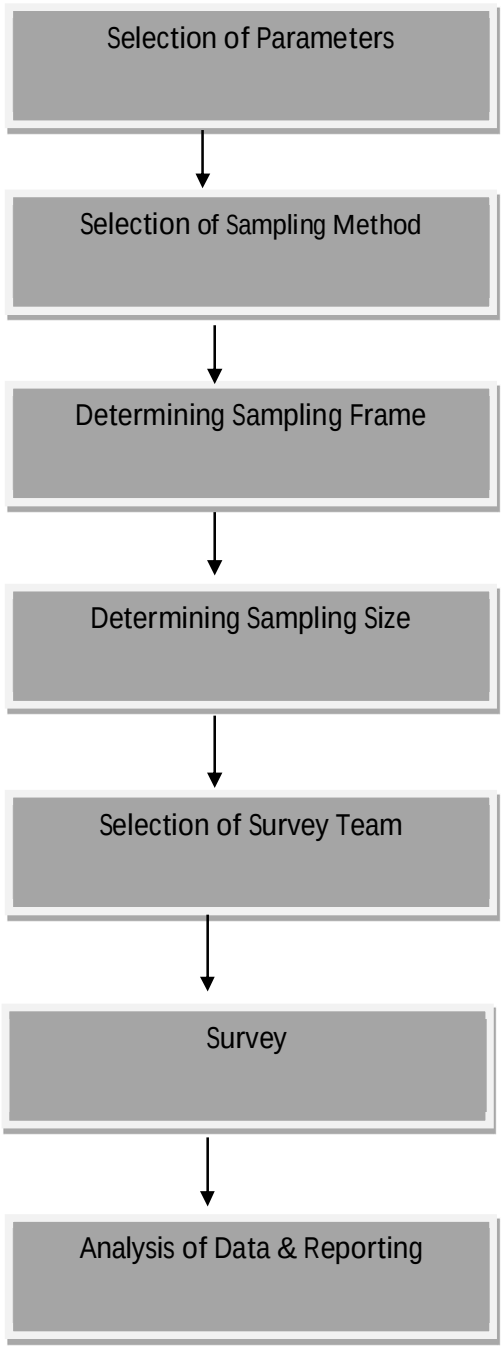
SAMPLING PLAN



SAMPLING PLAN

❖ Objective

The objective is to obtain an unbiased and reliable estimate of the proportion or mean value of the following key variables over the course of the crediting period, and with 95/10 confidence/precision (as per paragraph 20 of EB 69 Annex 4) for annual and 95/5 for biennial sampling across CPAs (as per Methodology AMS-II.G version 03 paragraph 22). The parameters to be sampled are:

a) $n_{y,j}$ - Proportion of ONIL Stoves still in operation
b) SS_y - Percentage of continued baseline stove use among ONIL stove households in the database
c) $\eta_{new,I}$ - Thermal Efficiency of operational ONIL Stoves

❖ Target population

The target population is the end user representative of the project scenario using the ONIL stove technology. A list of end users with contact details will be maintained in the Project Database, to be managed and updated by the CPA implementer.

Serial Number	Unique ID no	Date of installation	Household no., Address + contact no.	Region	Geographic Coordinates
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Typical Recording System for sampling

❖ Sampling Method

The sampling method used will be 'Simple Random Sampling' in which unbiased random selection of individual households is carried out to ensure that from the many samples which are drawn, the average sample would accurately represent the population.

To ensure a random selection of ONIL Stoves, random number generators shall be applied. Each ONIL stove in the target population is uniquely identifiable by its unique ID number. Each ONIL stove can thus be allocated a Sample Selection Number in each monitoring period, starting at 1 and increasing up to the total number of ONIL Stoves in the Database for that pre-defined sampling frame. Applying the random number generators, the ONIL stove can then be randomly chosen from the defined population up to the required sample size as calculated by the CME.

To determine the parameters, sampling will involve the following approach-

ny,j:- Visual inspection of the premises to see if ONIL stove is operational and in use. Interview with end user if required to verify that ONIL stove is still in use (Yes/No)

SSy:- Interview with end user and visual inspection to determine if a baseline (replaced) stove is still being used in addition to ONIL stove (Yes/No)

Ƞnew,i:- Thermal efficiency of ONIL Stoves will be tested using Water Boiling Test (WBT)

The efficiency of ONIL Stoves will be determined across CPAs using the same stove model and same vintage. It is important to note that the samples of same vintage shall belong to a single Primary Sampling Unit representing the Vintage. For each vintage, ONIL Stoves are to be randomly selected and sampled and the sample sizes are to be determined using the below equations. The mean thermal efficiency of each vintage shall be used for calculating emission reductions for all

stoves of vintage. In order to avoid misrepresentation of data, for every monitoring period, all ONIL Stove vintages will be sampled and the thermal efficiency for each vintage shall be established and used for the calculation of emission reductions for that monitoring period.

❖ Sampling Frame

To ensure the homogeneity of the CPAs included for a single sampling plan, two sampling frames shall be defined. As all CPAs will have similar end user characteristics which is rural populace of Guatemala thus it is expected that the geographical locations do not have influence on the parameter of interest. It can therefore be safely assumed that all the 3 parameters namely $n_{y,j}$, SS_y & $\eta_{new,I}$ are homogeneous for each ICS model regardless of how the end user group and distribution/installation location is defined.

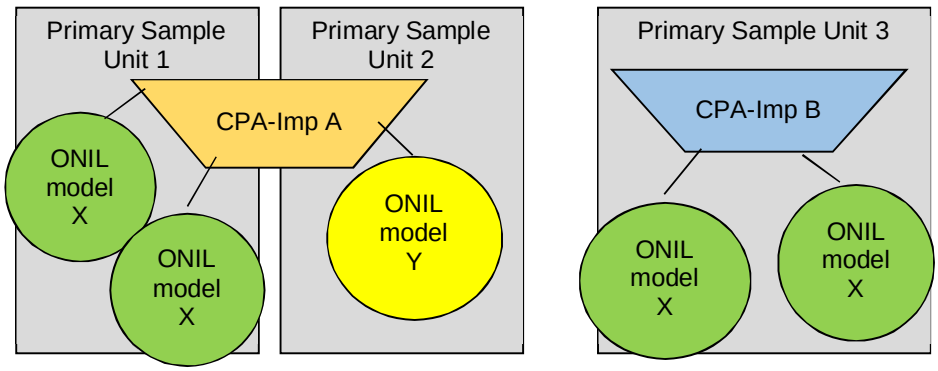
1) <u>Sampling frame for proportion of ONIL Stoves still in operation (ny,j) and percentage of continued baseline stove use among ONIL Stoves households in the database (SS,y)</u>

To account for differences in different ONIL stove models as well as CPA implementers, the CPAs with identical stove models and implemneters shall be grouped to create a Primary Sampling Unit which is homogenous. The "Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities, version 07.0, states that - for the use of a single sampling plan covering a group of CPAs, provided the homogeneity of population can be demonstrated, or differences are considered in the sample size calculation, a 95/10 confidence/precision must be applied for annual sampling. In case of biennial sampling the applied methodology AMS-II.G version 03, states a requirement of 95/5 confidence/precision. If sampling for a single CPA is being carried out, then following applies: 90/10 confidence/precision for annual and 95/5 confidence/precision for biennial sampling.

In order to identify the CPAs forming the Primary Sampling Units, the following shall apply:
The same CPA Implementer
The same ONIL stove model

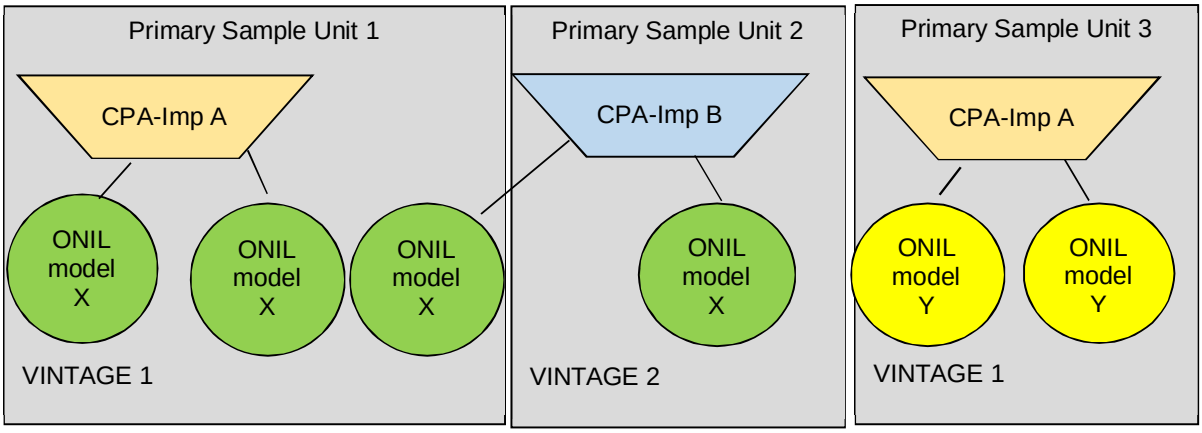
That is CPAs with the same CPA Implementer and same ONIL stove model can therefore be grouped together and form a Primary Sampling Unit. In the event the POA has CPAs with two different CPA Implementers using the same ONIL stove model, these form two different Primary Sampling Units. The same is true if the same CPA Implementer has two different ONIL stove models being implemented. Each will be considered as a separate Primary Sampling Unit.

The below schematics illustrate the example used above. This is justified by the fact that CPA Implementer might vary in terms of performance and it is important for the CME to collect and monitor accurate data for each CPA Implementer distributing each stove model.



2) Thermal Efficiency of operational ONIL Stoves ($\eta_{new,i}$)

The thermal efficiency of operational ONIL Stoves shall vary in accordance with its model, but not within different CPA Implementers. The thermal efficiency of the ONIL Stove is expected to change over the time. Hence for parameter $\eta_{new,i}$ the Primary Sampling Unit shall be defined as the group of ONIL Stoves of the same model and same vintage. If the same CPA Implementer has two different ONIL Stove models being implemented in the same vintage – this will form two Primary Sampling Units. Similarly separate primary sampling units will be formed by ONIL Stove from two different vintages and all other factors (Stove model and CPA Implementer) remaining equal. The below schematics illustrate the example used above assuming all stoves in the schematic are in one vintage.



SELECTION OF SAMPLE SIZE

The procedure to determine the sample of households will ensure that they adequately represent the broader project population, minimizing sampling error. Using, a 95 per cent confidence level, and a 10 per cent margin of error, the samples will be randomly selected from each Primary Sampling Unit. The following three parameters will be estimated through sampling:

- Number of stoves still in operation during the monitoring period as determined by the monitoring survey **($n_{y,j}$),**
- The fraction of baseline stoves in use within the population of operational ONIL Stoves during a monitoring period **(SS_y),**
- The average ONIL stove efficiency, **($\eta_{new,i}$).**

Of the three parameters to be monitored, two are proportions/percentages (SS_y and $n_{y,j}$) and one is a mean value $\eta_{new,i}$.

In order to calculate the required sample size estimates, values for the proportions, mean values, and standard deviations are required. As per Guideline for Sampling and surveys for CDM project activities and programmes of activities, version 04.0, there are different ways available to obtain the estimates of the parameter of interest:

(a) Refer to the result of previous studies and use these results;
(b) In a situation where information from previous studies is not available, a preliminary sample as a pilot could be conducted and use that sample is used to provide the estimates;
(c) Use best guesses based on the researcher's own experiences.

For the registration/inclusion purpose of CPA-DD, option C shall be applied. For the first monitoring period, values from a pilot shall be applied. For the following monitoring periods, the estimates shall be

adjusted taking into account the results of the previous monitoring period(s) or the result from recent pilot study which is conducted after the previous monitoring periods.

For estimation of the sample size for parameters $n_{y,j}$ and SS_y the following equation[1] is used:

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

Where:

n	= Sample size
N	= Population size (Total number of households/ICS)
p	= Expected proportion
1.96	= Represents the 95% confidence required (In the case of 90% confidence, 1.645 shall be used)
0.1	= Represents the 10% relative precision

The following assumptions are made to exemplify the sample size calculation for parameters: $n_{y,j}$, SS_y, and $\eta_{newy,,i}$.

1. The population size, N, is taken as 100,000 households. (Assuming one ONIL Stove for one household).
2. It is expected at least 80% of ICS still in operation, hence the expected proportion *p* for $n_{y,l}$ is taken as 0.8.
3. According to Baseline study, it is expected that 17.2% of baseline stoves will continue to be in use. As per Standard for sampling and surveys for CDM project activities and programme of activities, a proportion can describe either of the two possible scenarios of the success rate or the failure rate and project proponents may use the larger of the two proportions in the sample size calculation, which is *p* or (1−*p*). The sample size calculation is therefore based on anticipating a discontinued use of 80%. Thus the expected proportion *p* for SS_y is taken as 0.828 which is the value of the larger proportion.
4. The expected mean of ICS thermal efficiency is 0.24 and its standard deviation is 0.048.

Sample size calculation:
The calculation of the required sample size for each parameter in the first monitoring period is illustrated below for a 95/10 level of confidence and precision (for biennial monitoring periods the sample sizes will be recalculated using 95/5 confidence/precision values as per Methodology AMS-II.G version 03 paragraph 22). In all cases a conservative approach is taken, however if for any parameter the required 95/10 confidence/precision is not met then the CME will randomly select an additional sample and collect further data from this sample to ensure the pooled data meet or exceed the required thresholds.

❖ **Parameter $n_{y,j}$**

Based on the values of the pilot and assumptions outlined above, the resulting sampling size for a 95/10 confidence/precision is calculated as:

$$n \geq \frac{1.96^2 \times 100{,}000 \times 0.8(1-0.8)}{(100{,}000-1) \times 0.1^2 \times 0.8^2 + 1.96^2 \times 0.8(1-0.8)} = 96$$

[1] Equation 1 of Appendix 2, *Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities (Version 04.0)*

Therefore, in this case a sample size of 96 needs to be sampled from the primary sampling unit.

❖ **Parameter SS_y**

Based on the above assumptions, the sample size calculation for a 95/10 confidence/precision would be:

$$n \geq \frac{1.96^2 \times 100{,}000 \times 0.828(1-0.828)}{(100{,}000-1) \times 0.1^2 \times 0.828^2 + 1.96^2 \times 0.828(1-0.828)} = 80$$

The required sample size to be sampled from the primary sampling unit is at least 80.

For both parameters $n_{y,i}$ and SSy if the resulting sample size based on the above equation is smaller than 30, a minimum sample size of 30 shall be chosen.

❖ **Parameter $\eta_{new,i}$**

For the purposes of determining sample size in the first monitoring period, the performance of ONIL Stoves can be categorized into two groups, which are characterized by the range of likely mean efficiency and the likely values of SD relative to the mean, according to the type of ONIL Stoves. The ONIL Stove models that are manufactured in modern factories tend to be very highly efficient and have been designed to meet stringent efficiency specifications so the standard deviation is expected to be relatively low. Where key components of ONIL Stoves (e.g. the combustion chamber and flue) are not manufactured but instead are installed on-site or handmade, then the mean efficiency is expected to be in the range of 20-30% with relatively higher variability.

To estimate the sample size for parameter $\eta_{new,i}$ the following equation[2] is used:

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

Where:

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

n	= Sample size
N	= Population size (Total number of households/ICS)
mean	= Expected mean of ICS thermal efficiency
SD	= Expected standard deviation
1.96	= Represents the 95% confidence required (In the case of 90% confidence, 1.645 shall be used)
0.1	= Represents the 10% relative precision

Based on the above assumptions, the sample size calculation for a 95/10 confidence/precision would be

$$n \geq \frac{1.96^2 \times 100{,}000 \times \left(\frac{0.048}{0.24}\right)^2}{(100{,}000-1) \times 0.1^2 + 1.96^2 \times \left(\frac{0.048}{0.24}\right)^2} = 15.36$$

[2] Equation 4 of Appendix 2, *Guidelines for Sampling and Surveys in CDM Project Activities and Programme of Activities (Version 04.0)*

If the resulting sample size based on the above equation is smaller than 30, then as the parameter of interest is a numeric mean value (i.e. not a proportion or percentage) the Student's t-distribution shall be used.

The sample size for parameter $\eta_{new,y,i}$ is referred to the equation below[3]:

$$n = \left(\frac{t_{n-1} \times SD}{0.1 \times mean} \right)^2$$

Where t_{n-1} is the value of the t-distribution for 95% confidence when the sample size is n. Since the sample size is not known yet, the first step is to use the value for 95% confidence when the sample is large, i.e. 1.96 and then redefine the calculation.

$$n = \left(\frac{1.96 \times 0.048}{0.1 \times 0.24} \right)^2 = 15.37$$

Thus n is rounded up to 16.
The calculation now need to repeat using t-value for 95% confidence and n = 16

$$n = \left(\frac{2.131 \times 0.048}{0.1 \times 0.24} \right)^2 = 18.17$$

And n is rounded to 19.

The calculation now need to repeat using t_{n-1} value for n = 19. The process should be iterated until there is no change to the value of n.

t_{19-1}	2.101
n=	17.66
Round up	18

t_{18-1}	2.110
n=	17.81
Round up	18

The repeated calculation shows that n = 18. Thus the sample size to be sampled from the sampling unit is 18.

The sampling for parameter $\boldsymbol{\eta}_{newy,I}$ shall comprise of ONIL Stove installed/distributed during the current vintage and oldest vintage. The annual efficiency loss of ONIL Stove established from these two vintages may be used to correct the initial efficiency of the ONIL Stove installed/distributed later on.

The CME may choose to use the same sample to monitor more than one parameter. According to the Standard for sampling and surveys for CDM project activities and programme of activities, if there is more than one parameter to be estimated, then a sample size calculation should be done for each of them. Then either the largest number for the sample size is chosen as sampling effort with one common survey, or separate sampling efforts and surveys are undertaken for each parameter. For instance, the CME can sample separately SS_y, $n_{y,i}$ and $\eta_{new,i}$ –or a combination of these parameters- in the same sample. Since parameters $n_{y,I}$ and SS_y sharing the same sampling units, CME may choose to have one common survey for these two parameters with largest number of sample size between these two parameters is chosen, then a separate sampling effort may be arranged for parameter $\boldsymbol{\eta}_{newy,,i}$. Sampling more than one parameter in the same sample helps reduce travel needs for monitoring and the associated costs. At the same time this approach ensures the random selection of samples for every parameter.

[3] Equation 38, page 46, *Guidelines for Sampling and Surveys in CDM Project Activities and Programme of Activities* (version 04.0)

Oversampling is strongly encouraged, not only to compensate for any attrition, outliers or non-response associated with the sample, but also to prevent a situation at the analysis stage where the required reliability is not achieved, and additional sampling efforts would be required. The sample size shown above will be adjusted upwards to account for non-responses, CME shall determine the appropriate non-responses rate based on previous experience.