



**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**

<b>Title of the PoA</b>	Ethiopia – Clean Cooking Energy Program	
<b>UNFCCC reference number of the PoA</b>	10268	
<b>Version numbers of the PoA-DD applicable to this monitoring report</b>	9.0	
<b>Version number of this monitoring report</b>	5.0	
<b>Completion date of this monitoring report</b>	30/09/2019	
<b>Monitoring period number</b>	1	
<b>Duration of this monitoring period</b>	01/04/2016 – 31/03/2018 (inclusive of both days)	
<b>Monitoring report number for this monitoring period</b>	1	
<b>Coordinating/managing entity</b>	Development Bank of Ethiopia	
<b>Host Parties</b>	Host Party of the PoA	Is this the host Party of a CPA covered in this monitoring report? (yes/no)
	Federal Democratic Republic of Ethiopia	Yes
<b>Sectoral scopes</b>	1: Energy industries (renewable - / non-renewable sources) 3: Energy Demand	
<b>Applied methodologies and standardized baselines</b>	AMS-I.E. Version 6 Switch from non-renewable biomass for thermal applications by the user  AMS-I.I Version 4 Biogas/biomass thermal applications for households/small users  AMS-II.G Version 6 Energy efficiency measures in thermal applications of non-renewable biomass	
<b>Amount of GHG emission reductions or net anthropogenic GHG removals achieved by all CPAs covered in this monitoring report in this monitoring period</b>	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0 tCO <sub>2</sub> e	34,480 tCO <sub>2</sub> 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	43,915 tCO <sub>2</sub> e
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## PART I Monitoring of programme of activities (PoA)

### SECTION A. Description of PoA

#### A.1. General description of PoA

The Ethiopia – Clean Cooking Energy Program (the PoA) is a nationwide program for Ethiopia that targets poor and vulnerable households, who rely primarily on wood fuels for cooking; national statistics show that 85% of cooking fuel currently used in Ethiopia is either collected or purchased<sup>1</sup>. The purpose of the PoA is to provide improved energy access to such households, with associated benefits for poverty alleviation, while simultaneously reducing greenhouse gas emissions from the exploitation of non-renewable biomass (NRB) resources and from fossil fuels.

The PoA seeks to promote the goals stated by the Government of Ethiopia (GoE) in its Growth and Transformation Plan 2010/11–2014/15 (GTP). Specifically, the PoA promotes the GTP goals for Alternative Energy Development and Promotion, where the GTP aims to disseminate the use of improved alternative technologies that can minimize deforestation, reduce indoor air pollution and associated health problems and save women's and children's working time on collecting wood fuels.<sup>2</sup> The PoA also contributes to the GTP implementation strategy of supporting and motivating private investors to involve in bio-fuel development activities on the short term.

To this end, three alternative energy technologies are implemented under the PoA. Via the PoA, households are encouraged to adopt domestic biogas plants (DBPs), which generate biogas for cooking and lighting, ethanol stoves for cooking, and improved cookstoves fuelled by non-renewable biomass. These technologies permit the substitution or reduced use of wood fuels, including non-renewable biomass (NRB), or fossil fuels, by a renewable fuel, either biogas or ethanol, thereby reducing mainly CO<sub>2</sub> emissions. DBPs were selected for promotion because of the high prevalence of suitable conditions for successful DBPs among rural Ethiopian households. For example, 80% of the rural population is involved in animal husbandry and many regions have plentiful water availability<sup>3</sup>, both of which provide the necessary inputs for a household level biogas digester. The other technology, ethanol stoves, was chosen because of the excellent potential for bio-ethanol production in Ethiopia<sup>4</sup>, which is largely untapped but targeted for growth. Improved cookstoves were included for the households that do not have the waste biomass to support a DBP or access to biofuels such as ethanol.

The unique feature of this PoA is that it takes advantage of useful experience that GoE has accumulated with DBPs in Ethiopia through the National Biogas Program Ethiopia (NBP), which began in a demonstration phase in 2008, and since 2009 has been a national program implemented

<sup>1</sup> Central Statistical Agency. *Welfare Monitoring Survey 2011*. Page 79 Table 8.7(a)

<sup>2</sup> Ministry of Finance and Economic Development. *Growth and Transformation Plan 2010/11 – 2014/15*. November 2010.

<sup>3</sup> SNV – Ethiopia. *Report on the feasibility study of a national programme for domestic biogas in Ethiopia*. Page 10. May 2006.

<sup>4</sup> The World Bank. *The Federal Democratic Republic of Ethiopia Joint IDA-IMF Staff Advisory Note on the Growth and Transformation Plan (GTP) (2010/11-2014/15)*. Page 37. August 15<sup>th</sup> 2011.

by the Ministry of Water and Energy (MoWE) and financed by a combination of rural households contribution, Government of Ethiopia funds, and donor funds from development organizations SNV and Hivos. Since 2008, a total of 6,252 biogas plants have been installed, whereas the government program planned to install about double this amount. At the time of this monitoring report, 4,812 of the 6,252 biogas digesters installed are covered under the PoA. Donor funds subsidized directly about 36% of the cost of each DBP for its purchaser. However, the existing donor, Hivos, manifested that it will only fund the DBP subsidy through the end of 2013<sup>5</sup>, and the GoE is unable to provide funds to continue the existing subsidy. Carbon finance is sought to contribute to part of the budget shortfall to continue and expand NBP implementation.

The CME of the PoA is the Development Bank of Ethiopia (DBE), a public enterprise that comprises a specialized financial institution established to promote the national development agenda through development finance and technical support to viable projects from the priority areas of the government. DBE mobilizes funds from domestic and foreign sources while ensuring its sustainability. The Carbon Initiative for Development (Ci-Dev) of the World Bank supports the PoA and will assist the program through direct support and capacity building to register the carbon component of the program in a timely manner and potentially purchase the generated credits.

#### 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: NBP Ethiopia Domestic Biogas Plants CPA CPA Type: Generic CPA Type 1	9.0	1	AMS-I.E. Version 6 Switch from non-renewable biomass for thermal applications by the user <sup>6</sup>
Title: NBP Ethiopia Ethanol Stove CPA CPA Type: Generic CPA Type 2	6.0	1	AMS-I.E. Version 6 Switch from non-renewable biomass for thermal applications by the user <sup>7</sup>
Title: NBP Ethiopia Ethanol Stove Switch CPA CPA Type: Generic CPA Type 3	6.0	1	AMS-I.I Version 4 Biogas/biomass thermal applications for households/small users <sup>8</sup>
Title: NBP Clean Cookstoves CPA Type: Generic CPA Type 4	6.0	3	AMS-II.G. Version 6 Energy efficiency measures in thermal applications of non-renewable biomass <sup>9</sup>

#### 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)
NBP Ethiopia Domestic Biogas Plants CPA 1	Title: NBP Ethiopia Domestic Biogas Plants CPA	9.0	Type: Renewable	Yes

<sup>5</sup> Hivos. Annual Plan 2013 Implications. Page 2. December 17<sup>th</sup> 2012

<sup>6</sup> <https://cdm.unfccc.int/methodologies/DB/9LFOR81TCT5FLI1AJYP46CQY8O2J79>

<sup>7</sup> <https://cdm.unfccc.int/methodologies/DB/9LFOR81TCT5FLI1AJYP46CQY8O2J79>

<sup>8</sup> <https://cdm.unfccc.int/methodologies/DB/3WJ6C7R0JFA62VYA2Z2K6WE1RK1PXI>

<sup>9</sup> <https://cdm.unfccc.int/methodologies/DB/DCO8WRRQVTGLH1GHQBCL035F5M13R8>

Reference Number: 10268-0001	Generic CPA Type 1		Duration: 01/04/2016 to 31/03/2023	
NBP Ethiopia Domestic Biogas Plants CPA 2  Reference Number: 10268-0002	Title: NBP Ethiopia Domestic Biogas Plants CPA  Generic CPA Type 1	6.0	Type: Renewable  Duration: 01/05/2017 to 30/04/2024	No

## A.2. Coordinating/managing entity

The CME is the Development Bank of Ethiopia (DBE). DBE is a state owned financial institution. The DBE is headquartered in Addis Ababa, with further staff in the branches and regions of Ethiopia. The address of the DBE is the following:

Development Bank of Ethiopia  
Kirkos  
Addis Ababa  
Ethiopia

## SECTION B. Implementation of PoA

### B.1. Description of implemented PoA

The Ethiopia – Clean Cooking Energy Program is a nationwide program for Ethiopia that targets poor and vulnerable households, who rely primarily on wood fuels for cooking. The purpose of the PoA is to provide improved energy access to such households, with associated benefits for poverty alleviation, while simultaneously reducing greenhouse gas emissions from the exploitation of non-renewable biomass (NRB) resources and from fossil fuels.

The Development Bank of Ethiopia, the CME, has worked to implement the PoA as per the management system in the PoA-DD. At the time of monitoring, two CPAs have been included under the PoA., namely two Type 1 CPAs, covering biogas digesters. This monitoring report covers only the first biogas CPA included at the time of registration. The PoA was registered on 18/03/2016.

Three alternative energy technologies are implemented under the PoA. Via the PoA, households are encouraged to adopt domestic biogas plants (DBPs), which generate biogas for cooking and lighting, ethanol stoves for cooking, and improved cookstoves fuelled by non-renewable biomass. These technologies permit the substitution or reduced use of wood fuels, including non-renewable biomass (NRB), or fossil fuels, by a renewable fuel, either biogas or ethanol, thereby reducing mainly CO<sub>2</sub> emissions. DBPs were selected for promotion because of the high prevalence of suitable conditions for successful DBPs among rural Ethiopian households.

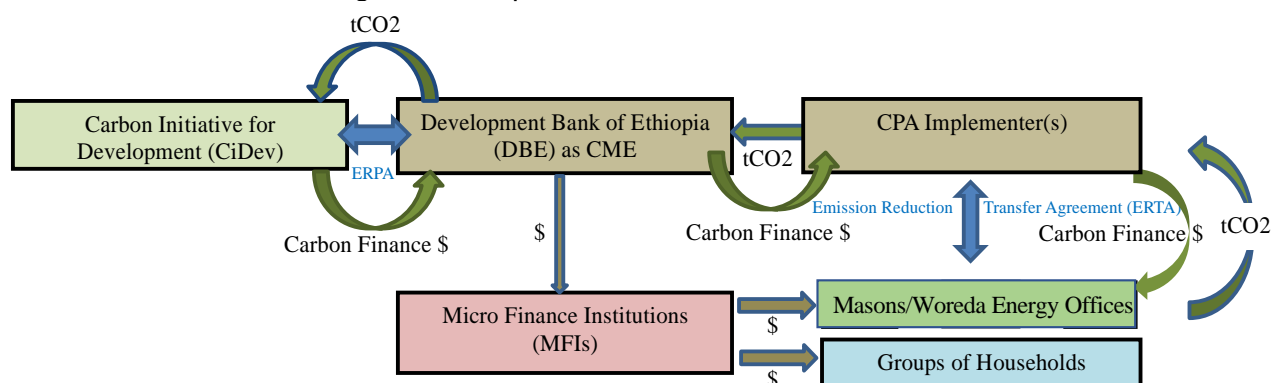


Figure 1. General implementation framework of the PoA

DBE, as the CME, will serve as the central warehouse for program information, the clearinghouse for carbon finance, and as the source of loan finance funds for micro-finance institutions (MFIs). The implementation of CPAs will rely upon CPA Implementers, separate entities from DBE, which will communicate implementation information directly to DBE. In the case of domestic biogas plants, the CPA implementer will be the National Biogas Program Ethiopia (NBPE), which will utilize and expand upon its existing implementation framework. In the case of ethanol stoves, a variety of entities may serve as CPA implementers. The CME will use the implementation information it receives to assign carbon finance to the CPA implementers, from where it will be redistributed to the subsequent levels of implementation.

A sampling approach was applied for monitoring of each CPA in this monitoring report. Only one CPA is covered in this monitoring report.

## **B.2. Post-registration changes to PoA**

### **B.2.1. Corrections**

The following PRCs were completed prior to this monitoring period:

Reference Number: PRC-10268-001

Date of Approval: 03/01/2018

Corrections covered under the PRC are the following:

The time limit boundary for all CPA types was originally specified as covering technologies installed or disseminated over a two-year period. As the restriction on CPA size limits has been revised to apply either at the CPA level or at the CDM unit level, the time limit on the CPAs has been revised to be specified at the specific CPA.

The measures to avoid double counting were specified as the recording of GPS coordinates and serial numbers. The measures to avoid double counting have been revised to be specified for the specific CPA, with GPS coordinates and serial numbers given as an example of the measure.

In addition, the size limit for all CPA types under the PoA was revised to reflect Methodological Tool 19 Version 8 *Demonstration of additionality of microscale project activities* in the eligibility criteria.

The eligibility criterion surrounding securing CER rights for the various CPA types has been clarified.

Revisions have been made to various sections of the design document as the document was updated to the latest template. From Version 4.0 to Version 8.1.

Reference Number: PRC-10268-006

Date of Approval: 27/08/2019

Parameter names and calculation methods were revised in sections I.6.2 and I.6.3 of generic CPA Type 1.

Eligibility criterion 15 has been revised to reflect the actual distribution methods under generic CPA Type 1.

Parameter  $N_d$  has been renamed to  $N_y$  in section I.6.1 of generic CPA Type 1.

### **B.2.2. Inclusion of monitoring plan**

Reference Number: PRC-10268-006

Date of Approval: 27/08/2019

There is a post-registration change to include a monitoring plan for generic CPA Type 1 only into the PoA-DD. The post-registration change is being submitted with this monitoring report.

### **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**

There are no permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baseline, or other applied standards or tools.

### **B.2.4. Changes to programme design**

Reference Number: PRC-10268-001

Date of Approval: 03/01/2018

Summary of approved changes:

The additionality argument has been revised from the positive list applying to small-scale projects, to use Methodological Tool 19 Version 8 *Demonstration of additionality of microscale project activities*.

The CPAs are now exempt from a debundling check through application of the microscale limit at the CDM Unit level.

## **PART II Monitoring of CPAs**

Title: NBP Ethiopia Domestic Biogas Plants CPA 1

Reference Number: 10268-0001

### **SECTION C. Implementation of CPAs**

#### **C.1. Description of implemented CPAs**

The CPA 1 targeted poor and vulnerable households mainly in rural areas<sup>10</sup>, who relied primarily on wood fuels for cooking, to provide improved energy access to such households, with associated benefits for poverty alleviation, while simultaneously reducing greenhouse gas emissions from avoiding the exploitation of non-renewable biomass (NRB) resources and from reduced use of fossil fuels. This CPA includes the installation of domestic biogas plants that generate biogas for cooking and lighting, for households or other end-users in Ethiopia.

The first digester under CPA 1 were constructed in the Tigray region of Ethiopia in January 2015. Digesters were installed in four regions of the country, Tigray, Amhara, Oromia, and SNNPR, on a continuous basis. By the end of the first monitoring period, the CPA covered 4,812 domestic biogas

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<sup>10</sup> Urban and peri-urban households may also benefit from the activity

plants installed throughout Ethiopia in 2015 and 2016. A complete list of digesters with their respective dates of installation is shown in the excel sheet provided.<sup>11</sup>

The biogas digesters installed have a “fixed dome” design, which is capable of significant gas pressure, advantageous for use in cooking and lighting. The fixed dome digesters include an inlet, a digester dome, gas line pipings and fittings, a slurry outlet, and at least one slurry pit. Construction materials are concrete, steel, and bricks. The appliances installed with the system include a biogas stove, and may include a biogas lamp and a gas pressure meter. The system may also include a toilet or latrine, with its own inlet device, providing the additional benefit of improved sanitation. The size of a digester ranges from 4 to 10 m<sup>3</sup>, with the most common size of a digester being 6 m<sup>3</sup>.

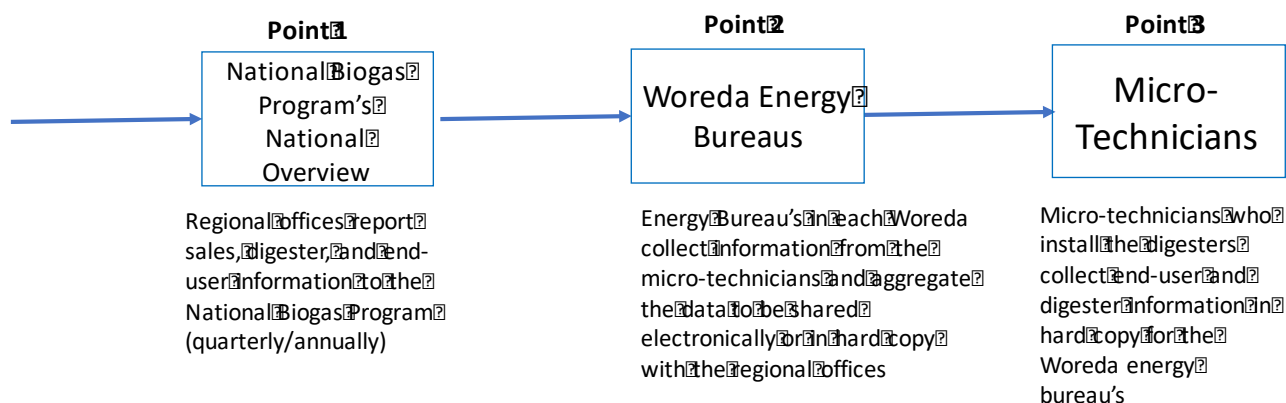
The table below shows the distribution across the four regions of Ethiopia in which digesters were installed.

**Table 1. Volumes of Digesters Installed by Region under the CPA<sup>12</sup>**

	Oromia Region	Tigray Region	SNNPR	Amhara Region	Total
Number of Digesters (2015)	364	782	513	601	2,260
Number of Digesters (2016)	736	490	603	723	2,552
Total by Region	1,100	1,272	1,116	1,324	4,812

The CPA reduces GHGs by substituting the renewable fuel biogas for the use of wood fuels, including NRB, for cooking. This substitution reduces mainly CO<sub>2</sub> emissions. It also will reduce the use of fossil fuel kerosene for lighting; however, these emission reductions are not quantified under the CPA. In the baseline scenario, end-users, targeted by the CPA, use wood fuels for cooking.

The following diagram shows the different monitoring points of the CPA.



**Figure 2. Monitoring Points of the CPA**

The emission reduction calculations are based on the NBP's overview of the regional office reports from Monitoring Point 1. The volumes installed can be validated from records at the Woreda Energy Bureaus at Monitoring Point 2. The details of the individual installations can be checked at the hard copy records kept by the regional or Woreda bureaus, and with the micro-technicians.

Operationality of the digesters installed as per the installation records from Monitoring Point 1 was assessed through a Biogas User Survey (BUS) across all four regions.

<sup>11</sup> ER Calculations (post-BUS) V3.xls

<sup>12</sup> ER Calculations (post-BUS) V3.xls

## C.2. Location of CPAs

The geographical boundary is the borders of the Federal Democratic Republic of Ethiopia. The CPA was implemented across Ethiopia, as shown in Figure 1 below.



Figure 2. Map of Ethiopia

The capital city, Addis Ababa, is located at 8.00° N and E 38.00° E.

## 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

There are no temporary deviations from the monitoring plans in the included CPA-DDs, applied methodologies or standardized baselines during this monitoring period, for any CPAs covered in this monitoring report.

### C.3.2. Corrections

Reference Number: PRC-10268-003

Date of Approval: 17/05/2018

Summary of approved changes:



The time limit boundary for the CPA was originally specified as covering technologies installed or disseminated over a two-year period. As the restriction on CPA size limits has been revised to apply either at the CPA level or at the CDM unit level, the time limit on the CPAs has been revised to be specified at the specific CPA

The measures to avoid double counting were specified as the recording of GPS coordinates and serial numbers. The measures to avoid double counting have been revised to be specified for the specific CPA, with GPS coordinates and serial numbers given as an example of the measure.

In addition, the size limit for all CPA types under the PoA was revised to reflect Methodological Tool 19 Version 8 *Demonstration of additionality of microscale project activities* in the eligibility criteria.

The eligibility criterion surrounding securing CER rights for the CPA has been clarified to match the PoA design document.

Revisions have been made to various sections of the design document as the document was updated to the latest template. From Version 4.0 to Version 8.0.

The emission reduction calculations under Appendix 4 have been revised to remove the debundling calculation.

Reference Number: PRC-10268-005

Date of Approval: 27/08/2019

Summary of approved changes:

Revisions have been made to various sections of the design document as the document was updated to the latest template. From Version 8.0 to Version 8.1.

Eligibility criterion 15 has been revised to reflect the actual distribution methods under the CPA.

In section B.4.3. Equation 3 was revised to label the leakage parameter as  $LE_y$  in place of  $L_y$ . In addition, Equation 4 was revised to match the methodology by removing the double application of leakage.

The measurement methods and procedures of the leakage parameter have been revised in section B.4.2.

Parameter  $N_d$  has been renamed to  $N_y$  in sections B.4.1, B.4.3, B.5.1, and B.5.3. The definition of parameter  $N_y$  has been updated in section B.4.1.

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

There are no changes to the start date of the crediting period fixed at the inclusion of any of the CPAs covered in this monitoring report.

### **C.3.4. Inclusion of monitoring plan**

There have been post-registration changes to include a monitoring plan into the CPA-DD, for which the delayed submission of the monitoring plan was chosen by the CME at the time of inclusion of the CPA.

Change notified to the secretariat prior to this monitoring period:

None.

Changes that have been notified as applicable to this monitoring period:

Reference Number: PRC-10268-005

Date of Approval: 27/08/2019

The addition of the monitoring plan to the CPA-DD.

### **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**

There are no permanent changes to the monitoring plans included in the CPA-DD, or permanent deviation of monitoring from the applied methodologies, or standardized baseline, or other applied standards or tools for the CPA covered in this monitoring report.

### **C.3.6. Changes to project design**

Reference Number: PRC-10268-003

Date of Approval: 17/05/2018

Summary of approved changes:

The additionality argument has been revised from the positive list applying to small-scale projects, to use Methodological Tool 19 Version 8 *Demonstration of additionality of microscale project activities*.

The CPA is now exempt from a debundling check through application of the microscale limit at the CDM Unit level.

## **SECTION D. Description of monitoring system of CPAs**

The information collected for the monitoring of the CPA 1 for each digester is the following.

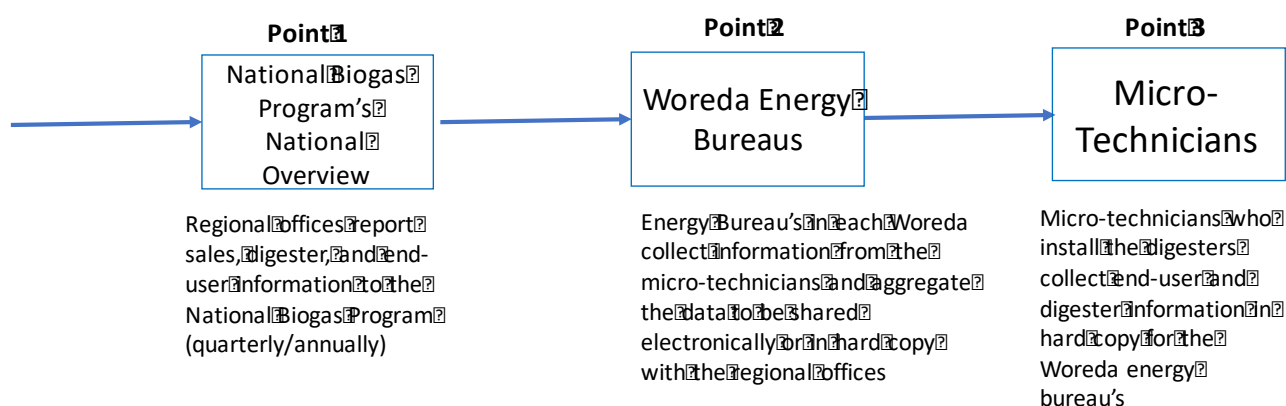
<b>Information</b>	<b>Source</b>	<b>Required for</b>
System Size (m <sup>3</sup> )	National Biogas Program Records	CPA Eligibility Criterion
Unique Identifiers (GPS, Serial Number, or end-user information such as mobile number, name etc.)	National Biogas Program Records	Methodology Eligibility
Installation Date	National Biogas Program Records	Parameter Determination

The information flow under the CPA is defined as follows. The end-user information and system information specified in the table above is recorded by the biogas technician or mason at the time of installation/construction. The information is collected by the technicians or mason and delivered to the Woreda's local biogas office. The local Woreda office periodically transfers the hard copies of the end-user information and carbon waiver form to the regional biogas office.

At the regional biogas office, the information collected is stored electronically by the National Biogas Program in a format approved by DBE. The hard copies of the documents will remain at the regional offices. The electronic end-user information is sent by the regional offices to the National Biogas

Office where it is compiled into a master file and sent to DBE where a second master file is maintained and accessible by MOWIE and the regional energy bureaus. At the time of monitoring the technicians or mason who installed the systems to be visited will conduct the inspection to certify if the system is still in operation.

The quality of the information maintained in the database managed by the National Biogas Program is crucial to the successful monitoring of the CPA. The information should be cross-checked as frequently as possible with hard copy records or sales reports from the regional biogas offices to ensure its accuracy.



The parameters determined during monitoring are based on the regional data supplied to the NBP in Monitoring Point 1. The number of full-time digesters ( $N_d$ ) is calculated in the emission reduction calculations provided.<sup>13</sup> The usage factor ( $UF_d$ ) was determined through the BUS which was conducted in all the regions covered under the CPA. The description of the sample size and survey principles is shown in section E.3.

### Monitored Parameters

The number of full-time operational biogas facilities is determined for each monitoring period through actual data. It is calculated through a summation of the operational fraction of each biogas digester in the monitoring period. The operational fraction of each biogas digester is determined through the installation date. For digesters under the CPA, the month of installation was not always known or not reliable. This was the case for all digesters installed in the Amhara and SNNPR regions, as well as 32 digesters in Tigray. These digesters are therefore deemed operational from the start of the next year following their installation. For example, a digester installed in 2015 is deemed operational from January 1<sup>st</sup> 2016. This is a conservative assumption.

The full-time operational biogas digesters are then multiplied by a Usage Factor, which measures and accounts for households not using the biogas digester to replace fuelwood completely.

Of the 4,812 digesters installed under the CPA in 2015 and 2016, only 4,097 digesters had a unique identifier as required by the CPA in the form of a serial number, GPS coordinates, or unique end-user information. The digesters without a unique identifier were removed when determining emission reductions.

The utilization rate of the biogas is monitored and determined through sampling surveys. The sampling surveys are conducted across all digesters installed in 2015 and 2016. The survey determined the operation fraction of the digesters under the CPA. Systems which cannot be located or are not operational are given a fraction of zero. The average usage fraction across all biogas systems in the sample is the value of parameter  $UF_d$ .

<sup>13</sup> ER Calculations (post-BUS) V3.xls

The Biogas Use Survey (BUS) was conducted by a 3<sup>rd</sup> party to determine  $UF_d$ . Such a survey was undertaken biennially and adhered to the rules below.

The survey principles required by the methodology are the following:

- The sampling size is determined by a minimum 90 percent confidence interval and 10 per cent margin of error
- Sampling was statistically robust and representative of the target population
- The method to select respondents were be random
- The survey was conducted as series of site visits to households with biogas digester installed in 2015 or 2016

Biogas systems were uniquely identified through a serial number, GPS coordinates, or end-user information in the installation records. Once the monitored parameters are determined, the emission reductions can be calculated, summarized in the monitoring report, and submitted for verification.

## SECTION E. Data and parameters

### E.1. Data and parameters fixed ex ante

<b>Data / Parameter:</b>	$B_{y, hh}$
Data unit:	Tonnes/household/year
Description:	Mass of fuelwood consumed per household per year in the baseline
Source of data:	Study for Biomass Energy Strategy in Ethiopia in cooperation with the Ethiopian Ministry of Water and Energy
Value(s) applied:	6.15

Choice of data or Measurement methods and procedures:	<p>The total fuelwood consumption by rural households in Ethiopia is estimated to be 89,115,753 tonnes per year and urban households are estimated to use 11,167,516 tonne per year.<sup>14</sup></p> <p>The total population of Ethiopia is 79.8 million with 84 per cent of the population living in rural areas.<sup>15</sup></p> <p>The average household size in Ethiopia was found to be 5.0 in 2005.<sup>16</sup></p> <p>The average fuelwood consumed per household in the baseline is derived as follows:</p> <p>Average Rural Household Consumption = <math>89,115,753 \text{ tonnes/year} / (79,800,000 \text{ people} * 0.84 \text{ rural population}) / 5 \text{ people per household}</math></p> <p>Average Rural Household Consumption = 6.49 tonnes/rural household/year</p> <p>Average Urban Household Consumption = <math>11,167,516 \text{ tonnes/year} / (79,800,000 \text{ people} * 0.16 \text{ urban population}) / 5 \text{ people per household}</math></p> <p>Average Urban Household Consumption = 4.37 tonnes/urban household/year</p> <p>Average Household Consumption = <math>(6.49 * 0.84 + 4.37 * 0.16) \text{ tonnes/household/year}</math></p> <p>Average Household Consumption = 6.15 tonnes/household/year</p>
Purpose of data	Calculation of baseline emissions
Additional comment:	

<b>Data / Parameter:</b>	$EF_{\text{projected\_fossilfuel}}$
Data unit:	tCO <sub>2</sub> /TJ
Description:	Emission factor for the substitution of non-renewable woody biomass by similar consumers
Source of data:	AMS-I.E. v 6.0
Value(s) applied:	81.6
Choice of data or Measurement methods and procedures:	Methodology default value
Purpose of data	Calculation of baseline emissions
Additional comment:	

<b>Data / Parameter:</b>	$\eta_{\text{old}}$
Data unit:	-
Description:	Efficiency of the system being replaced (conventional stove)
Source of data:	AMS-I.E. v 6.0
Value(s) applied:	0.1

<sup>14</sup> European Union Energy Initiative. *Biomass Energy Strategy Ethiopia*. Table 7 and 8. 23<sup>rd</sup> December 2013.

<sup>15</sup> European Union Energy Initiative. *Biomass Energy Strategy Ethiopia*. Page 7. 23<sup>rd</sup> December 2013.

<sup>16</sup> USAID. *Trends in Demographic and Reproductive Health in Ethiopia*. Figure 2.3. Accessed at <http://dhsprogram.com/pubs/pdf/TR4/TR4.pdf>

Choice of data or Measurement methods and procedures:	Methodology default value
Purpose of data	Calculation of baseline emissions
Additional comment:	

<b>Data / Parameter:</b>	$LE_y$
Data unit:	-
Description:	Leakage related to the non-renewable woody biomass saved by the project activity
Source of data:	AMS-I.E. v 6.0
Value(s) applied:	0.95
Choice of data or Measurement methods and procedures:	Methodology default value as per paragraphs 19 and 27 of the methodology AMS-I.E v 6.0. Using the default value is applicable as per paragraph 19 as an alternative to estimating leakage through surveys. Paragraph 27 states that the same approach applies to CPAs under a PoA.
Purpose of data	Calculation of leakage
Additional comment:	

<b>Data / Parameter:</b>	$f_{NRB}$
Data unit:	-
Description:	Fraction of non-renewable biomass in year y
Source of data:	CDM Executive Board
Value(s) applied:	0.88
Choice of data or Measurement methods and procedures:	Value endorsed by the DNA of Ethiopia and approved by the Board is available at <a href="http://cdm.unfccc.int/DNA/fNRB/index.html">http://cdm.unfccc.int/DNA/fNRB/index.html</a>
Purpose of data	Calculation of leakage
Additional comment:	

<b>Data / Parameter:</b>	$NCV_{biomass}$
Data unit:	TJ/Ton
Description:	Net calorific value of the non-renewable woody biomass that is substituted
Source of data:	AMS-I.E. v 6.0
Value(s) applied:	0.015
Choice of data or Measurement methods and procedures:	Methodology default value
Purpose of data	Calculation of baseline emissions
Additional comment:	

**E.2. Data and parameters monitored**

<b>Data/Parameter</b>	$N_y$
Unit	Unit-Years
Description	Full-time equivalent digesters in the monitoring period
Measured/calculated/default	Calculated
Source of data	Installation records
Value(s) of monitored parameter	5,479.32
Monitoring equipment	N/A
Measuring/reading/recording frequency	Continuously
Calculation method (if applicable)	Summation of the full-time equivalent of all digesters in the monitoring period, multiplied by the fraction of digesters deemed operational during the monitoring period, i.e parameter $UF_d$
QA/QC procedures	The serial number of GPS may be cross-checked with the installation records
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	

<b>Data/Parameter</b>	$UF_d$
Unit	Fraction
Description	Fraction of digesters found to be operational during the monitoring period
Measured/calculated/default	Measured
Source of data	BUS Survey
Value(s) of monitored parameter	0.77
Monitoring equipment	Surveys, in-person inspection
Measuring/reading/recording frequency	Annually or biennially
Calculation method (if applicable)	Calculated as the fraction of digesters in operation through sampling
QA/QC procedures	The survey will conform to 90/10 confidence / precision requirements for annual inspection and 95/10 confidence / precision requirements for biennial inspection  Only digesters with a unique identifier can be counted as operating and in service, taking into account the additional comments
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Digesters that had been replaced as part of a regular maintenance or warranty program can be counted as operating at the time of the survey

**E.3. Implementation of sampling plan**

The parameter  $UF_d$  was determined through sampling. The BUS survey details the calculation method and sampling method to determine the parameter. As per the requirements of the methodology, a survey on operability of the biogas digesters is to be undertaken at least once every two years. The monitoring period covers spans the 2-year period from 01/04/2016 through 31/03/2018. The survey began in January 2018 and completed in March 2018. The survey has conformed to 95/10 confidence/precision requirements. The minimum sample size for 95/10

confidence/precision for a population size of 4,812 is 95.<sup>17</sup> The BUS report sampled a total of 200 digesters. This exceeds the minimum required sample size.

The survey was undertaken by a 3<sup>rd</sup> party to ensure no bias in the undertaking of the survey. The company appointed was Connect Deveopment and Training Consultants PLC (CDTC). CDTC randomly selected the sample to be surveyed from the list of digesters provided by the regional offices to the NBP, which are summarized in the excel worksheet.<sup>18</sup> The sample was randomly selected to meet the minimum sample size and be representative of the volumes of digesters installed in each region.

Inspection of the digesters for the BUS was conducted in person by trained representatives of the CDTC to verify the existence and operationality of the selected digesters. The sample selection procedure and survey methodology has been summarized in the BUS report under the Approach and Methodology section.<sup>19</sup>

The 200 respondents to the survey were disirbuted among the regions and 2015/2016 vintages as shown in the table below.

**Table 2. Distribution of Sampled Digesters for BUS**

Region	Survey Years		Total Beneficiaries	Sample Per Region
	2015	2016		
<b>Oromia</b>	364	736	<b>1100</b>	<b>45</b>
<b>Amhara</b>	601	723	<b>1324</b>	<b>54</b>
<b>SNNPR</b>	513	603	<b>1116</b>	<b>48</b>
<b>Tigray</b>	782	490	<b>1272</b>	<b>53</b>
<b>Total</b>	<b>2260</b>	<b>2552</b>	<b>4812</b>	<b>200</b>

The random sample was drawn from the full set of 4,812, covering digesters with and without unique identifiers. Digesters without unique identifiers were included in the random sample, as the sampling was to determine the operational fraction of the digesters, regardless of availability of unique identifiers. Digesters without unique identifiers however, were not included in the calculation of emission reduction during the monitoring period.

A software application called Random UX<sup>20</sup> was used to randomly select the digesters from the database provided. The households selected were visited by the team and a household survey was administered. The survey was extensive, covering aspects of the digester performance, end-user details, and confirmation that the end-user is willing to participate in the survey. A copy of the end-user survey has been provided.<sup>21</sup>

Parameter  $UF_d$  was assessed by evaluating if the digesters visited were generating biogas at the time of inspection. Digesters producing gas were deemed operational and the fraction of operationality was determined on this basis.

<sup>17</sup><https://www.calculator.net/sample-size-calculator.html?type=1&cl=95&ci=10&pp=50&ps=4812&x=52&y=17>

<sup>18</sup> ER Calculations (post-BUS) V3.xlsx

<sup>19</sup> 2018 BUS Report.pdf

<sup>20</sup> <https://random-ux.en.aptoide.com/>

<sup>21</sup> BUS Household Survey.pdf



## SECTION F. Calculation of emission reductions or net anthropogenic removals

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

The number of full-time equivalent digesters in the monitoring period is 7,116 unit-years. The operational fraction from the BUS Report is 0.77 for digesters of vintages 2015 and 2016.<sup>22</sup>

As such, parameter  $N_y$  is determined as follows:

$$N_y = 7,116 \text{ unit-years} * 0.77 = 5,479.32 \text{ unit-years}$$

The amount of woody biomass is calculated as:

$$\begin{aligned} B_y &= B_{y,hh} * N_y * LE_y \\ &= 6.15 \text{ tonnes/household/year} * 5,479.32 \text{ unit-years} * 0.95 \\ &= 32,011 \text{ tonnes} \end{aligned}$$

And emission reductions are calculated as follows:

$$\begin{aligned} ER_y &= B_y * f_{NRB,y} * NCV_{\text{biomass}} * EF_{\text{projected\_fossilfuel}} - PE_{BC,y} \\ &= (32,011 \text{ tonnes/year}) * 88\% * 0.015 \text{ TJ/tonne} * 81.6 \text{ tCO}_2/\text{TJ} - 0 \text{ tCO}_2 \\ &= 34,480 \text{ tCO}_2 \end{aligned}$$

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

Project emissions are considered zero as per paragraph 13 of AMS-I.E Version 6, no biomass is sourced from plantations.

### F.3. Calculation of leakage emissions

Leakage has been considered by using a net gross adjustment factor of 0.95 as per the methodology. The parameter  $B_y$  was multiplied by 0.95 in section F.1, above.

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

CPA UNFCCC reference number	Baseline GHG emissions or baseline net GHG removals (t CO <sub>2</sub> e)	Project GHG emissions or actual net GHG removals (t CO <sub>2</sub> e)	Leakage GHG emissions (t CO <sub>2</sub> e)	GHG emission reductions or net anthropogenic GHG removals (t CO <sub>2</sub> e)		
				Before 01/01/2013	From 01/01/2013	Total amount
10268-0001	34,480	0	0	0	34,480	34,480
<b>Total</b>	34,480	0	0	0	34,480	34,480

<sup>22</sup> 2018 BUS Report.pdf

**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 <sub>2</sub> e)	Amount estimated ex ante (t CO <sub>2</sub> e)
10268-0001	34,480	43,915
<b>Total</b>	<b>34,480</b>	<b>43,915</b>

**F.6. Remarks on increase in achieved emission reductions**

The emission reductions achieved by the CPA during the monitoring period are 43,915 tCO<sub>2</sub>e. The estimated ex ante emissions were estimated as follows:

01/04/2016 – 31/12/2016 : 12,450 tCO<sub>2</sub>e

01/01/2017 – 31/12/2017 : 25,172 tCO<sub>2</sub>e

01/01/2018 – 31/03/2018 : 25,172 tCO<sub>2</sub>e \* 3 / 12 = 6,293 tCO<sub>2</sub>e

12,450 tCO<sub>2</sub>e + 25,172 tCO<sub>2</sub>e + 6,293 tCO<sub>2</sub>e = 43,915 tCO<sub>2</sub>e

The total ex ante estimated emission reductions for the monitoring period are 43,915 tCO<sub>2</sub>e.

The achieved emissions are about 21 per cent less than estimated ex ante. This is due to a lower than expected functionality of the digesters during the operational of the CPA for the monitoring period in question. The expected functionality ex ante was 1.00 and surveys confirmed the proportion of functional digesters to be 0.77.

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**Document information**

<i>Version</i>	<i>Date</i>	<i>Description</i>
02.0	7 June 2017	Revision to: <ul style="list-style-type: none"><li>• Ensure consistency with version 01.0 of the “CDM project standard for programmes of activities (CDM-EB93-A07-STAN);</li><li>• Make editorial improvements.</li></ul>
01.0	1 April 2015	Initial publication.
Decision Class: Regulatory Document Type: Form Business Function: Issuance Keywords: monitoring report, programme of activities		