

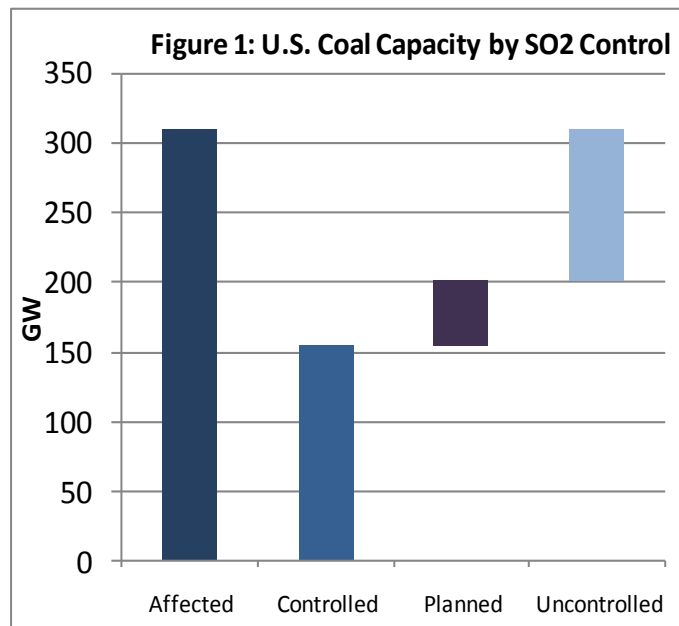


Coal-Fired Electric Generation Unit Retirement Analysis

Executive Summary

May 11, 2010

A number of impending environmental regulations have created uncertainties about the ability of certain coal-fired power plants (utility owned and merchant owned) to remain profitable into the extended future. While impending greenhouse gas (GHG) regulation is one of the largest threats to coal-fired power plants' economic viability, a number of other increasingly stringent environmental programs, including new rules regulating emissions of sulfur dioxide (SO₂), nitrogen oxides (NO_x) and Hazardous Air Pollutants (HAPs), will adversely affect these plants' economics. Most significantly, upcoming HAPs regulations will likely compel an increasing number of coal-fired power plants to install SO₂ capture technology called "scrubbers" if they wish to operate into the extended future. Additional controls, including fabric filters, activated carbon injection, and potentially selective catalytic reduction (SCRs), will also likely be required. Scrubbers, as well as the other control technologies, represent a significant capital investment. Thus the operators of many coal-fired power plants will face the choice between installing this control equipment and continuing to operate under these increasingly stringent regulations or avoid the large capital expenditures associated with installing control equipment by retiring the marginally economic power plants before these regulations take effect. These pressures will only be exacerbated by increasingly stringent water and ash disposal regulations that effect coal-fired generation. Further, in addition to federal regulation, some states are requiring even more stringent water, air, and waste emission reductions adding pressure to utilities to retire older, higher emitting power plants.

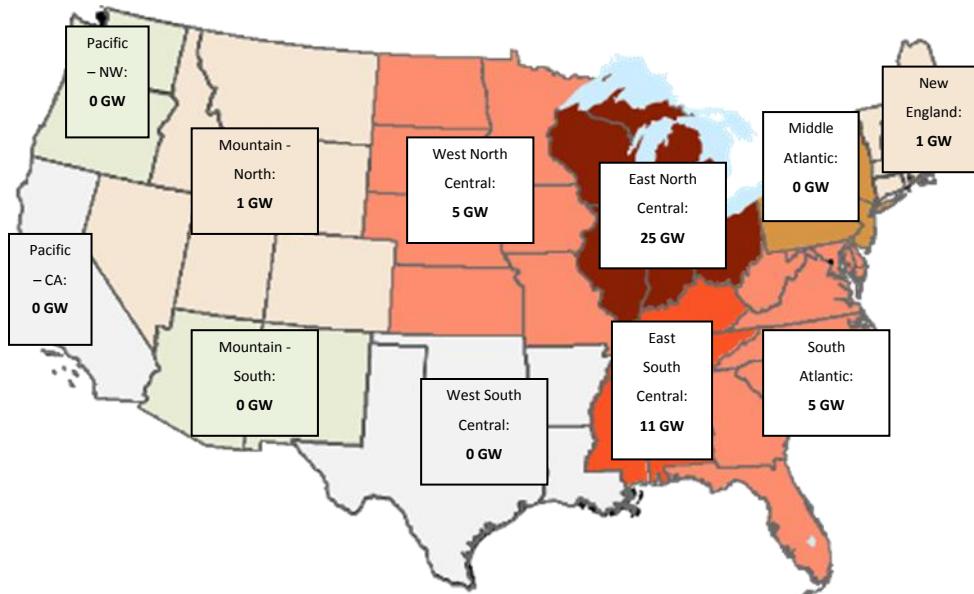


Not all coal-fired power plants in service face the dilemma of installing the necessary emission control equipment. Of the approximately 310 GW of coal fired generating capacity in the U.S., about 150 GW already have installed the scrubbers (see Figure 1). Another approximately 50 GW have scrubbers permitted or under construction. Thus only about one third of the U.S. coal-fired generating capacity, or

about 110 GW, will have to decide whether to install the necessary control equipment or potentially shut down.

INGAA commissioned ICF International to provide a simple estimate of the amount of coal-fired generation capacity that is currently not scrubbed, or planned to be scrubbed, and that is potentially at risk due to these impending air regulations. Of this universe of unscrubbed units, ICF estimated which units are potentially at risk based on two criteria: 1) age; and 2) efficiency, as measured by the plant's heat rate.

Figure 2: "At Risk" Coal Generating Capacity by U.S. Census Region



Along the first dimension, a simplifying assumption was made that the operators of many power plants that came online before 1970 would be less likely to attract the capital investment in control equipment. In addition to incurring significant capital expenditures in order to maintain the major components of the plant as they aged, they would have less time to recoup the investments in additional control technologies during their remaining life. Along the second dimension, ICF assumed that the operators of power plants that have relatively higher heat rates (lower efficiency) would be less likely to justify the large capital investment of a scrubber given that their profit margin would be squeezed most under future economic scenarios. A 10,000 Btu/kWh heat rate was used as a benchmark for average efficiency of a coal power plant. Therefore, ICF identified all unscrubbed coal generating units that came on-line before 1970 and whose heat rate was greater than 10,000 Btu/kWh as potentially "at risk" for retirement.¹ Because of the high heat rate of these plants, they are higher up the dispatch curve as compared to lower heat rate plants within the same electric control region and therefore are disadvantaged economically. According to these assumptions, approximately 50 percent of the unscrubbed plants or roughly 50 GW of coal fueled generating capacity is "at risk" for retirement across the U.S. in the near- mid-term. The vast majority of these plants are located in the five of the central and eastern U.S. Census regions (see Figure 2). In order to meet electric demand, the system would need to replace the roughly 250,000 GWh per year of this retired capacity from the "at risk" coal power plants.

¹ The units ICF identified as "at risk" simply provide an estimate for which units have a higher probability of retiring in advance of GHG and SO₂ regulation, not a projection based on expected market conditions.

A portion of this demand could be met by increasing generation at existing natural gas fueled electric generation plants. While natural gas generally is more expensive than coal, natural gas fueled power plants emit fewer GHGs and NOX, and do not emit SO2 or HAPs, and thus do not face the same pressures from impending environmental regulations.

Currently, natural gas fueled combined cycle (NGCC) electric generation units are running at relatively low capacity utilization factors of seven to 35 percent in the regions with the most “at risk” coal-fired generating capacity. To replace the generating capacity of “at risk” coal-fired power plants and dispatch power in these regions, NGCCs would need to increase their capacity utilization factors to a range of 40 to 138 percent. A capacity factor increase over 100 percent implies that new generation would need to be built in the region, or that other existing capacity (such as natural gas fueled combustion turbines) would also have to increase generation.

This resulting rise in NGCC capacity utilization factors would increase annual natural gas consumption by about 2,000 TBtu (~2Tcf). Furthermore, replacing the generation from “at risk” coal with natural gas fueled generation on a one-for-one basis (an overly simplistic assumption – but used here for illustrative purposes) could result in a CO2 emissions reductions of about 170 million tons CO2 annually nationwide.

Prepared By



**Coal-Fired Electric Generation Unit Retirement
Analysis
Presented to: The INGAA Foundation & INGAA**

May 18, 2010



Agenda



Introduction

- Coal –Fired Capacity and Generation Statistics by Region
- Natural Gas-Fired Capacity and Generation Statistics by Region
- Impact of Retiring At-Risk Coal-Fired Electric Generation on Natural Gas Consumption



Introduction

- Coal Statistics by Region
- Natural Gas Statistics by Region
- Impact of Retiring At-Risk Coal-Fired Generation on Natural Gas Consumption

Goals of Presentation



- Approximate how much coal-fired generation capacity is at risk of retiring in light of pending and potential emission regulations
 - Show detail at U.S. Census regional level
- Determine if the existing natural gas-fired generation capacity is sufficient to replace generation from “at risk” coal-fired generation capacity
- Estimate the impact on natural gas consumption if “at risk” coal-fired generation retires
- Compare the annual GHG emissions from “at risk” coal-fired generation to the emissions from natural gas replacement capacity
- Important note – the analysis contained in this presentation represents a very approximate “what if” analysis.¹

¹It does not represent ICF’s view that all uncontrolled coal units could simply be replaced by existing available natural gas-fired capacity.

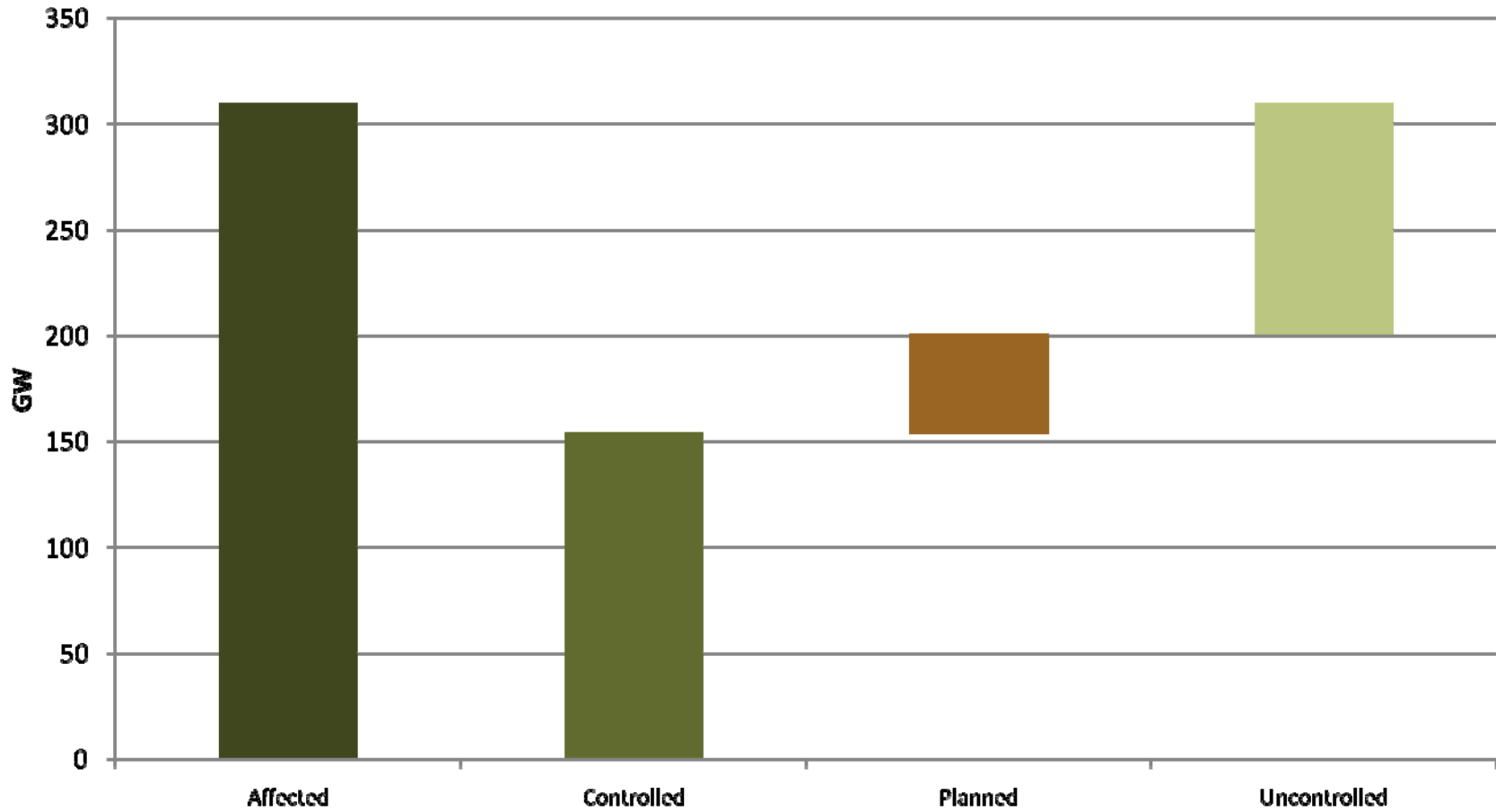


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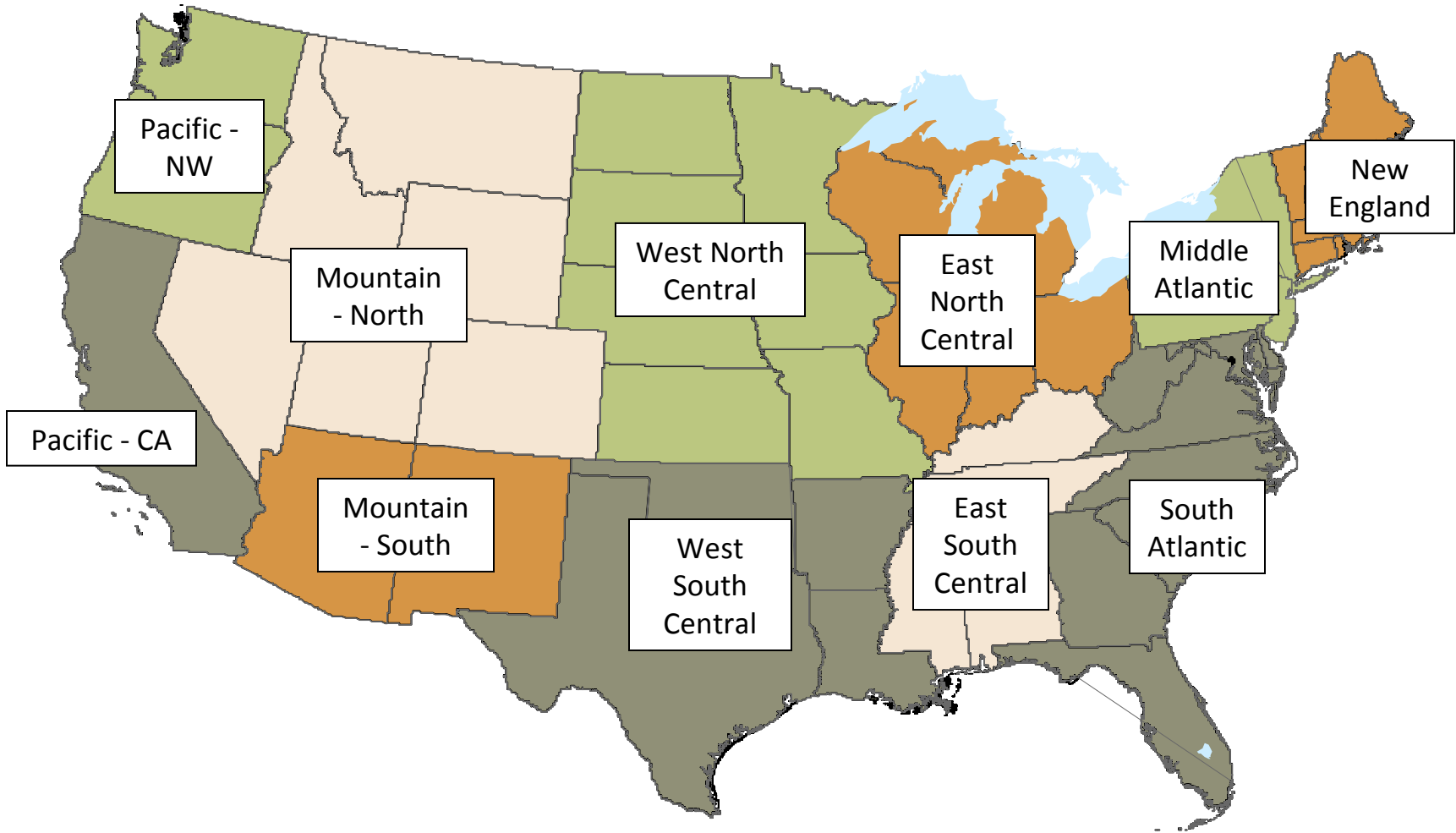
Coal Statistics by Region

- Natural Gas Statistics by Region
- Impact of Retiring At-Risk Coal-Fired Generation on Natural Gas Consumption

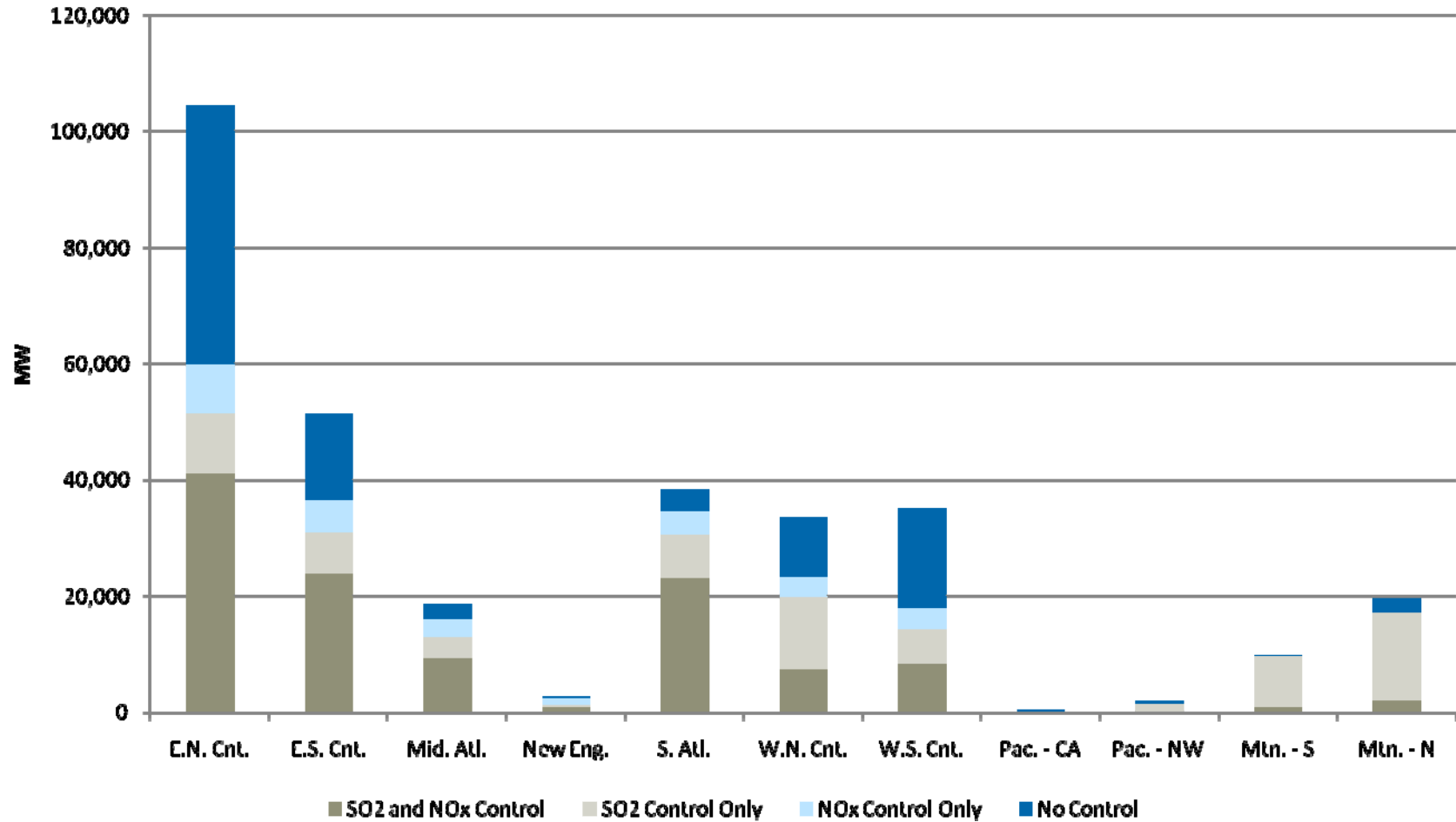
U.S. Coal Generation Capacity: SO₂ Control Installations



U.S. Census Energy Regions Used in Analysis



Total Projected Coal Generation Capacity in 2011

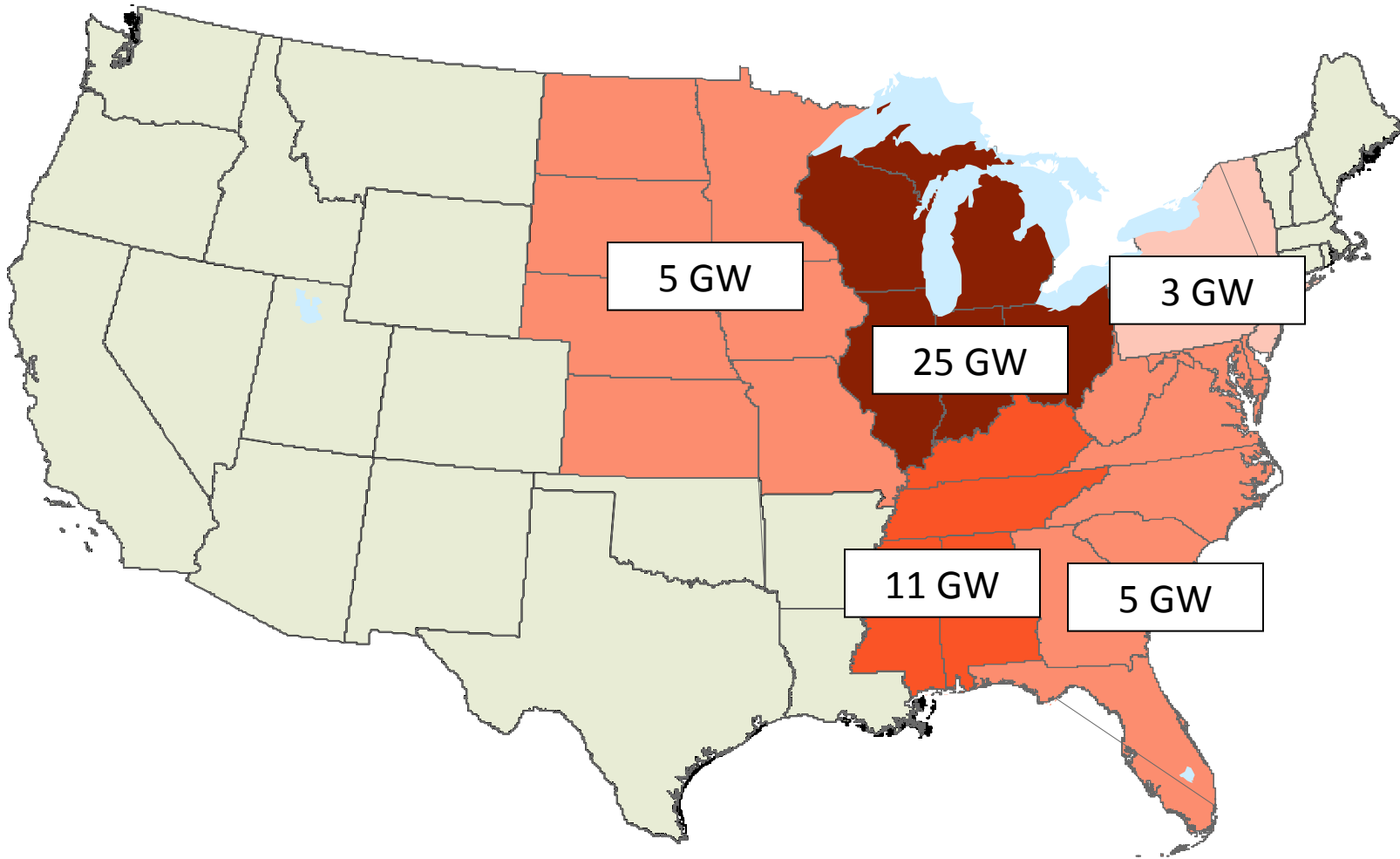


What unscrubbed coal-fired generation capacity is at greatest risk of retiring?

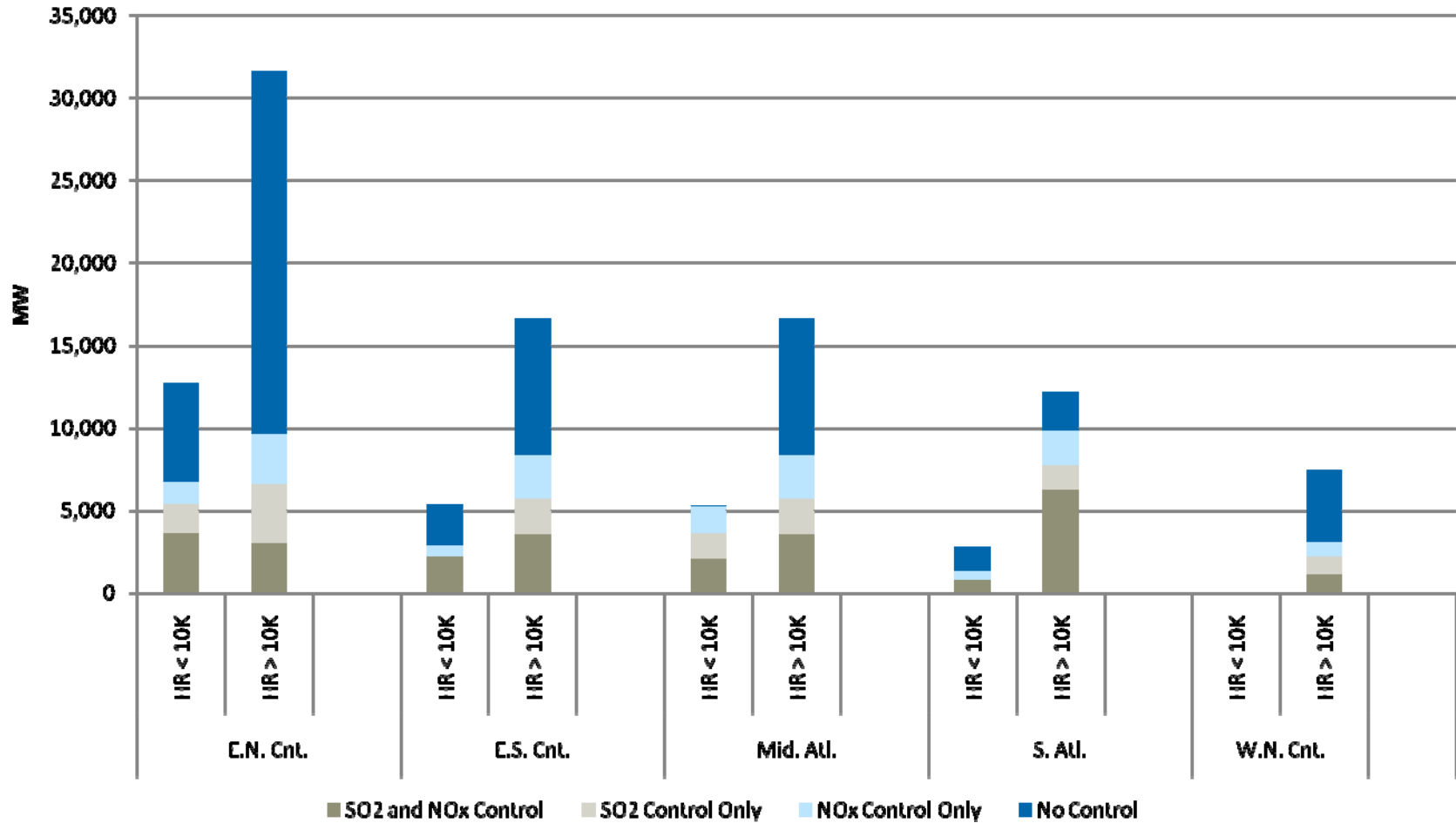


- Factors to consider when deciding whether to “scrub” a coal plant:
 - Heat rate: higher heat rates result in higher dispatch costs causing units to often be “shoulder” and not baseload units. CO₂ regulations can compound this issue. Units with higher heat rates will have their margins squeezed more by carbon regulation, and thus companies are more likely to retire these units than to invest significant capital in them
 - Age: coal units require capital intensive repairs as they age. It is likely that investing in pollution control equipment, in addition to the necessary repairs to old coal plants, will be uneconomic given impending carbon regulation and the plants declining useful life
- Thus coal is considered “at risk” of retirement if:
 - It will be over 40 years old in 2010 (online before 1970)
 - It has a heat rate greater than 10,000 Btu/kWh

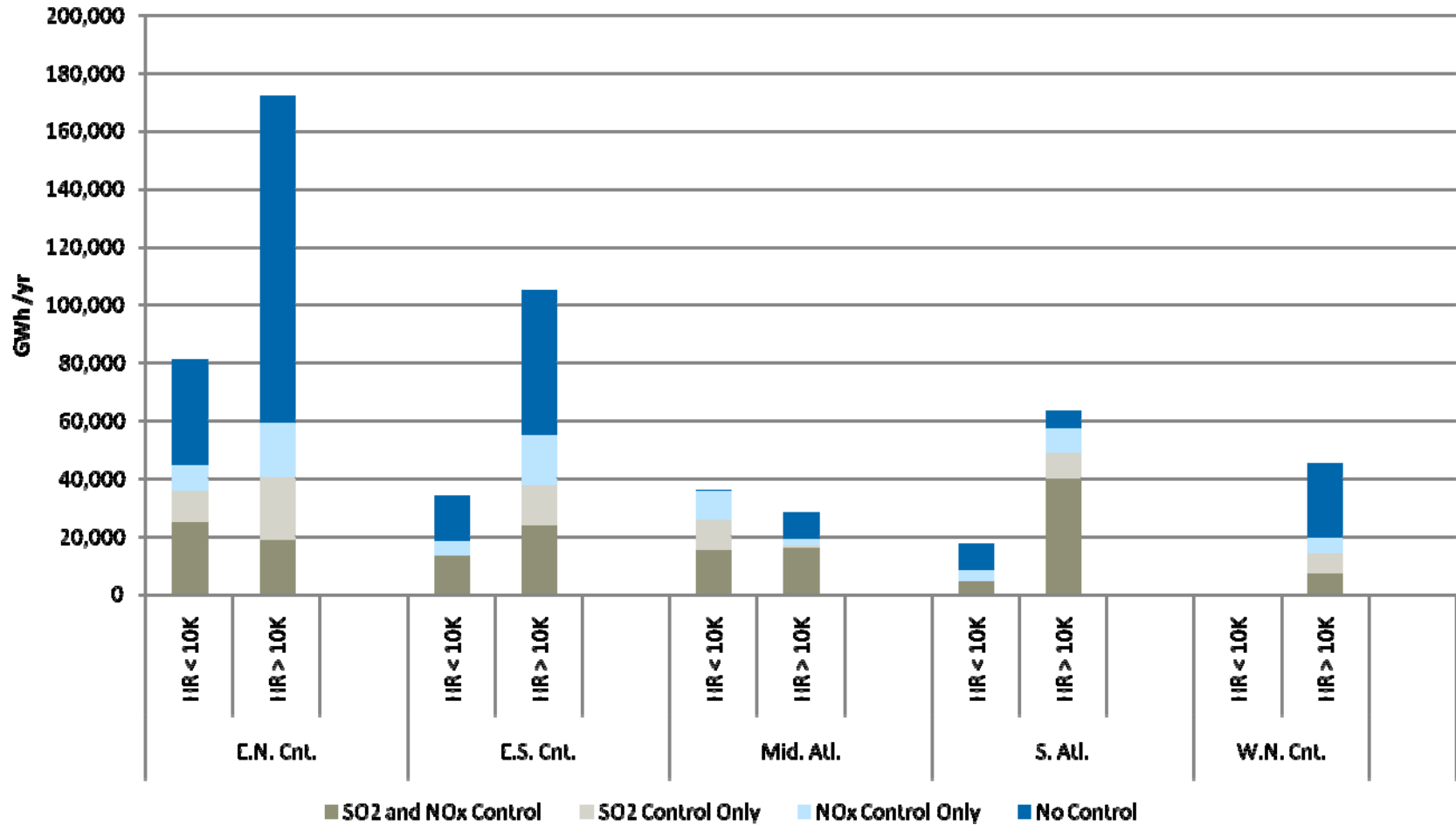
Regions with Most “at Risk” Coal Generation Plants



Coal Generation Capacity over 40 Years Old (Online before 1970)



Coal Generation per Year by Units over 40 Years Old (Online before 1970)





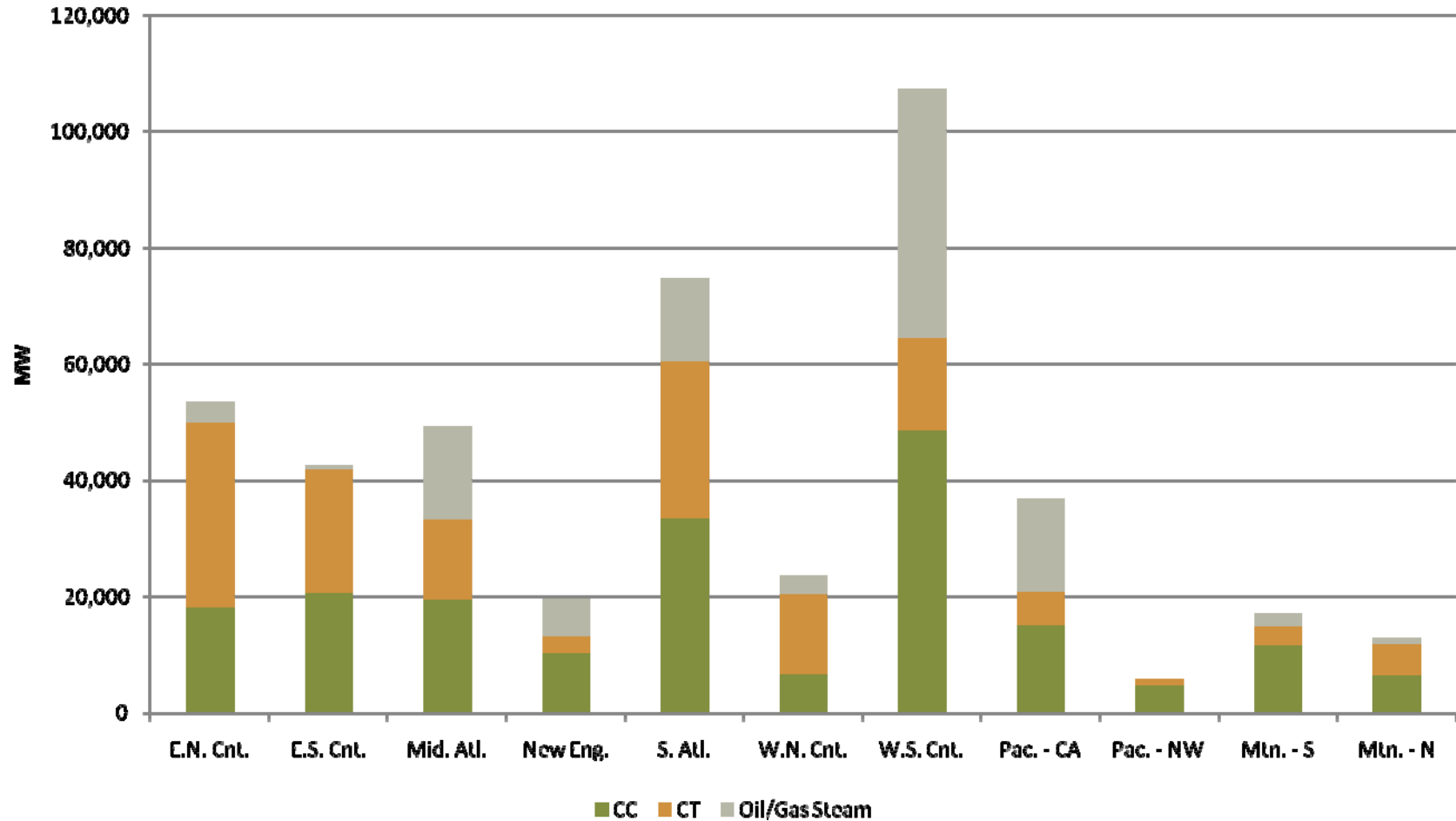
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Coal-Fired Generation Statistics by Region

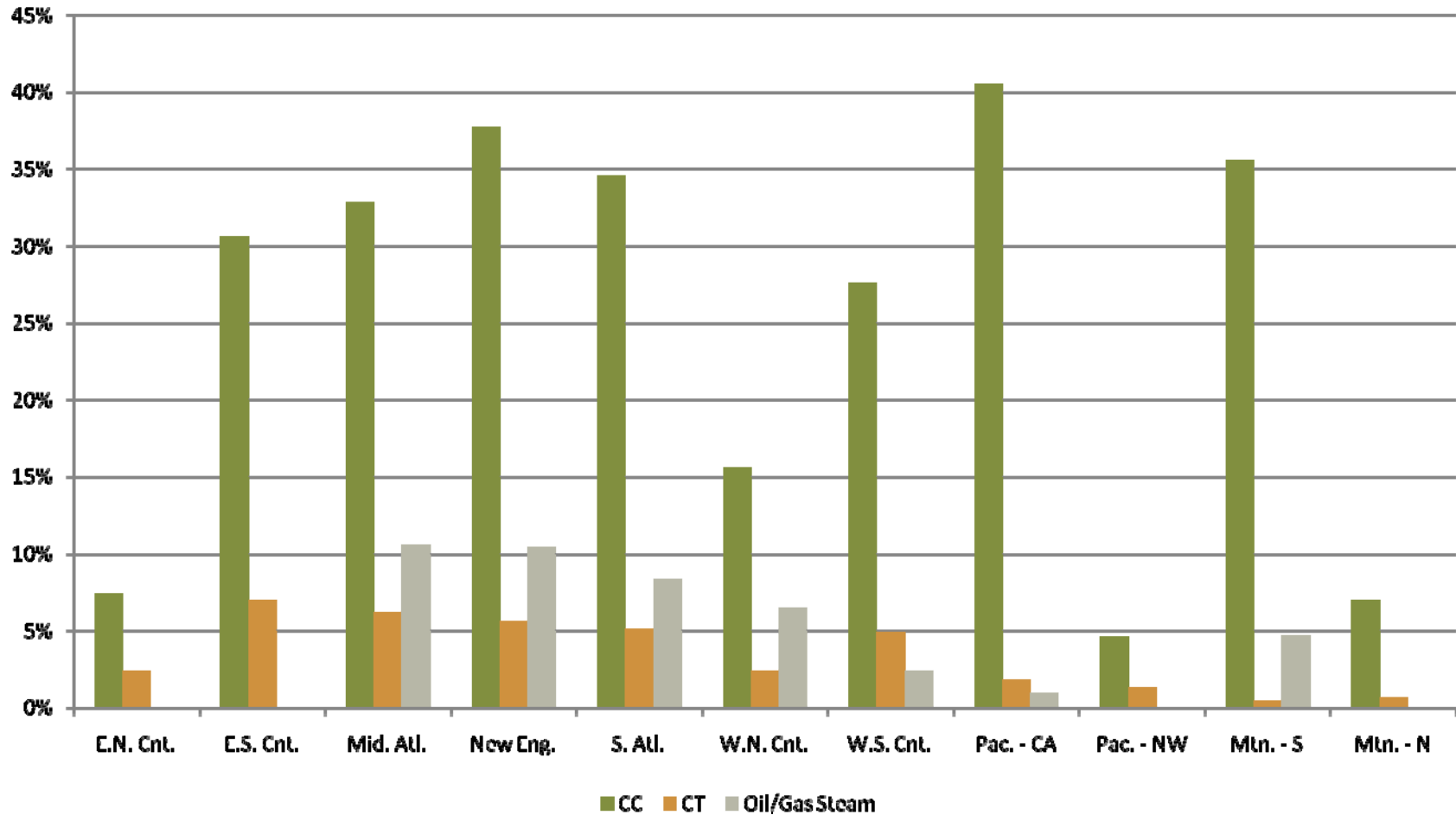
Natural Gas Statistics by Region

Impact of Retiring At-Risk Coal Generation on Natural Gas Consumption

U.S. has significant natural gas generation capacity, much of which lies in areas with “at risk” coal-fired power plants



Projected natural gas generation capacity factors in 2011 are relatively low





Introduction

Coal Statistics by Region

Gas Statistics by Region

Impact of Retiring at Risk Coal-Fired Power Plants on Natural Gas Consumption

SUMMARY

At Risk Coal-Fired Power Plants– Units Online before 1970 with Heat Rate Greater than 10,000 Btu/kWh



	East North Central	East South Central	Middle Atlantic	South Atlantic	West North Central
Capacity (MW)	25,054	10,949	3,085	4,457	5,282
Generation (GWh /yr)	132,212	67,564	11,720	14,761	31,315
CO2 Emissions (Mtons / yr)	151,628	74,719	12,928	16,147	38,241
Average Natural Gas CC Capacity Factor (%)	7%	31%	33%	35%	16%
Equivalent Natural Gas Consumption (Tbtu/yr)	1,058	541	94	118	251
Increase in CC Capacity Factor to Replace Coal Generation (%)	131%	42%	12%	6%	58%
Equivalent Gas CO2 Emissions (<tons)	61,875	31,620	5,485	6,908	14,656
CO2 Emissions Reduced by Switching to Natural Gas (Mtons)	89,753	43,099	7,443	9,239	23,586

- Heat rate for existing natural gas units assumed to be 8,000 Btu/kWh
- At 117 lbs.CO2/MMBtu of fuel consumed and an 8,000 BTU/kWh heat rate, the assumed emissions rate of the natural gas generation is 936 lb/MWh