Preliminary Report of the South Carolina Clean Energy Industry Manufacturing Market Development Advisory Commission

December 30, 2014

In Partial Fulfillment of the Requirements of South Carolina 2014 Act 171

South Carolina Department of Commerce
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Introduction

From its 100 year-old, operational hydroelectric stations to new investments in state-of-the-art clean energy systems including utility-scale and distributed solar generation, South Carolina has a rich and evolving history in the clean energy industry. The state's research enterprise, from Clemson University and the University of South Carolina to the Savannah River National Lab, push the frontier of clean energy systems, providing innovators opportunities for the development of new products and services. In an effort to prepare the state for future growth in developing sectors of this vibrant market, the South Carolina Clean Energy Industry Manufacturing Market Development Advisory Commission (henceforth referred to as "the Commission") was formed as set forth in the South Carolina 2014 Act 171. Representing leaders in higher education, manufacturing and services industries and the state's electric utilities, the Commission is charged with developing a strategy "to assist in the development of clean energy technology, materials, and products manufactured in this State."

The clean energy industry is growing exponentially on a global scale. The International Energy Agency of the OECD expects renewable energy capacity will grow 40 percent between 2013 and 2018, requiring an annual global investment of $800 billion.[i] In addition, opportunities are emerging to transition global electric grids to support new renewable technologies, including improvements to grid security and reliability. This represents an enormous opportunity for South Carolina manufacturers to expand in these export markets. Moreover, domestic demand for renewable energy and energy efficient products will continue to grow rapidly, spurred by consumer demand and federal regulations on power generation and vehicle fuel efficiency. Bloomberg New Energy Finance estimates that US private-sector investment in renewable energy projects surpassed $100 billion in 2012-2013[ii].

Rather than focusing solely on industrial recruitment, the commission favors a holistic approach to developing the clean energy economy. Realizing that the perception of state's clean energy business climate reflects both its stance towards clean energy manufacturing and the market deployment of clean energy products, the Commission has focused its attention on policies and strategies to attract and grow manufacturing firms and develop in-state markets for the use of clean energy generation and energy efficient products. The Commission believes manufacturers of clean energy products are more likely to locate and expand in states that have a business climate conducive to the use of these products in-state. At the same time, the Commission also realizes that the low cost of energy in South Carolina is a primary driver of economic development in the state. As such, policies and programs to develop clean energy markets in South Carolina should not undermine this competitive advantage.

This preliminary report details some of the strategic advantages and institutional assets South Carolina can leverage to grow clean energy industry manufacturing. The report details the market potential for certain clean energy technologies and broadly defined opportunities for improvement in South Carolina's business environment needed to capture a greater share of the growing, global clean energy manufacturing sector.

The final recommendations of the Commission will be presented in a report to the Governor and South Carolina General Assembly by September 30, 2015.

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South Carolina Clean Energy Industry

As a state where the two tallest buildings are not office towers, but structures devoted solely to the manufacture of high voltage cables, South Carolina is clearly positioned to be a leader in the global clean energy economy (see sidebar). South Carolina benefits from a wealth of natural advantages, industrial firms and research institutions that collectively contribute to a viable clean energy industry with enormous growth potential. While the precise number of jobs and establishments linked in some way to the clean energy economy is difficult to quantify, recent developments clearly point to the growth and dynamism of this sector in South Carolina. Solar energy generation in South Carolina is expected to grow from nearly zero to approximately two percent of the state's total energy mix by 2020. Demand for clean energy products will be further stimulated by similar expectations of growing renewable energy use in Georgia and North Carolina, which was identified as third in the US for new installed solar capacity in 2013[iii].

Growing industry in the state also underscores South Carolina's potential to grow the clean energy sector. A prime example is General Electric Power and Water, which announced a $400 million advanced manufacturing facility focused on manufacturing process development and prototyping for water processing, wind turbines, gas turbines and nuclear power services[iv]. GE's expanded Greenville presence includes design and engineering, field support engineering, and component testing of wind turbine systems. Recent announcements by Proctor & Gamble (Duracell), Carbon Recovery Resources LLC[v], B3C Fuel Systems[vi], Climax Global Energy[vii], ECAPS[viii] and Sensor Electronic Technology, Inc. all point to the favorable business climate in South Carolina for growing and attracting clean energy technology and manufacturing businesses, both large and small.

Spotlight: High Voltage Cable Manufacturing

At 427 feet and 373 feet, the vertical continuous vulcanization (CVC) towers at the Nexans location in Summerville and the Prysmian Group operation in Abbeville, respectively, are the two tallest structures in the state. These sophisticated facilities manufacture medium and high voltage cable for underground and undersea transmission of power. The use of these state-of-the-art cables is critical for the deployment of distributed generation systems such as solar farms and off-shore-wind. The Prysmian facility, which celebrated its 50th anniversary in Abbeville in 2014, reinvested $8.2 million and created 20 new jobs with an expansion of the plant and addition of a second CVC line. The Nexans facility opened for business in 2014 and represents an $85 million investment creating 200 new jobs.

Pictured: The Nexans CVC Tower in Charleston

The map in the following report section shows the distribution of clean energy manufacturing and related firms in South Carolina. As shown, the I-85 corridor and the Charleston region have the highest concentration of clean energy related firms. In addition to firms developing clean energy products and their direct supply chains, the automotive, aerospace, electronics and advanced materials sectors share resources, suppliers and customers creating a fully formed manufacturing cluster. For instance, the growing composites industry in South Carolina, with cornerstones Boeing Commercial Airplanes and the Toray carbon fiber facility currently under construction, is very relevant to the materials, technologies and manufacturing processes

employed in the wind turbine sector. The firms in and around Charlotte, North Carolina including Siemens, Areva, ABB and Alstom also form a part of the state's larger clean energy cluster. Local industry and researchers also benefit from close access to key utility partners on a national stage, including Duke Energy, SCANA and Santee Cooper in South Carolina and regional companies like Southern Company, Dominion and FPL.

During the past five years, several surveys and studies have attempted to measure the total employment and economic impact of the clean energy sector in South Carolina. A 2011 study by Clemson University's Strom Thurmond Institute provides the most comprehensive assessment of the "green" economy in South Carolina[ix]. According to this study, about 4.3 percent of South Carolina's workforce is engaged in the direct production of green products or delivery of green services. In 2010, this was nearly 86,700 jobs. This study takes a broader view of the green economy, including both the manufacture of clean energy products, but also efforts in conservation, pollution prevention, recycling and complimentary services. In addition, the study captures employment and output of "green" employees (i.e. recycling, pollution control, remediation employees) working in companies whose overall mission is not "green." Nevertheless, several important conclusions can be drawn from this study:

- More than half of the estimated green jobs (58 percent) are in large firms with more than 250 employees.
- Most green jobs are part of the long-term workforce. Only four percent of green jobs were part time, and only one percent were created as a result of the federal American Recovery and Reinvestment (ARRA) Act of 2009. Combined, these two findings indicate that green jobs are firmly rooted in the South Carolina Economy. This percentage of part-time work is consistent with manufacturing as a whole. Over the last four years, according to the South Carolina Department of Employment and Workforce, only 3.2 percent of manufacturing employees were employed on a part-time basis on average.[x] It's expected that clean energy industry manufacturing is no different in this respect.
- The most frequently mentioned green occupations reflect core components of South Carolina's manufacturing economy: production, architecture, engineering and management.
- Forty-three percent of green occupations reported required a bachelor's degree and an additional 16 percent require an associate's degree. Less than a third of identified "green occupations" are accessible with only a high-school diploma. Most green jobs in South Carolina that require some sort of special certification also require an associate's or bachelor's degree.

For a closer look at South Carolina's renewable energy industry, the Southeast Clean Energy Industry Census focuses on sectors more pertinent to clean energy manufacturing. While the green jobs analysis described above uses a sampling approach and infers a larger number of green jobs and businesses, the Clean Energy Industry Census only includes self-reported data provided directly by companies and organizations directly involved in the renewable energy industry. The census was conducted by the North Carolina Sustainable Energy Association in cooperation with the South Carolina Clean Energy Business Alliance.[xi] The SC Clean Energy Census finds:

- 220 firms participated in the census reporting 5,977 total clean energy full-time jobs.
- The energy efficiency and building sciences sector represented the greatest share of total employment with 2,109 full-time jobs.

- For power generation, the biomass sector reported the highest employment figure with 1,331 jobs, followed by solar (534 jobs), hydroelectric (317 jobs) and wind (251 jobs). The energy storage and fuel cell sector and alternative vehicle fuels sector also reported sizable employment with 374 and 260 jobs, respectively.

The Brookings Institute, as a part of its Metropolitan Policy Program, has employed the Brookings-Battelle Clean Economy Database to provide an apples-to-apples comparison of state clean economies as of 2010 and the relative levels of growth in various subsectors between 2007 and 2010[xii]. During this span, total employment in the clean energy sectors grew 10.6 percent nationwide whereas South Carolina's clean energy employment expanded by 7.8 percent, ranking 38th in the US. During the 2007 to 2010 timespan, South Carolina saw the most growth in absolute and percentage terms in green building and energy efficiency, environmental management and recycling. The Brookings study does highlight specific clean energy sectors where South Carolina has a relatively large active workforce including: green building materials, ranking 4th in the US; wind energy components, ranking 3rd; hydropower, ranking 5th; electric vehicle technology, ranking 6th; nuclear energy, ranking 7th; recycled content products, ranking 5th; and energy efficient appliances, ranking 9th.

Spotlight: Tetramer Technologies

In 2014, the research and development firm Tetramer Technologies announced a $1 million investment to create 25 new jobs in Pendleton, South Carolina. A prime example of collaboration between academia and industry, Tetramer Technologies is the top awardee of Small Business Innovation Research (SBIR) grants in the state. SBIR grants are made by Federal agencies to advance technology commercialization of basic sciences research. Tetramer Technologies has been awarded more than $7 million in SBIR funding in the field of materials science. In the field of energy, Tetramer Technologies is developing new electrolyzer systems for hydrogen fuel cells and nanocomposite coatings for the nuclear industry.

Clearly, South Carolina has strength in a number of clean energy sectors. This report details the strategic assets the industry will leverage for future growth. The clean energy manufacturing cluster in South Carolina can be divided into subsectors for further analysis and consideration. Each of these subsectors plays a unique role in the development of the clean energy economy in the state and responds to different sets of investment motives and external pressures. Similarly, these firms can be classified as larger, established companies and entrepreneurial small and medium-sized firms. The following section details the classification of the clean energy economy in South Carolina and provides a few examples of firms in each part of the cluster.

Clean Energy Cluster

Original Equipment Manufacturers: manufacturers and designers of clean energy generation equipment including solar panels and wind turbines. In South Carolina, these companies range from the very large such as General Electric wind turbines to the very small, such as Trulite Inc., which designs and manufactures small-scale fuel cells for emergency power back-up applications.

Complementary Equipment Manufacturers: These companies produce energy-related products that are critical to the deployment of clean energy systems including meters, inverters, and transmission and distribution equipment. South Carolina equipment manufacturers include: Prysmian and Nexans (high voltage cables), Itron (meters), Hubbell Power Systems (high voltage insulators), PRETTL (wire harnesses, electromechanical components, inverters), IMO USA Corporation (slewing rings and drives for wind turbines), and Eaton (power transformers).

Component Suppliers: these tier one and two suppliers to the clean energy manufacturing industry, include manufacturers bearings, tubing, belts and actuators and other parts. These component parts are used both in the energy sector and in related durable goods such as automotive, aerospace and industrial machinery. Example companies falling into this category include: Kemet and AVX (capacitors), Ulbrich Solar Technologies (photovoltaic ribbon), Siemens (relays and controls), several bearing manufacturers (Kaydon, ILJIN America, JTEKT/Koyo), Zeus (wire harness tubing), and MeadWestvaco Specialty Chemicals (adsorbed natural gas products for vehicles).

Energy Efficient Product Manufacturers: An important part of the clean energy sector is manufacturers and designers of products differentiated on their energy efficiency. Appliance, lighting, construction products, vehicles and other sustainable products fall into these categories. Prime examples in South Carolina include: Hubbell Lighting, Electrolux (refrigerators), VELUX America (skylights and solar water heating), and Proterra (zero-emission electric buses).

Clean Energy Generation System Operators: These project developers and operators build and run generating facilities interconnected with utility's transmission systems. Examples in South Carolina include EDF Renewable Energy (biomass facilities in Allendale and Dorchester Counties), TIG Sun Energy (a division of The Intertech Group and owner of the 3MW Colleton Solar Farm) and GenEarth Bioenergy (1.6 MW waste to biogas facility in partnership with Santee Cooper).

Spotlight: Proterra

In 2010, the electric bus manufacturer, Proterra, put down roots in South Carolina. Working closely with the Clemson University International Center for Automotive Research and the South Carolina Department of Commerce, Proterra identified Greenville as the optimal site to launch a new bus manufacturing operation. Since then, the company has raised millions of dollars in venture capital financing, led by the established investment firms of Kleiner Perkins and GM Ventures. Proterra is a leader in the growing zero-emission fleet bus market.

A Proterra zero-emission bus and charging station

Construction and Design Firms: These firms design and build clean energy systems for commercial, industrial, government and residential applications. The solar market is developing quickly with a number of players including Hannah Solar Government Services and Sunstore Solar. Consultants and construction firms building larger scale systems include small firms such as Peregrine Energy and Greenway Energy and larger corporations with global footprints like Fluor Corporation, CH2M Hill, CDM Smith and URS Corporation.

Market Development and Clean Energy Services: Developing the local and global market for clean energy generation, producers of fuels and ancillary services are a vital part of the growing clean-tech industry in South Carolina. LowCountry BioMass (wood pellet manufacturer), Midlands Biofuels (biofuel processor), The Green Way Group (efficiency consulting), Southeast BioDiesel (biofuels) are South Carolina examples of firms serving this function.

Spotlight: The Lockhart Power Pacolet Hydroelectric Facility

Sustainability Champions: Many of South Carolina's largest multinational corporations have implemented clean energy systems as part of their sustainability efforts. While these firms may not produce goods or services directly related to the clean energy economy, they are oftentimes primary drivers of technology adoption and policy shifts in the state. Examples include Sonoco ($75 million biomass boiler facility), Boeing (with SCE&G, 2.6MW rooftop solar installation), and BMW ($12 million landfill gas to energy facility and a 96KW solar array).

Technologically Related Companies: The clean energy industry, and specifically its workforce development and research and development needs, is supported by complimentary sectors that share similar manufacturing processes and technologies. For instance, the carbon fiber composites industry (with Toray, Cytec, Boeing, GKN Aerostructures), the automotive industry (specifically as it relates to battery and fuel cell technology) and industrial machinery (turbines, engines, manufacturing equipment) contribute to the manufacturing ecosystem that supports clean energy equipment manufacturing.

Utilities: Each of South Carolina's major utilities actively plays a role in developing the clean energy market in the state. Santee Cooper (SC Public Service Authority) operates two anaerobic digestion biogas plants (26.8 MW), six landfill gas stations (28MW) and through power-purchase contracts offers 74MW of woody biomass capacity. Santee Cooper operates four solar demonstration projects in the state (367KW total) and the largest solar installation in South Carolina at the Colleton Solar Farm (3MW). Santee Cooper was also the first utility in South Carolina to install a grid-connected demonstration wind turbine in Myrtle Beach (2.4KW).

With 4MW of total capacity, South Carolina Electric and Gas (SCE&G) produces the most solar energy in South Carolina. Approximately 10 percent of the SCE&G energy portfolio comes from renewable and hydroelectric sources. SCE&G's rooftop solar array at Boeing's manufacturing facility in Charleston, installed in 2011, generates 2.6 MW and is one of the largest rooftop installations in the country. SCE&G

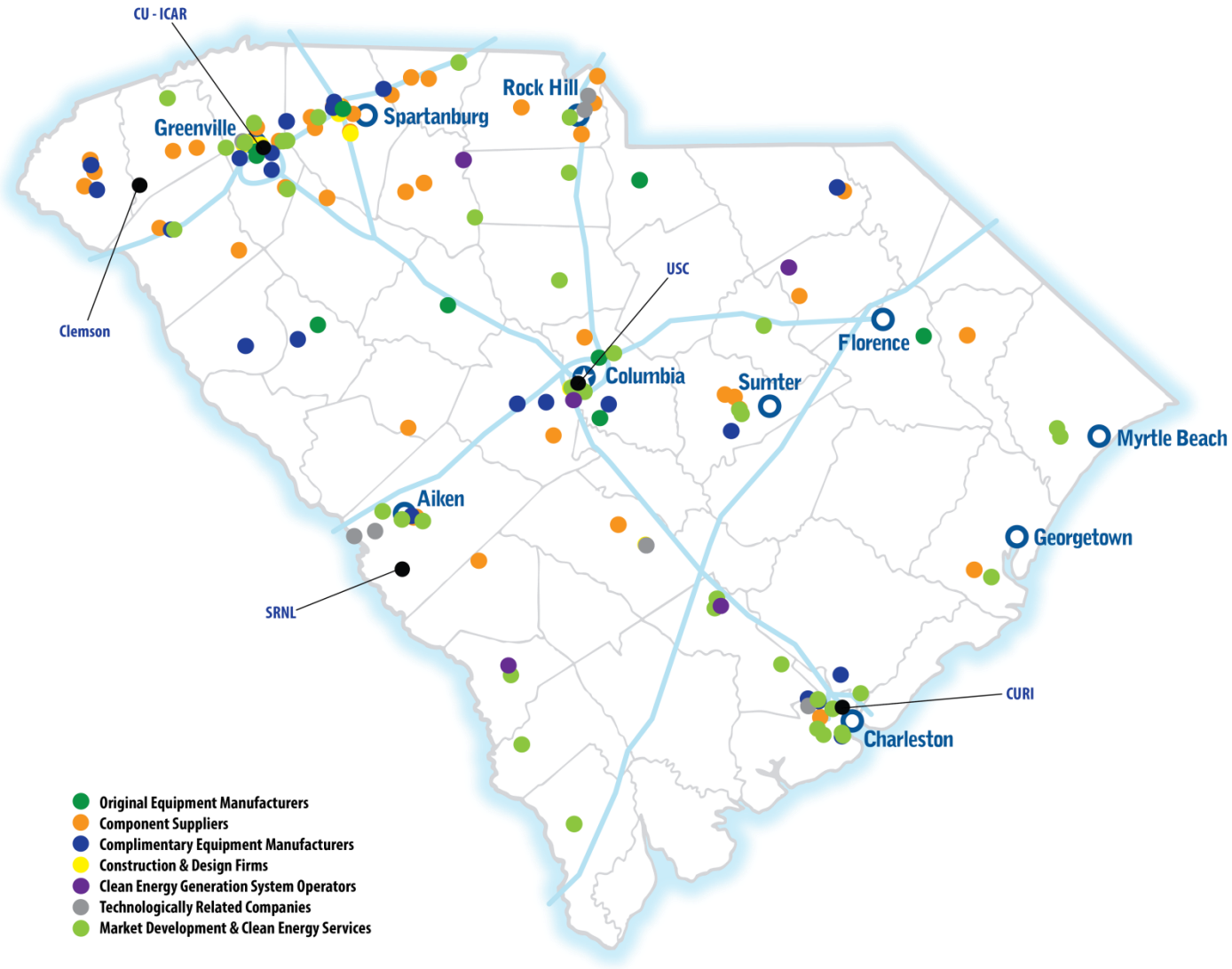
also has plans for two new solar farms (a 400KW array in Charleston and a 3 to 4MW array in Cayce), further increasing its investment in solar energy. Far surpassing the generating capacity of its solar investments, SCE&G profits from its legacy of five hydroelectric stations built between 1905 and 1978. These plants produce a combined 820MW in South Carolina.

Nationwide, Duke Energy has invested more than $3 billion in wind and solar energy projects; however, much of this investment has been out of South Carolina, driven by state-level policies and renewable portfolio standards. As such, Duke's solar generating capacity in South Carolina is approximately 1 MW. Duke Energy in South Carolina is a partner in a landfill gas project in Greenville, producing about 3.2MW. Most of Duke Energy's solar investments have been in California, Arizona and North Carolina while more than $2.5 billion have been invested in the wind energy sector, predominately in Texas, Wyoming, Pennsylvania and Kansas. In North Carolina, Duke Energy is exploring the potential for small-scale wind turbines in the 1 to 100KW range and studying the potential for offshore wind in collaboration with UNC Chapel Hill. In the future, South Carolina can benefit from Duke Energy's experience in North Carolina and other states for cost-effectively deploying these developing technologies.

Smaller investor owned utilities and the electric cooperatives of South Carolina also play a role in generating renewable power. The SC Electric Co-ops use landfill methane gas to produce electricity at five facilities, generating 23.9MW. Lockhart Power, an investor-owned utility, operates two hydroelectric plants and the Columbia Canal Hydro Project. Lockhart Power also owns and operates a landfill gas-to-energy project in Wellford, SC.

Complementary to the use of renewable resources, South Carolina generates roughly 49 percent of its power through non-emitting, carbon neutral nuclear power. With the completion of VC Summer Units 2 and 3, even more nuclear power will come online in the state before the end of the decade. By 2020, 60 percent of energy production in South Carolina will be non-carbon emitting. Utilities also offer a range of programs to assist homeowners and businesses with on-site installation of renewable energy systems and energy efficiency improvements.

Selected Firms and Establishment in the South Carolina Clean Energy Cluster

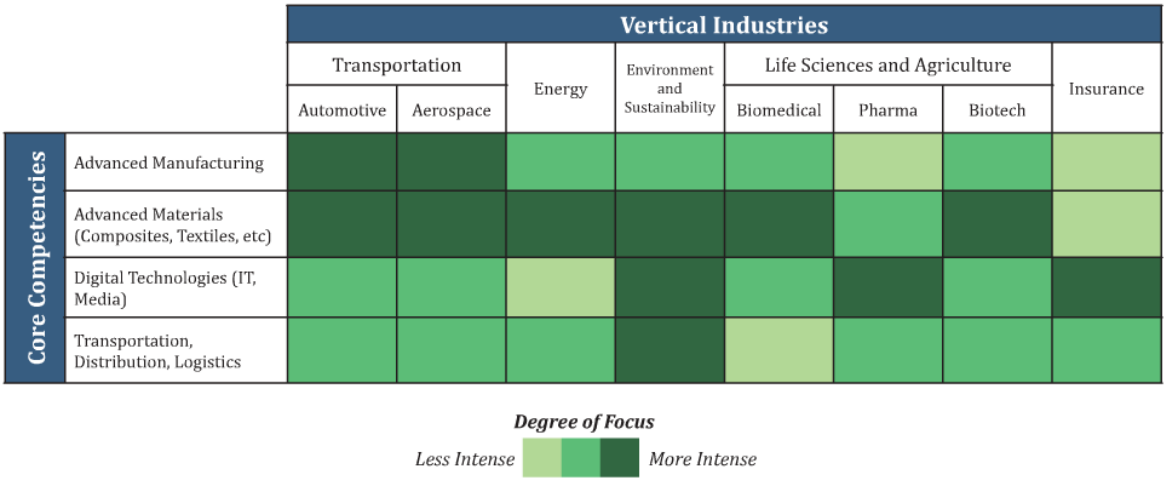


Source: South Carolina Industrial Directory, South Carolina Department of Commerce, 2014

Clean Energy Related Research Centers

The rapid technological evolution of the clean energy industry is heavily dependent on research and development efforts of universities, national laboratories and private industry. In South Carolina's Science and Technology Plan, *Vision 2025*, leaders from the state's universities, government research institutions and industry identified South Carolina's core research competencies and the industry focus areas projected to grow[xiii]. The plan posits that focusing on enhancing the four competencies – Advanced Manufacturing; Advanced Materials; Digital Technologies; and Transportation, Distribution and Logistics – South Carolina will foster the growth of the vertical industry sectors – Transportation; Energy; Environment and Sustainability; Life Sciences.

As shown in the diagram below, the sectors of Energy and Environment and Sustainability have a strong relation to the research competencies of Advanced Materials, Transportation and Manufacturing. Fortunately, South Carolina is home to several world-renown research organizations working in this field.



Increased support for alignment between college and university education and research programs and technical colleges with workforce development programs in the vertical, technology-intensive industries is critical to their future growth in South Carolina.

University of South Carolina

Through the South Carolina Endowed Chairs Program (SmartState), the state has made targeted investments in numerous endowed professorships related to clean energy production. These research centers have accumulated more than $150 million in state and extramural funding to support their efforts. The Centers and Chairs listed below have all been awarded to the University of South Carolina[xiv]:

- Catalysis for Renewable Fuels Center - developing catalysts that allow fuels to be produced from renewable sources. These new catalysts are the next wellhead as the transportation sector moves to less dependence on imported oil and carbon fuel. Work associated with this Center has led to the creation of a startup company, Palmetto Fuel Cell Technologies. The Catalysis for Renewable Fuels Center also serves as a resource for recruiting activities in the Midlands of South Carolina for companies associated with renewable fuels, fuel cells and alternative energy sources.
- General Atomics Chair - developing strategies for improving and enhancing the use of nuclear energy to ensure nuclear power remains safe, clean and affordable. It also supports technological improvements, including using nuclear power as a heat source to generate alternative fuels such as hydrogen.
- Hydrogen and Fuel Cell Economy – will conduct research to develop hydrogen storage materials and sensors for fuel cells. Fuel cells produce electricity from hydrogen and hydrogen-rich carbon fuels without thermal combustion and are more efficient for power generation than existing coal and natural gas technology.
- Nuclear Science and Energy - focus on the design, development, and analysis of advanced materials that will be required to extend the life of existing nuclear power reactors and to develop a new generation of more efficient reactors.
- Solid Oxide Fuel Cells - working to remove barriers to the use of solid oxide fuel cells by designing components to accommodate variations in temperature and transport associated with practical uses, understanding long-term behavior and durability of solid oxide, developing testing protocols that simulate solid oxide fuel cells' behavior over their lifetime, and developing systems for stationary power generation.
- Strategic Approaches to the Generation of Electricity (SAGE) - focusing on improving environmental control technologies for coal power plants, including improving emission controls and developing new materials and processes to capture and store or find a use for carbon emissions.

Many of the University of South Carolina research areas above fall into the realm of advanced materials, which intersect the growing aerospace and automotive sectors in South Carolina. The wider clean energy efforts of the University of South Carolina will fall into a university wide collaborative, the Energy Leadership Institute, including more than 125 faculty members from six of the university's colleges – College of Engineering and Computing, College of Arts and Sciences, Darla Moore School of Business, School of Law, Arnold School of Public Health and College of Mass Communications and Information Studies. The interdisciplinary research team covers the technical, economic and environmental aspects of energy production, distribution and utilization including wind, solar, nuclear, wave, coal, natural gas and fuel.

Clemson University

With the Clemson University Restoration Institute (CURI) and the Clemson University International Center for Automotive Research (CU-ICAR), Clemson offers two important assets for the development of the clean energy economy in the state. CURI in Charleston is home to the $98 million SCE&G Energy Innovation Center. The center was partly funded by a $45 million grant from the US Department of Energy, making it the largest single grant by US DOE for wind power.[xv] This center is anchored by the two wind turbine drive train test facilities (15MW and 7.5MW), making it the only facility in the world capable of testing wind turbine drive trains in the 5-megawatt to 15-megawatt range with 30 percent overload capacity. In addition, the facility offers a 15MW Hardware-in-the-Loop Grid Simulator (the Duke Energy eGRID) leveraging the existing infrastructure of the drivetrain test facilities to allow manufacturers to test both mechanical and electrical characteristics of their machines in a well-controlled and calibrated environment. The eGRID can simulate the electrical grid of any country in the world. More importantly, the eGRID was designed for testing and development of all multi-megawatt devices bound for the electrical market. These facilities are unique in the world and provide a true competitive advantage for recruiting firms engaged in the manufacture and design of wind turbines and other electrical infrastructure. The SC SmartState Program has also made investments in an endowed chair for Clemson University to support smart grid technology.

Spotlight: The CURI Wind Turbine Drive Train Test Facility in Charleston, South Carolina

On the automotive front, CU-ICAR in Greenville has several programs and facilities dedicated to improving the energy efficiency of vehicles. CU-ICAR is home to four SmartState endowed chairs in four key research areas: automotive systems integration, automotive manufacturing, vehicle electronic systems integration and automotive design and development.[xvi] Each of these disciplines can ultimately contribute to the energy efficiency of the automobile. The most relevant research topic pursued at CU-ICAR is Advanced Powertrains, where researchers focus on reducing the environmental impact of ground vehicles. Research focuses on advanced engine concepts, powertrain integration, flexible drivelines, electrification and connectivity, and hybrid propulsion. In addition, CU-ICAR explores Automotive System Integration as a research topic, where researchers study and apply interdisciplinary, collaborative systems engineering approaches to create and integrate sustainable solutions that consider environmental, social, and economic factors. Other topical areas also touch on vehicle efficiency, including Vehicle-to-Vehicle and Vehicle-Infrastructure Integration (communications, sensors) and Manufacturing and Materials (light-weighting of vehicles, sustainable manufacturing). To partner with industry on product

development, CU-ICAR also offers industrial-scale laboratories accessible for commercial use. More than $12 million in vehicle, component and material testing equipment includes a chassis dynamometer, road simulator, engine test cell, electromagnetic compatibility chamber, vibration chamber and solar chamber. CU-ICAR also offers flexible space for small R&D companies on campus, data acquisition and instrumentation services, and access to faculty and graduate students to participate on industry-university collaborative projects.[xvii]

Savannah River National Lab

The Savannah River Site (SRS) and its collocated Savannah River National Lab (SRNL) are obvious assets to the potential of clean energy research and development. In addition, the Site's technical workforce provides an ample supply to attract prospective clean energy firms to the state. Thanks to presence of SRS and other nuclear industry in South Carolina, the state has one of the highest workforce concentrations of Nuclear Engineers and Nuclear Engineering Technicians in the country.[xviii] While the primary objectives of SRS and SRNL are environmental remediation and nuclear security, SRNL is a multi-program lab supporting national needs encompassing clean energy. SRNL collaborates with public partners (US Department of Energy - Energy Efficiency and Renewable Energy, Department of Defense, Department of Homeland Security, state and national universities) and private partners (Ford Motor Company, BASF, Areva, Tokyo Electric Power Company) on a variety of topics including clean energy production. SRNL has research interests in hydrogen, nuclear fuel, wind, natural gas, and solar energy. SRNL's Center for Hydrogen Research provides a state-of-the-art facility for the development of innovative hydrogen technology and research. SRNL is also a partner laboratory for the international ITER project to demonstrate the scientific and technological feasibility of a full-scale fusion power reactor. Additionally, SRNL as a partner with Clemson University Restoration Institute (CURI) has world class capability in testing and simulation facilities. SRNL's specific energy-related research efforts are summarized in greater detail in Appendix A.

Infrastructure

Midway between New York City and Miami and within a day's drive of more than 60 million people, South Carolina's location offers a strategic advantage to manufacturers in any sector. Crisscrossed by five interstate highways and rail access in each of the state's 46 counties, South Carolina possesses the transportation infrastructure to serve a global market and efficiently source products with just-in-time certainty. Particularly useful for a clean energy sector that is increasingly export dependent, the Ports of Charleston and Georgetown offer access with container and break-bulk traffic to Europe and Asia. The Port of Charleston offers weekly shipping service in eight key lanes to China, Taiwan and Hong Kong, eleven direct to Europe and three to Southeast Asia. The Port of Charleston handled 1.56 million 20-ft equivalent cargo units in FY2013, up 8.9 percent over the previous year and break-bulk cargo totaled more than 700,000 tons.[xix] This cargo includes heavy equipment from General Electric, Siemens and Nexans.

Spotlight: The Port of Charleston

Georgetown, a dedicated break-bulk facility with the potential to serve the biomass market, handled nearly 500,000 tons in FY2013. Additionally, the infrastructure around the Port of Charleston offers a great opportunity for port-side manufacturing of large, export-bound energy equipment. Facilitated by the new South Carolina Inland Port and unusually wide rail clearances on some of the state's freight corridors, South Carolina also has the unique advantage to manufacture larger energy products inland and ship via the Port of Charleston. These assets are vital for the growth of the clean energy manufacturing industry and to further develop the state's maritime capabilities, nearly $2 billion will be invested in a new container terminal, an intermodal container transfer facility, improvements to existing facilities, and dredging of the Charleston harbor to accommodate larger, post-panamax ships.

South Carolina's existing energy infrastructure provides secure, reliable power at very competitive rates. In a way, South Carolina's energy infrastructure is a double edge sword for the clean energy product manufacturing industry. With industrial power rates typically 10 to 15 percent below the national average, manufacturing firms can take advantage of a lower cost of doing business in South Carolina. However, the lower cost energy also creates a higher hurdle for the cost-effective implementation of clean energy generation in the state, thereby diminishing the in-state market potential of energy products manufactured locally.

Workforce

South Carolina offers businesses one of the fastest-growing, most productive workforces in the nation. As the 10th fastest growing state in the US, the South Carolina population expanded 17.4 percent between 2000 and 2012 compared to a national growth of 11.3 percent over the same period.[xx] Businesses also profit from relatively low wages thanks to a cost of living 12 percent less than the national average.[xxi] Right-to-work laws and practically union-free business environments, ranking 3rd lowest union coverage in the US, give employers flexibility in staffing and work assignments allowing for better efficiencies in manufacturing.[xxii]

South Carolina also has a relatively high concentration of workers in occupations critical to the development of the clean energy economy. The Palmetto State is home to 25,800 engineers, including 6,300 mechanical engineers – the largest segment of the engineering population in the state.[xxiii] South Carolina's concentration of employment in mechanical engineering is 78 percent higher than the national average and is the third highest concentration among all US states. The table below provides detail on a number of key occupations for clean energy product manufacturing, research and development. The location quotient shows the relative concentration of South Carolina's workforce in each occupation, with a value greater than 1.0 indicating a higher concentration than the national average. For example, a location quotient of 1.42 indicates that South Carolina has a 42 percent higher concentration of Chemical Engineers than the national average. The last column in the table shows the rank of South Carolina's location quotient for each occupation relative to the 50 US states.

Table 1: South Carolina Workforce for Clean Energy Manufacturing Total Employment and Workforce Concentration

Occupation	South Carolina Employment	SC Location Quotient (LQ)	Rank of SC LQ
Chemical Engineers	650	1.42	9
Civil Engineers	5,920	1.64	5
Environmental Engineers	1,320	1.81	6
Industrial Engineers	5,930	1.87	2
Mechanical Engineers	6,360	1.78	3
Nuclear Engineers	750	3.30	4
Mechanical Engineering Technicians	790	1.25	9
Industrial Engineering Technicians	1,400	1.49	7
Machine Assemblers	940	1.71	10
Industrial Machinery Mechanics	6,550	1.55	10
Machinists	7,710	1.43	8
Team Assemblers	40,420	2.77	2

The engineering workforce in and around South Carolina continues to grow. Dozens of universities within 150 miles offer undergraduate and graduate programs in engineering producing more than 4,800 Bachelor's graduates and 2,800 Master's and Doctorate graduates each year. Mechanical and Electrical and Electronics Engineering are the two most popular engineering disciplines in and around South Carolina, producing a combined 2,800 graduates annually.[xxiv]

Appendix B provides data on the numbers and wages of South Carolina workers employed in occupations that are critical to the development of the clean energy industry manufacturing sector. These occupations include engineers, production workers and support occupations. Statewide, the average manufacturing wage is 6.5 percent higher than the average private wage in 2013. In addition, most clean energy related products fall into the durables manufacturing sector, which pays on average 24 percent more than non-durables manufacturing.[xxv] Unquestionably, clean energy industry manufacturing jobs have a net positive contribution to wealth creation and average per capita income in South Carolina.

While most of the jobs related to clean energy product manufacturing are found in other manufacturing sectors, some skills and certifications are specific to clean energy. To meet this need, the state has established a number of training centers and certificate programs. The State Energy Office collaborated with the South Carolina Technical College System to establish four solar training centers at York, Greenville, Trident and Aiken Technical Colleges. These centers focus on solar photovoltaic system design and installation. Energy Efficiency Training Centers have been established at seven technical colleges in the state, covering every corner of South Carolina. In addition, two Geothermal Energy Training Centers and a Small Wind Energy Training Center at Orangeburg-Technical College develop the workforce in those industries. Clemson University also offers specialized certificate programs in renewable energy, power systems engineering and advanced power systems engineering suitable for post-graduate continuing education. Lastly, the readySC program has helped a number of expanding clean energy firms meet their workforce needs while the Apprenticeship Carolina program develops the workforce of the future. Specialized programs such as these help the state develop the required workforce for growing clean energy companies.

Taxes and Incentives

South Carolina economic development profits from one of the most business-friendly tax climates in the country. The Tax Foundation ranks South Carolina's corporate tax as the 13th lowest in the US, primarily due to the relatively low rate of 5 percent and the method that corporate income tax is apportioned in the state.[xxvi] Corporations are only liable for the fraction of tax due that is derived from in-state sales. Because South Carolina is a relatively small state, for most manufacturers engaged in serving the national and global markets, the fraction of in-state sales is usually very small. In addition, a host of existing statutory incentives available to all manufacturers, including the Job Development Credit and Research and Development Credit, further diminish a company's tax liability.

Manufacturers of clean energy products also benefit from one of the few South Carolina incentives that is industry sector-specific, the South Carolina Clean Energy Tax Incentive Program, which provides a tax credit up to 10 percent credit of the qualifying investment in manufacturing facilities, applied to income tax liability for up to five years. This incentive was further improved with legislation in 2014 that reduced the investment threshold criteria manufacturers had to meet to qualify for the incentive. In Tier IV counties, those that are most economically distressed, the investment threshold to qualify for this incentive is $50 million. In Tier III counties, clean energy manufacturing companies must invest $100 million; $150 million in Tier II counties; and $200 million in Tier I counties. This credit had not been used by manufacturers in the two years previous to this change, and while the lowered thresholds improve the odds that the credit will be claimed in the future, relatively few manufacturing projects reach the scale of $50 million or greater. As shown in the table below, of the 227 new manufacturing firms recruited to South Carolina in the last four years, the average capital investment is $30 million and only 12, or roughly 5 percent, would have met the investment threshold for their respective county tiers. Assuming that the investment profile of clean energy product manufacturers is similar to all manufacturers, we could expect that in the future only one in twenty clean energy firms would qualify for this credit. However, clean energy systems projects tend to be more capital intensive, so a fair estimate that between one in five and one in ten qualifying projects is reasonable.

Table 2: Recruitment of New Manufacturing Facilities to South Carolina by County Economic Development Tier, 2011 to 2014

County Tier	Number of New Manufacturing Facilities Committed to SC	Average Capital Investment Committed in New Facilities	Number of Projects Meeting Investment Threshold
Tier I	93	$20 Million	2
Tier II	56	$47 Million	4
Tier III	49	$34 Million	2
Tier IV	29	$24 Million	4
Total	**227**	**$30 Million**	**12**

Incentives applied specifically to clean energy product manufacturers are not unique to South Carolina. Nationwide, twenty-one states offer similar incentives, either applied to all clean energy products or a subsector that is a target sector in the states' economic development strategies. In most cases, the investment thresholds for other states is also fairly high; in the

$50 to $100 million range, with some states incenting projects as low as $1 million and others with thresholds as high as $200 million.

As for the deployment and use of clean energy systems and energy efficient products in South Carolina, the state offers a host of tax incentives targeting a number of different technologies. Appendix C, D, E and F details the state's clean energy incentives and provides an overview of similar incentives in the other states. Appendix C covers incentives specifically tailored for clean energy manufacturing recruitment and does not include incentives applicable to all manufacturing. As outlined in the appendix, there is a vast array of incentives in the form of tax credits, loans, grants and other programs. In all cases, these incentives are best considered in the context of the tax structure of each state. Most incentives offset taxes that are not as onerous in South Carolina including income tax or franchise fees. For start-up businesses, grants and loans are typically the most attractive for businesses, but place a larger burden of risk on the state. All of South Carolina's incentives are performance-based and require companies to meet certain jobs and investment targets. This is not the case in all states.

Appendix D details incentives comparable to South Carolina's ethanol and biodiesel production incentive. These incentives range from grants for the construction of new facilities to credits against income tax or per gallon premiums applied to the sale of biofuels. Appendix E covers nationwide incentives applicable to hybrid, electric and alternative fuel vehicle use. States incent the use of alternative fuels in a variety of ways, from offsetting the purchase of the vehicle with one-time tax credits to sponsoring the installation of alternative fueling stations. Some states have offset the requirement for vehicle inspection or induced the installation of residential vehicle charging stations. Perhaps most common is the legislation of perks for owners of alternative vehicles, allowing them to drive in high occupancy vehicle (HOV) lanes or by requiring businesses to designated parking spaces for electric vehicles. South Carolina's 20 percent match to the federal credit for fuel cell vehicles is among the simpler of policies adopted nationwide.

Appendix F covers the sale and distribution of fuel produced from renewable sources. The Commission will further explore tax policies to incent clean energy manufacturing in South Carolina in 2015 and will provide recommendations on this topic in the final Commission report. The Commission does believe that a more coherent, holistic and inclusive approach to tax incentives would send a clear signal to potential clean energy investors that South Carolina is a favorable business environment for all clean energy projects.

Market Potential

With the passage of the Distributed Energy Resource Program Act in South Carolina, Act 236, in 2014, the state made an important step towards the application of clean energy generation through distributed generation and utility investments. With the Act, South Carolina has targeted, at a minimum, renewable energy generation equal to 2 percent of utilities' total retail peak demand by 2021. With this goal, South Carolina will join North Carolina (12.5 percent renewable energy goal by 2021) and Virginia (15 percent by 2025) as the few southeastern states with a stated policy. However, domestically, the largest demand for renewable generation is outside the Southeast.

Nationwide, 29 states, Washington DC and two US territories have renewable portfolio standards in place, requiring their utilities to generate a portion of energy from renewable sources by a target date. In most cases, the standard is between 15 and 25 percent renewable generation by 2020 to 2025. Because the southeast has not embraced these policies, the regional market for South Carolina-based manufacturers and service firms may be limited. The US Environmental Protection Agency's proposed and contested Clean Power Plan, which may require utilities to drastically reduce CO2 emissions by 2030, will spur the market for renewable and nuclear generation nationwide if it does take effect and may overshadow the impact of any statewide renewable portfolio standards in place.

The uncertainty of federal policy and constant changes in state policies create a challenging environment for businesses planning investments to capitalize on the domestic clean energy market. Nevertheless, the continuing population growth in the southeast and increasing power demands of industrial customers, utilities in the region will likely continue to drive demand for clean energy products. The state will continue to see Investments by consumers in on-site, distributed generation, energy efficient lighting and building products, and fuel efficient vehicles - especially facing the 54.5 miles per gallon CAFE standards by 2025.

However, the global clean energy market is considerably larger and, in aggregate, more stable than the domestic market. As one of the most trade dependent states in the nation and with the Port of Charleston's reach to customers globally, South Carolina is well positioned to capitalize on the worldwide growth of clean energy applications. The OECD International Energy Agency, in its 2014 Clean Energy Progress Report[xxvii], reveals several important trends that will influence the market for clean energy goods domestically and abroad:

- Global investment in clean energy generation, to meet stated national targets, is expected to approach $800 billion annually through 2025. However, global investment in renewable power fell 12 percent in 2013, the second consecutive year of decline. The falling cost of technology contributed to part of the decline as each megawatt of power installed this year cost less than last year, but changing and uncertain national policies and slowing global economies also played a role.

- The production of energy from renewable sources is accelerating worldwide. The annual growth of renewable generation was 5.5 percent between 2006 and 2013, up from 3 percent annual growth between 2000 and 2006.

- Renewable energy use is accelerating in Asia and emerging economies, more than making up for the volatile and slowing growth in Europe and the United States. In 2013, China was the first market in the world for both wind and solar photovoltaic (PV) installations. China, India and Brazil accounted for approximately 54 percent of global renewable power generation in 2013. Worldwide capacity of solar PV investments is expected to reach 403 GW by 2020, up from 137 GW today. Solar energy was the second largest source of new generating capacity in the US in 2013, after natural gas, and the number of installations increased nearly 40 percent in 2013. Solar installation costs have also fallen dramatically, down by about 15 percent last year.

- Hydropower continued stable growth in 2013 and remains the largest generator of renewable electricity. Most of the recent growth in hydropower in China and developing economies. Global hydropower capacity is expected to grow from just over 1,692 GW to nearly 2,555 GW by 2020.

- Clean energy power plants are quickly approaching cost parity with new conventional power plants; however, weak power demand in Europe due to its stagnating economy and plant overcapacity make any new energy investments less attractive. In addition, most developed and developing countries fail to implement long-term policies that will drive demand in clean energy manufacturing, increasing investment risk for new manufacturing operations.

- Global capacity of onshore wind generation is expected to nearly double from 312 GW in 2013 to 602 GW in 2020. Offshore wind is still in its initial phase of development and is expected to grow from 7 GW installed capacity to 29 GW over the next six years. Wind turbine manufacturers have focused on bringing costs down and on site-tailored total project development and management, often in the 2.0 MW to 2.5 MW capacity range. According to the US Department of Energy, the cost of deployed wind energy generation has declined 43 percent over the last four years. Onshore wind power has nearly approached cost parity with hydroelectric, geothermal and bioenergy plants and is approaching leveled cost of new coal and gas turbine facilities. Wind energy powered approximately 4 percent of the US grid at the start of 2014, with Iowa, South Dakota and Kansas deriving the largest fraction of their power needs from wind energy – each at 20 percent or greater. As 2014 began, there were more US wind power projects under construction than any time in history; with more than 10.9 GW capacity being built in 20 different states. Several demonstration projects around the country also test the viability of offshore wind. The US Department of Energy has awarded funding of $50 million to three off-shore demonstration projects, the closest being a Dominion Energy installation of two grid-connected 6 MW turbines in Virginia. The success of these projects will serve as important proof of the viability and cost-effectiveness of off-shore wind deployment in the Southeast.

Spotlight: Quality Farms

In 2014, the Dayton, Ohio based company Quality Farms announced plans to invest $1.9 million in Mullins, South Carolina creating 27 new jobs. Quality Farms is a processor and convertor of wine and beer waste into fuel-grade ethanol. The recycling company will divert unusable beverage products, otherwise destined for a landfill, into biofuels for a variety of applications.

- While still holding a relatively small market share, clean fuel vehicles, hybrids and plug-ins all captured more of the transportation market in 2013. Eight out of ten manufacturers now offer electric vehicles. Clean transportation policies and population growth in China will drive much of the global demand for clean energy vehicles worldwide, driven primarily by urban air pollution. Chinese demand for battery electric, plug-in hybrid and fuel cell vehicles, especially buses and small cars, will grow exponentially. The cost of batteries continues to fall, by roughly 18 percent in 2014 and fuel cell vehicles are receiving renewed attention. This is a welcome development considering South Carolina's strength in fuel cell research and development, with research centers at USC and SRNL. Biodiesel, advanced biofuels and natural gas vehicles continue to gain traction domestically, but are still nascent in terms of adoption. Distribution and fueling infrastructure continue to pose the greatest challenge these technologies, despite proven energy efficiencies and environmental benefit.

- Bioenergy capacity is expected to grow from 88 GW worldwide in 2013 to 133 GW in 2020. Biofuels production rose globally by approximately 7 percent in 2013, with strong ethanol production in Brazil and the United States. While policy support for biofuels has wavered in developed economies, the US and EU nations, it is expanding in developing markets like Southeast Asia. Due to concerns over urban pollution, bioenergy is expected to grow slower than other renewable sources in China. Domestically, the biomass sector completed several large-scale projects in 2013 with all regions of the country experiencing some biomass growth. However, the Southeast experienced the greatest surge of activity with new facilities opening in Florida, Virginia, Georgia and South Carolina. Much of the recent growth was driven by federal incentive programs which have since expired, casting uncertainty on future growth of the sector. A Treasury Department Grant Program, established in 2009, helped make several of these facilities attractive for securing loans from outside investors. The growth of the biomass sector in the near future, especially wood pellets from forest by-products, hinges on price competition from fossil fuels, production incentives, and end-use incentives domestically and in Europe.

- Global nuclear generating capacity has stagnated, although 72 new reactors were under construction in 2013 including two new plants in South Carolina at the V.C. Summer Nuclear Station. Capacity increases from new plants coming on line were offset by decommissioning of ageing plants in Europe and Japan. China and Russia continue to push ahead with ambitious building plans while new construction starts have stalled in the United States and Europe.

- Grid modernization and smart grid technology represents a huge market opportunity globally. Grid modernization will be required for market penetration of renewable systems at any significant level. Grid modernization also opens up new opportunities in micro-grids, security and resiliency. Market barriers and regulatory challenges have stalled the deployment of smart grid technology globally. Involving multiple stakeholders, the implementation of smart grids is complicated because many of the cost savings realized by their use are not realized in the same sectors in which the investments are made. Regulatory leadership and collaboration on national and regional levels are necessary for effective growth of this technology. Similarly, patchwork policies and incentives related to energy efficiency make investment decisions more difficult at the national and state level.

South Carolina Opportunities

The Commission intends to delve deeper into these topics and evaluate potential programs and policies to grow the clean energy manufacturing economy in South Carolina. Specific recommendations are forthcoming by September, 2015 with the final Commission report. The broad themes and goals outlined below were the early focus of the Commission's discussions and will serve as the starting point for further deliberations in 2015.

Developing the Future Clean Energy Workforce

Availability of skilled labor is perennially a top site selection factor when company executives are locating a new manufacturing facility. In this respect, manufacturers of clean energy products are no different than manufacturers of other advanced, high-technology products. In the 28th Annual Survey of Corporate Executives (2014) by Area Development Magazine, skilled workforce availability ranked first among all site selection factors nationwide, ahead of transportation access, labor costs, taxes and incentives.[xxviii] For a statewide perspective, the 2013 Industry Survey conducted by the SC Department of Commerce found that workforce issues was the top issue facing manufacturers seeking to expand their operations with approximately one third of respondents listing hiring or workforce development challenges as their top concern. Likewise, in the Southeast Clean Energy Industry Census, more than a third of respondents indicated skills gaps in clean energy systems engineering and design.[xxix]

An in-depth analysis of workforce supply and demand gaps was completed in the Charleston region in 2014.[xxx] Despite the state's matriculation of hundreds of engineering graduates each year and relatively high concentrations of workforce in certain occupations, this study shows a severe shortage of mechanical engineers, electrical engineers, and industrial and electrical engineering technicians in the near future. The study also revealed expected workforce shortages in general assemblers and fabricators, machinists and welders. Companies also routinely mention unmet demand for industrial maintenance mechanics and operators and programmers of advanced, automated factory equipment including mechatronics and CNC machines.

Surveys and interviews with some of the state's largest and fastest growing manufacturing and information technology services firms, including some in the clean energy industry, reveal specific opportunities for workforce development in South Carolina:

- Build a robust pipeline of high school graduates, both in aptitude and quantity, interested in manufacturing and information technology with functional literacy (reading, writing, mathematics) and workplace readiness (soft skills). Build interest in the clean energy sector by developing programs at the K-12 level to raise awareness and support existing, successful programs such as the Palmetto Clean Energy (PaCE), a nonprofit organization that promotes the development of renewable energy resources. Through PaCE, utilities fund a pilot program that provides matching grants to K-12 schools and not-for-profit educational institutions interested in installing rooftop solar systems. These school-based installations give students the opportunity to learn, first-hand the benefits and technology of clean energy generation.

- At the technical college and university level, build capacity for interdisciplinary programs to develop graduates capable of systems thinking, cross-functional aptitude and business acumen. These skills are vital to the evolving clean energy industry with the electro-mechanical nature of power systems.

- Develop more opportunities for experiential learning at the high school, technical college and university level to include apprenticeships, internships, co-ops, work-study, boot camps and on-facility training.

- Integrate multiple, stackable credentials with formal degrees (associates and bachelors). This approach couples theory-based learning with skill-specific certifications, including programs concurrent to degrees and executive and ongoing education.

Improving the Capacity for Clean Energy Innovation

By most metrics of an innovation economy, South Carolina falls behind its peer states in the Southeast and the national average. Relatively fewer patents issued, less venture capital raised, and fewer advanced degree holders in science and engineering all point to challenges facing technology-based firms seeking growth in South Carolina. According to South Carolina's 2013 Innovation Plan, the state must "prioritize improvements in K-12 education, STEM higher education, and the South Carolina research enterprise" to ensure sustainable development of the technology economy, including the clean energy manufacturing sector.[xxxi] Upstream research and development efforts are critical to developing products and commercialization downstream. Beyond education and basic research, South Carolina should focus on building a viable cluster of clean-tech firms and commercialize technologies invented at the state's universities and the Savannah River National Lab. These 2013 SC Innovation Plan identified four themes or challenges that are as equally applicable to clean energy innovators as start-up software firms and biotechnology companies:

- Consider opportunities to expand investment in Clean Energy research through the SmartState Endowed Chairs program or other funding mechanisms. The state should build world-class research centers from existing state assets and competencies. With established research centers, South Carolina should also develop programs or incentives to facilitate technology commercialization from lab bench to factory floor.

- South Carolina should focus its efforts and resources on stimulating growth in sectors that have the most high-growth potential. Nearly all subsectors of the clean energy economy fall into this category; however, several are most aligned with the efforts of the state's research enterprise including fuel cell technology, nuclear technology, advanced materials, wind turbine technology, smart grids, biofuel applications and automotive technology.

- South Carolina does not benefit from the same innovator-friendly perception as more developed hubs of entrepreneurship like Research Triangle Park in North Carolina or Austin, Texas. The state should nurture an entrepreneurial climate by: growing interest in STEM careers and entrepreneurship, promoting successes of home-grown businesses and incenting investments in R&D and venture capital.

- South Carolina must develop the managerial and technical talent necessary to commercialize technology and secure venture capital funding. Most existing training programs in the state are geared towards preparing workers for a resources driven economy. Building a cadre of technical experts and executive mentors with experience scaling companies is critical to developing the entrepreneurial economy. States making early strides in the commercialization of quickly developing clean energy technology will capture an important first mover advantage in attracting subsequent manufacturing operations.

Building the Market for Clean Energy Generation and Improving the Perception of South Carolina as Clean Energy State

Realizing South Carolina's competitive advantage afforded by low cost energy, the state must maintain the balance among sustainability, affordability and competitiveness in designing clean energy policies. Policy uncertainty drives up project costs for capital-intensive clean energy generation in the US and South Carolina. To address these challenges, the Commission will explore opportunities to:

- Focus on long-term policies that provide predictable and reliable market and regulatory frameworks, rather than short-term incentives or programs, to develop a stable investment environment for clean energy generation. Evaluate incentives to promote use of clean energy and alternative fuels. Consider adoption of technology-agnostic policies that support the entire clean energy sector.

- Raise awareness of the benefits of clean energy to build public support for the application of new technology and to grow interest in careers in the energy sector. Support marketing, awareness and engagement plans to grow the clean energy industry and interest in STEM and manufacturing careers.

Spotlight: The Colleton Solar Farm

Covering 14 acres and comprised of 10,000 panels, the Colleton Solar Farm is a joint venture between Santee Cooper, the Electric Cooperatives of South Carolina, TIG Sun Energy, Colleton County and the City of Walterboro. The 3 MW project was completed on time and under budget in 2014.

- Promote energy efficiency improvements during building refurbishment projects and improve incentives to increase rate of energy efficient renovations.

- Take steps to mitigate deployment risk of new technologies. Utilities and private project developers are reluctant to build first-of-a-kind plants in the US due to risks of cost overruns and regulations. These risks are especially pertinent to technologies well suited to South Carolina's core competencies including new nuclear technology, off-shore wind and utility-scale fuel cells.

Build a Critical Mass of Clean Energy Firms in South Carolina

Working with utility partners and the manufacturing community, the state should target industry recruitment of growing clean energy companies that either fill a necessary gap in the clean energy system supply chain or are directly complementary to South Carolina's core competencies in certain subsectors. These subsectors could include areas where South Carolina has particular research strength (i.e. fuel cells) or where the state has developed a skilled manufacturing workforce (i.e. carbon fiber composites or machinery manufacturing). Targeted industries should include larger, multinational firms seeking a location for a new manufacturing facility and smaller, entrepreneurial firms expanding to develop manufacturing for the first time or grow their research and development efforts. To fulfill this goal, the state should:

- Understand the supply chains of mature clean energy technology and determine subsectors that could be attractive for South Carolina, filling gaps in the regional supply chain for the technology or leveraging synergies with existing South Carolina manufacturing clusters. The recruitment of complementary equipment, such as inverters, sensors, transmission and distribution equipment, serves to improve the supply chain of a variety of clean energy industries.

- Evaluate incentives offered to clean energy manufacturing firms, especially the South Carolina Clean Energy Tax Incentive Program, in the context of the state's overall tax structure and other incentives offered to manufacturing firms.

- Consider efforts to market South Carolina as a global destination for clean energy manufacturing by developing industry-specific marketing material and strategies to reach the international market to potentially include trade shows and other lead generation activities. Target industries that are complementary to South Carolina's research and development expertise, especially those sectors where collocation of manufacturing and product development is advantageous. Engage incumbent multinational firms with stated clean energy or sustainability goals to establish their manufacturing operations in South Carolina.

Conclusion

South Carolina is rich in natural assets important to the growth of a clean energy sector. Natural assets include solar capacity of approximately 450 daily watt-hours per square foot, which is 10 to 15 percent higher than the solar capacity of states with more developed distributed generation markets in the Northeast and Midwest. South Carolina possesses remarkable wind speeds for off-shore wind turbine applications, by some estimates ranking 2nd in the United States. Coupled with the lowest cost for implementation of off-shore wind construction in the nation, according to the US Energy Information Administration, the economics for future off-shore wind applications appears to be bright. New biomass projects come on line every year in South Carolina and new legislation is beginning to form a framework for distributed generation. Most importantly, South Carolina's skilled and growing workforce, pro-business tax environment, infrastructure and regulatory climate make the state an attractive location for manufacturers in all sectors.

To capitalize on these assets and industry developments already underway, the Commission will work through September, 2015 and develop a set of recommendations for future growth of the clean energy industry manufacturing sector. A comprehensive review of tax incentives, market development efforts and awareness and education programs will be part of the final report to be issued next year.

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Appendix A

Savannah River National Lab Clean Energy Research Initiatives

[Source: Savannah River National Lab website, http://srnl.doe.gov/energy-secure.htm, accessed December 2014.]

Savannah River National Laboratory has over 50 years of experience in developing and deploying technologies for safely and efficiently working with hydrogen. This expertise is grounded in decades of technology support for the Savannah River Site's (SRS) work with tritium, the radioactive isotope of hydrogen that is a vital component of modern nuclear defense. SRNL's leading-edge hydrogen research and development not only sustains national security, but also works to ensure our nation's long-term energy security and a clean environment. That experience has led to the development of technologies for the safe, cost-effective handling of hydrogen. These technologies are equally applicable to the development of hydrogen as an energy source.

Using hydrogen to fuel our economy can reduce dependence on imported petroleum, diversify energy resources, and reduce pollution and greenhouse gas emissions. Today, SRNL has the largest collection of hydrogen experts in the country, with more than 80 scientists and engineers dedicated to hydrogen and tritium missions. SRNL expertise ranges from molecular and process modeling to the development of new materials and techniques for separating and storing hydrogen safely and efficiently. Their work is critical to the most important challenges that must be addressed to make the hydrogen economy a reality: safe, clean production of hydrogen without the use of fossil fuels; light-weight, cost-effective storage of hydrogen; hydrogen separation.

Hydrogen Production

Hydrogen is plentiful across our planet, but it is bound in water or other compounds. Breaking apart those compounds to release the hydrogen requires energy, so the quest is to find the cleanest, most energy-efficient method possible to do this. SRNL expertise is being focused on a number of initiatives to support our nation's hydrogen program, including:

- Leading a team of industrial and academic partners to evaluate the technical and economic issues associated with using the heat from an advanced nuclear reactor or a solar furnace to "crack" water into hydrogen and oxygen.
- Participating in a team studying algae that produce hydrogen when exposed to sunlight.
- Developing thermochemical cycles for use with an advanced nuclear reactor or other high-temperature heat source to produce hydrogen directly from water.

Storage

Safe, efficient hydrogen storage is equally important for defense and for transportation applications. How to store hydrogen on board a vehicle is one of the key technological challenges that must be addressed to make future hydrogen-powered vehicles practical for the American consumer. SRNL focuses its research on solid-state hydrogen storage because it is safe, and at the same time more compact and convenient than storage as a gas or liquid.

SRNL is a leader in the development and application of technologies that use metal hydrides – materials which reversibly absorb and release hydrogen like a sponge. SRNL has developed and patented several devices using hydride for storing hydrogen. The hydrides developed for tritium use, however, are too heavy to be practical for transportation applications. Current storage research is studying the potential for:

- A new generation of lighter-weight, complex metal hydrides
- Metal-doped carbon nanotubes - long, thin structures (approximately 1/10,000 the width of a human hair) that show great potential because they may be able to bond with large amounts of hydrogen at room temperature.
- Hollow glass microspheres - microscopic glass "beads" with porous walls, which can be filled with hydrogen storage material.
- SRNL is supporting the American Society of Mechanical Engineers Code Committee on Hydrogen Storage Tanks to help provide the needed changes to the pressure vessel code for safe hydrogen storage.

SRNL's patented hydrogen storage device uses metal hydrides – metal granules that hold hydrogen in an inherently safe, easily-handled solid state, releasing it based on temperature. Safe, compact, reliable, and efficient, this device has been used to power a public transit bus and an industrial fuel cell vehicle. SRNL has long been a leader in the development and use of metal hydrides, with various patents for hydride compositions and their applications. The laboratory is now at the forefront of research into new classes of lighter-weight hydride materials, which may expand the technology's applicability for powering vehicles.

Natural Gas to Fuel Vehicles

SRNL, in collaboration with Ford Motor Company, BASF, and the University of California-Berkeley, has been awarded a grant to develop vehicles fueled by natural gas. This research will explore an innovative low-pressure material for use in fuel systems for automobiles and other light vehicles. This project will use high surface area materials within a heat exchange system to increase natural gas density.

This research is part of the Department of Energy's Methane Opportunities for Vehicular Energy – or MOVE – program, which is aimed to engineer light-weight, affordable natural gas tanks for vehicles.

Ceramic Coating for Accident Tolerant Fuels

In accident conditions, nuclear fuel cladding material must remain strong and avoid chemical reactions like those that released hydrogen and caused the Fukushima reactor explosions. MAX phase ceramics are similar to titanium metal in density, but are three times as stiff. The compounds have good thermal conductivity, elevated temperature ductility and fracture toughness, and are "weldable." The material has a high resistance to chemical attack and resists heavy ion

irradiation damage. In an upcoming test, samples of MAX phase carbides will be sprayed onto cladding used in existing Light Water Reactor fuel and compatible with Small Modular Reactor designs. The coating demonstrates remarkable promise to provide increased reaction time under accident conditions.

SunShot Thermal Energy Storage Technologies for Concentrating Solar Power Systems

The current practice for energy storage in many concentrating solar power (CSP) systems is to produce more hot molten salt during daylight hours than is needed to run the turbine to produce power. The excess hot salt is kept in a large volume insulated tank to be used for power produce when the sun is not available. Using molten salts as heat transfer fluids and reaction media at high temperatures is common in industrial processes such as metal refining, but more understanding is needed on high temperature heat transfer fluids and corrosion at high temperatures because advanced power cycles at high temperatures are needed to increase CSP system efficiency.

A multi-disciplinary team led by SRNL is researching the durability of high-temperature alloys in molten chloride and molten fluoride salts and testing the effectiveness of proposed corrosion mitigation methods. Through this project, SRNL will develop an increased understanding of high-temperature corrosion and how to minimize it for CSP applications. Today's state of the art heat transfer fluids are capable of operating at temperatures up to about 550°C. Temperatures in excess of 650°C are needed to reach efficiencies greater than 50%, which allows CSP plants to capture more energy. This SRNL project focuses on identifying corrosion resistant materials and corrosion prevention strategies that will allow operation at temperatures up to 1000°C.

Power Grid Simulator

The electrical transmission infrastructure in the United States needs to be updated to improve efficiency, reliability and security. Central to that update is the development and certification of new technologies that can be added into the existing electrical grid and meet this challenge. The nation lacks a high fidelity independent capability for testing, validating, and certifying new electrical power system technology without the risk of service disruption or grid collapse. A paradigm shift in the electric power industry is vital in meeting the needs of the future. This shift begins with the creation of a high power grid simulator that puts real hardware to the test. The Savannah River National Laboratory and Clemson University have joined forces in the design and construction of an electrical grid simulator for testing multi-megawatt power systems. The system will be capable of testing, certifying, and simulating the full-scale effects of new large-scale power system technology under stressed or hypothetical operating conditions. This unique grid simulator capability with appropriate programmatic focus will accelerate innovation and commercialization of new power systems by reducing risk to utilities and rate payers.

The Smart Grid Simulator will allow for the testing of cyber security approaches and technology in order to eliminate vulnerabilities. The simulator will rigorously test equipment at full scale for code compliance, examine energy storage and distribution capabilities, and investigate wireless sensors and cyber security – all without exposing transmission systems to risks. The 15MW grid simulator will be the highest power experimental utility-scale facility in the world, combining testing of energy sources with advanced power instruments and systems.

Appendix B

Occupational Employment Information for Occupations Relevant to Clean Energy Industry Manufacturing

[Source: United States Department of Labor, Bureau of Labor Statistics, Occupational Employment Survey, May 2014.]

SOC Code	Occupation Title	South Carolina Employment	SC Location Quotient	25th Percentile SC Wage	Median SC Wage	75th Percentile SC Wage
00-0000	All Occupations	1,826,120	1.00	$9.69	$14.56	$22.56
11-0000	Management Occupations	75,740	0.84	$27.87	$39.63	$55.51
11-1021	General and Operations Managers	25,030	0.92	$28.40	$40.88	$57.95
11-3051	Industrial Production Managers	2,790	1.22	$36.59	$46.03	$59.30
11-3061	Purchasing Managers	770	0.80	$30.37	$38.43	$51.99
11-3071	Transportation, Storage, and Distribution Managers	840	0.60	$32.02	$41.72	$53.57
11-9041	Architectural and Engineering Managers	2,540	1.01	$41.41	$53.30	$67.08
11-9121	Natural Sciences Managers	270	0.37	$32.21	$39.02	$47.21
13-0000	Business and Financial Operations Occupations	65,250	0.71	$18.90	$25.58	$34.50
13-1023	Purchasing Agents	3,170	0.81	$20.02	$25.88	$34.37
13-1051	Cost Estimators	2,720	0.97	$19.36	$25.80	$33.43
13-1081	Logisticians	1,630	0.98	$23.68	$29.43	$37.28
13-1111	Management Analysts	7,730	0.99	$22.56	$30.83	$40.90
15-0000	Computer and Mathematical Occupations	32,170	0.63	$21.39	$29.32	$38.65
15-1121	Computer Systems Analysts	5,500	0.79	$24.97	$31.84	$39.18
15-1131	Computer Programmers	3,820	0.89	$24.35	$31.92	$40.76
15-1132	Software Developers, Applications	3,110	0.35	$28.26	$36.53	$45.38
15-1133	Software Developers, Systems Software	1,760	0.34	$26.56	$33.44	$41.17
15-2031	Operations Research Analysts	830	0.83	$23.11	$30.53	$38.04
17-0000	Architecture and Engineering Occupations	36,170	1.10	$24.84	$33.50	$43.85
17-2011	Aerospace Engineers	250	0.25	$36.91	$45.56	$53.72
17-2041	Chemical Engineers	650	1.42	$31.24	$36.88	$45.37
17-2051	Civil Engineers	5,920	1.64	$24.81	$34.11	$45.83
17-2061	Computer Hardware Engineers	210	0.19	$33.92	$41.75	$51.13
17-2071	Electrical Engineers	1,880	0.81	$30.22	$37.17	$45.75
17-2072	Electronics Engineers, Except Computer	1,100	0.59	$34.59	$43.88	$51.14
17-2081	Environmental Engineers	1,320	1.81	$23.48	$31.04	$39.14
17-2111	Health and Safety Engineers	410	1.24	$24.13	$34.31	$44.06
17-2112	Industrial Engineers	5,930	1.87	$30.75	$36.81	$44.17

SOC Code	Occupation Title	South Carolina Employment	SC Location Quotient	25th Percentile SC Wage	Median SC Wage	75th Percentile SC Wage
17-2131	Materials Engineers	290	0.87	$30.30	$37.99	$44.78
17-2141	Mechanical Engineers	6,360	1.78	$31.38	$39.89	$50.68
17-2161	Nuclear Engineers	750	3.30	$36.68	$42.30	$50.25
17-3011	Architectural and Civil Drafters	900	0.73	$18.65	$22.23	$27.48
17-3012	Electrical and Electronics Drafters	330	0.81	$22.29	$27.33	$36.19
17-3013	Mechanical Drafters	880	1.01	$21.10	$26.04	$33.29
17-3022	Civil Engineering Technicians	770	0.81	$15.71	$20.73	$26.90
17-3023	Electrical and Electronics Engineering Technicians	1,670	0.86	$21.60	$27.44	$33.56
17-3024	Electro-Mechanical Technicians	130	0.63	$17.43	$20.62	$24.29
17-3025	Environmental Engineering Technicians	410	1.63	$20.29	$28.60	$37.27
17-3026	Industrial Engineering Technicians	1,400	1.49	$18.93	$22.60	$27.44
17-3027	Mechanical Engineering Technicians	790	1.25	$20.42	$24.64	$28.89
19-0000	Life, Physical, and Social Science Occupations	8,410	0.54	$18.23	$25.85	$33.97
19-1031	Conservation Scientists	160	0.64	$13.90	$23.22	$33.11
19-2031	Chemists	740	0.61	$23.55	$32.14	$43.01
19-2032	Materials Scientists	80	0.82	$28.57	$37.33	$43.58
19-2041	Environmental Scientists and Specialists	640	0.53	$16.41	$26.02	$33.96
19-4031	Chemical Technicians	870	0.99	$15.61	$19.74	$23.54
19-4041	Geological and Petroleum Technicians	40	0.19	$15.48	$17.83	$22.06
19-4051	Nuclear Technicians	N/A	N/A	$27.19	$31.87	$36.42
19-4093	Forest and Conservation Technicians	240	0.58	$14.28	$18.31	$24.24
45-0000	Farming, Fishing, and Forestry Occupations	4,620	0.77	$9.74	$12.93	$18.12
45-2091	Agricultural Equipment Operators	250	0.80	$7.95	$8.55	$9.15
45-4011	Forest and Conservation Workers	160	1.66	$11.07	$12.94	$15.40
45-4021	Fallers	190	2.43	$10.93	$13.17	$16.30
45-4022	Logging Equipment Operators	1,500	4.44	$12.22	$15.46	$18.31
45-4023	Log Graders and Scalers	110	2.78	$11.00	$13.99	$17.22
49-0000	Installation, Maintenance, and Repair Occupations	83,230	1.18	$13.48	$18.25	$24.31
49-1011	First-Line Supervisors of Mechanics, Installers	7,250	1.23	$20.79	$26.73	$33.63
49-2094	Electrical and Electronics Repairers	1,400	1.51	$14.35	$22.35	$27.30
49-3042	Mobile Heavy Equipment Mechanics	2,160	1.34	$18.48	$22.15	$27.40
49-9012	Control and Valve Installers and Repairers	480	0.84	$18.95	$24.76	$28.84
49-9041	Industrial Machinery Mechanics	6,550	1.55	$18.22	$21.88	$26.71
49-9043	Maintenance Workers, Machinery	1,360	1.10	$15.99	$18.79	$22.69
49-9051	Electrical Power-Line Installers and Repairers	2,850	1.86	$18.57	$24.23	$30.23
51-0000	Production Occupations	177,630	1.47	$11.50	$15.36	$20.13
51-1011	First-Line Supervisors of Production Workers	11,500	1.44	$20.50	$27.08	$34.75
51-2021	Coil Winders, Tapers, and Finishers	30	0.15	$9.17	$12.80	$16.40

SOC Code	Occupation Title	South Carolina Employment	SC Location Quotient	25th Percentile SC Wage	Median SC Wage	75th Percentile SC Wage
51-2022	Electrical and Electronic Equipment Assemblers	2,380	0.85	$13.50	$16.27	$19.09
51-2023	Electromechanical Equipment Assemblers	220	0.32	$11.52	$13.97	$17.03
51-2031	Engine and Other Machine Assemblers	940	1.71	$15.20	$18.40	$21.54
51-2041	Structural Metal Fabricators and Fitters	930	0.86	$12.80	$16.40	$20.17
51-2091	Fiberglass Laminators and Fabricators	670	2.58	$11.96	$14.07	$16.95
51-2092	Team Assemblers	40,420	2.77	$11.12	$14.37	$17.88
51-2099	Assemblers and Fabricators, All Other	1,440	0.42	$9.26	$11.30	$15.15
51-4011	Computer-Controlled Machine Tool Operators	3,200	1.66	$15.30	$17.73	$20.74
51-4012	CNC Machine Tool Programmers	300	0.89	$18.88	$24.02	$28.11
51-4021	Extruding and Drawing Machine Operators	1,700	1.68	$15.72	$19.74	$22.21
51-4022	Forging Machine Operators	220	0.69	$16.64	$20.44	$37.65
51-4023	Rolling Machine Operators	510	1.13	$16.56	$20.12	$23.62
51-4031	Cutting, Punching, and Press Machine Operators	2,290	0.89	$13.06	$16.19	$18.94
51-4032	Drilling and Boring Machine Tool Operators	340	1.23	$17.70	$24.40	$34.70
51-4033	Grinding and Polishing Machine Tool Operators	2,110	2.16	$15.06	$18.87	$21.26
51-4034	Lathe and Turning Machine Tool Operators	1,260	2.19	$15.75	$18.17	$21.00
51-4035	Milling and Planing Machine Operators	70	0.21	$14.34	$18.85	$36.99
51-4041	Machinists	7,710	1.43	$14.62	$17.43	$21.56
51-4051	Metal-Refining Furnace Operators and Tenders	430	1.43	$16.04	$20.21	$22.56
51-4052	Pourers and Casters	270	1.86	$15.79	$20.67	$35.65
51-4061	Model Makers	50	0.56	$14.70	$18.29	$21.33
51-4071	Foundry Mold and Coremakers	90	0.51	$10.24	$11.11	$14.28
51-4072	Molding and Casting Machine Operators	1,780	1.04	$10.44	$12.41	$16.73
51-4081	Multiple Machine Tool Operators	1,450	1.13	$14.80	$18.06	$21.65
51-4111	Tool and Die Makers	N/A	N/A	$19.82	$24.74	$28.13
51-4121	Welders, Cutters, Solderers, and Brazers	5,730	1.18	$14.00	$16.74	$20.13
51-4122	Welding, Soldering, and Brazing Machine Operators	650	0.93	$15.42	$17.37	$20.16
51-4191	Heat Treating Equipment Operators	740	2.51	$13.79	$16.35	$19.26
51-4192	Layout Workers, Metal and Plastic	120	0.63	N/A	N/A	N/A
51-4193	Plating and Coating Machine Operators	460	0.92	$12.85	$16.09	$20.07
51-4194	Tool Grinders, Filers, and Sharpeners	240	1.49	$11.03	$14.07	$17.85
51-4199	Metal Workers and Plastic Workers, All Other	140	0.46	$9.73	$10.56	$11.39
51-5111	Prepress Technicians and Workers	250	0.49	$11.22	$14.20	$18.22
51-8012	Power Distributors and Dispatchers	30	0.22	$19.46	$22.34	$26.70
51-8021	Stationary Engineers and Boiler Operators	450	0.90	$20.87	$25.31	$28.79
51-8091	Chemical Plant and System Operators	2,230	4.16	$16.59	$19.73	$24.17
51-9011	Chemical Equipment Operators and Tenders	1,060	1.27	$17.17	$21.31	$27.08
51-9032	Cutting and Slicing Machine Operators	1,290	1.58	$13.70	$17.39	$20.92

SOC Code	Occupation Title	South Carolina Employment	SC Location Quotient	25th Percentile SC Wage	Median SC Wage	75th Percentile SC Wage
51-9041	Extruding and Forming Machine Operators	2,000	2.08	$13.94	$17.74	$20.92
51-9061	Inspectors, Testers, Sorters, and Weighers	10,590	1.63	$12.44	$15.59	$19.42
53-0000	Transportation and Material Moving Occupations	125,070	1.01	$9.30	$12.49	$17.60
53-1021	First-Line Supervisors of Material Movers	2,510	1.09	$17.76	$21.86	$27.70
53-7011	Conveyor Operators and Tenders	580	1.03	$8.91	$11.69	$16.09
53-7051	Industrial Truck and Tractor Operators	6,500	0.94	$11.08	$13.68	$16.87
53-7062	Freight, Stock, and Material Movers	40,830	1.30	$8.92	$10.80	$14.24
53-7063	Machine Feeders and Offbearers	1,870	1.28	$10.11	$13.72	$16.93
53-7064	Packers and Packagers, Hand	9,540	1.03	$8.48	$9.78	$13.58
53-7081	Refuse and Recyclable Material Collectors	2,570	1.60	$8.60	$10.11	$13.23

Appendix C

State Tax Incentives for Recruitment of Clean Energy Industry Manufacturing

[Source: US Department of Energy, Database of State Incentives for Renewables and Efficiency, December 2014]

Arizona

Renewable Energy Business Tax Incentives

Eligible Renewable Technologies: Solar Water Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Solar Pool Heating, Anaerobic Digestion, Small Hydroelectric, Fuel Cells using Renewable Fuels
Applicable Sectors: Commercial, Industrial
Amount: Varies
Maximum Incentive: The tax credit is up to 10% of the investment amount. No individual limit on property tax reductions. The aggregate amount of tax credits that can be approved state-wide is $70 million per taxable year.
Start Date: 1/1/2010
Expiration Date: 12/31/2019

Arkansas

Wind Energy Manufacturing Tax Incentive

Eligible Renewable Technologies: Wind
Applicable Sectors: Commercial, Industrial
Amount: Varies, depending on amount invested and other factors
Maximum Incentive: Up to 100% income tax exemption
Start Date: 1/1/2008
Expiration Date: 12/31/2033

California

Sales and Use Tax Exclusion for Advanced Transportation and Alternative Energy Manufacturing Program

Eligible Renewable Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Municipal Solid Waste, "Advanced Transportation", Tidal Energy, Wave Energy, Ocean Thermal, Fuel Cells using Renewable Fuels
Applicable Sectors: Industrial
Amount: 100% exemption
Terms: Projects must apply for an exemption through the California Alternative Energy and Advanced Transportation Financing Authority
Program Budget: $100,000,000 per year
Start Date: 3/24/2010
Expiration Date: 1/1/2021

Connecticut

Sales and Use Taxes for Items Used in Renewable Energy Industries

Eligible Renewable Technologies: Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Geothermal Heat Pumps, Solar Pool Heating, Geothermal Direct-Use

Applicable Sectors: Commercial, Industrial

Amount: 100% sales tax exemption

Start Date: 01/01/2010

Kentucky

Incentives for Energy Independence

Eligible Renewable Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Renewable Fuels

Applicable Sectors: Commercial

Maximum Incentive: 100% of the corporate income tax
100% of Limited Liability Entity Tax
4% of gross wages of each employee
All tax credits combined may not exceed 50% of the capital investment in the project

Terms: $1,000,000 minimum capital investment
Solar power facilities must generate at least 50 kW
Other energy facilities must generate at least 1 MW
Negotiated incentive package may not exceed 25 years

Funding Source: General Funds

Start Date: 1/1/2008

Massachusetts

Alternative Energy and Energy Conservation Patent Exemption (Corporate)

Eligible Renewable Technologies: Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, Fuel Cells using Renewable Fuels

Applicable Sectors: Commercial

Amount: 100% deduction

Start Date: 1979

Mississippi

Mississippi Clean Energy Initiative

Eligible Renewable Technologies: Solar Water Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric

Applicable Sectors: Commercial, Industrial

Amount: 100% exemption from income, franchise, and sales & use tax for 10 years

Terms: Manufacturers must have a minimum investment of $50 million and create 50 new jobs

Start Date: 07/01/2010

Montana

Alternative Energy Investment Tax Credit

Eligible Renewable Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Fuel Cells using Renewable Fuels
Applicable Sectors: Commercial, Industrial
Amount: 35% tax credit
Maximum Incentive: Not specified.
Terms: Participant investment must be greater than or equal to $5,000. Unused credit may be carried forward 7 years. See below for criteria to qualify for a 15-year carryover.
Start Date: 1/1/2002

New Jersey

Edison Innovation Green Growth Fund Loans

Eligible Efficiency Technologies: Lighting, Furnaces , Boilers, Central Air conditioners, Energy Mgmt. Systems/Building Controls, LED Lighting, Other Technologies that Reduce Electricity or Natural Gas Consumption (e.g., Efficient Appliances)
Eligible Renewable Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Balance of System Components, Anaerobic Digestion, Tidal Energy, Wave Energy, Fuel Cells using Renewable Fuels
Applicable Sectors: Commercial, Industrial
Amount: Varies
Maximum Incentive: Total (grants and loans): $3.3 million
Grants: $300,000
Loans: $3 million
Terms: 50% cost share required; Loans at 2% interest for up to 10 years with three year deferral of principal repayment
Funding Source: New Jersey Societal Benefits Charge (public benefits fund)
Program Budget: $2 million (2012 funding)
Start Date: May 23, 2011 (most recent solicitation)
Expiration Date: Applications accepted on a rolling basis

New Mexico

Alternative Energy Product Manufacturers Tax Credit

Eligible Renewable Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Fuel Cells, Municipal Solid Waste, Batteries, Hybrid Electric Vehicles, Electric Vehicles, products extracted from or secreted by a single cell photosynthetic organism, Anaerobic Digestion, Fuel Cells using Renewable Fuels
Applicable Sectors: Commercial, Industrial
Amount: Determined by New Mexico Department of Taxation and Revenue
Maximum Incentive: 5% of taxpayer's qualified expenditures
Terms: 5-year tax credit carryover
Start Date: 07/01/2006

New York

Low-rise Residential New Construction Program

Eligible Efficiency Technologies: Comprehensive Measures/Whole Building
Applicable Sectors: Construction, Installer/Contractor, Low-Income Residential, Home Energy Raters, and Home Energy Rating Providers

Amount: Tier 1- $2,000 per qualified unit

Tier 2 - $2,500 for units < 1,500 sq. ft. and $3,000 for units >1,500 sq. ft.

Tier 3- $4,000 for units < 1,500 sq. ft. and $8,000 for units > 1,500 sq. ft

Model or Display home – an additional $1,000

First Plan Review & Rating Incentive – an additional $1,000

Affordable Housing Homeowner Incentive - $500

HERS Provider Incentive- $100

Cooperative Advertising Incentive: $5,000 (1-9 homes); $25,000 (10 - 19 homes); $50,000 (20 – 49 homes); $100,000 (50+ homes)

Terms: Builder must be a participant in NYSERDA's Low-rise Residential New Construction Program

Funding Source: Energy Efficiency Portfolio Standard (EEPS); Regional Greenhouse Gas Initiative (RGGI); System Benefits Charge (SBC)

Program Budget: $33,272,896 (January 1, 2012 - December 31, 2015)

Start Date: 01/01/2012

Expiration Date: 12/31/2015

NYSERDA - ENERGY STAR Home Builders

Eligible Efficiency Technologies: Comprehensive Measures/Whole Building

Applicable Sectors: Construction, Installer/Contractor

Amount: General Builder Home Incentive (BHI): $1,250 (upstate); $1,500 (downstate)

Model Home: $3,000

Display Home: $2,500

First Plan Review/Rating: $200 - $500

Quality Installer (envelope, insulation, air sealing): $250

Quality Installer (primary heating): $250

Quality Installer (primary cooling): $250

Owner Incentive (affordable housing): $500 per unit

HERS Provider Incentive: $75 per unit

Cooperative Advertising Incentives: 25% or 50% of expenditures (depending on content)

Maximum Incentive: Cooperative Advertising Incentive: $5,000 (1-9 homes); $50,000 (10 - 49 homes); $100,000 (50+ homes)

Other Incentives: determined by standardized incentive schedule

Terms: Work must be performed by a New York ENERGY STAR Home Program Partner

Funding Source: System Benefits Charge (SBC); Energy Efficiency Portfolio Standard (EEPS)

Program Budget: $33.3 million (January 1, 2012 - December 31, 2015)

Start Date: 01/01/2012 (current solicitation)

Expiration Date: 12/31/2015

Oregon

Tax Credit for Renewable Energy Equipment Manufacturers

Eligible Renewable Technologies: Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Solar Pool Heating, Small Hydroelectric, Tidal Energy, Wave Energy

Applicable Sectors: Commercial, Industrial

Amount: 50% of eligible costs (10% per year for 5 years)

Maximum Incentive: $20 million

Expiration Date: 1/1/2014

Pennsylvania

Alternative and Clean Energy Program

Eligible Efficiency Technologies: Clothes Washers, Dishwasher, Refrigerators, Dehumidifiers, Ceiling Fan, Water Heaters, Lighting, Lighting Controls/Sensors, Chillers , Furnaces , Boilers, Heat pumps, Central Air conditioners, CHP/Cogeneration, Energy Mgmt. Systems/Building Controls, Comprehensive Measures/Whole Building, LED Lighting, Other Unspecified Technologies

Eligible Renewable Technologies: Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, MSW must be Waste-to-Energy, Anaerobic Digestion, Small Hydroelectric, Renewable Fuels, Fuel Cells using Renewable Fuels, Geothermal Direct-Use

Applicable Sectors: Commercial, Industrial

Amount: Varies by project, but program generally requires matching funds at least equivalent to DCED funding

Maximum Incentive: Manufacturer Loans: $40,000 per job created within 3 years

Manufacturer Grants: $10,000 per job created within 3 years

Loans for distribution projects, high performance buildings: $5 million (also $3/square foot of space served for geothermal)

Grants for distribution projects, high performance buildings: $2 million

Grants for Energy Savings Contracts (ESCO): $500,000

Grants for Feasibility Studies: $175,000

Loan guarantee grants: Up to 75% of deficient funds up to $5 million

Incentives: Generally limited to 50% of project costs, except grants for high performance buildings limited to 10% of project costs.

Terms: Loan interest rates set at 250 basis points higher than 10 year treasury bond (5% for 2014); failure to meet job creation requirements may result in repayment of grants or additional interest payments over the remaining term of the loan.

Funding Source: Alternative Energy Investment Fund (state-issued bonds)

Program Budget: $165 million

Start Date: May 2009

Wind and Geothermal Incentives Program

Eligible Renewable Technologies: Wind, Geothermal Electric, Geothermal Heat Pumps, Geothermal Direct-Use

Applicable Sectors: Commercial, Industrial

Amount: Varies by project, but program generally requires matching funds at least equivalent to DCED funding

Maximum Incentive: Manufacturer loans: $40,000 per job created within 3 years

Manufacturer grants: $5,000 per job created within 3 years

Loans for geothermal systems: $3 per square foot of space served up to $5 million

Loans for wind energy production projects: $5 million

Grants for wind energy production projects: $1 million

Grants for feasibility studies: 50% of cost up to $175,000

Loan guarantee grants: Up to 75% of deficient funds up to $5 million

Terms: Loans provided at interest rate that is 250 basis points above the 10 year Treasury note(5% as of July 2011), up to 10 years (equipment) or 15 years (real estate). Loan guarantee grants have a maximum term of 5 years.

Funding Source: Alternative Energy Investment Fund (state issued bonds)
Program Budget: $25 million
Start Date: January 2009

South Carolina

Eligible Renewable Technologies: Manufacturers of systems or components that are used in manufacturing or operation of clean energy equipment for the generation, storage, testing and research and development, and transmission or distribution of electricity from clean energy sources, including specialized packaging for the clean energy equipment manufactured at the facility.
Applicable Sectors: Industrial
Amount: 10%
Maximum Incentive: $500,000 for any year and $5 million total per taxpayer. The income tax credit is allowed for up to sixty months beginning with the first taxable year for which the business or corporation is eligible to receive the credit, so long as the business or corporation becomes eligible to receive the credit no later than the tax year ending on December 31, 2020.
Terms: Investment criteria depending on county designation. Investment must create one full-time job for every $1 million invested. Qualifying expenditures must be certified by the Department of Revenue
Start Date: 01/01/2013
Expiration Date: 12/31/2020

Tennessee

Green Energy Tax Credit

Eligible Renewable Technologies: Component Manufacturing
Applicable Sectors: Industrial
Amount: The incentive is based on how much less the manufacturer pays for electricity than the maximum certified rate.
Maximum Incentive: Green Energy Tax Credit: $1,500,000/tax year for $250 million in capital investment
Terms: The investment must equal at least $250 million within three years. The tax credit is applied against the Franchise and Excise Tax.
Start Date: 11/1/2009
Expiration Date: 1/1/2029

Sales and Use Tax Credit for Emerging Clean Energy Industry

Eligible Renewable Technologies: Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Hydrogen, Clean Energy Technology, Solar Pool Heating, Anaerobic Digestion, Small Hydroelectric, Other Distributed Generation Technologies
Applicable Sectors: Commercial, Industrial
Amount: Tax rate reduced to 0.5%
Terms: Taxpayer must make $100 million investment (minimum) and create 50 full-time jobs at 150% rate of Tennessee's average occupational wage.
Start Date: 07/01/2009

Texas

Solar and Wind Energy Business Franchise Tax Exemption

Eligible Renewable Technologies: Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind

Applicable Sectors: Commercial, Industrial
Amount: All
Start Date: 1982

Utah

Alternative Energy Manufacturing Tax Credit

Eligible Renewable Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Other Non-Renewable Alternative Energy Resources (see summary for list), Small Hydroelectric
Applicable Sectors: Commercial, Industrial, Manufacturers
Amount: Determined on a case-by-case basis by the Governor's Office of Economic Development based on statutory guidelines and evaluation criteria.
Maximum Incentive: Up to 100% of new state tax revenues (including, state, corporate, sales and withholding taxes) over the life of the project or 20 years, whichever is less.
Start Date: 5/12/2009

Virginia

Clean Energy Manufacturing Incentive Grant Program

Eligible Renewable Technologies: Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Nuclear, Solar Pool Heating, Small Hydroelectric, Tidal Energy, Wave Energy, Renewable Fuels, Ethanol, Biodiesel, Fuel Cells using Renewable Fuels, Geothermal Direct-Use
Applicable Sectors: Commercial, Industrial
Maximum Incentive: Aggregate amount of grants awarded and outstanding at any time cannot exceed $36 million
Terms: 6 years maximum
Program Budget: $36,000,000
Start Date: July 1, 2011

Green Jobs Tax Credit

Eligible Renewable Technologies: Solar Water Heat, Solar Space Heat, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Heat Pumps, Solar Pool Heating, Fuel Cells using Renewable Fuels, Geothermal Direct-Use
Applicable Sectors: Commercial, Industrial
Amount: $500 per each job created
Maximum Incentive: $175,000
Terms: Must create a new job in the alternative energy/renewable energy fields. The Department of Commerce and Trade will promulgate rules regarding qualifying jobs.
Expiration Date: 12/31/2014

Washington

Tax Abatement for Solar Manufacturers

Eligible Renewable Technologies: Photovoltaics, Stirling Converters
Applicable Sectors: Industrial
Amount: 43% reduction of state's business and occupation (B&O) tax
Maximum Incentive: None
Start Date: 7/1/2005
Expiration Date: 6/30/2017

Tax Credit for Forest Derived Biomass

Eligible Renewable Technologies: Biomass

Applicable Sectors: Commercial, Industrial

Amount: Harvested July 1, 2010 through June 30, 2013: $3/ton

Harvested July 1, 2013 through June 30, 2015: $5/ton

Maximum Incentive: Credit allowed may not exceed tax due for the same reporting period

Start Date: 10/01/2009

Expiration Date: 06/30/2015

Appendix D

State Tax Incentives for Ethanol and Biodiesel Production

[Source: US Department of Energy, Database of State Incentives for Renewables and Efficiency, December 2014]

Alabama

Biofuel Production Facility Tax Credit

Companies that invest in the development of a biofuel production facility may be eligible for a tax credit of up to 5% of project costs per year for up to 20 years. For the purposes of the credit, biofuel is defined as a motor vehicle fuel that is produced from grain, starch, oilseeds, vegetable, algae, animal materials, or other biomass. To be eligible for the tax credit, the capital costs of the production facility must be at least $2,000,000, or $500,000 if the facility is located in a favored geographic area, which includes enterprise zones and less developed areas. The credit expires December 31, 2018.

Arkansas

Alternative Fuel Grants and Rebates

The Arkansas Alternative Fuels Development Program (Program) provides grants to alternative fuel producers, feedstock processors, and alternative fuel distributors. Producers may be eligible to receive $0.20 per gallon of alternative fuels produced, not to exceed $2 million. Alternative fuels include biofuel, ethanol, compressed natural gas, or a synthetic transportation fuel.

Connecticut

Biofuels Research Grants

The Connecticut Department of Economic and Community Development administers a fuel diversification grant program to provide funding to Connecticut higher education or agricultural research institutions for research to promote biofuel production from agricultural products, algae, and waste grease, as well as biofuel quality testing.

Florida

Biofuels Investment Tax Credit

An income tax credit is available for 75% of all capital, operation, maintenance, and research and development costs incurred in connection with an investment in the production, storage, and distribution of biodiesel (B10-B100), ethanol (E10-E100), or other renewable fuel in the state, up to $1 million annually per taxpayer and $10 million annually for all taxpayers combined. Costs associated with retrofitting gasoline fueling station dispenser retrofits for B10-B100, E10-E100, or other renewable fuel distribution also qualify. Taxpayers must incur costs between July 1, 2012, and June 30, 2016. Renewable fuel is defined as a fuel produced from biomass that is used to replace or reduce conventional fuel use.

Excise Tax Exemption for Biodiesel produced by schools

Biodiesel fuel manufactured by a public or private secondary school is exempt from the diesel fuel excise tax and the associated registration requirements. To qualify for the exemption, total annual production of biodiesel must be less than 1,000 gallons and may only be used by the school, its employees, or its students.

Hawaii

Ethanol Production Incentive

Ethanol producers may qualify for an income tax credit equal to 30% of production facility nameplate capacity between 500,000 and 15 million gallons per year. The facility must produce at least 75% of its nameplate capacity to receive the tax credit each year and may claim the tax credit for up to eight years. Qualifying ethanol production facilities must be in operation on or before January 1, 2017. Once the total nameplate capacities of all qualifying ethanol production facilities built within the state reaches 40 million gallons per year, credits are not allowed for new facilities. The total amount of all credits distributed across the state may not exceed $12 million in a given year.

Illinois

Biofuels Business Planning Grants

The Illinois Department of Commerce and Economic Opportunity provides grants up to $25,000 for the development of new biofuel production facilities through its Biofuels Business Planning Grant Program. Eligible activities include business planning, engineering designs, permit applications, and legal work.

Biofuels Production Facilities Grants

The Illinois Department of Commerce and Economic Opportunity's Renewable Fuels Development Program provides grants for the construction or expansion of biodiesel and ethanol production facilities. Each new facility must have a production capacity of at least 30 million gallons per year, and an existing facility must expand its production capacity by at least 30 million gallons per year to be eligible for funding. The total amount of the grant awarded may be up to 10% of the total construction costs of the facility or $5.5 million, whichever is less.

Indiana

Ethanol Production Tax Credit

An ethanol producer located in Indiana is entitled to a credit of $0.125 per gallon of ethanol produced, including cellulosic ethanol. The credit granted to a single taxpayer may not exceed the following amounts for all taxable years:

Tax Credit	Annual Production
$2 million	More than 40 million and less than 60 million gallons of grain ethanol
$3 million	At least 60 million gallons of grain ethanol
$20 million	At least 20 million gallons of cellulosic ethanol

Biodiesel Production Tax Credit

A biodiesel producer located in Indiana may receive a credit of $1.00 per gallon of biodiesel produced and used in biodiesel blends. The IEDC may approve up to $5 million in credits for a single producer for all taxable years.

Biodiesel Blending Tax Credit

A biodiesel blender located in Indiana may receive a credit of $0.02 per gallon of blended biodiesel produced at a facility located in Indiana. The IEDC may grant a single taxpayer no more than $3 million total for all taxable years.

Biodiesel Blend Tax Exemption

Biodiesel blends of at least 20% (B20) that are used for personal, noncommercial use by the individual that produced the biodiesel portion of the fuel are exempt from the $0.16 per gallon license tax. The maximum number of gallons of fuel for which the exemption may be claimed is based on the percentage volume of biodiesel in each gallon used.

Iowa

Alternative Fuel Production Tax Credits

The High Quality Jobs Program offers state tax incentives to business projects for the production of biomass or alternative fuels. Incentives may include an investment tax credit equal to a percentage of the qualifying investment, amortized over five years; a refund of state sales, service, or use taxes paid to contractors or subcontractors during construction; an increase of the state's refundable research activities credit; and a local property tax exemption of up to 100% of the value added to the property.

Biodiesel Producer Tax Refund

A biodiesel producer may apply for a refund of Iowa state sales or use taxes paid on purchases. To qualify, the producer must be registered with the U.S. Environmental Protection Agency and any biodiesel produced must be used in biodiesel fuel blends. The refund amount is based on the total gallons of biodiesel produced in the state multiplied by the designated rate of $0.02. A biodiesel producer is only eligible to receive a refund for up to 25 million gallons of biodiesel produced during each calendar year through 2017. This incentive expires January 1, 2018.

Kansas

Biofuel Production Facility Tax Exemption

Any newly constructed or expanded biomass-to-energy facility is exempt from state property taxes for up to 10 taxable years immediately following the taxable year in which construction or installation is completed. A biomass-to-energy facility includes any industrial process plant that uses biomass to produce at least 500,000 gallons of cellulosic alcohol fuel, liquid or gaseous fuel, or other source of energy in a quantity with energy content at least equal to that of 500,000 gallons of cellulosic alcohol fuel. Expansion of an existing biomass-to-energy facility means expansion of the facility's production capacity by a minimum of 10%.

Biofuel Blending Equipment Tax Exemption

Qualified equipment used for storing and blending petroleum-based fuel with biodiesel, ethanol, or other biofuel is exempt from state property taxes. The exemption begins at the time of installation at a fuel terminal, refinery, or biofuel production plant, and ends 10 taxable years following the year in which the equipment was installed. Equipment used only for denaturing ethyl alcohol is not eligible.

Kentucky

Ethanol Production Tax Credit

Qualified ethanol producers are eligible for an income tax credit of $1.00 per gallon of corn- or cellulosic-based ethanol that meets ASTM specification D4806. The total credit amount available for producers is $5 million for each fuel type in each taxable year.

Biodiesel Production and Blending Tax Credit

Qualified biodiesel producers or blenders are eligible for an income tax credit of $1.00 per gallon of pure biodiesel (B100) or renewable diesel produced or used in the blending process. Re-blending of blended biodiesel does not qualify for the tax credit. The total amount of credits claimed by all biodiesel producers may not exceed the annual biodiesel tax credit cap of $10 million.

Louisiana

Biodiesel Equipment and Fuel Tax Exemption

Certain property and equipment used to manufacture, produce, or extract unblended biodiesel are exempt from state sales and use taxes. Unblended biodiesel used as fuel by a registered manufacturer is also exempt from state sales and use taxes until June 30, 2015. Unblended biodiesel is defined as B100 fuel that meets ASTM specification D6751.

Maine

Biofuels Production Tax Credit

A certified commercial biofuel producer is eligible for an income tax credit of $0.05 per gasoline gallon equivalent of biofuel produced for use in motor vehicles or otherwise used as a substitute for liquid fuels. Biofuel is defined as ethanol, biodiesel, hydrogen, methanol, or any other transportation fuel derived from agricultural crops or residues, or from forest products or byproducts. For biofuels blended with petroleum or other non-biofuels, the credit is allowed only on the biofuels portion of that blend.

Biodiesel Fuel Tax Exemption

An individual that produces biodiesel for personal use or use by a member of his or her immediate family is exempt from the state fuel excise tax.

Maryland

Biofuel Production Incentive

Ethanol production credits are as follows: a) $0.20 per gallon of ethanol produced from small grains such as wheat, rye, triticale, oats, and hulled or hull-less barley; or b) $0.05 per gallon of ethanol produced from other agricultural products.
Biodiesel production credits are as follows: a) $0.20 per gallon of biodiesel produced from soybean oil (the soybean oil must be produced in a facility or through expanded capacity of a facility that began operating after December 31, 2004), or b) $0.05 per gallon for biodiesel produced from other feedstocks, including soybean oil produced in a facility that began operating on or before December 31, 2004.
Credits are offered to certified producers in Maryland for ethanol or biodiesel produced between December 31, 2007, and December 31, 2017.

Massachusetts

Cellulosic Biofuel Tax Exemption

Fuel consisting of cellulosic biofuel or a blend of gasoline and cellulosic biofuel is eligible for an exemption of the $0.21 per gallon fuel tax, in proportion to the percentage of the fuel content consisting of cellulosic biofuel. This exemption is available through the 2017 tax year.

Mississippi

Biofuels Production incentive

The Mississippi Department of Agriculture and Commerce (Department) provides incentive payments to qualified ethanol and biodiesel producers located in Mississippi. The Department may issue payments of $0.20 per gallon for up to 30 million gallons per year per producer for a period of up to 10 years following the start date of production. The Department may not make payments for production after June 30, 2015, and the maximum total annual payment to a single producer per fiscal year is $6 million.

Montana

Ethanol Production Incentive

Montana-based ethanol producers are eligible for a tax incentive of $0.20 per gallon of ethanol produced solely from Montana agricultural products or ethanol produced from non-Montana agricultural products when Montana products are unavailable. The tax incentive is available to a facility for the first six years from the date production begins. Ethanol eligible for the incentive must be blended with gasoline for sale as ethanol-blended gasoline in Montana, exported from Montana for sale as ethanol-blended gasoline, or used in the production of ethyl butyl ether for use in reformulated gasoline.

Nebraska

Ethanol and Biodiesel Tax Exemption

Motor fuels sold to an ethanol or biodiesel production facility and motor fuels manufactured at and sold from an ethanol or biodiesel facility are exempt from certain motor fuel tax laws the Motor Fuels Division of the Nebraska Department of Revenue enforces.

New Mexico

Biofuels Production Tax Deduction

The cost of purchasing qualified biomass feedstocks to be processed into biofuels, as well as the associated equipment, may be deducted in computing the compensating tax due under the New Mexico Gross Receipts and Compensating Tax Act. For the purpose of this incentive, biofuels include ethanol, methanol, methane, and hydrogen.

New York

Biofuel Production Tax Credit

Biofuel producers in New York State may qualify for a state tax credit of $0.15 per gallon of biodiesel (B100) or denatured ethanol produced after the production facility has produced, and made available for sale, 40,000 gallons of biofuel per year. The maximum annual credit available is $2.5 million per taxpayer for no more than four consecutive taxable years per production facility. This credit expires December 31, 2019.

North Carolina

Biodiesel Tax Exemption

An individual who produces biodiesel for use in that individual's private passenger vehicle is exempt from the state motor fuel excise tax.

North Dakota

Ethanol Production Incentive

The Ethanol Production Incentive provides qualified ethanol producers with quarterly payments based on production volume during times when ethanol prices are unusually low and/or corn prices are unusually high. If an ethanol production facility was in operation in North Dakota before July 1, 1995, it is only eligible to receive incentive payments if that facility increases its production by 10 million gallons or 50% of its production capacity, whichever is less, during any 12-month period beginning on or after July 1, 2005. The incentive amount is based on the average North Dakota wholesale ethanol price for the preceding quarter and the average North Dakota corn price for the preceding quarter. The total cumulative incentive available to all eligible producers in any single year is $1.6 million. A single eligible facility may not receive more than $10 million in incentive payments over the life of the facility.

South Carolina

Ethanol or Biodiesel Production Credit

For tax years beginning after 2006 and before 2017, a corn-based ethanol or soy-based biodiesel facility in production of corn-based ethanol or soy-based biodiesel, before denaturing, at a rate of at least 25% of its name plate design capacity for the production on or before December 31, 2011.

The amount of credit is 20¢ a gallon of corn-based ethanol or soy-based biodiesel produced and the amount of credit is 30¢ a gallon of noncorn ethanol or nonsoy oil biodiesel produced is allowed for 60 months beginning with the first month for which the facility is eligible to receive the credit and ending not later than December 31, 2016.The taxpayer becomes eligible for the credit after the facility has 6 consecutive months of operation at an average production rate of at least 25% of its name plate design capacity.

South Dakota

Ethanol and Biobutanol Production Incentive

Qualified and licensed ethanol and biobutanol producers are eligible for a $0.20 per gallon production incentive for ethanol and biobutanol that is fully distilled and produced in South Dakota. Annual production incentives paid to one facility may not exceed $1 million. Cumulative annual production incentives paid out to all facilities may not exceed $4.5 million in 2014, 2015, and 2016, and $7 million each year thereafter. Funds are apportioned each month based on the claims submitted and the total funds available.

Virginia

Biofuels Production Grants

To qualify, a producer must have begun selling neat biofuels on or after January 1, 2014. A qualified producer must produce a minimum of one million gallons of biofuels annually in the Commonwealth with feedstock originating in the United States. Beginning January 1, 2016, grants will not be awarded for corn-derived biofuels. This program expires June 30, 2017

Appendix E

State Tax Incentives for Use of Hybrid, Electric and Alternative Fuel Vehicles

[Source: US Department of Energy, Database of State Incentives for Renewables and Efficiency, December 2014]

Arizona

HOV Lane Exemption: Qualified alternative fuel vehicles may use designated HOV lanes regardless of the number of occupants in the vehicle.

Electric Vehicle Equipment Tax Credit: Maximum of $75 available to individuals for installation of EV charging outlets.

Reduced Alternative Fuel Vehicle License Tax: Reduction in the annual vehicle license tax for an electric vehicle to a minimum of $5 per year.

Alternative Fuel Vehicle Tax Exemption: S. B. 1413, enacted in 2014, exempts certain alternative fuels such as natural gas, electricity and hydrogen from the state use tax.

Vehicle Emissions Inspection Exemption: H.B. 2226 and H.B. 2580 (2014) exempt qualified plug-in electric vehicles from an annual emissions inspection for the first five registration years.

Plug-In Electric Vehicle Charging Rates: The Arizona Public Service Company offers a residential time-of-use plan to customers who own a qualified PEV. The pilot program is available through Dec. 31, 2014.

California

HOV Lane Exemption: Qualified alternative fuel vehicles—including hydrogen, hybrid, and electric vehicles—may use designated HOV lanes regardless of the number of occupants in the vehicle. Qualified vehicles are also exempt from toll fees in High Occupancy Toll (HOT) lanes.

Alternative Fuel Vehicle Rebate Program: The Clean Vehicle Rebate Project (CVRP) offers rebates for the purchase or lease of qualified vehicles. The rebates offer up to $2,500 for light-duty zero emission and plug-in hybrid vehicles that the California Air Resources Board (ARB) has approved or certified.

Alternative Fuel Vehicle Tax Exemption: California's Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) provides a sales tax exclusion for advanced manufacturers and manufacturers of alternative source and advanced transportation products, components or systems.

Alternative Fuel Vehicle Rebate Program: The San Joaquin Valley Air Pollution Control District administers the Drive Clean! Rebate Program, which provides rebates of up to $3,000 for the purchase or lease of eligible new vehicles, including qualified natural gas and plug-in electric vehicles.

Alternative Fuel & Vehicle Incentives: Through the Alternative and Renewable Fuel Vehicle Technology Program, the California Energy Commission provide financial incentives for businesses, vehicle and technology manufacturers, workforce training partners, fleet owners, consumers and academic institutions with the goal of developing and deploying alternative and renewable fuels and advanced transportation technologies.

Electric Vehicle Supply Equipment Rebate: The Los Angeles Department of Water and Power (LADWP) Charge Up L.A.! program provides rebates to residential and commercial customers who install Level 2 (240 Volt) chargers. Rebates are offered to the first 2,000 customers who apply. Glendale Water and Power (GWP) also offers a $200 rebate to residential customers owning an electric vehicle and installing a Level 2 charging station. Certain restrictions apply.

Alternative Fuel Vehicle Parking: The California Department of General Services (DGS) and California Department of Transportation (DOT) must provide 50 or more parking spaces and park-and-ride lots owned and operated by DOT to incentivize the use of alternative fuel vehicles.

Colorado

Alternative Fuel & Advanced Vehicle Technology Tax Credit: An income tax credit of up to $6,000 is available for a motor vehicle that uses or is converted to use an alternative fuel, is a hybrid electric vehicle or has its power source replaced with one that uses an alternative fuel.

Plug-in Electric Vehicle and Electric Vehicle Supply Equipment Grants: The Colorado Energy Office (CEO) and Regional Air Quality Council (RAQC) provide grants to support PEV adoption in fleets. RAQC grants cover 80 percent of the incremental cost of a qualified PEV, up to $8,260. Both CEO and RAQC grants fund 80 percent of the cost of electric vehicle supply equipment (EVSE), up to $6,260.

Plug-In Electric Vehicle Fee: Colorado requires PEV owners to pay an annual fee of $50.

Connecticut

Alternative Fuel Vehicle Funding: The Connecticut Clean Fuel Program provides funding to municipalities and public agencies that purchase, operate, and maintain alternative fuel and advanced technology vehicles, including those that operate on compressed natural gas, propane, hydrogen, and electricity. The Connecticut Department of Energy and Environmental Protection also provides funding to municipalities and state agencies for the project cost and installation of electric vehicle supply equipment.

Vehicle-to-Grid Energy Credit: Retail electricity customers with at least one grid-integrated electric vehicle may qualify to receive kilowatt-hour credits for energy discharged to the grid from the EV's battery at the same rate that the customer pays to charge the battery.

District of Columbia

Alternative Fuel and Fuel-Efficient Vehicle Title Tax Exemption: Qualified alternative fuel vehicles are exempt from the excise tax imposed on an original certificate of title.

Reduced Registration Fee: A new motor vehicle with a U.S. Environmental Protection Agency estimated average city fuel economy of at least 40 miles per gallon is eligible for a reduced vehicle registration fee of $36. This reduced rate applies to the first-time registration only.

Alternative Fuel Vehicle Tax Credit: An income tax credit of 50 percent—up to $19,000 per vehicle—is available for the incremental or conversion cost for qualified vehicles. A tax credit is also available for 50 percent of the equipment costs for the purchase and installation of alternative fuel infrastructure. The maximum credit is $1,000 per residential electric vehicle charging station and $10,000 for each public fueling station.

Florida

HOV Lane Exemption: Qualified alternative fuel vehicles may use designated HOV lanes regardless of the number of occupants in the vehicle. The vehicle must display a Florida Division of Motor Vehicles issued decal, which is renewed annually. Vehicles with decals may also use any HOV lane designated as a HOV toll lane without paying the toll.

Electric Vehicle Supply Equipment Financing: Property owners may apply to their local government for funding to help finance EVSE installations on their property or enter into a financing agreement with the local government for the same purpose.

Georgia

HOV Lane Exemption: Qualified EVs and PHEVs may use designated HOV lanes regardless of the number of occupants in the vehicle.

Alternative Fuel Vehicle Tax Credit: An income tax credit is available to individuals who purchase or lease a new dedicated AFV or convert a vehicle to operate solely on an alternative fuel. The amount of the tax credit is 10 percent of the vehicle cost, up to $2,500.

Zero Emission Vehicle Tax Credit: An income tax credit is available for 20 percent or up to $5,000 for individuals who purchase or lease a new zero emission vehicle.

Electric Vehicle Supply Equipment Tax Credit: An income tax credit of 10 percent of the cost of the electric vehicle charging equipment, up to $2,500.

Hawaii

HOV Lane Exemption: Qualified EVs and PHEVs may use designated HOV lanes regardless of the number of occupants in the vehicle.

Parking Fee Exemption: Qualified vehicles with electric vehicle license plates are exempt from certain parking fees charged by any non-federal government authority.

Parking Requirement: Public parking systems with 100 parking spaces or more must include at least one designated parking space for EVs and provide an EV charging system.

PEV Charging Rate Incentive: Hawaiian Electric Company offers time-of-use rates for residential and commercial customers who own an electric vehicle. This pilot program is offered to customers on Oahu, Maui County, and the Island of Hawaii.

Idaho

Vehicle Inspection Exemptions: Hybrid and electric vehicles are exempt from state motor vehicle inspection and maintenance programs.

Illinois

Alternative Fuel Vehicle and Alternative Fuel Rebates: The Illinois Alternate Fuels Rebate Program provides a rebate of 80 percent, or up to $4,000 of the cost of purchasing an alternative fuel vehicle or converting a conventional vehicle.

Electric Vehicle Supply Equipment Rebates: The Illinois Department of Commerce and Economic Opportunity provides rebates to offset the cost of Level 2 EVSE. The maximum possible total rebate award is $49,000 or 50 percent of the total project cost for up to 15 EVSE, whichever is less.

Electric Vehicle Registration Fee Reduction: The owner of an EV may register for a discounted registration fee not to exceed $35 for a two-year registration period or $18 for a one-year registration period.

Indiana

Plug-In Electric Vehicle Charging Rate Incentive: Indianapolis Power & Light Company (IPL) offers special plug-in EV charging rates for residential and fleet customers who own a licensed electric or plug-in electric vehicle.

Electric Vehicle Supply Equipment Credit and Charging Incentive: NIPSCO's IN-Charge Electric Vehicle Program offers a credit of up to $1,650 to purchase and install residential EVSE, as well as free plug-in electric vehicle charging during off-peak hours.

Louisiana

Alternative Fuel Vehicle and Fueling Infrastructure Tax Credit: An income tax credit is available for 50 percent of the cost of converting or purchasing an alternative fuel vehicle or constructing an alternative fueling station. Alternatively, a tax credit of 10 percent of the cost of the motor vehicle, up to $3,000 is available for alternative fuel vehicles registered in the state.

Authorization for Alternative Fuel Vehicle Loans: The Louisiana Department of Natural Resources will administer the AFV Revolving Loan Fund to provide loan assistance to local government entities, including cities, parishes, school boards, and local municipal subdivisions for the cost of converting conventional vehicles to operate on alternative fuels, or the incremental cost of purchasing new AFVs.

Maryland

HOV Lane Exemption: S.B. 33 (2014) allows qualified alternative fuel vehicles may use designated HOV lanes regardless of the number of occupants in the vehicle.

Plug-in Electric Vehicle Tax Credit: Effective July 1, 2013 through June 30, 2014, a tax credit of up to $1,000 is available against the excise tax imposed for the purchase of a qualified plug-in electric vehicles. Effective July 1, 2014, H.B. 1345 and S.B. 908 (2014) replace the existing tax credit by providing a tax credit equal to $125 times the number of kilowatt-hours of battery capacity of the vehicle, or up to $,3000.

Electric Vehicle Supply Equipment Tax Credit: The Maryland Energy Administration (MEA) offers an income tax credit equal to 20 percent of the cost of qualified electric vehicle supply equipment. The credit may not exceed the lesser of $400 or the state income tax imposed for that tax year.

Massachusetts

Plug-In Electric Vehicle Rebates: The Massachusetts Department of Energy Resources has a program called Massachusetts Offers Rebates for Electric Vehicles (MOR-EV), which offers rebates of up to $2,500 to customers purchasing PEVs. The program will launch in the summer of 2014.

Alternative Fuel Vehicle and Infrastructure Grants: The Massachusetts Department of Energy Resources' Clean Vehicle Project provides grant funding for public and private fleets to purchase alternative fuel vehicles and infrastructure, as well as idle reduction technology.

Michigan

Vehicle Inspection Exemption: Alternative fuel vehicles are exempt from emissions inspection requirements.

Electric Vehicle Supply Equipment Rebate: Indiana Michigan Power provides rebates of up to $2,500 to residential customers who purchase or lease a new plug-in electric vehicle and install a Level 2 EVSE with a separate meter. Customers must also sign up for the Indiana Michigan Power PEV time-of-use rate. The rebate is available to the first 250 qualified customers who submit a completed application. Consumers Energy provides qualified customers with a reimbursement of up to $2,500 to cover the purchase, installation, and wiring for qualified Level 2 electric vehicle supply equipment. Additionally, DTE Energy will provide up to $2,500 for the purchase and installation of separately metered EVSE to the first 2,500 qualified customers who purchase PEVs and enroll in the DTE PEV rate.

Plug-In Electric Vehicle Charging Rate Reduction: Indiana Michigan Power and Consumers Energy offer a special time-of-use rate option to residential customers who own a qualified PEV.

Minnesota

Electric Vehicle Charging Tariff: H.B. 2834 (2014) requires each public utility selling electricity to file a tariff that allows a customer to purchase electricity solely for the purpose of recharging an electric vehicle. The tariff must include either a time-of-day or off-peak rate.

Plug-In Electric Vehicle Charging Rate Reduction: Dakota Electric offers a discounted rate for electricity used to charge electric vehicles during off-peak times. Connexus Energy also offers a reduced rate and a $270 rebate to install a time-of-day meter.

Mississippi

Revolving Loan Fund: The Mississippi Development Authority established a revolving loan program to provide zero-interest loans for public school districts and municipalities to purchase alternative fuel school buses and other motor vehicles, convert school buses and other motor vehicles to use alternative fuels, purchase alternative fuel equipment, and install fueling stations. Loans provide up to $300,000 for the purchase of vehicles and up to $500,000 for the purchase and installation of fueling infrastructure.

Missouri

Alternative Fueling Infrastructure Tax Credit: Between Jan. 1, 2015 and Jan. 1, 2018, S.B. 729 (2014) provides an income tax credit for the cost of installing a qualified alternative fueling station. The credit provides 20 percent or up to $15,000 for residential and $20,000 for commercial installation of qualified refueling property.

Vehicle Inspection Exemption: Alternative fuel vehicles are exempt from state emissions inspection requirements.

Montana

Alternative Fuel Vehicle Conversion Tax Credit: Businesses or individuals are eligible for an income tax credit of up to 50 percent of the equipment and labor costs for converting vehicles to operate using alternative fuels.

Nebraska

Alternative Fuel Vehicle and Fueling Infrastructure Loans: The Nebraska Energy Office administers the Dollar and Energy Saving Loan Program, which provides low-cost loans for a variety of alternative fuel projects, including the replacement of conventional vehicles with AFVs, the purchase of new AFVs, the conversion of conventional vehicles to operate on alternative fuels, and the construction or purchase of a fueling station or equipment.

Alternative Fuel Vehicle Registration Fee: Nebraska requires a $75 fee for the registration of an alternative fuel vehicle that operates on electricity or any other source of energy not otherwise taxed under the state motor fuel tax laws.

Nevada

HOV Lane Exemption: The Nevada Department of Transportation may establish a program allowing federally certified low emission, energy-efficient, and alternative fuel vehicles to operate in HOV lanes regardless of the number of passengers.

Plug-In Electric Vehicle Charging Rate Incentive: NV Energy offers discounted electricity rates to residential customers who charge electric or plug-in hybrid electric vehicles during off-peak hours.

Vehicle Inspection Exemption: Alternative fuel vehicles are exempt from emissions testing requirements. A new HEV is exempt from emissions inspection testing for the first five model years, after which the vehicle must comply with emissions inspection testing requirements on an annual basis.

Parking Fee Exemption: All local authorities with public metered parking areas within their jurisdiction must establish a program for AFVs to park in these areas without paying a fee.

New Jersey

Zero Emission Vehicle Tax Exemption: ZEVs sold, rented or leased in New Jersey are exempt from state sales and use tax.

New York

HOV Lane Exemption: Through the Clean Pass Program, qualified vehicles may use the Long Island Expressway HOV lanes regardless of the number of passengers in the vehicle.

Alternative Fuel Vehicle Recharging Tax Credit: S.B. 2609 and A.B. 3009, passed in 2013, provide a tax credit for 50 percent of the cost, up to $5,000, for the purchase and installation of alternative fuel vehicle refueling and electric vehicle recharging property. The credit is available through Dec. 31, 2017.

North Carolina

HOV Lane Exemption: Qualified alternative fuel vehicles may use designated HOV lanes regardless of the number of occupants in the vehicle.

Vehicle Inspection Exemption: Qualified PEVs are exempt from state emissions inspection requirements.

Alternative Fuel Tax Exemption: The retail sale, use, storage, and consumption of alternative fuels is exempt from the state retail sales and use tax.

Plug-In Electric Vehicle Fee: S.B. 402 (2013) requires electric vehicle owners to pay an annual registration fee of $100.

Oklahoma

Alternative Fueling Infrastructure Tax Credit: A tax credit is available for up to 75 percent of the cost of installing alternative fueling infrastructure, including electric vehicle charging stations.

Oregon

Alternative Fueling Infrastructure Tax Credit for Residents: Through the Residential Energy Tax Credits program, qualified residents may receive a tax credit for 25 percent of alternative fuel infrastructure project costs, up to $750.

Alternative Fueling Infrastructure Tax Credit for Businesses: Business owners and others may be eligible for a tax credit of 35 percent of eligible costs for qualified alternative fuel infrastructure projects.

Pennsylvania

Alternative Fuel Vehicle Funding: The Alternative Fuels Incentive Grant (AFIG) Program provides financial assistance for qualified projects and information on alternative fuels, including plug-in hybrid electric vehicles. The AFIG Program also offers Alternative Fuel Vehicle Rebates to assist with the incremental cost of the purchase of new AFVs. Rebates of $3,000 are available for qualified EVs and PHEVs.

Plug-In Electric Vehicle Rebate: PECO provides rebates of $50 to residential customers who purchase a new, qualified PEV.

South Carolina

Fuel Cell Vehicle Tax Credit: Residents who claim the federal fuel cell vehicle tax credit are eligible for a state income tax credit equal to 20 percent of the federal credit.

Tennessee

HOV Lane Exemption: Qualified alternative fuel vehicles may use designated HOV lanes regardless of the number of occupants in the vehicle.

Texas

Alternative Fuel Vehicle Rebate: Qualified vehicles purchased or leased may be eligible for a rebate of up to $2,500. The Light-Duty Motor Vehicle Purchase or Lease Incentive (LDPLI) Program is available until June 26, 2015 or until total funding of $7.75 million is awarded. Only purchases made on or after May 13, 2014 are eligible to apply for the rebate.

Alternative Fueling Infrastructure Grants: The Texas Commission on Environmental Quality administers the Alternative Fueling Facilities Program, which provides grants for 50 percent of eligible costs, up to $600,000, to construct, reconstruct, or acquire a facility to store, compress, or dispense alternative fuels, including electricity, in Texas air quality nonattainment areas.

Vehicle Replacement Vouchers: The Texas Commission on Environmental Quality administers the AirCheckTexas, Drive a Clean Machine program, which provides vouchers of $3,500 to qualified individuals for the purchase of hybrid, electric or natural gas vehicles.

Electric Vehicle Supply Equipment Incentive: Austin Energy customers who own a plug-in electric vehicle are eligible for a rebate of 50 percent or up to $1,500 of the cost to purchase and install a qualified Level 2 EVSE.

Utah

HOV Lane Exemption: Qualified vehicles may use designated HOV lanes regardless of the number of occupants in the vehicle. Vehicles must display a special clean fuel decal issued by the Utah Department of Transportation.

Alternative Fuel Tax Exemption: Propane, compressed natural gas, liquefied natural gas, and electricity used to operate motor vehicles are exempt from state fuel taxes.

Alternative Fuel and Fuel Efficient Vehicle Tax Credit: H.B. 96 (2013), provides that new clean fuel vehicles that meet air quality and fuel economy standards may be eligible for a credit of $605, including certain electric and hybrid electric vehicles. An income tax credit is also available for 50 percent or up to $2,500 of the cost to convert a vehicle to run on propane, natural gas, or electricity.

Free Electric Vehicle Parking: Free metered parking in Salt Lake City for electric vehicles displaying a Clean Air license plate.

Vermont

Alternative Fuel and Vehicle Research and Development Tax Credit: Vermont businesses that qualify as a high-tech business involved exclusively in the design, development, and manufacture of alternative fuel vehicles, hybrid electric vehicles, all-electric vehicles, or energy technology involving fuel sources other than fossil fuels are eligible for up to three of the following tax credits: 1) payroll income tax credit; 2) qualified research and development income tax credit; 3) export tax credit; 4) small business investment tax credit and 5) high-tech growth tax credit.

Virginia

HOV Lane Exemption: For HOV lanes serving the I-95/I-395 corridor, only registered vehicles displaying Clean Special Fuel license plates issued before July 1, 2006, are exempt from HOV lane requirements. For HOV lanes serving the I-66 corridor, only registered vehicles displaying Clean Special Fuel license plates issued before July 1, 2011, are exempt from HOV lane requirements.

Plug-In Electric Vehicle Charging Rate Reduction: Dominion Virginia Power offers discounted electricity rates to residential customers who charge electric vehicles during off-peak hours.

Vehicle Inspection Exemption: Alternative fuel and hybrid electric vehicles are exempt from emissions testing.

Alternative Fuel Vehicle Fee: S.B. 127 (2014) requires that alternative fuel vehicles and all-electric vehicles—hybrid vehicles are excluded—registered in the state pay an annual vehicle license tax of $64. Electric vehicles must also pay a $50 annual license tax.

Washington

Alternative Fuel Vehicle Tax Exemption: New passenger cars, light-duty trucks, and medium-duty passenger vehicles that are dedicated alternative fuel vehicles are exempt from the state motor vehicle sales and use taxes.

Electric Vehicle Infrastructure Exemptions: Public lands used for installing, maintaining, and operating EV infrastructure are exempt from leasehold excise taxes until Jan. 1, 2020. Additionally, the state sales and use taxes do not apply to EV batteries; labor and services for installing, repairing, altering, or improving EV batteries and EV infrastructure; and the sale of property used for EV infrastructure.

Vehicle Inspection Exemption: Alternative fuel and hybrid electric vehicles are exempt from emissions testing.

Electric Vehicle Supply Equipment Rebate: Puget Sound Energy (PSE) provides a rebate of $500 to qualified customers for the purchase and installation of Level 2 EVSE. PSE expects the rebate program to remain open until Nov. 1, 2016, depending on available funds.

Plug-In Electric Vehicle Fee: Electric vehicle owners must pay an annual vehicle registration fee of $100. The fee will expire if the legislature imposes a vehicle miles traveled fee or tax in the state.

Appendix F

State Tax Incentives for Distribution of Renewable-Based Fuels

[Source: US Department of Energy, Database of State Incentives for Renewables and Efficiency, December 2014]

Alabama

Biodiesel Fuel Storage Grants

The Alabama Department of Economic and Community Affairs (ADECA) Energy Division administers the Alabama Biodiesel Incentive Program, which provides grants of up to $2,500 to cover the cost of cleaning existing fuel tanks in preparation for storing biodiesel blends of at least 20% (B20) for use in public school, state college and university, and local government fleets. Successful applicants must provide B20 for a minimum of three years.

Colorado

Ethanol Infrastructure Grants

The Colorado Corn Blender Pump Program provides funding assistance for each qualified station dispensing mid-level ethanol blends. Projects must meet the application requirements and receive approval from Colorado Corn and the Colorado Department of Oil and Public Safety.

Illinois

E85 Fueling Infrastructure Grants

The Illinois Department of Commerce and Economic Opportunity's (Department) Renewable Fuels Development Program is partnered with the Illinois Corn Marketing Board to fund new E85 fueling infrastructure at retail gasoline stations. The American Lung Association of Illinois-Iowa administers grants of up to $15,000 for a blender pump installation, $10,000 for a new E85 dispenser installation, and $7,500 to convert existing stations to dispense E85. The maximum grant amount is $15,000 per facility or $75,000 for four or more facilities.

Iowa

Biofuel Infrastructure Grants

The Renewable Fuel Infrastructure Program provides financial assistance to qualified E85 and biodiesel retailers. Cost-share grants are available for up to 70% of the total cost of the project, up to $50,000, to upgrade or install new E85 or biodiesel infrastructure.

Biodiesel distributors may apply for cost-share grants for infrastructure upgrades and installations at biodiesel terminal facilities. Facilities blending or dispensing blends ranging from 2% biodiesel (B2) to 98% biodiesel (B98) are eligible for up to 50% of the total project, up to $50,000. Facilities blending or dispensing B99 or B100 are eligible for up to 50% of the total project, up to $100,000.

Kansas

Alternative Fueling Infrastructure Tax Credit

An income tax credit is available for 40% of the total cost to install alternative fueling infrastructure after January 1, 2009. Qualified property must be directly related to the delivery of alternative fuel into the fuel tank of a motor vehicle propelled by such fuel. The tax credit may not exceed $100,000 per fueling station. Alternative fuels are defined as combustible liquids derived from grain starch, oil seed, animal fat, or other biomass, or produced from a biogas source.

Kentucky

Ethanol Infrastructure Grants

The Kentucky Corn Growers' Association (KyCGA) offers grants of $5,000 per pump to retailers installing new E85 dispensers in Kentucky.

Louisiana

Alternative Fuel Vehicle and Fueling Infrastructure Tax Credit

The state offers an income tax credit of 50% of the cost of converting a vehicle to operate on an alternative fuel, 50% of the incremental cost of purchasing an original equipment manufacturer AFV, and 50% of the cost of alternative fueling equipment. Alternatively, a taxpayer may take a tax credit of 10% of the cost of the motor vehicle, up to $3,000. To qualify for the tax credit, vehicles must be dedicated AFVs and registered in Louisiana. For the purpose of this incentive, alternative fuels include natural gas; propane; non-ethanol based advanced biofuels (excludes flexible fuel vehicles).

Minnesota

Ethanol Fueling Infrastructure Grants

The Minnesota Corn Research & Promotion Council and the Minnesota Department of Agriculture offer funding assistance to fuel retailers for the installation of equipment to dispense ethanol fuel blends ranging from E15 through E85. Grant amounts are based on the extent to which the installation meets project priorities.

Missouri

Alternative Fueling Infrastructure Tax Credit

For tax years beginning on or after January 1, 2015, an income tax credit is available for the cost of constructing a qualified alternative fueling station. The credit is 20% of the costs directly associated with the purchase and installation of any alternative fuel storage and dispensing equipment or electric vehicle supply equipment (EVSE), up to $15,000 for individuals or $20,000 for businesses. Eligible fuels include any mixture of biodiesel and diesel fuel, as well as fuel containing at least 70% of the following alternative fuels: ethanol, compressed natural gas (CNG), liquefied natural gas (LNG), liquefied petroleum gas or propane, hydrogen, and electricity. This tax credit expires on January 1, 2018.

New Mexico

Alternative Fuel Vehicle and Fueling Infrastructure Grants

The New Mexico Energy, Minerals, and Natural Resources Department administers the Clean Energy Grants Program, which provides grants for projects using clean energy technologies, including alternative fuel vehicles and fueling infrastructure, as well as projects that provide clean energy education, technical assistance, and training programs. These grants are provided on a competitive basis to qualifying entities such as municipalities and county governments, state agencies, state universities, public schools, post-secondary educational institutions, and Indian nations, tribes, and pueblos.

Ohio

Alternative Fuel and Fueling Infrastructure Incentives

The Alternative Fuel Transportation Grant Program (Program) provides grants and loans for up to 80% of the cost of purchasing and installing fueling facilities offering E85, fuel blends containing at least 20% biodiesel (B20), natural gas; liquefied petroleum gas or propane; hydrogen; electricity; or any fuel that the U.S. Department of Energy determines, by final rule, to be substantially not petroleum. The Program also provides funding for up to 80% of the incremental cost of purchasing and using alternative fuel for businesses, nonprofit organizations, public school systems, and local governments.

Oregon

Alternative Fueling Infrastructure Tax Credit for Residents

Through the Residential Energy Tax Credit program, qualified residents may receive a tax credit for 25% of alternative fuel infrastructure project costs, up to $750. Qualified alternative fuels include electricity, natural gas, gasoline blended with at least 85% ethanol (E85), propane, and other fuels that the Oregon Department of Energy approves. A company that constructs a dwelling in Oregon and installs fueling infrastructure in the dwelling may claim the credit. All qualified infrastructure must be installed to meet all state and local codes and be capable of fueling or charging an alternative fuel vehicle within 14 hours. This credit is available through December 31, 2017.

South Carolina

Renewable Fuel Facility Credits

A taxpayer that purchases, constructs, or installs, and places into service a qualified commercial facility for distributing or dispensing biofuels is eligible for an income tax credit of up to 25% of the purchase, construction, and installation costs. Eligible property includes pumps, storage tanks, and related equipment used exclusively for distributing, dispensing, and storing biofuels. A qualified facility must clearly label the equipment used to store or dispense the fuel as being associated with the biofuel. The credit must be taken in three equal annual installments beginning with the taxable year in which the facility is placed into service. Qualifying fuels include blends containing at least 70% ethanol (E70) dispensed at the retail level for use in motor vehicles, and pure ethanol or biodiesel fuel dispensed by a distributor or facility that blends these non-petroleum liquids with gasoline or diesel fuel for use in motor vehicles.

Wisconsin

Renewable Fuel Infrastructure Tax Credit

A tax credit is available for 25% of the cost to install or retrofit fueling pumps that dispense gasoline fuel blends of at least 85% ethanol or diesel fuel blends of at least 20% biodiesel fuel or that mix fuel from separate storage tanks and allow the user to select the percentage of renewable fuel. The maximum credit amount is $5,000 per taxable year for each fueling station that has installed or retrofitted a pump. The credit must be claimed within four years of the tax return and expires December 31, 2017.

Appendix G

Solar Industry Manufacturing Market Overview

Solar generation shows great promise in meeting global renewable energy goals and the mature technology continues to improve in terms of efficiency and cost. According to some estimates, the land use required to power the entire United States would require approximately 0.6 percent of the country's total land area. New advanced materials and manufacturing processes push prices down and performance up similar to the semiconductor industry of the 1980s and 1990s. However, manufacturing of solar panels is now dominated by the Asian market and predominately China, leveraging technology that was first developed in the United States and Europe. The top four solar panel manufacturers globally are shown in the accompanying table. Among the top ten solar firms, seven are publicly traded, vertically integrated manufacturers located in China. Note that Canadian Solar is a Canada-based firm, but the majority of manufacturing operations are in China. Among the top ten, only First Solar, out of Tempe, Arizona, is based in the United States and currently manufactures in Ohio and Malaysia.

Table 1: Top Manufacturers of PV Modules, 2013

Company	Primary Country for Manufacturing	Module Shipments (MW)
Yingli Green Energy	China	3,300
Trina Solar	China	2,600
Canadian Solar	China	1,894
Sharp Solar	Japan	1,865

Solar power is principally harnessed one of two ways: by photovoltaic (PV) cells or solar thermal. Photovoltaic technology has come to dominate the market for solar applications, and has become a symbol of the clean energy economy. The PV industry has grown from a cottage industry in the 1990's to a multi-billion dollar industry today, expanding around 20 percent per annum for the past 20 years. [1] During the past several years, PV module prices have dropped from more than $4 per Watt-peak (Wp) in 2008 to under $1 per Wp in 2012.[2] Much of this drop in price is attributable to low-cost Chinese manufacturers entering the market; backed by generous government subsidies and un-matched scale, these manufacturers have come to dominate the polysilicon photovoltaic market for cells and modules.

Investment Highlight (January 2014)

Japanese based Solar Frontier, the largest manufacturer of Copper Indium Selenium (CIS) thin-film photovoltaic solar modules, announced the construction of a 70,000 square meter manufacturing plant in the Tohoku region of Japan. The company plans to employ about 100 and reach annual production capacity of 150 MW, investing 13bn Yen. This will be Solar Frontier's fourth manufacturing facility.

[1] IHS Global Insights: http://www.solarbuzz.com/facts-and-figures/markets-growth/market-growth
[2] Aanesen, Krister, Stefan Heck, Dikon Pinner. "Solar Power: Darkest before dawn." *McKinsey on Sustainability & Resource Productivity. May, 2012.*

Technology

PV modules are typically manufactured from polysilicon feedstock which is processed into ingots and then wafers. The wafers are converted to cells, which make up the finished solar modules. The silicon wafers make up 40-50 percent of the cost of crystalline module cost[3]

High Efficiency Cadmium Telluride (CdTe) and Copper indium gallium selenide (CIGS) Thin Film Solar Cells are the most hopeful new technologies that are expected to compete with conventional crystalline polysilicon modules. The companies engaged in research and production are mostly located in the US, Germany, and Japan. In fact, First Solar, the largest solar manufacturer in the US, uses CdTe technology.

The availability of natural resources play an important role in China is the world's largest producer of Indium with 390 tons, followed by Canada, Japan, and South Korea, with much smaller sums. At a price of $1,000/kg, Indium prices have been a growing burden for CIGS manufacturers. China is also the world leader in the production of Cadmium, followed by Korea.

Suppliers

Although a majority of polysilicon is produced outside of China, polysilicon wafers are primarily manufactured in mainland China. Together with Taiwan, China produces over 80 percent of worldwide solar polysilicon wafers. The industry is dominated by a few major firms that are becoming increasingly vertically integrated with polysilicon producers expanding into wafers and wafer producers expanding into polysilicon. Polysilicon production capacity is expected to increase by 260,000MT by 2018, with most new capacity in Asia. In Q1'14, silicon sold for around $21/kg, but expectations are that it will decrease to $9-15/kg within the next few years.[4] The accompanying table details the largest global suppliers of polysicon and their respective production capacity.

Table 2: Top Manufacturers of Polysilicon, 2013

Company	Country	Polysilicon Capacity
Hemlock Semiconductor	United States	27,500
Wacker Chemie	Germany	67,000
OCI	South Korea	62,000
GCL-Poly	Hong Kong	46,000
Tokuyama	Japan	31,000

Markets

Although Germany has solar irradiation levels similar to Alaska, it is the world leader in installed capacity with 33 percent of the world total. Italy is the next largest market worldwide, followed by North America, with 17 percent and 9 percent, respectively. However, the global solar marketplace is in flux, with European demand slowing down while demand in Asia

[3] Overview of the Solar Energy Industry and Supply Chain, Blue Green Alliance Foundation, January 2011
[4] IHS Global Insights: http://www.solarbuzz.com/resources/analyst-insights/growing-polysilicon-imports-and-falling-prices-provide-chinese-solar-manufacturers-anti-dumping-fodd

and North America is growing. [5] A new focus on global warming in the U.S. and general air pollution in mainland China is expected to greatly increase the demand in these markets.

In 2013, global PV market demand exceeded 37 GW with an annual growth rate of 37 percent. In 2013 China, Japan and the rest of Asia made up 55 percent of global demand, while Germany, Italy, France, and the UK only made up 19 percent, despite having dominated global demand during the last ten years. Over the next five years, approximately 375 GW of PV demand is expected globally, with China, Japan, and the U.S. making up around half of this total. [6]

Consumption Incentives

Although many parts of Northern Europe receive solar irradiation comparable to Alaska, many of these countries, Germany in particular, are world leaders in solar power generation, which is a direct result of government policy. The German government incentivizes solar power through feed-in tariffs and low interest loans. Feed-in tariffs allow private producers to sell their excess electricity to the grid for a set price, which is gradually lowered over the course of fifteen years. Depending on the location, solar power is bought at €24.17 ct/kWh to €32.88 ct/kWh.[7]

In 2013, China announced that it would implement a new Feed-In tariff for photovoltaic power; however, at $7 ct/kWh to $16 ct/kWh, it is much lower than European rates. The Chinese government has also offered qualified investors the ability to receive a 15 percent reduction in corporate income tax for installing solar power. [8]

In the United States, the federal government does not mandate a feed-in tariff program; however, some states and utilities offer feed-in tariff programs. Net-metering programs are much more common in the US, where customers' production of solar energy is deducted from their total electricity bill. Only four states don't offer some form of net-metering to individual producers. Each state has limitations on capacity limits for individual installations, and aggregate capacity. Arizona, depending on the electric cooperative, has several rebate programs that pay $.35/W to $1.00/W-DC, with a maximum incentive of $10,000 to $25,000 or 40 percent of cost, or whichever is less.[9] [10]

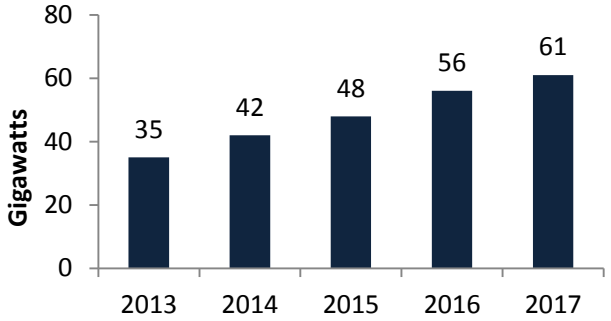
[5] Fraunhofer Institute: http://www.ise.fraunhofer.de/en/downloads-englisch/pdf-files-englisch/photovoltaics-report-slides.pdf
[6] IHS Global Insights: www.solarbuzz.com/sites/default/files/140502_poised_for_strong_demand_growth.pdf
[7] KPMG: http://www.kpmg.com/UA/en/IssuesAndInsights/ArticlesPublications/Documents/KPMG-ENR-Sustainability-Taxes-and-Incentives.pdf

[9] US Energy Information Administration: http://www.eia.gov/todayinenergy/detail.cfm?id=11471
[10] US Department of Energy National Renewable Energy Laboratory: DSIRE Database, http://www.dsireusa.org/

Projected Demand

The US Energy Information Administration expects domestic solar capacity to grow 530 percent between 2012 and 2040; in fact, California doubled their solar capacity in 2013. While Europe has led global demand for the past decade, China, Japan and the U.S will be the drivers of future growth. In the next five years, approximately 375 GW of PV demand is expected, with Japan, China and the US making up 50 percent of that total. [11] [12]

Figure 1: Global PV Installation Forecast



Competiveness

The majority of polysilicon is produced in China, the USA, Germany, Korea, and Japan, with China controlling over 40% of world production. Most new plants coming on-line are in Asia, and the region is expected to grab an even larger market share from western countries. Compared to polysilicon production, solar wafer production is very concentrated, with mainland China controlling over 75 percent of total production. Because China is the global center of solar wafer production, it has been forced to import thousands of tons of polysilicon annually from the USA, Germany, and South Korea. [13]

The driving factor for silicon plant placement is cheap reliable energy because of the requirement of high temperature operations. Proximity to cell manufacturers is of secondary concern, as wafer transportation is cheap, but many polysilicon plants are being built close to cell manufacturers as a way to secure a consistent supply chain. Cell manufacturing has resisted automation and requires a large, inexpensive labor force, which explains the dramatic success of Chinese suppliers.

The US DOE Energy Information administration projects that total system levelized cost of electricity for PV solar generation will reach $130 per MWh for plants entering service in 2019. This compares favorably with $147 projected for integrated coal-gasification combined cycle systems or $128 for conventional gas turbines. These costs reflect plant capacity factor (utilization), operations and maintenance cost, fuel and investment in transmission and distribution.[14]

Manufacturing Subsidies

Chinese solar manufacturers receive the largest subsidies of any national solar industry; however, due to the scale of government intervention in the economy, quantifying that support can be difficult. Many Chinese solar producers have received large government loans, for example: the U.S. Department of Energy recently identified a WTO-illegal subsidy of $7 billion for Wuxi Suntech. The Coalition for American Solar Manufacturing puts these subsidies at $40 billion; including: subsidized inputs, subsidized land and power, tax exemptions, rebates, and export assistance.

In the US, the American Recovery and Reinvestment Act of 2009 initiated the Advanced Energy Manufacturing Investment Tax Credit. The tax credit is equal to 30 percent of the qualified investment in advanced energy projects. The program was

[11] IHS Insights: http://www.solarbuzz.com/sites/default/files/140502_poised_for_strong_demand_growth.pdf
[12] http://www.seia.org/research-resources/2013-top-10-solar-states
[13] IHS Insights: http://www.solarbuzz.com/resources/analyst-insights/growing-polysilicon-imports-and-falling-prices-provide-chinese-solar-manufacturers-anti-dumping-fodd
[14] US Energy Information Administration: http://www.eia.gov/forecasts/aeo/electricity_generation.cfm

capped at $2.3 billion in total available tax credits but was oversubscribed, with over 500 applications and a total of $ 8 billion in tax credits.

Several US states have solar manufacturing incentives. For example, in Kansas, manufacturers of solar or wind equipment or components are eligible for financing to support research, development, engineering, or manufacturing projects. To qualify, the projects must invest at least $30 million and hire at least 200 employees. The maximum incentive is $5 million.[15] [16] In North Carolina, the Renewable Energy Equipment Manufacturer Tax Credit allowed companies to deduct 25 percent of costs for the construction or retooling of a facility to manufacture renewable energy products. The credit expired in 2013.[17] In the case of North Carolina, the Renewable Energy and Energy Efficiency Portfolio Standard requires that investor-owned utilities provide 12.5 percent of their electricity from renewable sources by 2020; this law has greatly increased investment in solar generation and has given rise to manufacturing facilities to service this growth.[18]

US Manufacturing

In the US, several states have been very successful in attracting and growing solar manufacturing companies; in particular New York, Colorado, Ohio, and California. In the case of California, much of this growth comes out of Silicon Valley start-up culture and the enormous solar market in the state. The Solar Energy Industries Association (SEIA) estimates that there are 1,861 solar companies in state, 357 of which are manufacturers.

Table 3: Top States for Solar Installations, 2013

Company	Installed Capacity (MW)
California	2745.8
Arizona	700.7
North Carolina	335.4
Massachusetts	237.2
New Jersey	235.6

In 2014, both Showa Shell—a Japanese solar company—and Solar City announced plans to build solar panel factories in New York State. The factory proposed by Solar City would be the world's largest and would employ around 1,000 people in the Buffalo area. Showa Shell is quoted as being attracted by proximity to the SUNY College of Nanoscale Science and Engineering in Albany, as well as access to the large New York market. This large solar market is a direct result of the state's implementation of renewable energy standards, which require utilities to source 29 percent of their electricity from renewable sources by 2015.

Colorado has attracted a number of solar firms. The state has the highest number of residents in the nation involved in solar businesses on a per-capita basis and has a large solar market, encouraged by a 30 percent renewable standard by 2030. Although ultimately abandoned, GE proposed a large solar manufacturing facility in the state in 2011.

Ohio has also grown as a solar hub, in particular the area around Toledo and Cleveland. In Toledo alone, there are 6,000 people employed in solar businesses, and First Solar, the nation's largest solar company, was founded there and continues having its sole US manufacturing facility there. Toledo has built its success in the solar industry off of a strong manufacturing tradition, especially glass manufacturing, and an integrated government push to diversify the local economy. The University of Toledo, along with local economic development agencies, has spearheaded the growth in the solar

[15] US Department of Energy National Renewable Energy Laboratory: DSIRE Database, http://www.dsireusa.org/

[16] Solar Energy Industry Association: http://www.seia.org/policy/manufacturing-trade/solar-manufacturing-incentives

[17] US Department of Energy National Renewable Energy Laboratory: DSIRE Database, http://www.dsireusa.org/

[18] US Department of Energy National Renewable Energy Laboratory: DSIRE Database, http://www.dsireusa.org/

industry, founding a School of Solar and Advanced Renewable Energy and a Center for Photovoltaics Innovation and Commercialization. The University also offers an MBA geared towards students that want to run companies in the solar industry. Ohio has instituted a renewable portfolio standard of 12.5 percent by 2026.

Ohio implemented the Advanced Energy Job Stimulus Fund, which is a $150 million fund meant to increased development, production, and use of advanced energy technologies through grants to local companies. New York and Colorado do not have manufacturing incentives for the solar industry. However, California has a sales and use tax exclusion for projects engaged in the "design, manufacture production, or assembly of advanced transportation technologies or alternative source products, component, or systems."[19]

Pennsylvania has one of the most aggressive incentive programs offering solar manufacturers loans of $35,000 per job created within 3 years and grants of $5,000 per worker. According to the SEIA, there are 83 solar manufacturers in the state; furthermore, the state has a renewable energy standard of 18 percent by 2021.

Other states have offered incentives to attract solar companies, but have met with minimal success. For instance, Texas exempts solar companies engaged in manufacturing, selling, or installing from paying their franchise tax—the Texas equivalent of a corporate tax. In North Carolina, renewable energy manufacturing firms can deduct 25 percent of eligible costs of constructing or retooling a facility from their income taxes. According to SEIA, there are thirteen solar manufacturers in North Carolina and around twenty in Texas.[20]

What all of these states have in common is a concentrated number of skilled professionals engaged in solar businesses, developed research institutions, and a history of strong government support, especially in the promotion of renewable energy production.

Direction of Industry

The global solar industry has seen unprecedented growth during the past decade. From humble beginnings, total world capacity has grown from 4.5 GW in 2005 to over 65 GW today. The industry is currently dealing with lower subsidies in developed markets, a rapid increase in Chinese manufacturing output, and exploding global demand. Although faced with lower prices for their products, and a growing emphasis on scale, most market consolidation has been vertical and not horizontal.

The marketplace conditions remain very dynamic, and it remains to be seen what the effects of increased US tariffs will have for Chinese producers. Currently, Chinese manufacturers control a large market share, and over 90 percent of Chinese capacity is sold abroad. Despite intense competition, the global solar industry continues to attract considerable amounts of capital, and with lower prices for PV modules and increasing grid-parity, global demand can only be expected to increase.[21]

South Carolina Solar Sector and Complementary Industries

Manufacturing solar cells and solar modules uses technology and components that evolved from the semiconductor industry, especially high grade silicon. In the case of thin-cell PV manufacturing, there are strong parallels between plastics film and sheet manufacturing. The National Renewable Energy Lab (NREL) has chosen eleven specific NAICS code industries

[19] US Department of Energy National Renewable Energy Laboratory: DSIRE Database, http://www.dsireusa.org/
[20] Solar Energy Industry Association: http://www.seia.org/policy/manufacturing-trade/solar-manufacturing-incentives
[21] Aanesen, Krister, Stefan Heck, Dikon Pinner. "Solar Power: Darkest before dawn." *Mckinsey on Sustainability & Resource Productivity. May, 2012.*

that are complementary to the solar industry. These industries range from Flat Glass Manufacturing to Electricity and Signal Testing Instruments. South Carolina is home to a relatively small number of firms engaged in these complementary industries.

Using the NREL's NAICS codes for solar manufacturers, South Carolina's solar manufacturing base mirrors the state's manufacturing base in geographic distribution. Greenville, Spartanburg, Richland, and Charleston counties have the largest number of firms, while Oconee, Greenville, and Richland counties lead the state in solar manufacturing jobs. These industries are complementary to the solar industry, such as flat glass manufacturers, or are directly engaged in solar manufacturing.

According to the Solar Energy Industries Association (SEIA), South Carolina has ten different solar industry-related manufacturers, ranging from inverter manufacturers to solar water heater manufacturers. There is a noted absence of solar related companies outside of the upstate region, and the state as whole has a lower density of solar companies when compared to neighboring North Carolina and Georgia. [22]

South Carolina Competitive Advantages for Solar Industry

According to the U.S. Energy Information Administration (EIA), South Carolina has the potential to produce over two million GWH of electricity a year from solar energy; this is over seven times our total current electric generation. Furthermore, as North Carolina has shown, the Southeast is a fertile market for solar products. In fact, in 2013, North Carolina was third in the nation for new installed solar capacity; this resulted in a total investment of $787 million.

Clemson University offers a Renewable Energy Certificate Program, which includes instruction on the fundamentals of Solar Energy. There are currently seven training centers for solar installation in the state. The South Carolina Energy Office and the US Department of Energy have designated four technical college programs as Solar Training Centers: York Technical College, Greenville Technical College, Trident Technical College and Aiken Technical College.

SC Company Highlight - Ulbrich

Ulbrich, in Westminster, SC, manufactures high quality tinned copper flat wire for solar cell tabbing, crystalline silicon bus wire, thin film bus wire, and substrates that go directly into solar cells. Westminster was the company's first PV Ribbon manufacturing facility, and remains the company headquarters for solar technologies.

South Carolina Challenges for Solar Industry Growth

South Carolina lags behind neighboring states in the number of solar manufacturing jobs and firms; as well, the state's installed solar capacity is considerably lower than its neighbors, especially North Carolina. Compared with other states, our state also lacks the broader supply chain necessary for solar manufacturing. There are only around 5,000 residents employed in industries that are directly involved in solar manufacturing or are complementary to solar manufacturing, representing less than one percent of the national total, while the state is home to around 1.5 percent of total U.S. population. Furthermore, with only around 5MW of installed capacity, South Carolina has an almost inexistent market for solar products, compared to over 592MW in North Carolina and 129 MW in Georgia. The South Carolina market is expected to grow over the next decade with the 2 percent renewable goal now in place.

[22] Solar Energy Industry Association: http://www.seia.org/research-resources/solar-industry-data

The United States has an 18 to 20 percent cost disadvantage in solar cell manufacturing when compared with China. However, the US only suffers a 10 percent cost disadvantage for thin film PV modules and just 2 percent for silicon module manufacturing. Furthermore, new Department of Commerce tariffs against Chinese crystalline silicon PV manufacturers and additional transportation costs are likely to make US modules much more competitive in the domestic market. [23]

Conclusion

South Carolina's solar industry, in terms of generation and manufacturing ability, is in its infancy when compared to other states and countries that have taken a proactive approach to incentivizing solar generation and renewable energy manufacturing. Until very recently, South Carolina had relatively restrictive rules governing the production of solar energy. Considering the scope of subsidies employed in other countries to incentivize solar generation and manufacturing facilities, South Carolina would need to make drastic changes in policy to develop a world-class solar manufacturing base involving each element of the solar PV supply chain.

Despite these challenges, the international solar energy market is expanding rapidly and is expected to continue doing so. The industry is also very dynamic, and as witnessed in neighboring North Carolina, significant progress can be made in a short period to spur solar investment. Considering the state's relatively low operating costs for manufacturers and access to large markets on the East Coast of the US and Europe, South Carolina could attract solar manufacturing firms, as it has attracted aerospace and automotive companies over the past twenty years.

Across the country, manufacturing and installation businesses concentrate together; this is to take advantage of the concentrated solar industry knowledge in the area. Therefore, widespread adoption of solar technology begets solar manufacturing. If the state is to grow its solar manufacturing base, offering manufacturing incentives need to be in conjunction with a growing local market for solar products. Other states have had tremendous success with renewable energy standards, which would require utilities to purchase more solar power.

North Carolina provides the most compelling example for South Carolina. In 2007, North Carolina required that investor-owned utilities meet up to 12.5 percent of their energy needs from renewable sources. By 2013, North Carolina had installed 592 MW of solar electric capacity, and the industry as a whole employed 3,100 individuals in the state.

[23] US Department of Energy, National Renewable Energy Laboratory: http://www.nrel.gov/docs/fy12osti/53938.pdf

Appendix H

Wind Industry Manufacturing Overview

Wind turbines have been growing in popularity in the past two decades, with a record breaking year in 2012 for new U.S. installations. In 2012, this sector of clean energy constituted 43 percent of all nameplate capacity additions in the U.S., overtaking natural gas-fired generation as the leading source of new capacity.[2] Fewer installations took place in 2013 in the U.S. with just over 1 GW installed domestically, but worldwide installations reached over 35 GW of new nameplate capacity. The wind turbine manufacturing industry is geographically diverse, with major players representing the US, Germany, China, India, and Denmark. Table 1 shows the top six turbine manufacturers with their respective market share in 2013.

Table 1: Top Manufacturers of Turbines, 2013[1]

Company	Country	2013 Global Market Share (%)
Vestas	Denmark	13.2
Goldwind	China	10.3
Enercon	China	10.1
Siemens	Germany	8.0
Suzlon Group	India	6.3
GE	U.S.	4.9

Strong growth in installations can be greatly attributed to federal tax credits issued to investors of clean energy technology. With continued development in wind technologies, the forecasted levelized cost of electricity for wind turbines entering service in 2019 is $0.08/kWh (in 2012 dollars).[3]

Technology

A wind turbine is made of three major components: the nacelle, which includes the turbine drivetrain; the blades, and the tower. Wind turns the rotor blades, which is converted into electricity by all of the components housed in the nacelle. The nacelle is located at the top of the tower, allowing the blades to reach winds high above the ground level.[4] The tower comprises 30 percent of a typical wind turbine's cost while the blades account for 25 percent. These two components are very large and require significant transportation expense if the location for installations is far from the manufacturing facility. Nacelle components make up about 45 percent of the total cost. The Nacelle and specialized components within it are opportunities for South Carolina manufacturing. The drivetrain test facility, the ease of

Investment Highlight (June 2014)

General Electric announced the construction of a new state-of-the-art Power & Water advanced manufacturing facility to be built in Greenville, SC. The facility will serve as an incubator for innovative advanced manufacturing process development and rapid prototyping for the Power & Water businesses, including wind turbines. The new Advanced Manufacturing Works is expected to open in 2015 and create more than 80 jobs.

[1] NA Wind Power, "Top 15 Wind Turbine Suppliers Of 2013 Revealed", March 2014: http://www.nawindpower.com/e107_plugins/content/content.php?content.12710
[2] U.S. Department of Energy, 2012, "2012 Wind Technologies Market Report"
[3] EIA, "Annual Energy Outlook", May 2014: http://www.eia.gov/forecasts/aeo/electricity_generation.cfm
[4] Wilburn, D.R., 2011, Wind energy in the United States and materials required for the land-based wind turbine industry from 2010 through 2030: U.S. Geological Survey Scientific Investigations Report 2011–5036, 22 p.

exporting from Charleston, combined with a low cost of doing business gives South Carolina a geographic and economic advantage in manufacturing these specialized components.

Offshore wind technology expands annually through the investments from companies like Vestas. Vestas continues to develop its new 8 MW offshore turbine, the 164-8.0 MW® IEC S. This 8 MW offshore turbine would be ideal for regions such as South Carolina where onshore wind potential is limited, but offshore wind is abundant. The V164-8.0 MW® has a 25-year structural design life and will require as little maintenance as possible. Vestas has installed over 1.5 GW of offshore wind turbine capacity worldwide since 1990.[5] GE's 1.5 MW turbine is one of the most common types of turbine, with over 16,500 installed globally.[6]

Another important project is the Virginia Offshore Wind Technology Advancement Project (VOWTAP).[7] VOWTAP is funded by the U.S. Department of Energy (DOE) and Dominion Virginia Power. It is an important demonstration project for the feasibility of offshore wind in the southeastern United States. The success of this project, with proven cost estimates, will reduce the deployment risk of commercial-scale off-shore wind in South Carolina. A similar demonstration project in South Carolina would send an important signal to the wind energy manufacturing industry that South Carolina is committed to the development of the sector.

Important raw materials needed for manufacturing wind turbines are cast iron, steel, concrete, fiberglass and composites, rare earth permanent magnets, and copper, as well as a large land area for installation. For wind energy to reach 20 percent penetration by 2030, the amount of cast iron, steel, and copper needed would require only 2 percent of each material's annual U.S. consumption.[4] The concrete required would be less than 3 percent of U.S. annual consumption, and the fiberglass required would amount to about 14 percent of annual U.S. consumption.[4] The rare earth elements needed would be about 2 percent of the projected 2010 world supply, of which China produced about 96 percent of the world's supply in 2009.[4]

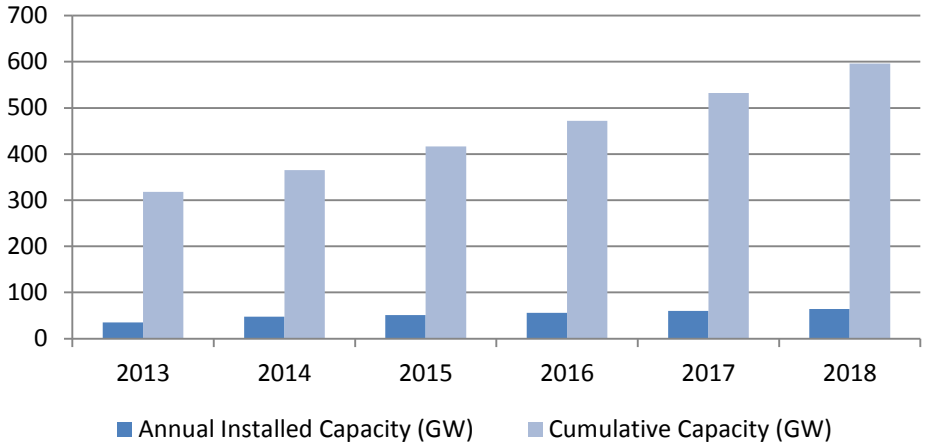
The U.S. has almost all of the resources needed for large-scale manufacturing of wind turbines to meet the growing demand for wind power, save rare earth elements needed for permanent magnet drivetrains for the wind turbines. Since 96 percent of the world's rare earth elements come from China, it will be necessary to ensure a consistent source for these permanent magnets. In July 2010, however, China's Ministry of Commerce reduced China's export quota for rare earth oxides. Continued restriction of Chinese rare earth exports could affect the short-term global supply, making it difficult for the U.S. to reach its 2030 penetration goal of about 310 GW in wind capacity.

Markets

China currently leads the world with 91.4 GW of cumulative wind capacity installed at the end of 2013, followed by the U.S with 61 GW, Germany with 34.3 GW, and Spain with 23 GW. Globally, 318.1 GW of wind capacity was installed at the end of 2013.[8] Collectively, China, the U.S., and Germany have over half of the entire world's installed capacity.

[5] Vestas: http://www.vestas.com/en/products_and_services/turbines/
[6] GE Power: http://www.ge-energy.com/products_and_services/products/wind_turbines/index.jsp
[7] Dominion Power, "Virginia Offshore Wind Technology Advancement Project": https://www.dom.com/corporate/what-we-do/electricity/generation/wind/virginia-offshore-wind-technology-advancement-project
[8] Global Wind Energy Council, "Top 10 Cumulative Capacity Dec 2013":http://www.gwec.net/wp-content/uploads/2014/04/9_Top-ten-cumulative.jpg

Figure 1: Global Annual Installed Capacity and Cumulative Installed Base Capacity (Nameplate)



To date, the majority of wind turbine capacity is for onshore generation, but technologies are advancing, making offshore turbines more affordable and attractive for regions that either do not have the land available for wind farms or do not have the necessary onshore wind resource.

The U.S. installed more than 13 GW of wind capacity in 2012 and then only slightly more than 1 GW in 2013.[9] This can be attributed to both the need to restock the project pipeline and the expiration of the Renewable Electricity Production Tax Credit. Within the U.S., Texas alone has about 20 percent of the country's installed capacity.

Table 2: Cumulative Installed Capacity 2013[10]

Company	Cumulative Installed Capacity 2013 (MW)	Homes Equivalent
Texas	12,355	3,178,020
California	5,830	1,499,624
Iowa	5.178	1,331,913
Illinois	3,568	917,780
Oregon	3,153	811,032

Consumption Incentives

Two federal tax credits have been made available in the U.S. to encourage the purchase, installation, and use of renewable energy sources, including wind power. The Renewable Electricity Production Tax Credit (PTC) allows owners of qualified renewable energy facilities to receive a tax credit of 2.3 cents/kWh of electricity generated from utility scale wind turbines,

[9] Global Wind Energy Council, "Top 10 New Installed Capacity Jan-Dec 2013": http://www.gwec.net/wp-content/uploads/2014/04/8_Top-ten-annual-2013.jpg

[10] Wind Exchange, "Installed Wind Capacity", Oct 2014: http://apps2.eere.energy.gov/wind/windexchange/wind_installed_capacity.asp

over a ten year period. The Business Energy Investment Tax Credit (ITC) allows for the owners of new wind energy systems of any size to receive tax credits worth 30 percent of the value of the facility (expanded from the original limit of turbines having a maximum size of 100 kW capacity through the American Recovery and Reinvestment Act of 2009).[11] Qualifying investors may take the PTC or the ITC. Both tax credits required the wind turbine projects to begin construction by December 31, 2013 to qualify for either credit. The PTC has expired and been extended five times, and many in the industry are urging congress to reinstate the PTC to provide a stable, predictable market to invest in.[12]

Programs such as feed-in tariffs and net metering guarantee some level of return for investors. Seven states have net metering or feed-in tariff legislation for independent energy producers through renewable energy sources such as wind power as of May 2013, however these types of programs are much more prominent internationally.[13] For example, in Germany, the basic feed-in tariff for a wind turbine commissioned in 2012 was € ct4.87/kWh, and in the Netherlands renewable energy sources are eligible for a feed-in tariff that has a maximum amount of € ct15/kWh for a certain period of time.[14]

Projected Demand

The U.S. Department of Energy placed the U.S. wind penetration goal at 310 GW by 2030, which would satisfy 20 percent of the national energy consumption. A DOE Report laid out the annual capacity additions required in order to meet the goal.

Other countries have similar energy goals, which will continue to drive global demand for wind turbine manufacturing. India's "Wind Mission" includes reaching 100 GW of capacity by 2022, and Australia is striving to be 20 percent renewable by 2020, which includes wind energy. China, already the country harnessing the largest amount of wind energy, has benchmarks of 100 GW by 2015 and 200 GW by 2020. At the end of 2013, China had over 91 GW of installed capacity, needing less than 9 GW to be installed in 2014 to meet the 100 GW benchmark.

Table 3: Projected US Wind Power Demand

Year	Annual Wind Installations (MW)
2013-2014	9,600
2015-2016	13,400
2017-2030	16,000

Global wind installations are forecasted to continue enjoying strong growth, with projected additions of 47 GW in 2014 and a cumulative capacity growth rate fluctuating between 12 percent and 14 percent from 2014 to 2018.[5] Continued financial incentives from the Chinese government will ensure meeting China's 2015 and 2020 benchmarks, as well as growth of Chinese wind companies. In 2011, the top 3 Chinese suppliers for wind capacity installed more capacity than was installed in the entire U.S.[15]

Multinational firms, such as Vestas, GE, Siemens, and Suzlon are expected to show strong growth in the global market. Companies are seeking out innovations in offshore technology will respond to that demand in a different ways—for example the joint venture between Mitsubishi and Vestas.

[11] Energy.gov, "Business Energy Investment Tax Credit": http://energy.gov/savings/business-energy-investment-tax-credit-itc
[12] Union of Concerned Scientists, "Production Tax Credit for Renewable Energy": http://www.ucsusa.org/clean_energy/smart-energy-solutions/increase-renewables/production-tax-credit-for.html
[13] EIA, "Feed-in tariff: A policy tool encouraging deployment of renewable electricity technologies", May 2013: http://www.eia.gov/todayinenergy/detail.cfm?id=11471
[14] KPMG, "The Netherlands": http://www.kpmg.com/global/en/issuesandinsights/articlespublications/taxes-and-incentives-for-renewable-energy/pages/the-netherlands.aspx
[15] Junfeng. LI, et al, 2012, "China Wind Energy Outlook"

South Carolina

The National Renewable Energy Laboratory lists 11 NAICS codes relevant to wind turbine manufacturing, and South Carolina's distribution of wind turbine-capable jobs reflects existing manufacturing regions and areas where turbine manufacturing are currently taking place.

The Upstate and Charleston, South Carolina already exhibit the competencies needed to participate in wind turbine and component manufacturing industry. These types of jobs are most concentrated in the Greenville-Spartanburg region, which is known as being a high-tech manufacturing hub. Greenville is also the destination for GE Power & Water's new facility, adding to GE's presence in Greenville for over 40 years. The Charleston area is another densely skilled part of the state, and the SCE&G Energy Innovation Center is testing wind turbines along the shore in the most advanced facility of its kind in the world.

The SCE&G Energy Innovation Center located in Charleston, SC, houses the world's most-advanced wind-turbine drivetrain testing facility capable of full-scale highly accelerated mechanical and electrical testing of advanced drivetrain systems for wind turbines.[16] This facility brings South Carolina to the forefront of wind turbine development, and may be accompanied with an increased wind technology related presence in the state.

According to the National Renewable Energy Laboratory, South Carolina's offshore wind potential at 90 meters hub height is 130,244 MW. This means that wind power is capable of meeting more than 50 times the state's current electricity needs.[17] Since installation and maintenance are on-site work by nature, it is useful that wind-related jobs in South Carolina are already present along the coast, in the Charleston region. Despite not having the wind farm presence as found in the interior region of the U.S., South Carolina is an integral part of the US wind turbine supply chain.

The Port of Charleston is the most central of all southeastern U.S. ports with 91 major metro areas within 500 miles. Home to 5 public terminals and more than 30 shipping lines serving 150 countries, the Port of Charleston is easily equipped to handle and move any cargo type. Currently the port is the only Southeastern port that is capable of handling fully-loaded post-Panamax ships and in 2011 the port handled over 150 post- Panamax ship calls. Labeled as one of the most productive ports in North America the Port of Charleston is a leader in streamlined efficiency with 43 crane moves per hour per crane on average, a 22 minute truck turn time, and easily accessible rail access. The port's oversized cargo service can handle large wind turbine components. There are also numerous industrial sites in the Charleston region with barge access, which reduces the complications in getting components from site to port.

Advanced manufacturing requires advanced materials, and South Carolina is increasingly supplying it to the world in the form of plastics, optics, photonics, advanced textiles, and composite materials. Since 2006, companies in the composites and advanced materials sector have announced over $1.5 billion in capital investment in South Carolina creating over 2,700 new jobs, including Toray, GKN Aerospace, and TIGHITCO. The existing advanced materials industry in South Carolina presents opportunities for synergy for a wind turbine manufacturer. Ahlstrom Specialty Reinforcements in Lee County, SC already supplies fiberglass for the wind industry.

[16] Clemson University, "SCE&G Energy Innovation Center / Duke Energy eGRID": http://clemsonenergy.com/facilities/drivetrain-testing-facility/

[17] American Wind Energy Association, "State Wind Energy Statistics: South Carolina": http://awea.rd.net/Resources/state.aspx?ItemNumber=5186

State Opportunities

The onshore wind resource in South Carolina is minimal, which is why the wind industry has been slow to take hold in the state. Companies, such as Vestas and Siemens, have built manufacturing plants in states like Colorado and Iowa, where there wind resources are more accessible and demand for wind industry products is strong. The states surrounding South Carolina also have limited onshore wind resources, with most potential being offshore wind. To date, no major offshore wind farm has been installed in the U.S., limiting demand to onshore wind farms.

Further, the states with the highest levels of wind capacity installed all have Renewable Portfolio Standards, which are policies designed to increase generation of electricity from renewable resources.[18] The majority of states with major wind turbine manufacturing facilities, such as Acciona, Gamesa, Siemens, Vestas, Suzlon, and GE, have Renewable Portfolio Standards as well.

However, the wind market shows a strong future with continued installation growth domestically and internationally, which will drive demand for wind turbine manufacturers. The Charleston and Greenville regions have already attracted industries with similar capabilities, and South Carolina has the potential to become more involved in the wind turbine supply chain. Development for offshore turbines is at the forefront of several companies' agendas, and harnessing the state's vast offshore wind resource has the potential to meet all of South Carolina's predicted electricity demand.

[18] EIA, "Most states have Renewable Portfolio Standards", Feb 2012: http://www.eia.gov/todayinenergy/detail.cfm?id=4850

Appendix I

Biomass Industry Manufacturing Overview

Although biomass is considered the oldest form of renewable energy, it represents an essential resource toward developing a clean energy future. The sustainable processing of plants and animal waste into usable energy is a promising area for growth over the next decade. Innovations in manufacturing have made biomass increasingly competitive as an alternative to more conventional sources of energy generation.

Technology

The process of generating biomass energy begins with the harvesting of raw materials. Landowners, harvesters, and loggers form the base of the biomass supply chain.[1] Wood products, including waste from the lumber and forestry industries, are the largest source of fuel for biomass facilities today. Grasses, especially switchgrass, are increasingly popular both domestically and internationally. Certain biomass facilities also process agricultural waste products. Residues from crops, such as rice hulls removed during grain processing, are one example. Manure from dairy or poultry farms may also be used as an effective fuel for biomass energy production.

Table 1: Multinational Corporations with Biomass Power Generation Projects

Corporation	Global Headquarters
ABB	Switzerland
Alstom	France
AREVA	France
General Electric	United States
Siemens	Germany

Raw materials are often transported, pre-processed, and stored prior to the final energy conversion process. Pellet fuel represents one of the most common forms of pre-processing. During this phase, "[m]any pellet manufacturers take by-products (like wood waste) and refine them into pencil-sized pellets that are uniform in size, shape, moisture, density and energy content." These pellets can easily be transported and stored for use miles away from the processing facility.[2]

Biomass "cofiring" is one of the most promising new technologies in the clean energy sector. Here, existing coal boilers are converted to process both coal and biomass materials, reducing emissions and reliance on fossil fuels. If biomass material can be obtained for less than the cost of coal, cofiring projects may also reduce costs. Although technical challenges remain, "[a] consensus is emerging that cofiring is feasible at most coal-fired power plants."[3] The Tennessee Valley Authority's Colbert Plant has burned wood waste with coal since 1994, and promises to convert entirely to biomass by 2016.[4] Opportunities exist for manufacturers involved in the processing of raw materials and the production of machinery for new cofiring power plants.

[1] Guidelines for Developing a Sustainable Biomass Supply Chain, J. Tallaksen, University of Minnesota, 2011
[2] Pellet Fuels Institute: http://pelletheat.org/pellets/what-are-pellets/
[3] US Department of Energy, National Renewable Energy Laboratory, Biopower Factsheet: http://www.nrel.gov/docs/fy00osti/28009.pdf
[4] Tennessee Valley Authority: http://www.tva.com/sites/colbert.htm

Although biomass "gasification" is not a new technology, it has developed to become increasingly feasible in recent years. The waste-to-energy gasification plant in Covington, TN has been among the most successful biomass projects. The plant was constructed in less than 1.5 years, and promises $3.5 million for the city over the life of the project. The gasification process uses wood and sewer wastes that otherwise would have been landfilled to produce clean electricity.[5] PHG Energy, the producer of the Covington Plant's gasifier, claims "[t]his system design is modular and can easily be upgraded to accommodate larger municipal or industrial facilities."[6] Manufacturers may take advantage of this opportunity to improve and expand upon existing gasification technology.

Suppliers

Although any number of feedstocks may be used, manufactured wood pellets represent one of the fastest growing markets in the biomass industry. Capacity at currently operational wood pellet plants in the United States and Canada exceeds 14.2 billion metric tons per year, supplying fuel for biomass power plants across several continents. Particularly in the United States, foreign investment has been critical to the development of these large manufacturing facilities. JCE Group AB, headquartered in Gothenburg, Sweden, invested in Green Circle Bio Energy Inc. to build one of the world's largest pellet plants, located in Cottondale, Florida. German Pellets GmbH operates twenty manufacturing facilities across Austria, Germany, and the United States.[7]

Table 2: Largest North American Wood Pellet Facilities

Largest Operational Wood Pellet Plants in U.S. (Capacity in metric tons/year)				
Company	**Plant**	**State**	**Feedstock**	**Capacity**
RWE Innogy Cogen	Georgia Biomass	GA	Softwood	825,000
JCE Group AB	Green Circle Bio Energy Inc	FL	Hardwood and Softwood	660,000
Enviva LP	Enviva Pellets Northampton, LLC	NC	Hardwood and Softwood	551,156
German Pellets GmbH	German Pellets Texas	TX	Hardwood and Softwood	551,155
Enviva LP	Enviva Pellets Ahoskie	NC	Hardwood and Softwood	365,000

Largest Operational Wood Pellet Plants in Canada				
Company	**Plant**	**State**	**Feedstock**	**Capacity**
Pinnacle Renewable Energy Inc.	Burns Lake	BC	Softwood	440,000
Pacific BioEnergy Corporation	Pacific Bioenergy Pellet Mill	BC	Softwood	400,000
Pinnacle Renewable Energy Inc.	Houston Pellet Limited Partnership	BC	Softwood	220,000
Pinnacle Renewable Energy Inc.	Strathnaver	BC	Hardwood and Softwood	220,000
Pinnacle Renewable Energy Inc.	Williams Lake	BC	Softwood	200,000

[5] Covington Biomass Gasification Plant Online , Memphis Daily News, November 1, 2013.
[6] PHG Energy Press Release: City of Covington Waste-To-Energy Gasification Plant, http://www.phgenergy.com/case-study/covington-tenn
[7] German Pellets: http://www.german-pellets.de/en/the-company/our-locations.html; accessed December, 2014.

Markets

The International Energy Agency's ten most important biomass energy users include countries from nearly every continent. Brazil leads global biomass energy usage, with the United States close behind. Three European Union members – Germany, Sweden, and France – also make the top ten. Indeed, the EU has shown significant growth in wood pellet imports over the last several years.

Table 3: Most Important Biomass Energy User Countries (2013)[8]

Country	Industrial Sector (PJ)	Energy Production Sector (PJ)	Transportation Sector (PJ)	Total (PJ)	Total (trillion Wh)
Brazil	1317	857	551	2725	757
US	1170	471	928	2569	714
India	1195	48	7	1250	347
Thailand	283	306	22	611	170
Germany	100	385	116	601	167
Nigeria	379	102	0	481	134
Canada	287	62	33	382	106
Sweden	169	160	16	345	96
Indonesia	272	30	1	303	84
France	98	37	103	238	66

Table 4: Top European Union Importers of Wood Pellets (1,000 MT)[9]

	Total Imports		Imports from U.S.	
Calendar Year	2011	2012	2011	2012
Denmark	2,295	2,032	38	43
UK	1,015	1,470	274	475
Italy	1,009	1,197	21	31
Netherlands	944	1,031	423	602
Belgium	514	972	203	572
Sweden	665	487	41	40
Germany	253	317	0	0
Austria	316	256	0	0
Total EU27	-	-	**1,029**	**1,764**

In the United States, biomass power generation is strong in states across several regions. Most notably, three Southern states are in the top five – Florida, Alabama, and Georgia. Per recent reports, the total technical potential for U.S. biopower is estimated at 62 GW.

[8] Large Industrial Users of Energy Biomass, IEA Bioenergy, September, 2013.
[9] USDA Foreign Agricultural Service, Global Agricultural Information Network Report, EU Biofuels Annual 2013, August, 2013.

Table 5: Total Renewable Net Generation by Energy Source and State, 2009[10] (Thousand kWh) – Top 5 US States

State	Landfill Gas/MSW Biogenic	Other Biomass	Wood and Derived Fuels	Total
California	1,841,859	625,802	3,732,016	**6,199,677**
Florida	1,846,339	530,398	1,954,125	**4,330,862**
Maine	232,254	40,618	3,366,750	**3,639,622**
Alabama	-	14,482	3,035,375	**3,049,857**
Georgia	50,719	28,881	2,745,569	**2,825,169**

Consumption Incentives and Manufacturing Subsidies

Although the United States does not have a federal incentive program specifically directed toward the consumption of biomass energy, a number of broader credits do apply. The USDA's Repowering Assistance Biorefinery Program offers up to 50 percent of total project costs for biorefineries to "replace fossil fuels used to produce heat or power to operate the biorefineries with renewable biomass." The Business Energy Investment Tax Credit (ITC) provides a corporate tax credit "equal to 10 percent of expenditures, with no maximum limit stated" for Biomass Combined Heat and Power (CHP) systems placed in service from 2008 through 2016.[11]

China offers a number of incentives that benefit the biomass industry. The government has traditionally placed a small, per-kWh surcharge on consumers, worth billions of dollars per year. These monies are then granted to "grid firms" to purchase more expensive forms of renewable energy. In 2010, the feed-in rate for biomass power was approximately $0.11/kWh, "higher than from coal-fired generators."[12] The Corporate Income Tax (CIT) may also be reduced or exempted for new biomass projects or for relevant research and development.

European nations provide similar incentive schemes. France allows for accelerated depreciation on renewable energy equipment. The UK exempts renewable energy generation from some EU regulations, including the Emissions Trading Scheme. The UK's Renewable Heat Incentive is a "financial incentive scheme designed to encourage uptake of renewable heating among domestic consumers," offering quarterly, per-kWh payments for technologies including biomass boilers and stoves.[13] Both France and Germany incentivize feed-in rates for biomass energy.[14]

In the Southeast, state governments have provided strong support for the biomass industry. Vireol Bio Energy LLC promises to invest $26.2 million and purchase more than $100 million of Virginia grains over three years, developing the East Coast's largest ethanol manufacturing facility. Virginia offered Vireol and local communities carefully structured grants from the

[10] US Department of Energy, Energy Information Administration, Trends in Renewable Energy Consumption, 2012.
[11] US Department of Energy, National Renewable Energy Laboratory, DSIRE Database, accessed September 2014.
[12] Factbox: China's Incentives for Renewable or Clean Energy, Reuters News Service, August 2010.
[13] UK Dept. of Energy and Climate Change: https://www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/renewable-heat-incentive-rhi, accessed November 2014.
[14] Taxes and Incentives for Renewable Energy, KPMG, 2011.

state's *Biofuels Production Incentive* and *Governor's Agriculture and Forestry Industries Development Fund*.[15] Partnerships between state and local governments have helped to establish a vibrant biomass sector in Virginia, focused on both ethanol and wood pellet manufacturing.

North Carolina has also seen success in attracting a variety of biomass firms. Since 2010, the state has announced more than $300 million in biomass manufacturing projects. Biochemtex and Tyton BioEnergy Systems convert local feedstocks into advanced biofuels, while Enviva manufactures wood pellets for use in European biomass facilities. The development of North Carolina's biomass industry can be attributed in part to the state's *One North Carolina Fund* and *Renewable Energy Tax Credit* program. The *One North Carolina Fund* is a performance-based grant program, offering money for new equipment, construction, or renovation projects conducted by new or expanding businesses. North Carolina's *Renewable Energy Tax Credit* program offers credits against the state's franchise tax, income tax, or gross premiums tax for costs associated with placing a renewable energy system into service. The maximum credit for a biomass system on a commercial or industrial facility is $2.5 million, taken annually over five years.[16]

Projected Demand

The biomass industry faces a number of opportunities and challenges as it attempts to improve market penetration. The NREL estimates that liquid biofuels have the potential to represent 25 percent of the jet fuel market, 15 percent of the gasoline market, and 8 percent of the diesel market by the year 2020. Those figures could double by the year 2050. The cost of alternatives plays a significant role; as the cost of petroleum increases, so do the opportunities for biomass. At the same time, biomass resources are sensitive to the prices of raw materials, especially agricultural resources. The market that offers the greatest potential for biomass is one that invests in R&D and where the high cost of petroleum encourages use of more cost-efficient, clean energy resources.

> "The EU is the world's largest wood pellet market, consuming about 14 MMT of pellets in 2012. Some experts are expecting the market to increase to as much as 80 MMT in 2020. Since 2008, the demand for pellets has significantly outpaced domestic production in Europe. This has resulted in increased imports from the United States. In 2012, U.S. wood pellets exports to the EU rose with 70 percent to nearly 1.8 MMT, valued at US$ 331 million. If trade flows remain consistent with current patterns, the United States has the potential to supply approximately US$ 650 million of wood pellets in 2014."
> -USDA Foreign Agricultural Service

In the United States, biomass power generation faces several difficulties. Biomass resources are most cost-effectively funneled toward liquid biofuel production, rather than capital-intensive biomass facilities. Co-firing biomass with coal in existing power plants has perhaps the brightest future, as it involves the least amount of up-front capital expenses.[17] It stands to reason that the most successful manufacturers will be those who reduce costs and improve efficiency in biomass resources and equipment.

The European market holds great potential for biomass wood pellets manufactured in the United States. From 2012 to 2013, American exports of wood pellets doubled from 1.6 to 3.2 million short tons. Nearly sixty percent of those exports went to the United Kingdom, where large, coal-fired power plants are being converted into biomass facilities. EU renewable energy policies also encouraged manufactured wood pellet exports to Belgium, Denmark, and Italy.[18]

[15] Virginia Office of the Governor, Press Release: https://governor.virginia.gov/news/newsarticle?articleId=3831
[16] NC Department of Commerce
[17] Projected Biomass Utilization for Fuels and Power in a Mature Market, US Department of Energy NREL, March 2013.
[18] U.S. Wood Pellet Exports Double on British Demand Surge, Bloomberg; May 22, 2014.

Competitiveness

Reducing costs is the key to improving the competitive position of biomass within the energy sector. From logging to processing and exporting, improving technologies and efficiencies is essential to increasing biomass market share within the industry. Biomass feedstocks come in a variety of forms, each requiring its own method of harvesting and processing. In terms of cost per MWh, logging residues have been shown to be most competitive with coal. Ultimately, biomass must be competitive not only with fossil fuels, but with other clean energy resources.

Ideally, sources of raw feedstocks should be located in close proximity to processing facilities in order to reduce transportation costs. In the case of manufactured wood pellet exports, identifying sites with clear and inexpensive routes to major ports is essential. "Southeast producers are viable for the markets where a transportation cost advantage due to proximity to market outweighs the production cost disadvantage."[19] Minimizing the capital required for new power plant construction (or for conversion of coal plants to co-firing) would help to reduce the most significant barrier to domestic biomass energy production.

Several international firms, such as General Electric and Siemens, manufacture turbines and generators designed to handle biomass materials. AREVA offers a number of solutions for large biomass projects, including engineering, construction, and financing. More than 100 bioenergy power plants have been built by AREVA worldwide.

Enviva Biomass, the largest wood pellet manufacturer in the United States, has located its facilities in five strategic locations throughout the Southeast. Two Mississippi plants export through the Port of Mobile, AL, while three plants in North Carolina and Virginia export through the Port of Chesapeake, VA.[20] The overwhelming majority of wood pellet exports from the United States is processed through ports in the Southeast and lower Mid-Atlantic states. Six ports between Brunswick, GA and Norfolk, VA currently handle, or plan to handle, wood pellets at their facilities. The Ports of Pascagoula, MS and Wilmington, NC are spending tens of millions of dollars to accommodate future pellet exports.[21]

At present, biomass production is "highly fragmented," a product of the industry's unique supply chain. The future of the industry will largely depend on the clean energy policies pursued by the United States, European Union, and other authorities. The cost of biomass relative to other renewable and conventional sources of energy will be another key factor.

Complementary Industries

Essential to the success of any state's biomass industry is a vibrant agriculture and forestry sector. Biomass development relies on an accessible, affordable, and reliable supply of feedstock for energy generation. These industries may also utilize similar equipment; sawmills and woodworking machinery may be used at certain stages in the biomass supply chain, for instance. The same companies that manufacture biomass turbines and generators also often produce equipment for other industrial applications. Siemens notes, "biomass is a common on-site energy source for industries which produce a usable feedstock as waste during factory operations."[22]

[19] North Carolina's Role in the Global Biomass Energy Market; University of North Carolina Biofuels Center; June, 2013.
[20] Enviva Corporate Website: http://www.envivabiomass.com/manufacturing-operations/ accessed September, 2014.
[21] Policy changes should not affect wood-pellet plans at port; Wilmington Star News; July, 2013.
[22] Turbines for Biomass Plants, Siemens Company; 2014.

South Carolina Competitive Advantages

South Carolina is already home to several biomass and biofuel manufacturers. From the I-77 corridor to Jasper County, these companies process agricultural and forest products into usable fuels. Lowcountry Biomass recycles residues from local sawmills into wood pellets for export to the European market. Midlands Biofuels uses Waste Vegetable Oils (WVO) to produce sustainable biofuels. Renewed World Energies (RWE) develops cutting-edge technologies that convert cultivated algae into oil for diesel fuel and jet fuel production.[23]

Table 6: SC Biomass & Biofuels Manufacturers

Company	County
Carolina Pacific LLC	Charleston
Ecogy Biofuels LLC	Hampton
GenEarth BioEnergy Technologies	Sumter
Lowcountry Biomass	Jasper
Midlands Biofuels LLC	Fairfield
Renewed World Energies (RWE)	Georgetown
Southeast BioDiesel	Charleston

Hundreds of South Carolina manufacturing facilities could play a complementary role in the state's biomass industry. ASCO Valve, for example, produces solenoid valves and fluid automation products with a direct application in biofuels manufacturing processes.[24] The company's Aiken County facility maintains approximately four hundred employees. General Electric, one of the world's largest turbine manufacturers, operates a large Greenville production facility that employs over three thousand associates. In June 2014, the company announced it was investing $400 million to develop a new Power & Water Advanced Manufacturing Works facility, emphasizing its commitment to the South Carolina Upstate. A variety of machining firms, primarily located near urban centers in Charleston, Columbia, and Greenville-Spartanburg, are another important asset.

South Carolina provides a number of fundamental strengths to the biomass industry. Biomass and biofuel companies rely on an innovative and educated workforce, a need met by South Carolina's dynamic higher education system. The University of South Carolina, which holds the Carnegie Foundation's highest research designation, is home to nationally-ranked chemistry, biochemistry, and engineering programs. Clemson University serves as the state's leading institution for education and research in the fields of agricultural science and a number of engineering specialties. The Sandhill Research and Education Center, a Clemson satellite facility, "was established in 1926 for agricultural research in the primarily rural Columbia area."

Spotlight: Sonoco

In 2011 Sonoco committed to a $75 million investment to replace two aging, coal-fired boilers and add the new biomass boiler at its plant in Hartsville. The new boiler is fueled primarily by woody biomass from regional logging activity, but can also run on natural gas. The boiler will produce about 16 megawatts of green energy that will be consumed by the manufacturing complex, as well as steam that is used in the paper making process.

The South Carolina Research Authority (SCRA) actively promotes several biomass initiatives, including the I-95 Corridor Revitalization *through Clean Energy and Biotechnology Program* and the *Agriculture Waste-to-Energy Initiative*. Together, these programs encourage economic development by advancing research and investment in clean energy technologies. SCRA also operates Research and Innovation Centers in the Lowcountry, Midlands, and Upstate.

[23] South Carolina Industrial Directory, South Carolina Department of Commerce, November 2014.
[24] Fluid Automation Solutions for the Biofuels Industry, ASCO Numatics, 2014.

In addition to skilled workers, successful biomass companies require natural resources that enable them to compete in local and global markets. South Carolina offers a stable and diverse agricultural market, as well as a thriving forestry industry. The state's infrastructural advantages, including highway/rail networks, world-class ports, and East Coast location, make it highly competitive for manufacturing investment.

Summary

In biomass and biofuel manufacturing, South Carolina is generally well positioned to succeed. The state's natural resources, existing industry, and transportation infrastructure are strong assets. Prospects for industry growth are especially strong in the manufacture and export of wood pellets. Demand for biomass fuel is expected to increase rapidly, as EU nations seek sustainable energy from stable trade partners. Reducing costs, improving efficiency, and competing with conventional fuel sources will be key to increasing biomass market penetration. Virginia and North Carolina serve as examples of Southeastern states that have capitalized on our unique regional opportunities to develop a broad, successful biomass cluster. By attracting advanced manufacturers, encouraging innovation, and promoting exports, South Carolina can become a leader in American biomass.