



METHODOLOGY TOOL

GS4GG PAA MT400-07

SDG 13

TOOL 7: DIGITAL STOVE MONITORING, ANALYSIS AND REPORTING TOOL (D-SMART)

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SUMMARY

This tool is an optional add-on to the Gold Standard for the Global Goals (GS4GG) Clean Cooking Solutions methodologies such as [Reduced Emissions from Cooking and Heating \(RECH\): \(Formerly TPDDTEC\) V5.0](#). This tool details digital monitoring requirements and methods for activities applying RECH V5.0¹.

While the tool is a comprehensive, optional add-on to RECH V5.0, specific components may also be applied to other GS4GG methodologies where Kitchen Performance Tests (KPTs) are used for fuel-consumption quantity determination, and where such modular use is explicitly compatible with the parent methodology. The digital tools and protocols described herein serve strictly as empirical data-collection mechanisms. All outputs generated by this tool shall be fed directly into the emission reduction equations of the applied parent methodology to ensure mandatory methodological caps and ambition adjustments remain intact.

The document describes the digitization of the following key elements:

1. **Digital kitchen performance test (dKPT)**: Utilizes digital data-logging scales to continuously log the amount of fuel consumed during the KPT, replacing manual daily logging. This increases measurement frequency, improves data granularity, reduces intrusiveness, and enhances auditability. The dKPT is designed to capture total fuel consumption across activity devices, ensuring the

¹ This tool is aligned with TPDDTEC V5.0 but may also be applied to activities using TPDDTEC V4.0, subject to continued compliance with the applied parent methodology. References to “activity” in certain KPT-related provisions are retained for consistency with the terminology used in the external KPT protocol.

internalization of rebound effects and stove-stacking and normalizing the resulting data per standard adult mean as required by KPT protocol.

2. **Digital sales platform/activity database:** Digitally records the deployment and categorization of activity technologies, ensuring a robust, traceable, and continuously maintained record of activity stove dissemination.
3. **Monitoring of activity stove usage:** Deploys sensors on a representative sample of activity stoves to monitor actual usage intensity (frequency) throughout the activity lifetime. This allows for more nuanced measurement and supports the application of Hawthorne effect adjustment (HE_{ind}) to correct or exempt results observed during short-term field tests (KPTs).

All aspects of the applicable parent methodology apply unless otherwise noted in this tool.

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TABLE OF CONTENTS

SUMMARY	1
ACKNOWLEDGEMENT	2
1 KEY INFORMATION	4
2 APPLICABILITY CONDITIONS	4
3 SOURCES AND REFERENCES.....	5
4 DEFINITIONS	6
5 SCOPE AND BOUNDARY	7
6 BASELINE EMISSIONS	7
7 ACTIVITY EMISSIONS	9
8 LEAKAGE EMISSIONS	9
9 NET GHG EMISSION REDUCTIONS	9
10 QUANTIFICATION OF UNCERTAINTY	11
11 MONITORING METHODOLOGY	12
ANNEX – A: CONTINUOUS STOVE MONITOR (CSM) GUIDELINES	22
A.1. Sensor Deployment on the stove (Sampling)	22
A.2. CSM general deployment requirements	24
A.3. Sensor Data Analysis and Validation.....	25
A.4. Missing Data Protocol	26
ANNEX – B: GUIDELINES FOR DIGITAL KITCHEN PERFORMANCE TESTING (dKPT)	27
ANNEX – C: ACTIVITY PREPARATION AND MONITORING SCHEDULE.....	33
ANNEX - D: GUIDELINES FOR BASELINE FIELD TEST SAMPLING	34

1| KEY INFORMATION

Key information	Details
Tool summary	Introduces digital MRV components (dKPT, CSM, digital activity database) to enhance the integrity and accuracy of emission reduction calculations for cookstove and thermal energy activities ² . The tool serves strictly as a high-precision data collection framework; final emission reductions shall be quantified using the exact equations defined in the applied parent methodology.
Applicable mitigation type	<input checked="" type="checkbox"/> Emission reductions
Applicable activity scale	<input checked="" type="checkbox"/> Micro scale (e.g., ≤10,000 tCO ₂ e per year) <input checked="" type="checkbox"/> Small-scale (≤ 180GWhth/yr energy savings) <input checked="" type="checkbox"/> Large-scale (> 180GWhth/yr energy savings)
Applicable methodologies	<ul style="list-style-type: none"> • RECH V5.0 or later version (specifically Intervention Types A and C utilizing Baseline Option A). • Modular Application (dKPT/Baseline Field Test Guidelines): Any GS4GG approved methodology where KPT is the prescribed method for fuel consumption assessment, including: <ul style="list-style-type: none"> - Simplified Methodology for Clean and Efficient Cookstoves (SMEC V4.0) - Animal Waste Management Systems (AWMS V2.0 - Thermal Method 1).
Limitations	When applied in full as an add-on to RECH V5.0, this tool is only applicable to Intervention Types A and C utilizing Baseline Option A. This tool provides empirical data inputs and shall not be used to bypass mandatory methodological adjustments (e.g., Downward Adjustment Factor, per-capita fuel consumption caps) defined in the parent methodology.

2| APPLICABILITY CONDITIONS

2.1| Scope

2.1.1 | This document details the requirements for implementing digital monitoring approaches. The applicability is defined under two pathways:

- a. Full Application as a comprehensive dMRV system, and

² The terms 'Mitigation Activity', 'Activity', 'Project' and 'Project Activity' refer to the activity certified by GS4GG and are used interchangeably

- b. Modular Application of specific components.

2.2| Full Application (Comprehensive dMRV System):

- 2.2.1 | This tool may be applied in its entirety as an optional add-on to latest version of RECH or a later version.
- 2.2.2 | All applicable requirements of the applied version of RECH shall apply unless stated otherwise in this document. In the event of any conflict regarding emission reduction equations, maximum fuel caps, or the Downward Adjustment Factor (DAF), the requirements of the parent methodology shall strictly supersede this tool.
- 2.2.3 | The full application of this tool, including the emission reduction data integration approach detailed in sections below which integrates long-term continuous stove monitor (CSM) data to qualify the activity for the Hawthorne Effect (HE_{ind}) exemption), only applies to intervention Type A and C utilizing Baseline Option A outlined in RECH.

2.3| Modular Application (Digital KPT and BFT Guidelines)

- 2.3.1 | The digital approaches detailed in this tool may be applied modularly to other GS4GG approved methodologies.
 - a. **General Applicability:** Components of this tool may be applied with any GS4GG approved methodology where the Kitchen Performance Test (KPT) is the prescribed method for assessing fuel consumption.
 - b. **Requirements for Modular Application:** When applying components of this tool to other methodologies, the activity developer shall ensure that:
 - i. All applicable requirements of the parent methodology are met, unless explicitly superseded by the requirements of this tool regarding KPT execution, usage monitoring, or baseline sampling.
 - ii. The implementation adheres strictly to the equipment standards, data processing guidelines, and QA/QC measures described in the relevant Annexes of this tool.
 - iii. If the parent methodology does not utilise long-term CSM deployment for usage calculation, the Hawthorne effect correction exemption ($HE_{ind} = 1.0$) may not be applicable. In such cases, CSM deployment during the dKPT for non-compliance detection may be used only where consistent with the parent methodology and the applied monitoring design.

3| SOURCES AND REFERENCES

- 3.1.1 | This tool relies on the sources and references cited in the applicable parent methodology (RECH V5.0). In addition, this tool references the following key standards and guidelines:

- a. [UNFCCC CDM Standard for sampling and surveys for CDM project activities and programme of activities.](#)
- b. [UNFCCC CDM Guideline for sampling and surveys for CDM project activities and programme of activities.](#)
- c. Clean Cooking Alliance (CCA) Kitchen Performance Test (KPT) Protocol (latest recognized version).

4| DEFINITIONS

4.1.1 | The definitions outlined in the [Glossary of GS4GG](#) and applicable parent methodology (e.g., Reduced Emissions from Cooking and Heating) shall apply in addition to those outlined below.

Table 1. Terms and Definitions

Term	Definition
Baseline Field Test (BFT)	The Kitchen Performance Test (KPT) implemented specifically in a baseline household. For the purposes of methodological compliance, a BFT is procedurally and mathematically equivalent to the Baseline Kitchen Performance Test (B-KPT) referenced in RECH V5.0 and SMEC V4.0.
Continuous Stove Monitors (CSM)	A sensor placed on a stove (e.g., measuring temperature, infrared light, or electric current) that continuously records data to determine the stove's usage intensity (frequency and duration). ³
Cooking Events (CE)	The preparation of one or several consecutive dishes on a stove that constitute a single meal or cooking session.
Digital Kitchen Performance Test (dKPT)	The sensor-based KPT protocol that utilizes digital data-logging scales and CSMs to automate fuel consumption and usage data collection, replacing manual field logging.
Digital Sales Platform/Activity Database	A digitally maintained and continuously updated record of all activity technology units deployed, listing, at a minimum, the unit's unique identifier, deployment date, and corresponding baseline and activity scenarios.
Kitchen Performance Test (KPT)	A field-based method for measuring the consumption of all cooking fuel types at the household level by tracking the change in fuel weight over a period of several days. All the

³ While the tool is open on the type of CSM used, it is important to ensure that the sensor technology chosen to monitor each stove is appropriate and that it deployed on a proper location on the stove. Requirements on these aspects are available in the Annex A.

	fuel types used by the household for cooking are included in the KPT ⁴ .
Project Field Test (PFT)	The Kitchen Performance Test (KPT) implemented specifically in an activity household. For the purposes of methodological compliance, a PFT is procedurally and mathematically equivalent to the Project Kitchen Performance Test (P-KPT) referenced in RECH V5.0 and SMEC V4.0.
Standard Adult (SA)	A standardization metric used internally within recognized KPT protocols (e.g., CCA guidelines) to normalize fuel consumption based on the age and gender of individuals partaking in a meal. This metric is used exclusively to evaluate analytical variance between BFT and PFT populations and shall not replace the absolute Household Size (<i>HN</i>) parameter required by parent methodologies for evaluating absolute fuel consumption caps.
Standard Adult Meal	An analytical unit representing a single meal consumed by one Standard Adult Equivalent. Utilized during the data processing phase of the dKPT to determine highly accurate daily specific emissions.

5| SCOPE AND BOUNDARY

5.1| Activity Scope

5.1.1 | The activity scope remains as defined by the applicable parent methodology. This tool provides requirements for the optional digitization of core monitoring elements described in the summary section. The tool does not alter the physical scope of the activity.

5.2| Activity Boundary

5.2.1 | The activity boundary, including all sources of baseline and activity emissions, shall be as defined by the applicable parent methodology. This tool applies only to the monitoring and data management procedures within that established boundary and does not alter the mandatory inclusion or exclusion of any GHG sources or sinks.

6| BASELINE EMISSIONS

6.1| Selection and justification of the baseline scenarios

6.1.1 | The requirements of the applicable parent methodology ([RECH V5.0 Section 7.1 and 7.2](#)) shall apply, with the following key considerations for digitisation:

⁴ More details on the KPT scope and protocol are available in Annex B.

- a. **Use-Case Differentiation:** Activity developers shall define distinct baseline scenarios primarily based on significant differences^{5,6} in end-user use cases (e.g., domestic vs. commercial cooking, or seasonal space heating).
- b. **Scenario Categorisation:** Baseline scenarios shall be defined during the initial baseline study. A definitive set of questions shall be designed and asked when the Activity technology is sold or installed to the end-user. The responses shall be digitally recorded in the Digital Sales Platform/Activity Database to accurately categorize each end-user unit into its respective baseline scenario (*b*) and Activity scenario (*p*).
- c. **Digital Demographic Consistency Check:** The activity developer shall utilize the digital database to perform the mandatory Standardized Retrospective Survey and consistency check mandated in [RECH V5.0 Section 7.3.2](#). Material discrepancies (deviations >20%) identified via the digital record shall trigger a re-definition of the baseline scenario for that cohort.

6.2| Calculation of baseline emissions

- 6.2.1 | The calculation of the Baseline Emissions (BE_y) shall follow the equations and mandatory adjustments (e.g., Downward Adjustment Factor, per-capita caps) set forth in the applicable parent methodology (See [RECH V5.0](#)).
- 6.2.2 | The mean baseline fuel consumption data ($P_{b,mean}$) shall be empirically derived from the Baseline Field Tests (BFTs), conducted using the Digital KPT (dKPT) protocol detailed in Annex B of this tool, and shall be fed directly into the unadjusted baseline emissions of the parent methodology.
- 6.2.3 | To ensure mathematical integrity:
 - 6.2.3.1 | Moisture Content and NCV Alignment: If the dKPT data processing converts the measured fuel mass into a 0% dry-mass equivalent, the activity

⁵ For example, let's take two groups A and B, which rely on primarily fuelwood for their energy needs. However, group A live in a warmer climate in the plains and group B in a colder climate at higher altitude. Group A does not need to heat their house in the colder season while group B do. Then the difference between these two groups would justify putting them in two distinct scenarios.

⁶ For example, households that carry out a commercial activity that involves cooking should be placed in a different scenario than however, households using different fuel types may be kept in the same baseline scenario. In a context of fuel stacking where households rely on several fuel types and where seasonality may affect the availability of fuels, it may be impossible to differentiate between scenarios based on fuel type alone.

- In peri-urban area, there are often the concurrent use of several type of fuel and cooking technology. The same household may very well use LPG, Charcoal and Firewood to varying degree. In these, in it is not really feasible to make different scenarios for like: household using only charcoal, household using only firewood, household using LPG, household using mostly firewood and a small fraction of charcoal, household using mostly charcoal and a small fraction of firewood but no LPG, etc The consumption of each of these fuels might change as well based on availability and price of each fuel type.
- The number of possible combinations is often too high to use fuel type consumption intensity meaningfully segregate between households.

developer shall either: a) Apply a corresponding dry-basis Net Calorific Value (NCV) in the parent methodology equations; or b) Mathematically normalize the dry mass back to the reference moisture content equivalent of the default wet-basis NCV (e.g., typical wood wet-basis NCV).

7| ACTIVITY EMISSIONS

7.1| Activity emission calculations

- 7.1.1 | The calculation of the Activity Emissions (AE_y) shall follow the equations and procedures set forth in the applicable parent methodology.
- 7.1.2 | The mean activity fuel consumption data ($P_{p,mean}$ or $P_{p,f}$) shall be empirically derived from the Project Field Tests (PFTs), conducted using the dKPT protocol detailed in [Annex B](#) of this tool and shall be fed directly into the unadjusted activity emission equations of the parent methodology.
 - 7.1.2.1 | **Internalization of Stove Stacking:** Because the dKPT continuously measures total household thermal energy fuel consumption across all devices on the digital scale, it inherently captures and internalises any continued use of baseline technologies (stove stacking) and rebound effects.
 - 7.1.2.2 | **Safeguard against Activity Capping:** Methodological threshold caps (e.g., P_{CAP}) are designed strictly to prevent the over-estimation of baselines. These caps shall NEVER be applied to limit or artificially reduce the measured Activity fuel consumption ($P_{p,mean}$). Activity emissions shall be reported based on empirical PFT data, to ensure the conservativeness.

8| LEAKAGE EMISSIONS

8.1| Calculation of Leakage Emissions

- 8.1.1 | The calculation of the Leakage Emissions (LE_y) shall follow the equations and procedures set forth in the applicable parent methodology e.g., [RECH V5.0 Section 9](#)). This includes the mandatory accounting of Cradle-to-Gate Embodied Emissions ($LE_{Embodied,y}$) and Market and Behavioural Leakage ($LE_{Market,y}$).

9| NET GHG EMISSION REDUCTIONS

9.1| Integration of Digital Parameters into Parent Equations

- 9.1.1 | To ensure all mandatory safeguards (e.g., threshold caps, DAF, statistical uncertainty bounds) are preserved, the Net GHG Emission Reductions (ER_y) shall be quantified exclusively using the final equation set forth in the applicable parent methodology (e.g., RECH V5.0 Eq. 22). The parameters generated by this digital tool shall map directly into the parent methodology equations as follows:

9.1.2 | **Digital Usage Rate ($U_{p,y}$):** In the parent methodologies, the usage rate ($U_{p,y}$) scales the credited emissions based on both the adoption and the continued intensity of use. The Usage Rate fed into the parent methodology shall be calculated objectively as the product of the physical Ownership Rate ($OR_{p,y}$) and the Continuous Usage Intensity Ratio:

$$U_{p,y} = OR_{p,y} \times \min\left(1, \frac{CE_{p,y}}{CE_{KPT,p}}\right) \quad (eq.1)$$

Where:

- $U_{p,y}$ = Cumulative Usage rate for technologies in project scenario p in year y (fed directly into the parent methodology equations) (fraction).
- $OR_{p,y}$ = Proportion of households that still physically possess and own their activity stoves
- $CE_{p,y}$ = Average number of Cooking Events per day recorded with CSMs during long term continuous monitoring
- $CE_{KPT,p}$ = Average number of cooking events per day recorded with CSMs during the latest short term project Field Test (PFT)
- 1 = Mathematical cap to ensure the ratio cannot exceed 1.0 (preventing inflation of emission reductions if long-term usage ($CE_{p,y}$) exceeds the usage recorded during the physical Project Field Test ($CE_{KPT,p}$).

9.1.3 | **Hawthorne Effect Exemption (HE_{ind}):** Because the actual drop-off in stove usage is fully quantified and internalised via the objective Digital Usage Rate ($U_{p,y}$), activities complying with the continuous dMRV requirements of this tool are exempt from the psychological observer-bias penalty. The Hawthorne Effect parameter (HE_{ind}) applied in the parent methodology's final equation shall be set to 1.0.

9.1.4 | **Standard Adult Meal (SAM) to Household Normalization:** To accurately account for daily demographic variations and absentee variance during observation periods, recognized KPT protocols (e.g., Clean Cooking Alliance guidelines) require the internalization of fuel consumption per "Standard Adult Meal" (SAM). To bridge this to the parent methodologies - which require absolute household level data ($P_{b,mean}$ and $P_{p,mean}$, typically in tonnes/household/day) for the application of absolute per-capita methodological threshold caps based on the project's established average baseline household size (HN_b) -the specific household daily fuel consumption shall be mathematically derived as follows:

$$P_{x,mean} = \left(\frac{\sum Fuel_x}{\sum SAM_x}\right) \times SAM_{avg,p} \quad (eq.2)$$

Where:

$P_{x,mean}$	=	Mean quantity of fuel consumed in the baseline (b) or project (p) scenario, formatted as mass/household/day.
$\sum Fuel_x$	=	Total mass of fuel consumed across all valid households during the test period.
$\sum SAM_x$	=	Total number of Standard Adult Meals served across all valid households during the test period.
$SAM_{avg,p}$	=	The average number of Standard Adult Meals served per day per household within the representative target population for activity scenario p.

9.1.5 | **Calculation of Technology-Days ($N_{p,b,y}$):** The number of activity technology-days ($N_{p,b,y}$) required by the parent methodology equation shall be calculated by cross-referencing the Digital Sales Platform/Activity Database and the monitoring period:

$$N_{p,b,y} = \sum_{stove\ n} \min(t_f - t_i, t_f - t_{sale,n}) \quad (eq.3)$$

Where:

$N_{b,p,y}$	=	Number of activity technology-days included in the activity database for baseline/activity scenario pair b,p in year y (days).
n	=	Activity technology unit belonging to scenario pair (b,p)
t_f	=	Date of the end of the monitoring period
t_i	=	Date of the beginning of the monitoring period
$t_{sale,n}$	=	Date of the sale/dissemination of activity technology unit n

10| QUANTIFICATION OF UNCERTAINTY

10.1.1 | The quantification of uncertainty shall follow the guidelines and requirements set forth in the applicable parent methodology. Activity developers shall ensure that all parameters derived from sampling (such as those from the BFT, PFT, Ownership Survey, and Usage Intensity Measurements) meet the standard 90/10 confidence/precision requirement, and minimum sample sizes mandated by the parent methodology.

10.1.2 | If 90/10 confidence/precision requirement is not achieved ex-post, supplementary sampling is not undertaken; strict directional conservativeness shall be applied:

10.1.2.1 | The lower bound of the one-sided 90% confidence interval shall be used for Baseline Fuel Consumption ($P_{b,mean}$), Ownership Rate ($OR_{p,y}$), and Long-Term Usage Intensity ($CE_{p,y}$):

10.1.2.2 | The upper bound of the one-sided 90% confidence interval shall be used to for Activity Fuel Consumption ($P_{b,mean}$) and Short-Term Usage Intensity ($CE_{KPT,p}$).

11 | MONITORING METHODOLOGY

11.1 | Activity Database

11.1.1 | The activity database shall list all of the technology units that have been sold or distributed under the activity and shall be maintained digitally at a minimum, with its:

- a. Unique identifier and date of sale/dissemination
- b. Corresponding activity scenario (p) and baseline scenario (b).
- c. Mandatory End-user Information: Name, address, telephone number (if available), and type of end-user (household, institutional, or commercial).
- d. Geographic Tracking: To comply with data privacy regulations, exact GPS coordinates are optional, provided alternative location descriptors (e.g., village, ward) are used alongside unique product identifiers to prevent double counting.

11.1.2 | Information on baseline use is needed for each sale of the technology to link it to its corresponding baseline scenario (domestic/commercial cooking, space heating during colder months). This information is needed so that the parameter $N_{b,p,y}$ may be calculated accurately for each pair of baseline/activity scenarios⁷

11.1.3 | The database shall record the ownership of the technology, specifically noting if the end-user previously owned the technology promoted by the activity. No Emission Reduction can be claimed for households that were not transitioning from a dirtier/less efficient stove to the more efficient/cleaner stoves⁸.

11.2 | Activity Surveys and Field Tests

11.2.1 | **Usage Intensity Measurements:** The number of cooking events ($CE_{p,y}$) carried out on the activity stove shall be monitored continuously using Continuous Stove Monitors (CSMs) placed on a sample of participating households, as detailed in [Annex A](#).

⁷ If this information is missing for some households, they might still be added to the activity database. Their classification in each scenario would then be done based on the proportions derived from households for which this information is available.

⁸ One exception: If the household previously had a stove sold/installed by the activity developer but is being replaced by a new stove then the new stove may be added to the database as long as the **old one is removed from it**. These cases must be clearly documented and closely checked by VVBs.

- a. **Sample Size:** The sample size shall be at least 50 households and be large enough to ensure that the $CE_{p,y}$ parameter meets the 90/10 confidence/precision⁹ requirement across each operational age cohort.
- b. **Age-Cohort Weighting:** Where multiple credited age cohorts are monitored, the sampling design shall reflect the credited age-cohort structure, and the resulting usage parameter shall be derived as a weighted average across operational age cohorts, in accordance with [RECH V5.0](#).
- c. **Deployment:** The sensors shall be installed either continuously on every stove, continuously on a sample of stoves, or by batch every 6 months, as specified in [Annex A](#).

11.2.1.1 | **Ownership Survey ($OR_{p,y}$):** The Ownership Rate ($OR_{p,y}$) is the proportion of households that still physically possess and own their activity stove.

- a. **Frequency:** This parameter shall be assessed every other year on the sample of households selected for the Project Field Test (PFT).
- b. **Assessment:** The physical presence of the stove shall be checked during the household visit for PFT enrolment. If the stove is not physically present, the household shall be considered a non-owner.
- c. **PFT Eligibility:** The PFT shall only be carried out in households that still own their activity stove. By definition, the sample size used for $OR_{p,y}$ determination shall be equal to or greater than the sample size required for the PFT, ensuring the $OR_{p,y}$ parameter also meets the required 90/10 confidence/precision.

11.2.1.2 | **Usage Survey – use of other stoves (ICS 23, RECH v5.0):** This parameter is not required to be monitored via manual recall surveys or applied as a separate mathematical deduction since the impact of residual use of baseline stoves is implicitly captured during the field tests (BFT and PFT) where the consumption of *all* thermal energy fuels used by the household is measured via the digital data-logging scales.

11.2.1.3 | **Field Tests:** The baseline and project performance field tests (BFT and PFT) shall measure real, observed technology performance in the field using the Digital KPT (dKPT) protocol.

- a. **Independence:** For most cases, an independent sample (different subjects) shall be tested for baseline and project field test with baseline households selected per [Annex D](#). However, when the specificities of the activity implementation allow for a paired design then this approach might be used. Baseline household selection guideline is not applicable with paired-design. However, care should be taken to ensure that both baseline and project Field Test are carried out during the same season.

⁹ In case the 90/10 or 95/10 requirement is not met, the lower confidence of the 90% confidence interval may be used instead of the mean.

- b. **Frequency:** Field tests shall be carried out during the first crediting year and then every other year.
- c. **Minimum Sample Size:** The sample size for both BFT and PFT shall be at least 50 households and shall be sufficient to meet the 90/10 confidence/precision requirement. Where stratification is required, the applicable minimum shall be met for each credited stratum or age cohort.
- d. **Location Selection (BFT):** The BFT shall take place in households that have not yet received or purchased the activity devices, selected among neighbours of the PFT households as detailed in [Annex D](#).
- e. **Aging Tests:** Aging tests are not allowed under this tool.

11.2.2 | Refer to [Annex B](#) for more details on field tests implementation.

11.3| Baseline Fuel Consumption

11.3.1 | To calculate the parent methodology's emission reductions, the consumption of each fuel type for both the baseline ($P_{b,mean}$) and the project ($P_{p,mean}$) shall be determined using project-specific Baseline Field Tests (BFTs) and Project Field Tests (PFTs), evaluated using the Standard Adult Meal (SAM) normalisation procedure.

11.4| Quality Assurance and Quality Control

11.4.1 | The QA/QC procedures outlined in the applicable parent methodology shall apply, with the following additions specific to the digital tool.

- a. **Auditing Sampling:** The sampling method for all surveys (BFT, PFT, CSM deployment)¹⁰ shall be clearly explained, and intermediary steps (e.g., random directions used for household selection) shall be recorded and made available so that an auditor can fully replicate the sampling process.
- b. **Methodological Threshold Caps (Safeguard Against Over-Crediting):** For fuel consumption derived from BFT ($P_{b,mean}$), if the values exceed a pre-defined threshold, the results shall be substantiated by independent third-party studies. In any case, the applied value shall not exceed the defined cap. These caps shall NEVER be applied to limit or artificially reduce fuel consumption data derived from Activity Project Field Tests (PFTs).
- c. **Orphan Events (Stove-Stacking Safeguard):** 24-hour periods showing 'orphan fuel events' (fuel consumed on the scale but no CSM cooking event registered) shall NOT be automatically removed from the PFT dataset. Deleting these events systematically underestimates stove-stacking behaviour and artificially inflates emission reductions. These must be conservatively treated as Activity fuel consumption.

¹⁰ One way of doing this using survey tools is to have a question that draws a random number and another one that displays a direction based on this number. See more details in Annex D.

Conversely, 24-hour periods showing 'orphan stove events' (cooking registered but zero fuel drop) indicate scale malfunction and shall be flagged as Invalid Measurement Days.

- d. **CSM Usage Safeguard:** No Emission Reductions may be claimed if the mean value of cooking events recorded by CSMs during the KPT ($CE_{KPT,p}$) is below a minimum usage threshold (e.g., 0.14 CE/day)¹¹. Measuring significant fuel savings with such low usage indicates savings originate from other factors outside the activity technology.

11.5| Data and Parameters Not Monitored

11.5.1 | This section shall follow the requirements of the applicable parent methodology.

11.6| Data and Parameters Monitored

Parameter ID	D-SMART 1
Data / Parameter:	$P_{p,mean}$
Data unit:	kg/household/day
Description:	Mean quantity of fuel consumed in activity scenario p
Source of data:	Project Field Test (PFT) carried out on households in activity scenario p . Calculated by aggregating total fuel consumption across the sample, dividing by the total number of Standard Adult Meals (SAM) to derive consumption per SAM, and then multiplying by the average number of SAMs per household per day in the target population.
Monitoring Frequency	During the first crediting year and then every other year.
QA/QC procedures:	Compliance with the general requirements for sampling QA/QC and Annex B Kitchen performance test. Absolute methodological caps must not be applied to this parameter to ensure conservative reporting of activity emissions.
Any comment:	Please refer to section 11.3 and further and to Annex B on requirement and guidance to conduct the dKPT.

Parameter ID	D-SMART 2
Data / Parameter:	$P_{b,mean}$
Data unit:	kg/household/day

¹¹ The goal of this safeguard is to prevent fuel savings claims (and associated ER) in the situation where the measured number of cooking event performed on the activity stove during the KPT period is negligible. Surely if the activity stove is not used any meaningful way during the 3-7 days KPT period then any fuel saving derived from KPT cannot be associated to the activity stove.

Description:	Mean quantity of fuel consumed in baseline scenario <i>b</i>
Source of data:	Baseline Field Test (BFT) carried out on households in baseline scenario <i>b</i> . Calculated by internalising values per Standard Adult Meal (SAM) as defined above.
Monitoring Frequency	During the first crediting year and then every other year. The BFT values are valid for two years and may be applied for before or after period, however, the gap between start date of first BFTs and second BFTs shall not be more than two years.
QA/QC procedures:	Compliance with the general requirements for sampling QA/QC (Section 11.3) and Annex B . If the values resulting from the activity BFTs are higher than the following threshold value (on equivalent terms), then the results shall be further substantiated by independent third-party studies. In any case, the value applied shall not be higher than the absolute per capita methodological cap value (on equivalent terms)
Any comment:	Please refer to Section 11.3 and further and to Annex B on requirement and guidance to conduct the KPT.

Parameter ID	D-SMART 3
Data / Parameter:	$\sum SAM_x$ and $SAM_{avg,x}$
Data unit:	Standard Adult Meals (SAM) / household / day
Description:	Standard Adult Meals consumed during the BFT for baseline scenario <i>b</i> to normalize absentee variance.
Source of data:	Calculated based on demographic data and attendance records in the households of baseline scenario <i>b</i> during the BFT.
Monitoring Frequency	During the first crediting year and then every other year.
QA/QC procedures:	Compliance with the general requirements for sampling QA/QC (Section 11.3) and Annex B
Any comment:	Please refer to section 11.3 and further and to Annex B on requirement and guidance to conduct the KPT.

Parameter ID	D-SMART 4
Data / Parameter:	$\sum SAM_p$ and $SAM_{avg,p}$
Data unit:	Standard Adult Meals (SAM) / household / day
Description:	Standard Adult Meals consumed during the PFT for activity scenario <i>p</i> to normalize absentee variance

Source of data:	Calculated based on demographic data and attendance records in the households of activity scenario p during the PFT.
Monitoring Frequency	During the first crediting year and then every other year.
QA/QC procedures:	Compliance with the general requirements for sampling QA/QC and Annex B
Any comment:	Please refer to Section 11.3 and further and to Annex B on requirement and guidance to conduct the KPT.

Parameter ID	D-SMART 5
Data / Parameter:	$CE_{KPT,p}$
Data unit:	Cooking events/household/day
Description:	Average number of cooking events per day recorded on the project (activity) technology using CSMs during the KPT for activity scenario p
Source of data:	Derived from Continuous Stove Monitors sensors placed on the activity technology during the KPT in activity scenario p .
Monitoring Frequency	During the first crediting year and then every other year.
QA/QC procedures:	<p>Compliance with the general requirements for sampling QA/QC and Annex B</p> <p>As a safeguard, no Emission Reductions may be claimed if the mean value of parameter across the sampled households for activity scenario p is below 0.14 CE/day during the KPT.</p> <p>Measuring significant fuel savings with such low usage of the activity technology would point instead to the observed fuel savings coming from other factors beside the activity technology.</p>
Any comment:	Please refer to (Section 11.3) and further and to Annex B on requirement and guidance to conduct the KPT.

Parameter ID	D-SMART 6
Data / Parameter:	$CE_{p,y}$
Data unit:	Cooking Events/household/day
Description:	Average number of cooking events per day recorded with CSMs on the activity technology p during long-term monitoring in year y .
Source of data:	This derived from Continuous Stove Monitors sensors placed on the activity technology during the KPT in activity scenario p .

Monitoring Frequency:	Continuous logging, aggregated for each monitoring period.
QA/QC procedures:	Compliance with the general requirements for sampling QA/QC and Annex A .If the loss rate of deployed CSMs exceeds 20%, the lower bound of the 90% confidence interval shall be applied.
Any comment:	Please refer to (Section 11.4) and further and to Annex B on requirement and guidance to conduct the KPT.

Parameter ID	D-SMART 7
Data/parameter:	HE_{ind}
Description:	Hawthorne effect adjustment factor
Data unit:	Fraction (%)
Purpose of data:	<input checked="" type="checkbox"/> Baseline emissions (Adjustment)
Monitoring frequency	Calculated for each monitoring period.
Measurement methods and procedures:	Set to a default exemption of 1.0 for activities fully compliant with the continuous dMRV requirements of this tool, as the actual drop-off in usage is quantified and integrated via the objective Usage Rate ($U_{p,y}$).
Entity/person responsible for the measurement:	CME/activity developer
QA/QC procedures:	VVB verification that the correct HE value has been applied based on the monitoring period year.
Treatment of uncertainty:	N/A
Comments:	N/A

Parameter ID	D-SMART 8
Data/parameter:	Avoidance of double counting or double claiming among participants
Description:	Evidence of avoidance of double counting or double claiming with other parties directly involved with the activity or programme (e.g., manufacturers, retailers).
Data unit:	NA
Purpose of data:	<input checked="" type="checkbox"/> Applicability
Monitoring frequency	N/A

Measurement methods and procedures:	<input type="checkbox"/> Measured <input checked="" type="checkbox"/> Other source
Entity/person responsible for the measurement:	Written assertions from the activity developer confirming ownership rights and the intention to sell emission reductions. These assertions shall be directed to or signed with all applicable parties, including: <ul style="list-style-type: none"> • All other activity participants; • Activity technology producers; and Retailers of the activity technology or the renewable fuel.
QA/QC procedures:	N/A
Treatment of uncertainty:	N/A
Comments:	The written assertions shall be provided and verified before the first verification.

Parameter ID	D-SMART 9
Data / Parameter:	$OR_{p,y}$
Data unit:	Percentage (%)
Description:	Ownership Rate in activity scenario p during year y. This reflects the percentage of household still owning their activity stove.
Source of data:	Ownership Rate survey when doing PFT enrolment. When households are visited to enrol them in the PFT, the physical presence of the stove should be checked. If the stove is not physically present in the household anymore, it should be counted as not owning the stove anymore.
Monitoring frequency:	Every other year
QA/QC procedures:	Compliance with the general requirements for sampling QA/QC (Section 11.4) and Annex B Kitchen performance test.
Any comment:	This parameter is multiplied against the usage intensity ratio to objectively determine the final Usage Rate ($U_{p,y}$) fed into the parent methodology.

Parameter ID	D-SMART 10
Data / Parameter:	$N_{b,p,y}$
Description:	Number of activity technology-days included in the activity database for baseline b/activity p pair in year y.

Data unit:	Days
Purpose of data:	<input checked="" type="checkbox"/> Baseline emissions <input checked="" type="checkbox"/> Activity emissions
Measurement and updating frequency	Continuous (Sales/Distribution Records). Annual (Calculation)
Measurement methods and procedures:	<p>Calculated based on the Digital Sales Platform/Activity Database (derived from Sales/Distribution records). The calculation accounts for the date of commissioning and excludes stoves that have completed their technical life (if not replaced/retrofitted). The data is segmented by baseline/activity scenario pair (b, p) and age group (cohort/batch). To simplify calculations for large-scale deployments, developers may utilize 'Monthly Batching'. Under this approach, all stoves installed within a given calendar month are treated as commissioned on the last day of that month for emission reduction calculation purposes (a conservative approach), provided the assumption is applied symmetrically across the crediting period.</p>
Entity/person responsible for the measurement:	CME/activity developer
QA/QC procedures:	The activity developer shall maintain a complete, accurate, and electronically backed-up activity database throughout the entire crediting period. The record shall be organized at the household/end-user's level. (Data privacy tracking maintained as per Section 11.1).
Treatment of uncertainty	N/A

Parameter ID	D-SMART 11
Data / Parameter:	MC_f
Description:	Moisture content of solid biomass fuel used during the dKPT.
Data unit:	Percentage (%)
Purpose of data:	<input checked="" type="checkbox"/> Baseline emissions <input checked="" type="checkbox"/> Activity emissions
Measurement and updating frequency	During the first crediting year and then every other year (concurrent with BFT AND PFT).

Measurement methods and procedures:	Measured using calibrated moisture meters via a random, representative sample of the household's daily fuel pile during the DKPT in accordance with RECH V5.0 Annex 2.
Entity/person responsible for the measurement:	CME/activity developer
QA/QC procedures:	As per RECH V5.0 Section 14.4, moisture meters shall be calibrated according to manufacturer instructions. RECH V5.0 Annex 2, measurements shall be taken via a random, representative sample (e.g., 3-5 pieces) rather than requiring the measurement of every individual piece of wood.
Treatment of uncertainty	N/A

11.7| Sampling requirements

11.7.1 | The sampling requirements of the applicable parent methodology shall apply the sample size for Usage Intensity Measurements (UIMs) and Field Tests must be large enough to ensure derived parameters meet 90/10 confidence/precision separately, subject to a mandatory minimum sample size of 50 households per credited stratum or age cohort.

ANNEX – A: CONTINUOUS STOVE MONITOR (CSM) GUIDELINES

This annex describes the requirements for measuring long-term usage intensity with Continuous Stove Monitors (CSMs). As the primary method for objective usage monitoring under this tool, sensors shall be deployed early in the crediting period and monitor the activity stoves continuously throughout their technical lifetime. Data shall be aggregated for each monitoring period to determine the objective usage intensity ($CE_{p,y}$) required for emission reduction calculations.

A.1. Sensor Deployment on the stove (Sampling)

A.1.1.1 The sample size shall meet 90/10 confidence/precision requirement and the minimum threshold of 50 households per operational age cohort, as established in Section 11.

A.1.1.2 To ensure the final $CE_{p,y}$ parameter accurately reflects the entire operational fleet, the usage data shall be mathematically weighted proportionally to the total number of stoves surviving in each respective age cohort, in strict accordance with the parent methodology.

For instance, sample designed for 90/10 might yield 340 sensors for the 10,000 stoves distributed in year 1 and yield 350 sensors for the 20,000 stoves distributed in year 2. The sample would then not be self-weighted and require careful weighting. For that example, CE would be calculated as such:

$$CE_{p,2} = \left(CE_{year1} * \frac{10,000}{30,000} \right) + \left(CE_{year2} * \frac{20,000}{30,000} \right)$$

With:

- $CE_{p,2}$ = average number of cooking event measured across the activity for the crediting year 2 (Jan 1st 2028-December 31st 2028)
- CE_{year1} = average number of cooking event measured during the crediting year 2 (Jan 1st 2028-December 31st 2028) across the stoves distributed during between Jan 1st 2027-December 31st 2027
- CE_{year2} = average number of cooking event measured during the crediting year 2 (Jan 1st 2028-December 31st 2028) across the stove distributed during between Jan 1st 2028-December 31st 2028

A.1.1.3 The following methods are acceptable for selecting which stoves will be equipped with a sensor:

A. Method 1: Universal Deployment (100% Installation):

A.1.1.4 CSMs are installed on 100% of the activity technology units during manufacturing or installation. **Data Collection:** For monitoring, a statistically representative sample of the households (meeting the requirements above) shall be chosen randomly from the Activity Database.

Data from these sensors shall be collected with a minimum of 3 months of valid continuous data for use in the emission reduction calculation.

A. Method 2: Sampled Continuous Deployment

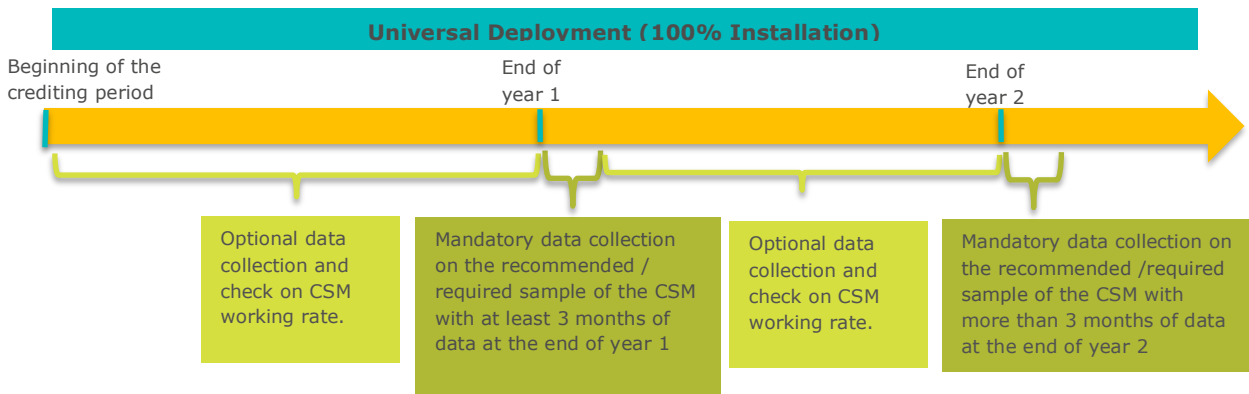
A.1.1.5 CSMs are installed on a representative sample of the stoves directly during manufacturing or installation. **Data Collection:** Data from all successfully deployed sensors shall be collected and used for the emission reduction calculation, provided the data meets minimum duration requirements (at least 3 months of valid continuous data per monitoring period).

B. Method 3: Biannual Batch Deployment.

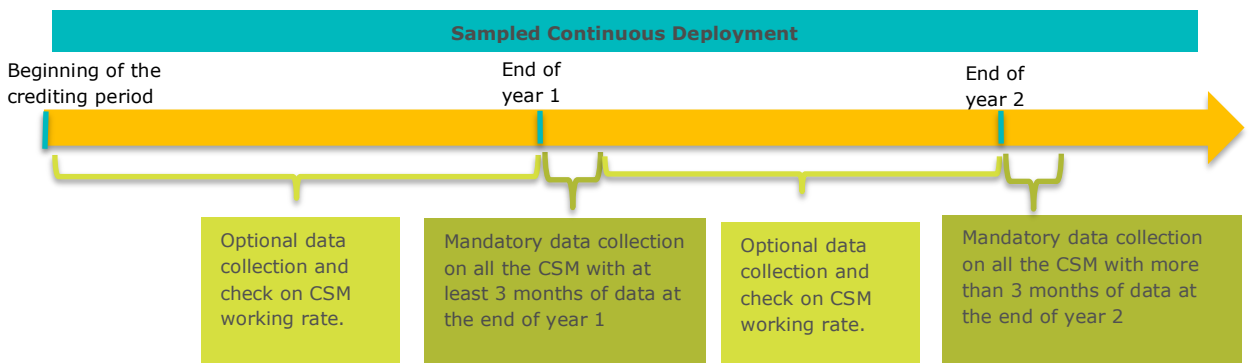
A.1.1.6 Every 6 months, the Digital Sales Platform/Activity Database shall be examined, and the new sales/disseminations from the preceding 6 months shall be used as the sampling frame. Sensors shall be installed on a minimum statistically representative sample of the activity technology units sold in that specific period. **Data Collection:** Data from all deployed sensors shall be collected and used for the emission reduction calculation, provided they meet the minimum valid data duration requirements.

Here are an example of sensor deployment and data collection schedule for each of the 3 methods described above.

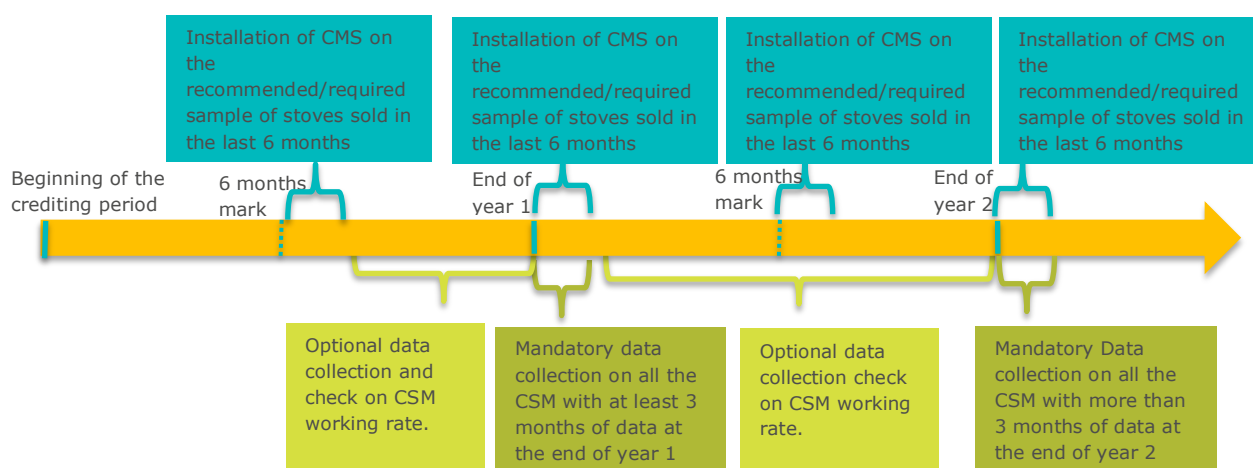
Method 1:



Method 2:



Method 3:



A.2. CSM general deployment requirements

A.2.1.1 Activity developers shall adhere to the following guidelines for CSM installation:

- a. **Placement for Signal Integrity:** The sensor shall be deployed such that the parameter being measured (e.g., temperature) is high enough to be easily and reliably detected as a cooking event. This placement shall be maintained consistently throughout the crediting period and shall be identical to the placement used during the dKPT.
- b. **Non-Obtrusive Placement:** The CSM shall be placed in a way that does not restrict or hinder the use of the stove by the cook. Whenever possible, sensors shall be placed on the back of the stove or internally.
- c. **Mobility:** For mobile stoves, the CSM shall be secured directly to the stove itself to allow for unrestricted use both indoors and outdoors.
- d. **Durability:** The CSMs deployed shall be adequately protected (e.g., waterproof) to withstand the environmental conditions of the deployment location (e.g., rain for outdoor use).
- e. **Attachment Methods:** Attachment methods, such as drilling and self-tapping screws, rivets, or high-temperature adhesives (epoxy putty or silicon sealant), shall be secure and appropriate for the stove material and the long-term nature of the deployment. Temporary methods like metallic wires are only suitable for short-term monitoring. The selected attachment method shall not damage or compromise the functionality of the activity stove.

A.3. Sensor Data Analysis and Validation

- A.3.1.1 The long-term usage data shall be processed to determine the average Cooking Events¹² per day ($CE_{p,y}$)
- a. **Metric:** The main metric of interest is Cooking Events per day (CE/day). Cooking Events are defined as the preparation of one or more dishes consecutively.
 - b. **Algorithm Documentation:** The algorithm used to process the raw sensor data (e.g., temperature trace) into discrete Cooking Events shall be thoroughly documented and validated by the VVB at the beginning of each crediting period or whenever the sensor hardware, firmware or placement protocol has been changed.
 - c. **Algorithm Validation for Logging CSMs:** For logging CSMs (which record continuous raw data), at least 50 raw data files representing a minimum duration of 72 hours each (and showing the complete sensor trace) shall be manually annotated by the activity developer to clearly indicate the beginning and end of each Cooking Event detected by the algorithm. These files shall be made available for random auditing by the VVB¹³.
 - d. **Algorithm Validation for Non-Logging CSMs:** For non-logging CSMs (which process data internally and only output aggregated events), they shall be co-located with validated logging CSMs in at least 50 households (e.g., during the initial PFT). The number of Cooking Events reported by both sensor types shall be compared. If the non-logging CSM reports a higher number of events, its figure shall be adjusted downward to match the more conservative result from the logging CSM. All co-location log files shall be made available for auditing.

¹² Cooking events are used here because they are the most robust way to derive usage from sensor data. The number of cooking event derived from temperature data does not depends much on the parameter and algorithm used to process the data. Different algorithm, with different parameter will likely yield number of events that are fairly similar. Furthermore, cooking events strikes the right balance between robustness and level of details. Cooking time is more precise for instance, but its measurement is subject to interpretation and will depend heavily on the algorithm used to process the data. On the other end, cooking days is very robust but lacks granularity.

¹³ To audit the algorithm, the VVB should select randomly some the annotated data provided and have a detailed look at the temperature trace and the cooking events detected by the algorithm. The number of false positive (cooking detected by the algorithm but not by the VVB) or false negative (cooking detected by the VVB but not by the algorithm) for each of these files. The error rate Err may be calculated as such: $Err = \frac{|false\ positive - false\ negative|}{total\ number\ of\ event}$. If the Error rate is greater than 5% then the $CE_{p,y}$ parameter should be discounted by the error rate such that it leads to a conservative result. If the error rate is 5% or less, then the mean value of the CE parameter may be used.

- e. **Consistency:** The sensor deployment location, the type of sensor, and the algorithm used to process data¹⁴ shall remain consistent throughout the crediting period. Any change requires robust justification, a re-examination of the algorithm by the VVB, and empirical proof that the change maintains conservativeness¹⁵ and does not artificially inflate the detection of Cooking Events.

A.4. Missing Data Protocol

- A.4.1.1 This protocol defines the treatment of data from lost, damaged, or malfunctioning CSMs.
 - a. **Non-Valid Data:** In cases where a CSM is lost, damaged, or malfunctions such that its data cannot be successfully downloaded, the household shall be considered as having non-valid data for that monitoring period. A replacement CSM must be installed in the same stove shortly after the issue is reported.
 - b. **Calculation:** The usage intensity analysis shall be carried out only on households with valid data. Households with partial data may be included if they possess more than 3 months of valid data for the respective monitoring period.
 - c. **Penalty for High Loss Rate:** If more than 20% of the deployed CSM sample yields non-valid data for a monitoring period, the activity developer shall apply the lower bound of one sided 90% confidence interval (as defined in section 10) instead of the mean for the $CE_{p,y}$ parameter to ensure conservativeness. Additionally, the activity developer shall implement a specific mitigation plan, documented for the VVB, to address the high loss rate in the subsequent monitoring period¹⁶.

¹⁴ Having the same algorithm and sensor placement during KPT and long-term usage monitoring is key for accuracy of the monitoring effort. This mostly renders the ER independent from the algorithm used.

¹⁵ One way to do this would be to provide 50 files using the old and new method on the same stoves and showing that the different algorithm and/or the different location still yield the same number of cooking events as with the old method. For algorithm changes, another way to do this would be to process old sensor data with the new algorithm and to show that it yields identical or conservative results.

¹⁶ For instance, replacing sensor that fails by new ones could be a good option. Or the placement could be updated to a new location where the sensors are less prone to overheating.

ANNEX – B: GUIDELINES FOR DIGITAL KITCHEN PERFORMANCE TESTING (dKPT)

This Annex details the mandatory requirements and procedures for implementing the Digital Kitchen Performance Test (dKPT) for all Baseline Field Tests (BFTs) and Project Field Tests (PFTs). The dKPT leverages digital data-logging scales and Continuous Stove Monitors (CSMs) to increase measurement granularity, auditability, and eliminate the behavioural bias associated with daily enumerator visits.

B.1. KPT Boundaries and Exclusions

- B.1.1. The dKPT boundary encompasses all fuel consumption for thermal energy use at the household level. This includes, but is not limited to cooking, space heating, water warming (for bathing or drinking), and food preparation for animals. Thermal energy use may be excluded from the dKPT boundary only if all three of the following conditions are met and documented:
- a. The excluded activity occurs outside of the primary cooking area, allowing the fuel to be kept physically separate.
 - b. The excluded thermal energy use is seasonal, infrequent, or the quantity of fuel consumed dwarfs the fuel quantity used for cooking.
 - c. The activity developer provides a reasonable explanation demonstrating that the introduction of the activity technology will not affect the excluded thermal energy use.

B.2. Household Eligibility Criteria

B.2.1. Scenario Screening

- B.2.1.1 Before inclusion, a detailed questionnaire shall confirm that the household adheres to the defined baseline (*b*) and activity (*p*) scenarios. For PFTs, this screening shall confirm the household's current ownership of the activity technology and its primary use case (e.g., domestic vs. commercial). Low usage of the activity technology is not grounds for exclusion from the PFT.

B.2.2. Zero Consumption Days

- B.2.2.1 Households, once selected and enrolled, shall be kept in the study even if they are travelling or have days with zero cooking activity or fuel consumption. The exclusion of such days shall be prohibited, as it leads to an upward bias and overestimation of average fuel consumption for the group.

B.3. dKPT Process and Schedule

B.3.1. Duration

- B.3.1.1 The dKPT measurement period shall be a minimum of 3 valid measurement days (non-consecutive days are permitted in the event of unavoidable field interruptions).
- a. Preparation and Training: Explain the test purpose to the household cooks. Stress that cooking practices must remain as close to normal as possible.
 - b. Initial Data Recording: Record the moisture content of the initial stock of solid fuels (Section 13.5) and the demographic data (age/gender) of household members for the Standard Adult calculation (SAx).
 - c. Equipment Deployment:
 - i. Place digital data-logging scales in the kitchen (Section below). One scale must be deployed for each fuel type used in the household.
 - ii. Deploy a CSM sensor on the activity stove (PFT) and potentially on all the other stoves (for non-compliance detection, Section below).
 - iii. Start the digital scales, allow them to zero themselves with the empty fuel holder, and then load the initial fuel stock.
 - d. Household Training: Provide clear, mandatory instructions to the cooks regarding scale usage and fuel management (Section B.7.1 below).
 - e. Monitoring Period: The enumerator shall not conduct intrusive daily visits, relying solely on the digital equipment for continuous data logging.
 - f. Final Data Collection: At the end of the dKPT period, the enumerator returns to the household to:
 - i. Download all data from the digital scales and CSMs.
 - ii. Take a final measurement of the moisture content of the remaining fuel.
 - iii. Conduct the final ownership check and compliance questionnaire.

B.3.2. Schedule Representativeness:

- B.3.2.1 When deciding on the schedule for the KPT implementation, the days of the week during which the measurement are taken should be considered. There are likely days where the consumption is different (e.g., weekend, market day, etc.). In order to limit bias from weekly variations (e.g., weekends vs. weekdays). Acceptable schedules include:
- a. Option 1: 7 consecutive days in each household.
 - b. Option 2: Weekdays only (Assuming lower, conservative fuel consumption).

- c. Option 3: A representative of the week (5 weekdays for 2 weekend-days). Deviation from this ratio is acceptable only if empirical analysis proves the result remains conservative.

B.4. Measurement Method and Equipment

B.4.1.1 All physical measurement equipment shall comply with the calibration requirements detailed in the parent methodology (e.g., RECH V5.0 Section 14.4).

B.4.1.2 Data-logging Scale Specifications:

- a. **Resolution**¹⁷: Shall have a resolution of 0.05% of its nominal weight or better (e.g., a scale rated for 20kg shall have a resolution of 10g minimum while a scale rated for 50kg shall have a resolution of 25g or better).
- b. **Capacity**: Shall have a capacity greater than 20kg.
- c. **Frequency**: Shall be set to record a measurement every 1 minute or more frequently.
- d. **Application**: Solid biomass fuel must be placed in an appropriate fuel holder below a single hanging scale dedicated to that fuel type. (For liquid or gaseous fuels like LPG canisters it is acceptable to weigh the initial and final weigh of the cannister over the dKPT period rather than doing continuous measurements¹⁸).

B.4.2. Moisture Content (MC)

B.4.2.1 Measured using calibrated moisture meters via a random, representative sample. If the resulting fuel consumption is mathematically converted to a 0% dry-mass equivalent using the formulas below, the activity developer must align the resulting data with a dry-basis NCV (or normalise it) in accordance with Section 6.2 of this tool:

$$MC_{wet-basis} = \frac{Mass_{wet} - Mass_{dry}}{Mass_{wet}}$$

Where M_{wet} and M_{dry} are the mass of the fuel sample before and after drying, respectively. The resulting fuel consumption shall be expressed in dry mass equivalent using the applicable formula:

When MC is expressed in dry basis

¹⁷ Resolution refers to the smallest difference that can be read from the scale. For instance, if the scale display weight with a granularity of 0.1g then the resolution is 0.1g, but that does not mean that its accuracy is 0.1g. Accuracy requirements are defined in paragraph e.

¹⁸ Before and after measurement provide more accurate assessment of LPG consumption because household tend to close/open the LPG cannister frequently or even to cook directly on the cannister by screwing a burner to it.

$$Fuel_{dry} = Fuel_{wet} \times \frac{1}{1 + MC_{dry-basis}}$$

When MC is expressed in wet basis

$$Fuel_{dry} = Fuel_{wet} \times [1 - MC_{wet-basis}]$$

B.5. Standard Adult Normalisation

- B.5.1.1 To correctly determine the $SAM_{avg,x}$ parameter required for normalising daily absentee variance (as mandated in Section 9.2), the number of people present at each meal shall be normalized and expressed as a Standard Adult Equivalent using the following factors:

Gender and age	Fraction of standard adult
Child: 0-14 years	0.5
Female: over 14 years	0.8
Male: 15-59 years	1.0
Male: over 59 years	0.8

B.6. Household and Field Team Training

B.6.1. Household Training and Scale Deployment

- B.6.1.1 Location & Security: Scales should hang freely near the stove, protected from rain. The fuel holder should be securely attached (e.g., via a small padlock) to ensure the cook only removes fuel, not the holder.
- B.6.1.2 **Cook Instructions:** Enumerators must instruct cooks to:
- Exclusive Use:** Only use fuel that has been placed in the secured holder for the household's thermal energy needs. Fuel from the holder must not be given away or sold.
 - Complete Measurement:** All fuel consumed in the household must first be placed in the designated fuel holder.
 - Refill Timing:** Wait until the fuel holder is empty or nearly empty before refilling.
 - Refill Stabilization:** Wait for a minimum of 5 minutes after refilling the fuel holder before taking any fuel away for use. This allows the scale measurement to stabilize.
 - Leftover Management:** Do not replace leftover fuel from a cooking event back into the holder. Keep it by the stove for the next use.

An Infographic in local language shall be prepared ahead of time and left in each household for the duration of the KPT. Compliance with these principles shall be checked with the cook at the end of the measurement period (on a self-declared basis) and recorded in the exit questionnaire.

B.7. Data Processing and Non-Compliance Algorithms

B.7.1. Data-logging Scales (Fuel Consumption)

- B.7.1.1 Fuel consumption shall be calculated by identifying sudden, sustained drops in weight. The following steps are recommended:
- a. **Spike Removal:** Apply a 5-minute running median pass to the raw weight trace data to remove short spikes caused by loading or unloading fuel.
 - b. **End-of-Test Filter:** Systematically discard the last 10 minutes of the recorded data trace to mitigate potential overestimation if fuel was removed immediately before the enumerator's final data download.
 - c. **Creep and Temperature Filter:** Apply a weight change threshold (e.g., 20g) to filter out slow variations in weight caused by scale temperature sensitivity or cell creep, ensuring only significant fuel removal events are captured.

B.7.2. Non-Compliance Detection (CSMs and Orphan Events)

- B.7.2.1 CSMs deployed on the activity stove(s) shall be used to detect potential non-compliance by correlating stove usage with recorded fuel consumption (scale drops) within a defined time window (e.g., 30 minutes).
- a. **Event Mapping:** Map fuel-use events (from scale drops) and stove-use events (from CSM detection) with corresponding timestamps.
 - b. For each 24h period, the specific fuel consumption/cooking events should be calculated.
 - c. For fuel types, the distribution of fuel consumption/CE parameter across all households from the same scenario should be examined. Outliers are determined by looking at the first and third quartiles (Q1 and Q3) and using these formulas: $\text{Outlier} > Q3 + 1.5 * (Q3 - Q1)$ or $\text{Outlier} < Q1 - 1.5 * (Q3 - Q1)$
 - d. If there is completeness in the sensor data available¹⁹, the sensor data for each of the identified 24h-period outliers should be examined for measurement errors and for event matching per the procedure below.
 - e. Matching: For each fuel-use event, determine if it is associated with a stove-use event within a defined time window (e.g., 30 minutes).
- B.7.2.2 Orphan Events: The treatment of unmatched ("orphan") events during the PFT is critical for ensuring methodological conservativeness regarding stove-stacking:
- a. Orphan Fuel Events (Stove-Stacking): A 24-hour period showing fuel consumption on the digital scale, but no corresponding cooking event on the activity stove CSM, indicates the household cooked using an unmonitored baseline device. These events shall not be removed. Deleting this data systematically underestimates stove-stacking and

¹⁹ That process can only be done if all the fuels and all the stoves in the household were equipped with sensors. If that is not the case, then the outlier maybe removed is there are evidence of error in the fuel measurement or non-compliance that is self-reported by the household from the questions asked at the end of the KPT period.

artificially inflates emission reductions. This fuel must be conservatively included in the calculation of Activity Emissions.

- b. Orphan Stove Events (Equipment Malfunction): A 24-hour period showing a CSM cooking event on the activity stove, but zero corresponding fuel consumption on the scale, indicates the cook bypassed the scale or the scale malfunctioned. Because actual fuel consumption cannot be verified, these specific 24-hour periods must be flagged as Invalid Measurement Days and excluded from the dataset.
- c. After these checks, households with at least 3 days of valid data maybe left into dataset. If a household has less than 3 days of valid data, the whole household shall be removed from the dataset.

ANNEX – C: ACTIVITY PREPARATION AND MONITORING SCHEDULE

Activity preparation and monitoring schedule	Prior to Design Certification	Prior to first verification	Annually (Per monitoring period)	Biennially	Every 6 months	Continuously
Ex-ante ER estimation for PDD	✓					
Baseline scenario survey	✓					
Indoor air pollution (IAP) levels	✓					
Digital Field Tests (dKPT)						
Baseline Field Tests (BFT) (Pb,mean)		✓		✓		
Project Field Tests (PFT) (Pp,mean)		✓		✓		
Digital Surveys & Usage Intensity						
Ownership Rate Monitoring (OR _{p,y} via PFT enrolment)		✓		✓		
Usage Intensity Monitoring (CE _{p,y} data aggregation & reporting)		✓	✓			
Usage Intensity Monitoring (CE _{p,y} sensor logging)						✓
CSM deployment (Annex A Method 3: Biannual Batches)					✓	
CSM deployment (Annex A Methods 1 & 2: At Installation)						✓
Maintenance of Digital Sales Platform / Activity Database						✓

ANNEX - D: GUIDELINES FOR BASELINE FIELD TEST SAMPLING

This Annex details the mandatory methodology for the selection of households for the Baseline Field Test (BFT) sample when a cross-sectional design is adopted²⁰. The objective is to ensure that the BFT sample serves as a robust counterfactual for the Project Field Test (PFT) sample, thereby limiting the influence of confounding factors on the measured fuel consumption difference.

D.1. Key measures:

D.1.1.1 Key measures mandatory for establishing the counterfactual:

- a. **Temporal Alignment:** BFTs and PFTs shall be carried out during the same time period to control for the influence of seasonality and climatic variations.
- b. **Longitudinal Consistency:** BFTs²¹ and PFTs shall be updated every other year to ensure that the sampled data captures longitudinal trends and remains representative of the activity area as the activity expands.
- c. **Proximity and Matching:** BFT households shall be selected from neighbours of PFT households (or from the nearest comparable community if saturation is high) and must be matched for socio-economic status and Willingness to Pay (for commercial activities).

D.2. Baseline household selection method²²

D.2.1.1 The selection method is contingent on the activity saturation within the target communities:

a. Method 1: Low Activity Saturation (Non-Activity Households Available)

D.2.1.2 This method shall be followed when sufficient households that have **not** purchased/received the activity technology are available within the targeted community. For each PFT household enrolled, one "matching" BFT household shall be enrolled using the following random walk procedure:

²⁰ When a paired-design is adopted, this approach is not needed since the baseline households are simply the activity households before the adoption of the technology.

²¹ Baseline Field Test update may not be required if both conditions below are met:

- Activity area has not changed by more than 10% since last update. Activity area is defined as the area of the polygon formed by the outermost households targeted by the activity.
- convincing evidence for the activity area that fuel consumption macro-level trends have not changed much since the baseline was last carried out.

²² Where neighbour-based random-walk sampling is unfeasible (e.g., high penetration or complex settlement patterns), developers may use a statistically valid alternative sampling frame, such as stratified random sampling from eligible non-activity households within the same community zone. Criterion could be households who have demonstrable homogenous characteristics as the study sample, income levels, baseline fuel use and who are within a 2-3 km radius of the study sample.

- a. Start the random walk at the front door of the selected PFT household.
- b. Determine a random direction using the auditable procedure defined in below.
- c. Proceed to the first non-activity household encountered in this direction.
- d. Check for the BFT Household Eligibility Criteria.
 - i. If the household is eligible, consents to the KPT, and is present, the household is enrolled.
 - ii. If the household is ineligible, does not consent, or is not present, restart the process from that household (i.e., determine another random direction and proceed with the next non-activity household in that direction).
- e. This process is repeated until a suitable control household is found for each selected PFT household.

b. Method 2: High Activity Saturation (Insufficient Non-Activity Households)









D.2.1.2 This method shall be followed when there are insufficient households without the Activity technology available in the immediate community of the selected PFT household to serve as a counterfactual.

- a. The closest community (with a sufficient number of available non-Activity households) shall be selected as the BFT location.
- b. Start the random walk at the centre of the selected BFT community.
- c. Determine a random direction using the auditable procedure defined in Section below.
- d. Proceed to the first household encountered in this direction.
- e. Check for the BFT Household Eligibility Criteria (Section below).
 - i. If the household is eligible, consents to the KPT, and is present, the household is enrolled.
 - ii. If the household is ineligible, does not consent, or is not present, restart the process from that household (i.e., determine another random direction and proceed with the next non-Activity household in that direction).
- f. This process is repeated until the required sample size of BFT households is met.

D.3. Auditable Random direction

D.3.1.1 To ensure that the process of determining random directions is auditable and reproducible, the direction shall be determined as follows:

- a. A random number (between 0 and 1) is first generated and recorded by the digital questionnaire interface.
- b. The corresponding direction is then displayed to the enumerator based on the range in which the random number falls (e.g., North, North-East, East, etc.).
- c. The specific attribution method (random number range to cardinal direction) shall be documented in the PDD.

Random Number	Direction	Cardinal direction
[0 ; 0.125]		North
[0.125 ; 0.250]		North-West
[0.250 ; 0.375]		West
[0.375 ; 0.5]		South-West
[0.5 ; 0.625]		South
[0.625 ; 0.750]		South-East
[0.750 ; 0.875]		East
[0.875 ; 1]		North-East

D.4. Baseline household Eligibility

D.4.1.1 A household is eligible for the BFT only if all the following deterministic criteria are met:

- a. Scenario Inclusion: The household must meet the specific scenario inclusion criteria defined for baseline scenario b.
- b. Non-Ownership: The household must not own the Activity technology being promoted.
- c. Socioeconomic Matching: The household must have a socioeconomic status (e.g., as determined by the Poverty Probability Index, PPI, or equivalent measure) that falls within $\pm 20\%$ of the score of the corresponding PFT household.
- d. Willingness to Pay (WTP) Assessment (Mandatory for commercial programs): The household's assessed Willingness to Pay for the Activity technology must be equal to or greater than the current retail price of the Activity technology in the area.

D.5. Willingness to Pay (WTP) Assessment Method

D.5.1.1 Willingness to Pay must be measured using the **Gabor-Granger method**.

- a. Price Levels: Specify a range of price levels (ideally 8 to 15) for the Activity technology, situated both below and above the actual retail cost.

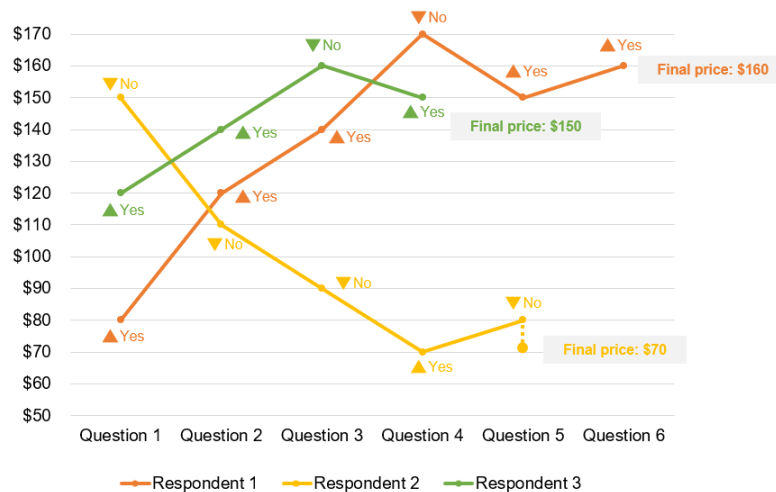
- b. Adaptive Questioning: The questionnaire shall be coded to present a series of questions to the respondent (e.g., "Would you buy product X at price Y?"). The price presented is adapted based on the respondent's previous answer (higher price if "Yes," lower price if "No") to determine the maximum price the respondent is willing to pay.
- c. Eligibility Threshold: The household is eligible only if this highest determined price is \geq the current retail price of the Activity technology.

Overview of Gabor-Granger method

Each respondent is given a series of almost identical questions, such as "Would you buy product X at price Y?". In each of the several questions, the price shown to a respondent is different: it is adapted based on the respondent's previous answer with the aim of finding the maximum price each respondent is willing to pay for a product.

In this example, we have price points from \$50 to \$170 (incremented by \$10):

1. Respondents are randomly assigned to one price.
2. If they are willing to pay that price, they are offered a higher (randomly chosen) price.
3. If they are not willing to pay that price, they are offered a lower (randomly chosen) price.
4. The algorithm repeats until we find the highest price each respondent is willing



to pay.

How to implement Gabor-Granger method

- You need to specify several price levels based on the actual retail cost of the Activity technology. Ideally, between 8 and 15 price levels situated both below and above the retail price. For example, if the Activity technology retails at 50 US\$ you could choose: \$30, \$35, \$40, \$45, \$50, \$55, \$60, \$65, \$70.
- You will also need to provide a description of your product that the consumer may make their decision upon.
- Code the questionnaire to start with a random initial price and to show higher or lower price based on the answers.

- Once all the price options have been explored, the household willingness to pay is the highest price the respondent agreed to pay.

The household meets this eligibility criteria if their willingness to pay is equal or greater than the current retail price of the Activity technology in the area.

D.6. Socioeconomic Assessment Method

Socioeconomic status shall be determined using a recognized tool such as the Poverty Probability Index (PPI) or equivalent method based on simple, verifiable questions.

The BFT household shall be considered a match only if its socioeconomic score (e.g., probability of being below the poverty line, or equivalent index score) falls within the $\pm 20\%$ range of the corresponding PFT household score.

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