A review of the cook stove test methods and their applicability in small scale CDM cook stove projects

By: Walter Kipruto, Intern, SDM/SSU

1. Introduction

a) Description of the exercise

The exercise involved the review of the cook stove test methods and their applicability in small scale CDM cook stove projects. The following four cook stove test methods were reviewed:

- Water Boiling Test (WBT),
- Controlled Cooking Test (CCT),
- Kitchen Performance Test (KPT),and
- Stove Use Monitors (SUMs).

The information reviewed was based on CDM Project Design Documents (PDDs)[1] for existing cook stove projects or projects under validation, published documents based on past studies by cook stove researchers and experts as well as discussions with cook stove project implementers (including current CDM project developers).

b) Objectives of the exercise

- Analyse the merits and demerits of the cook stove testing procedures.
- Obtain the views of project implementers and other stakeholders on cookstove testing methods.
- Propose a more practical method for testing cook stoves under small scale CDM projects.

c) Summary of the document

This document analyses the four methods of cook stove testing i.e. Water Boiling Test (WBT), Controlled Cooking Test (CCT), Kitchen Performance Test (KPT) and Stove Use Monitors (SUMs). The information is based on published documents based on past studies by cook stove researchers and experts as well reports from and discussions with cook stove project implementers (including current CDM project developers). The merits and demerits of the cook stove test methods have been analysed and the application capability of each method assessed and compared under different situations. More importantly, the document recommends how the test methods could be applied under CDM methodologies.

2. Methodology

a) Review of relevant published articles, reports and presentations

The following set of documents were reviewed as part of collecting the information during the exercise:

- Consultant's report on specific questions regarding the methodologies AMS-IE and AMS-II.G -This was a report of a consultant contracted by the UNFCCC to look into some specific issues regarding the methodologies AMS-I.E "Switch from Non-Renewable Biomass for Thermal Applications by the User" and AMS-II.G "Energy Efficiency Measures in Thermal Applications of Non-Renewable Biomass".
- Project Design Documents (PDDs) for existing cook stove projects or projects under validation - A total of 6 PDDs were reviewed.

[1] Project Design Document (PDD) - This is a standard document used by the project developers provide precise project description. The document serves as the basis for the CDM project validation by the Designated Operational Entities (DoEs).

- Published documents based on past studies by cook stove researchers and experts (See reference)
- Relevant websites (such as HEDON and PCIA)

b) Communication with project proponents and stakeholders

In addition, we contacted several project proponets to obtain their views on cookstove testing methods with regard to CDM projects. About 10 project participants were contacted. The correspondence was through phone discussions and email. For email correspondence a small questionnaire to guide the respondents was used.

c) Discussion with SSU/Small scale team and members of SSC-WG

Finally, face to face discussions with the SSU/Small scale team and members of the SSC-WG was a very important during the review exercise. This was extremely important since the exercise coincided with the 30th SSC-WG (14-18 March 2011) meeting during which the methodologies were being discussed.

3. Findings and conclusions

a) Types of the cook stove testing methods reviewed

There are four methods of testing cooking stoves namely:

- Water Boiling Test (WBT)
- Controlled Cooking Test (CCT); and
- Kitchen Performance Test (KPT).
- Stove Use Monitors (SUMs) which is currently under development.

b) Water Boiling Test (WBT)

Overview

WBT is a laboratory test that involves the investigation of the cooking stoves in a controlled environment in order to evaluate or reveal their technical performance. This method focuses on simulation of cooking practices by water boiling hence does not present the actual cooking conditions. WBT is very vital at the time of the design of the cook stoves (Kirk R. Smith et al., 2007).

Note: Although WBTs were initially designed as laboratory tests, it is important to note that they can as well be carried out in the field particularly for in situ cook stoves[2] or huge cook stoves that cannot be transported to the laboratory.

The process of testing involves three main stages i.e.

- Cold-start-high-power phase - This stage involves raising the temperature of water from ambient temperature to boiling point[3] from a cold start. This simulates rapid cooking tasks like making tea, boiling milk e.t.c (Kirk R. Smith et al., 2007).
- Hot-start-high-power phase - This stage involves raising the temperature of water from ambient temperature to boiling point when the stove is already hot.
- Low power simmering phase - This phase involves maintaining the boiling water at simmering temperatures i.e. about 2-3 degrees below the boiling point of water. This simulates slow cooking tasks like cooking rice, beans or hard grains (Kirk R. Smith et al., 2007).

The key parameters that can be investigated by WBT include; *thermal efficiency, combustion efficiency, fuel consumption, fuel burn rate* and *time to boil*. These parameters measure the technical performance of stoves and vary from one stove to the other. Note that the tests must be carried under the same conditions in order to obtain meaningful results.

---

[2] In situ cook stoves can be defined as fixed stoves constructed on site or those that are not mobile.

[3] The boiling point of water differs from place to place and therefore has to be measured for a specific place where the measurements are to be taken.

Merits

- The method is quick and simple;
- WBT is cheap and requires minimal resources (finances, technical and human resources) to carry out;
- WBT is suitable for comparing different stove designs in terms of technical performance;
- WBT does not involve complex logistics;
- This method allows easy computation and quantitative analysis of data hence can give exact values of parameters to measure;
- It is easier to replicate WBT from one area to another;

Demerits

- WBT does not reveal the performance of the stoves during actual/real cooking. It only provides a rough approximation. The accuracy of the measured parameters are therefore not ascertained hence may give inaccurate results during application;
- Difficulty in extrapolating WBT results to actual field performance without complimentary data from actual users;
- The tests must be carried out under the same conditions in order to obtain meaningful results.
- This approach cannot be used to compare the performance of stoves situated at different locations due to different prevailing conditions e.g. types of fuel, cooking habits, types of cooking pots e.t.c;
- This method only focuses on the quantitative indicators of performance such as efficiency, burn rate, specific fuel consumption e.t.c. However, it is important to note that there are other qualitative factors particularly those emanating from stove users and the environment which affect stove performance and these cannot be measured using this method;
- Trained technicians are required to perform WBT tests hence this limits the applications in areas (particularly remote areas) where they may be difficulty in getting trained technicians.
- This method cannot evaluate user satisfaction and utilisation patterns of the cook stoves;
- This method cannot be used to evaluate the impact or effectiveness of the cook stove project/interventions on the community/beneficiaries;
- WBT cannot assess fuel savings among the beneficiaries.

c) Controlled Cooking Test (CCT)

Overview

CCT is a laboratory or a field test that evaluates the performance of the cooking stoves using a standardised local cooking task(s). This method reveals behaviour of the stove under the ideal cooking conditions in a locality/project area. CCT tests the efficacy[4] of the cook stoves.

The summary of the CCT process is enumerated below:

- The first step involves identification of the appropriate cooking task based on the cooking practices within the project area. In addition, it is also important to identify the prevailing local conditions and cooking behaviours. This can be achieved through consulation with community or through a survey.
- The next step is to describe in detail the procedures to be employed during the test while taking into consideration the identified cooking task, local conditions as well as cooking practices.

---

[4] Efficacy test means the evaluation of ideal/maximum performance of the cook stoves under the actual operating conditions in the households.

- Last but not least, the test is performed in accordance with the set out procedures and results documented and evaluated. Note that local cooks may be employed to carry out the cooking tasks hence providing realistic results regarding the project area.

The key indicators that can be measured from this technique are the *fuel consumption* and the *speed of cooking (time of cooking)*. Considering that this procedure simulates the actual cooking, it is therefore capable of providing reliable results as compared to the WBT with regard to predicting actual performance and fuel consumption in the field. However, it may not predict the outcomes of uncontrolled usage of the cook stoves in actual practice.

Merits

- CCT is capable of providing reliable results as compared to the WBT with regard to predicting actual performance and fuel consumption in the field;
- CCT is relatively simple and consumes less time as compared to the KPT. However, it is relatively complex and time consuming as compared to WBT;
- It is easier to replicate CCT from one area/cook stove to another provided the cooking tasks and operating conditions are similar;
- CCT is relatively cheaper and requires minimal resources as compared to KPT but is relatively expensive as compared to WBT. However, the output of CCT is more reliable as compared to the WBT;
- CCT allows the possibility of considering qualitative factors.

Demerits

- The outcomes of CCT for one project area cannot be translated to a different project area;
- CCT cannot measure stove utilisation patterns and adoption of cook stoves by the beneficiaries;
- CCT cannot measure the effectiveness, impact and sustainability of the cook stoves projects;
- In case local cooks are used to carry out the tasks, they need adequate training on how to handle the stoves beforehand;
- The process of obtaining prior information (e.g. through surveys) before performing the tests increase the logistics required under this technique;
- Although CCT simulates actual cooking tasks, the method may not be able to predict the outcomes of uncontrolled usage of the cook stoves in actual practice.

d) Kitchen Performance Test (KPT)

Overview

Of the four tests, KPT is the most complex. KPT is a field test that evaluates the performance of the stove as well as the effectiveness and impact of the cook stoves in real cooking settings.

The process of KPT involves both qualitative survey and quantitative measurements. Two kinds of qualitative surveys are carried out i.e. pre-treatment survey which is designed to assess the situation of households before dissemination of stoves and post treatment surveys which are designed to assess the impact of the cook stoves in the households. KPT is useful in *determining the fuel consumption*, *gauging user satisfaction* and *assessing the impact and effectiveness of the cook stove interventions*.

Merits

- Measures the real performance of stoves in the households under the real operating conditions;
- This method assess the impact of stoves on fuel use and stove utilisation patterns/trends over long term;

- KPT determines the behavioural changes of the beneficiaries after the introduction of the cook stoves;
- KPT is able to predict the outcomes of uncontrolled usage of the cook stoves in actual practice;
- KPT is able to assess the adaption of the stoves by the beneficiaries.

Demerits

- This method is expensive, time consuming and labour intensive;
- This method is relatively complex in terms of logistics and requires field research skills;
- KPT has a limitation because it leads to intrusion into beneficiaries daily activities hence may not be popular;
- Due to lack of controlled scenario, there is a high possibility of variability of results in KPT than the controlled testing methods (WBT and CCT). This can be mitigated by selecting large samples which is more expensive;
- KPT requires complicated sample selection processes;
- KPT is not suitable for stove design and cannot be used to compare the performances of different stoves.

e) Stove Use Monitors (SUMs)

Overview

This is a new development of installing electronic temperature data loggers in the cookstoves in order to monitor stove use. The temperature data loggers are commercially available and are small, rugged and low cost. This method can be used to replace survey methods in determining reliable estimates of stove utilisation by the beneficiaries.

The SUMs mainly measure the temperature changes over a period of time which are stored in the memory of the data logger. As a result, the temperature profile of the cook stove can be determined. This information can be analysed in order to establish stove utilisation patterns by the beneficiaries.

Merits

- This method is relatively cheap and reliable;
- The results obtained from SUMs are accurate and safe since they are stored in the memory of the data logger;
- This method can be used to replace survey methods in determining reliable estimates of stove utilisation by the beneficiaries;
- The SUM is small and easy to install in the cook stove;
- The SUMs are easy to maintain;
- The SUMs can be modified to transmit data wirelessly;
- The SUMs can be programmed to suit the application;
- This methods makes data analysis easy;
- SUMs can facilitate the establishment of a live database for the cookstoves maintained within a project.

Demerits

- The SUM is currently limited to measuring stove utilisation only. As a result it is not able to measure other important parameters such as efficiency, fuel consumption e.t.c;
- The amount of data is limited by the size of the memory of the SUM;
- The SUM uses a battery and therefore requires battery replacement;
- The beneficiaries (especially from rural areas) need to be informed to take care of the SUMs to avoid damage.

f) Comparison of the three techniques

The table below summarises the comparison of the four testing techniques (categorised as controlled and non controlled) with regard to the measurement of the key indicators/parameters:

Parameter	Controlled		Non controlled	
	WBT	CCT	KPT	SUMs
Determining stove overall efficiency	✓	✓	✗	✗
Determining fuel consumption	✓	✓	✓	✗
Time or speed of cooking (a specific meal)	✓	✓	✗	✗
Assessing stove utilisation patterns	✗	✗	✓	✓
Evaluating the adaptation of cook stoves	✗	✗	✓	✓
Evaluating the sustainability of the cook stove project	✗	✗	✓	✗
Gauging user satisfaction	✗	✗	✓	✗

Key:

✓ - Measurement possible
✗ - Measurement not possible (or difficult)

g) Correlation of the three main cook stove testing techniques

There is very limited information regarding the correlation of the three main cook stove testing methods. However, there is a study that was carried out in Mexico that tried to correlate the three testing methods on two types of cook stoves {i.e. Patsari improved cook stove and a three stone fire (TSF)}. The following results regarding the fuel consumption for the three testing methods were obtained from a study titled *Energy Performance of wood-burning cookstoves in Michioacan, Mexico (By Victor M. Berrueta, Rufus D. Edwards, Omar R. Masera, 2007).*

Test	Details	Patsari	TSF	Variance	% savings	Remarks
WBT	High power cold start	0.49	0.19	0.30	N/A	Specific fuel consumption (kg wood/kg water). No savings
	High power hot start	0.18	0.13	0.05	N/A	Specific fuel consumption (kg wood/kg water). No savings
	Low power simmer	0.19	0.29	-0.10	-34%	Specific fuel consumption (kg wood/kg water)
CCT	Standard cooking task	0.64	1.49	-0.85	-57%	Fuel for cooking tortilla per task (Kg wood/kg tortilla)
KPT	Household study	1.40	3.26	-1.86	-57%	Fuel consumed per household per day (Kg/cap/day). Survey done 6 months after the dissemination of the cook stoves

The results indicate that fuel consumption for the three techniques can be correlated. However, the results from the WBT is different from CCT and KPT. This information is useful and gives an indication that default factors linking the three methods can be derived. However, this information may be biased to the specific project and therefore more information regarding the correlation is required from different studies before making a conclusion.

h) Summary of public comments on WBT 4.0 (latest version)

As part of the exercise, the public comments on the latest version of the Water Boiling Test (WBT 4.0) were reviewed. Most of the reviewers agreed that the latest version was better than the earlier version. However, a number of issues were noted which are summarised below (See annex 3 for details)

- **Procedures -** Some reviewers recommended a number of improvements on the procedures in order to enhance the performance.
- **Calculations and formulas -** Some reviewers identified errors in the formulas while others required clarifications on some parameters.
- **Indicators/Parameters to measure -** A number of reviewers suggested inclusion of some additional parameters in the testing protocol.
- **Application of the test method -** A few reviewers suggested that the WBT should not be used for CDM methodology or for proving real fuel savings in the field. This is because the WBT does not predict the performance of the cook stove in the field.
- **Documentation -** There were documentation errors such as formatting, phrasing and grammar which were identified and recommended for revision.

i) Key cook stove parameters and their respective monitoring challenges

A close examination of the key indicators (mentioned above in section h) for monitoring cook stoves, reveal that they can be categorised in three main areas particularly as regard to CDM methodologies:

- **Baseline scenario determination** - This mainly affect the computation of the amount of verifiable emissions reduction and accuracy is of great significance. Therefore, the indicators used should be quantifiable, specific and easily verifiable.
- **Continuous monitoring/verifications** - Continous verifications are necessary during project implementation in order to monitor the actual emission reduction. This determines the amount of CERs issued and therefore accuracy of the test methods is of great significance. Furthermore, the frequency of carrying out the tests is equally very important in order to ensure that the information required (depending on the nature) is obtained on a timely manner.
- **Evaluation** - Evaluation is necessary in measuring the impact or the effectiveness of the outcomes of the cook stove projects. This aids in assessing the sustainability of the activities as well as impact on emission reduction. Accuracy of the results is not of great significance since the objective is normally to get the overall trend of the situation.

Objectively verifiable indicator	Possible category of indicator	Means of verification	Remarks including monitoring challenges and limitations
Stove overall efficiency	Baseline & continous monitoring	WBT or CCT	• This indicator is useful for continous monitoring particularly in the assessment of the condition or the technical performance of the cook stoves over time. • Stove efficiency is inversely proportional to the specific fuel consumption (for a specific cooking task). • Stove efficiency is a dynamic indicator that is highly influenced by the operating conditions. It is therefore not a reliable indicator for determining the baseline scenario especially if determined under controlled conditions without considering field factors. • Analysis of stove efficiency using CCT method is difficult, involving and limited.
Fuel consumption	Baseline & continous monitoring	WBT or CCT	• Fuel consumption can be used to determine the energy requirements and therefore is a useful indicator for determining the baseline scenario if accurately measured. • Accuracy is of paramount importance while verifying this indicator. • This indicator can also be used to assess the performance or condition of the cook stoves continuously over the project period as it is linked to stove efficiency. • The controlled tests have a limitation of predicting the fuel consumption during actual cooking. However, CCT can be modified as much as possible to reflect actual cooking hence may give relatively better results than WBT.
Time or speed of cooking (a specific meal)	Continous monitoring	WBT or CCT	• This parameter is important for comparing the technical performance of different cook stoves as well as assessing the condition of the cooke stoves over time. • As fuel consumption, speed of cooking/time of cooking is a function of the efficiency of the cook stove. • Time of cooking also varies from one place to the other depending on the cooking practices.
Stove utilisation	Continous	KPT or	• This is an outcome of the cook stove projects, an indicator of

Objectively verifiable indicator	Possible category of indicator	Means of verification	Remarks including monitoring challenges and limitations
patterns	monitoring & evaluation	SUMs	behavioural change in the community. • KPT will mainly rely on surveys to establish the utilisation patterns. • On the other hand, SUMs are installed on the cook stoves hence determine their usage continuously during the project duration. SUMs therefore, offers the best mode of checking utilisation patterns. • The output of the stove utilisation patterns are useful in determining the adaptation of the cook stoves by the beneficiaries.
Adaptation of cook stoves	Evaluation	KPT or SUMs	• This is an impact indicator which can be evaluated in long term. It indicates the level of acceptance of the cook stove by the beneficiaries. It is also an indicator of the sustainability of the cook stove project. • This can be measured through KPT surveys or assessing the long term data from the SUMs. • Accuracy of the testing method is not a major factor while measuring this indicator.
Sustainability of the cook stove project	Evaluation	KPT	• This is an impact indicator measuring the overall performance of the stoves in terms of qualitative and quantitative factors. It can only be evaluated on a long term basis in order to obtain meaningful results. • This can be determined by establishing the adaptation and success of the cook stoves, good technical performance as well as the continuity of usage. • KPT is the best method for evaluating this indicator by employing both qualitative and quantitative techniques.
Cook stove user satisfaction	Continous monitoring & evaluation	KPT	• This indicator can be measured continuously and on a long term to assess the trend of cook stove user satisfaction. • This depends on the performance of the stoves, ease of use, durability, flexibility and aesthetic values from the users point of view. • This outcome varies from user to user hence KPT surveys are the best for measuring this indicator.

j) Application of the tests in current projects (based on available PDDs)

A review of the ongoing projects or projects under validation reveals that most of them prefer WBT for determining the efficiencies of the new stoves, household survey for determining the average fuel consumption and IPCC default values for the efficiency of the old stoves (See table below for examples reviewed). Therefore, it is evident that without restricting the method of test, the project developers will most likely choose WBT due to simplicity and low costs involved. However, this is purely dependent on the kind of the project developer and the methodologies they employ in their organisations.

Project	Indicator/Means of determining the indicator		
	f_c	η_{old}	η_{new}
Efficient Wood Fuel Stove-Cooking-Sets, Lesotho (CDM7122, Lesotho/Atmosfair)	Household baseline survey	IPCC default values	WBT
Improved cook stove project for SAMUHA (CDM6591, India/Fair Climate)	Historical & Past Studies	IPCC default values	WBT
Improved Cook Stoves CDM project of JSMBT (CDM6594, India/Fair Climate)	Historical & Past Studies	IPCC default values	WBT
Efficient Fuel Wood Cooking Stoves Project in Foothills and Plains of Central Region of Nepal (CDM5957, NEPAL/Egluro)	Household baseline survey	IPCC default values	WBT
Protection of Cameroon estuary mangroves through improved smoke houses (CDM6677, Cameroon/ONF International)	Household baseline survey	CCT (Wood Consumption test)	CCT (Wood consumption test)
Efficient Fuel Wood Stoves for Nigeria (CDM4491, Nigeria/Atmosfair)	Household baseline survey	IPCC default values	WBT

NB: The results from the examples above may be biased because of the few project proponents.

Where:

f_c =Average fuel consumption per appliance per unit time (or per household)

η_{old} =Efficiency of the replaced cook stove

η_{new} =Efficiency of the new cook stove

k) Feedback from project proponents and other stakeholders

One of the important part of this exercise was to obtain the feedback from project proponents. The following project proponents/stakeholders have provided their views regarding the testing techniques:

- Atmosfair (See annex 1 for details of the discussions).
- Fair Climate Network (See annex 2 for details of the discussions)

Summary of the key points is provided in the table below:

Project proponent/ stakeholder	Key points
Atmosfair (Germany)	• Project proponents should be given the choice to select the mode of testing that suits them. However, if uniformity is to be achieved, then default values for uncertainty corrections for each test is recommended. • There is lack of adequate guidance with regard to the implementation of the tests particularly field tests and especially on sampling. UNFCCC should provide clear guidance on this. • KPT presents actual settings in the field but is more expensive and has complex logistics and may not be suitable for small projects.
Fair Climate Network (India)	• There is inadequate guidance on the application of the methodology for cook stove testing methods especially for field studies. Therefore, there is a need for comprehensive guidelines that are easy to apply in order to provide an operating framework as well as direction during the implementation of the methodology hence ensuring consistency. • In addition to having a comprehensive guidance, default correction factors for each testing method may be a good option of simplifying the cook stove testing process.

l) Application of the test techniques in CDM methodologies (including preliminary recommendations)

The choice of the test method to be applied for CDM methodologies should be based on the following factors:

- **Purpose of the test** - The results of the test methods may be required for baseline scenario or verification/continous monitoring or evaluation. For instance, baseline scenario and verification require a high degree of accuracy because they determine the amount of verifiable emissions reduced. However, the high degree of accuracy is not of high significance while evaluating the impact or sustainability of the cook stove projects.
- **Indicators to test** - Some of the indicators can be determined from a controlled environment while others can be determined in the field.
- **Size of the project** - The size of the project determines the level of effort and resources required as well as the amount of emissions reduced. As a result, a combined assessment of cost, benefits and reliability is relevant while selecting the test method.
- **Duration of the project** - Similar to the size of the project, this factor determines the level of effort and resources required hence a combined assessment of cost, benefits and reliability is relevant while selecting the test method .
- **Frequency of verification/testing** - This determines when and how often the tests should be carried out. The amount of resources required for the test and the type of the indicator determines the frequency of testing.
- **Operational conditions** - It is very important to understand the conditions under which the stoves will work before prescribing the method of testing. These includes but not limited to the cooking practices, environmental factors, types of fuel among others.

Depending on the size of the project, this can be determined from local knowledge or through survey.

- **Situation before project implementation** - A critical review of the situation before project implementation is necessary for determining the suitable test method. This is important particularly for establishing the baseline scenario. Information of the project beneficiaries such as the nature and types of stoves available, types of food, social classes, types of fuel, environmental conditions e.t.c should be identified and these will provide the necessary inputs to be considered while determining the test procedures hence ensuring the reliability of the outcomes.

Considering the varying application of the testing methods on the key indicators, it is therefore necessary to consider the above factors and develop the guidelines for selecting the cook stove testing method. The guidelines can be modelled in the following ways:

- **Modified CCT** - CCT method should be modified to include the information regarding the situation of the project before implementation as well as operational conditions in order to obtain results which predict field utilisation of cook stoves. This will present an immediate intervention that will ensure accuracy and more reliable data for determining the emission reduction. But guidelines should be developed depending on the various project scenarios.

- **Testing matrix** - Also, as an immediate intervention, a matrix that will guide the project implementers on the selection of the test methods to be applied may be prepared. The matrix should consider all the different project scenarios in order to mitigate the associated risks. In addition, the matrix should be straight forward and easy to apply. Development of the matrix should involve the current project proponents and stakeholders.

- **Tests correlation factors** - In the long term, a study should be carried out to determine the correlation between the laboratory based tests and the actual field tests. This will enable the project proponents to rely on the laboratory tests and apply the correlation factors in order to obtain reliable results. It is important to note that the correlation factors may differ from region to region and therefore a database maintaining such information is necessary.

- **Modelling of SUMs to enhance monitoring capability** - SUMs provide a very reliable and flexible means of monitoring cook stoves. The monitoring process will be eased if the SUMs are modelled to enhance their monitoring capacity for instance to measure stove efficiency and fuel consumption. However, this will require further research since use of SUMs is new.

4. References

1. Rufus Edwards, Technical Advisor to SSG WG of the CDM Executive Board of UNFCCC, *Final Report on the Technical Inputs on Methodological Approaches for Improving the Usability and Robustness of Estimation Methods in Non-Renewable Biomass Methodologies*
2. Karen Weinbaum, *Standard Stove Performance Testing: Darfur Stoves*, University of California, Berkeley
3. Kirk R. Smith et al., 2007, *Performance testing for monitoring improved biomass stove interventions: Experiences of the Household Energy Project*, Energy for Sustainable Development (Vol. XI No. 2)
4. Victor M. Berrueta, Rufus D. Edwards, Omar R. Masera, 2007, *Energy Performance of wood-burning cookstoves in Michioacan, Mexico*, Sceince Direct
5. Kirk R. Smith et al., 2007, *Monitoring and evaluation of improved biomass cookstove programs for indoor air quality and stove performance: conclusions on the Household Energy and Health Project,* School of Public Health, University of California, Berkeley

6. Ilse Ruiz-Mercado, Nick L. Lam, Eduardo Canuz, Gilberto Davila, Kirk R. Smith, *Low-cost temperature loggers as stove use monitors (SUMs)*, University of California, Berkeley
7. Household Energy Network(HEDON) website <http://www.hedon.info/>
8. The Partnership for Clean Indoor Air(PCIA) website <http://www.pciaonline.org/>
9. Cookstove.net website <http://www.cookstove.net/others/fuel-economy.html>

5. Annexes

Annex 1: Discussions with Atmosfair on cooking stoves

Situation at Atmosfair

- Atmosfair has two cook stove CDM projects in Africa i.e. Nigeria and Lesotho.
- Atmosfair has so far used WBT and KPT (partial) in their cook stove CDM projects implemented in Nigeria and Lesotho.
- WBT is used to determine the efficiency of the cook stoves which is an important parameter for determining the quantity of fuel used.
- The selection of the WBT was mainly driven by the requirements of the methodology which requires the efficiencies of the cook stove to be determined.
- KPT (partial) is only used at the beginning of the project when determining the baseline scenario particularly while collecting information regarding the fuel consumption per household and cooking practices.
- CCT has not been used on the current CDM projects hence no valuable experience.

Comments on testing

- Florian would recommend that the PPs should be left to decide on the choice of the testing.
- However, for uniformity purposes across the CDM projects, default values for uncertainty correction for each test is recommended. The default values may be regional since the tests may provide varying results from region to region.
- WBT is simple and easy to carry out while at the same time the results can be reproduced. However, it does not represent the real settings in the households.
- On the other hand KPT is expensive and involve a lot of logistics. The variability of the outcomes is also high hence requires large samples in order to obtain useful and meaningful statistical data.
- Regarding guidance, Florian notes that there is limited guidance on how to carry the tests, particularly field tests where sampling is necessary. It is therefore important to provide comprehensive, simple and easy to understand guidelines to the PPs regarding the implementation of the tests.
- Also, it was noted from the discussion that the size of the project should be a key factor in determining the type of the test to use.
- Regarding the DOEs, the discussions revealed that the PPs and DOEs may conflict as regards the best method for carrying out the tests. For instance in the Nigeria project, the DOEs had to carry out their tests in order to be comfortable with the results. In order to avoid such conflicts and mistrusts, the UNFCCC should come up with guidelines clear to both parties on how to carry out the tests.

-Annex 2: Discussions with Fair Climate on cooking stoves

Situation at Fair Climate

- Fair climate has two cook stove small scale CDM projects in India. The projects are still at validation stage.
- In addition, Fair Climate is also developing project documents for another cook stove project but under the Gold Standard methodology.
- WBT (in accordance with the PCIA guidelines) was used in the determination of baseline scenario for the two CDM projects.
- Kitchen Test was used in for the cook stove project under Gold Standard in accordance with the requirements of the methodology.

Comments on testing methods

- Use of the cook stove testing methods is a new experience to Fair Climate since the organisation has not used them before and that the current projects are new. As a result, there is inadequate information to conclude on the effectiveness of these cook stove testing methods. However, this is expected to improve during the implementation of the cook stove projects as more information will be collected.
- Although WBT and KPT have been used by Fair Climate for the new cook stove projects, no comparison with regard to their performance has been made.
- Regarding comparison of the Gold Standard and CDM methodologies, Gold Standard methodology is the most comprehensive for the cook stove projects. However, the implementation is time consuming and expensive. On the other hand the CDM methodology for cook stove is easier to use, less expensive and allows the project developers to decide on the specific tasks.
- A very important point coming out of the discussion was inadequate guidance to apply the methodology. It is important to have comprehensive and easy to apply guidance which provide a framework as well as direction during the implementation of the methodology hence ensuring consistency.
- In addition to having a comprehensive guidance, default correction factors for each testing method may be a good option of simplifying the cook stove testing process.

Annex 3: A summary of public comments on WBT 4.0 (latest version)

Source	Summary of key messages and issues from the comments
Aga Khan Planning and Building Services, Pakistan	• The method does not consider heating requirements • Other stove accessories such as water warming facility have not been considered
Appropriate Rural Technology Institute, Pune	• Issues with the procedure of testing particularly on the treatment of charcoal during high power test • Difference between the thermal efficiency during high and low power phases. Thermal efficiency should be recorded for two phases separately.
Asian Regional Cookstove Programme (ARECOP)	• Unusually high thermal efficiency when the water is bioled for long time. Evaporated water should be considered in order to mitigate • Net change in char should be monitored since it is an indication of combustion quality • Comments on improvement of the procedure
Berkeley Air Monitoring Group	• Suggestion on inclusion of guidance on sample size calculation in order to treat the variability of the tests • Noting lack of direction on instrumentation calibration • Queries regarding consideration of other functions of multi-pot stoves such as water warming in an integrated water tank or jacket • Recommendation that the tests should be based on final products and not prototypes
China Association of Rural Energy Industry (CAREI)	• Highlights the differences between WBT 4.1.2 and Thermal Performance Test Method for Household Firewood Stoves of China Standard • Suggestion that WBT should be simple so that users can easily understand and operate.
Chip Energy, and Biomass Energy Foundation	• Suggestion Alcohol should be included as part of liquid fuels • Suggestions on procedures - Cold start to Simmer to Hot start (optional)
Dian Desa Foundation, Indonesia	• Formula documentation clarifications • Unusually high thermal efficiency when the water is boiled for long time. Evaporated water should be considered in order to mitigate • Net change in char should be monitored since it is an indication of combustion quality • Comments on improvement of the procedure
Eco Limited	• Issues on whether the test can relate to field performance. Suggestion to validate it if it tests field performance(preferably in different countries). • Scepticism on whether the WBT 4.1.2 matches or predicts real performance as stated in the protocol • Clarifications on some procedure steps
ENDEV/GTZ, Peru	• Improvement on the procedure regarding indoor air pollution • Suggestion to review some sections of the documentation.
Energy Institute, Cape Peninsula	• Recommendation on improvement on phrasing and language to be easy and understandable
Envirofit, Philips and Colorado State University	• Suggestion on improvements of cook stove testing to enhance accuracy and mitigate variability
EPA	• Suggestions on improving phrasing as well as procedures
Gratis Foundation	• Clarification on the impact of time of day and wind
Grupo Interniscipplinario de Technolgia Rural Apropiada	• Suggestion of considering energy contribution for multi-pots in low power phase • Suggestion of modification of the calculation of thermal efficiency and the energy transfer rate • Suggestion to include the temperature profile of the cook stove during testing
GTZ	• Suggestion to include biogas data
GTZ Bolivia	• Suggestions to improve the spreadsheets • Suggestions to improve the testing procedure
Moi University, Kenya	• Suggestions on improvement of test procedures • Suggestions for measuring burn rate
Pro Peru	• Suggestions on factors to consider while carrying out the tests e.g. material of pot, size of pot e.t.c
Resource Efficient Agricultural Production	• Issue on using pre-selected use of fuel would create bias due to variability of fuels across the world
Rozis Jean-Francouis	• Suggestion that WBT should not be used for CDM or any tentative to prove real fuel savings in the field • Issue on missing information regarding accuracy of result • Suggestions on improving the test method
Soil Control Lab	• Suggestion on characterising the fuel
Solar Connect Association	• Suggestion that WBT cannot reflect what happens in the kitchen
Sustainable Energy Testing and Research Centre	• Suggestion that heterogeneous (non uniform) method of testing is needed and that the homogeneous method is not sufficient. • WBT give little indication of how stoves are actually used • Suggestion that CCT and KPT are the only once which can enable understanding of how stoves perform in real settings • Suggestion that KPT is the measure of community behaviour and not the performance of the stoves • Identifies issues on the procedures and suggestions on improving the procedure of test • Suggestions on how indicators should be determined and units
University of California, Irvine	• WBT should not be used in the determination of carbon dioxide equivalent savings nor used to estimate contributions to CGH emissions or pollution