Standardized Crediting Framework: Article 6 Model for Energy Access Rwanda

Methodology for improved cookstoves in Rwanda

1. Methodology title, version and date

|  |  |
| --- | --- |
| Methodology title | Improved cookstoves in Rwanda |
| Version | 1.0 |
| Date | 06/04/2023 |

1. Definitions

For this methodology, the following definitions apply:

**Batch:** is defined as the number of devices of the same type sold in a certain calendar year.

**Water boiling test:** is a laboratory test that evaluates stove performance while completing a standard task (i.e., boiling and simmering water) in a controlled environment to investigate the heat transfer and combustion efficiency of the stove. The Activity Participant[[1]](#footnote-2) can submit testing results performed in laboratories that follow the method ISO 19867-1, according to the guidelines published by the Ministry of Infrastructure of Rwanda (MININFRA).[[2]](#footnote-3)

1. Summary

|  |  |
| --- | --- |
| Typical activity(ies)[[3]](#footnote-4) | Replacement of traditional firewood and/or charcoal stoves with improved-efficiency biomass-burning stoves.  |
| Type of GHG emissions mitigation action | Energy efficiency: Displacement or energy efficiency enhancement of existing heat generation units results in saving of non-renewable biomass and reduction of GHG emissions. |

1. Eligibility criteria

|  |  |
| --- | --- |
| Technology | Improved biomass-burning cookstoves with a thermal efficiency of at least 30%.[[4]](#footnote-5) The stoves may be portable, in-situ or multi-pot stoves.The stove to be replaced must be either a three-stone fire or a traditional unimproved charcoal cookstove.This methodology is not applicable to households switching from firewood to charcoal (i.e., households using firewood as primary fuel in the pre-activity scenario that receive an improved charcoal stove in the activity scenario).[[5]](#footnote-6)In addition to the above, the optional accounting of emission reductions from the use of renewable biomass fuel to replace firewood and/or charcoal used for cooking. |
| Target group | Rural and urban households using fuelwood and/or charcoal to meet their domestic cooking needs in the baseline scenario. |
| Technical standards | The improved stoves must have a thermal efficiency of at least 30% measured through the water boiling test (WBT).[[6]](#footnote-7) Activity Participant can submit testing results performed in laboratories that follow the method ISO 19867-1, according to the guidelines published by MININFRA.[[7]](#footnote-8)  |
| Double counting | The activity seeking registration may not be registered under Article 6.4 of the Paris Agreement or a Voluntary Carbon Market standard or registry. |

1. Emission sources and gases

|  |  |  |  |
| --- | --- | --- | --- |
| Source | GHG | Included? | Explanation |
| Baseline scenario: Combustion of non-renewable biomass for cooking | CO2 | Yes | Major source of emissions |
| CH4 | Yes | Major source of emissions |
| N2O | Yes | Major source of emissions |
| Activity scenario: Continued combustion of non-renewable biomass for cooking  | CO2 | Yes | Major source of emissions |
| CH4 | Yes | Major source of emissions |
| N2O | Yes | Major source of emissions |

1. Total emission reductions

The following equation is applied to calculate emission reductions:

 ERy = $\sum\_{i}^{}\sum\_{j}^{}ER\_{y,i,j}$ (Eq 1)

Where:

|  |  |  |
| --- | --- | --- |
| i | = | Index for type of activity device (wood or charcoal-using devices) |
| j | = | Index for batch number of activity devices |
| ERy | = | Emission reductions during year *y* in t CO2e |
| ERy,I,j | = | Emission reductions by activity device of type *i* and batch *j* during year *y* in t CO2e |

Calculation of ERy,i,j :

 ERy,i,j = By,i,j x 0.95 x Ny,i,j x Sy,i,j x $μ\_{y,i,j}$ x fNRB,y x NCVbiomass x (EFCO2+EFNon-CO2) *(Eq 2)*

Where:

|  |  |  |
| --- | --- | --- |
| By,i,j | = | Quantity of woody biomass that is saved in tonnes per cookstove device of type *i* and batch *j* during year *y.* |
| Ny,i,j | = | Cumulative number of activity devices of type *i* and batch *j* sold up to year *y.* |
| Sy,i,j | = | Share of activity devices of type *i* (grouped into charcoal and firewood-using devices) and batch *j* operating during year *y.* |
| $$μ\_{y,i,j}$$ | = | Adjustment to account for any continued use of pre-activity devices of type i (grouped into charcoal and firewood-using devices) and batch j in year y .  |
| fNRB,y | = | Fraction of woody biomass that is non-renewable. For Rwanda, this value is 64.7%. [[8]](#footnote-9) |
| NCVbiomass | = | Net calorific value of the baseline fuel. Use IPCC default values for wood fuel of 0.0156 TJ/tonne and for charcoal: 0.029 TJ/tonne. |
| EFCO2 | = | CO2 emission factor for woody biomass used. Use a default IPCC value of 112 t CO2/TJ. |
| EFNon-CO2 | =  | Non-CO2 emission factor of baseline fuel. Use a value of 9.46 t CO2e/TJ for wood. |
| 0.95 | =  | Default factor to account for leakage. |

The cumulative number of activity devices should be adjusted to remove any devices that have reached the end of their lifetime. For example, if a device lasts five years, then in year six of the activity, all devices installed in year one should be removed from the cumulative total.

*6.1 Determining biomass savings: Water boiling test based on efficiency of the activity device*.

The fuel savings are calculated from the amount of biomass consumed by the stove in the pre-activity scenario (default) and the efficiency gains of the new compared to the old stove. Determining *By,i,j* from the implementation of efficient thermal devices is estimated as follows:

 By,i,j = Bold,i,j x (1 - $\frac{η\_{old,i,j}}{η\_{new,i,j}}$) (Eq 3)

Where:

|  |  |  |
| --- | --- | --- |
| Bold,i,j | = | Annual quantity of woody biomass in tonnes that would have been used in the absence of the activity to generate useful thermal energy equivalent to that provided by the activity device type *i* and batch *j.* |
| $$η\_{new,i,j}$$ | = | Efficiency of the activity device *i* and batch *j.* Use the manufacturer’s specifications.[[9]](#footnote-10) |
| $$η\_{old,i,j}$$ | = | Efficiency of the old devices being replaced by activity devices of type *i* and batch *j.*  |

Equation 3 assumes that there is only one activity device per household. [[10]](#footnote-11)

*6.2 The following conditions apply to the calculation of By,,i,j:*

1. Where charcoal is used as the fuel by the baseline or activity devices, the quantity of woody biomass shall be determined by using a default wood-to-charcoal conversion factor of 7.7 kg of firewood (wet basis) per kg of charcoal (dry basis) (*CFcharcoal*).[[11]](#footnote-12)
2. The lifespan of each type of activity device shall be documented based on the manufacturer’s specification. If the lifespan of devices is less than the crediting period, it shall be demonstrated that the devices shall be replaced after the lifespan has ended. If it cannot be demonstrated that the activity devices shall be replaced with new devices, no emission reductions can be claimed beyond the lifespan of the activity devices.
3. The loss in efficiency of the activity device *i* in each batch *j* due to aging shall be accounted for during the monitoring period. A default linear decrease in efficiency up to the terminal efficiency (i.e., efficiency during last year of device life) of 20% shall be applied through the life of the activity device. For example, if the life of the activity device is five years and the activity device has an efficiency of 30% at commissioning, then a 2% decrease in efficiency every year shall be applied.[[12]](#footnote-13) Alternatively, the manufacturer of the activity devices shall confirm with technical justification based on certification by a national standards body or a certifying body recognized by the Rwandan government that no decrease in efficiency of activity devices is envisaged during the crediting period.
4. Leakage shall be determined based on multiplying *By,i,j*by a “net to gross adjustment factor” of 0.95. This is based on the standard default value to account for leakage under the CDM and is already included in Equation 2.
5. Data and parameters not monitored

| *Parameter* | *Description* | *Value* | *Units* |
| --- | --- | --- | --- |
| fNRB | Fraction of non-renewable biomass | 64.7%[[13]](#footnote-14) | % |
| $$η\_{old,i,j}$$ | Efficiency of the baseline system being replaced. There are two options depending on the type of stove used predominantly in the baseline. Fixed for each individual household when included in the activity database | Traditional wood stove: 15%Charcoal stove: 25% | % |
| Bold,i,j | Annual quantity of woody biomass per device that would have been used in the absence of the activity to generate useful thermal energy equivalent to that provided by the activity device type *i* and batch *j* | 2.81 for firewood and 0.67 for charcoal[[14]](#footnote-15)  | Tonnes/ device/ year |
| Np,HH | Average number of persons per household | 4.0 [[15]](#footnote-16) | Number  |
| NCVbiomass | Net calorific value of non-renewable woody biomass that is substituted | For wood fuel: 0.0156 For charcoal: 0.029  | TJ/tonne |
| CFcharcoal | Conversion factor from woody biomass to charcoal, defining the number of mass units of wood consumed to produce one unit of charcoal.  | 7.7[[16]](#footnote-17) | - |
| EFCO2 | CO2 emission factor for woody biomass used (same value for firewood and charcoal). | 112 [[17]](#footnote-18) | t CO2/TJ |
| EFNon-CO2 | Non-CO2 emission factor for biomass that is substituted. | For wood fuel: 9.46  | t CO2e/TJ |
| LEy | Leakage emissions in year y to account for leakage effects due to the use/diversion of non-renewable woody biomass saved under the activity by non-activity households. *By,i,j* is multiplied by this net to gross adjustment factor to account for leakage | 0.95 | - |
| Operating life | The operating lifetime of the activity device, reported by the stove manufacturer (certified by a national standards body or a certifying agent recognized by that body). | Reported by stove manufacturer[[18]](#footnote-19) | Years |
| $$η\_{new,i,j}$$ | Efficiency of the device of each type *i* and batch *j* implemented as part of the activity. Activity Participant can submit testing results performed in laboratories that follow the method ISO 19867-1, according to the guidelines published by MININFRA.[[19]](#footnote-20)The loss of efficiency of activity devices *i* in each batch *j* due to aging shall be accounted for during the monitoring period *y* as described below. | Efficiency  | % |
| Loss in efficiency of activity device | One of the following two options can be used to determine the efficiency loss:1. The loss in efficiency of the activity device i in each batch j due to aging shall be accounted for during the monitoring period.
2. Alternatively, the manufacturer of the project devices shall confirm with technical justification based on certification by a national standards body or an appropriate certifying agent recognized by that body that no decrease in efficiency of project device is envisaged during the crediting period.
 | Linear decrease in efficiency up to the terminal efficiency (i.e., efficiency during last year of device life) of 20%. |  |

1. Upfront data collection

In order to be able to track and trace the cookstoves implemented, the following information must be collected in a centralized, transparent database:

* Cookstove owner’s name and personal identification number.
* Cookstove owner’s phone number.
* Cookstove owner’s address.
* Unique serial number allocated to the cookstove.[[20]](#footnote-21)
* Date of sale of the cookstove to the end user.
* Primary fuel used before receiving an improved cookstove (i.e., firewood or charcoal).
* Type of activity device.
1. Monitoring requirements

| *Parameter* | *Unit* | *Description* | *Monitoring approach* | *Monitoring frequency* |
| --- | --- | --- | --- | --- |
|  |  |  |  | *Once upfront/first year* | *Contin-uous* | *Annual* |
| Ny,i,j | Number | Cumulative number of activity devices of type i and batch j sold up to year y | **Source of data:** Recorded in the activity database, with verifiable documentary evidence to support numbers reported.During project activity implementation, the data summarized in Section 8 shall be recorded for each cookstove sold. |  |  |  |
| Date of sale | Date | Date of sale of batch *j* or activity device *i* | **Source of data:** Recorded in the activity database, with verifiable documentary evidence to support numbers reported. [[21]](#footnote-22)  |  |  |  |
| Sy,i,j | % | Share of activity devices of type *i* and batch *j* operating during year *y* | **Source of data:** Representative sample survey.**Sample size:** Minimum sample size of 68 for activity devices of type *i* (grouped into charcoal and firewood-using devices)and batch *j* (year of sale). [[22]](#footnote-23)**Measurement procedures:** The parameter is based on the percentage of devices operational as determined by the sample survey (e.g., if survey shows that 10% of the devices are non-operating, an adjustment of 0.9 shall be applied to activity devices sold in a particular batch). Separate samples shall be taken for each batch.[[23]](#footnote-24) Monitoring shall take place via onsite visits to determine whether they still use their cookstove. [[24]](#footnote-25) |  |  |  |
| $$μ\_{y,i,j}$$ | % | Adjustment to account for any continued use of pre-activity devices of type *i* and batch *j* operating during year *y*  | **Source of data:** Representative sample survey.**Sample size:** Minimum sample size of 68 for activity devices of type *i* (grouped into charcoal and firewood-using devices)and batch *j* (year of sale). [[25]](#footnote-26)**Measurement procedures:** The parameter is based on the number of meals per day cooked in the pre-activity device as determined by the sample survey. The value of the parameter shall be set as follows:* 100% if the pre-activity deviceis not used**,**
* 66% if onemeal a day is cooked in the pre-activity device.
* 33% if two meals a day are cooked in the pre-activity device.
* 0% if the pre-activity device is used alongside the activity stove
 |  |  |  |

1. Version history

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| --- | --- | --- |
| *Version* | *Date* | *Contents revised* |
| 1.0 | 06/04/2023 | Initial adoption  |

Appendix 1. Sample size

There are different equations to calculate a required sample size for different situations and parameters of interest. This appendix includes the equations to calculate sample sizes for parameters measuring percentages or proportions, and continuous numeric values. All equations included here are to be used following a simple random sampling approach.

Percentages or proportions

The sample shall meet a 95/10 level of confidence/precision for all parameters monitored via sampling. The sample size shall be calculated using the following equation:

$$n \geq \frac{t^{2} × N × p(1-p)}{\left(N-1\right) × 0.1^{2}× p^{2}+ t^{2}× p(1-p)}$$

Where

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| --- | --- | --- |
| $$n$$ | = | Sample size (number of households to be included in the sample) |
| N | = | Total number of households |
| p | = | Expected proportion of households with operating cookstoves. A value of 0.85 is used |
| t | = | Represents the confidence required (%). Use a value of 1.96 for annual monitoring, in which 95% confidence is required. |
| 0.1 | = | Represents the 10% relative precision |

Using the values above, the minimum sample size to meet 95/10 level of confidence/precision is 68. An oversampling factor of 10% is used to compensate for any attrition, outliers or non-response associated with the sample, and to prevent a situation at the analysis stage where the required reliability is not achieved, and additional sampling efforts would be required. The resulting recommended sample size is then 75 households 95/10 level of confidence/precision.

Appendix 2. Updates to SCF pilot methodology

The SCF pilot was based on the Inyenyeri improved cookstove program. For the current roll out of the SCF in Rwanda, the methodology has been updated to reflect current best practice in international carbon markets. The table below explains the impact on specific parameters and rationale for the updates.

**Table A1: Updates to Rwanda SCF clean cooking methodology**

| *Approach in SCF Pilot* | *Approach in SCF roll out* | *Rationale* |
| --- | --- | --- |
| For a three-stone fire using firewood (not charcoal), or a cookstove with no improved combustion air supply or flue gas ventilation (i.e., without a grate or a chimney), the default value is 0.10; b) For other type of devices, the default value is 0.20. | For a three-stone fire using firewood (not charcoal), or a cookstove with no improved combustion air supply or flue gas ventilation (i.e., without a grate or a chimney), the default value is 0.15; b) For other type of devices, the default value is 0.25. | Following the default parameters from the updated version of the CDM methodology AMS-II.G. v13. |
| An average household size of 4.25 pp/hh. | An average household size of 4.0 pp/hh. | This value applied in the SCF Pilot was based on the 2012 household census in Rwanda. The value applied in SCF Rollout is sourced from the 5th Rwanda Population and Housing Census, conducted in 2022 and published in 2023 by the National Institute of Statistics of Rwanda. |
| The default value for the average annual consumption of woody biomass is 0.5 tonnes/person/year (wet basis). | The fuel consumption per household per year is the following:2.81 tonnes for firewood, and 0.67 tonnes for charcoal. | Options to calculate fuel include fuel consumption per household, assuming one device per household. Values sourced from the *National Survey on Cooking Fuel Energy and Technologies in Households, Commercial and Public Institutions in Rwanda,* implemented by the Centre for Economic and Social Studies (CESS) in 2020 |
| Applies a fNRB value of 90%. | Applies a fNBR value of 64.7%, based on more spatially disaggregated analysis of forest cover in Rwanda. | Sourced from research commissioned by CiDev and supporting analysis - Bailis (2015) [[26]](#footnote-27) |
| Applies a wood-to-charcoal conversion factor of 9. | Applies a wood-to-charcoal conversion factor of 7.7. | In absence of a national research or peer reviewed and published literature, the value from the CDM standardized baseline for Rwanda is used.  |
| Five options to measure the biomass savings | One option to measure the biomass savings | Options 1 and 2 were dropped for simplicity. Option 1 required monitoring the usage hours of the activity stove, while Option 2 required conducting a KPT to measure fuel consumption. Option 4 (pellet stoves) was dropped because no pellet stoves have been sold in Rwanda in recent years. This option might be added in the future. |

1. Activity Participant is the public or private entity that is the developer or owner of the activity (i.e., project or program) and/or has the legal right to the mitigation outcomes  [↑](#footnote-ref-2)
2. See Table 3 of the Ministerial Guidelines for Clean Cooking Technologies published by MININFRA to see the standards that apply to different cooking technologies at: https://www.reg.rw/fileadmin/user\_upload/Ministerial\_Guidelines\_for\_Clean\_Cooking\_Technologies.pdf [↑](#footnote-ref-3)
3. The activity (i.e., projects or programs) described in the activity documentation under the CDM, SCF, Article 6.4 Mechanism, or another Crediting Mechanism, capable of generating Emission Reductions under a crediting mechanism [↑](#footnote-ref-4)
4. The efficiency of activity devices distributed in 2022 and 2023 shall be at least 24%. [↑](#footnote-ref-5)
5. When switching from firewood to charcoal, there is a risk that emissions in the activity scenario are higher than the emissions in in the baseline scenario because of the energy intensity of charcoal production. [↑](#footnote-ref-6)
6. This value matches the value adopted by the Rwanda Environment Management Authority for activities seeking financing from the Green Climate Fund. [↑](#footnote-ref-7)
7. See Table 3 of the Ministerial Guidelines for Clean Cooking Technologies published by MININFRA to see the standards that apply to different cooking technologies, at: https://www.reg.rw/fileadmin/user\_upload/Ministerial\_Guidelines\_for\_Clean\_Cooking\_Technologies.pdf [↑](#footnote-ref-8)
8. World Bank (2020). Fraction of non-renewable biomass in emission crediting in clean and efficient cooking projects. A review of concepts, rules, and challenges. Available at <https://www.ci-dev.org/knowledge-center/fraction-non-renewable-biomass-emission-crediting-clean-and-effiecient-cooking>; Country-specific values can be found at Bailis et.al. (2015). The Carbon Footprint of Traditional Woodfuels. Available at: <https://www.researchgate.net/publication/271503594_The_Carbon_Footprint_of_Traditional_Woodfuels>. Alternatively, official values published or recognized by relevant Rwandan authorities may be used, if available. [↑](#footnote-ref-9)
9. Activity Participant can submit testing results performed in laboratories that follow the method ISO 19867-1, according to the guidelines published by MININFRA. [↑](#footnote-ref-10)
10. For households that have more than one stove, credits can only be claimed for one stove. [↑](#footnote-ref-11)
11. CDM Standardized baseline on sustainable charcoal production in Rwanda, PSB0045. Available at: https://cdm.unfccc.int/methodologies/standard\_base/2015/sb117.html [↑](#footnote-ref-12)
12. Note that the 2% mentioned in this paragraph is just an illustrative example, based on the hypothetical situation in which the lifetime of the device as per the manufacturer’s specifications is five years. The efficiency drop shall be calculated based on the lifetime of each device as per manufacturer’s specifications. [↑](#footnote-ref-13)
13. Value sourced from World Bank (2020). Fraction of non-renewable biomass in emission crediting in clean and efficient cooking projects. A review of concepts, rules, and challenges. Available at <https://www.ci-dev.org/knowledge-center/fraction-non-renewable-biomass-emission-crediting-clean-and-effiecient-cooking>; Country-specific values can be found at Bailis et.al. (2015). The Carbon Footprint of Traditional Woodfuels. Available at: <https://www.researchgate.net/publication/271503594_The_Carbon_Footprint_of_Traditional_Woodfuels>.

 Alternatively, official values published or recognized by relevant Rwandan authorities may be used, if available. The source of these values shall be backed up by research either using the CDM Tool 30 for the calculation of fNRB or other appropriate methodology. [↑](#footnote-ref-14)
14. Values sourced from the *National Survey on Cooking Fuel Energy and Technologies in Households, Commercial and Public Institutions in Rwanda,* implemented by the Centre for Economic and Social Studies (CESS) in 2020. To express the amount of charcoal into wood-equivalent, the 0.67 tons/year must be multiplied by the wood to charcoal conversion factor applied. For example, applying the default conversion factor of 4, the amount of wood equivalent for charcoal using households is calculated as 0.67 tons/year x 4 = 2.67 tons of wood equivalent per year. [↑](#footnote-ref-15)
15. Value sourced from *5th Rwanda Population and Housing Census (PHC)*, conducted in 2022 and published in 2023 by the National Institute of Statistics of Rwanda*.* Available at: https://www.statistics.gov.rw/publication/key-figures-5th-rwanda-population-and-housing-census-phc. [↑](#footnote-ref-16)
16. CDM Standardized baseline on sustainable charcoal production in Rwanda, PSB0045. Available at: https://cdm.unfccc.int/methodologies/standard\_base/2015/sb117.html. [↑](#footnote-ref-17)
17. IPCC default for wood fuel. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Tables 1.4 and 2.2. Available [here](https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf). [↑](#footnote-ref-18)
18. Average lifetime is 3.69 years for a wood-burning stove and 4.4 years for a charcoal stove. For source, see Jeuland, M., & Soo, T. S. (2019). Analyzing the costs and benefits of clean and improved cooking solutions. Table 4. Available at: https://www.cleancookingalliance.org/binary-data/ATTACHMENT/file/000/000/355-1.pdf. [↑](#footnote-ref-19)
19. See Table 3 of the Ministerial Guidelines for Clean Cooking Technologies published by MININFRA to see the standards that apply to different cooking technologies, at: https://www.reg.rw/fileadmin/user\_upload/Ministerial\_Guidelines\_for\_Clean\_Cooking\_Technologies.pdf [↑](#footnote-ref-20)
20. For households that have more than one improved cookstove, credits can only be claimed for one stove. [↑](#footnote-ref-21)
21. Separate batch sampling is required for devices sold in different calendar years. [↑](#footnote-ref-22)
22. The minimum sample size (target) is 68 households. Activity Participant shall add +10% (i.e., 7 households) to the survey campaign to ensure this minimum sample size is reached [↑](#footnote-ref-23)
23. Separate batch sampling is required for devices sold in different calendar years. [↑](#footnote-ref-24)
24. Monitoring via phone calls and time-stamped pictures is allowed only when unforeseeable circumstances prevent from conducting onsite visits (e.g., armed conflicts, pandemic). [↑](#footnote-ref-25)
25. The minimum sample size (target) is 68 households. Activity Participant shall add +10% (i.e., 7 households) to the survey campaign to ensure this minimum sample size is reached [↑](#footnote-ref-26)
26. World Bank (2020). Fraction of non-renewable biomass in emission crediting in clean and efficient cooking projects. A review of concepts, rules, and challenges. Available at <https://www.ci-dev.org/knowledge-center/fraction-non-renewable-biomass-emission-crediting-clean-and-effiecient-cooking>; Country-specific values can be found at Bailis et.al. (2015). The Carbon Footprint of Traditional Woodfuels. Available at: https://www.researchgate.net/publication/271503594\_The\_Carbon\_Footprint\_of\_Traditional\_Woodfuels [↑](#footnote-ref-27)