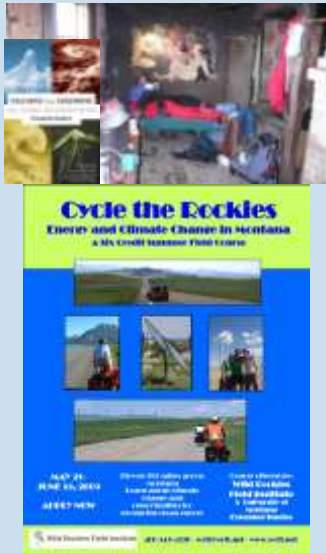


Climate Change Solutions: Climate Stabilization and the Wedge Solution

Nicky Phear
November 4, 2013



2007



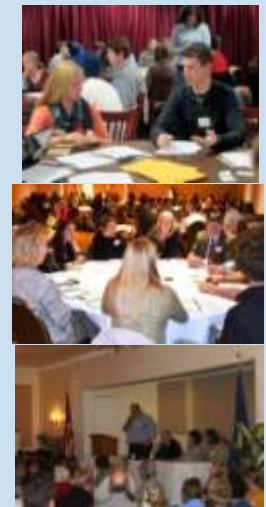
2008



2009



2011



2012-13

“If you’re looking for your calling you will find it at the place where your greatest joy intersects with the world’s deepest needs.”

--words of Fredrick Buechner adapted by Katherine Dean Moore



Climate Change

- What need does climate change present?
- How will you engage with or participate in meeting this need?



Exam #3 Questions

(1) Climate Change and You

- Explain why you think climate change is a problem.
- What need does climate change present?
- How will you (or might you) participate in meeting this need?

(2) Climate Stabilization and Wedge Solution

- What atmospheric CO₂ target should we set for stabilizing the climate and why?
- How many wedges will this require; which ones do you think should be used and why?

***You are welcome, and in fact encouraged, to work with others to formulate your answers.**

Climate Stabilization and the Wedge Solution

A Concept and Game

This presentation is based on the “Stabilization Wedges”
concept first presented in:

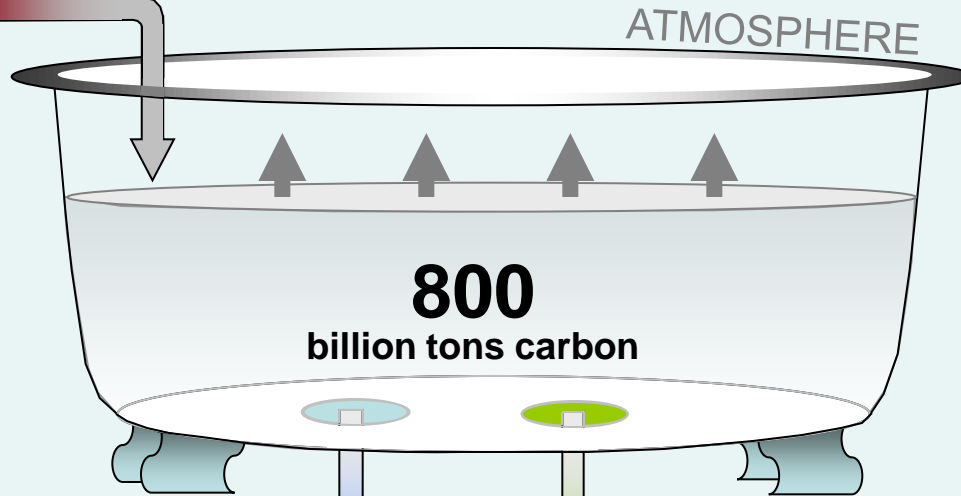
"Stabilization Wedges: Solving the Climate Problem for the next
50 Years with Current Technologies," S. Pacala and R. Socolow,
Science, August 13, 2004

Presentation available at: <http://cmi.princeton.edu/wedges/>



 **Fossil Fuel
Burning**

8
billion
tons go in



4 billion tons added
every year

Ocean

2

+

2

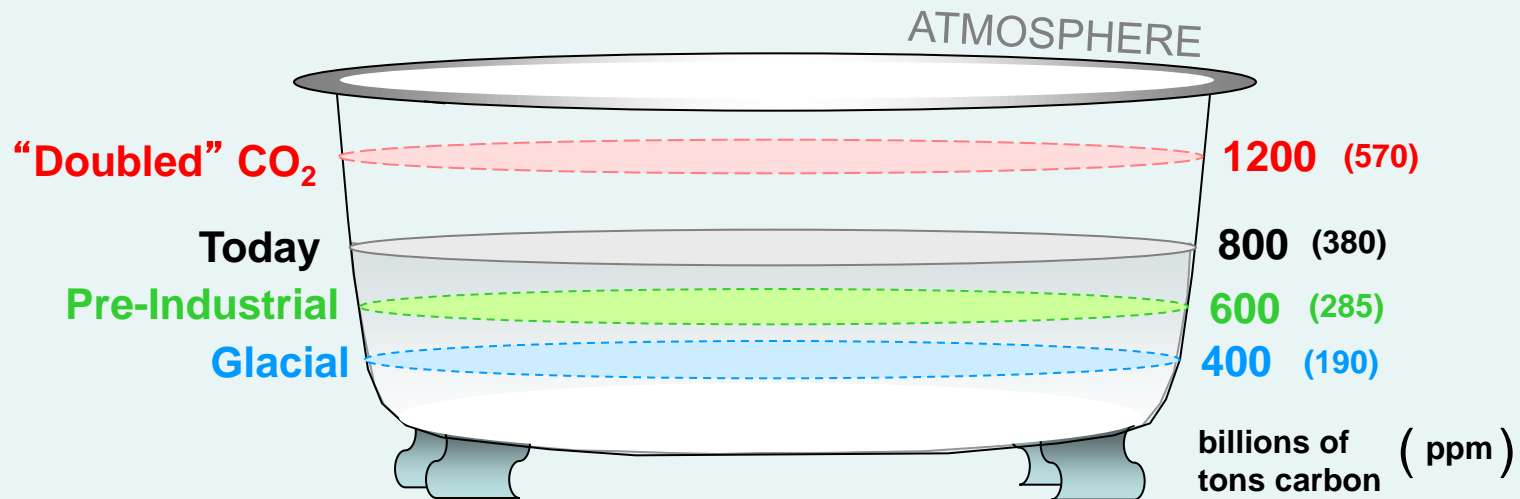
=

Land Biosphere (net)

4

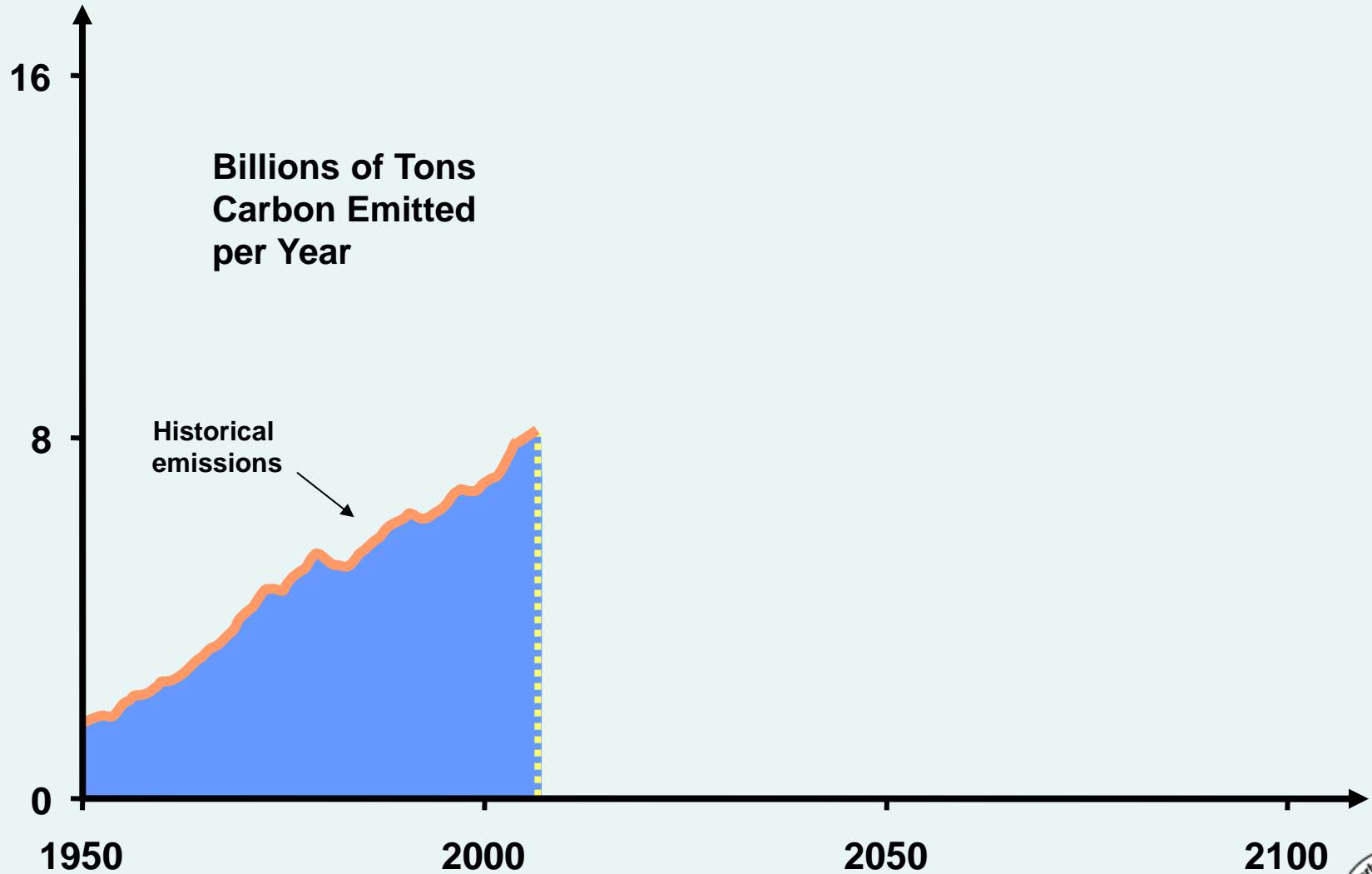
billion tons go out

Past, Present, and Potential Future Carbon Levels in the Atmosphere

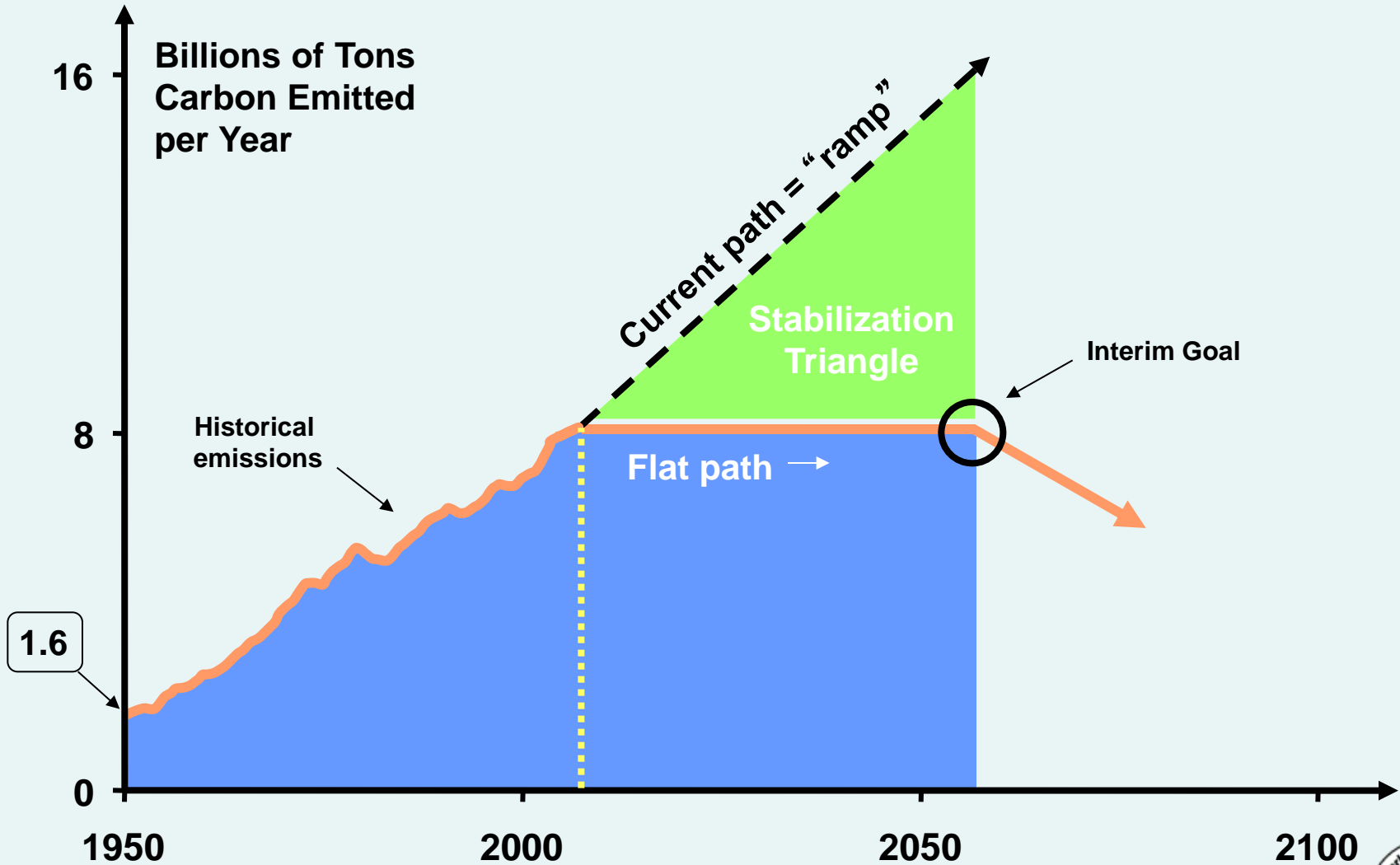


"Today" numbers are from 2006; we are currently at 393ppm.
See: <http://co2now.org/>

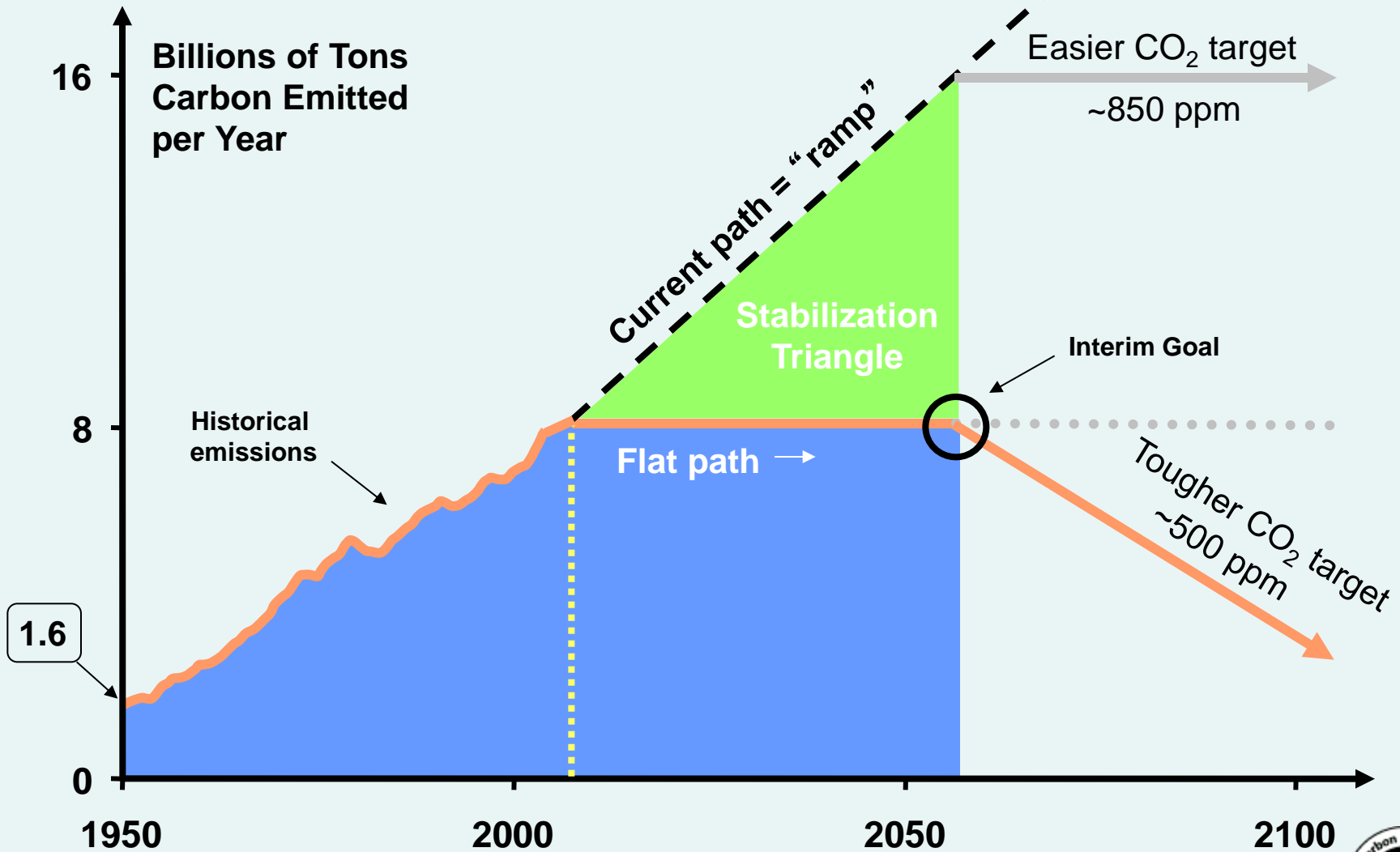
Historical Emissions



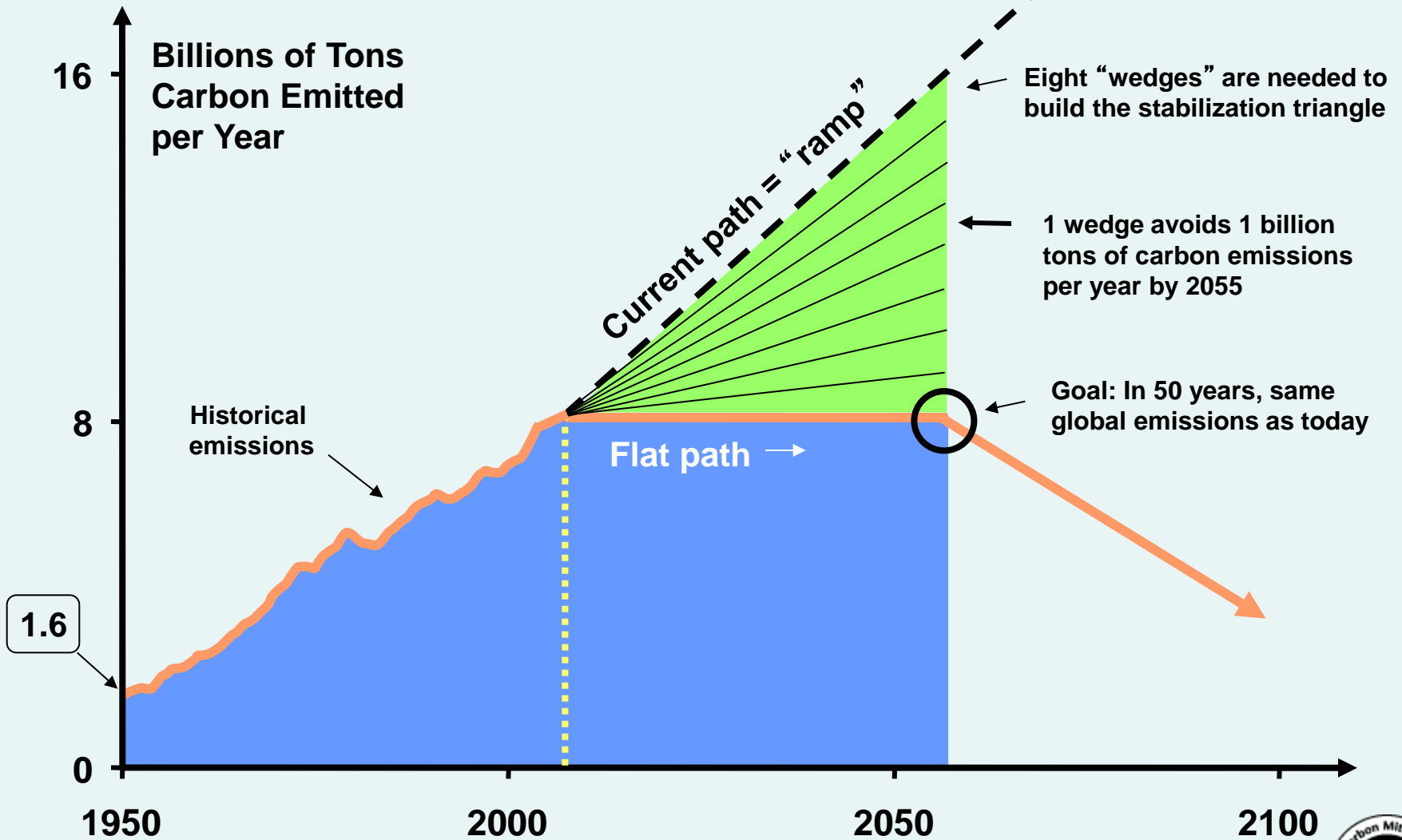
The Stabilization Triangle



The Stabilization Triangle

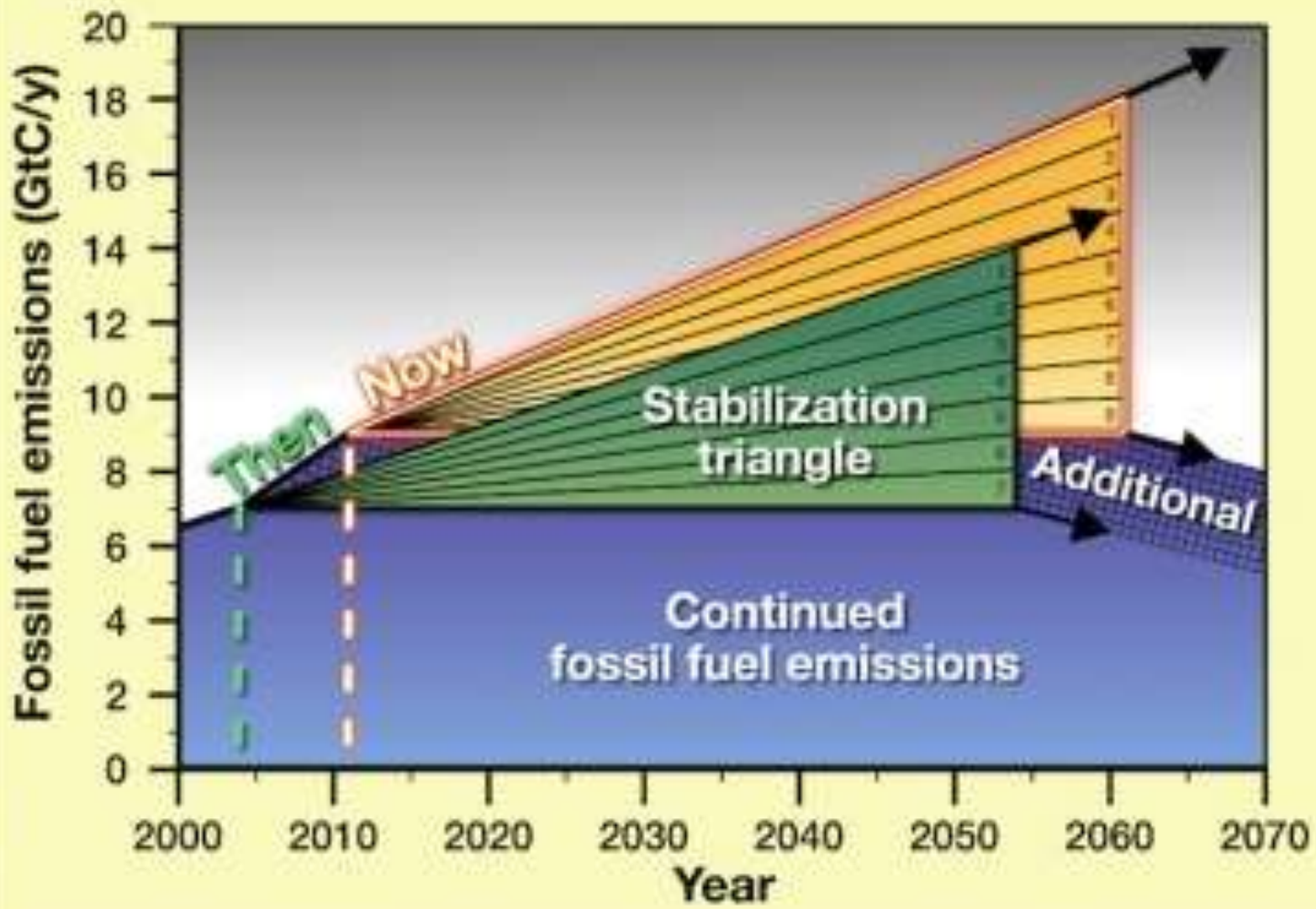


Stabilization Wedges



As Socolow puts it, "we decomposed a heroic challenge into a limited set of monumental tasks".





Important point about growth rates

Global emissions of carbon dioxide*:

- Growth rate in 2012: 1.4%
- Growth rate for past decade: 3%

Look at growth rates!

- 1% growth rate – double in 72 years - 400 to 800 ppm by 2085 (you 92 years old)
- 3% growth rate – double in 22.5 years ($72 / 3$) - 400 to 800 ppm by 2036 (you at 45)
- 5% growth rate – double in 14.4 years ($72 / 5$) - 400 to 800 ppm by 2027 (you at 34)
- 10% growth rate -- double in 7.2 years ($72 / 10$) - 400 to 800 ppm by 2020 (you at 27)

*Reference: <http://www.pbl.nl/en/publications/trends-in-global-co2-emissions-2013-report>



CLIMATE PROGRESS

EDITED BY JOE ROMM



- ECONOMY
- GREEN
- HEALTH
- JUSTICE
- LGBT
- SECURITY

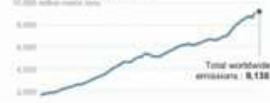
Seven Way



Update: Top Ten Occupy Wall Street Cartoons

Greenhouse gases

Worldwide emissions of heat-trapping carbon dioxide soared by 6 percent in 2010, producing the highest annual net increase of carbon pollution ever. It suggests the economy was improving last year.



Huge Jump in Global Warming Pollution, Chinese Emissions Exceed Ours by 50%



14 U.S. Billion-Dollar Weather Disasters in 2011, a New Record

The full global warming solution: How the world can stabilize at 350 to 450 ppm

By Joe Romm on Jan 10, 2011 at 4:32 pm

- 84
- Tweet
- 174
- Like
- Envelope icon
- Printer icon
- Share icon
- Comments icon (74)

In this post I will lay out 'the solution' to global warming.

This post is an update of a [2008 analysis](#) I revised in [2009](#). A report by the International Energy Agency came to almost exactly the same conclusion as I did, and has relatively similar wedges, so I view that as a vindication of this overall analysis.

Stabilizing atmospheric concentrations of carbon dioxide at 450 ppm or lower is not politically possible today — not even close — but is certainly achievable from an economic and technological perspective, as I and others have said for years.

Humanity has only two paths forward at this point. Either we voluntarily switch to a low-carbon, low-oil, low-net water use, low-net-material use economy over the next two decades or the post-Ponzi-scheme-collapse forces us to do so circa 2030. The only difference between the two paths is that the first one spares our children and grandchildren and countless future generations untold misery (see "[Intro to global warming impacts: Hell and High Water](#)" and "[A stunning year in climate science reveals that human civilization is on the precipice](#)").

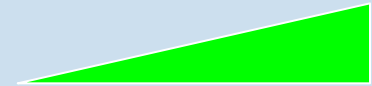
It would require some 12-14 of Princeton's "stabilization wedges" "" strategies and/or technologies that over a period of a few decades each ultimately reduce projected global carbon emissions by one billion metric tons per year (see Princeton website [here](#)). These 12-14 wedges are my focus here.

The reason that we need twice as many wedges as Princeton's Pacala and Socolow have said we need was explained [here](#). That my analysis is largely correct can be seen here: "[IEA report, Part 2: Climate Progress has the 450-ppm solution about right.](#)"

<http://thinkprogress.org/romm/2011/01/10/207320/the-full-global-warming-solution-how-the-world-can-stabilize-at-350-to-450-ppm/>

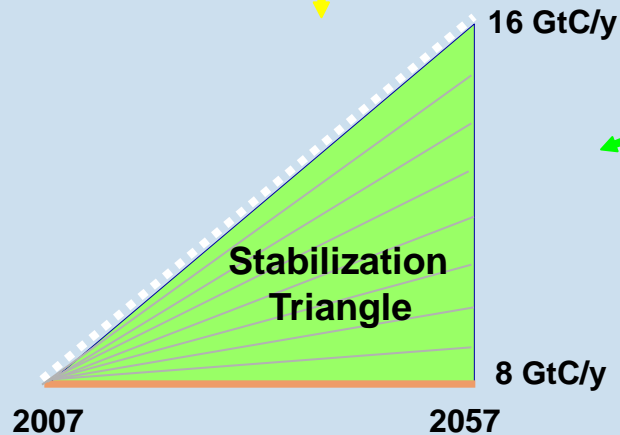
15 Wedge Strategies in 4 Categories

Energy Efficiency & Conservation (4)



Renewable Fuels & Electricity (4)

Forest and Soil Storage (2)



Nuclear Fission (1)



Fuel Switching (1)

CO₂ Capture & Storage (3)



Efficiency - Transport



**Double the fuel efficiency of
the world's cars**

**There are around 1 billion cars today,
with 2 billion projected for 2055**

Conservation - Transport



Halve the miles driven

Efficiency - Buildings

Use best efficiency practices in all residential and commercial buildings



Davidson Honors College, University of Montana
--\$12,500 investment, 8 month pay-back
--40%+ decrease in building energy usage

Efficiency - Electricity



**Produce today's
electric capacity with
double today's
efficiency**

**Average coal
plant efficiency
is 32% today**

Wind – Electricity



**Install 1 million
2 MW windmills
to replace coal-
based
electricity**

**A wedge worth of
wind electricity will
require increasing
current capacity by
a factor of 30**

Solar



A wedge of solar electricity would mean increasing current capacity 700 times



Rooftop solar water and space heaters are good for the 1.6 billion people in the world without electricity

Biofuels



Scale up current global ethanol production by 30 times

Using current practices, one wedge requires planting an area the size of India with biofuels crops

Forest Storage



Eliminate deforestation

Natural Sinks

Forest Storage



Plant new forests

Natural Sinks

Soil Storage



**Use conservation tillage
on *all* cropland**

**Conservation tillage is
currently practiced on less
than 10% of global cropland**

Natural Sinks

Nuclear Energy



Triple the world's nuclear electricity capacity by 2055

The rate of installation required for a wedge from electricity is equal to the global rate of nuclear expansion from 1975-1990

Fuel Switching



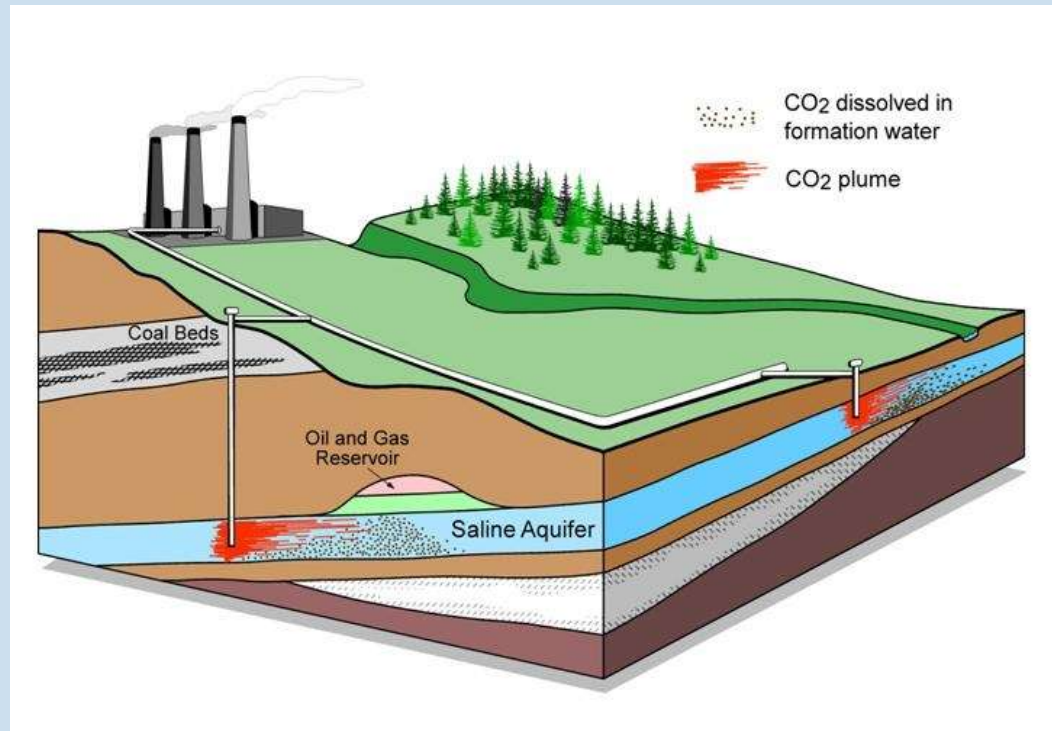
**Substitute natural gas electric plants for coal-fired facilities;
natural gas burns more efficiently and cleanly than coal**

**Combined cycle generation plants with natural gas achieve
60% efficiency**

Carbon Capture & Storage

Implement CCS at

- 800 GW coal electric plants or
- 180 coal synfuels plants or
- 10 times today's capacity of hydrogen plants



There are currently three storage projects that each inject 1 million tons of CO₂ per year – by 2055 need 3500

Take Home Messages

- In order to avoid a doubling of atmospheric CO₂, we need to rapidly deploy low-carbon energy technologies and/or enhance natural sinks
- We already have an adequate portfolio of technologies to make large cuts in emissions
- No one technology can do the whole job – a variety of strategies will need to be used to stay on a path that avoids a CO₂ doubling
- Every “wedge” has associated impacts and costs

