The Pathway to Southeast Energy Innovation Leadership

Recommendations from the Southeast Energy Innovation Collaborative

NC DEPARTMENT of COMMERCE
SCIENCE, TECHNOLOGY & INNOVATION

E4 CAROLINAS®

The Office of Science, Technology & Innovation in the North Carolina Department of Commerce supports communities and businesses by expanding North Carolina's technology infrastructure, enhancing public and private innovation, and fostering a dynamic and diverse entrepreneurial economy. It develops, administers and evaluates policies and programs that accelerate both the development of next-generation technology companies and the adoption of technology across existing industry. The Office also staffs the North Carolina Board of Science, Technology & Innovation. The Board advises and makes recommendations to the Governor, the Secretary of Commerce, and the General Assembly on the role of science, technology & innovation in the economic growth and development of North Carolina. More information about the Office of Science, Technology & Innovation can be found at **nccommerce.com/sti**.

E4 Carolinas is the trade association for Carolina energy companies and organizations, providing a platform whereby members become more valuable and successful through collaboration in the areas of Workforce Development, Economic Development, Innovation & Capital, Communications & Networking and Policy. E4 Carolinas' membership is representative of the 1,000+ Carolina energy companies and organizations with every sector and every energy supply chain link included. More information about E4 Carolinas can be found at **e4carolinas.org**.

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ACKNOWLEDGEMENTS

E4 Carolinas and the North Carolina Office of Science, Technology & Innovation thank all members of the Southeast Energy Innovation Collaborative (Appendix) who took part in this effort, which included private sector executives, government officials and policymakers, college and university scholars, and advocates of the industry's prominent issues. Special thanks also go to members of the Collaborative's steering committee, who aided in the organization and leadership of this important task. Additional thanks to Joshua Klein, Office of Science, Technology & Innovation intern, who provided research assistance, as well as the North Carolina Department of Commerce graphics team, who compiled this report.

SUGGESTED CITATION

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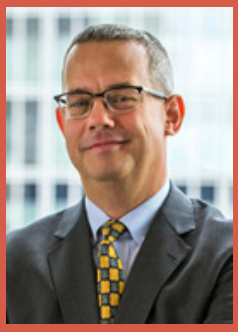
This report, *The Pathway to Southeast Energy Innovation Leadership: Recommendations from the Southeast Energy Innovation Collaborative*, reflects the work product of E4 Carolinas, the North Carolina Office of Science, Technology & Innovation, and numerous members of the Southeast Energy Innovation Collaborative, including private sector executives, government officials and policymakers, college and university scholars, and advocates of the industry's prominent issues. **The views, opinions, and recommendations expressed in this report do not necessarily reflect unanimity of position among Collaborative members or the official policy or position of any single Collaborative member.**

Letters from the Board Chairmen



MICHAEL CUNNINGHAM

Chair, North Carolina Board of Science, Technology & Innovation

Dear Policymakers and Readers:

On behalf of the North Carolina Board of Science, Technology & Innovation, we proudly present, *The Pathway to Southeast Energy Innovation Leadership: Policy Recommendations from the Southeast Energy Innovation Collaborative*. This report, completed in partnership with the E4 Carolinas, provides policy recommendations for advancing the energy sector's prominence within our region and nation.

The Board of Science, Technology & Innovation encourages, promotes, and supports scientific, engineering, and industrial research applications in North Carolina, thereby improving the economic well-being and quality of life of all its citizens. This report supports the Board's mission directly within the energy sector, which has played a vital role in the economic development of our State and has the potential for being a significant driver of innovation within and beyond our borders.

It is with tremendous honor that the Board presents these recommendations.

Sincerely,

Michael Cunningham

JEFF MERRIFIELD

Chair, E4 Carolinas Board of Directors

Partner, Pillsbury Law

Dear Energy Professionals:

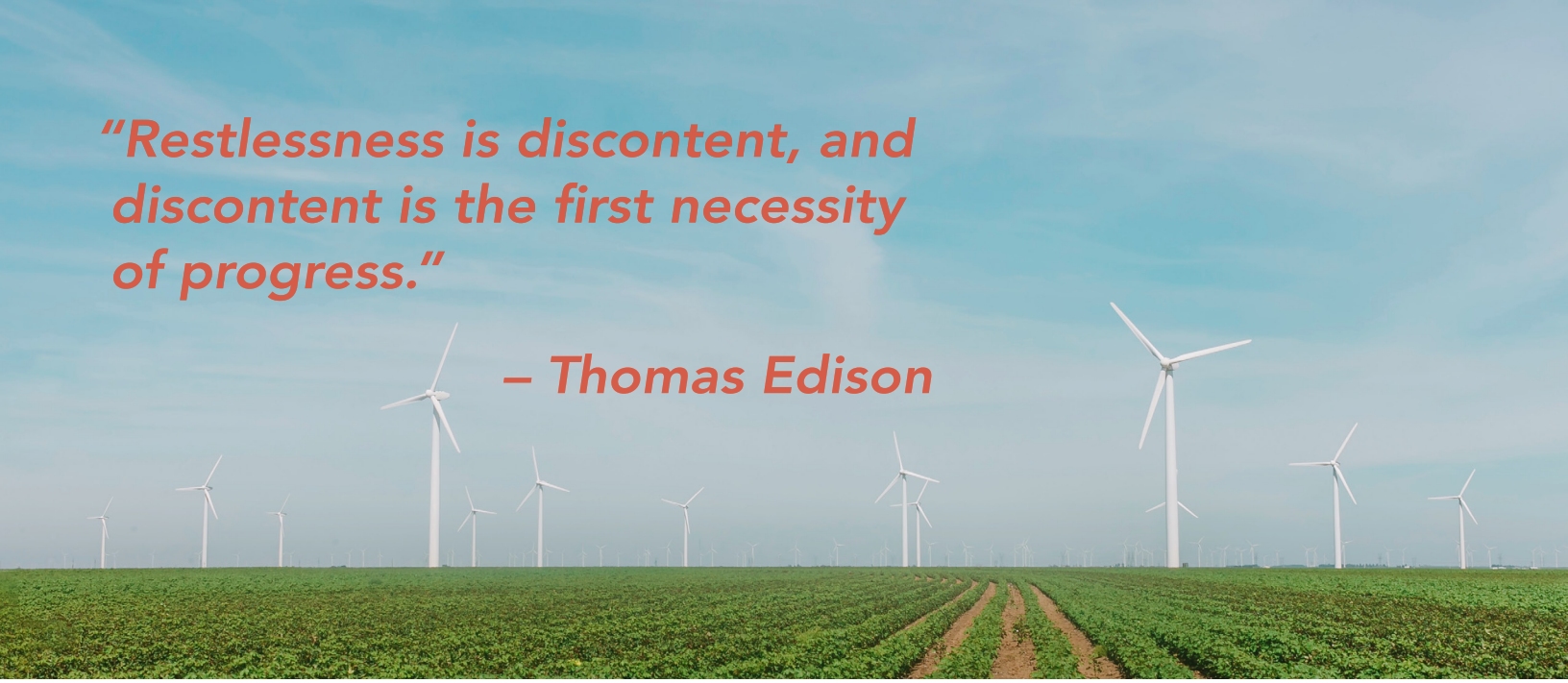
Solutions to some of the world's toughest energy problems are born in the Carolinas. Our technology and engineering companies, in collaboration with our energy research colleges, universities, and institutes, produce globally impactful energy intellectual property and are individually recognized as energy innovation leaders.

The Southeast Energy Innovation Collaborative is a partnership between E4 Carolinas, the North Carolina Board of Science, Technology & Innovation, and a host of other energy sector senior professionals from the private, public, and research sectors. For the past two years, this Collaborative has convened multiple times to develop formal recommendations useful for policymakers and company and organization executives in all southeastern states to help expand the industry's place as an energy innovation leader.

The Southeast and all energy companies and organizations within it will benefit by supporting this plan to create recognition of our role as an energy innovation leader.

Sincerely,

Jeff Merrifield



"Restlessness is discontent, and discontent is the first necessity of progress."

– Thomas Edison

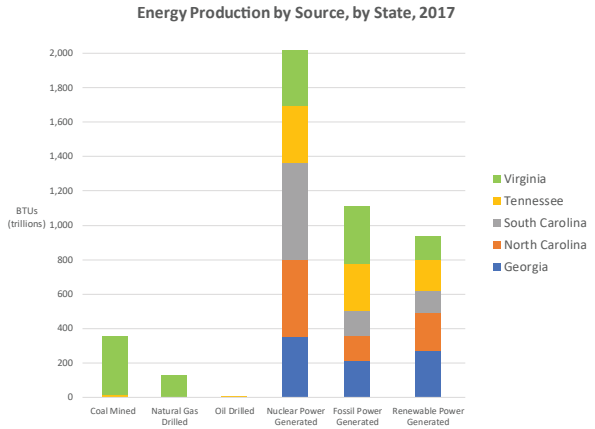
Introduction

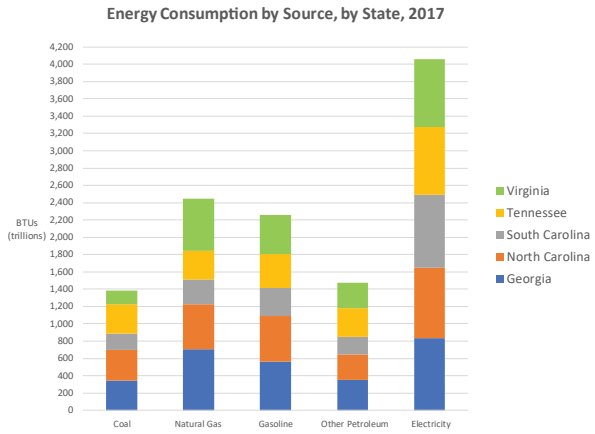
WHY A PATHWAY TO ENERGY INNOVATION LEADERSHIP?

Currently, the United States energy economy is comprised primarily of infrastructure designed to produce and deliver electricity, natural gas, and petroleum products to residential, commercial, industrial, power generation and transportation consumers. In the southeastern United States, electricity generation and transmission are largely undertaken by investor-owned regulated utilities. In addition to regulated utilities, self-regulated electric cooperative and municipal utilities engage in distribution to consumers. No appreciable natural gas or oil production occurs in the Southeast, and regulated interstate pipelines and distribution companies connect the Gulf Coast and Appalachian supply fields with southeastern U.S. natural gas consumers. Petroleum products are delivered by pipelines to terminals, with trucks providing the "last mile" connection to retail outlets. Figure 1 provides estimates on the types and quantities of energy produced and consumed by selected southeast states as of 2017.

The Southeast's energy economy is the largest in the eastern United States and is rooted in traditional energy sources. Yet it is also the most representative of the nation's emerging "clean energy" economy, producing a significant amount of carbon-free power and inventing, designing, building, and manufacturing low and no-carbon energy technology for the world. The Carolinas alone are home to more than 1,000 companies and organizations with an energy interest. Over 100 smart grid companies— the nation's largest concentration—operate in North Carolina's Research Triangle region, according to a 2017 report by RTI International.[2] Nuclear service companies spanning South Carolina and North Carolina make up the nation's largest nuclear service cluster, with about 25,000 employees creating more than $13 billion in annual value, according to a 2013 Clemson University Study.[3] Companies are already making steps toward clean energy innovation, like Dominion Energy, which announced it will create the largest offshore wind project in the United States.[4]

FIGURE 1: ENERGY PRODUCTION AND CONSUMPTION ESTIMATES, BY SOURCE, 2017 [1]

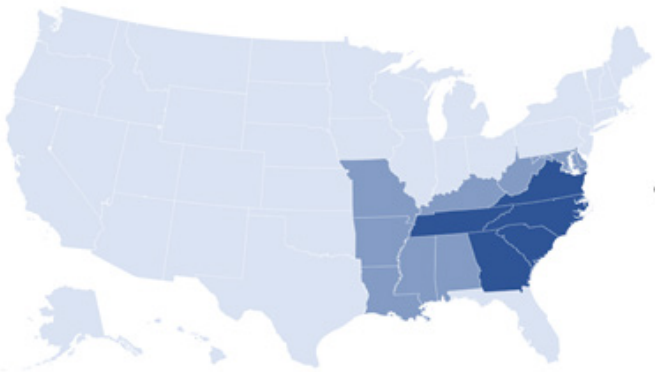




Source: U.S. Department of Energy, Energy Information Administration.

North Carolina also has the second largest solar generating capacity nationally and an extensively developed supply chain supporting national renewable energy operations. In the previously cited RTI International study, North Carolina's renewable energy industry was found to contribute an average of $1 billion to the state's economy, with an average of 12,000 employees, over the 2007-16 study period.[5] Charlotte, with long-established lithium mines to its west, is North Carolina's largest city and one of the nation's energy storage hubs. A multitude of manufacturing, engineering, and construction companies operate from the greater southeastern U.S., building and supplying the world's energy infrastructure.

FIGURE 2: THE SOUTHEASTERN UNITED STATES AND THE FIVE STATES REPRESENTING THE SOUTHEAST ENERGY INNOVATION COLLABORATIVE



As illustrated in Figure 2, and as defined in this report, the southeastern U.S. is comprised of fourteen states, with the energy economy concentrated mainly in five states, which are centered around the Carolinas. The diversity and concentration of energy companies has spurred research at a nation-leading number of southeastern U.S. colleges and universities and supports the existence of three major, non-academic research institutes: RTI International, Electric Power Research Institute & Savannah River National Lab. Those colleges and universities also produce talent for the Southeast's energy industry, which graduate with a broad range of energy degrees and certificates and go on to become members of the energy sector workforce.

Collectively, the energy economy is made up of the following diverse set of entities:

> **Energy Economy:** *The businesses, institutions, and workforce that engage in the production, transmission, distribution, or delivery of energy, or are a consequential provider of products, services, workforce, regulation, capital, or other energy industry necessity.*

This definition incorporates wide range of energy assets from the private, public, research, institutional, nonprofit and advocacy sectors that have the potential to contribute to energy innovation:

> **Energy Innovation:** *The creation and adoption of new products, services, and business models that promote the energy economy by adding new value.*

Yet even with strong industry concentration, as well as significant set of research and innovative activities already occurring, the Southeast's energy economy faces a context whose ongoing changes create challenges that should be viewed as opportunities, if not imperatives, for additional innovation:

- a growing population in many of its urban areas increases the demand for energy;
- an urban-rural divide, where workforce, training, and supply issues are exacerbated in rural areas;
- an aging energy grid and infrastructure;
- shortages in a specialty trained energy workforce;
- budget constraints in local governments and educational and research institutions; and
- the need for collective thinking in the promotion, awareness, and planning among energy leaders.

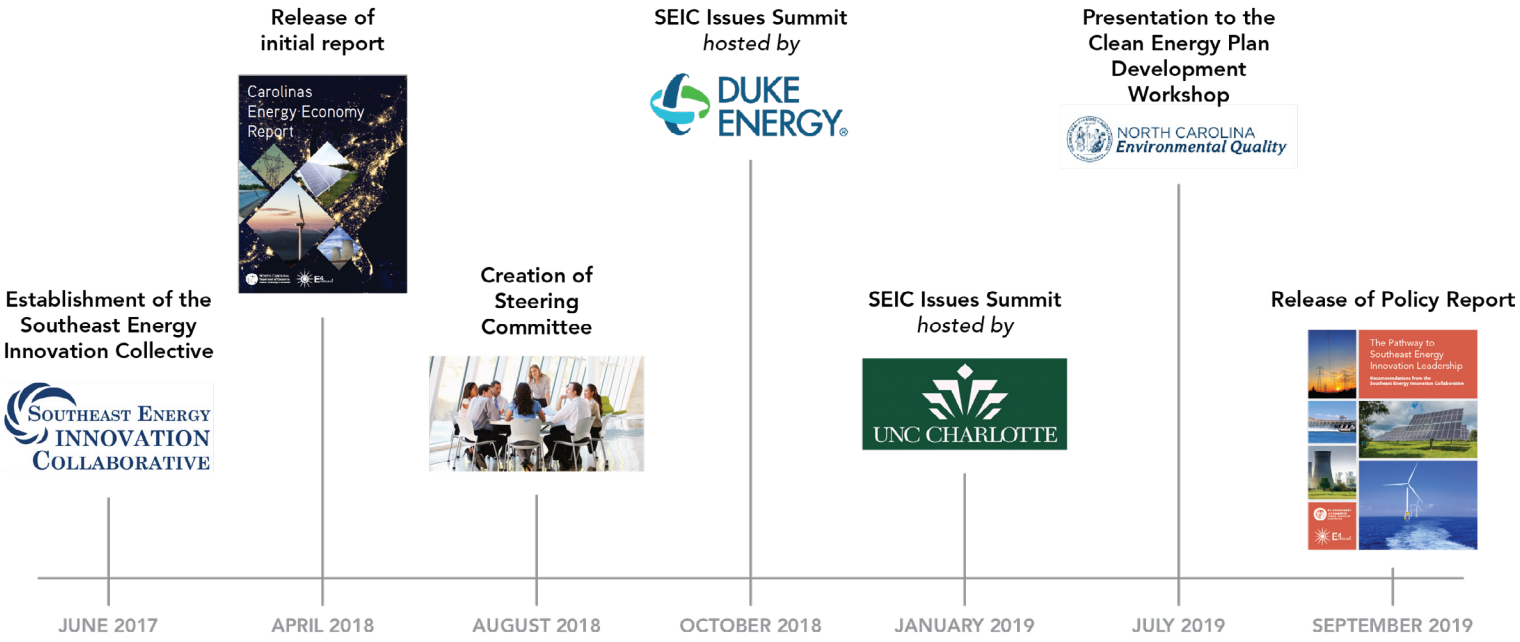
While these challenges and opportunities are not unique to the Southeast, the region's energy innovation ecosystem is uniquely positioned to develop, implement, and model solutions. The southeast region's energy business, research, and advocacy leaders should also recognize the calls for greater energy innovation also being made at the national level.[6]

Recognizing the opportunities, E4 Carolinas and the North Carolina Department of Commerce, Office of Science, Technology, & Innovation joined forces to investigate how the Southeast's energy economy might organize steps to create an energy innovation leadership pathway and, in the process, address these various opportunities, rapidly, efficiently, effectively. Together, along with nearly fifty senior-level professionals from the energy sector across five Southeastern states (listed in the Appendix), they formed the Southeast Energy Innovation Collaborative.

The Collaborative developed a pathway for the Southeastern United States' energy sector to capitalize on its many opportunities, thus establishing it as the national energy innovation leader. This report, The Pathway to Southeast Energy Innovation Leadership: Recommendations from the Southeast Energy Innovation Collaborative, presents the pathway and steps for business leaders and policymakers to implement in order to establish the Southeast's energy sector standing as an innovation leader.

Overview of the Pathway

FIGURE 3: THE ENERGY INNOVATION PATHWAY



On a visit to the University of North Carolina at Charlotte on September 5, 2019, Under Secretary for Science, U.S. Department of Energy, Paul Dabbar, noted "Policy varies with time and interest, but innovation is enduring." The pathway to energy leadership began with a series of preliminary steps. As illustrated in Figure 3, the pathway to energy innovation leadership in the Southeastern U.S. began in June 2017 with the establishment of the Southeast Energy Innovation Collaborative (the Collaborative) as a joint effort between E4 Carolinas and the North Carolina Department of Commerce, Office of Science, Technology, & Innovation. The Collaborative's initial work began in late 2017 with a survey of nearly 250 senior level energy sector officials that yielded three important findings:

1. The Region's energy economy and assets were ranked as very important, but at the same time as not being effectively promoted and leveraged.

2. There was an indirect relationship in size of markets to the Region's assets' leadership within those markets; less influence internationally, but much regionally.

3. The private sector was more bullish on the Region's leadership potential than public sector professionals.[7]

The results indicated that the energy sector leadership believes the Region has the potential to become the national energy innovation leader but lacks a cohesive plan for doing so.

Following the release of the survey in April 2018, the Collaborative formed a steering committee that following August to help guide the actions of its next activities. The steering committee consisted of E4 Carolinas and OSTI staff and four external advisers:

- **Leandre Adifon**, Vice President, Enterprise Systems Engineering and Advanced Technology, Ingersoll Rand—representing technology.
- **Jochen Lauterbach**, Professor, University of South Carolina College of Engineering—representing academia;
- **Jennifer Mundt**, Senior Policy Advisor, North Carolina Department of Environmental Quality— representing state government; and
- **Michael Shore**, Founder & CEO, Tipping Point Renewable Strategies—representing entrepreneurship.

The steering committee met five times over the course of ten weeks to plan how the Collaborative would develop the pathway for attaining energy innovation leadership. A broader stakeholder group was organized, sufficient to represent the Southeastern U.S. energy innovation interests and large enough to undertake the efforts of the Collaborative. More than fifty energy professionals joined the effort (Appendix), representing private, public, and educational/nonprofit-institutions across five states in the Southeastern U.S.: Georgia, North Carolina, South Carolina, Tennessee, and Virginia (the "Southeast," for the purposes of this report).

The Collaborative held its first convening, titled the Southeast Energy Innovation Collaborative "Issues Summit," on October 25, 2018 at Duke Energy's Regional Headquarters in Raleigh, North Carolina. The purpose of this convening was to identify issues keeping the Region from attaining energy innovation leadership and the challenges associated with becoming a leader. Five working groups of Collaborative members (also shown in Appendix) were formed to define issues and develop solutions. Altogether, the working groups identified eight major issue areas for energy innovation within the Southeast, as illustrated in Table 2:

TABLE 2: ISSUE AND SOLUTION AREAS IDENTIFIED BY THE SOUTHEAST ENERGY INNOVATION COLLABORATIVE

ISSUE AREA	SOLUTION AREA
1. Communication and Marketing	1. Branding
2. Entrepreneurship and Investment	2. Entrepreneurship Expansion
3. Metrics and Goals	3. Metrics: Common Reporting Tools 4. Price Signals for Markets
4. Research, Education, and Workforce	5. Industry Inventory/Promotion 6. Community College/University Collaborations 7. Energy Workforce Need/Shortage Assessment
5. Grid Infrastructure	8. Electric Grid Resiliency and Security 9. Integrated Energy Infrastructure Tech Roadmap
6. Policy and Regulation	10. Energy Leadership and Vision Forum Creation
7. Energy Sector Collaboration	11. Energy Sector Collaboration
8. Consumer Awareness and Access	12. Consumer Awareness and Access

Following the Issues Summit, the working groups operated independently for three months to create solutions for the eight identified issues. On January 31, 2019, the working groups re-convened at the University of North Carolina at Charlotte for a "Solutions Summit" to report their solutions and prioritize them for action, producing twelve solution areas (Table 2). A preliminary draft of the solutions was then presented to the North Carolina Department of Environmental Quality's Clean Energy Plan Development Workshop on July 24, 2019.

The steps described below are the result of that months-long process. They are prioritized in recommended order of implementation, mapping out the next steps along the pathway for attaining energy innovation leadership.

First, as detailed in the four steps outlined in Section 1, Initial Steps on the Pathway to Southeast Energy Innovation Leadership, the Southeast will gather and catalogue facts demonstrating its energy innovation assets' strength relative to other areas nationally. All Southeast energy companies, organizations, assets and interests will be inventoried, valued, and compared nationally and globally to demonstrate our leadership potential. Then, to foster an energy innovation culture, a forum for energy leadership and vision will be created to engage policymakers, corporate leaders, academia and other stakeholders. The leadership opportunities identified, as well as key energy economy attributes, will provide the basis for a "brand" and an ongoing promotion program giving our recommendation to pursue a single, significant identity. Throughout this first phase, collaboration within the Southeast energy sector will be promoted to unite the Region on the pathway to energy innovation leadership.

Additionally, as detailed in the steps 2.1 – 2.8 in Section 2, Sustaining Steps on the Pathway to Southeast Energy Innovation Leadership, once the pathway's initial steps are taken, industry-building initiatives will enhance the Region's leadership position. The Southeast Energy Innovation Collaborative will lead efforts in creating standard metrics to monitor the region's key performance areas and leadership status. As commercial activity increases, ensuring a well-trained and mobile workforce will be important to support energy innovation growth. The development of reliable price signals and market indicators will contribute to product and service innovation, increasing the likelihood of commercial adoption. Furthermore, integrated system operations planning will help ensure the Region's energy infrastructure continues to evolve as a technology leader. Entrepreneurship will be elevated within all energy sectors, and energy research and creativity will be channeled into innovation, thereby creating commercial value and increasing the influx of revenue, companies and talent to the Region.

Energy Innovation Spotlights

Under each of the steps outlined below, this report spotlights current examples of business, institution, and research center success stories illustrating the Region's energy innovation leadership. The examples presented, of course, represent only a fraction of the Region's innovators, and this Pathway for energy innovation leadership represents only the beginning of being recognized as a national and global energy innovation leader.

The pathway to energy leadership begins with the initial steps outlined in Section 1 and can be sustained with the recommendations made in Section 2.

1. Initial Steps on the Pathway to Southeast Energy Innovation Leadership

1.1. CREATE ENERGY INNOVATION ASSET INVENTORY

Overview:

The Southeast energy economy is considered to be among the largest in the United States.[8] However, a comprehensive assessment of its size, value, members, clusters, etc., is needed. An assessment of the overall size, key players, etc., is necessary for driving better-informed policy and business decisions.

Recommended Action:

Develop a comprehensive, online, publicly available energy industry inventory to catalog the energy assets across the Southeast that will allow industry members to better find and collaborate with each other and allow others outside the Region to access our services, products, and assets, resulting in increased revenues, jobs, venture creations, and company relocations.

Implementation Details:

- **The Value:** Assessing the energy industry's scope and key players will spur greater innovative activity within the industry, as such information is useful to policymakers, business leaders, entrepreneurs, and energy advocates.
- **Organization(s):** Currently, E4 Carolinas maintains a database of Carolina energy companies and organizations. This database will be expanded, validated, and then used to identify and connect organizations engaged in energy research, innovation, new product and service development, new venture creation, financing, and energy innovation support. Other Southeast energy association databases will also be utilized in this process.

Expected Outcomes:

- **Expanded Knowledge:** The inventory will catalog all energy innovation assets in the Southeast and help the Region's energy stakeholders stay connected and informed.
- **Creation of a Widely Accessible Tool:** Such an inventory vastly reduces the cost and time of finding energy-related assets and collaborators and ensuring market relevance for innovations.
- **Broadened Community and Expanded Communications:** The inventory will include researchers, technologists, government, capital providers, and other professionals from the private, public, research/university, and advocacy sectors.
- **Greater Industry Understanding:** Information on energy assets will change over time, and such changes which will indicate strengths, weaknesses, and successes in the energy sector. This time-series information should drive case studies and provide strategic input to both public and private entities.
- **Greater Innovation and Partnerships:** Ultimately, the directory will provide important information relevant for entrepreneurs, energy researchers, businesses, government officials, and energy advocates in providing an overall estimate of the energy-related industry landscape (and its gaps), with details on every energy innovation asset in the inventory.
- **Information for Local Action:** Once completed, the inventory could be used several ways: to identify existing clusters or create new ones; as a key input into clean energy planning, zero emission vehicle planning, workforce assessment and economic development, and the NC Zero Emission Vehicle Infrastructure Plan; in supporting NC Department of Commerce Clean Energy and Clean Transportation Workforce Assessments; and to support efforts such as E4 Carolinas, the Research Triangle Cleantech Cluster, and others to drive venture capital, green banks, etc.[9]

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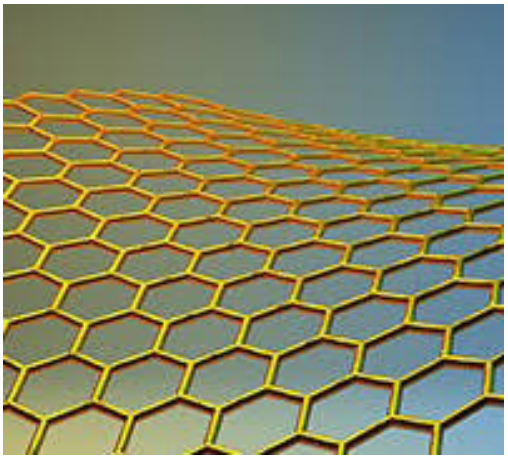
nuscalepower.com

NuScale Power is developing a new modular light-water reactor to supply reliable and abundant carbon-free nuclear energy. Its groundbreaking small modular reactor (SMR) design features a fully fabricated power module capable of generating 60 MW of electricity using a safer, smaller, scalable version of pressurized water reactor technology. NuScale's SMR technology is ideally suited across diverse platforms including base load electricity, load-following support for renewables, very high-reliability micro-grids, and process heat or steam for district heating, desalination, and other industrial uses.

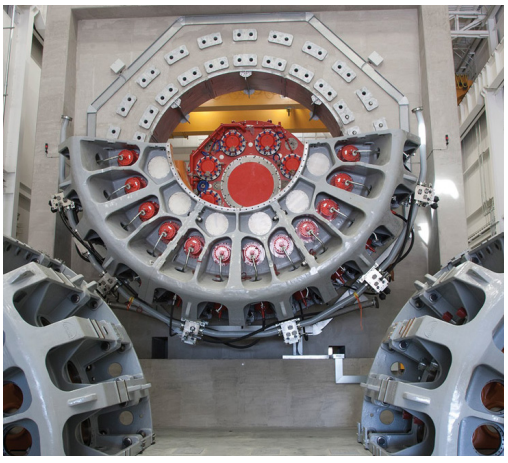


OAK RIDGE
National Laboratory

Oak Ridge National Library

energy.gov/orem/cleanup-sites/oak-ridge-national-laboratory

Oak Ridge National Laboratory (ORNL) is the nation's largest multi-program science and technology laboratory. ORNL's mission is to deliver scientific discoveries and technical breakthroughs that will accelerate the development and deployment of solutions in clean energy and global security. Today, ORNL pioneers the development of new energy sources, technologies, and materials and the advancement of knowledge in the biological, chemical, computational, engineering, environmental, physical, and social sciences.



CLEMSON
UNIVERSITY

Clemson Wind Turbine Test Facility

clemsonenergy.com

At more than three stories tall, the Clemson Wind Turbine Test Facility's 15-megawatt wind testing dynamometer is the centerpiece of Clemson University's SCE&G Energy Innovation Center in North Charleston, South Carolina. Made of steel and concrete, the unique test instrument measures more than 20 feet wide. Researcher's bolt prototype nacelles to it and then simulate wind and other stress loads to which these turbines may be subject in the field. Much of the world evolving wind turbine technology has earned Clemson's stamp of approval to move forward.

1.2. ESTABLISH A FORUM FOR ENERGY LEADERSHIP AND VISION

Overview:

Despite what are nation-leading assets, the Southeast is not yet recognized as an energy innovation leader. Leadership by energy policymakers, government officials, executives and companies will be necessary to elevate the Region's energy innovation stature nationally.

Recommended Action:

Establish a forum of energy sector leadership (private and public) that will shape policy and long-term plans for creating and sustaining energy innovation within the Region. This forum's aim will be creating the vision to drive priorities rather than allocating new funds. This will be the responsibility of a very large number of public and private entities. The effort will be ongoing, even after the Region's energy innovation leadership is recognized.

The forum will create an entity or initiative to sustain the Region's advantage of energy innovation leadership and benefits, including the Region's low cost of energy, decreasing cost of renewables, numerous emerging energy technologies, increasing need for energy infrastructure resiliency/sustainability and others. Innovation occurring at the Region's universities, research institutes and technology companies will be connected with entities both in and outside the Region that are commercializing such innovations and with the Region's policymakers who determine which innovations are most useful and cost effective for consumers. The Region's competitive positioning will be dynamic, and stakeholders will be informed on a sustained basis on its advantages, need for repositioning, change in visibility, etc.

Implementation Details:

- **The Value:** Energy policy leaders, state and regional agency officials, economic development professionals, energy company executives, and academics will unify to promote and support the Region's energy leadership assets and formulate a plan for sustaining energy sector innovations.
- **Organization(s):** Governor's office/administrations, State Legislatures, Utility Commissions, Energy Policy Councils (and like agencies), State Departments of Commerce, energy associations, private sector energy executives, and other relevant economic development agencies.

Expected Outcomes:

- **"Dream team" of Energy Leaders:** Built from senior professionals from all energy sectors and interests, this leadership forum will foster the communication and collaboration to advance energy innovation.
- **Roadmap Built on Shared Visions:** Energy sector leadership will develop a regional innovation roadmap with everyone at the table.
- **Greater Innovation Leadership Visibility:** Several advanced energy technology demonstrations should be developed in the Region through public, academic and private partnerships coupled with appropriate demonstration incentives.
- **Greater Advancements in Innovation and Policy:** All assets will be incorporated into the appropriate state, regional, county and metropolitan economic development and attraction initiates to serve as a catalyst for market development, recruitment, jobs creation and retraining.

Central Carolina Community College

cccc.edu/sustainability

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

Dominion Energy

dominionenergy.com

Dominion Energy, Columbia, SC and Smithfield Foods have teamed up to convert biomass into renewable energy. Align Renewable Natural Gas (RNG)[SM] is their new company that has the rare ability to align the interests of farmers, food processors, neighbors, municipalities, energy consumers, policymakers and indeed the planet by capturing methane before it is released into the atmosphere and, instead, turning it into a valuable clean fuel.

Virginia Polytechnic Institute and State University

ece.vt.edu/research/area/power

Virginia Tech has the largest university-based power electronics research program in the country. The Center for Power Electronics Systems is a former NSF Engineering Research Center and has more than 70 industry partners. The Future Energy Electronics Center is noted for its technology for PV and EV inverters that achieve greater than 99 percent peak efficiency. Coal and renewable energy are also research focus areas.

1.3. FOSTER ENERGY SECTOR COLLABORATION

Overview:

Energy innovation stakeholders can be better aligned and aware of the Region's technology companies and energy research universities and institutes. Collaboration to create an energy innovation ecosystem of national caliber has not reached its potential.

Recommended Action:

Identify all companies, institutions, and government bodies participating in the Southeast's energy sector, including generation, distribution (transmission/delivery systems), measurement (efficiency), consumption (consumers), support (supply chain and service companies), and regulation. Once completed, the information should be organized to help identify clusters that already exist and/or where they can be created.

Development clusters typically offer market intelligence that cluster members can't easily access alone. The increased familiarity among cluster members and the deeper understanding of each other's businesses allows for members to identify collaborative business opportunities. Similarly, the inclusion of technology companies and research universities and institutes in the cluster creates the opportunity to identify research and development opportunities on which to collaborate. Giving a cluster a formal identity makes it more easily understood by academia and potential workers, thus increasing the cluster's access to talent. Likewise, supply chain members can more readily define their role and will be more forthcoming with services and products as the cluster offers scale. Members of the cluster offer each other increased access to experts on critical or special topics through the network of the cluster's stakeholders. Cluster members can more readily explore, understand and assess new ideas, using various members as an informal consulting collaborative. Business development can be undertaken collaboratively through the attraction and organization of trade missions to the Region to highlight the cluster's products and services.

Implementation Details:

- **The Value:** Quantitative analysis will produce knowledge about the existing energy sector, and assets will drive specific initiatives around collaboration and deficiencies that need to be boosted.
- **Organization(s):** The Region's numerous energy associations, research organizations, selected colleges, and universities.

Expected Outcomes:

- **Identification of Energy Asset Clusters:** By use of the Energy Innovation Asset Inventory described above, asset clusters will be identified and assessed to determine whether enough commercial concentration exists to become a national or global leader and warrant organization of an economic development cluster. If clusters with commercial potential exist, stakeholders of the potential cluster will be convened to determine their interest in organizing and supporting a cluster.
- **Greater Collaboration:** The Region's existing economic development organizations and its energy associations promoting economic development will collaborate in the cluster identification process. Upon identification of the Region's promising energy clusters, the appropriate energy association will take responsibility for fostering energy sector collaboration related to that cluster.
- **Increased Value of Energy Sector Assets:** Making the Region's energy innovation stakeholders aware of all energy assets in the Region, so they can easily find research, entrepreneurship, technology development, commercialization and other type of collaboration partners, will increase the likelihood of the Region producing new and additional energy intellectual property, technology and ventures. The engagement of organizations to foster and sustain such collaboration will further increase the likelihood of value creation.

PHDS© Gamma Ray Imaging Detectors

PHDS Co.

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PHDS Co. develops and manufactures HPGe gamma-ray imaging detector systems. PHDS Co. has partnered with the National Laboratories, the U.S. Department of Energy, military laboratories, and several universities to develop commercially viable products that improve germanium-detection technologies that are now at a significant point in commercialization.

PROTERRA

Proterra

proterra.com

Proterra is rapidly reinventing the transit industry with its Catalyst® battery-electric vehicles designed and manufactured in Greenville, South Carolina. Communities across North America have put these high-performance buses to the test through more than 8 million miles of service. Designed from the start as an exclusively electric vehicle, the Catalyst delivers exceptional route flexibility and proven operational performance, with the greatest range of any zero-emission, battery-electric bus in its class.

GE Energy

GE Power

ge.com/power

GE has become one of the world leaders in the application of fuels containing hydrogen in gas turbines. The use of hydrogen as a gas turbine fuel has been demonstrated commercially, but there are differences between natural gas and hydrogen that must be taken into account to properly and safely use hydrogen in a gas turbine. GE's broad field experience enables our engineers to understand the impact of using hydrogen as a gas turbine fuel.

1.4. INCREASE ENERGY INNOVATION BRANDING

Overview:

Because the Southeast is made up of diverse energy interests, finding common brand themes is challenging, as there are many qualities which could be promoted. Many facts supporting the Region's leadership exist, but not as a single leadership profile. Government, business and academia do not have a coordinated message regarding the Region's energy economy and state of energy innovation. Our energy leaders have national visibility, but not a comprehensive energy innovation leadership message to promote. Nor do our economic development professionals have proper information with which to promote the Region's energy innovation leadership.

Recommended Action:

Develop a branding based on compelling, fact-based successes and accomplishments highlighting topics in energy policy, research and commercial leadership.

Implementation Details:

- **The Value:** The stories will have multiple purposes and audiences. Each story will be used to convince those within the Region of the clusters' value and opportunity for collaborative value creation. They will also be used to convince those outside the Region to avail themselves of cluster member products and services, engage with cluster members in research and locate in the Region to accelerate their growth. These stories will be valuable to cluster members wishing to promote their products and services outside the Region and to economic development professionals in supporting recruitment and development initiatives.

- **Organization(s):** The Region's numerous energy association, technology companies and research organizations.

Expected Outcomes:

- **Unified Branding for the Southeast Energy Sector:** A unifying brand will be crafted that appeals to a broad audience and is easily communicated and shared.

- **Increased Marketing Power for Energy Sector Players:** This initiative will require the engagement and input of stakeholder representatives of the Region's energy economy and the brand will be one that all regional energy economy members may incorporate into their own marketing and communications programs.

Georgia Tech Strategic Energy Institute

energy.gatech.edu

Georgia Tech is playing an integral role in developing the technologies that are enabling companies worldwide to make better, cleaner decisions about how they generate, distribute, and use energy. Scientists at the Georgia Tech Strategic Energy Institute are not just helping to create cleaner, more efficient fuel options or mitigate the environmental impact of conventional energy supplies, they are creating better performing, more economically viable energy options and tracking systems.

Strategic Power Systems, Inc.

spsinc.co

Strategic Power Systems provides its customers industry-leading data analytics to allow them to understand how their running Reliability and Availability stacks up with their "peers." SPS customers operate some of the most sophisticated facilities and complex technologies in the world. SPS helps operators understand how their performance compares with the fleet. Data is abundant in power facilities and competitive markets place a premium on "good data."

NetPower

netpower.com

Using a patented thermodynamic cycle called the Allam Cycle, NET Power is able to generate lower-cost power from fossil fuels than existing power plants while eliminating all air emissions, including carbon dioxide. Additionally, the CO2 that NET Power plants generate from burning fuel is produced as a high-pressure, high-quality byproduct, ready for pipeline transportation and storage. In many places, this CO2 can be sold for use in enhanced oil recovery (EOR), permanently sequestering the CO2 and providing significant added value for NET Power plant owners.

2. Sustaining Steps on the Pathway to Southeast Energy Innovation Leadership

2.1. BUILD COMMON METRICS AND REPORTING TOOLS

Overview:

Relevant energy innovation regional data is available and includes the following: workforce demographics; talent information (such as undergraduate/graduate degrees in STEM fields, community college graduates, etc.); grants and investment capital available to support energy innovation growth; intellectual property creation; and energy production, imports, consumption, efficiency, emissions, etc. Metrics to tie data to energy innovation provide measures of where the Region stands nationally or globally with regard to energy innovation and whether it is advancing. Standard metrics, if existing, could be used to promote a single story and create a unified voice of the Region's energy innovation leaders.

Recommended Action:

Develop a standard set of metrics for all private and public sector organizations to track and report regarding identified energy innovation-related measures. Knowing the Region's strengths and weaknesses, and the use of standard measures, is important to ensure that all players are on the same page for defining the Region as an energy innovation leader. Once energy innovation leadership is established, creating metrics and goals by which status and growth are measured become important. Government data analytics could be important data sources to leverage for this action.

Implementation Details:

- **The Value:** The key implementation item to explore is the possibility for better collection and aggregation of data from various reporting tools across many different organizations to create a systemized and integrated view of business trends pertaining to energy innovation. Implementation will first require agreement by the Region's stakeholders of the energy innovation leadership goal and objectives, and then the metrics by which progress is measured. Implementing this recommendation will be a significant undertaking, in large part due to the agreement on goals and objectives that must first be obtained and then the permissions to access the various information sources.

- **Organization(s):** A single entity for the Region or perhaps coordination of single entities within each state in the Region will be appropriate for implementing this solution. These entities will most likely be governmental, to provide consistency and continuity.

Expected Outcomes:

- **Increased Awareness:** Data from the metrics will advise those implementing various energy innovation solutions the result of their efforts and on how those efforts may need to be modified. The data will also provide input for branding and marketing programs.

- **Increased Possibilities:** A greater, more complete, and fully transparent set of data and a better understanding of trends will allow for increased possibilities to improve energy innovation.

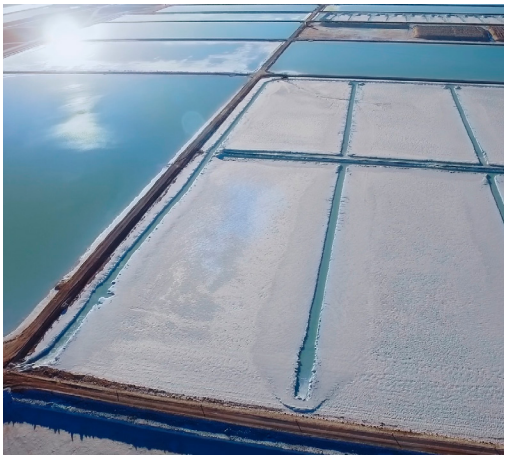
- **Increased Innovation and Competition:** Data that is available to all players in the market makes the markets more competitive and encourages innovation.

NC COMMUNITY COLLEGES
CREATING SUCCESS

North Carolina Community College Foundation

nccommunitycolleges.edu/foundation

Grants from the Duke Energy/Piedmont Natural Gas Community College Grant Program are awarded to North Carolina community and technical colleges in Duke Energy's or Piedmont Natural Gas' service areas. The grants are open to community colleges throughout the state for registered apprenticeship and pre-apprenticeship programs designed for new and incumbent workers, preferably within the manufacturing industry, giving students hands-on experience and giving businesses access to a pipeline of skilled workers.

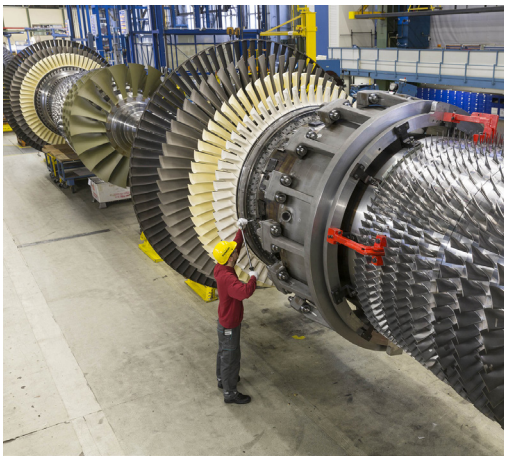


ALBEMARLE®

Albemarle Lithium

albemarle.com/businesses/lithium

Albemarle is the industry leader in lithium and lithium derivatives, one of the highest growth markets in the specialty chemicals industry. Albemarle controls a diverse and high-quality network of natural resources that are geographically situated in low-risk environments with good infrastructure. Albemarle possesses a deep and broad process technology expertise that has grown in scale with recent acquisitions.

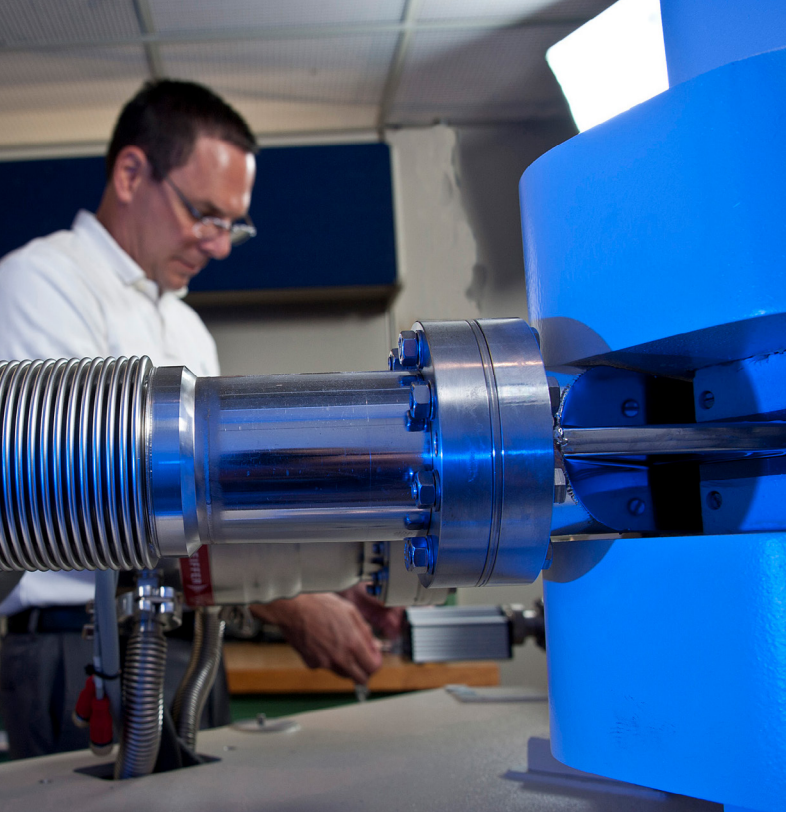


SIEMENS

Siemens

new.siemens.com/us/en.html

Siemens' new HL-class, the next generation of larger air-cooled gas turbines can attain industry-leading combined-cycle operating efficiency of nearly 65%. These turbines are also designed to plug-in to Siemens digital offering via connectivity to MindSphere, the company's open, cloud-based operating system for the Internet of Things. And, the HL-class produces 25% more power output, doubles maintenance frequency and has the operating flexibility to load-follow renewable energy production.



2.2. ASSESS ENERGY WORKFORCE NEEDS

Overview:

The Southeast has several education institutes (high schools, community colleges and universities) producing energy workforce members. Several types of energy-related employers report challenges in hiring the 'right workers', highlighting the opportunity for more efficient distribution of the workforce. Opportunities existing for better aligning the existing and growing energy workforce with industry needs, as is evidenced in recent studies.[10]

Additionally, research has suggested there may not be enough training opportunities (such as internships, apprenticeships programs, etc.) and/or new workers are not experienced enough to adequately enter the energy workforce.[11] Factors contributing to this energy workforce issue are believed to include the following: the Region's technical workforce is smaller than demand, with energy being a segment of this; both workforce members and employers have a bias toward four-year degrees versus technical degrees, which reduces the number of high school students who choose to pursue energy careers; high school, community college and university career counseling is largely unaware of the opportunity and compensation offered by the Region's energy innovation and technology opportunities; the Region's "technology qualified" workers leave for places where technology innovation is promoted; and the Region lacks organized internship and apprenticeship programs to engage prospective energy workforce members.

Recommended Action:

Assess the unmet labor needs for energy employers across the Carolinas region through the following or comparable steps:

- **Define and Assess the Supply of the Energy-Workforce:** "Suppliers" of the energy-workforce which educate, train, and certify energy-related workers will be identified and their capacity for producing energy workers and their actual production determined.
- **Define and Assess the Demand of the Energy-Workforce:** "Demanders" of the energy-workforce (all companies and organizations identified in the Energy Innovation Asset Inventory, as well as an expected growth rates based on historical statistics) will be identified and their current and future need for energy workers and satisfaction of that need determined.
- **Define and Assess the Need/Shortage of the Energy-Workforce:** Following the assessment of the supply and demand for the workforce, unmet need or over supply will be quantified by at least geography (by state, urban vs. rural, economic status, demographic status, etc.); private sector vs. public sector; specific energy sectors or business types; job types; and education and training requirements.

To support the Region's energy innovation leadership, the workforce needs of current energy employers must be understood. The needs identified must be met and the Region must become regarded as a highly desirable location for energy technology trades, professions and innovators. The Region's energy economy will be properly supported and its energy innovation leadership better positioned to be promoted.

Implementation Details:

- **The Value:** The result of this study will provide facts that training and education organizations may invest in curriculum and facilities. Energy employment sectors, geographies, and companies will be identified with which the education organizations may partner. Policymakers and government officials will have facts upon which to base the allocation of resources and initiate the creation of programs.
- **Organization(s):** State agencies familiar with workforce and/or energy-related workforce assessments (such as the North Carolina Department of Commerce and North Carolina Department of Environmental Quality).

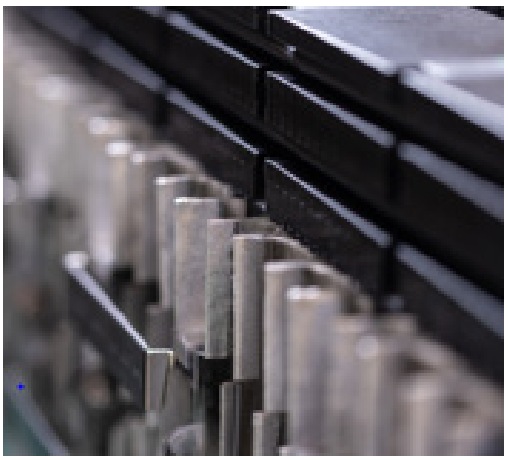
Expected Outcomes:

- **Workforce Supply and Demand Estimates:** This effort will determine the Energy-Workforce Supply (including "suppliers" and current supply) and Demand (including "demanders" and current demand).
- **Workforce Shortage Estimate:** By combining the data from the Supply and Demand estimates, the need/shortage in the energy-related workforce (including information on who, what, where, why, and how to the extent of the need/shortage) can be derived to:
    - Drive policy decisions about responding to the shortage of an available workforce.
    - Develop guidelines/knowledge base for future decision making.
- **Significant Value to be Added:** By determining the need/shortage, this information will increase the communication and coordination between the "suppliers" and the "demanders" of the energy-related workforce.

ABB

new.abb.com

ABB offers a full range of transportation electrification solution for DC and AC applications containing switchgear, protection and control equipment. ABB's diverse power portfolio for rail and urban transport solutions is complemented by electric vehicle charging solutions, ranging from AC wall boxes to fast-charging DC stations for buses.



Fuel Cell Enabling Technology, Inc.

fcet-inc.com

FCET is an applied engineering and technology company utilizing nanoscale film technology to extend the life, reduce the cost, and increase the performance of solid oxide fuel cell systems ("SOFCs"). The core of FCET's technology, and the foundation of FCET's advantage, is its unique highly conductive electrolyte film that allows our SOFCs to operate at very low temperatures, thereby drastically reducing the total system cost, among other benefits.

EnergyXchain, LLC

energyxchain.com

Siemens' new HL-class, the next generation of larger air-cooled gas turbines can attain industry-leading combined-cycle operating efficiency of nearly 65%. These turbines are also designed to plug-in to Siemens digital offering via connectivity to MindSphere, the company's open, cloud-based operating system for the Internet of Things. And, the HL-class produces 25% more power output, doubles maintenance frequency and has the operating flexibility to load-follow renewable energy production.

2.3. SUPPORT ENERGY INNOVATION WITH MARKET SIGNALS

Overview:

Commercializing a new or innovative energy technology is difficult. Several barriers inhibit adoption, including availability of substitutes, economies of scale, capital requirements, switching costs, and, occasionally, government policy. This recommendation encourages energy innovation by improving consideration of innovative technologies in energy planning processes and encouraging accurate price signal information about benefits and costs. This will allow for new technologies to compete and deliver economic and environmental value for customers and the utility, aiding technology commercialization.

Recommended Actions:

Improve energy planning processes to consider how innovative technologies can provide multiple values and encourage accurate price signal information. For example: Smart inverters can provide frequency and voltage stabilization for power produced by grid-scale solar generation Additionally, energy storage can likewise provide multiple services; frequency and voltage control, and deferral of transmission or distribution investments.

- Evolve utility planning processes to enable analysis of innovative solutions like customer Distributed Energy Resources (DER) programs and non-wires solutions (such as software or energy efficiency technologies) as alternatives to traditional investments.
- Develop a method for providing accurate price signal information for end-user and utility-level service providers within the region so that new technologies can be commercialized. Such information could include:
  - Utility rates reflecting actual location and/or time-specific conditions and cost of delivering specific services. This would drive optimization of customer-side energy use and technology to support both utility and customer value.
  - Location-specific information on the value of services and transmission and distribution challenges within electric and natural gas markets that can be developed into actionable pricing information for evaluating alternatives, procurement, incentives and regulatory filings.

Many innovative energy technologies can provide potentially valuable services and products but either don't enter the market or enter the marketplace at a disadvantage because those commercializing the technology lack information about the value of providing specific energy services or lack explicit valuation of the services they provide. Many of these services are bundled in the price signals that consumers in the Southeast face today.

Implementation Details:

- **The Value:** Initially, baseline static price signals will be developed that could be planned against in ratemaking or procurement processes. Eventually, these will become real-time values through dynamic rates and/or something like the GridLAB-D platform, which is a simulation and analysis software that provides information to users designing and operating energy distribution systems.[12] This could be accompanied by an application interface, website, newsletter, or other efficient platform for relaying energy sector price signal information.
- **Organization(s):** State agencies will likely be appropriate for obtaining and relaying the information. Utilities and/or the Public Utilities Commissions may also be appropriate champions for this recommendation.

Expected Outcomes:

- **Increased Adoption of Innovative Technologies:** Price signal information creates a more competitive marketplace by bringing new technologies to the Region's energy infrastructure.
- **Increased Efficiency:** Proper market signals allow capital to be more efficiently invested, and increased new technology adoption results in greater energy efficiency.[13]
- **Greater Technological Development:** A more competitive landscape, with regularly updated price signal information, will foster a market for new, innovative energy technologies creating value for all energy economy stakeholders.

Joules Accelerator

joulesaccelerator.com

Joules Accelerator enables the growth of high-potential clean energy startups by facilitating training, mentoring and access to utilities, customers and key industry players through the bi-annual Catalyst Program based in Charlotte, N.C. Since its 2013 founding, the accelerator has supported the creation of over 100 jobs, $18 million in investment, and ten pilot projects. Joules does not take equity in startups, and does not charge for the application process or participation in the program. Companies selected to participate in the Catalyst Program have all expenses covered during the events.

PhosphorTech

phosphortech.com

PhosphorTech offers a wide range of materials and optoelectronic technologies. These include LED phosphors, nanocrystals, color conversion films, as well as specialized LED devices and lamp fixtures for a wide range of applications. With help of U.S. Department of Energy Small Business Innovation Research (SBIR) funding, PhosphorTech has developed customized new photonic materials and color conversion films by fine-tuning their properties to achieve optimal performance metrics for lighting, imaging and display products.

Goldfinch Sensor Technologies and Analytics, LLC

goldfinchsta.com

Goldfinch Sensor Technologies and Analytics identifies and solves problems of complex networks and their security. Goldfinch understands and employs electromagnetics and statistical signal processing to address two very common problems; signal detection and signal classification. For signal detection, it employs methods such as constant false alarm rate (CFAR) detectors, computed receiver operating characteristics (ROC) on VLF EM, RFID sensors, and microwave problems. In signal classification, Goldfinch uses joint-time frequency analysis, pattern matching, signal strength compression algorithms, and artificial neural networks.

2.4. DEVELOP INTEGRATED ENERGY INFRASTRUCTURE TECHNOLOGY ROADMAPS

Overview:

Since the early 1900s, the nation's electricity and natural gas transmission and distribution systems have been successful in their primary mission: delivering reliable and affordable energy from central production to end use customers. Recent technology innovations, the rise of discrete, distributed electric generation (DER), and the development of locally and organically produced natural gas place new demands on our distribution systems. Distributed energy resources may require grid planning to evolve from hourly to sub-second increments to fully maximize how innovations support the grid. A modernized, and transparent, modeling of transmission and distribution value and behavior is needed to provide a foundation for energy innovation in the Region.

Energy resource planning within just the past few years has become very complex and of interest to a wide range of stakeholders. The process previously considered the prudent cost of delivering competitively priced, reliable energy from used and useful facilities. Among recent, new considerations are carbon emissions, resiliency, data analytics, cyber security, consumer choice, aging infrastructure, DER integration and "electrification." The cost or "affordability" of energy, centrally produced and locally delivered, has long been the predominant driver of value determination. The way in which cost is balanced against the other factors, especially the emerging factors, will affect how or whether our overall valuation of utility infrastructure drives adoption of innovative technology at scale.

Recommended Action:

State governments in the Region should work with utility providers to:

- Prioritize modernized infrastructure planning via an integrated resource planning algorithm, and
- Provide support for robust Integrated System Operations Planning (ISOP)-enabling technology (e.g., software).

The Southeast should prioritize modernized utility infrastructure planning via an integrated resource planning algorithm and provide support for robust ISOP-enabling technology. This increased prioritization, combined with the necessary enabling technology, will equip the Region to maximize energy innovation via its transmission and distribution infrastructure and value it appropriately. The Region should develop analytical methodologies and frameworks for improving business models that can deliver to consumers the value and benefits of transmission and distribution modernization at an appropriate price.

Implementation Details:

- **The Value:** State utilities commissions would open "generic" dockets, direct parties to convene and seek consensus on ISOP next steps, and then take comments from parties about any disagreements, after which the commissions would issue orders suggesting next steps.
- **Organization(s):** State Utilities Commissions, utility providers, distributed energy resources (DER) advocates, original equipment manufacturers (OEMs), and software developers who could help inform the entire stakeholder group about what is possible from a software perspective.

Expected Outcomes:

- **Greater Productivity:** For utility providers, enhanced transmission and distribution infrastructure will improve valuation, pricing, and optimization of energy resources across the Region to enable increased automation, increased distributed intelligence, improved reliability, enabling of voltage control, accommodation of two-way power controls, and increased hosting capacity.
- **Increased Customer Satisfaction:** For utility customers, this recommendation will enable the continuation of reasonable rates, improved reliability, safety, and resiliency, and should meet or exceed customer expectations.
- **Increased Opportunities for Innovation:** This recommendation will increase opportunities to enhance current transmission and distribution assets and help develop new business opportunities.

AVANTech Inc.

avantechinc.com

AVANTech supplies superior quality water, wastewater and wet-waste treatment equipment that is custom tailored to meet energy industry facility standards and performance requirements. AVANTech's products are designed and built to meet the rigorous standards of the U.S. nuclear industry. The company's engineers and technical staff has extensive experience working with commercial and government facilities to solve complex process and fabrication problems. AVANTech's capability was demonstrated when it was called on to "save" the disabled Fukushima nuclear plant.

University of North Carolina at Chapel Hill

unc.edu

North Carolina is home to the second largest installed solar generating capacity in the United States. But its researchers are looking beyond the capability of photovoltaic. UNC Chapel Hill is home to a US Department of Energy (DOE) Energy Frontier Research Center where researchers are working to develop "solar fuels". These are liquids which efficiently store the sun's energy for transport and use in various locations and times.

Atom Power, Inc.

atompower.com

Goldfinch Sensor Technologies and Analytics identifies and solves problems of complex networks and their security. Goldfinch understands and employs electromagnetics and statistical signal processing to address two very common problems; signal detection and signal classification. For signal detection, it employs methods such as constant false alarm rate (CFAR) detectors, computed receiver operating characteristics (ROC) on VLF EM, RFID sensors, and microwave problems. In signal classification, Goldfinch uses joint-time frequency analysis, pattern matching, signal strength compression algorithms, and artificial neural networks.

2.5. FOSTER ENERGY ENTREPRENEURSHIP

Overview:

The Southeast produces a respectable amount of new energy ventures, products and services, and may already be a leader in certain sectors. However, what is not known, but may result from the Energy Innovation Asset Inventory, is understanding how the Region performs regarding energy entrepreneurship. Regardless of the Region's leadership standing, the sense of the Region's energy innovators is that our potential is not being attained.

Recommended Action:

Develop an energy entrepreneurship task force to organize a study of the Region's energy entrepreneurship. The Task Force study would be designed to understand the strengths, opportunities, and gaps related to the Region's energy entrepreneurship. The Task Force would include universities, investors, utilities, large energy companies, incubators, and energy entrepreneurs. All of the Region's energy entrepreneurship stakeholders would be surveyed with regard to the Region's attributes and needs. Other regions and their energy entrepreneurs would be studied to learn from their best practices. From this study the Region would gain a clear understanding of its strengths and gaps, along with ideas from outside the Region for fostering increased energy entrepreneurship.

Implementation Details:

- **The Value:** Several important questions should be answered by the Task Force, including the following:
  - Does the Region lack ideas?
  - Does the Region lack the connection of ideas and implementers?
  - Do aspiring entrepreneurs lack an understanding of how to commercialize their idea?
  - Is the Region not attractive to energy capital providers?
  - Does the Region invest too little in research and development?
  - Does the Region's industry make-up or structure hinder entrepreneurship?
  - Is there a lack of corporate support for early stage ventures?
- **Organization(s):** E4 Carolinas, the North Carolina Office of Science, Technology & Innovation, other state and regional economic development agencies would direct the efforts of the Task Force.

Expected Outcomes:

- **Identified Champions for Energy Innovation:** Support of energy entrepreneurship is key to the Region sustaining a national or global reputation for energy innovation. This activity will be ongoing and part of the Region's energy innovation culture and will consistently draw from energy sector leadership.
- **Identification of Energy Innovation Assets:** Upon completion of the inventory phase of the Energy Innovation Asset Inventory, energy entrepreneurs and the Region's entrepreneurship assets may be identified and then surveyed and studied.

Duke Energy

duke-energy.com

In Hot Springs, North Carolina Duke Energy will proceed with a solar and battery-powered micro-grid system that will help improve electric reliability, provide services to the overall electric system and serve as a backup power supply to the town of more than 500 residents. The micro-grid will consist of a 2-megawatt (AC) solar facility and a 4-megawatt lithium-based battery storage facility to provide a safe, cost-effective and reliable grid solution for serving for Hot Springs' customers, as well as provide energy and additional bulk system benefits for all customers.

Savanah River National Laboratory

srnl.doe.gov

The Savannah River National Laboratory, part of the United States Department of Energy and located in Aiken, SC, is a world leader in developing means to cleanup nuclear contaminated groundwater and soils, the development of hydrogen as an energy source, and the safe management of hazardous materials. With over 50 years of technological achievement, the laboratory identifies, develops and deploys innovative technologies to meet the needs of the region's, nation's and world's energy community and stakeholders.

OneH2

oneh2.com

OneH2, headquartered in Hickory, NC, has created and commercialized a hydrogen refueling system. Its solution is mobile, scalable and requires no customer infrastructure or long-term contracts. OneH2's mobile system delivers hydrogen fuel ready for "immediate use" - already converted to high-pressure gaseous fuel, taking only minutes to dispense. Telemetry monitors customer use and schedules the next fuel delivery and fueling unit replacement, ensuring fuel continuity.

2.6. ENSURE TRANSMISSION AND DISTRIBUTION SYSTEM RELIABILITY, RESILIENCE, AND CYBER AND PHYSICAL SECURITY

Overview:

The existing electric grid is susceptible to hazardous conditions (hurricanes, ice storm, etc.), physical attacks, cyber intrusions, line losses, transmission congestion and equipment failures. The electric grid's reliability, resiliency and security may be improved through the utilization of strategically implemented micro-grids, combined heat and power (CHP) installations, renewable energy sources, battery storage, energy efficiency initiatives, use of alternate fuel resources, electric vehicles and emerging new technologies, services and practices. As electricity becomes increasingly important and coal ceases to be a significant power generation fuel, the natural gas transmission and distribution infrastructure becomes increasingly important to the Southeast. The quality of the Region's electric and natural gas utility transmission and distribution infrastructure is emblematic of the quality of energy innovation leadership existing in the Region and should be superior to other Regions.

Recommended Action:

Begin building, maintaining, and systematically upgrading the Region's electric and natural gas transmission and distribution infrastructure to assure that its reliability, resiliency, and security meet the long-term health, safety and economic needs of its customers. To assure that the infrastructure modernization is both accepted and acceptable, a comprehensive stakeholder involvement process including all stakeholders of a utility regulatory jurisdiction should occur.

In those regulatory jurisdictions where a modernization initiative is undertaken, utilities can consciously collaborate with technology developers to showcase the Region's energy innovation leadership. Accordingly, the reliability, resilience and security of these transmission and distribution systems will be key indicators of the Region's energy innovation leadership. The Region's energy producers and distributors should be provided enough incentive to predict, prevent, mitigate and alleviate damage from transmission and distribution threats and hazards.

Implementation Details:

- **The Value:** Energy and utility infrastructure interdependence (petroleum, natural gas, transportation, communications, water/wastewater) can create cascading negative impacts on the Region's economy and the well-being of its citizens when utility service fails. Transmission and distribution modernization will require the identification of actions for improvement, their prioritization, appropriate funding, and attainable milestones. To achieve this goal, the Region should address the enhancement of current utility regulations; cost-benefit of transmission and distribution outage mitigation versus recovery expenses; impact on customers and the economy; and the overall economic benefit.

- **Organization(s):** Electricity producers and electricity and natural gas distributors serving the Region, utility commissions, and others as identified as pertinent. In addition to the respective utilities and their regulatory oversight entities, their residential, commercial and industrial rate-paying customers, and other interested citizens and/or agencies should be engaged in the process.

Expected Outcomes:

- **An Energy Innovation Showcase:** The Region's electric and natural gas transmission and distribution innovators and technology providers will have the opportunity to locally showcase their technology. Maintaining the nation's most reliable, resilient, and effective transmission and distribution infrastructure will be a testament to the Region's energy innovation and contribute to the marketing and branding programs promoting the Region's leadership.

- **Greater Security and Resiliency:** A more reliable and secure electric natural gas transmission and distribution infrastructure that is better protected from natural and man-made hazards, and one whose resiliency is much improved and quicker to "heal itself."

- **Greater Cooperation:** Maintaining a comprehensive utility transmission and distribution modernization process which specifically considers reliability, resilience and security and is applicable to all areas in the Region will require private and public collaboration, regulatory support, and appropriate incentives.

2.7. DRIVE COLLABORATION BETWEEN COMMUNITY COLLEGES AND UNIVERSITIES

Overview:

The Southeast has a nation-leading number of public and private universities and institutes engaging in energy research. Academically, the Region's universities produce energy professionals and its two-year colleges produce a large number and variety of technologists and skilled trade workers, all of whom enter the Region's energy sector. However, it appears that given the disparities in energy innovation in the public-private sectors and rural-urban landscapes, community colleges and university systems are not collaborating to the extent they could to optimize energy innovation. Disparities appear to exist geographically, economically and organizationally about various institution's understanding of the need to address energy research problems and produce related energy industry talent, as well as the development of intellectual property and talent geared toward supporting and accelerating the Region's energy innovation leadership.

Recommended Action:

Create collaborations to better foster innovative activities between community colleges and universities across the Southeast. Three specific actions where community colleges and universities could better align to advance innovation within the broader energy industry are recommended:

1. **Determine Relevant Players:** All two-year and four-year colleges and universities in the Region should be analyzed regarding their conduct of energy research or their graduation of energy professionals, technologists of skilled trade workers. Research institutes should be analyzed only for the energy research interests. All producers of energy research or talent should be included in a single inventory and that inventory made searchable by various attributes.

2. **Increase Communication:** Improve communication between community colleges and universities in order to gain a better understanding of each other's energy research efforts, grants, relevant administrative action, and academic programs. Possible solutions include:

    - **Tech Transfer Process Education –** A forum should be created whereby each institution producing energy intellectual property explain for the others their technology transfer process. Opportunities for collaboration, increased product and service commercialization and new venture creation could be explored by all. Additional parties, including technology companies, entrepreneurs, policymakers, utilities and capital providers should be invited to participate in the forums.

    - **Energy Academic and Research Directory –** A universal and periodic publication or online directory of the Region's energy research and academic assets should be developed and maintained.[14]

    - **Curriculum Directory –** An online, publicly available, comprehensive directory of all community college and university energy curricula should be made accessible to prospective students and parents, academic counselors and employers.

    - **Workforce Training Opportunities Directory –** Such a mechanism would help identify and promote the training opportunities for workforce participants, along with any state offers and incentives for subsidizing the cost of education. The directory would also be useful for energy businesses as a means of finding skilled workers.

3. **Increase Opportunities for Collaboration:** Opportunities for collaboration in support of the Region's energy industry and energy innovation should be made in various ways. Two are described here:

    - **Energy Industry Job Fairs –** Two-year and four-year colleges and universities that graduate students prepared for energy industry service would collaborate in producing periodic job fairs at which prospective employers would meet with prospective graduates and alumni of programs appropriate for the energy industry and with academic leaders to discuss how curricula might be better designed to meet industry needs.

    - **Energy Industry Conferences –** A variety of energy conferences are held in the Region. Conference content could serve as a means of educating academics of energy industry issues and the conferences also provide a convenient gathering point for academia and industry to meet.

Implementation Details:

- **The Value:** Fostering collaborations between community colleges and universities will optimize their programs and research, better align the requirements of their tech transfer processes, and highlight the important, innovative work they are doing. The energy economy will benefit from a higher quality workforce and more targeted energy intellectual property.

- **Organization(s):** A state agency (or agencies) or an energy trade association with a focus on workforce, energy, and/or technology may be an appropriate lead for these recommendations. Further, to publicize media and convene meetings, community colleges and universities may be appropriate partners for conducting such tasks.

Expected Outcomes:

- **Expanded Information and Communication:** Highlighting and explaining the research, programs, and processes of community colleges and universities relevant to the energy sector should better inform research and academic stakeholders on resource allocation

- **Increased Collaborations:** The greater the knowledge/information on community colleges and universities, the greater the opportunity for them to work together and the greater access to their energy graduates and intellectual property by industry.

2.8. INCREASE CONSUMER ACCESS AND AWARENESS

Overview:

Consumption of energy products and services is the ultimate gauge of successful innovation. The Southeast is at a slight disadvantage to other regions as a result of its success in producing low-cost, highly reliable energy for its consumers, as cost is typically a prime driver of innovation. However, instances of increasing adoption are evident, in part due to non-economic reasons such as personal choice in style or concern for the environment. Availability of innovation is sometimes uneven geographically, as economies of scale for offering a product or service may only exist in urban areas. However, a major barrier to attaining scale for the delivery of many innovative energy products and service is thought to be awareness of the energy consumption, the cost of a customer's current energy usage, the alternatives to that energy consumption available and the value of employing an alternative. There is no single source of such information and gaining the knowledge, confidence, and financial ability to employ a new alternative is likely a barrier to adoption for many consumers. Additionally, energy consumption data is often relayed to consumers several weeks after consumption, giving consumers a historic look at usage trends versus a current look. Optimum adoption of innovative energy products and services would provide the greatest value to consumers and demonstrate the Region's energy innovation leadership position.

Recommended Action:

Develop a multi-prong initiative to drive residential, commercial and industrial consumer awareness around innovative solutions in real time. The initiative will provide a better picture of customer-based needs and wants based on existing research and recent events to drive the following:

- Educate and provide to residential customers a concise roadmap of better energy utilization and innovative products that addresses economy, the environment and convenience.
- Develop an incentive-based approach either through community recognition and/or financial incentives for commercial and industrial consumers to become more responsible for their energy decisions.

Implementation Details:

- **The Value:** Residential commercial and industrial consumers will gain information and resources by which they may become more responsible for their energy decisions and better influence the cost, environmental impact and convenience of their energy use.
- **Organization(s):** The North Carolina Department of Environmental Quality, relevant organizations from other participating states within the Region, regional/state Departments of Commerce, Transportation, Housing and Urban Development, Agriculture, etc., and market research from Duke Energy. State and local governments should also develop financial plans around public housing and school systems by understanding their energy needs and proposing various implementations and corresponding incentives.

Expected Outcomes:

- **Increased Understanding:** Understanding of current consumption patterns and costs and alternative product and service value, state and local governments can develop plans for public housing, school districts, government buildings and facilities and, perhaps, consider updating or including energy management and consumption criteria and planning and zoning regulations and building code specifications.
- **Increased Awareness and Adoption:** Interpreting and communicating survey results to a wide variety of stakeholders along with appropriate education programs will allow consumers to better satisfy their objectives and lead to greater innovation adoption.

Conclusion

The energy sector is fundamental to the Southeast's economy, and innovation is fundamental to driving any economy. Respondents to the 2017 survey, and the energy professionals who engaged in issue identification and then solution planning during 2018-19, strongly believe the Southeast can become a national energy innovation leader and realize the multitude of associated benefits. This document describes a pathway by which the Southeast may attain energy innovation leadership.

To become a leader, the Southeast must first inventory, quantify and assess its energy innovation assets. The Region's leadership attributes and potential must be factually quantified and better employed to identify leadership opportunities, connect innovators, and promote increased access by energy innovators in and outside the region. At the same time, Southeast government, business, and academic leaders must collectively agree upon and promote goals to attain energy innovation leadership. This document does not identify specific implementers for various Pathway "steps," but rather calls upon companies and other volunteers to lead, if energy innovation leadership is to be attained. With the Region's assets identified and leaders aligned, a new brand will emerge to support the Region's leadership pursuit.

The second series of steps in the Pathway expand and sustain the Energy Innovation Leadership initiative. Metrics to measure success will be created and assessed, and market signals necessary to support the Region's energy economy workforce developed and monitored to guide the initiative's progress. The Region's energy infrastructure will be employed as an energy innovation technology showcase and its reliability and resilience will become a testimony of the Region's superiority. Entrepreneurship—highly correlated with innovation—will become a key ingredient to fueling the Region's energy industry growth and national and global leader leadership will become apparent.

Funding for some of these steps will be necessary, and states and corporations will need to invest. However, the amounts are not extraordinary, and some steps in the Pathway will qualify for federal and foundation funding support. Policy is not necessary to support the Pathway, but in some instances could accelerate leadership attainment. The Pathway's steps are not extraordinary or far outside the steps that organizations and companies now pursue. The key is coordination, cooperation, persistence, focus on the leadership goal, and several of the Region's companies and organizations taking responsibility for the steps prescribed along the Pathway.

This Pathway will enable the Southeast to become the nation's energy innovation leader.

Appendix

SOUTHEAST ENERGY INNOVATION COLLABORATIVE MEMBERS

	FIRST	LAST	TITLE	COMPANY	CITY, STATE
GROUP 1	Sarah	Adair	Principal Environmental Specialist	Duke Energy	Raleigh, NC
	Beth	Clark	Business Development Manager US & Canada	Blue Sphere Corp.	Charlotte, NC
	Thad	Culley	Regional Director	Vote Solar	Raleigh, NC
	Nate	Harrill	Attorney	K&L Gates	Raleigh, NC
	Tim	Lewis	AVP | Regional Director	Lime Energy	Charlotte, NC
	Ryan	Miller	Executive Director	NC Building Performance Association	Raleigh, NC
	Keyes	Niemer	Senior Vice President	Atkins, Member, SNC-Lavalin Group	Charlotte, NC
	Michael	Shore	Founder & CEO	Tipping Point Renewable Strategies	Asheville, NC
	Richard	Simmons	Director, Energy Policy & Innovation	GA Tech Strategic Energy Institute	Atlanta, GA
	Christopher	Wedding	Chief Executive Officer	IronOak Energy	Chapel Hill, NC
	Wayne	Wilkins	CEO	Energy United	Charlotte, NC
GROUP 2	Leandre	Adifon	VP, Enterprise Systems Eng. & Adv.Tech.	Ingersoll-Rand	Davidson, NC
	Zach	Ambrose	Principal	Ambrose Strategy	Raleigh, NC
	Lee	Ball	Chief Sustainability Officer	Appalachian State University	Boone, NC
	Damian	Beauchamp	Principal and Chemist	8 Rivers Capital	Durham, NC
	Lori	Collins	Principal	Collins Climate Consulting	Charlotte, NC
	Paul	Fisher	Chairman	C3-FCET	Alpharetta, GA
	Timothy	Fratta	CEO	Carolina Solar Services	Durham, NC
	David	Kaiser	A.D., Office of Science, Tech. & Innovation	NC Department of Commerce	Raleigh, NC
	Ward	Lenz	Managing Director	NC Sustainable Energy Association	Raleigh, NC
	Jennifer	Weiss	Senior Policy Associate	Duke University Nicholas Institute	Durham, NC
	Thad	Wingo	Business Development & Project Manager	BMC - BM Engineering	Charlotte, NC
GROUP 3	Don	Dracon	Vice President, Business Development, Power	AECOM/URS	Ft. Mill, SC
	John	Hardin	Ex. Dir., Office of Science, Tech. & Innovation	NC Department of Commerce	Raleigh, NC
	Nick	Justice	Executive Director	Power America	Raleigh, NC
	Luis	Martinez	Senior Attorney, Director of Southeast Energy	Natural Resources Defense Council	Asheville, NC
	Ian	Perrin	Vice President	Structural Integrity Associates	Huntersville, NC
	Kevin	Poet	Head, Charlotte Energy Hub	Siemens	Charlotte, NC
	Susan	Sanford	Executive Director	Research Triangle Cleantech Cluster	Raleigh, NC
	Jill	Sorensen	Director	SCRA Entrepreneurial Programs	Summerville, SC
	Chris	Vlahoplus	Partner	ScottMadden	Raleigh, NC
	Michael	Youth	Associate General Counsel	NC Electric Membership Corporation	Raleigh, NC
	Russell	Duncan	Program Manager	NC Dept of Environmental Quality	Raleigh, NC
GROUP 4	Emil	Avram	Vice President, Innovation	Dominion	Richmond, VA
	Dionne	Delli-Gatti	Director, Southeast Clean Energy	Environmental Defense Fund	Raleigh, NC
	Steve	Kalland	Executive Director, Clean Energy Tech. Center	NC State University	Raleigh, NC
	Jochen	Lauterbach	Professor	University of South Carolina	Columbia, SC
	Bence	Oliver	Chief Financial Officer	Windlift	Raleigh, NC
	Gary	Rackliffe	Vice President, Smart Grids N.A.	ABB	Raleigh, NC
	Rocky	Sease	Chief Executive Officer	SOS Intl	Charlotte, NC
	Michael	Teden	Principal	The Whitehall Group	Charlotte, NC
	Alan	Thomas	Vice President, Innovation & Development	Framatome	Lynchburg, VA
	Kwame	Yeboah	Vice President, Energy Service Group	ProGlobal Partners	Raleigh, NC
GROUP 5	George	Baldwin	Principal	Baldwin Consulting Group	Waxhaw, NC
	John	Camilleri	Chief Technology Officer	Green Energy Corporation	Durham, NC
	Scott	Carlton	President	Tokai Carbon USA	Charlotte, NC
	David	Dalton	President / CEO	General Microcircuits	Charlotte, NC
	Thomas	DelViscio	Strategic Account Executive	Lime Energy	Durham, NC
	Bob	Irvin	Executive Director	Joules Accelerator	Charlotte, NC
	David	McGowan	Executive Director	NC American Petroleum Council	Raleigh, NC
	Mark	McIntire	Director, Environmental Policy & Affairs	Duke Energy	Raleigh, NC
	Greg	Monty	Dir, Center for Energy Research & Technology	North Carolina A&T	Greensboro, NC
	Star	Hodge	Program Manager	NC Dept of Environmental Quality	Raleigh, NC
	Ron	Schoff	Sr. Program Manager - Technology Innovation	EPRI (Electric Power Research Inst.)	Charlotte, NC
	Ronak	Bhatt	Principal	RIN Advisors	Charlotte, NC
	David	Doctor	President & CEO	E4 Carolinas	Charlotte, NC

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