

Sharing Global CO₂ Emission Reductions Among One Billion High Emitters

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with Laurence Tubiana
Chaire développement durable de Sciences Po
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Co-authors

This talk is based on a recent paper with the same title, published in the July 21, 2009, issue of the *Proceedings of the National Academy of Sciences*. My co-authors are:

Shoibal Chakravarty (Princeton University)

Ananth Chikkatur (Harvard University).

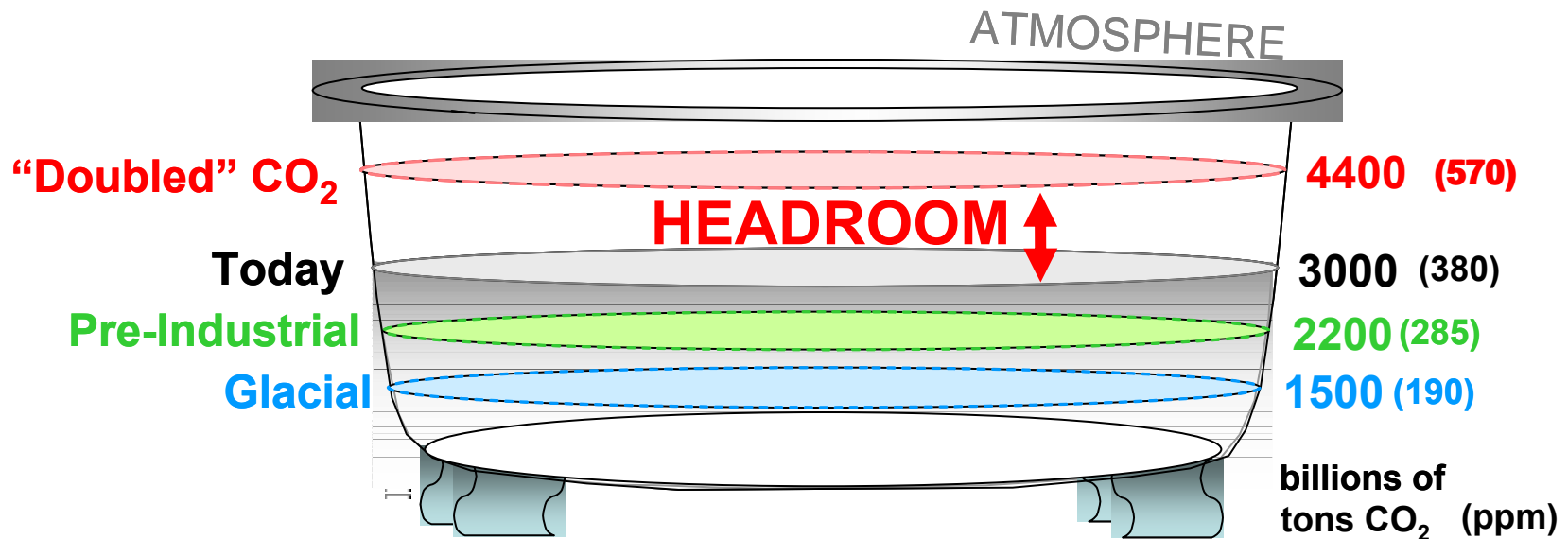
Heleen de Coninck (Energy Research Center of the Netherlands)

Steve Pacala (Princeton University)

Massimo Tavoni (Princeton University and FEEM)

Massimo Tavoni is here with me.

Past, present, and potential future levels of CO₂ in the atmosphere

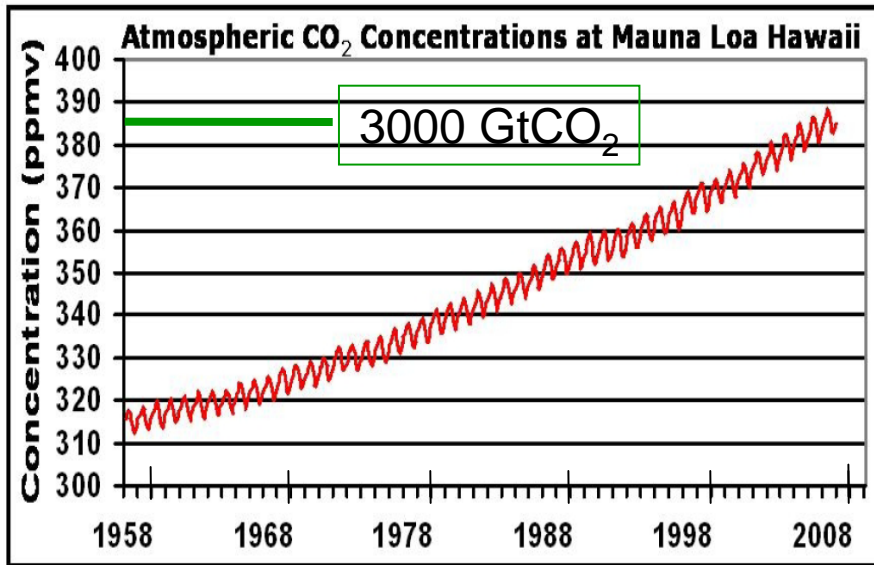
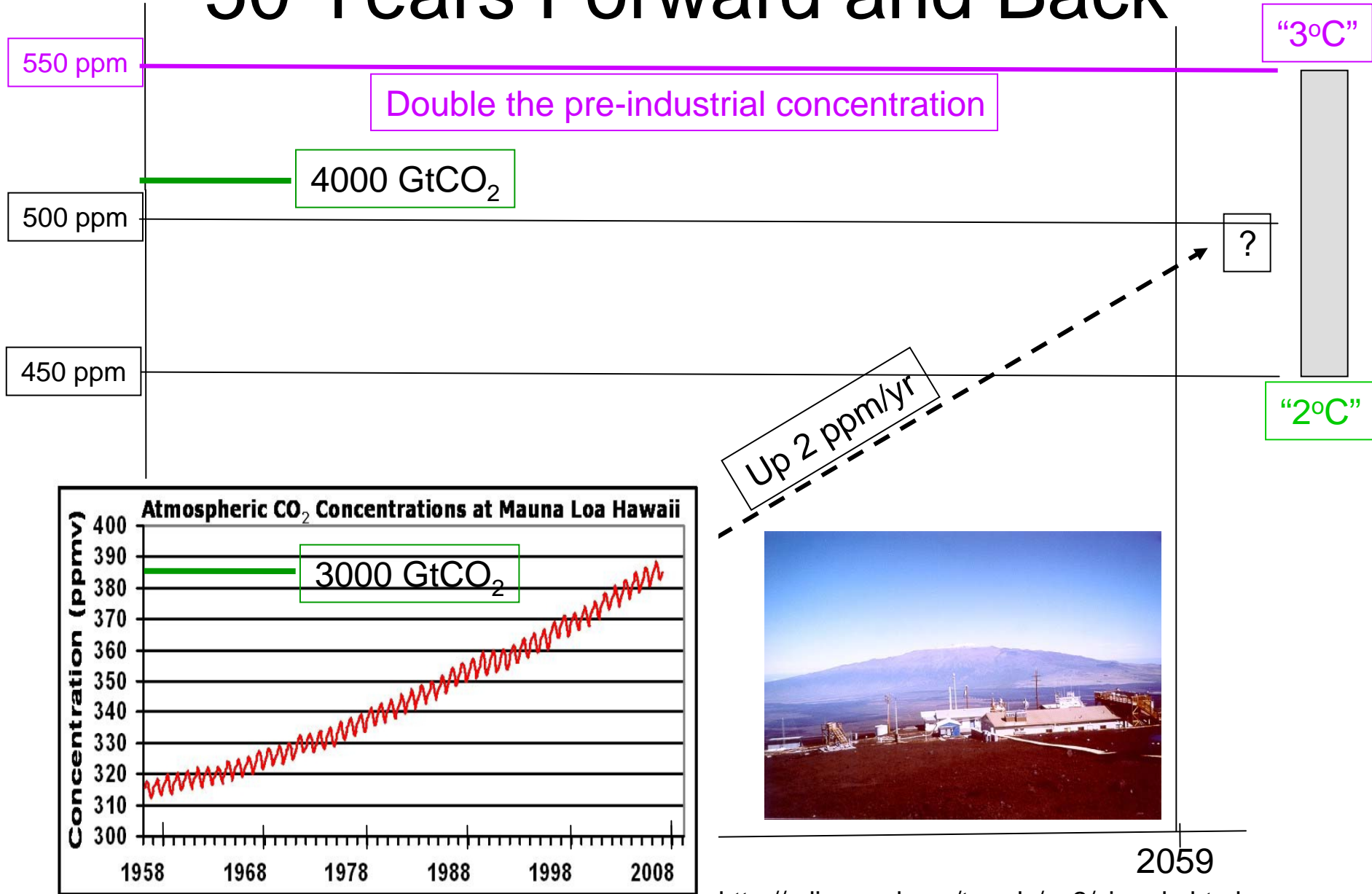


Rosetta Stone: To raise the concentration of CO₂ in the atmosphere by **one part per million**:

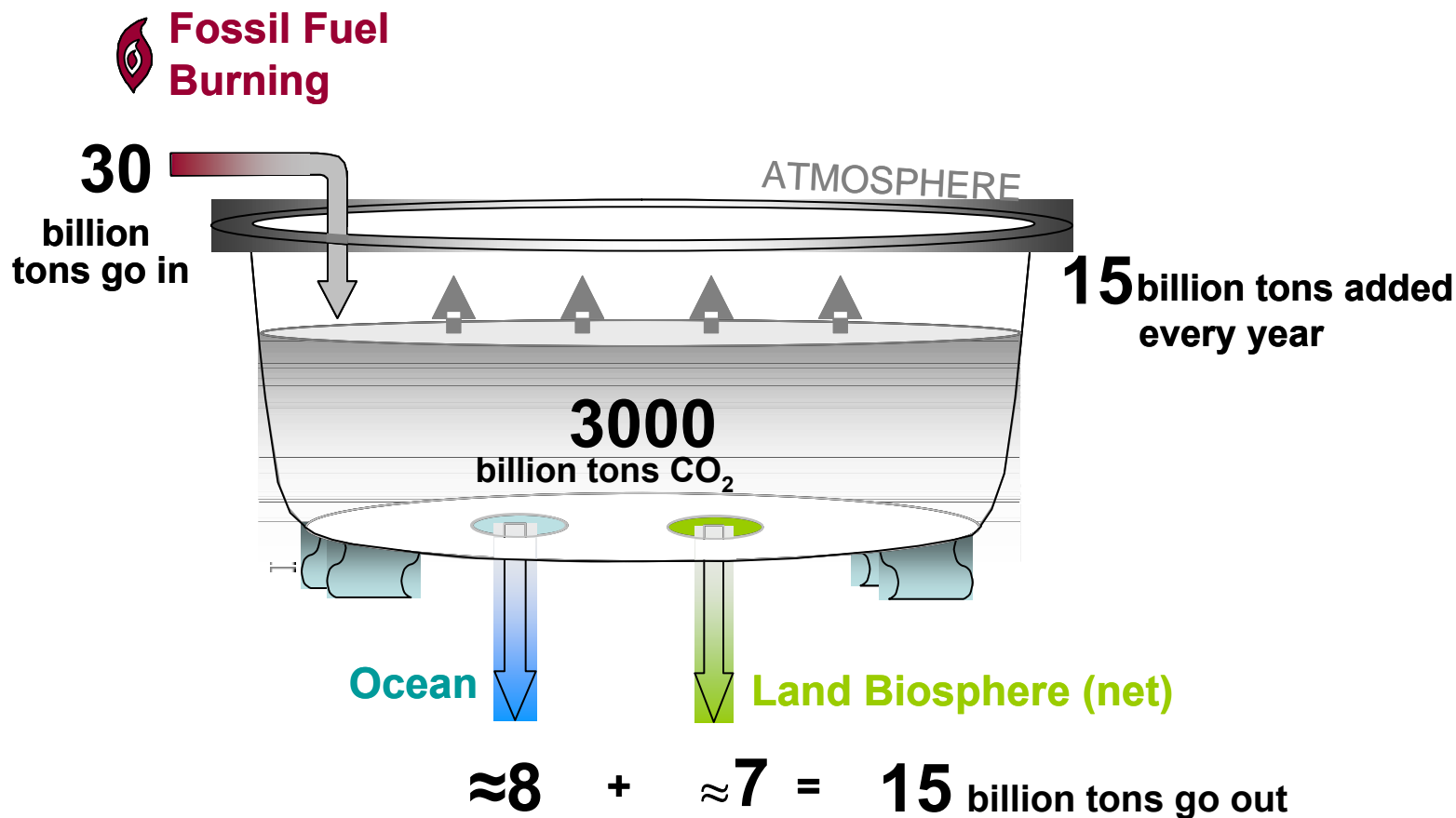
add **7.8 billion tons of CO₂**,

in which are **2.1 billion tons of carbon**.

50 Years Forward and Back



About half of the CO₂ we burn stays in the atmosphere for centuries

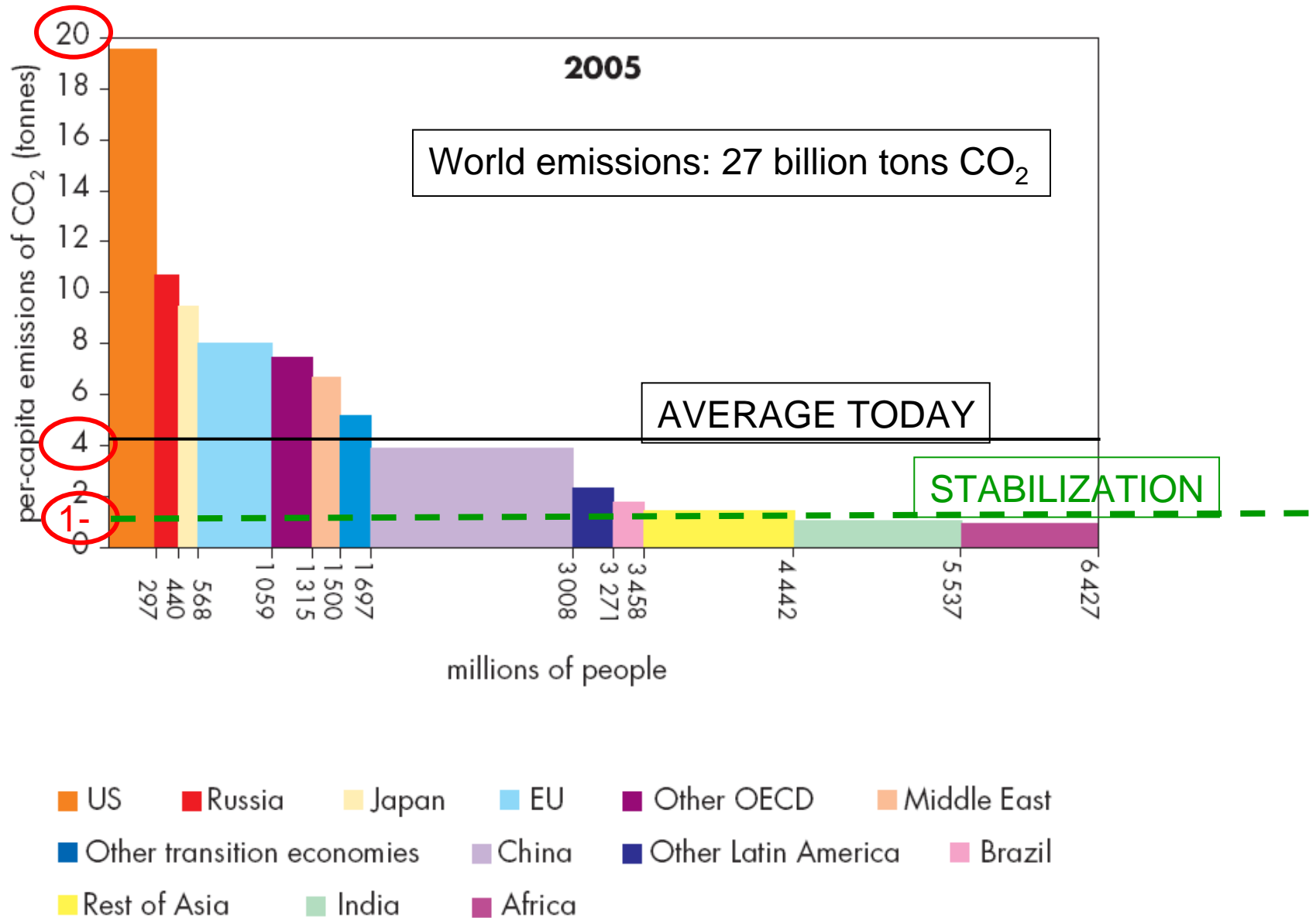


Today, global per-capita emissions are ≈ 4 tCO₂/yr.

Four ways to emit 4 tonCO₂/yr (today's global per capita average)

Activity	Amount producing 4 ton CO₂/yr emissions
a) Drive	24,000 km/yr, 5 liters/100km
b) Fly	24,000 km/yr
c) Heat home	Natural gas, average house, average climate
d) Lights	300 kWh/month when all coal-power (600 kWh/month, natural-gas-power)

Per-capita fossil-fuel CO₂ emissions, 2005



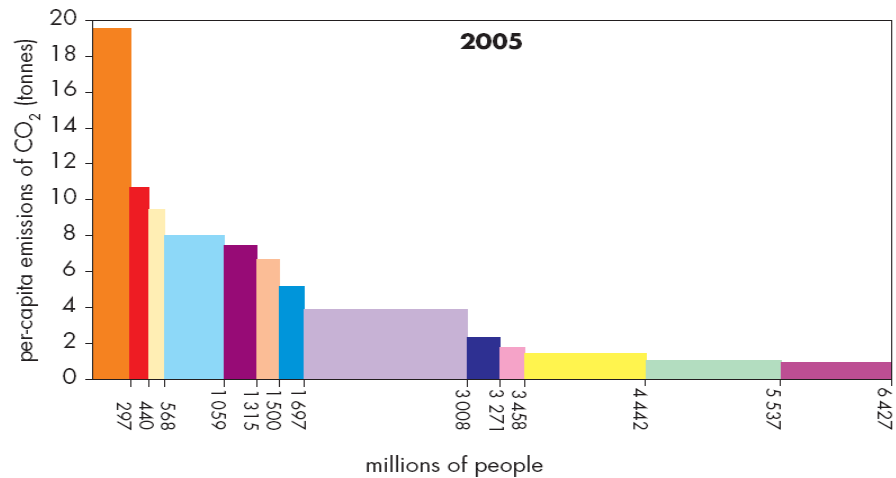
“Stabilization”: 1 ton CO₂/yr per capita

It is *not* sufficient to limit emissions in the prosperous parts of the world and allow the less fortunate to catch up. Such an outcome would overwhelm the planet.

The emissions of the future rich must eventually equal the emissions of today's poor, ...

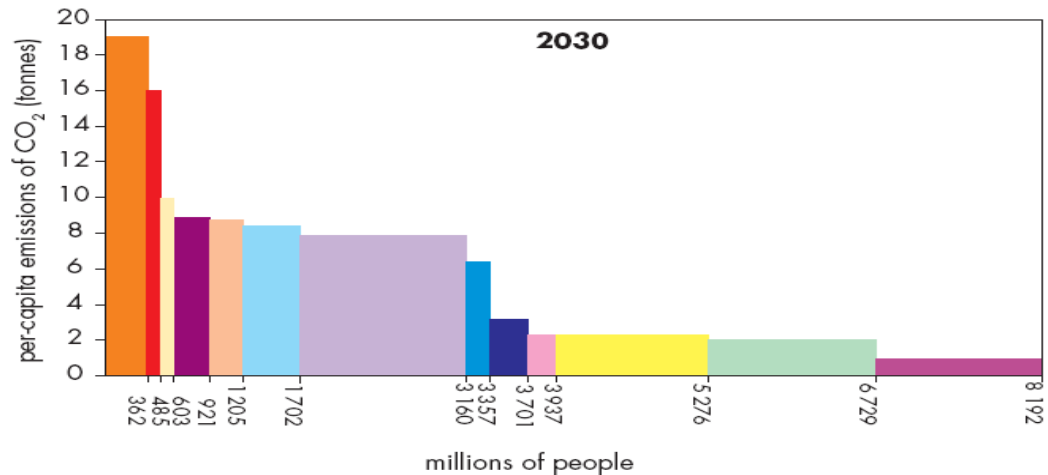
...not the other way around.

CO₂ emissions, 2005 and 2030, by region



OECD: Less than 50% in 2005

- US Russia Japan EU Other OECD Middle East
- Other transition economies China Other Latin America Brazil
- Rest of Asia India Africa



What does fairness look like when historic emissions are taken into account?

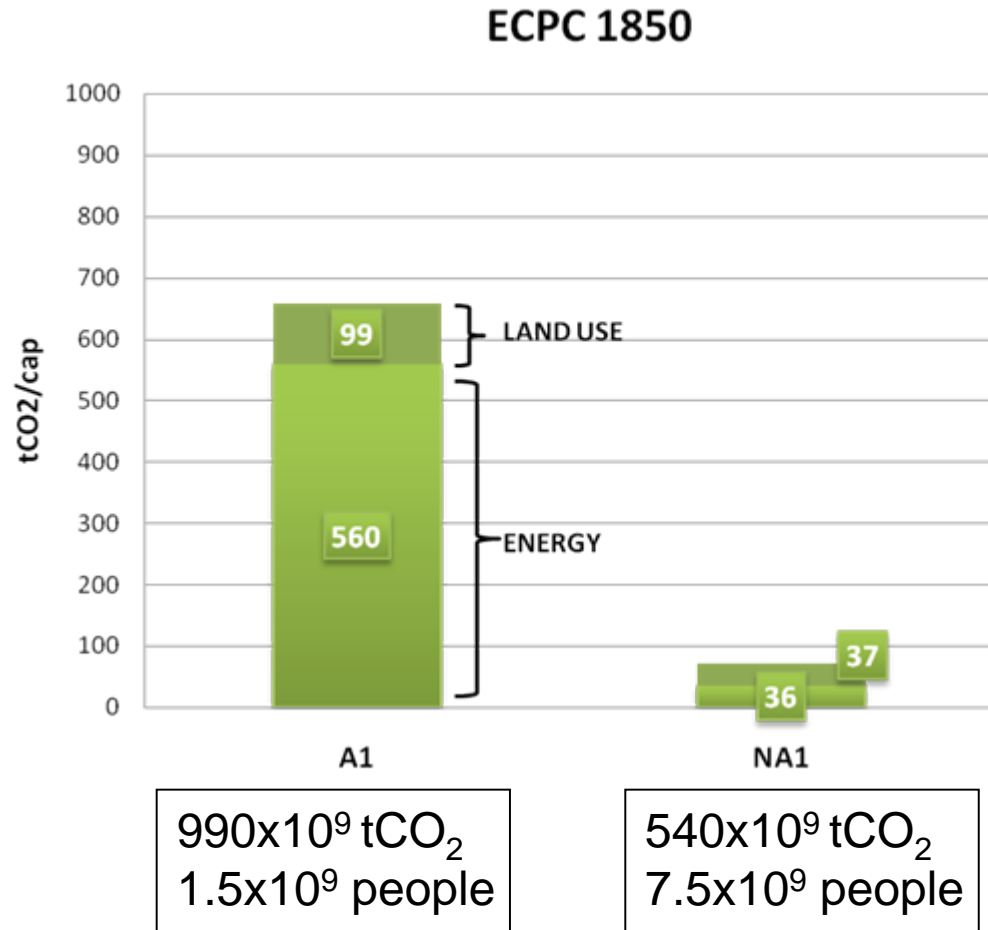
A simple formulation of fairness that takes history into account: Equal Cumulative Per Capita emissions (ECPC)

Over some time interval (partially past and partially ahead) the cumulative emissions of the Annex1 countries and the NonAnnex1 countries are proportional to their populations.

We explore three time intervals, all ending in 2100, but beginning in 1850, 1950 and 1990.

We assume that Annex1 and NonAnnex1 populations are 1.5 billion and 7.5 billion, respectively.

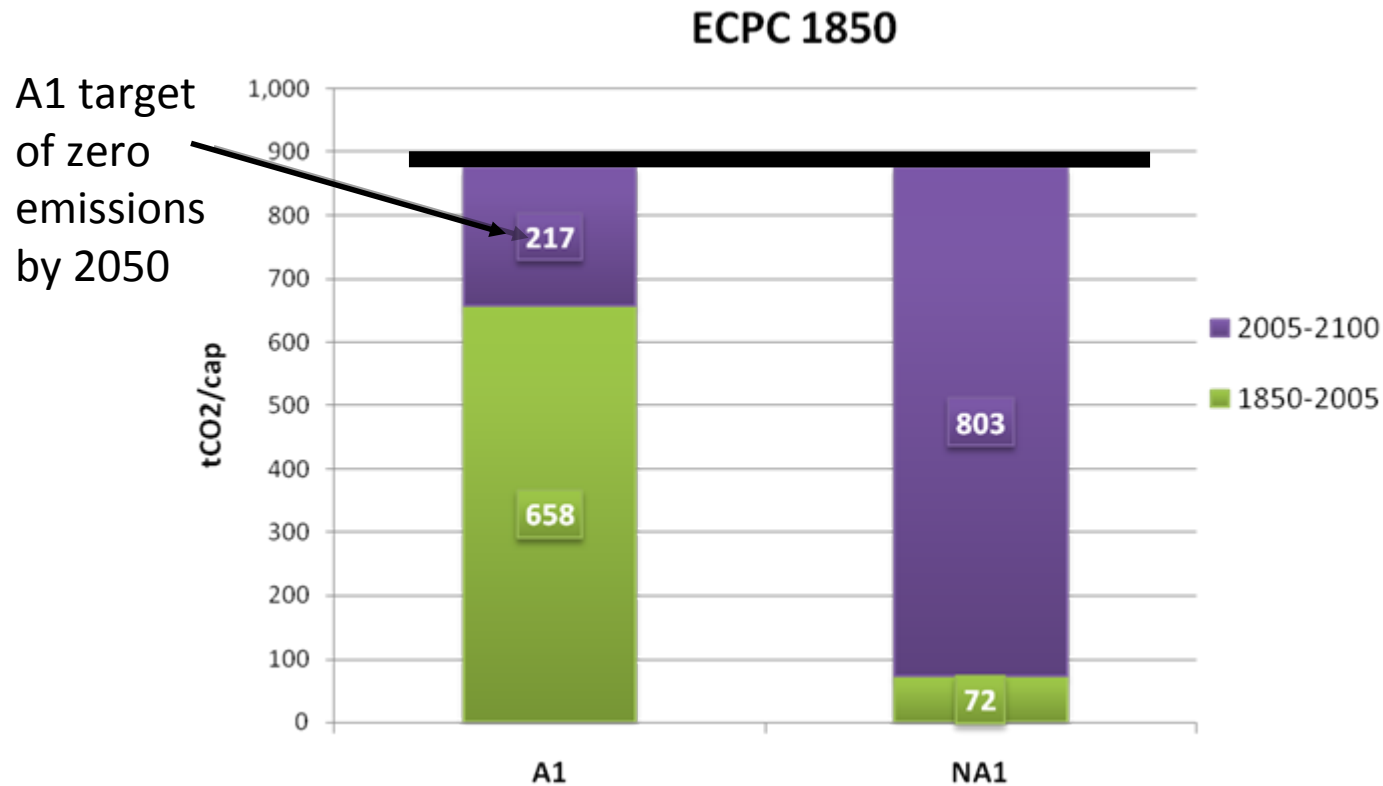
Cumulative Per Capita Emissions (1850-2005)



Included: Fossil fuels and most deforestation

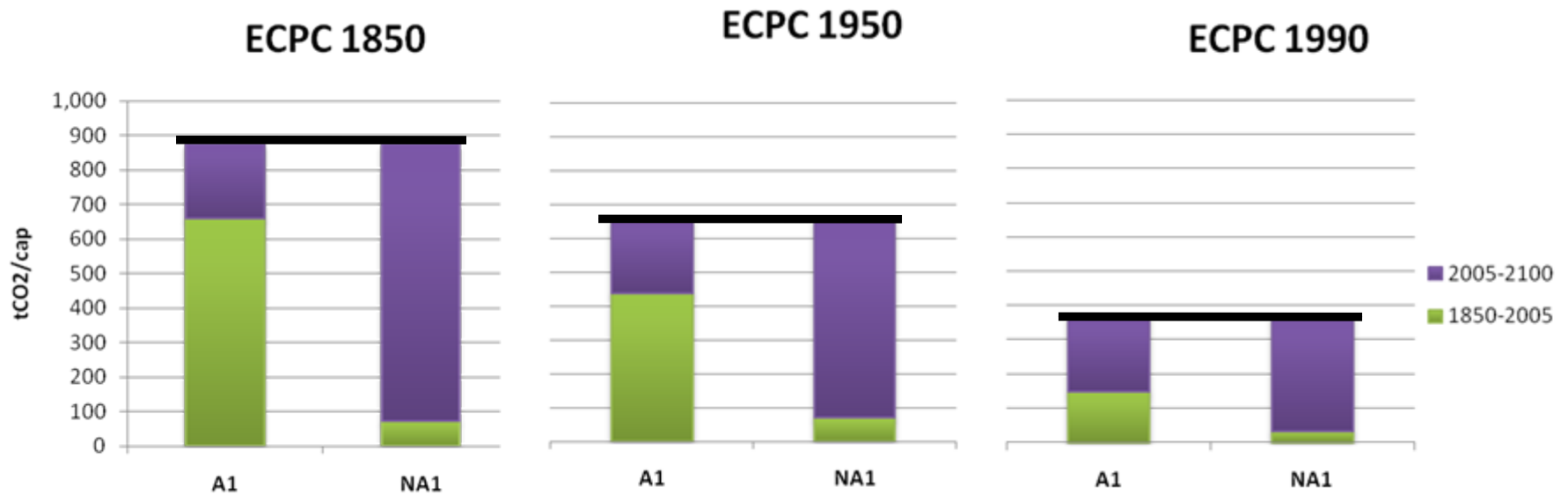
Not included: All non-CO₂ greenhouse gases and pre-1950 non-Annex1 deforestation emissions (150 GtCO₂, or 20 tCO₂/capita)

The ECPC Scheme at work: Compensating Emissions for the 1850-2100 Interval

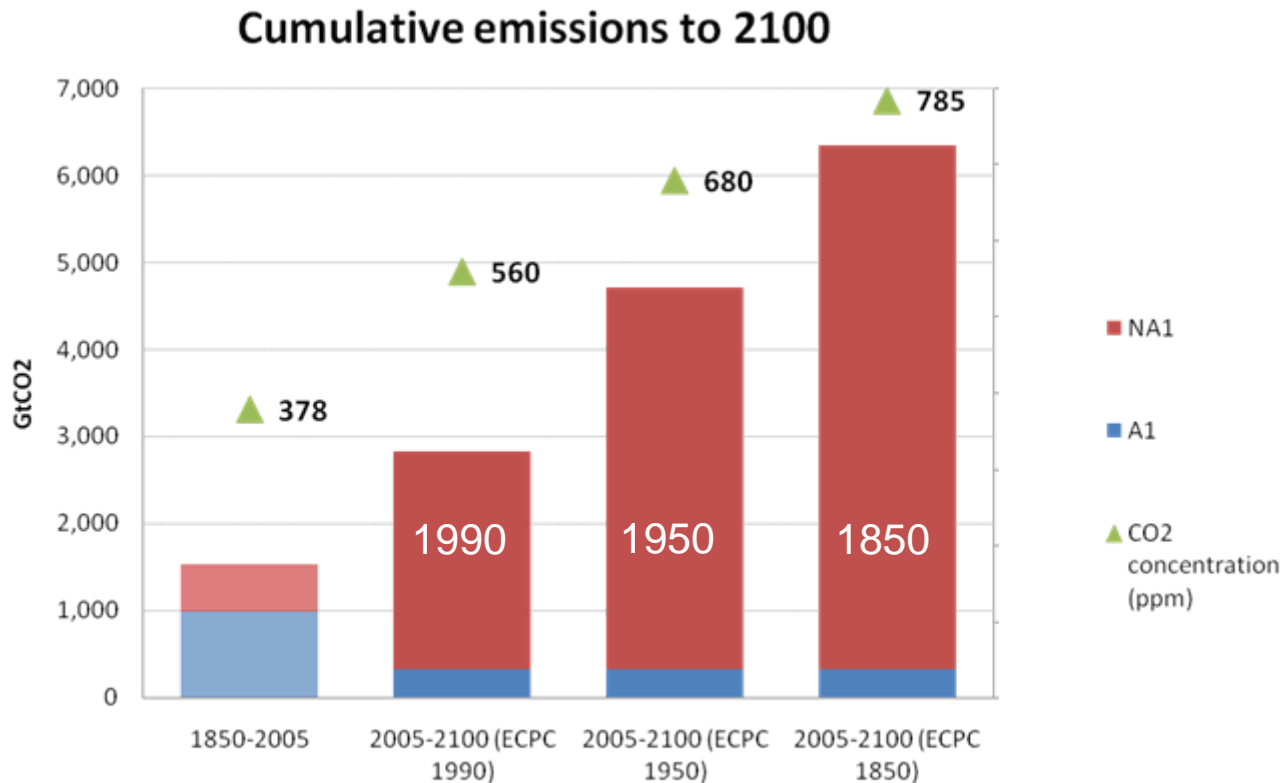


Every additional ton of future Annex1 CO₂ emissions legitimates five tons of future CO₂ emissions from the NonAnnex1 countries.

The ECPC Scheme for Three Start-times



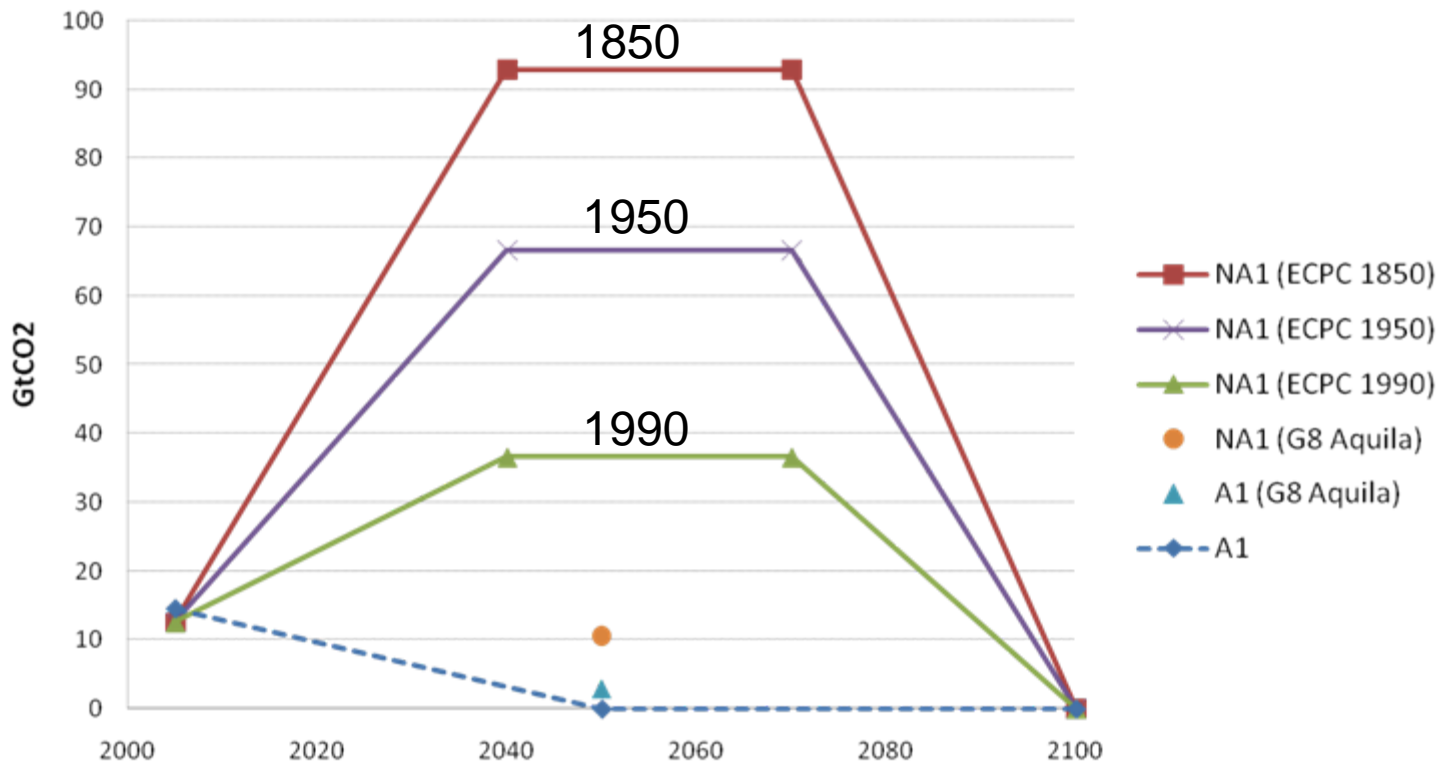
In 2100, from double to nearly triple the pre-industrial concentration



Model: Half of the emissions remain in the atmosphere.
Pre-industrial level: 280 ppm = 2200 GtCO₂ (1 ppm = 7.8 GtCO₂)
The 2100 concentration of 785 ppm is 2.8 x pre-industrial.

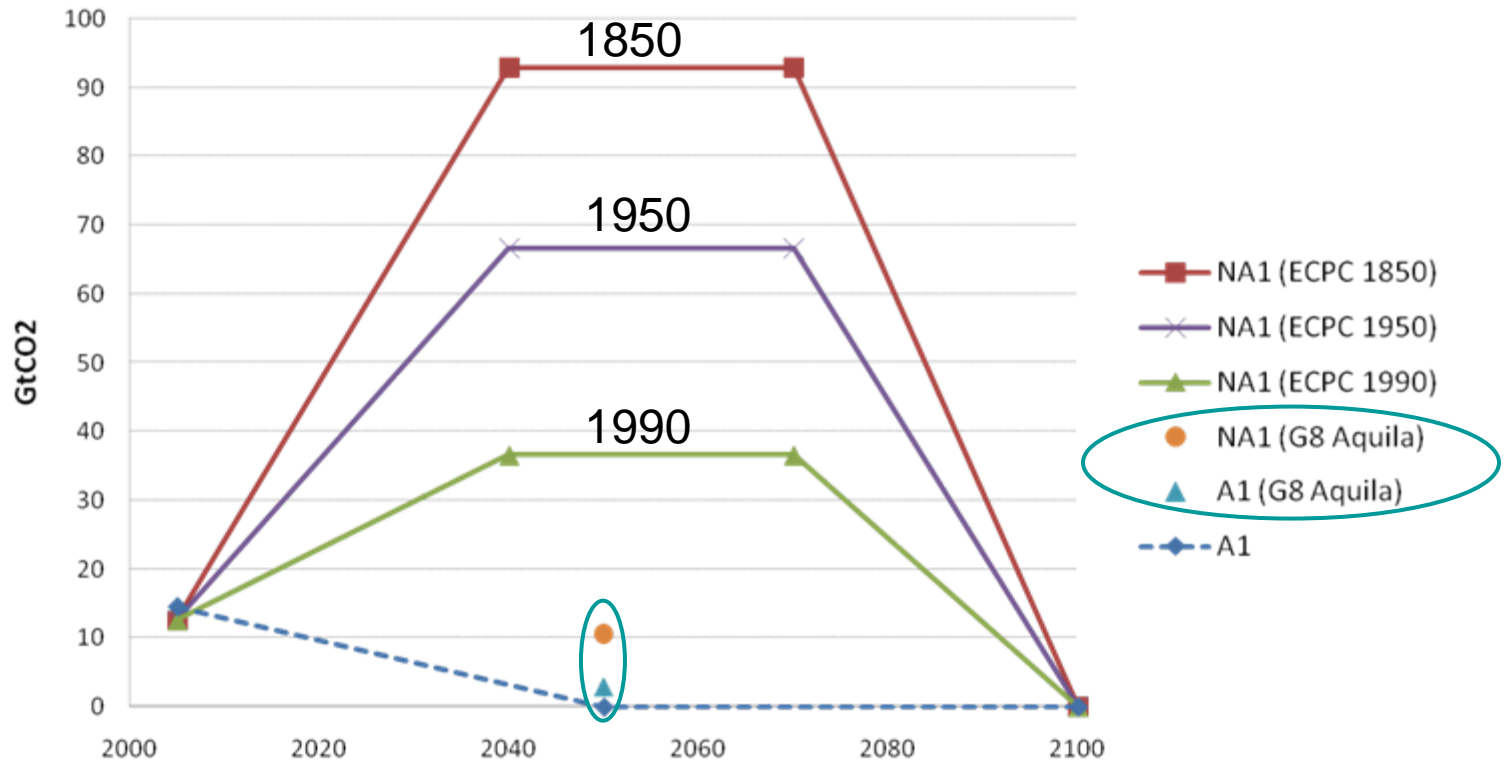
ECPC Compensatory Annual Aggregate Emissions

CO2 emissions



ECPC Compensatory Annual Aggregate Emissions

CO2 emissions



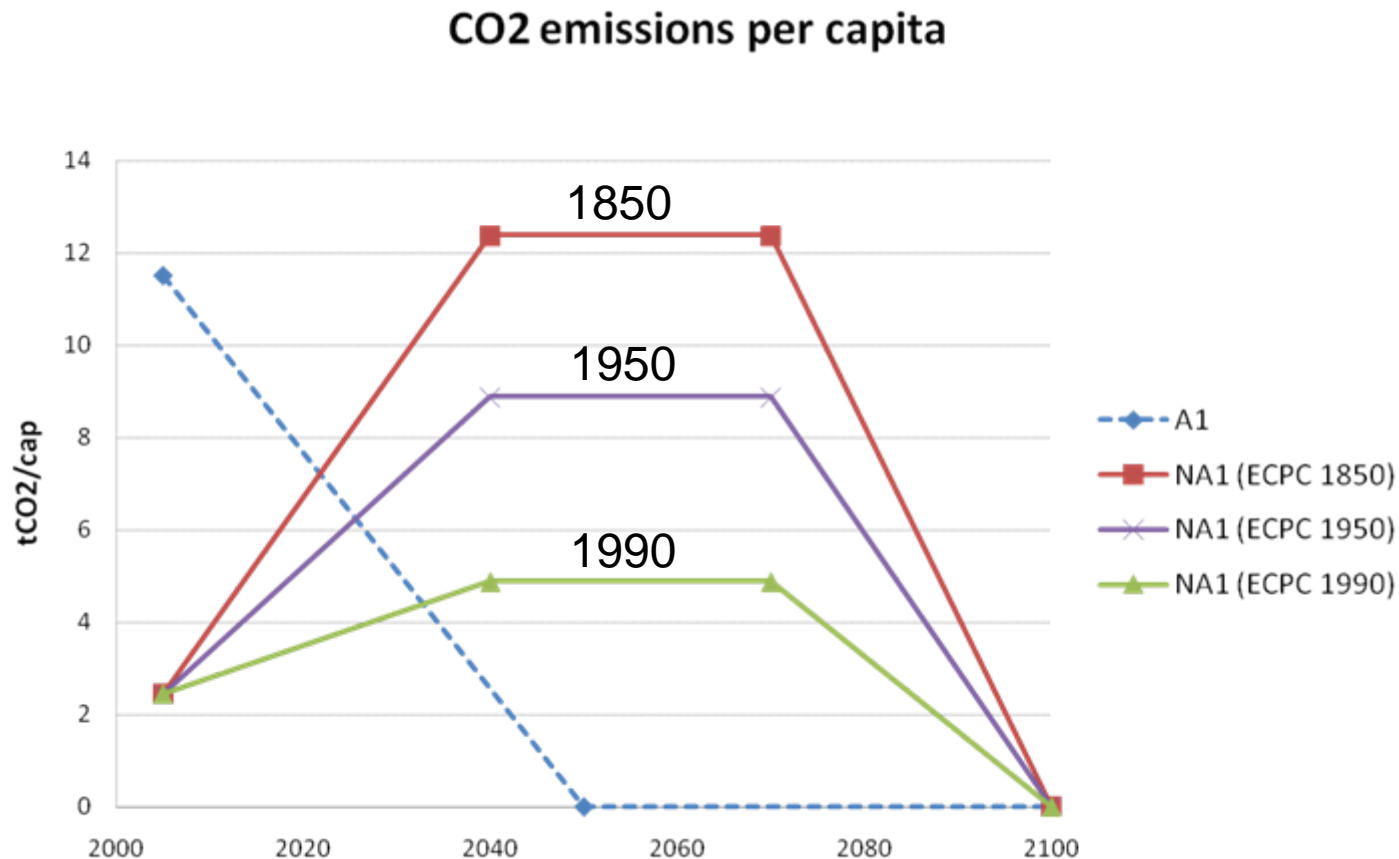
For ECPC1850:

2005 14 GtCO₂ (Annex1) + 13 GtCO₂ (NonAnnex1) = 27 GtCO₂ (global)

2050 0 GtCO₂ (Annex1) + 93 GtCO₂ (NonAnnex1) = 93 GtCO₂ (global)

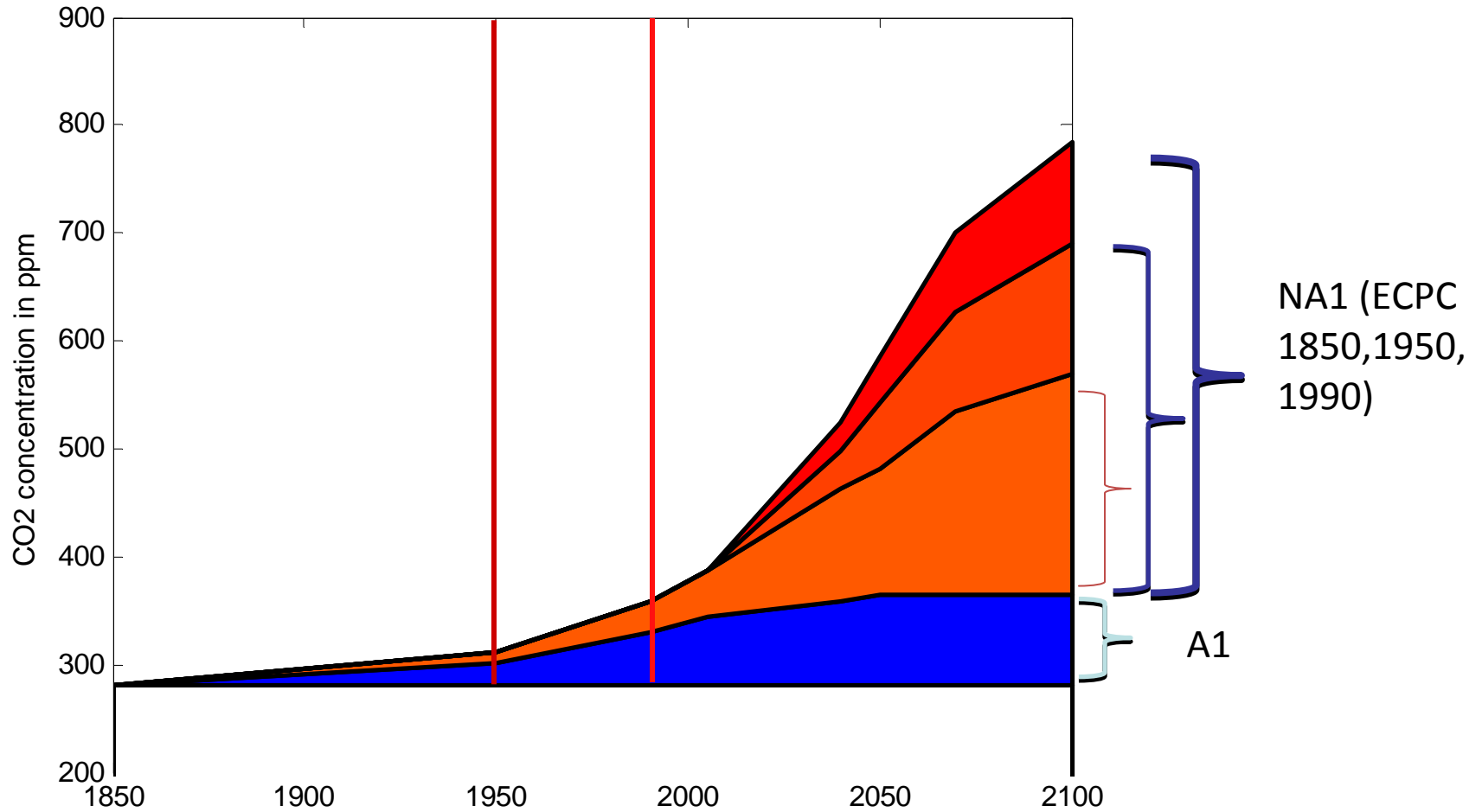
Aquila 2050 3 GtCO₂ (Annex1) + 11 GtCO₂ (NonAnnex1) = 14 GtCO₂ (global)

ECPC Compensatory Annual Per Capita Emissions



For ECPC-1850, per capita NonAnnex1 emissions along the 2040-2070 plateau roughly equal today's per capita Annex1 emissions (12 tCO₂/person-yr).

Integrated emissions, three start-times



Safe or Fair: A tragic choice

If the unit of attention is the nation:

Safe is not fair.

Fair is not safe.

Can the unit of attention be other than the nation?

Can the unit of attention be the individual?

Another View of Fairness

Sharing global CO₂ emission reductions among one billion high emitters

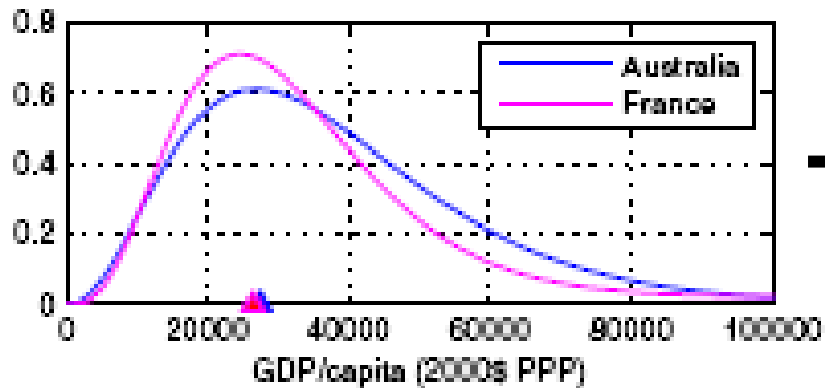
Shoibal Chakravarty^a, Ananth Chikkatur^{b,1}, Heleen de Coninck^c, Stephen Pacala^{a,2}, Robert Socolow^a, and Massimo Tavoni^{a,d}

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

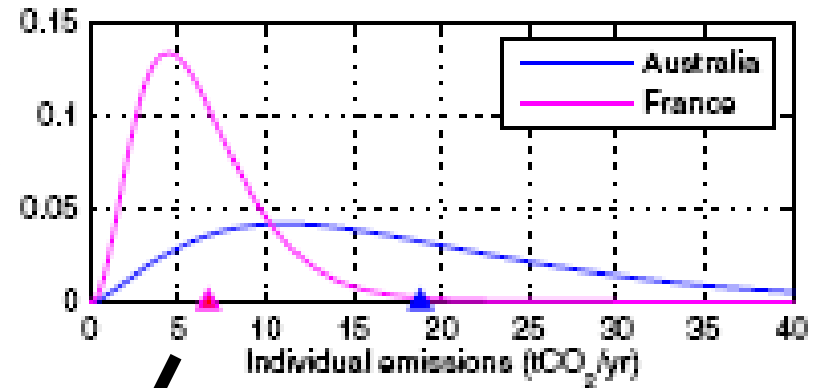
Published online before print July 6, 2009, doi: 10.1073/pnas.0905232106

Available at: <http://www.pnas.org/content/106/29/11884>

From national income distributions to a global emissions distribution



(1)



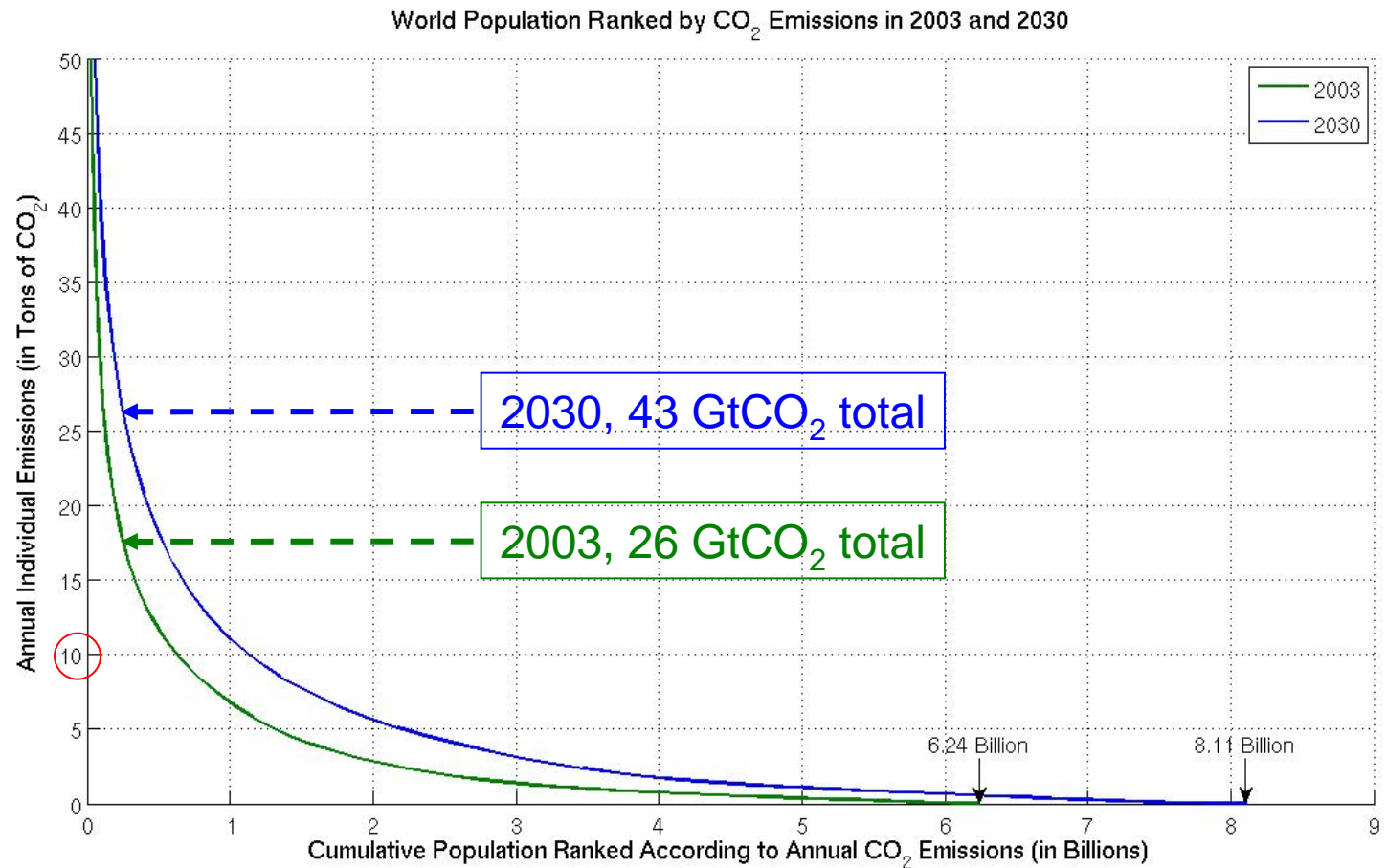
(2)

Sum over all countries to generate a current emissions distribution for all the world's individuals.

(3)

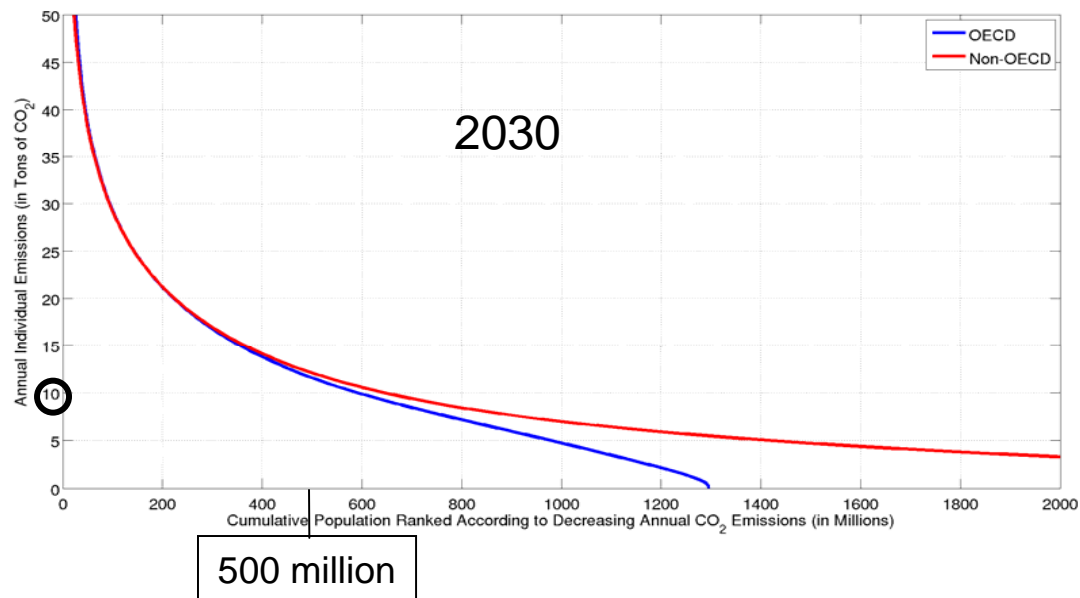
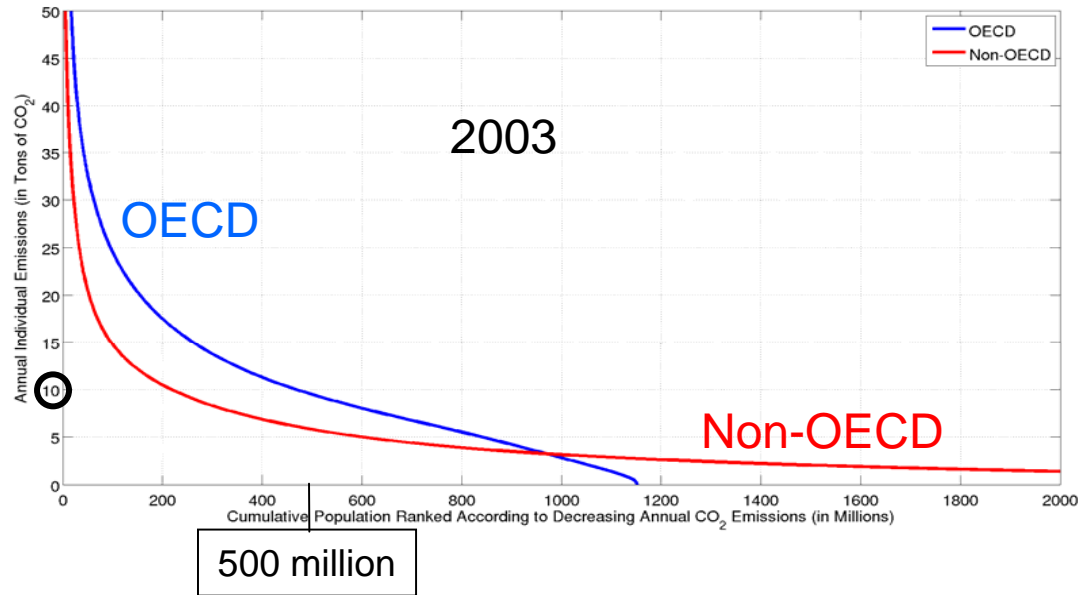
Repeat (2) for future times, using projected national emissions and assuming invariant national emissions distributions.

Rank all people in the world, highest to lowest emissions

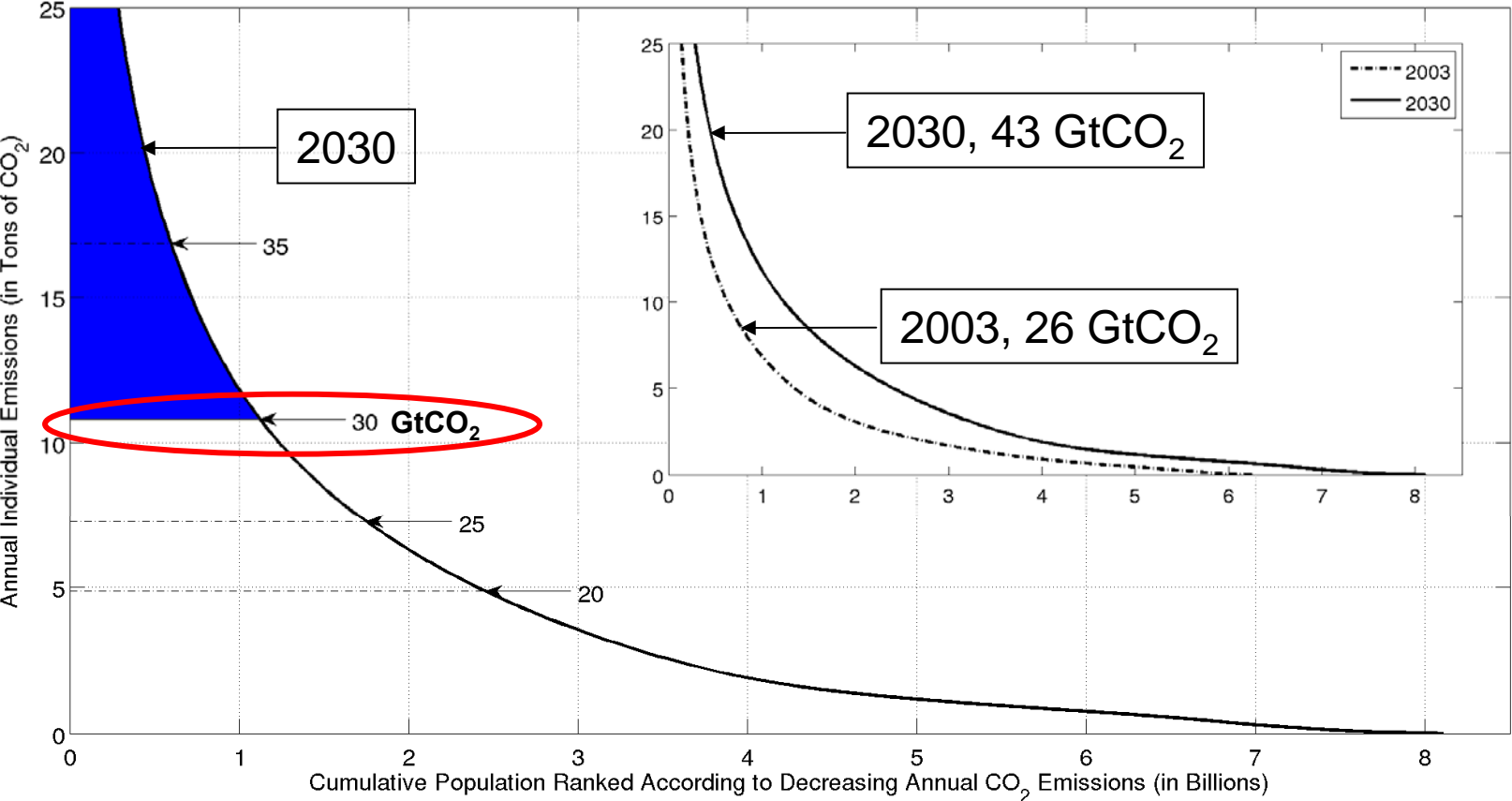


For 2030, use EIA regional CO₂ projections, assume regional emissions distributions are unchanged.

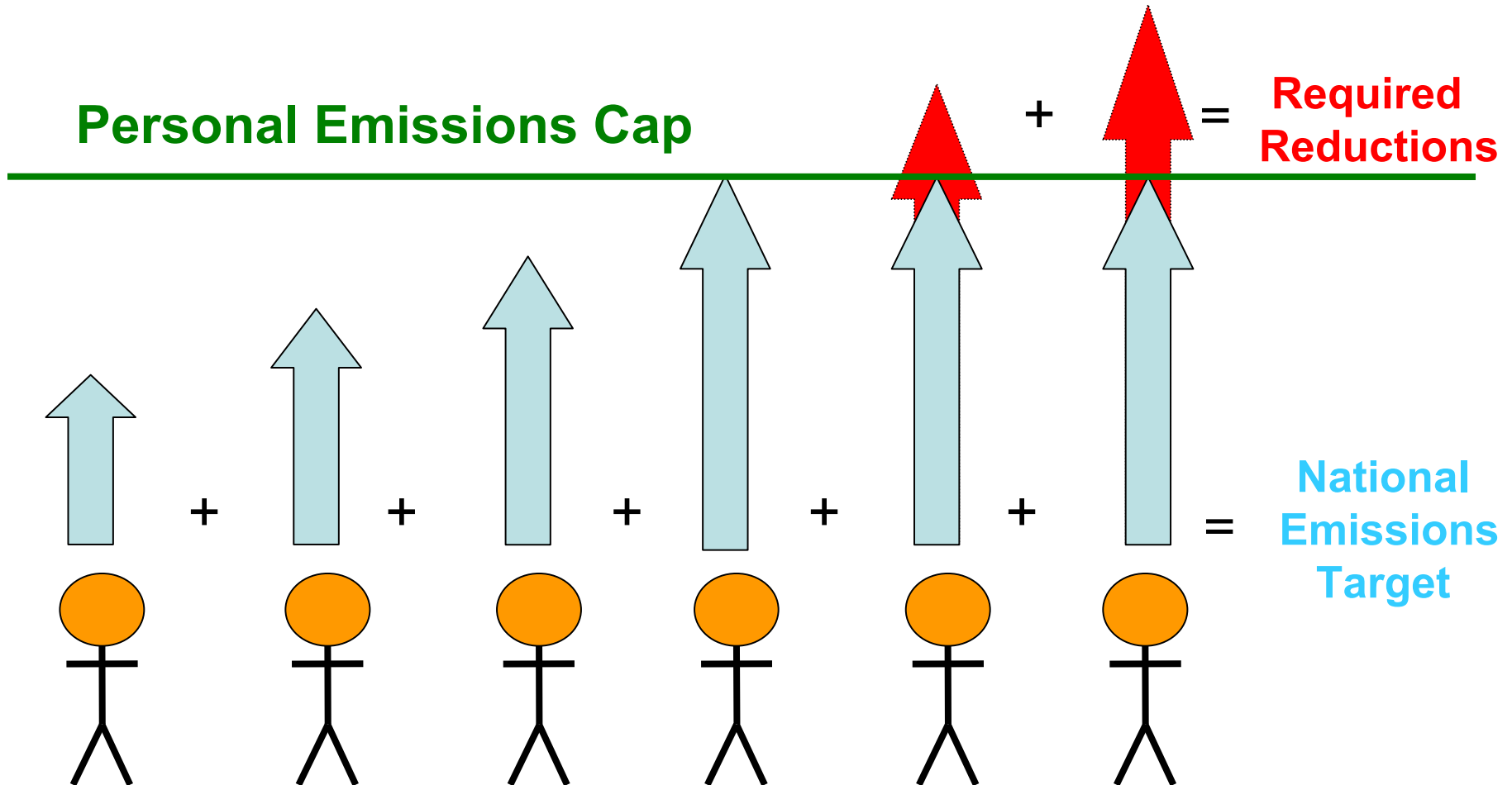
Ever more high emitters outside the OECD



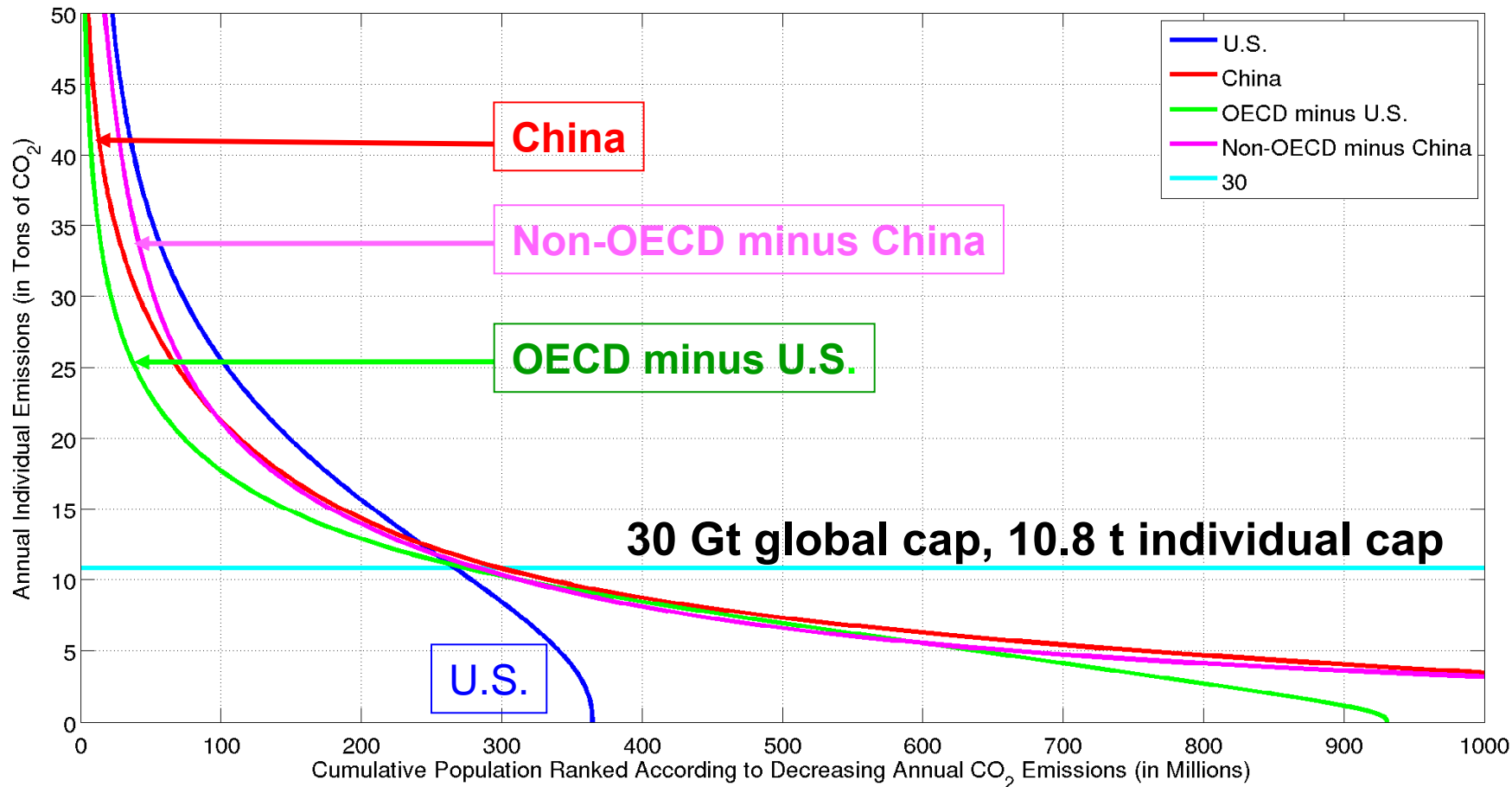
Count high-emitting individuals



Add the individual capped emissions to determine the national target

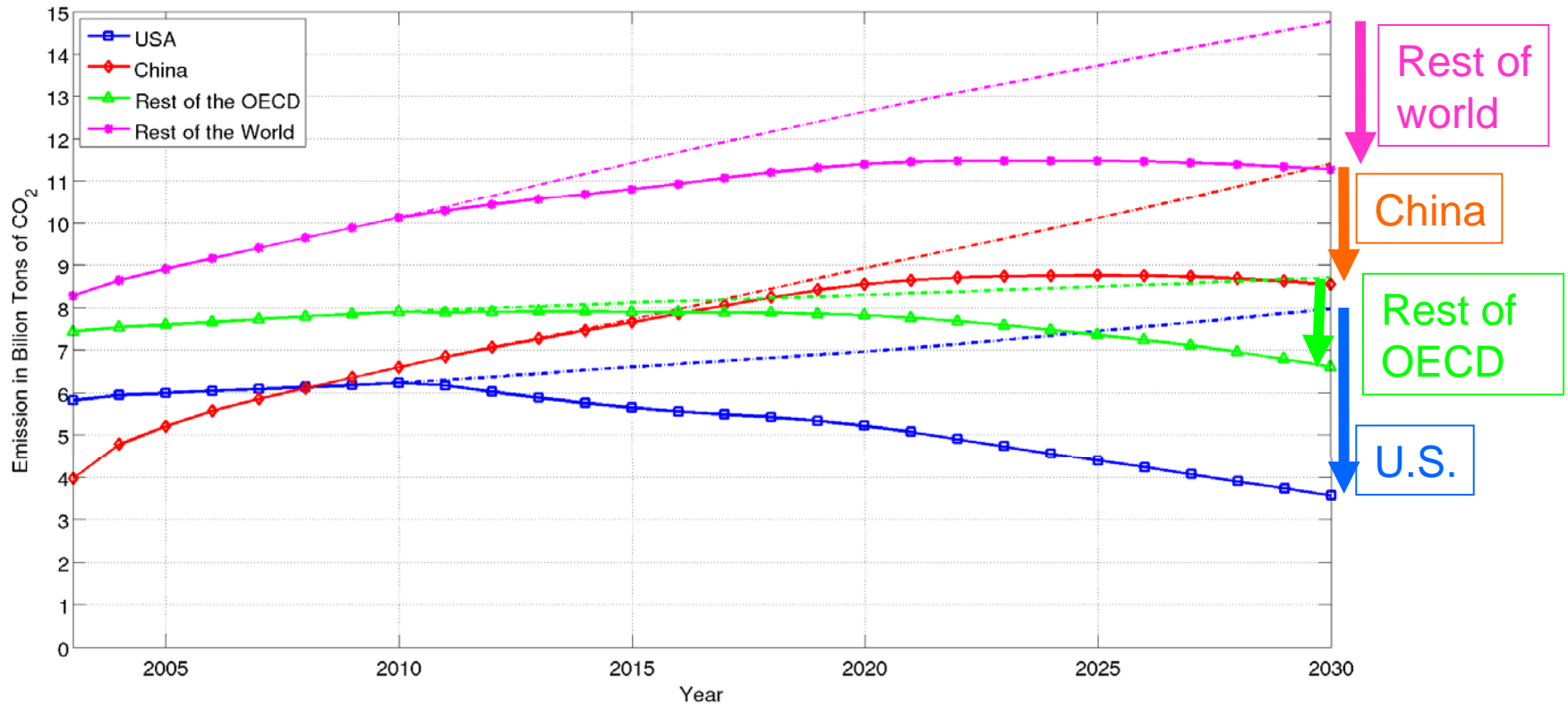


Regional emissions in 2030



For a 30 GtCO₂ global cap in 2030, four regions have comparable assignments

Might China and the U.S. reach a deal?

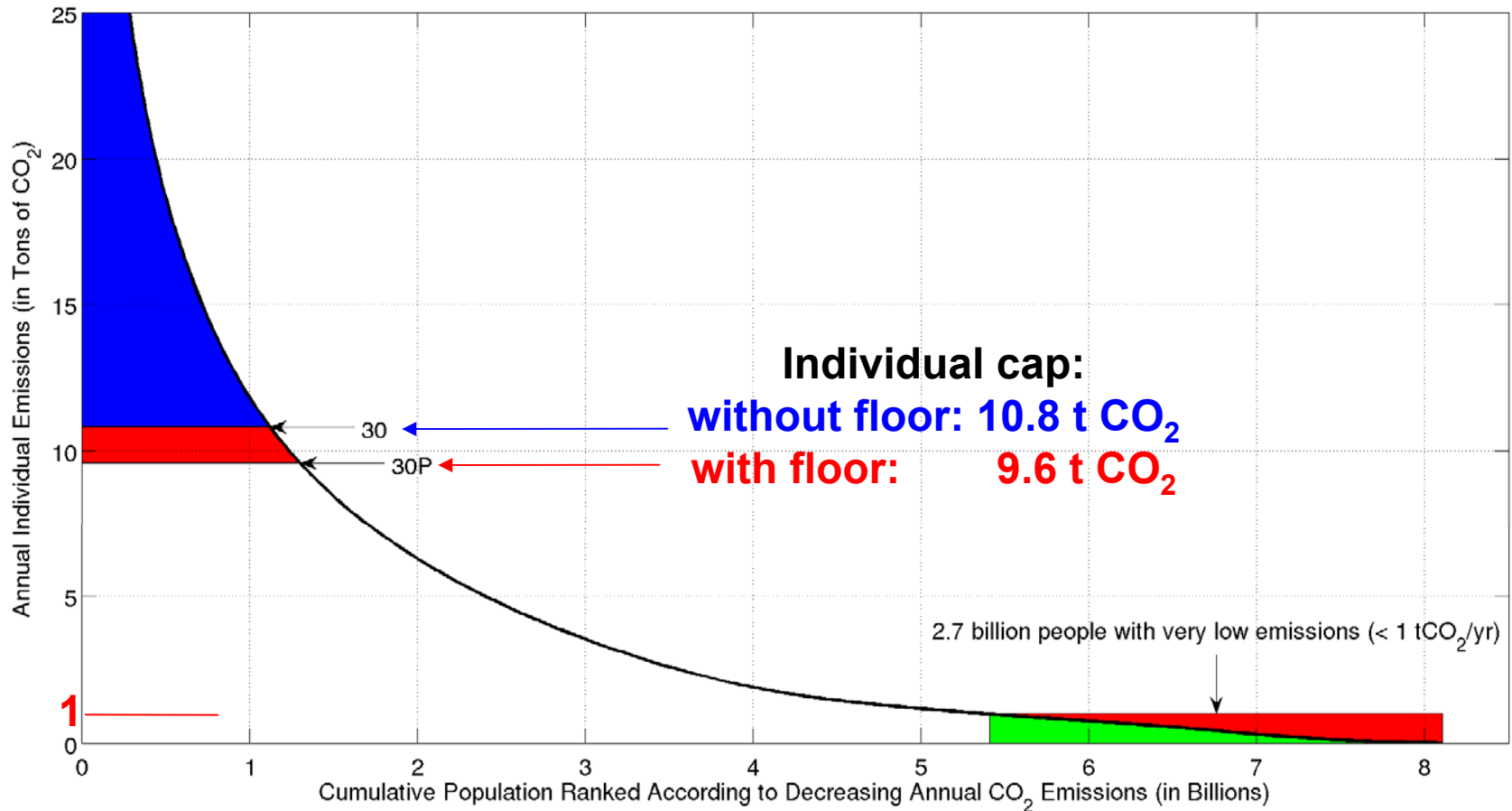


Dashed lines: EIA Business As Usual

Solid lines: Global cap is 30 GtCO₂ in 2010, 33 GtCO₂ in 2020, 30 GtCO₂ in 2030.

This scheme, based on individual emissions, results in much less international trade in CO₂ emissions than most other schemes.

Combine a global-emissions cap and an individual-emissions floor



The world's poor do not need to be denied fossil fuels

What does 1 tCO₂/person-yr allow today?

<i>Direct Energy Use</i>	<i>Household rate of use (4.5 people)</i>	<i>Individual emissions (kgCO₂/yr)</i>
Cooking	1 LPG canister per month	120
Transport	70 km by bus, car, motorbike per day	220
Electricity	800 kWh per year	160
<i>Total</i>		500

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

R-P countries will dominate global environmental problem- solving over this century

R-P countries are countries with a significant fraction of rich people sharing global consumptions patterns

and

abundant abject poverty.

Post-post-colonialism

The North-South relationship needs marriage counseling. Behaviors are driven by outdated assumptions. The two partners are not listening to each other.

The UNFCCC, like many post-colonial international institutions, created two-tier behavior. Annex I expresses guilt and affirmative action. We now need *post-post-colonial* institutions.

Every strategy can be implemented well or poorly

Every “solution” has a dark side.

Conservation

Regimentation

Renewables

Competing uses of land

“Clean coal”

Mining: worker and land impacts

Nuclear power

Nuclear war

Geoengineering

Technological hegemony

Risk Management: We must trade the risks of disruption from climate change against the risks of disruption from mitigation. We and our children and grandchildren will search for an optimum pace.

The U.S. Scene (1 of 2)

The Good News

Obama is personally interested. He gets it. He has surrounded himself with scientists as no President before him. "I'm a science guy."

The new team are veterans of the Bush climate wars and are in a hurry.

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The U.S. Scene (2 of 2)

Other News

1. Obama did not win by much. No one should assume that he will be reelected in 2012.
2. The ox gored by climate change is coal. Federalism allows coal to fight back.
3. Abundant, mischievous offsets are in the Waxman-Markey bill. They embody the belief in government *and the ngo's* that mitigation can be inexpensive.
4. The U.S. public mistrusts government and rejects transfers from rich to poor (Joe, the Plumber).

Grounds for optimism

- The world today has a terribly inefficient energy system.
- Carbon emissions have just begun to be priced.
- Most of the 2059 physical plant is not yet built.

Planetary identity

In the process of taking climate change seriously, we develop a planetary identity.

We augment our previous loyalties to family, village, tribe, and nation.

Never in history has the work of so few led to so much being asked of so many!

The “few” are the climate science researchers.

The “many” are the rest of us.

Understandably, we wish we lived on a larger planet, with a larger atmosphere so that our emissions would be less significant –

and also a planet with larger fisheries, bigger forests, more abundant ground water, so that *all* our actions mattered less.

Fitting on the Earth

But our planet, Earth, is the only one we have.

Fortunately:

Our science has discovered threats fairly early;

We can identify a myriad of helpful technologies;

We have a moral compass that tells us to care not only about those alive today but also about the collective future of our species.

What has seemed too hard becomes what simply must be done.