Clean Energy & Clean Transportation in NC:

A Workforce Assessment




NORTH CAROLINA
DEPARTMENT of
COMMERCE

CLEAN ENERGY & CLEAN TRANSPORTATION IN NC: A WORKFORCE ASSESSMENT

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NORTH CAROLINA
DEPARTMENT of COMMERCE

Labor & Economic Analysis Division | Office of Science, Technology & Innovation

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EXECUTIVE SUMMARY

On October 29th, 2018, Governor Roy Cooper signed Executive Order 80, entitled "North Carolina's Commitment to Address Climate Change and Transition to a Clean Energy Economy." The order directed the NC Department of Commerce to:

- Evaluate the **current and projected workforce demands** in North Carolina's **clean energy** and **clean transportation** sectors,
- Assess the **skills and education required** for employment in these sectors, and
- **Recommend actions** to help North Carolinians develop such skills and education.

Based on this charge, the Department of Commerce found the following:

North Carolina has a large clean economy workforce in a range of industries and occupations.

- Nearly 300,000 workers currently work in clean economy industries, including clean energy generation, energy efficiency, and clean transportation.
- While not all of these industries are 100% "clean," they employ the workforce needed to transition to a clean economy.
- These industries employ workers in a wide range of occupations, with jobs available at all education, skill, and wage levels.

North Carolina is meeting current clean economy workforce needs overall, in large part because of its strong workforce and education systems.

- High School CTE programs, Community College programs, and University Energy Research Centers all contribute workers to the clean economy workforce.
- One out of three workers currently working in the clean economy has participated in a Community College education or training program.
- Over 29,000 credentials were granted at all post-secondary institutions in the state in relevant curricular programs, with large numbers in Business-related degrees, Mechanic and Repair Technologies, Engineering, Production, Construction, and Transportation related programs.

North Carolina has opportunities to prepare its workforce for growth of the clean economy.

- Strong employer engagement with workforce and education partners will be vital to meeting future needs.
- Workforce and education providers should work to increase awareness of job opportunities for youth to develop the pipeline of future workers including apprenticeships and other work-based learning.
- The Department of Commerce's business and workforce development programs should be utilized to support the clean economy.
- North Carolina should specialize in strategic sectors of the clean economy and work to become a leading clean economy state—great potential exists in offshore wind energy production, for example.

The clean energy and transportation sectors are made up of a diverse set of industries.

Based on previous research and existing industry classifications, the clean energy and transportation sectors can be divided into three broad groups of industries.

CLEAN ENERGY GENERATION+

- **Production of energy** not derived from fossil fuels: electric power generation from hydroelectric, solar, wind, and geothermal
- Construction and maintenance of the facilities and infrastructure to **transmit, distribute, and store energy**
- **Manufacturing of products** used in energy production and use such as turbines, transformers, wiring, and storage batteries

ENERGY EFFICIENCY

- Efforts to **increase energy efficiency** in buildings and products
- **Construction**, including residential, industrial, and commercial; specialty contracting industries such as roofing, plumbing and HVAC; and finish carpentry
- **Manufacturing**, including HVAC equipment, semiconductors, instruments, lighting and appliances

CLEAN TRANSPORTATION

- Transportation based on **low- or zero-emission** vehicles
- **Manufacturing of transportation equipment**, including trucks, buses, rail, and motor vehicle parts
- **Transportation service industries** such as bus, rail, and freight trucking are also important industries in this category

This workforce assessment identifies the industries and occupations that make up the clean generation, energy efficiency, and clean transportation industry groups. The standard classification systems used in this assessment to identify industries and occupation in these three industry groups capture some jobs that are not 100% clean. For example, electricians are a key occupation in the clean energy generation industry group, but not all electricians spend all of their time on clean energy activities.

As a result, this assessment does not provide a definitive accounting of clean energy and clean transportation jobs in North Carolina. Rather, this assessment provides valuable data on the industries and occupations that comprise these clean industry groups. The industries identified employ the workforce needed in the clean generation, energy efficiency, and clean transportation sectors. If these sectors continue to expand, North Carolina will see an increase in associated clean jobs. By supporting the workforce in these industries, North Carolina will continue to be well positioned in an increasingly clean economy.

FASTEST-GROWING PROJECTED OCCUPATIONS (BY 2026) INCLUDE:

Solar Photovoltaic Installers	43%
Transit and Intercity Bus Drivers	15%
Electrical Power-Line Installers	15%
First-Line Construction Supervisors	12%
Plumbers and Pipefitters	12%
Construction Managers	12%
HVAC Mechanics and Installers	12%
Electrical Engineers	11%

LARGEST GROUPS OF WORKERS BY OCCUPATION	
Electricians	12,000
Power-Line Installers & Repairers	3,500
HVAC Mechanics & Installers	11,000
Construction Laborers	11,000
First-Line Construction Supervisors	25,000
Construction Managers	7,000
Carpenters	9,500
Plumbers	9,500
Roofers	2,700
Welders	2,500
Manufacturing Assemblers & Fabricators	17,000
Heavy & Tractor-Trailer Truck Drivers	28,000
Light Truck & Delivery Services Drivers	7,000
Freight Laborers	12,000
Bus Drivers	3,400
Bus & Truck Mechanics	2,200

Core industries for the clean economy employ workers in a wide range of occupations.

The clean economy includes a wide range of occupations, including truck drivers, electricians, construction supervisors, and HVAC installers and mechanics.

Projected job growth is particularly high for occupations including solar photovoltaic installers, bus drivers, electrical line workers, and construction supervisors.

Jobs are available at all education, skill, and wage levels

- Many of these jobs require only high school education and some additional training
- Community Colleges offer a range of credentials and short-term training relevant to these occupations
- Four-year degrees are required for jobs such as electrical engineers, architects, and managers
- Median annual wages range from $30k (Construction Laborers) to $100k (Engineers and Managers)

Seven of these occupations are ranked as "5-Star" jobs, based on wages, projected growth rate, and projected job openings:

Occupation	Growth Rate (by 2026)	Job Openings (by 2026)	2018 Median Annual Wages
Construction Managers	11.8%	12,123	$97,290
Cost Estimators	10.0%	7,143	$59,750
Electrical Engineers	11.2%	3,969	$91,680
Electrical Power-Line Installers & Repairers	14.5%	4,178	$59,690
First-Line Supervisors of Construction Trades & Extraction Workers	12.4%	27,095	$59,040
First-Line Supervisors of Mechanics, Installers, & Repairers	8.9%	14,590	$63,620
General & Operations Managers	10.6%	46,843	$108,750

INTRODUCTION

On October 29th, 2018, Governor Roy Cooper signed Executive Order 80, entitled "North Carolina's Commitment to Address Climate Change and Transition to a Clean Energy Economy." The order directed the NC Department of Commerce to develop clean energy and clean transportation workforce assessments, which shall:

- Evaluate the **current and projected workforce demands** in North Carolina's clean energy and clean transportation sectors,
- Assess the **skills and education required** for employment in these sectors, and
- **Recommend actions** to help North Carolinians develop such skills and education.

In order to carry out this charge, members of the Department of Commerce consulted with industry experts and other stakeholders (including other state agencies and education and workforce development partners); consulted with national and state-level research organizations; conducted a literature review; and carried out analysis of industry and occupational data available to the Labor and Economic Analysis Division (a list of stakeholders is provided in the Appendix).

Though this process, the NC Department of Commerce has determined the following:

1. North Carolina has a large clean energy economy, including clean generation, energy efficiency, and clean transportation industries;
2. North Carolina is meeting current workforce needs overall, in large part because of its strong workforce and education systems;
3. North Carolina has opportunities to prepare its workforce for growth of the clean economy.

5-STAR JOB PROFILE

Construction Managers

Projected Growth Rate by 2026: 11.8%
Job Openings by 2026: 12,123
2018 Annual Median Wages: $97,290

Construction managers plan, coordinate, budget, and supervise construction projects from start to finish.

Construction managers typically must have a bachelor's degree, and learn management techniques through on-the-job training. Large construction firms increasingly prefer candidates with both construction experience and a bachelor's degree in a construction-related field.

See more at bls.gov/ooh

After an explanation of the methodology underlying this assessment, this document discusses workforce finding and opportunities for North Carolina's clean generation, energy efficiency, and clean transportation industry groups.

I. Clean Economy Workforce Assessment Methodology

To assess North Carolina's clean energy and clean transportation workforce, Commerce identified three industry groups and the occupations they include. This enables the identification of valuable information related to employment levels, salary, required education and skills, and demographics, as well as projected growth.

A. *What are Clean Energy and Clean Transportation Industries?*

While there are various definitions of "clean" energy or transportation industries, this document groups these industries into three categories: 1) **Clean Energy Generation+**: the production, storage, transmission and distribution of energy from zero-emission sources[1]; 2) **Energy Efficiency**: efforts to broadly increase energy efficiency; and 3) **Clean Transportation**: transportation based on reduced- or zero-emission vehicles.

Due to the relatively recent emergence of these technologies, the existing, commonly used industrial classification system does not comprehensively capture the many types of activities and jobs occurring under the broad "clean" umbrella term. Specifically, the 2017 North American Industrial Classification System (NAICS) defines industries as groups of establishments (business locations) that provide similar goods or services and serves as the primary classification system for industrial activity used by the federal statistical agencies such as the Bureau of Labor Statistics.[2] Although the 2017 NAICS system includes some directly relevant industries such as Solar Electric Power Generation, this industry includes only establishments with this specific code and their direct employees. This industry code, would not, however, include employees of establishments categorized in other ways. For example, establishments whose employees install solar panels on a house may be classified as part of the Residential Electrical Contractors industry or the Residential Roofing Contractors industry, or even as Temporary Help Services, depending on the primary activity and coding of the establishment. Furthermore, establishments that produce the solar panels themselves would be categorized as a Manufacturing industry. Therefore, capturing the range of business activities relevant to the clean economy requires analyses across a relatively broad range of industry classifications rather than a limiting the analyses to a narrowly defined group of industries.

B. *What are Clean Energy and Clean Transportation Occupations?*

While the NAICS system classifies establishments into similar *activities*, workers can be classified into occupations based upon the work they regularly carry out as well as their skills, education, training, and credentials. The Bureau of Labor Statistics uses the Standard Occupational Classification (SOC) system to categorize workers in occupations.[3] A small number of occupations work only in specialized industries, but most work across many different industries. For example, an Electrician could work in any of the industries mentioned above. The SOC system is periodically updated as new occupations emerge (and older ones disappear), however many of the current occupational titles may not be fully reflective of the changing nature of job activities. For example, the SOC system currently has occupations such as Wind Turbine Technicians and Solar Photovoltaic Installers, but these are relatively small groups, and similar work may be performed by workers currently categorized as Mechanics, Electricians, or even Roofers.

Although these classification systems do not fully capture all of the relevant industries and occupations involved in the clean economy, they are the best systems available and are essential to accessing state and national data on employment, wages, education and skills and other economic data. While it is relatively easy to recognize certain industries and occupations (such as Solar Electric Power Generation and Solar Photovoltaic Installers), there are many other types of activities that are less obvious but relevant to clean energy and clean transportation, including

Professional and Business Services (including Scientific Research and Development Services), Education Services, and even Public Administration. In addition, as industries and occupations shift over time in response to changing technologies, some may become more relevant to the clean economy. For example, while clean energy or energy efficiency may have been more of a distinct (and perhaps "niche") set of activities in the past, it is now much more common for a wide range of businesses and individuals to seek out clean energy sources to power their operations and homes, to upgrade their existing facilities and homes to be more energy efficient, and to generally incorporate more sustainability principles into their overall businesses and lives. Similarly, aspects of clean transportation, such as improved fuel efficiency, increased electrification of vehicles, and automation and connectivity technology will have broad impacts for many businesses and individuals.

C. *How Have Other Researchers Defined These Industries and Occupations?*

Deciding which industries and occupations to include, and whether to count all employment and activity as "clean," is a challenge that researchers and industry groups have tackled in various ways. Typically, these fall into three different approaches:

1. Surveys of Businesses (either of energy-related or unknown firms)
2. Economic Impact Modeling
3. Industry and Occupational data analysis

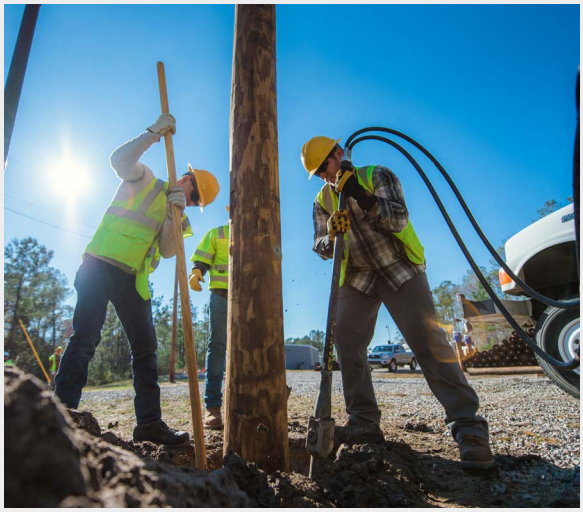
In terms of the *survey approach*, one of the most comprehensive national energy-related employment surveys is the U.S. Energy and Employment Report (USEER), conducted by BW Research partnership on behalf of the National

CLEAN ENERGY WORKFORCE INITIATIVE EXAMPLES

Cape Fear Community College

Electrical Lineworker Training Program

cfcc.edu/workforce/lineman



The Carolina Energy Workforce Consortium (representing North and South Carolina) estimates that the industry will need approximately 800 new lineworker each year for the next 5 years. To meet that demand, Cape Fear Community College's Electrical Lineworker Training Program is a 10-week course designed to prepare students career as an electrical lineworker. Students in the program learn the skills and knowledge required of an apprentice lineworker: setting and climbing poles; Installing cross arms, hardware, lines and transformers; using tools and equipment of the trade through field experience; overhead & underground construction practices; electric theory & practice; safety and teamwork; and commercial driving.

Association of State Energy Officials (NASEO) and the Energy Futures Initiative (EFI). Building on previous versions of the survey carried out by the U.S. Department of Energy until 2017, the USEER is a survey of 22,500 business establishments across the nation and seeks to determine the proportion of establishments and employees that work with specific energy-related technologies (including both fossil-fuel based as well as clean energy). Based on the 6,100 responses to the survey, the researchers developed incidence rates among industries (by state) as well as apportioned employment across industry categories, seeking to overcome some of the classification challenges noted above. Based on these responses, the researchers provide state-level breakouts of energy-related employment in five categories: 1) Electric Power Generation, 2) Fuels, 3) Transmission, Distribution, and Storage, 4) Energy Efficiency, and 5) Motor Vehicles. Within each category, the researchers are further able to breakout the employment by detailed technology (such as Solar Electric within Electric Power Generation). According to the 2019 results (based on 2018 employment), North Carolina has a low concentration of energy employment compared to the U.S. overall, with 54,198 "Traditional Energy" workers (19,894 in Electric Power Generation, 8,342 in Fuels, and 25,962 in Transmission, Distribution, and Storage), an additional 86,559 jobs in energy efficiency, and 71,414 jobs in motor vehicles. Within Electric Power Generation, the researchers estimate NC's Solar Electric Generation employment at 8,912 (including 6,719 full-time jobs), with smaller numbers of other clean technology applications such as wind and hydroelectric.

Building on these state-level breakouts of the USEER data, Environmental Entrepreneurs (E2) and the Clean Jobs Counts campaign focus specifically on what they define as clean energy jobs in five categories: 1) Energy Efficiency (86,559), 2) Renewable Energy (12,091), 3) Grid and Storage (3,469), 4) Clean Vehicles (7,280), and 5) Fuels (1,513). Based on their analysis, NC has a total of 110,913 clean energy jobs across these five categories, making up over half of NC's total energy-related employment as calculated by the USEER (212,172).

Another survey-based approach to estimating the size of these industries comes from the NC Sustainable Energy Association (NC SEA)'s 2018 North Carolina Clean Energy Industry Census, a survey of 2,368 firms with 1,495 responses (and supplemental modeling for non-respondents). Based on the results, clean energy employs 43,238 jobs in the state, with the highest levels in Energy Efficiency (23,892), Solar (6,457), and Alternative Fuel Vehicles (2,542), followed by Energy Storage (1,749), Bioenergy (1,629), Geothermal (1,075) and Wind (1,062), among other technologies.

CLEAN ENERGY WORKFORCE INITIATIVE EXAMPLES

Central Carolina Community College

Sustainability Technologies Program

cccc.edu/sustainability

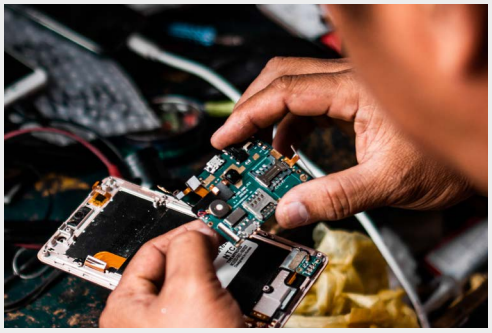
The Sustainability Technologies Program at Central Carolina Community College opens the door to a variety of careers in the growing green economy. The Associate in Applied Science in Sustainability Technologies degree builds on the college's long experience in training workers and entrepreneurs for fields that are both earth- and consumer-friendly. Career options for graduates are varied, including building performance analysts, renewable energy technicians, green building specialists, and sustainability managers

NC SEA has also used an *economic impact approach*, specifically commissioning Research Triangle International (RTI) to update their Economic Impact Analysis of Clean Energy Development in North Carolina in 2019, which modeled the "direct and secondary effects associated with major energy efficiency initiatives and the construction, operation, and maintenance of renewable energy projects" in the state between 2007 and 2018. Based on the $14.8 billion invested in clean energy development (at an estimated cost of $1.2 billion to state government) during this time period, their model estimates employment of 169,127 annual full-time equivalents (FTEs).[4]

An example of the *industry and occupational data analysis approach* to defining clean energy jobs comes from the Brookings Metropolitan Policy Program's recent report entitled "Advancing Inclusion Through Clean Energy Jobs" (April 2019). While recognizing previous national and state-level approaches aimed at quantifying the number of jobs in the clean energy economy (including the USEER and others), the Brookings researchers take a different approach by first identifying groups of relevant industries and then focusing on *occupations* that are particularly concentrated in those industries. The researchers claim the advantages to this approach are both specific (by defining a clear set of power generating sectors) and flexible (as occupations shift over time in response to industry shifts).

They then proceed to create sets of 6-digit NAICS industries[5] for each of the three industry categories, based on industries identified in previous studies such as the USEER, the BLS's green jobs survey, and a 2011 Brookings report called "Sizing the Clean Economy". Brookings analyzes the occupations working in these industries (through a staffing pattern breaking out all the occupations within a given industry) and focuses on the concentration quotient for each occupation. This quotient simply divides an occupation's share of sectoral employment by the occupation's share of national employment, resulting in a value of greater than one (more concentrated in those industries than in the overall economy) or less than one (less concentrated). Based on this methodology, the researchers develop lists of 113, 172, and 186 occupations for the clean energy, energy efficiency, and environmental management sectors, respectively, and utilize these sets of occupations for additional analysis.

5-STAR JOB PROFILE



Electrical Engineers

Projected Growth Rate by 2026: 11.2%
Job Openings by 2026: 3,969
2018 Annual Median Wages: $91,680

Electrical engineers design, develop, test, and supervise the manufacture of electrical equipment, such as electric motors, radar and navigation systems, communications systems, or power generation equipment. Electrical engineers also design the electrical systems of automobiles and aircraft.

Electrical engineers must have a bachelor's degree. Employers also value practical experience, such as internships or participation in cooperative engineering programs.

See more at bls.gov/ooh

D. *How Does This Workforce Assessment Differ?*

These various approaches to studying the clean economy differ in their definitions, methodologies, and therefore their ultimate results. While they each have advantages and drawbacks, they all provide valuable perspectives on the challenges of capturing these emerging sets of industries and jobs. To fulfill the directive outlined in Executive Order 80, the workforce assessment used in this report borrows most closely from the Brookings approach, but with a few differences. Like the Brookings report, this assessment begins with defining groups of industries, but is more focused on occupational analysis than industry job counts. This assessment also includes three broad industry groups, but does not include environmental management industries and instead creates a *clean transportation* group. And finally, this assessment also analyzes occupations working in these industries, but focuses on the *largest* occupational groups within each industry group (rather than concentration). This allows a focus on the occupations with the largest job opportunities across the state, rather than highly concentrated but perhaps smaller-scale occupations.

This approach to selecting industries, like the Brookings approach, is a broad one—by including a large set, it seeks to capture relevant industries, some proportion of which may be involved in "clean" activities. While survey-based approaches are more appropriate to estimating what proportions of industry employment are clean, this approach is more focused on specific worker occupations. As the Brookings report points out, as new technologies are adopted these jobs will be affected in various ways, with some growing or shrinking in size, as well as changing in job activities.

CLEAN ENERGY WORKFORCE INITIATIVE EXAMPLES

Central Piedmont Community College

Tesla START Program

cpcc.edu/programs/automotive-systems-technology

In April 2018, Central Piedmont Community College became the first community college in the country to host the Tesla START program, a partnership that provides students with the skills necessary for job placement as a service technician at Tesla service centers. The START Program Technician will go through an intensive 12-week EV service training program designed to provide the candidate with the skills necessary for a successful career with Tesla. During the program, students will develop technical expertise and earn certifications through a blended approach of in-class theory, hands-on labs and self-paced learning. Students are also given enhanced soft skills and team-based repair practices.

II. Workforce Assessment Findings

The NC Department of Commerce has reached the following findings based upon its analysis using the methodology described above. This section describes these findings in more detail.

1. North Carolina has a large clean economy workforce;
2. North Carolina is meeting current workforce needs overall, in large part because of strong workforce and education systems;
3. North Carolina can do more to prepare its workforce for growth of the clean economy.

A. *North Carolina Has a Large Clean Economy Workforce*

THREE CLEAN INDUSTRY GROUPS

Based on previous research and existing industry classifications, North Carolina's clean energy and transportation sectors can be divided into three broad groups of industries: ***Clean Energy Generation+***, ***Energy Efficiency***, and ***Clean Transportation***. While not all these industries are exclusively "clean", they all involve products and services relevant to clean energy and transportation and employ the ***workforce*** needed in these emerging industries. If recent trends continue, a greater share of these industries are expected to become clean in response to market demands. The goal in creating these groups is not to produce a definitive employment count or to capture all possibly relevant activities, but rather to use them as a starting point for identifying important occupations in the clean workforce. The job counts below should therefore be considered as the maximum clean energy- and transportation-related industry employment. (See Appendix 1 for a complete list of 6-digit NAICS industries).

Clean Energy Generation+ is comprised of 18 industries defined at the 6-digit NAICS level (presented below in broader groups to avoid data suppression). These industries include several Utilities industries involved in electric power generation from multiple zero-emission sources including hydroelectric, solar, wind, and geothermal. Electric power transmission and control as well as distribution are also included, while recognizing that these activities do not distinguish between power generated by "clean" sources or fossil-fuel based sources. Several Construction industries are included in this grouping, including power and communication line construction and electrical contractors. Finally, this group include some Manufacturing industries relevant to grid components such as the manufacturing of turbines and turbine generator sets, transformers, storage batteries, and current-carrying wiring devices.

CLEAN ENERGY GENERATION+ INDUSTRIES

Grouped to avoid data suppression

	2018 Jobs	5-Year Growth Rate
Utility Construction and Electrical Contractors	41,589	28.3%
Power Generation and Supply	8,260	84.9%
Other Electrical Equipment & Component Manufacturing	4,338	-6.0%
Power Boiler, Heat Exchanger, Turbine & Turbine Generator Set Units Manufacturing	2,244	-10.9%
Power, Distribution, & Specialty Transformer Manufacturing	640	6.3%
***CLEAN ENERGY GENERATION+* TOTAL**	**57,071**	**27.9%**

Energy Efficiency is a set of 37 industries defined at the 6-digit NAICS level (presented below in broader groups to avoid data suppression). These industries involve the Construction of energy-efficient buildings and provisions of energy efficient services, as well as the Manufacturing of energy-efficient products. A large range of Construction industries are included, from construction of new housing, commercial, and industrial buildings to remodeling and specialty contracting industries such as roofing, plumbing and HVAC, and carpentry contractors. This category also includes Professional and Technical Services such as architectural, drafting, and building inspection services. Manufacturing industries in this category includes manufacturing of energy-related products and equipment used in energy production and energy efficiency more broadly, such as metal window and door manufacturing, electric lighting, heating and cooling equipment, and household appliance manufacturing.

ENERGY EFFICIENCY INDUSTRIES

Grouped to avoid data suppression

	2018 Jobs	5-Year Growth Rate
Building Construction & Land Subdivision	49,083	31.3%
Plumbing & HVAC Contractors	39,779	32.2%
Electronic Instrument & Semiconductor Manufacturing	12,587	13.8%
Carpentry & Other Specialty Contractors	10,924	10.5%
Architectural, Landscape, Drafting & Building Inspection Services	6,395	10.2%
HVAC & Commercial Refrigeration Equipment Manufacturing	5,877	8.5%
Roofing Contractors	5,328	9.4%
Nonmetallic Mineral Product and Architectural & Structural Metals Manufacturing	4,335	22.6%
Household Appliance, Miscellaneous Electrical Equipment & Component Manufacturing	3,497	233.6%
Motor & Generator Manufacturing	3,038	9.1%
Electric Lighting Equipment Manufacturing	900	-7.2%
***ENERGY EFFICIENCY* TOTAL**	**141,744**	**25.6%**

Clean Transportation is a set of 33 industries defined at the 6-digit NAICS level (presented below in broader groups to avoid data suppression). The industries involve the Manufacturing of motor vehicles and parts, rail components as well as transportation service industries. A large range of Manufacturing is included, from automobile and truck manufacturing to a variety of motor vehicle parts manufacturing and railroad rolling stock manufacturing. A variety of transportation service industries are also included, such as rail transportation,[6] freight trucking, public and school buses, and other specialty transportation such as taxi service and charter buses.

CLEAN TRANSPORTATION INDUSTRIES

Grouped to avoid data suppression

	2018 Jobs	5-Year Growth Rate
Truck Transportation	43,075	15.7%
Transportation Equipment Manufacturing	27,310	21.3%
Couriers and Messengers	18,741	31.2%
Transit and Ground Passenger Transportation	8,480	14.2%
Support Activities for Rail Transportation	346	25.9%
***CLEAN TRANSPORTATION* TOTAL**	**97,951**	**19.9%**

LARGEST OCCUPATIONS IN NC'S CLEAN INDUSTRIES

For each of the three industry categories, analysts applied a staffing pattern of occupations working in each of the industries.[7] This approach reveals the largest occupations (at the most detailed 5-digit SOC level), focusing on those occupations comprising *at least one percent* of all occupations in the industry group. While this approach differs from the methodology used in the Brookings report, which focuses on occupational *concentration* within an industry group, this methodology captures the *most common jobs* within each industry rather than highly specialized (but smaller in number) types of jobs.[8]

This approach resulted in a set of 21 occupations within the Clean Energy Generation+ group, 20 occupations in Energy Efficiency and 15 occupations in the Clean Transportation group. These occupations account for nearly 2/3 of the total jobs in the Clean Energy Generation+ and Energy Efficiency categories and approximately 3/4 of the Clean Transportation jobs. While these highlighted occupations represent the majority of the workforce in these industries, it is important to recognize there are many smaller but significant occupations within each group. The occupations that account for the largest amount of employment are worth highlighting in that they offer significant opportunities for existing and prospective workers throughout the state.

CLEAN ENERGY GENERATION+ OCCUPATIONS

Occupation	2018 Jobs in Group	% of Total Jobs in Group
Electricians	12,385	21.7%
Helpers—Electricians	4,839	8.5%
Electrical Power-Line Installers & Repairers	3,519	6.2%
First-Line Supervisors of Construction Trades & Extraction Workers	3,266	5.7%

Occupation	2018 Jobs in Group	% of Total Jobs in Group
Construction Laborers	2,086	3.7%
Construction Managers	1,386	2.4%
Office Clerks, General	1,281	2.2%
Operating Engineers & Other Construction Equipment Operators	1,229	2.2%
Telecommunications Line Installers and Repairers	1,185	2.1%
First-Line Supervisors of Mechanics, Installers, & Repairers	1,122	2.0%
General & Operations Managers	960	1.7%
Telecommunications Equipment Installers & Repairers, Except Line Installers	880	1.5%
Secretaries & Administrative Assistants, Except Legal, Medical, & Executive	851	1.5%
Assemblers & Fabricators, All Other, Including Team Assemblers	808	1.4%
Electrical, Electronic, & Electromechanical Assemblers, Except Coil Winders, Tapers, & Finishers	798	1.4%
Customer Service Representatives	690	1.2%
Bookkeeping, Accounting, & Auditing Clerks	678	1.2%
Security & Fire Alarm Systems Installers	630	1.1%
Cost Estimators	597	1.0%
Electrical Engineers	592	1.0%
Solar Photovoltaic Installers	272	0.5%

ENERGY EFFICIENCY OCCUPATIONS

Occupation	2018 Jobs in Group	% of Total Jobs in Group
First-Line Supervisors of Construction Trades & Extraction Workers	10,844	7.7%
Heating, Air Conditioning, & Refrigeration Mechanics & Installers	10,772	7.6%
Carpenters	9,541	6.7%
Plumbers, Pipefitters, & Steamfitters	9,445	6.7%
Construction Laborers	8,727	6.2%
Construction Managers	5,762	4.1%
Office Clerks, General	4,638	3.3%
Assemblers & Fabricators, All Other, Including Team Assemblers	3,655	2.6%

Occupation	2018 Jobs in Group	% of Total Jobs in Group
General & Operations Managers	2,878	2.0%
Secretaries & Administrative Assistants, Except Legal, Medical, & Executive	2,864	2.0%
Helpers—Pipelayers, Plumbers, Pipefitters, & Steamfitters	2,730	1.9%
Roofers	2,710	1.9%
Bookkeeping, Accounting, & Auditing Clerks	2,483	1.8%
Electrical, Electronic, & Electromechanical Assemblers, Except Coil Winders, Tapers, & Finishers	2,438	1.7%
Cost Estimators	2,118	1.5%
Sales Representatives, Services, All Other	1,981	1.4%
Sheet Metal Workers	1,926	1.4%
Operating Engineers & Other Construction Equipment Operators	1,922	1.4%
Welders, Cutters, Solderers, & Brazers	1,526	1.1%
Architects, Except Landscape & Naval	1,387	1.0%

CLEAN TRANSPORTATION OCCUPATIONS

Occupation	2018 Jobs in Group	% of Total Jobs in Group
Heavy & Tractor-Trailer Truck Drivers	27,963	28.5%
Laborers & Freight, Stock, & Material Movers, Hand	11,788	12.0%
Assemblers and Fabricators, All Other, Including Team Assemblers	9,113	9.3%
Light Truck or Delivery Services Drivers	7,109	7.3%
First-line Supervisors of Transportation & Material Moving Workers, Except Aircraft Cargo Handling Supervisors	2,919	3.0%
Bus & Truck Mechanics & Diesel Engine Specialists	2,189	2.2%
Bus Drivers, School or Special Client	1,858	1.9%
Bus Drivers, Transit & Intercity	1,555	1.6%
Office Clerks, General	1,504	1.5%
Dispatchers, Except Police, Fire, & Ambulance	1,291	1.3%
Industrial Truck and Tractor Operators	1,212	1.2%
First-Line Supervisors of Production & Operating Workers	1,137	1.2%
Customer Service Representatives	1,041	1.1%

Occupation	2018 Jobs in Group	% of Total Jobs in Group
Inspectors, Testers, Sorters, Samplers, & Weighers	989	1.0%
Welders, Cutters, Solderers, & Brazers	940	1.0%

As can be seen in the tables above, the largest occupations in the Clean Energy Generation+ category are construction occupations (such as electricians and electricians' helpers, first-line supervisors, and operating engineers) and installation and repair occupations (electrical powerline and telecommunication line installers). These are followed by a mix of production, management, and office and administrative occupations. The Energy Efficiency group also has large numbers of construction occupations, including supervisors, plumbers, carpenters, and roofers, and HVAC mechanics and installers. The Clean Transportation group contains a large number of truck drivers (both heavy and light truck or delivery), assemblers and fabricators, bus and truck mechanics, and various types of bus drivers.

WAGES AND EDUCATIONAL REQUIREMENTS FOR CLEAN ECONOMY OCCUPATIONS

The wages for these occupations cover a wide range, from $28,880 annually for freight laborers to $108,750 annually for general and operations managers. The majority of these occupations pay higher wages than state average for all occupations. Of the 41 occupations in all three industry groups, 25 (61%) have median wages higher than the state median for all occupations ($35,750), while 16 (39%) of the occupations have median annual wages lower than the state median.

Occupation	Median Annual Wage 2018
General & Operations Managers	$108,750
Construction Managers	$97,290
Electrical Engineers	$91,680
Architects, Except Landscape & Naval	$78,200
First-Line Supervisors of Mechanics, Installers, & Repairers	$63,620
Cost Estimators	$59,750
Electrical Power-Line Installers & Repairers	$59,690
First-Line Supervisors of Construction Trades & Extraction Workers	$59,040
First-Line Supervisors of Production & Operating Workers	$58,560
Telecommunications Equipment Installers & Repairers, Except Line Installers	$53,950
First-Line Supervisors of Transportation & Material Moving Workers, Except Aircraft Cargo Handling Supervisors	$53,950
Sales Representatives, Services, All Other	$50,430
Security & Fire Alarm Systems Installers	$44,230
Bus and Truck Mechanics & Diesel Engine Specialists	$44,150
Telecommunications Line Installers & Repairers	$43,360

Occupation	Median Annual Wage 2018
Plumbers, Pipefitters, & Steamfitters	$43,140
Electricians	$43,110
Heavy & Tractor-Trailer Truck Drivers	$42,140
Heating, Air Conditioning, & Refrigeration Mechanics & Installers	$41,820
Welders, Cutters, Solderers, & Brazers	$39,610
Bookkeeping, Accounting, & Auditing Clerks	$38,550
Dispatchers, Except Police, Fire, & Ambulance	$38,330
Operating Engineers & Other Construction Equipment Operators	$37,930
Carpenters	$36,370
Secretaries & Administrative Assistants, Except Legal, Medical, & Executive	$36,330
ALL NC OCCUPATIONS	**$35,750**
Sheet Metal Workers	$35,580
Roofers	$35,290
Inspectors, Testers, Sorters, Samplers, & Weighers	$34,540
Industrial Truck & Tractor Operators	$33,200
Solar Photovoltaic Installers	$33,040
Customer Service Representatives	$32,910
Electrical, Electronic, & Electromechanical Assemblers, Except Coil Winders, Tapers, & Finishers	$30,330
Office Clerks, General	$30,230
Light Truck or Delivery Services Drivers	$29,930
Construction Laborers	$29,730
Bus Drivers, Transit & Intercity	$29,710
Helpers—Electricians	$29,470
Helpers—Pipelayers, Plumbers, Pipefitters, & Steamfitters	$29,470
Assemblers & Fabricators, All Other, Including Team Assemblers	$28,550
Bus Drivers, School or Special Client	$27,750
Laborers & Freight, Stock, & Material Movers, Hand	$25,880

The Bureau of Labor Statistics provides information on the educational requirements, work experience and job training needed to enter into an occupation.[9] The occupations identified in this assessment cover a large range of educational and training requirements. Five of the occupations (12%) require a Bachelor's degree for entry, four (10%) require more than a high school degree, 28 of the occupations (68%) only require a high school diploma or equivalent, and four (10%) have no formal education credential for entry according to the BLS. Only two occupations require five years or more of work experience for entry, three occupations require less than five years, and the remaining 36 occupations do not require any work experience. Five occupations generally require an apprenticeship or internship to enter, 30 occupations require some amount of on-the-job training, and six occupations do not require on-the-job training. It is important to recognize these are minimum requirements to

enter an occupation, according to the BLS, and may not match the actual educational attainment of incumbent workers or the minimum requirements demanded by employers in job postings, for example. They should therefore be considered as a rough guide to the requirements of any specific occupation.

HIGH SCHOOL DIPLOMA REQUIRED

Occupation	Occupation
Assemblers & Fabricators, All Other, Including Team Assemblers	Dispatchers, Except Police, Fire, & Ambulance
Bus & Truck Mechanics & Diesel Engine Specialists	Electrical Power-Line Installers & Repairers
Bus Drivers, School or Special Client	Electrical, Electronic, & Electromechanical Assemblers, Except Coil Winders, Tapers, & Finishers
Bus Drivers, Transit and Intercity	Electricians
Carpenters	First-Line Supervisors of Construction Trades & Extraction Workers
Construction Laborers*	First-Line Supervisors of Mechanics, Installers, & Repairers
Customer Service Representatives	First-Line Supervisors of Production & Operating Workers
First-Line Supervisors of Transportation & Material Moving Workers, Except Aircraft Cargo Handling Supervisors	Security & Fire Alarm Systems Installers
Helpers—Electricians	Sheet Metal Workers
Helpers—Pipelayers, Plumbers, Pipefitters, & Steamfitters	Solar Photovoltaic Installers
Sales Representatives, Services, All Other	Telecommunications Line Installers & Repairers
Secretaries and Administrative Assistants, Except Legal, Medical, & Executive	Welders, Cutters, Solderers, & Brazers

**No formal educational credential required*

SOME POSTSECONDARY EDUCATION REQUIRED

Includes Postsecondary Nondegree Award and Some College, No Degree

Occupation
Heating, Air Conditioning, & Refrigeration Mechanics & Installers
Heavy & Tractor-Trailer Truck Drivers
Telecommunications Equipment Installers & Repairers, Except Line Installers
Bookkeeping, Accounting, & Auditing Clerks

BACHELOR'S DEGREE REQUIRED

Occupation
Architects, Except Landscape & Naval
Construction Managers
Cost Estimators
Electrical Engineers
General & Operations Managers

In addition to the BLS minimum requirements, more detailed information on occupational characteristics is available through O*Net OnLine, including a description of the knowledge areas, skills, and abilities required for every occupation. Using a similar methodology to the Brookings report, it is possible to compare the level of knowledge required for each of the selected occupations to the average for all occupations. Using this approach, occupations in both the Clean Energy and Energy Efficiency categories rank higher in the following areas: Engineering and Technology, Design, Building and Construction, and Mechanical knowledge areas, while occupations in the Clean Transportation category rank higher in Transportation knowledge. Occupations in Clean Energy also rank higher in Telecommunications knowledge. These knowledge areas, while fairly general, may be useful in mapping onto the education and training offerings of relevance to workers seeking to enter these industries. O*Net Online is also a useful resource for assessing more detailed and emerging occupations of relevance to Clean Energy, Energy Efficiency, and Clean Transportation, and maintains its own set of what it defines as "Green Economy" occupations.

PROJECTED GROWTH FOR CLEAN ECONOMY OCCUPATIONS

The Labor and Economic Analysis Division (LEAD) of the North Carolina Department of Commerce prepares projections of employment growth by industry and occupation for the state and sub-state areas. Employment projections are widely used by North Carolina's workforce, educational, and economic development partners for their planning in workforce development, programs and budgets, public policy, and career exploration activities. The 2017-2026 Employment Projections at the state and sub-state areas are based on a 10-year projection (2016-2026), with an updated data point estimate for 2017. The long-term projections are revised every two years to maintain currency and incorporate economic changes that occur in the state and local areas.

Projected growth rates for the 41 occupations are generally positive: 36 occupations are projected to grow by 2026 (from a base year of 2017), while five are projected to shrink in size.[10] Nineteen occupations are projected to grow at a faster rate than the overall state growth rate of 8.3 percent, while 17 occupations are projected to grow at a slower rate than the state. The top three occupations with the highest growth rates include solar photovoltaic installers (42.9%), transit and intercity bus drivers (15.0%), and electrical power-line installers and repairers (14.5%).

TOP 10 CLEAN ENERGY GEN+, EFFICIENCY, & TRANSPORTATION PROJECTED GROWTH OCCUPATIONS

Occupation	% Change	Job Change
Solar Photovoltaic Installers	42.9%	260
Bus Drivers, Transit & Intercity	15.0%	572
Electrical Power-Line Installers & Repairers	14.5%	678
Security & Fire Alarm Systems Installers	14.3%	393
Helpers--Pipelayers, Plumbers, Pipefitters, & Steamfitters	14.0%	415
First-Line Supervisors of Construction Trades & Extraction Workers	12.4%	3,258
Plumbers, Pipefitters, & Steamfitters	12.4%	1,540
Construction Managers	11.8%	1,879
Heating, Air Conditioning, & Refrigeration Mechanics & Installers	11.5%	1,746
Electrical Engineers	11.2%	627

The occupations with low or basically flat growth include dispatchers, bookkeepers, and office clerks. Those with negative growth rates include school bus drivers, secretaries, assemblers and fabricators, inspectors, and electrical assemblers. These occupations have high exit rates, indicative of an older workforce with many anticipated retirees. It is important to remember that despite negative overall growth, these occupational groups are still large and will continue to have openings for workers during this time period due to the need to replace exiting and transferring workers.

BOTTOM 10 CLEAN ENERGY GEN+, EFFICIENCY, & TRANSPORTATION PROJECTED GROWTH OCCUPATIONS

Occupation	% Change	Job Change
Telecommunications Equipment Installers & Repairers, Except Line Installers	2.7%	184
First-Line Supervisors of Production & Operating Workers	2.0%	426
Dispatchers, Except Police, Fire, & Ambulance	1.0%	49
Bookkeeping, Accounting, & Auditing Clerks	1.0%	455
Office Clerks, General	0.1%	80
Bus Drivers, School or Special Client	-0.8%	-125
Secretaries & Administrative Assistants, Except Legal, Medical, & Executive	-3.8%	-2,438
Assemblers & Fabricators, All Other, Including Team Assemblers	-7.8%	-3,339
Inspectors, Testers, Sorters, Samplers, & Weighers	-9.9%	-1,923
Electrical, Electronic, & Electromechanical Assemblers, Except Coil Winders, Tapers, & Finishers	-17.9%	-1,199

Based on these projections, the Labor and Economic Analysis Division also produces a "Star Jobs" ranking to identify promising occupations. Star ratings are assigned based on wages, projected growth rate, and projected job openings, and each occupation has a rating of between one and five stars. Occupations with five stars are considered to have better career prospects than occupations with fewer stars. Of the 41 occupations, seven have a 5-star ranking:

5-STAR JOBS IN CLEAN ENERGY GEN+, EFFICIENCY, & TRANSPORTATION PROJECTED GROWTH OCCUPATIONS

Occupation	2017-2026 Growth Rate	2017-2026 Total Openings	2018 Median Wage
Construction Managers	11.8%	12,123	$97,290
Cost Estimators	10.0%	7,143	$59,750
Electrical Engineers	11.2%	3,969	$91,680
Electrical Power-Line Installers & Repairers	14.5%	4,178	$59,690
First-Line Supervisors of Construction Trades & Extraction Workers	12.4%	27,095	$59,040
First-Line Supervisors of Mechanics, Installers, & Repairers	8.9%	14,590	$63,620
General and Operations Managers	10.6%	46,843	$108,750

In addition to these top-ranked occupations, another 15 occupations have a 4-star ranking, resulting in over half of the 41 occupations with a four or five-star ranking.

DEMOGRAPHICS OF THE CLEAN ECONOMY WORKFORCE

Data available from the US Census Bureau gives a more detailed look at the demographic characteristics of the current workforce in the identified occupations, including age, gender, race, and educational attainment. Using the results of the most recently available survey, the 2017 American Community Survey, it is possible to compare the 41 occupations of interest to the overall workforce in the state.

Overall, workers in the 41 occupations are more frequently men than women (67% men compared to 51% for the NC total), slightly older (23% of workers 55 years or older vs. 22% for NC), and less educated as whole than the state's total workforce (16% with a BA or higher vs. 34% for NC). Workers in the 41 occupations are similar in race/ethnicity to the overall state workforce (64% white non-Hispanic vs. 65% for NC), although with a higher percentage of Hispanic workers (11% vs. 9% for NC).

These demographic characteristics vary widely by specific occupation—construction occupations, for example, tend to be more male-dominated, have more Hispanic workers, and lower levels of educational attainment, while office and administrative support occupations tend to be female dominated, whiter, and older than the state averages. The presence and relative weight of these occupations can therefore influence the overall averages. However, as the Brookings report stresses, there are opportunities to grow the percentages of women, minority groups, and younger workers in many of these occupations. As employers report struggling to fill positions in a tight labor market, it is worth pursuing a strategy of reaching out to underrepresented workers in order to meet staffing needs.

CLEAN ENERGY WORKFORCE INITIATIVE EXAMPLES

Fayetteville Technical Community College

High School Connections: Introduction to Photovoltaic Systems Career & Technical Education Pathways

faytechcc.edu/academics/high-school-connections/career-technical-education-pathways/

High School Connections is a partnership between local high schools and Fayetteville Technical Community College that provides seamless dual enrollment educational opportunities for high school students in order to accelerate completion of college certificates, diplomas, and associate degrees that lead to college transfer or provide entry-level skill jobs. The Introduction to Photovoltaics Systems pathway provides training for persons interested in the installation and maintenance of electrical systems in residential and industrial facilities.

B. *North Carolina is Meeting Current Workforce Needs Overall, in Large Part Because of Strong Workforce and Education Systems*

In order to meet the hiring demands of employers in these industries, the education and workforce development systems in the state help produce new workers as well as retrain existing ones. Despite a tight labor market throughout the state and the nation, these providers seek to respond to industry needs and train workers at all levels, from high school through community college and university credentials, as well as through shorter-term and customized training. While the workforce and education system can not perfectly predict or quickly match supply to demand for every occupation, the systems are able to respond over time to increased demand from employers and workers. The following sections examine the supply of workers as well as recent demand for the occupations of interest to this assessment.

NC PROVIDES A HEALTHY SUPPLY OF WORKERS FOR CLEAN ECONOMY INDUSTRIES

In addition to assessing the current level of employment in the identified occupations, this assessment seeks to understand the role of North Carolina's post-secondary educational institutions and programs in developing the supply of workers in these occupations. To do so, analysts matched the education and training programs associated with the identified occupations in order to examine the supply of recent graduates. One source of data on recent graduates is the national Integrated Postsecondary Education Data System or IPEDS.[11] IPEDS includes information on the number of graduates by program and institution. This includes information from all colleges that are part of the North Carolina Community College System, University of North Carolina System institutions as well as private post-secondary institutions. IPEDS utilizes the Classification of Instructional Programs (CIP) taxonomic structure to classify programs, and through the use of a national crosswalk provides a means to align educational programs with specific occupations.[12] Utilizing the 41 identified occupations and several other closely associated occupations, analysts identified a set of nearly 170 related program codes (CIP).

IPEDS provides information regarding the number of "completions" by program and academic credential, these range from certificates, diplomas, and associate degrees at the community college level to Bachelor's, Master's, Doctoral degrees as well as post bachelors and master's certificates at the university level. According to the most recently

5-STAR JOB PROFILE

Electrical Line Installers & Repairers

Projected Growth Rate by 2026: 14.5%
Job Openings by 2026: 4,178
2018 Annual Median Wages: $59,690

Electrical Power-Line Installers and Repairers install and maintain the power grid—the network of power lines that moves electricity from generating plants to customers.

Line workers who maintain the interstate power grid work in crews that travel to locations throughout a large region to service transmission lines and towers. Workers employed by local utilities work mainly with lower voltage distribution lines, maintaining equipment such as transformers, voltage regulators, and switches.

See more at bls.gov/ooh

available data (2016-2017), North Carolina's public and private postsecondary institutions reported over 29,000 completions within the 170 program areas (CIPS). Of these, over 14,000 completions were in Business-related program areas (CIPs). These Business-related programs are most relevant to the office and administrative support occupations within the identified industries. Other program (CIPS) areas with large number of completions included:

- Mechanic and Repair Technologies/Technicians (3,198 completions)
- Engineering Technologies/Technicians (2,962 completions)
- Engineering (2,824 completions)
- Precision Production (2,295 completions)
- Construction Trades (1,595 completions)
- Transportation and Materials Moving (1,016 completions)

The largest number of academic awards were at the bachelor's level (33%), followed by awards of less than one year (such as diplomas and certificates at the community college level) (29%), Master's degrees (17%), and Associate degrees (13%).

In addition to the graduate information available through the national IPEDS, North Carolina has an expansive informational resource that is critical for understanding the role of North Carolina's education and training programs in developing North Carolina's workforce. This resource is the North Carolina Common Follow-up System (CFS).[13] CFS is a longitudinal data system that contains a repository of workforce and education data and is a joint effort among several of the North Carolina's education and workforce development agencies that is operated and maintained as a collaborative effort between the North Carolina Department of Commerce's Labor and Economic Analysis Division (LEAD) and the North Carolina Department of Information Technology's Government Data Analytics Center (GDAC). The CFS contains information on individual participants from North Carolina publicly supported education, employment and training programs dating back to the late 1990's and contains more than

CLEAN ENERGY WORKFORCE INITIATIVE EXAMPLES

Blue Ridge Community College

Diploma in Alternative Transportation Technology and Certificates in Alternative Fuels & Advanced Electric Drives

blueridge.edu/academics/alternative-transportation-technology

The Alternative Transportation Technology program at Blue Ridge Community College prepares individuals to apply technical knowledge and skills to the maintenance of alternative fuel vehicles (AFV), hybrid electric vehicles and the conversion of standard vehicles to AFV status. The program provides an introduction to transportation industry careers and increases student awareness of the diverse technologies associated with this dynamic and challenging field. Graduates of the program are prepared to take professional licensure exams and to enter careers as technicians in the alternative transportation technology industry.

25 years of employment and wage information on individuals working in jobs covered by North Carolina's Unemployment Insurance system. Available employment and wage related information includes data on individuals working in jobs covered by North Carolina's UI laws and does not include the self-employed, employment outside of the state and other non-covered workers.

Using data from the CFS, it is possible to assess the employment and wage patterns of individuals completing North Carolina public education and training programs associated with the identified CIPs. Analysts looked at data covering over 18,600 unique individuals who received an academic credential from a University of North Carolina (UNC) System institution or North Carolina Community College System (NCCCS) institution during the 2017-2018 Academic Year. More than half (52%) of these individuals received an academic credential through the Community College System, while 35 percent received undergraduate degrees through the UNC System and 13 percent received graduate level degrees through the UNC System. The large proportion of graduates from the NCCCS demonstrates the vital role that North Carolina's community colleges play in helping to prepare the state's current and future workforce, and particularly in energy related occupations (such as construction and installation), which tend to require fewer credentials at the Bachelor's and graduate level and more Community College related academic awards.

While CFS can be utilized to provide information on the number of graduates by academic credential it can also be utilized to assess the post completion employment patterns of individuals in the years subsequent to their completion. This information is critical in understanding the role of North Carolina's educational institutions in preparing the energy-related workforce as well as the retention of these workers in North Carolina's job market. Utilizing CFS, analysts evaluated the post-completion employment patterns of individuals in the related CIPS beginning with the 2009-2010 academic year. Analysis revealed that roughly 75 percent of the 2009-2010 graduates were employed in the state one year after graduation. The post-graduation employment percentage tends to go down over time as individuals may leave the state, work in jobs not covered by UI or stop working completely. Employment patterns for community college graduates tended to decrease slightly over time while employment patterns of UNC System undergraduates decreased at a faster rate, from approximately 75 percent employed in North Carolina one year after graduation to approximately 63 percent by the fifth year after graduation. UNC System graduate degree recipients tend to have much lower initial rates of employment in North Carolina, closer to 60 percent, and this rate declined to approximately 50 percent over the next five years. It is important to note that in addition to leaving the state, working in non-covered employment, or not working at all, some graduates may be enrolled in further education and not working.

5-STAR JOB PROFILE

Cost Estimators

Projected Growth Rate by 2026: 10.0%
Job Openings by 2026: 7,143
2018 Annual Median Wages: $59,750

Cost Estimators prepare estimates for buildings, roads, and other construction projects. They may calculate the total cost of building a bridge or commercial shopping center, or they may calculate the cost of just one component, such as the foundation. They identify costs of elements such as raw materials and labor, and they may set a timeline for how long they expect the project to take. Although many work directly for construction firms, some work for contractors and engineering firms.

See more at bls.gov/ooh

In contrast to the decline in post-graduation employment over time, wage progression generally increased over time for both NCCCS and UNC graduates. For the cohorts graduating from 2010 to 2014, analysts calculated the average annual wages after one year and after five years. For NCCCS graduates in the energy related program areas, average annual wages ranged from $21,000-$25,000 one year after graduation to $32,000-$38,000 after five years. For UNC undergraduates, average annual wages rose from $22,000-$28,000 one year after graduation to $46,000-$53,000 after five years. For UNC graduate-level degree earners, wages rose from a $48,000-$61,000 one year after graduation to $81,000-$87,000 after five years. It is important to keep in mind that these average wage rates cover a diverse and large set of program areas that reflect large variation in employment and wage outcomes by program and graduation cohorts.

In addition to the curriculum programs that lead to academic awards, including diplomas, certificates, and associate degrees, the North Carolina Community College System provides a diverse set of education and training programs and courses through its continuing education and customized training programs. These programs typically entail short-term trainings with many offerings related to energy and transportation related occupations. In addition to the supply of workers from North Carolina's higher education institutions, students graduating from high schools provide another source of worker supply to the identified energy and transportation related occupations, particularly in those occupations related to construction, installation, and production, which only generally require a high school degree and some on the job training.

5-STAR JOB PROFILE

First-Line Supervisors of Mechanics, Installers, & Repairers

Projected Growth Rate by 2026: 8.9%
Job Openings by 2026: 14,590
2018 Annual Median Wages: $63,620

These First-Line Supervisors directly supervise and coordinate the activities of mechanics, installers, and repairers. These supervisors have a high concentration in the electric power generation, transmission, and distribution industry.

These positions typically require a High school diploma or equivalent for entry and generally require less than 5 years of work experience in a related occupation.

See more at bls.gov/ooh

In addition to utilizing information from the CFS to analyze the supply of workers from the North Carolina Community College System and UNC System, analysts utilized the Unemployment Insurance wage information to study the current workforce in the energy and transportation industries and their participation in various public education, employment and training programs that broadly comprise North Carolina's workforce development system. To do so, analysts identified individuals who were working in 2018 in one of the clean energy generation+, energy efficiency, and clean transportation industries and assessed their participation in North Carolina's education, training and workforce development programs over the over the past 10 years.

In 2018, there were over 440,000 unique wage earners across the identified industries. Of these individuals, 261,000 (59%) had participated in at least one education, training or workforce development program during the ten years prior (2008-2017). This includes individuals participating in public high school education programs

through the Department of Public Instruction (including Career and Technical Education (CTE) and other academic programs), individuals participating in any of the workforce development programs offered through the NC Commerce's Division of Workforce Solutions, individuals participating in education and training program through the North Carolina Community College System, individuals participating in educational program through the UNC System as well as other workforce development programs including those offered by the Department of Social Services and the Department of Public Safety.

Nearly 150,000 individuals (34%) or one out of every three workers in these energy generation+, energy efficiency, and clean transportation industries had participated in education or training program through the North Carolina Community College System. This includes large numbers from the NCCCS Continuing Education and Customized Training (14%) programs as well as the Curriculum programs (10%). While more than 25,000 workers (6%) in these industries participated in educational programs through the UNC system during the previous 10 years.

In addition to the continuing education and curriculum programs offered through the North Carolina Community College System has responsibility for North Carolina's registered apprenticeship programs through the ApprenticeshipNC programs. These programs provide a valuable resource in helping to prepare North Carolina's workforce—in 2019 the ApprenticeshipNC programs had over 8,400 active apprentices in a diverse set of occupations. Over 4,500 individuals were enrolled in registered apprenticeship occupations related to North Carolina's clean economy. This included over 1,040 in Electrical Power-Line Installers and Repairers, 967 Electricians, 688 Telecommunications Equipment Installers and Repairers, 248 Telecommunications Line Installers and Repairers, 212 Pipe Fitters and Steamfitters and 180 Heavy and Tractor-Trailer Truck Drivers.

Overall, the analysis of worker supply demonstrates that North Carolina's education and training programs provide a significant pipeline of workers to the energy generation+, energy efficiency and clean transportation industries. North Carolina's education and workforce development system provides large numbers of workers each year from programs that span the education and workforce continuum including the state's public educational high schools, private high schools, North Carolina's Community College System, University of North Carolina System, North Carolina private colleges and universities as well as a diverse set of other workforce development programs operated by the Department of Commerce, Department of Health and Human Services and the Department of Public Safety. Of particular note is the large and significant role that the North Carolina Community College System programs play in helping to prepare workers for North Carolina's clean economy.

DEMAND IN KEY OCCUPATIONS FOR NC'S CLEAN ECONOMY

As discussed above, the occupational projections provide estimates of future demand. Another measure of current and recent demand are online job postings as collected by the Conference Board's Help Wanted Online (HWOL).[14] This tool aggregates and deduplicates online job posting from a variety of sources and codes them by occupation and geography. Because online jobs postings are more commonly used for certain occupations, these data are adjusted using estimates from the Bureau of Labor Statistics' national Jobs Openings, Layoffs, and Turnover Survey (JOLTS).[15] Using this methodology, it is possible to look at average monthly online postings by occupation for North Carolina and can compare the growth or decline in postings for a given occupation over time.

One way to measure demand is to look at the ratio of the number of monthly postings for an occupation to the total employment in that occupation. The occupations with the highest ratios are highlighted in the following table.

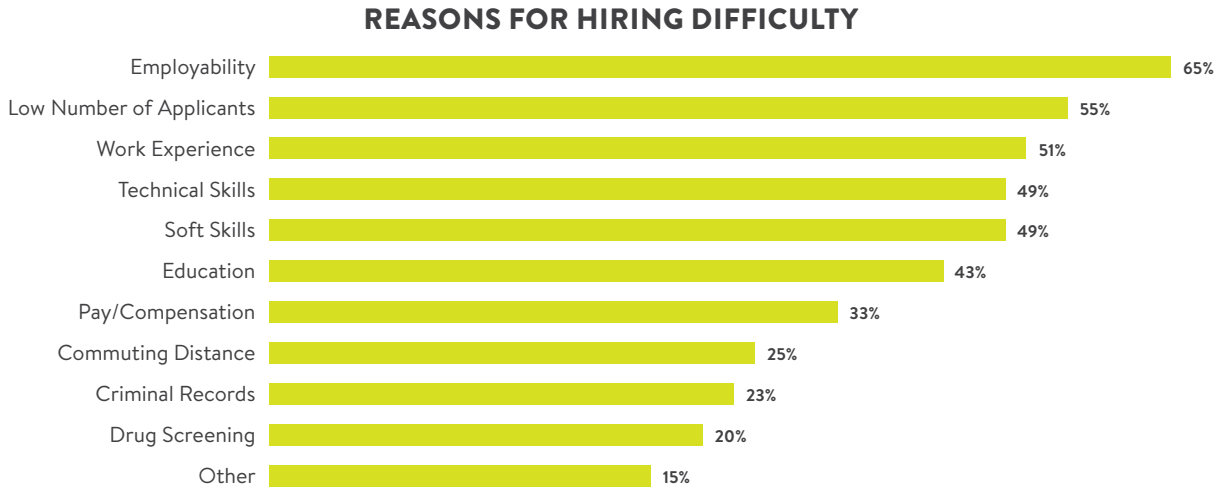
OCCUPATIONS IN HIGH DEMAND

Occupation	Monthly Postings/ 2017 Employment
First-Line Supervisors of Production & Operating Workers	15%
Heavy and Tractor-Trailer Truck Drivers	10%
Light Truck or Delivery Services Drivers	8%
Customer Service Representatives	7%
Bus & Truck Mechanics & Diesel Engine Specialists	6%
Sales Representatives, Services, All Other	6%
First-Line Supervisors of Construction Trades & Extraction Workers	5%
Sheet Metal Workers	5%
Telecommunications Equipment Installers & Repairers	5%
First-Line Supervisors of Mechanics, Installers, & Repairers	5%
Roofers	5%
Electrical Engineers	5%

In other words, in an average month in 2018, employers are trying to hire 15 percent of the total employment for production supervisors, 10 percent of total heavy truck drivers and 8 percent of the total light truck drivers, and so on. The remainder of the 41 occupations have a posting intensity of less than 5 percent. A posting intensity of this level suggests either a high level of "churn" in these occupations (larger numbers of new hires and quitting workers at any one time) or a difficulty attracting new entrants into the occupation. Several of these occupations have also seen a large increase in postings from 2013 to 2018, including production supervisors (147%), heavy truck drivers (98%), light truck drivers (188%), bus and truck mechanics (128%), construction supervisors (163%), and supervisors of mechanics (95%). This suggests these occupations were in high and increasing demand in 2018.

Another measure of demand comes directly from employers and industry associations with whom the analysts met over the course of the past year. Employers frequently mentioned strong hiring demand in construction, skilled trades, and technical fields such as engineering. They stressed both technical skills as well as soft skills or general employability, touching on topics such as applicants' drug use or criminal records as barriers to hiring. One frequent comment was that, due to an aging workforce, there was a strong need to hire younger workers. Yet due to a lack of interest in these particular occupations or industries, as well as employability challenges, employers struggled to hire sufficient numbers of workers.

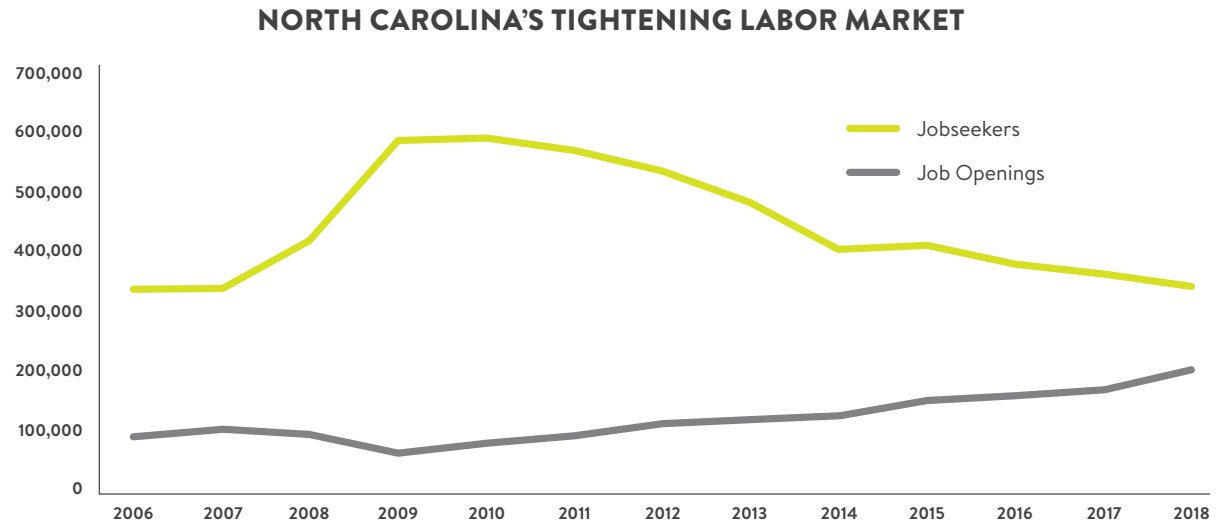
These comments have been expressed across a wide range of employers, and since 2014 the Department has conducted a biennial Employer Needs Survey on behalf of the NCWorks Commission to try to quantify and provide perspective on the hiring needs and difficulties of employers in the state. In the 2018 survey, employers experiencing hiring difficulties gave the following reasons for difficulty:



Source: NC Department of Commerce, 2018 Employer Needs Survey

A lack of employability was the top reason for hiring difficulties in 2018, with criminal records and inability to pass a drug test less frequently selected. A low number of applicants may be a function of a rural location, unappealing working conditions or negative industry perceptions, or low wages. In a tight labor market, it is expected that employers will continue to have hiring challenges and may have to reexamine wage levels and working conditions as well as to get creative about recruitment and marketing strategies.

In general, North Carolina's labor market is tighter than at any point since before the Great Recession, meaning that the number of jobseekers per job opening is low. Jobseekers consist of all unemployed persons as well as a portion of the employed and not-in-the-labor-force workers with recent work experience. Job openings are estimated using online job postings data from Help Wanted OnLine (HWOL) as well as a federal survey of employers.



Source: NC Department of Commerce, Labor Supply/Demand Analyzer

This situation, although good for workers, can be challenging for employers. It is important to remember that this tightness is not necessarily permanent, but it is a result of the long economic expansion since the Great Recession. In addition to the cyclical nature of the business cycle, longer term structural trends such as the aging of the workforce, greater use of automation and artificial intelligence, and changes in productivity will also have impacts on the amount and type of human capital required by employers. Changes in technology, such as the increased adoption of clean energy and clean transportation technologies, will also change the industrial and occupational makeup of the economy, creating opportunities as well as challenges.

III. North Carolina has Opportunities to Prepare its Workforce for Growth of the Clean Economy

In assessing the state's clean energy, energy efficiency, and clean transportation workforce, several trends and themes emerge that inform actions by businesses, workers, government, education institutions, and workforce training programs. This section identifies opportunities for these actors to ensure North Carolina's workforce remains competitive in a rapidly evolving clean economy.

A. *Maintain Flexibility for a Dynamic Clean Economy*

The clean generation, energy efficiency, and clean transportation industries are in transition globally, nationally, and in North Carolina. As technologies evolve, new policies at the state and federal level are implemented, customer expectations shift, and public awareness of climate change increases, markets will continue to shift. As industries change and incorporate clean technologies and practices (to varying degrees), the workforce needs of these industries also will shift. Therefore, workers and employers, as well as the education and training providers in the state, will need to remain flexible in terms of workforce preparation. As these technologies becomes more integrated into all aspects of the economy, there will be both challenges and opportunities for workforce. Ideally, workers in the clean economy will possess a high level of technical skills (such as engineering, design, math and computing), soft skills (creativity, problem-solving, teamwork), and basic employability (strong work ethic, ability to pass a drug test). Workers will need to be aware that they may have to continually upskill, retrain, and be willing to switch industries and occupations as the economy shifts in unexpected ways.

Employers may find they also need to be flexible, particularly around the expectations of jobseekers who may be uninterested or wary of certain industries or occupations. In addition, there may need to be flexibility around credentials in an economy where intensive, short-term, training may become more important than degrees. Employers also may need to change expectations about who is responsible for worker training. Rather than expect the education and workforce development system to fully prepare workers for rapidly changing needs, employers may need to reevaluate their own internal training and promotion strategies as well as proactively reach out to workforce development partners to help define and respond to specific needs. Finally, wage levels, working conditions, and hiring qualifications may need to be adjusted in order to respond to a tight labor market.

The state's workforce development system also has a role to play in bringing together employers, workers, and education and training providers to meet changing needs. The following recommendations are suggestions to bring together all these stakeholders in order to take advantage of the opportunities and tackle challenges that the clean economy will bring.

B. *Increase Collaboration between Employers and Education Providers*

Several existing collaborations in North Carolina among employers and education providers serve as models for increased engagement around workforce development.

- The Community College Council of Associations for Engagement (CAFE) is a group of statewide industry associations created in 2017 to focus on "specific workforce issues such as turnover associated with the graying of the workforce, need for employability skills, perceptions of their industries, and the need for flexible short-term training."[16] A recent meeting of this group featured the success of the Carolinas Energy Workforce Consortium (CEWC), a group of electric utilities, municipals, electric cooperatives, as well as contractor companies which service these energy provide in the Carolinas. Faced with the intense need for electric lineworkers in 2017, this industry consortium partnered with 11 community colleges to create curriculum for lineworker programs and establish programs within two years of formation, demonstrating the potential for relatively quick response when industry clearly articulates a need and partners with willing education providers.
- The Research Triangle Cleantech Cluster's Talent Action Committee is an example of an industry and education collaboration which identifies talent needs, challenges, and opportunities relevant to the energy and technology industry. One recent project of this group is an educator-focused program in which public school teachers are exposed to trends and opportunities in the clean energy economy which they can then take back to fellow teachers and students.
- The NC Business Council on Education (NCBE) is a business-led, education non-profit organization that provides a critical link between North Carolina business leaders and the state's education decision makers, helping to create connections between the education curriculum and the overall work readiness of people across the state. It partners with statewide education departments and organizations to implement experiential projects that create a contextual fabric of understanding of the critical link between curriculum content and workforce talent needs. One such example is its Navigator platform, a free, first-of-its-kind, online tool to lead the way in connecting education to career. The platform brings together members of the business, education, and workforce development communities in a space where they can post, search for, and measure work-based learning opportunities. These opportunities are experiential learning activities ranging from guest speaking roles to apprenticeships, posted by businesses and used by educators and members of the workforce communities.
- The UNC system has valuable assets in three clean energy research centers: NC State University's NC Clean Energy Technology Center (founded in December 1987 as the North Carolina Solar Center); The Appalachian Energy Center (AEC) at Appalachian State University; and North Carolina A&T State University's Center for Energy Research and Technology. These centers combine clean energy research, education, and applied activities for a wide range of stakeholders and are valuable connection points between industry and higher education providers and students.

C. *Increase Awareness of Job Opportunities for Youth to Develop the Pipeline of Future Workers*

One of the most common challenges employers mentioned in meeting their workforce needs was bringing in younger workers into their industries and occupations, particularly in the skilled trades and manufacturing. Many of these industries and occupations have a large percentage of older workers facing retirement and a limited number of younger workers to fill vacancies. Tackling the "interest gap" involves educating young people about opportunities in these fields and addressing potential misperceptions about the industries and jobs involved. One key theme will be the increased role of technology and automation in many of these fields, which will require a higher level of technical skills and ability to collaborate with technology in all fields. Educating current and future workers about the wages paid by in-demand occupations can also help reorient perceptions.

Efforts to tackle this interest gap need to target students in high school and middle school (as well as their parents), building on several existing state assets.

- The Community Colleges currently employ career coaches that work in public high schools across the state to assist students in forming their career goals and enrolling in an educational pathway that suits this goal. However, there are currently only 72 career coaches employed by 34 colleges serving 143 high schools, a number that could be significantly increased with additional funding.
- An increased emphasis on career and technical education (CTE) by the Department of Public Instruction (DPI), as well as early-college and pre-apprenticeship programs can all be important pieces of tackling the interest gap.
- NCCareers is a one-stop career planning solution for North Carolinians at every stage in the education to employment continuum. Created by a variety of education and workforce partners (including Commerce's Labor and Economic Analysis Division and the Division of Workforce Solutions, the State Educational Assistance Authority, NCCCS, DPI, the UNC System, and the Department of Health and Human Services), the tool will allow users recognize their skills/interests; explore occupations and local job/employer needs; identify education and training opportunities; and prepare to enter the job market. Set to launch by the 2020-2021 school year, the tool will be promoted to counselors, educators, parents, students and job seekers (including those with disabilities) to become NC's premier career information platform.
- Increase employer awareness of the benefits of working with the ApprenticeshipNC program, an employer-driven model that combines on-the job learning with related classroom instruction. This program, administered by the North Carolina Community College System, can serve as a recruitment tool for employers seeking to fill positions in the clean economy. Additional sources for training future workers are Union Apprenticeship programs, such as the International Brotherhood of Electrical Workers' (IBEW) Joint Apprenticeship and Training Committee (JATC), that train apprentices at five centers across North Carolina. Many of these programs have existing relationships with the Community College system and provide training for sustainable and renewable energy sources including solar and wind. The IBEW also runs pre-apprenticeship programs with a goal of getting more women and people of color trained as electricians.

In addition to the state's efforts, employers themselves can play an active role in addressing the interest gap through improved marketing and active participation in school programming—ideally with employers going into schools as well as bringing students into the workplace. Work-based learning opportunities are also key, whether through formal pre-apprenticeship and apprenticeship programs, paid internships, or less formal opportunities for students to gain exposure to these industries and occupations.

D. *Leverage the NC Department of Commerce's Stakeholder Relationships as well as Business and Workforce Development Programs to Better Support the Clean Economy*

The NC Department of Commerce can help support the development of the state's clean economy in several ways:

- Convey to stakeholders the findings of this workforce assessment and work with them to implement next steps;
- Consider the development or expansion of incentive programs geared towards growing and recruiting clean economy businesses;
- Consider reviewing clean energy and energy efficiency adoption by companies under consideration for grants and loans; and
- Develop collaborative workforce development activities among the Division of Workforce Solutions, the NCWorks Commission, and the state's 23 Workforce Development Boards.

One existing program of particular relevance to the clean economy is the One North Carolina Small Business Program, which provides matching funds to North Carolina businesses who have received a federal Phase I Small Business Innovation Research (SBIR) Program or Small Business Technology Transfer (STTR) award. These awards support the development and commercialization of innovative new technologies, many of which focus on Clean Energy and Clean Transportation. The One North Carolina Small Business Program is administered by the Office of Science, Technology & Innovation on behalf of the Board of Science, Technology & Innovation. This program could be increased and perhaps specifically targeted more toward clean economy businesses.

The North Carolina Green Business Fund, also administered by the Office of Science, Technology & Innovation, provides competitive grants to help small businesses develop commercial innovations and applications in the biofuels industry and the green building industry, as well as attract and leverage private sector investments and entrepreneurial growth in environmentally conscious technologies and renewable energy products and businesses. While this program is currently inactive due to a lack of funding, it could be reactivated with additional funding.

The Department of Commerce's Division of Workforce Solutions can play an expanded role in the development of the clean energy and clean transportation economy by coordinating with the NCWorks Commission and local workforce development boards to increase awareness of and training for clean economy occupations. One recent initiative worth highlighting is the approval by the NCWorks Commission of the state's first Energy Career Pathway, a collaboration among the Carolinas Energy Workforce Consortium and six local workforce development boards (Region C, Mountain Area, Gaston, Western Piedmont, Charlotte Works and Centralina Workforce Development Boards). This workforce assessment can help inform the decision-making process as local areas, regions, and the state seek to take advantage of opportunities in the clean economy, as well as prepare for the possibility for challenges to certain occupations and industries as the economy changes.

E. *Specialize in Strategic Sectors of the Clean Economy and Work to become a Leading Clean Economy State*

North Carolina has numerous workforce assets upon which to build a competitive advantage in the clean economy.

CLEAN TRANSPORTATION MANUFACTURING

As a state with a strong manufacturing workforce, particularly in automotive parts and truck manufacturing, North Carolina has the potential to help lead a transformation in clean transportation manufacturing. North Carolina had over 37,000 jobs and 403 establishments in Transportation Manufacturing in NC in 2018, with nearly half (49%) in Motor Vehicle Parts (18,000 jobs). Aerospace Product and Parts (17%) had over 6,000 jobs, Motor Vehicle Manufacturing (14%) had over 5,000 jobs, and Motor Vehicle Body and Trailer Manufacturing (11%) had over 4,000 jobs.

Recent clean transportation manufacturing announcements show the potential for NC as a clean transportation center. At a recent Advanced Clean Transportation Expo, Daimler Trucks North America announced its Thomas Built unit will assemble electric school buses in High Point, NC, employing a battery-electric system from Proterra Inc., in which Daimler Trucks invested $155 million.[17] Siemens will begin manufacturing the company's Rave Charger, an electric bus and truck charger capable of supporting shuttle services at locations such as airports or public depots, at its Wendell facility.[18] Finally, Volvo Trucks, headquartered in Greensboro, will put its Volvo LIGHTS' all-electric Volvo VNR regional-haul demonstrator trucks into operation in California in late 2019, ahead of a planned commercial North American roll-out in 2020.[19]

CLEAN ENERGY: SOLAR AND OFFSHORE WIND

North Carolina also has strengths in clean energy, particularly solar energy, and has been ranked second in the country in adding new solar energy and fourth for growth projection, according to the Solar Energy Industries Association.[20] In addition, the state has potential for developing offshore wind energy. Building on these types of strengths will require the state and industry to partner to identify areas of comparative advantage and to make strategic investments in these areas, including investments in workforce development throughout the state.

ADDITIONAL OPPORTUNITIES

In order to explore the opportunities and potential challenges involved in the emerging clean economy, the state should consider funding additional industry-focused research. One area of interest is an analysis of the supply chain for electric vehicles and the potential impacts that growth in this market would have on North Carolina's motor vehicle parts manufacturers. A similar study on the supply chain for offshore wind turbines would also be useful in understanding how the state's manufacturers and other industries could be impacted by the development of this resource. Finally, more detailed surveys of businesses involved in the clean economy would be useful, particularly of firms engaged in research and development and other professional and business services that support the clean economy.

IV. Conclusion

This workforce assessment has examined the current and projected needs of the clean energy and clean transportation workforce, the skills and education required for such jobs, and made recommendations to help more North Carolinians achieve these skills and education. This report has identified areas of strengths, including examples of innovative collaborations, as well as areas for improvement and future growth. While much about the specific technologies and future innovations that will drive the clean economy are uncertain, the general trend towards cleaner forms of energy and mobility is likely to continue as the state, nation, and the world begin to seriously engage the many interrelated problems of climate change. This process will involve changes to the economy and to the workforce, but also holds great potential and opportunities. This assessment can help guide future activities as North Carolinians embrace this future.

APPENDICES

Appendix 1: Stakeholder Organizations Consulted by the Department of Commerce

AFL-CIO North Carolina

BW Research

Clean Air Carolina

Duke University Nicholas Institute (Energy Efficiency Roadmap Workforce Subcommittee)

E2 (Environmental Entrepreneurs)

E4 Carolinas

Energy Futures Initiative (EFI)

Environmental Entrepreneurs (E2) North Carolina

International Brotherhood of Electrical Workers (IBEW)

National Association of State Energy Officials (NASEO)

NC Building Performance Association

North Carolina Clean Energy Technology Center

North Carolina Climate Change Interagency Council

North Carolina Community College System

North Carolina Department of Environmental Quality

North Carolina Department of Transportation

North Carolina Department of Environmental Quality Stakeholder Engagement Sessions

North Carolina State Energy Conference

North Carolina Sustainable Energy Association (NC SEA)

Partnership for Transportation Innovation Opportunity (PTIO)

Research Triangle Cleantech Cluster

State of Washington Employment Security Department

TREDPLAN

UNC System

U.S. Bureau of Labor Statistics

In addition to the organizations listed above, the Department of Commerce would like to acknowledge the contributions to this report by the following Department staff:

Project Managers: George Sherrill and John Hardin

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Graphic Design: Laura Murray

Appendix 2: Response to Public Comments

Following the publication of the initial draft of this report and a call for public comments, the Department of Commerce received written comments from six stakeholder organizations. In general, the comments were broadly supportive of the Department's approach but also suggested additional areas of focus or clarification. This feedback has been helpful to guide the final version of this report, and the Department appreciates these external perspectives.

One recommendation was that the state support the concept of a "just transition," in which current workers who become displaced as a result of the transition to a clean economy are able to be supported, potentially retrained, and reemployed in high-quality jobs. In North Carolina, this may apply to workers in coal-fueled power plants who may be unable to transfer easily to jobs in clean energy production. This recommendation calls for the state to help codify best practices around protections for displaced workers in the fossil fuel industry, to create a "Just Transition Task Force," to create a dedicated funding stream for workforce training for these workers, and to look to best practices from other states with existing transition task forces. In response to these needs, the Department could explore the feasibility of aligning existing federal dislocated worker resources through its federal Workforce Innovation and Opportunity Act (WIOA) Dislocated Worker funding.

Another area of omission was a mention of the Union Apprenticeship programs, such as the International Brotherhood of Electrical Workers' (IBEW) Joint Apprenticeship and Training Committee (JATC) that train apprentices at five centers across North Carolina. Many of these programs have existing relationships with the Community College system and provide training for sustainable and renewable energy sources including solar and wind. The IBEW also runs pre-apprenticeship programs with a goal of getting more women and people of color trained as electricians.

Other recommendations received included the creation of a more detailed inventory or census of the entire North Carolina energy industry, workforce projections of specific policy scenarios contained in DEQ's Clean Energy plan, and analyses of specific aspects of the clean economy (such as offshore wind). Another common recommendation was to increase apprenticeship opportunities specifically for clean energy occupations. The Department agrees that these topics deserve additional research and actions, and this document can serve as a starting point for more detailed future activities.

Appendix 3: NAICS Industry Classification to Clean Energy Generation+, Efficiency, and Transportation Crosswalk

CLEAN ENERGY GENERATION+

NAICS	Description	Industry Group
221111	Hydroelectric Power Generation	Power Generation & Supply
221114	Solar Electric Power Generation	Power Generation & Supply
221115	Wind Electric Power Generation	Power Generation & Supply
221116	Geothermal Electric Power Generation	Power Generation & Supply
221118	Other Electric Power Generation	Power Generation & Supply
221121	Electric Bulk Power Transmission & Control	Power Generation & Supply
221122	Electric Power Distribution	Power Generation & Supply
221330	Steam & Air-Conditioning Supply	Power Generation & Supply
237130	Power & Communication Line & Related Structures Construction	Utility Construction & Electrical Contractors
237990	Other Heavy & Civil Engineering Construction	Utility Construction & Electrical Contractors
238211	Residential electrical contractors	Utility Construction & Electrical Contractors
238212	Nonresidential electrical contractors	Utility Construction & Electrical Contractors
332410	Power Boiler & Heat Exchanger Manufacturing	Power Boiler, Heat Exchanger, Turbine & Turbine Generator Set Units Manufacturing
333611	Turbine & Turbine Generator Set Units Manufacturing	Power Boiler, Heat Exchanger, Turbine & Turbine Generator Set Units Manufacturing
335311	Power, Distribution, & Specialty Transformer Manufacturing	Power, Distribution, & Specialty Transformer Manufacturing
335911	Storage Battery Manufacturing	Other Electrical Equipment & Component Manufacturing
335929	Other Communication & Energy Wire Manufacturing	Other Electrical Equipment & Component Manufacturing
335931	Current-Carrying Wiring Device Manufacturing	Other Electrical Equipment & Component Manufacturing

ENERGY EFFICIENCY

NAICS	Description	Industry Group
236115	New Single-Family Housing Construction (except For-Sale Builders)	Building Construction & Land Subdivision
236116	New Multifamily Housing Construction (except For-Sale Builders)	Building Construction & Land Subdivision
236117	New Housing For-Sale Builders	Building Construction & Land Subdivision
236118	Residential Remodelers	Building Construction & Land Subdivision
236210	Industrial Building Construction	Building Construction & Land Subdivision

236220	Commercial & Institutional Building Construction	Building Construction & Land Subdivision
237210	Land Subdivision	Building Construction & Land Subdivision
238161	Residential Roofing Contractors	Roofing Contractors
238162	Nonresidential Roofing Contractors	Roofing Contractors
238221	Residential plumbing & HVAC contractors	Plumbing & HVAC Contractors
238222	Nonresidential plumbing & HVAC contractors	Plumbing & HVAC Contractors
238351	Residential Finish Carpentry Contractors	Carpentry & Other Specialty Contractors
238352	Nonresidential Finish Carpentry Contractors	Carpentry & Other Specialty Contractors
238991	All Other Residential Specialty Trade Contractors	Carpentry & Other Specialty Contractors
238992	All Other Nonresidential Specialty Trade Contractors	Carpentry & Other Specialty Contractors
327993	Mineral Wool Manufacturing	Nonmetallic Mineral Product & Architectural and Structural Metals Manufacturing
332321	Metal Window and Door Manufacturing	Nonmetallic Mineral Product & Architectural and Structural Metals Manufacturing
332322	Sheet Metal Work Manufacturing	Nonmetallic Mineral Product & Architectural and Structural Metals Manufacturing
333413	Industrial & Commercial Fan & Blower & Air Purification Equipment Manufacturing	HVAC & Commercial Refrigeration Equipment Manufacturing
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	HVAC & Commercial Refrigeration Equipment Manufacturing
333415	Air-Conditioning & Warm Air Heating Equipment & Commercial & Industrial Refrigeration Equipment Manufacturing	HVAC & Commercial Refrigeration Equipment Manufacturing
334413	Semiconductor & Related Device Manufacturing	Electronic Instrument & Semiconductor Manufacturing
334512	Automatic Environmental Control Manufacturing for Residential, Commercial, & Appliance Use	Electronic Instrument & Semiconductor Manufacturing
334513	Instruments and Related Products Manufacturing for Measuring, Displaying, & Controlling Industrial Process Variables	Electronic Instrument & Semiconductor Manufacturing
334515	Instrument Manufacturing for Measuring & Testing Electricity & Electrical Signals	Electronic Instrument & Semiconductor Manufacturing
335110	Electric Lamp Bulb and Part Manufacturing	Electric Lighting Equipment Manufacturing
335121	Residential Electric Lighting Fixture Manufacturing	Electric Lighting Equipment Manufacturing

335122	Commercial, Industrial, and Institutional Electric Lighting Fixture Manufacturing	Electric Lighting Equipment Manufacturing
335129	Other Lighting Equipment Manufacturing	Electric Lighting Equipment Manufacturing
335312	Motor and Generator Manufacturing	Motor and Generator Manufacturing
335210	Small Electrical Appliance Manufacturing	Household Appliance, Miscellaneous Electrical Equipment & Component Manufacturing
335220	Major Household Appliance Manufacturing	Household Appliance, Miscellaneous Electrical Equipment & Component Manufacturing
335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	Household Appliance, Miscellaneous Electrical Equipment & Component Manufacturing
541310	Architectural Services	Architectural, Landscape, Drafting & Building Inspection Services
541320	Landscape Architectural Services	Architectural, Landscape, Drafting & Building Inspection Services
541340	Drafting Services	Architectural, Landscape, Drafting & Building Inspection Services
541350	Building Inspection Services	Architectural, Landscape, Drafting & Building Inspection Services

CLEAN TRANSPORTATION

NAICS	Description	Industry Group
336111	Automobile Manufacturing	Transportation Equipment Manufacturing
336112	Light Truck & Utility Vehicle Manufacturing	Transportation Equipment Manufacturing
336120	Heavy Duty Truck Manufacturing	Transportation Equipment Manufacturing
336211	Motor Vehicle Body Manufacturing	Transportation Equipment Manufacturing
336310	Motor Vehicle Gasoline Engine & Engine Parts Manufacturing	Transportation Equipment Manufacturing
336320	Motor Vehicle Electrical & Electronic Equipment Manufacturing	Transportation Equipment Manufacturing
336330	Motor Vehicle Steering & Suspension Components (except Spring) Manufacturing	Transportation Equipment Manufacturing
336340	Motor Vehicle Brake System Manufacturing	Transportation Equipment Manufacturing
336350	Motor Vehicle Transmission & Power Train Parts Manufacturing	Transportation Equipment Manufacturing
336360	Motor Vehicle Seating & Interior Trim Manufacturing	Transportation Equipment Manufacturing
336370	Motor Vehicle Metal Stamping	Transportation Equipment Manufacturing
336390	Other Motor Vehicle Parts Manufacturing	Transportation Equipment Manufacturing
336510	Railroad Rolling Stock Manufacturing	Transportation Equipment Manufacturing

482110	Rail transportation	Rail Transportation
484110	General Freight Trucking, Local	Truck Transportation
484121	General Freight Trucking, Long-Distance, Truckload	Truck Transportation
484122	General Freight Trucking, Long-Distance, Less Than Truckload	Truck Transportation
484220	Specialized Freight (except Used Goods) Trucking, Local	Truck Transportation
484230	Specialized Freight (except Used Goods) Trucking, Long-Distance	Truck Transportation
485111	Mixed Mode Transit Systems	Transit & Ground Passenger Transportation
485112	Commuter Rail Systems	Transit & Ground Passenger Transportation
485113	Bus & Other Motor Vehicle Transit Systems	Transit & Ground Passenger Transportation
485119	Other Urban Transit Systems	Transit & Ground Passenger Transportation
485210	Interurban & Rural Bus Transportation	Transit & Ground Passenger Transportation
485310	Taxi Service	Transit & Ground Passenger Transportation
485320	Limousine Service	Transit & Ground Passenger Transportation
485410	School & Employee Bus Transportation	Transit & Ground Passenger Transportation
485510	Charter Bus Industry	Transit & Ground Passenger Transportation
485991	Special Needs Transportation	Transit & Ground Passenger Transportation
485999	All Other Transit & Ground Passenger Transportation	Transit & Ground Passenger Transportation
488210	Support Activities for Rail Transportation	Support Activities for Rail Transportation
492110	Couriers & Express Delivery Services	Couriers & Messengers
492210	Local Messengers & Local Delivery	Couriers & Messengers

Appendix 4: Occupational Projections for Select Occupations (Statewide Totals)

Occupational Title	Employment Estimate 2017[1]	Employment Estimate 2026[1]	Net Change[2]	Percent Change[3]	Total Openings Exits[4]	Total Openings Transfers[5]	Total Openings Change[6]	Total Openings[7]	Education[8]	Work Experience[8]	Job Training[8]	2018 Regional Median Annual Wage[9]	Star Jobs Rating
First-Line Supervisors of Production & Operating Workers	21,332	21,758	426	2.00	6,182	12,410	426	19,018	High school diploma or equivalent	Less than 5 years	None	$58,560	3
Heavy and Tractor-Trailer Truck Drivers	61,732	65,120	3,388	5.49	24,203	35,860	3,388	63,451	Postsecondary nondegree award	None	Short-term on-the-job training	$42,140	4
Light Truck or Delivery Services Drivers	28,355	30,224	1,869	6.59	11,177	16,560	1,869	29,606	High school diploma or equivalent	None	Short-term on-the-job training	$29,930	3
Customer Service Representatives	99,178	107,185	8,007	8.07	47,472	69,666	8,007	125,145	High school diploma or equivalent	None	Short-term on-the-job training	$32,910	4
Bus and Truck Mechanics & Diesel Engine Specialists	9,695	10,564	869	8.96	2,797	5,201	869	8,867	High school diploma or equivalent	None	Long-term on-the-job training	$44,150	4
Sales Representatives, Services, All Other	33,115	36,166	3,051	9.21	9,861	26,912	3,051	39,824	High school diploma or equivalent	None	Moderate-term on-the-job training	$50,430	0
First-Line Supervisors of Construction Trades & Extraction Workers	26,225	29,483	3,258	12.42	8,024	15,813	3,258	27,095	High school diploma or equivalent	5 years or more	None	$59,040	5
Sheet Metal Workers	3,528	3,776	248	7.03	1,136	2,254	248	3,638	High school diploma or equivalent	None	Apprenticeship	$35,580	3
Telecommunications Equipment Installers & Repairers, Except Line Installers	6,851	7,035	184	2.69	2,073	4,416	184	6,673	Postsecondary nondegree award	None	Moderate-term on-the-job training	$53,950	3
First-Line Supervisors of Mechanics, Installers, & Repairers	16,615	18,095	1,480	8.91	5,058	8,052	1,480	14,590	High school diploma or equivalent	Less than 5 years	None	$63,620	5
Roofers	3,141	3,391	250	7.96	845	1,991	250	3,086	No formal educational credential	None	Moderate-term on-the-job training	$35,290	3
Electrical Engineers	5,617	6,244	627	11.16	1,205	2,137	627	3,969	Bachelor's degree	None	None	$91,680	5
Security & Fire Alarm Systems Installers	2,748	3,141	393	14.30	865	1,984	393	3,242	High school diploma or equivalent	None	Moderate-term on-the-job training	$44,230	4
Plumbers, Pipefitters, & Steamfitters	12,408	13,948	1,540	12.41	4,302	7,933	1,540	13,775	High school diploma or equivalent	None	Apprenticeship	$43,140	4

Occupational Title	Employment Estimate 2017[1]	Employment Estimate 2026[1]	Net Change[2]	Percent Change[3]	Total Openings Exits[4]	Total Openings Transfers[5]	Total Openings Change[6]	Total Openings[7]	Education[8]	Work Experience[8]	Job Training[8]	2018 Regional Median Annual Wage[9]	Star Jobs Rating
Inspectors, Testers, Sorters, Samplers, & Weighers	19,520	17,597	-1,923	-9.85	6,943	12,788	-1,923	17,808	High school diploma or equivalent	None	Moderate-term on-the-job training	$34,540	2
Construction Laborers	29,848	32,990	3,142	10.53	9,863	18,640	3,142	31,645	No formal educational credential	None	Short-term on-the-job training	$29,730	3
Carpenters	24,986	27,337	2,351	9.41	8,095	13,087	2,351	23,533	High school diploma or equivalent	None	Apprenticeship	$36,370	4
Welders, Cutters, Solderers, & Brazers	10,402	11,202	800	7.69	2,589	7,593	800	10,982	High school diploma or equivalent	None	Moderate-term on-the-job training	$39,610	4
Dispatchers, Except Police, Fire, & Ambulance	4,869	4,918	49	1.01	1,555	2,373	49	3,977	High school diploma or equivalent	None	Moderate-term on-the-job training	$38,330	2
Helpers--Electricians	5,157	5,492	335	6.50	2,025	4,627	335	6,987	High school diploma or equivalent	None	Short-term on-the-job training	$29,470	3
Helpers--Pipelayers, Plumbers, Pipefitters, & Steamfitters	2,956	3,371	415	14.04	1,203	2,749	415	4,367	High school diploma or equivalent	None	Short-term on-the-job training	$29,470	3
Operating Engineers & Other Construction Equipment Operators	12,301	13,336	1,035	8.41	4,406	8,091	1,035	13,532	High school diploma or equivalent	None	Moderate-term on-the-job training	$37,930	4
Heating, Air Conditioning, & Refrigeration Mechanics & Installers	15,200	16,946	1,746	11.49	3,995	9,699	1,746	15,440	Postsecondary nondegree award	None	Long-term on-the-job training	$41,820	4
Electrical Power-Line Installers & Repairers	4,667	5,345	678	14.53	1,136	2,364	678	4,178	High school diploma or equivalent	None	Long-term on-the-job training	$59,690	5
Secretaries & Administrative Assistants, Except Legal, Medical, & Executive	64,035	61,597	-2,438	-3.81	30,455	29,624	-2,438	57,641	High school diploma or equivalent	None	Short-term on-the-job training	$36,330	2
Solar Photovoltaic Installers	606	866	260	42.90	263	426	260	949	High school diploma or equivalent	None	Moderate-term on-the-job training	$33,040	4
Construction Managers	15,958	17,837	1,879	11.77	3,486	6,758	1,879	12,123	Bachelor's degree	None	Moderate-term on-the-job training	$97,290	5
Industrial Truck & Tractor Operators	23,325	24,448	1,123	4.81	7,488	16,087	1,123	24,698	No formal educational credential	None	Short-term on-the-job training	$33,200	3
Telecommunications Line Installers & Repairers	2,760	3,051	291	10.54	639	1,937	291	2,867	High school diploma or equivalent	None	Long-term on-the-job training	$43,360	4

Occupational Title	Employment Estimate 2017[1]	Employment Estimate 2026[1]	Net Change[2]	Percent Change[3]	Total Openings Exits[4]	Total Openings Transfers[5]	Total Openings Change[6]	Total Openings[7]	Education[8]	Work Experience[8]	Job Training[8]	2018 Regional Median Annual Wage[9]	Star Jobs Rating
Bookkeeping, Accounting, & Auditing Clerks	47,417	47,872	455	0.96	26,551	20,604	455	47,610	Some college, no degree	None	Moderate-term on-the-job training	$38,550	2
Electricians	17,134	18,205	1,071	6.25	5,539	11,819	1,071	18,429	High school diploma or equivalent	None	Apprenticeship	$43,110	4
Bus Drivers, Transit & Intercity	3,806	4,378	572	15.03	2,889	1,504	572	4,965	High school diploma or equivalent	None	Moderate-term on-the-job training	$29,710	4
Cost Estimators	7,061	7,769	708	10.03	2,102	4,333	708	7,143	Bachelor's degree	None	Moderate-term on-the-job training	$59,750	5
General & Operations Managers	54,022	59,722	5,700	10.55	10,611	30,532	5,700	46,843	Bachelor's degree	5 years or more	None	$108,750	5
Laborers & Freight, Stock, & Material Movers, Hand	91,793	98,911	7,118	7.75	42,514	73,373	7,118	123,005	No formal educational credential	None	Short-term on-the-job training	$25,880	3
Architects, Except Landscape & Naval	2,804	2,965	161	5.74	656	1,158	161	1,975	Bachelor's degree	None	Internship / Residency	$78,200	4
Bus Drivers, School or Special Client	16,264	16,139	-125	-0.77	11,438	5,955	-125	17,268	High school diploma or equivalent	None	Short-term on-the-job training	$27,750	2
Office Clerks, General	87,191	87,271	80	0.09	46,068	44,891	80	91,039	High school diploma or equivalent	None	Short-term on-the-job training	$30,230	2
Assemblers & Fabricators, All Other, Including Team Assemblers	42,756	39,417	-3,339	-7.81	15,793	26,783	-3,339	39,237	High school diploma or equivalent	None	Moderate-term on-the-job training	$28,550	0
First-Line Supervisors of Transportation & Material Moving Workers, Except Aircraft Cargo Handling Supervisors	11,933	12,834	901	7.55	3,580	7,661	901	12,142	High school diploma or equivalent	Less than 5 years	None	$53,950	4
Electrical, Electronic, & Electromechanical Assemblers, Except Coil Winders, Tapers, & Finishers	6,714	5,515	-1,199	-17.86	2,789	3,595	-1,199	5,185	High school diploma or equivalent	None	Moderate-term on-the-job training	$30,330	2
TOTAL, ALL NC OCCUPATIONS	**4,684,945**	**5,073,989**	**389,044**	**8.30**	**2,067,741**	**2,754,431**	**389,044**	**5,211,216**				**$35,750**	

1 *Base (2017) and projected year (2026) employment estimate.*

2 *The difference between the projected (2026) and base year (2017) employment.*

3 *Percentage change between base (2017) and projected (2026) year employment.*

4 *Exits are estimated positions based on workers leaving the labor force from this occupation.*

5 *Transfers are estimated positions based on workers leaving this occupation for a different occupation.*

6 *Total Change reflects the difference between the projected (2026) and base year (2017) employment.*

7 *Openings from exits, transfers, and change.*

8 *Minimum Educational Requirement, Work Experience, and Job Training to enter an occupation are from the 2016 Bureau of Labor Statistics (BLS) classification and are not available at total or 2-digit SOC level.*

9 *All wages are from the NC Occupational Employment Statistics (OES) 2018 data released in April 2019.*

ENDNOTES

1. This assessment uses the definition from the NC Department of Environmental Quality's Clean Energy Plan: "Clean" energy resources include solar, energy efficiency, battery storage, wind, efficient electrification, and other zero emitting technology options capable of quickly decarbonizing the power sector and modernizing the electric power sector." Page 17 of the Draft Clean Energy Plan at https://files.nc.gov/ncdeq/climate-change/clean-energy-plan/Clean-Energy-Plan--DRAFT-REPORT-08162019.pdf.
2. Further information on the NAICS available at https://www.bls.gov/bls/naics.htm.
3. Further information on the SOC available at https://www.bls.gov/bls/occupation.htm.
4. An FTE is equivalent to one person working full time for a year.
5. NAICS is a 2- through 6-digit hierarchical classification system, offering five levels of detail. Each digit in the code is part of a series of progressively narrower categories, and the more digits in the code signify greater classification detail. The first two digits designate the economic sector, the third digit designates the subsector, the fourth digit designates the industry group, the fifth digit designates the NAICS industry, and the sixth digit designates the national industry. The 5-digit NAICS code is the level at which there is comparability in code and definitions for most of the NAICS sectors across the three countries participating in NAICS (the United States, Canada, and Mexico). The 6-digit level allows for the United States, Canada, and Mexico each to have country-specific detail. A complete and valid NAICS code contains six digits (https://www.census.gov/eos/www/naics/faqs/faqs.html#q5).
6. Railroad employment is not covered employment under Unemployment Insurance law and will not be counted here.
7. Staffing Patterns from EMSI, Inc., a proprietary software.
8. One exception to this methodology is the inclusion of Solar Photovoltaic Installers, an occupation which fall below the 1% threshold but are included due to its relevance to the clean energy group as well as their high level of projected growth.
9. Available at https://www.bls.gov/emp/tables/education-and-training-by-occupation.htm.
10. Occupational projections, 2017-2026, produced by the NC Department of Commerce, Labor and Economic Analysis Division. In addition to projecting the net change in the size of an occupation, the total number of openings are also projected. Total openings in an occupation are the sum of net change in an occupation plus exits (workers leaving the labor force due to retirement or other reasons) plus transfers (workers leaving that particular occupation for another occupation).
11. Available at https://nces.ed.gov/ipeds/about-ipeds.
12. CIP descriptions available at https://nces.ed.gov/ipeds/cipcode/Default.aspx?y=55. Crosswalk available at https://nces.ed.gov/ipeds/cipcode/resources.aspx?y=55.
13. Description and select data available at https://nccareers.org/cfs.
14. More information available at https://www.conference-board.org/data/helpwantedonline.cfm.
15. Adjustment methodology described here: https://www.nccommerce.com/blog/2016/08/02/mismatch-mystery-searching-%E2%80%9Cskills-gap%E2%80%9D-north-carolina.
16. North Carolina Community Colleges: Putting Education to Work 2018-2022 Strategic Plan, p.9. Available at

https://www.nccommunitycolleges.edu/sites/default/files/a4ncw-basic-page/smallqualityfinal3.8.18.pdf.

17. Source: https://img03.en25.com/Web/GNA/%7B835c759d-fb1d-4f51-b90a-743950eb26a4%7D_ACTNewsLive_042519.pdf.
18. Source: https://www.bizjournals.com/triangle/news/2019/05/14/multinational-conglomerate-to-beef-up-its-triangle.html.
19. Source: https://img03.en25.com/Web/GNA/%7B835c759d-fb1d-4f51-b90a-743950eb26a4%7D_ACTNewsLive_042519.pdf.
20. Source: https://www.seia.org/states-map.

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