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Economic and Rate Impact Analysis of Clean Energy Development in North Carolina—2015 Update

Prepared for

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Executive Summary

This report presents an update to the retrospective economic impact analysis of renewable energy and energy efficiency investment included in the 2014 report *Economic Impact Analysis of Clean Energy Development in North Carolina—2014 Update*, prepared by RTI International (2014). This report also includes a rate impact analysis of clean energy development to date and expected in the future to meet the Renewable Energy and Energy Efficiency Portfolio Standard set for the State of North Carolina, prepared by ScottMadden Management Consultants.

In this supplement to the 2014 report, the direct and secondary effects associated with major energy efficiency initiatives and the construction, operation, and maintenance of renewable energy projects (collectively, "clean energy development") are analyzed to measure the magnitude of clean energy development's contribution to North Carolina's economy.

Changes in consumer, utility, and government spending patterns are analyzed, including

- investment in clean energy projects in North Carolina and their ongoing operation and maintenance,
- how renewable energy generation and energy savings from energy efficiency projects have changed spending on conventional energy generation,
- reductions in spending due to the Renewable Energy and Energy Efficiency Portfolio Standard (REPS)[1] rider requirement.
- government funds that would have been spent on other government services in the absence of state support for clean energy investment.

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[1] Under this law investor-owned utilities in North Carolina will be required to meet up to 12.5% of their energy needs through renewable energy resources or energy efficiency measures. Rural electric cooperatives and municipal electric suppliers are subject to a 10% REPS requirement.

Our research findings are as follows:

- Approximately $3,472.8 million was invested in clean energy development in North Carolina between 2007 and 2014, which was supported, in part, by the state government at an estimated cost of $195.6 million. Clean energy investments were nearly 18 times larger than the state incentives for them.
- Renewable energy project investment in 2014 was $651.9 million, or nearly 38 times the $17.3 million investment observed in 2007.
- Total contribution to gross state product (GSP) was $4,197.9 million between 2007 and 2014 (see **Table ES-1**).
- Clean energy development supported 44,549 annual full-time equivalents (FTEs), equivalent to one person working full time for a year, from 2007 to 2014.
- Catawba, Davidson, Duplin, Person, Robeson, and Wayne Counties experienced the greatest amount of investment—more than $100 million each between 2007 and 2014.
- Beaufort, Cabarrus, Columbus, Cleveland, Wake, Nash, Chatham, Harnett, Montgomery, Lenoir, and Davie Counties each experienced between $50 million and $100 million in investment between 2007 and 2014.
- The net present value of the Renewable Energy and Energy Efficiency Portfolio Standard savings compared to a conventional portfolio equals $651 million. The analysis finds the greatest annual savings occur in 2029, when the portfolio provides $287 million in savings.
- Over the 21-year period since the start of the clean energy policies in North Carolina, rates are expected to be lower than they would have been had the state continued to only use existing, conventional generation sources.

Table ES-1. Total Economic Impacts, 2007–2014

	Total Output[a] (Million, 2013$)	Gross State Product[b] (Million, 2013$)	Employment (Full-Time Equivalents)	Fiscal Impacts[c] (Million, 2013$)
Direct economic impact from clean energy development	3,472.8	2,086.6	19,671	213.4
Direct economic impact from change in government spending[d]	−165.7	−83.5	−1,219	−3.3
Secondary economic impact[e]	3,001.2	2,194.8	26,096	59.1
Total economic impact	6,308.3	4,197.9	44,549	269.1

[a] Total output refers to revenue received by North Carolina individuals and businesses. [b] GSP represents the total value added. [c] State support for clean energy projects is included in the analysis as an offset to output and is not reflected in the fiscal impact results. Note: Sums may not add to totals because of rounding. See Appendix A for details. [d] Direct economic impact from change in government spending refers to the in-state impact of $135.2 million in state clean energy incentives, less $25.7 million that, based on historical spending patterns, would have otherwise procured goods and services from out of state. [e] Secondary impacts represent spending changes resulting from renewable energy generation and energy savings and indirect and induced impacts associated with supply chain effects and increased labor income spending.

1 Introduction and Analysis Approach

Between 2007 and 2014, annual investment in clean energy development in North Carolina increased nearly 20-fold from $47.7 million to $900.7 million, of which $651.9 million (72%) was for renewable energy projects and $248.7 million (28%) was for major energy efficiency initiatives.

The total amount of energy generated or saved through renewable energy and energy efficiency programs amounted to 16.1 million MWh, which is sufficient to power nearly 1.2 million homes for 1 year.[2]

Although the growth in energy generation from renewable sources has been documented in annual energy reports,[3] the economic impact of clean energy development—economic activity from construction, operation, maintenance, changes in energy use, and consequent changes in spending—on North Carolina's economy had not been comprehensively measured until the 2013 report *The Economic, Utility Portfolio, and Rate Impact of Clean Energy Development in North Carolina*, prepared by RTI International and LaCapra Associates (2013).

This report updates the economic impact results to include clean energy investments made in 2014. Otherwise, the data and analysis methodology are unchanged.

This report also includes a rate impact analysis.

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[2] The Energy Information Administration (EIA) estimates that in 2012 a North Carolina residential utility customer consumed 12,924 kWh (or 12.924 MWh) per year. See EIA (2012): http://www.eia.gov/tools/faqs/faq.cfm?id=97&t=3.

[3] For more information on renewable energy generation in the United States, see EIA (2014): http://www.eia.gov/electricity/annual/?src=Electricity-f4.

This work was commissioned by the North Carolina Sustainable Energy Association, a professional and membership association, which had no role in the preparation of the analysis or report apart from posing research questions, suggesting data sources, and reviewing drafts.

Similar to previous reports, this analysis answered two principal research questions:

- *What are the comprehensive retrospective statewide economic and fiscal impacts of clean energy development?*
- *What is the expected electric utility rate impact of the renewable energy and energy efficiency portfolio standard?*

1.1 ANALYSIS APPROACH

The economic impact analysis contained herein uses methods that provide results about the portion of North Carolina's economic activity directly and indirectly associated with clean energy development. Clean energy development is defined to include the construction, operation, and maintenance of renewable energy facilities and energy efficiency initiatives.

This retrospective analysis of clean energy development

- analyzed the most current data available from the North Carolina Utilities Commission (NCUC), North Carolina Renewable Energy Tracking System (NC-RETS), the North Carolina Department of Revenue, the North Carolina Department of Environment and Natural Resources, and the U.S. Energy Information Administration (EIA);
- measured spending for clean energy investments made in North Carolina over the 8-year period from 2007 through 2014 along multiple dimensions, including project value and megawatt capacity or equivalent;
- used a regional input-output (I-O) analysis to estimate the gross indirect (supply chain) and induced (consumer spending from increased labor income) impacts throughout the state economy resulting from those investments, including the impacts of reduced conventional energy generation and of government incentives over the study period; and

- presented the gross employment, fiscal, economic output, and valued added (gross state product [GSP]) impacts of clean energy development on North Carolina's economy.

Two categories of economic effects were considered.

1. Direct effects: Information was gathered to quantify the direct investment (expenditures) related to clean energy development over the period 2007 through 2014. The following impact categories were in scope: investment in renewable energy and energy efficiency projects and reduction in government spending on other services to account for the foregone tax revenue (e.g., the costs of state policies).
2. Secondary effects: These direct economic impact estimates were combined with spending changes resulting from renewable energy generation and energy savings and modeled using a regional I-O model to measure the indirect (supply chain) and induced (consumer spending) impacts resulting from clean energy development.

The total economy-wide impacts represent the combination of the two categories. Analysis results are presented as the cumulative impact from 2007 through 2014; therefore, results should not be interpreted as annual totals.

Unlike other studies, the analysis accounts for selected displacement effects such as

- reduced spending on conventional energy production,
- how households and businesses would have otherwise spent the REPS rider for the renewable energy and energy efficiency performance standard, and
- how state government funding would have been spent in the absence of state incentives for clean energy development.

However, the analysis does not consider the alternative uses for the investment dollars devoted to clean energy projects. As a result, the economic impact measures used in this report are best interpreted as gross versus net changes in state-level economic activity.[4]

It is also important to note that the selected methodology does not evaluate how North Carolina's clean energy incentives and

[4] See also http://www.nrel.gov/analysis/jedi/limitations.html.

policies influence investment or how state incentives and policy interact with other federal policy. Thus, for example, the methodology does not estimate the portion of investment that occurred as a result of state incentives; instead, it estimates gross changes in economic activity associated with all clean energy investment that took place over the study period.

1.2 ABOUT RTI INTERNATIONAL

RTI International is one of the world's leading independent nonprofit research institutes. Based in Research Triangle Park, North Carolina, RTI has a mission to improve the human condition by turning knowledge into practice. Founded in 1958 with the guidance of government, education, and business leaders in North Carolina, RTI was the first tenant of Research Triangle Park. Today we have nine offices in the United States and nine in international locations. We employ over 2,200 staff in North Carolina, 500 across the United States, and over 900 worldwide. RTI performs independent and objective analysis for governments and businesses in more than 75 countries in the areas of energy and the environment, health and pharmaceuticals, education and training, surveys and statistics, advanced technology, international development, economic and social policy, and laboratory testing and chemical analysis. In 2013, RTI's revenue was $783 million.

2 Economic Impacts, 2007–2014

From 2007 through 2014, $2,613.5 million was invested in the construction and installation of renewable energy projects in North Carolina. An additional $859.3 million was spent on implementing energy efficiency projects.[5] Total clean energy development was valued at $3,472.8 million.

Although investment was distributed across the state, Catawba, Davidson, Duplin, Person, Robeson, and Wayne Counties each experienced the greatest amount, with more than $100 million in renewable energy project investment each.

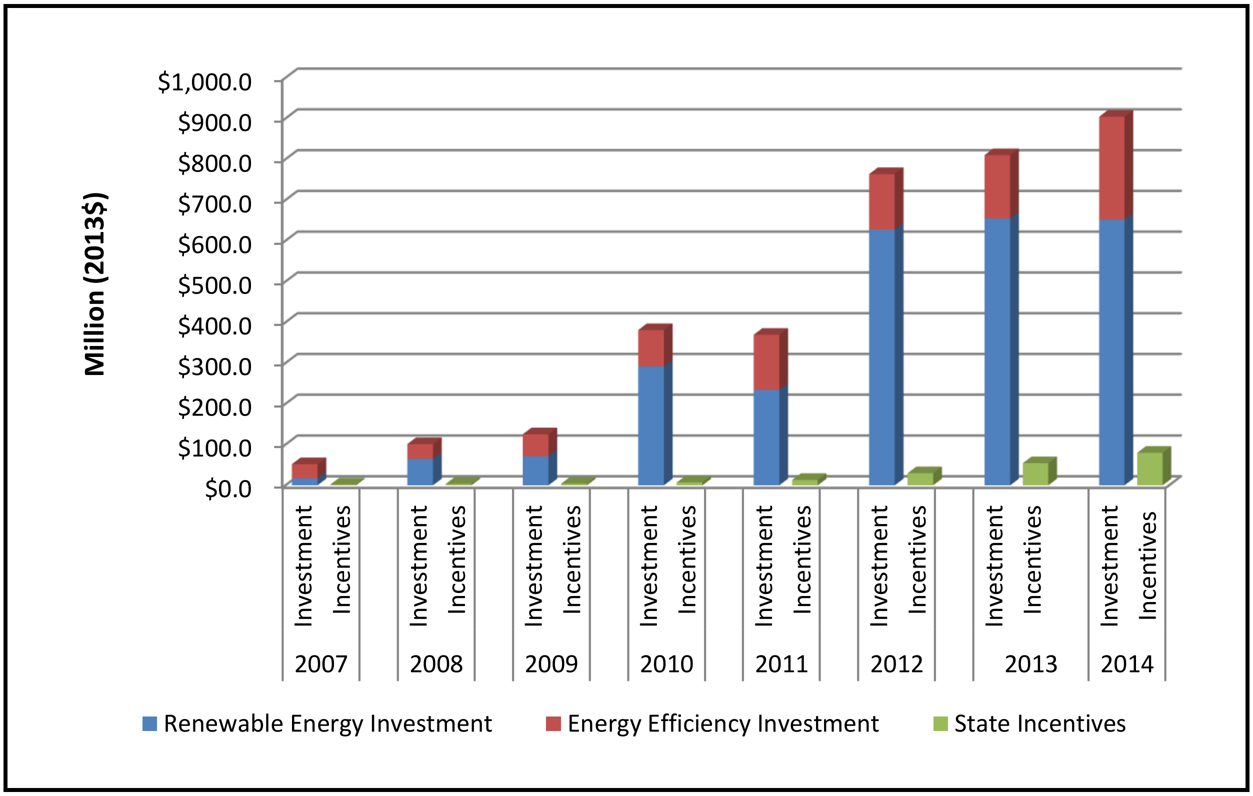
Clean energy development contributed $4,197.9 million in GSP and supported 44,549 annual FTEs statewide. As a result of changes in economic activity from the development of clean energy in North Carolina, state and local governments realized tax revenue of $269.1 million.

2.1 ESTIMATED DIRECT IMPACTS OF CLEAN ENERGY DEVELOPMENT

As depicted in **Figure 2-1** and **Table 2-1**, investment in clean energy development increased substantially over the 8-year analysis period. For example, renewable energy project investment in 2014 was $651.9 million, which was about 38 times the size of 2007's $17.3 million. In 2013 and 2014 combined, clean energy investment was 49% of the total investment from 2007 to 2014.

[5] All dollar values are presented in real 2013 terms. Nominal values were adjusted using the U.S. city average annual consumer price index on all items, developed by the Bureau of Labor Statistics.

Figure 2-1. Clean Energy Investment in North Carolina, 2007–2014



See Appendix A for data sources.

Table 2-1. Clean Energy Investment in North Carolina, 2007–2014

	Renewable Energy		Energy Efficiency		Clean Energy Investment		State Incentives
Year	**(Million, 2013$)**	**% of Total**	**(Million, 2013$)**	**% of Total**	**(Million, 2013$)**	**% of Total**	**(Million, 2013$)**
2007	$17.3	1%	$30.4	4%	$47.7	1%	$2.1
2008	$64.8	2%	$32.0	4%	$96.8	3%	$3.9
2009	$71.5	3%	$49.3	6%	$120.9	3%	$4.5
2010	$291.6	11%	$84.9	10%	$376.5	11%	$7.2
2011	$234.3	9%	$130.8	15%	$365.1	11%	$13.3
2012	$627.4	24%	$131.9	15%	$759.3	22%	$29.9
2013	$654.6	25%	$151.2	18%	$805.8	23%	$54.5
2014	$651.9	25%	$248.7	29%	$900.7	26%	$80.0
Total	$2,613.5	100%	$859.3	100%	$3,472.8	100%	$195.6

See Appendix A for data sources. Sums may not add to totals because of independent rounding.

In addition to demonstrating growth in investment value over time, Figure 2-1 and Table 2-1 illustrate that clean energy projects were nearly 18 times as large as the state incentives for them. Although we do not attempt to statistically estimate the share of these investments that was motivated by these incentive programs, it is likely that there is a strong positive relationship.

The remainder of Section 2.1 reviews in-depth

- investment value of clean energy projects,
- energy generated or saved by clean energy projects, and
- state incentives for clean energy development.

2.1.1 Investment Value of Clean Energy Projects

Renewable energy investment was estimated primarily from facilities registered with NC-RETS, supplemented with data from EIA databases—EIA-860 and EIA-923; North Carolina's Department of Environment and Natural Resources; North Carolina Utility Commission (NCUC) dockets for individual projects; North Carolina GreenPower; and personal communication with industry experts to adjust reported data or address areas where information was incomplete. Investments in energy efficiency were taken from program reports submitted by utilities to the NCUC and annual reports of the Utility Savings Initiative. See **Appendix A** for more information.

Table 2-2 summarizes the cumulative direct spending in renewable energy by category between 2007 and 2014. Investment in renewable energy projects totaled $2,613.5 million. Investment in energy efficiency totaled $859.3 million. Thus, total clean energy investment was $3,472.8 million during the study period.

Of the $2,613.5 million investment in renewable energy projects,

- solar photovoltaics made up $2,143.1 million (82%),
- landfill gas made up $234.4 million (9%), and
- biomass made up $136.0 million (5%).

Table 2-2. Direct Spending in Clean Energy Development by Technology, 2007–2014

Category	Technology	Value (Million, 2013$)	%
Renewable energy direct investment	Biogas fuel cell	$70.5	3%
	Biomass	$136.0	5%
	Geothermal	$24.5	1%
	Hydroelectric (<10 MW capacity)[a]	$25.0	1%
	Landfill gas	$169.9	7%
	Passive solar	$3.6	0%
	Solar photovoltaic	$2,143.1	82%
	Solar thermal	$40.2	2%
	Wind	$0.7	0%
	Total	$2,613.5	100%
Energy efficiency direct investment	Utility energy efficiency and demand-side management programs	$617.4	72%
	Utility Savings Initiative	$241.8	28%
	Total	$859.3	100%
Total		$3,472.8	

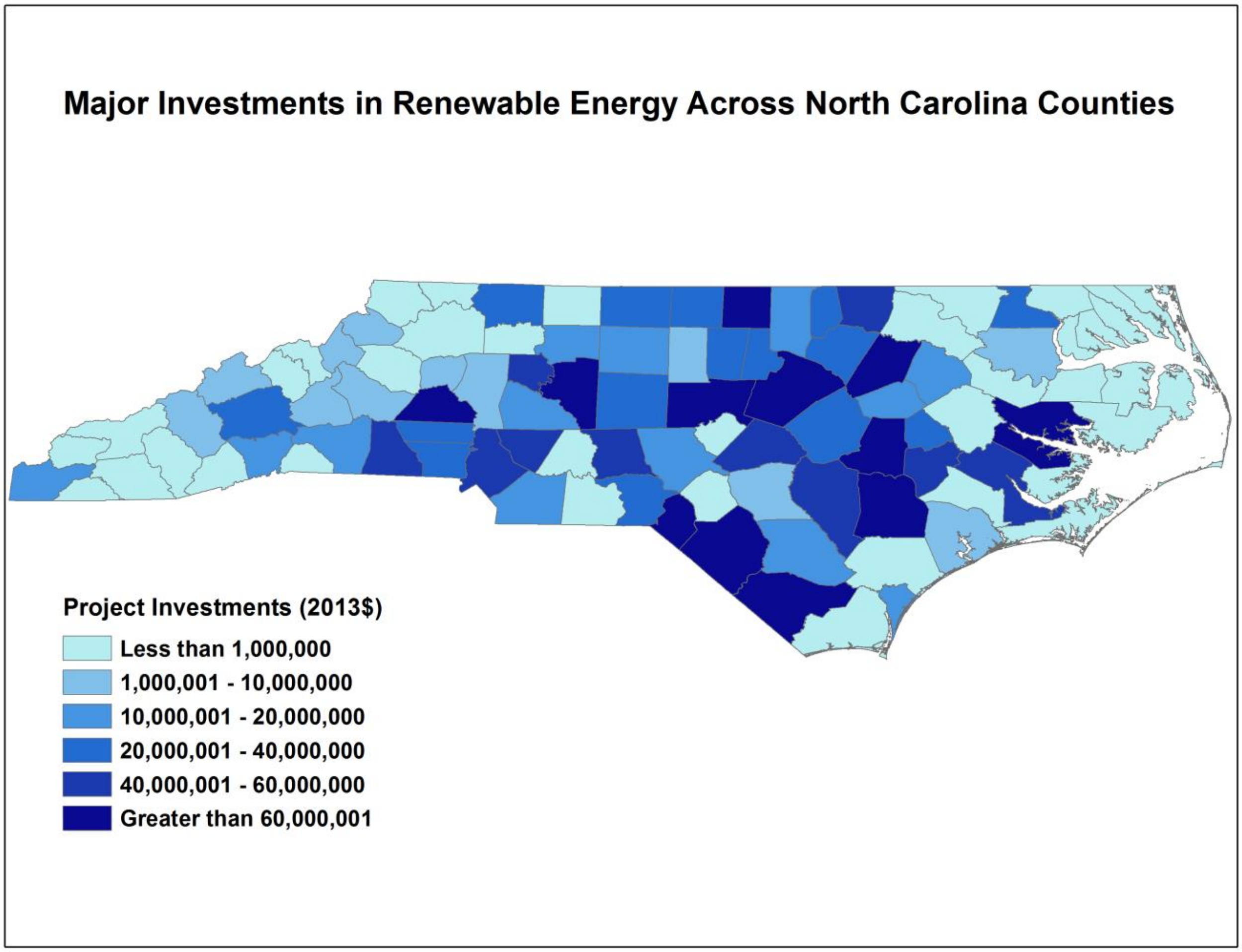
[a] Hydroelectric projects were found using NC-RETS. RTI worked in collaboration with ScottMadden to verify capacity added within the study period. Only projects under 10 MW are tracked in NC-RETS, so these results may be an underestimate of hydroelectric capacity and investment.

See also Appendix A. Sums may not add to totals because of independent rounding.

Renewable energy projects are widely distributed across North Carolina, bringing investment to both urban and rural counties. **Figure 2-2** illustrates the geographic distribution of renewable energy projects individually valued at $1 million or greater. The figure including all eligible wind, landfill gas, biomass, hydroelectric, solar photovoltaics, and solar thermal projects valued over $1 million. These projects account for renewable energy investment of approximately $2,383.8 million (91% of the total $2,613.5 million in renewable investment over the period).

Catawba, Davidson, Duplin, Person, Robeson, and Wayne Counties each experienced more than $100 million in renewable energy project investment, and Beaufort, Cabarrus, Cleveland, Columbus, Nash, Scotland, and Wake Counties each experienced between $50 million and $100 million in renewable project investment from 2007 through 2014.

Figure 2-2. Distribution of Renewable Energy Projects Valued at $1 Million or Greater across North Carolina Counties



See also Appendix B.

2.1.2 Energy Generated or Saved from Clean Energy Projects

Tables 2-3 and **2-4** summarize the energy generated by renewable projects and the energy saved by energy efficiency projects between 2007 and 2014.

Table 2-3. Renewable Energy Generation, 2007–2014

	Facilities		Energy Equivalent Generated	
Technology	**Number**	**%**	**Thousand MWh**	**%**
Biogas fuel cell[a]	1	0%	51	1%
Biomass (including combined heat and power)	18	1%	6,291	65%
Geothermal	831	40%	66	1%
Hydroelectric (<10 MW capacity)	10	0%	208	2%
Landfill gas	20	1%	1,569	16%
Passive solar	N/A	N/A	3	0%
Solar photovoltaic	1,108	53%	1,437	15%
Solar thermal	83	4%	53	1%
Wind	9	0%	2	0%
Total	2,080	100%	9,679	100%

a. Biogas Fuel Cell generation has doubled due to a doubling of capacity at this facility over the past two years.

See also Appendix A. Sums may not add to totals because of independent rounding.

Table 2-4. Energy Efficiency Energy Savings, 2007–2014

Program	**Energy Saved[a] (Thousand MWh)**	**Energy Costs Saved (Million, 2013$)**
Utility Programs	6,424	$385.5
Utility Savings Initiative	N/A[b]	$732.2
Total	6,424	$1,117.6

[a] Energy savings were estimated using an estimate of $0.06/kWh for years 2007 through 2014.[6]

[b] Data on the energy savings from the Utility Savings Initiative were not provided. We were unable to calculate the energy savings from standard EIA estimates because of uncertainties regarding the costs of energy for Utility Savings Initiative projects.

[6] Avoided costs received by qualified facilities vary by utility and length of contract. These values represents a central value among those reported in avoided cost schedules to NCUC.

Renewable energy facilities generated 9.7 million MWh of energy, of which

- 65% was biomass,
- 16% was landfill gas, and
- 15% was solar photovoltaics.

Efficiency initiatives also produced large savings in North Carolina. Energy efficiency programs run by utility companies saved 6.4 million MWh of energy during the study period. The Utility Savings Initiative, a government-run energy efficiency program, lacked data on specific MWh saved, but the program documents note savings of $732.2 million on energy expenses.[7]

Thus, the total energy generated or saved from clean energy projects is estimated to amount to at least 16.1 million MWh.

2.1.3 State Incentives for Clean Energy Investment

State incentives for clean energy investment, including the renewable energy investment tax credit and state appropriations for the Utility Savings Initiative, are modeled as a reduction in spending on other government services.

Investment spending was funded, in part, through state incentives. Through direct state government appropriations, renewable energy projects received $182.6 million in tax credits and energy efficiency projects received $13.0 million. Total government expenditures were $195.6 million between 2007 and 2014 (**Table 2-5**).

For the purpose of this study, it was assumed that the money the government spent on renewable energy and energy efficiency programs was not spent on other government services. Thus, the government programs contributed to the positive investment in renewable energy and energy efficiency of $3,472.8 million.

[7] The cost of energy avoided from the Utility Savings Initiative was calculated using data from the "Annual Report for the Utility Savings Initiative for Fiscal Year July 1, 2012–June 30, 2014." First, sums of avoided energy costs per calendar year were calculated from the fiscal year sums, assuming that energy savings were equally split between the calendar years in each fiscal year. Without full data for 2014, RTI assumed energy costs were avoided at the same rate in the second half of 2014 as they were during the fiscal year from 2013 to 2014. To convert sums to 2013 U.S. dollars, we applied inflation multipliers calculated from the CPI-U (see Table A-3).

However, the $195.6 million spent on renewable energy and energy efficiency programs was shifted from what the government could have otherwise spent the money on, creating a minor offset that reduces gross impacts slightly. Section 2.3 includes discussion that illustrates these offsets.

Table 2-5. State Incentives for Clean Energy Development, 2007–2014

Year	Renewable Energy Investment Tax Credit[a,b] (Million, 2013$)	Energy Efficiency[c] (Utility Savings Initiative, Million, 2013$)	Total (Million, 2013$)
2007	$0.5	$1.6	$2.1
2008	$2.3	$1.6	$3.9
2009	$2.9	$1.6	$4.5
2010	$5.6	$1.6	$7.2
2011	$11.7	$1.6	$13.3
2012	$28.3	$1.6	$29.9
2013	$52.9	$1.6	$54.5
2014	$78.3	$1.6	$80.0
Total	$182.6	$13.0	$195.6

Note: For the Utility Savings Initiative, an appropriation of $13.0 million was taken, which we distributed evenly across the study period for the purposes of the analysis. The tax credit for 2013 was estimated, and this estimation is detailed in Appendix A.

[a] North Carolina Department of Revenue, Policy Analysis and Statistics Division. (2007-2011). Unaudited NC-478G. Raleigh, NC: North Carolina Department of Revenue, Policy Analysis and Statistics Division.

[b] North Carolina Department of Revenue, Revenue Research Division. (2012). "Credit for Investing in Renewable Energy Property Processed during Calendar Year 2012." Raleigh, NC: North Carolina Department of Revenue, Revenue Research Division.

[c] North Carolina Department of Commerce. (November 1, 2013). "Annual Report for the Utility Savings Initiative for Fiscal Year July 1, 2012–June 30, 2014." Raleigh, NC: North Carolina Department of Commerce.

2.2 SECONDARY IMPACTS OF CLEAN ENERGY DEVELOPMENT

To estimate the overall impact of clean energy development in North Carolina, the spending described in Section 2.1 was analyzed using an I-O model of the North Carolina economy. The I-O model was constructed using IMPLAN software, which is widely used to assess regional economic impacts at the local, state, and regional levels.

I-O models provide a detailed snapshot of the purchasing relationships between sectors in the regional economy. In response to these direct inputs, the I-O model estimates the increases in in-state output, employment, and spending within the supply chain for clean energy and the decreases in in-state output, employment, and spending within the supply chain for conventional energy.

Increased renewable energy production requires increased employment in that sector and in the sectors in its supply chain (indirect impacts). This increased employment, and associated increased income, will result in increased purchases of consumer goods and services within the state. The model estimates these increased household expenditures (induced impacts), including both the increased consumer spending derived from the increased direct and indirect employment associated with renewable energy production and the decreased consumer spending resulting from decreased direct and indirect employment associated with conventional energy production.

The total economic impact of clean energy development for North Carolina is the sum of the direct, indirect, and induced impacts. **Figures 2-3** and **2-4** describe direct, indirect, and induced impacts.

Two types of secondary economic impacts were modeled in this study:

- those resulting from the value of investment dollars spent on a clean energy project, representing indirect and induced supply chain effects, and
- those resulting from the reduction in spending on the production of conventional energy and that are reallocated to energy efficiency and renewable project owners.

Figure 2-3. Renewable Energy Direct, Indirect, and Induced Economic Impacts Related to Clean Energy Incentives

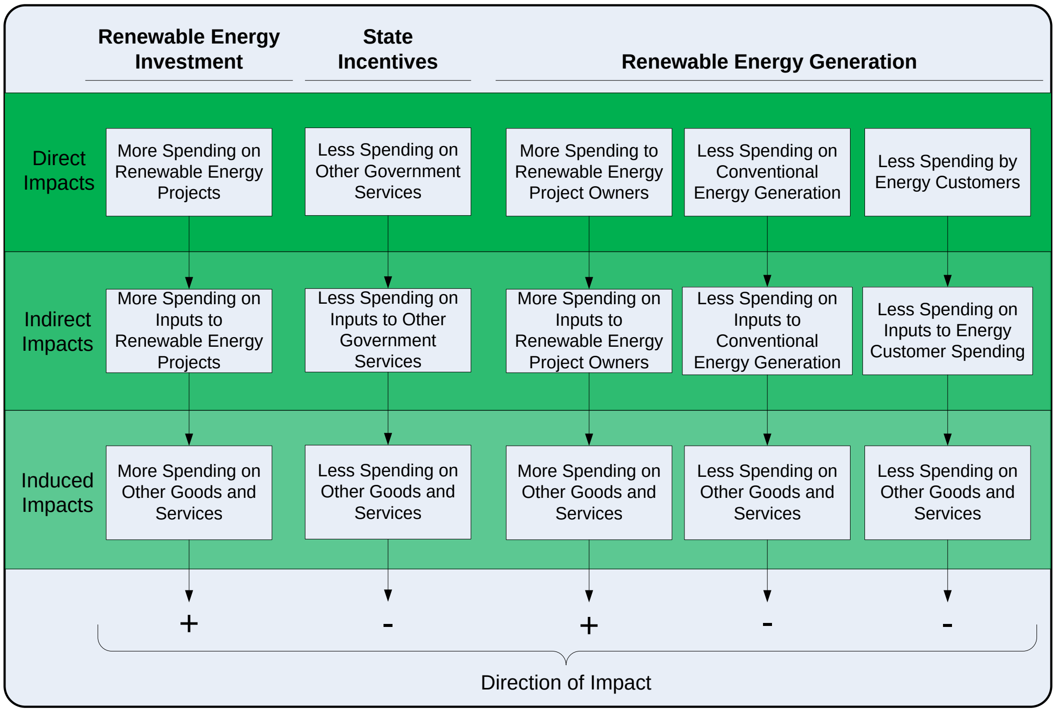
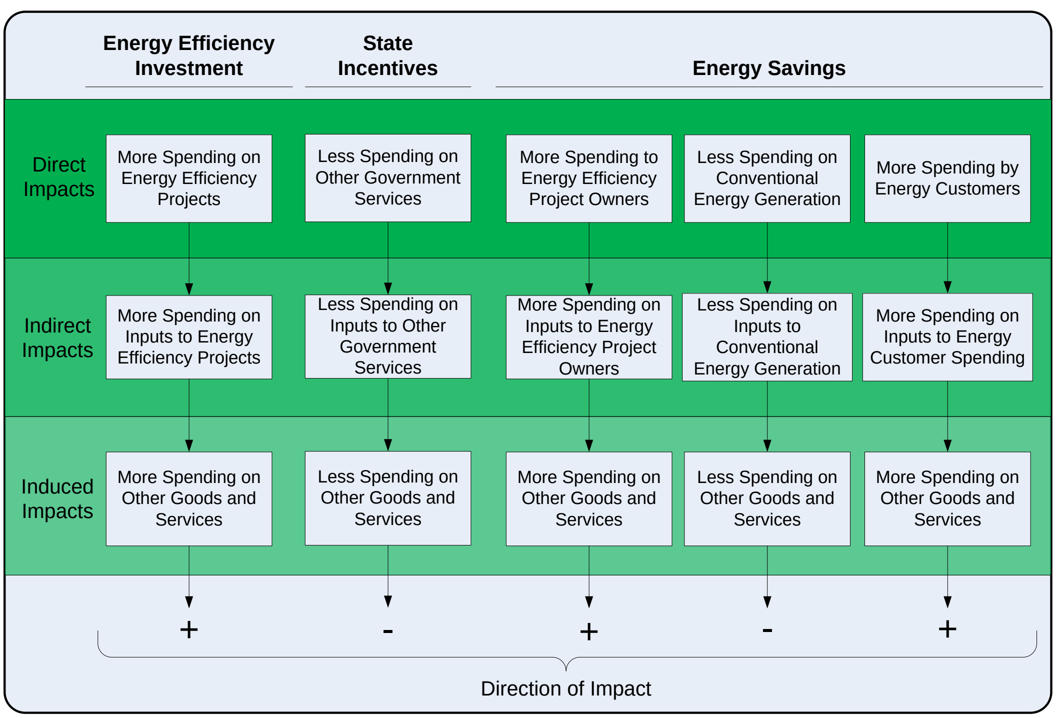


Figure 2-4. Energy Efficiency Direct, Indirect, and Induced Economic Impacts Related to Clean Energy Incentives



2.2.1 Changes in North Carolina Spending Patterns from Renewable Energy Generation

To estimate the changes in spending resulting from renewable energy *generation*, renewable energy produced by facilities was estimated by applying capacity factors, either at the facility level based on 2011 generation (EIA-923) or the technology level (see Table 2-1). Electricity generated by these facilities was assumed to receive $0.06/kWh[8] in avoided costs for the years 2007 through 2014, which was modeled as a transfer to renewable generation from inputs to conventional generation. Renewable thermal energy produced by these facilities was modeled as a transfer of the retail electricity rate between utilities and utility customers ($0.0682/kWh for industrial and $0.099/kWh for commercial and residential customers [EIA, 2013]). Finally, the full Renewable Energy Portfolio Standard (REPS) rider over these years was modeled as a transfer from utility customers to renewable project owners.

As Table 2-3 stated, renewable energy facilities have generated an estimated 9.7 million MWh of energy over the study period. This generation is estimated to have resulted in a total of $606.6 million[9] in avoided cost and retail energy savings no longer spent on conventional energy. The total REPS rider over the study period is estimated to be $220.8 million.[10]

2.2.2 Changes in North Carolina Spending Patterns from Energy Efficiency Initiatives

To estimate changes in spending resulting from *energy savings* from energy efficiency, the avoided cost of energy saved by utility energy efficiency and demand-side management programs. These avoided costs were modeled as a transfer

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[8] Avoided costs received by qualified facilities vary by utility and length of contract. This value represents a central value among those reported in avoided cost schedules to NCUC.

[9] This $606.6 million was calculated by multiplying 6,950,034 MWh generated by nonthermal renewable projects by $60/MWh avoided cost to yield $417,002,048. The 2,607,319 industrial thermal MWh generated was multiplied by industrial retail savings of $68.20/MWh (EIA, 2012) to yield $177,819,124. Lastly, the 119,152 commercial and residential thermal MWh generated was multiplied by the average retail savings of $99/MWh (EIA, 2012) to yield $11,796,018. Summing the three totals together yields $606,617,190.

[10] This total was estimated using the most recent REPS cost data available at the time of the analysis. Documents issued after this analysis was performed include some minor adjustments, as well as providing costs for Dominion North Carolina Power, which did not file for REPS cost recovery prior to 2013.

from the inputs of conventional energy generation to utility customers, in line with Duke Energy's Save-A-Watt program.[11] Energy savings from the Utility Savings Initiative were a transfer from utilities to government spending. A full description of how these assumptions were implemented is provided in Appendix A.

As Table 2-4 indicated, utility programs yielded 6.4 million MWh in energy savings. The avoided cost for these programs, assuming $0.06/kWh and $0.05/kWh stated previously, was $370.1 million.[12] Combining this with the $732.2 million saved by the Utility Savings Initiative yields a total energy efficiency savings of $1,102.3 million.

2.3 NORTH CAROLINA ECONOMY-WIDE IMPACTS

In summary, total output (gross revenue) in North Carolina associated with clean energy development, after accounting for secondary effects, is estimated at $6,308.3 million over the 8-year period from 2007 to 2014. Clean energy development accounted for $4,197.9 million in GSP over the study period. Total employment effects were estimated to be 44,549 FTEs over the study period.

2.3.1 Impacts Associated with Renewable Energy Projects

As shown in the first data row of **Table 2-6**, $2,613.5 million in in-state spending on renewable energy projects has a direct impact on GSP ($1,614.6 million), employment (14,636 FTEs), and state and local tax revenue ($186.1 million).

These renewable projects received an estimated $182.6 million in state tax credits between 2007 and 2014. Because in the absence of the incentive program, the state government would have spent the money on other government services, there is an offsetting direct economic impact that must be considered.

[11] Duke Energy's Save-A-Watt program was chosen as a model for simulating the transfer of avoided energy costs for both its size and the simplicity of its avoided cost allocation method. The "Shared Savings Mechanism" replaced the Save-A-Watt program effective January 1, 2014. As such the impact of this change is was not reflected in the current study.

[12] The avoided cost was calculated by multiplying 4,888,502 MWh by $60/MWh ($0.06/kWh) and 1,535,964 MWh by $50/MWh ($0.05/kWh) avoided cost to yield $370.1 million.

According to IMPLAN's assumptions out of $182.6 million, the state government would have spent $154.7 million in state and spent $27.9 million out of state for goods and services Therefore, the direct economic impact from the change in government spending patterns is −$154.7 million. GSP, employment, and fiscal impacts are reduced as well. Note that the second data row of Table 2-6 shows an offsetting direct economic impact using negative values.

Table 2-6. Renewable Energy Projects Economic Impacts, 2007–2014

	Total Output[a] (Million, $2013)	Gross State Product[b] (Million, $2013)	Employment (Full-Time Employee Equivalents)	Fiscal Impacts (Million, $2013)
Direct economic impact from renewable energy	2,613.5	1,614.6	14,636	186.1
Direct economic impact from change in government spending[c]	−154.7	−74.3	−1,076	−3.0
Secondary economic impact	2,259.9	1,627.2	13,107	97.6
Total economic impact	4,718.8	3,167.5	26,667	280.7

[a] Total output refers to revenue received by North Carolina individuals and businesses. [b] Gross state product represents the total value added. [c] Direct economic impact from change in government spending refers to the in-state impact of $182.6 million in renewable tax credits, less $27.9 million that would have otherwise procured goods and services from out of state. Note: Sums may not add to totals because of rounding. See also Appendix A.

The two direct impacts—the increase in renewable energy project spending and the reduction in state government spending on other things—are combined and analyzed to estimate the changes in spending resulting from renewable energy generation and the indirect and induced impacts resulting from supply chain effects and changes in income.

Ultimately, the total economic impact amounts to a contribution to GSP of $3,167.5 million, 26,667 FTEs, and $280.7 million in state and local tax revenue.[13]

2.3.2 Impacts Associated with Major Energy Efficiency Initiatives

Table 2-7 provides the same impact information as Table 2-6 for the energy efficiency initiatives. It was estimated that there

[13] Although not broken out in Table 2-6, the substitution of renewable energy for conventional energy, including reduced household spending due to the REPS rider, resulted in a small positive impact to employment, economic output, and state and local tax revenue.

was $859.3 million in energy efficiency investment, and the resulting energy savings and changes in spending over the study period contributed $1,030.4 million to total GSP and supported 17,881 FTEs.

Table 2-7. Energy Efficiency Initiatives Economic Impacts, 2007–2014

	Total Output[a] (Million, 2013$)	Gross State Product[b] (Million, 2013$)	Employment (Full-Time Employee Equivalents)	Fiscal Impacts (Million, 2013$)
Direct economic impact from energy efficiency	859.3	472.0	5,035	27.3
Direct economic impact from change in government spending[c]	−11.0	−9.1	−143	−0.3
Secondary economic impact	741.2	567.6	12,989	−38.6
Total economic impact	1,589.5	1,030.4	17,881	−11.6

[a] Total output refers to revenue received by North Carolina individuals and businesses. [b] Gross state product represents the total value added. [c] Direct economic impact from change in government spending refers to the in-state impact of $13.0 million in state government procurement to the Utility Savings Initiative, less $2.0 million that would have otherwise procured goods and services from out of state. Note: Sums may not add to totals because of rounding. See also Appendix A.

As with state incentives for renewable energy projects, there is an offsetting negative direct impact associated with government spending on the Utility Savings Initiative and not on other activities. If the state government were to spend $13.0 million on other government services, $2.0 million would have been spent out of state. See the second data row in Table 2-7.

A net negative fiscal impact of $11.6 million was estimated for energy efficiency projects due primarily to negative fiscal impacts from their resulting energy savings. This is primarily because more state and local taxes are estimated to be recovered from a dollar of spending on utilities than on other government services now purchased from Utility Savings Initiative savings.

2.3.3 Total Impact Associated with Clean Energy Projects

For 2007 through 2014, the total economic activity associated with renewable energy projects and energy efficiency initiatives was (**Table 2-8**):

- $6,308.3 million in gross output (revenue),
- $4,197.9 million in GSP (value-added),

- 44,549 FTEs, and
- $269.1 million in state and local tax revenues.

Table 2-8. Total Economic Impacts, 2007–2014

	Total Output[a] (Million, 2013$)	Gross State Product[b] (Million, 2013$)	Employment (Full-Time Employee Equivalents)	Fiscal Impacts (Million, 2013$)
Direct economic impact	3,472.8	2,086.6	19,671	213.4
Direct economic impact from change in government spending[c]	−165.7	−83.5	−1,219	−3.3
Secondary economic impact	3,001.2	2,194.8	26,096	59.1
Total economic impact	6,308.3	4,197.9	44,549	269.1

[a] Total output refers to revenue received by North Carolina individuals and businesses. [b] Gross state product represents the total value added. [c] Direct economic impact from change in government spending refers to the in-state impact of $195.6 million in state clean energy incentives, less $29.9 million that would have otherwise procured goods and services from out of state. Note: Sums may not add to totals because of rounding. See also Appendix A.

These results account for a comparatively small offset associated with government spending changes because the tax credit and appropriations for the Utility Savings Initiative caused an estimated loss in output of $165.7 million. It should be noted that these losses are due to a reduction in government spending and not from any assumed issues with governmental involvement in the energy sector.

In Table 2-8, the fiscal impact analysis shows that state and local governments realized revenue of $269.1 million as a result of gross changes in economic activity.

3 Prospective Rate Impacts of Clean Energy Policies

In this section, we discuss the rate impacts of North Carolina's Renewable Energy and Energy Efficiency Portfolio Standard (REPS). The analysis compares the cost of two alternative energy policy scenarios– one where existing clean energy policies are in place throughout the study period (Compliance Portfolio) and one where only the energy policies prior to 2007 are in place (Conventional Portfolio). The rate impacts are analyzed for years 2008 to 2029.

The Compliance Portfolio assumed renewable energy certificates (RECs) from actual renewable energy and energy efficiency measures in place through 2014. In future years, the analysis used the least-cost resources to meet remaining REPS requirements. The Conventional Portfolio considers a scenario where the North Carolina REPS does not exist. In this portfolio, new conventional combined cycle natural gas capacity is used to replace incremental electricity needs met by post-REPS portions of the Compliance Portfolio. The methodology is described in detail below.

3.1 METHODOLOGY

The North Carolina REPS requires electric utilities to acquire RECs to meet a total requirement and within that total meet "set-aside" requirements for poultry litter, swine waste, and solar resources. Having satisfied the set-aside requirements, utilities are free to use any qualifying REC to meet the remaining, or general, requirement. A REC is produced when an eligible renewable energy technology generates one megawatt hour (MMh) of electricity or approved energy efficiency measures supplies one MWh of energy savings. RECs from poultry, swine and solar in excess of the set-aside requirement may be used to satisfy the overall general requirement.

North Carolina REPS requirements are based on a set percentage of retail MWh sales from the previous year. The analysis calculated North Carolina retail sales for each utility using REPS compliance reports and REPS compliance plans filed with the North Carolina Utilities Commission.[14] Total retail sales for North Carolina are shown in **Table 3-1**.

Table 3-1. North Carolina Retail Sales (MWh), 2008–2029[a]

Year	NC Retail Sales	Year	NC Retail Sales
2008	130,069,257	2019	140,626,289
2009	126,419,351	2020	142,032,552
2010	135,618,702	2021	143,452,878
2011	131,371,429	2022	144,887,407
2012	127,718,921	2023	146,336,281
2013	128,612,020	2024	147,799,643
2014	133,486,566	2025	149,277,640
2015	135,125,993	2026	150,770,416
2016	136,498,098	2027	152,278,120
2017	137,858,750	2028	153,800,902
2018	139,233,950	2029	155,338,911

[a] Data from 2008 to 2013 represent historical retail sales. Data from 2014 to 2029 are forecasted retail sales.

The analysis calculated general and set-aside requirements for each utility based on the required percentage of retail sales. With the exception of poultry litter, RPS requirements are calculated independently for each utility. The North Carolina REPS only mandates a statewide MWh energy requirement for poultry litter. For this analysis, the poultry requirement was allocated to each utility based on their percentage of North Carolina retail sales. Individual utility requirements were then aggregated to determine the total North Carolina requirements shown in **Table 3-2**.

[14] Duke Energy Carolinas and Duke Energy Progress forecast 1.0% net load growth in 2014 integrated resource plans filed with the North Carolina Utilities Commission. The analysis assumes retail sales grew 1.0% when forecasts were unavailable.

Table 3-2. North Carolina REPS REC Requirements, 2008–2029[a]

Year	Solar	Poultry	Swine	General	Total
2008	—	—	—	—	—
2009	—	—	—	—	—
2010	25,290	—	—	—	25,290
2011	27,131	—	—	—	27,131
2012	91,967	—	—	3,849,185	3,941,152
2013	89,413	—	—	3,742,164	3,831,575
2014	90,037	170,007	—	3,598,325	3,858,369
2015	186,889	700,010	93,450	7,028,851	8,009,200
2016	189,184	900,009	189,184	6,829,191	8,107,568
2017	191,106	900,010	191,106	6,907,670	8,189,892
2018	275,727	900,008	193,011	12,417,137	13,785,883
2019	278,476	900,008	278,476	12,466,443	13,923,403
2020	281,261	900,008	281,261	12,600,108	14,062,638
2021	284,074	900,008	284,074	15,364,740	16,832,896
2022	286,914	900,008	286,914	15,527,388	17,001,224
2023	289,785	900,008	289,785	15,691,656	17,171,234
2024	292,683	900,008	292,683	15,857,575	17,342,949
2025	295,609	900,008	295,609	16,025,150	17,516,376
2026	298,563	900,008	298,563	16,194,406	17,691,540
2027	301,549	900,008	301,549	16,365,352	17,868,458
2028	304,564	900,008	304,564	16,538,007	18,047,143
2029	307,610	900,008	307,610	16,712,384	18,227,612

[a] Following existing regulatory orders and requests, the analysis assumed delayed starts for poultry and swine requirements. See: North Carolina Utilities Commission. (2014a). "Annual Report Regarding Renewable Energy and Energy Efficiency Portfolio Standard in North Carolina."

The Compliance Portfolio was designed to meet the required number of RECS each year allowing for the use of extra RECS produced in early years of production in excess of RPS requirements. The Compliance Portfolio assumed RECs from actual renewable energy and energy efficiency measures in place through 2014 as the baseline.[15] Based on compliance plans, Duke Energy Carolinas and Duke Energy Progress meet 25% of their general requirement with out-of-state RECs through 2014. The analysis assumes Dominion North Carolina

[15] Data for existing renewable energy generation and capacity were collected from the North Carolina Renewable Energy Tracking System (NC-RETS). Energy efficiency savings data were collected from NC-RETS and 2014 integrated resource plans.

Power (DNCP) meets 100% of their general requirement with out-of-state RECs through 2014.[16]

Going forward, the Compliance Portfolio assumes additions of set aside capacity sufficient to meet specific requirements (net of banked RECs). Energy efficiency, as the least cost option, is used to the maximum extent possible to meet the remaining general requirement.[17] Out of state RECS are included in two instances: (1) DNCP's ability to meet 100% of general REPS requirements and (2) as the next best alternative to energy efficiency where percentage limitations do not allow individual utilities to meet the full requirement with energy efficiency.[18] The portfolio was also designed to maintain a reasonable long-term reserve of excess energy efficiency RECS in order to mitigate the risk associated with an unexpected shortfall in REC generation. The use of each resource is discussed in more detail below:

- **Existing Renewable Energy and Energy Efficiency**—The analysis uses existing renewable energy capacity and energy efficiency savings to meet set-aside and general REPS requirements.[19] The analysis retired excess RECs from previous years and then retired newly generated RECs. Solar resources produce RECs in excess of the solar set-aside requirement. These RECs are used to meet the general requirement.
- **New Set-Aside Capacity**—Existing poultry litter and swine waste capacity are not sufficient to meet the final set-aside requirements. The analysis added poultry litter and swine waste capacity to ensure that the combination of generation and excess RECs from the prior years meet the minimum REPS requirements in each year.
- **New Energy Efficiency Measures**—Energy efficiency is added before out-of-state RECs because the resource offsets the need for alternative generation and is more

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[16] North Carolina general statute § 62-133.8.(1)(2)(e) authorizes DNCP to meet 100% of general requirement with out-of-state RECs.

[17] The North Carolina REPS allows utilities to meet 25% of requirement with energy efficiency. In 2021, Duke Energy Carolinas and Duke Energy Progress are allowed to meet 40% of requirement with energy efficiency.

[18] With the exception of DNCP, the North Carolina REPS allows utilities to meet up to 25% of annual requirements with out-of-state RECs.

[19] The analysis assumes Duke Energy Progress, Duke Energy Carolinas, municipal utilities, and electric cooperatives meet 25% of the total requirements with energy efficiency RECs through 2020 and 40% of the total requirement through 2029.

cost effective than out-of-state RECs when these costs are considered.

- **Purchase Out-of-State RECs**—The remaining REPS requirements are met through the purchase of-out-state RECs. The exception is DNCP is assumed to meet 100% of general requirements with out-of-state RECs.

Table 3-3 shows the resources used in the Compliance Portfolio. The table distinguishes pre-REPS renewable capacity as resources operational before 2008. Post-REPS renewable capacity represents resources operational in 2008 and later. The analysis assumes post-REPS renewable capacity was built to support compliance with the North Carolina REPS. These resources are included in the cost analysis while pre-REPS renewable capacity is excluded.

Figure 3-1 shows the RECs generated from the Compliance Portfolio over the study period. The majority of compliance is met with post-REPS generation and energy efficiency savings. **Figure 3-2** shows the RECs generated from the Compliance Portfolio compared to the overall REPS requirement. It should be noted that the resources in the Compliance Portfolio does not reflect the resources forecasted in integrated resource plans submitted to the North Carolina Utilities Commission. The integrated resource plans forecast renewable energy and energy efficiency beyond the resources used in the Compliance Portfolio. The analysis excluded the majority of these resources as they were not needed for REPS compliance during the study period and therefore outside the scope of the analysis.

The analysis used the levelized cost of energy to determine the generation costs associated with the Compliance Portfolio and Conventional Portfolios. The levelized cost of energy reflects the lifetime expenses required to construct and operate a generation facility. The analysis calculated the levelized cost of energy for each generation technology for each year of the analysis. All calculations were in nominal dollars and assumed

Table 3-3. Compliance Portfolio Resources by Year

Resource	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Pre-REPS Renewable Capacity (Operational before 2008) (MWh)											
Dedicated biomass	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301
Hydropower	536,219	645,468	683,804	556,686	502,613	677,140	677,140	677,140	677,140	677,140	677,140
Solar PV	17	17	17	17	17	17	17	17	17	17	17
Post-REPS Renewable Capacity (Operational 2008 or Later) (MWh)											
Dedicated biomass	85,048	239,271	292,181	1,029,763	1,327,355	1,376,525	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738
Biomass co-firing	0	0	118,976	251,243	304,144	312,969	312,969	312,969	312,969	312,969	312,969
Landfill gas	0	96,463	138,175	232,735	324,000	425,475	496,957	496,957	496,957	496,957	496,957
Hydropower	2,387	137,751	119,766	103,341	126,425	327,772	327,772	327,772	327,772	327,772	327,772
Onshore wind	0	0	87	105	93	110	110	110	110	110	110
Biomass thermal savings	0	0	0	405,986	916,772	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438
Set-Aside Requirements (MWh)											
Poultry litter	2,046	0	0	1,401	14,220	24,884	127,456	886,675	886,675	886,675	886,675
Swine waste	68,957	2,063	2,143	1,574	2,438	1,864	1,864	253,796	253,796	253,796	253,796
Solar PV	283	5,407	23,309	53,999	134,665	382,817	568,935	568,935	568,935	568,935	568,935
Solar thermal savings	236	1,541	2,928	5,524	9,362	8,857	8,857	8,857	8,857	8,857	8,857
Energy Efficiency (MWh)											
Energy savings	19,837	74,488	492,357	1,119,925	1,269,063	2,091,317	3,258,564	3,258,564	3,258,564	3,258,564	3,258,564
Out-of-State RECs											
RECs	0	0	0	0	822,338	804,147	805,619	217,741	212,474	215,498	387,391
Results											
Total REC Production	1,082,331	1,569,770	2,241,044	4,129,600	6,120,806	7,914,633	9,454,737	9,878,009	9,872,742	9,875,766	10,047,659
REPS Requirement	—	—	25,290	27,131	3,941,152	3,831,575	3,858,369	8,009,200	8,107,568	8,189,892	13,785,883
REC Surplus/Deficit	1,082,331	1,569,770	2,215,754	4,102,469	2,179,654	4,083,058	5,596,368	1,868,809	1,765,174	1,685,874	−3,738,224
NET Excess RECs	1,082,331	2,652,101	4,867,854	8,970,323	11,149,977	15,233,035	20,829,403	22,698,212	24,463,387	26,149,261	22,411,038

(continued)

Table 3-3. Compliance Portfolio Resources by Year (continued)

Resource	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Pre-REPS Renewable Capacity (Before 2008) (MWh)											
Dedicated biomass	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301	367,301
Hydropower	677,140	677,140	677,140	677,140	677,140	677,140	677,140	677,140	677,140	677,140	677,140
Solar PV	17	17	17	17	17	17	17	17	17	17	17
Post-REPS Renewable Capacity (2008 or Later) (MWh)											
Dedicated biomass	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738	1,387,738
Biomass co-firing	312,969	312,969	312,969	312,969	312,969	312,969	312,969	312,969	312,969	312,969	312,969
Landfill gas	496,957	496,957	496,957	496,957	496,957	496,957	496,957	496,957	496,957	496,957	496,957
Hydropower	327,772	327,772	327,772	327,772	327,772	327,772	327,772	327,772	327,772	327,772	327,772
Onshore wind	110	110	110	110	110	110	110	110	110	110	110
Biomass thermal savings	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438	1,113,438
Set-Aside Requirements (MWh)											
Poultry litter	886,675	886,675	886,675	886,675	886,675	886,675	886,675	886,675	886,675	886,675	886,675
Swine waste	253,796	253,796	253,796	253,796	253,796	253,796	253,796	253,796	253,796	253,796	253,796
Solar PV	568,935	568,935	568,935	568,935	568,935	568,935	568,935	568,935	568,935	568,935	568,935
Solar thermal savings	8,857	8,857	8,857	8,857	8,857	8,857	8,857	8,857	8,857	8,857	8,857
Energy Efficiency (MWh)											
Energy savings	3,258,564	3,258,564	3,258,564	5,026,835	6,708,244	6,775,329	6,843,079	6,911,511	6,980,628	7,050,434	7,120,936
Out-of-State RECs											
RECs	388,940	393,110	1,225,203	3,976,357	4,077,730	4,180,121	4,283,534	4,387,984	4,493,478	4,600,026	4,704,971
Results											
Total REC Production	10,049,208	10,053,378	10,885,472	15,404,897	17,187,678	17,357,155	17,528,318	17,701,200	17,875,810	18,052,164	18,227,612
REPS Requirement	13,923,403	14,062,638	16,832,896	17,001,224	17,171,234	17,342,949	17,516,376	17,691,540	17,868,458	18,047,143	18,227,612
REC Surplus/ Deficit	−3,874,195	−4,009,260	−5,947,424	−1,596,327	16,444	14,206	11,942	9,660	7,352	5,021	0
Net Excess RECs	18,536,843	14,527,584	8,580,159	6,983,832	7,000,276	7,014,482	7,026,423	7,036,083	7,043,435	7,048,455	7,048,455

Figure 3-1. Renewable Energy Certificates Generated from Compliance Portfolio

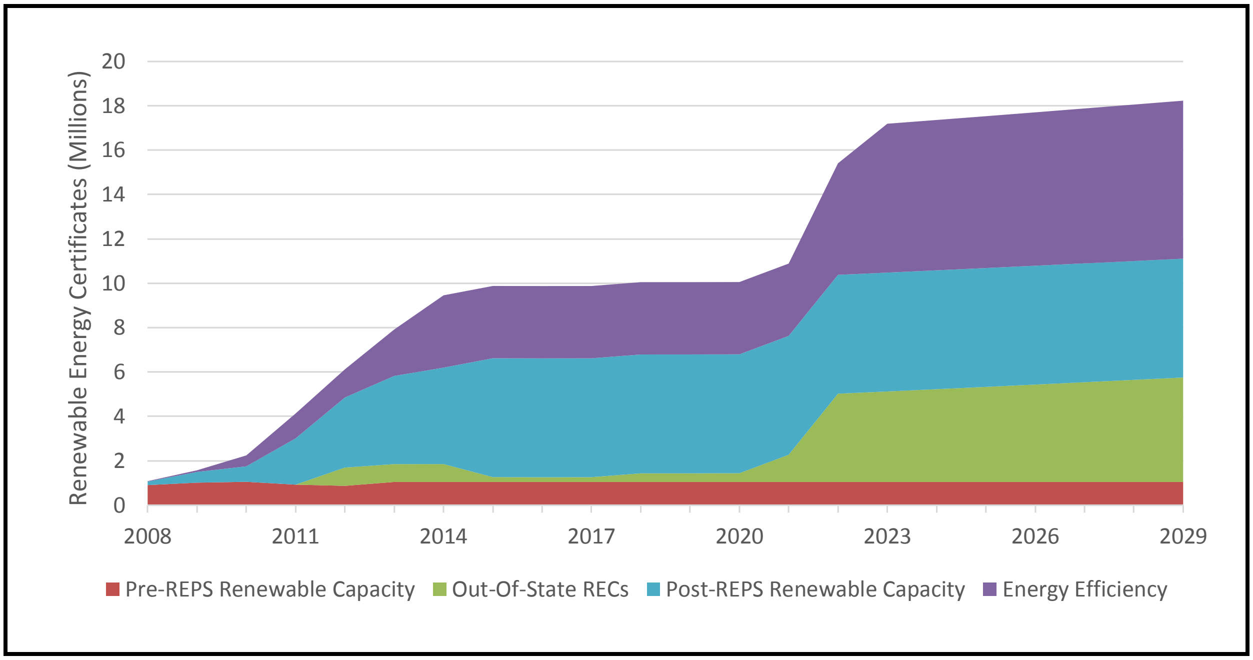
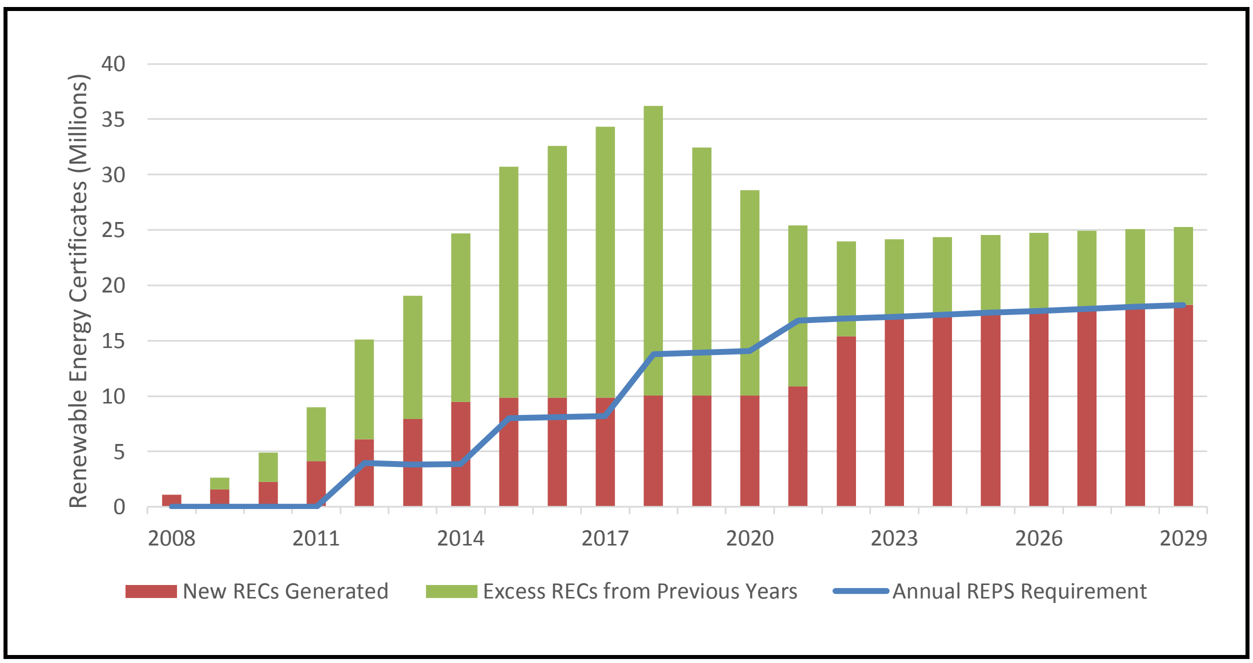


Figure 3-2. Compliance Portfolio Renewable Energy Certificates Compared to REPS Requirement



an annual rate of inflation of 2.4%.[20] In addition, the analysis included project financing,[21] state and federal tax credits,[22] and modified depreciation.[23]

Table 3-4 shows the key assumptions for each technology. The assumptions are based on a similar analysis conducted in February 2013.[24] Updates to assumptions are noted with footnotes in the table. The technology decline rate reflects the annual decrease in installed cost of a technology. The analysis assumed historical natural gas fuel prices through 2013. Additional years used a forecast from the U.S. Energy Information Administration.[25] Other fuel prices were benchmarked to inflation.

The cost of the Compliance Portfolio included the costs of post-REPS generation, energy efficiency, and out-of-state RECs. As noted earlier, pre-REPS generation was not included because the capacity was constructed in the absence of REPS requirements and therefore outside the scope of the rate impact analysis.

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[20] Inflation assumption reflects the compound annual growth rate of the consumer price index from 2004 to 2013.

[21] The analysis assumed 50% debt financing at an 8% interest rate for 20 years. Equity investment required a 12% return on investment.

[22] A 30% federal investment tax credit was assumed for solar technologies operational between 2008 and 2016; the tax credit decreased to 10% beginning in 2017. A federal production tax credit was assumed for eligible technologies operational between 2008 and 2014; the tax credit expired at the beginning of 2015. A 35% North Carolina investment tax credit was assumed for renewable facilities becoming operational between 2008 and 2015.

[23] Depreciation was assumed for all generation technologies. Renewable energy technologies were permitted accelerated depreciation. Further, the analysis assumed 50% bonus depreciation for all technologies from 2008 through 2013. The one exception was 2011, when all technologies were eligible for 100% bonus depreciation.

[24] RTI International and La Capra Associates. (2013). The Economic, Utility Portfolio, and Rate Impact of Clean Energy Development in North Carolina. Prepared for the North Carolina Sustainable Energy Association.

[25] U.S. Energy Information Administration. (2014a). Annual Energy Outlook 2014.

Table 3-4. Levelized Cost Assumptions for 2013 (Nominal Dollars)

Resource	Capacity Factor[a]	Installed Cost ($/MW)	Technol-ogy Decline Rate	Fixed O&M ($/kW-yr)	Variable O&M ($/MWh)	Fuel Heat Rate (Btu/kWh)[b]	Fuel Costs ($/mmBtu)
Biomass Co-firing	70%	$461	0%	$0.00	$0.00	12,000	$2.38
Dedicated Biomass[c]	80%	$3,799	0%	$108.17	$5.39	13,500	$2.38
Hydropower[c]	45%	$3,027	0%	$14.47	$0.00	—	$0.00
Landfill Gas[d]	85%	$2,053	0%	$148.48	$0.00	11,428[e]	$0.00
Natural Gas (Conventional Combined Cycle)[c]	70%	$862	0%	$13.49	$3.69	7,050	$3.73
Poultry Litter	90%	$3,880	0%	$104.86	$10.49	13,000	$5.24
Solar PV (<10 kW)[c]	16%	$6,235 [f]	5%	$25.28	$0.00	—	$0.00
Solar PV (10-100 kW)[c]	16%	$4,705 [f]	5%	$25.28	$0.00	—	$0.00
Solar PV (>100 kW)[c]	16%	$2,941 [f]	5%	$25.28	$0.00	—	$0.00
Solar Thermal[c]	42%	$4,457	3%	$68.87	$0.00	—	$0.00
Swine Waste	75%	$5,243	0%	$238.12	$0.00	—	$0.00
Onshore Wind[c]	30%	$2,152	0%	$40.50	$0.00	—	$0.00

[a] Solar PV capacity factor was updated to better reflect the sola resource available in North Carolina. See: National Renewable Energy Laboratory. (2014). "PVWatts. Version 1." Available at http://rredc.nrel.gov/solar/calculators/pvwatts/version1/.

[b] Biomass fuel costs were updated with more recent data. See: U.S. Energy Information Administration. (2014d). State Energy Data 2012: Prices and Expenditures.

[c] Analysis updated installed cost, fixed O&M variable O&M and fuel heat data. Installed costs reflect data for generation being installed in North Carolina. See: U.S. Energy Information Administration. (2014d). Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants.

[d] Analysis updated installed cost, fixed O&M, and variable O&M data. See: "World Energy Council. (2013). World Energy Perspective: Cost of Energy Technologies.

[e] The fuel heat rate for landfill gas represents the capacity weighted average among existing landfill gas facilities in North Carolina. Weighted average fuel heat was calculated from SNL Financial data.

[f] The installed cost for solar PV represents North Carolina data reported by Lawrence Berkley National Laboratory. Figures have been adjusted from DC to AC using an 85% conversion factor. See: Lawrence Berkeley National Laboratory. (2014). Tracking the Sun VII: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2013.

Within each year of the study, the cost of the Compliance Portfolio was determined by:

- Calculating the levelized cost of energy for incremental new renewable generation
- Calculating the levelized cost of saved energy for incremental new energy efficiency savings[26]
- Summing the levelized cost of energy and saved energy from current and previous years
- Adding the cost to purchase out-of-state RECs[27]

The cost of the Conventional Portfolio was determined in a similar manner. The analysis replaced generation from post-REPS renewable capacity and energy efficiency with generation from new conventional combined cycle natural gas facilities. The Conventional Portfolio did not include offsetting costs of RECs produced by thermal resources or out-of-state RECs because these resources did not generate electricity that needed to be replaced by the Conventional Portfolio. The levelized cost of energy was calculated for new incremental generation within each year. The cumulative cost of the Conventional Portfolio was determined by adding the annual costs of new generation from current and previous years.

The analysis acknowledges several limitations of the methodology. An important consideration is the Conventional Portfolio may not reflect operational changes or capacity additions that would have occurred in the absence of the North Carolina REPS. In addition, investor-owned utilities are unable to recover costs associated with the REPS until a REC is retired for compliance. However, this analysis assumes costs are recovered from ratepayers in the year the generation becomes operational. Finally, the analysis does not consider research and development or administrative expense associated with REPS compliance.

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[26] The analysis used $28/MWh in 2011 as the cost of energy savings. This figure represents the average cost of energy savings for 20 jurisdictions delivering energy efficiency to electric customers from 2009 to 2013 See: American Council for an Energy-Efficient Economy, (2014).

[27] The price of an out-of-state REC was assumed to be the average price of wind REC from Texas.

3.2 RATE IMPACT ANALYSIS

Figure 3-3 compares the costs incurred by electric ratepayers in the Compliance Portfolio to the Conventional Portfolio. The Compliance Portfolio shows small cost savings until 2022 when the addition of new energy efficiency results increases the savings. Considering the length of the study period, it is necessary to calculate the net present value of the Compliance Portfolio. The net present value of the Compliance Portfolio savings compared to the Conventional Portfolio equals $651 million. The analysis finds the greatest annual savings occur in 2029, when the Compliance Portfolio provides $287 million in savings compared to the Conventional Portfolio.

Figure 3-3. Cost of Compliance Portfolio Compared with Conventional Portfolio

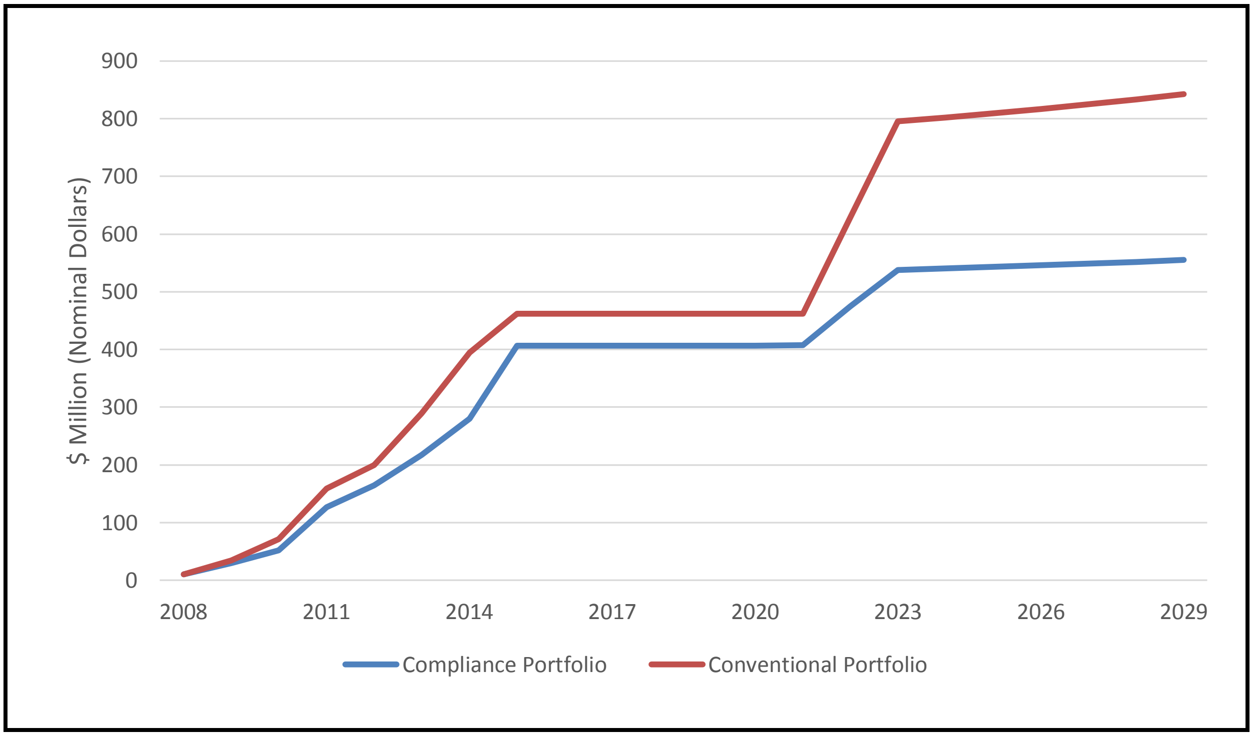
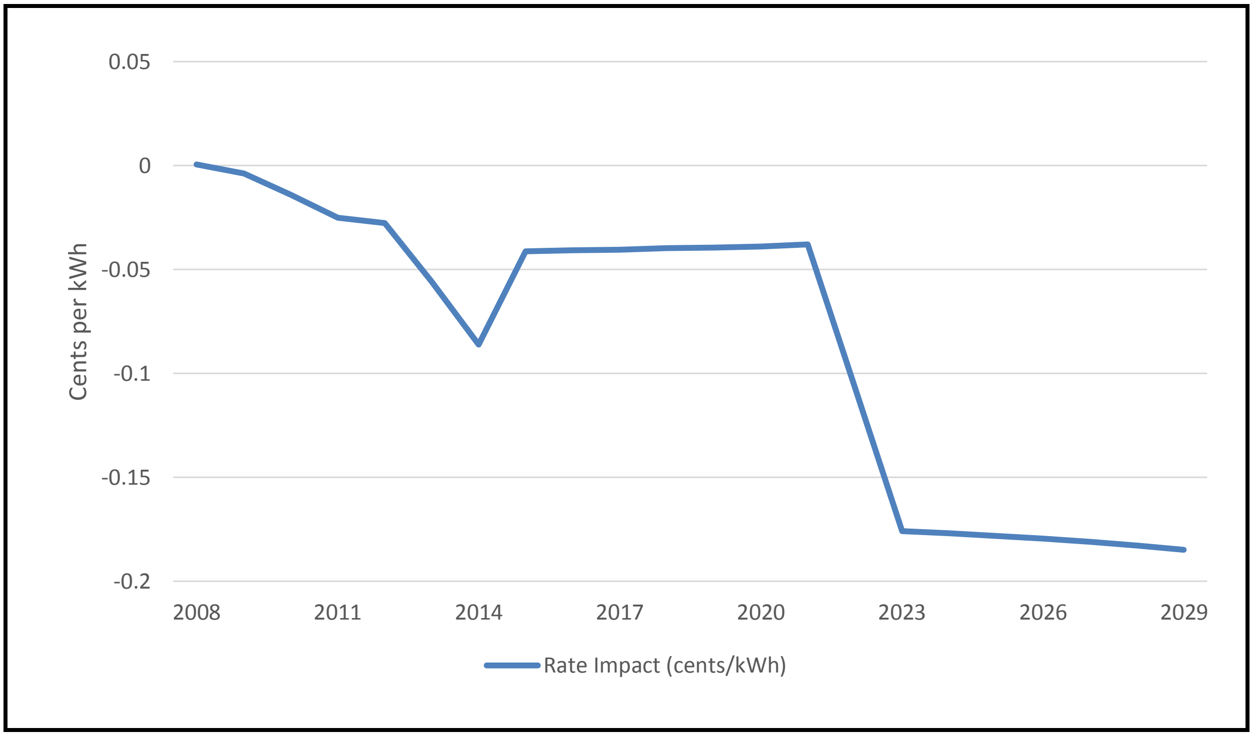


Figure 3-4 divides North Carolina retail sales by the savings of the Compliance Portfolio in order to determine the impact in cents per kilowatt-hour (kWh). The results show savings from the Compliance Portfolio grow steadily through 2014. The savings are reduced in 2015 with the addition of new poultry litter and swine waste capacity to meet set-aside requirements. The savings grow significantly in 2022 with the addition of new energy efficiency measures. Overall, the net present value of

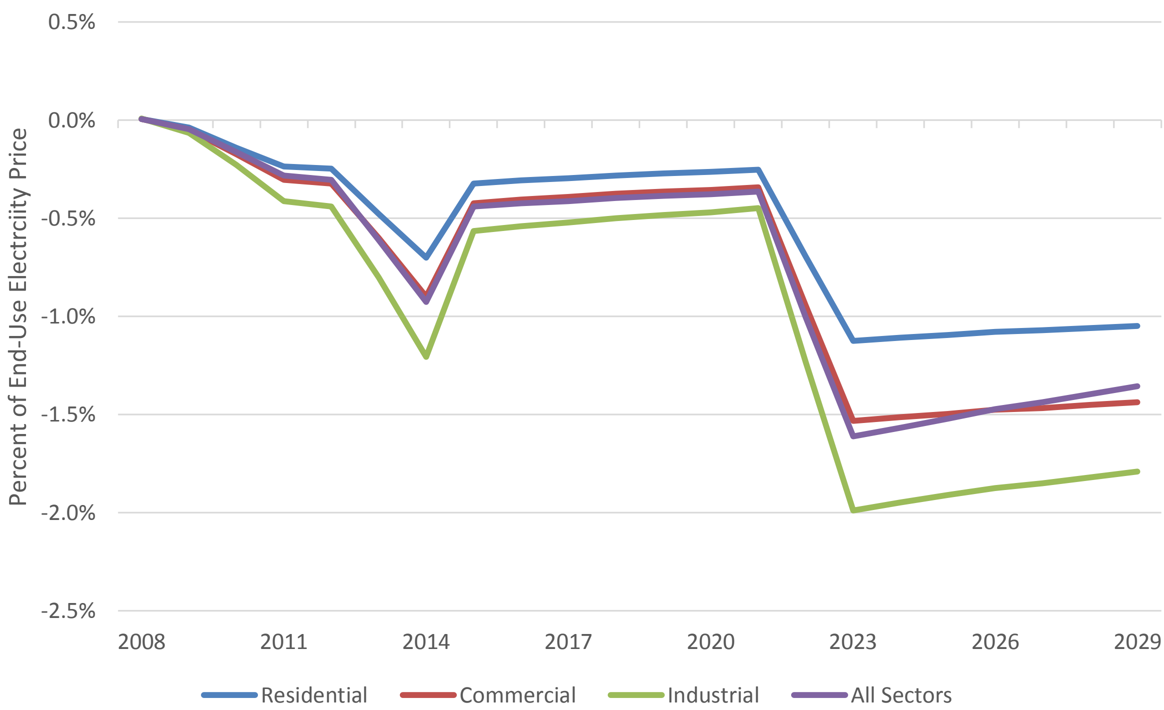
the Compliance Portfolio savings compared to the Conventional Portfolio is 0.46 cents per kWh.

Figure 3-4. Rate Impact of Compliance Portfolio in Cents per kWh Compared with Conventional Portfolio



The analysis also calculated the rate impact as a percentage of the end-use electricity price for different customer classes. The analysis divided the Compliance cost savings (in cents per kWh) by the electricity price of each customer class. **Figure 3-5** shows residential customers receive the smallest savings as a percentage of end-use electricity prices. The residential customer class receives the smallest rate impact because it has the highest electricity prices among the three customer classes. Industrial customers receive the largest savings as a percentage of end-use electricity prices because of lower end-use electricity prices. The decrease in savings from 2021 to 2029 reflects an increase in end-use electricity prices while the annual rate impact remains relatively unchanged.

Figure 3-5. Rate Impact of Compliance Portfolio as a Percentage of End-Use Electricity Price Compared with Conventional Portfolio



Overall, the analysis shows considerable renewable energy and energy efficiency resources are available as a result of the North Carolina REPS. Despite the robust development in recent years, additional resources will be required to meet REPS compliance through 2029. The analysis finds the use of existing resources and the addition of least-cost resources in a Compliance Portfolio results in a savings over time when compared to the Conventional Portfolio. While significant in absolute dollars, the savings result in a small reduction in the electricity rates. Even though the savings are small, the North Carolina REPS has a positive impact on electric ratepayers under the assumptions outlined in this analysis.

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Appendix A: Technical Appendix

A.1 RENEWABLE TECHNOLOGY DATA SOURCES AND ASSUMPTIONS

A.1.1 Solar Photovoltaic

Installed solar photovoltaic capacity between 2007 and 2014 was estimated based on data from North Carolina Renewable Energy Tracking System (NC-RETS, 2014), North Carolina GreenPower (North Carolina GreenPower, personal communication, February 20, 2014), and three additional systems totaling 16.48 MW not in these data sets verified via a press release (Duke Energy, 2013) and personal communication with project developers. Energy generated was estimated by applying a capacity factor of 19%, based on RTI's review of 2011 photovoltaic generation in North Carolina (U.S. Energy Information Administration [EIA], 2011) and PVWattv2 (National Renewable Energy Laboratory [NREL], 2012b).

Because of the magnitude of solar photovoltaic relative to other clean energy projects and the rapid decline in the cost of photovoltaic installations over the time period (NREL, 2012a), we developed cost estimates for installations by size of system and year of installation. These estimates rely on projected photovoltaic project costs from developers through December 31, 2014, that the North Carolina Sustainable Energy Association (NCSEA) compiled from NCUC.[28] For systems in the database with capacity not specified as AC, RTI converted from DC to AC by applying a derate factor of 0.79. As a data quality check, RTI independently reviewed several registrations to verify values within the database against North Carolina Utilities Commission (NCUC) dockets. RTI further cleaned the data by removing outliers (removing values 1.5x the interquartile range below the first and above the third quartile for each year). Costs for each year were then adjusted to 2013$ using the consumer price index (CPI) (Bureau of Labor Statistics [BLS], 2013). **Table A-1** shows RTI's estimates of the average costs per kW (AC), which are consistent with other available photovoltaic cost data sources over the study period. Annual

[28]It is worth noting that projected costs reported by developers frequently are much higher than the actual project costs incurred once installation is complete. Unfortunately, the more accurate post-installation cost data is not publicly reported. Using the projected costs rather than the actual installed costs may obscure the economies of scale for the installed cost of larger solar PV projects.

fixed operating and maintenance (O&M) costs were assumed to be $26/kW.[29]

Table A-1. Average Cost for Solar Photovoltaic Installations by Year and Size (AC kW, 2013$)

Expected Year Online	<10 kW	10 kW–100 kW	100 kW–1 MW	1 MW–2 MW	>2 MW
2006	15,791				
2007	10,298	9,114			
2008	10,622	10,672	12,025		
2009	9,942	9,407	7,017		
2010	8,850	7,644	5,889	5,355	
2011	8,195	6,652	5,952	5,417	3,781
2012	7,841	6,320	5,126	4,676	4,087
2013	6,799	4,850	3,271	3,185	3,365
2014	6,260	4,798	3,137	2,433	2,956

A.1.2 Landfill Gas

Capacity for landfill gas (LFG) facilities was estimated using data from NC-RETS (2014) and modified based on personal communication for one facility. We estimated generation by LFG facilities based on EIA 2011 and 2012 generation data (EIA, 2011; EIA, 2012) where available and otherwise applied a uniform capacity factor. Installation and O&M costs were also based on uniform estimates with the exception of personal communication regarding installation costs for one facility.

In addition to standard LFG facilities, the NC-RETS (2014) database indicated the addition of an LFG fuel cell project in 2012. Project capacity was provided by NC-RETS but was modified based on EIA generation data (EIA, 2012). Installation costs were assumed to be $7,000 per kW of rated output, with variable O&M costs of $43 per MWh (EIA, 2013a; EIA, 2013c).

A.1.3 Hydroelectric

NC-RETS (2014) represents the universe from which we pulled specific hydroelectric projects. Because NC-RETS tracks only hydroelectric projects under 10 MW, our analysis may underestimate total hydroelectric investment over the study

[29] Installment costs, O&M costs, capacity factor, and fuel cost assumptions for all renewable technologies included in our analysis are reported in Table 3-4 of this report.

period. RTI estimated new or incremental capacity at hydroelectric facilities between 2007 and 2014 from NC-RETS, EIA data (EIA, 2011), and NCUC registrations (Duke Energy, 2012; Kleinschmidt, N/A; Brooks Energy, 2008; Advantage Investment Group LLC, 2004; Cliffside Mills LLC, 2008; Madison Hydro Partners, 2010).

A.1.4 Biomass

Capacity for biomass facilities installed between 2007 and 2014 was estimated using data from NC-RETS (2014) and adjusted to reflect data in NCUC registrations for two facilities (EPCOR USA, 2009). Capacity for co-fired facilities was adjusted to reflect the 2011 fraction of renewable fuel consumed (EIA, 2011). We estimated generation by biomass facilities based on EIA 2011 generation data (EIA, 2011) where available and otherwise applied a uniform capacity factor. Installation, O&M, and fuel costs were based on uniform estimates or reported costs in NCUC dockets or press releases where available (Capital Power, 2011; Coastal Carolina Clean Power LLC, 2008; Prestage Farms Incorporated, 2011).

A.1.5 Biomass Combined Heat and Power

Thermal output capacity at biomass combined heat and power (CHP) facilities was developed from NC-RETS (2014) and NCUC registrations for eight facilities (EPCOR USA, 2009). Capacity for co-fired facilities was adjusted to reflect the fraction of renewable fuel consumed (EIA, 2011). For CHP facilities in the EIA-923 database, capacity was further adjusted to reflect the fraction of heat generated used for electricity. We estimated generation by biomass facilities based on EIA generation data (EIA, 2011) where available and otherwise applied a uniform capacity factor. Costs of these facilities are incorporated in the biomass cost estimates discussed above.

A.1.6 Wind

Wind power installations were developed from NC-RETS (2014) and North Carolina GreenPower (personal communication, February 20, 2014). Capacity factor and installation and O&M costs were based on uniform estimates or reported costs in NCUC dockets or press releases where available (ASU News, 2009; Madison County School System, 2009).

A.1.7 Solar Thermal Heating

Estimates of solar thermal heating capacity installed between 2007 and 2013 are based on data reported in NC-RETS (2014). RTI reviewed publicly available sources of project installation costs, annual energy generation, and system O&M (North Carolina Department of Commerce, 2010; NREL, 2011a) to develop the assumptions that solar thermal systems cost $3,500/kW to install and $60/kW for annual O&M. Installation costs for one project were taken from a news report (*News and Observer*, 2012). We assumed that solar thermal heating systems have the same capacity factor as photovoltaic systems.

A.1.8 Geothermal Heat Pumps

Geothermal heat pump capacity is not reported in NC-RETS. The North Carolina Department of Environment and Natural Resources (NCDENR) provided permit data for geothermal wells (NCDENR, personal communication, September 9, 2014). Although the number of wells per system varies based on system type and local conditions, given the available data, we assumed that a typical 3 ton system in North Carolina required five wells to convert wells to system size based on a project case study (Bosch Group, 2007). Based on personal communication with geothermal system contractors in North Carolina, we assumed the cost of an average 3 ton system to be $20,000. Because of a lack of suitable publicly available data in North Carolina, conversion of system tons to kW and annual energy savings per ton were estimated from available project data for a large installation in Louisiana (NREL, 2011b). O&M cost per year are assumed to be $35/kW (International Energy Agency [IEA], 2010).

A.1.9 Passive Solar

Passive solar tax credit spending data from the North Carolina Department of Revenue (2007–2013) are the only available data for passive solar projects over the study period. Energy savings were estimated based on the number of passive solar projects from North Carolina Department of Revenue data, as well as information on typical kWh savings provided by the Oregon Department of Energy (2012) and a study by RETScreen International (2004).

A.1.10 State Incentives for Renewable Energy

Tax credits taken for 2007 through 2013 were developed from figures provided by the North Carolina Department of Revenue (2011b; 2012a). We estimated the 2014 tax credits by looking at the trend in increasing tax credits from the previous 7 years and forecasting that trend out to 2014. This is a change in the methodology from the previous analysis to correct for overestimation of tax credits taken.

A.1.11 Spending Changes from Renewable Energy Generation

We applied the following assumptions to estimate spending changes resulting from energy generated at renewable energy facilities. For electricity produced by renewable facilities, we assumed that renewable project owners receive the avoided cost of electricity net of O&M and fuel costs that would be otherwise spent on conventional energy generation. Based on a review of avoided cost schedules for qualifying facilities from Duke Energy Carolinas (2012b) and Progress (2012a), we applied the simplifying assumption that the avoided cost paid to all renewable facilities is $60/MWh. For the most recent years we assumed this avoided cost decreased to $50/MWh. This value was concluded using the same methodology that was used to assume $60/MWh.

For nonelectric renewable energy, we assumed that the energy saved results in a reduction in retail energy spending. For biomass thermal generation at CHP facilities, we assumed the cost of energy saved is the industrial retail price for electricity, $68.20/MWh (EIA, 2013b). For geothermal, solar thermal, and passive solar, we assumed that the cost of energy saved is the average retail price for electricity, $99/MWh (EIA, 2013b).

The total Renewable Energy Portfolio Standard (REPS) rider charged to customers over the study period was taken from NCUC dockets (Duke Energy Carolinas, 2009b, 2010, 2011, 2012a, 2013b, 2014 Progress, 2009b, 2010a, 2011b, 2012a, 2013a, 2014, GreenCo, 2010a, 2010c, 2012a, 2012b, 2013, 2014, ElectriCities, 2009, 2010, 2011a, 2012a, 2013a, 2014) and included in the analysis as a change in spending to project owners from utility customers.

A.1.12 Universe of Included Projects

Table A-2 summarizes the sources used to compile our list of renewable energy and energy efficiency projects. Although additional resources were used to characterize these projects, the universe of projects in this analysis was limited to the sources below.

Table A-2. Sources Used in Compiling the Universe of Included Projects

	NC-RETS	NC Green-Power	Press Releases	Personal Communi-cation	NCDENR	NC DOR	NCUC Dockets
Solar photovoltaic	x	x	x	x			
Landfill gas	x						
Hydroelectric	x						
Biomass	x						
Wind	x	x					
Solar thermal heating	x						
Geothermal heat pumps					x		
Passive solar						x	
Utility energy efficiency							x

A.1.13 Inflation Adjustments

To accurately compare expenditures over time, it was necessary to convert all dollars to the same year. **Table A-3** presents the CPI data from the BLS that we used to adjust for inflation.

Table A-3. Inflation Adjustment Factors

Year	Consumer Price Index for All Urban Consumers	Multiplier for Conversion to 2013 USD
2006	201.60	1.16
2007	207.34	1.12
2008	215.30	1.08
2009	214.54	1.09
2010	218.06	1.07
2011	224.94	1.04
2012	229.59	1.01
2013	232.96	1.00
2014	236.38	0.99

Source: BLS, 2014.

A.2 ENERGY EFFICIENCY DATA SOURCES AND ASSUMPTIONS

A.2.1 Utility Programs

Energy efficiency program costs were taken from the start of the program until 2014 (Dominion North Carolina Power, 2010, 2011, 2012, 2013, 2014), Duke Energy Carolinas (2013a), NC GreenCo (2010b), NCMPA1 and NCEMPA (ElectriCities, 2011b; 2011c; 2011d; 2011e; 2011f; 2011g; 2012b; 2012c; 2013b; 2013c), and Progress (Progress, 2008, 2009a, 2010b, 2011a, 2012b, 2013b). Demand-side management program costs were only included for 2011 through 2014 because these programs could not pass along costs to consumers until 2011 (General Assembly, 2011).

Energy savings associated with utility programs between 2007 and 2011 were estimated based on NC-RETS data (2014). Energy savings from utility programs in 2014 were estimated from expected 2014 savings from NCUC dockets. We assumed that the change in spending associated with these energy savings is equal to the avoided cost of electricity, $60/MWh for the previous analysis and $50/MWh for 2014 values, and is distributed evenly between the utilities and utility customers, consistent with cost savings under Duke's Save-A-Watt program (Duke Energy Carolinas, 2009a).

A list of the utility programs considered in our analysis is included in **Table A-4**.

Table A-4. Utility Energy Efficiency Programs

Program	Utility
Commercial Distributed Generation Program	Dominion
Commercial Energy Audit	Dominion
Commercial Duct Testing & Sealing	Dominion
Commercial HVAC Upgrade Program	Dominion
Commercial Lighting Program	Dominion
Low Income Program	Dominion
Residential Air Conditioning Cycling	Dominion
Residential Audit	Dominion
Residential Duct Testing & Sealing	Dominion
Residential Heat Pump Tune-up	Dominion
Residential Heat Pump Upgrade	Dominion

(continued)

Table A-4. Utility Energy Efficiency Programs (continued)

Program	Utility
Residential Lighting Program	Dominion
Appliance Recycling Program	Duke
Energy Efficiency in Schools	Duke
Home Retrofit	Duke
Low Income Weatherization	Duke
Non Residential Smart Saver Lighting	Duke
Non-Residential Energy Assessments	Duke
Non-Residential Smart Saver	Duke
Power Manager	Duke
Power Share	Duke
Residential Energy Assessments	Duke
Residential Energy Comparison Report	Duke
Residential Neighborhood Program	Duke
Residential Smart Saver	Duke
Smart Energy Now	Duke
Agricultural Energy Efficiency	GreenCo
Commercial Energy Efficiency	GreenCo
Commercial New Construction	GreenCo
Community Efficiency Campaign	GreenCo
Energy Cost Monitor	GreenCo
Energy Star Appliances	GreenCo
Energy Star Lighting	GreenCo
Low Income Efficiency Campaign	GreenCo
Refrigerator/Freezer Turn-In	GreenCo
Residential New Home Construction	GreenCo
Water Heating Efficiency	GreenCo
C&I Energy Efficiency Program	NCMPA
Commercial Prescriptive Lighting Program	NCMPA
High Efficiency Heat Pump Rebate	NCMPA
Home Energy Efficiency Kit	NCMPA
LED and ECM Pilot for Refrigeration Cases	NCMPA
Municipal Energy Efficiency Program	NCMPA
Commercial, Industrial, and Government Demand Response	Progress
Commercial, Industrial, and Government Energy Efficiency	Progress
Compact Fluorescent Light Pilot	Progress
Distribution System Demand Response	Progress
EnergyWise	Progress
Lighting—General Service	Progress
Residential Energy Efficiency Benchmarking	Progress

(continued)

Table A-4. Utility Energy Efficiency Programs (continued)

Program	Utility
Residential Appliance Recycling	Progress
Residential Home Advantage	Progress
Residential Home Energy Improvement	Progress
Residential Lighting	Progress
Residential Low Income Program	Progress
Residential New Construction	Progress
Small Business Energy Saver	Progress
Solar Hot Water Heating Pilot	Progress

A.2.1 Utility Savings Initiative

Data on the cost, savings, and incentives for the Utility Savings Initiative were taken from the project's 2014 annual report (North Carolina Department of Commerce, 2014).

A.3 IMPLAN ANALYSIS

We distributed spending for each renewable facility, efficiency program, government incentive, and change in spending resulting from renewable energy generation and energy savings across IMPLAN sectors based on distributions in other comparable reports and models where appropriate (NREL, 2012c; NREL, 2012d; Regulatory Assistance Project, 2005; Bipartisan Policy Center, 2009), 2011 IMPLAN default data for North Carolina (MIG Inc., 2012), and original assumptions where necessary (**Table A-5**).

Three breakouts were developed using IMPLAN default data to model additional spending or savings to utility customers. First, post-tax consumer income was created using the proportion of money spent by consumers. Second, corporate net income was created using the proportion of money spent, saved, and taxed from corporations. Third, state spending was developed using the three categories that IMPLAN has for state spending: investment, education, and noneducation. Dollars not spent by the state were deducted based on the proportion of state spending in these three categories.

Table A-5. IMPLAN Breakout for Renewable Energy, Energy Efficiency, and State Spending

Type	Direct Spending	Secondary Effects
Renewable Energy		
Solar Photovoltaic	Investment spending was allocated across IMPLAN sectors using the default breakout in the JEDI Photovoltaic model (NREL, 2012c) according to the installation size.	The avoided cost of energy produced was transferred to Sector 366, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution.
Hydroelectric	Investment spending was allocated to IMPLAN Sector 36, Construction of Other New Nonresidential Structures.	Avoided cost net of fixed and variable O&M costs was transferred to Sector 366, Lessors of Non-financial intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed and variable O&M costs were allocated to IMPLAN Sector 39, Maintenance and Repair Construction of Non-residential Structures.
Wood Biomass	Investment spending was allocated based on the Wood Biomass IMPLAN distribution in the 2009 Bipartisan Policy Center report.	Avoided cost of energy produced net of fuel, fixed O&M, and variable O&M costs were transferred to Sector 366, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed and variable O&M costs were allocated based on the Wood Biomass IMPLAN distribution in the 2009 Bipartisan Policy Center. Fuel costs were allocated to Sector 15, Forestry, Forest Products, and Timber Tract Production.
Biomass Co-fire	Investment spending was allocated based on the Biomass Co-Fire IMPLAN distribution in the 2009 Bipartisan Policy Center report.	Avoided cost net of fuel, fixed O&M, and variable O&M costs were transferred to Sector 366, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed and variable O&M costs were allocated based on the Biomass Co-Fire IMPLAN distribution in the 2009 Bipartisan Policy Center report. Fuel costs were allocated to Sector 15, Forestry, Forest Products, and Timber Tract Production.

(continued)

Table A-5. IMPLAN Breakout for Renewable Energy, Energy Efficiency, and State Spending (continued)

Type	Direct Spending	Secondary Effects
Renewable Energy (cont.)		
Swine Biomass	Investment spending was allocated based on the Swine Biomass IMPLAN distribution in the 2009 Bipartisan Policy Center report.	Avoided cost net of fixed O&M and variable O&M costs were transferred to Sector 366, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed and variable O&M costs were allocated based on the Swine Biomass IMPLAN distribution in the 2009 Bipartisan Policy Center report.
Wind	Investment spending was allocated across IMPLAN sectors using the default breakout in JEDI Wind model (NREL, 2012d).	The avoided cost of energy net of fixed O&M produced was transferred to Sector 366, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed O&M costs were allocated across IMPLAN sectors using the default breakout in JEDI Wind model (NREL, 2012d).
Landfill Gas	Investment spending was allocated based on the Landfill Gas IMPLAN distribution in the 2009 Bipartisan Policy Center report.	The avoided cost of energy produced net of fixed O&M costs was transferred to Sector 366, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed O&M costs were allocated based on the Landfill Gas IMPLAN distribution in the 2009 Bipartisan Policy Center report.
Geothermal Heat Pumps	Investment spending was allocated 50% to Sector 216, Air Conditioning, Refrigeration, and Warm Air Heating Equipment Manufacturing, 25% to Sector 36, Construction of Other New Non-residential Structures, and 25% to Sector 319, Wholesale Trade.	The retail cost of energy saved net of O&M costs was transferred 70% to corporate net income and 30% to post-tax consumer spending (assuming systems with 10 or fewer wells were for residential customers, and those with more were commercial customers) from Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed O&M costs were allocated to IMPLAN Sector 39, Maintenance and Repair Construction of Non-residential Structures.
Passive Solar	Investment spending was allocated to Sector 37, Construction of New Residential Permanent Site Single and Multi-family Structures.	The retail cost of energy saved was transferred to Post-Tax Consumer Spending from Sector 31, Electricity, Generation, Transmission, and Distribution.

(continued)

Table A-5. IMPLAN Breakout for Renewable Energy, Energy Efficiency, and State Spending (continued)

Type	Direct Spending	Secondary Effects
Renewable Energy (cont.)		
Solar Thermal	Investment spending was allocated across IMPLAN sectors using the photovoltaic breakout for 100 kW–1 MW systems from JEDI Photovoltaic model (NREL, 2012c).	The retail cost of energy saved net of O&M costs was transferred to Corporate Net Income from Sector 31, Electricity, Generation, Transmission, and Distribution. Fixed O&M costs were allocated to IMPLAN Sector 39, Maintenance and repair construction of non-residential structures.
REPS Rider		REPS rider was transferred to Sector 366, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from a split of 50% from corporate net income for commercial and industrial customers and 50% from post-tax consumer spending for residential customers.
Efficiency Programs		
Utility Programs	Efficiency program investments were allocated to IMPLAN sectors according to the 2005 Regulatory Assistance Project report breakouts for the following categories: residential retrofit, residential new construction, commercial retrofit and commercial new construction. In addition, for residential appliance recycling program, we distributed investment spending 10% to Sector 390, Waste Management and Remediation Services, and 90% to Sector 319, Wholesale Trade Businesses. For school education programs, we distributed spending across 100% to Sector 380, All Other Miscellaneous Professional, Scientific and Technical Services.	The avoided cost of energy saved was transferred 50% to Sector 366, Lessors of Non-financial Intangible Assets for Utility Recovery of Avoided Costs, 25% to corporate net income for industrial and commercial customer savings and 25% to post-tax consumer spending for residential customer savings from inputs to Sector 31, Electricity, Generation, Transmission, and Distribution.
Utility Savings Initiative	Utility Savings Initiative program investments were allocated to IMPLAN sectors according to the Commercial Retrofit category in the 2005 Regulatory Assistance Project report.	Utility Savings Initiative savings transferred to State Spending and taken from Sector 31, Electricity, Generation, Transmission, and Distribution.
Government Initiatives		
Tax Credit		Tax credit deducted from IMPLAN State Spending breakout.
Utility Savings Initiative		Utility Savings Initiative appropriations deducted from IMPLAN State Spending breakout.

A.4 DIFFERENCES FROM LAST YEAR'S REPORT

The results of this analysis differ from last year's *Economic Impact Analysis of Clean Energy Development in North Carolina—2014 Update* (RTI, 2014). The list below outlines several changes to the underlying data, study scope, and reporting conventions that may lead to differences between the reports.

- The study frame was expanded to include 2014, whereas the last report's study frame was 2007 to 2013.
- Differences in yearly renewable energy investment can be explained by the availability of new data on the timing of photovoltaic investments from North Carolina GreenPower, the addition of new renewable energy projects in the NC-RETS database that were not present at the time of the 2014 report, updated geothermal data from NC DENR, updated data for estimating passive solar investments, and increased data on photovoltaic costs per kW.
- Utility Savings Initiative spending data are not available annually; lengthening the study frame requires a new allocation of total investment to prior years.
- Differences in yearly state incentives can be explained by several factors. For one, because Utility Savings Initiative state appropriation data are not available annually, lengthening the study frame requires a new allocation of total appropriation to prior years. Also, whereas the 2014 report estimated 2013 tax credits taken, this study used retrospective data provided by the North Carolina Department of Revenue for this year's tax credits.
- To account for the entire year of renewable energy investment, RTI estimated renewable energy investment for the months of November and December based on average investment trends in the final 2 months of the previous 2 years.

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Appendix B: Renewable Energy Projects Valued at $1 Million or Greater by County

Table B-1. Major Investments in Renewable Energy Across North Carolina Counties ($)

County Name	Solar	Landfill Gas	Hydro	Biomass	Solar Thermal	Total
Alamance	3,421,086	—	—	—	—	3,421,086
Alexander	6,584,279	—	—	—	—	6,584,279
Alleghany	—	—	—	—	—	—
Anson	—	—	—	—	—	—
Ashe	—	—	—	—	—	—
Avery	4,931,295	—	—	—	—	4,931,295
Beaufort	66,230,319	—	—	—	—	66,230,319
Bertie	—	—	—	1,696,437	—	1,696,437
Bladen	19,825,375	—	—	—	—	19,825,375
Brunswick	—	—	—	—	—	—
Buncombe	18,045,187	3,590,323	—	—	—	21,635,510
Burke	1,232,824	—	4,585,831	—	—	5,818,654
Cabarrus	23,319,011	28,339,107	—	—	1,446,279	53,104,396
Caldwell	—	—	—	—	—	—
Camden	—	—	—	—	—	—
Carteret	—	—	—	—	—	—
Caswell	39,650,750	—	—	—	—	39,650,750
Catawba	143,510,545	70,492,159	—	—	—	214,002,704
Chatham	24,031,236	—	14,243,051	—	—	38,274,287
Cherokee	14,793,884	—	—	—	—	14,793,884
Chowan	—	—	—	—	—	—
Clay	—	—	—	—	—	—
Cleveland	58,265,081	—	—	—	—	58,265,081
Columbus	69,898,323	—	—	—	—	69,898,323
Craven	21,900,098	11,010,691	—	—	—	32,910,788
Cumberland	6,306,114	—	2,589,646	—	—	8,895,759
Currituck	—	—	—	—	—	—
Dare	—	—	—	—	—	—
Davidson	130,792,574	4,187,876	—	—	—	134,980,450
Davie	35,053,949	—	—	—	—	35,053,949
Duplin	102,632,853	—	—	20,440,023	—	123,072,875
Durham	18,805,353	8,459,930	—	—	—	27,265,283
Edgecombe	12,126,574	—	—	—	—	12,126,574
Forsyth	1,785,084	6,089,594	—	—	2,182,104	10,056,783
Franklin	26,894,835	—	—	—	—	26,894,835
Gaston	30,526,654	7,180,646	—	—	—	37,707,300
Gates	—	—	—	—	—	—
Graham	—	—	—	—	—	—
Granville	12,400,088	—	—	—	—	12,400,088
Greene	9,541,091	—	—	—	—	9,541,091

(continued)

Table B-1. Major Investments in Renewable Energy Across North Carolina Counties ($) (continued)

County Name	Solar	Landfill Gas	Hydro	Biomass	Solar Thermal	Total
Guilford	14,869,301	—	—	—	1,178,046	16,047,348
Halifax	—	—	—	—	—	—
Harnett	41,444,391	—	—	—	—	41,444,391
Haywood	5,814,317	—	—	—	—	5,814,317
Henderson	7,074,259	—	—	—	2,537,331	9,611,590
Hertford	19,576,648	—	—	1,339,292	—	20,915,940
Hoke	—	—	—	—	—	—
Hyde	—	—	—	—	—	—
Iredell	—	8,482,849	—	—	—	8,482,849
Jackson	—	—	—	—	—	—
Johnston	17,963,763	3,920,000	—	—	—	21,883,763
Jones	—	—	—	—	—	—
Lee	—	—	—	—	—	—
Lenoir	44,421,296	—	—	—	—	44,421,296
Lincoln	19,825,375	—	—	—	—	19,825,375
Macon	—	—	—	—	—	—
Madison	—	—	—	—	—	—
Martin	—	—	—	—	—	—
McDowell	—	—	4,585,831	—	—	4,585,831
Mecklenburg	24,366,077	4,587,514	—	11,530,871	—	40,484,462
Mitchell	—	—	—	—	—	—
Montgomery	14,563,287	23,179,017	—	—	—	37,742,303
Moore	13,543,857	—	—	—	—	13,543,857
Nash	66,067,096	—	—	—	—	66,067,096
New Hanover	13,988,368	—	—	—	1,051,180	15,039,547
Northampton	—	—	—	—	—	—
Onslow	—	4,784,850	—	—	—	4,784,850
Orange	21,913,289	—	—	—	1,424,530	23,337,819
Pamlico	—	—	—	—	—	—
Pasquotank	—	—	—	—	—	—
Pender	—	—	—	—	—	—
Perquimans	—	—	—	—	—	—
Person	54,929,281	—	—	92,945,202	—	147,874,483
Pitt	—	—	—	—	—	—
Polk	—	—	—	—	—	—
Randolph	18,070,343	—	—	—	—	18,070,343
Richmond	26,163,338	—	—	—	—	26,163,338
Robeson	170,585,373	2,485,887	—	—	15,534,678	188,605,938
Rockingham	20,867,111	1,960,000	—	2,306,174	—	25,133,285

(continued)

Table B-1. Major Investments in Renewable Energy Across North Carolina Counties ($) (continued)

County Name	Solar	Landfill Gas	Hydro	Biomass	Solar Thermal	Total
Rowan	9,559,759	—	—	1,286,120	—	10,845,879
Rutherford	4,065,751	—	—	—	—	4,065,751
Sampson	28,762,492	15,435,000	—	1,724,901	—	45,922,392
Scotland	71,011,766	—	—	—	—	71,011,766
Stanly	—	—	—	—	—	—
Stokes	—	—	—	—	—	—
Surry	20,301,121	11,515,000	—	—	—	31,816,121
Swain	—	—	—	—	—	—
Transylvania	—	—	—	—	—	—
Tyrrell	—	—	—	—	—	—
Union	19,825,375	—	—	—	—	19,825,375
Vance	28,563,347	—	—	—	—	28,563,347
Wake	81,563,307	15,534,678	—	—	—	97,097,985
Warren	40,388,854	—	—	—	—	40,388,854
Washington	—	—	—	—	—	—
Watauga	9,228,048	—	—	—	—	9,228,048
Wayne	107,936,531	8,323,403	—	—	—	116,259,934
Wilkes	—	—	—	—	—	—
Wilson	19,825,375	—	—	—	—	19,825,375
Yadkin	—	—	—	—	—	—
Yancey	—	—	—	—	—	—
Total	**1,959,582,956**	**239,558,523**	**26,004,358**	**133,269,020**	**25,354,148**	**2,383,769,006**

Note: This table only includes renewable projects with installment costs greater than $1,000,000 (in 2013 dollars). Total renewable investment was $2.61 billion across North Carolina.