The Economic of Existing Coal-Fired Power Plants

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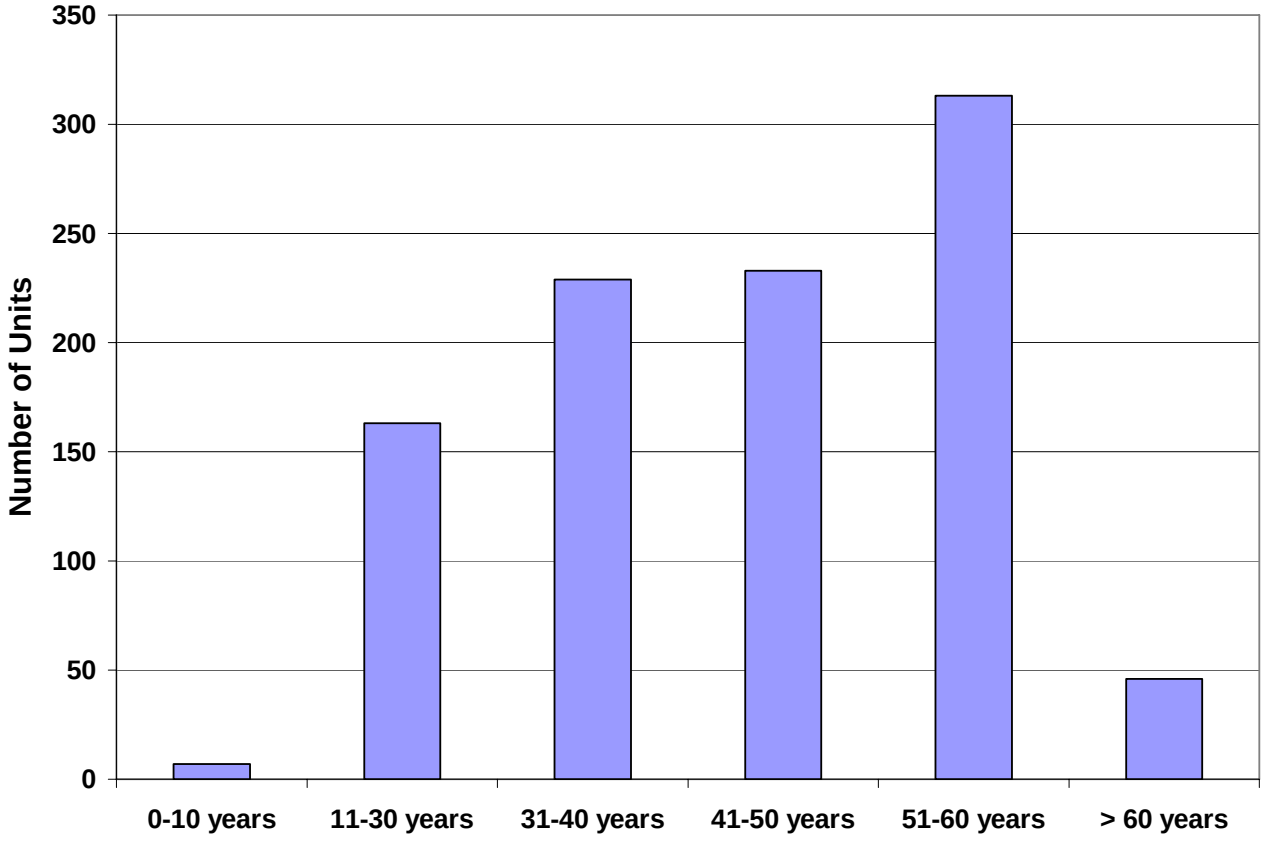
Key Takeaways

- **Many units around the nation are at-risk for early retirement in near- and mid-term.**
- **Existing U.S. coal fleet is aging and almost half of the units are uncontrolled for NOx or SO_2.**
- **Retirement/repowering appear to be lower cost/lower risk options than adding controls.**
- **Large coal plant owning utilities are starting to take steps to retire their older, unscrubbed units.**
- **Carbon capture and sequestration (CCS) unlikely to extend lives of many, if any, existing coal-fired units.**

Existing U.S. Coal Fleet is Aging



- **83 percent of units already 30 years or older.**
- **60 percent of units already 40 years or older**

Many Existing U.S. Coal Units Don't Have SO_2 and/or NO_x Controls

- **Only 41% of existing units have scrubbers**
- **Only 36% of existing units have SCR or SNCR NO_x controls**
- **48% of existing units are uncontrolled for either SO_2 or NO_x**
  - **Approximately 30% of units under 40 years old are uncontrolled and 60% of units over 40 years old**

Source: M.J. Bradley/Analysis Group, *Ensuring a Clean, Modern Electric Generating Fleet While Maintaining Electric System Reliability*, August 2010

Main Economic Risks for Existing Coal-Fired Power Plants (1)

1. **Potential for more stringent regulation of criteria pollutants.**
2. **Need for large capital expenditures on scrubbers and other emissions control projects and/or replacing other major plant components (e.g., turbine or generator).**
3. **Uncertainty of cost recovery for large capital expenditures.**
4. **Displacement by gas-fired capacity due to low natural gas prices.**
5. **Uncertainty in the costs of complying with greenhouse gas regulations.**

Main Economic Risks for Existing Coal-Fired Power Plants (2)

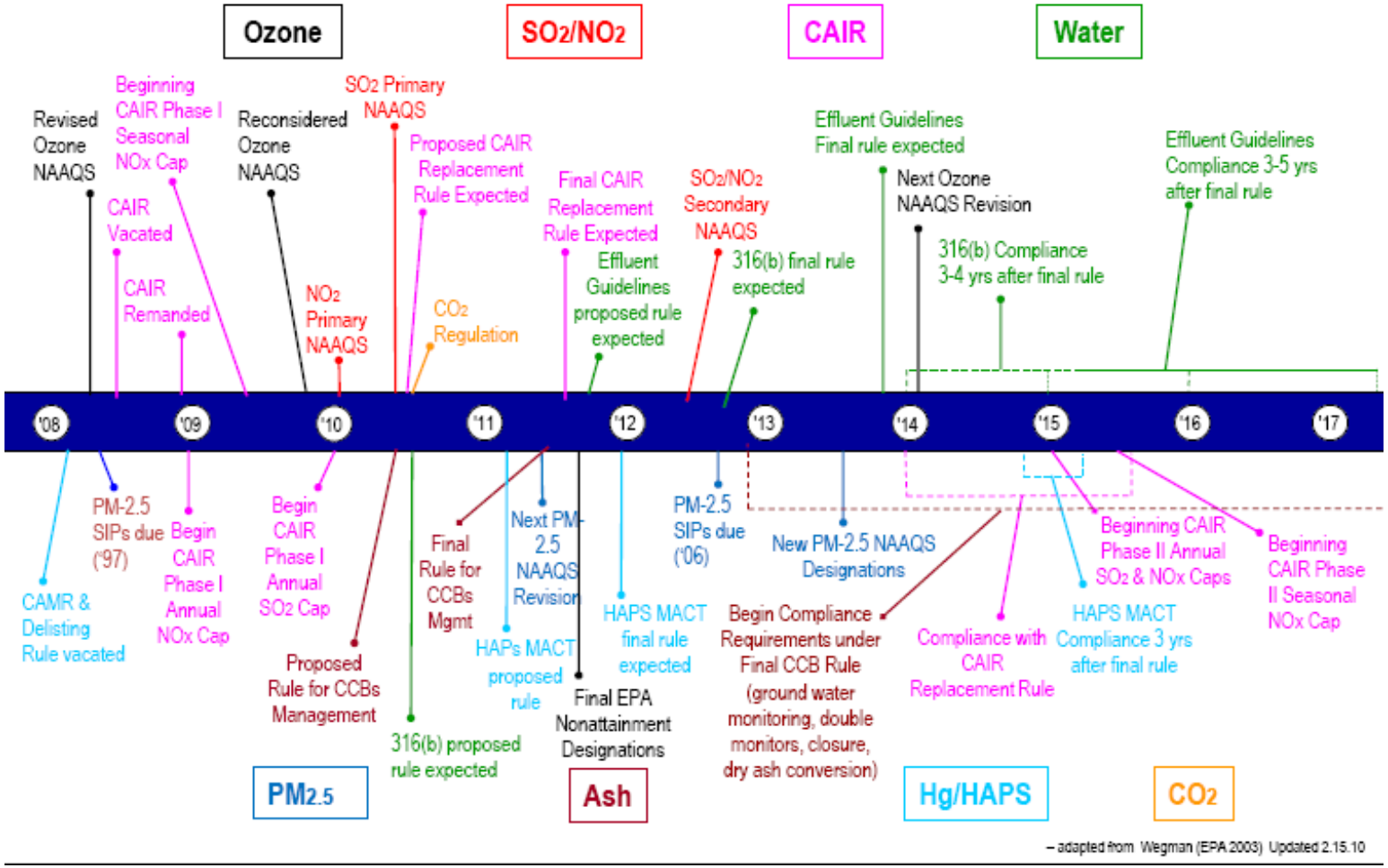
6. **Reduced need for capacity and/or energy due to economy, energy efficiency or renewable resources.**
7. **Pending coal ash regulation and/or litigation.**
8. **Declining performance as units age (higher heat rate, higher forced outage rate, lower availability and equivalent availability) and higher plant operating costs.**
9. **Coal price and supply uncertainty – reduced produced in CAPP, increased exports, increased demand for PRB coal.**
10. **Water issues – including potential cost of converting to closed-cycle cooling.**

Pending Environmental Regulations

- **American Electric Power**

“Cumulative effects of EPA proposed rules and carbon legislation/regulation are a major concern for utility resource planning”

Possible Timeline for Environmental Regulations

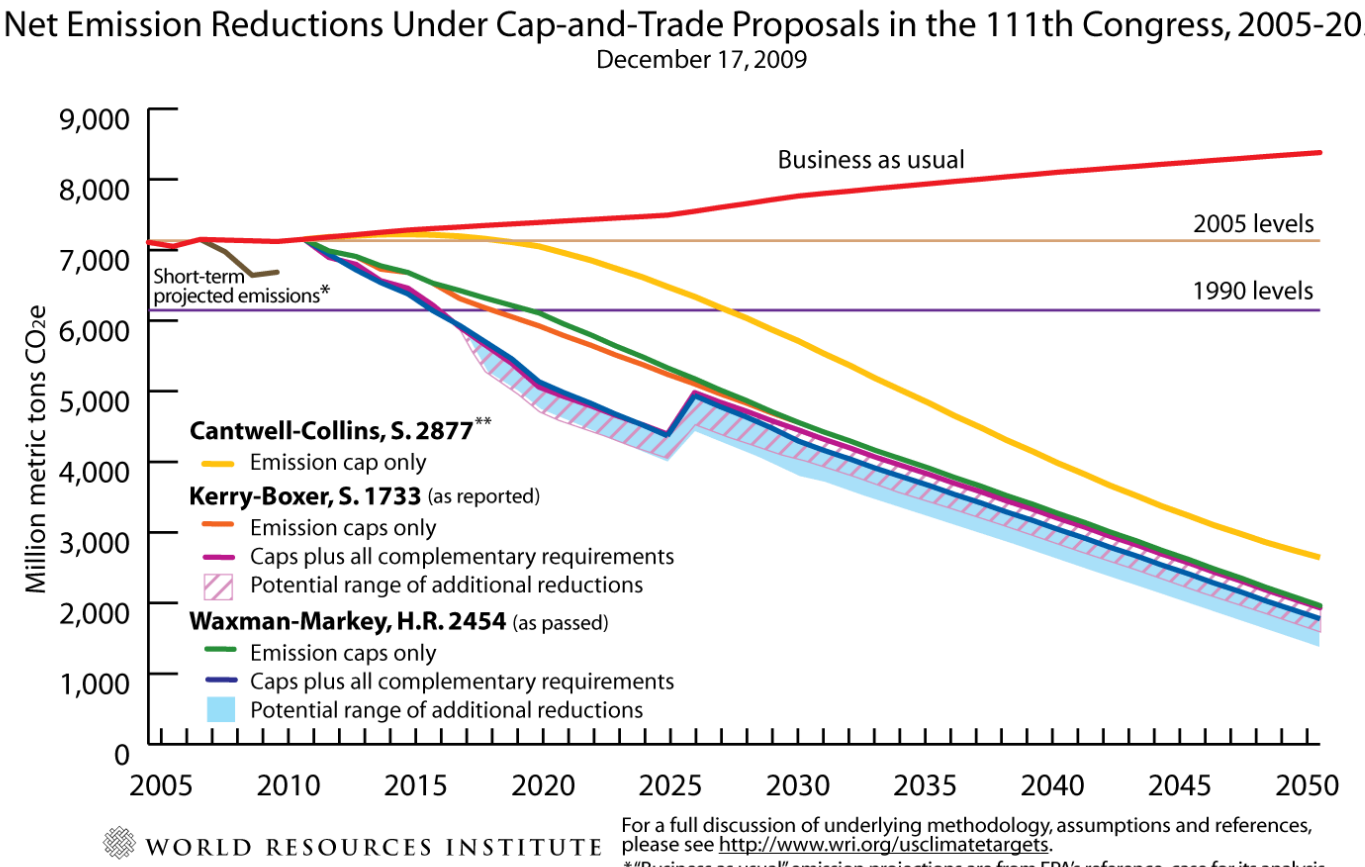


Source: *Economic Impacts of Coal*, Statement of the Edison Electric Institute to the Congressional Caucus on Coal, May 25, 2010

Regulation of Greenhouse Gas Emissions

- **Timing for comprehensive federal legislation uncertain.**
- **But goal remains the same – 80% reductions by 2050.**
- **EPA set to regulate CO_2 under the Clean Air Act.**

GHG Regulation - The Goal

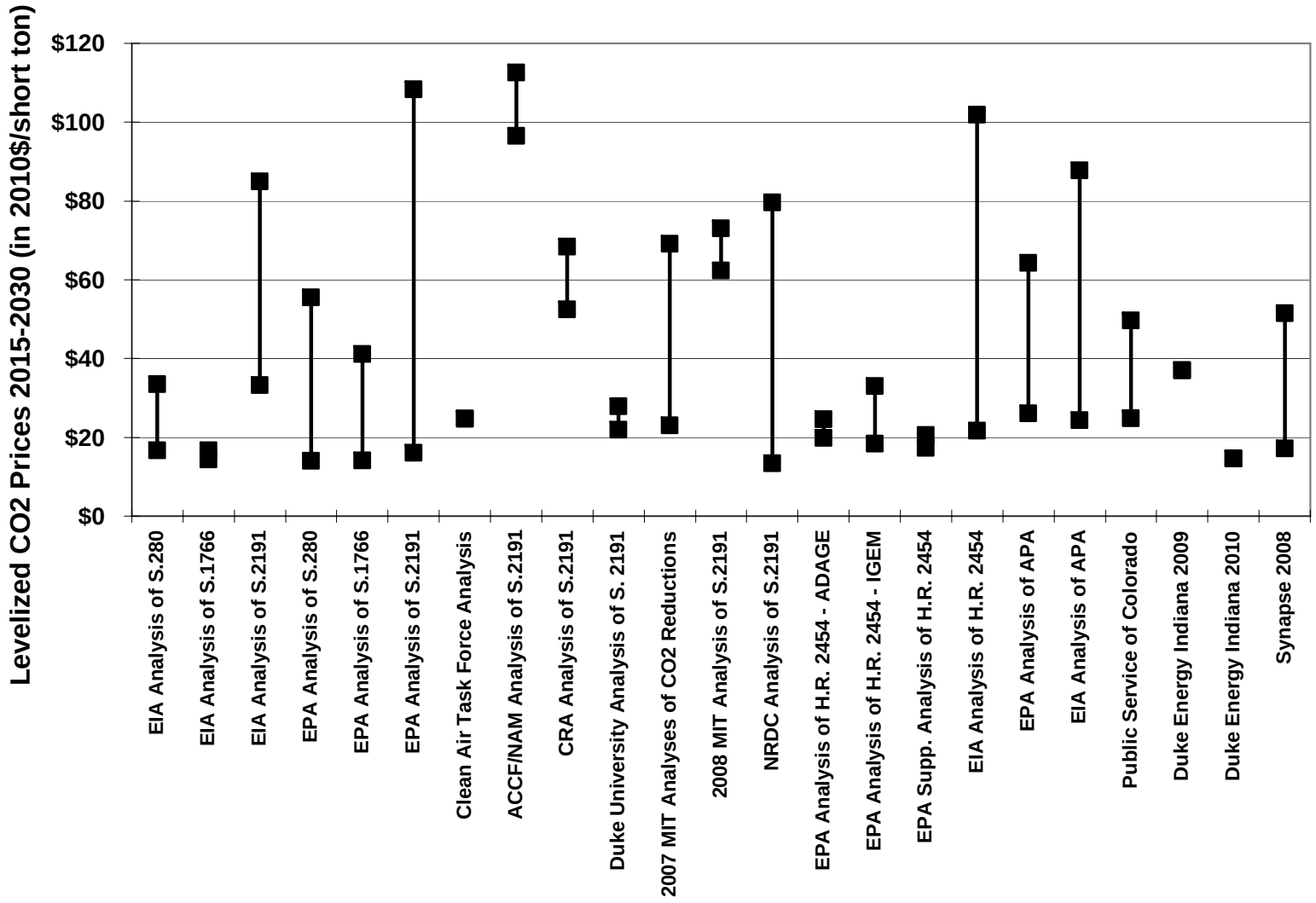


For a full discussion of underlying methodology, assumptions and references, please see http://www.wri.org/usclimatetargets.

*"Business as usual" emission projections are from EPA's reference case for its analysis of the Waxman-Markey bill. "Short-term projected emissions" represent EIA's most recent estimates of emissions for 2008-2010.

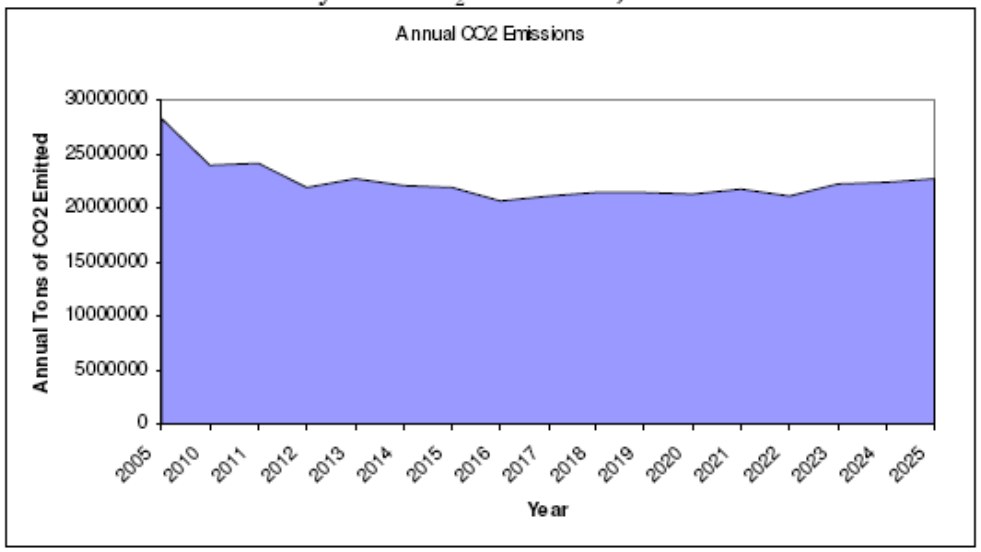
** Cantwell-Collins sets economy-wide reduction targets beginning with a 20 percent reduction from 2005 levels by 2020. However, additional action by Congress would be required before these targets could be met. Reduction estimates do not include emissions above the cap that could occur due to the safety-valve.

Due to Uncertainties Need to Look at Range of CO_2 Prices in Resource Planning

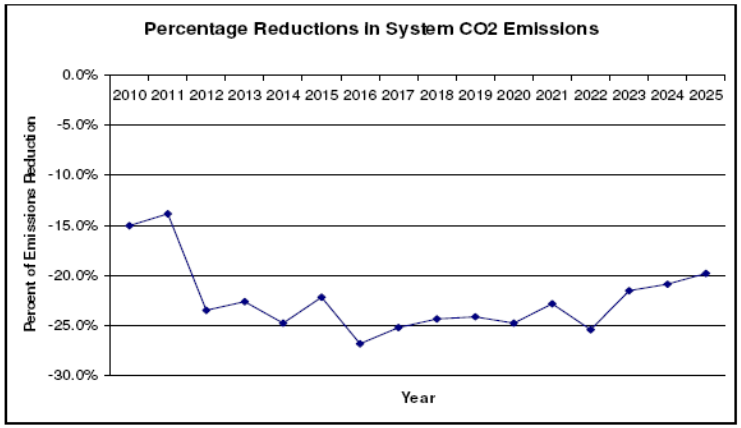


Example of Company with a Plan to Actually Reduce Future CO_2 Emissions – Xcel Energy

NSP System CO_2 Emissions, 2010-2025



Percentage Reductions in NSP System CO_2 Reductions over 2005 Baseline, 2010-2025



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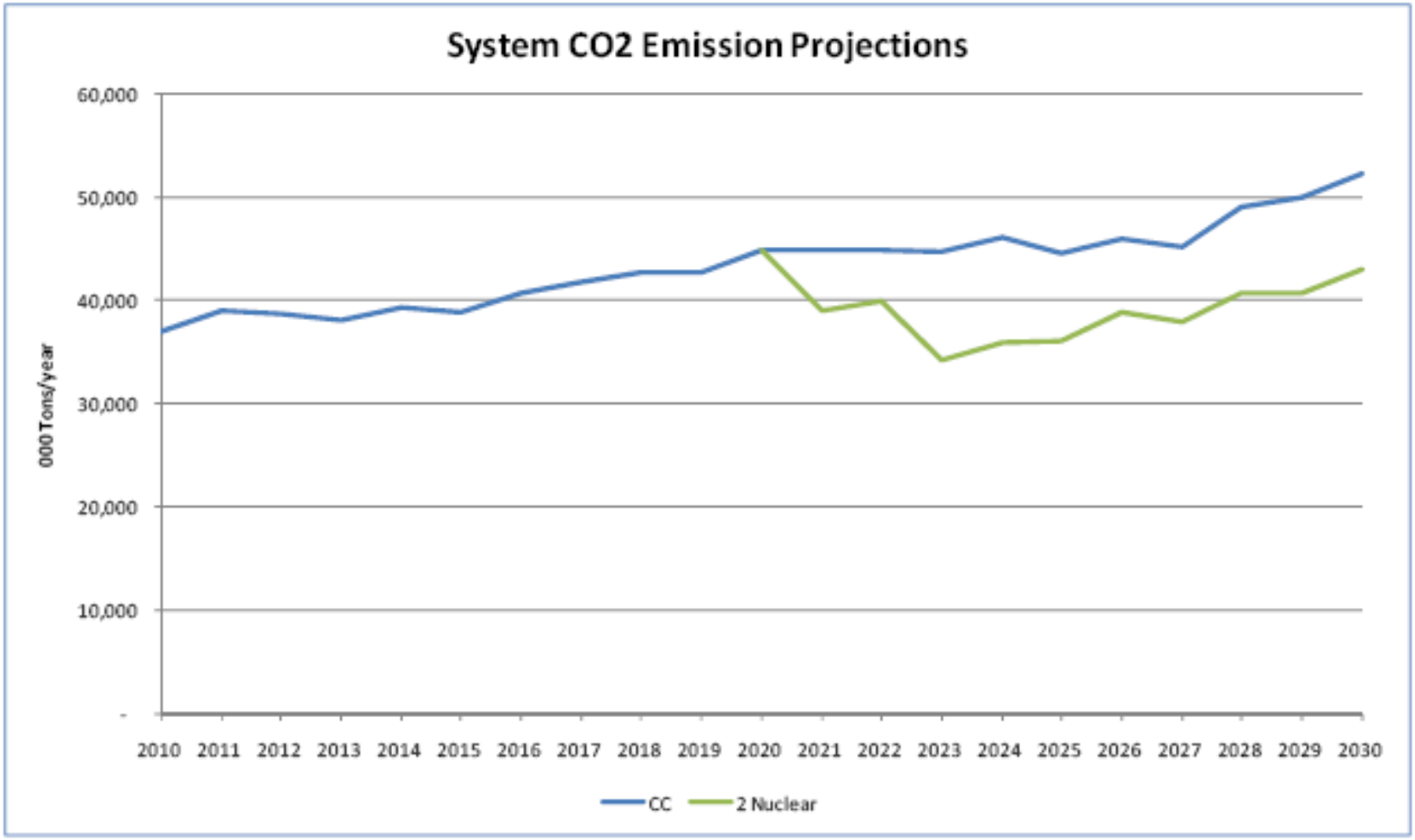
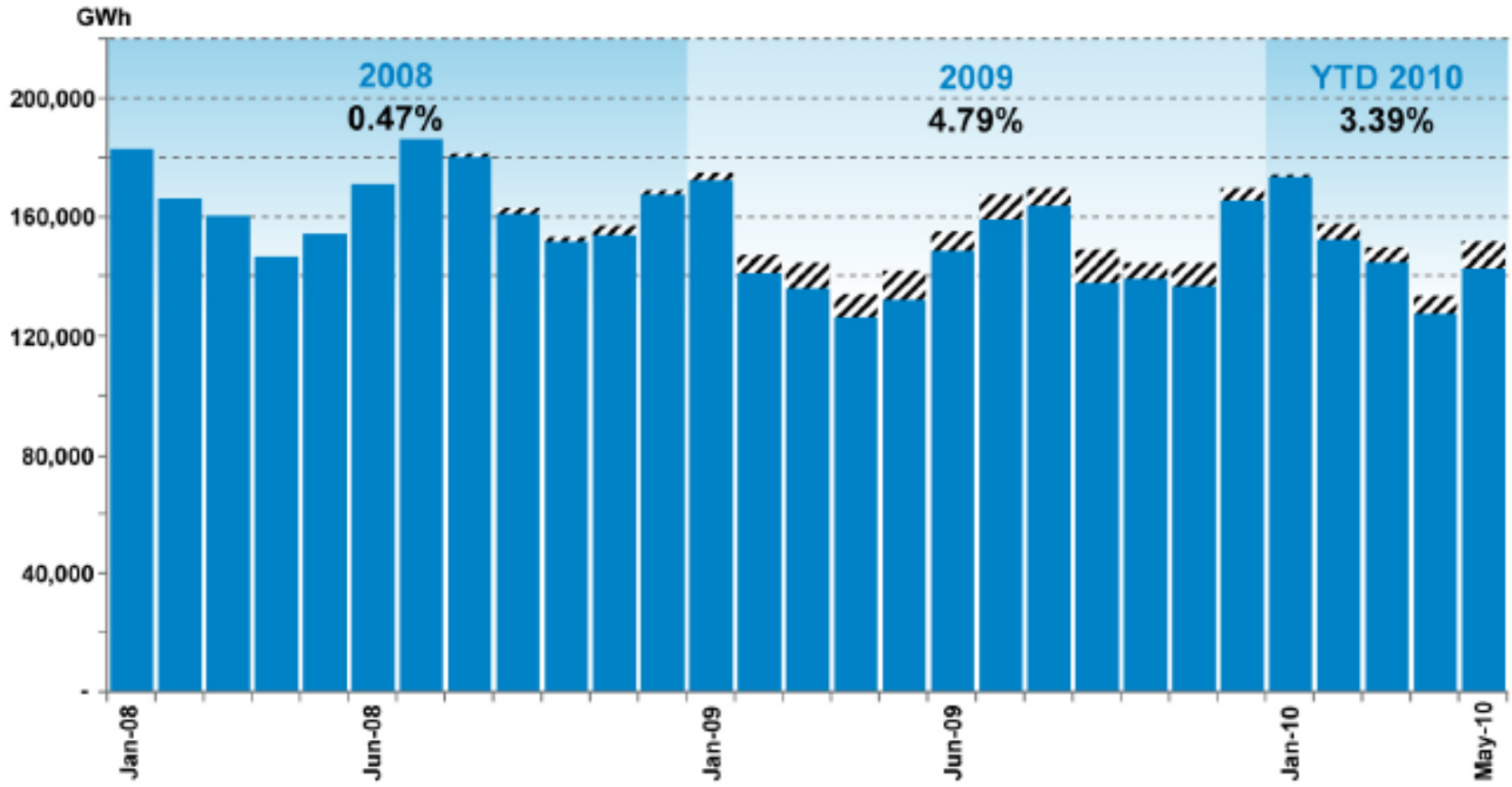
Example of Company That Does Not Appear to Have a Plan to Actually Reduce Future CO_2 Emissions – Duke Energy



Coal Generation "At-Risk" of Being Displaced by Natural Gas

- **Coal generation increasingly displaced by dispatching of natural gas units – especially in Southeast and PJM.**
- **Natural gas prices expected to stay low for foreseeable future.**
- **Existing gas-fired units have significant untapped power production potential – NGCC can run at 60%-70% capacity factors but actually operate far less.**

Coal Generation Displaced by Gas



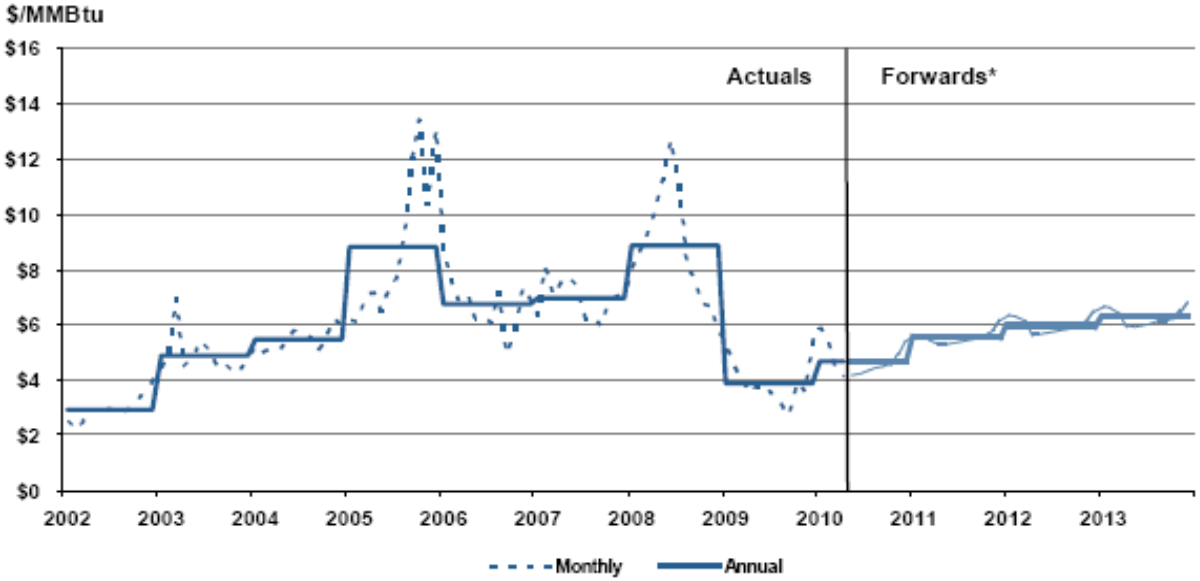
Source – Natural Gas Supply Association assessment on data from Energy Ventures Analysis

Gas Prices Expected to Remain Relatively Low for Foreseeable Future

- **Natural gas prices expected to remain low for foreseeable future – some predict as long as 12 years.**
- **Example from recent First Energy presentation to security ana**

Power Markets Update and Trends

Natural Gas



* New York Mercantile Exchange Henry Hub Forwards 10-day exponential moving average with most recent trade date from April 22, 2010.

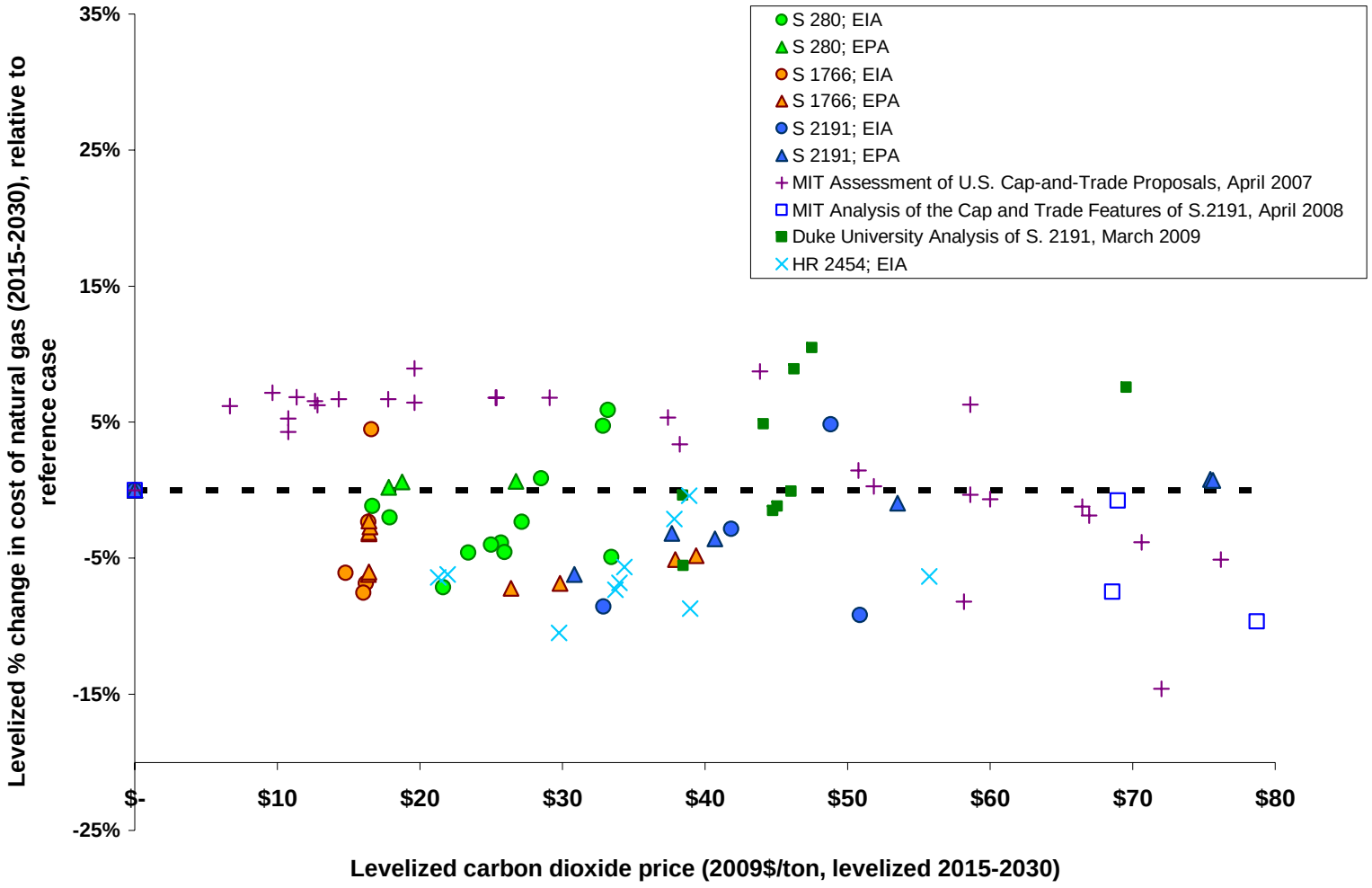
Under-utilized Natural Gas Capacity in the U.S.

Capacity Factor %

Census Region	Weighted Average Capacity Factor									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
New England	40.6%	44.2%	45.5%	46.4%	47.0%	49.1%	51.2%	52.2%	49.4%	48.6%
Middle Atlantic	57.0%	52.9%	39.3%	26.6%	24.1%	23.8%	27.0%	33.1%	33.8%	39.8%
East North Central	47.9%	24.7%	22.4%	14.2%	15.3%	17.0%	15.7%	19.9%	14.1%	14.8%
West North Central	18.0%	16.2%	18.1%	13.1%	13.9%	21.7%	18.9%	26.4%	24.7%	14.8%
Florida	57.5%	50.9%	50.7%	48.7%	55.7%	51.7%	56.7%	51.6%	53.9%	55.8%
South Atlantic w/o Florida	20.4%	18.0%	13.9%	13.7%	16.2%	22.0%	23.3%	28.9%	26.4%	37.7%
East South Central	21.4%	34.6%	31.3%	14.8%	17.7%	20.8%	24.0%	30.5%	28.3%	36.9%
ERCOT	43.8%	46.0%	45.9%	41.7%	47.1%	51.2%	50.8%	52.1%	49.8%	47.6%
West South Central w/o ERCOT	39.5%	32.5%	22.7%	28.8%	26.8%	30.2%	35.6%	34.1%	35.4%	37.8%
Mountain	59.2%	44.2%	46.9%	39.0%	33.9%	40.0%	42.5%	48.0%	50.2%	45.8%
California	44.4%	44.2%	52.1%	52.6%	56.7%	49.5%	54.1%	60.8%	61.3%	42.1%
Pacific Contiguous w/o CA	73.3%	67.6%	39.7%	44.9%	51.0%	50.6%	43.5%	44.6%	51.2%	50.8%
Pacific Noncontiguous	68.0%	70.7%	72.5%	58.7%	74.9%	77.9%	83.1%	85.2%	80.9%	80.9%
TOTAL U.S.	45.5%	41.8%	37.7%	33.5%	35.0%	36.9%	38.9%	42.1%	41.5%	41.2%

Source – *Outlook for Natural Gas Demand for 2010-2011* Energy Ventures Analysis, Inc.

Will CO_2 Regulation Lead to Higher Natural Gas prices?



Units That Are "At Risk" for Near- to Mid-Term Retirement

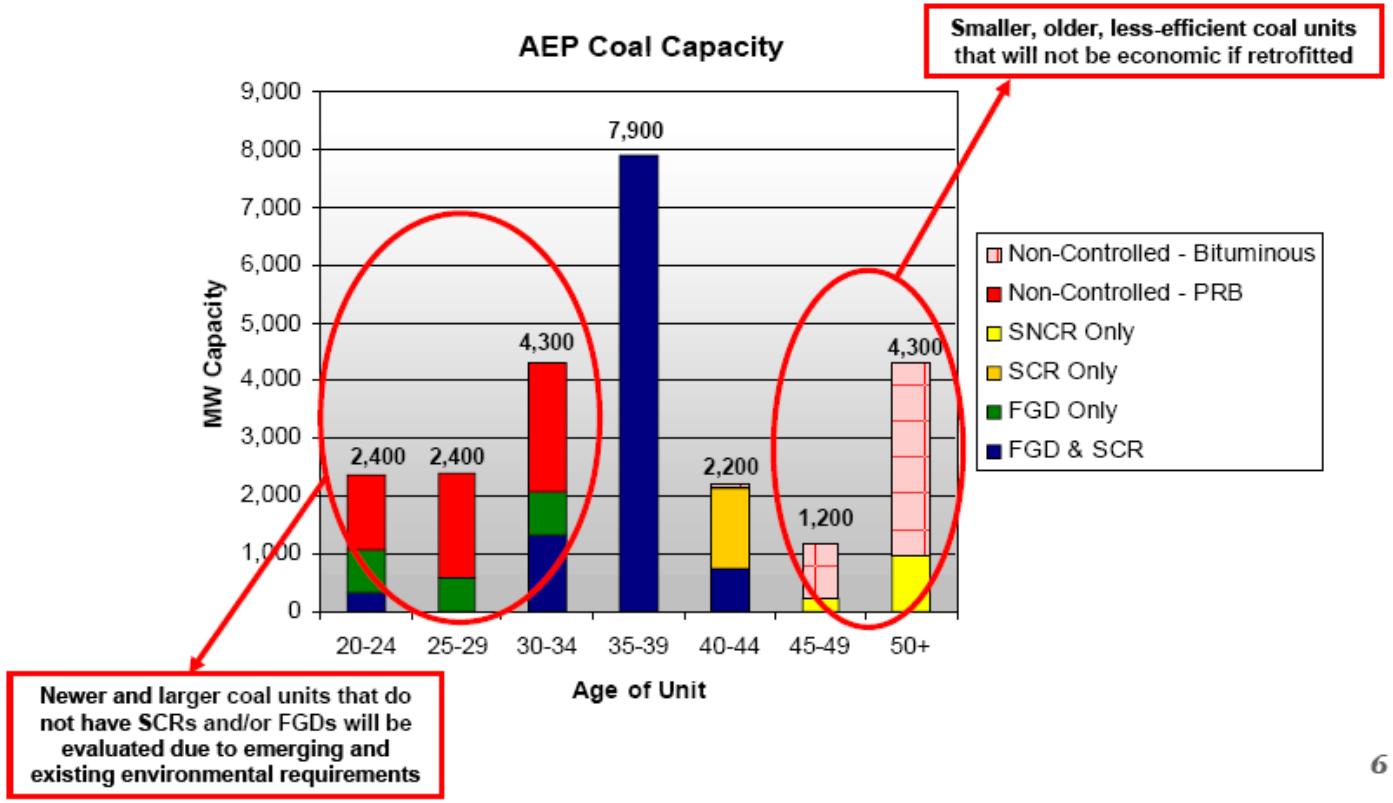
- **Generally older, unscrubbed units - but newer units without SO_2 or NO_x controls also at risk.**
- **2009 PJM State of the Market Report -- 11,250 MW of installed subcritical and supercritical coal capacity did not cover their avoidable costs in 2009 due to displacement by natural gas and the economy**

  "If this result is expected to continue, the retirement of these plants would be an economically rational decision."

- **ICF International May 2010 Report – up to 50% of unscrubbed coal units in U.S., or roughly 50 GW, are "at risk" for retirement in the near-mid-term. Includes older units and those with higher heat rates.**
- **Wood Mackenzie July 2010 – Depending on environmental policy decisions and economic circumstances, between 15 GW and 50 GW of capacity coal could be "at risk" of retirement by 2020 and between 23 GW and 60 GW by 2030.**

Which Units Are At Risk – Example AEP

Plant Retirements are Inevitable



- **Mike Morris, Chairman, President & CEO of AEP, Bank of America/Merrill Lynch Power & Gas Leaders Conference, September 29, 2010**

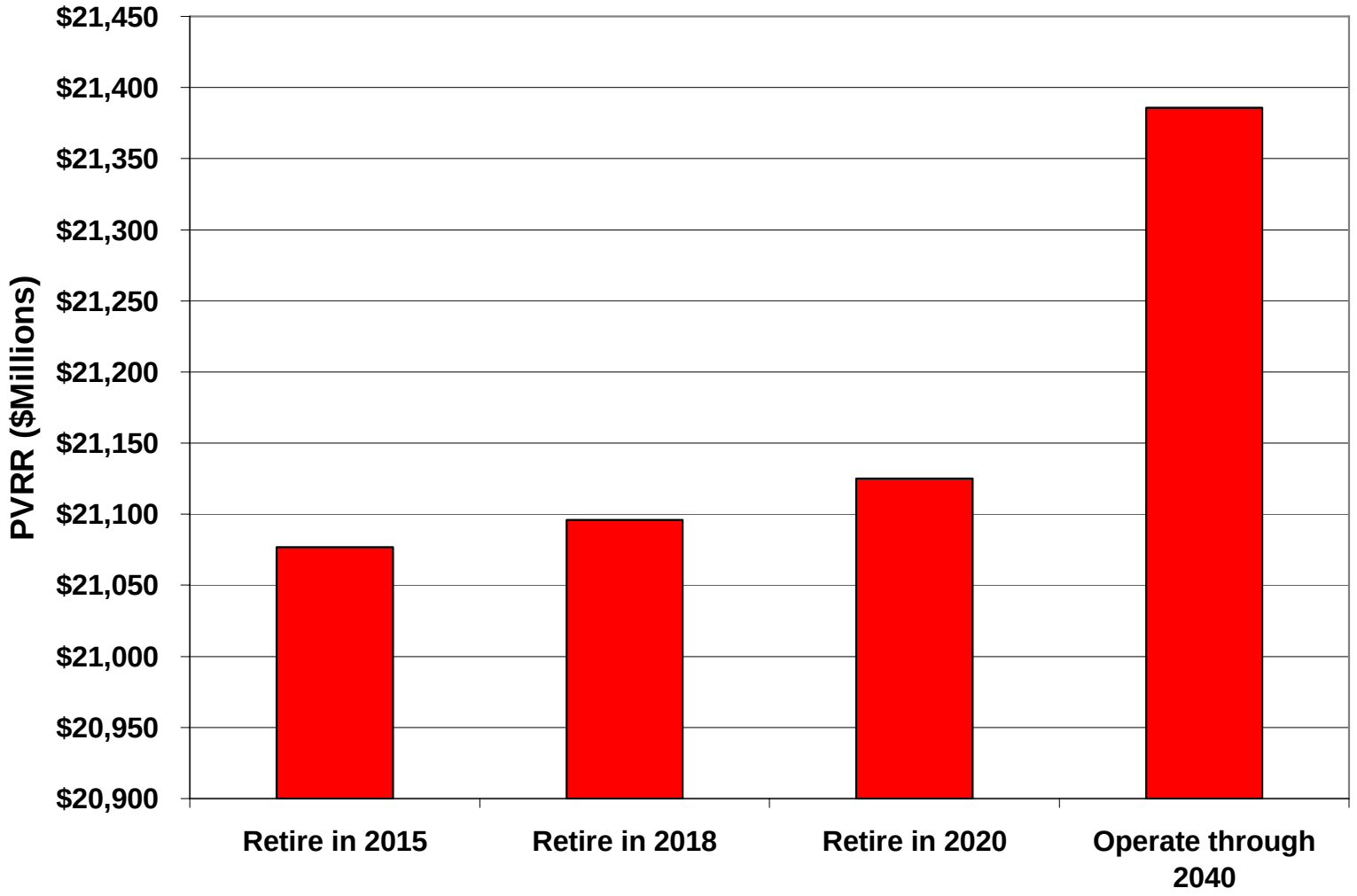
Recently Announced Plans to Retire or Idle Coal Units

- **Progress Energy Carolinas - retire 1,485 MW of unscrubbed coal**
- **Duke Energy Carolinas - retire a total of 1,690 MWs of unscrubbed coal capacity by ~ 2018**
- **American Electric Power - retire 5,000 MW of coal capacity by 2017 & operate another 1,925 MW of older units only during peak demand periods.**
- **Xcel (Public Service of Colorado) - proposed a plan to retire 901 MW of coal capacity by 2017.**
- **First Energy - reduce generation at four smaller and older coal plants (total of 1,600 MW) for the next 3 years.**
- **TVA - idle 9 coal units at 3 sites – the units will be taken offline between 2011 and 2015.**

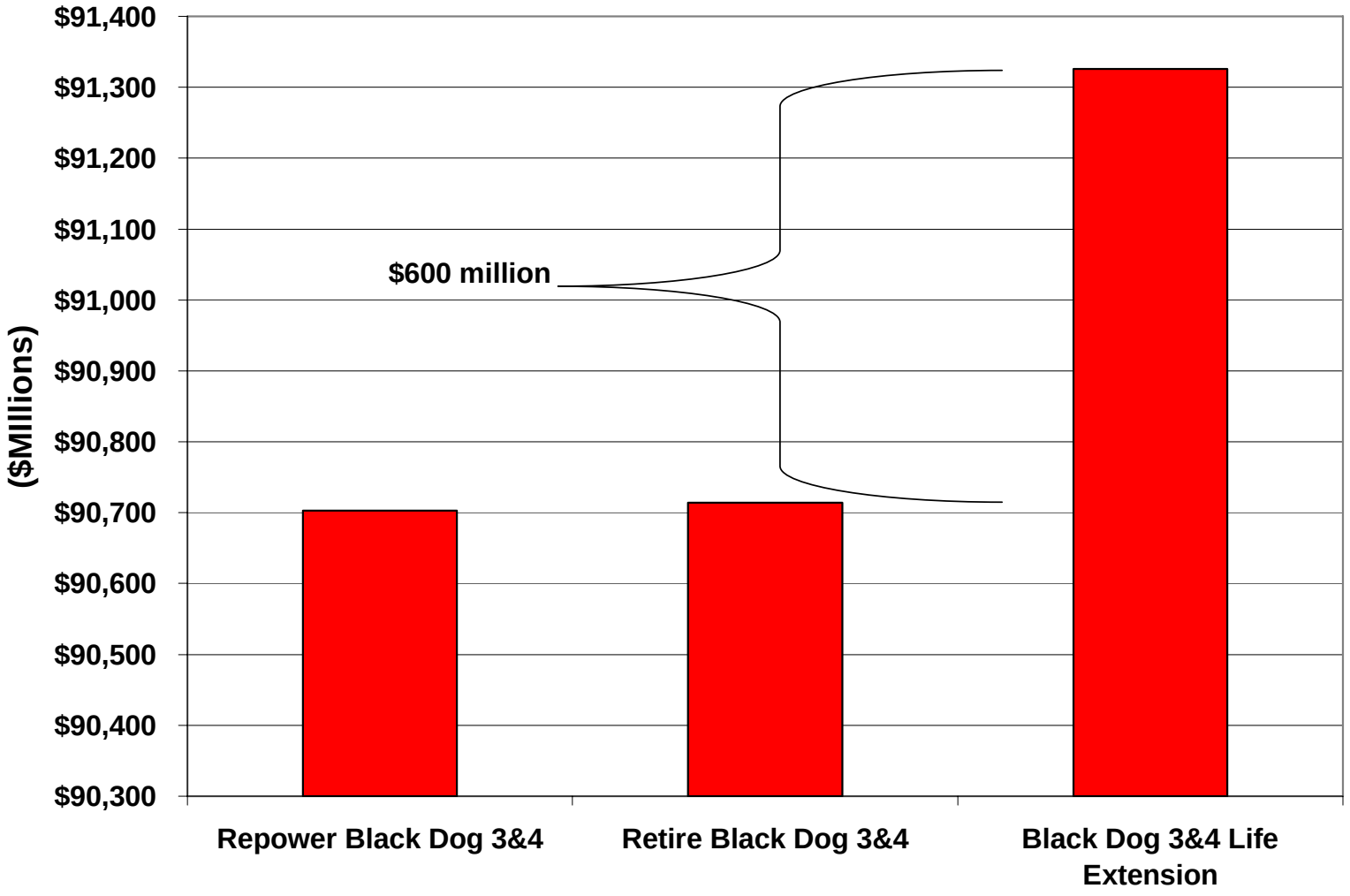
Examples of Expensive Retrofits to Meet Air Emissions Requirements

- **Boardman (Oregon) - $510 million – Scrubber and SCR**
- **Merrimack (New Hampshire) - $430-457 million - Scrubber**
- **Columbia Units 1 & 2 (Wisconsin) - $627 million – Scrubber and Mercury Control**
- **Edgewater Unit 5 (Wisconsin) - $154 million - SCR**

Economics of Adding Controls - PGE's Boardman Coal Plant

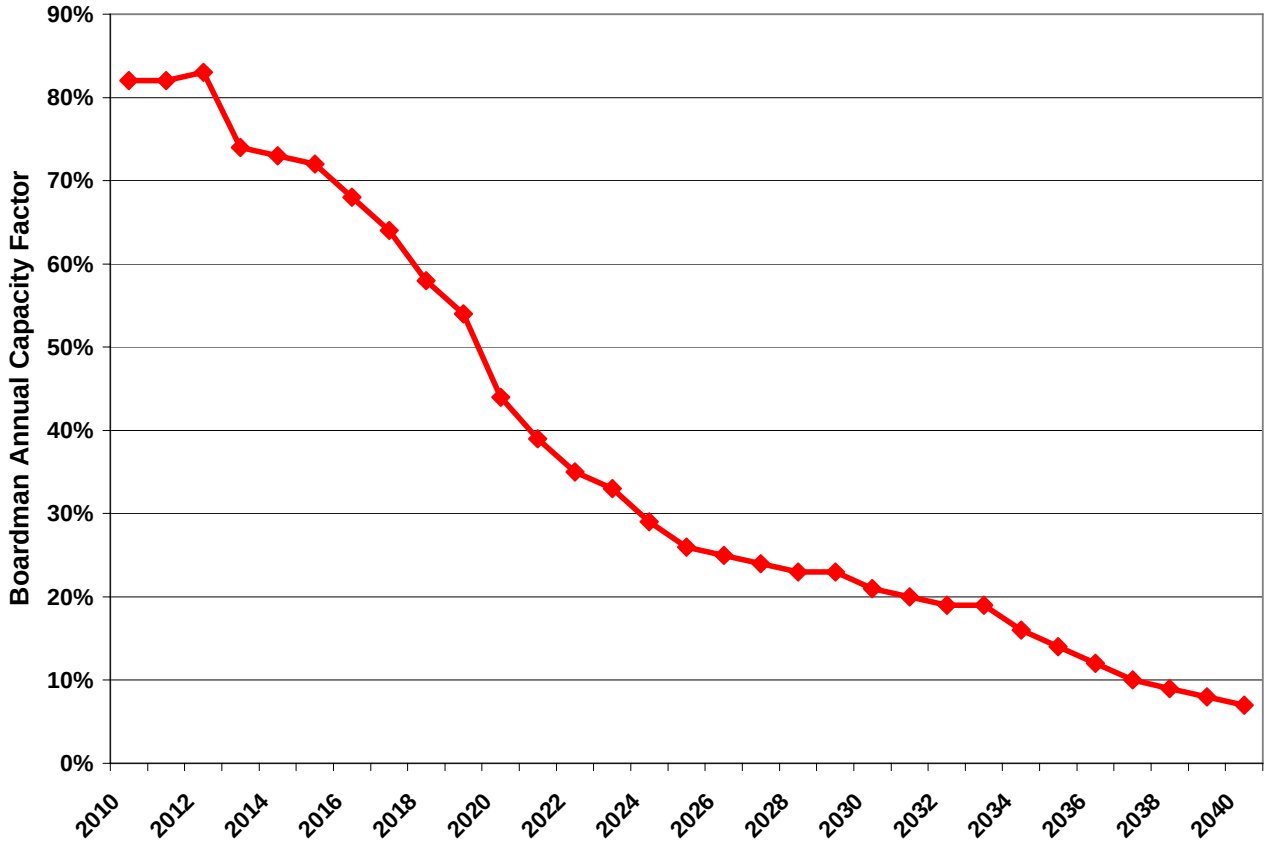


Economics of Adding Controls - Xcel Energy's Black Dog 3&4 Coal Units

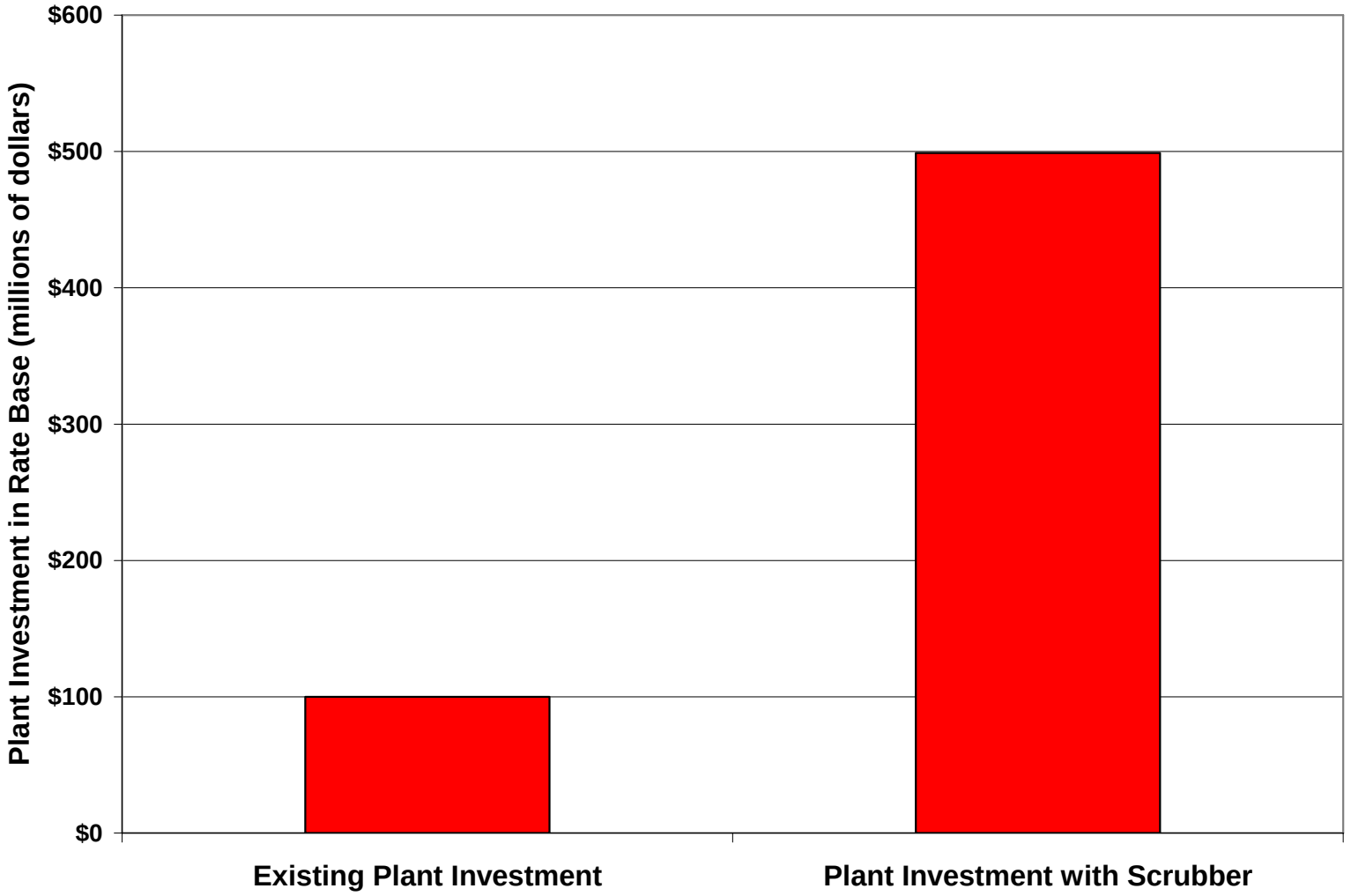


Is it Prudent to Add Controls to Coal Plants That Will No Longer Be Baseload Units?

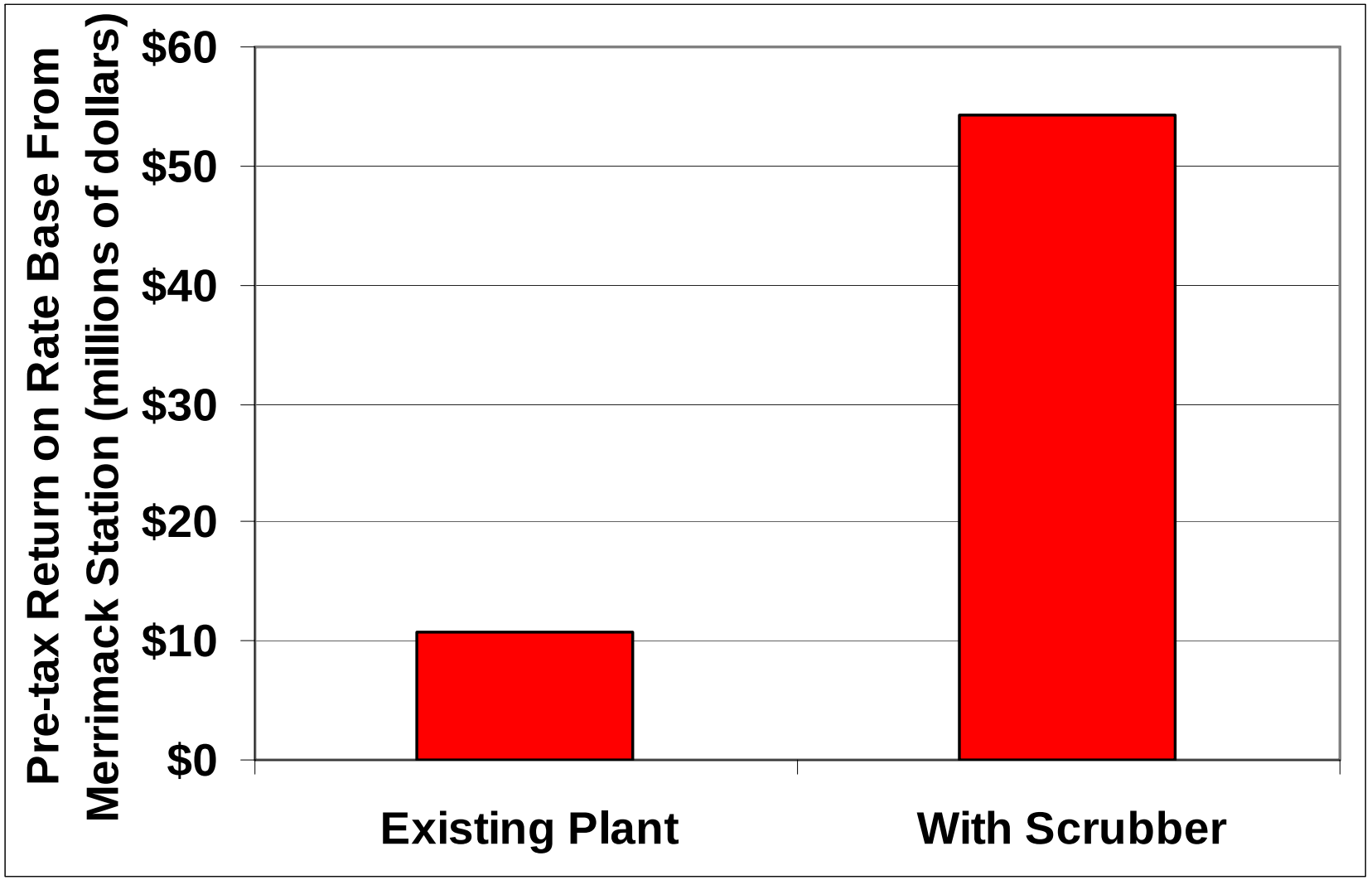
- **PGE projected Boardman operating performance if controls added and plant operates through 2040**



Why IOU's Like Investing in Emissions Controls (1)



Why IOU's Like Investing in Emissions Controls (2)



However, Cost Recovery of Plant Capital Investments Can Be Uncertain

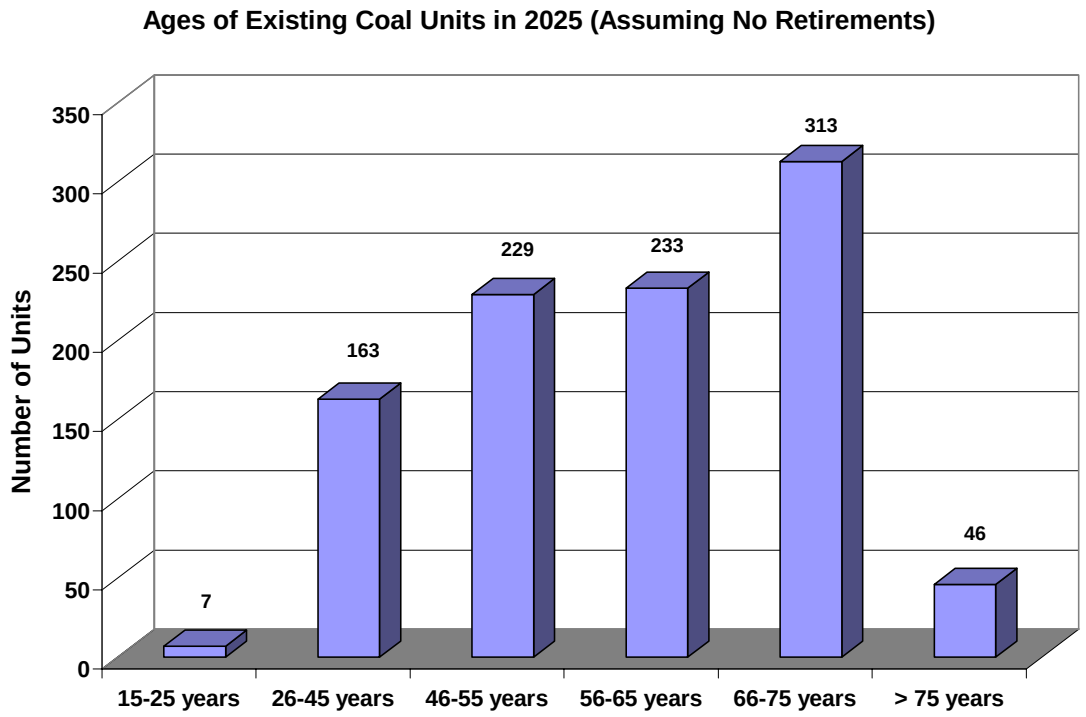
- **Cost recovery for expensive environmental upgrade and plant modifications not assured.**
- **State regulatory commissions can conduct prudence reviews – like those for nuclear plants in 1980s and 1990s – these can lead to large disallowances.**
- **Costs could be disallowed if it is shown there was mismanagement or less expensive alternatives.**
- **Costs of some scrubber projects have increased significantly.**
  - **PSNH Merrimack plant estimated scrubber cost increased by 83% from 2006 to 2008 – now at $430 million.**
  - **Ameren's Sioux plant scrubber cost increased from $372 million (2005) to $498 million (May 2008) to current $594 million – 60% increase. $110 million of current rate case in Missouri said to be due to scrubber cost.**

Is Retrofitting with CCS Going to Save Existing Coal Units?

- **CCS and "green coal" are presented as 'silver bullets' to save existing coal.**
- **But CCS has significant technical, economic, legal and environmental uncertainties.**
- **When, if ever, will CCS be commercially viable? 2020? 2030? 2045?**
- **How much will it cost to retrofit CCS to existing coal units?**
- **Will it be economic to add CCS without significant gov't incentives?**
- **By how much will CCS have on the output and heat rates of coal units?**
- **Will it be economical to retrofit CCS to existing coal plants?**

Will It Be Prudent to Retrofit CCS to Aging Coal Units?

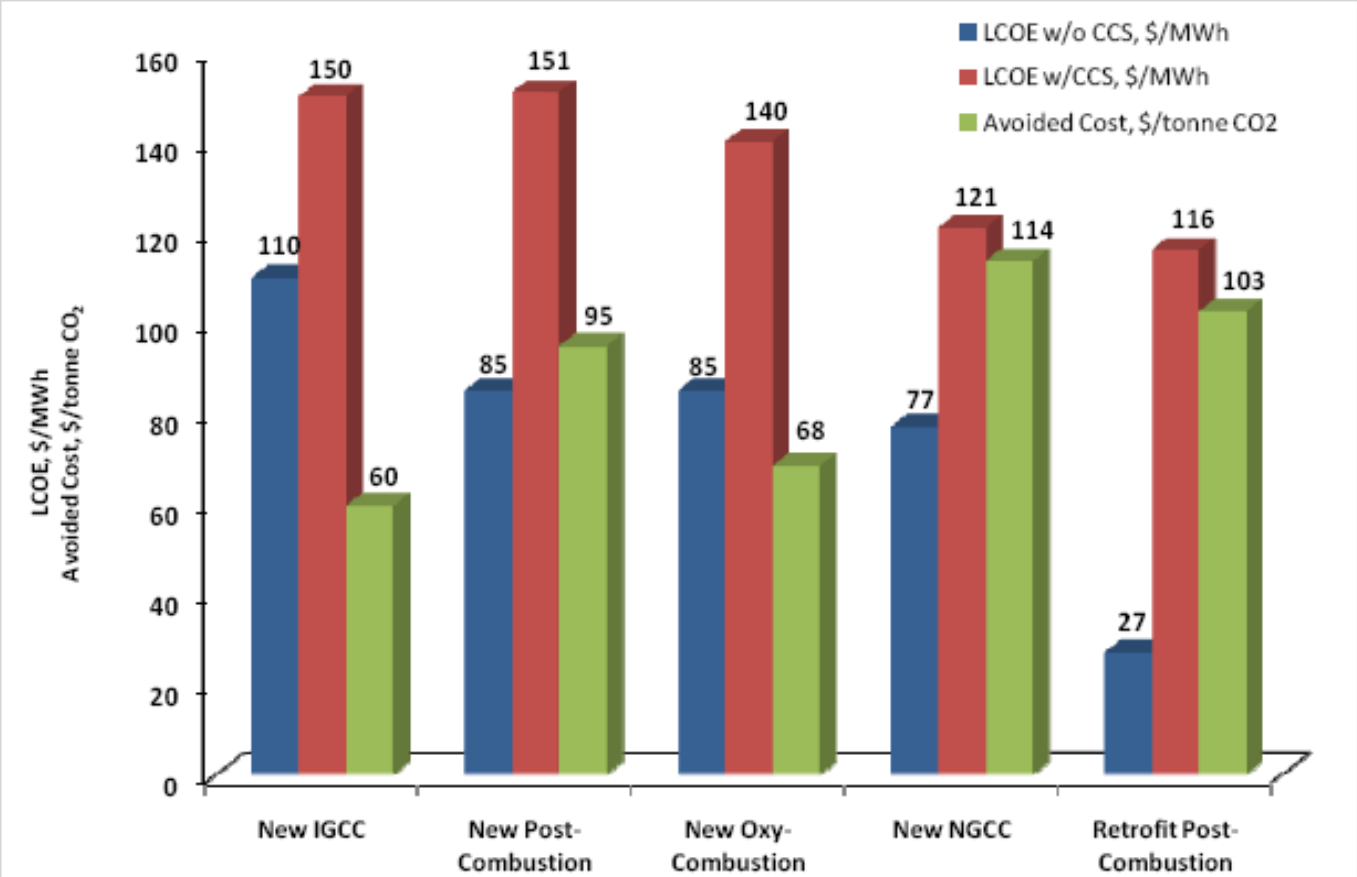
- **Is it going to be economically prudent to spend tens to hundreds of millions of dollars retrofitting CCS to older coal units with relatively short remaining lives for recovering investments?**
- **By 2025, 83% of existing coal fleet will be at least 45 years old. 60% will be more than 55 years old.**



The Economics of Retrofitting CCS to Existing Coal Units (1)

- **MIT 2007 *Future of Coal* study calculated that retrofitting post-combustion CCS would increase cost of power from existing coal units by 220%-250%.**
- **Preliminary EPRI analysis has calculated that adding CCS would increase cost of power from existing coal plants by 275%.**
- **The February 2010 *Report of the Interagency Task Force on Carbon Capture and Storage* calculated that addition of post-combustion CCS would increase the cost of power from existing coal plant by 330%.**

The Economics of Retrofitting CCS to Existing Coal Units (2)



LCOE--Levelized Cost of Electricity is a cost of generating electricity for a particular system. It is an economic assessment of the cost of the energy-generating system including all the costs over its lifetime: initial investment, operations and maintenance, cost of fuel, cost of capital. See Appendix A.4 for a complete description of financial assumptions and costing methodology