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

September 30, 2015

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

South Carolina Department of Commerce
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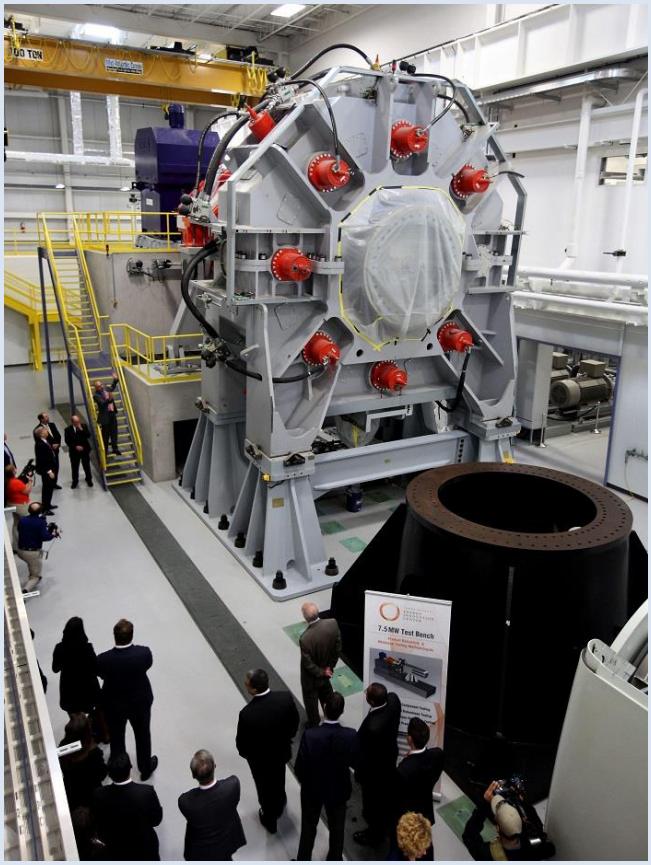
Introduction

With rapid advancements in clean energy technology, falling prices for most renewable energy sources, and an evolving global landscape for the production of clean energy products, the current market for clean energy manufacturing is in a time of significant transition. South Carolina is advantageously poised to capture a considerable portion of the growing clean energy manufacturing sector thanks to its skilled and growing manufacturing workforce, strategic location on the east coast and world renowned research infrastructure. 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 the services industries, as well as 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." This plan, the culmination of the valuable input from the Commission's sixteen industry experts, offers strategic policy and programmatic recommendations for South Carolina to capitalize on the opportunities presented by the evolving clean energy manufacturing sector, taking advantage of the state's unique combination of assets and capabilities:

- A world-class manufacturing environment with very favorable business conditions including competitive labor costs, low energy costs, tradition of quality production, low rates of unionization, and strong government support for the manufacturing community.
- Independently developed clean energy clusters with world-class technological capabilities.
- Widespread recognition of the value of sustainable business practices and technologies to protect the environment and build profitable industries.

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



The world of clean energy is evolving rapidly. The production of energy from solar and wind sources is approaching cost parity with traditional, fossil-based generation in some parts of the world. Oil rich countries like Saudi Arabia and the United Arab Emirates are investing domestically in new solar facilities and research and development.[i] Meanwhile, the first large, utility-scale solar arrays have recently been installed in South Carolina and the first utility-scale windfarm has been announced in North Carolina. The US Environmental Protection Agency's Clean Power Plan, if enacted, will further accelerate the transition to renewable energy sources in the US. In the

context of this developing market, South Carolina must act quickly and decisively to capture the manufacturing activity that will support the deployment of clean energy technology around the world.

Clean energy's potential to change the global marketplace has also triggered significant foreign direct investment (FDI). Renewables have been, in recent years, one of the fastest growing FDI sectors, achieving an 11 percent share of all global FDI in 2011.[ii] This investment activity was disrupted somewhat in 2012 and 2013 by lower gas prices, but the availability of crude oil is unlikely to exert a prolonged effect on electricity demand because it plays such a limited role in electricity generation. Clean energy is also likely to drive private domestic investment. According to surveys by audit firm Ernst & Young, corporations sought to increase their clean technology budgets from 2012 to 2014, much of it going to research and development.[iii] Additionally, Ernst & Young foresees greater inflows of venture capital to the clean economy in coming years. There is an expectation that the ongoing innovation in the sector will create new processes and new industries, along with all the productivity and jobs that accompany them.

South Carolina possesses a number of strategic advantages making it an attractive place for clean energy manufacturing. The state is home to the world's largest wind turbine drive train test facility and Hardware-in-the-Loop Grid Simulator at Clemson University's SCE&G Energy Innovation Center in Charleston. Important research is also conducted in the fields of hydrogen fuel cells, vehicle fuel efficiency, advanced lightweight materials and nuclear energy at the campuses of the University of South Carolina, Clemson University and the Savannah River National Lab.

At the forefront of deploying new nuclear technology in South Carolina, SCANA and Santee Cooper have collaborated in the financing and construction of two new Westinghouse AP1000 nuclear units at the V. C. Summer Station in Fairfield County. These plants are employing thousands of construction workers and, when complete, will employee nearly 800 full-time employees in support of operations. Together with the work at the Savannah River Site and industrial firms involved in the nuclear supply chain, this sector is an important part of the South Carolina economy.

South Carolina can also build on its existing industrial base, including a significant number of firms engaged in the manufacture of components and equipment essential to the generation and distribution of clean energy. Most importantly, South Carolina is home to a large and growing manufacturing workforce, skilled with the equipment, production processes and quality systems that are common to much of advanced manufacturing.

This plan offers strategic guidance and specific recommendations to leverage the state's existing assets and capture a share of the growing clean energy manufacturing economy. A detailed assessment of the state's clean energy manufacturing assets, the market conditions of various clean energy sectors and a general introduction to the specific recommendations outlined in this document are found in the Commission's preliminary report, which was released in December 2014. This report can be retrieved from the publications directory on the South Carolina Department of Commerce website (www.sccommerce.com).

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Economic Potential of Clean Energy Manufacturing in South Carolina

The transition to clean energy sources and the introduction of new energy efficient products will have a profound impact on global economic development in the coming decades. In 2013, SolarCity announced an investment of $5 billion for a new solar cell manufacturing and R&D facility that will create 2,850 jobs. Similarly, Tesla's $5 billion "Giga" factory for the production of advanced lithium-ion batteries will create 6,500 jobs in the Reno, Nevada area. Aside from the large-scale manufacturing of clean energy products, thousands more jobs will be created during the sale, installation and maintenance of these clean energy products. While a number of clean energy manufacturing firms have chosen South Carolina for new facilities, the state still has vast potential to increase the amount of clean energy investment during the next five to ten years.

Spotlight: Colleton Solar Farm

The 15 –acre Colleton Solar Farm, operated by TIG Sun Energy under contract with Santee Cooper, consists of 10,010 photovoltaic panels and generated 4,687 megawatt-hours in its first year of operation.

The most objective study of clean economy jobs conducted on a state-by-state basis was the Brookings Institute's "Sizing the Clean Economy," released in 2013. This study showed that South Carolina ranked 47th among states for the number of clean economy jobs added between 2003 and 2010, with a 1.1 percent increase to 50,424 jobs. Over the same period, North Carolina saw a 5.9 percent increase and Georgia a 3.7 percent increase. This disparity in clean jobs growth is due, in some part, to the state policies and programs that have promoted the development of their respective economies. In evaluating the economic potential presented by growing the clean energy sector in South Carolina, it is worthwhile to track the progress of our neighboring states that have seen faster clean energy economy growth in recent years.

Clean Energy Growth in Neighboring States

Data from the Brookings Institute show that North Carolina's clean economy job growth during the period came largely from a ramping up of long-standing segments such as waste management, conservation and regulation/compliance. All three segments added 2,000 to 4,000 jobs, representing an average annual change of approximately 10 percent. Its most dramatic growth, however, came from segments involved in innovation, such as electric vehicle technologies, smart grids and solar photovoltaic systems. The previously mentioned windfarm, the state's first, was announced in 2015.

Electric vehicle technologies created more than 1,100 jobs in North Carolina from 2003-2010 (for an average annual change of +61.2 percent), spurring the formation of the North Carolina Plug-in Electric Vehicle Taskforce, a public-private partnership that aims to identify and address barriers to electrified transportation. Development of smart grids, modernized electric infrastructure that can interpret and act on consumption patterns to more efficiently deliver power, created more than 650

jobs for an average annual change of +53.1 percent. Solar photovoltaic systems, which convert sunlight into electricity, created 129 jobs for an average annual change of +33.6 percent. As of the end of the period, clean economy jobs accounted for 1.9 percent of all jobs in the state.

Georgia's clean economy, though also growing, has followed a different path. The state had less separation between its larger, more traditional segments and its fastest growing segments. In fact, conservation, with 10,411 jobs and +12.4 percent average annual change, was both the second largest and second fastest growing segment for Georgia. Green building materials topped the list of largest segments, with more than 14,000 jobs; jobs in lighting grew the fastest, with +20.7 percent average annual change. The state had less robust investment in technologies like solar power or electric vehicles, but the state has seen growth in the number of operating biomass plants. Biomass is material derived from plant sources that can be sustainably converted to energy, typically for use as heat or fuel. As of the end of the period, clean economy jobs accounted for 2.1 percent of all jobs in Georgia.[iv]

International Trade and Foreign Direct Investment

The clean sector presents two additional benefits to local economies: it is manufacturing intensive and creates inroads to export activity. According to the Brookings Institute, more than 25 percent of all clean energy jobs are based in manufacturing. That is true of only 9 percent of all jobs in the domestic economy. Clean energy also accounts for $20,000 in exports on a per-job basis, double the value of the average US job. By specific segments, electric vehicles, green chemicals and lighting are most likely to involve manufacturing. Electric vehicles and green chemicals are also likely to stimulate exporting, as is biomass or biofuels. In terms of exports, South Carolina may be uniquely positioned to take advantage of clean energy. In 2010, each of its clean economy jobs produced $38,172 in exports, ahead of 43 other states by that measure.

Clean energy also presents new opportunities for attracting foreign direct investment. According to the Financial Times of London's 2015 report on worldwide FDI, alternative/renewable energy had the fifth most foreign direct investment of all sectors in 2014, at approximately $45 billion.[v] This sum placed the sector above financial services, metals, and chemicals. The value of FDI to the clean energy industrial base in the US is plainly evident in the activities of the French nuclear and renewable energy company AREVA in Charlotte, NC; German company SolarWorld's solar module production plant in Hillsboro, OR; the operations of Danish wind turbine maker Vestas in Pueblo, CO; and South Korean company LG Chem's electric vehicle battery plant in Holland, MI.

Competition for outside investment in clean energy is competitive and will become more so as countries achieve mature technologies and build power infrastructure that utilizes renewable energy. Ernst & Young has devised a Renewable Energy Country Attractiveness Index that assesses a country's likelihood of drawing FDI for the sector. The US performs well in the Index (its score in March 2015 placed it in second worldwide, ahead of Germany and behind only China), but sustaining that high level will require accelerated growth in the future. Furthermore, governments, at the national and sub-national level, can play an essential role by implementing policies that are clean energy friendly. Political support, in fact, is one of the parameters measured by the Index to determine attractiveness. Among the others are cost and availability of finance, the technology pipeline and strength of the local supply chain. At this level of competition, any actor intending to capture its maximum share of the global clean energy market will need to marshal all available tools, resources and relationships.

Research and Technology Commercialization

Evidence of both the heightened activity in clean energy and the success of research and development efforts can be seen in the growing number of patents being awarded in the sector, defined by the Clean Energy Patent Growth Index as technologies relating to solar energy, wind energy, electric vehicles, fuel cells, hydroelectric, tidal energy, geothermal, biomass/biofuels or other renewable energy. For 2014, clean energy technologies earned 3,609 US patents, the most ever for the sector, and a gain of 13.7 percent from 2013. Solar technology patents led the year's field with 1,238, followed by fuel cell patents with 880 and wind technology patents with 623. Despite the dominance of solar patents, however, the leading new patent holders were automakers, such as General Motors, Honda and Toyota in the top three spots, receiving patents for electric vehicle and fuel cell technologies. Strong performers outside of the automobile industry for 2014 included General Electric, in the top ten for its solar and wind patents, and Samsung, which also received solar technology patents. By parent country, companies from the US received the most clean energy US patents, with Japan, Germany, South Korea and Taiwan filling out the top five.[vi]

Venture capital and private equity investors play an important role in the commercialization of new technologies. The federal government took steps in February 2015 to encourage the flow of private sector financing into clean energy with the Clean Energy Investment Initiative. To facilitate public/private collaboration, the initiative established the Department of Energy (DOE) Clean Energy Impact Investment Center. The center acts as a single integrated source for investors or members of the public seeking information on DOE programs, clean energy research and analysis, and current projects. For companies hoping to fund development of their technology or accelerate its time to market, the center will also act as a potential connection point to investors. Investment firms and philanthropic foundations have responded to the initiative by allocating assets specifically for funding clean energy innovation. Goldman Sachs has set a $500 million target for financing companies pursuing advanced clean energy technologies, including smart grids and electric car batteries. Investments in advanced technologies are important in order to modernize the grid and facilitate reliable and flexible expansion of clean energy, and are part of Goldman Sachs' longstanding commitment to deploying capital to scale up clean technology and renewable energy. The CREO (Cleantech, Renewable Energy and Environmental Opportunities) Syndicate, a network of more than 100 private investors and advisors, plans to invest $2 billion (on top of an already committed $1.5 billion) into clean energy over five years. Overall, the initiative has drawn more the $4 billion in announced commitments from institutional investors, foundations and other long-term investors.[vii]

All these factors taken together – the acceleration of clean energy innovation, an increasingly feasible political outlook and the growth of private investment – lay the foundation for South Carolina's pursuit of the clean energy sector. Given the importance of innovation and technology commercialization in this evolving industry, the state can deploy policy changes and economic development initiatives into an accepting and opportunity-rich atmosphere.

Clean Energy Cluster Development in the Southeast

A business cluster is a geographically concentrated mass of same-industry firms, suppliers, and related institutions. Such an environment can confer a competitive advantage by using close proximity between interconnected units to accelerate information transfer, stimulate innovation and boost productivity. In South Carolina, 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, complementing existing firms in the industry like GE, ILJIN and IMO USA. 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.

The cultivation of new clean energy clusters may require forms of thinking and policy that differ from traditional economic development. Firms that are capable of coalescing as a cluster will have shared strengths and needs, as well as shared obstacles. The most effective economic development policies, therefore, will be oriented toward the firms as a group rather than focused on individual entities. A Brookings Institute's report on the nature of industry clusters found, for example, that clusters are less responsive to subsidies and recruitment efforts unless those actions are deployed to attract a business that complements the existing cluster. Policymaking for clusters involves continuous communication with cluster firms to capitalize on both their unique attributes and the particularities of the region. Of course, if a region is starting from zero, with the goal of coaxing a cluster into being, there is no opportunity for communication. In such cases, the most effective public policies will be those that promote a fertile economic environment and avoid excluding industries.

Global Competition for Clean Energy Manufacturing

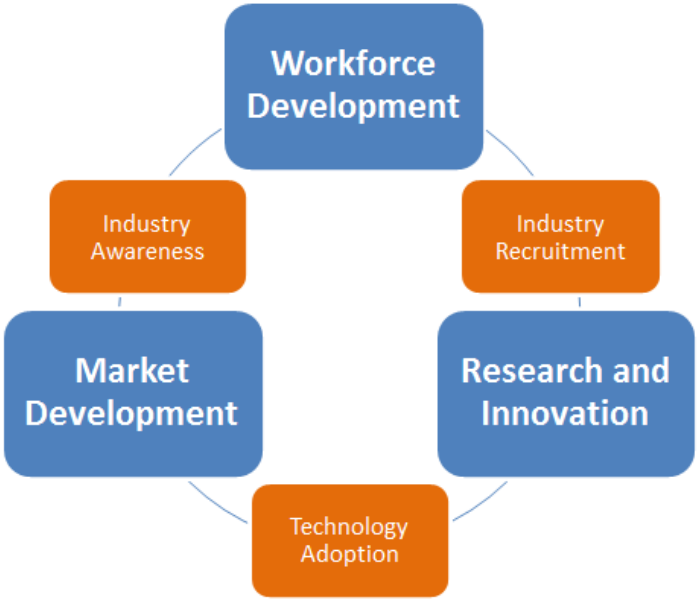
As this report's discussion of foreign direct investment suggests, the United States is not the only country turning its attention to clean energy. The global economic superpower China is mobilizing capital for use in clean energy manufacturing, as is the major energy player Saudi Arabia. However, smaller global actors like Chile, Mexico and Egypt are also gearing up for projects and setting ambitious targets for renewable energy production.

According to an Ernst & Young report, China set a record in 2014, investing $90 billion in clean energy. This sum involved a 23 percent boost year over year in wind and solar asset financing. The country, already the world's largest wind market, added 19 gigawatts of wind capacity to reach a total installation capacity of 96 gigawatts. Forecasting indicates it will make even greater additions in 2015, adding another 22 to 25 gigawatts. Chinese policy has facilitated these projects, which often have a hefty fixed cost, by allowing a total life cycle accounting of cost rather than favoring low up-front expenses. In its solar sector, the country added 13 gigawatts of capacity with photovoltaic installations, just shy of 2014's 14 gigawatt target. Similar to the wind investments, this build-up was possible because the government prioritized the more difficult to finance solar installations over other utility projects.

Saudi Arabia, in a bid to diversify its energy consumption, has announced a $109 billion solar project expected to produce 41 gigawatts of power by 2040. The country hopes to become the Middle East's hub for renewable energy technology exports. Chile, following a tender for 11 terawatts (one terawatt is equal to 1,000 gigawatts) over 15 years, saw 20 percent of the contracts go to renewables developers. Its policies have been among the friendliest toward clean energy in South America, with a carbon tax – the first on the continent – and a provision that allows intermittent suppliers to sell power in supplemental hour increments. In 2014, Chile launched almost 80 wind and solar projects with a total estimated value of $7 billion. Mexico, in 2014, passed a critical energy transition bill signifying broad political support for renewables. The country, already operating at 12 percent clean energy, intends to reach 35 percent by 2024. Part of this plan involves a proposed $14 billion windfarm that would produce 6.5 gigawatts by 2018.

Strategic Framework for Clean Energy Manufacturing in South Carolina

The Commission believes that improving South Carolina's competitiveness in clean energy manufacturing requires a holistic approach addressing the critical issues impeding the state's development. Analogous to a three-legged stool, the strategic framework for improving the business climate for clean energy manufacturing involves improving each of these facets: workforce, innovation and market acceptance. The diagram below depicts how each of these strategic imperatives are interrelated. By growing the clean energy workforce and developing markets for clean energy generation, the public will have greater exposure and appreciation for the sector thereby increasing industry awareness. A skilled and growing workforce along with innovative research at the state's labs and universities will assist in attracting new companies to the state. Finally, these research advancements can be deployed in a developed clean energy market, resulting in technology adoption in the commercial markets.



By improving each of these aspects of South Carolina's clean energy economy, the state will be more competitive in attracting foreign and domestic firms investing in new manufacturing facilities. In addition, each of these aspects will help raise awareness of the opportunities presented in clean energy manufacturing for the developing workforce. Without a skilled and abundant workforce, manufacturers will not be able to expand their operations or meet the quality expectations of their customers. Developing the market for clean energy generation, alongside favorable policies and incentives, is important for signaling to potential investors worldwide that South Carolina is aligned strategically and philosophically with clean energy companies' stated goals of sustainability and stewardship. A strong position on sustainability is also attractive to investors not directly engaged in the clean energy sector, especially European firms, because their customers and shareholders expect environmentally conscious decision making. Furthermore, states with favorable clean energy policies are more attractive for federal research grants and other research funding opportunities because of the greater likelihood that the technologies being developed would be market-tested and deployed in the local economy.

Innovation and technology commercialization is important to the overall clean energy manufacturing sector because the fastest growing firms in this industry will be those that advance the efficiency of their products and innovate manufacturing processes to reduce cost and improve durability. Oftentimes, manufacturing investments will follow from industry-university research collaboration and the technology commercialization efforts of start-up firms. Investments in innovation benefit workforce development through collaboration between technical colleges, universities and industry providing students at all educational levels access to advanced technology, new manufacturing processes and experiential learning through capstone projects, internships and apprenticeships.

Although states could opt to address one or two of the three cornerstone issues of clean energy manufacturing economic development, the states that have most successfully developed clean energy sectors are those that have addressed all three aspects. The commission believes that this will also hold true in the future.

Recommendations

Workforce Development

The challenges this sector faces with respect to workforce development are not unique to clean energy manufacturing. The entire advanced manufacturing economy requires a skilled and educated workforce to operate the capital-intensive, precision-oriented processes of modern manufacturing plants. Many of the occupations involved in clean energy manufacturing, from mechanical and electrical technicians to machine tool and CNC operators, are common to clean energy product manufacturing as well as automotive, aerospace and other sectors prevalent in South Carolina. This synergy presents an opportunity for the clean energy sector to support existing efforts to raise awareness of careers in advanced manufacturing and to participate in workforce training programs with a successful track record in South Carolina. Furthermore, the larger advanced manufacturing sector will benefit by using the positive marketing message of sustainable, clean technology to attract more students to careers in advanced manufacturing. The Council advocates for the following two recommendations to expand and educate the manufacturing talent pool in South Carolina:

1 Support programs and initiatives to raise awareness for careers in advanced manufacturing.

Availability of a large and skilled workforce is typically among the top two site selection factors for firms considering establishing a new manufacturing facility in the US. 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.[viii] In 2013, South Carolina's higher education system produced approximately 420 associate's degree technicians in key fields such as electrical engineering, electromechanical instrumentation, industrial production and drafting/design engineering. On a per capita basis, the number of graduates in these disciplines was roughly 30 percent less than the totals produced by Alabama, Tennessee and North Carolina – states that routinely compete with South Carolina for economic development projects. To remain attractive in the global competition for new advanced manufacturing investments, the state must increase the number of students earning degrees and certificates in pertinent fields. The primary obstacle for growing the pipeline of talent is increasing the number of students interested in

careers in advanced manufacturing. To stimulate interest in the advanced manufacturing sector, the Commission recommends that the state support programs targeted to middle and high-school students, engaging them in the manufacturing economy and demonstrating the career potential and public benefits of a career in the clean energy sector. Several programs and institutions are already pursuing this goal; the state can further enhance these efforts through collaborative and financial support. Examples include the "SC Future Makers" initiative, led by the SC Manufacturer's Alliance and the SC Department of Commerce, and the advanced manufacturing centers of the technical college system that highlight careers in manufacturing and the potential of technological advancement. The Center for Manufacturing Innovation under construction at Greenville Technical College, the Southeastern Institute of Manufacturing and Technology at Florence-Darlington Technical College, and the Midlands Enterprise Campus at Midlands Technical College. These innovative campuses serve as talent magnets for the advanced manufacturing sector; the state should ensure adequate funding and support to guarantee that they can realize their goals and grow the manufacturing workforce for the state.

2 Fund training programs tied to specific employment opportunities

Rather than speculatively creating new training programs in fields that the state expects to grow in the future, the Commission believes the state should allocate funding to train workers, either in degree or certificate programs, that have identified specific career opportunities with South Carolina employers. Ideally, these training programs should be jointly developed with employers to fill specific positions that are growing in number and difficult to fill without supplemental training. The Apprenticeship Carolina program has a long history of success in the state, marrying training in advanced manufacturing at the state's technical colleges with experiential education at employers' plants, ultimately leading to long term placement and career growth. Similarly, the technical scholars programs established by Michelin, BMW and other employers allow students hands-on experience in manufacturing facilities while completing engineering technology degrees at local technical colleges. The state should work to expand the Apprenticeship Carolina program and support industry-led initiatives such as the Tech Scholars programs, specifically in the clean energy sector. The state should advertise the successes of these programs to prospective clean energy firms considering investment in the southeast.

Research and Innovation

From advanced energy efficient vehicles to smart meters and solar panels, clean energy products manufactured in the US are technologically advanced, but require innovations in material science, information technology, engineering design and many other disciplines to stay competitive in the global market. Research and development jobs typically pay higher wages and make a more significant contribution to regional productivity than the average job. Furthermore, manufacturing operations often collocate near research and development centers. Some examples of R&D spawning local manufacturing operations include LED lighting manufacturing around Durham, NC, spurred by R&D at NC State University, and solar cell manufacturing in upstate New York with close synergies to the semiconductor and solar research conducted at the nearby state universities.

Technology commercialization is a critical link in turning the efforts of basic and applied research at universities and national laboratories into marketable products and services, improving the lives of the public and creating jobs in all disciplines from sales and marketing to manufacturing and distribution. Technology commercialization requires close coordination between a variety of stakeholders: the inventors and their institutions and the businesses, large and established or small and entrepreneurial, who seek to develop these technologies into goods and services. To stimulate research and technology commercialization in the clean

energy sector, the Commission offers the following recommendations for consideration by state leaders:

3 Establish Clean Energy Manufacturing Innovation Centers

Realizing the complexity of technology commercialization, the Commission recommends the establishment of applied research centers, or Innovation Centers, administered by the state. These centers would focus on critical energy technologies and would be formed as non-profit, public-private partnerships requiring the collaboration of multiple universities, research labs, industry stakeholders and interested organizations. The centers would plan for self-sufficiency after five to ten years, relying on cost sharing from industry partners and research grants. Initially, the state would partially fund the centers in the model similar to the strategy developed for the National Science Foundation Engineering Research Centers. Ideally, the Manufacturing Innovation Centers would be integrative and support existing strengths of the state in transportation, building energy efficiency, advanced materials, wind and smart grid technology, or other strengths highlighted in this document. The Centers would conduct translational research in conjunction with industry partners already present in South Carolina, with the potential of attracting new research and manufacturing facilities from out of state.

This model of the Innovation Center is inspired by the successful Fraunhofer Centers of Germany, which have made important contributions to science and technology while stimulating the country's manufacturing sector. Since the inception of the Fraunhofer model, dozens of centers have been established around the world including nine centers in the United States. As the leading research and technology commercialization organization in Europe, the Fraunhofer Centers have created thousands of jobs and made important advancements in the fields of biotechnology, materials, information technology, manufacturing and clean energy. The Fraunhofer Center model is similar to the industry-university collaboration goal of the Clemson University International Center for Automotive Research; however, the main difference is the involvement and buy-in from industry stakeholders at the outset. This allows for cost-sharing from these partners and a clear assessment plan that would dictate future funding, to be reviewed every three years. The basis for renewal of state funding would depend on economic development metrics such as the number of new industrial investments, start-up companies formed and jobs created. The state could invite requests for proposals from university-industry collaborations every five years and limit the number of state-supported centers to two or three funded at any time.

The proposed Center would also leverage the SmartState endowed chairs program, providing organizational support and a technology commercialization outlet for professors receiving funding for focused clean energy areas. For future SmartState funding, smaller, multiple professorships in focused areas tied to industry-applicable technologies are preferred over larger awards for basic research. Like the SmartState program, the Innovation Centers should be competitively awarded to joint industry-university teams that focus on technology applications and with strong commitments of matching industry contributions. This model is similar to the approach favored by the US government's National Network for Manufacturing Innovation (NNMI) initiative that funds large scale ($50 million plus) research programs in specific manufacturing disciplines. With established Innovation Centers in areas complementary to the federal research agenda, South Carolina will be in a better position competitively to attract and match these large federal awards, making the state an innovation hub for both the nation and world in these specific research areas.

The proposed Innovation Centers would include, as part of their missions, engagement with the K-20 education system with the purpose of raising awareness and interest in careers in advanced, clean energy manufacturing. The Centers would showcase advances in clean energy technology, exciting prospective students, their teachers

and parents in the possibilities presented by the clean energy sector. The Innovation Centers program would start with one Center dedicated to a niche area of clean energy manufacturing and branch into other subsectors as industry interest and state funding dictate in the future, after the concept is proven. Innovation Centers would also be strategically aligned with new or existing business accelerator programs that typically offer office space, networking and mentor services, and access to a host of service and capital providers. These accelerator programs would benefit from a flow of technologies in a fast growing sector, clean energy, and have the capacity to match the resident technical talent with managerial expertise and a network of customers and partners.

4 Create a Research and Development Voucher Program

The Commission recommends consideration for a voucher program, either through a tax credit, grant or rebate, available to South Carolina industry, including large manufacturing plants and smaller firms, to engage the state's research enterprise in joint research and development projects. Working with the proposed Innovation Centers, or other university and research labs in the state, industry would propose specific research topics or projects that would be explored jointly to the benefit of industrial growth, increased manufacturing employment and strengthened relationships between the universities, Savannah River National Laboratory and South Carolina industry. The research programs would be developed in partnership with industry and competitively awarded through a state agency with an annual cap. The industry would match this voucher to fund research at the public laboratory, with the intent that after the initial grant is expended, the industry-lab relationship would continue without incentives into other projects or areas of interest. The voucher program could be used to incent involvement with the proposed Innovation Centers. Once the model is proven for industry members, they would continue supporting the Centers on a subscription or per-project basis. Similar voucher programs have been established successfully in other states and through the US Department of Energy to stimulate technology commercialization and strategic partnerships. The goal of the program would be to establish and expand collaboration between universities and industry while commercializing technologies developed at the state's research labs.

Market Development

In order to market itself to the world as a "clean energy state," South Carolina should have clear policies that provide a stable investment environment for firms in this sector. The following recommendations will improve South Carolina's position for both clean energy generation projects, such as utility-scale solar installations and biomass plants, and manufacturing of clean energy products.

5 Implement a Competitive Clean Energy Generation Strategy

With the intent to attract clean energy manufacturing firms and other businesses with a sustainability mandate, the state should consider developing a competitive and comprehensive energy plan. A reasonable clean energy plan would protect South Carolina's strategic advantage of low energy costs while attracting sustainability-minded firms. A market-based clean energy approach is now more feasible than ever as the current cost of renewable energy sources have plummeted in recent decades, and industry projections forecast a similar trend. Many experts expect solar and wind energy will reach cost parity with conventional, fossil fuel-based energy sources in the near future. Bringing a larger share of alternative energy sources to market will undoubtedly place strains on the transmission and distribution system since the availability and capacity of renewable energy sources depends on sun, wind or other factors. Therefore, the proposed plan would include a framework for upgrading the electrical infrastructure, including smart grids, meters

and devices. A comprehensive energy plan will not only address the renewable or clean share of generating capacity, but also the reliability and resiliency of the entire electrical system.

6 Improve tax incentives for clean energy manufacturing.

Manufacturers of clean energy products 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 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. Despite the changes made in 2014, the threshold investment to qualify for this incentive is still quite high, ranging from $50 million in "Tier 4" counties to $200 million in "Tier 1" counties. An evaluation of this credit, detailed in the preliminary Commission report last year, shows that a very small number of firms are likely to qualify for this credit. To make the incentive more applicable and attractive to firms evaluating South Carolina as a potential business location, especially start-up firms developing innovative, new clean energy technologies, it is recommended that the investment threshold be adjusted to less than $10 million for all South Carolina counties. By modifying the clean energy manufacturing tax credit in this way, this incentive will be more competitive with similar programs offered by many US states including Virginia, Mississippi, Kentucky, Arizona, Oregon and Utah. The improved South Carolina incentive program will make the state more attractive to clean energy manufacturing firms considering new operations in the region.

Conclusion

From its world-class infrastructure and research institutions to its talented workforce and strong industrial base, South Carolina can deploy a number of strategic advantages to grow a robust clean energy manufacturing economy. In order to capitalize on the expected growth of this sector, the South Carolina Clean Energy Industry Manufacturing Market Development Advisory Commission proposes a number of recommendations to the South Carolina General Assembly and Governor. In broad terms these recommendations encompass the areas of workforce development, research and market development. Specifically, the Commission recommends state leaders consider:

- Investments in programs dedicated to raising awareness and interest in careers in manufacturing, specifically in the clean energy sector, and support for training programs tied to specific career opportunities in the clean energy manufacturing economy.
- The establishment of research Innovation Centers dedicated to applied research in clean energy technologies and the commercialization of these technologies. In addition, funding should be available to support industry/university/lab collaborations in the clean energy sector through a technology voucher program.
- The development of a comprehensive, competitive clean energy generation strategy for South Carolina that sets realistic goals for clean energy generation and a plan for a reliable and resilient electrical grid. Lastly, the investment threshold for the existing clean energy manufacturing tax credit should be lowered so that more firms, especially smaller entrepreneurial companies, would qualify for the program.

Endnotes

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