



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

(Version 05.0)

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) – Uganda - VPA003
Version number of the VPA-DD	2.3
Completion date of the VPA-DD	21/02/2017
Title of the PoA to which the VPA is included	African Biogas Carbon Programme (ABC)
Host Party	Uganda
Estimated amount of annual average GHG emission reductions	7,460
Applied methodology(ies) and, where applicable, applied standardized baseline(s)	Technologies and Practices to Displace Decentralized Energy Consumption (Version 1.0)
Sectoral scope(s) linked to the applied methodology(ies)	Sectoral scope 1: Energy industries (renewable - / non-renewable sources) Sectoral scope 15: Agriculture

SECTION A. General description of VPA**A.1. Title of the proposed or registered PoA**

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African Biogas Carbon Programme (ABC)

A.2. Title of the VPA

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VPA Title: African Biogas Carbon Programme (ABC) – Uganda – VPA003

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.

Biogas Solutions Uganda Ltd, founded in 2014, is the entity 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 Uganda under this VPA. The VPA is an activity that falls under the Uganda Domestic Biogas Program (UDBP), which is part of the regional African Biogas Partnership Program (ABPP).

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 Uganda, 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 of 4 m³, 6 m³, 9 m³, and 13 m³ capacities (other sizes may be included under the VPA). This VPA is retroactive and includes biogas systems that have been installed since November 2009.

The aim of the Uganda Domestic Biogas Programme is to disseminate domestic biogas in rural and peri-urban areas with the ultimate goal of establishing a sustainable and commercially viable biogas sector in Uganda. The goal of the programme is to improve the livelihoods and quality of life of rural and peri-urban farmers in Uganda through utilizing the market and non-market benefits of domestic biogas.

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

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Biogas Solutions Uganda Ltd is the VPA implementer of the Uganda Domestic Biogas Program. This VPA 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. The ABPP is currently operating in five African countries namely; Ethiopia, Burkina Faso, Kenya, Tanzania and Uganda.

Biogas Solutions Uganda Ltd is a company managed jointly by Hivos and SNV and is funded by the Netherlands Ministry of Foreign Affairs. The objective of the company is to develop and nurture the

biogas sector in Uganda through the dissemination of information to households, ensuring the quality of biogas plants and building capacities of various stakeholders in the biogas sector.

A.5. Technical description of the VPA

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The VPA will stimulate the installation of domestic biogas systems country wide, of 4m³, 6m³, 8m³, 10m³ and 12m³ capacity, as well as other capacities as long as these remain below the scale limit of the VPA. 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.

Biogas Solutions Uganda Ltd selected the appropriate biogas technology to be implemented through engagement with a wide range of stakeholders. They agreed on a fixed dome digester - a drawing of this model is shown in Figure 1. However, the VPA recognises that in certain geographical regions availability of construction material may be limited, allowing for the inclusion of other types of biodigesters of similar capacities.

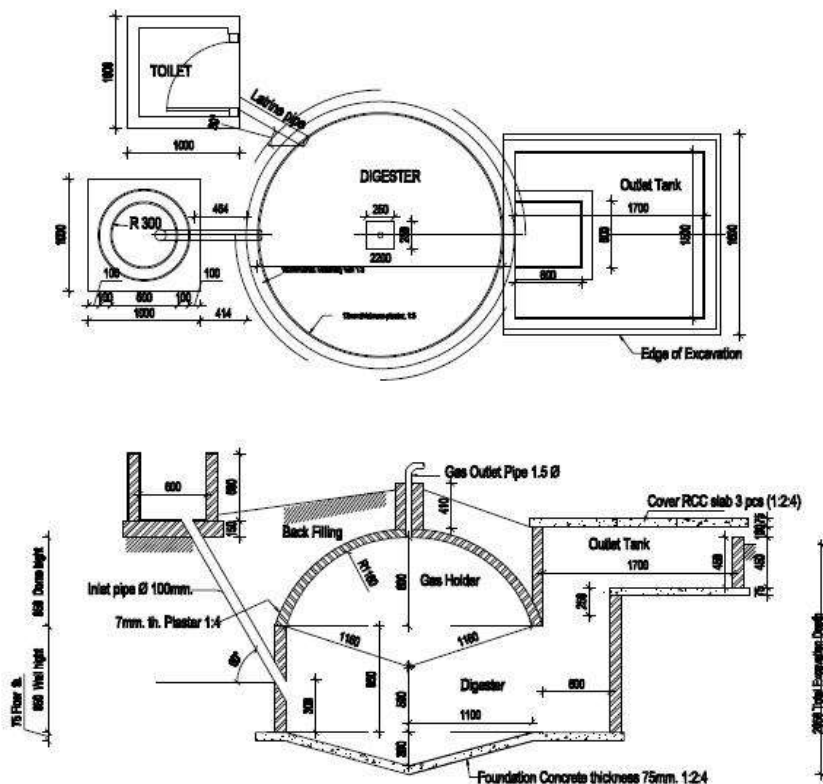


Figure 1: Fixed dome biogas system technical drawing

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.

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)
Republic of Uganda (host)	Biogas Solutions Uganda Ltd	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 Uganda. 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, date of sale, name of VPA implementer (Biogas Solutions Uganda Ltd), biogas model and size.

The unique identification of the VPA is the code VPA003.

The co-ordinates of Uganda are represented approximately by: 4°12'53.79" to -1°28'19.22" N, 29°34'17.52" to 35°2'33.81" E.



Figure 1: Geographical boundary of Uganda and the VPA.

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 11/11/2009, which is the earliest date at which either the implementation or construction or real action of the VPA begins. This is the date of the first Sales Agreement signed for the first digester to be included under this VPA. Retroactive inclusion is pursued.

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. A well maintained fixed-dome biogas system has an operational lifetime of over 30 years. This means that the systems should be operational beyond the potential crediting period of the VPA.

The total installed capacity of the initially planned 11,368 units amounts to 37.36 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.¹

Table 1: Implementation schedule of the VPA²

Year	Number of new biogas digesters installed	Cumulative total
2009	1	1
2010	332	333
2011	1,032	1,365
2012	1,003	2,368
2013	1,631	3,999
2014	848	4,847
2015	664	5,511
2016	362	5,873
2017	1,099	6,972
2018	1,099	8,071
2019	1,099	9,170
2020	1,099	10,269
2021	1,099	11,368

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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¹ Figures are based on sales projections for future years, and for the second half of 2016. The total capacity is calculated assuming sales of each biogas system size will occur in the same proportion as the pre VPA phase. Details have been provided to the DOE on the Emission Reduction calculation spreadsheet.

² ABPP (2013) Construction per month 2010 – 2013

The start date of the crediting period is on 01/04/2015 (estimated date) or 2 years prior to the end date of the inclusion review period, whichever is later.³

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 ₂ e) for each year
01/04/2015 - 31/12/2015	4,430
01/01/2016 - 31/12/2016	6,529
01/01/2017 - 31/12/2017	7,247
01/01/2018 - 31/12/2018	8,496
01/01/2019 - 31/12/2019	9,744
01/01/2020 - 31/12/2020	10,993
01/01/2021 – 31/12/2021	12,242
Total number of crediting years	7
Annual average GHG emission reductions over the crediting period	7,460
Total estimated reductions (tonnes of CO ₂ e)	59,682

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 54⁴ 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 applied⁵, 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.*

³ The Gold Standard’s Annex F (V2.2) states that “A VPA submitted for Gold Standard inclusion/registration under the regular/retroactive project cycle is potentially eligible to receive credits for realised emission reductions generated prior to Gold Standard inclusion/registration for a maximum period of two years.”

⁴ EB 54 Annex 13

⁵ i.e. 150 kW installed capacity or 0.6 GWh annual energy savings or 0.6 ktCO₂e annual emission reductions. See EB65 Report, page 25. Guidelines changed from 15kW to 150kW electrical, or 450kW thermal

Each of the biogas systems included in the VPA is not greater than 1% of the small scale threshold (at 450 kW for thermal energy). A 100 m³ digester, which is considerably larger than any digester size included in this VPA, has a thermal capacity of 44.77 kWth. ⁶ This is considerably below the 1% small scale threshold.

A.13. Confirmation for VPA

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This VPA is neither registered as an individual carbon project activity nor 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 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 (EIA) is required under Ugandan law if the proposed activity is found to have significant impacts on the environment. This is assessed by the Executive Director of the National Environment Management Authority (NEMA) after the submission of a Project Brief, and falls under the terms set forth by the National Environment Act of 19 May, 1995. A VPA does not require to submit a Project Brief if it covers the installation of small biogas systems as these activities do not fall under the Third Schedule of the National Environment Act (pages 55-58).⁷

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. Stakeholders were invited to attend a public meeting to be informed and give their comments on the VPA. The meeting was held on 14/12/2011 at 14:00 at the Fairway Hotel, Kampala. Invitations were distributed to specific stakeholders via e-mail and telephone between 01/12/11 – 05/12/11 and a public invitation was advertised in the national newspaper, The New Vision on 05/12/11. The process for identifying stakeholders is described in more detail in the Local Stakeholder Consultation report. 59 people who represented a wide range of stakeholders attended the meeting. Women were represented with 29% of the attendees. Stakeholders included representatives from government ministries, non-governmental organisations, private businesses, financiers and farmers including

⁶ Detailed calculations were provided to the DOE on Emission Reduction spreadsheet, Tab 'Capacity Calculation'

⁷ The National Environmental Act, Cap 153 (Commencement 19 May, 1995). Available from: nemaug.org/regulations/national_environment_act.pdf

some that had already installed biogas systems. Stakeholders that were unable to attend the meeting were invited to send in comments via e-mail.

A follow-up Stakeholder Feedback Round has been organized in the first half of 2016 (starting 11/03/2016). Stakeholders have been invited to review the LSC Report, PDDs and Passports for the PoA and VPA.

The Gold Standard Local Stakeholder Consultation Report provides a detailed description of the consultations and the results.

C.2. Summary of comments received

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The comments received were very positive and only a small fraction of respondents offered non-positive responses. Their responses mainly called for UDBP to be expanded beyond domestic fixed dome installations. A summary of the action items raised and UDBP’s response to these actions appear below:

Table 2: Summary of comments received during the stakeholder consultations.

Stakeholder comment	Was comment taken into account (Yes/ No)?	Explanation (Why? How?)
It is important to ensure that the farmers that own the biogas digesters are engaged so as to have a proper appreciation of the programme beforehand.	Yes	The comment was already taken into account at the design stage of the Programme. Biogas Solutions Uganda Ltd will be working closely with the UDBP to ensure awareness of the programme and monitoring requirements is built at the grassroots.
The bio-slurry produced from the biogas digesters could become a pollutant if it is not utilized properly.	Yes	Under UDBP farmers are sensitised about the value of bio-slurry as a fertiliser with an increased demand for the bio-slurry. Therefore this risk would be mitigated through effective quality control during construction and training in bio-slurry management and utilisation during operation.
How do you ensure the households with a biogas digester unit benefits from the Programme. There is not direct benefit from the programme at household level.	No	The carbon credits from the programme will be utilised to substitute the current subsidies by ABPP or reduce further the cost of installation of biogas digesters and contribute to continuous maintenance to ensure a long life of the technology (e.g. by setting up a Customer Service Centre). Hence the biogas digester owner benefits.
The Programme would be a good tool to drive up sustainability concerns under the Uganda Domestic Biogas Programme.	No	No action required.
The carbon credits resulting from the Programme provide no incentive to the investing households.	Yes	The carbon credits will be used to reduce the upfront cost of the biogas digester, and to provide maintenance services throughout the lifetime of the digester. These are both incentives to the investing household.

The initial cost of the digester is still relatively high.	No	The price of the digesters is not something that could be addressed directly by the PoA/CME. The price, which is already subsidised, is determined by market forces.
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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 1.0)

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 3: Methodological applicability conditions applied

Applicability criteria	Justification
<p>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.</p>	<p>The project boundary is the physical, geographical site of the methane recovery and combustion systems, located within Uganda.</p> <p>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:</p> <ul style="list-style-type: none"> – the complete address of each biogas system is recorded – the biogas systems have a unique serial number (only for non-retroactively included digesters) – the VPA implementer has not included these biogas systems in another VPA or stand-alone project. <p>The unique serial number is recorded in the project database.</p>
<p>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</p>	<p>The maximum energy output of the biodigesters implemented in the project activities is 44.77</p>

Applicability criteria	Justification
start to end of operation of a unit divided by time of operation).	kWth ⁸ , below the indicated 450 kWth limit per unit.
<p>3. <i>Continued use of baseline technology:</i> 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.</p>	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.
<p>4. <i>Settling of ownership rights over generated emission reductions:</i> The project proponent must clearly communicate to all project participants to whom the ownership rights of the emission reductions resulting from the project activity belong. This must be communicated to the technology producers and the retailers of the system by contract or clear written assertions in the transaction paperwork.</p>	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 Sales Agreement. Copies of these signed contracts will be kept by the VPA Implementer.
<p>5. <i>Use of new biomass feedstock</i> 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.</p>	This applicability criterion is not applicable as no new biomass feedstock is used in the project scenario.
<p>6. <i>Climate zones</i> 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.</p>	<p>The distinct geographical boundary of this VPA is the Republic of Uganda. The GPS co-ordinates of Uganda are represented approximately by: 4°12'53.79" to -1°28'19.22" N, 29°34'17.52" to 35°2'33.81" E.</p> <p>Regarding climate zones, the current MCF calculation is based on a national average temperature of 23.4 C⁹. According to the applicable methodology, "if more than one</p>

⁸ As demonstrated in section B.3. of the PoA-DD

⁹ Average temperatures derived from World Bank (2015) Climate Change Knowledge Portal: Uganda, Average monthly temperature and rainfall for Uganda from 1990 – 2012 [online] Available from http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisRegion=Africa&ThisCCCode=UGA and McSweeney, C; New, M. and Lizcano, G. (no date) Uganda: UNDP Climate Change Country Profiles, Page 5. Available from http://www.geog.ox.ac.uk/research/climate/projects/undp-cp/UNDP_reports/Uganda/Uganda.lowres.report.pdf

Applicability criteria	Justification
	climate zone is included in the project activity, a distinction per climate zone must be considered". The term climate zone is not defined, but the only impact on emission reduction achieved would come from variations in temperature which affect the methane conversion factor (MCF) applied. The PP has conducted research to try to find reputable evidence that numerous climatic zones exist in Uganda. The Ugandan Meteorological Authority http://www.unma.go.ug/ has been consulted but no distinction of climatic zones is provided. A report from UNDP ¹⁰ states that "temperature vary little throughout the year, but the average temperatures increase in the north of the country as the elevation decreases towards the Sudanese plain. Average temperatures in the coolest regions of the south-west remain below 20°C, and reach 25°C in the warmest, northernmost parts". Applying an average temperature of 23.4 C across the VPA is therefore considered appropriate.

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
Baseline Heat delivery Treatment of manure	CO ₂	Yes	CO ₂ emissions from - cook stoves using non-renewable biomass
	CH ₄	Yes	CH ₄ emissions from the baseline treatment methods of manure
	N ₂ O	No	Excluded, insignificant source of emissions.
Project Activity Combustion of biogas	CO ₂	Yes	CO ₂ emissions from - cook stoves using non-renewable biomass
	CH ₄	Yes	Emissions due to the manure not fed into the biogas digester, as per the applied methodology.
	N ₂ O	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 2.

¹⁰ McSweeney, C; New, M. and Lizcano, G. (no date) Uganda: UNDP Climate Change Country Profiles. Available from http://www.geog.ox.ac.uk/research/climate/projects/undp-cp/UNDP_reports/Uganda/Uganda.lowres.report.pdf

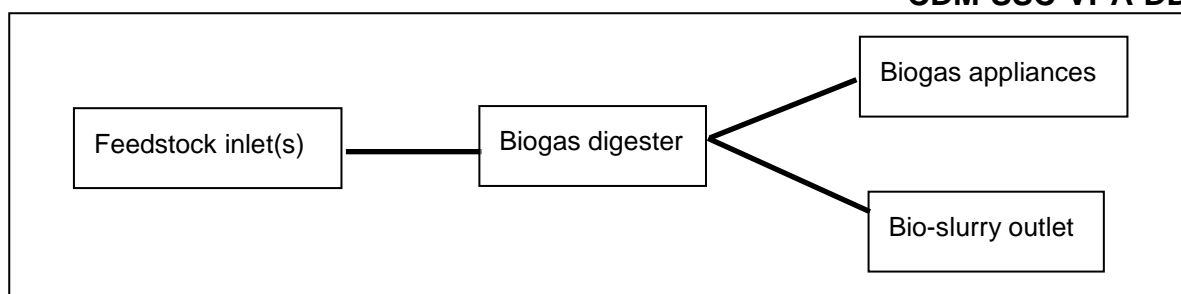


Figure 2: Schematic diagram of biogas system project boundary

D.4. Description of the baseline scenario

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In Uganda, about 90% of the total population of 37 million has no access to electricity.¹¹ Most of the rural population almost completely depends on biomass, particularly non-renewable firewood for their daily energy consumption for cooking, boiling and heating.

Biogas systems in Uganda are a fuel switch from non-renewable biomass. 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 combustible and can be used as a fuel.

To determine parameters $BB_{b,bio}$ and $BB_{b,fuel}$, this VPA-3 applies Option 2 as per the PoA-DD. Under Option 2, $BB_{b,bio}$ and $BB_{b,fuel}$ 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 conducted for the Uganda Domestic Biogas Programme in 2010 assessed the VPA's target population characteristics, including welfare, housing conditions and cooking habits. The Baseline Survey was used to define the baseline scenarios, and ex-ante baseline scenario ratios. The survey met the requirements of the applied methodology, and surveyed 300 households (compared to the requirement of a minimum of 100 households)¹². Table 4 illustrates the different baseline scenarios and their corresponding ratios, as per the Baseline Survey results. The ratios will be updated annually as part of the Monitoring Survey.

Table 4: Type of ex-ante baseline scenarios and distribution per identified baseline scenario¹³

Baseline scenario	Parameter	Baseline Survey results (%)
Households using firewood	$BB_{b1,bio/fuel}$	78.50%
Households using charcoal	$BB_{b2,bio/fuel}$	6.70%
Households using firewood + charcoal	$BB_{b3,bio/fuel}$	14.80%
Others (excluded for conservativeness)	n/a	0.00%
Total		100%

It is important to note that the four baseline scenarios are defined by asking the households “*what is your primary fuel source for cooking purposes?*”. The purpose of this question is to allocate a household to a baseline scenario, whereby ‘primary’ fuel consumption is defined as that fuel meeting more than 50% of their fuel needs for cooking purposes. The households that respond “*firewood*”, for example, are subsequently allocated to the baseline scenario b1. This means that households in, for example, baseline scenario b1 may also use small amounts of fossil fuels (i.e. secondary and tertiary fuels) for cooking, which will be included in the baseline emissions.

¹¹Programme Implementation Document Uganda Domestic Biogas Programme. January 2010

¹² Baseline Survey conducted for the Uganda Domestic Biogas Programme in 2010

¹³ Baseline Survey conducted for the Uganda Domestic Biogas Programme in 2010, p.46

Another explanatory note is the estimation of the ex-ante ratio for baseline scenario b3. The Baseline Survey asked households to indicate what type of primary fuels are used for overall purposes, not cooking specifically. Kerosene and electricity are some of the sources of energy that were mentioned by several households. However, the Baseline Survey also states (p.47) that firewood and charcoal are main fuel sources when it comes to cooking. This is reconfirmed by another statement (p.47) that explains that kerosene and electricity are mainly used for lighting, and by the Uganda Bureau of Statistics (2010)¹⁴ on fuels used for cooking in rural settings. For this reason, only the first two values from Table 13 of the Baseline Survey are applied (78.50% for firewood and 6.70% for charcoal), and other fuels are excluded. For the purpose of the ex-ante ratio definition, the remaining percentage (14.80%) has been allocated to baseline scenario b3, which represents a fuel mix of firewood and charcoal.

The ex-ante ratios presented in this VPA will be updated through the annual Monitoring Survey. Any households that does not fall into either of the three baseline scenarios will still be included in the ratio calculation as b4, meaning that upon verification scenarios b1, b2, and b3 may represent less than 100%.¹⁵ This is deemed to be conservative as the emission reductions generated by these households will be excluded from the ex-post emission reduction calculation. This also implies that before the first verification of emission reductions, three distinct BFTs shall be conducted. The results of these KPTs (b1, b2 and b3) shall be subsequently fixed for the crediting period.

As the Baseline Survey conducted for the Uganda Domestic Biogas Programme in 2010 did not assess the exact fuel usage of households, reference to baseline figures is made to another registered Gold Standard project for ex-ante calculation purposes. This project is the UpEnergy's Uganda Biomass Cookstove Project.¹⁶ The project targets households of similar socio-economic conditions that rely on firewood for cooking purposes, and are therefore considered representative of the households covered under this VPA. According to the latest Monitoring Report of this project (01.01.2013 – 31.12.2013), a total of 3.380 tonnes of firewood are used annually per household. The results include only the usage of firewood, therefore baseline scenario b1. To derive the total biomass value for charcoal (b2) and a combination of both fuels (b3), the tonnes of firewood will be combined with the tonnes of charcoal multiplied by a factor of 8 for the ex-post calculation.¹⁷

It should be noted that the presented baseline scenario data are devised for the purpose of the VPA inclusion into the registered PoA. Three separate baseline KPTs will be implemented prior to the first verification of the emission reductions generated under this VPA in line with the three baseline scenarios identified in the Baseline Survey. These results will substitute the baseline parameters presented in this PDD in future years.

Table 5: 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: 3.380 Total: 3.380	UpEnergy's Uganda Biomass Cookstove Project Monitoring Report, page 9 ¹⁸
BB _{b2,bio}	tonnes/ year	Amount of charcoal used in the baseline scenario b2	Charcoal: 0.000 * 8 Total: 0.000	Not available for ex-ante calculation

¹⁴ Uganda National Household Survey Report 2009/2010 [online] Available from http://www.ubos.org/UNHS0910/chapter9_Domestic%20Energy%20Resources.html

¹⁵ Email communication with The Gold Standard has confirmed this approach to exclude small amounts of other fuels (kerosene and electricity) used in the baseline scenarios. See '9. GS Email Confirmation Baseline Scenarios 24Sep2015'

¹⁶ Source: https://mer.markit.com/br-reg/public/project.jsp?project_id=103000000001886

¹⁷ UNDP (no date) Nationally Appropriate Mitigation Action Study on Sustainable Charcoal in Uganda, Page 15. Available from <http://bit.ly/1J2VSc0>

¹⁸ Monitoring Report covering the period 01.01 2013 – 31.12.2013, available at: <http://bit.ly/1QE3IkK>

BB _{b3,bio}	tonnes/ year	Amount of charcoal and firewood used in the baseline scenario b3	Firewood: 0.000 Charcoal: 0.000 * 8 Total: 0.000	Not available for ex-ante calculation
BB _{p1,bio}	tonnes/ year	Quantity of biomass consumed in project scenario p1 during year y	Firewood: 2.170 Charcoal: 0.000 Total: 2.170	UpEnergy's Uganda Biomass Cookstove Project Monitoring Report, page 10

As for the number of animals raised and the manure handling methods, the baseline results from the Ugandan Baseline Survey conducted in 2010 are used.¹⁹ According to the results of this survey, households owned an average of 8.0 cattle each (see *Table 6*)

Table 6: Possession of livestock reported in the Uganda Baseline Survey 2010²⁰

Animal T	Average amount
Dairy cow	8.00
Goat	7.19
Market swine	3.41
Sheep	4.20
Other cattle	0.00
Poultry	20.44

The Ugandan Baseline Survey did not assess the manure handling methods. Therefore, for the ex-ante calculations, baseline results gathered by the Kenya Biogas User Survey conducted in 2014 are referred to, as VPA-1 and VPA-3 of the African Biogas Carbon Programme are deemed comparable for the purpose of ex-ante emission reduction calculations. This survey looked at the baseline conditions and surveyed 120 households without biodigesters throughout Kenya (*Table 7*). As the manure handling methods are monitored parameters, Ugandan figures will be applied prior to verification and shall be taken for the annual Monitoring Survey.

The Kenya Biogas User Survey results indicate that daily spread is the most common manure handling method, followed by dry lot, composting and solid storage. 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. An average temperature for Uganda of 23.4 C is assumed²¹. The resulting average MCF, in line with these guidelines, is 3.59%.

Table 7: Applicable MCF at national average temperature of 23.4 C

Method	Uncovered lagoon	Liquid slurry	Solid storage	Drylot	Pasture/ Range / Paddock	Daily spread	Burned for fuel	Compo sting
Fraction observed	1.65%	2.48%	5.79%	29.75%	0.00%	44.63%	0.00%	15.70%
MCF (at 23.4 C)	78.0%	50.0%	4.0%	1.5%	1.5%	0.5%	10.0%	1.0%

¹⁹ Baseline Survey conducted for the Uganda Biogas Programme in 2010

²⁰ Charcoal production in Uganda is inefficient. It is estimated that 8 – 12 kg of firewood are needed to produce 1 kg of firewood in Uganda. A conservative conversion factor of 8 is therefore proposed. Source: Baseline Survey conducted for the Uganda Biogas Programme in 2010

²¹ Average temperatures derived from World Bank (2015) Climate Change Knowledge Portal: Uganda, Average monthly temperature and rainfall for Uganda from 1990 – 2012. Available from <http://bit.ly/1GLb4Ho>

MCF _{x,k}	3.59%
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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 8: Eligibility criteria for VPA inclusion in the PoA

Nr.	Requirement ²²	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: <ul style="list-style-type: none"> – Recording the address/location of the system in the Sales Agreement – Recording the GPS coordinates of the systems (not relevant for retroactive digesters) – 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: <ul style="list-style-type: none"> – Uganda Implementation document 2010 – 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: <ul style="list-style-type: none"> – 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: <ul style="list-style-type: none"> – Contractual agreement between CME and Biogas Solutions Uganda Ltd (signed ERPA) – Declaration from Biogas Solutions Uganda Ltd – Sales Agreement
3.	The specifications of technology/measure including the level and type of service, performance specifications including	The biogas systems disseminated are renewable energy generation units to provide thermal energy and will be required to conform to	The following document is provided: <ul style="list-style-type: none"> – Technical documentation describing the operation of the biogas system

²² 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 VPA.

Nr.	Requirement ²²	Eligibility criteria	Evidence provided
	compliance with testing/certifications	any applicable national standards.	(Operation Manual of Biogas plants) There are no national standards regulating biogas digester technologies in Uganda.
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 date of the VPA will be defined as the date on which the first Sales Agreement is signed under the VPA.	The following documents are provided: – 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 1.0), 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 List²³ 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: – Calculation showing the capacity of the biogas system(s) in MW – 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 (Uganda) An environmental impact assessment is not required for activities implementing household biodigesters in Uganda (see Section B.1 above)
8.	Conditions to provide an affirmation that funding from	The VPA will demonstrate that any Official Development	The following document is provided:

²³ As per the “Guidelines on the Demonstration of Additionality of Small-Scale Project Activities” Version 09, EB68 Annex 27 clause 2 (c)

Nr.	Requirement ²²	Eligibility criteria	Evidence provided
	Annex I parties, if any, does not result in a diversion of official development assistance	Assistance received for the VPA has not occurred on the condition that the resulting credits are transferred to the donor country ²⁴ .	– ODA Declaration
9.	Where applicable, target group (e.g. domestic / commercial / industrial, rural / urban, grid connected / off-grid) and distribution mechanisms (e.g. direct installation)	The VPA will demonstrate which target group(s) is/are to be targeted by the VPA and the distribution mechanism. Target groups shall include: <ul style="list-style-type: none"> – Households – Small/Medium Enterprises – Communities 	The following document is provided: <ul style="list-style-type: none"> – Implementation document (Uganda Domestic Biogas 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 Biogas Solutions Uganda Ltd
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 ²⁵ , each VPA in aggregate will remain below 15 MW (45MW _{th}) per year. For activities falling under Type III ²⁶ , each VPA will achieve below 60,000 tCO ₂ e in emission reductions annually.	The following documents are provided: <ul style="list-style-type: none"> – Capacity calculation of the biogas system(s), showing that the VPA Type I installed capacity is below the 15MW (45MW_{th})²⁷ threshold. – Emission reduction calculation, showing that the VPA Type III emissions are below the 60,000 tCO₂e threshold.²⁸
12.	Where applicable, the requirements for the	The VPA implementer will demonstrate that the VPA is	The following evidence is provided:

²⁴ Gold Standard Toolkit, Version 2.1, Section 1.2.5.

²⁵ 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)

²⁶ 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 CO₂e per year in any year of the crediting period”, CDM Project Standard, (version 07.0), paragraph 89 (b)

²⁷ See Emission Reduction calculation spreadsheet, sheet ‘Capacity calculation’, cell C8

²⁸ See Emission Reduction calculation spreadsheet, sheet ‘Capacity calculation’, cell C9

Nr.	Requirement ²²	Eligibility criteria	Evidence provided
	debundling check, in case VPAs belong to small-scale (SSC) or microscale project categories.	not a de-bundled component via the following approach: 1. The biogas systems are less than 1% of the SSC threshold (as per paragraph 10 EB54 Annex 13)	– Calculation showing the capacity of the biogas system(s)
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 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 Biogas Solutions Uganda Ltd
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: 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 .
Value(s) applied	Uganda: 82% (approved by Ugandan DNA on 11 April 2012)

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	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	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	EF_{p, fuel}
Unit	tCO ₂ /TJ
Description	Emission factor of fossil fuels used in project scenario
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	Kerosene = 71.9 LPG = 63.1
Choice of data or Measurement methods and procedures	As per requirement of the methodology and Table 2.3, Chapter 2, Volume 2 of the 2006 IPCC Guidelines. The IPCC is a standard, credible source of emissions factors.
Purpose of data	Calculation of project emissions
Additional comment	IPCC (2006); May be updated according to any future changes by the IPCC

Data / Parameter	NCV_{bio}
Unit	TJ/tonne
Description	Net calorific value of the non-renewable biomass used in the baseline scenario
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.015

Choice of data or Measurement methods and procedures	As per requirement of the methodology and Table 2.3, Chapter 2, Volume 2 of the 2006 IPCC Guidelines. The IPCC is a standard, credible source of emissions factors.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	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	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	<table border="1"> <thead> <tr> <th>Animal T</th> <th>kg/head/day</th> </tr> </thead> <tbody> <tr> <td>Dairy cow</td> <td>1.90</td> </tr> <tr> <td>Goat</td> <td>0.35</td> </tr> <tr> <td>Other cattle</td> <td>1.50</td> </tr> <tr> <td>Sheep</td> <td>0.32</td> </tr> <tr> <td>Market swine</td> <td>0.30</td> </tr> <tr> <td>Poultry</td> <td>0.01</td> </tr> </tbody> </table>	Animal T	kg/head/day	Dairy cow	1.90	Goat	0.35	Other cattle	1.50	Sheep	0.32	Market swine	0.30	Poultry	0.01
Animal T	kg/head/day														
Dairy cow	1.90														
Goat	0.35														
Other cattle	1.50														
Sheep	0.32														
Market swine	0.30														
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
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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	<table border="1"> <thead> <tr> <th>Animal T</th> <th>m³ CH₄/kg</th> </tr> </thead> <tbody> <tr> <td>Dairy cow</td> <td>0.13</td> </tr> <tr> <td>Goat</td> <td>0.13</td> </tr> <tr> <td>Other cattle</td> <td>0.10</td> </tr> <tr> <td>Sheep</td> <td>0.13</td> </tr> <tr> <td>Market swine</td> <td>0.29</td> </tr> <tr> <td>Poultry</td> <td>0.36</td> </tr> </tbody> </table>	Animal T	m ³ CH ₄ /kg	Dairy cow	0.13	Goat	0.13	Other cattle	0.10	Sheep	0.13	Market swine	0.29	Poultry	0.36
Animal T	m ³ CH ₄ /kg														
Dairy cow	0.13														
Goat	0.13														
Other cattle	0.10														
Sheep	0.13														
Market swine	0.29														
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	$\eta_{\text{biogas stove}}$																								
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	<p>UDBP does not specify the type of biogas stove that should be installed by a household, however they specifically promote the following five stove types:</p> <table border="1"> <thead> <tr> <th>Manufacturer</th> <th>Model No. / Name</th> <th>No. of burners</th> <th>Thermal Efficiency</th> </tr> </thead> <tbody> <tr> <td>Puxin</td> <td>JZZ2-A13</td> <td>2</td> <td>>57%</td> </tr> <tr> <td>Wusi</td> <td>JZZ.2-A1</td> <td>2</td> <td>56.8%</td> </tr> <tr> <td>Xunda</td> <td>JZZ2-88</td> <td>2</td> <td>>58%</td> </tr> <tr> <td>Xunda</td> <td>JZZ1-6128</td> <td>1</td> <td>>58%</td> </tr> <tr> <td>SNV</td> <td>Lotus III (Cambodia)</td> <td>1</td> <td>55%</td> </tr> </tbody> </table> <p>To be conservative the lowest value of efficiency has been taken.</p>	Manufacturer	Model No. / Name	No. of burners	Thermal Efficiency	Puxin	JZZ2-A13	2	>57%	Wusi	JZZ.2-A1	2	56.8%	Xunda	JZZ2-88	2	>58%	Xunda	JZZ1-6128	1	>58%	SNV	Lotus III (Cambodia)	1	55%
Manufacturer	Model No. / Name	No. of burners	Thermal Efficiency																						
Puxin	JZZ2-A13	2	>57%																						
Wusi	JZZ.2-A1	2	56.8%																						
Xunda	JZZ2-88	2	>58%																						
Xunda	JZZ1-6128	1	>58%																						
SNV	Lotus III (Cambodia)	1	55%																						
Purpose of data	Calculation of project emissions																								
Additional comment	-																								

Data / Parameter	$MCF_{x,k}$
Unit	%
Description	Methane Conversion Factor for the animal waste handling system in the baseline situation by climate zone k (%)
Source of data	Baseline Biogas User Survey 2014, Kenya; Tables 10.A-4 through A-9., Chapter 10, Volume 4 of the 2006 IPCC Guidelines; World Bank Climate Change Knowledge Portal ²⁹

²⁹ Average temperatures for Uganda are available [here](#)

Value(s) applied	Average MCF at 23.4 C temperature: 3.59%								
	Method	Uncovered lagoon	Liquid slurry	Solid storage	Drylot	Pasture / Range	Daily spread	Burned for fuel	Composting
	Fraction observed (temporary results for PFA)	1.65%	2.48%	5.79%	29.75%	0.00%	44.63%	0.00%	15.70%
	MCF (at 23.4 C)	78.0%	50.0%	4.0%	1.5%	1.5%	0.5%	10.0%	1.0%
	MCF_{x,k}	3.59%							
Choice of data or Measurement methods and procedures	As per requirement of the methodology for Tier 2 and sourced from Tables 10.A-4 through A-9., Chapter 10, Volume 4 of the 2006 IPCC Guidelines. The baseline manure handling methods for Uganda will be established prior to the first verification. The IPCC is a standard, credible source of emissions factors.								
Purpose of data	Calculation of baseline emissions <i>ex-ante</i> .								
Additional comment	IPCC (2006); May be updated according to any future changes by the IPCC								

Data / Parameter:	EF_{awms,T}														
Data unit:	kg CH ₄														
Description:	Emission factor for the defined livestock population category T by average temperature (Uganda: 23.4 °C)														
Source of data:	2006 IPCC Guidelines for National Greenhouse Gas Inventories														
Value(s) applied:	<table border="1"> <thead> <tr> <th>Animal T</th> <th>m3 CH₄/kg</th> </tr> </thead> <tbody> <tr> <td>Dairy cow</td> <td>0.0015</td> </tr> <tr> <td>Goat</td> <td>0.0000</td> </tr> <tr> <td>Other cattle</td> <td>0.0001</td> </tr> <tr> <td>Sheep</td> <td>0</td> </tr> <tr> <td>Market swine</td> <td>0.0000</td> </tr> <tr> <td>Poultry</td> <td>0.0000</td> </tr> </tbody> </table>	Animal T	m3 CH ₄ /kg	Dairy cow	0.0015	Goat	0.0000	Other cattle	0.0001	Sheep	0	Market swine	0.0000	Poultry	0.0000
Animal T	m3 CH ₄ /kg														
Dairy cow	0.0015														
Goat	0.0000														
Other cattle	0.0001														
Sheep	0														
Market swine	0.0000														
Poultry	0.0000														
Choice of data or Measurement methods and procedures:	Calculated following the values provided 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 project emissions														
Additional comment:	IPCC (2006); May be updated according to any future changes by the IPCC														

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
Purpose of data	Calculation of project emissions
Additional comment	Not applicable

D.6.3. Ex-ante calculation of emission reductions

>>

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 Ugandan VPA-3. As the baseline fuel and the project fuel and the corresponding emission factors are different, the overall GHG reductions achieved by this Ugandan VPA-3 in year y are calculated as follows:

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

Where:

- ER_{CO2,y} Cumulative CO₂ 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 CO₂ emission savings for an individual technology of project p1 against an individual technology of baseline b1, b2 and b3 in year y, in tCO₂/year, and as derived from the statistical analysis of the data collected from the field tests
- ER_{b1,p1,y,non-CO2} Specific non-CO₂ emission savings for an individual technology of project p1 against an individual technology of baseline b1, b2 and b3 in year y, converted in tCO₂/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 (tCO₂e/yr)

As specific non-CO₂ emission savings are treated in a separate equation (equation 7 onwards), the Ugandan VPA-3 can apply the following formula for calculating emission reductions:

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

Where:

- $\sum ER_{CO2,y}$ Cumulative CO₂ 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

$\Sigma LE_{p1,CO2,y}$	Cumulative leakage as per methodology guidance ³⁰
$N_{p1,y}$	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-3 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, which indicates there are three baseline scenarios: firewood only (b1), charcoal only (b2), and a combination of firewood and charcoal (b3). As explained in Section D.4, these baseline scenarios refer to the *primary* (>50%) sources of fuel used for cooking and thereby allow for the inclusion of fossil fuels as secondary or tertiary fuels in the baseline. Any households falling into other baseline scenarios are allocated to a fourth baseline scenario (b4), which are excluded from the baseline emissions for this VPA.

$$BE_{b1,2,3,4,CO2,y} = (\Sigma_b BB_{b1,2,3,4,fuel} * NCV_{fuel} * EF_{fuel}) + (BB_{b1,2,3,4,bio} * NCV_{bio} * EF_{bio} * f_{NRB}) \quad (3)$$

Where:

$BE_{b1,2,3,4,CO2,y}$	Cumulative baseline CO ₂ emissions from the use non-renewable biomass and fossil fuels at households in baseline scenarios b1 – b4 during year y
$BB_{b1,2,3,4,fuel}$	The quantity of fossil fuel consumed in baseline scenarios b1 – b4, 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
$BB_{b1,2,3,4,bio}$	The quantity of biomass consumed in baseline scenarios b1 – b4, 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:

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

Where:

$PE_{p1,CO2,y}$	Cumulative project CO ₂ emissions from the use non-renewable biomass and fossil fuels at households in project scenario p1 during year y
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³⁰ ‘Technologies and Practices to Displace Decentralized Thermal Energy Consumption’ (Version 1.0) p.11 - 12

$BB_{p1,fuel}$	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_{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_{bio}	CO ₂ emission factor of biomass in project scenario 1 in tonnes/TJ
f_{NRB}	Fraction of non-renewable biomass, in percentage

Fuel usage data referred to in this VPA-DD for the purpose of the ex-ante calculation comes from the Monitoring Report prepared by the UpEnergy's Uganda Biomass Cookstove Project, which is registered under The Gold Standard³¹. The reason for this is that the Baseline Survey conducted by the Uganda Domestic Biogas Programme in 2010 did not quantify the fuel usage for cooking purposes. The fuel usage data from the referred Gold Standard project is applicable as it applies to results from a KPT that targeted a nation-wide, Ugandan efficient cookstove programme. The targeted households therefore live in similar socio-economic conditions as the households targeted under this VPA-3.

The fuel usage results applied in this VPA for the purpose of the ex-ante calculation are based on the Monitoring Report of UpEnergy's Uganda Biomass Cookstove Project, which covered the period 01 January 2013 – 31 December 2013.

It should be noted that the presented baseline scenario data are devised for the purpose of the inclusion of the VPA. A baseline KPT will need to be implemented prior to the first verification of the emission reductions generated under this VPA, which will substitute the baseline parameters presented in this PDD. As such, while this ex-ante emission reduction calculation only presents emission reductions from the usage of firewood and therefore only offers quantifiable results for scenario b1, charcoal use may also be included in the ex-post calculations (scenarios b2 and b3) as indicated by the fuel usage ratios in the Baseline Survey. Following the initial baseline KPT, the baseline fuel usage parameters will be fixed throughout the crediting period.

The results for the ex-ante purposes therefore only report usage of firewood only (b1). The results of are reported in *Table 9*. To derive the total biomass value for scenarios b2 and b3 in the ex-post calculation, the tonnes of firewood will be combined with the tonnes of charcoal multiplied by a factor of 8. In Uganda, the use of traditional kilns to produce charcoal is widespread. These traditional kilns have a low biomass-to-charcoal conversion efficiency. Traditional kilns used have an estimated conversion efficiency of only 8 – 12 %. To remain conservative the lower value is used (ie. 8 kg of woodfuel from every 1 kg of fuelwood).³²

Table 7: Biomass usage result

³¹ https://mer.markit.com/br-reg/public/project.jsp?project_id=103000000001886

³² United Nations World Food Programme (2010) Safe Access to Firewood and Alternative Energy in Kenya: An Appraisal Report (pg 21), World Bank; and Africa Renewable Energy Access Program (AFREA) (2011) Wood-Based Biomass Energy Development for Sub-Saharan Africa (Section 3.2.2, pg 21); and Njenga, M. et al (2014) Additional cooking fuel supply and reduced global warming potential from recycling charcoal dust into charcoal briquette in Kenya, *Journal of Cleaner Production* (pg 81, pg 82); and International Network for Sustainable Energy (INFORSE) (2011) Case: Kenya Afforestation for Charcoal [online] Available from: <http://www.inforse.org/Case/Case-Kenya-Afforestation.php3>

Table 9: Ex-ante biomass usage results in the baseline and project scenario

Baseline scenario	Description	Amount	Source
B1	Amount of woody biomass and fossil fuels in tonnes per year used in the baseline scenario b1	BB _{b1,bio} : 3.380 BB _{b1,fuel} : 0.000	UpEnergy's Uganda Biomass Cookstove Project Monitoring Report, page 9 ³³
B2	Amount of woody biomass and fossil fuels in tonnes per year used in the baseline scenario b2	BB _{b2,bio} : 0.000 BB _{b2,fuel} : 0.000	Not available for ex-ante calculation
B3	Amount of woody biomass and fossil fuels in tonnes per year used in the baseline scenario b3	BB _{b3,bio} : 0.000 BB _{b3,fuel} : 0.000	Not available for ex-ante calculation
P1	Amount of woody biomass and fossil fuels in tonnes per year used in project scenario p1	BB _{p1,bio} : 2.170 BB _{p1,fuel} : 0.000	UpEnergy's Uganda Biomass Cookstove Project Monitoring Report, page 10

The f_{NRB} is estimated to be 82.0%, as per the PoA-DD³⁴. The f_{NRB} value is applicable to CO₂ emissions from firewood and charcoal consumption and production. The calculated ex-ante baseline emissions are shown in next table:

Table 10: Emission reductions from fuel switch³⁵

Baseline scenario	Baseline emissions from fuel use (tCO ₂ e/yr)	Project emissions from fuel use (tCO ₂ e/yr)	Leakage emissions from fuel use (tCO ₂ e/yr)	Emissions from fuel switch to biogas (tCO ₂ e/yr)
B1	4.656	2.989	0	1.667
B2	0	0	0	0
B3	0	0	0	0

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:

$$BE_{b,CH_4,h,y} = \frac{(VS_T * 365) * (B_{0,T} * 0.67 \text{ kg/m}^3 * MCF_{x,k} * MS_{T,x,k} * GWP_{CH_4} * N_{T,h})}{1000} \quad (3)$$

Where:

BE_{b,CH₄,h,y} Baseline emissions from manure handling during the year y in tCO₂e for manure handling method h

³³ Monitoring Report covering the period 01.01 2013 – 31.12.2013, available on: <http://bit.ly/1QE3lkK>

³⁴ Also, see <http://cdm.unfccc.int/DNA/fNRB/index.html>

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

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.

As for the number of animals raised and the manure handling methods, the baseline results from a Baseline Survey conducted in 2010 are used. 300 households were randomly selected to participate in the Baseline Survey. According to the results of this survey, households owned an average of 8.0 cattle each, amongst other animal types (see Table 11).

However, the Baseline Survey did not assess the manure handling methods. For this purpose, the baseline results gathered by the Kenya Biogas User Survey conducted in 2014 are referred to, as this and VPA-3 of the African Biogas Carbon Programme are deemed comparable. This survey looked at the baseline conditioned and surveyed 120 households without biodigesters throughout Kenya. The Kenyan Biogas User Survey results indicate that daily spread is the most common manure handling method, followed by dry lot, composting and solid storage. Note that the baseline manure handling methods for Uganda shall be established via a survey prior to the first verification.

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 3.59%.

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

According to the Uganda Baseline Survey conducted in 2010, households owned an average of 8 cows, amongst other animal types.

Table 11: Possession of livestock reported in the Uganda Baseline Survey 2010³⁶

Animal T	Average amount
Dairy cow	8.00
Goat	7.19
Market swine	3.41
Sheep	4.20

³⁶ Baseline Survey conducted for the Uganda Domestic Biogas Programme in 2010, page 37 Table 8

Other cattle	0.00
Poultry	20.44

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 12: Manure characteristics of different livestock categories

Animal type	VS (kg/head/day)	B_o (m ³ CH ₄ /kg VS)
Dairy Cow	1.90	0.13
Goat	0.35	0.13
Market swine	0.30	0.29
Sheep	0.32	0.13
Other cattle	1.50	0.10
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 Inventories³⁷. 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 Biogas User Survey 2014 for Kenya. 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 3.59%.

Table 13: Applicable MCF at national average temperature of 23.4 C³⁸

Method	Uncovered lagoon	Liquid slurry	Solid storage	Drylot	Pasture/ Range / Paddock	Daily spread	Burned for fuel	Composting
Fraction observed	1.65%	2.48%	5.79%	29.75%	0.00%	44.63%	0.00%	15.70%
MCF (at 23.4 C)	78.0%	50.0%	4.0%	1.5%	1.5%	0.5%	10.0%	1.0%

MCF _{x,k}	3.59%
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With the data from the previous tables the tentative estimates for the baseline emission can be determined for the Uganda VPA. The emissions per household of all the animals under the VPA are calculated below. The number of animals originates from the Uganda Baseline Survey from 2010 and the manure handling methods is based on the Kenyan Biogas User Survey from 2014.

The baseline methane emissions per household per year under the VPA-3 are³⁹:

$$BE_{b1,2,3,CH4,h,y} = \frac{\sum VS_T * B_{OT} * 0.67kg/m^3 * 3.59\% * 1 * 25 * 365}{1000} = 0.624 \text{ tCO}_2\text{e}$$

³⁷ IPCC Guidelines for National Greenhouse Gas Inventories: Chapter 10: Emissions from Livestock and Manure Management (2006)

³⁸ Average temperatures for Uganda provided by the World Bank: <http://bit.ly/1GLb4Ho>. See Emission reduction calculation spreadsheet, Tab 'Temperature', Cell E5 for temperature calculation

³⁹ Figures may not add up due to rounding – see emission reduction calculation

Therefore⁴⁰:

$$BE_{b1,2,3,CH4,h,y} = \frac{(1.90) * (328)}{1000} = 0.624 \text{ tCO}_2$$

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:

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

Where:

$PE_{p,CH4,y}$	Project emissions from manure handling during the year y in tCO ₂ e
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)
$\eta_{new\ stove}$	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:

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

Where:

$EF_{awms(T)}$	CH ₄ emission factor for livestock category T, (tCH ₄ per animal per year)
$VS_{(T)}$ day)	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)
$B_{0(T)}$	Maximum methane production capacity for manure produced by livestock category T, (m ³ CH ₄ per kg of VS excreted)
D_{CH4}	CH ₄ density 0.67 kg 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, (%) (i.e. for the animal waste handling not fed into the biogas digester in the project scenario)

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

$MS_{(p,S,k)}$ Fraction of livestock category T's manure treated in the animal waste management system, in climate region k

The project methane emissions per household per year under the VPA-3 are therefore⁴¹:

$$PE_{p1,CH4,y} = 25 * 0.01 * 0.1 + 0.01 * 25 * (1 - 55%) * (1 - 10\%)) = \mathbf{0.154 \text{ tCO}_2}$$

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:

$$ER_{CH4,y} = (BE_{b,CH4,y} - PE_{p,CH4,y}) * N_{p,y} * U_{p,y} \tag{5}$$

Where:

- $ER_{CH4,y}$ Methane emissions reductions in year y (tCO₂)
- $BE_{b,CH4,y}$ Baseline methane emissions during the year y (tCO₂)
- $PE_{p,CH4,y}$ Project methane emissions during the year y (tCO₂)
- $N_{p,y}$ 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 ex-ante emission reductions from methane avoidance per household per year under the VPA-3 are⁴²:

$$0.624 - 0.154 = \mathbf{0.470 \text{ tCO}_2e}$$

The actual baseline conditions (manure handling methods and quantity of baseline fuels used) for verification purposes will be confirmed via a survey and baseline fuel test (BFT) that is to be conducted by Biogas Solutions Uganda Ltd prior to the first verification of this VPA.

6.3.3 Leakage emissions

The project proponent investigated the following potential sources of leakage:

Table 14: 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	Most household rely on wood and charcoal in Uganda. The small share of household that use a lower emitting

⁴¹ Figures may not add up due to rounding – see emission reduction calculation

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

	non-project users who previously used lower emitting energy sources.	energy source, such as kerosene, 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 biodigester project in Uganda 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 Uganda.
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 for all baseline scenarios⁴³:

Table 15: Average annual emission reductions for all baseline scenarios identified

	BE_{b,CH4,y} (tCO₂e/year)	PE_{b,CH4,y} (tCO₂e/year)	ER_{CH4,y} (tCO₂e/year)
Per biogas digester (total)	4.279	3.143	1.136
Per biogas digester (from fuel use)	3.655	2.989	0.666
Per biogas digester (from manure handling)	0.624	0.154	0.470

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

$$ER_{Total} = (ER_{CO_2,y} + ER_{CH_4,y}) * N_{p,y} * U_{p,y}$$

Where:

ER_{CO₂,y} CO₂ emissions reductions in year y (tCO₂)

ER_{CH₄,y} Methane emissions reductions in year y (tCO₂)

N_{p,y} Cumulative project operational rate included in the project database for project scenario p against baseline scenario b in year y

⁴³ Figures may not add up due to rounding. See emission reduction calculation spreadsheet for values

$U_{p,y}$ 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 16: Project emission, baseline emissions, leakage and overall emissions per year

Year	Baseline emissions (t CO ₂ e)	Project emissions (t CO ₂ e)	Leakage (t CO ₂ e)	Emission reductions (t CO ₂ e)
01/04/2015 - 31/12/2015	16,682	12,252	0	4,430
01/01/2016 - 31/12/2016	24,587	18,058	0	6,529
01/01/2017 - 31/12/2017	27,289	20,042	0	7,247
01/01/2018 - 31/12/2018	31,992	23,496	0	8,496
01/01/2019 - 31/12/2019	36,695	26,950	0	9,744
01/01/2020 - 31/12/2020	41,398	30,405	0	10,993
01/01/2021 - 31/12/2021	46,101	33,859	0	12,242
Total	224,743	165,062	0	59,682
Total number of crediting years		7		
Annual average over the crediting period	28,093	20,633	0	7,460

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 Biogas User Survey.
Value(s) applied	2014: 100% 2015: 100% 2016: 100% 2017: 100% 2018: 100% 2019: 100% 2020: 100%

Measurement methods and procedures	<p>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.</p> <p>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 1.0)</p>
Monitoring frequency	Annual
QA/QC procedures	<p>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.</p> <p>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.</p>
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	11,368
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. In addition, households are required to notify provincial office staff in a situation when a biodigester stops working.
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	Reported as a result of ($No_{p1,y} * (O_{p1,y} / 365)$)

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	11,368
Measurement methods and procedures	For each digester sold, a Sales Agreement is completed. Details of each Agreements are recorded in the Project Database.
Monitoring frequency	Continuous
QA/QC procedures	As per procedures of the Project Database
Purpose of data	Calculation of project emissions

Additional comment	N/A
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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.
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	Not applicable
Value(s) applied	0.000
Measurement methods and procedures	Not applicable.
Monitoring frequency	Not applicable
QA/QC procedures	Not applicable
Purpose of data	Calculation of leakage
Additional comment	According to the methodology applied “leakage risks deemed very low can be ignored as long as the case for their insignificance is substantiated” (p.11 – 12). Section 6.3.3 of the VPA-DD provides an overview of potential sources of leakage, including their applicability and justification for excluding the sources of leakage. This approach was approved by the Gold Standard on 20 October 2016.

Data / Parameter	N_{T,h}														
Unit	Number														
Description	Number of animals of livestock category T in premise h														
Source of data	Baseline survey (ex-ante calculation only), see page 37 Table 8 of the Baseline Survey conducted by the Uganda Domestic Biogas Programme, 2010														
Value(s) applied	<table border="1"> <thead> <tr> <th>Animal T</th> <th>Average amount</th> </tr> </thead> <tbody> <tr> <td>Dairy cow</td> <td>8.00</td> </tr> <tr> <td>Goat</td> <td>7.19</td> </tr> <tr> <td>Other cattle</td> <td>0.00</td> </tr> <tr> <td>Sheep</td> <td>4.20</td> </tr> <tr> <td>Market swine</td> <td>3.41</td> </tr> <tr> <td>Poultry</td> <td>20.44</td> </tr> </tbody> </table>	Animal T	Average amount	Dairy cow	8.00	Goat	7.19	Other cattle	0.00	Sheep	4.20	Market swine	3.41	Poultry	20.44
Animal T	Average amount														
Dairy cow	8.00														
Goat	7.19														
Other cattle	0.00														
Sheep	4.20														
Market swine	3.41														
Poultry	20.44														
Measurement methods and procedures	Data on the number of animals will be collected through the annual Biogas User Survey conducted under the VPA.														
Monitoring frequency	Annual														
QA/QC procedures	-														
Purpose of data	Calculation of baseline emissions														

Additional comment	-
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Data / Parameter:	BB_b ratio
Data unit:	%
Description:	Baseline scenario ratios
Source of data:	Baseline survey (ex-ante calculation only), see p. 46 of the Baseline Survey conducted by the Uganda Domestic Biogas Programme, 2010
Value(s) applied	Determined on VPA level, with 'b' being sub-categorised into: b1: households using firewood = 78.5% b2: household using charcoal = 6.7% b3: households using firewood + charcoal = 14.8% b4: households using other fuels as their main source of cooking fuel (excluded) = 0%
Measurement methods and procedures:	Households/communities/SMEs will be asked which baseline scenario they fell into before receiving a biogas digester. The four baseline scenarios are defined by asking the households " <i>what is your primary fuel source for cooking purposes?</i> ". The purpose of this question is to allocate a household to a baseline scenario, whereby 'primary' fuel consumption is defined as that fuel meeting more than 50% of their fuel needs for cooking purposes. The households that respond " <i>firewood</i> ", for example, are subsequently allocated to the baseline scenario b1. This means that households in, for example, baseline scenario b1 may also use small amounts of fossil fuels (i.e. secondary and tertiary fuels) for cooking, which will be included in the baseline emissions.
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	BB_{b1,bio}
Data unit	Tonnes/year
Description	Amount of woody biomass used in the baseline scenario b1
Source of data	Monitoring Report UpEnergy's Uganda Biomass Cookstove Project (ex-ante calculation only)
Value(s) applied	3.380
Measurement methods and procedures	Fixed baseline through Baseline Fuel Test performed prior to first verification. Households/communities/SMEs will be 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	Not applicable: Option B BFT conducted once upfront and parameter fixed throughout the crediting period.
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 baseline emissions
Additional comment	As per Annex 5 of the Technologies and Practices to Displace Decentralized Thermal Energy Consumption methodology

Data / Parameter	BB_{b2,bio}
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Data unit	Tonnes/year
Description	Amount of woody biomass used in the baseline scenario b2
Source of data	Monitoring Report UpEnergy's Uganda Biomass Cookstove Project (ex-ante calculation only)
Value(s) applied	0.000
Measurement methods and procedures	Fixed baseline through Baseline Fuel Test performed prior to first verification. Households/communities/SMEs will be 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	Not applicable: Option B BFT conducted once upfront and parameter fixed throughout the crediting period.
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 baseline emissions
Additional comment	As per Annex 5 of the Technologies and Practices to Displace Decentralized Thermal Energy Consumption methodology

Data / Parameter	BB_{b3,bio}
Data unit	Tonnes/year
Description	Amount of woody biomass used in the baseline scenario b3
Source of data	Monitoring Report UpEnergy's Uganda Biomass Cookstove Project (ex-ante calculation only)
Value(s) applied	0.000
Measurement methods and procedures	Fixed baseline through Baseline Fuel Test performed prior to first verification. Households/communities/SMEs will be 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	Not applicable: Option B BFT conducted once upfront and parameter fixed throughout the crediting period.
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 baseline emissions
Additional comment	As per Annex 5 of the Technologies and Practices to Displace Decentralized Thermal Energy Consumption methodology

Data / Parameter	BB_{b1,2,3, fuel}
Unit	Tonnes/year
Description	Amount of fossil fuel used in the baseline scenarios b1, b2 and b3
Source of data	Monitoring Report UpEnergy's Uganda Biomass Cookstove Project (ex-ante calculation only)
Value(s) applied	0
Measurement methods and procedures	Fixed baseline through Baseline Fuel Test performed prior to the first verification. Households/communities/SMEs will be asked how much fossil fuels they use, and undergo a Kitchen Performance Test as per the requirements of the TPDDTEC methodology
Monitoring frequency	Not applicable: Option B BFT conducted once upfront and parameter fixed throughout the crediting period.
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, bio}
Unit	Tonnes/year
Description	Amount of woody biomass used in the project scenario p1 (one value)
Source of data	Monitoring Report UpEnergy's Uganda Biomass Cookstove Project (ex-ante calculation only)
Value(s) applied	2.170
Measurement methods and procedures	Households/communities/SMEs will be asked how much woody biomass they use per week, and undergo a Kitchen Performance Test prior to the first verification as per the requirements of the TPDDTEC methodology.
Monitoring frequency	<i>Ex-post</i> , 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, fuel}
Unit	Tonnes/year
Description	Amount of fossil fuels used in the project scenario p1
Source of data	Kitchen Performance Test 2014 (Baseline)
Value(s) applied	0
Measurement methods and procedures	Households/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	<i>Ex-post</i> , 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 (PFT) will be updated once every two years.

Data / Parameter	MS_{T,s,k}														
Unit	%														
Description	Fraction of livestock category T's manure fed into the bio-digester, S in climate region k														
Source of data	Baseline Biogas User Survey 2014, Kenya (ex-ante calculation only)														
Value(s) applied	<table border="1"> <thead> <tr> <th>Animal T</th> <th>Average amount</th> </tr> </thead> <tbody> <tr> <td>Dairy cow</td> <td>69.90%</td> </tr> <tr> <td>Goat</td> <td>0.00%</td> </tr> <tr> <td>Other cattle</td> <td>11.4%</td> </tr> <tr> <td>Sheep</td> <td>0.00%</td> </tr> <tr> <td>Market swine</td> <td>2.0%</td> </tr> <tr> <td>Poultry</td> <td>1.00%</td> </tr> </tbody> </table>	Animal T	Average amount	Dairy cow	69.90%	Goat	0.00%	Other cattle	11.4%	Sheep	0.00%	Market swine	2.0%	Poultry	1.00%
Animal T	Average amount														
Dairy cow	69.90%														
Goat	0.00%														
Other cattle	11.4%														
Sheep	0.00%														
Market swine	2.0%														
Poultry	1.00%														
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	Applicable to VPAs applying Tier 2 only														

Data / Parameter	MS_{P,S,K}														
Unit	%														
Description	Fraction of livestock category T's manure not fed into the bio-digester, in climate region k														
Source of data	Baseline Biogas User Survey 2014, Kenya (ex-ante calculation only)														
Value(s) applied	<table border="1"> <thead> <tr> <th>Animal T</th> <th>Average amount</th> </tr> </thead> <tbody> <tr> <td>Dairy cow</td> <td>30.1%</td> </tr> <tr> <td>Goat</td> <td>100%</td> </tr> <tr> <td>Other cattle</td> <td>88.6%</td> </tr> <tr> <td>Sheep</td> <td>100%</td> </tr> <tr> <td>Market swine</td> <td>98%</td> </tr> <tr> <td>Poultry</td> <td>99.00%</td> </tr> </tbody> </table>	Animal T	Average amount	Dairy cow	30.1%	Goat	100%	Other cattle	88.6%	Sheep	100%	Market swine	98%	Poultry	99.00%
Animal T	Average amount														
Dairy cow	30.1%														
Goat	100%														
Other cattle	88.6%														
Sheep	100%														
Market swine	98%														
Poultry	99.00%														
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.
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The VPA will also monitor the following social and environmental parameters, as defined under the Gold Standard⁴⁴:

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-02 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-03 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

⁴⁴ Refer to accompanying Gold Standard PoA-Passport for further details.

Data / Parameter	GS-04 Livelihood of the poor
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-05 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-06 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-07 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)"⁴⁵. The guidelines 'Sampling and surveys for CDM project activities and programmes of activities' (Version 04.2) 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 1.0). 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

Biogas Solutions Uganda Ltd, 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 should 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.

45 EB 74, Annex 6

Data to be collected

Field measurements

Biogas Solutions Uganda Ltd 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 VPA-3, as outlined in the applied methodology, are as follows:

A Biogas User Survey shall be completed annually and covers the following data:

- Number of users applying the final biodigester slurry on agricultural fields;
- 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 types and number of animals held by households;
- The fraction of manure that is not treated in the biodigester;
- Ratio of households falling in separate baseline fuel scenarios.

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

- 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 project scenario in a 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.

Kitchen Performance Tests:

- KPTs for the three baseline scenarios will be conducted only once, prior to the first verification. The resulting fuel data will be fixed throughout the crediting period. Separate KPTs shall be conducted per identified baseline scenario as per the Baseline Survey;
- KPTs for the project scenario will be conducted once every two years.

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, Biogas Solutions Uganda Ltd, 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 the Biogas Solutions Uganda Ltd 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.⁴⁶

Implementation plan

Biogas Solutions Uganda Ltd 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. Biogas Solutions Uganda Ltd 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

Biogas Solutions Uganda Ltd 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.

⁴⁶ 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	<input checked="" type="checkbox"/> VPA implementer(s) <input type="checkbox"/> Responsible person/ entity for completing the SSC-VPA-DD-FORM
Organization	Biogas Solutions Uganda Ltd
Street/P.O. Box	P.O. Box 8339
Building	Plot 36 Luthuli Rise, Bugolobi
City	Kampala
State/Region	Kampala
Postcode	P.O. Box 8339
Country	Uganda
Telephone	0750 899 238/ 0750 899 236
Fax	Not applicable
E-mail	info@biogassolutions.co.ug
Website	www.biogassolutions.co.ug
Contact person	Juliet Kyokunda
Title	Managing Director
Salutation	Ms.
Last name	Kyokunda
Middle name	Not applicable
First name	Juliet
Department	Not applicable
Mobile	+256750899156
Direct fax	Not applicable
Direct tel.	+256750899156
Personal e-mail	jkyokunda@biogassolutions.co.ug

Appendix 2. Affirmation regarding public funding

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