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Fact Sheet

POWER SECTOR OPPORTUNITIES FOR REDUCING CARBON DIOXIDE EMISSIONS: NORTH CAROLINA

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WHAT WILL CO_2 STANDARDS MEAN FOR NORTH CAROLINA?

President Obama announced a national climate plan in June 2013 and directed the U.S. Environmental Protection Agency (EPA) to set carbon pollution standards for the power sector. Once EPA establishes those standards, states will implement their own plans for achieving those reductions. In this fact sheet, WRI examines existing tools North Carolina can use to reduce power plant emissions.

Box 1 | What's Ahead for the Power Sector?

The power sector is the leading source of carbon dioxide (CO_2) emissions in the United States, but also offers some of the most cost-effective opportunities to reduce those emissions. Despite recent decreases in power sector emissions—due to the recession, increasing competition from renewable energy, and the low price of natural gas—current projections show that, absent policy action, emissions will increase in the coming decades.[1]

New Power Plants: President Obama directed EPA to update draft CO_2 emissions standards for new power plants by September 2013.[2] These standards will likely provide a backstop ensuring that new power plants produce significantly lower CO_2 emissions per megawatt-hour of power generation than the average existing coal plant. However, new coal plants are unlikely to be built even in the absence of the standards because of relatively low natural gas prices, among other factors.[3] If the re-proposed standards are largely similar to the draft proposal issued last April, it is unlikely they will have a significant impact on near-term GHG emissions.

Existing Power Plants: EPA also has been directed to (a) propose CO_2 emissions standards for existing power plants by June 1, 2014; (b) finalize these standards by June 1, 2015; and (c) require states to submit their proposed implementation plans by June 30, 2016. The Clean Air Act provides EPA with considerable flexibility in setting guidelines for states to meet these standards. States could be allowed to pursue a range of programs that encourage activities—such as fuel switching, dispatch of existing low-carbon power plants, increased generation by renewable sources, and energy efficiency, among other options—for meeting emissions targets. EPA also could set guidelines that allow for emissions rate averaging across power sector generation units to help meet the standard.

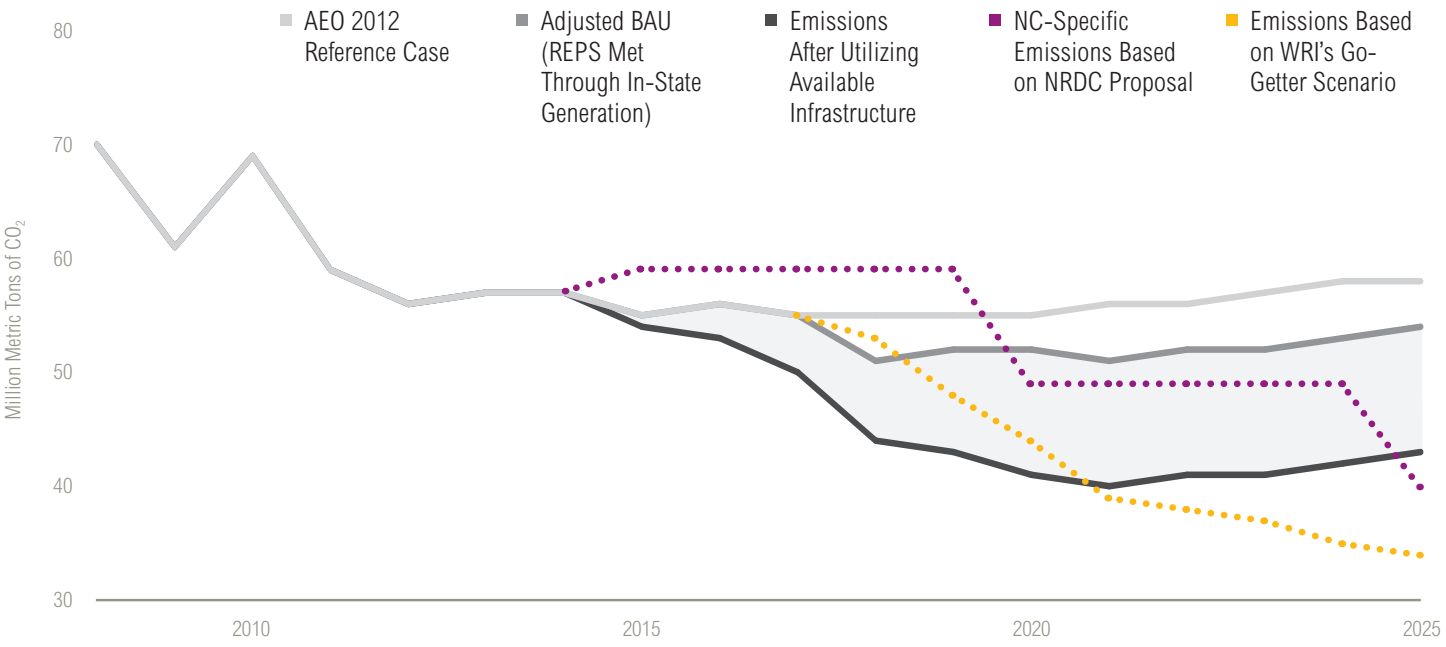
HOW NORTH CAROLINA CAN REDUCE POWER SECTOR EMISSIONS

WRI analysis shows that North Carolina has many opportunities to reduce carbon pollution from its power sector. The state actually is in a strong position to meet, and possibly exceed, forthcoming emissions standards for existing power plants in the near- to mid-term. Carbon dioxide emissions from North Carolina's power sector were 17 percent below 2005 levels in 2011 (the most recent year for which we have energy data for North Carolina). According to reference case projections from the U.S. Energy Information Administration's (EIA) *Annual Energy Outlook 2012 (AEO 2012)*, emissions are projected to decrease by 7 percent compared to 2011 levels by 2020, before slowly increasing again.

The *AEO 2012* reference case includes the emission reduction impacts expected from the state's existing renewable energy and energy efficiency portfolio standard (REPS; see below for more detail). However, we adjust the reference case to assume that the renewable energy generation required by the REPS occurs through in-state renewable generation as opposed to purchasing renewable energy credits generated out of state.[4] North Carolina can reduce power sector CO_2 emissions to 29 percent below 2011 levels in 2020 by achieving the targets in these existing state policies and taking advantage of the CO_2 reduction opportunities that use the existing infrastructure listed below.[5] This is equivalent to a 41 percent reduction in emissions from 2005 levels. Reductions of this magnitude would likely exceed the reductions required by a stringent set of standards for existing power plants.[6]

- CO_2 reductions from existing policies
  - Meeting the REPS through in-state renewable generation (-6 percent in 2020 compared to 2011 levels)[7]
- CO_2 reduction opportunities using available infrastructure
  - Increasing combined heat and power (CHP) at commercial and industrial facilities can help North Carolina meet requirements under the REPS program[8]

Figure 1 | **North Carolina Carbon Dioxide Reduction Opportunities for Power Sector Compliance Under The Clean Air Act**



Note: EPA has not yet proposed a national emissions standard for existing power plants. For purposes of illustration, this analysis shows emissions reductions that would occur if EPA adopted the Natural Resources Defense Council's proposed standards for existing power plants; in North Carolina, this would require CO_2 emissions reductions of 16 percent below 2011 levels in 2020. We also show the emissions reductions that would occur if EPA were to adopt a more ambitious "go-getter" reduction schedule that aligns with a national reduction pathway necessary to meet the administration's goal of reducing economy-wide GHG emissions 17 percent below 2005 levels by 2020.[11] National power sector emissions in the "go-getter" scenario drop 38 percent from 2005 to 2020; we show the equivalent percent reductions applied to North Carolina's power sector (26 percent from 2011 to 2020). See footnote 6 for additional explanation.

- Fully utilizing existing combined cycle natural gas capacity (-17 percent in 2020 compared to 2011 levels)
- Increasing the efficiency of the existing coal-fired power plant fleet (-1 percent in 2020 compared to 2011 levels)

North Carolina could achieve even greater long-term emissions reductions by expanding existing policies. By taking the actions listed below, which would likely require additional legislation, North Carolina can reduce power sector CO_2 emissions by an additional 16 percent in the next six years, to 45 percent below 2011 levels by 2020 and 69 percent below 2011 levels by 2030.[9]

- Expanding the renewable requirement under the REPS (-7 percent in 2030 compared to 2011 levels, additional to existing renewable requirements)[10]
- Establishing an energy efficiency set-aside under the REPS (-16 percent in 2020 compared to 2011 levels, additional to existing efficiency levels)
- Further increasing CHP capacity at commercial and industrial facilities can help North Carolina meet an expanded and accelerated REPS program

OPPORTUNITIES IN DETAIL

Existing and Expanded Renewable Energy and Energy Efficiency Standards. In 2007 North Carolina enacted a renewable energy and energy efficiency portfolio standard (REPS) requiring utilities to generate or purchase electric power from renewable energy sources or reduce electricity demand equivalent to 12.5 percent of North Carolina retail sales by 2021.[12] Utilities may meet up to 25 percent of these requirements through energy efficiency measures through 2020, and up to 40 percent starting in 2021. As electric demand is expected to rise after 2020, while the REPS requirement remains constant at 12.5 percent of sales, utilities can increasingly use more efficiency to meet the REPS requirement.[13] Electric membership corporations or municipalities that sell electricity to retail electric power customers in the state must also generate or purchase electric power from renewable energy sources or reduce electricity demand equivalent to 10 percent of North Carolina retail sales by 2018. Solar and swine waste resources must each be used to supply at least 0.2 percent of total retail sales in the state by 2018, whereas by 2014 at least 900,000 MWh of electricity sales must be supplied by poultry waste resources. Solar energy is growing rapidly in North Carolina, in part due to favorable state incentives.[14] Preliminary data show the state had 80 MW of installed capacity as of 2012, with over 100 MW of additional capacity proposed to come online in 2013.[15]

A recent study found that the renewable requirement will not have an appreciable impact on electricity rates for any customer groups through 2026, after which the state's clean energy use will lead to $173 million in cost savings. Rates are actually expected to be lower over the first 20-year period of North Carolina's clean energy policies than if the state continued using existing, conventional generation sources.[16] By meeting its renewable standard using in-state renewable generation,[17] North Carolina can reduce its power sector emissions by an additional 6 percent in 2020 compared to 2011 levels, which is beyond the reductions captured in the *AEO 2012* reference case. If North Carolina continues to increase its renewable sales at the same rate after its target has been reached in 2021, it can reduce power sector CO_2 emissions by an additional 7 percent in 2030 compared to 2011 levels.

North Carolina could also benefit from increased energy efficiency. Analysis by ACEEE has shown that the economic benefits of energy efficiency programs in North Carolina could outweigh the costs, with the potential to save electricity customers in North Carolina almost $16 billion from 2010 through 2025.[18] If North Carolina enacts new legislation that requires annual electricity savings of 2 percent per year below the reference case scenario from 2015 through 2030, it can reduce power sector CO_2 emissions by a total of 16 percent in 2020.This would lead to a 22 percent decrease in projected electricity demand in 2025, on par with North Carolina's estimated cost-effective energy efficiency potential.[19]

Increasing CHP at Commercial and Industrial Facilities. North Carolina is among the top ten states with the greatest technical potential for new CHP capacity.[20] As with energy efficiency, studies have shown that installation of CHP systems can save industrial facilities up to 30 percent in electricity costs per year,[21] and many industrial facilities can achieve savings of 15 percent or greater in total energy costs with systems that pay for themselves in under three years.[22] In 2010, North Carolina extended its business and energy tax credits so that businesses can receive up to $2.5 million for the installation of a CHP system through 2015.[23] This tax credit, in combination with sustained lower industrial and commercial natural gas prices in recent years, has improved the economics for CHP development in North Carolina. North Carolina also allows energy produced from a CHP system that uses nonrenewable energy sources to be counted as an energy efficiency measure under its renewable energy and energy efficiency standard.[24] There are not currently any utility energy efficiency programs for CHP in North Carolina; however, a working group led by Duke Energy has been investigating options for a cost-effective CHP program. Duke Energy will soon begin discussing CHP with the Carolinas Collaborative, an energy efficiency stakeholder advisory group, in an effort to determine what type of utility energy efficiency programs would stimulate CHP development.[25]

In addition to the approximately 1.5 GW of CHP currently installed, North Carolina has nearly 5 GW of technical potential for new natural gas-fueled CHP.[26] If the state could achieve 25 percent of the remaining technical potential by 2030 (resulting in 2.8 GW installed CHP capacity in 2030), it would help meet requirements under the REPS through 2030. An ICF International analysis for ACEEE estimated that it would be cost-effective to add this amount of new CHP capacity (about 1.3 GW) in the state.[27,28] Further increasing CHP capacity to 50 percent of its remaining technical potential by 2030 (resulting in 4.0 GW installed CHP capacity in 2030) at commercial and industrial facilities can also help North Carolina meet an expanded and accelerated REPS program.

Utilizing Slack Natural Gas Capacity. According to EIA data, the capacity factor of North Carolina's existing combined cycle natural gas fleet was only 38 percent in 2011—meaning that these plants generated less than half the electricity they are capable of producing.[29] Increasing the operating capacity of all existing units—including three that have come online since 2011—to 75 percent would cut power sector CO_2 emissions by 17 percent in 2020 compared to 2011 levels.[30,31] See Box 3 for additional information on North Carolina's power sector.

Increasing Efficiency at Existing Coal Plants. According to the National Energy Technology Laboratory (NETL) and researchers at Lehigh University, the existing coal fleet could achieve a 5 percent increase in efficiency on average.[32] For purposes of this analysis, we conservatively assume that North Carolina's coal fleet would achieve a 2.5 percent increase in efficiency, half of these potential levels. Existing coal plants can increase efficiency through refurbishment and improved operation and maintenance practices, though the actual efficiency potential depends on plant age and other physical limitations.[33,34] While there are high upfront costs associated with refurbishing existing coal units, the resulting increase in unit efficiency will lead to annual fuel savings.[35] Another option to reduce the emissions intensity of a coal plant is co-firing with natural gas using the igniters that are already built into many existing pulverized coal boilers.[36] These actions can lead to reductions in power-sector CO_2 emissions of up to 1 percent compared to 2011 levels in 2020.

OUTLOOK FOR NORTH CAROLINA

North Carolina has already put measures in place that will achieve GHG emissions reductions and has the opportunity to achieve greater reductions building off of its progress to date. While there have been recent proposals to repeal the state's REPS, doing so would limit the future growth of renewables and energy efficiency going forward and make meeting forthcoming emissions standards more difficult.[37] By meeting the requirements of this existing policy and taking advantage of available infrastructure and underutilized resources, North Carolina is in a strong position to comply with upcoming EPA standards for existing power plants in the near term. Through federal and state-level actions, the United States can meet its commitment to reduce economy-wide GHG emissions 17 percent below 2005 levels by 2020.

Box 2 | About This Series

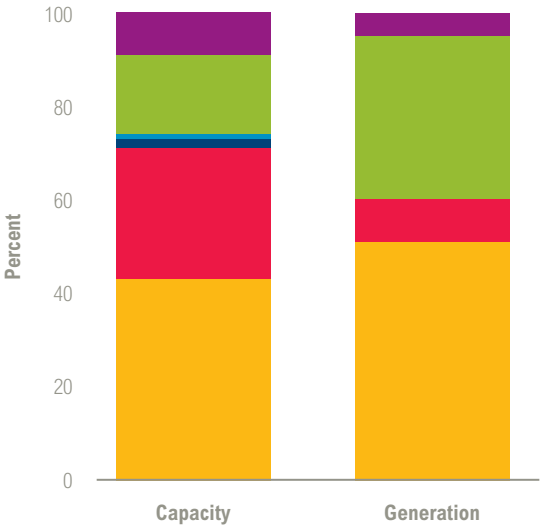
In *Can The U.S. Get There From Here?*, WRI identified four key actions the Obama Administration must take in the absence of congressional action in order to meet the U.S. commitment to reducing greenhouse gas (GHG) emissions by 17 percent below 2005 levels by 2020. These actions include setting performance standards for existing power plants, reducing consumption of hydrofluorocarbons, reducing fugitive methane emissions from natural gas systems, and increasing energy efficiency. Of these four actions, the greatest opportunity for reductions comes from the power sector. In his recently announced Climate Action Plan, President Obama has directed EPA to work expeditiously to finalize carbon dioxide (CO_2) emission standards for new power plants and adopt standards for existing power plants. As states prepare to comply with these standards, it will be necessary to understand available opportunities for reducing CO_2 emissions from the power sector. This series of fact sheets aims to shed light on these opportunities by illustrating the CO_2 emissions reduction potential from measures in a variety of states. We show how these emissions savings stack up against the reductions that could be required under forthcoming standards. This series is based on WRI analysis conducted using publicly available data. See the appendix for additional information on our methodology and modeling assumptions.

Box 3 | North Carolina Power Sector Profile

Until the early 1990s, the vast majority of new capacity being built in North Carolina was coal- and nuclear-fired. In fact, 47 percent of North Carolina's coal-fired capacity was built before 1970. In the last two decades, natural gas has comprised the bulk of new capacity additions, with some renewable capacity coming online during the past several years. Between 2005 and 2011, coal-fired generation in North Carolina decreased by 24 percent, due to a drop in electricity demand and a slight change in the fuel mix, including increased use of natural gas. This trend is likely to continue as North Carolina's aging coal plants retire. As of 2012, twenty-six coal generators (2,900 MW capacity) in the state were slated for retirement. However, coal still represents around 50 percent of total generation, while nuclear and natural gas sources make up around 34 percent and 9 percent of total generation, respectively. In 2011, North Carolina contributed 3 percent of total U.S. CO_2 emissions in the power sector, with a state CO_2 emissions intensity of about 1,140 lbs per MWh. While this is slightly lower than the U.S. average (about 1,200 lbs per MWh), our analysis shows that by using existing policies and infrastructure, North Carolina could reduce the carbon intensity of its power sector to around 753 lbs per MWh by 2020.

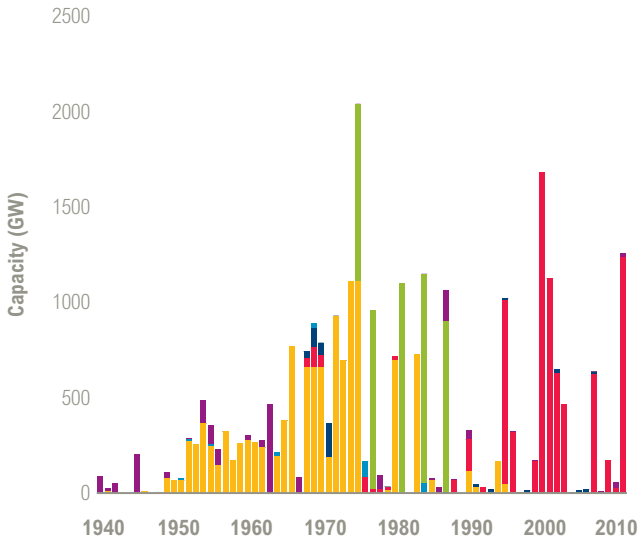
Source: U.S. Energy Information Administration, Annual Energy Review and Form EIA-860; Union for Concerned Scientists, Ripe for Retirement.

North Carolina Generation and Generating Capacity by Fuel, 2011



Source: U.S. Energy Information Administration, Form EIA-860 and Annual Energy Review.

New Electric Generating Capacity Additions by Fuel Type



Source: U.S. Energy Information Administration Form EIA-860, which includes existing electric generating units at plants with at least 1 MW capacity (electric utilities, independent power producers, and combined heat and power plants) that are connected to a power grid. Data represents installed summer capacity.

BOTH CHARTS USE THE FOLLOWING LEGEND: Coal | Natural Gas | Oil | Other Fossil | Nuclear | Renewables

POLICY FRAMEWORK AND INTERACTION

This analysis assumes the existing policies and other reduction opportunities listed above are fully implemented. Depending on the combination of measures actually implemented by North Carolina, each will have different impacts on the generation mix and resulting emissions. For example, increasing the efficiency of existing coal-fired power plants results in fewer emissions reductions in this analysis than would be the case if it were considered in isolation, because implementation of the REPS and an increase in natural gas generation all decrease the state's coal-fired generation. The emissions reductions presented in the text are a result of each policy in combination with all other policies. We first applied the existing REPS policy to calculate an adjusted reference case. Next, we increased CHP capacity and increased utilization of existing natural gas capacity compared to this adjusted reference case. Last, we increased the efficiency of any remaining coal plants. When considering the expanded policies, we applied the accelerated energy efficiency requirement under the REPS followed by increased CHP capacity, and then applied the expanded renewable requirement under the REPS to the resulting adjusted demand.

Equally as important is the policy framework, which will define how each of these measures counts toward compliance under the EPA's standards. We assumed that the emissions reductions from each measure would count directly toward the standard. State measures may be counted differently in the actual standards, thus actual compliance levels could potentially be greater or less than what was modeled. See the appendix for additional information on our methodology and modeling assumptions.

ENDNOTES

1. According to EIA's AEO2013 Reference Case, CO_2 emissions from the power sector will be 14 percent below 2005 levels by 2020 and only 5 percent below 2005 levels by 2035. See U.S. Department of Energy/Energy Information Administration. 2013. "Energy-Related Carbon Dioxide Emissions by Sector and Source, United States, Reference Case." In U.S. DOE/EIA. *Annual Energy Outlook 2013*. Washington, D.C.: Government Printing Office. Accessible at: <http://www.eia.gov/forecasts/aeo/>.
2. "Fact Sheet: President Obama's Climate Action Plan." White House, Office of the Press Secretary, June 25, 2013. Accessible at: <http://www.whitehouse.gov/the-press-office/2013/06/25/fact-sheet-president-obama-s-climate-action-plan>. "Memorandum for the Administrator of the Environmental Protection Agency." White House, Office of the Press Secretary, June 25, 2013. Accessible at: <http://www.ucsusa.org/assets/documents/global_warming/White-House-Memo-to-EPA-Administrator-on-Power-Sector-Carbon-Pollution-Standards-June-25-2013.pdf>.
3. U.S. Department of Energy/Energy Information Administration. 2013. "Electric Generating Capacity, Reference Case." In U.S. DOE/EIA. 2013. *Annual Energy Outlook 2013*. Washington, D.C.: Government Printing Office. Accessible at: <http://www.eia.gov/forecasts/aeo/>. For more details, see also: <http://www.wri.org/publication/us-electricity-markets-increasingly-favor-alternatives-to-coal>.
4. *AEO 2012* models compliance with renewable portfolio standards through a combination of in-state generation and purchases of renewable energy credits (RECs) from out of state. Utilities in the state have used out-of-state RECs up to the legal limit of 25 percent during the first few years of compliance (personal communication, Jason Hoyle, Appalachian State University). In addition, some RECs qualify as in-state if they are bundled with electricity that is purchased by a utility and delivered to the state's borders—even if the source is located outside the geographic boundaries of North Carolina. However, for purposes of this analysis, we assume that in the face of new CO_2 standards, all renewable electricity generation applied toward compliance with the state's REPS occurs in-state, and adjust the reference case accordingly.
5. The sum of reductions from the individual measures listed— along with the reductions captured in the reference case—may not match this total due to rounding. We calculated emission reductions for existing policies using the annual reference case emissions rates for each fuel type. See the appendix for additional information on the assumptions and methodology used for this analysis.
6. EPA has not yet proposed a national emissions standard for existing power plants. To illustrate the possible stringency of the future standards, this analysis shows emissions reductions for two scenarios. Proposed standards by the Natural Resources Defense Council (available at: <http://www.nrdc.org/air/pollution-standards/files/pollution-standards-report.pdf>) would result in GHG emissions reductions in North Carolina of 16 percent below 2011 levels in 2020. In WRI's *Can the U.S. Get There From Here?*, which focuses on reductions from 2005 levels, the most stringent scenario (the "go-getter" scenario) would achieve a 38 percent reduction from the power sector nationally between 2005 and 2020. For North Carolina, this is equivalent to a 26 percent reduction from 2011 levels. (It is unlikely that EPA standards would require identical reductions in each state, given the wide variation in emission intensities when the standards will be implemented.)
7. Estimated CO_2 savings from the energy efficiency standard, which are incorporated in the *AEO 2012* reference case, are approximately 8 percent below 2011 levels in 2020.
8. Increasing CHP capacity does not result in CO_2 benefits in 2020 in our analysis because 100 percent of the electricity savings from the assumed new CHP capacity could be used to comply with the REPS.
9. Emissions reductions were calculated using the emissions rate resulting from the adjusted reference case projection, which includes North Carolina's REPS policy. Reductions listed as a result of an expanded or accelerated policy are additional to reductions from existing policies.
10. We assume that North Carolina expands its REPS program after current targets have been reached. Since the current REPS target stops increasing on a percentage basis in 2021, our assumed expanded renewables requirement does not yield additional savings in 2020.
11. Nicholas Bianco, Franz Litz, Kristin Meek, and Rebecca Gasper. 2013. *Can The U.S. Get There From Here? Using Existing Federal Laws and State Action to Reduce Greenhouse Gas Emissions*. Washington, DC: World Resources Institute. Accessible at: <http://pdf.wri.org/can_us_get_there_from_here.pdf>.
12. § 62-133.8. Renewable Energy and Energy Efficiency Portfolio Standard (REPS). Accessible at: <http://www.ncleg.net/EnactedLegislation/Statutes/HTML/BySection/Chapter_62/GS_62-133.8.html>.
13. Because there is no minimum efficiency target, we assumed that the *AEO 2012* reference case captured an annual efficiency gain of 0.5 percent, which is consistent with ACEEE estimates. See *The 2012 State Energy Efficiency Scorecard*. American Council for an Energy-Efficient Economy. October 2012. Accessible at: <http://www.aceee.org/sites/default/files/publications/researchreports/e12c.pdf>.
14. North Carolina policies that drive solar investment include a 35 percent investment tax credit through 2015, as well as an 80 percent property tax exemption for commercial PV systems and a 100 percent property tax exemption for residential PV systems. See North Carolina General Statues § 105-129.16A. *Credit for investing in renewable energy property*, Accessible at <http://law.onecle.com/north-carolina/105-taxation/105-129.16a.html>; and North Carolina Department of Revenue. *Memorandum RE: Solar Energy Electric Systems*, accessible at <http://www.dornc.com/taxes/property/memos/solar_energy.pdf>.
15. U.S. Department of Energy/Energy Information Administration. *EIA-860 2012 Early Release*. Accessible at: <http://www.eia.gov/electricity/data/eia860/>.
16. *The Economic, Utility Portfolio, and Rate Impact of Clean Energy Development in North Carolina*, Prepared for North Carolina Sustainable Energy Association by RTI International and La Capra Associates, Inc. February 2013. Accessible at: <http://energync.org/assets/files/RTI%20Study%202013.pdf>.
17. For purposes of this analysis, we assume that in the face of new GHG standards, all renewable electricity generated for compliance with the state's REPS occurs in-state. See footnote 4 for additional explanation.
18. Estimate includes the costs through 2025 and benefits through the life of the measures considered. For more details, see: <http://www.energync.net/Portals/14/Documents/EnergyPolicyCouncil/ACEEE_03182010_final_report_text.pdf>.
19. An assessment prepared by ACEEE suggests that North Carolina has the potential to achieve 22 to 32 percent total cost-effective energy efficiency savings by 2025. Accessible at: <http://www.energync.net/Portals/14/Documents/EnergyPolicyCouncil/ACEEE_03182010_final_report_text.pdf>.
20. According to state-level estimates of CHP technical potential by ICF International. For more information, see: Bruce Hedman. 2011. *The Potential for CHP in North Carolina*. ICF International. Accessible at: <http://www.meede.org/wp-content/uploads/IECA-RAC-NC-8-4-Hedman-V2.pdf>.
21. Southeast Clean Energy Application Center. 2012. *Combined Heat and Power in North Carolina*. Accessible at: <http://www.southeastcleanenergy.org/resources/policy_recommendations/CHP_NC_Policy-Brief_120511.pdf>.

22. See Action Network. 2012. *Industrial Energy Efficiency and Combined Heat and Power*. Accessible at: <http://www1.eere.energy.gov/seeaction/pdfs/industrial_factsheet.pdf>.
23. *Article 3B. Business and Energy Tax Credits*. Accessible at: <http://www.ncga.state.nc.us/EnactedLegislation/Statutes/PDF/ByArticle/Chapter_105/Article_3B.pdf>.
24. REPS also allows the thermal energy savings from CHP systems powered by nonrenewable fuels to generate energy efficiency credits. However, to remain within the scope of the power sector and to provide a conservative estimate of CO_2 savings from new CHP systems in North Carolina, we only included the electricity savings generated from new CHP systems in our analysis. We model 34 trillion btu of fuel avoided due to new CHP systems, which is equivalent to 10 TWh of electricity savings.
25. NC Utilities Commission Docket E-7, sub 1032, Terms of Settlement Agreement between NCUC Public Staff, EDF/NCSEA and Duke Energy, stipulation no. 5. Accessible at: < http://ncuc.commerce.state.nc.us/cgi-bin/webview/senddoc.pgm?dispfmt=&itype=Q&authorization=&parm2=TAAAAA13231B&parm3=000141791>.
26. Bruce Hedman. 2011. *The Potential for CHP in North Carolina*. ICF International. Accessible at: <http://www.meede.org/wp-content/uploads/IECA-RAC-NC-8-4-Hedman-V2.pdf>. ICF International. *Combined Heat and Power Units located in North Carolina*. Accessible at: <http://www.eea-inc.com/chpdata/States/NC.html>. We assume all new CHP systems installed in the state are fired by natural gas. North Carolina's REPS allows CHP systems that are fired using qualifying renewable energy sources to generate renewable electricity credits (as opposed to energy efficiency credits).
27. ACEEE. 2012. *Coal Retirements and the CHP Investment Opportunity*. Accessible at: <http://www.aceee.org/sites/default/files/publications/researchreports/ie123.pdf>.
28. Assuming 100 percent acceptance of a five-year payback period and 50 percent acceptance of a ten-year payback period.
29. WRI estimates based on data from U.S. Energy Information Administration, *EIA-923 Generation and Fuel Data* (http://www.eia.gov/electricity/data/eia923/); and *EIA-860 Annual Electric Generator Data* (http://www.eia.gov/electricity/data/eia860/).
30. NGCC units are designed to be operated up to 85 percent capacity (see http://mitei.mit.edu/system/files/NaturalGas_Chapter4_Electricity.pdf), but actual maximum capacity factors may differ among units. We conservatively assume a maximum capacity factor of 75 percent. The CO_2 benefit is based on increasing the generation of the underutilized NGCC units while lowering the generation of the state's coal-fired units an equivalent amount.
31. We did not account for the associated increases in methane associated with the increased production of natural gas due to a higher demand for the fuel. Going forward, industry should work with EPA to reduce methane leakage rates from natural gas systems. For more information, see: <http://www.wri.org/publication/clearing-the-air>.
32. Phil DiPetro and Katrina Krulla. 2010. *Improving the Efficiency of Coal-Fired Power Plants for Near Term Greenhouse Gas Emissions Reductions*. National Energy Technology Laboratory, Office of Systems, Analyses and Planning. DOE/NETL-2010/1411. Accessible at: <http://www.netl.doe.gov/energy-analyses/pubs/ImpCFPPGHGRdctns_0410.pdf>. Chris Nichols, Gregson Vaux, Connie Zaremsky, James Murphy, and Massood Ramezan. 2008. *Reducing CO_2 Emissions by Improving the Efficiency of the Existing Coal-fired Power Plant Fleet*. National Energy Technology Laboratory, Office of Systems, Analyses, and Planning, and Research and Development Solutions, LLC.DOE/NETL-2008/1329. Accessible at:<http://www.netl.doe.gov/energy-analyses/pubs/CFPP%20Efficiency-FINAL.pdf>."Analyses Show Benefits of Improving Unit Heat Rate as Part of a Carbon Mitigation Strategy." *Lehigh Energy Update*28 (1), February 2010. Accessible at: <http://www.lehigh.edu/~inenr/leu/leu_65.pdf>.
33. Phil DiPetro and Katrina Krulla. 2010. *Improving the Efficiency of Coal-Fired Power Plants for Near Term Greenhouse Gas Emissions Reductions*. National Energy Technology Laboratory, Office of Systems, Analyses and Planning. DOE/NETL-2010/1411. Accessible at: <http://www.netl.doe.gov/energy-analyses/pubs/ImpCFPPGHGRdctns_0410.pdf>.
34. "Regulating Greenhouse Gas Emissions Under the Clean Air Act." 73 *Register* §147(2008). Accessible at: <http://www.gpo.gov/fdsys/pkg/FR-2008-07-30/pdf/E8-16432.pdf>.
35. For example, the National Energy Technology Laboratory found a payback period of less than four years for a refurbishment technology that achieves a 2 percent heat rate improvement. For more information, see *Benefits of the Big Bend Power Station Project*, National Energy Technology Laboratory. Accessible at: <http://www.netl.doe.gov/technologies/coalpower/cctc/ccpi/pubs/tampa.pdf>; and "Analyses Show Benefits of Improving Unit Heat Rate as Part of a Carbon Mitigation Strategy." *Lehigh Energy Update* 28 (1), February 2010. Accessible at: <http://www.lehigh.edu/~inenr/leu/leu_65.pdf>.
36. Personal communication with Tomas Carbonell, Environmental Defense Fund, July 12, 2013.
37. House Bill 298, http://www.ncga.state.nc.us/Sessions/2013/Bills/House/PDF/H298v1.pdf. This bill did not pass, upholding the current REPS program.