LINKING INDIVIDUAL AND NATIONAL RESPONSIBILITY OF CLIMATE MITIGATION: A CONSUMPTION BASED ANALYSIS OF GLOBAL EMISSIONS DISTRIBUTION

M. Tavoni, Princeton U. and FEEM

The responsibility challenge

	China/US ratio	
	Total Emissions	
Rio:1992	48%	
Kyoto:1997	55%	
2008*	125%	

The responsibility challenge

	China/US ratio	
	Total Emissions	Per Capita Emissions
Rio:1992	48%	10%
Kyoto:1997	55%	12%
2008*	125%	30%

Focus of this analysis

- Benchmarks for guiding the transition to a low carbon society in a continuously evolving world
- Look beyond national averages, focus on the individual
  - How many people emit how much now and in the future and where ?
- Estimate carbon emission distribution for 150 countries, projections for 16 regions

Sharing global CO_2 emission reductions among one billion high emitters

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Proceedings of the National Academy of Sciences, July 21, 2009, vol. 106 no. 29, pp. 11884-11888

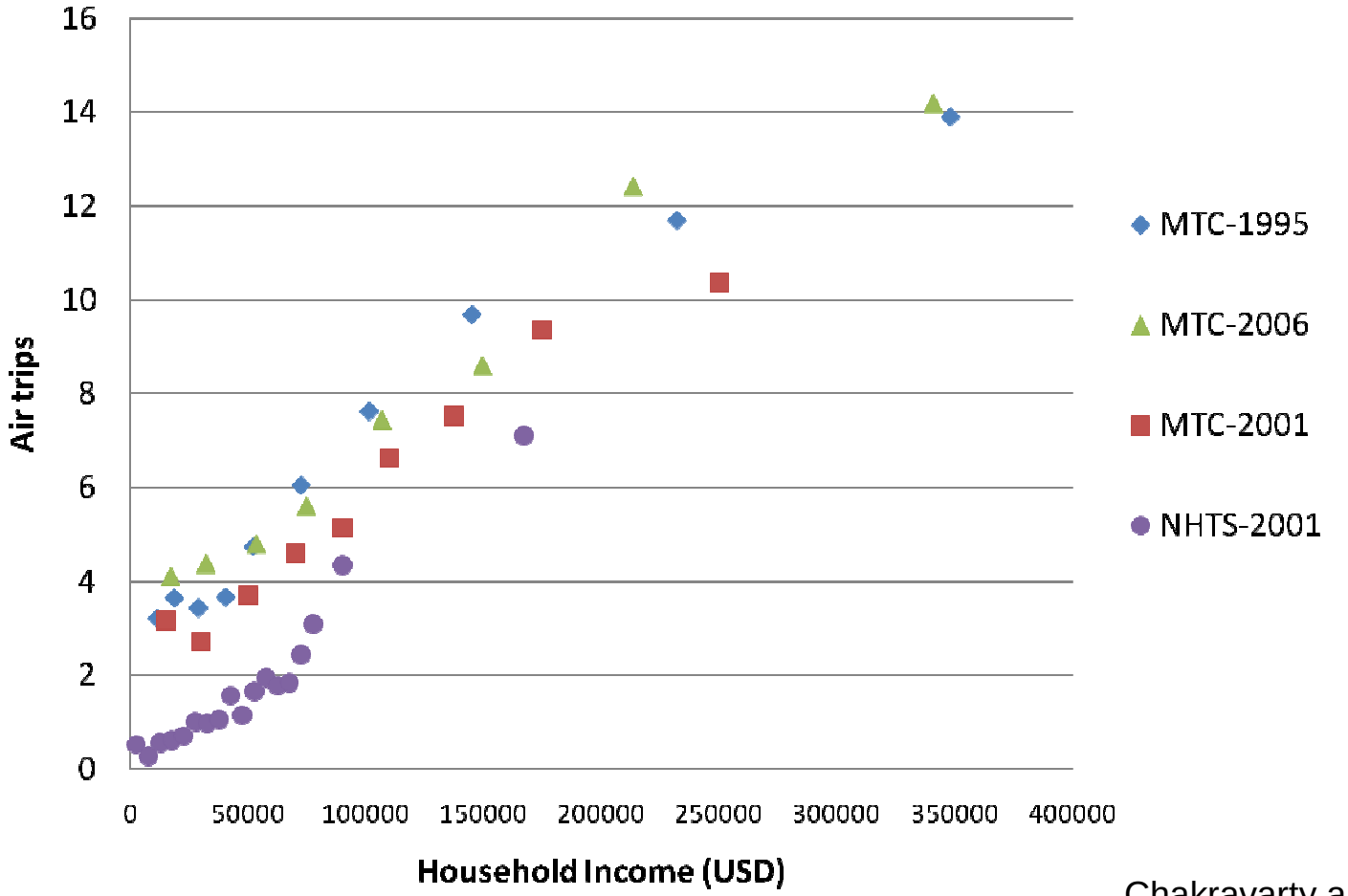
"A focus on individuals can guide nations towards a low carbon world"
S. Chakravarty, R. Socolow, M. Tavoni, *Climate Science and Policy,* 2009

Income elasticity of emissions from household surveys and input-output tables

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]

Limitations of expenditure surveys

- do not explore consumption at high incomes
- at times important information are missing (e.g. flying)



Chakravarty and Tavoni, 2010

How to measure individual emissions ?

- Large empirical literature based (Lenzen, Peters, Serrano, Hereenden etc.) points to strong relation between energy/emissions and income
  - Elasticities from surveys 0.8/1
  - Panel from data in this paper 0.72

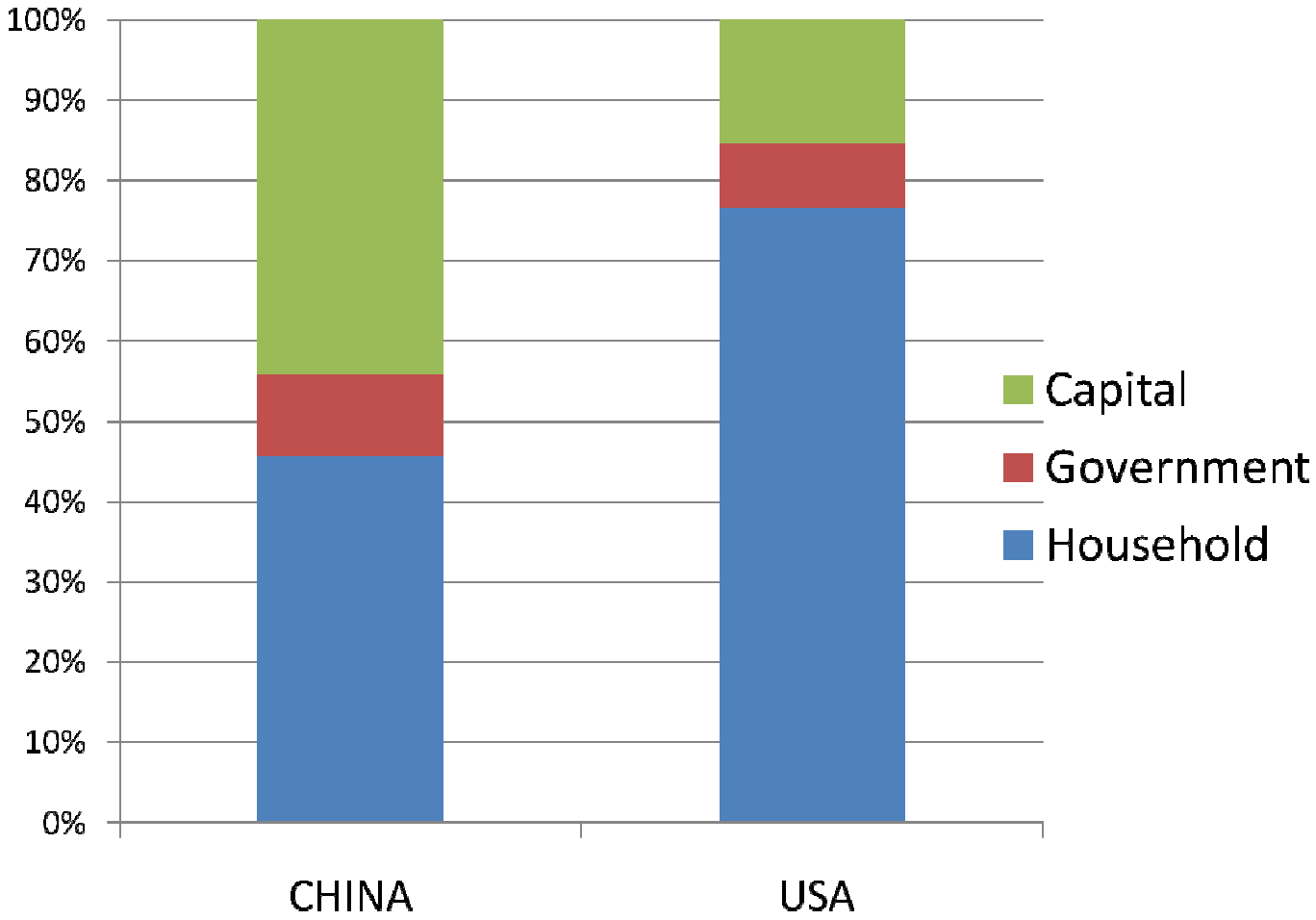
- Use income/expenditure distribution data from WDI (WB), PovCalNet (WB), WIID (UN univ.) to derive the global distribution of emissions

Building Carbon Emission Distribution

- We fit income/consumption distributions using the sum of two Gamma pdfs on quintiles or deciles data at the country level.
- We rescale them to match their nation per capita GDP (in PPP) of 2003 (PWT).
- Assuming income and emissions are related by a power law, we translate them into emission distributions, ensuring that the averages match the national emission inventories.

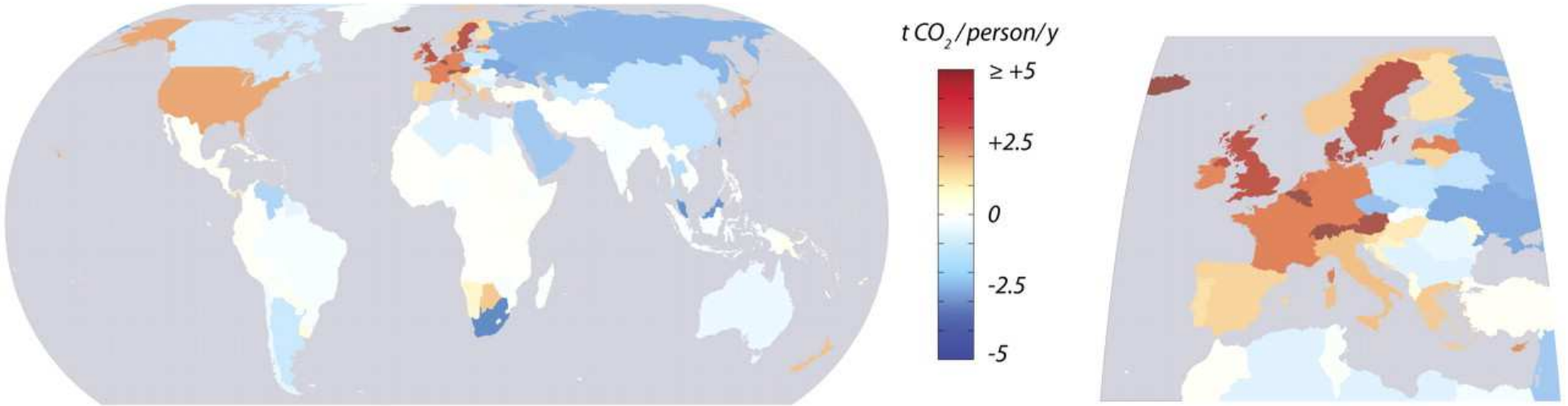
We attribute all production-based national emissions to their individuals on the basis of their income. That is, we assume that the emissions generated by government consumption and the investments in the economy are attributed to individuals according to their income, in the same way those deriving directly or indirectly from consumption. The scheme ignores emissions embedded in inter-regional trade.`

The relevance of household consumption



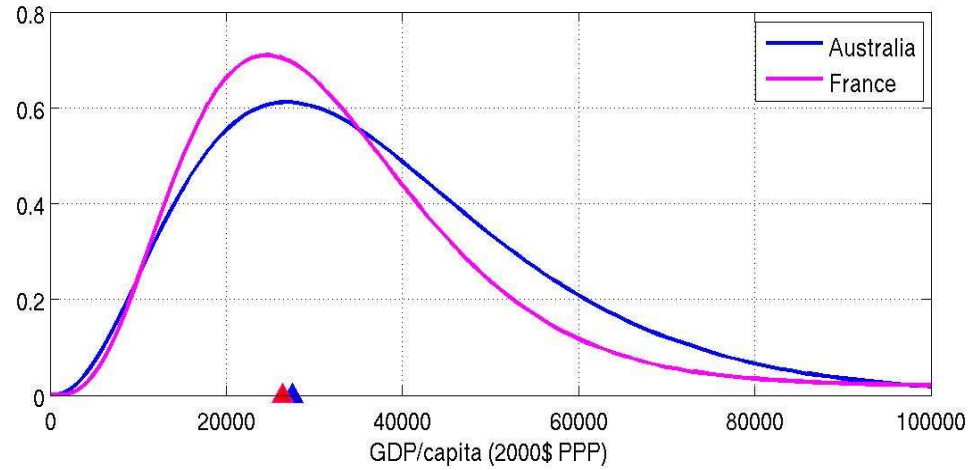
data from G. Peters, for 2001

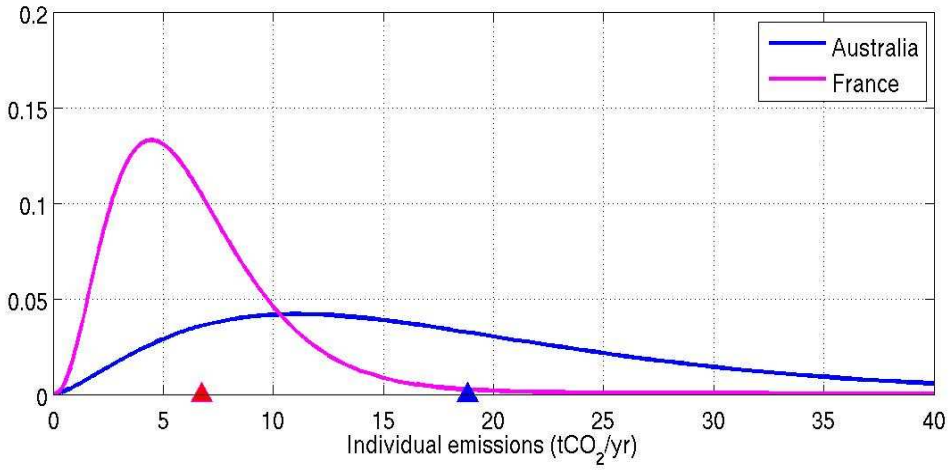
Consumption versus production emissions



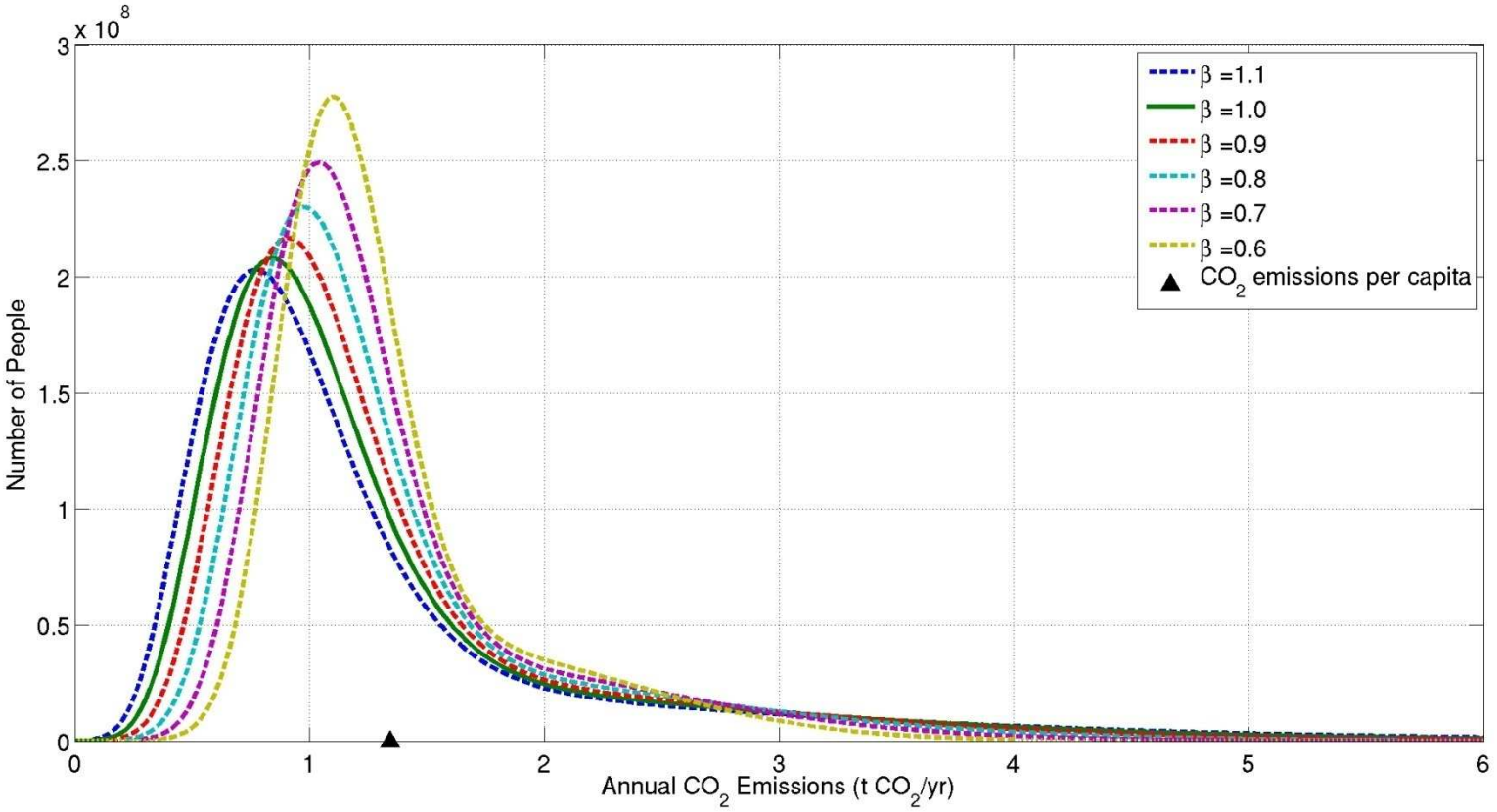
Davis S J , Caldeira K PNAS 2010, differences between consumption and production emissions.

From income to carbon distributions



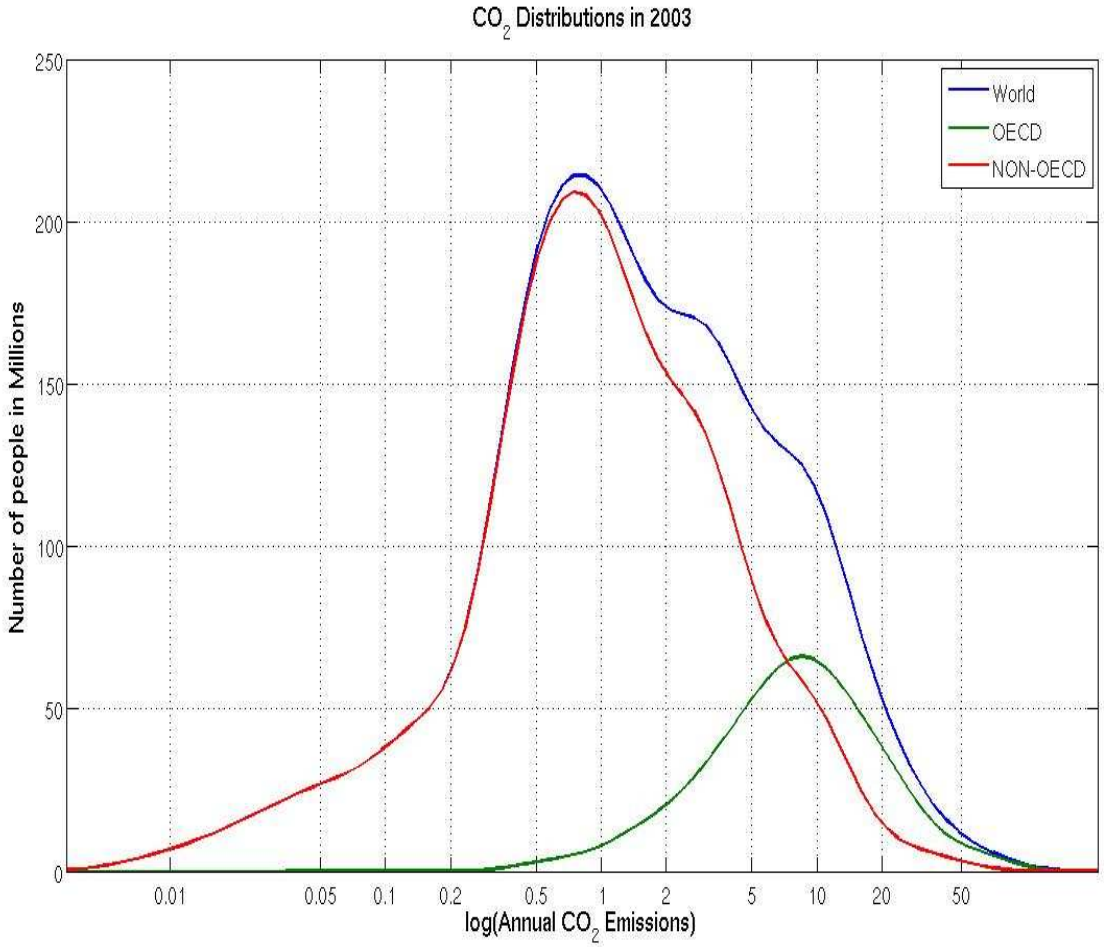


The role of income elasticity of emissions



Indonesia

Add up countries to determine regional and global distributions



Three broad categories of global individual emitters

Low: <2 tCO_2

Middle: 2-10 tCO_2

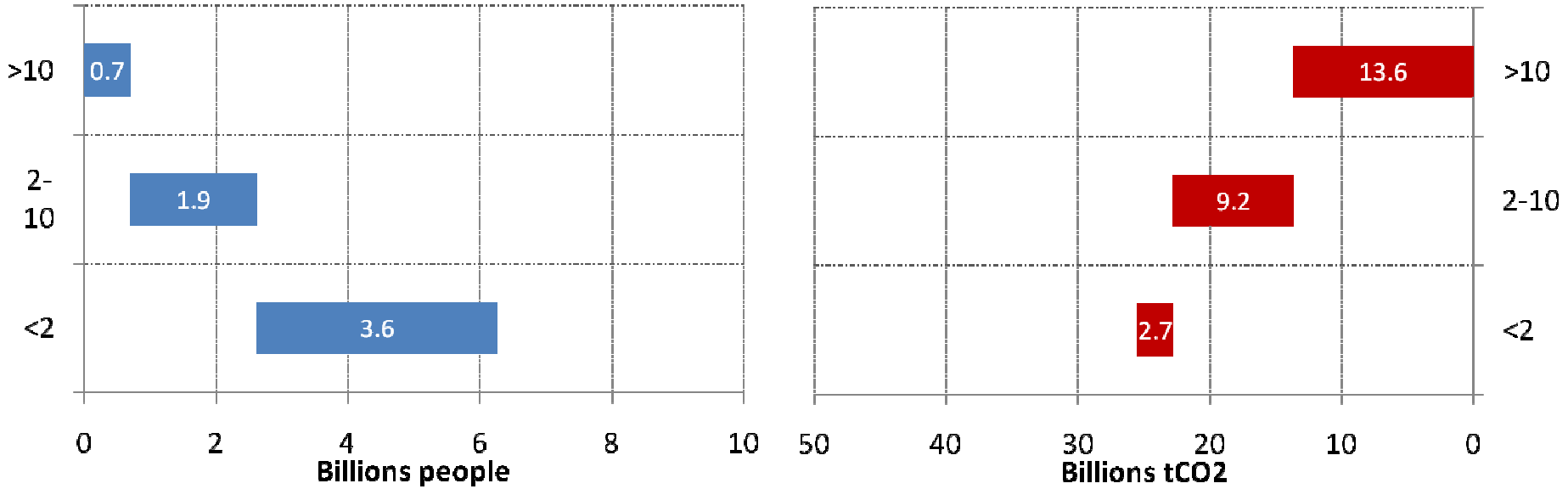
High: >10 tCO_2

2~Brazil, 10~Europe (the global “middle class”)

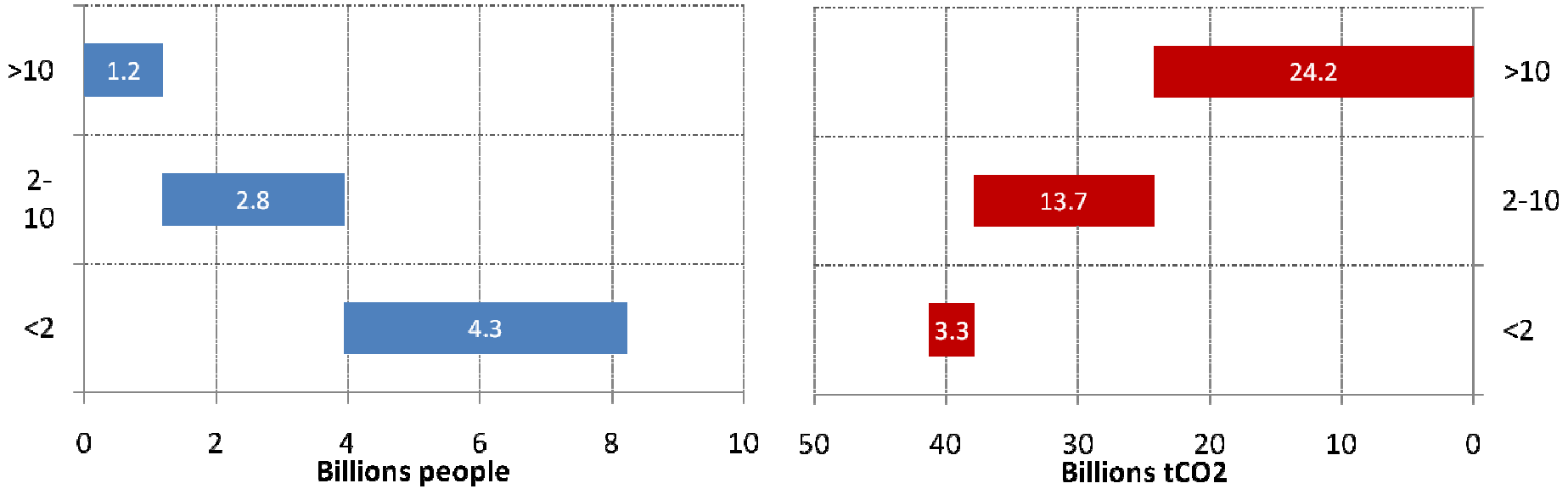
4 - one return flight New York to New Delhi

3 - efficient sedan car (10000 miles per year)

Global population and emission distribution in 2003…



… and 2030

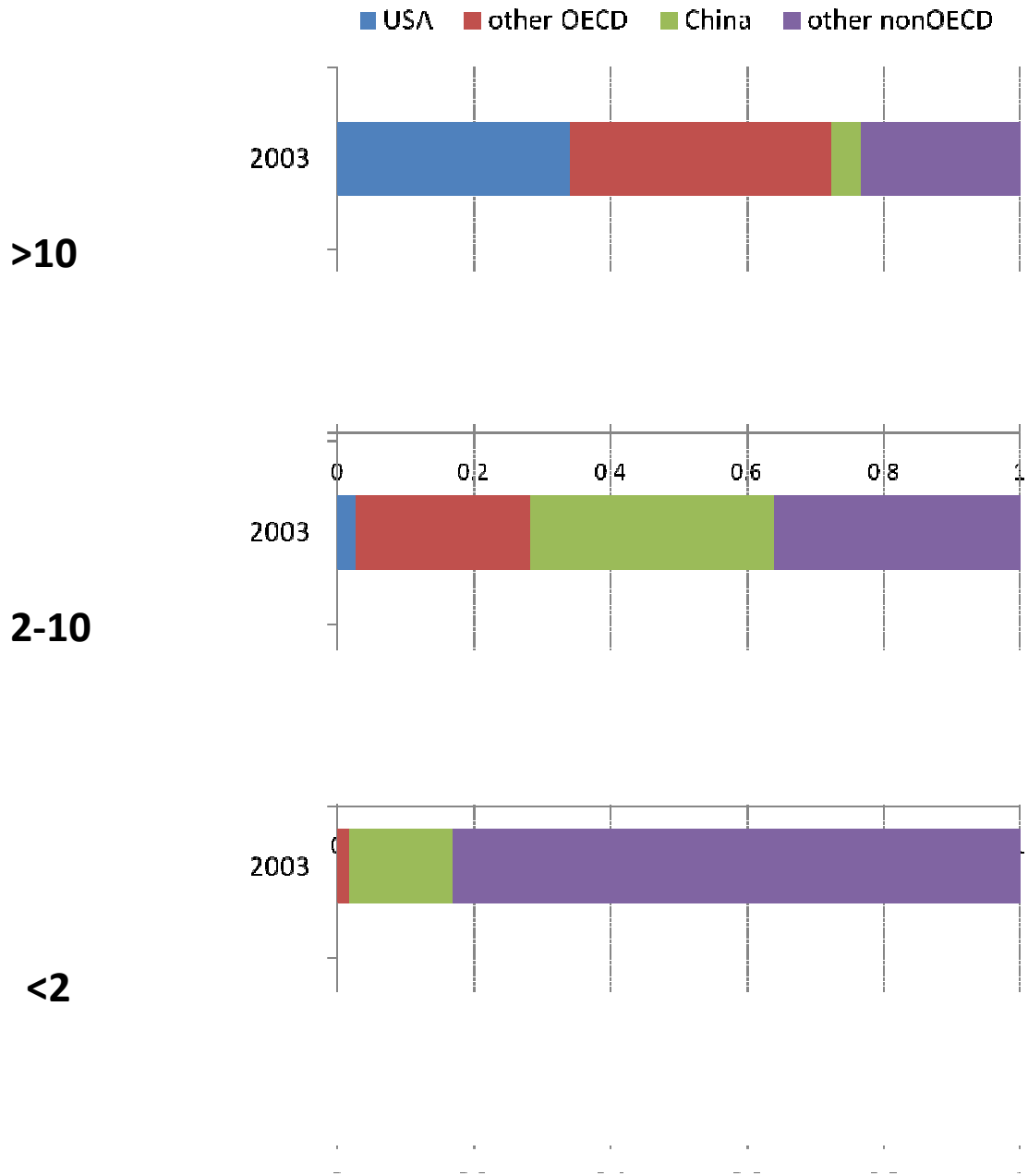

>10
2-10
<2
1.2
2.8
4.3
0
2
4
6
8
10
Billions people
24.2
13.7
3.3
50
40
30
20
10
0
Billions tCO2

Reactions …

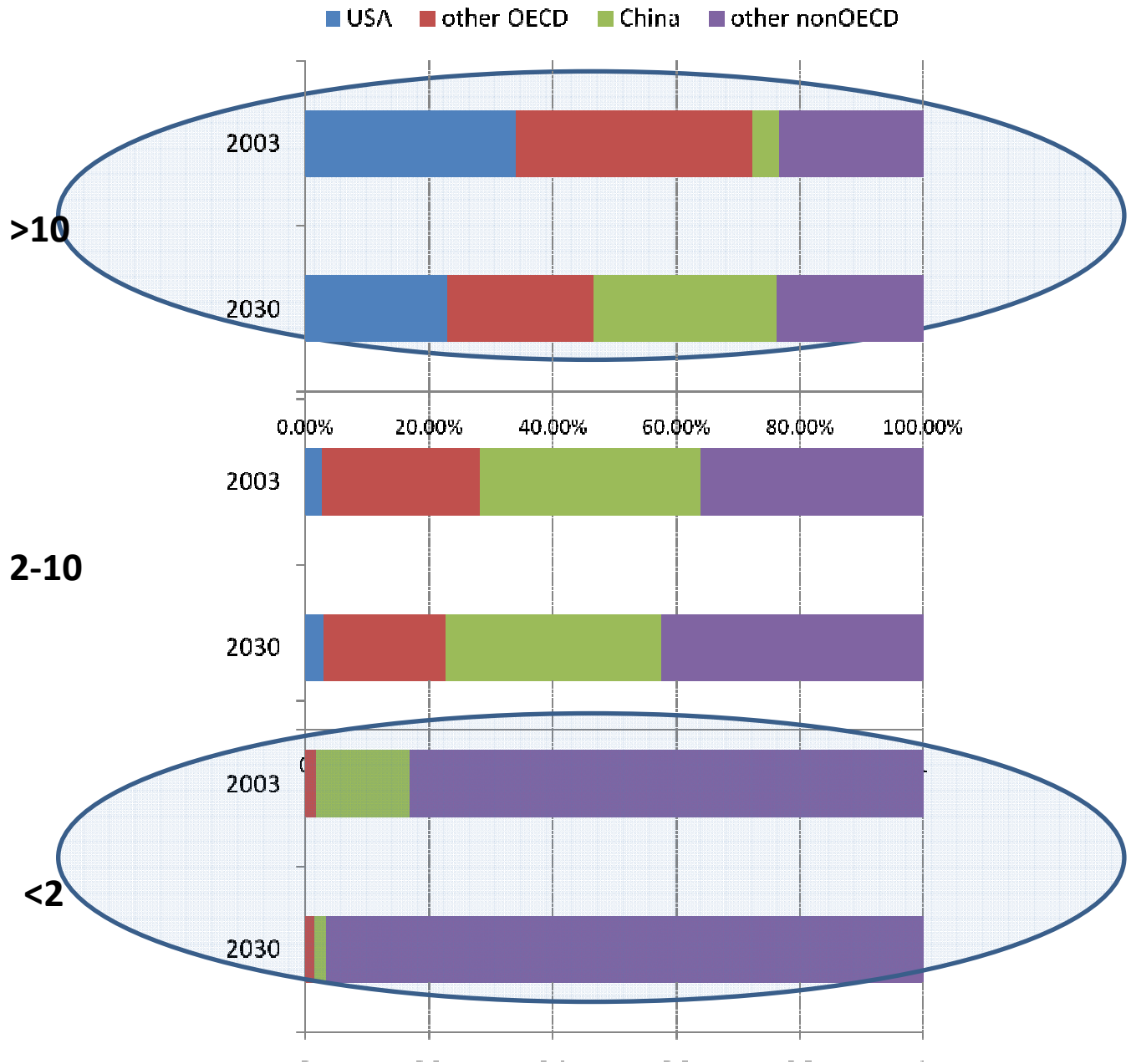
• "*500 million richest people are responsible for 50 percent of emissions, while the poorest 50 percent accounts for only seven percent of emissions"* H. Chavez, speech at COP15 in Copenhagen

• **where are (and will be) the low, middle and high emitters ?**

Regional responsibilities (population share) over time



Countries responsibilities (population share) over time



A look at CHINA

	Population change 2030-2003	Population in 2030
>10	+299	356
2-10	+319	922
<2	-460	175

A look at MIDDLE EAST

	Population change 2030-2003	Population in 2030
>10	+34	65
2-10	+55	145
<2	+11	65

High bin (>10t) in **2010**: top 5 regions

	Population (millions)	Emissions (GtCO2)	Share of country emissions
USA	222.0	5.5	91%
CHINA	189.0	3.2	43%
EU	147.6	2.4	53%
other OECD	68.1	1.4	73%
RUSSIA	48.9	1.3	69%

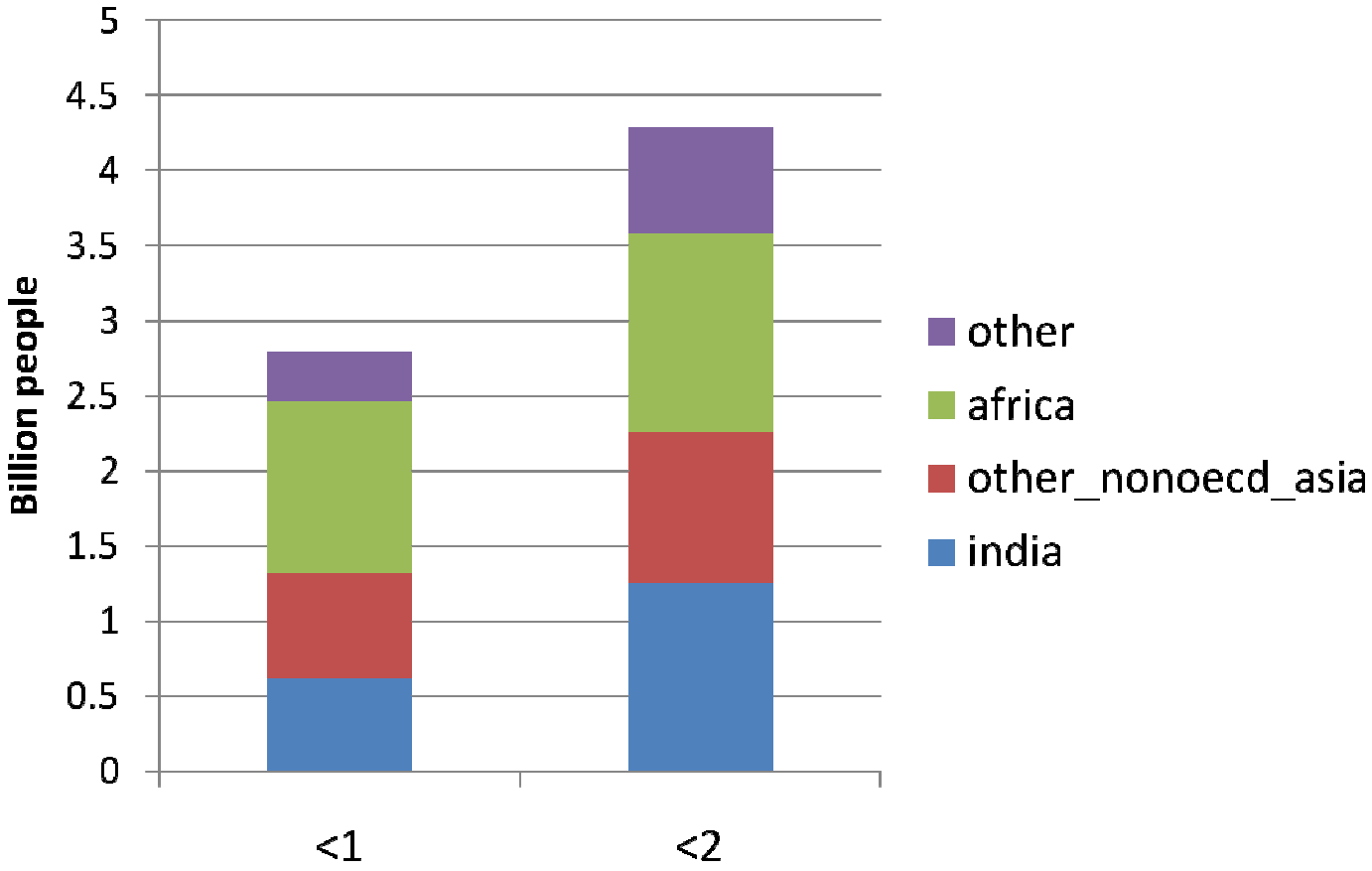
High bin (>10t) in **2020**: top 5 regions

	Population (millions)	Emissions (GtCO2)	Share of country emissions
USA	236.2	5.6	89%
CHINA	271.2	5.0	51%
EU	149.9	2.4	53%
other OECD	85.4	1.5	79%
RUSSIA	56.6	1.5	69%

High bin (>10t) in **2030**: top 5 regions

	Population (millions)	Emissions (GtCO2)	Share of country emissions
CHINA	356.6	7.0	58%
USA	254.1	6.0	89%
EU	151.0	2.4	53%
other OECD	90.0	1.6	88%
RUSSIA	72.6	1.6	64%

Energy Poverty: low and very low emitters in 2030



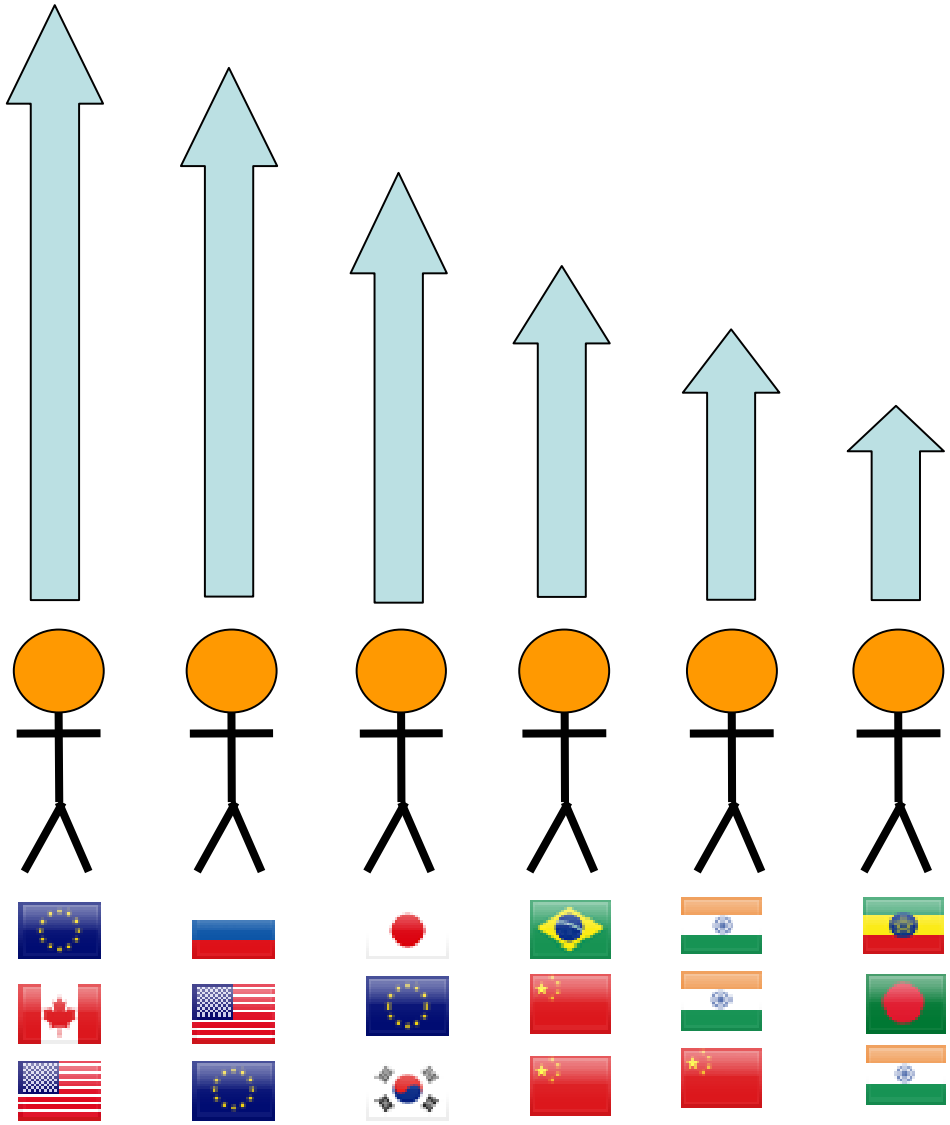
What does 1 tCO_2/person-yr allow today?

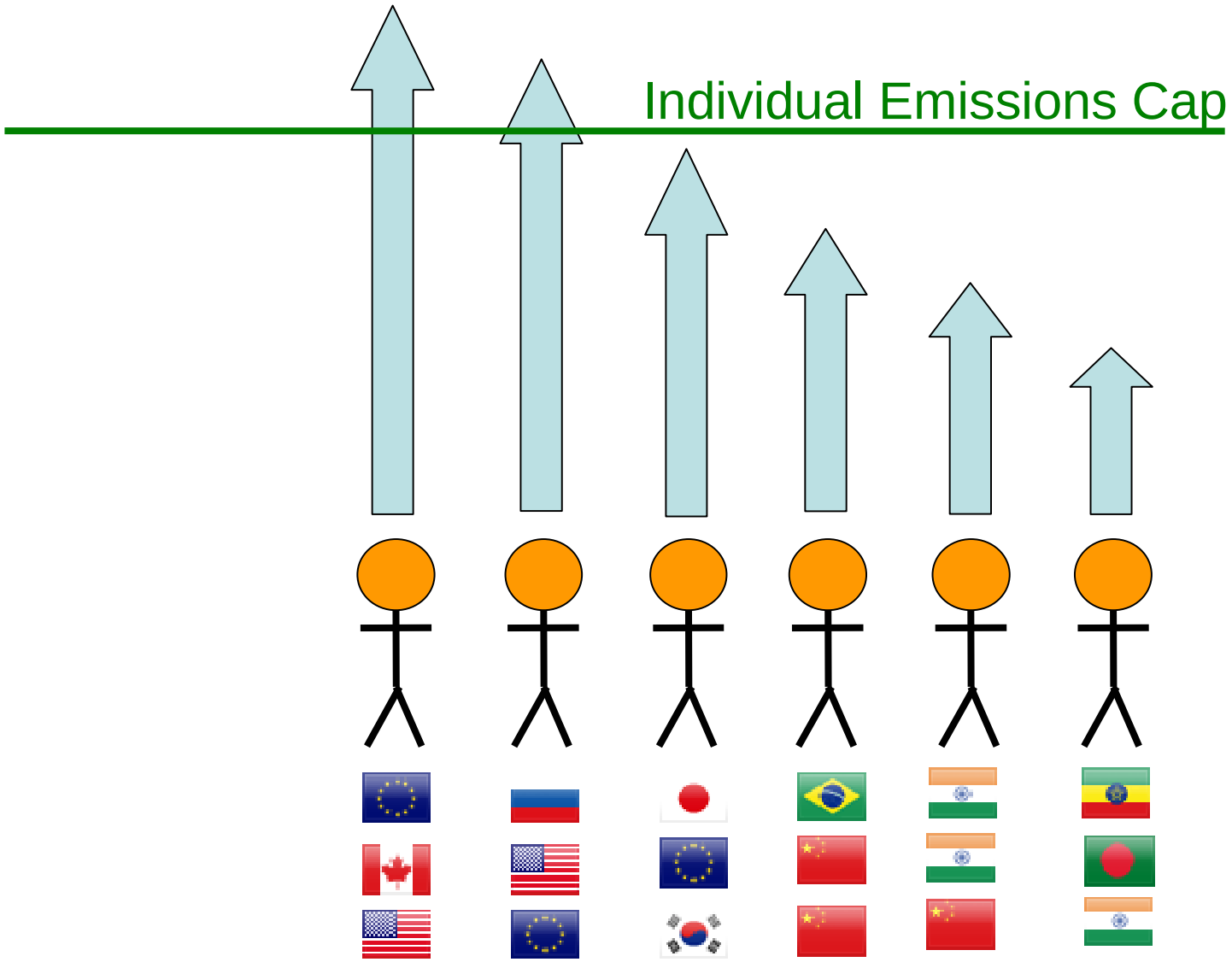
Direct Energy Use	*Household rate of use (4.5 people)*	*Individual emissions ($kgCO_2$/yr)*
Cooking	1 LPG canister per month	120
Transport	70 km by bus, car, motorbike per day	220
Electricity	800 kWh per year	160
Total		*500*

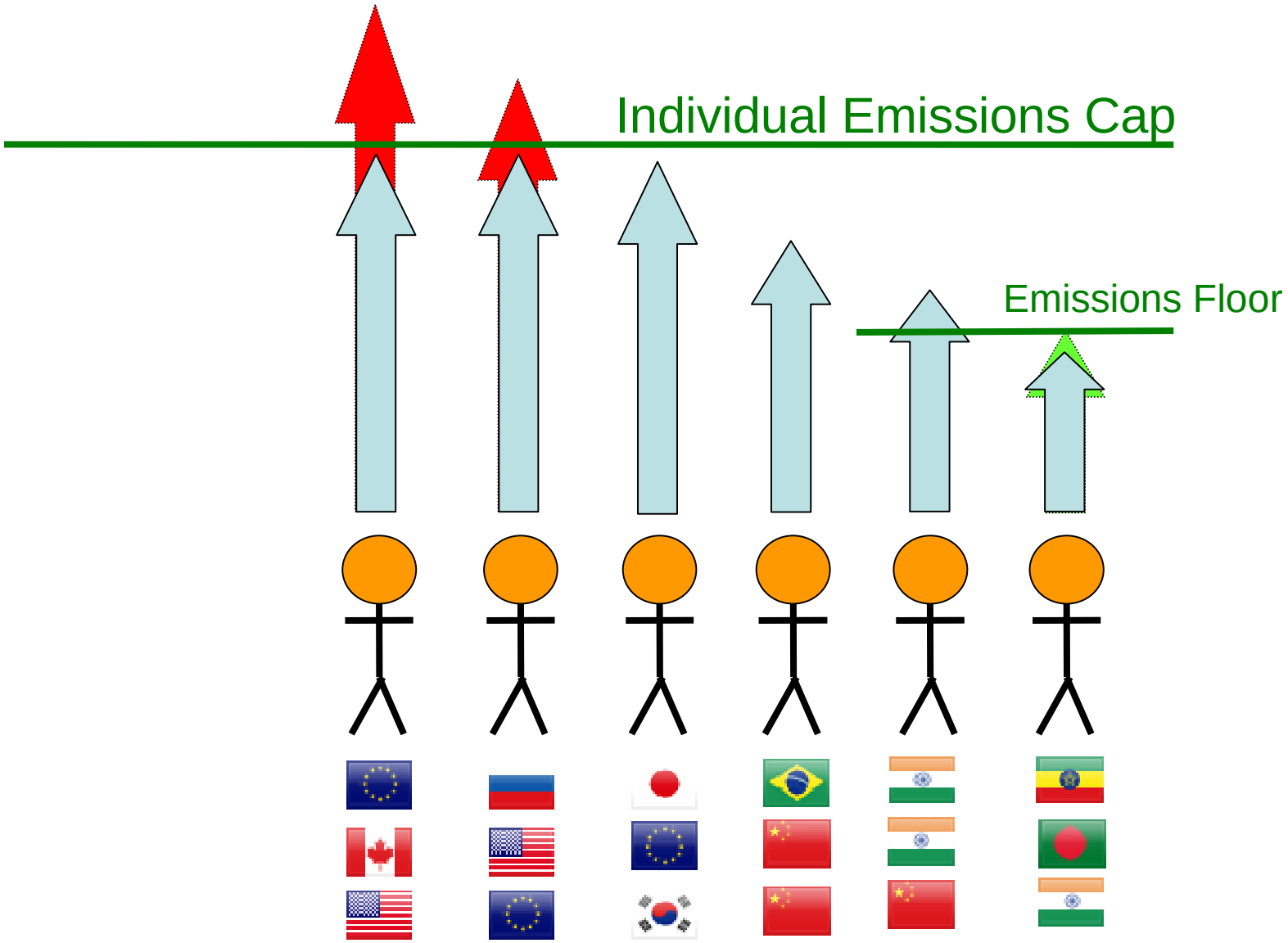
1 tCO2/yr: Double the "direct" emissions to account for "indirect" emissions.

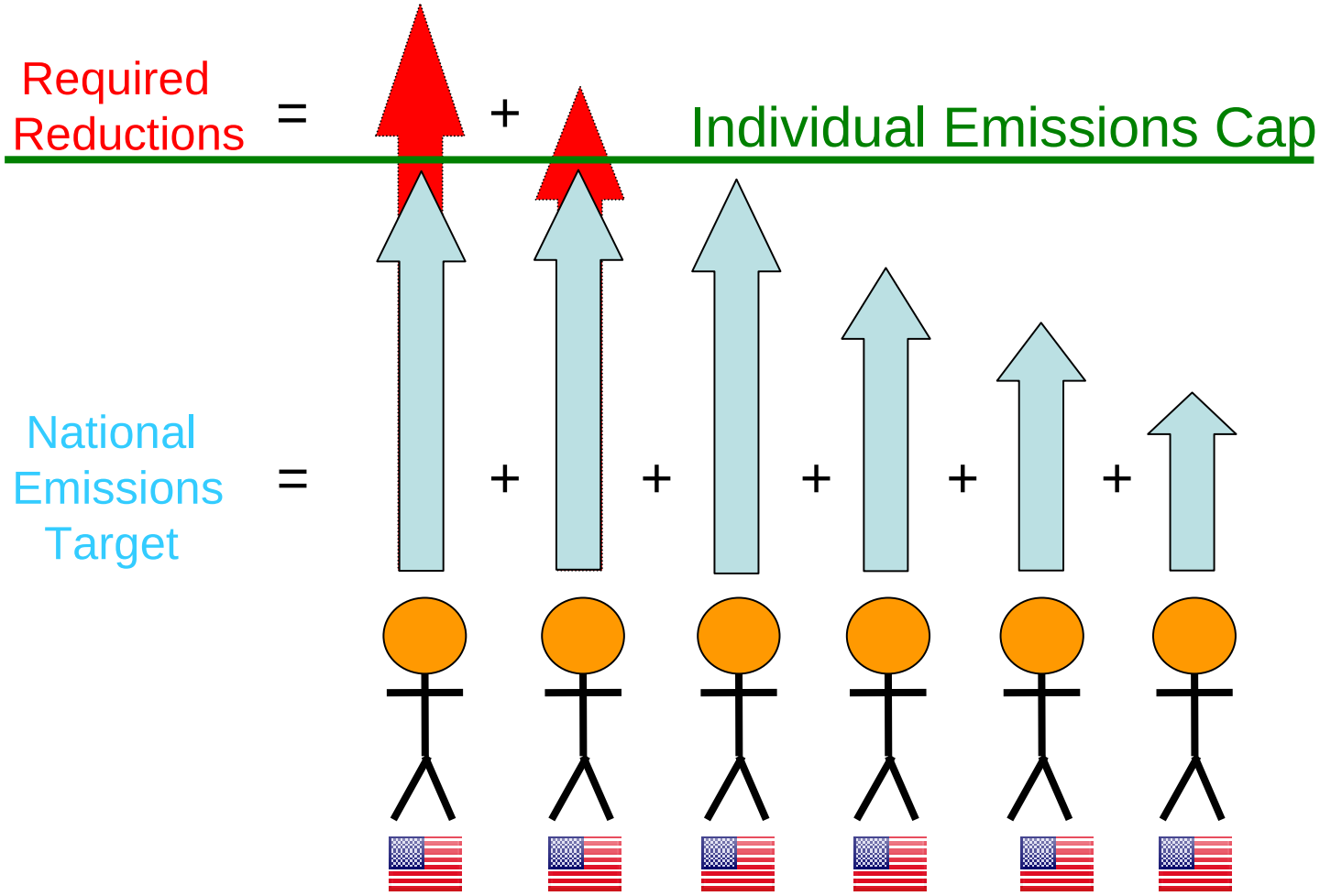
A scheme for determining countries' responsibilities to mitigation from the individual level

People ranked by individual emissions globally



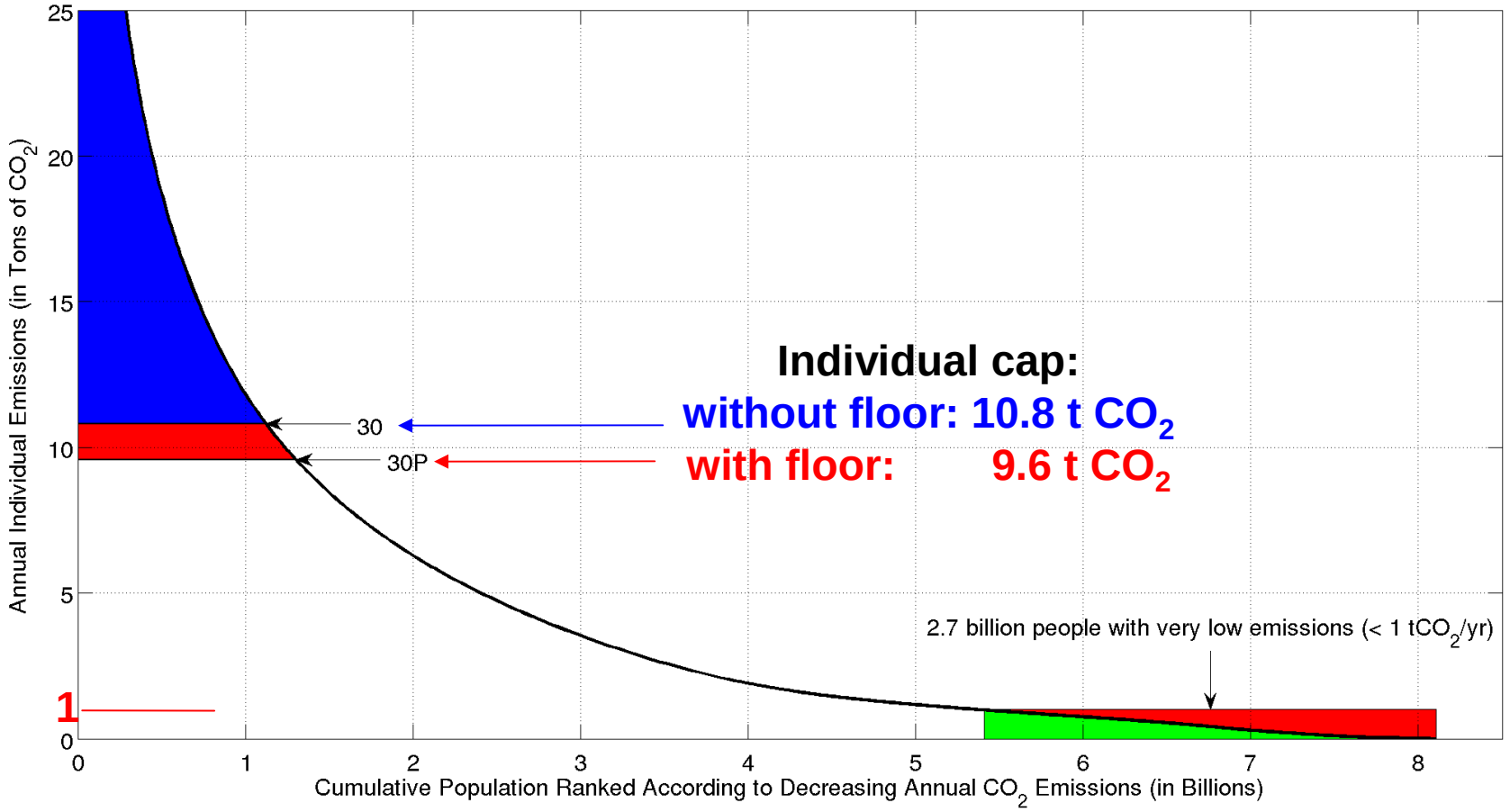

Individual Emissions Cap


Individual Emissions Cap
Emissions Floor

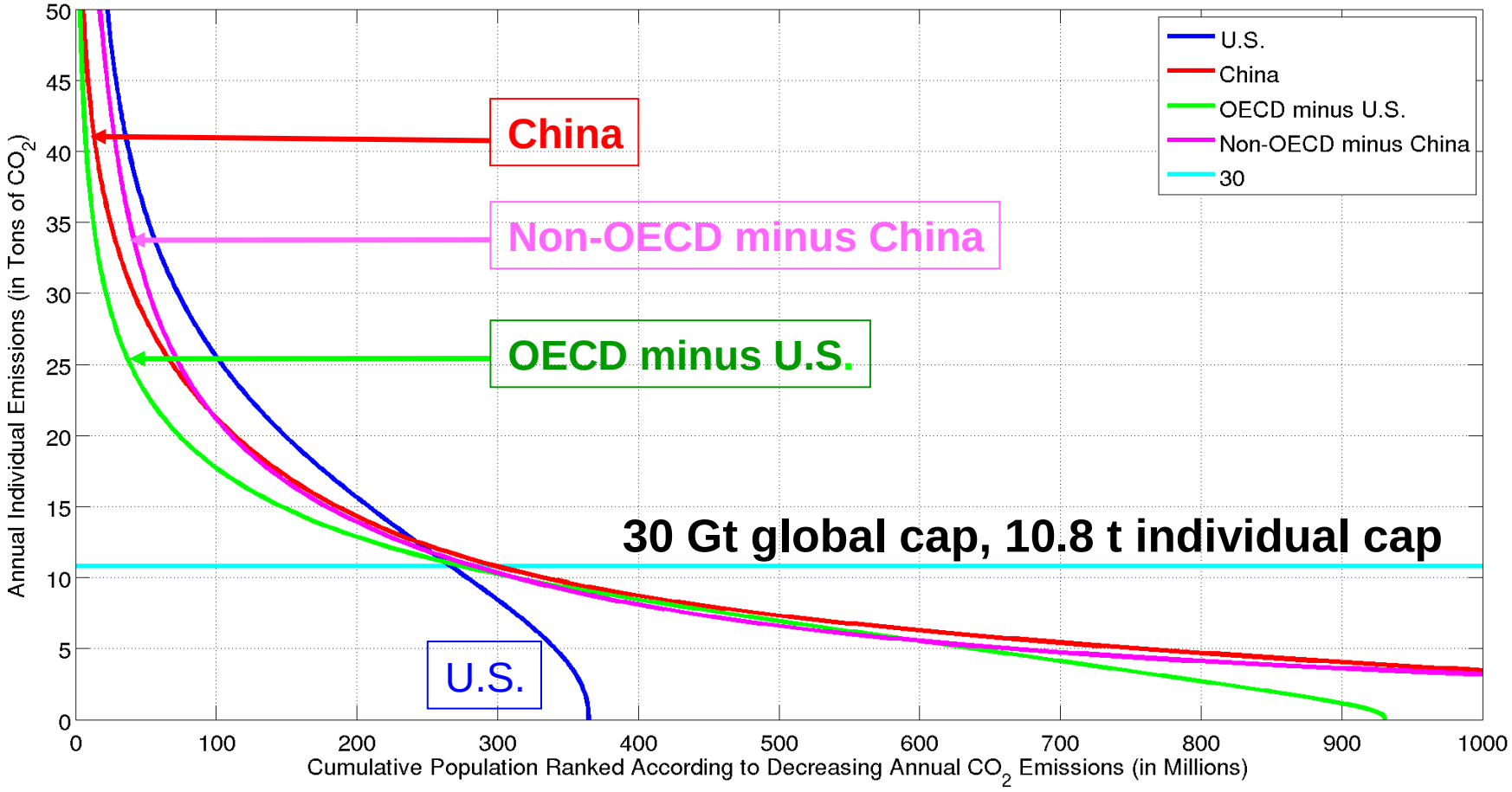


For example, the proposal is applied to the U.S. here.

A global-emissions cap (30 GtCO2 in 2030) and its individual-emissions floor

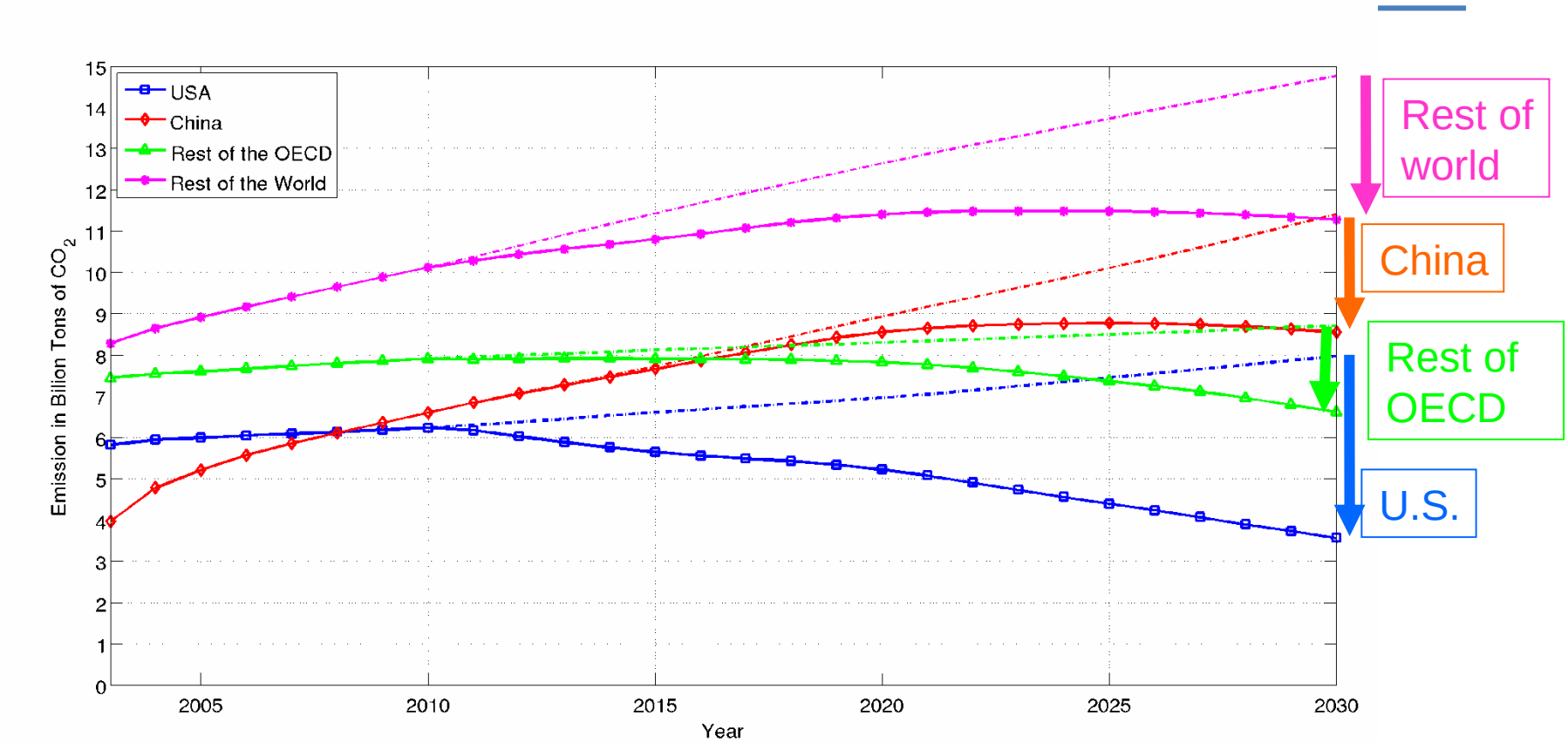


Regional emissions in 2030



For a 30 $GtCO_2$ global cap in 2030, four regions have comparable assignments

Emission obligations over time



Dashed lines: EIA Business As Usual

Solid lines: Global cap is 30 $GtCO_2$ in 2010, 33 $GtCO_2$ in 2020, 30 $GtCO_2$ in 2030.

Conclusions

- Individual emissions as a benchmark for tracking country responsibilities over time towards a low carbon world

- The globally high emitters (>10tCO2) category is the most relevant, and the one where the biggest regional shifts will occur.

- Keep focus on the very low emitters. The world's poor do not need to be denied fossil fuels.