Looking Out for Energy Related Multiple Pollutant Legislation

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Resources for the Future

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Background materials at http://www.rff.org/multipollutant

Allocation Schedules under Multipollutant Proposals

Pollutant	S. 556 – Jeffords	S. 2815 – Clear Skies	S. 3135 – Carper	Efficient Levels[1]	2000 Emissions
National Annual Allowance Allocation Caps					
Sulfur Dioxide (SO_2)	2.25 million tons in 2008. The SO_2 cap is split into two regions.[2]	4.5 million tons in 2010. 3.0 million tons in 2018.	4.5 million tons in 2008. 3.5 million tons in 2012. 2.25 million tons in 2015.	Between 0.9 and 3.1 million tons.	11.2 million tons.
Nitrogen Oxides (NO_x)	1.51 million tons in 2008.	2.1 million tons in 2008. 1.7 million tons in 2018. The NO_x cap is split into two regions.[3]	1.87 million tons in 2008. 1.7 million tons in 2012.	Between 1.0 and 2.8 million tons.	5.1 million tons.
Mercury	5 tons in 2008.	26 tons in 2010. 15 tons in 2018.	24 tons in 2008. 5 to 16 tons in 2012.[4] Facility-specific limitations also apply.[5]	Not analyzed.	48 tons.
Carbon Dioxide (CO_2)	2.05 billion tons in 2008.[6]	None.	2.56 billion tons in 2008.[7] 2.39 billion tons in 2012.[8]	Not analyzed.	2.6 billion tons.

The full version of this table can be found at www.rff.org/multipollutant/.

[1] Banzhaf, Burtraw, and Palmer 2002.

[2] Under S. 556, the western region has a 0.275 million ton cap on SO_2 and the non-western region has a 1.975 million ton cap on SO_2.

[3] Under S. 2815, the western region has a 0.538 million ton cap on NO_x and the eastern region has a 1.562 million ton cap on NO_x. The eastern NO_x cap is reduced to 1.162 million tons in 2018.

[4] Beginning in 2012, the S. 3135 mercury cap is 7% to 21% of the quantity of mercury in delivered coal in 1999 as determined by the administrator.

[5] For S. 3135, from 2008 to 2011, mercury emissions cannot exceed 50% of the total mercury present in delivered coal at each affected facility. In 2012, the percentage drops to 30%. Also, emissions may not exceed an output-based rate determined by the administrator.

[6] The CO_2 cap is specified in S. 556 and it approximates 1990 level CO_2 emissions from the electricity sector.

[7] The S. 3135 2008 allowance cap is equal to 2005 electricity sector CO_2 emissions as projected by EIA in the most recent report as of date of enactment. The number we report is EIA's *AEO 2002* projection for 2005.

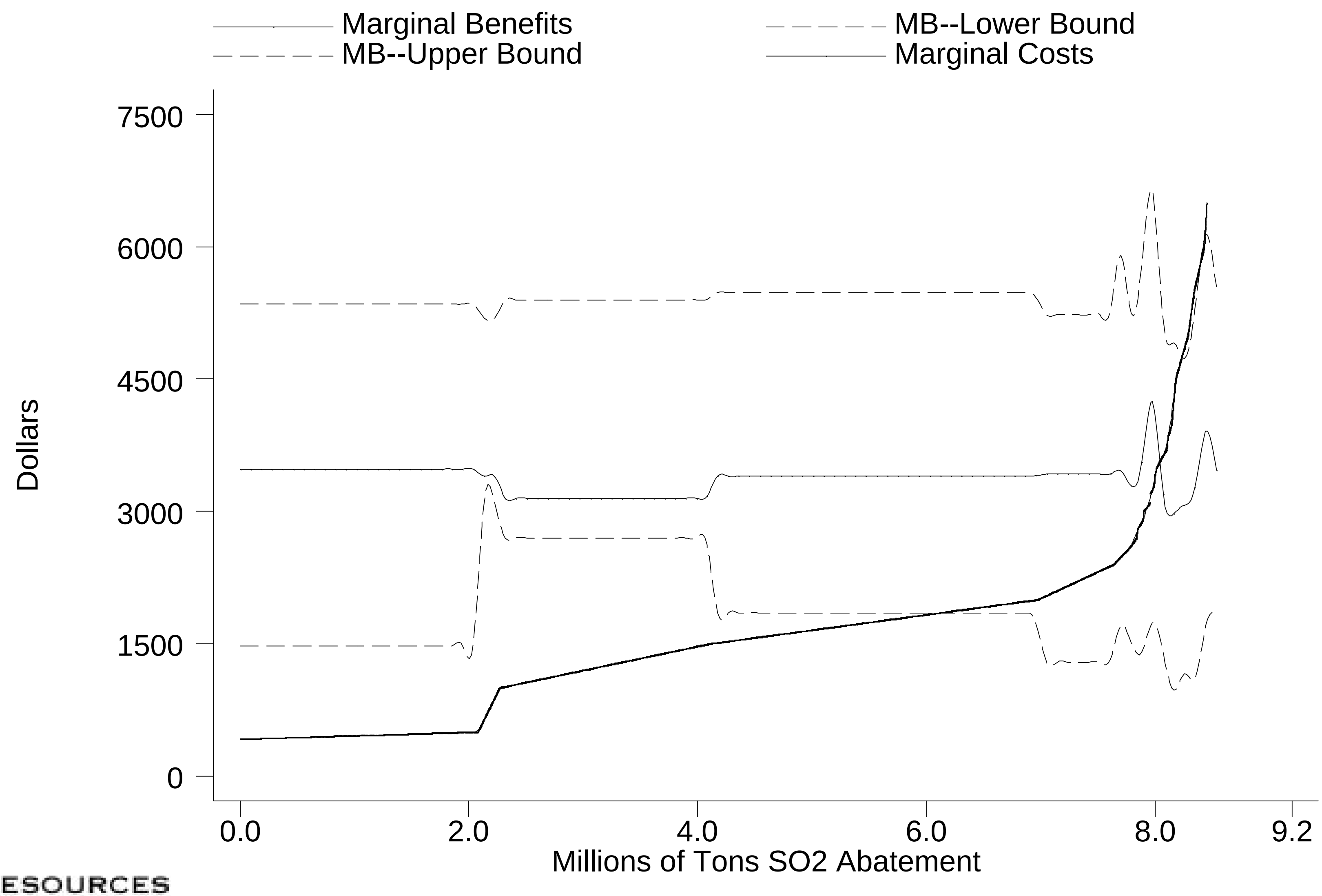
[8] The S. 3135 2012 emissions cap is equal to actual 2001 electricity sector CO_2 emissions. The number we report is EIA's *AEO 2002* projection for 2001.

Efficient Emission Levels for SO2 and NOx

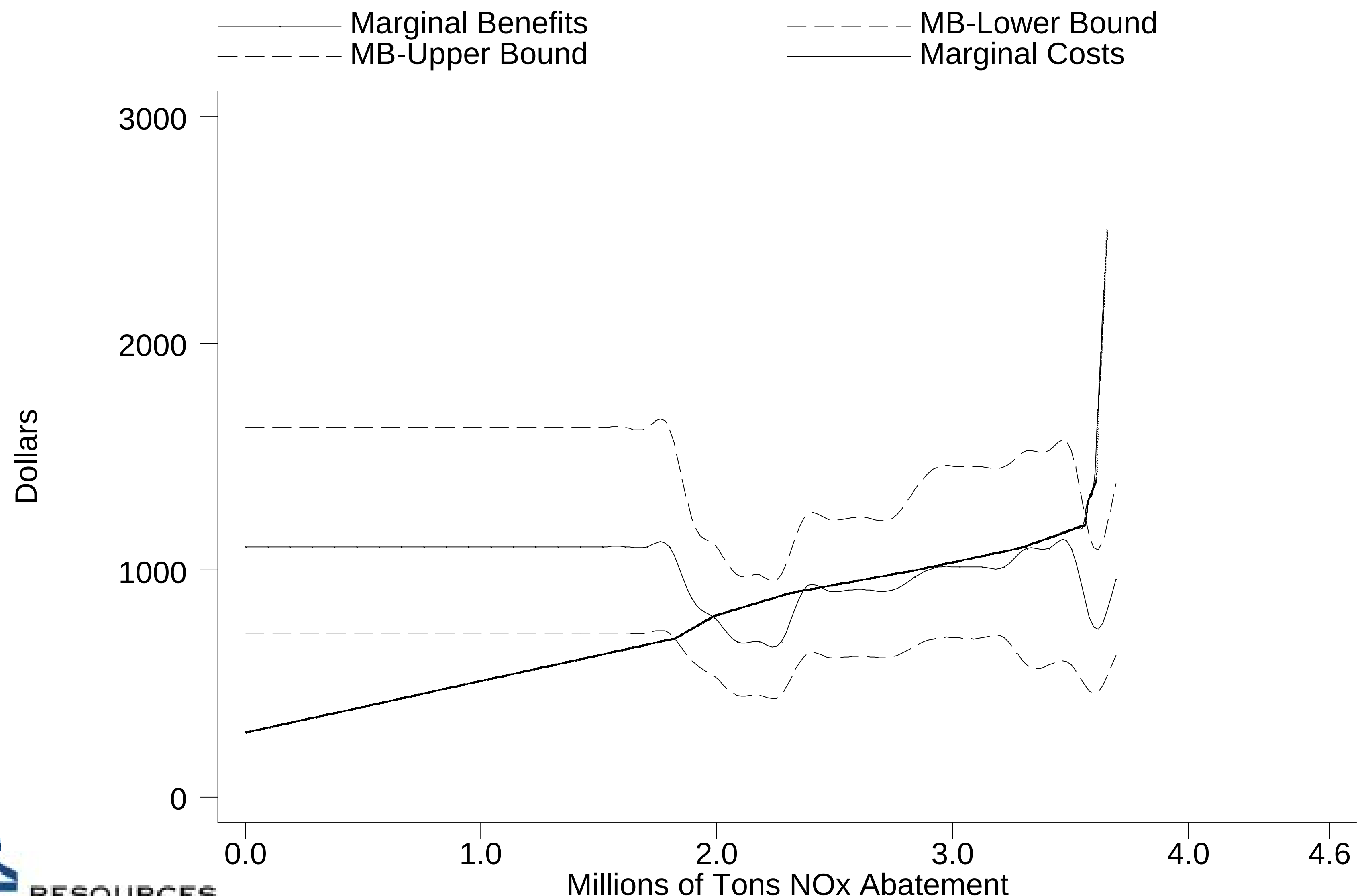
Scenario and Key Assumptions

- PM-health modeled only; no ozone benefits
- Examine SO2 and NOx emission fees
- No CO2 or mercury requirements
- Results for 2010
- Title IV SO2, SIP Call NOx baseline
- Pope et al. (1995) for sulfates
- Nitrates as ordinary PM_{10}
- VSL=$2.25 million (Mrozek and Taylor, 2001)

Marginal Benefits and Costs: SO_2



Marginal Benefits and Costs: NO_X



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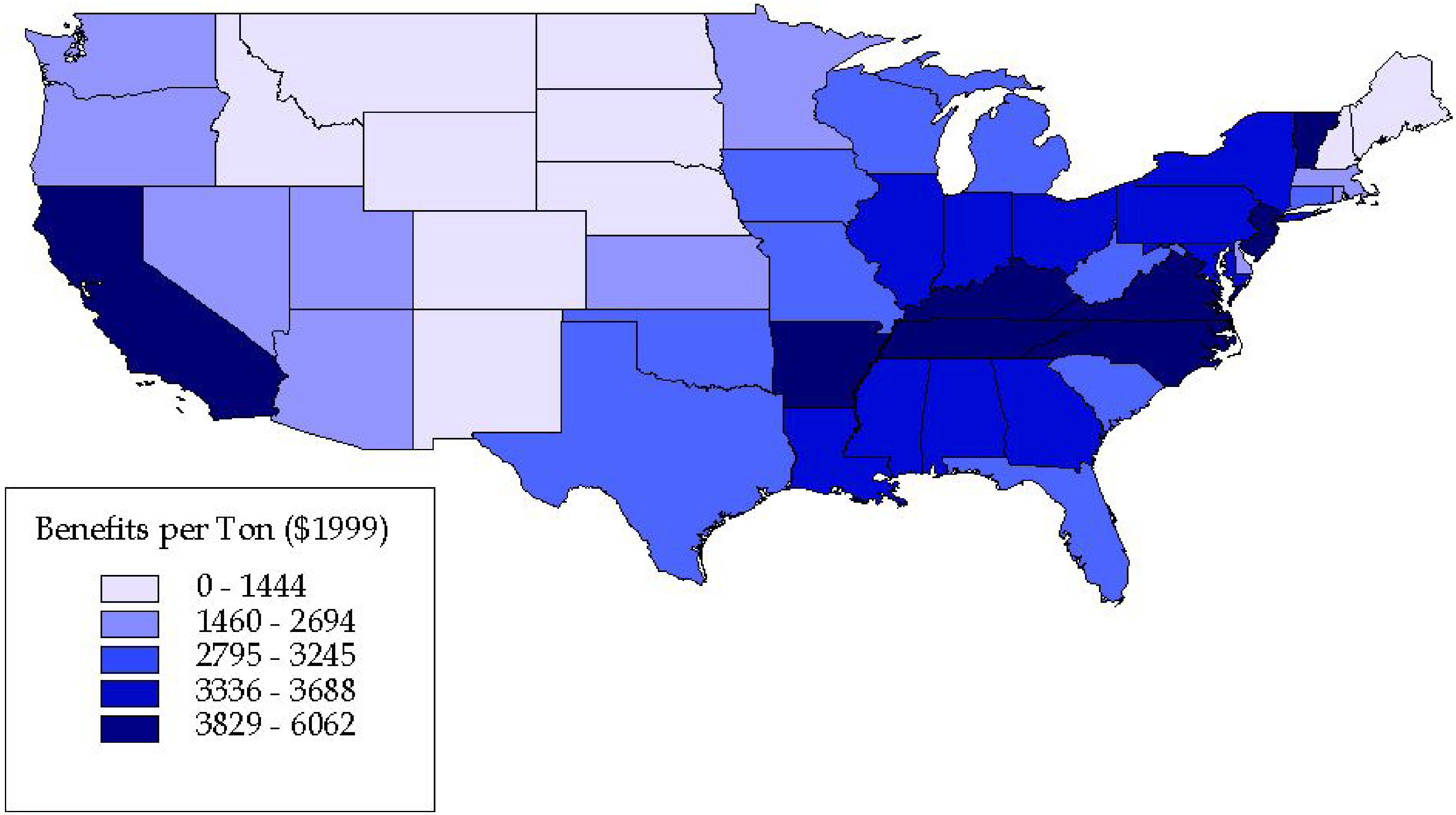
November 25th, 2002

Value of SO_2 Emission Reductions by State



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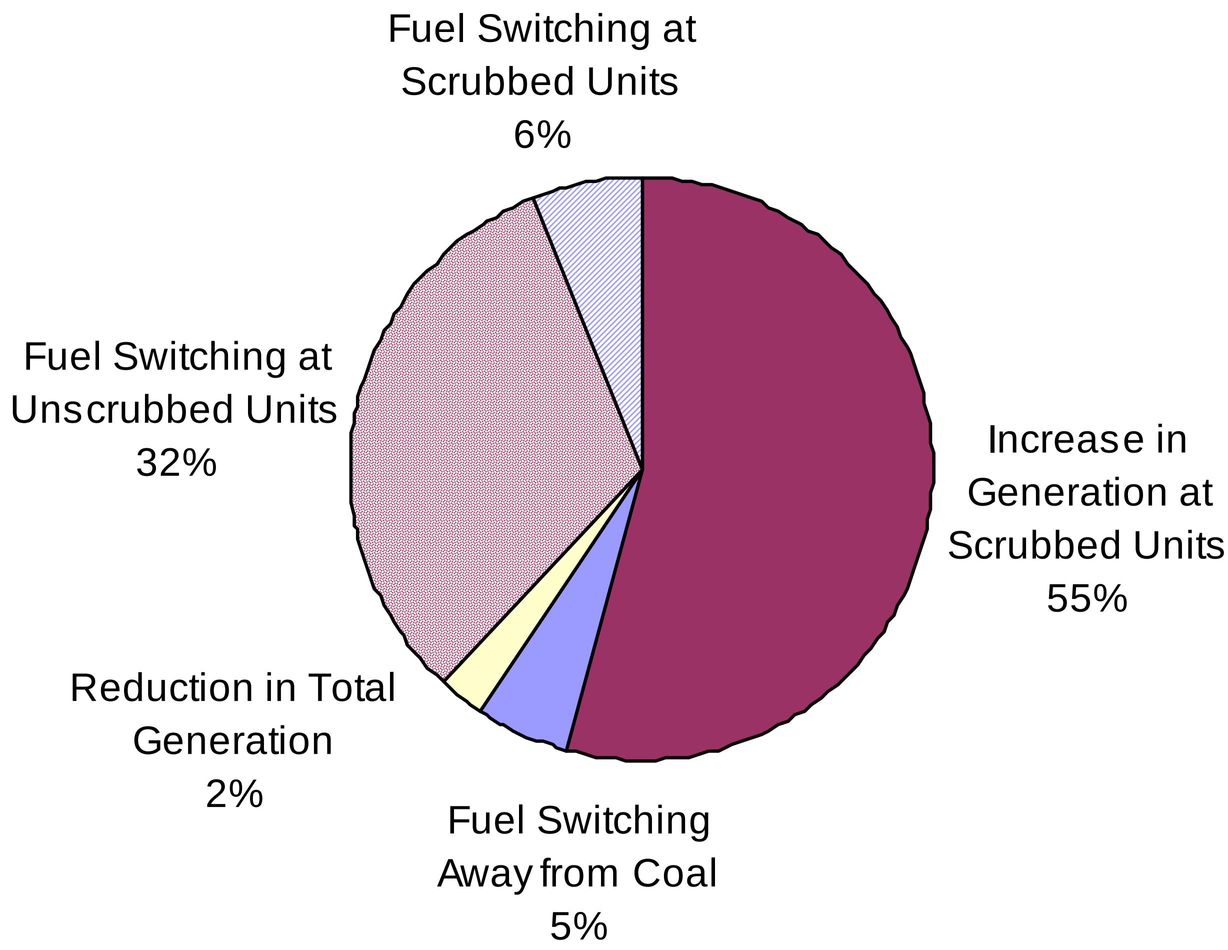
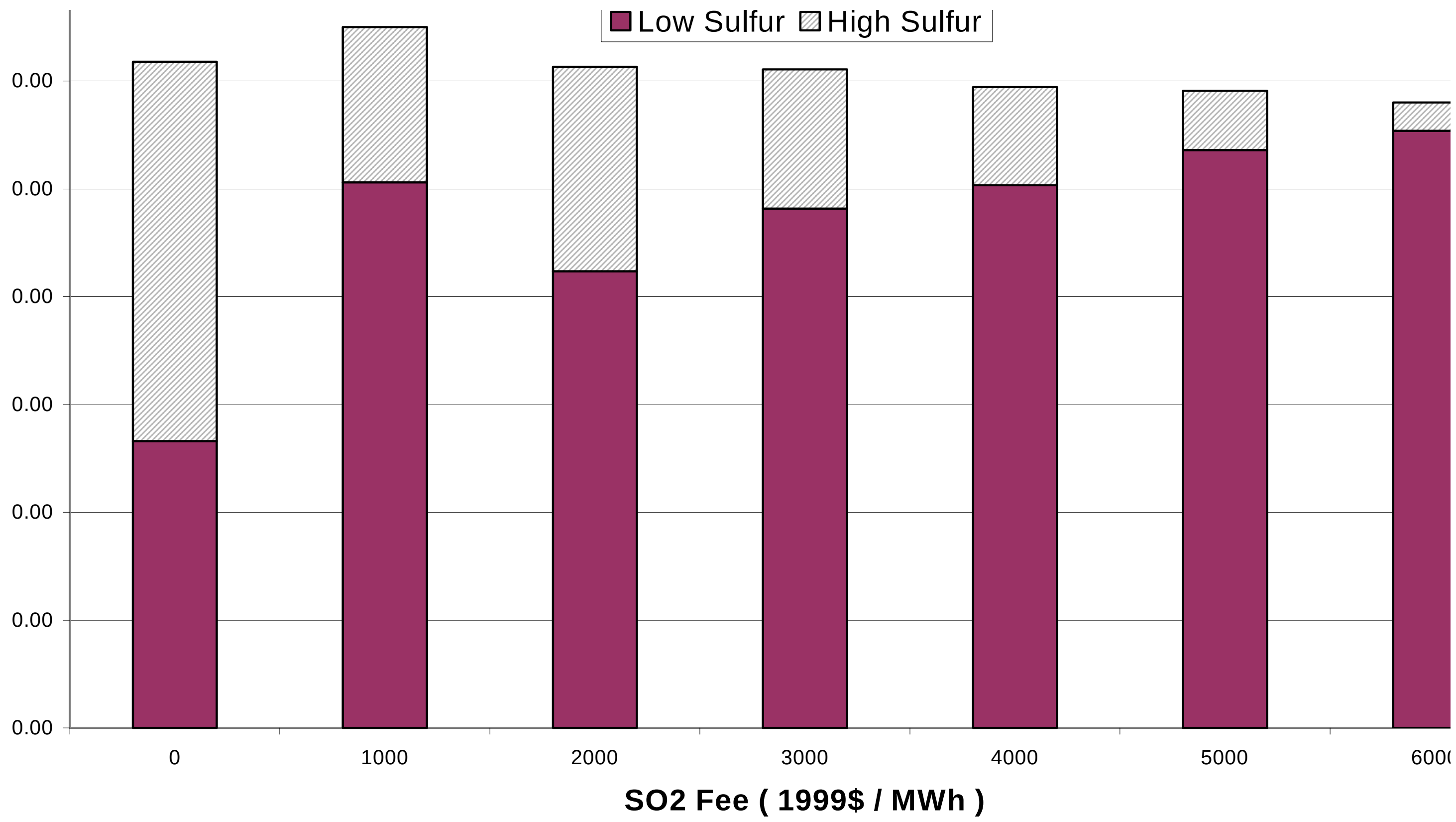
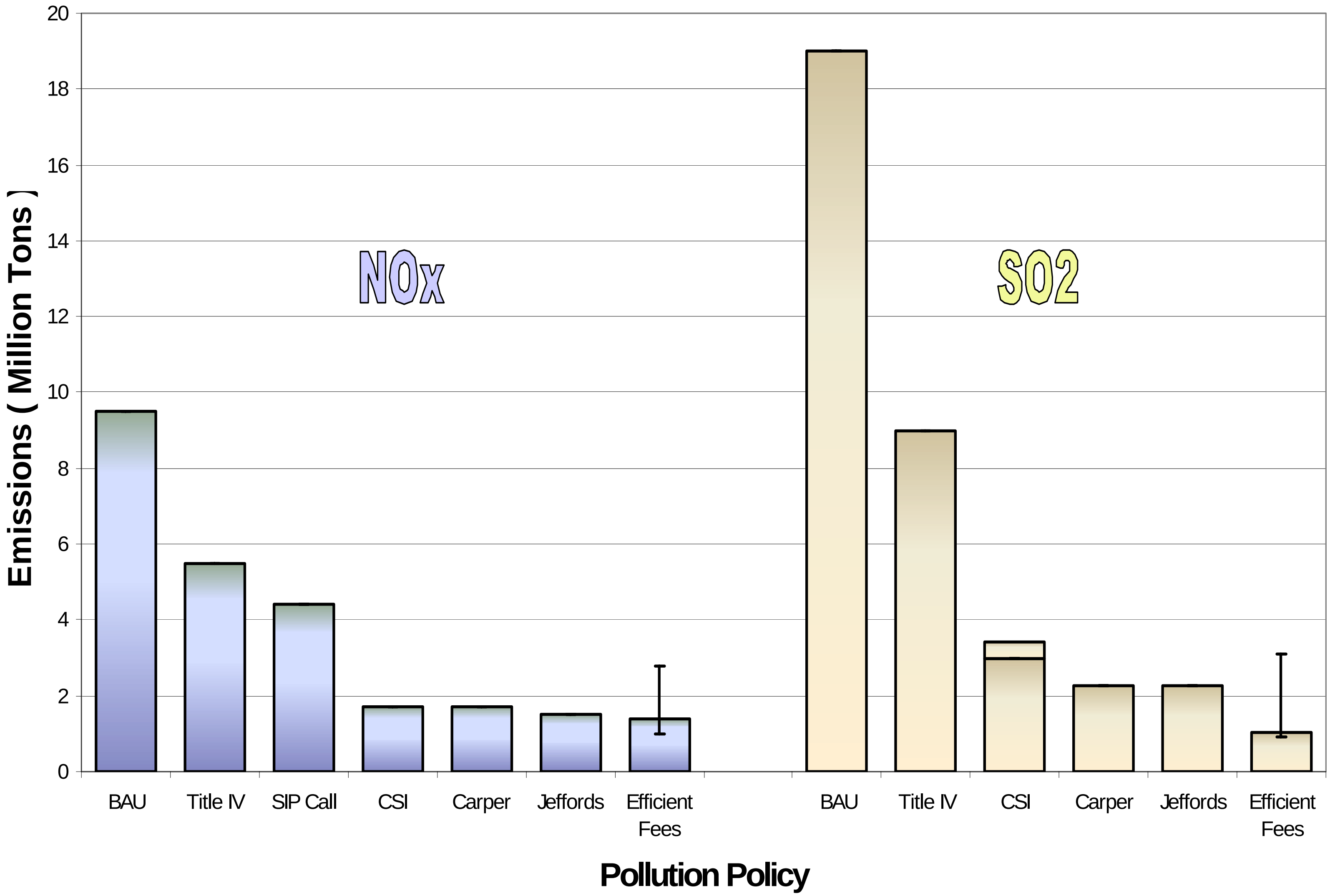
How SO_2 Reductions Are Achieved



Coal Demand


Low Sulfur
High Sulfur
0.00
0.00
0.00
0.00
0.00
0.00
0.00
0
1000
2000
3000
4000
5000
600(
SO2 Fee (1999$ / MWh)

NO_X & SO_2 Electricity Sector Emissions in 2020



Source: Banzhaf, Burtraw and Palmer, 2002. *Public Utilities Fortnightly*

Main Points on Criteria Pollutants

- $SO2$ and NOx caps for all of the proposals appear justified... there is room for more SO_2 reductions; NO_x reductions about right.
  - Efficient SO_2 fee ($4,700 - $1,800 per ton) would yield 0.9 – 3.1 million tons.
  - Efficient NO_X fee ($1,200 - $700 per ton) would yield 1.0 – 2.8 million tons.
- Evidence supporting regional caps.
- Ancillary CO_2 reductions.

Mercury

Target (tons/yr):

What does benefit literature say?

MACT~7.4 to Ancillary~25

(current levels in coal burned: ~75)

Timetable:

Help states

Design:

Trading enables tougher goals. Perhaps with…

- Maximum emission rate constraint

(not minimum emission rate reduction), and

- State opt out of trading for local protection

Architecture for Carbon

Principles:

1. The fundamental divide: voluntary or binding
2. More important to start early than to start large
3. More important to end economy-wide than to start there
4. Compensation through allocation
5. Efficiency is essential if constraints tighten

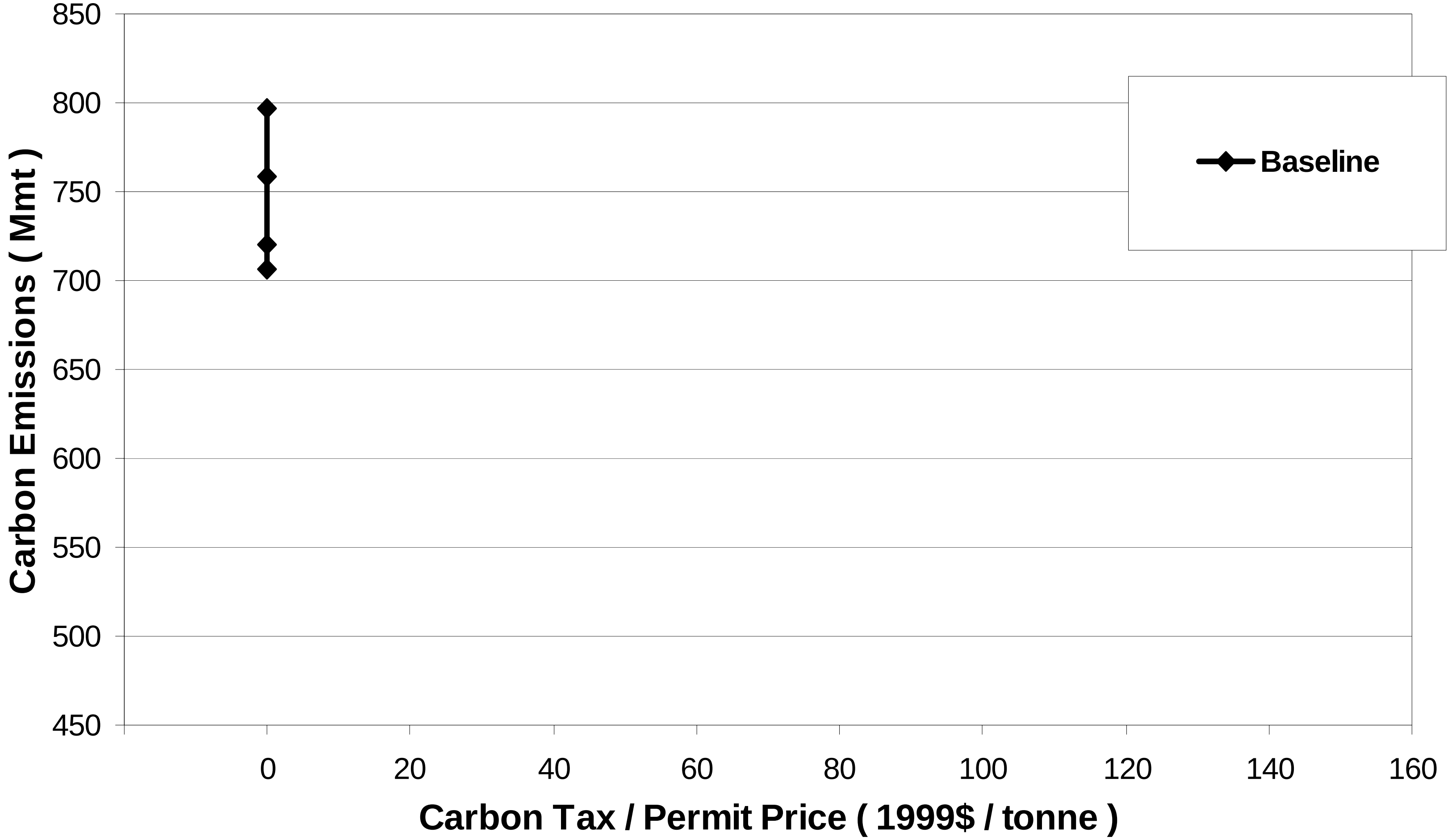
1. Binding Policy

- A cap provides environmental and economic integrity.
- Voluntary programs have limited possibility in a competitive economy.
- Sequestration out-of-system has to be limited or carefully prescribed. Otherwise, in-system investments are undermined.

2. Start Early Rather Than Start Big

- Signal to R&D, investment communities, households
- Reward, not punish, early reductions
- Banking builds *buy-in* to program for firms
- Develop institutions
- *Time to plan* for stricter policy serves as compensation
- Harvest low hanging fruit
- Buy time to learn about science, costs, economic trade-offs

Carbon Schedules in Electricity Sector



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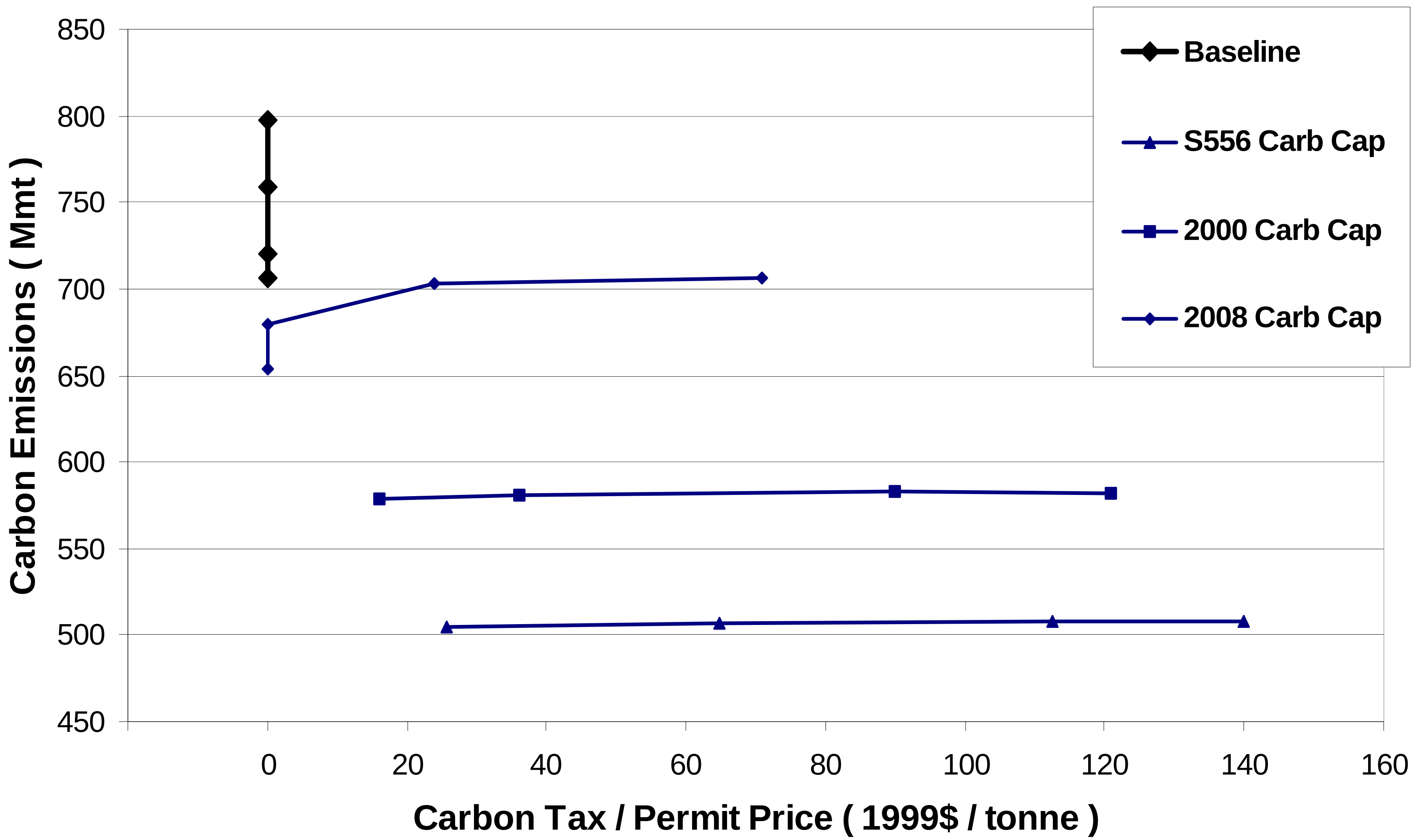
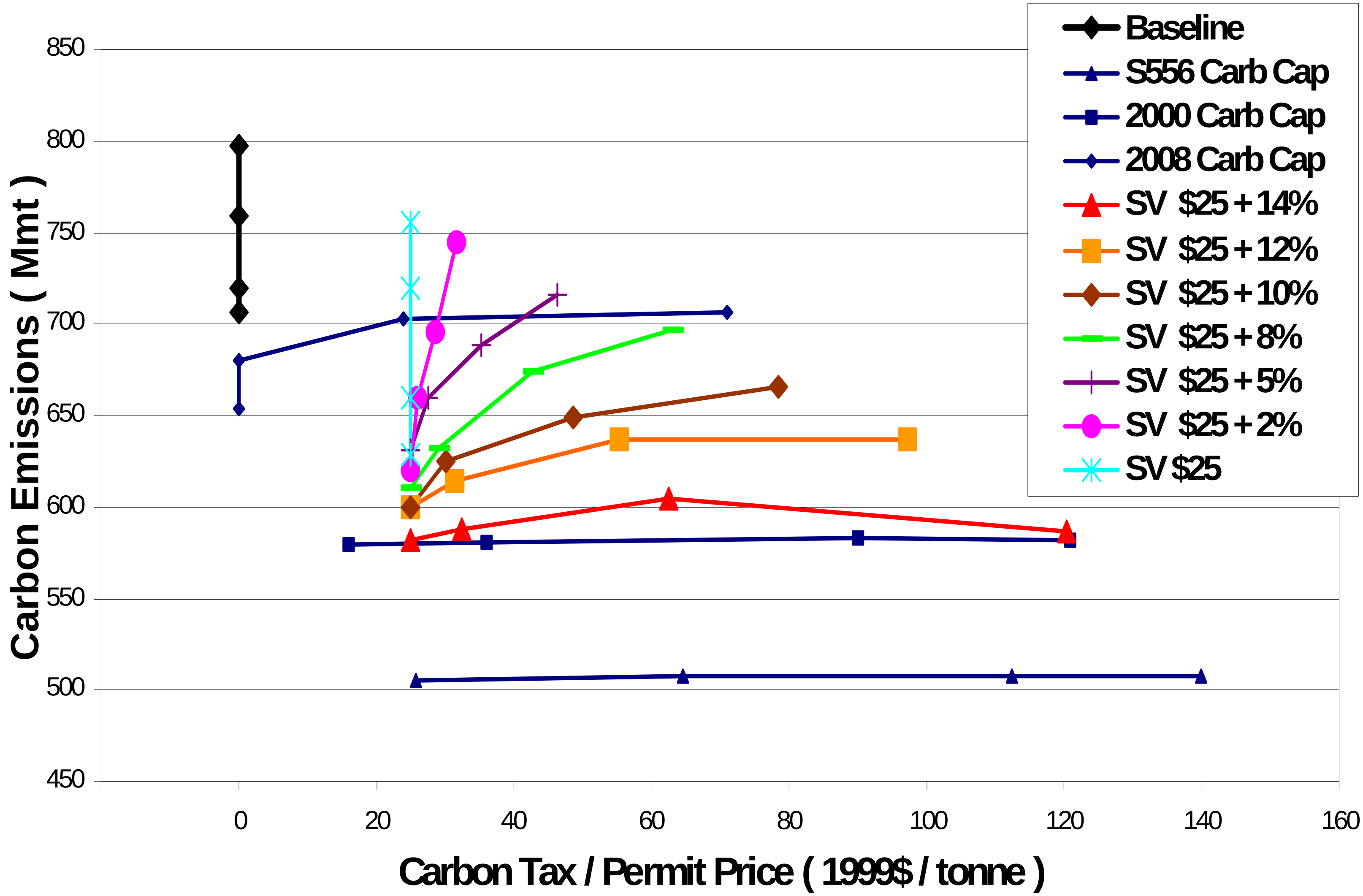
Carbon Cap Schedules in Electricity Sector



All allowances are auctioned. SO_2 and NO_2 caps from S.556, no mercury caps are modeled. SV=Safety Valve, with annual increase.

Carbon Schedules in Electricity Sector



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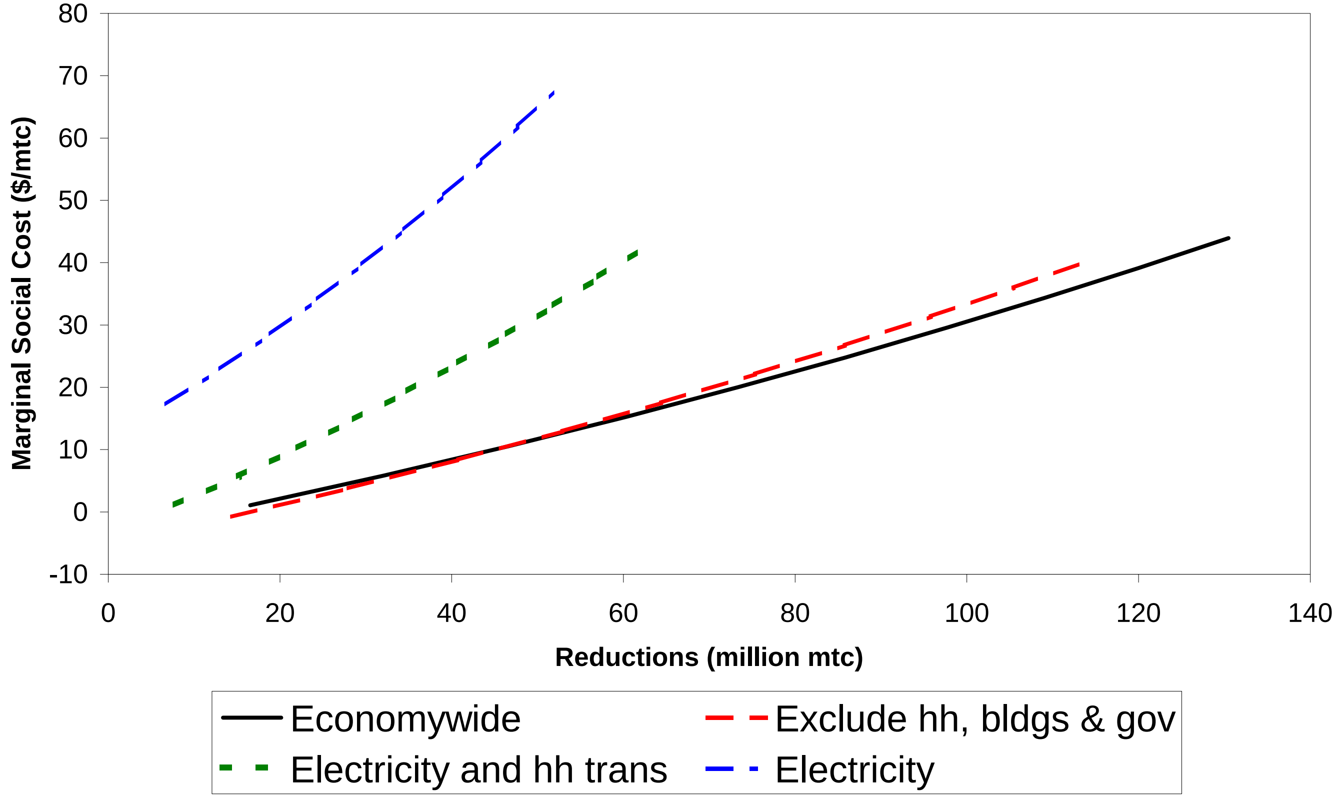
Carbon Targets and Schedules

MODEL	SIMULATION YEAR	2008	2010	2015	2020
Baseline	Emissions (million metric tonnes)	706	720	759	797
	Carbon Price ($ / metric tonne)	0.00	0.00	0.00	0.00
	Electricity Price ($ / MWh)	61.71	61.87	62.98	64.59
2000 Carbon	Emissions (million metric tonnes)	579	581	583	582
	Carbon Price ($ / metric tonne)	16.00	36.00	90.00	121.00
	Electricity Price ($ / MWh)	72.26	74.89	80.56	86.03
2008 Carbon	Emissions (million metric tonnes)	654	680	703	706
	Carbon Price ($ / metric tonne)	0.00	0.00	24.00	71.00
	Electricity Price ($ / MWh)	66.89	65.72	70.07	76.81
S556 Carbon	Emissions (million metric tonnes)	505	507	508	508
	Carbon Price ($ / metric tonne)	25.80	64.70	112.50	139.90
	Electricity Price ($ / MWh)	78.37	80.92	84.99	89.81
S3135 Carbon	Emissions (million metric tonnes)	635	597	592	591
	Carbon Price ($ / metric tonne)	0.00	0.77	89.68	117.90
	Electricity Price ($ / MWh)	71.58	71.29	80.06	85.99
Safety Valve:	Emissions (million metric tonnes)	629	659	720	755
$25	Carbon Price ($ / metric tonne)	25.00	25.00	25.00	25.00
	Electricity Price ($ / MWh)	71.32	69.82	68.91	70.38
Safety Valve:	Emissions (million metric tonnes)	620	659	696	745
$25 + 2%	Carbon Price ($ / metric tonne)	25.00	26.00	28.70	31.70
	Electricity Price ($ / MWh)	72.05	69.70	70.52	71.31
Safety Valve	Emissions (million metric tonnes)	631	659	688	716
$25 + 5%	Carbon Price ($ / metric tonne)	25.00	27.60	35.20	46.25
	Electricity Price ($ / MWh)	70.80	70.02	71.63	74.10
Safety Valve	Emissions (million metric tonnes)	611	632	674	697
$25 + 8%	Carbon Price ($ / metric tonne)	25.00	29.16	42.86	62.94
	Electricity Price ($ / MWh)	72.72	72.14	72.79	76.55
Safety Valve	Emissions (million metric tonnes)	600	625	649	665
$25 + 10%	Carbon Price ($ / metric tonne)	25.00	30.25	48.71	78.47
	Electricity Price ($ / MWh)	72.06	71.35	74.11	79.26
Safety Valve	Emissions (million metric tonnes)	600	615	637	637
$25 + 12%	Carbon Price ($ / metric tonne)	25.00	31.36	55.28	97.38
	Electricity Price ($ / MWh)	72.02	72.91	75.37	81.77
Safety Valve	Emissions (million metric tonnes)	582	588	604	586
$25 + 14%	Carbon Price ($ / metric tonne)	25.00	32.49	62.54	120.44
	Electricity Price ($ / MWh)	73.53	74.37	77.48	85.53

In all runs, allowances are auctioned. SO_2 and NO_2 caps from S.556, no mercury caps are modeled.

3. Open Architecture: Economy-wide

- Do economy-wide, or it’s not worth doing at all
- Capture least cost reductions across sectors

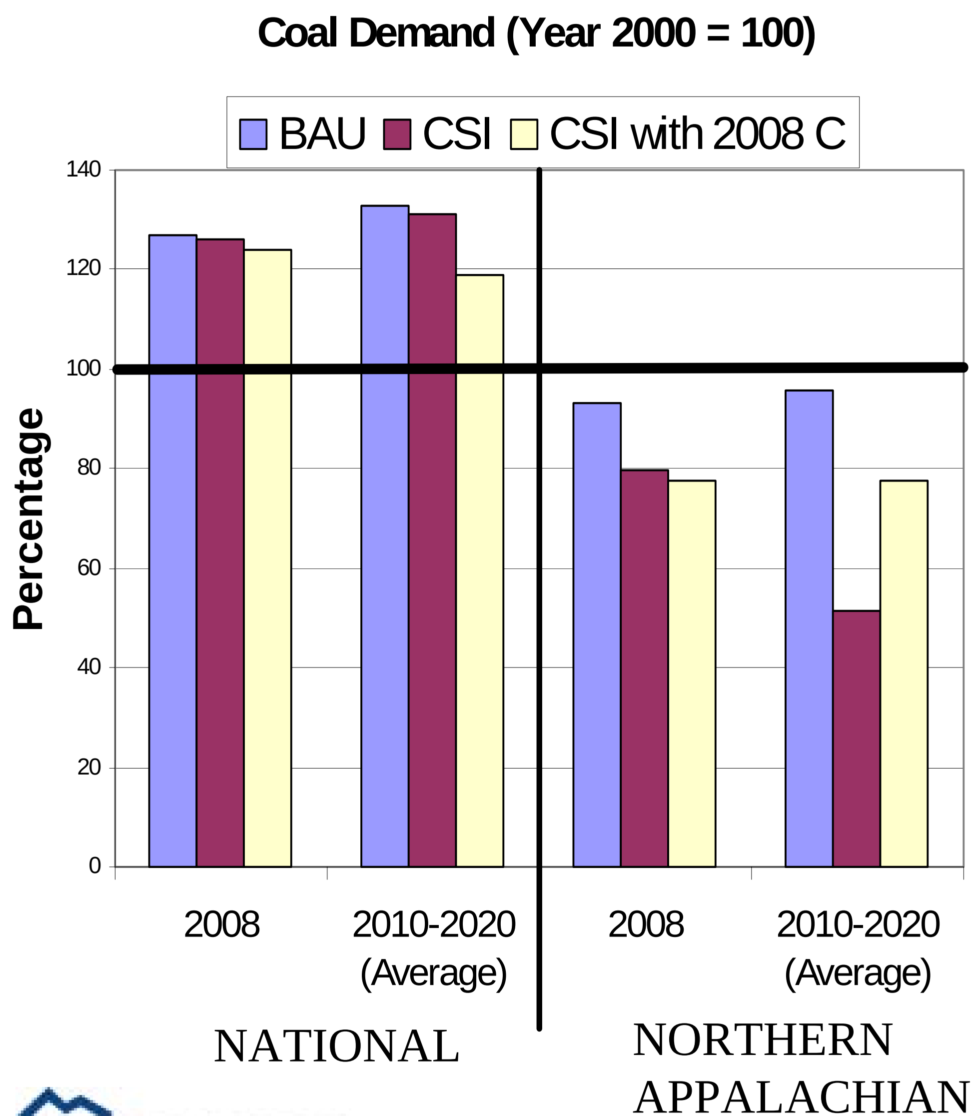


Source: Pizer et al., General and Partial Equilibrium Modeling of Sectoral Policies to Address Climate Change in the United States, in preparation.

4. Compensation through Allocation

- Free distribution of allowances with grandfathering can (over) compensate firms
- Free distribution through output-based allocation undermines asset values and harms many firms
- Auction revenues can compensate households/taxpayers
- A hybrid approach can achieve important compensation goals for affected groups
- But if allowance price provides incentives, interest group claims for allowances dilute efficiency

Effects on Coal Demand Of Adding Carbon to CSI



- CSI maintains total coal demand (tons), but causes shifts among supply regions
- Adding carbon reduces aggregate demand but lessens regional shift

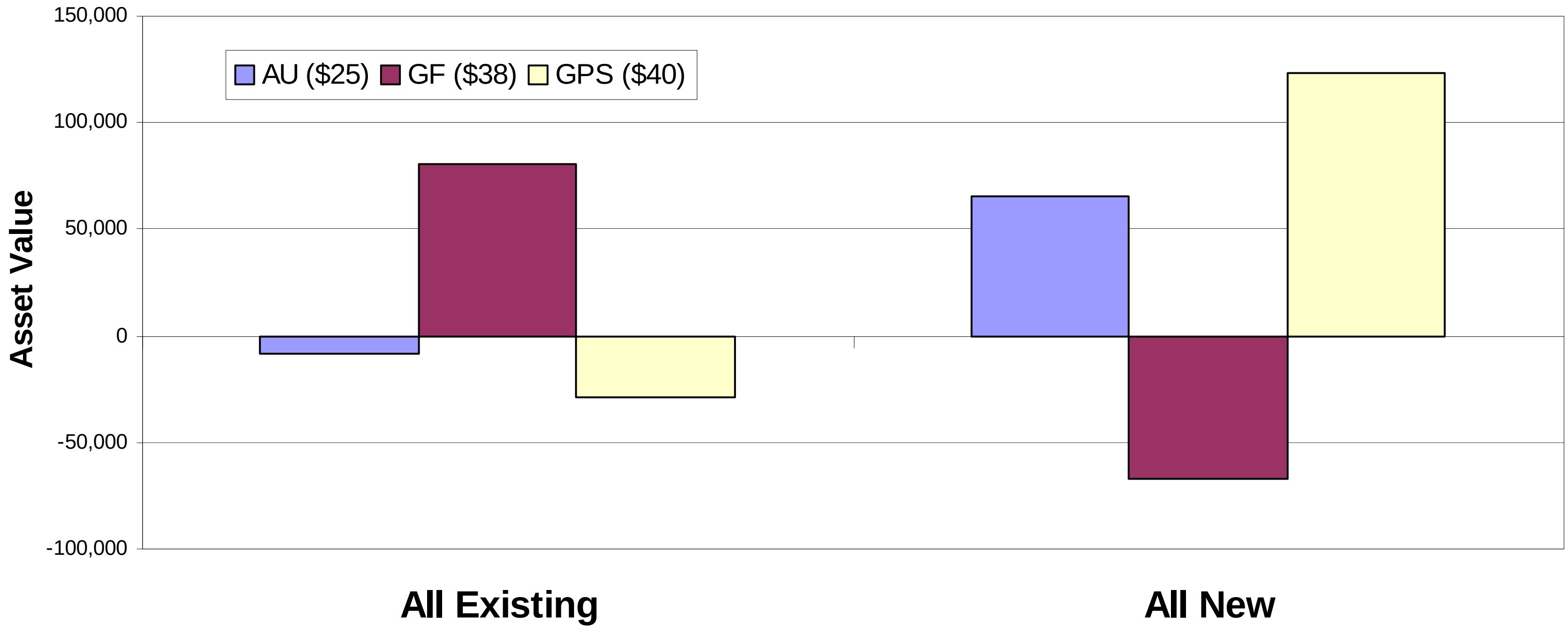
Mercury constraints not modeled; would strengthen result.

Three Allocation Schemes

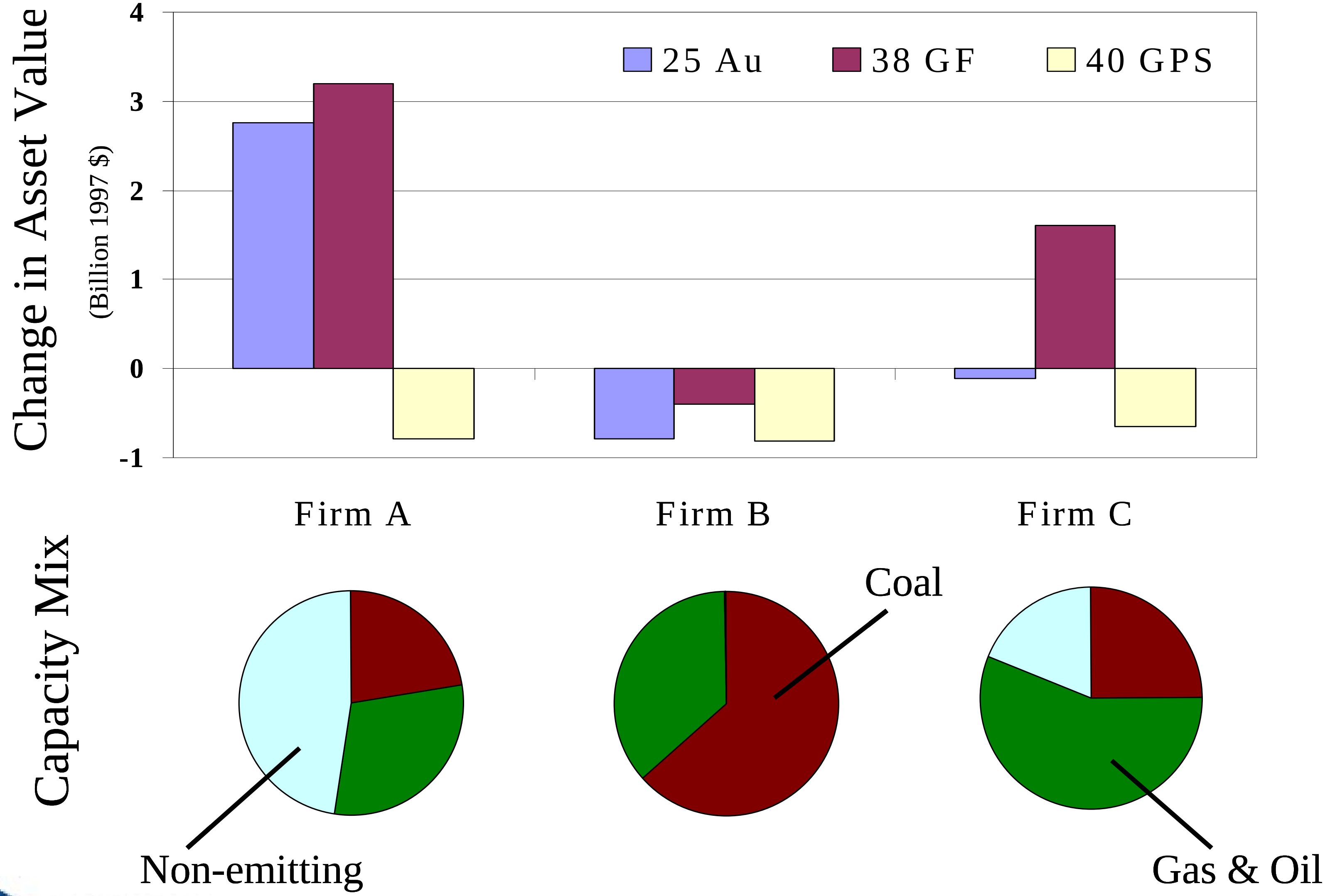
- (Au) Auction (Safety Valve)
- (GF) Grandfathering
- (OBA) Output Based Allocation (updating)

Change in Asset Values and Compensation

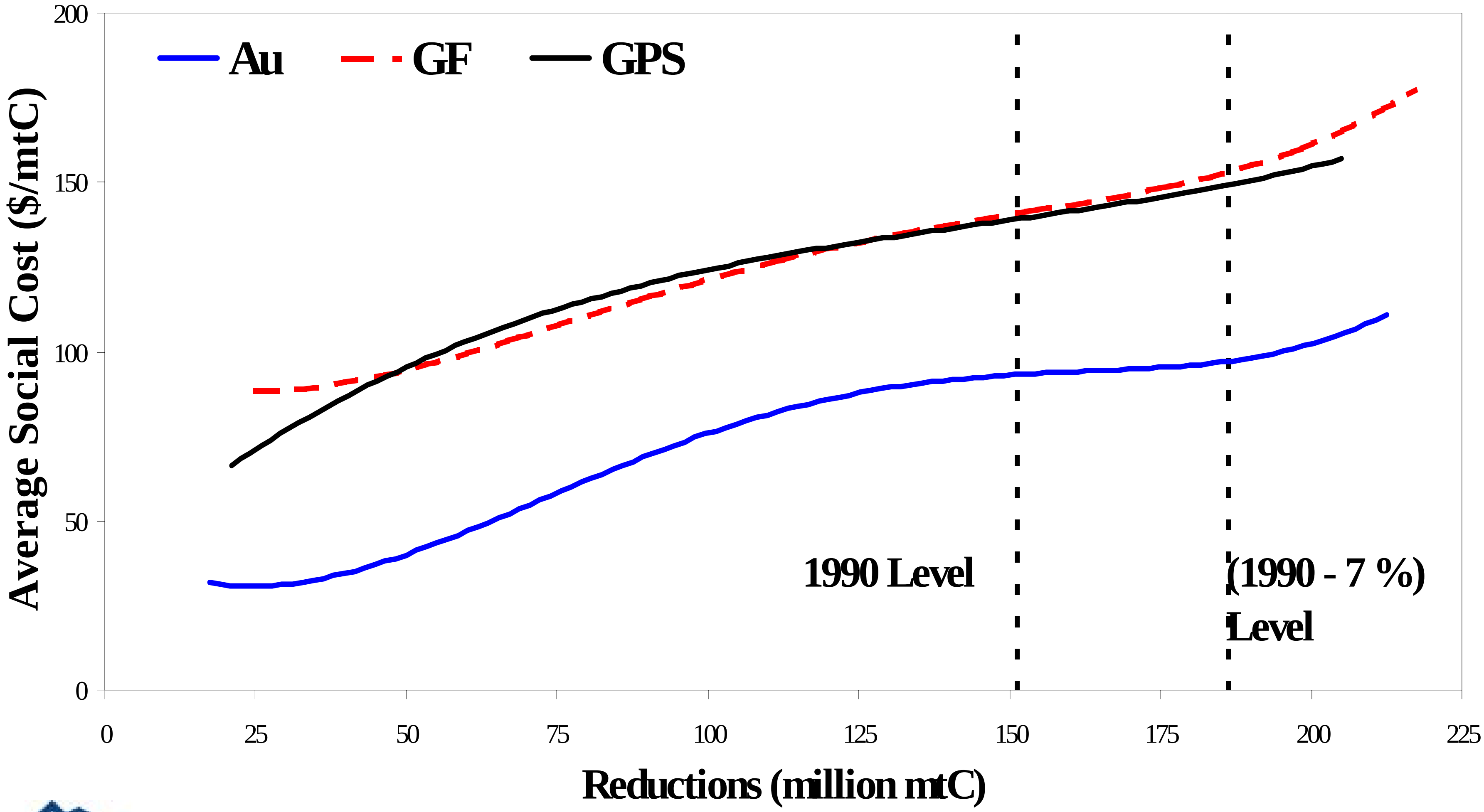
(1997 $/MW in 2001; 35 million mtc carbon)



Illustrative Effects on Three Firms



5. Efficiency is essential if constraints have to tighten because costs grow large



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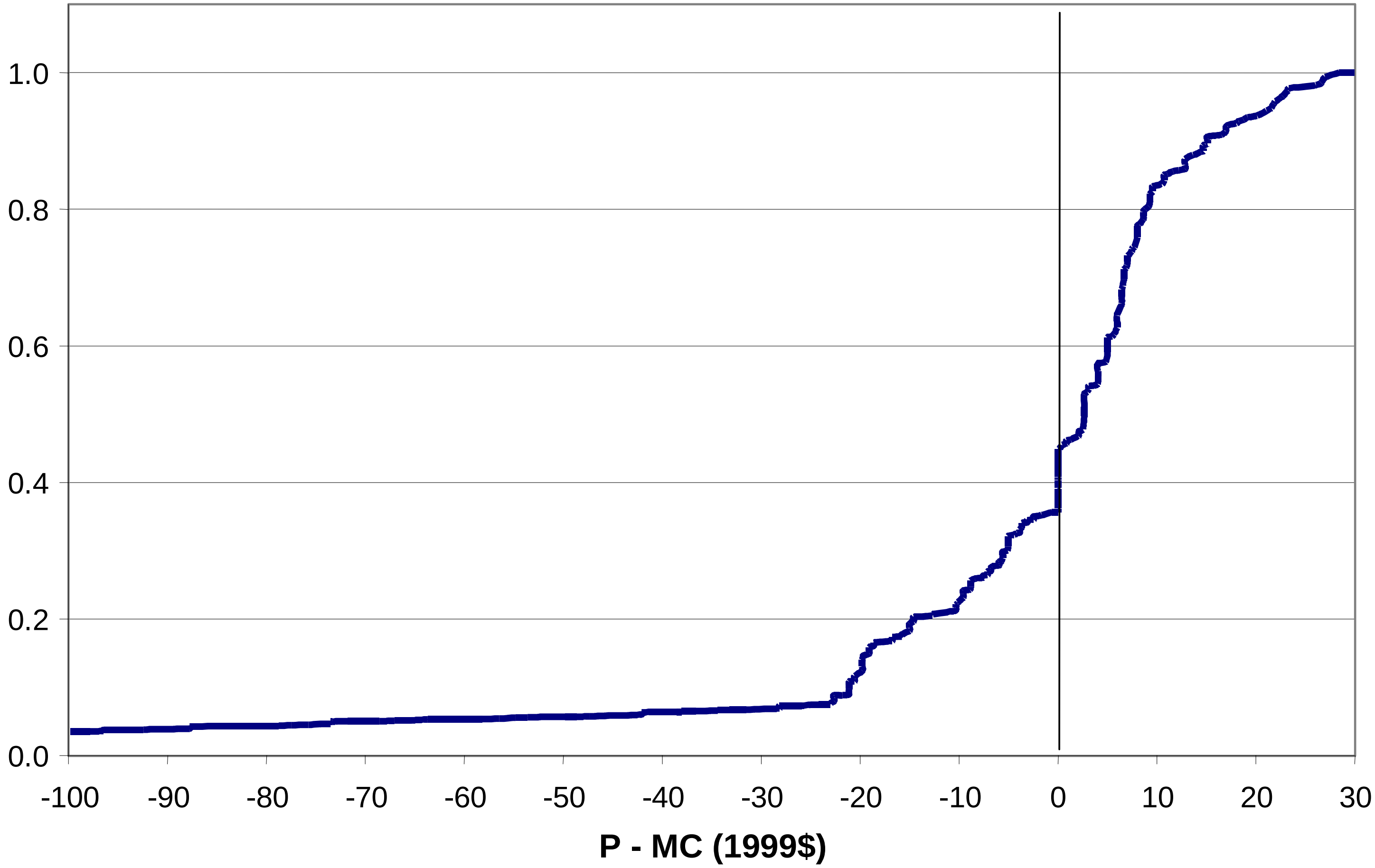
Why Allocation Matters to the Cost of Reducing Carbon Emissions

- The loss in economic surplus from inefficient pricing is measured by the difference between willingness to pay (price) and marginal cost.
- How allowances are allocated will affect electricity price.

Inefficiency from $P \neq MC$



Determining Electricity Price

- Total Cost ($):
  capital + FOM + fuel + VOM + poll.allowances [Au]
- Variable Cost Ordering ($/MWh):
  fuel + VOM + poll.allowances - subsidy [OBA]
- Price ($/MWh):

Regulated Price = Average Cost = (Total Cost ÷ Production)

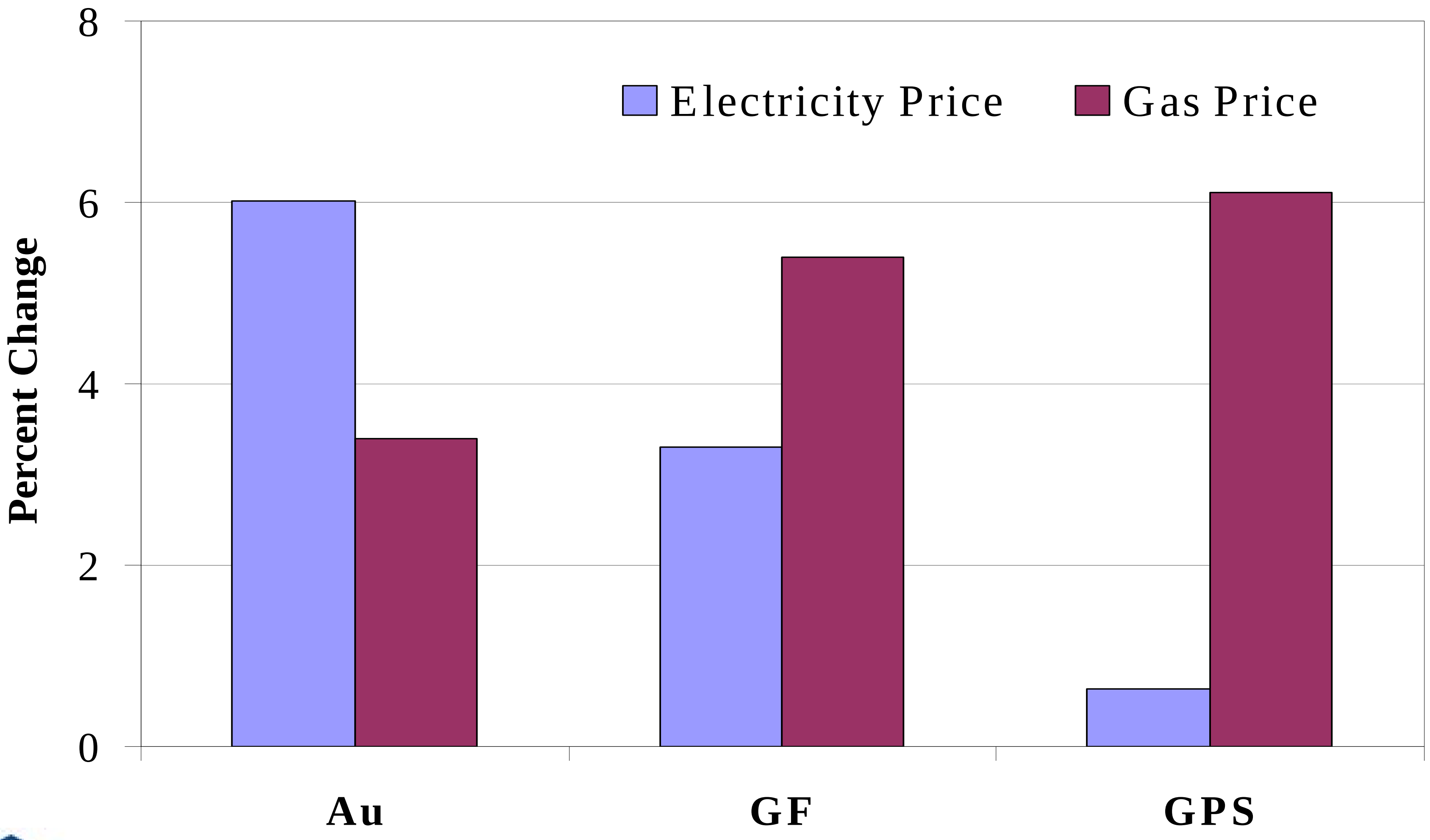
=> Price [Au] > Price [GF, OBA]

Competitive Price = Variable Cost

=> Price [Au, GF] > Price [OBA]

Price Effects Vary

(35 million mtC)



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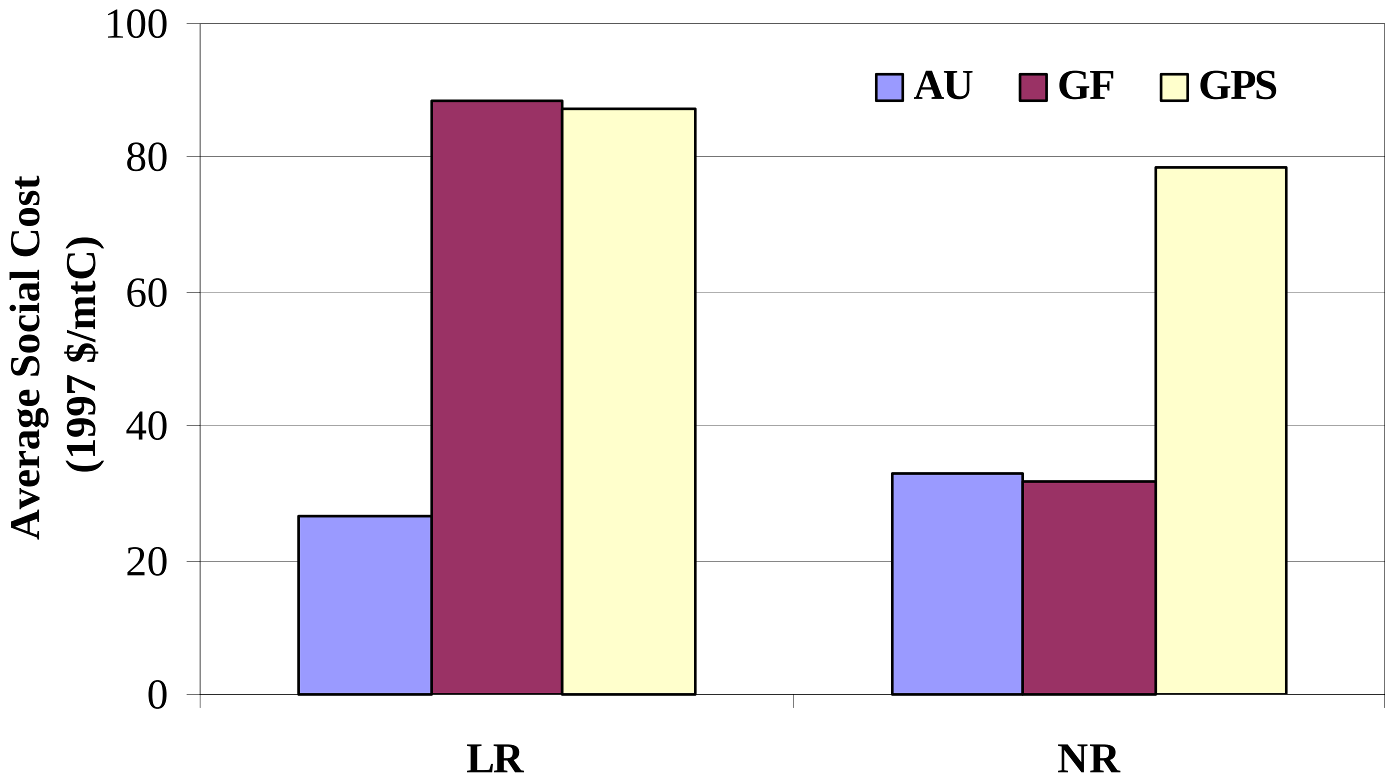
Social Cost under Limited & Nationwide Restructuring

(1997 $ in 2012; required reductions vary to achieve same target)



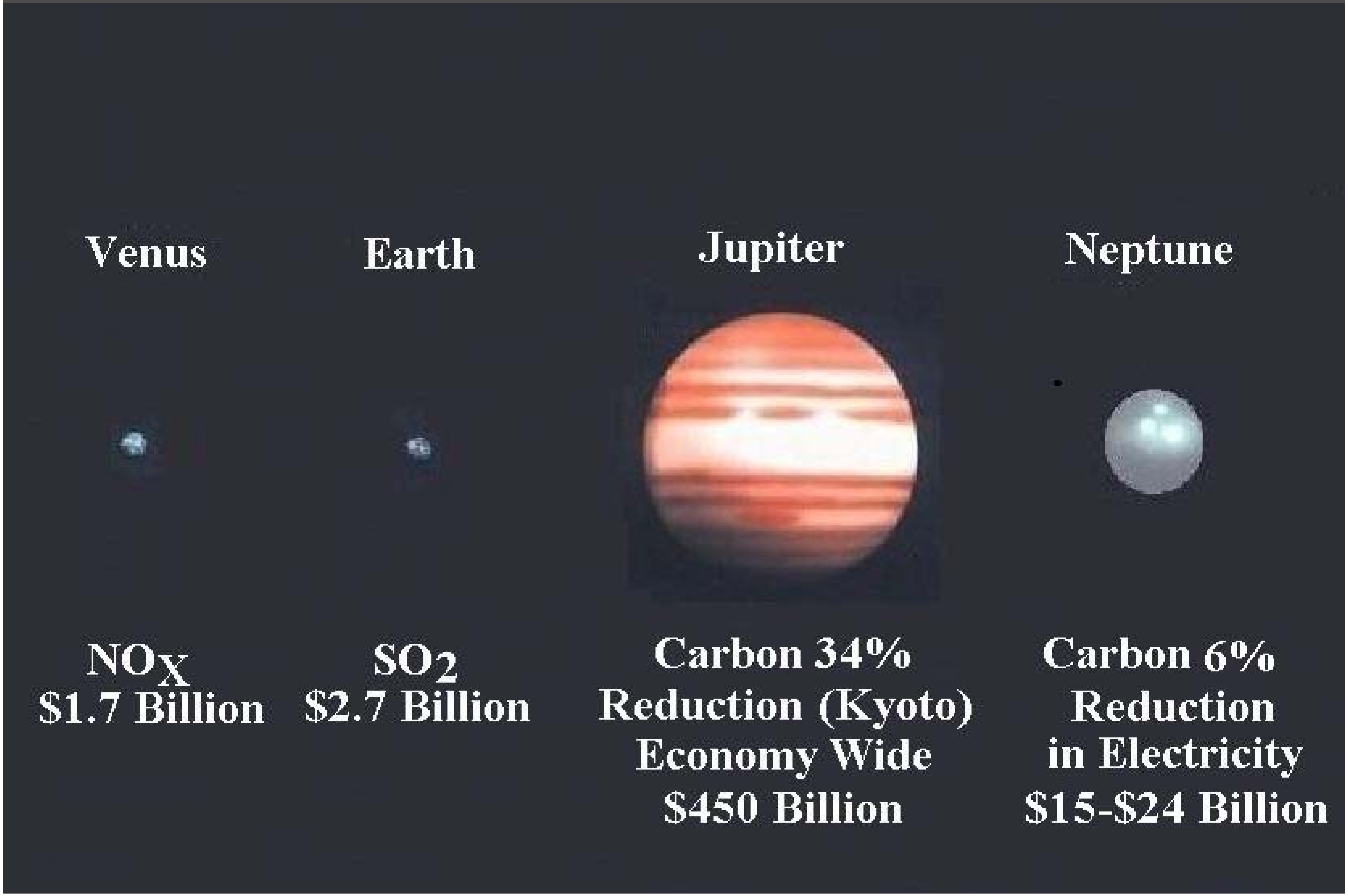
Raising Revenue from Carbon Policy Can Provide Dramatic Efficiency Gains

There are actually *two* reasons an auction (safety valve) is dramatically more efficient from social perspective:

1. Market Imperfections $P \neq MC$ (discussed above)

2. Tax/Regulatory Interaction Effects …if revenues are linked to reducing distortionary taxes!

Annual Asset Value of Emission Allowances



Key Ingredients to Multipollutant Policy

- **SO_2 and NO_X caps** are justified on benefit-cost.
- **Mercury trading,** with constraints, can lower costs; benefits not well quantified.
- Architecture is very important for **carbon** policy.
  - ✓ Start soon rather than start large.
  - ✓ Auction is **less costly** to society, and preserves **asset values** better than output-based allocation.
  - ✓ The auction institution is **expandable** beyond electricity.
  - ✓ A hybrid allocation approach to balance **compensation** and **efficiency**.