CLEAN DEVELOPMENT MECHANISM

**CDM-MP88-A19**

# Concept note

# Review of default baseline assumptions applied in AMS-I.E, AMS-II.G and TOOL30

Version 01.0

United Nations
Framework Convention on
Climate Change

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# 1. Procedural background

1. The Executive Board of the clean development mechanism (CDM) (hereinafter referred to as the Board), at its 111th meeting (EB 111), considered the concept note "Analysis and options regarding caps used in AMS-I.E,[1] AMS-II.G[2] and TOOL30[3]" that proposed, besides the existing default values, threshold values for the parameters fraction of non-renewable biomass (fNRB), per capita baseline wood fuel consumption and wood-to-charcoal conversion factor. The Board agreed that the information provided has been useful and requested the Methodologies Panel (MP) to continue the work and provide an updated concept note for consideration by the Board at a future meeting, including the following elements:

   (a) A thorough review of the scientific literature regarding these values;

   (b) Based on an analysis, a proposal for up-to-date default values, including region-specific values where necessary;

   (c) A further assessment of the necessity of the thresholds, i.e. what additional guidance may be necessary for project participants to use other data and information sources (e.g. conditions for the data quality and data vintage and the evidence required) and whether this guidance should be applicable to all projects or be applicable only when thresholds are exceeded;

   (d) If thresholds are to be proposed based on the analysis above, the statistical basis of the proposed values shall be justified (e.g. based on 95 per cent confidence interval or average plus two- or three-times standard deviation);

   (e) If necessary, a study by an acknowledged expert may be commissioned to develop region-specific values, in particular for fNRB.

# 2. Purpose

2. The purpose of this concept note is to address the mandates provided at EB 111, and make recommendations to the Board.

# 3. Key issues and proposed solutions

3. The sections below provide a summary of current provisions and some background information on the parameters that are key determinants of the emission reduction estimates of the methodology (e.g. the wood-to-charcoal conversion factor, the average annual consumption of woody biomass per person, the fraction of non-renewable biomass, efficiency of pre-project device, the uncertainty factor on account of stove stacking). It also includes, for some of the parameters, values reported in CDM documentation and other publications and reports. Based on the analysis, the need for further guidance in the methodologies and tools related to the data sources, data vintage

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[1] AMS-I.E: Switch from non-renewable biomass for thermal application by the user.

[2] AMS-II.G: Energy-efficiency measures in thermal applications of non-renewable biomass.

[3] TOOL30: Calculation of the fraction of non-renewable biomass.

and other characteristics to ensure the reliability of emission reduction estimates is also discussed.

## 3.1. Wood-to-charcoal conversion factor

4. Paragraph 35 of AMS-I.E., paragraph 35 of AMS-II.G. and data/parameter table 1 of AMS-III.BG have the following provision:

> *Where charcoal is used as the fuel by baseline (old) or project (new) devices, the quantity of woody biomass shall be determined by using a default wood to charcoal conversion factor of 6 kg of firewood (wet basis) per kg of charcoal (dry basis).*[4] *Alternatively, credible local conversion factors determined from a field study or literature may be applied.*

5. The Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, Reference Manual (Chapter 1: Energy) states, "*…the wood-to-charcoal factor is stated to be* ***between 4 and 8.*** *If no local information is available, 6 kg of wood input per kg of charcoal may be used as default (FAO, 1990*[5]*).*" No updated information is found in 2006 IPCC Guidelines for National Greenhouse Gas Inventories or in its 2019 Refinement.

6. Based on a review of project design documents (PDDs), component project activity design documents and monitoring reports for 19 project activities and programmes of activities (PoAs) involving the use of charcoal cookstoves, it is observed that 14 project activities and PoAs used the default factor of 6 provided in the methodology, while 5 PoAs used values based on literature. As shown in table 1 below, not all literature is peer-reviewed or publicly available.

**Table 1. Conversion factor values reported in project design documents and monitoring reports**

| | Conversion factor | Comments on literature cited |
|---|---|---|
| **PoA 9981 (Mozambique)** | 7.14 | Publication dated September 2004[a] |
| **PoA 9666 (Togo)** | 7 | Baseline survey undertaken by an independent third-party consulting firm;<br>Baseline report dated July 2011[b] |
| **PoA 7359 (Kenya)** | 10 | Source published in March 2011 by the Forests Philanthropy Action Network[c] |
| **PoA 7359 (Madagascar)** | 12 | Government report from Ministry of Energy[d] |
| **PoA 6207 (Rwanda)** | 9 | Source published in 2017 by USAID[e] |

[a] Brouwer, R. and Falcão, M. P. (2004), Wood fuel consumption in Maputo, Mozambique. Biomass and Bioenergy. Volume 27, Issue 3, September 2004, pp. 233–245

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[4] Refer to:<http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref3.pdf>.The term "wet basis" assumes that the wood is "air-dried", as is specified in the IPCC default table.

[5] FAO (1990), FAO Yearbook, Forest products 1979–1990, FAO Forestry series no. 25. FAO Statistics series no. 103, Food and Agricultural Organization of the United Nations, Rome, Italy.

(b) HED Consulting (2011), Togo Baseline Report

(c) Forests Philanthropy Action Network (2011), Protecting and restoring forest carbon in tropical Africa, Chapter 6: Wood fuels and forests in tropical Africa (http://files.forestsnetwork.org/FPAN_LR.pdf)

(d) Ministry of Energy, Madagascar (2012), Diagnostic Du Secteur Energie a Madagascar, p. 21

(e) USAID (2007), Improved cookstoves in Rwanda, version 2.0, Standardized Crediting Framework Rwanda Pilot: http://climateportal.rema.gov.rw/rules-of-scf

7. A wood-to-charcoal factor of 4.4 is indicated in Unified bioenergy terminology (FAO, 2004),[6] to be used for the FAOSTAT Statistical Database.

8. The typical yield of charcoal from fuelwood using different types of kilns is shown in table 2 below.

**Table 2. Fuelwood requirement for charcoal production (tonne of wood/tonne of charcoal)**

| Kiln type | Fuelwood moisture (%, dry basis) | | | | | |
|---|---|---|---|---|---|---|
| | 15 | 20 | 40 | 60 | 80 | 100 |
| Earth kiln | 7.3 | 9.4 | 11.6 | 15.2 | 17.4 | 19.6 |
| Portable steel kiln | 4.4 | 5.1 | 6.5 | 9.4 | 10.9 | 11.6 |
| Brick kiln | 4.4 | 4.4 | 5.1 | 7.3 | 8.0 | 8.7 |

*Source*: FAO, 2004, assuming that the density of dry wood is 0.725 t/m$^3$

9. Further, Chidumayo, E.N. and Gumbo, D. J. (2013)[7] analysed the wood-to-charcoal conversion rate data for 209 charcoal kilns in Africa, South America and Asia, and proposed a mean wood-to-charcoal conversion rate of 4.9, while the conversion rate for the most commonly used kilns was found to be 5.3. Santos, M.J. et al. (2017)[8] assumed a conversion rate of 5 in their study. Also, in the experimental study conducted by Saravanakumar, A. et al. (2006)[9] to test charcoal production in a partial combustion kiln, the conversion rate used was as low as 4.

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[6] FAO (2004), Unified bioenergy terminology, Food and Agricultural Organization of the United Nations, Rome, Italy. http://www.fao.org/3/j4504e/j4504e00.pdf.

[7] Chidumayo, E.N. and Gumbo, D. J. (2013). The environmental impacts of charcoal production in tropical ecosystems of the world: A synthesis, Energy for Sustainable Development, 17(2), pp. 86–94.

[8] Santos, M.J., Dekker, S.C., Daioglou, V., Braakhekke, M.C. and van Vuuren, D.P. (2017). Modeling the effects of future growing demand for charcoal in the tropics, Frontier in Environmental Science, 5(28).

[9] Saravanakumar, A. and Haridasan, T.M. (2006). A novel performance study of kiln using long stick wood pyrolytic conversion for charcoal production. Energy, Education, Science and Technology, 31(2), pp. 711–722.

**Table 3. Wood-to-charcoal conversion factor values reported in literature**

| Country/Region | Conversion factor | Source |
|---|---|---|
| **India** | 4 | Saravanakumar, A. and Haridasan, T.M. (2006) |
| **Global** | 5 | Santos, M.J., Dekker, S.C., Daioglou, V., Braakhekke, M.C. and van Vuuren, D.P. (2017). |
| **Global** | 4.9 for mean value; 5.3 for most commonly used kilns<br>(3.9 for surface earth mound kiln; 6.0 for casamance surface earth mound kiln; and 8.5 for pit mound kiln) | Chidumayo, E.N. and Gumbo, D. J. (2013) |

10. Furthermore, Energypedia included various types of kilns and respective efficiencies, being 8 to12 per cent for traditional kils and 25 to 33 per cent for the most advanced kilns.

**Table 4. Efficiencies of various types of kilns**

| | Conversion factor | Kiln efficiency |
|---|---|---|
| **Traditional kilns** | 8 – 12 | 8 – 12% |
| **Improved traditional kilns** | 6 – 8 | 12 – 17% |
| **Industrial production technologies** | 5 – 7 | 20 – 14% |
| **New high-yield, low-emission systems** | 3 – 4 | 25 – 33% |

*Source*: Energypedia, Table 7[10]

11. While noting that the conversion factor could vary with charcoal production technique and several other factors (e.g. type of kiln, moisture content of wood, weather conditions), the MP observed that a conservative value should be used as a default value. The MP recommends a default value of 4 because it is the lower end of the range indicated in most literature reviewed, including the Revised 1996 IPCC Guidelines, Unified bioenergy terminology (FAO, 2004), Chidumayo, E.N. and Gumbo, D. J. (2013) and Energypedia. The MP also noted that proposed default value will not preclude the project proponent from using a higher value as long as credible justification can be provided.

12. Therefore, the MP recommends that the current default value of 6 be revised to 4.

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[10] https://energypedia.info/wiki/Charcoal_Production.

13. The following additional guidance is proposed for inclusion in the related methodologies to address the issue of reliability of data sources, data vintage and other data characteristics:

    (a) Project participants should justify the proposed value of wood-to-charcoal conversion factor when the default value of 4 is not applied but a higher value is proposed. Such justifications should include:

        (i) Evidence that the proposed values are applicable to project-specific contexts, for its validation by designated operational entities (DOEs), such as the example below:

            a. A sample based testing of the kilns for efficiency in charcoal production, providing a clear description of the testing method used, including the standard followed;

        (ii) A comparison of the proposed values against the values reported in relevant scientific literature, and credible justification for any differences;

    (b) Project participants may use country- or region-specific values approved through the “Procedure for development, revision, clarification and update of standardized baselines,” which are available on the CDM website <http://cdm.unfccc.int/methodologies/standard_base/index.html>.

## 3.2. Average annual consumption of woody biomass per person

14. Data/parameter table 6 of the current version of AMS-I.E. and data/parameter table 2 of the current version of AMS-II.G. provide the following options for ex-ante determination of data/parameter:

    (a) A default value of 0.5 tonnes/person per year.[11] If project proponents wish to use the default value for institutions (e.g. schools, prisons), the value should be adjusted, based on the number of meals cooked;[12]

    (b) Historical data or a sample survey conducted as per the latest version of the “Standard: Sampling and surveys for CDM project activities and programmes of activities”;

    (c) Country- or region-specific values approved through the “Procedure for development, revision, clarification and update of standardized baselines,” which is available on the CDM website http://cdm.unfccc.int/methodologies/standard_base/index.html.

15. The values reported in 109 PDDs were analysed. For converting into per capita value and per household value, the household size information from the United Nations Department

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[11] Refer to “Annex 5 - Information note on the rationale for default factors used in AMS-I.E. and AMS-II.G.” of the SSC WG 42 meeting report. https://cdm.unfccc.int/Panels/ssc_wg/index.html.

[12] For example, in case of day schools, only one meal may be prepared by schools and provided to students and staff, except during school holidays, when the use of fuel may be not significant.

of Economic and Social Affairs was used. Table 5 below provides a summary of the information compiled.

**Table 5. Annual average woodfuel consumption per capita and per household by region based on values reported in project design documents**

| **Region(a)** | **Annual average woodfuel consumption per capita (tonnes/capita/year)** | | | | | **Annual average woodfuel consumption per household (tonnes/household/year)** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **No. of PDDs** | **Mean** | **SD(b)** | **Mean - SD** | **Q1(c)** | **No. of PDDs** | **Mean** | **SD** | **Mean - SD** | **Q1** |
| Sub-Saharan Africa | 58 | 0.87 | | | | 58 | 3.95 | | | |
| Eastern | 38 | 0.89 | | | | 38 | 4.04 | | | |
| Middle | 1 | 0.75 | | | | 1 | 3.24 | | | |
| Southern | 4 | 1.14 | | | | 4 | 4.80 | | | |
| Western | 15 | 0.77 | | | | 15 | 3.54 | | | |
| Latin America and the Caribbean | 6 | 1.11 | | | | 6 | 4.82 | | | |
| Eastern Asia, South-eastern Asia and Oceania | 10 | 0.95 | | | | 10 | 3.86 | | | |
| Southern Asia | 35 | 0.40 | | | | 35 | 1.84 | | | |
| Europe and Central Asia | 0 | - | | | | 0 | - | | | |
| Western Asia and North Africa | 0 | - | | | | 0 | - | | | |
| **Total (global average)** | **109** | **0.74** | **0.39** | **0.35** | **0.32** | **109** | **3.32** | **1.76** | **1.56** | **1.47** |

(a) According to subregions defined by the United Nations. https://unstats.un.org/unsd/methodology/m49/

(b) Standard deviation.

(c) First quartile or 25th percentile.

16. Based on the data from the United Nations[13] and Demographic and Health Surveys (DHS) Program[14], the values of per capita and per household fuelwood consumption for cooking were caculated. The actual total population that uses firewood was considered rather than the total population. DHS data was only available for 58 countries, the majority of which are in Sub-Saharan Africa. A summary of the findings is presented in table 6 below.

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[13] https://data.un.org/.

[14] https://dhsprogram.com/.

**Table 6. Annual average woodfuel consumption per capita and per household by region based on values reported in UN and DHS**

| **Region** | **Annual average woodfuel consumption per capita (tonnes/capita/year)** | | | | | **Annual average woodfuel consumption per household (tonnes/household/year)** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **No. of countries** | **Mean** | **SD** | **Mean - SD** | **Q1** | **No. of countries** | **Mean** | **SD** | **Mean - SD** | **Q1** |
| Sub-Saharan Africa | 33 | 0.59 | | | | 31 | 2.86 | | | |
| Eastern | 13 | 0.58 | | | | 12 | 2.82 | | | |
| Middle | 5 | 0.65 | | | | 5 | 3.02 | | | |
| Southern | 3 | 0.78 | | | | 2 | 1.92 | | | |
| Western | 12 | 0.53 | | | | 12 | 2.98 | | | |
| Latin America and the Caribbean | 8 | 1.10 | | | | 8 | 4.58 | | | |
| Eastern Asia, South-eastern Asia and Oceania | 7 | 0.44 | | | | 7 | 1.94 | | | |
| Southern Asia | 5 | 0.57 | | | | 5 | 2.80 | | | |
| Europe and Central Asia | 4 | 0.32 | | | | 3 | 0.85 | | | |
| Western Asia and North Africa | 1 | 0.59 | | | | 1 | 3.11 | | | |
| **Total (global average)** | **58** | **0.62** | **0.45** | **0.17** | **0.27** | **55** | **2.88** | **1.98** | **0.90** | **1.38** |

17. Several studies[15] that have undertaken Kitchen Performance Tests (KPTs) were also reviewed. Generally, the lower end of baseline woodfuel consumption observed is about 0.36 tonnes/capita/year, and the upper end is around 1.1 tonnes/capita/year.

18. Based on the analysis above, the following observations can be made:

    (a) From the analysis based on PDDs, the global average per capita value is 0.74 tonnes/capita/year, one standard deviation is 0.39, median is 0.74 and the 1st quartile is 0.32.

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[15] Garland, C., and others (2015), Impacts of household energy programs on fuel consumption in Benin, Uganda, and India. Energy for Sustainable Development 27, pp. 168–173.

Johnson, M.A., and others (2013), Impacts on household fuel consumption from biomass stove programs in India, Nepal, and Peru. Energy for Sustainable Development 17, pp. 403–41.

Ventrella, J., and others (2020), An international, multi-site, longitudinal case study of the design of a sensor-based system for monitoring impacts of clean energy technologies. Design Studies 66, pp. 82–113.

Wallmo, K. and Jacobson, S.K. (1998), A social and environmental evaluation of fuel-efficient cook-stoves and conservation in Uganda. Environmental Conservation 25, pp. 99–108.

Granderson, J., and others (2009), Fuel use and design analysis of improved woodburning cookstoves in the Guatemalan Highlands. Biomass and Bioenergy 33, pp. 306–315.

Berrueta, V.M., and others (2008), Energy performance of wood-burning cookstoves in Michoacan, Mexico. Renewable Energy 33, pp. 859–870.

(b) From the analysis based on UN and DHS data, the global average per capita value is 0.62 tonnes/capita/year, one standard deviation is 0.45, median is 0.5 and the 1st quartile is 0.27.

(c) The current default value of 0.5 tonnes/capita/year is below the global average values derived from both analyses above.

19. The current value of 0.5 tonnes/capita/year is conservative compared to the values reported in the PDDs. However, based on the UN and DHS data, it was found that the average values for over half of countries for which data is available were equal to or lower than 0.5.

20. Therefore, the MP recommends that the default value be lowered to 0.4 tonnes/capita/year in order to ensure that it is conservative, while recognizing that project participants have an option to determine the value based on historical data or a sample survey conducted as per the latest version of the “Standard: Sampling and surveys for CDM project activities and programme of activities” according to the methodology AMS-II.G.

## 3.3. Fraction of non-renewable biomass

21. The Board has approved “TOOL30: Calculation of the fraction of non-renewable biomass” for estimating fNRB.

22. The project participants currently have three options when determining fNRB values:

(a) Use a default value of 0.3 indicated in TOOL30; or

(b) Use default country-specific values approved through the standardized baseline procedures, if available; or

(c) Calculate fNRB values for their own project activities/PoAs using TOOL30.

23. To date, only four countries[16] have developed new default country-specific fNRB values using TOOL30, following the standardized baseline procedure.

24. Based on the assessment of pan-tropical woodfuel supply and demand, Bailis, et al, (2015)[17] estimated that global fNRB value was 27 to 34 per cent, with large geographic variations.

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[16] Uganda (ASB0002-2017), Rwanda (ASB0041-2018), Ethiopia (ASB0044-2019) and Myanmar (ASB0049-2020).

[17] Bailis, R., Drigo, R., Ghilardi, A. and Masera, O. (2015), The carbon footprint of traditional woodfuels. Nature Climate Change, 5(3), pp. 266–272.

**Table 7. Regional fraction of non-renewable biomass values**

| Region | fNRB |
|---|---|
| Africa | 35 – 41% |
| Latin America and Carribean | 21 – 31% |
| Asia & Oceania | 24 – 30% |
| **Total** | **27 – 34%** |

*Source*: Table 15 of supplementary information to Bailis, et al (2015)

25. Other studies that have estimated the share of non-renewable biomass are given in table 8 below.

**Table 8. Fraction of non-renewable biomass values reported in other studies**

| | Area | Source |
|---|---|---|
| 41 – 43% | India and China | Cashman, S., Rodgers, M., Huff, M., Feraldi, R. and Morelli, B. (2016), Life Cycle Assessment of cookstove fuels in India and China. Washington, DC U.S.A. Environmental Protection Agency |
| 0 – 89% | Uganda | Zanchi, G., Frieden, D., Pucker, J., Bird, D. N., Buchholz, T. and Windhorst, K. (2013), Climate benefits from alternative energy uses of biomass plantations in Uganda. Biomass and Bioenergy, 59, pp. 128–136 |
| 0 – 96% | Mexico | Ghilardi, A., Guerrero, G. and Masera, O. (2009), A GIS-based methodology for highlighting fuelwood supply/demand imbalances at the local level: A case study for Central Mexico. Biomass and Bioenergy, 33, pp. 957–972 |
| 42 – 64% | Kenya | Drigo, R., Bailis, R., Ghilardi, A. and Masera, O. (2015), WISDOM Kenya, GACC Yale-UNAM Project |

26. Considering the uncertainity in estimating fNRB, the MP proposes to include the additional guidance below in TOOL30 to address the issue of reliability of data sources, data vintage and other characteristics of the data:

(a) Project participants should justify the proposed value of fNRB if the default value of 0.3 is not applied to their CDM project activity. The project participants shall compare and analyse the proposed values against the values for fNRB reported in relevant scientific literature and credibly justify any differences. This analysis shall be included in the appropriate section of the PDD. The relevant scientific literature includes at least:

*Bailis, R.; Drigo, R.; Ghilardi, A. & Masera, O. (2015). The carbon footprint of traditional woodfuels. Nature Climate Change, 5(3), pp. 266–272.*

## 3.4. Efficiency of project device

27. According to paragraph 3 of the methodology AMS-II.G., the methodology is applicable to the introduction of single pot or multi pot portable or in-situ cookstoves with rated efficiency of at least 20 per cent. Further, “Data/Parameter table 14” details the options for testing and certification as well as supporting documentation (e.g. certificate issued by third party or test results) that needs to be presented to the validating DOE. It requires that the efficiency be measured/estimated i) based on certification by a national standards body or an appropriate certifying agent recognized by that body, or ii) by manufacturer specifications on efficiency based on water boiling test.

28. The efficiency values reported in CDM project documentation for project stoves used in CDM projects/PoAs were analysed as follows:

    (a) For project stove efficiency, out of the 186 monitoring reports analysed, approximately 92 per cent monitored and reported stove efficiency using water boiling tests.

    (b) Table 9 and table 10 provide a summary of the efficiency values reported in monitoring reports (ex-post monitored effiency values) and PDDs (ex-ante efficiency values), respectively.

    (c) In a very small number of cases, the value of ex-post monitored efficiency has gone up as compared to the one of ex-ante efficiency.

**Table 9. Thermal efficiency values of project cookstoves reported in monitoring reports**[18]

| Type | No. of Monitoring Reports | Mean | SD | Mean + SD |
|---|---|---|---|---|
| Ex-post monitored efficiency values of charcoal stoves | 54 | 32.0 | 4.6 | 36.6 |
| Ex-post monitored efficiency values of firewood stoves | 141 | 31.5 | 6.6 | 38.1 |

**Table 10. Thermal efficiency values of project cookstoves reported in project design documents**[19]

| Type | No. of PDDs | Mean | SD | Mean + SD |
|---|---|---|---|---|
| Ex-ante efficiency of charcoal stoves | 38 | 33.7 | 5.4 | 39.1 |
| Ex-ante efficiency of firewood stoves | 46 | 30.8 | 4.1 | 34.9 |

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[18] Outlier values were excluded for further analysis.

[19] Outlier values were excluded for further analysis.

29. On a related issue, while there may a possible small improvement in the ex-post monitored efficiency, the MP recommends that, in case of significant increase in the ex-post monitored efficiency as compared to the ex-ante efficiency, sufficient justification should be provided by the project participants, which should be checked during verification.

### 3.5. Efficiency of pre-project device

30. Data/parameter table 7 of the current version of AMS-I.E. and data/parameter table 9 of the current version of AMS-II.G. have the following requirements:

| | |
|---|---|
| Measurement procedures (if any): | The parameter may be established based on a representative sample survey of the pre-project devices and fixed ex ante (i.e. there is no need to determine baseline efficiency for each individual household when including in the project activity database). The survey is to be conducted in line with the “Standard for sampling and surveys for CDM project activities and programmes of activities”.<br>The representative sampling survey may ask whether the pre-project device is a traditional three-stone fire or another conventional device with no improved combustion air supply or flue gas ventilation.<br>In that case, it is possible not to conduct efficiency tests and to use the following default efficiency values to calculate the weighted average:<br>(i) 0.1 for a three-stone fire using firewood (not charcoal), or a conventional device with no improved combustion air supply or flue gas ventilation; that, is without a grate or a chimney;<br>(ii) 0.2 for other types of devices.<br>Conducting efficiency tests on pre-project devices is not a mandatory requirement under this methodology.<br>Further, project participants may also conservatively assume that the efficiency of all pre-project devices is 0.2, in which case there is no need to conduct a survey to determine the weighted average efficiency referred above. |

31. As per the current requirements above, project participants may determine the efficiency of pre-project devices by conducting a questionnaire survey to estimate the percentage share of different stove types and then calculate the weighted average value.[20]

32. The efficiency values reported in CDM project documentation for pre-project stoves used in CDM projects/PoAs were analysed with regard to the data sources used to determine the values. Out of 217 cases analysed:

(a) 69 per cent used a default efficiency of 0.1;

(b) 26 per cent used a value between 0.1 and 0.2, by calculating a weighted average value based on the percentage share of 0.1 type stoves and 0.2 type stoves;

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[20] For example, assume that the percentage shares of three-stone fire (10% efficiency), conventional stoves (20% default efficiency) and improved stoves (30% efficiency) are 15 per cent, 80 percent and 5 per cent, respectively. In this case, weighted average efficiency value is calculated as 19 per cent (= 0.1 x 0.15 + 0.20 x 0.80 + 0.30 x 0.05).

(c) 2 per cent used a default efficiency of 0.2;

(d) 2 percent used a efficiency value higher than 0.2;

(e) 1 per cent used standardized baseline values approved by the Board.

33. Clean Cooking Alliance developed the Clean Cooking Catalog,[21] which is a global database of cookstoves, fuels, fuel products and performance data. It includes information on features and specifications, as well as emissions, efficiency and safety based on laboratory and field-testing. The Catalog contains data from over 700 sets of test results, including both third-party and self-reported data on performance and safety. Table 11 below summarizes the information in the catalog.

**Table 11. Thermal efficiency values of cookstoves reported in Clean Cooking Catalog**

| **Type[(a)]** | **No. of stoves tested** | **Mean** | **SD** | **Mean + SD** |
|---|---|---|---|---|
| Three-stone fires using firewood | 11 | 16.6 | 3.5 | 20.1 |
| Traditional firewood stoves | 9 | 22.1 | 7.8 | 29.9 |
| Traditional charcoal stoves | 4 | 21.8 | 3.2 | 25.0 |
| Non-traditional firewood stoves | 93 | 30.2 | 10.5 | 40.7 |
| Non-traditional charcoal stoves | 33 | 32.5 | 8.2 | 40.7 |

(a) "Traditional" refers to local methods of cooking using cultural practices and methods. "Non-traditional" refers to newer stove technology designed to improve efficiency, cleanliness and/or safety. http://catalog.cleancookstoves.org/glossary#stove-characteristics

34. Unlike in the case of traditional or non-traditional (improved) stoves, in the case of three-stone fires, the variables that affect the efficiency are the characteristic of fuel wood used, such as the calorific value, moisture content, ambient weather conditions, and type of cooking vessel used. Stoves themselves are undefined for this case.

35. A default value of 10 per cent efficiency for three-stone fires was included in the first versions of the methodology approved before 2010 based on references available at the time (e.g. see table 12 from Bhattacharya et al., 2002).[22] Further, in the absence of a mandate from the Board, the default value itself was not revisited for a long period of time. Recently approved methodogical tool "TOOL33: Default values for common parameters" includes default values with inbuilt provisions to review the default values every three years.

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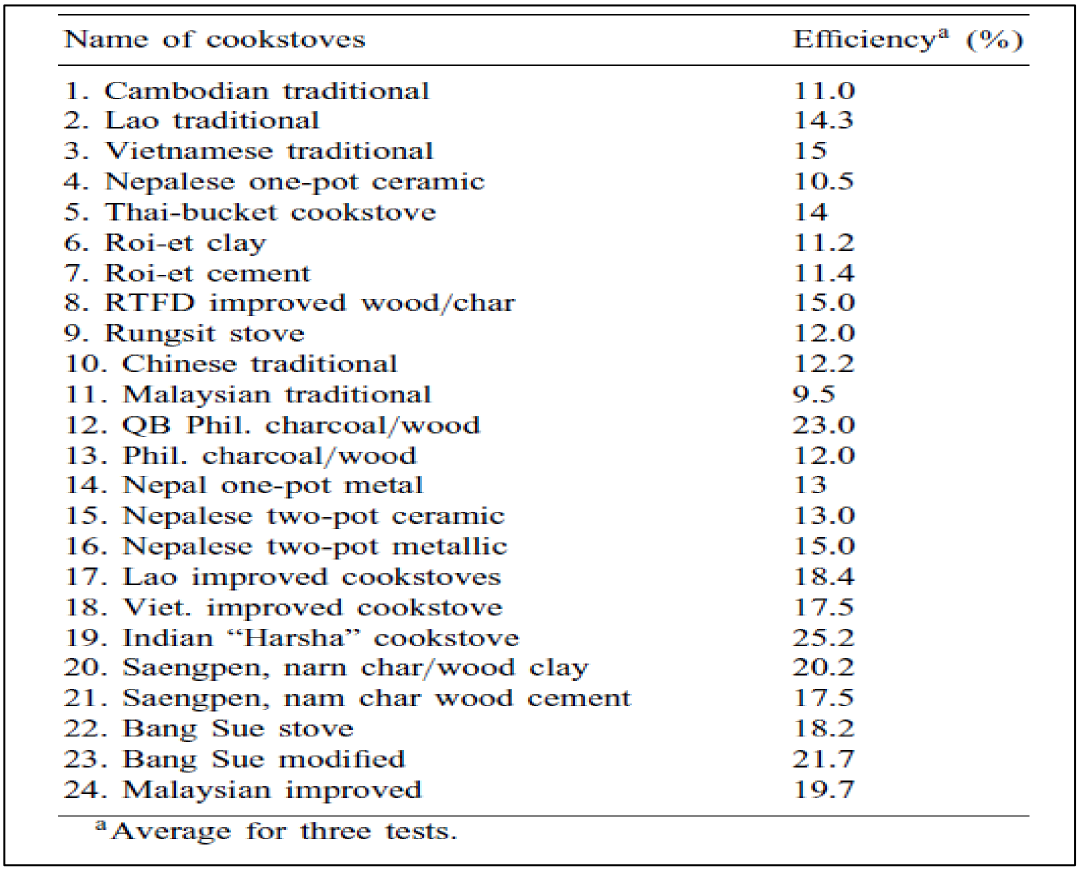
[21] http://catalog.cleancookstoves.org/

[22] Bhattacharya, S.C., Albina, D.O. and Salam, P.A. (2002), Emission factors of wood and charcoal-fired cookstoves. Biomass and Bioenergy 23, pp. 453-469

**Table 12. Thermal efficiency values**



| Name of cookstoves | Efficiency[a] (%) |
|---|---|
| 1. Cambodian traditional | 11.0 |
| 2. Lao traditional | 14.3 |
| 3. Vietnamese traditional | 15 |
| 4. Nepalese one-pot ceramic | 10.5 |
| 5. Thai-bucket cookstove | 14 |
| 6. Roi-et clay | 11.2 |
| 7. Roi-et cement | 11.4 |
| 8. RTFD improved wood/char | 15.0 |
| 9. Rungsit stove | 12.0 |
| 10. Chinese traditional | 12.2 |
| 11. Malaysian traditional | 9.5 |
| 12. QB Phil. charcoal/wood | 23.0 |
| 13. Phil. charcoal/wood | 12.0 |
| 14. Nepal one-pot metal | 13 |
| 15. Nepalese two-pot ceramic | 13.0 |
| 16. Nepalese two-pot metallic | 15.0 |
| 17. Lao improved cookstoves | 18.4 |
| 18. Viet. improved cookstove | 17.5 |
| 19. Indian "Harsha" cookstove | 25.2 |
| 20. Saengpen, narn char/wood clay | 20.2 |
| 21. Saengpen, nam char wood cement | 17.5 |
| 22. Bang Sue stove | 18.2 |
| 23. Bang Sue modified | 21.7 |
| 24. Malaysian improved | 19.7 |

[a] Average for three tests.

*Source:* Bhattacharya et al., 2002

36. A USAID study[23] conducted water boiling tests for all the stove models observed in the camps in Uganda, and the results are summarized in table 13.[24] The range varies from as low as 6.5 per cent to 14.4 per cent.

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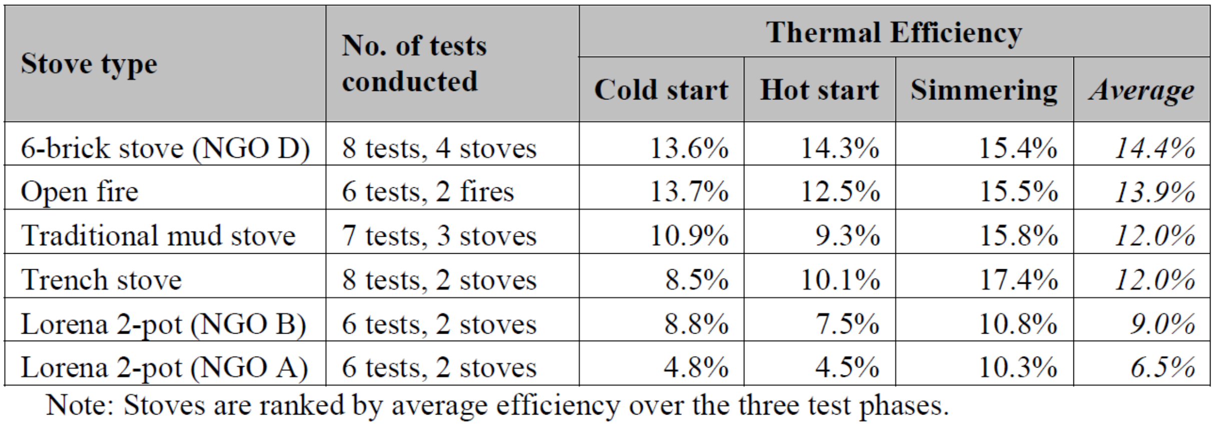
[23] USAID (2007), Fuel-efficient stove programmes in internally displaced persons setting – Summary Evaluation Report, Uganda.

[24] The report says that, given the relatively small sample sizes and lack of lab conditions, results should be considered indicative rather than definitive.

**Table 13. Results of water boiling tests for stove models observed in the camps in Uganda**



| **Stove type** | **No. of tests conducted** | **Thermal Efficiency** | | | |
|---|---|---|---|---|---|
| | | **Cold start** | **Hot start** | **Simmering** | ***Average*** |
| 6-brick stove (NGO D) | 8 tests, 4 stoves | 13.6% | 14.3% | 15.4% | *14.4%* |
| Open fire | 6 tests, 2 fires | 13.7% | 12.5% | 15.5% | *13.9%* |
| Traditional mud stove | 7 tests, 3 stoves | 10.9% | 9.3% | 15.8% | *12.0%* |
| Trench stove | 8 tests, 2 stoves | 8.5% | 10.1% | 17.4% | *12.0%* |
| Lorena 2-pot (NGO B) | 6 tests, 2 stoves | 8.8% | 7.5% | 10.8% | *9.0%* |
| Lorena 2-pot (NGO A) | 6 tests, 2 stoves | 4.8% | 4.5% | 10.3% | *6.5%* |

Note: Stoves are ranked by average efficiency over the three test phases.

*Source*: USAID, 2007

37. It is acknowledged that in table 11, as compared to non-traditional stoves, the number of data points available for three-stone fires and traditional stoves is limited.

38. However, balance of evidence suggests that there is a need to propose a conservative value for the efficiency of three-stone fires to replace the currently indicated 10 per cent efficiency, based on more recent studies.

39. The MP agreed to propose the following changes to the default values:

    (a) 15 per cent for three-stone fires or conventional stoves with no improved combustion air supply or flue gas ventilation; that is, without a grate or a chimney;

    (b) 25 per cent for other types of stoves.

40. Proposed changes to the methodology are as follows:

| | |
|---|---|
| Measurement procedures (if any): | The parameter may be established based on a representative sample survey of the pre-project devices and fixed ex ante (i.e. there is no need to determine baseline efficiency for each individual household when including in the project activity database). The survey is to be conducted in the applicable geographical area in line with the "Standard for sampling and surveys for CDM project activities and programmes of activities".<br>The representative sampling survey may ask whether the pre-project device is a traditional three-stone fire or another conventional device with no improved combustion air supply or flue gas ventilation.<br>In that case, it is possible not to conduct efficiency tests and to use the following default efficiency values to calculate the weighted average.<br>(i) ~~0.1~~ 0.15 for a three-stone fire using firewood (not charcoal), or a conventional device with no improved combustion air supply or flue gas ventilation; that is, without a grate or a chimney;<br>(ii) ~~0.2~~ 0.25 for other types of devices.<br>Conducting efficiency tests on pre-project devices is not a mandatory requirement under this methodology.<br>Further, project participants may also conservatively assume that the efficiency of all pre-project devices is ~~0.2~~ the value indicated in (ii) above, in which case there is no need to conduct a survey to determine the weighted average efficiency referred above. |

### 3.6. Adjustment to account for any continued use of pre-project device (stove stacking)

41. Generally, there is a continued use of pre-project cookstoves alongside the project cookstoves in various CDM project activities and PoAs. Many studies found that the continued use of traditional/baseline stoves remained high (Dickinson et al., 2019[25]; Ochieng et al., 2020[26]; Piedrahita et al., 2016[27]; Shankar et al., 2020[28]).

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[25] Dickinson L. K., Piedrahita R., Coffey R. E., Kanyomse E., Alirigia R., Molnar T., Hagar Y., Hannigan O. M., Oduro R. A., & Wiedinmyer C. (2019). Adoption of improved biomass stoves and stove/fuel stacking in the REACCTING intervention study in Northern Ghana. Energy Policy.

[26] Ochieng A. C., Yabei Z., Nyabwa K. J., Otieno I. D., & Spillane C. (2020). Household perspectives on cookstove and fuel stacking: A qualitative study in urban and rural Kenya. Energy for Sustainable Development.

[27] Piedrahita R., Dickinson L. K., Kanyomse E., Coffey E., Alirigia R., Hagar Y., Rivera I., Oduro A., Dukic V., Wiedinmeyer C., & Hannigan M. (2016). Assessment of cookstoves stacking in Northern Ghana using surveys and stove use monitors. Energy for Sustainable Development.

[28] Shankar V. A., Quinn K. A., Dickinson L. K., Williams N. K., Masera O., Charron D., Jack D., Hyman J., Pillarissetti A., Bailis R., Kumar P., Ruiz-Mercado I., & Rosenthal P. J. (2020). Everybody stacks: Lessons from household energy case studies to inform design principles for clean energy transitions. Energy Policy.

42. According to the literature reviewed, households continue to stove-stack because of several reasons, including:

(a) Inability of primary cookstove to cook all dishes (Dickinson et al., 2019; Jewit et al., 2020[29]; Ochieng et al., 2020; Piedrahita et al., 2016);

(b) Time-saving from parallel cooking (Ochieng et al., 2020);

(c) Housing arrangements that preclude the use of certain fuel types (Ochieng et al., 2020);

(d) Fuel availability and costs (Ochieng et al., 2020; Jewit et al., 2020);

(e) Technical problems with the distributed improved cookstoves – for instance, battery failure with gasifier stoves (Dickinson et al., 2019);

(f) Utilitarian and sociocultural factors such as “wood smoke adds flavour to food and for food preservation”, perceptions such as “wood fuel cooks faster than any other fuel”, minimal preparation time for fuel used for three-stone fires, risk of burns and explosions when using liquefied petroleum gas (LPG), and seasonal weather patterns (Jewit et al., 2020, Dickinson et al., 2019).

43. Shankar et al., 2020 reviewed and synthesized stove stacking data gathered from eleven case studies of clean cooking programs in low- and middle-income country settings, and it showed that significant (28%–100%) stacking with traditional cooking methods was observed in all cases, as shown in table 14.

**Table 14. Stove-stacking in different programmes**

| Country/Region | Clean fuel promoted | Stacking/stove use behaviour |
|---|---|---|
| **Ghana** | LPG | In rural areas, there is almost no sustained use of LPG: 100% of surveyed respondents still used wood as their primary fuel 9 months after LPG distribution; and only 8% still used any LPG 18 months post-distribution. |
| **Peru** | LPG | In rural areas, among households that used LPG stoves, 95% reported stacking with traditional biomass stoves; approximately 60% of cooking is done with LPG and 40% with biomass. |
| **Ecuador** | LPG | In a region where LPG has been heavily subsidized (Carchi district, Ecuador), 93% report LPG is primary fuel, but only 19% use LPG exclusively; 79% of households use wood at least once per week. |
| | Electric/ induction cooking | Despite the introduction of an induction cooking programme, sustained use of electricity for cooking is almost nonexistent in region studied. |
| **Indonesia** | LPG | Primary LPG users: Central Jakarta (73%), Yogyakarta (63%); exclusive LPG users: Central Java subdistricts (19.5%), Yogyakarta City (9%). There is some stacking with clean fuel (electricity), but 73% of stackers continue to use wood alongside |

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[29] Jewitt S., Atagher P., & Clifford M. (2020). “We cannot stop cooking”: Stove stacking, seasonality and the risky practices of household cookstove transitions in Nigeria. Energy Research & Social Science.

| Country/Region | Clean fuel promoted | Stacking/stove use behaviour |
|---|---|---|
| | | LPG. The quantity of biomass use per month is similar in households with and without LPG. |
| **Cameroon** | LPG | In rural areas, 16% report primary LPG use but only 1% use it exclusively. In peri-urban populations, 58% report primary LPG use but only 10% use it exclusively. Thus, 90% of peri-urban and 99% of rural LPG-using households reported stacking LPG with biomass; stackers only obtain about 50% of the LPG per year that would support exclusive use. |
| **Nigeria** | Ethanol | In an urban population, four to five months after receiving CleanCook, 65% reported using it regularly. Of those, approximately 35% reported exclusive use, with the remainder stacking with kerosene. One-third also reported cooking with two stoves simultaneously primarily to save time. Fuel canisters were sold at an average rate of 2.3 canisters per household/month. This rate provides approximatively one-third of the estimated amount of fuel that a typical Lagos household requires to meet all of its cooking needs. |
| **Ethiopia (Refugee camps)** | Ethanol | Stacking varied across camps depending on foodstuffs. For some, CleanCook stove was well adapted to cooking; for others less so. |
| **Ethiopia (Urban program)** | Ethanol | All surveyed respondents stacked, using between two and five stoves; 98% report using charcoal, 70% firewood, 6% kerosene, and 50% electricity in addition to ethanol. |
| **Rwanda** | Biomass pellets | In urban areas, 65% of cooking is done with traditional biomass fuels. Exclusive use of the clean technology is extremely rare. |
| **China** | Biomass pellets | In a rural population, 77% of homes continued to regularly use their traditional wood chimney stoves. Daily use of gasifier stoves was modest initially (40% of days in month) and declined over time. |
| **East Africa (Kenya, Tanzania, Uganda)** | Biogas | In rural areas (where nearly 93% of households rely primarily on wood or charcoal fuels), after biogas installation 46% report stacking in Kenya, 71% in Tanzania and 89% in Uganda. |
| **Cambodia** | Biogas | In rural areas, surveys found between 28% and 50% of adopters stacked with wood or charcoal. Measures of wood consumption in control versus intervention households show that biogas adoption reduces wood consumption between 54% and 78% but does not eliminate the use of wood fuel. |

*Source*: based on synthesis study by Shankar et al., 2020

44. To address this issue of stove stacking, the methodology AMS-II.G has already included requirements to monitor the paratemer $\mu_y$, which is an adjustment factor to account for any continued use of pre-project devices during the year *y*. See Data/Parameter table 12 of AMS-II.G version 12, for details. According to the methodology, this parameter should be monitored using one of the following methods:

    (a) If the pre-project devices are decommissioned and no longer used, as determined by the monitoring survey, its value is 1.0. If both the project devices and pre-project devices are used together, measurement campaigns shall be undertaken using data loggers such as stove utilization monitors;

(b) Alternatively, surveys may be conducted if the use of data loggers to record the continued operation of baseline devices is demonstrated to not be practical – for example, when the baseline device is the three-stone fire.

45. An analysis was undertaken for the values reported in monitoring reports of the registered CDM project activities and PoAs. Table 14 below provides a summary of the results.

**Table 15. Values reported to account for stove stacking**

| Parameter | No. of Monitoring Reports | Mean | SD | Mean – SD |
|---|---|---|---|---|
| Adjustment to account for any continued use of pre-project devices during the year *y* | 44[(a)] | 91.7 | 7.5 | 84.2 |

[(a)] A few outlier values were excluded for further analysis.

46. The MP agreed to propose the following approaches for inclusion in the methodology AMS-II.G:

(a) If measurement campaigns are undertaken using data loggers/sensors such as stove utilization monitors by project participants, **the value determined using the data loggers/sensors** shall be applied.

(b) If end-user survey (e.g. questionnaire surveys) to determine the continued use of of the pre-project device (frequency and duration of usage) is undertaken, the results should be adjusted downward – i.e. if a survey according to CDM sampling guidelines is conducted to determine the extent of the usage of both the project devices and pre-project devices, **the average minus one standard deviation value of the parameter $\mu_y$ determined using the questionnaire surveys** shall be applied.

# 4. Impacts

47. The proposed improvement of the methodological approaches in AMS-I.E, AMS-II.G, AMS-III.BG and TOOL30 will ensure the reliability of calculating emission reductions and facilitate the implementation of CDM project activities and PoAs in the household cookstove sector.

# 5. Subsequent work and timelines

48. Not applicable (recommendation).

# 6. Recommendations to the Board

49. The MP recommends that the Board consider the concept note and provide further guidance.

50. The MP will also recommend that the draft revision to the methodologies and tools AMS-I.E., AMS-II.G, AMS-III.BG and TOOL30 include a reference to “TOOL33: Default values for common parameters”. The default values contained in AMS-I.E, AMS-II.G, AMS-III.BG and TOOL30 should be moved to TOOL33.

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## Document information

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