin "Gas analyzer Sewerin_Prüfprotokoll SR2-DO"
2. Photo of the specification plate of the gas analyzer from Geotec named "Gas analyzer Geotech_Technical specifications_Photo"
3. Inaccuracy of CHP runtime counters under "Runtime counter - Accuracy - Jenbacher"
4. Report containing information about electricity (and heat) production, their technical description, the monitoring methods as well as calibration reports named "Meetprotocol elektriciteit en warmte - Princepeel - 2018"
5. Technical specification of weighing scale "Weighing scale_Technical specifications"
6. Monthly electricity production rates are recorded and evaluated in excel files named "Overzicht vollasturen Princepeel BV [year]"
7. Monthly electricity production rates sent from CertiQ named "CQ_BIN_Meetwaarden_per_installatie_2013-2017"
8. Email information about operation, maintenance and calibration of electric meters complying with MID according to Fudura adviser named "Fudura_Electric meters"
9. Runtime hours from the CHPs recorded via on e-mail as pdf document named "Bedrijfsuren motoren_2012-2016"
10. Calculation of annual runtime hours of each CHP in questionnaire named "20210114_VCS_Data Inquiry_Princepeel"
11. Daily records of methane content in excel files named "[year] Controle gasmetingen"
12. Accuracy of methane measurement device from Geotec "Biogas 5000 - Datasheet"
13. Annual calibration reports of gas analyzer named "Gas analyzer - Calibration reports_2010-2017"
14. Electronical records of co-substrates entering the biogas plant exported fom Wincc to excel files named "Overzicht productleveringen Princepeel BV [year]"
15. Manure records from external farms "Overzicht aan- en afvoer mest [year]"
16. Daily manure records from own farm "Aanvoer mest eigen bedrijven [year]"

APPENDIX E: REQUEST FOR EXEMPTION FROM QUANTITATIVE MONITORING FOR THE CREDITING PERIOD FROM 01/01/2008 TO 31/05/2010