Methodology for Installation of High Efficiency Firewood Cookstoves

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1 SOURCES

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

This methodology uses as sources[1]:

- Energy efficiency measures in thermal applications of non-renewable biomass; version 11.1
- The latest version of the CDM General guidelines for SSC CDM methodologies[2]
- The latest version of the CDM Standard for sampling and surveys for CDM project activities and programme of activities[3]
- Water Boiling Test Protocol 4.2.3[4]
- Gold Standard "Technologies and Practices to Displace Decentralized Thermal Energy Consumption" (Version 03.1)
- CDM methodology "Biogas/Biomass thermal applications for households/small users" (version 04.0)
- The GHG Protocol for Project Accounting

2 SUMMARY DESCRIPTION OF THE METHODOLOGY

Additionality and Crediting Method	
Additionality	Activity Method
Crediting Baseline	Project Method

CDM small-scale methodology AMS-II.G. is applicable to project activities that introduce new efficient thermal energy generation units, e.g. efficient biomass fired cookstoves, ovens, or dryers, or the retrofit of existing units to reduce the use of nonrenewable biomass for combustion. Through this methodology revision, efficient biomass fired cookstoves, ovens, or dryers, may replace fossil fuel fired baseline stoves/dryers or oven as well which are not

[1] Links have been provided in Section 10- References.

permitted under the original methodology. Further, the revision will result in following changes to the applicability criteria outlined in the methodology:

1. The project stove is a single pot or multi pot portable or an in-situ cookstove using only woody biomass; Additional requirement to demonstrate that the biomass used is solely renewable[2] biomass for project activities replacing baseline stoves using fossil fuel; and
2. Project stoves to be implemented shall have specified high-power thermal efficiency of at least 25%; and
3. Non-renewable biomass has been used in the project region since 31 December 1989, using survey methods or referring to published literature, official reports or statistics[3]; and
4. For the specific case of biomass residues processed as a fuel (e.g. briquettes, wood chips), it shall be demonstrated that: (a) It is produced using exclusively renewable biomass (more than one type of biomass may be used). (b) The consumption of the fuel should be monitored during the crediting period and (c) Energy use for renewable biomass processing (e.g. shredding and compacting in the case of briquetting) may be considered as equivalent to the upstream emissions associated with the processing of the displaced fossil fuel and hence disregarded.

Applicability criteria numbers 8 and 9 of AMS II.G, version 11.1 shall be applicable in addition to above.

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

3 DEFINITIONS

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

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

[2] Refer to EB 23 Annex 18 for definition of renewable biomass.

[3] Not required in case of project stoves replacing fossil fuel baseline stoves.

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

Basic Chimney ICS

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

Basic Portable ICS

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

Intermediate ICS

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

Advanced Cookstoves (ACS)

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

Project Technology

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

Rudimentary Cookstove

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

Rural Area

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

Vintage

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

4 APPLICABILITY CONDITIONS

This methodology is applicable under the following conditions:

- Project activities shall be implemented in domestic premises, or in community-based kitchens.
- The project stove shall have specified high-power thermal efficiency of at least 25% per the manufacturer's specifications and shall exclusively use woody biomass and can be single pot or multi-pot; in case of project stove replacing fossil fuel baseline stove, it shall exclusively use renewable biomass.
- Both 'Projects' and 'Large Projects' can use this methodology.
- Non-renewable biomass has been used in the project region since 31 December 1989, using survey methods or referring to published literature, official reports or statistics[5].
- For the specific case of biomass residues processed as a fuel (e.g. briquettes, wood chips), it shall be demonstrated that: (a) It is produced using exclusively renewable biomass (more than one type of biomass may be used). (b) The consumption of the fuel should be monitored during the crediting period and (c) Energy use for renewable biomass processing (e.g. shredding and compacting in the case of briquetting) may be considered as equivalent to the upstream emissions associated with the processing of the displaced fossil fuel and hence disregarded.

Additionally, applicability criteria numbers 8 and 9 set out in Section 2.2 of AMS II.G, version 11.1 shall apply.

5 PROJECT BOUNDARY

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

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

[5] Not required in case of project stoves replacing fossil fuel baseline stoves.

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

Source		Gas	Included?	Justification/Explanation
Baseline	Emission from use of non-renewable biomass/Fossil fuel	CO_2	Yes	Major source
		CH_4	Yes	Major source
		N_2O	Yes	Major source
		Other	No	No other source identified
	Production & Transport of Fuel	CO_2	Yes	Can be a major source
		CH_4	Yes	Can be a major source
		N_2O	Yes	Can be a major source
		Other	No	No other source identified
Project	Emission from use of non-renewable biomass	CO_2	Yes	Major source
		CH_4	Yes	Major source
		N_2O	Yes	Major source
		Other	No	No other source identified
	Production & Transport of Fuel	CO_2	Yes	Can be a major source
		CH_4	Yes	Can be a major source
		N_2O	Yes	Can be a major source
		Other	Yo	No other source identified

6 BASELINE SCENARIO

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

7 ADDITIONALITY

This methodology uses activity method for the demonstration of additionality.

Step 1: Regulatory Surplus

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

Step 2: Positive List

The applicability conditions of this methodology represent the positive list. The project must demonstrate that it meets all of the applicability conditions of the methodology as well as the below condition. In so doing, ithe project is deemed as complying with the positive list.

1. Where the project activity installs or distributes stoves at zero cost to the end-user and has no other source of revenue other than the sale of GHG credits, the project activity shall be deemed additional.
2. Project activities that are implemented as part of government schemes or are supported by multilateral funds cannot be considered additional even if the stoves are distributed free of cost or at a highly subsidized rate and hence are not eligible to use this methodology.

The positive list was established using the revenue stream option (Option C in the *VCS Standard, v4.0*). Please refer to Appendix A for justification of the revenue streams option.

Step 3. Project Method

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

8 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

8.1 Baseline Emissions

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

8.2 Project Emissions

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

8.3 Leakage

Leakage shall be considered as default 0.95 in accordance with Section 5.4 of AMS-II.*G.*

8.4 Net GHG Emission Reductions and Removals

Net GHG emission reductions are calculated by applying Equations 1 and 2 for project activities replacing baseline stoves using non-renewable biomass (firewood/charcoal) and Equation 1 and 7 for project activities replacing baseline stoves using fossil fuel (coal/kerosene):

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

Where:

i	=	Indices for the situation where mo re than one type/model of improved cook stove is introduced to replace three-stone fire
j	=	Indices for the situation where there is more than one batch of improved cook stove of type i
ER_y	=	Emission reductions during year *y* in t CO_2e
$ER_{y,i,j}$	=	Emission reductions by improved cook stove of type i and batch j during year *y* in t CO_2e

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

Where:

$B_{y,savings,i,j}$	=	Quantity of woody biomass that is saved in tonnes per improved cook stove of type i and batch j during year y
$f_{NRB,y}$	=	Fraction of woody biomass that can be established as non-renewable biomass (fNRB)[6]
$NCV_{wood\ fuel}$	=	Net calorific value of the non-renewable woody biomass that is substituted or reduced (IPCC default for wood fuel, 0.0156 TJ/tonne)[7]
$EF_{wf,CO2}$	=	CO_2 emission factor for the use of wood fuel in baseline scenario (IPCC default for wood fuel, 112 tCO_2/TJ)[8]
$EF_{wf,non\ CO2}$	=	Non-CO_2 emission factor for the use of wood fuel in baseline scenario (IPCC default for wood fuel, 26.23 tCO_2/TJ)[9]
$N_{y,i,j}$	=	Number of improved cook stoves of type *i* and batch *j* operating during year *y*
0.95	=	Discount factor to account for leakage

The quantify of woody biomass saved $B_{y,savings,i,j}$due to implementation of improved cook stoves can be estimated by one of the following options[10] set out in Equations 3 and 4:

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

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

Where:

B_{old}	=	Annual quantity of woody biomass that would have been used in the absence of the project activity (in tonnes per device) to generate useful thermal energy equivalent to that provided by the improved cook stove. The value of B_{old} can be sourced from historical data or baseline surveys. Alternatively, a default value of 0.5t/capita/year may be used.

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

[7] AMS II.G. Version 11

[8] 2006 IPCC Guidelines for National Greenhouse Gas Inventories; Chapter 2 Stationary Combustion

[9] 2006 IPCC Guidelines for National Greenhouse Gas Inventories; Chapter 2 Stationary Combustion

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

η_{old}	=	Efficiency of baseline cookstove
$\eta_{new,i,y}$	=	Efficiency of the improved cook stove type *i* and batch *j* determined through water boiling test (WBT). Alternatively, efficiency may be determined using Equation 5.
$B_{y=1,new,i,j,survey}$	=	Annual quantity of woody biomass used by improved cook stoves in tonnes per device of type *i* and batch *j*, determined in the first year of the implementation of the project through a sample survey.

$$\eta_{new,i,y} = \eta_p \times (DF_n)^{y-1} \times 0.94 \qquad \text{Equation (5)}$$

Where:

η_p	=	Efficiency of project stove (fraction) at the start of project activity
$(DF_n)^{y-1}$	=	Discount factor to account for efficiency loss of project cookstove per year of operation (fraction). This value may be based on actual monitoring or based on manufacturer's declaration on expected loss in efficiency or through publicly available literature on relevant industry standards Alternatively default value of 0.99 efficiency loss per year can be considered.
0.94	=	Adjustment factor to account for uncertainty related to project cookstove efficiency test

Where the project households continue to use baseline cookstoves along with improved cookstoves, B_{old} shall be adjusted *ex-post* based on the percentage of project households found to continue such practice according to Equation 6. For such cases, the quantity of woody biomass saved $B_{y,savings,i,j}$ due to implementation of improved cook stoves shall be calculated using an adjusted value to account for *ex-post* use of baseline stoves in addition to improved cookstove.

$$B_{old,adjusted} = B_{old} \times \left(1 - \mu_y\right) \qquad \text{Equation (6)}$$

Where:

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

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

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

(b) **Baseline Survey of Local Usage.** Project proponent shall carry out a survey of usage prior to implementation of the project activity following the sampling approach described in the latest version of CDM document *Sampling and surveys for CDM project activities and programme of activities*. Alternatively, the project participant may follow the simple random sampling approach and the minimum sample size should be determined as per the following guidelines:

- Project target population < 300: Minimum sample size 30
- Project target population 300 – 1000: Minimum sample size 10% of group size
- Project target population > 1000: Minimum sample size 100

This simplified approach may also be used for determining minimum sample size for parameters listed under Sections 9.1 and 9.2 in which case it is not requisite for the sample size to meet confidence/precision requirements

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

In order to address the potential source of leakage which can be attributed to diversion of non-renewable biomass saved by project devices to non-project households which previously used renewable biomass; a net to gross adjustment factor of 0.95 is applied to ERy,i,j.

The above equations assume that a single baseline stove is replaced by a single project stove. However, in some cases more than one project stove may be required to achieve service levels equal to baseline stove. For such cases, the displaced biomass shall be apportioned between the project stoves while calculating B_{old}.

The equations below shall be used for calculating biomass consumed in absence of project activity in case more than one project stove is used in household:

$$B_{old,\,i,\,j} = B_{old,\,HH} \div N_{d,\,HH}$$

$$B_{old,\,HH} = B_{old,\,p} \times N_{p,\,HH}$$

Where:

$B_{old,\,HH}$	=	Annual quantity of woody biomass that would have been used in the household in the absence of the project activity to generate useful thermal energy equivalent to that provided by the project devices (tonnes/household/year)
$N_{d,\,HH}$	=	Number of project devices per household
$B_{old,\,p}$	=	Annual quantity of woody biomass that would have been used per person in the household in the absence of the project activity to generate useful thermal energy equivalent to that provided by the project devices (tonnes/person/year)
$N_{p,\,HH}$	=	Average number of households

For projects opting for $B_{y=1,new,i,j,survey}$, it shall be demonstrated that the consumption of biomass for individual project stoves can be measured exclusive of one another.

For project stoves replacing fossil fuel with renewable biomass, the following equations shall apply

$$ER_{y,i,j} = N_{y,i} \times B_{renewable,y} \times EF_{ff} \times \eta_{PJ/BL} \times NCV_{biomass} - LE_y \qquad \text{Equation (7)}$$

Where:

$N_{y,i}$	=	Number of improved cook stoves of type *i* operating during year *y*
$B_{renewable,y}$	=	The net quantity of renewable biomass consumed by the project stove in year y (tons)
EF_{ff}	=	CO_2 emission factor for fossil fuel j (tCO_2/TJ)
$\eta_{PJ/BL}$	=	Ratio of efficiencies of project equipment and baseline equipment
$NCV_{biomass}$	=	Net calorific value of renewable biomass substituting fossil fue
LE_y	=	Only, if the energy generating equipment introduced by the project activity is transferred from outside the boundary to the project activity, leakage is to be considered.

$$EF_{ff} = EF_{ff\_CO2} + EF_{ff\_CH4} \times GWP_{CH4} + EF_{ff\_N2O} \times GWP_{N2O} \qquad \text{Equation (8)}$$

Where:

EF_{ff_CO2}	=	CO_2 emission factor for fossil fuel 'j'. Default values are mentioned in the table below
EF_{ff_CH4}	=	CH_4 emission factor for fossil fuel 'j'. Default values are mentioned in the table below
GWP_{CH4}	=	Global warming potential of CH_4 according to fifth assessment report. [11]
EF_{ff_N2O}	=	N_2O emission factor for fossil fuel 'j'. Default values are mentioned in the table below
GWP_{N2O}	=	Global warming potential of N_2O according to fifth assessment report

11 https://www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf

Table 2: GHG Sources Included In or Excluded From the Project Boundary

Emission factor	Kerosone	Coal
CO_2 emission factor (kg/TJ)	71,900	94,600
CH_4 emission factor (kg/TJ)	10	300
N_2O emission factor (kg/TJ)	0.6	1.5

9 MONITORING

9.1 Data and Parameters Available at Validation

Project proponents must follow the monitoring procedures provided in CDM Methodology AMS-II.G. version 11; noting the revisions set out in sections 9.1 below.

Data / Parameter	B_{old}
Data unit	tonnes/year
Description	Annual quantity of woody biomass that would have been used in the household in the absence of the project activity to generate useful thermal energy equivalent to that provided by the project devices.
Equations	3, 6
Source of data	calculated according to options stated in 'Determination of quantity of firewood consumed in absence of project activity as per options provided in Section 8.4 above
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	This parameter shall be determined ex-ante
Purpose of Data	Calculation of emission reduction
Comments	Parameter B_{old} once determined shall remain fixed for the entire crediting period.

	Where charcoal is used by baseline devices, a default wood to charcoal conversion factor of 6 kg of firewood per kg of charcoal may be used in line with paragraph 35 of AMS II.G, version 11

Data / Parameter	η_p
Data unit	Fraction
Description	Efficiency of project stove at the start of project activity
Equations	5
Source of data	Manufacturer's specification
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	This parameter shall be determined ex-ante
Purpose of Data	Calculation of η_{new}
Comments	N/A

9.2 Data and Parameters Monitored

Project proponents must follow the monitoring procedures provided in CDM methodology AMS-II.G. version 11; noting the revisions set out in sections 9.2 below.

Data / Parameter:	$N_{y,j,k}$
Data unit:	Number
Description:	Number of project devices of type i and batch j operating during year y
Equations	2
Source of data:	Monitoring
Description of measurement methods and procedures to be applied:	Measured directly or based on a representative sample. Sampling standard shall be used for determining the sample size to achieve 90/10 confidence precision according to the latest version of Standard for sampling and surveys for project activities and programme of activities. Alternately, simplified approach proposed in option (b) under Section 8.4 above may be used for determining the minimum sample size in which case compliance with 90/10 confidence precision is not obligatory.

Frequency of monitoring/recording:	At least once every two years
QA/QC procedures to be applied:	
Purpose of data:	Calculation of emission reduction
Calculation method:	
Comments:	Proportion of operational stoves obtained from the survey is multiplied by the total commissioned stoves to arrive at this value.

Data / Parameter:	$\eta_{new,i,j}$
Data unit:	Fraction
Description:	Efficiency of the device of each type *i and* batch *j* implemented as part of the project activity
Equations	3, 4 and 5
Source of data:	Measurements at project facility
Description of measurement methods and procedures to be applied:	Project stoves produced in the formal sector do not vary in characteristics such as design, material, critical dimensions, etc. beyond a range of acceptable limits hence efficiency shall be measured as per following i. Conduct WBT test on a sample of three improved cookstoves with three tests conducted for each stove. The test can be carried out by project proponents by themselves or stove manufacturers or other third parties. ii. Efficiency to be tested is high-power thermal efficiency. The high-power thermal efficiency is the average of the Cold Start and Hot Start phases[12]. iii. The average of all results for each device type/model and batch shall be taken as the efficiency for each device type and batch. iv. If the standard deviation of the test results indicated above is very small[13] and 90/10 precision requirement is met (in this case, the value of the t-distribution for 90 per cent confidence shall be used instead of Z value), the efficiency determined is

[12] CDM Methodologies Panel Clarification on water boiling test under AMS II.G (SSC_752)

[13] Less than or equal to 0.05

	acceptable, otherwise more sample tests would be required until 90/10 precision is met. v. Efficiency of the improved cookstoves can also be estimated ex-ante using equation 5 above where loss in efficiency per year is calculated, and therefore this parameter does not need to be monitored.
Frequency of monitoring/recording:	Annually
QA/QC procedures to be applied:	
Purpose of data:	Calculation of emission reduction
Calculation method:	
Comments:	

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

	device that consumes firewood, are in use in project households, then the sample survey needs to distinguish the quantity of firewood used by the project device and the other devices that use firewood.
Frequency of monitoring/recording:	Determined in the first year of project implementation
QA/QC procedures to be applied:	
Purpose of data:	Calculation of emission reduction
Calculation method:	
Comments:	

Data / Parameter:	μ_y
Data unit:	Fraction
Description:	Adjustment to account for any continued use of pre-project devices during the year *y*
Equations	6
Source of data:	Monitoring
Description of measurement methods and procedures to be applied:	Minimum sample size of each type i and batch j should be in line with the guidelines provide in section 8.4 option (b) above. This parameter should be monitored using one of the following methods: (a) If the baseline cookstoves are decommissioned and no longer used, as determined by the monitoring survey its value is 0 and B_{old}, adjusted is equal to B_{old}. (b) If both the improved cookstove and baseline cookstoves are used together then surveys shall be conducted to record the average continued operation of baseline cookstoves in a sample of households. The surveys should be designed to capture the cooking habits and stove usage of households in the region, including quantification of use of baseline cookstoves, by formulating questions and/or collecting evidences to determine the frequency of usage of both the improved cookstoves and baseline cookstoves. For example, if there were 3 baseline cookstoves in a household and it was determined during the survey that use of one of them continues during the crediting period then a conservative

	adjustment factor of 0.33 is applied to Bold. Another example would be the case where there was only one baseline cookstove per household and its use during the project period continues along with the improved cookstove to meet 25% of the cooking needs of the household in which case the adjustment factor will be 0.25. Another example would be to interview the household and have them estimate the time of usage of the baseline cookstoves and improved cookstove on an average day.[14]
Frequency of monitoring/recording:	At least once every two years
QA/QC procedures to be applied:	
Purpose of data:	Calculation of emission reduction
Calculation method:	For Projects that opt for $B_{y=1,new,l,j,survey}$, i.e., direct measurement of biomass used in project stoves, then μ_y is not required to be computed.
Comments:	

Data / Parameter:	η_{old}
Data unit:	Fraction
Description:	Efficiency of baseline stove
Equations	3, 4
Source of data:	• Default value: 0.1 or 0.2; or • Surveyed prior to implementation of project activity
Description of measurement methods and procedures to be applied:	(c) A default value of 0.1 shall be used if baseline device is a three-stone fire using firewood (not charcoal), or a conventional device with no improved combustion air supply or flue gas ventilation, that is without a grate or a chimney. (d) A default value of 0.2 shall be used for other types of devices. (e) If more than one type of baseline device is being replaced in the project region, weighted average values (taking the

[14] For example, if a household reports to be preparing 3 meals in a day using 35 minutes each, out of which one meal is prepared on the baseline stove, then cooking time on secondary stove and project stove would be 0.33 and 0.66 respectively.

	amount of woody biomass consumed by each device as the weighting factor) shall be used. (f) If this parameter is surveyed, project promoters may use simplified guidelines stated under Option (b) in Section 8.4 above for arriving at the minimum sample size.
Frequency of monitoring/recording:	Fixed for each individual household at the time of project implementation.
QA/QC procedures to be applied:	
Purpose of data:	Calculation of emission reduction
Calculation method:	
Comments:	

Data / Parameter:	Life span
Data unit:	Years
Description:	Project promoters to state the operating lifetime of project device for projects opting Equation 5 for determining project stove efficiency.
Equations	5
Source of data:	Manufacturer's specification
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Once at the time of Project stove installation
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$N_{y,i}$
Data unit:	Number

Description:	Number of project devices of type i operating during year *y*
Equations	7
Source of data:	Monitoring
Description of measurement methods and procedures to be applied:	Measured directly or based on a representative sample. Sampling standard shall be used for determining the sample size to achieve 90/10 confidence precision according to the latest version of Standard for sampling and surveys for project activities and programme of activities Alternately, simplified approach proposed in option (b) under Section 8.4 above may be used for determining the minimum sample size in which case compliance with 90/10 confidence precision is not obligatory.
Frequency of monitoring/recording:	Annual
QA/QC procedures to be applied:	
Purpose of data:	Calculation of emission reduction
Calculation method:	
Comments:	Proportion of operational stoves obtained from the survey is multiplied by the total commissioned stoves to arrive at this value.

Data / Parameter:	$B_{renewable,y}$
Data unit:	tonnes
Description:	Quantity of renewable biomass used by project devices in tonnes per device of type *i*.
Equations	7
Source of data:	Survey
Description of measurement methods and procedures to be applied:	Minimum sample size of each type i and batch j should be in line with the latest version of Standard for sampling and surveys for project activities and programme of activities or guidelines provided in section 8.4 option (b) in which case requirements to meet confidence/ precision is not obligatory. Determined through measurement campaigns at representative households and/or sample survey. Sample surveys to estimate this parameter, that are solely based on questionnaires or interviews (i.e. that do not implement measurement campaigns) may only be used if the following conditions are satisfied. (i)

	Baseline cookstoves have been completely decommissioned and only improved cookstoves are exclusively used in the project households; (ii) If multiple devices are used in the project, it is possible from the results of the survey questions to clearly differentiate the quantity of firewood being used by each device. In other words, if more than one device, or another device that consumes firewood, are in use in project households, then the sample survey needs to distinguish the quantity of firewood used by the project device and the other devices that use firewood.
Frequency of monitoring/recording:	annual
QA/QC procedures to be applied:	
Purpose of data:	Calculation of emission reduction
Calculation method:	
Comments:	

Data / Parameter:	$\eta_{PJ,BL}$
Data unit:	Fraction
Description:	Ratio of Efficiency of project stove and baseline stove
Equations	7
Source of data:	Calculated
Description of measurement methods and procedures to be applied:	(a) Both PJ and BL to be measured once prior to validation using same test procedure. (b) Test results from accredited lab are acceptable if it can be established that it was done as per national/international standards. (c) Alternatively WBT test on a sample of three cookstoves with three tests conducted for each stove can be used. The test can be carried out by project proponents by themselves or stove manufacturers or other third parties.
Frequency of monitoring/recording:	Once prior to validation
QA/QC procedures to be applied:	
Purpose of data:	Calculation of emission reduction
Calculation method:	

Comments:	

Data / Parameter:	$NCV_{biomass}$
Data unit:	TJ/tonne
Description:	Net calorific value of the non-renewable woody biomass, renewable biomass, briquettes or pellets used in project devices
Equations	2, 7
Source of data:	Default or measured
Description of measurement methods and procedures to be applied:	i. IPCC default for wood fuel, 0.0156 TJ/tonne, based on the gross weight of the wood that is 'air-dried' may be used if fuel used in project device is woody biomass/renewable biomass. ii. For the case of processed renewable biomass (e.g. briquettes), test report from laboratories according to relevant national/international standards or manufacturue's data or test reports.
Frequency of monitoring/recording:	Annual
QA/QC procedures to be applied:	Measurement in laboratories according to relevant national/international standards based on dry biomass. Consistency of the measurements to be checked by comparing the measurement results with measurements from previous years, relevant data sources (e.g. values in the literature, values used in the national GHG inventory) and default values by the IPCC.
Purpose of data:	Calculation of emission reduction
Calculation method:	
Comments:	

9.3 Description of the Monitoring Plan

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

Data Recording

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

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

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

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

The survey must obtain, at minimum, the following:

1. The cookstoves distributed under the project are being used.
2. The project stoves are operational and in good condition
3. Baseline stoves, if any are being used along with project stoves.

10 REFERENCES

1. Energy efficiency measures in thermal applications of non-renewable biomass; version 11.0.

2. The latest version of the CDM General guidelines for SSC CDM methodologies.

3. The latest version of the CDM Standard for sampling and surveys for CDM project activities and programme of activities.

4. Water Boiling Test Protocol 4.2.3; https://www.cleancookingalliance.org/binary-data/DOCUMENT/file/000/000/399-1.pdf

5. Gold Standard "Technologies and Practices to Displace Decentralized Thermal Energy Consumption" (Version 03.1); https://www.goldstandard.org/project-developers/standard-documents

6. Clean Development Mechanism, Clarification request SSC_752

7. Fuel-efficient Cook Stoves- A triple win for child health, development and environment, http://wvfoodandclimate.com/home/portfolio-2/climate/fuel-efficient-cookstoves/#.XFL8cFwzZPY

8. Technical Report 007/15: The State of the Global Clean And Improved Cooking Sector, https://openknowledge.worldbank.org/handle/10986/21878

9. Policy Research Working Paper 6903- Household Cooking Fuel Choice and Adoption of Improved Cookstoves in Developing Countries – A Review, https://openknowledge.worldbank.org/handle/10986/18775

10. Fuel efficiency and performance of traditional and innovative cookstoves - Howard S Geller; https://www.ias.ac.in/article/fulltext/sadh/005/04/0373-0393

11. GHG Protocol, Global Warming Potential Values, https://www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf

APPENDIX 1: ACTIVITY METHOD

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

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

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

Common Practice Analysis

According to a World Health Organization report published in 2016[15], percentage of population relying on solid fuel for cooking has remained static at around 2.7 and 2.8 billion over the last three decades. This, despite the fact that enormous efforts have been undertaken by various government and non-governmental organizations to displace the use of solid fuel on one hand and to introduce clean cookstoves on the other to tackle the problem of indoor air pollution. Eventually WHO acknowledged the fact that efforts required to bring down the household air pollution levels, have been slow, under-funded and ineffective. This in essence sums up the fact that greater efforts have to be put in place to achieve satisfactory levels of penetration and uptake of clean cooking technologies.

While a considerable number of improved cookstoves have been distributed in the developing countries in the last three decades, the problem of indoor air pollution does not show any trend in reduction, and

[15] https://www.who.int/bulletin/volumes/94/3/15-155812/en/

this can be attributed primarily to two or three reasons, the primary among them being economic constraint. The adoption of improved cookstoves faces substantial obstacles[16] such as limited ability of consumers to afford high quality clean cookstoves and lack of awareness. Moreover, large gaps in financial and technical capacity across stove and fuel supply chains, and gaps in the enabling environment for both fuel and stove markets, including the continued absence of coherent quality and performance standards, present additional challenges.

Classification of ICS Technology

The ISO technical committee formulated voluntary performance targets to provide guidance on performance of clean cookstoves. There are five indicators covered by the targets: thermal efficiency, fine particulate matter emissions, carbon monoxide emissions, safety, and durability. For each indicator, lab test results are rated along six tiers (0: lowest performing to 5: highest performing). Tier 0 represents performance typical of open fires and the simplest cookstoves[17].

Tier	Thermal Efficiency (%)	Carbon Monoxide Emissions (gram/megajoule delivered)	Fine Particulate Matter Emissions (milligram/megajoule delivered)	Safety (score)	Durability (score)
5	≥50	≤3.0	≤5	≥95	<10
4	≥40	≤4.4	≤62	≥86	<15
3	≥30	≤7.2	≤218	≥77	<20
2	≥20	≤11.5	≤481	≥68	<25
1	≥10	≤18.3	≤1031	≥60	<35
0	<10	>18.3	>1031	<60	>35

Using this performance benchmark, the clean cooking technologies can be divided under following categories

[16] Clean and Improved Cooking in Sub Saharan Africa. (second edition, November 2014)

[17] https://www.cleancookingalliance.org/technology-and-fuels/standards/iwa-tiers-of-performance.html

	"Improved" solutions		"Clean" solutions		
	Legacy and basic ICS	Intermediate ICS	Advanced ICS	Modern fuel	Renewable fuel
					
Key features	Small functional improvements in fuel efficiency over baseline technologies; typically artisanally produced	Rocket-style designs with focus on highly improved fuel efficiency; includes both portable and built-in models	Fan or natural-draft gasifiers with high fuel and combustion efficiency; often designed for pellet/ briquette fuels	Stoves that rely on fossil fuels or electricity; have high fuel efficiency and low emissions	Derive energy from renewable non-woodfuel energy; often used as supplementary stoves
Technologies	• Legacy biomass and coal chimney stoves[1] • Basic efficient charcoal • Basic efficient wood	• Portable rocket stoves • Fixed rocket chimney • Highly improved (low CO_2) charcoal stoves	• Natural-draft gasifier (top-loading updraft (TLUD) or side-loading) • Fan gasifier/fan jet • Combination TLUD and charcoal stoves	• LPG • Electric (including induction) • Natural gas stoves • Kerosene stoves[2]	• Biogas • Ethanol • Solar • Retained heat cookers
Efficiency	Tier 0–2	Tier 2–3	Tier 3–4	Tier 4	Tier 3–4
Emissions[3]	Tier 0–1	Tier 1–2	Tier 2–3	Tier 3–4	Tier 3–4
Overall benefits	Moderate				High

In order to establish less than 20% penetration rate of the ICS technology, reference of UN SDG 7 progress report[18], has been used. Sections dealing with access to clean fuel and clean technology have been attached below. However based on above classification, the ICS applicable under this methodology belong to Tier 2 and above category that is either intermediate or advanced cooking solutions and hence for some of the countries while penetration of improved cooking solutions may be higher than 20%, the penetration of intermediate ICS and advanced ICS may be still very low. Project promoters may use other sources to establish a less than 20% penetration rate for respective technologies.

2019 THE ENERGY PROGRESS REPORT TRACKING SDG7[19]

[18] https://sustainabledevelopment.un.org/content/documents/2019_Tracking_SDG7_Report.pdf

[19] https://sustainabledevelopment.un.org/content/documents/2019_Tracking_SDG7_Report.pdf

TOTAL ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Afghanistan	7	19	32	21	34	45	71	88	>95	<5	12	28
Albania	41	65	78	49	80	95	70	92	>95	21	65	95
Algeria	88	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
American Samoa												
Andorra	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Angola	34	44	48	36	49	62	64	78	90	<5	8	15
Anguilla												
Antigua and Barbuda	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Argentina	>95	>95	>95	94	>95	>95	95	>95	>95	66	93	>95
Armenia	83	95	>95	88	>95	>95	95	>95	>95	76	>95	>95
Aruba												
Australia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Austria	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Azerbaijan	73	93	>95	89	>95	>95	94	>95	>95	73	95	>95
Bahamas	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Bahrain	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Bangladesh	7	13	19	13	19	28	31	50	70	<5	6	15
Barbados	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Belarus	92	>95	>95	68	>95	>95	76	>95	>95	63	>95	>95
Belgium	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Belize	78	84	86	78	87	93	92	>95	>95	57	78	92
Benin	<5	<5	6	<5	6	13	<5	9	18	<5	<5	<5
Bermuda												
Bhutan	27	61	76	55	79	94	77	>95	>95	46	75	92
Bolivia (Plurinational State of)	63	76	81	74	83	90	94	>95	>95	32	52	71

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Bosnia and Herzegovina	39	53	62	43	63	80	45	70	92	23	58	89
Botswana	42	53	58	31	59	74	42	73	93	21	41	63
Brazil	87	94	>95	88	>95	>95	94	>95	>95	56	79	92
British Virgin Islands												
Brunei Darussalam	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Bulgaria	66	84	90	61	91	>95	30	94	>95	13	85	>94
Burkina Faso	<5	6	9	<5	10	17	17	30	44	<5	<5	<5
Burundi	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cambodia	<5	11	18	11	20	30	53	66	77	<5	7	16
Cameroon	10	18	24	9	25	36	33	46	60	<5	<5	7
Canada	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Cabo Verde	58	69	75	37	75	83	71	92	>95	27	40	49
Cayman Islands												
Central African Republic	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	<5
Chad	<5	<5	<5	<5	<5	6	5	14	25	<5	<5	<5
Channel Islands												
Chile	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
China	49	54	58	30	58	83	66	82	91	12	32	60
Colombia	79	90	94	84	94	>95	94	>95	>95	37	61	80
Comoros	<5	<5	8	<5	10	23	<5	20	43	<5	<5	17
Democratic Republic of the Congo	<5	<5	<5	<5	<5	11	<5	9	20	<5	<5	5
Congo	9	17	24	11	25	43	20	37	55	<5	<5	13
Cook Islands	84	85	84	54	84	>95	57	95	>95	<5	62	>95
Costa Rica	88	92	94	85	95	>95	93	>95	>95	58	83	>95
Côte d'Ivoire	16	18	20	8	21	40	32	47	62	<5	<5	8
Croatia	84	90	92	79	93	>95	80	>95	>95	50	89	>95
Cuba	77	86	89	10	90	>95	31	94	>95	<5	77	>95

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Curaçao												
Cyprus	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Czechia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Denmark	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Djibouti	5	8	10	<5	10	37	17	18	19	<5	<5	14
Dominica	78	87	91	79	91	>95	88	>95	>95	46	81	>95
Dominican Republic	80	87	90	83	91	>95	90	>95	>95	46	74	93
Ecuador	88	95	>95	91	>95	>95	>95	>95	>95	66	91	>95
Egypt	85	>95	>95	>95	>95	>95	>95	>95	>95	86	>95	>95
El Salvador	57	79	88	79	89	95	89	95	>95	52	79	95
Equatorial Guinea	14	29	37	<5	37	70	11	42	76	<5	9	34
Eritrea	<5	12	17	<5	18	45	15	31	51	<5	<5	9
Estonia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Ethiopia	<5	<5	<5	<5	<5	10	7	16	29	<5	<5	<5
Faroe Islands												
Fiji	32	43	48	7	51	82	18	67	93	<5	17	50
Finland	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
France	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
French Polynesia												
Gabon	60	76	81	33	81	94	75	92	>95	24	43	60
Gambia	<5	<5	<5	<5	<5	9	<5	<5	16	<5	<5	<5
Georgia	41	66	78	60	79	93	89	>95	>95	6	33	73
Germany	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Ghana	6	16	23	16	25	36	30	41	51	<5	8	18
Gibraltar												
Greece	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Greenland												

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Grenada	94	>95	>95	91	>95	>95	63	>95	>95	73	>95	>95
Guam												
Guatemala	37	41	43	33	43	53	7	50	94	2	32	81
Guinea	<5	<5	<5	<5	<5	<5	<5	<5	24	<5	<5	5
Guinea-Bissau	<5	<5	<5	<5	<5	<5	<5	<5	28	<5	<5	<5
Guyana	36	62	75	59	77	90	57	84	>95	50	71	87
Haiti	<5	<5	<5	<5	<5	11	<5	12	46	<5	<5	18
Honduras	30	45	52	37	54	70	40	82	>95	6	25	53
China, Hong Kong Special Administrative Region												
Hungary	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Iceland	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
India	22	36	44	26	45	65	63	78	88	12	22	35
Indonesia	7	42	63	42	65	82	70	85	93	38	51	64
Iran (Islamic Republic of)	87	>95	>95	95	>95	>95	>95	>95	>95	87	>95	>95
Iraq	72	>95	>95	94	>95	>95	>95	>95	>95	84	>95	>95
Ireland	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Isle of Man												
Israel	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Italy	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Jamaica	72	86	91	84	92	>95	86	>95	>95	62	85	>95
Japan	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Jordan	>95	>95	>95	>95	>95	>95	94	>95	>95	91	>95	>95
Kazakhstan	85	94	>95	88	>95	>95	88	>95	>95	71	95	>95
Kenya	<5	7	13	6	14	26	12	28	48	<5	<5	6
Kiribati	<5	<5	6	<5	6	29	<5	14	48	<5	<5	16
Democratic People's Republic of Korea	<5	6	10	<5	11	33	5	15	33	<5	<5	14

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Republic of Korea	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Kosovo												
Kuwait	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Kyrgyzstan	53	73	81	58	83	>95	67	95	>95	48	74	94
Lao People's Democratic Republic	<5	<5	5	<5	5	21	5	14	27	<5	<5	7
Latvia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Lebanon												
Lesotho	16	27	32	17	33	51	67	82	92	9	17	28
Liberia	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Libya												
Liechtenstein												
Lithuania	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Luxembourg	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
China, Macao Special Administrative Region												
The former Yugoslav Republic of Macedonia	41	59	65	47	66	83	70	87	95	15	45	76
Madagascar	<5	<5	<5	<5	<5	<5	<5	<5	5	<5	<5	<5
Malawi	<5	<5	<5	<5	<5	5	6	10	16	<5	<5	<5
Malaysia	95	>95	>95	37	>95	>95	84	>95	>95	14	95	>95
Maldives	32	87	>95	72	>95	>95	82	>95	>95	85	>95	>95
Mali	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	<5
Malta	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Marshall Islands	7	57	65	36	66	87	61	91	>95	<5	7	29
Mauritania	30	39	44	30	46	58	39	71	85	8	21	29
Mauritius	94	>95	>95	89	>95	>95	84	>95	>95	88	>95	>95
Mexico	81	84	86	79	86	91	88	93	>95	40	55	72
Micronesia (Federated States of)	11	12	12	5	12	27	6	75	>95	<5	9	49

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Republic of Moldova	68	89	94	81	94	>95	92	>95	>95	62	92	>95
Monaco	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Mongolia	15	29	38	6	41	60	25	57	78	<5	11	29
Montenegro	55	62	65	44	66	87	51	77	>95	18	50	83
Morocco	91	>95	>95	93	>95	>95	>95	>95	>95	74	94	>95
Mozambique	<5	<5	<5	<5	<5	7	<5	9	21	<5	<5	<5
Myanmar	<5	10	19	7	20	38	28	54	74	<5	6	22
Namibia	32	40	44	<5	44	58	49	75	89	5	12	21
Nauru	72	89	92	35	92	>95	69	91	>95	<5	27	>95
Nepal	14	22	29	18	29	43	41	65	84	7	15	25
Netherlands	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
New Caledonia												
New Zealand	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Nicaragua	34	45	52	44	54	63	69	79	87	<5	13	32
Niger	<5	<5	<5	<5	<5	8	<5	8	22	<5	<5	<5
Nigeria	<5	<5	6	<5	7	12	6	14	26	<5	<5	5
Niue	75	89	93	81	93	>95	67	>95	>95	73	94	>95
Northern Mariana Islands												
Norway	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Oman	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Pakistan	23	35	43	29	44	62	77	92	>95	<5	14	35
Palau	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Panama	79	86	89	82	90	>95	95	>95	>95	53	75	92
Papua New Guinea	6	9	11	<5	12	30	19	47	74	<5	<5	22
Paraguay	46	58	65	56	66	75	73	83	90	25	38	53
Peru	35	66	74	66	76	84	80	90	>95	17	29	43
Philippines	36	42	44	29	44	61	42	64	83	11	21	33

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Poland	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Portugal	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Puerto Rico												
Qatar	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Romania	67	83	88	59	89	>95	74	>95	>95	45	80	95
Russian Federation	93	>95	>95	91	>95	>95	93	>95	>95	74	>95	>95
Rwanda	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Samoa	16	26	31	17	31	45	42	65	81	12	24	43
San Marino	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Sao Tome and Principe	<5	<5	<5	<5	<5	12	<5	<5	15	<5	<5	5
Saudi Arabia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Senegal	34	33	31	17	31	46	34	55	74	<5	6	13
Serbia	52	67	74	43	74	93	63	86	>95	18	57	89
Seychelles	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Sierra Leone	<5	<5	<5	<5	<5	<5	<5	<5	9	<5	<5	<5
Singapore	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Sint Maarten (Dutch part)												
Slovakia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Slovenia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Solomon Islands	6	8	8	<5	8	20	21	39	59	<5	<5	15
Somalia	<5	<5	<5	<5	<5	6	<5	5	14	<5	<5	11
South Africa	55	76	84	72	86	93	85	95	>95	56	73	85
South Sudan	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Spain	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Sri Lanka	14	22	27	14	28	43	48	66	80	8	20	36
Saint Kitts and Nevis	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Saint Lucia	87	95	>95	92	>95	>95	84	>95	>95	85	>95	>95

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Sint Maarten (Dutch part)												
Saint Vincent and the Grenadines	>95	>95	>95	91	>95	>95	84	>95	>95	80	>95	>95
Sudan	13	29	41	30	44	57	56	70	83	7	30	58
Suriname	80	87	90	79	91	>95	86	95	>95	60	81	95
Swaziland	27	42	50	39	51	64	74	87	94	20	33	46
Sweden	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Switzerland	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Syrian Arab Republic	>95	>95	>95	>95	>95	>95	>95	>95	>95	84	>95	>95
Tajikistan	38	68	81	61	83	95	90	>95	>95	37	74	95
United Republic of Tanzania	<5	<5	<5	<5	<5	7	5	11	22	<5	<5	<5
Thailand	65	73	78	61	78	90	76	88	>95	60	73	84
Timor-Leste	<5	5	10	<5	11	21	15	25	36	<5	5	13
Togo	<5	<5	7	<5	8	14	8	18	28	<5	<5	<5
Tonga	49	54	55	34	55	74	68	85	>95	23	49	74
Trinidad and Tobago	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Tunisia	93	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Turkey	90	94	>95	91	>95	>95	>95	>95	>95	71	88	>95
Turkmenistan	>95	>95	>95	>95	>95	>95	>95	>95	>95	59	>95	>95
Turks and Caicos Islands												
Tuvalu	20	44	52	12	52	77	18	75	>95	<5	32	95
Uganda	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	<5
Ukraine	89	95	>95	82	>95	>95	94	>95	>95	74	93	>95
United Arab Emirates	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
United Kingdom of Great Britain and Northern Ireland	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
United States of America	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Uruguay	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Uzbekistan	80	89	92	77	92	>95	90	>95	>95	60	91	>95
Vanuatu	12	12	11	<5	11	22	16	35	57	<5	<5	11
Venezuela (Bolivarian Republic of)	>95	>95	>95	92	>95	>95	92	>95	>95	64	88	>95
Viet Nam	14	46	67	55	70	81	80	92	>95	35	60	76
United States Virgin Islands												
State of Palestine												
Yemen	55	60	63	52	63	75	90	>95	>95	26	48	71
Zambia	14	15	16	10	16	24	24	38	55	<5	<5	7
Zimbabwe	32	30	29	19	29	37	61	78	90	<5	5	11
World	50	57	60	54	61	67	29	34	40	79	83	85
Northern America (M49) and Europe (M49)	>95	>95	>95	>95	>95	>95	92	>95	>95	>95	>95	>95
Latin America and the Caribbean (MDG=M49)	78	85	88	85	88	90	55	62	68	92	94	>95
Central Asia (M49) and Southern Asia (MDG=M49)	26	38	45	33	46	60	16	23	32	70	79	87
Eastern Asia (M49) and South-eastern Asia (MDG=M49)	46	55	60	44	61	77	25	38	55	73	82	89
Sub-Saharan Africa (M49)	9	11	13	12	14	15	3	4	5	27	30	33
Oceania (MDG) / Oceania (M49) excluding Australia and New Zealand (M49)	11	14	16	8	17	30	2	7	21	34	52	70
Western Asia (M49) and Northern Africa (M49)	78	87	90	83	90	93	76	81	86	>95	>95	>95
Australia and New Zealand (M49)	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95

Source: World Health Organization
Note:
L = 95% confidence interval lower bound
M = point estimate
U = 95% confidence interval upper bound