Gold Standard for the Global Goals

TEMPLATE

MONITORING REPORT

PUBLICATION DATE **14.10.2020**

VERSION **v. 1.1**

RELATED SUPPORT – **TEMPLATE GUIDE Monitoring Report v. 1.1**

This document contains the following Sections

KEY PROJECT INFORMATION

Programme of Activity Information – (delete below table if N/A)

GS ID of Programme	GS1172 (PoA)
Title of Programme	Indonesia Domestic Biogas Programme of Activities (IDBP) (ID 1172)
Version of POA-DD applicable to this monitoring report	Version 7.0
Name and GS ID of fully Validated CPA/VPAs (i.e. non compliance check)	Indonesia Domestic Biogas Programme of Activities (IDBP) (ID 1172), VPA-2 (GS 5303)

Key Project Information

GS ID (s) of Project (s)	(GS 5303)
Title of the project (s) covered by monitoring report	Indonesia Domestic Biogas Programme of Activities (IDBP) (ID 1172), VPA-2 (GS 5303)
Version number of the PDD/VPA-DD (s) applicable to this monitoring report	Version 1.4
Version number of the monitoring report	Version 1.6
Completion date of the monitoring report	26/11/2021
Date of project design certification	04/05/2017
Date of Last Annual Report	Not applicable
Monitoring period number	MP4 CP1
Duration of this monitoring period	01/01/2020 to 31/12/2020 (inclusive of both dates)
Project Representative	Hivos
Host Country	Indonesia
Activity Requirements applied	☒ Community Services Activities ☐ Renewable Energy Activities ☐ Land Use and Forestry Activities/Risks & Capacities ☐ N/A
Methodology (ies) applied and version number	Technologies and practices to displace decentralized thermal energy consumption (11/04/2011)
Product Requirements applied	☒ GHG Emissions Reduction & Sequestration ☐ Renewable Energy Label ☐ N/A

Table 1 - Sustainable Development Contributions Achieved

Sustainable Development Goals Targeted	SDG Impact	Amount Achieved	Units/ Products
SDG 13: Climate Action	-	**10,975**	VER
SDG 7: Affordable and Clean Energy	GS-08 Access to affordable and clean energy services	**4,636**	Biodigesters installed in the period 2017-2020
		372	Biodigesters installed during MP4 (between 01/01/2020 and 31/12/2020)
	GS-12 Technology transfer and technological self-reliance	**4,408**	Users attending training in the period 2017-2020
		325	Users attending training during this MP4
SDG 5: Gender Equality	GS-09 Human and institutional capacity	**1,082**	Women attending Operation and Maintenance training in the period 2017-2020
		126	Women attending Operation and Maintenance training during MP4
	GS-14 Time saved	**2,803**	Women reporting to have saved time during MP4
	GS-15 Productive use of time	**1,234**	Women reporting to have more time for productive use during MP4
SDG 2: No Hunger	GS-03 Soil condition	**1,946**	Households using bio-slurry on land during MP4
	GS-13 Establishment of sustainable food production area	**15.45**	Hectares applying bio-slurry, per month during MP4
SDG 1: No Poverty	GS-06 Quality of employment	**63**	Vocational trainings conducted during VPA implementation
		5	

			Vocational trainings conducted during MP4
	GS-07 Livelihood of the poor	**113** **1,318** **3,205**	'Worsened' during MP4 'The same' during MP4 'Improved' during MP4
	GS-10 Quantitative employment and income generation	**144** **40** **32.19**	Number of direct jobs created by the VPA during MP4 Number of constructors employed under the VPA during MP4 Households selling bio-slurry during MP4

Table 2 – Product Vintages

		Amount Achieved	
Start Dates	**End Dates**	**VER**	
01/01/2020	31/12/2020	10,975	

SECTION A. DESCRIPTION OF PROJECT

A.1. General description of project

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The Indonesia Domestic Biogas Programme (IDBP) is a development programme managed and implemented by Hivos (Humanist Institute for Co-operation with Developing Countries) in partnership with Yayasan Rumah Energy (YRE) and national support from the Directorate General of New Renewable Energy and Energy Conservation. The overall development objective of the IDBP is to disseminate domestic biodigesters as a local, sustainable energy source through the development of a commercial, market-oriented sector in selected Indonesian provinces. Biodigesters are fed with a mixture of water and animal manure that is anaerobically digested. The generated biogas is intended for use as fuel for cooking. The biodigester type implemented is the fixed-dome type, constructed with bricks and stone masonry.

The VPA-2 started implementation of biodigesters on 02/01/2017, following the filling of the VPA-1 which ended on 31/12/2016. The overall development objective of the VPA-2, and the IDBP programme which manages it, is to disseminate domestic biodigesters as a local, sustainable energy source through the development of a commercial, market-oriented sector in selected Indonesian provinces.

The monitoring period covered in this Monitoring Report is 01/01/2020 - 31/12/2020, which is the fourth monitoring period of the first crediting period running from 02/01/2017 – 01/01/2024.

A.2. Location of project

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The project is located in the Indonesian provinces shown below.

Table 2: Project location by provinces in Indonesia and GPS coordinates of provincial capitals

Province	Latitude	Longitude
Lampung	5° 27' 0.0000" S	105° 16' 0.0120" E
West Java	6° 54' 53.0784" S	107° 36' 35.3160" E
Central Java	7° 47' 49.4448" S	110° 22' 13.9044" E
East Java	7° 15' 1.6020" S	112° 46' 7.8420" E
Bali	8° 24' 34.2648" S	115° 11' 20.1084" E
Nusa Tenggara Barat	8° 39' 10.5602" S	117° 21' 41.9314" E
Nusa Tenggara Timur	8° 39' 26.575" S	121° 4' 45.732" E
Yogyakarta	7° 47' 49.4448" S	110° 22' 13.9044" E
South Sulawesi	5° 8' 51.5940" S	119° 25' 57.8352" E

Provinces Banten and Sumatera Selatan are included in the West Java province
Province Kalinantan Tengah is included in South Sulawesi province

A.3. Reference of applied methodology

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Technologies and Practices to Displace Decentralized Thermal Energy Consumption (11/04/2011).

Guidance, of the General Guidelines for Sampling and Surveys for Small-Scale CDM Project Activities (EB 50 Report, Annex 30)

IPCC Guidelines for National Greenhouse Gas Inventories (2006)

Requirements and Guidelines for carrying out usage surveys for projects implementing improved cooking devices (Annex 10)

A.4. Crediting period of project

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The project applies a renewable crediting period of 7 years running between 02/01/2017 – 01/01/2024 (including both days). This Monitoring Report covers the fourth monitoring period of the first crediting period, and covers GHG emission reductions generated in the period between 01/01/2020 - 31/12/2020.

SECTION B. IMPLEMENTATION OF PROJECT

B.1. Description of implemented project

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The IDBP started implementation of biodigesters on 24/10/2009, following an agreement reached between the Royal Netherlands Embassy to support the Indonesian Ministry of Energy and Mineral Resources in rolling out a national biodigester initiative. A first Voluntary Project Activity (VPA-1) was retroactively included to cover the emission reductions that have been generated up to two years prior to the registration date of this PoA, which occurred on 31/05/2013. Hivos is the official project representative of the IDBP PoA, whereas YRE is the VPA implementer.

The second VPA (VPA-2) targets the same programme and includes biogas digesters installed from 02/01/2017 onwards. The inclusion of a second VPA into the registered PoA was needed due to VPA-1 reaching its small-scale methodology threshold limit as defined under the CDM. As such, VPA-2 represents a continuation of the existing IDBP programme, and does not differ in terms of target geographical area, technology type, or end-user type. One Post Registration Design Change was adopted for VPA-2 by the Gold Standard on 21/07/2020 to allow for the inclusion of biodigesters smaller than 4m^3, as well as of a new type: plastic bag.

The next table shows the units built and commissioned in the period from 02/01/2017 to 31/12/2020 in the VPA-2.

Table 3: Total Number of units installed by month and cumulative, VPA-2[1]

Period	Number of biodigesters in VPA-2	Cumulative number of biodigesters in VPA-2
02/01/2017 – 31/12/2017	2,040	2,040
01/01/2018 – 31/12/2018	1,454	3,494
01/01/2019 – 31/12/2019	770	4,264
01/01/2020 – 31/12/2020	372	4,636
		Total: 4,636

In total **4,636** biodigesters were constructed as of 31/12/2020 in the VPA-2 project boundary.

Table 4 shows the distribution of the biodigesters across the nine targeted provinces.

Table 4: Distribution of biodigesters per province, until 31/12/2020 [2]

Province	Number of biodigesters
Lampung	169
West Java	235
Central Java	126
East Java	653
Bali	249
Nusa Tenggara Barat	940
Nusa Tenggara Timur	470
Yogyakarta	961

[1] As per "20211011_IDBP_Database_VPA2_v3.xls" | sheet 'Master VPA-2' | cells J4727 to J4781

Presented cumulative figures exclude the drop-off rate.

[2] As per "20211011_IDBP_Database_VPA2_v3.xls" | sheet 'Master VPA-2' | cells R4726 to R4735

South Sulawesi	833
Total:	**4,636**

The figure below shows the cumulative number of installed biodigesters as well as the number of units that are installed each month.

Figure 1: Cumulative and monthly number of units installed until 31/12/2020

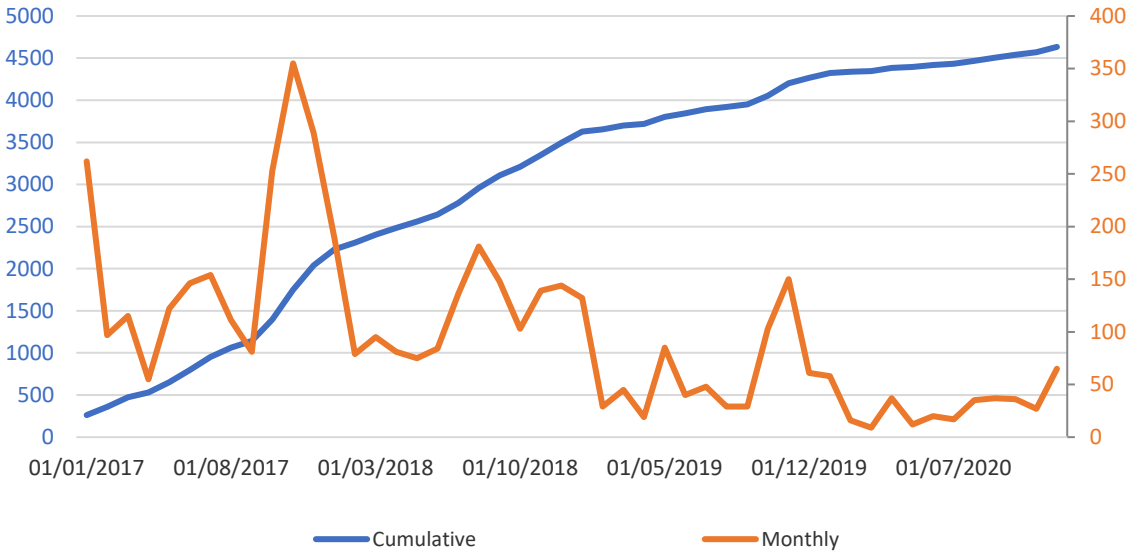


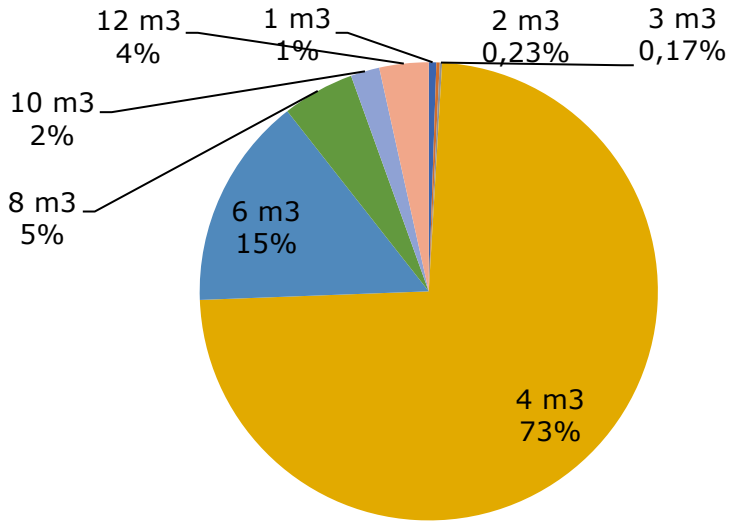
Figure 1 shows that the cumulative number of units installed is steadily increasing, and that there is a small seasonal difference in the implementation effort.

The VPA-2 installs eight different biodigester sizes, with the 3m³, 2m³ and 1m³ plastic bag units being added in this MP as a result of a Post Registration Design Change; the figure below shows the proportions of each biodigester size expressed in fraction of total number of digesters built during the assessed period:

Figure 2: Biodigester capacities implemented in VPA-2 (as per 31/12/2020) [3]

[3] As per "20211011_IDBP_Database_VPA2_v3.xls" | sheet 'Master VPA-2' | cells O4349to O4359

Figures may not add up due to rounding



The most proliferated digester has a volume of 4 m^3, followed by the 6 m^3; according to the IDBP database. Other digester sizes are built to a much smaller extent, with the 8 m^3, 10 m^3 and 12 m^3 joining totalling around 10% of all the digesters built. The average digester size built has a volume of 4.88 m^3.[4] The VPA-2 has a cumulative digester volume of 22,629 m^3.[5]

The VPA-2 meets the small-scale VPAs thresholds set forth by the CDM i.e., (45 MW_{th}) for the renewable energy component and an emissions cap of 60,000 tCO_2e for the methane avoidance component. The average biodigester size implemented in this VPA-2 is 4.88 m^3. As per the calculation presented in footnote 8 below, this biodigester size requires daily feeding of (4.88 m^3 * 7.5 kg =) 36.600 kg of manure, equivalent to 1.46 m^3 of biogas per day. As per the Table below, this amounts to a maximum output of 1.56 kW_{th}, which is below the established threshold of 150 kW_{th} per unit. Also, given 4,636 units implemented to date under the VPA-2, this cumulates to 7.22 MW_{th}, below the 45 MW_{th} threshold.

The calculation is presented below:

Table 5: Calculation of total capacity under VPA-2

$\mathbf{Th_{cap} = \frac{E}{t}} \quad \boldsymbol{where} \quad \mathbf{E = \eta * H_b * V_b}$		
Where:	Value:	Comments:

[4] As per "20211011_IDBP_Database_VPA2_v3.xlsx"" | sheet 'Master VPA-2' | cell P4751

[5] As per "20211011_IDBP_Database_VPA2_v3.xlsx" |sheet 'Master VPA-2' | cell P4752

t = hours/day usage	2.74	See "Crosstab BUS by Province_18May2016.xls", sheet "raw_data" cell J2683. Fixed for future verifications[6]
η = efficiency of stove	50%	Indonesian Government standard on stove efficiency
H_b = heat of combustion per unit volume of biogas	21.0 MJ/m³[7]	Derived from IPCC defaults
V_b = volume of biogas	1.46 m³/day[8]	Data provided by Hivos
E = Energy available from the biogas system	15.37 MJ/day[9]	Calculated
E_{th} =	4.27 kWh/day	1 MJ = 0.2778 kWh
Th_{cap} =	1.56 kW_{th}	Given a 2.74 hour/day usage
Total capacity	7.22 MW_{th}[10]	Given 4,636 units installed

As each biodigester produces a maximum emission reduction of 1.998 tCO_2e from methane avoidance, given 4,636 biodigesters installed, the cumulative amount of emission reductions from the methane avoidance component is 9,261 tCO_2e. This is below the methodological threshold of 60,000 tCO_2e.

B.1.1. Forward Action Requests

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Not applicable.

B.2. Post-Design Certification changes

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B.2.1. Temporary deviations from the approved Monitoring & Reporting Plan, methodology or standardized baseline

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No post-registration design changes have been implemented for VPA-2.

B.2.2. Corrections

>>
Not applicable.

B.2.3. Changes to start date of crediting period

>>
Not applicable.

[6] As per Gold Standard confirmation by email, the parameter 't' can be fixed at value 2.74 going forward to enable the definition of the VPA-2 threshold. See email communication dated 11 April 2016

[7] Methane has an energy value of 37.78 MJ/m³; thus, biogas at 55% CH_4 has an energy value of 21 MJ/m³

[8] Cow dung produces approximately 40 litres biogas per kg. Each m³ capacity of the biodigester needs 7.5 kg dung per day. Given an average biodigester size of 4.88 m³, 36.600 kg of cow dung per day is required. This translates into approximately 1.46 m³ of gas produced per day. See Document P_Biogas_as_renewable_energy _2005.pdf, pages 79 and 140.

[9] Calculated as: 50% efficiency * 21 MJ/m³ * 1.46 m³/day

[10] Figures may not add up due to rounding – see "2021115 ER Calculation VPA2 MP4 CP1_v062021115 ER Calculation VPA2 MP4 CP1_v06.xls" | sheet "Capacity calculation" | cell "C6"

B.2.4. Permanent changes from the Design Certified monitoring plan, applied methodology or applied standardized baseline

>>
Not applicable.

B.2.5. Changes to project design of approved project

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A design change approved by the GS on 21/07/2020 was introduced in this MP.

The programme explicitly allows for the inclusion of two types of biogas systems: (i) a fixed dome digester made from bricks and cement; and (ii) a plastic digester. All biogas digesters implemented under VPA-1 of the PoA were fixed dome digesters. VPA-2 of the PoA commenced operations (start date 02/01/2017) with implementing the fixed dome digester as well, but meanwhile the programme has developed a new biodigester type made from plastic (poly-ethylene) to cater for demands from potential users. This new biodigester model is called "bio-miru", and has been tested and approved by the IDBP programme.

While biodigesters made from plastic are allowed under the PoA, the VPA-2 DD originally did not explicitly mention the eligibility of plastic digesters. Furthermore, the VPA-2 originally also specified that the capacity of the biodigesters ranges from 4 m^3 to 12 m^3. In order to both allow for VPA-2 to include i) plastic digesters; and ii) capacity sizes below 4 m^3, a PRC was requested. As a result of this approved PRC (approved on 21/07/2020), this Monitoring Report now includes also the emission reductions generated by plastic digesters. Also, smaller capacities of units have also been added in this MP, including 1 m^3, 2m^3, and 3m^3 units (please see Figure 2 in the Section B.1).

SECTION C. DESCRIPTION OF MONITORING SYSTEM APPLIED BY THE PROJECT

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Article I. Organisational Setup of the carbon and SDG monitoring

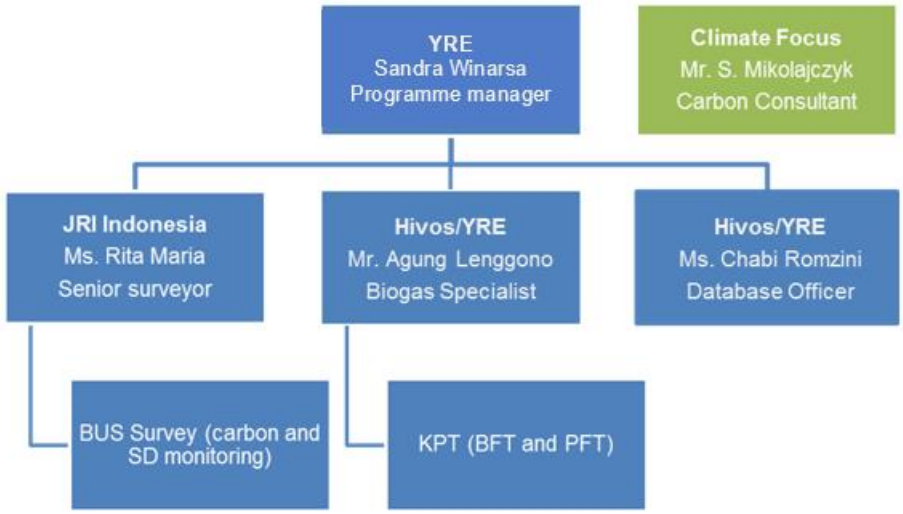
All monitoring was coordinated by YRE. The objective of the monitoring effort conducted under this VPA-2 was to meet the monitoring requirements set forth in the methodology Technologies and Practices to Displace Decentralized Thermal Energy Consumption (11/04/2011).

YRE appointed Ms. Rita Maria from JRI Research to conduct the Biogas User Survey, which serves as the monitoring survey under the VPA-2 (BUS 2021). The survey was designed and implemented in accordance with the requirements set forth in the methodology, whereby the selected sample size follows at least the 90% confidence interval and a 10% margin of error (90/10) requirements. Mr. Szymon Mikolajczyk from Climate Focus was placed in charge of advising JRI Research on the VPA specific monitoring procedures. JRI recruited 17 surveyors and 3 supervisors for the enumeration. All these surveyors received training on survey and data collection techniques and they were supervised by the Project Leader during survey implementation. Office training was conducted on November 9th 2020; meanwhile field training was conducted on November 13th. Data tabulation, analysis and reporting was prepared by JRI Research.

Hivos internally designed and implemented the KPT in December 2019 and January 2020, which was supervised by Mr. Agung Lenggono and supported by Mr. Szymon Mikolajczyk. Data collection for the KPT was conducted by JRI, employing an experienced team (also responsible to carry out the Biogas User Survey). Tabulation and analysis of results was conducted by Mr. Szymon Mikolajczyk.

As per registered VPA-DD and GS PoA Transition Annex a number of monitoring activities were undertaken for this monitoring period. The monitoring surveys that were executed and the entities involved are shown in the next figure:

Figure 3: Surveys executed and entities involved



In terms of data monitoring, IDBP has two dedicated staff to monitor all data into the IDBP Database that submitted to the National Office.[11] These Database Officers ensures the data are complete and correct from all CPOs. Recently in 2019 IDBP has improved its data efficiency management by applying Kobo Collect App where all CPOs submitted their data through this application, then using 3G connection the app will send the data to the main server in Jakarta. Two Database Officers regularly check and verify all submissions before submitting confirmation to Finance for any payment release. Quality Inspectors in the provinces also have access to Kobo to monitor their CPO's progress.[12]

YRE, based on the hard copies of the Household Agreement, is responsible for entering data into the centralised record-keeping database. It is YRE's responsibility to ensure that data is entered correctly and to follow-up with the supplier where errors or missing data appeared.

Only the National Office can carry out payments to the CPOs. All sales records are sent to the National Office in the form of electronic files while the hard copies are stored in the provincial offices.

Article II. Description of human resources

Sandra Winarsa: Sandra Winarsa is the Programme Development Manager of IDBP. Sandra is in charge of overall project management and acts as the key contact person between YRE and the Indonesian Government. Sandra approves any financial payments that are made to participating partners and monitors the partners' progress on a monthly basis. The Provincial Coordinators coordinate with Rebekka Angelyn, the Executive Director of YRE directly on a daily basis to provide updates about any occurring issues, implementation progress and working relations with partners.

Rita Maria: Rita Maria is in charge of running operations at JRI Research, a surveyor company operating in Indonesia. JRI Research employs researchers, surveyors and statisticians and has been associated with the IBDP programme since 2009. JRI has been in charge of implementing and analysis the BUS 2021, as well as previous versions of this survey (including BUS 2020 applied in the previous monitoring period).

Agung Lenggono: Agung was responsible for the preparation of the KPT (BFT and PFT) that was implemented in December 2019 (as well as the KPT in 2017). He works as the senior biogas expert coordinating in the IDBP programme in Indonesia and has been involved in overseeing the carbon asset development process of the programme since 2015.

Chabi Romzini: Chabi is responsible for overseeing all data entry processes into the IDBP Database. This includes updating implementation figures on a monthly basis, tracking the operational rate of installed biodigesters, and tracking CPO and user trainings, amongst others. Chabi is responsible for centralising all the data that is sent in from the provincial offices.

11 The national office relates to the head quarter of IDBP located in Jakarta. From this office, all payments to CPOs for the confirmed biodigester constructions (as confirmed by the quality inspectors) are processed. These payments relate to the subsidy payments that CPOs receive for completed works.
12 Quality inspector is permanent staff of IDBP (8 staff). CPOs send completion reports to the database input. The database people coordinate with the finance department to release the payments to CPOs. Quality inspectors they verify that corrects inputs in database have been made.

Szymon Mikolajczyk: The key responsible person for the preparation of this Monitoring Report. Szymon was selected consultant based on a tendering process conducted by YRE. He has been involved with the IDBP since 2010 and assisted the IDBP through the Gold Standard validation, registration and first three verifications process of VPA-2.

Article III. Survey design

The next table summarizes the design of the surveys:

Table 6: Survey designs summary (data for VPA-2 only)

Item	BUS 2021 (US + CMS)	KPT (PFT) [13]	KPT (BFT)
Target group	Households with a biodigester that has been in use for at least 6 months for each age group	Users with a biodigester	Households without a biodigester
Main topics	Drop-off rate, user characteristics, fuel usage and SDG impacts	Project fuel use	Baseline fuel use
Sampling method	Cluster sampling[14] based on year of use, and multi-stage sampling[15] to account for population size per province	Simple random sampling	Simple random sampling using PFT sampling frame
Cluster	Age group	N/A	N/A
Cluster size	38 - 39 households[16]	N/A	N/A
Number of clusters	4 cluster is relevant to this MR	N/A	N/A
Total sample size	**154**	**81**	**27**

Article IV. Biogas user survey (US + CMS)

The Biogas User Survey (BUS) is the survey implemented under the VPA-2 annually that includes both the a) User Survey (US) and b) the Carbon Monitoring Survey (CMS). The survey was executed in November and December 2020 (referred to in this document as "BUS 2021") amongst a representative sample of biodigester households with the objective to obtain reliable and unbiased data on the user characteristics, impact on the Sustainable Development Goals (SDG), on GHG emission modalities such as fossil and fuel wood consumption, cattle types and amounts. Furthermore, the usage parameter (in some programmes assessed in a separate user survey) has also been included in the BUS 2021. This parameter must be established to account for drop off rates as project technologies age and are replaced. Prior to the verification, a usage parameter is required that is weighted to be representative of the quantity of project technologies of each age being credited in a given project scenario.

The next table shows the studies included in the BUS 2021.

Table 7: BUS studies

13 The reason for the higher selection of hhs for the PFT (81) was that the PFT results are applicable to both VPA1 and VPA2, covering a total of nearly 25,000 biodigesters. The BFT was only applicable to VPA2, as for VPA1 BFT results have been fixed for the crediting period. For this reason, the sample size was reduced, but ensuring that the 90/30 level is met.

[14] Please note that both VPAs only cover one user group type (i.e. households) and only small-scale digesters (i.e. max of 12m3). As such, sampling was done on the basis of this one user group only. Sampling approach for the BUS has remained unchanged since the past seven verifications.

[15] Cluster sampling is applied to identify the geographical areas where the sampling is to take place. Multi-stage sampling is used to ensure that the random selection of households from each region is proportional to the overall population size of the population, while ensuring at least 30 hhs are covered from each age group.

[16] 20210712 BUS 2021 Tabulation JRI v3.xlsx | sheet Drop-off | cells C7 – F7

#	Name of study	Monitoring interval	Conversion in MP4
1	Project non-renewable biomass (NRB) assessment;	Once for the first crediting period	fNRB is established once for the entire first crediting period of VPA-2.
2	Project studies (PS) of target population characteristics;	Annual	Included in BUS 2021
3	Monitoring of the SDG parameters.	Annual	Included in BUS 2021
4	Leakage emission assessment	Every two years after first verification	Investigated alongside BUS 2020
5	Maintenance of total sale record and project database	Continuous	Continuous activity

1. NRB Assessment

Over the course of a project activity the project proponent may at any time choose to re-examine renewability by conducting a new NRB assessment. In case of a renewal of the crediting period and as per Gold Standard rules, the NRB fraction must be reassessed as any other baseline parameters and updated in line with most recent data available. Since this Monitoring Report still covers the first crediting period of VPA-2, the PP refers to the fNRB of 64.8% as per the PDD.

2. Project survey (PS) of the target population characteristic

In addition to the parameters monitored as per VPA-DD and GS Transition Annex, the BUS survey includes a set of target population parameters, such as household size, digester size, ID code.

3. Sustainability assessment

The BUS survey includes the monitoring of the SDG parameters where it applies to biogas households. Section D details the results of the SDG monitoring and the sources of data used.

4. Leakage emission assessment

A leakage investigation has been conducted (once every two years). Physical leakage is also included in the calculations.

5. Maintenance of total sale record and project database

All data sale records are collected and stored in a central database that is continuously updated. Excerpts of this database will be made available in the excel workbook belonging to this report.

BUS Survey and Usage Survey design

In November - December 2020 (November 12th to December 12th), the surveys were executed by a team of surveyors from IDBP. The BUS 2021 monitoring procedure applied consisted of the following steps:

I. Details of the biogas households of each age group were gathered;
II. Random selection of at least 30 households from each age group, proportional to the overall population size of the province (multi-stage sampling). Sample selection in accordance to age groups was applied to the BUS as this survey also covers part of the Usage Survey, which needs to be arranged by age group. The sampling was executed using a web based random number

generator.[17] The sample size for each province was determined based on the biodigester user populations derived from the IDBP database to ensure representativeness.

III. IDBP staff surveyed the sampled households, and the gathered data was entered into a database at the head office following a data quality check.

To establish the sample size and the sample distribution, guidance from the applied Gold Standard methodology was applied relating to both the Carbon Monitoring Survey (i.e. minimum of 100 households for group size > 1,000) and the Usage Survey (i.e. at least 30 households per age group). As per the guidance, to ensure conservativeness, participants in a user survey with technologies in the first year of use must have technologies that have been in use on average longer than 0.5 years. For technologies in the second year of use, the user survey must be conducted with technologies that have been in use on average at least 1.5 years, and so on. For the VPA-2, the BUS approached a sample of **154** households. This exceeds the 4 age groups * 30 households = 120 households minimum threshold. The Usage Survey was fully included in the BUS.

For the BUS 2021, biogas users classified as the 4th year of use are those who have been using an IDBP biodigester in the first year of VPA-2 (i.e. implementation between 02/01/2017 to 30/06/2017); as 3rd year as the second year of the VPA-2 (i.e. implementation between 01/07/2017 to 30/06/2018); and as 2nd year as the third year of the VPA-2 (i.e. implementation between 01/07/2019 to 30/06/2019), and 1st year as the most recent year of the VPA-2 (i.e. implementation between 01/07/2020 to 30/06/2020).

The BUS 2021 covered all nine provinces that have become intervention areas of the VPA-2. Total sample of respondents per province determined proportionally to the total population of the respected province. A total of **154** households was reached, with **123** households completing the interview. The difference (**31** households) has been reported as drop-offs. Some households did not respond due to a non-functioning biodigester. The distribution of respondent sample for each province, and each year of use, is described in Table 8.

Table 8: BUS 2021 random sample size selection and geographical distribution (Age groups 1 through 4 are applicable to this MR)[18]

PROVINCES	STATUS	Y 1	Y 2	Y3	Y4	TOTAL
Bali	**Total approached**	1	3	1	2	7
	Total completed	1	3	1	0	5
West Java	**Total approached**	5	3	1	1	10
	Total completed	5	3	1	1	10
Central Java	**Total approached**	0	0	1	2	3
	Total completed	0	0	0	0	0
East Java	**Total approached**	7	4	3	11	25
	Total completed	7	4	3	9	23
Lampung	**Total approached**	2	0	1	2	5
	Total completed	2	0	0	1	3
NTB	**Total approached**	6	8	10	5	29
	Total completed	6	7	10	5	28

[17] See http://www.randomnumbergenerator.com/

[18] Where "Total approached" refers to the number of households reached during the BUS survey, and "Total completed" indicates the number of respondents that could complete the survey due to a functioning biodigester at that moment in time. Source: "20210712 BUS 2021 Tabulation JRI v3.xlsx" | "Drop-off" | Cells "N7" and "N8"

NTT	**Total approached**	1	0	4	4	9
	Total completed	1	0	2	1	4
South Sulawesi	**Total approached**	2	9	9	8	28
	Total completed	2	9	9	7	27
Yogyakarta	**Total approached**	15	11	9	3	38
	Total completed	12	5	6	0	23
Total						
9 provinces	**Total sampled**	41	44	46	44	175
	Total approached	39	38	39	38	154
	Total completed	36	31	32	24	123

The described BUS sampling plan is developed using guidance of the applied GS methodology and the UNFCCC standard on sampling ('Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities' (EB 69, Annex 4))[19], see the next table:

Table 9: BUS survey design

#	Item	Description
1	Objectives and Reliability Requirements	The objective is to obtain unbiased and reliable estimates of the monitoring parameters at a confidence / precision level of at least 90/10. The actual design of the survey was done to ensure a confidence / precision level of 95/5, exceeding this requirement.
2	Target population	Households that have installed an IDBP certified biodigester.
3	Sampling method and sampling frame	Simple random sampling within similar cluster (on the age of usage), with Probability-Proportional-to-size (PPS) of users when determining distribution number of respondents for each province (multi-stage sampling, within similar cluster).
3.1	Number of clusters	Number of cluster was determined based on the objective of the study; i.e.: to understand the impact of the biogas plants installed among different age of usage – based on the Gold Standard's definition.
4	Sampling frame	The sampling frame is a random selection of households that belong to the target population in the selected cluster.

Article V. Survey implementation

Surveyors

Cooperation with JRI Research, an Indonesian surveyor company that has an established working relationship with YRE, was established to execute the survey. JRI recruited 17 surveyors and 3 supervisors for data collection with face-to-face interviews using structured questionnaire. All these surveyors received training on survey and data collection techniques (trainings took place between November 9th and November 13th, 2020) and they were supervised by JRI's supervisors during implementation each province. Analysis and reporting were prepared by JRI Research.

Data collection tools

The questionnaire was developed jointly by the carbon consultant and JRI Research, in consultation with YRE. The questionnaire was pilot tested during the field visit organised as part of the surveyor training.

19 https://cdm.unfccc.int/Reference/Standards/meth/meth_stan05.pdf

Feedback from the field was used to finalise the questionnaire. Subsequently the questionnaire has been translated into Bahasa (Indonesian).

Quality control

Questionnaires for this survey were drafted by JRI Research with reference to the objectives of the study and in consultation with YRE. Pre-testing of the questionnaire was conducted by the JRI team. Based on the results of this field test, the questionnaire was finalised and sent to YRE for approval.

The fieldwork process was carried out by JRI staff through house-to-house personal interviews using the structured questionnaire. To ensure good data quality, oversight of the fieldwork process was conducted by field supervisors, through the following ways:

- Team members internally discussed the findings with the senior staff to ensure reliability;
- Solving any new problem that might arise in the field;

Quality control process was also conducted by JRI Research, through the following ways:

- Conduct control toward the filled questionnaires, for checking reliability of data on the questionnaires as well as their completeness;
- Follow up with phone calls to the interviewed household to verify that the surveys took place.[20]

Article VI. Baseline Fuel Test (BFT) and the Project Performance Field Test (PFT)

The baseline performance field tests (BFT) and project performance field test (PFT) measure real, observed technology performance in the field. Consumption is measured with a representative sample of end users under each defined baseline scenario (in the absence of the project technology) and project scenario. **The last KPT was conducted in December 2019, which has a validity for two years. For the purpose of VPA-2, these BFT and PFT therefore still apply, and all KPT results are presented in the identical way as during the previous MP.**

The KPT 2019 was executed according to this protocol:

- Test period shall be 1 days[21] = the measurement campaign (MC).
- The selected test day will span fuel measurement consumption for human food cooking and boiling water totaling 24 hours.
- Cooking practices shall be during 'normal days'. Normal days are defined as periods without extra eaters. Depending on the family, this excludes days like festivals or holidays or weekend days. The MC can take place in the weekend if it can be proven that fuel use is not higher during these days (i.e. the same number of people eat meals as during the week).
- Households are instructed that they cook normally during the test. The aim is to capture their usual behavior in the kitchen, as if no tests were happening, to feed the usual variation of people with the usual variation of food types.
- To conduct the tests, ensured is that the cook uses fuel only from a designated stock which is pre-weighed.
- During the tests, surveyor is to find out how many people have eaten and how many meals each, with the data to be entered into the data sheet as the number of "person-meals" (individual meals as opposed to meals shared) cooked with the weighed fuel each day. Note that this count can

20 There were no irregularities uncovered by the quality control performed by JRI staff to confirm that the BUS surveys indeed had taken place.
21 A MC of 1 days (24 hour) is allowed by the Gold Standard.

include meals sold commercially as well as meals consumed in the domestic environment. The number of people eating meals shall be recorded using the following categories: Child 0-14 years, Female over 14 years, male 15-59 and male over 59 years old.

- It is important that the fuel is typical of the fuel normally used through the year, particularly in terms of moisture content. It is also important that the subjects are paying for fuel, or have an incentive to conserve it, otherwise they may use excessive amounts due to the free hand-out. Subjects can be told they will be rewarded for their effort and time at the end of the test, once it is successfully completed.

Article VII. KPT survey design

The KPT for VPA-2 targets two groups. Oversampling was conducted to minimise the necessity to redo the KPT in cases of wrongly filled out questionnaires or unreliable results:

Table 10: KPT 2019 target groups

Group	Description of target group	Sample size
PFT household	Randomly selected household from the project database with a biodigester	81
BFT household	Nearest equivalent households[22] to the randomly selected project household without a biodigester	27
	Total sample	**108**

Only after data collection it can be known if the data meets the required precision, this is per Annex 4 of the applied methodology.

Table 11: KPT survey design

Item	Conversion in KPT
Sampling objective:	The objective of the sampling effort is to obtain reliable fuel use data of project and equivalent baseline households
Field Measurement Objectives and Data to be collected:	The survey will consist of a 24-hour measurement campaign amongst PFT and BFT households
Target Population and Sampling Frame:	The sampling frame will be drawn from the project database
Sampling method (approach):	Simple random sampling, each observation is chosen randomly and entirely by chance, such that each observation has the same probability of being chosen. The BFT household is a neighboring equivalent household to the selected PFT
Implementation:	The KPT was executed between in December 2019 and January 2020.
Desired Precision/Expected Variance and Sample Size.	90/30 rule of the applied methodology

[22] Equivalent households is defined as a household with comparable characteristics as the selected project households in terms of the number of animals owned (at least two cows, or three pigs) and socio-economic characteristics (type of house). The selected baseline household may be slightly poorer as once they adopt a biodigester they often improve their livelihood.

Procedures for Administering Data Collection and Minimizing Non-Sampling Errors:	The survey data was entered by JRI's data processing staff and served as an independent check on the data collected by the IDBP

Representativeness of the KPT

The KPT is executed for one day instead of the recommend 3-day minimum testing period by the Gold Standard. The GS confirmed that a one-day testing period is possible as long as it is representative. The next table shows how representativeness is safeguarded.

Table 12: KPT representativeness issues and conversion

#	Issue	Conversion
1	Questionnaire design	The questionnaire includes a question on if this is a normal day without extra eaters. If there are extra eaters, an appointment would be made with the household for a day with normal cooking conditions. To maintain conservativeness, weekends have also been regarded as non-normal days and have been excluded in the assessment.
2	Seasonality	The KPT was implemented in December 2019 and January 2020, which is during the dry season.[23] As during the dry season less wood is needed for cooking purposes as the wood fuel, the primary fuel for cooking purposes of most households, contains less moisture. Seasonality does not impact usage rate of other fuels such as LPG and kerosene. Measurements conducted during the dry season can therefore be assumed to be conservative.
3	Applicability	The KPT is basically a test designed for improved cook stoves. As these stoves typically only reduce 20% of fuel a longer test period is necessary. Biogas project on the other hand replace typically 90 to 100% of the baseline fuel and it is therefore much easier to measure savings in a shorter period.
4	Representativeness	The KPT was implemented in a way to ensure that the households selected in the baseline KPT are representative of the households participating in the VPA. The surveyors ensured that the baseline KPT respondents have similar socio-economic conditions in terms of a similar household size, housing type, number and type of animals. Also, the sample was spread out geographically across a number of provinces to support representativeness.
5	Biodigester size distribution	Random sampling can result in a different size distribution than in the project database. Therefore, the sampling is done a couple of times to ensure a good match with the size distribution of the project database. However, since the KPT results apply to both VPA-1 and VPA-2, an ideal match across all biodigester sizes in both VPAs could not be achieved. For this reason, in the smallest size category the number of samples is lower than the share in the database.

Size (m^3)	n[24]	% in Sample	% in Project database
4	36	44%	74%
6	24	30%	15%
8	14	17%	5%

[23] WWF. Climate Change in Indonesia - Implications for Humans and Nature

[24] Based on the 81 PFT KPT samples. See 20200214 KPT December 2019.xls | sheet Biogas HH 2019 | cells P88 – P92

		10	5	6%	2%
		12	2	2%	3%

Article VIII. KPT implementation

KPT Implementation

KPT survey was performed with the same team who carried out the BUS. The surveying team is composed of 17 surveyors and 3 field supervisors.

Questionnaire development and training

The survey supervisor and the lead consultant developed a questionnaire based on the Berkeley Air Kitchen Performance test questionnaire. This document is also referenced in the applied TPDDTEC methodology. The KPT survey used a similar questionnaire structure as past years and therefore did not require any additional piloting test.

All selected surveyors received a 1-day office training by IDBP and 1-day field training by JRI supervisor. Office training was conducted 2 days prior the field survey; meanwhile field training was conducted a day prior to the field survey. The lead trainers were Mr. Agung Lenggono from IDBP and Rita Maria from JRI (survey coordinator).

Data Collection Tools

As discussed above, the questionnaire was based on Berkeley Air KPT questionnaire.[25] Calibration was done with the comparison of traditional weighing scale on 29/07/2019. The scales were also compared to each other and all weighing scales were found accurate. The calibration procedure was as follows:

1. Calibrated and certified weight stones were manufactured by Wei Hang, Portable Electronic Scale company;
2. The newton scales were checked with the weight stones to ensure that the scales were reliable before the start of the survey;
3. The scales were also compared to each other and all weighing scales were found accurate.
4. The survey team was instructed to check each morning if the scale was still providing reliable and unbiased weights using the calibrated weight.

KPT execution

The KPT was executed in the period from the 7 December 2019 to 2 January 2020. A day prior to the KPT, target respondents were visited to answer a set of screening questions[26], and asking their willingness to participate to the survey. In total, 81 households participated in the PFT testing. Another 27 samples of non-biogas households residing close to the biogas household participants were also chosen for becoming comparison sample used for the baseline KPT. Care was taken that these households were similar in nature (household size, number of cattle, similar socio-economic conditions) as their neighbours with the biodigester. Note that a smaller number of households for the BFT applied as the BFT results are only applicable to VPA-2, while the PFT to both VPA-1 and VPA-2.

The KPT was executed across 9 provinces: Bali, West Java, Central Java, Lampung, West Nusa Tenggara, East Nusa Tenggara, South Sulawesi and Yogyakarta. All surveyed data were checked and processed by JRI Research, and then reported to head office in Jakarta (NBPSO).

[25] Household Energy and Health Programme: Kitchen Performance Test. Available on:

https://cleancookstoves.org/binary-data/DOCUMENT/file/000/000/83-1.pdf

[26] Determining their eligibility to take part in the KPT. For instance no changes in the number of family members at the selected households, or no event or any other festive ceremonies scheduled during the test period.

KPT data tabulation

To translate the collected primary data into results that feed into the monitoring data as per the PDD requirements, the following steps were followed. First, the primary data was screened for consistency and reliability by the surveyor supervisor. Oversampling was conducted to minimise the necessity to redo the KPT in cases of wrongly filled out questionnaires or unreliable results. Outliers were excluded using the Grubb's test. A significance of 0.01, two-sided has been applied.[27] All data has been deemed consistent and passes the Grubb's test assessment.

Table 13 describes the approach applied in converting the obtained results to monitoring parameters as per PDD requirements.

Table 13: Converting KPT results into monitoring parameters

Parameter	Description	Approach
$BB_{b,bio}$	Amount of woody biomass used in the baseline scenario b	The amount of biomass consumed in the baseline and project scenarios was weighted and average usage for one day was established. This amount was multiplied by 365 to generate the tonnes/year.
$BB_{p,bio}$	Quantity of biomass consumed in project scenario p during year y	
$BB_{b,fuel}$	Amount of fossil fuels used in the baseline scenario b	The amount of LPG and kerosene consumed in the baseline and project scenarios was measured in time and average usage for one day was established. This amount was multiplied by 365 to generate the tonnes/year.
$BB_{p,fuel}$	Quantity of fossil fuel consumed in project scenario p	

During the KPT, LPG and kerosene was measured by calibrated weights.

SECTION D. DATA AND PARAMETERS

D.1. Data and parameters fixed ex ante or at renewal of crediting period

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Data/parameter:	$f_{NRB,y}$
Unit	%
Description	Fraction of biomass used in the absence of the project activity in year y that can be established as non-renewable biomass using nationally approved methods
Source of data	Reports, surveys, and government data
Value(s) applied)	64.8

[27] For more on the Grubbs' test, please refer to http://www.itl.nist.gov/div898/handbook/eda/section3/eda35h1.htm

For a cross-check of the significance of the results, please refer to an online tool available on: http://www.graphpad.com/quickcalcs/Grubbs1.cfm

Choice of data or measurement methods and procedures	Calculated as per guidance of the applied methodology: $f_{NRB,y} = \frac{NRB}{NRB+DRB}$
Purpose of data	For the calculation of the fraction of non-renewable biomass
Additional comments	Since the MR of VPA2 still covers the first crediting period of VPA-2, the PP refers to the fNRB of 64.8% as per the approved PDD.

Data / Parameter	**NRB**
Unit	m^3
Description	Non-renewable woody biomass
Source of data	FAO (2010) Global Forest Resources Assessment 2010 Country Report Indonesia; calculation
Value(s) applied	55,984,649
Choice of data or Measurement methods and procedures	NRB can be calculated by subtracting the DRB of 30,411,351 m3 from By of 86,396,000 m3. By is the amount of firewood removed from forests which amounts to 86,396,000 m3 (FAO, 2010).
Purpose of data	For the calculation of the fraction of non-renewable biomass
Additional comment	-

Data / Parameter	**DRB**
Unit	m^3
Description	Demonstrably renewable woody biomass
Source of data	FAO (2010) Global Forest Resources Assessment 2010 Country Report Indonesia; calculation
Value(s) applied	30,411,351
Choice of data or Measurement methods and procedures	The annual sustainable yield from the plantations is determined to be 35,490,000 m^3, in line with 35,378,000 m^3 estimated by ITTO (2009). The more conservative number 35,490,000 m^3 is multiplied by the fraction of wood fuel removals from total wood removals (85.57%) reported by FAO, yielding yields the demonstrably renewable biomass (DRB) of 30,411,351 m3.
Purpose of data	For the calculation of the fraction of non-renewable biomass
Additional comment	-

Data / Parameter	**$EF_{b1, bio}$**
Unit	tCO_2/TJ
Description	Emission factor of the woody biomass used in the baseline scenario
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	112
Choice of data or Measurement methods and procedures	As per requirement of the methodology and Table 2.3, Chapter 2, Volume 2 of the 2006 IPCC Guidelines. The IPCC is a standard, credible source of emissions factors.
Purpose of data	For the calculation of emission reductions derived from fuel usage

Additional comment	IPCC (2006); May be updated according to any future changes by the IPCC. CO_2 and non-CO_2 emissions factors for charcoal may be estimated from project specific monitoring or alternatively by researching a conservative wood to charcoal production ratio (from IPCC, credible published literature, project-relevant measurement reports, or project-specific monitoring) and multiplying this value by the pertinent EF for wood

Data/parameter:	**$EF_{p1, bio}$**
Unit	tCO2/TJ
Description	Emission factor of the woody biomass used in the project scenario
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied)	112
Choice of data or measurement methods and procedures	As per requirement of the methodology and Table 2.3, Chapter 2, Volume 2 of the 2006 IPCC Guidelines. The IPCC is a standard, credible source of emissions factors.
Purpose of data	For the calculation of emission reductions derived from fuel usage
Additional comments	IPCC (2006); May be updated according to any future changes by the IPCC.

Data/parameter:	NCV_{bio}
Unit	TJ/tonne
Description	Net calorific value of the non-renewable biomass used in the baseline scenario
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied)	0.015
Choice of data or measurement methods and procedures	As per requirement of the methodology and Table 2.3, Chapter 2, Volume 2 of the 2006 IPCC Guidelines. The IPCC is a standard, credible source of emissions factors.
Purpose of data	For the calculation of emission reductions derived from fuel usage
Additional comments	IPCC (2006); May be updated according to any future changes by the IPCC

Data/parameter:	**$EF_{b1, fuel}$**
Unit	tCO2/TJ
Description	Emission factor of fossil fuels used in the baseline scenario
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied)	Kerosene = 71.9 LPG = 63.1
Choice of data or measurement methods and procedures	As per requirement of the methodology and Table 2.3, Chapter 2, Volume 2 of the 2006 IPCC Guidelines. The IPCC is a standard, credible source of emissions factors.
Purpose of data	For the calculation of emission reductions derived from fuel usage
Additional comments	IPCC (2006); May be updated according to any future changes by the IPCC

Data/parameter:	$EF_{p1, fuel}$
Unit	tCO2/TJ
Description	Emission factor of fossil fuels used in the project scenario
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied)	Kerosene = 71.9 LPG = 63.1
Choice of data or measurement methods and procedures	As per requirement of the methodology and Table 2.3, Chapter 2, Volume 2 of the 2006 IPCC Guidelines. The IPCC is a standard, credible source of emissions factors.
Purpose of data	For the calculation of emission reductions derived from fuel usage
Additional comments	IPCC (2006); May be updated according to any future changes by the IPCC

Data/parameter:	NCV_{fuel}
Unit	TJ/tonne
Description	Net calorific value of fossil fuels used in the baseline scenario
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied)	Kerosene = 0.0438 LPG = 0.0473
Choice of data or measurement methods and procedures	As per requirement of the methodology and Table 2.3, Chapter 2, Volume 2 of the 2006 IPCC Guidelines. The IPCC is a standard, credible source of emissions factors.
Purpose of data	For the calculation of emission reductions derived from fuel usage
Additional comments	IPCC (2006); May be updated according to any future changes by the IPCC

Data/parameter:	$\eta_{biogas\ stove}$
Unit	%
Description	Combustion efficiency of the biogas stove introduced by the VPA
Source of data	LIPI Stove Report, 2010; Indonesian Government standard on stove efficiency
Value(s) applied)	50
Choice of data or measurement methods and procedures	A comprehensive combustion efficiency test of the biogas stove introduced by the VPA was conducted in 2010 by LIPI, a governmental testing institute. The resulting efficiency of the biogas stoves was 52%. The Indonesian Government standard on stove efficiency indicates an efficiency of 50% is prevalent. The latter has been used to be conservative.
Purpose of data	For the calculation of emission reductions derived from fuel usage
Additional comments	-

Data/parameter:	$EF_{awms,T}$
Unit	kg CH_4
Description	Emission factor for the defined livestock population category T by average temperature (27.1°C)

Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories; Indonesian Meteorological Climatological and Geophysical Agency
Value(s) applied)	Dairy cows = 31 Other cattle = 1 Buffalo = 2 Market swine = 7 Goats = 0.22 Sheep = 0.20 Poultry = 0.02
Choice of data or measurement methods and procedures	As per requirement of the methodology and sourced from Tables 10.A-4 through A-9., Chapter 10, Volume 4 of the 2006 IPCC Guidelines The IPCC is a standard, credible source of emissions factors.
Purpose of data	For the calculation of emission reductions derived from fuel usage
Additional comments	IPCC (2006); May be updated according to any future changes by the IPCC.

D.2. Data and parameters monitored[28]

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Data/parameter:	**$U_{p1,y}$**
Unit	Fraction
Description	Cumulative usage rate for technologies in project scenario p1 in year y, based on cumulative adoption rate and drop off rate (fraction)
Measured/calculated/default	Measured
Source of data	Collected through the annual Biogas User Survey; Biogas User Survey 2021 results have been used for the purpose of the ex-ante calculation – 20210712 BUS 2021 Tabulation JRI v3.xlsx | Sheet Drop-off | Cell I28 and E22 – E25
Value(s) of monitored parameter	0.8649 With the following usage rate for each age group:

Age group	Usage rate
Age group 4	0.7632
Age group 3	0.9231
Age group 2	0.8947
Age group 1	0.9487

[28] Note that all parameters collected from the BUS 2021 and the KPT 2019 are derived from a sample. All parameters derived from the IDBP Database are not based on a sample.

Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	
QA/QC procedures:	The usage rate of thermal applications is monitored annually using survey methods to satisfy a 90/10 precision/confidence, following the 'Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities' (EB 69, Annex 4).
Purpose of data:	To account for the impact of dropped off units in the emission reduction calculation
Additional comments:	A single usage parameter is weighted to be representative of the quantity of project technologies of each age being credited in a given project scenario.

Data/parameter:	**$N_{p1,y}$**
Unit	Number
Description	Cumulative project operational rate included in the project database for project scenario p1 against baseline scenario b1 in year y
Measured/calculated/default	Measured
Source of data	IDBP database. See 2021115 ER Calculation VPA2 MP4 CP1_v06.xls sheet GS VER 2020, cell E86
Value(s) of monitored parameter	Reported as a result of (Nop1,y * (Op1,y / 366)), which equals (4,636 * 361.58/366) = 4,043
Monitoring equipment	NA
Measuring/reading/recording frequency:	Continuous
Calculation method (if applicable):	
QA/QC procedures:	The supplier shall provide hard copies of the 'Household Agreement and the Completion Report to the CME, who will be responsible for entering data for the number of units installed each month into the centralised record-keeping database. It will be the CME's responsibility to ensure that data is entered correctly and to follow-up with the supplier if there are errors or missing data. The database will not allow double-entries of the serial numbers. All original hard copies are filed and stored.
Purpose of data:	To account for non-operational units in the emission reduction calculation
Additional comments:	

Data/parameter:	**$No_{p1,y}$**
Unit	Number
Description	Cumulative number of project technologies included in the project database for project scenario p in year y
Measured/calculated/default	Measured
Source of data	20211115_IDBP_Database_VPA2_v4.xlsx
Value(s) of monitored parameter	4,636
Monitoring equipment	NA
Measuring/reading/recording frequency:	Continuous

Calculation method (if applicable):	
QA/QC procedures:	The supplier shall provide hard copies of the 'Household Agreement and the Completion Report to the CME, who will be responsible for entering data for the number of units installed each month into the centralised record-keeping database. This will enable the calculation of the cumulative number of units in the VPA.
Purpose of data:	To account for the cumulative number of units in the emission reduction calculation
Additional comments:	The actual cumulative number of biodigester operational days will be confirmed upon verification.

Data/parameter:	**$O_{p1,y}$**
Unit	Number
Description	The average technology-days during which the biodigesters are operational for project scenario p1 against baseline scenario b1 in year y
Measured/calculated/default	Measured
Source of data	See spreadsheet "2021115 ER Calculation VPA2 MP4 CP1_v06.xls" | sheet "GS VER 2020" | cell E85
Value(s) of monitored parameter	361.58
Monitoring equipment	NA
Measuring/reading/recording frequency:	Continuous
Calculation method (if applicable):	The actual cumulative number of biodigester non-operational days will be confirmed upon verification. The equation to calculate this is ($O_{p,y}$ = 366 – non-operational days). Non-operational days are based on the number of observations of technical drop-offs, which need to be repaired within a 15 day period. For number of incidences reported during this MP, see: "20211115_IDBP_Database_VPA2_v4.xls" | sheet "PLANTMAINT" | cell J41093
QA/QC procedures:	As per procedures of the IDBP database
Purpose of data:	Emission reduction calculation
Additional comments:	-

Data/parameter:	**$LE_{p1,y}$**
Unit	tCO_2e/year
Description	Leakage in project scenario p during year y
Measured/calculated/default	Measured
Source of data	Collected through the annual Biogas User Survey. "2021115 ER Calculation VPA2 MP4 CP1_v06.xls" | sheet GS VER2019 | cell E77
Value(s) of monitored parameter	0.019
Monitoring equipment	NA
Measuring/reading/recording frequency:	Every two years
Calculation method (if applicable):	

QA/QC procedures:	The leakage will be monitored once every two years using survey methods to satisfy the requirements put forth by the methodology 'Technologies and Practices to Displace Decentralized Thermal Energy Consumption' (11/04/2011).
Purpose of data:	To account for leakage
Additional comments:	-

Data/parameter:	**$N_{T,h}$**
Unit	Number
Description	Number of animals of livestock category T in premise h
Measured/calculated/default	Measured
Source of data	BUS 2021 – "20210712 BUS 2021 Tabulation JRI v3.xlsx" | sheet BUS 2021 | cell AI2743
Value(s) of monitored parameter	Dairy cow = 5.84
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	Analysis of animal ownership from the BUS 2021 shows that dairy cows are the dominant type of animal owned by almost all biodigesters users (93.5%). Given the marginal emission impact of the latter two categories and for conservativeness, only methane emissions from dairy cows will be considered in this emissions reduction calculation. Methane emissions from secondary and any following animal types are not included for conservativeness. This means that the total average number of animals kept amounted to 5.84 dairy cows per household.
QA/QC procedures:	Ex-post value to be derived from the Biogas User Survey
Purpose of data:	To calculate the baseline and project emissions associated with animal waste handling
Additional comments:	

Data/parameter:	**PL**
Unit	%
Description	Physical leakage of the biodigester
Measured/calculated/default	Default
Source of data	IPCC
Value(s) of monitored parameter	Estimated using a 10% default rate of total methane production
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	
QA/QC procedures:	
Purpose of data:	To calculate the physical leakage associated with the use of the technology
Additional comments:	As per Annex 6 of the applied methodology

Data/parameter:	$BB_{b1,bio}$
Unit	Tonnes/year
Description	Amount of woody biomass used in the baseline scenario 1: households
Measured/calculated/default	Measured
Source of data	KPT Survey, December 02019 – "20200214 KPT December 2019.xls" | sheet 90-30 test | cell F38
Value(s) of monitored parameter	1.178
Monitoring equipment	NA
Measuring/reading/recording frequency:	Updated every two years through the Baseline Performance Field Test
Calculation method (if applicable):	
QA/QC procedures:	Ex-post value to be determined through the Baseline Performance Field Test
Purpose of data:	To calculate the baseline emissions associated with fuel use
Additional comments:	

Data/parameter:	$BB_{b1,fuel}$
Unit	Tonnes/year
Description	Amount of fossil fuels used in the baseline scenario 1: households
Measured/calculated/default	Measured
Source of data	KPT Survey, December 2019- "20200214 KPT December 2019.xls" | sheet 90-30 test | cell L38, I38
Value(s) of monitored parameter	LPG = 0.074 Kerosene = 0.028
Monitoring equipment	NA
Measuring/reading/recording frequency:	Updated every two years through the Baseline Performance Field Test
Calculation method (if applicable):	
QA/QC procedures:	The following conversion factor for kerosene is applied: 1 liter = 0.82 kg[29] Ex-post value to be determined through the Baseline Performance Field Test.
Purpose of data:	To calculate the baseline emissions associated with fuel use
Additional comments:	

[29] Lawrence Berkeley National Laboratory (2003) 'Technical and Economic Performance Analysis of Kerosene Lamps and Alternative Approaches to Illumination in Developing Countries'

Data/parameter:	$BB_{p1,fuel}$
Unit	Tonnes
Description	Quantity of fossil fuel consumed in project scenario 1 during year y, in tonnes
Measured/calculated/default	Measured
Source of data	KPT Survey, December 2019 – "20200214 KPT December 2019.xls" | sheet 90-30 test | cell AC91, Z91
Value(s) of monitored parameter	LPG: 0.087 Kerosene: 0.000
Monitoring equipment	Weight scale
Measuring/reading/recording frequency:	Updated every two years through the Project Performance Field Test
Calculation method (if applicable):	Project KPT was executed in December 2019 targeting 81 households. A weight scale manufactured by Wei Hang, Portable Electronic Scale company, was applied.
QA/QC procedures:	Shall be in line with Section 7 of the applied methodology.
Purpose of data:	To calculate the project emissions associated with fuel use
Additional comments:	

Data/parameter:	$BB_{p1,bio}$
Unit	Tonnes
Description	Quantity of biomass consumed in project scenario p during year y, in tonnes
Measured/calculated/default	Measured
Source of data	KPT Survey, December 2019 – "20200214 KPT December 2019.xls" | sheet 90-30 test | cell W91
Value(s) of monitored parameter	0.621
Monitoring equipment	Weight scale
Measuring/reading/recording frequency:	Updated every two years through the Project Performance Field Test
Calculation method (if applicable):	Project KPT was executed in December 2019 targeting 81 households. A weight scale manufactured by Wei Hang, Portable Electronic Scale company, was applied.
QA/QC procedures:	Shall be in line with Section 7 of the applied methodology.
Purpose of data:	To calculate the project emissions associated with fuel use
Additional comments:	

Data/parameter:	$MS_{P,S,K}$
Unit	%
Description	Fraction of livestock category T's manure not treated in bio-digester, in climate region k
Measured/calculated/default	Measured
Source of data	BUS 2021 – "20210712 BUS 2021 Tabulation JRI v3.xlsx" | sheet BUS 2021 | Cell T2291
Value(s) of monitored parameter	27.7

Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	Survey
QA/QC procedures:	-
Purpose of data:	To calculate the project emissions associated with bio-slurry
Additional comments:	-

Data/parameter:	**$MS_{T,S,k}$**
Unit	%
Description	Fraction of livestock category T's manure fed into the bio-digester, S in climate region k
Measured/calculated/default	Measured
Source of data	BUS 2021 – "20210712 BUS 2021 Tabulation JRI v3.xlsx" | sheet BUS 2021 | cell T2290
Value(s) of monitored parameter	72.3
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	Survey
QA/QC procedures:	
Purpose of data:	To calculate the project emissions associated with bio-slurry
Additional comments:	Applicable to VPAs applying Tier 2 only

Data/parameter:	**GWP_{CH4}**
Unit	-
Description	Global Warming Potential of methane
Measured/calculated/default	Default
Source of data	IPCC (2006); May be updated according to any future changes by the IPCC
Value(s) of monitored parameter	25
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	IPCC default
QA/QC procedures:	
Purpose of data:	To calculate the baseline and project emissions associated with animal waste handling
Additional comments:	May be updated according to any future changes by the IPCC

Data/parameter:	**Bio**
Unit	%

Description	Use of bio-slurry
Measured/calculated/default	Measured
Source of data	BUS 2021 – "20210712 BUS 2021 Tabulation JRI v3.xlsx" | sheet BUS 2021 | cell Y2977
Value(s) of monitored parameter	42
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	To be updated through the annual Biogas User Survey
QA/QC procedures:	The application of bio-slurry shall be monitored according the applied methodology, and in line with the approach used in project GS 1083. If there is any anaerobic use/storage of bio-slurry under anaerobic conditions reported from the monitoring survey, project emissions shall be accounted for accordingly.
Purpose of data:	To be used for the calculation of project emissions associated with bio-slurry usage – the CH_4 emissions from the anaerobic decay of the residual organic content of digestate subjected to anaerobic storage.
Additional comments:	

The report will also consider the following SDG impact parameters:[30]

Data/parameter:	**GS-03 Soil condition**
Unit	Number
Description	Soil condition refers to changes compared to the baseline in organic matter content.
Measured/calculated/default	Measured
Source of data	Collected through the annual Biogas User Survey. "20210712 BUS 2021 Tabulation JRI v3.xlsx" | sheet BUS 2021 | cell Y2990
Value(s) of monitored parameter	42%, equivalent to 1,946 households (42% * 4,636 biodigesters)
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	Number of users applying the final biodigester slurry on agricultural land. Data is to be collected annually.
QA/QC procedures:	This will be monitored through sampling to satisfy the requirements put forth by the methodology 'Technologies and Practices to Displace Decentralized Thermal Energy Consumption' (11/04/2011).
Purpose of data:	SDG impact monitoring
Additional comments:	-

[30] Refer to accompanying GS Transition Annex for further details

Data/parameter:	GS-06 Quality of employment
Unit	Number
Description	Quality of employment refers to changes compared to the baseline in the qualitative value of employment, such as whether the jobs resulting from the project activity are highly or poorly qualified, temporary or permanent. The proportion of employees attending vocational training programs as well as Health and Safety courses, as proven through issuance of a certificate to all constructors, will be monitored.
Measured/calculated/default	Measured
Source of data	IDBP Database. "20211115_IDBP_Database_VPA2_v4.xls" | sheet "SPV" | cell L221
Value(s) of monitored parameter	63 vocational trainings conducted during VPA implementation 5 vocational trainings conducted during this monitoring period (i.e., MP4, between 01/01/2021 and 31/12/2021)
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	All vocational training and Health and Safety training attendees will be issued with a certificate proving their attendance, and a record of their names, contact details and gender, will be kept as part of the CME's consolidated monitoring database. Data is to be collected annually.
QA/QC procedures:	This will be monitored through sampling to satisfy the requirements put forth by the methodology 'Technologies and Practices to Displace Decentralized Thermal Energy Consumption' (11/04/2011). Hard copies of all certificates issued will be kept by the CME.
Purpose of data:	SDG impact monitoring
Additional comments:	

Data/parameter:	GS-07 Livelihood of the poor
Unit	%
Description	Livelihood of the poor refers to changes compared to the baseline in living conditions, access to healthcare services including affordability and poverty alleviation.
Measured/calculated/default	Measured
Source of data	Collected through the annual Biogas User Survey. "20210712 BUS 2021 Tabulation JRI v3.xlsx" | sheet BUS 2021 | cell V3718 – V3720
Value(s) of monitored parameter	'Worsened': 113 (equivalent to 2.4% of total units in operation) 'The same': 1,318 (equivalent to 28.4% of total units in operation) 'Improved': 3,205 (equivalent to 69.1% of total units in operation)
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	Carried out as part of the annual Biogas User Survey conducted by the IDBP. As part of this survey the following question will be included: "Do you feel that your living conditions have a) improved, b) stayed the same, c) worsened; since the installation of the biogas digester?"

QA/QC procedures:	This will be monitored through sampling to satisfy the requirements put forth by the methodology 'Technologies and Practices to Displace Decentralized Thermal Energy Consumption' (11/04/2011).
Purpose of data:	SDG impact monitoring
Additional comments:	-

Data/parameter:	**GS-o8 Access to affordable and clean energy services**
Unit	Number
Description	Access to energy services refer to changes in unsustainable energy use. This will be monitored through the number of biogas units commissioned.
Measured/calculated/default	
Source of data	Collected through the IDBP Database. "20211115_IDBP_Database_VPA2_v4.xls" |sheet "Master VPA-2" |cell R4735
Value(s) of monitored parameter	4,636
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	As in the assessment of parameter 'N' above, the unique serial number of each installation will be recorded upon commissioning and entered into the electronic database, with clear divisions between VPAs. This will allow a count of the number of systems commissioned.
QA/QC procedures:	This will be monitored through sampling to satisfy the requirements put forth by the methodology 'Technologies and Practices to Displace Decentralized Thermal Energy Consumption' (11/04/2011).
Purpose of data:	SDG impact monitoring
Additional comments:	

Data/parameter:	**GS-o9 Human and institutional capacity**
Unit	Number
Description	Changes compared to the baseline in education and skills, gender equality and empowerment. Women spend much of their time collecting firewood and cooking, and have little spare time to undertake activities that stimulate personal and entrepreneurial development. The number of women attending the Operation and Maintenance training as well as the bio-slurry utilization training will be monitored.
Measured/calculated/default	Measured
Source of data	IDBP Database; "20211115_IDBP_Database_VPA2_v4.xls" |sheet "O&M training"| cell I4411
Value(s) of monitored parameter	1,082 Women attending Operation and Maintenance training in the period 2017-2020 126 Women attending Operation and Maintenance training in this monitoring period (i.e., MP4, between 01/01/2020 and 31/12/2020)
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual

Calculation method (if applicable):	As per the VPA-DD, the number of women attending the Operation and Maintenance training as well as the bio-slurry utilization training are monitored to indicate changes in gender equality. This data concerns cumulative results over the VPAs lifetime
QA/QC procedures:	This will be monitored through sampling to satisfy the requirements put forth by the methodology 'Technologies and Practices to Displace Decentralized Thermal Energy Consumption' (11/04/2011).
Purpose of data:	SDG impact monitoring
Additional comments:	-

Data/parameter:	**GS-10 Quantitative employment and income generation**
Unit	Number
Description	The number of jobs generated by within the IDBP as well as the number of constructors employed will be monitored. To evidence income generation, the number of users selling biodigester slurry on the market will be monitored.
Measured/calculated/default	Annual
Source of data	Employment records and through the IDBP Database; Biogas User Survey. "20211115_IDBP_Database_VPA2_v4.xls"| sheet "SPV"| cell "L223" "20211115_IDBP_Database_VPA2_v4.xls"| sheet "SPV"| cell "L225" "20210712 BUS 2021 Tabulation JRI v3.xlsx"| sheet "BUS 2021"| cell S3007
Value(s) of monitored parameter	144 number of direct jobs created by the VPA 40 number of constructors employed under the VPA 32.19 households sell the bio-slurry on the market (0.7% of total) As per the VPA-DD, the number of jobs generated by the VPA as well as the number of constructors employed is monitored. To evidence income generation, the number of users selling biodigester slurry on the market is also monitored.
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	Through the Biogas User Survey, the number of users selling biodigester slurry on the market will be monitored.
QA/QC procedures:	This will be monitored through sampling to satisfy the requirements put forth by the methodology 'Technologies and Practices to Displace Decentralized Thermal Energy Consumption' (11/04/2011).
Purpose of data:	SDG impact monitoring
Additional comments:	-

Data/parameter:	**GS-12 Technology transfer and technological self-reliance**
Unit	Number
Description	Refers to changes compared to the baseline in activities that build usable and sustainable know-how in a region/country for a technology, where know-how was previously lacking. The number of constructors trained and users attending the operation and maintenance training will be monitored. Also, the entities outside of the programme in general and technical training about the functioning of the biodigester technology to promote knowledge dissemination and strengthen the domestic biogas market will be monitored.
Measured/calculated/default	NA

Source of data	Training records and through the IDBP Database; Biogas User Survey. " 20211115_IDBP_Database_VPA2_v4.xls" | sheet "O&M training" | cell I4413
Value(s) of monitored parameter	4,408 users trained in the period 2017-2020 325 users trained during this monitoring period (i.e., MP4, from 01/01/2020 to 31/21/2020)
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	Records will be kept of all staff and their attendance at the vocational training programmes. All attendees will be issued with a certificate proving attendance and skills gained. Monitoring of this parameter will be combined with the monitoring of GS- 10. A record of all training held, and attendees, will be kept in the programme database.
QA/QC procedures:	This will be monitored through sampling to satisfy the requirements put forth by the methodology 'Technologies and Practices to Displace Decentralized Thermal Energy Consumption' (11/04/2011).
Purpose of data:	SDG impact monitoring
Additional comments:	-

Data / Parameter	**GS-13 Establishment of sustainable food production area**
Unit	Hectare
Description	Area with application of bio-slurry or compost.
Source of data	See: "20210525 GS-13 calculation v2.xls" | sheet 'Analysis' | cell C29
Value(s) applied	15.45
Measurement methods and procedures	Area of agricultural land with application of final biodigester slurry. Data is to be collected annually.
Monitoring frequency	Annually.
QA/QC procedures	This will be monitored through sampling to satisfy the requirements put forth by the methodology Technologies and Practices to Displace Decentralized Thermal Energy Consumption (11/04/2011).
Purpose of data	SDG impact monitoring.
Additional comment	

Data / Parameter	**GS-14 Time saved**
Unit	%
Description	The share of women indicating to save time by not having to collect biomass for cooking purposes after the installation of the biodigester.
Source of data	Collected through the annual Biogas User Survey. See: 20210712 BUS 2021 Tabulation JRI v3.xlsx | sheet 'BUS 2021' | cells R3913 and R3914
Value(s) applied	60.5 (equivalent to 2,803 women)
Measurement methods and procedures	The BUS will ask respondents whether after the installation of a biodigester they have (1) more time; (2) same amount of time; or (3) less time than before.
Monitoring frequency	Annually
QA/QC procedures	This will be monitored through sampling to satisfy the requirements put forth by the methodology Technologies and Practices to Displace Decentralized Thermal Energy Consumption (11/04/2011).
Purpose of data	SDG impact monitoring.
Additional comment	

Data / Parameter	**GS-15 Productive use of time**
Unit	%

Description	Share of women indicating to use the additional saved time that has been freed up by not having to collect biomass for cooking purposes for income generating activities.
Source of data	Collected through the annual Biogas User Survey. 20210712 BUS 2021 Tabulation JRI v3.xlsx | sheet 'BUS 2021' | cells R3939 and R3943
Value(s) applied	26.6 (equivalent to 1,234 women)
Measurement methods and procedures	The BUS will ask respondents how they use the saved time, with income generation activities as one of the possible responses.
Monitoring frequency	Annually.
QA/QC procedures	This will be monitored through sampling to satisfy the requirements put forth by the methodology Technologies and Practices to Displace Decentralized Thermal Energy Consumption (11/04/2011).
Purpose of data	SDG impact monitoring.
Additional comment	

D.3. Comparison of monitored parameters with last monitoring period

Data/Parameter	Value obtained in this monitoring period	Value obtained last monitoring period
SDG 13 Climate action	10,975 tCO_2e	7,248 tCO_2e
GS-03 Soil condition	1,946 households	2,738 households
GS-06 Quality of employment	63 people attending vocational training during VPA implementation 5 vocational trainings conducted during this monitoring period (i.e., MP4, between 01/01/2021 and 31/12/2021)	58 people attending vocational training
GS-07 Livelihood of the poor	'Worsened': 113 (equivalent to 2.4% of total units in operation) 'The same': 1,318 (equivalent to 28.4% of total units in operation) 'Improved': 3,205 (equivalent to 69.1% of total units in operation)	'Worsened': 145 (equivalent to 3.4% of total units in operation) 'The same': 1,362 (equivalent to 31.9% of total units in operation) 'Improved': 2,757 (equivalent to 64.7% of total units in operation)
GS-08 Access to affordable and clean energy services	4,636 units in operation	4,264 units in operation
GS-09 Human and institutional capacity	Women attending Operation and Maintenance training in the period 2017-2020 126 Women attending Operation and Maintenance training in this monitoring period (i.e., MP4, between 01/01/2020 and 31/12/2020).	951 women attend the Operation and Maintenance training.
GS-10 Quantitative employment and income generation	144 number of direct jobs created by the VPA 40 number of constructors employed under the VPA 32.19 households sell the bio-slurry on the market (0.7% of total)	124 number of direct jobs created by the VPA 66 number of constructors employed under the VPA 42.64 households sell the bio-slurry on the market (1% of total)

GS-12 Technology transfer and technological self-reliance	4,408 users attending training between 2017-2020. 325 users trained during this monitoring period (i.e., MP4, from 01/01/2020 to 31/21/2020)	4,074 users attending training
GS-13 Establishment of sustainable food production area	15.45 hectares	33.04 hectares
GS-14 Time saved	60.5% (equivalent to 2,803 women)	46% (equivalent to 1,980 women)
GS-15 Productive use of time	26.6% (equivalent to 1,234 women)	37% (equivalent to 1,563 women)

D.4. Implementation of sampling plan

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Sampling Design

Objectives and reliability requirements

The objective of the sampling effort is to meet the monitoring requirements set forth in the methodology 'Technologies and Practices to Displace Decentralized Thermal Energy Consumption' (11/04/2011). In accordance with the requirements set forth in the methodology, the sample size will be selected following at least a 90% confidence interval and a 10% margin of error (90/10), where applicable.

Multi-stage sampling[31] will be applied, where clusters consisted of geographical areas and subunits. It is considered more cost-effective to treat several respondents within a local area as a cluster. In order to account that not all the geographical clusters are the same size, sampling will be employed proportionate to cluster size. Clusters will be selected with a probability proportionate to the size of the target population within each cluster such that larger clusters have a greater probability of selection, and smaller clusters a lower probability. This helps to ensure that sampling remains representative of the entire population. Sampling shall be done per user group (i.e. households, SMEs, communities) and shall differentiate between small-scale digesters (defined as capacity up to $12m^3$) and medium-scale digesters (defined as capacities larger than $12m^3$).

As the PoA progresses and the number of VPAs increases, this VPA may also fall under a single monitoring plan that can be applied as outlined in Section of E.7.2 of the PoA-DD, covering several VPAs, adopting a confidence/precision level of 95/10 according paragraph 20 of the "Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities" (EB 69, Annex 4). This option can be applied to a group of similar VPAs.

Target population and sampling frame

The monitoring survey is only conducted with end users representative of the project scenario using the biodigester at the time of the survey. There are three distinct target populations for the application of monitoring procedure (households, local communities, and SMEs with installed biodigesters), as identified through the centralised record-keeping database managed by the CME.

Sampling method and sample size

[31] As defined by the General Guidelines for Sampling and Surveys for Small-Scale CDM project activities, EB 50 Annex 30

The CME is responsible for the production of periodical monitoring reports for the VPA-2, following the criteria outlined in below. The minimum total sample size is 100, with at least 30 samples for project technologies of each age being credited[32]. Sampling shall be performed separately per target population (households, communities, SMEs). A usage parameter must be established to account for the drop off rates as project technologies age and are replaced. This parameter shall be representative of the quantity of project technologies of each age being credited in the project scenario.

Implementation
All sampling efforts will be conducted by qualified personnel who have undergone training as part of the VPA. This training will cover information on the project background and basic functioning of the biogas systems, as well as the data collection process, including the format in which data should be collected. The personnel will be issued with a certificate confirming their attendance at relevant trainings and their qualification to complete the monitoring. A paper copy of the certificate will also be kept by the CME. Surveyor staff will be required to speak the native language (Bahasa Indonesia) in which biogas systems have been implemented, allowing for full understanding of any responses given by users, and any questions therein.

Baseline scenario data collection
Baseline data for the VPA-2 has been established *ex-ante* for households through Baseline KPT implemented in December 2015. A day prior to the KPT, target respondents were visited to answer a set of screening questions[33], and asking their willingness to participate to the survey. In total, 51 samples of non-biogas households residing close to the biogas households participants were also chosen for becoming comparison sample used for the baseline KPT. Care was taken that these households were similar in nature (household size, number of cattle, similar socio-economic conditions) as their neighbours with the biodigester. The Baseline KPT was executed across 4 provinces: West Java, Central Java, East Java, and NTB (West Nusa Tenggara). All surveyed data were checked and processed by JRI Research, and then reported to head office in Jakarta (NBPSO).

Baseline emissions relating to use of biomass and fossil fuel are confirmed *ex-post* through the Baseline Performance Field test (BFT) of fuel consumption, as described in Section 7 of the methodology.

Project scenario data collection
Project emissions relating to continued use of biomass and fossil fuel are confirmed *ex-post* through the Project Performance Field tests (PFTs) of fuel consumption, as described in Section 7 of the methodology.

All personnel conducting the Project Performance Field tests and annual monitoring of the VPA-2, will receive training on the procedures to be used for data collection, including the format in which data should be collected, project background, basic functioning of the biogas systems, training given to users on the application of slurry to soil and record-keeping system for the quantity of manure fed into the system and any other relevant project background. Response rates will be maximised by contacting all randomly-

[32] Technologies and Practices to Displace Decentralized Thermal Energy Consumption (11/04/2011), p.24

[33] Determining their eligibility to take part in the KPT. For instance no changes in the number of family members at the selected households, or no event or any other festive ceremonies scheduled during the test period.

selected biogas system users beforehand to arrange a practical site visit date and sampling over the minimum required number to compensate for any non-responses. The programme database will have a provision for recording any monitoring carried out in reference to the serial number of the installed system. In cases where participants refuse to participate in the monitoring, the reason shall be documented in the CME's programme database. The CME will explain that monitoring is part of the requirements of the general programme and try to arrange an alternative date for a site visit, or carryout monitoring with another member of the households.

Quality control procedures include training of all surveyors to ensure streamlined data collection procedures, a system for filing all completed paper surveys by the VPA and serial number, and for ensuring that all monitored data is complete. The name, date and contact details of the surveyor will be detailed on all completed monitoring surveys, therefore allowing for the follow-up of all incomplete data.

Field measurement objectives and data to be collected
The parameters to be monitored within VPA-2, as outlined in the applied methodology, are as follows:

A Biogas User Survey shall be completed annually and covers the following data:
- Number of users applying the final biodigester slurry on agricultural fields– annually;
- Perceived improvement of living conditions – annually;
- Number of women attending trainings – annually;
- Percentage of biodigester in use in the given year (y) – annually.
- The number of operational days of the biodigesters in the given year (y) – annually.
- The fraction of manure that is not treated in the biodigester – annually.

A Monitoring Survey shall be completed periodically and covers the following data:
- Quantity of biomass and fossil fuel that is used for cooking in a given baseline scenario in a given year (y) – once every two years;
- Quantity of biomass and fossil fuel that is used for cooking in a given project scenario in a given year (y) – once every two years;
- Leakage in the given project scenario in the given year (y) – once every two years.

The application of bio-slurry shall be monitored according the applied methodology. If there is any anaerobic use/storage of bio-slurry under anaerobic conditions reported from the monitoring survey, project emissions shall be accounted for accordingly. The following approach shall be followed:
- Estimation of the total amount of VS entering the biodigester;
- Assessment of remaining VS content of digestate;
- Assessment of methane potential of bio-slurry;
- MCF of the digestate management systems;
- Calculation of project emissions using the information obtained in the previous steps.

SECTION E. CALCULATION OF SDG IMPACTS

E.1. Calculation of baseline value or estimation of baseline situation of each SDG Impact

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SDG indicator	GS indicator	Baseline situation
SDG13: Climate action The estimated annual emission reduction is based on methodology "Technologies and practices to displace decentralized thermal energy consumption". The cumulative ex-ante emission reductions are calculated with the following calculation: ER y = BE y - PE y – LE y Whereby: **BE y: $BE_{b1,CO2,y+CH4,y}$** PE y: $PE_{p1\ CO2,y+CH4,y}$ LE y: $LE_{p1\ CO2,y+CH4,y}$	Climate change	Baseline emissions from fuel consumption: $BE_{b1CO2,y} = (\sum_b BB_{b1,fuel} * NCV_{fuel} * EF_{b1,fuel}) + (BB_{b1,bio} * NCV_{bio} * EF_{b1,bio} * f_{NRB})$ Baseline emissions from the animal waste management system: $BE_{b1,CH4,y} = GWP_{CH4} * \sum_T (EF_{awms,T} * N_{T,h})$ Together amounting to: **25,491 tCO_2e** ** Please refer to cell G96 of "2021115 ER Calculation VPA2 MP4 CP1_v06.xls"*
SDG 7: Affordable and Clean Energy	GS-08 Access to affordable and clean energy services	No access to biodigester technology. Combustion of LPG, kerosene and biomass continues to lead to particulate matter and carbon monoxide pollution and deforestation.
	GS-12 Technology transfer and technological self-reliance	No training opportunities and transfer of technology in the biogas sector.
SDG 5: Gender Equality	GS-09 Human and institutional capacity	No development as women spend much of their time collecting biomass and cooking, and remain with little spare time to undertake activities that stimulate personal and entrepreneurial development.
	GS-14 Time saved	No time savings, as women spend a significant proportion of their time having to collect biomass for cooking purposes.
	GS-15 Productive use of time	No productive use of time as women lack spare time to pursue income generating activities.
SDG 2: No Hunger	GS-03 Soil condition	No slurry is used as fertilizer on agricultural land (in terms of number of farmers).
	GS-13 Establishment of sustainable food production area	No slurry is used as fertilizer on agricultural land (in terms of area).
SDG 1: No Poverty	GS-06 Quality of employment	No training and employment opportunities linked to biogas market.
	GS-07 Livelihood of the poor	Livelihood of the poor is unchanged.
	GS-10 Quantitative employment and income generation	No training and employment opportunities linked to biogas market.

E.2. Calculation of project value or estimation of project situation of each SDG Impact

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SDG indicator	GS indicator	Project situation
SDG13: Climate action The estimated annual emission reduction is based on methodology "Technologies and practices to displace decentralized thermal energy consumption". The cumulative ex-ante emission reductions are calculated with the following calculation: ER y = BE y - PE y – LE y Whereby: BE y: $BE_{b1,CO2,y + CH2,y}$ **PE y: $PE_{p1\ CO2,y + CH4,y}$** LE y: $LE_{p1\ CO2,y + CH4,y}$	Climate change	Project emissions from fuel consumption: $PE_{p1,CO2,y} = \sum(BB_{p1,fuel} * NCV_{fuel} * EF_{p1,fuel}) + (BB_{p1,bio} * NCV_{bio} * EF_{p1,bio} * f_{NRB})$ Project emissions from the animal waste management system: $\mathbf{PE_{p1,CH4,y}} = GWP_{CH4} * \sum (N_{T,h,y} * EF_{awms,T}) * PL_y + \sum (N_{T,h,y} * EF_{awms,T}) * (1 - \eta_{new\ stove}) (1 - PL_y) + PE_{awms,NT}$ Together amounting to: **14,438 tCO_2e** ** Please refer to cell G97 of "2021115 ER Calculation VPA2 MP4 CP1_v06.xls"*
SDG 7: Affordable and Clean Energy	GS-08 Access to affordable and clean energy services	**4,636** biodigester technologies installed, calculated by tracking in the IDBP database all eligible biodigesters installed until 31/12/2020.
	GS-12 Technology transfer and technological self-reliance	**4,408** users attending training, calculated by tracking in the IDBP database all user trainings until 31/12/2020. **325** users attending training in this monitoring period (i.e., MP4, between 01/01/2020 and 31/12/2020), calculated by tracking in the IDBP database all user trainings during 2020
SDG 5: Gender Equality	GS-09 Human and institutional capacity	**1,082** women attend the Operation and Maintenance training, calculated by tracking in the IDBP database all O&M trainings until 31/12/2020. **126** women attending training in this monitoring period (i.e., MP4, between 01/01/2020 and 31/12/2020), calculated by tracking in the IDBP database all O&M trainings during 2020
	GS-14 Time saved	**2,803** women reporting to have saved time, as calculated by the BUS survey responses with 60.5% of the 4,636

		biodigesters installed (0.605* (4,636 = 2,803) during MP4
	GS-15 Productive use of time	**1,234** women reporting to have more time for productive use, as calculated by the BUS survey responses with 26.6% of the 4,636 biodigesters installed (0.266* 4,636 = 1,234) during MP4
SDG 2: No Hunger	GS-03 Soil condition	**1,946** households use bio-slurry on land, as calculated by the BUS survey responses with 42% of the 4,636 biodigesters installed (0.42* 4,636 = 1,946) during MP4
	GS-13 Establishment of sustainable food production area	**15.45** hectares applying bio-slurry, per month, calculated by correcting the total units (4,636) by the drop-off rate (26.7%) and multiplying it by bio-slurry usage as fertilizer according to the BUS (67%) and finally applying conversions to get to hectares during MP4
SDG 1: No Poverty	GS-06 Quality of employment	**63** vocational trainings conducted, calculated by tracking in the IDBP database all vocational trainings until 31/12/2020. **5** vocational trainings conducted during this monitoring period, calculated by tracking in the IDBP database all vocational trainings during MP4
	GS-07 Livelihood of the poor	'Worsened': **113** (equivalent to 2.4% of total units in operation (4,636)) during MP4 'The same': **1,318** (equivalent to 28.4% of total units in operation) during MP4 'Improved': **3,205** (equivalent to 69.1% of total units in operation) during MP4
	GS-10 Quantitative employment and income generation	**144** number of direct jobs created by the VPA during MP4, calculated by tracking in the IDBP database all employment opportunities. **40** number of constructors employed under the VPA during MP4, calculated by tracking in the IDBP database all constructor employment opportunities. **32.19** households sell the bio-slurry on the market (equivalent to 0.7% taken from BUS of total units in operation (4,636)) during MP4

E.3. Calculation of leakage

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SDG indicator	GS indicator	Project situation
SDG13: Climate action	Climate change	**LE y:** $LE_{p1\ CO2,y + CH4,y}$

The estimated annual emission reduction is based on methodology "Technologies and practices to displace decentralized thermal energy consumption". The cumulative ex-ante emission reductions are calculated with the following calculation: ER y = BE y - PE y – LE y Whereby: BE y: $BE_{b1,CO2,y + CH2,y}$ PE y: $PE_{p1\ CO2,y + CH4,y}$ **LE y: $LE_{p1\ CO2,y + CH4,y}$**		0.019 tCO_2e per unit. 4,636 units * 0.019 * drop-off = 78 tCO_2e

E.4. Calculation of net benefits or direct calculation for each SDG Impact

SDG	SDG Impact	Baseline estimate	Project estimate	Net benefit
SDG13: Climate action The estimated annual emission reduction is based on methodology "Technologies and practices to displace decentralized thermal energy consumption". The cumulative ex-ante emission reductions are calculated with the following calculation: ER y = BE y - PE y – LE y Whereby: BE y: $BE_{b1,CO2,y + CH2,y}$ PE y: $PE_{p1\ CO2,y + CH4,y}$ LE y: $LE_{p1\ CO2,y + CH4,y}$	Climate change	**25,491** tCO_2e	**14,438** tCO_2e as per the equation:	**10,975** tCO_2e ER y = BE y - PE y – LE y Outlined in Sections E.1 through to E.3

SDG 7: Affordable and Clean Energy	GS-08 Access to affordable and clean energy services	No access to biodigester technology. Combustion of LPG, kerosene and biomass continues to lead to particulate matter and carbon monoxide pollution and deforestation.	**4,636** biodigester technologies installed in the period 2017 - 2020. **372** biodigester technologies installed during MP4	**4,636** biodigester technologies installed in the period 2017 - 2020. **372** biodigester technologies installed during MP4
	GS-12 Technology transfer and technological self-reliance	No training opportunities and transfer of technology in the biogas sector.	**4,408** users attending training in the period 2017-2020. **325** users trained during MP4	**4,408** users attending training in the period 2017-2020. **325** users trained during MP4
SDG 5: Gender Equality	GS-09 Human and institutional capacity	No development as women spend much of their time collecting biomass and cooking, and remain with little spare time to undertake activities that stimulate personal and entrepreneurial development.	**1,082** women attend the Operation and Maintenance training in the period 2017-2020. **126** Women attending Operation and Maintenance training during MP4	**1,082** women attend the Operation and Maintenance training in the period 2017-2020. **126** Women attending Operation and Maintenance training during MP4
	GS-14 Time saved	No time savings, as women spend a significant proportion of their time having to collect biomass for cooking purposes.	**2,803** women reporting to have saved time during MP4	**2,803** women reporting to have saved time during MP4
	GS-15 Productive use of time	No productive use of time as women lack spare time to pursue income generating activities.	**1,234** women reporting to have more time for productive use during MP4	**1,234** women reporting to have more time for productive use during MP4
SDG 2: No Hunger	GS-03 Soil condition	No slurry is used as fertiliser on agricultural land (in terms of number of farmers).	**1,946** households use bio-slurry on land during MP4	**1,946** households use bio-slurry on land during MP4
	GS-13 Establishment of sustainable food production area	No slurry is used as fertiliser on agricultural land (in terms of area).	**15.45** hectares applying bio-slurry, per month during MP4	**15.45** hectares applying bio-slurry, per month during MP4

SDG 1: No Poverty	GS-06 Quality of employment	No training and employment opportunities linked to biogas market.	**63** vocational trainings conducted in the period 2017-2020. **5** vocational trainings conducted during MP4	**63** vocational trainings conducted in the period 2017-2020. **5** vocational trainings conducted during MP4
	GS-07 Livelihood of the poor	Livelihood of the poor is unchanged.	'Worsened': **113** (equivalent to 2.4% of total units in operation) during MP4 'The same': **1,318** (equivalent to 28.4% of total units in operation) during MP4 'Improved': **3,205** (equivalent to 69.1% of total units in operation) during MP4	'Worsened': **113** (equivalent to 2.4% of total units in operation) during MP4 'The same': **1,318** (equivalent to 28.4% of total units in operation) during MP4 'Improved': **3,205** (equivalent to 69.1% of total units in operation) during MP4
	GS-10 Quantitative employment and income generation	No training and employment opportunities linked to biogas market.	**144** number of direct jobs created by the VPA during MP4 **40** number of constructors employed under the VPA during MP4 **32.19** households sell the bio-slurry on the market (0.7% of total) during MP4	**144** number of direct jobs created by the VPA during MP4 **40** number of constructors employed under the VPA during MP4 **32.19** households sell the bio-slurry on the market (0.7% of total) during MP4

E.5. Comparison of actual SDG Impacts with estimates in approved PDD

SDG	Values estimated in ex ante calculation of approved PDD for this monitoring period	Actual values achieved during this monitoring period
SDG 13: Climate action	ER y = BE y – PE y – LE y Being:	ER y = BE y – PE y – LE y Being:

	53,162 – 25,255 – 596= **27,311** tCO_2e	25,491 – 14,438 – 78 = **10,975** tCO_2e
SDG 7: Affordable and Clean Energy	No access to biodigester technology. Combustion of LPG, kerosene and biomass continues to lead to particulate matter and carbon monoxide pollution and deforestation (GS-08)	**4,636** biodigester technologies installed in the period 2017 – 2020. **372** biodigester technologies installed during MP4
	No training opportunities and transfer of technology in the biogas sector (GS-08)	**4,408** users attending training in the period 2017-2020. **325** users trained during MP4
SDG 5: Gender Equality	No development as women spend much of their time collecting biomass and cooking, and remain with little spare time to undertake activities that stimulate personal and entrepreneurial development (GS-09)	**1,082** women attend the Operation and Maintenance training in the period 2017-2020. **126** Women attending Operation and Maintenance training during MP4
	No time savings, as women spend a significant proportion of their time having to collect biomass for cooking purposes (GS-09)	**2,803** women reporting to have saved time during MP4
	No productive use of time as women lack spare time to pursue income generating activities (GS-09)	**1,234** women reporting to have more time for productive use during MP4
SDG 2: No Hunger	No slurry is used as fertilizer on agricultural land (in terms of number of farmers) (GS-03)	**1,946** households use bio-slurry on land during MP4
	No slurry is used as fertilizer on agricultural land (in terms of area) (GS-03)	**15.45** hectares applying bio-slurry, per month during MP4
SDG 1: No Poverty	No training and employment opportunities linked to biogas market (GS-06)	**63** vocational trainings conducted in the period 2017 - 2020 **5** vocational trainings conducted during MP4
	Livelihood of the poor is unchanged (GS-07)	'Worsened': **113** (equivalent to 2.4% of total units in operation) during MP4 'The same': **1,318** (equivalent to 28.4% of total units in operation) during MP4 'Improved': **3,205** (equivalent to 69.1% of total units in operation during MP4
	No training and employment opportunities linked to biogas market (GS-06)	**144** number of direct jobs created by the VPA during MP4**40** number of constructors employed under the VPA during MP4 **32.19** households sell the bio-slurry on the market (0.7% of total) during MP4

E.5.1. Explanation of calculation of value estimated ex ante calculation of approved PDD for this monitoring period

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The BE, PE and ER that were estimated in the PDD are shown in the next table:

Table 14: BE, PE and ER as estimated in the PDD (per household, per year)

Scenario	BE (tCO_2e)	PE (tCO_2e)	LE (tCO_2e)	**ER** (tCO_2e)

Biomass and fossil fuel substitution	1.720	0.557	0.058	**1.104**
Methane avoidance	3.464	1.905	-	**1.559**
Total	5.36	2.40	0.074	**2.663**

The ex-ante estimated ER is in line with the ER estimated in this MR. The small observed differences are caused by:

- On the household level: The amounts of biomass reported in the baseline study (1.259 tonnes/year) is higher than the amounts measured in the KPT (1.178 tonnes/year); the KPT results also indicate a slightly lower usage of LPG (0.074 tonnes/year compared to 0.117 tonnes/year, ex-ante). These factors combined explain the decrease from the ex-ante ER estimate of 1.104 tCO_2e to ex-post 0.637 tCO_2e due to biomass and fossil fuel substitution.
- On the household level: The number of dairy cows reported in the baseline study (average of 4.47 per household) is higher than the number reported in the BUS 2021 (average of 5.84 per household). This factor explains the increase from the ex-ante ER of 1.559 tCO_2e to ex-post 1.998 tCO_2e due to methane avoidance.

The difference between the ex-ante (2.663 tCO_2e) and ex-post (2.635 tCO_2e) emission reductions on the household level explain part of the variation of the total annual differences between the ex-ante and ex-post emission reductions.

- On the VPA level: total annual ex-post emission reductions (10,975 tCO_2e) are below the ex-ante annual average emission reduction reported in the VPA-DD (27,311 tCO_2e). While the decrease in ex-post emission reduction per unit is one explanation, the other reason for this difference is the lower implementation rate than the 20,000 units estimated ex-ante in the VPA-DD.

The small-scale thresholds of 45MW_{th} (Type I) and 60,000 tCO_2e (Type III) are not surpassed by the VPA. For evidence of fit within the Type I threshold, refer to Table 4 of this MR which shows that given 4,636 units implemented to date under the VPA-2, this VPAs capacity cumulates to 7.18 MW_{th}. This is below the 45MW_{th}.

For Type III, as each biodigester produces a maximum emission reduction of 1.998tCO_2e, given 4,636 biodigesters installed, the cumulative amount of emission reductions from the methane avoidance component is 9,261 tCO_2e (after adjustment for drop-off rate and operational rate). This is below the 60,000 tCO_2e. Annualised, the results are as follows:

Table 15: Overview of ex-ante and ex-post VPA results versus applicable small-scale thresholds

Type	01/01/2020 to 31/12/2020
Ex-ante	
Type I (45 MW_{th})	39.2 MW_{th}[34]
Type III (60,000 tCO_2e)	30,000 tCO_2e[35]
Ex-post	
Type I (45 MW_{th})	7.18 MW_{th}[36]

[34] See footnote 18 of the VPA-DD

[35] See page 15 of the VPA-DD (table 4)

[36] For calculation, refer to "2021115 ER Calculation VPA2 MP4 CP1_v062021115 ER Calculation VPA2 MP4 CP1_v06.xls" | sheet "Capacity calculation"

Type III (60,000 tCO_2e)	9,261 tCO_2e[37]

E.6. Remarks on increase in achieved SDG Impacts from estimated value in approved PDD

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[37] For calculation, refer to "2021115 ER Calculation VPA2 MP4 CP1_v062021115 ER Calculation VPA2 MP4 CP1_v06.xls" | sheet "Cumulative VER" | cell E90

	Current MP	PDD estimate	Explanation
SDG 13	Total emission reduction: **10,975** tCO_2e/ this monitoring period.	Total emission reduction: **27,311** tCO_2e/ average ex ante estimate in PDD.	The monitored value under this monitoring period is 59.8% lower than the estimated value. This is due to a lower implementation number, as the current VPA is not yet filled to its maximum allowed capacity.
SDG 7: Affordable and Clean Energy	**4,636** biodigester technologies installed in the period 2017 – 2020. **372** biodigester technologies installed during MP4.	**20,000** biodigester technologies installed.	VPA-2 is still being implemented and has not yet reached its full capacity.
	4,408 users attending training in the period 2017-2020. **325** users trained during MP4	-	As the PDDs were developed prior to the GS for Global Goals, no other ex-ante SDG impacts are reported in the approved PDDs.
SDG 5: Gender Equality	**1,082** women attend the Operation and Maintenance training in the period 2017-2020 **126** Women attending Operation and Maintenance training during MP4	-	Same as above
	2,803 women reporting to have saved time during MP4	-	Same as above
	1,234 women reporting to have more time for productive use during MP4	-	Same as above
SDG 2: No Hunger	**1,946** households use bio-slurry on land during MP4	-	Same as above
	15.45 hectares applying bio-slurry, per month during MP4	-	Same as above
SDG 1: No Poverty	**63** vocational trainings conducted in the period 2017 - 2020 **5** vocational trainings conducted during MP4	-	Same as above
	'Worsened': **113** (equivalent to 2.4% of total units in operation) during MP4 'The same': **1,318** (equivalent to 28.4% of total units in operation) during MP4 'Improved': **3,205** (equivalent to 69.1% of total units in operation during MP4	-	Same as above

	144 number of direct jobs created by the VPA during MP4**40** number of constructors employed under the VPA during MP4 **32.19** households sell the bio-slurry on the market (0.7% of total) during MP4	-	Same as above

SECTION F. SAFEGUARDS REPORTING

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No additional safeguarding principles that were added to the monitoring plan.

SECTION G. STAKEHOLDER INPUTS AND LEGAL DISPUTES

G.1. List all Inputs and Grievances which have been received via the Continuous Input and Grievance Mechanism together with their respective responses/mitigations.

Period	Grievances ongoing	Grievances closed	Total
01/01/2020 – 31/12/2020	26	45	71

All grievances are repair requests. 3 main problems are: Broken mixer, broken stove and dome problems.

G.2. Report on any stakeholder mitigations that were agreed to be monitored.

There are no reports from stakeholders to be mitigated for this monitoring period.

G.3. Provide details of any legal contest that has arisen with the project during the monitoring period

There are no legal contests or disputes that have arisen in the project during this MP.

SECTION H. DETAILED EMISSION REDUCTION CALCULATION

(A) EMISSION REDUCTION COMPONENT 1: ACCOUNTING FOR EMISSION REDUCTIONS DUE TO THE DISPLACEMENT OF FOSSIL FUELS AND NON-RENEWABLE BIOMASS

Emission reductions are credited by comparing fuel consumption in a project scenario to the baseline scenario of VPA-2. As the baseline fuel and the project fuel and the corresponding emission factors are different, the overall GHG reductions achieved by VPA-2 in year *y* are calculated as follows:

$$\mathbf{ER_{CO2,y}} = \sum_{b1,p1} N_{p1,y} * U_{p1,y} * \left(f_{NRB} * ER_{b1,p1,y,CO2} + ER_{b1,p1,y,non-CO2}\right) - \sum LE_{p1,y} \quad \textbf{(1)}$$

Where:

$ER_{CO_2,y}$	Cumulative CO_2 emission reductions from the substitution of non-renewable biomass and fossil fuels
$\sum_{b1,p1}$	Sum over all relevant (baseline b1/project p1) couples
$N_{p1,y}$	Cumulative project operational rate included in the project database for project scenario p1 against baseline scenario b1 in year y
$U_{p1,y}$	Cumulative usage rate for technologies in project scenario p1 in year y, based on cumulative adoption rate and drop off rate (fraction)
$ER_{b1,p1,y,CO_2}$	Specific CO_2 emission savings for an individual technology of project p1 against an individual technology of baseline b1 in year y, in tCO_2/year, and as derived from the statistical analysis of the data collected from the field tests
$ER_{b1,p1,y,non\text{-}CO_2}$	Specific non-CO_2 emission savings for an individual technology of project p1 against an individual technology of baseline b1 in year y, converted in tCO_2/year, and as derived from the statistical analysis of the data collected from the field tests
f_{NRB}	Fraction of biomass used that can be established as non-renewable biomass
$LE_{p1,y}$	Leakage for project scenario p1 in year y (tCO_2e/yr)

As there is one common baseline scenario and one type of technology applied, and specific non-CO_2 emission savings are treated in a separate equation (equation **7** onwards), the VPA-2 can apply the following formula for calculating emission reductions:

$$\sum ER_{CO2,y} = \left(\sum BE_{b1,CO2,y} - \sum PE_{p1,CO2,y} - \sum LE_{p1,CO2,y}\right) * N_{p1,y} * U_{p1,y} \quad \textbf{(2)}$$

Where:

$\sum ER_{CO_2,y}$	Cumulative CO_2 emission reductions from the substitution of non-renewable biomass and fossil fuels
$\sum BE_{b1,CO_2,y}$	Cumulative baseline emissions as calculated below under formula (**3**) of the VPA PDD
$\sum PE_{p1,CO_2,y}$	Cumulative project emissions as calculated below under formula (**4**) of VPA PDD
$\sum LE_{p1,CO_2,y}$	Cumulative leakage as per methodology guidance[38]

[38] Technologies and practices to displace decentralized thermal energy – 11/04/2011' p.11 - 12

$N_{p1,y}$ Cumulative project operational rate included in the project database for project scenario p1 against baseline scenario b1 in year y

$U_{p1,y}$ Cumulative usage rate for technologies in project scenario p1 in year y, based on cumulative adoption rate and drop off rate (fraction)

Baseline emissions

Baseline emissions are calculated as follows:

$$BE_{b1CO2,y} = (\sum_b BB_{b1,fuel} * NCV_{fuel} * EF_{b1,fuel}) + (BB_{b1,bio} * NCV_{bio} * EF_{b1,bio} * f_{NRB}) \quad (3)$$

Where:

$BE_{b1,CO2,y}$ Cumulative baseline CO_2 emissions from the use non-renewable biomass and fossil fuels at households during year y

$BB_{b1,fuel}$ The quantity of fossil fuel consumed in the baseline scenario 1, in tonnes/year

NCV_{fuel} Net calorific value of fossil fuel, in TJ/tonne

$EF_{b1,fuel}$ CO_2 emission factor of fossil fuel in baseline scenario 1, in tonnes/TJ

$BB_{b1,bio}$ The quantity of biomass consumed in the baseline scenario 1, in tonnes/year

NCV_{bio} Net calorific value of biomass, in TJ/tonne

$EF_{b1,bio}$ CO_2 emission factor of biomass in baseline scenario 1, in tonnes/TJ

f_{NRB} Fraction of non-renewable biomass, in percentage

The inputs for the fuel usage data were collected by the KPT survey.

The next table shows the outcome of the BFT, fuel used and the amount of energy.

Table 16: Thermal energy demand based on KPT results[39]

Fuel	Average per household (tonne/year)	NCV (TJ/tonne)	Thermal energy demand (TJ/year)
Biomass	1.178	0.015	0.01767
LPG	0.074	0.0473	0.0035
Kerosene	0.028	0.0438	0.00122

[39] See: 20200214 KPT December 2019.xls | sheet '90-30 test' | cells F38, I38, and L38

In absence of national relevant emission factors, the default emission factors from the IPCC 2006 Guidelines for National Greenhouse Gas Inventories, volume 2: Energy, Chapter 1 are used, see the next table.

Table 17: CO2 emission factors

Fuel *i*	EF_{CO_2}, (tonne/TJ)
Biomass	112.00
LPG	63.1
Kerosene	71.9

The f_{NRB} is estimated to be 64.8%, as per the respective registered VPA-DD. The f_{NRB} value is applicable to CO_2 emissions from biomass and charcoal consumption and production. Methane and nitrous oxide emission are not included in the emission reduction calculation for conservativeness. The calculated ex-post baseline emissions are shown in next table:

Table 18: Ex-post baseline emission of each fuel and total from thermal energy use[40]

Fuel	Baseline emissions from CO_2 (tCO_2e/yr)
Biomass	1.282
LPG	0.221
Kerosene	0.088
Total	**1.591**

Project emissions

The project scenario is defined by the fuel consumption of end users within the targeted population that adopts the biodigester technology. This formula calculates the project emissions per household:

$$PE_{p1,CO2,y} = \sum(BB_{p1,fuel} * NCV_{fuel} * EF_{p1,fuel}) + (BB_{p1,bio} * NCV_{bio} * EF_{p1,bio} * f_{NRB}) \quad \textbf{(4)}$$

Where:

$PE_{p1,CO2,y}$	Cumulative project CO_2 emissions from the use non-renewable biomass and fossil fuels at households during year y
$BB_{p1,fuel}$	The quantity of fossil fuel consumed in the project scenario 1, in tonnes/year
NCV_{fuel}	Net calorific value of fossil fuel, in TJ/tonne
$EF_{p1,fuel}$	CO_2 emission factor of fossil fuel in project scenario 1, in tonnes/TJ
$BB_{p1,bio}$	The quantity of biomass consumed in the project scenario 1, in tonnes/year
NCV_{bio}	Net calorific value of biomass, in TJ/tonne
$EF_{p1,bio}$	CO_2 emission factor of biomass in project scenario 1in tonnes/TJ

[40] Figures may not add up due to rounding – see emission reduction calculation

f_{NRB} Fraction of non-renewable biomass, in percentage

Not all fuels will be replaced by biogas. The fuels that people continue to use in the project scenario is sourced from the KPT-PFT.

Table 19: KPT PFT fuel use[41]

Fuel	Average per household (tonne/year)	NCV (TJ/tonne)	Thermal energy demand (TJ/year)
Biomass	0.621	0.015	0.009315
LPG	0.087	0.0473	0.00412
Kerosene	0.00	0.0438	0.00

The calculated emissions from fuel use in the project scenario are depicted in the following table:

Table 20: KPT PFT emissions[42]

Fuel	Project emissions from CO_2 (tCO_2e/yr)
Biomass	0.676
LPG	0.26
Kerosene	0.00
Total	**0.936**

Leakage emissions

Leakage per household per year shall be calculated as a quantitative emissions volume (tCO_2e) or as a percentage of total emission reductions. The former approach is followed in this MR.

A leakage assessment has been conducted as part of the BUS 2020, and is valid for a period of two years as per Gold Standard guidance. According to the results reported by households that are neighbors to biogas users, 18/129 of the households uses more fuel (biomass, LPG, and/or kerosene) because of the neighbor having a biogas digester. This amounts to leakage emissions of 0.019 tCO_2e per year.[43]

Emission reductions

Total emission reductions due to the displacement of non-renewable biomass and fossil fuels per VPA per year will be calculated as:

$$ER_{CO2,y} = \left(BE_{b1,CO2,y} - PE_{p1,CO2,y} - LE_{p1,CO2,y}\right) \quad \textbf{(5)}$$

Where:

[41] See: 20200214 KPT December 2019.xls | sheet '90-30 test' | cells W91 and AC91

[42] Figures may not add up due to rounding – see emission reduction calculation

[43] See "2021115 ER Calculation VPA2 MP4 CP1_v062021115 ER Calculation VPA2 MP4 CP1_v06.xls"| sheet "GS VER 2019" | cell E77

$ER_{CO2,y}$ Emission reductions in year y (tCO_2)

$BE_{b1,CO2,y}$ Baseline emissions during the year y (tCO_2)

$PE_{p1,CO2,y}$ Project emissions during the year y (tCO_2)

$LE_{p1,CO2,y}$ Leakage during the year y (tCO_2)

In other words, emission reductions from fuel savings are the difference between the BFT and the PFT and corrected for any leakage emissions, provided that the mean emission reductions are satisfy the 90/30 rule[44], i.e. the endpoints of the 90% confidence interval lie within +/-30% of the estimated mean.

90/30 rule check
The check is calculated using the approved method that was communicated with the Gold Standards and is based on:

- GHG emission from all fuels of BFT and PFT
- fNRB of 64.8%

The calculations itself are based on the reference in the TPPDEC methodology[45] and based on two independent samples. Paired sampling in the case of a market-oriented biogas programme is not possible as it is not known who will adopt the technology beforehand. The next tables show that both baseline emissions and project emissions calculations meet the 90/30 rule.

Table 21: 90/30 rule check on baseline emissions[46]

Item	Unit	Baseline	
Sample	n	27	
	Analysis		
	Mean		1.65
	Standard error		1.1671
	Minimum requirement n		14.91
	Satisfy the 90/30 rule		Yes, as: 27 > 14.91

Table 22: 90/30 rule check on project emissions[47]

Item	Unit		Project
Sample	n		81
	Analysis		
	Mean		0.87
	Standard error		0.7536
	Minimum requirement n		22.27

[44] The methodology specifies the 90/15 rule but also the 90/30 rule. The GS confirmed that is should be 90/30 and that 90/15 is a typo.

[45] http://www.climatecare.org/media/documents/pdf/ClimateCare_Guidelines_for_Performance_Tests_and_KPTsx.pdf

[46] See: 20200214 KPT December 2019.xls | sheet '90-30 test' | cells AN36 – AN40

[47] See: 20200214 KPT December 2019.xls | sheet '90-30 test' | cells AN45 – AN49

	Satisfy the 90/30 rule	Yes, as: 81 > 22.27

The KPT test meets the 90/30 rule allowing the use of mean saving values for ER calculations. The following table summarises the total emission reduction from fuel-switch, per average biodigester:

Table 23: Emission reductions from fuel switch[48]

Baseline emissions from fuel use (tCO_2e/yr)	Project emissions from fuel use (tCO_2e/yr)	Leakage emissions from fuel use (tCO_2e/yr)	Emissions from fuel switch to biogas (tCO_2e/yr)
1.591	0.936	0.019	**0.637**

(B) EMISSION REDUCTION COMPONENT 2: ACCOUNTING FOR EMISSION REDUCTIONS DUE TO THE AVOIDANCE OF METHANE EMISSIONS FROM MANURE HANDLING.

The emissions from the animal waste management system of the baseline are determined using the IPCC 2006 Tier 1 approach. The Tier 1 approach is applicable to situations where baseline data required for the estimation of the methane emission factor per category of livestock in *not* available, or where it is difficult to define a distinct practice of manure handling within the programme boundary.

Baseline emissions

This formula calculates the baseline emissions per household:

$$\mathbf{BE_{b1,CH4,y}} = \mathrm{GWP_{CH4}} * \sum_T (\mathrm{EF_{awms,T}} * \mathrm{N_{T,h}}) \quad \textbf{(6)}$$

Where:

$BE_{b1,CH4,y}$	Baseline emissions from manure handling during the year y in tCO_2e
GWP_{CH4}	Global Warming Potential of methane (25)
$EF_{awms,T}$	Emission factor for the defined livestock population category T
$N_{T,h}$	Number of livestock category T in premise h

Step 1: Determination of $EF_{awms,T}$

The relevant default methane emission factor ($EF_{awms,T}$) for Asian livestock is sourced from Tables 10.14 – 10.16 of the IPCC Guidelines for National Greenhouse Gas Inventories[49]. These values are reported in Table 24. A national average temperature of 27.1°C applies, as reported by the Indonesian Meteorological Climatological and Geophysical Agency.[50]

[48] Figures may not add up due to rounding – see emission reduction calculation

[49] IPCC Guidelines for National Greenhouse Gas Inventories (2006) 'Chapter 10: Emissions from Livestock and Manure Management'

[50] http://www.bmkg.go.id

Table 24: IPCC 2006 default values for EFawms, T[51]

Animal T	$EF_{awms,T}$
Dairy cow	0.031 tonne CH_4

Step 2: Determination of $N_{T,h}$

Analysis of animal ownership from the BUS (2021) shows that dairy cows are the dominant type of animal owned by almost all biodigesters users (93.5%). Given the marginal emission impact of the other categories of animals and for conservativeness, only methane emissions from dairy cows will be considered in this emissions reduction calculation. Methane emissions from secondary and any following animal types are not included for conservativeness.

With the data from the previous tables the baseline emission can be determined. The emission per household of all dairy cows under the VPA are calculated and depicted in the next table. The number of dairy cows originates from the BUS survey and based on the $EF_{awms,T}$ from the relevant default methane emission factor.

Table 25: Ex-post Baseline emission from animal waste management[52]

Animal T	Average population $N_{T,h}$/hh[53]	$EF_{awms,T}$ (tonneCH_4/year)	GWP_{CH4}	$BE_{b1,CH4,y}$ (tCO_2e/year)
Dairy cow	5.84	0.031	25	**4.528**

Project emissions

Project emissions include both the physical leakage of biogas from the biodigester and the incomplete combustion of biogas. This formula calculates the project emissions per household:

$$\mathbf{PE_{p1,CH4,y}} = \mathrm{GWP_{CH4}} * \sum(\mathrm{N_{T,h,y}} * \mathrm{EF_{awms,T}}) * \mathrm{PL_y} + \sum(\mathrm{N_{T,h,y}} * \mathrm{EF_{awms,T}}) * (1 - \eta_{new\ stove})(1 - \mathrm{PL_y}) + \mathrm{PE_{awms,NT}} \quad (7)$$

Where:

$PE_{p1,CH4,y}$	Project emissions from manure handling during the year y in tCO_2e
GWP_{CH4}	Global Warming Potential of methane (25)
$N_{T,h}$	Number of livestock category T in premise h
$EF_{awms,T}$	Emission factor for the defined livestock population category T

[51] According to the BUS 2021, for 93.5% of households dairy cows were the primary animals. For this reason, no other animals are included

[52] Figures may not add up due to rounding – see emission reduction calculation

[53] Source: "20210128 BUS 2021 Tabulation JRI | sheet BUS 2021 | cell AI2743 "

PL_y	Physical leakage of the biodigester (through measurement or application of 10% default)
$\eta_{new\ stove}$	Combustion efficiency of the used type of biogas stove
$PE_{awms,NT}$	Project emission from the animal waste not treated in the biodigester

Project emissions from the animal waste not treated in the biodigester in the project scenario will be zero since the non-treated animals in the project scenario will have the same situation as they would have had in the baseline.

Table 26: Ex-post Project emission from animal waste management[54,55]

Animal T	$BE_{b1,CH_4,y}$ (tCO_2e/year)	PL_y	$\eta_{new\ stove}$	$PE_{p1,CH_4,y}$ (tCO_2e/year)
Dairy cow	4.528	10%	50%	**2.490**

The emission reductions from animal waste are the difference between the baseline and the project, as per the table below. Please note that here project emissions from bio-slurry are not included – refer to the section below for an overview of the calculation of project emissions from bio-slurry and Section D.4 (c) for how these project emissions have been accounted for in the final calculation.

LEAKAGE EMISSIONS

The project proponent investigated the following potential sources of leakage:

Table 27: Leakage emission assessment

#	Leakage source	Applicability
a	The displaced baseline technologies are reused outside the project boundary in place of lower emitting technology or in a manner suggesting more usage than would have occurred in the absence of the project.	The baseline technologies are not reused outside the project boundary. Traditional biomass stoves cannot be moved as they are fixed to the floor of the kitchenette. LPG stoves are retained by households and are needed for days with larger cookeries, such as festivals or national celebrations.
b	The non-renewable biomass or fossil fuels saved under the project activity are used by non-project users who previously used lower emitting energy sources.	It is considered as project emissions – see Section D.4 (a) Leakage. A leakage assessment has been conducted as part of the BUS 2020, and is valid for a period of two years as per Gold Standard guidance. According to the results reported by households that are neighbors to biogas users, 18/129 of the households uses more fuel (biomass, LPG, and/or kerosene) because of the neighbor

[54] Figures may not add up due to rounding – see emission reduction calculation

[55] According to the BUS 2021, for 93.5% of VPA-2 households dairy cows were the primary animals. For this reason, no other animals are included

		having a biogas digester. This amounts to leakage emissions of 0.019 tCO_2e per year.[56]
c	The project significantly impacts the NRB fraction within an area where other CDM or VER project activities account for NRB fraction in their baseline scenario.	There is no registered project in Indonesia that has a NRB component in the project. It is therefore not likely that the NRB fraction is impacted significantly.
d	The project population compensates for loss of the space heating effect of inefficient technology by adopting some other form of heating or by retaining some use of inefficient technology	Space heating does not occur in Indonesia.
e	By virtue of promotion and marketing of a new technology with high efficiency, the project stimulates substitution within households who commonly used a technology with relatively lower emissions, in cases where such a trend is not eligible as an evolving baseline.	The combustion of biogas is both more efficient than using open-source fires for cooking purposes and leads to lower emissions compared to the baseline fuels (biomass and LPG) as it is 100% renewable.
F	Physical leakage emissions	It is considered as project emissions - see section D.4 and the emission reduction calculation spread sheet
G	Emissions from biogas slurry	It is considered as project emissions - see section D.4 and the emission reduction calculation spread sheet. This amounts to leakage emissions of 0.019 tCO_2e per year.[57]

EMISSIONS FROM BIO-SLURRY (DIGESTATE)

The following leakage emission source is accounted for in this section: CH_4 emissions from the anaerobic decay of the residual organic content of bio-slurry subjected to anaerobic storage. Bio-slurry typically has low biodegradability because easily biodegradable organic matter has been converted in the anaerobic digester and therefore the biodegradability of bio-slurry is much lower than manure. This approach has been approved by the GS for the project GS1083 and is therefore followed.

This emission source is determined through the following steps:

1. Estimation of the total amount of volatile solids (VS) entering the biodigester
2. Assessment of remaining VS content of bio-slurry
3. Assessment of methane potential of bio-slurry
4. Calculation of project emissions from bio-slurry using the information obtained in the previous steps

1. Estimation of the total amount of VS entering the biodigester

[56] See "2021115 ER Calculation VPA2 MP4 CP1_v062021115 ER Calculation VPA2 MP4 CP1_v06.xls"| sheet "GS VER 2019" | cell E77

[57] See "2021115 ER Calculation VPA2 MP4 CP1_v062021115 ER Calculation VPA2 MP4 CP1_v06.xls" | sheet "GS VER 2020" | cell E78

The total amount of VS entering the biogas plant depends on the type of animal and the share of manure that is fed into the biogas plant. The share of manure fed into the biogas plant can be found in section D.2, and is calculated as:

$$MS_{T,S,k} = 1 - MS_{P,S,K}$$

Where, $MS_{T,S,k}$ is the share of manure fed into the digester and $MS_{P,S,K}$ the share not fed into the digester of animal category T.

The next tables depict the total amount of VS that enters the average biodigester which is calculated by multiplying the amount of VS excreted by the average number of animals and the $MS_{T,S,k}$ into the biodigester.

Table 28: Daily VS production of the average biodigester[58,59]

Animal T	VS excretion kgVS/hd/day	Head/average biodigester[60]	Total amount of VS excreted kgVS.day^{-1}	$MS_{T,S,k}$ Share fed into biodigester	Total VS entering the biodigester kgVS.day^{-1}
	A	**B**	**AxB =C**	**D**	**CxD**
Dairy Cow	2.80	5.84	16.36	0.72	11.78
				Sum	**11.78**

2. Assessment of remaining VS content of bio-slurry

During anaerobic digestion VS is converted into biogas. The efficiency of that process determines how much VS remains in bio-slurry. The efficiency depends on many factors and is difficult to estimate, such as retention time, dilution ratio, temperature C/N ratio etc.

According to the Biogas Handbook (2008) of Big East, the digestion efficiency of agricultural biogas plants is typically in the range 50-60%[61]. This means that bio-slurry contains 40-50% of the initial organic dry matter, primarily as fibers.

In other words, it can be assumed that around 55% of the initial concentration of VS is converted into biogas and that around 45% remains in bio-slurry. This means that the $MS_{T,S,k}$ is 55% and the $MS_{P,S,K}$ is 45% of total VS entering the biogas plant.

The remaining VS however has a different composition than VS in manure, it is more fibrous and therefore it will more slowly degrade under continued anaerobic conditions. Some compounds, could even be recalcitrant to further anaerobic biodegradation. The next table shows the calculated amount of VS that leaves the average biodigester per day:

[58] Figures may not add up due to rounding – see sheet emission reduction calculation sheet

[59] According to the BUS 2021, for 93.5% of VPA-2 households dairy cows were the primary animals. For this reason, no other animals are included

[60] Source: "20210712 BUS 2021 Tabulation JRI v3.xlsx | sheet BUS | cell AI2743

[61] P55 http://www.lemvigbiogas.com/BiogasHandbook.pdf

Table 29: Average amount of VS in digester effluent[62]

(A) Total VS entering the biodigester kgVS.day^{-1}	Digester efficiency[63]	(B) Total VS destroyed in the biodigester kgVS.day^{-1}	A-B Total VS in bio-slurry kgVS.day^{-1}
11.78	55%	45%	5.30

3. Assessment of the methane potential of bio-slurry

As the nature of VS has changed during anaerobic conversion, the default methane potential (B_0) value is no longer applicable to VS in bio-slurry. According to EB66 Annex 32[64] the remaining fraction of the original methane potential is 20% for the liquid bio-slurry of conventional digesters. The effluent from biodigesters in Indonesia is liquid and therefore this fraction was applied. The B_0 of bio-slurry is calculated with the following equation:

$$B_{0,dig,T} = F_{ww,CH4,default} \times B_{0,T}$$

Equation 1: Calculation of methane potential of bio-slurry

Where:

$B_{0,dig,T}$	=	Methane potential of bio-slurry from animal type T manure
$F_{ww,CH4,}$	=	Default factor representing the remaining CH_4 production capacity of liquid bio-slurry
$B_{0,T}$	=	Methane potential of manure from animal type T

With this equation it is possible to calculate for each animal the remaining methane potential.

Table 30: Calculated methane potential of digestate from manure by animal type[65]

Animal T	$F_{ww,CH4,}$	Bo(T) (m^3CH_4/kgVS)	$B_{0,dig}$ (m^3CH_4/kgVS)
Dairy cow	0.20	0.13	0.026

As discussed above, only dairy cows are taken into consideration for analysis, relevant calculation is shown in the table below:

Table 31: Average methane potential of bio-slurry from manure by animal type[66]

Animal T	Number	Fraction	Average $B_{0,dig}$ (m^3CH_4/kgVS)
Dairy cow	5.84	100%	0.026
			0.026

[62] According to the BUS 2021, for 93.5% of VPA-2 households dairy cows were the primary animals. For this reason, no other animals are included

[63] The 55% digester efficiency features in the approved PoA-DD and VPA-DDs, and relates to http://www.lemvigbiogas.com/BiogasHandbook.pdf on which this figure has been based.

[64] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-14-v1.pdf

[65] According to the BUS 2021, for 93.5% of VPA-2 households dairy cows were the primary animals. For this reason, no other animals are included in this MP4

[66] According to the BUS 2021, for 93.5% of VPA-2 households dairy cows were the primary animals. For this reason, no other animals are included in this MP4

Based on this, the weighted averaged $B_{o,dig}$ is 0.026 ($m^3CH_4/kgVS$)

4. Calculation of bio-slurry emissions using the information obtained in the previous steps

F_{ww} and $Bo_{,dig}$ is a default factor and applicable to the remaining VS in the bio-slurry, see equation 6 of EB 66 Annex 32. However, as it is now known what the COD concentration of liquid bio-slurry is, the proxy VS remaining in bio-slurry is used. The next table shows the calculated emissions from bio-slurry using the IPCC tier 1 approach.

Equation 2: Calculation of methane potential of bio-slurry

$$PE_{bio\text{-}slurry} = (VS_{dig} * 365) \times B_{o,dig} \times (\sum DMS \times MCF) \times (D_{CH_4}/1000) \times GWP\ CH_4$$

Where:

$PE_{bio\text{-}slurry}$		Annual average project emissions from bio-slurry, $tCO_2e/hh/yr$
VS_{dig}	=	Daily volatile solid remaining in the bio-slurry, kgVS/day
365	=	Basis for calculating annual VS production, days yr-1
$B_{o,dig}$	=	Weighted methane producing capacity of the bio-slurry, $m^3CH_4/kgVS$
∑MCF	=	Cumulative methane conversion factors for digestate management system DMS, %
D_{CH_4}	=	Conversion factor of m^3 CH_4 to kilograms CH_4
GWP CH_4	=	Global Warming Potential of methane (25)

The MCF applied to the bio-slurry emissions is 4.75%. The table below indicates the usage method of the bio-slurry and the corresponding calculation of the MCF.

Table 32: Overview of bio-slurry handling methods[67]

Bio-slurry handling method	Percentage	Corresponding IPCC definition	MCF
Use as fertilizer	42.0%	Daily spread	0.42%
Given away for free	2.5%	Daily spread	0.02%
Left where it is	5.0%	Liquid/slurry	3.92%
Dumped into open drain	16.0%	Aerobic treatment	0.00%
Dumped into river or lake	2.9%	Aerobic treatment	0.00%
Solid storage	1.7%	Solid storage	0.09%
Dumped on land	29.5%	Daily spread	0.29%
Composting	0.0%	Composting	0.00%
		Average MCF	**4.75%**

[67] Source: "20210712 BUS 2021 Tabulation JRI v3.xlsx" | sheet "BUS 2021" | cells Y2977 to Y2987

Table 33: Calculated emissions from bio-slurry, per household

Total VS in bio-slurry kgVS.day^{-1}	$B_{o,dig}$ (m^3CH_4/kgVS)	∑DMSxMCF	D_{CH_4} (kg/m^3CH_4)	$PE_{bio\text{-}slurry}$ (tCO_2/year/hh)
5.30	0.026	4.75%	0.67	0.040

The project emissions from bio-slurry equate to 0.040 tCO_2e. These have been included in the ER assessment.

Emission reductions

Total emission reductions due to avoided methane from animal waste management per VPA per year will be calculated as follows:

$$ER_{CH4,y} = \left(BE_{b1,CH4,y} - PE_{p1,CH4,y} - PE_{bio\text{-}slurry} - LE_{p1,CH4,y}\right) \quad (7)$$

Where:

$ER_{CH4,y}$	Methane emissions reductions in year y (tCO_2)
$BE_{b1,CH4,y}$	Baseline methane emissions during the year y (tCO_2)
$PE_{p1,CH4,y}$	Project methane emissions during the year y (tCO_2)
$PE_{bio\text{-}slurry}$	Project emissions from bio-slurry during the year y (tCO_2)
$LE_{p1,CH4,y}$	Leakage during the year y (tCO_2)

Table 34: Emission reductions from animal waste management[68]

Baseline emissions from animal waste management (tCO_2e/yr)	Project emissions from animal waste management (tCO_2e/yr)	Project emissions bio-slurry (tCO_2e/yr)	Leakage emissions from animal waste management (tCO_2e/yr)	Emissions from animal waste management (tCO_2e/yr)
4.528	2.490	0.040	-	**1.998**

(C) EX-POST ESTIMATE OF THE EMISSION REDUCTIONS

The next table shows the ex-ante estimate of the emission reductions for each biogas unit:[69]

Table 35: Average annual emission reductions

[68] Figures may not add up due to rounding – see emission reduction calculation

[69] Figures may not add up due to rounding

	$BE_{b1,y}$ (tCO_2e/year)	PE_{p1y} (tCO_2e/year)	$PE_{bio\text{-}slurry}$ (tCO_2e/year)	LE_{b1y} (tCO_2e/year)	$ER_{,y}$ (tCO_2e/year)
Biomass and fossil fuel substitution	1.591	0.936	-	0.019	**0.637**
Manure handling	4.528	2.490	0.040	-	**1.998**
Sum (rounded down)					**2.635**

The cumulative ex-post emission reductions are calculated with the following calculation:

$$\mathbf{ER_{Total}} = (ER_{CO2,y} + ER_{CH4,y}) * N_{p,y} * U_{p,y}$$

Where:

$ER_{CO2,y}$	CO_2 emissions reductions in year y (tCO_2)
$ER_{CH4,y}$	Methane emissions reductions in year y (tCO_2)
$N_{p,y}$	Cumulative project operational rate included in the project database for project scenario p against baseline scenario b in year y
$U_{p,y}$	Cumulative usage rate for technologies in project scenario p in year y, based on cumulative adoption rate and drop off rate (fraction)

The usage rate is used to discount the ERs and is calculated in section D.3. The next table shows the ER by month.

Table 36: Emission reductions realised by the VPA 2

Month of program	Period, begin and end date inclusive		Cumulative number of units	Monthly ER (tCO_2e)	Cumulative ER (tCO_2e)
37	1/1/2020	1/31/2020	4,325	883	883
38	2/1/2020	2/29/2020	4,341	895	1,778
39	3/1/2020	3/31/2020	4,350	899	2,677
40	4/1/2020	4/30/2020	4,387	901	3,578
41	5/1/2020	5/31/2020	4,399	908	4,486
42	6/1/2020	6/30/2020	4,419	911	5,397
43	7/1/2020	7/31/2020	4,436	915	6,311
44	8/1/2020	8/31/2020	4,471	918	7,230
45	9/1/2020	9/30/2020	4,508	925	8,155
46	10/1/2020	10/31/2020	4,544	933	9,088
47	11/1/2020	11/30/2020	4,571	941	10,029
48	12/1/2020	12/31/2020	4,636	946	10,975
				Total	**10,975**

The table shows that the total number of ERs realized is **10,975 tCO_2e**.

Table 37: Emission reductions realised by the VPA 2, per vintage

Vintage	Start	End	Volume

2020	01/01/2020	31/12/2020	10,975
Total			**10,975**

Revision History

Version	Date	Remarks
1.1	14 October 2020	Hyperlinked section summary to enable quick access to key sections Improved clarity on Key Project Information Section for POA monitoring Forward action request section Improved Clarity on SDG contribution/SDG Impact term used throughout Clarity on safeguard reporting Clarity on design changes Leakage section added for VER/CER projects Addition of Comparison of monitored parameters with last monitoring period Provision of an accompanying Guide to help the user understand detailed rules and requirements
1.0	10 July 2017	Initial adoption