GHG Mitigation and the Energy Sector

Conference on Cost-Effective Carbon Restrictions
Federal Reserve Bank of Chicago
Detroit, Michigan

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October 15, 2007

Energy Information Administration
Official Energy Statistics from the U.S. Government

Outline

- Background on greenhouse gas (GHG) emissions and concentrations
- Economic considerations in designing GHG mitigation policies
- Insights from recent EIA analyses of GHG mitigation

EIA

- Energy Data: 80-85 percent of EIA's mission
  - Weekly, monthly, annual surveys covering oil, natural gas, electricity, coal, and renewable energy. Quadrennial surveys of energy consumption.
  - Statistical agency independence (pretty standard)
- Projections/ Other Analysis: 15-20 percent of EIA's mission
  - Analysis products are not subject to Administration clearance (pretty unusual)
  - Often respond directly to requests from Congress
  - Analytical support for Administration/DOE offices when requested
- EIA does not promote, formulate, or take positions on policy issues, and our views should not be construed as representing those of the Department or the Administration

The Climate Change Issue

The threat of climate change due to rising atmospheric concentrations of greenhouse gases (GHGs) differs in both scope and nature from energy-related environmental issues that have previously been confronted, such as acid rain, smog, and depletion of stratospheric ozone.

- **Intergenerational** – the benefits of GHG mitigation will accrue in the future, while costs are both now and in the future.
  - How do we appropriately reflect the interests of our grandchildren, who we expect to enjoy far higher levels of per-capita income than we enjoy today, with those of our “brothers and sisters” in the current generation?
- **Uncertainty** due to a wide range of possible “no policy” energy and emissions paths coupled with an uncertain sensitivity of the climate to changes in GHG concentrations.
- **Inertia** in energy systems and the atmosphere makes it difficult to rapidly change atmospheric concentrations of GHGs, which mitigates against a “wait and see” approach while uncertainties are resolved.
- Policies to reduce GHG emissions have **both synergies and conflicts with other energy-related objectives**, such as energy security.
- **Limitation of GHG emissions would directly constrain the use of fossil fuels**, which currently provides 80% of world energy and 85% of U.S. energy
- **International cooperation is essential,** since reductions by all major emitters will be required to significantly bend the path of atmospheric GHG concentrations.

Emissions, energy, and concentration facts

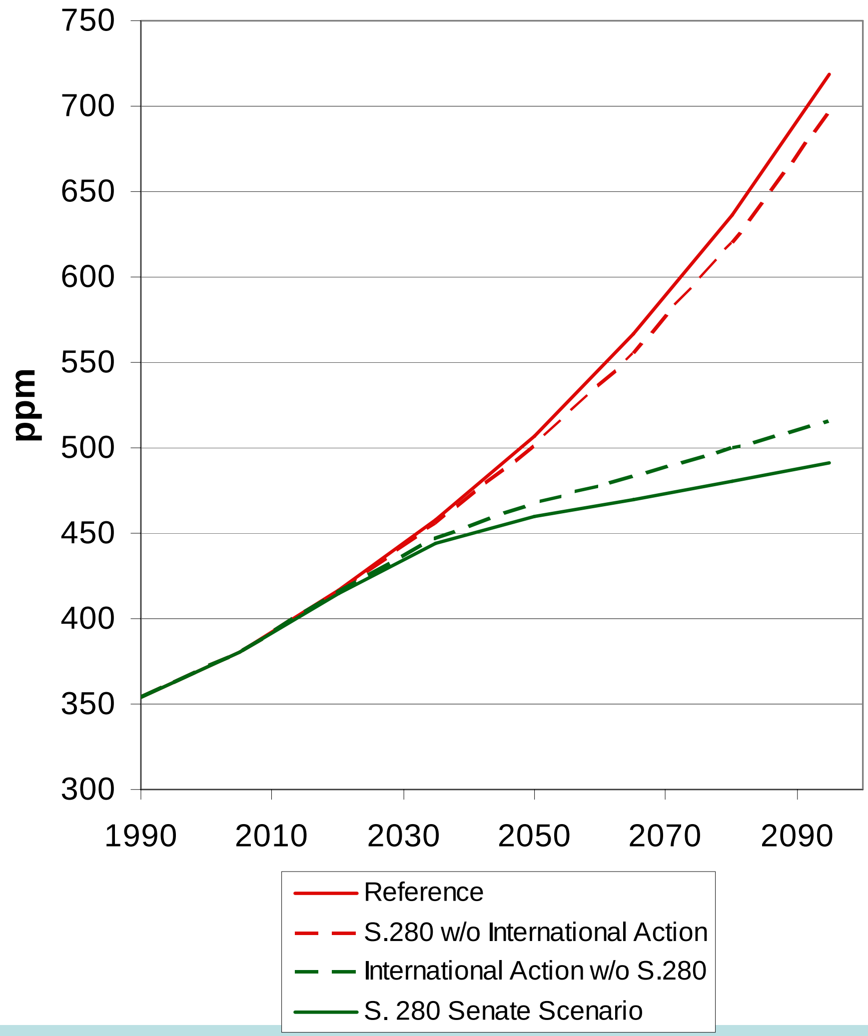
EMISSIONS AND CONCENTRATIONS

- Concentrations of carbon dioxide (CO_2) are currently about 382 parts per million (ppm), compared to 275 ppm two centuries ago.
- Other GHGs attributable to human activities add radiative forcing equivalent to an additional 50 ppm CO_2, bringing the total to roughly 430 ppm on a CO_2-equivalent (CO_2e) basis.
- In order to stabilize concentrations of GHGs, emissions must be reduced 60 to 80 percent from current levels, or 80 to 90 percent from the level projected for 2030.

ENERGY

- Energy-related CO_2 emissions currently account for 83 percent of total U.S. GHG emissions.
- Globally, considering all GHGs and the effects of land use change, energy-related CO_2 accounts for about 58 percent of total GHG emissions.
- In 2000, the U.S. was responsible for 24 % of global energy related CO_2 emissions, and about 16% of overall GHG emissions including land use change.
- Energy-related emissions from China are growing rapidly, and are currently close to (or slightly above) the U.S. level.

S. 280 Senate Scenario: Global CO_2 Concentration



S. 280 Senate Scenario

- USA adopts S. 280.
- Group 1 countries (Kyoto group less Russia) follow an allowance path that is falling gradually from the simulated Kyoto emissions levels in 2012 to 50% below 1990 in 2050 and beyond.
- Group 2 countries (rest of world) adopt a policy beginning in 2025 that returns and holds them at year 2015 emissions levels through 2034, and then returns and maintains them at 2000 emissions levels from 2035 and beyond.

CO_2 Concentration Results

- In the reference scenario, Global CO_2 concentrations rise from historical levels of 354 parts per million (ppm) in 1990 to 718 ppm in 2095
- In the Senate scenario, CO_2 concentrations are 481 ppm in 2095.
- While CO_2 concentrations are significantly reduced in the Senate scenario, they are not on a stabilization trajectory.

Incremental Effect of S. 280

- If the U.S. adopts S. 280 and no other countries adopt emissions caps, then CO_2 concentrations in 2095 are 23 ppm lower than the reference scenario. If the U.S. does not cap emissions, and all other countries take on the targets from the Senate scenario, then CO_2 concentrations in 2095 are 25 ppm higher than the Senate scenario.

Options for GHG Mitigation Policy

- Voluntary programs
  - Information sharing
  - Incentives
- Support for Clean Technology Development (R&D)
- Mandatory Programs
  - "Command and control" regulation
    - Emissions/energy efficiency regulations for specific sources
  - Economic instruments
    - Cap-and-trade programs
    - Emissions fees or taxes
    - Hybrid instruments (e.g. cap-and-trade w/ "safety valve"

Per the agenda, this talk focuses on mandatory policies

Advantages of Economic Instruments for GHG Mitigation

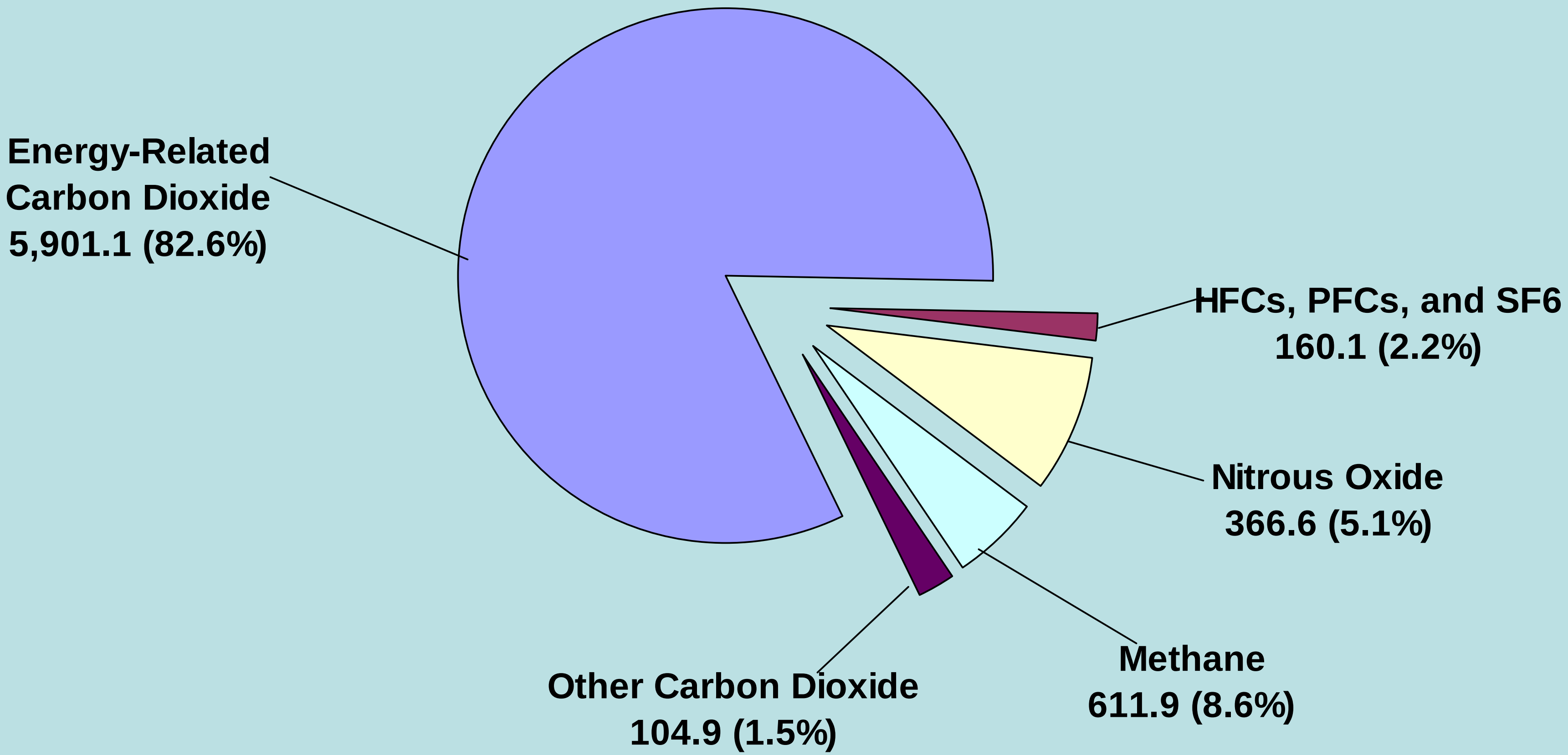
CHARACTERISTICS OF EMISSIONS SOURCES

- GHG emissions come from a wide variety of sources – command and control regulation is unlikely to provide emissions reductions at the lowest cost.
- Both supply and demand-side decisions contribute to GHG emissions.

MECHANISMS OF CLIMATE CHANGE PROCESSES

- The location of emissions are not a concern – climate impacts are the same whether or not emissions are concentrated at particular locations
- Year-to-year emissions variation is also not a concern -- what matters is the total stock of GHGs in the atmosphere, which depends on long-term emissions trends.

US GHG Emissions in 2005
(million metric tons of CO_2-equivalent)



Source: *Emissions of Greenhouse Gases in the United States 2005*. DOE/EIA-0573(2005), Washington, DC, November 2006

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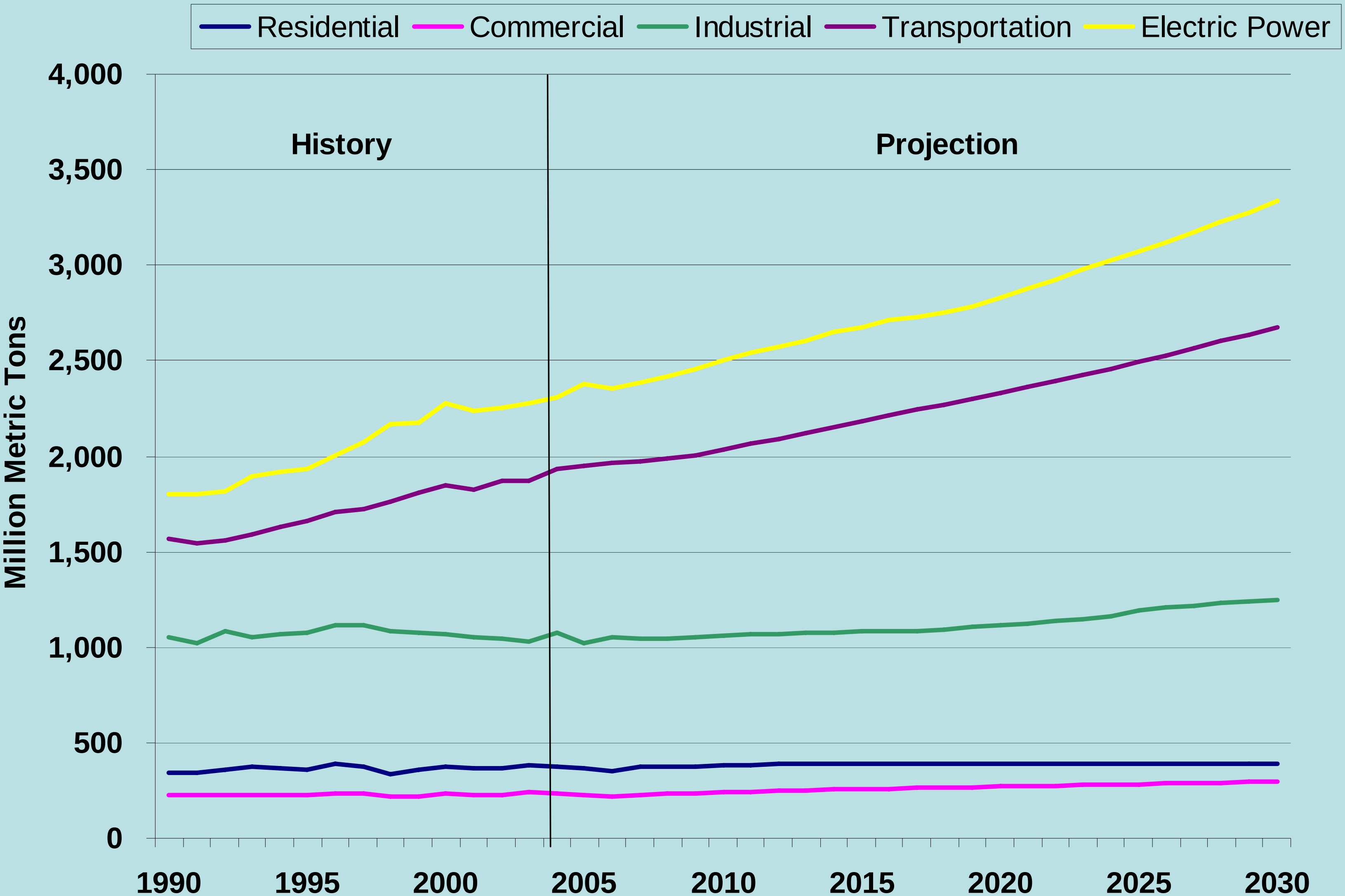
Energy-related CO_2 emissions by sector
AEO2007 Reference Case



Policy to Reduce GHGs Could Significantly Affect the Energy Outlook

- EIA Reference Case projections are generally based on existing laws and policies.
- In several recent reports, EIA has examined the energy implications of alternative cap and trade programs for greenhouse gas (GHG) emissions.
  - Additional analyses are in progress.
- The electricity sector, particularly projected coal use, is most significantly affected.

Impact of a CO_2 Value on Fossil Fuel Prices

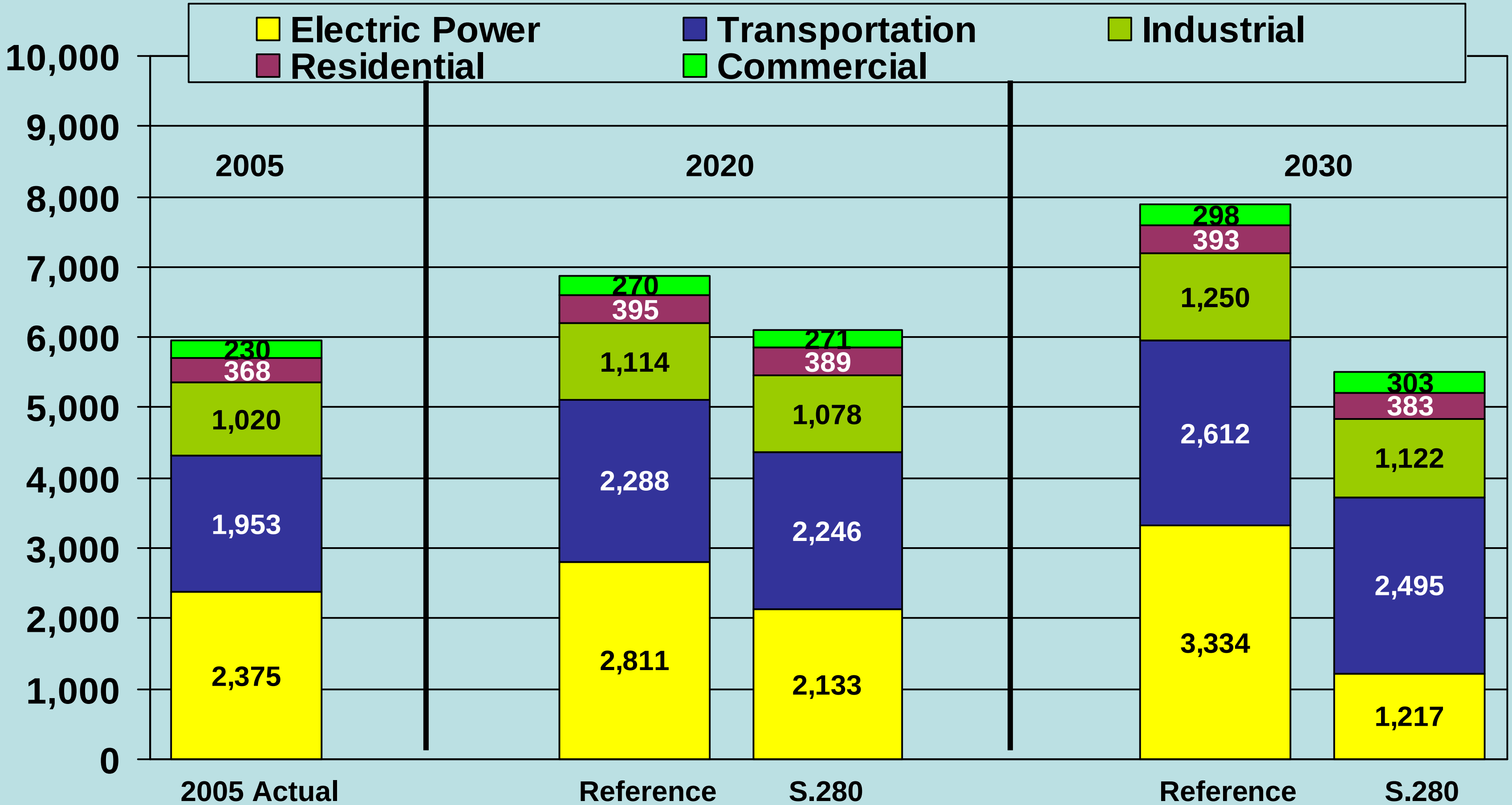
Fuel	CO_2 content per million Btu	Delivered Price (2005, all sectors, per million Btu)	Impact of $10 per ton CO_2 value		Impact of $50 per ton CO_2 value	
			$	percent	$	percent
Coal	0.094	1.57	0.94	59.9	4.70	299
Oil	0.074	18.60	0.74	4.0	3.70	19.9
Nat. Gas	0.053	9.65	0.53	5.5	2.65	27.5

•As shown above, placing a value on GHGs through either a tax or a cap-and-trade program has a relatively large impact on the delivered price of coal.

•This refects both the substantially lower price of coal relative to other fossil fuels under baseline conditions and its higher emission of CO_2 per unit of energy

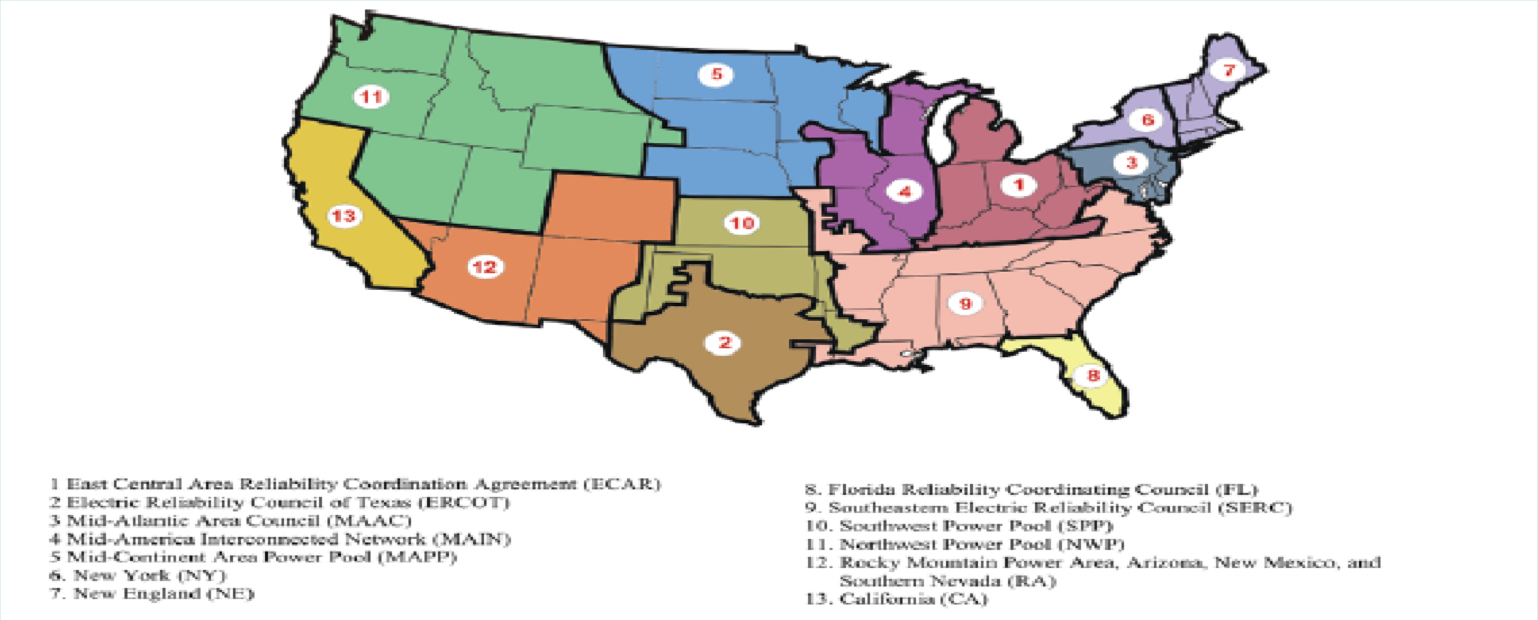
•A $25/ton value on CO_2 raises gasoline prices by about 23 cents per gallon.

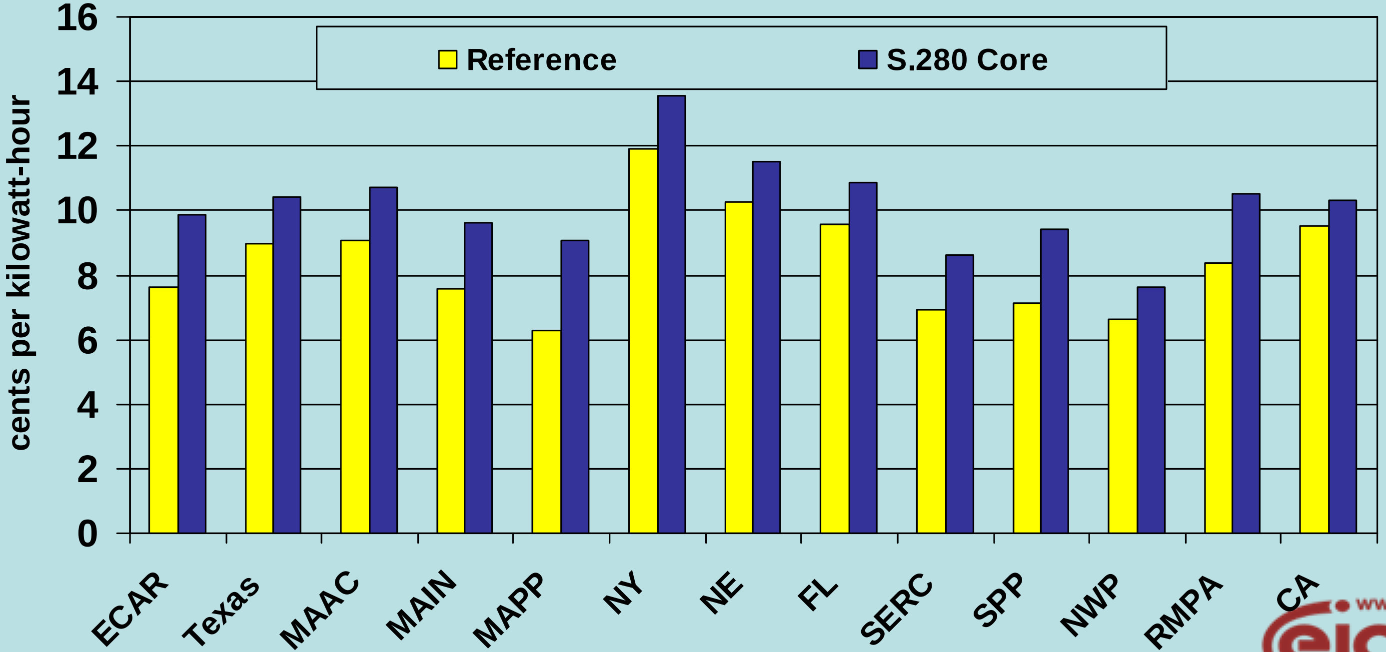
Energy-Related CO_2 Emissions: EIA Analysis of S.280 (million metric tons)



- The electric power sector dominates energy-related CO_2 emission reductions.
- Although the S.280 GHG target for covered entity emissions in 2030 is 18 percent below the 1990 level (equivalent to 34 percent below the 2005 level), total energy-related CO_2 emissions in the S.280 Core Case are only about 7% below the 2005 level in 2030 due to the use of offsets and banked allowances, partial coverage and greater reduction of other GHGs. If more (less) international offsets were available, projected 2030 energy-related emissions under S.280 would be higher (lower).

2030 Regional Electricity Price Impacts: EIA S.280 Analysis





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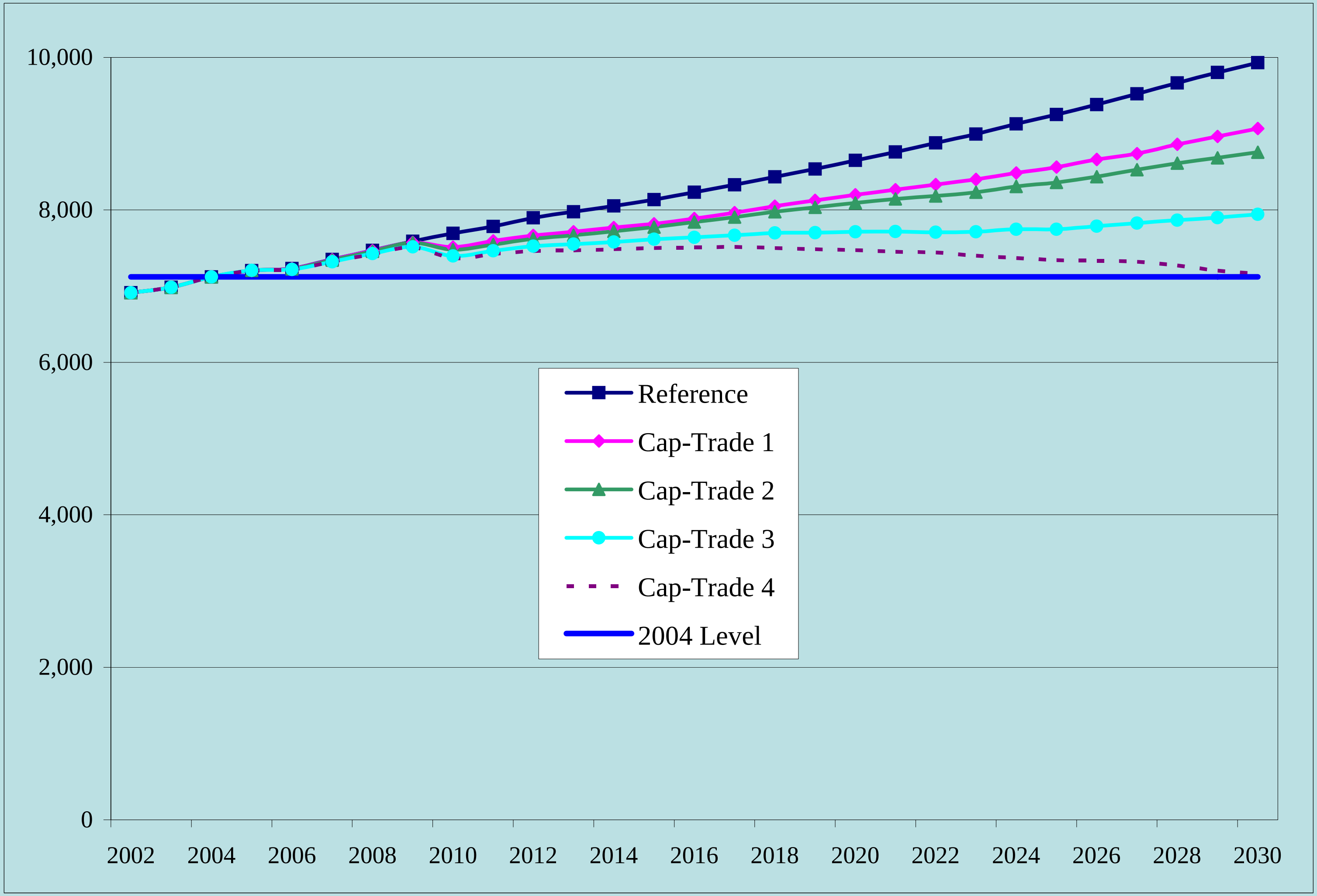
GHG Cap & Trade Analysis Cases
From Study for Senator Salazar, 2006

Case Name	GHG Intensity Reduction Goal (percent per year)		Safety Valve Price (2004 dollars per metric ton CO_2 equivalent)		Other
	2010-2019	2020-2030	2010	2030	
Cap-Trade 1	2.4	2.8	$ 6.16	$ 9.86	Greenhouse gas cap-and-trade system with safety valve.
Cap-Trade 2	2.6	3.0	$ 8.83	$14.13	
Cap-Trade 3	2.8	3.5	$22.09	$35.34	
Cap-Trade 4	3.0	4.0	$30.92	$49.47	
Cap-Trade 3 Low Other	2.8	3.5	$22.09	$35.34	Cap-Trade 3 with 50 percent reduction in other GHG abatement supply.
Cap-Trade 3 Low Safety	2.8	3.5	$ 8.83	$14.13	Cap-Trade 3 with lower assumed safety valves.
Cap-Trade 3 High Tech	2.8	3.5	$22.09	$35.34	Cap-Trade 3 with more optimistic technology assumptions.

Targeted Reduction in GHG Emissions in 2025
(Million Metric Tons Carbon Dioxide Equivalent)

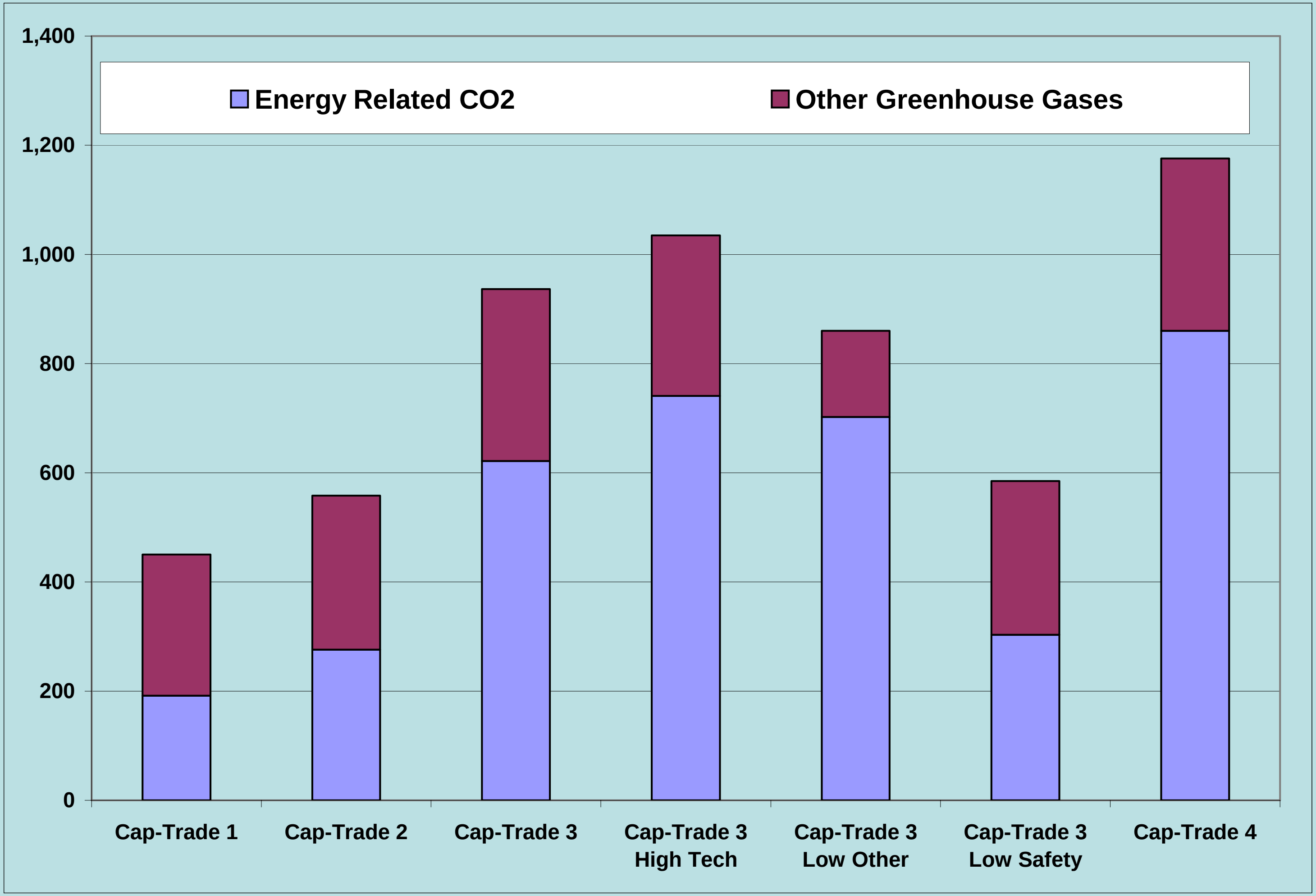
- Higher projected energy prices have reduced projected U.S.CO_2 emissions

Total GHG Emissions in Alternative Cases (million metric tons CO_2 equivalent)



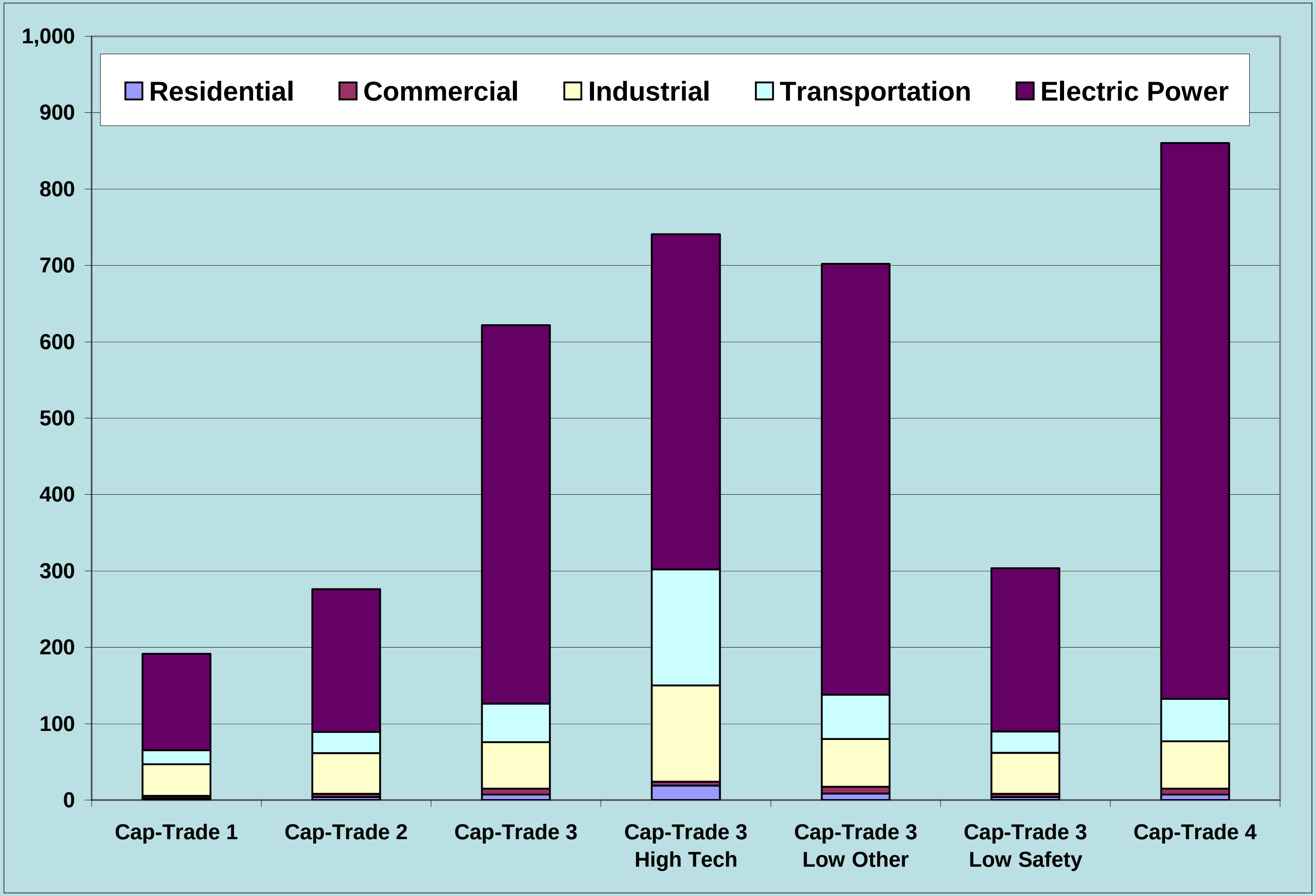
- The toughest program examined in the study for Senator Salazar returns emissions to the 2004 level by 2030

GHG Emissions Reduction in 2020 in Alternative Cases
(million metric tons CO_2 equivalent)



- EPA sees significant opportunity for low-cost reduction of non-energy GHGs

Energy-Related CO_2 Emissions Reductions in 2020 (million metric tons CO_2)

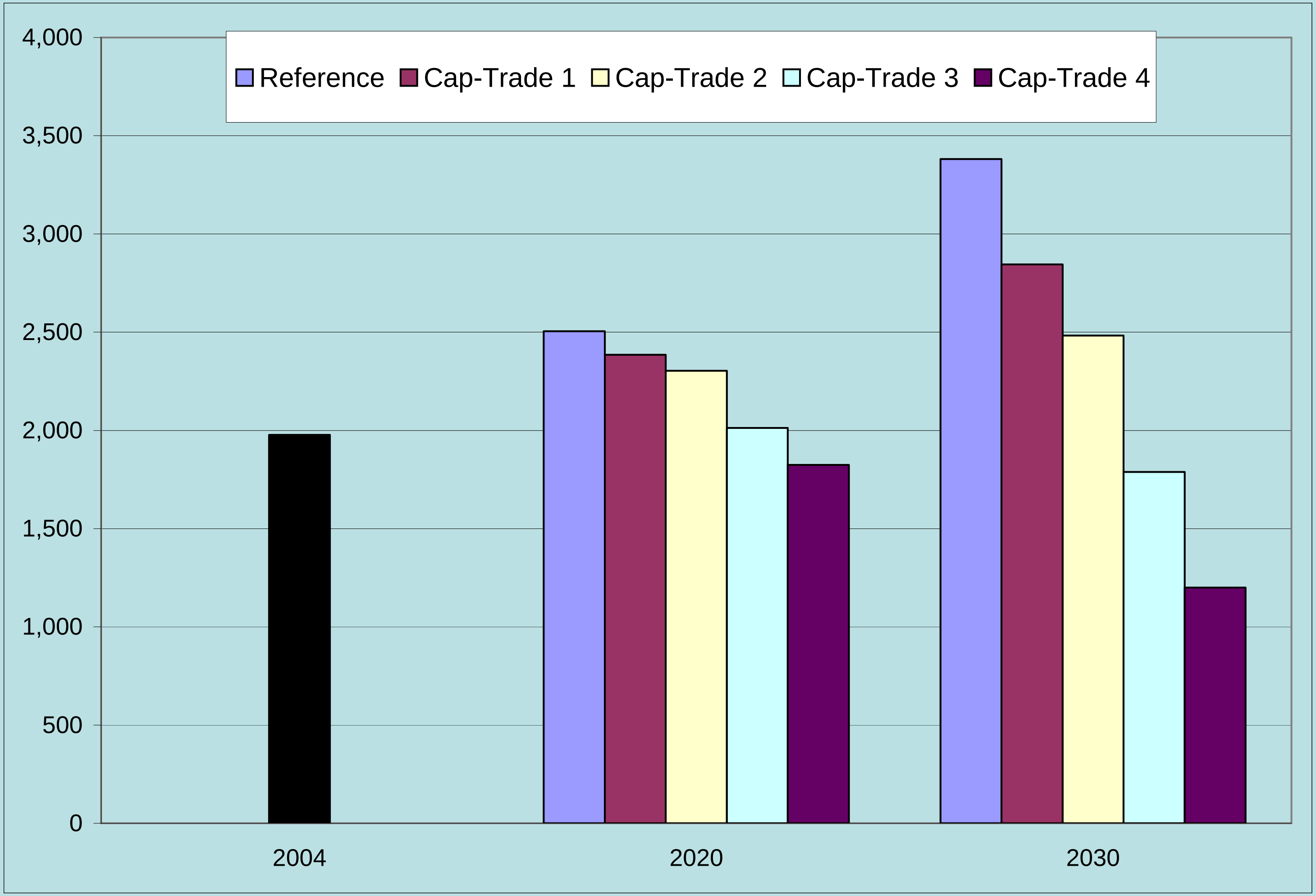


- The electricity sector is the main source of energy-related GHG reductions

Energy Security and GHG Emission Reduction: some synergies (S), some conflicts (C)

- (S) Improved vehicle efficiency: lowers GHG emissions and oil demand/imports (=more energy security?)
- (S/C) Biomass: should it back out coal used in electricity generation or oil used in transport fuels?
- (C) Coal to liquids: reduces oil import dependence, but not helpful on GHGs
- (S/C) CO2 sequestration requirements: helpful on GHGs, hurts coal, but can reduce oil imports via enhanced production from aging fields.

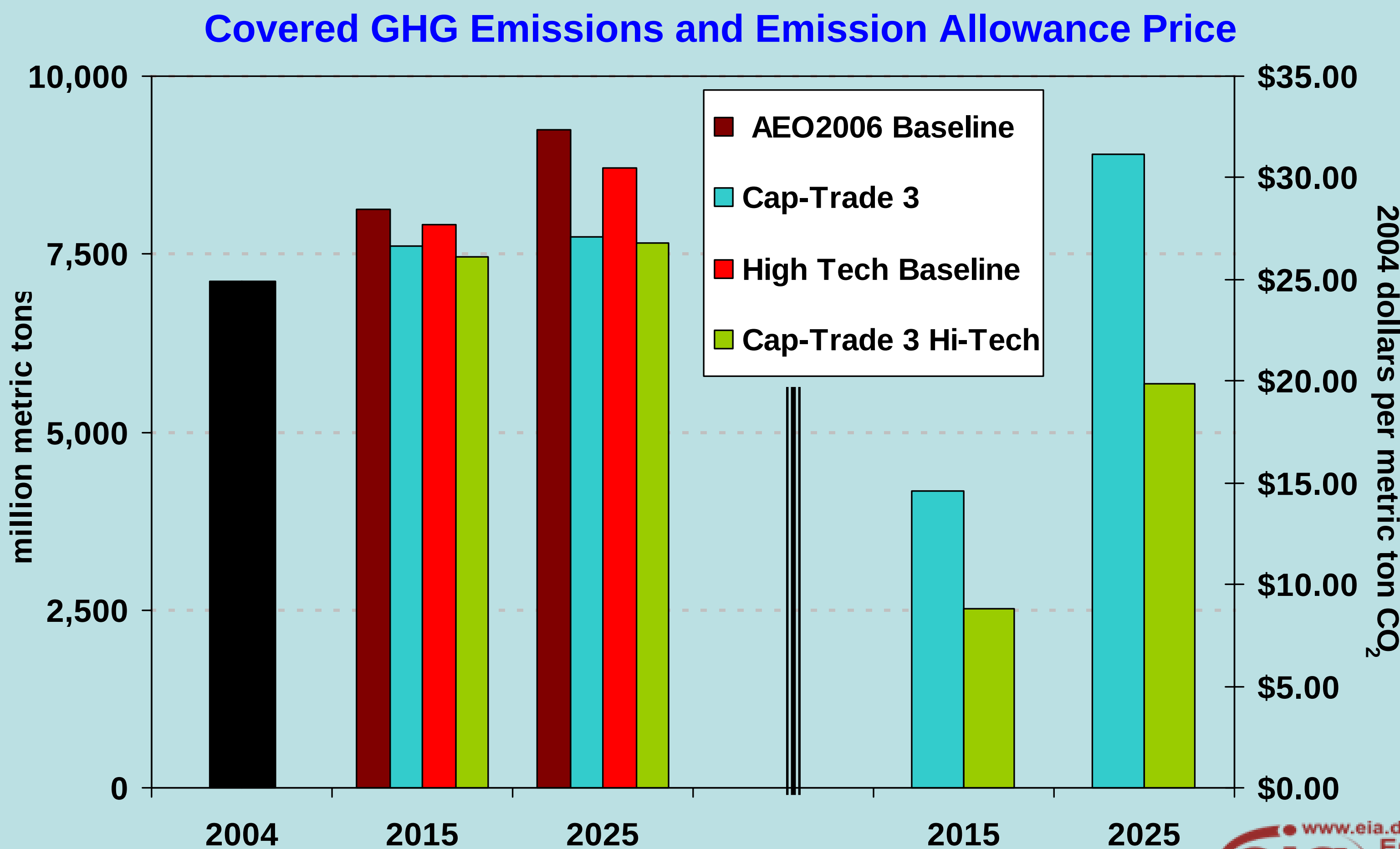
Coal Generation in Alternative Cases (billion kilowatthours)



- As the emissions cap is lowered, coal-fired generation is reduced

The State of Energy Technology Matters

- With lower cost and earlier availability of advanced energy technology, it is both easier and cheaper to reach any given GHG emissions target. Advanced technology lowers baseline GHG emissions and also makes it cheaper to further reduce emissions.
- EIA is not able to relate the state of future technology to specific government initiatives.



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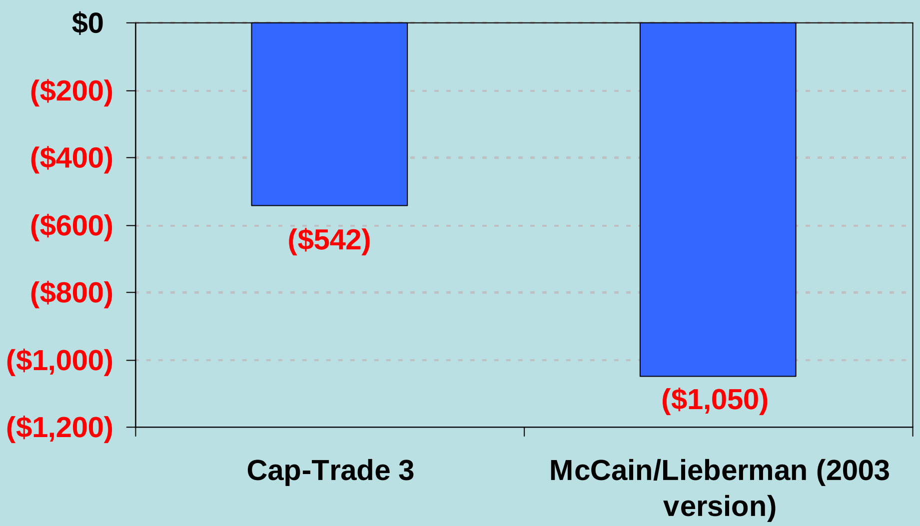
Economic Impacts of GHG Reduction: small % changes = big $

Given the overall size and expected growth of the U.S. economy, small changes in growth rates of consumption or output translate into large absolute dollar changes. The same estimated impacts can be "framed" to sound either large or small.

Sum of Discounted (@4%)Change in Real Gross Domestic Product, 2010 - 2025, (billion 2000 dollars)



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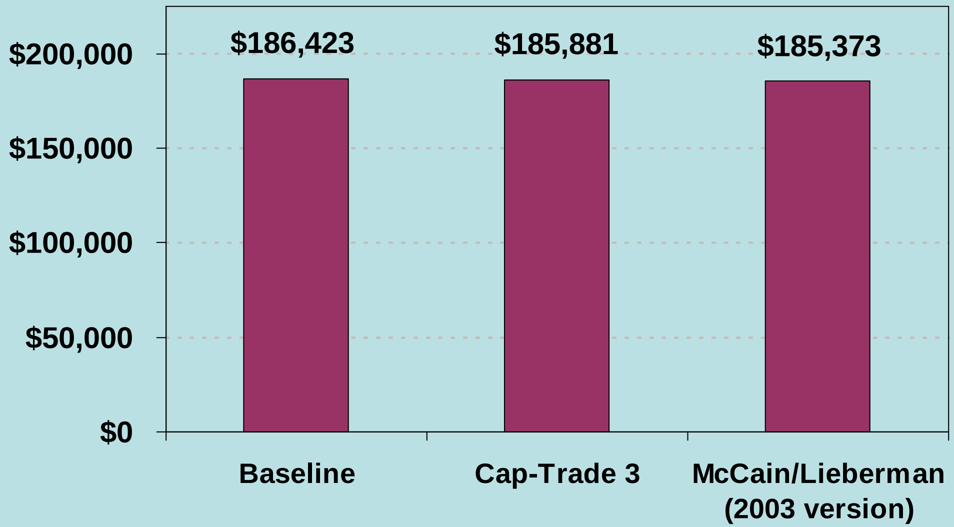

The Devil is in the Details

- Efforts to hide costs or pick winners (or prevent particular technologies from coming to market) can affect the realized costs of mitigation
  - Experience with the Public Utility Regulatory Policies Act
  - Prospects for new nuclear and biomass power are a critical issue
- Policymakers need to consider how policy design affects incentives for *ex post* behavior
  - Analyses generally reflect "efficient" responses without regard to public (or private) concerns other than GHG mitigation.
  - Different policy approaches that are analytically similar can have very different implications for post-implementation behavior.

Additional Observations

- All long-run energy projections are highly uncertain. Differences between scenarios and general trends are more important than specific model results.
- Distributional effects as well as overall impacts matter. The rules for handing out or auctioning emissions allowances are very important in this regard.
- Coal will bear the brunt of efficient GHG emissions reduction in the energy sector. Carbon capture and sequestration may be too expensive for coal to maintain its share of total energy supply.
- Losers from action to limit GHG emissions can probably self-identify much more readily than winners.

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