

# Wedges Reaffirmed

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**A guest lecture in F&ES 880a, “U.S. Climate Policy”  
School of Forestry and Environmental Studies  
Yale University**

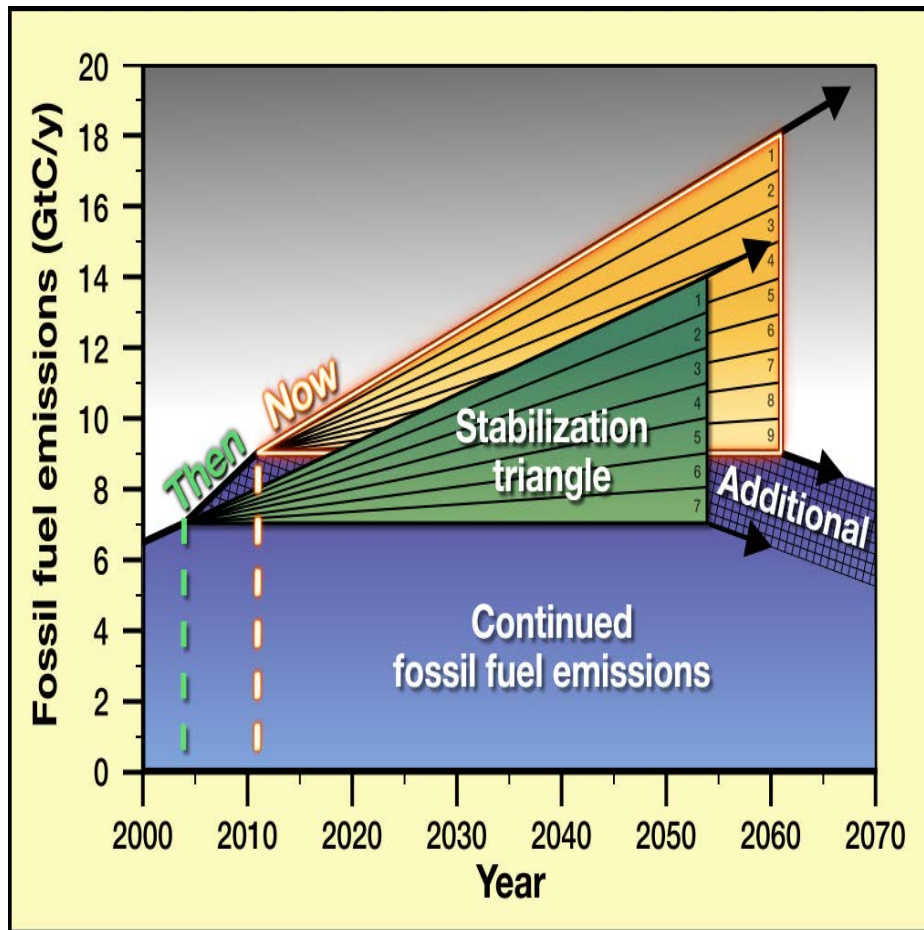
**October 4, 2011**

By videoconference

Revised, Oct 2, 2011

# “Wedges reaffirmed,”

a short essay released on Sept 27, 2011

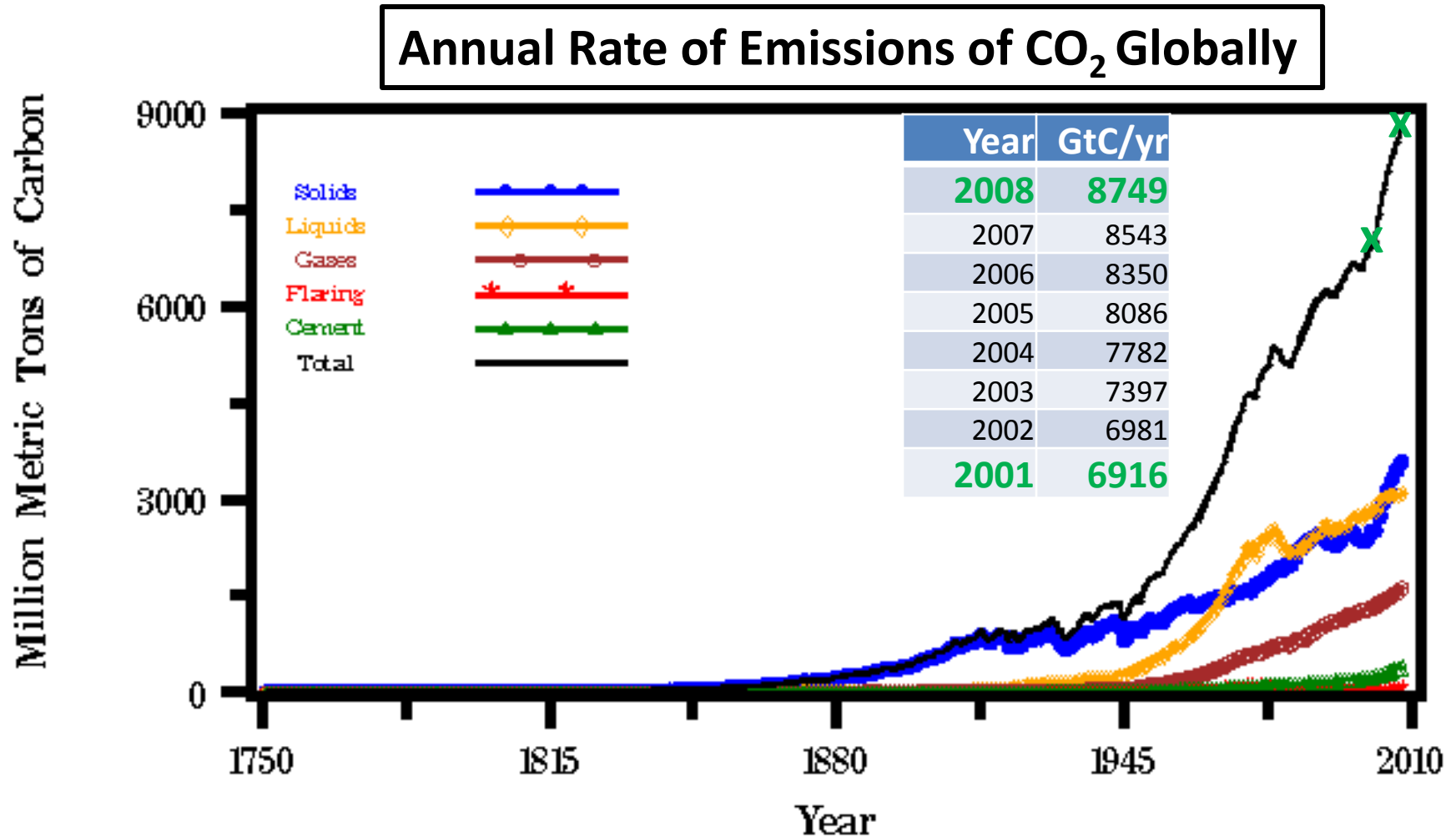


*The essay was accompanied by comments from:*

Carter Bales  
Ralph Cicerone  
Freeman Dyson  
Christopher Field  
Robert Fri  
David Hawkins  
Rush Holt  
Robert May  
Phil Sharp  
Nicholas Stern

Released at [www.thebulletin.org](http://www.thebulletin.org) and [www.climatecentral.org](http://www.climatecentral.org).  
Commenting is continuing at [www.dotearth.blogs.nytimes.com](http://www.dotearth.blogs.nytimes.com).

# We have lost precious time.



Source (accessed 10/1/11): <http://cdiac.ornl.gov/trends/emis/glo.html>.

# What's in the way of action?

Important factors have been beyond the control of the environmental community:

- The recent recession
- The political influence of the fossil fuel industries and the beneficiaries of low-cost power (e.g., the coal-power states)
- Economic development imperatives in countries undergoing industrialization.

However, advocates for prompt action, of whom I am one, also bear responsibility for the poor quality of the discussion and the lack of momentum. We could and should have acknowledged that:

- The news is unwelcome
- The science is incomplete
- “Solutions” can bring serious problems of their own.

Might these three domains of political discourse be seedbeds for the restarting of serious discussion and ensuing action?

# The news is unwelcome.

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

The “few” are today’s climate science researchers.

The “many” are the rest of us.

We are asked to reduce our emissions promptly and substantially.

# “Shooting the messenger”? No surprise.

The messenger has been shot before.

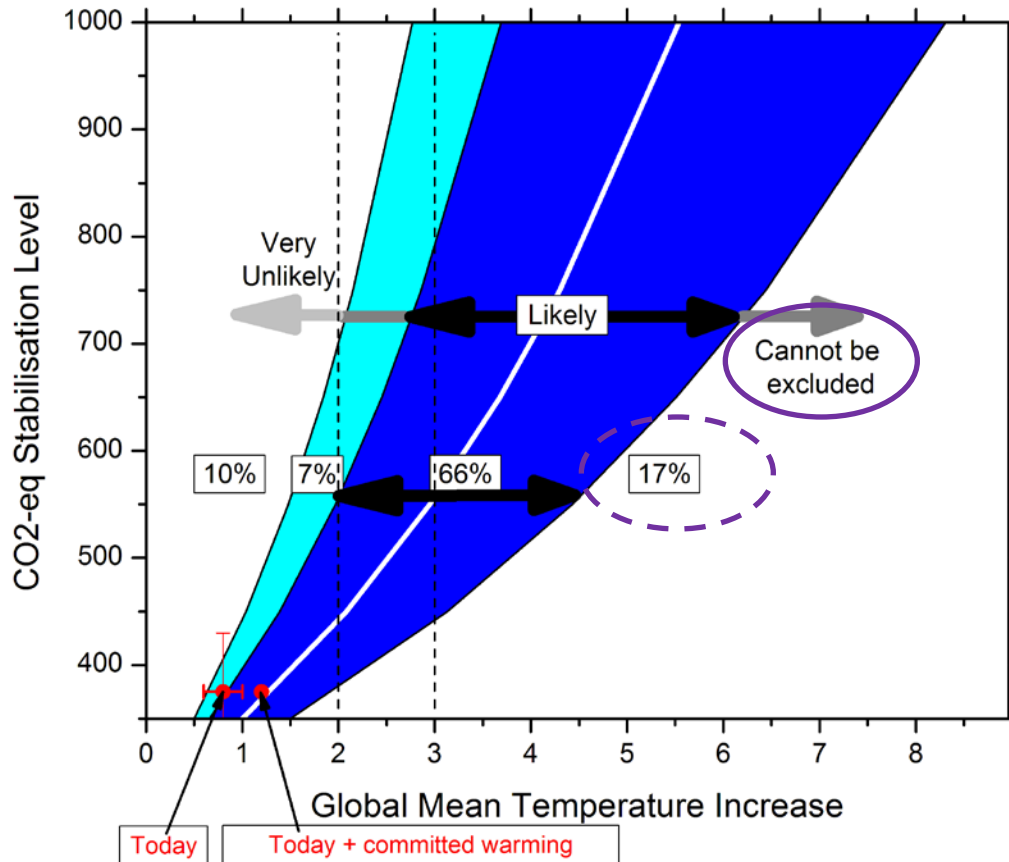
Galileo argued that the earth wasn't at the center of the universe and was excommunicated.

Darwin argued that human beings were part of the animal kingdom and was cruelly mocked.

The idea that humans can't change our planet is as out-of-date and wrong as the earth-centered universe and the separate creation of Man.

But all three ideas have such appeal that they will fade away only very slowly.

# The science is incomplete

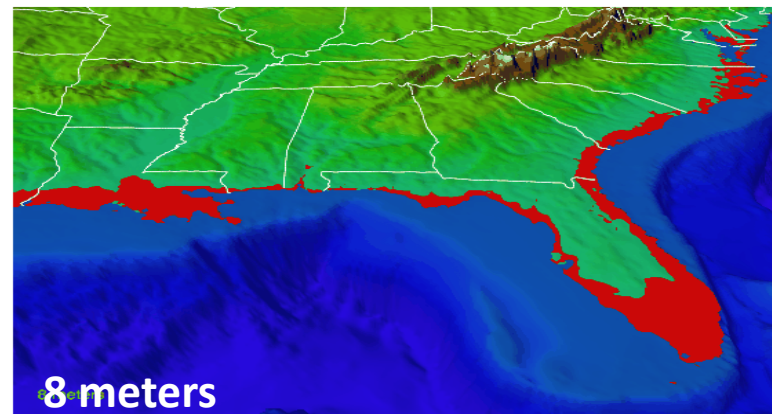
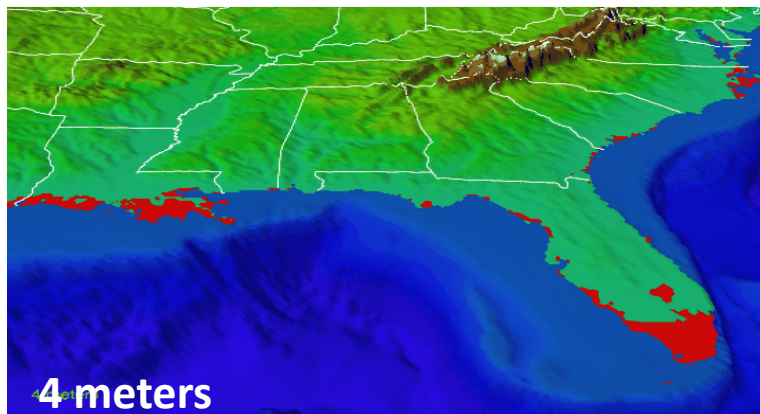
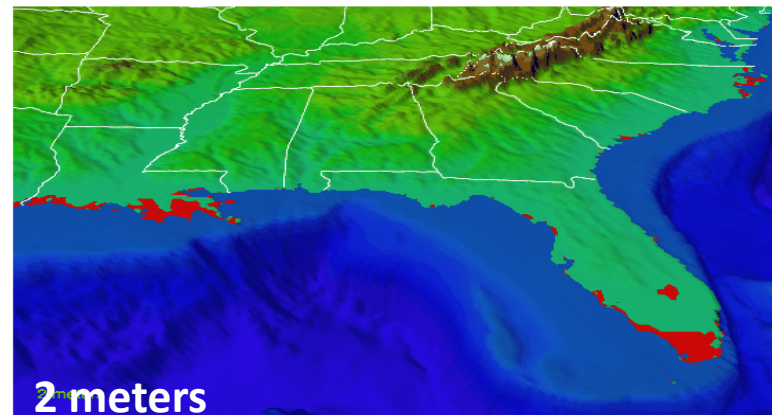
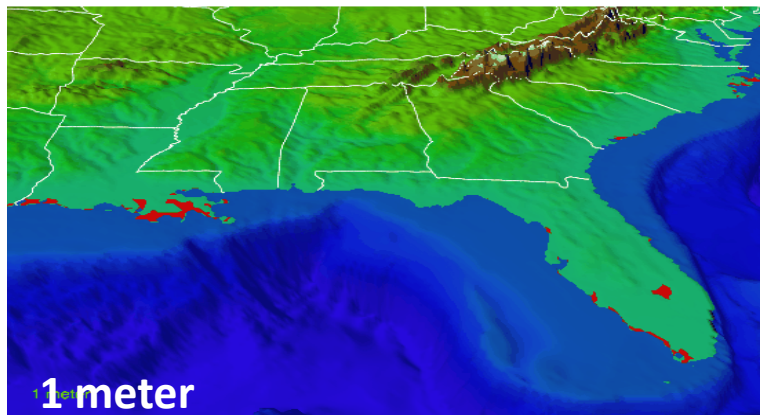


**“Cannot be excluded”  
won out over “17%” in  
AR4 Working Group 1.**

This Figure was used internally in WG1 in an unsuccessful search for consensus about the probability of a very large temperature response to rising CO<sub>2</sub>. It was not published.

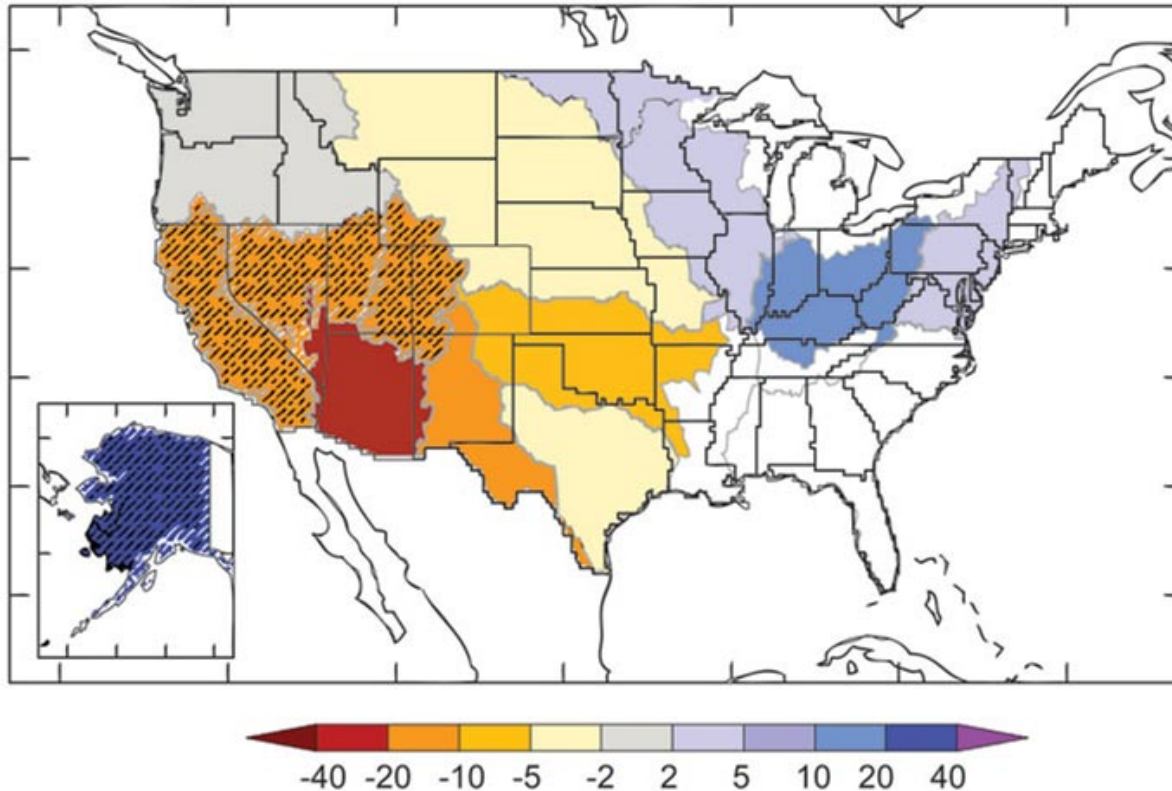
# Greenland: 7 meters. West Antarctica : 5 meters

## Sea Level Rise



**A falling sea level would also be disruptive!**

# How much wetter? How much drier?



Projected Changes  
in Annual Runoff,  
2041-60 vs. 1901-70

**Hatched areas** indicate greater confidence due to **strong agreement among model projections**. **White areas** indicate **divergence among model projections**. Emissions rate used is in-between the lower and higher emissions scenarios.

# How much hotter summers?

*Note:* The uncertainty here is due to alternative emissions paths, not alternative climate models.

This graph probably shows how winters could feel too (to be verified).

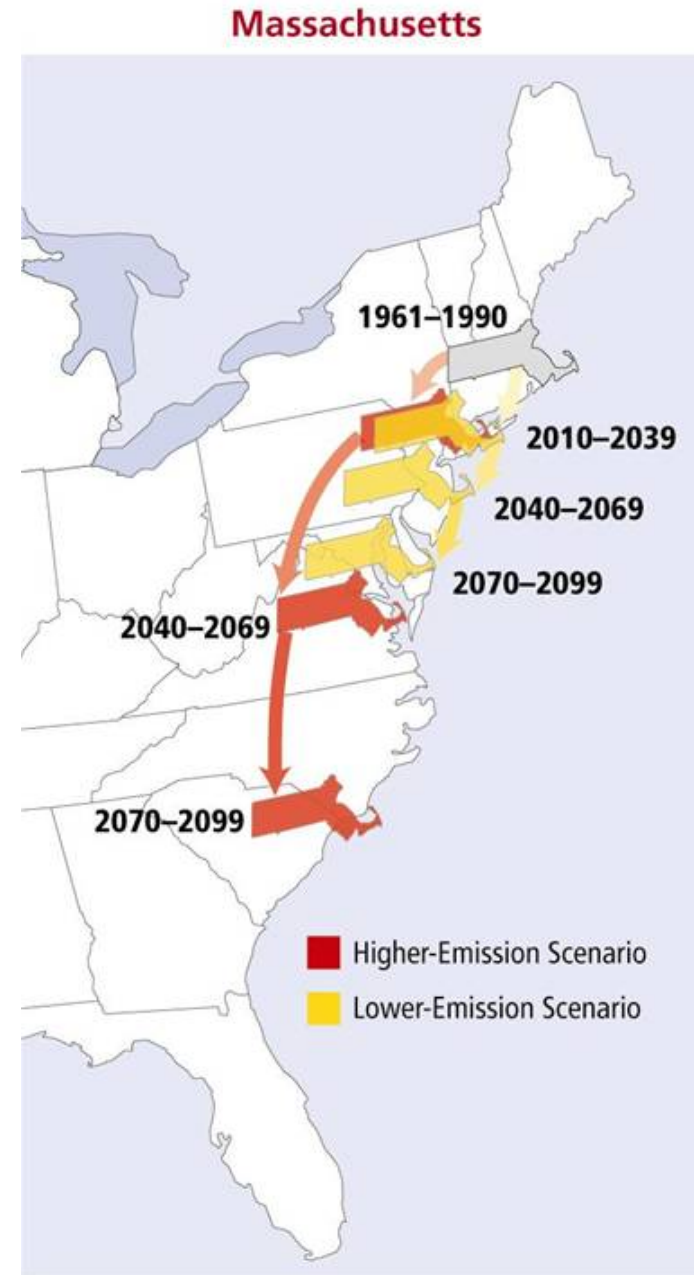


Figure from James McCarthy, Harvard

NECIA, 2007 (see: [www.climatechoices.org/ne/](http://www.climatechoices.org/ne/))

# What should we be doing?

## *Right away:*

Phase out the obsolete.

Build well, at all spatial scales.

Improve what we can already do, and replicate widely.

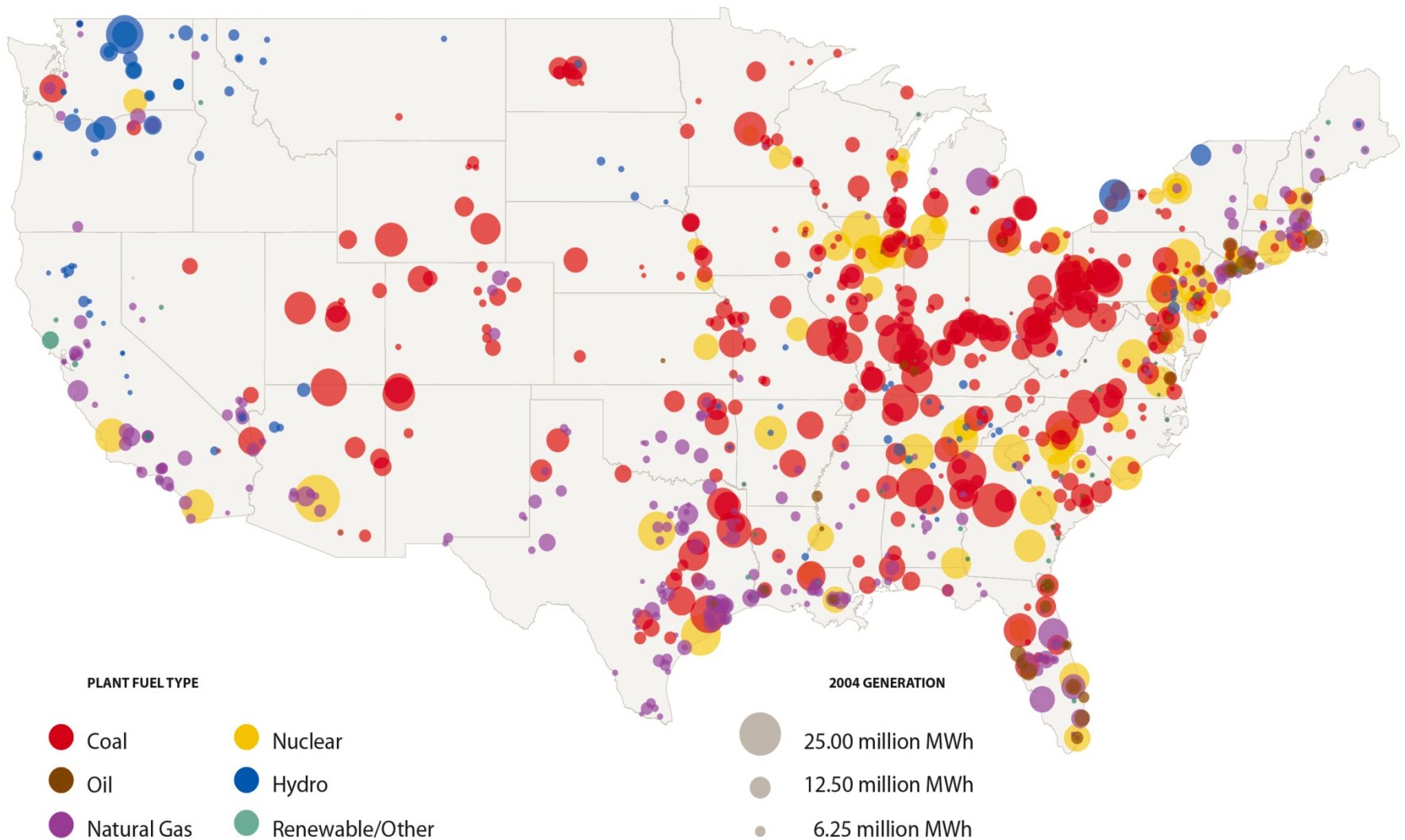
## *Steadily, for a long time:*

Seek new options (but don't bet the store on finding them).

Encourage transitions that reduced cumulative impact  
(including a falling global population).

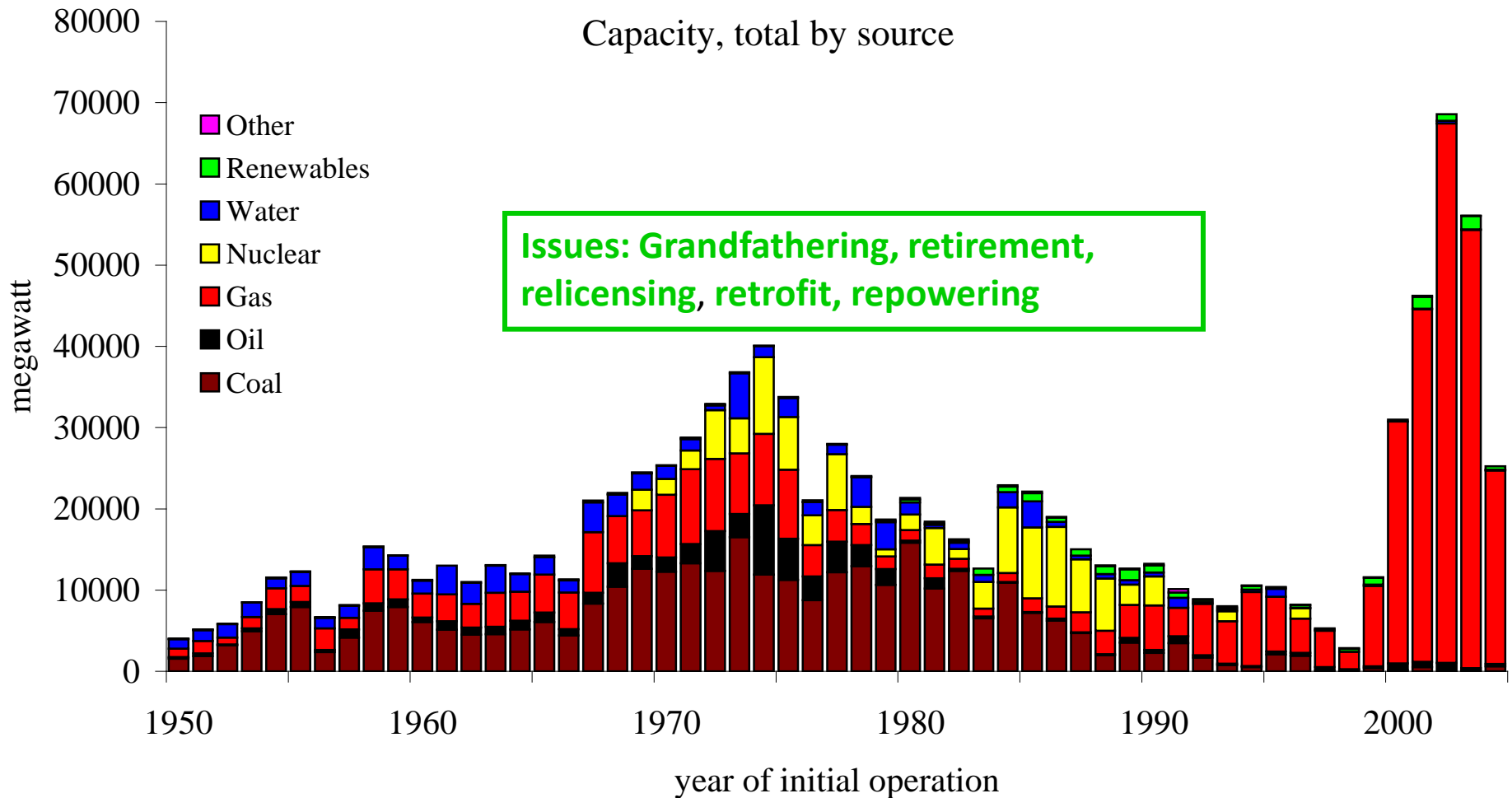
Build resilience (“adaptation capacity”).

# Legacy: U.S. Power Plants

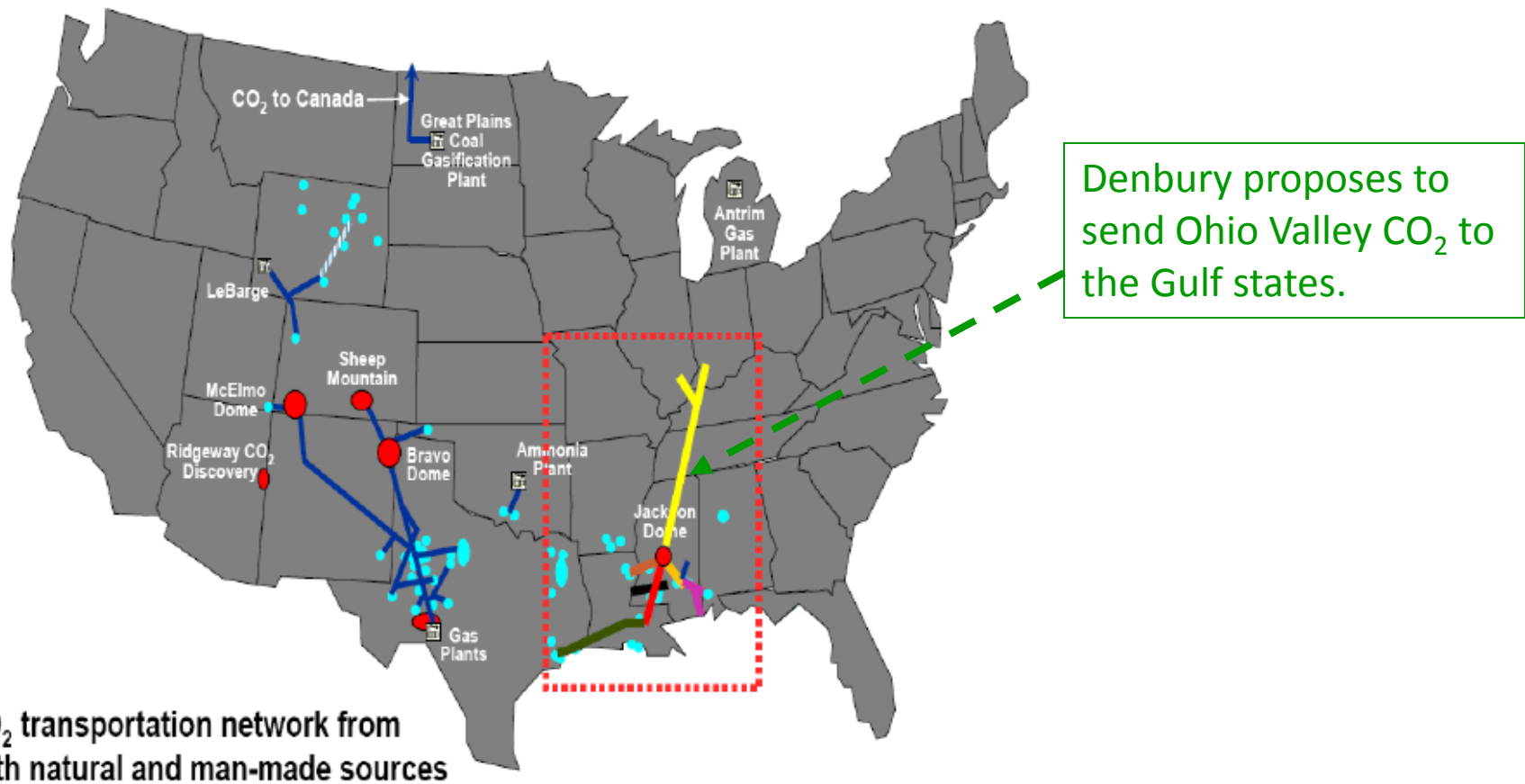


Source: *Benchmarking Air Emissions*, April 2006. The report was co-sponsored by CERES, NRDC and PSEG.

# U.S. power plant capacity, by vintage



# U.S. CO<sub>2</sub> pipeline infrastructure

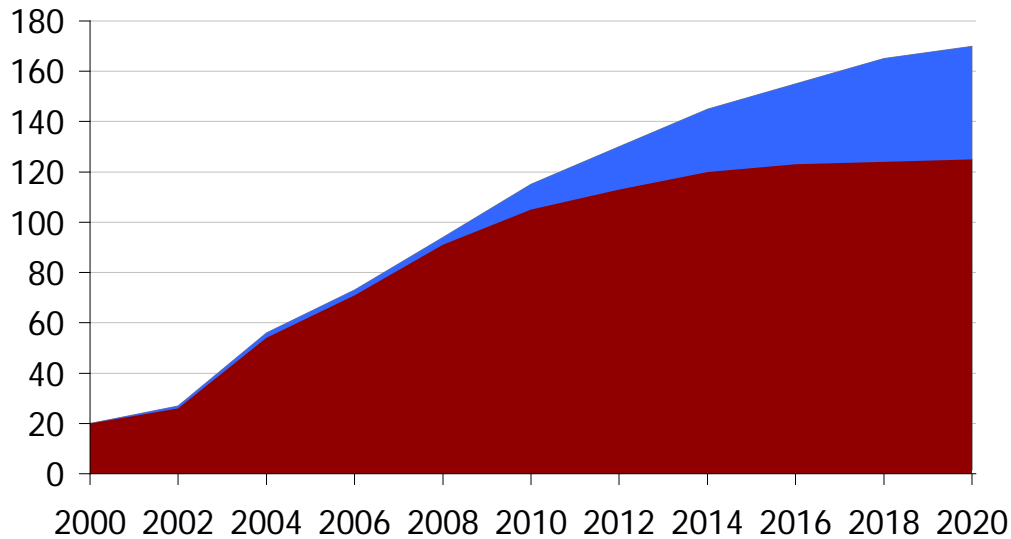


Source: "Reducing CO<sub>2</sub> Emissions from Coal-Fired Power Plants," John Wheeldon, EPRI, presented at the CCTR Advisory Panel Meeting, Vincennes University, Vincennes IN, September 10, 2009. Reproduced in Science Applications International Corporation, *Indiana and Coal: Keeping Indiana Energy Cost Competitive*, June 2010, Fig. 2-15, submitted to Indiana Center for Coal Technology Research

# China Appliance Standards

Business as Usual: CO<sub>2</sub> emissions from air conditioners in 2020 are 9x those in 2000.

**New Air Conditioner Standard: Down 25% (45 MtCO<sub>2</sub>/yr) in 2020.**



**50 million new, efficient air conditioners per year in 2020**

Analysis of low-carbon industrialization has been far too casual. There's work to do.

# “Solutions” can bring serious problems of their own.

Every “solution” has a dark side.

Conservation

Renewables

“Clean coal”

Nuclear power

Geoengineering

Regimentation

Competing uses of land

Mining: worker and land impacts

Nuclear war

Technological hegemony

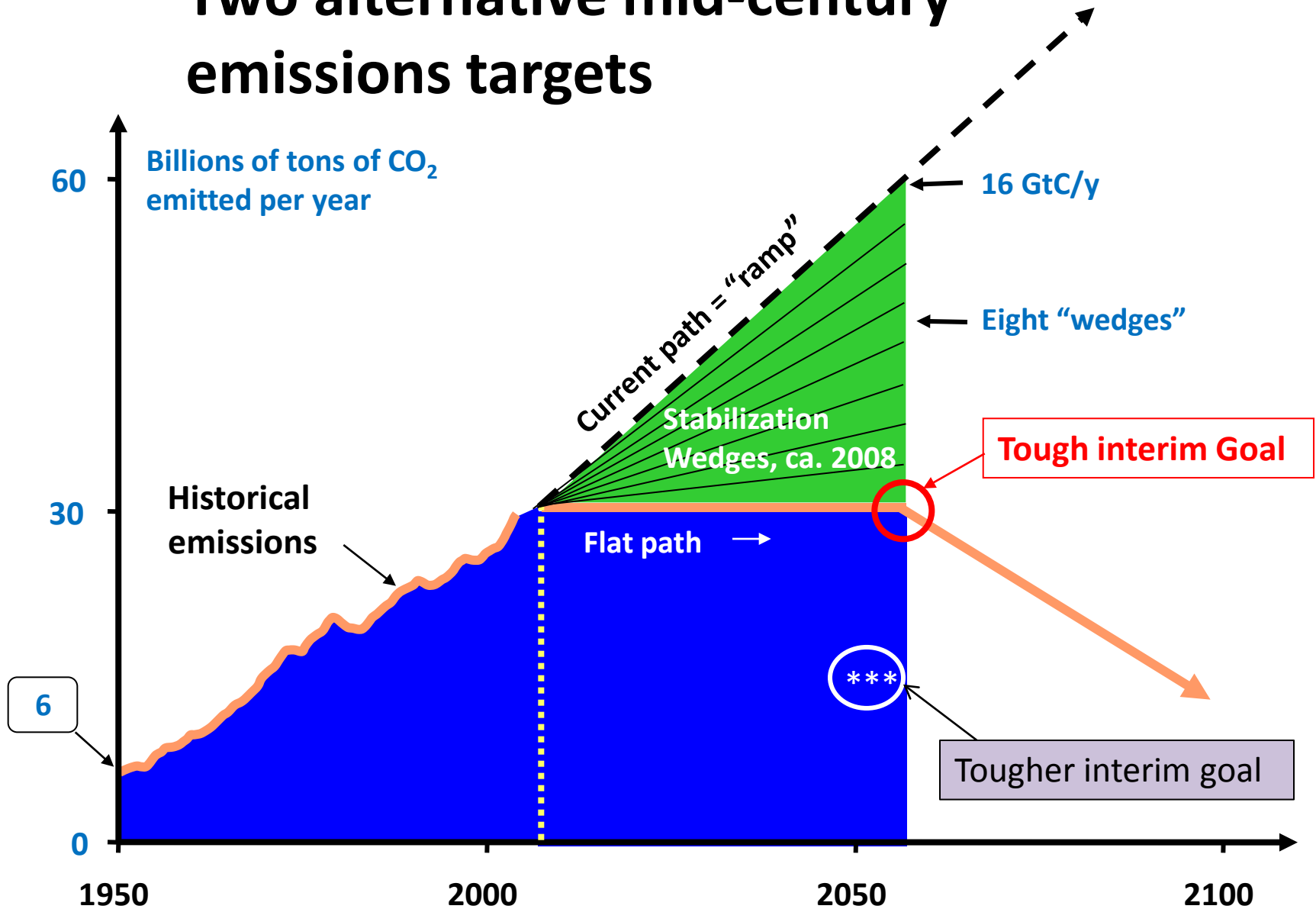
*Risk management*: In choosing targets, we must take into account both the risks of disruption from climate change and the risks of disruption from mitigation.

# *Iterative* risk management: the basis for a renewed commitment

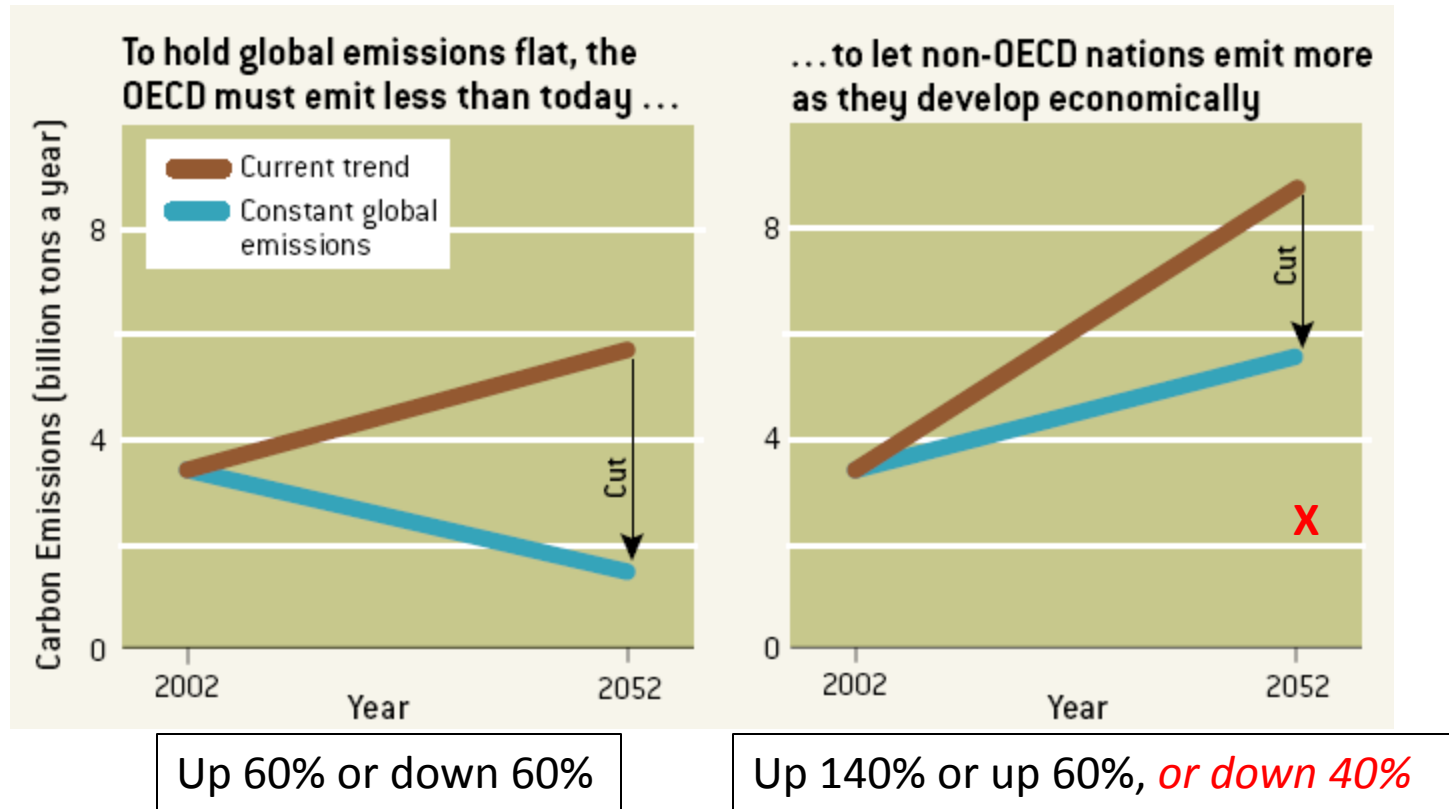
We should make decisions *iteratively*. Specifically, we can wait at least a decade before deciding whether 1) flat emissions are as heroic an outcome as we can achieve safely and equitably, or 2) whether we can achieve still more.

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, both thanks to R&D and thanks to field experience.

# Two alternative mid-century emissions targets



# “Flat” vs. “down 50%” is about the developing world’s emissions

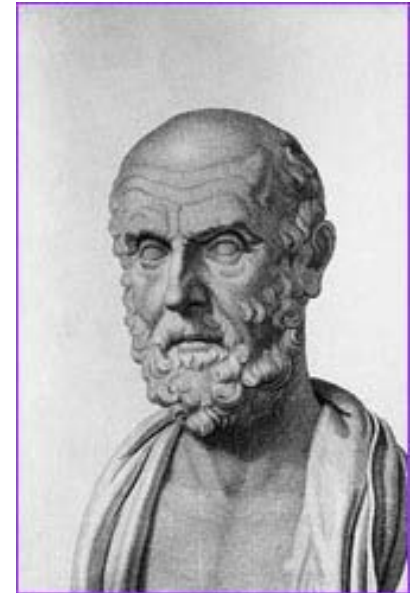


Analysis of low-carbon industrialization has been far too casual for me to be comfortable endorsing the lower fifty-year target at this time.

# Iterative risk management

“I will apply, for the benefit of the sick, all measures that are required, avoiding those twin traps of overtreatment and therapeutic nihilism.”

Hippocrates



\* Modern version of the Hippocratic oath, Louis Lasagna, 1964,  
[http://www.pbs.org/wgbh/nova/doctors/oath\\_modern.html](http://www.pbs.org/wgbh/nova/doctors/oath_modern.html)

# Grounds for optimism

1. The world today has a terribly inefficient energy system.
2. Carbon emissions have just begun to be priced.
3. Most of the 2061 physical plant is not yet built.
4. Very smart scientists and engineers now find energy problems exciting.

# Fitting on the Earth

*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.**