VCS Methodology

VM0050

ENERGY EFFICIENCY AND FUEL-SWITCH MEASURES IN COOKSTOVES

Version 1.0

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Sectoral Scope 3: Energy Demand

Version 1.0 of this methodology was developed by Atmosphere Alternative S.A.S. and Verra.

CONTENTS

1 SUMMARY DESCRIPTION

Additionality, Crediting Method, and Mitigation Outcome	
Additionality	Activity Method / Project Method
Crediting Baseline	Project Method
Mitigation Outcome	Reductions

This methodology applies to project activities that introduce energy efficiency and fuel-switch measures in cookstoves. Projects must be implemented in households, community-based kitchens, institutions (e.g., schools, hospitals), or small and medium-sized enterprises[1] (SMEs).

2 SOURCES

This methodology is based on the following methodologies:

- *CDM AMS-II.G. Energy Efficiency Measures in Thermal Applications of Non-Renewable Biomass, v13.1*
- *CDM AMS-I.E. Switch from Non-renewable Biomass for Thermal Applications by the User, v13.0*
- *VMR0006 Energy Efficiency and Fuel Switch Measures in Thermal Applications, v1.2*

This methodology uses the most recent versions of the following methodologies, tools, and guidelines:

- *VCS Tool VT0008 Additionality Assessment*
- *VCS Tool VT0010 Emissions from Electricity Consumption* (under development)
- *CDM AMS-III.K. Avoidance of Methane Release from Charcoal Production*
- *CDM General Guidelines for SSC CDM Methodologies*
- *CDM Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*
- *CDM TOOL01 Tool for the Demonstration and Assessment of Additionality*

[1] This includes micro enterprises. Some regions and countries refer to micro, small, and medium enterprises (MSMEs).

- *CDM TOOL03 Tool to Calculate Project or Leakage CO_2 Emissions from Fossil Fuel Combustion*
- *CDM TOOL05 Baseline, Project and/or Leakage Emissions from Electricity Consumption and Monitoring of Electricity Generation*
- *CDM TOOL07 Tool to Calculate the Emission Factor for an Electricity System*
- *CDM TOOL12 Project and Leakage Emissions from Transportation of Freight*
- *CDM TOOL15 Upstream Leakage Emissions Associated with Fossil Fuel Use*
- *CDM TOOL16 Project and Leakage Emissions from Biomass*
- *CDM TOOL24 Common Practice*
- *CDM TOOL30 Calculation of the Fraction of Non-renewable Biomass*
- *CDM TOOL33 Default Values for Common Parameters*

This methodology refers to the most recent versions of the following protocols developed collaboratively between Clean Cooking Alliance (CCA) and partners:

- *Durability Protocol*
- *Controlled Cooking Test Protocol*
- *Kitchen Performance Test Protocol*
- *Water Boiling Test Protocol*

3 DEFINITIONS

Batch
The population of a device of the same type commissioned during a certain period (e.g., week or month) in a certain calendar year[2]

Biomass[3]
Non-fossilized and biodegradable organic material originating from plants, animals, and micro-organisms. This also includes products, by-products, residues, and waste from agriculture, forestry, and related industries as well as the non-fossilized and biodegradable organic fractions of industrial and municipal wastes.

[2] Multiple batches may be installed within a single calendar year, and the date of commissioning of the last project device of the batch is used as the commissioning date for the entire batch.

[3] Based on the CDM definition, available at: https://cdm.unfccc.int/Reference/Guidclarif/mclbiocarbon.pdf

Biomass residue[3]
Organic material that remains after the primary product has been extracted or harvested. These residues are often biomass by-products, residues, and waste streams from agriculture, forestry, and related industries.

Electric cooking device
Project device powered by electricity and connected to national/regional grid or mini grids. Examples include induction cook stoves, hot plates, ceramic cooking-hob with heating coils, electric pressure cookers, slow cookers, crock pots, electric rice cookers, and multi cookers.

Improved cookstove
A cooking device that reduces greenhouse gas (GHG) emissions from traditional baseline technologies through energy efficiency improvements and/or fuel switching to a less GHG-intensive fuel

Project device
An individual improved cookstove unit used as part of the project activity

Self-generated renewable electricity
Electricity produced locally in off-grid systems using renewable energy sources, such as photovoltaic solar energy, that is used to power cookstoves

Technical life
Total time for which an improved cookstove is technically designed to operate from its first commissioning, expressed in years or hours of operation

Note – All references to "average" in this document refer to the mean, calculated as the sum of all values divided by the number of values.

4 APPLICABILITY CONDITIONS

This methodology applies to project activities that introduce energy efficiency and fuel-switch measures in cookstoves.

This methodology is applicable where all of the following conditions are met:

1) The project activity corresponds to:

   a) Replacement of non-renewable biomass (e.g., firewood, charcoal)-fired cookstoves with any of the following:

      i) More efficient project devices that use the same fuel as in the baseline;

      ii) Efficient project devices fired by renewable biomass or bioethanol;

      iii) Efficient project devices fired by liquefied petroleum gas (LPG); or

iv) Electric-powered project devices.

b) Replacement of solid or liquid fossil fuel (e.g., coal, kerosene)-fired cookstoves with any of the following:

i) Efficient project devices fired by renewable biomass or bioethanol;

ii) Efficient project devices fired by LPG; or

iii) Electric-powered project devices.

2) Project devices are used in households, communities, institutions, or small or medium enterprises (SMEs),[4] collectively referred to in this methodology as the “target population.”

Use of renewable biomass

3) Where renewable biomass is used, it is exclusively renewable[5] and qualifies as one of the following:

a) A by-product, residue, or waste stream from agriculture, forestry, and related industries; or

b) Originating from dedicated plantations that comply with all relevant applicability conditions in the most recent version of CDM *TOOL16*.

4) Where biomass residues are used, they would have been left to decay or burned without energy recovery before implementation of the project activity, and their use does not involve a decrease in carbon pools – in particular of dead wood, litter, or soil organic carbon – on the land areas from which the biomass residues originate.

5) Where biomass residues from a production process are used, project implementation does not result in an increase in the processing capacity of raw input or any other substantial changes (e.g., product change) in this process.

6) Where more than one type of renewable biomass is used, each of the biomass types used complies with the applicability conditions.

Note – Renewable biomass may be processed into fuels, such as briquettes, wood chips, or charcoal.

7) Where project activities introduce renewable biomass as charcoal, it is renewable charcoal produced by efficient charcoal production processes[6] (e.g., retort sedentary

4 This includes micro enterprises.

5 Refer to EB 23 Annex 18 for definition of renewable biomass; available at: https://cdm.unfccc.int/EB/023/eb23_repan18.pdf

6 Where kilns emit a minimal amount of methane during the charcoaling process (i.e., an efficient process is employed that results in high charcoal yield) and the small amount of methane that is emitted is captured and used or destroyed.

kilns, improved sedentary kilns, Casamance kilns). Methane produced during the charcoaling process is captured and destroyed or combusted for energy purposes.

Cookstove characteristics[7] and use

8) Project devices using renewable biomass (fuel-switch) or non-renewable biomass (improved efficiency) are single-pot, multi-pot portable, or in-situ cookstoves with an initial thermal efficiency[8] of at least 25%.[9]

9) Project devices using LPG or bioethanol are single-pot, multi-pot portable, or in-situ cookstoves with an initial thermal efficiency of at least 30%.

10) Electric project devices[10] meet the maximum risk factor score of 15 on the *Cookstove Durability Protocol*[11] and have the following minimum thermal efficiency:

    a) Hot plates and electric hobs: 40%

    b) Induction stoves and other electric stoves: 70%

11) Project devices using LPG comply with all of the following conditions:

    a) The baseline fuel either includes non-renewable biomass or is a more carbon-intensive fossil fuel (demonstrated by the baseline survey, see Section 6.2);

    b) The project has a provision for metering LPG supplied to each consumer at the LPG filling station, in order to determine household LPG consumption; and

    c) The project does not seek to issue any carbon credits for periods after 31 December 2045.

12) Electric project devices use the following electricity sources:

    a) Decentralized renewable energy systems: Decentralized energy systems using fossil fuels are not eligible, except for backup generators that supply less than 1% of the annual electricity of the decentralized renewable energy system.[12]

    b) Self-generated renewable electricity (with a maximum of 20% electricity from non-renewable sources for backup); or

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[7] Only thermal efficiency and durability of cookstoves are evaluated.

[8] Initial thermal efficiency for a new stove, which is expected to deteriorate during the project lifetime

[9] Efficiency thresholds of 20% (Tier 2), 30% (Tier 3), and 40% (Tier 4) from ISO/TR 19867-3, available at: https://www.iso.org/standard/73935.html

[10] Defined as clean technologies by WHO; see https://www.who.int/tools/clean-household-energy-solutions-toolkit/module-7-defining-clean

[11] The *Cookstove Durability Protocol* (endorsed by the Clean Cooking Alliance) provides methods for evaluating cookstove durability by carrying out a range of targeted tests. Each test incorporates a numeric scoring method and cookstoves are scored based on their (durability) risk level. The higher the risk of durability issues, the higher the overall score. The most recent version of the protocol is available here.

[12] This restriction aims to avoid the introduction of new, inefficient fossil fuel-fired electricity generation to fuel electric cookstoves.

c) National or regional electricity grid.

13) The project proponent designs incentive mechanisms to reduce the use of inefficient baseline devices and practices that can be replaced by the project devices and describes these mechanisms in the project description.

14) Where a project device has ended its technical life, the project proponent either replaces it with a comparable or better project device or retrofits its essential components to continue meeting the minimum service level requirements (i.e., thermal energy generation), otherwise no further emission reductions may be claimed for the project device.

Avoiding harm and double counting

15) Project proponents implement a method for the distribution and identification of project devices that avoids double counting of emission reductions by other mitigation actions and includes unique product identification on the stove itself at the time of distribution/sale (e.g., program logo, alpha/numeric ID, and end-user location, such as geographic coordinates, complete address information).

16) The project complies with any national, sub-national, or local regulations or guidance for the installation, commercialization, distribution, and use of improved cookstoves and/or fuel supply and use for the target population. National, regional, and local regulatory frameworks for the provision of the type of thermal energy services provided by the project activity must be documented.

17) Where project activities reduce emissions from non-renewable biomass, including firewood and charcoal, the risk of double counting is assessed on a national basis by evaluating at validation and crediting period renewal whether there are REDD+ projects or jurisdictional REDD+ programs whose project boundary overlaps with the expected fuel source area of the project. The project proponent must report on the findings of this assessment for informational purposes in the project description.

Note – In the future, the VCS Program may adopt further requirements or guidelines related to the risk of double counting between improved cooking and REDD+ activities.

5 PROJECT BOUNDARY

The project boundary includes the project devices, the geographical site where they are located, and the locations from which baseline and project fuels are sourced.

Where project devices use electricity, the project boundary also includes the electricity generation, transmission, and distribution system.

The GHG sources included in or excluded from the project boundary are shown in Table 1.

Methane and nitrous oxide may be significant sources of GHG emissions especially where charcoal, biomass fuels, and biomass residues are used. The project proponent must assess the significance of such fuel emissions and apply the de minimis criterion in line with the most recent version of the *VCS Methodology Requirements* to determine which sources must be included.

Emissions from fuel production[13] and transportation may be ignored where they are higher in the baseline than the project scenario.

Table 1: GHG sources included in or excluded from the project boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Thermal energy generation	CO_2	Yes	Major source
		CH_4	Yes	May be significant for some fuels
		N_2O	Yes	May be significant for some fuels
	Production of charcoal fuel[14]	CO_2	Yes	Major source
		CH_4	Yes	May be significant for charcoal
		N_2O	Yes	May be significant for charcoal
Project	Thermal energy generation	CO_2	Yes	Major source
		CH_4	Yes	May be significant for some fuels
		N_2O	Yes	May be significant for some fuels
	Transport of fuel (where applicable)	CO_2	Yes	Major source
		CH_4	Yes	May be significant for some fuels
		N_2O	Yes	May be significant for some fuels
	Production of fuel (where applicable)	CO_2	Yes	Major source
		CH_4	Yes	May be significant for some fuels
		N_2O	Yes	May be significant for some fuels
	Self-generated electricity (non-renewable energy for backup)	CO_2	Yes	Major source
		CH_4	Yes	May be significant for some fuels
		N_2O	Yes	May be significant for some fuels
	Grid electricity generation and distribution	CO_2	Yes	Major source
		CH_4	No	Negligible
		N_2O	No	Negligible

[13] For example, energy use for renewable biomass processing, such as shredding and compacting in the case of briquetting, may be considered to be equivalent to the upstream emissions associated with the processing of a displaced fossil fuel and hence may be disregarded.

[14] Includes fugitive emissions from charcoal production. Production of fossil fuels is not considered, which is conservative.

For non-renewable biomass fuels, the project proponent must provide a kml file delimiting the geographic area(s) of origin of the biomass fuel used in the project and a description of how that area is defined.

6 BASELINE SCENARIO

The baseline scenario including the GHG sources must be defined according to the technologies, practices, fuel types, and fuel consumption patterns that will be replaced by the project devices in the defined target population.

6.1 Selection and Justification of the Baseline Scenario

Step 1: Identify alternative baseline scenarios

Define the alternative baseline scenarios according to the cookstove unit type, the type of thermal energy service provided, the fuel type and source, and describe the GHG sources involved.

The alternative baseline scenarios must include both existing and alternative cookstove technologies that provide comparable outputs for cooking to the users of the target population. The project activity without being registered as a project activity under a GHG program must be included as an alternative.

Where the project activity replaces a mix of technologies, services, and/or fuel types, the baseline alternative must be defined in a conservative way considering these variables. Where multiple fuels are used in the baseline, the proportion of baseline fuel usage may be established in terms of energy supplied by each of the identified fuels.

The baseline alternatives must be defined using the results of a baseline survey of the target population and cross-checked with relevant and current information from credible literature from the specific project region, official publications (e.g., surveys, studies), or official statistics from government entities or other credible agencies. The baseline survey of the target population must apply the procedures and practices described in Section 6.2.

Step 2: Consider existing and forthcoming government policies and legal requirements

Eliminate the baseline alternatives that are inconsistent with existing and forthcoming mandatory legal or regulatory requirements. These may include minimum product efficiency standards and air quality requirements.

Where the legal or regulatory requirements are systematically not enforced and non-compliance is widespread in the applicable geographic region, include the alternative scenarios in the list for further consideration. Demonstration of non-enforcement must be based on authoritative and up-to-date information that is relevant and applicable to the alternative scenario.

Where the mandatory legal or regulatory requirements are enforced, eliminate the alternative scenario from further consideration.

Step 3: Assess financial, institutional, and information barriers

Establish a complete list of realistic and credible barriers that may prevent alternative scenarios from occurring. The barriers must be based on the actual context of the project activity and alternatives and the applicable geographic area, reflecting practical challenges to activity implementation. The applicable geographic region is:

a) the entire host country (default); or
b) defined as per the most recent version of *VT0008 Additionality Tool*.

Eliminate the baseline alternatives that face financial, institutional, or information barriers. These barriers are further explained in Step 2a of *VT0008*.

The remaining baseline scenario(s) must be one, or a combination, of the following:

i) Non-renewable biomass: The baseline scenario is the target population's continued use of inefficient cookstoves fired with non-renewable firewood or charcoal to meet similar thermal energy outputs for cooking as the project devices. Project proponents may use a combination of different non-renewable biomass types in the baseline.
ii) Fossil fuels: The baseline scenario is the target population's continued use of cookstoves fueled by solid or liquid fossil fuels (e.g., coal, kerosene) to meet similar thermal energy outputs for cooking as the project devices.

Cookstoves that have a fuel other than non-renewable biomass or solid or liquid fossil fuels (e.g., electricity, solar thermal, renewable biomass, LPG) in the baseline scenario must be excluded from the project activity.

6.2 Baseline Scenario Survey Requirements

The objective of the baseline survey is to collect critical information related to existing baseline technologies, services, fuel types, and fuel sources in the target population. The survey must be designed, carried out, and analyzed in line with the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*.

The survey results must define the following for each target population:

1) Baseline fuel type(s) and the percentage of their use by the target population;
2) Source(s) of each baseline fuel (i.e., collected, purchased, or procured through other means);
3) Baseline technologies for cooking and the percentage of their use by the target population; and
4) Average household size (Hh_i).

The survey results must be validated against relevant and current information from credible literature, official publications (e.g., independent surveys, studies), or official statistics from government entities or other credible agencies.

Where survey results for any of the above criteria (i.e., baseline fuel types, fuel sources, cooking technologies, or average household size) deviate significantly from official statistics or credible literature and may lead to a non-conservative baseline, project proponents must:

1) provide additional justification and rationale to explain the deviation, including specific evidence demonstrating why the official literature or statistics are not representative of the target population; or
2) use the values from the literature, official publications, or official statistics for the target population.

The initial baseline survey must be performed prior to validation. The project proponent may employ local third-party agencies to carry out the baseline survey. Follow-up baseline surveys must be conducted every two years in control households that do not participate in the project.

These control households must be established prior to validation and must be shown to be statistically equivalent to the pre-project conditions of project households regarding baseline fuel type(s) and percentage of use by the target population, source(s) of each baseline fuel, and baseline technologies for cooking. For existing projects updating to *VM0050*, control households must be established before the first verification under *VM0050*.

A binding questionnaire is presented in Appendix 3. The project proponent may adopt a different format but must include these questions as a minimum.

Survey and data collection methods: The baseline survey performed prior to validation and prior to crediting period renewal must be conducted as physical on-site visits (face-to-face), whereas follow-up baseline surveys during the crediting period may be conducted either as physical on-site visits (face-to-face) or through remote surveys via phone call or virtual meeting.

Timing: The baseline survey must be scheduled to avoid major festivals, holidays, and similar events that could impact the outcomes. It must be scheduled in a way that ensures that the results are conservative, given seasonal variability.

Sample size calculations: The surveys must be conducted for each target population. Where project devices are distributed within regions or target populations with heterogenous conditions (e.g., regional variations in fuel types or cooking practices), the target population must be divided into clusters/groups with homogeneous conditions.

The minimum sample size must be determined with respect to use of baseline fuel types and baseline technologies, and household size.

The following key factors must be considered when determining the minimum sample size:

a) Calculations may be completed manually or with appropriate statistical software.

b) The confidence level and precision must be at least 90/10.

c) The target value must be identified (i.e., the expected value of the parameter).

Where a survey covers two or more project activity instances, and the population is homogeneous, simple random sampling must be used. Where the population consists of varying sub-populations (i.e., is not homogenous), stratified random sampling must be used.

Survey reporting: The data collection method and the protocol for producing the final dataset and results must be documented in the project description and monitoring reports.

7 ADDITIONALITY

Project proponents must demonstrate additionality through demonstration of regulatory surplus and either confirming that the project activity is on the positive list (activity method) or conducting an investment analysis and common practice analysis (project method).

Step 1: Regulatory surplus

The project proponent must demonstrate regulatory surplus in accordance with the rules and requirements regarding regulatory surplus set out in the most recent versions of the *VCS Standard* and *VCS Methodology Requirements*.

Step 2: Positive list

The project activity must meet both of the following conditions to qualify for the positive list:

1) The project activity introduces:

    a) Efficient biomass-fired cookstoves that replace inefficient biomass-fired cookstoves;

    b) Efficient, solely renewable biomass-fired cookstoves that replace fossil fuel-fired cookstoves; or

    c) Electric cookstoves that replace inefficient biomass-fired or fossil fuel-fired cookstoves.

2) The project activity installs or distributes improved cookstoves at zero cost to the end-user and has no revenue source[15] other than from the sale of verified carbon units (VCUs).

[15] Including revenues from selling of firewood, charcoal, LPG, bioethanol, or any commercial relationship with fuel providers

Projects that pass the regulatory surplus test (Step 1) and are on the positive list (Step 2) are deemed additional and are not required to apply Step 3.

Step 3: Project method

If the project activity is not on the positive list (Step 2), additionality must be demonstrated by applying a barrier analysis or investment analysis as per the most recent version of *VT0008*.

The project proponent must also demonstrate that the project activity is not a common practice as per the most recent version of *VT0008.*

8 QUANTIFICATION OF REDUCTIONS AND REMOVALS

8.1 Baseline Emissions

Baseline emissions are calculated as follows:

$$BE_y = \sum_{i,j,k} EC_{i,y} \times N_{j,k,y} \times n_{j,k,y} \times \left(EF_{b,i,CO2} \times f_{NRB,y} + EF_{b,i,nonCO2}\right) \quad (1)$$

Where:

BE_y	=	Baseline emissions during year y (t CO_2e)
$EC_{i,y}$	=	Average energy consumption of baseline device type i in year y (TJ)
$N_{j,k,y}$	=	Number of commissioned project devices of type j from batch k in year y
$n_{j,k,y}$	=	Proportion of commissioned project devices of type j from batch k that remain operating in year y (fraction)
$EF_{b,i,CO2}$	=	CO_2 emission factor for fuel used by baseline device type i in the baseline scenario (t CO_2/TJ)
$f_{NRB,y}$	=	Fraction of woody biomass that is established to be non-renewable used by baseline device in year y; this variable is not considered for fossil fuels (fraction)
$EF_{b,i,nonCO2}$	=	Non-CO_2 emission factor for fuel used by baseline device type i in the baseline scenario (t CO_2e/TJ)
i	=	Baseline device type and its respective fuel type
j	=	Project device type and its respective fuel type

8.1.1 Average Energy Consumption of Baseline Device ($EC_{i,y}$)

The average energy consumption of baseline device type *i* is calculated as follows:[16]

$$EC_{i,y} = BC_{b,i,y} \times NCV_{b,i} \tag{2}$$

Where:

$BC_{b,i,y}$	=	Fuel used per baseline device type *i* during year *y* (tonnes)[17]
$NCV_{b,i}$	=	Net calorific value of baseline fuel for baseline device type *i* (TJ/tonne)

The quantity of fuel that would be used in the baseline scenario must be determined by one of the following two methods.

Option 1: Measurement campaign

A measurement campaign must be conducted following the procedures in the most recent version of the *Kitchen Performance Test Protocol.* Appendix 4 provides further guidance on measurement techniques. The sampling must comply with the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*. The campaign must achieve confidence and precision of at least 90/10 for the target parameter of average daily fuel consumption per adult equivalent. The result must be scaled appropriately using the average household size (Hh_i)[18] to obtain the value of $BC_{b,i,y}$. Where the project does not achieve the target precision in a monitoring period, the project proponent must apply an appropriate conservativeness deduction as per the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*. Energy consumption calculated using this option must be determined once prior to validation to obtain $BC_{ex\text{-}ante,b,i}$.

Option 2: Default values

$EC_{i,y}$ is calculated based on the default value for the average annual consumption of woody biomass per person for cooking:

- Firewood: 0.5 tonnes/capita/year of air-dried wood
- Charcoal: 0.13 tonnes/capita/year

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[16] Where charcoal is used as the fuel by baseline and/or project devices, the average energy consumption (derived from the average quantity of charcoal fuel used) in the baseline and/or project scenario may be determined by using a wood to charcoal conversion factor (*CF*) instead of the fuel emission factor. Further information is provided in the parameter table for *CF* in Section 9.1.

[17] This parameter corresponds to $BC_{ex\text{-}ante,b,i}$ for the first two years and where the follow-up baseline survey campaign shows that there are no significant changes in baseline fuel consumption. Otherwise, it corresponds to $BC_{b,i,y}$.

[18] This parameter is determined using the procedure described in Section6.2 9.1.

Where fuels other than firewood or charcoal are also used in the baseline, their energy use must be accounted for in equivalent terms to the values above.

The result must be scaled appropriately using the average household size (Hh_i) to obtain the value of $BC_{b,i,y}$.

Follow-up baseline surveys must be conducted every two years in control households that do not participate in the project. These households must be established prior to validation as statistically equivalent to the pre-project conditions of project households regarding fuel consumption. Where the biennial follow-up baseline survey campaigns reflect statistically significant changes to the baseline, baseline energy consumption must be updated (using a new measurement campaign conducted in control households) to obtain $BC_{b,i,y}$.

Cross-check of $EC_{i,y}$ to address stove stacking

Project proponents must address stove stacking (continued use of pre-project devices in project households) by comparing the quantity of baseline energy consumption determined by both options above ($EC_{i,y}$) to energy used in the project scenario ($EC_{p,y}$) using back-calculation. Where the results indicate that baseline consumption ($EC_{i,y}$) is higher than that indicated by back-calculation from the project scenario ($EC_{est,y}$) then stove stacking is occurring (as $EC_{p,y}$ is unable to completely capture household energy consumption from cooking due to the presence/use of pre-project devices). The back-calculation results ($EC_{est,y}$) must be applied in Equation (1) as a conservative cap, except where project devices are electric cooking devices with efficiency of 70% or higher. In this case, the back-calculation result is considered a reference value and project proponents may justify why it is not an appropriate cap by referring to peer-reviewed literature, third party assessments, and/or official data or statistics. Where it is not possible to justify energy use using these sources of information, the reference value must be applied as a conservative cap for such cases as well.

$$EC_{est,y} = EC_{p,y} \times \frac{\eta_{new,avg,y}}{\eta_{old,avg}} \tag{3}$$

Where:

$EC_{est,y}$	=	Back-calculated energy consumption of the potential mix of devices and fuels in the baseline in year y (TJ)
$EC_{p,y}$	=	Energy used in project scenario by project devices during year y (TJ)
$\eta_{new,avg,,y}$	=	Weighted average efficiency of project devices in year y (fraction)
$\eta_{old,avg}$	=	Weighted average efficiency of baseline devices that are eplaced by project devices (fraction)

$EC_{p,y}$ must be determined as follows, using the parameters determined as per Section 8.2. Alternatively, conversion from MWh to TJ must be undertaken where $EC_{p,y}$ is derived from Section 8.2.2.

$$EC_{p,,y} = \sum_{j,k} BC_{p,j,k,y} \times NCV_{p,j} \quad (4)$$

Where:

$BC_{p,j,k,y}$	=	Average quantity of fuel used by project device type *j* from batch *k* during year *y* (tonnes or m^3)
$NCV_{p,j}$	=	Net calorific value of project fuel used in project device type *j* (TJ/tonne or TJ/m^3)

8.1.1.1 Electric Project Devices With Additional Characteristics Affecting Energy Consumption

For electric pressure cooker project devices with additional characteristics that affect energy consumption (i.e., pressure), thermal efficiency does not reflect the cookstove's thermal performance. In such cases, Equation (5) must be applied to determine specific energy consumption. This requires the determination of specific energy consumption for both baseline and project scenarios using a Controlled Cooking Test (CCT). CCT is applied since the electric pressure cooker is not expected to replace all baseline cooking activities, but only those that can be performed by an electric pressure cooker.

The CCT must be conducted using dishes and cooking practices typical of the project region. The CCT must be performed for the same cooking tasks with both the project electric pressure cooker and baseline device(s). Cooking tasks that cannot be performed with the project electric pressure cooker must be excluded from the baseline CCT.

$$EC_{i,y} = EC_{p,j,k,y} \times 0.0036 \times \frac{SC_{p,j}}{SC_{b,i}} \quad (5)$$

Where:

$EC_{p,j,k,y}$	=	Annual consumption of electricity by electric project device type *j* from batch *k* in year *y* (MWh)
$SC_{p,j}$	=	Specific energy consumption of electric pressure cooker project device type *j* in the project scenario (TJ/test/person)
$SC_{b,i}$	=	Specific energy consumption of baseline device type *i* in the baseline scenario (TJ/test/person)

Where the project device replaces more than one type of baseline device, the specific consumption ($SC_{b,i}$) must be determined as the weighted average of the specific energy consumption of the replaced baseline cooking devices, weighted by the proportion of cooking tasks performed by the target population with each type of baseline cooking device.

$EC_{i,y}$ must be cross-checked as described above. $EC_{p,j,k,y}$ must be determined as per Section 8.2.2.

8.2 Project Emissions

Project emissions are calculated as follows:

$$PE_y = PE_{energy,y} + PE_{others,y} \tag{6}$$

Where:

PE_y	=	Project emissions during year *y* (t CO_2e)
$PE_{energy,y}$	=	Project emissions from energy consumption of project devices in year *y* (t CO_2e)
$PE_{others,y}$	=	Project emissions from other sources in year *y* (t CO_2e)

To determine project emissions from energy consumption of project devices ($PE_{energy,y}$), one of the following options (Sections 8.2.1–8.2.3) must be used.

8.2.1 $PE_{energy,y}$ from Biomass, Fossil Fuels, or Bioethanol

Project emissions from energy consumption of project devices using biomass, fossil fuels, or bioethanol in year *y* are calculated as follows:

$$PE_{energy,y} = \sum_j \sum_k BC_{p,j,k,y} \times N_{j,k,y} \times NCV_{p,j} \times n_{j,k,y} \times \left(EF_{p,j,CO2} \times f_{NRB,y} + EF_{p,j,nonCO2}\right) \tag{7}$$

Where:

$EF_{p,j,CO2}$	=	CO_2 emission factor for fuel used by project device type *j* in the project scenario (t CO_2/TJ)
$EF_{p,j,nonCO2}$	=	Non-CO_2 emission factor for fuel used by project device type *j* (t CO_2e/TJ)

The CO_2 emission factors for renewable biomass and other renewable energy sources are zero. Non-CO_2 emissions of these fuels must be accounted for where they are not deemed de minimis (see Section 5).

8.2.1.1 $BC_{p,j,k,y}$ for Project Devices

There are three approaches to calculating $BC_{p,j,k,y}$.

Option 1: Kitchen Performance Test

A measurement campaign following the *Kitchen Performance Test Protocol* must be designed, carried out, and analyzed in compliance with the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*. The campaign must achieve a confidence and precision of at least 90/10 for the target parameter of average daily fuel consumption per adult equivalent. Only the results for project stove fuel consumption are used to calculate project emissions. The result must be scaled appropriately using the average household size ($Hh_{j,k}$) to obtain the value of $BC_{p,j,k,y}$. Where the project does not achieve the target precision in a monitoring period, the project proponent must apply an appropriate conservativeness deduction as per Section 4 of the most recent version of CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities.*

Option 2: Direct measurement

Use direct measurement with equipment calibrated in accordance with national/international requirements. A sample of project devices may be measured such that a confidence and precision of 90/10 is achieved for the target parameter of total annual fuel use. The sampling must comply with the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*. Where the project does not achieve the target precision in a monitoring period, the project proponent must apply an appropriate conservativeness deduction as per Section 4 of the most recent version of CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities.*

Option 3: Fuel purchase monitoring (only for project devices using fossil fuels or bioethanol)

Where applying this option, the project proponent must:

1) keep continuous records of all fuel purchases (e.g., fuel purchase invoices from the supplier).
2) ensure fuel is used only for thermal energy generation by the project device (e.g., by using a fuel cylinder design that may only be attached to the project device).

8.2.2 $PE_{energy,y}$ from Electricity

Where the project activity involves the introduction of electric devices, project emissions are calculated as follows:

$$PE_{energy,y} = \sum_{j}\sum_{k} EC_{p,j,k,y} \times N_{j,k,y} \times n_{j,k,y} \times EF_{el,y} \times \left(1 + TDL_{j,y}\right) \qquad (8)$$

Where:

$EF_{el,y}$	=	Emission factor of the electricity system in year *y*; equal to zero for 100% renewable sources (t CO_2e/MWh)
$TDL_{j,y}$	=	Average technical transmission and distribution losses for providing electricity to project device type *j* in year *y*

Electricity consumption $EC_{p,j,k,y}$ must be estimated by one of the following two options (in MWh). For both options, where the project does not achieve the target precision in a monitoring period, the project proponent must apply an appropriate conservativeness deduction as per Section 4 of the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*.

Option 1: Kitchen Performance Test

A measurement campaign following the *Kitchen Performance Test Protocol* must be designed, carried out, and analyzed in compliance with the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*. The campaign must achieve a confidence and precision of at least 90/10 for the target parameter of average daily fuel consumption per adult equivalent. Only the results for project stove fuel consumption are used to calculate project emissions. The result must be scaled appropriately using the average household size ($Hh_{j,k}$) to obtain the value of $BC_{p,j,k,y}$.

Option 2: Direct measurement

Use direct measurement by metering. All project devices may be measured, or a sample of project devices may be measured, following the sampling approach described in the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities* with a confidence level and precision of at least 90/10. Where electricity consumption of all project devices is measured continuously, adoption rate ($n_{j,k,y}$) may be considered equal to one.

8.2.3 $PE_{others,y}$ from Transportation, Fuel Production, Fugitive Emissions, and Backup Generators

$$PE_{others,y} = PE_{transp,y} + PE_{prod,y} + PE_{fugitive,y} + PE_{backup,y} \quad (9)$$

Where:

$PE_{transp,y}$	=	Project emissions due to fuel transportation in year y (t CO_2e)
$PE_{prod,y}$	=	Project emissions due to fuel production in year y (t CO_2e)
$PE_{fugitive,y}$	=	Fugitive emissions in year y (t CO_2e)
$PE_{backup,y}$	=	Project emissions from backup generators in year y (t CO_2e)

Project emissions from fuel transportation ($PE_{transp,y}$)

$PE_{transp,y}$ must be estimated where the average transportation distance is greater than 200 km or where it is not demonstrated through valid means (like mapping tools) to be less than 200 km. In the latter case, a conservative estimate of the transportation distance must be used. The most recent version of CDM *TOOL12 Project and Leakage Emissions from Transportation of Freight* must be applied.

Where the average transportation distance is less than 200 km, it may be assumed that baseline and project emissions from fuel transportation are similar and project emissions may be excluded.

Project emissions from fuel production ($PE_{prod,y}$)

$PE_{prod,y}$ must be determined for renewable biomass (e.g., firewood) or biomass-derived fuels (e.g., bioethanol) by applying CDM *TOOL16 Project and Leakage Emissions from Biomass.* $PE_{prod,y}$ must include applicable emissions resulting from soil management, cultivation, thermal/mechanical processing, and biomass burning associated with fuel production.

Projects using LPG must apply CDM *TOOL15 Upstream Leakage Emissions Associated With Fossil Fuel Use* to determine upstream emissions.

Fugitive emissions ($PE_{fugitive,y}$)

$PE_{fugitive,y}$ from renewable charcoal must be estimated by applying the most recent version of *AMS-III.K. Avoidance of Methane Release from Charcoal Production*.[19]

Project emissions from backup generators ($PE_{backup,y}$)

For project devices using electricity from a mini-grid with backup generators, emissions from fuel consumption must be determined as follows:

$$PE_{backup,y} = \sum_{h} FC_{h,y} \times NCV_{h} \times EF_{fuel,h} \quad (10)$$

Where:

$FC_{h,y}$	=	Fuel consumption of backup generator *h* in year *y* (tonnes)
NCV_h	=	Net calorific value of fuel used by backup generator *h* (TJ/tonne)
$EF_{fuel,h}$	=	Emission factor for fuel used by backup generator *h* (t CO_2e/TJ)

8.3 Leakage Emissions

Leakage emissions (LE_y) must be accounted as follows:

1) Leakage emissions associated with reduced or avoided use of non-renewable biomass:

   a) Use of non-renewable biomass by other users and other types of GHG reversals[20]

[19] Using Equation 4 of *AMS-III.K, v5.0* or the equivalent equation in the most recent version.

[20] Other non-permanence risks, such as fires

b) Reuse outside the project boundaries of baseline devices that were replaced by project devices

An adjustment factor of 0.95 is applied to the GHG emission reductions in Equation (11) (i.e., 0.95 × (BE_y – PE_y)).

2) Leakage emissions associated with fossil fuel use:

a) Increased emissions from fossil fuel use by non-project participants

An adjustment factor of 0.95 is applied to the GHG emission reductions in Equation (11) (i.e., 0.95 × (BE_y – PE_y)).

3) Leakage emissions associated with use of renewable biomass ($LE_{RB,y}$):

a) Shift of pre-project activities due to the establishment of dedicated plantations for renewable biomass supply

b) Diversion of biomass residues from other uses to the project activity

These leakage emissions must be calculated using CDM *TOOL16*.

8.4 Net GHG Emission Reductions

Net GHG emission reductions are calculated as follows:

$$ER_y = (BE_y - PE_y) \times 0.95 - LE_{RB,y} \quad (11)$$

Where:

ER_y	=	Emission reductions during year *y* (t CO_2e)
$LE_{RB,y}$	=	Leakage emissions associated with use of renewable biomass during year *y* (t CO_2e)

9 MONITORING

9.1 Data and Parameters Available at Validation

Data/Parameter	$EF_{b,i,CO2}$ $EF_{p,j,CO2}$ $EF_{fuel,h}$
Data unit	t CO_2/TJ
Description	CO_2 emission factor for fuel used by baseline device type *i* in the baseline scenario CO_2 emission factor for fuel used by project device type *j* in the project scenario Emission factor for fuel used by backup generator *h*
Equations	(1, (7), (10)
Source of data	The following data sources may be used, listed in descending order of preference: • Option 1: Project-specific value • Option 2: Regional or national default values • Option 3: Default value from the most recent version of the *IPCC Guidelines for National Greenhouse Gas Inventories*
Value applied	Depends on the source of data chosen.
Justification of choice of data or description of measurement methods and procedures applied	The values must be determined ex ante by using one of the following means: 1) Testing in accredited/recognized laboratories: Measurements must be undertaken in line with national or international fuel standards. 2) Use of national default values 3) Use of default values from the most recent version of the *IPCC Guidelines for National Greenhouse Gas Inventories* **Wood:** 112 t CO_2/TJ **Charcoal:** • 112 t CO_2/TJ (combustion only): Apply where renewable charcoal is used in the project[21] and emissions from production of charcoal are estimated as project emissions ($PE_{fugitive,y}$). • 165.22 t CO_2/TJ (combustion and charcoal production emissions): Apply where non-renewable biomass charcoal is used in the baseline, or in the baseline and project.

[21] In this case, f_{NRB} is zero.

	IPCC guidelines are a recognized source.
Purpose of data	Calculation of baseline and project emissions
Comments	N/A

Data/Parameter	$EF_{b,i,nonCO2}$ $EF_{p,j,nonCO2}$
Data unit	t CO_2e/TJ
Description	Non-CO_2 emission factor for fuel used by baseline device type *i* in the baseline scenario Non-CO_2 emission factor for fuel used by project device type *j* in the project scenario
Equations	(1, (7)
Source of data	The following data sources may be used, listed in descending order of preference: • Option 1: Project-specific value • Option 2: Regional or national default values • Option 3: Default value from the most recent version of the *IPCC Guidelines for National Greenhouse Gas Inventories*
Value applied	Depends on source of data chosen.
Justification of choice of data or description of measurement methods and procedures applied	The values must be determined ex ante by using one of the following means: 1) Testing in accredited/recognized laboratories: Measurements must be undertaken in line with national or international fuel standards 2) Use of national default values 3) Use of default values from the most recent version of the *IPCC Guidelines for National Greenhouse Gas Inventories* **Wood:** 9.46 t CO_2e/TJ (AR5 GWP) **Charcoal:** 5.865 t CO_2e/TJ (combustion only, AR5 GWP) 44.83 t CO_2e/TJ (includes charcoal production)
Purpose of data	Calculation of baseline emissions
Comments	Where the factor *CF* is applied (see parameter table for *CF*), the emissions factor for charcoal production must be derived using Option 1 or 2.

Data/Parameter	*CF*
Data unit	unitless
Description	Wood-to-charcoal conversion factor
Equations	(1, (7)
Source of data	CDM *TOOL33* default value
Value applied	4 tonnes of dry wood input per tonne of charcoal output The project proponent may use a default value of up to 6 tonnes of dry wood input per tonne of charcoal output where the value is substantiated by government-approved/endorsed national or regional values.
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of data	Calculation of baseline emissions
Comments	Only applicable where charcoal is used as the fuel by baseline and/or project devices and the project proponent chooses to apply the CF method instead of the charcoal emission factors method included in the equations. Where the CF method is used, the wood-to-charcoal conversion factor must be applied (in Equations (1 and (7), as applicable) in the following manner: 1) For CO_2 emissions, the conversion factor is multiplied by the EF_{CO2} term, which is the CO_2 emission factor for wood. 2) For non-CO_2 emissions, the EF_{nonCO2} term is the non-CO_2 emission factor for charcoal combustion. Where applying *CF*, the non-CO_2 emission factor for the production of charcoal may only be included where Option 1 or 2 (in parameter table for EF_{nonCO2}) is used.

Data/Parameter	$NCV_{b,i}$ $NCV_{p,j}$ NCV_h
Data unit	TJ/tonne or TJ/m^3
Description	Net calorific value of baseline fuel used by baseline device type *i* Net calorific value of project fuel used by project device type *j* Net calorific value of fuel used by backup generator *h*

Equations	(2), (4) , (7), (10)
Source of data	The following data sources may be used, listed in descending order of preference: • Option 1: Project-specific values • Option 2: National default value • Option 3: Default value from the most recent version of the *IPCC Guidelines for National Greenhouse Gas Inventories*
Value applied	Depends on the source of data chosen.
Justification of choice of data or description of measurement methods and procedures applied	The values must be determined ex ante by using one of the following means: 1) Testing using standardized methods (e.g., ASTM D5865-12, ISO 1928) 2) Use of regional or national default values 3) Use of default values from the most recent version of the *IPCC Guidelines for National Greenhouse Gas Inventories* The values for wood and charcoal in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* are: • **Wood:** 0.0156 TJ/tonne • **Charcoal:** 0.0295 TJ/tonne
Purpose of data	Calculation of baseline emissions
Comments	Where the factor *CF* is applied (see parameter table for *CF*), the net calorific value for charcoal must be derived using Option 1 or 2, consistent with the option for determining the non-CO_2 emission factor for production of charcoal.

Data/Parameter	$BC_{ex\text{-}ante,b,i}$
Data unit	tonnes
Description	Ex-ante annual average quantity of fuel used per baseline device type *i*
Equations	(2)
Source of data	**Option 1:** A measurement campaign following the *Kitchen Performance Test Protocol* must be designed, carried out, and analyzed in compliance with the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*. The campaign must achieve a confidence and precision of at least 90/10 for the target parameter of average daily fuel consumption per adult equivalent. Where the project does not achieve the target precision in a monitoring period, the project proponent must apply an appropriate conservativeness deduction as per Section 4 of the most

	recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*. The result must be scaled appropriately using the average household size to obtain the value of $BC_{ex\text{-}ante,b,i}$. **Option 2**: Calculated based on the default value for the average annual consumption of woody biomass per person for cooking • Firewood: 0.5 tonnes/capita/year of air-dried wood (from 0.0012 TJ delivered/capita/year with 0.0156 TJ/tonne NCV, and thermal efficiency of 15%) • Charcoal: 0.13 tonnes/capita/year (from 0.00075 TJ delivered/capita/year with 29.5 TJ/tonne NCV, and thermal efficiency of 25%) Where fuels other than firewood or charcoal are also used in the baseline, their energy use must be accounted for in the 0.0012 and 0.00075 TJ delivered/capita/year. The default value must be scaled appropriately using the average household size to obtain the value of $BC_{ex\text{-}ante,b,i}$.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of data	Calculation of baseline emissions
Comments	Energy consumption must be determined once prior to validation.

Data/Parameter	$\eta_{old,avg}$
Data unit	Fraction
Description	Weighted average efficiency of baseline devices that are replaced by project devices
Equations	(3)

Source of data	The efficiency must be established using one of the following methods, and the corresponding documentation must be presented: 1) For three-stone fire using firewood or a cookstove with no improved combustion air supply or flue gas ventilation, default value of 15% For other baseline devices: 2) Water Boiling Test surveys in compliance with the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*; 3) Manufacturer-certified value that is determined via the Water Boiling Test; 4) Certification by the host country's national standards body or certifying agency; or 5) Approved default values from the most recent version of CDM *TOOL33*. The weighted average efficiency is calculated by multiplying the energy consumption $EC_{i,y}$ of the baseline device *i* by its thermal efficiency $\eta_{old,i}$, and then summing these values for all baseline devices. The resulting sum is divided by the total energy consumption of all baseline devices to determine the weighted average efficiency.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	These methods and sources are recognized by the VCS Program.
Purpose of data	Calculation of baseline emissions
Comments	N/A

Data/Parameter	Hh_i $Hh_{j,k}$
Data unit	Equivalent standard male adults
Description	Average household size of the target population using device type *i* Average household size of the target population using device type *j* from batch *k*
Equations	Input to $EC_{i,y}$, $BC_{b,i,y}$, and $BC_{p,j,k,y}$
Source of data	Baseline survey The campaign must achieve a confidence and precision of at least 90/10 for the target parameter of average household size.

Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	Recognized survey methods based on the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*
Purpose of data	Estimation of average energy consumption when applying Option 1: Measurement campaign (Section 8.1.1) Cross-checking energy and fuel consumption values
Comments	This parameter must be determined ex ante via the baseline survey as described in Section 6.2. Equivalent standard male adults according to Guidelines for Woodfuel Surveys for FAO by Keith Openshaw, cited in Joseph, S. (1990). *Guidelines for Planning, Monitoring and Evaluating Cookstove Programmes*, UNFAO: Community Forestry Field Manual 1.

Data/Parameter	$SC_{b,i}$ $SC_{p,j}$
Data unit	TJ/test/person
Description	Specific energy consumption of baseline device type *i* in the baseline scenario Specific energy consumption of project device type *j* in the project scenario
Equations	(5))
Source of data	Controlled Cooking Test following the most recent version of the *Controlled Cooking Test (CCT) Protocol* (Clean Cooking Alliance) and in compliance with the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*. The campaign must achieve a confidence and precision of at least 90/10 for the target parameter of TJ/test/person. Where the project does not achieve the target precision in a monitoring period, the project proponent must apply an appropriate conservativeness deduction as per Section 4 of the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities.*
Value applied	N/A
Justification of choice of data or description of	This parameter must be estimated ex ante.

measurement methods and procedures applied	
Purpose of data	Calculation of baseline and project emissions
Comments	The CCT must use the same cooking tasks when assessing baseline and project devices. Cooking tasks that are not compatible with project devices must be excluded from the CCT for baseline devices. When renewing the crediting period, the project proponent must check whether the end users use the project device for preparation of the expected dishes. Where the project device is used differently than expected, the CCT design must be updated to reflect the observed cooking practices of end users using the project device and the CCT campaigns must be undertaken again to redefine $SC_{b,i}$ and $SC_{p,j}$.

9.2 Data and Parameters Monitored

Data/Parameter	$N_{j,k,y}$
Data unit	Number
Description	Number of commissioned project devices of type *j* from batch *k* in year *y*
Equations	(1, (7), (8)
Source of data	Monitoring
Description of measurement methods and procedures to be applied	The following data must be recorded during project activity implementation: 1) Number of new devices distributed under the project activity, identified by the type of device and date of commissioning; and 2) Identification information of the recipient of the device distributed under the project activity (e.g., name, address, phone number). Data management and reporting of this information must adhere to both data privacy requirements and good practice.
Frequency of monitoring/recording	Every time that new project devices are distributed
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of baseline and project emissions
Calculation method	N/A
Comments	The number of project devices must be recorded in a database, sales record, or similar to ensure transparency.

Data/Parameter	$n_{j,k,y}$
Data unit	Fraction
Description	Proportion of commissioned project devices of type *j* from batch *k* that are still being used regularly in year *y*
Equations	(1, (7), (8)
Source of data	Monitoring
Description of measurement methods and procedures to be applied	**Option 1 (SUMs):** Measured directly using stove use monitors (SUMs) in a sample of users according to the most recent version of the CDM *Standard for Sampling and Surveys for Project Activities and Programmes of Activities* and achieving 90/10 confidence precision for the proportion of devices in operation. The SUMs must confirm that the stove is frequently used and functional. **Option 2 (surveys):** Based on an adoption rate determined by a survey according to the most recent version of the CDM *Standard for Sampling and Surveys for Project Activities and Programmes of Activities* and achieving 90/10 confidence precision for the proportion of devices in operation. The lower end of the 90% confidence interval must be used to ensure conservativeness. The adoption survey must include: a) Kitchen observation (which includes visual and physical checks of the stove and its components), including photographic evidence; and b) Interview with the primary cook. The project proponent must provide proof of training and supervision to ensure field teams have the capacity required to complete adoption surveys successfully. The average of the sum of "yes" (1) responses to the adoption survey question "If yes, have you used the stove regularly since you installed it?" (where this response is cross-checked and confirmed with the physical check of the stove and the coherency with the responses to the following questions of the survey), and “no” (0) responses to the questions “do you use the project cookstove?” and "If yes, have you used the stove regularly since you installed it?". For both Options 1 and 2, where the project does not achieve the target precision in a monitoring period, the project proponent must apply an appropriate conservativeness deduction as per Section 4 of the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities.*
Frequency of monitoring/recording	**Option 1: (SUMs):** continuous **Option 2 (surveys):** annually

QA/QC procedures to be applied	The date on which a sample project device stopped being used should be taken as follows: **Option 1: (SUMs):** The date on which the SUM ceased registering any activity of the project device **Option 2 (surveys):** Where the project device is not working or not being used at the time of conducting the survey, it should be conservatively assumed that the project device has not been active since the date on which the last adoption survey was conducted.
Purpose of data	Calculation of baseline and project emissions
Calculation method	N/A
Comments	Option 1 is the preferred method. This parameter does not need to be monitored separately and is considered equal to one where project devices are electric cooking devices and the electricity consumption of all devices is measured continuously.

Data/Parameter	$f_{NRB,y}$
Data unit	Fraction or %
Description	Fraction of woody biomass that is established to be non-renewable used by device in year *y*
Equations	(1, (7)
Source of data	One of the following sources must be used: 1) The most recent national default value(s) published by UNFCCC 2) Calculated based on CDM *TOOL30* and applying an uncertainty discount of 26%[22] 3) Default value of the most recent version of CDM *TOOL33*
Description of measurement methods and procedures to be applied	See "Source of data"

[22] For example, if f_{NRB} calculated based on *TOOL30* is 0.60, the f_{NRB} applied to emission reduction calculations is 0.60 × (1 − 0.26) = 0.44. The 26% uncertainty discount is derived from 100% uncertainty in f_{NRB}, assuming a normal distribution. The discount is calculated using a standard deviation of 61% (100%/1.6449) and a one-sided 66.6% confidence interval (61% × 0.4307 = 26%). A fixed uncertainty discount is applied across all projects using *TOOL30*.

Frequency of monitoring/recording	Ex-ante for each crediting period Proponents applying draft UNFCCC national default values must apply updated approved default values in any verification requests submitted after UNFCCC approval of the default values.
QA/QC procedures to be applied	Where using the UNFCCC f_{NRB} value(s), the project proponent must report the related uncertainties along with the value in the project description.
Purpose of data	Calculation of baseline and project emissions
Calculation method	N/A
Comments	UNFCCC has not approved the national default values at the time of publishing this methodology. Project proponents may use the most recent available draft f_{NRB} default values but must apply the updated approved default values for any verification requests submitted after UNFCCC approval of the default values. Where switching to the approved default f_{NRB} is the only proposed change to a registered project design, project proponents do not need to follow the methodology and/or project description deviation process.

Data/Parameter	$BC_{b,i,y}$
Data unit	tonnes
Description	Fuel used per baseline device type *i* during year *y*
Equations	(2)
Source of data	**Option 1:** A measurement campaign following the *Kitchen Performance Test Protocol* in control households that do not participate in the project, established prior to validation as statistically equivalent to the pre-project conditions of project households regarding baseline fuel consumption **Option 2**: For project activities applying the default values, this parameter does not need to be updated during the crediting period and the same values as for $BC_{ex\text{-}ante,b,i}$ are applied.
Description of measurement methods and procedures to be applied	**Option 1:** Follow-up baseline surveys must be conducted every two years in control households that do not participate in the project, established prior to validation as statistically equivalent to the pre-project conditions of project households regarding baseline fuel consumption. Measurement campaign must be updated where follow-up baseline surveys show that the fuels, fuel sources, or technologies used by the control group are no longer statistically equivalent to the pre-project conditions of project households.

	The measurement campaign must be designed, carried out, and analyzed in compliance with the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*. The result must be scaled appropriately using the average household size to obtain the value of $BC_{b,i,y}$. **Option 2**: See "Source of data"
Frequency of monitoring/recording	Every two years
QA/QC procedures to be applied	The campaign must achieve a confidence and precision of at least 90/10 for the target parameter of average daily fuel consumption per adult equivalent. Where the project does not achieve the target precision in a monitoring period, the project proponent must apply an appropriate conservativeness deduction as per Section 4 of the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities.*
Purpose of data	Calculation of baseline emissions
Calculation method	N/A
Comments	N/A

Data/Parameter	$\eta_{new,avg,y}$
Data unit	Fraction
Description	Weighted average efficiency of project devices in year *y*
Equations	(3)
Source of data	Monitoring
Description of measurement methods and procedures to be applied	The efficiency must be established using one of the following methods, and the corresponding documentation must be presented: 1) Water Boiling Test campaigns achieving 90/10 confidence and precision levels as per the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*; 2) Manufacturer-certified value that is determined via Water Boiling Test; or 3) Certification from the host country's national standards body or certifying agency. The decrease in thermal efficiency of project device *j* from batch *k* due to aging must be accounted for during the monitoring period, as presented below.

	For devices using biomass or fossil fuel, one of the following options must be selected, listed in descending order of preference: a) Standard Water Boiling Test campaigns[23] b) A linear decrease approach, applying a default schedule of linearly decreasing efficiency up to the terminal efficiency (assumed to be 25%) through the lifespan of the project device[24] For all other electric project devices, efficiency loss is calculated by measuring the total heat absorbed by a known mass for a given time and dividing it by the input of electrical energy measured by a power analyzer and comparing to the result of the previous year. The weighted average efficiency is calculated by multiplying the energy consumption $EC_{p,j,k,y}$ of the project device j of batch k by its thermal efficiency $\eta_{new,j,k,y}$ and then summing these values for all project devices. The resulting sum is divided by the total energy consumption of all project devices to determine the weighted average efficiency.
Frequency of monitoring/recording	Annually
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of baseline and project emissions
Calculation method	N/A
Comments	N/A

Data/Parameter	$BC_{p,j,k,y}$
Data unit	tonnes or m^3
Description	Average quantity of fuel used by project device type *j* from batch *k* during year *y*
Equations	(4), (7)
Source of data	Monitoring
Description of measurement methods and procedures to be applied	**Option 1: Kitchen Performance Test (KPT)** A measurement campaign following the Kitchen Performance Test protocol must be designed, carried out, and analyzed in compliance with the most recent version of the CDM *Standard for Sampling and*

[23] Must be carried out following national standards (where available) or international standards or guidelines.

[24] Consider non-binding best practice example 6 in AMS-II.G.

	Surveys for CDM Project Activities and Programmes of Activities. The campaign must achieve confidence and precision of at least 90/10 for the target parameter of average daily fuel consumption per adult equivalent. The result must be scaled appropriately using the average household size to obtain the value of $BC_{p,j,k,y}$. Project activities applying KPTs must also measure the quantity of fuel used by pre-project devices that are still operational and provide it in the calculation sheet and monitoring reports (this is a reporting-only requirement). **Option 2: Direct measurement** Apply continuous direct measurement using equipment calibrated in accordance with national/international requirements. A sample of project devices may be measured in such a way that confidence and precision of 90/10 is achieved for the target parameter of total annual fuel use. The sampling must comply with the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities*. **Option 3: Fuel purchase monitoring (only for project devices using fossil fuels or bioethanol)** Under this option, the project developer must: 1) keep continuous records of all fuel purchases (e.g., fuel purchase invoices from the supplier). 2) ensure fuel is used only for thermal energy generation by the project device (e.g., by using a fuel cylinder design that may only be attached to the project device). For any of the options above, where the project does not achieve the target precision in a monitoring period, the project proponent must apply an appropriate conservativeness deduction as per Section 4 of the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities.*
Frequency of monitoring/recording	Biennial or annual for Option 1 Continuous and aggregated annually for Options 2 and 3
QA/QC procedures to be applied	As a crosscheck, compare results to government publications, peer-reviewed literature, third party assessments, and/or official data or statistics. Where SUMs are used to measure project stove adoption, the stove usage indicated by the measurements for this parameter must be consistent with the frequency of use indicated by SUM measurements.
Purpose of data	Calculation of baseline and project emissions
Calculation method	N/A
Comments	N/A

Data/Parameter	$EC_{p,j,k,y}$
Data unit	MWh
Description	Annual consumption of electricity by electric project device type *j* from batch *k* in year *y*
Equations	(5), (8)
Source of data	Monitoring
Description of measurement methods and procedures to be applied	Apply direct measurement by metering. This may be applied to a sample of project devices, following the sampling approach described in the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities* with a confidence level and precision of at least 90/10. Where the project does not achieve the target precision in a monitoring period, the project proponent must apply an appropriate conservativeness deduction as per Section 4 of the most recent version of CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities.*
Frequency of monitoring/recording	Continuous and aggregated annually
QA/QC procedures to be applied	Measurement must use credible and calibrated equipment. Calibration frequency must be specified by the manufacturer. Attached or in-built data loggers may be used where they conform with industry standards and are calibrated according to relevant national requirements. As a cross-check, compare measurements to government publications, peer-reviewed literature, third party assessments, and/or official data or statistics. Where it is not possible to justify energy use using these sources of information, the reference value must be used in Equation (5), while the real monitored value must be used in Equation (8).
Purpose of data	Calculation of baseline and project emissions
Calculation method	N/A
Comments	Where backup generators in decentralized energy systems supply more than 1% of the annual electricity, the same percentage of emission reductions from project devices powered by these systems must be excluded during the monitoring period. The total energy generation of self-generated renewable electricity systems must be estimated and compared to the electricity use of the project device. Where self-generated renewable electricity is

	supplemented by non-renewable electricity (e.g., a back-up generator), such non-renewable electricity must not account for more than 20% of the electricity consumed by the project devices. Where a verification audit finds that the threshold has been exceeded, the project device must be excluded from emission reduction calculations.

Data/Parameter	$EF_{el,y}$
Data unit	t CO_2e/MWh
Description	Emission factor of the electricity system in year *y*
Equations	(8)
Source of data	Calculated
Description of measurement methods and procedures to be applied	Must be determined using CDM *TOOL07.* Where the electricity comes from a renewable source, the emission factor is considered to be zero.
Frequency of monitoring/recording	Annually
QA/QC procedures to be applied	Use credible data for the electricity system.
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Data/Parameter	$TDL_{j,y}$
Data unit	Fraction
Description	Average technical transmission and distribution losses for providing electricity to project device type *j* in year *y*
Equations	(8)
Source of data	Calculated
Description of measurement methods and procedures to be applied	Must be determined using CDM *TOOL 05*.

Frequency of monitoring/recording	Once per monitoring period
QA/QC procedures to be applied	Use credible data for the electricity system.
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Data/Parameter	$FC_{h,y}$
Data unit	tonnes
Description	Fuel consumption of backup generator *h* in year *y*
Equations	(10)
Source of data	Measured
Description of measurement methods and procedures to be applied	The amount of fuel used by the backup generator(s) is determined using one of the following options: 1) Apply direct measurement by metering using credible, manufacturer-calibrated equipment; or 2) Keep continuous records of fuel purchases.
Frequency of monitoring/recording	Annually
QA/QC procedures to be applied	N/A
Purpose of data	Compliance with applicability conditions for project devices using grid electricity
Calculation method	N/A
Comments	N/A

9.3 Description of the Monitoring Plan

The project proponent must maintain a record of the date of commissioning of project devices of each type *j* and batch *k*. Relevant parameters must be monitored and recorded during the crediting period as indicated in Section 9.2. The project proponent must apply the requirements specified in the *General Guidelines for SSC CDM methodologies*.

Data recording

The project proponent must compile data on each device that is derived from the total sales record, with project technologies differentiated by different project scenarios. These data must be differentiated into sections based on the results of the applicable monitoring studies for each project scenario, so that emission reductions can be calculated appropriately, section by section.

The information captured for each project device included in the project activity must include, at a minimum:

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

Sampling

Where measurement campaigns are conducted, the sampling approach described in the most recent version of the CDM *Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities* must be followed.

When developing a sampling plan, project proponents must calculate the sample size required to achieve the required level of reliability. The sample size should be determined manually or using appropriate statistical software.

The calculation is dependent on all of the following as well as the target level of confidence and the precision of 90/10:

a) The type of parameter of interest (i.e., mean value or proportion);
b) The target value (i.e., the expected value of the parameter), which should be determined using the project proponent’s knowledge and experience; and
c) Expected variance (or standard deviation) for that measure in the sample, based on results from similar studies including other similar mitigation projects or previous monitoring periods, pilot studies, or from the project proponent’s own knowledge.

The project proponent is encouraged to ensure that all surveys and tests performed for the quantification of GHG emission reductions within this methodology are performed by an independent party qualified for these procedures. This ensures the integrity, accuracy, and transparency of reduction claims and supports the credibility of the project's environmental benefits.

Avoidance of double counting

Project proponents must demonstrate that the project prevents double counting of GHG emission reductions by any actor[25] who may wish to claim reductions from project devices. Ownership of the reductions resulting from the project activity must be clearly communicated by contract or clear written assertions in the transaction paperwork to all involved parties. Users must be notified that they are not permitted to claim reductions from the project.

Use of renewable biomass

For project activities introducing renewable biomass in the form of charcoal, it must be demonstrated (on an ongoing basis) that methane produced during the charcoaling process is captured and destroyed or combusted for energy purposes. The project proponent must document this both in the project description and monitoring reports.

Project activities must ensure that renewable biomass sources are documented in the project description and monitoring reports, including origin, quantities, and conditions prior to use under the project activity. Where the biomass is sourced from a third party, proof of purchase must be provided (e.g., contractual agreements or purchase receipts).

Decentralized energy systems

Where backup generators in decentralized energy systems supply more than 1% of the annual electricity, the same percentage of emission reductions from project devices powered by these systems must be excluded during the monitoring period.

Self-generated renewable electricity system

The total energy generation of the self-generated renewable electricity system must be estimated and compared to the electricity use of the project device. Where self-generated renewable electricity is supplemented by non-renewable electricity (e.g., a back-up generator), such non-renewable electricity must not account for more than 20% of the electricity consumed by the project devices. Where a verification audit finds that the threshold has been exceeded, the project device must be excluded from emission reduction calculations.

[25] For example, project technology manufacturers, wholesale providers, target population, among others

10 REFERENCES

Clean Cooking Alliance (2004). *Controlled Cooking Test Protocol 2.0*. Available at: https://cleancooking.org/binary-data/DOCUMENT/file/000/000/80-1.pdf

Clean Cooking Alliance (2014). *Water Boiling Test Protocol 4.2.3.* Available at: https://cleancooking.org/binary-data/DOCUMENT/file/000/000/399-1.pdf

Clean Cooking Alliance (2018). *Kitchen Performance Test Protocol 4.0*. Available at: https://cleancooking.org/binary-data/DOCUMENT/file/000/000/604-1.pdf

APPENDIX 1: THERMAL EFFICIENCY PERFORMANCE THRESHOLDS

The following default values for thermal efficiency performance thresholds are taken from *ISO/TR 19867-3: Clean cookstoves and clean cooking solutions — Harmonized laboratory test protocols — Part 3: Voluntary performance targets for cookstoves based on laboratory testing*.[26]

Table 2: Default values for voluntary performance targets

	Tier	Thermal efficiency (%)	Durability score
Better performance ↑	5	≥50	<10
	4	≥40	<15
	3	≥30	<20
	2	≥20	<25
	1	≥10	<35
	0	<10	>35

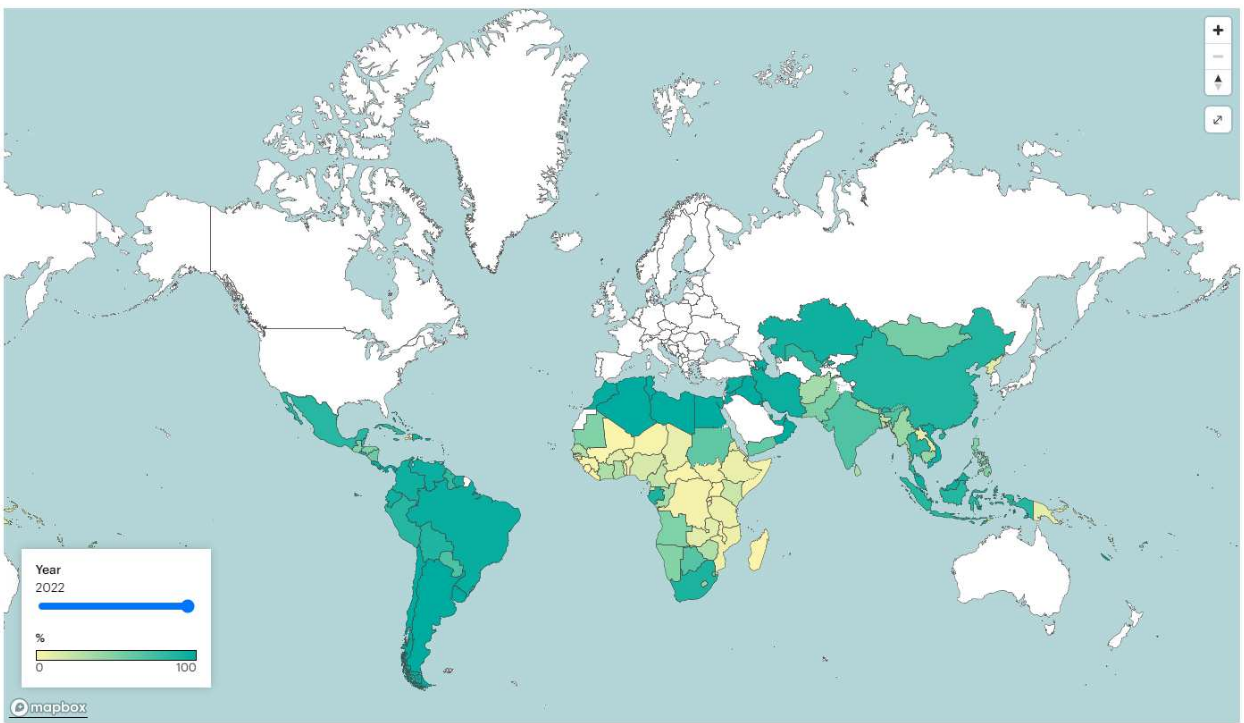
[26] Publicly available sections of ISO/TR 19867-3 are available at: https://www.iso.org/standard/73935.html A technical report providing a preview of some of the other content is available at: https://cdn.standards.iteh.ai/samples/73935/feb537d3c06f400dbe46e1b44ecbb67b/ISO-TR-19867-3-2018.pdf

APPENDIX 2: ACTIVITY PENETRATION

To establish a penetration rate of less than 20% for the project device technology, the UN SDG 7 progress report[27] has been used as a reference. Based on Appendix 1, the cookstoves applicable under this methodology belong to Tier 2 and above, meaning either intermediate or advanced cooking solutions. Hence, for some countries, while penetration of improved cooking solutions may be higher than 20%, the penetration of intermediate and advanced improved cooking solutions may be very low. Project proponents may use other sources to establish penetration rates of less than 20% for respective technologies.

The International Energy Agency (IEA) uses the World Health Organisation (WHO) Household Energy Database for people without access to clean cooking for historic numbers and the World Energy Model and official energy balances to present the map shown in Figure 1.

Figure 1: Share of population with access to clean cooking[28]



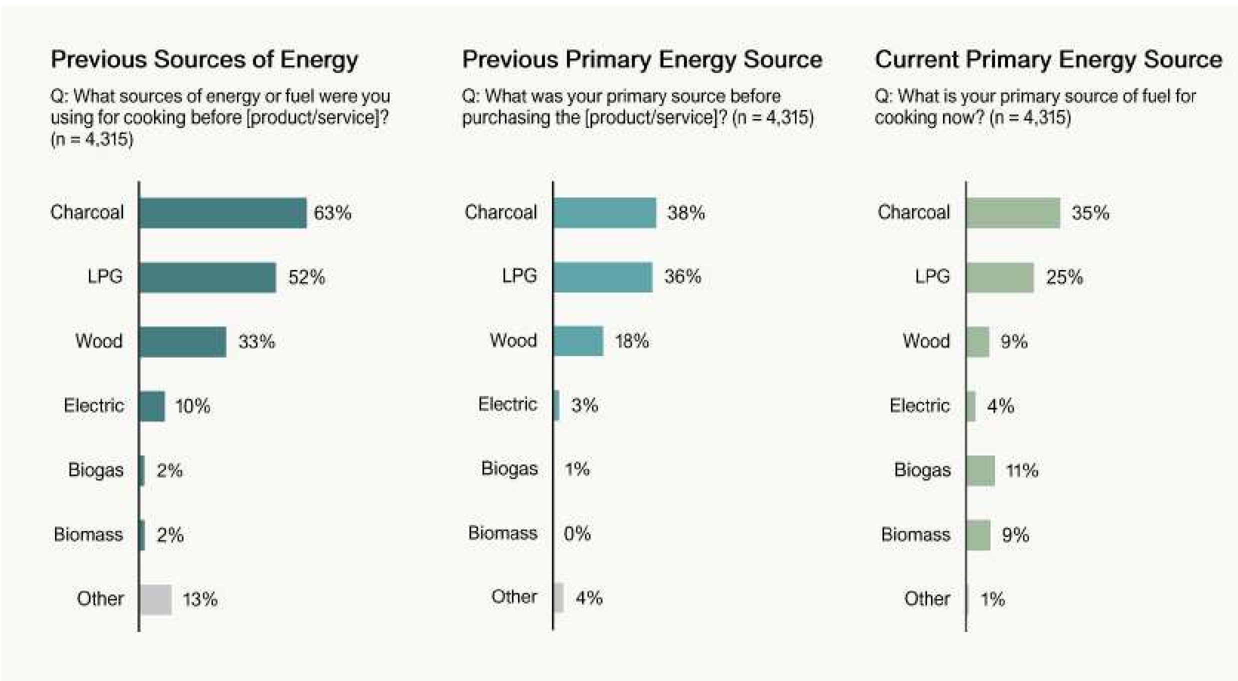
The Clean Cooking Alliance (CCA) in its *Lean Data Insights Aggregate Report* presents the sources of fuels used for cooking before and after purchasing products from CCA portfolio companies (Figure 2). Cleaner and safer energy sources such as biomass, biogas, and electricity have a lower penetration rate compared to common fuels such as charcoal.

[27] Available at: https://sustainabledevelopment.un.org/content/documents/2019_Tracking_SDG7_Report.pdf

[28] Source: https://www.iea.org/reports/sdg7-data-and-projections/access-to-clean-cooking

Figure 2 presents the results based on a sample of surveyed households. According to the report, the distribution of these households was as follows: rural households 32% (village or countryside), peri-urban households 29% (town), and urban households 39% (city). This distribution reflects the diversity of contexts in which the surveys have been carried out, thus allowing for a broader and more representative view of the situation in different areas.

Figure 2: Sources of cooking fuels before and after purchasing products from CCA portfolio companies[29]



[29] Source: https://cleancooking.org/wp-content/uploads/2023/07/Clean-Cooking-Alliance_Lean-Data-Insights-Aggregate-Report.pdf

APPENDIX 3: BINDING SURVEY QUESTIONNAIRE

The following is a binding questionnaire with the minimum requirements for the baseline survey. The project proponent may choose a different format but must include these questions, at minimum.

1. Survey Format A: Baseline Fuel Consumption Pattern

1.1. General information

Title of project activity	
Name of surveyor	
Date of survey	dd/mm/yyyy
Survey method	Face to face / remote / telephone

1.2. Household profile[30]

Name (household representative)	
Household size (total number of people)	
- Females over 14 years	
- Males 15–59 years	
- Males over 59 years	
- Children 0–14 years	
Type of area (urban/rural)	
Address or coordinates	
Phone number	

1.3. Stove used prior to project implementation

(Mark "x" for all that apply)

A three-stone fire or a conventional system with no improved combustion air supply nor flue gas ventilation system (i.e., without a grate or chimney)	
Basic charcoal stove	
Improved woodfuel cookstove	
Improved charcoal cookstove	
LPG cookstove	
Electric cookstove	
Other (describe)	

[30] Selection of households should be based on a sampling plan.

1.4. Household fuel consumption pattern prior to project implementation

How many meals did you prepare yesterday? Is this a typical value? If the answer is "No," how many meals are prepared in a typical day?	meals/day Yes/No meals/day
Is there any difference with the amount of meals prepared during a typical weekend day?	(open response)
Describe any other ways in which you used your stove last week (e.g., water boiling for drinking, water boiling for hygiene, space heating).	(open response)

1.4.1. Fuel used for cooking[31]

	Yes/No	Quantity of usage	Unit
Charcoal			kg/ month or year
Wood			kg/ month or year
LPG			kg or cylinders / month or year
Kerosene			liters/ month or year
Coal			kg/ month or year
Electricity			kWh/ month or year
Other fuels (explain)			

1.4.2. Fuel sources

	Collected/ Purchased	Source or location of fuel
Charcoal		
Wood		
LPG		
Kerosene		
Coal		
Electricity		
Other fuels (explain)		

[31] Where surveys are biennial, they may be designed to capture results for each year separately (e.g., the survey may ask for utilization hours for year 1 and year 2 separately). The end-user may not be able to provide information on the quantity of cooking fuel in the units given here. In many places, the volume of firewood (e.g., the volume capacity and level of filling of the transporting/storage room) is measured, rather than its weight. Local measurement practices vary. The project proponent should include such local measurement units in the questionnaire. The measurement unit may also be given in terms of money spent on purchasing fuel. The project proponent must provide guidelines for how to convert the reported values to required units (mass or volume). For example, where a household uses a bag of charcoal every 10 days, the monthly average may be calculated if the weight (or volume and bulk density) of the full bag is determined.

2. Survey Format B: Adoption Rate Survey

2.1. General information

Title of project activity	
Name of surveyor	
Date of survey	dd/mm/yyyy
Survey method	Face to face
Period of usage (for adoption rate)	dd/mm/yyyy to dd/mm/yyyy

2.2. Household profile[32]

Name (household representative)	
Household size (total number of people)	
- Female over 14 years	
- Male 15–59 years	
- Male over 59 years	
- Children 0–14 years	
Type of area (urban/rural)	
Address or coordinates	
Phone number	

2.3. Household fuel consumption pattern following project implementation

Cooking device	
Model name/number	
Unique ID	
Date of installation	dd/mm/yyyy
Do you use the project cookstove? (Physically check the stove)[33]	Yes/No
If yes, have you used the stove regularly since you installed it?[34]	Yes/No
If yes, is your stove in good condition?[35]	Yes/No
If no, why did you stop using the stove?	
How many meals did you prepare using the project cookstove last week or last month?	meals/ week or month

[32] Selection of households should be based on a sampling plan.

[33] This is to determine whether the cookstove is currently in use and includes visual checks. Physical checks to verify usage may include checking stove conditions (e.g., warm to touch, ashes in grate, soot on stove).

[34] This is to determine whether the cookstove has been continuously used.

[35] The project proponent may rephrase the question keeping in mind the objective (i.e., whether or not the project cookstove is in usable condition). Where the project cookstove is not in usable condition, the project proponent must exclude such stoves from the project database for the whole crediting year and subsequent years. The project proponent may include such stoves again on replacing them with new cookstoves of similar efficiency.

Do you also use your traditional (baseline) cookstove?	Yes/No
If yes, how many meals did you prepare using the traditional (baseline) cookstove last week or last month?[36]	meals/ week or month
Do you use any other stove?[37]	Yes/No
If yes, list the types and number of other non-project stoves.	
How many times a week do you use the non-project stoves?	
How much do you spend on fuel for cooking per type of cooking device in a week/month?	

[36] This is to determine whether the baseline stove is being used, in order to accurately account for project emissions. Where celebrations and/or festivals at the time of the survey may alter the number of meals prepared, provide an average value considering normal conditions.

[37] This is to cross-check whether the project cookstove is used for all cooking requirements. It may also detect situations where a household is taking part in more than one project activity, thereby avoiding double counting.

APPENDIX 4: MONITORING/ MEASUREMENT TECHNIQUE GUIDANCE

Stove Use Monitors

Stove use monitors (SUMs) are devices that quantify stove usage through direct measurements of physical or chemical parameters (e.g., temperature, heat flow, light, power, motion, gas concentration) on stoves, kitchen technologies, and cookware, among others. These monitors are often employed in regions where cooking primarily uses solid fuels such as wood, charcoal, or dung. The data collected by these monitors can provide valuable insights into cooking behaviors, patterns, and the effectiveness of interventions aimed at promoting cleaner cooking practices.

SUMs used for determining stove usage are sensors containing internal software that identifies stove usage when a temperature threshold is reached. Event identification can be performed using the "fire-finder" method for instance[38], which allows removal of events that are too short, and detects the beginning (threshold, high slope) and the end (threshold, low slope, and slowing decreasing temperature) of stove use events.

Parameters such as threshold values, positive slope, and negative slope must be adjusted based on the stove type, and it is recommended that stove usage start and stop times are periodically verified manually as a cross-check. SUMs require careful positioning to ensure a robust response capturing temperature variation and avoiding heat damage.

When characteristic temperature signals or "signatures" of the main cooking tasks are obtained and their frequency is measured, the adoption niche of each cooking device can be quantified from SUMs-based data in terms of the redistribution of cooking tasks.

The following table describes some recommendations that the project proponent may adopt for field deployment of SUMs to quantify adoption.[39]

Table 3: Recommendations for stove use monitors (SUMs)

Placement of SUMs and sampling frequency	• Determine the stove locations and SUM support configuration that will keep the SUMs within the temperature limits specified by each manufacturer. • Use real-time temperature indicators to check locations during a firing cycle performed at maximum fuel intensity.

[38] Wilson, Daniel Lawrence, Kendra N. Williams, and Ajay Pillarisetti on behalf of the HAPIN Investigators. 2020. "An Integrated Sensor Data Logging, Survey, and Analytics Platform for Field Research and Its Application in HAPIN, a Multi-Center Household Energy Intervention Trial" *Sustainability* 12, no. 5: 1805. https://doi.org/10.3390/su12051805

[39] Recommendations adapted from Ruiz Mercado I. 2012. *The Stove Adoption Process: Quantification Using Stove Use Monitors (SUMs) in Households Cooking with Fuelwood*, University of California, Berkeley.

	• Record temperature with SUMs and holder setup at selected stove locations for two to three days in real homes. Identify the least obtrusive locations. • Check that the signals are not saturated and that the temperature of the SUMs is not too close to the operating limits. • Determine the appropriate sampling frequency for the level of detail desired (days of use, number of meals per day, duration of cooking events, duration for which the stove is on) and for the number of samples needed per monitoring period. Placement recommendations • Avoid stoves where water may drip on the monitors. • In most monitors, slower sampling rates and lower operating temperatures lead to longer battery life.
Data collection and management	• Staff should be monitored and trained to follow strict protocols to ensure the integrity of SUM data. • Implement data collection field forms for each SUM in each deployment-programming-download cycle. • Document relevant observations of household behavior on the forms. • Keep a record of the operation and status of the sensors at each location. • Establish a data file protocol that includes all identified keys such as name and specifications of the monitor, household, stove identification numbers, start and end date of temperature readings, monitoring cycle number, among others, in order to have an accurate and reliable file. • Perform annual baseline measurements on all deployed monitors.

Kitchen Performance Test (KPT) with digital monitors

Digital monitors can be included in traditional KPTs to optimize fuel consumption monitoring, since fuel consumption is one of the most important metrics of cooking intervention performance. To directly monitor fuel consumption in households, digital monitors record time-stamped fuel mass data using a logging load cell.

Digital monitoring systems can operate in tension for fuels like firewood, charcoal, and agricultural residues, or in compression for LPG, ethanol, or kerosene. Where households stack with multiple stoves or fuels, a separate sensor can be installed for each stove or fuel type.

Two versions of the system have been developed, one manufactured by Waltech Systems that relies on SD cards (first generation) and an updated model manufactured by Climate Solutions Consulting that collects data wirelessly using a custom-designed launcher and collection device (second generation).[40] Wireless data collection allows for faster data collection integrated with multiple sensors (fuel, temperature, emissions) in a home, and enables troubleshooting and preliminary data reporting at the source.

General system components include:

- Off-the-shelf S-type tensile or compressive load cell with eye bolts for attachment
- Internal temperature sensor
- Integrated power supply, analog-to-digital converter (ADC), and control module with internal clock
- Battery power supply
- Plastic housing
- Fuel storage container

Components specific to first generation systems include:

- External thermocouple port
- SD card port for data storage

Components specific to second generation systems include:

- Wireless data launcher
- Initial pre-processed data analytics (calibration equations applied before storing data)
- Wireless infrared temperature logger

For first generation systems, logging rate is normally programmed to 49 seconds and decreased to 7 seconds when a specified weight change is detected, until no additional changes in mass are detected. Data is stored on SD cards as .csv files.

For second generation systems, the measurement rate is normally programmed to 30 seconds, with data written to memory once per minute. The data are stored in the device's internal memory and then downloaded wirelessly to the launcher SD card as a .csv file.

For adequate operation, a household cook must be trained to store his or her fuel supply in the bucket- or sling-type fuel holder, remove fuel as needed for cooking, and refill when empty. These actions result in discrete reductions in weight, which are recorded by the load cell and integrated to determine total fuel use over a specified time.

[40] Ventrella J., Lefebvre O., and MacCarty N. 2020. Techno-economic comparison of the FUEL sensor and Kitchen Performance Test to quantify household fuel consumption with multiple cookstoves and fuels. *Development Engineering*, 5, 100047. https://doi.org/10.1016/j.deveng.2020.100047

How to approach seasonality with KPT

Project proponents must provide a description of seasonality at the project location(s) (e.g., wet/dry, cold/warm, temporality during the year), as well as observed and expected impacts on cooking practices and cooking energy use.

The project proponent must consider one of the following options to address seasonality.

- Perform the measurement campaign in such a way that it captures seasonal factors that may affect fuel consumption over the year, or
- Perform the measurement campaign in a way that ensures that the results are conservative, given seasonal variability and ensure that baseline and project KPT are performed at the same moment.

APPENDIX 5: SAMPLING GUIDANCE

According to the *Guidelines on Sampling and Surveys for CDM Project Activities and Programmes of Activities*,[41] it is important to distinguish between two categories of data when determining sample size: those related to mean and those related to proportions.

Sample size refers to the number of observations or individuals included in a statistical study or experiment. Determining the appropriate sample size is critical to ensuring that the results of the study are accurate and representative of the population being studied.

- **Mean values:** Corresponding to average values inferred from data that are often referred to as continuous variables
- **Proportion (or percentage) values:** Values that are derived from data that are described as attributes, yes/no data, or binary data

The "population" in this methodology refers to the total number of project devices commissioned, whereas the sample target represents a specific subset of these devices. The following table specifies the parameters described in the methodology to be considered in relation to the CDM sampling guidelines, together with a description of the type of data to which they correspond (mean or proportion).

Scenario	Parameter	Description	Mean value	Proportion
General	$N_{j,k,y}$	Number of commissioned project devices of type *j* from batch *k* in year *y*	X	
	$n_{j,k,y}$	Proportion of commissioned project devices of type *j* from batch *k* that remain operating in year *y* (fraction)		X
Baseline	$BC_{b,i,y}$	Fuel used per baseline device type *i* during year *y*	X	
	$SC_{b,i}$	Specific energy consumption of baseline device type *i* in the baseline scenario	X	
Project	$BC_{p,j,k,y}$	Average quantity of fuel used by project device type *j* from batch *k* during year *y*	X	
	$EC_{p,j,k,y}$	Annual consumption of electricity by electric project device type *j* from batch *k* in year *y*	X	

[41] Available at: https://cdm.unfccc.int/Reference/Guidclarif/index.html

	$SC_{p,j}$	Specific energy consumption of project device type *j* in the project scenario	X	

Recommended sampling methods selected based on specific project conditions and available sampling and/or prospecting capabilities are listed below.

Sampling Method	Characteristics
Simple random sampling	• Conceptually straightforward and easy to implement • Particularly advantageous when assuming population homogeneity, such as within the same climate zone or socioeconomic circumstances • Costs of data collection can be higher than other sampling approaches when the population is large and geographically dispersed. • Not applied where the population covers a large geographical area.
Stratified random sampling	• Ensures that each subgroup is represented proportionally in the final sample, which can lead to more accurate and reliable results compared to simple random sampling. • Applied for heterogeneous populations and most applicable to situations where there are obvious groupings of population elements whose characteristics are more similar. • Stratification factors should be selected to reflect significant differences in the population regarding the parameter of interest. • Requires prior knowledge or information about the population to correctly identify and define the strata. • Tends to be more complex, demanding additional calculations in contrast to simple random sampling.

To perform sample size calculations, the parameters of interest must be estimated. This procedure can be accomplished by:

1) **Preliminary data analysis:** Conduct an exploratory study using previously collected data, where available. This can give a first idea of the data distribution and parameter variability.
2) **Literature research:** Previous research related to the topic of study can be examined.
3) **Pilot or feasibility studies:** Conduct pilot or feasibility studies to gather preliminary data. This can help estimate parameters of interest and adjust sample size calculations accordingly.
4) **Expert consultation:** Obtain opinions and knowledge from experts in the relevant field.
5) **Own experience:** Using estimates based on the researcher's own experiences.

The following equations must be followed to determine the sampling plan.

A5.1 Simple Random Sampling

Simple random sampling is suited to populations that are homogeneous. This method is often used because it is straightforward and ensures that each member of the population has an equal chance of being included in the sample. The sample-based estimate (mean or proportion) is an unbiased estimate of the population parameter.

Sample size determination for mean parameter

$$n \geq \frac{1.645^2 N \times V}{(N-1) \times 0.1^2 + 1.645^2 \times V}$$

$$V = \left(\frac{SD}{mean}\right)^2$$

Where:

n	=	Sample size for households
N	=	Total number of households
SD	=	Expected standard deviation
mean	=	Expected mean, depends on similar studies or location
1.645	=	Represents the 90% confidence required
0.1	=	Represents the 10% relative precision

Sample size determination for proportion parameter

The equation for a 90/10 confidence/precision to give the required sample size is:

$$n \geq \frac{1.645^2 N \times p(1-p)}{(N-1) \times 0.1^2 \times p^2 + 1.645^2 \times p(1-p)}$$

Where:

n	=	Sample size for households
N	=	Total number of households
p	=	Expected proportion of parameter of interest
1.645	=	Represents the 90% confidence required
0.1	=	Represents the 10% relative precision

The result, *n*, represents the number of households with data available for analysis. Where it is anticipated that a certain proportion of the sampled households will respond, adjust this number accordingly by dividing *n* by the anticipated proportion.

The expected proportion must not be more than one. A conservative range to apply could be between 0.5 to 0.7.

The equation for 95/10 confidence/precision to give the required sample size is:

$$n \geq \frac{1.96^2 N \times p(1-p)}{(N-1) \times 0.1^2 \times p^2 + 1.96^2 \times p(1-p)}$$

Where:

n	=	Sample size for households
N	=	Total number of households
p	=	Expected proportion of operating cookstoves
1.96	=	Represents the 95% confidence required
0.1	=	Represents the 10% relative precision

A5.2 Stratified Random Sampling

Where the project covers a large geographic area, stratified random sampling may be applied. This consists of dividing the area into different districts based on the likelihood that stoves will continue to operate. The number of districts (D) should cover the total number of households. Estimates of the proportion of cookstoves still in operation in each district, as well as the population size of each district, are required.

Total sample size determination for proportion parameter

$$n \geq \frac{1.645^2 \times NV}{(N-1) \times 0.1^2 + 1.645^2 \times V}$$

$$V = \frac{SD^2}{\bar{p}^2}$$

Where:

n	=	Sample size for households
N	=	Total number of households
V	=	Overall variance
1.645	=	Represents the 90% confidence required
0.1	=	Represents the 10% relative precision
SD	=	Standard deviation
$\bar{p}$	=	Overall proportion

Then, standard deviation is based on g_d and proportion p_d.

$$SD = \sum_d \frac{g_d \times p_d(1-p_d)}{N}$$

Where:

SD	=	Standard deviation
g_d	=	Number of households with cookstoves in district d
$p_d(1 - p_d)$	=	Variance of a proportion
N	=	Total number of households

The overall proportion is based on the number of households in a district and the proportion with cookstoves.

$$\bar{p} = \sum_d \frac{(g_d + p_d)}{N}$$

Where:

$\bar{p}$	=	Overall proportion
g_d	=	Number of households with cookstoves in district *d*
p_d	=	Proportion of households with cookstoves in district *d*
N	=	Total number of households

To decide on the number of households in the sample that come from each district, proportional allocation can be used, where the proportion from different districts is the same as the proportion of that district in the population.

$$n_d = \frac{g_d}{N} \times n$$

Where:

n_d	=	Sample size for district *d*
g_d	=	Number of households with cookstoves in district *d*
N	=	Total number of households
n	=	Total sample size

Sample size determination for mean parameter

$$n \geq \frac{1.645^2 \times NV}{(N-1) \times 0.1^2 + 1.645^2 \times V}$$

$$V = \left(\frac{SD_{overall}}{mean}\right)^2$$

Where:

$SD_{overall}$	=	Weighted overall standard deviation
mean	=	Weighted overall mean

The overall standard deviation is:

$$SD_{overall} = \sqrt{\frac{\sum_{d=1}^{D} g_d \times SD_d^2}{N}}$$

Where:

$SD_{overall}$	=	Weighted overall standard deviation
SD_d	=	Standard deviation for district *d*

g_d	=	Number of households with cookstoves in district *d*
N	=	Total number of households

The overall mean is:

$$mean = \sum_{d=1}^{D} \frac{(g_d + m_d)}{N}$$

Where:

mean	=	Weighted overall mean
g_d	=	Number of households with cookstoves in district *d*
m_d	=	Mean cookstoves in district *d*
N	=	Total number of households

DOCUMENT HISTORY

Version	Date	Comment
v1.0	09 Oct 2024	Initial version