Sharing Global CO2 Emission Reductions among 1 Billion High Emitters.

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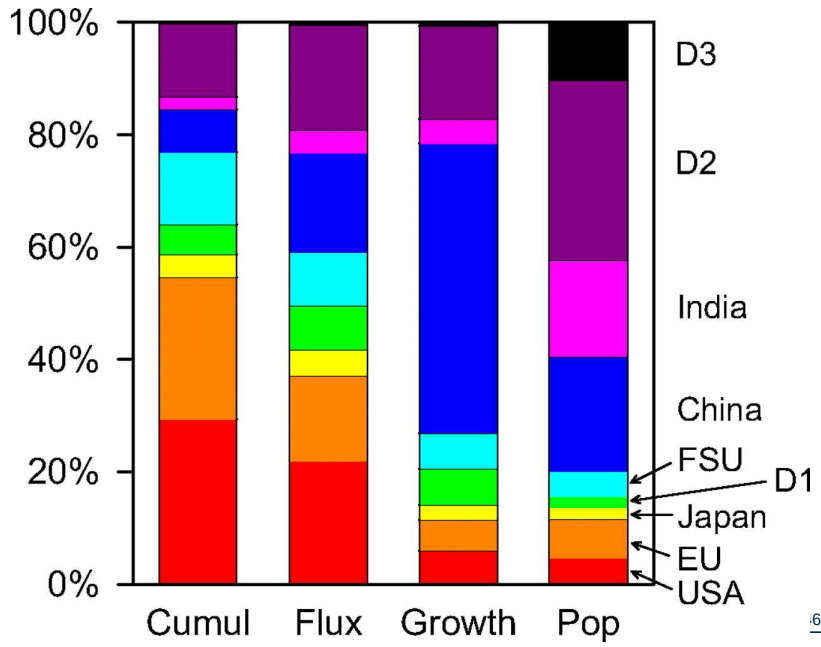
International Energy Workshop
Venice, 18th June 2009

The challenge of sharing the burden



Source: Raupach M. R. et.al. PNAS 2007;104:10288-10293

What is a fair distribution of emission allowances among countries?

- Based on a negotiated outcome? (Kyoto)
- Based on cumulative historical contribution to climate change?
- Or perhaps on future contribution to the climate problem?
- Based on the reduction potentials (geography, climate)?
- Based on national per capita greenhouse gas emissions?

- Based on the emissions of the individuals in a country?

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What this paper does (and does not) do

It does:

- Treat every individual in the world the same, regardless of the country they live in
- Provide an ordering principle on which to base emission allocation to countries

It does not:

- Does not include historical responsibility, land use emissions and non-CO2 gases

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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 distribution data from WB and UN to derive the global distribution of emissions

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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.
- 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.`

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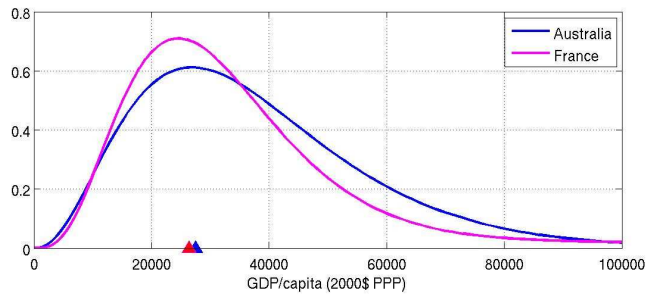
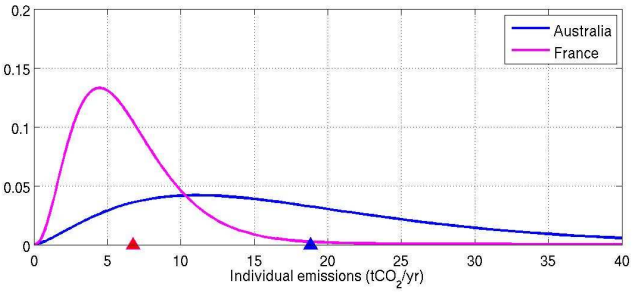
From income to carbon distributions





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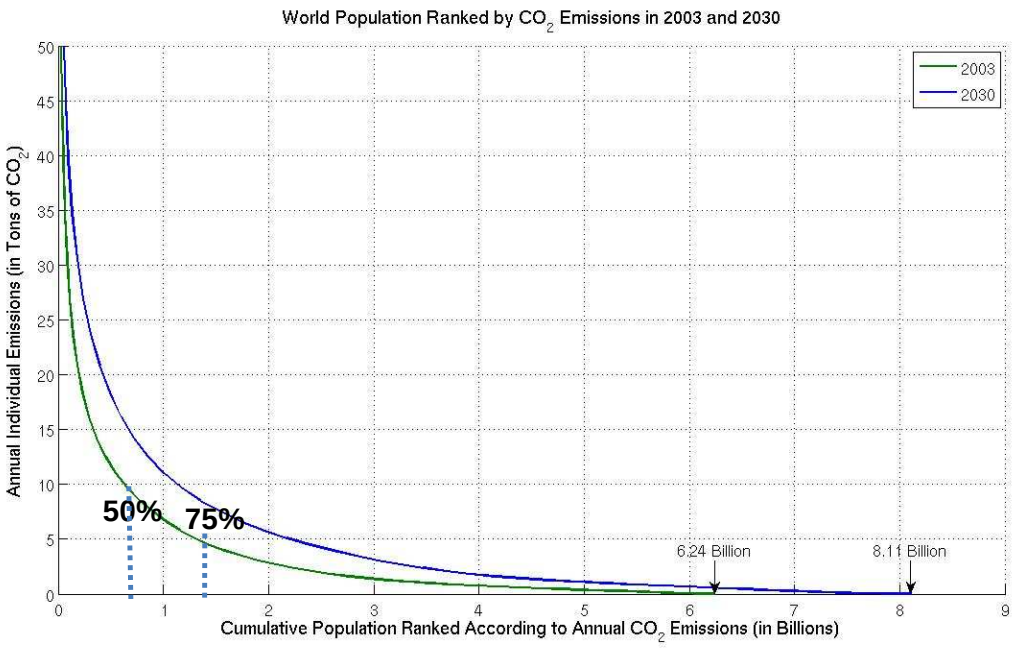
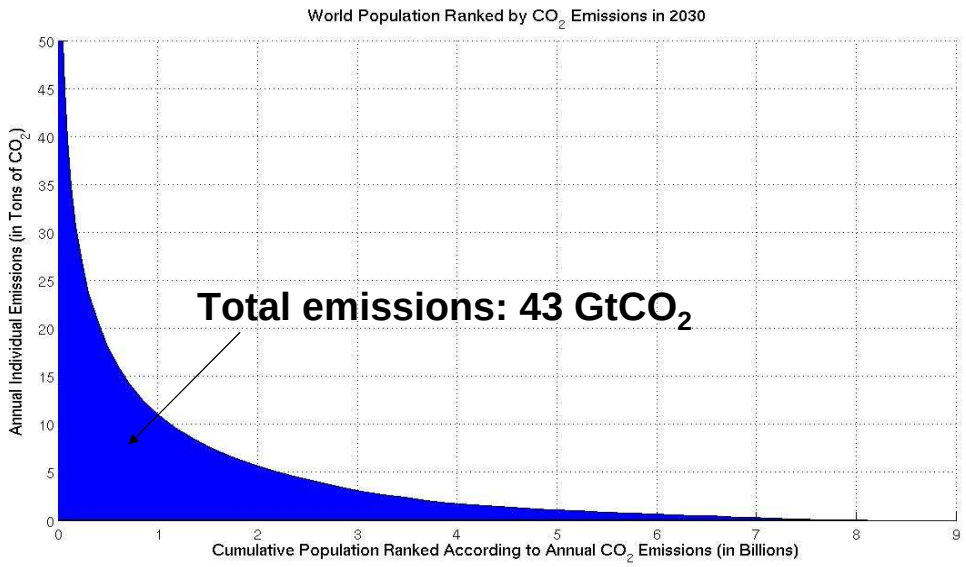
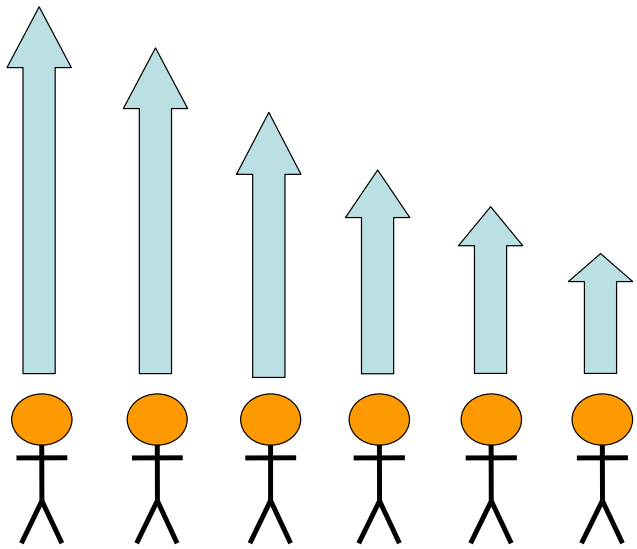
Rank all people in the world, highest to lowest emission-wise



Mitigating from 2030 BAU



People ranked by personal emissions



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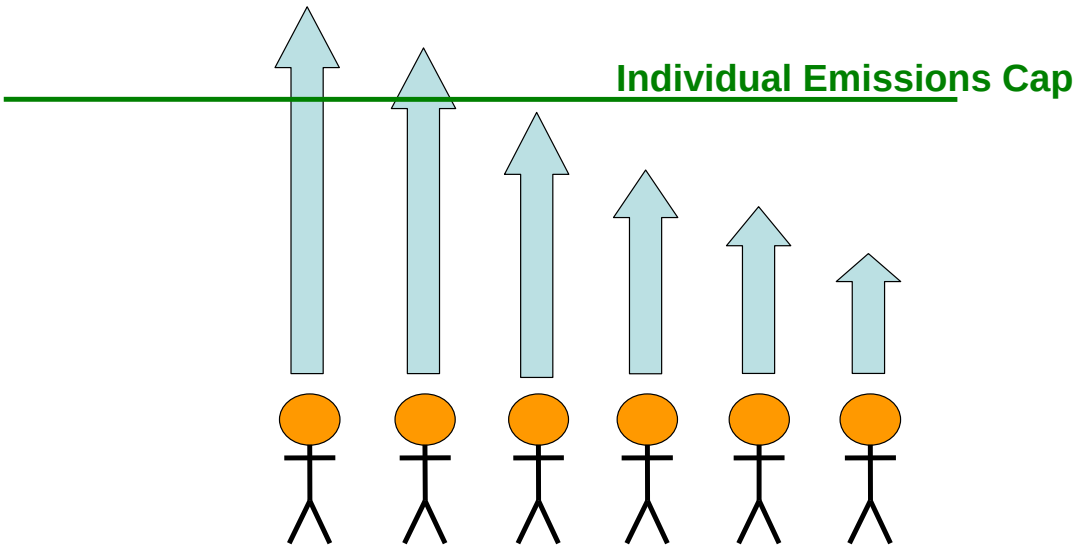
Determine globally applicable personal emissions cap



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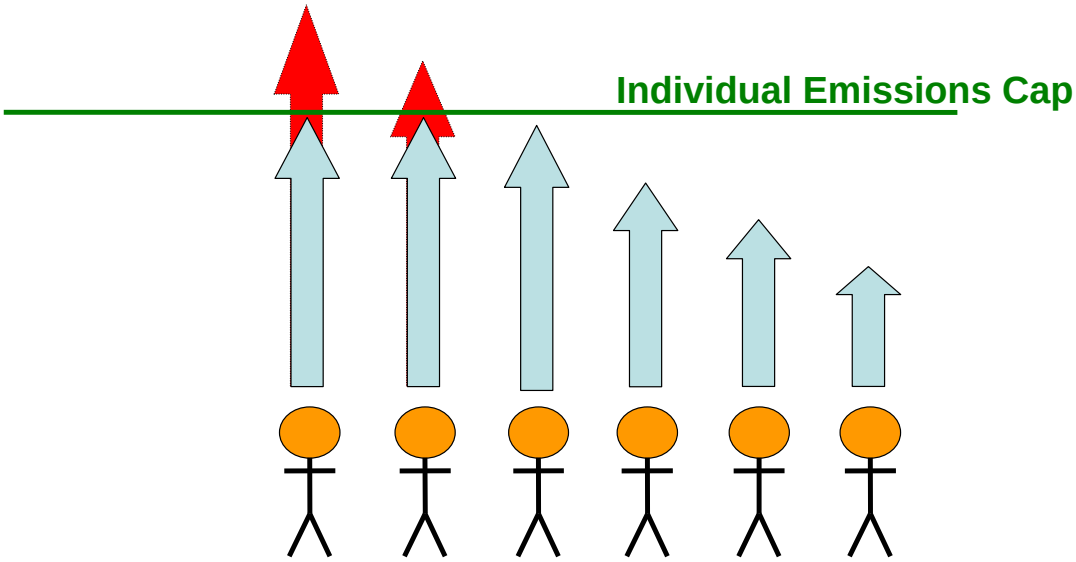
Some people exceed personal cap



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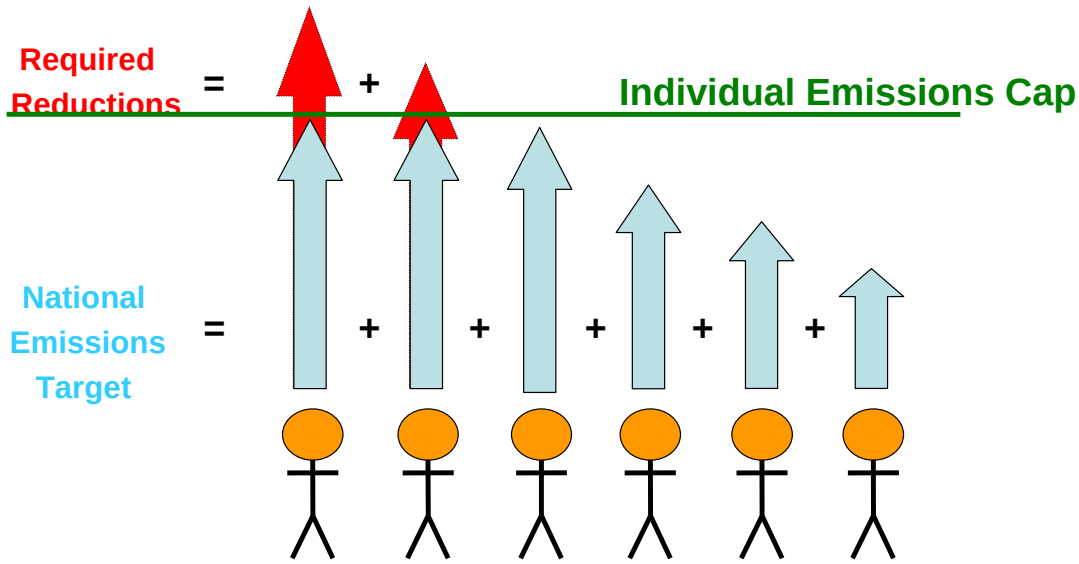
People in a nation determine national cap



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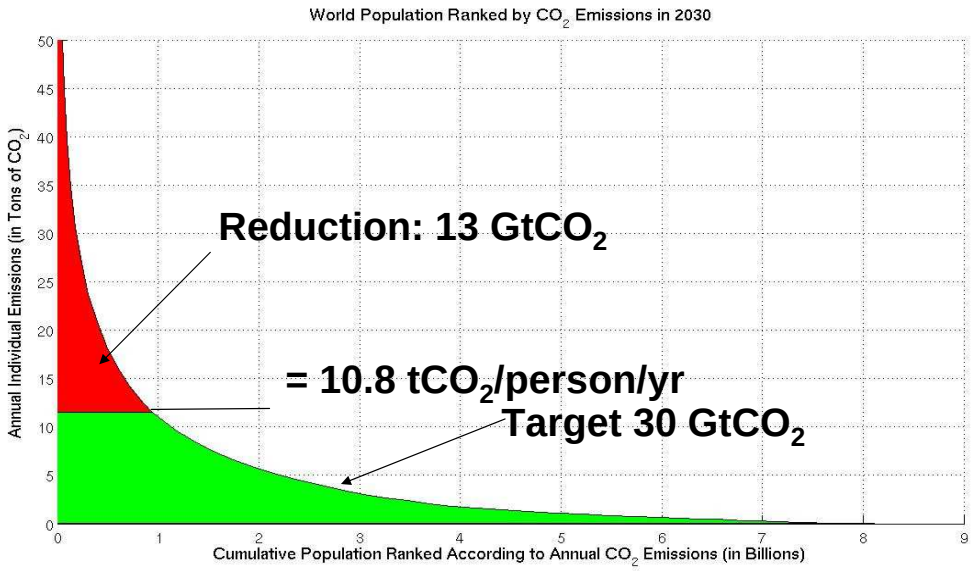
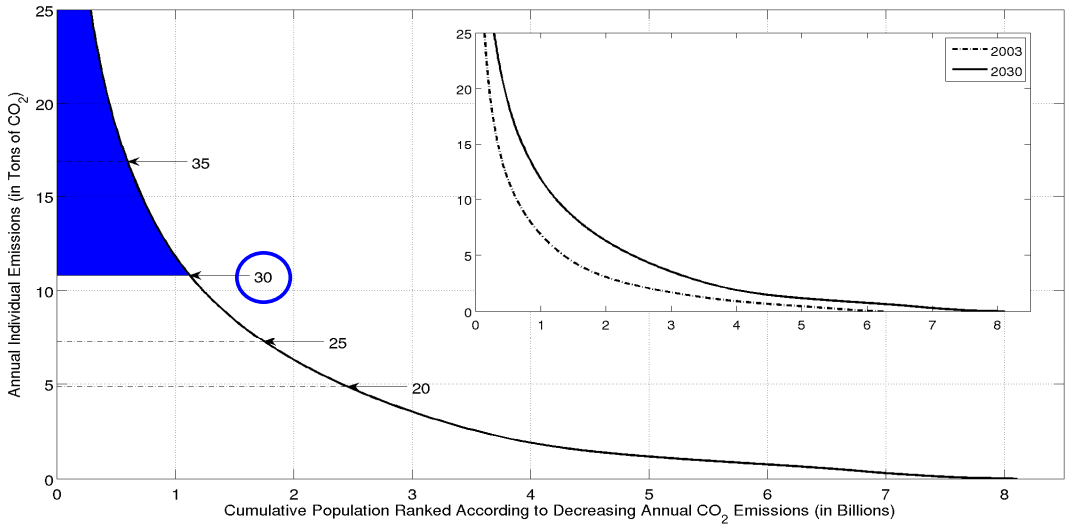
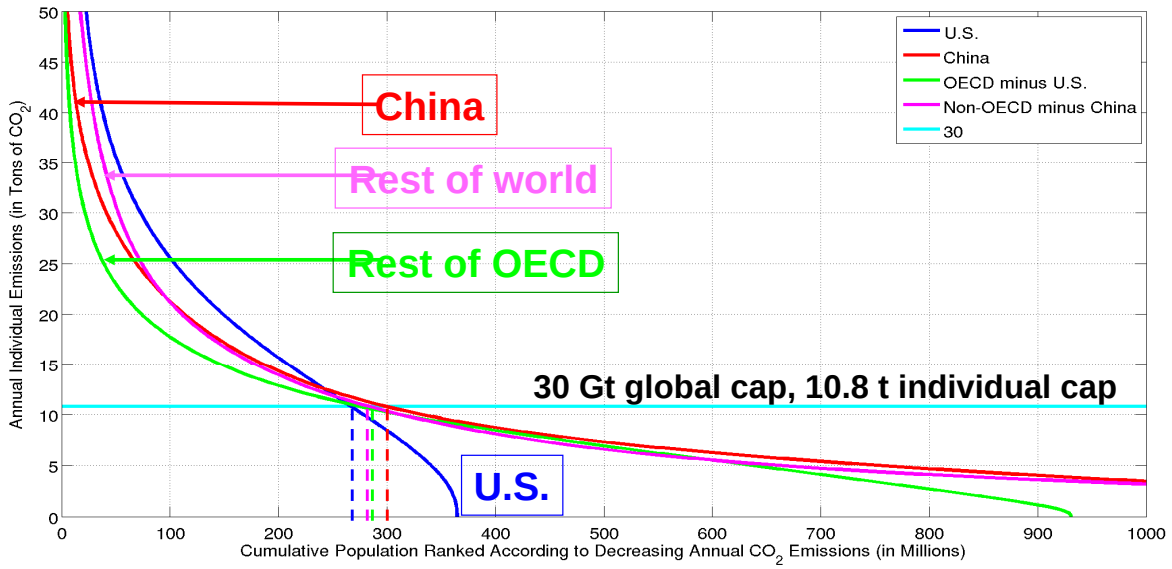
Choose a global target: 30 GtCO2 in 2030



Other global targets in 2030



Regional distributions in 2030



For a 30 $GtCO_2$ global cap in 2030, similar population on which targets are based for four groupings

Headroom for the poor

- Climate and poverty agenda
- Allow carbon poor to raise their emissions to 1 tCO2/cap*yr
- What does 1 tCO_2/person/yr mean
  - Electricity: 800 kWh coal-fired power;
  - Transport: 65km/day;
  - Cooking: 14 kg LPG/month
  - X 2 for indirect emissions

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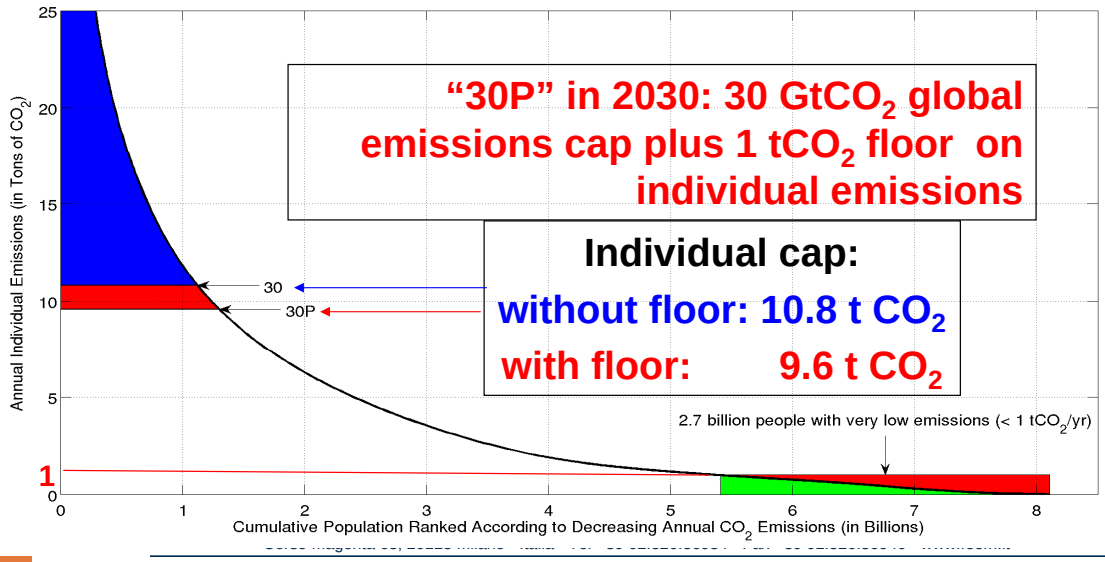
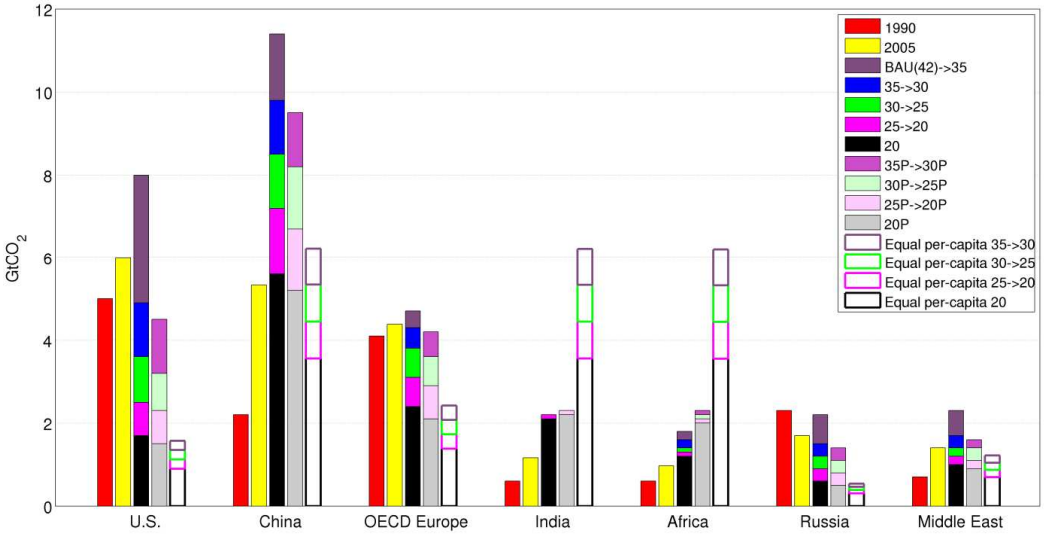
Combine global-emissions cap and individual-emissions floor



Regional targets in 2030



Conclusion

- Focus on individuals to determine national mitigation efforts
- Computing carbon emission distributions globally shows large inequalities. Go beyond national averages.
- Assuming an individual capping policy, a global target of 30 $GtCO_2$ in 2030 results in about 1 billion people having to reduce emissions, equally found in the US, rest of OECD, China and rest of non-OECD.
- The energy needs of the poorest 2.7 billion people can be accommodated with a rather small impact on climate mitigation
- In 2030, industrialized countries bear the highest mitigation job, but China (and to less extend Russia and the Middle East) are also held responsible.

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Emissions embedded in trade (production minus consumption)

	MtCO2	% of country emissions
US	-439	-7.3%
Switzerland	-63	-122%
Australia	57.9	16.5%
ANNEX B	-822	-5.6%

	MtCO2	% of country emissions
China	585	17.8%
India	71	6.9%
Mozambique	-2.8	-172.4%
NON ANNEX B	822	8.1%

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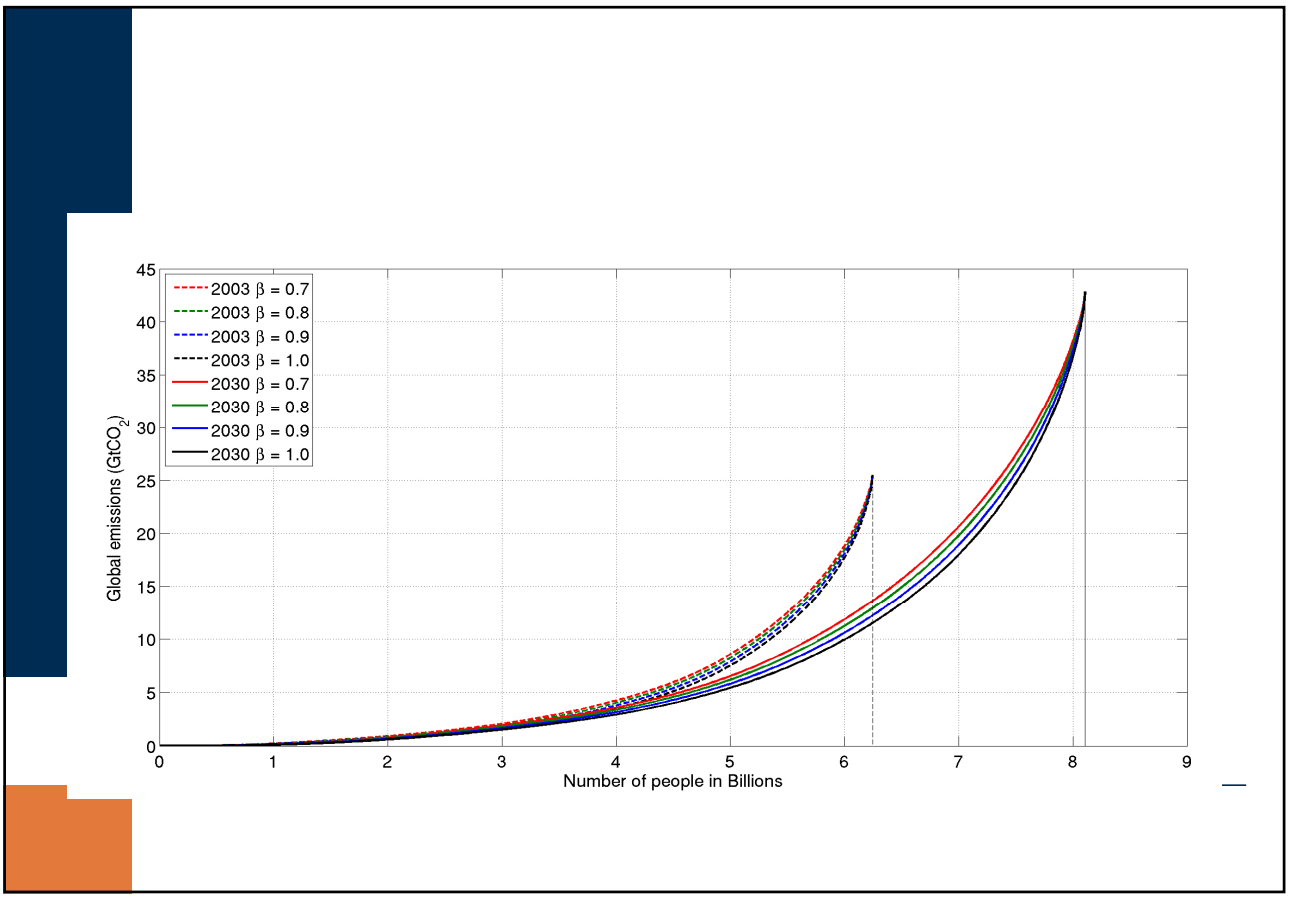
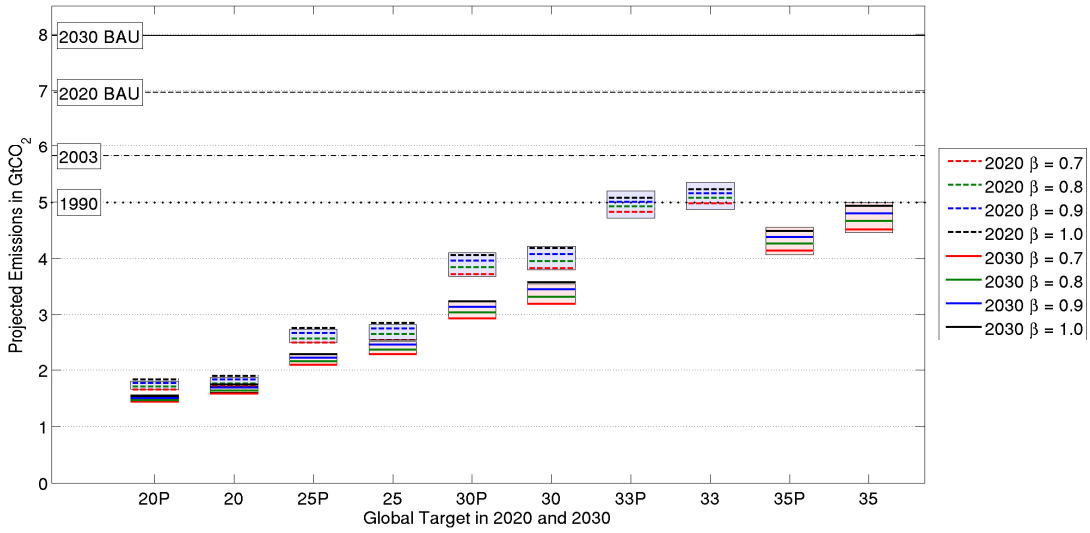
Source: Peters and Hertwich, 2007


2003 β = 0.7
2003 β = 0.8
2003 β = 0.9
2003 β = 1.0
2030 β = 0.7
2030 β = 0.8
2030 β = 0.9
2030 β = 1.0
Global emissions (GtCO2)
Number of people in Billions
0
5
10
15
20
25
30
35
40
45
0
1
2
3
4
5
6
7
8
9

U.S.


2030 BAU
2020 BAU
2003
1990
Projected Emissions in GtCO2
0
1
2
3
4
5
6
7
8
20P
20
25P
25
30P
30
33P
33
35P
35
Global Target in 2020 and 2030
2020 β = 0.7
2020 β = 0.8
2020 β = 0.9
2020 β = 1.0
2030 β = 0.7
2030 β = 0.8
2030 β = 0.9
2030 β = 1.0

A rapidly changing world…

	China/US ratio	
	Total Emissions	Per Capita Emissions
Rio:1992	0.48	0.10
Kyoto:1997	0.55	0.12
2007	1.13	0.26
2030	*1.75*	*0.44*

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Source: EIA for the 1992, 1997 and 2030 projections. 2007 estimate is from MNP and BP

Per-capita energy related CO2 emissions (2005)

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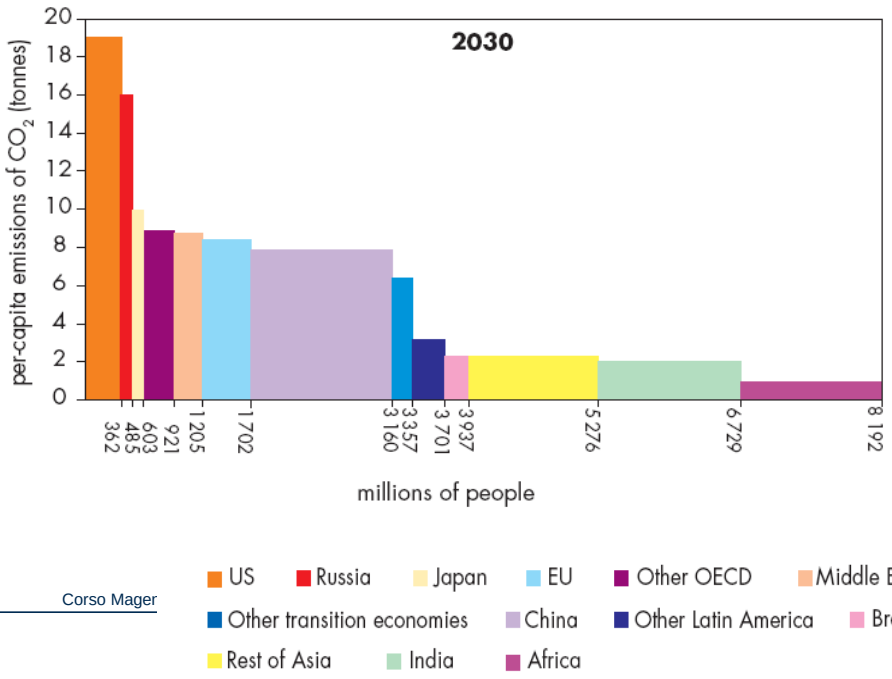
Source: IEA WEO 2007

Per-capita energy related CO2 emissions (2030)



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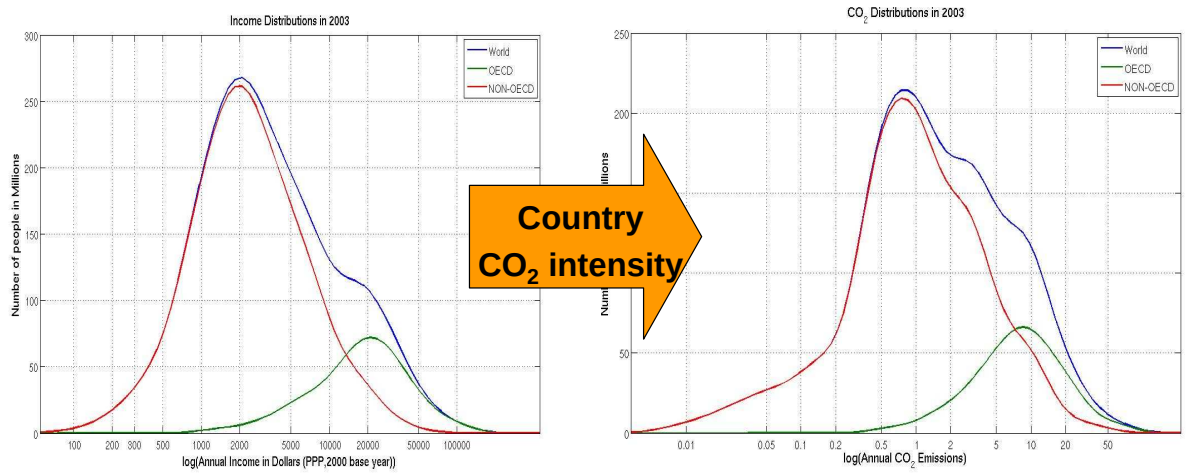
Source: IEA WEO 2007

Use income distribution data to arrive at individual carbon distributions



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Emissions-income elasticity 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]

$$C_i = A_i * I^x$$

We will proceed with elasticity of x = 1.0 as the basic idea is independent of the elasticity.

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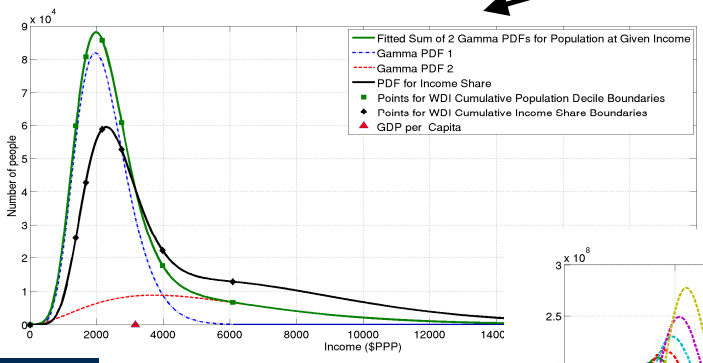
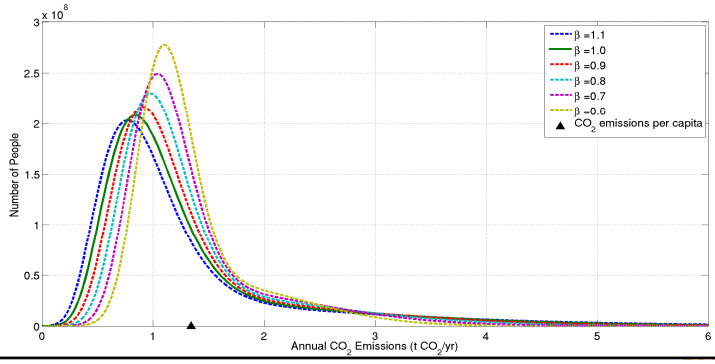
From income to carbon distributions

urce: World Bank's national surveys on income distribution

Population	0	0.1	0.2	0.4	0.6	0.8	0.9	1.0
Income share	0	0.036	0.084	0.20	0.36	0.57	0.71	1.0





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Procedure for Projections

- Add country level distributions to obtain regional emissions distributions
- Project forward to 2030 using EIA IEO 2007.
- Derive a universal individual cap from global target and timetable.
- Apply individual caps to regions/countries to obtain regional/national targets.

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Emission path over time for a trajectory that peaks at 33 Gt in 2020 and reduces to 30 Gt in 2030