

THE ECONOMICS OF CLIMATE CHANGE: AN OVERVIEW

Great Swamp Watershed Association
13 December 2012

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American Gothic (Grant Wood, 1930)



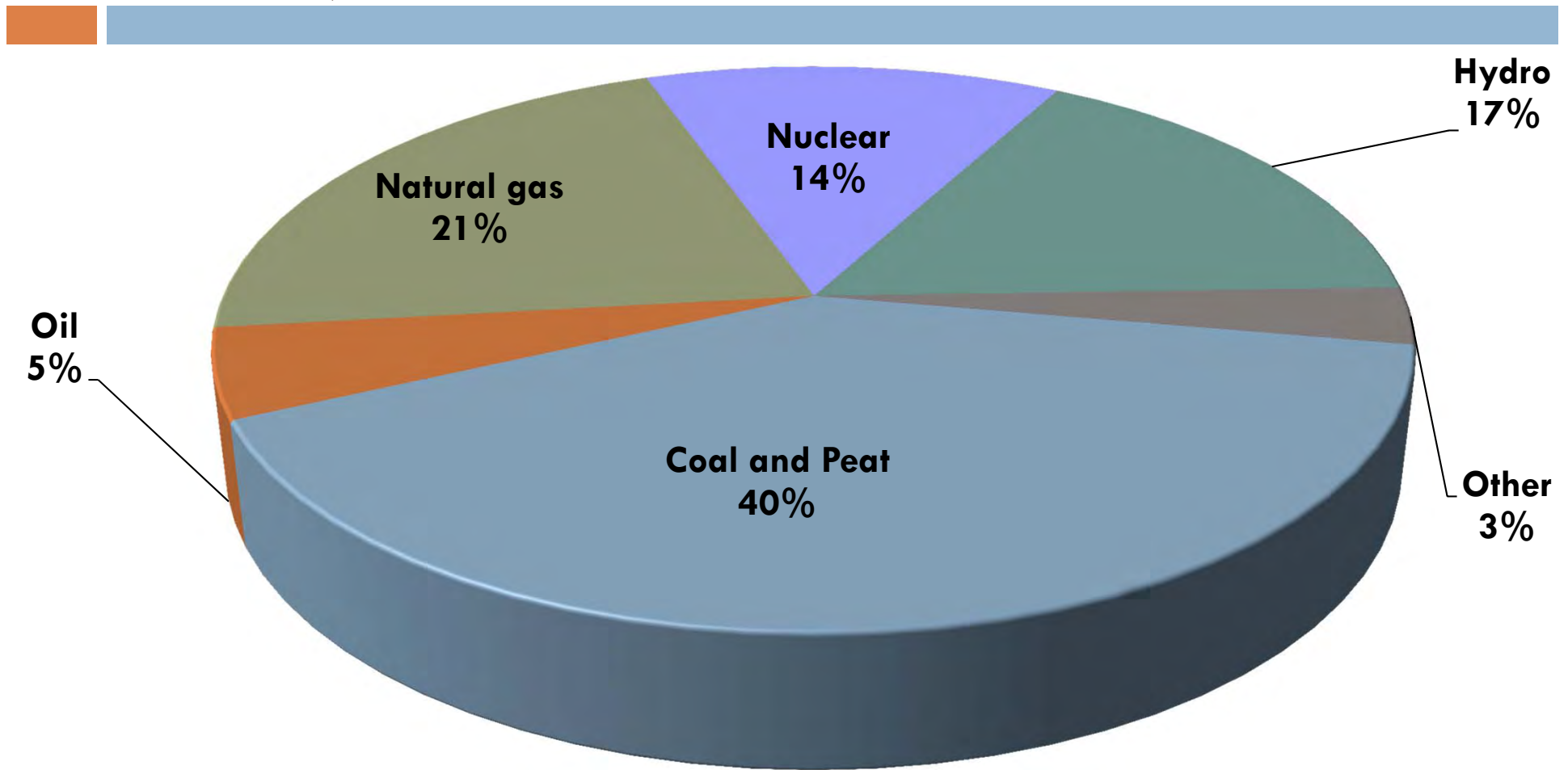
Source: The Art Institute of Chicago (http://www.artic.edu/artaccess/AA_Modern/pages/MOD_5_lg.shtml).

Addressing Climate Change



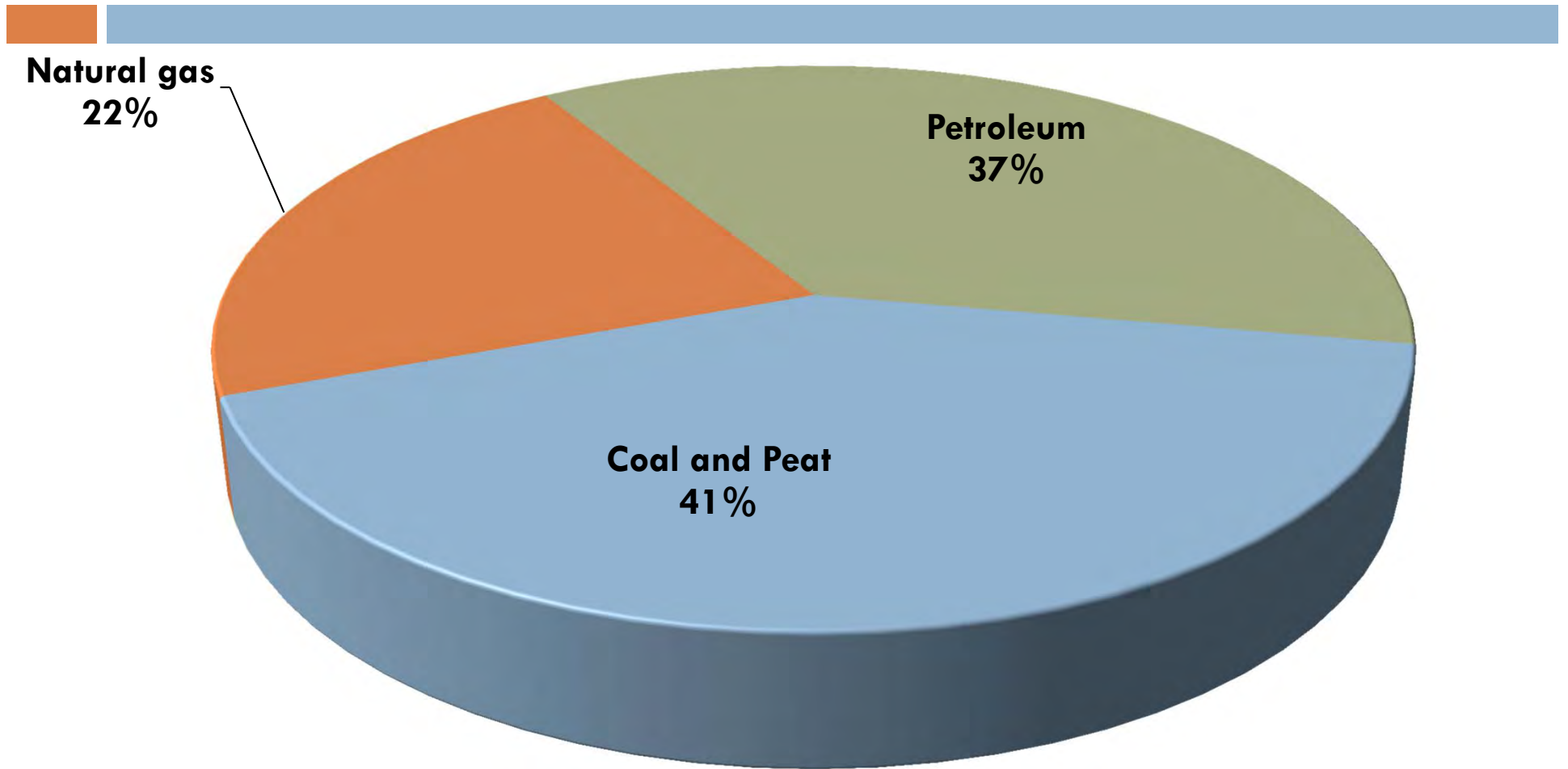
Source: *The Economist*, November 27-December 2, 2010.

World Electricity Generation by Fuel Source, 2009



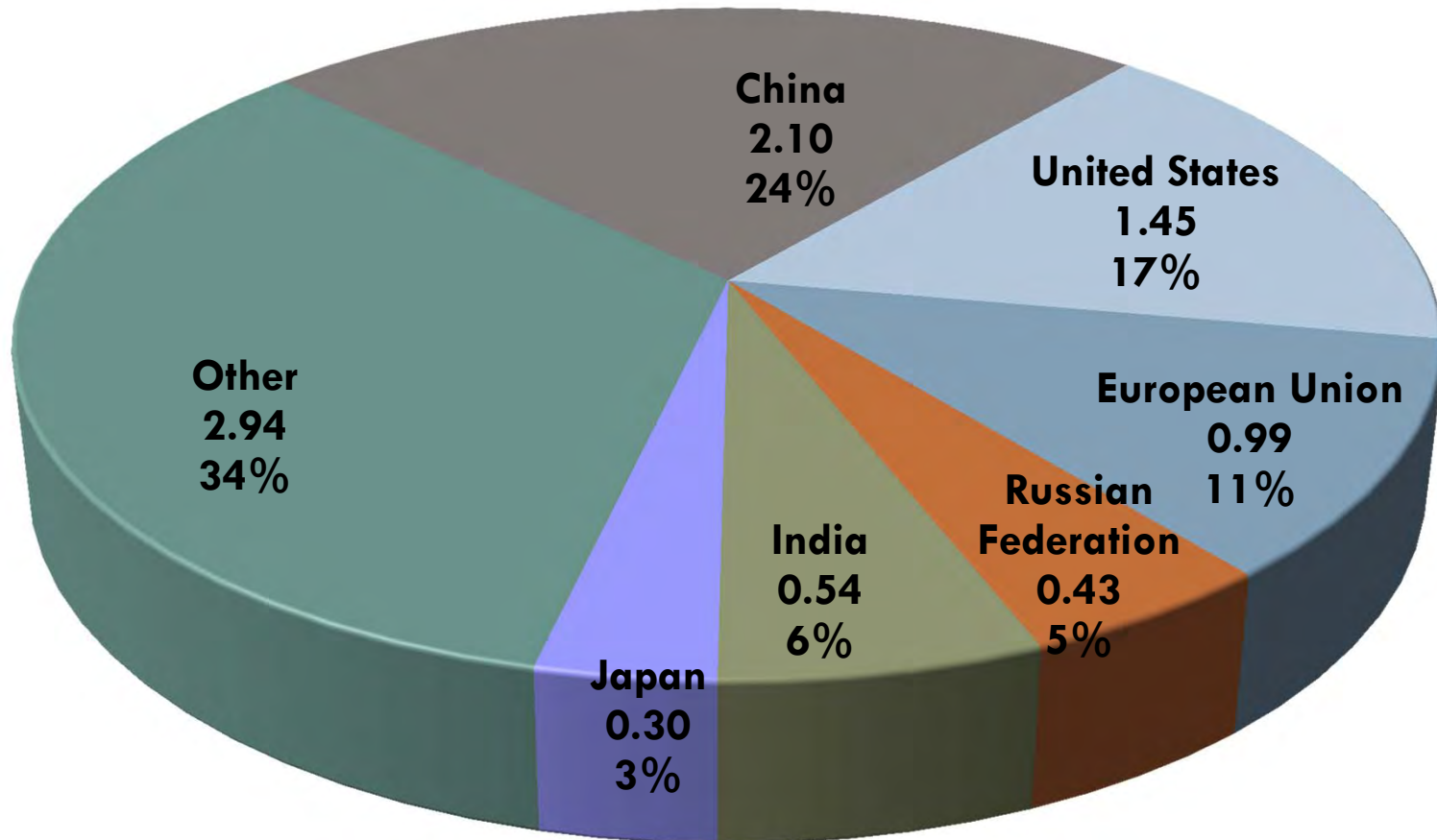
Global Total: 20.1 million GwH

World CO2 Emissions by Fuel Type, 2010



Global Emissions: 31.8 Billion Tons of CO2

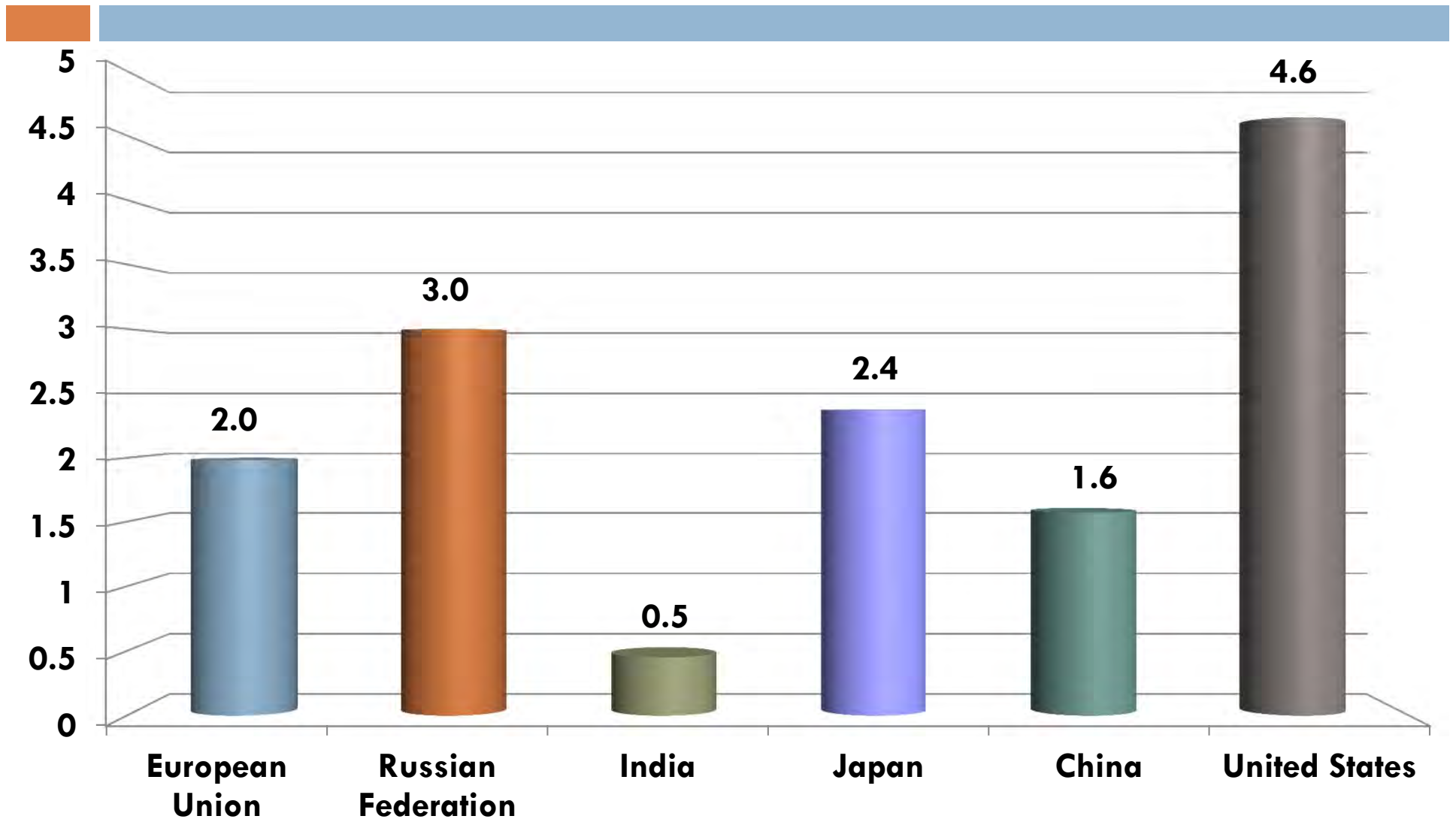
Fossil-Fuel CO₂ Emissions by Country, 2009 (billions of metric tons of carbon)



Global Emissions: 8.7 Billion Metric Tons of CARBON

Per Capita Emissions by Country, 2009

(in metric tons of carbon)



Source: Emissions Database for Global Atmospheric Research (EDGAR).

Implications of Carbon Emissions Data



- Global Issue
- Needs International Solution(s)
- How to mitigate/adapt to climate change?
- How to reduce carbon fuel emissions?
- Costs – who pays?
- Equity/Fairness

U.N. CO₂ Emission Reduction Targets for Selected Countries

Country	Target for 2020
United States	17% from 2005 level (4% from 1990) (stated goal, not legislated)
European Union	20%-30% reduction from 1990 level
China	40-45% per unit of GDP from 2005 baseline
Russia	15%-25% reduction from 1990 level

Markets: Information & Signals



- Prices
- Costs
- Outputs
- Incomes
- Employment
- Changes in all of the above

External Costs



- **External to Consumer or Producer**
- **A Cost is generated**
- **But not reflected in market**
- **Market Outcomes are wrong (inefficient)**

Examples of External Effects of Carbon Based Energy

- Downwind damages from coal combustion
- Sea-level rise from CO₂ emissions
- Storm frequency and severity
- Droughts/Floods
- Ecological system disruption
- Threshold catastrophe(s) (rapid melting of Greenland ice sheet)
- Public health hazards

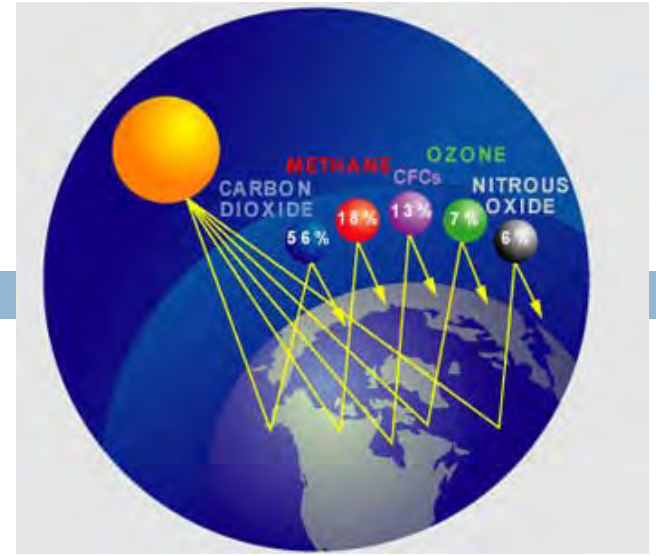
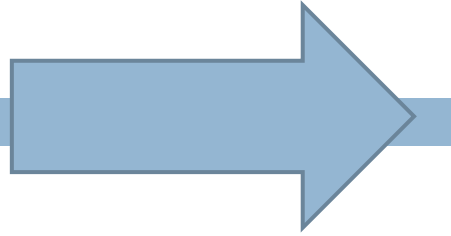
Issues: External Costs of Climate Change from CO₂ Emissions



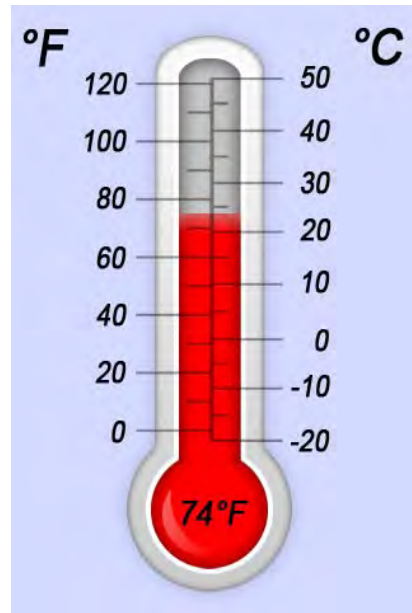
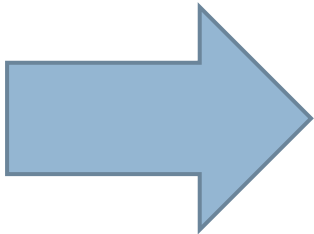
- Complex and Uncertain
- Effects Increase with Time
- Difficult to Measure in \$
- Changes in Probabilities of Large Catastrophes (heat waves, floods, hurricanes, etc.)



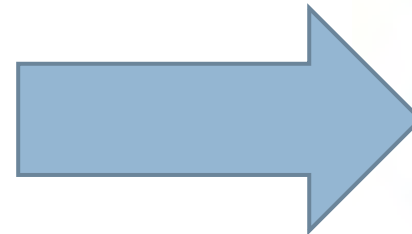
Emissions



GHG Concentrations



Temperature Change



**Economic Damages
Social Cost of Carbon**

External Cost of Carbon Estimate

U.S. Interagency Working Group, 2010



- \$42 (in \$2007) per ton of CO₂ emitted in 2020
(central tendency – wide variation)
- What's in the number?
 - Agriculture
 - Health
 - Ecosystem services
 - Property damages

Demand Side Policies



Can policies reduce and redirect energy demand to less carbon-intensive energy sources?

- **For consumers who use heating and cooling, transportation, etc.?**
- **For *businesses* that use energy as an input?**
- **For public sector energy use (federal, state, local governments.)?**

Supply Side Policies



Lower the amount of energy produced from carbon fuels

Provide incentives to change how energy is generated

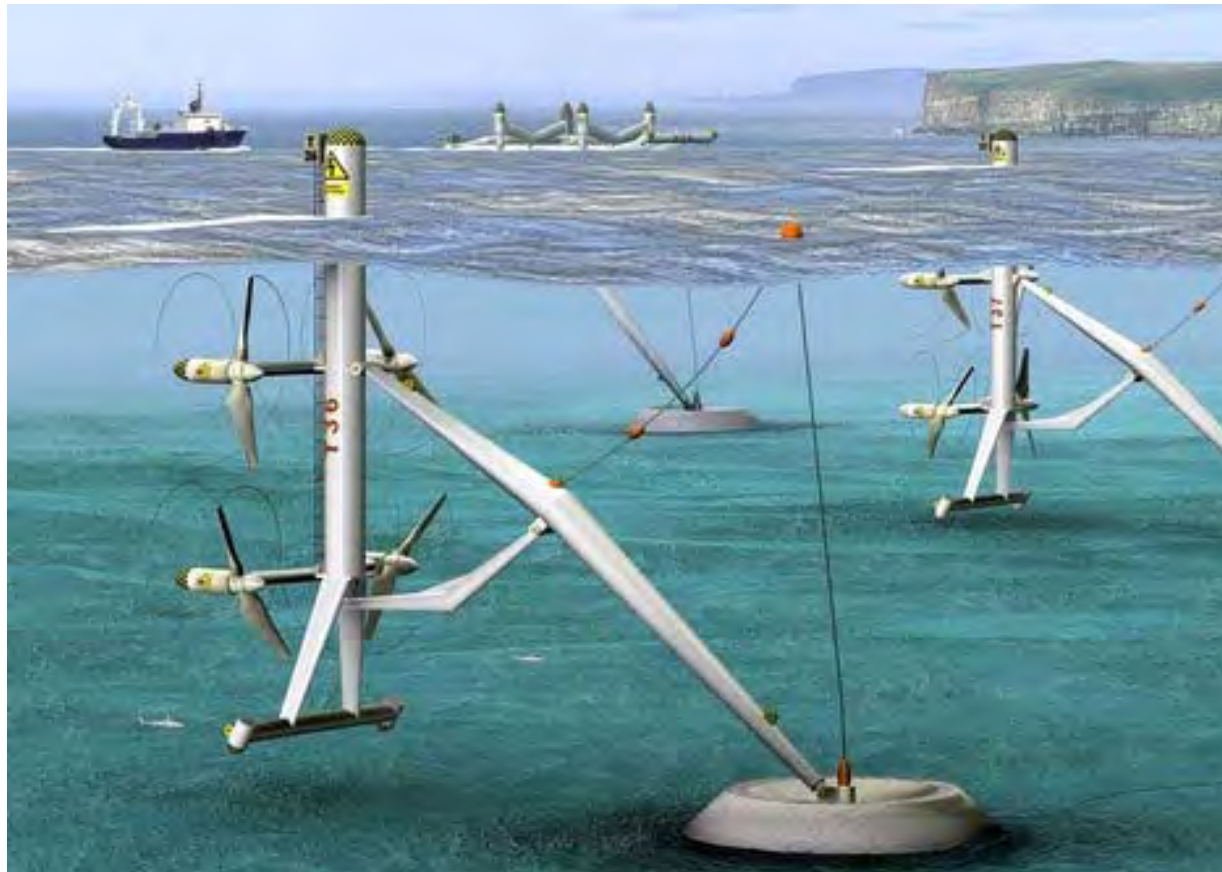
Supply Side Policy: Technology

Incentives for new/clean Energy Technology

- Solar
 - Wind
 - Biofuels
 - Nuclear (?)
 - Hydroelectric
-
- INNOVATION!

Next-Generation Technologies

Tidal Farms



Key Issues in Alternative Fuels



Are the technologies scalable?

What are the costs of new energy sources?

Are the costs competitive?

Public Policies To Change Energy Market Outcomes



- Regulations
- Taxes
- Subsidies
- Market Incentives

Policy Examples: Regulation

Technology Standards:

Require specific technologies

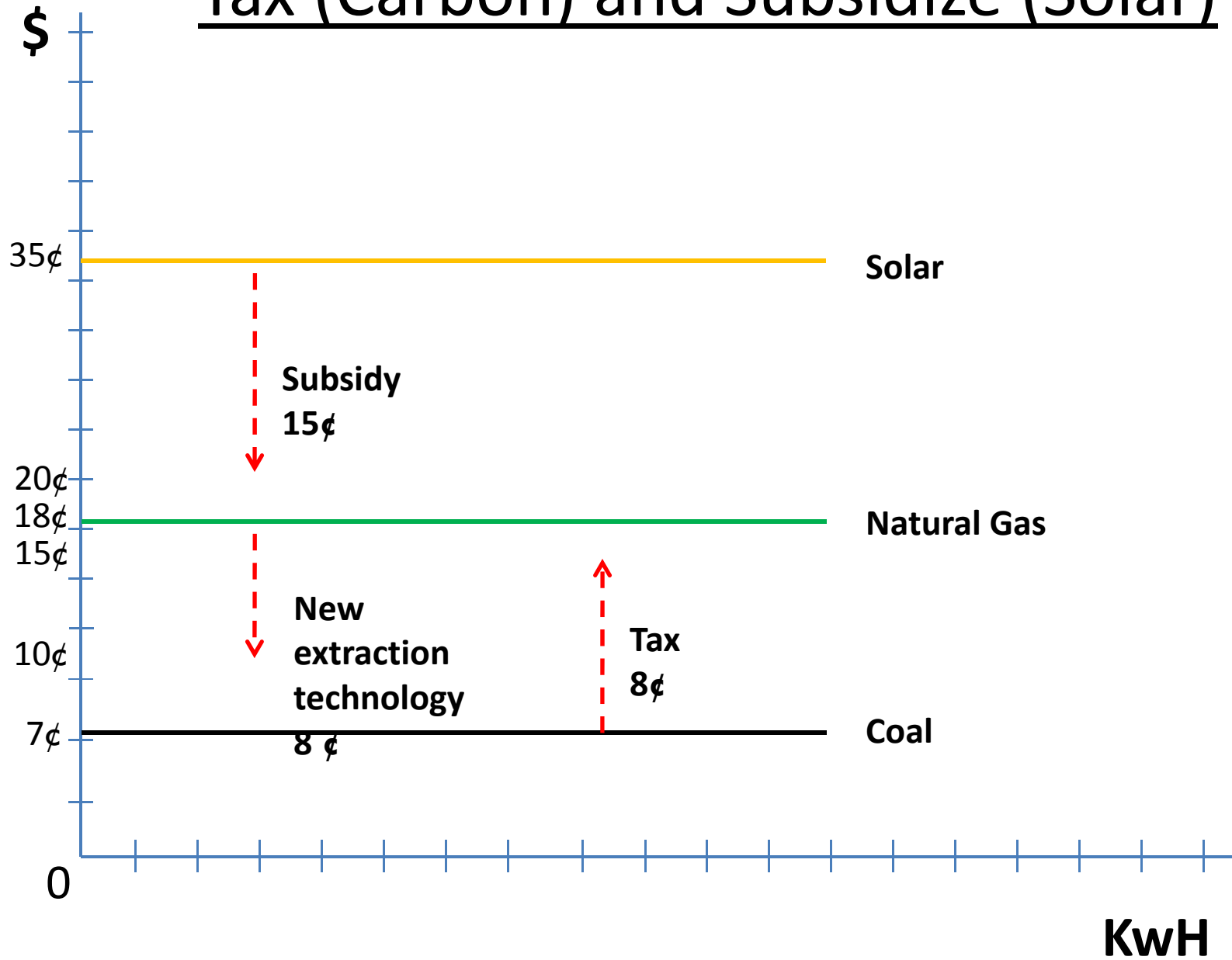
Performance Standards:

Producers meet them however they choose

Ambient Standards:

Target for ambient levels of carbon, temp., etc.

Tax (Carbon) and Subsidize (Solar)



Economic Implications of Tax/Subsidy Policies



- **Who pays subsidies?**
- **Do subsidies (ever) end?**
- **Can we put a price on carbon?**
- **Prices and costs matter!**

The New Age of Sail!









Carbon Tax Policy Examples

Country	Carbon Tax
Sweden	\$150 (US) / ton CO ₂
British Columbia	\$30 (CAN) / ton CO ₂
Australia	\$23 (AUS) / ton CO ₂
Norway	\$15 - \$62 / ton CO ₂

Cap and Trade



Source: The Economist.

Advantages of Cap and Trade

The CAP creates scarcity and can be tightened

The carbon price creates incentives to reduce emissions

Emitters can trade among themselves

Lowens the overall cost of CO₂ reduction

Cap and Trade Examples



- California – GHG Cap and Trade Program (2012!)
- U.S. - SO₂ Emissions (Acid Rain Reduction) (1990)
- European Union – GHG Emissions Trading Scheme
- New Zealand – Emissions Trading Scheme

Mitigation vs. Adaptation: Example



- **Sea Level Rise/Storm Surge (one of many consequences of global warming)**
 - **Is it more cost effective to:**
 - **Reduce emissions to prevent it?**
 - **Or to develop ways to deal with the consequences after it has happened? E.g., defense, strategic retreat**

 - **Example: What to do for the Jersey Shore?**

The Jersey Shore



Source: http://www.hi-techboats.com/Website_Pics/NEW_JERSEY_INLETS/07_Great_Egg_Harbor_Inlet.JPG



Photo by Brian Thompson. Accessed from <http://inhabitat.com/nyc/this-roller-coaster-is-in-the-ocean-thanks-to-hurricane-sandy/>

Sediment Budget Impacts

beach budget versus dune budget



Psuty, May, 2011

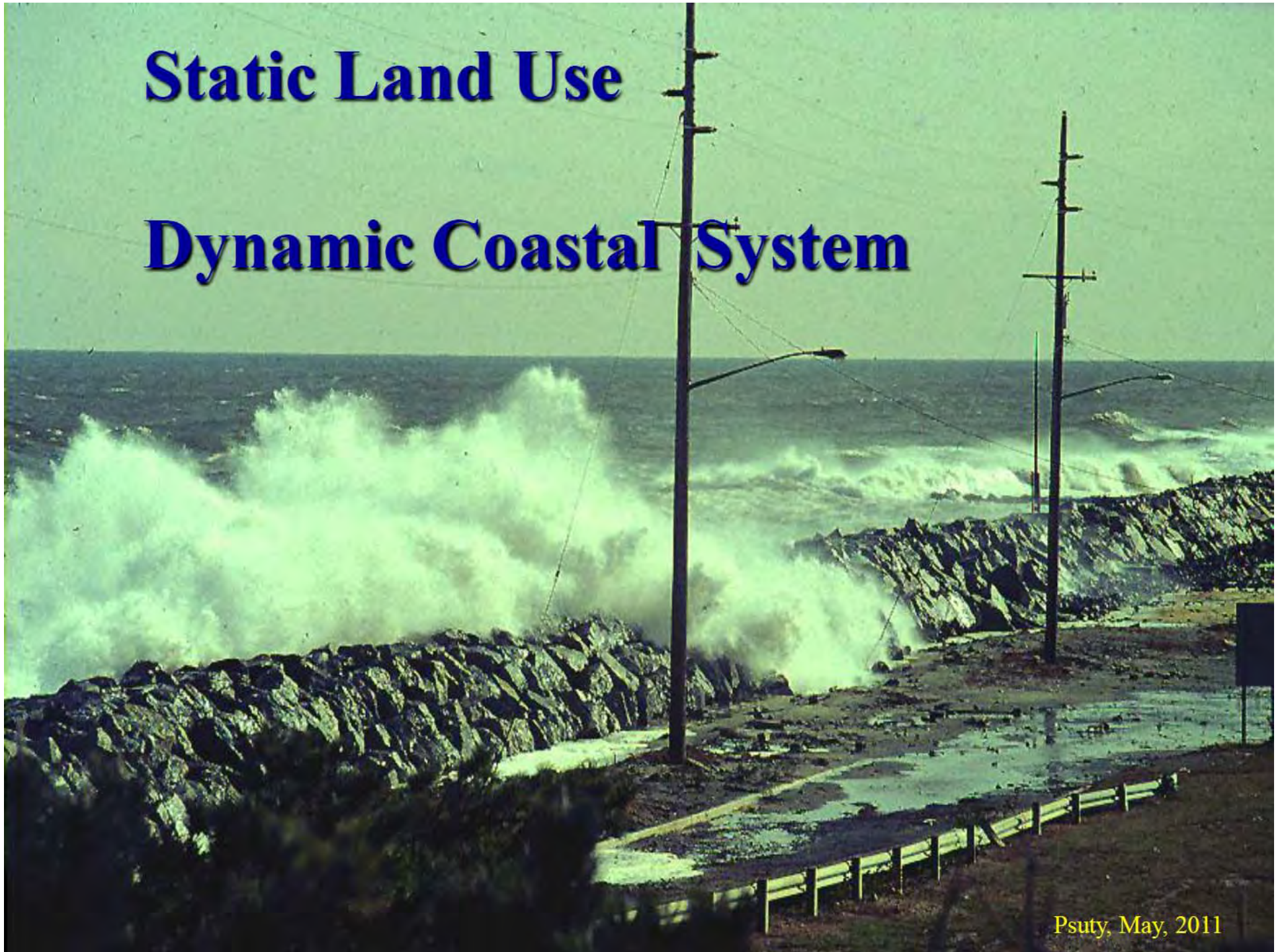


Beach and Dune Displacement

Psuty, May 2011

Static Land Use

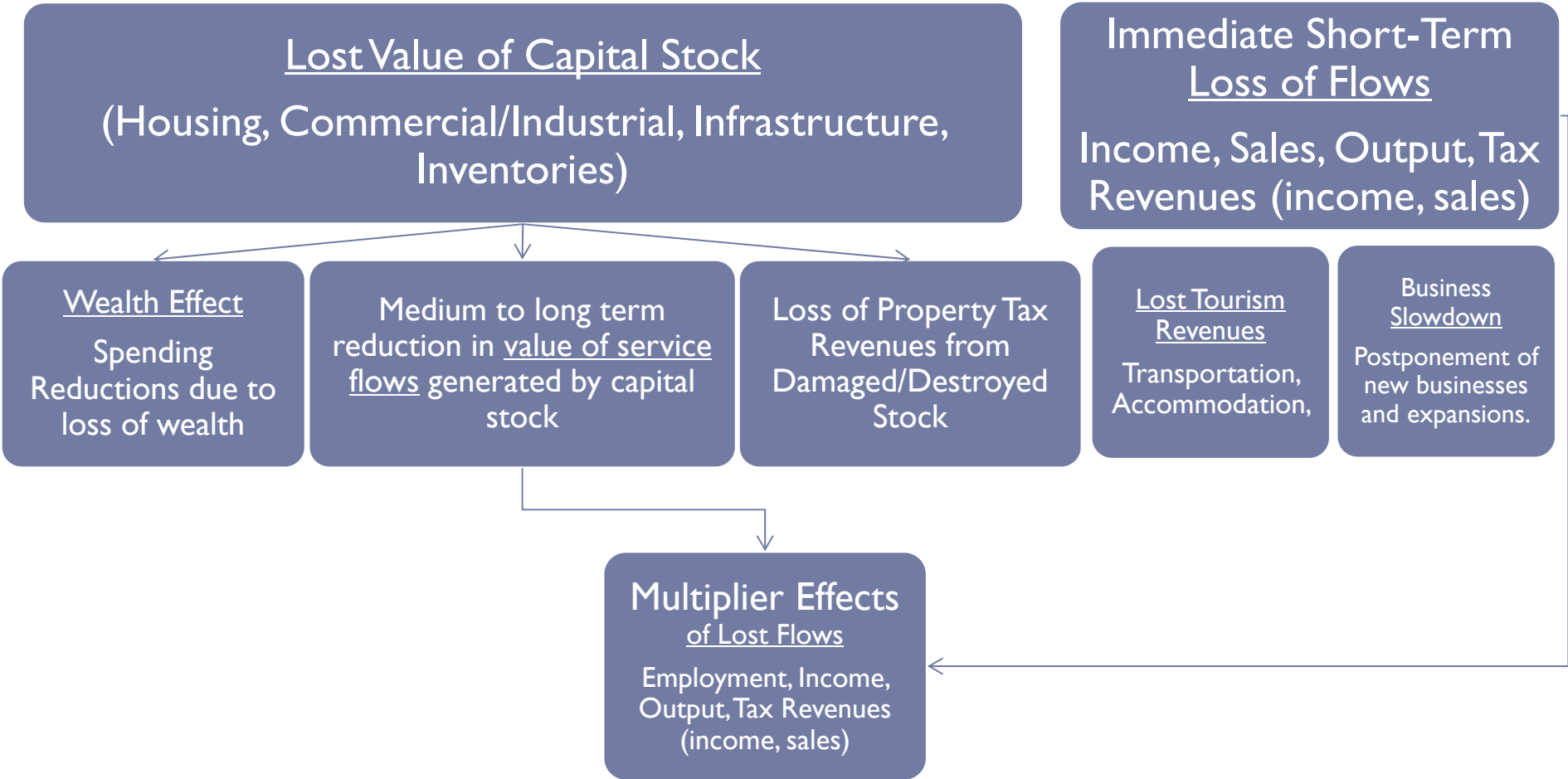
Dynamic Coastal System



Psuty, May, 2011

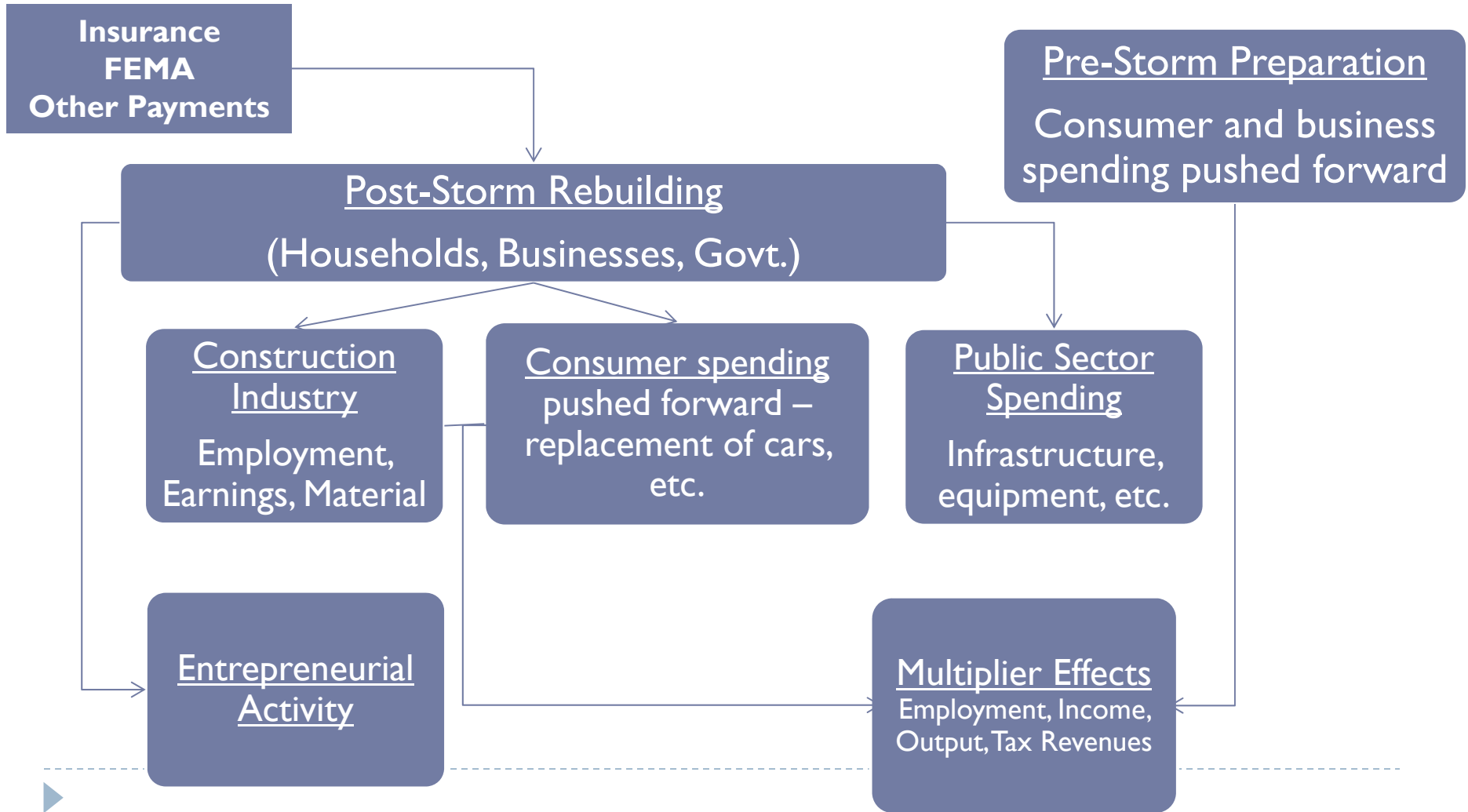
Negative Impacts of Sandy

Losses in Economic Activity



Offsetting Impacts of Sandy

Gains in Economic Activity



References



- *The Challenge of Global Warming: Economic Models and Environmental Policy*. Nordhaus, William, Yale University, July 2007.
http://nordhaus.econ.yale.edu/dice_mss_072407_all.pdf
- *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use* (Press Release and Executive Summary). National Research Council, October 2009.
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References

- *Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866*, Interagency Working Group on Social Cost of Carbon, U.S. Government, 2010.
- Integrated Assessment Models:
 - ▣ DICE: <http://sedac.ciesin.columbia.edu/mva/iamcc.tg/TGsec4-2-15.html>
 - ▣ PAGE: <http://sedac.ciesin.columbia.edu/mva/iamcc.tg/TGsec4-2-16.html>
 - ▣ CFUND: <http://sedac.ciesin.columbia.edu/mva/iamcc.tg/TGsec4-2-21.html>