# Brief on Quantification Methodologies for Black Carbon (BC) Reduction Benefits

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1. Short-lived Climate Pollutants (SLCPs) include black carbon (a component of fine particulate air pollution), methane and several short-lived HFCs. They last in the atmosphere for a few days or weeks, in the case of black carbon, up to a few years and have a strong warming impact on the climate in the short-term. They are emitted from source that are closely aligned with World Bank lending sectors including energy, transportation, waste management, and agriculture.

2. Long-term climate stabilization requires decarbonization regardless of action on SLCPs; however, complementary action on SLCP provides the opportunity to slow the rate of warming over the next several decades and avoid up to 0.6°C in 2050; extend and improve the quality of lives (potentially saving 2.4 million lives through air quality improvement and avoiding 30 million tons of crop losses by 2030); and provide additional time to adapt to eventual climate stabilization targets.

3. Within the energy sector, residential combustion of solid biomass fuels for cooking, heating and lighting is one of the largest sources of black carbon.

4. Health and/or climate benefits are distinct from estimates of black carbon emission reduction and can vary widely for a given magnitude of black carbon emission reduction depending on technology choice (affecting pollutant mix), exposure characteristics (determining health benefits) and geographical location and combustion conditions (climate impacts).

5. The World Bank-led Black Carbon Finance Study Group (BCFSG) has found, "efforts are needed to strengthen the performance measurement tools and enabling environment that will make it possible to channel finance for black carbon abatement – including clean cooking – on a wider scale." Specifically, the BCFSG report calls for partners to:
    a. Continue to fund and support the development and use of black carbon performance standards.
    b. Convene a group of 10-15 black carbon science and finance experts to reach consensus on and recommend the indicator (or indicators) on the basis of which black carbon [climate and health] performance shall be measured and financed across sectors.
    c. Task the group with developing a standardized approach for determining and communicating estimation uncertainty to financiers (using risk ratings or other approaches), as well as other guidance on the development of black carbon accounting methodologies.
    d. Initiate a dialogue on mainstreaming black carbon among development finance institutions, to determine and coordinate appropriate approaches.

6. Based – in part – on these recommendations, the Climate and Clean Air Coalition (CCAC) is hosting a panel of climate and health experts at a workshop to take place on 16 and 17 March 2017 in Ottawa, Canada. One objective of the workshop is to forge greater consensus around potential metrics and approaches appropriate to key global institutions for use in methodologies to translate various measures of black carbon abatement into health and or climate benefits.

7. The Gold Standard has a methodology for estimating the health benefits of reduced exposure to total fine particulate matter from clean cooking interventions – including BC and other components of $PM_{2.5}$ – expressed in Avoided Disability-Adjusted Life Years (ADALYs).[1] This methodology requires project developers to measure personal exposure to $PM_{2.5}$ pre- and post-intervention and to utilize the web-based HAPIT tool to convert these exposures to ADALYs. The methodology cautions that *exposure* is not necessarily correlated with *emissions* or *concentrations*, thus the importance of having a distinct methodology for each attribute being valued.

8. Gold Standard has also developed a methodology[2] for the quantification of black carbon (and co-emitted species) *emissions reductions* for cookstove interventions. This was developed and reviewed with support of diverse group of stakeholders, contributing to general international acceptance of this methodology for cookstove emissions (including BC, OC, CO, NMVOC, and sulfates) many of which are not covered by existing CDM methodologies.

9. The Gold Standard BC methodology expresses all co-emitted species emissions in terms of "black carbon equivalent" emissions by means of a BC equivalent conversion factor, which is a ratio of the average GWP of co-emitted species to the average GWP of BC using a 20-year time horizon as calculated by the IPCC on a global basis, but the resulting estimate is kg of BC reduced, not climate impact. The methodology allows for use of region-specific factors, but those are subject to further review.

10. Project Surya has developed a methodology[3] for taking emissions reductions of GHGs and SLCPs one step further to estimate the *climate* benefits of cookstove intervention emissions reductions. This approach makes use of some region-specific assumptions for South Asia (e.g. fraction of non-renewable biomass~0.88, regional forcing estimates of direct effects and surface forcing, regional assumptions about an assumed fraction and behavior of OC that is emitted as so-called *brown carbon*, which consists of organic compounds that have been shown to be highly absorbing rather than reflective as is the case with typical organic carbon emissions, etc.). The result is a methodology that is highly specific to forced-draft improved stoves that replace mud stoves using typical fuels from, and located in India and the Gangetic plain.

11. Jeuland et al.[4] have conducted a global cost-benefit analysis of clean cooking solutions that makes use of a novel approach to valuing the near-term climate benefits of BC and co-emitted pollution reductions in an economically consistent manner to the long-term climate stabilization benefits of CO2 and other long-lived greenhouse gases. He credits colleague Drew Shindell with calculations of emissions that are normalized according to the time-discounted global warming potential of $CO_2$ for $CO_2$, CO, $CH_4$, N2O, $SO_2$, BC and OC. This approach yields a metric measured in $CO_2$e that has a more physically appropriate basis for comparing one species against another relative to the standard GWP (especially for shorter-lived species like BC), however is very dependent on the choice of a social discount rate and discounts future warming relative to current warming. This could be one potential basis for a future multi-pollutant climate benefit methodology.

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[1] *Methodology to Estimate and Verify Averted Mortality and Disability Adjusted Life Years (ADALYs) from Cleaner Household Air*, Draft 0.1, November 2, 2016 at: http://www.goldstandard.org/sites/default/files/documents/adalys_methodology_draft_public_consultation_v0.1_02112016.docx

[2] *Quantification of climate related emission reductions of Black Carbon and Co-emitted Species due to the replacement of less efficient cookstoves with improved efficiency cookstoves, Version 1.0, March 2015.*

[3] *Surya Methodology for Deriving Climate Credits for Improved Solid Biofuel Cookstoves, N. Ramanathan, I. H. Rehman, A. Kar, R. Bahadur, O. Patange, V. Jha, V. Ramanathan, March, 2014.*

[4] *Analyzing the costs and benefits of clean and improved cooking solutions, M. Jeuland and J.T. Soo, Global Alliance for Clean Cookstoves Research Report 459, http://cleancookstoves.org/resources/459.html*

12. Lacey et al.[5] have developed a method for assessing climate and health benefits of clean cooking interventions globally based upon modeling and observations. While not a methodology for use by project developers, it does provide estimates of the per-cookstove impacts on ambient air quality and global mean surface temperature for every individual country with significant cookstove use (accounting for location and typical fuel characteristics) and considering reductions to both aerosols and long-lived greenhouse gases over the next century. This could also serve as the technical basis and methodological approach for a project-based climate benefit methodology. Namely, to utilize model-derived factors that are regionally-specific but that estimate the globally and annually averaged impact of a given intervention based upon relatively few inputs (e.g. location, degree of combustion oxidation).

13. As described, a variety of approaches for estimating the climate impacts of BC and co-emitted pollutants (BC_climate) have been considered; however, there remain significant uncertainties and assumptions within each approach that warrant further consideration by an international accrediting body such as Gold Standard. Questions that should be considered by such a body include:
    - What metric should be used to estimate BC_climate credit? [$CO_2e$? degrees of warming in a given year, or degrees of warming 10 years out? Based on GWP or GTP?]
    - Can/should BC_climate credits be fungible with carbon credits? [partly determines the metric, i.e. whether to use $CO_2e$ or not]
    - Can/should BC_climate credits allow for partial impacts of BC and co-pollutant emissions? [i.e. can a methodology quantify the direct radiative forcing or snow/ice surface forcing, but ignore the more uncertain cloud impacts?]
    - Can/should BC_climate credits be based on global average impacts and calculations or should credits be specific to the geographic location where a project occurs? [i.e. Do we need to develop a "look-up table of forcing efficiency of various pollutants for every region of the planet? Can these be based on model calculations? Or do we need observational verification for each region?]

14. Summary: Given the number of open questions, there may not yet be demand for "financeable" certified BC_climate benefits; however, given the increasing evidence of global benefit (e.g. Lacy et al. referenced above) that the vast majority of cookstove interventions that result in simultaneous reductions of BC, OC, $SO_2$ and $CO_2$ are likely to yield a net cooling or Jeuland et al.'s finding that benefits significantly outweigh costs for cleaner cooking interventions on a global basis), there may be significant donor demand for financeable credits based solely on a black carbon equivalent emissions reduction (i.e. to credit *BC emissions reductions* with an implicit assumption that clean cooking interventions *on a global scale* will yield large net health and climate benefits even if every single project may not). For that purpose, the existing Gold Standard BC emissions methodology is sufficient. To establish more certainty around the specific climate benefits of a given clean cooking interventions, a methodology similar to what has been developed for estimating health-related $PM_{2.5}$ exposure reduction benefits in units of ADALYs is needed to translate the estimated emissions reductions of all co-emitted pollutants (short- and long-lived species) into some climate-relevant metric based upon internationally agreed methods.

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*[5] Lacy F, Henze D, Lee C, van Donkelaar A, and Martin R, (2016) Transient climate and ambient health impacts due to national solid fuel cookstove emissions, PNAS at http:www.pnas.org/cgi/doi/10.1073/pnas.1612430114 and Lacey F, Henze D (2015) Global climate impacts of country-level primary carbonaceous aerosol from solid-fuel cookstove emissions, Environ Res Lett 10(11):114003.*