Incentivizing Health and Climate Stoves with Carbon Credits

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Global Warming Potential and You

In 2017, Gold Standard releases: "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"

What would CO2e savings look like for a baseline/project scenario when **tech-specific emission factors** are included?

Species	Global Warming Potential (GWP)-20 (IPCC, 2013)
BC	2421
OC	-244
CO	5.9
VOCs	14
SO_4^{-2}	-141
CH4*	81

*included for clarity, already factored in methodology

Six Stoves from “Cookstove Emissions and Performance Evaluation…”

A. LPG B. Pellet C. Wood Fan D. Wood Rocket E. TSF F. Charcoal

Experimental Set-up

Definitions:

- EF: emission factor (ton/TJ)
  - Amount of mass emitted for each terajoule of fuel combusted
- fNRB: factor of non-renewability (%)
  - Proportion of trees that are harvested unsustainably
- GWP: Global Warming Potential
  - Determines future radiative forcing from climate gasses; a ratio related to CO2

Default Factors:

$$ER_y = (SFC_{b,y} - SFC_{p,y}) \times \left((fNRB \times EF_{b,f,CO2}) + EF_{b,f,non-CO2}\right) \times NCV_{b,fuel} - \sum LE_{p,y}$$

$$EF_{b.f.non-CO2} = 9.46\ tCO2e/TJ$$

$$EF_{b,f,CO2} = 112\ tCO2/TJ$$

Tech-Specific Factors:

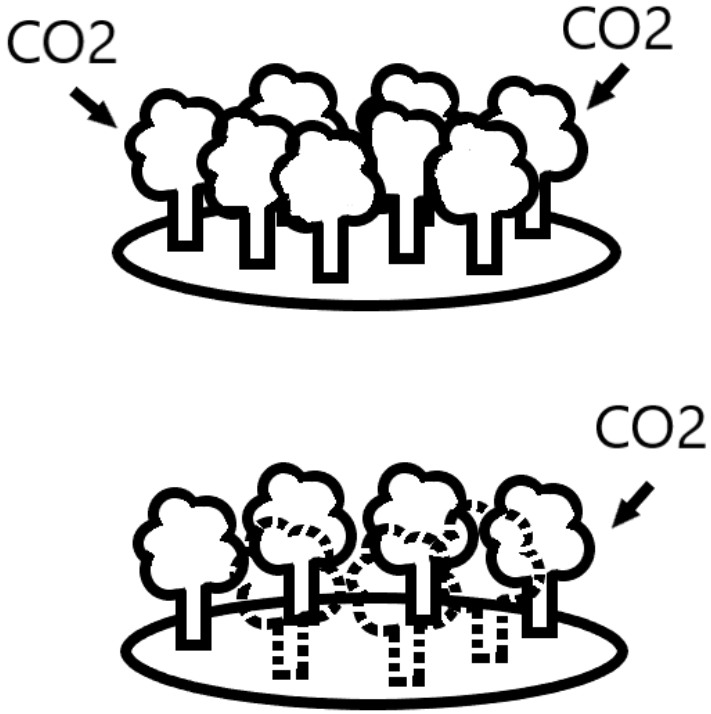
$$ER_y = (B_{b,y}EF_b - (U_{p,y} \cdot B_{p,y}EF_p + DF_{b,stove,y} \cdot B_{b,y}EF_b)) \times NCV_{biomass} \times Adj_{LE}$$

$$EF_b = \left(f_{NRB,y} * EF_{CO2} + \sum_i GWP_{non\ CO2,i} \times EF_{non\ CO2,i}\right)$$

$$EF_p = \left(f_{NRB,y} * EF_{CO2} + \sum_i GWP_{non\ CO2,i} \times EF_{non\ CO2,i}\right)$$

Methodology Assumptions

- Ignoring usage and adoption
- fNRB set to 30%, applied to CO2 only
- SO_4^{-2} not included in analysis
- Emissions factors vary each test
- Short-lived climate forcers (SLCFs) GWP values vary depending on location, altitude, and concentration
- Valuable for comparison of technology-specific emissions factors



As non-renewable biomass is consumed, CO2 absorption shrinks until enough biomass regrows

Emissions Reductions using Default Emission Factors - fNRB @ 30%

	Emissions per Year, CO2 only (tonnes)	Emissions per Year, CO2 + CH4 + CO (tonnes CO2e)	Emissions Reductions per Year, CO2 + CH4 & CO (tonnes CO2e)
TSF	1.95	2.49	-
Pellet	0.59	0.76	1.73
Wood Fan	0.70	0.89	1.60
Wood Rocket	0.69	0.88	1.62
Charcoal	0.80	1.02	1.47
Jetflame Stove	0.50	0.65	1.85

Emissions Reductions using Measured Emission Factors - fNRB @ 30%

	Emissions per Year, CO2 + CH4 + CO (tonnes CO2e)	BC/OC Ratio	Increase/Decrease in CO2e due to Tech Emissions Factors	Emissions per Year, CO2 + CH4 + CO + SLCFs (tonnes CO2e)	Emissions Reductions per year in CO2e due to Tech Emissions Factors + SLCFs	Change in CO2e due to Tech Emission Factors + SLCFs
TSF	2.49	38.4%	0.22	6.01	-	141%
Pellet	0.76	101.5%	-0.11	0.71	5.30	-6.77%
Wood Fan	0.89	46.7%	-0.09	1.14	4.88	27.5%
Wood Rocket	0.88	129.1%	0.13	4.61	1.40	424%
Charcoal	1.02	147.4%	1.31	3.44	2.57	235%
Jetflame Stove	0.65	5.65%	0.50	0.99	5.03	52.6%

Results

CO_2e emissions for the TSF **more than double** when including BC and OC.

CO_2e emissions for all stoves increase, especially stoves with high PM2.5.

Charcoal stoves produce CO, increasing CO_2e

Wood Rocket stoves produce high BC, increasing CO_2e

Forced draft stoves emit low CO_2e via reduced BC and OC emissions compared to the TSF.

Recommendations

Allowing for technology specific emissions factors better represents emissions.

Tracking BC & SLCFs (**like NOx**) in general will potentially lead to high CO2e emissions reductions **when using forced draft stoves**

Verra's VMR0006 and CDM's AMS-II.G do not apply fNRB in the same way, this must change.

$$ER_{y,i,j} = B_{y,savings,i,j} \times N_{o,i,j} \times n_{y,i,j} \times \mu_y \times f_{NRB,y} \times NCV_{biomass} \times EF_{projected\_fossil\ fuel}$$

Source: AMS-II.G Methodology

$$ER_y = \sum_i \sum_j B_{y,savings,i,j} \times N_{0,i,j} \times n_{y,i,j} \times \mu_y \times f_{NRB,y} \times NCV_{biomass}$$
$$\times \left(EF_{wf,CO2} + EF_{wf,non\ CO2}\right) \times Adj_{LE} \times (1 - u_d)$$

Figure: VMR0006 Methodology

QUESTIONS?