Methodology for Installation of High Efficiency Firewood Cookstoves

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1 SOURCES

This methodology revision applies to CDM small-scale methodology AMS-II. G, "Energy efficiency measures in thermal applications of non-renewable biomass[1]". Project proponents must apply this methodology revision in conjunction with the latest version of AMS II.G.

This methodology uses as sources:

- Energy efficiency measures in thermal applications of non-renewable biomass; version 10.0
- The latest version of the CDM General guidelines for SSC CDM methodologies.
- The latest version of the CDM Standard for sampling and surveys for CDM project activities and programme of activities
- Water Boiling Test Protocol 4.2.3
- Gold Standard "Technologies and Practices to Displace Decentralized Thermal Energy Consumption" (Version 03.1)
- The GHG Protocol for Project Accounting

2 SUMMARY DESCRIPTION OF THE METHODOLOGY

Additionality and Crediting Method	
Additionality	Activity Method
Crediting Baseline	Project Method

CDM small-scale methodology AMS-II.G. is applicable to project activities that introduce new efficient thermal energy generation units, e.g. efficient biomass fired cookstoves or ovens or dryers or retrofit existing units to reduce the use of nonrenewable biomass for combustion. This methodology revision adds the following conditions to cookstove projects in addition to applicability criteria outlined in the methodology:

1. The project stove is a single pot or multi pot[2] portable or an in-situ cookstove using only woody biomass; and
2. Project stoves to be implemented shall have specified high-power thermal efficiency of at least 25%; and

3. The baseline stove is a three stone fire, or conventional device without a grate or a chimney i.e. with no improved combustion air supply or flue gas ventilation[3]

[1] https://cdm.unfccc.int/methodologies/DB/HLXIKEIBAXBE4EHO24H5IAB824MBD8

[2] Multiple pot cookstove may include stoves with single combustion chamber or two combustion chambers with arrangement to use two or more pots simultaneously

[3] Examples include open fires with pots resting on tripods, basic mud and clay pot support structures over open fires and the equivalent.

This revision also provides alternative methods for monitoring parameters and quantifying emission reductions. Specifically, this revision allows for the use of default factors for the estimation of certain parameters as an alternative to direct measurement

3 DEFINITIONS

In addition to the definitions provided in CDM methodology AMS-II.G, and the definitions set out in VCS document Program Definitions, the following definitions apply to this methodology revision

Improved Cookstove (ICS)[4]
Solid-fuel stoves that improve on traditional baseline biomass technologies in terms of fuel savings via improved fuel efficiency and lower emissions through improved combustion efficiency. Examples include, but at not limited to, basic chimney ICS, intermediate ICS, portable ICS etc.

Basic Chimney ICS
Solid-fuel cookstoves whose chimneys feature minimal to moderate improvements in thermal efficiency.

Basic Portable ICS
Portable biomass cookstoves that are unvented and feature moderate improvements in thermal efficiency. This category includes minimally improved ceramic and clay cookstoves simple efficient wood cookstoves and metal insulator-lined cookstove technologies.

Intermediate ICS
A wide range of solid fuel cookstoves with significant improvements in fuel efficiency (>25%). Intermediate cookstoves utilize rocket stove principles (i.e., an L-shaped combustion chamber design) for wood/crop or waste/ dung fuel cooking or have other design features that promote thermal efficiency as in the case of intermediate coal and charcoal ICS. Stoves in this category can be portable, semi-portable or built in and may be either unvented or combined with chimneys, depending on the design.

Advanced Cookstoves (ACS)
Fan draft or natural draft biomass gasification cookstoves. Stoves in this category include natural draft models, fan draft rocket style stoves, and top loading fan gasifiers.

Project Technology
Design and performance characteristics of the improved cookstove. Project technologies can be considered similar if they are based on the same fundamental combustion technology and their respective thermal efficiencies or specific consumptions do not differ by more than +/-5% in absolute terms. Comparable project technologies can share same monitoring procedures. Project technologies with significantly different performance characteristics such combustion technology or fuel consumption characteristics must be treated as independent project scenarios and hence monitored separately.

[4] Definitions adopted from 'The State of The Global Clean And The Improved Cooking Sector' – Technical report 007/15

Rudimentary Cookstove
Traditional solid-fuel cooking solutions such as open fire, three-stone fires, unvented mud/clay "U" shaped stoves, basic charcoal or coal cookstoves.

Rural Area
Area or region that consists of population who predominantly use traditional cookstoves.

Vintage
Operational cookstoves corresponding with one calendar year. Example: cookstoves that have been in operation for less than or equal to 365 days belong to Vintage 1. Cookstoves that have been operational for more than 365 days but less than or equal to 730 days belong to vintage 2.

4 APPLICABILITY CONDITIONS

Project Activities must comply with all applicability criteria set out in section 2.2 of the latest version of AMS II.G. Additionally, the following conditions shall apply:

1. Project activities shall be implemented in domestic premises or in community-based kitchens;
2. The project stove shall have specified high-power thermal efficiency of at least 25% and shall exclusively use woody biomass;
3. The baseline stove shall be a three stone fire, or conventional device without a grate or a chimney i.e. with no improved combustion air supply or flue gas ventilation.

5 PROJECT BOUNDARY

The project boundary must be determined following the procedure provided in CDM methodology AMS-II.G.

The greenhouse gases included in or excluded from the project boundary are shown in Table 1 below.

Table 1: GHG Sources Included In or Excluded From the Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Emission from use of non-renewable biomass	CO_2	yes	Major source
		CH_4	yes	Major source
		N_2O	yes	Major source
	Production &	CO_2	yes	Can be a major source
		CH_4	yes	Can be a major source

Source		Gas	Included?	Justification/Explanation
	Transport of Fuel	N_2O	yes	Can be a major source
Project	Emission from use of non-renewable biomass	CO_2	yes	Major source
		CH_4	yes	Major source
		N_2O	yes	Major source
	Production & Transport of Fuel	CO_2	yes	Can be a major source
		CH_4	yes	Can be a major source
		N_2O	yes	Can be a major source

6 BASELINE SCENARIO

The baseline scenario is continued use of non-renewable wood fuel (firewood/charcoal) in the target population to meet similar thermal energy needs as provided by project cookstoves in absence of project activity.

7 ADDITIONALITY

This methodology uses activity method for the demonstration of additionality.

Activity Method

Step 1: Regulatory Surplus

Project proponents must demonstrate regulatory surplus in accordance with the rules and requirements regarding regulatory surplus set out in the latest version of the VCS Standard and ensure that the project is not mandated by any law, statute or other regulatory framework, or for UNFCCC non-Annex I countries, any systematically enforced law, statute or other regulatory framework.

Step 2: Positive List

The applicability conditions of this methodology represent the positive list. The project must demonstrate that it meets all of the applicability conditions, and in so doing, it is deemed as complying with the positive list.

The positive list was established using the revenue stream option.

Where the project activity installs or distributes stoves at zero cost to the end-user and has no other source of revenue other than the sale of GHG credits, the project activity shall be deemed additional.

For any project activity where stoves are not provided at zero cost to the end-user or has any other source of revenues other than the sale of GHG credits, then the project activity shall apply investment analysis method set out in the CDM Tool for the demonstration and assessment of additionality to determine that the proposed project activity is either: 1) not the most economically or financially attractive, or 2) not economically or financially feasible.

Project activities that are implemented as part of government schemes or are supported by multilateral funds cannot be considered additional even if the stoves are distributed free of cost or at a highly subsidized rate and hence are not eligible to use this methodology.

8 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

8.1 Baseline Emissions

AMS-II.G does not account for baseline emissions separately, but instead quantifies emission reductions as a function of the reduction in the amount of non- renewable biomass fuel consumption in the efficient project stoves as compared to baseline stoves. This revision follows the same convention.

8.2 Project Emissions

AMS-II.G does not account for project emissions separately, but instead quantifies emission reductions as a function of the reduction in the amount of non- renewable biomass fuel consumption in the efficient project stoves as compared to baseline stoves. This revision follows the same convention.

8.3 Leakage

Leakage shall be determined in accordance with section 5.4 of methodology AMS II.*G.*

8.4 Net GHG Emission Reduction and Removals

Net GHG emission reductions are calculated by applying Equations 1 and 2:

$$ER_y = \sum_i \sum_j ER_{y,i,j}$$ Equation (1)

Where:

i = Indices for the situation where more than one type/model of improved cook stove is introduced to replace three-stone fire

j	=	Indices for the situation where there is more than one batch of improved cook stove of type *i*
ER_y	=	Emission reductions during year *y* in t CO_2e
$ER_{y,i,j}$	=	Emission reductions by improved cook stove of type *i* and batch *j* during year *y* in t CO_2e

$$ER_{y,i,j} = B_{y,savings,i,j} \times f_{NRB,y} \times NCV_{wood\ fuel} \times \left(EF_{wood\ fuel,CO2} + EF_{wood\ fuel,non\ CO2}\right) \times N_{y,i,j} \times 0.95$$ Equation (2)

Where:

$B_{y,savings,i,j}$	=	Quantity of woody biomass that is saved in tonnes per improved cook stove of type *i* and batch *j* during year *y*
$f_{NRB,y}$	=	Fraction of woody biomass that can be established as non-renewable biomass (fNRB)[5]
$NCV_{wood\ fuel}$	=	Net calorific value of the non-renewable woody biomass that is substituted or reduced (IPCC default for wood fuel, 0.0156 TJ/tonne)
$EF_{wood\ fuel,CO2}$	=	CO_2 emission factor for the use of wood fuel in baseline scenario (IPCC default for wood fuel, 112 tCO_2/TJ)
$EF_{wood\ fuel,non\ CO2}$	=	Non-CO_2 emission factor for the use of wood fuel in baseline scenario (IPCC default for wood fuel, 26.23 tCO_2/TJ)
$N_{y,i,j}$	=	Number of improved cook stoves of type *i* and batch *j* operating during year *y*
0.95	=	Discount factor to account for leakage

The quantify of woody biomass saved due to implementation of improved cook stoves can be estimated by one of the following options[6] set out in Equations 3 and 4:

$$B_{y,savings,i,j} = B_{old} \times \left(1 - \frac{0.1}{\eta_{new,i,j}}\right)$$ Equation (3)

$$B_{y,savings,i,j} = B_{y=1,new,i,j,survey} \times \left(\frac{\eta_{new,i,j}}{0.1} - 1\right)$$ Equation (4)

[5] Default values endorsed by designated national authorities and approved by the Board are available at <http://cdm.unfccc.int/methodologies/standard_base/index.html>.

[6] The option to determine the $B_{y,savings,i,j}$ shall be decided prior to registration of the project.

Where:

B_{old}	=	Annual quantity of woody biomass that would have been used in the absence of the project activity (in tonnes per device) to generate useful thermal energy equivalent to that provided by the improved cook stove. The value of B_{old} can be sourced from historical data or baseline surveys. Alternatively, a default value of 0.5t/capita/year may be used.
0.1	=	Efficiency of baseline cookstove
$\eta_{new,i,j}$	=	Efficiency of the improved cook stove type *i* and batch *j* determined through water boiling test (WBT). Alternatively, efficiency may be determined as $\eta_{new,i,j} = \eta_p \times (DF_n)^{y-1} \times 0.94$

Where

η_p	=	Efficiency of project stove (fraction) at the start of project activity.
$(DF_n)^{y-1}$	=	Discount factor to account for efficiency loss of project cookstove per year of operation (fraction). Alternatively default value of 0.99 efficiency loss per year can be considered.
0.94	=	Adjustment factor to account for uncertainty related to project cookstove efficiency test.

$B_{y=1,new,i,j,survey}$	=	Annual quantity of woody biomass used by improved cook stoves in tonnes per device of type *i* and batch *j*, determined in the first year of the implementation of the project through a sample survey.

Where the project households continue to use baseline cookstoves along with improved cookstoves, B_{old} shall be adjusted ex post based on the percentage of project households found to continue such practice according to Equation 5. For such cases, the quantify of woody biomass saved due to implementation of improved cook stoves shall be calculated using and adjusted value to account for ex post use of baseline stoves in addition to improved cookstove.

$$B_{old,adjusted} = B_{old} \times (1 - \mu_y) \qquad \text{Equation (5)}$$

Where:

$B_{old,adjusted}$	=	Adjusted B_{old} to account the ex post usage of firewood in baseline cookstove(s) by project households in addition to improved cookstove (in tonnes per device)
μ_y	=	Baseline stove usage factor to account for use of baseline cookstoves along with improved cookstoves.

The quantity of firewood consumed in absence of project activity (B_{old}) shall be determined using an Estimation of average annual consumption of firewood per household may be derived using any of the following options:

a. **Historical Data.** Project proponent shall ensure that the relevance of data is appropriately justified for the target population and is the latest available data from credible source(s).

b. **Baseline Survey of Local Usage.** Project proponent shall carry out a survey of usage prior to implementation of the project activity following the sampling approach described in the latest version of "sampling and surveys for CDM project activities and programme of activities". Alternatively, the project participant may follow the simple random sampling approach and the minimum sample size should be determined as per guidelines below:
   - Project target population < 300: Minimum sample size 30
   - Project target population 300 – 1000: Minimum sample size 10% of group size
   - Project target population > 1000: Minimum sample size 100

c. **Minimum Service Level.** Where historical data or a baseline survey has not been conducted, a default value of 0.5 ton/capita/year[7] may be considered as the baseline biomass consumption. Household size shall be determined using credible references/literature or target population specific surveys. The survey shall be conducted as per guidelines outlined in option (b) above.

Leakage related to the non-renewable firewood saved by the project activity shall be assessed based on ex-post surveys of users and the areas from which this firewood is sourced (using 90/30 precision for a selection of samples). The potential source of leakage due to the use/diversion of non-renewable firewood saved under the project activity by non-project households/users that previously used renewable energy sources shall be considered. If this leakage assessment quantifies an increase in the use of non-renewable firewood by the non-project households/users, that is attributable to the project activity, then $Bold,i,j$ is adjusted to account for the quantified leakage. Alternatively, $ER_{y,i,j}$ may be multiplied by a net to gross adjustment factor of 0.95 to account for leakages, in which case surveys are not required.

9 MONITORING

9.1 Data and Parameters Available at Validation

Data / Parameter:	B_{old}
Data unit	Tons/year
Description	Annual quantity of woody biomass that would have been used in the household in the absence of the project activity to generate useful thermal energy equivalent to that provided by the project devices.
Equations	3
Source of data	calculated according to options stated in 'Determination of quantity of firewood consumed in absence of project activity' above
Value applied	N/A
Justification of choice of data or description of measurement methods	This parameter shall be determined ex-ante

[7] Annex 5 of 42nd meeting of Small- Scale working group (SSC WG) on use of default fuel wood consumption figure to be used in AMS I.E and AMS II.G. https://cdm.unfccc.int/Panels/ssc_wg

and procedures applied	
Purpose of Data	Calculation of emission reduction
Comments	N/A

9.2 Data and Parameters Monitored

Data / Parameter:	Ny,i,j
Data unit:	number
Description:	Number of project devices of type *i* and batch *j* operating during year *y*
Equations	2
Source of data:	monitoring
Description of measurement methods and procedures to be applied:	Measured directly or based on a representative sample. Sampling standard shall be used for determining the sample size to achieve 90/10 confidence precision. Alternately, minimum sample size can be determined according to paragraph 3.b under Section 8.4 above. A discount shall be applied based on the percentage of devices operational as determined by the sample survey, e.g. if survey shows that 10% of the devices is non-operating, an adjustment factor of 0.9 shall be applied to number of project devices commissioned in a particular batch. Separate samples shall be taken for each batch.
Frequency of monitoring/recording:	At least once every two years
QA/QC procedures to be applied:	
Purpose of data:	Calculation of emission reduction
Calculation method:	number
Comments:	

Data / Parameter	$\eta_{new,i,j}$
Data unit	number
Description	Efficiency of the device of each type *i and* batch *j* implemented as part of the project activity
Equations	3 & 4
Source of data	
Description of measurement methods and procedures to be applied	Since each individual equipment produced does not vary beyond the range of acceptance limits (e.g. characteristics such as design, materials, critical dimensions), hence efficiency shall be measured as per following i. Conduct WBT test on a sample of three improved cookstoves with three tests conducted for each stove. The

	test can be carried out by project proponents by themselves or stove manufacturers or other third parties. ii. Efficiency to be tested is high-power thermal efficiency. The high-power thermal efficiency is the average of the Cold Start and Hot Start phases. iii. The average of all results for each device type and batch shall be taken as the efficiency for each device type and batch. iv. If the standard deviation of the test results indicated above is very small and 90/10 precision requirement is met (in this case, the value of the t-distribution for 90 per cent confidence shall be used instead of Z value), the efficiency determined is acceptable, otherwise more sample tests would be required until 90/10 precision is met. v. Efficiency of the improved cookstoves can also be estimated ex-ante using equation 5 above where loss in efficiency per year is calculated, and therefore this parameter does not need to be monitored.
Frequency of monitoring/recording	annually
QA/QC procedures to be applied	
Purpose of data	Calculation of emission reduction
Comments	

Data / Parameter	$B_{y=1,new,i,j,survey}$
Data unit	tons
Description	Quantity of woody biomass used by project devices in tonnes per device of type *i*.
Equations	4
Source of data	survey
Description of measurement methods and procedures to be applied	Minimum sample size of each type *i* and batch j should be in line with the guidelines provide in section 8.4 option 3 b. Determined in the first year of the introduction of the devices (e.g. during the first year of the crediting period, y=1) through measurement campaigns at representative households and/or sample survey. Sample surveys to estimate this parameter, that are solely based on questionnaires or interviews (i.e. that do not implement measurement campaigns) may only be used if the following conditions are satisfied. (i) Baseline cookstoves have been completely decommissioned and only improved cookstoves are exclusively used in the project households; (ii) If multiple devices are used in the project, it is possible from the results of the survey questions to clearly differentiate the quantity of firewood being used by each device. In other words, if more than one device, or another device that consumes firewood, are in use in project households, then the sample survey needs to

	distinguish the quantity of firewood used by the project device and the other devices that use firewood.
Frequency of monitoring/recording	First year of installation
QA/QC procedures to be applied	
Purpose of data	Calculation of emission reduction
Comments	

Data / Parameter	μy
Data unit	Fraction
Description	Adjustment to account for any continued use of pre-project devices during the year *y*
Equations	
Source of data	monitoring
Description of measurement methods and procedures to be applied	Minimum sample size of each type *i* and batch j should be in line with the guidelines provide in section 8.4 option 3 b above. This parameter should be monitored using one of the following methods: If the baseline cookstoves are decommissioned and no longer used, as determined by the monitoring survey its value is 0 and $B_{old,\ adjusted}$ is equal to B_{old}. If both the improved cookstove and baseline cookstoves are used together then surveys shall be conducted to record the average continued operation of baseline cookstoves in a sample of households. The surveys should be designed to capture the cooking habits and stove usage of households in the region, including quantification of use of baseline cookstoves, by formulating questions and/or collecting evidences to determine the frequency of usage of both the improved cookstoves and baseline cookstoves. For example, if there were 3 baseline cookstoves in a household and it was determined during the survey that use of one of them continues during the crediting period then a conservative adjustment factor of 0.33 is applied to B_{old}. Another example would be the case where there was only one baseline cookstove per household and its use during the project period continues along with the improved cookstove to meet 25% of the cooking needs of the household in which case the adjustment factor will be 0.25. Another example would be to interview the household and have them estimate the time of usage of the baseline cookstoves and improved cookstove on an average day.
Frequency of monitoring/recording	At least once every two years

QA/QC procedures to be applied	
Purpose of data	Calculation of emission reduction
Comments	For Projects that opt for $B_{y=1,new,i,j,survey}$ i.e, direct measurement of biomass used in project stoves, then μy is not required to be computed.

9.3 Description of the Monitoring Plan

The project proponent shall maintain a record for the date of commissioning of project devices of each type i and batch j. Relevant parameters shall be monitored and recorded during the crediting period as indicated in section 9 above. The applicable requirements specified in the "General guidelines for SSC CDM methodologies" shall be followed by the project participants.

9.3.1 Data Recording & Compilation

The project proponent must compile data on each cook stove that is derived from the total sales record with project technologies differentiated by different project scenarios. This data must be differentiated into sections based on the results of the applicable monitoring studies for each project scenario, so that emission reduction calculations can be conducted appropriately section by section. Technologies aged beyond their useful lifetime, as established in the usage survey, are removed from the project and no longer credited.

The following is the minimum information that must be captured for each project device in order to be eligible for inclusion in the project:

1. Date of sale
2. Geographic area of sale
3. Model/type of project technology sold/distributed
4. Quantity of project technologies sold/distributed
5. Name and telephone number (if available), and address of recipient
6. unique identification alpha/numeric ID for each device that is sold/distributed

9.3.2 Monitoring Survey

In any given year, emission reductions can only be claimed for devices that are demonstrated to be in place and operational. An annual survey must be conducted for sites included in the project to determine the number of cookstoves that remain in operation.

The survey must obtain, at minimum, the following:

1. The cookstoves distributed under the project are being used on a continuous basis.

2. The project stoves are operational and in good condition

3. Baseline stoves, if any are being used along with project stoves.

A statistically valid sample of the locations where cookstoves have been installed must be used to determine the percentage of devices in continuous operation. The selection of cookstoves to be surveyed must be determined and recorded prior to surveying. Each of the selected cookstove must be surveyed and a record must be kept of the number of stoves that are still in operation and those that are no longer in operation.

10 REFERENCES

None.

APPENDIX 1: ACTIVITY METHOD

Over the years, studies have established that exposure to indoor air pollution (IAP) from the inefficient combustion of solid fuels in low-quality stoves is a significant public health hazard (Smith and others 2009; Venkataraman and others 2010), yet much is left to be done in order to tackle this global scourge that so shortens and diminishes the quality of life for women and in most cases even children. Despite the recognized benefits of clean cookstoves for health, local environment and climate change, their large-scale adoption and sustained use are not yet occurring.

Among the reasons is, affordability, ease of use, poor access to technology in rural & peri-urban areas and cultural resistance. Cookstove technologies have rarely met the multiple demands placed on them to be at once energy-efficient, safe, durable, fit for use according to myriad traditional cooking practices and low-priced. Without the right technology, and faced with limited markets for such stoves, financing for them has proven scarce. Amidst these barriers, efficient cookstove projects do not find many takers. In addition to these there are other factors. Most often, as the target population cannot afford these stoves, project promoters have to heavily subsidize it or give it off free of cost. Another aspect is design of the stove which has to match with the requirements of population in question, hence the promoter also has to invest in customization of the stove according to project region which increases the financial burden on the project promoter. While the expenses are numerous, revenue from such projects are limited and uncertain. Despite being energy efficiency project, the savings in terms of reduced fuel use is passed on to the stove user and not the promoter. Thus, a project promoter seeking to invest in acquiring the stoves, funding its customization, distribution and installation has no substantial revenue source other than revenue from sale of carbon credits.

The following project examples from Sub-Saharan Africa (SSA) and South-East Asia demonstrate that without the sale of GHG credits, providing stoves at zero cost to end-users is financially unattractive as there are no sources of revenue. The project examples include fixed stoves in Zambia and Malawi that cost $30 per stove and portable stoves in Lao PDR and Cambodia that cost $29.50 per stove. The price per stove includes the cost of the stove technology itself as well as the cost to install/distribute the stove to the end-user. No carbon related costs have been included in the financial analysis. Without any revenues the project activity's gross annual revenue (including cost savings) excluding from the sale of GHG credits does not exceed five percent of capital expenditure throughout the crediting period, and thus these project activities are deemed additional.