Climate Science and Policy

Lecture 6

Climate Change Agenda

- **Today**: How would a global Czar (which economists like to assume) construct an efficient global climate policy – considering only total costs/benefits/risks?
  - Even for a Czar, this would be a hard problem!
- **Wednesday & Friday**: Without a Czar and even without a world government, can the nations of the world (YOU!) agree to a reasonable, if perhaps not fully efficient, climate policy?

What Do We Know? (I)

- Global Mean Temperatures are Rising

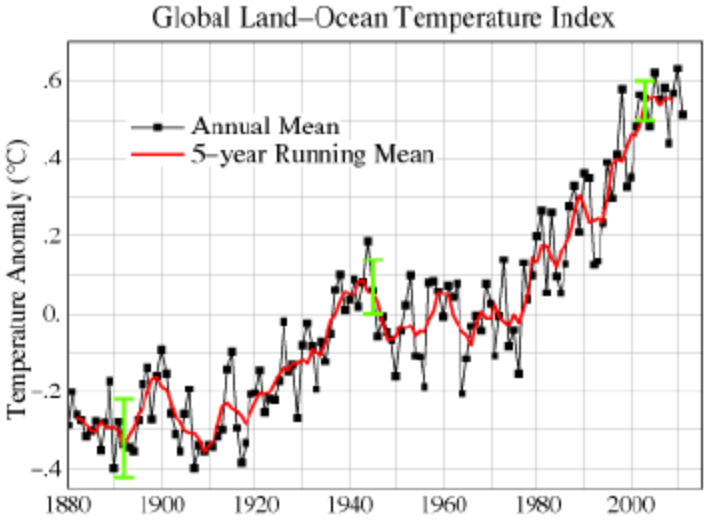


Figure 2. Global surface air temperature anomalies relative to 1951-1980 base period for annual and 5-year running means. Green vertical bars are 2σ error estimates (Hansen et al., 2010).

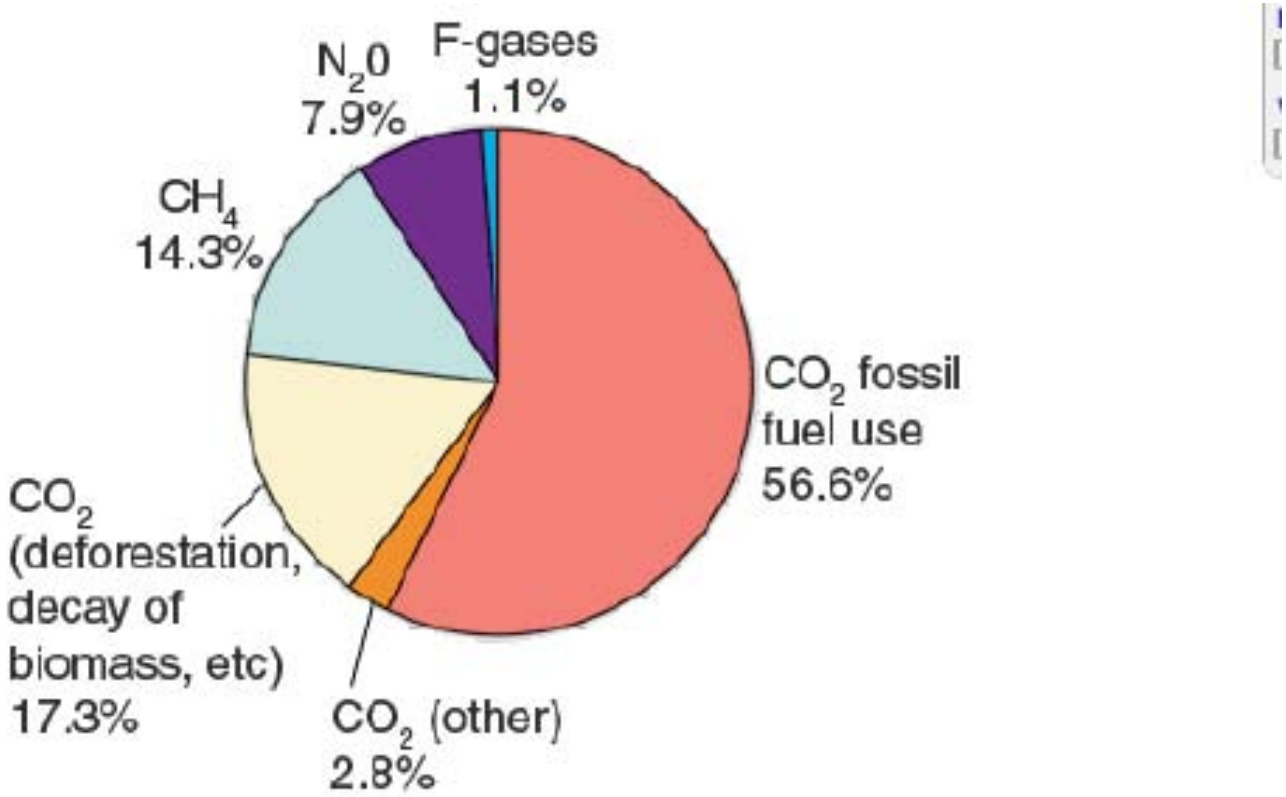
- Apparent slowdown in recent years likely reflects La Niña conditions plus a solar radiation minimum

Source: Hansen, J., R. Ruedy, M. Sato, and K. Lo. *Global surface temperature change*. Reviews of Geophysics, 48 (2010): 12.

What Do We Know? (II)

Strong evidence that human activity is a major cause

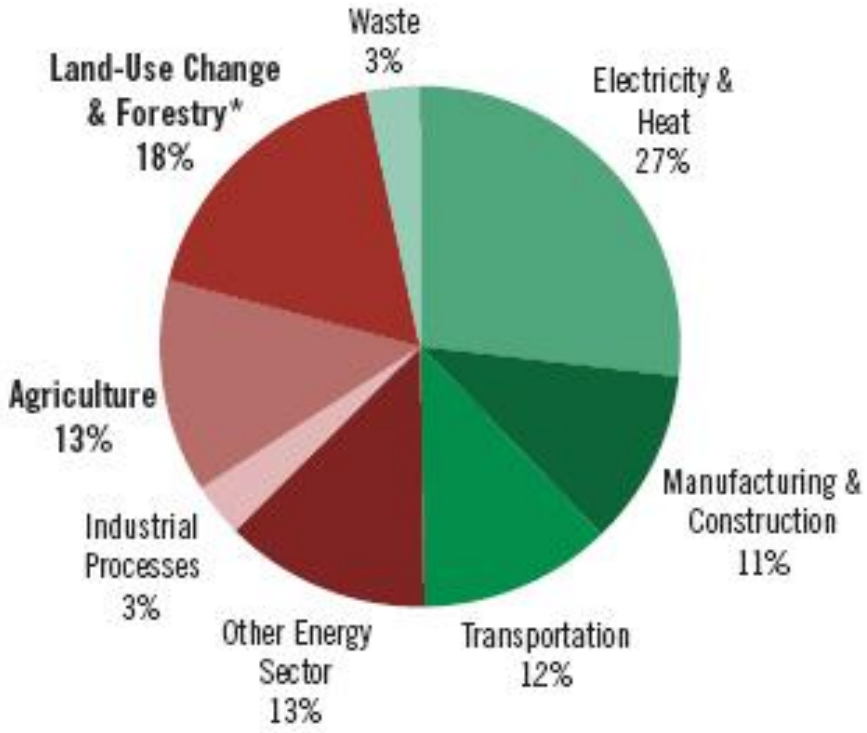
Global greenhouse gas emissions, 2004



Reference: IPCC 4th Assessment Report:Climate Change 2007: Synthesis Report

Source: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Figure 2.1. (b). IPCC, Geneva, Switzerland. This figure is in the public domain.

GHG Emissions by Sector, 2008

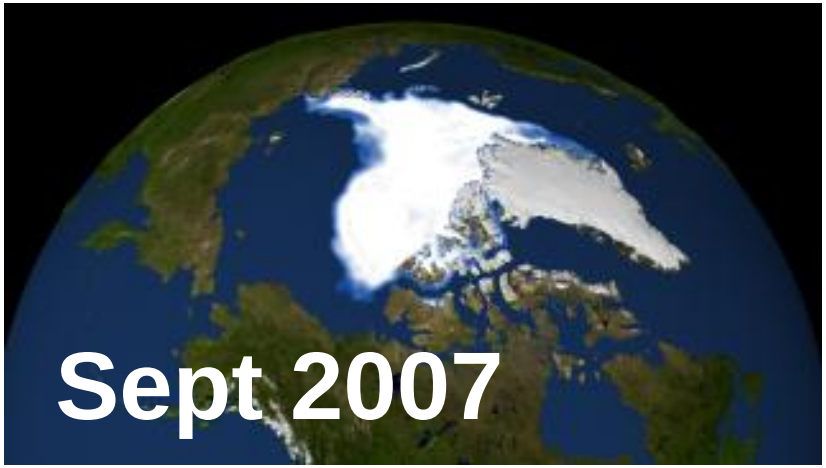


Policy debates focus on CO_2 from fossil fuels (mainly), cement, deforestation; important, easier to measure

Source: World Resources Institute. "Expanding Agriculture and **Protecting** Ecosystems: Can Payments to Farmers Accomplish Both?" *EarthTrends,* April 3, 2008.

What Do We Know? (III)

We have already seen some impacts of warming; there will be more if warming continues



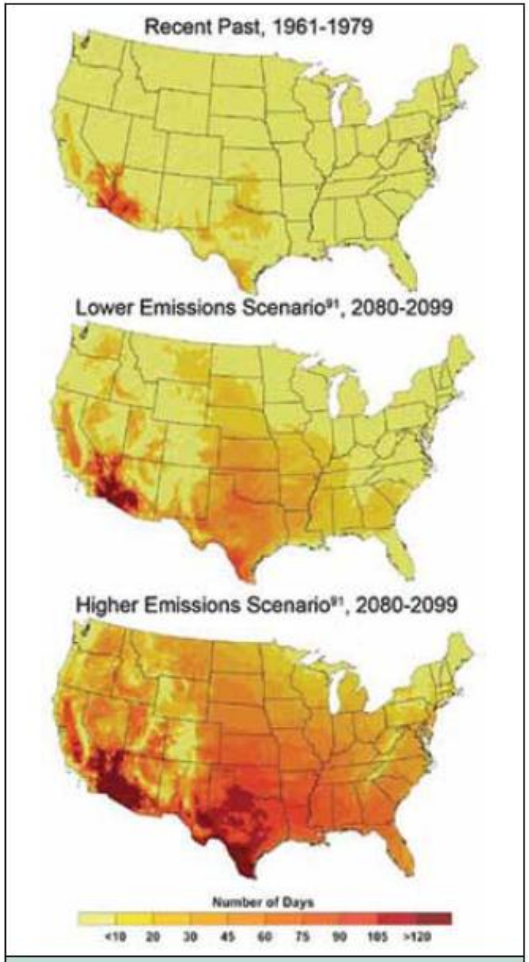


Figure 1. Higher emissions will result in more severe impacts. Models compare the number of days per year projected to exceed 100°F by the end of the century under a higher and lower emissions scenario.
Source: U.S. Global Change Research Program, 2009

Source: U.S. Global Change Research Program. *Global Climate Change Impacts in the United States*. Washington, DC: Government Printing Office, 2009, p. 16.

Why is this Problem Hard? Time-Scales

- Emissions of CO_2 have a half-life (not from exponential decay, but…) of around a century
- The earth is not in equilibrium with respect to *current* GHG concentrations; it takes lots of heat to warm the deep oceans, lots of time to diffuse
- Thus even if GHG emissions were cut sharply, concentrations would remain high & climate change would continue, with a variety of known and unknown damages, for decades
- Decisions thus involve time-scales of centuries: the Czar must decide how much to spend today to produce benefits far into the future and for people not yet born

Value Today of Preventing This Florida in 2112?

Courtesy of ACIA and Clifford Grabhorn. Used with permission.

Discounting and Future Generations

- Economists *disagree* about how to discount future benefits to set public policies; three views:
  - Use the rate the private sector would use, since public investments crowd out private investments
  - Discount future benefits by "pure rate of time preference" + because people will be wealthier over time (so marginal utility of $ lower)
  - Zero "pure rate of time preference" (don't discriminate among generations); discount only because people will be wealthier
- Illustrative rates are 7%, 3% (both US OMB), and 1% (Stern report). Value of $1 million in 100 years:
  - Discounted at 1% (xe^{-1}) $\Rightarrow$ $368,000
  - Discounted at 3% (xe^{-3}) $\Rightarrow$ $49,800
  - Discounted at 7% (xe^{-7}) $\Rightarrow$ $9,120 ("magic ray gun")

Why is this Problem Hard? Uncertainty

- Meaning of "uncertain" in technical v. popular discourse…
- Emissions GHGs depend on population, per-capital GDP, mix of economic activity, future policies, and present and future technologies – all of which are *uncertain*.
- Much is uncertain about the climate system – e.g., warming of the deep ocean, possible irreversibilities & tipping points – so global climate impacts of any given GHG emissions trajectory are *uncertain*
- Climate models disagree on regional effects (e.g., warming, rainfall) produced by given global changes, thus impacts *very uncertain*
- Regional impacts will likely take us into new ground & produce surprises (esp. in ecology), so damages are *very, very uncertain*!
- Little experience, historically, in successful adaptation to climate change (e.g., Mayans), so ability/cost of adaptation uncertain
- Costs of reducing damages via emissions reductions are also uncertain – depend on population, technology, etc.
- CAN'T CREDIBLY COMPARE COSTS & BENEFITS OF POLICIES

The Czar Needs to do *Adaptive* Risk Management

- Slow down to reduce the likelihood of a collision – **reduce GHG emissions**
- Lifeboat drills in case of a collision – **invest in adapting to climate change**
- *Station lookouts* – **study the evolving climate system, improve forecasts**
- *Develop maneuvering options* – **new technologies, geoengineering**
- *Ensure lookouts are heard* – **build responsive decision processes**
- ***Probabilities unknown; judgment & risk-tolerance must drive decisions***

Adaptation is Essential, but tricky

- Reactive = suffering; proactive = using information about future change to guide investment decisions
  - Water supply, agriculture, seawalls, disaster preparedness…
  - Key: past weather patterns can't be assumed to hold
- Problem 1: climate models differ in the small-scale predictions that matter
  - E.g., agriculture in Ethiopia either much dryer or much wetter
  - Seek robust policies: pave roads to avoid washout, ok if dry
- Problem 2: investments are made at state & local levels and in developing nations; expertise lacking
  - Important federal coordination, research, education roles
  - Poor nations will be hardest hit; aid, national security issues

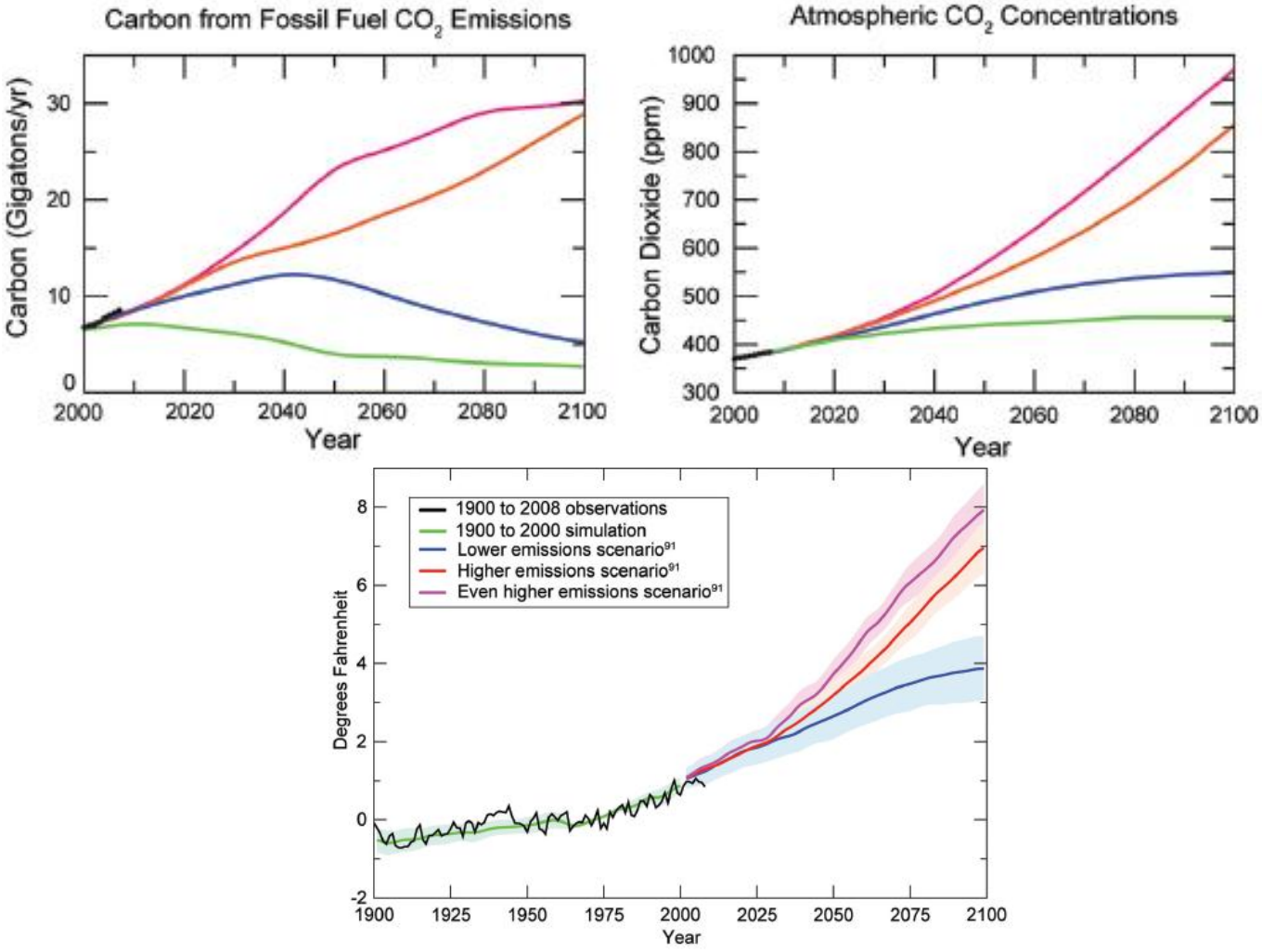
New Technologies are Essential, but…

- Governments have a role in supporting basic research, here as elsewhere
- Governments (esp. in the US?) have a *terrible* record of developing competitive civilian technologies
  - Government seems to experiment too little, stick with popular approaches too long, confuse technical & economic issues…
  - A much discussed "government failure"; no obvious fixes
- Winning combination seems to be government support for basic work, technical education plus industrial R&D to make real products – more later
  - But industry won't invest in R&D without reasonable expectations of a market for the final product (other policies)
- So MUST reduce emissions…

Why the Policy Focus on CO_2 Emissions from Fossil Fuels in the Near Term?

- Geoengineering (e.g., artificial volcanoes) lets ocean acidification continue, many unknowns; harder as emissions increase
- CO_2 is the main component of greenhouse emissions, emissions stay in the atmosphere for ~100 years
- 75-85% of CO_2 emissions come from fossil fuels, & these emissions are *relatively* easy to monitor (v. other gases, land use)
- The world's energy system represents a $15 trillion capital investment that takes 30-40 years to turn over (plus other path-dependent stickiness), so near-term decisions can have long-term emissions effects

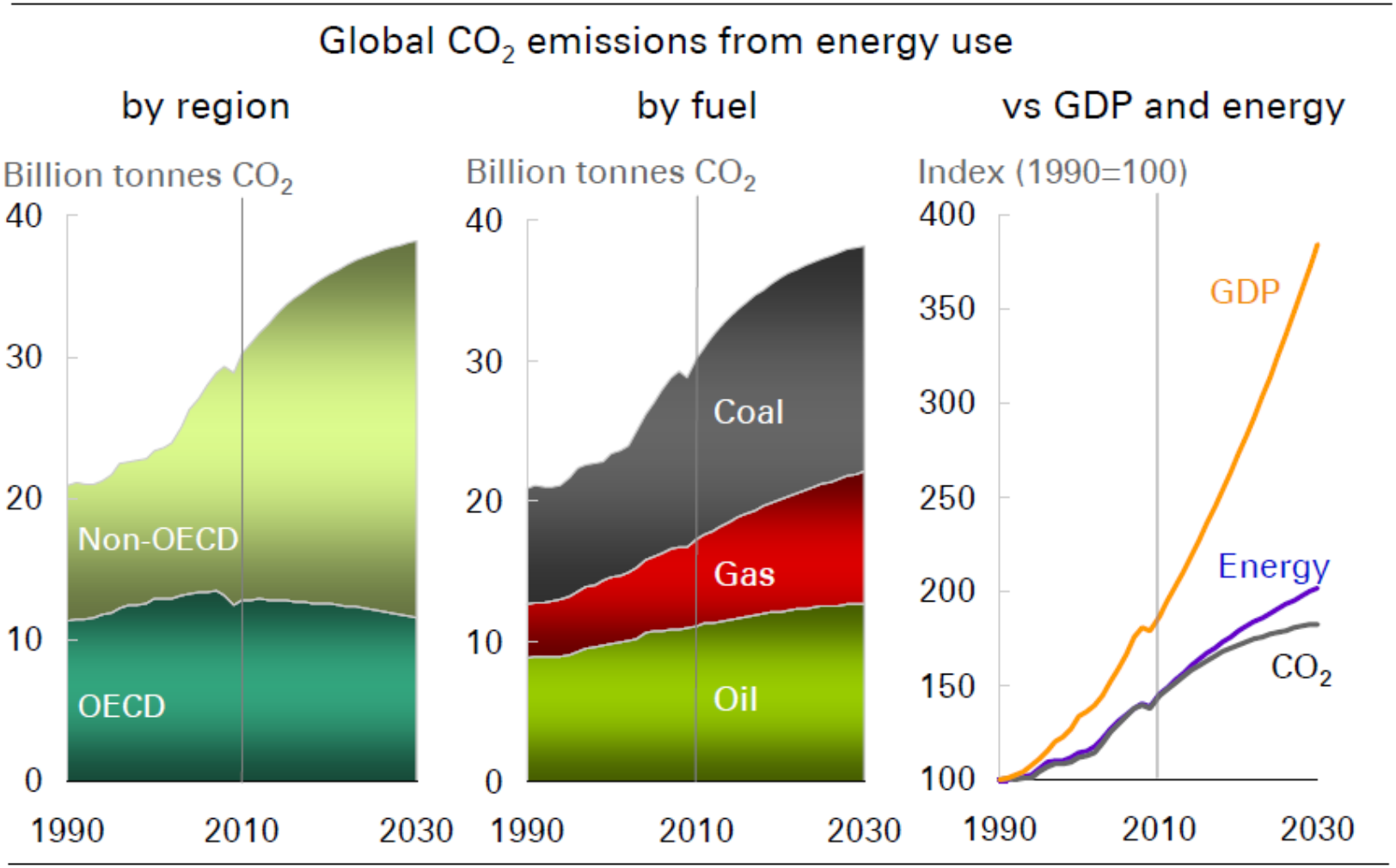
Why is That Problem Hard? The World Runs on Fossil Fuels, Big Emissions Cuts Needed to Limit ΔT



Why is this Problem Hard? Poor Countries

- Picking a goal – e.g. to decide to stabilize CO_2 at 550 ppm by 2050 – roughly fixes global emissions "budget" until then because of CO_2's long lifetime
- Want to make cheap reductions ASAP to avoid the need for draconian cuts later to meet the "budget"
- Want to raise intensity over time as new technologies come on line, existing capital stock wears out
- ***Czar's modelers: to minimize global costs, developing nations must make significant cuts versus "business as usual"***

Why Must the Poor Cut? They Will Drive Growth!



Courtesy of BP Energy Outlook 2030, January 2012. Used with permission.

Why Must the Poor Cut? To Reduce Global Costs

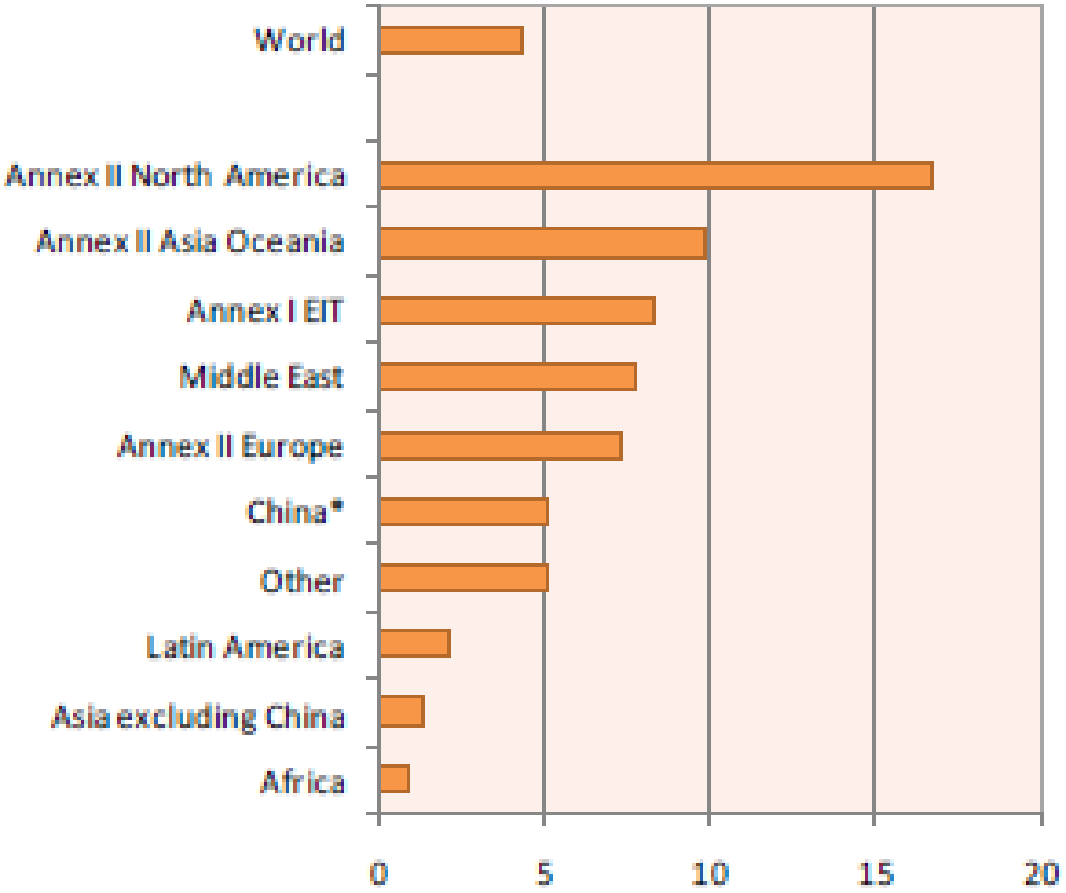
- Principle (between and within countries): To minimize total cost, want to equate marginal cost across countries (or whatever)

  Suppose national costs of reduction are $C_i(r_i)$, I = 1, …, N.
  Czar: min ΣC_i subject to $\Sigma r_i = R$. Necessary: $MC_i = \lambda$, all i.
  - A competitive market $\Rightarrow$ p = mc for all producers; yields efficient production
  - Same principle applies to a firm producing from multiple plants

- How to do it? Two approaches (more later):
  - Put a price on emissions; all reduce until p = mc
  - Cap & trade: price of allowances serves the same function (Parsons et al)

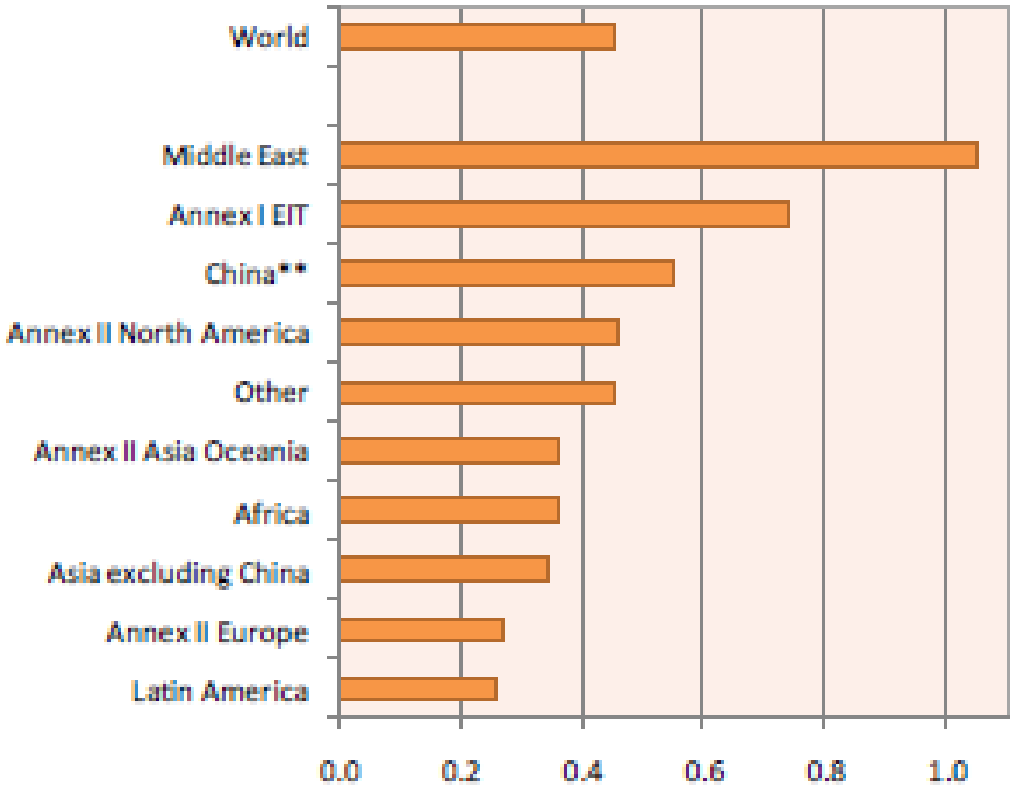
- Why are poor countries' costs of abatement relatively low?
  - They are building more new facilities, buildings, etc.; it is generally cheaper to make new facilities, etc. efficient than to retrofit old facilities
  - Much energy use in poor countries is now dirty and inefficient, so the net cost of making it clean (which has benefits) and efficient is relatively low

BUT – IS IT FAIR? Emissions per capita:



Metric tons CO_2 from fossil fuels per capita, 2009.
Source: International Energy Agency

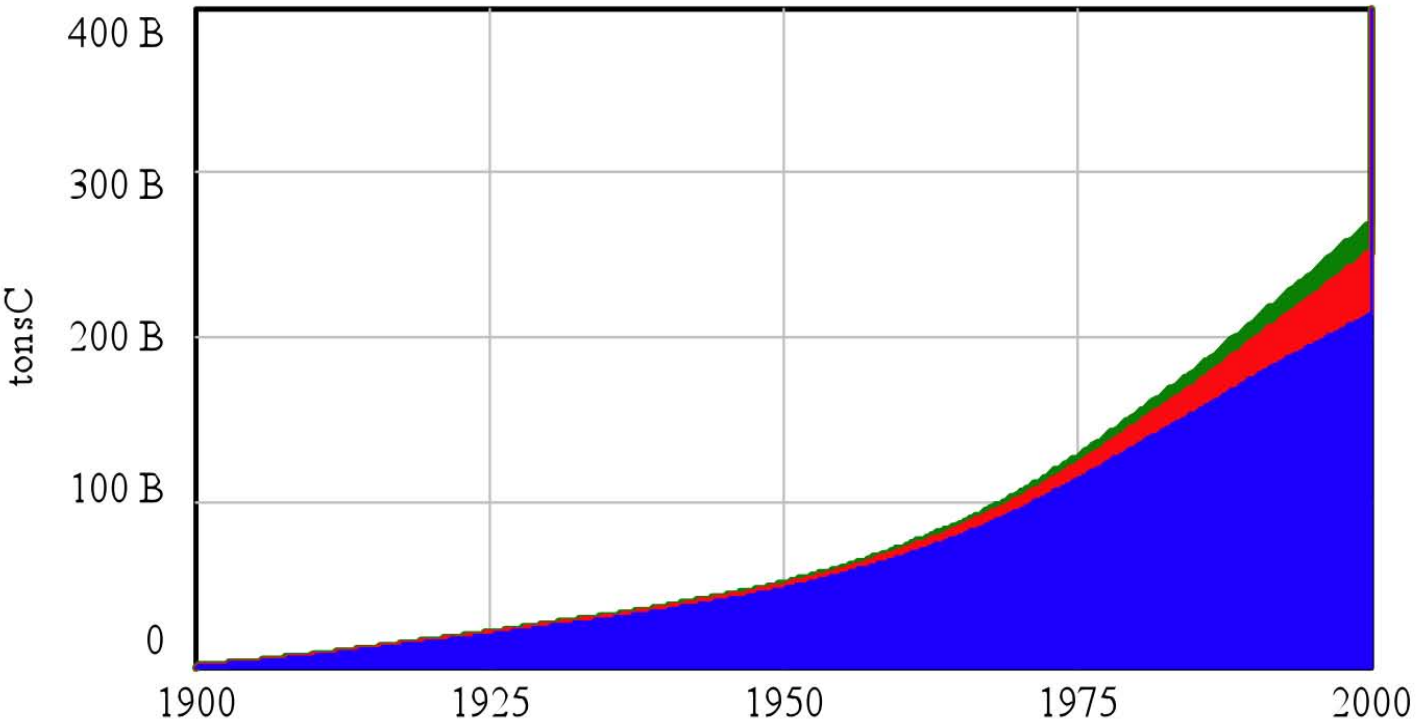
But what is fair? Emissions per $GDP:



Kg of CO_2 from fossil fuels per $US of GDP, 2009. Source: International Energy Agency

BUT – IS IT FAIR? Who made the problem?

Cumulative CO_2 emissions from fossil fuels – rich countries' contribution is blue



Poor Countries have prevailed, so far

- **Since 1992, there have been 17 conferences of the parties to the UNFCC (COPs), most recently in Durban, South Africa**
- **COP 3 in 1997 produced the Kyoto Protocol, calling for Annex I nations (mainly rich) only(!) to make reductions in 2008-12; others resisted even promises to promise one day…**
- **The EU & others ratified; the US did not, and President George W. Bush formally rejected the Protocol in 2001**
  - **The EU established a CO_2 emissions trading system (EU ETS), may make its goal; others likely will not do so**
- **Subsequent COPs have failed to produce a global agreement on emissions, & the US won't pass emissions-limiting legislation any time soon**

The Czar could solve the fairness problem & maintain efficiency by taxing the rich and using the proceeds to pay for the poor's emissions reductions…

But, sadly(?), there is no Czar

It's All Up to Your COP,

Wednesday & Friday!

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