



U.S. Environmental Protection Agency  
Office of Atmospheric Programs

# *EPA Climate Economic Analysis Using Multiple Models and Tools*

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NREL, CO Nov 27, 2007**

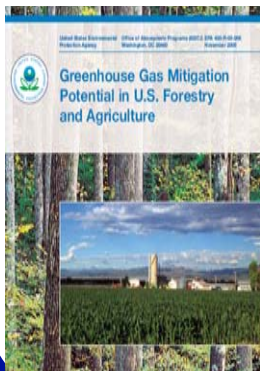
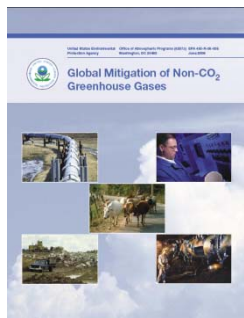


# EPA Climate Economic Work

- Currently analyzing
  - “Low Carbon Economy Act of 2007” introduced by Sens. Bingaman and Specter
  - “America’s Climate Security Act of 2007” introduced by Sens. Lieberman and Warner

- Recent work & publications

- “Climate Stewardship and Innovation Act of 2007” introduced by Sens. Lieberman & McCain
- Lead Authors on 4 Chapters of the IPCC *Climate Change Mitigation Volume*
- “Multigas Mitigation and Climate Policy”. *The Energy Journal Special Issue 2006*
- *Global Mitigation of Non-CO<sub>2</sub> Greenhouse Gases*
- *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture*





## Recent Supreme Court Decision – *Massachusetts v. EPA*

- Section 202(a)(1) of the Clean Air Act, 42 U.S.C. § 7521(a)(1), requires the administrator of the Environmental Protection Agency to set emission standards for "any air pollutant" from motor vehicles or motor vehicle engines "which in his judgment cause[s], or contribute[s] to, air pollution which may reasonably be anticipated to endanger public health or welfare."

The Supreme Court sided with Massachusetts + 10 states and 13 environmental groups. Key issues decided:

- Whether Massachusetts (and other states) have standing to sue over the issue of climate change. *YES*
- Whether the EPA Administrator has authority to regulate carbon dioxide and other air pollutants associated with climate change under section 202(a)(1). *YES*
- Whether the EPA Administrator may decline to issue emission standards for motor vehicles based on policy considerations not enumerated in section 202(a)(1). *Left the issue open, EPA needs to better justify.*

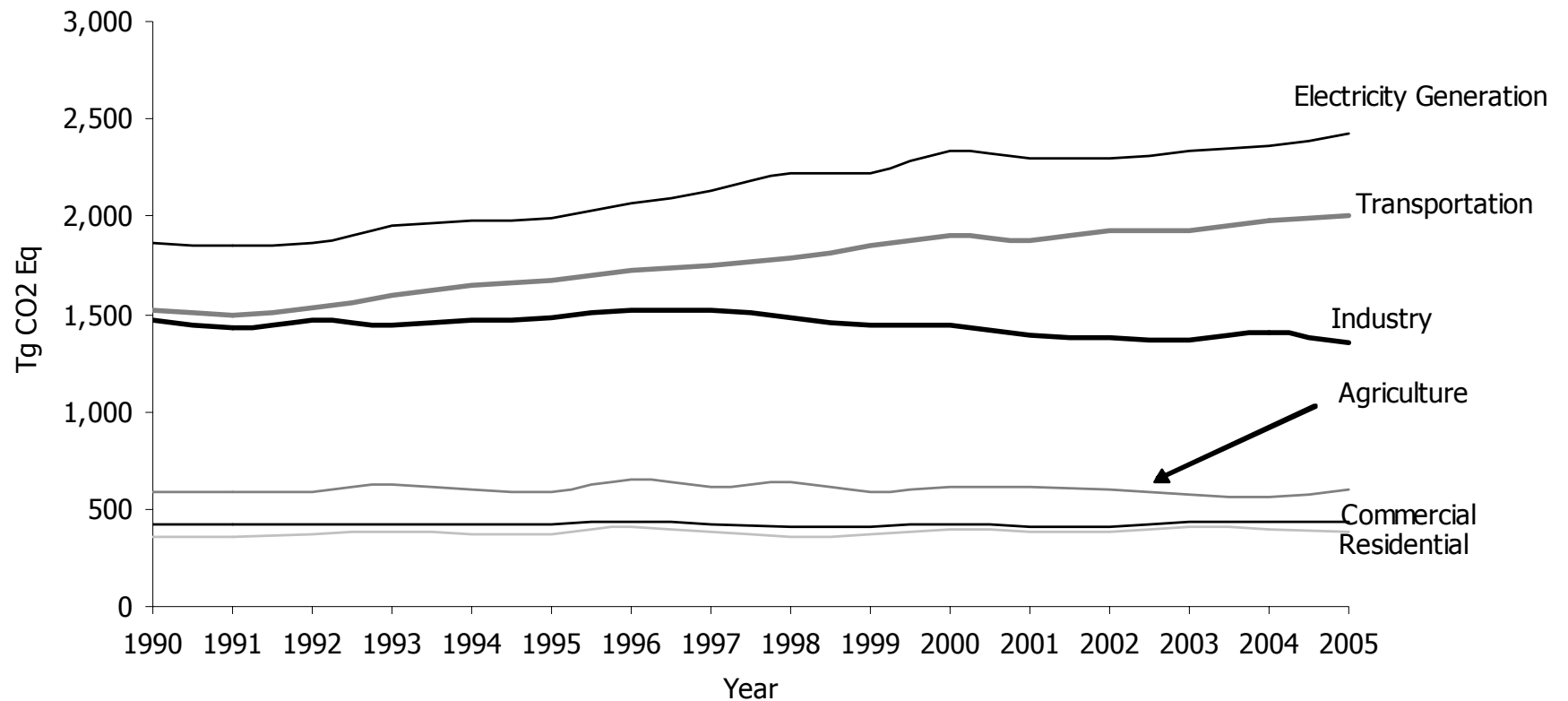


# Executive Order on GHG and Vehicles

- Executive Order issued May 15, 2007: Cooperation Among Agencies in Protecting the Environment with Respect to Greenhouse Gas Emissions From Motor Vehicles, Nonroad Vehicles, and Nonroad Engines.
- Directs EPA and the Departments of Energy, Transportation, and Agriculture to take the first steps toward regulations that would cut gasoline consumption and reduce greenhouse gas emissions from motor vehicles.
- Based on the President's "Twenty in Ten" plan to reduce U.S. gasoline consumption by 20 percent over the next ten years.
  - Mandatory use of the equivalent of 35 billion gallons of renewable and other alternative fuels in 2017 or about 15% of projected gasoline use.
  - Reform and modernize Corporate Average Fuel Economy (CAFE) standards for cars (incr. 4% by in 2010), and further increase the CAFE standards for light trucks (incr. 4% by in 2012). Another 5% reduction in gasoline use by 2017.
- Any regulation of GHGs from new motor vehicles under Clean Air Act section 202(a) requires that EPA make a determination that GHGs, primarily CO<sub>2</sub>, cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare.
- Proposal by end of 2007, with a final rule completed by October 2008



# U.S. GHG Emissions allocated to economic sectors



Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005 (EPA #430-R-07-002)



# OAP Climate Economics Modeling

Sector		Economy-wide Computable General Equilibrium (CGE) Models		Models Used to Provide Inputs to CGEs				Partial Equilibrium Model (Uses CGE Outputs)
		ADAGE	IGEM	NCGM	FASOM	GTM	MiniCAM	IPM
Domestic	Electricity Generation	All GHGs	All GHGs					CO <sub>2</sub>
	Transportation	All GHGs	All GHGs					
	Industry	All GHGs	All GHGs	CH <sub>4</sub> , N <sub>2</sub> O, F-gases				
	Commercial	All GHGs	All GHGs					
	Agriculture (& Forestry)	All GHGs	All GHGs	CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O				
	Residential	All GHGs	All GHGs	CH <sub>4</sub> , N <sub>2</sub> O,				
International Credits*			CH <sub>4</sub> , N <sub>2</sub> O, F-gases		CO <sub>2</sub>	CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O, F-gases		

**ADAGE** Applied Dynamic Analysis of the Global Economy (Ross, 2007)

**IGEM** Intertemporal General Equilibrium Model (Jorgenson, 2007)

**IPM** Integrated Planning Model (EPA, 2007)

**NCGM** EPA's non-CO<sub>2</sub> GHG spreadsheet tools for estimating projections and mitigation of CH<sub>4</sub>, N<sub>2</sub>O, and F-gases (EPA, 2005)

**FASOMGHG** Forest and Agriculture Sector Optimization Model, GHG version (EPA, 2005)

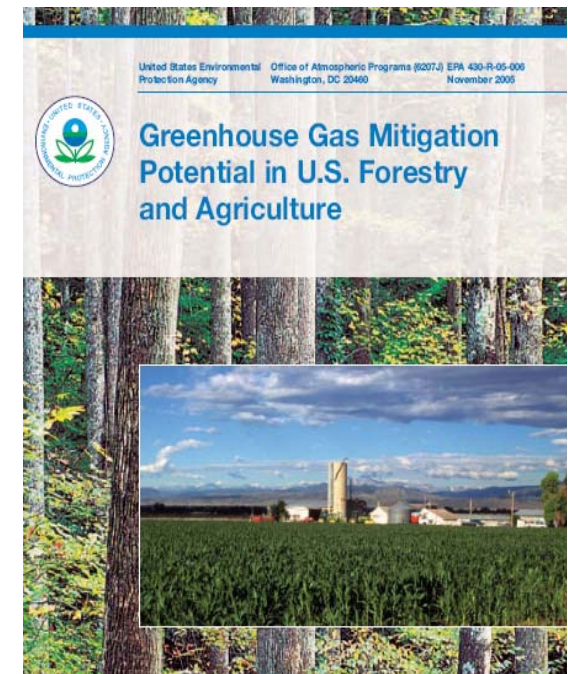
**GTM** Global Timber Model (Sonhgen, 2006)

**MiniCAM** Mini-Climate Assessment Model (Edmonds, 2005)



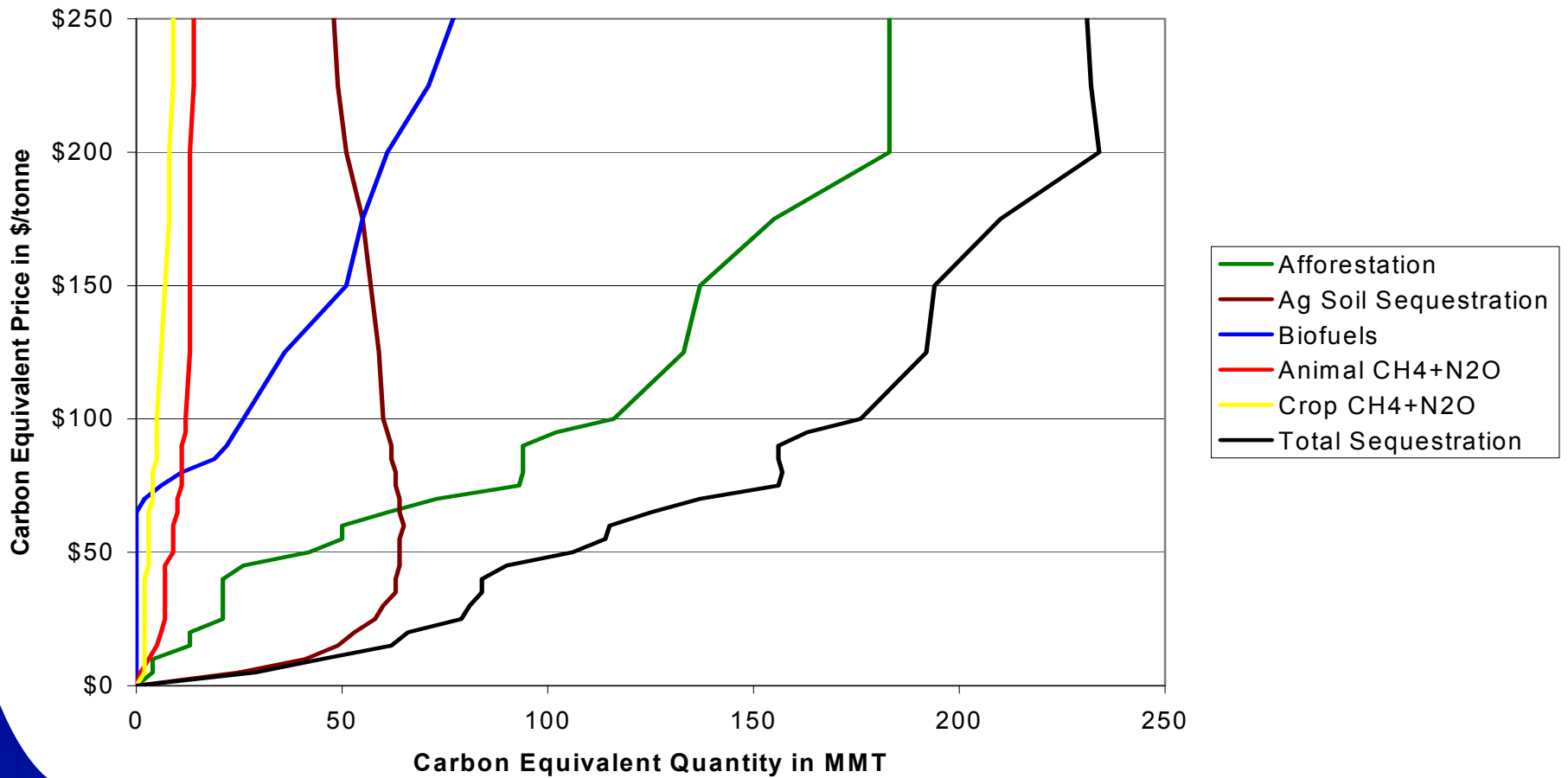
## *Sequestration and GHG Mitigation in U.S. Forestry and Agriculture*

- Carbon Sequestered in Cropped Soil (no till farming)
- Carbon in Cropland converted to Grassland
- Carbon in Forests from afforestation and management practices
- Carbon (CO<sub>2</sub>) avoided by Biomass for electricity generation
- Methane from Livestock (Enteric Fermentation)
- Methane from Livestock Liquid Manure Management
- Nitrous Oxide released from Fertilization
- Nitrous Oxide released from Animal Manure





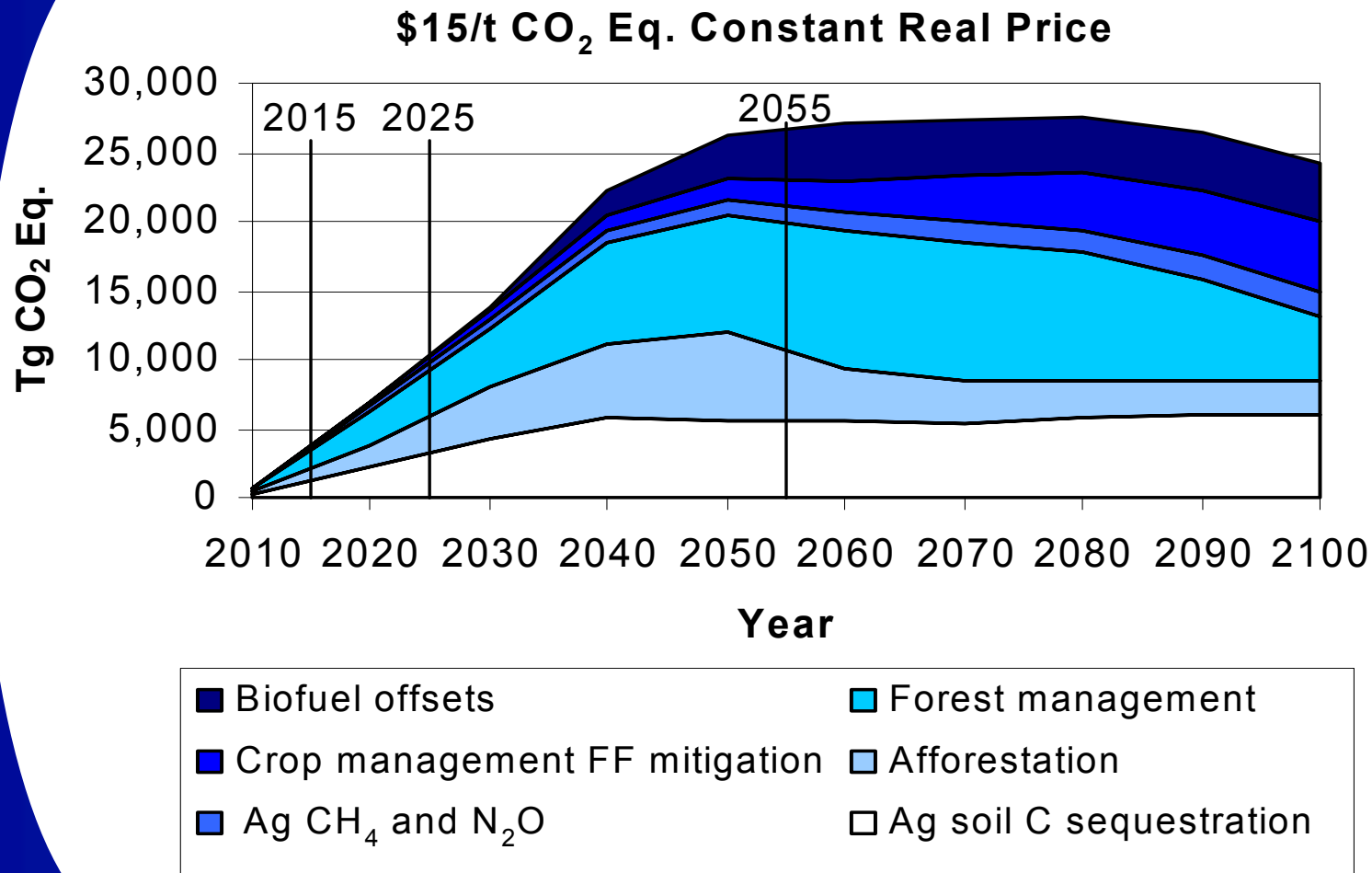
## Agricultural and Forest Carbon Equivalent GHG Mitigation by Strategy (Annual Avg. - 2000-2030)







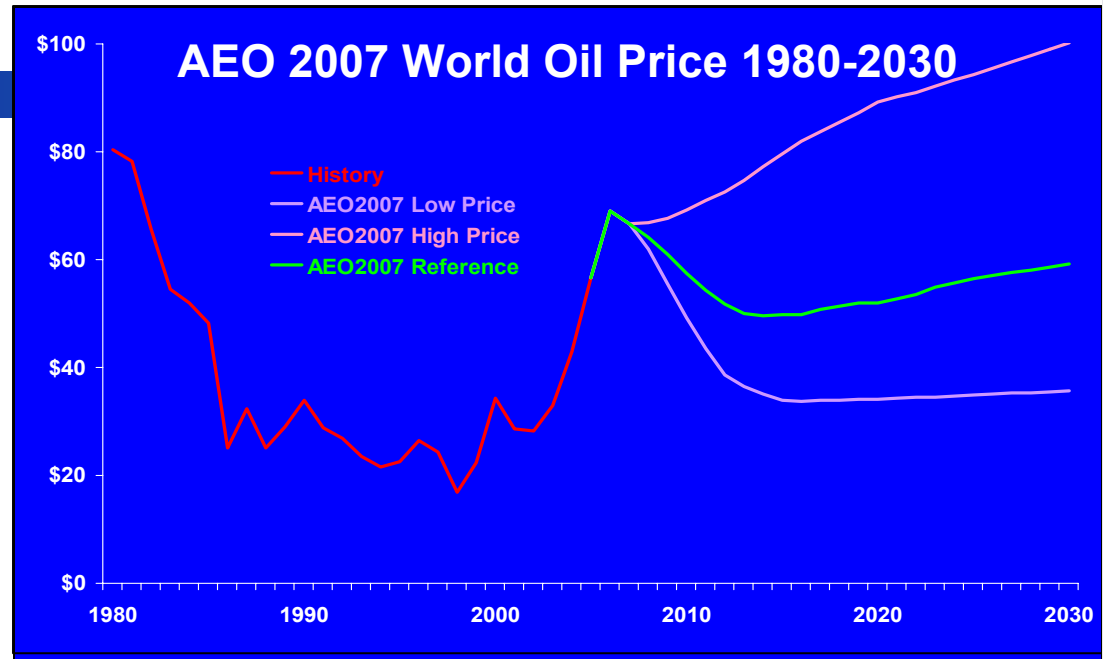
# GHG mitigation from forestry & agriculture: over time, by activity



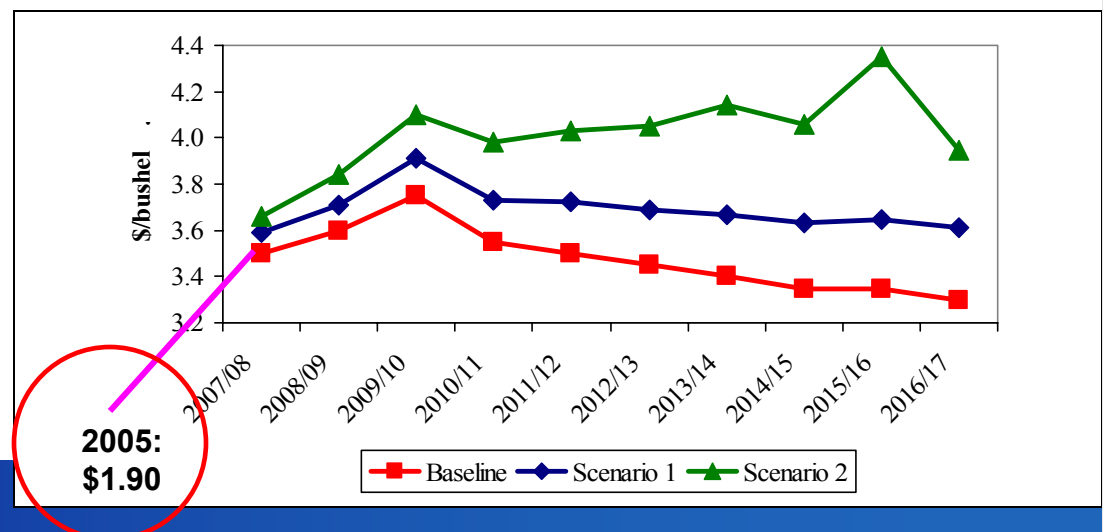


# Changes Since Report: Energy & Corn Prices, Demand for Ethanol, Climate Policy

1. EPA RFS + President's 20 in 10 Initiative
2. Legislative proposals include ag/forest offsets & bioenergy (e.g., Lieberman-McCain, Bingaman)
3. Cropland shift to biofuels implies ag commodity price, and envir. impacts
4. Globalization of energy and ag international effects (palm oil)



**USDA Corn Price Projection, 5/07**

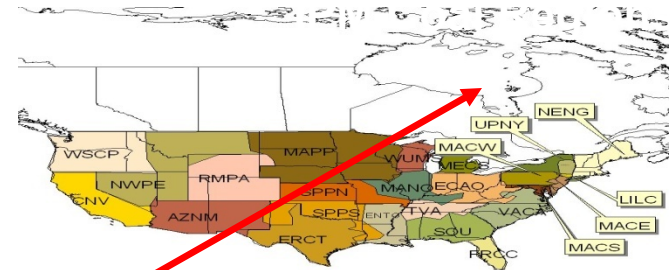
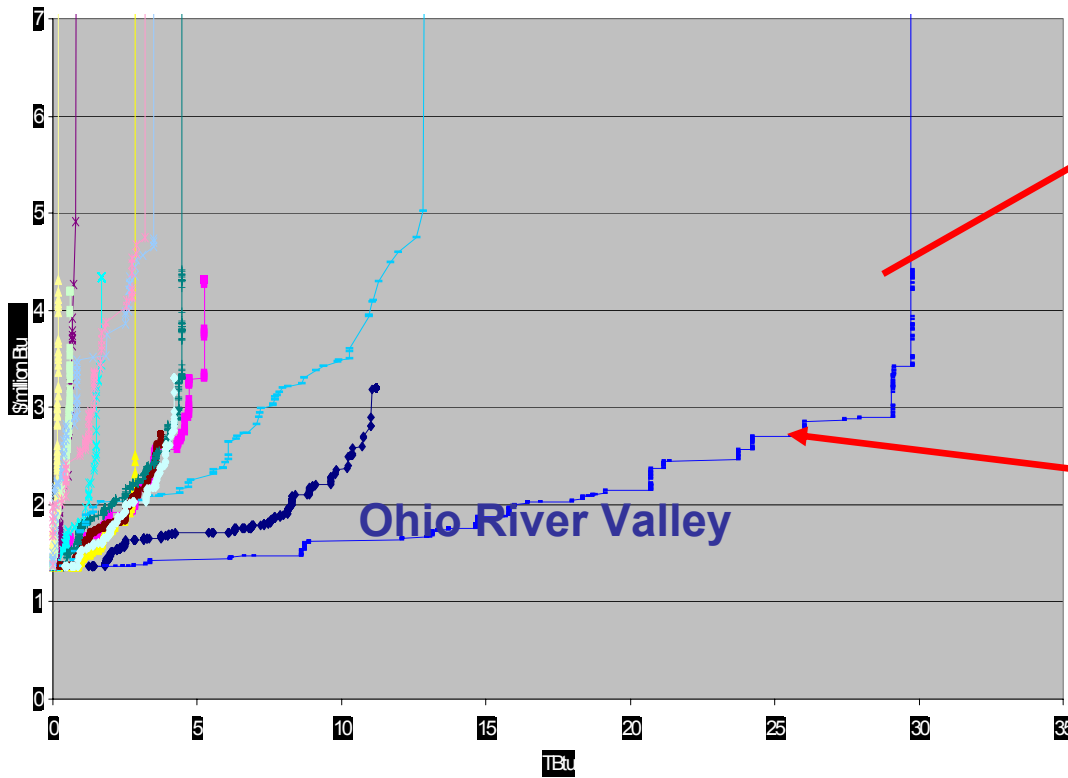


# Improving Bioenergy Representation in FASOM, IPM:

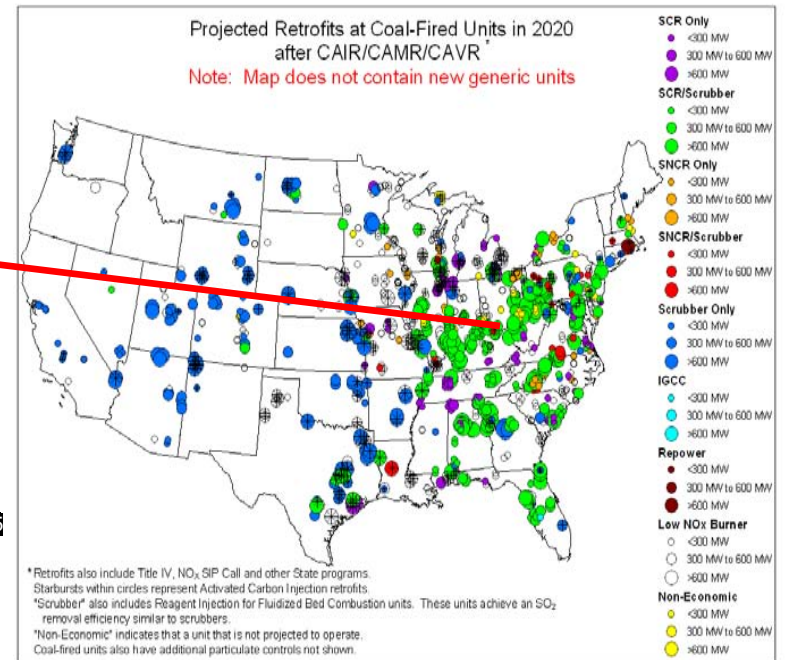
- FASOM biomass supply curves to IPM in 14 new FASOM regions (9/07)
- Reviewing technology (capital stock) turnover rates
- Exporting FASOM results to ADAGE bioenergy

## Biomass Cost Curve from Forest Residues (RTI)

US Public Lands Forest Residue Supply

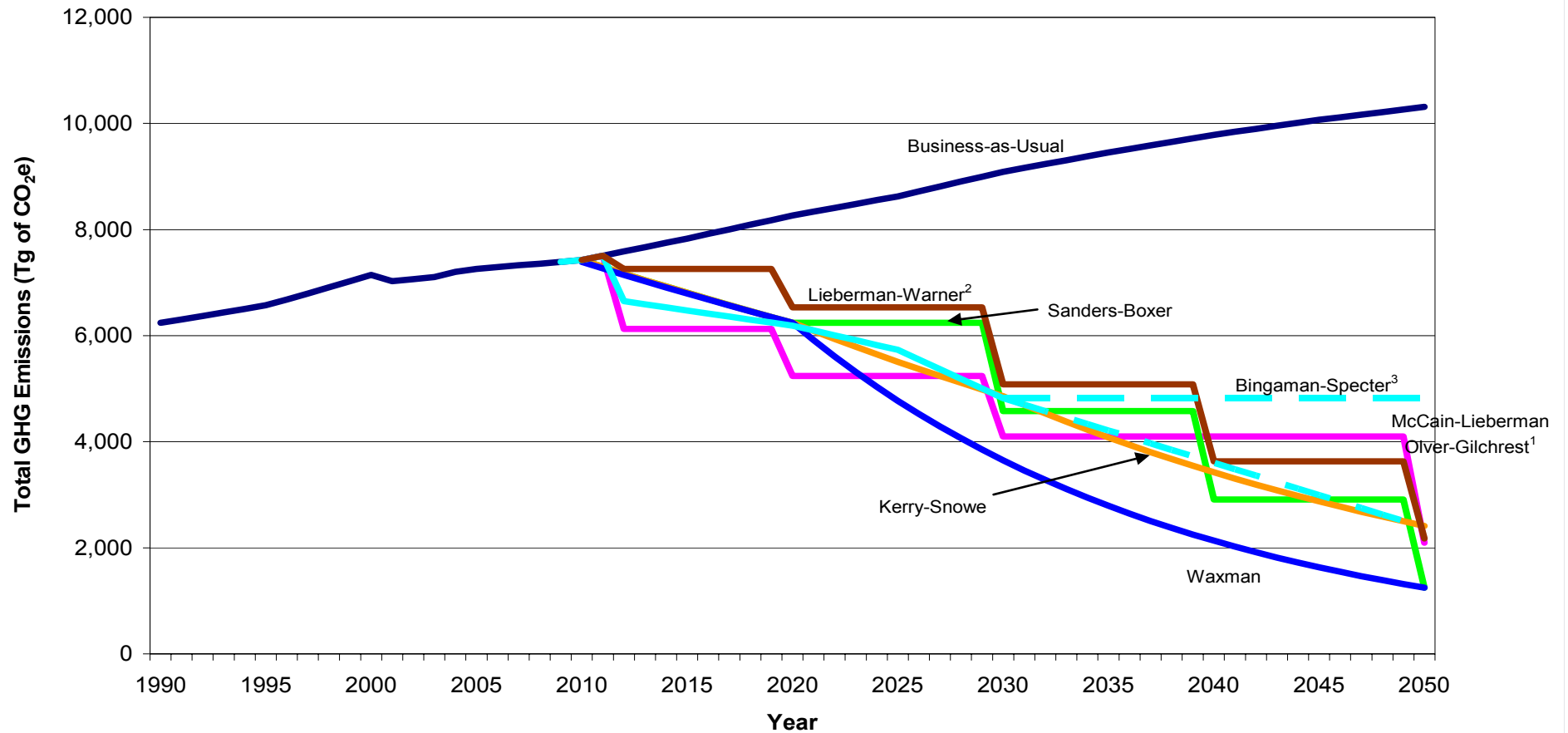


IPM Coal Regions





# U.S. National Legislative Proposals: 110th Congress

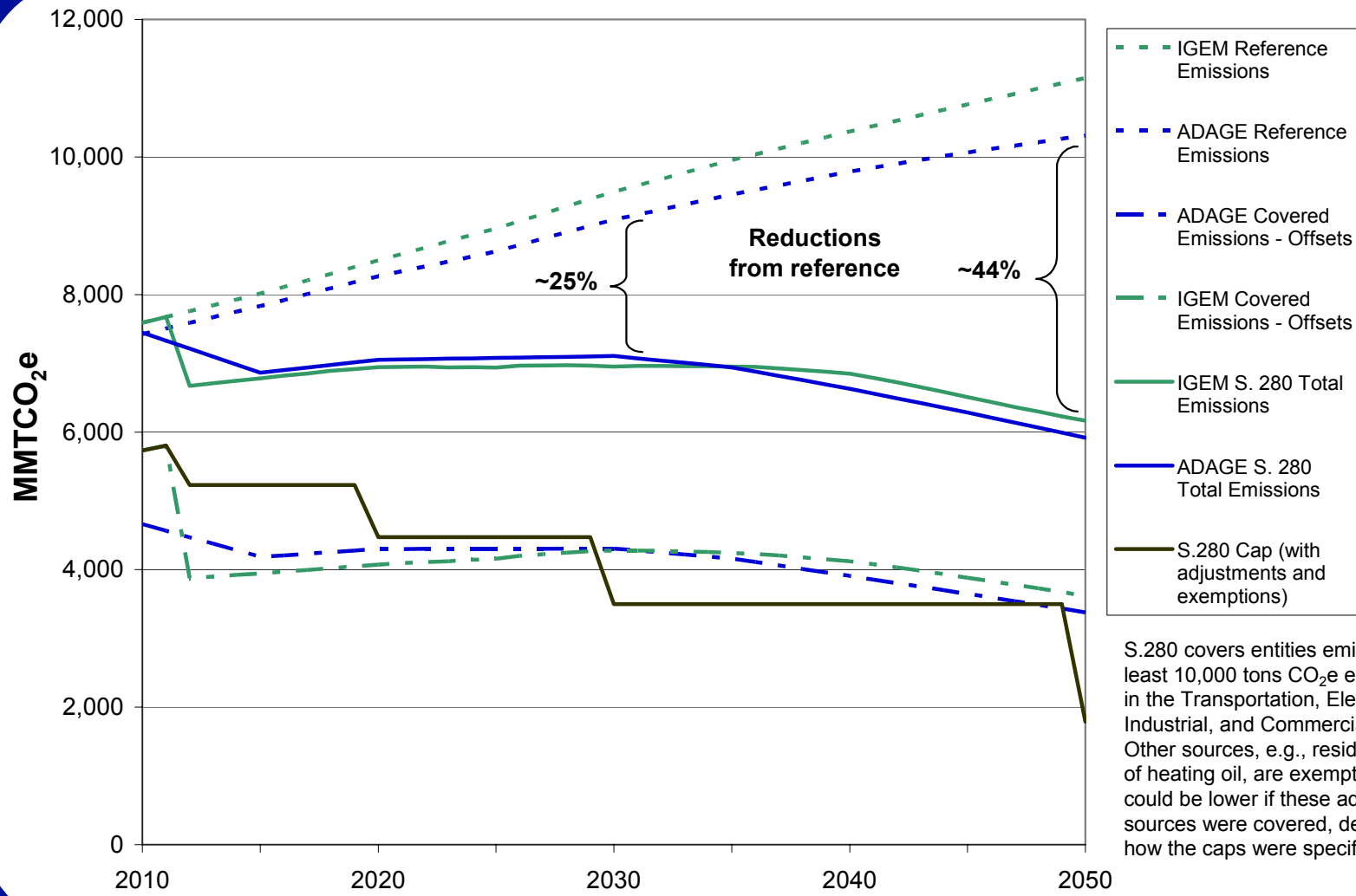


(1) Companion Bills; (2) Based on draft outline introduced Aug 2, 2007. Will be revised when bill is introduced in Sep 2007; (3) 2030 cap held constant through 2050 unless provision enacted to target 60% below 2006 levels in 2050



# Results: S. 280 Senate Scenario

## U.S. GHG Emissions

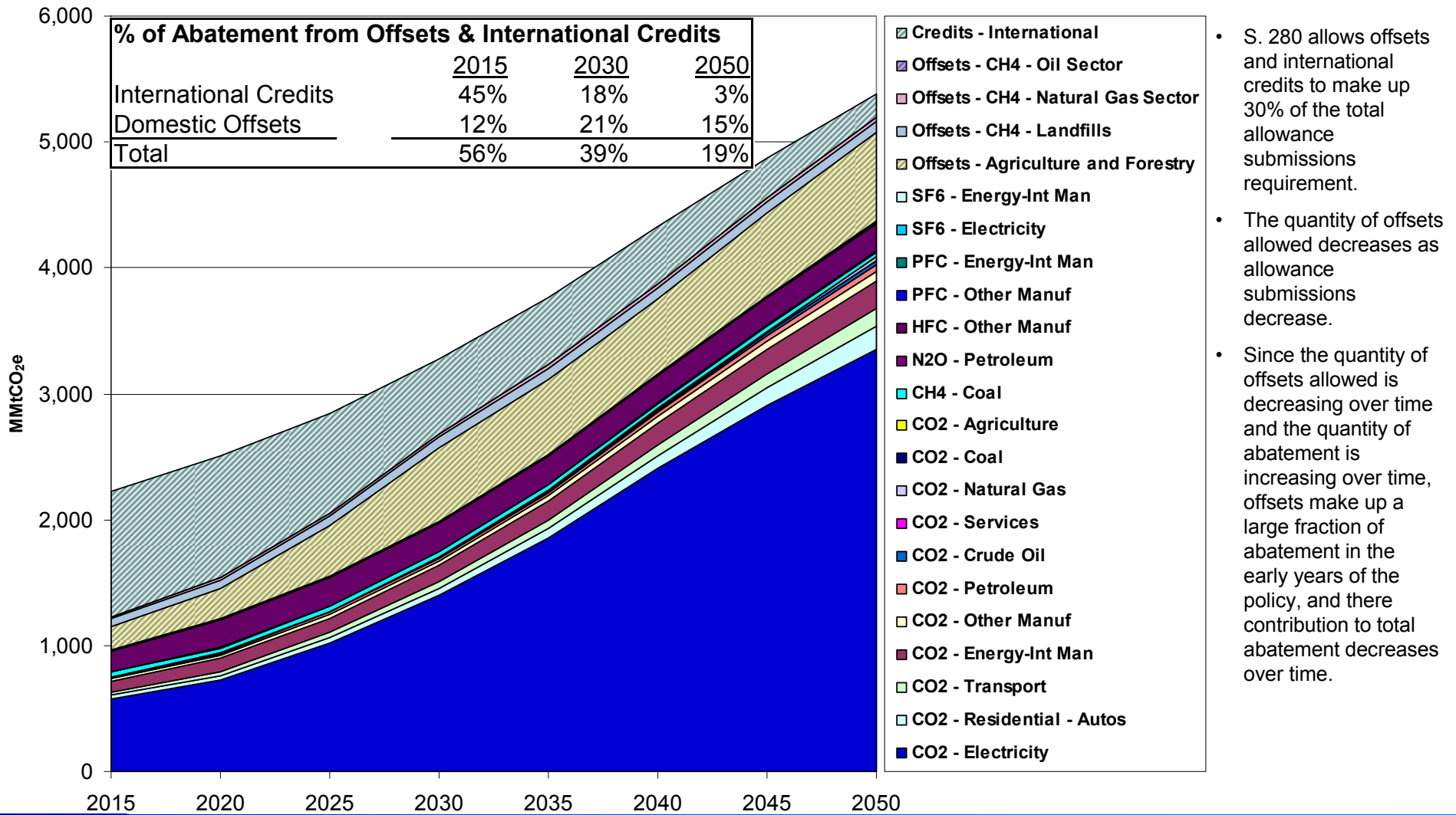


S.280 covers entities emitting at least 10,000 tons CO<sub>2</sub>e emissions/yr in the Transportation, Electricity, Industrial, and Commercial sectors. Other sources, e.g., residential use of heating oil, are exempt. Costs could be lower if these additional sources were covered, depending on how the caps were specified.



# Results: S. 280 Senate Scenario

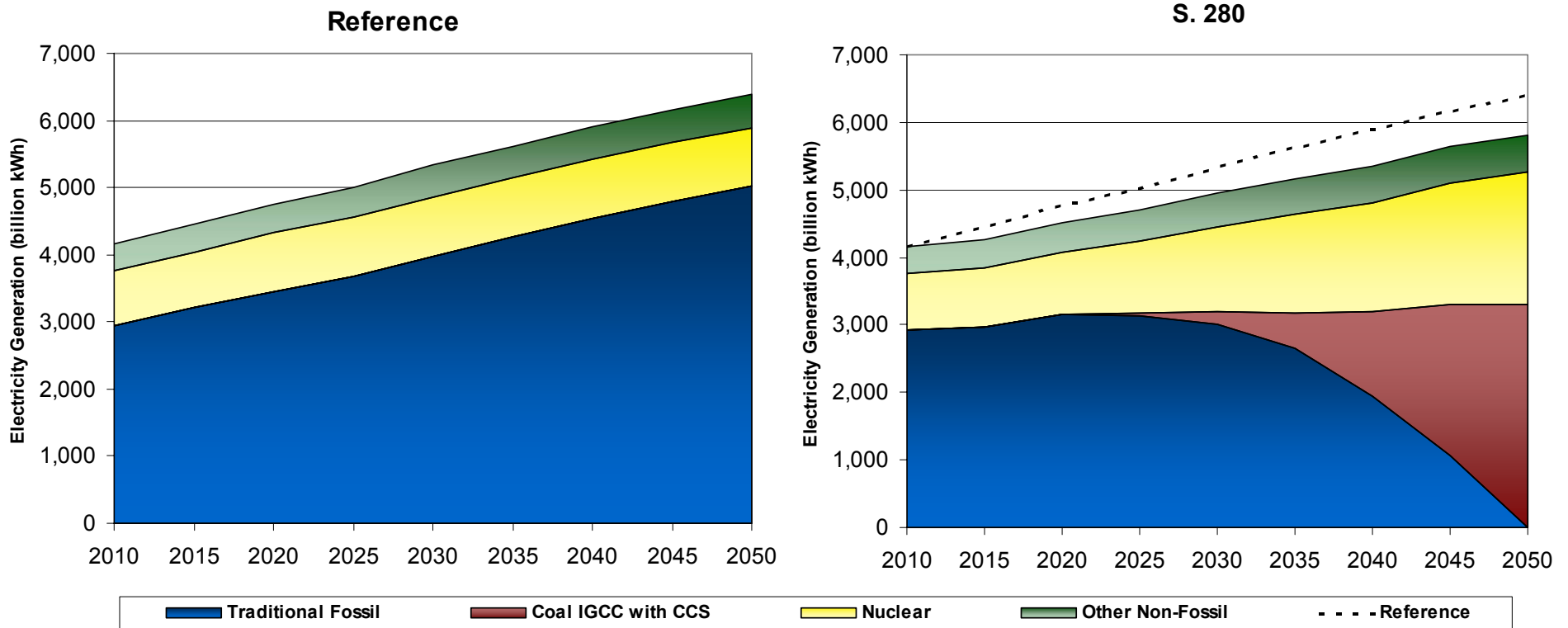
## Sources of GHG Abatement (ADAGE)





# Results: S. 280 Senate Scenario

## U.S. Electricity Generation, mid-term results (ADAGE)



Note: Other non-fossil includes hydro, geothermal, wind, solar, biomass and municipal solid waste.



## **Contact Information**

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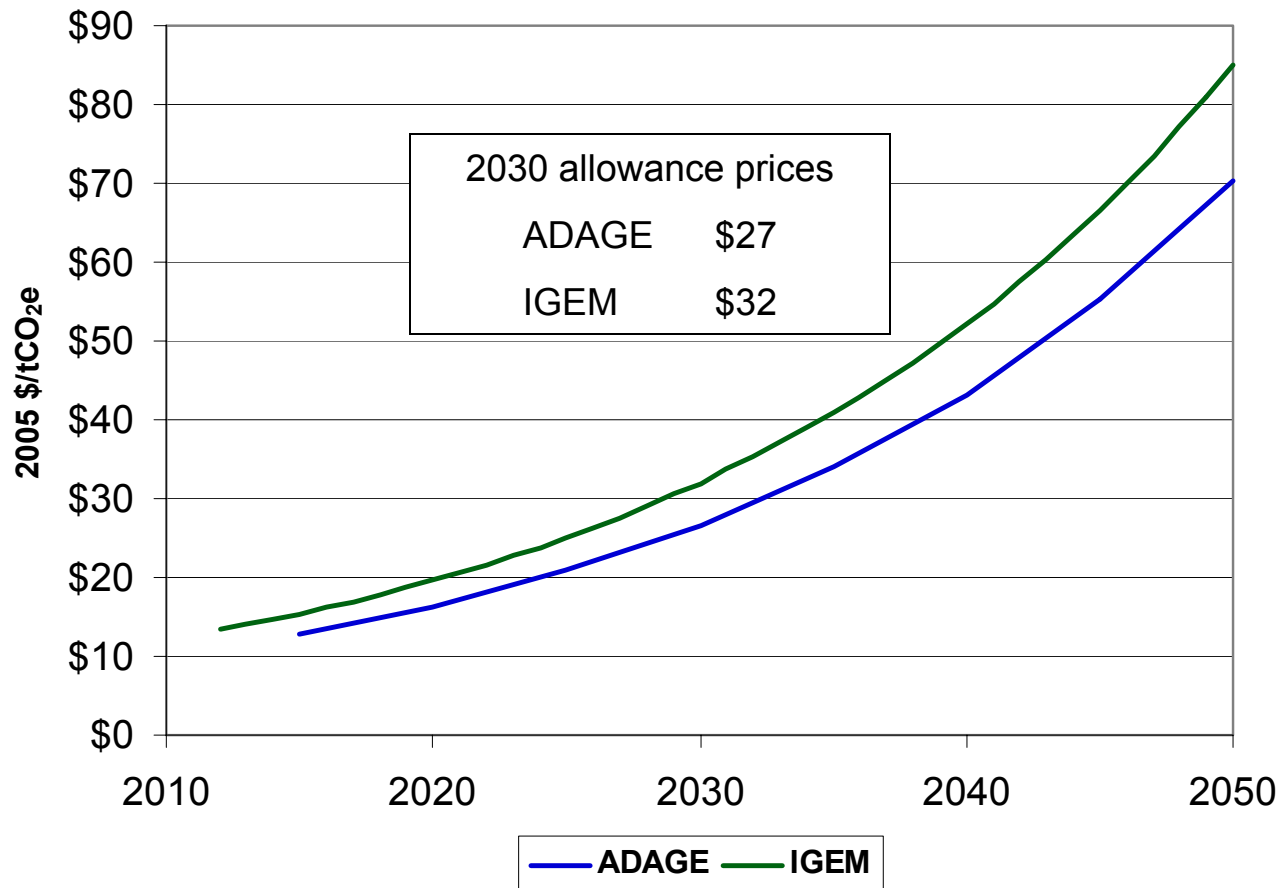
**E-mail: [smith.eric@epa.gov](mailto:smith.eric@epa.gov)**





# Results: S. 280 Senate Scenario

## GHG Allowance Prices



- The \$27 - 30 range of 2030 allowance prices only reflects differences in the models and does not reflect other scenarios or additional uncertainties discussed elsewhere.

### Comparison with Other Analyses

- The recent MIT report, “Assessment of U.S. Cap-and-Trade Proposals” analyzed several scenarios, none of which directly corresponded to S. 280.
- For comparison, we ran one of the MIT scenarios (203 bmt) with the ADAGE model.
- For the 203 bmt scenario, the MIT analysis gave an allowance price of \$41 in 2015 rising at 4%, while the ADAGE model gave a price of \$40 in 2015 rising at 5%.



# Results: S. 280 Senate Scenario

## GDP

**Table: Impact of S. 280 on U.S. GDP (Billion 2005 Dollars)**

	2010	2020	2030	2040	2050	Average Annual Growth (2010 - 2050)
<b>Reference</b>						
ADAGE	\$14,609	\$19,821	\$26,452	\$33,979	\$42,723	2.72%
IGEM	\$14,733	\$19,851	\$26,173	\$33,716	\$41,372	2.61%
<b>S.280</b>						
ADAGE	\$14,606	\$19,749	\$26,306	\$33,750	\$42,266	2.69%
IGEM	\$14,678	\$19,645	\$25,754	\$32,937	\$40,040	2.54%
<b>Absolute Change</b>						
ADAGE	-\$3	-\$72	-\$146	-\$229	-\$457	-0.03 Percentage Points
IGEM	-\$55	-\$206	-\$419	-\$779	-\$1,332	-0.07 Percentage Points
<b>% Change</b>						
ADAGE	-0.02%	-0.36%	-0.55%	-0.67%	-1.07%	
IGEM	-0.37%	-1.04%	-1.60%	-2.31%	-3.22%	



# Results: S. 280 Senate Scenario

## 2030 Selected Sectoral Results (IGEM)

Sector	2007	2030				
		Reference		S. 280		
	Output (\$Billions)	Output (\$Billions)	Percent Change from 2007	Output (\$Billions)	Percent Change from 2007	Percent Change from Reference
Personal and business services	4304	8108	88%	8088	88%	0%
Finance, insurance and real estate	2642	6075	130%	6038	129%	-1%
Transportation and warehousing	681	1284	89%	1257	85%	-2%
Food and kindred products	565	1155	104%	1183	109%	2%
Motor vehicles	513	1095	114%	1063	107%	-3%
Electric utilities (services)	384	548	43%	499	30%	-9%
Petroleum refining	296	389	31%	344	16%	-11%
Gas utilities (services)	51	60	20%	56	11%	-8%
Coal mining	29	40	39%	25	-13%	-37%

- Detailed near-term electricity sector modeling in IPM indicates that the decrease in coal usage may be smaller than the decrease shown in the economy-wide models.
- The results for all 35 sectors and for 2050 are available in Appendix 2.



# Results: S. 280 Senate Scenario

## Total Abatement Costs

Table: Abatement Cost Calculations

	2015	2020	2025	2030	2035	2040	2045	2050
<b>Domestic Covered Abatement (MMTCO<sub>2</sub>e)</b>								
ADAGE	969	1,217	1,553	1,986	2,514	3,156	3,776	4,369
IGEM	971	1,230	1,524	1,845	2,282	2,802	3,460	4,150
<b>Domestic Offset Abatement (MMTCO<sub>2</sub>e)</b>								
ADAGE	259	322	498	695	720	719	796	832
IGEM	259	322	498	695	720	719	796	832
<b>International Credits (MMTCO<sub>2</sub>e)</b>								
ADAGE	996	968	793	596	528	453	298	182
IGEM	924	900	749	588	553	517	369	253
<b>Allowance Price (\$/tCO<sub>2</sub>e)</b>								
ADAGE	\$13	\$16	\$21	\$27	\$34	\$43	\$55	\$70
IGEM	\$15	\$20	\$25	\$32	\$41	\$52	\$67	\$85
<b>Offset Price (\$/tCO<sub>2</sub>e)</b>								
ADAGE	\$9	\$12	\$15	\$20	\$25	\$32	\$41	\$52
IGEM	\$9	\$12	\$15	\$20	\$25	\$32	\$41	\$52
<b>Domestic Covered Abatement Cost (Billion 2005 Dollars)</b>								
ADAGE	\$6	\$10	\$16	\$26	\$43	\$68	\$104	\$154
IGEM	\$7	\$12	\$19	\$30	\$47	\$73	\$115	\$176
<b>Domestic Offset Abatement Cost (Billion 2005 Dollars)</b>								
ADAGE	\$1	\$2	\$4	\$7	\$9	\$12	\$16	\$22
IGEM	\$1	\$2	\$4	\$7	\$9	\$12	\$16	\$22
<b>International Credit Payments (Billion 2005 Dollars)</b>								
ADAGE	\$9	\$12	\$12	\$12	\$13	\$15	\$12	\$10
IGEM	\$9	\$11	\$12	\$12	\$14	\$17	\$15	\$13
<b>Total Abatement Cost (Billion 2005 Dollars)</b>								
ADAGE	\$17	\$24	\$32	\$45	\$65	\$94	\$133	\$185
IGEM	\$17	\$25	\$35	\$48	\$70	\$101	\$147	\$211