Component project activity design document form for small-scale CDM component project activities

(Version 04.0)

Complete this form in accordance with the Attachment "Instructions for filling out the component project activity design document form for CDM small-scale component project activities" at the end of this form.

COMPONENT PROJECT DESIGN DOCUMENT (VPA-DD)

Title of the VPA: African Biogas Carbon Programme (ABC) – Tanzania – CAMARTEC - VPA004

Version number of the VPA-DD: 1

Completion date of the VPA-DD: 27/06/2016

Title of the PoA to which the VPA is included: African Biogas Carbon Programme (ABC)

Host Party: Tanzania

Estimated amount of annual average GHG emission reductions: xxx

SECTION A. General description of VPA

A.1. Title of the proposed or registered PoA

>>
African Biogas Carbon Programme (ABC)

A.2. Title of the VPA

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VPA Title: African Biogas Carbon Programme (ABC) – Tanzania – CAMARTEC - VPA004

Version: 1
Date: 27/06/2016

A.3. Description of the VPA

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The overall objective of the VPA is to contribute to the achievement of the Sustainable Development Goals (SDGs) through the dissemination of domestic biogas systems as a local, sustainable energy source and the development of a commercially viable, market-oriented biogas sector. By encouraging the switch from traditional non-renewable biomass (NRB) fuels to renewable biogas the VPA is reducing greenhouse gas (GHG) emissions.

The Centre for Agricultural Mechanisation and Rural Technology (CAMARTEC) is the VPA implementer of this VPA. CAMARTEC operate as part of the Tanzania Domestic Biogas Programme (TDBP), a component of the Africa Biogas Partnership Programme (ABPP), which is supported by this PoA.

CAMARTEC is the sector leader with the responsibility of coordinating, facilitating and monitoring sector functions and supporting the technical, financial and institutional architecture necessary for development of the domestic biogas sector in United Republic of Tanzania.

The VPA is to be implemented based on private sector market oriented principles, but developing governmental support for a favourable regulatory and policy environment, as well as general buy-in promotion and extension.

There is significant potential for domestic biogas in Tanzania, however, to date a viable market has not developed. The VPA is implemented based on private sector market oriented principles, but developing governmental support for a favourable regulatory and policy environment, as well as general buy-in promotion and extension. The VPA will stimulate the installation of domestic biogas systems from 4 to 13 m^3 capacities[1].

The Tanzania National Energy Policy 2003[2] indicates that biomass, particularly charcoal and fuelwood, are the main source of energy to both urban and rural areas and accounts for more than 90% of primary energy supply in Tanzania. It also states that for the foreseeable future biomass energy will remain the main energy source. This makes biogas an attractive renewable source of alternative energy.

[1] Page ii, TDBP Programme Implementation Document, 2009

[2] Pages 6 and 24

A.4. Entity/individual responsible for the operation of VPA

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The Centre for Agricultural Mechanisation and Rural Technology (CAMARTEC) is the VPA implementer of the Tanzanian Domestic Biogas Programme (TDBP). TDBP is a component of the Africa Biogas Partnership Programme (ABPP). The African Biogas Carbon PoA has been set up to support the ABPP initiative with carbon finance.

Currently, CAMARTEC partners with six Implementing Partners located in different regions of Tanzania. The Implementing Partners support the installation of biogas digesters, collection of user information through the Sales Agreement and forwarding accurate project data to CAMARTEC on a regular basis to be entered into the project database. Current Implementing Partners include FIDE, ELCT, KDA, NRCF, MIGESADO and CARITAS. Other Implementing Partners may be included in future.

The Biogas Construction Enterprises (BCEs) and masons are responsible for the process of plant installation and direct user data collection through the Sales Agreement.

A.5. Technical description of the VPA

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The VPA will stimulate the installation of domestic biogas systems country wide, of 4 m^3, 6 m^3, 9 m^3, and 13m^3 capacities. It will install and maintain biogas systems through biogas-related enterprises engaged in construction, appliances and parts. In order to make biogas technologies more affordable to the end-user, the digesters will be offered at a reduced price, subsidised in part by carbon revenues. The initial target of the VPA is to support the installation of some 11,952 biogas systems from 01/01/2017 onwards[3], retaining the option to fill the VPA up until its eligible threshold defined by the small scale methodology guidance is met. See Section D.5 for a detailed calculation of this VPA's limit.

The VPA includes a biogas model that has a fixed dome based on the original CAMARTEC design with some modifications. A drawing of the modified CAMARTEC model is shown in Figure 1. CAMARTEC selected the appropriate biogas technology to be implemented through engagement with a wide range of stakeholders. They agreed on the fixed dome digester design as being the most suitable for the Tanzanian context.

[3] Figure is based on the annual average implementation rate over 2014 and 2015 for VPA-002 of the ABC PoA.

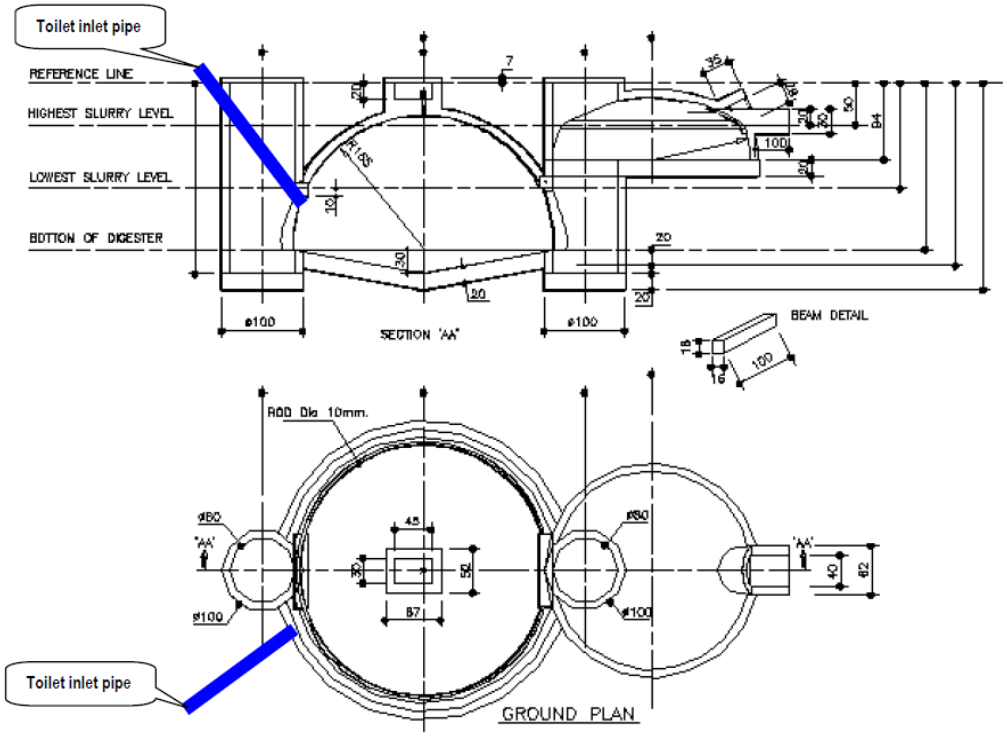

Figure 1: CAMARTEC biogas system technical drawing4

The biogas system is made up of several interconnected parts. The specific role of each component is summarised below:

- Inlet – The main purpose of the inlet is to mix organic material and water into a semi solid state. This mixture is fed into the digester via an inlet pipe.
- Digester – The digester holds the mixture of manure and water, creating a conducive environment for anaerobic digestion where microorganisms produce biogas. The digester is cylindrical in shape and is usually made of brick masonry with a concave concrete cover, or dome. Typically the digester is built underground with only the plumbing, inlet and outlets visible.
- Dome - The purpose of the dome is to collect the gas produced in the digester. This is typically plastered in several layers and painted with a special paint in order to minimise gas leakage. Gas accumulates under the dome creating pressure and pushing down the level of the slurry and increasing the slurry level in the connected slurry tank. It is the difference in slurry levels between the slurry tank and the inside of the dome that maintains the pressure to push the gas into the outlet pipe.
- Outlet - The outlet valve releases the collected gas under the dome to biogas appliances such as stoves or lamps.
- Slurry Tank - The slurry tank holds the slurry that the gas pressure from under the dome displaces. This slurry overflows into a composting tank as more manure is fed into the digester. This slurry can then be used as a fertiliser.

[4] Tanzania Domestic Biogas Programme (no date) *Biogas Plant Construction Manual Solid State Digester,* page 14

A.6. Party(ies)

Name of Party involved (host) indicates host Party	Private and/or public entity(ies) VPA implementer(s) (as applicable)	Indicate if the Party involved wishes to be considered as VPA implementer (Yes/No)
United Republic of Tanzania (host)	Centre for Agricultural Mechanisation and Rural Technology (CAMARTEC)	No

A.7. Geographic reference or other means of identification

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This VPA will disseminate biogas systems over the entire territory of Tanzania. The primary means to uniquely identify the activities under the VPA is by means of buyer information collected through Sales Agreements. These include a serial number, customer name, address, GPS coordinates, date of sale, name of VPA implementer (CAMARTEC), biogas model and size.

The unique identification of the VPA is the code (CAMARTEC-VPA004).

The VPA implementer is the Centre for Agricultural Mechanisation and Rural Technology (CAMARTEC). The main offices are used to represent the physical location of the project, Njiro Road, Themi, Arusha, United Republic of Tanzania[5].

The co-ordinates of Tanzania are represented approximately by: 6 00 S, 35 00 E[6]

[5] Further contact details of the VPA implementer can be found in Annex 1

[6] Coordinates include rounded latitude and longitude figures for the centroid or center point of a country expressed in degrees and minutes; it is based on the locations provided in the Geographic Names Server (GNS), maintained by the National Geospatial-Intelligence Agency on behalf of the US Board on Geographic Names. Available from https://www.cia.gov/library/publications/the-world-factbook/fields/2011.html

Figure 2: Location of CAMARTEC and border of Tanzania.

A.8. Duration of the VPA

A.8.1. Start date of the VPA

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The starting date of this programme activity is 01/01/2017, the date of signing the first Sales Agreement for the first digester to be included in this VPA.

A.8.2. Expected operational lifetime of the VPA

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The expected lifetime of the VPA is the full duration of the crediting period, at 21 years.

CAMARTEC's partnership with ABPP began the development of a commercially viable biogas sector in Tanzania in 2009.The total installed capacity of the initially planned 11,952 units amounts to 42.6 MW_{th}, below the 45 MW_{th} threshold. The VPA will be available for future biodigesters as long as the threshold defined by the small scale methodology guidance is met. See capacity calculation in the Eligibility Section (Section D.5) for a detailed calculation of this VPA's limit.

Table 1: Implementation schedule of the VPA

Year	Number of new biogas digesters installed
2017	1,992
2018	1,992
2019	1,992
2020	1,992

2021	1,992
2022	1,992
2023	0
Total	**11,952**

A.9. Choice of the crediting period and related information

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Renewable crediting period

A.9.1. Start date of the crediting period

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The start date of the crediting period is on 01/01/2017 (estimated date) or 2 years prior to the end date of the inclusion review period, whichever is later.

A.9.2. Length of the crediting period

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The crediting period for the VPA is 7 years, renewable twice. The duration of the crediting period will not exceed the end date of the programme.

A.10. Estimated amount of GHG emission reductions

Emission reductions during the crediting period	
Years	Annual GHG emission reductions (in tonnes of CO_2e) for each year
01/01/2017 – 31/12/2017	
01/01/2018 – 31/12/2018	
01/01/2019 – 31/12/2019	
01/01/2020 – 31/12/2020	
01/01/2021 – 31/12/2021	
01/01/2022 – 31/12/2022	
01/01/2023 – 31/12/2023	
Total number of crediting years	7
Annual average GHG emission reductions over the crediting period	
Total estimated reductions (tonnes of CO_2e)	

A.11. Public funding of the VPA

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The Directorate General for International Cooperation (DGIS) under the Netherlands Ministry of Foreign Affairs provides public funding. The VPA is being supported by DGIS through the Humanist Institute for Cooperation with Developing Countries (Hivos). There has been no diversion of Official Development Assistance (ODA) as demonstrated in the declarations provided to the DOE.

A.12. Debundling of small-scale component project activities

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According to the Guidelines on assessment of de-bundling for SSC project activities (version 03) published as annex 13 of the meeting report of EB 54[7] the VPA is exempted from performing a de-bundling check i.e. considered as being not a de-bundled component of a large scale activity if the following condition applies:

10. If each of the independent subsystems/measures (e.g. biogas digester, solar home system) included in the VPA of a PoA is no greater than 1% of the small scale thresholds defined by the methodology applied[8], then that VPA of PoA is exempted from performing de-bundling check i.e. considered as not being a de-bundled component of a large scale activity.

Each of the biogas systems included in the VPA is not greater than 1% of the small scale threshold which is 450 kW_{th} for thermal energy as shown in Table 2[9]:

Table 2: Capacity of CAMARTEC biogas systems

Size of digester (m^3)	Maximum daily feed (kg)	Maximum daily gas production (m^3)	Maximum capacity of digester (kW)
4	30	1.2	1.00
6	45	1.8	1.47
9	60	2.4	2.21
13	90	3.6	3.34

A.13. Confirmation for VPA

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This VPA is neither registered as an individual carbon project activity or is part of another registered PoA. Double counting is avoided through recording the unique serial number and name and address of users of each biodigester in a centralised database system operated by the CME.

A.14. Contact information of responsible persons/ entities for completing the CDM-SSC-VPA-DD-FORM

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The CDM-SSC-VPA-DD-FORM was completed by Climate Focus (Hilda Galt, email: h.galt@climatefocus.com; and Szymon Mikolajczyk, email: s.mikolajczyk@climatefocus.com).

SECTION B. Environmental analysis

B.1. Analysis of the environmental impacts

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An environmental impact assessment is not required for activities implementing household biodigesters. The Environment Management Act, 2004[10], states that only projects which are under the Third Schedule of the act are required to undertake an EIA. As biogas is not contained in this Schedule (pages 127 -128) no EIA is required by a VPA installing small biogas systems

7 EB 54 Annex 13

8 i.e. 150 kW installed capacity or 0.6 GWh annual energy savings or 0.6 $ktCO_2e$ annual emission reductions. See EB65 Report, page 25. Guidelines changed from 15kW to 150kW electrical, or 450kW thermal

9 Detailed calculations were provided to the DOE on Emission Reduction spreadsheet.

10 The Environmental Management Act, page 56, paragraph 81, 2004. Available from : http://faolex.fao.org/docs/pdf/tan61491.pdf

A broad environmental impact assessment has been carried out during the stakeholder consultation, as reported in both the Local Stakeholder Consultation Report and the VPA Passport.

SECTION C. Local stakeholder consultation

C.1. Solicitation of comments from local stakeholders

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Comments were solicited from stakeholders in accordance with the Gold Standard's procedures for the first VPA included in Tanzania under the ABC PoA. Confirmation was received from the Gold Standard that the outcomes of this LSC can be used for this VPA due to the fact that the target population and technology applied is exactly the same. However, a new Stakeholder Feedback Round (SFR) is needed. Below we outline the outcomes of the 2012 LSC, as well as the SFR conducted in 2016.

Local Stakeholder Consultation

Stakeholders were invited to attend a public meeting to be informed and give their comments on the VPA. The meeting was held on 23/02/2012 at 08:30 till 13:00, at the Landmark Hotel in Dar es Salaam, Tanzania. Invitations were distributed to specific stakeholders via e-mail and telephone between 09/02/2012 – 20/02/2012 and a public invitation was advertised in the national newspaper Daily News on 09/02/2012. The process for identifying stakeholders is described in more detail in the Local Stakeholder Consultation (LSC) report. 41 people, who represented a wide range of stakeholders, attended the meeting.

Stakeholders included representatives from the Regional Government and Local Authority, the National Environmental Management Council (NEMC), the Ministry of Health and Social Welfare (ILALA), the Ministry of Natural Resources and Tourism (MNRT), the Ministry of Livestock and Fisheries Development, as well as a number of journalists.

Participants were briefed on the background to the CDM and the PoA with questions and answer sessions for each topic. Participants were then presented with the specifics of the VPA and invited to make comments and ask any questions. The participants then engaged in an exercise to examine the sustainability of the VPA. Participants were also invited to provide written feedback, evaluation forms were received in English. Stakeholders that were unable to attend the meeting were invited to send in comments via e-mail.

Stakeholder Feedback Round

A Stakeholder Feedback Round was organized from XX/XX/2016 to XX/XX/2016. Stakeholders were invited to review the LSC Report, PoA-DD, VPA-DD and Passports. All stakeholders that were invited to the original LSC meeting were sent the invitation letter to provide feedback.

[Provide details of outcome of SFR once completed]

The Gold Standard Local Stakeholder Consultation Report for this VPA provides a detailed description of the consultation and the results.

C.2. Summary of comments received

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The comments received were addressed, as summarised in Table 3 below. A summary of the action items raised and CAMARTEC's response to these actions appear below.

Most negative comments related to the modalities of CDM since this consultation was originally carried out with the intention to develop the project under the CDM. However, these comments are

still relevant under the Gold Standard and have therefore been considered below. Other comments regarded the set up and implementation of the Tanzania Domestic Biogas Programme as opposed to concern over the impacts of the project.

Table 3: Summary of comments received during the stakeholder consultations.

Stakeholder comment	Was comment taken into account (Yes/ No)?	Explanation (Why? How?)
It takes long to realise the carbon credits from the programme	No, not necessary	This is as a result of the nature of the UNFCCC CDM modalities, which the project proponents are not in a position to change. This is also relevant under the Gold Standard.
Even with the subsidy, the cost of constructing a biogas digester is still relatively high. The subsidy is still small.	Yes	We acknowledge that the price of biogas digesters is prohibitively high for some groups. However, given current market conditions, both with regards to carbon price and the state of the biogas digester market in Tanzania as a whole, the subsidy on biogas digesters cannot be increased. The payback period for households is estimated at around three years.
The Programme does not specify how the private sector will be engaged or supported.	Yes	It was further clarified that TDBP will mainly work via the private sector and CSOs/NGOs working as Implementation Partners of TDBP to install the digesters on the ground. It is then up to these organisations to drive the number of digesters installed.
The farmers need access to loan facilities to further support the implementation of biogas systems.	Yes	Financing is one issue that the Africa Biogas Partnership Programme (ABPP) is already looking into, especially being aware that the remaining cost of the biogas digesters even with a subsidy is unaffordable to many people. TDBP will further investigate the possibility for micro-financing options for biogas digesters.

Details on comments that have been received during the stakeholder consultation process are contained in the Gold Standard Local Stakeholder Consultation Report.

C.3. Report on consideration of comments received

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All comments received were taken into account within the overall design of the VPA. No comments required modifying the design of the VPA.

SECTION D. Eligibility of VPA and estimation of emissions reductions

D.1. Reference of methodology(ies) and standardized baseline(s)

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The VPA applies the Gold Standard methodology 'Technologies and Practices to Displace Decentralized Thermal Energy Consumption' (Version 2.0)

D.2. Applicability of methodology(ies) and standardized baseline(s)

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This methodology is applicable to programs or activities introducing technologies and/or practices that reduce or displace greenhouse gas (GHG) emissions from the thermal energy consumption of households, communities and SMEs. This includes biodigesters.

Table 4: Methodological applicability conditions applied

Applicability criteria	Justification
1. *Clearly identifiable project boundary:* The project boundary can be clearly identified, and the biodigesters counted in the project are not included in another voluntary market or CDM project activity (i.e. no double counting takes place). Project proponents must have a survey mechanism in place together with appropriate mitigation measures so as to prevent double-counting in case of another similar activity with some of the target area in common.	The project boundary is the physical, geographical site of the methane recovery and combustion systems, located within Tanzania. The VPA shall demonstrate that it does not double-count any of its appliances, as specified in the eligibility criteria for inclusion in the PoA, for the ERs estimation by confirming that: – the complete address of each biogas system is recorded – the biogas systems have a unique serial number recorded in the project database – the VPA implementer has not included these biogas systems in another VPA or stand-alone project.
2. *Limited level of energy output per biodigester:* The biodigesters each have continuous useful energy outputs of less than 450 kWth per unit (defined as total energy delivered usefully from start to end of operation of a unit divided by time of operation).	The maximum energy output of the biodigesters implemented in the project activities is 44.77 kWth[11], below the indicated 450 kWth limit per unit.
3. *Continued use of baseline technology:* The use of the baseline cook stoves as a backup in parallel with the new, biogas fuelled cook stoves introduced by the project activity is permitted as long as a mechanism is put into place to encourage the removal of the old technology and the definitive discontinuity of its use. The project documentation must provide a clear description of the approach chosen and the monitoring plan must allow for a good understanding of the extent to which the baseline cook stove is still in use after the introduction of the improved technology. The success of the mechanism put into place must therefore be monitored, and the approach must be adjusted if proven unsuccessful.	Monitoring will include an assessment of the continued use of the baseline stove through survey methods and biennial Kitchen Performance Tests. All biogas digester users will be asked to provide feedback on the extent to which they continue to use their baseline cookstoves.
4. *Settling of ownership rights over generated emission reductions:* The project proponent must clearly communicate to all project participants to whom the ownership rights of the emission reductions	As set out in the operational and management plan explained in Section C of the PoA-DD, each end user of a biodigester will be asked to confirm that they transfer the right and title to VERs to the VPA Implementer as part of the

[11] As demonstrated in section B.3. of the PoA-DD

Applicability criteria	Justification
resulting from the project activity belong. This must be communicated to the technology producers and the retailers of the by contract or clear written assertions in the transaction paperwork.	Sales Agreement. Copies of these signed contracts will be kept by the VPA Implementer.
5. *Use of new biomass feedstock* Project activities making use of a new biomass feedstock in the project situation (e.g. shift from non-renewable to green charcoal, plant oil or renewable biomass briquettes) must comply with relevant Gold Standard specific requirements for biomass related project activities, as defined in the latest version of the Gold Standard rules.	This applicability criterion is not applicable as no new biomass feedstock is used in the project scenario.
6. Climate zones If more than one climate zone is included in the project activity, a distinction per climate zone must be considered. The distinct geographical boundary of each project area must be clearly documented in the project documentation, using representative GPS data.	The distinct geographical boundary of this VPA is the Republic of Tanzania. The GPS co-ordinates of Tanzania are represented approximately by: 6 00 S, 35 00 E[12]. Regarding climate zones, the current MCF calculation is based on a national average temperature of 22C. According to the applicable methodology, "if more than one climate zone is included in the project activity, a distinction per climate zone must be considered". The PP has conducted research to try to find reputable evidence that numerous climatic zones exist in Tanzania. The Tanzanian Meteorological Service http://www.meteo.go.tz/ has been consulted but no distinction of climatic zones is provided. The United Republic of Tanzania (2010) Statistical Abstract 2009, National Bureau of Statistics, Ministry of Finance and Economic Affairs, Dar Es Salaam, June 2010, Table A.5 and A.6. (2008) provides annual average maximum and minimum temperatures. If the average temperatures of this source would be assumed, the average national temperature would be 23C, which is less conservative than the 22C applied.

D.3. Sources and GHGs

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The gases included are carbon dioxide and methane in the VPA-boundary that is the physical, geographical site of the biogas system.

Source	Gas	Included?	Justification / Explanation

[12] Coordinates include rounded latitude and longitude figures for the centroid or center point of a country expressed in degrees and minutes; it is based on the locations provided in the Geographic Names Server (GNS), maintained by the National Geospatial-Intelligence Agency on behalf of the US Board on Geographic Names. Available from https://www.cia.gov/library/publications/the-world-factbook/fields/2011.html

Baseline	Heat delivery Treatment of manure	CO_2	Yes	CO_2 emissions from - fossil fuels used for cooking - non-renewable biomass used for cooking
		CH_4	Yes	CH_4 emissions from the baseline treatment methods of manure
		N_2O	No	Excluded, insignificant source of emissions.
Project Activity	Combustion of biogas	CO_2	Yes	CO_2 emissions from - fossil fuels used for cooking - non-renewable biomass used for cooking
		CH_4	Yes	Emissions due to the manure not fed into the biodigester, as per the applied methodology.
		N_2O	No	Excluded, insignificant source of emissions.

The project boundary is the physical, geographical site of the use of biomass or the renewable energy as demonstrated in
Figure *3*.

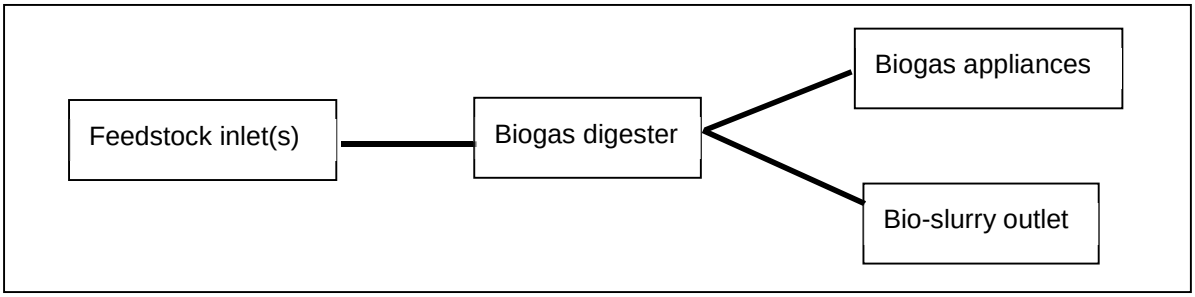

Figure 3: Schematic diagram of biogas system project boundary

D.4. Description of the baseline scenario

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Biomass fuels are the most important source of primary energy in Tanzania with fuelwood and charcoal accounting for over 90% of the total primary energy consumption[13]. In the foreseeable future, biomass energy is likely to remain a main energy source. The CDM's EB 67, Annex 22[14] reports an fNRB value of 96% for Tanzania.

Biogas systems in Tanzania are a fuel switch from NRB. Biogas is a renewable fuel produced by waste products of humans, animals and/or plants by placing them in a digester under anaerobic conditions. Biogas is mostly made up of methane, which is combustible and enables biogas to be used as a fuel.

To determine parameters $BB_{b,fuel}$ and $BB_{b,bio}$, this VPA applies Option 2. Under Option 2, $BB_{b,fuel}$ and $BB_{b,bio}$ shall be defined *ex-ante* on the VPA level through Baseline Performance Field Tests (BFT) directly. As per the PoA-DD, a separate BFT needs to be conducted per identified baseline scenario.

A Baseline Survey was conducted in 2016 to define the baseline ratios and manure handling techniques, and ex-ante baseline scenario ratios. The Baseline Survey targeted 180 non-biogas users (i.e. 180 baseline households). It meets the requirements set forth by the applied methodology,

[13] Tanzania National Energy Policy (2003), pages 6 and 24

[14] '*Default values of fraction of non-renewable biomass for least developed countries and small island developing states'* (version 01.0) Information Note

which requires a minimum of 100 households to be surveyed. All respondents have a similar socio-economic background as the target group of the project. Table 5 illustrates the different baseline scenarios and their corresponding ratios, as per the Baseline Survey results. This will be updated annually as part of the monitoring survey.

Table 5: Type of baseline scenarios and distribution per identified baseline scenario[15]. The term 'mainly' is used to define households that use the respective fuel(s) to meet >50% of their cooking needs.

Baseline scenario	Parameter	Baseline Survey results (number)	Baseline survey results (%)
Households using mainly firewood	$BB_{b1,bio}$	51	43.6 %
Households using mainly charcoal	$BB_{b2,bio}$	10	8.5 %
Households using mainly firewood + charcoal	$BB_{b3,bio}$	56	47.9 %
Others (excluded for conservativeness)	n/a	0	0 %
Total		117[16]	100%

As per the three identified baseline scenarios, three distinct BFTs can be conducted.

A baseline Field Performance Test in the form of a Kitchen Performance Test (KPT) was implemented in January 2015 by the University of Dar es Salam targeting 50 households across Tanzania. The surveyed households were identified as having a similar social and economic status as their neighbours that possess biodigesters, therefore making for a realistic baseline scenario. Amongst other things, the households were asked to report on their baseline biomass and fossil fuel consumption rates over a 24 hour measurement campaign.

The results of the KPT are reported in Table 6. The results include both the usage of firewood and charcoal. To derive the total biomass value, the tonnes of firewood have been combined with the tonnes of charcoal multiplied by a factor of ten.[17] This charcoal-to-biomass ratio has been approved by another registered biogas programme in the region.

Table 6: Biomass usage results in the baseline scenario

Item	Unit	Description	Amount	Source
$BB_{b1,bio}$	tonnes/ year	Amount of woody biomass used in the baseline scenario b1	Firewood: 2.530 Total: **2.530**	B1 KPT data and analysis,sheet '90/30 test' Cell G92
$BB_{b2,bio}$	tonnes/year	Amount of charcoal used in the baseline scenario b2	Charcoal: 1.6005 * 10 Total: 16.005	B2 KPT data and analysis,sheet '90/30 test' Cell G35
$BB_{b3,bio}$	Tonnes/year	Amount of charcoal and firewood used in the baseline scenario b3	Firewood: 2.92 Charcoal: 1.46 * 10 Total: 17.520	B3 KPT data and analysis,sheet '90/30 test' Cell G68

As for the number of animals raised and the manure handling methods, the baseline results have been gathered by the Baseline Survey conducted in 2016, which also looked at the baseline

[15] Source: BUS Raw Data Tanzania 2014 Baseline Households spreadsheet, columns AO to BA

[16] Those household surveyed that did not provide any data on their baseline fuel usage, or where results were contradictory, were excluded from the ratio calculations. Therefore, the total is 117, rather than the 180 households that were visited. A large number did not provide information on their baseline fuel usage, but results are still significantly above the minimum sample size of 100 for the baseline survey.

[17] FPAN (2011) Protecting and restoring forest carbon in tropical Africa, Chapter 6: Woodfuels and forests in tropical Africa, pg 208.

conditions and surveyed XXX households without biodigesters throughout Tanzania. According to the results of this survey, the dominant type of cattle owned by the respondents was dairy cows, with the average amount of cows being XX per household. This was followed by goats, other cattle sheep and market swine.

Table 7: Possession of livestock reported in the BUS 2014[18]

Animal T	Average amount
Dairy cow	XX
Goat	XX
Other cattle	XX
Sheep	XX
Market swine	XX
Poultry	XX

The baseline study results indicate that solid storage is the most common manure handling method, followed by dry lot, liquid slurry and uncovered lagoons. The system-specific methane conversion factors applicable to the baseline are provided in the IPCC Guidelines for National Greenhouse Gas Inventories. The applicable MCF, which is an input for the emission reduction calculation explored below, is chosen from the default values presented in Table 10.17, Chapter 10, Volume 4 of the 2006 IPCC Guidelines. Average temperatures are defined on the province level. The resulting average MCF, in line with these guidelines, is XX.XX%.

Table 8: Applicable MCF at national average temperature of 22.0 C[19]

Method	Uncovered lagoon	Liquid slurry	Solid storage	Drylot	Pasture/ Range / Paddock	Daily spread	Burned for fuel	Composting
Fraction observed	XX %	XX %	XX %	XX %	XX %	XX %	XX %	XX %
MCF (at 22 C)	78.0%	50.0%	4.0%	1.5%	1.5%	0.5%	10.0%	0.5%

$MCF_{x,k}$	XX %[20]

D.5. Demonstration of eligibility for a VPA

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This VPA follows the stated goal of the PoA and eligibility criteria for inclusion in the PoA as determined in Section B.2. of the PoA-DD:

Table 9: Eligibility criteria for VPA inclusion in the PoA

[18] For reference see document [include source once conducted]

[19] See: http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisRegion=Africa&ThisCCode=TZA

[20] For calculation see document 'BUS Raw Data Tanzania 2014 BASELINE HHs- Reviewed 18Aug2015', cell DV205

Nr.	Requirement[21]	Eligibility criteria	Evidence provided
1.	The geographical boundary of the VPA including any time-induced boundary consistent with the geographical boundary set in the PoA	All biogas systems included in the VPA will demonstrate they fall within the geographical boundary of the PoA through: – Recording the address/location of the system in the Sales Agreement – Recording the GPS coordinates of the systems – Physically attaching a Programme or VPA logo to the digester which identifies it as being part of the African Biogas Partnership Programme on a national scale.	The following document is provided: – TDBP Programme Implementation document – Sales Agreement
2.	Conditions that avoid double counting of emission reductions like unique identifications of product and end-user locations	The VPA shall demonstrate that it does not double-count any of its appliances for the ERs estimation by confirming that: – The complete address of each biogas system will be recorded – the biogas systems have unique serial numbers (not relevant for the retroactive digesters) – the VPA implementer has not included these biogas systems in another VPA or carbon project.	The following documents are provided: – Contractual agreement between CME and CAMARTEC (signed ERPA) – Declaration from CAMARTEC – Sales Agreement
3.	The specifications of technology/measure including the level and type of service, performance specifications including compliance with testing/certifications	The biogas systems disseminated are renewable energy generation units to provide thermal energy and will be required to conform to any applicable national standards.	The following document is provided: – Technical documentation describing the operation of the biogas system (Construction Manual of Biogas plants) There are no national standards regulating biogas digester technologies in Tanzania.
4.	Conditions to check the start date of the VPA through documentary evidence	The VPA implementer will demonstrate the start date of the VPA is on or after the start date of the PoA. The start	The following documents are provided:

[21] Requirements 1-12 are taken from EB65 Annex 3 paragraph 14. Requirement 13 is taken from EB47, Annex 29, paragraph 3. Requirement 14 is a CME requirement to ensure successful implementation of the VP.

Nr.	Requirement[21]	Eligibility criteria	Evidence provided
		date of the VPA will be defined as the date on which the first Sales Agreement is signed under the VPA.	– Sales Agreements for the first digester included under the VPA. – Project Database
5.	Conditions that ensure compliance with applicability and other requirements of single or multiple methodologies applied by VPAs	The VPA complies with the baseline and monitoring methodology requirements of the 'Technologies and Practices to Displace Decentralised Thermal Energy Consumption' (version 2.0). and should meet its eligibility criteria as discussed in Section B.2 of the PoA-DD.	The following documents are provided as evidence: – Project Database – Kitchen Performance Test (KPT) reports – Sales Agreement
6.	The conditions that ensure that VPAs meet the requirements pertaining to the demonstration of additionality	The VPA will prove additionality as per the following approach: ***1) Positive List[22]*** 1. Biogas system rated capacity is less than 2.25MW_{th} each 2. Biogas systems are disseminated to households or communities or Small and Medium Enterprises (SMEs).	The following evidence is provided: 1. Calculation showing the capacity of the biogas system(s) in MW 2. Implementation document (TDBP Programme Implementation Document)
7.	The PoA-specific requirements stipulated by the CME including any conditions related to undertaking local stakeholder consultations and environmental impact analysis	1. The VPA, organised a local stakeholder consultation (LSC) in accordance with Gold Standard requirements 2. The VPA, or a group of VPAs, got environmental clearance for the project related activities, if applicable	The following document is provided: – Local Stakeholder Report (Tanzania) An environmental impact assessment is not required for activities implementing household biodigesters in Tanzania, as stipulated by the Environment Management, 2004 (see Section B.1 above)
8.	Conditions to provide an affirmation that funding from Annex I parties, if any, does not result in a diversion of official development assistance	The VPA will demonstrate that any Official Development Assistance received for the VPA has not occurred on the condition that the resulting credits are transferred to the donor country[23].	The following document is provided: – ODA Declaration
9.	Where applicable, target group (e.g. domestic / commercial / industrial, rural / urban, grid connected / off-	The VPA will demonstrate which target group(s) is/are to be targeted by the VPA and	The following document is provided:

[22] As per the "Guidelines on the Demonstration of Additionality of Small-Scale Project Activities" Version 09, EB68 Annex 27 clause 2 (c)

[23] Gold Standard Toolkit, Version 2.1, Section 1.2.5.

Nr.	Requirement[21]	Eligibility criteria	Evidence provided
	grid) and distribution mechanisms (e.g. direct installation)	the distribution mechanism. Target groups shall include: – Households – Small/Medium Enterprises – Communities	Implementation document (TDBP Programme Implementation Document) The VPA shall include households as the target group. The biogas digesters are directly installed at the user's household.
10.	Where applicable, the conditions related to sampling requirements for a PoA in accordance with the approved guidelines/standard from the Board pertaining to sampling and surveys	The VPA Implementer will agree to support the sampling and survey activities of CME in accordance with B.7.2 of the PoA-DD.	The following document is provided: Contractual agreement between CME and CAMARTEC (ERPA)
11.	Where applicable, the conditions that ensure that every VPA in aggregate meets the small-scale threshold criteria and remains within those thresholds throughout the crediting period of the VPA	The VPA Implementer will ensure that each VPA remains below the small scale limits. For activities falling under Type I[24], each VPA in aggregate will remain below 15 MW (45MW_{th}) per year. For activities falling under Type III[25], each VPA will achieve below 60,000 tCO_2e in emission reductions annually.	The following documents are provided: – Capacity calculation of the biogas system(s), showing that the VPA Type I installed capacity is below the 15MW (45MW_{th})[26] threshold. – Emission reduction calculation, showing that the VPA Type III emissions are below the 60,000 tCO_2e threshold.[27]
12.	Where applicable, the requirements for the debundling check, in case VPAs belong to small-scale (SSC) or microscale project categories.	The VPA implementer will demonstrate that the VPA is not a de-bundled component via the following approach: 1. The biogas systems are less than 1% of the SSC threshold (as per	The following evidence is provided: 1. Calculation showing the capacity of the biogas system(s)

[24] Type I activities are "renewable energy project activities with a maximum output capacity of 15 MW (or an appropriate equivalent)", CDM Project Standard (version 07.0), paragraph 89 (a)

[25] Type III activities are "other project activities not included in Type I or Type II that result in GHG emission reductions not exceeding 60 kt CO_2e per year in any year of the crediting period", CDM Project Standard, (version 07.0), paragraph 89 (b)

[26] Explanation: Section B.3. of the PoA-DD indicates that the thermal capacity of the largest possible biodigester allowed under the programme (100m3) is 44.77 kW_{th}. In this VPA, the average biodigester size is 7.93 m^3, resulting in a capacity of 3.55 kW_{th} per unit. Given 9,928 units installed, this results in a total of 35.38 MW_{th} installed capacity under VPA-1. This is lower than the 45 MW_{th} threshold.

[27] Explanation: Per biodigester, emission reductions from methane avoidance (Type III) are 1.010 tCO_2e/year. Given 9,928 planned digesters, total emission reductions from Type III activities amounts to 10,027 tCO_2e per year.

Nr.	Requirement[21]	Eligibility criteria	Evidence provided
		paragraph 10 EB54 Annex 13)	
13.	The proposed VPA must ensure that sufficient training has been carried out to ensure the construction / installation of the biogas system is done by competent persons	The VPA implementer will provide sufficient evidence of training or qualification to implement the proposed VPA.	The following documents are provided: – Training certificates – Training records – Qualification certificates
14.	Transfer of rights to carbon credits.	The end user of each biogas digester has been properly informed during the stake holders consultation on the transfer of credit ownership and agreed to transfer all rights to any carbon credits to the VPA Implementer.	The following documents are provided: – Sales Agreement – Contractual agreement between CME and CAMARTEC – Local Stakeholder report and/or Passport
15.	Prior consideration of carbon revenues	For retroactive VPAs, prior consideration of carbon revenues shall be checked at the time of inclusion by checking that carbon revenues are considered in early project documentation before the date of VPA inclusion (e.g. in a feasibility report, a programme implementation document or similar documentation)	The following documents are provided: - TDBP Programme Implementation Document

D.6. Estimation of emission reductions

D.6.1. Explanation of methodological choices

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Please see D.6.3 below.

D.6.2. Data and parameters fixed ex-ante

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	Default $f_{NRB,y}$ factors from the CDM, available from http://cdm.unfccc.int/DNA/fNRB/index.html, EB67 Annex 22 (available here: https://cdm.unfccc.int/UserManagement/FileStorage/H29X6EKQMJU7RY85DIT4ZPFAL3O1GW)
Value(s) applied	Tanzania: 96%

Choice of data or Measurement methods and procedures	N/A
Purpose of data	Calculation of baseline and project emissions
Additional comment	N/A

Data / Parameter	$\mathbf{BB_{b1,bio}}$
Unit	Tonnes/year
Description	Amount of woody biomass used in the baseline scenario b1
Source of data	Option 2: Kitchen Performance Test 2014 (Baseline)
Value(s) applied	2.530
Choice of data or Measurement methods and procedures	Households/communities/SMEs have been asked how much woody biomass they use, and undergo a Kitchen Performance test as per the requirements of the TPDDTEC methodology.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$\mathbf{BB_{b2,bio}}$
Unit	Tonnes/year
Description	Amount of woody biomass used in the baseline scenario b2
Source of data	Option 2: Kitchen Performance Test 2014 (Baseline)
Value(s) applied	16.005
Choice of data or Measurement methods and procedures	Households/communities/SMEs have been asked how much woody biomass they use, and undergo a Kitchen Performance test as per the requirements of the TPDDTEC methodology.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$\mathbf{BB_{b3,bio}}$
Unit	Tonnes/year
Description	Amount of woody biomass used in the baseline scenario b3
Source of data	Option 2: Kitchen Performance Test 2014 (Baseline)
Value(s) applied	\17.520
Choice of data or Measurement methods and procedures	Households/communities/SMEs have been asked how much woody biomass they use, and undergo a Kitchen Performance test as per the requirements of the TPDDTEC methodology.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$\mathbf{EF_{b,\ bio}}$
Unit	tCO_2/TJ
Description	Emission factor of the woody biomass used in baseline scenario b
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 the baseline scenario
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	$\mathbf{EF_{p,\,bio}}$
Unit	tCO_2/TJ
Description	Emission factor of the woody biomass used in project scenario p
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	$\mathbf{NCV_{bio}}$
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	N/A

Data / Parameter	$\mathbf{EF_{b,\,fuel}}$
Unit	tCO_2/TJ
Description	Emission factor of fossil fuels used in baseline scenario b
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	$\mathbf{EF_{p,\,fuel}}$
Unit	tCO_2/TJ

Description	Emission factor of fossil fuels used in project scenario p
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	**VS_T**
Unit	kg/head/day
Description	Daily volatile solid excreted for livestock category T
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	Dairy Cow: 1.9 Goat: 0.35 Market swine: 0.3 Sheep: 0.32 Other cattle: 1.5 Poultry: 0.01
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. National data can replace the IPCC value, if available

Data / Parameter	**Bo_T**
Unit	m^3 CH_4/kg
Description	Maximum methane producing capacity for manure produced by animal type T
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	Dairy Cow: 0.13 Goat: 0.13 Market swine: 0.29 Sheep: 0.13 Other cattle: 0.10 Poultry: 0.36

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. National data can replace the IPCC value, if available

Data / Parameter:	**$EF_{awms,T}$**
Data unit:	kg CH_4
Description:	Emission factor for the defined livestock population category T by average temperature (Tanzania: 24 °C)
Source of data:	2006 IPCC Guidelines for National Greenhouse Gas Inventories;
Value(s) applied:	Dairy cows = 1 Other cattle = 1 Market swine = 1 Breeding swine = 1 Goats = 0.17 Sheep = 0.15 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

Data / Parameter:	**$MCF_{x,k}$**
Data unit:	%
Description:	The methane conversion factor for the baseline manure management systems (x) in all the regions (k).(Tanzania: 22C)
Source of data:	Baseline Survey 2016 2006 IPCC Guidelines for National Greenhouse Gas Inventories; Historical temperature data from the World Bank[28] :
Value(s) applied:	

Method	Uncovered lagoon	Liquid slurry	Solid storage	Drylot	Pasture / Range / Paddock	Daily spread	Burned for fuel	Composting
Fraction observed	XX%	XX %	XX %	XX %	XX %	XX %	XX %	XX %
MCF (at 22 C)	78.0%	50.0%	4.0%	1.5%	1.5%	0.5%	10.0%	0.5%

$MCF_{x,k}$	XX %

[28] See: http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisRegion=Africa&ThisCCode=TZA

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
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	Fraction
Description	Combustion efficiency of the new biogas stove introduced by the programme
Source of data	Manufacturers specification
Value(s) applied	0.55
Choice of data or Measurement methods and procedures	CAMARTEC does not specify the type of biogas stove that should be installed by a household, however they specifically promote the following five stove types:

Manufacturer	Model No. / Name	No. of burners	Thermal Efficiency
Puxin	JZZ2-A13	2	>57%
Wusi	JZZ.2-A1	2	>57%
Xunda	JZZ2-88	2	>58%
Xunda	JZZ1-6128	1	>58%
SNV	Lotus III (Cambodia)	1	55%

To be conservative the lowest value of efficiency has been taken.

Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	**PL**
Unit	%
Description	Physical leakage of the biodigester
Source of data	IPCC
Value(s) applied	Estimated using a 10% default rate of total methane production
Measurement methods and procedures	Not applicable
Monitoring frequency	Annual
QA/QC procedures	As per Annex 6 of the applied methodology
Purpose of data	Calculation of project emissions
Additional comment	

D.6.3. Ex-ante calculation of emission reductions

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6.3.1 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 this VPA. As the baseline fuel and the project fuel and the corresponding emission factors are different, the overall GHG reductions achieved by this VPA 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/b2/b3/project p1) couples
$N_{p1,y}$	Cumulative project operational rate included in the project database for project scenario p1 against baseline scenarios b1, b2 and b3 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, b2 and b3 in year y, in tCO_2/year, and as derived from the statistical analysis of the data collected from the field tests
$ER_{b1,p1,y,non-CO2}$	Specific non-CO_2 emission savings for an individual technology of project p1 against an individual technology of baseline b1, b2 and b3 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 specific non-CO_2 emission savings are treated in a separate equation (equation **7** onwards), the VPA can apply the following formula for calculating emission reductions:

$$\sum \mathrm{ER}_{\mathrm{CO2,y}} = (\sum \mathrm{BE}_{\mathrm{b1,CO2,y}} - \sum \mathrm{PE}_{\mathrm{p1,CO2,y}} - \sum \mathrm{LE}_{\mathrm{p1,CO2,y}}) * \mathrm{N}_{\mathrm{p1,y}} * \mathrm{U}_{\mathrm{p1,y}} \quad \textbf{(2)}$$

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[29]
$N_{p1,y}$	Cumulative project operational rate included in the project database for project scenario p1 against baseline scenario b1, b2 and b3 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

Applicable baseline scenarios for this VPA are defined by the typical baseline fuel consumption patterns in a population that is targeted for adoption of the biodigester technology. The amount of baseline scenarios for this VPA has been defined through a baseline survey conducted for the first

[29] Technologies and practices to displace decentralized thermal energy – 2.0 p.11 - 12

VPA included in Tanzania. The baseline survey also determined the ratio of users for each identified baseline scenario. In addition to the defined per-project situation, the methodology allows for a baseline scenario to be assessed in terms of suppressed demand if adequate evidence is provided that in the baseline scenarios the target population consumes less fuel than would satisfy their human development needs.

$$BE_{bCO2,y} = \sum_b BB_{b,fuel} * NCV_{fuel} * EF_{b,fuel}) + (BB_{b,bio} * NCV_{bio} * EF_{b,bio} * f_{NRB}) \quad \textbf{(3)}$$

Where:

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

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

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

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

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

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

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

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

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

Fuel usage data for the three baseline scenarios and project scenario was collected by the KPT survey, as explained above. The results include both the usage of mainly firewood (b1), mainly charcoal (b2) and mainly both firewood and charcoal (b3). The results of all three BFTs are reported in *Table 10*. To derive the total biomass value, the tonnes of firewood have been combined with the tonnes of charcoal multiplied by a factor of ten. This charcoal-to-biomass ratio has been approved by another registered biogas programme in the region.[30]

Table 10: Biomass usage results in the baseline and project scenario

Item	Unit	Description	Amount	Source
$BB_{b1,bio}$	tonnes/ year	Amount of woody biomass used in the baseline scenario b1	Firewood: 2.530 Total: **2.530**	B1 KPT data and analysis,sheet '90/30 test' Cell G92
$BB_{b2,bio}$	tonnes/ year	Amount of charcoal used in the baseline scenario b2	Charcoal: 1.6005 * 10 Total: **16.005**	B2 KPT data and analysis,sheet '90/30 test' Cell G35
$BB_{b3,bio}$	tonnes/ year	Amount of charcoal and firewood used in the baseline scenario b3	Firewood: 2.92 Charcoal: 1.46 * 10 Total: **17.520**	B3 KPT data and analysis,sheet '90/30 test' Cell G68
$BB_{p1,bio}$	tonnes/ year	Quantity of biomass consumed in project scenario p1 during year y.	Firewood: 1.01 Charcoal: 0.324 * 10 Total: **4.250**	Project emissions KPT data and analysis sheet '90/30 test' Cell G67

The f_{NRB} is estimated to be 96.0%, as per the PoA-DD. The f_{NRB} value is applicable to CO_2 emissions from firewood and charcoal consumption and production. Methane and nitrous oxide emission are not included in the emission reduction calculation for conservativeness. The calculated ex-post baseline emissions are shown in next table:

Table 11: Emission reductions from fuel switch[31]

Baseline scenario	Baseline emissions from fuel use (tCO_2e/yr)	Baseline ratio	Weighted average baseline emission from fuel use (tCO2e/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)
B1 (firewood)	4.080	43.6%	XXX	6.854	0	XXX
B2 (charcoal)	25.813	8.5%				
B3 (firewood +charcoal)	28.256	47.9%				

6.3.2 Emission reduction component 2: Accounting for emission reductions due to the avoidance of methane emissions from manure handling.

The emissions from the animal waste management system of the baseline are determined using the IPCC 2006 Tier 2 approach The Tier 2 approach is applicable to situations where baseline data for an estimation of the methane emission factor per category of livestock are available. The baseline emissions per household shall be calculated as follows:

[30]See https://cdm.unfccc.int/ProgrammeOfActivities/cpa_db/ JWAK1UTZSNFL479D2YG0QIR5VB8XEC/view

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

$$BE_{b,CH4,h,y} = \frac{(VS_T * 365) * (B_{0,T} * 0.67 kg/m^3 * MCF_{x,k} * MS_{T,x,k} * GWP_{CH4} * N_{T,h})}{1000} \quad (3)$$

Where:

$BE_{b,CH4,h,y}$	Baseline emissions from manure handling during the year y in tCO_2e for manure handling method h
VS_T	Daily volatile solid excreted for livestock category T in kg dry matter per animal per day
$B_{0,T}$	Maximum methane producing capacity for manure produced by livestock category T in m^3 CH_4
$MCF_{x,k}$	Methane conversion factors for the animal waste handling system in the baseline situation by climate zone k, (%)
$MS_{T,x,k}$	Fraction of livestock category T's manure handled using manure management system x in climate region k (determined through survey method ex-post)
GWP_{CH4}	Global Warming Potential of methane (25)
$N_{T,h}$	Number of livestock category T in premise h

$MCF_{x,k}$, $MS_{T,x,k}$ and $N_{T,h}$ is defined *ex-ante* on the VPA level referencing a baseline survey applicable to the target user . The conversion factors applicable to the baseline scenario will be sourced from default values presented in Table 10.17 of the IPCC Guidelines for National Greenhouse Gas Inventories.

VS_T and $B_{0,T}$ can be defined *ex-ante* as per the default values presented in the IPCC Guidelines for National Greenhouse Gas Inventories, where no country-specific data is available. These can be found in Tables 10A-4 through 10A-9 of the referenced report.

Step 1: Determination of $N_{T,h}$

According to the Baseline Survey, the dominant type of cattle owned by the respondents was dairy cows, with the average amount of cows being XX per household. This was followed by goats, other cattle, sheep and market swine.

Table 12: Possession of livestock reported in the Baseline Survey[32]

Animal T	**Average amount**
Dairy cow	XX
Goat	XX
Other cattle	XX
Sheep	XX
Market swine	XX
Poultry	XX

Step 2: Determination of manure characteristic of targeted animals

Manure characteristics are determined by default IPCC values as no national specific data is available. These include the amount of volatile solids (VS) produced in the manure from animal category T and the maximum amount of methane able to be produced from that manure (B_{OT}).

Table 13: Manure characteristics of different livestock categories

Animal type	**VS** (kg/head/day)	**B_O** (m^3 CH_4/kg VS)
Dairy Cow	1.9	0.13

[32] For reference see document '[include reference once completed]

Goat	0.35	0.13
Market swine	0.3	0.29
Sheep	0.32	0.13
Other cattle	1.5	0.1
Poultry	0.01	0.36

Step 3: Determination of the applicable Methane Conversion Factor (MCF)
The system-specific methane conversion factors applicable to the baseline are provided in the IPCC Guidelines for National Greenhouse Gas Inventories[33]. The applicable MCF is chosen from the default values presented in Table 10.17, Chapter 10, Volume 4 of the 2006 IPCC Guidelines. Average temperatures are defined on the province level.

The *ex-ante* data is collected through the Baseline Survey. The baseline study results indicate that daily spread is the most common manure handling method, followed by dry lot, composting and solid storage. The resulting average MCF is XX.XX%.

Table 14: Applicable MCF at national average temperature of 22.0 C[34]

Method	**Uncovered lagoon**	**Liquid slurry**	**Solid storage**	**Drylot**	**Pasture/ Range / Paddock**	**Daily spread**	**Burned for fuel**	**Composting**
Fraction observed	XX%	XX %	XX %	XX %	XX %	XX %	XX %	XX %
MCF (at 22 C)	78.0%	50.0%	4.0%	1.5%	1.5%	0.5%	10.0%	0.5%

$MCF_{x,k}$	XX %

With the data from the previous tables the baseline emission can be determined. The emission per household of all the animals under the VPA are calculated and depicted in the next table. The number of animals originates from the Baseline survey and based on the manure handling methods and resulting average MCF established above.

The baseline methane emissions per household per year under the VPA are[35]:

$$\mathbf{BE_{b1,CH4,h,}}_{y} = \frac{\sum \mathrm{VS_T} * \mathrm{Bo_T} * 0.67 kg/m^3 \ * 17.25\% \ * \ 1 * 25 * 365)}{1000} = \boldsymbol{XXX}\ \mathbf{tCO_2e}$$

Therefore[36]:

$$\mathbf{BE_{b1,CH4,h,}}_{y} = \frac{(XXX) * (\mathrm{XX})}{1000} = \mathrm{XX}\ \mathbf{tCO_2e}$$

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

[34] See: http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisRegion=Africa&ThisCCode=TZA

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

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

Project emissions of the methane avoidance component include both the physical leakage of biogas from the biodigester and the incomplete combustion of biogas. These shall be accounted for in accordance with equation (8) of the PoA-DD:

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

Where:

$PE_{p,CH4,y}$	Project emissions from manure handling during the year y in tCO_2e
GWP_{CH4}	Global Warming Potential of methane (25)
$N_{T,h}$	Number of livestock category T in premise h
$EF_{awms,\ T}$	Emission factor for the defined livestock population category T
PL_y	Physical leakage of the biodigester (through measurement or application of 10% default)
$\eta_{\text{new stove}}$	Combustion efficiency of the used type of biogas stove
$PE_{awms,NT}$	Project emission from the animal waste not treated in the biodigester

In the above equation, $EF_{awms,\ T}$ is further defined as:

$$\mathrm{EF_{awms,h}} = \frac{(\mathrm{VS_T} * 365) * (\mathrm{B_{0,T}} * 0.67\mathrm{kg/m^3} * \mathrm{MCF_{x,k}} * \mathrm{MS_{T,x,k}})}{1000}$$

Where:

$EF_{awms(T)}$	CH_4 emission factor for livestock category *T*, (tCH_4per animal per year)
$VS_{(T)}$	Daily volatile solid excreted for livestock category *T*, (kg dry matter per animal per day)
365	Basis for calculating annual VS production, (days per year)
$Bo_{(T)}$	Maximum methane production capacity for manure produced by livestock category *T*, (m_3CH_4 per kg of VS excreted)
D_{CH4}	CH_4 density (0.00067 t per m_3 at room temperature)
$MCF_{(BL,k)}$	Methane conversion factors for the animal waste handling system in the baseline situation by climate zone *k*, (%)
$MS_{(T,S,k)}$	Fraction of livestock category *T*'s manure treated in the animal waste management system, in climate region *k* (dimensionless)

The project methane emissions per household per year under the first Tanzanian VPA are therefore[37]:

$$\mathbf{PE_{p1,CH4,y}} = \mathrm{XXX} = \mathbf{XXX\ tCO_2e}$$

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

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.

Emission reductions per VPA will be calculated as:

$$\mathbf{ER_{CH4,y}} = \left(\mathrm{BE_{b,CH4,y}} - \mathrm{PE_{p,CH4,y}}\right) * \mathrm{N_{p,y}} * \mathrm{U_{p,y}} \quad \textbf{(5)}$$

Where:

$ER_{CH4,y}$	Methane emissions reductions in year y (tCO_2)
$BE_{b,CH4,y}$	Baseline methane emissions during the year y (tCO_2)
$PE_{p,CH4,y}$	Project methane emissions during the 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)

Calculation
The emission reductions from methane avoidance per household per year under the VPA are[38]:

XXX– XXX **= XXXX tCO_2e**

6.3.3 Leakage emissions

The project proponent investigated the following potential sources of leakage:

Table 15: 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 firewood stoves cannot be moved as they are fixed to the floor of the kitchenette.
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.	Most household rely on wood and charcoal in Tanzania. The small share of household that use a lower emitting energy source, such as LPG, will not switch back to NRB due to the project activity.
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 Tanzania 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 Tanzania.

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

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 baseline is not fixed in this project, and the combustion of biogas always leads to lower emissions compared to all baseline fuels as it is 100% renewable.
F	Physical leakage emissions	It is considered as project emissions - see chapter 3.24
G	Emissions from biogas slurry	It is considered as project emissions – see chapter 3.26.

D.6.4. Summary of the ex-ante estimates of emission reductions

The next table shows the ex-ante estimate of the emission reductions for each biogas unit[39]:

Table 16: Average annual emission reductions for each baseline scenario identified

Emission source	**$BE_{b,CH4,y}$ (tCO_2e/year)**	**$PE_{b,CH4,y}$ (tCO_2e/year)**	**$ER_{CH4,y}$ (tCO_2e/year)**
Biomass and fossil fuel substitution	XXX.XX	6.854	XXX.XX
Manure handling	XXX.XX	XXX.XX	XXX.XX
Total			XXX.XX

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 3.1. The next table shows the ER.

Table 17: Project emission, baseline emissions, leakage and overall emissions per year

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
Year A (2017)			0	
Year B (2018)				
Year C (2019)				

[39] Figures may not add up due to rounding

Year D (2020)				
Year E (2021)				
Year F (2022)				
Year G (2023)				
Total				
Total number of crediting years	7			
Annual average over the crediting period				

D.7. Application of the monitoring methodology and description of the monitoring plan

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D.7.1. Data and parameters to be monitored

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)
Source of data	Collected through the annual Monitoring Survey.
Value(s) applied	2017: 95% 2018: 95% 2019: 95% 2020: 95% 2021: 95% 2022: 95% 2023: 95%
Measurement methods and procedures	An assessment of the drop-off rate of usage requires that digesters of different age groups are assessed. Monitoring shall be carried out on a random sample of digesters of different ages. The minimum total sample size is 100, with at least 30 samples for biogas digesters of each age bracket (measured in annual increments) being surveyed. The usage rate of thermal applications will be monitored annually using survey methods to satisfy the requirements put forth by the methodology 'Technologies and practices to displace decentralized thermal energy consumption' (version 2.0).
Monitoring frequency	Annual
QA/QC procedures	To account for void responses and lack of availability of some households on the day of the survey, additional households within each age group should be questioned. To ensure conservativeness, participants in a usage survey with technologies in the first year of use (age 0-1) must have technologies that have been in use on average longer than 0.5 years. For technologies in the second year of use (age 1-2), the usage survey must be conducted with technologies that have been in use on average at least 1.5 years, and so on.
Purpose of data	Calculation of project emissions
Additional comment	A single usage parameter is weighted to be representative of the quantity of project technologies of each age being credited in a given project scenario.

Data / Parameter	$N_{p1,y}$
Unit	Number

Description	Cumulative number of project technology-days included in the project database for project scenario p1 against baseline scenario b1 in year y
Source of data	Total sales record from the Project Database.
Value(s) applied	Reported as a result of ($No_{p1,y}$ * ($O_{p1,y}$ / 365)), which equals (XXX* 365/365) = XXX
Measurement methods and procedures	New biogas digesters included under the PoA will be entered into the Project Database as and when they come online. This will enable a running cumulative total of biogas digesters installed to be kept. The operational rate is determined on a sampling basis through annual monitoring surveys.
Monitoring frequency	Continuous
QA/QC procedures	$N_{p,y}$ shall be calculated from (a) the number of installed system (parameter $No_{p,y}$); and (b) the average operational days of the system ($O_{p,y}$). The equation is therefore ($N_{p,y} = No_{p,y} * (O_{p,y} / 365)$). The average operational days will be confirmed upon verification.
Purpose of data	Calculation of project emissions
Additional comment	N/A

Data / Parameter	**$No_{p1,y}$**
Unit	Number
Description	Cumulative number of project technologies included in the project database for project scenario p1 in year y
Source of data	Project Database
Value(s) applied	1,992
Measurement methods and procedures	The date presented in the Sales Agreement for each biogas digester is recorded in the Project Database. On average, biogas is produced and used 40 – 60 days after completion. To be conservative, 60 days are assumed. **$N_{0p,y}$** will be calculated from this date.
Monitoring frequency	Continuous
QA/QC procedures	As per procedures of the Project Database
Purpose of data	Calculation of project emissions
Additional comment	The actual cumulative number of biodigester operational days will be confirmed upon verification. The annual number of digesters presented here is based on the historical distribution rate from previous years of the first VPA in Tanzania.

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
Source of data	Project Database
Value(s) applied	365
Measurement methods and procedures	The operational rate is determined on a sampling basis through annual monitoring surveys. In addition, households are required to notify provincial office staff in a situation when a biodigester stops working. This information is recorded in the Project 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.
Monitoring frequency	Continuous
QA/QC procedures	The average operational days will be confirmed upon verification.
Purpose of data	As per procedures of the Project Database.
Additional comment	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)

Data / Parameter	$LE_{p1,y}$
Unit	tCO_2e/year
Description	Leakage in project scenario p1 during year y
Source of data	Collected through the annual Biogas User Survey.
Value(s) applied	0.00
Measurement methods and procedures	Non-biogas digester users will be surveyed through a questionnaire to determine whether leakage has occurred.
Monitoring frequency	Every two years
QA/QC procedures	The leakage will be monitored annually using survey methods to satisfy the requirements put forth by the methodology 'Technologies and practices to displace decentralized thermal energy consumption' (version 2.0).
Purpose of data	Calculation of leakage
Additional comment	N/A

Data / Parameter	$BB_{p1,2,3,\,bio}$
Unit	Tonnes/year
Description	Amount of woody biomass used in the project scenario p1 (one value)
Source of data	Kitchen Performance Test 2015
Value(s) applied	4.250
Measurement methods and procedures	*H*ouseholds/communities/SMEs have been asked how much woody biomass they use per week, and undergo a Kitchen Performance Test as per the requirements of the TPDDTEC methodology.
Monitoring frequency	*Ex-post*, once every two years
QA/QC procedures	To account for void responses and lack of availability of some households/communities/SMEs on the day of the survey, at least 10 additional households should be questioned.
Purpose of data	To calculate project emissions
Additional comment	Project Performance Field Test will be updated once every two years.

Data / Parameter	$BB_{p1,2,3,fuel}$
Unit	Tonnes/year
Description	Projected amount of fossil fuels used in the project scenario p1
Source of data	Kitchen Performance Test 2015
Value(s) applied	0
Measurement methods and procedures	*H*ouseholds/communities/SMEs have been asked how much fossil fuels they use per week, and undergo a Kitchen Performance Test as per the requirements of the TPDDTEC methodology.
Monitoring frequency	*Ex-post*, once every two years
QA/QC procedures	To account for void responses and lack of availability of some households/communities/SMEs on the day of the survey, at least 10 additional households should be questioned.
Purpose of data	Calculation of project emissions
Additional comment	Project Performance Field Test will be updated once every two years.

Data / Parameter:	$BB_{b\ ratio}$
Data unit:	%
Description:	Baseline scenario ratios

Source of data:	Biogas User Survey (ex-ante figures), see spreadsheet Biogas User Survey 2014, see spreadsheet 'Raw Data BUS BIOGAS HH-Reviewed24Sept15', column BB
Value(s) applied	Determined on VPA level, with 'b' being sub-categorised into: b1: households using mainly firewood = 43.6% b2: household using mainly charcoal = 8.5% b3: households using mainly firewood + charcoal = 47.9%
Measurement methods and procedures:	Households/communities/SMEs will be asked which baseline scenario they fell into before receiving a biogas digester as part of the Monitoring Survey.
Monitoring frequency:	Annually
QA/QC procedures:	To account for void responses and lack of availability of some households/communities/SMEs on the day of the survey, additional households should be questioned.
Purpose of data	Calculation of baseline emissions
Additional comment:	The ratio to apply for each baseline scenario in the project population will be determined as part of the monitoring survey on a sampling basis. The survey results will be applied to the project population to calculate the emission reductions.

Data / Parameter	$\mathbf{N_{,T}}$
Unit	Number of animals
Description	Number of livestock category T in premise
Source of data	Baseline Survey 2016
Value(s) applied	**Animal T** / **Average amount** Dairy cow: XX Goat: XX Other cattle: XX Sheep: XX Market swine: XX Poultry: XX
Measurement methods and procedures	A baseline survey was conducted in 2016
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$\mathbf{MS_{T,S,k}}$
Unit	%
Description	Fraction of livestock category T's manure fed into the bio-digester, S in climate region k
Source of data	Monitoring survey
Value(s) applied	1
Measurement methods and procedures	Households/communities/SMEs have been asked to estimate the fraction of their animal's manure that is fed into the biogas digester for the different relevant livestock categories.
Monitoring frequency	Annual
QA/QC procedures	To account for void responses and lack of availability of some households/communities/SMEs on the day of the survey, at least 10 additional households should be questioned.
Purpose of data	Calculation of project emissions
Additional comment	Applicable to VPAs applying Tier 2 only

Data / Parameter	**$MS_{P,S,K}$**
Unit	fraction
Description	Fraction of livestock category T's manure not fed into the bio-digester, in climate region k
Source of data	Monitoring survey
Value(s) applied	0
Measurement methods and procedures	Households/communities/SMEs have been asked to estimate the fraction of their animal's manure that is not fed into the biogas digester for the different relevant livestock categories.
Monitoring frequency	Annual
QA/QC procedures	To account for void responses and lack of availability of some households/communities/SMEs on the day of the survey, at least 10 additional households should be questioned.
Purpose of data	Calculation of project emissions
Additional comment	N/A

Data / Parameter	**GWP_{CH4}**
Unit	Unit
Description	Global Warming Potential of methane
Source of data	IPCC (2006); May be updated according to any future changes by the IPCC
Value(s) applied	As per the Gold Standard's rule update 'The application of Global Warming Potentials for Gold Standard project activities': 25 for VPAs seeking issuance for emission reductions incurred after 1 January 2013
Measurement methods and procedures	The IPCC guidelines will be checked on an annual basis during verification to determine if the GWP of methane has changed from the above.
Monitoring frequency	Annual
QA/QC procedures	As per the Gold Standard's rule update 'The application of Global Warming Potentials for Gold Standard project activities'
Purpose of data	Calculation of project emissions
Additional comment	N/A

Data / Parameter	**Bio**
Unit	-
Description	Use of bio-slurry
Source of data	Biogas User Survey
Value(s) applied	Not applicable, no effect on emission reductions
Measurement methods and procedures	Households will be asked how they use the bio-slurry produced as a bio-product of the anaerobic digestion process.
Monitoring frequency	Annual
QA/QC procedures	Sampling in accordance with the procedures in the methodology applied shall be carried out.
Purpose of data	Calculation of project emissions
Additional comment	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.

The VPA will also monitor the following social and environmental parameters, as defined under the Gold Standard[40]:

Data / Parameter	**GS-01 Air quality**
Unit	Percentage
Description	Perceived improvement in health by the user. (incidence of eye problems and respiratory illness)
Source of data	Annual monitoring surveys
Value(s) applied	Not applicable, no effect on emission reductions
Measurement methods and procedures	Users of the biogas digesters will be asked if they feel the incidence of eye problems and respiratory illness have a) increased, b) stayed the same or c) decreased as a result of getting a biogas digester.
Monitoring frequency	Annual
QA/QC procedures	Not applicable
Purpose of data	Monitoring of sustainable development benefits
Additional comment	-

Data / Parameter	**GS-03 Soil condition**
Unit	%
Description	Percentage of biogas users who use slurry as a fertilizer
Source of data	Annual monitoring surveys
Value(s) applied	Not applicable, no effect on emission reductions
Measurement methods and procedures	The occurrence of application of slurry to agricultural land will be monitored through sampling as part of the annual monitoring effort. Stakeholders will be asked how they use the slurry, if at all.
Monitoring frequency	Annual
QA/QC procedures	N/A
Purpose of data	Monitoring of sustainable development benefits
Additional comment	N/A

Data / Parameter	**GS-06 Quality of employment**
Unit	Number
Description	Number of masons attending training programmes
Source of data	Electronic Project Database
Value(s) applied	Not applicable, no effect on emission reductions
Measurement methods and procedures	All vocational 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. This will be updated as and when trainings are conducted.
Monitoring frequency	Annual
QA/QC procedures	N/A
Purpose of data	Monitoring of sustainable development benefits
Additional comment	N/A

Data / Parameter	**GS-07 Livelihood of the poor**

[40] Refer to accompanying Gold Standard PoA-Passport for further details.

Unit	%
Description	Percentage of users reporting changes in expenditure on fuel for cooking
Source of data	Annual user survey
Value(s) applied	Not applicable, no effect on emission reductions
Measurement methods and procedures	Stakeholders will be asked: Has your expenditure of fuel for cooking a) increased, b) decrease or c) stayed the same since purchasing the biogas digester?
Monitoring frequency	Annual
QA/QC procedures	N/A
Purpose of data	Monitoring of sustainable development benefits
Additional comment	N/A

Data / Parameter	**GS-08 Access to affordable and clean energy services**
Unit	Number
Description	Number of biogas units installed
Source of data	Electronic Project Database
Value(s) applied	To be determined per VPA
Measurement methods and procedures	The total number of biogas digesters will be determined via the electronic Project Database.
Monitoring frequency	Annual
QA/QC procedures	N/A
Purpose of data	Monitoring of sustainable development benefits
Additional comment	N/A

Data / Parameter	**GS-10 Quantitative employment and income generation**
Unit	Number
Description	Number of employees in the project
Source of data	Employment records
Value(s) applied	Not applicable, no effect on emission reduction calculations
Measurement methods and procedures	Records will be kept of all employees and jobs created as part of the programme. Hard copies of employment contracts will be kept by VPA Implementers as evidence. Will include part-time work.
Monitoring frequency	Annual
QA/QC procedures	N/A
Purpose of data	Monitoring of sustainable development benefits
Additional comment	N/A

Data / Parameter	**GS-12 Technology transfer and technological self-reliance**
Unit	Number
Description	Number of employees attending training programmes
Source of data	Electronic Project Database
Value(s) applied	Not applicable, no effect on emission reduction calculations
Measurement methods and procedures	All vocational 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. This will be updated as and when trainings are conducted.
Monitoring frequency	Annual
QA/QC procedures	N/A
Purpose of data	Monitoring of sustainable development benefits
Additional comment	N/A

D.7.2. Description of the monitoring plan

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The monitoring plan describes how to collect, assess and archive all relevant data to be monitored according to the methodology. Data from the monitoring procedures will be recorded in the electronic project database and summarised in an annual Monitoring Report. The data collection will follow the standard "Sampling and surveys for CDM project activities and programme of activities (Version 04)"[41]. The guidelines 'Sampling and surveys for CDM project activities and programmes of activities' (Version 03) has been used to structure the monitoring plan.

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 2.0). Monitoring will be carried out on an annual basis, with those parameters that can be monitored on a biennial basis monitored once every two years.

Target population

The target population for the application of monitoring procedure is the households, local communities and SMEs with installed biodigesters, as identified through the Project Database managed by the CME. Those parameters required to assess the extent of leakage for non-biogas users every two years will be asked to similar households in the same region.

Sampling method

CAMARTEC, with support from the CME, is responsible for the production of periodical monitoring reports for each VPA. Multi-stage sampling will be applied within the PoA, where clusters consist of regions and the subunits (biogas digesters) within them. It is more cost effective to monitor several subunits within each region. In order to account for the fact that not all regions have the same number of biogas digesters commissioned, 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.

Sample size

In order to combine monitoring with an assessment of the drop-off rate of usage (which requires that digesters of different age groups are assessed), monitoring can be carried out on a random sample of digesters of different ages. The minimum total sample size is 100, with at least 30 samples for biogas digesters of each age bracket (measured in annual increments) being surveyed. In accordance with the requirements set forth in the methodology, the sample size will be selected following a 90% confidence interval and a 10% margin of error (90/10), where applicable. For the Kitchen Performance Test, a 90% confidence interval and a 30% margin of error (90/30) is to be applied. For more details on the sample size determination, refer to Section B.7.2 of the PoA-DD.

Sampling frame

The sampling frame shall be defined based on the information in the Project Database, which outlines the location of each biogas digester and the number installed in each geographical region. The sample selection consists of two stages: the first step considers the larger sample units (country regions) whilst the second step involves randomly selecting biogas digesters to be monitored within these units.

Data to be collected

Field measurements

41 EB 74, Annex 6

CAMARTEC will collect the data necessary for the monitoring and for the emission reductions calculation. Field measurements and data to be collected are listed in section B.6.2. above. To account for seasonal fluctuations, monitoring of fuel wood consumption (KPT) should by preference be carried out during the dry season. This ensures conservativeness since during this 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. In case monitoring of fuel wood consumption is not taking place during the dry season moisture meters should be used.

The parameters to be monitored within the VPA, as outlined in the applied methodology, are as follows:

A Monitoring Survey shall be completed periodically and covers the following data:

- Number of users applying the final biodigester slurry on agricultural fields;
- Perceived improvement of living conditions;
- Number of individuals attending trainings;
- Percentage of biodigester in use in the given year (y).
- The number of operational days of the biodigesters in the given year (y).
- The fraction of manure that is not treated in the biodigester.
- Ratio of households falling in separate baseline fuel scenarios.
- Continued use of baseline stoves – once per year. Biogas digester users will be asked to confirm whether they use their baseline stove in addition to (or instead of) their biogas digester, and if so, how often they use it.
- Quantity of biomass and fossil fuel that is used for cooking in a given baseline scenario in a given year (y) – once upfront under Option B, whereby the baseline scenario fuel usage is fixed for the crediting period;
- Quantity of biomass and fossil fuel that is used for cooking in a given project scenario in a given year (y) – once every two years;
- Leakage in the given project scenario in the given year (y) – once every two years.

The application of bioslurry shall be monitored according the applied methodology. If there is any anaerobic use/storage of bioslurry 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.

Quality assurance/Quality control

The CME will provide the necessary training to the VPA implementers and the parties involved in the monitoring to ensure that the data recorded is complete and accurate. The VPA Implementer, CAMARTEC, will prepare data collection protocols to be given to the research assistants to guide them during the data collection exercise.

Response rates will be maximized by contacting all randomly-selected biogas digester users beforehand to arrange a practical site visit date and sampling over the minimum required number to compensate for any non-responses. The right of the CME to perform these monitoring efforts will be included in the Sales Agreement signed with each user. In special cases where participants refuse to participate in the monitoring, the reason shall be documented in the CME's Project Database. The surveyor will explain that monitoring is part of the requirements of the programme and try to arrange an alternative date for a site visit, or carryout monitoring with another member of the households, community or SME.

Sales Agreements will be stored by CAMARTEC with copies sent to the CME, if requested. A back-up of the project database will also be stored on an electronic medium by the CME. All data

monitored and required for verification and issuance will be kept for at least five years after the end of the crediting period or the last issuance of VERs for the project activity, whichever is later.

Analysis
All the sales data and the survey data will be captured in a computerised database. The analysis will include a calculation of the proportion of biogas system in use and of the emission reductions according to the methodology applied. Outliers will be excluded using the Grubb's Test.[42]

Implementation plan

CAMARTEC will be responsible for the collection of all Sales Agreement data and the creation of the Monitoring Report at the end of each Monitoring Period. CAMARTEC will also be responsible for entering user data into the Project Database and for ensuring that the information in the Sales Agreements is complete and correct. The total number of Sales Agreements will reveal the quantity of biogas systems sold at the end of a Monitoring Period. The Project Database will record the start and end dates of each selling year *y* for each biogas system ($t_{fraction}$), and calculate the emission reductions attributable to each Monitoring Period. Appropriate record keeping procedures will be implemented to ensure that each Monitoring Period dataset can be transparently attributed to its corresponding VPA, preventing any occurrences of double counting.

Monitoring Responsibilities
CAMARTEC is responsible for all the monitoring activities carried out within this VPA, including data collection, data monitoring, and writing the Monitoring Report.

SECTION E. Approval and authorization

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Obtaining a Letter of Approval is not applicable to voluntary Gold Standard projects.

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[42] 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.

Appendix 1. Contact information of VPA implementer(s) and responsible person(s)/ entity(ies) for completing the CDM-SSC-VPA-DD-FORM

VPA implementer and/or responsible person/ entity	☐ VPA implementer(s) ☒ Responsible person/ entity for completing the CDM-SSC-VPA-DD-FORM
Organization	Centre for Agricultural Mechanisation and Rural Technology (CAMARTEC)
Street/P.O. Box	Njiro Road, P.O. Box 764
Building	Themi hill, Opp General Tyre,
City	Themi hill, Arusha
State/Region	Arusha Region
Postcode	P.O. Box 764
Country	United Republic of Tanzania
Telephone	+255 27 254 9214
Fax	+225272549000
E-mail	lehadas7@gmail.com
Website	www.biogas-tanzania.org
Contact person	Lehada Shila
Title	Programme Coordinator, CAMARTEC/Tanzania Domestic Biogas Programme (TDBP)
Salutation	Mr
Last name	Shila
Middle name	Cyprian
First name	Lehada
Department	CAMARTEC/Tanzania Domestic Biogas Programme (TDBP)
Mobile	+255 714 739 661
Direct fax	+225272549000
Direct tel.	+255 27 254 9214
Personal e-mail	lehadas7@gmail.com

Appendix 2. Affirmation regarding public funding

Please see Official Development Assistance (ODA) Declaration.

Appendix 3. Applicability of methodology(ies) and standardized baseline(s)

Please see section D.2 of the VPA-DD for details.

Appendix 4. Further background information on ex ante calculation of emission reductions

No further background information necessary.

Appendix 5. Further background information on monitoring plan

No further background information necessary.

Appendix 6. Summary of post registration changes

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