IRENA
International Renewable Energy Agency

The potential for improved cookstoves to reduce carbon dioxide emissions

Adrian Whiteman, International Renewable Energy Agency (IRENA)

International Energy Workshop, Abu Dhabi, 3-5 June 2015

Background

Deforestation:

1980s fuelwood crisis

Health effects:

Indoor air pollution

Climate change:

Greenhouse gas emissions

Background

Carbon dioxide emissions in 2010 (in $MtCO_2$)

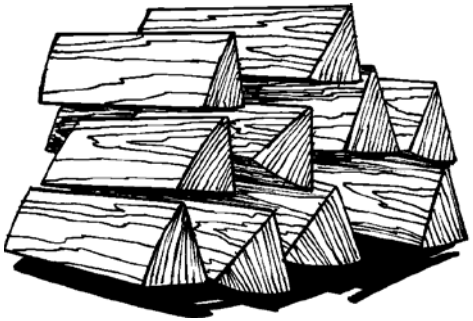
Region	Type of emission			Emissions from woodfuel use			Woodfuel share of total
	F. Fuel	LUC	Total	FW	CH	Total	
Africa	1,171	1,256	2,427	590	226	817	34%
Asia and Oceania	16,529	630	17,159	952	66	1,018	8%
Europe	6,009	-720	5,289	195	4	199	4%
North America	5,933	-116	5,817	50	7	57	1%
Latin America & Caribbean	1,691	1,365	3,056	297	74	371	12%
World	31,332	2,415	33,747	2,084	378	2,462	7%

Emissions from cooking = 1.8 billion tCO_2

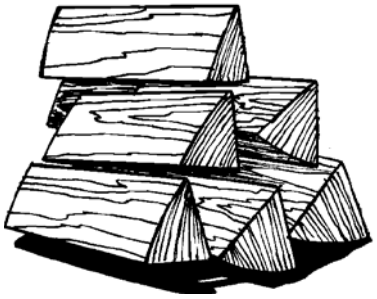
- 1.5 billion tCO_2 from direct use
- 0.3 billion tCO_2 from associated charcoal manufacturing

The basic economics

IRENA
International Renewable Energy Agency



$C\text{-}FW_{BASE}$ EM_{BASE}



$C\text{-}FW_{ICS}$ + C-ICS EM_{ICS}

$$\text{EMISSION REDUCTION COST} = \frac{C\text{-}FW_{ICS} + C\text{-}ICS - C\text{-}FW_{BASE}}{EM_{BASE} - EM_{ICS}}$$

Modelling framework

- Monte Carlo simulation, using ranges of cost, consumption and emission estimates
- 500 x 3 types of user (charcoal, urban FW, rural FW) x 73 countries
- 109,500 paired estimates of emission reductions and cost
- Scale-up to total user population, rank by emission cost and aggregate by emissions

Assumptions

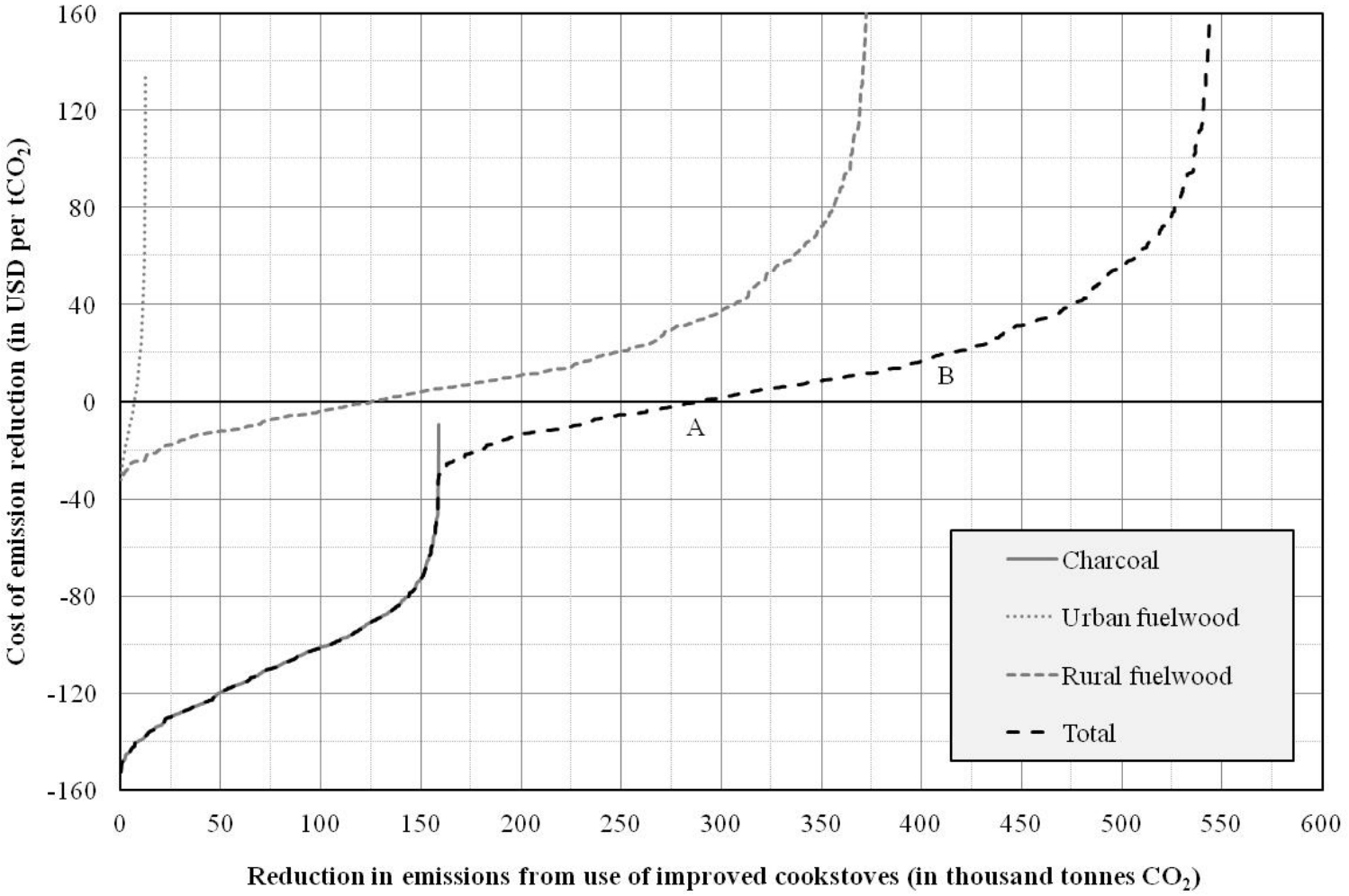
- A switch to an improved cookstove (ICS) would use the same type of fuel
- Charcoal and urban fuelwood users purchase fuel
- Rural fuelwood users collect or purchase, depending on the opportunity cost of time
- Additional distribution and extension cost for rural users

Cost data (ranges)

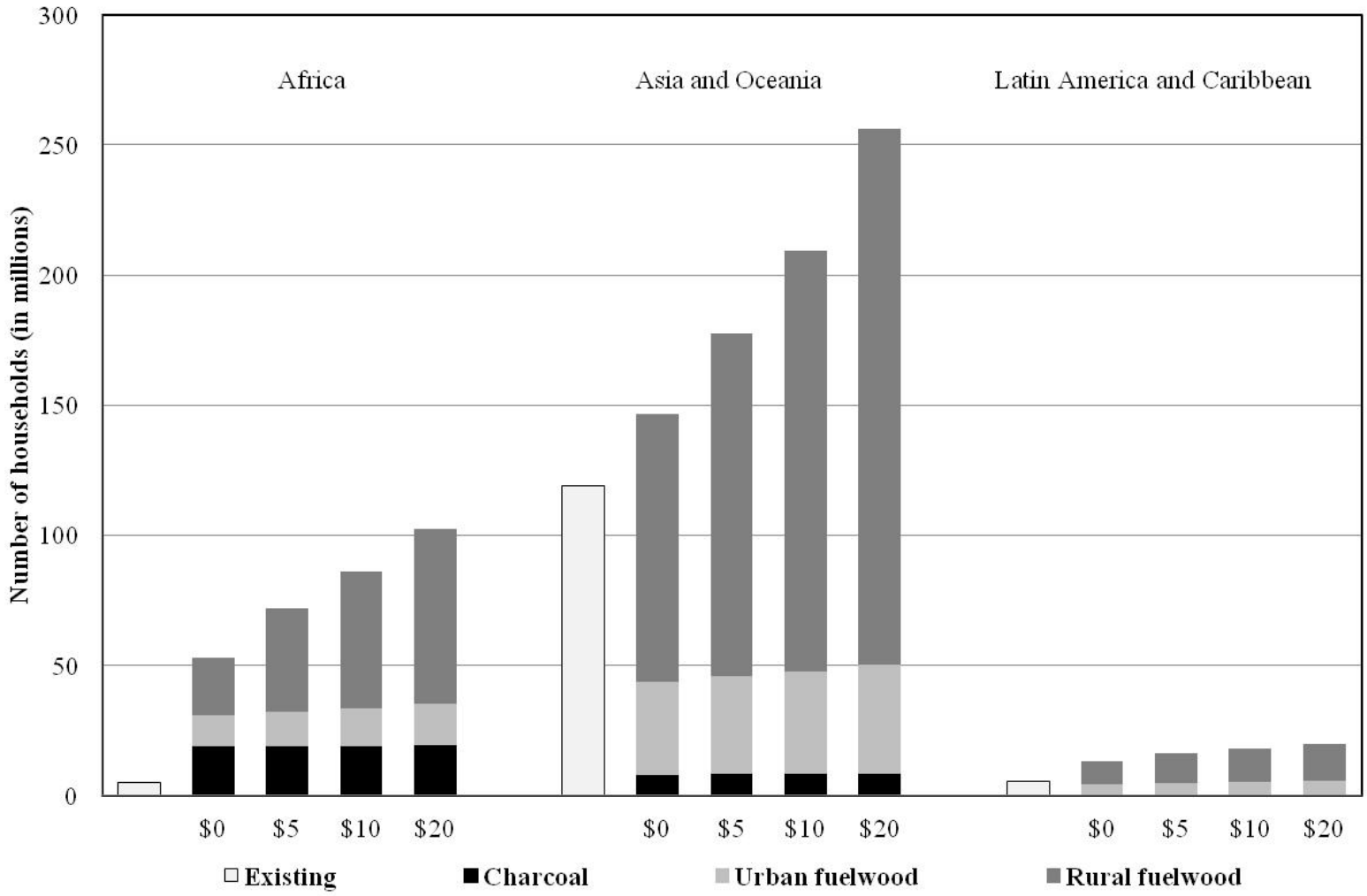
IRENA
International Renewable Energy Agency

- Fuelwood and charcoal price from FAOSTAT
- Collection time from literature review
- Cost of time from WB poverty statistics and per capita value-added in agriculture
- Stove cost, durability, adoption and fuel reductions from literature review
- Distribution and extension costs based on fuels and labour costs in countries.
- Emissions from IPCC conversion factors

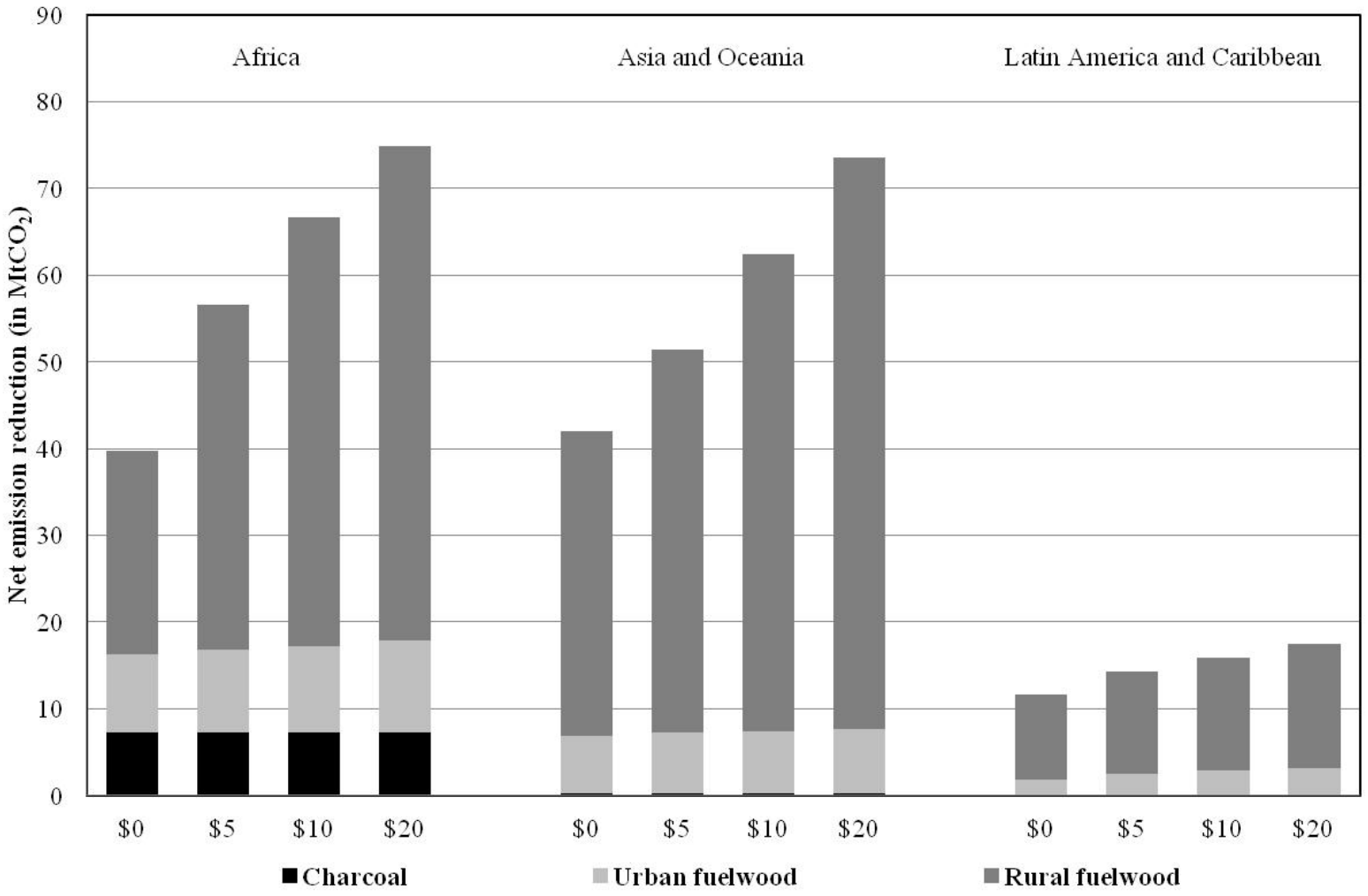
Mitigation cost: Angola



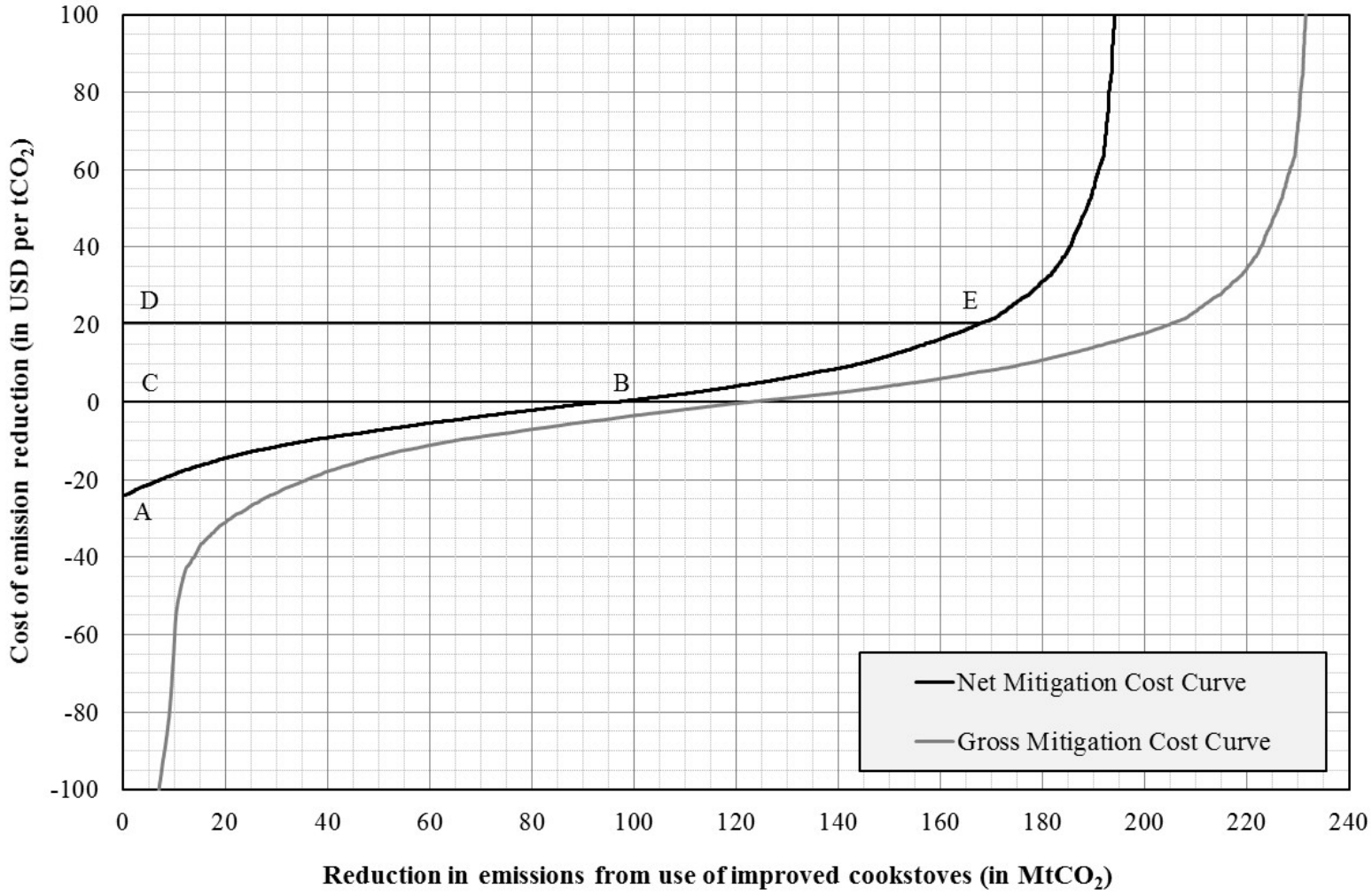
Results (gross)



Results (net)


Africa
Asia and Oceania
Latin America and Caribbean
Net emission reduction (in MtCO2)
90
80
70
60
50
40
30
20
10
0
$0
$5
$10
$20
Charcoal
Urban fuelwood
Rural fuelwood

Benefit-cost ratio



Benefit-cost ratio

IRENA
International Renewable Energy Agency

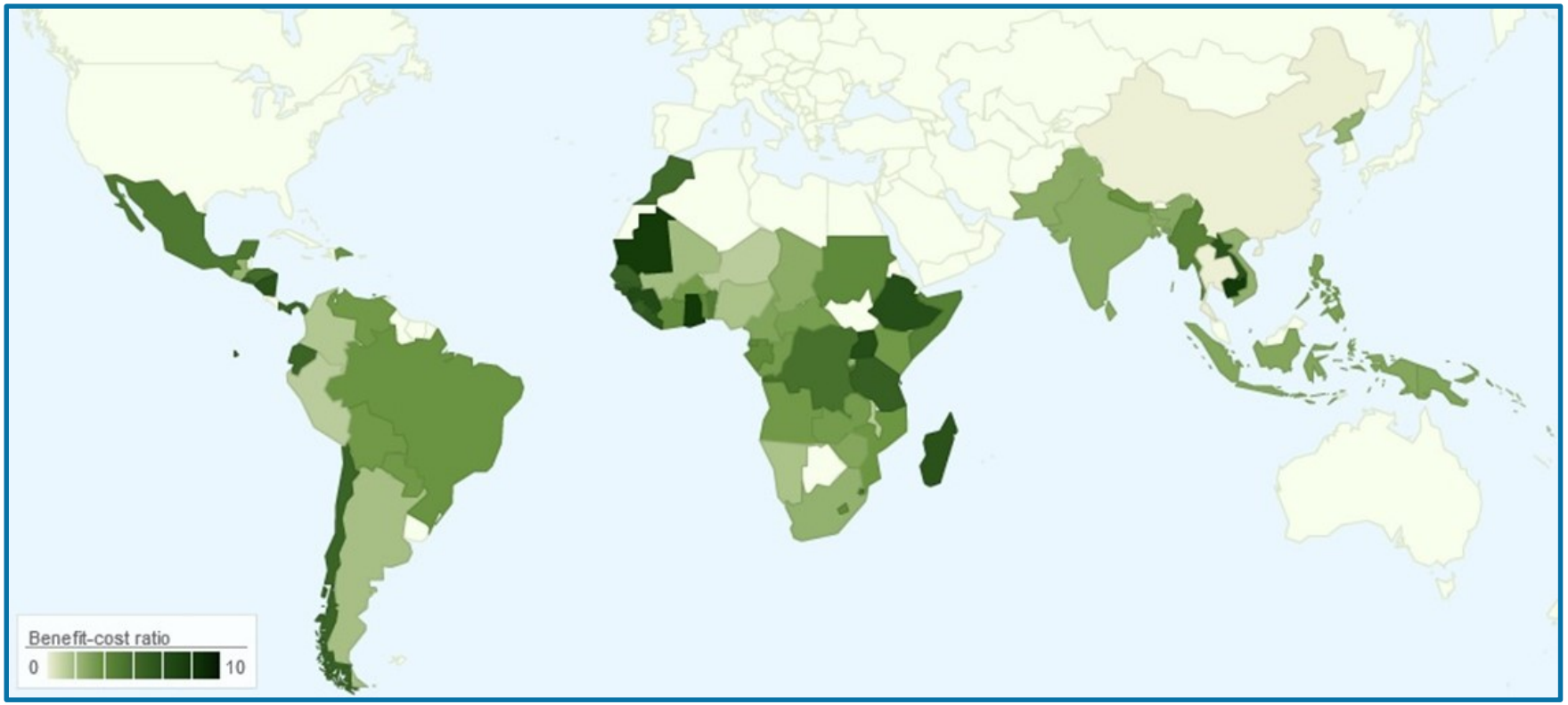
Annual costs and benefits for 285 million stoves to reduce emissions by 166 $MtCO_2$ (optimal at USD 20/tCO_2)

Region	Stove Cost (million USD)	Producer Surplus (million USD)			Benefit/cost ratio
		Private	CO2	Total	
Africa	655	1,157	1,290	2,447	4.7
Asia and Oceania	1,072	714	1,228	1,943	2.8
Latin America and Caribbean	162	107	319	426	3.6
World	1,889	1,978	2,838	4,816	3.5

No regrets option (zero carbon value – 155 million stoves)

Region	Stove Cost (million USD)	Producer Surplus (million USD)			Benefit/cost ratio
		Private	CO2	Total	
Africa	290	1,157	0	1,157	5.3
Asia and Oceania	607	714	0	714	2.2
Latin America and Caribbean	83	107	0	107	2.3
World	980	1,978	0	1,978	3.0

B/C ratio by country



Benefit-cost ratio at a carbon value of USD 20/tCO_2

Conclusions

- Mitigation potential: 95 - 165 $MtCO_2$
- Equal to 0.3 - 0.5% of global emissions
- In Africa: 1.5 – 3.0% of emissions
- High benefit-cost ratio
- Additional benefits (health, deforestation)
- Leakage/additionality?