CME 3010 Solar Power for Africa

Monday, Wednesday 9:00 to ~10:00
University of Cincinnati, Zimmer 302

University of Cincinnati
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1-513-556-3063
Office Hours: Tuesday and Thursday 10:30 to 11:30, or by arrangement
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Skype: greg.beaucage (www.skype.com 2-way video link)
Zoom: gbeaucage@gmail.com (www.zoom.us Multiway video link gmail or facebook based)
Stickam: gbeaucage (www.stickam.com 10 or more video link as a "group")

CME 3010 Solar Power for Africa

University of Cincinnati, Ohio, USA
14 Students (need more students)

University of Cape Town, South Africa
Prof. David Britton, Prof. Margit Härting

Rhodes University, Grahamstown South Africa
Prof. Schadrack Nsengiyumva

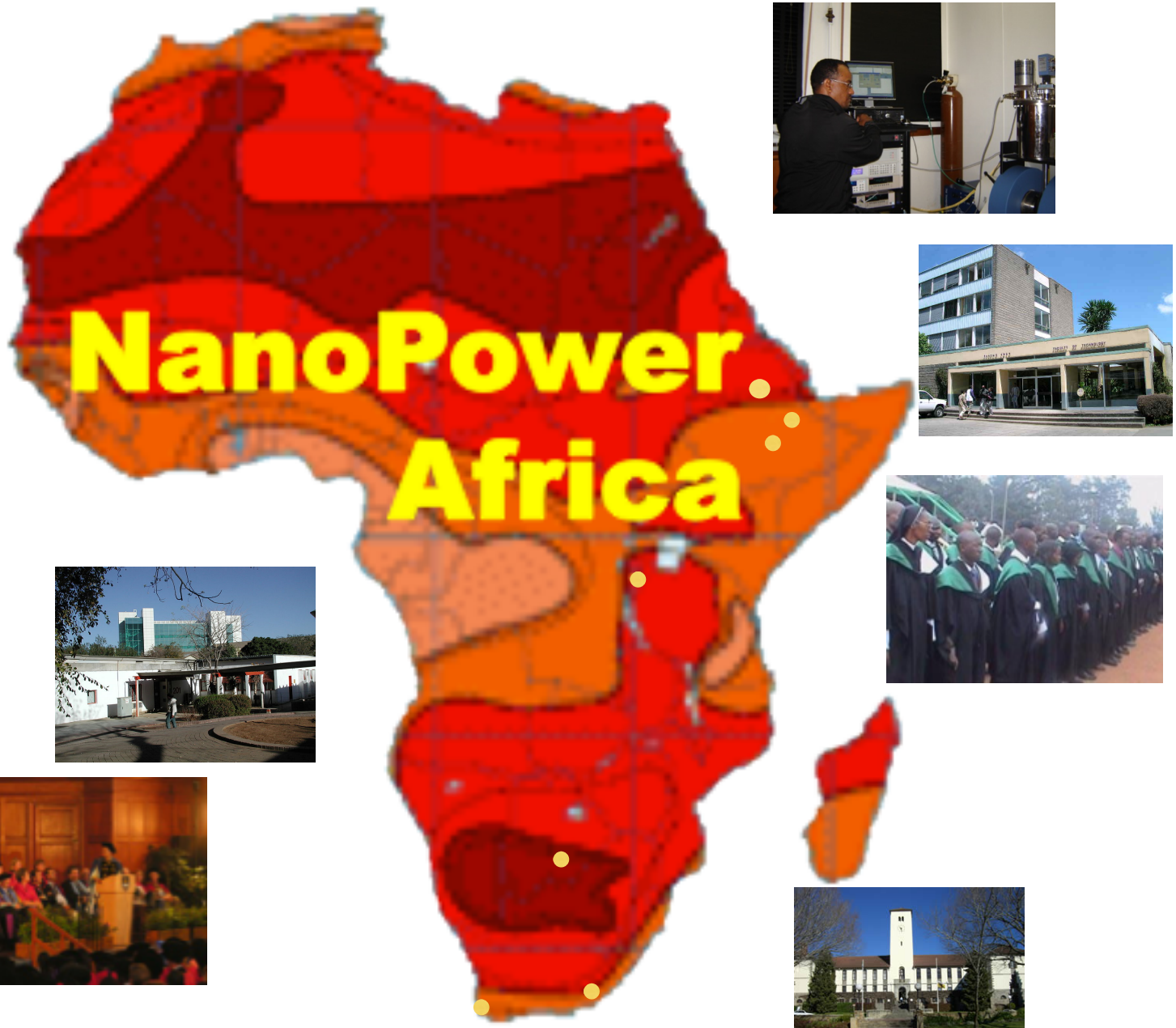
Kigali Institute of Education, Rwanda
Prof. Evariste Minani

Haramaya University, Ethiopia
Prof. & Associate Dean Girma Goro Gonfa
Students

University of Botswana, Gaborone, Botswana
Prof. Cheddi Kiravu
Students

Mekelle University, Mekelle Ethiopia
Prof. Tadele Hunde
Students

Addis Ababa University, Ethiopia
Prof. & Dept. Head Shimelis Admassie
Students



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NETHERLANDS
BELGIUM
PORTUGAL
SWITZERLAND
FRANCE
SPAIN
GERMANY
ITALY
EASTERN EUROPE
UNITED STATES
INDIA
INDIA PART 2
CHINA
CHINA PART 2
UK
JAPAN

CME 3010 Solar Power for Africa

Purposes of Course:

1) Expose students to different cultures within Africa and the US
2) Learn how we can work together towards development goals following a pan-African approach with US interaction
3) Learn how photovoltaics and technology can play a role in underdeveloped countries specifically in Africa
4) Understand the various "stake-holders" in various parts of sub-Saharan Africa (SSA)
5) Develop a critical understanding of US, European and Asian aid in Africa
6) Understand the fundamentals of photovoltaic (PV) technology
7) Develop a basic understanding of how an off grid PV system for a clinic or school is specified, purchased, installed, maintained and operated
8) Other technologies to utilize solar energy.
   Solar Oven; Solar Chimney; Solar water heater; Solar heat; etc.
9) Technical issues involved in use of nanoparticles in PV devices

CME 3010 Solar Power for Africa

Logistics:

1) Two seminars per week with some type of associated activity

2) Participation in class will be graded for UC students

3) The main part of the grade is a project constructed with collaboration between US students and students in Africa. The more locations involved the better. The purpose of the project is to develop a viable plan for a small NGO that uses photovoltaics to address a development goal. The best scenario is if the African partners identify a development need and suggest a pathway that is viable in their circumstances and the US students serve as facilitators and assistants. For example, cell phone charging system is determined to be important. Subsidized entrepreneurial approach where by the NGO supplies PV devices at reduced cost to vendors who access the local market. UC students develop a funding scheme using jumo or a similar web based appeal.

GlobalGiving - GlobalGiving is a non-profit that connects donors with ... - globalgiving.org

Quora - Quora is a continually improving collection of questions and ... - quora.com

Crowdrise - Online fundraising pages at Crowdrise. Raise money ... - crowdrise.com

Asana - Justin and I are excited to welcome Kenny Van Zant as the ... - asana.com

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First assignment is to sign up for the course and to join skype and zoom and register your user names on the web page so that an web-based first meeting can be held between the group partners. I will make groups from those who register and will send members of the group the user names so that you can setup either a Google+, Skype, or a zoom web conference. This should be done as soon as we formalize African participants.

The movie "What are we doing here?" is linked to the web page and you should watch this hopefully before the next class.

This documentary was made by a group of what look to be college age American family members -- middle class or better -- as they spent six months journeying in Africa to answer their own questions about African poverty and aid effectiveness. It personalizes and puts human faces on some African problems and has a fair amount of impressive scenery. It gives shallow attention to a number of aid dilemmas, with spokespeople for the various points of view -- more aid is needed, aid should be cut off, monitoring and evaluation are insufficient, aid is being directed by people in foreign capitals who don't know the realities on the ground, aid helps individuals, aid doesn't change structural poverty, aid creates dependence, some aid is diverted, child sponsorship programs don't give money to a child or his family, sometimes people just need help, there is no single magic solution, humanitarian neutrality creates ethical dilemmas in war zones.

These appear to be new thoughts for the creators of the film, who make themselves actors in it as they incorporate their own conversations about privilege and poverty. The film might be eye opening for those who never think about Africa or aid or don't know much about either one of them. I could see it being useful for teaching American undergraduates or high school students. If it is judged as a student project, the film is remarkable, with professional production values.

Not one of these messages is new or surprising, however, to those who have even a passing familiarity with Africa or aid or the voluminous and contested literature. The arguments are raised, glossed over, and gone; no factual support for any point of view is provided; speakers seem to be taken at face value with no effort to get to the roots of any particular issue, any one of which would warrant its own documentary. Some of the information provided by speakers is factually incorrect -- such as the idea that U.S. food aid benefits American farmers. (It benefits a tiny handful of food aid providers as well as U.S. shippers who together form a powerful lobby. For the real story, see "Food Aid After Fifty Years" by Barrett.) The film makers seem convinced that they have a handle on things after spending up to six days in a single location. As a consequence, there isn't much content here, except perhaps, "gee, poverty and aid are complicated, who would have thought it?" The adolescent conversational interludes of the film makers are a little painful to watch, and I wonder what the film makers themselves will think of them when they are about twenty years older. The overall impression is exactly what the film is presented as in the introduction -- a journey of initial discovery by people who know nothing whatsoever about a topic. Unfortunately, this is not what I want or expect from a professional documentary.

The first things you notice watching the opening minutes of the film are the spectacular sights and sounds of a world that most of us have never experienced first-hand. The picture is raw, yet so alive, and the words of the Africans are so rich and shocking at the same time in what they reveal. You will learn more than you've probably ever learned from school or a textbook about poverty, aid, development, and Africa in this film...and you will form your own opinions about each of those issues. The brothers who directed, photographed, and captured their experiences came to NYU for a discussion and you could tell how much their journey had changed their lives and how much they want to affect change. They did the easy part for us, as we can just sit back and let the journey and thought-provoking issues come to us.....of course, YOU will want to get up and do SOMETHING once you have watched the film.

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Week	**Topic**
1	Energy in the Third World and Off Grid Power
	Practical Action's "three A's" of Affordable, Accessible and Appropriate technology
	Electric Capitalism: Recolonizing Africa on the Power Grid, David A. McDonald (2009)
	Energy Access in Africa Challenges.pdf
	Energy and the Millennium Development Goals
	Energy Access for the Poor in East Africa
	Solar Resource Map, Africa Solar Map
	Energy for Development
	The Boy Who Harnessed the Wind, W. Kamkwamba and B. Mealer (2009)

Energy access in Africa: Challenges ahead

Abeeku Brew-Hammond

The Energy Center, KNUST, Kumasi, Ghana

Household Access, Penetration Rate

Low Income ⟶ Poor Energy "Access" ⟶ Low Income

What does "Access" mean? (Are we measuring the correct aspect?)

Grid versus "Decentralized Source"

"Modern" versus Traditional Sources of Energy

Selling state subsidized energy below cost can lead to decreased availability.

(Motivation for expansion is lost) Availability versus Affordability

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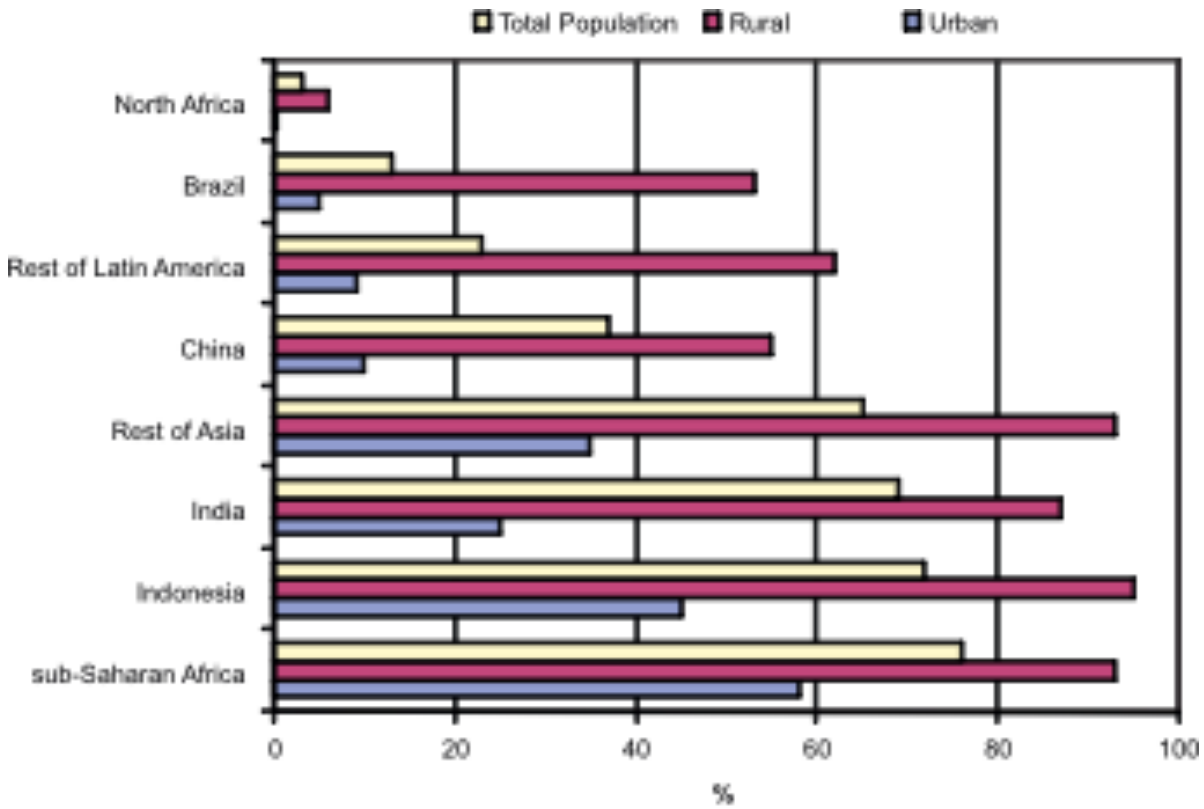

Fig. 1. Proportion of the population relying on traditional biomass for cooking.

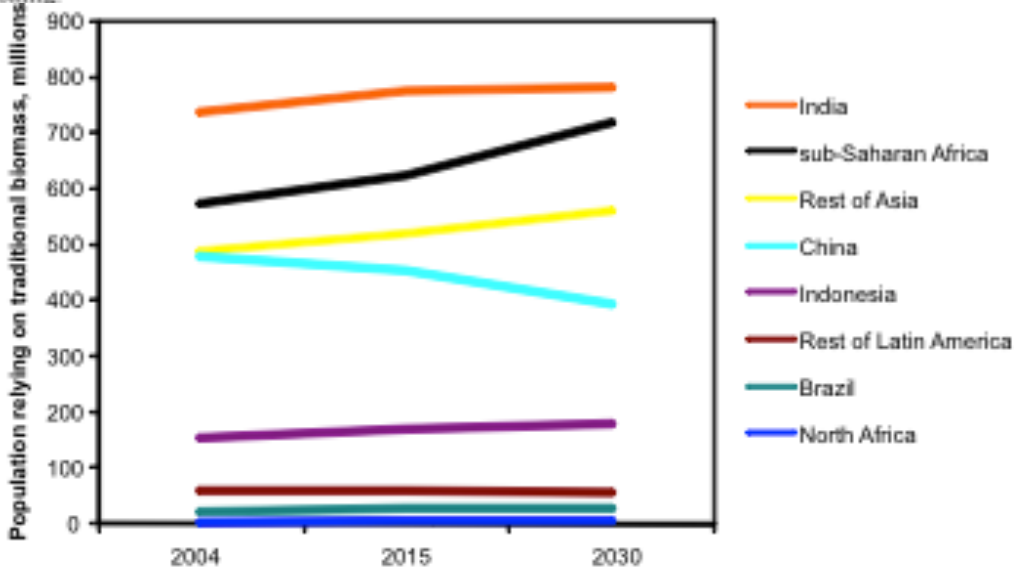

Fig. 2. Projections of people relying on traditional biomass for cooking.
Data Source: IEA (2006).

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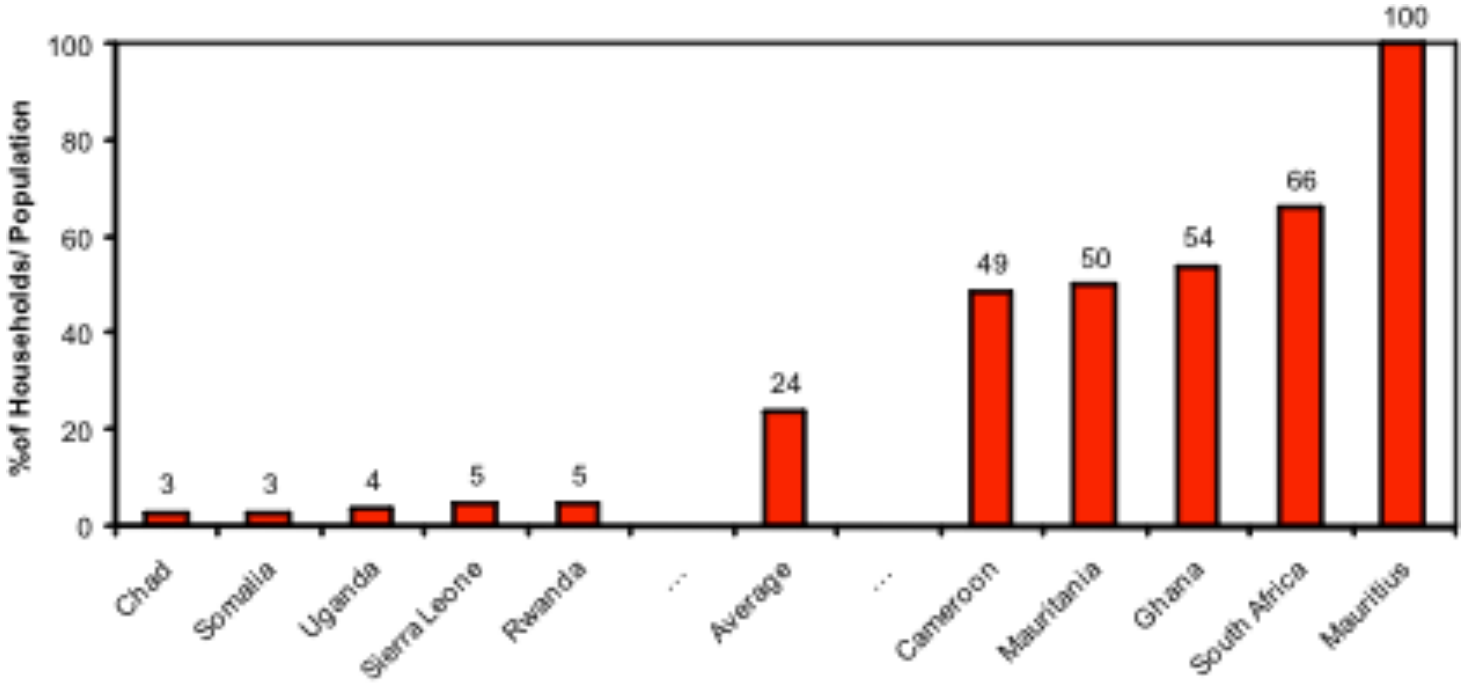

Fig. 3. Access rates for least and most electrified countries in sub-Saharan Africa.

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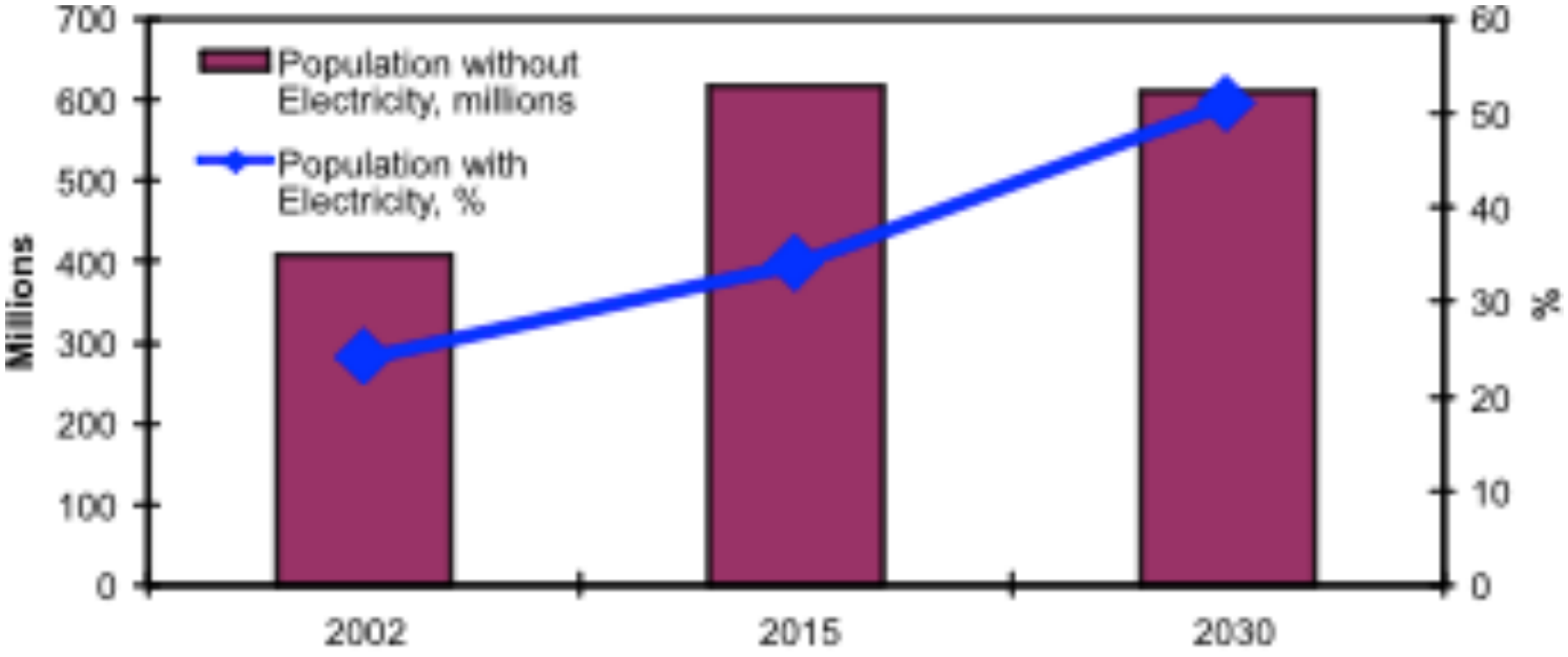

Fig. 4. Projections for population with and without electricity in sub-Saharan Africa.

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Table 1
Sub-regional estimates of energy access investment costs — ECOWAS regional plan of action.

						Investment		Programme development and support			Cost of energy consumption		Total	
Programme	**2005 Status**	**Objective 2015**	**Number of connections added**		**% Total pop served in 2015**	**Cost over 10 yrs (M$)**	**$ per capita per year**	**%**	**Cost over 10 yrs (M$)**	**$ per capita per year**	**Cost over 10 yrs (M$)**	**$ per capita per year**	**Average yearly cost (M$)**	**$ per capita per year**
Improved cooking fuels	~10 (i) tot pop LPG access	100%	29,656	'000 LPG households	100% pop has access (ii)	2850	0.88	30	855	0.26	25,467	7.52	2817	8.65
Mechanical power (vii)	0% (i)	100% villages	46,228	Decentralised and secondary settlements		741	0.23	30	222	0.07	1696	0.52	266	0.82
Electrification	20%	~60%				10,957	3.37		1909	0.59	8458	2.60	2132	6.55
Periurban and urban electrification (iii)	~20% urban pop	100% urban population	15,683	'000 households	54%	5484	1.68	15	823	0.25	3882	1.19	1019	3.13
Productive uses, social and community services (iv) (viii)	~25% (i)	100% secondary towns	24,611	Secondary towns (ix)	idem	3703	1.14	15	555	0.17	−162	−0.05	410	1.26
Household connection in electrified settlements (iv)	–	40% village population	13,429	'000 households	64%	1494	0.46	30	448	0.14	3693	1.13	564	1.73
Decentralised electrification (v) (vi)	Negligible	80%	21,617 1081	Decentralised localities (ix) '000 households	66%	276	0.08	30	83	0.03	1046	0.32	141	0.43
Rural electrification programme						5473	1.68		1086	0.33	4577	1.41	1114	3.42
Total cost						**14,549**	**4.47**		**2986**	**0.92**	**34,621**	**10.64**	**5216**	**16.02**

(i) Estimate
(ii) Access rate: % total population being served
(iii) Business as usual tendency regarding rural population access
(iv) Target settlements: > 2000 inhabitants for category 2 and > 1000 for category 1; investment NET of cost of mechanical power
(v) Target settlements: > 1000 inhabitants < 2000 for category 2 and > 500 and < 1000 for category 1; investment NET of cost of mechanical power — hence only for 50 household connections per settlement
(vi) Energy consumption includes household consumption but not mechanical power, which is in the related programme
(vii) Investment in settlements > 100 inhabitants for category 2 and > 500 for category 1; energy consumptions are @ 12,000 kWh/yr and @ 0.4 cts for secondary towns and decentralised settlements
(viii) Once village is connected to network the consumption exceeds 18,000 kWh @ 0.2 cts, which implies a savings as compared to 12,000 kWh @ 0.4 cts (mechanical power)
(ix) 24,611 secondary towns and 21,617 decentralised settlements total 46,228 settlements under the mechanical power programme
(x) Population access rate

Table 1 Percentage share of population that depends on traditional biomass

Country/region	*Percentage share of population*
China	56
Indonesia	74
Rest of East Asia	37
India	58
Rest of South Asia	41
Latin America and the Caribbean	23
North Africa and Middle East	0.05
Sub-Saharan Africa	89

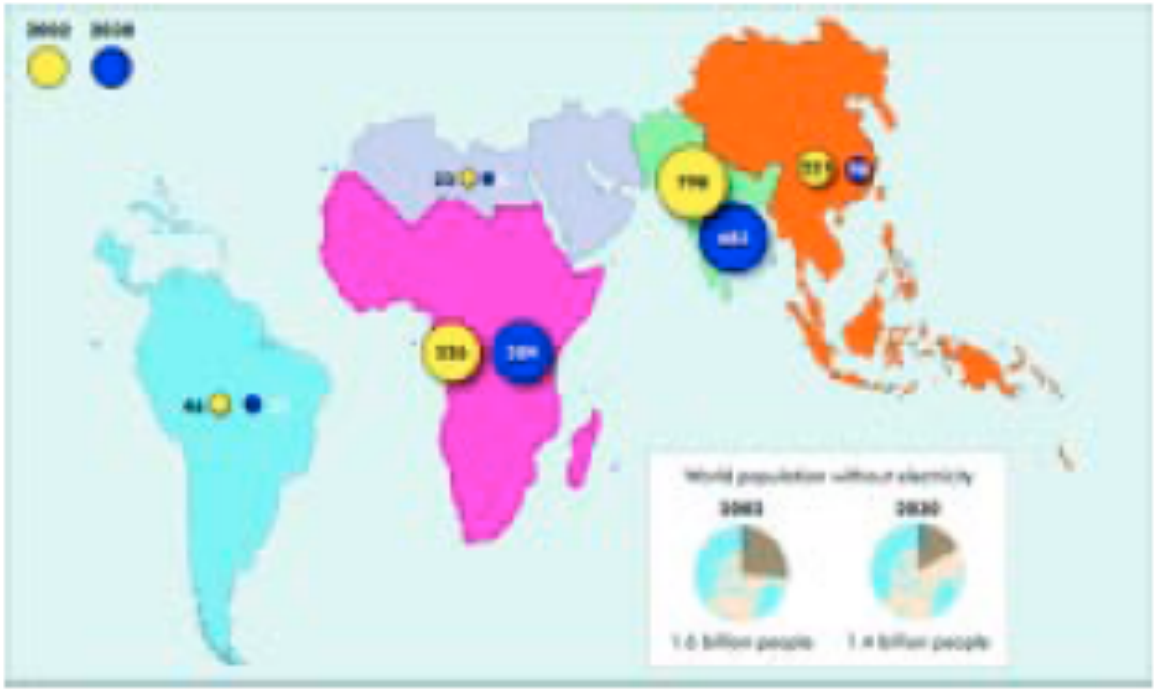
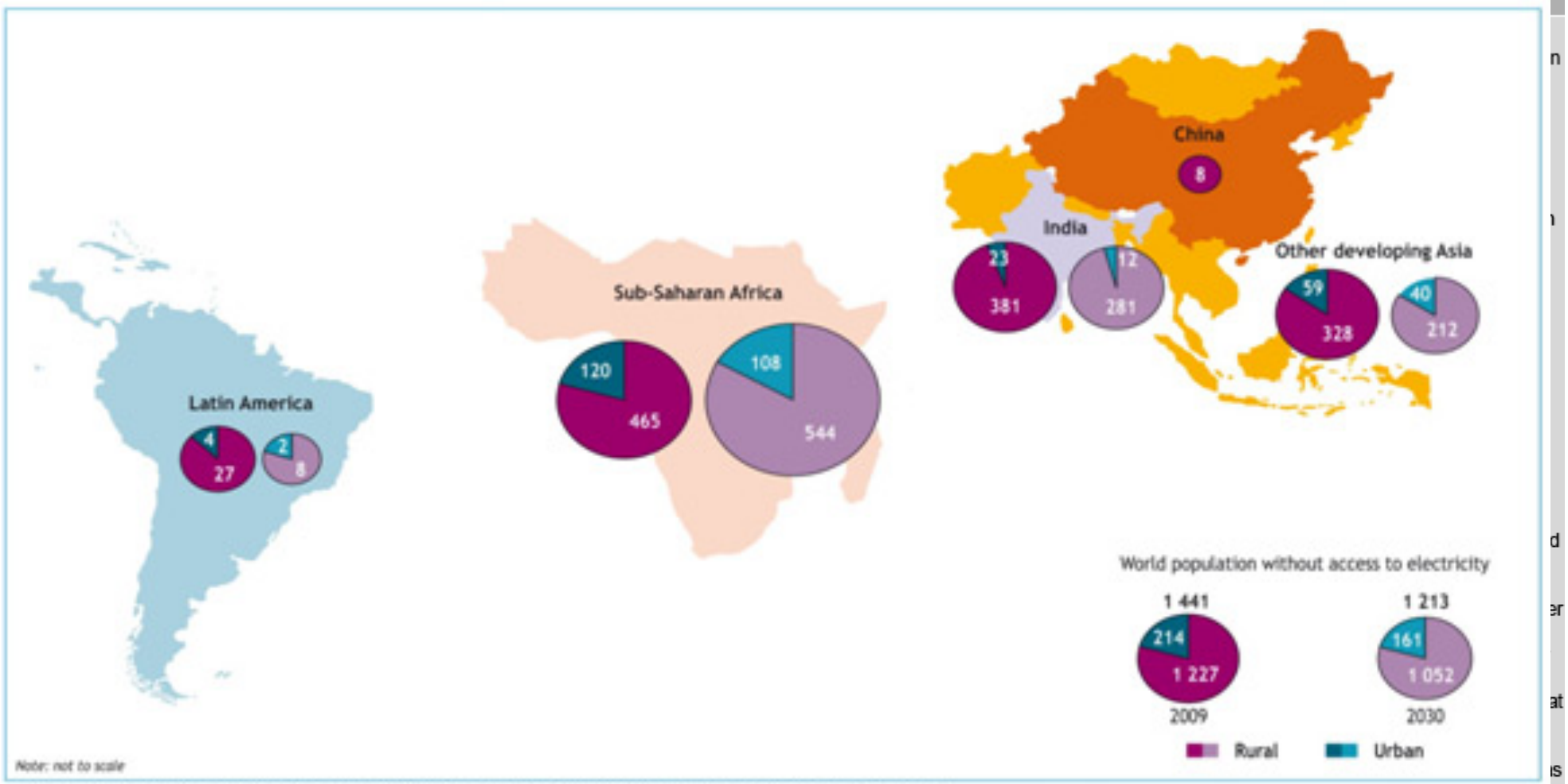


Figure 1 Population with no electricity (million)
Source IEA (2005b)

Myth	*Reality*
The poor do not consider access to energy a priority.	The poor may not use the term 'energy' but they often spend far more time and effort obtaining energy services compared to the richer section of the population. They spend a substantial proportion of their household income on energy for basic survival activities, that is cooking, keeping warm, and so on.
Access to electricity, grid or decentralized, will solve all the energy service needs of the poor.	People need to access a range of energy sources to satisfy their energy needs, that is cooking, heating, transport, and communication.
Poor people cannot pay for their energy services.	Many poor people pay more per unit of energy than the better off, partly due to inefficient conversion and lack of integrated planning.
Only rural areas suffer from lack of access to energy.	Poor people in urban and peri-urban areas also suffer from lack of access to energy services, and their numbers are likely to increase. It is predicted that almost 61% of the world's population will be living in urban and peri-urban areas and services are not expected to grow commensurately.
Commercial energy required to satisfy the needs of the poor is significant with respect to total global energy consumption.	Reaching the poor with basic modern energy services as envisioned in the *MDG Energy Vision* would increase global commercial energy consumption by about 900 TWh (terrawatt-hour) per year, which is less than 1% of the global energy demand.



The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

Figure 1 Population with no electricity (million)
Source IEA (2005b)

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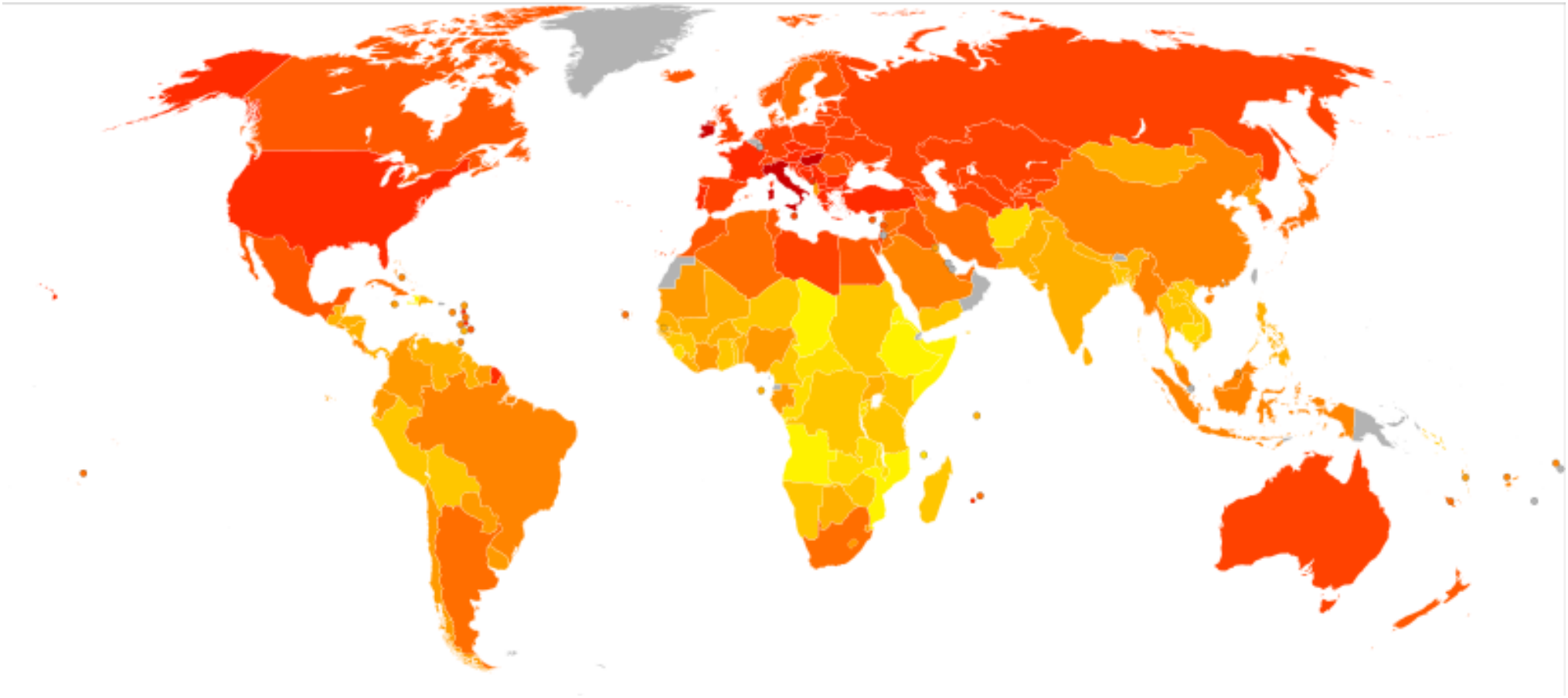
Energy Consumption



http://www.charcoalproject.org/2010/06/how-bp-is-going-to-help-alleviate-energy-poverty/

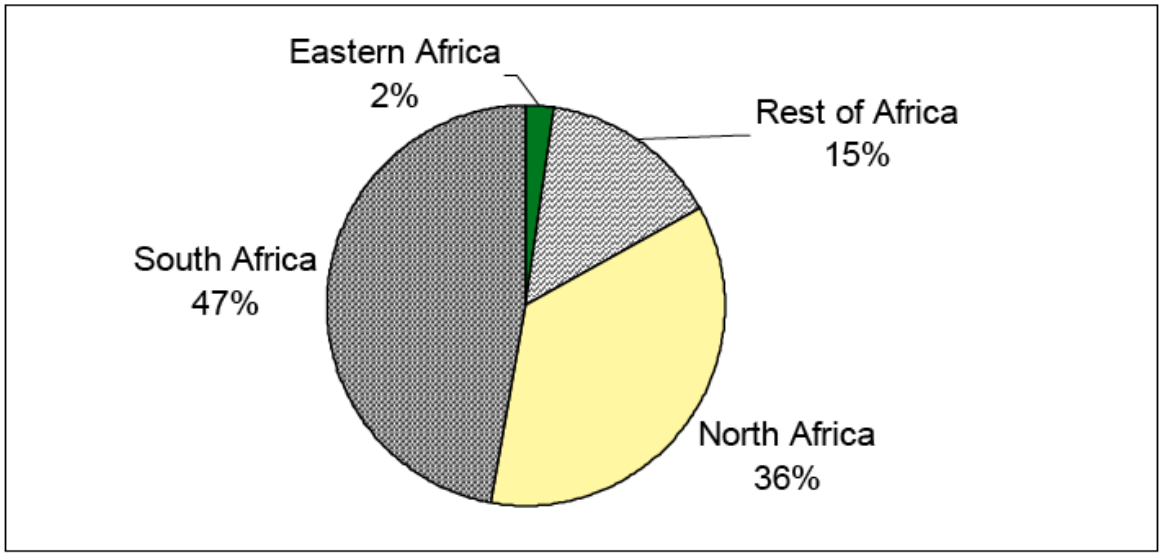
About 2.8 billion people or close to half of the world's population is estimated to survive on less than US$ 2 per day[3] – the "poor" as defined by international agencies such as the IEA, World Bank, UNDP, UNEP and OECD. A key distinguishing feature of the world's poor is inadequate access to cleaner energy sources. The majority of those earning less than US$ 2 per day rely on traditional biofuels to meet the bulk of their energy needs and have no access to electricity. Traditional biofuels meet the bulk of the energy needs of an estimated 2.4 billion people. Some 1.6 billion people have no access to electricity and a significant portion have limited or no access to cleaner and more modern fuels such as kerosene, LPG and natural gas.

Table 1 Electricity Consumption per capita for Selected Developing Regions of the World

Region	Annual Electricity Consumption per capita (kWh) – 2000
Latin America and the Caribbean	1,528
East Asia and the Pacific	760
South Asia	323
Sub-Saharan Africa[9]	432
Eastern Africa	60

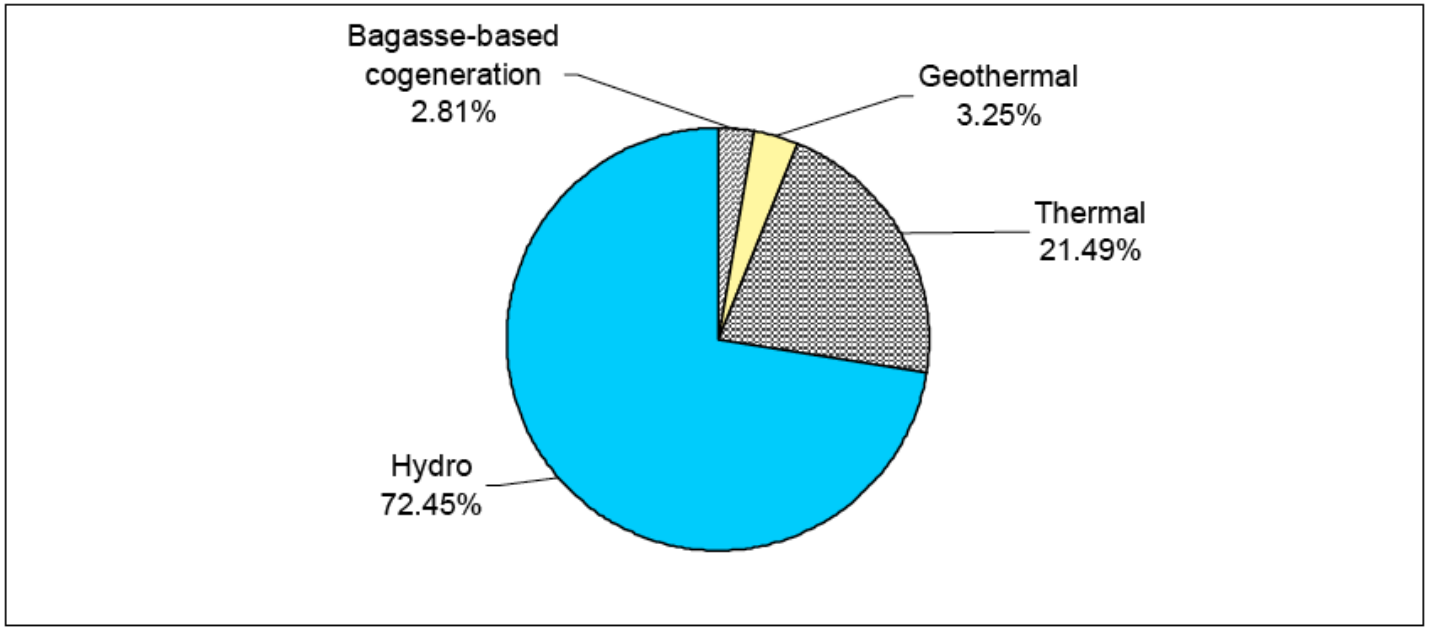
Sources: World Bank 2003, AFREPREN 2002, UEB 1999, and UNDP 2002.

Figure 1 Share of Installed Capacity in Africa (2000).



Sources: World Bank 2003, IEA 2002.

Figure 2 Electricity Production in Eastern Africa (2000)



Sources: Karekezi et al (eds), 2002b, AFREPREN, 2002, IEA, 2002

Poverty levels in the East African sub-region are very high, particularly in the rural areas. For instance, in Kenya, virtually the entire (100%)[1] rural population falls under the US$ 2 per capita per day. In urban areas (using the US$ 2 figure) about 80% of the population is poor. When the US$ 1 measure is used, the proportion of the poor remains significantly high at 80% in rural areas (World Bank, 2003) compared to only 40% for urban areas. It is for this reason that the rural population has been used as a proxy for the poor in this study.

Summary Data of the Case Studies

	KENYA						UGANDA					
	National		Urban		Rural		National		Urban		Rural	
Indicator	Pre-reform	Post-reform	Pre-reform	Post-reform	Pre-reform	Post-reform	Pre-reform	Post-reform	Pre-reform	Post-reform	Pre-reform	Post-reform
Electrification levels (%)	4.4	5.5	16.7	20.4	0.5	0.8	2.9	4.1	16.7	18.9	0.7	1.1
Electrification rates (%)	7.0	6.2	6.2	6.0	16.1	7.7	13.7	10.5	17.9	12.0	-3.3	5.4
Tariff/Cost of Electricity (USc/kWh)	4.1	7. 8	4.1	7.8	4.3	7.6	9.6	7.4	-	-	-	-
Per Household Consumption (kWh)	2,991	1,714	3,119	1,821	1,702	902	3,185	2,325	3,475	2,700	2,015	965
Per Capita Consumption (kWh/capita)	598	428	520	304	340	225	637	471	695	468	403	202

Table 2 Electrification Levels in Eastern Africa

Country	National Electrification levels (%) - 2001
Ethiopia	2
Uganda	4
Kenya	6**
Tanzania	10*
Mauritius	100

* 2002 data

** This figure only refers to the proportion of households connected to the electricity grid and may differ significantly from other sources which indicate the proportion of electrified population derived from the total number of grid electricity customers.

Sources: AFREPREN, 2002, Karekezi et al (eds), 2002b; Republic of Kenya, 2002; Okumu, 2003; Kinuthia, 2003

Table 3 Status of Power Sector Reforms in Eastern African Countries (2003)

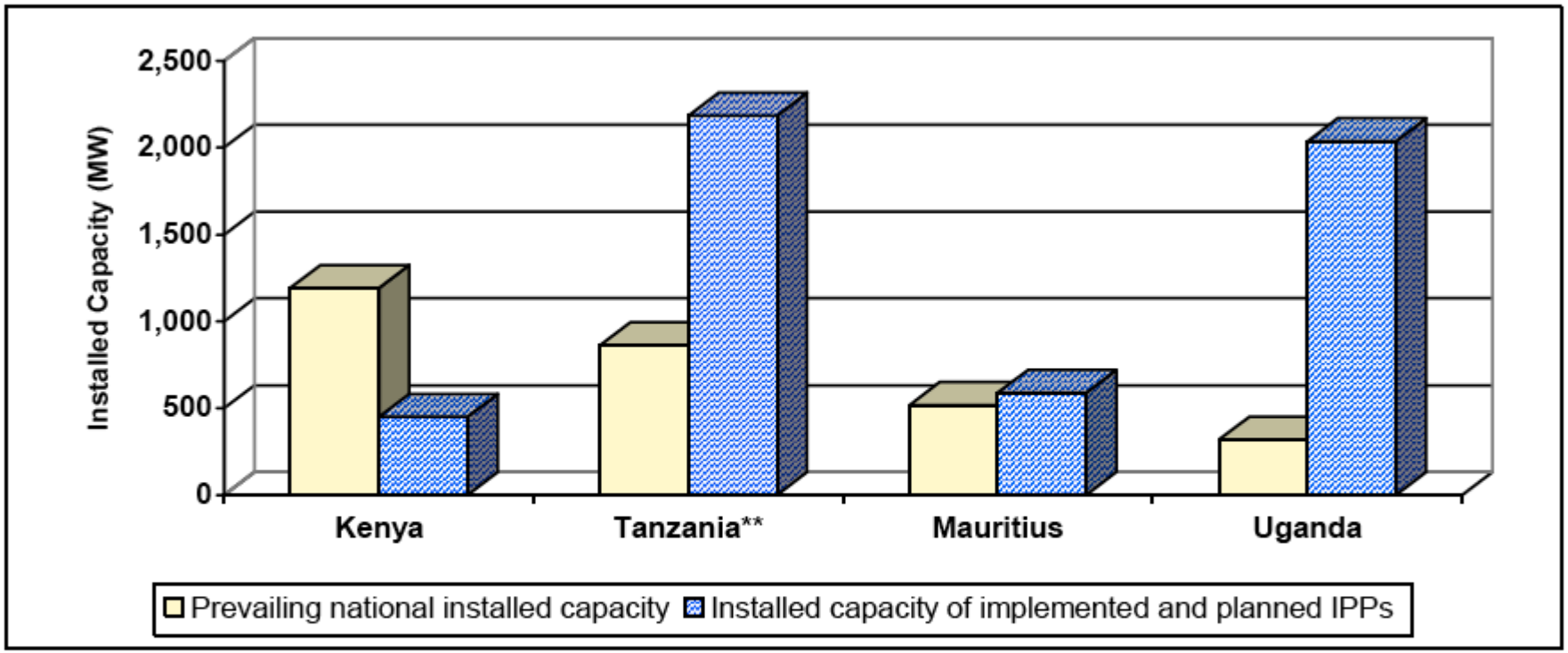
Reform Measures	Mauritius	Ethiopia	Tanzania	Kenya	Uganda
Amendment of the Electricity Act		Y		Y	Y
Corporatisation/Commercialisation		Y	Y	Y	Y
Establishment of Independent Regulator				Y	Y
Restructuring (unbundling)				Y	Y
Independent Power Producers	Y		Y	Y	Y
Privatisation of Generation					Y*
Privatisation of Distribution					?

Notes:

* Concession awarded to Eskom in 2002

? As of 2003, concession agreement yet to be concluded following disagreement over concession terms between Government and proposed concessionaire (Mugarura, 2003)

Figure 3 "Prevailing National Installed" Capacity Compared to IPPs for Eastern African Countries (2002)*



* There has been no IPP development in Ethiopia to date.
** Year 2001 data

Sources: Adapted from Karekezi et al (eds), 2002b; Okumu, 2003; Kinuthia, 2003; Veragoo, 2003

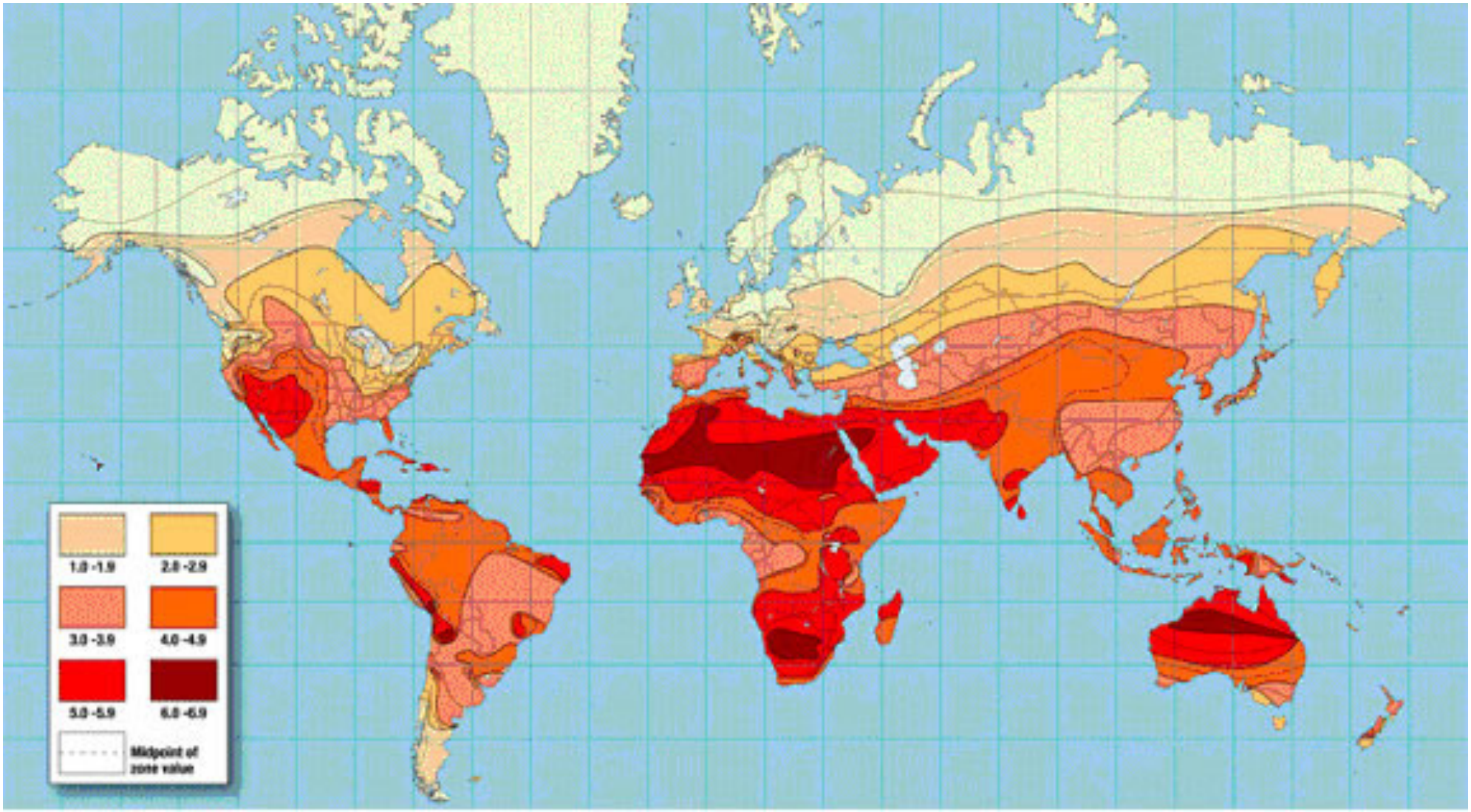
Table 4 Modern Energy Consumption per capita (kgoe)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
South Africa	1,094	1,107	1,114	1,185	1,150	1,285	1,166	1,108	1,090	1,091
Kenya	88.4	86.7	88.9	88.8	91.6	86.5	84.0	79.6	79.4	78.8
Uganda	24.0	23.0	23.0	15.5	16.2	19.0	19.5	19.9	19.8	23.7

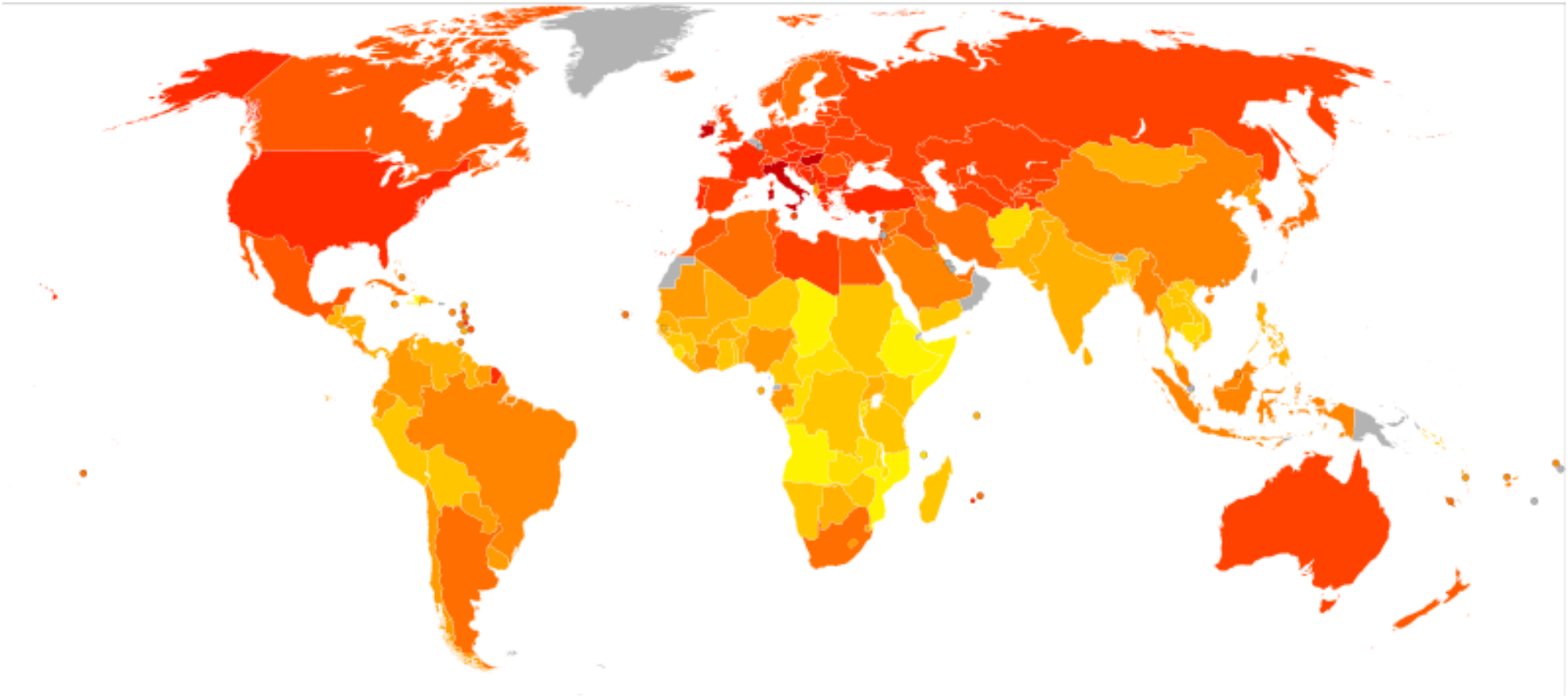
Source: AFREPREN, 2002 ; IEA,2003 ; EIU, 1995-2003

Table 5 Percentage of Households connected

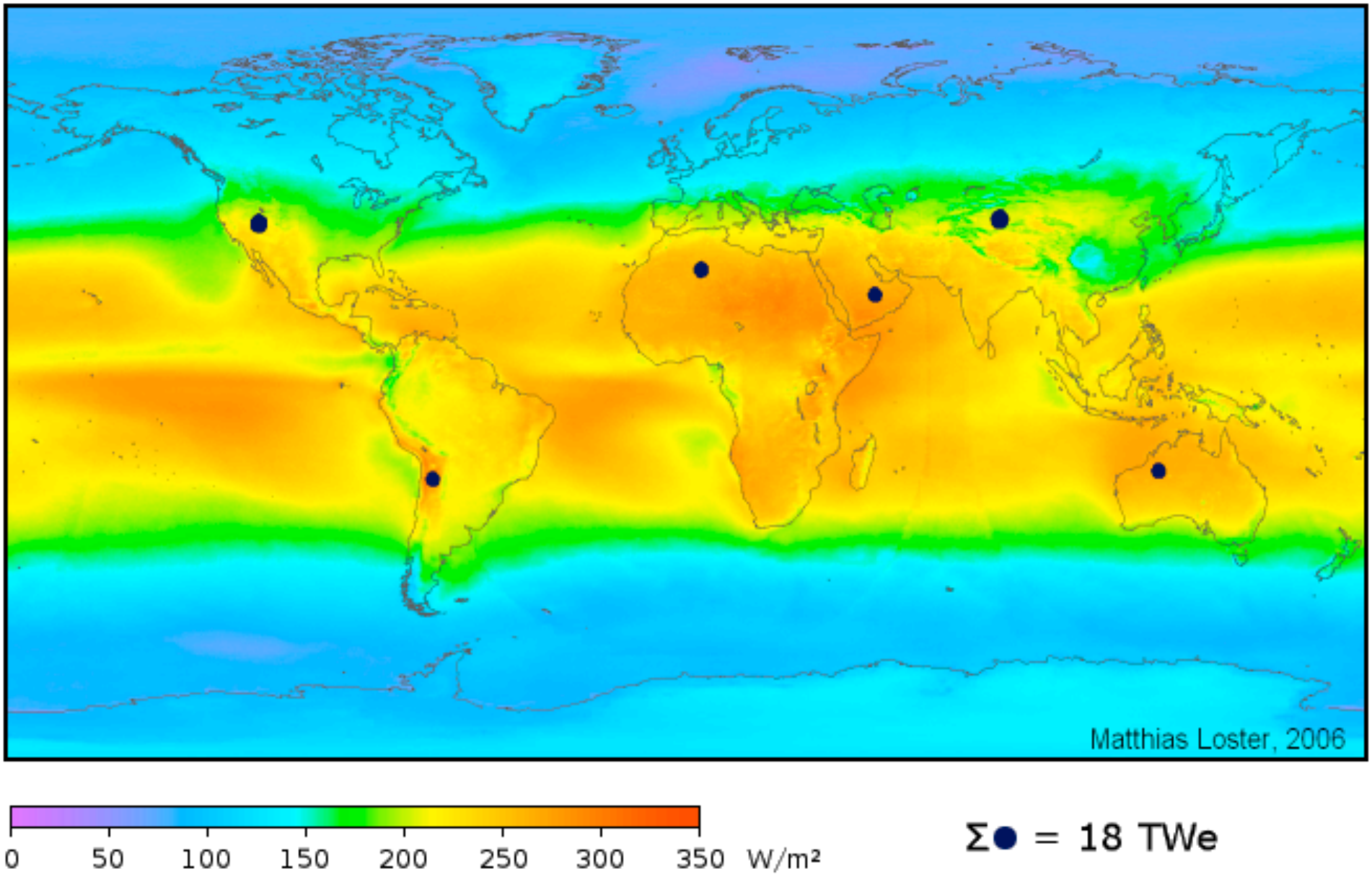
	National	Urban	Rural
South Africa (2002)	68.00	80.00	50.00
Zimbabwe (1999)	39.00	80.00	18.00
Kenya (2002)	6.12	22.68	0.94
Uganda (2002)	4.10	18.90	1.10


1.0 -1.9
2.0 -2.9
3.0 -3.9
4.0 -4.9
5.0 -5.9
6.0 -6.9
Midpoint of zone value

Energy Consumption World Map

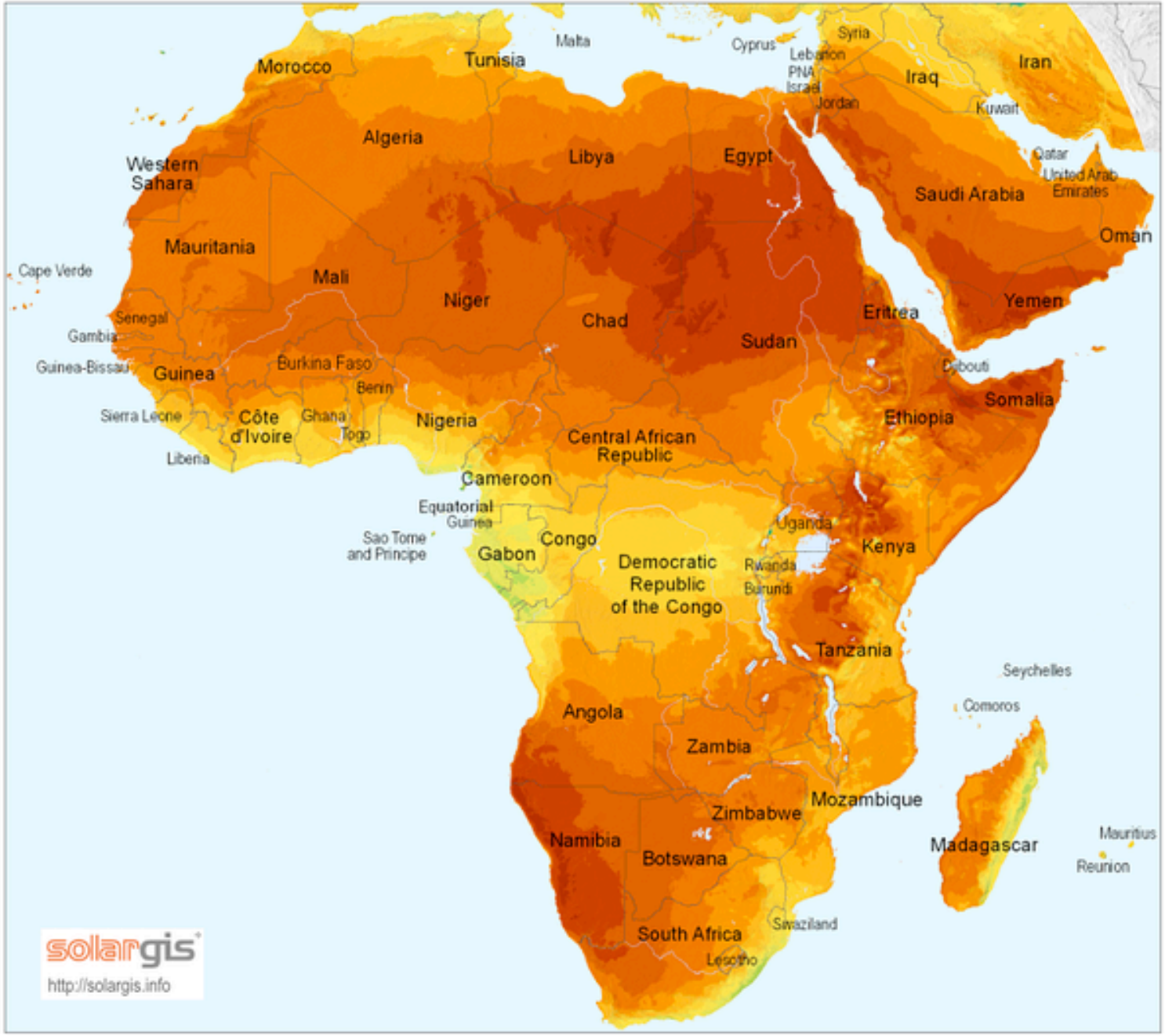


http://www.charcoalproject.org/2010/06/how-bp-is-going-to-help-alleviate-energy-poverty/


Matthias Loster, 2006
0
50
100
150
200
250
300
350
W/m²
Σ● = 18 TWe

Global horizontal irradiation

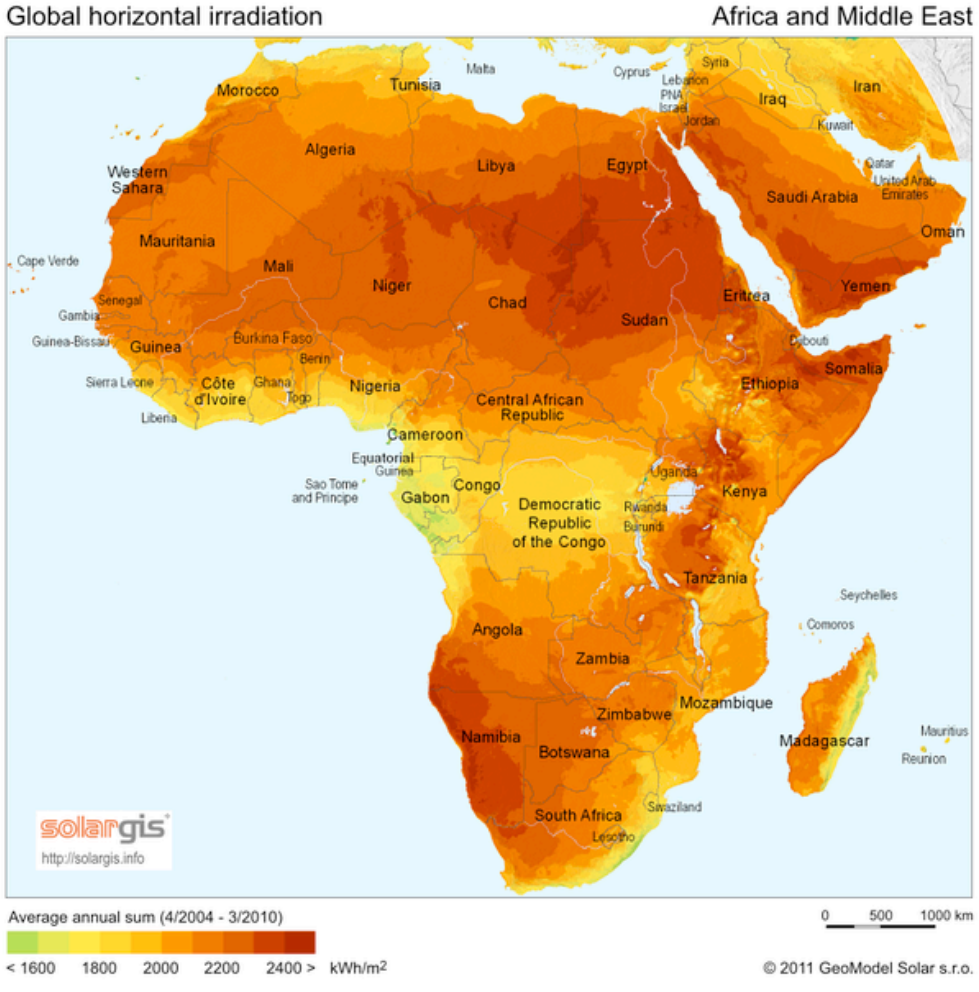
Africa and Middle East



Average annual sum (4/2004 - 3/2010)

< 1600 1800 2000 2200 2400 > kWh/m²

0 500 1000 km


Global horizontal irradiation
Africa and Middle East
Morocco
Tunisia
Malta
Cyprus
Syria
Lebanon
PNA
Israel
Jordan
Iraq
Iran
Kuwait
Qatar
United Arab Emirates
Saudi Arabia
Oman
Yemen
Algeria
Libya
Egypt
Western Sahara
Mauritania
Cape Verde
Mali
Niger
Chad
Sudan
Eritrea
Djibouti
Somalia
Ethiopia
Senegal
Gambia
Guinea-Bissau
Guinea
Burkina Faso
Benin
Sierra Leone
Côte d'Ivoire
Ghana
Togo
Nigeria
Liberia
Central African Republic
Cameroon
Equatorial Guinea
Sao Tome and Principe
Gabon
Congo
Uganda
Kenya
Rwanda
Burundi
Democratic Republic of the Congo
Tanzania
Seychelles
Comoros
Angola
Zambia
Mozambique
Zimbabwe
Namibia
Botswana
Madagascar
Mauritius
Reunion
South Africa
Swaziland
Lesotho
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Average annual sum (4/2004 - 3/2010)
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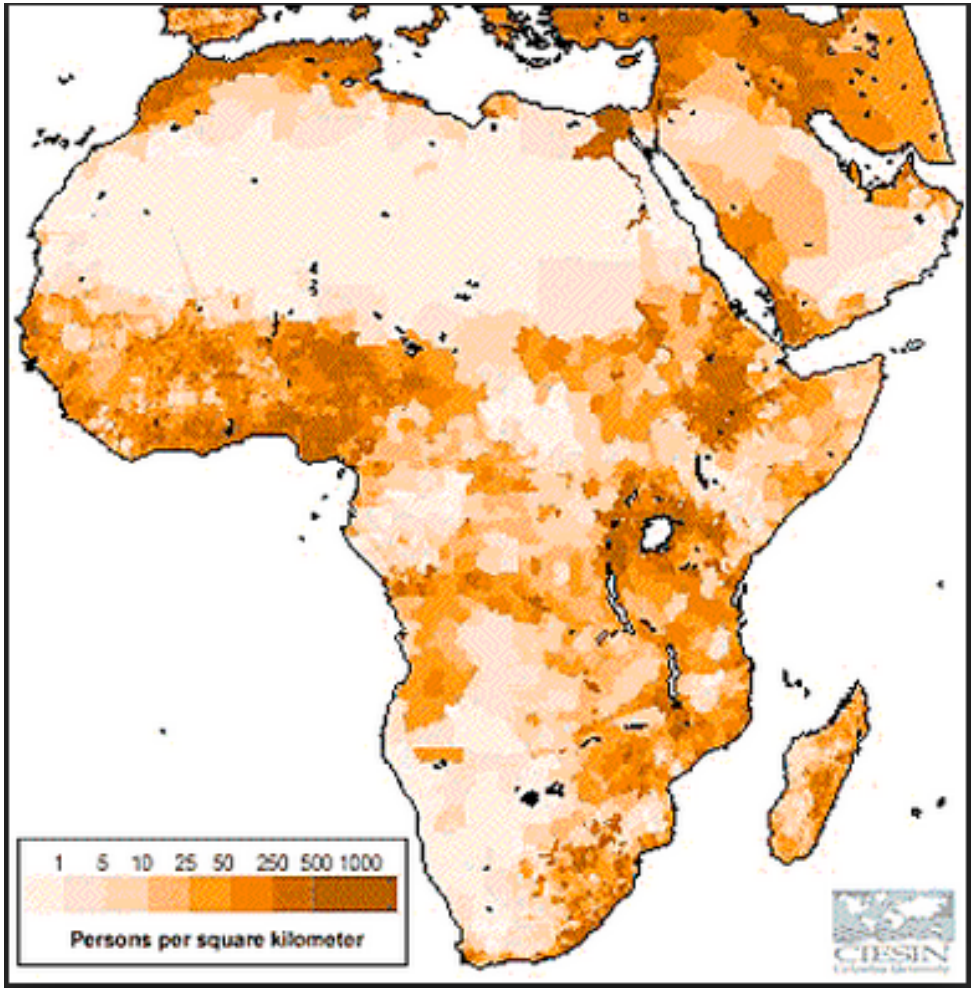
0 500 1000 km
© 2011 GeoModel Solar s.r.o.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Persons per square kilometer
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