Potential Effects of Proposed Climate Change Policies on PJM's Energy Market

Energy, Environmental Policy, and the Recession:
Impacts of Proposed Federal Policies
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Paul M. Sotkiewicz, Ph.D.,
Senior Economist
PJM Interconnection, L.L.C.

Background

- Almost a dozen bills plus additional proposals to address climate change in the 110th Congress plus the Waxman-Markey draft in the 111th Congress
- Most proposals are cap-and-trade, but details matter
  - Emissions targets, both in level and timing
  - Safety valve prices
  - Ability to use offsets and the source of allowed offsets
- In either tax or cap-and-trade, the price of CO_2 will be permitted in generation supply offers
  - In the same fashion as with SO_2 and NO_x

Purpose

- Inform members, regulators, policymakers, and other interested parties about the range of potential outcomes under different scenarios
- Outcomes of interest:
  - LMP
  - Wholesale power costs and consumer bills
  - Generation mix (by fuel type) and emissions reductions
- Scenarios of interest:
  - Natural gas prices
  - Varying levels of load for energy to account for potential efficiency measures
  - Wind power penetration

Analysis Strategy

- Use models and data used for market efficiency analysis done for 2007 RTEP and focus on 2013.
- Use a CO_2 price adder as a proxy for outcomes of different policy variants
- Use a consistent set of assumptions (including CO_2 prices) to isolate effects of
  - Gas prices and CO_2 prices
  - Different reduction levels in energy for load
  - Wind power penetration

Cost of CO_2 Reduction Through Re-Dispatch

- By 2013, the most likely source of emissions reductions outside of increasing energy efficiency or building new renewable resources will be through re-dispatch from coal to combined cycle gas.
- The CO_2 price at which combined cycle gas would be dispatched ahead of coal will depend on the spread between coal and gas prices as well as the relative thermal efficiencies of the technologies.
  - And thus the CO_2 price determines the emissions reductions and generation mix.

Cost of CO_2 Reduction Through Re-Dispatch

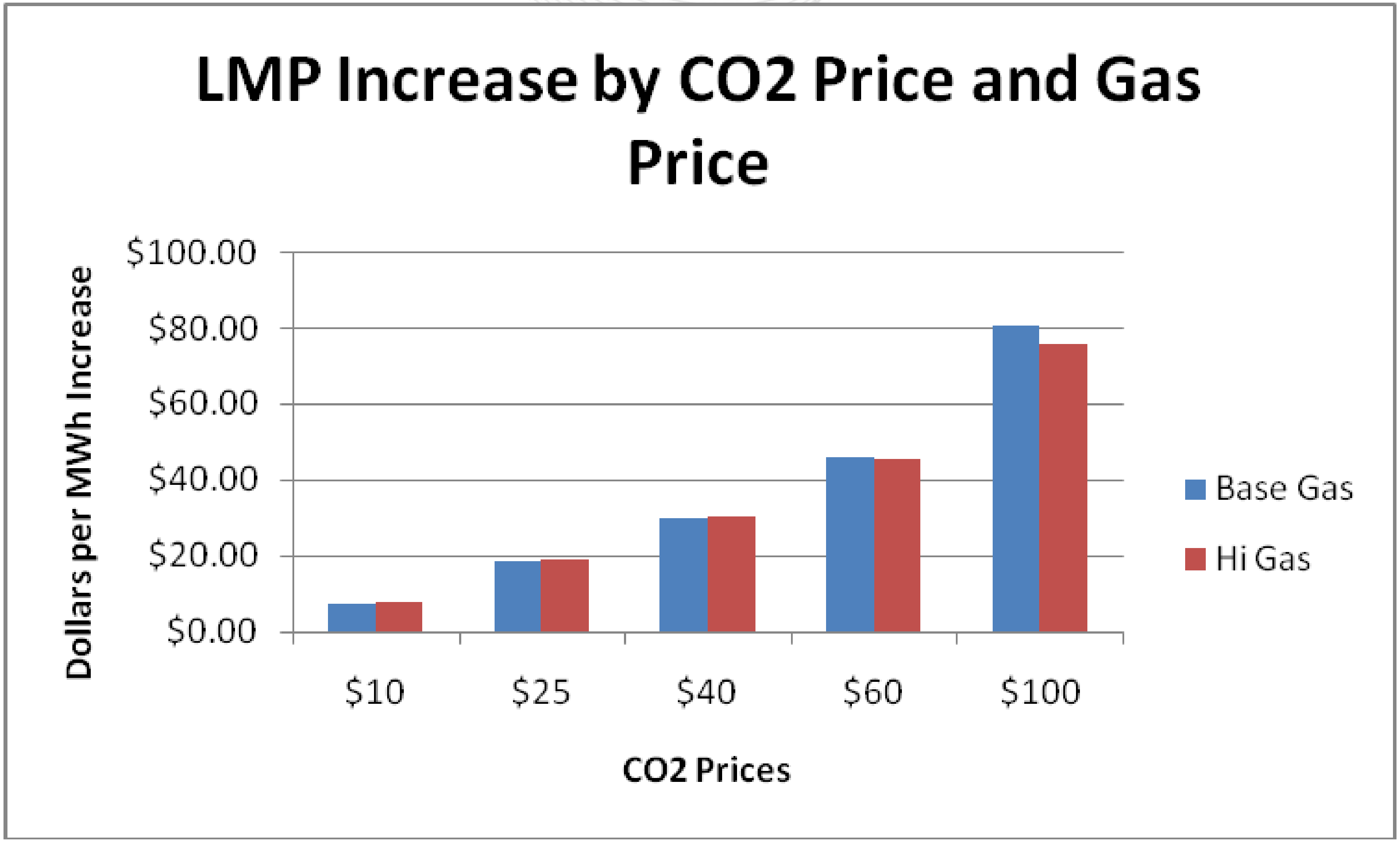
Marginal Cost of Abatement ($/short ton)
Re-dispatch from Coal (10 mmBtu/MWh) to Gas
Combined Cycle (7 mmBtu/MWh)

		Gas price ($/mmBtu)		
Region	Coal Price ($/mmBtu)	$3.60 (Recent)	$6.44 (Base)	$10.00 (High)
Mid-Atl	$2.30	**$3.57**	**$35.80**	**$76.21**
ComEd	$1.54	**$15.89**	**$48.13**	**$88.53**
West	$1.97	**$8.92**	**$41.15**	**$81.56**
South	$2.43	**$1.46**	**$33.69**	**$74.10**

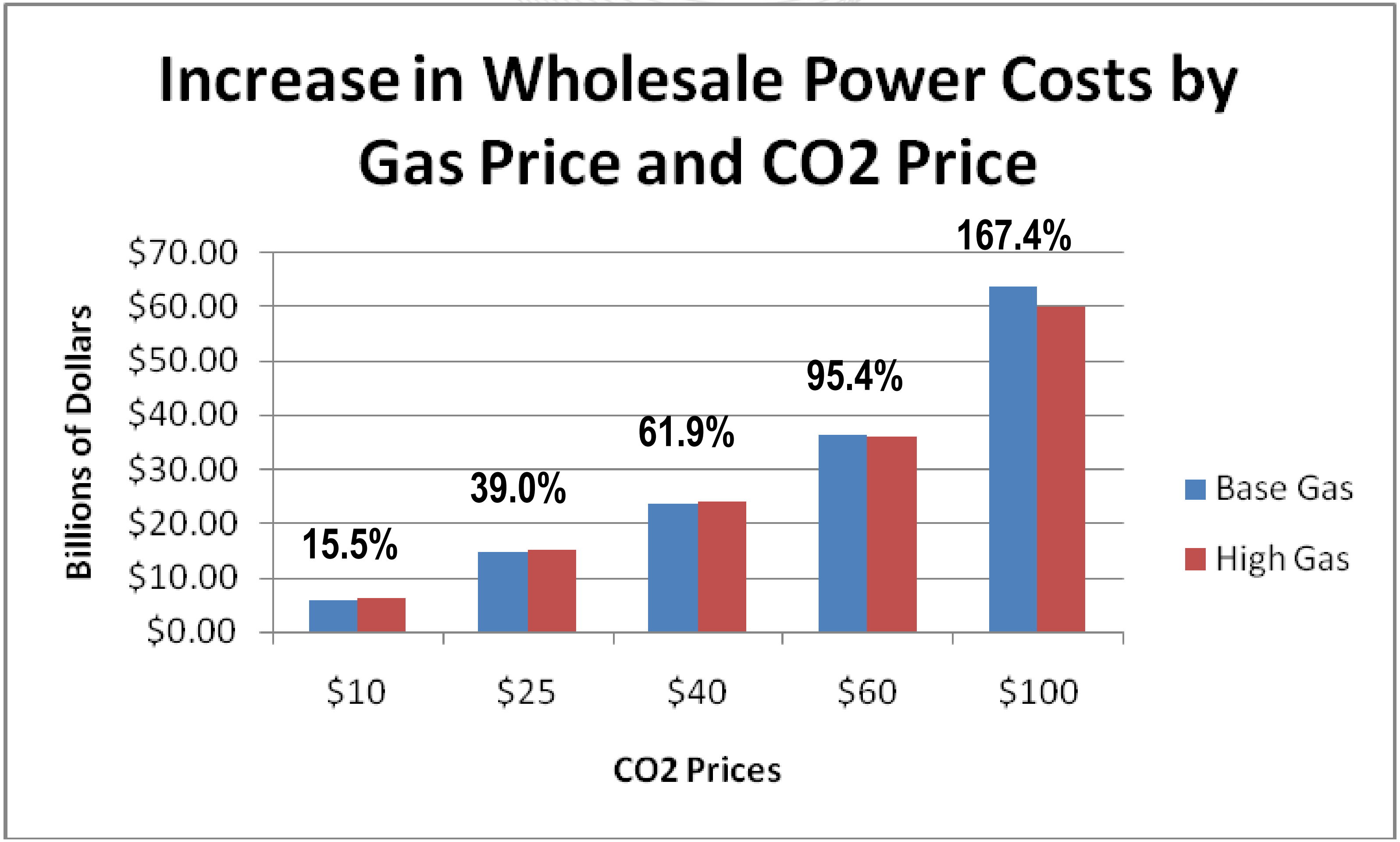
Change in Load-Weighted Average LMP

- For every \$10/ton increase in the price of CO_2 the load-weighted average LMP increase between \$7.50/MWh to \$8.00/MWh
  - 75-80 percent of the CO_2 price appears as the increase in LMP
- Why? Some intuition
  - Coal has an emission rate of just over 1 ton/MWh and is currently on the margin in 70% of hours and remains on the margin almost as many hours
  - Coal capacity is almost three times greater than combined cycle capacity, so even at high CO_2 prices coal is required to meet load and is often on the margin

Change in Load-Weighted Average LMP



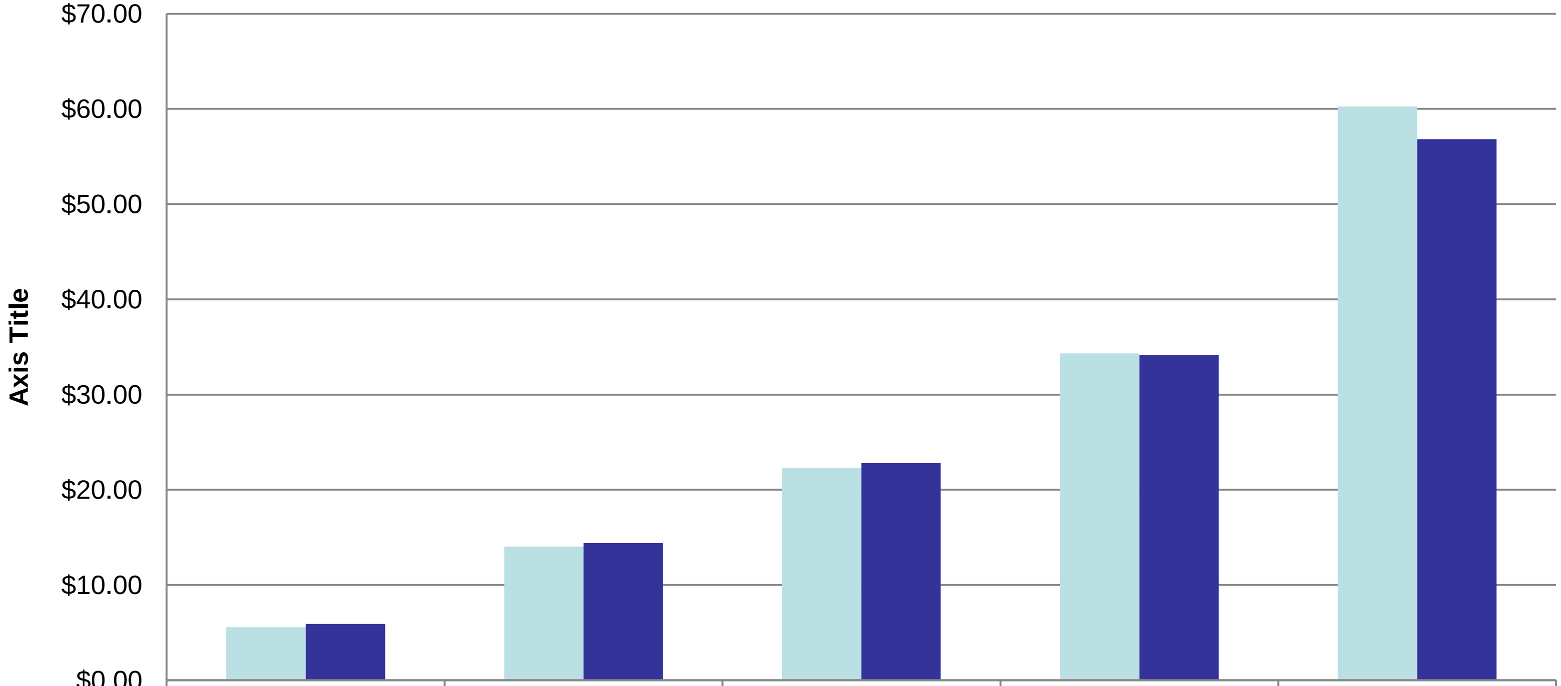
Change in Wholesale Power Costs



Percentages are increase for the base gas case.

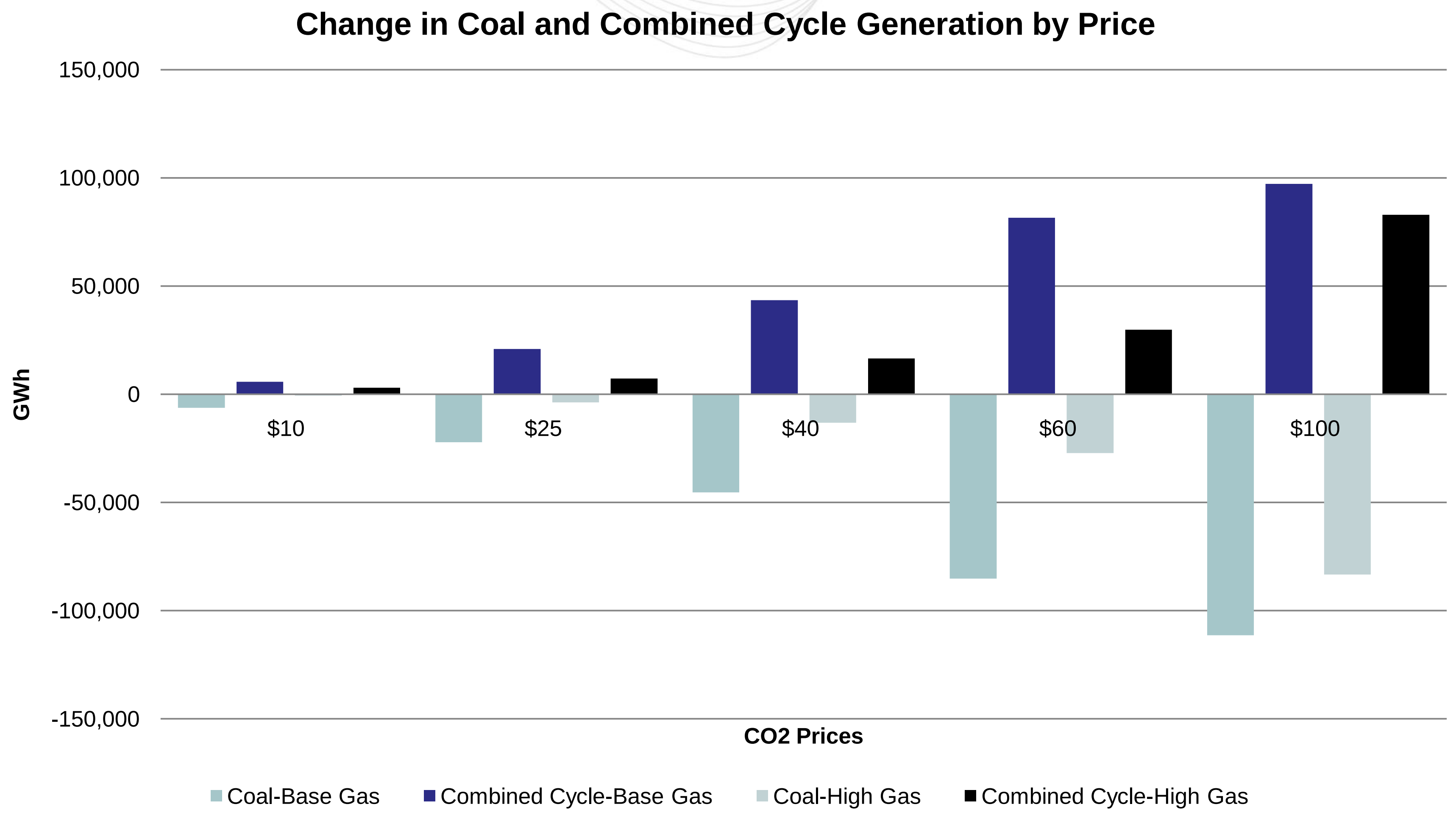
Potential Consumer Bill Impacts

Increase in Monthly Bill of a Residential Customer Using 750 kWh

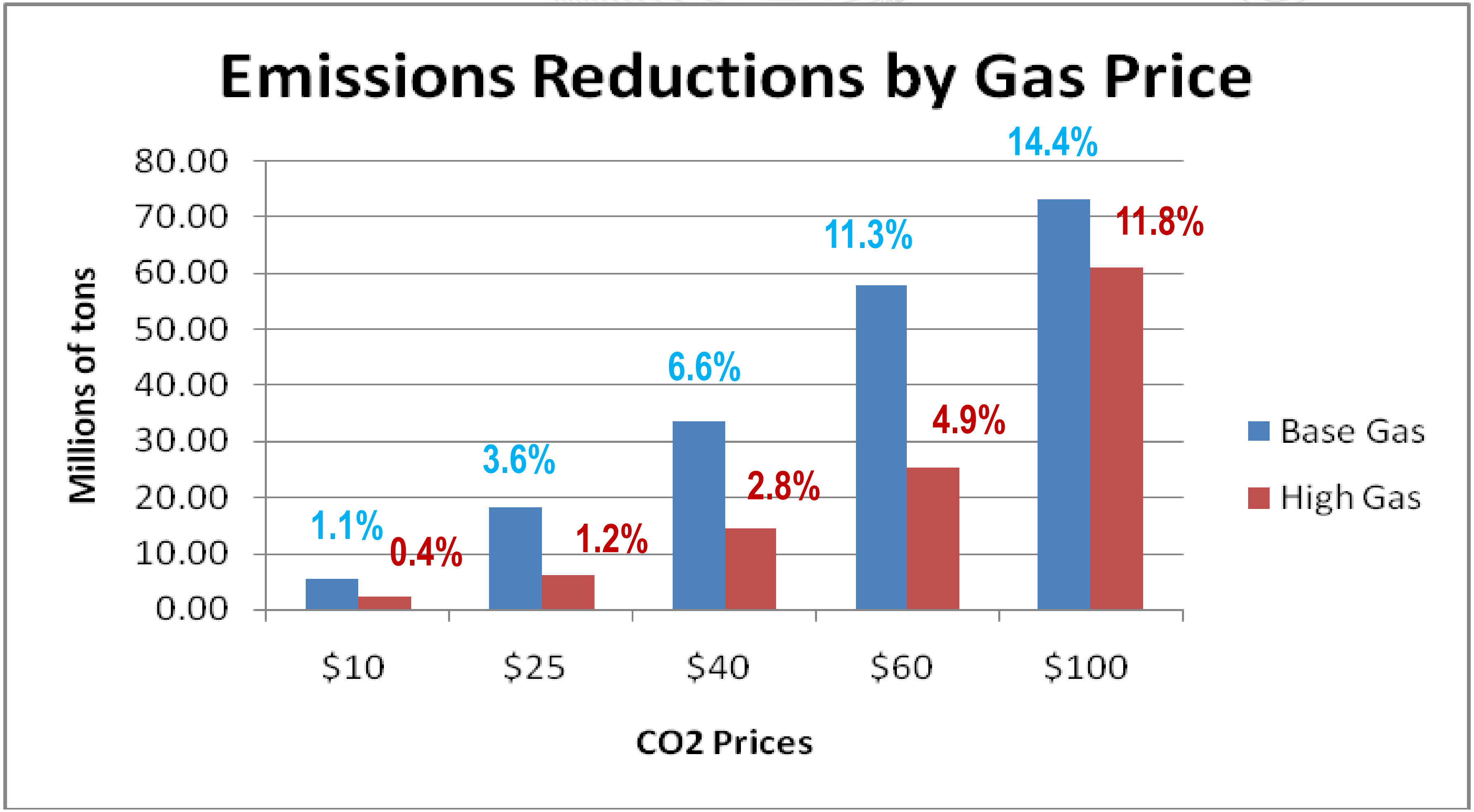


	$10	$25	$40	$60	$100
Base Gas	$5.58	$14.03	$22.28	$34.34	$60.26
High Gas	$5.90	$14.42	$22.82	$34.16	$56.83

Change in Generation Mix



Emissions Reductions



Percent and absolute reductions from 2013 baseline

Effects of Demand (Load for Energy) Reductions

- Actions that can reduce energy consumption can be related to energy efficiency and some types of demand response activities.
- In terms of LMP, there should be a reduction due to being lower on the supply stack, all else equal.
- In terms of wholesale power costs, reduction in consumption and LMP.
- Also a displacement of generation in total and consequently emissions as well.

Reductions in Demand (Load for Energy)

Demand (Load for Energy) Scenarios in GWh for 2013

Forecast Demand	Forecast minus 2%	Forecast minus 5%	Forecast minus 10%
789,270	773,495	750,141	710,383

- The reductions in demand were uniform reductions in consumption over all hours, including the peak hours, and across all locations.
- Effectively shifting down the entire load profile by 2%, 5%, and 10%

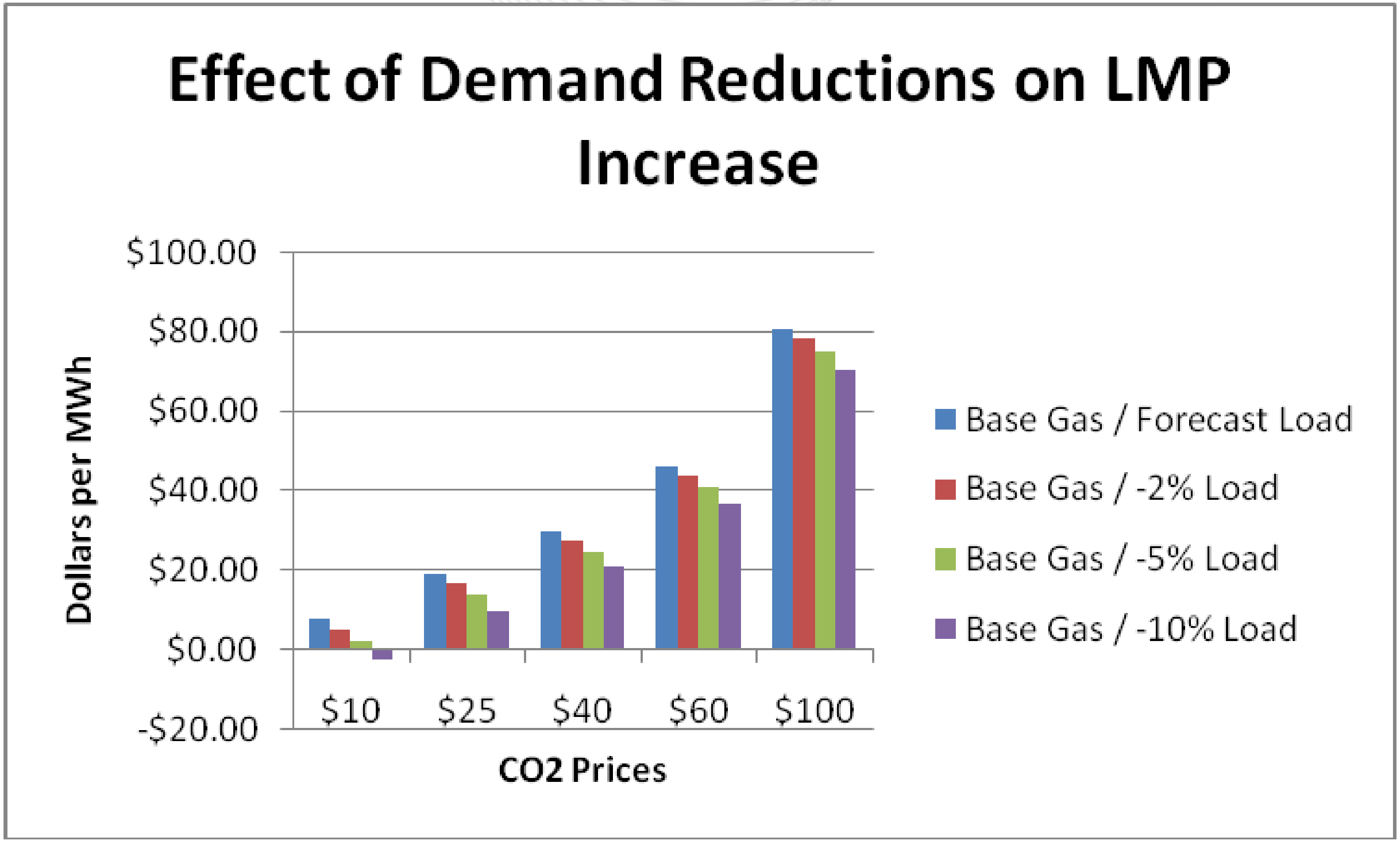
- Keep in mind these forecast did not account for the recent downturn. The 2013 forecast from January 2009 is about 1.33% less than used here.

Demand Reductions Mitigate Price and Cost Increases

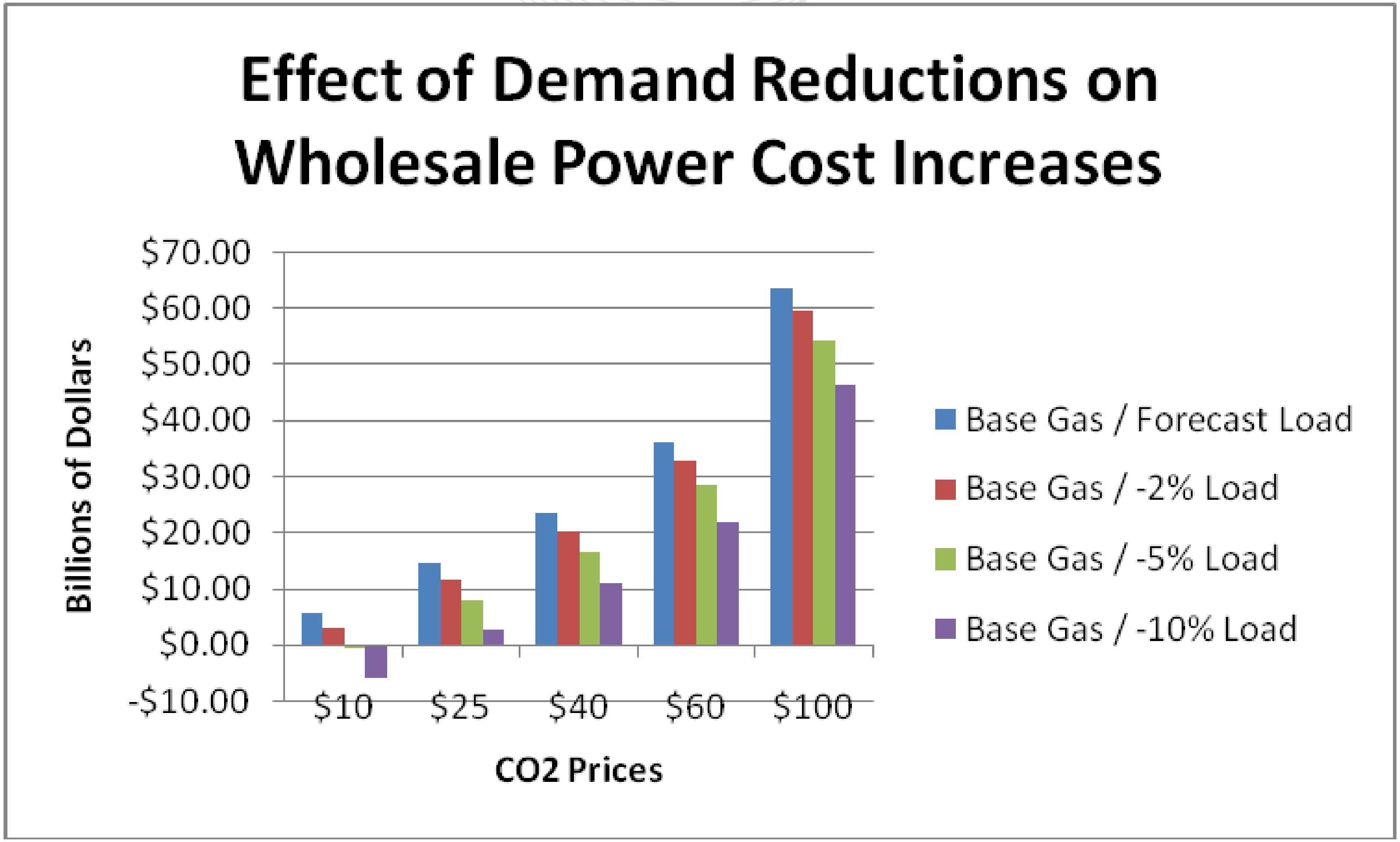
Amounts by Which Price and Cost Increases are Mitigated			
	Load Reduction Percentage		
	2%	**5%**	**10%**
LMP ($/MWh)	$2-$4 per MWh	$5-$9 per MWh	$11-$17 per MWh
Wholesale Power Cost	$3-$4 billion	$6-$11 billion	$10-$18 billion
Consumer Bill	$1-$3 monthly	$4-$6.50 monthly	$7-$12.50 monthly

- Amount depends upon gas and CO_2 prices. Savings are generally greater in the high gas price case.
- Consumer bill savings only reflects change in price as consumption is assumed to stay at 750 kWh/month.

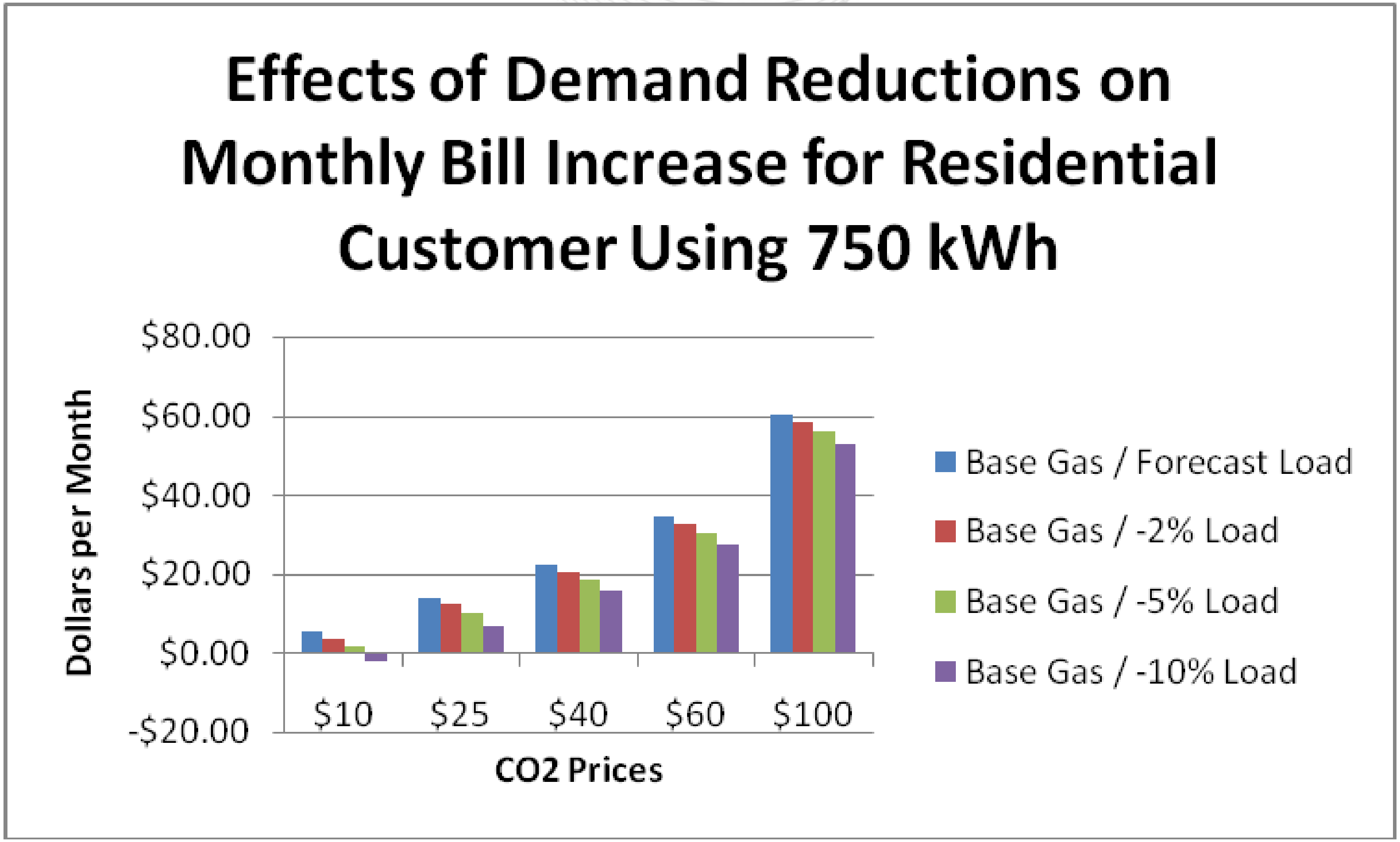
Effect of Demand Reductions on LMP



Effect of Demand Reduction on Wholesale Power Costs



Effect of Demand Reduction on a Representative Customer Bill

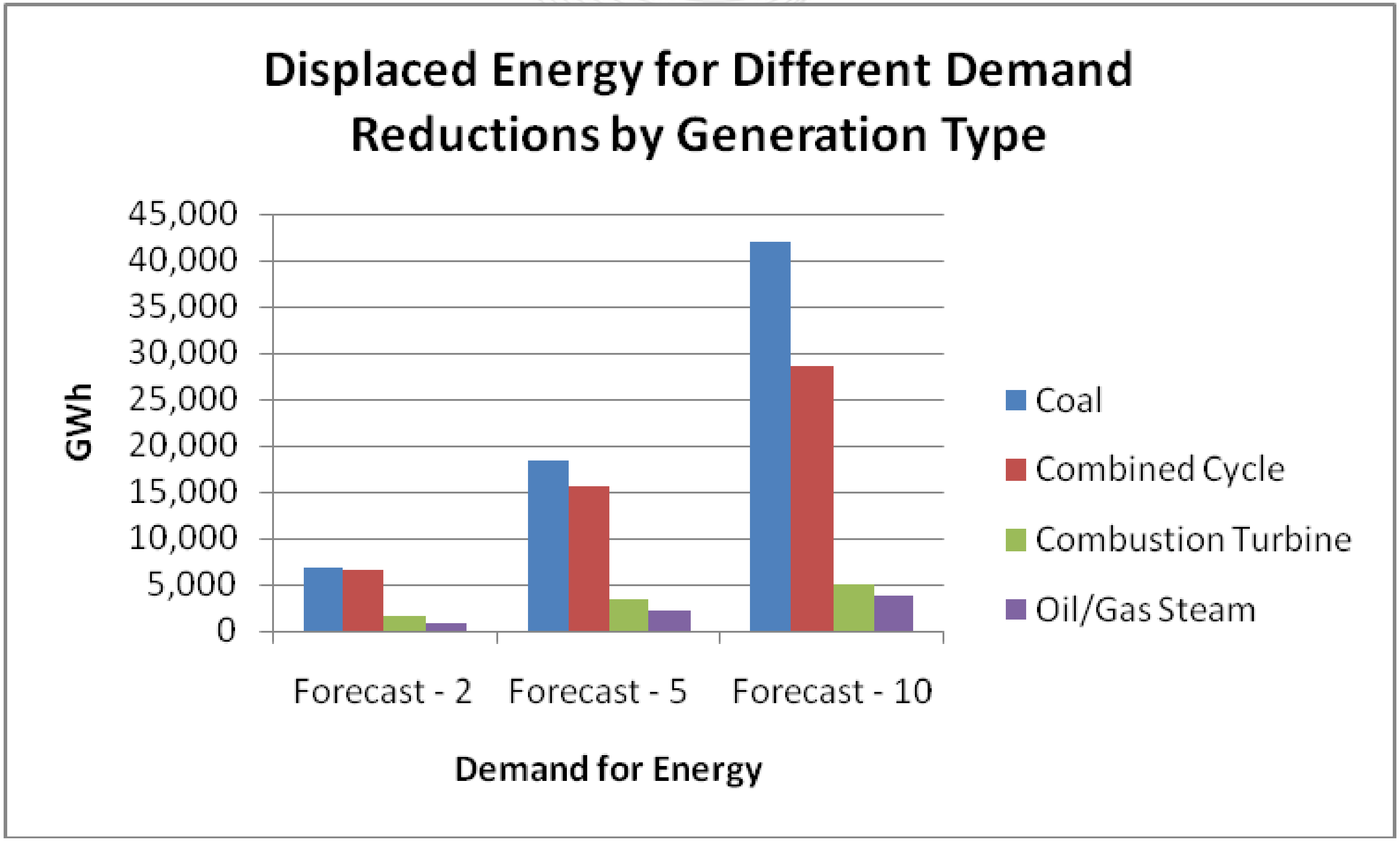


Demand Reductions Displace Generation and Reduce Emissions

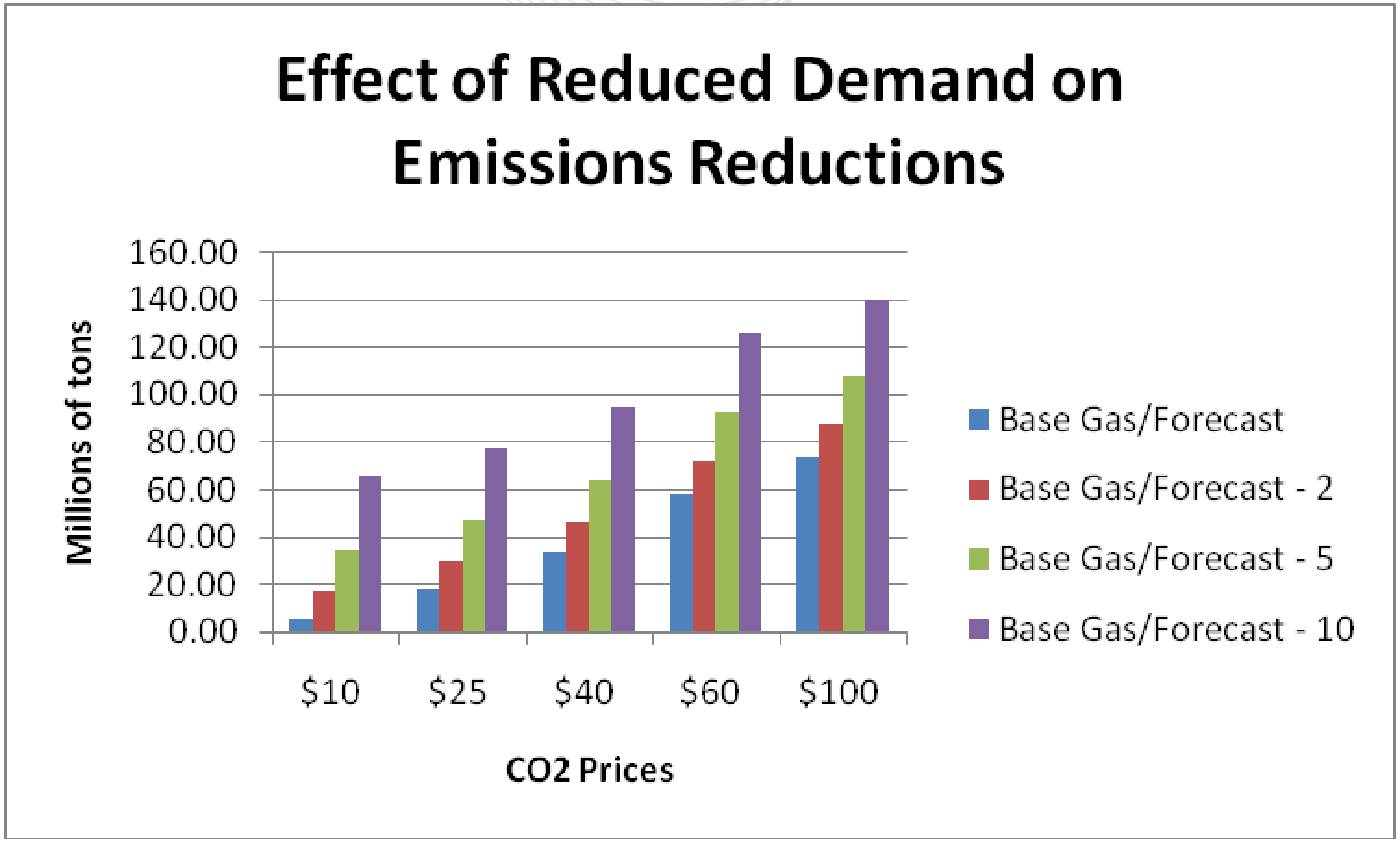
Amounts by Which Generation is Displaced and Additional Emissions Reductions Achieved			
	Load Reduction Percentage		
	2%	**5%**	**10%**
Coal	6,741 GWh	18,376 GWh	41,972 GWh
Combined Cycle Gas	6,555 GWh	15,685 GWh	28,587 GWh
Additional CO_2 Reductions (tons)	10-14 million	29-34 million	58-64 million

- Displaced generation is at a $0 CO_2 price in the base gas case. High gas case numbers are comparable.
- Additional CO_2 reductions depend on gas price and CO_2 price.

Demand Reductions Displace Generation



Demand Reductions Enhance Emissions Reductions



Adding 15,000 MW of Wind Mitigates Price and Cost Increases

Amounts by Which Price and Cost Increases are Mitigated	
	15,000 MW Wind
LMP ($/MWh)	$5-$5.50 per MWh
Wholesale Power Cost	$4-$4.5 billion
Consumer Bill	$3.50-$4 monthly

- Wind additions were only run in the base gas case
- Exact amount depends on the CO_2 price

Adding 15,000 MW of Wind Displaces Generation and Reduces Emissions

Amounts by Which Generation is Displaced and Additional Emissions Reductions Achieved	
	15,000 MW Wind
Coal	26,303 GWh
Combined Cycle Gas	13,009 GWh
Additional CO_2 Reductions (tons)	34-37 million

- Displaced generation is at a $0 CO_2 price in the base gas case only.
- Additional CO_2 reductions depend on CO_2 price.

Conclusions

- Load-weighted average LMP increases by about 75-80% of the CO_2 price in short tons.
  - With the associated increase in wholesale power costs and customer bills
- Re-dispatch of combined cycle gas ahead of coal on a large scale (and associated emissions reductions) only occurs at
  - Approximately $40/ton in the base gas case ($6.44/mmBtu)
  - Approximately $80/ton in the high gas case ($10/mmBtu)
- Penetration of actions that reduce consumption and wind power have mitigating effects on LMP, wholesale power costs, and customer bills while enhancing emissions reductions
  - Displaces emitting resources with non-emitting resources/actions.