SEI STOCKHOLM ENVIRONMENT INSTITUTE

POLICY BRIEF

Assessing the Climate Impacts of Cookstove Projects: Issues in Emissions Accounting

Key Findings

- **Carbon finance is gaining appeal as a way to scale-up improved cookstove projects while also meeting the need for standardization and accountability. Researchers have found the potential volume of credits could exceed 1 billion tonnes of carbon dioxide equivalent (CO_2e) per year.**
- **To be viable and ensure environmental integrity, these projects need credible, scientifically robust methodologies to measure and verify emission reductions. More research is needed to improve methodologies.**
- **Cookstove projects can generate offsets through the Clean Development Mechanism (CDM) and from three voluntary offset programs: the Gold Standard, the American Carbon Registry, and the Verified Carbon Standard (VCS). To date, all but one project has used the CDM, the Gold Standard, or both.**
- **Emission reductions from cookstove projects are calculated as the product of the amount of woody biomass saved, the fraction that is considered non-renewable biomass, the net calorific value of the biomass, and an emission factor for the fuel used. Each of these factors presents technical challenges that would benefit from further methodology work.**
- **Cookstove projects' climate benefits are not limited to carbon dioxide; they can also significantly reduce emissions of black carbon, carbon monoxide, and total non-methane hydrocarbons. However, these benefits are not yet quantified by the methodologies, nor can credits be earned for them.**

Globally around 2.6 billion people – 40% of the world's population – still rely on traditional biomass fuels (wood, crop residues, dung, etc.) for cooking. Indoor air pollution from open fires and smoky stoves is a major health hazard, and fuelwood collection puts pressure on forests and scrubland and keeps women and children away from school or income-producing work. Moreover, traditional biomass burning produces greenhouse gases (GHGs) and black carbon, contributing to climate change.

A wide range of private and public funders have supported clean-cookstove projects to date, but attracting sufficient finance, especially for large-scale projects, has been difficult. This has made carbon markets an attractive option, and several projects have already monetized the emission-reduction benefits of improved cookstoves through the Clean Development Mechanism (CDM) and other market mechanisms.

Yet more could be done. The global technical potential for GHG emission reductions from improved cookstove projects has been estimated at 1 gigatonne of carbon dioxide (1 Gt CO_2) per year, based on 1 to 3 tonnes of CO_2e per stove. The low relative cost of GHG abatement, combined with strong development and environmental co-benefits, have added to cookstove projects' appeal.

This policy brief, based on an SEI working paper, focuses on a key precondition for cookstove projects to obtain carbon finance and to ensure environmental integrity: credible, scientifically robust methodologies to measure and verify emission reductions. We review existing methodologies, drawing on a literature review as well as interviews with market actors and technical experts, and identify gaps that need to be filled.

A Guatemalan mother prepares a meal on an improved cookstove

While our analysis focuses on project-based offset methodologies, the findings may also be relevant to Nationally Appropriate Mitigation Actions (NAMAs), broader sectoral crediting mechanisms, or non-crediting mechanisms that involve quantification of GHG benefits.

Methodologies reviewed

Cookstove projects can currently generate offsets through the CDM or through three voluntary offset programs: the Gold Standard, the American Carbon Registry (ACR), and the Verified Carbon Standard (VCS). All four programs' methodologies apply to projects that are introducing a stove technology and consider the emissions savings from reducing or displacing the use of non-renewable biomass for household heating and cooking. Table 1 outlines the specific methodologies and applicable versions that we reviewed.

Table 1: Improved cookstove carbon crediting methodologies reviewed

Programme	Gold Standard	CDM – AMS II.G[a]	CDM – AMS I.E[a]	ACR version of AMS I.E.
Methodology version reviewed	Version 1.0, 11/04/2011[b]	Version 05[c]	Version 05[d]	April 2011[e]
Applicability	Introduction of technologies/practices that reduce or displace GHG emissions from thermal energy consumption by households, institutions, commercial or industrial premises	Introduction of high-efficiency thermal appliances utilizing non-renewable biomass or retrofitting existing units to reduce the use of non-renewable biomass	Introduction of renewable energy technologies that displace the use of non-renewable biomass	

a All CDM methodologies may be used to develop projects under the Verified Carbon Standard (VCS): http://v-c-s.org/methodologies/what-methodology

b The Gold Standard (2011) Technologies and Practices to Displace Decentralized Thermal Energy Consumption. Geneva. http://www.cdmgoldstandard.org/wp-content/uploads/2011/10/GS_110411_TPDDTEC_Methodology.pdf.

c UNFCCC (2012). AMS II.G.: Energy Efficiency Measures in Thermal Applications of Non-renewable Biomass – Version 5.0. Valid from 7 December 2012. United Nations Framework Convention on Climate Change, Executive Board of the Clean Development Mechanism. http://cdm.unfccc.int/methodologies/DB/REQC2MYZJJ6I7BC9SKCS32T2K87AOW.

d UNFCCC (2012). AMS-I.E.: Switch from Non-renewable Biomass for Thermal Applications by the User – Version 5.0. Valid from 3 August 2012 onwards. United Nations Framework Convention on Climate Change, Executive Board of the Clean Development Mechanism, Bonn. http://cdm.unfccc.int/methodologies/DB/WHTQUFLWCVNB9CIUZC198A712WGQR4.

e American Carbon Registry (2011). Switch from Non-renewable Biomass for Thermal Applications by the User. Methodology based on CDM approved simplified baseline and monitoring methodology AMS I.E, Version 03, modified for ACR by Katene Kadji. Arlington, VA, US. http://americancarbonregistry.org/carbon-accounting/carbon-accounting/switch-from-non-renewable-biomass-for-thermal-applications-by-the-user.

The projects

Approved and under-development cookstove projects are expected to yield more than 10 million offset units over their first crediting periods (7 or 10 years). All but one have gone either through the Gold Standard or the CDM; to date no projects are under development under the ACR, and only one has been developed under the VCS. Project activity has increased considerably since methodologies were first approved in 2008.

Although over half the credits under development are through the CDM, the Gold Standard plays a pivotal role in the market for cookstove offsets. Close to 40% of CERs projected under the CDM also aim to be certified under the Gold Standard. Together, Gold Standard Verified Emission Reductions (VERs) and Gold Standard-certified CERs account for over three-quarters of the offsets under development from cookstove projects.

To give a sense of typical CDM projects, one Nigerian project involved distribution of up to 12,500 efficient wood stoves in the Guinea Savannah Zone. A Program of Activities (PoA) CDM project in El Salvador, meanwhile, distributed over 100,000 stoves designed to use pieces of wood from tree trimmings, which avoids cutting whole trees.

The geographic distribution of cookstove projects is distinct from other project types in the CDM pipeline, with relatively few projects in Asia and the Pacific region and a majority in Africa.

The European Union's decision to restrict eligibility of Certified Emission Reductions (CERs) for CDM projects approved after 2012 to those hosted in Least Developed Countries (LDCs) could provide new opportunities for cookstove projects in LDCs. However, LDCs are a restricted group of developing countries that represent less than 10% of the developing world's population. There remains a considerable need for such projects in non-LDC countries such as Kenya, Nigeria and India, where much of the population is poor and at least two-thirds still rely on traditional biomass for cooking.

Measuring emission reductions

Emission reductions in cookstove projects are calculated as the product of the biomass fuel savings, the fraction that is considered non-renewable biomass, the net calorific value (NCV) of the biomass, and an emission factor for the fuel used. These are not just one-time measurements, but require monitoring to ensure that the projected emission reductions are achieved. Below we address four of these factors.

Estimating biomass fuel savings

There are three options for quantifying the biomass fuel saved by an improved stove: the Kitchen Performance Test (KPT), the Water Boiling Test (WBT), and the Controlled Cooking Test (CCT).

The Kitchen Performance Test is performed in an actual kitchen in the field. The KPT better represents actual cooking behaviour, but KPT measurements are subject to large uncertainties. The laboratory-based *Water Boiling Test,* which compares how much fuel is needed to boil water with different cooking technologies, is simple, standardized and replicable, but the results do not necessarily match what happens when meals are cooked in households. The *Controlled Cooking Test,* which replicates cooking tasks in a lab, offers a compromise, better representing local cooking while being conducted in a controlled environment.

Published studies and project developers interviewed generally agree that the KPT is a more robust method to gauge actual fuel savings. It is costlier, but can also deliver a larger volume of offset credits, because stoves that are optimized for real-life cooking tasks such as making tortillas may underperform at boiling water, which requires more intense heat.

However, market actors interviewed noted that most project developers using the CDM methodology choose the WBT, because it is cheaper and easier, with default values provided by the stove manufacturer. The decision to use the WBT vs. KPT may also depend on the project size: project developers said that for a larger-scale project or PoA, the KPT is likely to be much less feasible.

To the extent that the WBT is still used, it can be improved. Quantification relies on separate methods to estimate values for baseline fuelwood consumption and for the efficiency of the traditional stove being replaced (this is also true for the CCT). Market actors interviewed suggested developing conservative default values for these parameters to use instead of in-field values, to reduce uncertainty. The CDM methodology provides some default values, but experts said they do not cover the range of cookstoves in most countries.

Monitoring stove usage

Monitoring ensures that projected emission reductions are actually achieved. A key challenge is determining the extent to which the new stoves have replaced the old. There is an assumption that new stoves meet all cooking needs, but technical experts interviewed said that is "definitely not the case" and results in an overestimation of new stove use. The KPT test helps address this, since it measures actual fuel usage in each household. One approach that has been suggested is to use data loggers affixed to stoves, such as the Stove Use Monitoring System (SUMS) developed at the University of California–Berkeley and sold by Berkeley Air.

The CDM methodology requires checking the efficiency of the stoves (all, or a representative sample) and confirming at least every two years that the stoves are still in use. Additional monitoring is required annually (or biennially if project proponents can demonstrate no significant efficiency losses in the new device), with the specific factor to be monitored depending on which test protocol is used (fuel consumption for the KPT, efficiency for the WBT, and specific fuel consumption for the CCT).

Measuring non-renewable biomass use
Cookstove offset projects are based on the premise that improved stove efficiency or fuel substitution reduces the use of non-renewable biomass. Yet determining the fraction of fuelwood that is non-renewable is perhaps the most difficult challenge for offset crediting methodologies.

The CDM Executive Board has defined woody biomass as non-renewable if at least two of the following four conditions are documented: a) an increase in time spent or distance travelled for gathering fuelwood or in the distance that fuelwood is being transported; b) depletion of carbon stocks in the project area; c) an increase in fuelwood prices, indicating scarcity; or d) changes in the types of cooking fuel collected by users that indicate a scarcity of woody biomass.

Specific approaches and guidelines for quantifying the fraction of non-renewable biomass (f_{NRB}) vary across the protocols. Until recently, CDM methodologies included guidance on how to interpret the definition of non-renewable biomass, but no quantification approaches or default factors to estimate the fraction. Technical experts and market actors interviewed said the lack of a standardized approach was a barrier to project development. One recent study found that differences in how non-renewable biomass is quantified contributed 47% to the uncertainty of emission reductions generated for a cookstove project in Mexico.

As a result, the CDM Executive Board sought to provide minimum default factor for fraction of non-renewable biomass. After requesting stakeholder input on potential approaches, in May 2012, the CDM Executive Board issued national default factors for fNRB for nearly 60 countries. Using the highly aggregated mean annual increment (MAI) approach, the aggregate country-specific values are determined based on the difference between total annual national biomass removals and the portion of demonstrably renewable biomass from growth in protected reserve areas. The large majority (over four-fifths) of default values exceed 80%, with the remainder ranging from 40% to 77%.

Several market actors interviewed characterized development of default fNRB values as a "huge triumph". However, there are still concerns that the values are based on poor-quality data from forest resource assessments and

Photo courtesy Uganda Carbon Bureau

A woman in Uganda uses the Okelo Kuc charcoal stove, from the International Lifeline Fund.

that national-level estimates fail to account for heterogeneous climatic and geographic conditions that impact fuelwood supply and demand, thus over- or under-estimating the fNRB parameter.

Fossil fuel emission factors
Under the CDM cookstove methodologies, one key element in quantifying emission reductions is the fossil fuel emission factor of "substitution fuels likely to be used by similar users". The use of this factor has been criticized as unscientific, with significant negative implications for the CERs awarded. The reason for using fossil fuel emission factors for cookstove projects is that the Marrakech Accords prohibit crediting for increasing carbon stocks due to avoided deforestation in the CDM Use of the notion fossil fuel substitution is thus a "workaround" to this limitation.

For charcoal production, the simplification is further stretched beyond reality: as shown in project design documents, developers may assume that the project would also displace the use of fossil fuels to make charcoal, even though such fuels are rarely, if ever, used. Nevertheless, project developers interviewed said moving away from this approach would be challenging, as it might require agreement among international negotiators to include avoided deforestation within the CDM.

Non-CO_2 emissions
Cookstove emissions include additional gases that have a large global warming impact but are not yet considered by offset methodologies (nor have they been considered, for the most part, in international climate negotiations). In particular, solid biomass used for cooking and heating is estimated to contribute 25% of black carbon emissions globally.

Under the CDM methodologies, however, stove projects can only receive credit for reducing CO_2 emissions. Under the Gold Standard methodology, however, projects may also get credit for reductions in methane and nitrous oxide (CH_4 and N_2O) emissions. Using the Gold Standard approach, the combined effect of the additional accounting of CH_4 and N_2O emissions from biomass combustion, plus the use of real conditions for the baseline (instead of fossil fuel values as in AMS II.G) can double the estimated emission reductions for stove projects.

Recent work suggests that of the options for reducing black carbon emissions, residential stove and fuel interventions offer the highest net benefits per cost. While development of emission factors for black carbon, and an applicable conservative crediting approach, was noted by market actors interviewed as providing a potential real benefit for capturing this emissions source from projects, progress has been limited by the site-specific nature and the complexity of black carbon compared with other emission sources.

Conclusion

Carbon offset markets can provide a valuable means to support the further dissemination of improved cookstoves in developing countries. Offset markets can bring new sources of private-sector finance into projects and help to establish standards for monitoring and accountability. In addition, the methodologies developed for offset projects could also be useful for NAMAs and other forms of carbon finance.

Nevertheless, this review suggests there remains considerable room for improvement in how offset methodologies account for the climate benefits of improved cookstoves. Below we identify several specific needs and potential directions for future research.

This policy brief is based on SEI Working Paper No. 2013-01, with the same title, by Carrie Lee, Chelsea Chandler, Michael Lazarus and Francis X. Johnson, available at http://www.sei-international.org/publications?pid=2252.

Policy recommendations

- **Require accounting of uncertainty in estimates of emission reductions:** Uncertainty in emission reduction estimates can be large, yet current methodologies do not require accounting for it. This could be addressed by requiring that the IPCC recommendations for uncertainty from the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories be applied to project emission reductions calculations.
- **Develop additional default factors for biomass consumption from baseline stoves:** Currently the CDM methodology only provides a very limited set of default baseline fuelwood consumption and efficiency values; additional default factors could reduce uncertainty and further standardize estimates. Development of default factors has been limited by high variability of existing data estimates.
- **Track the application, and review the integrity, of the new CDM default factors for fNRB**: There are reasons to believe that the current default factors, which imply that over 80% of all biomass use is non-renewable in most countries assessed, may be too high. Application of community and sub-national modeling assessments should be encouraged to validate and improve upon these values.
- **Refine approaches to incorporate the use of data loggers in project monitoring:** While it is generally assumed that new stoves replace old stoves for all cooking needs, observations suggest that this is not the case. Some have proposed using data loggers to measure real fuel usage in households and gauge the new stoves' impact. However, further refinement is needed on how best to incorporate data loggers into monitoring plans and quantification of emission reductions in methodologies.
- **Revisit the use of fossil-fuel CO_2 emission factors as surrogates for biomass combustion:** Under the CDM methodology, CO_2 emissions factors for cookstoves are based on fossil fuel emissions, justified as the "substitution fuels likely to be used by similar users". This approach may result in a large under-crediting of cookstove projects and deserves further evaluation and review.
- **Consider black carbon and non-CO_2 greenhouse gas emissions:** Black carbon can make up a large portion of the climate impact of cookstove use, and yet it is not currently considered by carbon market methodologies. Under the CDM methodologies, neither are methane and nitrous oxide emissions (the Gold Standard methodology does include it). Omission of these emissions may not only result in under-crediting of cookstove projects, limiting their implementation, but could also lead to incorrect judgments about the relative benefit of different stoves.

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