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Rural Electrification: Policy conclusions from valuation studies in Kenya

Sabah Abdullah

Fondazione Eni Enrico Mattei (FEEM)/University of Bath, UK

&

Anil Markandya, Ikerbasque Professor

Basque Centre for Climate Change Bilbao, Spain

Fuel for thought…(a video link)

New York Times

BEYOND FOSSIL FUELS

African Huts Far From the Grid Glow With Renewable Power

Ed Ou/The New York Times

Thanks to this solar panel, Sara Ruto no longer takes a three-hour taxi ride to a town with electricity to recharge her cellphone. More Photos »

By ELISABETH ROSENTHAL
Published: December 24, 2010

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http://video.nytimes.com/video/2010/12/24/science/earth/1248069478546/power-off-the-grid.html?scp=1&sq=grid&st=cse

Motivation of the study

- Sub-Saharan Africa (SSA) rural area heavily rely on traditional fuel sources: firewood, charcoal and farm residues, for their lighting, cooking and heating
- The case of Kenya (residential): 70% of its total energy consumption is from wood based sources and more than 93% of rural households depend on them
- Severely problematic as such fuels are unhealthy, environmentally unfriendly and non-sustainable

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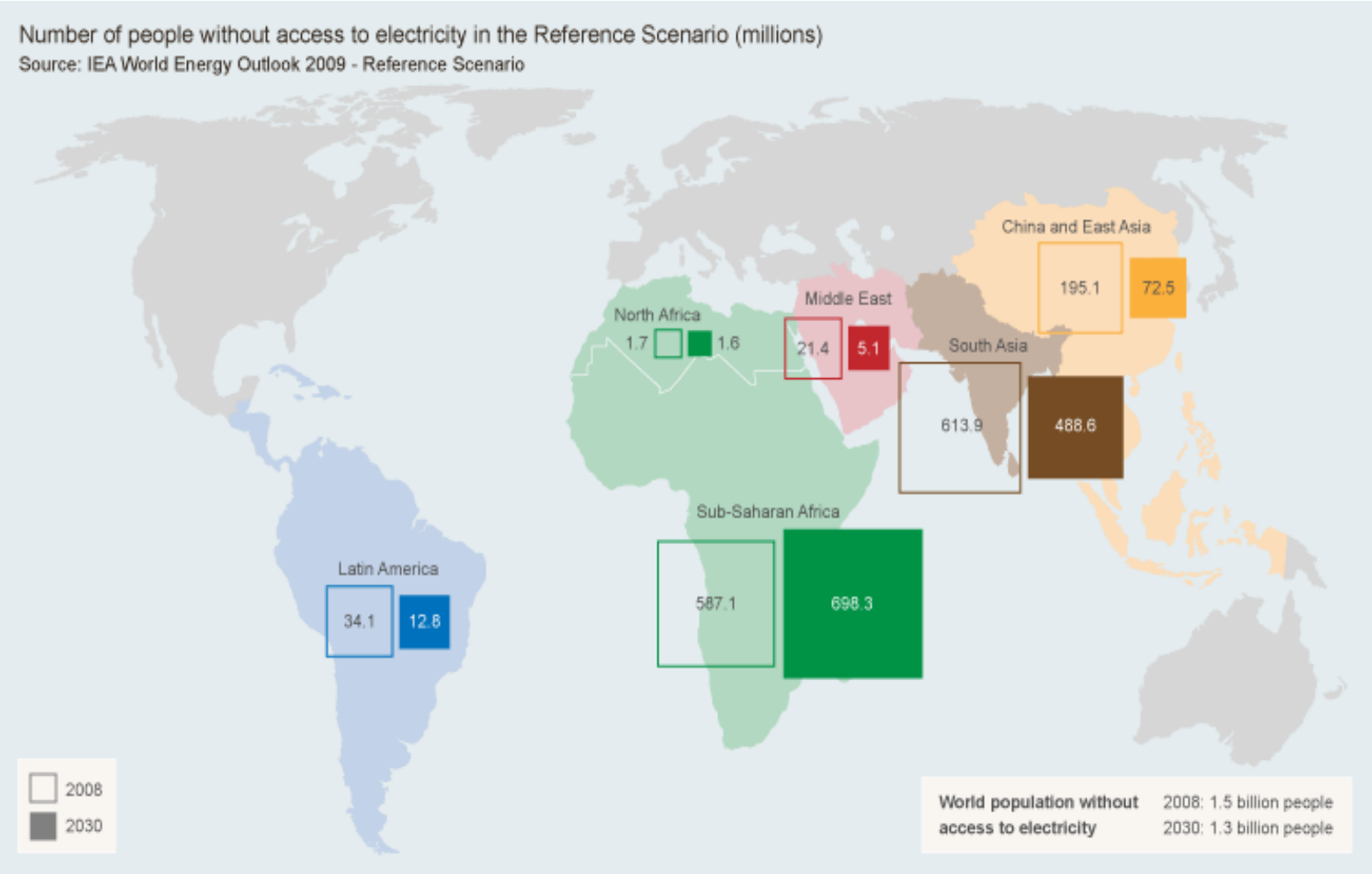
Overview of electricity access



Access rates in SSA (2008):overall 28.5%, urban 57.5%, rural 11.9%

Kenya: overall 15%, urban 51.3%, rural 5%

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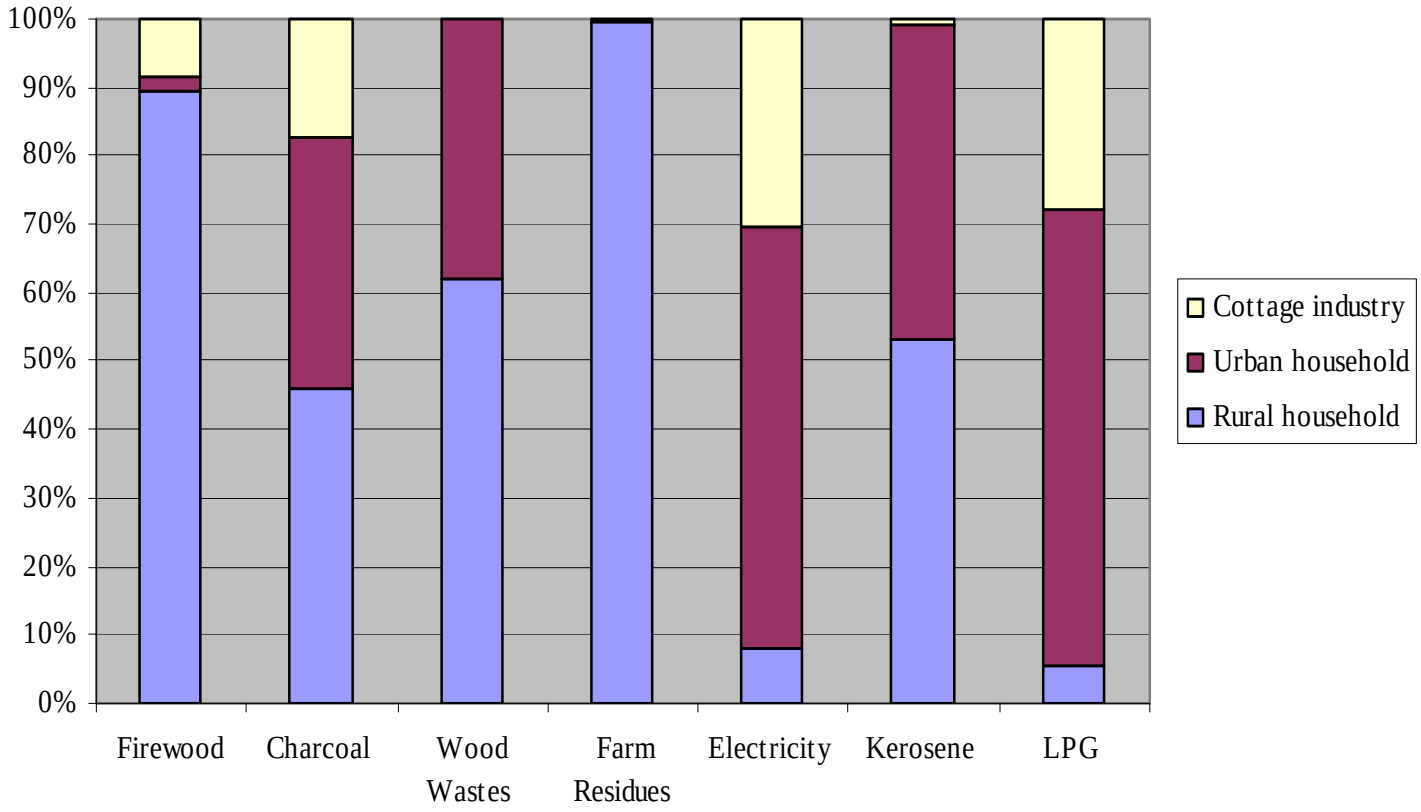
Kenya's annual energy consumption in households & cottage industry



Source: Kenya Energy Atlas (UNDP, 2005)

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Reasons for low rural electrification levels

- lack of available finance to cover capital and operating costs for generation, transmission and distribution of electricity, & the costs are higher in rural than urban

- high connection costs coupled with low consumption of electricity and low incomes among rural households

Key research question

"whether there are cost-effective approaches in connecting non-electrified rural households to grid and/or off-grid sources to meet their present and future needs"

To help us answer this question we take into account factors such as affordability, disposable income, availability and demand for high quality of modern sources

Background of Kenya electricity sector

- Several legislations to promote rural electricity generation, transmission & distribution (Energy Power Act, 1997 & Energy Act 2006), Rural Electrification Programme (REP) established since 1973
- Privatisation is at generation only
- Transmission & Distribution is owned partly by government & Kenya Power Lighting Company (KPLC)
- Community initiative to promote electricity access in 2006/7, "*Umeme Pamoja*" financed by the KPLC

Energy consumption pattern (rural)

- Used affordability methodology as illustrated in Kebede (2006) estimation of energy subsidies on Ethiopian households
- The mean monthly fuel consumption for all fuel sources consumed by electrified and non-electrified rural households in the Kisumu sample are converted into gross energy use in mega joules (MJ)

Mean monthly energy consumption for electrified and non-electrified rural households

		Electrified							Non-electrified					
		Energy content (MJ per unit)	Quantity	Price	Expenditure (Ksh.)	Gross energy use (MJ)	Typical efficiency	Useful energy in MJ	Quantity	Price	Expenditure (Ksh.)	Gross energy use (MJ)	Typical efficiency	Useful energy in MJ
Agriculture residue	Kg	13.5	2.37	0.00	0.00	31.95	0.12	3.83	7.59	0.00	0.00	102.47	0.12	12.30
Dung Cakes	Kg	14.5	0.00	0.00	0.00	0.00	0.12	0.00	6.00	0.00	0.00	87.00	0.12	10.44
Firewood	Kg	16	32.09	14.04	450.35	513.40	0.15	77.01	35.79	10.94	391.55	572.61	0.15	85.89
Charcoal	Kg	30	18.17	81.31	1477.56	545.13	0.20	109.03	29.57	48.79	1442.59	886.98	0.20	177.40
LPG	Kg	45.5	19.25	47.72	918.49	875.69	0.60	525.42	0.00	0.00	0.00	0.00	0.60	0.00
Kerosene	L	43	52.61	5.65	297.17	2262.09	0.35	791.73	81.64	4.32	352.81	3510.53	0.35	1228.69
Electricity	KWh	3.6	59.09	4.21	248.63	212.73	0.65	138.27	0.00	0.00	0.00	0.00	0.65	0.00
Candles	Klumen	0.2	6.94	6.27	43.48	0.00			13.00	3.46	45.00	0.00		
Total monthly energy expenses (Ksh.)					3,436	4,441		1,645.29			2,232	5,160		1,514.71
Total monthly household expenses (Ksh.)					18,037						10,755			
proportion of total energy to total expense					19%						21%			
Efficiency (%)							37.05%						29.36%	

Energy consumption patterns

- Electrified household (EH) are better off compared to non-electrified household (NEH) i.e. proportion of expenditure on total energy use for the former is 19%, as compared with 21%
- EH and NEH use three major fuel sources: firewood, charcoal and kerosene—takes 65% for electrified and 98% for non-electrified of total energy expenses
- One way to shift these sources among NEH especially kerosene is to provide them with electricity for lighting and entertainment purposes

Connecting to electricity sources

- Evaluate how rural household can afford to connect and pay for monthly electricity consumption by willingness to pay (WTP) values
- To obtain WTP values households state maximum amounts that they wish to pay for electricity services
- WTP estimates are hypothetical in nature as well as varying according to individual preferences, tastes and experiences

Examples of valuation studies (energy)

Conjoint Analysis & Contingent Valuation

Roe *et al.*, USA (2001)

Beenstock *et al.*, Israel (1998)

Choice Experiment/Modelling

Giraldo *et al.*, Spain (2010)

Paulrud & Laitila, Sweden (2010)

Carlson & Martinsson, Sweden (2008)

Longo *et al.*, UK (2008)

Bergmann *et al.*, UK (2006)

Arkesteijn and Oerelemans, The Netherlands (2005)

Ladenburg *et al*. Denmark, (2005)

An *et al.*, China (2002)

Alvarez-Farizo and Hanley, Spain (2002)

Goett *et al*, USA (2000)

In SSA limited valuation studies related to energy sector except agriculture, tourism and wildlife

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Background to Survey

a) Choice Experiment- electrified household (EH)
b) Contingent Valuation-non electrified household (NEH)

Kisumu District, Kenya
Household (HH) level only
Tested survey in focus groups (April 2007)
Clustered random sample in 20 villages (August 2007)

200 personal interviews with NEH
202 personal interviews with EH

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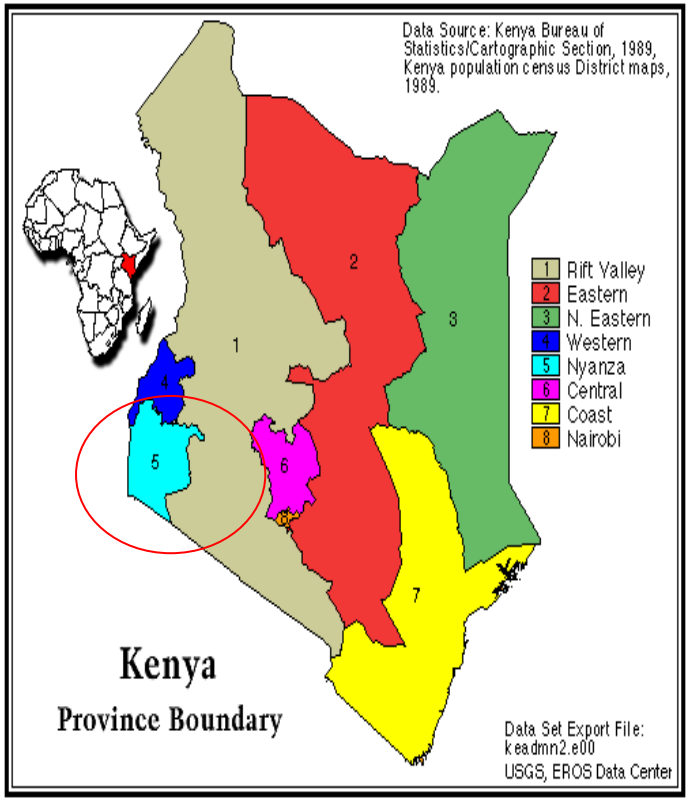
Key facts of survey district



	Kisumu District	Province	National
Total population 2006	650,846	5,051,562	35,514,542
Rural Population 2002 (%)	36.03%	87.10%	67.20%
Urban Population 2002 (%)	63.97%	9.15%	32.80%
Annual income per Capita 2004 (Ksh.)	17,535	12,616	24, 836
Electrification cover 1999 (%)	11.62%	4.80%	13.50%
Poor Individuals 1999 (%)	47.10%	42.10%	43.70%
Household Number 1999	169,458	897,978	4,489,890
Household Mean Size 1999	4.9	5	5.2
HDI indicator 2004	----	0.41	0.52

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Valuation estimation: Willingness to pay (WTP) results

	Connection fee amount	
	Ksh.	US$
Grid Electricity (GE) Lump	20,090	301
Grid Electricity (GE) Monthly [a]	870	13
Photovoltaic (PV) Lump	18,560	278
Photovoltaic (PV) Monthly [a]	700	10

Notes:
[a] Monthly payments are over 5 years
Source: Survey 2007

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Valuation estimation discussion

Product options (GE & PV)

- WTP for grid-system has a higher values than those of a solar PV system, hence household preferring the former than the latter
- The cost of connecting to grid are higher than PV and other off-grid options (mini-hydro or pico-hydro systems)

Payment options (monthly & lump-sum)

- Lower deciles would face prohibitive payment levels for one-off payment, regardless of whether they were subsidized or not
- Preferred payment system is monthly payments as it is affordable for the lower deciles

Valuation estimation discussion

Biggest obstacle for low income households: initial connection fees & monthly consumption costs for electricity

We need to examine how NEH can afford to buy electricity and still maintain present energy consumption levels without compromising the total energy provided in MJ

Energy consumption pattern revisited (NEH only)

(Assuming no increase in expenditure on energy and same total energy provision)

Energy source	Quantity (pre-electrification)	Typical efficiency	Shift factor	Quantity (post-electrification)	Price	Expenditure (Ksh)	Energy content (MJ per unit)	Gross energy use (MJ)	Useful energy (MJ)
Agriculture residue	7.59	0.12	0.20	1.52	0.00	0.00	13.50	20.49	2.46
Dung Cakes	6.00	0.12	0.20	1.20	0.00	0.00	14.50	17.40	2.09
Firewood	35.79	0.15	0.60	21.47	10.94	234.91	16.00	343.57	51.53
Charcoal	29.57	0.20	0.70	20.70	48.79	1009.76	30.00	620.88	124.18
LPG	0.00	0.60	0.00	0.00	47.72	0.00	45.50	0.00	0.00
Kerosene	81.64	0.35	0.50	40.82	4.32	176.34	43.00	1755.26	614.34
Electricity	0.00	0.65	1.00	35	24.99	874.65	3.60	126.00	81.90
Candles	13.00		0.20	2.60	3.46	9.00	0.20	0.52	
Total monthly energy expenses (Ksh.)						2,304.67		2,884.13	876.50
Total monthly household expenses (Ksh.)						10,755			
Proportion of total monthly energy to household expenses						21%			
Efficiency (%)									30%

A lot of scope for reducing kerosene and firewood and moving to electricity without increasing share on energy

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Policy Recommendation: Establishing financial schemes

- Need to establish long term schemes to finance initial or upfront costs for low or intermittent incomes in 5-10 years payment plan e.g. Bolivia, number of new customers doubled when connection cost was spread over five years
- PV option would appear more fruitful direction for government programmes to poor because of low subsidy as well as repayments
- Careful attention needs to be paid with loan defaults

Policy Recommendation: Subsidizing connection and consumption including tax charges

- Subsidize 1/3 of connection costs for both GE and PV systems, i.e. the national government through the local authorities
- Exclusion of monthly electricity taxes for those consuming 35 kWh or less
- Inclusion of monthly taxes increase monthly energy expenditures from nearly Ksh. 2,305 to Ksh. 2,524 i.e. from 21% of total expenditure to 23%
- Develop an appropriate system that can identify the target group for subsidized connection and lifeline tariff rate

Policy Recommendation: Multi-level critical analysis of the political economy of energy systems

- Understanding political economy to address energy issues with various stakeholders: politicians, firms, consumers and other interest groups
- In the case of Kenya, poor electricity coverage in rural areas is attributed to the failure of governance at all levels
- Best way forward: to galvanise local communities into taking action through collaboration with NGOs, the private sector and financial institutions
- Policy to reduce dependency on woodfuel is essential to address the long term costs to people's health and the environment in turn bolster the economy as a whole

Conclusion

- Rural electrification programmes in developing countries face socio-economic and political barriers
- Key factor is inability of rural households to connect to electricity services
- Poor governance is an issue and involvement of actors, including the rural poor in the decision- making will increase higher level of transparency
- A set of proposals to maximize uptake of either GE or PV systems by rural households:
  - lengthening payment schedule
  - reducing the interest rate
  - lowering the monthly taxes on the lifeline tariff

For further details about the survey see:

Abdullah, S. and Mariel, P., 2010. A choice experiment study on the willingness to pay to improve electricity services, *Energy Policy*, Vol. 38(8), 4570-4581

Abdullah, S. and Jeanty, P.W., 2011.Willingness to pay for renewable energy: Evidence from a contingent valuation survey in Kenya, *Renewable & Sustainable Energy Review*, doi: 10.11016/j.rser.2011.03.016

Abdullah, S. and Markandya, A. Rural electrification programmes in Kenya: Policy conclusion from a valuation study, Department of Economics Working Papers 25/09, University of Bath, 2009 (in review *Energy for Sustainable Development*)

More fuel for thought…

One of the fast-action strategies complementing cuts in CO2 emissions is to reduce emissions of black carbon i.e. BC (soot)

Nearly 50% of the world still using fossil fuels for cooking, indoor air pollution from BC is associated with respiratory illness, the fourth leading cause of excess mortality in developing countries

Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO_2 emissions

Mario Molina[a], Durwood Zaelke[b,1], K. Madhava Sarma[c], Stephen O. Andersen[d], Veerabhadran Ramanathan[e], and Donald Kaniaru[f]

[a]Department of Chemistry and Biochemistry, University of California, San Diego, 9500 Gilman Drive, MC 0356, La Jolla, CA 92093; [b]Institute for Governance and Sustainable Development, and International Network for Environmental Compliance and Enforcement, 2300 Wisconsin Ave., NW, Washington, DC 20007; [c]Montreal Protocol Technology and Economics Assessment Panel, AB 50, Anna Nagar, Chennai, India 600040; [d]Montreal Protocol Technology and Economic Assessment Panel, 2317 North Road, Barnard, VT 05031-0257; [e]Scripps Institution of Oceanography, University of California, San Diego, 9500 Gilman Drive, La Jolla CA 92093-0221; and [f]National Environment Tribunal of Kenya, Woodvale Grove, Sarit Centre, Nairobi, Kenya

Edited by Hans Joachim Schellnhuber, Environmental Change Institute, Oxford, United Kingdom, and approved August 31, 2009 (received for review March 9, 2009)

Current emissions of anthropogenic greenhouse gases (GHGs) have already committed the planet to an increase in average surface temperature by the end of the century that may be above the critical threshold for tipping elements of the climate system into abrupt change with potentially irreversible and unmanageable consequences. This would mean that the climate system is close to entering if not already within the zone of "dangerous anthropogenic interference" (DAI). Scientific and policy literature refers to the need for "early," "urgent," "rapid," and "fast-action" mitigation to help avoid DAI and abrupt climate changes. We define "fast-action" to include regulatory measures that can begin within 2–3 years, be substantially implemented in 5–10 years, and produce a climate response within decades. We discuss strategies for short-lived non-CO_2 GHGs and particles, where existing agreements can be used to accomplish mitigation objectives. Policy makers can amend the Montreal Protocol to phase down the production and consumption of hydrofluorocarbons (HFCs) with high global warming potential. Other fast-action strategies can reduce emissions of black carbon particles and precursor gases that lead to ozone formation in the lower atmosphere, and increase biosequestration, including through biochar. These and other fast-action strategies may reduce the risk of abrupt climate change in the next few decades by complementing cuts in CO_2 emissions.

calculate will have a >75% chance of staying <2 °C. The Alliance of Small Island States calls for the more aggressive goals of stabilizing temperatures below a 1.5 °C increase and maximum of 350 ppm CO_2-equivalent (CO_2-eq.) (7).

Tipping Points for Abrupt Climate Change. Paleoclimate records include steady linear changes as well as abrupt nonlinear changes, where small increases in average surface temperature produced qualitatively different modes of operation of the climate system that were irreversible on a timescale of millennia (5, 8). Lenton et al. (8) extend the concept of abrupt climate change to include "tipping points" that refer to a critical threshold at which a very small perturbation can switch the state of a system to a qualitatively different one, possibly on a long time scale. They define the corresponding "tipping elements" as large-scale components of the Earth's system that are at least subcontinental in scale.

There are large uncertainties associated with tipping points, which are often considered as examples of "surprises." Ramanathan and Feng (9) estimate the likelihood of reaching the predicted critical temperature threshold that triggers various tipping elements by considering the probability distribution for the temperature increase associated with the "committed" level

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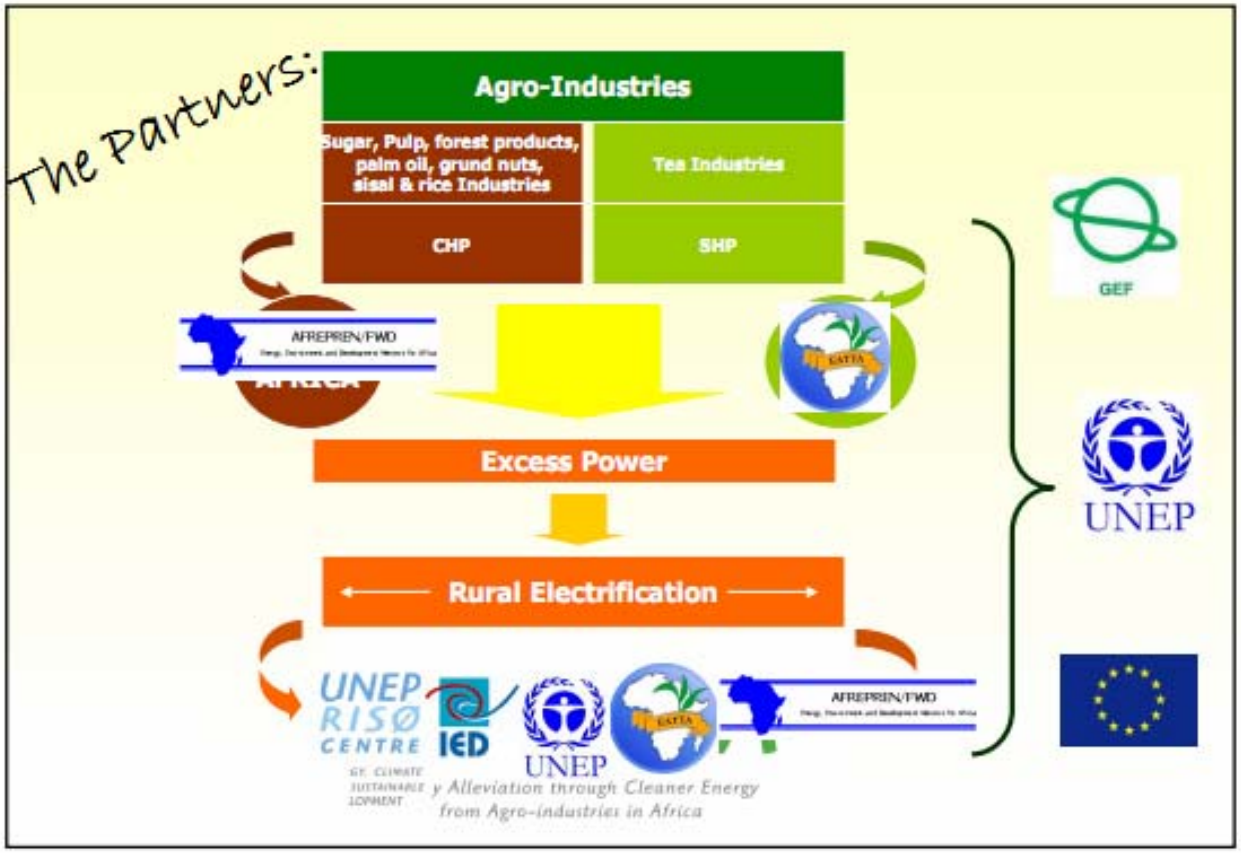
Another one….



Business models: Local agro-industries & corporate social responsibility (CSR)

Changes to consider: climate urbanization & shift of wealth

Source:
http://www.paceaa.org/workshops/Rwanda%20Training%20Workshop/01.%20Objectives%20Of%20Paceaa%20Project%20and%20The%20Seminar.pdf

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Grazie mille ☺

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