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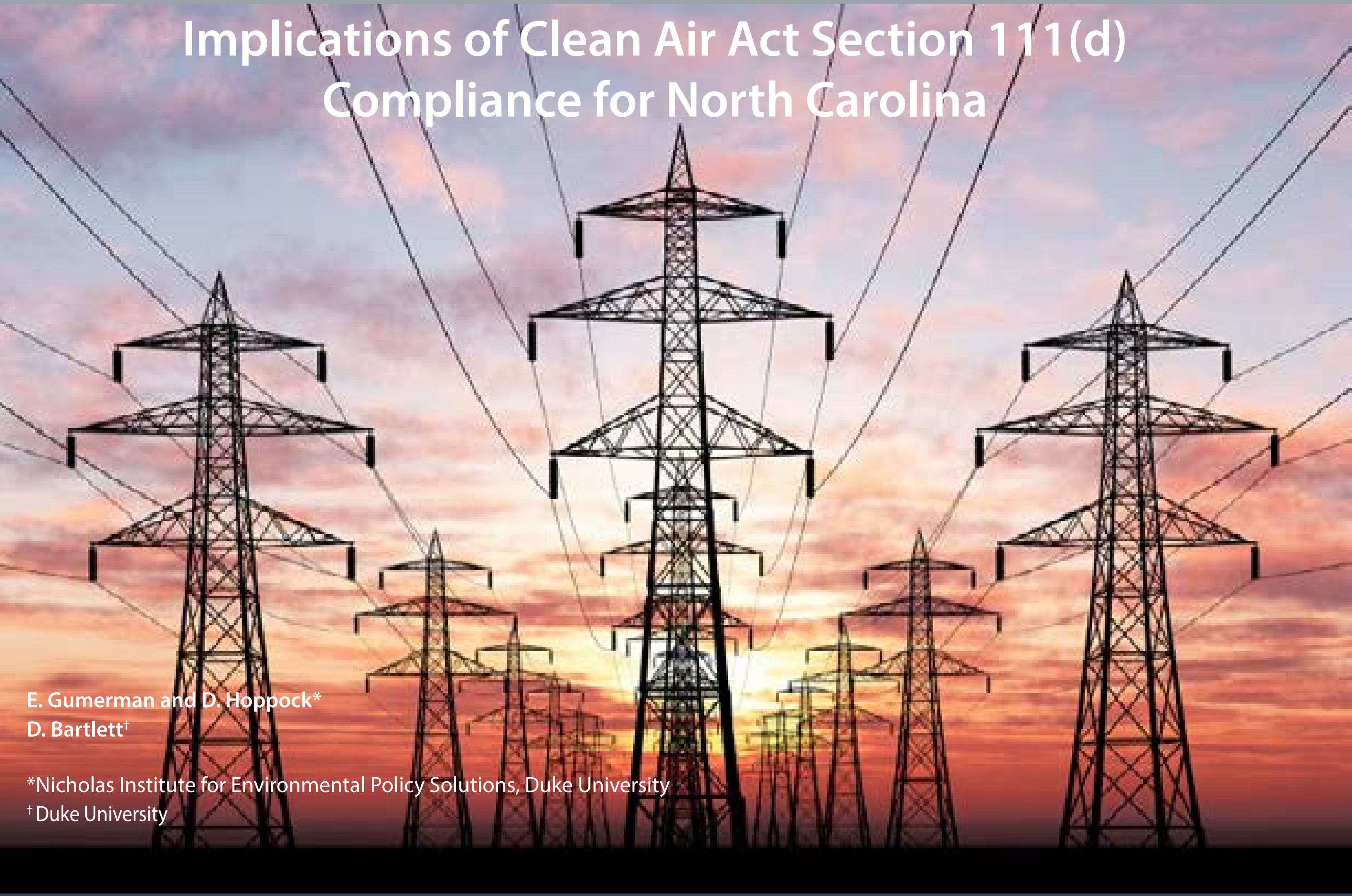

Implications of Clean Air Act Section 111(d) Compliance for North Carolina

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ABSTRACT

Since the mid-2000s, North Carolina has increased natural gas generation, reduced coal dependence, established a renewable energy and energy-efficiency portfolio standard, and taken other actions that will assist it in meeting new carbon emissions targets under the U.S. Environmental Protection Agency's proposed Clean Power Plan (CPP) promulgated under Clean Air Act (CAA) section 111(d). The CPP, as proposed, assigns state-specific emissions rate targets for existing fossil-fueled generators—targets adjusted for levels of renewable generation and energy efficiency measures. This analysis examines possible implications of meeting proposed CPP targets in North Carolina. To achieve those targets, North Carolina will increasingly shift from coal-fired to natural gas-fired electricity generation, incurring a modest rise in resource costs but creating a potentially significant revenue stream, which policy makers must decide how to allocate. Although the CPP will likely drive down overall emissions in North Carolina, the reductions are smaller than might be expected because North Carolina has already made headway in meeting its emissions targets and because new natural gas generation that is not covered under the 111(d) mass-based target will likely be a component of compliance. Alternative compliance measures, such as specific zero-carbon (e.g., nuclear and solar) investments and increased energy efficiency, reduce future natural gas dependence and hedge against natural gas price risk, though potentially at a cost higher than market-based compliance.

CONTENTS

INTRODUCTION

On June 18, 2014, the U.S. Environmental Protection Agency (EPA) proposed the Clean Power Plan (CPP) to regulate carbon dioxide emissions from existing power plants. The CPP, promulgated under Section 111(d) of the Clean Air Act, assigns binding emissions targets for each state that cover most existing fossil fuel–fired electrical generation units (EGUs), and nationally is expected to reduce power sector emissions by 30% relative to 2005 levels.[1] New fossil fuel–fired power plants are regulated under a different section of Clean Air Act.[2]

The CPP assigns each state a rate-based emissions goal (pounds of carbon dioxide per megawatt-hour, MWh, of generation). The EPA's proposed 2030 emissions goal for North Carolina is 992 lbs/MWh. North Carolina's 2012 adjusted emissions rate, including non-hydro renewable electric generation and a portion of existing nuclear generation, was 1,647 lbs/MWh. Although this goal is formulated as a rate, the CPP allows states to convert the goal into a mass-based goal that limits total tons of emissions.[3]

The Nicholas Institute for Environmental Policy Solutions used AURORAxmp to model power plant dispatch, emissions, capacity changes, and cost indicators to assess some of the CPP's implications for North Carolina as well as ran multiple modeling scenarios to compare alternative compliance options. The Nicholas Institute takes no position on the proposed CPP or on the assumptions that the EPA used in formulating state goals. The analysis assumes that North Carolina complies with the CPP individually, rather than as part of a multistate compliance scheme.[4] In the modeling, the Nicholas Institute included both North Carolina and South Carolina to reflect the fact that the state's largest utility, Duke Energy Carolinas, has a service territory that spans North Carolina and South Carolina and that operates as a single system, with energy flows across state boundaries.[5]

As with all modeling, a number of simplifying assumptions were made.[6] Mass-based CO_2 emissions limits were used to model CPP compliance for both North Carolina and South Carolina.[7] The use of mass-

[1] These binding emissions targets begin in 2020, increase in stringency until 2029, and remain in force thereafter at the final emissions rate. States must meet an interim goal based on the average emissions goal from 2020 to 2029. From 2030 onward, states must meet the final 2029 emissions rate on a three-year rolling average. See the Clean Power Plan at http://www2.epa.gov/carbon-pollution-standards/clean-power-plan-proposed-rule. Affected units include existing fossil fuel–fired steam generating units and combustion turbines larger than 25 megawatts (MW), but not combustion turbines operating at less than a 33% capacity factor (peaking units). North Carolina units that EPA identifies as affected by the rule in the TSD Plant Level Data spreadsheet are Asheville, Belews Creek, Buck, Butler-Warner Generation, Cape Fear, Cliffside, Dan River, Edgecombe, Elizabethtown, GG Allen, HF Lee, LV Sutton, Lee Combined Cycle, Lumberton, Marshall, Mayo, Riverbend, Roanoke Valley Energy, Rosemary Power Station, Rowan, Roxboro, and Sherwood H Smith. The new natural gas combined cycle (NGCC) unit at LV Sutton is also included as an affected unit. The CPP covers NGCC units that were not operating in 2012, the CPP's baseline year, but that had begun construction, site preparation, or testing before January 8, 2014.

[2] The EPA seeks comment on whether to include new NGCC units in the building blocks and whether to consider emissions from new units in compliance calculations. Therefore, it's not clear that new units are wholly outside regulation under the Clean Power Plan. CPP Section VI.C.5(c). See footnote 3 for additional information about the building blocks.

[3] The proposal also allows states and electric generating units to use various forms of energy resources to reduce utilization of affected fossil fuel–fired units and to facilitate compliance through the use of lower-emissions fossil fuel–fired generation, zero-carbon generation, and end-use energy efficiency. The EPA determined state emissions rate targets by applying an equation that incorporates use of alternative generation—the so-called building block approach. For a detailed explanation of the proposed CPP and how the EPA computed state emission goals, see http://nicholasinstitute.duke.edu/climate/publications/epa%E2%80%99s-proposed-guidelines-regulating-carbon-dioxide-emissions-existing-power-plants#.VFhdVefB0c8 and Tarr, Jeremy M., and David Hoppock, "Apples and Oranges: Assessing the Stringency of EPA's Clean Power Plan," *Envtl. Law Rep.* 44 (2015).

[4] As proposed, the Clean Power Plan allows for state-by-state or multi-state compliance.

[5] The model meets all load in North Carolina and South Carolina using resources available within the states and does not include imports or exports of power from other states.

[6] A few notable ones are mentioned. Geographically, the North Carolina evaluation included three regions within the Carolinas: North Carolina, the Duke Energy Carolinas parts of South Carolina, and all Other South Carolina. Transmission links between Other South Carolina and the other two areas were removed; Duke Energy Carolinas South Carolina and North Carolina could transfer power freely.

based compliance reflects the limitations of the version of the AURORAxmp electricity dispatch model used in this analysis.[8] AURORAxmp's default demand growth, 1% per year prior to energy efficiency investments, for the Carolinas is used in all modeling scenarios.[9]

The following scenarios were developed and modeled for an initial comparison of the effects of the Clean Power Plan on emissions, net generation, capacity, and cost:

- **2012 (historical values):** Because the EPA used 2012 as its reference year for compliance, that year is included for context.
- **2014 Modeled Results:** These results represent the starting point of the business-as-usual (BAU) scenario, which embeds progress and changes relative to 2012.
- **Business-as-Usual (BAU) Scenario:** This scenario includes under-construction and new units and announced retirements as of summer 2014 as well as near-term assumptions from Duke Energy Carolinas and Duke Energy Progress 2013 Integrated Resource Plan Base Case and solar additions to meet the North Carolina Renewable Energy and Energy Efficiency Portfolio Standard (NC REPS) and to represent recent solar growth trends.[10]
- **Proposed Clean Power Plan (CPP) Scenario:** This scenario starts with the same input assumptions as the BAU scenario and includes CO_2 mass limits for North Carolina and South Carolina.

RESULTS

Due to a combination of recent, competitive natural gas prices and construction of new efficient natural gas capacity, North Carolina has been increasing generation from natural gas while decreasing coal dependency (Figure 1).[11] By 2030, total generation increases in both the BAU Scenario and the CPP Scenario to meet increased demand.[12] In the BAU Scenario ("BAU 2030"), this increased demand is met largely through increased utilization of existing coal capacity, whereas in the CPP Scenario, generation from existing natural gas generation expands significantly as a substitute for existing coal. New natural gas and solar capacity also provide generation to meet increased demand. Thus, in the CPP Scenario, North Carolina is projected to comply with the mass cap by switching fuels and building new natural gas capacity.

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[7] The Nicholas Institute uses the mass-based caps for existing affected sources for North Carolina and South Carolina given in the EPA document, Translation of the Clean Power Plan Emission Rate-Based CO2 Goals to Mass-Based Equivalents (2014), available at http://www2.epa.gov/carbon-pollution-standards/clean-power-plan-proposed-rule-technical-documents. A mass-based approach is administratively simpler that a rate-based approach. The EPA intends for rate- and mass-based compliance to lead to equivalent outcomes.

[8] This analysis uses AURORAxmp dispatch model version 11.4.1021 and a combination of AURORA input assumption and near-term assumptions from the Duke Energy Carolinas and Progress Energy Carolinas 2013 integrated resource plans. More model details found in Appendix. A newly released version of AURORAxmp can model rate-based compliance.

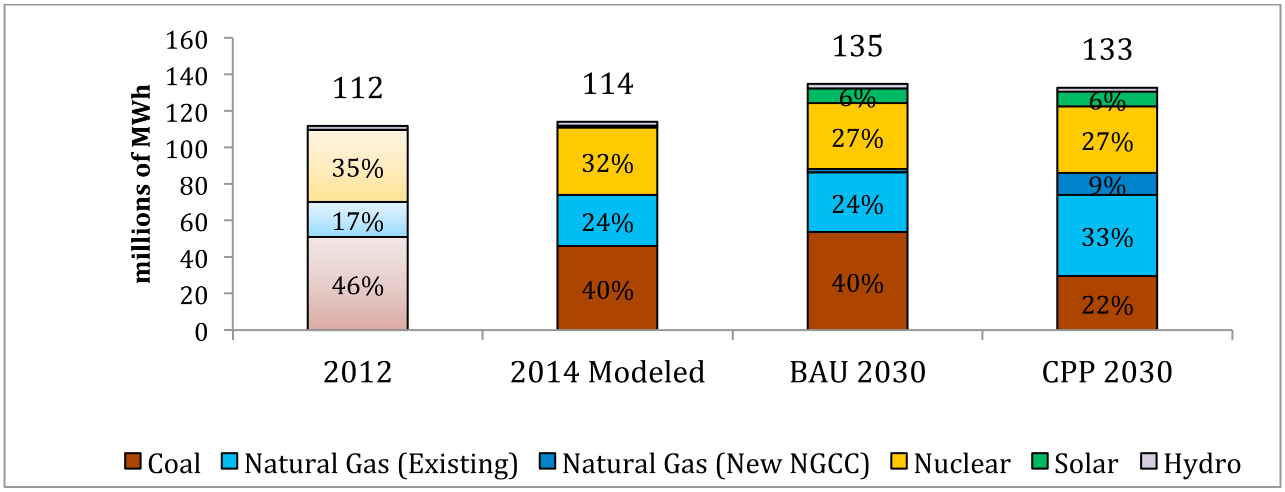
[9] The Energy Information Administration's Annual Energy Outlook (AEO) 2013 and 2014 have the same demand growth rate, 1% per year, for the region encompassing the Carolinas. see http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2014&subject=6-AEO2014&table=62-AEO2014&region=3-16&cases=ref2014-d102413a for AEO 2014 Reference Case demand growth in the Carolinas. End-use energy efficiency is not an investment option in the AURORAxmp model. All energy efficiency investments were added exogenously to the model. See the appendix for energy efficiency assumptions.

[10] After 2021 the NC REPS allows more energy efficiency to count toward compliance, potentially reducing the renewable generation needed relative to 2012; http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NC09R&re=0&ee=0.

[11] Since 2011, approximately 2,700 MW of coal has been retired in North Carolina. The state has approximately 11,000 MW of coal capacity.

[12] Modeled North Carolina demand in both scenarios increases from ~ 13.4 million MWh to ~ 14.9 million MWh between 2014 and 2030.

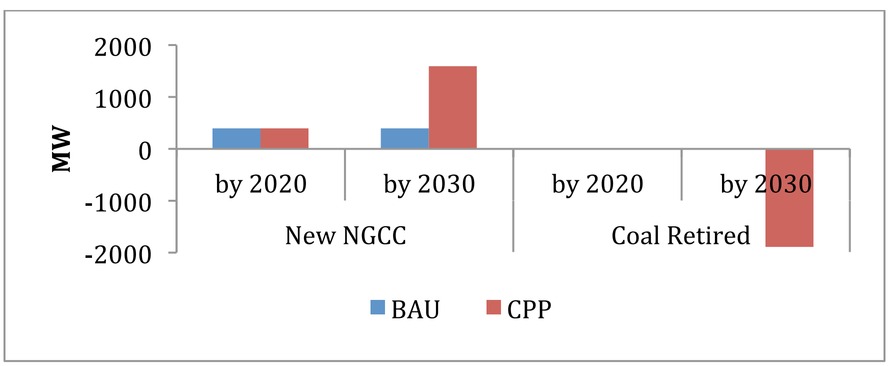
Figure 1. Total North Carolina generation, by fuel type



Note: See the appendix for details on 2012 data sources. Total generation is lower in the CPP scenario because of increased imports from Duke Energy Carolinas South Carolina.

Despite the large difference in natural gas and coal generation between the BAU Scenario and the CPP Scenario in 2030, only a fraction of the shift in dispatch relates to new capacity, which is not covered under the proposed CPP. In both these scenarios, the model builds approximately 400 MW of new natural gas capacity before 2020 (see Figure 2). In the CPP Scenario, additional coal units retire between 2025 and 2030. These units represent about ~ 13% of existing coal capacity in North Carolina.

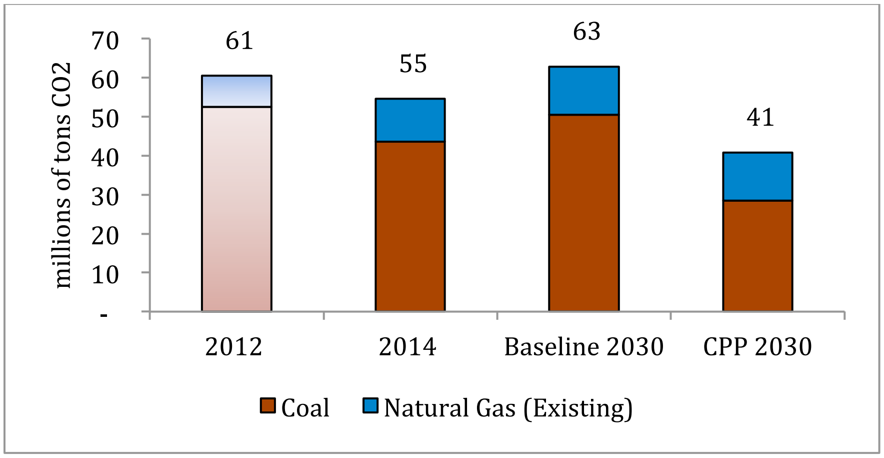
Figure 2. North Carolina capacity additions and retirements by scenario



To understand the impact of these changes in generation on carbon emissions, it is worth looking both at emissions from units affected by the proposed regulation and at total state emissions. Figure 3 shows that emissions from affected units decrease in 2014, relative to 2012, due to higher natural gas generation and lower coal generation. By 2030, under the BAU Scenario, emissions increase by approximately 7% over 2012 levels, while under the CPP Scenario 2030, affected units emissions are 30% below 2012 levels.

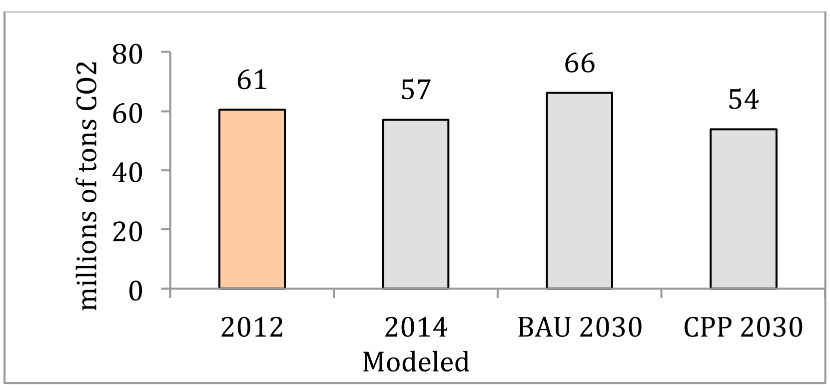
The solar growth embedded in both the BAU and CPP scenarios (Figure 1) helps limit the need to expand generation from natural gas and potentially coal. A baseline scenario without solar growth was not modeled; nonetheless, changes in emissions without solar growth and NC REPS can be estimated. If solar generation displaces only natural gas generation, 2.7 tons of CO_2 emissions could be avoided in 2030. That figure would be even higher if a fraction of the solar were built to displace coal generation.

Figure 3. Affected North Carolina emissions, by fuel type



North Carolina emissions by fuel type (Figure 3) can be interpreted in multiple ways; total North Carolina emissions (Figure 4) reveal a more nuanced story. Total 2030 emissions in the CPP scenario decrease relative to 2012 and 2014 total emissions, but much less than affected unit emissions, because the CPP applies neither to new natural gas combined cycle units nor to some existing units. In the modeled scenarios, CO_2 emissions have decreased from 61 million tons in 2012 to 57 million in 2014, and they can be expected to drop to 54 million tons in 2030 in the CPP scenario.[13] Without appreciating the subtleties, analysts could easily characterize compliance as resulting in significant emissions reductions or in modest reductions. Of course there are many approaches to compliance, and key inputs like fuel prices and future solar installation costs are uncertain.

Figure 4. Total North Carolina emissions from generation



[13] Of the 13 million CO_2 ton difference between CPP 2030 North Carolina statewide emissions and affected units emissions, 3 million tons are the same as the difference in BAU 2030 (i.e., from generation at unaffected coal units and combustion turbine/peaking units). The other ten million tons come from new natural gas combined cycle capacity and from increasing generation at existing natural gas combustion turbines.

The picture is incomplete without considering the costs to achieve the emission reductions. In the CPP scenario, there are two types of costs to consider: (1) the additional costs of operating the electricity system and building additional capacity to meet the CPP and (2) any purchases of carbon allowances (credits) required to meet the emissions constraint. Of these, only the change in operating and capacity cost is a real net cost of the regulation. Allowances are simply instruments created to facilitate exchange of emissions responsibilities within the CPP system; therefore, allowance purchases are just monetary transfers from the buyers of allowances to the sellers; the costs to the buyers are equivalent gains to the sellers, and they zero each other out, rather than add to the actual resource cost of the regulation. How these two costs together affect consumer costs for electricity will depend on how the policy is designed. The change in operating and capacity costs represents additional costs that presumably will be passed on to consumers through the rate-setting process. However, whether and how much final consumers pay for carbon allowance costs is dependent on policy design factors that remain to be determined. These factors include whether the target is mass based or rate based; whether any allowances are given for free or auctioned; and whether any revenues generated by allowance sales are returned to utilities or consumers or are used, for example, to develop programs to reduce emissions. Decisions on these factors will affect the distribution of the costs among parties, but not the total cost of the regulation.

Figure 5 shows average system costs for the BAU and CPP scenarios and average carbon allowances costs for the CPP Scenario from 2020 to 2030.[14] Average system costs are $112 million higher in the CPP Scenario than in the BAU Scenario. These future costs are not directly comparable to historical customer costs; however, to provide some context, in 2012 total electricity sales in North Carolina were approximately $12 billion, about two orders of magnitude higher than $112 million.[15] Average allowance transfer costs are $573 million per year. The transfer value is much higher than additional system costs, meaning that the state's choices for how to handle the transfers will be the most determining factor in how much costs consumers face under the CPP, if the state adopts a mass-based cap.[16]

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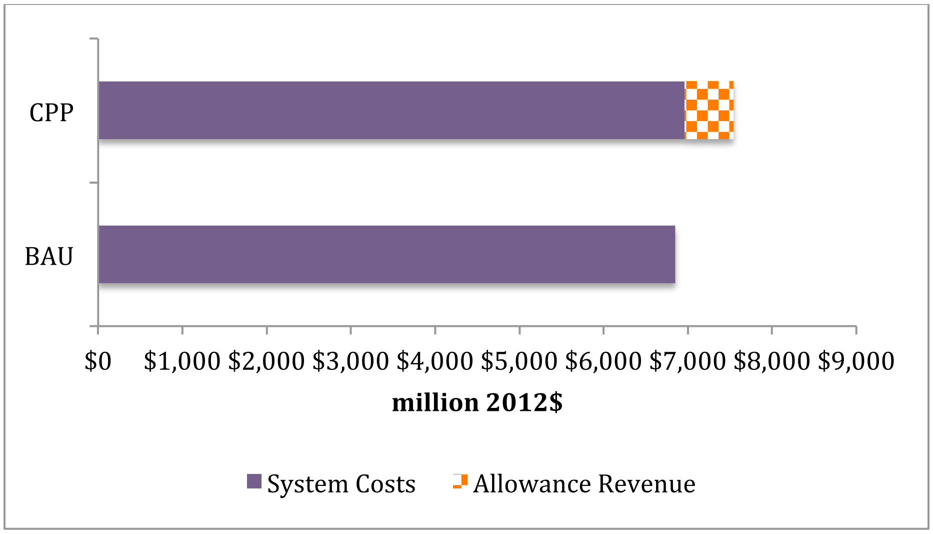
[14] System costs refer to costs for generators, including startup costs, fuel costs, limited emissions costs other than carbon allowance costs, fixed and variable operating costs, and capital costs for new generations. System costs do not include existing capital costs (rate base) that are slowly paid off over time and that are unlikely to vary across scenarios or transmission costs. Nor do they include energy efficiency costs, which would be the same for these two scenarios. See the appendix for an explanation of energy efficiency and solar cost assumptions.

[15] EIA Form EIA861 data files for 2012. Available from http://www.eia.gov/electricity/data/eia861/.

[16] The CPP Scenario uses the EPA's conversion to a mass-based emissions target from the rate-based target. Economic transfers from rate-based targets are fewer than those from mass-based targets—a critical consideration in the state's decision to use the rate-based or the mass-based target.

Figure 5. Average system cost for North Carolina for the BAU and CPP scenarios over the first 11 years of compliance (2020 to 2030)



Note: Costs are shown as an 11-year average, because picking individual years could be misleading as there is no simple declining or increasing pattern.

ALTERNATIVE COMPLIANCE SCENARIOS

In addition to the primary scenarios described above, three CPP compliance scenarios that rely on specific zero-emissions resources were modeled. These scenarios are based on increased efficiency and solar investments as well as the addition of nuclear units similar to those identified in Duke Energy Carolinas' 2013 Integrated Resource Plan (IRP). These scenarios, in which the state makes specific investments to reduce CO_2 emissions, are provided for comparison with the CPP Scenario, in which all investment decisions are determined by the model to optimize compliance with the CPP.

- **EE & CPP Scenario:** Higher end-use efficiency results in zero load growth.[17]
- **New Nuclear & CPP Scenario:** New nuclear units begin operation in 2024 and 2026.[18]
- **High Solar & CPP Scenario:** An additional 200 MW of solar is installed annually beginning in 2021.[19]

By 2030, all alternative compliance scenarios reduce reliance on natural gas generation relative to the CPP Scenario, largely by reducing the amount of new natural gas capacity. Figure 6 compares future generation for different approaches to CPP compliance. The EE & CPP Scenario avoids the need to build natural gas capacity because demand growth is reduced, and it has less coal generation than the CPP Scenario. The new nuclear units in the New Nuclear & CPP Scenario lead to compliance with much less natural gas than the CPP Scenario. This scenario has, by design, the biggest impact; in 2030, nuclear generation is 50% higher than in the other scenarios. The High Solar & CPP Scenario is the most similar to the CPP Scenario because the 60% increase in annual solar capacity additions does not significantly shift overall generation, given solar's low capacity factor.[20]

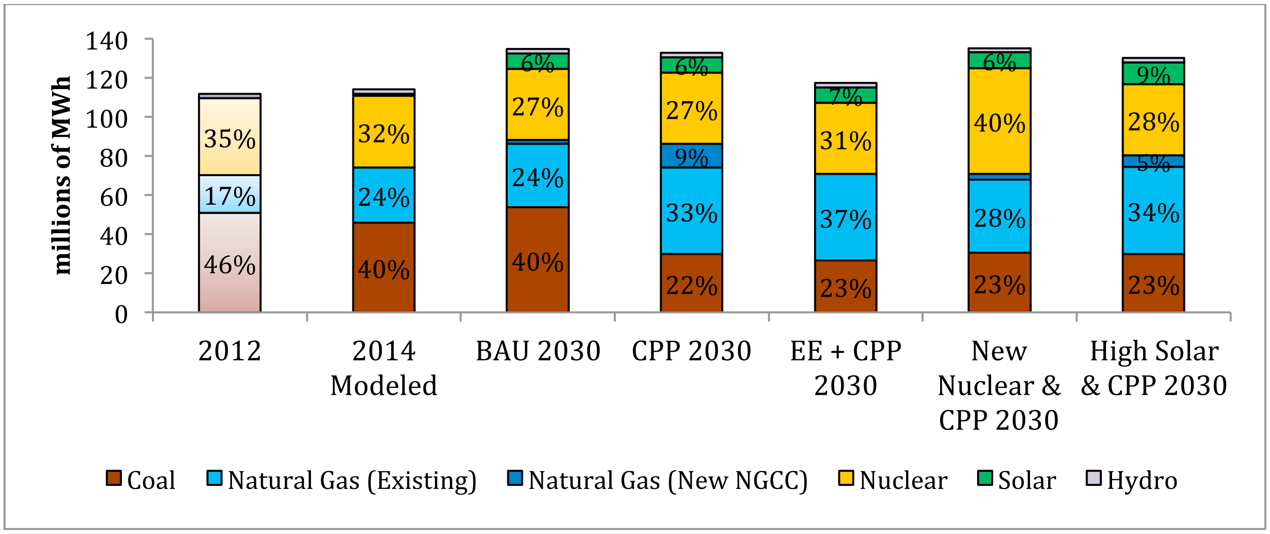
[17] North Carolina utilities achieve an energy efficiency of 1% per year demand reduction, resulting in zero-load growth. This energy efficiency leads to more than 13 million fewer MWh of demand in North Carolina in 2030. Like the BAU and CPP scenarios, energy efficiency investments are added exogenously to the model to reduce demand growth.

[18] Two 1,100 MW nuclear units are added, one in 2024 and one in 2026. By 2030, these units account for almost 18 million additional MWh of nuclear generation.

[19] This scenario leads to an additional 3 million MWh of solar generation by 2030.

[20] All solar installed in North Carolina and all solar capacity additions in the model are photovoltaic (PV) solar.

Figure 6. North Carolina total generation, by fuel type (alternative scenarios)



Note: Differences in total generation in 2030, other than in the EE & CPP Scenario, are due to differences in imports across scenarios.

In general, coal fares about the same in every CPP compliance scenario. As seen in Figure 7, nuclear additions may lead to fewer coal retirements, but the capacity impacts are fairly consistent across all the alternative scenarios, other than the spike in new natural gas capacity in the CPP Scenario.

Figure 7. Cumulative North Carolina coal retirements and capacity additions, 2020 and 2030

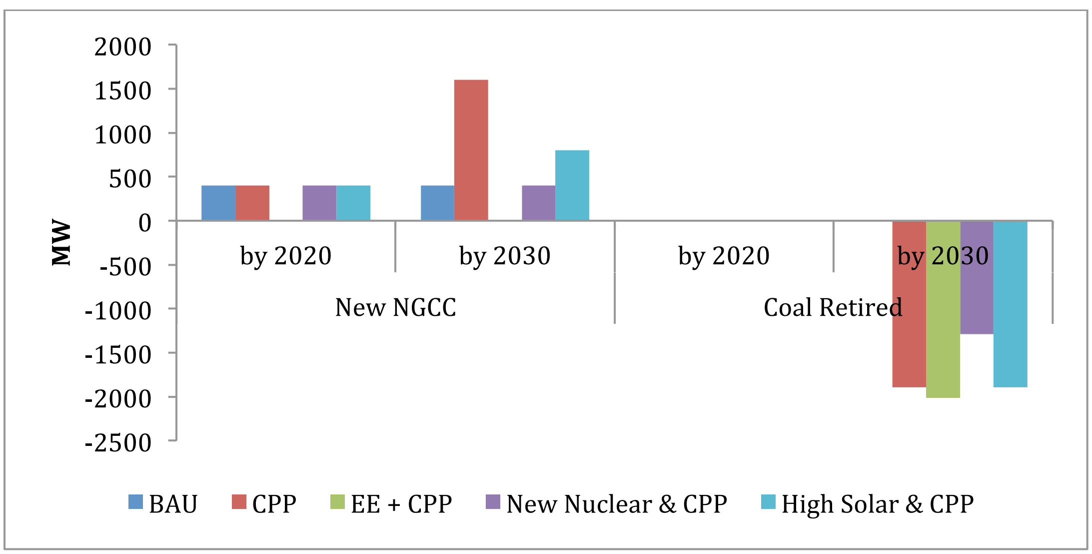
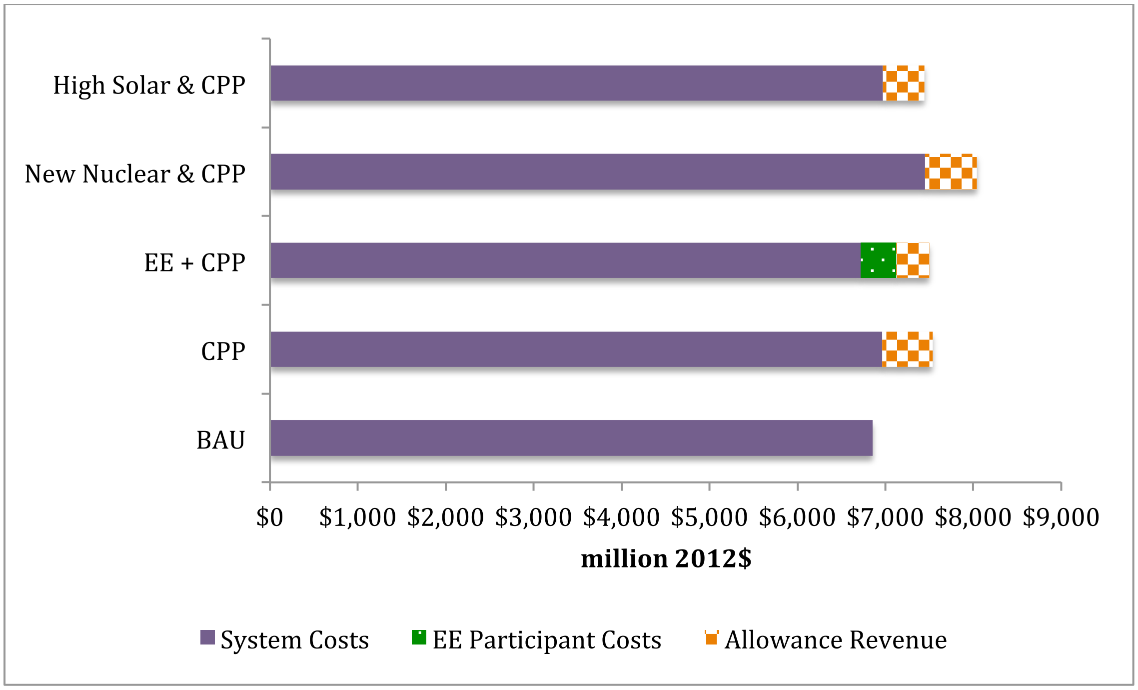


Figure 8 shows average system costs and emissions allowance transfer costs for the alternative compliance scenarios. These cost estimates include input assumptions, namely new nuclear construction costs, future solar costs, and natural gas price forecasts with significant uncertainty. For the EE + CPP scenario, incremental efficiency program costs are included as part of the system cost, but participant costs are highlighted separately.[21] Participant costs average about $400 million across the 2020–2030 horizon. The new Nuclear & CPP Scenario has the highest average resource cost. The EE & CPP Scenario has the lowest allowance transfer costs. As noted above, aggressive energy efficiency also reduces natural gas dependence relative to the CPP Scenario. Constructing new nuclear capacity leads to the greatest reduction in natural gas dependence but at the highest cost for the modeled scenarios and their assumptions.

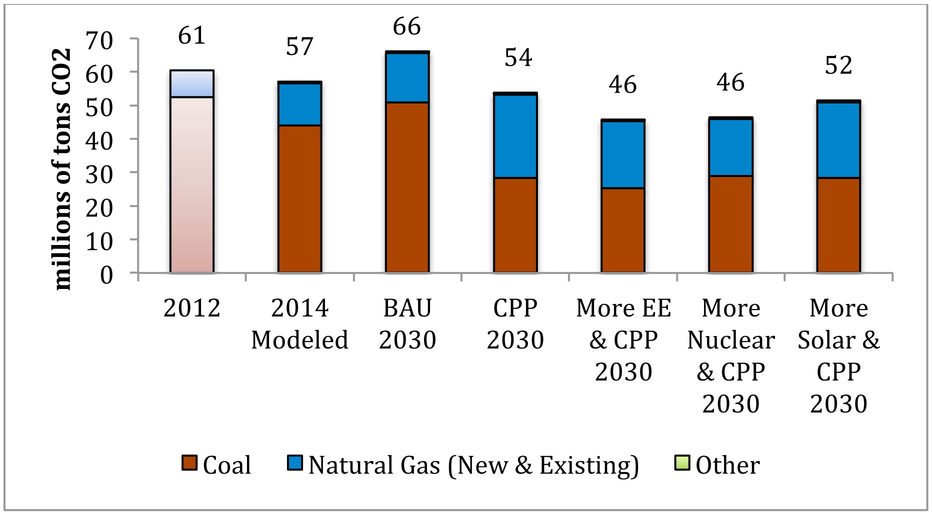
Figure 8. Alternative compliance approaches: Average North Carolina system cost comparison, 2020–2030



North Carolina regulators and utilities may be interested in balancing multiple strategies to hedge risk and reduce compliance cost. All the alternative compliance scenarios reduce total North Carolina emissions, affected and unaffected, relative to the CPP Scenario (Figure 9). This is because they have lower generation from new natural gas capacity than the CPP Scenario.

[21] Energy efficiency program and participant costs are from the EPA and are detailed in the appendix under Energy Efficiency and Solar Cost Assumptions. Participant costs are distinguished from average system costs, because they are voluntary investments and participants benefit individually from participating in the efficiency program. Program costs, like other operations and capital costs, are shared across customers.

Figure 9. Total NC CO_2 emissions, affected and unaffected, across scenarios (in 2030 and compared with 2012 and 2014)



CONCLUSIONS

There is a lot of speculation about how states will comply with the yet to be finalized Clean Power Plan and about how challenging and expensive meeting CPP targets will be. The final CPP may differ significantly from the proposed CPP, and compliance may be achieved through either an emissions rate or a mass-based approach, at the state or regional level. Nonetheless, some key takeaways from this analysis can highlight some of the most important elements of CPP compliance:

1. In North Carolina, 2014 power sector CO_2 emissions are lower than 2012 emissions, the reference point for the Clean Power Plan. North Carolina has been diversifying its electric generation mix away from coal. Decreasing solar prices, the NC RECS, as well as the CPP are likely to continue this trend.
2. In all the modeled scenarios, continued switching from coal to natural gas dispatch will be a major component of compliance at relatively modest system costs.
3. Impacts on utility and consumer costs will be highly dependent on the state's approach to policy design and compliance. Under a mass-based target, the value of carbon allowances will reflect a substantial share of total policy costs, and the state will have significant flexibility in apportioning these revenues, which are economic transfers among parties rather than net costs to the state.
4. Alternative strategies can hedge the amount of fuel switching to natural gas that is required to comply with the Clean Power Plan and reduce exposure to natural gas price risk. Alternatives that involve zero-emission generation and increased efficiency generally reduce the need for new natural gas generation, which affects total power sector CO_2 emissions, because new natural gas generation is not expected to be regulated under the CPP.

APPENDIX

Modeling Details

AURORAxmp simulates future conditions and projects changes in electricity infrastructure and electricity dispatch (how and when power plants supply electricity) that are needed to meet projected demand for electricity in North Carolina and South Carolina at minimum cost. The model also accounts for the numerous technical and operating constraints of the electricity system, including environmental regulations. Models like AURORAxmp provide detailed information about how the hundreds of power generation resources meet variable electricity demand given the baseline assumptions in each modeling scenario, facilitating comparisons among different future conditions. AURORA plant- and unit-level data are populated with basic data from NERC Electricity and Supply Database, EIA Forms 860 and 411, and other similar sources. Load shape data come from FERC Form 714 and some of the independent system operators.

In its modeling scenarios, this analysis used a combination of AURORAxmp input assumptions and near-term assumptions from the Duke Energy Carolinas and Progress Energy Carolinas 2013 IRPs. Additional information about AURORAxmp input assumptions is provided below. The analysis also used AURORAxmp's default demand growth,1% per year prior to energy efficiency investments, for the Carolinas in all its modeling scenarios.[22] Long-term fuel price forecasts in AURORAxmp and the scenarios are primarily based on the *Annual Energy Outlook 2013* Reference Scenario.

Scenario Descriptions

Actual 2012 emissions and generation data are included for reference in the results section.

2014 Modeled Results: These results represent the BAU Scenario modeled results for the current year and are used for comparison purposes. These values are not extrapolated from history. The model was calibrated to include new units and announced retirements as of summer 2014.

Business-As-Usual (BAU) Scenario: This scenario includes under-construction and new units and announced retirements as of summer 2014 as well as near-term assumptions from the Duke Energy Carolinas and Duke Energy Progress 2013 IRP Base Case regarding nuclear uprates, fuel switching from coal to natural gas at an existing coal unit, and energy efficiency savings.[23] To meet the North Carolina Renewable Energy and Energy Efficiency Portfolio Standard (NC REPS) and to represent solar growth trends, 78 MW of solar was added by 2015 in North Carolina, and starting in 2017 annual capacity growth is the equivalent of 335 MW in North Carolina and 50 MW in South Carolina through 2035. This amount of solar is greater than that projected in the IRPs but is consistent with renewable generation requirements under NC REPS, assuming that all new renewable energy growth comes from solar.

Clean Power Plan (CPP) Scenario: This scenario has the same input assumptions as the BAU Scenario and includes CO_2 mass limits for North Carolina and South Carolina emissions from affected EGUs based on an EPA technical support document.[24] In 2030, these values are 40.6 million tons and 17.4 million tons, respectively. For comparison, affected EGUs emissions in North Carolina were 59 million tons in 2012 and 35.9 million tons in South Carolina in 2012.

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[22] The Energy Information Administration's 2013 and 2014 Annual Energy Outlooks have the same demand growth rate, 1% per year, for the region encompassing the Carolinas. See http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2014&subject=6-AEO2014&table=62-AEO2014&region=3-16&cases=ref2014-d102413a for AEO 2014 Reference Case demand growth in the Carolinas.

[23] Duke Energy Carolinas, Integrated Resource Plan (Annual Report), October 15, 2013; Duke Energy Progress, Integrated Resource Plan (Annual Report), October 15, 2013.

[24] Translation of the Clean Power Plan Emission Rate-Based CO_2 Goals to Mass-Based Equivalents. U.S. EPA November 2014.

This scenario includes the same investment choices as the BAU Scenario and does not exogenously increase low-carbon generation or energy efficiency. Increased solar installations and energy efficiency are not offered as an economic choice in the CPP Scenario or the BAU Scenario. The CPP Scenario is an example of how North Carolina could comply with the CPP if it chooses to use a mass-based emissions target. The state could pursue a different compliance strategy, for example, a rate-based emissions target. Moreover, differences in factors such as future fuel prices could affect compliance outcomes.

Baseline Scenario and Clean Power Plan Scenario Demand-Side Energy Efficiency

This analysis calculated the combined reduction in demand from energy efficiency in the Duke Energy Carolinas 2013 Base Case and Duke Energy Progress 2013 Base Case as a percent of combined Duke Energy Carolinas and Progress Energy Carolina Base Case demand prior to new energy efficiency. This percent demand reduction was then applied to all of North Carolina, assuming 1% demand growth (AURORAxmp and *Annual Energy Outlook 2013* demand growth) to calculate an adjusted demand growth, 0.63% per year, net of efficiency. In the modeling scenarios, energy efficiency is a predetermined (exogenous) choice, rather than an endogenous investment decision within the model. Because demand reductions from energy efficiency are the same across both scenarios, the Nicholas Institute did not calculate energy efficiency costs or add them to the system costs for these scenarios.

BAU Scenario and CPP Scenario Solar Assumptions and NC REPS

To match installed North Carolina solar capacity at the end of 2013, 592 MW of solar were added to AURORAxmp's base solar capacity. Projecting future changes in solar capacity is difficult because much of this capacity is built by non-utility developers and because future growth is dependent on state and federal incentives that may expire as well as on expectations for continuing declines in the cost of solar installation. In 2013, 335 MW of solar were installed in North Carolina.[25] In 2014, at least 78 MW of solar was under construction; 1,277 MW was in advanced development.[26] The Duke Energy Carolinas and Duke Energy Progress 2014 IRPs together list more than 3,300 MW of solar in interconnection queues.[27]

NC REPS requires investor-owned utilities (IOUs), municipal utilities, and cooperative utilities to source a percent of their generation from qualifying resources such as solar, biomass, end use energy efficiency and new small-scale hydro. Efficiency is capped at 25% of NC REPS compliance for IOUs but is unlimited for municipal utilities and cooperatives. All utilities can meet a portion of their REPS requirement with out-of-state renewable energy credits (RECs).[28] Assuming utilities maximize efficiency, as Duke Energy Carolinas and Duke Energy Progress are currently doing, and maximize out-of-state RECs, it is possible to estimate a minimum renewable energy generation requirement for this analysis' modeling scenarios.[29] After combining solar generation from AURORAxmp with historical biomass generation (AURORAxmp only captures a portion of biomass generation), renewable generation in the BAU and CPP scenarios closely track the renewable requirements under NC REPS.[30] Additionally, NC

[25] http://www.seia.org/state-solar-policy/north-carolina.
[26] John Downey, "Report: N.C. Ranks Second in U.S. for New Solar Capacity under Development," *Charlotte Business Journal,* May 21, 2014, http://www.bizjournals.com/charlotte/blog/energy/2014/05/report-nc-ranks-second-in-us-for-new-solar.html.
[27] Duke Energy Carolinas, Integrated Resource Plan (Annual Report), September 1, 2014; Duke Energy Progress, Integrated Resource Plan (Annual Report), September 1, 2014.
[28] http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NC09R&re=0&ee=0.
[29] Duke Energy Carolinas, Integrated Resource Plan (Annual Report), September 1, 2014; Duke Energy Progress, Integrated Resource Plan (Annual Report), September 1, 2014.
[30] http://www.eia.gov/electricity/data/browser/#/topic/1?agg=2,0,1&fuel=0008&geo=00000004&sec=g&freq=A&start=2001&end=2013&ctype=linechart&ltype=pin&rtype=s&pin=&rse=0&maptype=0&datecode=2013.

REPS allows for banking of compliance credits and some combined heat and power that AURORAxmp does not capture, providing compliance flexibility for North Carolina utilities.[31]

Energy Efficiency and Solar Cost Assumptions

Solar costs are based on the Duke Energy Carolinas 2013 avoided cost rate of $58/MWh. This cost was selected because significant North Carolina solar capacity is currently installed on the basis of this avoided cost rate. Because efficiency costs to reduce demand growth based on the 2013 Duke Energy Carolinas IRP and 2013 Progress Energy Carolinas IRP are constant across all scenarios, only the additional efficiency costs to reduce demand growth to zero in the EE + CPP Scenario were calculated. The cost of the additional energy efficiency in the EE + CPP Scenario, $46.4/MWh, is based on the EPA's technical support document Data File: GHG Abatement – Scenario 1 (XLS).[32] The efficiency costs, referred to as program costs by the EPA, represent the costs to ratepayers for the energy efficiency-induced demand reduction and do not include the participant costs of efficiency savings, which the EPA assumes are equal to program costs.[33]

[31] http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NC09R&re=0&ee=0.

[32] U.S. EPA, Technical Support Document Data File: GHG Abatement – Scenario 1 (XLS), available from http://www2.epa.gov/carbon-pollution-standards/clean-power-plan-proposed-rule-technical-documents.

[33] Thus the total cost of energy efficiency is $92.8/WMh. System costs presented in this paper include only the program costs of efficiency savings. Utility planning documents typically include only program costs as well.

The Nicholas Institute for Environmental Policy Solutions

The Nicholas Institute for Environmental Policy Solutions at Duke University is a nonpartisan institute founded in 2005 to help decision makers in government, the private sector, and the nonprofit community address critical environmental challenges. The Nichols Institute responds to the demand for high-quality and timely data and acts as an "honest broker" in policy debates by convening and fostering open, ongoing dialogue between stakeholders on all sides of the issues and providing policy-relevant analysis based on academic research. The Nicholas Institute's leadership and staff leverage the broad expertise of Duke University as well as public and private partners worldwide. Since its inception, the Nicholas Institute has earned a distinguished reputation for its innovative approach to developing multilateral, nonpartisan, and economically viable solutions to pressing environmental challenges.

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