

# Creating a Sustainable World: Challenges and Opportunities for Business and Society

MIT Sloan Alumni Convocation  
19 September 2008

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## MIT Sloan Sustainable Business & Society Initiative

### Changing the Discourse on Sustainability

- **Away** from constraint, scolding, and despair.
  - Loggers vs. Environmentalists
  - Drilling in ANWR vs. Polar Bears
  - Growth vs. green
- **To** challenge, opportunity, empowerment
  - Fundamental alignment between a healthy environment and healthy businesses and economy to serve human needs
  - Reducing our ecological footprint can boost profits, save money
  - Building a sustainable society is exciting & fulfilling

## Building a sustainable world requires

### – **INVENTION: Creating new opportunities**

- Advances in basic science; new technologies
- MIT schools of Engineering, Science, Architecture, etc.

### – **IMPLEMENTATION: Getting it done**

- Entrepreneurship and commercialization
- The dynamics of organizational and social change
- Process Improvement, organizational learning and adaptation
- Interactions of markets, firms & organizations
- Sloan School, Dept. of Economics, Pol. Science, etc.

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## Sloan Sustainability Initiative Objectives

- Develop cutting-edge sustainability management tools
- Build deeper understanding, through research, of how firms can:
  - Operate in sustainable ways AND
  - Play a positive role in environmental regeneration and support of human welfare
- Prepare students with skills to lead in a resource-sensitive world
- Create community that includes, engages, motivates and organizes stakeholders towards integrative solutions:
  - MIT/Sloan faculty, students, staff, alumni
  - Partners in business, government, nonprofits/NGOs.

## **Initial areas of focus:**

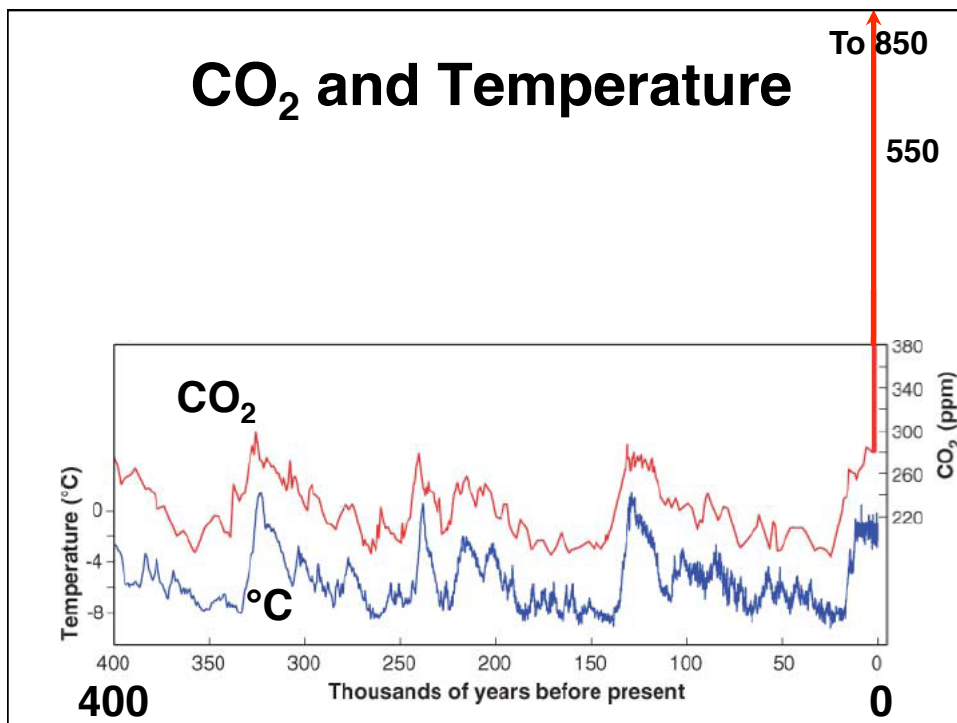
- **Global climate change and energy systems**
  - How can we build public understanding of climate change?
  - How can existing businesses be redesigned? New ones built?
  - How can sustainable industries be launched? Example: Alternative Fuel Vehicles
- **Global justice and economic development:**
  - How do we direct economic development to distribute benefits more equitably while preserving the environment?
  - What opportunities can profit-oriented companies pursue?
  - What evidence do we have that this works?
- **Business practices and sustainability:**
  - How do we identify and disseminate best practices that
    - Decrease all forms of “waste” and
    - Increase economic/social/environmental benefits?

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## **Example: Overcoming Public Complacency about Climate Change**

## Which comes closest to your view on climate change?

1. Until we are sure that climate change is really a problem, we should not take any steps that would have economic costs.
2. Climate change should be addressed, but its effects will be gradual, so we can deal with the problem gradually by taking steps that are low in cost.
3. Climate change is a serious and pressing problem. We should begin taking steps now even if this involves significant costs.





**What kind of problem is global warming?**

**How do people think about climate change?**

**What tools can help?**

**How do we move beyond delay, denial and despair?**

# Manhattan Project?

**Albert Einstein**  
Old Grove Rd.  
Nassau Point  
Peconic, Long Island  
August 2nd, 1939

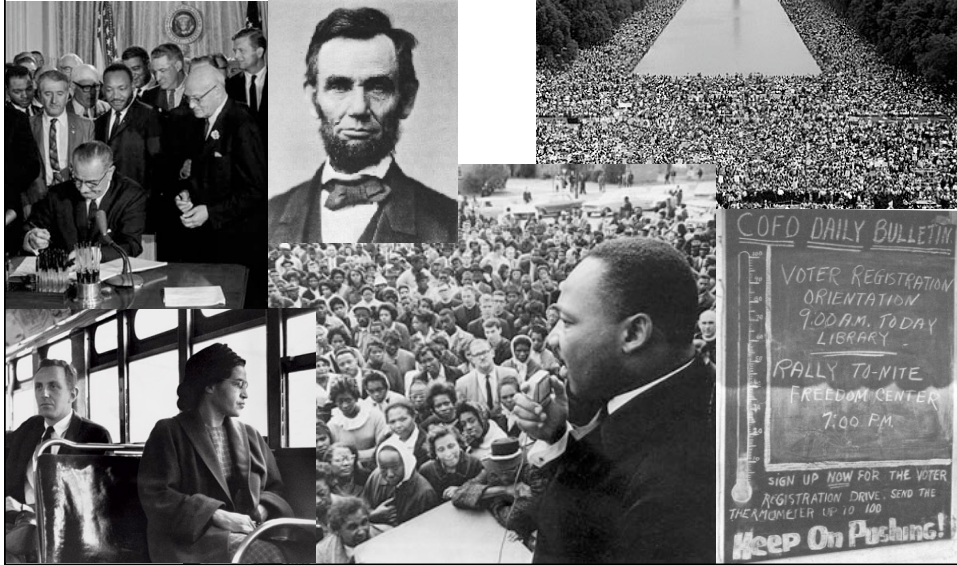
**F.D. Roosevelt,**  
President of the United States,  
White House  
Washington, D.C.

Sir:

Some recent work by E.Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations:

**16 July 1945**

# Civil Rights Movement?



# Creating a Sustainable World Requires



**Technical, economic and social innovation**

- Dramatic shift in beliefs and behavior of entire populations
- Public understanding and participation in policymaking
- Distributed leadership— Gov't, Corporate, Individual

## Americans believe Global Warming is real...

- **> 90%** have heard of global warming (Pew, 2006)
- **85%** believe it is a critical or important national threat (CCGA/WPO 2007)
- **90%** believe US should reduce its GHG emissions

## ...but we aren't willing to pay to reduce GHG emissions

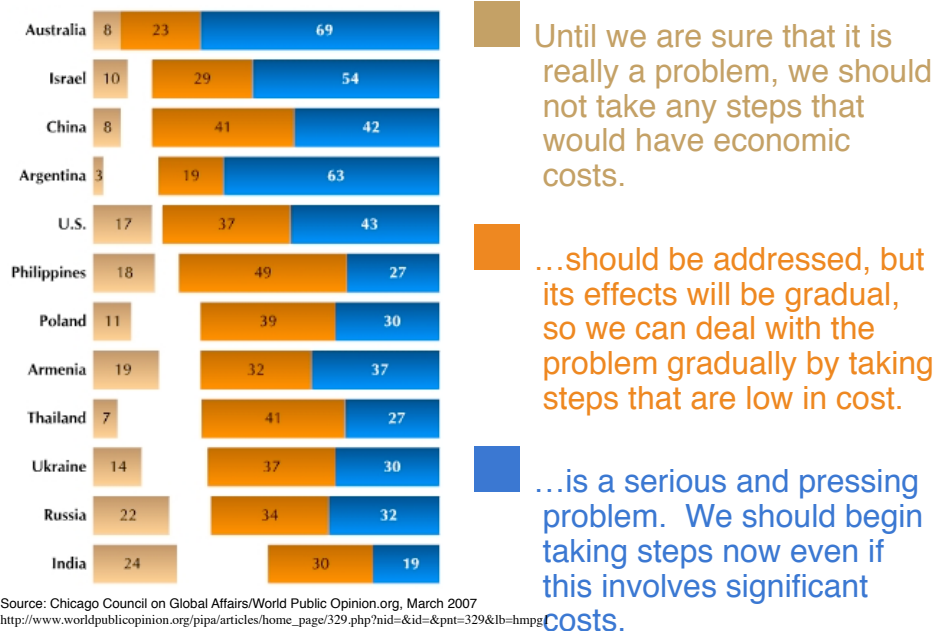
- **60%** oppose a business energy tax
- **78%** oppose a gasoline tax  
Source: Univ. of Oregon, June 2003
- **81%** oppose an electricity tax
- **68%** oppose a gasoline tax  
Source: ABC/Stanford April 2006

## ...and the majority advocate a “Wait and See” approach:

- **37%** agree that the effects of global warming “*will be gradual, so we can deal with the problem gradually by taking steps that are low in cost.*”
- **17%** believe that “*until we are sure that global warming is really a problem, we should not take any steps that would have economic costs.*”

Source: Chicago Council on Global Affairs/World Public Opinion.org, 3/2007


## International Views of Global Warming



## “Wait and see” is prudent *if...*

- Short delays between
  - Scientific knowledge of threat and public pressure for action
  - Public pressure and policy change
  - Policy change and emissions reductions
  - Emissions reductions and climate reaction
- Damage is readily reversed

## “Wait and see” is prudent *if...*

- Short delays between
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  - Damage is readily reversed
- 



## “Wait and See” contradicts best available climate science:

- Atmospheric CO<sub>2</sub> higher today than any time in past 650,000 years, likely higher than any time in past 20 million years
- Rising faster than any time in past 20,000 years
- Time delays in climate response are very long (decades to centuries to millennia)
- Many climate change impacts are irreversible
- Large changes in climate may trigger instabilities
- Limiting the risk of “severe consequences” requires large cuts in emissions

 **Climate Interactive** is a growing coalition of business, academic, & nonprofit organizations

**Creating a portfolio of fast, accessible, robust, transparent simulations to help build understanding of climate change among policymakers and the public**

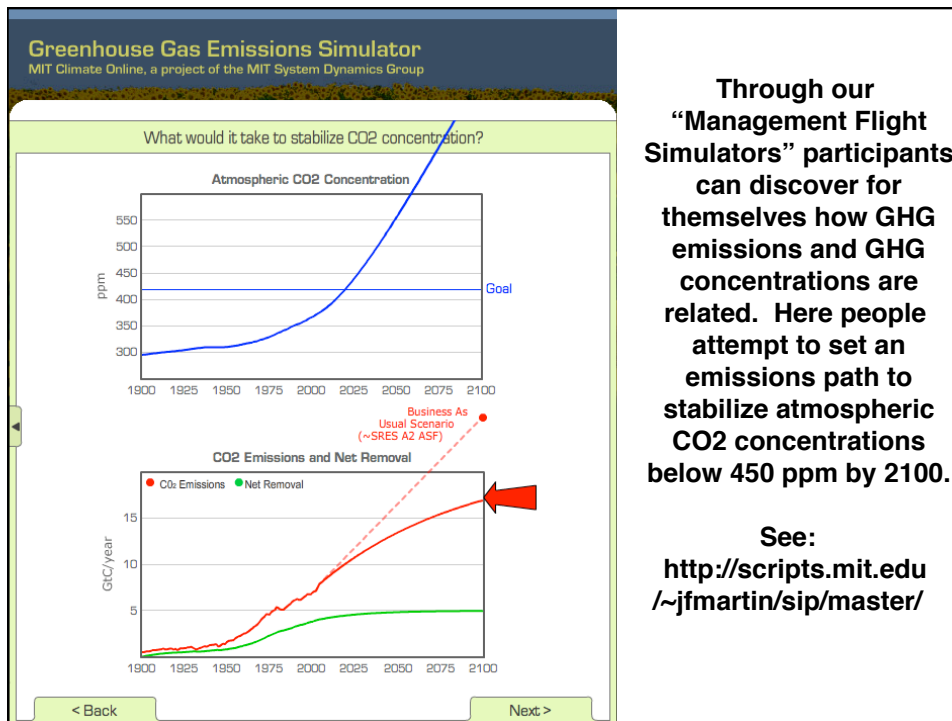
## “Management Flight Simulators” for Climate Understanding

- See:

[http://scripts.mit.edu/~jsterman/Management\\_Flight\\_Simulators\\_\(MFS\).html](http://scripts.mit.edu/~jsterman/Management_Flight_Simulators_(MFS).html)

- Climate Interactive Consortium:

<http://www.climateinteractive.org/>



Through our “Management Flight Simulators” participants can discover for themselves how GHG emissions and GHG concentrations are related. Here people attempt to set an emissions path to stabilize atmospheric CO<sub>2</sub> concentrations below 450 ppm by 2100.

See:  
<http://scripts.mit.edu/~jfmartin/sip/master/>

## Modeling the Carbon Cycle

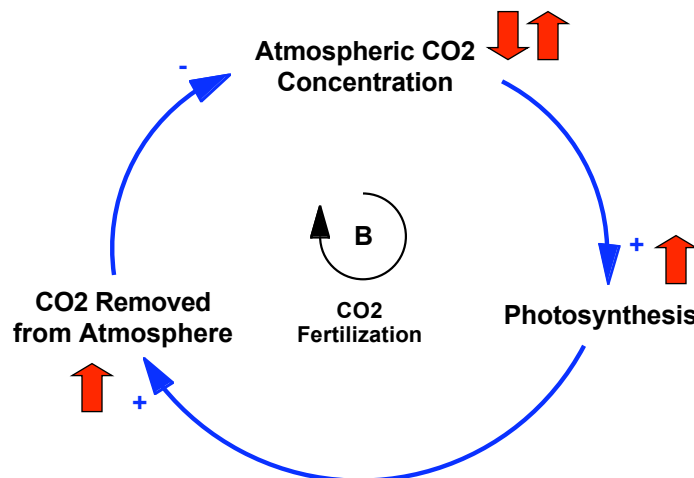
- Simulators capture key feedbacks, time delays, accumulations and nonlinearities in the climate and economy
- These dynamics are poorly understood by most people, including many with strong technical backgrounds

See: Sterman, J. and L. Booth Sweeney (2007).

Understanding Public Complacency About Climate Change: Adults' Mental Models of Climate Change Violate Conservation of Matter. *Climatic Change* **80(3-4): 213-238.**

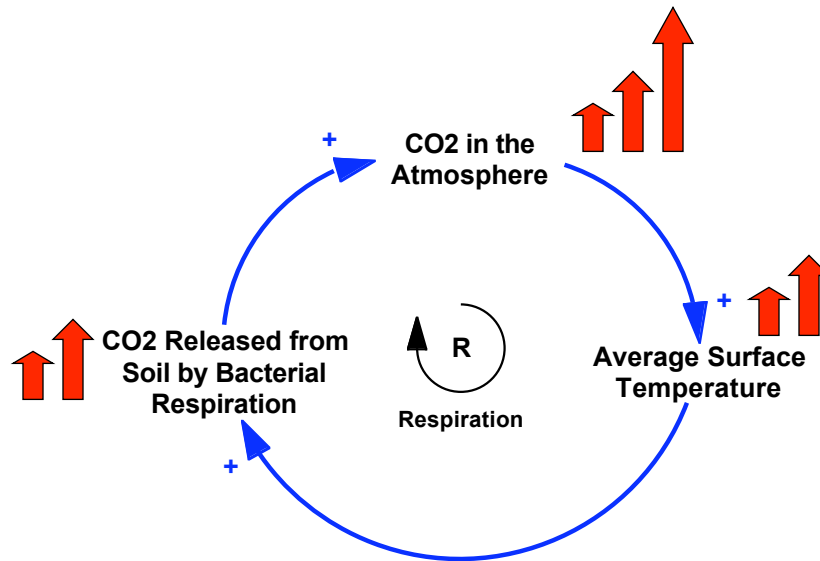
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## Balancing (Negative) Feedback





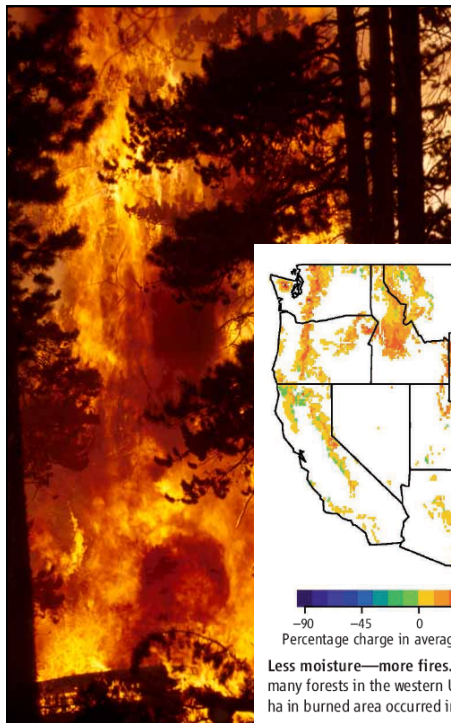
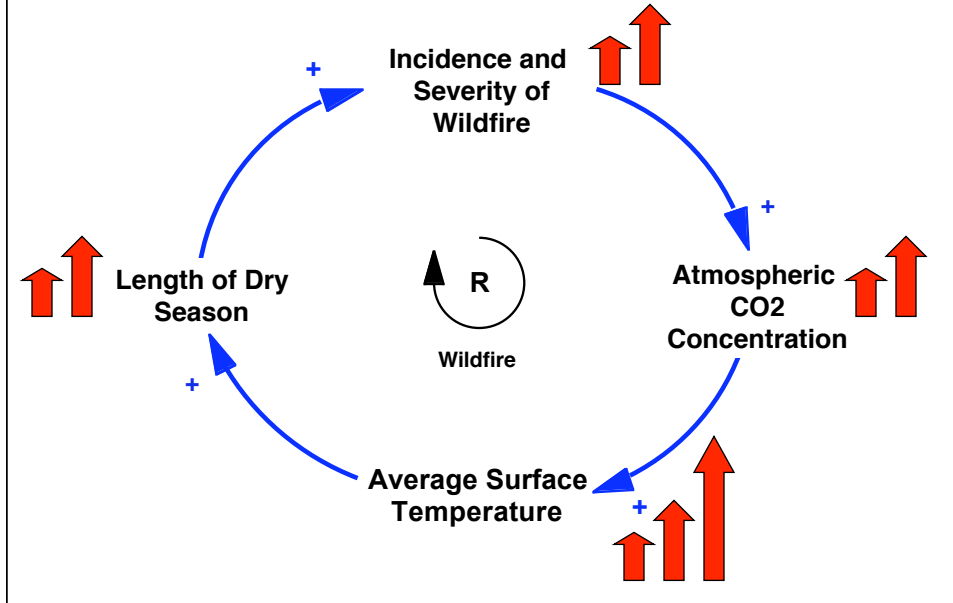
## Reinforcing (Positive) Feedback



## Newly Bio-available Carbon in Thawing Permafrost

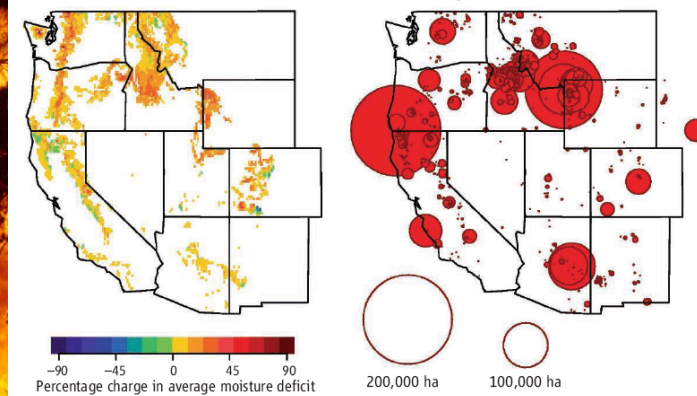


# More Reinforcing Feedbacks



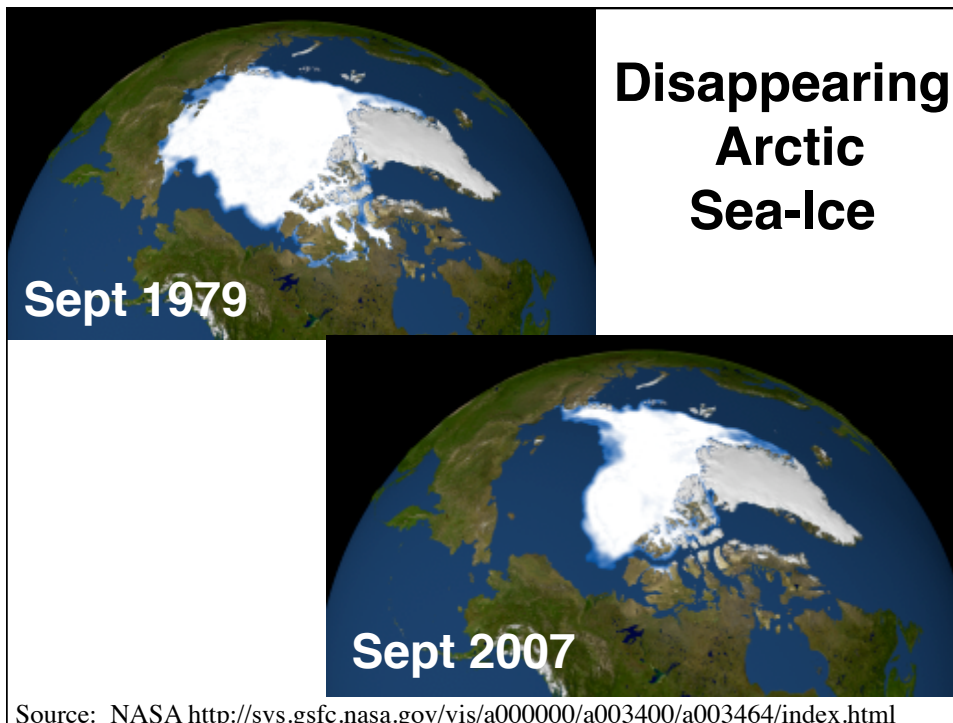
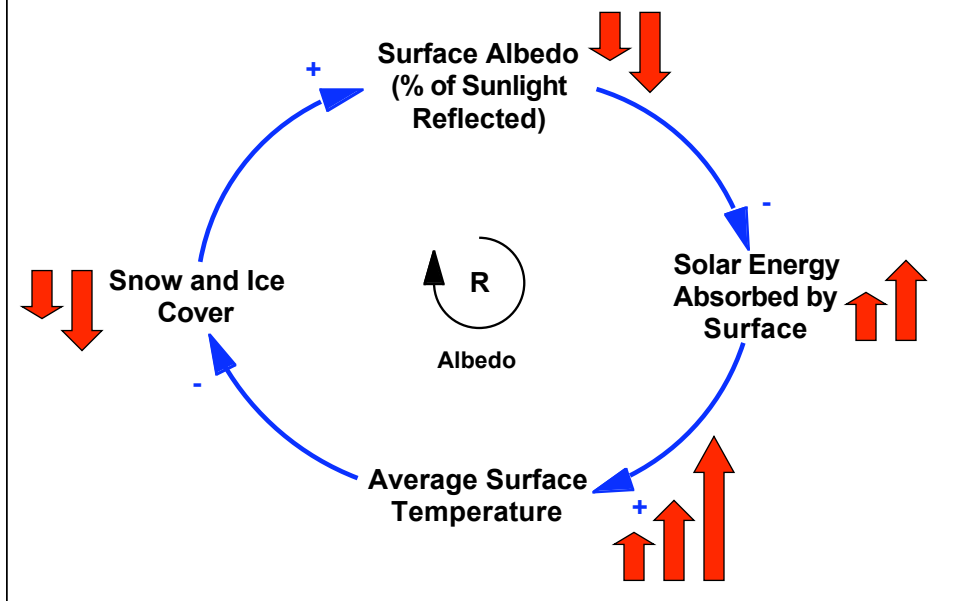
# Wildfire Incidence Growing

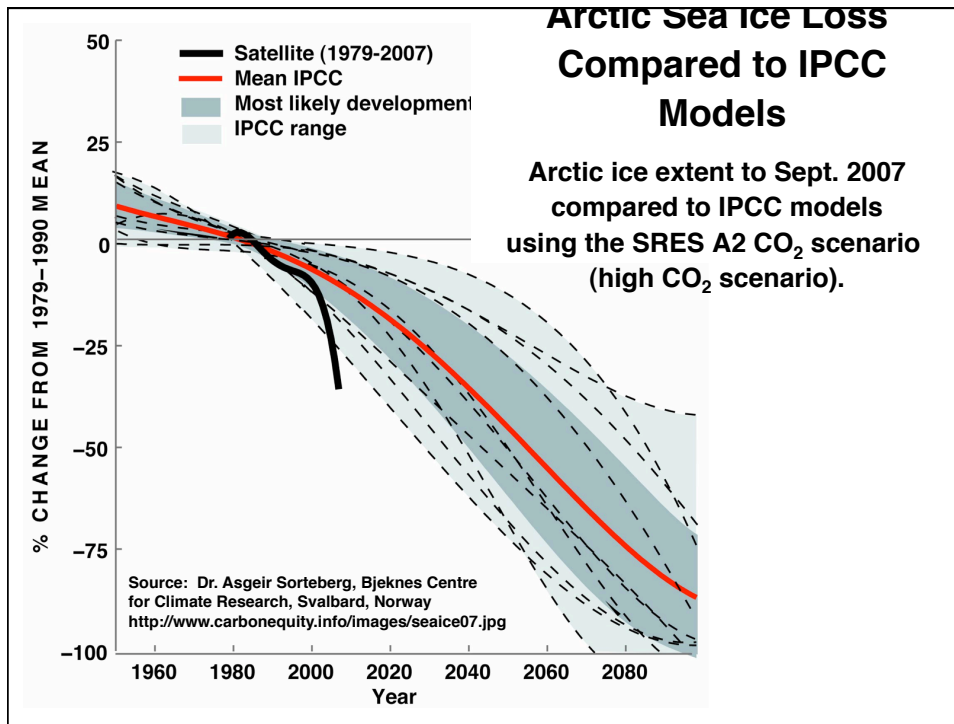
Science 18 August 2006 313: 927-928



Less moisture—more fires. Between 1970 and 2003, spring and summer moisture availability declined in many forests in the western United States (left). During the same time span, most wildfires exceeding 1000 ha in burned area occurred in these regions of reduced moisture availability (right). [Data from (4)]

# More Reinforcing Feedbacks





#### Greenhouse Gas Emissions Simulator

MIT Climate Online, a project of the MIT System Dynamics Group

Time Delays and Climate Change

Population (10 Billion)

Income / Capita (100,000 \$)

CO<sub>2</sub> / \$ (1 GtC/\$B)

TIME DELAY CONTROL:  no delay,  20 years delay,  40 years delay

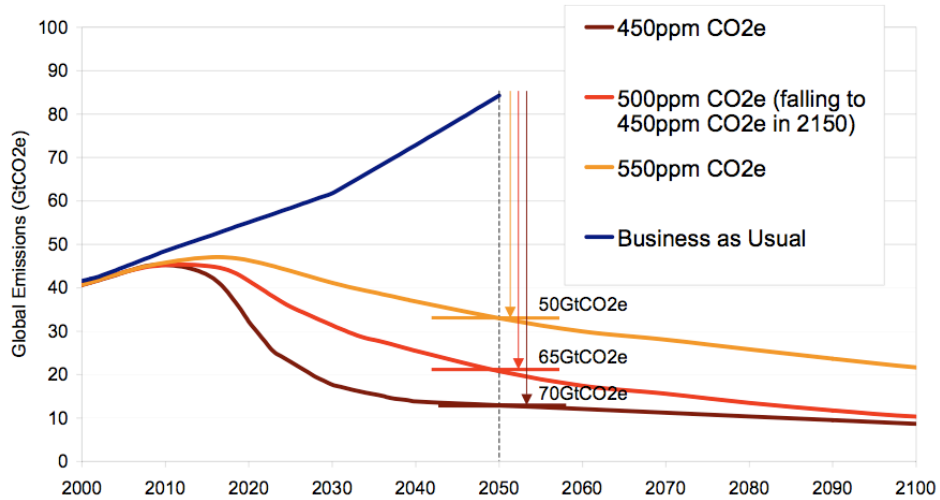
CO<sub>2</sub> Concentration in the Atmosphere (ppm)

CO<sub>2</sub> Emissions and Net Removal (GtC/year)

In this simulation, emissions are determined by population, income per capita and the carbon intensity of the economy. Carbon intensity responds with a delay to the action of the user, capturing long lags in reaching and implementing agreements to reduce emissions, deploying new technologies, and replacing existing capital stocks. In addition, participants can select different assumptions about the carbon cycle. In this simulation, removal of CO<sub>2</sub> from the atmosphere falls over time through the positive feedbacks described above.

See:  
<http://scripts.mit.edu/~jfmartin/sip/master/>

# Stabilizing GHG Concentrations Requires Large Drop in Emissions



Source: Stern Review, Fig. 8.4

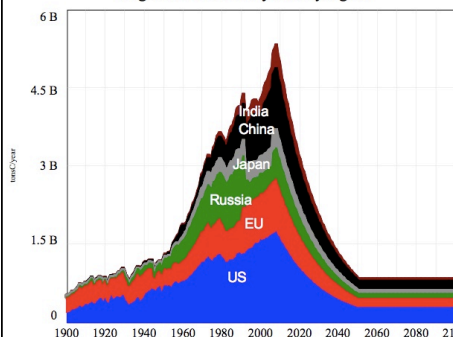
In more advanced versions of the simulator, global emissions are the sum of emissions from individual nations and regions. Participants work in teams representing the parties to the UNFCCC process to negotiate a global agreement to reduce GHG emissions. This simulation has been used with groups ranging from students at MIT to senior policymakers.

For examples of such model-supported "climate war games" see Climate Interactive <http://www.climateinteractive.org/> and the Center for a New American Security Climate Change Wargame: <http://www.cnas.org/climatewargame/>



Professor John Sterman checks in with students negotiating greenhouse gas emissions. Credit: Marc Bernsau

Regional Emissions by country/region



"Future News for a Future World"

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MONDAY, OCTOBER 5, 2015

## Climate Game Times

### Climate Change Group to Try Framework Agreement

**NEWS ANALYSIS**

creation of a new international disaster relief agency. Finally, the Secretary General will urge delegates to set a strategy for deep near-term reductions in greenhouse gas emissions and for speeding up the pace of innovation and commercialization of new energy technologies. The meeting takes place against a backdrop of growing global alarm and tension over global climate change. The last seven years have seen an increase in heatwaves, droughts, floods, wildfires, high food prices, and intense tropical storms, including Cyclone Bhola II, which killed nearly 200,000 people in Bangladesh in 2013, and the Category 5 hurricane that hit the Caribbean and Mexico in July of this year, causing an estimated \$75 billion in damage.

Representatives from China, the European Union, India and the United States convene today in Washington, D.C., to attempt to reach a Framework Agreement on Managing Long-Term Climate Change

Washington Today, humid, 95 degrees, severe thunderstorms in late afternoon, low 75.

**LEADERS DISCUSS ENVIRONMENT, NATIONAL SECURITY & WAR GAMES**

A Summary of Remarks by Hon. Carol Browner, Gen. Chuck Wald (Ret.) & Peter Schwartz

By CHRISTINE FATHENMORE

Last night, a crowd of more than 500 attendees heard from three experts about the intersection of climate change and national security and how to deal for an uncertain future. The speakers were part of the opening ceremonies of the four-day meeting on long-term disaster response.

The evening started with what was billed as a conversation between Carol M. Browner, former Administrator of the U.S. Environmental Protection Agency, and Chuck Wald, a retired four-star U.S. Air Force General.

Browner described several of the most alarming impacts of the effects of climate change projected by scientists fifteen years ago, when she was head of the EPA.

"The biggest difference with how this category is measured today is the expected sea level rise in low-lying coastal areas. It is now clear that climate change is far more than just an environmental issue," today, the business community is con-

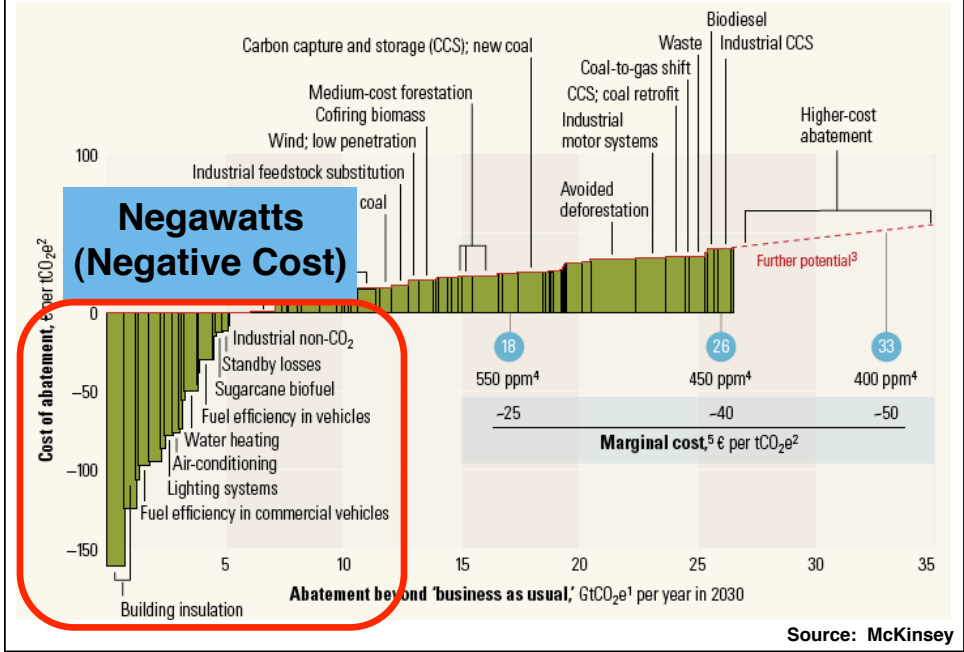
## **But won't it hurt the economy?**

- *“Responding to climate change is just too expensive”*
- *“It will slow economic growth and cost jobs”*
- *“It will put our country at a competitive disadvantage”*

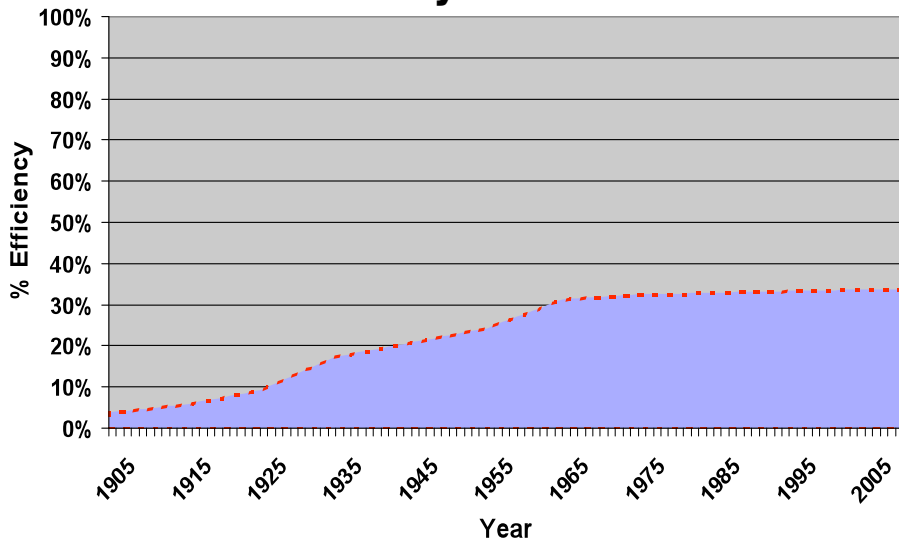
## **The Climate Dividend**

- **Cutting GHG emissions puts \$\$ in our pockets**
  - Cuts oil imports ( $\approx$  \$500 billion/year @ \$90/bbl)
  - Reduce need to defend insecure supplies
  - Reduce other harmful pollutants & their health costs, saving lives and money while improving quality of life
- **Investing in emissions reductions**
  - Stimulates innovation and new businesses that enhance competitiveness and create jobs
  - Creates opportunity for global leadership in emerging critical technologies
  - Getting cheaper every day

# Cost of GHG Abatement



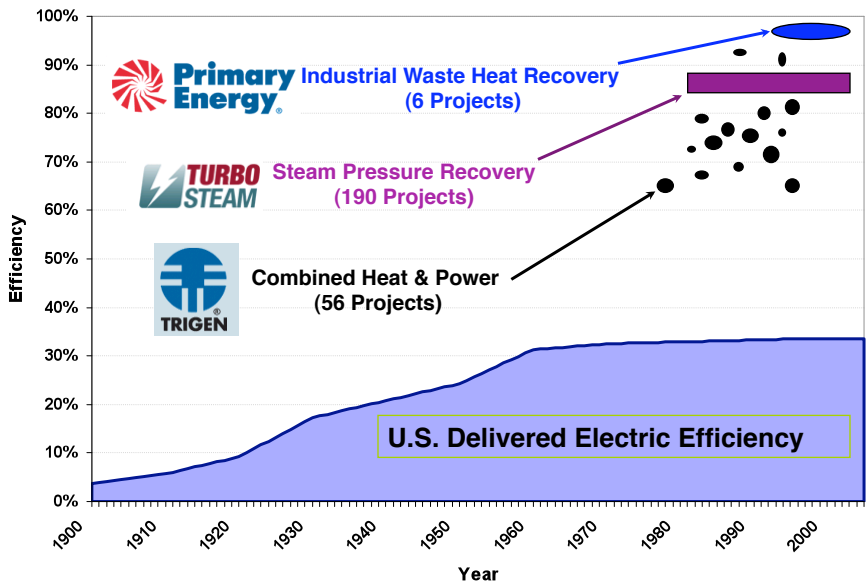
# Primary Efficiency Electricity Generation



Source: Thomas Casten, Recycled Energy Development; US EIA



# Energy Recycling Plants



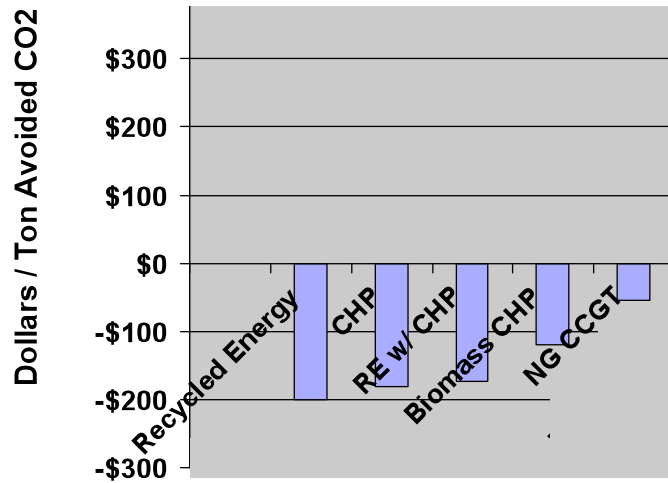
Source: Thomas Casten, Recycled Energy Development; US EIA

## Cokenergy, Mittal Steel (courtesy Tom Casten, CEO, Recycled Energy Development) Northern Indiana





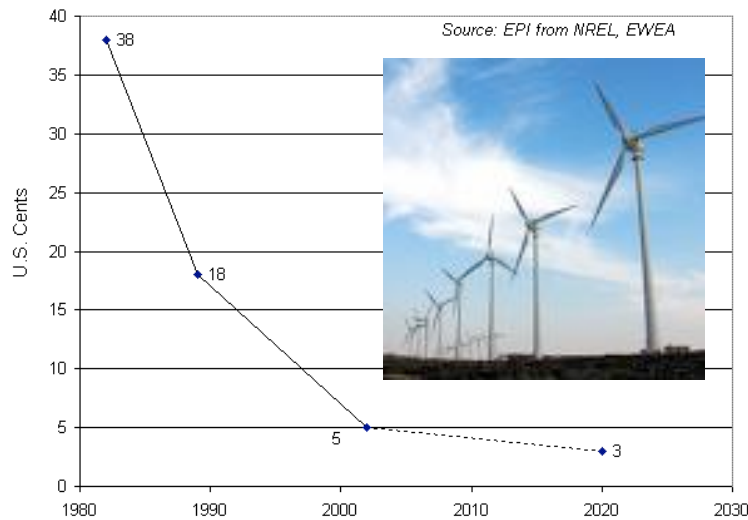
## Cost (Savings) / Ton of Avoided CO<sub>2</sub> Emissions for Recycled Energy and CHP



Source: Thomas Casten, Recycled Energy Development

## Cost of Wind Power

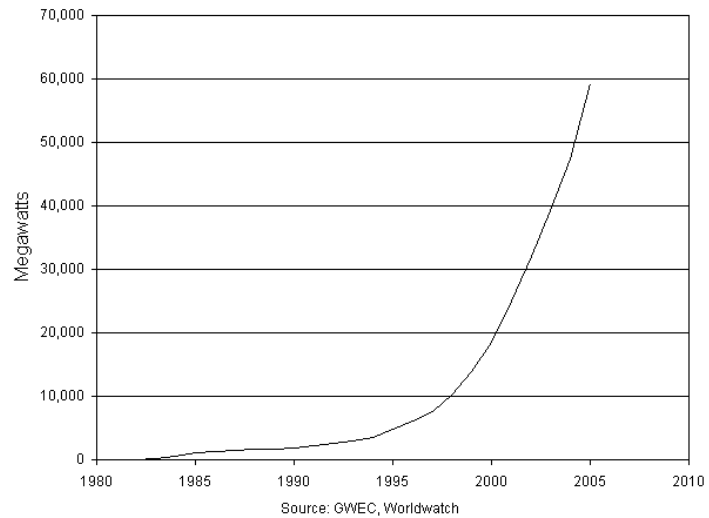
Average Cost Per Kilowatt-Hour of Wind-Generated Electricity, 1982-2002, with Projection to 2020



[http://www.earth-policy.org/Updates/2006/Update52\\_data.htm](http://www.earth-policy.org/Updates/2006/Update52_data.htm)

## Global Wind Power Capacity

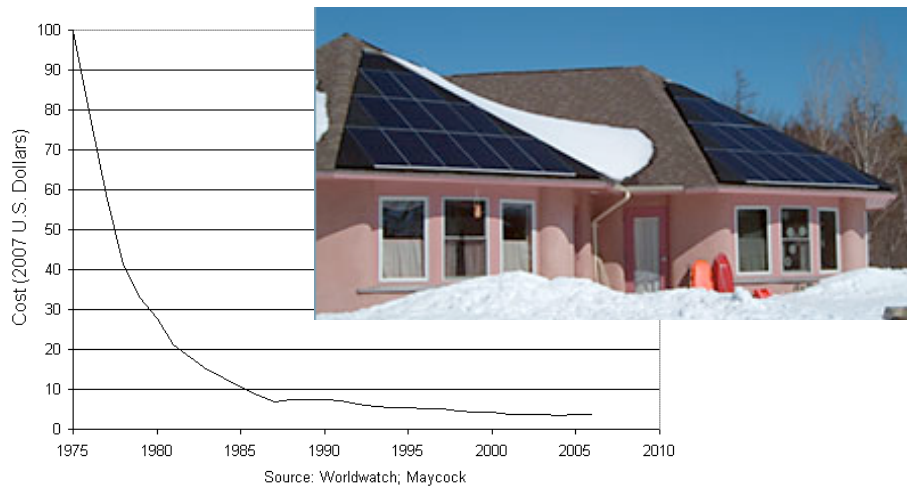
World Wind Electricity-Generating Capacity, 1980-2005



[http://www.earth-policy.org/Updates/2006/Update52\\_data.htm](http://www.earth-policy.org/Updates/2006/Update52_data.htm)

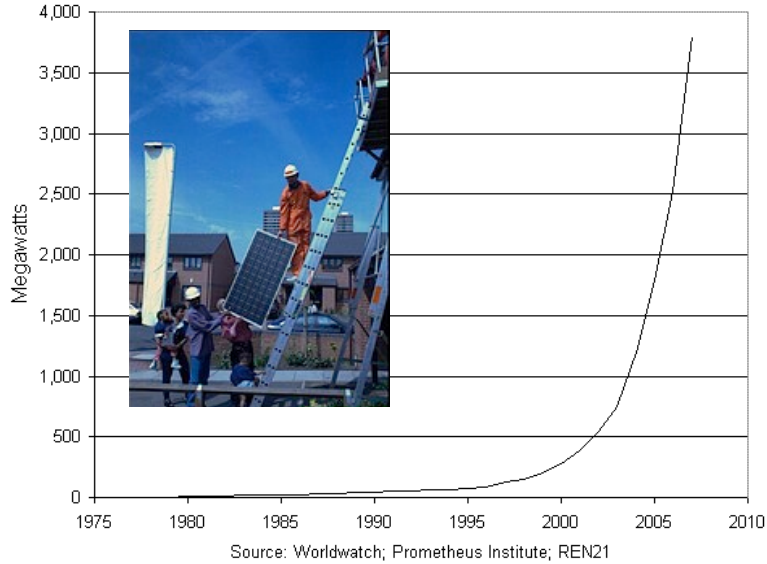
## Cost of Solar PV Power

World Average Photovoltaic Module Cost per Watt, 1975-2006



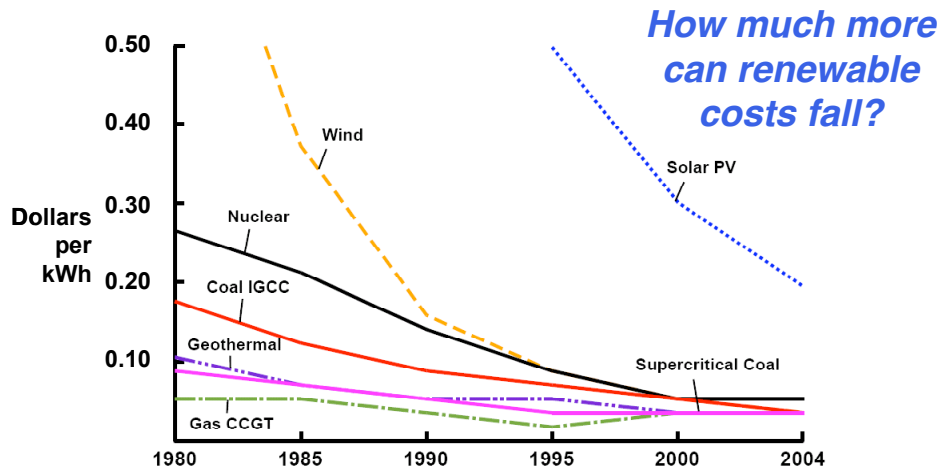
[http://www.earth-policy.org/Updates/2006/Update52\\_data.htm](http://www.earth-policy.org/Updates/2006/Update52_data.htm)

## World Solar PV Production



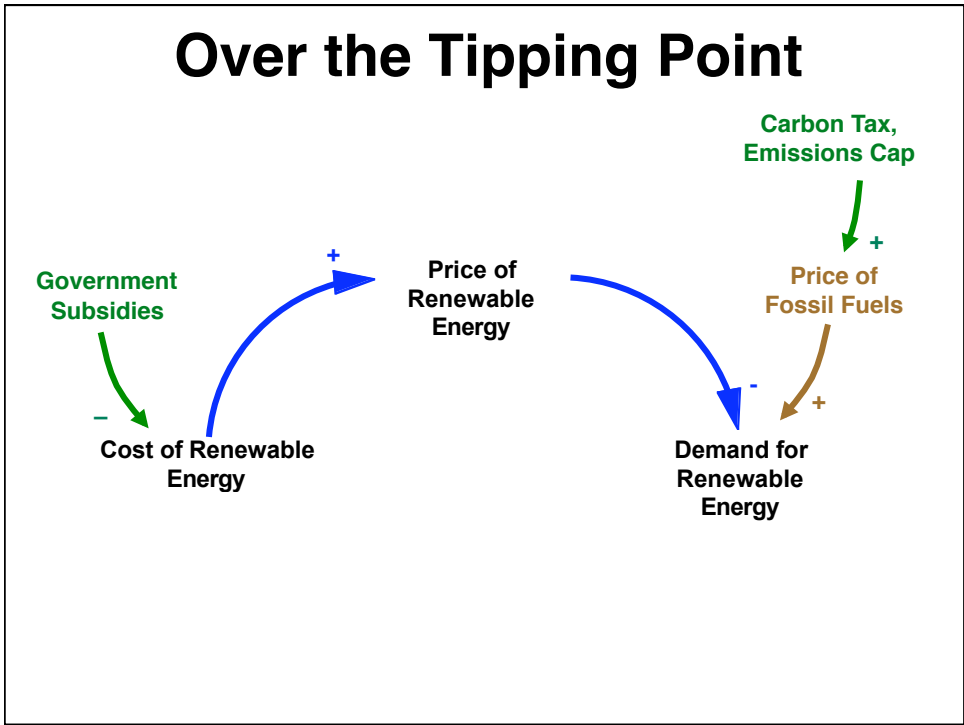
[http://www.earth-policy.org/Indicators/Solar/2007\\_data.htm#fig2](http://www.earth-policy.org/Indicators/Solar/2007_data.htm#fig2)

## Electricity Generation Costs



**Cumulative US solar energy production:  
 $\approx 0.0004$  of cumulative US fossil fuel production since 1950.**

# Over the Tipping Point



# Over the Tipping Point

