



**Monitoring report form for CDM programme of activities
(Version 02.0)**

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT

Title of the PoA	African Improved Cooking Stoves Programme of Activities	
UNFCCC reference number of the PoA	5342	
Version numbers of the PoA-DD applicable to this monitoring report	4.3	
Version number of this monitoring report	<u>3.0</u>	
Completion date of this monitoring report	<u>22/01/2019</u>	
Monitoring period number	Fifth monitoring period	
Duration of this monitoring period	25/10/2016 - 24/10/2017	
Monitoring report number for this monitoring period	2.0	
Coordinating/managing entity	Envirofit International Ltd.	
Host Parties	Host Party of the PoA	Is this the host Party of a CPA covered in this monitoring report? (yes/no)
	Ghana	Yes
	Nigeria	No
	Liberia	No
Sectoral scopes	Sectoral scope: 3: Energy demand	
Applied methodologies and standardized baselines	AMS-II.G ver 3.0: Energy efficiency measures in thermal applications of non-renewable biomass	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by all CPAs covered in this monitoring report in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0	<u>27,082</u> tCO ₂ e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the CPA-DDs for the CPAs covered in this monitoring report	109,493 tCO ₂ e	

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PART I Monitoring of programme of activities (PoA)

SECTION A. Description of PoA

A.1. General description of PoA

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The purpose of this Programme of Activities (PoA) is the dissemination of improved biomass cooking stoves (ICS) in Ghana, Nigeria and Liberia. The Programme will promote stove categories that replace existing less efficient cooking stoves using woody-biomass (wood-fuel and/or charcoal).

The ICS distributed under the programme are more efficient in transferring heat from the fuel to the pot when compared to the stoves typically being used in the baseline. By replacing inefficient baseline stoves, the PoA saves on consumption of woody biomass (either wood or charcoal made from wood) which is the dominant fuel used for cooking in project households. The ICSs applied in this PoA have been designed to match the traditional utensils and cooking habits of the target consumers in host countries.

In accordance with version 3.0 of the small-scale CDM methodology AMS-II.G, in the absence of the project activity, the baseline scenario would be the use of fossil fuels for meeting similar thermal energy needs. Therefore, by reducing the amount of fuel required for cooking and thus the use of non-renewable woody biomass, the replacement of less efficient stoves with more efficient ICS reduces the amount of greenhouse gases (GHG) emitted into the atmosphere.

Envirofit International Ltd (Envirofit) is the coordinating/managing entity (CME) for this PoA and coordinates the efforts of different Distribution Organizations (DOs) who are involved in distribution of ICS within the boundary of the PoA and comply with the requirements of this PoA. Each DO sells ICSs either directly or through retailers, entrepreneurs or other agents sub-contracted by the DO. The CME provides training and guidance on the correct distribution and monitoring procedures to each DO. Each DO acts individually, implementing the CPA(s) in accordance with local circumstances and the requirements prescribed by CME.

A.1.1. Corresponding generic component project activities (CPAs)

Title and reference number of the corresponding generic CPA	Version of the PoA-DD	Sectoral scopes	Applied methodologies and standardized baselines
Title: African Improved Cooking Stoves Programme of Activities – Generic CPA Identification: Part II of revised PoA-DD version 4.3 dated 07/06/2014 Reference: http://cdm.unfccc.int/UserManagement/FileStorage/V96Q8RJG3DUWTMXIYH20Z4LPE5B7OF Version: 1.0	version 4.3 dated 07/06/2014	Sectoral Scope 3	AMS-II.G, version 3: Energy Efficiency Measures in Thermal Applications of Non-Renewable Biomass

A.1.2. CPAs included in the PoA

Title and UNFCCC reference number of the CPA	Title and reference number of the corresponding generic CPA	Version of the PoA-DD	Crediting period type and duration	Covered in this monitoring report? (yes/no)
African Improved Cooking Stoves Programme of Activities - CPA No. 00001 (Ghana) 5342-0001	Title: African Improved Cooking Stoves Programme of	Version 4.3 dated 07/06/2014	15 Dec 2012 – 14 Dec 2022	Yes

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African Improved Cooking Stoves Programme of Activities - CPA No. 00002 (Ghana) 5342-0002	Activities – Generic CPA Identification: Part II of revised PoA-DD version 4.3 dated 07/06/2014	Version 4.3 dated 07/06/2014	01 Nov 2013 - 31 Oct 2023	Yes
African Improved Cooking Stoves Programme of Activities CPA 00003 (Ghana) 5342-0003	Reference: http://cdm.unfccc.int/UserManagement/FileStorage/V96Q8RJG3DUWTMXIYH20Z4LPE5B7OF	Version 4.3 dated 07/06/2014	01 Dec 2013 – 30 Nov 2023	Yes
African Improved Cooking Stoves Programme of Activities CPA 00004 (Nigeria) 5342-0004	Version: 1.0	Version 4.3 dated 07/06/2014	25 Oct 2014 – 24 Oct 2024	No
African Improved Cooking Stoves Programme of Activities CPA 00005 (Nigeria) 5342-0005		Version 4.3 dated 07/06/2014	25 Oct 2014 – 24 Oct 2024	No
African Improved Cooking Stoves Programme of Activities - CPA 00006 (Liberia) 5342-0006		Version 4.3 dated 07/06/2014	01 Feb 2015 – 31 Jan 2025	No

A.2. Coordinating/managing entity

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Envirofit International Limited is the CME for the PoA. The responsible person for completing the CDM-PoA-MR-Form are as follows:

Rohit Lohia
Carbon Projects Development Manager
Envirofit International
rohit.lohia@envirofit.org

SECTION B. Implementation of PoA

B.1. Description of implemented PoA

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Envirofit International Limited is the Coordinating and Managing Entity (CME) for the PoA. The Distributing Organization(DO) for the CPAs included in the PoA are as follows:

CPA	Name of DO	Status of CPA Implementation
5342-0001	The Centre of Energy, Environment and Sustainable Energy (CEESD)	Implemented
5342-0002	--	Not implemented
5342-0003	Envirofit International	Implemented

The DOs have subcontracted retailers/entrepreneurs (referred as dealers) for dissemination of project stoves. The implemented CPA follow the following management system:

1. Envirofit provided instructions to dealers to collect the end user information at the time of sales to make the stove eligible under the PoA. Envirofit made them aware of requirements of end user data collection. Guidance was provided to them on the correct procedures to be followed during distribution.
2. Envirofit maintains a PoA Distribution and Monitoring database. This database is a compilation of CPA distribution records. The database includes CPA wise list of stoves sales, based on following information, received from dealers (collected this information at the time of sale):
 - a. Name of customer
 - b. Address / location of the customer

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- c. Stove unique serial ID number
 - d. Stove Model
 - e. Stove distribution date
 - f. Type of old / baseline stove replaced by ICS, i.e. the fuel type used in the old / baseline stove.
3. Envirofit performed cross-checks on the ICS sales information received from the dealers. The CME's logo is clearly displayed on the CPA Distribution Record, with a copy retained by Envirofit. A unique stove id is punched on each stove and the same serial ID is mentioned on the CPA distribution record. Therefore it is possible to identify each stove in the PoA with its unique serial ID number. The unique serial number linked to each stove and its association with a unique CPA bearing a CPA ID number eliminates any risk of double-counting of ICSs between CPAs.
4. Envirofit obtained the customer's approval during distribution to exclusively assign carbon rights to the CME as per the disclaimer specified on CPA distribution records / stove boxes.
5. Envirofit coordinated all ex-post monitoring activities in the PoA as follows:
 - a. Implemented the monitoring plan,
 - b. Determined the sample size as per sampling plan and identified the samples to be monitored (the sampling plan has been applied across group of CPAs as detailed in section E.3 below)
 - c. Ensured the quality of monitoring data (QA/QC)
 - d. Used this data for emissions reduction calculations.
6. Envirofit checked and recorded the following key parameters in a CPA Monitoring Record. Key monitored parameters were:
 - a. Efficiency of project stoves ($\eta_{new,y}$)
 - b. Check if project stoves are operational and in use (SOF)
 - c. Check fraction of end users continuing to use replaced stoves (f_{old})
 - d. If replaced stoves are being used, the consumption accounted for by the old stoves (μ_{old})
7. Envirofit calculated emission reductions based on monitoring data collected and prepared monitoring report

Thus, by carrying out the aforesaid, Envirofit ensured that the PoA Operational and Management plan as given in section A.4.4.1 of registered PoA-DD is duly implemented for concerned CPAs.

B.2. Post-registration changes to PoA

B.2.1. Corrections

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NA

B.2.2. Inclusion of monitoring plan

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NA

B.2.3. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

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NA

B.2.4. Changes to programme design

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NA

PART II Monitoring of CPAs

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This Monitoring Report covers all the three CPAs in Ghana, as included in the concerned monitoring period. These CPAs have the same project boundary and follow a common generic CPA as identified in section A.1.1, Part I of this monitoring report. The following sections therefore represent all these three CPAs.

SECTION C. Implementation of CPAs**C.1. Description of implemented CPAs**

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- (a) ***Purpose of the specific-case CPA(s) and the measures taken for GHG emission reductions or net GHG removals by sinks;***

The purpose of the CDM Programme Activities (CPAs) is dissemination of improved cooking stoves (ICS) in the Republic of Ghana. The CPAs replace cooking stoves using charcoal / woodfuel with more efficient stoves using charcoal / woodfuel.

The project ICS are more efficient in transferring heat from the fuel to the pot, thus saving fuel compared to the baseline stoves which would have been used in the absence of the project activity. Furthermore, the ICSs applied in these CPAs have been designed not only to increase heat transfer, but also to match traditional utensils and cooking habits of people in Ghana.

- (b) ***Description of the technology employed and installed equipment and/or infrastructure, including information requested by the eligibility criteria;***

The Envirofit stoves have been designed with the specific intention of maximizing thermal efficiency while simultaneously minimizing the production of toxic emissions. While many interrelated factors need to be considered in order to achieve these goals, primary aspects of stove performance were explored during the development of the stoves: 1) fuel and air mixing 2) heat transfer to the pot. In order to maximize temperature, the combustion chamber shape, fuel amount, and air flow through the stove all need to be considered and correctly coordinated. In order to use the available thermal energy in the most efficient manner possible, specific stove geometry and configuration choices were made; including reducing stove thermal mass and minimizing heat flux through the sides and bottom of the stove. In order to minimize emissions, the combustion chamber shape, fuel amount, and air flow rate through the stove all need to be considered and correctly coordinated in order to maintain a proper air to fuel mixture.

The following table details the implementation status of the CPAs along with technology involved:

CPA	Type of Project stoves eligible	Stove models installed ¹	Total number of stoves installed
5342-0001	Charcoal	CH2200, CH2300	9,375
5342-0002	Wood fuel	--	0
5342-0003	Charcoal	CH2300, CH5200	5,866

CPA 5342-0002 has not been implemented, hence all ICS under the CPAs covered in the monitoring report are charcoal stoves that replace traditional charcoal stoves in the baseline. The stove models referred above are shown below:

¹ At the end of monitoring period.

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CH2200



CH2300



CH5200

Information required by Eligibility criteria

Eligibility criteria # 3, 4 and 11 that require information related to project technology / infrastructure are discussed below:

No.	Eligibility criteria		Assessment for CPAs	
	Description	Conditions to be met	Means of proof	Confirmation
#3	Applicability of Methodology AMS-II. G -Technology type	The ICS uses one of the following fuel types: <ul style="list-style-type: none"> Wood fuel Charcoal 	Technical specification of ICS provided	Refer D.1 (b) above for the type and number of stoves distributed in the CPAs till the end of the monitoring period. All these models are charcoal stoves
#4	Applicability of Methodology AMS-II. G – Minimum ICS efficiency/ specifications of technology including the level and type of service	The ICS has a minimum efficiency of 20% (AMS-II.G, V.3, para 1)	Technical specification of ICS provided (either from manufacturer's specifications or test results using the Emissions & Performance Test Protocol (EPTP))	Already specified in the registered CPA-DD for CH2200 and CH2300. Manufacturer's specifications for CH5200 substantiate that the design efficiency of CH5200 is 37%
#11	SSC Limit for CPAs	The annual energy savings of each CPA shall not go beyond the limits of 180 GWh _{th} /year over the entire crediting period. In the case of using option 1 to prove additionality under Eligibility Criteria 7, the limit shall be 60 GWh _{th} /year over the entire crediting period.	The maximum number of ICS will be determined in each CPA-DD depending on the technology used (excel sheet will be provided to show calculated energy savings). If a CPA exceeds the applicable limit in any year, the claimable emission reduction shall be capped based on the estimated GHG reductions in the CPA-DD).	Refer ER calculator, worksheet 'MP#5 ER Calculations' which calculates the annual energy savings in 5342-0001 and 5342-0003.

For detailed information on complete list of eligibility criteria refer the CPA-DDs available on UNFCCC website as mentioned in Section A.1.2, Part I of this monitoring report.

(c) **Relevant dates for the specific-case CPA(s) (e.g. construction, commissioning, continued operation periods, etc.);**

Description	5342-0001	5342-0002	5342-0003	Reference
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Start Date	03/01/2012	11/08/2013	06/06/2012	Respective CPA-DD
Date of first stove distribution	23/02/2012	--	20/06/2012	PoA / CPA distribution database

The CPAs have been in continued operation since the date of first stove distribution.

- (d) **Total GHG emission reductions or net GHG removals by sinks achieved in this monitoring period for the specific-case CPA(s), including information on how double counting is avoided**

CPA	Emission Reductions tCO ₂ e
5342-0001	15,477
5342-0002	0
5342-0003	11,605
Total	27,082

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Each stove bears a unique serial ID punched on the stove. The same is recorded to trace the stove later and avoid double counting. Further, for each stove included under each CPA, information on the location of the stove has been collected by collecting address of the user at the time of sale in CPA Distribution Record. Thus, location of each stove in CPA distribution database can be traced. Please refer the ER calculator, worksheet 'CPA Distribution data' in which the sales information i.e. Stove unit details and the end user information for each stove is mentioned. The system of recording the unique serial on each stove along with its location serves toward avoiding double counting of stoves amongst various CPAs.

C.2. Location of CPAs

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Host Parties: Ghana

Region/State/Province: All across Ghana

City/Town/Community: All across Ghana

Physical Geographical location: The geographical locations of Ghana is depicted by the map below.



Figure: Map of Ghana

C.3. Post-registration changes to CPAs

C.3.1. Temporary deviations from the monitoring plans in the included CPA-DDs, applied methodologies or standardized baselines

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NA

C.3.2. Corrections

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NA

C.3.3. Changes to the start date of the crediting period

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NA

C.3.4. Inclusion of monitoring plan

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NA

C.3.5. Permanent changes to the included monitoring plans, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

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NA

C.3.6. Changes to project design

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NA

SECTION D. Description of monitoring system of CPAs

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Stoves were either distributed to end-users by CEESD directly or via dealers sub-contracted. Any such third parties were trained by CEESD for ensuring correct procedures according to the PoA are fulfilled.

At the CPA level, CEESD ensured that necessary data was correctly obtained from the customer and recorded in the CPA Distribution Record, firstly to avoid double counting and secondly to enable tracking of the ICS for monitoring purposes. This data captured included:

- a. Name of customer
- b. Address / location of the customer
- c. Stove unique serial ID number
- d. Stove Model
- e. Stove distribution date
- f. Type of old stove which the ICS replaced, i.e. the fuel type used in the old / baseline stove (in this case charcoal)

All other monitoring activities have been carried out at the PoA level, single stage sampling plan. The monitoring surveys and efficiency tests were conducted during the period Feb - April 2018.

SECTION E. Data and parameters**E.1. Data and parameters fixed ex ante**

(Copy this table for each data or parameter.)

Data/parameter	Q _{biomass}
Unit	Tonnes/year
Description	Annual average biomass consumption per appliance
Source of data	Historical data from literature, as allowed by the methodology
Value(s) applied	4.36
Choice of data or measurement methods and procedures	As per registered CPA-DDs

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Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Used for calculation of B _{old}

Data/parameter	f_{NRB,y}
Unit	Fraction
Description	Fraction of woody biomass saved by the project activity in year y that can be established as non-renewable biomass.
Source of data	FAO and IPCC
Value(s) applied	0.99
Choice of data or measurement methods and procedures	As per registered CPA-DDs
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	

Data/parameter	NCV_{biomass}
Unit	TJ/tonne
Description	Net calorific value of the non-renewable biomass that is substituted
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 registered CPA-DDs
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/parameter	EF_{projected_fossilfuel}
Unit	tCO ₂ /TJ
Description	Emission factor for the substitution of non-renewable biomass by similar consumers
Source of data	2006 IPCC guidelines for National Greenhouse Gas Inventories
Value(s) applied	81.6
Choice of data or measurement methods and procedures	As per registered CPA-DDs
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/parameter	η_{old}
Unit	Efficiency
Description	Efficiency of the system being replaced
Source of data	AMS-II.G version 03
Value(s) applied	0.101
Choice of data or measurement methods and procedures	As per registered CPA-DDs
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	

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Data/parameter	LAF
Unit	Fraction
Description	Net to gross adjustment factor to account for leakages
Source of data	AMS-II.G version 03
Value(s) applied	0.95
Choice of data or measurement methods and procedures	As per registered CPA-DDs
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

E.2. Data and parameters monitored

(Copy this table for each data or parameter.)

Copy this table for each data parameter.				
Data/parameter	$\eta_{new,y}$			
Unit	Efficiency			
Description	Efficiency of the system being deployed as part of the project activity			
Measured/calculated/default	Measured			
Source of data	As determined through sample testing of stoves by performing WBTs			
Value(s) of monitored parameter	Stove model		Value (%)	
	CH2200		32.58%	
	CH2300		31.74%	
	CH5200		33.36%	
	Weighted average 5342-0001		31.93%	
	Weighted average 5342-0003		31.91%	
Monitoring equipment	Name of equipment	Thermocouple Thermo-meter	Weighing Scale	Moisture meter
	Name of manufacturer	Omega Engineering	OHAUS Corporation	Voltcraft
	Name of model	HT-L13	Aviator 2000	FM-200
	Measurement accuracy	0.15% rdg	+2% of full scale	+1%
	Number of units used for testing	1	1	1
	Serial number of each unit	201605016643	8334210635	171210050
	The equipment were newly purchased at the time of use so measurements were done with the necessary guarantees.			
Measuring/reading/recording frequency	WBTs were carried out for a sample of installed ICSs in operation in line with the PoA Sampling Plan on an annual basis.			
Calculation method (if applicable)	n/a			
QA/QC procedures	WBTs were conducted in line with the guidance provided by the CME and according to a methodology supported by PCIA. Documentation can be found on PCIA website http://www.pciaonline.org/testing			
Purpose of data/parameter	Calculation of baseline emissions			
Additional comments				

Data/parameter	N_{all}
Unit	Number
Description	Total number of stoves installed
Measured/calculated/default	Calculated

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Source of data	CPA Distribution Records and logbooks
Value(s) of monitored parameter	5342-0001: 9375 5342-0003: 5866
Monitoring equipment	n/a
Measuring/reading/recording frequency	The DO maintained CPA Distribution Records which provided the data used to calculate this parameter. This data was uploaded to the PoA Distribution and Monitoring Database maintained by the CME. The recording of the sales was done in a regular basis during the crediting period and the monitoring in a yearly basis.
Calculation method (if applicable)	Sum of all stove records in the CPA Distribution Records.
QA/QC procedures	The CME supervised the activities of the DO, and provided training, guidelines and distribution templates to facilitate accurate record keeping during the ICS distribution. The CME also maintained a record of the stove serial numbers supplied to the DO, and was able to cross-check these against the CPA Distribution Reports it receives back from the DO.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Based on the monitoring survey results, the stove number in each CPA has been discounted by the fraction of samples that have reported using more than one EF stove.

Data/parameter	SOF
Unit	Fraction
Description	Stove Operation Fraction – used to determine the share of distributed stoves that are still operating, measured ex-post through sampling
Measured/calculated/default	Measured
Source of data	Survey of end user behaviour as part of the PoA Sampling Plan
Value(s) of monitored parameter	0.8381
Monitoring equipment	No specific monitoring equipment has been used for the surveys.
Measuring/reading/recording frequency	The actual value applied for emissions reduction calculations and request for issuance of CERs was measured ex-post by investigation of the number of ICS installations within the sampled ICS which are operational. This was done on an annual basis as per the PoA monitoring requirements
Calculation method (if applicable)	Since 88 out of 105 stoves have been found to be in operation, SOF has been calculated as 88 divided by 105.
QA/QC procedures	The CME provided training, guidelines and monitoring templates to ensure that the Monitoring Organization responsible for monitoring followed appropriate procedures.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/parameter	f_{old}
Unit	Fraction
Description	The fraction of end users that are still using baseline (replaced) stoves
Measured/calculated/default	Measured
Source of data	Survey data of end user behaviour as part of the PoA Sampling Plan
Value(s) of monitored parameter	0.1477
Monitoring equipment	No specific monitoring equipment has been used for the surveys.

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Measuring/reading/recording frequency	<p>The actual value applied for emissions reduction calculations and request for issuance of CERs was measured ex-post by estimation of a representative sample of end users using the deployed ICS, as conducted in line with the PoA Sampling Plan.</p> <p>Sampling estimated the value of this parameter through monitoring the fraction of end users not using baseline stoves ($f_{non,old}$),</p> <p>This was done on an annual basis as per the PoA monitoring requirements</p>
Calculation method (if applicable)	Based on the registered CPA-DD, the fraction of users not using the baseline stoves ($f_{non,old}$) has been monitored. Then f_{old} has been calculated as $1 - f_{non,old}$
QA/QC procedures	The CME provided training, guidelines and monitoring templates to ensure that the Monitoring Organization responsible for monitoring followed appropriate procedures.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/parameter	μ_{old}
Unit	kg/year
Description	The amount of woody biomass consumption that is consumed through the continued use of old stoves
Measured/calculated/default	Measured
Source of data	Data from survey of end user behaviour as part of PoA Sampling Plan combined with the same source of data as for $Q_{biomass}$
Value(s) of monitored parameter	1,489 kg/year
Monitoring equipment	No specific monitoring equipment has been used for the surveys.
Measuring/reading/recording frequency	<p>The actual value applied for emissions reduction calculations and request for issuance of CERs was measured ex-post by estimation of a representative sample of end users using the deployed ICS, as conducted in line with the PoA Sampling Plan.</p> <p>During the survey, the interviewer conducted an interview with the end user to identify how much the baseline (replaced) stove as being used. The value of μ_{old} will be estimated by comparing the number of meals before and after buying ICS.</p> <p>This was done on an annual basis as per the PoA monitoring requirements</p>
Calculation method (if applicable)	Based on the registered CPA-DDs, this parameter has been calculated by multiplying the Total Annual Fuel Consumption, $Q_{biomass}$, by the ratio of meals cooked by the traditional stove in operation before and after purchasing the Envirofit Stove.
QA/QC procedures	The CME provided training, guidelines and monitoring templates to ensure that the Monitoring Organization responsible for monitoring followed appropriate procedures
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	

Data/parameter	Stove_{year}
Unit	Year
Description	Calculated average stove operation years in the monitoring period. If stoves have been operating for 365 days then Stove _{year} = 1.0. If less than 365 days, then Stove _{year} is represented as a fraction of 365 (eg. 180 days= 0.5).

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Measured/calculated/default	Calculated
Source of data	PoA Distribution and Monitoring Database
Value(s) of monitored parameter	5342-0001: <u>0.716</u> 5342-0003: <u>0.721</u>
Monitoring equipment	No specific monitoring equipment has been used for the surveys.
Measuring/reading/recording frequency	Each ICS entered into the PoA Distribution and Monitoring Database was linked to a distribution date (recorded during distribution). Thus for any monitoring period it is possible to calculate the period of time that the stoves included in the emissions reduction calculations for that period have been operating.. The recording of the sales date was done in a regular basis during the crediting period and the monitoring on an annual basis.
Calculation method (if applicable)	Average of all stove records in the CPA Distribution Records.
QA/QC procedures	The CME was responsible for overseeing the collection of data by DOs during distribution, training the DOs in correct data recording practices, maintaining a secure Database, and back up of files contained in the Database.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

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E.3. Implementation of sampling plan

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a) List of CPAs to which the single sampling was applied

The eligible stoves distributed under the CPAs included in the PoA are as follows:

Table 1: CPA and Stove Installation

CPA	Scale	Type of Project stoves eligible under CPA	Total number of stoves in the CPA	CPA monitoring period covered under this PoA monitoring period
5342-0001	Micro	Charcoal	9375 ²	25/10/2016 – 24/10/2017
5342-0002	Small	Woodfuel	0	25/10/2016 – 24/10/2017
5342-0003	Small	Charcoal	5866	25/10/2016 – 24/10/2017

No eligible stoves were distributed in 5342-0002 till the end of monitoring period. Hence, no ERs are being claimed for 5342-0002 for this entire monitoring period. Only 5342-0001 and 5342-0003 have been monitored under the single PoA sampling plan for this monitoring period.

b) Description of implemented single sampling design;

Due to the large number of ICS distributed under the PoA it was not economically feasible to monitor each individual ICS unit distributed. Therefore, representative sampling was undertaken as part of a PoA-wide Sampling Plan. The sampling plan consisted of monitoring the following four parameters mentioned in section D.2.:

Sl.No.	Parameter	Description of parameter
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² Section A.2, page 2 of the registered CPA-DD, clearly mentions, "CPA will have a maximum energy saving of less than or equal to 60/180 GWh_m/year, thus staying within the micro/small-scale threshold. Based on the estimated energy savings, it is envisaged that 4,500 number of stoves will be distributed under the CPA." It must be noted that the CPA-DD does not restrict or set a limit on the number of stoves that may be implemented under the CPA and the number of stoves mentioned in respective CPA-DD is only an indicative number. The number of cookstoves under the CPA can change ex-post during the crediting period based on monitored performance.

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1	$\eta_{new,y}$	The thermal efficiency of the ICS distributed (%)
2	SOF	The Stove Operating Fraction, i.e. the fraction of users using the ICS
3	f_{old}	The fraction of stove users still using baseline (replaced) stoves
4	μ_{old}	The amount of woody biomass that continues to be used in the replaced stoves (kg)

Based on the registered PoA-DD and CPA-DD for 5342-0001 & 5342-0003, 95/10 reliability level was selected for cross-CPA sampling for the parameters mentioned above.

As per page 53 of the PoA-DD, for the parameter η_{new} , the population of each stove model shall be deemed homogeneous across CPAs as the stoves have been designed to meet stringent efficiency specifications and are manufactured in factories to specification. Hence the sample size was calculated for η_{new} considering each stove model as separate population. As per page 53 and page 57 of the PoA-DD, for other parameters (SOF, f_{old} , μ_{old}), the homogeneity of the population is demonstrated in compliance with the following conditions;

Homogeneity condition	Characteristic of Population	Status of population
Country	all units have been distributed in the same geographical area, i.e. Ghana	homogeneous
Fuel Type – charcoal / wood fuel	all units that have been distributed are charcoal stoves	homogeneous
End user – domestic / small-medium enterprises / community	all units are for domestic (household) usage as per their design	homogeneous
Stove Type - efficiencies are in a similar range defined as being within +/-10% of each other and they have other common design features	the stove models disseminated have efficiencies within +/-10% of each other (CH2300 considered as the base model which constitutes more than 80% of the stove population)	homogeneous

Thus, the sample size calculations for parameters SOF, f_{old} , μ_{old} were calculated considering CPA population as one sampling frame.

The required sample sizes were derived using equation (1) on page 68 and equation (4) on page 70 of the Guideline: Sampling and surveys for CDM project activities and programmes of activities, Version 04.0 for proportion based and mean based parameters respectively as follows:

$$n = \frac{z^2 \cdot N \cdot V}{(N-1) \cdot c^2 + z^2 \cdot V}$$

$$V = \left(\frac{SD}{Mean} \right)^2 \text{ for mean parameters}$$

$$V = p \cdot (1-p) / p^2 \text{ for proportion parameters}$$

Where:

n = sample size

N = population size

z = Confidence value constant (1.96 for 95%)

c = Desired precision (10%)

SD = expected standard deviation for mean parameter

$Mean$ = expected mean for mean parameter

p = expected proportion for proportion based parameter

The following table gives the number of samples covered during the monitoring activity. Refer ER calculator worksheet MP#5 'Sample Size Calculations' for more details on calculation of sample size for each parameter. The expected parameter values (mean, standard deviation and proportion) have been determined based on project developer's knowledge and experience as per para 12(b) and 12(c) of the "Standard: Sampling and surveys for CDM project activities and programmes of activities", Version 07.0 available at:

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https://cdm.unfccc.int/filestorage/e/x/t/extfile-20170509173059588Methodology_standard05_EB94a02-ver07.0-4may17-.pdf/Methodology_standard05_EB94a02%28ver07.0%2C%204may17%29?t=RG18cGJzcnFifDBRUFYalLUWYwFhMb4j2VLa

Parameter	Total population (N)	Expected results	Reliability	Required Size (n)	Sample	Monitored samples
η_{new} (CH2200)	2,131	31.0	95/10		7	10
η_{new} (CH2300)	12,466	32.0	95/10		7	12
η_{new} (CH5200)	644	34.0	95/10		7	11
SOF	15,241	85%	95/10		68	105
f_{old}	12,995	85%	95/10		68	88
μ_{old}	1943	2200	95/10		7	13

The stoves were selected by randomly assigning a number to each stove and sorting in increasing order from lower to higher number. 130 Random numbers were generated using online random number generator for each sampling frame separately and the numbers obtained were used to identify the samples from the population within the applicable sampling frame. A higher number of samples were monitored than that required to ensure that the desired precision / confidence is achieved as well as have sufficient number of samples that use both ICS and baseline stove for determining μ_{old} .

c) Collected data (electronic spreadsheets may be attached and referenced);

Data was collected for SOF, f_{old} and μ_{old} following a specially designed survey form. The information collected was introduced into an electronic database, the CPA Monitoring Record. This survey form was design in a way that would allow the surveyor first to check the validity of the records from the CPA Distribution Records, and secondly to collect the necessary information from field visits for the ER calculations. In order to achieve the 95/10 reliability level for cross-CPA sampling, a few additional stoves were sampled from the database (as mentioned in the table above) to cover for non-responses, if any.

As per the PDD, to calculate the thermal efficiency of the stoves, water boiling tests were conducted using the "Emissions and Performance Test Protocol", or EPTP, (a water boiling test protocol developed by Colorado State University). Refer ER calculator worksheet "Monitoring Survey" and "WBT Data" for details on data collected during monitoring.

The surveys and tests were conducted during February – April 2018.

d) Analysis of the collected data;

Analysis of the data monitored through sampling revealed the following results:

Parameter	Results
SOF	0.8381
f_{old}	0.1477
μ_{old}	1489 kg/y
η_{new} (CH2200)	32.58%
η_{new} (CH2300)	31.74%
η_{new} (CH5200)	33.36%

e) Demonstration of whether the required confidence/precision has been met;

The following tables demonstrate the status of precision/confidence for each of the monitored parameters:

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$\eta_{\text{new CH2200}}$	32.58%	%	Calculated
Total number of stoves	2131	number	CPA Installation Databases
Sample Size for ($\eta_{\text{newCH2200}}$)	10	number	WBT data
Mean ($\eta_{\text{newCH2200}}$)	32.58%	%	Calculated
Standard Deviation ($\eta_{\text{newCH2200}}$)	0.80%	%	Calculated
Standard error of mean ($\eta_{\text{newCH2200}}$)	0.0025		Calculated
Precision for $\eta_{\text{newCH2200}}$	1.75%	%	Calculated
Result for $\eta_{\text{newCH2200}}$	ok, acceptable	--	Calculated

$\eta_{\text{new CH2300}}$	31.74%	%	Calculated
total number of stoves	12466	number	CPA Installation Databases
Sample Size for ($\eta_{\text{newCH2300}}$)	12	number	WBT data
Mean ($\eta_{\text{newCH2300}}$)	31.74%	%	Calculated
Standard Deviation ($\eta_{\text{newCH2300}}$)	0.86%	%	Calculated
Standard error of mean ($\eta_{\text{newCH2300}}$)	0.0025		Calculated
Precision for $\eta_{\text{newCH2300}}$	1.72%	%	Calculated
Result for $\eta_{\text{newCH2300}}$	ok, acceptable	--	Calculated

$\eta_{\text{new CH5200}}$	33.36%	%	Calculated
total number of stoves	644	number	CPA Installation Databases
Sample Size for ($\eta_{\text{newCH5200}}$)	11	number	WBT data
Mean ($\eta_{\text{newCH5200}}$)	33.36%	%	Calculated
Standard Deviation ($\eta_{\text{newCH5200}}$)	0.47%	%	Calculated
Standard error of mean ($\eta_{\text{newCH5200}}$)	0.0014		Calculated
Precision for $\eta_{\text{newCH5200}}$	0.94%	%	Calculated
Result for $\eta_{\text{newCH5200}}$	ok, acceptable	--	Calculated

SOF	0.8381	Fraction	Calculated
Population Size	15241	number	CPA Installation Databases
Sample Size	105	number	Calculated
Proportion for SOF	0.838	Fraction	Calculated
Standard error of proportion for SOF	0.036		Calculated
Precision for SOF	8.38%	%	Calculated
Result for SOF	ok, acceptable	--	Calculated

As per paragraph 11(a) of the Standard - Sampling and surveys for CDM project activities and programmes of activities, $f_{\text{non-old}}$ has been determined through sampling and f_{old} has been determined as $f_{\text{old}} = 1 - f_{\text{non-old}}$.

f_{old}	0.1477	Fraction	Calculated
Population Size	12773	number	CPA Installation Databases
Sample Size	88	number	Calculated
Proportion for $f_{\text{non-old}}$	0.85	Fraction	Calculated
Standard error of proportion for $f_{\text{non-old}}$	0.038		Calculated
Precision for $f_{\text{non-old}}$	8.67%	%	Calculated
Result for $f_{\text{non-old}}$	ok, acceptable	--	Calculated

μ_{old}	1489	Kg/y	Calculated
Population Size	1887	number	CPA Installation Databases
Sample Size	13	number	Calculated
Mean for μ_{old}	1489	kg/y	Calculated
Standard Deviation μ_{old}	258.74	kg/y	Calculated
Standard error of mean μ_{old}	71.51		Calculated
Precision for μ_{old}	9.42%	%	Calculated
Result for μ_{old}	ok, acceptable	--	Calculated

For detailed calculations refer ER calculator, worksheet 'Monitoring Survey'

a) Demonstration of whether the samples were randomly selected and are representative of the population.

Stoves were selected by randomly after arranging them in chronological order of date of sale and assigning a number to each stove. Random numbers were generated using online random number generator available at <http://stattrek.com/statistics/random-number-generator.aspx> for each sampling frame and the random numbers received were selected from sampling frames to identify the samples to be monitored. The approach ensured that the samples picked are random and represent the population.

SECTION F. Calculation of emission reductions or net anthropogenic removals

F.1. Calculation of baseline emissions or baseline net removals

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$$ER_y = B_{y,savings} \cdot f_{NRB} \cdot NCV_{biomass} \cdot EF_{projected\ fossil\ fuel}$$

$$B_{y,savings} = B_{old} \cdot \left(1 - \frac{\eta_{old}}{\eta_{new}}\right)$$

$$B_{old} = LAF \cdot N_{all} \cdot SOF \cdot (Q_{biomass} - \left(\frac{\mu_{old}}{1000} \cdot f_{old}\right)) \cdot Stove_{year}$$

Data Ex Ante	Value	Unit	Source
Q _{biomass} (charcoal)	4.36	tonne/year	Ex-ante, CPA-DD
Q _{biomass} (Firewood)	-		
f _{NRB}	0.9949	fraction	Ex-ante, CPA-DD
NCV _{biomass}	0.015	TJ/tonne	Ex-ante, CPA-DD
EF _{fossil_fuel}	81.6	tCO ₂ /TJ	Ex-ante, CPA-DD
Efficiency _{old} (charcoal)	0.101	fraction	Ex-ante, CPA-DD
Efficiency _{old} (firewood)	-		
LAF	0.95	fraction	Ex-ante, CPA-DD
Data Ex Post	Value	Unit	Source
Monitored			
Efficiency _{new} CH2200	32.58%	%	Monitored - "WBT data"
Efficiency _{new} CH2300	31.74%	%	Monitored - "WBT data"
Efficiency _{new} CH5200	33.36%	%	Monitored - "WBT data"
SOF	0.8381	fraction	Monitored - "Monitoring Survey"
f _{old}	0.1477	fraction	Monitored - "Monitoring Survey"
μ _{old}	1489	kg/year	Monitored - "Monitoring Survey"

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Data Ex Post	5342-0001	5342-0003	Unit	Source
N _{CH2200}	2131	0	number	Monitored - "CPA Distribution data"
N _{CH2300}	7244	5222	number	Monitored - "CPA Distribution data"
N _{CH5200}	0	644	number	Monitored - "CPA Distribution data"
N _{all}	9375	5866	stoves	Calculated
STOVE _{year}	0.716	0.721	fraction	Calculated
Efficiency _{new}	31.93%	31.91%	%	Calculated
B _{old}	22141.21	13942.80	t biomass	Calculated
B _{y,savings}	15136.93	9530.35	t biomass	Calculated
Annual Energy savings	88.03	55.07	GWh	Calculated
Scale?	Micro	Small	-scale	
Capacity Utilization	1.47	0.31		Calculated
CPA-DD ER cap	15477	46879	tCO ₂ e	calculated
ER _y	15477	11605	tCO ₂ e	Calculated

F.2. Calculation of project emissions or actual net removals

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As explained above, the methodology directly provides equation for emission reductions; without separate baseline, project or leakage emission reduction equations. Calculation of Emission Reductions has already been explained above as per the methodology. Thus, this section is not applicable

F.3. Calculation of leakage emissions

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As explained above, the methodology directly provides equation for emission reductions; without separate baseline, project or leakage emission reduction equations. Calculation of Emission Reductions has already been explained above as per the methodology by application of Gross to Net Leakage adjustment factor of 0.95 to baseline emissions. Thus, this section is not applicable.

F.4. Calculation of emission reductions or net anthropogenic removals

CPA UNFCCC reference number	Baseline GHG emissions or baseline net GHG removals (t CO ₂ e)	Project GHG emissions or actual net GHG removals (t CO ₂ e)	Leakage GHG emissions (t CO ₂ e)	GHG emission reductions or net anthropogenic GHG removals (t CO ₂ e)		
				Before 01/01/2013	From 01/01/2013	Total amount
5342-0001	15,477	0	0	0	15,477	15,477
5342-0002	0	0	0	0	0	0
5342-0003	11,605	0	0	0	11,605	11,605
Total	27,082	0	0	0	27,082	27,082

F.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the included CPA-DDs

CPA UNFCCC reference number	Amount achieved during this monitoring period (t CO ₂ e)	Amount estimated ex ante (t CO ₂ e)
5342-0001	15,477	15,477
5342-0002	0	47,008
5342-0003	11,605	47,008
Total	27,082	109,493

Data Ex Post	5342-0001
N _{CH2200}	2131
N _{CH2300}	7244
N _{CH5200}	0
N _{all}	9375
STOVE _{year}	1.00
Efficiency _{new}	31.93%
B _{old}	30902.76
B _{y,savings}	21126.80
Annual Energy savings	88.03
Scale?	Micro
Capacity Utilization	1.47
CPA-DD ER cap	15477
ER _y	15477

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F.6. Remarks on increase in achieved emission reductions

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There is no increase in the GHG emission reductions or net GHG removals by sinks achieved by the specific-case CPA(s) during this monitoring period.

Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
02.0	7 June 2017	Revision to: <ul style="list-style-type: none">• Ensure consistency with version 01.0 of the "CDM project standard for programmes of activities (CDM-EB93-A07-STAN);• Make editorial improvements.
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