Supplementary material to Sundberg et al, Biochar from cookstoves reduces greenhouse gas emissions from smallholder farms in Africa

Table S1. Feedstock source and use (in kg dry mass per household and year)

Own calculations based on project data, Drigo et al. 2015; Kituyi et al. 2001a; Kituyi et al. 2001b

Feedstock	Source	Fraction of NRB	Reference system	Charcoal system	Biochar system
Eucalyptus wood	On farm, market	0%	1400	1400	1400
Grevillea robusta wood	On farm, market	0%	1400	976	1400
Acacia wood	Off farm, market	43%	700	0	190
Maize cobs	On farm	0%	0	0	700
Conventional charcoal	Market (20% off-farm wood)	9%	450	0	0

Table S2. Properties of the available primary and secondary fuels (on dry mass basis)

Own calculations based on Njenga et al., 2016; Pennise et al., 2001; Phyllis database

Feedstock	LHV [MJ/kg]	Moisture [%]	Carbon [%]	Ash [%]
Eucalyptus wood	16,9	10,7	45,6	1,4
Grevillea robusta wood	19,6	10,7	68,0	5,5
Acacia wood	18,5	10,7	42,0	1,0
Maize cobs	18,9	9,9	47,0	4,2
Conventional charcoal	32,4	5,3	78,7	2,4
Eucalyptus charcoal	27,1	7,2	75,7	3,1
Grevillea robusta charcoal	26,5	7,2	75,7	5,9
Acacia charcoal	32,0	7,2	75,7	2,2
Maize cob charcoal	28,7	8,7	82,8	5,8

Table S3. Performance of stove-fuel combinations

Own calculations based on project data, Bailis et al. 2003; Bond et al. 2004; Jain 1999; MacCarty et al. 2008; Pennise et al. 2001; Roden et al. 2006; Smith et al

Stove	Feedstock	Thermal efficiency [%]	Conversion efficiency [%]	Char yield [%]	Fuel carbon in [g/kg]	Solid carbon out [g/kg]	Carbon emitted [g/kg]	CO2 [g/kg]
Combustion								
Three-stone open fire	Eucalyptus wood	15	0		456	1,2	454,8	1536
	Grevillea robusta wood	15	0		680	1,8	678,2	2290
	Acacia wood	15	0		420	1,5	418,5	1390
Traditional charcoal stove	Conventional charcoal	30	0		750	0	750	2400
	Eucalyptus charcoal	40	0		757	0	757	2423
	Grevillea robusta charcoal	40	0		757	0	757	2423
	Acacia charcoal	30	0		757	0	757	2423
	Maize cob charcoal	32	0		828	0	828	2341
Conversion								
Earth mound kiln	Eucalyptus and Acacia wood	0	47,3	27,5	1600	750	716	1897
TLUD gasifier	Eucalyptus wood	21	29,2	18,2	456	137	319	1095
	Grevillea robusta wood	21	29,2	21,6	680	163	517	1775
	Acacia wood	21	29,2	16,9	420	127	293	1006
	Maize cobs	19	29,5	19,4	453	160	293	985
Biochar in soil	Eucalyptus and Grevillea robusta charcoal	0	0	0	757	0	151	555
	Acacia charcoal	0	0	0	757	0	151	555
	Maize cob charcoal	0	0	0	828	0	165	607

. 2000; Torres 2011; Whitman et al. 2010; Phyllis database

CH4 [g/kg]	N2O [g/kg]	CO [g/kg]	NMHCs [g/kg]	BC [g/kg]	OC [g/kg]	SO2 [g/kg]	RB credit [g CO2/kg]	Biochar credit [g CO2/kg]
2,83	0,07	60	7,98	0,282	0,659	0,40	1666	0
4,22	0,07	90	11,9	0,421	0,983	0,40	2485	0
3,20	0,18	79	1,60	0,330	0,770	0,20	869	0
18,9	0,25	274	3,37	0,183	0,238	1,26	2521	0
19,1	0,25	276	3,40	0,185	0,240	1,76	2774	0
19,1	0,25	276	3,40	0,185	0,240	1,48	2774	0
19,1	0,25	276	3,40	0,185	0,240	0,95	1573	0
18,5	0,25	400	3,29	0,357	0,464	1,65	3034	0
47,0	0,15	235	97,5	2,400	15,60	0,32	2407	0
1,64	0,04	30	6,87	0,060	0,352	0,08	1169	0
2,65	0,04	49	11,1	0,097	0,571	0,08	1894	0
1,50	0,04	28	6,31	0,055	0,323	0,04	609	0
1,47	0,12	40	6,18	0,108	0,634	0,28	1074	0
0	0	0	0	0	0	0	355	2219
0	0	0	0	0	0	0	316	1258
0	0	0	0	0	0	0	607	2427

Table S4. Global Warming Potentials for for a 100-year (GWP100) or 20-year (GWP20) time horizon

In calculations with pollutant set 1, characterisation factors for renewable biomass (RB) and non-renewable biomass (NRB) were used

In calculations with pollutant set 2, characterisation factors for NRB were used, complemented with carbon credits for RB

Bond et al. 2013; Bond et al. 2011; Fuglestvedt et al. 2010; IPCC, 2013; Shindell et al. 2009

		Non-renewable biomass		Renewable biomass	
	Pollutant group	GWP100, NRB	GWP20, NRB	GWP100, RB	GWP20, RB
Pollutant set 1					
CO_2	Kyoto gases	1	1	0	0
CH4	Kyoto gases	36	87	34	86
N_2O	Kyoto gases	298	268	298	268
Pollutant set 2					
CO_2	Kyoto gases	1	1		
CH4	Kyoto gases	36	87		
N_2O	Kyoto gases	298	268		
CO	Ozone precursors	4,98	18,6		
NMHCs	Ozone precursors	4,23	14		
BC	Aerosols and precursors	846	3200		
OC	Aerosols and precursors	-43,2	-160		
SO_2	Aerosols and precursors	-71,4	-140		