Gold Standard for the Global Goals

TEMPLATE

MONITORING REPORT

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VERSION **v. 1.1**

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

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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-1 (GS 1174)

Key Project Information

GS ID (s) of Project (s)	(GS 1174)
Title of the project (s) covered by monitoring report	Indonesia Domestic Biogas Programme of Activities (IDBP) (ID 1172), VPA-1 (GS 1174)
Version number of the PDD/VPA-DD (s) applicable to this monitoring report	Version 10.1
Version number of the monitoring report	Version 4.0
Completion date of the monitoring report	18/11/2024
Date of project design certification	31/05/2013
Date of Last Annual Report	Not applicable
Monitoring period number	MP6 CP2
Duration of this monitoring period	01/01/2023 to 31/12/2023 (inclusive of both dates)
Project Representative	YRE
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, Version 3.1
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	-	**45,098**	VER
SDG 7: Affordable and Clean Energy	GS-08 Access to affordable and clean energy services	**18,215**	Biodigesters in operation
	GS-12 Technology transfer and technological self-reliance	**0**	Users attending training
SDG 5: Gender Equality	GS-09 Human and institutional capacity	**0**	Women attending Operation and Maintenance training
	GS-14 Time saved	**19,320**	Women reporting to have saved time
	GS-15 Productive use of time	**4,454**	Women reporting to have more time for productive use
SDG 2: No Hunger	GS-03 Soil condition	**3,979**	Households using bio-slurry on land
	GS-13 Establishment of sustainable food production area	**305.10**	Hectares applying bio-slurry, per month
SDG 1: No Poverty	GS-06 Quality of employment	**0**	Vocational trainings conducted
	GS-07 Livelihood of the poor	**3,096** **17,156**	'The same' 'Improved'
	GS-10 Quantitative employment and income generation	**0** **355**	Number of direct jobs created by the VPA Households selling bio-slurry

Table 2 – Product Vintages

		Amount Achieved	
Start Dates	**End Dates**	**VER**	**SDG achievements**
01/01/2023	31/12/2023	**45,098**	

01/01/2023	31/12/2023		SDG 7: Affordable and Clean Energy: **18,215** biodigester technologies in operation
01/01/2023	31/12/2023		SDG 5: Gender Equality: **19,320** women reported to have saved time **4,454** reported to have more time for productive activities
01/01/2023	31/12/2023		SDG 2: No Hunger: **3,979** households reported using bio-slurry on land **305.10** hectares of land where bio-slurry was applied per month for food production
01/01/2023	31/12/2023		SDG 1: No Poverty **17,156** householders reported their livelihoods improved **355** households reported selling bio-slurry

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.

This VPA-1 started implementation of biodigesters on 24/10/2009. The overall development objective of the VPA-1, 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 01/01/2023 - 31/12/2023, which is the sixth monitoring period of the second crediting period running from 01/06/2018 – 31/05/2025.

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

Note: provinces Banten and Sumatera Selatan are included under West Java

A.3. Reference of applied methodology

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Technologies and Practices to Displace Decentralized Thermal Energy Consumption, Version 3.1.

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 01/06/2018 and 31/05/2025 (2nd crediting period). This report covers the sixth monitoring period of this second crediting period and covers GHG emission reductions generated in the period between 01/01/2023 - 31/12/2023.

SECTION B. IMPLEMENTATION OF PROJECT

B.1. Description of implemented project

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The VPA-1 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. The overall development objective of the VPA-1, 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. YRE is the official project representative of the IDBP PoA and the VPA implementer. In February 2021, YRE and Hivos signed MoU to transfer the facility management, disbursement and MRV from Hivos to YRE. It also stated Hivos transfers the full responsibility for the management of Carbon Fund, ownership of the VER and MRV of the PoA and VPAs to YRE. In January 2022, Hivos sent a letter to Gold Standard to inform about the handover of CME function from Hivos to YRE with the supporting document: Cover Letter signed by Hivos and YRE. In Feb 2022, Gold Standard has confirmed the changes in the registry accounts of IDBP. To comply with the Presidential Regulation 98/2021 about Carbon Economic Value which regulates the provision for conduction carbon trading system must be in the form of business entity, YRE established PT. Biru Karbon Nusantara (BKN) as a company who will continue manage carbon fund of IDBP. In October 2023, YRE send a letter to Gold Standard to inform about the handover of CME function from YRE to PT. BKN. Also in October, Gold Standard has confirmed the changes in the registry accounts of IDBP.

The next table shows the units built and commissioned in the period from the start date of the VPA-1 to 31/12/2016, when the VPA-1 was closed.

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

Period	Number of biodigesters in VPA-1	Cumulative number of biodigesters in VPA-1
24/10/2009 – 31/12/2009	62	62
01/01/2010 – 31/12/2010	1,586	1,648
01/01/2011 – 31/12/2011	2,991	4,639
01/01/2012 – 31/12/2012	3,324	7,963
01/01/2013 – 31/12/2013	3,256	11,219
01/01/2014 – 31/12/2014	2,942	14,161
01/01/2015 – 31/12/2015	2,314	16,475
01/01/2016 – 31/12/2016	3,777	20,252
01/01/2017 – 31/12/2017	0	20,252
01/01/2018 – 31/12/2018	0	20,252
01/01/2019 – 31/12/2019	0	20,252
01/01/2020 – 31/12/2020	0	20,252
01/01/2021 – 31/12/2021	0	20,252
01/01/2022 – 31/12/2022	0	20,252
01/01/2023 – 31/12/2023	0	20,252
		Total: 20,252

In total **20,252** biodigesters were constructed as of 31/12/2016 (end date VPA-1) in the VPA-1 project boundary. As the VPA is a small-scale activity, as per the methodology, the limit of the VPA is defined as "15 MW (45 MWth) for the renewable energy component and an emissions cap of 60,000 tCO2e for the methane avoidance component", as per CDM guidance. As per Eligibility Criterion #17 in the VPA-DD, "given there are a total of 20,253 units installed in the VPA, this amounts to 38.74 MWth in total, below the 45 MWth threshold for the renewable energy component." As the 38.74 MWth was already nearing the 45

[1] As per "2024_IDBP_Database_VPA1.xls" | sheet 'Master VPA-1' | cells M20447 to M20454. Presented cumulative figures exclude the drop-off rate.

MWth threshold in 2016, the PD decided to open up VPA-2. Table 4 shows the distribution of the biodigesters across the nine targeted provinces.

Table 4: Distribution of biodigesters per province, until 31/12/2023[2]

Province	Number of biodigesters
Lampung	419
West Java	1,448
Central Java	1,367
East Java	7,638
Bali	1,066
Nusa Tenggara Barat	4,330
Nusa Tenggara Timur	649
Yogyakarta	1,408
South Sulawesi	1,930
Total:	**20,252**

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 31-12-2023 (no further implementation post-2017)

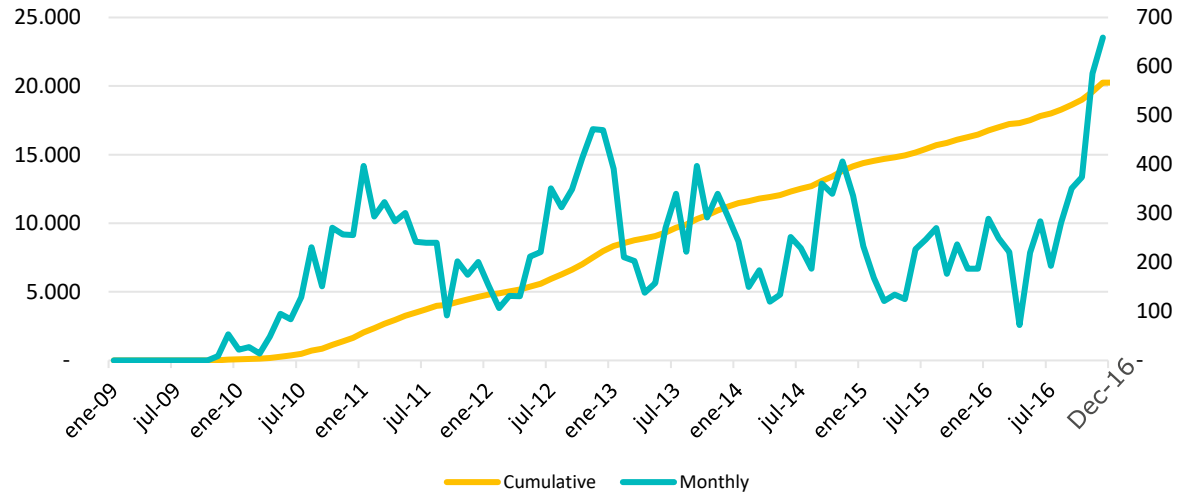


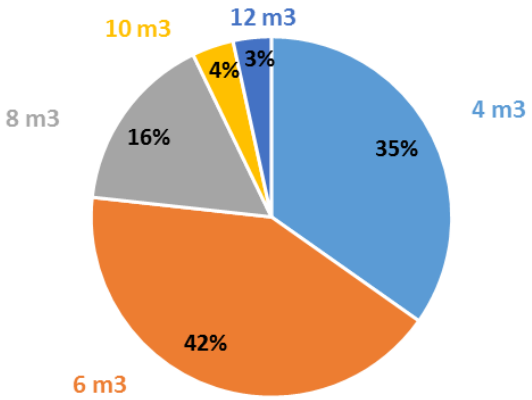
Figure 1 shows that the cumulative number of units installed is steadily increasing. The figure also shows that there are seasonal effects affecting the number of units installed.

The VPA-1 installs five different biodigester sizes; 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 1 (as per 31-12-2023)[3]

[2] As per "2024_IDBP_Database_VPA1.xls" sheet 'Master VPA-1' cells Q20447 to T20455

[3] As per "2024_IDBP_Database_VPA1.xls" | sheet 'Master VPA-1' | cells R20461 to S20465. Figures may not add up due to rounding



The most proliferated digester has a volume of 6 m^3, followed by the 4 m^3; according to the IDBP database. Other digester sizes are built to a much smaller extent, with the 10 m^3 and 12 m^3 joining totalling around 7% of all the digesters built. The average digester size built has a volume of 5.99 m^3.[4] The VPA-1 has a cumulative digester volume of 122,446 m^3.[5]

The VPA-1 meets the small-scale VPAs thresholds set forth by the CDM i.e., 15 MW (45 MW_{th}) for the renewable energy component and an emissions cap of 60,000 tCO_2e for the methane avoidance component. As indicated above, the average biodigester size implemented in this VPA-1 is 5.99 m^3. As per the calculation presented in footnote 8 below, this biodigester size requires daily feeding of (5.99 m^3 * 7.5 kg =) 44.92 kg of manure, equivalent to 1.80 m^3 of biogas per day. As per the Table below, this amounts to a maximum output of 1.91 kW_{th}, which is below the established threshold of 150 kW_{th} per unit. Also, given 20,252 units implemented to date under the VPA-1, this cumulates to 38.74 MW_{th}, below the 45 MW_{th} threshold.

The calculation is presented below:

Table 5: Calculation of total capacity under VPA-1

$\mathbf{Th_{cap}} = \frac{\mathbf{E}}{\mathbf{t}}$ *where* $\mathbf{E} = \eta * H_b * V_b$		
Where:	Value:	Comments:
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/m^3 [7]	Derived from IPCC defaults
V_b = volume of biogas	1.80 m^3/day[8]	Data provided by Hivos
E = Energy available from the biogas system	18.87 MJ/day[9]	Calculated
$\mathbf{E_{th}}$ =	5.24 kWh/day	1 MJ = 0.2778 kWh
$\mathbf{Th_{cap}}$ =	1.91 kW_{th}	Given a 2.74 hour/day usage

[4] As per "2024_IDBP_Database_VPA1.xls" | sheet 'Master VPA-1' | cell R20468

[5] As per "2024_IDBP_Database_VPA1.xls" | sheet 'Master VPA-1' | cell R20469

[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-1 threshold. See email communication dated 11 April 2016

[7] Methane has an energy value of 37.78 MJ/m^3; thus, biogas at 55% CH_4 has an energy value of 21 MJ/m^3

[8] Cow dung produces approximately 40 litres biogas per kg. Each m^3 capacity of the biodigester needs 7.5 kg dung per day. Given an average biodigester size of 5.99 m^3, 44.92 kg of cow dung per day is required. This translates into 1.80 m^3 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/m^3 * 1.80 m^3/day

Total capacity	38.738 MW_{th}[10]	Given 20,252 units installed

As each biodigester produces a maximum emission reduction of 1.761 tCO_2e from methane avoidance[11], given 20,252 biodigesters installed, the cumulative amount of emission reductions from the methane avoidance component is 35,667 tCO_2e. This is below the methodological threshold of 60,000 tCO_2e.

B.1.1. Forward Action Requests

>>
Not applicable.

B.2. Post-Design Certification changes

>>
No post-registration design changes have been implemented for VPA-1.

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

>>
Not applicable.

B.2.2. Corrections

>>
Not applicable.

B.2.3. Changes to start date of crediting period

>>
Not applicable.

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

>>
Not applicable.

[10] Figures may not add up due to rounding – see "20240930 ER Calculation VPA1 MP6 CP2.xls"| sheet "capacity calculation" | cell "C6"

[11] Emission reduction of 1.761 tCO2e from methane avoidance by each digester was calculated by: subtracting from total Baseline Emissions from methane avoidance per household (BEb1,CH4,y), the total Project Emissions from methane avoidance per household (PEp1,CH4,y), plus total Project Emissions from bio-slurry (PEp1 bio-slurry), and total Leakage Emissions from methane avoidance per household (LEp1 CH4,y): See "20240930 ER Calculation VPA1 MP6 CP2.xls" | sheet "GS VER 2023" | cell "E84"

SECTION C. DESCRIPTION OF MONITORING SYSTEM APPLIED BY THE PROJECT

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Article I. Organisational Setup of the carbon and SDG monitoring

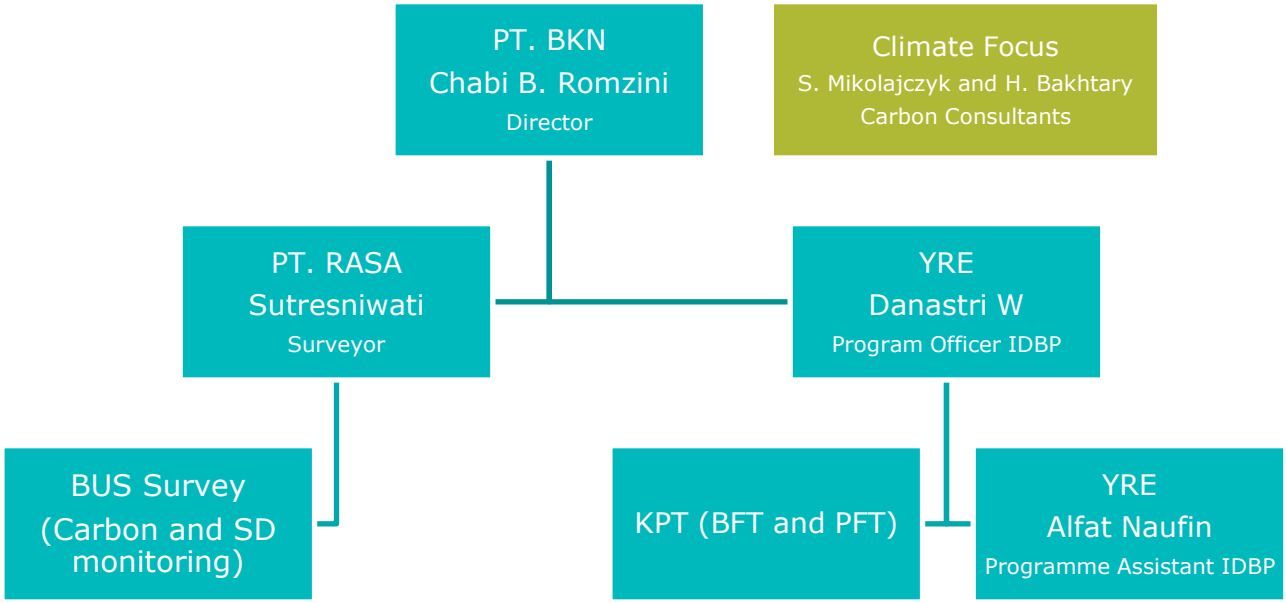
All monitoring was coordinated by YRE and PT. BKN. The objective of the monitoring effort conducted under this VPA-1 was to meet the monitoring requirements set forth in the methodology Technologies and Practices to Displace Decentralized Thermal Energy Consumption (Version 3.1).

PT. BKN appointed Ms. Sutresniwati from PT. RASA to conduct the Biogas User Survey, which serves as the monitoring survey under the VPA-1 (BUS 2023). The survey was designed and implemented in accordance with the requirements set forth in the methodology, whereby the selected sample size follows at least a 90% confidence interval and a 10% margin of error (90/10) requirements. Mr. Szymon Mikolajczyk and Mr. Haseeb Bakhtary from Climate Focus were placed in charge of advising PT. RASA on the VPA specific monitoring procedures. PT. RASA recruited 11 surveyors and 2 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 December 26, 2023; meanwhile field training was conducted on December 27, 2023. Data tabulation, analysis and reporting was prepared by PT. RASA.

PT. BKN internally designed and implemented the KPT in 29 December 2023 and 2 April 2024, which was supervised by Ms. Chabi Romzini and supported by Mr. Szymon Mikolajczyk. Data collection for the KPT was conducted by PT. RASA, employing an experienced team (also responsible to carry out the Biogas User Survey). Tabulation and analysis of results was conducted by Mr. Szymon Mikolajczyk and Mr. Haseeb Bakhtary.

As per registered VPA-DD and GS 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 one dedicated staff to monitor all data into the IDBP Database that submitted to the National Office.[12] These Programme Assistant of IDBP takes charge in ensuring 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. Programme Assistant regularly check and verify all submissions before submitting confirmation to Finance for any payment release. Quality Inspectors[13] in the provinces also have access to Kobo to monitor their CPO's progress.

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 CPOs 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 and stored as printed hard copies in the National Office.

Article II. Description of human resources

Chabi B. Romzini: Chabi is the Director of PT. BKN. Chabi is in charge of supervise IDBP Program Manager who coordinates with Quality Inspectors on daily basis to provide updates about any occurring issues, implementation progress and working relations with partners.

Sutresniwati: Sutresniwati is in charge of running operations at PT. RASA, a surveyor company operating in Indonesia. PT. RASA delivers two types of services since 2015: field research, training and coaching. For field researchers, PT. RASA focus to serve clients who need assessment, baseline survey, gender sensitive study and impact assessment as well as project evaluation. PT. RASA has been in charge of implementing and analysis the BUS, KPT and Leakage Assessment since 2021.

Danastri W.: Danastri works as IDBP Program Manager in YRE. Danastri was responsible for the preparation of the KPT (BFT and PFT) that was implemented in 29 December 2023 – 2 April 2024. Danastri also responsible for overseeing all data entry process 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, among others.

Alfat Naufin: Alfat is the IDBP Programme Assistant in YRE. Alfat is responsible in managing the IDBP database, which includes data entry process and data verification for subsidy disbursement. Danastri also responsible in assisting the Programme Manager regarding IDBP on the daily basis.

Szymon Mikolajczyk and Haseeb Bakhtary: The key responsible persons for the preparation of this Monitoring Report. Szymon and Haseeb were selected consultants based on a tendering process conducted by YRE. Mr. S. Mikolajczyk has been involved with the IDBP since 2010 and assisted the IDBP through the Gold Standard validation, registration and first eight verifications process of VPA-1.

Article III. Survey design

The next table summarizes the design of the surveys:

Table 6: Survey designs summary (data for VPA-1 only)

Item	BUS 2023 (US + CMS)	KPT (PFT)	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 survey	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	35 – 59 households[16]	N/A	N/A
Number of clusters	7 cluster is relevant to this MR	N/A	N/A
Total sample size	**329**	**89**[17]	**39**

Article IV. Biogas user survey (US + CMS)

The Biogas User Survey (BUS) is the survey implemented under the VPA-1 annually that includes both the a) User Survey (US) and b) the Carbon Monitoring Survey (CMS). The survey was executed in 29 December 2023 - 2 April 2024 (referred to in this document as "BUS 2023") amongst a representative sample of biodigester households with the objective to obtain reliable and unbiased data on the user characteristics, impact of the programme on the Sustainable Development Goals (SDGs), 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 2023. 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 2023.

Table 7: BUS studies

#	Name of study	Monitoring interval	Conversion in MP4 of CPII
1	Project non-renewable biomass (NRB) assessment;	Once for the first crediting period	fNRB is established once for the entire second crediting period of VPA-1.
2	Project studies (PS) of target population characteristics;	Annual	Included in BUS 2023
3	Monitoring of the SDG parameters.	Annual	Included in BUS 2023
4	Leakage emission assessment	Every two years after first verification	Investigated alongside BUS 2023
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 second crediting period of VPA-1, the PP refers to the f_{NRB} of **58.36%** 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

12 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.

13 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.

14 VPA-1 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 "Drop_off_BUS_2023_rev.xlsx | Sheet "Drop off_2023" | cells J6 – P6

17 "20240705 KPT December 2023_YRE"1 | Sheet 90-30 test | cell AN48

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 29 December 2023 – 2 April 2024, the surveys were executed by a team of surveyors from IDBP. The BUS 2023 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). Given seven age groups, this exceeds the minimum threshold of 100 households for the Carbon Monitoring Survey. Note that the only requirement from the Gold Standard is that the Carbon Monitoring Survey includes a minimum of 100 households. 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.[18] 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) 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-1, the BUS approached a sample of **329** households. This exceeds the 7 age groups * 30 households = 210 households minimum threshold. The Usage Survey was fully included in the BUS.

For the BUS 2023, biogas users classified as the first year of use are those who have been using an IDBP biodigester from the start date of the VPA (October 2009) to May 2010. Biogas users classified as the second year of use are those who have been using an IDBP biodigester from June 2010 until May 2011. Biogas users classified as the third year of use are those who have been using an IDBP biodigester from June 2011 until May 2012. And so on.

The BUS 2023 covered all nine provinces that have become intervention areas of the VPA-1. Total sample of respondents per province determined proportionally to the total population of the respected province. Out of **329** households sampled, a total of **280** households was approached for VPA-1, with **221** households completing the interview and **59** not finishing it. **26** households have been reported as non-technical 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.

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

Table 8: BUS 2023 random sample size selection and geographical distribution (Age groups 8 through 14 are applicable to this MR)[19][20]

PROVINCES	Status	Y8	Y9	Y10	Y11	Y12	Y13	Y14	TOTAL
Bali	**Total approached**	**1**	**0**	**1**	**1**	**0**	**2**	**0**	**5**
	Total completed	1	0	0	0	0	2	0	3
West Java	**Total approached**	**1**	**0**	**5**	**1**	**12**	**7**	**1**	**27**
	Total completed	1	0	5	1	12	7	1	27
Central Java	**Total approached**	**6**	**2**	**3**	**1**	**2**	**4**	**3**	**21**
	Total completed	6	2	3	1	2	4	3	21
East Java	**Total approached**	**9**	**16**	**19**	**12**	**19**	**25**	**31**	**131**
	Total completed	8	14	15	10	16	21	29	113
Lampung	**Total approached**	**2**	**1**	**1**	**1**	**0**	**0**	**0**	**5**
	Total completed	2	1	1	1	0	0	0	5
NTB	**Total approached**	**9**	**8**	**9**	**14**	**6**	**4**	**0**	**50**
	Total completed	3	8	8	7	5	3	0	34
NTT	**Total approached**	**1**	**1**	**1**	**4**	**1**	**0**	**0**	**8**
	Total completed	0	0	1	3	1	0	0	5
South Sulawesi	**Total approached**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**4**
	Total completed	2	0	0	0	0	0	0	2
Yogyakarta	**Total approached**	**11**	**7**	**5**	**1**	**2**	**0**	**3**	**29**
	Total completed	3	3	3	0	2	0	0	11
									Total:
9 provinces	**Total sampled**	59	35	58	35	48	49	45	329
	Total approached	**44**	**35**	**44**	**35**	**42**	**42**	**38**	**280**
	Total completed	**26**	**28**	**36**	**23**	**38**	**37**	**33**	**221**

After random selection of the households by age group, the obtained drop-off rate of each year will be weighted according to the numbers of units built in that period. The drop-off rate will be applied when calculating the quantity of fuel consumed, where it is assumed that any drop off rate is replaced by fuel consumption of the applicable baseline scenario. 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))[21], 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 least at a confidence / precision level of 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 clusters was determined based on the objective of the study; i.e.: to understand the impact of the biogas plants installed among different age of

[19] 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.

[20] "Drop_off_BUS2023_rev" | Sheet Drop-off_2023 | cells K37:Q61 & S37:S61

[21] https://cdm.unfccc.int/Reference/Standards/meth/meth_stan05.pdf

		usage – based on the Gold Standard's definition (i.e.: Year 6 through Year 12 for this MR[22])
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 PT. RASA, an Indonesian surveyor company that has an established working relationship with YRE, was established to execute the survey. PT. RASA recruited 11 surveyors and 2 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 December 26, 2023; meanwhile field training was conducted on December 27. Data tabulation, analysis and reporting was prepared by PT. RASA.

Data collection tools

The questionnaire was developed jointly by the carbon consultant and PT. RASA, in consultation with YRE. The questionnaire was pilot tested during the field visit organised as part of the surveyor training. 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 PT. RASA with reference to the objectives of the study and in consultation with YRE. Pre-testing of the questionnaire was conducted by the PT. RASA team. Based on the results of this field test, questionnaire was finalised and sent to YRE for approval.

The fieldwork process was carried out by PT. RASA 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 PT. RASA, 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.[23]

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 29 December 2023 and 2 April 2024. The BFT results for VPA-1 are fixed throughout the crediting period.**

The KPT 2023 was executed according to this protocol:

- Test period shall be 1 days[24] = the measurement campaign (MC).
- The selected test day will span fuel measurement consumption for human food cooking and boiling water totaling 24 hours.

[22] The first year of use (age 12) must have technologies that have been in use on average longer than 0.5 years. For technologies in the second year of use (age 11), the technologies have been in use on average at least 1.5 years, and so on.

[23] There were no irregularities uncovered by the quality control performed by PT. RASA staff to confirm that the BUS surveys indeed had taken place.

[24] A MC of 1 days (24 hour) is allowed by the Gold Standard.

- 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 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-1 targets one group – biogas users (PFT only). Oversampling was conducted to minimise the necessity to redo the KPT in cases of wrongly filled out questionnaires or unreliable results:

Table 10: KPT 2023 target group

Group	Description of target group	Sample size
PFT household	Randomly selected household from the project database with a biodigester	89
	Total sample	**89**

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 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.
Implementation:	The KPT was executed in 29 December 2023 and 2 April 2024.
Desired Precision/Expected Variance and Sample Size.	90/30 rule of the applied methodology
Procedures for Administering Data Collection and Minimizing Non-Sampling Errors:	The survey data was entered by PT. RASA'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

Article VIII. KPT implementation

#	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 29 December 2023 and 2 April 2024, which is during the dry season.[25] 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. As the table hereunder demonstrates, the selected sample matches very well with the database.[26]

Size (m^3)	n[27]	% in Sample	% in Project database
4	41	46%	35%
6	21	24%	42%
8	16	18%	16%
10	6	7%	4%
12	2	2%	3%

KPT Implementation

KPT survey was performed with the same team who carried out the BUS 2023. The surveying team is composed of 11 surveyors and 2 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

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

[26] "2024_IDBP_Database_VPA1" | Tab "MASTER VPA1" | Cells Q20459:T20466

[27] Based on the 89 PFT KPT samples. See 20230410 20240705 KPT December 2023_YRE1_v.1.xls | sheet Biogas HH 2021 | cells P3 – P95

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 PT. RASA 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 trainer was Chabi Romzini from IDBP and Pak Andri Sugiono from PT RASA.

Data Collection Tools

As discussed above, the questionnaire was based on Berkeley Air KPT questionnaire.[28] 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 29 December 2023 – 2 April 2024. A day prior to the KPT, target respondents were visited to answer a set of screening questions[29], and asking their willingness to participate to the survey. In total, 89 households participated in the PFT part of the KPT testing. 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. No BFT was included in the KPT for VPA-1, as the BFT results are fixed.

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

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.[30] 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

[28] Household Energy and Health Programme: Kitchen Performance Test. Available on: https://cleancookstoves.org/binary-data/DOCUMENT/file/000/000/83-1.pdf

[29] 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.

[30] 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

$BB_{p,bio}$	Quantity of biomass consumed in project scenario p during year y	The amount of biomass consumed in the project scenario was weighted 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	The amount of LPG consumed in the project scenario was measured in time and average usage for one day was established. This amount was multiplied by 365 to generate the tonnes/year.

During the KPT, LPG was measured by calibrated weights.

SECTION D. DATA AND PARAMETERS

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

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	58.36
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	Calculation of baseline emissions
Additional comment	Since the MR of VPA1 covers the second crediting period of VPA-1, the PP refers to the fNRB of 58.36% as per that approved PDD.

Data/parameter	**NRB**
Unit	m3
Description	Non-renewable woody biomass
Source of data	FAO (2010) Global Forest Resources Assessment 2010 Country Report Indonesia; FAO (2015) Global Forest Assessment 2015; calculation
Value(s) applied	50,421,516
Choice of data or Measurement methods and procedures	NRB can be calculated by subtracting the DRB of 35,974,483 m3 from 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	Calculation of baseline emissions
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; FAO (2015) Global Forest Assessment 2015; calculation
Value(s) applied	35,974,483

Choice of data or Measurement methods and procedures	The annual sustainable yield from the plantations is determined to be 42,041,000 m^3, which is more conservative than the 35,378,000 m^3 estimated by ITTO (2009). The more conservative number 42,041,000 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 35,974,483 m^3.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	**$BB_{b1,bio}$**
Unit	Tonnes/year
Description	Amount of woody biomass used in the baseline scenario 1: households
Source of data	Baseline Survey, December 2017; Baseline December KPT 2017
Value(s) applied	1.435
Choice of data or Measurement methods and procedures	Baseline KPT was executed in December 2017 targeting 55 households. These households reported an average daily use of 3.93 kg of biomass, equivalent to 1.435 tonnes of biomass per year.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	**$BB_{b1,fuel}$**
Unit	Tonnes/year
Description	Amount of fossil fuels used in the baseline scenario 1: households
Source of data	Baseline Survey, December 2017; Baseline December KPT 2017
Value(s) applied	LPG: 0.088
Choice of data or Measurement methods and procedures	Baseline KPT was executed in the period from in of December 2017 targeting 55 households. These households reported an average daily use of 0.24 kg of LPG, equivalent to 0.088 tonnes of LPG per year.
Purpose of data	Calculation of baseline emissions
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	Calculation of baseline emissions
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	tCO_2/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	Calculation of project emissions
Additional comment	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	Calculation of baseline emissions
Additional comment	IPCC (2006); May be updated according to any future changes by the IPCC

Data/parameter	**$EF_{b1,\,fuel}$**
Unit	tCO_2/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	Calculation of baseline emissions
Additional comment	IPCC (2006); May be updated according to any future changes by the IPCC

Data/parameter	**$EF_{p1,\,fuel}$**
Unit	tCO_2/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	Calculation of baseline emissions
Additional comment	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	Calculation of baseline emissions
Additional comment	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	Calculation of baseline emissions
Additional comment	-

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	Calculation of baseline emissions
Additional comment	IPCC (2006); May be updated according to any future changes by the IPCC

D.2. Data and parameters monitored[31]

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 2023 results have been used for the purpose of the ex-post calculation – Drop_off_BUS2023_rev.xlsx | Sheet Drop-off_2023 | Cell E15 - E21
Value(s) of monitored parameter	0.899 With the following usage rate for each age group: **Age group** – **Usage rate** Age group 14 – 0.921 Age group 13 – 0.881 Age group 12 – 0.952 Age group 11 – 0.914 Age group 10 – 0.909 Age group 9 – 0.914 Age group 8 – 0.864
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	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
QA/QC procedures:	The usage rate of thermal applications will be 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:	Emission reduction calculation
Additional comments:	

Data/parameter:	**$N_{p1,y}$**
Unit	Number
Description	Cumulative number of project technology-days included in the project database for project scenario p1 against baseline scenario b1 in year y

[31] Note that all parameters collected from the BUS 2023 and the KPT 2021 are derived from a sample. All parameters derived from the IDBP Database are not based on a sample.

Measured/calculated/default	Measured
Source of data	IDBP database and Biogas User Survey; Biogas User Survey 2023 results have been used for the purpose of the ex-post calculation
Value(s) of monitored parameter	Reported as a result of ($No_{p1,y}$ * $U_{p1,y}$ *($O_{p1,y}$ / 365), which equals (20,252 * 0,899*364.9052/365) = 18,210 when rounded up
Monitoring equipment	NA
Measuring/reading/recording frequency:	Continuous
Calculation method (if applicable):	$N_{p1,y}$ is calculated from (a) the number of installed system (parameter $No_{p1,y}$); and (b) the average operational days of the system ($O_{p1,y}$). The equation is therefore ($N_{p,y}$ = $No_{p,y}$ * $U_{p1,y}$ *($O_{p,y}$ / 365))The average operational days will be confirmed upon verification. Households are required to notify provincial office staff in a situation when a biodigester stops working. This information is recorded in the IDBP database, allowing the identification per included biodigester the amount of operational days per year. In a scenario where the biodigester stops operating, the number of non-operational days is recorded in the database.
QA/QC procedures:	As per procedures of the IDBP database
Purpose of data:	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	2024_IDBP_Database_VPA1.xls
Value(s) of monitored parameter	20,252
Monitoring equipment	NA
Measuring/reading/recording frequency:	Continuous
Calculation method (if applicable):	The actual number of biodigesters.
QA/QC procedures:	As per procedures of the IDBP database
Purpose of data:	Emission reduction calculation
Additional comments:	-

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	ER Calculation with data from IDBP Database – "20240930 ER Calculation VPA1 MP6 CP2" sheet "GS VER 2023" cell E89
Value(s) of monitored parameter	364.9052
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 ($O_{p,y}$ = 365 – 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: 2024_IDBP_Database_VPA1" sheet "PLANT MAINTENANCE" cell I43056
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. See "20240930 ER Calculation VPA1 MP6 CP2.xls" | sheet GS VER2023 | cell E82
Value(s) of monitored parameter	0.067
Monitoring equipment	NA
Measuring/reading/recording frequency:	Every two years
Calculation method (if applicable):	
QA/QC procedures:	The leakage is 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, Version 3.1.
Purpose of data:	Calculation of leakage emissions
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 2023 – "BUS_2023_Tabulation_15072024.xlsx" | sheet "Tabulasi" | cells AD3860 & AG3953
Value(s) of monitored parameter	Dairy cows = 4.62[32] Beef cows = 0.79
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	Analysis of animal ownership from the BUS 2023 shows that dairy cows are the dominant type of animal owned by majority of biodigesters users (61%) followed by beef cows (28% of biodigesters users). Given the marginal emission impact of the latter two categories and for conservativeness, only methane emissions from dairy and beef cows will be considered in this emissions reduction calculation. Methane emissions from tertiary and any following animal types are not included for conservativeness. This means that the total average number of animals kept amounted to 4.62 dairy cows and 0.79 beef cows per household.
QA/QC procedures:	-
Purpose of data:	Calculation of baseline emissions

[32] According to the BUS 2023, dairy cows are the dominant type of animal owned by majority of biodigesters users (61%) followed by beef cows (28% of biodigesters users). Some households reported pigs and other animals such as goat and poultry, but their figures are immaterial and have been excluded from the ex-ante calculation presented in this PDD for conservativeness

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	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	As per Annex 6 of the applied methodology
QA/QC procedures:	-
Purpose of data:	Calculation of project emissions
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, 29 December 2023- 2 April 2024 – "20240705 KPT December 2023_YRE1.xls" | sheet 90-30 test | cell W99
Value(s) of monitored parameter	0.252
Monitoring equipment	Weight scale
Measuring/reading/recording frequency:	Updated every two years through a Project KPT
Calculation method (if applicable):	Project KPT was executed in 29 December 2023 - 2 April 2024 targeting 89 households. These households reported an average daily use of 0.69 kg of wood, equivalent to 0.252 tonnes of wood per year. 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:	Calculation of project emissions
Additional comments:	-

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, 29 December 2023- 2 April 2024 – "20240705 KPT December 2023_YRE1.xls" | sheet 90-30 test | cells AC99 & Z99
Value(s) of monitored parameter	LPG: 0.143 Kerosene: 0.068
Monitoring equipment	Weight scale
Measuring/reading/recording frequency:	Updated every two years through a Project KPT
Calculation method (if applicable):	Project KPT was executed in 29 December 2023 - 2 April 2024 targeting 89 households. These households reported an average daily use of 0.39 kg of LPG, equivalent to 0.143 tonnes of LPG per year, and a average daily use of 0.19 kg of kerosene, equivalent to 0.068 tonnes of Kerosene per year. 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:	Calculation of project emissions
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_2023_Tabulation_15072024.xlsx" | sheet "Tabulasi" | cell AI5064
Value(s) of monitored parameter	17.0
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	
QA/QC procedures:	-
Purpose of data:	Calculation of project emissions
Additional comments:	-

Data/parameter:	**$MS_{T,S,k}$**
Unit	%
Description	Fraction of livestock category T's manure fed into the bio-digester, in climate region k
Measured/calculated/default	Measured
Source of data	"BUS_2023_Tabulation_15072024.xlsx" | sheet "Tabulasi"| cell AI5063
Value(s) of monitored parameter	83.0
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	-
QA/QC procedures:	-
Purpose of data:	Calculation of project emissions
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 AR5; Updated according to changes by the IPCC
Value(s) of monitored parameter	28
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	
QA/QC procedures:	-
Purpose of data:	Emission reduction calculation
Additional comments:	-

Data/parameter:	Bio
Unit	%
Description	Use of bio-slurry
Measured/calculated/default	Measured
Source of data	"BUS_2023_Tabulation_15072024.xlsx" | sheet "Tabulasi"| cell Z4129
Value(s) of monitored parameter	19.6
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	To be updated through the annual Biogas User Survey
QA/QC procedures:	-
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 monitoring report will consider the following SDG impacts:[33]

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	"BUS_2023_Tabulation_150702024.xlsx" | sheet "Tabulasi"| cell Z4129
Value(s) of monitored parameter	19.6%, equivalent to 3,979 households (19.6% * 20,252 biodigesters)
Monitoring equipment	NA
Measuring/reading/recording frequency:	Number of users applying the final biodigester slurry on agricultural land. Data is to be collected annually.
Calculation method (if applicable):	
QA/QC procedures:	
Purpose of data:	SDG impact monitoring **for SDG-2 Zero Hunger**
Additional comments:	-

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.

[33] Refer to accompanying GS Transition Annex for further details.

Measured/calculated/default	Measured
Source of data	IDBP Database. See: "2024_IDBP_Database_VPA1.xls" | sheet "SPV" | cells L211 and M211
Value(s) of monitored parameter	0 during the monitoring period 01/01/2023 – 31/12/2023. The trainings are conducted after new biodigesters are installed. In VPA1, there was no new installations in 2023 and hence no trainings were conducted. Please see page 8 above. 1,382 during the lifetime of the project
Monitoring equipment	NA
Measuring/reading/recording frequency:	
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'. Hard copies of all certificates issued will be kept by the CME.
Purpose of data:	SDG impact monitoring for **SDG-1 No Poverty**
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	"BUS_2023_Tabulation_15072024.xlsx" | sheet "Tabulasi"| cells AD1834 and AD1835
Value(s) of monitored parameter	'The same': 3,096 (equivalent to 15,3% of total units in operation) 'Improved': 17,156 (equivalent to 84.7% of total units in operation)
Monitoring equipment	NA
Measuring/reading/recording frequency:	Annually
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) no answer; 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'.
Purpose of data:	SDG impact monitoring for **SDG-1 No Poverty**
Additional comments:	-

Data/parameter:	**GS-08 Access to affordable and clean energy services**
Unit	Number
Description	Access to energy services refer to changes in unsustainable energy use.
Measured/calculated/default	Measured
Source of data	See: "Drop_off_BUS2023_rev.xlsx" | sheet "'Drop_off_2023"| cell H30
Value(s) of monitored parameter	**18,215** biodigester technologies in operation during monitoring period 01/01/2023 – 31/12/2023 and **20,252** biodigester technologies installed until 31/12/2023

Monitoring equipment	NA
Measuring/reading/recording frequency:	
Calculation method (if applicable):	
QA/QC procedures:	As per the VPA-DD, access to energy services refers to changes in unsustainable energy use. This parameter is monitored through the number of biogas units commissioned, and is therefore same as parameter 'Np1,y'
Purpose of data:	SDG impact monitoring for **SDG-7 Affordable and Clean Energy**
Additional comments:	

Data/parameter:	**GS-09 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. See: " 2024_IDBP_Database_VPA1.xls" | sheet "O&M training" | cell G14558 and H14558
Value(s) of monitored parameter	0 during the monitoring period 01/01/2023 – 31/12/2023. The trainings are conducted after new biodigesters are installed. In VPA1, there was no new installations in 2023 and hence no trainings were conducted. Please see page 8 above. 4,050 during the lifetime of the project
Monitoring equipment	NA
Measuring/reading/recording frequency:	
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, Version 3.1.
Purpose of data:	SDG impact monitoring for **SDG-5 Gender Equality**
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 amount of users selling biodigester slurry on the market will be monitored.
Measured/calculated/default	
Source of data	Employment records and through the IDBP Database; Biogas User Survey: 2024_IDBP_Database_VPA1.xls | sheet "SPV"| cells L213 and M213 "BUS_2023_Tabulation_15072024.xlsx" | sheet "Tabulasi"| cell Z4131

Value(s) of monitored parameter	0 number of direct jobs created by the VPA during monitoring period 01/01/2023 – 31/12/2023 355 households sell the bio-slurry on the market (1.8% of total) 1,501 number of direct jobs created by the VPA during the lifetime of VPA 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 2023 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, Version 3.1.
Purpose of data:	SDG impact monitoring for **SDG-1 No Poverty**
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	Measured
Source of data	Training records and through the IDBP Database. See: 2024_IDBP_Database_VPA1.xls | sheet "O&M training" | cell G14560 and H14560
Value(s) of monitored parameter	0 during monitoring period 01/01/2023 – 31/12/2023 14,529 during the lifetime of the VPA
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, Version 3.1.
Purpose of data:	SDG impact monitoring for **SDG-7 Affordable and Clean Energy**
Additional comments:	

Data / Parameter	**GS-13 Establishment of sustainable food production area**
Unit	Hectare
Description	Area with application of bioslurry or compost.
Source of data	Collected through the annual Biogas User Survey. See: GS-13 calculation 2023_ver1 | sheet 'Analysis' | cell B28
Value(s) applied	305.10

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 (Version 3.1).
Purpose of data	SDG impact monitoring for **SDG-2 No Hunger**
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: "BUS_2023_Tabulation_150702024.xlsx" | sheet "Tabulasi"| cell AE3203 and cell AC3203
Value(s) applied	95.4 (equivalent to 19,320 women)
Measurement methods and procedures	The BUS will ask respondents whether after the installation of a biodigester if they still collect firewood
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 (Version 3.1).
Purpose of data	SDG impact monitoring for **SDG-5 Gender Equality**
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. See: "BUS_2023_Tabulation_1500702024.xlsx" | sheet "Tabulasi"| cell AC3211
Value(s) applied	22.0% (equivalent to 4,454 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 (Version 3.1).
Purpose of data	SDG impact monitoring for **SDG-5 Gender Equality**
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	**45,098** tCO_2e	**50,568** tCO_2e
GS-03 Soil condition	3,979 households	4,974 households
GS-06 Quality of employment	0 during monitoring period 01/01/2023 – 31/12/2023 1,382 people attending vocational training during the lifetime of the project	0 during monitoring period 01/01/2022 – 31/12/2022 1,382 people attending vocational training during the lifetime of the project

GS-07 Livelihood of the poor	'The same': 3,096 (equivalent to 15,3% of total units in operation) 'Improved': 17,156 (equivalent to 84.795.4% of total units in operation)	'The same': 3,931 (equivalent to 19,4% of total units in operation) 'Improved': 16,065 (equivalent to 79.3% of total units in operation)
GS-08 Access to affordable and clean energy services	**18,215** biodigester technologies in operation during monitoring period 01/01/2023 – 31/12/2023 and **20,252** biodigester technologies installed until 31/12/2023	**19,834** biodigester technologies in operation during monitoring period 01/01/2022 – 31/12/2022 and **20,252** biodigester technologies installed until 31/12/2022
GS-09 Human and institutional capacity	0 women attend the Operation and Maintenance training during monitoring period 01/01/2023 – 31/12/2023 4,050 women attend the Operation and Maintenance training during the lifetime of the project	0 women attend the Operation and Maintenance training during monitoring period 01/01/2022 – 31/12/2022 4,050 women attend the Operation and Maintenance training during the lifetime of the project
GS-10 Quantitative employment and income generation	0 number of direct jobs created by the VPA during monitoring period 01/01/2023 – 31/12/2023 355 households sell the bio-slurry on the market (1.8% of total during monitoring period 01/01/2023 – 31/12/2023 1,501 number of direct jobs created by the VPA during the lifetime of the project	0 number of direct jobs created by the VPA during monitoring period 01/01/2022 – 31/12/2022 497 households sell the bio-slurry on the market (2.5% of total during monitoring period 01/01/2022 – 31/12/2022 1,501 number of direct jobs created by the VPA during the lifetime of the project
GS-12 Technology transfer and technological self-reliance	0 users attending training during monitoring period 01/01/2023 – 31/12/2023 14,529 users attending training during the lifetime of the project	0 users attending training during monitoring period 01/01/2022 – 31/12/2022 14,529 users attending training during the lifetime of the project
GS-13 Establishment of sustainable food production area	305.10 hectares	341.90 hectares
GS-14 Time saved	95.4% (equivalent to 19,320 women)	87.3% (equivalent to 17,688 women)
GS-15 Productive use of time	22.0% (equivalent to 4,454 women)	23.6% (equivalent to 4,785 women)

D.4. Implementation of sampling plan

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All monitoring is coordinated by YRE, the implementer of VPA-1 and the CME of the programme. The sampling plan of this VPA is in line with 'Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities' (EB 69, Annex 4) is outlined below.

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, Version 3.1. 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[34] 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 B.3 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 fertilizer record-keeping database managed by the CME.

Sampling method and sample size
The CME is responsible for the production of periodical monitoring reports for the VPA-1, 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.[35] 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

[34] As defined by the Guidelines for Sampling and Surveys for Small-Scale CDM project activities, Version 04.0 (EB 67)

[35] Technologies and Practices to Displace Decentralized Thermal Energy Consumption, Version 3.1 p.31

Baseline data for the VPA-1 has been established *ex-ante* for households through the IDBP Baseline Survey implemented in December 2017. This survey was prepared in accordance with the Gold Standard guidelines with the aim to source critical information on the target population characteristics and the applicable baseline scenario of the VPA. The questionnaire included sections to capture information regarding the socio-economic profile of the respondent, its historical fuel use, and the development of indicators on forest degradation. The survey targeted a sample of households in the target population of the programme which resided in Indonesia and were using biomass and/or fossil fuel for cooking purposes and owned a minimum of two dairy cows or buffalo, three pigs or 100 chickens. The surveyors were asked to only approach the head of each household who was aware of the household's fuel use habits and manure handling practices.

A total of 123 respondents were surveyed nationwide, exceeding the minimum sample size of 100 required by the applicable Gold Standard methodology to ensure compliance with the 90/10 confidence/precision level. The households were selected using simple random sampling applied cross all nine provinces where VPA-1 is being implemented. To increase the representativeness of the sample population, more populated provinces were surveyed in multiple districts and sub-districts. The final list of target households therefore offers a randomly selected sample group representative for the target population, accounting for population size differences through determining the sampling frequency proportionally to the target cluster size.

Table 14: Baseline Survey design[36]

Item	Conversion in Baseline Survey
Sampling objective:	The objective of the sampling effort is to obtain data of baseline households
Field Measurement Objectives and Data to be collected:	The survey consists of a 24-hour measurement campaign amongst BFT households
Target Population and Sampling Frame:	The survey was conducted in 9 provinces of Indonesia, with total sample is 123 households. Sample distribution for each province was determined proportionally to the total biogas user population covered under the VPA
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.
Implementation:	The Baseline Survey was executed between the 12th and 30th of December 2017
Desired Precision/Expected Variance and Sample Size.	Group size > 1000 Minimum sample size 100, which was exceeded by 23 households
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

Baseline emissions relating to use of biomass and fossil fuel have been confirmed *ex-post* through the Baseline Performance Field test (BFT) of fuel consumption conducted in December 2017, as described in Section 7 of the methodology. The values for parameters $BB_{b1,bio}$ and $BB_{b1,bio}$ will be applied ex-post to VPA-1 across the second CP, as reported in Section B.4.2 of the VPA-DD.

Table 15: KPT survey design[37]

Item	Conversion in KPT
Sampling objective:	The objective of the sampling effort is to obtain reliable fuel use data of baseline households
Field Measurement Objectives and Data to be collected:	The survey consists of a 24-hour measurement campaign amongst BFT households

[36] Please see BUS_2023_Tabulation_15072024 for the Biogas User Survey and analysis
[37] Please see 20240705 KPT December 2023_YRE1

Target Population and Sampling Frame:	The sampling frame was drawn from the project database (neighboring households)
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 neighbouring equivalent household to the selected PFT
Implementation:	The KPT was executed in 29 December 2023 and 2 April 2024
Desired Precision/Expected Variance and Sample Size.	90/30 rule of the applied methodology
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

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

All personnel conducting the Project Performance Field test and annual monitoring of the VPA-1, 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 fertilized by contacting all randomly-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[38] 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-1, as outlined in the applied methodology, are as follows:

A Biogas User Survey[39] 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 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.

[38] Please see BUS_2023_Tabulation_15072024 for the 2023 data
[39] Please see BUS_2023_Tabulation_15072024 for the Biogas User Survey and analysis

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

>>

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 Version 3.1". 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	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: $\mathbf{BE_{b1,CH4,y}} = GWP_{CH4} * \sum_T (EF_{awms,T} * N_{T,h})$ Together amounting to (after correcting for drop off): **103,835** tCO_2e * *Please refer to cell G100 of "20240930 ER Calculation VPA1 MP6 CP2.xls" | "Sheet GS VER 2023"*
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

>>

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 Version 3.1". 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 after correcting for drop off: **57,523** tCO_2e * *Please refer to cell G101 of "20240930 ER Calculation VPA1 MP6 CP2.xls" | "Sheet GS VER 2023"*
SDG 7: Affordable and Clean Energy	GS-08 Access to affordable and clean energy services	**18,215** units in operation and **20,252** biodigester technologies installed, calculated by tracking in the IDBP database all eligible biodigesters installed until 31/12/2023 and usage rate.
	GS-12 Technology transfer and technological self-reliance	0 users attending training during monitoring period 01/01/2023 – 31/12/2023 14,529 users attending training during the lifetime of the project
SDG 5: Gender Equality	GS-09 Human and institutional capacity	**0** women attend the Operation and Maintenance training during monitoring period 01/01/2023 – 31/12/2023 **4,050** women attend the Operation and Maintenance training during the lifetime of the project, calculated by tracking in the IDBP database all O&M trainings until 31/12/2023.
	GS-14 Time saved	**19,320** women reporting to have saved time, as calculated by the BUS survey responses with 95.4% of the 20,252 biodigesters installed (0.954* 20,252 = 19,320)
	GS-15 Productive use of time	**4,454** women reporting to have more time for productive use, as calculated by the BUS survey responses with 22.0% of the 20,252 biodigesters installed (0.22* 20,252 = 4,454)
SDG 2: No Hunger	GS-03 Soil condition	**3,979** households use bio-slurry on land, as calculated by the BUS survey responses with 19.6% of the 20,252 biodigesters installed (0.196* 20,252 = 3,979)
	GS-13 Establishment of sustainable food production area	**305.10** hectares applying bio-slurry, per month, calculated by correcting the total units (20,252) by the drop-off rate

		(9.29%) and multiplying it by bio-slurry usage as fertilizer according to the BUS (19.6%) and finally applying conversions to get to hectares
SDG 1: No Poverty	GS-06 Quality of employment	**0** in the 2023 during monitoring period 01/01/2023 – 31/12/2023 **1,382** people attending vocational training during the lifetime of the project
	GS-07 Livelihood of the poor	'No answer': 0 (equivalent to 0.0% of total units in operation) 'The same': 3,096 (equivalent to 15.3% of total units in operation) 'Improved': 17,156 (equivalent to 84.7% of total units in operation)
	GS-10 Quantitative employment and income generation	**0** number of direct jobs created by the VPA during monitoring period 01/01/2023 – 31/12/2023 **355** households sell the bio-slurry on the market (equivalent to 1.8% taken from BUS of total units in operation (20,252) during the monitoring period 01/01/2023 – 31/12/2023 **1,501** number of direct jobs created by the VPA during the lifetime of the project, calculated by tracking in the IDBP database all employment opportunities until 31/12/2023.

E.3. Calculation of leakage

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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 Version 3.1". 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	**LE y: $LE_{p1\ CO2,y + CH4,y}$** 0.067 tCO_2e per unit. 20,252 units * 0.067 * Usage rate = 1,213 tCO_2e See: "20240930 ER Calculation VPA1 MP6 CP2, Sheet GS VER 2023, Cell G102.

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	Climate change	**103,835** tCO_2e	**57,523** tCO_2e as per the equation:	**45,098** tCO_2e

The estimated annual emission reduction is based on methodology "Technologies and practices to displace decentralized thermal energy consumption Version 3.1". 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			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.	**18,215** biodigester technologies in operation during monitoring period 01/01/2023 – 31/12/2023 and **20,252** biodigester technologies installed until 31/12/2023.	**18,215** biodigester technologies in operation during monitoring period 01/01/2023 – 31/12/2023 and **20,252** biodigester technologies installed until 31/12/2023.
	GS-12 Technology transfer and technological self-reliance	No training opportunities and transfer of technology in the biogas sector.	**0** users attending training during the monitoring period 01/01/2023 – 31/12/2023 **14,529** users attending training during project lifetime	**0** users attending training during the monitoring period 01/01/2023 – 31/12/2023 **14,529** users attending training during project lifetime
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.	**0** women attend the Operation and Maintenance training during monitoring period 01/01/2023 – 31/12/2023 **4,050** women attend the Operation and Maintenance training during the lifetime of the project	**0** women attend the Operation and Maintenance training during monitoring period 01/01/2023 – 31/12/2023 **4,050** women attend the Operation and Maintenance training during the lifetime of the project

	GS-14 Time saved	No time savings, as women spend a significant proportion of their time having to collect biomass for cooking purposes.	**19,320** women reporting to have saved time.	**19,320** women reporting to have saved time.
	GS-15 Productive use of time	No productive use of time as women lack spare time to pursue income generating activities.	**4,454** women reporting to have more time for productive use.	**4,454** women reporting to have more time for productive use.
SDG 2: No Hunger	GS-03 Soil condition	No slurry is used as fertilizer on agricultural land (in terms of number of farmers).	**3,979** households use bio-slurry on land	**3,979** households use bio-slurry on land
	GS-13 Establishment of sustainable food production area	No slurry is used as fertilizer on agricultural land (in terms of area).	**305.10** hectares applying bio-slurry, per month	**305.10** hectares applying bio-slurry, per month
SDG 1: No Poverty	GS-06 Quality of employment	No training and employment opportunities linked to biogas market.	**0** in the 2023 during monitoring period 01/01/2023 – 31/12/2023 **1,382** people attending vocational training during the lifetime of the project	**0** during monitoring period 01/01/2023 – 31/12/2023 **1,382** people attending vocational training during the lifetime of the project
	GS-07 Livelihood of the poor	Livelihood of the poor is unchanged.	'No answer': 0 (equivalent to 0.0% of total units in operation) 'The same': 3,096 (equivalent to 15.3% of total units in operation) 'Improved': 17,156 (equivalent to 84.7% of total units in operation)	'No answer': 0 (equivalent to 0.0% of total units in operation) 'The same': 3,096 (equivalent to 15.3% of total units in operation) 'Improved': 17,156 (equivalent to 84.7% of total units in operation)
	GS-10 Quantitative employment and income generation	No training and employment opportunities linked to biogas market.	**0** number of direct jobs created by the VPA during monitoring period 01/01/2023 – 31/12/2023 **355** households sell the bio-slurry on the market (1.8% of total) during monitoring period 01/01/2023 – 31/12/2023 **1,501** number of direct jobs created by the VPA during the lifetime of the project	**0** number of direct jobs created by the VPA during monitoring period 01/01/2023 – 31/12/2023 **355** households sell the bio-slurry on the market (1.8% of total) during monitoring period 01/01/2023 – 31/12/2023 **1,501** number of direct jobs created by the VPA during the lifetime of the project

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: 104,353 - 47,854 - 1,443 = **55,056** tCO_2e	ER y = BE y - PE y – LE y Being: 103,835- 57,523– 1,213 = **45,098** 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)	**18,215** biodigester technologies in operation during monitoring period 01/01/2023 – 31/12/2023 and **20,252** biodigester technologies installed until 31/12/2023
	No training opportunities and transfer of technology in the biogas sector (GS-12)	**0** users attending training during monitoring period 01/01/2023 – 31/12/2023 **14,529** users attending training during the lifetime of the project
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)	**0** women attend the Operation and Maintenance training during monitoring period 01/01/2023 – 31/12/2023 **4,050** women attend the Operation and Maintenance training during the lifetime of the project
	No time savings, as women spend a significant proportion of their time having to collect biomass for cooking purposes (GS-14)	**19,320** women reporting to have saved time.
	No productive use of time as women lack spare time to pursue income generating activities (GS-15)	**4,454** women reporting to have more time for productive use.
SDG 2: No Hunger	No slurry is used as fertilizer on agricultural land (in terms of number of farmers) (GS-03)	**3,979** households use bio-slurry on land
	No slurry is used as fertilizer on agricultural land (in terms of area) (GS-13)	**305.10** hectares applying bio-slurry, per month
SDG 1: No Poverty	No training and employment opportunities linked to biogas market (GS-06)	**0** during monitoring period 01/01/2023 – 31/12/2023. **1,382** people attending vocational training during the lifetime of the project
	Livelihood of the poor is unchanged (GS-07)	'No answer': 0 (equivalent to 0.0% of total units in operation) 'The same': 3,096 (equivalent to 15.3% of total units in operation) 'Improved': 17,156 (equivalent to 84.7% of total units in operation)
	No training and employment opportunities linked to biogas market (GS-10)	**0** number of direct jobs created by the VPA during monitoring period 01/01/2023 – 31/12/2023 **355** households sell the bio-slurry on the market (1.8% of total) during monitoring period 01/01/2023 – 31/12/2023 **1,501** number of direct jobs created by the VPA during the lifetime of the project

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

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

Table 16: 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	2.433	0.776	0.083	**1.574**
Methane avoidance	3.557	1.971	-	**1.586**
Total	5.990	2.747	0.083	**3.160**

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 (2.244 tonnes/year) is higher than the amounts measured in the KPT (0.311 tonnes/year); however, the KPT results indicate a slightly higher usage of LPG (0.143 tonnes/year compared to 0.078 tonnes/year, ex-ante). The amounts of kerosene observed in the KPT are higher than those reported in the baseline study (0.068 tonnes/year compared to 0 tonnes/year, ex-ante). These factors combined explain the decrease from the ex-ante ER estimate of 1.574 tCO_2e to ex-post 0.695 tCO_2e due to biomass and fossil fuel substitution.
- On the household level: The number of cows reported in the baseline study (average of 4.59 per household) is lower than the number reported in the BUS 2023 (average of 4.62 dairy cows and 0.79 beef cows per household). This factor explains the increase from the ex-ante ER of 1.586 tCO_2e to ex-post 1.761 tCO_2e) due to methane avoidance.
- On the VPA level: total annual ex-post emission reductions (45,098 tCO2e) are lower than the ex-ante annual emission reduction reported in the VPA-DD (55,056 tCO2e).

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 20,252 units implemented to date under the VPA-1, this cumulates to 38.74 MW_{th} (see Section B.1 for the calculation). This is below the 45MW_{th}. For Type III, as each biodigester produces a maximum emission reduction of 1.761 tCO_2e, given 20,252 biodigesters installed, the cumulative amount of emission reductions from the methane avoidance component is 35,667 tCO_2e. This is below the 60,000 tCO_2e. Annualised, the results are as follows:

Table 17: Overview of ex-ante and ex-post VPA results versus applicable small-scale thresholds

Type	01/01/2023 to 31/12/2023
Ex-ante	
Type I (45 MW_{th})	38.74 MW_{th}[40]
Type III (60,000 tCO_2e)	32,129 tCO_2e[41]
Ex-post	
Type I (45 MW_{th})	38.74 MW_{th}[42]
Type III (60,000 tCO_2e)	35,667 tCO_2e[43]

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

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[40] See footnote 50 of the VPA-DD

[41] See page 35 of the VPA-DD

[42] For calculation, refer to "20240930 ER Calculation VPA1 MP6 CP2.xls" | sheet "Capacity calculation"

[43] For calculation, refer to "20240930 ER Calculation VPA1 MP6 CP2.xls" | sheet "GS VER 2023"| Cell E94

	Current MP	PDD estimate	Explanation
SDG 13	Total emission reduction: **45,098** tCO_2e/ this monitoring period.	Total emission reduction: **55,056** tCO_2e/ ex ante estimate in PDD.	The monitored value under this monitoring period is 23% lower than the estimated value. This is due to a higher drop off rate than expected.
SDG 7: Affordable and Clean Energy	**18,215** biodigester technologies in operation during monitoring period 01/01/2023 – 31/12/2023 and **20,252** biodigester technologies installed until 31/12/2023.	**20,253** biodigester technologies installed.	One unit was taken out as it related to a household that switched to using tofu as input for feed, rather than dung.
	0 users attending training.	-	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	**0** women attend the Operation and Maintenance training.	-	Same as above
	19,320 women reporting to have saved time.	-	Same as above
	4,454 women reporting to have more time for productive use.	-	Same as above
SDG 2: No Hunger	**3,979** households use bio-slurry on land	-	Same as above
	305.10 hectares applying bio-slurry, per month	-	Same as above
SDG 1: No Poverty	**0** number of direct jobs created by the VPA **355** households sell the bio-slurry on the market (1.8% of total)	-	Same as above
	'No answer': 0 (equivalent to 0.0% of total units in operation) 'The same': 3,096 (equivalent to 15.3% of total units in operation) 'Improved': 17,156 (equivalent to 84.7% of total units in operation)	-	Same as above
	0 vocational trainings conducted	-	Same as above

SECTION F. SAFEGUARDS REPORTING

>>

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.

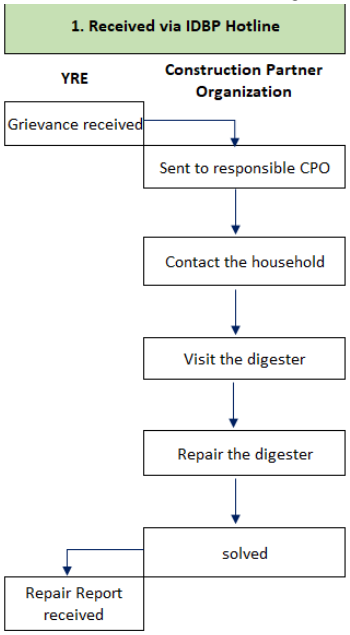
>>

Period	Grievances ongoing	Grievances closed	Total
01/01/2023 – 31/12/2023	0	141	141

All grievances are repair requests. 2 main problems are: Dome leakage and clogged pipe.

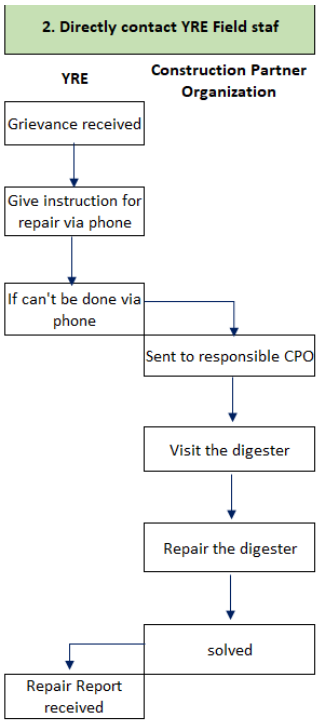
The grievance mechanism has three main components to receive, respond and address grievances: 1. IDBP Hotline, 2. Directly contact YRE Field officer, and 3. Directly contact the CPO

1. IDBP Hotline:
IDBP has one Hotline with active phone number and WhatsApp. Grievances might be received through messages and/or phone calls to the Hotline from households. YRE will assign responsible CPO to follow up the grievance. CPO will contact the household directly to confirm the grievance and to determine visit date for repairment/service. After the service or repairment is done and solved, CPO needs to report back to YRE with proof of photos (during service process or after the service/repairment). Below is a flow of how grievances are received and handled through this channel:

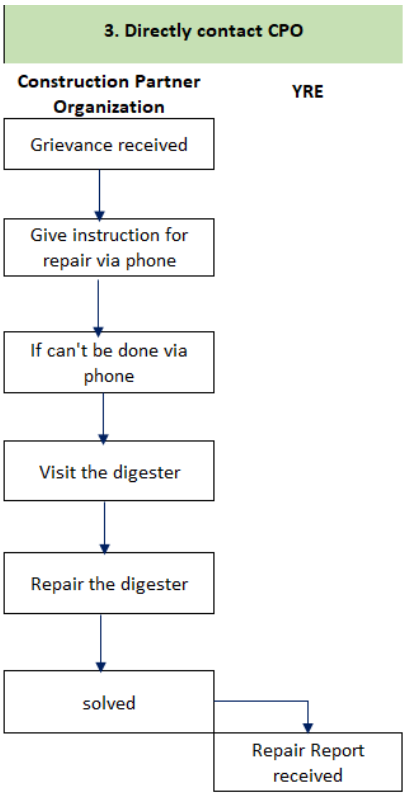


2. Directly contact YRE Field officer:
Grievances might be received through messages and/or phone calls by the Field Officer from households. Field officer will give instructions and recommendations for self-repairment over the phone to households. In the event that biogas installation problem could not be done by the household themselves, YRE will assign responsible

CPO to follow up the grievance and to determine visit date for repairment/service. After the service or repairment is done and solved, CPO needs to report back to YRE with proof of photos (during service process or after the service/repairment). Below is a flow of how grievances are handled through this channel:



3. Directly contact the CPO:
Household might deliver their grievances directly to CPO through messages and/or phone calls. CPO will give instructions and recommendations for self-repairment over the phone to households. In the event that biogas installation problem could not be done by the household themselves, CPO will determine visit date for repairment/service. After the service or repairment is done and solved, CPO needs to report to YRE with proof of photos (during service process or after the service/repairment). Below is a flow of how grievances are handled through this channel:



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

>>
As per G.1, there are 0 grievances ongoing during the 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.

APPENDIX. 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-1. As the baseline fuel and the project fuel and the corresponding emission factors are different, the overall GHG reductions achieved by VPA-1 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:

$ER_{CO2,y}$	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)
$ER_{b1,p1,y,CO2}$	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
$ER_{b1,p1,y,non\text{-}CO2}$	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-1 can apply the following formula for calculating emission reductions:

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

Where:

$\sum ER_{CO2,y}$	Cumulative CO_2 emission reductions from the substitution of non-renewable biomass and fossil fuels
$\sum BE_{b1,CO2,y}$	Cumulative baseline emissions as calculated below under formula (**3**) of the VPA PDD
$\sum PE_{p1,CO2,y}$	Cumulative project emissions as calculated below under formula (**4**) of VPA PDD
$\sum LE_{p1,CO2,y}$	Cumulative leakage as per methodology guidance[44]
$N_{p1,y}$	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:

[44] Technologies and practices to displace decentralized thermal energy (Version 3.1) p.11 - 12

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

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 18: Thermal energy demand based on KPT results[45]

Fuel	Average per household (tonne/year)	NCV (TJ/tonne)	Thermal energy demand (TJ/year) (Fuel * NCV)
Biomass	1.435	0.015	0.0215
LPG	0.088	0.0473	0.0042
Kerosene	0.0	0.0438	0

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 19: CO2 emission factors

Fuel *i*	$EF_{CO2,}$ (tonne/TJ)
Biomass	112.00
LPG	63.1
Kerosene	71.9

The f_{NRB} is estimated to be 58.36%, as per the respective registered PDD. The f_{NRB} value is applicable to CO_2 emissions from biomass and charcoal consumption and production. Methane and nitrous oxide emission are not

[45] See: 20180407 KPT December 2017.xls | sheet '90-30 test' | cells F65 and I65

included in the emission reduction calculation for conservativeness. The calculated ex-post baseline emissions are shown in next table:

Table 20: Ex-post baseline emission of each fuel and total from thermal energy use[46]

Fuel	Baseline emissions from CO_2 (tCO_2e/yr)
Biomass	1.407
LPG	0.263
Kerosene	0
Total	**1.670**

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
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 21: KPT PFT fuel use[47]

Fuel	Average per household (tonne/year)	NCV (TJ/tonne)	Thermal energy demand (TJ/year) (Fuel * NCV)
Biomass	0.252	0.015	0.0038

[46] Figures may not add up due to rounding – see emission reduction calculation at: "20240930 ER Calculation VPA1 MP6 CP2"| Sheet "GS VER 2023".

[47] 20240705 KPT December 2023_YRE1.xls | sheet '90-30 test' | cells W103 and AC103 and See "20240930 ER Calculation VPA1 MP6 CP2.xls"| sheet "GS VER 2023"

LPG	0.143	0.0473	0.0068
Kerosene	0.068	0.0438	0.0029

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

Table 22: KPT PFT emissions[48]

Fuel	Project emissions from CO_2 ($tCO_2e/yr/hh$)
Biomass	0.247
LPG	0.427
Kerosene	0.214
Total	**0.888**

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 2023, 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, 4/46 of the households uses more fuel (biomass, LPG, and/or kerosene) because of the neighbor having a biogas digester.[49] This amounts to leakage emissions of 0.067 tCO_2e per year.[50]

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:

$ER_{CO2,y}$	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[51], 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

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

[49] 20240930 ER Calculation VPA1 MP6 CP2| Tab GS VER 2023 | cell E81

[50] See "20240930 ER Calculation VPA1 MP6 CP2.xls"| sheet "GS VER 2023" | cell E81

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

- f_{NRB} of 58.36%

The calculations itself are based on the reference in the TPPDEC methodology[52] 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 23: 90/30 rule check on baseline emissions[53]

Item	Unit	Baseline	
Sample	n	55	
	Analysis		
	Mean		1.83
	Standard error		1.4231
	Minimum requirement n		18.15
	Satisfy the 90/30 rule		Yes, as: 55 > 18.15

-

Table 24: 90/30 rule check on project emissions[54]

Item	Unit		Project
Sample	n		89
	Analysis		
	Mean		0.76
	Standard error		0.9850
	Minimum requirement n		50.26
	Satisfy the 90/30 rule		Yes, as: 89 > 50.26

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 25: Emission reductions from fuel switch[55]

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)
1.670	0.888	0.067	**0.715**

(B) <u>EMISSION REDUCTION COMPONENT 2:</u> 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.

[52] Harvey, A. & Thomas A. (2011) Guidelines for Performance Tests of Energy Saving Devices and Kitchen Performance Test (KPTs). Retrieved from: https://1library.net/document/zwr7290y-guidelines-field-performance-energy-saving-devices-kitchen-performance.html

[53] See: 20180407 KPT December 2017, sheet '90-30 Test', Cells AF27-30. 2017 KPT is made as baseline as KPT results are a fixed parameter for this VPA

[54] See: 20240705 KPT December 2023_YRE1.xls | sheet '90-30 test' | cells AN45 – AN49

[55] Figures may not add up due to rounding – see emission reduction calculation 20240930 ER Calculation VPA1 MP6 CP2 | tab GS VER 2023 | cell E85

Baseline emissions

This formula calculates the baseline emissions per household:

$$\mathbf{BE_{b1,CH4,y}} = GWP_{CH4} * \sum_T (EF_{awms,T} * N_{T,h}) \quad \textbf{(7)}$$

Where:

$BE_{b1,CH4,y}$	Baseline emissions from manure handling during the year y in tCO_2e
GWP_{CH4}	Global Warming Potential of methane (28)
$EF_{awms,T}$	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[56]. These values are reported in Table 26. A national average temperature of 27.1°C applies, as reported by the Indonesian Meteorological Climatological and Geophysical Agency.[57]

Table 26: IPCC 2006 default values for EFawms, T[58]

Animal T	$EF_{awms,T}$
Dairy cow	0.031 tonne CH_4
Beef cow	0.001 tonne CH_4

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

Analysis of animal ownership from the BUS 2023 shows that dairy cows are the dominant type of animal owned by the majority of biodigester users (61%), followed by beef cows (28% of biodigester users). Given the marginal emission impact of the other categories of animals and for conservativeness, only methane emissions from dairy and beef 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 table the baseline emission can be determined. The emission per household of cows under the VPA are calculated and depicted in the next table. The number of cows originates from the BUS survey and based on the $EF_{awms,T}$ from the relevant default methane emission factor.

Table 27: Ex-post Baseline emission from animal waste management[59]

Animal T	Average population $N_{T,h}$/hh[60]	$EF_{awms,T}$ (tonneCH_4/year)	GWP_{CH4}	$BE_{b1,CH4,y}$ (tCO_2e/year)
Dairy cows	4.62	0.031	28	**4.010**
Beef cows	0.79	0.001	28	**0.022**

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

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

[58] According to the BUS 2023, dairy cows are the dominant type of animal owned by majority of biodigesters users (61%) followed by beef cows (28% of biodigesters users).

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

[60] Source: BUS_2023_Tabulation_15072024 | sheet Tabulasi | cells AD3860 & AG3953

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:

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

(**6**)

Where:

$PE_{p1,CH4,y}$	Project emissions from manure handling during the year y in tCO_2e
GWP_{CH4}	Global Warming Potential of methane (28)
$N_{T,h}$	Number of livestock category T in premise h
$EF_{awms,\ T}$	Emission factor for the defined livestock population category T
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 28: Ex-post Project emission from animal waste management[61,62,63]

Animal T	$BE_{b1,CH4,y}$ (tCO_2e/year)	PL_y	$\eta_{new\ stove}$	$PE_{p1,CH4,y}$ (tCO_2e/year)
Dairy cow	4.010	10%	50%	**2.205**
Beef cow	0.022	10%	50%	**0.012**

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.

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

[62] According to the BUS 2023, dairy cows are the dominant type of animal owned by majority of biodigesters users (61%) followed by beef cows (28% of biodigesters users). For this reason, no other animals are included in this MP6 of CP2

[63] 20240930 ER Calculation VPA1 MP6 CP2 | tab GS VER 2023 | cell E52

LEAKAGE EMISSIONS

The project proponent investigated the following potential sources of leakage:

Table 29: 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 2023, 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, 4/46 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 0.067 tCO_2e per year.[64]
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 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 0.067 tCO_2e per year.[65]

[64] See "20240930 ER Calculation VPA1 MP6 CP2.xls"| sheet "GS VER 2023" | cell E81

[65] See "20240930 ER Calculation VPA1 MP6 CP2.xls"| sheet "GS VER 2023" | cell E82

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

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 30: Daily VS production of the average biodigester[66,67]

Animal T	VS excretion kgVS/hd/day [68]	Head/average biodigester[69]	Total amount of VS excreted kgVS.day^{-1}	$MS_{T,S,k}$ Share fed into biodigester[70]	Total VS entering the biodigester kgVS.day^{-1}
	A	**B**	**AxB =C**	**D**	**CxD**
Dairy Cow	2.80	4.62	12.936	83.03%	10.74
Beef Cow	2.30	0.79	1.817	83.03%	1.51
				Sum	**12.25**

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.

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

[67] According to the BUS 2023, dairy cows are the dominant type of animal owned by majority of biodigesters users (61%) followed by beef cows (28% of biodigesters users).

[68] Source: Tables 10.A-4 to 10.A-8 from: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_10_Ch10_Livestock.pdf

[69] Source: BUS_2023_Tabulation_15072024 | sheet Tabulasi | cell AF3860 & AG3953

[70] Source:" BUS_2023_Tabulation_15072024 " sheet "Tabulasi" cell AI5063

According to the Biogas Handbook (2008) of Big East, the digestion efficiency of agricultural biogas plants is typically in the range 50-60%[71]. 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:

Table 31: Average amount of VS in digester effluent[72]

(A) Total VS entering the biodigester kgVS.day^{-1}	Digester efficiency[73]	(B) Total VS destroyed in the biodigester kgVS.day^{-1}	A*B Total VS in bio-slurry kgVS.day^{-1}
12.25	55%	45%	5.51

3. Assessment of the methane potential of bio-slurry

As the nature of VS has changed during anaerobic conversion, the default methane potential (B_o) value is no longer applicable to VS in bio-slurry. According to EB66 Annex 32[74] 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:

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

Equation 1: Calculation of methane potential of bio-slurry

Where:

$B_{o,dig,T}$	=	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 32: Calculated methane potential of digestate from manure by animal type[75]

Animal T	$F_{ww,CH4,}$	Bo(T) ($m^3CH4/kgVS$)	$B_{o,dig}$ ($m^3CH4/kgVS$)
Dairy cow	0.20	0.13	0.026
Beef cow	0.20	0.10	0.02

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

[72] According to the BUS 2023, dairy cows are the dominant type of animal owned by majority of biodigesters users (61%) followed by beef cows (28% of biodigesters users).

[73] 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.

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

[75] According to the BUS 2023, for 70% of VPA-1 households' cows were the primary animals. 2

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

Table 33: Average methane potential of bio-slurry from manure by animal type[76],[77]

Animal T	Number	Fraction	Average $B_{o,dig}$ ($m^3CH4/kgVS$)
Cattle Cow	4.62	85%	0.022
Beef Cow	0.79	15%	0.003
			0.025

Based on this, the weighted averaged $B_{0,dig}$ is 0.025 ($m^3CH4/kgVS$)

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

$$PE_{bio\text{-}slurry} = (VS_{dig} * 365) \times B_{0,dig} \times (\sum DMS \times MCF) \times (D_{CH4}/1000) \times GWP\ CH4$$

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
$B_{0,dig}$	=	Weighted methane producing capacity of the bio-slurry, $m^3CH_4/kgVS$
∑MCF	=	Cumulative methane conversion factors for digestate management system DMS, %
D_{CH4}	=	Conversion factor of m^3 CH_4 to kilograms CH_4
GWP CH4	=	Global Warming Potential of methane (28)

The MCF applied to the bio-slurry emissions is 5.63%. The table below indicates the usage method of the bio-slurry and the corresponding calculation of the MCF.

[76] According to BUS 2023, dairy cows are the dominant type of animal owned by the majority of biodigester users (61%), followed by beef cows (28% of biodigester users). For this reason, no other animals are included in this MP6 of CP2

[77] 20240930 ER Calculation VPA1 MP6 CP2" | Sheet Bio-slurry | 2023 | cells D30:G34

Table 34: Overview of bio-slurry handling methods[78]

Bio-slurry handling method	Percentage	Corresponding IPCC definition	MCF
Dumped into the land around the pen – which is planted with grass for livestock/shrubs/other plants	57.54%	Aerobic treatment	0.000%
Give away for free to others	14.39%	Daily spread	0.144%
Leave it alone/leave it in place (in the slurry storage tank/pond)	6.67%	Liquid/slurry	5.200%
For sale – both unprocessed/processed/made vermicompost	1.75%	Composting	0.088%
Used for fertilizer on the farm itself	19.6%	Daily spread	0.196%
		Average MCF	**5.63%**

Table 35: Calculated emissions from bio-slurry, per household[79]

Total VS in bio-slurry kgVS.day^{-1}	$B_{0,dig}$ ($m^3CH4/kgVS$)	∑DMSxMCF	D_{CH4} (kg/m^3CH_4)	$PE_{bio\text{-}slurry}$ ($tCO_2/year/hh$)
5.51	0.025	5.63%	0.67	0.053

The project emissions from bio-slurry equate to 0.053 tCO_2e. These have been included in the ER assessment.[80]

Emission reductions

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

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

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 36: Emission reductions from animal waste management [81]

[78] Source: "BUS_2023_Tabulation_15072024.xls | sheet "Tabulasi"| cells Z4119-Z4123 & AC4119-AC4123

[79] "20240930 ER Calculation VPA1 MP6 CP2" | sheet "Bio-slurry | 2023" | cells C38:G40

[80] ER Calculation VPA1 MP6 CP2 | sheet "Bio-slurry 2023" | Cell E76

[81] Figures may not add up due to rounding – see emission reduction calculation: "20240930 ER Calculation VPA1 MP6 CP2" | Sheet "GS VER 2023"

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[82] (tCO_2e/yr)
4.032	2.218	0.053	-	**1.76116**

(C) EX-POST ESTIMATE OF THE EMISSION REDUCTIONS

The next table shows the ex-ante estimate of the emission reductions for each biogas unit:[83]

Table 37: Average annual emission reductions

	$BE_{b1,y}$ ($tCO_2e/year$)	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	1.670	0.888	-	0.067	**1.061**
Manure handling	4.032	2.218	0.053	-	**1.761**
Sum (rounded down)					**2.322**

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

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

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 (a). The next table shows the ER by month.

Table 38: Emission reductions realized by the VPA 1 (MP6 of CPII)[84]

[82] See 20240930 ER Calculation VPA1 MP6 CP2, Sheet 'GS VER 2023', Cell E84

[83] Figures may not add up due to rounding

[84] See 20240930 ER Calculation VPA1 MP6 CP2| Sheet "Cumulative VER"

Month of program	Period, begin and end date inclusive		Cumulative number of units	Monthly ER (tCO_2e)	Cumulative ER (tCO_2e)
128	01.01.23	31.01.23	20,252	3,758	3,758
129	01.02.23	28.02.23	20,252	3,758	7,516
130	01.03.23	31.03.23	20,252	3,758	11,275
131	01.04.23	30.04.23	20,252	3,758	15,033
132	01.05.23	31.05.23	20,252	3,758	18,791
133	01.06.23	30.06.23	20,252	3,758	22,549
134	01.07.23	31.07.23	20,252	3,758	26,307
135	01.08.23	31.08.23	20,252	3,758	30,065
136	01.09.23	30.09.23	20,252	3,758	33,824
137	01.10.23	31.10.23	20,252	3,758	37,582
138	01.11.23	30.11.23	20,252	3,758	41,340
139	01.12.23	31.12.23	20,252	3,758	45,098
				Total	**45,098**

The table shows that the total number of ERs realized is **45,098 tCO_2e**.

Table 39: Emission reductions realised by the VPA 1, per vintage

Vintage	Start	End	Volume
2023	01/01/2023	31/12/2023	**45,098**
Total			**45,098**

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