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Energy efficiency measures in thermal applications of non-renewable biomass

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Methodology based on CDM-approved methodology AMS-II.G, Version 05.0

A nonprofit enterprise of

WINROCK INTERNATIONAL

AMS-II.G

Small-scale Methodology

Energy efficiency measures in thermal applications of non-renewable biomass

Version 05.0

Sectoral scope(s): 03

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1. Introduction

1. **Modification for American Carbon Registry**. This methodology is based on Clean Development Mechanism (CDM) small-scale methodology AMS-II.G, Version 05.0. The American Carbon Registry (ACR) accepts CDM-approved methodologies but provides a process by which project proponents may propose modifications to an existing CDM-approved methodology and have these approved by ACR, either through ACR's regular public consultation and scientific peer review process, or by an independent ACR technical committee in cases where the proposed modifications are minor enough not to require the full public consultation and scientific peer review process.

   This methodology modification was reviewed and approved by the ACR Agriculture, Forestry and Other Land-Use (AFOLU) Technical Committee. Revisions to AMS-II.G, Version 05.0 approved under this modification are shown in red text.

2. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical project(s)	Introduction of high-efficient thermal energy generation units utilizing non-renewable biomass or retrofitting of existing units (e.g. complete replacement of existing biomass fired cook stoves or ovens or dryers with more-efficient appliances) reduces use of non-renewable biomass for combustion
Type of GHG emissions mitigation action	(a) Energy efficiency. Displacement or energy efficiency enhancement of existing heat generation units results in saving of non-renewable biomass and reduction of GHG emissions

2. Scope, applicability, and entry into force

2.1. Scope

3. This category comprises efficiency improvements in thermal applications of non-renewable biomass. Examples of applicable technologies and measures include the introduction of high efficiency[1] biomass fired cook stoves[2] or ovens or dryers and/or energy efficiency improvements in existing biomass fired cook stoves or ovens or dryers.

4. Project participants shall be able to show that non-renewable biomass has been used in the project region since 31 December 1989, using survey methods or referring to published literature, official reports or statistics.

2.2. Applicability

5. The aggregate energy savings of a single project activity shall not exceed the equivalent of 60 GWh per year or 180 GWh thermal per year in fuel input.

[1] The efficiency of the project systems as certified by a national standards body or an appropriate certifying agent recognized by that body. Alternatively, manufacturers' specifications may be used.

[2] Single pot or multi pot portable or in-situ cook stoves with specified efficiency of at least 20%.

2.3. Entry into force

6. The date of entry into force of the revision is 14 days after the date of the publication of the EB 70 meeting report on the 7 December 2012.

2.4. Normative references

7. Project participants shall apply the "General guidelines for SSC CDM methodologies", "Guidelines on the demonstration of additionality of small-scale project activities" and "General guidance on leakage in biomass project activities" (Attachment C to Appendix B) available at <http://cdm.unfccc.int/Reference/Guidclarif/index.html#meth> mutatis mutandis.

3. Definitions

8. The definitions contained in the "Glossary of CDM terms" shall apply.

9. The definitions of demonstrably renewable woody biomass and non-renewable biomass provided in paragraphs 16 and 17 shall apply.

4. Baseline methodology

4.1. Project boundary

10. The project boundary is the physical, geographical site of the efficient devices that burn biomass.

4.2. Baseline emissions

11. It is assumed that in the absence of the project activity, the baseline scenario is–the continuation of the current situation, i.e. use of non-renewable biomass as fuel for the existing, less-efficient thermal applications. Compared to a project scenario of the installation of more efficient thermal energy generation units utilizing non-renewable biomass and/or complete replacement of existing less efficient thermal applications and/or retrofitting of existing thermal energy generating appliances, this reduces GHG emissions by saving non-renewable biomass.[3]

12. Emission reductions are calculated as:

$$ER_y = B_{y,savings} \times f_{NRB,y} \times NCV_{biomass} \times EF_{biomass} \times N_{y,i} \qquad \text{Equation (1)}$$

Where:

ER_y = Emission reductions during year *y* in t CO_2e

$B_{y,savings}$ = Quantity of woody biomass that is saved in tonnes per device

[3] Taken from *CDM Methodology Booklet*, November 2010, page 140. Copyright 2010 United Nations Framework Convention on Climate Change, available online at https://cdm.unfccc.int/methodologies/.

$f_{NRB,y}$	=	Fraction of woody biomass saved by the project activity in year *y* that can be established as non-renewable biomass using survey methods or government data or default country specific fraction of non-renewable woody biomass (fNRB) values available on the CDM website[4]
$NCV_{biomass}$	=	Net calorific value of the non-renewable woody biomass that is substituted (IPCC default for wood fuel, 0.015 TJ/tonne, wet basis)
$EF_{biomass}$	=	Emission factor for the biomass fuels whose consumption is reduced by the project activity. Use a value of 119.5 t CO_2/TJ for wood and 116.5 tCO_2/TJ for charcoal[5]
$N_{y,i}$	=	Number of project devices of type *i* operating in year *y*, determined as per paragraph 22

13. $B_{y,savings}$ is estimated using one the following methods:

Option 1:

$$B_{y,savings} = B_{old} - B_{y,new,KPT} \quad \text{Equation (2)}$$

Where:

B_{old}	=	Quantity of woody biomass used in the absence of the project activity in tonnes per device
$B_{y,new,KPT}$	=	Annual quantity of woody biomass used in year *y* in tonnes per device, measured as per the Kitchen Performance Test (KPT) protocol. The KPT should be carried out in accordance with national standards (if available) or international standards or guidelines (e.g. the KPT procedures specified by the Partnership for Clean Indoor Air (PCIA) <http://www.pciaonline.org/node/1049)>

Option 2:[6]

$$B_{y,savings} = B_{old} \times (1 - \frac{\eta_{old}}{\eta_{new,y}}) \quad \text{Equation (3)}$$

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

[5] This value represents the emission factor of the fuels likely to be used by similar users. The emission factor is derived from the 2006 IPCC *Guidelines for National Greenhouse Gas Inventories*, 2006, Volume 2, Table 2.5 (page 2.23). It is based on the default emission factors for CO_2, CH_4 and N_2O, calculated as carbon dioxide equivalents using a GWP of 21 for CH_4 and 310 for N_2O.

[6] Based on whether $\eta_{new,y}$ or $B_{y,new,survey}$ is used for monitoring, either the Equation (3) or (4) can be used.

$$B_{y,savings} = B_{y,new,survey} \times (\frac{\eta_{new,y}}{\eta_{old}} - 1) \quad \text{Equation (4)}$$

Where:

B_{old} = Quantity of woody biomass used in the absence of the project activity in tonnes per device

$B_{y,new,survey}$ = Annual quantity of woody biomass used during the project activity in tonnes per device, determined through a survey

η_{old} = 1. Efficiency of the device being replaced (fraction); measured using representative sampling methods or based on referenced literature values use weighted average values if more than one type of device is being replaced;
2. A default value of 0.10 may be optionally used if the replaced device is a three stone fire, or a conventional device with no improved combustion air supply or flue gas ventilation, that is without a grate or a chimney; for other types of devices, a default value of 0.2 may be optionally used

$\eta_{new,y}$ = Efficiency of the device being deployed as part of the project activity (fraction), as determined annually[12] using the water boiling test (WBT) protocol carried out in accordance with national standards (if available) or international standards or guidelines.[7] Use weighted average values if more than one type of system is being introduced by the project activity

Option 3:

$$B_{y,savings} = B_{old} \; x \, (1 - \frac{SC_{new,y}}{SC_{old}}) \quad \text{Equation (5)}$$

Where:

SC_{old} = Specific fuel consumption or fuel consumption rate[8] of the baseline devices i.e. fuel consumption per quantity of item/s processed (e.g. food cooked) or fuel consumption per hour, respectively. Use weighted average values if more than one type of device is being replaced

[7] In all cases the testing protocol shall be the same for both the device being replaced and the device being deployed.

[8] Specific fuel consumption or fuel consumption rate are to be determined using the controlled cooking test (CCT) protocol carried out in accordance with national standards (if available) or international standards or guidelines (e.g. the CCT procedures specified by the Partnership for Clean Indoor Air (PCIA) <http://www.pciaonline.org/node/1050>).

$SC_{new,y}$ = Specific fuel consumption or the fuel consumption rate in year *y* of the devices deployed as part of the project i.e. fuel consumption per quantity of item/s processed (e.g. food cooked) or fuel consumption per hour respectively. Use weighted average values if more than one type of system is being introduced by the project activity

14. B_{old} is determined with one of the following two options:

(a) Calculated as the product of the number of devices multiplied by the estimated average annual consumption of woody biomass per device (tonnes/year). This may be derived from historical data or a survey of local usage;

OR

(b) Calculated from the thermal energy generated in the project activity as:

$$B_{old} = \frac{HG_{p,y}}{NCV_{biomass} * \eta_{old}} \qquad \text{Equation (6)}$$

Where:

$HG_{p,y}$ = Amount of thermal energy generated by the project devices in year *y* (TJ), if the thermal output of the devices can be directly measured

15. Where charcoal is used as the fuel, the quantity of woody biomass (B_{old} or $B_{y,new,KPT}$ or $B_{y,new,survey}$ or $B_{y,savings}$) may be determined by using a default wood to charcoal conversion factor of 6 kg of firewood (wet basis) per kg of charcoal (dry basis).[9] Alternatively, credible local conversion factors determined from a field study or literature may be applied.

16. For all options above, B_{old} and B_{new} may be multiplied by 1.32 to reflect the emissions associated with the harvesting of biomass. It is assumed that 10% of the aboveground biomass is not extracted as fuel, and (conservatively) root biomass is estimated as 20%. These adjustments are applied in sequence, i.e. biomass removed for fuelwood is multiplied by 10% to include aboveground biomass not extracted, then this number multiplied by 20% to include root biomass (1.1 * 1.2 = 1.32). Note that if this adjustment is applied to B_{old} it must be applied to B_{new} as well, and vice versa.

4.2.1. Differentiation between non-renewable and renewable woody biomass

[9] <http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref3.pdf>.

17. Project participants shall determine the shares of renewable and non-renewable woody biomass in B_{old} (the quantity of woody biomass used in the absence of the project activity) the total biomass consumption using nationally approved methods (e.g. surveys or government data if available) and then determine $f_{NRB,y}$ as described below. The following principles shall be taken into account:

4.2.2. Demonstrably renewable woody biomass[10] (DRB)

18. Woody[11] biomass is "renewable" if one of the following two conditions is satisfied:

    (a) The woody biomass originates from land areas that are forests[12] where:

        (i) The land area remains a forest;

        (ii) Sustainable management practices are undertaken on these land areas to ensure, in particular, that the level of carbon stocks on these land areas does not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting); and

        (iii) Any national or regional forestry and nature conservation regulations are complied with;

    (b) The biomass is woody biomass and originates from non-forest areas (e.g. croplands, grasslands) where:

        (i) The land area remains as non-forest or is reverted to forest;

        (ii) Sustainable management practices are undertaken on these land areas to ensure that the level of carbon stocks on these land areas does not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting); and

        (iii) Any national or regional forestry, agriculture and nature conservation regulations are complied with.

4.2.3. Non-renewable biomass

19. *NRB* is the quantity of woody biomass used in the absence of the project activity (B_{old}) minus the *DRB* component, as long as at least two of the following supporting indicators are shown to exist:

    (a) A trend showing an increase in time spent or distance travelled for gathering fuel-wood, by users (or fuel-wood suppliers) or alternatively, a trend showing an increase in the distance the fuel-wood is transported to the project area;

[10] This definition uses elements of annex 18, EB 23.

[11] In the case of charcoal produced from woody biomass, the demonstration of renewability shall be done for the areas where the woody biomass is sourced.

[12] The forest definitions as established by the country in accordance with the decisions 11/CP.7 and 19/CP.9 should apply.

(b) Survey results, national or local statistics, studies, maps or other sources of information, such as remote-sensing data, that show that carbon stocks are depleting in the project area;

(c) Increasing trends in fuel wood prices indicating a scarcity of fuel-wood;

(d) Trends in the types of cooking fuel collected by users that indicate a scarcity of woody biomass.

20. Thus the fraction of woody biomass saved by the project activity in year *y* that can be established as non-renewable is:

$$f_{NRB,y} = \frac{NRB}{NRB + DRB} \quad \text{Equation (7)}$$

21. Project participants shall also provide evidence that the identified trends are not occurring due to the enforcement of local/national regulations.

4.3. Leakage

22. Leakage related to the non-renewable woody biomass saved by the project activity shall be assessed based on ex post surveys of users and the areas from which this woody biomass is sourced (using 90/30 precision for a selection of samples). The potential source of leakage due to the use/diversion of non-renewable woody biomass 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 woody biomass by the non-project households/users, that is attributable to the project activity, then B_{old} is adjusted to account for the quantified leakage. Alternatively, B_{old} is multiplied by a net to gross adjustment factor of 0.95 to account for leakages, in which case surveys are not required.

23. If devices currently being utilised outside the project boundary are transferred to the project activity, then leakage is to be considered.

5. Monitoring methodology

24. Monitoring shall consist of checking of all devices or a representative sample thereof, at least once every two years (biennial) to determine if they are still operating; those devices that have been replaced by an equivalent in-service device can be counted as operating.

25. Monitoring shall also consist of checking the efficiency of all devices or a representative sample thereof annually[13] as below:

(a) For project activities using the Kitchen Performance Test Protocol to determine the quantity of fuel saved (i.e. paragraph 12, Option 1), monitoring shall

[13] Biennial monitoring (i.e. monitoring once every two years) may be chosen, if the project proponents are able to demonstrate that the efficiency of the cook stove does not drop significantly as compared to the initial efficiency of the new device, over a time period of two years of typical usage.

determine the fuel consumption per operating device ($B_{y,new,KPT}$) of all operating devices or a representative sample thereof, annually;[12]

(b) For project activities using the Water Boiling Test protocol (i.e. paragraph 12, Option 2), monitoring shall consist of determining the efficiency of all operating devices or a representative sample thereof, annually.[12] For the purpose of calculating emissions reductions, the ex post monitored value of the efficiency of the operating devices ($\eta_{new,y}$) shall be used;

(c) For project activities using the Controlled Cooking Test protocol (i.e. paragraph 12, Option 3), monitoring shall consist of determining the specific fuel consumption of all operating devices or a representative sample thereof, annually.[12]

26. If Option (b) in paragraph 13 is chosen for determining B_{old}, monitoring shall also determine the amount of thermal energy generated by the project technology *t* in year *y*.

27. In order to assess the leakage described above, monitoring shall include data on the amount of woody biomass saved under the project activity that is used by non-project households/users (who previously used renewable energy sources). Other data on non-renewable woody biomass use required for leakage assessment shall also be collected.

28. Monitoring shall ensure that either:

(a) The replaced low efficiency devices are disposed of and not used within the boundary or within the region; or

(b) If baseline stoves continue to be used, monitoring shall ensure that the fuel-wood consumption of those stoves is excluded from B_{old}.

29. Relevant parameters shall be monitored and recorded during the crediting period as indicated in section 5.1 below. The applicable requirements specified in the "General guidelines for SSC CDM methodologies" are also an integral part of the monitoring guidelines specified below and therefore shall be followed by the project participants.

5.1. Data and parameters monitored

Data / Parameter table 1.

Data / Parameter:	N_y
Data unit:	-
Description:	Number of project devices that are operating in year *y*
Source of data:	-
Measurement procedures (if any):	As per paragraph 11 and 22
Monitoring frequency:	At least once every two years (biennial)
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 2.

Data / Parameter:	$B_{y,new,KPT}$
Data unit:	t/year
Description:	Annual quantity of woody biomass used during the project activity in tonnes per device
Source of data:	-
Measurement procedures (if any):	As per paragraph 12 and 23(a)
Monitoring frequency:	Yearly (or biennially)
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 3.

Data / Parameter:	$B_{y,new,survey}$
Data unit:	t/year
Description:	Annual quantity of woody biomass used during the project activity in tonnes per device
Source of data:	-
Measurement procedures (if any):	As per paragraph 12
Monitoring frequency:	Yearly (or biennially)
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 4.

Data / Parameter:	$HG_{p,y}$
Data unit:	TJ
Description:	Amount of thermal energy generated by the project technology in year *y*
Source of data:	-
Measurement procedures (if any):	As per paragraph 13 and 24
Monitoring frequency:	Yearly
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 5.

Data / Parameter:	$\eta_{new,y}$
Data unit:	Fraction
Description:	Efficiency of the device being deployed as part of the project activity in year *y*
Source of data:	-
Measurement procedures (if any):	As per paragraph 12 and 23(b)
Monitoring frequency:	Yearly (or biennially)
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 6.

Data / Parameter:	$SC_{new,y}$
Data unit:	t fuel/unit output or t fuel/hour
Description:	Specific fuel consumption or fuel consumption rate in year *y* of the device(s) deployed as part of the project that is fuel consumption per quantity of item/s processed (e.g. food cooked) or fuel consumption per hour respectively
Source of data:	-
Measurement procedures (if any):	As per paragraph 12 and 23 (c)
Monitoring frequency:	Yearly (or biennially)
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 7.

Data / Parameter:	$f_{NRB,y}$
Data unit:	-
Description:	Fraction of woody biomass saved by the project activity in year *y* that can be established as non-renewable biomass
Source of data:	-
Measurement procedures (if any):	As per paragraph 11
Monitoring frequency:	Yearly

QA/QC procedures:	-
Any comment:	-

5.2. Representative sampling methods

30. A statistically valid sample of the locations where the devices are deployed, with consideration, in the sampling design, of occupancy and demographic differences can be used to determine parameter values used to calculate emission reductions, as per the relevant requirements for sampling in the "Standard for sampling and surveys for CDM project activities and programmes of activities". When biennial inspection is chosen a 95% confidence interval and a 10% margin of error shall be achieved for the sampling parameter. On the other hand when the project proponent chooses to inspect annually, a 90% confidence interval and a 10% margin of error shall be achieved for the sampled parameters. In cases where survey results indicate that 90/10 precision or 95/10 precision are not achieved, the lower bound of the 90% or 95% confidence interval of the parameter value may be chosen as an alternative to repeating the survey efforts to achieve the 90/10 or 95/10 precision.

5.3. Project activity under a programme of activities

31. The use of this methodology in a project activity under a programme of activities is legitimate if the following leakages are estimated and accounted for, as required on a sample basis using a 90/30 precision for the selection of samples:

    (a) Use of non-renewable woody biomass saved under the project activity to justify the baseline of other CDM project activities can also be a potential source of leakage. If this leakage assessment quantifies a portion of non-renewable woody biomass saved under the project activity that is then used as the baseline of other CDM project activities then B_{old} is adjusted to account for the quantified leakage;

    (b) Increase in the use of non-renewable woody biomass outside the project boundary to create non-renewable woody biomass baselines can also be a potential source of leakage. If this leakage assessment quantifies an increase in the use of non-renewable woody biomass outside the project boundary then B_{old} is adjusted to account for the quantified leakage;

    (c) As an alternative to subparagraphs (a) and (b), B_{old} can be multiplied by a net to gross adjustment factor of 0.95 to account for leakages, in which case surveys are not required.

32. To determine the value of the fraction of non-renewable (f_{NRB}) to be applied in a component project activity (CPA) of a POA, use one of the two options as follows: (a) Conduct local ~~own~~ studies to determine the local f_{NRB} value (sub national values); or (b) Use default national values approved by the Board (see footnote 3). The choice of which option to use shall be made ex ante. However, a switch from a national value of f_{NRB} (i.e. option (b)) to sub-national values (i.e. option (a)) is permitted, under the condition that the selected approach is consistently applied to all CPAs.

33. Monitoring approaches for $B_{y,savings}$ (Option 1, 2 or 3 in paragraph 12),[14] and values for parameters f_{NRB} (when Option (a) in paragraph 30 is chosen) and the quantity of woody biomass B_{old}, may be determined either at the CPA level before the inclusion of CPA or at the PoA level before the registration of the PoA-DD.

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Document information

Version	*Date*	*Description*
01 ACR	22 July 2013	Initial adoption. Adapted from CDM methodology II.G, Version 05.0, with revision for biomass emission factors and adjustment for above- and below-ground biomass not removed as fuelwood.
05.0	23 November 2012	EB 70, Annex 30 Includes clarification on monitoring requirements under different options; and provides a provision of wood to charcoal conversion factor.
04.0	20 July 2012	EB 68, Annex 23 Includes a reference to the available country specific default values for f_{NRB} and specifies requirements of using national or local f_{NRB} values for CPAs under a PoA.
03	15 April 2011	EB 60, Annex 21 KPT for stove testing included, requirements for leakage estimation simplified, default net gross adjustment factor is included as an option to account for any leakages, emission factor for the projected fossil fuel revised, more options for sampling and survey included.
02	04 December 2009	EB 51, Annex 18 To include: (a) Default efficiency factors for baseline cook stoves; (b) Procedures for sampling, (c) Revised procedures for determination of quantity of woody biomass that can be considered as non-renewable; and (d) Clarifications as to which leakage requirements are appropriate for projects versus PoAs.
01	01 February 2008	EB 37, Annex 7 Initial adoption.

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[14] Any one of the three options in paragraph 12 may be used for a particular CPA, but there should be no change in the chosen option during the crediting period.