Sharing Global CO₂ Emission Reductions Among One Billion High Emitters

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with Laurence Tubiana
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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

Double the pre-industrial concentration

4000 GtCO₂

550 ppm

500 ppm

450 ppm

Up 2 ppm/yr

“2°C”

“3°C”

Atmospheric CO₂ Concentrations at Mauna Loa Hawaii

3000 GtCO₂

About half of the CO$_2$ we burn stays in the atmosphere for centuries.

Today, global per-capita emissions are $\approx 4$ tCO$_2$/yr.
Four ways to emit 4 ton CO$_2$/yr (today’s global per capita average)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Amount producing 4 ton CO$_2$/yr emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Drive</td>
<td>24,000 km/yr, 5 liters/100km</td>
</tr>
<tr>
<td>b) Fly</td>
<td>24,000 km/yr</td>
</tr>
<tr>
<td>c) Heat home</td>
<td>Natural gas, average house, average climate</td>
</tr>
<tr>
<td>d) Lights</td>
<td>300 kWh/month when all coal-power (600 kWh/month, natural-gas-power)</td>
</tr>
</tbody>
</table>
Per-capita fossil-fuel CO₂ emissions, 2005

World emissions: 27 billion tons CO₂

Source: IEA WEO 2007
“Stabilization”: 1 ton CO$_2$/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

Source: IEA, WEO 2007
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 CO$_2$ emissions legitimates five tons of future CO$_2$ 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.
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)
For ECPC-1850, per capita NonAnnex1 emissions along the 2040-2070 plateau roughly equal today's per capita Annex1 emissions (12 tCO$_2$/person-yr).
Integrated emissions, three start-times

CO₂ concentration in ppm

NA1 (ECPC 1850, 1950, 1990)

A1
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 CO$_2$ emission reductions among one billion high emitters

Shoibl Chakravartya, Ananth Chikkaturb,c, Heleen de Coninckc, Stephen Pacalaa,2, Robert Socolowa, and Massimo Tavonida,d


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From national income distributions to a global emissions distribution

1. Sum over all countries to generate a current emissions distribution for all the world’s individuals.
2. 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 CO$_2$ projections, assume regional emissions distributions are unchanged.
Ever more high emitters outside the OECD

- OECD
- Non-OECD

2003

- 500 million

2030

- 500 million
Count high-emitting individuals

2003, 26 GtCO₂

2030, 43 GtCO₂

2003, 26 GtCO₂

2030, 43 GtCO₂
Add the individual capped emissions to determine the national target

Personal Emissions Cap + + + + + = Required Reductions

National Emissions Target

Source: Steve Pacala, private communication, 2008
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 GtCO$_2$ in 2010, 33 GtCO$_2$ in 2020, 30 GtCO$_2$ in 2030.

This scheme, based on individual emissions, results in much less international trade in CO$_2$ 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?

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

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  Reglementation
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.
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.