# ANALYSIS OF THE ECONOMIC IMPACT OF THE NORTH CAROLINA RENEWABLE ENERGY AND ENERGY EFFICIENCY PORTFOLIO STANDARD

Technical Report

PREPARED FOR

**North Carolina Sustainable Energy Association**

PREPARED BY


**La Capra Associates, Inc.**
Twenty Winthrop Square
Boston, MA 02110

**GDS Associates, Inc.**
1850 Parkway Place, Suite 800
Marietta, GA 30067


November 2008

# TABLE OF CONTENTS

# TABLE AND FIGURE REFERENCE

# 1. Overview

This Analysis of the Economic Impact of the North Carolina Renewable Energy and Energy Efficiency Portfolio Standard (REPS) provides an update to the 2006 North Carolina Renewable Portfolio Standard Study (2006 NC RPS Study) conducted by La Capra Associates and GDS Associates. This study update continues to use the renewable energy supply model developed for the 2006 NC RPS Study, maintains the same 2006 generator costs and resource potential assumptions, and continues to use the IMPLAN model for analyzing economic impact. However, as we will discuss in more detail later, changes in assumptions were necessary given the passage of the NC REPS. The changes and updates include:

- Revised the North Carolina load forecast;
- Incorporated the newly legislated REPS standards;
- Included the REPS legislated carve-outs for solar, swine waste, and poultry waste;
- Assumed the maximum allowance for large hydro and energy efficiency measures where applicable;
- Treated municipalities/cooperatives and utilities separately according to their somewhat different REPS requirements; and
- Updated the projected conventional generation portfolio based on utilities' most recently filed Integrated Resource Plans (IRP).

To reiterate the basic principles of the study approach, we first develop a renewable energy supply curve comprised of all of the viable renewable energy options in the state sorted from least cost to highest cost. Next, we calculate the REPS demand based on projected state demand for electricity coupled with the REPS requirements. The resulting REPS demand is used to "clear" the supply curve to estimate the potential renewable energy mix to meet the REPS requirements each year. Finally, in order to determine the cost impact to ratepayers as a result of the REPS, we compare a portfolio comprised of conventional new generation, as proposed by the utilities, with a Revised Portfolio that contains both REPS resources and conventional generation. To develop the Revised Portfolio, the "cleared" renewable resources are used to offset a portion of the new conventional (fossil-fuel) generation that would otherwise be needed. Both portfolios should provide adequate firm capacity and energy to meet future growth in demand.

The resources that "clear" for each year, the avoided conventional generation, and the rate impact resulting from the REPS are used in the economic modeling to estimate the jobs (economic) impact for the state. The assumptions used in the economic analysis for IMPLAN also remains the same as the 2006 NC RPS study, with some minor adjustments for allocation of spending associated with certain industries (which is elaborated in Appendix A – Description of Economic Analysis).

# 2. Renewable Supply Model Updates

## *2.1 Load Forecast*

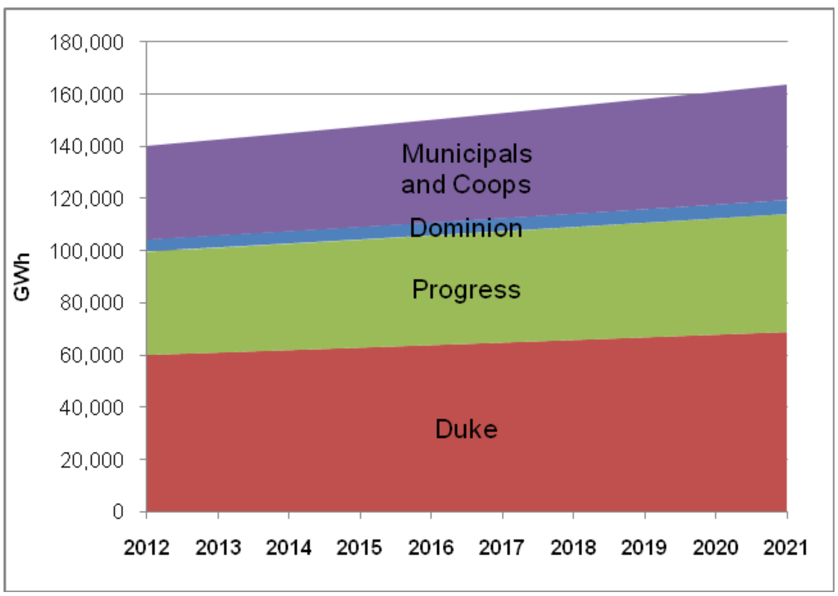
We updated the electricity demand forecast to reflect more updated IRP filings. Most of the retail energy providers submitted a 2007 Integrated Resource Plan (IRP) to the North Carolina

Utilities Commission. Not all of the municipalities and cooperatives submitted load forecasts. Also, the service territories of the three public utilities in North Carolina extend beyond the borders of the state so state specific load forecasts were not available in these filings. Because of the incomplete nature of the load information that is publicly available for North Carolina, we opted to derive a North Carolina state load forecast using a combination of historical utility retail sales as reported to the EIA and the estimated growth derived from the 2007 IRPs.[1] We used the IRP forecasts to determine the annual growth rate for each utility and for the municipals and cooperatives. The growth rates were applied to North Carolina specific electricity demand data that is reported to the EIA. The most recent available data from the EIA was for 2006 (Table 1). Figure 1 and Table 2 show the resulting load forecasts.

**Table 1 - EIA Reported 2006 Retail Sales in North Carolina**

| | Retail Sales (GWh) |
|---:|---:|
| Municipalities and Cooperatives | 31,377 |
| Dominion | 4,172 |
| Progress | 36,225 |
| Duke | 54,919 |
| **Total** | **126,693** |

**Figure 1 - North Carolina Forecasted Retail Sales by Entity**




[1] In the developing the load growth estimates, we used the utilities' load forecasts before energy efficiency and conservation measures are netted out, when such distinctions were available.

**Table 2 - North Carolina Forecasted Retail Sales by Entity**

| North Carolina Forecasted Retail Sales (GWh) | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|
| Municipals and Coops | 36,023 | 36,862 | 37,720 | 38,598 | 39,497 | 40,416 | 41,357 | 42,320 | 43,305 | 44,314 |
| Dominion | 4,646 | 4,730 | 4,816 | 4,903 | 4,992 | 5,082 | 5,174 | 5,268 | 5,363 | 5,460 |
| Progress | 39,583 | 40,172 | 40,770 | 41,376 | 41,992 | 42,617 | 43,251 | 43,895 | 44,548 | 45,211 |
| Duke | 60,146 | 61,064 | 61,997 | 62,943 | 63,905 | 64,880 | 65,871 | 66,877 | 67,898 | 68,935 |
| **Total** | **140,398** | **142,828** | **145,303** | **147,821** | **150,386** | **152,996** | **155,654** | **158,360** | **161,115** | **163,920** |

## *2.2 REPS Demand*

The Renewable Energy and Energy Efficiency Portfolio Standard (REPS) requires all retail electricity providers to supply a certain percentage of total retail energy sales from new renewable resources. The legislation distinguishes between the requirements for municipalities/cooperatives and public utilities (investor owned utilities). Table 3 provides these two separate targets.

**Table 3 - North Carolina REPS Requirements**

**(% of Total Retail Sales)**

| Year | Public Utilities (IOUs) | Municipalities and Cooperatives |
|---|---|---|
| **2012** | 3% | 3% |
| **2013** | 3% | 3% |
| **2014** | 3% | 3% |
| **2015** | 6% | 6% |
| **2016** | 6% | 6% |
| **2017** | 6% | 6% |
| **2018** | 10% | 10% |
| **2019** | 10% | 10% |
| **2020** | 10% | 10% |
| **2021** | 12.5% | 10% |

In addition to modeling these REPS targets, we incorporated special treatment for certain resources. For example, there are requirements for portions of the REPS to be fulfilled exclusively from solar, swine waste, and poultry waste resources (these are referred to as "carve-outs"). There are allowances for a portion of the REPS to be satisfied by implementing energy efficiency programs. Furthermore, municipalities and cooperatives are allowed to satisfy up to 30% of their REPS requirement from hydro facilities larger than 10 MW without a vintage requirement. Finally, although retail electric providers can meet up to 25% of their renewable obligation with out of state resources, we assume all is sourced from within North Carolina.

The REPS requirements follow stepped increases in the years 2012, 2015, 2018 and 2021, so we focused the analysis on these years. The following table shows the detailed REPS requirements for the study years. Note the slightly different treatment of the municipals and public utilities.

**Table 4 - REPS Requirements with Carve-Outs and Allowances**

| Public Utility REPS Demand | 2012 | 2015 | 2018 | 2021 |
|---|---|---|---|---|
| **REPS Requirements (% of Total Retail Sales)** | 3% | 6% | 10% | 12.5% |
| **Total REPS Requirements (GWh)** | 3,084 | 6,455 | 11,258 | 14,726 |
| | | | | |
| **Specified Carve-Outs and Allowances** | | | | |
| Solar (% of Retail Sales) | 0.07% | 0.14% | 0.20% | 0.20% |
| Swine Waste (% of Retail Sales) | 0.07% | 0.14% | 0.20% | 0.20% |
| Poultry Waste by IOUs (GWh)* | 85 | 450 | 450 | 450 |
| Energy Efficiency (% of REPS Requirement)** | 25% | 25% | 25% | 40% |

| Municipality and Cooperative REPS Demand | 2012 | 2015 | 2018 | 2021 |
|---|---|---|---|---|
| **REPS Requirements (% of Total Retail Sales)** | 3% | 6% | 10% | 10.0% |
| **Total REPS Requirements (GWh)** | 1,056 | 2,263 | 4,042 | 4,331 |
| | | | | |
| **Specified Carve-Outs and Allowances** | | | | |
| Solar (% of Retail Sales) | 0.07% | 0.14% | 0.20% | 0.20% |
| Swine Waste (% of Retail Sales) | 0.07% | 0.14% | 0.20% | 0.20% |
| Poultry Waste by MuniCoops (GWh)* | 85 | 450 | 450 | 450 |
| DSM and Energy Efficiency(% of REPS Requirement)** | 25% | 25% | 25% | 25% |
| Large Hydro (% of REPS Requirement) | 30% | 30% | 30% | 30% |

*This carve-out was specified in GWh but was not allocated between utilities and munis/coops; we assumed a 50/50 split.

**Assumed to be 100% energy efficiency.

| Total REPS Demand | 2012 | 2015 | 2018 | 2021 |
|---|---|---|---|---|
| **Total Combined REPS Requirements (GWh)** | **4,140** | **8,718** | **15,300** | **19,057** |
| | | | | |
| **Combined Carve-Outs and Allowances (GWh)** | | | | |
| Solar | 97 | 203 | 306 | 322 |
| Swine Waste | 97 | 203 | 306 | 322 |
| Poultry Waste | 170 | 900 | 900 | 900 |
| Energy Efficiency | 1,035 | 2,180 | 3,825 | 6,973 |
| Large Hydro | 317 | 679 | 1,212 | 1,299 |
| **Total Carve-Outs and Allowances** | **1,715** | **4,165** | **6,549** | **9,817** |
| | | | | |
| **Cumulative Combined REPS Requirements Net of Carve Outs and Allowances (GWh)** | **2,425** | **4,553** | **8,750** | **9,240** |

To develop the net combined REPS demand of public utilities and municipalities/cooperatives for "clearing" the renewable supply model, we subtracted out the REPS carve-outs and the maximum large hydro and maximum energy efficiency allowances from the total REPS demand. We assumed that the portion of the requirement that municipalities/cooperatives met with generation from large hydro would come from existing hydro facilities. This demand would not contribute to incremental new hydro in North Carolina so the amount attributable to large hydro is deducted from the Municipalities and Cooperatives' REPS demand. Similarly, we assumed that the utilities would seek to maximize energy efficiency measures, so the associated demand was also deducted from the net demand for renewables "clearing" purposes.

## *2.3 Renewable Resources*

Resources such as solar, swine waste and poultry waste that were previously included in the renewables supply curve were removed because they are used to satisfy the carve-out requirements. Additionally, new hydro facilities larger than 10 MW were removed because only municipalities/cooperatives can use hydro of this size to satisfy their requirements and it is assumed that existing facilities will be used, as described previously. Otherwise, all other assumptions associated with renewable resources (MW potential, modeled size, cost, performance, etc) remain the same as the 2006 NC Study.[2] A summary of the resource assumptions is presented in Table 5.

**Table 5 - Resource Potential and Cost Assumptions for Renewables Supply Curve**

| Resources (Technology) | Practical Resource Potential | Modeled Size | Installed Cost | Fixed O&M | Variable O&M | Heat Rate | Fuel Cost | PTC |
|---|---|---|---|---|---|---|---|---|
| *(Costs in 2006$)* | MW | MW | $/kW | $/kW-year | $/MWh | btu/ kWh | $/mmbtu | |
| **Renewable Technologies** | | | | | | | | |
| Eastern Wind Farm | 500 | 30 | $1,700 | $45 | $2 | - | - | 100% |
| Eastern Wind Cluster | | 5 | $2,000 | $55 | $2 | - | - | 100% |
| Eastern Offshore Wind | 2000 | 50 | $2,400 | $65 | $2 | - | - | 100% |
| Western Wind Farm | 1000 | 30 | $1,700 | $45 | $2 | - | - | 100% |
| Western Wind Cluster | | 5 | $2,000 | $55 | $2 | - | - | 100% |
| Biomass (Co-Fire with Coal) | 950-1240 | 20 | $75-$230 | $12 | $5 | 12,000 | $2-$3 | - |
| Biomass (Stoker) | | 25 | $2,700 | $75 | $10 | 13,000 | $2-$3 | 50% |
| Biomass (Fluidized Bed) | | 25 | $3,000 | $75 | $10 | 13,800 | $2-$3 | 50% |
| Biomass (Gasification) | | 25 | $3,700 | $100 | $10 | 12,500 | $2-$3 | 50% |
| Incremental Hydro | 13 | 13 | $1,100 | - | $3 | - | - | 50% |
| Hydro without Power* | 50 (300) | 2.5 (25) | $3,300($2,750) | $20($10) | $5($3) | - | - | 50% |
| Undeveloped Hydro* | 15 (30) | 2.5 (30) | $4,400($3,850) | $20($10) | $5($3) | - | - | 50% |
| Landfill Gas (ICE) | 150 | 5 | $1,450 | $200 | - | 12,000 | - | 50% |
| Poultry Litter (Stoker)** | | 35 | $2,927 | $100 | - | 13,000 | $2.25 | 50% |
| Swine Waste (Anaerobic Digester)** | | 100 kW | $3,333 | $270 | - | 14,000 | - | 50% |
| Solar (Photovoltaic)** | | 2-25 kW | $8,000 | $75 | - | - | - | - |
| **Conventional Technologies** | | | | | | | | |
| Pulverized Coal | | 750 | $1,750 | $30 | $5 | 9,100 | | - |
| Gas Combined Cycle | | 250 | $700 | $12 | $2 | 7,000 | | - |
| Gas Combustion Turbine | | 150 | $500 | $12 | $8 | 10,200 | | - |

*Numbers in parenthesis represents larger size projects, which are excluded from the renewables supply curve.
**Resources not included in the supply curve because the NC REPS has specific carve-out provisions for these resources.

Using the REPS demand net of carve-outs and allowances to "clear" the renewables supply curve, the resulting renewable capacity and energy generation mix for the study years are shown in the following figures and tables.

[2] We recognize that generation costs have increased since the 2006 study, but for consistency and timeliness we continue to use assumptions developed at the time of the 2006 study.

**Figure 2 - Cumulative Renewable Capacity Additions and Energy Efficiency Contributions**

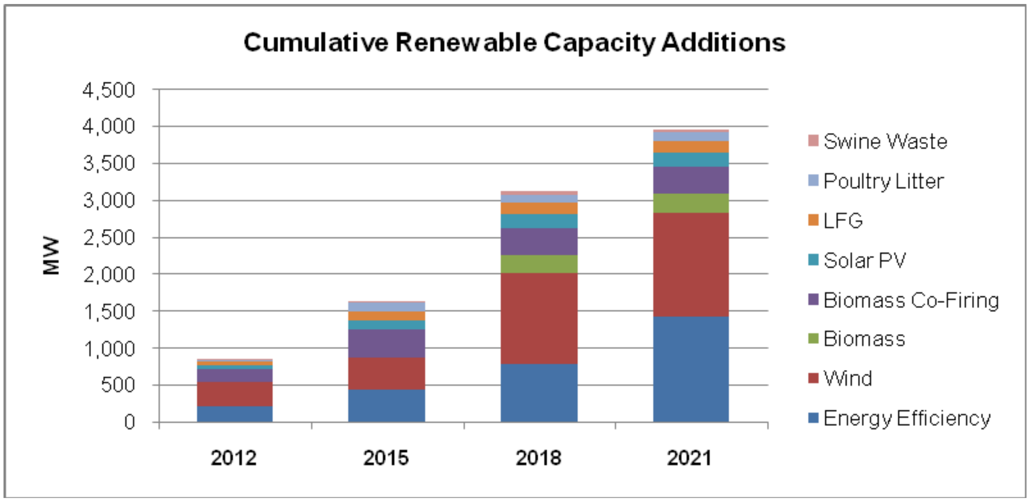



**Table 6 - Cumulative Renewable Capacity Additions and Energy Efficiency Contributions**

| Cumulative Renewable Capacity Additions (MW) | 2012 | 2015 | 2018 | 2021 |
|---|---|---|---|---|
| Energy Efficiency | 210 | 443 | 778 | 1,417 |
| Solar PV | 58 | 122 | 184 | 194 |
| Poultry Litter | 22 | 114 | 114 | 114 |
| Swine Waste | 15 | 31 | 47 | 49 |
| Large Hydro* | 0 | 0 | 0 | 0 |
| Wind | 324 | 428 | 1,230 | 1,421 |
| Biomass | 0 | 0 | 247 | 247 |
| Biomass Co-Firing** | 180 | 376 | 376 | 376 |
| LFG | 50 | 125 | 150 | 150 |
| **Total** | **859** | **1,639** | **3,125** | **3,967** |

*Assumed Munis/Coops will use existing resources to fulfill their 30% Large Hydro Allowance.
**Co-firing does not contribute incremental capacity.

**Figure 3 - Cumulative Annual Energy from Renewable Additions and Energy Efficiency Contributions**

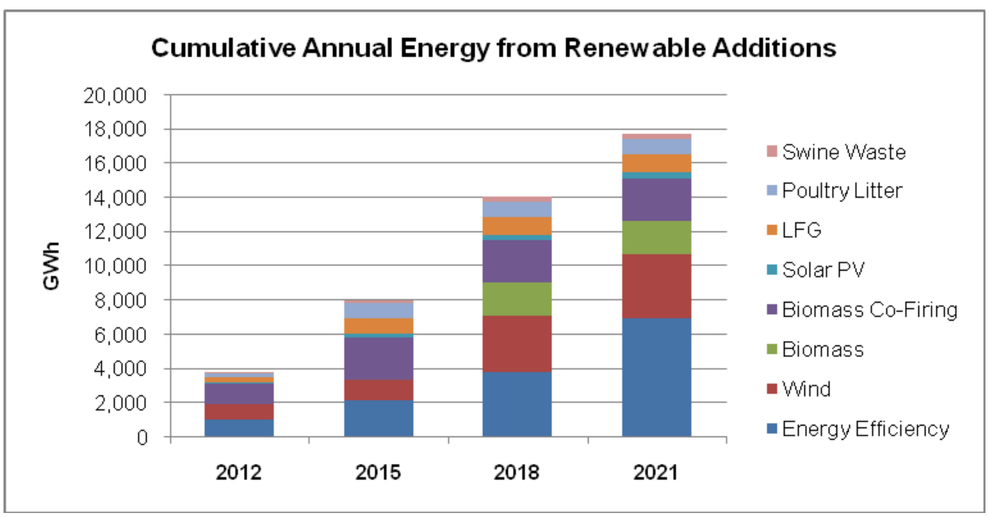


**Table 7 - Cumulative Annual Energy from Renewable Additions and Energy Efficiency Contributions**

| Cumulative Annual Energy from Renewable Additions (GWh) | 2012 | 2015 | 2018 | 2021 |
|---|---|---|---|---|
| Energy Efficiency | 1,035 | 2,180 | 3,825 | 6,973 |
| Solar PV | 97 | 203 | 306 | 322 |
| Poultry Litter | 170 | 900 | 900 | 900 |
| Swine Waste | 97 | 203 | 306 | 322 |
| Large Hydro (from exisitng facilities)* | 317 | 679 | 1,212 | 1,299 |
| **Total from Carve-Outs and Allowances** | **1,715** | **4,165** | **6,549** | **9,817** |
| | | | | |
| Wind | 892 | 1,207 | 3,285 | 3,775 |
| Biomass | 0 | 0 | 1,944 | 1,944 |
| Biomass Co-Firing | 1,183 | 2,470 | 2,470 | 2,470 |
| LFG | 350 | 876 | 1,051 | 1,051 |
| **Total from Supply Curve** | **2,425** | **4,553** | **8,750** | **9,240** |
| | | | | |
| **REPS Total** | **4,140** | **8,718** | **15,300** | **19,057** |

*Assumed Munis/Coops will use existing resources to fulfill their 30% Large Hydro Allowance. The assumed contribution of Large Hydro towards meeting total REPS demand is not included in Figure 3.

# 3. Comparing Generation Portfolios

As we described in the introduction section, in order to determine the cost impact of an REPS to ratepayers, we must compare a portfolio comprised of conventional new generation, as proposed by the utilities in the state, with a Revised Portfolio that contains both REPS resources and conventional generation. We used the 2007 IRPs filed by the utilities to determine the combined resource plan for new conventional generating capacity to meet growing system needs (Utilities' Portfolio). Figure 4 and Table 8 depict the amount of capacity by type (peaker, intermediate and baseload)[3] by year as well as the estimated energy generation associated with that expansion.

[3] For resources described as "peaker/intermediate" found in the IRPs, we assumed that 50% would be intermediate (combined-cycle) and 50% would be peaking (combustion turbines) units. For "undesignated" resources found in the IRPs, we assumed that near-term, smaller capacity additions would likely be peakers and larger additions in later years would be baseload units.

**Figure 4 - Combined Utilities' Capacity Expansion Plans and Associated Energy**

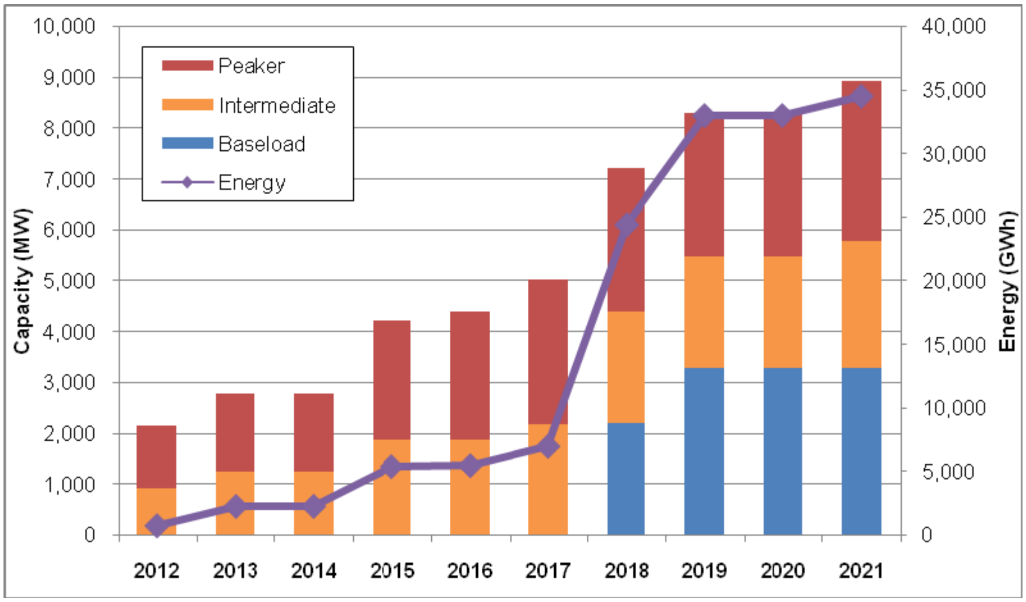



**Table 8 - Combined Utilities' Capacity Expansion Plans and Associated Energy**

| Combined Utilities' Capacity and Energy Expansion Plans | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|
| Peaker (MW) | 1,232 | 1,548 | 1,548 | 2,348 | 2,516 | 2,832 | 2,832 | 2,832 | 2,832 | 3,149 |
| Intermediate (MW) | 935 | 1,250 | 1,250 | 1,883 | 1,883 | 2,198 | 2,198 | 2,198 | 2,198 | 2,513 |
| Baseload (MW) | 0 | 0 | 0 | 0 | 0 | 0 | 2,205 | 3,293 | 3,293 | 3,293 |
| **Total Capacity Additions (MW)** | **2,167** | **2,798** | **2,798** | **4,230** | **4,398** | **5,030** | **7,235** | **8,322** | **8,322** | **8,954** |
| **Energy (GWh)** | **791** | **2,309** | **2,309** | **5,430** | **5,503** | **7,022** | **24,406** | **32,980** | **32,980** | **34,498** |

After "clearing" the supply model with the REPS demand, we use the cleared renewable resources to determine how much conventional generation the renewable resources/energy efficiency measures can offset and what the resulting Revised Portfolio mix.[4] We included all the "firm" renewables that cleared the supply model, including carve-out resources, as well as the expected energy efficiency measures[5] into the expansion plan. The Revised Portfolio mix is shown in Figure 5 and Table 9. The Revised Portfolio is surplus in energy because the energy associated with the REPS includes the generation from non-firm renewable resources.[6]

[4] LFG, poultry litter, swine waste, and biomass are considered firm resources whereas solar, hydro, and wind resources are dependent on weather conditions and are not firm. Energy efficiency measures are assumed to have a 50% load factor.

[5] Costs for energy efficiency measures are assumed to occur in the year the measure is implemented; EE costs are not amortized over the life of the measure.

[6] Surplus energy is valued at marginal avoided cost, which is the same as the 2006 NC RPS study.

**Figure 5 - Capacity Expansion for Revised Portfolio**

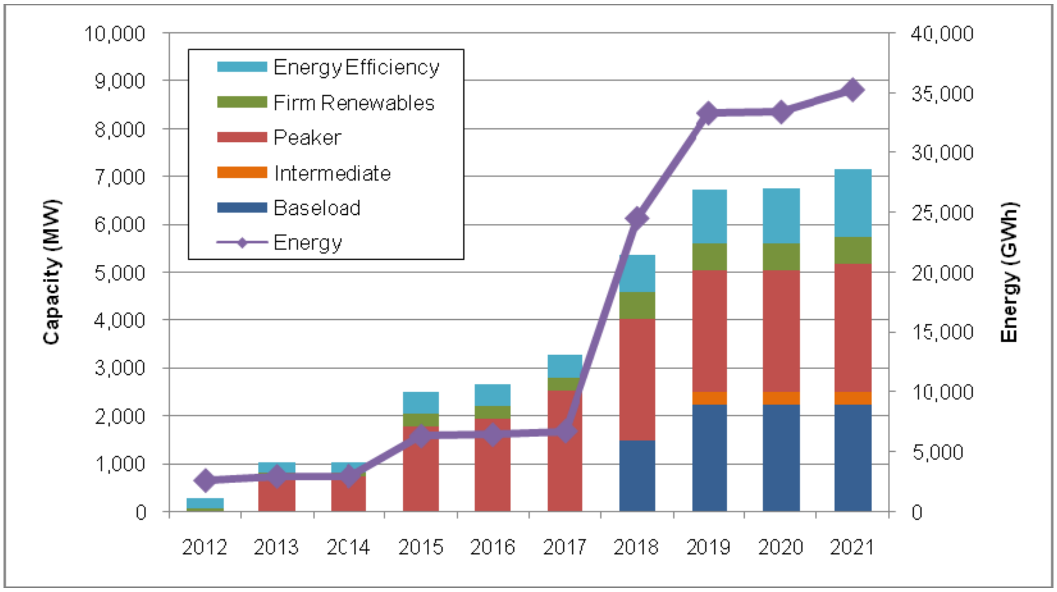
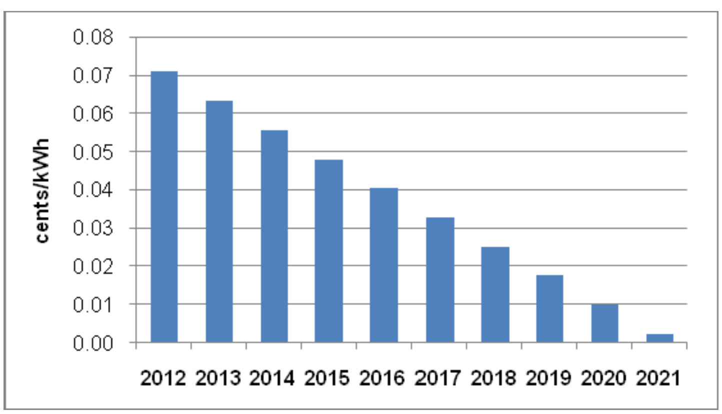



**Table 9 - Capacity Expansion for Revised Portfolio**

| Combined Capacity and Energy Expansion Plans with REPS | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|
| Peaker (MW) | 0 | 750 | 750 | 1,800 | 1,950 | 2,550 | 2,550 | 2,550 | 2,550 | 2,700 |
| Intermediate (MW) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 250 | 250 | 250 |
| Baseload (MW) | 0 | 0 | 0 | 0 | 0 | 0 | 1,500 | 2,250 | 2,250 | 2,250 |
| Firm Renewable Capacity Additions (MW) | 86 | 86 | 86 | 270 | 270 | 270 | 557 | 557 | 557 | 560 |
| REPS Energy Efficiency (MW) | 210 | 214 | 218 | 443 | 451 | 459 | 778 | 1,139 | 1,159 | 1,417 |
| **Total Capacity Additions (MW)** | **297** | **1,050** | **1,054** | **2,513** | **2,671** | **3,279** | **5,385** | **6,747** | **6,766** | **7,177** |
| **Energy (GWh)** | **2,641** | **2,987** | **3,005** | **6,357** | **6,461** | **6,762** | **24,560** | **33,349** | **33,442** | **35,304** |

Figure 6 shows the projected rate impact of the Revised Portfolio compared to the Utilities' Portfolio.

**Figure 6 - Projected Rate Impact from Revised Portfolio**



# 4. Economic Impact

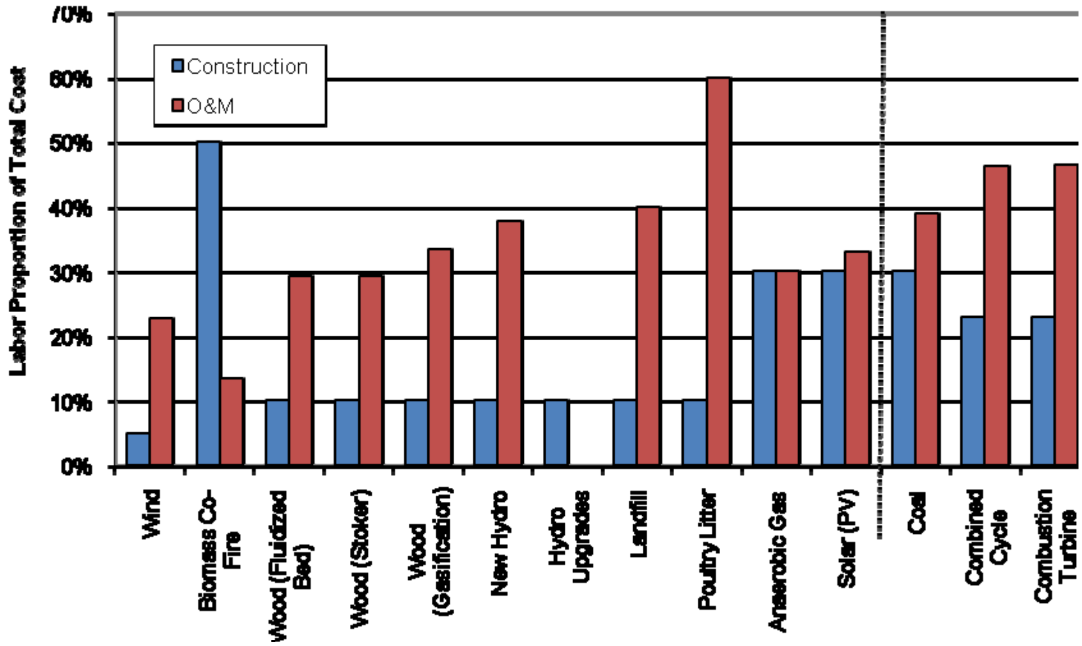
IMPLAN, an input-output economic model, was used to analyze the impacts of the REPS on North Carolina's economy.[7] We assessed the economic impacts, measured in job-years, from the addition of renewable energy facilities and the development of local-sourced biomass fuels. This is offset by a reduction in jobs associated with less development of conventional generation. We also considered the economic impact of increases to electricity rates. We examined the net change in jobs-years for the study years 2012, 2018 and 2021, by comparing the difference in economic impact of the Utilities' Portfolio and the Revised Portfolio. The following section summarizes the economic analysis approach and results. (See Appendix A for a more detailed description of the economic modeling.) The net results of the economic impact of North Carolina's REPS are presented in Section 5.

## *4.1 Economic Impact of Increased Renewables*

The IMPLAN model was utilized to measure the economic impacts of an REPS in two steps: 1) estimate the economic job impact of each of the renewable resources and energy efficiency measures for the REPS based on the costs associated with each resource and 2) calculate the difference in jobs creation between the two portfolios—Utilities' Portfolio vs. Revised Portfolio. The first step provides the estimated job impacts for individual resources. The latter demonstrates the effective net gain or loss of jobs due to implementation of the REPS in lieu of a conventional generation portfolio. As an input, we developed estimates of the portion of capital and O&M costs that are directly attributable to labor, as shown in Figure 7, to estimate the impact of labor spending in specific sectors.

[7] The USDA Forest Service in the mid-70s developed IMPLAN for community impact analysis. The current IMPLAN input-output database and model is maintained and sold by MIG, Inc (Minnesota IMPLAN Group). Over 1,500 clients across the country use the IMPLAN model, making the results acceptable in inter-agency analysis. GDS Associates, a subcontractor to La Capra Associates for this study, is a registered and licensed user of the IMPLAN model.

**Figure 7 - Assumed Labor Portion of Costs by Resource Type**




Depending on the resource type, as shown in Figure 7, the portion of costs associated with labor is different. Construction and O&M spending are assigned to "Other New Construction" and "Power Generation & Supply" sectors respectively. Additionally, collection and harvest of biomass fuels will also contribute to the Animal Production Excl Cattle & Poultry (for swine waste)[8] and Logging & Forestry (for woody biomass) sectors.

The sectors impacted by the implementation of energy efficiency measures are quite varied, depending on the target customer group. The allocation of spending by sector is detailed in Table 10 for each customer group. We assumed spending would be 35.5% for Residential, 47.7% for Commercial, and 16.8% for Industrial customers.

**Table 10 - Breakdown of Energy Efficiency Equipment Costs**

| | Residential | Commercial | Industrial |
|---|---|---|---|
| **Percent of Total Costs by Sector** | **35.5%** | **47.7%** | **16.8%** |
| Lubricants Manufacturing | | | 12.5% |
| AC, Refrigeration, & Forced Air Heating Manufacturing | | 12.5% | 12.5% |
| Electric Lamp Bulb and Part Manufacturing | | | 12.5% |
| Lighting Fixture Manufacturing | | 12.5% | 12.5% |
| Electric Power & Specialty Transformer Manufacturing | | 12.5% | 12.5% |
| Motor & Generator Manufacturing | | | 12.5% |
| Relay and Industrial Control Manufacturing | | | 12.5% |
| Wholesale Trade | | 12.5% | 12.5% |
| Building Material & Garden Supply Store | 50.0% | 25.0% | |
| General Merchandise Stores | 50.0% | 25.0% | |
| Total by Sector | 100.0% | 100.0% | 100.0% |

[8] Jobs created through transportation of the poultry litter to potential biomass plants would likely offset existing jobs related to waste management and field application of the resource. See Appendix A – Description of Economic Analysis for more details.

The IMPLAN model then estimated the jobs created within each sector in three ways: direct jobs, indirect jobs, and induced jobs. The direct jobs are those jobs created for the impacted sector. The indirect jobs are estimated using state-specific multipliers that impact other sectors due to an increase in direct jobs. Finally, induced jobs are those jobs generated by the fact that local households have more disposable income available for personal consumption due to increased economic activity. These job impacts are specific to North Carolina.

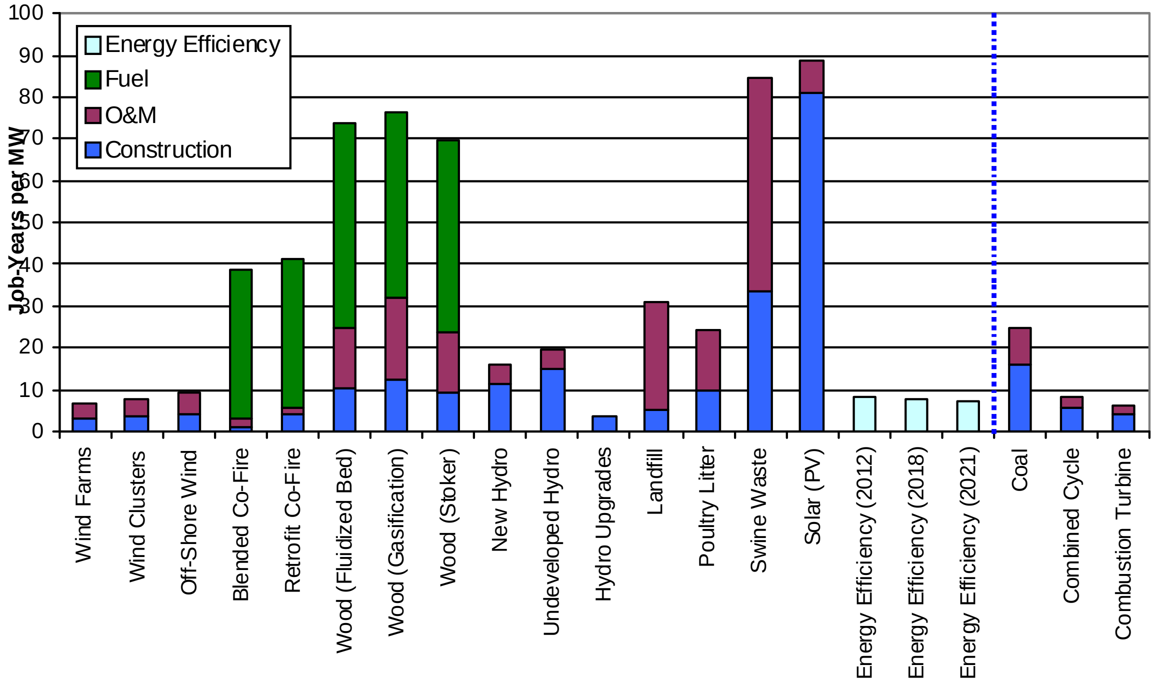
The IMPLAN model provides job impacts for a single expenditure in a single year. Table 11 shows the relationship between direct and indirect plus induced jobs for the various sectors used in this impact analysis.

**Table 11 - Relationship of Direct Jobs to Indirect and Induced Jobs by Industrial Sector**

| Sector | Direct Jobs | Indirect & Induced Jobs |
|---|---|---|
| Other New Construction | 1 | 0.28 |
| Power Generation & Supply | 1 | 0.81 |
| Animal Production Excl Cattle & Poultry | 1 | 0.31 |
| Logging & Forestry | 1 | 1.10 |
| Lubricants Manufacturing | 1 | 3.19 |
| AC, Refrigeration, & Forced Air Heating Manufacturing | 1 | 1.44 |
| Electric Lamp Bulb and Part Manufacturing | 1 | 1.33 |
| Lighting Fixture Manufacturing | 1 | 1.12 |
| Electric Power & Specialty Transformer Manufacturing | 1 | 1.48 |
| Motor & Generator Manufacturing | 1 | 1.04 |
| Relay and Industrial Control Manufacturing | 1 | 1.46 |
| Wholesale Trade | 1 | 0.71 |
| Building Material & Garden Supply Stores | 1 | 0.37 |
| General Merchandise Stores | 1 | 0.22 |

Since lead times on construction vary by resource, we converted the jobs from IMPLAN output into job-years to facilitate comparison. The results in job-years per MW by resource are provided in Figure 8, assuming a twenty-year operations horizon for O&M and fuel. The job-years impact from operations would be greater if the years of operation were extended, and less if the years were shortened. The energy efficiency impact shown for 2021 reflects the cumulative effect of ten years of the program. Typically, there is no ongoing O&M expenditures associated with energy efficiency measures, once implemented, so the economic impact reflects the implementation cost only.

**Figure 8 - Job-Years per MW by Resource Type**




From these individual resource assessments, we can conclude the following:

- Solar PV and Swine Waste (using anaerobic digesters) create the most jobs per MW because of the relatively small size of each installation and the larger portion of the installation cost being attributable to labor.

- Biomass wood generation and co-firing create the next most jobs primarily from sourcing fuel from within North Carolina.

- Wind and hydro generation do not provide as many jobs per MW as other renewable resources because they do not require a fuel input. However, if the capacity factor of the resources were taken into account, the job impact per Average MW would be more significant for wind and hydro resources (about three times higher for wind and two times higher for hydro).

- Jobs per MW created by energy efficiency measures are similar to wind and hydro because the labor is only associated with the initial sale and installation of the measure and there is no ongoing O&M.

- Coal generation actually creates more construction job-years per MW than some of the alternative options (except for solar PV and anaerobic digesters) primarily because the construction time frame for coal generation is 4-5 years compared to much shorter construction lead times for renewables. For example, wind projects take 6-9 months, landfill gas take 3-4 months, and even greenfield biomass projects are expected to take about 2-2.5 years. However, since North Carolina does not have indigenous fossil fuels, the sourcing of fuel does not contribute to the state's economy.

## *4.2 Economic Impact of Rate Increases*

To start, basic economic theory specifies that increases in costs to consumers, typically, result in some reduction in demand. The magnitude of that reduction is determined by the elasticity of demand. Based on previous work by the NC Department of Commerce, the elasticity of demand for electricity rates was found to be negative 0.01 (for every 1 percent increase in electricity rates, there is a 0.01 percent decline in demand).[9] Thus, the increase in rates of 0.05 to 0.08 cents per kWh has only a slight impact on demand. However, the increased cost of energy may impact a consumer's disposable income, which can affect the rest of the economy.

There are two ways to consider the economic impact of rate increases. On one hand, an increase in electricity rates due to the REPS implies that households have less available funds for spending in other parts of the economy, resulting in a decline in jobs. On the other hand, although the rate will increase slightly, energy efficiency programs should reduce energy consumption on average, resulting in very little net impact on consumers' bills. The latter approach was what was used in the 2006 NC RPS Study, resulting in no job losses due to rate increases. In this update, we show the impact of both approaches in the next section.

**Figure 9 - Maximum Job-Years Lost From Price Impacts of REPS**

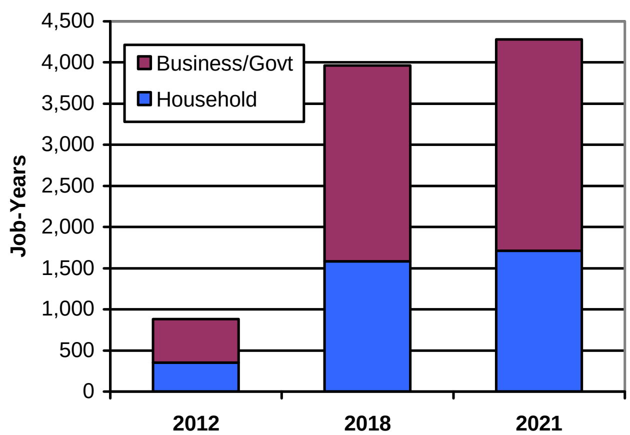



**Table 12- Maximum Job-Years Lost Through Price Impacts of REPS**

| Year | Average Price Increase (2008 ¢/kWh) | Household Income Impacts | Business & Government Impacts | Total Job-Years Lost |
|---|---|---|---|---|
| 2012 | 0.071 | 352 | 528 | 880 |
| 2018 | 0.048 | 1,585 | 2,378 | 3,963 |
| 2021 | 0.037 | 1,711 | 2,568 | 4,279 |

# 5. Results

The results of the economic analysis are shown in Figure 10 (for 2012), Figure 11 (for 2018), and Figure 12 (for 2021). The figures reflect the net increase in job-years related to renewable generation and energy efficiency, the net decrease in job-years related to displacement of

[9] The long term electricity price elasticity for North Carolina used in this study was determined by the North Carolina Department of Commerce using the Regional Economic Models Inc (REMI) economic model.

conventional generation units, the maximum job-years lost due to rate impact, and finally the net change of the combined impacts (For detail results see Appendix B). The 2012 RPS Portfolio produces a net gain, considering rate impact, for the North Carolina economy of about 15,400 job-years over a twenty-year operating time frame or, on average, about 770 jobs per year. If we assume that there would be no rate impacts, due to energy efficiency offsetting rate increases, the economy is estimated to experience over 16,300 job-years, or about 813 jobs per year. In 2018 the net gain is about 44,500 job-years or about 2,222 jobs which rises to 48,400 job-years or about 2,420 jobs if rate impacts are not considered. Finally, by 2021 the REPS produces a net gain of about 41,000 job-years, or 2,050 jobs per year over twenty years. The impact is greater at almost 45,300 jobs-year, or 2,260 jobs per year over twenty years, if no rate impact was assumed. The total net gain by 2021 is less than by 2018 because more conventional generation is being offset in the later years. These results are detailed in Figure 10, Figure 11, Figure 12, and Table 13.

**Figure 10 - Net Job Impact in Job-Years for Revised Portfolio in 2012**

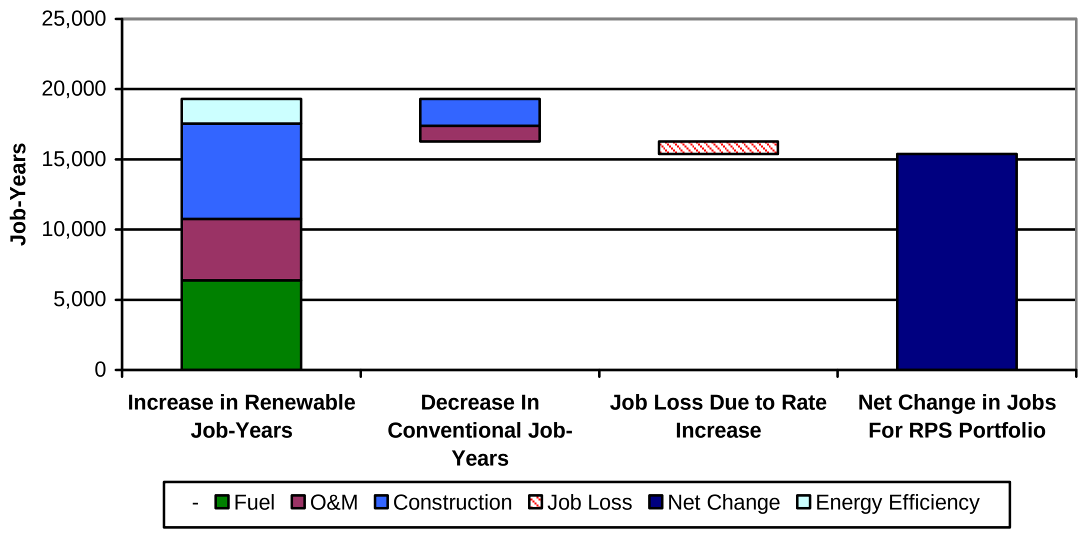


**Figure 11 - Net Job Impact in Job-Years for Revised Portfolio in 2018**

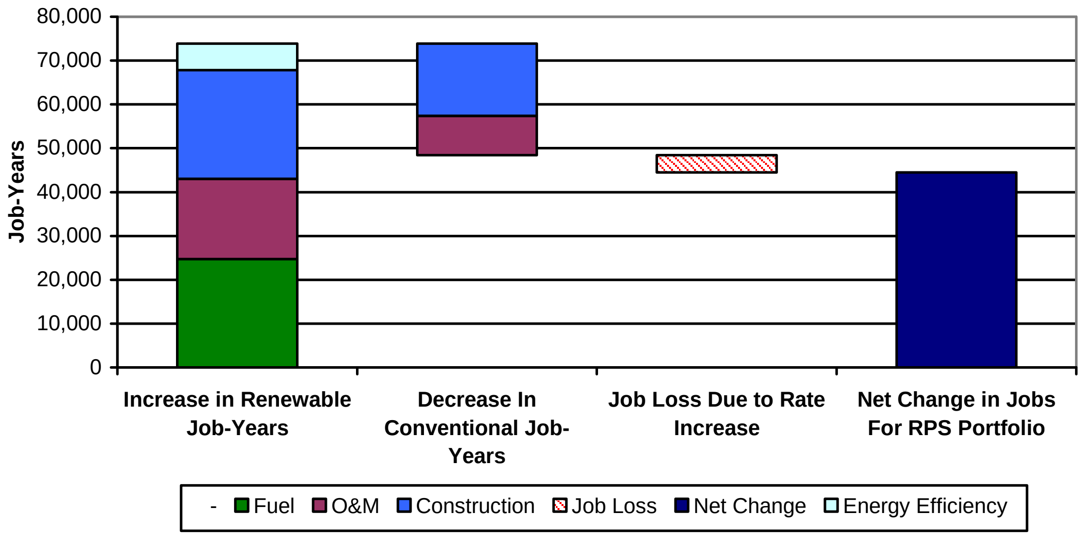



**Figure 12 - Net Job Impact in Job-Years for Revised Portfolio in 2021**

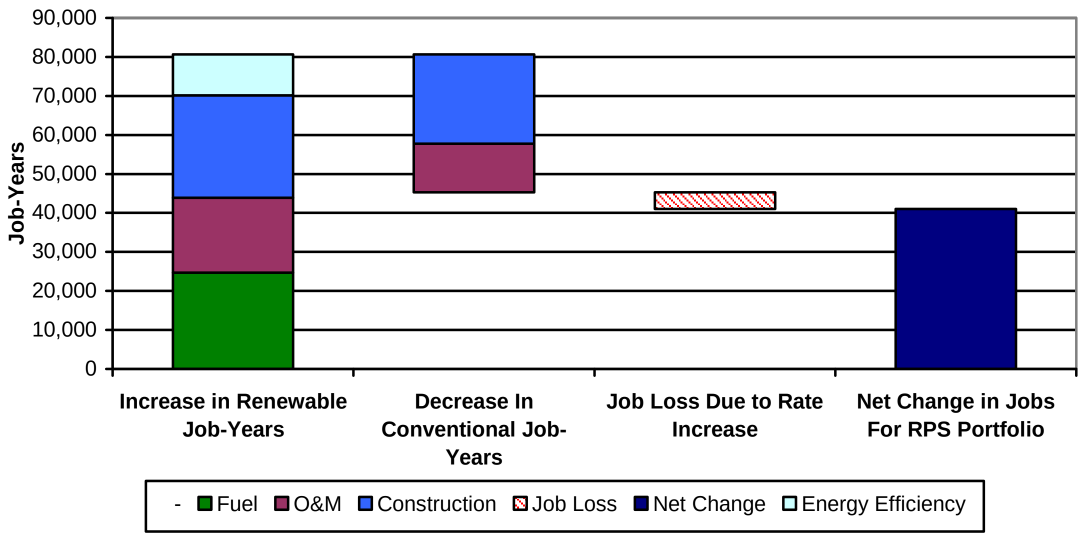



**Table 13 - Net Job-Years Gained by Revised Portfolio Compared to Utilities' Portfolio**

| Year | Renewable and EE Job-Years Added | Conventional Job-Years Replaced | Net Gain/(Loss) in Job-Years Without Rate Impact | Loss of Jobs Through Rate Increases | Net Gain/(Loss) in Job-Years |
|---|---|---|---|---|---|
| 2012 | 19,308 | (3,039) | 16,269 | (880) | 15,389 |
| 2018 | 73,849 | (25,432) | 48,417 | (3,963) | 44,454 |
| 2021 | 80,681 | (35,417) | 45,264 | (4,278) | 40,986 |

# Appendix A – Description of Economic Analysis

## *Economic Analysis of Increased Renewables*

The IMPLAN model was utilized to measure job impacts in two ways: 1) the average expected jobs per MW produced by construction and operation (O&M) of various resources; and 2) the net job impact of the RPS Portfolio versus the conventional Utility Portfolio. The first output provides comparative job impacts between resources. The latter demonstrates the effective net gain or loss of jobs due to implementation of the RPS in lieu of a conventional generation.

Development of the IMPLAN model inputs requires two primary tasks: 1) development of total construction, operation and maintenance, and fuel costs for each resource; and 2) determination of the amount of these costs that would be spent in North Carolina. Total construction costs are based on assumptions of installed cost per kW by resource. O&M and fuel costs are based on assumed capacity factors, heat rates, and fixed and variable costs per unit used in the 2006 RPS Study. All of these input assumptions were developed outside of the IMPLAN model. For this analysis, it has been assumed that only the labor portion of construction and O&M for each of the resources would impact the North Carolina economy, because material and supplies and other capital expenditures would be made outside of the State and would therefore not impact the local economy. *This is likely a conservative assumption, but it was not possible to properly estimate how non-labor costs would be distributed within or outside the State, given the construct of the model.*

Since the IMPLAN database does not have customized sectors for renewable energy generation, general assumptions were made regarding construction and O&M jobs. To the extent possible, fuel assumptions would impact their respective sectors beyond just labor additions.

- All construction labor spending associated with any of the generation technologies were assumed to impact the "Other Construction Sector".
- O&M labor spending for most generation technologies was assumed to impact the "Power Generation and Supply Sector," with the exception that anaerobic digester O&M would likely impact the "Animal Production" sector.
- Fuel input costs for biomass co-firing and biomass wood resources would directly contribute to the North Carolina's economy as a result of a strong logging industry presence and the assumption that biomass wood resources would be sourced from within the State. Therefore, much of the biomass fuel expenditures (90%) were assumed to benefit the "Logging and Forestry Sector." The remaining 10% of biomass fuel cost, representing diesel fuel used in hauling and transporting the biomass, was assumed to be leakage.[10]

[10] Leakages are payments made for imported goods or to sectors which do not in turn re-spend the dollars within the state. Leaked dollars therefore can have no impact on the local economy.

- Another fuel source, poultry litter, can also be sourced completely from in-state poultry farms, but the jobs created through transportation of the resource to potential biomass plants would likely offset existing jobs related to waste management and field application of poultry litter (see Appendix E of the 2006 North Carolina RPS Study). Therefore, transportation of poultry litter fuel was assumed to have no net impact on the State economy and jobs.

- Fuel costs associated with conventional fossil fuel resources are assumed to have no impact on the State as there are no in-state extraction activity of these coal and natural gas and would need to be imported . It was assumed that the transportation of conventional fuels within the State would not contribute to the local economy in terms of jobs, since the payments for delivery of conventional fuels are often paid to entities outside of North Carolina.

- Labor associated with administration of an energy efficiency program was assigned to the "Power Generation and Supply Sector."

- The remaining equipment cost of the energy efficiency program was assigned first to residential, commercial, and industrial programs and then further assigned to various sectors (See Table 10 for the breakdown). It is assumed that commercial and industrial customers can take advantage of wholesale sources. The industries were selected to match the types of energy efficiency equipment targeted for each classification.

**Table 10 - Breakdown of Energy Efficiency Equipment Costs**

| | Residential | Commercial | Industrial |
|---|---|---|---|
| **Percent of Total Costs by Sector** | **35.5%** | **47.7%** | **16.8%** |
| Lubricants Manufacturing | | | 12.5% |
| AC, Refrigeration, & Forced Air Heating Manufacturing | | 12.5% | 12.5% |
| Electric Lamp Bulb and Part Manufacturing | | | 12.5% |
| Lighting Fixture Manufacturing | | 12.5% | 12.5% |
| Electric Power & Specialty Transformer Manufacturing | | 12.5% | 12.5% |
| Motor & Generator Manufacturing | | | 12.5% |
| Relay and Industrial Control Manufacturing | | | 12.5% |
| Wholesale Trade | | 12.5% | 12.5% |
| Building Material & Garden Supply Store | 50.0% | 25.0% | |
| General Merchandise Stores | 50.0% | 25.0% | |
| Total by Sector | 100.0% | 100.0% | 100.0% |

The first three sectors in Table 11 are used to show impacts of labor-related costs only and do not therefore have an indirect effect on industry's use of money to purchase goods and services (i.e., all the value goes to direct labor). The Logging and Forestry Sector has greater impact on indirect and induced jobs because much of the fuel expenditures for biomass contribute directly to the Sector as a whole, not just for labor-related costs. The sectors impacted by the energy efficiency programs (see Table 11) include indirect and induced effects because energy efficiency equipment is being purchased from those sectors, therefore impacts are not exclusively labor.

**Table 11 - Relationship of Direct Jobs to Indirect and Induced Jobs by Industrial Sector**

| Sector | Direct Jobs | Indirect & Induced Jobs |
|---|---|---|
| Other New Construction | 1 | 0.28 |
| Power Generation & Supply | 1 | 0.81 |
| Animal Production Excl Cattle & Poultry | 1 | 0.31 |
| Logging & Forestry | 1 | 1.10 |
| Lubricants Manufacturing | 1 | 3.19 |
| AC, Refrigeration, & Forced Air Heating Manufacturing | 1 | 1.44 |
| Electric Lamp Bulb and Part Manufacturing | 1 | 1.33 |
| Lighting Fixture Manufacturing | 1 | 1.12 |
| Electric Power & Specialty Transformer Manufacturing | 1 | 1.48 |
| Motor & Generator Manufacturing | 1 | 1.04 |
| Relay and Industrial Control Manufacturing | 1 | 1.46 |
| Wholesale Trade | 1 | 0.71 |
| Building Material & Garden Supply Stores | 1 | 0.37 |
| General Merchandise Stores | 1 | 0.22 |

Since lead times on construction vary by resource, we converted the jobs from IMPLAN output into job-years to facilitate comparison. One person working for one year represents one job-year and one person working for twenty years represents twenty job-years. For the construction estimates, the jobs provided in job-years, since years of construction costs vary depending on the resource. Ongoing jobs for O&M and fuel are generated as single year jobs, which were multiplied by twenty to convert O&M and fuel related jobs to job-years. The results in job-years per MW by resource are provided in Figure 3, assuming a twenty-year operations horizon for O&M and fuel. The job-years impact from operations would be greater if the years of operation were extended, and less if the years were shortened. The energy efficiency impacts are based on the cumulative effect of ten years of the program by 2021.

## *Economic Analysis of Rate Increases*

To assess the economic impact of increases in the price of electricity due to the implementation of the Renewable Portfolio Standard in North Carolina, we used the following analytical procedure:

- Using the cost impact analysis derived by La Capra using the supply model, GDS adjusted the base case forecast of the demand for electricity to reflect impacts due to electricity price elasticity.

- The long term electricity price elasticity for North Carolina used in this study was determined by the North Carolina Department of Commerce using the Regional Economic Models Inc (REMI) economic model. The long-term electricity price elasticity is estimated to be negative 0.01 (for a one percent increase in the price of electricity, overall consumption of electricity in North Carolina declines by 0.01 percent).

- In the residential sector, higher electricity prices cause electric bills to be higher, and, thus, disposable household personal income to be lower. Based on the long term electricity price elasticity for North Carolina, GDS calculated the increase in expenditures for electricity, the decrease in electricity sales, as well as the decrease in disposable household personal income. The decreased personal income was then entered into the model to determine the jobs lost due to less spending in the local economy. IMPLAN's databases include personal consumption patterns for various household sectors that were used to estimate the job-years lost due to price increases.

- In the business sector, higher electricity prices may result in several reactions. With the price elasticity being relatively low, businesses are not very sensitive to small changes in electricity prices, so a change in direct demand for electricity would be less likely. Instead, we assumed that businesses would pay the higher prices and have less money to spend on other goods and services. The additional cost of electricity was entered into the IMPLAN model to determine the number of indirect jobs lost through less spending on other products by businesses.

Given that energy efficiency programs will reduce consumption, there is some offset in electricity bills between higher prices and lower consumption. Therefore, the job impacts calculated through the methodology above would constitute the maximum jobs lost due to increased prices because it assumes no decrease in consumption due to energy efficiency. In 2012, for instance, the price impact will be roughly 0.7%, and the energy efficiency program is expected to reduce consumption by about 0.8%. Therefore, the jobs lost due to the increase in electricity price are somewhere between 0 and the amount calculated by IMPLAN for allowing the full price increase with no assumed energy reduction from the energy efficiency program.

# Appendix B – Detailed Results of Economic Analysis

**JOB IMPACTS FOR**
**UTILITY PORTFOLIO - 2012**

| Line | | Total | Total | Construction | | O&M | | | Fuel | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Line No. | Resource | Total MW | Total MWh | Jobs per MW | Total Job-Years | Jobs per MW per Yr | Years | Total Job-Years | Jobs per MWh per Yr | Years | Total Job-Years | Total Job-Years |
| (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (i) | (j) | (k) | (l) | (m) |
| 1 | Coal | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 2 | Combined Cycle | 153 | 667,950 | 5.4 | 825.2 | 0.2 | 20 | 472.8 | 0.00000 | 20 | 0.0 | 1,297.9 |
| 3 | Combustion Turbine | 281 | 122,859 | 3.9 | 1,084.7 | 0.1 | 20 | 656.4 | 0.00000 | 20 | 0.0 | 1,741.1 |
| **19** | **Total Portfolio** | **433** | **790,809** | **4.4** | **1,909.9** | **0.13** | **20** | **1,129.1** | **0.00000** | **20** | **0.0** | **3,039.0** |

**JOB IMPACTS FOR**
**REVISED PORTFOLIO - 2012**

| Line No. | Resource | Total MW | Total MWh | Construction Jobs per MW | Construction Total Job-Years | O&M Jobs per MW per Yr | O&M Years | O&M Total Job-Years | Fuel Jobs per MWh per Yr | Fuel Years | Fuel Total Job-Years | Total Job-Years |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (i) | (j) | (k) | (l) | (m) |
| 1 | Wind Farms | 314 | 839,693 | 2.9 | 899 | 0.2 | 20 | 1,144 | 0.00000 | 20 | 0.0 | 2,043 |
| 2 | Wind Clusters | 10 | 26,718 | 3.4 | 34 | 0.2 | 20 | 45 | 0.00000 | 20 | 0.0 | 78 |
| 3 | Off-Shore Wind | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 4 | Blended Co-Fire | 180 | 1,182,600 | 1.3 | 227 | 0.1 | 20 | 349 | 0.00027 | 20 | 6,382.8 | 6,959 |
| 5 | Retrofit Co-Fire | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 6 | Wood (Fluidized Bed) | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 7 | Wood (Gasification) | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 8 | Wood (Stoker) | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 9 | New Hydro | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 10 | Undeveloped Hydro | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 11 | Hydro Upgrades | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 12 | Landfill | 50 | 350,400 | 4.9 | 244 | 1.3 | 20 | 1,295 | 0.00000 | 20 | 0.0 | 1,539 |
| 13 | Poultry Litter | 22 | 170,000 | 9.8 | 212 | 0.7 | 20 | 314 | 0.00000 | 20 | 0.0 | 526 |
| 14 | Hog Waste | 15 | 96,608 | 33.6 | 494 | 2.6 | 20 | 752 | 0.00000 | 20 | 0.0 | 1,246 |
| 15 | Solar (PV) | 58 | 101,692 | 80.7 | 4,685 | 0.4 | 20 | 466 | 0.00000 | 20 | 0.0 | 5,150 |
| 16 | Energy Efficiency | | | | | | | | | | | 1,767 |
| **17** | **Total RE/EE** | **649** | **2,767,711** | | **6,794** | **0.34** | **20** | **4,364** | **0.00012** | **20** | **6,383** | **19,308** |
| 18 | Coal | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 19 | Combined Cycle | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 20 | Combustion Turbine | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| **21** | **Change In Conventional Jobs** | **(433)** | **(790,809)** | | **(1,910)** | | | **(1,129)** | | | **0** | **(3,039)** |
| **22** | **Job Loss Due to Price Increase** | | | | | | | | | | | **(880)** |
| **23** | **Net Gain/(Loss)** | | | | | | | | | | | **15,389** |

## JOB IMPACTS FOR
## UTILITY PORTFOLIO - 2018

| | | | | Construction | | O&M | | | Fuel | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Line No. | Resource | Total MW | Total MWh | Jobs per MW | Total Job-Years | Jobs per MW per Yr | Years | Total Job-Years | Jobs per MWh per Yr | Years | Total Job-Years | Total Job-Years |
| (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (i) | (j) | (k) | (l) | (m) |
| 1 | Coal | 2,205 | 17,384,220 | 16.1 | 35,593.1 | 0.4 | 20 | 19,271.7 | 0.00000 | 20 | 0.0 | 54,864.8 |
| 2 | Combined Cycle | 1,415 | 6,197,700 | 5.4 | 7,656.6 | 0.2 | 20 | 4,386.5 | 0.00000 | 20 | 0.0 | 12,043.1 |
| 3 | Combustion Turbine | 1,881 | 823,878 | 3.9 | 7,273.8 | 0.1 | 20 | 4,401.5 | 0.00000 | 20 | 0.0 | 11,675.4 |
| **19** | **Total Portfolio** | **5,501** | **24,405,798** | **9.2** | **50,523.5** | **0.26** | **20** | **28,059.7** | **0.00000** | **20** | **0.0** | **78,583.2** |

**JOB IMPACTS FOR**
**REVISED PORTFOLIO - 2018**

| | | | | Construction | | O&M | | | Fuel | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Line No. | Resource | Total MW | Total MWh | Jobs per MW | Total Job-Years | Jobs per MW per Yr | Years | Total Job-Years | Jobs per MWh per Yr | Years | Total Job-Years | Total Job-Years |
| (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (i) | (j) | (k) | (l) | (m) |
| 1 | Wind Farms | 1,110 | 2,965,698 | 2.9 | 3,173 | 0.2 | 20 | 4,040 | 0.00000 | 20 | 0.0 | 7,213.9 |
| 2 | Wind Clusters | 120 | 320,616 | 3.4 | 404 | 0.2 | 20 | 535 | 0.00000 | 20 | 0.0 | 938.8 |
| 3 | Off-Shore Wind | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 4 | Blended Co-Fire | 260 | 1,708,200 | 1.3 | 328 | 0.1 | 20 | 504 | 0.00027 | 20 | 9,220 | 10,051.9 |
| 5 | Retrofit Co-Fire | 116 | 762,120 | 3.9 | 449 | 0.1 | 20 | 225 | 0.00027 | 20 | 4,113 | 4,787.0 |
| 6 | Wood (Fluidized Bed) | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 7 | Wood (Gasification) | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 8 | Wood (Stoker) | 247 | 1,943,761 | 9.1 | 2,239 | 0.7 | 20 | 3,590 | 0.00029 | 20 | 11,366 | 17,194.0 |
| 9 | New Hydro | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 10 | Undeveloped Hydro | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 11 | Hydro Upgrades | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 12 | Landfill | 150 | 1,051,200 | 4.9 | 731 | 1.3 | 20 | 3,885 | 0.00000 | 20 | 0.0 | 4,616.4 |
| 13 | Poultry Litter | 114 | 900,000 | 9.8 | 1,124 | 0.7 | 20 | 1,662 | 0.00000 | 20 | 0.0 | 2,785.7 |
| 14 | Hog Waste | 47 | 305,992 | 33.6 | 1,566 | 2.6 | 20 | 2,382 | 0.00000 | 20 | 0.0 | 3,947.9 |
| 15 | Solar (PV) | 184 | 322,097 | 80.7 | 14,838 | 0.4 | 20 | 1,474 | 0.00000 | 20 | 0.0 | 16,312.8 |
| 16 | Energy Efficiency | | | | | | | | | | | 6,001.0 |
| **17** | **Total RE/EE** | **2,347** | **10,279,684** | | **24,852** | **0.39** | **20** | **18,298** | **0.00012** | **20** | **24,699** | **73,849** |
| 18 | Coal | 1,500 | 11,826,000 | 16.1 | 24,213 | 0.4 | 20 | 13,110 | 0.00000 | 20 | 0.0 | 37,323.0 |
| 19 | Combined Cycle | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 20 | Combustion Turbine | 2,550 | 1,116,900 | 3.9 | 9,861 | 0.1 | 20 | 5,967 | 0.00000 | 20 | 0.0 | 15,827.9 |
| **21** | **Change In Conventional Jobs** | **(1,451)** | **(11,462,898)** | | **(16,450)** | | | **(8,983)** | | | **0** | **(25,432)** |
| **22** | **Job Loss Due to Price Increase** | | | | | | | | | | | **(3,963)** |
| **23** | **Net Gain/(Loss)** | | | | | | | | | | | **44,454** |

**JOB IMPACTS FOR**
**UTILITY PORTFOLIO - 2021**

| | | | | Construction | | O&M | | | Fuel | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Line No. | Resource | Total MW | Total MWh | Jobs per MW | Total Job-Years | Jobs per MW per Yr | Years | Total Job-Years | Jobs per MWh per Yr | Years | Total Job-Years | Total Job-Years |
| (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (i) | (j) | (k) | (l) | (m) |
| 1 | Coal | 3,293 | 25,958,070 | 16.1 | 53,147.5 | 0.4 | 20 | 28,776.5 | 0.00000 | 20 | 0.0 | 81,924.0 |
| 2 | Combined Cycle | 1,730 | 7,577,400 | 5.4 | 9,361.0 | 0.2 | 20 | 5,363.0 | 0.00000 | 20 | 0.0 | 14,724.0 |
| 3 | Combustion Turbine | 2,198 | 962,505 | 3.9 | 8,497.7 | 0.1 | 20 | 5,142.2 | 0.00000 | 20 | 0.0 | 13,639.9 |
| **19** | **Total Portfolio** | **7,220** | **34,497,975** | **9.8** | **71,006.3** | **0.27** | **20** | **39,281.6** | **0.00000** | **20** | **0.0** | **110,287.9** |

**JOB IMPACTS FOR**
**REVISED PORTFOLIO - 2021**

| | | | | Construction | | O&M | | | Fuel | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Line No. | Resource | Total MW | Total MWh | Jobs per MW | Total Job-Years | Jobs per MW per Yr | Years | Total Job-Years | Jobs per MWh per Yr | Years | Total Job-Years | Total Job-Years |
| (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (i) | (j) | (k) | (l) | (m) |
| 1 | Wind Farms | 1,291 | 3,448,385 | 2.9 | 3,690 | 0.2 | 20 | 4,698 | 0.00000 | 20 | 0.0 | 8,388 |
| 2 | Wind Clusters | 130 | 347,334 | 3.4 | 437 | 0.2 | 20 | 580 | 0.00000 | 20 | 0.0 | 1,017 |
| 3 | Off-Shore Wind | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 4 | Blended Co-Fire | 260 | 1,708,200 | 1.3 | 328 | 0.1 | 20 | 504 | 0.00027 | 20 | 9,219.6 | 10,052 |
| 5 | Retrofit Co-Fire | 116 | 762,120 | 3.9 | 449 | 0.1 | 20 | 225 | 0.00027 | 20 | 4,113.4 | 4,787 |
| 6 | Wood (Fluidized Bed) | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 7 | Wood (Gasification) | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 8 | Wood (Stoker) | 247 | 1,943,761 | 9.1 | 2,239 | 0.7 | 20 | 3,590 | 0.00029 | 20 | 11,365.7 | 17,194 |
| 9 | New Hydro | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 10 | Undeveloped Hydro | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 11 | Hydro Upgrades | 0 | 0 | 0.0 | 0.0 | 0.0 | 20 | 0.0 | 0.00000 | 20 | 0.0 | 0.0 |
| 12 | Landfill | 150 | 1,051,200 | 4.9 | 731 | 1.3 | 20 | 3,885 | 0.00000 | 20 | 0.0 | 4,616 |
| 13 | Poultry Litter | 114 | 900,000 | 9.8 | 1,124 | 0.7 | 20 | 1,662 | 0.00000 | 20 | 0.0 | 2,786 |
| 14 | Hog Waste | 49 | 322,230 | 33.6 | 1,649 | 2.6 | 20 | 2,508 | 0.00000 | 20 | 0.0 | 4,157 |
| 15 | Solar (PV) | 194 | 339,190 | 80.7 | 15,626 | 0.4 | 20 | 1,553 | 0.00000 | 20 | 0.0 | 17,178 |
| 16 | Energy Efficiency | | | | | | | | | | | 10,505 |
| **17** | **Total RE/EE** | **2,550** | **10,822,420** | | **26,272** | | | **19,205** | **0.00011** | **20** | **24,699** | **80,681** |
| 18 | Coal | 2,250 | 17,739,000 | 16.1 | 36,320 | 0.4 | 20 | 19,665 | 0.00000 | 20 | 0.0 | 55,985 |
| 19 | Combined Cycle | 250 | 1,095,000 | 5.4 | 1,353 | 0.2 | 20 | 775 | 0.00000 | 20 | 0.0 | 2,128 |
| 20 | Combustion Turbine | 2,700 | 1,182,600 | 3.9 | 10,441 | 0.1 | 20 | 6,318 | 0.00000 | 20 | 0.0 | 16,759 |
| **21** | **Change In Conventional Jobs** | **(2,020)** | **(14,481,375)** | | **(22,893)** | | | **(12,524)** | | | **0** | **(35,417)** |
| **22** | **Job Loss Due to Price Increase** | | | | | | | | | | | **(4,278)** |
| **23** | **Net Gain/(Loss)** | | | | | | | | | | | **40,986** |