Energy poverty

ENERGY	FOOD	HEALTH	**INCOME**
1.3 Billion without access to electricity (IEA)	1 Billion under-nourished (FAO)	830 Million urban residents live in slum conditions (WHO)	**1.3 Billion below poverty line of 1.25 $/ day (WB 2012)**

What impacts will energy poverty reduction have on global energy demand (and on CO_2 emissions)?

QUITE MODERATE
Universal access by 2030 would increase electricity by 2.5%, fossil fuels by 0.8% (IEA 2011)
The additional emissions needed to provide universal access to electricity could be offset by a switch of the US vehicle fleet to European standards (World Bank, 2010).
Africa power installed capacity in 2030 would increase from 79 to 500 GW to provide full electricity access (Bazilian et. al 2011)

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POTENTIALLY SIGNIFICANT
Not accounting for pro-poor growth could grossly underestimate future energy use (Gertler et. al..2011)
The current forecasts for energy demand in the developing world may be understated because they do not accurately capture the dramatic increase in demand associated with poverty reduction (Wolfram et. al 2012)
Bi-directional causality between energy consumption and economic growth (vast literature)

Relating energy to consumption

The correlation between energy and income is not always high for the poorer (Pachauri and Spreng 2011), but it is quite high across income classes

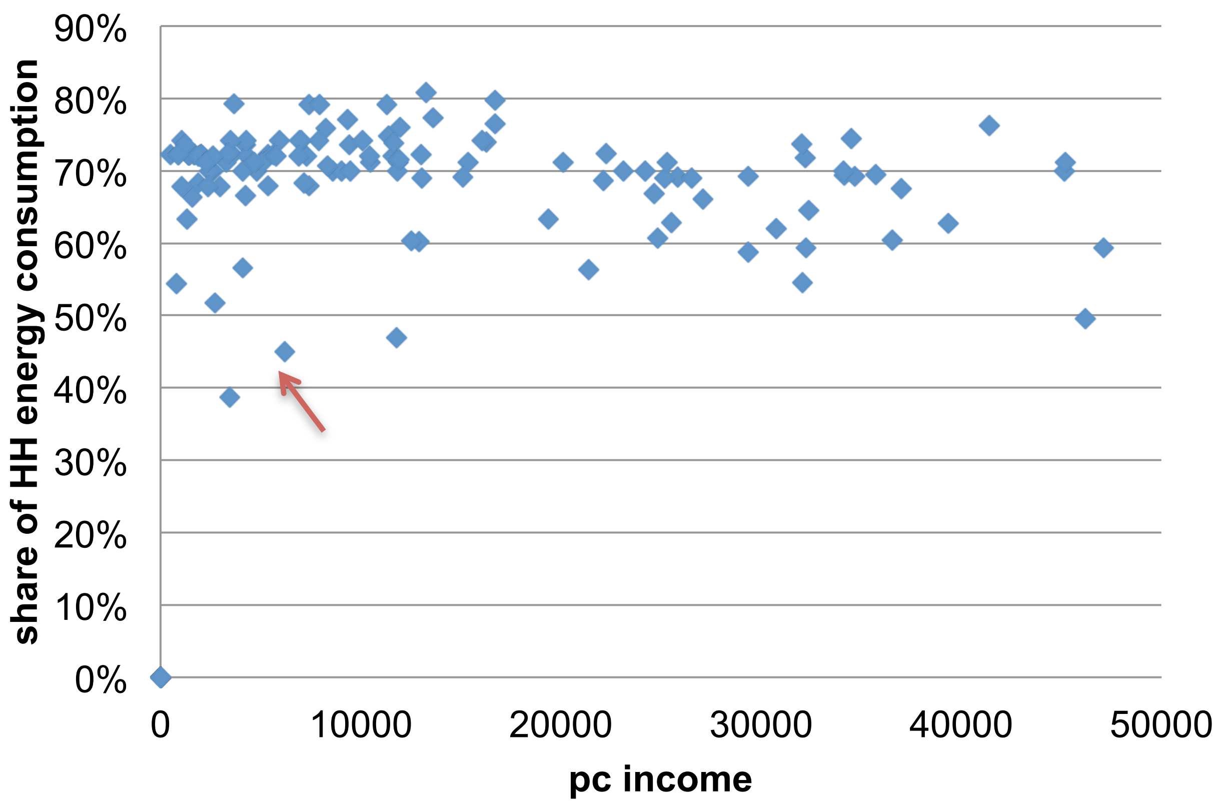
Country	Reference	Year	Elasticity of energy[a]	Elasticity of CO_2 emissions[a]
Australia	*(1)* Lenzen (1998)	1993-94	0.74	0.7
Australia	*(2)* Lenzen et al. (2006)	1998-99	0.78	
Brazil[b]	*(2)* Lenzen et al. (2006)	1995-96	1	
Denmark	*(3)* Wier et al. (2001)	1995	0.9	0.9
Denmark	*(2)* Lenzen et al. (2006)	1995	0.86	
India	*(2)* Lenzen et al. (2006)	1997-98	0.86	
Japan	*(2)* Lenzen et al. (2006)	1999	0.64	
Netherlands	*(4)* Vringer & Blok (1995)	1990	0.83	
New Zealand	*(5)* Peet et al. (1985)	1980	0.4[c]	
Norway	*(6)* Herendeen (1978)	1973	0.72	
Norway	*(7)* Peters et al. (2006)	1999-2001		0.88
Spain	*(8)* Roca & Serrano (2007)	2000		0.91-0.99[d]
U.S.	*(9)* Herendeen & Tanaka (1976)	1960-61	0.85	
U.S.	*(10)* Herendeen et al. (1981)	1972-73	0.78	
U.S.	*(11)* Weber & Matthews (2008)	2004		0.6-0.8[e]

[a]w.r.t. to consumption expenditure
[b]Survey covers 11 state capitals only.
[c]Low value due to high use of hydroelectric electricity in poor households.
[d]Range depends on assumptions used to convert from household emissions to per capita emissions.
[e]Range depends on the specific model used to fit data.

Counting both direct and indirect energy consumption

In DCs, household contribute less to total final energy demand.

However, this is no longer necessary true when both direct and indirect energy is accounted for.



Elaboration on data from Glen Peters

Mapping energy consumption

- Generate income/consumption probability distributions using surveys for most countries of the world

- For a given consumption/energy functional form, derive energy distributions for each country

- Project them into the future in a BAU taking some exogenous regional projection (and derive implications for policy)

Data and methodology

Data:

- GDP: WDI, PWT, CIA
- Income/consumption distributions for 153 countries: quintiles/deciles data from WDI, Povcalnet, UNU WIID
- Modern Final Energy Consumption by HH (direct + indirect): IEA, Peters and Hertwich
- Energy projections growth: EIA projections to 2030 for 14 regional aggregates

Methodology:

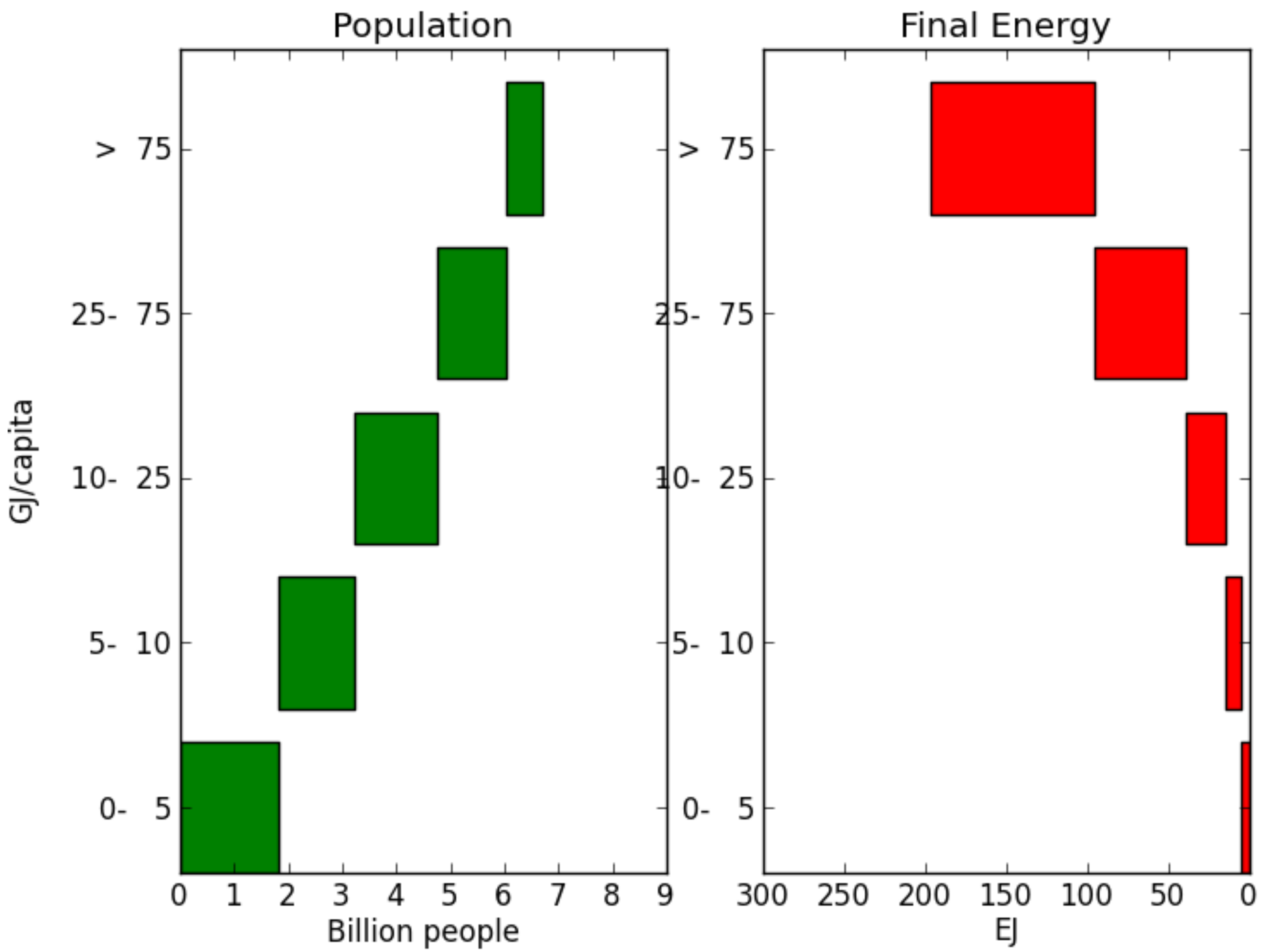
- ML Fit of consumption/income distribution using Beta-2 pdfs
- Power law relation beween consumption and energy for each country
- (depending on elasticity) -> Generalized Beta-2 pdf for energy consumption
- projections to the future consistent with IEA average regional forecasts (given the same pdf)
- model code available (open source iPython)

Setting energy consumption categories

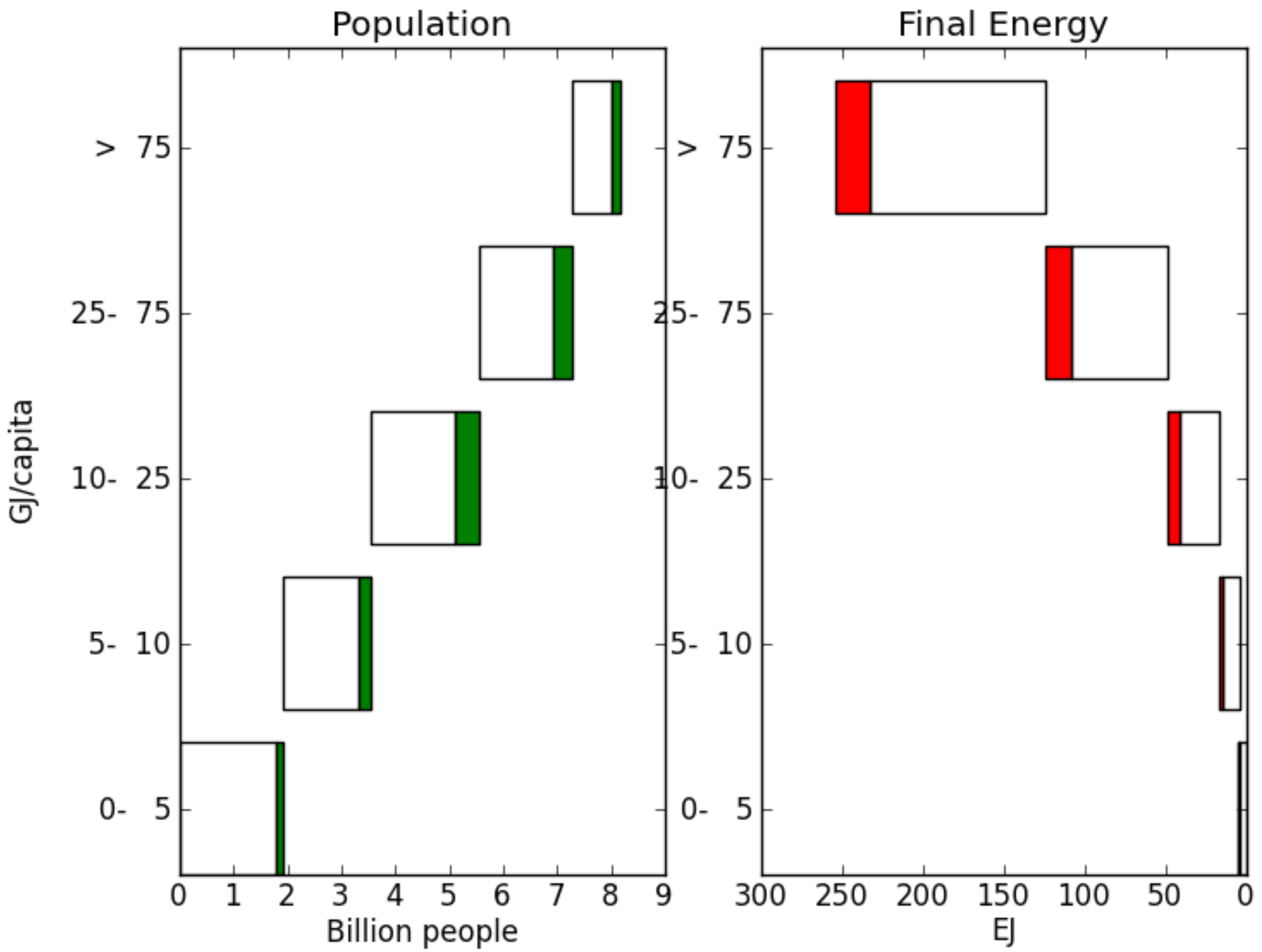
This model generates full energy consumption pdfs, but for the sake of reporting we focus on the following thresholds:

5 GJ/(cap*yr)	**Basic Human Needs** (UN-Energy/IEA): 100kwh/yr + 100 kgoil/yr
10 GJ/(cap*yr)	**Productive Uses** (UN-Energy/IEA): 750kwh/yr + 150 kgoil/yr
25 GJ/(cap*yr)	**Modern society** (UN-Energy/IEA): 2000kwh/yr + 375 kgoil/yr
75 GJ/(cap*yr)	**EU average** (half the US average)

Global Distributions currently..



and to 2030 (BAU)



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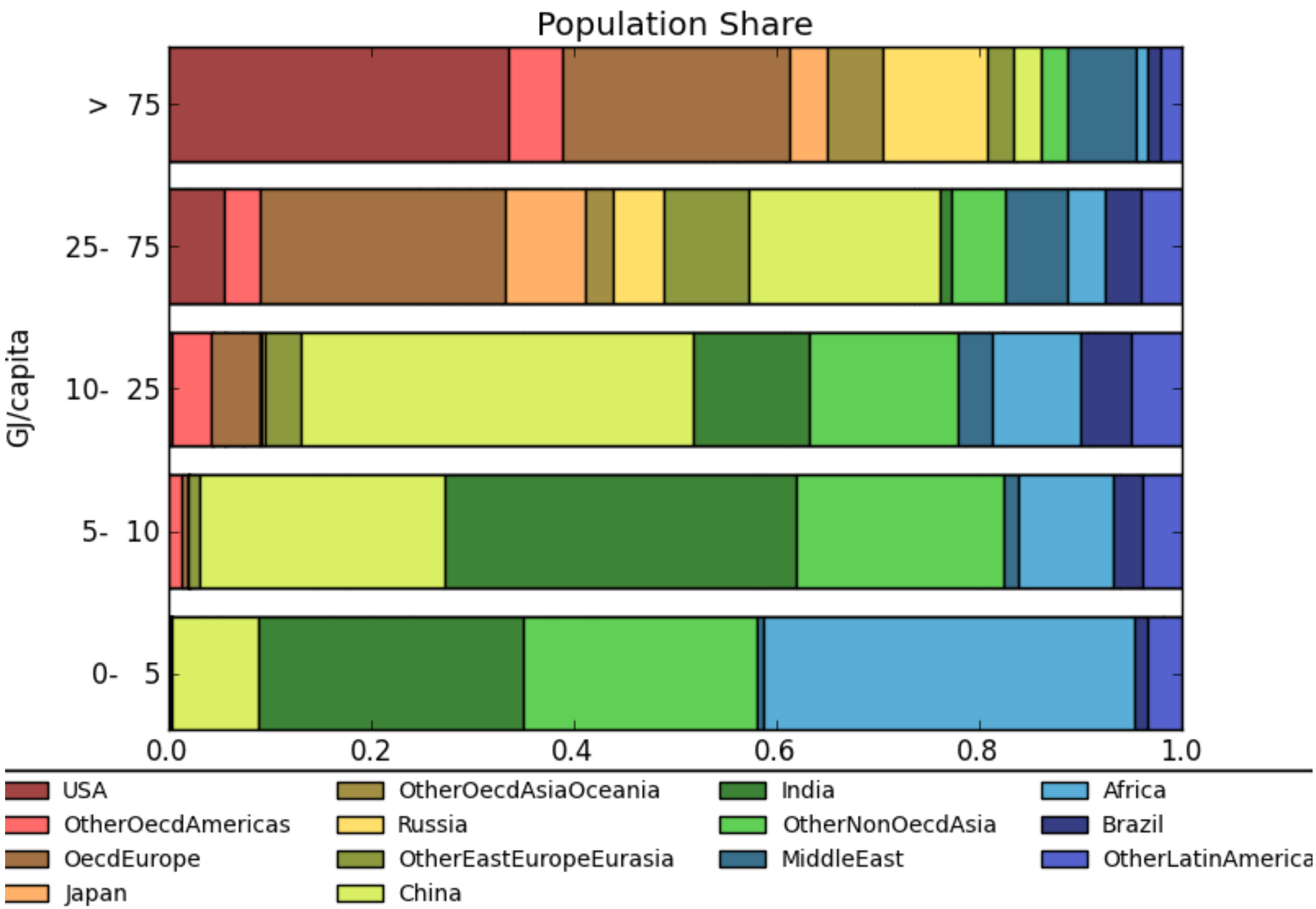
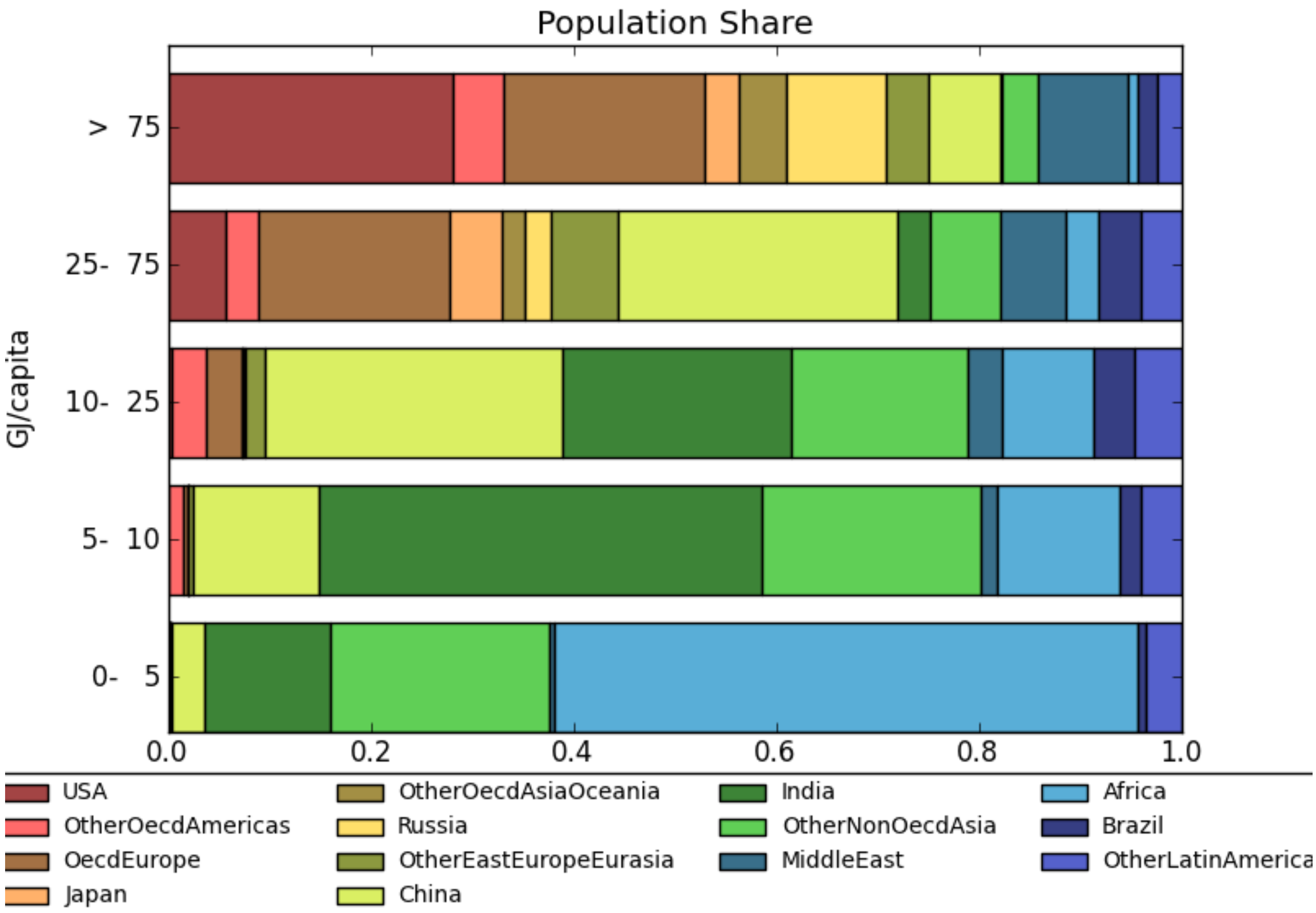
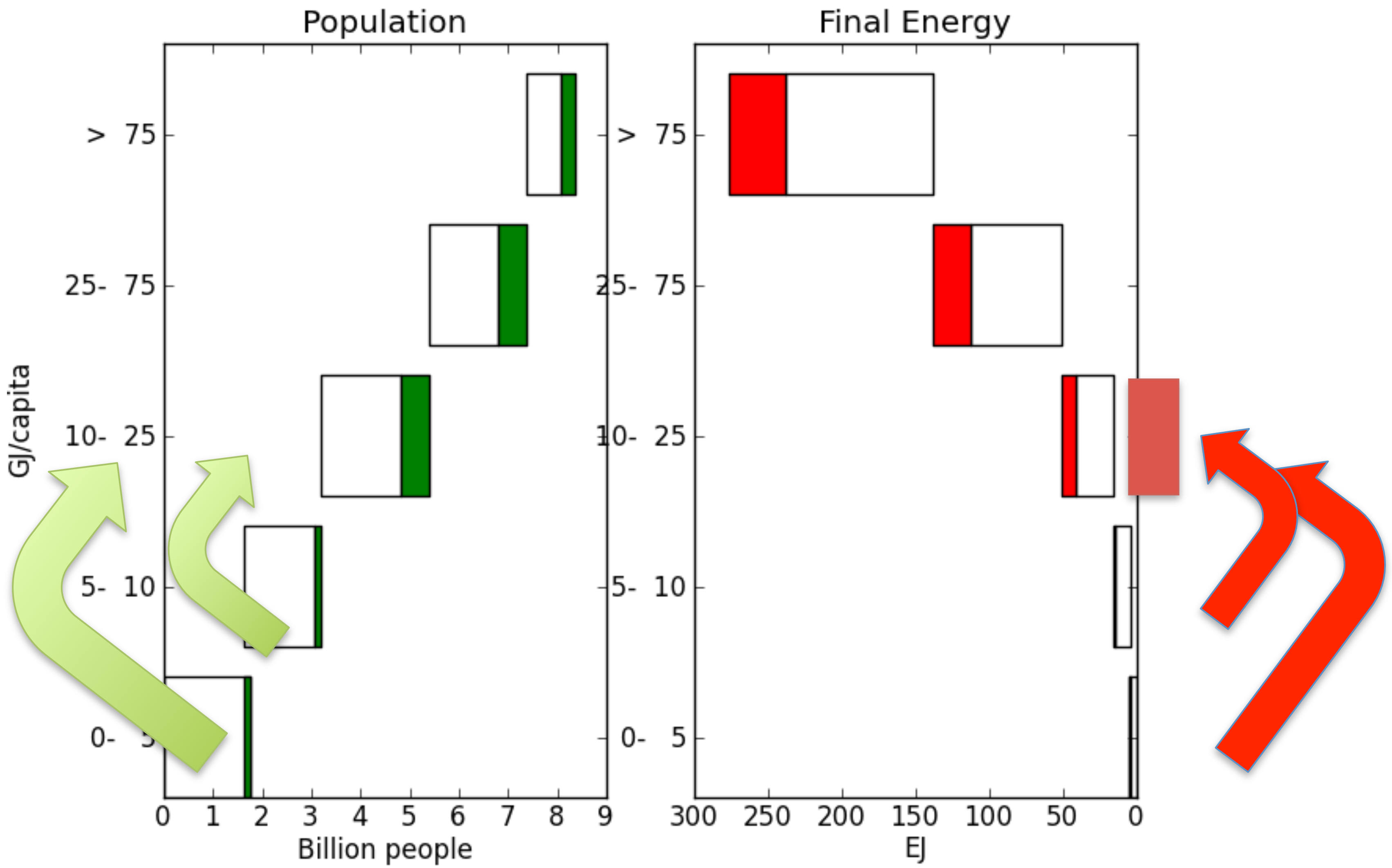
Regional population shares now



Regional population shares in 2030



Poverty alleviation policy to ensure at least 10GJ/cap*yr



The impacts of energy alleviation policies in 2030 on energy consumption and CO2 emissions, regionally and globally

Region	*Final Energy in a BAU (EJ)*	*Additional Energy consumption for a poverty alleviation policy (EJ)*	*Additional emissions at the average carbon intensity (GtCO2)*	*Costs of compensating the emissions at 70$/tCO2 (Billions USD)*
World	**254.4**	**18.9**	**1.75**	**123**
Africa	9.5	9.7	0.80	56
India	14.8	3.4	0.35	24
Other Asian DCs	18.0	3.9	0.39	27

- IAMs scenarios suggest an average mitigation of 17 GtCO2-eq in 2030 to achieve 550 ppm-eq in a cost effective way
- Traditional biomass harvesting and incomplete burning also generates emissions of GHGs and aerosols

Conclusions

- A sufficiently simple model for mapping household/individual energy consumption can be built using consumption distribution data, with decent fit to current situation.
- Useful tool for mapping imbalances: 3 Billion people with negligible energy consumption, 800 million people responsible for 55% of total energy
- In a 2030 BAU, minor changes in the low energy consumption categories (5 and 10 GJ), additions in terms of people will be roughly balanced across 10-25/25-75/>75 GJ categories, but half of the additions in terms of energy will come from the >75 GJ category.
- Africa and Asia are and will continue to be the major regions in the low categories, China is expected to move up rapidly.
- Providing universal access to a minimum of 10GJ by 2030 would increase total energy by about 20EJ, less than 10% of projected bau.
- The additional emissions are in the order of 2GtCO2/yr, roughly 10% of the mitigation effort required for climate stabilization

Thanks!

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