Economic Efficiency and Distributional Consequences of Different Approaches to NO_x and SO_2 Allowance Allocation

FINAL REPORT

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Resources for the Future
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Project Summary

This study examines various approaches to the allocation of emission allowances for reducing only NO_x and SO_2 to Clear Skies Act levels. Three of the approaches to allocation that are studied include: (1) allocation based on *historic* output (also known as grandfathering), (2) *updating* allocation based on output, and (3) an *auction*. Variations in updating are also considered.

The study does not provide estimates of costs because the exclusion of mercury will cause numerical estimates to differ from CSA. Instead the study focuses on relative differences in approaches to allocation. We focus on differences in economic efficiency, incentives for new technology, and the distributional effects on consumers and producers.

The Project Summary highlights the key observations. The Introduction in the next section provides further background on modeling assumptions. Part I of this report presents benchmark results. Part 2 presents variations in parameters across all allocation scenarios. Part 3 presents variations in the updating approach, in particular.

- **In general,** the approach used to initially distribute emission allowances (historic, auction, or updating) leads to small differences (less than or equal to one year of compliance cost) in total economic efficiency. There are also small differences in electricity price, generation, and asset values. (This contrasts significantly from previous work that showed large differences when considering regulation of CO_2.)

Project Summary:
Economic Efficiency

- The historic approach to allocating NO_X and SO_2 allowances with CSA caps and timing is the **most economically efficient** in regulated regions and across the country as a whole in the benchmark comparisons (see Part 1). The auction is the most efficient approach in competitive regions. For the nation as a whole, updating is more efficient than an auction. This contradicts earlier findings about approaches to allocation for CO_2, where the auction is dramatically more efficient. However, as noted the differences among the approaches are very small in this analysis.
- The **relative efficiency** of the auction, with respect to historic, improves as the percentage of profits accruing to producers in regulated regions from interregional trades decreases. In the benchmark, producers receive 100% of these profits. When producers earn 50% of the profits (with consumers receiving the other 50%), the historic and auction approaches are equally efficient. When consumers receive 100% of the profits the auction is the most efficient approach. In fact, consumers keeping 100% of the profits may be the more accurate characterization of regulatory policy of the three choices we modeled, although this parameter varies by state..
- The historic approach is **most efficient** under sensitivity analysis (Part 2) with lower gas prices and with nationwide restructuring. With stricter caps, the auction is most efficient.
- Among the updating scenarios (see Part 3), the most efficient is allocation to fossil generators and to households on the basis of conservation. This approach also is **the most efficient overall** (slightly more efficient than historic allocation). Updating allocation to all generators and allocation to fossil & renewable generators are more efficient than the central case updating scenario, but not as efficient as historic.

Project Summary:
Incentives for New Technology

Incentives for New Technology:

- As expected, updating allocations accelerates **the introduction of natural gas**, but only by 1% in 2020. An auction has a greater effect, increasing natural gas generation by 6%.
- Updating allocations also accelerates the **introduction of renewables** by 3.5% by 2020. Again an auction is more potent, however, increasing renewable generation by 5%.
- Updating allocations to **conservation** as well as fossil generators leads to almost 1% reduction in total electricity demand. Presumably this is accomplished in part through the introduction of demand-side technologies that are unspecified in the model.

Project Summary:
Distributional Effects on Consumers and Producers

- **Consumers** prefer the updating approach because it leads to lower electricity prices, while in the aggregate **producers** realize the lowest value of existing generation assets under updating.
- **Coal-fired assets** almost always achieve the highest value under historic allocation.
- Existing **gas** plants realize lowest asset values under historic and the highest under updating.
- Existing **non-emitting** units are always most profitable under an auction.
- In sensitivity analysis we find:
  - Under nationwide competition existing coal and gas units experience a greater loss in asset values with a shift from historic to auction or updating than in the benchmark or other cases.
  - Under stricter caps existing gas units experience much higher asset values with an auction or updating relative to historic.
  - We find that varying gas prices is at least as important to both producers and consumers as the way allowances are allocated. Moreover, under lower gas prices, both producers and consumers are more sensitive to the choice of allocation approach than in the benchmark.
- The choice of updating scenario affects asset values. Expanding the set of generators eligible for allowances beyond fossil generators to also include renewables, all generation or conservation *waters down* the allocation earned per unit of generation, and it transfers asset value away from fossil generators.

Introduction

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Introduction

- The method for distributing allowances is an important design feature for emission trading programs.
- Allocation to coal and oil fired generators on the basis of historic heat input was the primary method for distributing SO_2 allowances under Title IV.
- Recent proposals have suggested auctioning allowances, and distributing allowances for free on the basis of electricity output with updating of those allocations over time.

Introduction (continued)

- **In the <u>context of CO_2 emissions</u>, recent research has shown that the initial distribution of allowances can affect the *economic cost* of the policy as well as *who wins and loses*.**
  - This result is attributable in part to regulated (cost-of-service) pricing of electricity in much of the country. In regulated regions, the opportunity cost of an allowance given to a firm for free is not directly reflected in the price of electricity whereas the cost of an auctioned allowance is.
  - In addition, allocation based on recent year electricity generation provides an incentive to increase generation.
  - Emission allowances represent a significant source of value that will be much greater than the cost of compliance.

Introduction (continued)

- In this analysis we study the effects of different approaches to allocation of NO_X and SO_2 emission allowances on the costs of an emission cap and trade program and the distribution of those costs across consumers and different categories of electricity producers.
- The policies we model replicate the NO_X and SO_2 emission caps and timetables found in the Clear Skies Act (S. 485).
- We use RFF's Haiku electricity market model to simulate three approaches to allocation: (1) allocation based on *historic* output (also known as grandfathering), (2) *updating* allocation based on output, and (3) an *auction*.

Clear Skies Policy

- National annual SO_2 allowance distributions are capped at 4.5 million tons beginning in 2010 and 3 million tons beginning in 2018. Actual emissions will be higher over the modeling time horizon due to the allowance bank.
- National annual NO_X allowance distributions are capped at 2.1 million tons beginning in 2008 and 1.7 million tons beginning in 2018. The nation is comprised of two trading regions, but a <u>single national region</u> is characterized in this analysis.
- Emissions of Hg are capped at 26 tons beginning in 2010 and 15 tons beginning in 2018, but <u>no cap</u> on Hg emissions is included in this analysis.
- The allocation of allowances is based initially on historic measures and transitions gradually to an auction. Only <u>pure approaches</u> to allocation are included in this analysis; we do not analyze the transition between approaches.

The Policy that is Modeled

Annual emissions for SO_2 differ from allocations in the statute due to banking. Emission levels are taken from recent EPA analysis.

(million tons)	2005	2010	2015	2020
NOx	3.723	2.120	2.060	1.760
SO_2	8.005	6.048	5.096	4.267

- This study is not a complete analysis of the Clear Skies Act, especially due to the exclusion of a cap on Hg in the scenarios.
- The simplifications in this modeling strategy are intended to highlight in a transparent manner the major characteristics of each approach to distributing emission allowances.

→ **We focus on economic efficiency, incentives for new technology, and the distributional effects on consumers and producers.**

Haiku Model

- Solves for 13 NERC subregions with inter-regional trading.
- About 48 model plants in each region.
- 3 seasons, 4 time blocks, 3 customer classes.
- Price responsive demand and fuel modules.
- EIA demand forecast with elasticity parameters from literature; EIA fuel price forecast.
- Combination of EIA and industry assumptions for technology characterization and cost and for planned generation capacity; data driven characterization of existing capacity.

Maintained Assumptions

- Only steam fossil plants install retrofit controls.
- No emissions cap on Hg or CO_2.
- Profits from inter-regional trades go to shareholders in regulated regions. (Varied in sensitivity analysis.)
- Limited restructuring: Five regions with competitive prices (NY, NE, MAAC, MAIN, ERCOT) with time of day pricing for industrial customers in these regions. (Varied in sensitivity analysis.)
- Announced NSR settlements are included.
- State-level multi-pollutant and RPS rules are not included.
- All prices in 1999 real dollars.

Part 1:
The Benchmark Allocation Scenarios

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Benchmark Allocation Scenarios

- **Historic allocation: SO_2 and NO_X allowances distributed to emitting units based on 1999 output shares.**
  - Other types of historic allocation could include, for example, allocation based on heat input. Variations in historic allocation are not examined and could have effects on relative asset values or other measures.
- **Updating allocation: SO_2 and NO_X allowances allocated to all fossil units based on output shares (Central Updating Case). We also consider allocation to emitting units only (Updating-E).**
  - Subsequent analysis in Part 3 will explore other variations.
- **Allowance auction: SO_2 and NO_X allowances auctioned to highest bidder.**
  - Revenues from the auction do not have to go to the government. The revenues could be recycled to households or to producers, or could be used to subsidize other policies.

Overview of Electricity Price and Generation in 2020:
Benchmark Cases

	Historic	Auction	Updating	Updating-E
Average Electricity Price (1999$/MWh)	69.9	71.1	69.3	69.8
Generation (billion kWh)				
Coal	2,638	2,587	2,650	2,673
Gas	824	876	836	809
Nuclear	788	772	784	774
Renewable	285	301	297	307
TOTAL	4,851	4,853	4,884	4,879

- In general, differences among the scenarios are small.
- Relative to historic, electricity price increases under an auction, and decreases under updating approaches, as expected. Note that while updating increases generation with gas, that increase is greater under an auction.

Allowance Value and Pollution Control Costs
Benchmark Cases

- Differences among approaches are small. The NPV of costs of pollution control for SO_2 and NO_x is roughly \$1.5 to \$3.0 billion (1.5% to 5.0%) greater than NPV of total allowance value.

(billion 1999$)	Historic	Auction	Updating	Updating-E
Pollution Control Costs*	64.4	61.4	64.5	63.8
Total Allowance Value*	61.8	59.8	61.6	61.7

*These measures should be interpreted with caution. Pollution Control Costs do not include the cost of fuel switching. Moreover, Total Allowance Value does not indicate whether the changes in electricity price under-compensate or over-compensate the industry.

Measuring Economic Efficiency

- Efficiency results are measured in 1999$ over the time horizon from 2003 until 2030 and valued according the usual method used in benefit-cost analysis as the net present value (NPV) of:

  change in **economic surplus** =

  change in **producer surplus** + change in **consumer surplus** + change in **auction revenues**.

  Producer surplus is analogous to change in profits. The NPV measure is equivalent to the change in market value.

  Consumer surplus is analogous to the change in profits that consumers earn from value in excess of price.

  Auction revenues are valued as equivalent to consumer surplus.

  Note that economic efficiency is just one measure of public policy. Equity and other concerns may override efficiency. An increase in electricity price may be viewed as efficiency enhancing, for example, because it provides a signal to encourage the purchase of energy efficient appliances; but, it also could cause hardship.

- **Results are reported as the difference of an auction and of updating from historic allocation.** This is done to focus on the differences among approaches to allocation, rather than on the total costs, which are misleading because of the exclusion of Hg from the scenarios and other simplifications.

Efficiency: Economic Surplus as Difference from Historic Benchmark Cases
(NPV Billions 1999$)

Auction	All Regions	Regulated Regions	Competitive Regions	All Regions (through 2015)
Consumers	-57.4	-41.5	-15.9	-47.7
Producers	-0.2	-5.8	5.6	5.4
NOx Revenue	17.2	12.0	5.2	13.4
SO2 Revenue	32.2	22.7	9.5	22.8
TOTAL	-8.3	-12.6	4.4	-6.1
Central Updating Case				
Consumers	8.4	1.3	7.1	3.0
Producers	-12.1	-5.6	-6.5	-5.1
NOx Revenue	0.0	0.0	0.0	0.0
SO2 Revenue	0.0	0.0	0.0	0.0
TOTAL	-3.7	-4.3	0.6	-2.1

Efficiency Effects: Economic Surplus
Benchmark Cases

- Allocation of allowances has **relatively small effects** on the efficiency of multi-pollutant policies in the case of SO_2 and NO_X allowances for the CSA target levels and timetables, compared to the magnitude of effects found in previous research for CO_2. The effects are relatively small both in absolute terms and in proportion to pollution control costs.
- **Total economic surplus is greatest under the historic approach for the country** as a whole and in regulated regions. However, it is highest under the **auction in competitive regions**. In the long-run total surplus tends to be equal under historic and auction in competitive regions, but the net present value calculations differ importantly because of inter-regional power trading and because of capacity decisions implemented before the CSA takes effect.
- **Consumer surplus + auction revenues taken together are highest under updating** in both regulated and unregulated regions and nationwide, and lowest under the auction.
- **Producer surplus is greatest under the historic approach for the nation** a whole and in regulated regions.
- **Producer surplus is greatest under the auction in competitive regions** because of the increase in revenues. Costs do not increase as much due to the large fraction of lower emitting generation in those regions. Less than 40% of generation in competitive regions is coal, while more than 60% of generation in regulated regions is coal.
- Using a **time horizon ending in 2015 narrows the efficiency differences** among the three approaches.

Efficiency: Updating to Emitters in the Benchmark Cases
Economic Surplus as Difference from Historic Allocation (NPV Billions 1999$)

The central case for updating is the approach discussed previously and includes allocation to all fossil generators. Here it is compared to updating only to emitters for each pollutant (Updating-E).

Central Updating Case	All Regions	Regulated Regions	Competitive Regions
Consumers	8.4	1.3	7.1
Producers	-12.1	-5.6	-6.5
TOTAL	-3.7	-4.3	0.6
Updating- Emitters			
Consumers	-0.6	0.0	-0.6
Producers	-5.9	-6.2	0.3
TOTAL	-6.5	-6.2	-0.3

Economic Efficiency: Updating to Emitters

- **Updating allowance allocations to all fossil units (Central Case) is more efficient** than updating only to emitters of each pollutant (Updating-E).
- Both approaches are **less efficient than historic allocation** on a nationwide basis. The biggest difference accrues in regulated regions.
- Across the nation as a whole, **producers are worse off and consumers are better off** when allowances are allocated to all fossil units than when they are only allocated to emitters.

Economic Efficiency:
Changes in Producer Surplus in the Benchmark Cases

- **Change in producer surplus depends on change in revenues (electricity price) and change in cost due to the policy.**
- **In competitive regions electricity price can increase by more than or by less than the change in cost.**

Value (billions 1999$) as Difference from Historic Allocation

	Auction	Updating	Updating-E
NPV Producer Surplus	0.185	-12.064	-5.860
NPV Annual Cost of Pollution Control	3.023	0.102	-0.643

Incentives for Investment:
Benchmark Cases

Prior expectations were that updating would yield an increase in gas-fired generation compared to historic.

Cumulative New Investment (MW) as Difference from Historic Allocation in 2020

	Auction	Updating	Updating-E
Coal	3,290	3,610	9,730
Gas	1,800	420	-8,970

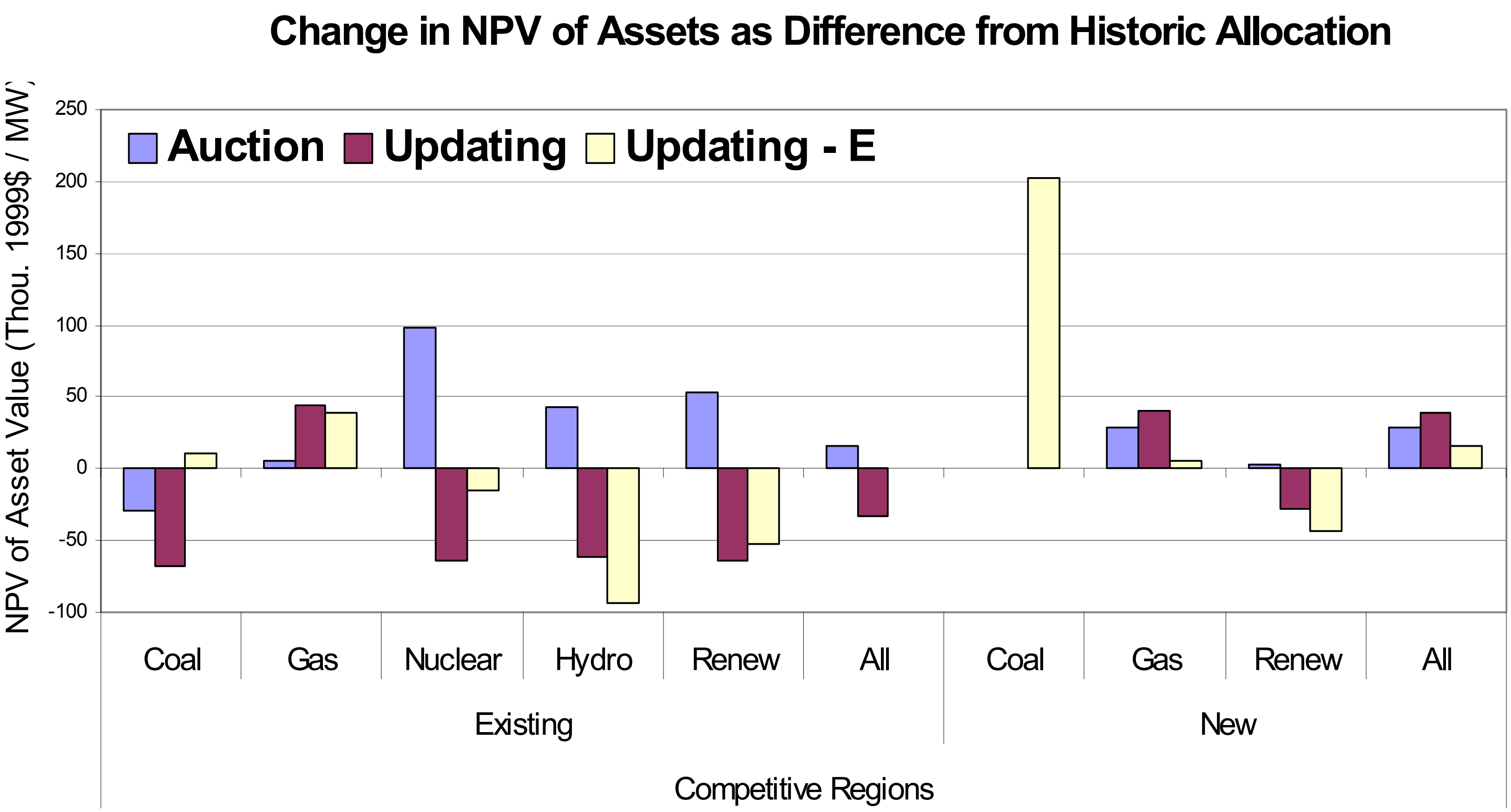
- We find **updating increases gas investment**, but that an **auction leads to a 4 fold greater increase** in gas investment than does the updating approach.
- Allocating SO_2 allowances only to emitting units (Updating-E) leads to substantially more investment in new coal and less investment in new gas than under the other approaches to allowance distribution.
- SO_2 allowances are key because their value is roughly twice that of NO_X allowances. Thus the output subsidy from increasing one's share of the SO_2 allowances is greater than that from increasing one's share of the NO_X allowances.

Measuring Asset Values:
Distributional Consequences for Industry

- We look at the distributional consequences of different approaches to allocation for the industry by evaluating how these approaches affect the market value of generating assets.
- Asset values are measured in 1999$ by calculating NPV of producer surplus of electricity generators of different types over the time horizon from 2003 until 2030.
- We aggregate generators by fuel, for new and existing generators, and look at regulated and competitive regions separately as well as the nation as a whole.

Results are reported as the difference of an auction and of updating from historic allocation.

Asset Values: Competitive Regions
Benchmark Cases



For comparison, under historic allocation, the NPV of all existing assets in competitive regions is $330 (Thou. 1999$ / MW).

Asset Value Results for Competitive Regions
Benchmark Cases

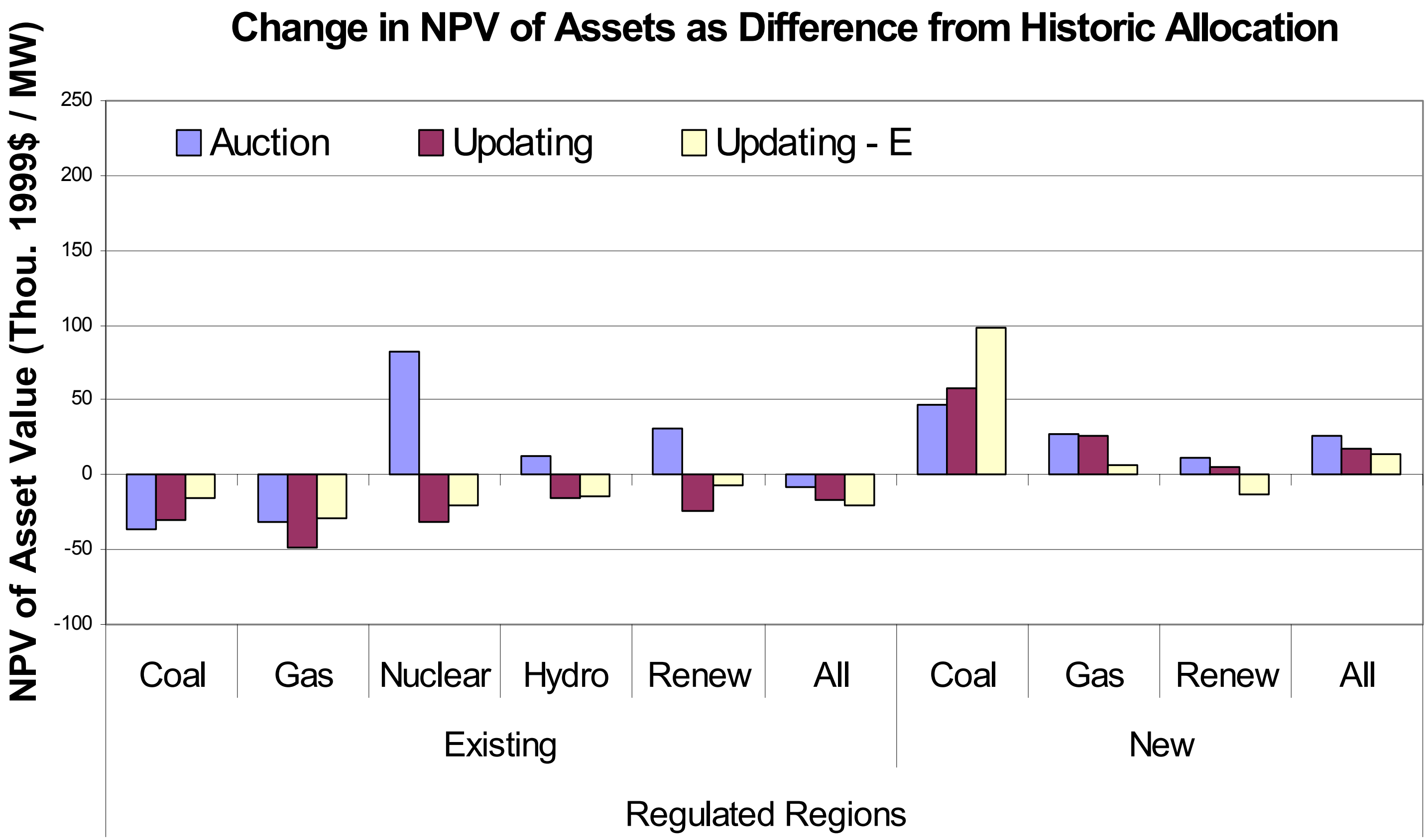
- The distributional effects of allocation on generators *in competitive regions* vary across fuels.
- The market value of **existing coal plants** is greatest when only emitting plants receive allowances (updating-E). The market value of existing coal plants is lowest under the central case updating approach under which gas plants are entitled to SO_2 allowances.
- Relative to the historic approach, **existing gas plants** realize higher asset values under all other approaches, but values are greatest with the updating approaches.
- Both **existing and new non-emitting plants** realize their highest market value with the auction. Because electricity prices tend to be lowest under updating, existing non-emitting plants are less profitable under updating than under the historic approach.
- In the aggregate, **existing plants in competitive regions** gain value under the auction and lose value under updating relative to historic allocation.
- Taken together as a group, **new plants** achieve their highest asset values under the central case updating approach followed by the auction and their lowest asset values under historic allocation.

Asset Value Results for Regulated Regions
Benchmark Cases

In regulated regions, electricity price is set to balance revenues and costs across the firm's portfolio of generation assets. New pollution policies that raise the costs for one technology affect its relative value within the portfolio, but leave the value of the overall portfolio unaffected as long as the firm remains under cost-of-service regulation. Therefore, from an accounting perspective, there is no justification for compensation for regulated firms (except due to changes in inter-regional power markets).

However, the portfolio of technologies also has economic value that differs from its accounting value and is determined in part by the market value of individual assets were they divested from the firm. The value the market would assign to assets will depend on the costs they bear as a result of the pollution policy compared to the expected change in revenues. Here we calculate the change in asset values by comparing the net present value of the change in costs and the change in revenues. A different comparison, on the basis of competitive prices under nationwide restructuring, is considered in Part 2.2.

Asset Values: Regulated Regions
Benchmark Cases



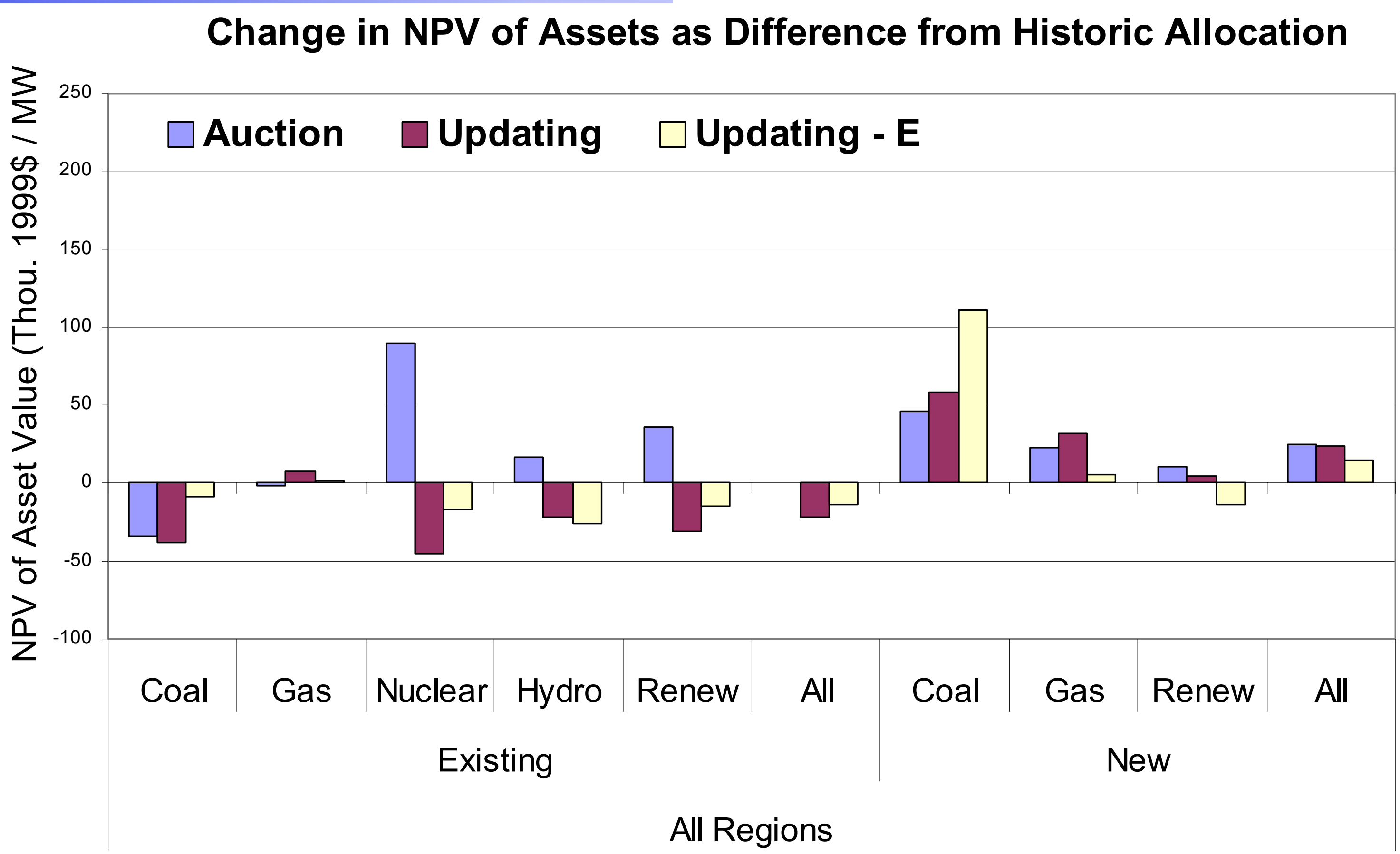
For comparison, under historic allocation, the NPV of all existing assets in regulated regions is $381 (Thou. 1999$ / MW).

Asset Value Results for Regulated Regions

Benchmark Cases

- In *regulated* regions, **in the aggregate, existing generators** perform best under the historic approach, and worst under updating.
- Asset values for **existing coal and gas plants** are lower under the auction and updating than under the historic approach.
- **Non-emitting generators** achieve higher asset values under the auction than under either the historic or either of the updating approaches.
- **New coal plants** achieve their highest asset values under the updating-E approach when they are entitled to the largest share of freely allocated SO_2 allowances.
- In the aggregate, **new assets** perform best under the auction approach, with its high electricity prices. They perform worst under the historic approach.

National Asset Values
Benchmark Cases



For comparison, under historic allocation, the NPV of all existing assets in all regions is $367 (Thou. 1999$ / MW).

National Asset Values

Benchmark Cases

- For the *nation as a whole,* **existing plants in the aggregate** perform equally as well under the auction as they do under the historic approach but they lose value under either updating approach.
- **Existing coal plants** lose asset value under the auction and updating approaches relative to historic. However, they are almost indifferent between updating to emitters (Updating-E) and historic.
- **Existing gas plants** are slightly more profitable under the central case updating approach than under historic.
- **Existing non-emitting plants** are more profitable under the auction than under the historic approach to allocation. Lower electricity prices under updating results in lower profits for these plants than under the historic approach.
- **New generators** in the aggregate are more profitable under the auction or one of the updating approaches than under the historic approach.

Part 1: Concluding Observations
Benchmark Allocation Scenarios

- The historic approach to allocating NO_X and SO_2 allowances with CSA caps and timing is the most efficient in regulated regions and across the country as a whole. However, the auction is the most efficient approach in competitive regions. In general, efficiency differences are small compared to analysis of CO_2.
- The value of SO_2 allowances is roughly twice that of NO_X allowances, so allocation of SO_2 allowances would be a key determinant of the incentives created by an updating approach.
- Consumers prefer the updating approach because it leads to lower electricity prices. In the aggregate producers realize the lowest value of existing generation assets under updating.
- The effect of allocation on asset values varies importantly across types of generators and by how electricity prices are determined. Coal-fired assets almost always achieve the highest value under historic allocation. Existing gas plants realize lowest asset values under historic and highest under updating.
- Existing non-emitting units are always more profitable under an auction than under the historic approach or either of the two approaches to updating considered here.
- Subsequent analysis to be presented in Part 2 explores the sensitivity of these results.

Appendix 1 – Summary of Benchmark Scenarios Historic, Auction, Updating, and Updating - E

Results for 2020				
RFF Haiku Model Run	Z21e_H	Z21e_A	Z21e_U2	Z21e_U
Permit Allocation Method	**Historic** (fossil)	**Auction**	**Updating** (fossil)	**Updating - E** (emitting)
Electricity Price (1999$ / MWh)				
National Average	69.90	71.09	69.26	69.80
Generation (billion kWh)				
Coal	2638.00	2587.00	2650.00	2673.00
Gas	824.40	875.90	835.90	808.70
Nuclear	787.80	772.00	783.90	773.80
Renewable	284.83	301.15	296.52	306.50
Total	4851.00	4853.00	4884.00	4879.00
New Capacity (MW)				
Coal	35410	38700	39020	45140
Combined Cycle	177900	195800	195500	174300
Combustion Turbine	99070	82970	81890	93700
Renewable	78407	83860	82412	85485
Total	390900	401400	398900	398800
Existing Capacity (MW)				
Coal	327700	318500	327700	324700
Combined Cycle	13180	13310	13300	13490
Combustion Turbine	71270	69170	66490	71400
Nuclear	104600	102500	104100	102800
Renewable	8952	8945	8956	8965
Total	694600	678600	686700	692500
Fuel Prices (1999$ / mmBtu)				
Coal	1.048	1.046	1.051	1.053
Gas	3.975	3.966	3.976	3.990
Emissions				
NOx (million tons)	1.757	1.751	1.765	1.766
SO2 (million tons)	4.507	4.453	4.456	4.423
CO2 (billion tons)	3.176	3.216	3.236	3.227
Hg (tons)	43.48	43.82	43.82	43.98
Permit Price (1999$ / ton)				
NOx	1161	1199	1142	1197
SO2	1080	1153	1162	1151
NOx Controls (MW)				
SCR	275300	266300	276500	270800
SNCR	12090	12490	12520	11760
Reburn	1631	1626	1631	1629
None	113300	110000	109000	117500
NOx Control Cost (billion 1999$ / year)				
O&M	2.056	1.985	2.050	2.022
Capital	2.393	2.302	2.393	2.351
Total	4.449	4.288	4.443	4.373
SO2 Controls (MW)				
Existing Scrubber	98630	97350	98630	98500
New Scrubber	29790	32640	32930	38460
Retrofit Scrubber	115290	104920	113990	112840
None	117400	119800	118700	117000
SO2 Control Costs (billion 1999$ / year)				
O&M	2.247	2.041	2.204	2.186
Capital	3.304	2.983	3.250	3.179
Total	5.551	5.024	5.454	5.365

Appendix 1 – Summary of Benchmark Scenarios Differences From Historic

Results for 2020				
RFF Haiku Model Run	Z21e_H	Z21e_A	Z21e_U2	Z21e_U
Permit Allocation Method	**Historic**	**Auction**	**Updating**	**Updating - E**
Difference from Historic	(fossil)		(fossil)	(emitting)
Electricity Price (1999$ / MWh)				
National Average	–	1.19	-0.64	-0.10
Generation (billion kWh)				
Coal	–	-51.00	12.00	35.00
Gas	–	51.50	11.50	-15.70
Nuclear	–	-15.80	-3.90	-14.00
Renewable	–	16.32	11.69	21.67
Total	–	2.00	33.00	28.00
New Capacity (MW)				
Coal	–	3290.00	3610.00	9730.00
Combined Cycle	–	17900.00	17600.00	-3600.00
Combustion Turbine	–	-16100.00	-17180.00	-5370.00
Renewable	–	5452.75	4004.58	7077.45
Total	–	10500.00	8000.00	7900.00
Existing Capacity (MW)				
Coal	–	-9200.00	0.00	-3000.00
Combined Cycle	–	130.00	120.00	310.00
Combustion Turbine	–	-2100.00	-4780.00	130.00
Nuclear	–	-2100.00	-500.00	-1800.00
Renewable	–	-6.89	4.04	12.96
Total	–	-16000.00	-7900.00	-2100.00
Fuel Prices (1999$ / mmBtu)				
Coal	–	0.00	0.00	0.00
Gas	–	-0.01	0.00	0.02
Emissions				
NOx (million tons)	–	-0.006	0.008	0.009
SO2 (million tons)	–	-0.054	-0.051	-0.084
CO2 (billion tons)	–	0.040	0.060	0.051
Hg (tons)	–	0.340	0.340	0.500
Permit Price (1999$ / ton)				
NOx	–	38.00	-19.00	36.00
SO2	–	73.00	82.00	71.00
NOx Controls (MW)				
SCR	–	-9000.00	1200.00	-4500.00
SNCR	–	400.00	430.00	-330.00
Reburn	–	-5.00	0.00	-2.00
None	–	-3300.00	-4300.00	4200.00
NOx Control Cost (billion 1999$ / year)				
O&M	–	-0.071	-0.006	-0.034
Capital	–	-0.091	0.000	-0.042
Total	–	-0.161	-0.006	-0.076
SO2 Controls (MW)				
Existing Scrubber	–	-1280.00	0.00	-130.00
New Scrubber	–	2850.00	3140.00	8670.00
Retrofit Scrubber	–	-10370.00	-1300.00	-2450.00
None	–	2400.00	1300.00	-400.00
SO2 Control Costs (billion 1999$ / year)				
O&M	–	-0.206	-0.043	-0.061
Capital	–	-0.321	-0.054	-0.125
Total	–	-0.527	-0.097	-0.186

Part 2:
Sensitivity of the Initial Benchmark

Sensitivity of Initial Benchmark to:

1. Gas Prices
2. Regulation
3. Tighter Emission Caps
4. Sharing of Profits from Power Exports

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Alternative Assumptions

1. **Lower Gas Prices:** We assume (lower) natural gas prices that are in line with price levels assumed in EPA's modeling analysis of Clear Skies Act.
2. **Nationwide Restructuring:** All regions complete the transition to retail competition by 2010. Restructuring includes marginal cost pricing for generation, with time of day pricing for industrial customers only, and modest stranded cost recovery. Also, nationwide restructuring leads to slightly accelerated rates of technological change.
3. **Tighter Caps:** Emissions caps are set at a tighter level that represent a mix of the Carper and Jeffords approaches.
4. **Sharing of Profits from Power Exports:** Consumers in regulated exporting regions keep 50% of the profits from unregulated wholesale power exports.

Part 2.1:
Lower Gas Prices

- In the benchmark (initial) case we assume (demand responsive) natural gas prices calibrated to EIA 2003 Annual Energy Outlook.
- In this scenario, we assume (demand responsive) natural gas prices that are in line with levels assumed in EPA's recent modeling.

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Overview of Electricity Price and Generation in 2020:
Lower Gas Price Scenarios

Gas Price ($/mill.Btu) obtained under Historic Allocation	2005	2010	2015	2020
Historic Benchmark	2.80	3.29	3.49	3.98
Lower Gas Price Case	2.57	3.09	3.31	3.47

	Benchmark	Lower Gas Price		
	Historic	Historic	Auction	Updating
Average Electricity Price (1999$/MWh)	69.9	68.1	69.4	67.6
Generation (billion kWh)				
Coal	2,638	2,607	2,615	2,634
Gas	824	915	877	936
Nuclear	788	787	786	778
Renewable	285	280	281	262
TOTAL	4,851	4,905	4,874	4,915

Overview

Lower Gas Price Scenarios

- Compared to the historic allocation in the benchmark, historic allocation with lower gas prices yields predictable results:
  - lower electricity prices, more total generation
  - less coal generation, more gas generation, less renewables generation.
- Comparing the updating allocation methods in the benchmark with the lower gas price case yields the same pattern.
- The auction yields a somewhat different pattern, when comparing benchmark with lower gas price case.
- **Among the approaches to allocation with lower gas prices,** as expected the auction yields the highest price and updating yields the lowest price. The effect of the auction in raising electricity price appears to be greater with lower gas prices than in the benchmark.

Allowance Value and Pollution Control Costs:
Lower Gas Price Scenario

- **The value of allowances and pollution control costs are virtually unchanged between the benchmark and lower gas price case.**
  - With lower gas prices, NPV of costs of pollution control for SO_2 and NO_x is roughly $1 to $5 billion (1.4% to 5.1%) greater than NPV of total allowance value, which is very comparable to the benchmark.

Efficiency: Lower Gas Price Scenario in All Regions.
Economic Surplus Measured as Difference from Historic (NPV Billions 1999$)

Auction	Benchmark All Regions	Lower Gas Prices All Regions	Lower Gas Prices Competitive Regions	Lower Gas Prices Regulated Regions
Consumers	-57.4	-35.7	2.7	-38.4
Producers	-0.2	-15.0	-17.0	2.0
NOx Revenue	17.2	17.3	5.0	12.4
SO2 Revenue	32.2	32.3	9.0	23.4
TOTAL	-8.3	-1.1	-0.4	-0.7
Central Updating Case				
Consumers	8.4	15.0	17.8	-2.8
Producers	-12.1	-17.4	-13.3	-4.1
NOx Revenue	0.0	0.0	0.0	0.0
SO2 Revenue	0.0	0.0	0.0	0.0
TOTAL	-3.7	-2.4	4.5	-6.9

Efficiency:
Economic Surplus in Lower Gas Price Scenarios

- With lower gas prices, allocation of allowances continues to have relatively small effects on the efficiency of multi-pollutant policies in the case of SO_2 and NO_X allowances for the CSI target levels and timetables.
- The efficiency ranking of different approaches is altered with the lower gas prices.
  - In the benchmark, economic surplus under historic was $8 billion greater than under the auction. In the lower gas case, this difference shrinks to $1 billion, and the auction is slightly more efficient than updating.
- In moving away from historic allocation to either an auction or updating, consumers benefit more than they did in the benchmark case. Many of these benefits come as a loss to producers. Lower gas prices lead to greater gas generation, which sets electricity price in competitive regions and sets price for inter-regional trade among regulated regions, to the benefit of consumers. The auction imposes new costs for permit acquisition that are fully reflected in electricity price in regulated regions, but relatively less of the auction cost is reflected in permit prices in competitive regions or inter-regional power trades compared to the benchmark. Hence, producers bear more of the costs related to the auction than do consumers.
- Most of the differences in comparing with the benchmark are in competitive regions.
- The PDV of total national allowance revenues is almost identical to that under the benchmark case.

Lower Gas Price Scenarios:
Gas Prices or Allocation - Which is More Important?

- For producer surplus, the difference in gas prices is somewhat more important than the differences in the way allowances are allocated.

(NPV billion $)	Historic	Auction	Updating
Benchmark	107.4	107.2	95.4
Lower Gas Price	92.4	77.4	75.0

- The change in electricity prices that consumers see (a proxy for change in consumer surplus) is of comparable magnitude when comparing the gas price scenarios and the approaches to allocation.

($/MWh)	Historic	Auction	Updating
Benchmark	69.9	71.1	69.3
Lower Gas Price	68.1	69.4	67.6

- Both producers and consumers are more sensitive to the choice of allocation approach under lower gas prices than in the benchmark.

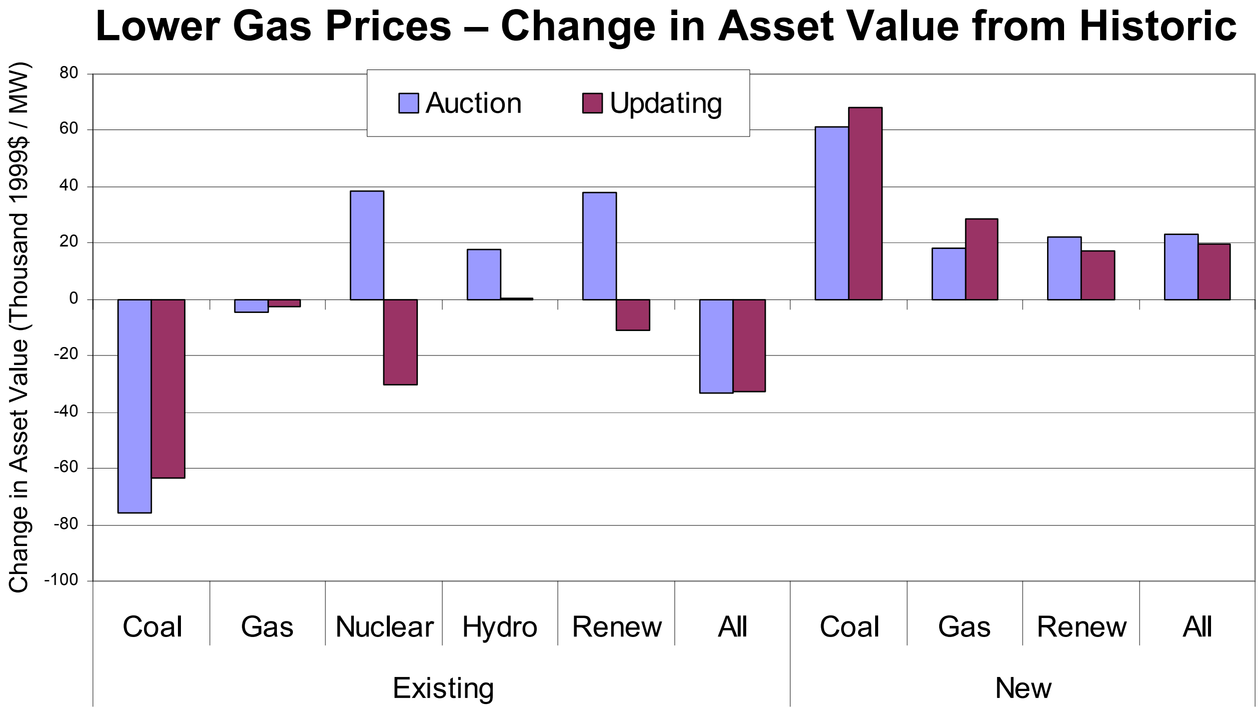
Measuring Asset Values in the Lower Gas Price Case: Distributional Consequences for Industry

- We look at the distributional consequences of different approaches to allocation for the industry by evaluating how these approaches affect the market value of generating assets.
- Asset values are measured in 1999$ by calculating NPV of producer surplus of electricity generators of different types over the time horizon from 2003 until 2030.
- We aggregate generators by fuel, for new and existing generators, and look at regulated and competitive regions separately as well as the nation as a whole.

Results are reported as the difference of an auction and of updating from historic allocation.

National Asset Values: Lower Gas Price Case

- In general, relationships under the benchmark are maintained.
- For existing coal the shift away from historic allocation has a more pronounced effect on asset value with lower gas prices.



For comparison, historic allocation under lower gas prices yields a NPV of all existing assets of $343 (Thou. 1999$ / MW).

Part 2.2:
Nationwide Restructuring

Under this scenario, all regions complete the transition to retail competition by 2010.

Overview of Electricity Price and Generation in 2020:
Nationwide Restructuring

	Benchmark	Nationwide Restructuring		
	Historic	Historic	Auction	Updating
Average Electricity Price (1999$/MWh)	69.9	76.3	76.8	75.2
Generation (billion kWh)				
Coal	2,638	2,561	2,557	2,575
Gas	824	912	927	962
Nuclear	788	804	803	802
Renewable	285	181	175	161
TOTAL	4,851	4,778	4,784	4,816

Overview: Nationwide Restructuring
(Marginal Cost Pricing and Industrial Time of Day Pricing)

- All regions complete the transition to retail competition by 2010. Restructuring includes modest stranded cost recovery and marginal cost pricing for generation, with time of day pricing for industrial customers only. Residential and commercial customers in marginal cost regions face the average of marginal costs over a 24-hour period. Also, nationwide restructuring leads to slightly accelerated rates of technological change.
- Other market efficiency benefits of Standard Market Design are not included in this analysis.
- Nationwide restructuring leads to fairly dramatic increases in average electricity price and a commensurate decline in total generation.
- As expected, in the long run (2020) under nationwide restructuring the historic and auction approaches have nearly identical effects on quantity and fuel mix of generation.
- Also as expected, updating leads to a lower electricity price because it provides an incentive for increased total generation, which is fulfilled mostly with natural gas.

Allowance Value and Pollution Control Costs:
Nationwide Restructuring

- Under nationwide restructuring, NPV of costs of pollution control is 7% to 9% greater than NPV of total allowance value. This is a greater ratio than in the benchmark.

	Benchmark	Nationwide Restructuring		
(billion 1999$)	Historic	Historic	Auction	Updating
Pollution Control Costs*	64.4	65.8	66.0	67.2
Total Allowance Value*	61.8	60.2	60.3	62.8

*These measures should be interpreted with caution. Pollution Control Costs do not include the cost of fuel switching. Moreover, Total Allowance Value does not indicate whether the changes in electricity price under-compensate or over-compensate the industry.

Efficiency: Economic Surplus Measured as Difference from Historic. Nationwide Restructuring Sensitivity in All Regions (NPV Billions 1999$)

	Benchmark	Nationwide Restructuring
Auction		
Consumers	-57.4	-10.6
Producers	-0.2	-43.1
NOx Revenue	17.2	17.3
SO2 Revenue	32.2	33.5
TOTAL	-8.3	-2.9
Central Updating Case		
Consumers	8.4	61.6
Producers	-12.1	-65.0
NOx Revenue	0.0	0.0
SO2 Revenue	0.0	0.0
TOTAL	-3.7	-3.4

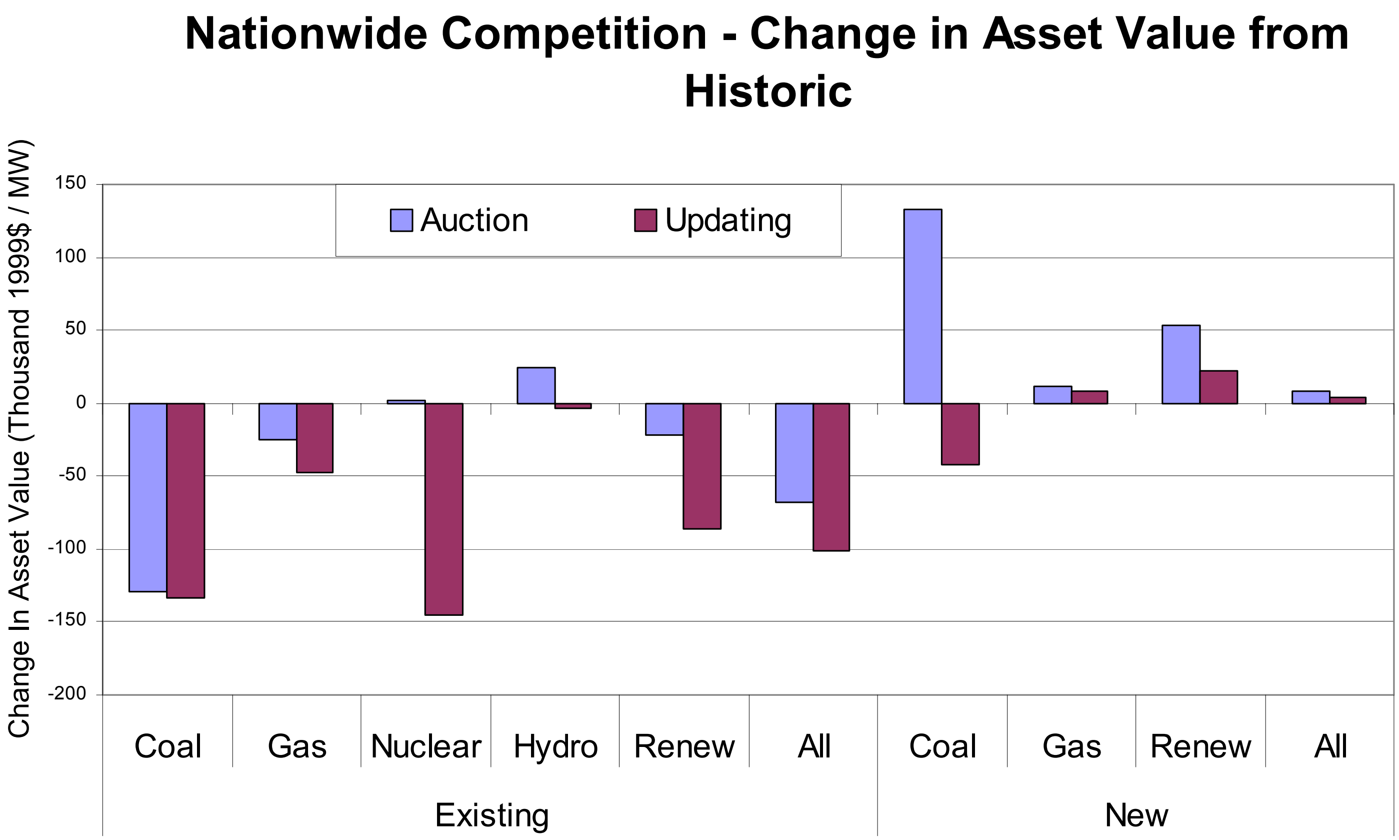
Efficiency:
Economic Surplus under Nationwide Restructuring

Although by 2020 the auction and historic yield nearly identical results, the NPV of economic surplus differs because of the delay before restructuring takes effect.

- In NPV terms, economic surplus is greatest under historic allocation.
- Auction and updating have similar overall efficiency results when compared to historic allocation. However, compared to historic, an updating approach leads to a large transfer from producers to consumers.

When broken down by region we see that the regions that are competitive by 2003 (the competitive regions in the benchmark case) tend to have higher economic surplus under an auction and updating than under a historic approach. The reverse is true for regions that move to competition in 2010 (the regulated regions in the benchmark case). We conjecture the difference in the effects of allocation on surplus is largely the result of a difference in the generation mix across the two regions – i.e., the regions that are competitive by 2003 have a larger share of lower emitting generation assets.

National Asset Values:
Nationwide Restructuring



For comparison, under historic allocation and nationwide competition, the NPV of all existing assets is $589 (Thou. 1999$ / MW).

National Asset Values:
Nationwide Restructuring

- In the benchmark, the value of existing assets was equal under the historic and auction approaches. **Under nationwide restructuring, the value of existing assets** is less under the auction than under historic, but it remains greater than under updating.
- Under the benchmark, the value of existing non-emitting assets was higher under the auction than under a historic approach. **Under nationwide restructuring, non-emitting assets** taken together (hydro, nuclear, and renewables) perform equally as well as under historic. However, they continue to do less well under updating.
- In general, **new assets** do best under the auction, as was the case in the benchmark. They also do better under updating than under historic allocation.

➢ These results conform to the effects of the different allocation approaches on electricity prices. In the benchmark, electricity prices are higher under the auction than under historic. In the nationwide restructuring case the difference between prices under these two allocation approaches is smaller.

Part 2.3:
Stricter Emission Caps

	(million tons)	2005	2010	2015	2020
Benchmark	**NOx**	3.723	2.120	2.060	1.760
	SO_2	8.005	6.048	5.096	4.267
Strict Caps	**NOx**	3.723	2.120	1.500	1.500
	SO_2	8.005	4.000	2.300	2.000

Overview of Electricity Price and Generation in 2020: Stricter Emission Caps

- The stricter caps are a hybrid of the Carper and Jeffords proposals.
- With the historic allocation approach, electricity prices are somewhat higher with the stricter caps… But stricter caps have virtually no effect on total generation nor on the mix of fuels used to generate electricity.

	Benchmark	Stricter Caps		
	Historic	Historic	Auction	Updating
Average Electricity Price (1999$/MWh)	69.9	70.3	71.5	70.0
Generation (billion kWh)				
Coal	2,638	2,613	2,623	2,594
Gas	824	834	803	889
Nuclear	788	787	788	781
Renewable	285	304	305	286
TOTAL	4,851	4,855	4,837	4,865

Allowance Value and Pollution Control Costs:
Stricter Emission Caps

- With stricter caps, costs of pollution control grows to be substantially more than the value of allowances.
- NPV of costs of pollution control for SO_2 and NO_x (not including the cost of fuel switching) is roughly $40 billion (65% to 74%) greater than NPV of total allowance value.

	Benchmark	Stricter Caps		
(billion 1999$)	Historic	Historic	Auction	Updating
Pollution Control Costs*	**64.4**	**95.1**	**95.1**	**93.3**
Total Allowance Value*	**61.8**	**56.2**	**54.8**	**56.5**

*These measures should be interpreted with caution. Pollution Control Costs do not include the cost of fuel switching. Moreover, Total Allowance Value does not indicate whether the changes in electricity price under-compensate or over-compensate the industry.

Efficiency: Economic Surplus as Difference from Historic. Stricter Emission Caps (NPV Billions 1999$)

	Benchmark	Stricter Caps		
	All Regions	All Regions	Regulated Regions	Competitive Regions
Auction				
Consumers	-57.4	-33.1	-32.7	-0.4
Producers	-0.2	-5.3	0.1	-5.5
NOx Revenue	17.2	15.3	10.8	4.5
SO2 Revenue	32.2	30.8	22.0	8.8
TOTAL	-8.3	7.7	0.2	7.5
Central Updating Case				
Consumers	8.4	13.6	0.3	13.3
Producers	-12.1	-13.7	-3.6	-10.1
NOx Revenue	0.0	0.0	0.0	0.0
SO2 Revenue	0.0	0.0	0.0	0.0
TOTAL	-3.7	-0.1	-3.3	3.2

Efficiency:
Economic Surplus with Stricter Caps

- With the stricter caps, the auction is more economically efficient than either historic or updating. This differs from the benchmark, where historic is most efficient.

  The difference stems in part from the change in the value of emission allowances and the cost of acquiring allowances associated with the auction. Under stricter caps, the price of allowances rises but the quantity falls compared to the benchmark, and the overall cost associated with the auction (price times quantity) falls compared to the benchmark. Hence, moving to an auction imposes a smaller change in electricity price under stricter caps. Compared to the benchmark, the difference is greatest in regulated regions, where the entire cost of an acquiring allowances through an auction is added to electricity price.

  This reasoning explains an important part of the difference between the economic efficiency of an auction under benchmark caps and stricter caps. A complete understanding will require additional sensitivity analysis.

- Compared to historic, consumers and producers are worse off under an auction, but auction revenues compensate.
- Economic surplus for the nation as a whole is the same under updating as under historic.

Effect of Stricter Caps on Producer Surplus and Consumer Prices

- Stricter caps lead to a 1.5% to 6.0% decline in producer surplus depending on the allocation approach.

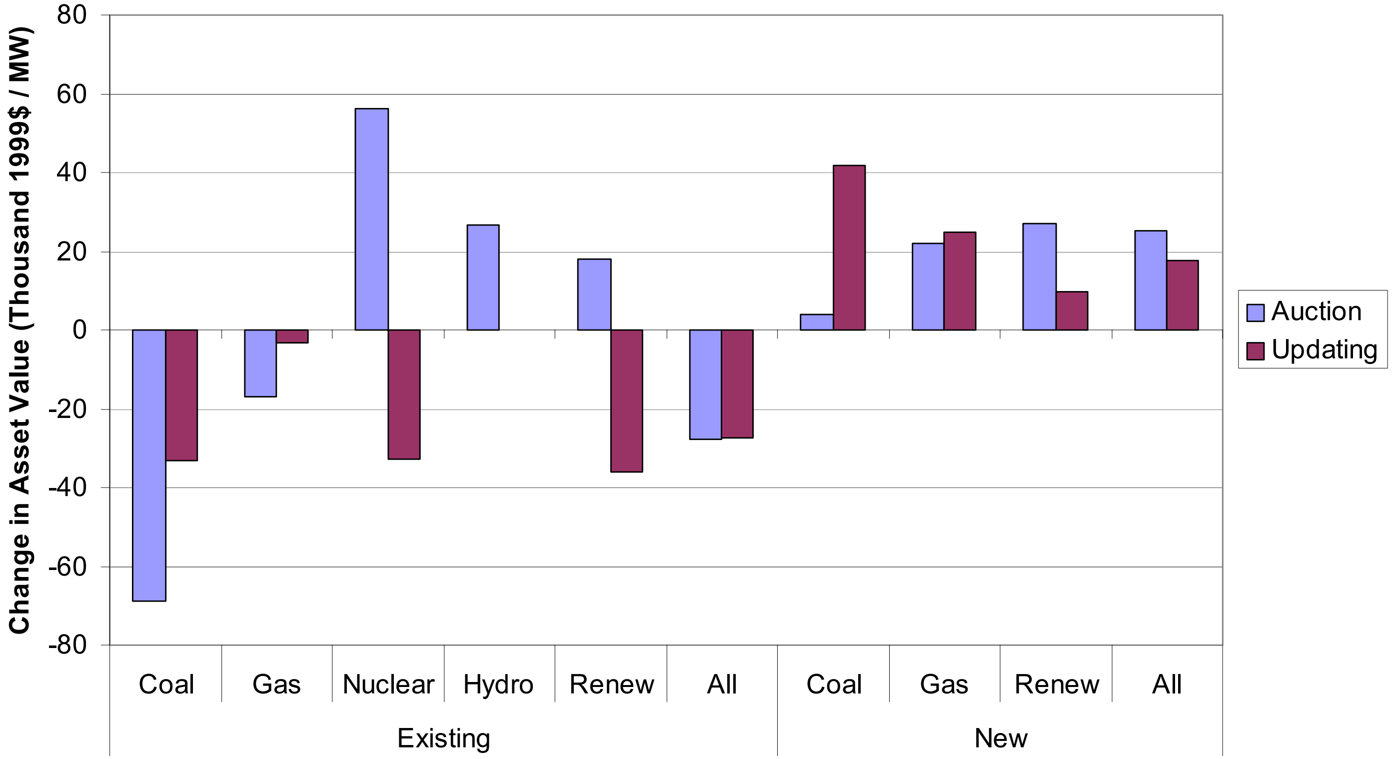
(NPV billion $)	Historic	Auction	Updating
Benchmark	107.4	107.2	95.4
Stricter Caps	106.0	100.7	92.3

- Stricter caps lead to a 1% or less increase in consumer prices (which serves as a proxy for change in consumer surplus).

($/MWh)	Historic	Auction	Updating
Benchmark	69.9	71.1	69.3
Stricter Caps	70.3	71.5	70.0

National Asset Values
Stricter Caps

- For new units as a group, asset values are highest under the auction and lowest under historic.
- For existing units as a group, assets values are highest under historic. Asset values fall by the same amount under the auction and updating.



For comparison, under historic allocation with strict caps, the NPV of all existing assets is $367 (Thou. 1999$ / MW).

Part 2.4:
Profit Sharing Sensitivity

- In the benchmark, in regulated regions, producers kept 100% of the profits from wholesale power exports.
- Under this scenario, in regulated regions, we explore different divisions of the profits from wholesale power exports.

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Efficiency: Economic Surplus as Difference from Historic. Consumers Keep 100% of Profits from Power Trades (NPV Billions 1999$)

	Benchmark	Consumers Keep 100% of Profits		
Auction	All Regions	All Regions	Competitive Regions	Regulated Regions
Consumers	-57.4	-26.8	-36.9	10.1
Producers	-0.2	-22.2	-1.1	-21.1
NOx Revenue	17.2	17.2	12.2	5.1
SO2 Revenue	32.2	35.9	26.7	9.2
TOTAL	-8.3	4.1	0.8	3.3
Central Updating Case				
Consumers	8.4	-35.8	-27.4	-8.4
Producers	-12.1	38.0	30.2	7.8
NOx Revenue	0.0	0.0	0.0	0.0
SO2 Revenue	0.0	0.0	0.0	0.0
TOTAL	-3.7	2.2	2.8	-0.6

Economic Efficiency:
Sharing of Profits from Inter-regional Power Trades

- The **relative efficiency** of the **auction** and **updating** scenarios improves as the percentage of profits accruing to producers in regulated regions from interregional trades decreases. That is, the greater the share of profits to consumers, the better the relative performance of the auction and (to a lesser extent) updating scenarios.
- In the benchmark, with producers in regulated regions keeping 100% of profits from inter-regional power trade, the historic approach is the most efficient. At 50% sharing between consumers and producers the auction and historic approaches are about equal with respect to economic efficiency, and both are slightly more efficient than updating. When consumers keep 100% of the profits from power trade, the auction is the most efficient and updating is also more efficient than historic allocation. In fact, consumers keeping 100% of the profits may be the more accurate characterization of regulatory policy of the three choices we modeled, although this parameter varies by state.

  The reason the auction performs relatively better when consumers retain a greater share of profits is that the electricity price necessary to balance revenues and costs in regulated regions is reduced. The lower electricity price exacerbates the gap between electricity price and marginal cost. Using an auction to distribute allowances raises electricity prices relative to the historic approach and helps to reduce the gap, leading to greater efficiency.
- It is still the case that compared to historic, consumers and producers are worse off under an auction, but auction revenues compensate.
- When consumers keep 100% of the profits, in **regulated regions**, economic surplus is nearly $1 billion higher under an auction than it is under historic. In contrast, under the benchmark, regulated regions experienced a $12.6 billion loss in economic surplus under the auction relative to historic. **Competitive regions** are affected only slightly.

Part 2: Concluding Observations
Sensitivity of Benchmark

- The effect of allowance allocation on the efficiency of multi-pollutant policies for SO_2 and NO_X remains small for the three sensitivity cases in which they are compared (lower gas prices, nationwide restructuring, tighter caps).
  - The historic approach to allocating SO_2 and NO_X allowances is the most efficient across the country as a whole in the benchmark, with lower gas prices and under nationwide restructuring.
  - However, with stricter caps, the auction is more efficient than either historic or updating.
  - The relative efficiency of the auction compared to historic improves over a range of values for profit sharing from power trading in regulated regions. When consumers in regulated regions keep 100% of the profits from power exports, the auction is more efficient than historic. In fact, consumers keeping 100% of the profits may be the more accurate characterization of regulatory policy of the three choices we modeled, although this parameter varies by state.
- The effect of allocation on asset values for existing coal and gas units varies across the sensitivity cases.
  - Existing coal and gas units experience a greater fall in asset values with a shift from historic to auction or updating under nationwide restructuring than in the benchmark or other cases.
  - Existing gas units experience much higher asset values with an auction or updating relative to historic under stricter caps.
  - Nonemitting units don't have as strong a preference for the auction under nationwide competition as they do under the benchmark or under other sensitivity cases.

Part 3:
Alternative Updating Scenarios

- In the benchmark updating case, all fossil-fueled generators are eligible for NO_X and SO_2 permit allocations. The allocations are based on current year generation.
- Four alternative updating scenarios are examined:
  1. Delayed Basis for Updating
  2. Allocation to All Generators
  3. Allocation to Fossil Generators & New Renewables
  4. Demand Conservation Incentives

Alternative Updating Scenarios

- Updating has been identified as a way to provide incentives for investment in the technologies qualifying for allowances.
- Updating is expected to lead to lower prices and increased generation, which can undermine the value of existing generation assets.
- In this analysis we study sensitivity of the benchmark updating case to <u>four</u> different approaches to updating.

Alternative Updating Scenarios (continued)

1. **Delayed Basis for Updating**
   - Allocations of allowances in the current year are based on generation quantities three years prior.
2. **Allocation to All Generators**
   - All generation is eligible for permit allocations.
3. **Allocation to Fossil Generators & New Renewables**
   - In addition to all fossil fuel generation, new renewables (biomass and wind) are eligible for permit allocations.
4. **Demand Conservation Incentives**
   - Allocation to fossil generation is supplemented by allocation to consumers in response to reduction in electricity demand.
   - It is important to note that the institution that would achieve this allocation as it is specified in the model would be challenging to implement as a policy.

Overview of Electricity Price and Generation in 2020:
Alternative Updating Scenarios

	Benchmark	Alternative Updating Scenarios			
	Updating	**3 Year Delay**	**All Generation**	**Fossil & New Renewables**	**Fossil & Conservation**
Average Electricity Price (1999$/MWh)	69.3	69.7	69.5	69.3	69.3
Generation (billion kWh)					
Coal	2,650	2,581	2,636	2,630	2,639
Gas	836	915	835	843	811
Nuclear	784	762	785	777	788
Renewable	297	293	295	311	289
TOTAL	4,884	4,867	4,867	4,877	4,844

Overview of Electricity Price and Generation in 2020:
Alternative Updating Scenarios

- Relative to the benchmark updating case, the four alternative updating scenarios:
  - Have a slight effect on national average electricity price.
  - Lead to slight decreases in total generation.
- The three year delay weakens the incentive to expand generation because a discount rate is applied to the value of the allocation. Compared to the benchmark, a three year delay causes a slight increase in electricity price and decrease in total generation. Coal, nuclear, and renewables fall, while gas generation increases.
- The all generation scenario spreads the value of allowances among more generation sources including hydro and nuclear that dispatch near full capacity in the benchmark and have little ability to expand. So this scenario "waters down" the incentive to expand generation for other sources. Allocation to all generation causes a slight increase in electricity price and has a small negative effect on total generation.
- The addition of new renewables to the benchmark (fossil generation) scenario has almost no effect on electricity price. The incentive yields only a small increase in renewable generation. Gas generation also increases slightly, and coal and nuclear generation decrease slightly.
- The conservation scenario has almost no effect on electricity price, but it leads to a noticeable decrease in total generation because of reduction in demand funded through conservation measures.

Allowance Value and Pollution Control Costs:
Alternative Updating Scenarios

- NPV of pollution control costs range from 99% to 109% of total allowance value among the four alternative updating scenarios.
- Under the benchmark updating scenario pollution control costs are greater than result under historic or auction. The three year delay in updating allocation causes pollution control costs to fall almost to the level of the auction, to a magnitude that is less than the total value of allowances. Under the other three alternative updating scenarios, pollution control costs are slightly greater than the total value of allowances. Pollution control costs among the four alternative updating scenarios all fall within 5% of the benchmark pollution control costs. (The control costs do not include the cost of fuel switching.)
- Total allowance value varies by less than pollution control costs among scenarios. In the conservation case, consumers win less than 1% of the value of allowances that are allocated.

NPV Billion 1999$	Benchmark	Alternative Updating Scenarios			
	Updating	3 Year Delay	All Generation	Fossil & New Renewables	Fossil & Conservation
Pollution Control Costs*	64.6	61.8	65.4	64.3	65.5
Total Allowance Value*	61.6	62.4	60.0	63.0	63.0

*These measures should be interpreted with caution. Pollution Control Costs do not include the cost of fuel switching. Moreover, Total Allowance Value does not indicate whether the changes in electricity price under-compensate or over-compensate the industry.

Efficiency:

Economic Surplus as Difference from Benchmark Updating Case

The greatest improvement in economic efficiency, relative to the benchmark updating case, occurs under the fossil & conservation scenario. Consumers benefit at the expense of producers because conservation reduces marginal cost of electricity generation and electricity price in competitive regions. However, consumers benefit more than producers are harmed, and there is a net improvement in economic efficiency, because surplus is enhanced by achieving reductions from a previously untapped source – conservation – which yields initial reductions that are less expensive than marginal cost at other sources in the benchmark. Conservation has a large positive effect on consumer surplus and a relatively small negative effect on producer surplus, resulting in a positive effect on total economic surplus.

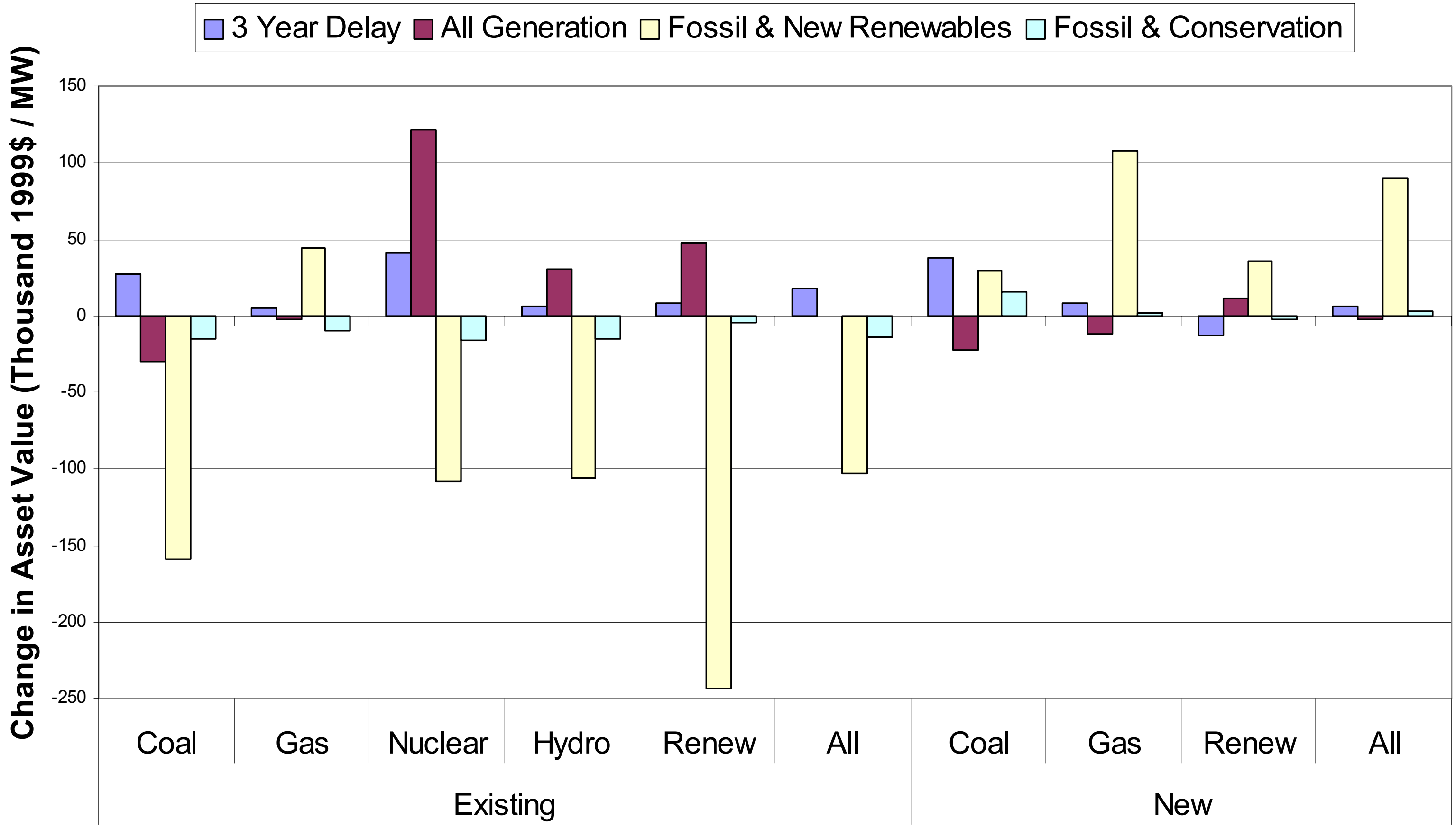
Relative to the benchmark updating case, the three year delay reduces total economic surplus substantially. Consumers, who benefit under updating due to lower electricity price, lose economic surplus when the effects of updating are discounted by the three year delay.

All generation and fossil & new renewables cases have a smaller positive effect on total surplus than the conservation scenario and remain less efficient than historic allocation. Only the conservation case improves (slightly) on historic.

(NPV Billion 1999$)	3 Year Delay			All Generation			Fossil & New Renewables			Fossil & Conservation		
	Com	**Reg**	**Nation**	**Com**	**Reg**	**Nation**	**Com**	**Reg**	**Nation**	**Com**	**Reg**	**Nation**
Consumer Surplus	-2.7	-14.9	-17.6	-1.6	0.4	-1.2	-0.1	0.4	0.3	7.9	1.1	9.4*
Producer Surplus	-0.5	3.8	3.4	1.5	2.5	4.0	1.3	0.3	1.7	-7.8	2.3	-5.5
Economic Surplus	-3.2	-11.1	-14.2	-0.1	2.9	2.8	1.2	0.7	2.0	0.1	3.4	3.8*

*Includes $360 million for the value of allowances allocated to households for conservation across the nation.

National Asset Value: Alternative Updating Scenarios
Change in NPV of Assets as Difference from Benchmark Updating Case



For comparison, under the benchmark updating case, the NPV of all existing assets in all regions is $345 (Thou. 1999$ / MW).

National Asset Value: The Difference from the Benchmark Updating Case
Alternative Updating Scenarios

- Relative to the benchmark updating case, the <u>three year delay</u> case has a small effect on most asset values:
  - Only new renewables experience a decrease in asset value.
  - Existing coal and nuclear and new coal experience the largest increases.
- The <u>all generation</u> scenario has positive effects on the value of non-emitting assets because they earn a share of allowances. It has a corresponding negative effect on emitting technologies, and has no overall effect relative to the benchmark.
- The <u>new renewables</u> scenario has large negative effects on most existing asset values, especially on existing renewables. Existing gas and all new technologies experience an increase in asset value.
- The <u>conservation</u> case never has a large effect on the asset values of specific technologies.
  - All existing technologies experience a small decrease in asset value.
  - New technologies experience a small increase in asset value.

Part 3: Concluding Observations
Alternative Updating Scenarios

- Choice of updating scenario has almost no effect on electricity price relative to the benchmark updating case.
- All four of the alternative updating scenarios result in slightly lower total generation relative to the benchmark updating case because the incentive for increased generation is weakened when additional generating units and demanders are eligible for permit allocations.
- Choice of updating scenario can have a significant effect on the size and distribution of economic surplus relative to the benchmark updating case:
  - The allocation to fossil generators & conservation leads to the greatest increase in economic surplus relative to the central updating case due to the emission reductions from conservation that come from a previously untapped source. Also, electricity price is reduced slightly in competitive regions, leading to a gain for consumers at the expense of producers. This is the only updating case that improves (slightly) on historic allocation.
  - When additional generation is eligible for allowances (all generation case and fossil & new renewables case) the effects on economic surplus are also positive compared to the central updating case.
  - A three year delay in allocation leads to a loss in economic surplus, most of which comes from a loss in consumer surplus.
- Choice of updating scenario will effect asset values relative to the benchmark updating case:
  - Allocation to all generators lowers the asset values of all emitters which received a larger share of the allowances under the benchmark.
  - Allocation to new renewables increases the asset value of all new assets at the expense of existing asset values (except gas).
  - The three year delay and the conservation scenarios have small effects compared to the benchmark.