Compensation Rules for Climate Policy in the Electricity Sector

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Principle Should Guide Allocation (1)

- Emission allowances represent enormous value and present strong incentives for rent seeking.
- Experience with Title IV – notional adherence to a simple rule lessened rent seeking and contributed to success of program.
- Principle rather than contest of self-interest should guide climate policy.

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Principle Should Guide Allocation (2)

Efficiency is one such bedrock principle.

- Overwhelming evidence is that free distribution has hidden cost.
  - Auction preferred when prices of goods and services differ from opportunity costs in:
    - Factor markets (e.g. taxes) (Goulder, Parry, others)
    - Product market (e.g. electricity regulation)(Burtraw and Palmer, Parry)
    - The allocation approach can amplify or diminish the distortion away from economic efficiency.
  - Rent seeking is another source of transaction cost.
- Most expansive environmental policy ever faced; free distribution would multiply the cost dramatically.
- Absent a public policy rationale, there is an economic case <u>against</u> free distribution of any emission allowances.

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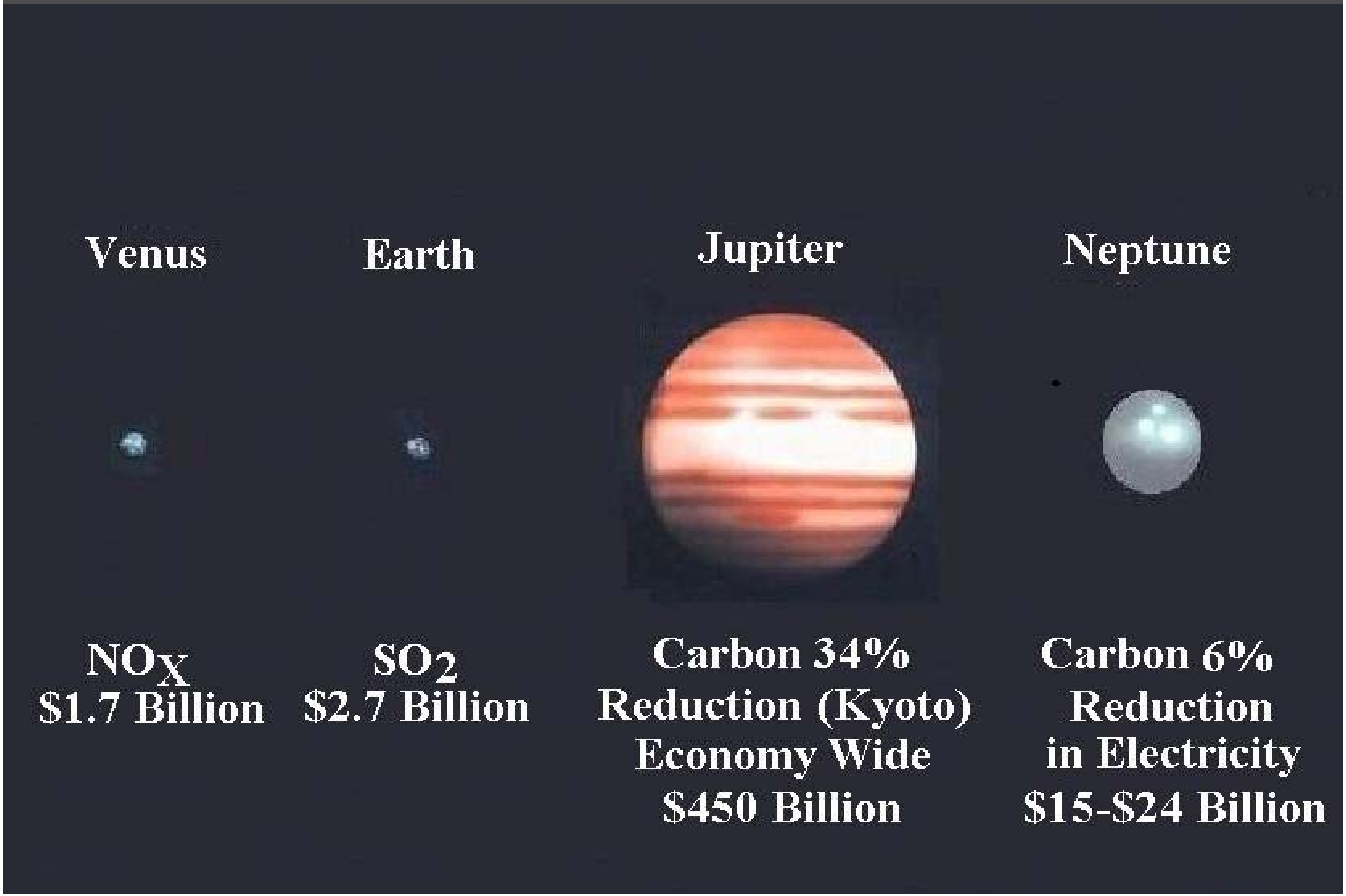
Annual Asset Value of Emission Allowances



Principle Should Guide Allocation (3)

However, there are at least three reasons for free distribution:

1. Compensation
   - Government should “do no direct harm” (Schultze)
   - Free initial distribution conveys substantial compensation that varies in magnitude automatically with variation in cost of policy
   - Political buy-in (Buchanan, Tullock)
2. Competitiveness of regulated sector
   - In context of open economy within a region (Burtraw et al.) or globally (Fischer and Fox).
3. Technology policy

We focus only on #1, the compensation rationale

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Principle Should Guide Allocation (4)

- Premise:
  - Goal is to maximize the portion of emission allowances that can be distributed in an efficient manner (auction).
  - Direct free distribution to mitigate the direct harm to severely affected parties.
- Maintained assumption, not questioned, but…
  - Should worst off firm be compensated for 100% of lost value?
- Organization of paper:
  1. Establish measure of harm to producers, consumers
  2. Identify strategy to achieve compensation goals at minimum cost

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Findings (1)

Key assumption: Long-run costs to shareholders accrue only in competitive regions.

- Consumers realize greatest loss, but harm is diffuse.
- Measure of "deserved" compensation for producers depends on the yard-stick.
  - Industry-level cost is $1/8^{th}$ of allowance value in competitive regions ($1/16^{th}$ nationally).
  - At firm-level, a revelation strategy invoking complete information/precise policy could achieve *full compensation* for **22%** of allowance value, creating $8 billion for winners.

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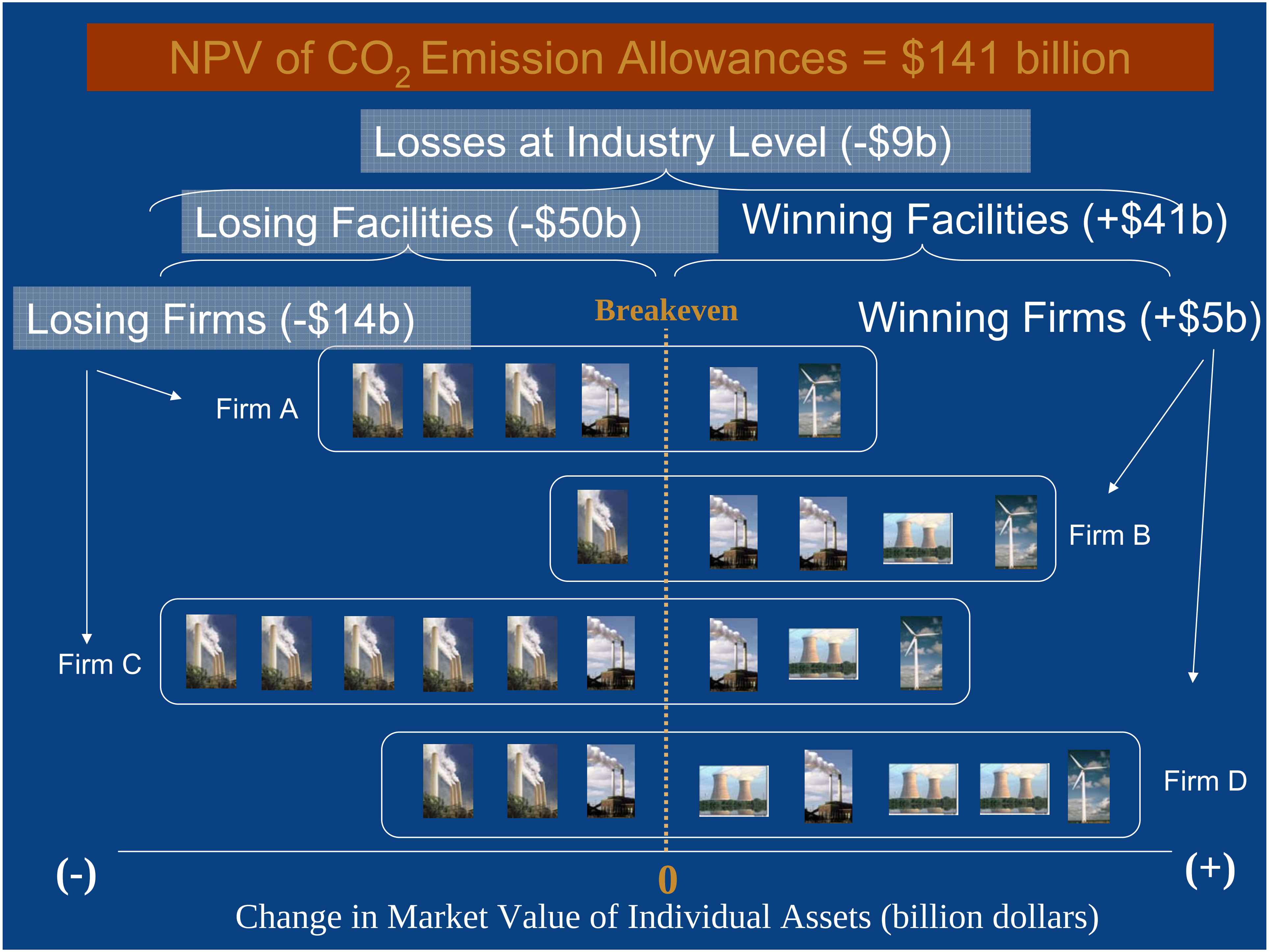

NPV of CO_2 Emission Allowances = $141 billion
Losses at Industry Level (-$9b)
Losing Facilities (-$50b)
Winning Facilities (+$41b)
Losing Firms (-$14b)
Breakeven
Winning Firms (+$5b)
Firm A
Firm B
Firm C
Firm D
(-)
0
(+)
Change in Market Value of Individual Assets (billion dollars)

Findings (2)

Compensation has a significant opportunity cost.

- Free allocation (100%) provides over-compensation of $65 billion (1999$).

Smart (blunt) rules provides cost savings. At the federal level:

- Allocation on fuel+tech requires 86% of allowances.
- Allocation on emission rates requires 65%
- The incremental opportunity cost of compensating for the last $2.6 billion is $26 billion at the federal level.

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Findings (3)

Apportionment to regions with allocation to firms provides ‘cost’ savings.

- Apportionment of allowances to regions/states for application of blunt policies can achieve compensation at less than half the cost of a national allocation rule.
- With information about fuel & technology characteristics a (smart) blunt policy can achieve the goal for **39%** of allowance value, with overcompensation of $19.5 billion.
- With information about firm-level emission rates a (smart) blunt policy can achieve the goal for **32%** of allowance value, with overcompensation of $15 billion.

These estimates assume *full compensation* for worst-off firm.

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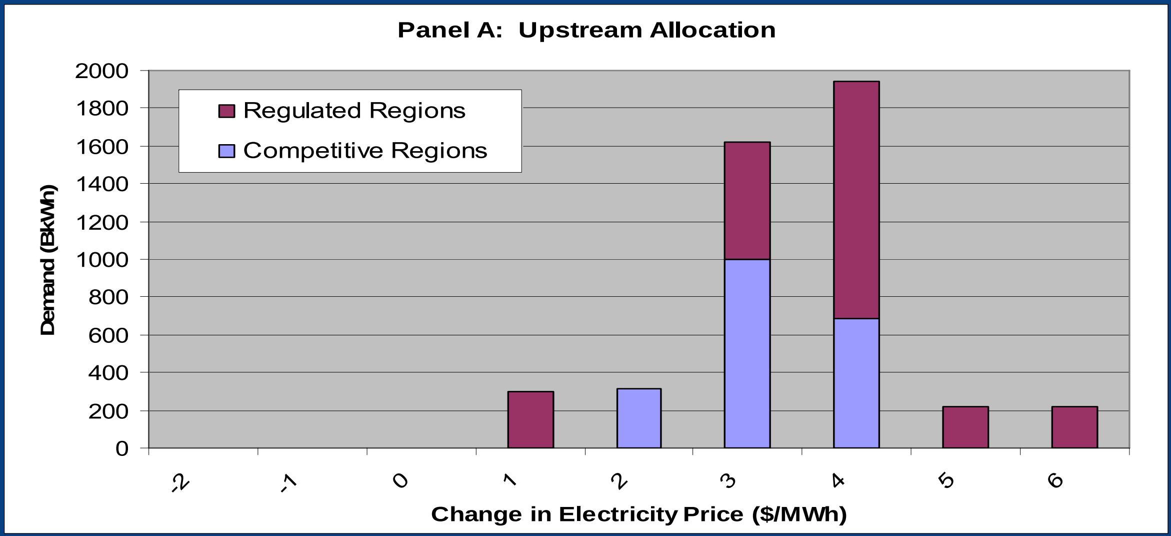
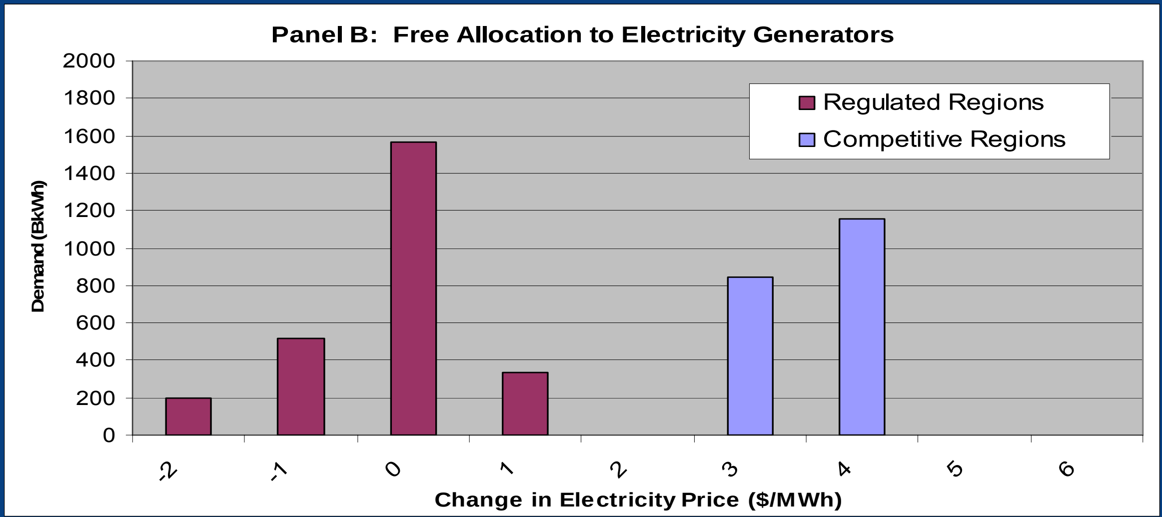
Modeled: Moderate Climate Policy (w/ safety valve)

	2010	2015	2020	2025
EIA (2005b)				
Baseline				
Emissions (tons CO_2)	2.88	3.07	3.31	3.65
NCEP Policy				
Emissions (tons CO_2)	2.85	3.01	3.20	3.41
Allowance Price ($/ton)	3.65	5.48	6.52	7.17
RFF Modeled Scenarios				
Baseline				
Emissions (tons CO_2)	2.76	2.92	3.10	3.37
Moderate Policy				
Emissions (tons CO_2)	2.67	2.83	3.01	3.19
Allowance Price ($/ton)	3.91	5.89	7.00	7.70

Electricity Price Effects of Allowance Allocation Depends on Electricity Regulation





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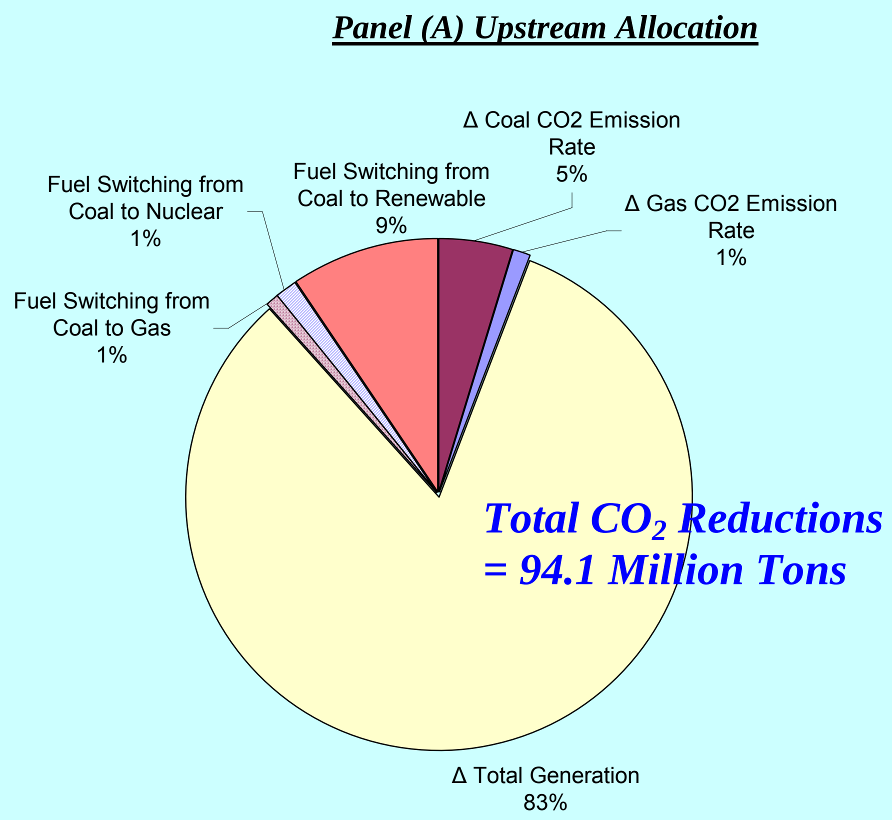
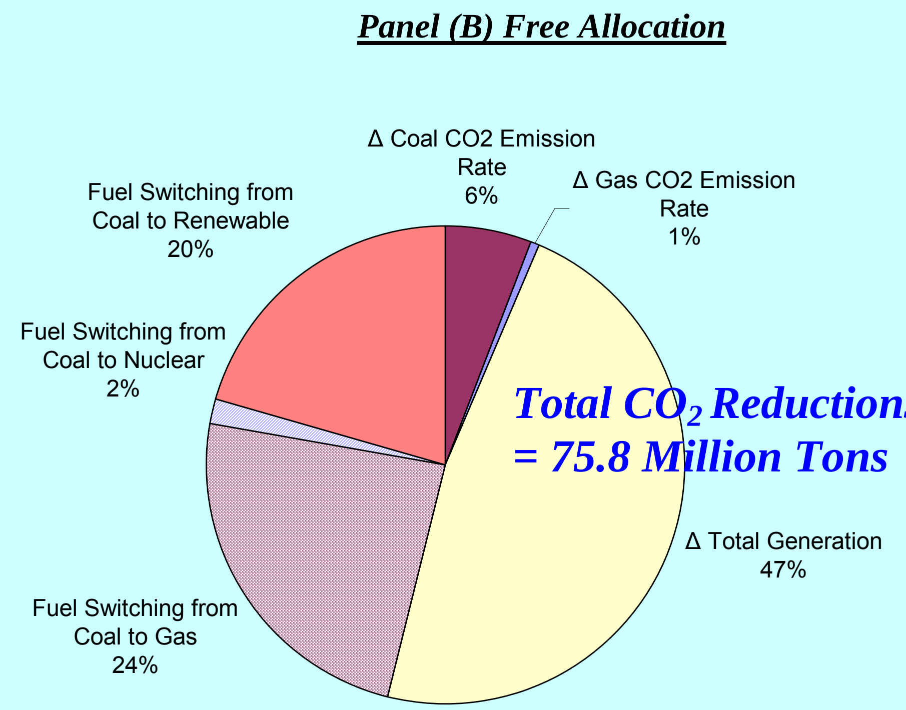
Sources of CO_2 Reductions Vary with Allocation Approach





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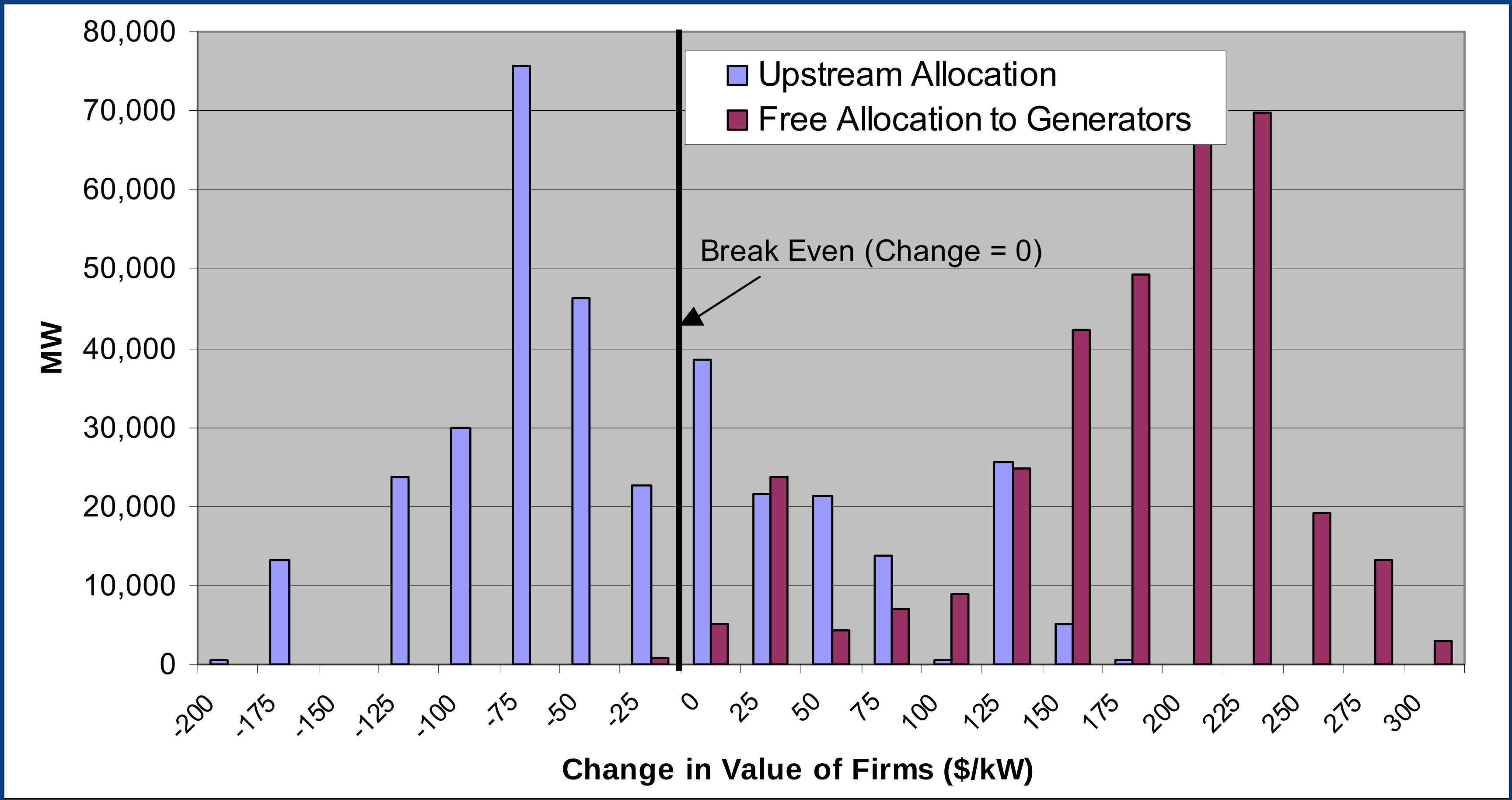
Distribution of Costs to Firms in Competitive Regions Under NCEP/Bingaman National Proposal



In competitive regions free allocation provides compensation to generators = 475% of cost

1) Allocation Using Simple Rules Based on Fuel, Technology

$$\min_{r_C, r_G, r_O} P^*\left[\sum_{f=1}^{F} r_C C_f + r_G G_f + r_O O_f\right] \text{ such that } \forall f \in F: P^*\left[r_C C_f + r_G G_f + r_O O_f\right] \geq \theta(V_f^{BL} - V_f^{A})$$

P = discounted weighted avg CO_2 price

F=firms

C_f G_f O_f = coal, gas, oil generation (MWh)

r_i = allocation rule for *i* = coal, gas, oil.

V = NPV of firm

$0 < \theta < 1$ = compensation target

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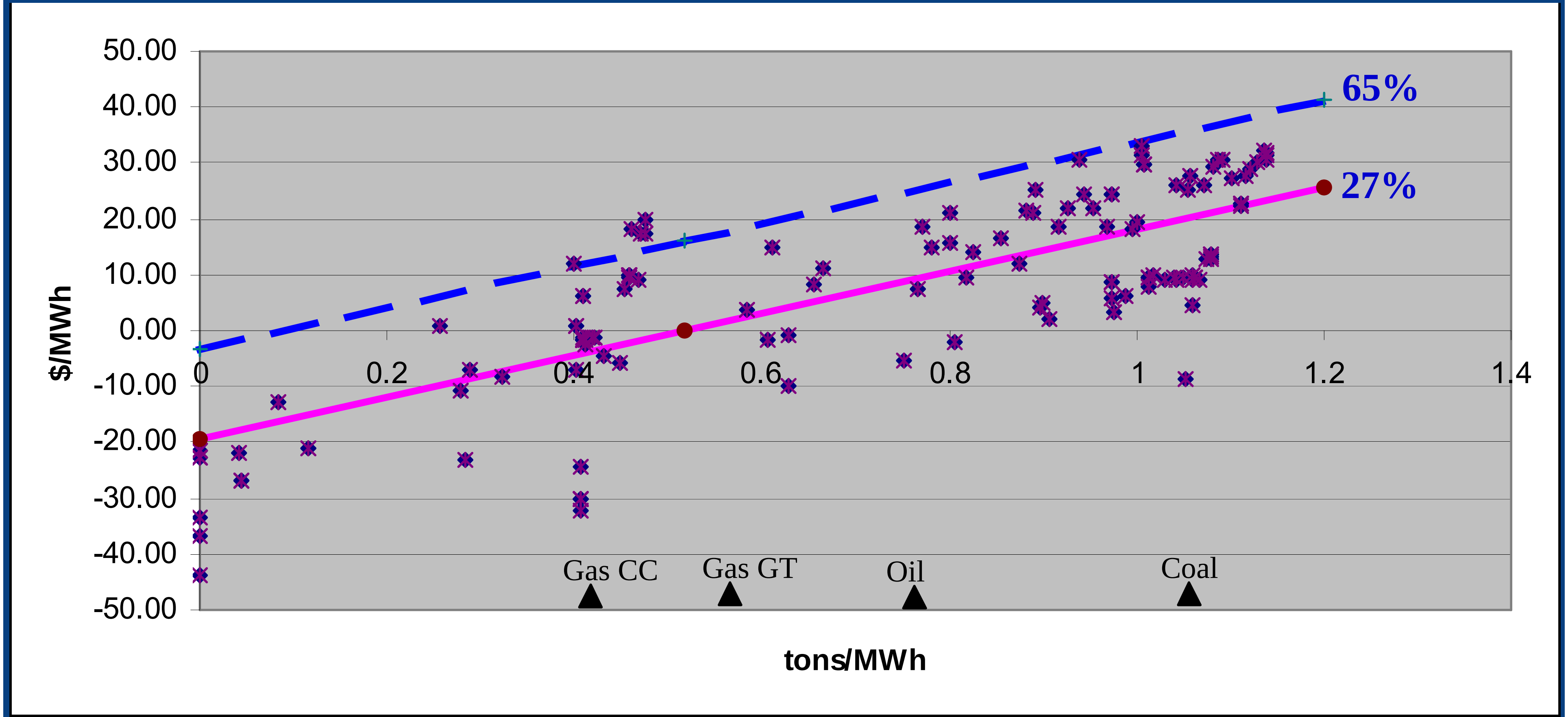
1) Allocation Using Simple Rules Based on Fuel, Technology

Units are percent and billion 1999$	Complete Information		Incomplete Information Using Simple Rules			
			Fuel Type		Fuel + Clean +Gas Technology	
	*Percent Free Allocation	Net Gain in Market Value	*Percent Free Allocation	Net Gain in Market Value	*Percent Free Allocation	Net Gain in Market Value
Federal Approach	22%	7.51	100%	60.72	86%	51.51
Regional/ State Approach						
ECAR	12%	1.74	27%	6.29	24%	5.63
ERCOT	25%	0.385	45%	2.56	37%	1.65
MAAC	34%	1.09	220%	15.61	54%	2.69
MAIN	40%	3.00	76%	7.44	48%	4.00
NY	40%	1.47	209%	5.96	130%	3.85
NE	21%	0.832	125%	3.18	56%	1.63
Aggregate Regions	23%	8.52	71%	41.04	39%	19.45

2) Loss in Market Value versus Firm-Level Emission Rate

Nation:182 firms operating in competitive regions under upstream allocation/auction. MWh is operation forecast in 2010 in baseline. Also indicated are average emission rates in competitive regions for four classes of technology.



"Fit" line with allocation of 27% of allowance value leaves $3 b in specific loss, $11 b in net gain for industry. At 65% (full comp.) industry net gain is $37b.

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The Federal / State Question

Precedent:

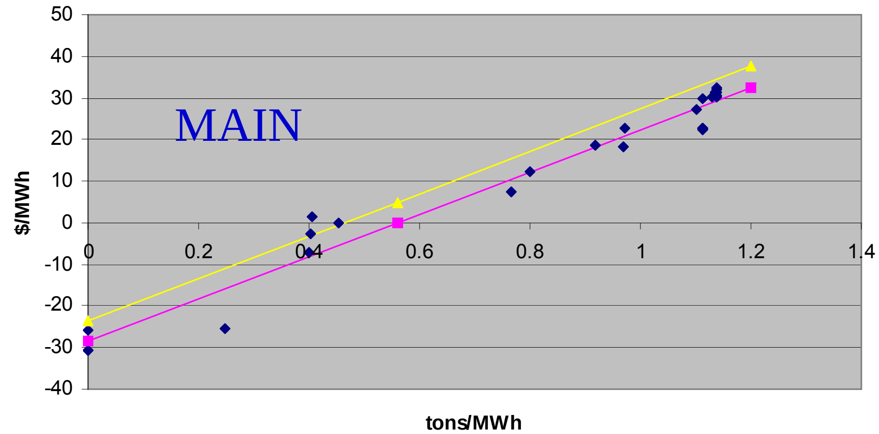
- Centralized Allocation: SO_2
- Decentralized Allocation: NO_x, EU ETS

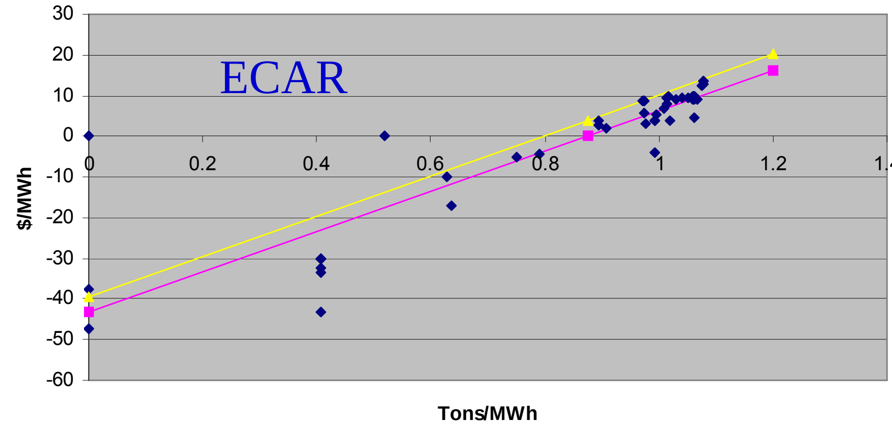
Effect of apportionment to states on cost?:

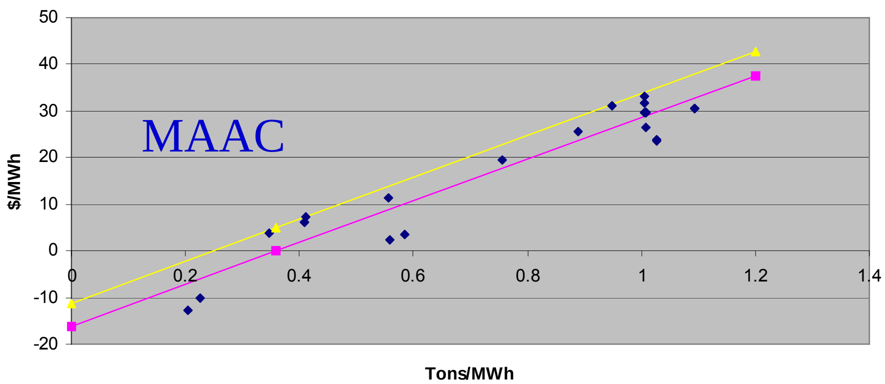
- Adverse Selection: "National winner" who is "local loser" gets compensated within a specific region (+)
- Precision in Formula: Regional formula takes advantage of heterogeneity among regions (-)

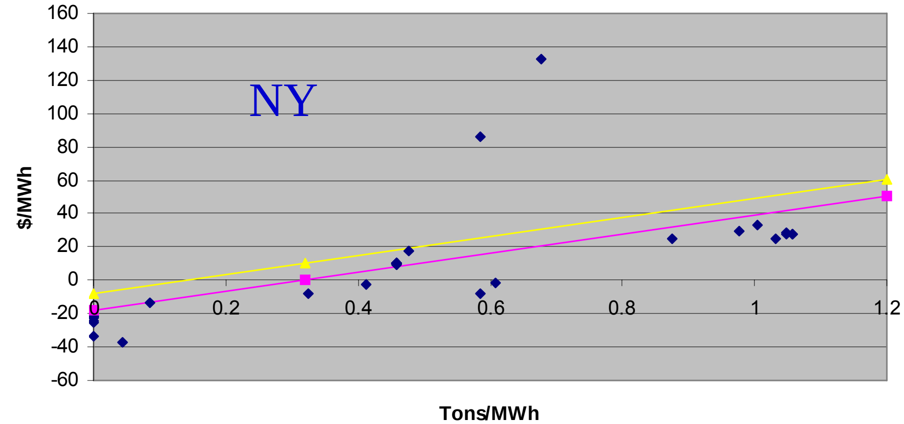
Regional Analysis: Loss in Market Value versus Emission Rate

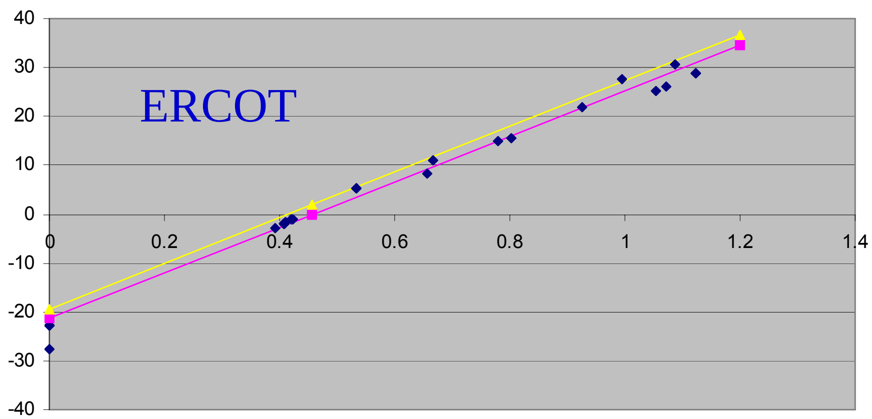
Subset of 182 firms operating in the region.

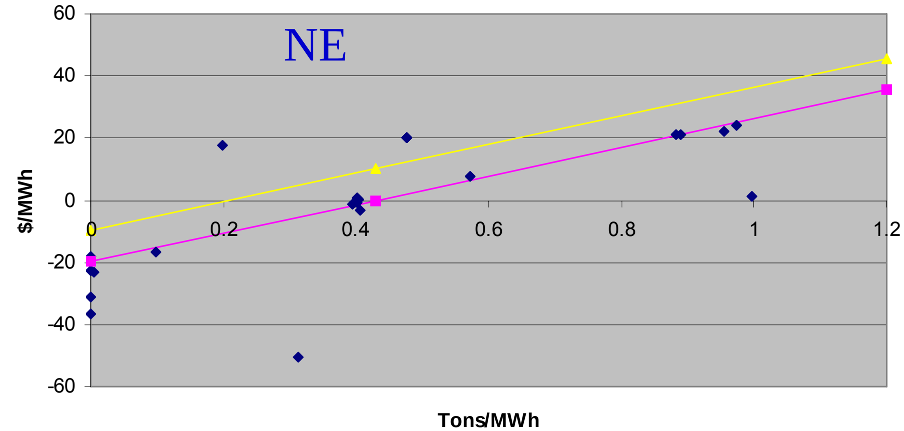












Finding: Regional approach is more cost effective

182 firms operating in competitive regions.

Information	Federal					Regional			
Information	n/a	Complete	Incomplete			Complete	Incomplete		
Metric	***Free***	Firm Value	Facility-Level Fuel+Tech	Firm-Level Emission Rate Fit	Firm-Level Emission Rate Full	Firm Value	Facility-Level Fuel+Tech	Firm-Level Emission Rate Fit	Firm-Level Emission Rate Full
#Winners	180	182	180	101	177				
Gain ($b)	65	8	52	14	37				
#Losers	2	0	2	81	5				
Loss ($b)	~0	0	~0	3	~0				
Industry Net ($b)	65	8	52	11	37	9	19	9	15
***% Free Allowance**	100	22	86	**27**	**65**	23	39	**23**	**32**

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*Percent of allowances in competitive regions.

Conclusion

- Consumers are most adversely affected, but harm is diffuse.
- Compensation of shareholders has significant opportunity costs.
- Best achieved through apportionment to regions.
- Roughly one-third of allowances in competitive regions fully compensate worst off firms, leaving $15+billion in net gain for industry.

❖ Key questions:

- ✓ Is it true that shareholders of firms in regulated regions are kept whole in the long run?
- ✓ Do shareholders of worst-off firm deserve full compensation?

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Method of Analysis:
Detailed Electricity Market Simulation Model

- Iterative simulation model of equilibria in electricity markets with perfect foresight over 20 year time horizon
- Cost of Service, Marginal Cost, Time of Day pricing
- Supply curves composed of Model Plants for 20 regions and inter-regional trading (38 Model Plants in each region)
- 3 seasons, 4 time blocks, 3 customer classes
- Price-responsive demand and fuel modules
- Endogenous investment & retirement
- Endogenous NO_X, SO_2, CO_2, Hg emissions compliance
- Technology characteristics and cost data from EIA, EPA and some industry sources. Learning.
- Welfare Analysis (in electricity market accounting for government revenues)

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Maintained Assumptions

- CAIR/CAMR. Only steam fossil plants install retrofit controls for conventional pollutants.
- Profits from inter-regional trades go to shareholders in regulated regions.
- Limited restructuring: Six regions (NY, NE, MAAC, MAIN, ECAR, ERCOT) with competitive prices and time of day pricing for industrial customers.
- Announced NSR settlements are included.
- State-level multi-pollutant and RPS rules are not included; some effects are modeled.
- All prices in 1999 real dollars.
- Firm-level assets are identified as of January 2004, including all currently built and in-construction facilities.

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Stylized Determination of Electricity Price

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

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

  => Price [Au] > Price [Free]

  Competitive Price = Variable Cost

  => Price [Au] = Price [Free]

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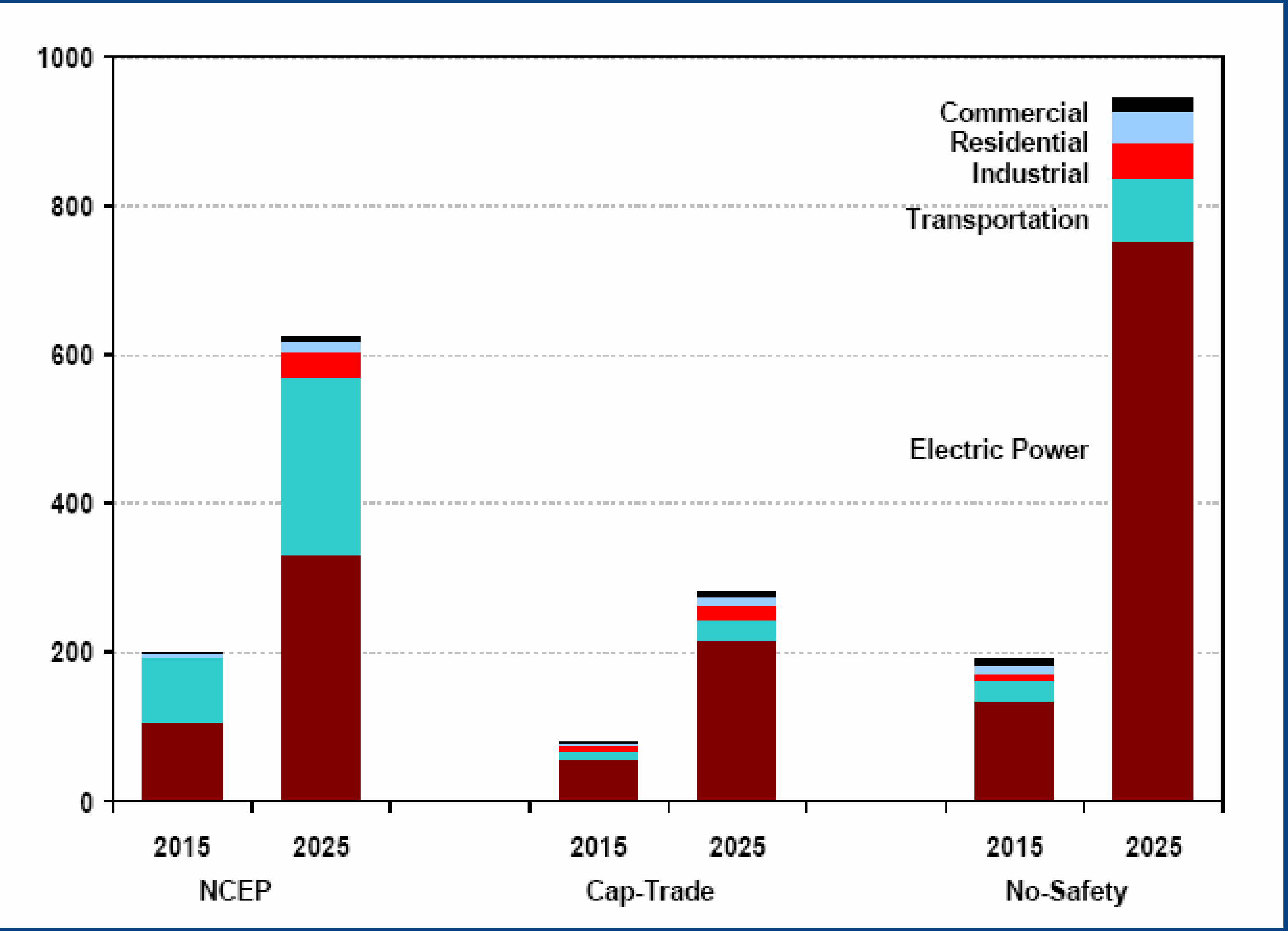
NCEP/Bingaman Climate Policy

- Economy wide cap on CO_2 emissions based on 2.4-2.8% decline in CO_2 intensity per year.
- \$7 (nominal) cap on CO_2 allowance price in 2010 increasing at 5% per year till 2025
- Full trading and banking of CO_2 allowances
- Small portion of allowances to be auctioned.
- NCEP proposal includes much more than CO_2 cap and trade.

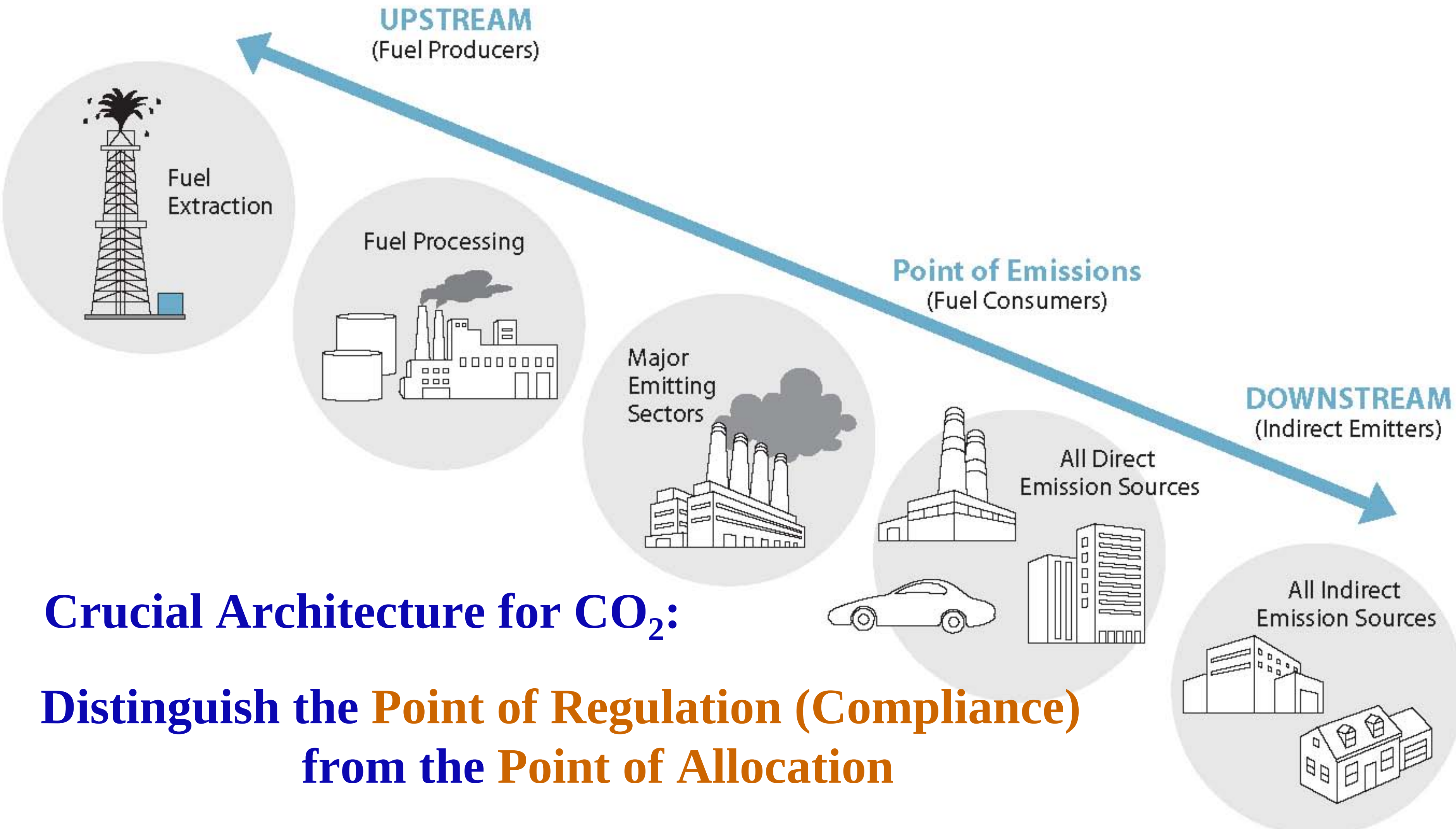
Carbon Dioxide Reductions by Sector in Variants of NCEP Proposal

(million metric tons)



Source: U.S. Energy Information Administration

Upstream Allocation Equivalent to Auction for Electricity Sector



Crucial Architecture for CO_2:

Distinguish the Point of Regulation (Compliance) from the Point of Allocation

Electricity Consumer Claims on Compensation

- Can be measured by changes in consumer surplus or electricity expenditures.
- Spearman rank correlation tests indicate that regions with higher average CO_2 emission rates tend to have larger consumer surplus change per MWh of electricity consumption.
- This correlation is stronger in regulated regions than in competitive regions.
- Impacts on prices and thus consumer surplus in competitive regions depend more on what's happening to the cost of the marginal generators than to the average generator.

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Annual Compensation (2020) and Percent of Losses Under Auction that are Compensated with 100% Free Allocation

Year 2020 (Billion 1999$)	Producers	Consumers
Competitive Regions	$11.14* (375%)	$-0.63 (-8%)
Regulated Regions	----	$10.09 (91%)

*The estimate includes both producers who were losers and winners under upstream allocation.

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Convergence Illustration

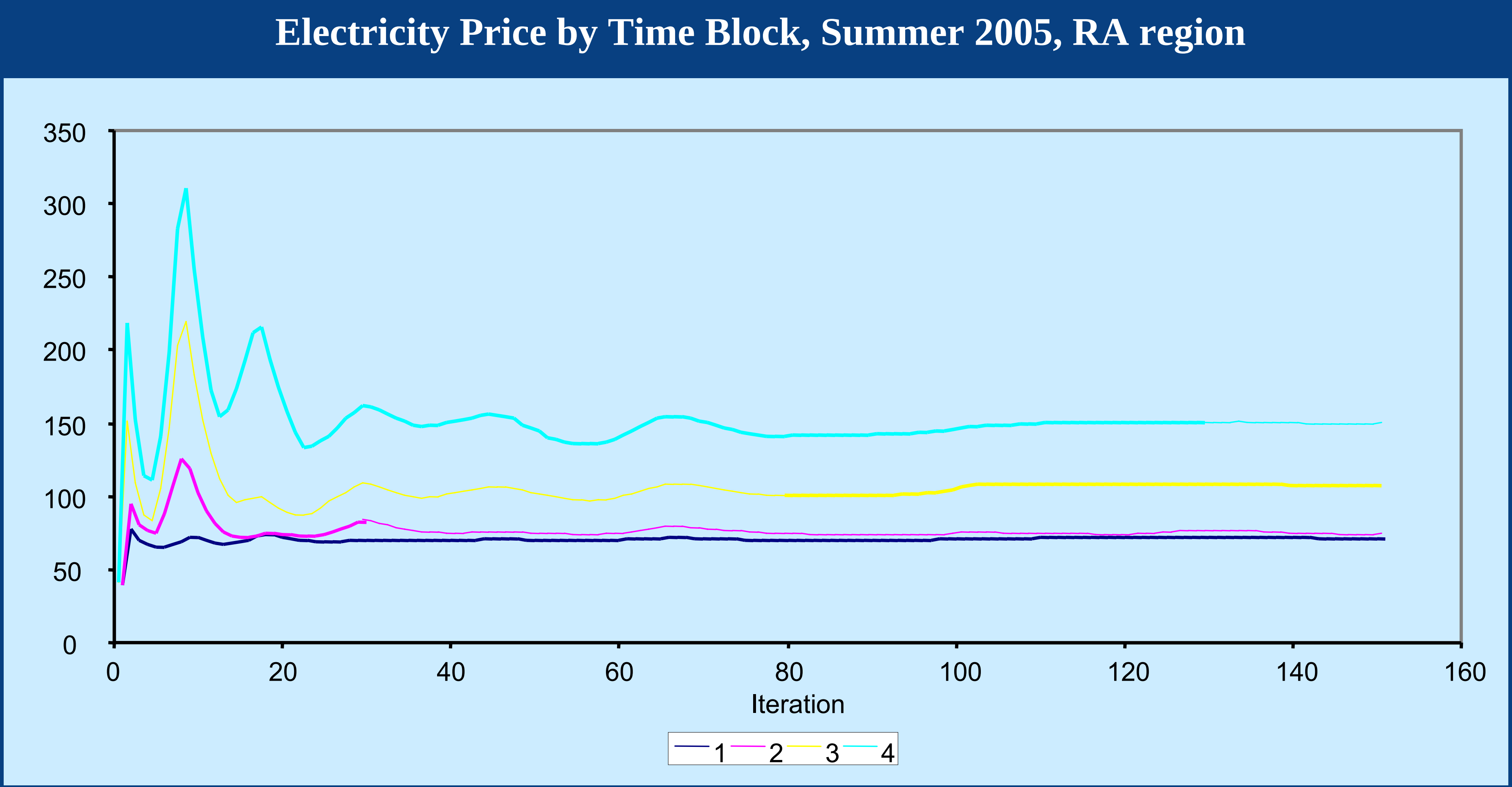

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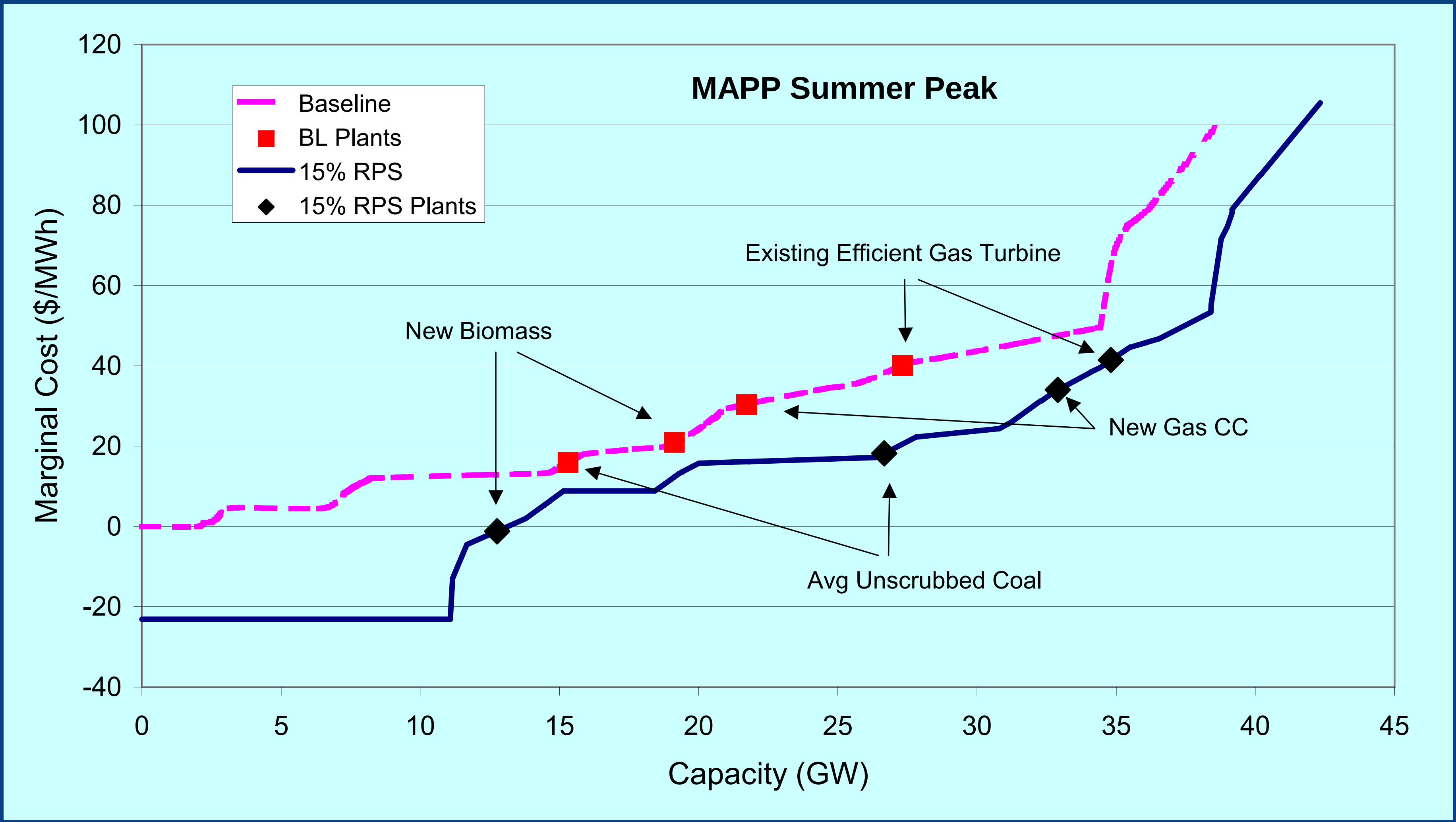
Illustration: Effect of RPS on System Dispatch



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RFF Haiku Electricity Model

Windows NT crashed.
I am the Blue Screen of Death.
No one hears your screams.

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