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BENEFITS OF EARLY STATE ACTION IN ENVIRONMENTAL REGULATION OF ELECTRIC UTILITIES: NORTH CAROLINA'S CLEAN SMOKESTACKS ACT

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Executive Summary

New federal environmental regulations for the electric utility sector often require compliance on restricted timelines, forcing some utilities to make significant investments over short time periods and causing sudden jumps in electricity rates for consumers. In addition, large numbers of environmental equipment retrofits across the U.S. electricity sector over short time periods can drive up retrofit costs, creating cost escalation risk for ratepayers. Despite the start-stop nature of federal environmental regulation, states can adopt policies that anticipate federal environmental regulations. State policies that move ahead of federal regulations, such as North Carolina's Clean Smokestacks Act, can (1) give utilities and utility customers longer compliance timelines, (2) spread out compliance costs, and (3) mitigate cost escalation risk, while simultaneously yielding public health benefits and furthering state environmental goals.

This report examines the ratepayer impacts and health benefits of North Carolina's Clean Smokestacks Act (Clean Smokestacks). Ratepayer impacts are estimated by comparing the capital cost of complying with the federal Cross-State Air Pollution Rule (CSAPR) and Mercury Air Toxics Standard (MATS) acid gas requirement with and without the state's Clean Smokestacks rule. Health benefits are estimated based on reduced premature mortality from emissions reductions achieved under Clean Smokestacks. Clean Smokestacks requires significant reductions in sulfur dioxide (SO_2) and nitrogen oxide (NO_x) emissions from investor-owned utility coal plants in North Carolina over an 11-year compliance period. North Carolina has benefited from these reductions in a variety of ways. North Carolina investor-owned utilities are largely in compliance with CSAPR and the acid gas (SO_2) requirements of MATS because of Clean Smokestacks. In addition, Clean Smokestacks spread out compliance costs and created the potential for future savings if retrofit costs escalate during the shorter compliance period for CSAPR and MATS (relative to Clean Smokestacks). Furthermore, the health benefits resulting from improved air quality are approximately an order of magnitude greater than potential increases in costs for ratepayers that may result from Clean Smokestacks. Finally, the emissions reductions achieved under Clean Smokestacks likely reduced other environmental compliance costs.

Net present value (NPV) of CSAPR and MATS acid gas requirement capital compliance costs for Duke Energy and Progress Energy North Carolina ratepayers over next 80 years for a 30-year capital cycle and next 70 years for a 20-year capital cycle in millions of dollars (2011) with and without Clean Smokestacks.

	NPV 80-year future capital costs, 30-year capital cycle M$ (2011)			NPV 70-year future capital cost, 20-year capital cycle M$ (2011)		
	Clean Smokestacks past + future costs	Without Clean Smokestacks	Without Clean Smokestacks, 25% capital cost escalation	Clean Smokestacks past + future costs	Without Clean Smokestacks	Without Clean Smokestacks, 25% capital cost escalation
End of capital cycle repairs 100% original retrofit costs						
Duke Energy	$4,374	$3,827	$4,539	$5,615	$4,659	$5,350
Progress Energy	$2,634	$2,376	$2,797	$3,430	$2,918	$3,326
End of capital cycle repairs 50% original retrofit costs						
Duke Energy	$3,666	$3,337	$4,048	$4,270	$3,712	$4,403
Progress Energy	$2,144	$2,031	$2,452	$2,532	$2,276	$2,684

North Carolina and national mortality benefits from reduced SO_2 emissions under Clean Smokestacks (in millions of dollars [2011]).

Year	NC SO_2 elec. sector emissions (tons)	SO_2 emissions reduction from Clean Smokestacks (tons)	Pope et. al mortality benefits (M$ 2011)		Laden et. al mortality benefits (M$ 2011)	
			Contiguous U.S.	North Carolina	Contiguous U.S.	North Carolina
2005	500,936	554	$13.3	$2.4	$33.6	$6.0
2006	462,143	17,069	$422.6	$75.2	$1,063.8	$189.4
2007	370,827	126,000	$3,186.5	$567.2	$8,021.3	$1,427.8
2008	227,030	260,010	$6,635.7	$1,181.1	$16,703.6	$2,973.2
2009	110,948	313,889	$8,071.2	$1,436.7	$20,317.2	$3,616.5
2010	116,627	344,809	$9,081.3	$1,616.5	$22,859.9	$4,069.1
2011	73,507	313,496	$8,362.5	$1,488.5	$21,050.5	$3,747.0
Cumulative benefits in millions of dollars (2011)			**$35,760**	**$6,365**	**$90,016**	**$16,023**

This issue is especially relevant today with forthcoming U.S. Environmental Protection Agency (EPA) regulations for electricity sector conventional and hazardous air emissions, coal ash, cooling water, and greenhouse gas emissions. States like North Carolina that moved ahead of federal regulations are better positioned to comply with these regulations and avoid sudden increases in electricity prices. Although determining what risks state utilities and ratepayers face and potential overlap with other state goals is not a simple task, North Carolina's experience demonstrates that collaborative thinking about future risks and interdependencies between state utility policy, environmental quality, and state energy policy goals can position state utilities to avoid price jumps and reliability risks while improving health and quality of life for state citizens.

Introduction

New federal environmental regulations for the electric utility sector often require compliance on restricted timelines, forcing some utilities to make significant investments over short time periods[1] and causing sudden jumps in electricity rates for consumers.[2] In addition, large numbers of environmental retrofits across the U.S. electricity sector over short time periods can drive up retrofit costs, creating cost escalation risk for ratepayers.[3] Despite unpredictable timetables for new federal environmental regulations, forward-looking states can create policies that anticipate more stringent federal environmental requirements. State policies that move ahead of federal regulations can give utilities and utility customers longer compliance timelines, spread out compliance costs, and mitigate cost escalation risk while simultaneously creating health and welfare benefits and furthering state environmental goals. Without legislative or regulatory directives, many state utility regulators are reluctant to approve early action by utilities to comply with federal environmental regulations until rules are finalized because of concerns about potential increases in rates and challenges by interveners.

The potential benefits of early action by states are especially relevant today with forthcoming U.S. Environmental Protection Agency (EPA) regulations for conventional and hazardous air pollutants, coal ash, cooling water, and greenhouse gas emissions. North Carolina's Clean Smokestacks Act (Clean Smokestacks) is an example of state policy that moved ahead of federal regulations. Clean Smokestacks required North Carolina's investor-owned utilities to reduce coal plant emissions well beyond then-current federal regulations. As a result, investor-owned utilities in North Carolina are well positioned to comply with the new federal Cross-State Air Pollution Rule (CASPR) and the acid gas requirements of the federal Mercury Air Toxics Standard (MATS). This report analyzes the net cost and risk benefits to electricity customers as well as the health and welfare benefits of Clean Smokestacks.

Section 1 of this report summarizes the requirements of Clean Smokestacks and explains why more stringent federal controls on air pollutants from coal-fired power plants were foreseeable at the time of passage. This section also explains the requirements of federal regulations promulgated after Clean Smokestacks, such CSAPR and MATS, and discusses the concept of environmental compliance cost escalation risk. Section 2 explains how Clean Smokestacks facilitated compliance with CSAPR and the acid gas requirements of MATS. Section 3 compares the capital costs to ratepayers of complying with CSAPR and MATS acid gas requirements with and without Clean Smokestacks. Section 4 explores the benefits of Clean Smokestacks. It begins with a quantitative assessment of the reduced premature mortality benefits from SO_2 emissions reductions. It then provides a qualitative discussion of other health, environmental, and regulatory compliance benefits. Finally, Section 5 discusses the benefits of state legislation that moves ahead of federal regulations given the results of Clean Smokestacks. Section 5 concludes with a discussion of what states should consider when creating similar legislation or regulations.

[1] Short compliance timelines are often determined by statute, and new standards often come in bursts as a result of court decisions. Citizen suits are common in environmental law and can lead to court-ordered new rules. In addition, most major EPA rules that are proposed are challenged in court, which can delay implementation for years. (*See* for example May, James. R. "Now more than ever: Trends in environmental citizen suits at 30."*Widener Law Review (*10) 1, 2003.; McCarthy, James E. and Claudia Copeland "EPA Regulations: Too much, too little, or on track?" Congressional Research Service. January 24, 2012").

[2] Hanser, Philip Q, Metin Celebi, and Bin Zhou. "State Regulatory Hurdles to Utility Environmental Compliance," The Electricity Journal, Vol 25, (3), April 2012. Describing potential rate shock when large capital investments are added to rate base to meet new federal environmental compliance.; Sickinger, Ted. "PacifiCorp sticks with coal despite cost of retrofitting," Mail Tribune, June 27, 2011. Available at: http://www.mailtribune.com/apps/pbcs.dll/article?AID=/20110627/BIZ/106270305 Describing expected rate impacts of updating coal plants to meet forthcoming EPA rules, which would occur primarily between 2013 and 2015.

[3] NERC, 2011 Long-Term Reliability Assessment; Potential Impact of Future Environmental Regulations, November 2011.

1. Legal and Theoretical Background

Clean Smokestacks Act

With passage of the Clean Smokestacks Act in 2002,[4] North Carolina required major investor-owned utilities to reduce SO_2 and NO_x emissions from in-state coal-fired power plants by more than 70% over an 11-year compliance period.[5] Clean Smokestacks set annual NO_x emissions caps for Duke Energy (Duke) and Progress Energy (Progress) at 35,000 and 25,000 tons, respectively, beginning in 2007. Duke's annual NO_x emissions cap ratchets down to 31,000 tons beginning in 2009. Clean Smokestacks sets a similar emissions cap and reduction schedule for SO_2, starting with an annual ceiling of 150,000 and 100,000 tons in 2009 for Duke and Progress, respectively, and dropping to 80,000 and 50,000 tons per year in 2013.[6] While the Act sets specific emissions limits, Clean Smokestacks does not dictate a method for achieving those limits.[7] In addition, Clean Smokestacks allows Duke and Progress to pass the costs of achieving emissions reductions to consumers, though indirectly. The Act freezes electric utility rates from 2002 through 2007[8] and requires Duke and Progress to amortize capital costs of at least $1.6 billion during that period,[9] without earning a return or recovering financing costs. The rate freeze, however, allowed Duke and Progress to retain 2002-level rates, which likely would have been lowered without Clean Smokestacks.[10]

North Carolina passed Clean Smokestacks at a time when more stringent federal limits on NO_x, SO_2, and hazardous emissions from power plants were foreseeable.[11] In a broad sense, federal environmental regulations become more stringent over time. This is largely because improved technology increases the scientific understanding of environmental and health impacts from air pollution and reduces the cost of emissions abatement. In 2002, chronic nonattainment of 8-hour ozone standards remained a significant problem across the eastern United States despite progress under the NO_x State Implementation Plan (SIP) Call. This suggested that the 1998 NO_x SIP Call would not adequately abate downwind emissions of NO_x, thus requiring additional EPA regulations.[12] The eastern states also experienced difficulty in meeting air quality standards for fine particulate matter ($PM_{2.5}$), a problem reflected in the EPA's $PM_{2.5}$ monitoring data for 2001–2003 (SO_2 is a precursor to $PM_{2.5}$).[13] The Clean Air Act requirement that air quality standards be reviewed every five years also suggested forthcoming federal air quality regulations. The most recent review of NO_x and SO_2 standards before 2002 was in 1996, six years prior,[14] and air quality

[4] Clean Smokestacks Act, 2002 N.C. Sess. Laws 72 (codified as amended at N.C. Gen. Stat. §§ 62-133.6 and in scattered sections of ch. 143, art. 21B (2011)).

[5] *See infra* Table 1 and accompanying text.

[6] N.C. Gen. State § 143-215.107D(b)–(e) (2011).

[7] § 143-215.107D(f) ("Each investor-owned public utility to which this section applies may determine how it will achieve the collective emissions limitations imposed by this section.").

[8] N.C. Gen. Stat. § 62-133.6(e) (2011).

[9] § 62-133.6(b).

[10] Morendi, Larry. "Clearing the Air: North Carolina's Clean Smokestacks Act N.C. Sess. Laws Chap. 4." National Council of State Legislatures. 2004.

[11] See for example, N.C. Division of Air Quality. "Press Release: Senate Passes Easley's Clean Smokestacks Bill," *NC DENR.* June 18, 2002 Accessed June 25, 2012 at: http://www.ncair.org/news/pr/2002/smokestack3_0602.shtml Stating that "The cuts in both SO_2 and NO_x emissions are expected to reduce acid rain and serve as a significant step toward meeting the new federal fine particle and ozone standards in North Carolina." EPA updated the 1997 particulate matter NAAQS in 2006 and the 1997 ozone NAAQS in 2008 (http://www.epa.gov/ttn/naaqs/).

[12] EPA. "Evaluating Ozone Control Programs in the Eastern United States: Focus on the NO_x Budget Trading Program, 2004." August 2005. Accessed from: http://www.epa.gov/airtrends/2005/ozonenbp/

[13] Clean Air Interstate Rule, 70 Fed. Reg. 25,162, 25,169 (May 12, 2005) ("The $PM_{2.5}$ ambient air quality monitoring for the 2001-2003 period shows that areas violating the standards are located across much of the eastern half of the United States . . . .").

[14] 61 Fed. Reg. 52,852 (Oct. 8, 1996) (declining to revise primary and secondary standards for NO_x); 61 Fed. Reg. 25,566 (May 22, 1996) (declining to revise primary and secondary standards for SO_2).

standards for those pollutants had not been strengthened in over 30 years.[15] Also, impending federal air quality regulations for hazardous air pollutants appeared certain. The EPA's 2000 decision to list coal- and oil-fired power plants as a new category of sources of hazardous air pollutants[16] required the EPA, by the end of 2003, to control mercury and other hazardous air pollutants emitted from power plants.[17] In this environment, rather than wait for federal implementation of more stringent air pollution controls, North Carolina responded to public health and environmental concerns and enacted its own laws to reduce air pollution.[18]

Current Federal Controls of Air Pollution

Within a decade of the passage of Clean Smokestacks, the EPA took stricter regulatory action to address NO_x, SO_2, and hazardous air emissions. In 2011 the EPA promulgated the Cross-State Air Pollution Rule (CSAPR) to reduce electricity-sector emissions of NO_x and SO_2 that migrate across state borders and contribute to nonattainment of air quality standards by downwind states.[19] CSAPR sets emissions caps for 27 states whose emissions adversely affect the ability of one or more downwind states to meet air quality standards for annual $PM_{2.5}$, 24-hour $PM_{2.5}$, and/or ozone.[20] The rule requires North Carolina to achieve emissions reductions of SO_2, annual NO_x, and ozone-season NO_x by 2012 and then stricter reductions of SO_2 emissions by 2014.[21]

The D.C. Circuit stayed CSAPR in January 2012, which left the Clean Air Interstate Rule (CAIR) in effect pending judicial review of CSAPR.[22] The EPA promulgated CAIR in 2005 to reduce migratory emissions from 28 states and the District of Columbia that significantly interfered with the ability of downwind states to meet air quality standards for ozone and fine particulate matter ($PM_{2.5}$). To this end, CAIR required upwind states either to reduce emissions of NO_x and SO_2 directly or to participate in a voluntary interstate trading program that would reduce total regional emissions of NO_x and SO_2.[23] The D.C. Circuit rejected CAIR in December 2008 due to "fundamental flaws"[24] and instructed the EPA to implement a new program to resolve the problem of migratory emissions.[25] Rather than vacate CAIR, the D.C. Circuit left the rule in place until the EPA finalized a replacement rule.[26] The EPA intends for CSAPR to replace CAIR.

The EPA proposed the Mercury and Air Toxics Standards (MATS) in December 2011 to limit the emission of heavy metals (e.g., mercury, arsenic, chromium, and nickel) and acid gases (e.g., hydrochloric acid and hydrofluoric acid) from new and existing coal- and oil-fired power plants.[27] Reducing these toxic emissions will concomitantly reduce emissions of SO_2 and fine particulate matter. The rule sets numerical emission limits for mercury, PM, hydrochloric acid, and hydrofluoric acid, depending on whether the source is coal- or oil-fired. To reduce emissions of organic air toxins, MATS

[15] EPA Table of Historical NO_x NAAQS, http://www.epa.gov/ttn/naaqs/standards/nox/s_nox_history.html (last visited May 21, 2012) (showing no revision of NAAQS for NO_x between 1971 and 2002); EPA Table of Historical SO_2 NAAQS, http://www.epa.gov/ttn/naaqs/standards/so2/s_so2_history.html (last visited May 21, 2012) (showing no tightening of NAAQS for SO_2 between 1971 and 2002).
[16] Regulatory Finding on the Emissions of Hazardous Air Pollutants from Electric Utility Steam Generating Units, 65 Fed. Reg. 79,825 (Dec. 20, 2000).
[17] EPA History of Mercury Air Toxics Standards, http://www.epa.gov/mats/actions.html (last visited May 16, 2012).
[18] Ross, Bill. "The North Carolina Clean Smokestacks Act," *NC Medical Journal Vol 72. No. 2.*, 2011.
[19] U.S. EPA, FACT Sheet the Cross-State Air Pollution Rule: Reducing the Interstate Transport of Fine Particulate Matter and Ozone, July 2011.
[20] EPA Cross-State Air Pollution Rule, 76 Fed. Reg. 48,208, 48,209 (Aug. 8 2011).
[21] 76 Fed. Reg. at 48,212–13.
[22] EME Homer City Generation, L.P. v. EPA, No. 11-1302 (D.C. Cir. Dec. 30, 2011).
[23] North Carolina v. EPA, 531 F.3d 896, 903 (D.C. Cir. 2008), *rev'd en banc*, 550 F.3d 1176 (D.C. Cir. 2008).
[24] North Carolina v. EPA, 550 F.3d 1176, 1178 (D.C. Cir. 2008) (rehearing en banc).
[25] *Id.* (remanding to EPA "to conduct further proceedings consistent with [its] prior opinion" published at 531 F.3d at 929–30).
[26] 550 F.3d at 1178.
[27] Mercury and Air Toxics Standards, 77 Fed. Reg. 9304 (Feb. 16, 2012).

establishes work practice standards rather than numerical limits.[28] Existing sources must comply with MATS within four years.[29]

Environmental Compliance Cost Escalation

New environmental regulations can create sudden increases in demand for environmental retrofits under short timeframes, thereby increasing retrofit costs. The North American Electric Reliability Corporation's (NERC) 2011 Long-Term Reliability Assessment of EPA regulations describes this risk as follows:[30]

> [I]implementation (of EPA regulations) will place demands on the equipment and construction sectors since multiple EPA programs will be phased in over the same time frame. This situation is compounded by a significant number of electric generation units…are likely to retrofit environmental controls, and there will be competition created by replacement generation capacity projects and other heavy U.S. infrastructure projects in other sectors. Costs could escalate beyond the assumed compliance costs, should the EPA require compliance within three years of the final rulemaking dates. Therefore, the Strict Case[31] includes an increase of 25 percent for the required control equipment.

Other research and industry groups also cite the potential for cost increases during short compliance periods. In 2011 The Brattle Group, a private consulting firm, conducted an assessment of likely coal-fired power plant retirements due to forthcoming EPA rules.[32] The assessment included a scenario in which retrofit costs double as a result of potential increases in demand for labor and control equipment and site-specific factors.[33] A separate 2012 Brattle Group study commissioned by Midwest Independent Transmissions System Operator (MISO) found that compliance period for MATS will likely create bottlenecks leading to delays or cost escalation.[34] This projection reflects expected increases in demand for specialized labor, engineering, equipment and construction needed to complete environmental retrofits.[35] For example, the analysis shows the number of boilermakers needed to comply with MATS is likely to be four times the amount currently employed by the U.S. utility industry.[36] Some upgrades are also likely to impose longer-than-normal plant outages.[37]

In a study of how EPA rules will affect electricity prices in Indiana, the State Utility Forecasting Group at Purdue University similarly noted that "if a large number of generating units are required to undergo similar retrofits of emission control devices in a relatively short time period, it could result in tight supply availability for materials, engineering services, skilled construction labor, and financing."[38] The Purdue University study did not quantify the potential cost escalation. A survey by the Electric Utility Cost

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[28] EPA, Fact Sheet: Mercury and Air Toxics Standards for Power Plants 3, *available at* http://www.epa.gov/mats/pdfs/20111221MATSsummaryfs.pdf (last visited May 17, 2012).
[29] *Id.*at 2.
[30] North American Electric Reliability Corporation, "2011 Long-Term Reliability Assessment," Nov. 2011, p. 127.
[31] The NERC 2011 Long Term Reliability Assessment's evaluation of the potential impacts of future environmental regulations includes two cases a "Moderate Case" and a "Strict Case." See NERC. "Long Term Reliability Assessment," 2011 pp 116-174.
[32] Celebi, Metin, Frank Graves, Gunjan Bathla, and Lucas Bressan, "Potential Coal Plant Retirements Under Emerging Environmental Regulations." The Brattle Group, Inc. December 2010, Update August 10, 2011.
[33] Celebi, Metin, Frank Graves, Gunjan Bathla, and Lucas Bressan, "Potential Coal Plant Retirements Under Emerging Environmental Regulations." The Brattle Group, Inc. December 2010, Update August 10, 2011.
[34] Celebi, Metin, Kathleen Spees, Quincy Liao, and Steven Eisenhart. "Supply Chain and Outage Analysis of MISO Coal Retrofits for MATS." May 2012. p. 42.
[35] *Id.* at 43.
[36] *Ibid.*
[37] *Ibid.*
[38] Velastegui, Marco A., Douglas J. Gotham, Timothy A. Phillips, Paul V. Preckel, David G. Nderitu, "The Impacts of Federal Environmental Regulations on Indiana Electricity Prices," Electricity Regulatory Cost Group, Purdue University, January 2012, p. 19.

Group, an industry association, also provides evidence of compliance cost escalation,[39] explaining that costs to install Selective Catalytic Reduction technology rose significantly following the NO_x SIP Call.[40]

In addition to potential increases in capital costs associated with compressed compliance schedules, ratepayers also face cost escalation risk from factors external to the electricity sector. Inflation-adjusted electricity sector capital costs (excluding nuclear) increased approximately 40% from 2005 to 2008 due primarily to increasing commodity prices and global economic growth.[41]

2. CSAPR and MATS Acid Gas Compliance with Clean Smokestacks

Compliance with Clean Smokestacks

Table 1 demonstrates that Duke and Progress are in compliance with the emissions requirements of Clean Smokestacks. The Act requires Duke and Progress to achieve emissions limits for NO_x in 2009 and SO_2 in 2010 and 2013. In practice, these limits require Duke and Progress to reduce NO_x emissions from their in-state coal plants 60% by 2009 and SO_2 emissions 72% by 2013 relative to 2002 emissions.[42] Duke has already met its 2009 NO_x and 2013 SO_2 compliance requirements. Progress has met its NO_x requirement and is on schedule to meet the 2013 SO_2 requirement.[43]

Table 1. Historic coal-plant emissions compared with Clean Smokestacks emissions limits for Duke and Progress (tons/year).

Annual SO_2 emissions (tons)		
Year	Duke	Progress
Actual emissions		
2002	263,909	195,734
2010	42,769	73,748
Clean Smokestacks caps		
2010	150,000	100,000
2013	80,000	50,000

Annual NO_x emissions (tons)		
Year	Duke	Progress
Actual emissions		
2002	81,896	58,793
2010	22,438	24,741
Clean Smokestacks caps		
2007	35,000	25,000
2009	31,000	25,000

Compliance with Cross-State Air Pollution Rule

North Carolina emissions caps under CSAPR are detailed in table 2. Net North Carolina electricity sector emissions in 2010,[44] subtracting emissions from Duke and Progress coal units scheduled to retire, are below the 2014 CSAPR caps. 2010 North Carolina net SO_2 and NO_x emissions are not an exact approximation of future emissions because they do not include additional emissions expected from new and existing generation that will need to operate at higher capacity factors to replace generation from retiring units. Nevertheless 2010 net emissions show that North Carolina is well positioned to comply with the CSAPR because of reductions achieved under Clean Smokestacks and scheduled retirements.[45]

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[39] The EUCG is an association of electric utility industry professionals. Although the details of the final survey data are only available to EUCG members that participate in a given survey, a 2006 Power Magazine article published a summary of the survey results: "Estimating SCR Installation Costs." POWER Magazine. February 15, 2006. Accessed March 1, 2012 at: http://www.powermag.com/coal/Estimating-SCR-installation-costs_506_p3.html.

[40] The article attributes the observed cost increases to both the increasing complexity of later projects and competition for skilled labor.

[41] HIS CERA Power Capital Cost Index, available from http://www.ihsindexes.com/.

[42] NC Division of Air Quality website - http://daq.state.nc.us/news/leg/. Percent reductions based on combined Duke and Progress emissions reduction requirements.

[43] Ibid.

[44] Includes all North Carolina emissions sources regulated by CAIR.

[45] The nonretiring units and new units that will operate at higher capacity factors in 2014 have significantly lower emissions rates than the retiring units. See table 3 for emissions rate retrofitted and retiring coal units.

In fact, Progress Energy's 2010 Integrated Resource notes that the company "is well positioned to comply with the requirements of the Transport Rule given the Clean Smokestacks Act's requirements."[46]

Table 2. CSAPR North Carolina emissions limits and historical emissions.

	Annual SO_2 tons	Annual NO_x tons	Ozone-season NO_x tons
2012-2013 CSAPR NC limit	136,881	50,587	22,168
2014 + CSAPR NC limit	57,620	41,553	18,455
2010 NC electricity emissions	120,387	54,635	26,470
2010 NC emissions from Duke & Progress coal units scheduled to be retired	75,684	18,496	8,605
2010 NC net emissions after subtracting emissions from units scheduled to be retired	44,703	36,139	17,865

Historical emissions data from http://ampd.epa.gov/ampd.

Compliance with Mercury Air Toxics Standards Acid Gas Standard

MATS sets numeric limits for mercury, particulate matter as a surrogate for nonmercury hazardous metals, and hydrochloric acid (HCl) as a surrogate for toxic acid gases. MATS includes an alternative acid gas compliance standard based on an SO_2 emissions limit of 1.5 lbs/MWh.[47] Table 3 lists all Duke and Progress coal units operating in 2010 as well as each unit's 2010 net generation, SO_2 emissions, and SO_2 emissions rate. Units that are retired or scheduled to be retired are shaded in blue. SO_2 emissions rates exceeding 1.5 lbs/MWh are highlighted with red text. With the exception of Cliffside unit 5, all units not scheduled to retire have SO_2 emissions below or near the MATS standard. Duke installed a scrubber on Cliffside unit 5 in 2010 that reduces SO_2 emissions approximately 95%.[48] EPA modeling of the MATS rule projects that all Duke and Progress North Carolina coal units not scheduled to retire are in compliance with the acid gas emissions standard using currently installed control technologies.[49,50]

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[46] Progress Energy, Progress Energy Carolinas Integrated Resource Plan, September 2010, Docket E-100 Sub 128

[47] EPA, Regulatory Impact Analysis for the Final Mercury and Air Toxics Standards, EPA-452/R-11-011 December 2011.

[48] Cliffside unit 5 2010 emissions include emissions before and after the scrubber began operating. http://www.duke-energy.com/power-plants/coal-fired/cliffside.asp.

[49] National Electric Energy Data System (NEEDS) v4.10_Ptox, USEPA Database, available from http://www.epa.gov/airmarkets/progsregs/epa-ipm/toxics.html.

[50] Documentation for Integrated Planning Model, Updates to EPA Base Case v4.10_PTox, USEPA, available from http://www.epa.gov/airmarkets/progsregs/epa-ipm/toxics.html.

Table 3. North Carolina Duke and Progress Coal Units in 2010, 2010 SO2 emissions, emissions rate, average capacity (winter and summer) and retirement date given in 2011 IRPs.

Plant name	Operator	Unit	2010 net generation (MWh)	2010 SO_2 emissions (tons)	2010 SO_2 emissions (lbs/MWh)	Capacity (MW)	Retirement date
Asheville	Progress Energy	1	1,250,462	850	1.36	193.5	
Asheville	Progress Energy	2	1,133,003	1,145	2.02	186	
Cape Fear	Progress Energy	5	936,920	5,512	11.77	146	6/13
Cape Fear	Progress Energy	6	1,094,391	7,826	14.30	173.5	6/13
Lee	Progress Energy	1	438,244	2,884	13.16	77	9/12
Lee	Progress Energy	2	374,378	2,902	15.50	78.5	9/12
Lee	Progress Energy	3	1,577,447	9,744	12.35	248.5	9/12
Roxboro	Progress Energy	1	2,692,339	2,140	1.59	369	
Roxboro	Progress Energy	2	3,904,461	3,071	1.57	664.5	
Roxboro	Progress Energy	3	4,884,695	4,201	1.72	695.5	
Roxboro*	Progress Energy*	4	4,497,771	2,702	1.20	704.5	
Sutton	Progress Energy	1	408,849	3,388	16.57	97.5	12/13
Sutton	Progress Energy	2	435,863	3,579	16.42	105.5	12/13
Sutton	Progress Energy	3	1,748,367	11,861	13.57	400	12/13
Weatherspoon	Progress Energy	1	162,021	1,687	20.83	48.5	Retired
Weatherspoon	Progress Energy	2	144,094	1,553	21.55	48.5	Retired
Weatherspoon	Progress Energy	3	331,067	3,334	20.14	76.5	Retired
Mayo*	Progress Energy*	1	4,875,172	5,369	2.20	731	
Allen	Duke Energy	1	672,523	296	0.88	164.5	
Allen	Duke Energy	2	597,457	272	0.91	164.5	
Allen	Duke Energy	3	1,437,545	489	0.68	265.5	
Allen	Duke Energy	4	1,468,005	484	0.66	279	
Allen	Duke Energy	5	1,297,851	530	0.82	270.5	
Buck	Duke Energy	*3*	*65,300*	*322*	*9.85*	75	Retired
Buck	Duke Energy	*4*	*36,115*	*259*	*14.34*	34	Retired
Buck	Duke Energy	5	537,204	2,834	10.55	129.5	1/15
Buck	Duke Energy	6	498,306	2,776	11.14	129.5	1/15
Cliffside	Duke Energy	*1*	*6,232*	*82*	*26.38*	38.5	Retired
Cliffside	Duke Energy	*2*	*6,863*	*92*	*26.79*	38.5	Retired
Cliffside	Duke Energy	*3*	*16,839*	*178*	*21.11*	61.5	Retired
Cliffside	Duke Energy	*4*	*17,240*	*162*	*18.77*	61.5	Retired
Cliffside	Duke Energy	5	2,514,574	11,703	9.31	559	
Dan River	Duke Energy	1	96,098	762	15.86	68	4/12
Dan River	Duke Energy	2	98,724	762	15.43	68	3/12
Dan River	Duke Energy	3	400,309	2,767	13.82	143.5	4/12
Marshall	Duke Energy	1	1,925,699	608	0.63	380	
Marshall	Duke Energy	2	1,747,382	568	0.65	380	
Marshall	Duke Energy	3	4,290,759	1,163	0.54	658	
Marshall	Duke Energy	4	4,811,737	1,319	0.55	660	
Riverbend	Duke Energy	4	238,014	1,997	16.78	95	1/15
Riverbend	Duke Energy	5	227,699	1,904	16.72	95	1/15
Riverbend	Duke Energy	6	403,714	3,170	15.70	134.5	1/15
Riverbend	Duke Energy	7	411,201	3,336	16.23	134.5	1/15
Belews Creek	Duke Energy	1	8,354,413	2,102	0.50	1,122.5	
Belews Creek	Duke Energy	2	6,356,717	1,523	0.48	1,122.5	

Annual generation data EIA923 database. Emissions data from EPA Clean Air Markets database: http://ampd.epa.gov/ampd.
*Joint owned

3. Cost of Complying with CSAPR and MATS with and without Clean Smokestacks and Capital Cost Risk

Summary

Whether the cost of compliance with CSAPR and MATS acid gas requirements is lower with or without Clean Smokestacks depends on assumptions about future costs and their timing. As noted in section 2, the cost of retrofits to comply with CSAPR and MATS could escalate beyond current estimates due to sudden increases in demand for specialized labor and equipment. In addition, compliance costs are dependent on the expected operating lifetimes of retrofits. For example, if environmental control equipment lasts 30 years before requiring refurbishment or replacement, compliance costs are less than they would be if the same environmental control equipment had an expected operating lifetime of 20 years.

To account for these uncertainties and represent a range of possible futures, the Nicholas Institute estimated compliance costs across multiple scenarios. In scenarios without Clean Smokestacks, compliance costs are calculated for two sets of scenarios: one set of scenarios with 25% compliance cost escalation based on the NERC Strict Case,[51] and another set of scenarios without a sudden escalation of compliance costs. In addition, scenarios vary by the expected operating lifetimes of retrofits, 20 or 30 years,[52] before environmental control equipment needs to be replaced or refurbished, henceforth referred to as *capital cost cycles*. Scenarios also vary by assumptions about refurbishment or replacement cost at the end of each environmental retrofit's capital cost cycle (100%, 75%, 50%, 25%). For example, refurbishment at the end of a 20-year capital cost cycle could be 25% of the original retrofit cost or 75%. Only capital costs are included in this compliance cost analysis. A qualitative discussion of operating costs is provided after the quantitative results.

The scenarios with Clean Smokestacks assume all Duke and Progress North Carolina coal plants not scheduled to retire are in compliance with CSAPR and the MATS acid gas requirements. This means that Duke and Progress ratepayers have already paid for a major portion of CSAPR and MATS compliance costs. Therefore total costs include the present value of past costs and net present value of future costs in the scenarios with Clean Smokestacks. In the scenarios without Clean Smokestacks, total compliance costs equal the net present value of future costs only.

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[51] The NERC 2011 Long Term Reliability Assessment's evaluation of the potential impacts of future environmental regulations includes two cases a "Moderate Case" and a "Strict Case." See NERC. "Long Term Reliability Assessment," 2011 pp 116-174.
[52] Most electricity generation is paid for over a 20- to 30-year period.

Table 4. Scenarios comparing CSAPR and MATS acid gas requirements compliance costs with and without Clean Smokestacks (24 total scenarios).

	30-year capital cost cycle			20-year capital cost cycle		
	Clean Smokestacks	Without Clean Smokestacks	Without Clean Smokestacks 25% capital cost escalation	Clean Smokestacks	Without Clean Smokestacks	Without Clean Smokestacks 25% capital cost escalation
Refurbishment costs at end of capital cost cycle as % original capital costs	100%	100%	100%	100%	100%	100%
	75%	75%	75%	75%	75%	75%
	50%	50%	50%	50%	50%	50%
	25%	25%	25%	25%	25%	25%

In scenarios without 25% compliance cost escalation, total compliance costs are higher with Clean Smokestacks. However, for most scenarios with 25% compliance cost escalation, total compliance costs with Clean Smokestacks are lower. This indicates that Clean Smokestacks likely protects ratepayers from cost escalation risk. Clean Smokestacks also spreads out compliance costs and provides health and environmental benefits discussed in section 4.

Key Assumptions

Precisely determining compliance costs for the scenarios without Clean Smokestacks is inherently difficult because they represent investment decisions for a set of conditions that do not exist. Without Clean Smokestacks, Duke and Progress would need to retrofit or retire and replace most of their coal units over a restricted compliance period with different economic conditions than existed from 2002 to 2011, when Duke and Progress retrofitted or made decisions to retire and replace the majority of their North Carolina coal units. To compare compliance costs with and without Clean Smokestacks, the Nicholas Institute employs two primary assumptions about Duke and Progress unit retirements and retrofits to comply with CSAPR and MATS acid gas requirements in the absence of Clean Smokestacks.

1. *Coal unit retirements are the same and retirement dates are approximately equivalent with and without Clean Smokestacks, thereby restricting the capital cost comparison to nonretiring coal units.*

The Nicholas Institute limits the capital cost comparison to nonretiring coal units because it is likely that the same coal units would have retired or be scheduled to retire with or without Clean Smokestacks, on a potentially different timeline. Duke and Progress have retired or announced plans to retire a number of older, small-capacity coal units,[53,54] many of which they planned to retrofit in their earlier Clean Smokestacks compliance plans.[55] Since Clean Smokestacks became law in 2002, capital costs to build new coal generation have increased relative to new natural gas generation. Technological advances have also increased the economic supply of unconventional natural gas resources and reduced fuel prices for natural gas generators. Combined with CSAPR, MATS, and proposed cooling water and coal ash regulations, these trends have caused many utilities throughout the country to announce retirements of coal units.[56] Furthermore, Duke's Cliffside unit 6 Certificate of Public Convenience and Necessity

[53] Duke Energy, The Duke Energy Carolinas Integrated Resource Plan (Annual Report), September, 2011, Docket E-100 Sub 128
[54] Progress Energy, Progress Energy Carolinas Integrated Resource Plan, September 2011, Docket E-100 Sub 128
[55] NC DENR & NCUC, Implementation of the 'Clean Smokestacks Act', 2002, available from http://www.ncuc.commerce.state.nc.us/reports/report.htm.
[56] Aden, Nate and James Bradbury. "EPA Mercury Rules Keeping the Lights On While Removing Toxics from Our Air." World Resources Institute. December 8, 2011. Citing 231 announced coal plant retirements attributed to forthcoming EPA rules,

requires it to retire Cliffside units 1–4 and retire an additional 800 MW of older coal capacity dependent on reliability constraints and demand reduction achieved through demand-side management programs.[57] Progress retired 173.5 MW of coal capacity at the end of 2011 and is scheduled to retire an additional 1,326 MW over the next two years.

Along with emissions reductions from plants retrofitted under Clean Smokestacks, these retirements should make total North Carolina electricity sector emissions approximately equal to the state's 2012 annual NO_x cap and the 2014 SO_2 and NO_x ozone-season caps under the CSAPR, making it likely that Duke and Progress would also retire these units in the absence of Clean Smokestacks.[58] Given that Duke and Progress coal retirements were either required by the NCUC outside of Clean Smokestacks or would have likely still occurred without Clean Smokestacks, the Nicholas Institute assumes that capital cost of new generation to meet increased demand and replace retired capacity is approximately the same for both the hypothetical scenarios without Clean Smokestacks and the scenarios with Clean Smokestacks.

2. *Duke and Progress would make the same retrofits to comply with CSAPR and the MATS acid gas requirement in the absence of Clean Smokestacks as were made to comply with Clean Smokestacks, but on a schedule dictated by the compliance timelines of the CSAPR and MATS. The cost of retrofits made in the scenario without Clean Smokestacks are adjusted to account for changes in capital cost in the electricity sector.*

The Nicholas Institute assumes that, absent Clean Smokestacks, Duke and Progress would make approximately the same retrofits to nonretiring coal units as were made under Clean Smokestacks because net 2010 North Carolina electricity sector emissions with Clean Smokestacks, after accounting for future retirements, approximately match cap limits under CSAPR, and because SO_2 emissions rates of all 2010 coal units (other than Cliffside unit 5) are near or below the MATS surrogate SO_2 emissions limit for acid gases.

Capital Cost Comparison Methodology

The Nicholas Institute compared CSAPR and MATS acid gas requirements compliance capital costs with a two-step process: 1) estimating future compliance costs paid by Duke and Progress ratepayers beginning in 2012 for all scenarios, and 2) calculating the present value of past costs and adding these to future costs to estimate total cost for scenarios with Clean Smokestacks. For scenarios with Clean Smokestacks, future CASPR and MATS acid gas compliance costs include unamortized Clean Smokestacks capital costs.[59] Total cost for scenarios with Clean Smokestacks includes the present value of capital costs paid

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compiled by Edison Electric Institute.; NERC, 2011 Long-Term Reliability Assessment; Potential Impact of Future Environmental Regulations, November 2011; McCarthy, James E. and Claudia Copeland. "EPA's Regulation of Coal-Fired Power: Is a 'Train Wreck' Coming?" Congressional Research Service. August 8, 2011.*; See also* Tierney, Susan F. "Why Coal Plants Retire: Power Market Fundamentals as of 2012" Analysis Group Inc, February 16, 2012.

[57] NCUC, Docket E-7, Sub 790 Order Granting Certificate of Public Convenience and Necessity with Conditions, March 2007.

[58] In service dates for new natural gas generation built by Duke and Progress to replace retiring coal generation and meet new demand largely coincide with CSAPR and MATS compliance timelines. Duke's Buck natural gas combined cycle (NGCC) plant entered service November 2011. The Dan River NGCC is scheduled to enter service at the end of 2012 and the Lee conversion to natural gas is scheduled to finish in 2014 or 2015. Progress' Richmond NGCC entered service June 2011. The Wayne and Sutton NGCC units are both scheduled to enter service in 2013. From Duke and Progress 2010 and 2011 Integrated Resource Plans.

[59] Unamortized Clean Smokestacks capital costs are capital costs associated with Clean Smokestacks compliance that have not been paid by ratepayers as of the beginning of 2012.

for by ratepayers through 2011, including returns on capital costs added to rate base[60] and future capital costs including returns on rate base.[61]

By statute, North Carolina investor-owned utilities may recover a "fair return" on all prudent capital investments, as determined by the North Carolina Utility Commissions (NCUC).[62] Approved capital costs are added to the utilities' rate base.[63] The overall rate of return earned by Duke and Progress is equal to their total profits after taxes from electricity sales to regulated customers, divided by their rate base.[64] Ratepayers' nominal rate of return and discount rate are both assumed to be equal to Duke and Progress' average overall rate of return from 2001 to 2010.

Table 5. Historical annual overall rates of return.[65]

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Progress	8.07%	9.32%	8.84%	8.77%	7.12%	7.78%	7.65%	8.60%	9.02%	9.52%
Duke	10.45%	9.79%	10.63%	9.28%	8.44%	8.55%	8.77%	8.61%	7.76%	7.74%

Capital costs of retrofits for compliance with CSAPR and MATS acid gas requirements without Clean Smokestacks are based on the annual compliance capital costs for Duke and Progress reported in the annual *Implementation of the "Clean Smokestacks Act"* reports co-authored by the North Carolina Department of Environment and Natural Resources (NC DENR) and the North Carolina Utilities Commission (NCUC).[66] Costs reported in each year are converted to 2011 dollars and adjusted for electricity sector capital cost escalation based on Cambridge Energy Research Associates Power Capital Cost Index (PCCI) for North America.[67] Future capital cost escalation beyond baseline inflation is based on a linear regression of PCCI cost escalation data from 2000–2011. Duke and Progress retrofitted existing coal plants over 11 and 10 years, respectively, to comply with Clean Smokestacks. In the absence of Clean Smokestacks, Duke and Progress would have approximately 4 years (2012–2015) to comply with CSAPR and MATS.[68]

Table 6. IHS CERA Power Capital Costs Index (PCCI) North America.

PCCI	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Overall PCCI	100	103	108	114	124	136	181	233	224	213	215	219
Overall PCCI, without nuclear	100	106	111	116	124	135	164	177	189	174	176	180

http://www.ihsindexes.com/, accessed July 18, 2012.

[60] Duke Clean Smokestacks capital costs beyond the $1.185 billion (2011$) cost amortized during the rate freeze were added to Duke's rate base. Similarly, Progress Clean Smokestacks capital costs beyond the $665 million (2011$) amortized during the rate freeze were added to Progress' rate base.
[61] The analysis does not include associated funds used during construction (AFUDC). Total capital cost for scenarios without Clean Smokestacks are equal to future costs including returns on rate base.
[62] § 62-133 (4)
[63] § 62-133 (4)
[64] The Nicholas Institute assumes all future capital costs to comply with CSAPR and MATS acid gas requirements are added on a one to one basis to the rate base. Ratepayers pay for capital costs through depreciation (amortization) costs, passed onto ratepayers as an expense and return on rate base.
[65] Quarterly Review Selected Financial and Operational Data, North Carolina Utility Commission, http://ncuc.commerce.state.nc.us/cgi-bin/miscfldrdocs.ndm/INPUT?flddesc=QUARTERLY+REVIEW&numret=20&Search=Search
[66] Available from http://www.ncuc.commerce.state.nc.us/reports/report.htm
[67] IHS CERA Power Capital Costs Index (PCCI) North America, http://www.ihsindexes.com/, accessed 1-9-12.
[68] In the absence of Clean Smokestacks, the Nicholas Institute divided total retrofit capital costs under Clean Smokestacks, converted to 2011 dollars and adjusted for cost escalation assuming construction in 2011, by four to estimate capital costs from 2012–2015. These costs were then adjusted to account for future cost escalation.

To estimate the total future capital cost of complying with CSAPR and MATS acid gas limits with and without Clean Smokestacks, the Nicholas Institute estimated the net present value of capital costs 80 years into the future for 30-year capital cost cycle scenarios and 70 years into the future for 20-year capital cost cycle scenarios. This assumes that all retrofitted coal units will operate for the next 70+ to 80+ years and must continuously comply with the CSAPR and MATS acid gas emissions limits.[69] In all scenarios, the original environmental retrofits are either replaced with equivalent "new" retrofits or refurbished at 25%, 50%, or 75% of the original capital cost, adjusted for cost escalation, at the end of each capital cost cycle. For the 25% compliance cost escalation scenarios (without Clean Smokestacks), the second, third, and fourth (if applicable) capital cycles do not include the 25% cost increase because it is assumed Duke and Progress (and other utilities) can anticipate these investment requirements in advance and plan accordingly to avoid the cost escalation associated with initial CSAPR and MATS compliance. Clean Smokestacks compliance costs remaining in the rate base after 2011 are included in future capital costs. The Nicholas Institute assumes constant depreciation and amortization over each capital cost cycle.

The Nicholas Institute included 70- to 80-year future capital costs in its analysis to account for the fact that at some point, all capital investments in the electricity sector must either be replaced or undergo significant refurbishment/repairs when the investments reach the end of their useful life. Thus the environmental retrofits to comply with Clean Smokestacks will reach the end of their useful life earlier and require additional capital investments prior to the retrofits made in the absence of Clean Smokestacks. Ignoring these earlier replacement costs with Clean Smokestacks would not account for the full capital costs ratepayers face. A shorter analysis timeframe would likely favor one scenario (with or without Clean Smokestacks) because the capital costs in this analysis are large and discontinuous.[70]

This method assumes that all unretired Duke and Progress coal units will operate more or less indefinitely and have to comply with emissions standards that are at least as stringent as CSAPR and MATS for the next 70 or 80 years. Forecasting what plants will be operating more than 30 years into the future is difficult but without an assumption of continuous operation the Nicholas Institute would be required to project potential replacements for these units. The 2011 Duke and Progress Integrated Resource Plans do not project that any of the retrofitted units will retire through their forecast periods,[71,72] and many coal plants have operated for 50 years or more.[73] Uncertainty about capital costs 30+ years in the future is mitigated by the fact that the present value of distant future costs is low because ratepayers' real discount rate is significantly higher than projected cost escalation.[74]

Compliance Cost Results

Comparison of future compliance expenditures

As expected, future capital costs for Duke and Progress ratepayers to comply with CSAPR and MATS acid gas requirements are significantly lower with Clean Smokestacks than without Clean Smokestacks (because ratepayers have effectively prepaid for CSAPR and MATS compliance through the Clean Smokestacks environmental retrofits). The magnitude of the future cost savings depends on the length of the capital cost cycle and future costs to refurbish or replace the original environmental retrofits. In

[69] 80 years in the future for a 30 year equipment lifecycles/capital cycle covers 3 cycles of capital investments for the scenarios with and without Clean Smokestacks. 70 years in the future for a 20 year capital cycle covers 4 cycles of capital investment for all scenarios.
[70] Whether a shorter analysis timeframe favors scenarios with or without Clean Smokestacks depends the timing of refurbishment/repairs relative to the analysis timeframe.
[71] Duke Energy, The Duke Energy Carolinas Integrated Resource Plan (Annual Report), September, 2011, Docket E-100 Sub 128.
[72] Progress Energy, Progress Energy Carolinas Integrated Resource Plan, September 2011, Docket E-100 Sub 128.
[73] Power Magazine, Predicting Coal Plant Retirements, Dr. Robert Peltier, May 1, 2011.
[74] Assuming a future inflation rate of 2%. Real discount rate equals nominal discount rate – inflation rate.

general, scenarios with lower replacement costs and a longer replacement cycle yield larger cost reductions associated with early action under Clean Smokestacks because future costs are higher if ratepayers face significant refurbishment costs relatively soon. Assuming no compliance cost escalation from 2012 to 2015, future capital costs savings for Duke ratepayers range from $1.2 billion with a 20-year capital cost cycle and 100% refurbishment (replacement) costs to $1.9 billion with a 30-year capital cost cycle and 25% refurbishment costs. For Progress ratepayers, future capital cost savings range from $600 million with a 20-year capital cost cycle and 100% refurbishment costs to $1.1 billion with a 30-year capital cost cycle and 25% refurbishment costs. If there is 25% compliance cost escalation during the initial CSAPR and MATS compliance period (2012–2015), future capital cost savings are as high as $2.6 billion for Duke ratepayers and up to $1.5 billion for Progress ratepayers. If compliance cost escalation is greater than 25%, future capital cost savings will be higher.[75]

Table 7. Net present value of future cost to ratepayers of capital investments to comply with CSAPR and MATS acid gas limits in millions of dollars ($2011). For Clean Smokestacks scenario this includes Clean Smokestacks retrofits costs remaining in rate base after 2011. Real discount rate based on historical overall rates of return for Duke and Progress and future inflation rate of 2% (real discount rate = overall rate of return – inflation).

	NPV 80 year future capital costs, 30-year capital cost cycle (M 2011$)			NPV 70 year future capital costs, 20-year capital cost cycle (M 2011$)		
	Clean Smokestacks	Without Clean Smokestacks	Without Clean Smokestacks, 25% Capital Cost Escalation	Clean Smokestacks	Without Clean Smokestacks	Without Clean Smokestacks, 25% Capital Cost Escalation
End-of-capital-cycle refurbishment, 100% original retrofit costs						
Duke Energy	$2,246	$3,827	$4,539	$3,439	$4,659	$5,350
Progress Energy	$1,492	$2,376	$2,797	$2,264	$2,918	$3,326
End-of-capital-cycle refurbishment, 75% original retrofit costs						
Duke Energy	$1,892	$3,582	$4,294	$2,767	$4,185	$4,877
Progress Energy	$1,247	$2,203	$2,624	$1,815	$2,597	$3,005
End-of-capital-cycle refurbishment, 50% original retrofit costs						
Duke Energy	$1,538	$3,337	$4,048	$2,094	$3,712	$4,403
Progress Energy	$1,002	$2,031	$2,452	$1,366	$2,276	$2,684
End-of-capital-cycle refurbishment 25% original retrofit costs						
Duke Energy	$1,184	$3,091	$3,803	$1,421	$3,238	$3,930
Progress Energy	$758	$1,858	$2,279	$917	$1,955	$2,364

Total capital cost comparison

Assuming a 20- or 30-year capital cost cycle and no compliance cost escalation, total compliance capital costs (present value of past expenditures + net present value of future expenditures) for ratepayers are higher with Clean Smokestacks than CSAPR and MATS acid gas compliance capital costs without Clean Smokestacks. If there is a 25% or greater compliance cost escalation, however, total CSAPR and MATS acid gas compliance capital costs to ratepayers are lower with Clean Smokestacks for a 30-year capital cost cycle.

[75] Cost escalation has the potential to exceed 25%. A recent Brattle Group analysis accounted for a potential doubling of retrofit cost due to potentially increasingly demand for labor and control equipment or due to site-specific constraints. See Celebi, Metin, Frank Graves, Gunjan Bathla, and Lucas Bressan, "Potential Coal Plant Retirements Under Emerging Environmental Regulations." The Brattle Group, Inc. December 2010, Update August 10, 2011.

For a 20-year capital cost cycle and 25% compliance cost escalation, total compliance capital costs with Clean Smokestacks are 3%–5% higher or approximately the same if end-of-capital-cost-cycle refurbishment costs are 100% or 75% of original retrofit costs.[76] However, with 25% compliance cost escalation, total capital costs are lower with Clean Smokestacks if refurbishing costs are 50% or 25% of original retrofit costs.[77] These results show that the ultimate result for ratepayers depends upon future costs. Clean Smokestacks protects Duke and Progress ratepayers from the risk of environmental compliance cost escalation during the shorter CSAPR and MATS compliance periods, while many coal plants across the country compete for resources to install environmental controls.

Table 8. Present value of ratepayer expenditures through 2011 to pay for capital costs of Clean Smokestacks compliance including return on rate base. Costs differ for 20 and 30-year capital cost cycles because amortization costs are lower for a 30-year capital cost cycle than a 20-year capital cost cycle.

Present Value of Past Expenditures (M $2011)	
20-year capital cycle	
Duke Energy	$2,176
Progress Energy	$1,166
30-year capital cycle	
Duke Energy	$2,128
Progress Energy	$1,142

*Based on historical average overall rates of return and historical inflation rates from the Consumer Price Index.

Table 9. Total capital cost of complying with CSAPR and MATS acid gas rule to ratepayers with and without Clean Smokestacks. Includes the present value of past expenditures paid by ratepayers and the net present value of future expenditures.

80 years, 30-year capital cycle						70 years, 20-year capital cycle				
	Clean Smokestacks			Without Clean Smokestacks	Without Clean Smokestacks, 25% capital cost increase	Clean Smokestacks			Without Clean Smokestacks	Without Clean Smokestacks, 25% capital cost increase
	Past CC	Future CC	Total			Past CC	Future CC	Total		
End-of-capital-cycle refurbishment, 100% original retrofit costs										
Duke	$2,128	$2,246	$4,374	$3,827	$4,539	$2,176	$3,439	$5,615	$4,659	$5,350
Progress	$1,142	$1,492	$2,634	$2,376	$2,797	$1,166	$2,264	$3,430	$2,918	$3,326
End-of-capital-cycle refurbishment, 75% original retrofit costs										
Duke	$2,128	$1,892	$4,020	$3,582	$4,294	$2,176	$2,767	$4,943	$4,185	$4,877
Progress	$1,142	$1,247	$2,389	$2,203	$2,624	$1,166	$1,815	$2,981	$2,597	$3,005
End-of-capital-cycle refurbishment, 50% original retrofit costs										
Duke	$2,128	$1,538	$3,666	$3,337	$4,048	$2,176	$2,094	$4,270	$3,712	$4,403
Progress	$1,142	$1,002	$2,144	$2,031	$2,452	$1,166	$1,366	$2,532	$2,276	$2,684
End-of-capital-cycle refurbishment, 25% original retrofit costs										
Duke	$2,128	$1,184	$3,312	$3,091	$3,803	$2,176	$1,421	$3,597	$3,238	$3,930
Progress	$1,142	$758	$1,900	$1,858	$2,279	$1,166	$917	$2,083	$1,955	$2,364

[76] Adjusted for cost escalation.
[77] Adjusted for cost escalation.

Costs not considered: O&M, dispatch, and reliability

This analysis only considers the capital cost impacts of Clean Smokestacks for ratepayers. Environmental control equipment also increases a coal plant's operating costs and creates minor energy penalties, on the order of 1.7% for flue gas desulfurization and 0.5% for selective catalytic reduction.[78] However, these costs are minor relative to the capital and financing costs of environmental control equipment[79] and individual Duke and Progress plant operating costs are not publicly available.

Although ratepayers have paid additional operating costs as a result of Clean Smokestacks, the extended compliance timeline of Clean Smokestacks and the compressed compliance timeline of CSAPR and MATS likely created operations cost savings for North Carolina ratepayers as well. As noted in the NERC 2011 Reliability Assessment,[80] retrofitting a significant portion of a utility's generation fleet could create difficulties for timing retrofit outages and would likely force utilities to run higher-cost plants for significant periods of time as low-cost baseload coal plants are retrofitted. According to their 2011 Integrated Resource Plans, 58% of Duke's North Carolina generating capacity and 41% of Progress' North Carolina capacity is coal.[81] Retrofitting all or a significant portion of these plants over four years would likely force large changes in plant dispatch, increasing costs. Additionally, retrofitting multiple plants simultaneously can diminish reserve margins.[82] Multiple utilities have expressed concern about these types of cost increases with the compressed compliance timeline for the forthcoming EPA regulations.[83] By providing an 11-year timeline for compliance, Clean Smokestacks mitigates these operation cost and reliability concerns for consumers.

Finally, in addition to the capital cost risk benefits, Clean Smokestacks has likely prevented a sudden jump in electricity rates. Delaying investments will often lead to sudden increases in energy costs, which tend to elicit strong reactions from consumers. The 11-year compliance period in Clean Smokestacks avoided sudden increases in electricity rates by providing regulatory certainty for Duke and Progress and allowing them to stagger investments.

4. Health, Welfare, and Environmental Benefits of Clean Smokestacks

As shown in tables 1 and 2, Clean Smokestacks created significant reductions in North Carolina's SO_2 and NO_x emissions earlier than otherwise would have been achieved exclusively under MATS and CSAPR. In fact, improving air quality was the primary goal of this legislation.[84] In addition to mitigating cost risk associated with future federal environmental standards, these reductions in air pollution helped the state meet existing federal environmental regulations that would have otherwise imposed additional compliance costs. Clean Smokestacks also yielded health and welfare benefits for North Carolina residents that are approximately an order of magnitude greater than potential increases in costs for ratepayers that may result from Clean Smokestacks.

[78] Carnegie Mellon University Center for Energy and Environmental Studies. IECM-cs 6.2.4 (c), 2010 Integrated Control Model, Carbon Sequestration Edition. http://www.cmu.edu/epp/iecm/, 500 MW subcritical coal plant.
[79] Ibid.
[80] NERC, 2011 Long-Term Reliability Assessment; Potential Impact of Future Environmental Regulations, November 2011
[81] Duke NC 2011 IRP; Progress NC 2011 IRP.
[82] Reserve margins are excess generation capacity available to insure reliability in the event that a generator unexpectedly goes offline or similar events. Utilities are required to maintain adequate reserve margins by the Federal Energy Regulatory Commissions (FERC) http://www.ferc.gov/enforcement/reliability.asp#skipnav.
[83] Bipartisan Policy Center Environmental Regulation and Electric System Reliability, Dec 7, 2010 John McManus (AEP) stated that there is insufficient time to comply with CATR, MACT and expressed concern about rate impacts (paraphrasing). January 19, 2011, Gary Rozier (Southern Company) stated that there is insufficient time to comply with forthcoming regulations (paraphrasing).
[84] Ross, William G. "North Carolina's Clean Smokestacks Act." Department of Environment and Natural Resources. May 13, 2009. http://daq.state.nc.us/news/leg/cleanstacks.shtml; S.L. 2002-4.

Section 4 begins with estimates of the health and welfare benefits of Clean Smokestacks using an adjusted benefits-per-ton methodology from EPA's Regulatory Impact Assessment for MATS. A qualitative discussion of additional health, welfare, environmental, and regulatory benefits follows.

Health and Welfare Benefits

The Nicholas Institute estimated the value of SO_2 emissions reduction using EPA methodology from its Regulatory Impact Analysis (RIA) of the MATS. The MATS RIA monetizes the benefits of SO_2 emissions reductions on a dollar-per-ton basis. The Nicholas Institute used EPA's Co-Benefits Risk Assessment Screening (COBRA) Model to determine the portion of Clean Smokestacks emissions reduction benefits realized in North Carolina. In the MATS RIA, EPA estimated the mortality benefits of reduced SO_2 emissions in the eastern and western United States versus a 2005 baseline. EPA projected reductions in ambient $PM_{2.5}$ levels based on SO_2 emissions reductions with MATS and applied estimates of health benefits from reduced ambient $PM_{2.5}$ levels based on epidemiological studies by Pope et al. and Laden et al. These benefits were then converted to benefits per ton of SO_2 emissions reduction in 2016.[85] (SO_2 is a precursor to particulate matter [$PM_{2.5}$], a criteria pollutant under the Clean Air Act.) COBRA is a simplified air pollution model that estimates changes in ambient particulate matter and subsequent health effects based on changes in emissions for 2010 and 2015 baselines.[86]

The Nicholas Institute adjusted the 2016 benefits-per-ton estimate for the eastern United States to benefits per ton in 2011 using an adjustment factor that accounts for real income and population growth from 2011 to 2016 from the MATS RIA. For years 2005–2010, the Nicholas Institute reduced the 2011 estimate of SO_2 emissions-reductions benefits per ton based on historical North Carolina population data and per capita North Carolina gross domestic product using EPA's estimate for elasticity of mortality benefits.[87]

To determine Clean Smokestacks SO_2 emissions reductions, the Nicholas Institute assumed that retrofitted units' emissions in the absence of Clean Smokestacks are equal to each unit's SO_2 emissions rate the year before the retrofit became operational multiplied by retrofitted units' annual heat input. This value is compared to actual SO_2 emissions to determine tons of emissions reduction per year. This methodology assumes that North Carolina utilities would have continued to purchase SO_2 emissions allowances to comply with the Acid Rain Program and CAIR. Prior to Clean Smokestacks retrofits, North Carolina SO_2 emissions increased under the Acid Rain Program (see table 9), and the significant supply of banked emissions allowances and their low market price[88] make it likely that in the absence of Clean Smokestacks the least-cost compliance strategy for North Carolina coal plants would have been to continue to purchase allowances rather than retrofit units prior to the release of the CSAPR. Clean Smokestacks SO_2 emissions reductions in 2010 were then disaggregated by county and input in the COBRA model to determine what percentage of particulate mortality benefits occurred in North Carolina (17.8%). Emissions reductions for each year were multiplied by adjusted benefits per ton and 17.8% to determine annual mortality benefits. Table 9 shows the annual and cumulative mortality health benefits of Clean Smokestacks SO_2 emissions reduction for the Pope et al. and Laden et al. adjusted benefits per ton. Median cumulative (2005–2011) North Carolina benefits range from $6 billion (Pope et al.) to $16 billion (Laden et al.). North Carolina benefits based on the low values from the 95% confidence intervals for Pope et al. and Laden et al. are $500 million and $1.4 billion, respectively.

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[85] EPA, Regulatory Impact Analysis for the Final Mercury and Air Toxics Standards, EPA-452/R-11-011 December 2011.
[86] EPA, User's Manual for the Co-Benefits Risk Assessment (COBRA) Screening Model Version: 2.3a, December 2010.
[87] Emissions reductions benefits are dependent on population, i.e., the NC population was smaller in the past so there were fewer people benefitting, and per capita wealth. Increasing wealth increases individual's willingness to pay to avoid health risks. EPA, Regulatory Impact Analysis for the Final Mercury and Air Toxics Standards, EPA-452/R-11-011, December 2011.
[88] EPA, Clean Air Interstate Rule, Acid Rain Program and Former NO_x Budget Trading Program 2010 Progress Report Emission, Compliance, and Market Analyses, October 2011.

Table 10. SO_2 mortality benefits in millions of dollars (2011) based on EPA benefits per ton methodology for MATS RIA.

Year	SO_2 (tons)	SO_2 emissions reduction from CSA (tons)	Benefits % discount factor relative 2011 benefits	Pope et. al (M$ 2011)		Pope et. al low range 95% confidence interval (M$ 2011)		Laden et. al (M$ 2011)		Laden et. al low range 95% confidence interval (M$ 2011)	
				Contiguous U.S.	North Carolina	Contiguous U.S.	North Carolina	Contiguous U.S.	North Carolina	Contiguous U.S.	North Carolina
2000	453,442.4										
2001	450,486.5										
2002	462,993.1										
2003	462,040.8										
2004	472,320.2										
2005	500,935.6	553.6	0.097	13.3	2.4	1.1	0.2	33.6	6.0	2.9	0.5
2006	462,143.2	17,068.7	0.072	422.6	75.2	33.5	6.0	1,063.8	189.4	93.3	16.6
2007	370,826.5	126,000.2	0.052	3,186.5	567.2	252.7	45.0	8,021.3	1,427.8	703.2	125.2
2008	227,030.1	260,009.5	0.043	6,635.7	1,181.1	526.3	93.7	16,703.6	2,973.2	1,464.4	260.7
2009	110,948.1	313,889.4	0.036	8,071.2	1,436.7	640.1	113.9	20,317.2	3,616.5	1,781.2	317.1
2010	116,627.2	344,809.4	0.013	9,081.3	1,616.5	720.2	128.2	22,859.9	4,069.1	2,004.2	356.7
2011*	73,506.9	313,496.3	0.000	8,362.5	1,488.5	663.2	118.1	21,050.5	3,747.0	1,845.5	328.5
Cumulative benefits million dollars (2011)				**35,760**	**6,365**	**2,836**	**505**	**90,016**	**16,023**	**7,892**	**1,405**

Statewide and unit level emissions from EPA Clean Air Markets Database (http://ampd.epa.gov/ampd).
* Based on preliminary data.

In addition to particulate mortality benefits, there are health benefits from reduced exposure to ozone, SO_2, and NO_2.[89] These benefits include reduced incidence of premature mortality, acute and chronic respiratory illness, and cardiovascular and nervous system effects.[90]

Reduced SO_2 and NO_2 emissions also improve environmental quality and visibility by reducing haze, acid rain, and mercury deposition.[91] Although not quantified here, these environmental quality improvements benefit the North Carolina economy and improve quality of life. Haze impairs visibility and is especially noticeable in scenic areas such as Great Smokey Mountain National Park in western North Carolina, which is regulated under EPA's Regional Haze Program.[92] Acid rain affects recreational fishing, contributes to tree mortality, and impairs ecosystem functions.[93] Mercury deposition impacts the reproductive cycles of fish, birds, and mammals, thereby negatively affecting commercial, subsistence, and recreational fishing.[94]

[89] EPA, MATS RIA; Ross, William G. "North Carolina's Clean Smokestacks Act." Department of Environment and Natural Resources. May 13, 2009. Available at: http://daq.state.nc.us/news/leg/cleanstacks.shtml stating that Clean Smokestacks will protect public health and the environment and improve visibility by reducing haze, acid rain, mercury, ozone and fine particles.
[90] Ibid.
[91] *Ibid.*
[92] EPA, "Parks & Wilderness Areas: Visibility," http://www.epa.gov/visibility/what.html.
[93] EPA, "Effects of acid rain," http://www.epa.gov/acidrain/effects/index.html.
[94] EPA, "Fate and Transport and Ecological Effects of Mercury," http://www.epa.gov/hg/eco.htm.

Air Quality Benefits and NAAQS Compliance

Improving air quality and attaining National Ambient Air Quality Standards (NAAQS) was a key goal of the Clean Smokestacks legislation.[95] Although not exclusively attributable to Clean Smokestacks, North Carolina air monitoring data reflects significant improvements in ambient air quality between 2002 and 2010. By 2011, six of North Carolina's seven 8-hour ozone nonattainment areas encompassing portions of more than 20 counties had been redesignated as attainment or maintenance areas.[96] Clean Smokestacks is now formally part of North Carolina's NAAQS State Implementation Plan.[97]

Without the emissions reductions achieved under Clean Smokestacks, North Carolina would have faced additional costs to comply with NAAQS. The Clean Air Act requires that states demonstrate "reasonable further progress" in nonattainment areas,[98] including adopting at a minimum, "reasonably available control technology" for existing sources.[99] For example, in marginal ozone nonattainment areas states must implement a vehicle inspection and maintenance program, require offsets for new sources with a ratio of at least 1.1 to 1, and submit emissions inventories every three years.[100] EPA also has authority to impose sanctions if states fail to demonstrate reasonable further progress, such as increasing offset requirements for new sources and, though rarely invoked, cutting off federal highway funds.[101]

As shown in tables 10 and 11 below, in the years 2002–2004 air monitors in 12 counties detected levels above the then-current NAAQS for ozone and fine particulates. In 2008–2010, most counties with NAAQS violations from 2002–2004 are attaining the standards, including 27 counties that are attaining the more stringent 2008 8-hour ozone standard.[102]

[95] Ross, William G. "North Carolina's Clean Smokestacks Act," Department of Environment and Natural Resources. Updated May 13, 2009 Accessed November 28, 2011 at: http://www.ncair.org/news/leg/cleanstacks.shtml.
[96] NC DENR Division of Air Quality, "Existing 8-hour Ozone Nonattainment Areas in North Carolina," December 19, 2011.
[97] State of North Carolina. "Petition Pursuant to Section 126 of the Clean Air Act 42 USC § 7426 To the Environmental Protection Agency for Relief from Certain Emissions from Large Electric Generating Units in the Following States: Alabama, Georgia, Illinois, Indiana, Kentucky, Maryland, Michigan, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia," March 18, 2004.
[98] 42 U.S.C. § 7502(c)(2) (2006).
[99] 42 U.S.C. § 7502(c)(3) (2006).
[100] 42 U.S.C. § 7511(a) (2006).
[101] 42 U.S.C. § 7509(b)(2) (2006).
[102] NC DENR Division of Air Quality, "Ozone Non-Attainment Areas & Memoranda": http://daq.state.nc.us/planning/ozone/; "PM 2.5 Non-Attainment Areas": http://www.ncair.org/planning/pm2dot5/ Accessed February 23, 2012.

Table 11. 8-Hour Ozone Standard Compliance Before (2002–2004) and After (2008–2010) Clean Smokestacks Implementation. Bolded counties are attaining the 0.076 ppm standard in 2002–2004. EPA lowered the standard to 0.076 ppm in 2008. Note that nonattainment boundaries may not follow county lines.

NC Counties 8-Hour Ozone Compliance 2002–2004 and 2008–2010			
Not Attaining 0.085ppm 2002–2004	**Attaining 0.085ppm 2002–2004**	**Not Attaining 0.076 ppm 2008–2010**	**Attaining 0.076 ppm 2008–2010**
Davie	Alexander	Forsyth	Alexander
Durham	Avery	Guilford	Avery
Edgecombe	Buncombe	Mecklenburg	Buncombe
Forsyth	Caldwell	Rowan	Caldwell
Franklin	Caswell		Caswell
Granville	Chatham		Chatham
Lincoln	Cumberland		Cumberland
Mecklenburg	Guilford		Davie
Person	Haywood		Durham
Rowan	Jackson		Edgecombe
	Johnston		Franklin
	Lenoir		Graham
	Martin		Granville
	New Hanover		Haywood
	Pitt		Jackson
	Randolph		Johnston
	Rockingham		Lenoir
	Swain		Lincoln
	Yancey		Martin
	Alexander		New Hanover
	Avery		Person
	Buncombe		Pitt
	Caldwell		Rockingham
	Caswell		Swain
	Chatham		Union
			Wake
			Yancey

Source: http://www.ncair.org/monitor/data/o3design/.

Table 12. $PM_{2.5}$ Compliance in 2002–2004 and 2008–2010. Well Below is NC DENR's classification (11.5–12.6 µg/m3). In 2002–2004, 25 additional counties are attaining but not well below. All monitored NC counties are well below in 2008–2010. To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations must not exceed 15.0 µg/m^3.[103] In 2011, EPA staff recommended lowering the standard to between 11 and 13 µg/m^3—a level that most North Carolina counties are already achieving.[104] Note that nonattainment boundaries may not follow county lines.

NC Counties $PM_{2.5}$ Compliance 2002–2004 and 2008–2010		
Not Attaining 2002–2004	**Well Below 2002–2004**	**Well Below 2008–2010**
Catawba Davidson	Lenoir New Hanover Onslow Pasquotank Watauga	Alamance Buncombe Caswell Catawba Chatham Cumberland Davidson Duplin Durham Edgecombe Forsyth Gaston Guilford Haywood Jackson Lenoir Martin McDowell Mecklenburg Mitchell Montgomery Pitt Robeson Rowan Swain Wake Watauga Wayne

Source: http://www.ncair.org/monitor/data/pm2pt5/.

5. Discussion

Rapid changes in the electricity sector are difficult for utilities because generation and transmission investments have long planning, permitting, and construction horizons; operating lifetimes that typically exceed 30 years; and significant capital costs. For this reason, electric utilities generally seek regulatory certainty and long compliance timelines. The lack of political consensus on energy and environmental policy at the federal level combined with frequent action by courts often creates unpredictable and short compliance timelines for environmental regulation. Given this context, states can make strategic investments to get ahead of future federal environmental regulations and provide regulatory certainty by enacting laws that require electric utilities to control emissions over longer compliance timelines.

State legislation or regulatory requirements that anticipate future regulations often increase electricity costs in the near term, but balancing near-term and long-term costs is a continuous tradeoff with almost

[103] EPA, "PM Standards," March 27, 2012. Accessed from: http://www.epa.gov/pm/standards.html.
[104] EPA, "Policy Assessment for the Review of the Particulate Matter National Ambient Air Quality Standards" April 2011.

all utility investments. By aligning Clean Smokestacks with local environmental quality goals, Clean Smokestacks likely avoided other compliance costs by improving NAAQS compliance in North Carolina. Clean Smokestacks demonstrates that utility policy and environmental policy can be aligned to achieve multiple objectives.

To achieve results similar to the future federal regulatory compliance benefits of Clean Smokestacks, states must think strategically about what may be required under forthcoming federal laws. States should also consider how state utility policy can help achieve other goals, such as reducing the health impacts of in-state air pollution, improving environmental quality, complying with existing federal environmental regulations, increasing generation portfolio diversity, or reducing carbon emissions. Because the timing and stringency of federal regulations—and therefore the long-term ratepayer impacts of early action—are unknown, forward-thinking state requirements should further other state policy goals while helping utilities to comply with future federal requirements. While Clean Smokestacks insulates ratepayers from potential cost escalation during the CSAPR and MATS compliance periods, the primary goals—and benefits—of the legislation are improvements in public health and environmental quality.

Legislation or regulatory requirements similar to Clean Smokestacks can act as hedging mechanisms that allow or require utilities to make investments to avoid exposure to different risks, such as over-reliance on a single fuel source or future climate change legislation. However, determining what risks state utilities and ratepayers face and potential overlap with state environmental or energy policy goals is not a simple task. In many states, understanding of potential opportunities lies with state environmental regulators, utility regulators, and state energy offices, but will likely require collaboration that may be outside of normal operations. Collaborative thinking about future risks and interdependencies between state utility policy, environmental quality, and state energy policy goals can lead to policies that position state utilities to avoid price jumps and reliability risks while improving health and quality of life for state citizens.