

11-17-2009

## Climate Change Economics 101

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# Climate Economics 101

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Adele C. Morris, Ph.D.

Fellow

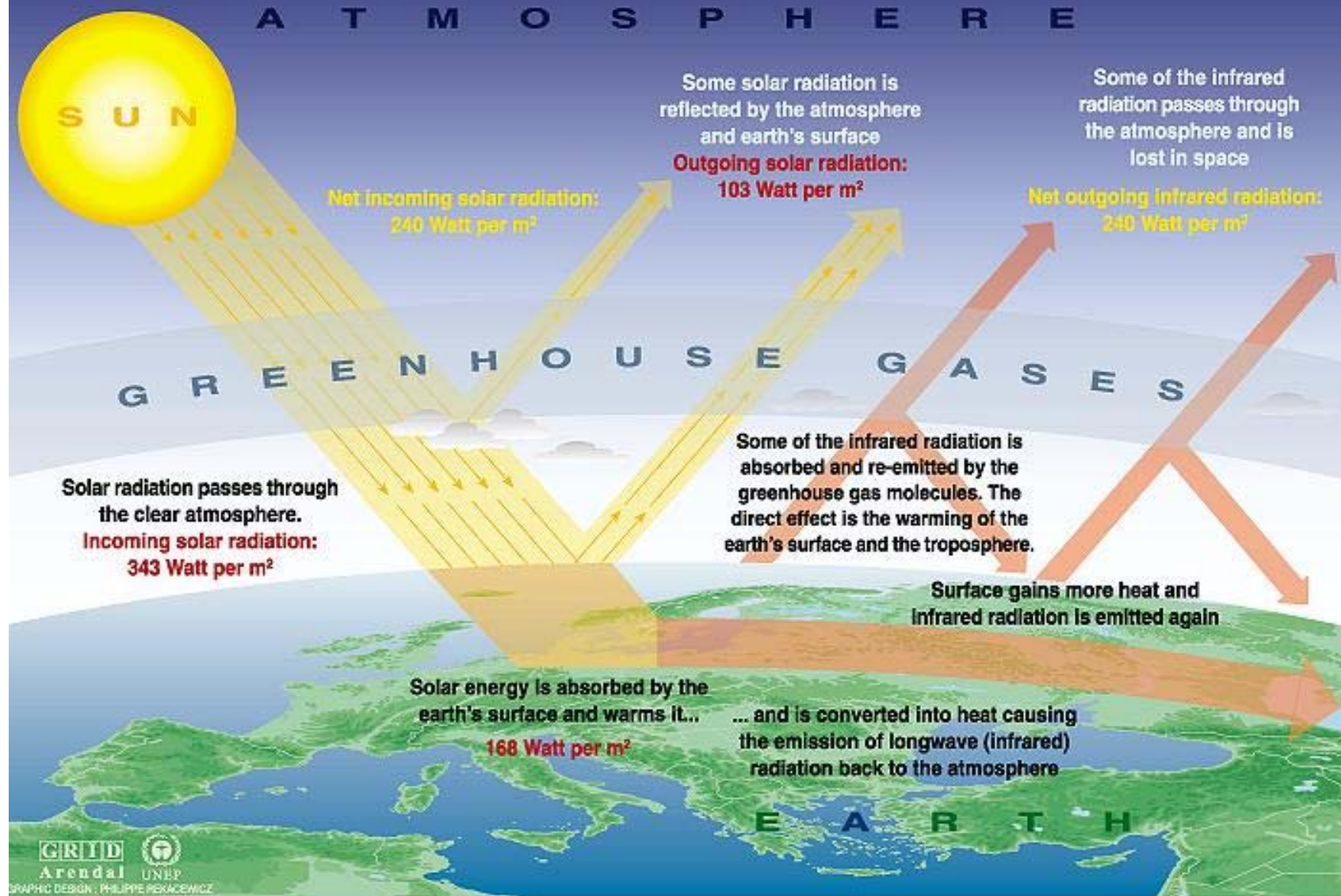
Policy Director, Climate and Energy Economics Project  
The Brookings Institution

November 17, 2009

# Outline of Talk

- Climate change is a market failure
- Climate and energy facts
- Economically efficient policy design
- Economics of Domestic Legislation

# The Greenhouse effect



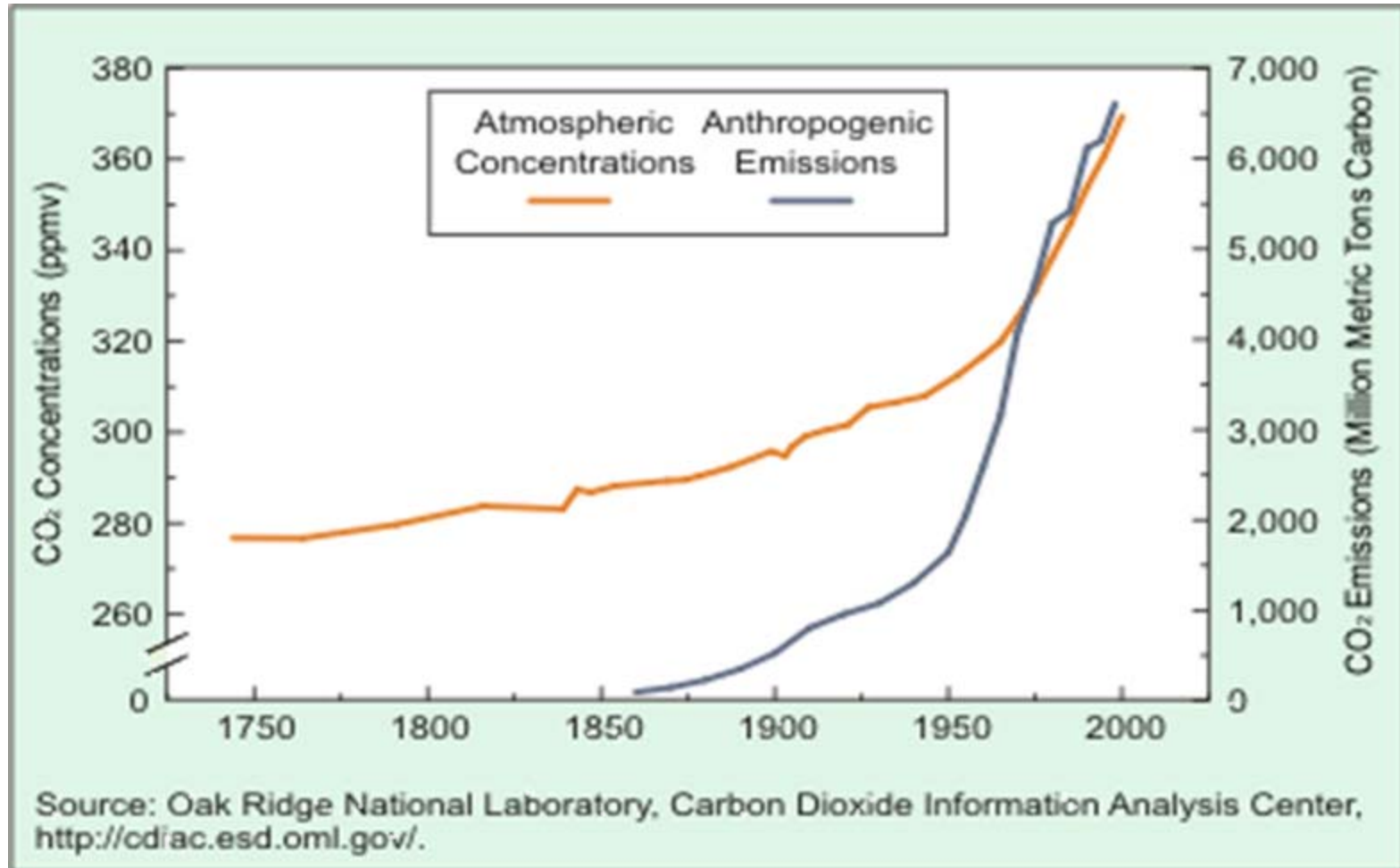
Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

Problem: Excess Radiative Forcing, measured in Watts per meter squared

# Climate Change is a Global Environmental Externality

- The risk of global climate change is an external cost of greenhouse gas emitting activities.
  - » The price of fossil fuels doesn't include the cost to the environment.

# CO<sub>2</sub> Emissions Drive Increased Concentrations

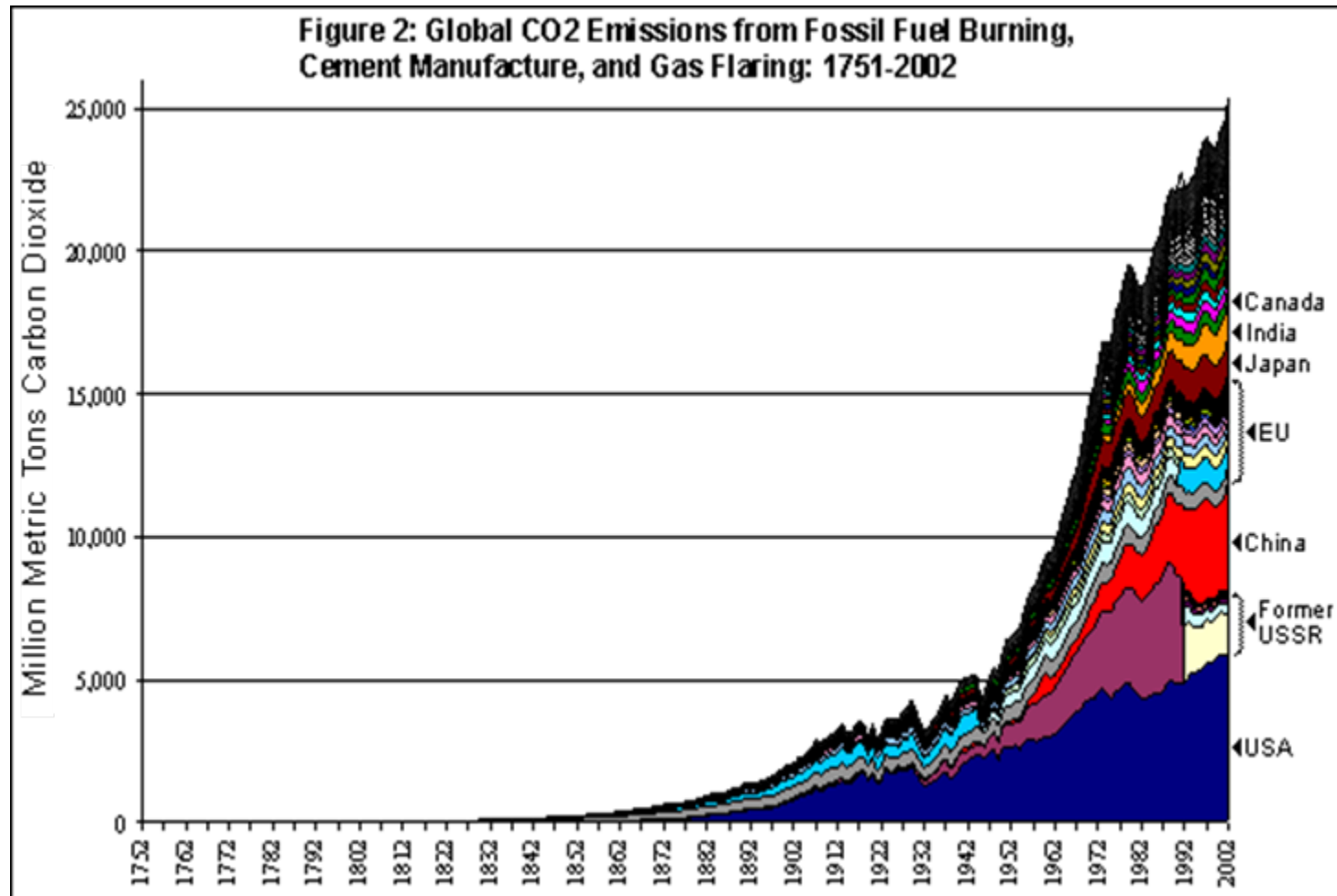


# Uncertainties

- Uncertainty in costs and benefits of mitigation
- Uncertainty in timing, extent, and location of impacts
- Uncertainty about relationship between concentration and temperature

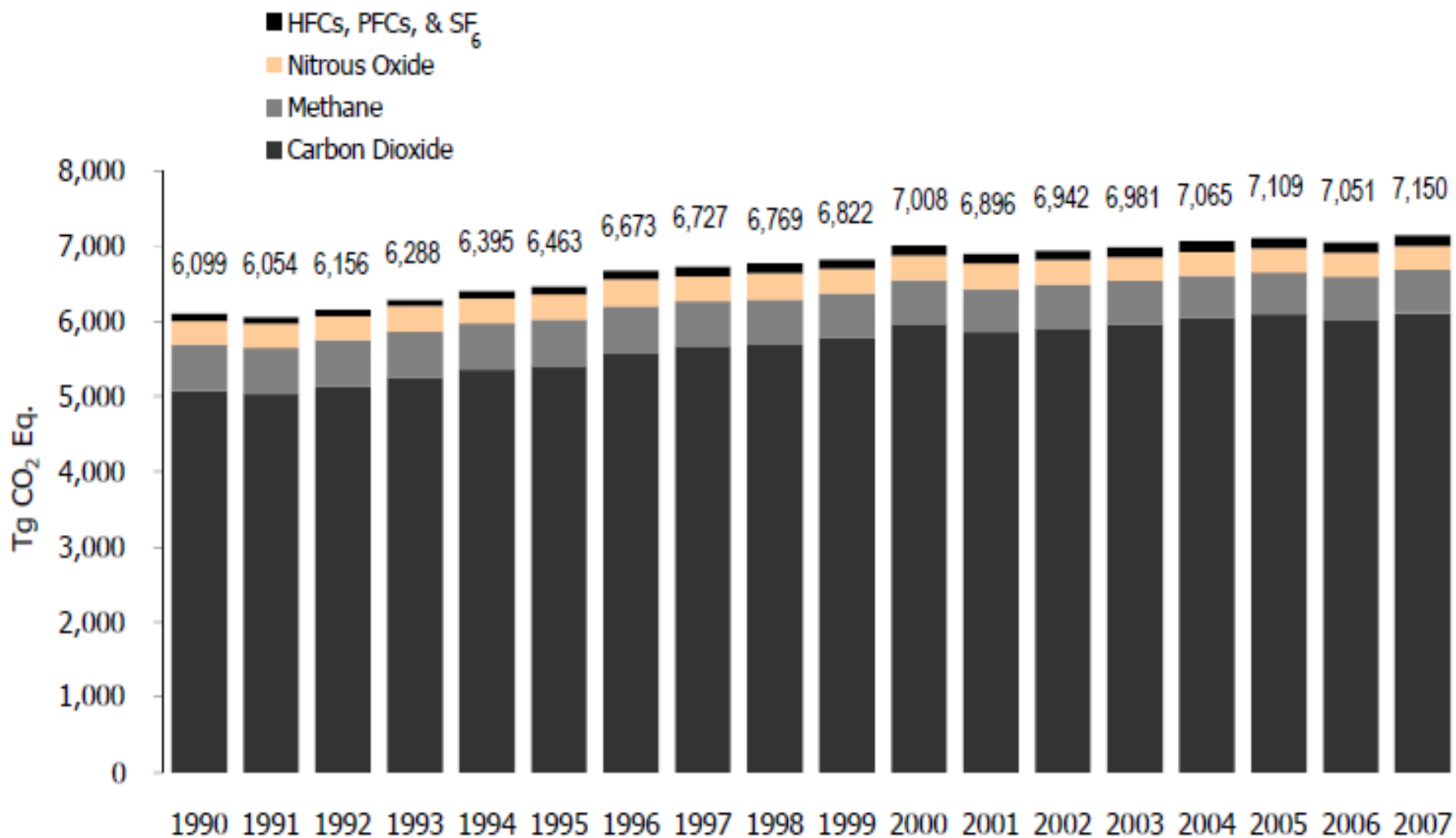


## Cross-country Comparison of Carbon Emissions Over Time (Not Counting Deforestation and Other Important Sources)



Source: <http://www.epa.gov/climatechange/emissions/globalghg.html>





Source: EPA, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2007  
(April 2009)

# What is an efficient policy outcome?

- Level of climate protection that maximizes net social benefits.
- Need least cost abatement & efficient long run stabilized concentration.
- Costs of mitigation justified by benefits of climate risk reduction.

# Complications

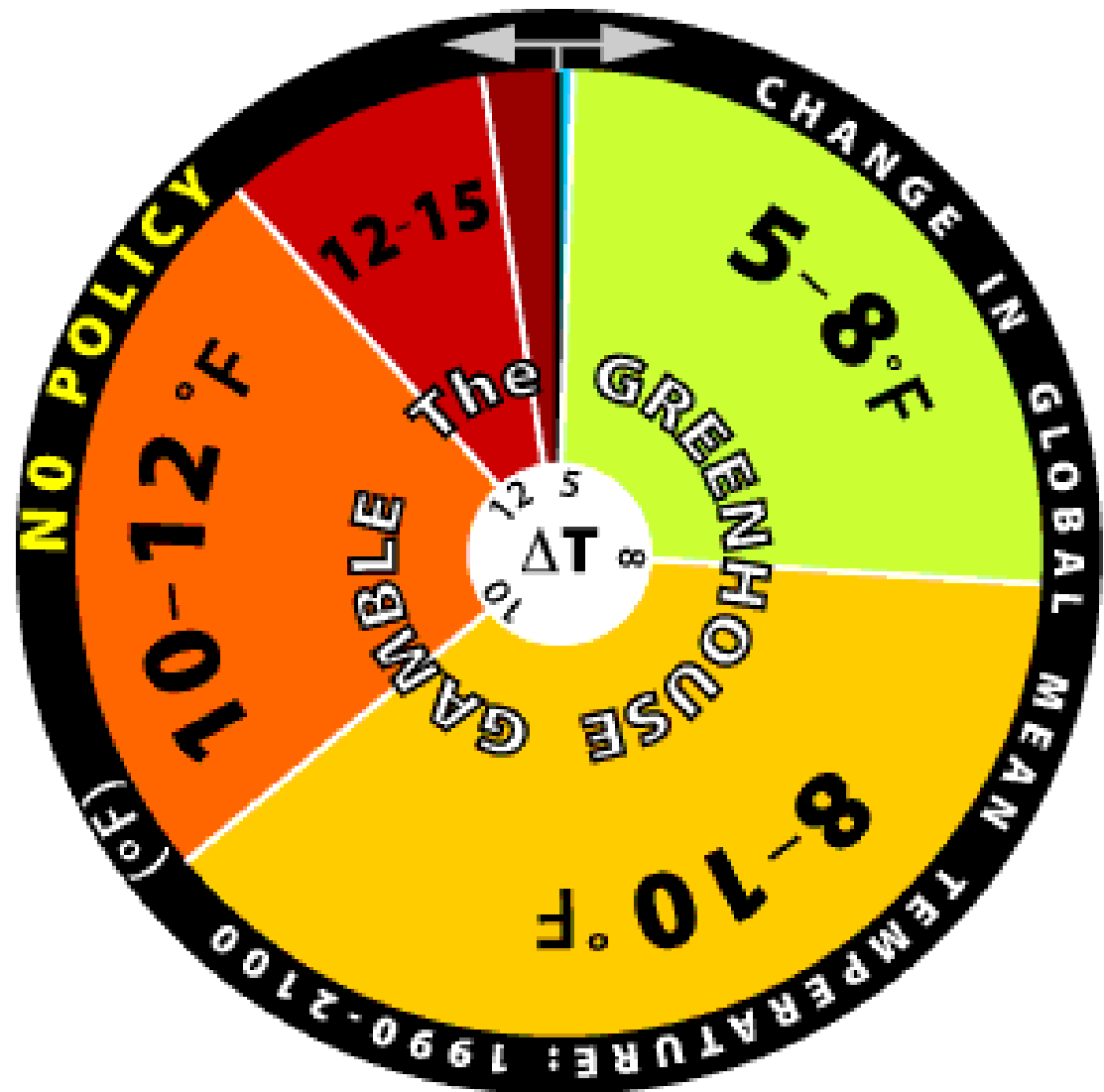
- How to monetize human health and ecological effects of climate disruption?
- Who bears costs and who benefits are different
- Is mitigating climate change the best way spend the incremental dollar to help the poor and vulnerable?

# Mitigation Benefits

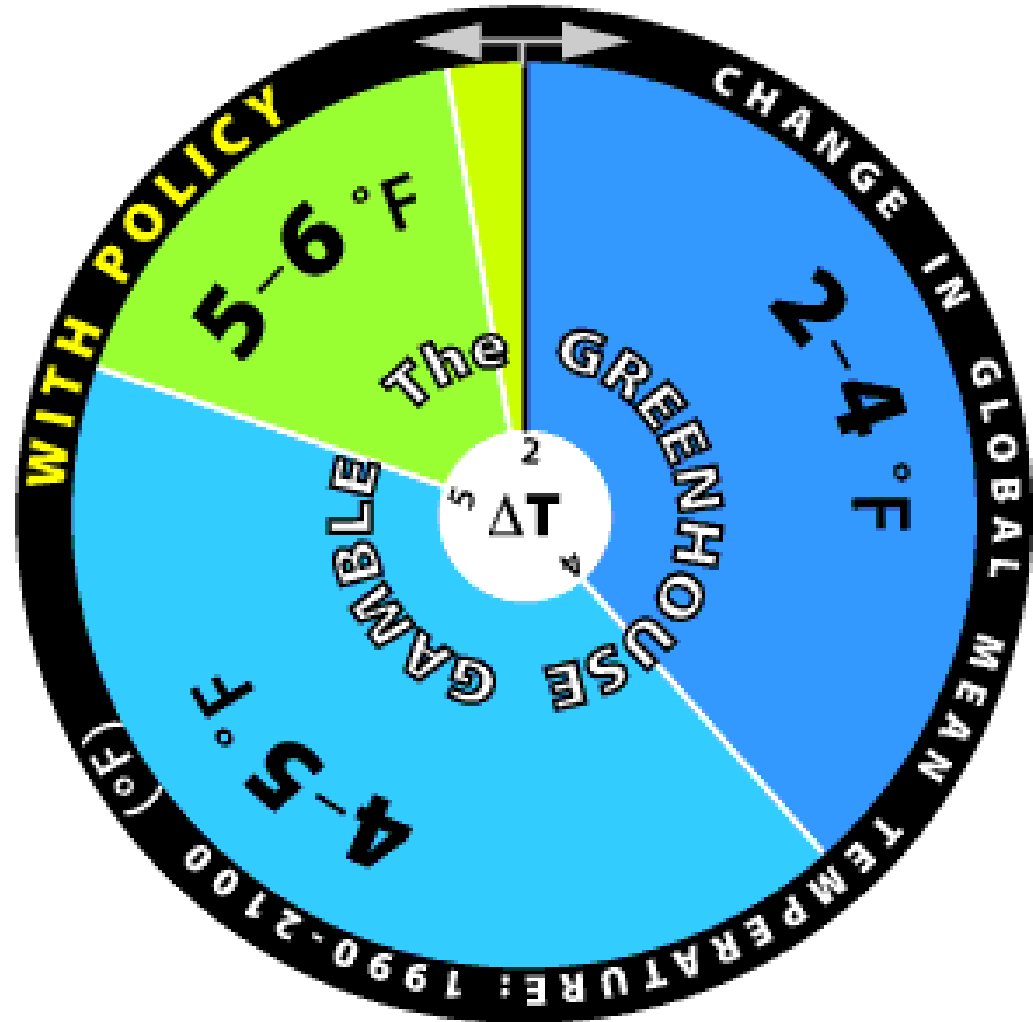
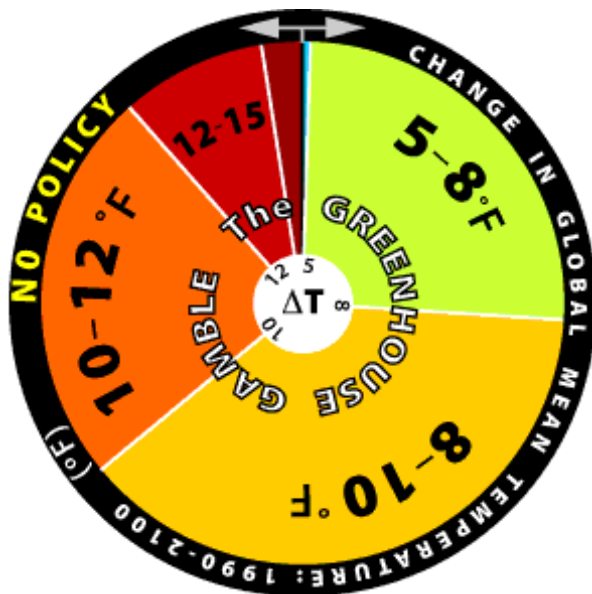
- Benefits of mitigation = net damages avoided
- Technical challenge: Quantify, monetize, and compute present discounted value of uncertain benefits
- Appropriate discount factor is uncertain, but very important – long time horizon
- Est. present value of benefits :
  - » \$10 to \$351 per ton of carbon

**What is  
the level  
of risk?**

**Thought  
experiment:  
 $\Delta T$  to 2100,  
no policy**



We buy a better wheel if we stabilize concentrations, e.g. at approx 550 ppmv



Source: MIT Joint Program on the Science and Policy of Global Change  
[http://globalchange.mit.edu/resources/gamble/policy\\_F.html](http://globalchange.mit.edu/resources/gamble/policy_F.html)

# A Price on Emissions Internalizes the Externality

- Economy-wide market-based incentive to cut emissions
- Cap-and-trade system or tax
- Economy-wide, all GHG's



# Climate Change – Other Market Failures

- Basic technology and science – a public good
- Early deployment? Maybe, maybe not.
- Infrastructure coordination

# Robust lessons from Economics

- Minimize costs by providing flexibility
  - » What
  - » When
  - » Where
  - » Who
- Least cost abatement means equalizing marginal costs

# Cap-and-Trade vs. Carbon Tax

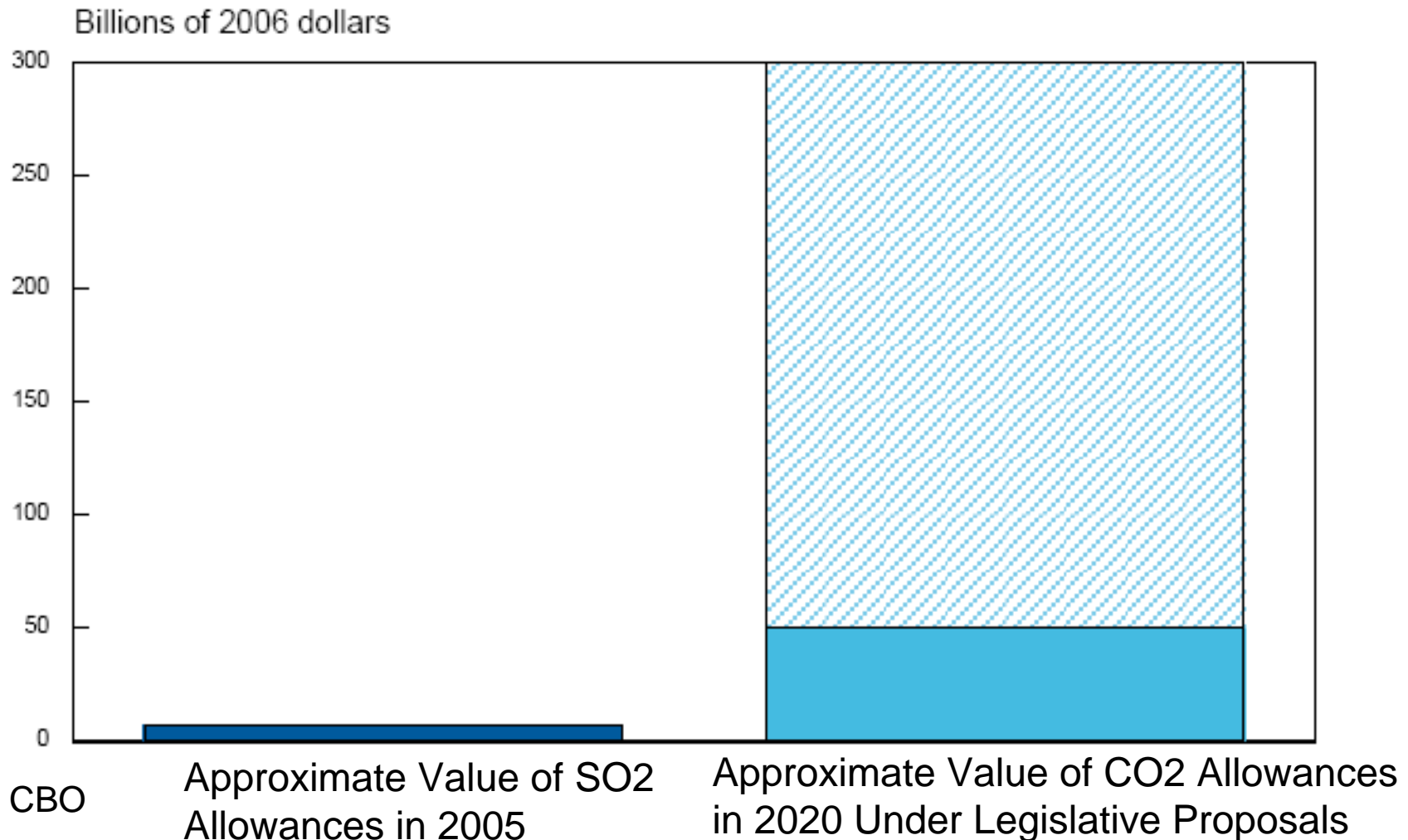
- Can be similar, depending on details
- Cap provides more environmental certainty and tax provides more economic certainty.
  - » More efficient to set prices than a strict cap
- Both systems result in higher prices for energy and energy-intensive products.

# Cap-and-trade

- Set total allowable emissions in a given period
- Allocate allowances.
- Allow trading.
- Require covered entities to hold allowances
  - » Can be upstream or downstream
- Firms use allowances to cover emissions with abatement costs above trading price.
- Price signals passed along up and down the supply chain.



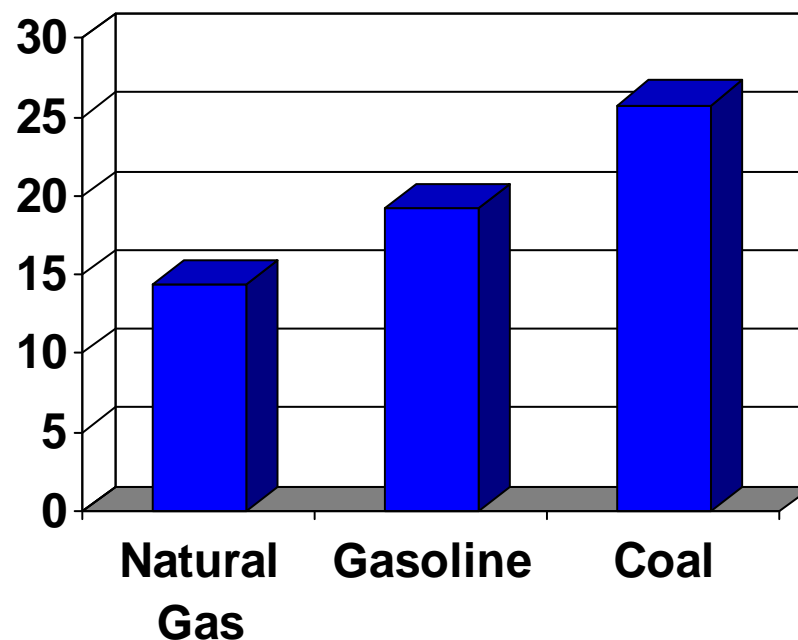
## Amount of Income Transferred (Allowance Value) Likely to Be Much Larger Under a Program Capping CO<sub>2</sub> Than SO<sub>2</sub>



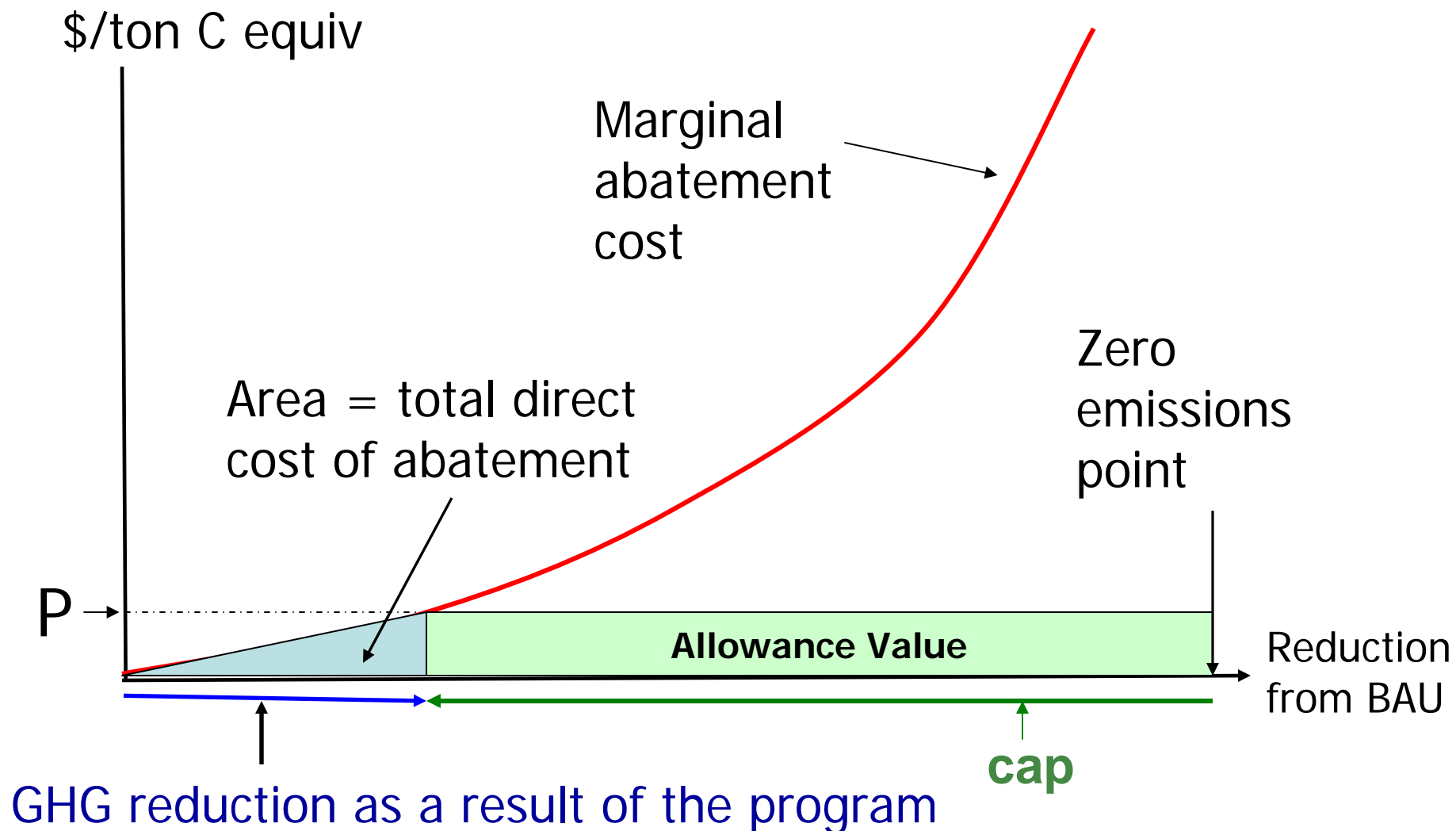
# The relative prices of fuels change

- Put a price on *carbon-equivalent* emissions
- Changes relative prices of inputs and outputs based on carbon content of energy
- Economic activity incorporates cost of emissions

Emissions in Kg C/mBTU



# Economics of Cap-and-Trade





# Categories of Economic Effects

- Costs to the U.S. Economy
  - » Direct abatement costs
  - » Economic drag from higher real price levels
- Transfers
  - » Transfer from those who pay higher prices to those who receive them.
- Benefits from avoided climate damages

# What Affects Costs

- Stringency of targets
- Details of cap-and-trade design
- Provisions other than cap-and-trade

# Waxman-Markey, HR 2454

- Passed House in June 2009
- Title 3 is Cap-and-trade
- 1418 pages
- 17 % reduction relative to 2005 by 2020
- 83% reduction by 2050

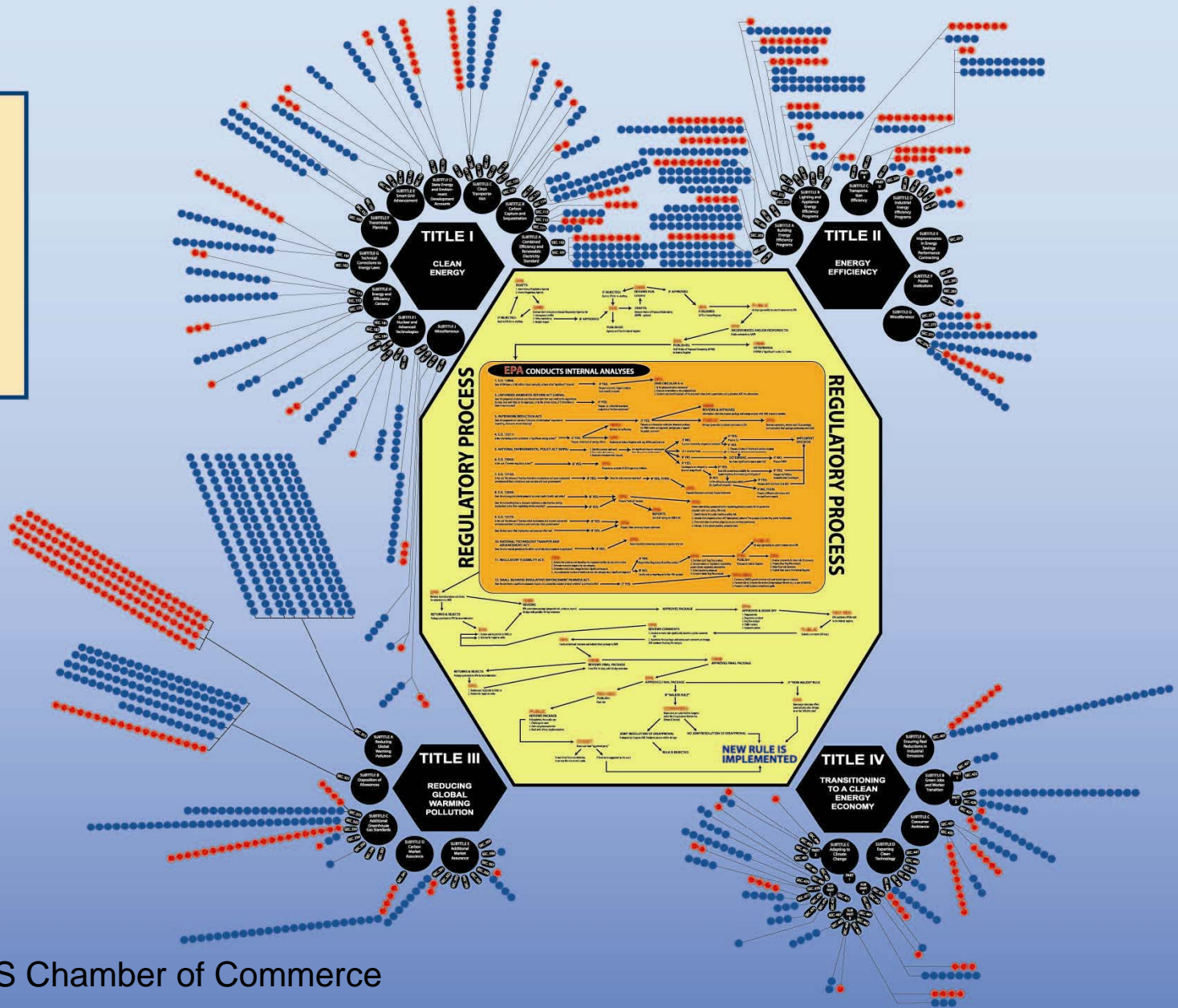
# AMERICAN CLEAN ENERGY AND SECURITY ACT OF 2009 (H.R. 2454)

## REGULATIONS & MANDATES

TOTAL

● 397

● 1060

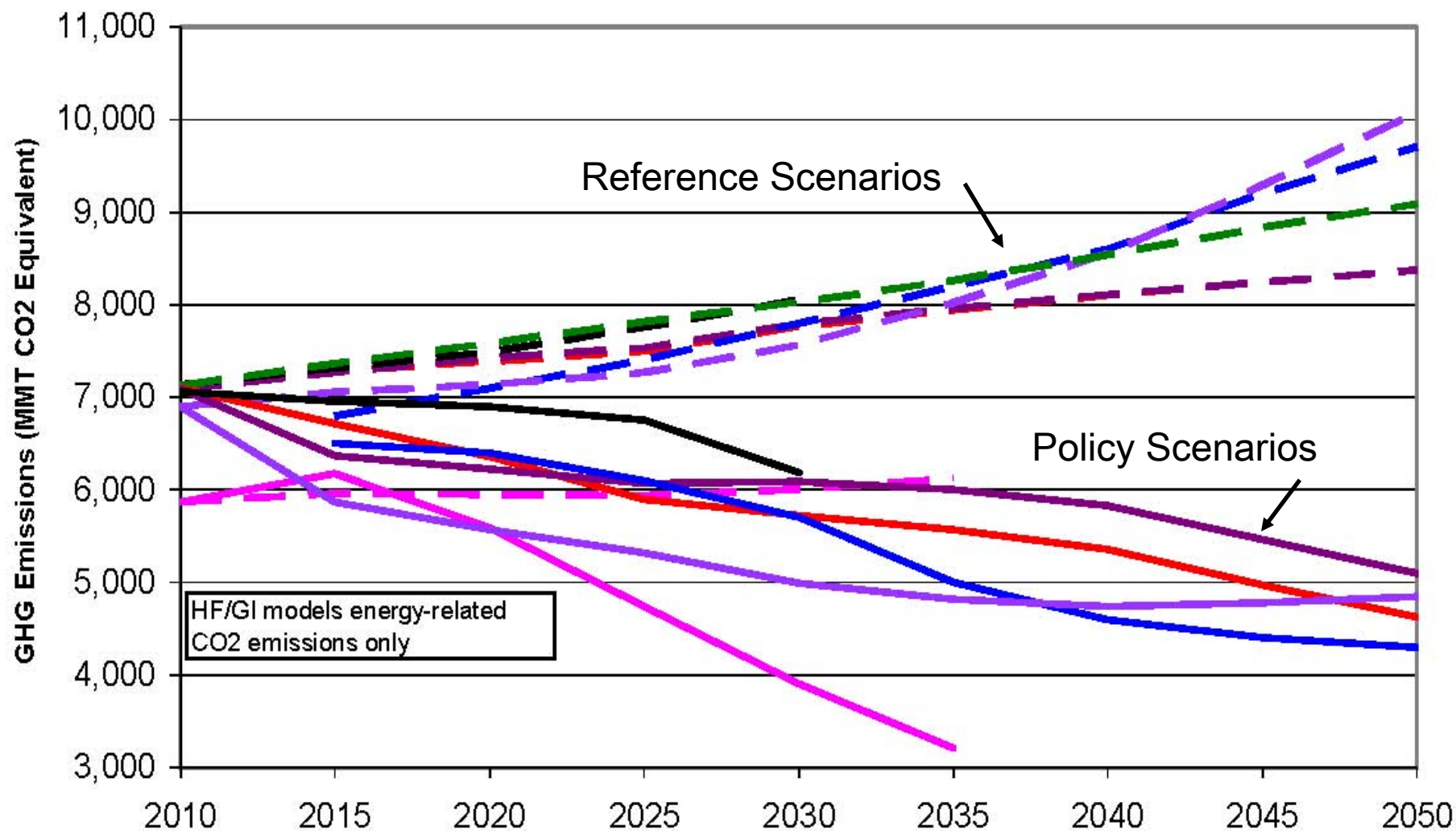


Source: US Chamber of Commerce

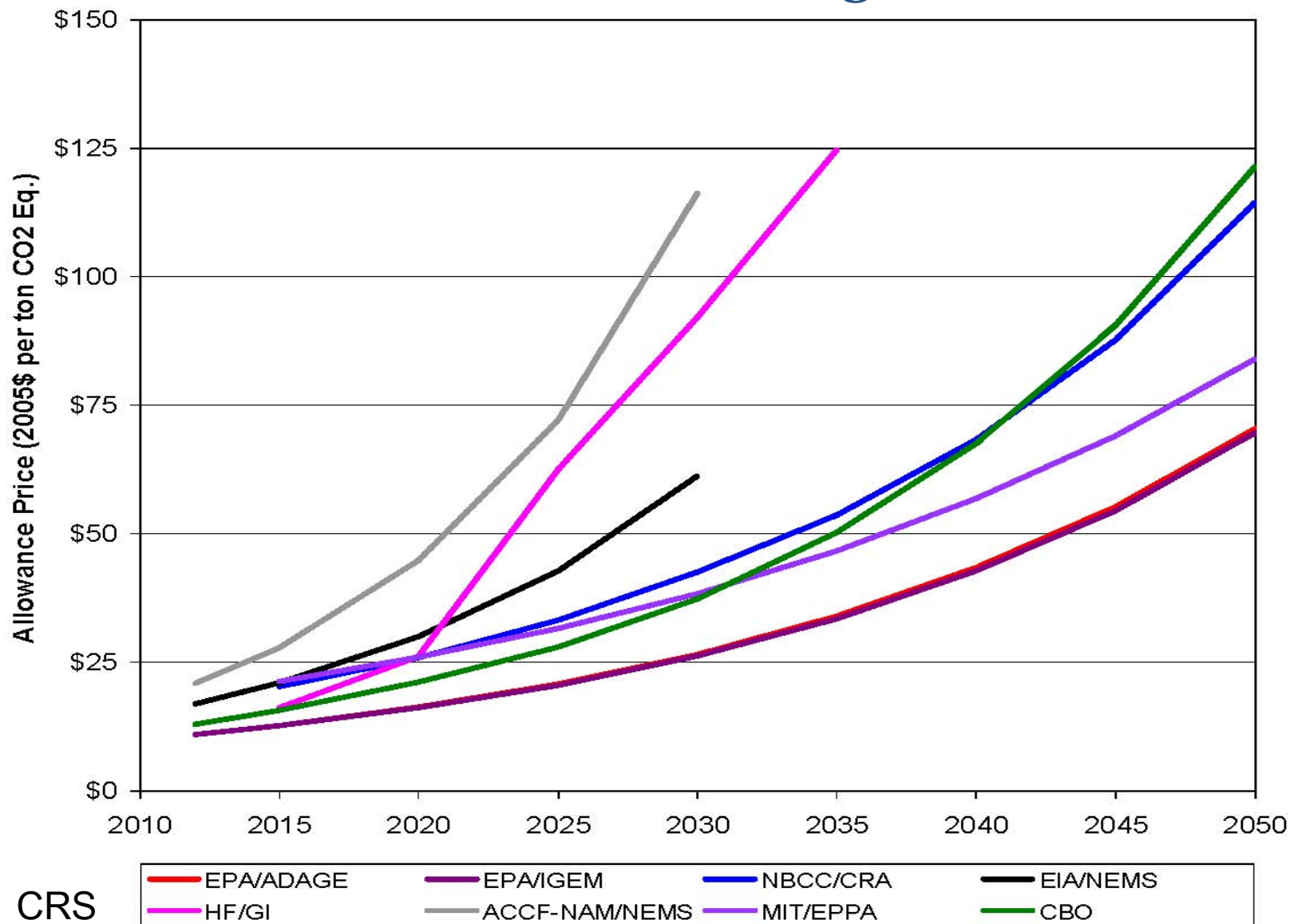
# Economic Analysis Compares Action to Inaction

- The benefits and costs depend on the difference between:
- The Reference Scenario
  - » Also called: Business As Usual, BAU, Baseline
- The Policy Scenario

## US Emissions under HR 2454 from Six Models



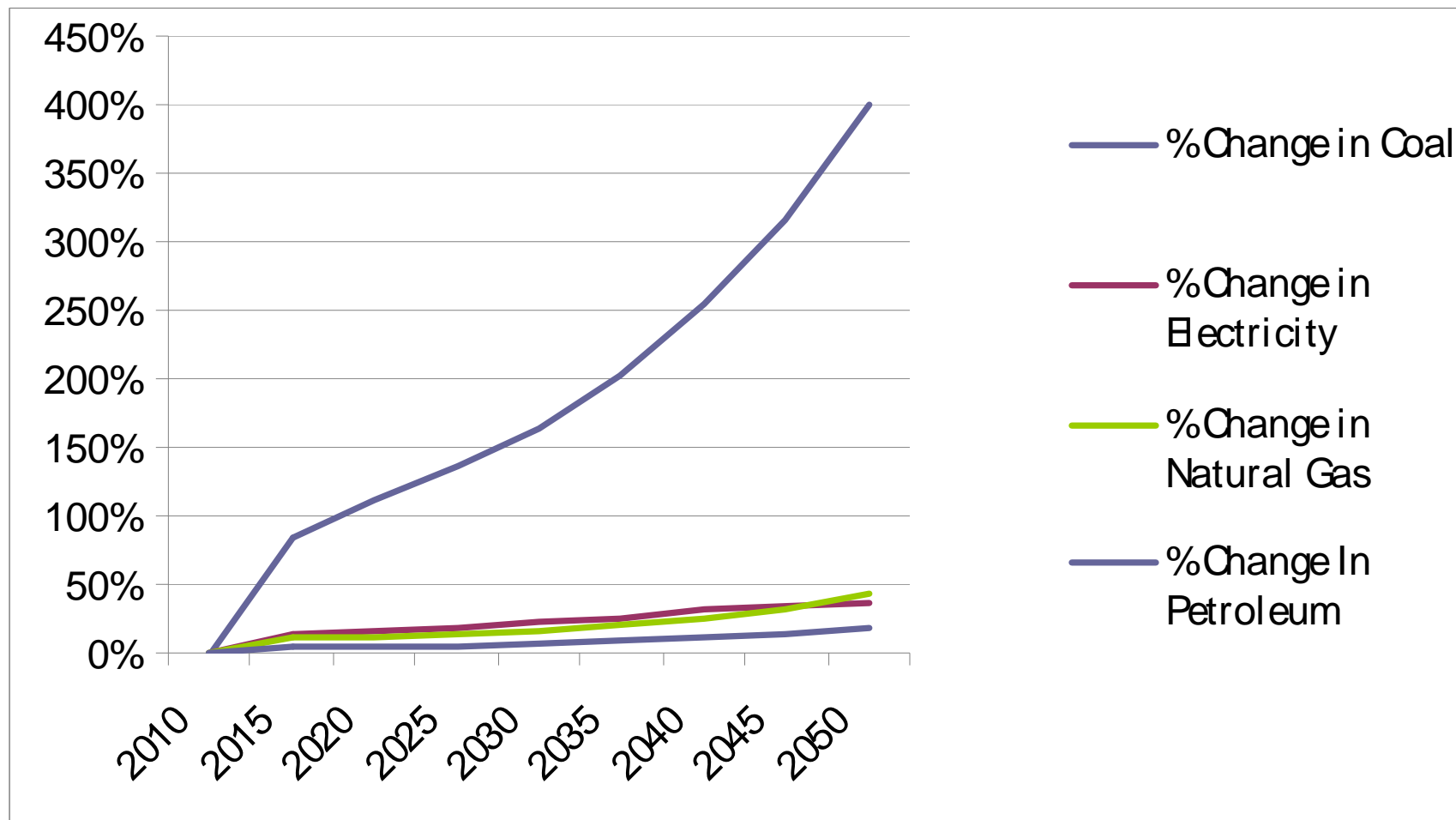
# HR 2454 Allowance Prices in Eight Models



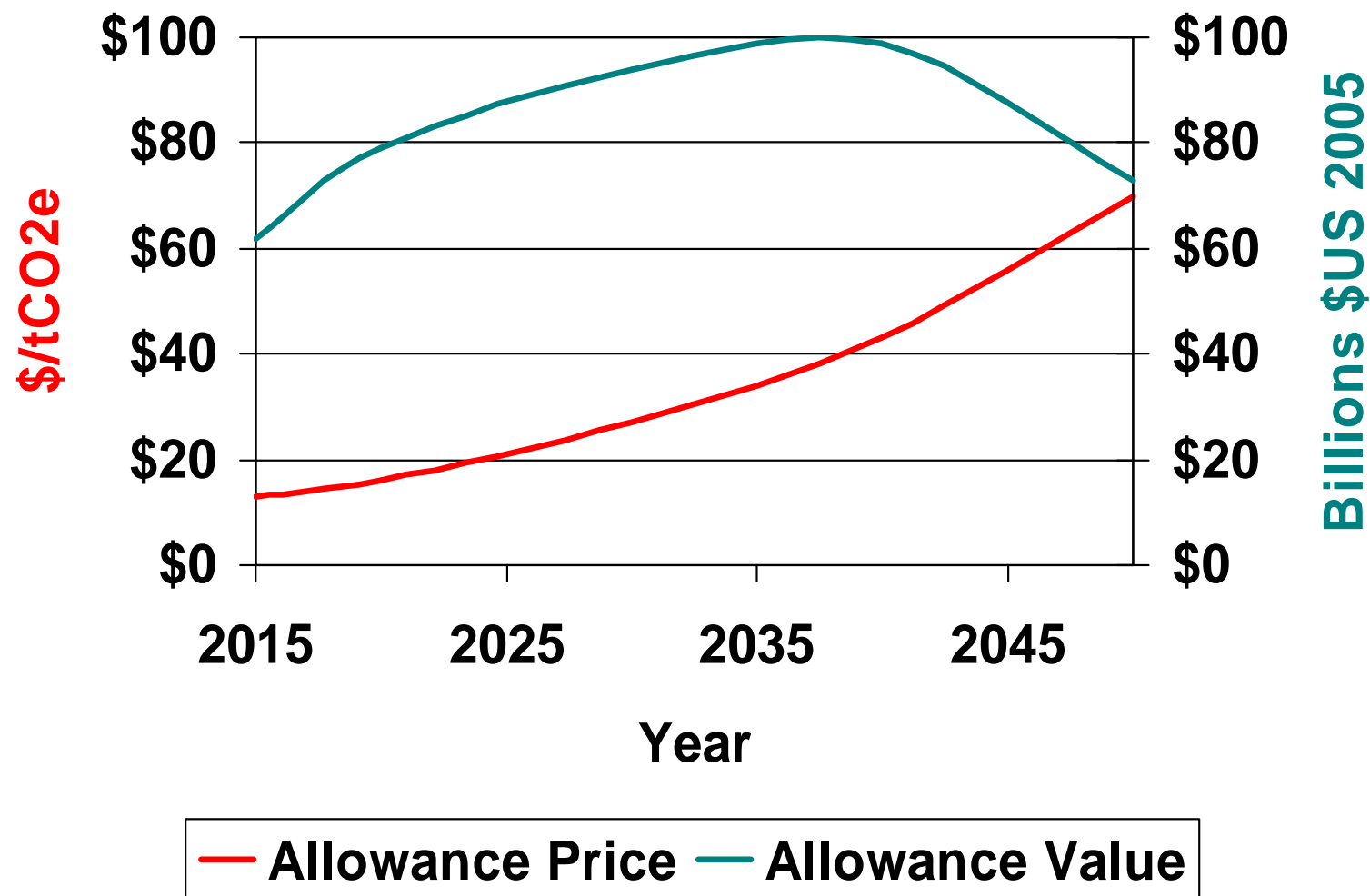
Source: CRS



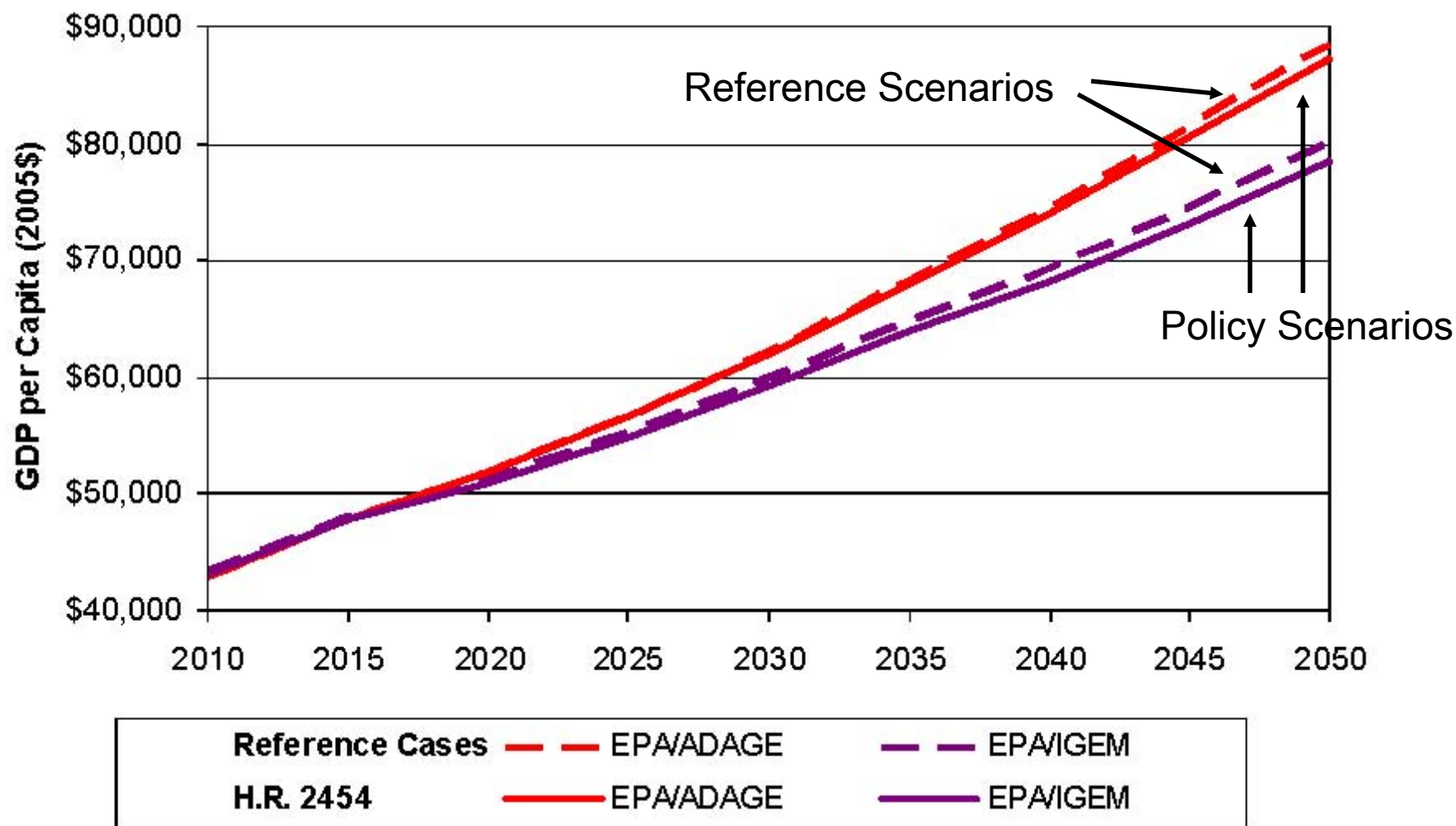
## HR 2454 Energy Prices from EPA Analysis (change relative to baseline)



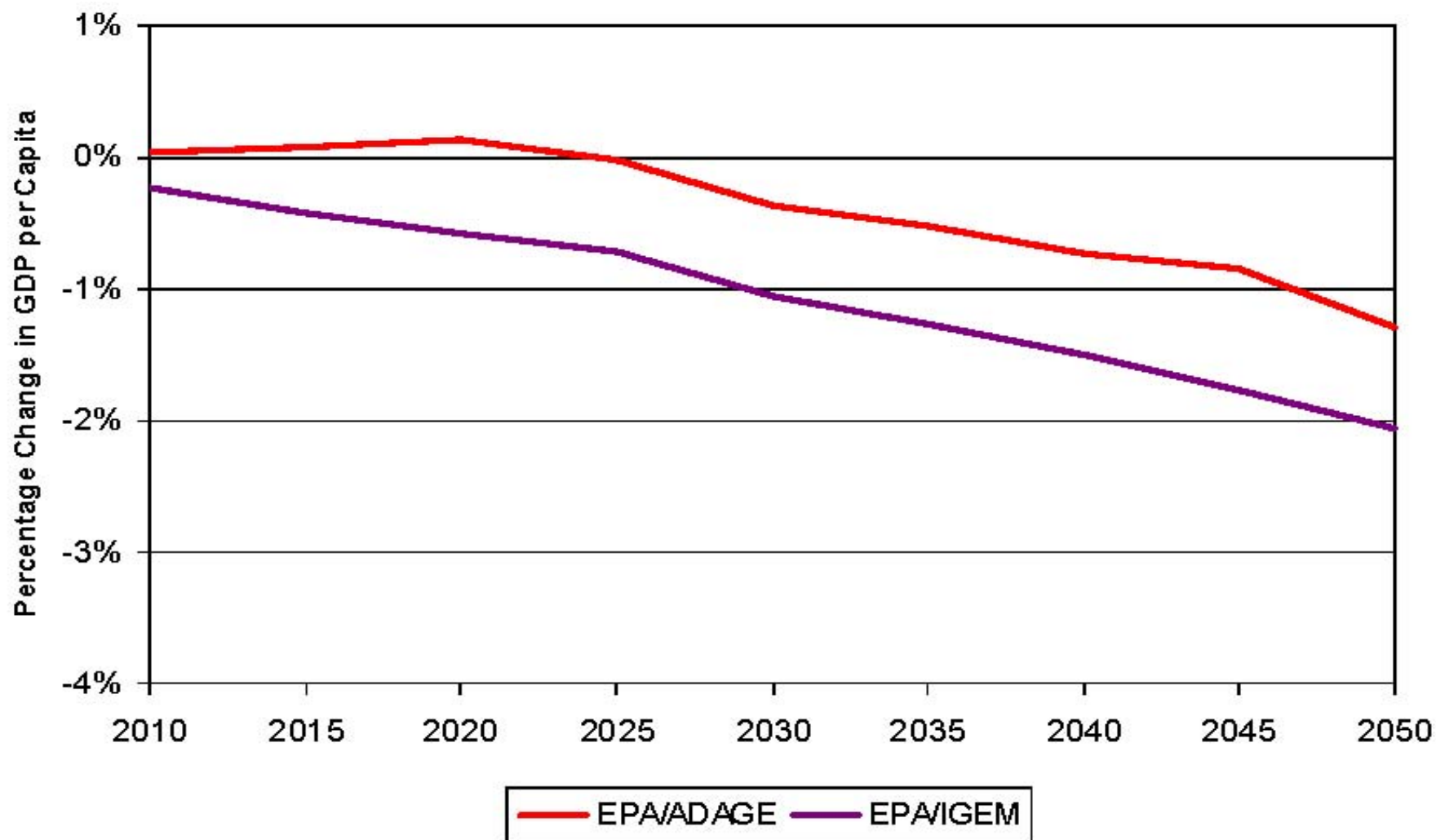
# EPA Analysis of HR 2454



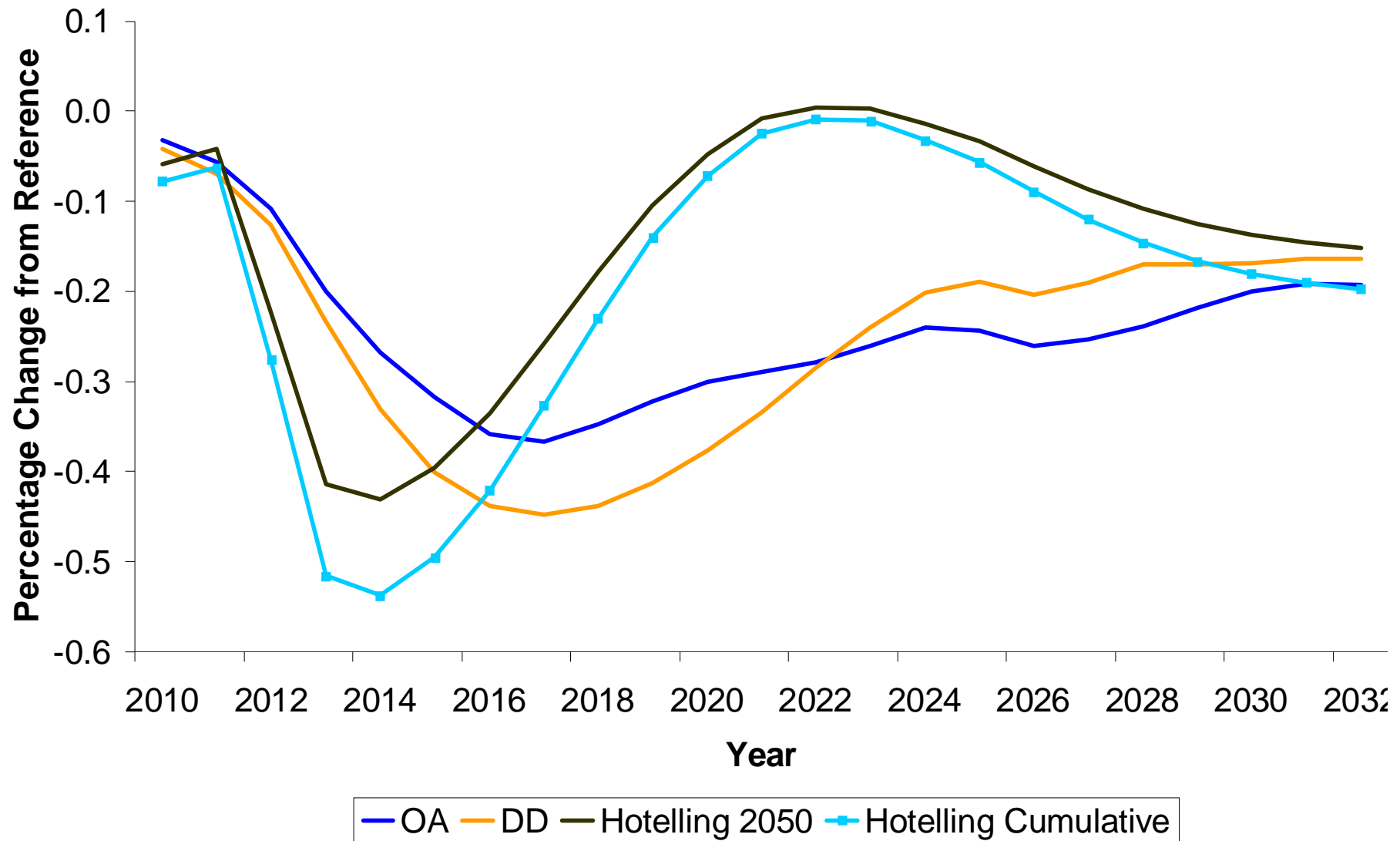
# EPA Estimates for GDP per Capita under HR 2454



## Percent decline in GDP per Capita under HR 2454



## Effect of Alternative Policies on US Employment



## “Where Flexibility”: Offsets

- Reduces overall cost of achieving cap
- Requires baselines and additionality
- Leakage
- Permanence, for forest projects
- Tradeoff between close monitoring/conservative baselines and cost
- Large income from selling international offsets could discourage developing countries to take a target

## Bills rely heavily on international offsets to control costs

- Without international offsets, carbon price would increase 65% to 250%\*
- Over \$1.2 trillion in international offset purchases projected by EPA through 2050
- At beginning of the program, offset payments could be over six times the cost incurred for domestic abatement in covered sectors.

\*Source: CRS Report R40809

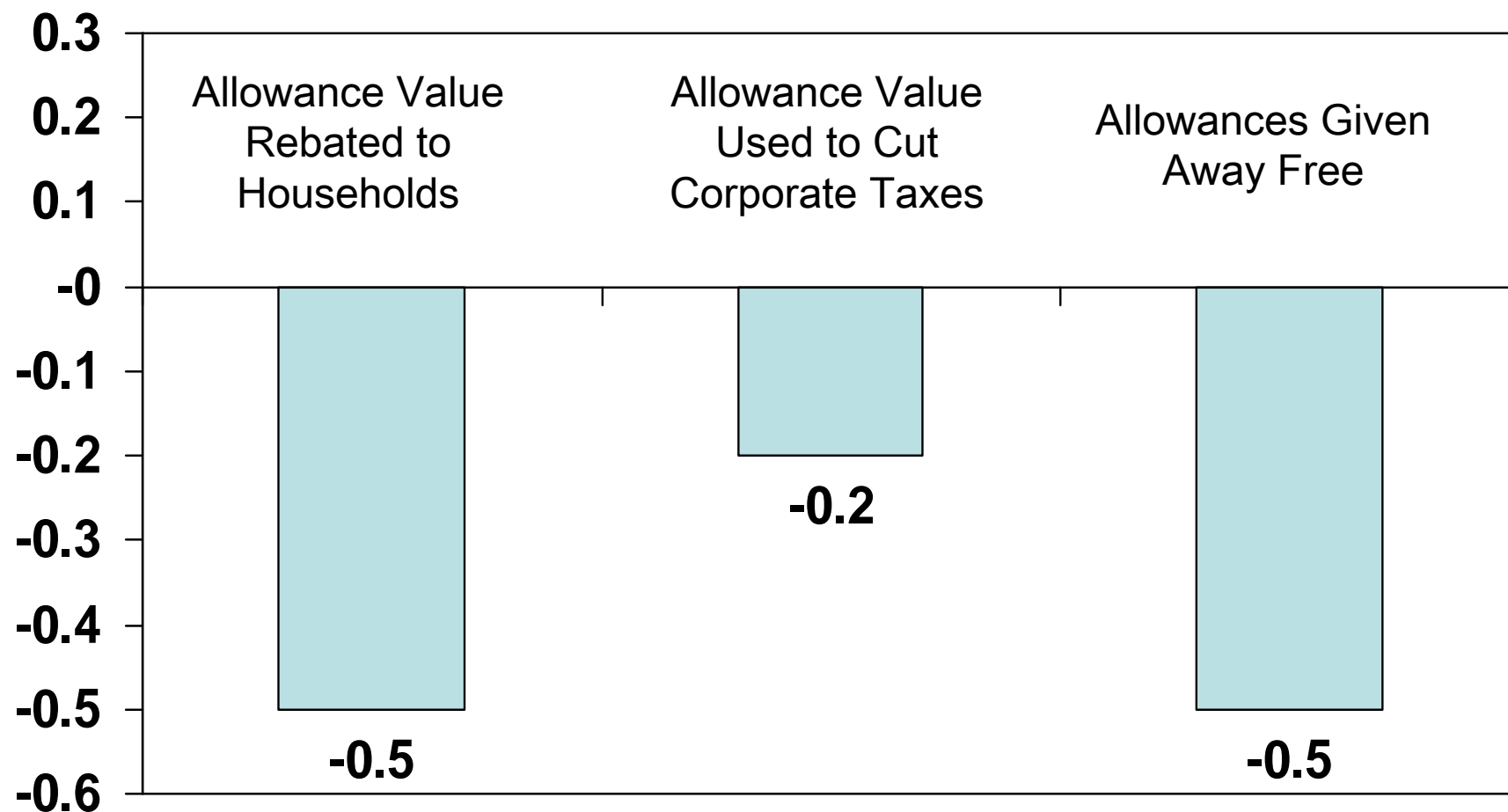


# Revenue Recycling Can Greatly Lower Costs

- Allowance auction revenue can offset the macroeconomic drag of higher real price levels.
- Using revenue to reduce the federal budget deficit or other taxes can reduce costs of the program by 15% to 70%.
- Reducing tax rates benefits higher income households most.
  - » Clear tradeoff between efficiency and equity

# Cost of a 15% cut in CO<sub>2</sub>

% Change in GDP



Source: CBO

# Allowance Giveaways Can Raise Costs

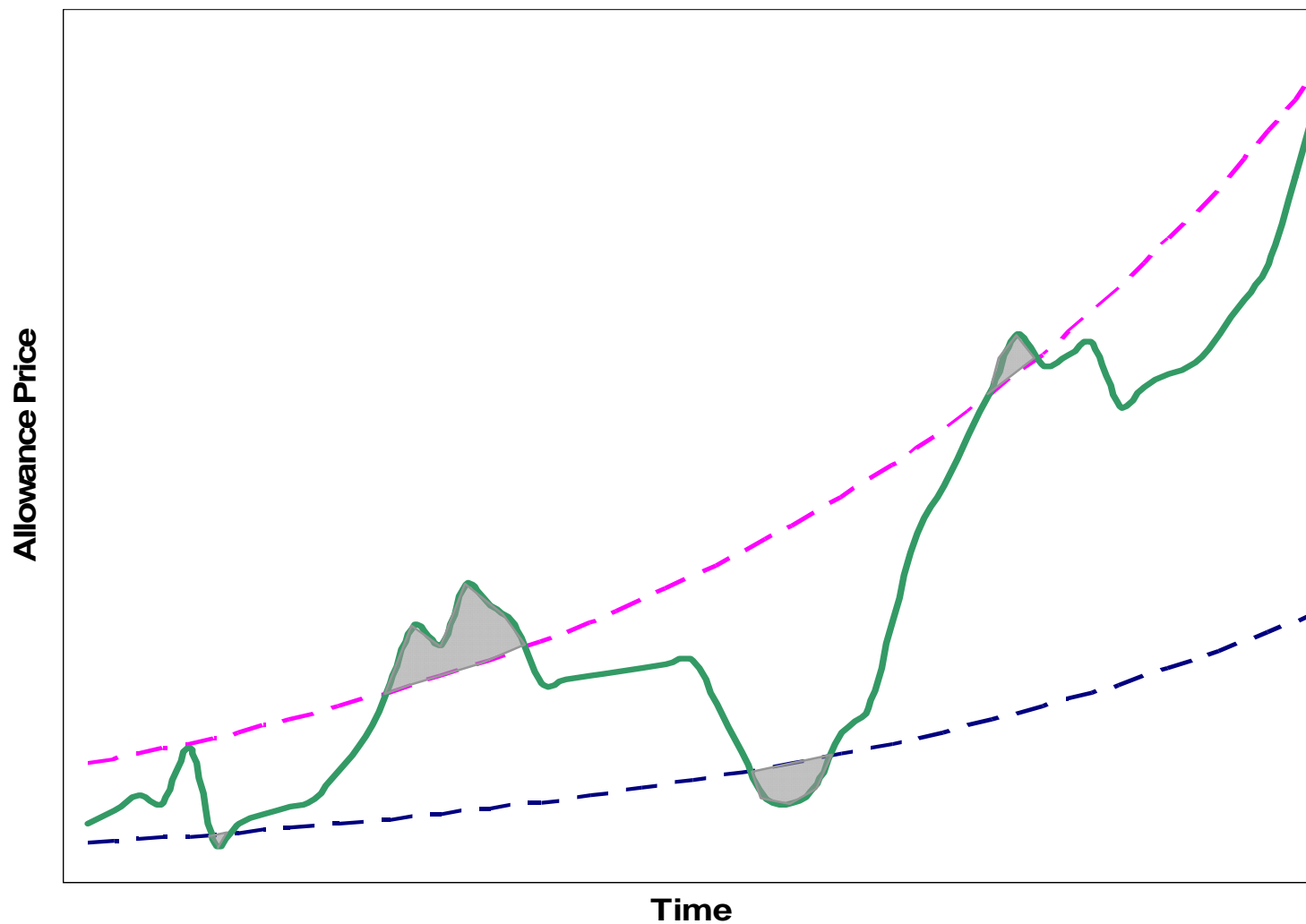
- Allocating to local energy distribution companies to lower energy bills will blunt the incentive to conserve energy.
- Requires more abatement elsewhere at higher cost
- Could raise overall costs by 12 to 15 %\*

• \*Source: Karen Palmer, Resources for the Future, Testimony before Senate Energy Committee, 10/21/2009

## Price Collar

- Sets a floor and ceiling on allowance prices
- Safety valve for ceiling and reserve price on allowance auction for floor
- Prevents price from going off the rails, but do nothing if predictions are correct.
- Even if price ceiling binds, emissions effects can be modest, depending on the collar parameters.

## Illustrative Price Collar



**SPEED BUMP** DAVE COVERLY

