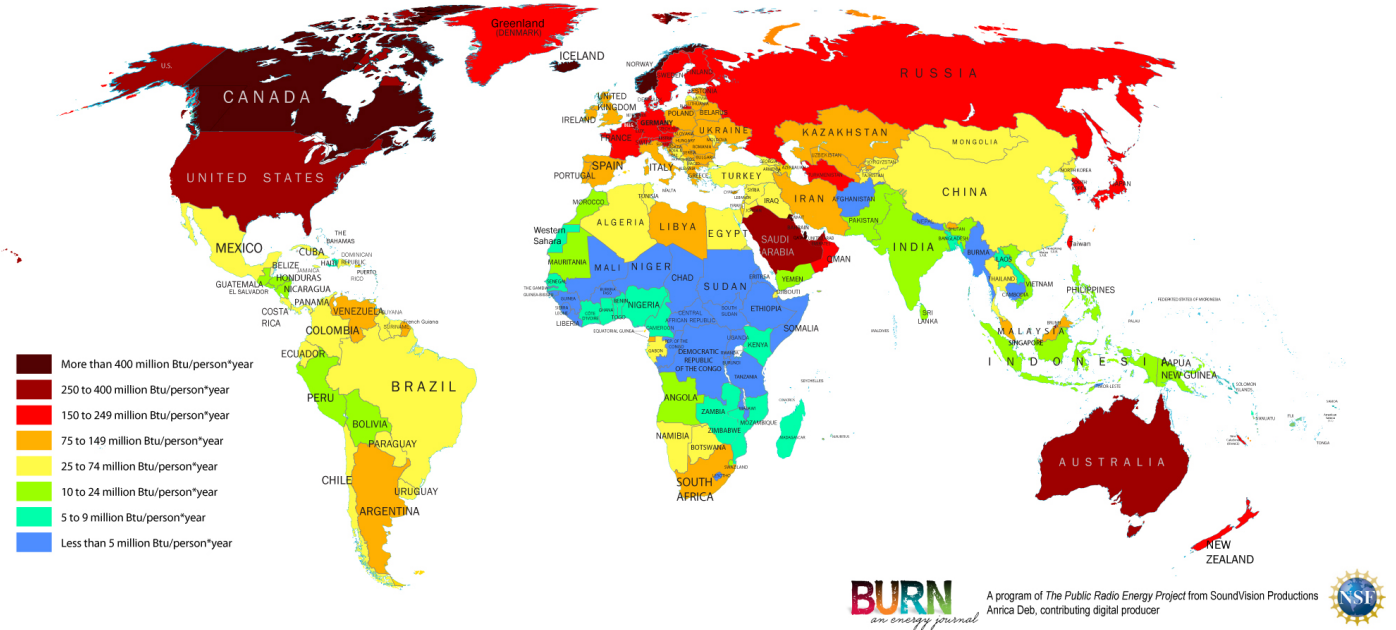


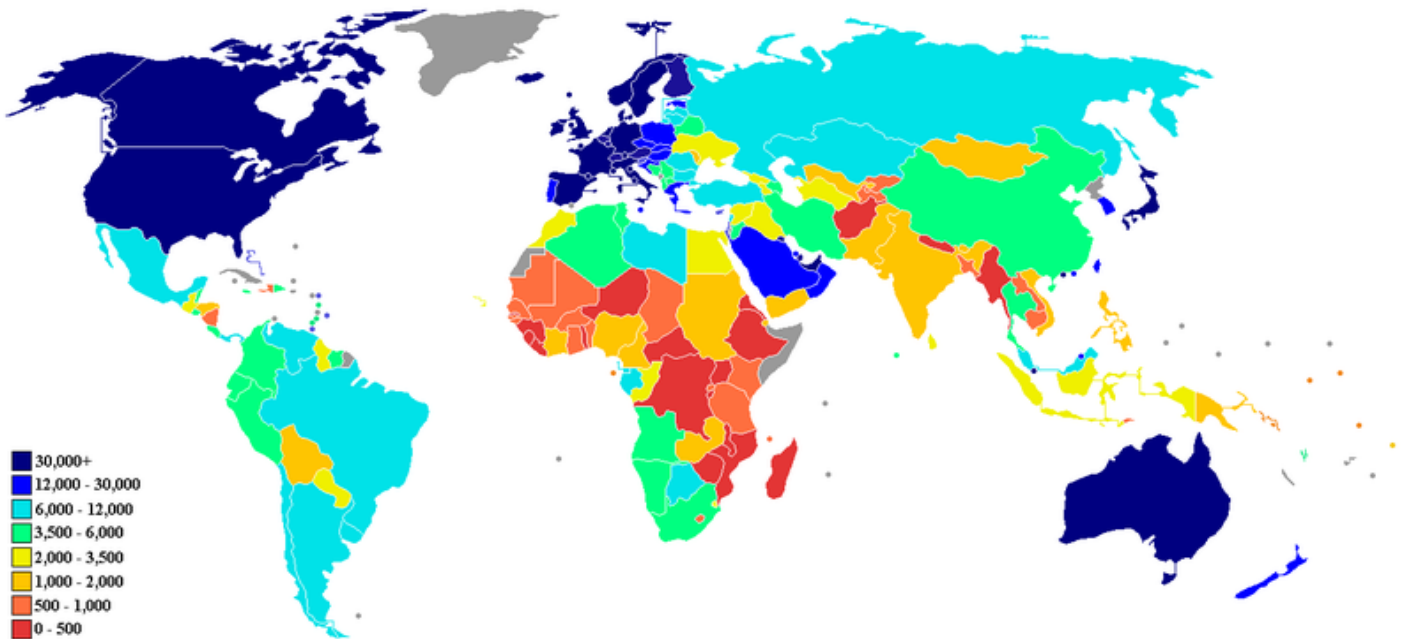
# Climate Change Science and Negotiation Graphs: Lecture 8

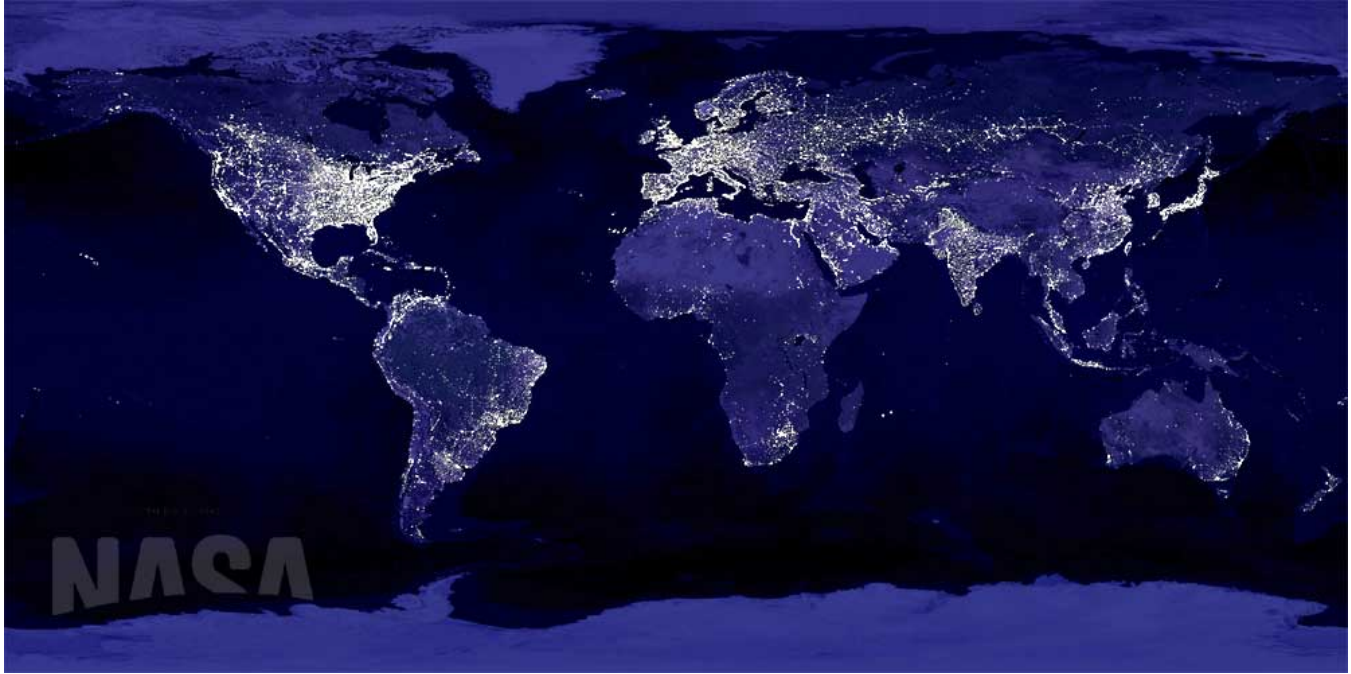
## Chapter 1

Energy Consumption Per Person, by country, 2009.



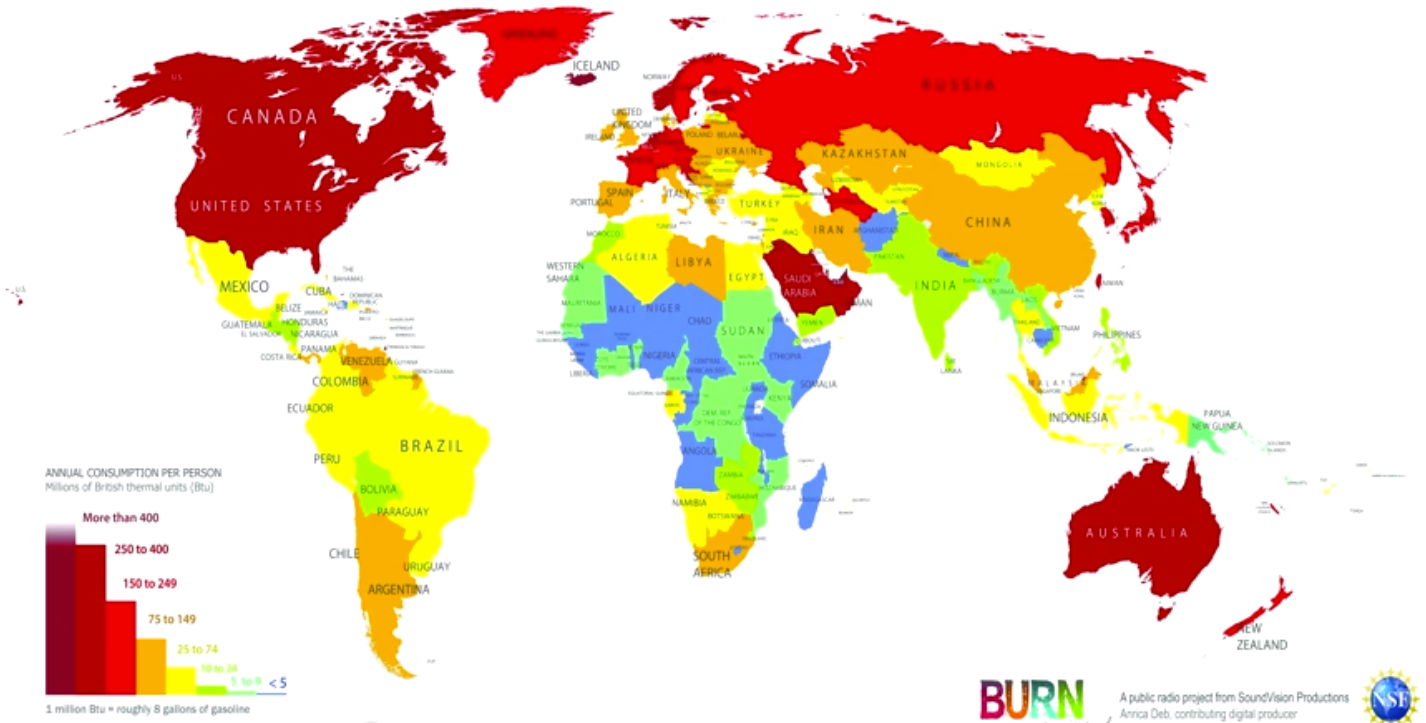
Gross Domestic Product, Per Person, 2011, Current \$US



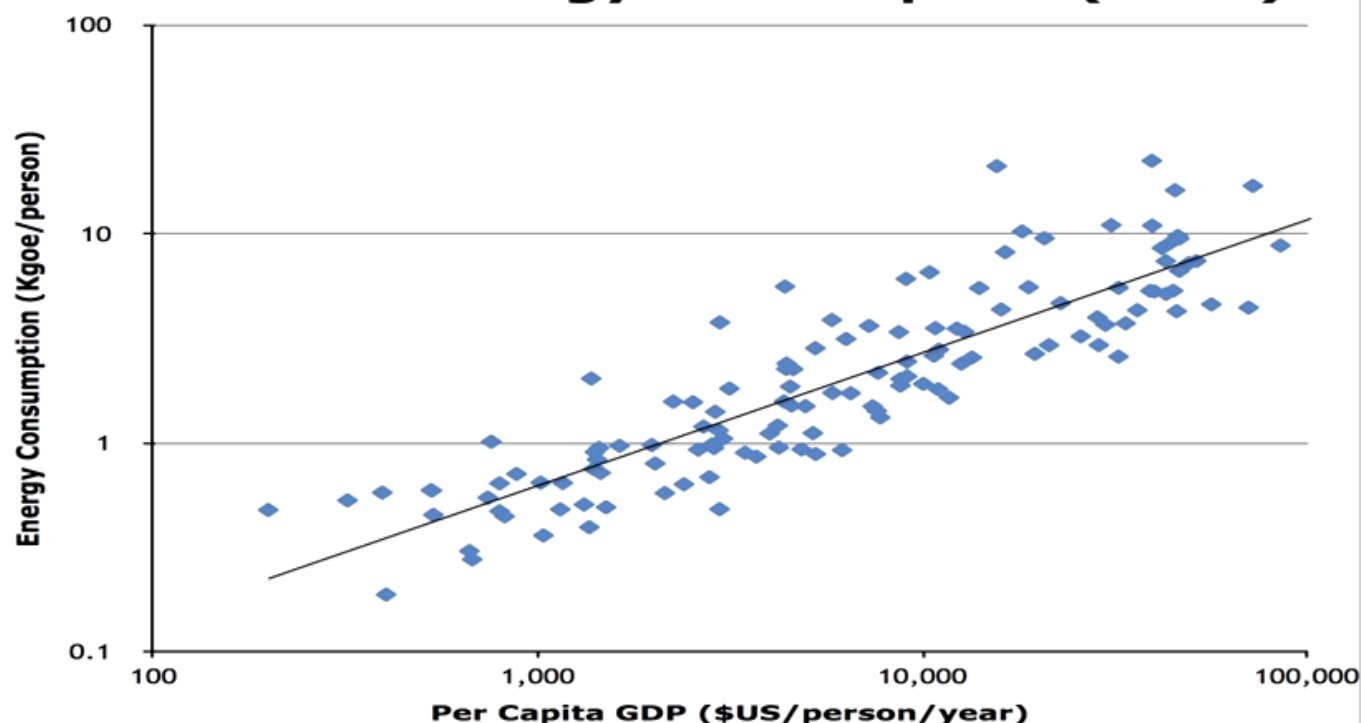


### Energy Consumption Per Person, by country, 2010.

SOURCES: U.S. Energy Information Administration, International Energy Agency, CIA World Factbook, U.N. Dept. of Economics & Social Affairs



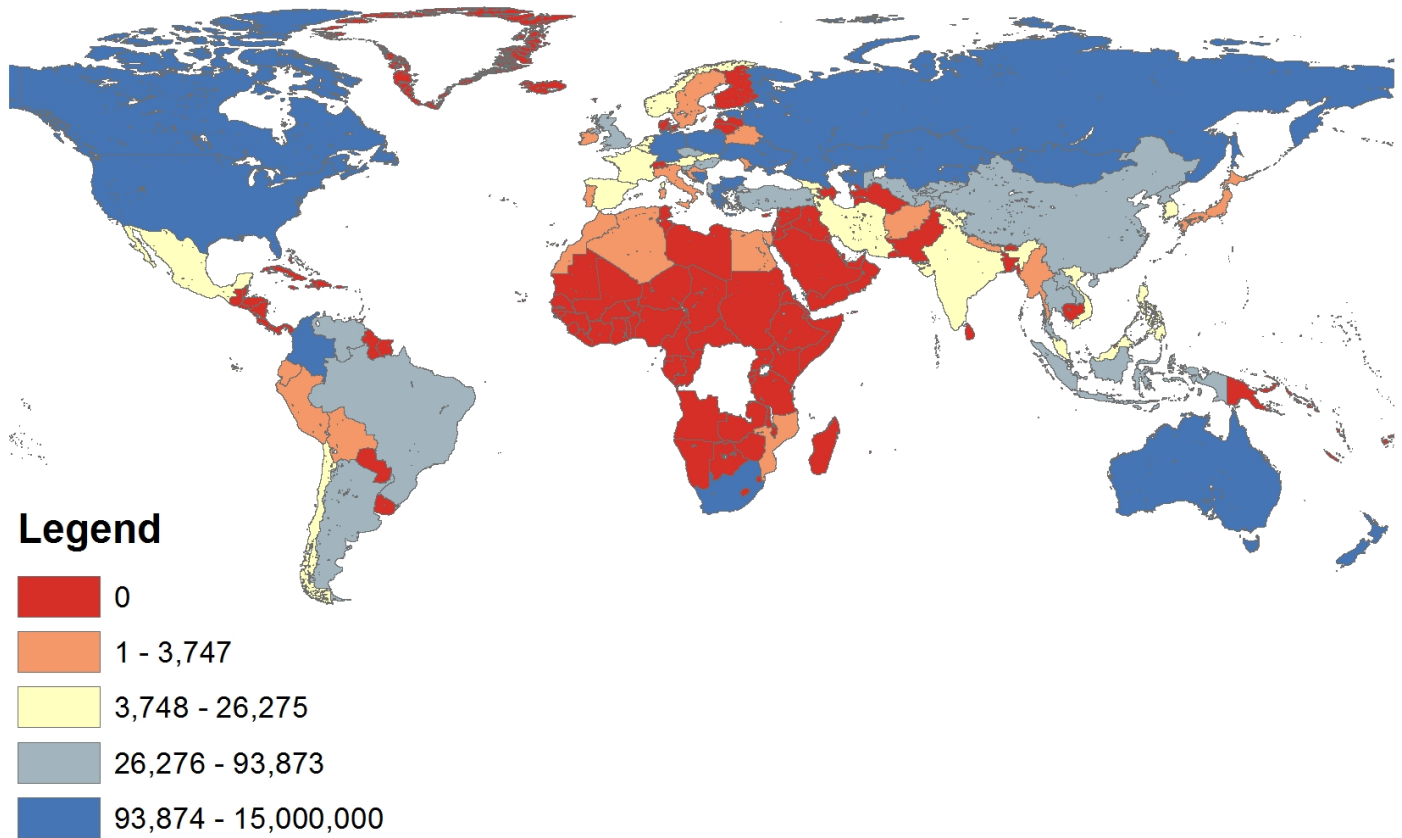
## GDP vs. Energy Consumption (2010)



## Selected Indicators for 2011

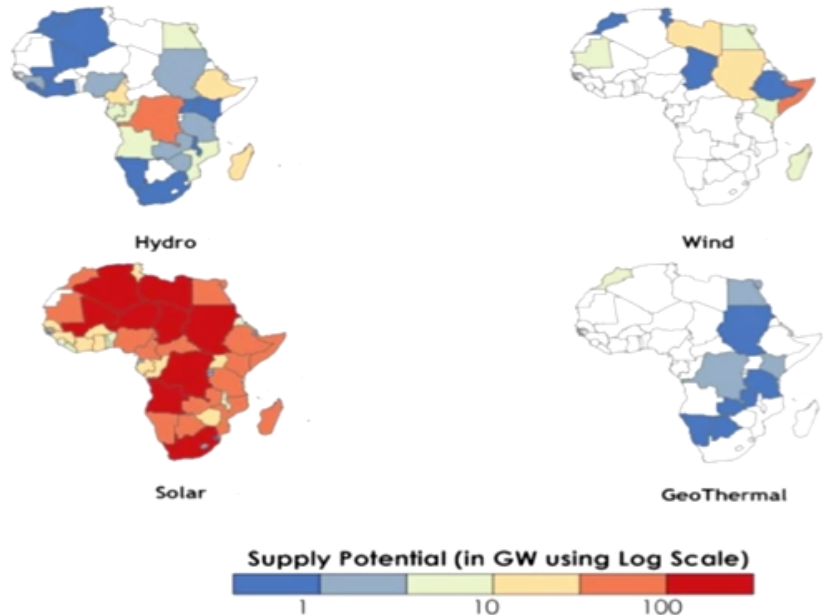
Region/ Country/ Economy	Popu- lation (million)	GDP (billion 2005 USD)	GDP (PPP) (billion 2005 USD)	Energy prod. (Mtoe)	Net imports (Mtoe)	TPES (Mtoe)	Elec. cons. <sup>(a)</sup> (TWh)	CO <sub>2</sub> emissions <sup>(b)</sup> (Mt of CO <sub>2</sub> )
World	6 958	52 486	70 313	13 202	-	13 113 <sup>(c)</sup>	20 407	31 342 <sup>(d)</sup>
OECD	1 241	38 239	37 906	3 854	1 622	5 305	10 205	12 341
Middle East	209	1 271	2 489	1 788	-1 106	647	737	1 607
Non-OECD Europe and Eurasia	340	1 597	3 666	1 822	-623	1 176	1 525	2 743
China	1 351	4 426	10 286	2 433	408	2 743	4 475	8 000
Asia	2 313	3 386	8 749	1 405	252	1 593	1 904	3 484
Non-OECD Americas	460	2 298	4 403	797	-186	589	942	1 087
Africa	1 045	1 267	2 814	1 104	-390	700	619	968
Africa as % Share	15		4			5.3	3.0	3.1

# Pre-Industrial Coal Reserves (\$ per 1820 population, using 2010 prices)



## RESEARCH FOCUS: RESOURCES Energy Supply Potential in Africa

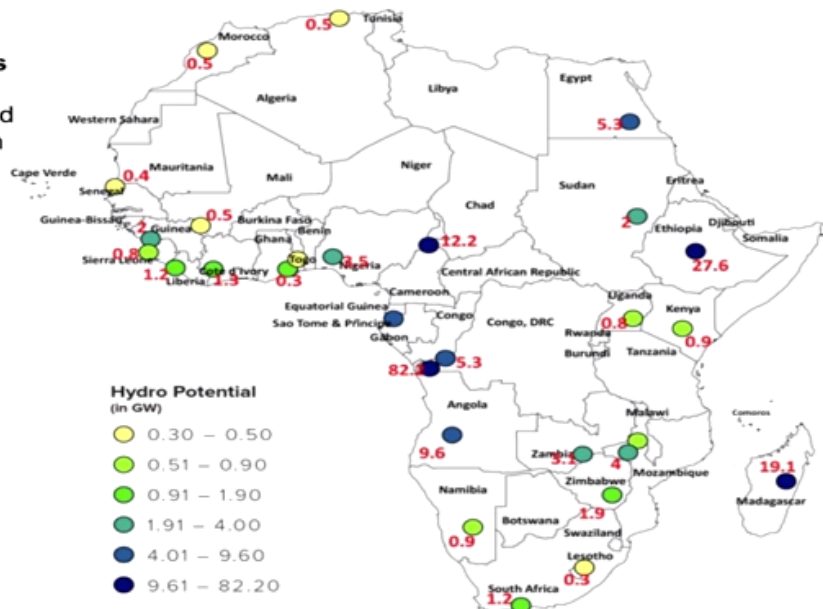
- **Large hydro and solar resources**
- 50% of the hydro resources are in central, eastern and southern Africa.
- Average daily solar irradiation of 5-6 kWh/m<sup>2</sup>. The highest available intensities are found in the desert and Sahel areas.
- Somalia, Sudan, Libya, Egypt, Mauritania and Madagascar have high potential for on-shore wind power.
- Overall potential for geothermal energy is smaller than that of other resources, however it can still be used in some countries such as Kenya, Tanzania, and Morocco, where 1–5 GW are exploitable.



Source: Sanoh, A., Kocaman, A. S., Kocak, S., Sherpa, S., & Modi, V. (2014). The economics of clean energy resource development and grid interconnection in Africa. *Renewable Energy*, 62, 598-609.

## RESEARCH FOCUS: HYDRO POWER Role of Hydroelectric Generation

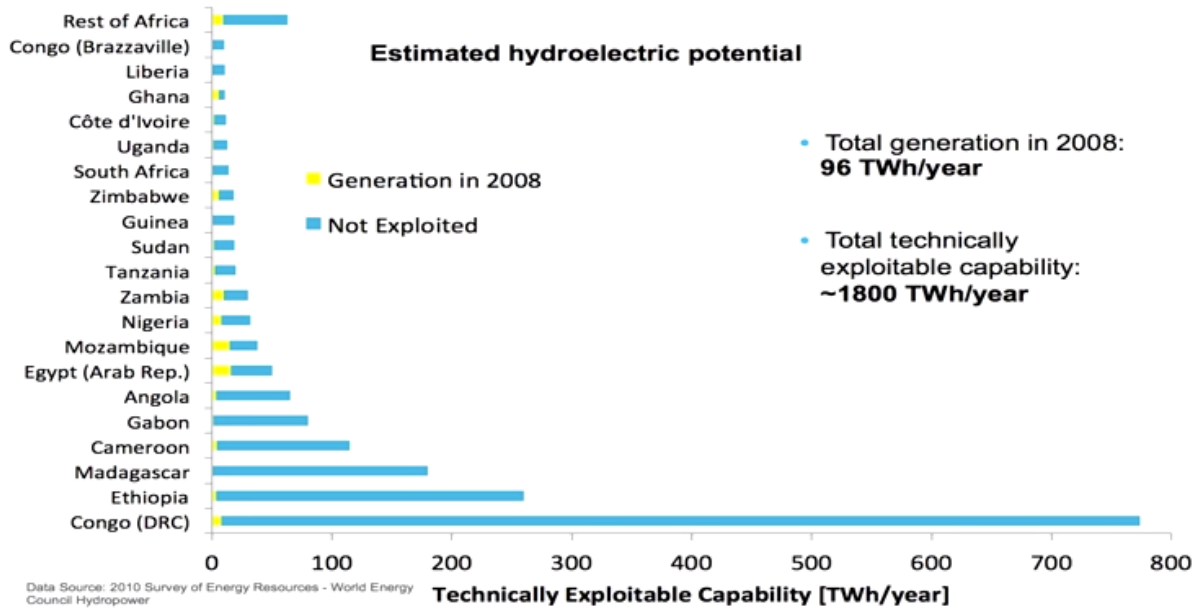
- **Most important hydro resources** are located in Central Africa, with largest at **Grand Inga (Congo)** and from **Cameroon to Angola**, and in **Ethiopia**.
- **Pumped-storage hydro** possibilities have to be identified and developed to assist with the **integration of intermittent renewable resources**.



Source: Aly Sanoh, Ph.D. dissertation: "Essays on Infrastructure Development and Public Finance", Columbia University, 2012

## RESEARCH FOCUS: HYDRO POWER

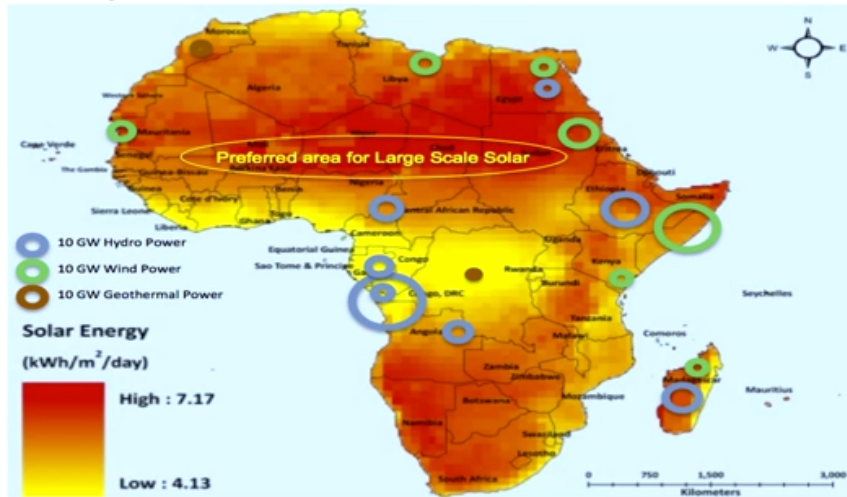
### Hydro Power in Africa: Present & Future



## RESEARCH FOCUS: LARGE NETWORK

### Integrating Renewable Resources

#### Most Important Renewable Resources



#### Benefits of large networks include:

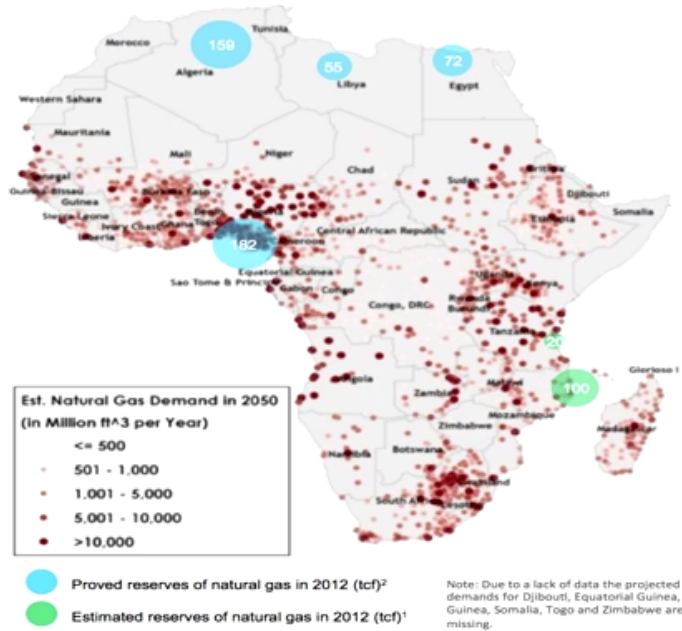
- Utilization of local resources at a large scale
- Facilitating the integration of renewables
- Improvement of the reliability
- Potential reduction of electricity cost

Sources:  
 Piet Buys, Uwe Deichmann, Craig M. Meisner, Thao Ton That, David Wheeler, 2007. *Country Stakes in Climate Change Negotiations: Two Dimensions of Vulnerability*. WPS4300; NASA

# RESEARCH FOCUS: NATURAL GAS

## Large Reserves, Potential High Demand

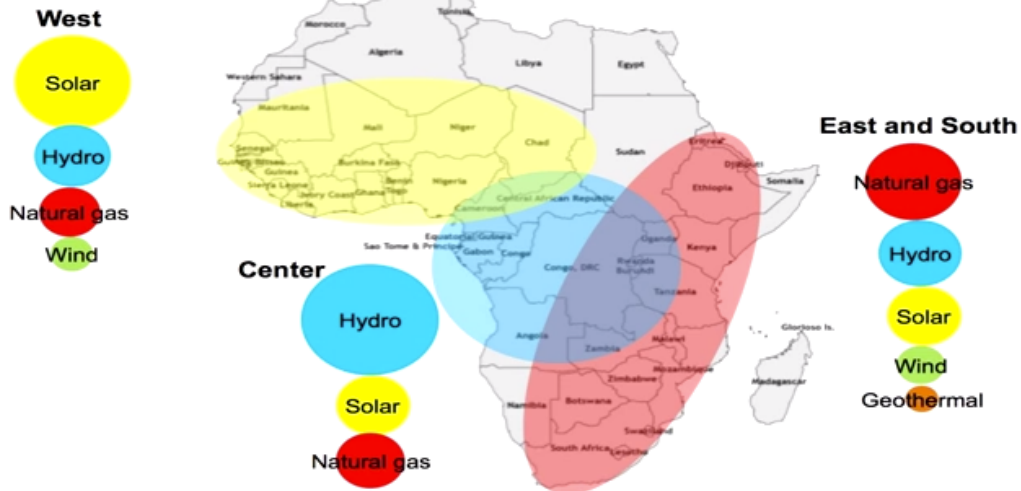
- In Africa, natural gas distribution networks are practically nonexistent.
- **Important natural gas resources** have been recently identified in **Mozambique and Tanzania.**
- This resource could benefit the high population density region of the Great Rift Valley, for different uses such as **cooking, power generation, transportation and fertilizer production.**
- The estimated potential demand for sub-Saharan Africa in 2050 is around 10 tcf per year.



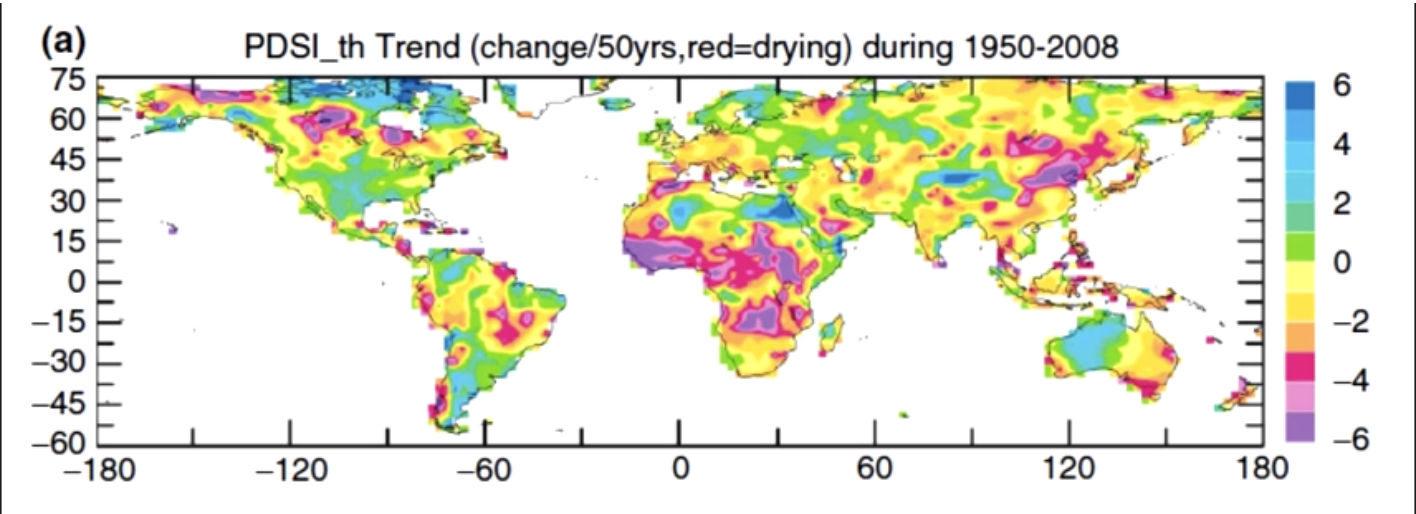
Sources:  
 Ledesma, D., 2013. « East Africa Gas – Potential for Export », The Oxford Institute for Energy Studies;  
 BP Statistical Review of World Energy 2013.

## CONCLUSION: What Energy Mix for Sub-Saharan Africa by 2050?

The future energy mix of Sub-Saharan Africa is the central question to answer. Here is a possible long-term scenario.

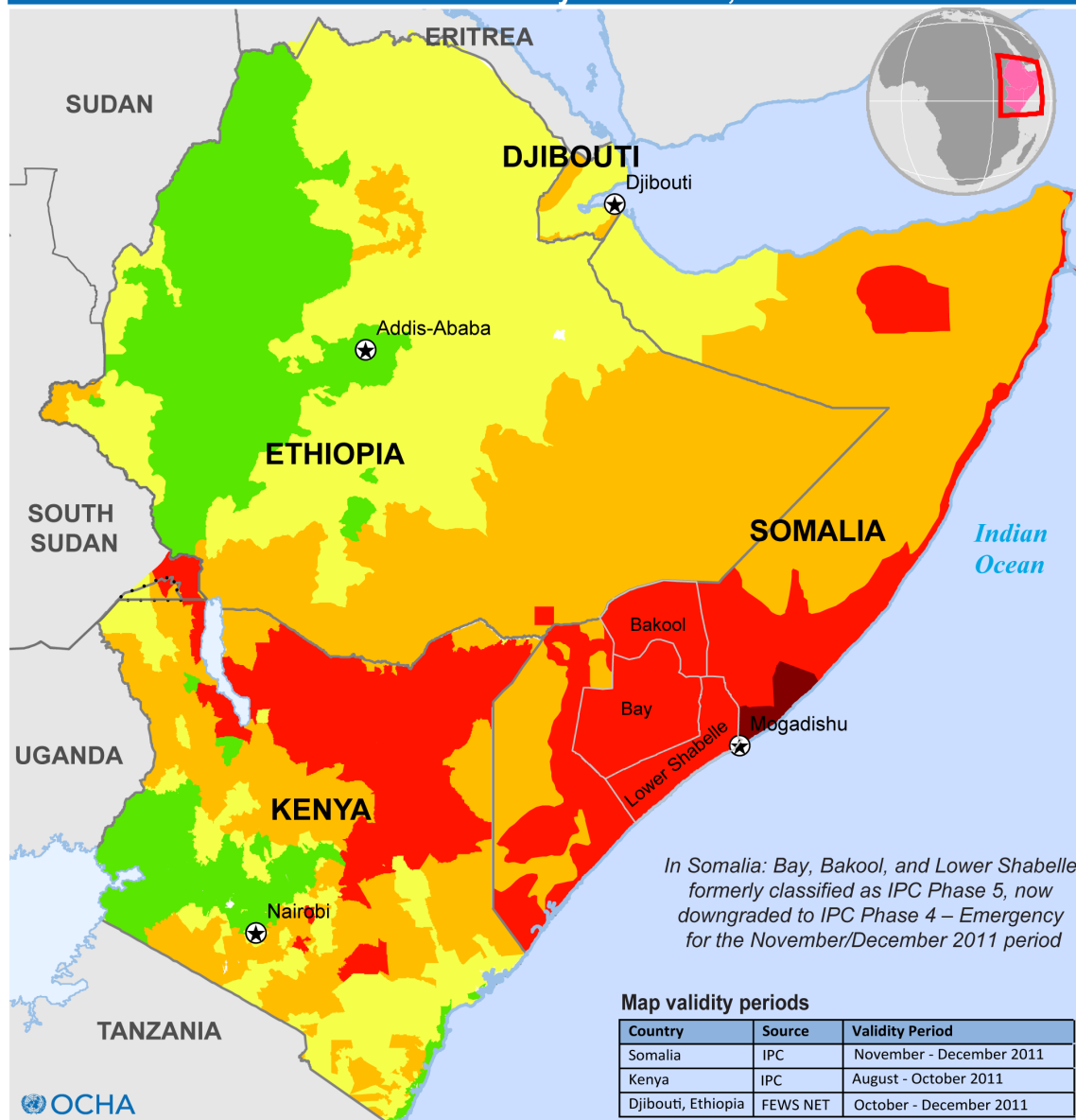


**CHAPTER 4**





# Horn of Africa: Food Security Situation, November 2011



## Integrated Food Security Phase Classification (IPC)

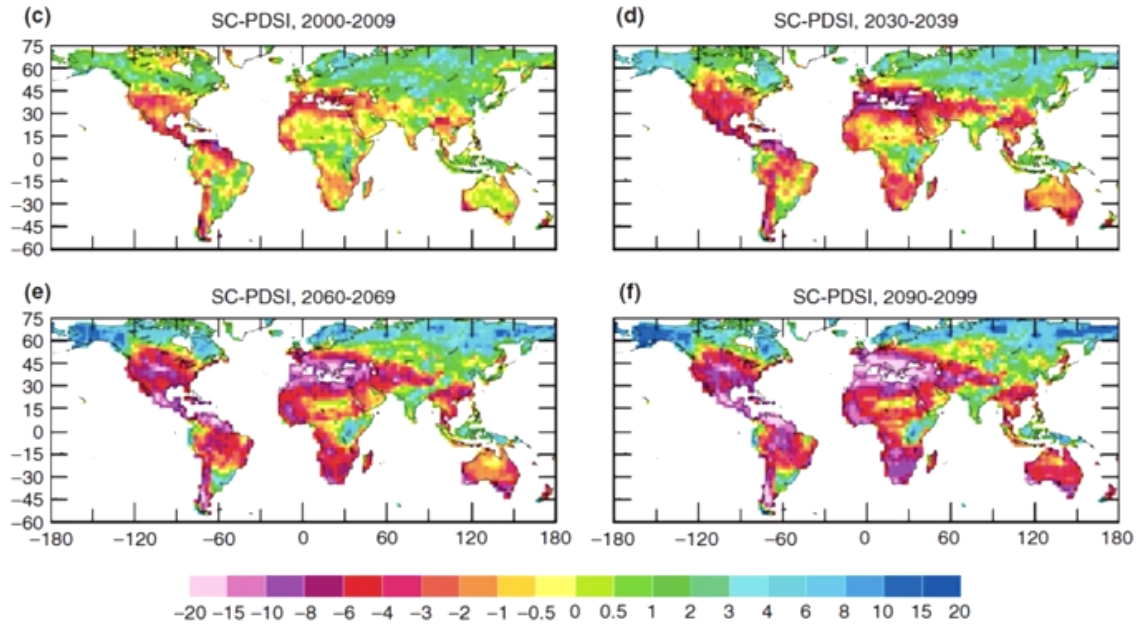
Map created 24 Nov 2011

### Acute Food Insecurity Phase

- 1. None or Minimal
- 2. Stressed
- 3. Crisis
- 4. Emergency
- 5. Catastrophe / Famine

Map Sources: FAO-ROEA/FSNWG, FEWS NET, OCHA, UNCS

*The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations*



**FIGURE 11** | Mean annual sc-PDSI<sub>pm</sub> for years (a) 1950–1959, (b) 1975–1984, (c) 2000–2009, (d) 2030–2039, (e) 2060–2069, and (f) 2090–2099 calculated using the 22-model ensemble-mean surface air temperature, precipitation, humidity, net radiation, and wind speed used in the IPCC AR4 from the 20th century and SRES A1B 21st century simulations.<sup>128</sup> Red to pink areas are extremely dry (severe drought) conditions while blue colors indicate wet areas relative to the 1950–1979 mean.

### a) Impacts of Climate Change on Crop Production (2030s)

