TREDPLAN Analysis Findings for North Carolina Department of Commerce
Implications for Clean Energy Workforce and Economic Development

January 2020

These findings were developed to expand upon insights reported in the NC Dept. of Commerce Document: "Clean Energy and Clean Transportation in NC: A Workforce Assessment."

Summary. North Carolina's energy generation mix is shifting from coal to cleaner, renewable sources – reflecting national trends. However, policy can affect the pattern and rate of change in energy sources, and this can bring significant economic opportunities for the state. The North Carolina Department of Commerce's (NCDOC) recent report, "Clean Energy and Clean Transportation in NC: A Workforce Assessment" found there are significant opportunities to prepare its workforce to participate in the coming growth of the clean economy. North Carolina needs to implement policy and programs to take advantage of the growth in the clean economy because under "business as usual" conditions, North Carolina is not well positioned to take full advantage of these opportunities. While North Carolina's strengths in the transportation and construction industry sectors will be responsible for implementing the infrastructure changes and will largely benefit from the transition period from conventional energy production and transportation to Clean Energy and Clean Transportation. Unfortunately, those jobs will phase out once the infrastructure is complete and implementation reaches a saturation point. The long-term operations of Clean Energy and Transportation is where there is significant opportunity for permanent, high-paying, quality jobs.

With an understanding of the skill needs, North Carolina can develop a strategy to (a) fill the skills gap for workers currently in the labor market, and (b) prepare future labor market participants for these emerging industries. This analysis leverages the TREDPLAN data from the workforce assessment report and describes ways that North Carolina can focus appropriate policy interventions involving business incentives and job training to substantially improve employment opportunities and increase incomes. Additionally, TREDPLAN can map energy and economic data, for example, where solar generation opportunities exist, and where infrastructure and employment shifts may occur, providing valuable data for addressing workforce development needs.

The TREDPLAN analysis tool incorporates existing labor market, industrial, and occupational data to provide a detailed snapshot of existing workforce and business conditions in North Carolina. TREDPLAN also incorporates forecasts from Moody's, IMPLAN, and other sources to the year 2045 for those topics enabling users to perform analysis of conditions under a "business as usual" scenario or perform scenario analyses of "what-if' scenarios, like improving market share of local North Carolina businesses, implementing workforce training for specific skills, or implementing policy changes.

The baseline. Below are some key bulleted data on North Carolina's economy, workforce, and growth. These data are important for considering the impacts of the Clean Energy scenarios, detailed in this memo, on the North Carolina economy. From an economic development standpoint, Clean Energy investments are an opportunity to create long-term well-paying good jobs. North Carolina's unemployment rate is historically low, and at under five percent is considered at full employment. North Carolina's unemployment rate is currently two-tenths of a percentage-point above the national average, but job growth is projected outpace the national average[1]. For North Carolina to keep its competitive advantage and meet growth expectations, economic development and workforce policy must consider the industries of the future and workforce training to fill any skill gaps in the existing labor force. Fortunately, the North Carolina workforce is educated, and North Carolina has many colleges, universities, and certificate granting institutions (as described in the "Clean Energy and Clean Transportation in NC: A Workforce Assessment" report) that are already implementing forward looking training programs for the workforce of the future. From this and forthcoming analysis, policy makers can assess whether current programs are adequate in terms of student capacity and topics to maintain a flexible and competitive workforce.

<u>High-level baseline labor force and demographic information:</u>

- Total jobs[2]: 4.9 million
- Projected annual job growth rate[3]: 0.89%
- Unemployment rate December 2019[4]: 3.7%
- Population[5]: 10.1 million
- Population projected annual growth[6]: 1.1%
- Educational attainment for North Carolina residents 25 years and older
    - High school graduate (or equivalency): 25.9%
    - Associates: 21.5%
    - Some College: 9.5%
    - Bachelor's degree or higher: 30.5%
- Total North Carolina universities, colleges (2 and 4 year), and certificate granting institutions[7]: 183

The Clean Energy and Clean Transportation report identifies the projected growth in key occupations tied to the clean economy. As the report shows, it is anticipated there will be growth in many of these industries, but the market share of North Carolina based supplier businesses is low for most supporting industry and occupations except installers. TREDPLAN's economic projections factor in local market share and can help us understand how much of that new

[1] Labor & Economic Analysis Division, North Carolina Department of Commerce
[2] Bureau of Labor Statistics, Local Area Unemployment Statistics (LAUS)
[3] "North Carolina Industry Employment Projections," Labor & Economic Analysis Division, North Carolina Department of Commerce
[4] Bureau of Labor Statistics, Local Area Unemployment Statistics (LAUS)
[5] U.S. Census Bureau, American Community Survey
[6] Labor & Economic Analysis Division, North Carolina Department of Commerce
[7] College Navigator. National Center for Education Statistics

activity in North Carolina will be absorbed by local firms. This is an opportunity to keep the economic growth and activity local, while mitigating the leakage from the North Carolina economy through appropriate policy and training.

The scenarios described and modeled in this memo are based on North Carolina Department of Environmental Quality's 2019 "Clean Energy Plan". The goals driving the scenarios are: (1) to reduce electric power sector greenhouse gas emissions by 70% below 2005 levels by 2030 and attain carbon neutrality by 2050; (2) foster long-term energy affordability and price stability for North Carolina's residents and businesses by modernizing regulatory and planning processes; and (3) accelerate clean energy innovation, development, and deployment to create economic opportunities for both rural and urban areas of the state. The scenarios themselves focus on implementation of HB589, doubling energy efficiency, increasing solar production by 30%, wind production by 15%, and energy storage by up to 13.5%.

The baseline and scenario analysis focused on the following six policy elements:

1) *Energy Shifts:* The shift from legacy generation to clean energy generators is occurring nationally as well as in North Carolina. As conventional generation declines, it will bring localized job losses with more dispersed job gains in the future.

2) *Job Growth:* Looking at North Carolina's industrial mix and assessing the state's competitive advantage and capacity to supply parts, and materials for new energy generation. With appropriate policy and programs, the industrial capacity can be improved to meet future demand.

3) *Job Skills:* Clean energy will change job skill requirements, creating identifiable occupation winners and losers in North Carolina.

4) *Job Location:* Clean energy jobs likely to follow projected growth in energy demand, and that pattern is shifting as North Carolina's economy evolves and population grows.

5) *Workforce Training:* North Carolina has education centers that can provide needed workforce training, though action is needed to ensure that they are prepared for that future.

6) *Impacts:* The projected future impact of Clean Energy Scenarios on North Carolina jobs can be significant but is muted by the fact that so much of the supplier activity is out of state. However, the job impact numbers can grow substantially if action is taken to better position and develop North Carolina's supply chains and workforce to provide for a clean energy future.

Observation 1 – The shift from legacy generation to clean energy generators is occurring. As conventional generation declines, it will bring sharp localized job losses with more dispersed job gains across North Carolina in the future.

The emerging shift in North Carolina's electricity generation mix will have important location implications. Job losses from fossil fuel plants will be concentrated in a few areas that have large generators located along coal and gas supply lines, while development of renewable generation can create jobs associated with smaller but more widely dispersed facilities across the state. Figure 1 shows the geographic distribution across the state, where wind and solar generation are more ubiquitous as opposed to coal and natural gas which require more geographically concentrated infrastructure for fuel delivery, generation, and operations. The red circles denote areas with today's generators. Many of these fossil fuel generators will likely stop producing electricity by the end of the facility lifespan as clean generators proliferate.

Figure 1: TREDPLAN Generation Profile by Location Map

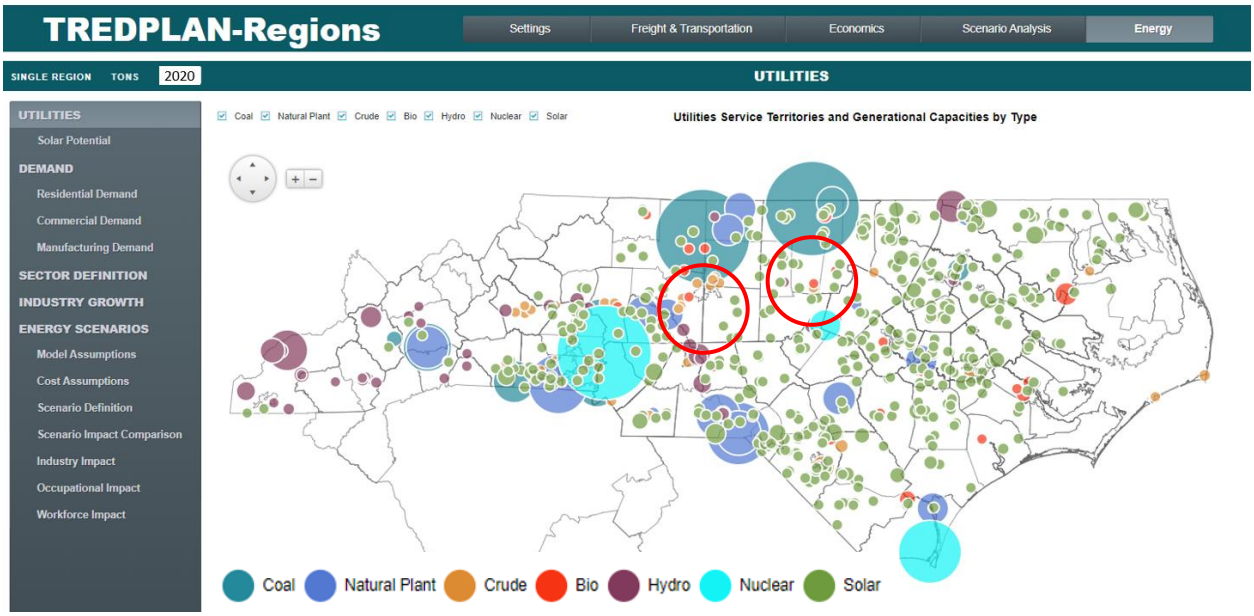
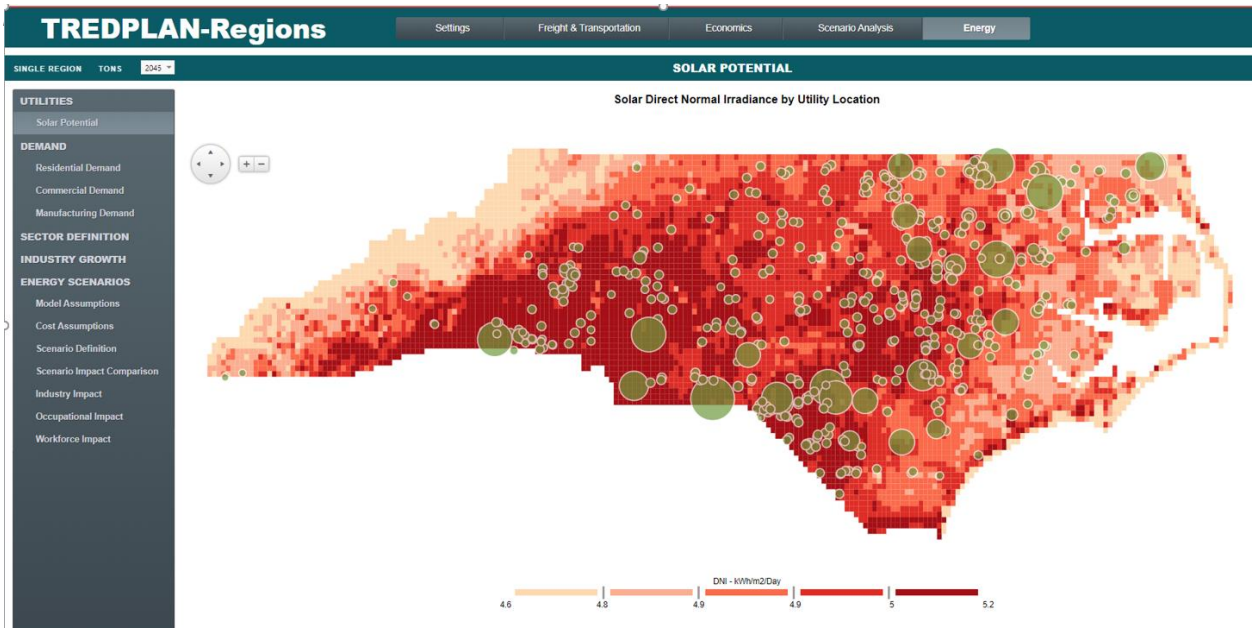


Figure 2, shows the overlay of solar irradiance and solar utilities in North Carolina, where the geographic distribution of good solar activity across the state justifies the economics of smaller scale generators.

Figure 2: TREDPLAN Photovoltaic Potential by Location Map



Observation 1 takeaway: Looking at future average statewide growth for industries and occupations misses the potential geographic mismatch from shifts in existing traditional fossil fuel power generation to clean energy production, including wind and solar which tends to be more dispersed. Looking at energy production and labor regionally within North Carolina can help for future planning to maximize North Carolina's resident labor force to take advantage of growth in clean energy.

Observation 2 – North Carolina's industrial mix is not prepared to competitively supply parts and materials for new energy generation.

Each type of clean energy source requires a specific set of parts and materials that can be sourced by firms locally, nationally, and internationally. The transition to clean energy can be a source of increased future jobs and business activity for suppliers in North Carolina, but only if North Carolina has the supply chains and in-state firms to produce the needed parts. While the North Carolina Department of Commerce report describes an existing strong transportation sector ready to supply parts for the future of clean transportation; other clean energy industry sectors are less prevalent in North Carolina.

The TREDPLAN results shown below indicate the types of firms needed for commercial solar generation, energy efficiency retrofits, and wind electrical generation. The tables show for commercial solar that only a very small portion of parts are likely to come from North Carolina suppliers under current conditions. For example, the NC suppliers can only provide around 10-18% for most of the parts including wiring controls, mounting racks and inverters, rising to 28% for other solar module parts. *Only installation, maintenance and operations are largely supplied by local firms in North Carolina*.

Energy efficiency is slightly better situated (with the exception of insulation and small appliances) capable of meeting between 13- 64% of demand for inputs for energy efficiency retrofits. Similar to solar and wind, the installation of energy efficient equipment is almost completely supplied by the local market. Wind generation will remain largely local, and as TREDPLAN shows, North Carolina is well positioned to absorb the vast majority, if not all of the economic activity surrounding electric generation from wind power.

The tables below show the major supplier industries for commercial solar, energy efficiency, and electrical wind generation. While all three clean energy sectors are important elements to achieving the policy goals for reduced carbon emissions from energy production, it also shows the capacity of local North Carolina firms to provide locally sourced material (red highlighted columns). For all three clean energy sectors, installation remains largely served by local North Carolina based firms. However, these tables also highlight the significant leakage out of the local economy for electrical suppliers of solar and energy efficient products and appliances.

Table 1: North Carolina's supplier industry shares for commercial solar

Cancel Changes

Spending Type	Naics Code	Naics Desc	Spending Dollar Per Watt	Percent Local Sourced
Electrical BOS				
Charge Controller	335312	Motor and Generator Manufacturing	0.09	0.18
Wire	335929	Other Communication and Energy Wire Manufacturing	0.03	0.13
Structural BOS				
Racking	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing	0.12	0.11
Inverter Only	335312	Motor and Generator Manufacturing	0.08	0.18
Module	334413	Semiconductor and Related Device Manufacturing	0.47	0.28
Install Labor & Equipment	238210	Electrical Contractors and Other Wiring Installation Contractors	0.12	1.00
Contingency				
Developer Overhead	561110	Office Administrative Services	0.36	0.84
EPC Overhead	493110	General Warehousing and Storage	0.16	0.81
EPC/Developer Net Profit				
PII (connection fee)	541350	Building Inspection Services	0.08	0.71
Sales Tax				

Table 2: North Carolina's supplier industry shares for energy efficiency

Cancel Changes

Spending Type	Naics Code	Naics Desc	Spending Dollar Per Watt	Percent Local Sourced
Appliance				
Appliances (Washer/Dryer)	335220	Major Household Appliance Manufacturing	0.01	0.64
Appliances (Refrigerator)	335220	Major Household Appliance Manufacturing	0.00	0.42
Appliances (Small)	335210	Small Electrical Appliance Manufacturing	0.00	0.00
Products (Trade and Mfg)				
Electric Controls/Equipment	335314	Relay and Industrial Control Manufacturing	0.02	0.14
Electric Light Bulbs and Fixtures	335110	Electric Lamp Bulb and Part Manufacturing	0.02	0.56
Fiberglass Insullation	327993	Mineral Wool Manufacturing	0.02	0.02
Flat Glass / Windows	332321	Metal Window and Door Manufacturing	0.01	0.25
HVAC	333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	0.04	0.13
Installation				
Commercial Building Reconstruction	236220	Commercial and Institutional Building Construction	0.04	0.99
Residential Building Reconstruction	236118	Residential Remodelers	0.04	0.99
Professional Services (Remodeling)	238220	Plumbing, Heating, and Air-Conditioning Contractors	0.02	0.99

Table 3: North Carolina's supplier industry shares for wind electrical generation

Cancel Changes

Spending Type	Naics Code	Naics Desc	Spending Dollar Per Watt	Percent Local Sourced
Balance of System				
Assembly and Installation	237130	Power & Communication Line, Related Structures Construction	0.29	1.00
Electrical Infrastructure	237130	Power & Communication Line, Related Structures Construction	1.11	1.00
Port and Staging, Logistics, Transportation	483113	Costal and Great Lakes Freight Transportation	0.06	1.00
Substructure & Foundation	237130	Power & Communication Line, Related Structures Construction	0.61	1.00
Engineering Management	541330	Engineering Services	0.08	1.00
Development	237130	Power & Communication Line, Related Structures Construction	0.15	1.00
Financial				
Plant Commissioning				
Decommissioning Bond				
Contingency				
Construction Finance	522292	Real Estate Credit	0.29	1.00
Insurance During Construction	524210	Insurance Agencies and Brokerages	0.04	1.00
Turbine	333611	Turbine and Turbine Generator Set Units Mfg	1.56	0.00

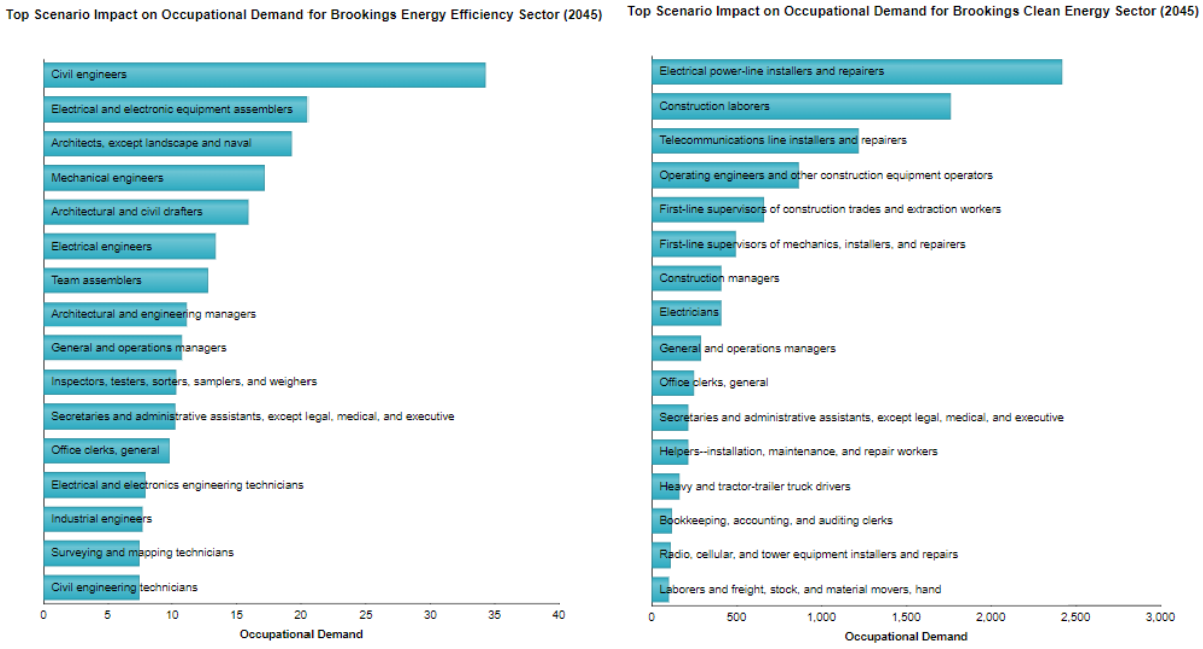
Observation 2 takeaway: These tables illustrate that a large portion of the money to be spent on energy efficiency and solar generation in North Carolina in the next twenty-five years will likely leak out of the state and go to firms and workers abroad; unless policies are instituted to encourage development of a supply chain of electrical manufacturing producers or energy efficiency product producers within North Carolina.

Observation 3 – Clean energy will change job skill requirements, creating identifiable occupation winners and losers.

Adoption of solar and wind energy in place of coal (and associated cogeneration) will affect occupational demand. It will create needs for new occupational skills (electrician, electric controls, construction, line and installation workers, architects and civil engineering), and reduce demand for others (nuclear and industrial engineering, machine tools and plant operations management). The figure below shows the forecasted occupations expected to grow in North Carolina, under the current conditions. The top three clean energy occupations expected to grow are electrical and power transmission installer – general, line worker, and electrical and power transmission installers – other. The remaining high growth clean energy occupations relate to the design, development and maintenance of distributed energy networks. They are related either to construction or to specializations such as automated manufacturing, and thus also create opportunities for retraining of existing trades for clean energy technology and installation. On the other side of this, there will be a decline in demand for supporting conventional energy occupations including operations, engineering, welding, and machining.

The figures below show the difference both in scale and occupation mix for the less aggressive energy efficiency alone scenario, compared to the combined scenario of energy efficiency paired with solar and wind. With energy efficiency alone, the top occupational demand will be for long-term high paying occupations, however, it is dwarfed by the large demand for installers and electric workers under the combined scenario.

Figure 3: Occupational Demand for Energy Efficiency and Clean Energy Sectors



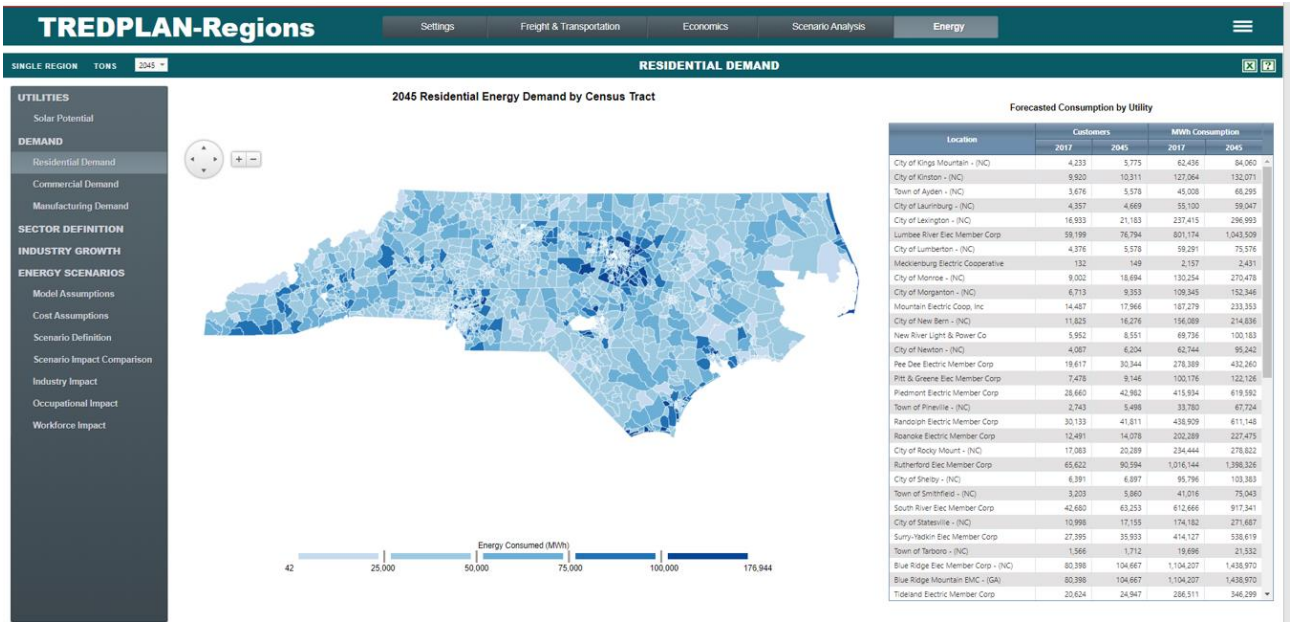
TREDPLAN traces these occupational needs to specific industries that are projected to grow or decline in future years. The scenario analysis showed occupations losing out as traditional fossil fuel powered generation and nuclear plants go offline, while the clean energy occupations gain as solar generation expands. The scenario shows reductions in turbines, boilers and nuclear generators and their associated occupations are being replaced by solar and wind generators that create more jobs in construction, installation, and professional occupations. North Carolina has substantial potential for offshore wind resources, not addressed in this scenario; offshore wind development will require significant transmission and other infrastructure upgrades, creating additional workforce impacts.

<u>Observation 3 takeaway:</u> Reevaluating the progress of clean energy and transportation overtime may help prepare North Carolina's labor force, as energy production will be more geographically dispersed and produced using different skills and occupations. Additionally, there is plenty of room for North Carolina firms to enter and absorb market share that is currently forecasted to be taken by firms outside of the state. Technology change and increases in productivity will also affect some of the high-paying positions now. As cited in the Clean Energy and Clean Transportation report, transportation industry offers good wages and there is a need for more truck drivers (p27), however, demand for these positions may decline as autonomous trucking technology becomes available.

Observation 4 – Clean energy jobs are likely to follow where there is the most projected growth in energy demand, and that pattern is shifting as the state's economy evolves.

The locations of clean energy industrial growth and production will be important for job growth and skills needs under a clean energy scenario (with increased solar, wind and energy storage development) compared to what would happen if we kept today's energy generation mix. The demand for jobs will be tied to projected growth from 2020 to 2045 in terms of residential energy demand and commercial energy demand, as well as sites suitable for wind, solar, and storage. The residential demand growth reflects shifts in population location and household size patterns across the state, while the commercial and industrial demand growth reflects projected shifts in the location and mix of industries across the state. The workforce needs for the future of clean energy will be centered around the major population and job centers including: Charlotte, Durham, Asheville, Raleigh, Winston-Salem, Greensboro, and Wilmington. The figure below shows the distribution of residential demand, where some metropolitan areas are forecasted to approach 180 billion MWh. Similarly, the commercial energy demand in the metro areas is forecasted exceed 11 trillion MWh. The concentration of demand for residential and commercial and industrial presents opportunities for workforce training and available labor to meet a larger share of the demand for energy efficiency growth in North Carolina than under the business as usual scenario and mitigate leakage from the North Carolina economy.

Figure 4: TREDPLAN Residential Energy Demand by Location Map

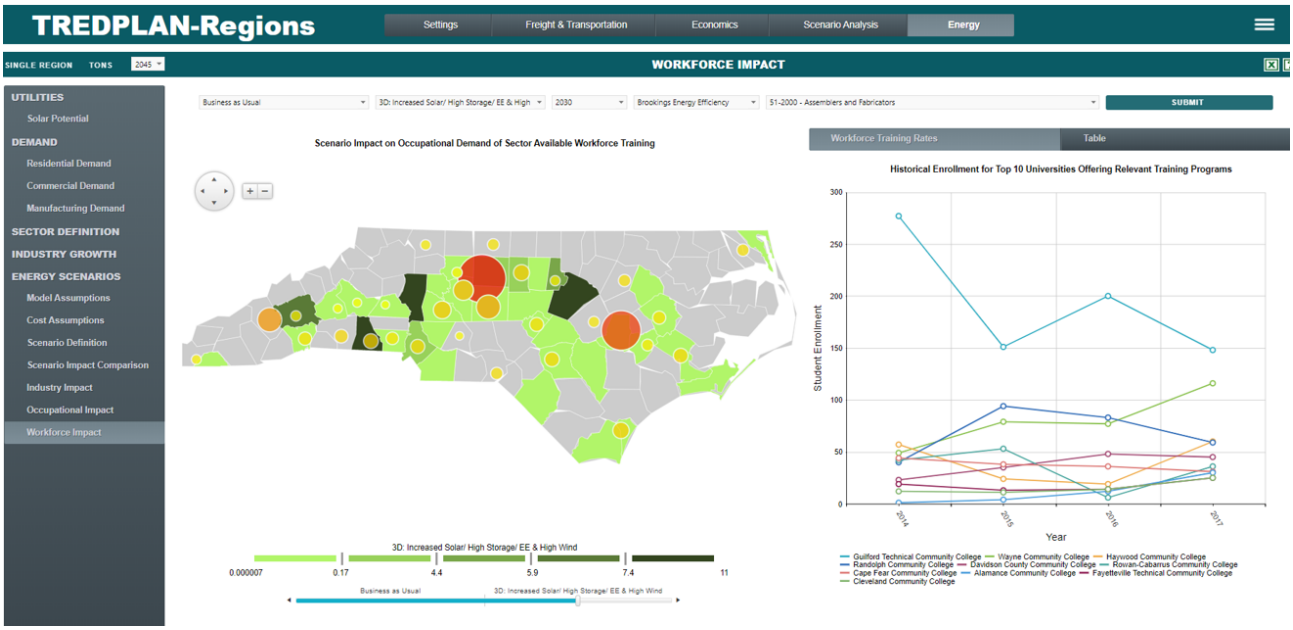


Observation 4 takeaway: Economic and demographic growth will drive the demand for installation and maintenance of energy efficiency equipment and retrofits. Clean energy production, unlike the traditional, centralized, fossil-fueled generation, will be located in the areas of the state that are optimal for wind and solar production. This shift to a more distributed system may require development of additional transmission and distribution resources to stabilize and optimize NC's electric system's robustness and reliability as well as non-wire alternatives such as greatly increased energy efficiency and demand management, development of microgrids for resilience and power quality, and other related new technologies for distributed generation. Energy efficiency represents the largest category of current clean energy employment. NC's scenarios foresee only modest increases in energy efficiency efforts, but the job impacts would greatly increase under more aggressive or concentrated efforts in energy efficiency and demand management such as New York's goal of achieving more than 1 Terawatt of savings. In addition to the direct job and income effects for the growth in these occupations, North Carolina businesses and residents will benefit from long-term cost savings, resulting in additional economic growth that will mitigate the future decline in nuclear and fossil fuel production.

Observation 5 – North Carolina has education centers that can provide needed workforce training, though action is needed to ensure that they are prepared for that future.

The locations of workforce training centers (shown by circles in the map below) are geographically positioned to meet the major population centers in North Carolina, where demand will be growing most for clean energy workforce skills. As the Workforce report shows on page 28, there is a tightening of the North Carolina's labor market with a growing number of open positions and a declining number of job seekers. Four of the top five reasons for hiring difficulty in the report as related to skills and experience. The need for training is paramount for growth in North Carolina's Clean Energy industries and employing residents with good quality, well-paying jobs. Developing the training programs, understanding the skills needs, utilizing the large existing college and university network, and providing the resources to train residents to meet this demand is key. The pairing of workforce training data, forecasts, and trade flow data in TREDPLAN enables location-based analysis of the labor force and skills, growth by industry sector, trade flows, and future demand to further contextualize the slack or tightness for future occupations.

Figure 5: TREDPLAN Wind Energy Scenario: Available Training Locations Map



As the table below shows there is a need for very specific set of direct occupations that training program can prepare North Carolina residents for, and if successful with other policies like economic development and firm attraction, North Carolina can gain additional clean energy market share. As the two maps below show, under the business as usual scenario, new clean energy occupations only account for up to 50 jobs in the most concentrated counties, whereas under the combined clean energy scenarios, we can see up to 4,300 new jobs in the major job centers across the state. Focusing on growth, training, and narrowing the skills gap can have major impacts for the North Carolina workforce, providing the opportunity for many high-paying jobs.

Figure 6: TREDPLAN Occupational Impact for Business as Usual Scenario

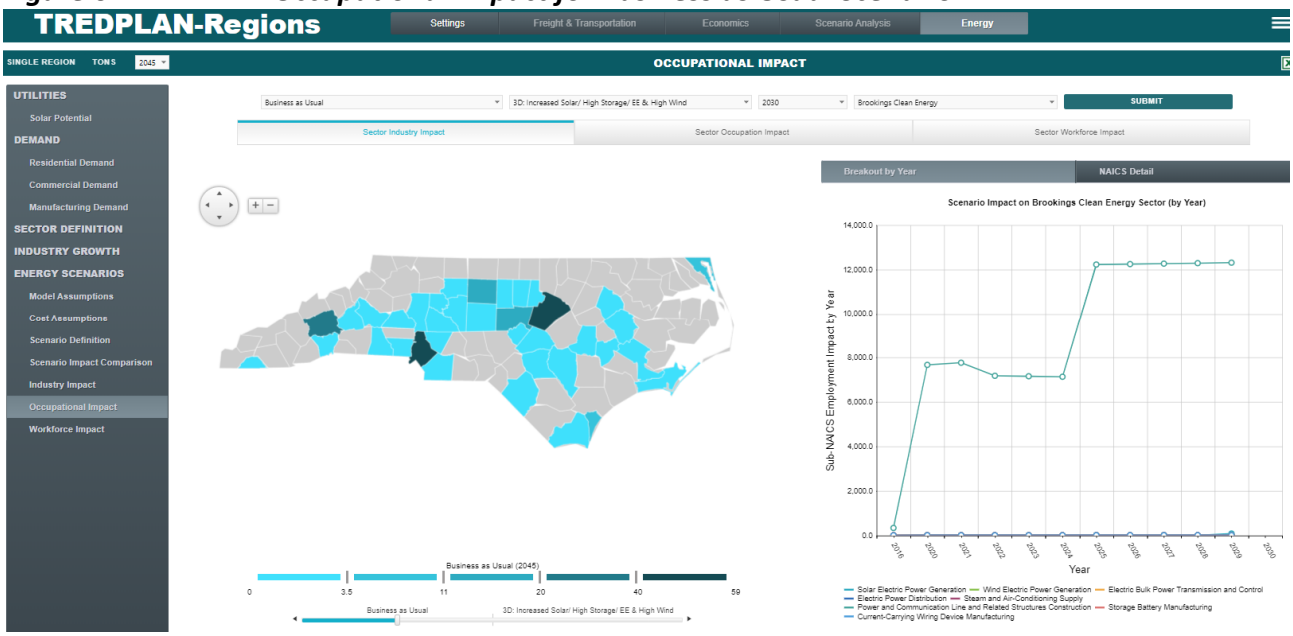
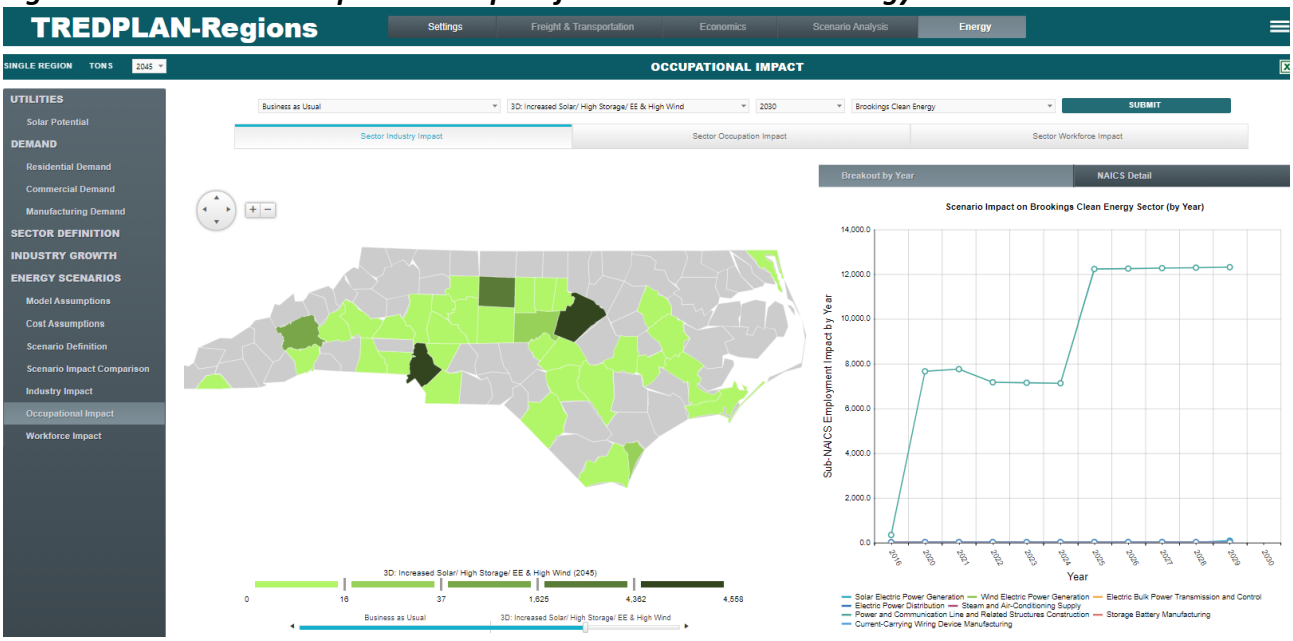
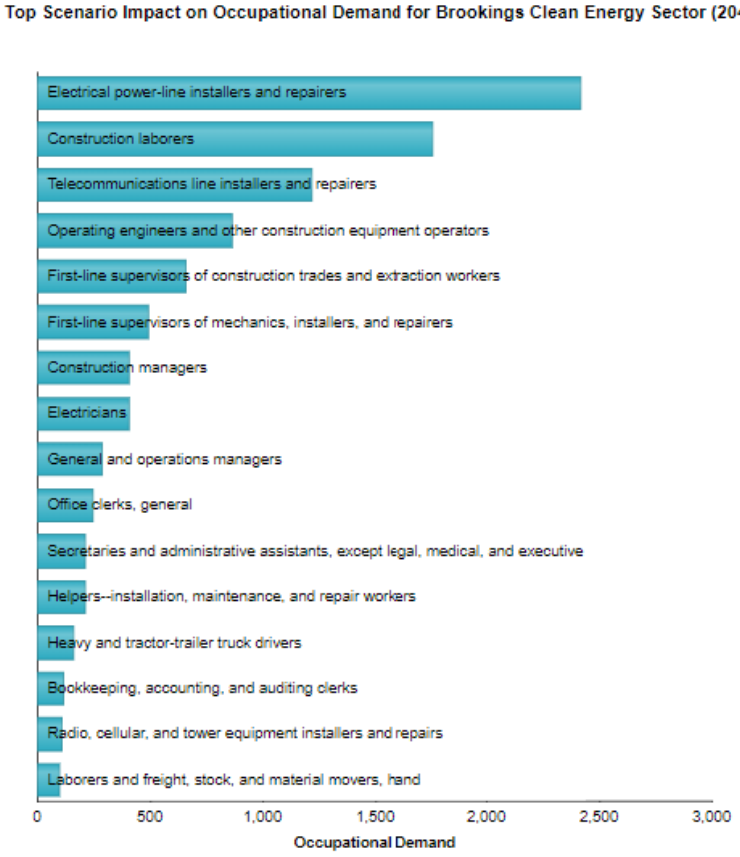


Figure 7: TREDPLAN Occupational Impact for Combined Clean Energy Plan Scenario



<u>Observation 5 takeaway:</u> The occupational demand for clean energy presents an opportunity for training and economic development. The occupational growth will likely come from two distinct activities, first from the construction activity needed for infrastructure development, then from generation and distribution. These operational activities will present long-term job opportunities for North Carolina residents in the electric distribution, electric bulk power transmission and control, and solar and wind generation industries. These occupations currently pay sustaining incomes over North Carolina's median income of $35,760. Additionally, the training workforce training needs identified by TREDPLAN focus on engineering, construction, business, and management. A list of occupations in demand for Clean Energy are show in the figure below.

Figure 8: Top Occupation Demand from Combined Scenario for 2045



Observation 6 – The projected future impact of Clean Energy Scenarios on North Carolina jobs is muted by the fact that so much of the supplier activity (as associated jobs) will occur out of state.

The results presented below should be considered conservative estimates based upon certain goals in the Clean Energy Plan. These impact estimates can quadruple if:

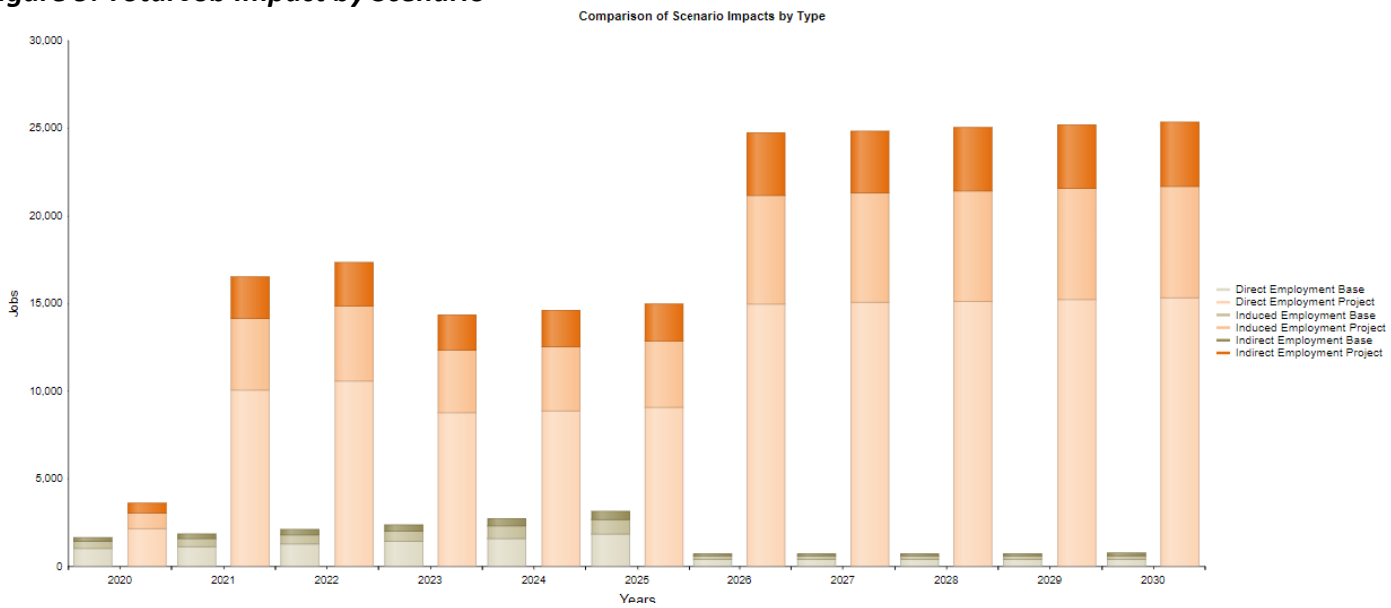
- the timing of clean energy investments accelerates,
- steps are taken to improve the local clean energy supply chain, or
- if the magnitude of clean energy production capacity increases.

Below the figures show the difference between business as usual case and the clean energy scenarios with proactive statewide policies. The clean energy scenario assumes a 30% increase in solar production, a 4.5% improvement in energy efficiency, a 13.5% increase in energy storage, and 15% increase in wind production. The Clean Energy scenario elements were modeled additively in TREDPLAN so that results can be displayed for the total scenario and each individual clean energy technology.

Total Impacts

The combined economic results of the Clean Energy Policy goals are an increase of 25,360 new jobs for the state of North Carolina by 2030. These job impacts include the direct hires from construction, implementation and operations of the expanding clean energy market in North Carolina, plus the supplier and income effects from workers purchases. This represents a-half percentage-point growth in the North Carolina residents employed in high quality jobs with wages, on average, exceeding $55,000. The figure below shows the total job growth under the Clean Energy Plan scenario (orange bars) compared to expected growth under the business as usual case (brown bars), which assumes no major clean energy investments. As the investments and energy capacity phases in, the Clean Energy scenario shows an influx of 15,000 new jobs through 2025 and increases to just over 25,000 total new jobs through 2030. These results show 60% of the job impacts come from direct clean energy investments, followed by 15% from suppliers, and the 25% remaining jobs come from the income effects of new wages and consumer spending. This activity results in $3.5 billion in net new local business sales per year, and almost two billion in Gross State Product (GSP) annually.

Figure 9: Total Job Impact by Scenario

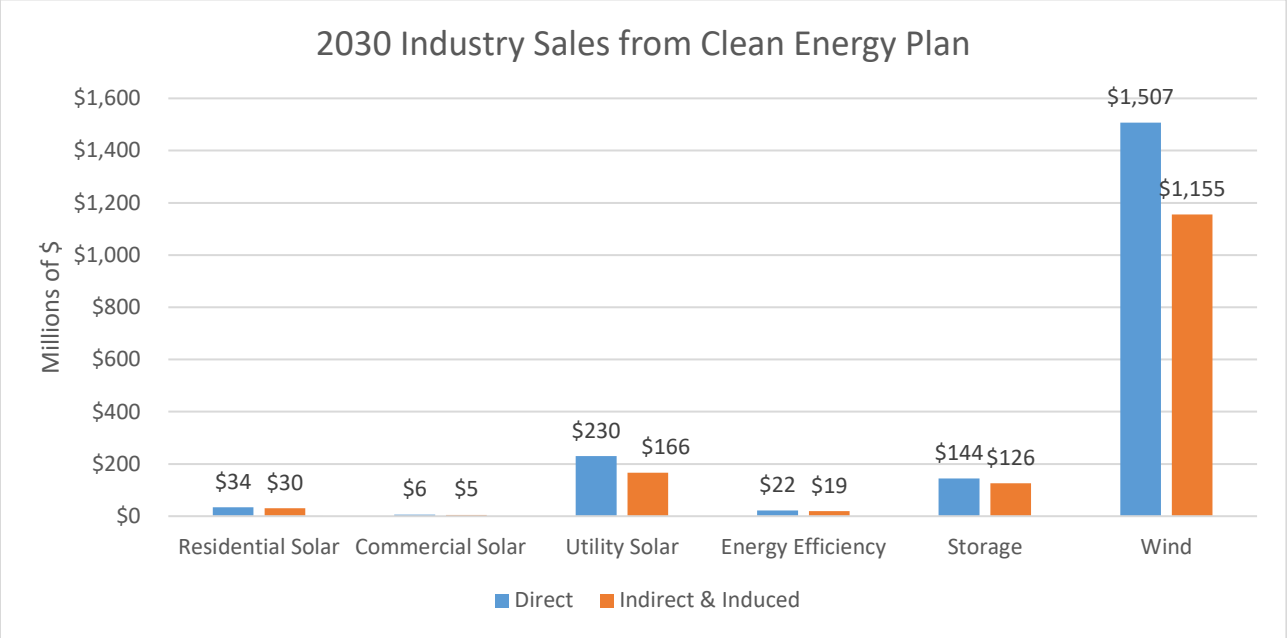


Impacts by Clean Energy Technology

The figure below shows the new business sales generated in North Carolina for each clean energy technology by direct impacts and the supplier and income impacts (indirect and induced). The largest contributor of economic activity is wind with $2.7 billion in annual sales, followed by the combined solar (residential, commercial, and utility) with $471 million, then energy storage with $270 million, and energy efficiency with $41 million.

The impacts of energy efficiency while important to reduce carbon emissions, under current projections its economic impact diminishes over time as the initial upfront implementation occurs earlier in the forecast. Once the energy retrofits are complete – construction and installation activity slows down and the energy efficiency benefits accrue on their own to commercial, industrial, and the residential building stock. Energy efficiency implementation may take longer than presented in this scenario, but at a certain point energy efficiency installations will flatten or decline. From 2025 to 2030, under this scenario timeline modeled, the economic impact and energy efficiency activities decline, as a share of total clean technology, and as this activity slows; wind, storage and solar operations increase across North Carolina. However, NC may well see expansion in energy efficiency and demand management beyond current projections. Residential and business needs drive much of increased peak electric demand, and NC utilities currently offer many demand management options. But energy efficiency can also lessen demand from the baseline, lowering the need to serve expensive system peaks. In some states, moves toward electrification of residential and business needs are expanding into area that are typically served by fossil fuels, for example, heating. As the electrification trend continues, more focus will be placed on meeting the growing demands on the electric system. We expect in NC this trend will develop on a longer timeline than other impacts analyzed through TREDPLAN and other means.

Figure 10: 2030 Industry Sales from Clean Energy Plan



Separating the impacts further by type we can see which options generate the most electricity and which technologies provide the most long-term economic gains. As energy production and retention ramps up through 2030 for wind, solar, and storage, energy efficiency retrofits taper-off and efficiency gains are assumed to reduce demand by freeing up 1,690 MW of capacity and produce $19 million annually in economic activity for North Carolina, as shown in table 4. Solar activity under this scenario produces the most production capacity at 11,145 MW and generates $282 million in economic activity per year. However, while wind production capacity is 5,500 MW, about half of the solar generation, wind produces an *economic impact five times larger than solar.*

Table 4: Electrical Production Capacity and Gross State Product Impacts by Clean Energy Technology in 2030

	Production Capacity (MW)	**GSP (Millions of $)**
All Solar	11,145	$282
Energy Efficiency*	-1,690	$19
Storage	5,000	$145
Wind	5,500	$1,523

**Megawatts saved*

Observation 6 takeaway:
From a workforce development perspective, expansion of wind under these scenarios will produce the most jobs for North Carolina residents, despite solar will have a much higher electrical production capacity. As described earlier, job training, economic development, and clean energy policy can expand North Carolina's supplier industrial base in solar and energy efficiency to absorb a larger share of this economic activity. By improving the supply chain, North Carolina could easily quadruple the long-term economic benefits outlined in this scenario.

Wind is the perfect example of this, as the local supply chain shows a high percentage of local industrial capacity available for installation and operations of new wind electric generation capacity. In contrast, solar generation and energy efficiency in North Carolina do not have the same in-state supplier presence as wind, and hence will leak more economic activity to outside suppliers, resulting in a smaller impact to North Carolina. On a per dollar basis, wind outperforms solar and energy efficiency for creating long-term high paying jobs in North Carolilna. While this demonstrates the supply chain and workforce calculations within TREDPLAN under a clean energy scenario, further scenario analysis can be performed to evaluate how policy changes will accelerate (or decelerate) the impacts or how shifts in the industrial mix in North Carolina will keep more economic activity local. This analysis did not factor in the social benefits of improved air quality but would result in additional positive impacts to the state economy.