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Economic Impact Analysis of Clean Energy Development in North Carolina—2016 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 2015 report *Economic Impact Analysis of Clean Energy Development in North Carolina—2015 Update*, prepared by RTI International (2015).

In this supplement to the 2015 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] requirements,
- Government funds that would have been spent on other government services in the absence of state support for clean energy investment.

Our research findings are as follows:

- Approximately $6,347.1 million was invested in clean energy development in North Carolina between 2007 and 2015, which was supported, in part, by the state government at an estimated cost of $322.1 million.

[1] Under this law investor-owned utilities in North Carolina will be required to meet up to 12.5% of their retail electricity sales through renewable energy resources or energy efficiency measures by 2021. Rural electric cooperatives and municipal electric suppliers are subject to a 10% REPS requirement.

Clean energy investments were nearly 20 times larger than the state incentives for them.

- Renewable energy project investment in 2015 was $1,972.3 million, or nearly 114 times the $17.4 million investment observed in 2007.
- Investment in 2014 and 2015 accounted for 58% of total cumulative investment over last 9 years.
- Total contribution to gross state product (GSP) was $7,073.7 million between 2007 and 2015 (see **Table ES-1**).
- Clean energy development supported 82,403 annual full-time equivalents (FTEs), equivalent to one person working full time for a year, from 2007 to 2015.
- Robeson, Duplin, Catawba, Edgecombe, and Beaufort Counties experienced the greatest amount of investment—more than $200 million each between 2007 and 2015.
- Wayne, Wilson, and Scotland Counties each experienced between $150 million and $200 million in investment between 2007 and 2015.

Table ES-1. Total Economic Impacts, 2007–2015

	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	6,347.7	3,743.9	35,987	378.8
Direct economic impact from change in government spending[d]	-275.2	-211.2	-2,999	-7.3
Secondary economic impact[e]	5,948.3	3,541.0	49,415	157.5
Total economic impact	12,020.9	7,073.7	82,403	529.0

[a] Total output refers to revenue received by North Carolina individuals and businesses. [b] GSP represents the total value added. Value added is a non-duplicative measure of production that when aggregated across all industries equals GDP. It provides a complimentary indicator to that of final sales. While gross output is a useful measure of an individual industry's output, gross output for the economy as a whole double-counts sales between industries and is a less reliable measure [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 $322.1 million in state clean energy incentives, less $46.9 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 2015, investment in clean energy development in North Carolina increased from $47.7 million to $6,347.7 million, of which $5,033.4 million (79%) was for renewable energy projects and $1,314.3 million (21%) was for major energy efficiency initiatives.

The total amount of energy generated or saved through renewable energy and energy efficiency programs amounted to 23.8 million MWh, which is sufficient to power nearly 1.75 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). Since its publication, RTI has published annual updates to capture the economic impacts of new clean energy investment for subsequent years 2013 (RTI, 2014) and 2014 (RTI, 2015).

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[2] The Energy Information Administration (EIA) estimates that in 2014 a North Carolina residential utility customer consumed 13,629 kWh (or 13.629 MWh) per year. See EIA (2015a): 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 (2015b): http://www.eia.gov/electricity/annual/?src=Electricity-f4.

This report updates the economic impact results to include clean energy investments made in 2015. Otherwise, the data and analysis methodology are unchanged.

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.

As in previous versions of the report, the principle research question answered by this analysis is: *What are the comprehensive retrospective statewide economic and fiscal impacts of clean energy development?*

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 Environmental Quality[4] (NC DEQ), and the U.S. Energy Information Administration (EIA);
- Measured spending for clean energy investments made in North Carolina over the 9-year period from 2007 through 2015 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

[4] Formally known as the North Carolina Department of Environment and Natural Resources

- Presents 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 2015. 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 2015; therefore, results should not be interpreted as annual totals.

Unlike other economic impact 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.
- 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 private 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.[5]

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

[5] 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 2,300 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 2015, RTI's revenue was $831.5 million.

2 Economic Impacts, 2007–2015

From 2007 through 2015, $5,033.4 million was invested in the construction and installation of renewable energy projects in North Carolina. An additional $1,314.3 million was spent on implementing energy efficiency initiatives.[6] Total clean energy development was valued at $6,347.7 million.

Although investment was distributed across the state, Catawba, Duplin, Robeson, Beaufort and Edgecombe Counties each experienced the greatest amount, with more than $200 million in renewable energy project investment each.

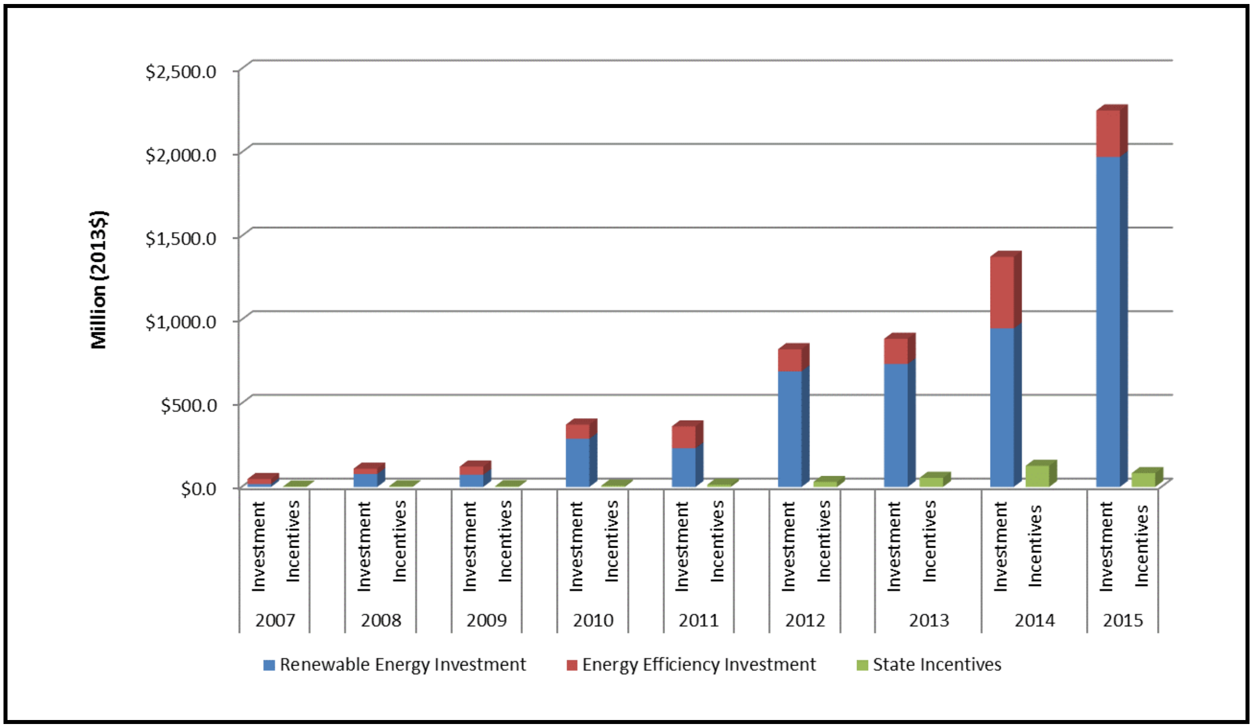
Clean energy development contributed $7,073.7 million in GSP and supported 82,403 annual FTEs statewide. As a result of changes in economic activity from the development of clean energy in North Carolina, state and local governments realized tax revenue of $529.0 million.

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 9-year analysis period. For example, renewable energy project investment in 2015 was $1,972.3 million, which was about 114 times the size of 2007's $17.4 million. The combined clean energy investments for 2014 and 2015, accounts for 58% of the total cumulative clean energy investment from 2007 to 2015.

[6] 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, 2007–2015



See Appendix A for data sources.

Table 2-1. Clean Energy Investment in North Carolina, 2007–2015

	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	$17.4	0%	$30.1	2%	$47.5	1%	$1.9
2008	$77.4	2%	$31.7	2%	$109.0	2%	$3.7
2009	$72.9	1%	$49.0	4%	$121.8	2%	$4.3
2010	$287.7	6%	$84.6	6%	$372.3	6%	$7.0
2011	$231.6	5%	$130.4	10%	$362.0	6%	$13.1
2012	$691.6	14%	$131.6	10%	$823.2	13%	$29.7
2013	$734.8	15%	$150.8	11%	$885.6	14%	$54.3
2014	$947.7	19%	$428.2	33%	$1,375.9	22%	$125.7
2015	$1,972.3	39%	$278.1	21%	$2,250.4	35%	$82.4
Total	$5,033.4	100%	$1,314.3	100%	$6,347.7	100%	$322.1

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 20 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.

It is also import to note that some of the historic values in table 2-1 have changed slightly from previous versions of this report due primarily to updating data sources. Overall, our methodology remains the same between different versions of the report to try and make them as comparable as possible.

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 Environmental Quality; 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 2015. Investment in renewable energy projects totaled $5,033.4 million. Investment in energy efficiency totaled $1,314.3 million. Thus, total clean energy investment was $6,347.7 million during the study period.

Of the $5,033.4 million investment in renewable energy projects,

- Solar photovoltaics made up $4,428 million (88%),

- Landfill gas made up $240.4 million (4%), and
- Biomass made up $266.7 million (5%).

Table 2-2. Direct Spending in Clean Energy Development by Technology, 2007–2015

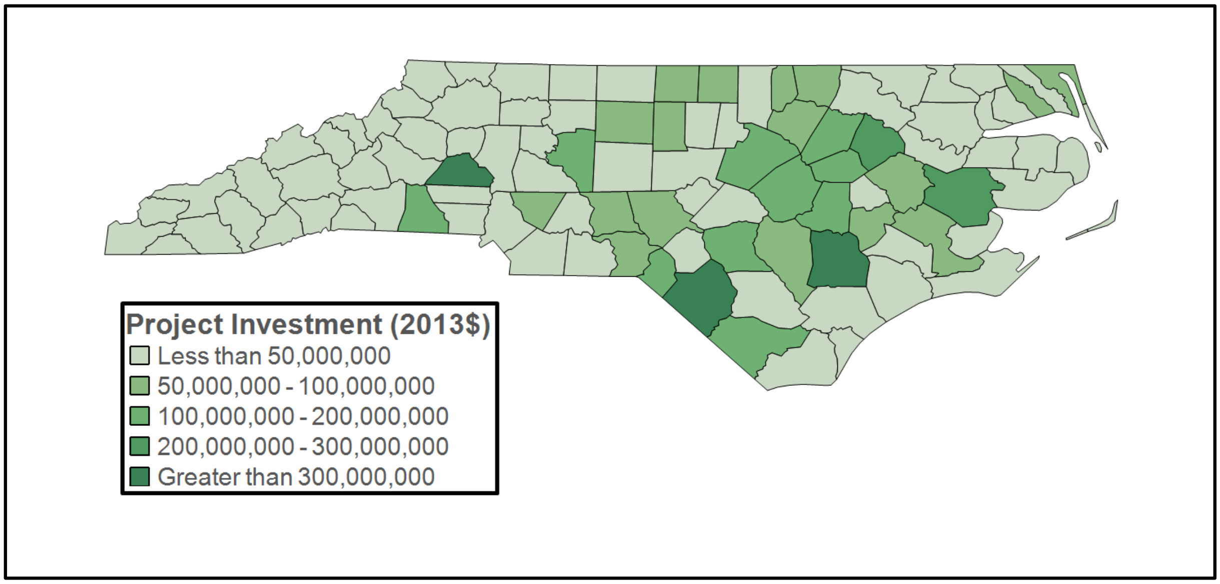
Category	Technology	Value (Million, 2013$)	%
Renewable energy direct investment	Biogas fuel cell	$70.5	1%
	Biomass	$266.7	5%
	Geothermal	$26.2	1%
	Hydroelectric (<10 MW capacity)[a]	$25.0	0%
	Landfill gas	$169.9	3%
	Passive solar	$4.9	0%
	Solar photovoltaic	$4,428.0	88%
	Solar thermal	$41.4	1%
	Wind	$0.7	0%
	Total	$5,033.4	100%
Energy efficiency direct investment	Utility energy efficiency and demand-side management programs	$1,045.4	80%
	Utility Savings Initiative	$268.9	20%
	Total	$1,314.3	100%
Total		$6,347.7	

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 $4,905.3 million (97% of the total $5,033.4 million in renewable investment over the period).

Robeson, Duplin, Catawba, Edgecombe, and Beaufort Counties each experienced more than $200 million in renewable energy project investment, and Wayne, Wilson, and Scotland Counties each experienced between $150 million and $200 million in renewable project investment from 2007 through 2015.

Figure 2-2. Distribution of Renewable Energy Projects Valued at $1 Million or Greater across North Carolina Counties 2007-2015



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 2015.

Table 2-3. Cumulative Renewable Energy Generation, 2007–2015

	Facilities		Energy Equivalent Generated	
Technology	**Number**	**%**	**Thousand MWh**	**%**
Biogas fuel cell	1	0%	75	1%
Biomass (including combined heat and power)	21	1%	7,845	58%
Geothermal	1,269	48%	86	1%
Hydroelectric (<10 MW capacity)	10	0%	208	2%
Landfill gas	20	1%	2,183	16%
Passive solar	N/A	N/A	5	0%
Solar photovoltaic	1,264	47%	2,961	22%
Solar thermal	83	3%	113	1%
Wind	9	0%	2	0%
Total	2,670	100%	13,476	100%

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

Table 2-4. Energy Efficiency Energy Savings, 2007–2015

Program	**Energy Saved[a] (Thousand MWh)**	**Energy Costs Saved (Million, 2013$)**
Utility Programs	10,401	$624.1
Utility Savings Initiative	N/A[b]	$935.8
Total	10,401	$1,559.8

[a] Energy savings were estimated using an estimate of $0.06/kWh for years 2007 through 2015.[7]

[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.

[7] 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 13.5 million MWh of energy, of which

- 58% was biomass,
- 16% was landfill gas, and
- 22% was solar photovoltaics.

Energy efficiency initiatives also produced large savings in North Carolina. Energy efficiency programs run by utility companies saved 10.4 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 $935.8 million on energy expenses.[8]

Thus, the total energy generated or saved from clean energy projects is estimated to amount to at least 23.8 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 $309.5 million in tax credits and energy efficiency projects received $12.6 million. Total government expenditures were $322.1 million between 2007 and 2015 (**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 $6,347.7 million.

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[8] 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, 2014–June 30, 2015." 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 2015, RTI assumed energy costs were avoided at the same rate in the second half of 2015 as they were during the fiscal year from 2014 to 2015. To convert sums to 2013 U.S. dollars, we applied inflation multipliers calculated from the CPI-U (see Table A-3).

However, the $322.1 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, 2007–2015

Year	Renewable Energy Investment Tax Credit[a,b] (Million, 2013$)	Energy Efficiency[c] (Utility Savings Initiative, Million, 2013$)	Total (Million, 2013$)
2007	$0.5	$1.4	$1.9
2008	$2.3	$1.4	$3.7
2009	$2.9	$1.4	$4.3
2010	$5.6	$1.4	$7.0
2011	$11.7	$1.4	$13.1
2012	$28.3	$1.4	$29.7
2013	$52.9	$1.4	$54.3
2014	$124.3	$1.4	$125.7
2015	$81.0	$1.4	$82.4
Total	**$309.5**	**$12.6**	**$322.1**

Note: For the Utility Savings Initiative, an appropriation of $12.6 million was taken, which we distributed evenly across the study period for the purposes of the analysis. The tax credit for 2015 was estimated, and this estimation is detailed in Appendix A.

[a] North Carolina Department of Revenue, Policy Analysis and Statistics Division. (2007-2015). Unaudited NC-478G. Raleigh, NC: North Carolina Department of Revenue, Policy Analysis and Statistics Division.

[b] North Carolina Department of Revenue, Revenue Research Division. (2015). "Credit for Investing in Renewable Energy Property Processed during Calendar Year 2014." Raleigh, NC: North Carolina Department of Revenue, Revenue Research Division.

[c] North Carolina Department of Commerce. (November 1, 2015). "Annual Report for the Utility Savings Initiative for Fiscal Year July 1, 2014–June 30, 2015." 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

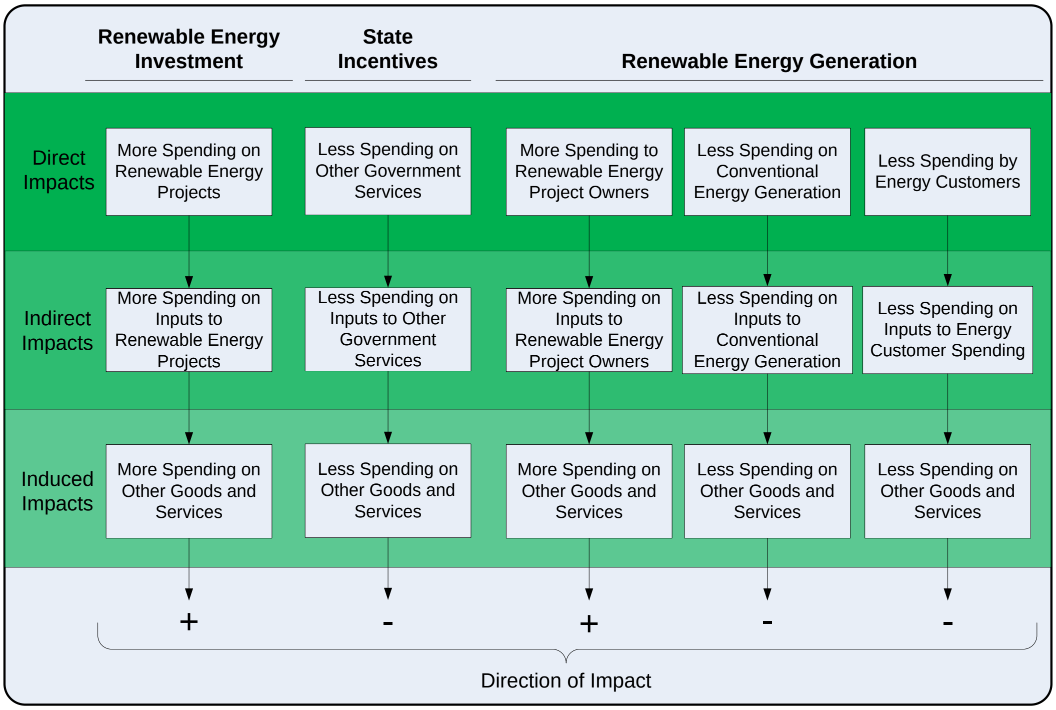
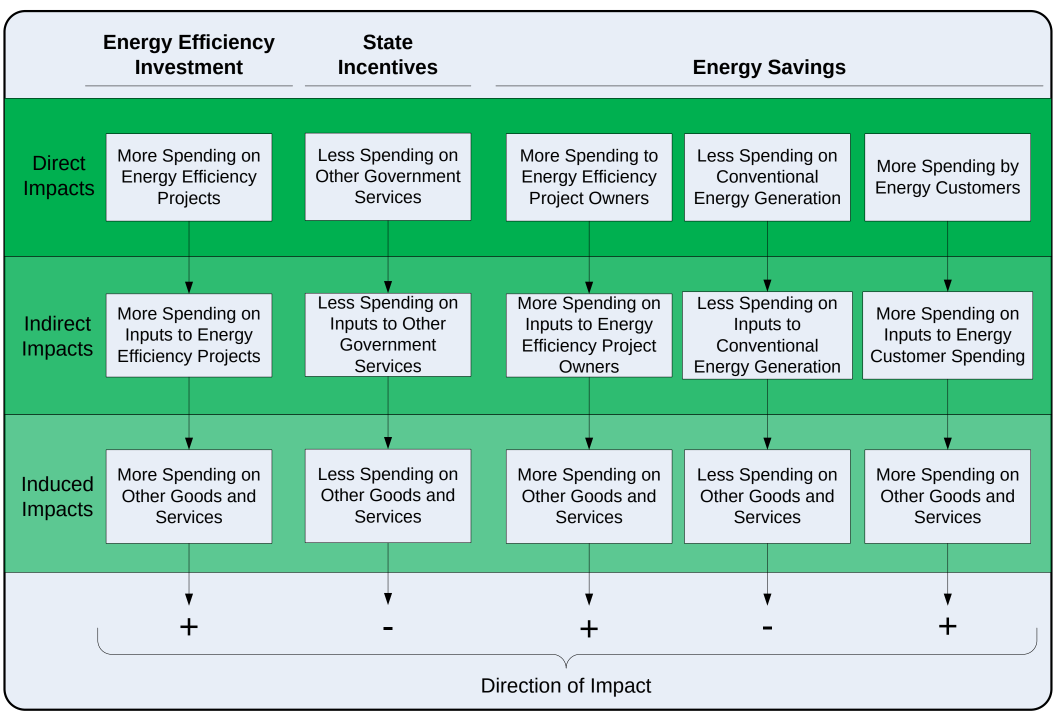


Figure 2-4. Energy Efficiency Direct, Indirect, and Induced Economic Impacts Related to Clean Energy Incentives



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[9] in avoided costs for the years 2007 through 2015, 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 ($0.071/kWh for industrial and $0.1044/kWh for commercial and residential customers [EIA, 2015]). 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 13.5 million MWh of energy over the study period. This generation is estimated to have resulted in a total of $853.5 million[10] 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 $343.1 million.[11]

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 from the inputs of conventional energy generation to utility

[9] 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.

[10] This $853.5 million was calculated by multiplying 10,010,119 MWh generated by non-thermal renewable projects by $60/MWh avoided cost to yield $600,607,155. The 3,263,355 industrial thermal MWh generated was multiplied by industrial retail savings of $71/MWh (EIA, 2015) to yield $231,698,232. Lastly, the 202,966 commercial and residential thermal MWh generated was multiplied by the average retail savings of $104/MWh (EIA, 2015) to yield $21,189,640. Summing the three totals together yields $853,495,028.

[11] This total was estimated using the most recent REPS cost data available at the time of the analysis.

customers, in line with Duke Energy's Save-A-Watt program.[12] 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 10.4 million MWh in energy savings over the study period. The avoided cost for these programs, assuming $0.06/kWh was $624.1 million.[13] Combining this with the $935.8 million saved by the Utility Savings Initiative yields a total energy efficiency savings of $1,559.8 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 $12,020.9 million over the 9-year period from 2007 to 2015. Clean energy development accounted for $7,073.7 million in GSP over the study period. Total employment effects were estimated to be 82,403 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**, $5,033.4 million in in-state spending on renewable energy projects has a direct impact on GSP ($3,178.3 million), employment (30,354 FTEs), and state and local tax revenue ($349.5 million).

These renewable projects received an estimated $309.5 million in state tax credits between 2007 and 2015. 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.

According to IMPLAN's assumptions out of the $309.5 million in state tax credits the state government would have otherwise

[12] 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 was not reflected in the current study.

[13] The avoided cost was calculated by multiplying 10,401,307 MWh by $60/MWh ($0.06/kWh) avoided cost to yield $624.1 million.

spent $264.4 million on in-state goods and services and spent $45.1 million out-of-state for goods and services. Therefore, the direct economic impact from the change in government spending patterns is −$264.4 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, 2007–2015

	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	5,033.4	3,178.3	30,354	349.5
Direct economic impact from change in government spending[c]	-264.4	-202.9	-2,882	-7.0
Secondary economic impact	4,387.9	2,529.5	28,450	191.2
Total economic impact	9,156.9	5,504.8	55,923	533.6

[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 $309.5 million in renewable tax credits, less $45.1 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 $5,504.8 million, 55,923 FTEs, and $533.6 million in state and local tax revenue.[14]

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 was $1,314.3 million in energy efficiency investment, and the

[14] 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.

resulting energy savings and changes in spending over the study period contributed $1,568.9 million to total GSP and supported 26,480 FTEs.

Table 2-7. Energy Efficiency Initiatives Economic Impacts, 2007–2015

	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	1,314.3	565.6	5,633	29.4
Direct economic impact from change in government spending[c]	-10.8	-8.3	-117	-0.3
Secondary economic impact	1,560.5	1,011.5	20,965	-33.6
Total economic impact	2,864.1	1,568.9	26,480	-4.6

[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 $12.6 million in state government procurement to the Utility Savings Initiative, less $1.8 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 $12.6 million on other government services, $1.8 million would have been spent out of state. See the second data row in Table 2-7.

A net negative fiscal impact of $4.6 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 2015, the total economic activity associated with renewable energy projects and energy efficiency initiatives was (**Table 2-8**):

- $12,020.9 million in gross output (revenue),
- $7,073.7 million in GSP (value-added),
- 82,403 FTEs, and

- $529.0 million in state and local tax revenues.

Table 2-8. Total Economic Impacts, 2007–2015

	Total Output[a] (Million, 2013$)	Gross State Product[b] (Million, 2013$)	Employment (Full-Time Employee Equivalents)	Fiscal Impacts (Million, 2013$)
Direct economic impact	6,347.7	3,743.9	35,987	378.8
Direct economic impact from change in government spending[c]	-275.2	-211.2	-2,999	-7.3
Secondary economic impact	5,948.3	3,541.0	49,415	157.5
Total economic impact	12,020.9	7,073.7	82,403	529.0

[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 $322.1 million in state clean energy incentives, less $46.9 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 $275.2 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 $529 million as a result of gross changes in economic activity.

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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 2015 was estimated based on data from North Carolina Renewable Energy Tracking System (NC-RETS, 2015), North Carolina GreenPower (North Carolina GreenPower, personal communication, January 20, 2016), and eight additional systems totaling 284.5 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, 2015, that the North Carolina Sustainable Energy Association (NCSEA) compiled from NCUC. 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], 2015).

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 fixed operating and maintenance (O&M) costs were assumed to be $26/kW.[15]

[15] 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.

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
2015	6,554	3,793	2,400	2,187	2,560

A.1.2 Landfill Gas

Capacity for landfill gas (LFG) facilities was estimated using data from NC-RETS (2015) 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 (2015) 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 (2015) 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 period. RTI estimated new or incremental capacity at hydroelectric facilities between 2007 and 2015 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 2015 was estimated using data from NC-RETS (2015) 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 (2015) 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 (2015) and North Carolina GreenPower (personal communication, February 8, 2016. 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 2015 are based on data reported in NC-RETS (2015). 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 Environmental Quality (NCDEQ) provided permit data for geothermal wells (NCDEQ, personal communication, February 6th, 2016). 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 (2007–2015) 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 2015 were developed from figures provided by the North Carolina Department of Revenue (2011b; 2012a; 2013; 2014; 2015). We estimated the 2015 tax credits taken by taking an average ratio between the value of property claiming the tax credit and total credits taken over the previous 8 years. We then multiplied this ratio by the total value of properties claiming the tax credit in 2015.

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 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, $71/MWh (EIA, 2015b). For geothermal, solar thermal, and passive solar, we assumed that the cost of energy saved is the average retail price for electricity, $104/MWh (EIA, 2015b).

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, 2015a Progress, 2009b, 2010a, 2011b, 2012a, 2013a, 2014, 2015a GreenCo, 2010a, 2010c, 2012a, 2012b, 2013, 2014, 2015, ElectriCities, 2009, 2010, 2011a, 2012a, 2013a, 2014, 2015) 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	NC DEQ	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
2015	237.03	0.98

Source: BLS, 2015.

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 2015 (Dominion North Carolina Power, 2010, 2011, 2012, 2013, 2014, 2015b), Duke Energy Carolinas (2013a; 2014), 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, 2014, 2015b). Demand-side management program costs were only included for 2011 through 2015 because these programs could not pass along costs to consumers until 2011 (General Assembly, 2011).

Energy savings associated with utility programs between 2007 and 2015 were estimated based on NC-RETS data (2015). Energy savings from utility programs in 2015 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, 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
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

(Continued)

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

Program	Utility
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
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 2015 annual report (North Carolina Department of Commerce, 2015).

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), 2013 IMPLAN default data for North Carolina (MIG Inc., 2015), and original assumptions where necessary (**Table A-5**).

In the updated version of IMPLAN many sectors have been disaggregated to include different subsectors. The most relevant of those for this study is the energy generation sector. Previously, energy generation was a single sector that captured all energy generation technologies. In the 2013 version of IMPLAN, the energy sector is broken out into a traditional fossil fuel sector and six separate renewable energy sectors.

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 non-education. 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 446, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 44, Electrical power generation - solar.
Hydroelectric	Investment spending was allocated to IMPLAN Sector 54, Construction of Other New Nonresidential Structures.	Avoided cost net of fixed and variable O&M costs was transferred to Sector 446, Lessors of Non-financial intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 41, Electrical power generation - Hydroelectric. Fixed and variable O&M costs were allocated to IMPLAN Sector 62, 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 446, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 47, Electrical power generation - Biomass. 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 446, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 47 Electrical power generation - Biomass. 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 446, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 47 Electrical power generation - Biomass. 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 446, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 45, Electrical power generation - wind. 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 446, Lessors of Non-financial Intangible Assets (Regulatory Assistance Project, 2005) from inputs to Sector 48, Electric power generation – all other. 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 277, Air Conditioning, Refrigeration, and Warm Air Heating Equipment Manufacturing, 25% to Sector 54, Construction of Other New Non-residential Structures, and 25% to Sector 395, 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 42, Electrical power generation – fossil fuels. Fixed O&M costs were allocated to IMPLAN Sector 62, Maintenance and Repair Construction of Non-residential Structures.
Passive Solar	Investment spending was allocated to Sector 59, 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 42, 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 42, Electricity, Generation, Transmission, and Distribution. Fixed O&M costs were allocated to IMPLAN Sector 62, Maintenance and repair construction of non-residential structures.
REPS Rider		REPS rider was transferred to Sector 446, 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 471, Waste Management and Remediation Services, and 90% to Sector 395, Wholesale Trade Businesses. For school education programs, we distributed spending across 100% to Sector 460, All Other Miscellaneous Professional, Scientific and Technical Services.	The avoided cost of energy saved was transferred 50% to Sector 446, 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 42, Electrical power generation – fossil fuels.
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 42, Electrical power generation – fossil fuels.
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—2015 Update* (RTI, 2015). 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 2015, whereas the last report's study frame was 2007 to 2014.
- 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 2015 report, updated geothermal data from NCDEQ, 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 2015 report estimated 2014 tax credits taken, this study used retrospective data provided by the North Carolina Department of Revenue for this year's tax credits.
- IMPLAN sectoring scheme has been adjusted to the new 2013 IMPLAN data. The biggest difference for this analysis is the disaggregation of the energy generation sector to include six different renewable energy sources. While these changes do not have a significant effect on the overall results, the heterogeneity in the energy subsectors adds nuance changes to the spending pattern of energy generation.

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Appendix B: Renewable Energy Projects Valued at $1 Million or Greater by County and NC State Legislative Districts

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

County Name	Solar	Landfill Gas	Hydro	Biomass	Solar Thermal	Total
Alamance	57,795,113	-	-	-	-	57,795,113
Alexander	6,584,296	-	-	-	-	6,584,296
Alleghany	-	-	-	-	-	-
Anson	12,573,170	-	-	-	-	12,573,170
Ashe	-	-	-	-	-	-
Avery	4,931,293	-	-	-	-	4,931,293
Beaufort	212,751,776	-	-	-	-	212,751,776
Bertie	-	-	-	1,644,526	-	1,644,526
Bladen	20,628,239	-	-	-	-	20,628,239
Brunswick	-	-	-	46,472,724	-	46,472,724
Buncombe	24,561,176	3,590,323	-	-	-	28,151,499
Burke	20,031,539	-	4,585,831	-	-	24,617,370
Cabarrus	35,897,202	28,339,107	-	6,200,962	1,446,279	71,883,550
Caldwell	-	-	-	-	-	-
Camden	-	-	-	-	-	-
Carteret	-	-	-	-	-	-
Caswell	58,642,237	-	-	-	-	58,642,237
Catawba	243,512,989	70,492,159	-	-	-	314,005,148
Chatham	23,977,360	-	13,527,282	-	-	37,504,642
Cherokee	19,725,171	-	-	-	-	19,725,171
Chowan	-	-	-	-	-	-
Clay	-	-	-	-	-	-
Cleveland	116,660,228	-	-	-	-	116,660,228
Columbus	108,041,879	-	-	-	-	108,041,879
Craven	46,747,011	11,010,691	-	-	-	57,757,702
Cumberland	113,770,458	-	2,622,758	-	-	116,393,217
Currituck	50,312,803	-	-	-	-	50,312,803
Dare	-	-	-	-	-	-
Davidson	123,758,329	4,187,876	-	-	-	127,946,205
Davie	35,097,159	-	-	-	-	35,097,159
Duplin	338,255,688	-	-	20,143,085	-	358,398,773
Durham	36,313,518	8,459,930	-	-	-	44,773,448
Edgecombe	229,338,267	-	-	-	-	229,338,267
Forsyth	1,654,558	6,089,594	-	-	2,182,104	9,926,256
Franklin	65,286,616	-	-	-	-	65,286,616
Gaston	27,444,214	7,180,646	-	-	-	34,624,860
Gates	12,578,201	-	-	-	-	12,578,201
Graham	-	-	-	-	-	-
Granville	24,992,184	-	-	-	-	24,992,184
Greene	9,526,902	-	-	-	-	9,526,902

(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	51,055,155	-	-	-	1,178,046	52,233,202
Halifax	8,724,977	-	-	-	-	8,724,977
Harnett	38,646,547	-	-	-	-	38,646,547
Haywood	9,037,758	-	-	-	-	9,037,758
Henderson	11,301,229	-	-	-	2,537,331	13,838,560
Hertford	19,576,641	-	-	1,298,310	-	20,874,951
Hoke	12,553,044	-	-	-	-	12,553,044
Hyde	-	-	-	-	-	-
Iredell	-	8,482,849	-	-	-	8,482,849
Jackson	-	-	-	-	-	-
Johnston	106,149,354	3,920,000	-	-	-	110,069,354
Jones	-	-	-	-	-	-
Lee	37,679,258	-	-	-	-	37,679,258
Lenoir	92,429,672	-	-	-	-	92,429,672
Lincoln	16,742,918	-	-	-	-	16,742,918
Macon	-	-	-	-	-	-
Madison	-	-	-	-	-	-
Martin	-	-	-	-	-	-
McDowell	-	-	4,585,831	-	-	4,585,831
Mecklenburg	23,619,620	4,587,514	-	21,053,663	-	49,260,796
Mitchell	-	-	-	-	-	-
Montgomery	64,854,431	23,179,017	-	-	-	88,033,448
Moore	58,218,909	-	-	-	-	58,218,909
Nash	115,461,001	-	-	-	-	115,461,001
New Hanover	13,970,547	-	-	-	1,051,180	15,021,727
Northampton	-	-	-	-	-	-
Onslow	32,200,194	4,784,850	-	-	-	36,985,044
Orange	32,324,673	-	-	-	1,424,530	33,749,203
Pamlico	-	-	-	-	-	-
Pasquotank	80,362,125	-	-	-	-	80,362,125
Pender	-	-	-	-	-	-
Perquimans	-	-	-	-	-	-
Person	51,622,458	-	-	46,472,724	-	98,095,183
Pitt	66,749,629	-	-	-	-	66,749,629
Polk	-	-	-	-	-	-
Randolph	16,663,489	-	-	-	-	16,663,489
Richmond	50,175,553	-	-	-	-	50,175,553
Robeson	242,086,096	2,485,887	-	114,992,402	15,534,678	375,099,063
Rockingham	44,831,774	1,960,000	-	2,302,744	-	49,094,518

(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	47,405,926	-	-	1,307,217	-	48,713,142
Rutherford	20,894,994	-	-	-	-	20,894,994
Sampson	54,560,833	15,435,000	-	1,724,902	-	71,720,735
Scotland	159,107,367	-	-	-	-	159,107,367
Stanly	25,030,620	-	-	-	-	25,030,620
Stokes	-	-	-	-	-	-
Surry	20,121,940	11,515,000	-	-	-	31,636,940
Swain	-	-	-	-	-	-
Transylvania	-	-	-	-	-	-
Tyrrell	-	-	-	-	-	-
Union	29,321,118	-	-	-	-	29,321,118
Vance	90,217,773	-	-	-	-	90,217,773
Wake	97,598,049	15,534,678	-	-	-	113,132,727
Warren	73,266,643	-	-	-	-	73,266,643
Washington	-	-	-	-	-	-
Watauga	9,987,190	-	-	-	-	9,987,190
Wayne	163,209,892	8,323,403	-	-	-	171,533,295
Wilkes	-	-	-	-	-	-
Wilson	160,964,325	-	-	-	-	160,964,325
Yadkin	21,338,397	-	-	-	-	21,338,397
Yancey	-	-	-	-	-	-
Total	**4,351,451,693**	**239,558,523**	**25,321,702**	**263,613,259**	**25,354,148**	**4,905,299,325**

Note: This table only includes renewable projects with installment costs greater than $1,000,000 (in 2013 dollars). Total renewable investment was $5.0 billion across North Carolina.

Figure B-1 and B-2 illustrate the geographic distribution of renewable energy projects individually valued at $1 million or greater aggregated to North Carolina Senate and House districts. 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 $4,905.3 million (97% of the total $5,033.4 million in renewable investment over the period).

Senate districts three, four, ten, thirteen and forty two had the most investment with over $300 million of investment each.

While none of the House districts broke the $300 million threshold several had between $200 and $300 million, including: four, twenty one, twenty three, forty seven, forty eight, and eighty nine. All of the House districts mentioned are located either partially or completely in the previously mentioned senate districts.

Table B-2. Major Investments in Renewable Energy Across North Carolina Senate Districts ($)

NC Senate District	Solar	LFG	Hydro	Biomass	Solar Thermal	Total
1	275,642,781					275,642,781
2	46,747,011	11,010,691				57,757,702
3	329,277,033			2,942,836		332,219,869
4	337,605,394					337,605,394
5	94,987,909	8,323,403				103,311,312
6	32,200,194	4,784,850				36,985,044
7	227,749,608					227,749,608
8	92,903,809			46,472,724		139,376,533
9	13,970,546				1,051,180	15,021,726
10	434,129,936	19,355,000		21,867,987		475,352,923
11	145,127,077					145,127,077
12	97,345,152					97,345,152
13	363,926,158	2,485,887		114,992,402	15,534,678	496,939,125
14	13,089,077					13,089,077
15	6,171,780					6,171,780
16	9,778,689					9,778,689
17	10,263,031	15,534,678				25,797,709
18	119,305,660					119,305,660
19	49,730,403		2,622,758			52,353,161
20	33,796,924	8,459,930				42,256,854
21	33,181,283					33,181,283
22	121,030,557			46,472,724		167,503,281

(continued)

Table B-2. Major Investments in Renewable Energy Across North Carolina Senate Districts ($) (continued)

NC Senate District	Solar	LFG	Hydro	Biomass	Solar Thermal	Total
23	56,302,034		13,527,282		1,424,530	71,253,846
24	55,428,092					55,428,092
25	267,128,410					267,128,410
26	71,205,562	1,960,000		2,302,744		75,468,306
27	55,965,914				1,178,046	57,143,960
29	62,327,415					62,327,415
30	20,121,940	11,515,000				31,636,940
31	22,992,955					22,992,955
32		6,089,594			2,182,104	8,271,698
33	188,612,759	27,366,893				215,979,652
34	62,261,384	8,482,849		1,307,217		72,051,450

Figure B-1. NC Senate Districts Map

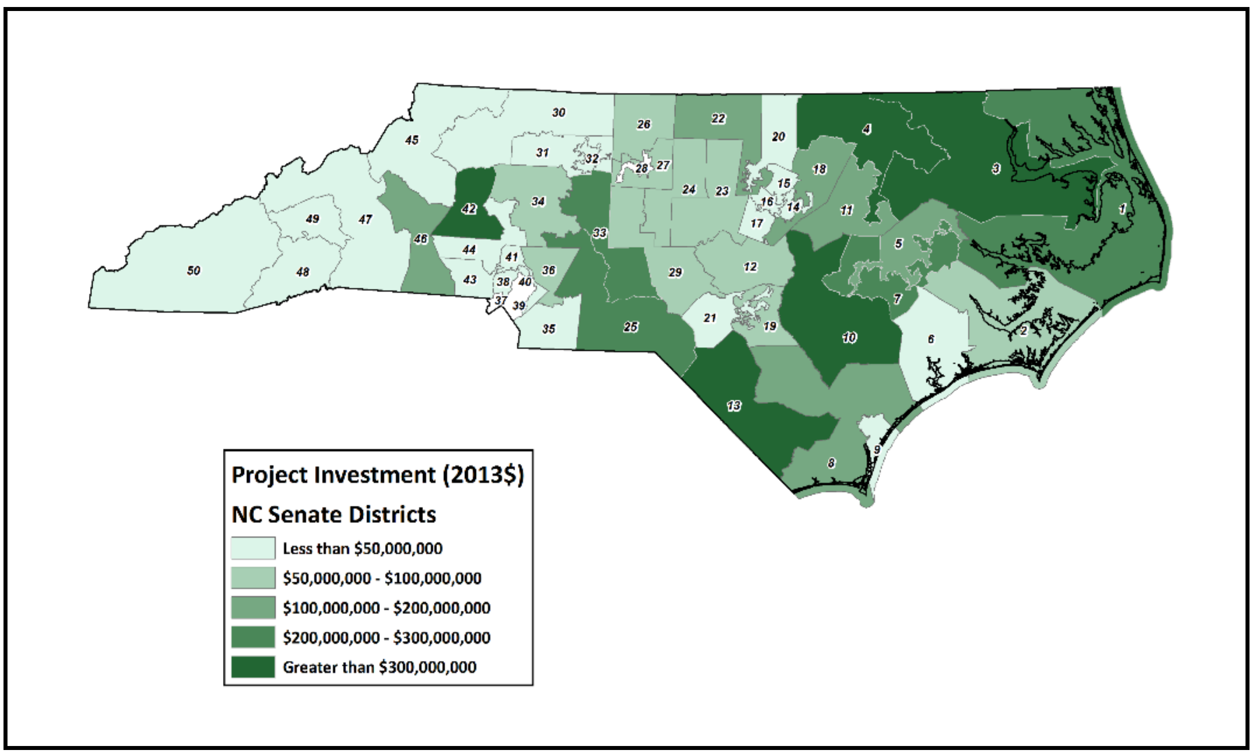

Table B-3. Major Investments in Renewable Energy Across North Carolina House districts ($)

NC Senate District	Solar	LFG	Hydro	Biomass	Solar Thermal	Total
1	50,312,803					50,312,803
2	51,622,459			46,472,724		98,095,183
3	119,724,473					119,724,473
4	206,087,506	8,323,403		15,797,185		230,208,094
5	112,516,967			2,942,836		115,459,803
6	120,071,909					120,071,909
7	35,232,361					35,232,361
8	157,061,524					157,061,524
9	14,512,545					14,512,545
10	81,562,131					81,562,131
11	7,698,433					7,698,433
12	53,928,240	11,010,691				64,938,931
15	32,200,194	4,784,850				36,985,044
17				46,472,724		46,472,724
18	13,970,546					13,970,546
20					1,051,180	1,051,180
21	264,313,036			4,345,900		268,658,936
22	112,294,775	15,435,000		1,724,902		129,454,677
23	229,338,267					229,338,267
24	43,566,718					43,566,718
25	145,515,258					145,515,258
26	6,614,568	3,920,000				10,534,568
27	8,724,977					8,724,977
28	103,811,215					103,811,215
30	13,039,858					13,039,858
31	8,804,741	8,459,930				17,264,671
32	192,908,274					192,908,274
33	12,022,946					12,022,946
34	3,146,387					3,146,387

(continued)

Table B-3. Major Investments in Renewable Energy Across North Carolina House districts ($) (continued)

NC Senate District	Solar	LFG	Hydro	Biomass	Solar Thermal	Total
36	7,117,484					7,117,484
37	36,601,174	15,534,678				52,135,852
39	20,563,417					20,563,417
40	3,127,001					3,127,001
43	24,604,189					24,604,189
45	25,126,214		2,622,758			27,748,972
46	145,997,537					145,997,537
47	107,226,122	2,485,887		114,992,402	15,534,678	240,239,089
48	217,486,492					217,486,492
49	3,044,779					3,044,779
50	46,793,594				1,424,530	48,218,124
51	37,679,258					37,679,258
52	58,218,910					58,218,910
53	55,389,465					55,389,465
54	23,977,360		13,527,282			37,504,642
55	41,894,289					41,894,289
57	2,994,155					2,994,155
58					1,178,046	1,178,046
59	50,895,698					50,895,698
61	2,076,061					2,076,061
62	9,630,869					9,630,869
63	13,607,108					13,607,108
64	41,820,984					41,820,984
65	75,385,156			2,302,744		77,687,900
66	156,308,449					156,308,449
67	89,885,051	23,179,017				113,064,068
70	4,108,505					4,108,505
72		6,089,594			2,182,104	8,271,698
73	27,922,693					27,922,693

(continued)

Table B-3. Major Investments in Renewable Energy Across North Carolina House districts ($) (continued)

NC Senate District	Solar	LFG	Hydro	Biomass	Solar Thermal	Total
75	1,654,558					1,654,558
76	21,686,518			1,307,217		22,993,735
77	25,719,407					25,719,407
79	35,097,159					35,097,159
80	9,816,818	4,187,876				14,004,694
81	113,941,510					113,941,510
82	3,840,244	28,339,107			1,446,279	33,625,630
83	32,056,958			6,200,962		38,257,920
84		8,482,849				8,482,849
85	4,931,293					4,931,293
86	20,031,539		9,171,662			29,203,201
89	165,430,436	70,492,159				235,922,595
90	20,121,940	11,515,000				31,636,940
91	28,088,857	1,960,000				30,048,857
92	10,565,765			21,053,663		31,619,428
96	78,082,553					78,082,553
97	16,742,918					16,742,918
98		4,587,514				4,587,514
101	1,572,774					1,572,774
102	2,824,702					2,824,702
107	3,346,862					3,346,862
108	6,910,365					6,910,365
109	3,790,931					3,790,931
110	21,019,347	7,180,646				28,199,993
111	112,383,800					112,383,800
112	20,894,994					20,894,994
113					1,236,043	1,236,043

(continued)

Table B-3. Major Investments in Renewable Energy Across North Carolina House districts ($) (continued)

NC Senate District	Solar	LFG	Hydro	Biomass	Solar Thermal	Total
115		3,590,323				3,590,323
116	20,750,183					20,750,183
117	11,301,229				1,301,288	12,602,517
118	9,037,758					9,037,758
120	19,725,172					19,725,172
Total	**4,351,451,715**	**239,558,524**	**25,321,702**	**263,613,259**	**25,354,148**	**4,905,299,348**

Figure B-2. NC House Districts Map