Calculation of Emission Reduction with improved Stoves, Thermos-Technology and Solar Cookers 11/27/2015 (11.04.2015)

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		A1	B1	C1	C2
	Equipment	**3-Stones-firewood**	**Ben 2**	**Charcoal tradit.**	**Charcoal improved**
Calculation of Efficiency and Power			**Ben 2 24cm pot**		
	Fuel	Firewood	Firewood	Charcoal	Charcoal
		Assumptions	**Test 03.02.2015**	**Assumptions**	**Assumptions**
Quantity Water	kg	**6**	**6**	**6**	**6**
Start-Temperature T1	**°C**	**25**	**12**	**25**	**25**
End-Temperature T2	**°C**	**100**	**100**	**100**	**100**
Temperature Difference	K	75	88	75	75
Specific Heat of Liquid Water	kJ/kg/K	4.18	4.18	4.18	4.18
Net Energy for Heat Up from T1 to T2	kJ	1,881	2,207	1,881	1,881
Amount of Vaporized Water	**kg**	**0.100**	**0.050**	**0.100**	**0.100**
Specific Heat of Vaporization	kJ/kg	2,260	2,260	2,260	2,260
Heat of Vaporization	kJ	226	113	226	226
Effective Energy E_eff	kJ	2,107	2,320	2,107	2,107
Amount of Consumed Fuel	**g**	**1405**	**411**	**351**	**234**
	kg	1.405	0.411	0.351	0.234
Mass Ratio Wood/Charcoal	**kg/kg**			**6.0**	**6.0**
Net Calorific Value Wood (15% Humidity)	kJ/kg	15,000	15,000	15,000	15,000
Net Calorific Value Charcoal	kJ/kg	30,000	30,000	30,000	30,000
Energy Input E_in	kJ	21,070	6,165	10,543	7,022
Remaining Mass of Charcoal	**g**	0	15	0	0
Remaining Energy E_rest	kJ	0	450	0	0
Consumed Energy E_consumed	kJ	21070	5715	10543	7022
Thermal Efficiency eta	%	**10.0%**	**40.6%**	**20.0%**	**30.0%**
Heat Up Time	**Minute**	**30.00**	**24.00**	**30.00**	**30.00**
Heat Up Time t	s	1800	1440	1800	1800
Effective Thermal Power Q_eff	kW	1.17	1.61	1.17	1.17
Firepower Q_fire	kW	11.71	3.97	5.86	3.90

	Equipment	**3-Stones-firewood**	**Ben 2**	**Charcoal tradit.**	**Charcoal improved**
			Ben 2 24cm pot		
	Fuel	Firewood	Firewood	Charcoal	Charcoal
Fuel Consumption per Year		**Assumptions**	**Test 03.02.2015**	**Assumptions**	**Assumptions**
Effective Energy Demand E_eff per Household per Year	**MJ/Year**	**6,000**	**6,000**	**6,000**	**6,000**
a) Fuel Consumption per Household per Year	**kg/Year**	**4,000**	**985**	**1,001**	**667**
Percentage of Saving f_thermo via Thermos Technique	**%**	**45%**	**45%**	**45%**	**45%**
Percentage of Saving f_solar via Solar Technique	**%**	**45%**	**45%**	**45%**	**45%**
b) Fuel Consumption including Thermos Technique	**kg/Year**	**2,200**	**542**	**550**	**367**
c) Fuel Consumption inluding Thermos and Solar Technique	**kg/Year**	**1,210**	**298**	**303**	**202**
Conversion to Consumption of Wood per Household per Year			from short rotation plant	stems and thick branches for charcoal prod.	
a) Without Thermos- and Solar Technique	**kg Wood/Year**	4,000	985	**6,005**	**3,999**
b) Including Thermos Technique	**kg/Year**	2,200	542	**3,303**	**2,200**
c) Including Thermos- and Solar Technique	**kg/Year**	1,210	298	**1,816**	**1,210**

Saving of Wood Consumption per Year					
a) Without Thermos- and Solar Technique	**kg Wood/Year**		**3,015**		**2,005**
b) Including Thermos Technique	**kg Wood/Year**		**3,458**		**3,805**
c) Including Thermos- and Solar Technique	**kg Wood/Year**		**3,702**		**4,795**
Saving if Transition from Charcoal to Ben Stove and Hay Basket	**kg Wood/Year**		**5,463**		
Saving if Transition from Charcoal to Ben, Hay Basket,Solar Cooker	**kg Wood/Year**		**5,707**		

Saving of CO2 with Assumption that Biomass is Non Renewably Harvested (f_nrb = 0,85).					
Emission Factor EF Wood (IPCC 2006)	**kg CO2/MJ**	**0.1120**	**0.1120**	**0.1120**	**0.1120**
Net Calorific Value NCV of Wood (UNFCCC, default value)	**MJ/kg Wood**	**15**	**15**	**15**	**15**
Fraction f_n of non-renewable biomass		**0.85**	**0.85**	**0.85**	**0.85**
Emission of CO2 per kg of Wood with f_nrb = 0,85	**kg CO2/kg Wood**	**1.428**	**1.428**	**1.428**	**1.428**
a) Without Thermos- and Solar Technique	**kg CO2/Year**		**4,305**		**2,864**
b) Including Thermos Technique	**kg CO2/Year**		**4,938**		**5,434**
c) Including Thermos- and Solar Technique	**kg CO2/Year**		**5,286**		**6,847**
Saving if Transition from Charcoal to Ben Stove and Hay Basket	**kg CO2/Year**		**7,801**		
Saving if Transition from Charcoal to Ben, Hay Basket,Solar Cooker	**kg CO2/Year**		**8,149**		

Calculation about Possible Savings Through Improved Stove, Thermos- and Solar Technique

Calulation of Stove Efficiency	Equipment	**3-Stones-firewood**	**Ben 2**	**Charcoal tradit.**	**Charcoal improved**
	Fuel	Firewood	Firewood	Charcoal	Charcoal
	Unit	**Assumptions**	**2/3/2015**	**Assumptions**	**Assumptions**
Amount of Water	kg	6	6	6	6
Rise of Temperature	K	75	88	75	75
Net Energy for Heat Up	kJ	1,881	2,207	1,881	1,881
Amount of Vaporized Water	kg	0.1	0.05	0.1	0.1
Heat of Vaporization	kJ	226	113	226	226
Effective Energy Delivered	kJ	2,107	2,320	2,107	2,107
Amount of Fuel	g	1,405	411	351	234
Energy Used	kJ	21,070	6,165	10,543	7,022
Remaining Amount of Produced Charcoal	g	0	15	0	0
Remaining Energy	kJ	0	450	0	0
Stove Efficiency		10%	41%	20%	30%
			Bailis:	15% … 25%	25% … 35%

Fuel Consumption per Year	Equipment	**3-Stones-firewood**	**Ben 2**	**Charcoal tradit.**	**Charcoal improved**
	Fuel	Firewood	Firewood	Charcoal	Charcoal
	Unit	**Assumptions**	**2/3/2015**	**Assumptions**	**Assumptions**
Net Energy Demand E_eff per Household per Year	MJ/Year	6,000	6,000	6,000	6,000
a) Fuel Consumption B per Household per Year	kg/Year	4,000	985	1,101	667
Percentage of Saving f_thermo via Thermos Technique		45%	45%	45%	45%
Percentage of Saving f_solar via Solar Technique		45%	45%	45%	45%
b) Fuel Consumption including Thermos Technique	kg/Year	2,200	542	550	367
c) Fuel Consumption including Thermos- and Solar Technique	kg/Year	1,210	298	303	202
Conversion to Fuelwood Consumption per Household per Year:			Short rotation plantation	Thick stems and branches for charcoal	
Mass Ration Wood/Charcoal (IPCC default value)	kg/kg			6	6
a) Without Thermos- and Solar Technique	kg Wood/Year	4,000	985	6,005	3,999
b) Including Thermos Technique	kg/Year	2,200	542	3,303	2,200
c) Including Thermos- and Solar Technique	kg/Year	1,210	298	1,816	1,210