Gold Standard
for the Global Goals

Technical Reference Manual

For Gold Standard Methodology to Estimate and Verify ADALYs from Cleaner Household Air

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TABLE OF CONTENTS

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GLOSSARY

ADALY	Averted disability-adjusted life year (also called DALY Averted)
CO	Carbon monoxide
CO_2	Carbon dioxide
COPD	Chronic obstructive pulmonary disease
CSM	Continuous Stove Monitors
HAP	Household Air Pollution
HAPIT	Household Air Pollution Intervention Tool
IHD	Ischemic heart disease
LPG	Liquid petroleum gas
NO_2	Nitrogen dioxide
PEM	Personal exposure monitoring
PNG	Piped natural gas
$PM_{2.5}$	Particulate matter less than 2.5 microns average diameter
SO_2	Sulfur dioxide
VER	Verified Emission Reduction

ABOUT GOLD STANDARD

Gold Standard was established in 2003 by WWF and other international NGOs as a best practice standard to ensure projects that reduced carbon emissions under the UN's Clean Development Mechanism (CDM) also fostered sustainable development. Now with more than 80 NGO supporters and 1400+ projects in over 80 countries, Gold Standard projects have created billions of dollars of shared value from climate and development action worldwide.

Gold Standard's vision is Climate Security and Sustainable Development for all and Mission is to catalyse more ambitious climate action to achieve the Global Goals through robust standards and verified impacts.

For more information about Gold Standard, please visit: www.goldstandard.org/

SECTION 1.0: INTRODUCTION

This technical reference manual aims to assist project developers and practitioners in applying the Gold Standard Methodology to Estimate and Verify ADALYs from Cleaner Household Air[1] (hereafter "ADALYs methodology").

While the specific requirements and guidelines are laid out in the ADALYs methodology, this document serves as a supplementary guide to support the successful implementation of the methodology. The manual also provides information on global and regional organisations and testing centres who have the expertise and capacity to monitor personal exposure – a mandatory requirement for the ADALYs methodology.

Gold Standard for Global Goals

Gold Standard has integrated its previous standards for Energy, Land Use and Water into one comprehensive standard, Gold Standard for the Global Goals. With enhanced safeguarding principles, alignment to the Sustainable Development Goals (SDGs) and innovative approaches to certification, this new standard keeps Gold Standard projects at the epicenter of the international agendas and helps catalyse faster progress towards the Global Goals.

Gold Standard for the Global Goals is designed to accelerate progress toward climate security and sustainable development. This next-generation standard enables a broad range of climate and development initiatives to quantify, certify, and maximise their impacts. Certification against the standard provides the confidence that these results are measured and verified, allowing us to track progress toward the Paris Climate Agreement and the SDGs.

The ADALYs methodology is fully integrated into the new standard and allows project developers to generate quantified impacts (ADALYs) corresponding to SDG 3 (Good Health and Wellbeing).

Under Gold Standard for the Global Goals, eligible projects can certify multiple products. For instance, an improved cookstove project can receive Gold Standard certified Verified Emission Reductions (VERs) by applying an eligible Gold Standard methodology and thus demonstrating a contribution to SDG 13 (Climate Action). The same project can also receive certified ADALYs by applying the Gold Standard methodology to estimate and verify ADALYs from cleaner household air and demonstrating a contribution to SDG 3.

For more information on Gold Standard for the Global Goals, please visit:
https://www.goldstandard.org/globalgoals

1.2. Structure of the Technical Reference Manual

This reference manual comprises the following main components:

[1] https://globalgoals.goldstandard.org/sdg_3/401-3-adalys-from-cleaner-household-air

SECTION 2.0: Overview of the Methodology

This section provides an overview of the eligibility requirements of the ADALYs methodology, including typical project types that are eligible. It also discusses the types of technologies and practices that are ineligible, and why this is. This section also summarises the methodological approaches presented in the methodology.

SECTION 3.0: Methodology Requirements

This section introduces the methodology requirements and guidance for establishing the project boundary, inclusion and exclusion of pollutants. It also goes in to further detail about monitoring requirements.

SECTION 4.0: Monitoring Requirements

This section provide further guidance on field monitoring and discusses best practices for conducting the monitoring. These best practices reflect on-the-ground experiences of sector experts who are currently implementing projects that aim to quantify health benefits.

The manual also includes annexes to present information on the Household Air Pollution Intervention Tool (HAPIT), monitoring instruments for $PM_{2.5}$ exposure levels and carbon monoxide (CO), the procedure for calibrating CO monitoring equipment, information on global and regional organisations with expertise for monitoring $PM_{2.5}$ and sample survey questionnaire.

SECTION 2.0:
OVERVIEW OF THE ADALYS METHODOLOGY

The Gold Standard ADALYs methodology uses exposure to fine particulate matter ($PM_{2.5}$) as the best indicator of household air pollution. Combustion of common fuels used in households for cooking, space heating, lighting, etc., results in several pollutants, such as carbon monoxide (CO), particulate matter ($PM_{2.5}$), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2). Of these, the pollutant that is most commonly and robustly associated with health impacts is particulate matter. $PM_{2.5}$ exposure causes negative health impacts, such as cardiovascular disease, respiratory disease, and lung cancer, all of which can lead to premature death. It is the dominant contributor to the overall burden of disease from air pollution, no matter what the source. The section below summarises key eligibility criteria for applying the ADALYs methodology to quantify and verify health impacts.

2.1. Methodology eligibility

The ADALYs methodology is applicable to projects that introduce clean and efficient technologies and/or practices for household thermal energy requirements and lighting that reduce household air pollution exposure and associated risk of harmful health impacts when compared to the baseline situation. Projects that lead to a verified reduction in $PM_{2.5}$ exposure levels via a change in household energy use and/or emissions for cooking, heating, and lighting are eligible under this methodology. The examples of cleaner cooking devices, fuels, or practices that projects can include is presented in Figure 1.

FIGURE 1.0: Eligible and Non-eligible Technologies and Practices

Non-eligible technologies and practices:

- Projects that involve a fuel switch to coal, charcoal, or kerosene: Such projects are not eligible as the Gold Standard does not recommend projects switching over to a fossil fuel despite it having a lower carbon content
- Projects leading to greater efficiency in use of coal or kerosene compared to the baseline: Again, such projects are not allowed as despite a potential reduction in the consumption of coal or kerosene, these fuels are highly polluting and a not eligible.
- Stand-alone ventilation projects

Eligible technologies and practices:

There are some exceptions to the above list of non- eligible project types, which are as follows:

- Efficient use of charcoal compared to the baseline is eligible
- Use of modern fuels (e.g. LPG and electricity derived from fossil fuels) can substantially reduce PM2.5 exposures and are eligible for this methodology
- Safe water supply and treatment technologies are only eligible if in the baseline practice is boiling water using solid fuels

In the case of clean cookstoves and heating stoves, project activities using the ADALYs methodology shall meet the following conditions for the project technology:

- **Minimum 20% thermal efficiency based on lab tests using the latest version of the Water Boiling Test (WBT) protocol[2].**

- **Inclusion of incentive mechanism(s) to discourage the parallel use of baseline technology:** The project developers shall encourage the removal of the old technology (e.g. discounted price for the cleaner technology) and target the definitive discontinuity of its use in the project scenario. The developer should monitor the success of the incentive mechanism, and must adjust it if proven unsuccessful. An example of incentive mechanisms could be providing free servicing for a year or discounts for spare parts if the project technology is repaired/serviced in exchange of the baseline technology.

- **Evaluation criteria to avoid double-counting of the same project technology in other activities:** Examples of such criteria could be imprinting unique identification numbers like the stove serial number to avoid double counting with other cookstove projects in the same geographical boundary.

2.2. Overview of the methodological approach

The following sections present an overview of the methodological approach followed for estimation of ADALYs using the ADALYs methodology.

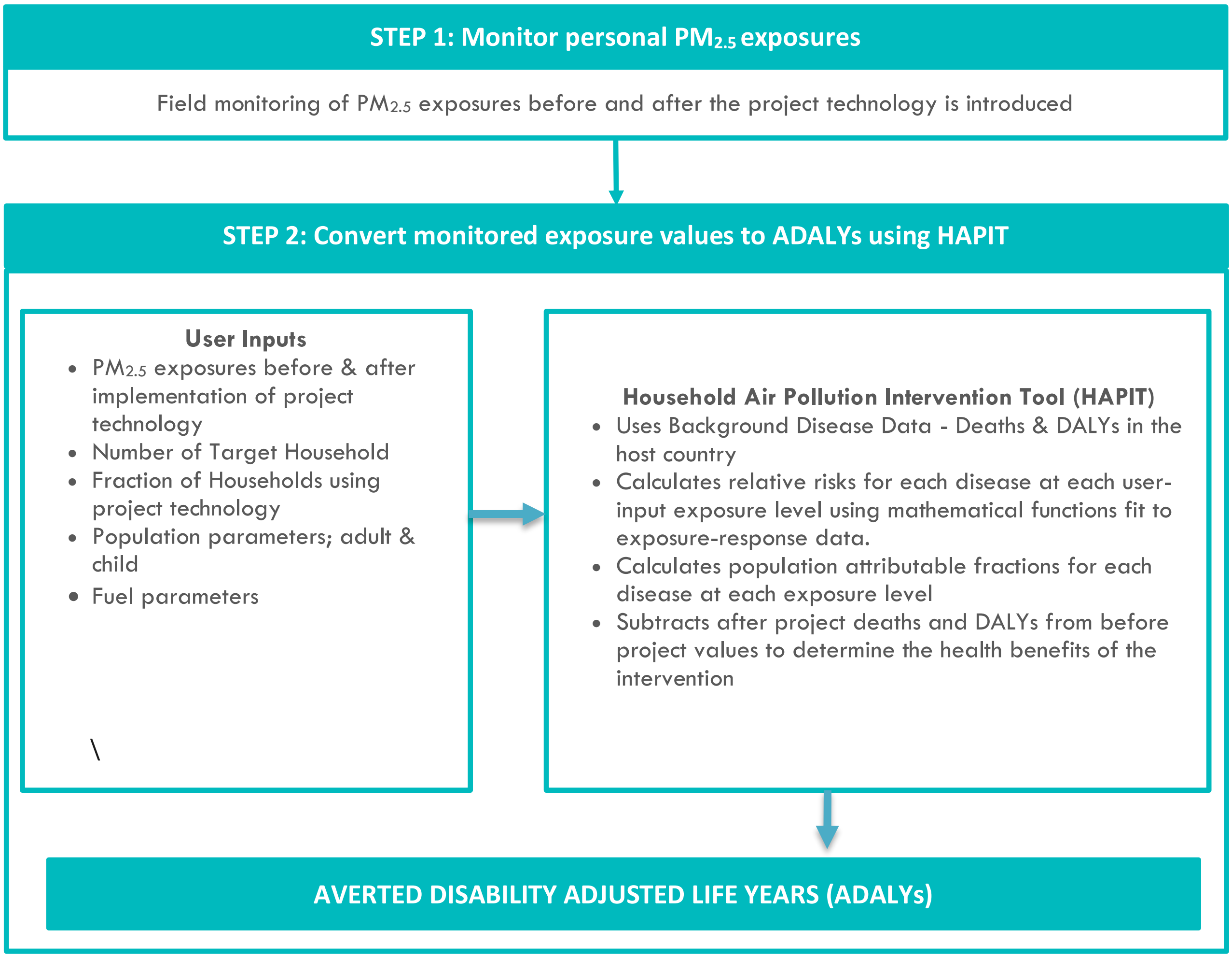
Approach for quantifying ADALYs

The ADALYs methodology provides a quantification approach to calculate health benefits from reductions in exposure to $PM_{2.5}$ resulting from the introduction of efficient/clean technologies and related practices. This approach leads to the quantification of premature deaths/disabilities expected

[2]Water Boiling Test (WBT) available at http://cleancookstoves.org/technology-and-fuels/testing/protocols.html

from diseases attributable to exposure to $PM_{2.5}$. The averted deaths/disabilities due to the difference in $PM_{2.5}$ exposures before and after the implementation of the intervention are claimed as ADALYs. This involves a two-step approach as summarised in Figure 2 below.

FIGURE 2.0: Methodological Approach for Quantification of ADALYs



The HAPIT uses background disease data of the host country and calculate relative risks of five major disease at user input $PM_{2.5}$ exposure level. These diseases are:

- Stroke
- Ischemic heart disease (IHD)
- Chronic obstructive pulmonary disease (COPD)
- Lung cancer, and
- Acute lower respiratory infection (for children of age < 5yr)

Since deaths of children are not easily added to those for adults (because years of life lost will be more for children when compared to adults) and the non-lethal impacts vary by disease (i.e. disability period from COPD will be different from disability period from IHD), the methodology also produces results for Disability-Adjusted Life Years (DALYs)[3], which include both years of life lost due to early death and years of healthy life lost due to onset of disease.

To summarise,

[3] The DALY is a single metric that combines both mortality (years of life lost) and morbidity (years of life with disability). It is a common metric used by public health and development entities globally as a way of comparing the burden of disease due to various risk factors.

Disability-Adjusted Life Years (DALYs) = Years of life lost (YLL) + Years of life with disability (YLD)

Further discussion on the background and application of HAPIT is provided in Section 4 and Section 6 of this document respectively.

SECTION 3.0: ADALYS METHODOLOGY REQUIREMENTS

This section provides an overview of the project boundary and the pollutants that should be included for the assessment. It also provides information on the monitoring requirements of the methodology, which are discussed in detail in the subsequent sections.

3.1 Project boundary

The project boundary should be clearly defined with careful consideration of the physical, geographical site of the baseline evaluation and the project technologies. For the purpose of using the ADALYs methodology, the project boundary encompasses the households where the project intervention is introduced. This boundary could also host the baseline and project fuel collection and production (e.g. charcoal, plant oil) facilities associated with fuel processing and transportation.

It should be noted that only permanent members of a household should be included in the project boundary for calculating ADALYs.

3.2 Pollutants included in the methodology

The ADALYs methodology only considers $PM_{2.5}$ exposure and its impact on health within a household. While combustion of fuels used for cooking also results in other pollutants, their health impacts are not well understood. Additionally, $PM_{2.5}$ itself is a mixture of many components like black carbon, organic carbon, etc., but the health impact of these individual components is not currently evidenced. On the other hand, $PM_{2.5}$ has well-established exposure-response functions for multiple health outcomes.

3.3 Monitoring requirements

The ADALYs methodology requires identifying the representative baseline and project scenario, in addition to conducting studies for the individual scenario as summarised in the table below.

TABLE 1.0: Monitoring Studies

Scenario	Key monitoring requirements
Baseline Scenario	i. Identify the Baseline Scenario ii. Household Survey iii. Personal Exposure Monitoring
Project Scenario	i. Household Survey ii. Personal Exposure Monitoring iii. Technology usage monitoring (drop-off)

These studies are outlined briefly in the following section. Please refer to the ADALYs methodology for further details.

3.4 Baseline scenario

The baseline scenario assessment includes the following studies:

Identification of Baseline scenario:

A baseline scenario represents the typical pre-project fuel consumption pattern, $PM_{2.5}$ exposure levels, and baseline technology use in the population that is targeted to adopt the new project technology. The identification of the baseline situation is done through baseline surveys.

Baseline survey

The baseline survey is carried out with following objectives:

- Collect information on baseline cooking practices (e.g. whether households cook within the house or outside, the number and type of meals cooked)

- Collect information about the "target population" characteristics, baseline fuel consumption (type/mix of fuels consumed) and baseline technology use (for example, three stone fires, traditional stove without grate and chimney), seasonal variations in baseline technology use (some communities cook indoors during winter while other communities cook inside in the same season) and fuel use

The project developer shall typically group the target population into representative "baseline scenario(s)" based on fuel and technology use patterns and cooking setup.

The project developer may identify multiple baseline scenarios that are applicable in relation to the different project technologies, depending on local fuel and technology use patterns. For example, one baseline scenario may represent rural end-users predominantly using inefficient wood stoves, while the second baseline scenario may represent a target population in semi-urban areas predominantly using inefficient charcoal stoves.

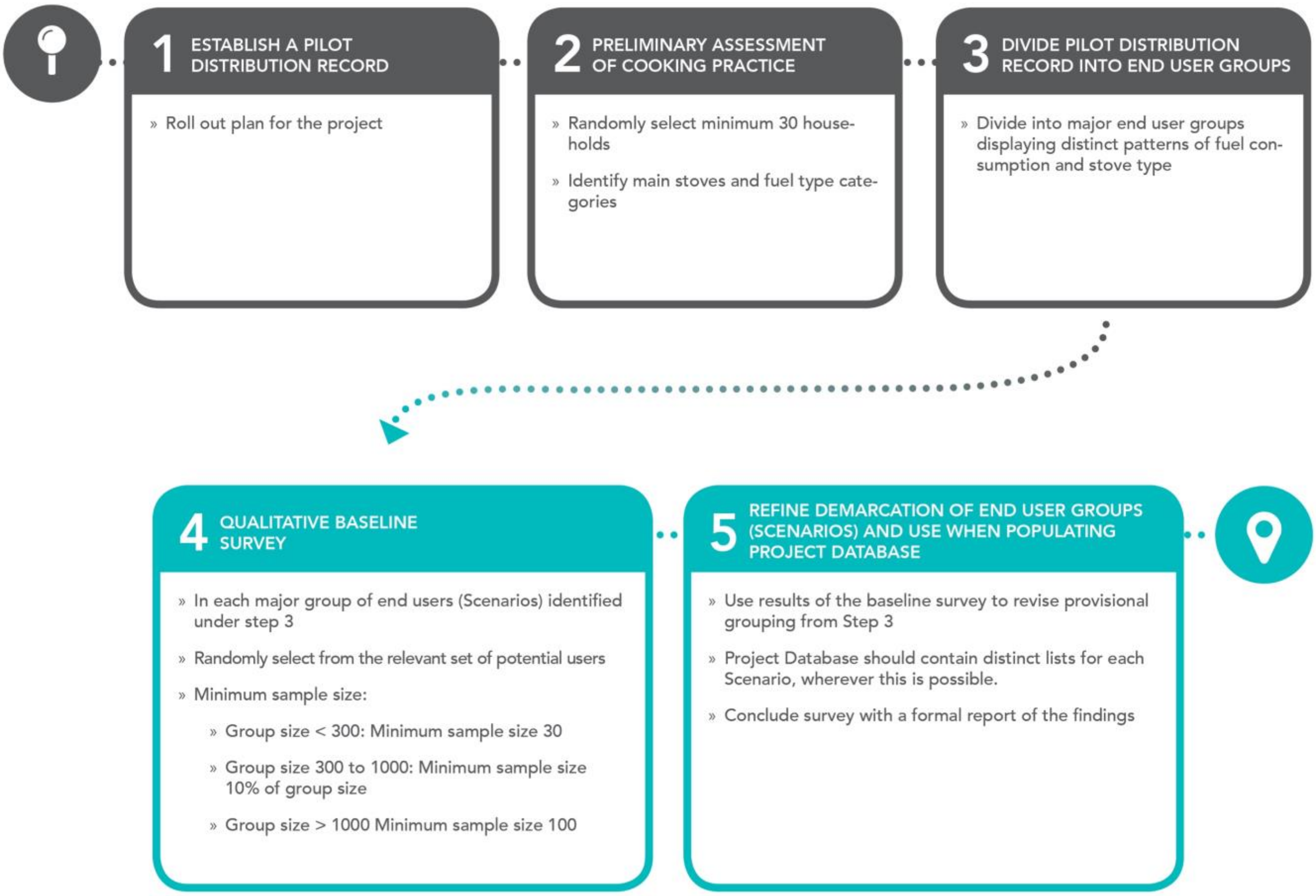
The stepwise approach for baseline survey is summarised in the Figure 3 and typical sample survey questionnaires are provided in Annex 9.

The baseline survey should be completed prior to distribution of the project technology and should be repeated at the time of crediting period renewal.

Personal Exposure Monitoring (PEM)

Project $PM_{2.5}$ exposure levels (µg/m3) are the primary input to HAPIT for quantifying ADALYs. Baseline personal exposure monitoring (PEM) of $PM_{2.5}$ establishes the baseline exposure before the project technology (for each Baseline Scenario). PEM is only required in a sample of households in the target population. Further details on PEM monitoring requirements are provided in section 4 of this manual.

FIGURE 3.0: Stepwise approach for baseline survey



3.5 Project scenario monitoring

A project scenario is defined by the $PM_{2.5}$ exposures and technology usage of end-users within the target population. The project studies include the following key monitoring requirements;

Project survey

The purpose of the project survey is to collect information on cooking patterns and $PM_{2.5}$ exposures in the project scenario, specifically this entails:

- Gathering information on year-to-year trends in end-user characteristics, such as technology use (e.g. has the household switched to other technologies?), types of fuel use, kitchen characteristics (e.g. the household has started cooking outside the house when previously they used to cook inside the house) and seasonal variations

- Identifying changes over time in a project scenario

The project monitoring should be carried out annually; the first study should be done no sooner than six months after new technology is disseminated in the households.

Project Personal Exposure Monitoring

Project $PM_{2.5}$ exposure levels (µg/m3) shall be monitored in sample households following the same guidelines as baseline PEM. Only households that are still using the project technology shall be included in the PEM sample to avoid averaging exposure levels with households not using the project technology and to match the population used to calculate ADALYs. Project PEM should be carried out at a minimum of every two years (for each project scenario). In summary, a minimum of 30 PEM measurements for each baseline and project scenario must be conducted. The set of measurements for each group must satisfy the 90/30 rule, which is described in more detail in Annex 6 (90/30 precision rule) of this document.

Annex 2 of the ADALYs Methodology (Household survey and PEM monitoring guidelines) outlines sample size requirements for PEM, baseline and project surveys and for usage monitoring.

After the baseline and project personal exposures have been determined, the next step is to enter the exposure values in to HAPIT, along with the other monitored parameters. This is discussed in sections 4 and 6 of this document.

Technology use monitoring (drop-off)

Usage monitoring is carried out to determine the fraction of users who have stopped using the project technology completely, i.e. the drop-off rate.

The minimum total sample size required for usage monitoring is 100 in each project group, with a minimum of 30 samples from each age group of the project technology. The usage monitoring can be done using surveys or continuous stove monitors (CSMs). If usage is monitored using CSMs, the duration of monitoring is 90 days. For further information on best practices of usage surveys, refer to Section 4 of this document and typical sample survey questionnaires are provided in Annex 9.

3.6 Additional monitoring requirements:

Baseline re-assessment:

For projects lasting longer than five years, the baseline scenario shall be reassessed every five years (i.e., a new round of baseline surveys and baseline personal exposure monitoring shall be conducted every five years).

Carbon monoxide (CO) monitoring for charcoal-based interventions:

CO levels above World Health Organization (WHO) air quality guidelines[4] could result in adverse health effects. For charcoal-based interventions only, room area monitoring of CO is required in all households undergoing $PM_{2.5}$ PEM. CO monitoring is required to run for 24 hours at a minimum in sample households.

3.7. Monitoring parameters and schedule

A summary of the monitoring parameters and corresponding study is presented below in Table 2. Details of the monitoring requirements for estimating ADALYs can be found in Section 2 of the ADALYS Methodology.

TABLE 2: Monitoring requirements for estimating ADALYs

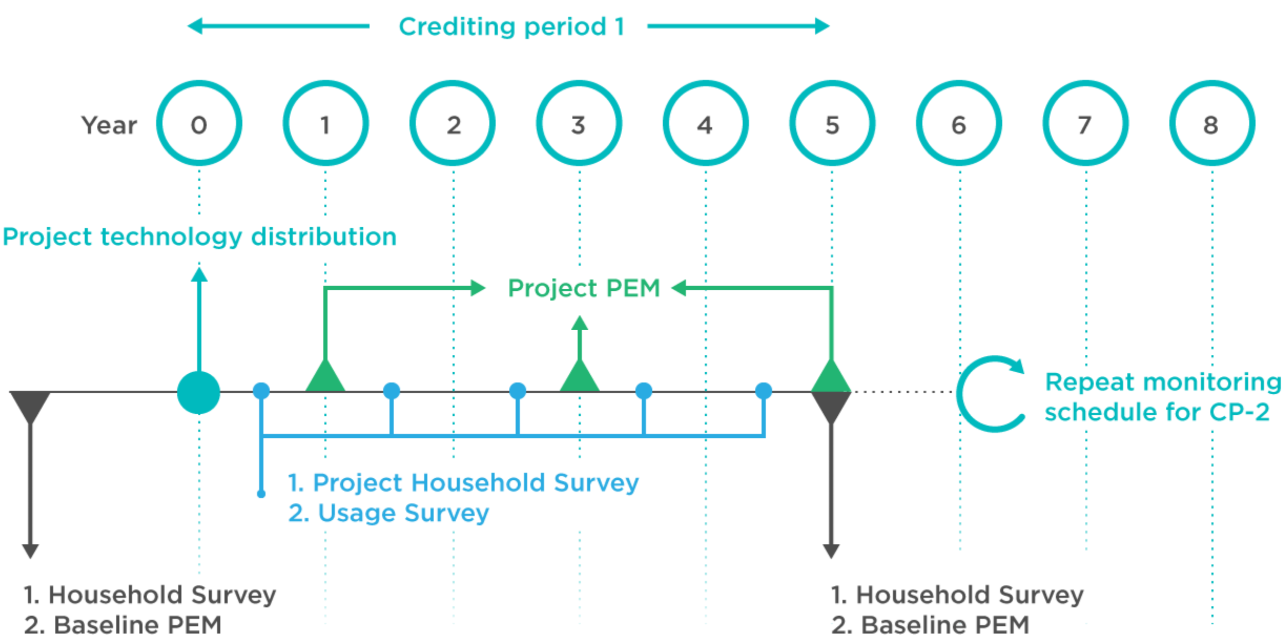
Parameter	Source

[4] World Health Organization (2014) Indoor Air Quality Guidelines: Household Fuel Combustion. WHO Guidelines for Indoor Air Quality. World Health Organization, Geneva, Switzerland. Available at: http://www.who.int/indoorair/guidelines/hhfc/en/, Accessed August 23, 2016.

• Personal exposure to $PM_{2.5}$ before and after the intervention (µg/m3)	Baseline PEM Project PEM
• Household size • Percentage of population using polluting fuel (%) • Number of adults per household and children (<5 yr.) • Baseline technology type and fuels being used • Primary cook details	Baseline household survey
• Household size • Number of adults per household and children (<5 yr.) • Types and extent of fuels used • Project stove use • Any changes within project boundary • Percentage of population using polluting fuel (%)	Project household survey
• Project technology usage rate (%)	Usage survey or Continuous Stove Monitors (CSMs)
• Number of targeted households	Project Database
• CO concentration (for charcoal-based interventions only)	CO monitoring

Figure 4 shows a schematic diagram of the typical monitoring schedule for different studies. Most importantly, follow-up project PEM measurements should not be done until the participant has had the project stove for at least six months. This allows for the end-user to adjust to the operation and use of the new technology.

FIGURE 4.0: Monitoring Schedule for ADALYs Methodology



SECTION 4.0: SAMPLING APPROACH AND PERSONAL EXPOSURE MONITORING

4.1. Sampling approach for PEM

4.1.1 Guidance

Comparison of study design options

Cross-sectional and before-and-after studies are two common study designs used for comparing impacts of different cookstoves and fuels. Descriptions of each type of study and the benefits and challenges of each approach are summarised below.

i. Cross-sectional study (independent/unpaired samples)

In a cross-sectional study, the samples for the baseline and project cookstove(s) are done in different homes, i.e., the baseline cookstove and project cookstove sample groups will be made up of different households. Measurements for cross-sectional studies are taken during the same time period, so they are not influenced by seasonal changes. Since the measurements are taken in different households, the measurement comparison is on a population level rather than an individual level, which introduces variability.

ii. Before-and-after study (paired samples)

In a before-and-after study, the samples for the baseline and project cookstoves are collected from the same households. Sampling occurs at two different time points: first with the baseline cookstove, and then after the introduction of the project cookstove. A minimum adjustment period of six months is mandatory between the project cookstove distribution and the follow-up "after" cookstove measurements, so the end-users of the project cookstove can become accustomed to their new technology. Since the monitoring periods are separated in time, seasonal changes that exist between the monitoring periods can influence the measurements and bring more variability in results. Changes such as fuel quality or moisture content, fuel and food availability, and participant schedules can have impacts on measurements.

Benefits and challenges of cross-sectional vs. before-and-after studies

The benefits and challenges of cross-sectional vs. before-and-after studies are presented in Table 3.

4.2. Personal exposure monitoring (PEM)

4.2.1 PEM Requirements

The ADALYs methodology presents two options for PEM measurements, (A) Gravimetric $PM_{2.5}$ measurement or (B) Optical $PM_{2.5}$ measurements (Gravimetrically-adjusted). These measurement approaches are discussed in detail below.

TABLE 3: Benefits and challenges of study design approaches

Cross - Sectional		Before and After	
Benefits	Challenges	Benefits	Challenges
• Requires least amount of planning	New cookstove users and baseline	Samples from new and baseline	• Greater burden on participants due to

• Can be conducted during a single field campaign without requiring a follow-up of study households at a later time	cookstove users must be carefully matched to ensure comparability	cookstove are directly comparable	multiple required visits • Possible changes between the before-and-after monitoring (i.e. seasons) can affect measurements

A. Gravimetric $PM_{2.5}$ Measurements

Gravimetric monitoring is considered the "gold standard" $PM_{2.5}$ measurement method, as it is more accurate than optical measurements. For gravimetric measurements, a pump draws air through a device (cyclone) that removes particles larger than 2.5 µm in diameter. The remaining particles smaller than 2.5µm are deposited onto a pre-weighed filter. The filter, which was weighed prior to deployment, is also weighed after sampling to calculate the integrated particle mass deposition (MD):

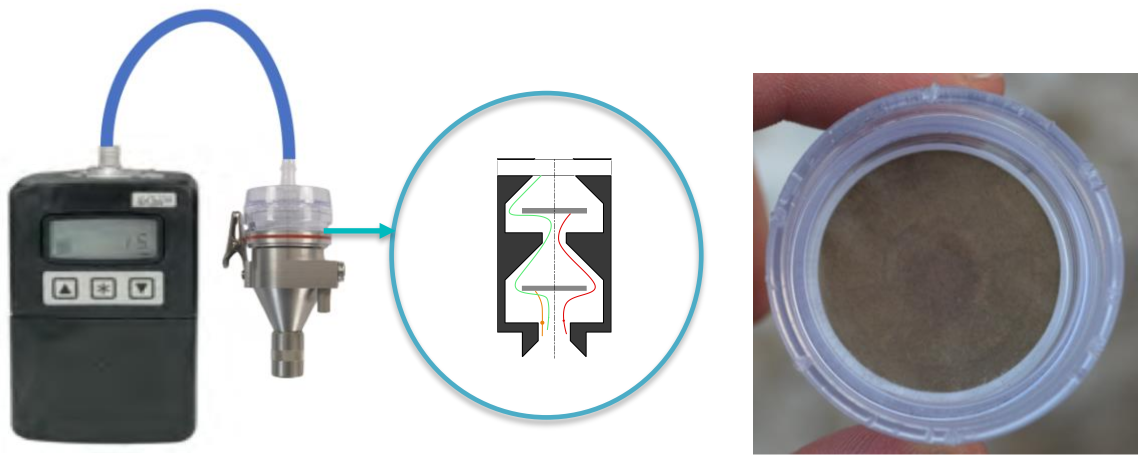
Mass Deposition = Filter post sampling weight – Filter pre-sampling weight

Particle mass deposition is then divided by the volume of air sampled to compute the average particle mass concentration in units of $\mu g/m^3$. Sample volume is determined using the flow rate in terms of liters per minute (LPM) and sample time in minutes. Gravimetric measurements require fairly expensive equipment, the use of a controlled laboratory, and often-times burdensome equipment worn by study participants. Filter contamination is also an issue that occurs during transport and handling and so "field blank filters" should be employed. All filter mass can then be corrected:

Field blank corrected MD = Filter MD – Average field blank MD

When collecting filter samples, one must also keep used filters cool. The expert should always use a cooler with ice packs when transporting filters. When storing the filters, they should be kept in a freezer.

FIGURE 5.0: Gravimetric Monitoring Equipment



Cyclone

Filter

B. Optical $PM_{2.5}$ Measurements

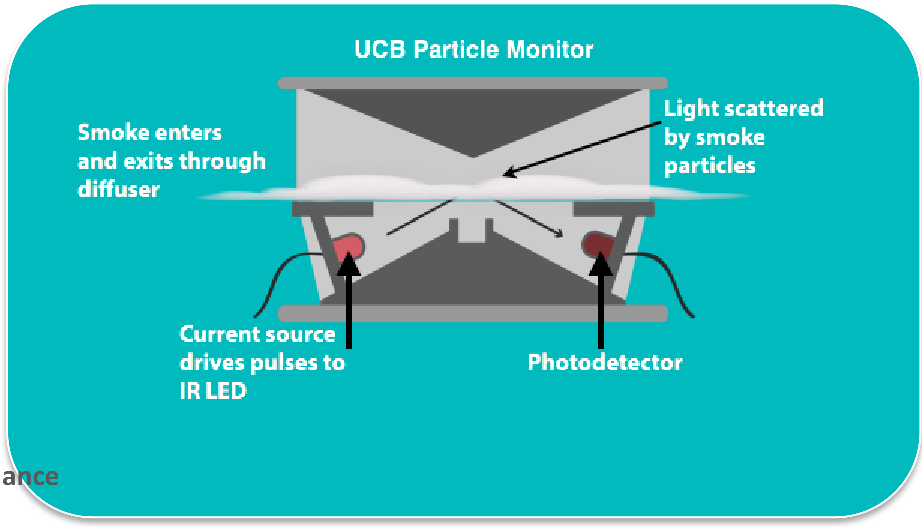
Light scattering PEM estimates particle mass concentrations based on the amount of light scattered by the particles in the sensor chamber and allows for near-continuous monitoring (minute-by-minute concentrations). Optical monitors usually report values for $PM_{2.5}$ that are biased either too high or too low as compared with gravimetric concentrations due to different optical properties of PM from variable sources. Where optical monitoring is used to measure exposures, an adjustment factor should be applied to the measurements to correct for bias and convert them to "gravimetrically equivalent" concentrations. When using optical measurements for PEM, at least ten 24-hour collocations shall be done with gravimetric PM methods during the first round of PEM measurements for a specific stove or fuel type. The optical and gravimetric PM measurements should show good agreement with an $R^2 \geq 0.75$ when fitting a simple linear regression to the two data sets. The slope of the linear regression relating gravimetric PM versus optically derived PM shall be used as the adjustment factor to scale optical measurements as follows:

Gravimetrically adjusted PM = average optical PM x slope gravimetric/optical$^+$

$^+$gravimetric/optical must have an $R^2 \geq 0.7$

Optical PM measurements can be used as part of pilot projects to determine the potential of the project technology to generate ADALYs before the project is scaled up. In such cases, the optical PM measurements can give the project developers a good indication of the potential ADALYs that can result from introduction of project technology.

FIGURE 6.0: Light Scattering device for $PM_{2.5}$ Measurement



4.2.2 Guidance

i. 48 hour versus 2 x 24 hour measurements

The ADALYs methodology allows both for 48 hour measurements or 2 x 24 hour measurements, collected consecutively and separated by only the time it takes to switch equipment, filters, or batteries. Whichever method is chosen should be used throughout all monitoring campaigns. The use of 48 versus 2 x 24 hour measurements is dependent on equipment ability, as not all pumps will run for 48 hours. Some equipment can be run on a "duty cycle", or intermittent on/off to preserve battery, which can aid in obtaining 48 hour measurements. Filter loading is likely not an issue with 48 hour measurements since PEM typically yields lower filter loading than indoor kitchen filter loading. In some cases, it is also recommended that a battery charging device is attached to the measurement equipment so it can operate for a longer period. The battery charging device could be plugged in when the primary cook is sleeping.

ii. Seasonal variability

It is recommended to conduct monitoring during the most representative season of the year. For example, if the country you are working in experiences ten rainy months and two dry months, it is recommended to monitor during the rainy months rather than the dry months. Follow-up measurements, especially for a before-and-after study design, should be done in the same season as the initial measurements to ensure comparability of results. If follow-up monitoring occurs in a different season, there is a risk that the results will be confounded by seasonal changes in cooking and fuel use behavior driven by factors such as food and fuel access, cooking location, availability due to crop harvest or migration, and seasonal heating. Although some of the confounding effects of seasonal behavior can be explored and controlled for, it is advisable to conduct the follow-up monitoring in the same season as the baseline monitoring. In geographical areas with extreme climatic seasons, possible constraints imposed by the weather should to be taken into account. For example, physical access to the study site might not be possible during the rainy season.

iii. Participant compliance and instruction

Participant compliance is one of the biggest challenges in PEM. Explaining expectations to the participants is critical for optimising compliance. The participants should be clearly told that they are expected to wear the exposure equipment at all times over the 48-hour monitoring period except during sleeping, bathing, and other activities during which the equipment may get wet. When engaging in any of these activities, participants can take the exposure equipment off, but should keep it as close to their bodies as possible without imposing any risk to the equipment getting wet. The participants should also be instructed to hang the equipment next to their bed when sleeping. You may want to install a nail for the participants to hang the equipment on, first getting permission to install the nail. Importantly, the participants should never take the equipment off while in the kitchen. The equipment should also not be hung in the kitchen when taken off, if the participant is not also in the kitchen.

Some equipment used for PEM is more invasive than others, however, there are two relatively new, integrated gravimetric systems that are lighter, quieter, and generally less intrusive than the traditional PEM pump and filter method. Examples of these instruments can be seen in Annex 2: PEM equipment for $PM_{2.5}$ that is currently commercially available.

Complaints about equipment include that it is too heavy, too loud, or the lights are too bright. Smaller equipment is almost always preferable over larger equipment for comfort reasons. If the device is too loud, it may be padded by sound insulating material. If the lights are too bright, opaque electrical tape is a good way to cover the lights to minimize distraction.

Specific equipment carrying holsters (or harnesses, vests, aprons, or other) should be engineered to work with your exposure equipment of choice. Gathering feedback from the participants is key to ensuring high compliance rates. The holsters should feel comfortable, be aesthetically pleasing, and easily taken off and put on. Including additional functionality, such as adding pockets or using a modified cooking apron as the holster, can be an attractive quality which increases compliance. Some examples of equipment and equipment holders are shown below in Figure 7.

Some devices come with accelerometers, which can be useful for assessing compliance. Typically, the data is only a binary moving/not moving measurement, however, it can be useful for extreme cases, such as seeing no movement for 10 or more hours.

FIGURE 7.0: Examples of equipment and equipment holders for PEM.

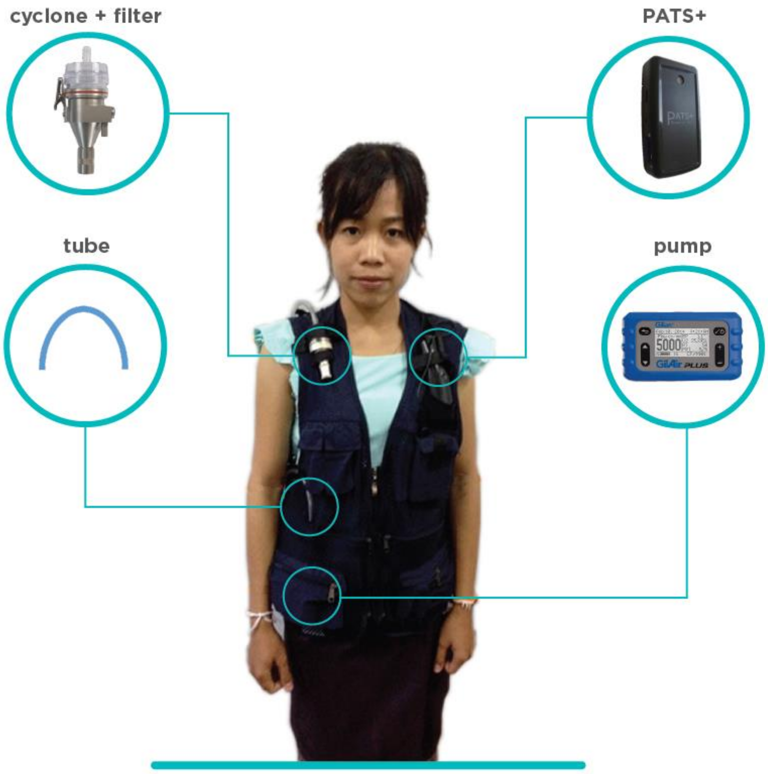
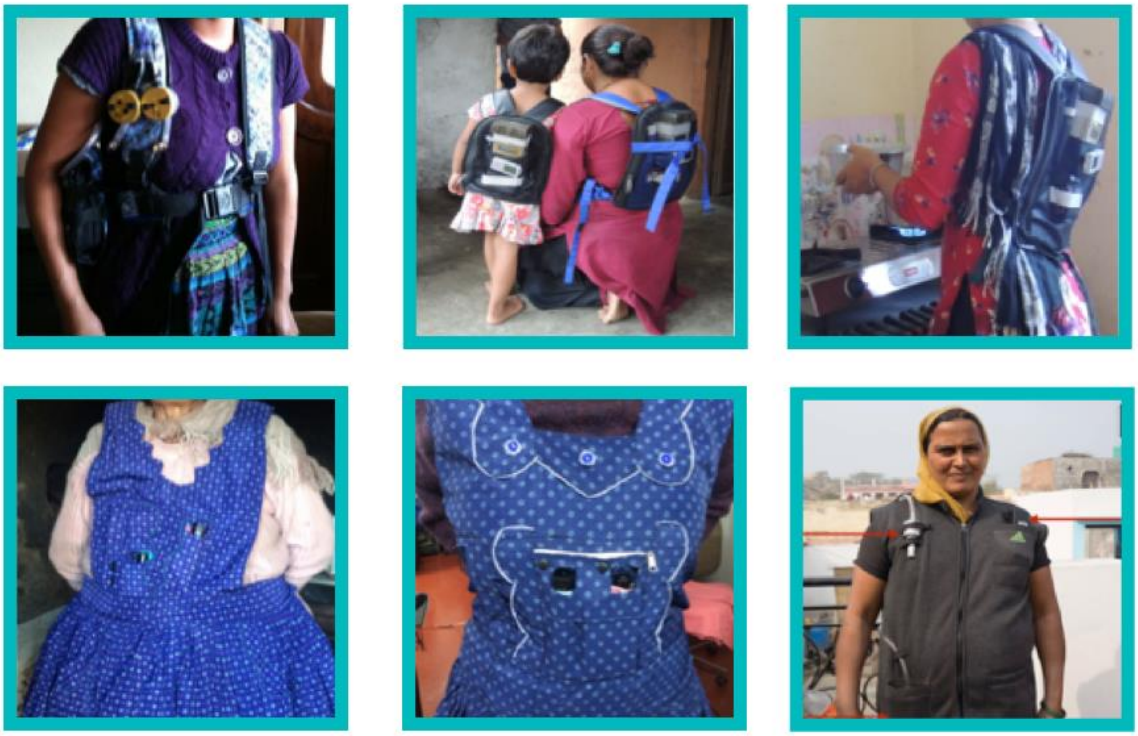


FIGURE 8.0: Examples of vests for PEM



iv. Incentivising participants for PEM

Often incentives or gifts for participation can increase compliance and participation, however, this is very culturally specific and not always recommended. It is important to understand what has worked and not worked in the past in the location you are working in to understand how to proceed. In some locations, incentives can be seen as bribes or perhaps create political unrest if some people from a community receive the gift and others do not. In other locations, it is perceived as disrespectful if no sign of gratitude is shown to the participants.

Regardless of your approach, it is important that the participants do not feel coerced into participating. Any gift should be seen as a token of appreciation, rather than compensation.

Gifts should always be given at the end of the study to avoid unexpected consequences that result from the gift giving; this is especially true of food, fuel, or stove related gifts, as it may change the normal cooking patterns of the participant. Some potential gifts may include giving the stove away for free or subsidised; cooking utensils; housewares such as soap, fan, or sponges; etc.

v. Impact of ventilation on PEM

PEM is influenced by many factors, one of which is kitchen ventilation. Kitchen location, room and wall material, presence of open doors and windows, and kitchen volume can all impact the ventilation and, thereby, the PEM of the participant. Sampling in homes with kitchens that are representative of those targeted to use the project stove is important.

When implementing a cross-sectional study, it is important to match the baseline or control participants to the project participants, including the kitchen types observed. During before-and-after studies, households may change their kitchen location after receiving a new stove for a variety of reasons. For example, lower emissions might enable them to move inside to cook; portable stoves could allow them to easily move to new locations to cook; while users may want to move valuable stoves inside for security reasons. These changes in cooking location in before-and-after studies are normal behavior patterns, and while they should not influence how you make your measurements, they are important to document to provide context for the PEM results.

4.2.3 Field Study Planning

Planning a field study can be very complicated and contains a lot of moving pieces. Drafting daily household visits for each of your field teams using a sampling frame such as that shown in Figure 9 can be a good method for organising a team and optimising efficiency. In the sample below we are using primarily optical measurements (OP), but we have a subset of gravimetric measurements (gravimetric). We are also using CSMs for usage monitoring in addition to surveys to assess cooking behavior. In this example, ambient measurements are also being made to understand the contribution of ambient PM to PEM.

FIGURE 9.0: Example of a sampling frame for a single team's daily visits for PEM and stove use monitoring

DAILY MONITORING

1 stove ADALY monitoring - cross-sectional	
HHs per week per team (week 1)	8
HHs per week per team (week 2)	8
field teams	4
Total weeks	4
total # of HHs	128

Team A Week 1	M	Tu	We	Th	Fr	Sa	
HH 1	I: Exp(grav,P+), HAP(P+), SUMs, P survey	check equipment, TA	pickup, TA, switch battery				
HH 2	I: Exp(grav,P+), HAP(P+), SUMs, P survey	check equipment, TA	pickup, TA, switch battery				
HH 3		Exp(grav), SUMs, P survey	check equipment, TA	pickup, TA, switch battery			
HH 4		Exp(grav), SUMs, P survey	check equipment, TA	pickup, TA, switch battery			
HH 5			Exp(grav), P survey	check equipment, TA	pickup, TA		
HH 6			Exp(grav), P survey	check equipment, TA	pickup, TA		
HH 7				Exp(grav), P survey	check equipment, TA	pickup, TA	TA = time activity
HH 8				Exp(grav), P survey	check equipment, TA	pickup, TA	P survey = participant survey
Central location	MiniVol-PM	MiniVol-PM	MiniVol-PM	MiniVol-PM	MiniVol-PM	pickup	

I: intensive HH

Note: we often plan for less HHs in week 1 than in the subsequent weeks, to allow for learning; but here we just plan for 8 HHs/week every week

TOTAL STUDY INSTRUMENTS/SAMPLES

	Grav systems (exp)	PATS+ (exp & HAP)	iButtons	exp filters	MiniVol filters	total filters
minimal	16	16	32	128	40	
total with blanks &						

In the above example, we would be able to monitor eight homes using one field team over six days. To reach our minimum sample size of 30 using this schedule, we would either need four field teams monitoring for one week, two field teams monitoring for two weeks, or one field team monitoring for four weeks.

The number of field teams is also driven by the number of available sets of equipment. In Figure 9.0 the equipment needs are shown for a single field team following the schedule outlined in Figure 9.0. The field team will need three gravimetric pumps and cyclones, six optical PM monitors, three optical PM external batteries, 20 CSMs, and one ambient monitor. If you increase your team from one to two field teams, this doubles the amount of equipment needed, and so on.

4.3. CO monitoring requirement for charcoal stoves

Under the ADALYs Methodology, carbon monoxide (CO) indoor pollution must be measured for projects that involve charcoal stoves due to the high levels of CO emissions typical of charcoal stoves, but rarely seen for wood stoves. The detailed requirements for monitoring CO during charcoal projects can be found in Section 5.5 of the ADALYs Methodology. Briefly, 24-hour samples of CO kitchen air pollution should be taken in all PEM households. If the 24-hour average CO concentration exceeds the WHO 24hr guideline (7 mg/m^3) in a fraction of monitored households, the same fraction of project households in the total project population will no longer be eligible for claiming ADALYs.

4.3.1 Guidance

Placement guidelines for HAP (CO)

For CO measurements in charcoal-using projects, CO sensors are placed in kitchens near the project stove. Find a spot to hang the CO sensor that is 1.0 meter from the edge of the main cooking stove, 1.5 meters above the floor, and at least 1.0 meter away from windows and doors. Mark placement with a labeled marker, which should be left in place for the duration of the study to ensure consistent placement during follow-up visits.

Installation considerations:

- If there is not a location 1.0 or more meters from doors and windows, place the sensor as far from doors and windows as possible and record the distance to the door/window
- Try to install instruments where they will not get wet from rain
- It is helpful to hang equipment on hooks or nails, but first ask participants if it is okay to put a nail in their wall
- You may use string, wire, zip ties, bags, etc. to hang instruments. Pilot these options at your study site before buying in bulk to ensure you have picked the most appropriate installation method
- CO instrument calibration protocol can be found in Annex 5.

4.4. Technology usage monitoring requirements

4.4.1 Overview

The objective of usage monitoring is to determine the fraction of users who have stopped using the project technology completely. Technology usage can be assessed by using either surveys or Continuous Stove Monitors (CSMs). Usage monitoring should begin no sooner than 6 months after receiving the technology to allow for adjustment time.

4.4.2 Guidance

This section provides the generic guidelines on usage monitoring, the project developer shall refer to ADALYs methodology for requirements. To obtain objective and reliable estimates of stove use you must:

- Define and understand stove use
- Decide on the measurement method
    - Survey-based measurements
    - Sensor-based measurements
- Understand seasonal influences
- Train and supervise field teams
- Ensure unbiased data collection using independent survey teams
- Prepare and pilot tools
- Implement verification checks

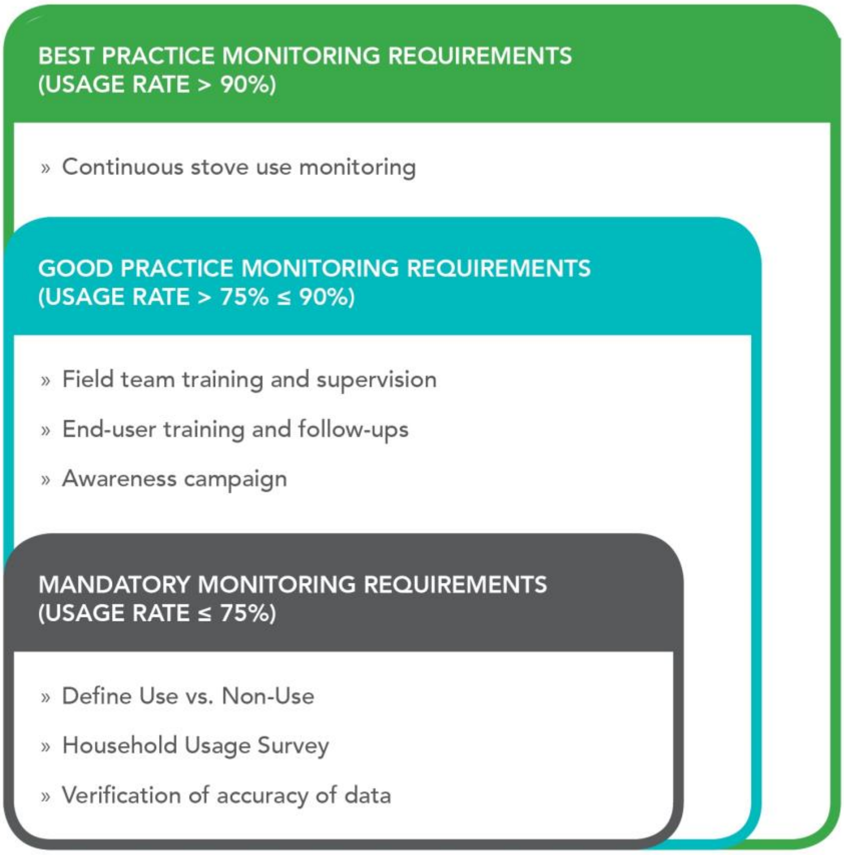
Defining and understanding stove use

ADALY methodology uses a binary measure of project stove usage, categorising project stove owners as user or non-user. This means use of the project stove for representative cooking results in a classification as a “user”, and others results in a “non-user” classification. This classification is used to determine the fraction of stove “users”, which is employed in HAPIT to determine total exposure reductions resulting from the full-scale stove dissemination program.

Technology Usage Monitoring requirements

The ADALYs methodology provides the detail requirements and guidance on usage monitoring. It includes three levels of usage rate monitoring requirements of increasing rigour that each have maximum usage rates that can be claimed by applying them; the *Level A. Mandatory requirement* must be followed by all projects. *The Level B. Good Practice* and *Level C. Best Practice levels* are optional and to apply a higher level of usage rate all the requirements from the levels beneath shall be followed. This is summarized in Figure 10 and described in more detail in the guidelines document available at
https://globalgoals.goldstandard.org/sdg_13/401-13-cookstove-usage-rate-guidelines

FIGURE 10.0: **Three levels of usage rate monitoring**



Deciding on measurement method

It is recommended that, at a minimum, each household is visited in person and a usage survey conducted that incorporates a 3D approach to determining stove use. This includes:

- Kitchen observations that include indicators of use (such as a hot stove) or non-use (such as cobwebs in the pot rests)
- Interview with main cook to understand user's recalled cooking behavior
- Photos of cooking areas, including evidence of use and/or non-use of baseline and project stoves

This 3D approach allows to limit the impact that reporting, recall, and observer bias can have on estimates of stove use. Because self-reported compliance is often exaggerated, we recommend that a representative sub-sample of selected households have CSMs placed on all stoves/fires in the household for a period of at least 1-2 weeks in conjunction with the usage survey. If relying solely on CSM data, the guideline in the ADALYs Methodology requires that usage monitoring shall be conducted in a minimum of 100 households for at least 90 days, with at least 30 samples for project technologies of each age being credited.

TABLE 4 shows some pros and cons of survey versus sensor-based usage monitoring. In most cases, a combination of the two will yield the most informative results.

TABLE 4: **Comparison of survey- and sensor-based usage monitoring**

Usage Surveys	Sensors - **Continuous Stove Monitors**

• Most studies use a survey in some form
• Versatile, adaptable, achievable
• Can be stand-alone or alongside other techniques and sampling event
• Types of questions
  ○ Questions with coded answers
  ○ Open- ended questions
  ○ A mixture of both above
• Administered via
  ○ Face to face interviews
  ○ Self-administered
  ○ Telephone surveys
• Administered to
  ○ Individuals
  ○ Groups
  ○ Relies on recall, which can be misleading
	• Objective measure and not reliant on recall
	• Allows scientifically robust testing of hypotheses
	• Sensors can be expensive
	• Sensor handling and data analysis can be technically complicated and require training

Guidelines for Continuous Stove Monitors (CSMs)

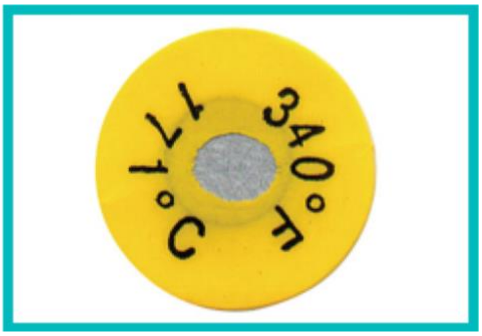
CSMs placement guidelines

- Do not obstruct or interrupt the cooking.
- Avoid the area where the cooking pots sit.
- Avoid the base of the stove if liquids are likely to collect there/ avoid areas where liquids are likely to boil over.
- If stove is moved around frequently, avoid the handle
- Locate the area of maximum temperature variation during stove use
- Avoid areas where the temperature exceeds the limits of the device [stove and sensor type dependent].
- Placement should be as consistent as possible within stove type so that temperature traces across stoves are similar
- Placement pilot highly recommended for all stove types.

Piloting CSM placement can be aided by using certain temperature sensitive materials. There are stickers, markers, and data logging thermocouples that can all be used for this purpose (Figure 11). These stickers and crayons irreversibly change color at specific temperature thresholds. These can help identify locations that are not suitable for CSMs if you can show that certain locations exceed the sensor's temperature threshold. Some piloting options are:

- Pilot placement in 2-3 homes which regularly use the stove for 2-3 days
- Draw across multiple, cool stove surfaces which would otherwise be good placement options for CSMs using an OMEGAMARKER®. Allow normal cooking to occur over 2-3 days. While the temperature of the stove surface is below the rated marker temperature, there will not be a visible mark, but as soon as the surface reaches the temperature on the marker, it will melt and make a visible mark on the surface. This is an indication that the surface has reached the rated temperature of the marker. The same can be done using temperature rated stickers (Figure 11).

FIGURE 11.0: Temperature sensitive sticker (left) and markers (right) for CSM placement piloting



- Another piloting option is to install a data logging thermocouple by installing the probe against the cool stove surfaces which would otherwise be good placement options for CSMs. Leave in place for 2-3 days and then download the data. An ideal placement would be a location where there are large, fast changes in temperature from cooking to not cooking and back again, without exceeding the CSMs upper temperature threshold.

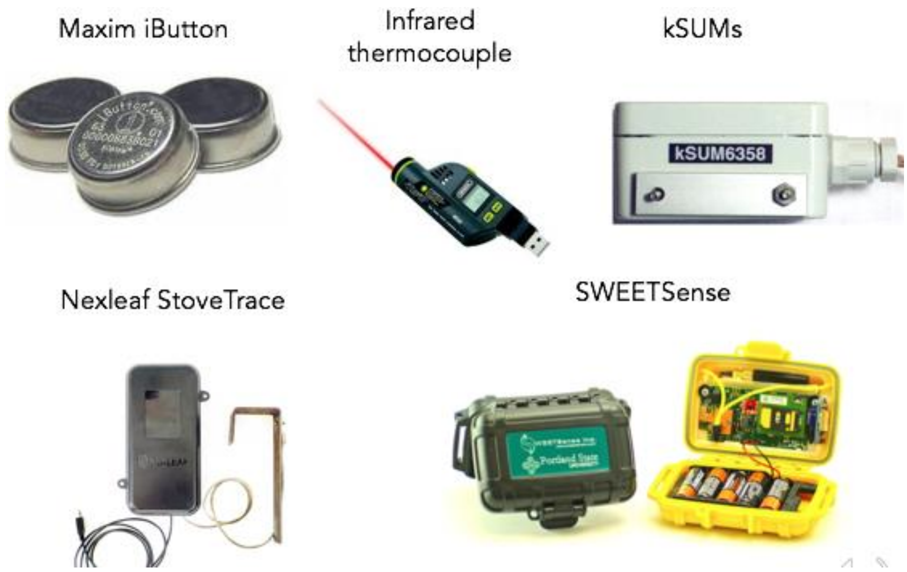
- The final piloting method for CSMs placement involves installing multiple CSMs used in the study on different locations on the study stove, allowing the stove to be used for several days, and comparatively assessing the resulting data. Piloting with CSMs can be risky due to the potential to break sensors if exceeding the CSM's threshold, which is common since little temperature profile data is known at the point of piloting. Difference CSM sensors have different temperature thresholds so if switching CSM type, you should always re-pilot placement.

Figure 12 below shows different type of CSM and placement that has worked during previous stove usage monitoring studies. The left photo shows an LPG stove and the right shows a charcoal stove and the bottom photo shows the different CSM available in the market.

Effective use of CSMs

It is recommended that during CSM monitoring, ambient temperature measurements are taken in 1-2 homes per study cluster to provide information on local ambient temperatures. These values can be used to subtract ambient temperature values from the stove CSM temperature data, providing a flat baseline and improving the ability to identify a cooking event. When placing ambient CSMs, place in the main kitchen area, out of direct sunlight and away from other heat sources.

FIGURE 12.0: **Placement of CSMs (iButtons in this figure) that work during usage studies and other CSM devices**



Insulation, such as a piece of wood or high temperature silicone, can be used to protect a CSM from exceeding its maximum rated temperature. As with placement, piloting of insulation should be carried out. You must be careful to not over-insulate. Putting an insulator on a spot on the stove that is relatively cool may impact the data quality.

When placing CSMs, it is suggested to take 2-3 photographs showing placement of the CSMs, making sure at least one picture clearly presents the writing on the CSM labels and another of the general placement of the button, with stove features for context.

Before you leave the house, you want to ensure the CSMs are placed on all stoves required by the study protocol, plus ambient, if required. Let the household members know where the CSMs are and ensure that they are not intrusive. Explain the purpose of the CSM and ensure them that they are not dangerous, not a bomb, or not a listening device (all real concerns!). Ask that they don't allow children to touch the CSMs, cook normally, and ignore the presence of the CSM, and set up an appointment for when you will return to download data.

Seasonal impacts on usage monitoring

Adaptations should be made to the assessment methods in areas where there are known, significant seasonal fluctuations in stove use. These fluctuations may be due to:

- fuel availability and quality,
- food availability,
- cooking location changes due to variable weather,
- heating requirements, and
- migration

Stove use surveys need to be able to capture any major changes in stove use that occur throughout the year as these seasonal variations can have a significant impact on personal exposure. One way to address seasonal changes would be to require stove use surveys to be conducted in each of the major seasons in the same randomly selected households every other year (i.e. year 1 in the dry season, year 2 in the wet season, year 3 in the dry season, etc.). It is important to have the most representative season(s) well captured during the usage monitoring.

4.5. Household surveys: Best practice guidelines

The following section presents best practice guidelines for carrying out the household survey. Sample survey questionnaires are available in Annex 9. In addition, a detailed overview of sampling methods, survey approaches with set of sample questions is provided in Annex 2 of the ADALYs methodology

a. The surveyors shall avoid loaded questions

Examples:

Do Ask: How many rooms does your house have?
Do Not Ask: Does your house have the same number of rooms as your neighbour's house?

Do Ask: Do you collect firewood to use for your stove?
Do Not Ask: You collect firewood from the forest, don't you?

Do Ask: Are there any features of the stove that you like?
Do Not Ask: What do you like about the improved stove?

Such 'loaded' or 'leading' questions encourage inaccurate answers. Also, due to social biases, respondents often prefer to express what they think you want to hear. Surveyors should be impartial and ensure the integrity of their open-ended questions are not translated into loaded questions. Also, surveyors must avoid using loaded terms like "improved" or "clean cookstove".

b. Use simple language

Surveyors should ask simple questions that are easy to understand. The surveyors should consider the following when asking questions:

Are the questions well understood?

- Too complex, too simple, or ambiguous?
- Avoid using technical stove terms or names, e.g., "Wheezing"

Ask questions that are relevant to the study objective.

- Avoid asking additional questions 'just in case'.

Use simple analogies and comparisons

- e.g. "Are burns smaller or larger than a coin?"

Consider using pictures when appropriate:

- e.g. "Which picture is the same as your stove model?"

Clear and consistent definitions for key concepts.

- e.g. households, rooms, employment, primary stove

c. Adjust for cultural variability:

When drafting the questions, the surveyors should consider the local cultural practice and adjust the questionnaire accordingly. For example:

- Local language and terminology:
  - Specific words for stove types and fuel types
  - Translating, back-translating, testing.
- Climatic and geographic conditions – need for heating.
- Cultural taboos - alcohol brewing if illegal
- Cultural practices - temescale (sauna) use in Guatemala.
- Locally specific cooking devices and practices - beer-brewing in Nepal.

d. Piloting

Survey Piloting is an important step to understand the local cooking pattern and adapt the questions accordingly. During piloting the surveyor should check if

- Do the response categories capture all options?
  - e.g. plastic used as fuel in South African slums.
- Are there any cultural sensitivities in relation to specific questions?
  - e.g. asking about stigmatised health symptoms or income
  - consider asking sensitive questions at the end of survey
- Are the questions interpreted in the same way by different respondents?
- Do they measure what they are supposed to measure? (validity)
- Are the questions answered in the same way if repeated with the same respondent? (reproducibility)

4.6. Challenges and Recommendations for Field Studies

All phases of the field study must be completed to implement a successful project. This section will discuss the challenges with each phase and make recommendations for overcoming them.

Preparation
Translation & interpretation
Workshop & training Sessions

In-field
Training field visits
Organising the study

Protocols & Procedures
Standard Operating Procedures
Equipment considerations

4.6.1 Preparation

Translation & interpretation

- To train local teams and overcome language barriers with participants, translation and interpretation services for training materials and presentations must be used.
- All training materials must be translated prior to training sessions.
- All workshops and training sessions should be conducted in the local language or have an interpreter present.
- Scheduling should be flexible to accommodate for the additional time needed for translation and interpretation services – which may double the usual time needed.
- Translators should be given enough time to familiarise themselves with the materials – especially for complex and technical content.
- During training field visits, teams should be accompanied by at least one native speaker to act as a translator and interpreter.
- Simultaneous interpretation is very effective in facilitating group discussion and Q&As.

Workshop & training session size and attendance

- Workshops and training sessions with high rates of attendance are good for building knowledge, but difficult to coordinate.
- Teams should be limited to 10-20 people during field training sessions. Follow-up sessions with smaller teams (2-3 people) should be organised.
- Ensure that at least one person is designated as a field supervisor or team leader, and is involved in all field projects. Ideally, the field supervisor should also organise and run the field study programme.
- Workshops and trainings should be scheduled to ensure that the programme manager is able to attend all sessions, otherwise the sessions should be filmed and shared later.
- Planning and scheduling should be sensitive to local customs and culture, e.g., typical business/work days/hours, religious observances and holidays, dietary restrictions for group lunches, etc.
- To accommodate for delays and interruptions, workshops and trainings occurring on the weekend may be proposed.

- Workshop and training materials should be condensed and conveyed in a simple and concise manner. Highly technical and complex content should be simplified and distributed evenly throughout the schedule to avoid overwhelming trainees.

4.6.2 In-Field

Scheduling Training Field Visits

- A schedule should be created and adhered to, whenever possible, that outlines the arrangements for household visits and data collection. The schedule should be clearly communicated to all participants.

- Trainees should understand that the training field visits are a 'trial run'. They should explain to participants that all forms – including consent forms and questionnaires – are for training purposes only.

- Teams visiting households should not exceed 5 people.

- It is preferable to schedule homes with large kitchens, whose occupants are friendly and can confirm their availability for training visits.

- Always notify the household occupants a day and immediately before arriving to remind them of the time, purpose, number of people expected, and length of time of the visit.
- Prior to field visits, the field supervisor should work with team members to create a mock consent form to prepare them, rather than relying on a generic form during training visits.

- To prevent households from withdrawing from the training, the occupants should be informed of the details of their commitment and may be given a small token of appreciation.

- If the scheduled households are spread across a wide geographic area, the field supervisor may use electronic surveys (e.g., ODK or REDcap) to collect the sample forms remotely. Otherwise, households may photograph and email their surveys to the supervisor to reduce travel time and costs.

Organising the study

- Miscommunication leads to the selection of households that are not appropriate for the study, undermining study design requirements.
    - The "Participant Selection" form should clearly state the selection and exclusion criteria for the study group. The survey team should be appropriately trained.
    - Direct communication should be made with the group in charge of organising the workshop, training and field study to minimise communication errors and allow the organisation to ask questions early-on in the planning process.
    - A remote "pre-trip check-in" by email or phone should be made, requesting a brief outline of the local organisation's work plan to make necessary corrections and ensure expectations are met.

- Some intervention stoves have specific installation requirements. It is important that the proper installation and ventilation of the cookstove be explained in the consent and selection process as a requirement of participation.

- Continuous communication with the survey team in the field can be difficult, especially remotely. A communication plan should be made before the team goes into the field that contains contact information and procedures.

- Urban or peri-urban locations are generally more complicated for study implementation because there are more variables associated with transportation, participant schedules/occupations, diversity in participant pools, and safety considerations. Field teams should be aware and prepared for these challenges.

- To ensure field teams and local partners are prepared to carry out field tests, it is recommended to prepare a list of questions within preliminary documents, covering transportation logistics, surveyor capacity, participant selection, etc. These questions can be used to check for understanding among team members and identify if any parts of the process require further explanation or training.
- In some locations, inhabitants may be resistant to non-locals. It is valuable to identify and partner with organisations and people who have a relationship with the local community.

4.6.3 Protocols and procedures

Standard Operating Procedures

- To prepare for unexpected situations, establishing standard operating procedures (SOPs) and documenting them in the local language of the teams conducting field visits is paramount.

- Team members should be encouraged to observe one another to minimise variations in protocols and processes.

- In the event of failed samples (e.g., due to monitor failure occurring before the 48h survey period), protocols should be establishing so that survey teams can deal with these issues and avoid losing useful data.

Equipment Considerations

- Heat and high humidity pose a challenge for calibrating and using survey equipment. To avoid equipment problems, it is best to consult the manufacturers for best practices in poor conditions. For example, humidity may be corrected if a flow calibration device with humidity-sensitivity is used, or a bubble meter may be used instead.

- Applying stove monitoring equipment on traditional stoves may be challenging. Field teams should be trained and prepared for this.

- Equipment failure or loss, or an unforeseen increase in sample size should be anticipated for by bringing extra equipment or establishing equipment sharing protocols among teams.

SECTION 5.0: KEY RECOMMENDATIONS

The aim of this section is to make suggestions on criteria that will aid project developers and practitioners in making informed decision on clean cooking interventions to achieve their intended impacts. This section provides a set of high-level criteria and associated indicators to shortlist the potential countries where implementation of clean cooking interventions would generate the greatest impact. The document also offers criteria to be considered when selecting project technologies, as well as guidance on the operational aspects involved in certifying health benefits using the ADALYs methodology.

This section considers the steps needed to implement the ADALYs methodology, starting with identifying potential locations, assessing the enabling environment in those countries hosting potential locations, moving on to selecting project technologies suitable for project implementation and operation to group the set of criteria and indicators. This is the suggested flow; however, the project developer may follow a different sequence that is sensitive to the status of decision-making process. To help project developers apply the selection criteria, an Excel database on key indicators used for these criteria is prepared and available at < https://www.goldstandard.org/blog-item/adalys-technical-reference-manual> . However, it is recommended this database only be used as a guide; project developers and practitioners must carry out their own due-diligence prior to decision making.

Guidance on selection criteria:

The stepwise approach to apply the selection criteria is discussed in detail below:

5.1. Shortlisting the potential locations

Project developers should identify a shortlist of potential countries where implementation of the clean cooking intervention will have the greatest potential to generate significant health impacts. This can be achieved with a set of indicators that provide available information on status development of cooking practice and its health impacts.

Regions/sub-regions:

If the project developer has any preference for region/sub-region due to the strategic mandate of the organisation or any other reason, the developer should select the region and sub-region, before shortlisting the countries accordingly.

Development status:

The project developer should consider shortlisting the countries based on indicators such as "developed" and "developing" countries which identify the level of development in the country. Priority should be given to countries with high impact potential. For example, the lack of access to clean cooking fuel is a bigger problem for developing countries and poor people in middle income countries. Approximately 85% of people without access to clean fuels and technologies for cooking live in just 20 high-impact countries[5], mostly including developing low-income and middle-income countries in Asia and Africa region.

Access to cooking fuel:

Subsequently, a set of indicators that provide information on existing cooking practice and access to clean cooking fuel should be applied. The suggested indicators for this purpose are listed below in the Table 5.

TABLE 5: Indicators for assessing the access to cooking fuel

[1] The top 20 high impact counties that lack access to clean fuels and technologies are India, China, Bangladesh, Indonesia, Nigeria, Pakistan, Ethiopia, Congo DR, Vietnam, Philippines, Myanmar, Tanzania, Sudan, Kenya, Uganda, Afghanistan, Nepal, Mozambique, Korea DR, Ghana. Adair-Rohani, Heather; Banerjee, Sudeshna Ghosh; Bonjour, Sophie; Portale, Elisa. 2014. *Tracking access to nonsolid fuel for cooking*. Live wire knowledge note series; no. 2014/8. Washington, DC ; World Bank Group. http://documents.worldbank.org/curated/en/867331468331258971/Tracking-access-to-nonsolid-fuel-for-cooking

	Indicator	Source of information
i.	Access to non-solid fuels (%)	SDG Index[6]
ii.	Population using solid fuels for cooking (%)	

Health impact of household air pollution:
The indicators used to assess the health impact of household air pollution are listed below in Table 6. These indicators provide information on the population exposed to household air pollution and severity of health impact in a country.

TABLE 6: Indicators for assessing the health impact of Household air pollution

	Indicator	Source of information
i.	Number of people affected by household air pollution	Global Alliance for Clean Cookstove[7]
ii.	Number of household affected by household air pollution	Global Alliance for Clean Cookstove[8]
iii.	Household air pollution attributable deaths	WHO, 2015[9]
iv.	Household air pollution attributable DALYs	Global Alliance for Clean Cookstove
v.	Prevailing death rate from household and ambient pollution (per 100,000)	SDG Index[10]

The indicators on access to cooking fuel and health impact of household air pollution provide information on different aspects of household air pollution and can be used individually and/or collectively to assess the potential scale of clean cooking initiatives. For instance, percent of population using solid fuels for cooking and number of households affected due to household air pollution indicates the potential target population in a country. For example, around 67% of overall Indian households rely primarily on solid fuel for cooking; in rural areas, this figure is much higher at ~85%. Indeed, the overall clean cookstove market size in India is ~235 million households, more than the total market sizes of many other developing countries combined.[11]

Information on these indicators is readily available and frequently updated by international organisation such as World Bank, World Health Organization (WHO), UN Statistics, International Energy Agency's (IEA), Global Alliance for Clean Cookstove (GACC), and SE4All. Also, a few of these indicators such as *Access to non-solid fuels (%) and Prevailing death rate from household and ambient pollution (per 100,000)* are part of the SDG indicators. The project developer should refer to the latest information on these indicators to shortlist the potential countries.

Subnational indicators:
After shortlisting the potential countries, the project developer should also consider assessing the subnational situation of these indicators in the target country. For example, there are significant differences in energy use patterns among the different regions, and between urban and rural areas around the world. According to recent analysis, over 20% of urban households surveyed worldwide rely primarily on polluting fuels and technologies, while the ratio is reversed in rural areas, where around 80% rely on polluting fuels and technologies (WHO, 2015).

These statistics can aid the project developer in identifying a list of potential target countries and their respective target areas. These indicators can inform a broad assessment of the baseline situation and potential opportunities at the national or subnational level, enabling the project design to achieve the

[6] http://www.sdgindex.org/
[7] http://cleancookstoves.org/country-profiles/all.html
[8] http://cleancookstoves.org/country-profiles/all.html
[9] http://www.who.int/indoorair/publications/burning-opportunities/en/
[10] http://www.sdgindex.org/
[11] http://cleancookstoves.org/resources_files/india-cookstove-and-fuels-market-assessment.pdf

greatest health impacts by taking into considerations rural vs. urban interventions and other important factors.

5.2. Enabling environment

The ADALYs methodology is relatively complex and can be expensive to implement due to high costs involved in monitoring changes to $PM_{2.5}$ exposure among end-users of clean cooking activities. Therefore, it is essential to assess the enabling environment in the shortlisted countries. There are several indicators, including but not limited to the following, which provide pertinent information regarding the level of expertise and infrastructure available for implementing cookstove interventions in a target country.

Access to carbon finance:
In the past decade, clean cooking interventions have drawn from a wide range of public and private sources of finance using both compliance and voluntary carbon offset schemes. Like the ADALYs methodology, a carbon offset project:

- relies on a result-based financing approach where issued carbon credits (tCO_2) are considered as a proof of outcome and delivery for payments, and
- follows similar project development requirements for clean cooking intervention.

Although the sale of carbon offsets provides a valuable revenue stream, clean cooking projects seeking to access carbon finance face barriers due to complex certification processes. Successfully implemented projects using carbon finance serve as a good indicator by providing information on the level of expertise and infrastructure available in the target country or region, for example, the availability of consultants, experts, auditors, as well as the level of awareness for designing and implementing similar interventions in a target country. Although there are individuals and organisations that provide services globally, their services may be more expensive. Therefore, the project developer should assess the available expertise in the target country or region. The developer may refer to publically available sources; for example, Global Alliance Carbon Finance Platform for Clean Cooking[12], which hosts relevant information on carbon finance based projects and relevant stakeholders.

Monitoring expertise:
ADALYs methodology requires personal exposure measurements (PEM) that are complex and not widely applied in the field yet which makes it relatively expensive at present. This reference manual also includes information on methodology requirements, non-exhaustive of organisation with PEM expertise and monitoring equipment. The developer should assess if the required expertise is available in the target country or the reason and plan accordingly.

Enabling policies and framework:
In several countries, the existing programme and policies provide a supportive policy framework for advancing clean cooking agenda. Existence of such policy and programme indicates likely availability of infrastructure to support for implementation of clean cooking intervention. The developer should review relevant information to access existing policy and related initiatives in target country to gauge the current situation.

Several countries have announced their commitment to focus on clean cooking initiatives. In this regard, the developer may refer to the initiatives such as GACC, SE4All, country's action plan for clean cookstove, national commitments for example; Intended Nationally Determined Contributions, Nationally Appropriate Mitigation Actions.

5.3. Project design

The project developer should consider the following criteria for designing a clean cooking intervention:

[12] http://carbonfinanceforcookstoves.org/

Technology selection:
The developer should consider several aspects while selecting the project technology. The new technology chosen for dissemination should meet the needs of the target population *and* should have low pollutant emissions.

The criteria such as performance of the technology, durability, fuel availability, user preferences and needs, cultural beliefs, user economic status and willingness to pay, etc. should critically assessed prior to start of the implementation. These factors play significant role in ensuring successful adoption of the project technology. Low adoption of the project technology leads to insignificant changes in exposure levels as compared to baseline situation and may not result in desired outcome.

There are publically available sources which provides global database of cookstove, features, performance data including efficiency, emissions and safety based on laboratory and filed testing. For example, Clean Cookstove Catalogue[13] from Global Alliance for clean cookstove. Along with other criteria, the developer should assess the usage, and technology survival and durability for the planned project technology in the target population prior to undertaking the project. The user should also consider carrying out a pre-feasibility assessment with new technology to collect the user feedback and gauge the likely adoption of project technology.

Operational issues:
It is now widely recognised fact that existing fuel use and/or stove 'stacking' – the continued use of the old fuel and stove as the new one is adopted, is a common phenomenon among cookstove user. The number of ADALYs that can be awarded to a project depend on both the new technology substantially displacing baseline stove use and on the degree to which the new technology reduces PM2.5 emissions. Even if the project technology is very clean, if it does not substantially displace use of the baseline technology, the project may only be awarded a small number of ADALYs. Project developers should, therefore, only proceed to project implementation and monitoring after usage, stacking, and survival of the project technology is found acceptable.

As a general rule, the project technology may be considered acceptable if it displaces at least 80% of the baseline technology use and if less than 10% of households experience technology failure over the period monitored. The developer should device mechanism to discourage the use of old stoves, for example awareness programme to help understand the user benefit of new technology.

[13] http://catalog.cleancookstoves.org/pages/about

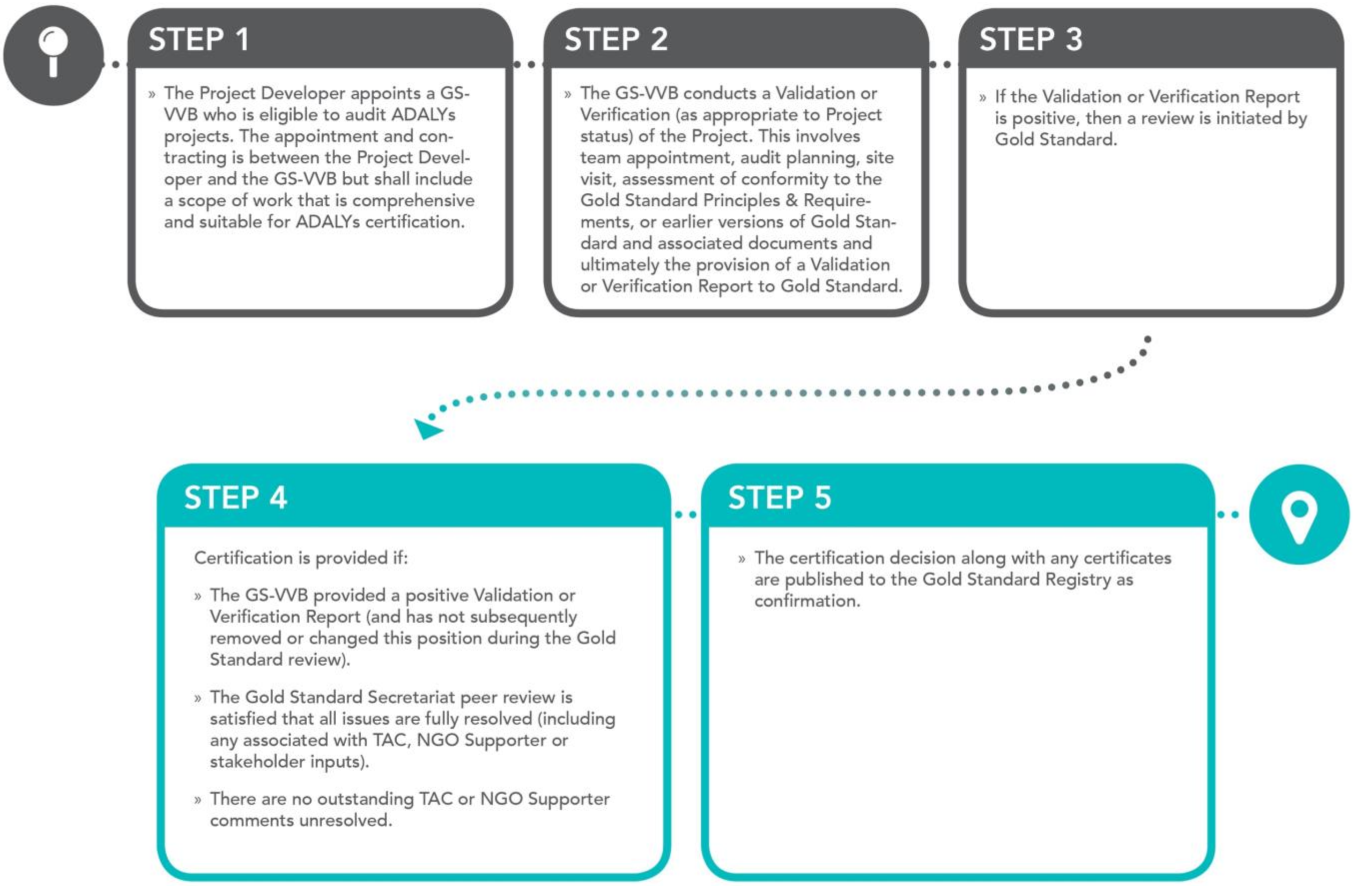
SECTION 6.0: REQUIREMENTS FOR AUDITING PROJECTS USING ADALYS METHODOLOGY

Eligible auditors

Auditors who have gone through GS4GG training, ADALYs methodology training, and who have the following accreditation are eligible to audit projects applying this methodology:

- ISO 14065 for Greenhouse gas activities accreditation offered under the ANSI-GS accreditation Program
- UNFCCC Accreditation (DOE or AIE status)
- ASI-FSC certification body status

The following steps describe the process of auditing a project applying the ADALYs methodology:



Key issues and best practices

The following key issues and best practices should be kept in mind while auditing projects applying the ADALYs methodology:

- To assess the results obtained from the HAPIT, auditors should independently use the HAPIT, entering the input parameters claimed by the project developers as a result of their monitoring. The generated report should be used to compare the report results with the results reported by project developers in the monitoring report.

- Telephonic interviews are not recommended as they are limiting in nature and may not provide the complete picture of the household's kitchen practices and reduction in PM2.5 exposures in the post-intervention scenario

- Auditors should randomly pick sample households to eliminate bias. Simple tools like Microsoft Excel can be used to randomly select samples. Typical sample sizes for auditing can be determined using the CDM Guidelines for sampling and survey for CDM project activities and Programme of Activities[14].

- Auditors should plan site-visits to ensure that there is no possibility of gaming.

- It is recommended that the exact households to be audited are informed on the day of the audit only

- Oversampling should be done to account for non-availability of the primary cook, etc.

[14] https://cdm.unfccc.int/Reference/Guidclarif/index.html

ANNEX 1: THE HOUSEHOLD AIR POLLUTION INTERVENTION TOOL (HAPIT)

Introduction

HAPIT, the Household Air Pollution Intervention Tool is a general-purpose tool used to estimate health changes due to interventions designed to lower exposure to household air pollution (HAP) of household members currently using polluting fuels (wood, dung, coal, charcoal, kerosene, and others). These interventions could be due to cleaner burning stoves, cleaner fuels, providing chimneys or other ventilation changes, movement of the traditional hearth to a different location, programs that motivate changes in behavior, or a combination of the above. HAPIT does not currently estimate changes in health due to changes in community or regional changes in air pollution from household interventions that would not be captured by normal household exposure measurements.

HAPIT relies (1) on country level data and (2) on the methods and databases developed as part of the Comparative Risk Assessment (CRA), a component of the Global Burden of Disease (GBD 2013) effort at the Institute for Health Metrics and Evaluation (IHME). It includes exposure-response information for each of the major disease categories – Acute Lower Respiratory Infection, Chronic Obstructive Pulmonary Disease, Ischemic Heart Disease, Stroke, and Lung Cancer – attributable to particle air pollution exposures, including those from HAP. It also includes background health, demographic, energy, and economic conditions from IHME[15].

HAPIT estimates averted deaths and disability adjusted life years (DALYs) from user-specified baseline and project $PM_{2.5}$ exposures using epidemiologically-derived integrated exposure-response functions. The specific methods underlying HAPIT are detailed in the full ADALY methodology, available online and in a prior publication about HAPIT[16]. HAPIT estimates the disease burden attributable to the change in exposure before and after a project is implemented. The pre-intervention burden of disease is subtracted from the post-intervention burden to estimate the burden averted by the project.

Outputs include avoided deaths and DALYs attributable to proposed interventions by disease category. The DALY[17], a commonly-used health metric, combines mortality and morbidity (non-fatal disease implications) into a single, consistent metric, allowing comparisons between and across interventions, diseases, and risk factors.
Meaningful use of HAPIT requires field work at the intervention dissemination site to demonstrate pollution exposures before and after the intervention in a representative sample of households. As each country's health and HAP situation is different, HAPIT currently contains the background data necessary to conduct analysis in 104 countries, 31 provinces of China, and 29 states of Mexico.

Using HAPIT

HAPIT is used to convert monitored $PM_{2.5}$ exposures to ADALYs; when running HAPIT in the context of the methodology, certain parameters must be fixed at default values. A discussion of these parameters – including annotated screenshots – follows. HAPIT is currently available at https://householdenergy.shinyapps.io/hapit3/. HAPIT uses consistent color schemes throughout its implementation to indicate areas where user inputs are required (red) and areas with background information and/or non-changeable parameters (blue).

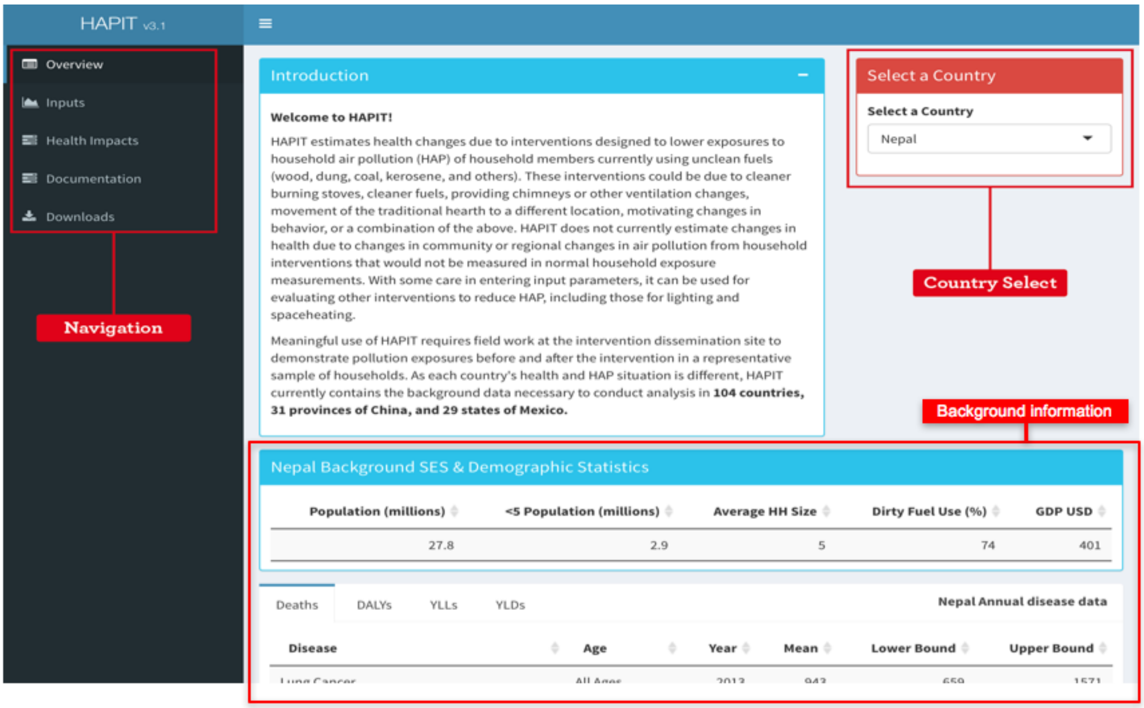
HAPIT's homepage contains a navigation panel (highlighted below), an introduction, and background information on the selected country (changeable via the "Select a Country" dropdown menu). Users can

[15] As of early August 2017, HAPIT relies on the 2013 integrated exposure-response curves and 2013 background disease data.

[16] Pillarisetti, A., S. Mehta, K. Smith. (2016). HAPIT, the Household Air Pollution Intervention Tool, to Evaluate the Health Benefits and Cost-Effectiveness of Clean Cooking Interventions. In E. Thomas (Ed), Broken Pumps and Promises: Incentivizing Impact in Environmental Health (pp. 147-169). Switzerland: Springer International Publishing.

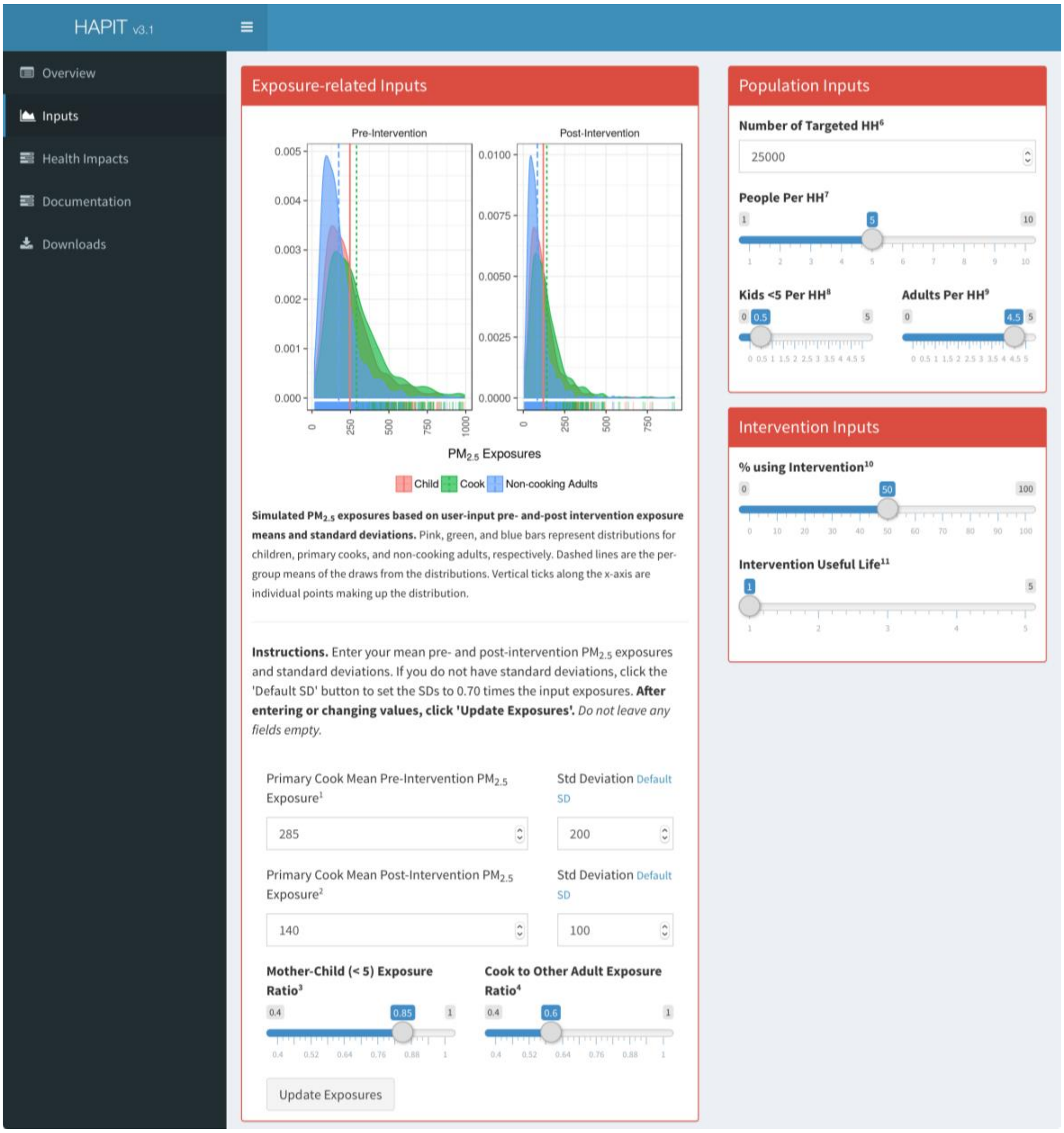
[17] For a high-level overview of DALYs, see Salomon, J. A. Disability-Adjusted Life Years. In Encyclopedia of Health Economics; Culyer, A. J., Ed.; Encyclopedia of Health Economics; Elsevier: San Diego, 2014; pp 200–203.

either scroll through the menu to identify their country of interest or start typing the country's name, filtering options based on user input.



Background information is split into two tables – one showing socioeconomic and demographic statistics and one showing annual disease data.

After selecting a country, users click the "Inputs" tab to enter exposure and intervention-related parameters. HAPIT defaults to an intervention in 25,000 households (which can be modified based on the project target households) and uses country-level data from the UN Population Division and the Global Alliance for Clean Cookstoves for the number of people and children aged under five years-old per household. The adults per household value is calculated automatically in HAPIT by subtracting the number of children per household from the people per household value.

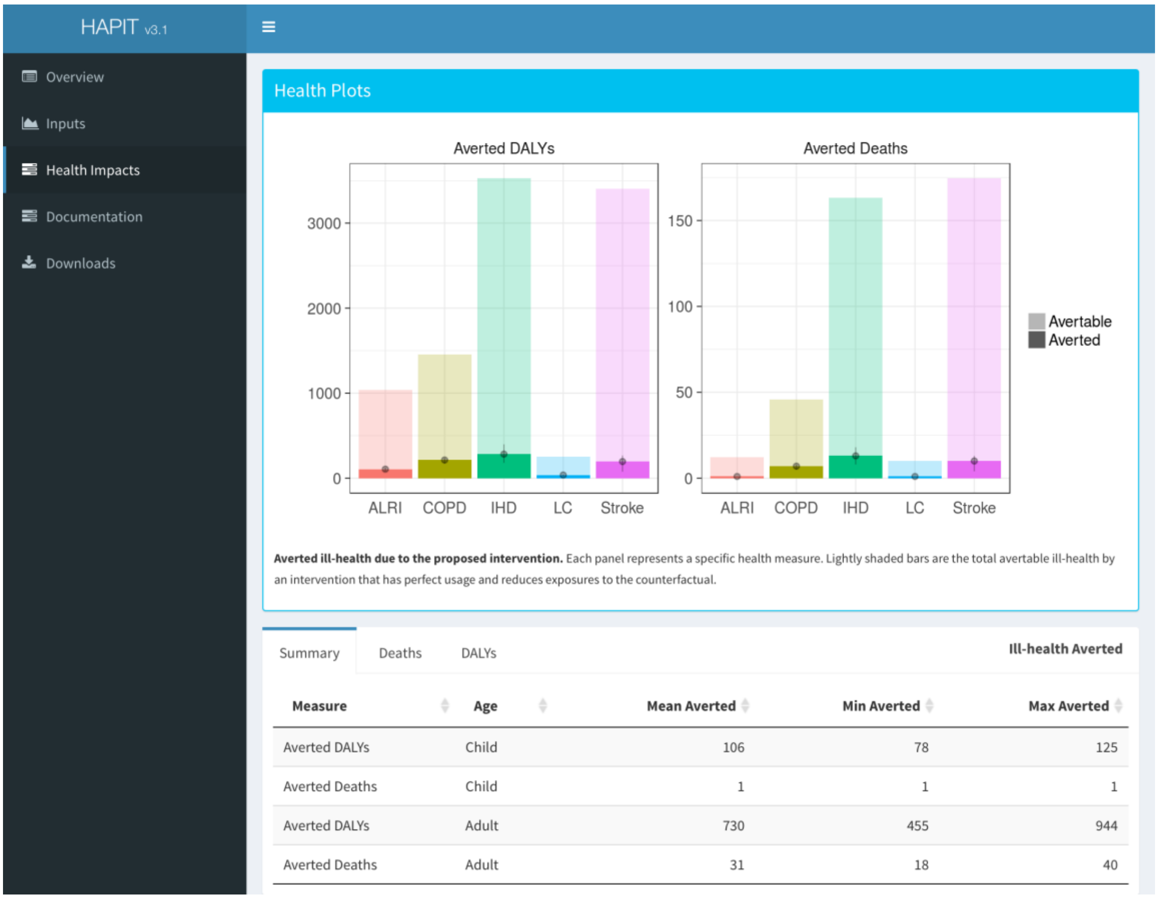


HAPIT defaults to a usage rate of 50% of intervened households; this can be changed based on work in the household performed by entities seeking credited ADALYs. Finally, HAPIT defaults to setting the 'useful lifetime of an intervention' as one year. This value should not be changed when applying for certified ADALYs for Gold Standard methodology.

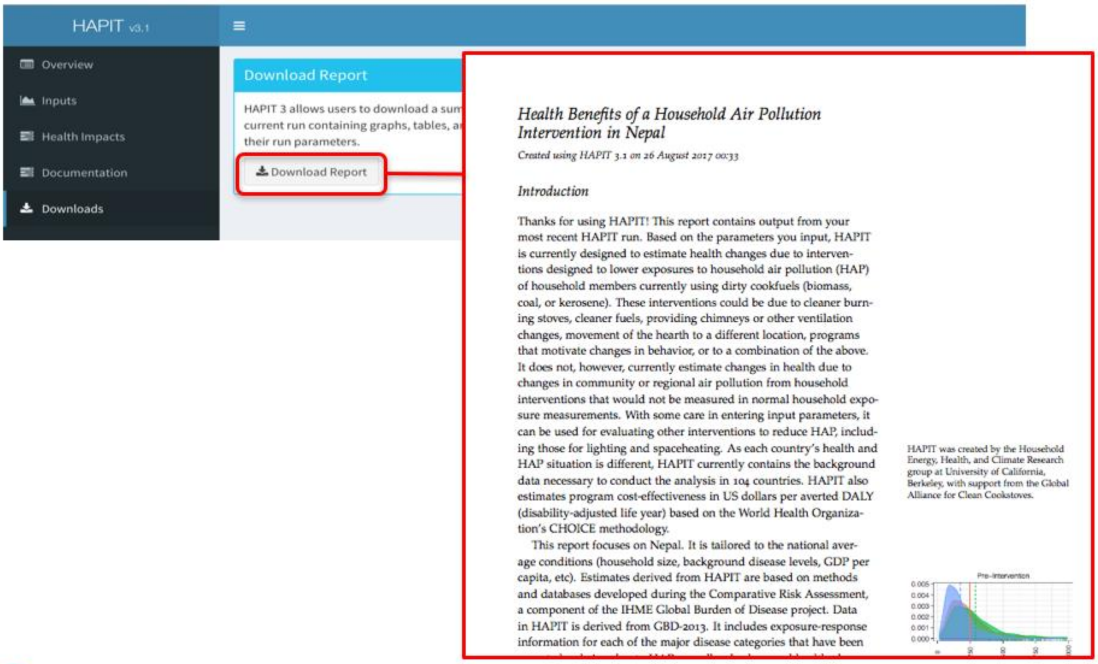
The final set of inputs are the primary cook's average pre- and post-intervention $PM_{2.5}$ exposures. These values and corresponding standard deviations should be input based on measured values from field personal exposure assessment or user may select the default value option provided in HAPIT. The mother-child and cook-other adult exposure ratios adjusted exposures for other household members based on measurements from the scientific literature. Currently, HAPIT uses default adjustment factors for other household members of 0.60 for non-cook adults and 0.85 for children, following methods used to calculate impacts in the IHME Global Burden of Disease project. These values should only be changed based on field measurements. After entering exposure inputs, click "Update Exposures" and then navigate to the 'Health Impacts' panel using the navigation sidebar.

Running HAPIT can take between 10 seconds and one minute depending on server load. A progress bar indicates whether the run has completed or not. Once the run has completed, plots of Averted

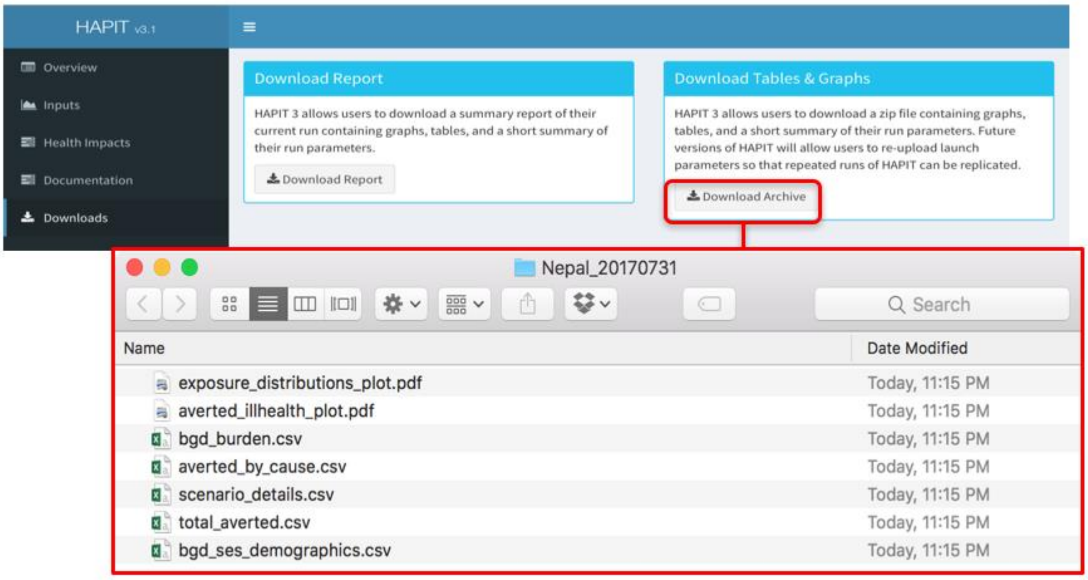
DALYs and Deaths are displayed by disease type. tables of averted ill-health – both in total for adult and child outcomes and separately for each disease by deaths and DALYs – are displayed.



Finally, HAPIT output can be downloaded either in the form a standardised, well-formatted report or separate tables by clicking "Downloads" from the sidebar. Downloads are clearly labelled.



The archive contains 7 items:



Description of HAPIT outputs:

- exposure_distributions_plot.pdf – Pre- and post-intervention $PM_{2.5}$ exposures based on user inputs.
- averted_illhealth_plot.pdf – A high-quality, PDF version of the plot displayed on the 'Health Impacts' panel.
- bgd_burden.csv – The background burden of disease from GBD 2013.
- averted_by_cause.csv – Averted deaths and DALYs by cause and age.
- scenario_details.csv – Details of the scenario run based on user inputs.
- total_averted.csv – Total averted deaths and DALYs by age group.
- bgd_ses_demographics.csv – Background population and socioeconomic data used by HAPIT.

HAPIT use with the Gold Standard ADALYs Methodology

As mentioned above, HAPIT is a general-purpose tool. For application in the context of the Gold Standard ADALYs Methodology, HAPIT output must be adjusted based on the specific project implementation details.

First, HAPIT runs in full calendar year increments; thus, results output by HAPIT should be multiplied by the weighted average fraction of days of the year during which the project stoves were operational. These fractions should take into account phase deployments (for example, deploying stoves over many months). Table 1.1, below, summarises the input parameters and guidance for the Gold Standard ADALYs methodology.

TABLE 1.1 Input Parameters required for HAPIT

HAPIT INPUT	Guidance for GS ADALYs Methodology	Source
Select the Country	Select the project host country	Project design document
Number of Targeted HH	Number of total targeted households where the interventions will be installed. For example, the number of households that will be provided with the efficient cookstoves in the project	Project implementation plan
People per Household	Household size	Baseline/project survey

Kids <5 Per HH	Number of children (<5 years-old) per household	Baseline/project survey
% Using Intervention	Project technology usage rate (%)	Usage survey or Continuous Stove Monitors (CSMs)
Intervention Useful Life	Useful life of the intervention; Use "1" as default for GS methodology	HAPIT
Primary Cook Mean pre- and post-intervention $PM_{2.5}$ Exposure	Baseline and project $PM_{2.5}$ exposure levels	Baseline and project PEM studies
Std Deviation	Use the default Standard Deviation value provided in HAPIT	HAPIT
Mother-Child (< 5) Exposure Ratio	Use the default value of 0.85 or measure project specific value	HAPIT
Cook to Other Adult Exposure Ratio	Use the default value of 0.60 or measure project specific value	HAPIT
Averted DALYs and Deaths	Use the sum of mean averted values for each diseases ADALYs and Total to estimate the project level ADALYs for crediting	HAPIT

Long-term health benefits associated with each year's exposure reduction are still included in the annual estimates and will be awarded to the project in the year exposure was reduced (i.e., for exposure reduction in year 2016, 80% of the associated health benefits in year 2016-2020 are awarded in 2016). ADALYs and avoided mortality will be awarded to projects each year of the project's lifetime using the monitored exposures and usage rates as per monitoring requirements. These benefits would be expected regardless of whether exposure levels return to baseline in the next year.

ANNEX 2: PEM EQUIPMENT FOR $PM_{2.5}$ THAT IS CURRENTLY COMMERCIALLY AVAILABLE

It should be noted that the costs given below are only indicative and actual costs may vary.

Instrument	Technology	Considerations	Approximate Cost (USD)
SKC AirChek 5000 pump[18]	Gravimetric system of filters, pumps and PM size cut device (cyclones, impactors). PM concentrations determined by dividing particulate mass deposited on filter by volume of sampled air.	-Single integrated measurement for sample duration -Requires careful handling and transportation of filters for massing on sensitive balances -Generally bulky and cumbersome; not typically suitable for children or some sample populations -Battery life can limit sampling durations	$900.00 - $2000.00 per fully operational unit
Casella Apex pump[19]			
Gilian 5000 pump[20]			
SKC Airlite pump[21]			
URG Personal samplers[22]			
SKC Personal Modular Impactor (PMI)[23]			
BGI Triplex cyclone[24]			
Access Sensor Technologies UPAS[25]	Integrated gravimetric system.	-Relatively new technology	$1,300.00
RTI MicroPEM[26]	Integrated gravimetric system.		$2,000.00

[18] http://www.skcltd.com/index.php/air-sampling-pumps/9-uncategorised/152-airchek-xr5000
[19] http://www.casellasolutions.com/us/en/products/dust-and-gases/bodily-worn/products/apex2.aspx
[20] http://www.sensidyne.com/air-sampling-equipment/gilian-air-sampling-pumps/gilian-3500gilian-5000-air-sampling-pump/
[21] http://www.skcinc.com/catalog/product_info.php?products_id=13
[22] http://www.urgcorp.com/beta/assets/library/brochures/URG Personal Samplers.pdf
[23] http://www.skcinc.com/catalog/product_info.php?products_id=363
[24] http://bgi.mesalabs.com/scc1-062-triplex-personal-sampling-cyclone/
[25] https://accsensors.com/technologies/#UPAS
[26] https://www.rti.org/impact/micropem-sensor-measuring-exposure-air-pollution

PATS+[27]	Estimates PM concentrations by detecting light scattered by particles suspended in beam of light source.	- Sensitivity changes depending on optical properties of aerosol. Requires calibration in target aerosol. -Instruments require calibration and zeroing; zero levels can drift over time - Different nephelometers can be configured to sample actively or passively. Those with active sampling options can use a size-cut device. - Can provide continuous concentration estimates	$500.00

[27] http://berkeleyair.com/monitoring-instruments-sales-rentals/particle-and-temperature-sensor-pats/

ANNEX 3: PEM EQUIPMENT FOR CO THAT IS CURRENTLY COMMERCIALLY AVAILABLE

It should be noted that all costs are only indicative and actual costs may vary.

Instrument	Technology	Considerations	Approximate Cost (USD)
SKC Drager diffusion tube[28]	Passive diffusion tubes. Tube changes color as CO diffuses through chemical in tube.	Light, small, and require no power. Well suited for infants and children. - Difficult to precisely determine extent of color change. - Single integrated measurement for sample duration	$120.00
Lascar[29]	Electrochemical sensors. Chemical reaction with CO produces a small current, which is converted to a concentration.	Many options which are relatively inexpensive, lightweight, and consume little power. - Other gases can interfere, and high concentrations of CO can poison cell. - can provide semi-continuous concentration estimates - Resolution at lower concentrations can be poor.	$130.00
PATS+ with CO[30]			$600.00

[28] http://www.skcinc.com/catalog/product_info.php?products_id=1501
[29] https://www.lascarelectronics.com/easylog-data-logger-el-usb-co300/
[30] http://berkeleyair.com/monitoring-instruments-sales-rentals/particle-and-temperature-sensor-pats/

ANNEX 4: ORGANISATIONS WITH PEM EXPERTISE*

PEM Facility				
Region	**Country**	**Agency Name/website**	**Contact details**	**Focal point**
South Asia	India	Sri RamaChandra University www.sriramachandra.edu.in	Department of Environmental Health Engineering, Sri Ramachandra University Porur, Chennai-600 116. Phone: 91-044-4592 8547 Fax:91-044-2476 7008	Dr. Kalpana Balakrishnan Dr. S. Sankar
South East Asia	Thailand	Asian Institute of Technology www.ait.ac.th	Environmental Engineering and Management, School of Environment, Resources and Development, PO Box 4, Klong Luang, PATHUMTHANI - 1210	Dr. Ekbordin Winjikul, Assistant Professor
West Africa	Ghana	Kintampo Health Research Centre www.kintampo-hrc.org/kintampo/	PO Box 200, Kintampo, Ghana, West Africa	Dr. Kwaku Poku Asante
West Africa	Ghana	Environmental Protection Agency www.epa.gov.gh	PO Box MB326, Ministries, Accra, Ghana	Mr. Emmanual K - E Appoh
South America	Peru	PRISMA www.prisma.org.pe	San Miguel, Lima, Peru	Ms. Marilu Chiang
Central America	Guatemala	Universidad Del Valle de Guatemala http://www.uvg.edu.gt/	Guatemala City, Guatemala	Dr. John McCracken
North America	USA	Berkeley Air Monitoring Group	1900 Addison Street Suite 350 Berkeley, CA 94704 E: info@berkeleyair.com P: +1 (510) 649-9355	
North America	USA	Climate Solutions Consulting www.climate-solutions.net	olivier@climate-solutions.net	Olivier Lefebvre

**These organization/agencies participated in regional training workshops. If your organization also rents equipment and/or provide services for PEM, please send your details to Gold Standard at help@goldstandard.org to add in this list.*

ANNEX 5: CO INSTRUMENT CALIBRATION REQUIREMENTS AND PROTOCOL

CO instruments should be calibrated monthly using a zero air, such as pure nitrogen, and a span gas, such as 50-150 ppm standard of CO in zero air or in nitrogen. Use the following protocol to guide your CO instrument calibration.

Materials

- Calibration chamber
- CO monitors
- Zero gas with regulator
- Span gas with regulator
- Flow meter
- Timer
- Calibration log sheet

Procedure

- Fill out a Calibration Log Sheet to keep important information during the calibration
- Start logging CO instrument at the one-minute sampling rate
- Make a list of instruments being calibrated
- Perform the calibration in a fume hood or well-ventilated area
- Place instruments in the calibration box (we are assuming a 2-liter box in this discussion), arranging the inlet vents near each other, and near the air inlet port in the calibration chamber. If desired, put a dead volume into the box to reduce the amount of gas needed.
- Flow in 8-12 liters of zero air, or use CO-free room air if not available
    - A flow of 2-3 lpm is preferable
    - Use a rotameter or other flow meter to measure the flow rate. If in doubt, use a higher flow.
    - This should take approximately 4 minutes
    - Slow the air flow to 1 lpm for a further 10 minutes
    - Record the times that the 10-minute period starts and ends
- Flow 8-12 liters of span gas into the chamber
    - A flow of 2-3 lpm is preferable
    - This should take 4 minutes
    - Slow the air flow to 1 lpm for a further 10 minutes
    - Record the times that the 10-minute period starts and ends
- Repeat the zero air flow procedure described above
- Open the chamber (in a well-ventilated area, or fume hood) and download CO data from all instruments
- Using the last 4 minutes of the 10-minute steady state periods of zero and span points, find the average CO concentration.
- Build a calibration adjustment relating the span gas to the CO response using:

CO sensor adjustment = Span gas concentration / (CO sensor span response – CO sensor zero response)

- Record the CO adjustment for that sensor and apply the adjustment to the CO data collected by the respective sensor.

Under the following conditions, the CO sensor should be taken out of circulation or re-tested:

- If the mean high concentration point has greater than 20% error
- Standard deviation of the offset (zero data) is greater than 1 ppm
- Calibration offset is greater than 5 ppm
- Coefficient of variation (standard deviation/mean) of the high concentration data is greater than 0.2

ANNEX 6: INTERPRETING CSM DATA

Suggested outcomes of interest that result from CSM data collection include:

- Average number of cooking events per day – total for all stoves and then per day by stove.
- Average time cooking – per-day total for all stoves and then per-day by stove.
- Average cooking time per-event – by stove.
- Proportion of total cooking carried out on intervention stove.

There are multiple new and old platforms available for CSM analysis, including:

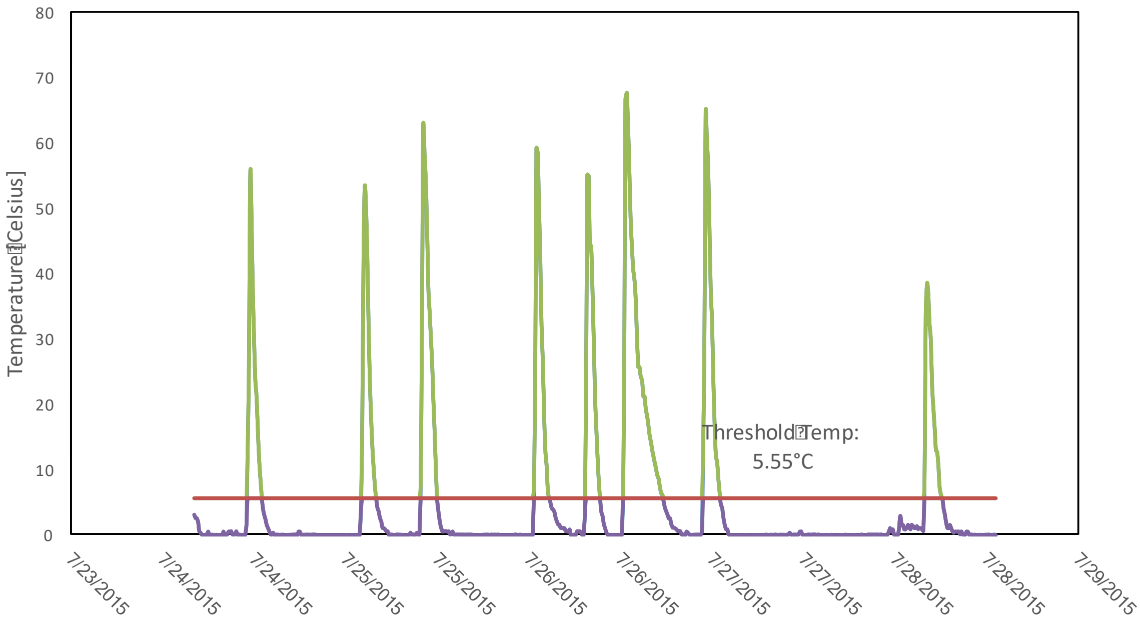
- SUMIT (https://householdenergy.shinyapps.io/sumit)
- SUMSarizer (http://www.sumsarizer.com/)
- SUMs iButton Analysis Software by Berkeley Air Monitoring Group

There is still a need for standardised methodologies for interpreting CSM data. The above-mentioned platforms all use different algorithms for the analysis, so results from different methods may not be directly comparable, especially when looking at cooking duration.

Event number is typically easier to compare across different analysis methods, since the definition of an “event” is less variable. Duration of use can be more difficult to interpret, since temperature profiles of different stove types look different. For example, stoves with low thermal mass (metal stoves) may show quick heat-up and cool-down times, while those with high thermal lass (clay or mud stoves) show slower heat-up and cool-down times.

How you set your parameters, such as the temperature at which the stove is considered ‘on’ vs. ‘off’, will impact your results. Figure 6.1, below, shows an example of ambient corrected (or subtracted) CSM data and a threshold of 5.5^{0}C defined for analysis. A “threshold” analysis is one of the simplest methods for analysing CSM data. It defines anything above a given threshold as cooking and below as not cooking. This is thought to be a coarse estimate, as it is uncommon for people to continue cooking during the entire “cool-down” period of the stove’s temperature trace. It is important to be clear in the reporting what parameters you selected and cut-offs used.

FIGURE 6.1: CSM temperature trace for a low thermal mass stove using a threshold of 5.5C above ambient temperature.


80
70
60
50
40
30
20
10
0
Temperature [Celsius]
Threshold Temp:
5.55°C
7/23/2015
7/24/2015
7/24/2015
7/25/2015
7/25/2015
7/26/2015
7/26/2015
7/27/2015
7/27/2015
7/28/2015
7/28/2015
7/29/2015

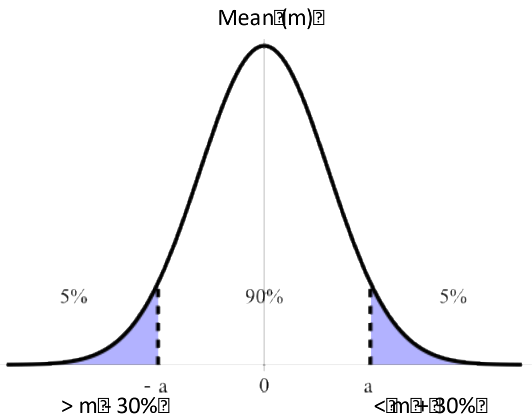
ANNEX 7: GUIDANCE FOR 90/30 PRECISION RULE

Due to the variability in PEM levels, the data must meet certain requirements to say with confidence that the project stove is or is not truly having an impact on health. A minimum sample size of 30 PEM samples is required for sampling and the 90/30 precision level should be met for both the baseline PEM and project PEM sample groups, regardless of whether the study is cross-sectional or before-and-after. For the 90/30 precision rule to be met, the end-points of the 90% confidence interval of the mean exposure value must lie within +/- 30% of the estimated mean, as shown in Figure 7.1 below.

If 90/30 statistical precision is not met in the baseline PEM, the mean PEM value should be conservatively adjusted with a two-sided lower bound of the error for baseline scenario PEM, and a two-sided upper bound of the error for the project scenario PEM values. Alternatively, more samples can be taken in either the baseline or project scenarios until the 90/30 precision rule is met.

More about the statistics that define the 90/30 rule, including discussion precision and confidence intervals can be found at http://researchhubs.com/post/ai/data-analysis-and-statistical-inference/accuracy-vs-precision.html.

FIGURE 7.1: Graphical depiction of the 90/30 rule.



An excel tool is available, with methodology for determining whether your dataset meets the 90/30 rule. The tool, Annex 1.2 - *Example 90/30 confidence/precision check,* is available within the ADALYs methodology. The screenshots of the tool are shown in Figure 7.2. The individual 48-hr exposure values are copied into the worksheet and it automatically excludes outliers and does the statistical analysis required to determine if the dataset meets the 90/30 rule. The worksheet tells you if the data set meets the 90/30 rule and guides you to use the mean, the upper bound, or lower bound as your average exposure value for HAPIT, which are all calculated for you in the worksheet. The tool includes the guidance and helps the user during the assessment. To download the tool, go to:

https://globalgoals.goldstandard.org/wp-content/uploads/2017/06/401.3-ICS-annex_1.2_90_30_assessment-2.xlsx

FIGURE 7.2: Example of worksheet for determining if your data set meets the 90/30 rule Sampling frame and logistics

Example: 90/30 confidence / precision level

Description

Baseline and project PM2.5 (µg/m3)

Reference - Column C and Column F

The project developer shall use the monitored PM2.5 value in column C and F for baseline and project scenario, respectively determined following the guidelines provided in section 4.3 and 5.3 of the ADALYs methodology. In this example, hypothetical values for baseline and project PM2.5 exposure level have been used to demonstrate 90/30 confidence / precision level assessment. (i.e., the end-points of the 90% confidence interval of the mean lie within +/- 30% of the estimated mean).

Outlier identification

Reference - Column D and Column G

Outliers are data points that differ greatly from the majority of a set of data. These values fall outside of an overall trend that is present in the data set. In this example, Interquartile Range (IQR) method is applied to identify the outliers. Here, potential outliers are identified as those data points which are either greater than 1.5 times the interquartile range (IQR) from the third quartile, or less than 1.5 times the IQR from the first quartile.

90/30 confidence/precision check

Reference - Cell - D62 and G62

Precision attained is estimated using the formula below

Precision =1.645*SEy/y*100

Where

SEy = Standard error

y = Sample mean

1.645 = Two-sided critical z-value

Standard error= Standard deviation/SQUARE ROOT of the sample size

Baseline PEM			Project PEM		
Household ID	Average 48-hr exposures PM2.5 (µg/m3)	Outlier removal PM 2.5 without outlier	Household ID Project	Average 48-hr exposures PM2.5 (µg/m3)	Outlier removal PM 2.5 without outlier
HH 1	600	Outlier	HH 1	55	Outlier
HH 2	700	Outlier	HH 2	65	65
HH 3	900	Outlier	HH 3	120	Outlier
HH 4	200	200	HH 4	110	Outlier
HH 5	100	Outlier	HH 5	125	Outlier
HH 6	900	Outlier	HH 6	67	67
HH 7	129	Outlier	HH 7	55	Outlier
HH 8	23	Outlier	HH 8	76	76
HH 9	213	213	HH 9	79	79
HH 10	189	189	HH 10	84	84
HH 11	134	Outlier	HH 11	89	89
HH 12	278	Outlier	HH 12	82	82
HH 13	100	Outlier	HH 13	77	77
HH 14	440	Outlier	HH 14	64	Outlier
HH 15	230	230	HH 15	75	75
HH 16	230	230	HH 16	34	Outlier
HH 17	239	Outlier	HH 17	23	Outlier
HH 18	230	230	HH 18	78	78
HH 19	230	230	HH 19	89	89
HH 20	230	230	HH 20	120	Outlier
HH 21	165	Outlier	HH 21	135	Outlier
HH 22	210	210	HH 22	98	Outlier
HH 23	220	220	HH 23	78	78
HH 24	232	232	HH 24	65	65
HH 25	278	Outlier	HH 25	35	Outlier
HH 26	187	Outlier	HH 26	78	78
HH 27	800	Outlier	HH 27	65	65
HH 28	100	Outlier	HH 28	85	85
HH 29	120	Outlier	HH 29	120	Outlier
HH 30	220	220	HH 30	78	78
HH 31	220	220	HH 31	77	77

Result

Reference - Baseline PM2.5 =Cell D64 and Project PM2.5 =G64

If Yes

If 90/30 precision level is achieved, the mean value for baseline (cell D65) and project scenario (cell G65) shall be applied for ADALYs calculation. In this example the 90/30 precision level is achieved therefore mean value can be applied.

If No

If 90/30 precision level is not achieved, the project developer shall increase the sample size or determine PM2.5 values; the lower bound for baseline scenario and upper bound for project scenario using the formula below

Lower bound = Mean - 1.645* Standard error

Upper bound = Mean +1.645* Standard error

Baseline 90/30 check		Project 90/30 check	
Mean	276.84	Mean	87.6
Standard Deviation	227.72	Standard Deviation	62.2
COV	0.82	COV	0.71
Upper Quartile	239.0	Upper Quartile	93.50
Lower Quartile	187.0	Lower Quartile	64.50
Interquartile Range	52.0	Interquartile Range	29.0
Outlier Threshold (Upper)	317.0	Outlier Threshold (Upper)	137.00
Outlier Threshold (Lower)	109.0	Outlier Threshold (Lower)	21.00
Sample Mean	217.73	*Sample Mean*	77.58
Valid Sample Size	15.00	*Valid Sample Size*	19.00
Standard Deviation	13.37	*Standard Deviation*	62.21
Standard error	3.45	*Standard error*	14.27
What is the precision attained?	2.61%	What is the precision attained?	30.26%
Does the result satisfy the 90/30 precision rule?	YES	Does the result satisfy the 90/30 rule?	NO
What baseline PM2.5 value may be applied for ADALYs calc	Use mean	What baseline PM2.5 value may be applied for ADALYs calc	Use upper bound or increase sample size
Mean	218	Mean	78
90% Lower bound		90% Upper bound	75

ANNEX 8: FREQUENTLY ASKED QUESTION (FAQ)

Eligibility requirements

Q: Is this methodology limited only to indoor Household air pollution?

A: The methodology is applicable to the projects that lead to verifiable reduction in Household Indoor Air Pollution; more precisely personal exposure to PM2.5 due to change in household energy use and/or emissions for cooking, heating, lighting. Projects shall include cleaner cooking devices, fuels, or practices (e.g., improved application of eligible technologies, a shift from solid fuel or kerosene to biogas, etc.). The projects that improve/enhance ventilation of indoor air only (i.e., there is no improvement in technology, fuel, or practices) are not currently eligible.

Q: The ADALYs methodology is for lighting, cooking or heating. Can one replace all at once and claim ADALYs? Can you claim for lighting only?
A: Improved lighting on its own is not applicable under the methodology, however, if replaced alongside eligible technology, then it is possible to claim the ADALYs from all interventions.

Q: It appears that the ventilation in itself is not an allowed technology?
A: If ventilation is applied in conjunction with an improved cookstove technology or practices then it is eligible. It is not eligible as a stand-alone technology as ventilation in itself.

Q: Is the 20% minimum thermal efficiency requirement for new stoves or does it also mean that in case during the project lifetime the efficiency comes below this value then the project stoves will no longer applicable?
A: It is a qualifying benchmark criterion for project cookstove. Thermal efficiency is not required to be monitored during the project life as per ADALYs methodology. Moreover, the ADALYs are estimated based on monitored personal exposure level which ideally should capture any degradation in performance of stoves during its life.

Q: Why is CO not required to be monitored for non-charcoal stoves?
A: CO levels above World Health Organization (WHO) air quality guidelines[31] could result in adverse health effects and Charcoal fuel based technologies tend to have high CO emission levels. Therefore, it is required to monitor the CO concentration for charcoal stoves only.

Q: Although CO concentration may be lower than 7 mg/m3; the peak concentration can still potentially be higher in the context of a project. Charcoal households can still be exposed to critically high levels. Why 24hrs monitoring is considered appropriate?
A: Regarding CO monitoring, WHO gives thresholds for 8 hrs., 1 hrs., 24 hrs. exposure but methodology relied require using the 24-hour average value for the CO which is a good representation of the risk from CO exposure.

Q: Can the methodology rely on monitoring of the room area concentration for PM2.5?
A: The methodology relies on personal exposure monitoring of PM2.5. It is very difficult to establish link between exposure to PM2.5 and room area concentrations. Therefore, room area concentration for PM2.5 can not be applied to estimate ADALYs.

Monitoring requirements

Q: Do all the stoves under a project need to be monitored?
A: No, ADALYs methodology requires monitoring of representative sample of the project population using the project stoves. The methodology provides the minimum sample size and sampling requirements for different monitoring parameters such as project survey, usage survey, personal exposure monitoring.

Q: Do you have any specific surveys that must be used?

[31] World Health Organization (2014) Indoor Air Quality Guidelines: Household Fuel Combustion. WHO Guidelines for Indoor Air Quality. World Health Organization, Geneva, Switzerland. Available at: http://www.who.int/indoorair/guidelines/hhfc/en/, Accessed August 23, 2016.

A: The methodology provides survey guidelines and sample questions. However, the project developer can design location specific surveys considering the local cooking practices and behavior following the guidance provided in the methodology.

Q: How should one decide on the number of samples for personal exposure monitoring and carry out analysis of the monitoring results to meet the precision requirement of the methodology?
A: The sample sizes for personal exposure should be large enough to meet the statistical precision. The methodology requires a minimal sample size of 30 households for personal exposure monitoring for each identified scenario in baseline and project situation. The methodology includes a table with the indicative size of the samples required for the target population for paired designs (before-and-after) and unpaired (cross-sectional) study designs to evaluate personal exposure for new compared to baseline technologies. Also, an example to illustrate 90/30 confidence/precision check approach is provided in excel sheet. One can use this sheet for project specific personal exposure data.

Q: The methodology requires randomly selected samples for personal exposure monitoring (PEM). If the 90/30 is not met then what are the options and if additional samples have to be taken, then should these sample households also be based on simple random sampling?
A: If the statistical precision is not met, conservative bound of the confidence interval shall be used. This means that in case of baseline PEM if the statistical precision is not met the mean PEM value should be adjusted with two sided lower bound of the error and vice-versa for project scenario PEM. An example to illustrate 90/30 confidence/precision check approach is provided in excel sheet available online at this link https://globalgoals.goldstandard.org/wp-content/uploads/2017/06/401.3-ICS-annex_1.2_90_30_assessment-2.xlsx.

As an alternative approach, one may also carry out monitoring in additional households. However, the sampling approach should be same as the approach for choosing 30 samples i.e. simple random sampling from the same pool of households. To be on safer side, more than 30 household should be randomly selected so that there are standby households that can be randomly chosen if all first 30 households are not able to participate in the survey or more households need to be added to meet precision requirements.

Q: In some countries, there are regulations that cover the type of surveys required by the methodology and it would normally be a requirement to get approval from the Ethics Review Board.
A: Generally, survey and monitoring activities may be exempt from ethics and/or Institutional Review Board (IRB) clearance if the results are used exclusively to assess programme performance and do not constitute research designed to develop or contribute to generalizable knowledge. Local requirements should be consulted. If survey and monitoring activities are not exempt, then the programme developer is obligated to secure such clearance.

Q: Monitoring requirements of ADALYs methodology includes annual surveys and biennial personal exposure monitoring. Will it not require significant resources and expertise to meet the monitoring requirements of this methodology?
A: The monitoring approach of ADALYs methodology is aligned with Gold Standard carbon credits methodology for cookstoves; **Technologies and practices to displace decentralized thermal energy consumption (TPDDTEC).** A project developer seeking ADALYs is required to carry out the personal exposure monitoring in addition to what is required for claiming carbon credits for cookstove project. The Gold Standard with several partners is working on capacity building and developing the required infrastructure; primarily identifying the relevant local monitoring agencies with personal exposure monitoring expertise.

Q: Since the first project Personal Exposure Measurement shall be conducted after the first six months of project implementation, how does it work in case there is a phased implementation of project technology?

A: In the case of phased implementation, at the time of carrying out the project PEM for e.g. 11th month of the crediting period, projects should take a random sample of minimum 30 households from project population that are at least six months old.

Q: How do you isolate exposure from multiple sources in this methodology?
A: This methodology does not consider isolating individual sources, rather it measures the overall exposure on the cook. It assumes that sources other than from cookstoves remain the same before and after the intervention.

HAPIT

Q: Is it possible to download a copy of HAPIT?
A: No, it is a web-based tool and cannot be downloaded.

Q: How can it be made sure that the ADALYs are attributable to these health diseases from exposure. If there are national statistics and it could change because of a number of reasons like conflict in the host country. How is it certain that we are calculating the right number of ADALYs?
A: The ADALYs are derived based on robust studies done at national level (sub-national for Mexico and China). HAPIT will be updated as and when new national level information is available, therefore any change in national disease burden will be accounted in ADLAYs calculated at the project level.

Auditing requirements

Q: During auditing if the stove is found to be outside the house, is this ok?
A: Yes, in principle, this is no problem presented by this as it should be captured by usage surveys and PEM. The auditor will confirm this by referring to the relevant studies.

Q: Will there be a requirement for an auditor?
A: Yes, an auditor will be required to conduct an on-site visit. They will carry out checks to make sure that the methods used to collect the personal exposure measurements are in line with the methodology and are adequately representative.

Q: Is an audit required every year?
A: Not necessarily, but they are required for every ADALYs issuance.

Q: How many are auditors and accredited for this methodology?
A: We rely on UN auditors for our work, and exposure monitoring requirements are very similar to carbon accounting so largely depend on UNFCCC auditors but we would require that audit team have experience in personal exposure assessments.

ANNEX 9: SURVEY EXAMPLE

The annex provides example questionnaires[32] for typical paired exposure baseline and project survey studies. These surveys may not be directly applicable to all studies and should be adapted to represent location, cultural cooking practices and type of study i.e., paired or cross-sectional study, following the ADALYs methodology requirements.

A. Baseline Survey

Note: Please ask to speak to the main end-user of the cookstove to ensure the household has completed the consent process before beginning the questionnaire. Please refer to page 26, Annex 2 of the ADALYs methodology for further detail.

A. Background Information: Visit #1		
A1	Date [dd-mm-yy]	
A2	Time of visit [hh:mm] 24-hr time	
A3	Household ID	
A4	Surveyor Name/ ID	
A5	Study group [Please check you are completing the correct form]	1= Baseline group 2= Project group 3= New stove (pre-dissemination)

B. Household Demographic Information Please note B1-B4 are to be asked to the main cook			
B1	What is your marital status?	1=Married 2=Single 3=Widowed 4=Separated 5=Divorced 6=Other [describe]	
B2	Age at last birthday	[Yrs]	
B3	Do you currently go outside the home to carry out paid work?	1-Yes 2=No [go to QB5]	
B4	What is the main type of paid work you do outside the home at this time of year? [Use codes Single answer only]		
Household characteristics			
B5	How many people live in this household?	[A household is defined as a person or group of related and unrelated persons who live together in the same dwelling unit(s) or in connected premises, who acknowledge one adult member as the head of the household, and who have common arrangements for cooking and eating meals. DHS 2010]	

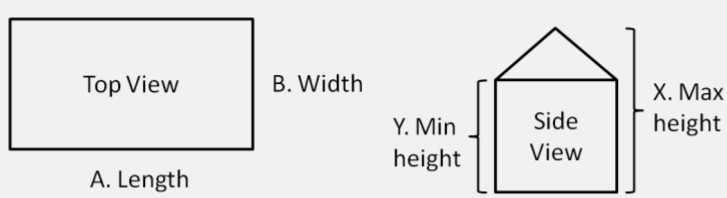
[32] These survey questionnaires were prepared and tested by Berkeley Air Monitoring Group for two different exposure studies.

B6	Not counting any bathrooms or kitchens, how many rooms are there in this house?	[Explain that this includes all rooms OTHER than the bathroom and kitchen, and make a note at the end of this section if you are worried about the accuracy of the number given. Please note the rooms must be divided by a wall and not just a curtain]			
B7	Does this house have access to electricity?	1=Yes for the full day [Go to QB9] 2=Yes only for some of the day 3=No [go to QB10]			
B8	How many hours per day do you have access to reliable electricity at this time of year?	[hrs]			
B9	What is the main source of electricity? [SA]	1=National grid 2=Solar panel 3=Car battery 4=Other [describe]			
B10	What are the sources of energy you use for lighting your home at this time of year? How long on average do you currently use each energy source for lighting each day? [SA per source then Enter hrs used per day.]		Primary energy source B10.1	2nd energy Source B10.2	Hrs used per day
		Wood	1	1	
		Car battery	2	2	
		Candles	3	3	
		Kerosene wick lamps	4	4	
		Kerosene pressurized lamp	5	5	
		Solar (lantern or other)	6	6	
		Wind up torch/lamp	7	7	
		Electricity (connection)	8	8	
		Electricity (generator)	9	9	
		Other [describe]: ________________	99	99	
B11	[Observe: Is this house on stilts?]	1=Yes 2=No			

C. Stove and fuel use			
B12	Approximately at what age did you start cooking for more than 5 days per week?	[Yrs]	
B13	What position do you usually cook in?	1=Standing 2=Squatting 3=Sitting	
B14	Is there a baby living in this house who is less than 5 year old? If yes, how many babies in the house are less than 5 year old?	1=Yes 2=No [go to B16] No of child below 5 years -	
B15	Where is this baby/child usually during the time when cooking is taking place?	1= On the cooks back 2= In a raised crib/ basket in the kitchen –within arm's length of the stove 3= On the floor - within arm's length of the stove.	

		4= In the kitchen but more than one arm's length away from the stove 5= Not in the kitchen 5=Other [describe]			
B16.1	Including electrical appliances, what is your primary stove type and which fuels do you use on it at this time of year? [This includes stoves for all uses household cooking, animal feed, heating bathing water etc. If they give you one fuel type please ask to make sure no other fuels are used on this stove]		Stove type	Primary fuel	Second fuel
		Primary stove			
B16.2	Including electrical appliances, what type of stove is your secondary stove? What type of fuels do you use on it at this time of year? [If no secondary stove enter 99 into the stove column and go to QB17]	Secondary stove			
B16.3	Including electrical appliances, what type of stove is your tertiary stove? What type of fuels do you use on it at this time of year? [If no tertiary stove enter 99 into the stove column and go to QB17]	Tertiary stove			
B17	How many times on an average day do you cook [or carry out other stove related tasks] with wood fuel at this time of year? [If they don't use WOOD enter 99 and go to B20]	[times per day]			
B18	How often do you need to use damp, green or wet wood at this time or year?	1=Often 2=Rarely 3=Never			
B19	How often do you need to use damp, green or wet wood during the dry season?	1=Often 2=Rarely 3=Never			
B20	How many times on an average day do you cook [or carry out other stove related tasks] with electric appliances? [if no electrical appliances enter 99 and go to QB22]	[times per day]			
B21	When you cook with electrical appliances on average how long do you cook for each time?	[mins]			
B22	How many times on an average day do you cook [or carry out other stove related tasks] with LPG at this time of year? [If they don't use LPG enter 99 and go to B25]	[times per day]			
B23	What weight LPG cylinder do you usually purchase?	[kg]			
B24	How often do you re-fill this cylinder?	[every X days]			
B25	How many times on an average day do you cook [or carry out other stove related tasks] with CHARCOAL at this time of year? [if they don't use CHARCOAL enter 99 and go to QB27]	[times per day]			
B26	At this time of year, do you make or purchase your charcoal, or use or a mixture of both?	1=Make own charcoal 2=Purchase charcoal 3=A mixture of both 4=Other [describe]			
B27	How many times on an average day do you cook [or carry out other stove related tasks] with CROP RESIDUE at this time of year? [if they don't use CROP RESIDUE enter]	[times per day]			

B28	How many times on an average day do you cook [or carry out other stove related tasks] with DUNG at this time of year? [if they don't use DUNG enter]	[times per day]	

C. Kitchen dimensions and details			
Primary cooking location - [Note: this is the room where most of the cooking takes place and main stove is located]			
C1	During which months does the WET season happen?	________ through _________	
C2	During which months does the DRY season happen?	________ through _________	
C3	Current location of main cooking area or kitchen with the main stove? [SA only. Remember this as the primary cooking location, as this will be referenced on future visits]	1 = Separate building (separate from main house) 2 = Separate kitchen attached to main house 3 = Inside main living area of house 4 = Outside under a porch, under a stilted house or on a veranda attached to main house 5=In an uncovered area such as a courtyard or in front of the house 6=Other [describe]	
C4	What types of stove(s) and fuels are used in this location at this time of year?		Stove type | Fuel
		C4.1 Stove #1	
		C4.2 Stove #2	
		C4.3 Stove #3	
C5	How many walls does this cooking location have? [if no walls enter a 0 and go to C7]	[Number of walls]	
C6	What are the walls made of in the kitchen with the main stove?	[Use kitchen material codes]	
C7	Does this cooking location have a roof?	1=Yes 2=No [Go to C9]	
C8	What is the roof made of in the kitchen with the main stove?	[Use kitchen material codes.]	
C9	Kitchen volume [Note: the shape of the ceiling can be different, but Y will always be the minimum ceiling height and X will always be the maximum ceiling height].  	A (metres)	
		B (metres)	
		X (metres)	
		Y (metres)	
C10	Does this cooking location have any doorways?	1=Yes 2=No [Go to C19]	
C11	Doorway dimensions in kitchen: Door 1	Length (metres)	

		Width (metres)	
C12	Is there EVER a door or covering on this doorway?	1= Yes 2=No [Go to C14]	
C13	Is this door or covering usually open or closed during cooking at this time of year?	1=Completely closed 2=Partially closed 3=Fully open/removed	
C14	Is this door or covering usually open or closed during cooking during the dry season?	1=Completely closed 2=Partially closed 3=Fully open/removed	
C15	Door dimensions in kitchen: Door 2 [If no second door enter 0 and go to C21]	Length (metres)	
		Width (metres)	
C16	Is there EVER door or covering on this doorway?	1= Yes 2=No [Go to C21]	
C17	Is this door or covering usually open or closed during cooking at this time of year?	1=Completely closed 2=Partially closed 3=Fully open	
C18	Is this door or covering usually open or closed during cooking during the dry season?	1=Completely closed 2=Partially closed 3=Fully open	
[If more than two windows, choose largest two]			
C19	Does this cooking area have any windows?	1=Yes 2=No [go to C28]	
C20	Window dimensions in kitchen- Window 1	Length (metres)	
		Width (metres)	
C21	Is there ever a glass, wood or other type of covering on this window?	1= Yes 2=No [Go to C22]	
C22	Is this window covering usually open or closed during cooking at this time of year?	1=Completely closed 2=Partially closed 3=Fully open/removed	
C23	Is this window covering usually open or closed during cooking in the dry season?	1=Completely closed 2=Partially closed 3=Fully open/removed	
C24	Window dimensions in kitchen - Window 2	Length (metres)	
		Width (metres)	
C25	Is there EVER a glass, wood or other type of covering on this window?	1= Yes 2=No [Go to C28]	
C26	Is this window covering usually open or closed during cooking at this time of year?	1=Completely closed 2=Partially closed	

		3=Fully open/removed	
C27	Is this window covering usually open or closed during cooking in the dry season?	1=Completely closed 2=Partially closed 3=Fully open/removed	
C28	[Observe: How would you describe the ventilation in the main kitchen area?]	1= Poorly ventilated 2=Moderately ventilated 3=Well ventilated	
C29	[Observe: What is the level of smoke in the kitchen?]	1=Very smoky 2=Moderately smoky 3= Very little smoke 4=No smoke	
C30	[Observe: Was cooking taking place in the kitchen at the time of survey?]	1=Yes 2=No	

C31.1. Kitchen Sketch (Top View) *Include location of stove and monitoring equipment	C31.2. House Sketch (Side View) *Include location of kitchen and all main rooms

Secondary cooking location

C32	Other than this kitchen/cooking area do you ever cook food, prepare animal feed, boil water etc. for household purposes anywhere else at least once per week at this time of year?	1-Yes 2=No [Go to CX]	
C33	Where is the additional/secondary cooking location apart from your main kitchen? [remember this location as it will be referred to on future visits as the "additional cooking location"]	1 = Separate building (separate from main house) 2 = Separate kitchen attached to main house 3 = Inside main living area of house 4 = Outside under a porch, under a stilted house or on a veranda attached to main house 5=In an uncovered area such as a courtyard or in front of the house 5=Other [describe]	
C34	Is this location at your own home or at another house?	1=Own home 2=Other house	

			Stove type	Fuel	Hours per day this stove used in this cooking location
C35	What types of stove(s) and fuels are used in this secondary location at this time of year? [Use codes MA allowed]				
		Stove #1			
		Stove #2			
		Stove #3			
C36	How many walls does this cooking location have? [if no walls enter a 0 and go to XX]	[Number of walls]			

C37	What are the walls made of in the kitchen with the main stove?	[Use kitchen material codes]	
C38	Does this cooking location have a roof?	1=Yes 2=No [Go to C40]	
C39	What is the roof made of in the kitchen with the main stove?	[Use kitchen material codes.]	
C40	How many windows does this location have?	[number of windows]	
C41	How many doors does this location have?	[number of doors]	
C42	[Observe: How would you describe the ventilation in the secondary kitchen area?]	1= Poorly ventilated 2=Moderately ventilated 3=Well ventilated	

Seasonal changes of main cooking location			
C43	Does your MAIN cooking location change during the DRY season?	1=Yes 2=No [go to section D]	
C44	What is your main cooking location during the DRY season?	1 = Separate building (separate from main house) 2 = Separate kitchen attached to main house 3 = Inside main living area of house 4 = Outside under a porch, under a stilted house or on a veranda attached to main house 5=In an uncovered area such as a courtyard or in front of the house 6=Other [describe]	
C45	How many walls does this cooking location have?	[Number of walls]	
C46	Does this cooking location have a roof?	1=Yes 2=No	

D. Additional Sources of Smoke				
D1	In the last WEEK were you exposed to any of the following sources of smoke? [Read through each of the sources listed. If they state they were exposed to that type of smoke please ask the number of hours the participant was near this non-cookstove source of smoke in the last WEEK and the location of the source. If they are not exposed to that source of smoke please enter a 0 in to the hours exposed and move to the next source.]		Hours exposed during previous WEEK	1 = In home kitchen 2 = In home not in kitchen 3 = Outdoors near home 4 = Elsewhere
		Charcoal making		
		Crop/agricultural residue burning		
		Trash burning		
		Kerosene wick lamps		
		Kerosene pressurized lamp		
		Mosquito coils		
		Candles		
		Incense		

		Heating with biomass burning		
		You smoked tobacco products [number of cigarettes or times pipe was lit]		
		Someone smoked tobacco products next to you [number of cigarettes or times pipe was lit]		
		Other [describe]: _______________		
	Notes from visit			

E. Photographs			
	Please take photographs if allowed. [Ensure the photograph clearly includes a HH ID card. Mark X when done]	Kitchen/cooking area including showing characteristics related to ventilation	
		All stoves	
		Outside the house	

B. Project Survey

A. Background Information		
A1	Date [dd-mm-yy]	
A2	Time of visit [hh:mm] 24-hr time	
A3	Household ID	
A4	Surveyor Name/ ID	

B. Cooking Practices – At your home

We now have some questions about stove usage inside and near your home since our last visit. Please include all cooking events and tasks, such as re-heating food, making food for animals, warming bath water, brewing drinks or alcohol, etc. Please try to remember all of the stoves used and the fuels used with these stoves.
[Enter the associated fuel, cooking location, and time cooking for each stove used. If the participant uses two or more stoves of the same type record the usage of EACH of these stoves on SEPARATE LINES. Ask the participant to show you the place where they cooked and enter the descriptive information accordingly. Recall the primary and secondary cooking locations from the baseline questionnaire the day before.]

	Since our last visit, which stoves and fuels did you use inside and near your home in the MORNING?		Is this the primary cooking location? [Y/N]	Is this the secondary cooking location? [Y/N]	How many walls does the cooking location have? [number]	Does the cooking location have a roof? [Y/N]	How many windows did the cooking location have?	How many of these windows were open or uncovered while the stove was on? [number]	How many doors did the cooking location have?	How many of these doors were open or uncovered while the stove was on? [number]	How long was the stove alight?	How long did you spend next to the alight/smoking stove during this event? [hour]
B1	Stove type [Use stove codes]	Fuel type [Use fuel code]										

Were any of the stoves used during the MORNING alight at the same time? [If two stoves of the same TYPE are alight simultaneously please still record BOTH stoves here]	1=Yes 2=No [Go to B2] 3= Only one stove used [Go to B2]	First stove simultaneously alight. [Use stove codes]	Second stove simultaneously alight. [Use stove codes]	How long were the stoves alight at the same time [hours]

Notes/observations [Explain other types of stove use and events here].

B. Cooking Practices – At your home

B2	Since our last visit, which stoves and fuels did you use inside and near your home in the AFTERNOON?		Is this the primary cooking location? [Y/N]	Is this the secondary cooking location? [Y/N]	How many walls does the cooking location have? [number]	Does the cooking location have a roof? [Y/N]	How many windows did the cooking location have?	How many of these windows were open or uncovered while the stove was on? [number]	How many doors did the cooking location have?	How many of these doors were open or uncovered while the stove was on? [number]	How long was the stove alight?	How long did you spend next to the alight/ smoking stove during this event? [hour]
	Stove type [Use stove codes]	Fuel type [Use fuel code]										

	Were any of the stoves used during the AFTERNOON alight at the same time?	1=Yes 2=No [Go to B3] 3= Only one stove used [Go to B3]	First stove simultaneously alight. [Use stove codes]	Second stove simultaneously alight. [Use stove codes]	How long were the stoves alight at the same time [hours]
	Notes/observations [Explain other types of stove use and events here].				

B. Cooking Practices – At your home

B3	Since our last visit, which stoves and fuels did you use inside and near your home in the EVENING?		Is this the primary cooking location? [Y/N]	Is this the secondary cooking location? [Y/N]	How many walls does the cooking location have? [number]	Does the cooking location have a roof? [Y/N]	How many windows did the cooking location have?	How many of these windows were open or uncovered while the stove was on? [number]	How many doors did the cooking location have?	How many of these doors were open or uncovered while the stove was on? [number]	How long was the stove alight?	How long did you spend next to the alight/smoking stove during this event? [hour]
	Stove type [Use stove codes]											

B3	Were any of the stoves used during the EVENING alight at the same time?	1=Yes 2=No [Go to C1] 3= Only one stove used [Go to C1]	First stove simultaneously alight. [Use stove codes]	Second stove simultaneously alight. [Use stove codes]	How long were the stoves alight at the same time [hours]
	Notes/observations [Explain other types of stove use and events here].				

C. Cooking Practices – Elsewhere : MORNING		
C1	Since our last visit have you used a stove or fire for any purpose in any location other than your home?	1=Yes 2=No [Go to section D]
We now have some questions about stove usage away from your home since our last visit. This refers to any cooking or other stove use done in someone else's home, at work, or anywhere not in or around your home. Please include all cooking events and tasks such as re-heating food, warming bath water, making food for animals, brewing drinks or alcohol, etc. Please try to remember all stoves used and the fuels used with all of the stoves. [Enter the associated fuel, cooking location, and cooking time for each stove type. You will need to ask them to describe the cooking location since they will not be showing you to the areas outside of their home.]		

C2	Since our last visit, which stoves and fuels did you use AWAY from your home in the MORNING?		Is this the secondary cooking location? [Y/N]	How many walls does the cooking location have [number]	Does the cooking location have a roof? [Y/N]	How many windows did the cooking location have?	How many of these windows were open or uncovered while the stove was on? [number]	How many doors did the cooking location have?	How many of these doors were open or uncovered while the stove was on? [number]	How long was the stove alight?	How long did you spend next to the alight/smoking stove during this event? [hour]
	Stove type [Use stove codes]	Fuel type [Use fuel code]									

C2	Were any of the stoves used during the MORNING away from your home alight at the same time?	1=Yes 2=No [Go to C2] 3= Only one stove used [Go to C2]	First stove simultaneously alight. [Use stove codes]	Second stove simultaneously alight. [Use stove codes]	How long were the stoves alight at the same time [hours]]
	Notes/observations [Explain other types of stove use and events here].				

C. Cooking Practices – Elsewhere : AFTERNOON											
C2	Since our last visit, which stoves and fuels did you use AWAY from your home in the AFTERNOON?		Is this the secondary cooking location? [Y/N]	How many walls does the cooking location have [number]	Does the cooking location have a roof? [Y/N]	How many windows did the cooking location have?	How many of these windows were open or uncovered while the stove was on? [number]	How many doors did the cooking location have?	How many of these doors were open or uncovered while the stove was on? [number]	How long was the stove alight?	How long did you spend next to the alight/smoking stove during this
	Stove type [Use stove codes]	Fuel type [Use fuel code]									

												event? [hour]
	Were any of the stoves used during the AFTERNOON away from your home alight at the same time?		1=Yes 2=No [Go to C3] 3= Only one stove used [Go to C3]					First stove simultaneously alight. [Use stove codes]		Second stove simultaneously alight. [Use stove codes]		How long were the stoves alight at the same time [hours]
	Notes/observations [Explain other types of stove use and events here].											

C. Cooking Practices – Elsewhere : EVENING											
C3	Since our last visit, which stoves and fuels did you use AWAY from your home in the EVENING?		Is this the secondary cooking location? [Y/N]	How many walls does the cooking location have [number]	Does the cooking location have a roof? [Y/N]	How many windows did the cooking location have?	How many of these windows were open or uncovered while the stove was on? [number]	How many doors did the cooking location have?	How many of these doors were open or uncovered while the stove was on? [number]	How long was the stove alight?	How long did you spend next to the alight/smoking stove during this event? [hour]
	Stove type [Use stove codes]	Fuel type [Use fuel code]									

<table>
<tr><td rowspan="3"></td><td rowspan="2">Where any of the stoves used during the EVENING away from your home alight at the same time?</td><td rowspan="2">1=Yes
2=No [Go to D1]
3= Only one stove used [Go to D1]</td><td>First stove simultaneously alight.
[Use stove codes]</td><td>Second stove simultaneously alight.
[Use stove codes]</td><td>How long were the stoves alight at the same time
[hours]]</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="5">Notes/observations [Explain other types of stove use and events here].</td></tr>
</table>

D. Additional questions about cooking				
D1	Did you use your stove more, less, or the same since our last visit than you typically do?	1 = More 2 = Less 3 = Same		
D2	Do you usually leave your stove alight when not using it or do you extinguish it after each use?	1=Leave alight all/most of day. 2=Extinguish it after each use.		
D3	Since our last visit did you spend any time in the same rooms as or if outside within arm's length of an alight/smoking stove WHEN NOT USING IT? [Please note this can include ANY stove or fire not just the cooks own household stove.]	1=Yes 2=No [go to D6]		
D4	Since our last visit, how much time did you spend in the same room as or if outside within arm's length of an alight/smoking stove when not using it? [Please note this can include any stove not just the cook's own household stove. If more than one stove help participant to calculate total time.]	[Record in hours]		
D5	What type of stove(s) did you spend any time next to when alight/smoking when not using it? What type of fuel was burning on that stove?		Stove type [Use codes]	Fuel type [Use codes]
		Stove #1		
		Stove #2		

E. Additional Sources of Smoke				
E1	Since our last visit were you exposed to any of the following sources of smoke during the last 24 hours? [Read through each of the sources listed below if they state they were exposed to that type of smoke please ask the number of hours the participant was near this non-cookstove source of smoke and the location of the source]		Time exposed since last visit [Minutes/hours]	Location of source 1 = In home kitchen 2 = In home not in kitchen 3 = Outdoors near home 4 = Elsewhere
		Charcoal making		
		Crop/agricultural residue burning		
		Trash burning		
		Kerosene wick lamps		
		Kerosene pressurized lamp		
		Mosquito coils		
		Candles		
		Incense		
		Heating with biomass burning		
		You smoked tobacco products [number of cigarettes or times pipe was lit]		
		Someone smoked tobacco products next to you [number of cigarettes or times pipe was lit]		
		Other [describe]: ______________		
	Notes from visit			