Alternate Scenarios for 111(d) Implementation in North Carolina

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1. EXECUTIVE SUMMARY

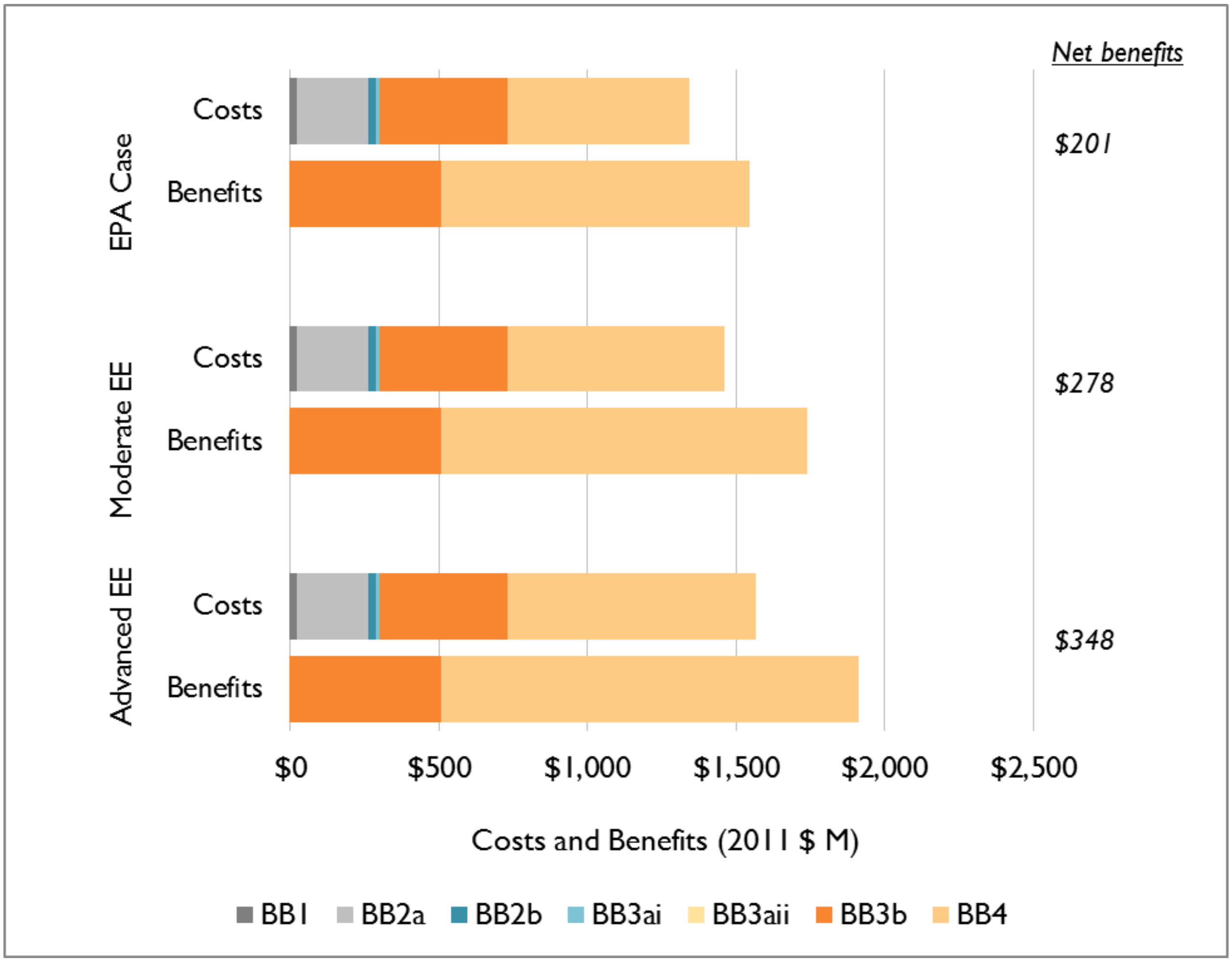
In order to comply with section 111(d) of the Clean Air Act, the U.S. Environmental Protection Agency (EPA) has proposed guidelines for reducing carbon dioxide (CO_2) from existing fossil fuel-fired power plants. This document describes the methodology used by EPA to calculate a target rate for North Carolina under 111(d), as well as considerations regarding future 111(d) compliance strategies for the state. Ultimately, this report estimates that achieving compliance with 111(d) by following each building block as prescribed by the EPA will result in $201 million in net benefits to North Carolina.

Synapse has developed a methodology to compare the generation, emissions, and net benefits of different strategies to comply with EPA's proposed 111(d) regulation, assuming a simplified mass-based translation. Figure ES 1 below reports the net benefits to North Carolina associated with EPA's scenario, along with two alternate scenarios.[1] The "Advanced EE" scenario evaluates EPA's building blocks plus the impacts of increasing North Carolina's energy efficiency savings target from 1.5 percent by 2025 to 2.0 percent by 2023, and changes the ramp rate of incremental efficiency savings from 0.2 percent per year in the EPA case to 0.25 percent per year. The "Moderate EE" scenario evaluates the impact of an energy efficiency savings trajectory in between the EPA and "Advanced EE" cases, with savings ramping by 0.25 percent per year to reach 1.75 percent annual incremental savings by 2023.

Figure ES 1 demonstrates that as energy efficiency programs are increased, net benefits also increase. As such, the net benefits to North Carolina of compliance for the Moderate and Advanced EE Cases are $278 million and $348 million, respectively, as compared to the $201 million in net benefits that would result from complying using EPA's scenario. The assumptions, methodology, and more detailed results provided in this report are an essential context to these summary results.

[1] In this report, as will be explained in greater detail below, Synapse assumes the costs associated with compliance with 111(d) to be those outlined by the EPA for all building blocks except 3b (renewables) and 4 (energy efficiency), for which Synapse developed original cost estimates. The benefits calculated in this report represent direct financial benefits to ratepayers that result from the use of cheaper energy resources. It does not, however, include other benefits, such as public health benefits. If all societal benefits were calculated, the net benefits associated with 111(d) compliance would grow.

Figure ES 1. 2030 costs and benefits from 111(d) building blocks



Note: In the figure above, the labels are as follows: BB1 is coal efficiency improvements, BB2a is redispatch to natural gas units, BB2b is redispatch to under construction gas units, BB3ai is at-risk nuclear, BB3aii is under-construction nuclear, BB3b is renewable energy, and BB4 is energy efficiency.

This first-cut analysis is preliminary. It relies on simplifying assumptions regarding the costs and emissions of displaced energy to arrive at indicative cost and emission impacts based on compliance according to EPA's building blocks, as well as under two alternate scenarios provided by SELC. The next steps for improving the accuracy and precision of these results would include electric-sector dispatch modeling and least-cost planning analysis.

2. THE IMPACT OF ALTERNATE ASSUMPTIONS FOR 111(d) COMPLIANCE ON NORTH CAROLINA'S COSTS AND EMISSIONS

In the following sections, we analyze the costs and emissions impacts of the EPA's assumptions for North Carolina's compliance target, in addition to two alternate scenarios. We define the alternate scenarios below. To make an "apples-to-apples" comparison between the alternate scenarios and the EPA's scenario, we designed a model using a mass-based approach.

For North Carolina, compliance with 111(d) requires either achieving a 111(d) emission rate of 992 lbs per MWh or lower in 2030, or achieving a "translated" equivalent mass-based target. In calculating target 111(d) emission rates, EPA considers the displacement of coal and steam generation by re-dispatched NGCC generation, but does not take into account the displacement of NGCC and other fossil generation by new nuclear and renewable generation and incremental energy efficiency. Because of the displacement effects of new generation and energy efficiency on fossil units, any state that complied exactly with the four building block measures as used by EPA for target setting would *overcomply* with its 111(d) emission rate, assuming no load growth.[2] This means that any state following its EPA building blocks will have a 111(d) emission rate that is lower than EPA's target; how much lower depends on how much of the displacement of fossil generation from new resources in Building Blocks 3 and 4 takes place in state versus out of state.

Our base case for this analysis (referred to as the "EPA Case") takes EPA's building block assumptions for North Carolina, adjusted for the fossil-fuel displacement necessary to keep the state's 2012 reconstituted generation (plus the assumed generation of the NGCCs under-construction in 2012) constant over time. When we apply this emissions displacement, EPA's 111(d) emission rate is fundamentally altered and comparisons of statewide rates are no longer meaningful. Instead, to examine the impact of different alternate compliance scenarios, we compare rough estimates of North Carolina's mass-based target—38.1 million metric tons of CO_2 in the EPA Case— given the assumption that all displacement occurs within state.[3] This analysis provides a high-level estimate of what emissions would be from 111(d) sources.

In keeping with EPA's methodology of looking at each state in isolation, the analysis described below assumes that all generation displacements occur in-state. We assume that new renewable generation and incremental energy efficiency displaces first coal generation, then oil/gas steam and other generation, then finally existing natural gas combined cycle generation. Electric-sector dispatch

[2] The assumption of no load growth, while simplifying, is in line with how EPA calculated the rate based goal. In order to better understand how load growth may impact compliance with 111(d), see Synapse's Clean Power Plan Planning Tool, available at: http://synapse-energy.com/tools/clean-power-plan-planning-tool-cp3t

[3] Although the EPA recently released guidelines for translating the rate-based targets to mass-based targets, we compare scenarios to the emissions reduction that would be achieved by following all of the building blocks precisely, while assuming that renewables and energy efficiency displace fossil generation in-state.

modeling would show that generation is displaced based on what resource is on the margin in a given hour, which would presumably produce different results—in terms of both benefits and costs and emission reductions—than our analysis.[4]

2.1. Illustrative example of the Synapse methodology

Imagine a hypothetical state that in 2012 had 100 MWh of coal generation, 50 MWh of NGCC generation, and 10 MWh of generation from oil and gas steam units (see Table 1, column (a)).

Table 1. Illustration of methodology for generation displacement

	Generation (MWh)		
	2012 (a)	*2020 – Building Blocks* (b)	*2020 – EPA Case with Displacement* (c)
Coal	100	82	62
NGCC	50	70	70
O/G Steam	10	8	8
New Renewables	-	10	10
Energy Efficiency	-	10	10
Total Fossil	**160**	**160**	**140**
Grand Total	**160**	**180**	**160**
NGCC CF	*50%*	*70%*	*70%*

In 2012, this state's NGCCs had capacity factors of 50 percent. Column (b) in Table 1 shows the effect of generation under EPA's building blocks in 2020 without considering displacement from new resources. NGCC generation ramps up to a 70 percent capacity factor, adding 20 MWh of generation from NGCCs to the system and displacing 20 MWh of coal and oil/gas (O/G) steam generation. Also added in 2020 are 10 MWh of new renewables and 10 MWh of energy efficiency, increasing the generation considered for setting the state's 111(d) emission rate target from 160 to 180 MWh.

In the *EPA Case with Displacement*, shown in column (c), these 20 MWh of combined renewable and energy efficiency displace 20 MWh of fossil generation, with coal generation being displaced first. Using this methodology, generation remains constant between 2012 and 2020 (except for the addition of generation from any NGCCs under construction in 2012). Emissions from each resource are then calculated using EPA's stated emission rates.

[4] The marginal electric generating unit is the unit whose energy output would be reduced by 1 MW if the system load were to be reduced by 1 MW. The marginal emissions rate is the emissions rate associated with the 1 MW reduction. In a system observing economic dispatch, the marginal unit is the most expensive (i.e. highest variable costs including fuel) unit being operating at any given moment and the marginal emissions rate is the emissions rate of that same unit.

Note that this methodology is only possible for states that are able to procure all new renewable generation in-state or through bundled (i.e., delivered) REC purchases. For states where renewable generation is procured out-of-state through unbundled REC purchases, renewable generation will have no displacing effect on in-state fossil generation. Instead, the state will be awarded emission reduction credits associated with the REC resource's marginal emitter, commonly an NGCC. In this analysis, we assume North Carolina complies through bundled REC purchases.

2.2. Scenario development

In this analysis of North Carolina's compliance with the Clean Power Plan, SELC requested the analysis of two scenarios in addition to EPA's assumptions for the compliance target. The scenarios are as follows:

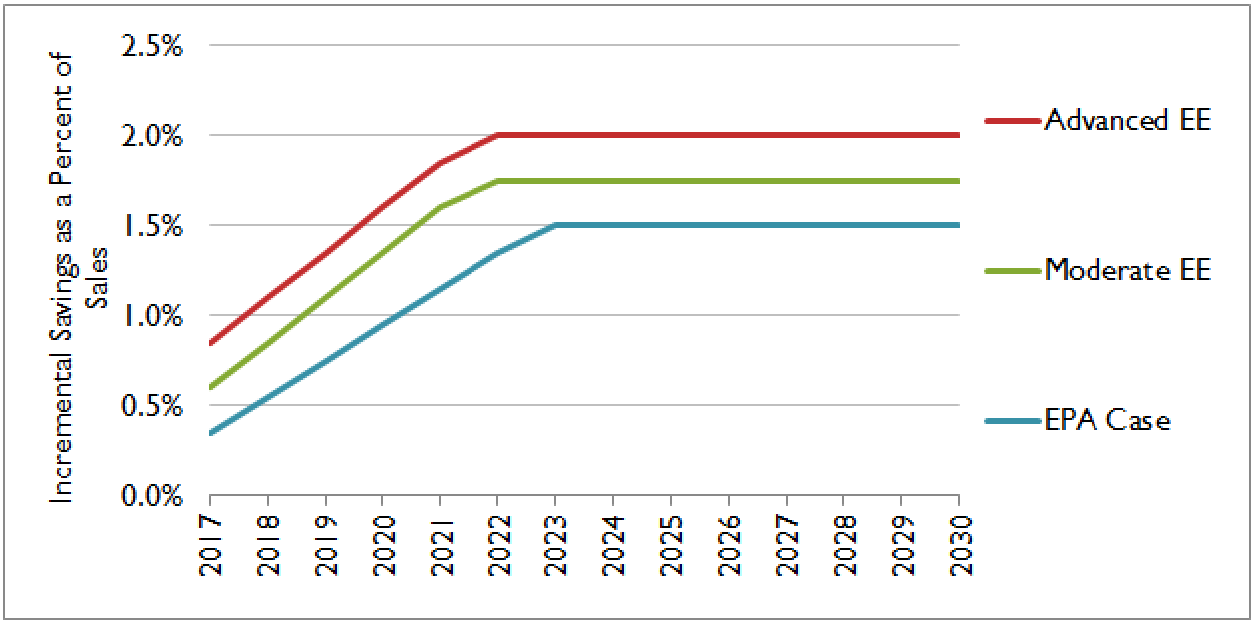
- **"Advanced EE":** This scenario evaluates EPA's building blocks plus the impacts of increasing North Carolina's energy efficiency savings level from 1.5 percent by 2023 to about 2 percent by 2022 (see Figure 1).[5] The 2 percent savings level represents an aggressive, but attainable, savings level, developed based upon recent savings achievements in Vermont, Massachusetts, and Rhode Island.[6] We estimated cumulative energy savings with the EPA's Clean Power Plan GHG Abatement Scenario 1 EE Savings Tool.[7]
- **"Moderate EE":** This scenario evaluates the impact of an EE savings trajectory in between the EPA and "Advanced EE" cases, with savings ramping by 0.25 percent per year to reach 1.75 percent annual incremental savings by 2023. Although this scenario calls for higher levels of efficiency than the EPA case, it is in line with what many states already target. Again, we estimated cumulative energy savings with the EPA's Clean Power Plan GHG Abatement Scenario 1 EE Savings Tool.

[5] Incremental savings as a percent of sales levels fluctuate year-to-year based on ACEEE's assumptions including baseline building codes, appliance standards, and consumer behavior.

[6] For achieved savings levels see: ACEEE. 2013. The 2013 State Energy Efficiency Scorecard, Appendix H, November 2013; EEAC Consultant. 2014. "2013 Plan-Year Reports, EECA Consultant, Initial Review." Available at: http://www.ma-eeac.org/Presentations.html; and: National Grid. 2014. 2013 Energy Efficiency Year-End Report, May 1, 2014.

[7] The EE Savings Tool is available at: http://www2.epa.gov/carbon-pollution-standards/clean-power-plan-proposed-rule-technical-documents.

Figure 1. Incremental savings as a percent of sales in the EPA Case and two modeled scenarios for North Carolina



In each scenario, there are two additional impacts on energy efficiency savings that are reflected in the trends as described above:

- **Transmission and distribution losses:** The savings from energy efficiency as described above are calculated based on sales to customers. Using the assumption of an 8-percent transmission and distribution (T&D) loss factor, for every 100 MWh of electricity sales avoided from an energy efficiency program, 108 MWh is avoided from electricity generation. Correctly accounting for T&D losses effectively increases the generation and emission benefits of an energy efficiency program without increasing costs.

- **Energy efficiency import derating:** Many states are net importers of electricity. This means that energy efficiency programs are only able to displace a portion of a state's in-state generation. In 2012, North Carolina imported 14 percent of its electricity. However, as a result of under-construction NGCC capacity in the state, in-state generation will account for 100 percent of sales in the future. As such, North Carolina receives full credit for the effect of energy efficiency programs on in-state generation is counted in 2020 and 2030.

2.3. Cost assumptions

Table 2 indicates the costs associated with each method of compliance, each of which is described in further detail in this section. Also noted is whether the cost as indicated is calculated net of electric system benefits. Net benefits to energy efficiency participants and society (for example, benefits of avoiding impacts of climate change) are not included in the costs below.

Table 2. Cost of compliance with 111(d) by strategy

	Cost of Avoiding one ton of CO_2 (2011 $/MWh)	Cost net of electric system benefits?
Coal efficiency upgrades	$3	Yes
Re-dispatch to NGCCs	$14	Yes
Maintaining "at-risk" nuclear plants	$6	Yes
Under-construction nuclear	$0	No
Renewables (incremental REC portion)	$48	No
Energy efficiency	$33	No

Coal efficiency upgrades

We use EPA's national average cost of lowering the emission rate of coal results: $8 per metric ton of CO_2.[8] Assuming a national average marginal unit emissions rate of 907 pounds per MWh, this compliance cost translates into a cost of $3 per MWh.[9]

Re-dispatch to NGCCs

We use EPA's national average cost of the price incentive necessary to re-dispatch from coal and steam generation to new and under-construction NGCCs: $33 per metric ton of CO_2.[10] Assuming a national average marginal unit emissions rate of 907 pounds per MWh, this compliance cost translates into a cost of $14 per MWh.

At-risk nuclear

We use EPA's national average cost of maintaining "at-risk" nuclear plants: $6 per MWh.[11]

Under-construction nuclear

We use EPA's national average cost for under-construction nuclear plants: $0 per MWh.[12]

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[8] 111(d) Greenhouse Gas Abatement TSD, p.2-39. Levelized capital costs less coal savings. Only 2020 cost of coal efficiency upgrades is provided, which is used for all years.

[9] The national average marginal unit emissions rate corresponds to the national average emissions rate for NGCCs

[10] 111(d) Greenhouse Gas Abatement TSD, p.3-26. Average cost to reach 70 percent capacity factor; state re-dispatch constraint; assumes "CO_2 charges on the variable cost of dispatch for existing coal, steam, IGCC, and O/G steam with emission rates greater than 1,100 lbs/MWh)." Only 2020-2029 cost is available; using for all years.

[11] 111(d) Greenhouse Gas Abatement TSD, p. 4-34. Only 2012 cost is available; using for all years.

[12] 111(d) Proposed Rule, p.215. "The EPA believes that since the decisions to construct these units were made prior to this proposal, it is reasonable to view the incremental cost associated with the CO_2 emission reductions available from completion of these units as zero for purposes of setting states' CO_2 reduction goals (although EPA acknowledges that the planning for those units likely included consideration of the possibility of future regulation of CO_2 emissions from EGUs)." Only 2012 cost is available; using for all years.

Renewables

We assume, for the purposes of this analysis, that North Carolina's most cost-effective source of renewable generation is the purchase of out-of-state RECs bundled together with energy purchases. This is a rule-of-thumb assessment based on the following considerations (and not on electric dispatch modeling):

- North Carolina's renewable resource potential is more limited than in some other states.
- Several states in the Southeast have already begun to procure energy in this manner. For instance, Alabama is already pursuing wind projects in nearby Central Plains states: one operational project in Kansas, and another under development in Oklahoma.[13] Given these current projects, we expect that North Carolina could procure out-of-state energy through bundled RECs at a lower cost than developing resources in-state.
- Because greenhouse gases are global pollutants, the location of emission reductions is immaterial, making a market for emission reductions, or related financial instruments such as RECs, feasible.

We assume that North Carolina's REC purchases for 111(d) compliance would be "bundled" together with their associated MWh (that is, the renewable or emission reducing attributes of electricity generation would be purchased together with the energy needed to satisfy North Carolina's electric demand). This means that purchased RECs are assumed to displace both in-state emissions and in-state generation. Table 3 indicates how costs and benefits are attributed to each renewable compliance strategy.

Table 3. Attribution of costs and benefits in various renewable compliance strategies

Strategy	Policy Cost	Avoided Emissions Benefits	Avoided Generation Benefits	Avoided Costs
Renewables built in-state	Cost to build renewables in-state	In-state	In-state	In-state
Bundled RECs	Incremental cost of purchasing RECs plus cost of purchasing wholesale energy	Avoided emissions benefits transferred to purchasing state	Avoided generation benefits transferred to purchasing state	Avoided cost benefits follow avoided generation in purchasing state
Unbundled RECs	Incremental cost of purchasing RECs	Avoided emissions benefits transferred to purchasing state	Generation is avoided in the state where renewables are generated	Costs are avoided in the state where renewables are generated

[13] SouthernCross. "SouthernCross Project Overview." Retrieved online 10/3/2014. Available at: http://www.southerncrosstransmission.com/overview.html; "PPA signed for wind power project in Kansas." *Power Engineering Magazine Online*. October 2012. Available at: http://www.power-eng.com/articles/2012/10/ppa-signed-for-wind-power-project-in-kansas.html.

Based on these assumptions, North Carolina could purchase bundled RECs from nearby states and would be willing to pay up to the standard cost of purchased energy plus the in-state marginal cost of 111(d) compliance in dollars per ton. For this analysis, we estimate a cost of $48 per MWh for bundled RECs in North Carolina based on the following components:

- **Cost of transmission projects:** Based on currently operational and under-development transmission projects from the Interior to the Southeast, in addition to a Black & Veatch report on transmission project costs, we estimated the unique cost of building transmission from Class 5 wind resources into North Carolina.[14] Given that transmission costs are primarily driven by the miles covered by a transmission line and the number of substations required, we estimated the distance from Class 5 wind resources to a large city in North Carolina with a similar spacing of substations as reported on a recently built line from Texas to Tennessee.[15] For North Carolina, we estimate the levelized cost of such a transmission project to be $26 per MWh.

- **Cost of energy:** Our analysis assumes that the cost of energy will be similar to recent costs associated with purchasing power from a wind developer through a long-term power purchase agreement (PPA). In this case, we estimate the cost of a wind PPA to be $22 per MWh.[16]

By adding the cost of a transmission project to the cost of energy, we are able to estimate the state-specific costs for a delivered REC.

Energy efficiency

Synapse currently estimates energy efficiency program administrator costs of 3.3 cents per kWh in 2020 up to 3.5 cents per kWh in 2030, based on the same annual energy efficiency price escalation used by EPA.[17] Assuming an average marginal unit emissions rate of 907 pounds per MWh, this compliance cost translates into a cost of $33 per MWh in 2020, rising to $35 per MWh in 2030. This preliminary cost estimate is based on an in-progress Synapse literature review of recent cost of saved energy (COSE) estimates, standardized to use the same basic assumptions of discount rate, measure life time and dollar year.

Table 4 summarizes basic COSE modeling methodologies used in ten studies of electric-sector energy-efficiency costs published from 2009 through 2014. This table reports COSE values both in their original

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[14] Black & Veatch. "Capital costs for transmissions and substations." Prepared for WECC. October 2012. Available at: https://www.wecc.biz/Reliability/BV_WECC_TransCostReport_Final.pdf

[15] Wind resources are divided into classes from 1 to 7 based on the speed and power at which the wind blows in a given area. While any wind above class 3 is typically developable, the most economic wind resources are in class 5 and above. For a better understanding of wind resource classification see: http://rredc.nrel.gov/wind/pubs/atlas/tables/1-1T.html

[16] Synapse market research.

[17] EPA Clean Power Plan Technical Support Document: GHG Abatement Measures, pg. 5-52.

dollar years and in 2011 dollars, but does not otherwise adjust for the important differences in the underlying terms of the COSE studies.

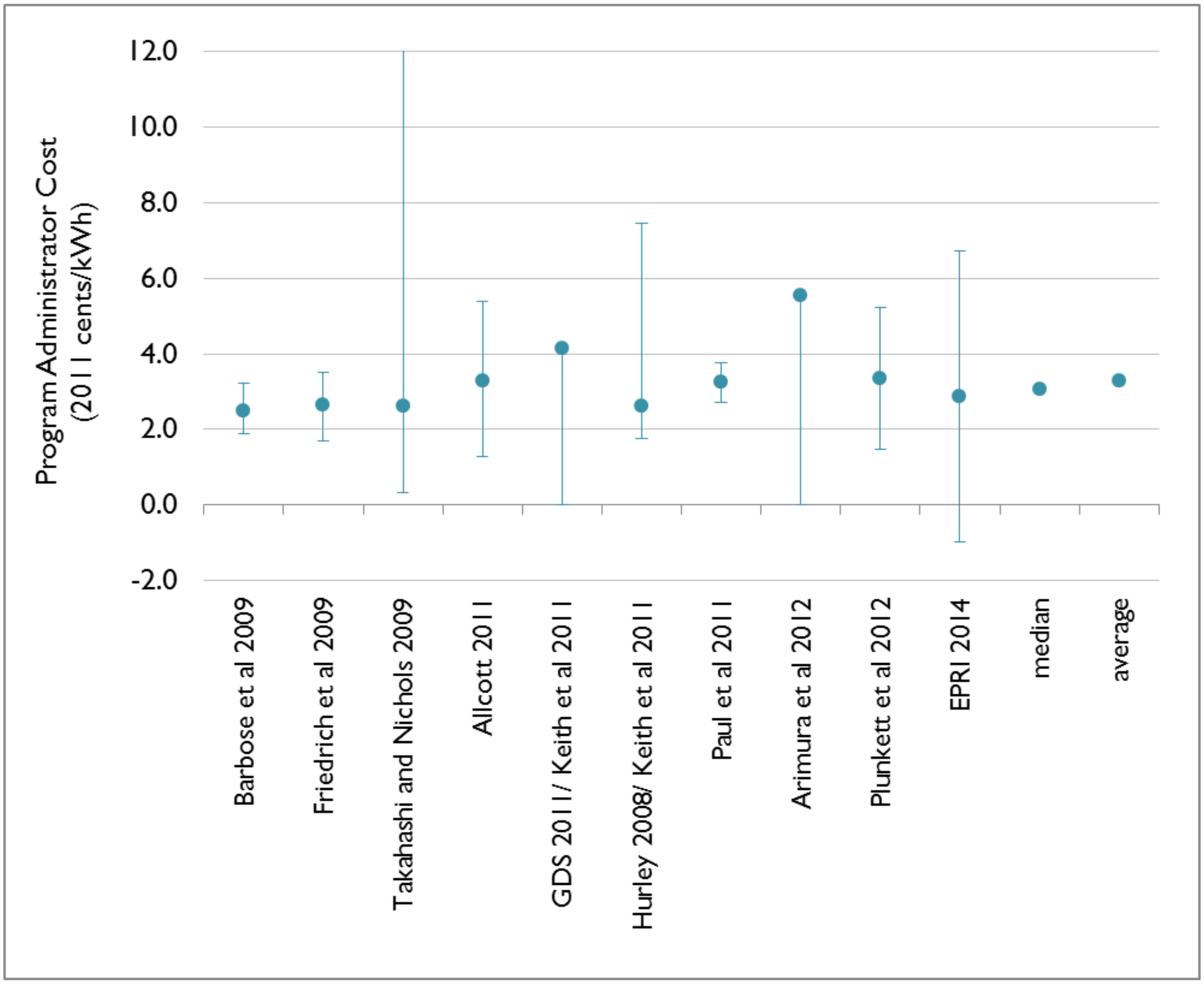
Across these ten studies, program administrators' COSE values range from 2.5 to 5.6 cents per kWh of lifetime savings, with a median value of 3.1 cents per kWh and an average value of 3.3 cents per kWh when standardized to a 10.5 percent capital recovery factor (CRF) in 2011 dollars. (See Figure 2: the whiskers in this figure denote the range of program or measure COSE values evaluated in the studies.) Given the range of potential CRF values in this literature, we estimate a range of COSE values from 1.9 to 3.8 cents per kWh. The studies in the review include a variety of data sources and estimation techniques. Eight of their central values fall between 1.9 and 3.8 cents per kWh. The two studies with central values outside of this range are a study of a single, relatively small-scale program (GDS 2011/Keith et al. 2009) and a study using costs and savings from different data sources (Arimura et al. 2012). Both of these study characteristics have a tendency to bias results toward higher COSE values.

Table 4. Summary of recent energy efficiency studies showing central COSE value from each study

	Barbose et al. 2009	Friedrich et al. 2009	Takahashi and Nichols 2009	Allcott 2011	GDS 2011/ Keith et al. 2011
Data years	2005-2011	2001-2008	1976-2006	2008-2009	2001-2009
# of program years	11	50	239	17	9
Type of cost	program admin.	program admin.	program admin.	program admin.	total resource
Cost basis	first-year savings	lifetime savings	lifetime savings	lifetime savings	lifetime savings
Central COSE (2011¢/kWh)	**23.7**	**2.7**	**2.7**	**3.3**	**5.9**
Dollar year	2007	2007	2006	2011	2010
Central COSE (reported ¢-yr/kWh)	21.9	2.5	2.4	3.3	5.7
CRF		**11%**	**11%**		
Real discount rate	not reported	5%	4%	not reported	not reported
Measure lifetime	not reported	13-years	12-years	not reported	20-years
End-use sector	mixed	mixed	mixed	residential	mixed
Cost estimation data	utility data	utility data	utility data	utility household-level data	utility data
Cost estimation method	reported data range	reported data range	reported data range	experiment /econometric	reported data range

	Hurley 2008/ Keith et al. 2011	Paul et al. 2011	Arimura et al. 2012	Plunkett et al. 2012	EPRI 2014
Data years	2000-2007	n/a	1992-2006	1999-2010	1992-2006
# of program years	91	n/a	307	219	307
Type of cost	program admin.	program admin.	program admin.	program admin.	program admin.
Cost basis	lifetime savings	lifetime savings	lifetime savings	first-year savings	lifetime savings
Central COSE (2011¢/kWh)	**2.9**	**2.9**	**4.4**	**31.9**	**3.2**
Dollar year	2006	2013	2007	2011	2007
Central COSE (reported ¢-yr/kWh)	2.6	3.0	4.1	32.0	3.0
CRF	**11%**		**8%**		
Real discount rate	4%	not reported	3%	not reported	not reported
Measure lifetime	12-years	not reported	15-years	not reported	various
End-use sector	mixed	mixed	mixed	mixed	mixed
Cost estimation data	utility data	utility data/ EIA demand	utility data/ EIA demand	utility data reported to EIA	EPRI measure database
Cost estimation method	reported data range	measure cost analysis	econometric	econometric	econometric

Figure 2. Central COSE in each study at standardized 10.5 percent CRF with ten-study median and average



Note: Circles represent central values at the standardized 10.5 percent CRF. Whiskers show the range of program-year or measure data used within each study. Median and average are of central values across the studies. The high range of measure costs presented in Takahashi and Nichols (2009), 142.3 cents per kWh, is truncated in this figure.

Displacement of existing fossil units

In each scenario, generation from existing coal, gas, oil and gas steam, and other fossil units is replaced with generation from energy efficiency and renewables. Coal units are displaced first, followed by oil and gas steam and other units, then followed by existing NGCCs. Under-construction NGCC units are displaced last. This methodology is consistent with the idea that the price mechanism driving re-dispatch to NGCCs in EPA Building Block 2 is still in effect, causing the non-natural gas units to be at the margin of the dispatch order.

The benefits of replacing existing generation are calculated by multiplying the displaced generation from each existing resource by its variable operating costs, including fuel. Operating and maintenance costs for existing units were derived from the Electricity Market Module used in the 2014 Annual Energy

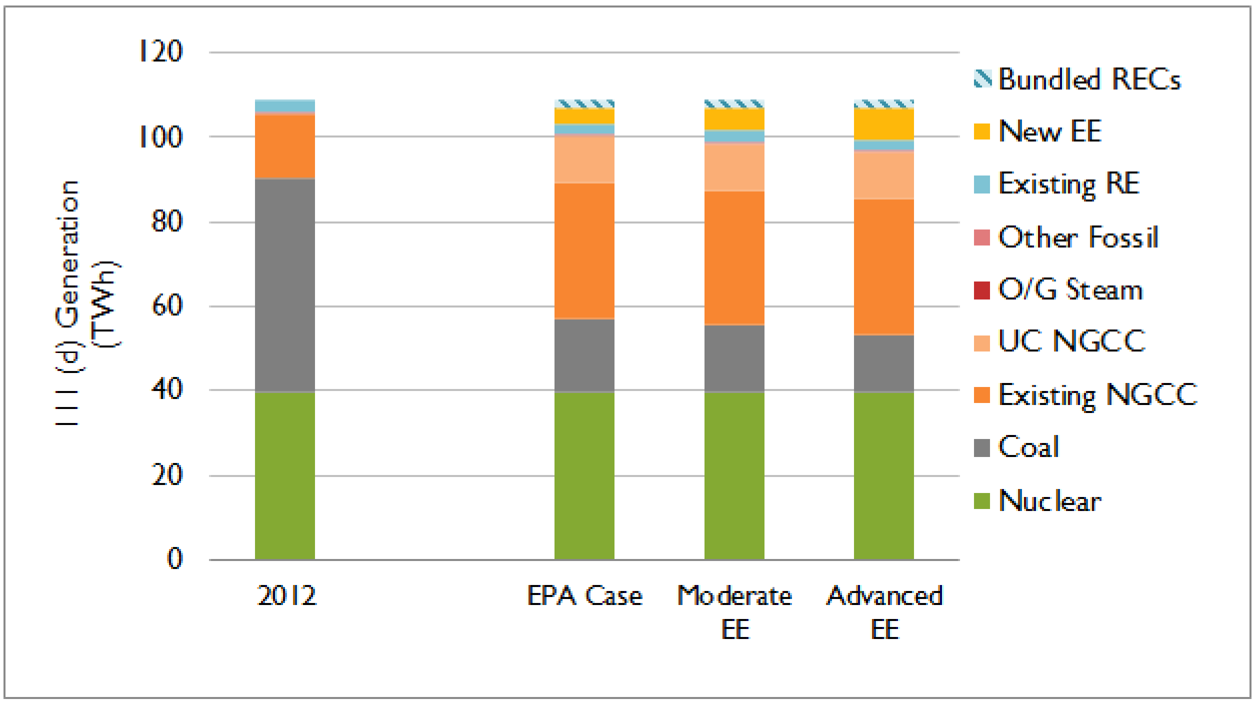
Outlook.[18] Fuel cost projections for existing units were calculated using the price of fuel delivered to electric power consumers in the South Atlantic region, as outlined in the 2014 Annual Energy Outlook.

2.4. Results of scenario analysis

The following first-cut analysis is preliminary. It relies on simplifying assumptions regarding the costs and emissions of displaced energy to estimate indicative cost and emission impacts based on compliance according to EPA's building blocks, as well as under two alternate scenario assumptions provided by the SELC. The next steps for improving the accuracy and precision of these results would include electric-sector dispatch modeling and least-cost planning analysis.

Under the methodology described above, energy efficiency and renewables units displace existing fossil generation. Figure 3, Figure 4, and Figure 5 illustrate the change in generation in each scenario in 2020, 2025, and 2030, as well as North Carolina's 2012 generation. Total generation (including energy efficiency and generation from out-of-state renewables) is held constant in each scenario.

Figure 3. 2020 generation in North Carolina's electric sector



[18] EIA. Electricity Market Module: Assumption to Annual Electricity Outlook 2014. Table 8.2, page 97.2. Available http://www.eia.gov/forecasts/aeo/assumptions/pdf/electricity.pdf.

Figure 4. 2025 generation in North Carolina's electric sector

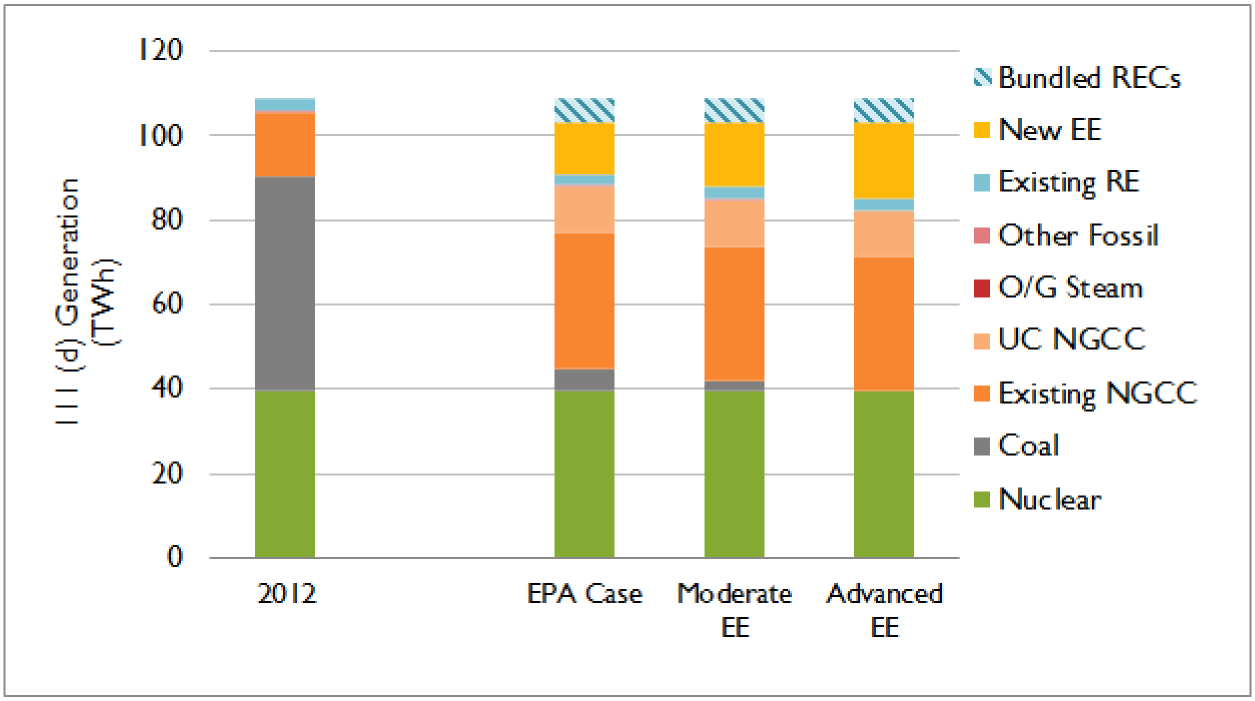
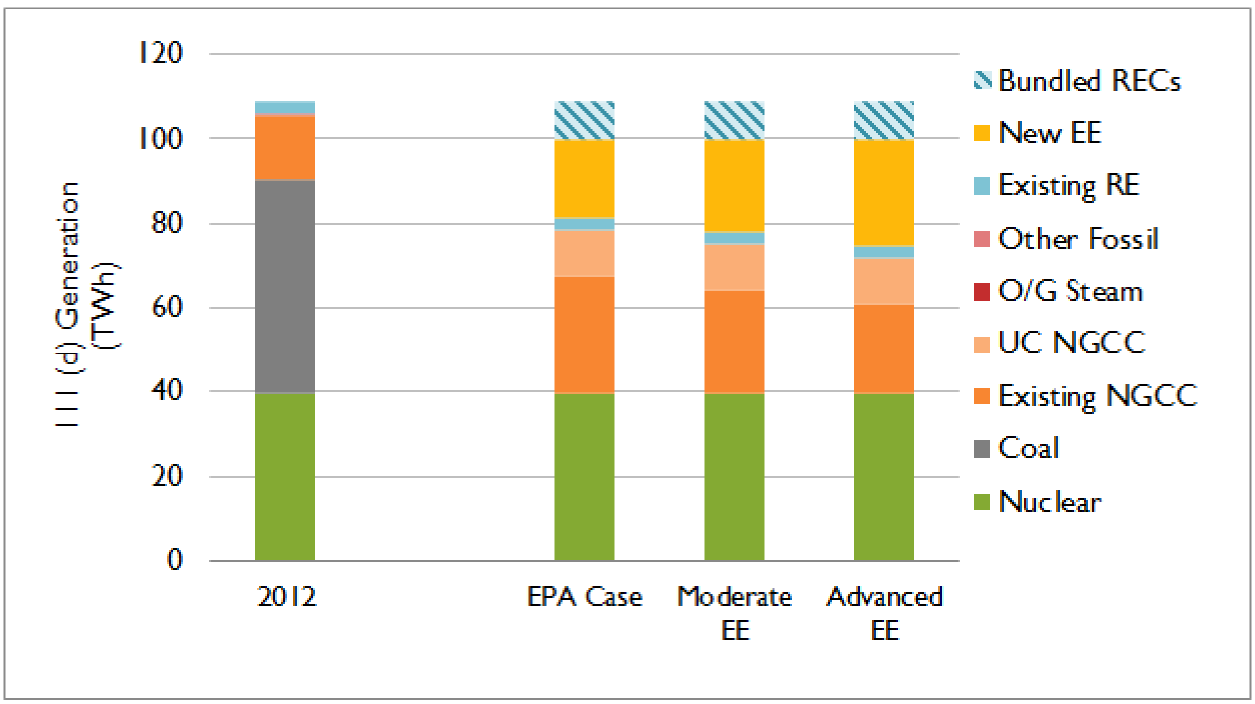


Figure 5. 2030 generation in North Carolina's electric sector



Increasing energy efficiency in the Moderate EE scenario has the effect of displacing 1.7 TWh of fossil generation in 2020 as compared to the Base case, rising to 3.5 TWh in 2030 (see Table 5). As a result of higher energy efficiency targets, the Advanced EE scenario displaces 3.7 TWh of existing fossil generation in 2020, and 6.6 TWh in 2030. Even after the redispatch to existing NGCCs and the displacement as a result of new renewable energy purchases and incremental energy efficiency investments, not all of North Carolina's existing coal generation is displaced. By 2030, all the coal, O/G steam, and other fossil resources have been completely displaced in each scenario, causing all differences in fossil generation to occur within the existing NGCC category.

Table 5. 2030 generation displacement by fossil type in each scenario, compared to the Base case

Generation Displacement from Base Case (TWh)	Coal	Existing NGCC	Under Construction NGCC	O/G Steam	Other Fossil	Total
Moderate EE	0.0	3.5	0.0	0.0	0.0	3.5
Advanced EE	0.0	6.6	0.0	0.0	0.0	6.6

Note: Although all three cases displace coal, the Moderate and Advanced EE cases do not displace any additional coal beyond what is displaced in the EPA case, as the EPA Base Case displaces all coal generation by 2030.

Figure 6, Figure 7, and Figure 8 report CO_2 emissions from 111(d) sources in each scenario for 2020, 2025, and 2030, respectively, along with North Carolina's 2012 emissions. EPA Case emissions are 32 million metric tons in 2020 declining to 15 million metric tons in 2030. Both scenarios produce fewer emissions than the EPA Case in each year. In the Moderate EE and Advanced EE scenarios, emissions are reduced by 1.3 million metric tons and 2.6 million metric tons compared to the EPA case in 2030 (see Table 6). As with generation, by 2030, all the coal, O/G steam, and other fossil resources have been completely displaced in each scenario, causing all differences in emissions to occur within the NGCC category.

Figure 6. 2020 carbon dioxide emissions in North Carolina's electric sector

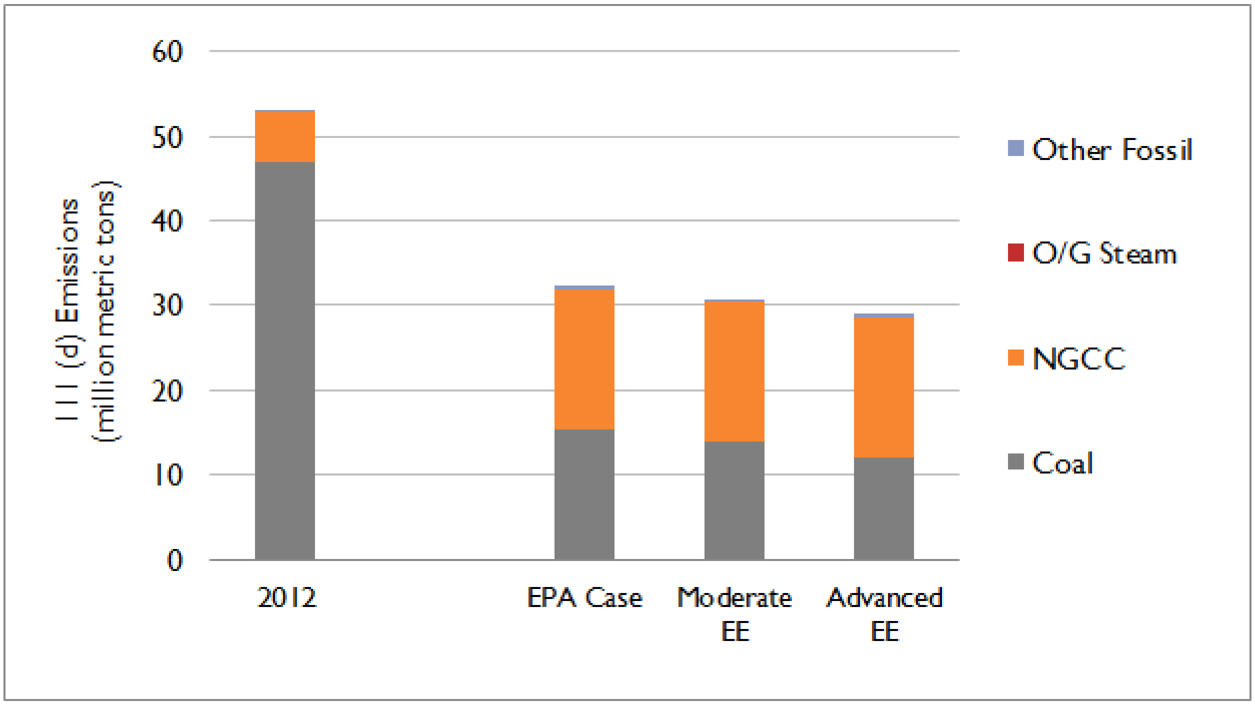


Figure 7. 2025 carbon dioxide emissions in North Carolina's electric sector

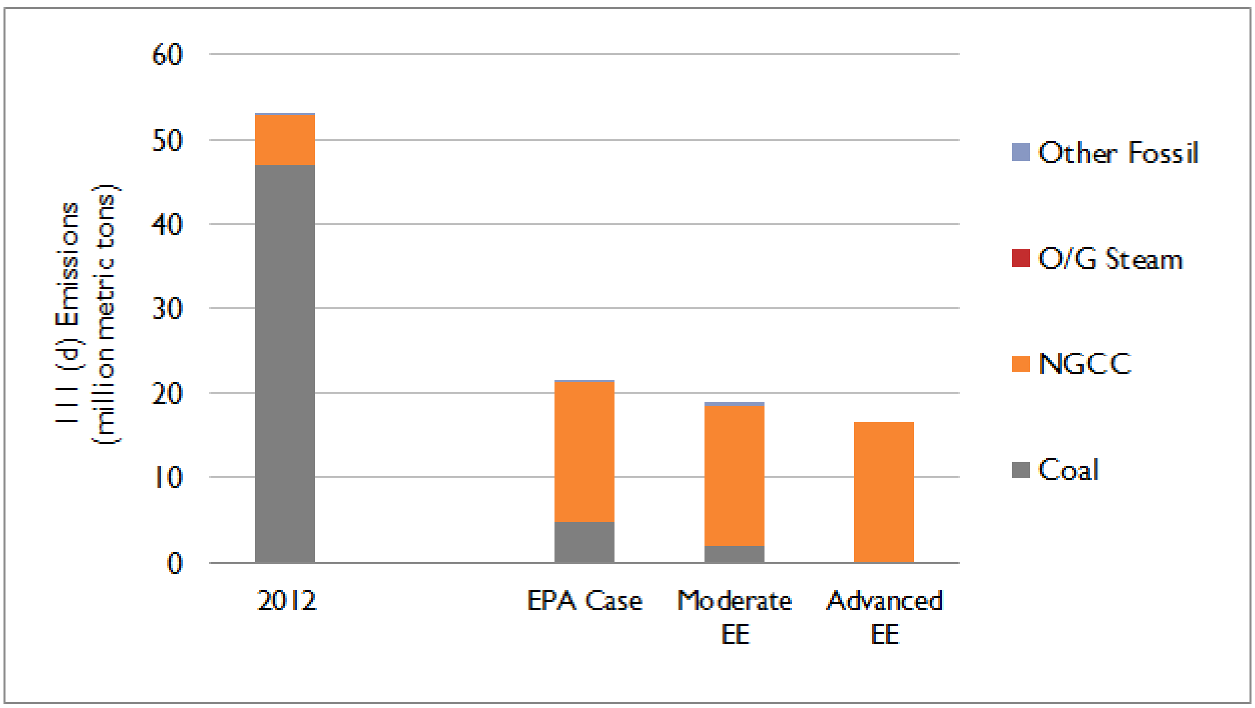


Figure 8. 2030 carbon dioxide emissions in North Carolina's electric sector

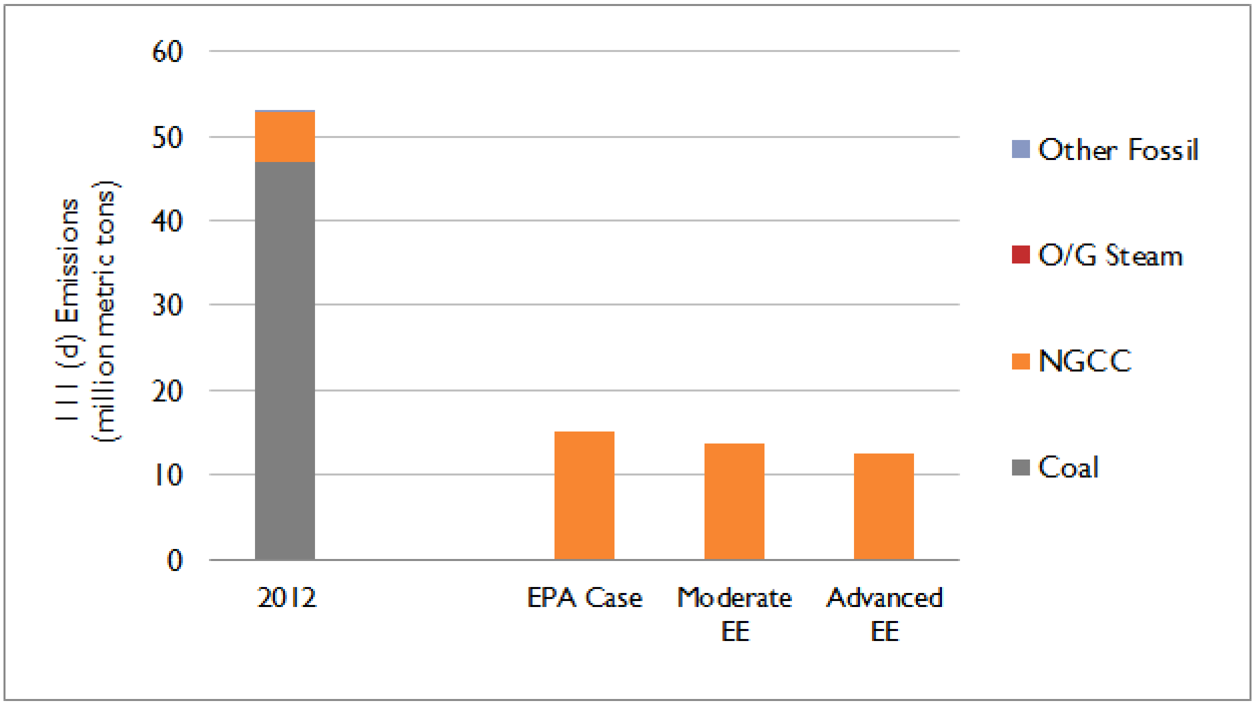
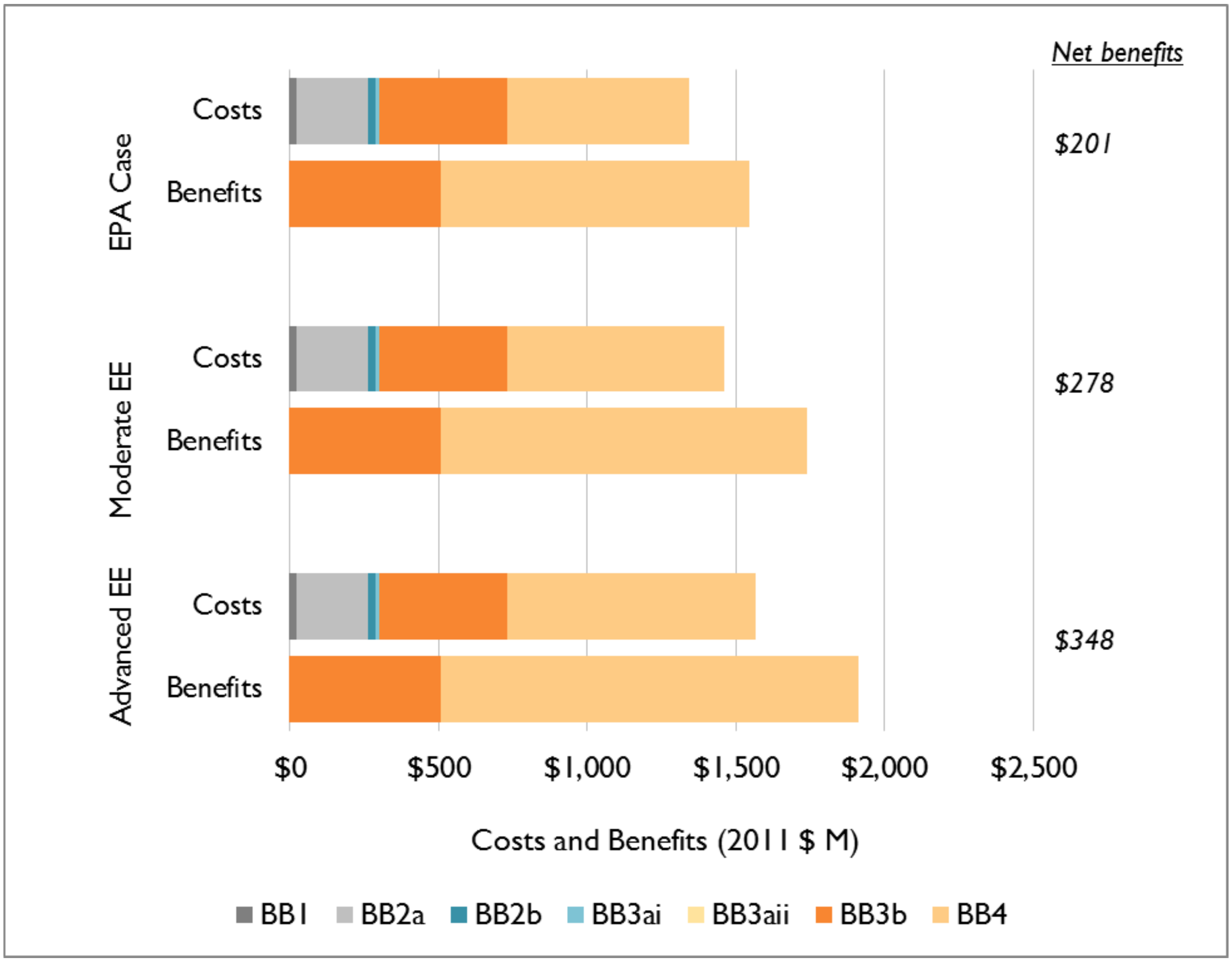


Table 6. 2030 emissions displacement by fossil type in each scenario, compared to the EPA Case

Emissions Displacement (million metric tons)	Coal	NGCC	O/G Steam	Other Fossil	Total
Moderate EE	0.0	1.3	0.0	0.0	1.3
Advanced EE	0.0	2.6	0.0	0.0	2.6

Figure 9 reports the estimated costs and benefits associated with each scenario for 2030, broken out by building block. In each scenario, costs for each building block are calculated based on the amount of displaced CO_2, multiplied by that building block's assumed costs (see "cost assumptions" above): the cost of improving coal plant heat rates, the cost of re-dispatching natural gas, the cost of maintaining "at risk" nuclear generation, the cost of purchasing RECs to meet a renewables obligation, and the cost of implementing energy efficiency. Net benefits shown below are only net benefits to the electric system; they do not include costs and benefits to energy efficiency participants or societal benefits (e.g., benefits of avoiding climate change).

Figure 9. 2030 costs and benefits from 111(d) building blocks



Benefits in each scenario are calculated by multiplying the amount of generation avoided by energy efficiency or newly built plants by the sum of the associated variable operating costs and fuel costs of existing fossil plants (coal, other fossil facilities, and NGCCs) at which generation is displaced. Each scenario has both costs and benefits associated with it, which are summed together to determine the total net benefit of each scenario. For example, while the costs of adding additional energy efficiency in the Moderate EE and Advanced EE scenarios are greater than the costs of adding energy efficiency in the EPA Case, the benefits associated with the increased energy efficiency are greater in the Moderate EE and Advanced EE scenarios, resulting in greater net benefits.

Italicized numbers to the right of each pair of bars are the net costs and benefits for each scenario. In this calculation, using the EPA's assumed costs for compliance, Synapse's estimates for the cost of energy efficiency and bundled RECs, as well as Synapse's estimates for the regional cost of avoided energy for various resources, compliance with EPA's 111(d) target in the EPA Case has a net benefit of $201 million. Under the assumptions used, energy efficiency, due to its ability to cheaply displace in-state generation, is the main driver of net benefits. In both the Moderate EE and Advanced EE Cases, increased benefits from displaced generation are enough to overcome increased costs of expanded energy efficiency and REC purchases, resulting in net benefits of $278 million and $348 million, respectively.

APPENDIX A: SCENARIO MODELING DATA

2 pages of detailed tables follow.

111(d) Generation Scenarios in North Carolina (TWh)										
2020										
	Nuclear	*Coal*	*Existing NGCC*	*UC NGCC*	*O/G Steam*	*Other Fossil*	*Existing RE*	*New EE*	*New Nuclear*	*Bundled RECs*
2012	40	51	15	0	0	0	3	0	0	0
EPA Case	40	18	32	11	0	0	3	4	0	2
Moderate EE	40	16	32	11	0	0	3	5	0	2
Advanced EE	40	14	32	11	0	0	3	7	0	2
2025										
	Nuclear	*Coal*	*Existing NGCC*	*UC NGCC*	*O/G Steam*	*Other Fossil*	*Existing RE*	*New EE*	*New Nuclear*	*Bundled RECs*
2012	40	51	15	0	0	0	3	0	0	0
EPA Case	40	5	32	11	0	0	3	12	0	6
Moderate EE	40	2	32	11	0	0	3	15	0	6
Advanced EE	40	0	32	11	0	0	3	18	0	6
2030										
	Nuclear	*Coal*	*Existing NGCC*	*UC NGCC*	*O/G Steam*	*Other Fossil*	*Existing RE*	*New EE*	*New Nuclear*	*Bundled RECs*
2012	40	51	15	0	0	0	3	0	0	0
EPA Case	40	0	28	11	0	0	3	18	0	9
Moderate EE	40	0	25	11	0	0	3	22	0	9
Advanced EE	40	0	22	11	0	0	3	25	0	9

111(d) Emissions Scenarios in North Carolina (million metric tons)					
2020					
	Coal	*NGCC*	*O/G Steam*	*Other Fossil*	*Other Fossil*
2012	47	6	0	0	0
EPA Case	15	17	0	0	0
Moderate EE	14	17	0	0	0
Advanced EE	12	17	0	0	0
2025					
	Coal	*NGCC*	*O/G Steam*	*Other Fossil*	*Other Fossil*
2012	47	6	0	0	0
EPA Case	5	17	0	0	0
Moderate EE	2	17	0	0	0
Advanced EE	0	16	0	0	0
2030					
	Coal	*NGCC*	*O/G Steam*	*Other Fossil*	*Other Fossil*
2012	47	6	0	0	0
EPA Case	0	15	0	0	0
Moderate EE	0	14	0	0	0
Advanced EE	0	13	0	0	0

Costs and Benefits for 111(d) Compliance Scenarios in North Carolina (2011 $ M)											
	2030	BB1	BB2a	BB2b	BB3ai	BB3aii	BB3b	BB4	Non-111(d)	Net
EPA Case	Costs	$22	$243	$25	$14	$0	$430	$609	$0	$201
	Benefits					$0	$509	$1,034	$0	
Moderate EE	Costs	$22	$243	$25	$14	$0	$430	$726	$0	$278
	Benefits					$0	$508	$1,229	$0	
Advanced EE	Costs	$22	$243	$25	$14	$0	$430	$831	$0	$348
	Benefits					$0	$507	$1,405	$0	