Fall Term - 2013

Woodrow Wilson School 585b

Living in a Greenhouse: Technology and Policy

Robert Socolow

Phil Hannam, AI

Week Six

October 16, 2013

Personal emissions

National and subnational policies

James Hansen visit

Next four classes

L4 (October 7, Monday last week)
Fossil energy below ground (begun in L3)
Conversion of fossil fuel into electricity, vehicle fuel, and heat

L5 (October 9, Wednesday, last week)
AR5 WG1 SPM (drawing on your First Papers)
Personal energy use
    One billion high emitters
    Poverty

L6 (October 16, today)
Personal energy use
    Your own, drawing on your Second Problem Sets
National and regional energy strategies
Guest at 3 pm: Jim Hansen

L7 (October 21, next Monday)
Phil Hannam: International governance and the climate regime

BREAK WEEK (L8 is November 6, 16 days later)

Discuss Problem Set 2: Your carbon footprint

What did you learn:

What surprised you?

What did you decide you needed to learn more about?

Let's list the topics you explored. Here's my guess:

Transport. Personal car vs. bike. University bus system. Car vs. plane.

Indoor living:

Electricity. Power for your refrigerator, lights, computer.

Food. "Food-miles" for what is sold at Hogie Haven or served by the University.

Discuss Problem Set 2: Your carbon footprint (p. 2)

Phil's additions:

Can you distinguish primary, secondary, and tertiary emissions?

How does this exercise relate to consumption-based emissions (a la Davis and Caldeira)?

Have you considered "social" emissions, associated with no-one specifically (such as the street lights in their neighborhoods)?

What about waste emissions?

How do we want to use our time with James Hansen?

Phil:

Get into fresh territory, relative to his earlier discussions with many of you.

Ask him about models and modelers.

Required readings for Week 7 International cooperation (Hannam) (1 of 2)

International cooperation and collective action:
Olsen, M. (1965). The Logic of Collective Action: Public Goods and the Theory of Groups. Harvard University Press. [Read Introduction pp. 1-4]

Barrett, S. (2003). Environment and Statecraft: The Strategy of Environmental Treaty-Making: The Strategy of Environmental Treaty-Making. Oxford University Press. [Chapter 3 on Transnational Cooperation Dilemmas: pp. 49-84; the entire book is excellent!]

Aldy, J. and Stavins, R. (2007). Architectures for agreement. Cambridge Univ Press. [Read Introduction pp.1-30]

Keohane, R. O., & Victor, D. G. (2011). The Regime Complex for Climate Change. Perspectives on Politics, 9(01), 7-23.

Required readings for Week 7 International cooperation (Hannam) (2 of 2)

Financial mechanisms and institutions:

Ghosh, A. and Woods, N. (2009). "Developing Country Concerns about Climate Finance Proposals: Priority, Trust, and the Credible Donor Problem." In

Stewart, R. B., Kingsbury, B., & Rudyk, B. (Eds.). (2009). Climate finance: Regulatory and funding strategies for climate change and global development. NYU Press.

Wara, M. (2007). "Is the global carbon market working?" Nature 445: 595-596.

DeSombre, E. and Kauffman, J. (1996). "The Montreal Protocol Multilateral Fund: Partial Success Story". in Keohane, R. and Levy, M.A., ed. "Institutions for Environmental Aid: Pitfalls and Promise." The MIT Press. [Chapter 4, pp. 89-126]

Recommended readings for Week 7 International cooperation (Hannam)

Dubash, N. K., & Florini, A. (2011). Mapping global energy governance. Global Policy, 2(s1), 6-18.

Haas, P. M., Keohane, R. O., & Levy, M. A. (Eds.). (1993). Institutions for the earth: sources of effective international environmental protection. The MIT Press. [Read Chapter 1, pp. 3-24].

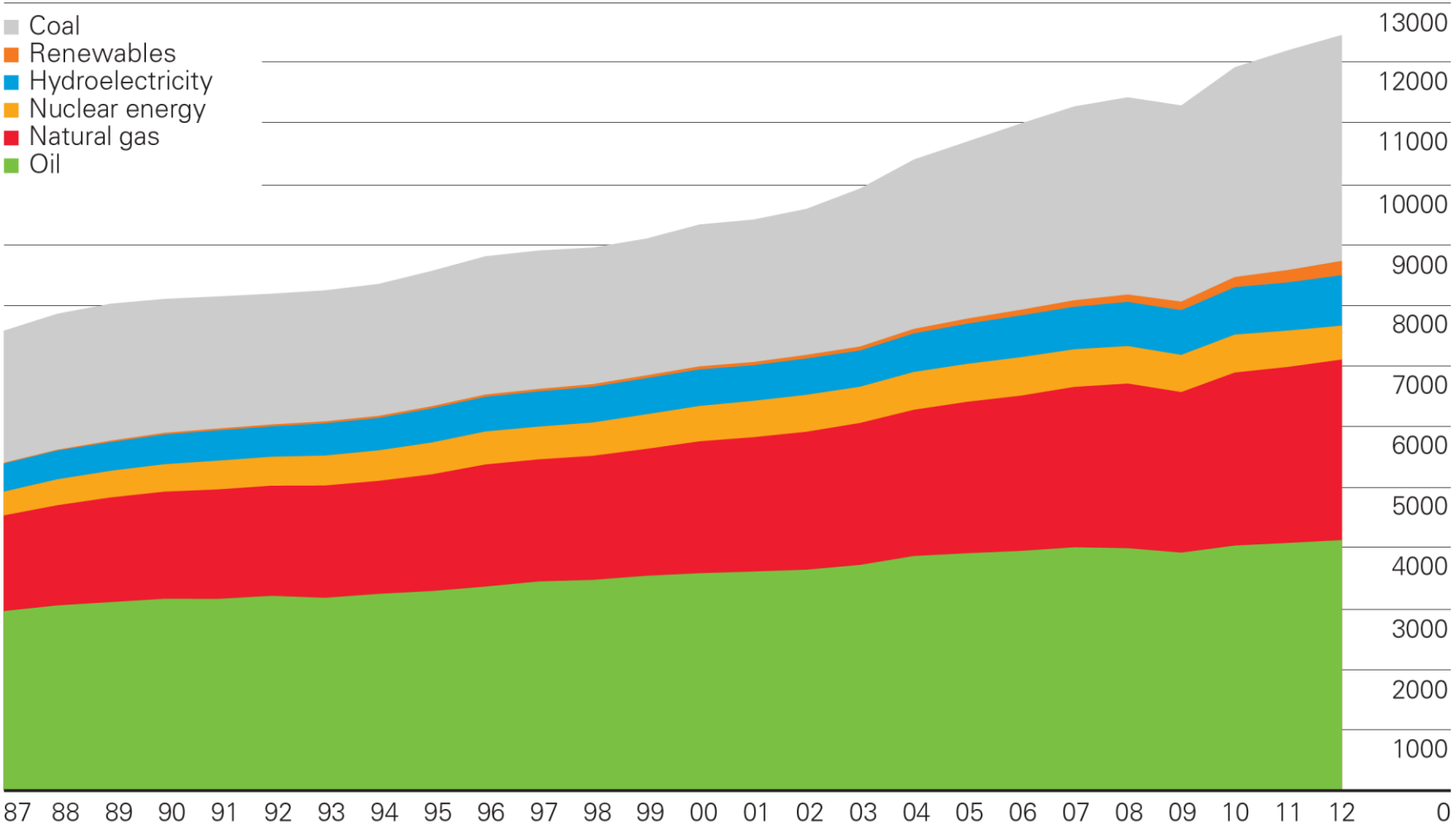
Downs, G.W., Rocke, D.M. and P.N. Barsoom (1996). "Is the good news about compliance good news about cooperation?" International Organization 50(03): 397-406.

Barrett, S., & Dannenberg, A. (2012). Climate negotiations under scientific uncertainty. Proceedings of the National Academy of Sciences, 109(43), 17372-17376.

Climate Policy Initiative (2012) "The Landscape of Climate Finance 2012". Available online: http://climatepolicyinitiative.org/wp-content/uploads/2012/12/The-Landscape-of-Climate-Finance-2012.pdf

Primary energy world consumption

Million tonnes oil equivalent



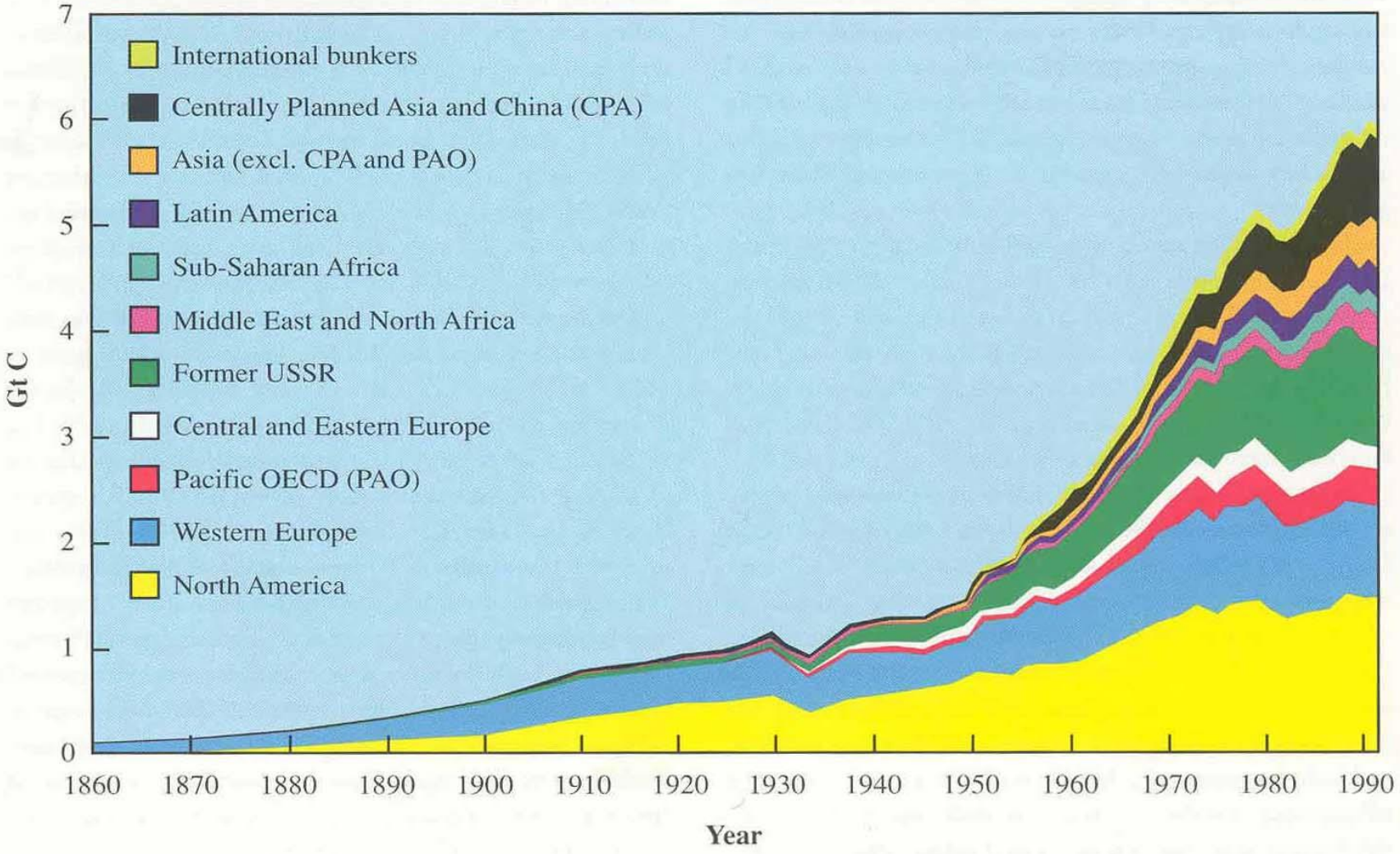
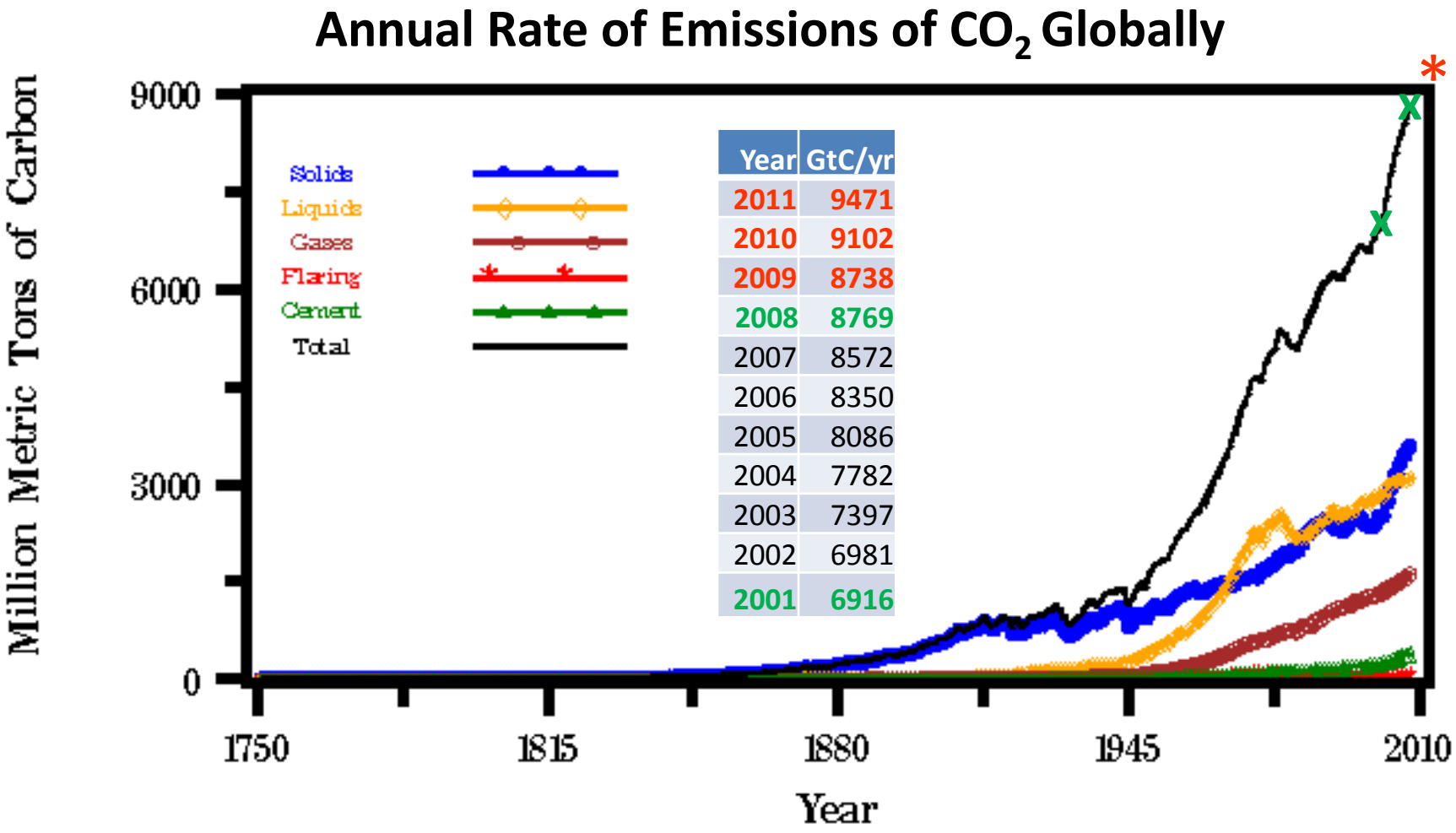


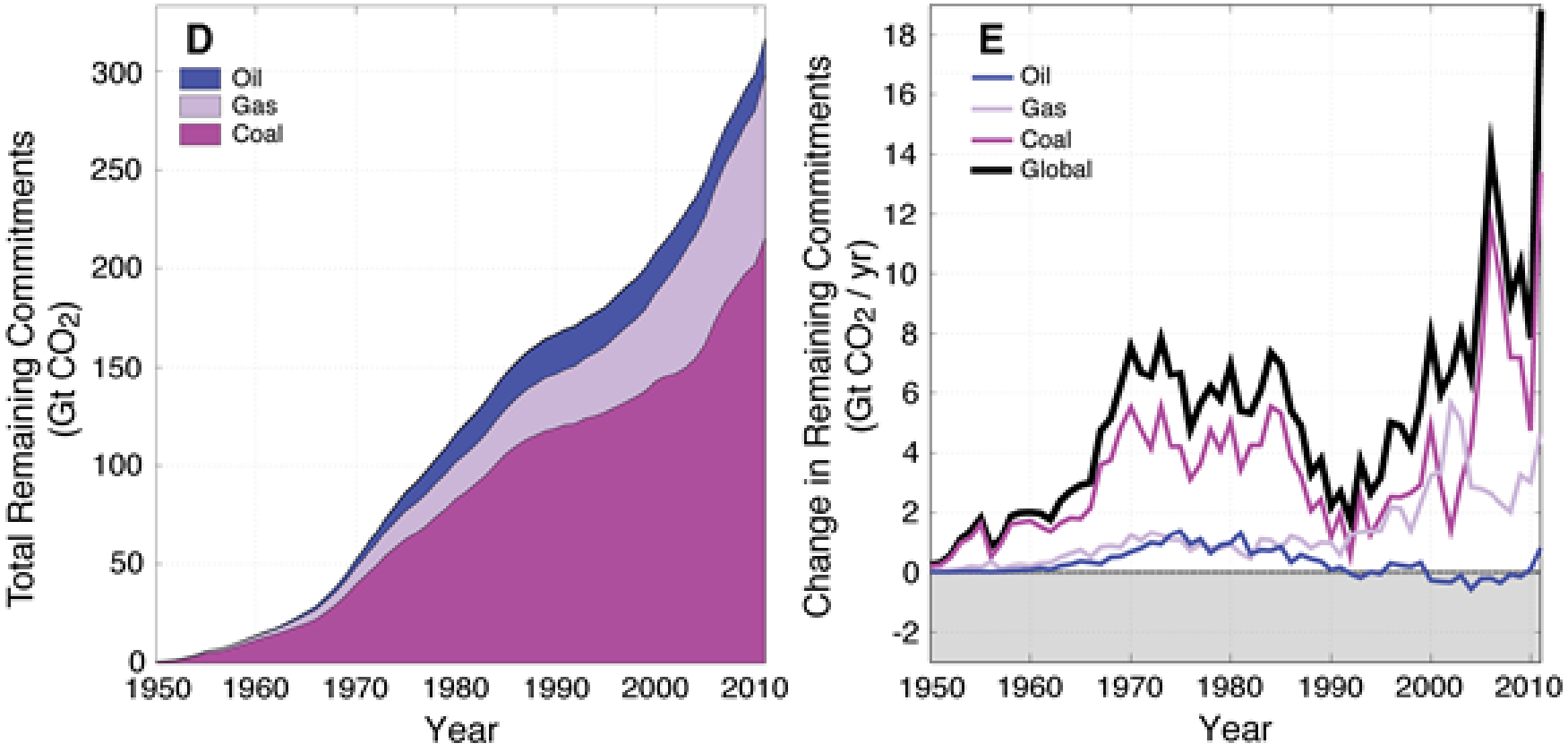
Figure 4: *Global energy-related CO_2 emissions by major world region in Gt C/yr (see the Energy Primer in the Working Group II SAR volume).*

Emissions keep rising



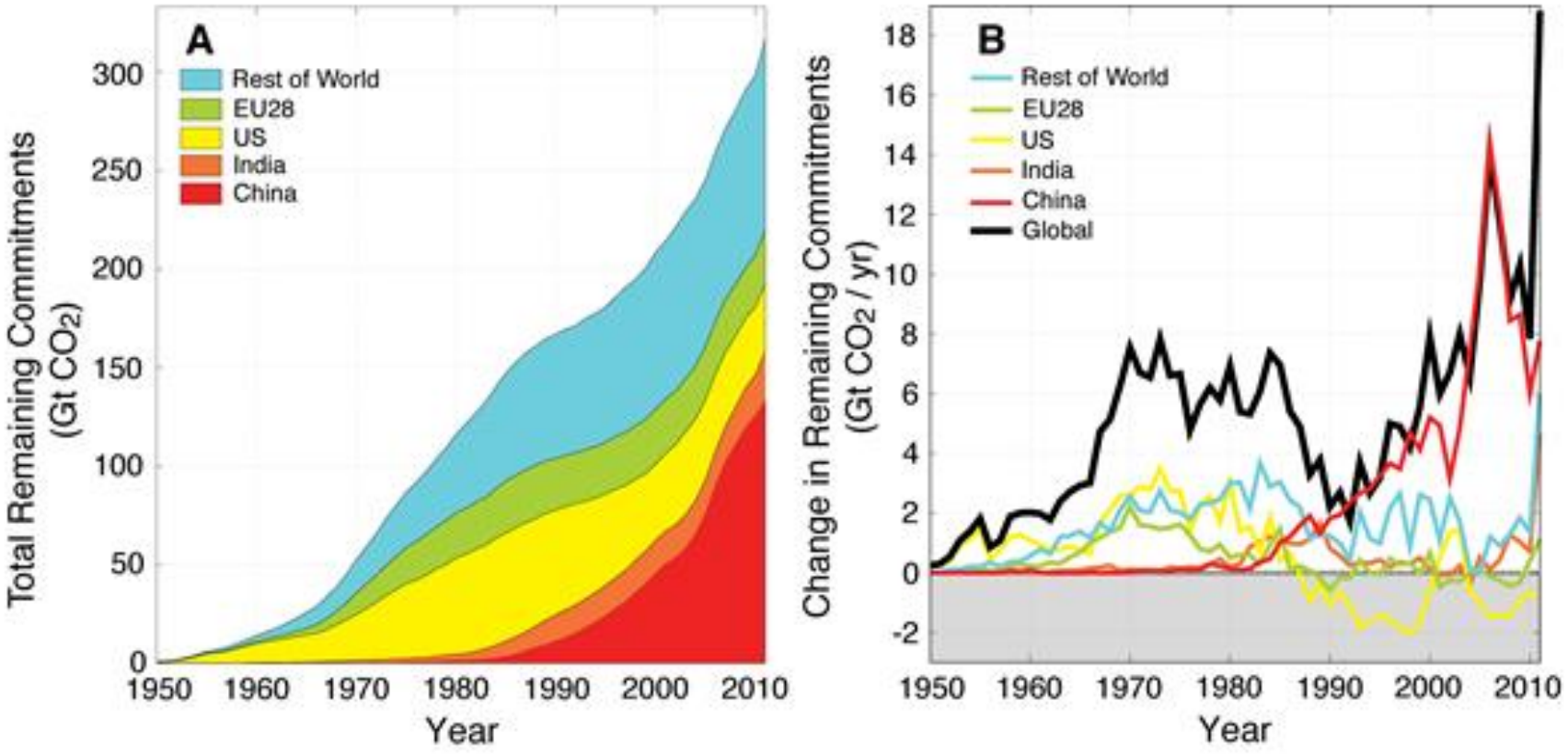
Source (accessed 10/1/11): http://cdiac.ornl.gov/trends/emis/glo.html.
Updated 1/5/13

Committed emissions keep rising: coal and gas for power (fuels view)



No sign of saturation. Rather, an acceleration in commitments to future emissions.

Committed emissions keep rising: coal and gas for power (regional view)



Note: The U.S. reduces its remaining commitments (negative values in panel B) when, as a "post-industrial" country, it runs on already-built plants. *Note also*: U.S. "rush to gas," 2000-2005.

How do we bend these curves?

Three ways:

Be very smart, so no policy is needed.

"S < C " (solar is cheaper than coal).

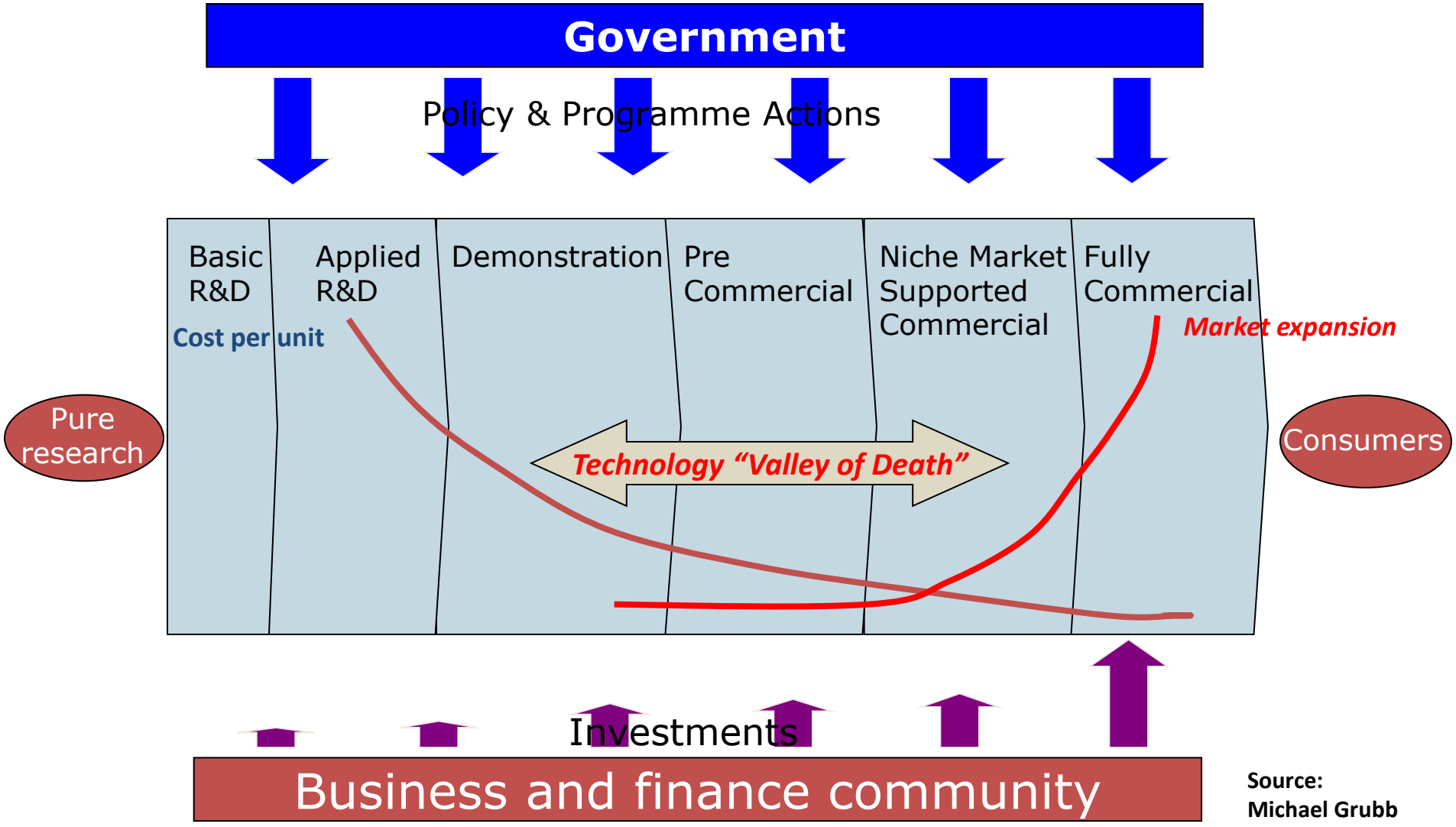
Regulatory policy and referenda: Forbid and require.

Market-based policies: Change relative prices.

Research and development (R&D) is an important and contentious policy arena

How much?
How close to market: “pre-competitive” vs. “picking winners”?
The Valley of Death

The Technology Innovation Chain – from R&D to Market



Source: Michael Grubb

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Regulatory issues ("Command and Control")

Rules and standards

- Framing (e.g., concentration vs. absolute amount – "the solution to pollution is dilution")
- Timing

Subsidies and penalties

- Fines to automakers and Corporate Average Fuel Economy (CAFE)
- Production tax credit (PTC), Investment tax credit (ITC)

Regulation of electric utilities

- Regulated and deregulated states
- Best available control technology (BACT)
- Public Utilities Regulatory Policy Ace (PURPA) and "avoided cost"
- Dispatch rules
- Net metering

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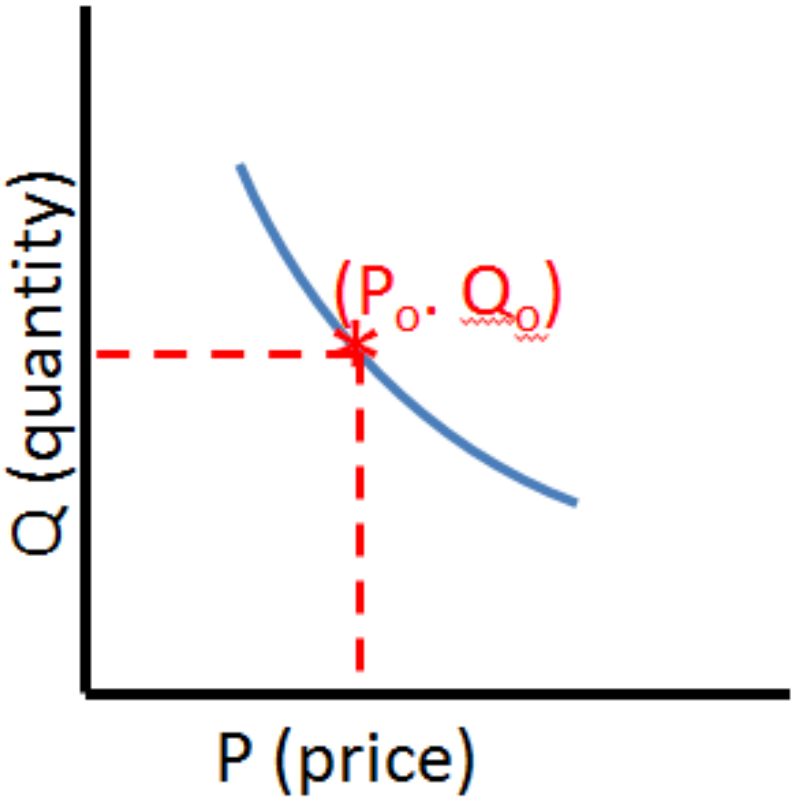
Ideal cap-and-trade = Ideal tax

Cap-and-trade and tax in their pure forms are identical.

Assume Q(P) exists:

Cap-and-trade: Fix Q_o, then find P_o.

Tax: Fix P_o, then find Q_o.



Design issues in cap and trade (and in most other market mechanisms)

System boundary and offsets

Schedule of cap reductions or tax increases

Mixed strategies (the collar)

Fines for non-compliance (the stick)

Auction or give for free? (the carrot)

Iteration: How soon? How often.

Iterative risk management

In another decade we'll know a lot more about the earth, both because of new climate science and because of what the earth tells us about itself.

We'll also know more about the solutions themselves, thanks to both R&D and field experience.

All this argues for making decisions *iteratively*.

> Specifically, we can wait at least a decade before deciding whether 1) flat emissions are as heroic an outcome as we can achieve safely and equitably, or 2) whether we can achieve still more.

One must also invest in adaptation

Vexing problem: How to apportion effort between mitigation and adaptation.

Adaptation can be organized by:

- The threat (extreme events, chronic change)
- The sector most affected (farmers, the elderly, the poor)
- The level of government most appropriately involved
- Structural (dikes) vs. non-structural (land use zoning, evacuation) responses

The adaptation literature is sparse. I have been told often that a wedge model for adaptation is needed. What people mean is that disciplined thinking and typologies are needed. I see a paper here for one of you.

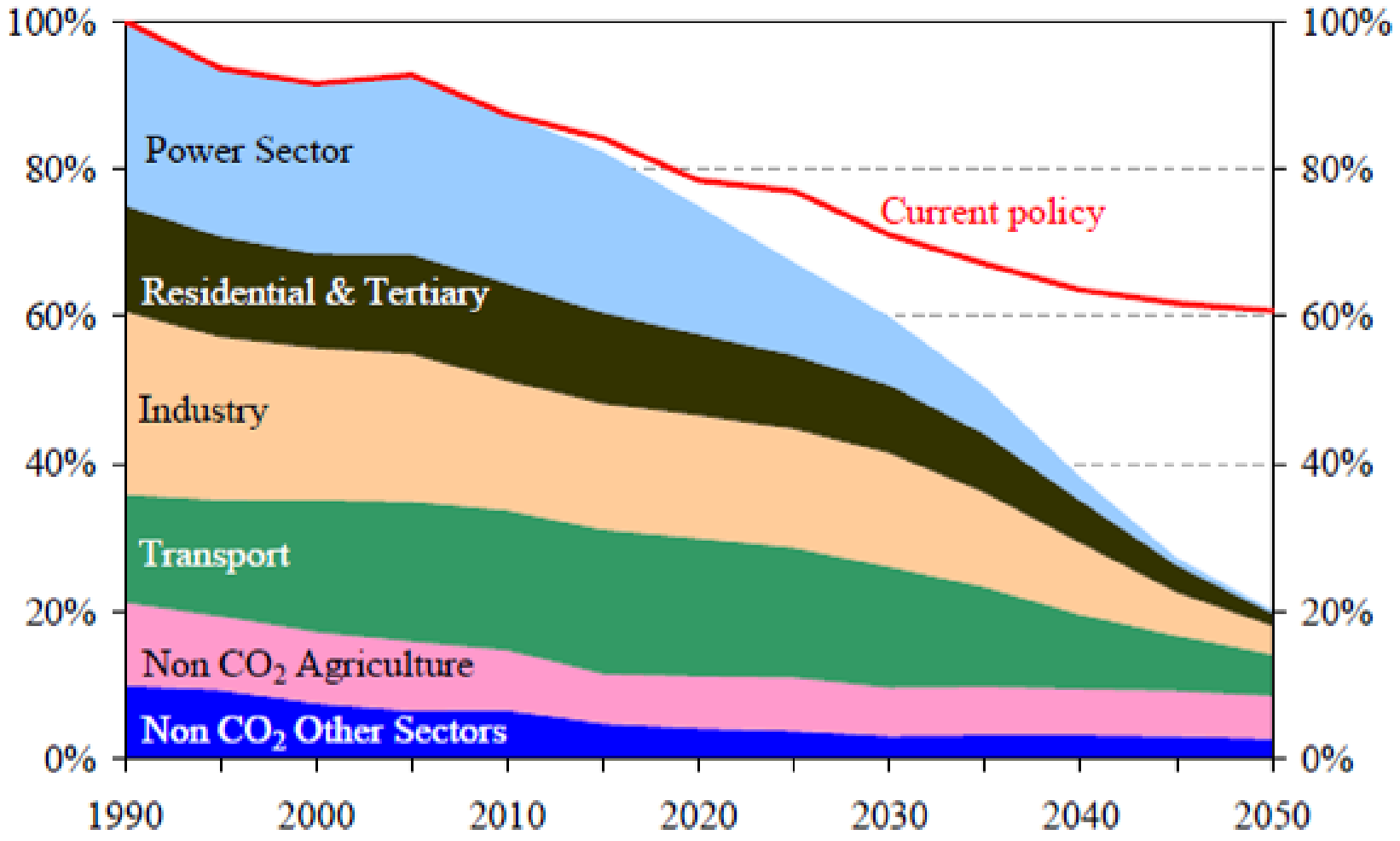
And one must set goals and make promises

Targets

- Long-term or interim?
- “Aspirational” or with compelling carrots and sticks?
- Conditional on the behavior of others?

Scenarios and road maps are important tools for exploring self-consistency.

Figure 1: EU GHG emissions towards an 80% domestic reduction (100% =1990)



Fonte: Roadmap for moving to a low-carbon economy in 2050
http://ec.europa.eu/clima/policies/roadmap/index_en.htm

America's Climate Choices

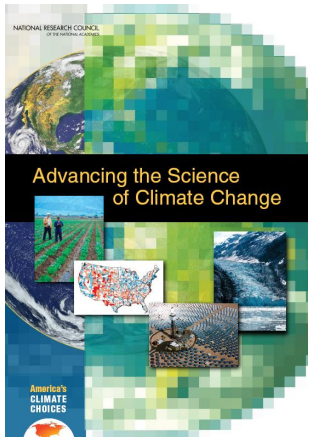
A congressional initiative in 2008 to:

> **"…investigate and study the serious and sweeping issues relating to global climate change and make recommendations regarding what steps must be taken and what strategies must be adopted in response to global climate change, including the science and technology challenges thereof."**

***Products already*: A summit (March 2009), four reports from "panels," and a Final Report from the overarching "*Committee on America's Climate Choices*" (of which I was a member).**

Information at http://americasclimatechoices.org

Four panel reports

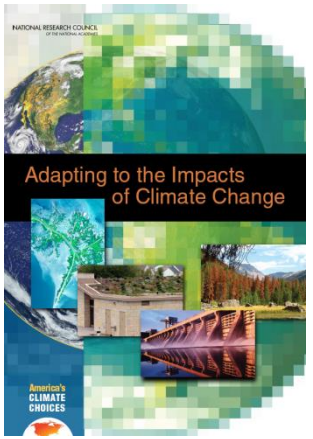


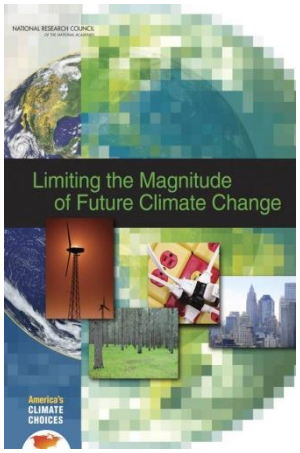
Advancing the Science of Climate Change

"Science panel"

Adapting to the Impacts of Climate Change

"Adapting panel"



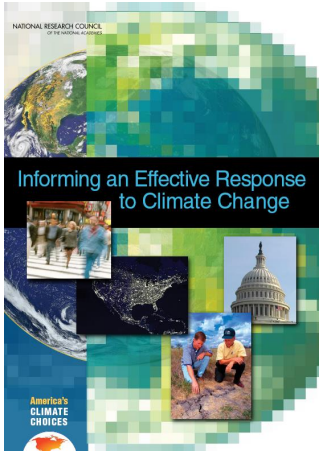


Limiting the Magnitude of Future Climate Change

"Limiting panel"

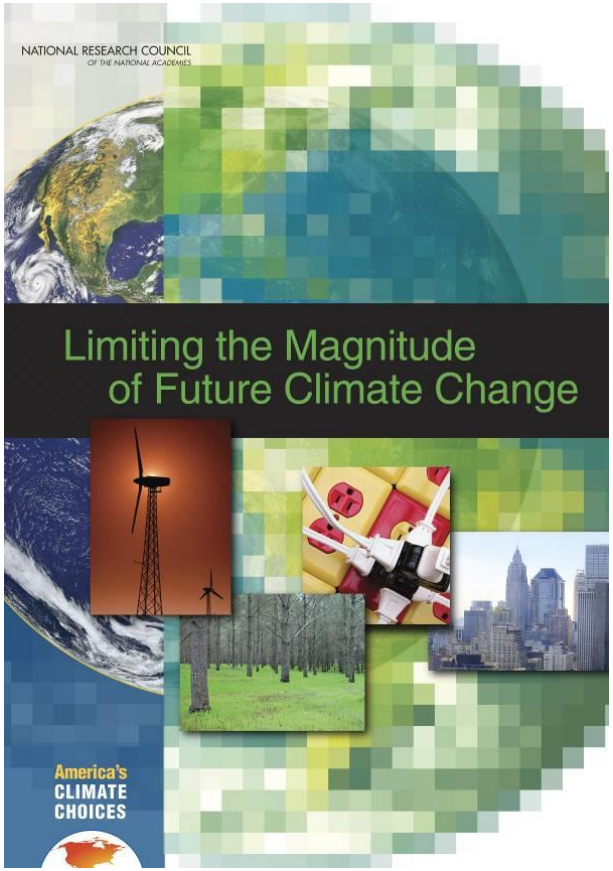
Informing an Effective Response to Climate Change

"Informing panel"



Available at http://www.nap.edu

Limiting Panel: Prompt, sustained efforts



A robust U.S. response requires:

- **An inclusive national framework for aligning the goals and efforts of actors at all levels**
- **Aggressive pursuit of all major near-term emission reduction opportunities *and* R&D to create new options**
- **Iterative management of policy responses**

Limiting Panel: Recommendations*

1. **Adopt a mechanism for setting an economy-wide price on carbon.**

2. **Complement the carbon price with policies to:**
   - Realize the practical potential for energy efficiency and low-emission energy sources;
   - Establish the feasibility of carbon capture and storage and new nuclear technologies;
   - Accelerate the retirement, retrofitting or replacement of GHG emission-intensive infrastructure.

3. **Create new technology choices by investing heavily in research and crafting policies to stimulate innovation.**

***first three of seven recommendations**

Limiting Panel: Recommendations

4. Consider potential equity implications when designing and implementing climate-change policies, with special attention to disadvantaged populations.

5. Establish the United States as a leader to stimulate other countries to adopt GHG reduction targets.

6. Enable flexibility and experimentation with policies to reduce GHG emissions at regional, state, and local levels.

7. Design policies that balance durability and consistency with flexibility and capacity for modification as we learn from experience.

The logic of national targets

Target: **limiting global mean temperature increase**
(e.g., 2 deg, 3 deg)

What is a 'safe' amount of climate change?
Depends on impacts associated with given temp targets; willingness of society to tolerate risks

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Target: **limiting global atmospheric GHG concentrations**
(e.g., 450 ppm, 550 ppm)

How does GHG concentration translate into global temp change (and other impacts)?
Depends on climate sensitivity and the strength of other forcing factors (e.g., aerosols)

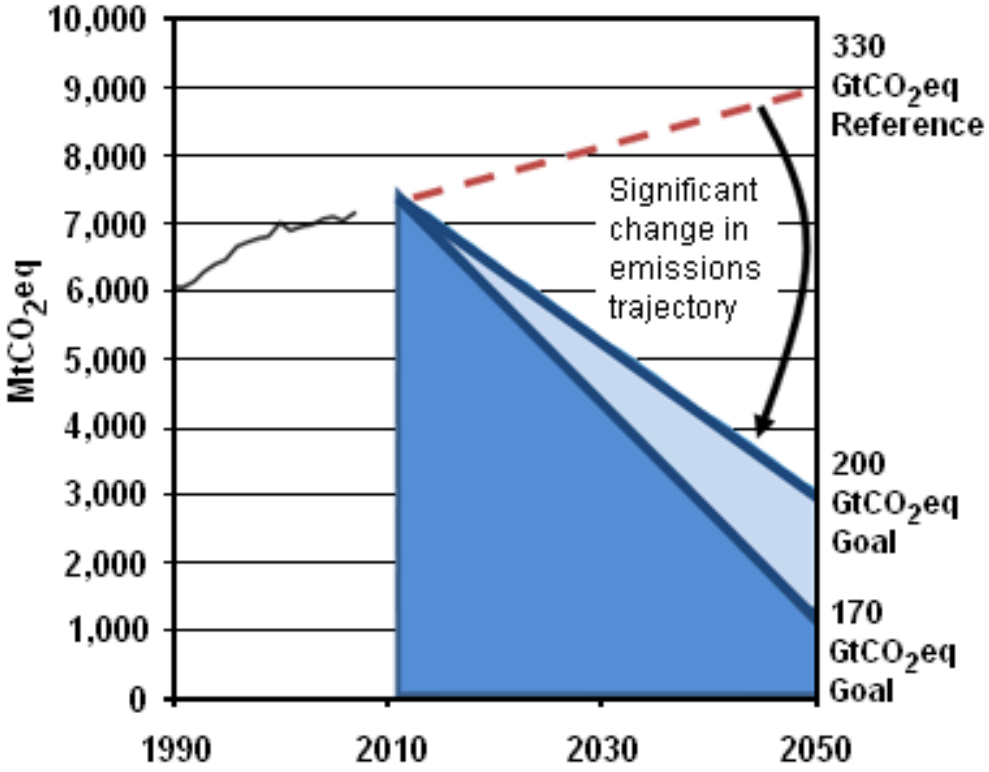
Target: **limiting global GHG emissions**
(e.g. global emission budget, or percent reduction)

How does a given level of emissions translate into atmospheric GHG concentrations?
Depends on carbon cycle dynamics and timing of emissions (e.g., are overshoots allowed?)

Target: **limiting U.S. GHG emissions**
(e.g. national emission budget, or percent reduction)

What is a 'reasonable' share of U.S. emission reductions relative to the global targets?
Depends on political, practical, economic, and ethical considerations

Limiting Panel: U.S. budget to 2050



'Representative' budget: 170–200 Gt $CO_{2\text{-eq}}$, 2012–2050.

Business-as-usual consumes this budget well before 2050.

AR5 WG1 (global) and ACC (US) budgets

AR5 WG1: 1000, 1200, 1500 GtC ever = 33%, 50%, 66% chance of not exceeding "2°C" (the average surface temperature excess relative to "pre-industrial times."

500 GtC emitted already.
Note: non-CO_2 greenhouse gases must be included.
700 GtC = 2600 $GtCO_2$

America's Climate Choices: 170-200 $GtCO_{2e}$ between 2012 and 2050.

So, non-CO_2 greenhouse gases are included.

Limiting Panel cautionary note

Meeting an emissions budget in the 170–200 Gt CO_2-eq range could be technically possible, but it is very difficult.

Essentially all available options (e.g. efficiency, renewables, CCS, nuclear, biofuels) would need to be deployed at levels close to what is estimated as technically possible; and these estimates are based on very optimistic assumptions.

Broad issues behind policy choices

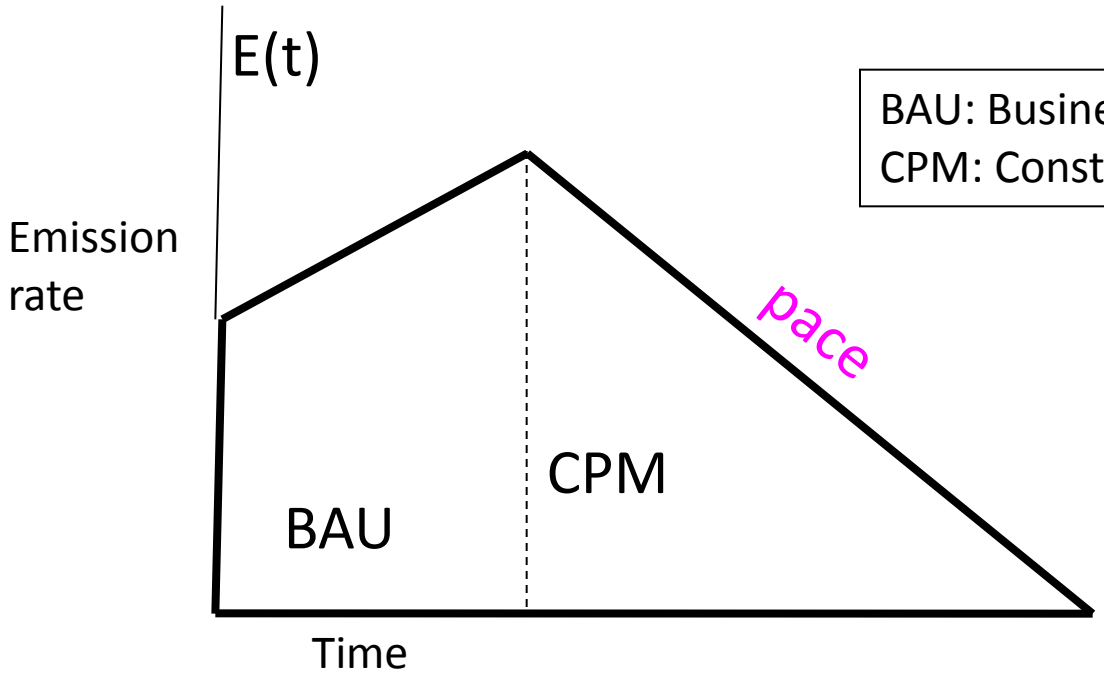
Why now?

Alliances and surrogate goals.

Getting to Yes. Just saying No.

Our collective destiny.

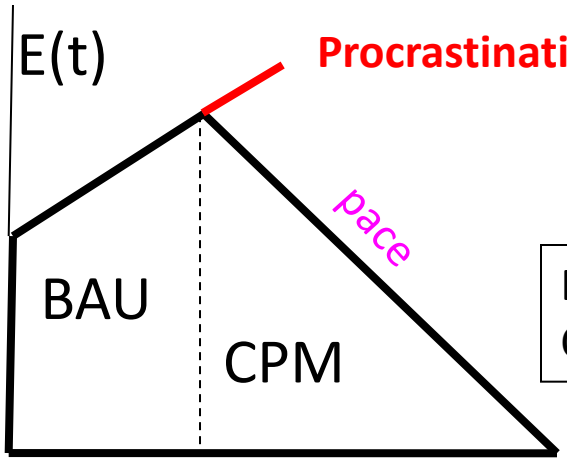
An idealization of mitigation



BAU: Business As Usual
CPM: Constant-Pace Mitigation

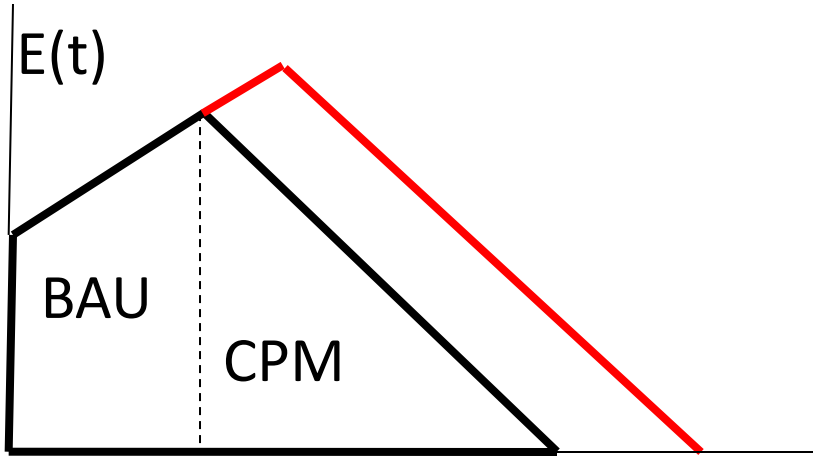
Today, approximately half of emissions are retained in the atmosphere and half move to other reservoirs.

Procrastination and “Pace”

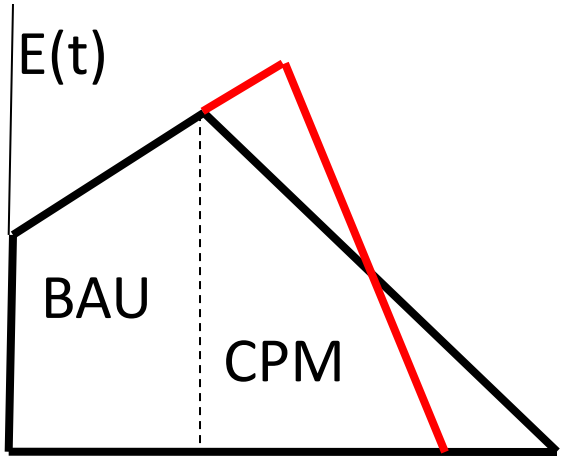


Procrastination can lead to…

BAU: Business As Usual
CPM: Constant-Pace Mitigation



(1) Extra total emissions, because pace cannot be increased,



OR (2) Constant total emissions, with a faster pace.

Arguments for Delay (1 of 2)

SCIENCE

- We don't know the science. Human activity may be having a negligible effect, swamped by natural variation.
- We may be having an effect, but the impacts are, on balance, favorable.

TECHNOLOGY

- We do not yet have the tools to solve the problem.
- The tools to solve the problem that we have are far inferior to the tools we will have if we conduct R&D for a few decades.
- We have tools that could solve the problem, but they are too dangerous. The cures are worse than the disease.

Arguments for Delay (2 of 2)

POLITICS, ECONOMICS

- The costs of mitigation are too high, relative to any willingness to pay.
- Government makes a mess of things when it intervenes in the economy.
- The world has more important things to do, notably to deal with world poverty.
- It is wasteful to engage developing countries in mitigation now, given that they will have much greater capacity for implementation later.
- Mitigation will hurt the poor in every country. Wait till we are richer.
- The net result will be to transfer wealth from rich to poor, not good policy.

PHILOSOPHY

- Government should not run our lives.
- People aren't ready to tackle climate change – the issue is too abstract.
- Whatever the impacts, we can adapt to them.
- We should not play God. We should not control nature.

Getting to Yes

The more we fear climate change, the less we can allow ourselves to be squeamish about imperfect “solutions.”

We must remember that we want solutions to work. It can’t be enough to identify what’s wrong with a strategy as it is first proposed. We must ask: With what changes, would this strategy become acceptable? How might we get from here to there?

Getting to No

However, we may decide, in some situations, to forego an option.

This may be the result of a moral judgment. We will prefer enduring some amount of climate change to the compromises required to avoid it.

Surrogate Goals (1 of 3)

Definition of a surrogate goal

A person who holds Goal A strongly and Goal B weakly, but believes that achieving Goal B will also achieve Goal A, can pursue Goal B as a *surrogate* for Goal A.

Usually, Goal A will be revealed only in special circumstances. Recognizing that a multiplicity of surrogate goals is at play has considerable explanatory power.

Surrogate Goals (2 of 3)

Surrogate goals and climate change

In the formulation of policy to deal with climate change, the general objective of slowing the rate of climate change is often a surrogate for more strongly held goals, such as:

- Augmenting financial transfers to developing countries
- Bringing the fossil fuel era to a close
- Curtailing consumerism and human centeredness
- Promoting self-sufficiency, autonomous communities
- Diminishing the power of technological elites
- Promoting environmental science
- Encouraging entrepreneurship

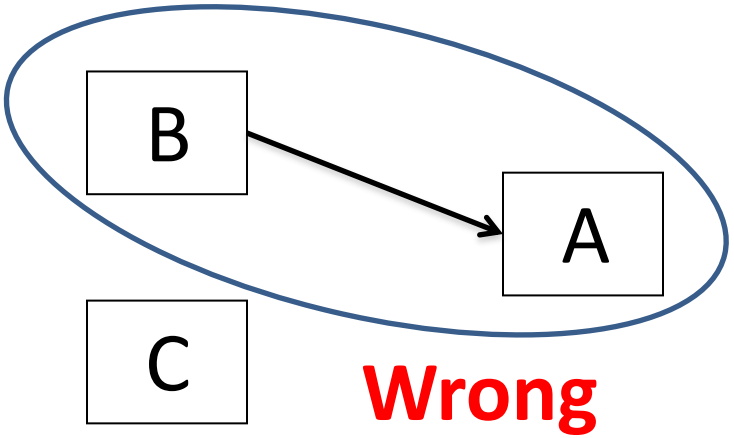
Surrogate Goals (3 of 3)

A problem arises when an action in support of the surrogate goal negates the person's more strongly held goal.

- Capturing and storing CO_2 prolongs the fossil fuel era.
- Large and distant solar arrays and windfarms do not promote local self-reliance.

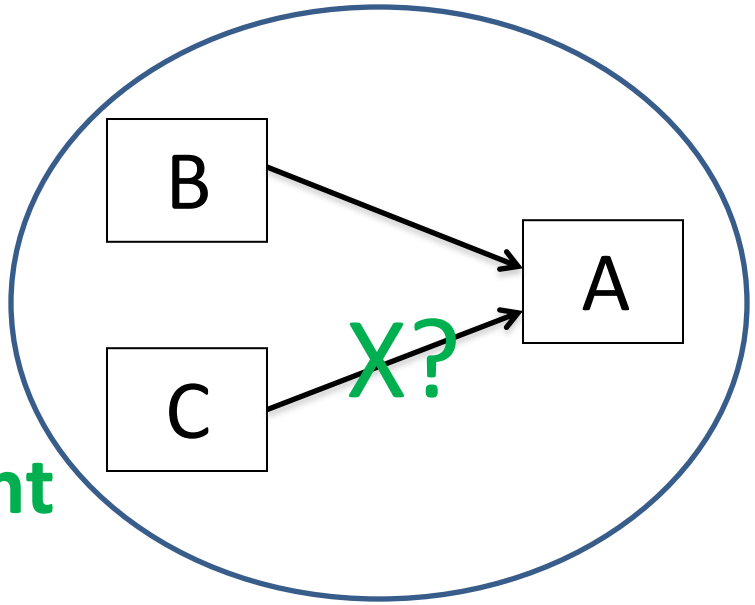
Be careful how you wish for what you wish for.

Principle: You want A. You figure out that B will get us to A, and you like B. You foster B. But *there is always a C that someone else likes and you don't like at all*, which also gets us to A. Unless you are alert, your efforts enable C.



Wrong

Right



***Message*: Add conditionality; bargain or walk away.**

Break, followed by conversation with James Hansen

EXTRA SLIDES

General Policy Design Principles

1. Every independent policy goal requires at least one independent policy instrument
2. Policies should strive to attain the necessary degree of macro-control with the *minimum* sacrifice of micro-level freedom and variability
3. Policies should leave a margin of error because of biological uncertainties *[spaceship earth]*
4. Policies must recognize that we must always start from historically given initial conditions *[e.g. the market is here to stay; owners of private property will not relinquish it, etc]*
5. Policies must be able to adapt to changing conditions
6. Design policies at the scale of their effects *[e.g. local problems need local solutions; global problems need global solutions]*

[Adopted from Daly and Farley 2003]

General Policy Design Principles
Property Rights

Coase theorem:

As long as property rights are assigned (and there are negligible transaction costs) the market can efficiently allocate resources

Three types of property rights:

- Property Rule: One person is free to interfere with another, or free to prevent interference
- Liability Rule: One person is free to "interfere" with another or prevent interference, but must pay compensation
- Inalienability Rule: If a person is entitled to the presence or absence of something, then no one can legally take that right away for any reason.

Policy slides from Phil Hannam October 15, 2013

Policy Tools

- Direct Regulation
- Pigouvian Taxes
- Pigouvian Subsidies
- Tradable Permits

Policy Tools

Direct Regulation >>>Command-and-Control regulations

Positive Features

- Limits pollution/ harvest to acceptable level
- Directly addressed biological limits
- Can be tailored to all, or some, individuals
- Familiar to most policy makers and easy/cheap to monitor and administer

Negative Features

- Low allocative efficiency
- No incentive to surpass the goal (mercury example)
- Does not allow micro-flexibility (violates our policy principles)

Policy Tools

Pigouvian Taxes >>> LIABILITY RULE (polluter pays principle)

Positive Features

- Ideally, the tax operates at the marginal external cost (effectively a market correction)
- Cost effectively reduces environmental costs
- Tax per unit of pollution creates an incentive for further reductions!
- If a firm is driven out of business, it implies it the social benefit was lower than the social cost

Negative Features

- If economy grows, more firms come online, who can still increase pollution/ extraction
- Assumes that revenue from the tax is used to remedy the environmental/ social harm
- Incentivizes outsourcing of the pollution

Policy Tools

Pigouvian Subsidies >>>Assume polluter has right to pollute!
(but society pays him/her not to)

Positive Features

- If the abatement costs are lower than the subsidy, the firm reduces pollution
- Useful as an incentive for ecosystem restoration (paying you to reforest your land)
- Useful as an international mechanism to get sovereign nations to reduce

Negative Features

- The subsidy might attract new entrants, thus increasing pollution (Example: HFC's in China)
- Reward goes to the polluter!

Policy Tools

Tradeable Permits >>> Impose a property right to the entity owning the quote (rights to absorptive capacity of a medium)

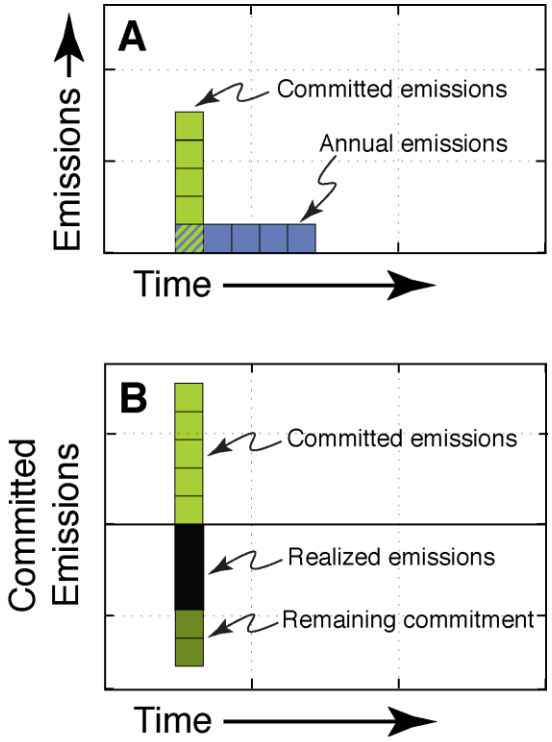
Positive Features

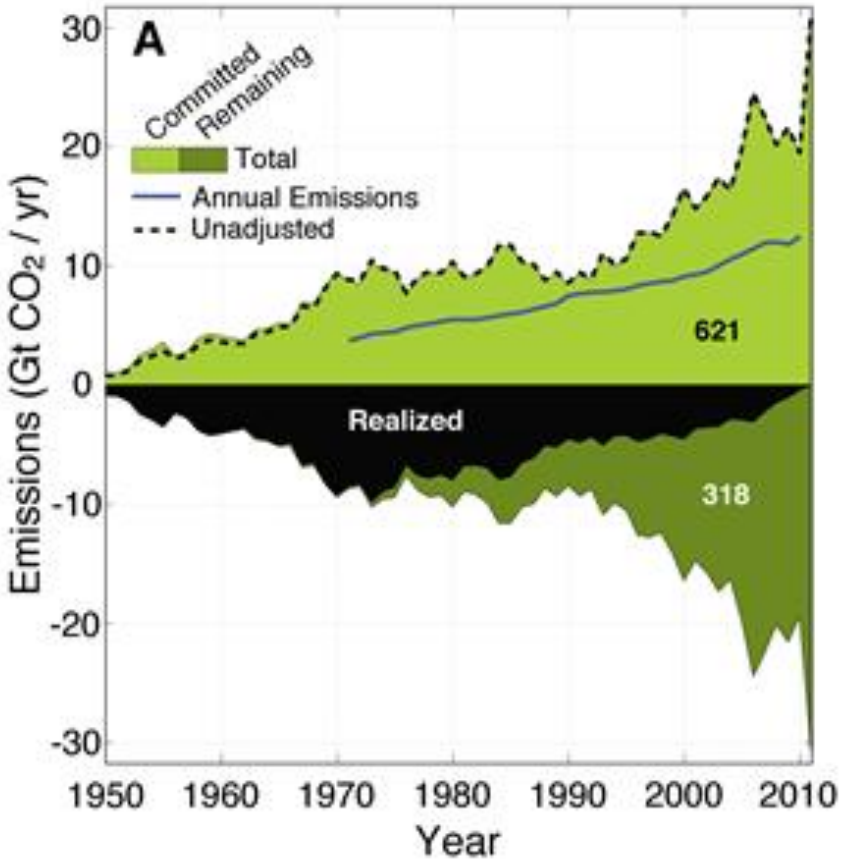
- Assigns rights to a rival good made excludable by quotas
- Distribution of the quotas can be designed to achieve other social goals
- If the economy grows, the quota does not
- Allows micro-level freedom: Harnesses power of markets

Negative Features

- Determination of the proper quota level is difficult and contentious
- If demand rises, or the quota is reduced, prices can spike (supply/ demand), creating political pressure.

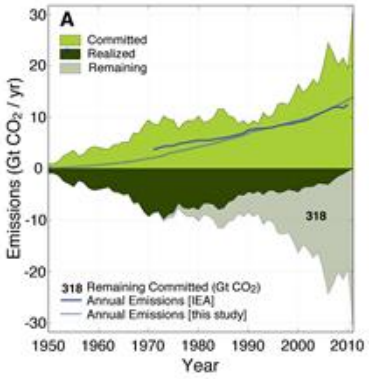
Committed CO_2 emissions from global power plants

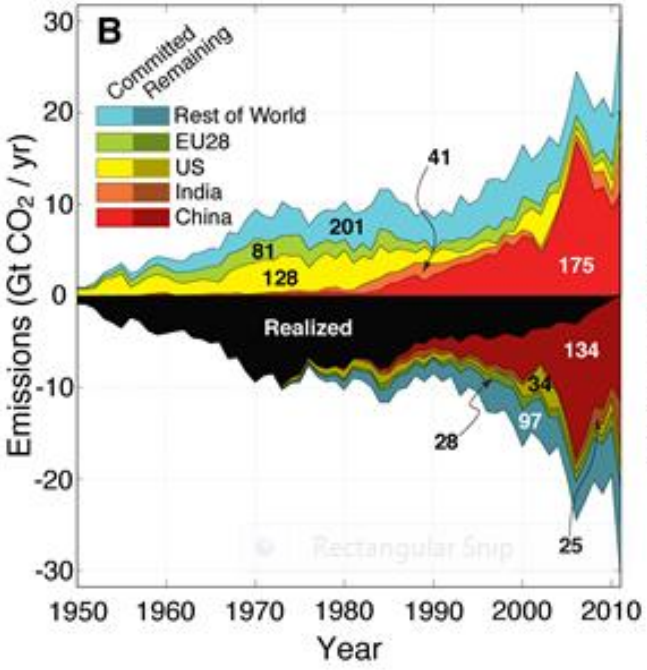


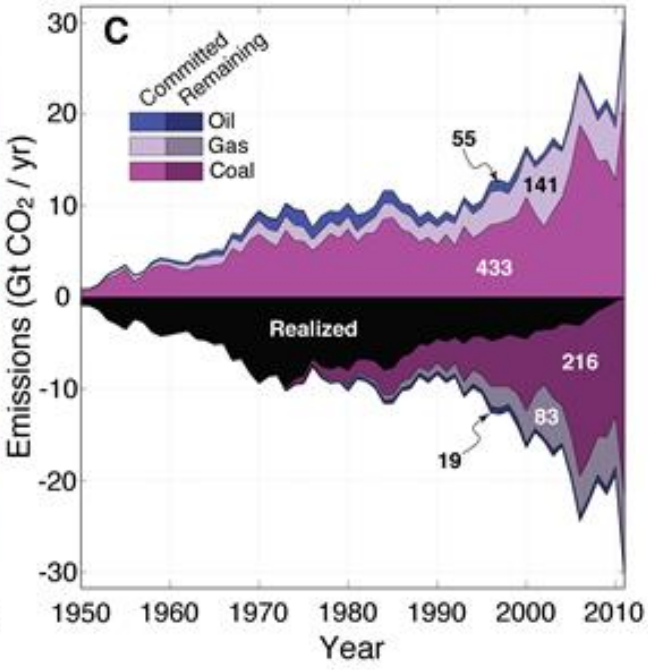


Assume 40-year life for power plants. Update for retirements and plant-life extensions. Figure shows 2009 view: remaining emissions are 318 $GtCO_2$.

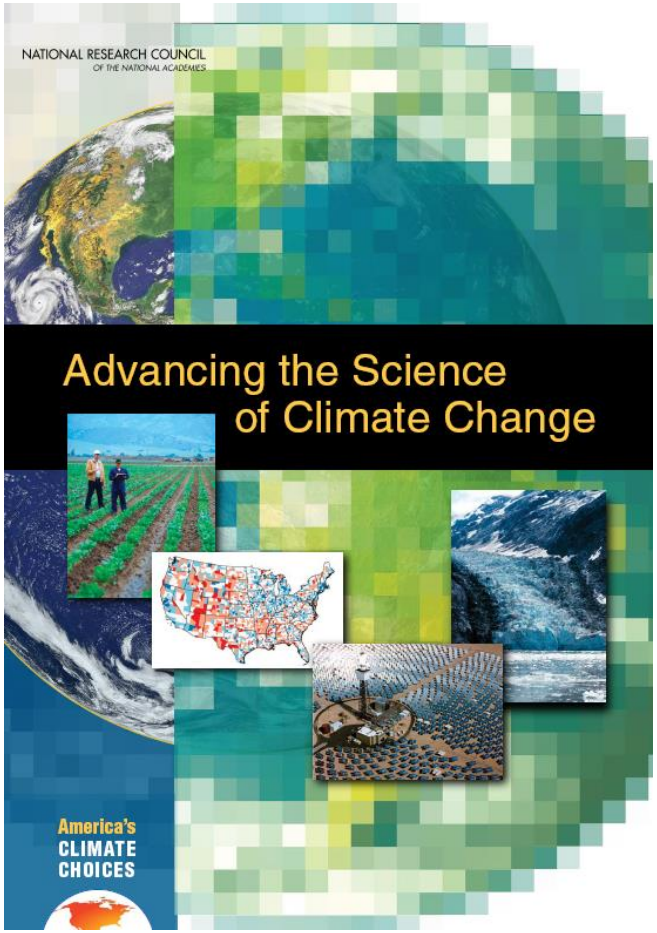
Committed emissions, 2009, by fuel and region







Science Panel: Sorry, it's real.



CONCLUSION #1: Climate change is occurring, is caused largely by human activities, and poses significant risks for a broad range of human and natural systems.

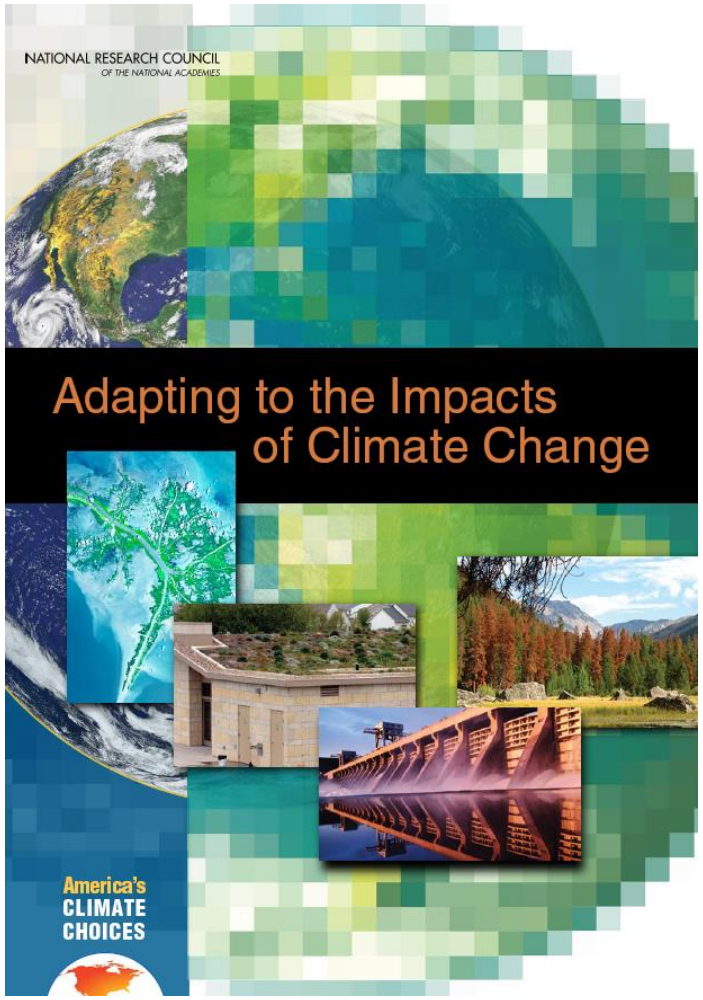
Science Panel: "A new era of climate research"

The nation needs a comprehensive and integrative climate change science enterprise that not only contributes fundamental understanding but also informs and expands America's climate choices.

Scientists need to engage stakeholders/citizens in order to build trust, access local knowledge, and learn about priorities.

The federal climate change research program should develop, deploy, and maintain a comprehensive observing system that supports all aspects of understanding and responding to climate change.

Adaptation: A U.S. perspective



There is a real risk that impacts could emerge rapidly and powerfully. Mobilizing now to increase the nation's adaptive capacity can be viewed as an insurance policy against an uncertain future.

Key sectors: ecosystems, agriculture and forestry, water, health, transportation, energy, and coastal regions.

Adaptation to extreme events

Example: The Hot Weather–Health Watch/Warning System, Philadelphia, 1995

Whenever the National Weather Service issues a heat wave warning, local media are required to provide information on how to avoid heat-related illnesses and how to help elderly persons.

Those involved include

- Philadelphia Corporation for the Aging
- Department of Public Health
- Local utility company and water department (halt service suspensions)
- Fire Department Emergency Medical Service (increase staffing)
- Senior centers (extend hours of operation of air-conditioned facilities)

Adaptation to the new normal

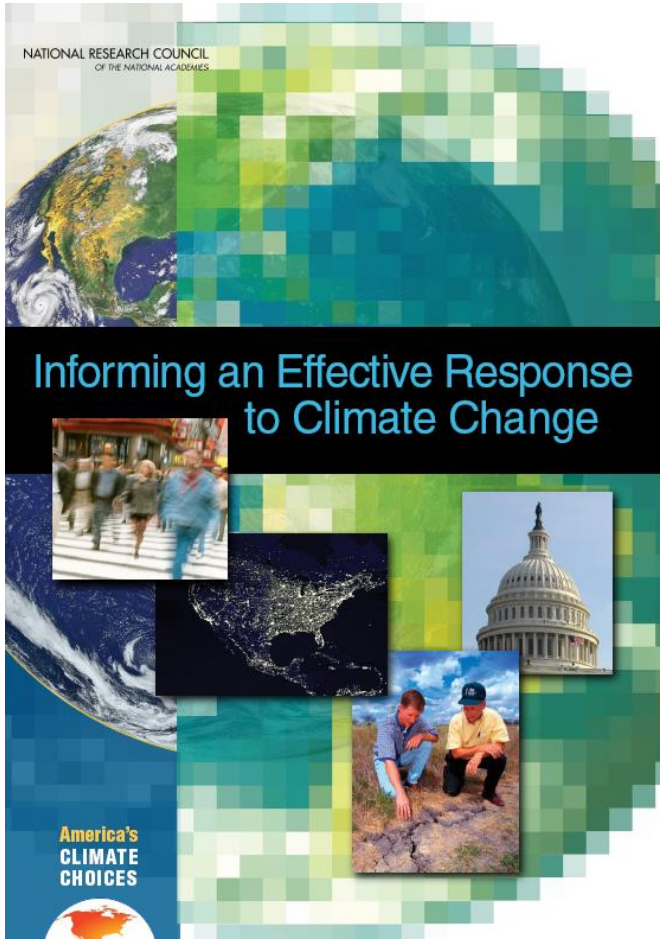
A “new normal” requires transformational adaptations:

- Movement of people and facilities away from vulnerable areas
- Changes in ecosystem and land management objectives
- Revisions of water-rights law

Contingency planning for high-impact/low-probability outcomes requires vigilant monitoring to detect early signals and continuous assessment of the adequacy of responses.

Adaptation needs to be adaptable.

Informing Panel: Improved information systems



- **Federal coordination of diverse decision-making**
- **Institutions that will produce improved tools**

Informing Panel: All sorts of decisionmakers

Climate response is and will always be decentralized.

Federal roles include:

- **clear leadership**
- **regular evaluation and assessment**
- **aggregation and dissemination of "best practices"**
- **development and diffusion of decision-support tools**
- **training of researchers and practitioners.**

The federal government must avoid preemption that discourages productive decisions by other actors.