



North Carolina Jobs Project

A Guide to Creating Advanced Energy Jobs

A Letter from the American Jobs Project

It's no secret that America's middle class is in crisis; indeed, "the hollowing out of the middle class" has become a well-worn phrase, causing politicians to rail, bloggers to rage, and citizens to reel. Polls consistently reveal that jobs and the economy are at or near the top of citizen concerns.¹ Over the last few decades, the loss of middle-income jobs in America has been due largely to the global shift in manufacturing ("tradable jobs") to emerging economies.² Of the millions of jobs lost during the recession, most were good-paying, middle-class jobs.³ Unfortunately, many of the jobs created during the recovery have been in low-skill, low-paying occupations.⁴ These trends are not going to reverse themselves. Leadership is needed, but the gridlocked U.S. Congress has failed in recent years to adopt robust policies to stoke middle-class jobs in America.

In President George W. Bush's autobiography, *Decision Points*, the former president recounts a conversation he had with the then-President of China, Hu Jintao. "What keeps you up at night?" President Bush asked President Hu as an ice-breaker. As we can easily guess, what kept President Bush up at night was worry about terrorism. Hu Jintao's response was telling: what kept him up at night was, "creating 25 million new jobs a year" for his people.⁵

Is it possible to create good-paying American jobs in today's global economy? And what if the solutions did not involve Congress at all? What if there were creative middle-class job creation strategies being developed and tested in the laboratories of democracy—the states and cities? The American Jobs Project seeks to answer these questions and provide a research-based roadmap for action for state and local leaders who are kept up at night trying to figure out how to create jobs for the people they serve.

Our quest starts with identifying the biggest market opportunity of our era: the global demand for advanced energy solutions. That demand—whether borne out of a need for diverse, reliable and clean power or to achieve energy independence from unstable regimes—creates "the mother of all markets" for local U.S. businesses to build and sell those solutions.⁶ Strategically minded businesspeople looking at global growth projections in advanced energy demand are making major investments and reaping large revenues. In 2014, the private sector reported \$1.3

trillion in global advanced energy revenues, the fastest growing year on record.⁷ Advanced energy investments are now bigger than the global apparel sector and almost four times the size of the global semiconductor industry.⁸ And jobs? Up to 16.7 million jobs are projected to be in the global advanced energy sector by 2030, almost tripling the 5.7 million people employed in the sector in 2012.⁹ The question for the United States is: Where will those new jobs be created?

The American Jobs Project is about finding ways to make our states the answer to this question. If countries across the globe, including the U.S., are seeking technical products and solutions for our growing energy needs, how can U.S. businesses take advantage of this demand and build products locally that can be exported to the world? And how can we equip U.S. residents with the skills those businesses need to build their advanced energy products?

It is true that the U.S. will not likely be able to attract back the traditional manufacturing jobs of the past; those jobs are gone—either to low-wage countries or to automation—and we have to accept the fact that they are not coming back.¹⁰ But our research shows that with innovative policies and a smart focus on industrial clusters, states can become hubs of innovation and job creation in specific advanced industries that soar with a state's strengths.

The American Jobs Project gives policymakers the tools to create good-paying jobs in their states. We propose innovative solutions built upon extensive research and tailored to each state. Many are best practices, some are new, and all are centered upon a state's business ecosystem. These solutions are written with an eye towards streamlining bureaucracy and are seasoned with the principles of competition, local control and fewer regulations.

If these recommendations are adopted, the beneficiaries will be those hard-working Americans looking for the dignity of a good-paying job.

Table of Contents

Acknowledgments	6
Executive Summary	10
Summary of Policy Recommendations	
North Carolina’s Energy Profile	16
Chapter 1: Introduction	18
Market Opportunity	
Economic Clusters	
Jobs Potential	
Report Structure	
Chapter 2: Utility-Scale Battery Technology	23
Utility-Scale Batteries and the Grid	
Strengths, Weaknesses, Opportunities, and Threats for Utility-Scale Batteries in North Carolina	
Utility-Scale Battery Market Trends	
Utility-Scale Battery Manufacturing	
Utility-Scale Battery Supply Chain	
North Carolina’s Potential for Battery Jobs	
Policy Recommendations	
Chapter Summary	
Chapter 3: Biogas	43
Strengths, Weaknesses, Opportunities, and Threats for Biogas in North Carolina	
Biogas Market Trends	
Biogas Technology	
Biogas Technology Supply Chain	
North Carolina’s Potential for Biogas Jobs	
Policy Recommendations	
Chapter Summary	

Chapter 4: Innovation Ecosystem and Access to Capital	63
North Carolina's Innovation Ecosystem	
Access to Capital	
Policy Recommendations	
Chapter Summary	
Chapter 5: Workforce Development	75
Workforce Development Strengths	
Utility-Scale Batteries: Jobs and Skills Needed	
Biogas: Jobs and Skills Needed	
Policy Recommendations	
Chapter Summary	
Conclusion	89
Appendix: Economic Impact Methodology	90
References	93

About us

American Jobs Project

The American Jobs Project is a national, interdisciplinary, research-based initiative. Our team has included nearly 100 student researchers with a broad range of expertise, including law, business, engineering, and public policy. We have ongoing relationships with hundreds of on-the-ground stakeholders and are actively collaborating with university partners and industry allies.

N.C. Clean Energy Technology Center

The N.C. Clean Energy Technology Center is a University of North Carolina (UNC) System-chartered Public Service Center administered by the College of Engineering at North Carolina State University. Its mission is to advance a sustainable energy economy by educating, demonstrating, and providing support for clean energy technologies, practices, and policies. The center provides services to businesses and citizens of North Carolina for the development and adoption of clean energy technologies. The center utilizes programs and activities to promote clean energy in ways that stimulate a sustainable economy, while also reducing dependence on foreign sources of energy and mitigating the environmental impacts of fossil fuel use.

Acknowledgments

This report would not be possible without the support of the JPB Foundation, the Berkeley Energy and Climate Institute, the Fung Institute, the Center for Information Technology Research in the Interest of Society, and the N.C. Clean Energy Technology Center at North Carolina State University.

We extend sincere gratitude to the dozens of individuals from business, government, nonprofits, and universities for meeting with us, exploring ideas, participating in working groups, collaborating on the report, and sharing their vision for the future. Many thanks to Steve Kalland, Isaac Panzarella, and Kate Daniel of the N.C. Clean Energy Technology Center for their tireless support and collaboration. Additional thanks to the following people for their gracious input and assistance: Bob Leker of the North Carolina Department of Environmental Quality, Jeff Gates of Alevo, Gus Simmons of Cavanaugh & Associates, Lee Anne Nance of the Research Triangle Cleantech Cluster, Tanja Vujic of the Environmental Defense Fund, and Ivan Urlaub of the North Carolina Sustainable Energy Association.



We are grateful to the following experts for their collaborative efforts:

Ted Abernathy, *Economic Leadership, LLC*

Bill Brown, *8 Rivers Capital*

Dr. Scott Ralls, *Former President of the North Carolina Community College System*

Michael Haley, *Wake County Business Development*

Ronak Bhatt, *E4 Carolinas*

Jim Simpson, *North Carolina Chamber of Commerce*

Christa Wagner Vinson, *Office of Energy & Sustainability, City of Charlotte*

Matt Raker, *Mountain BizWorks*

Sara Lawrence, *RTI International*

David Hollars, *Centralina Workforce Development Board*

Martin Cavanaugh, *Cavanaugh & Associates*

Jay Lucas, *North Carolina Public Staff*

Sam Watson, *North Carolina Utilities Commission*

Zach Ambrose, *Ambrose Strategy*

Gene Upchurch, *Consultant*

Angie Maier, *North Carolina Pork Council*

Pat Davis, *Orange Wastewater*

Tom Butler, *Butler Farms*

Mike Rowand, *Duke Energy*

Mike Williams, *North Carolina State University*

Mark Rice, *North Carolina State University*

Charles Adair, *Duke Carbon Offsets Initiative*

Robin Aldina, *North Carolina Sustainable Energy Association*

Gale Boyd, *Duke University*

Bill Capp, *Grid Storage Consulting*

Audrey Choi, *Morgan Stanley*

John Classen, *North Carolina State University*

Wade Fulghum, *North Carolina State University*

Cassie Gavin, *Sierra Club*

Katherine Heller, *RTI International*

Jim Kennerly, *Sustainable Energy Advantage, LLC*

Jim Little, *E4 Carolinas*

Ryke Longest, *Duke University Law School*

Luis Martinez, *Natural Resources Defense Council*
Lee Mazzocchi, *Duke Energy*
Betsy McCorkle, *Southern Strategy Group North Carolina*
Jonas Monast, *Duke Law School*
Matt Roberts, *Energy Storage Association*
Gudrun Thompson, *Southern Environmental Law Center*
Tom White, *North Carolina State University*
Heather Youngs, *Energy Biosciences Institute, University of California, Berkeley*
Scott Schotter, *Alevo*
Chris Carmody, *North Carolina Chambers for Innovation and Clean Energy*
Daniel Vermeer, *Duke University*
Ravi Manghani, *GTM Research*
Jeffery Cramer, *38 North Solutions*
Helen Chananie, *Duke University, Sanford School of Public Policy, student*
Del Ruff, *North Carolina Center for Afterschool Programs*
Brian Buzby, *North Carolina Conservation Network*
Joshua Bar-Lev, *Consultant*
Gary Gereffi, *Duke University*
Lewis Milford, *Clean Energy Group*
Christy Marcinkowski, *North Carolina Sustainable Energy Association*
Heather Calderwood, *North Carolina State University*
Mike Whitson, *PCG Solar*
Brian Raichle, *Appalachian State University*
Jeff Tiller, *Appalachian State University*
Jack Floyd, *North Carolina Public Staff*
Brad Atkinson, *North Carolina Department of Environmental Quality*
Cyrus K. Dastur, *Advanced Energy Corporation*
John Moth, *Power America, North Carolina State University*
Emmit Owens, *Research Triangle Cleantech Cluster*
Donna Robichaud, *QF Solutions, LLC*
Helene Cser, *North Carolina State University*
Kacey Hoover, *North Carolina Sustainable Energy Association*
Patrick Kastian, *GACC West*



Patrick Serfass, *American Biogas Council*

Sam Brake, *North Carolina Department of Agricultural and Consumer Services*

Morry Cater, *Cater Communications*

Jim Verdonik, *Ward and Smith, P.A.*

Dozens of hands were involved in the process of researching, writing, and designing this report. The lead researcher and writer was Kate Ringness, the lead editor was Stephanie Smith, the lead analyst was Henry Love, and the graphic designer was Amariah Baker. Other contributors include Tiffany Wong, Rachel Young, Brian Mick, Andrew Herrmann, Peter Florin, Ben Cotts, Karl Walter, and Matt Nguyen.

Executive Summary

The American Jobs Project was borne of two tough problems: loss of middle-class jobs in the United States and congressional paralysis. It seeks to address these problems by taking advantage of one of the biggest market opportunities of our era—the advanced energy sector—and to do so at the state, not the federal level. Policymakers who leverage the unique strategic advantages of their state to grow localized sectors of interconnected companies and institutions are poised to create quality jobs.

As a result of the state’s skilled labor force, world-class universities and research facilities, and strong manufacturing and engineering sectors, North Carolina is in a prime position to benefit from the growing demand for advanced energy. As of the end of 2015, the state boasted nearly 1,000 clean energy businesses that provide more than 26,000 full-time equivalent (FTE) jobs to North Carolinians.¹¹ A strong advanced energy economy has already taken hold in North Carolina and the sector is growing. From 2012 to 2015, employment in the clean energy industry increased from 15,200 to 26,000 FTE positions, representing an annual increase of 24 percent.¹² Leveraging this momentum to serve growing regional, national, and global markets would offer significant benefits for North Carolina’s economy and provide good-paying jobs for the state’s residents.

Extensive research and more than ninety interviews with local stakeholders and experts in North Carolina have resulted in identifying two economic sectors showing particular promise: utility-scale batteries and biogas.

There are several barriers hindering North Carolina’s advanced energy industries and preventing supply chains from reaching full potential. North Carolina must address these roadblocks to grow the state’s advanced energy sectors and realize economic gains. To take full advantage of these opportunities, North Carolina’s leaders can enact policies to increase demand for utility-scale batteries and biogas technology and to help the state’s businesses grow, innovate, and outcompete regional, national, and global competitors. Indeed, with the right policies, North Carolina can support over 19,000 jobs per year through 2030.

This project serves as a research-based roadmap for state and local leaders who seek to develop smart policies that leverage North Carolina’s resources to create skilled, good-paying jobs. The number of jobs created is highly dependent on action taken by state and local policymakers. Concerted effort at the state and



local levels can create an environment that attracts advanced energy businesses to take root in North Carolina. Employees in the advanced energy sector will spend their earnings in the local economy at grocery stores and restaurants, and those local establishments will need to hire additional staff to satisfy demand. This creates a multiplier effect throughout North Carolina's economy, where a single dollar spent in a community circulates through local businesses and their employees numerous times.

Summary of Policy Recommendations

The analysis presented in this report culminates in four thematic sets of recommendations for North Carolina's leaders. Each set of recommendations identifies opportunities for barrier removal and future growth in the utility-scale battery and biogas sectors. While the recommendations are intended to be complementary and would be powerful if adopted as a package, each can also be viewed as a stand-alone option. These recommendations chart a course for North Carolina policymakers to create and enhance jobs in the advanced energy sector.

Utility-Scale Batteries

Properly Define the Value Utility-Scale Batteries Add to the Grid:

The most significant barrier for the utility-scale battery industry is accurately valuing the multitude of services that batteries provide to the grid. The North Carolina Utilities Commission (NCUC) could establish a proper valuation method in order to demonstrate that energy storage is economically and technically feasible. Based on its feasibility, the NCUC could require utilities to include energy storage in their Integrated Resource Plans, signaling to manufacturers that North Carolina is ripe for investment.

Require Cost of Service Transparency: Utility-scale batteries can provide the grid with flexibility on a minute-by-minute basis, yet this value is currently undiscoverable due to the scale of data available. The NCUC could require all utilities to disclose sub-hourly pricing information, which is actively collected but inaccessible to industry. Transparent costs could allow the utility-scale battery industry to better demonstrate the feasibility and potential cost savings of deployment, enabling the proper valuation of energy storage.

Enhance Cost Recovery by Utilities: Pilot projects for utility-scale batteries must be large-scale in order to accurately demonstrate the value of the technology, increasing the financial and regulatory burden for utilities. To enable more pilot projects, the NCUC could authorize utilities to lease equipment from battery

companies and recover costs of the lease from ratepayers, ultimately saving a large capital expense. Alternatively, the legislature could increase the amount that utilities are permitted to recover from ratepayers without additional review.

Provide Refundable and Transferrable Tax Credits for Battery Manufacturers and Installers: Tax credits are an important support mechanism for businesses. However, income tax credits are only valuable to entities that have a tax liability (i.e., taxable profits). Thus, most new and expanding companies are unable to take advantage of them due to slow profit growth or large capital investments. The legislature could allow a franchise tax exemption or an income tax credit for in-state businesses engaged in the manufacturing or installation of utility-scale batteries and related equipment. The income tax credits could be refundable and transferrable to allow companies to benefit from the incentive immediately. By stimulating in-state manufacturing and installation, North Carolina could secure good-paying local jobs.

Biogas

Create a North Carolina Biogas Public-Private Partnership: Misinformation and lack of understanding about the costs and benefits of anaerobic digestion hinder market growth in the state. North Carolina's governor's office could create a targeted biogas public-private partnership (the "Partnership") with the NC Bioenergy Council and the Economic Development Partnership of North Carolina to help cultivate strong leadership, educate policymakers, foster strategic public-private relationships, and identify opportunities for growth. Once formed, the Partnership could recruit foreign direct investment, streamline the project development process, focus on farmer education, and create an aggregate purchasing agreement with equipment manufacturers in order to foster industry growth.

Exempt Biogas Projects from Property Tax: Capital investments, such as an anaerobic digester and associated equipment, significantly increase the value of farms. However, a major barrier to these upgrades is that farms' tax liabilities increase according to the improved value of their property, negatively impacting the economics of the investment. To encourage project development, North Carolina policymakers could offer property tax exemptions to properties installing new biogas or waste-to-energy equipment. The legislation could provide fifteen to twenty years of abatements in order to give farmers and developers the certainty and stability they need to invest in projects.

Establish a Loan Program for Biogas Projects: Due to large upfront costs of biogas projects, low-cost financing is critical to creating



favorable project economics. Given the economic potential and public health benefits of capturing methane from waste, the state government could consider creating a streamlined loan program for biogas projects by issuing low-rate bonds using a guarantee under the Clean Water State Revolving Fund. The North Carolina Department of Environmental Quality could use the revenue from the bonds to establish a loan program dedicated solely to the biogas industry. As loans are repaid, the fund would continue to invest in new projects, cultivating the manufacturing base and attracting good-paying jobs.

Enable the Use of Performance Contracts for Biogas Fleet Vehicles: Alternative fuel vehicle (AFV) fleets allow municipal governments to improve energy security, decrease fuel costs, and stimulate demand for locally sourced fuels. Despite these benefits, barriers such as lack of experience, inability to accurately predict cost savings, limited budget authority, and lack of access to financing and incentives prevent governments from retooling fleets to biogas-powered vehicles. To streamline the retooling process, North Carolina could take advantage of performance contracts. The legislature could expand energy service contracts to include public fleets. Encouraging AFV fleets could provide cost savings, increase local demand, stimulate job growth, and preserve public health in the process.

Create a Carbon Offset Market Aggregator: Biogas projects qualify as carbon offsets because they reduce methane gas emissions. Carbon offsets can improve a project's financial viability and create significant revenue streams for the project developer. However, participation in these markets presents high transaction costs for single players. Carbon offset aggregators reduce this cost burden by pooling offsets from multiple projects. To encourage market aggregation, a private company could establish a public-private partnership with the North Carolina Cooperative Extension or the Natural Resources Conservation Services to facilitate the program. This partnership could leverage existing relationships with the farming community to promote and facilitate the program, expanding benefits to more farms throughout the state.

Allow Third-Party Sales of Biogas-Generated Electricity: Farmers cite barriers such as time, cost burden, and risks associated with feedstock supply as major deterrents of biogas project development. In some states, third-party ownership of biogas systems alleviates this barrier, by allowing farmers to generate energy on their own property without purchasing the energy system outright. Currently, North Carolina does not allow third-party sales of electricity, which effectively prohibits this alternative ownership model. North Carolina policymakers could authorize third-party electricity sales for biogas projects to enable

third parties to develop, own, and sell electricity from biogas projects directly to farmers and nearby customers. Increasing access to biogas technology could help the industry achieve economies of scale and spur in-state demand.

Innovation Ecosystem and Access to Capital

Enable and Promote Equity Crowdfunding: North Carolina has consistently lost out to other states in attracting venture capital investment. To attract private funding for new in-state companies, the legislature could create a securities exemption for equity crowdfunding. Equity crowdfunding is a mechanism for early-stage companies to raise money from a large group of investors by issuing ownership shares through a streamlined process. North Carolina could further support equity crowdfunding by creating an online portal for businesses and investors. These efforts could spur innovation, economic activity, and small business growth by easing the regulatory burden faced by entrepreneurs when raising public funds.

Create Tax Incentives for Investment in Startups: North Carolina's high capital gains taxes are a barrier for investors because they cut into the profit made from investments. Investors are also often reluctant to invest in early-stage companies because of the high level of risk involved. To address this barrier, North Carolina legislators could establish a statewide policy that reduces or eliminates capital gains taxes for investments in targeted early-stage North Carolina companies, such as utility-scale battery and biogas companies. This targeted tax exemption could help attract advanced energy startups to the state by offering support during the technology development and commercialization stages, often called "the valleys of death."

Workforce Development

Improve Industry-Wide Participation in Apprenticeships: Apprenticeship programs provide valuable on-the-job skills, making them an important component of career development and workforce training in emerging industries. However, North Carolina ranked last in the country in per capita apprenticeships. The North Carolina Department of Commerce could improve the quantity and quality of apprenticeships by providing fiscal incentives for participating companies, working directly with employers to tailor program guidelines, collaborating with colleges to create career pathways, and bolstering programs through industry-wide recognition. Increased apprenticeship opportunities could reinvigorate job training and career



exploration for North Carolina students.

Enable Dislocated Veterans to Get Back to Work: North Carolina's veteran population represents a well-trained and motivated sector of the workforce that can contribute to the growth of the advanced energy sector. Despite the high demand for their skill set and supportive state policies, North Carolina's unemployment rate for veterans is equal to the state average. Drawing from New Jersey's upSKILL program, partnerships between the North Carolina Department of Veterans Affairs, local workforce development boards, and community colleges could effectively connect veterans and employers, especially in the advanced energy industry. Targeted workforce development could enable veterans to return to work and help stimulate the economy.

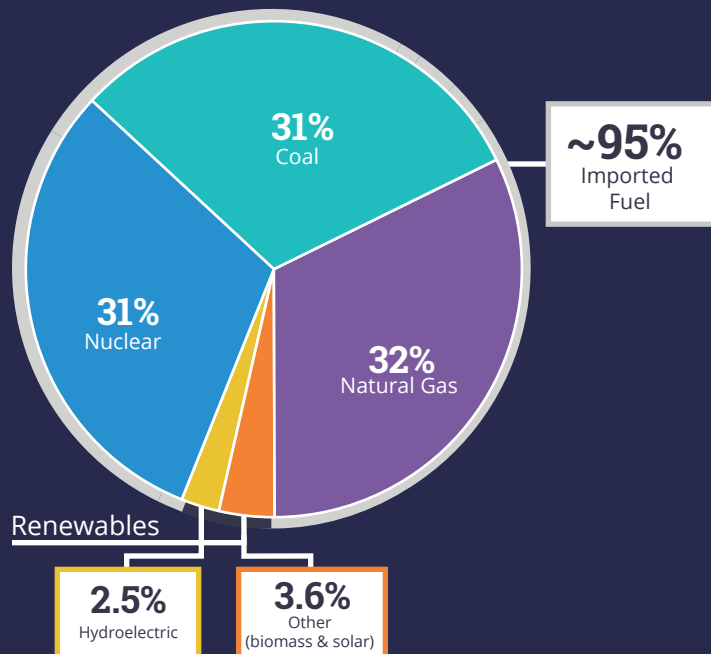
Expand Public-Private Training Partnerships with Local Community Colleges, Workforce Development Boards, and Employers: Employers in North Carolina are having difficulty finding qualified workers to fill open positions due to lack of specialized work experience and technical skills. North Carolina could address the skills gaps in the utility-scale battery sector by expanding public-private training partnerships. Specifically, employers could collaborate with local community colleges to enhance the existing NCWorks Customized Training Program through tailored training and internship opportunities. These partnerships could support job growth, increase investment in technology, and improve productivity for local businesses.

Enhance Higher Education Programs Relevant to Advanced Energy: Employers in the state report difficulty in finding workers with cross-cutting skills. North Carolina's universities could enhance existing degree programs throughout the state by incorporating energy-related coursework into the curriculum and providing a means for interdisciplinary collaboration. Furthermore, establishing a battery technology degree program would provide employers with workers with the specialized education needed by the industry. These programs could attract manufacturers to the state and create an environment conducive to innovation and advancement in the energy storage industry.

North Carolina's Electricity Infrastructure

Electricity Generation

As of September 2015



NC Energy sales are projected to increase 21.5% by 2028



Customers Served

■ Duke Energy
 ■ Municipal Utility and University
 ■ Electric Cooperatives
 ■ Dominion

Duke Energy* supplies approximately 96% of the utility-generated electricity used in North Carolina

KEY POLICIES

1977

Renewable Energy Investment Tax Credit

- Providing a tax credit for 35 percent of the cost of investments in renewable assets by individuals and corporations.

1979

PURPA

- North Carolina implements the Public Utility Regulatory Policies Act, creating a market for renewable energy facilities.

2002

Utility Savings Initiative Program

- Supporting energy efficiency in public buildings.

2003

North Carolina Green Power

- Promoting green power and carbon offsets to electricity customers through a voluntary program.

*Duke Energy refers to Duke Energy Carolinas and Duke Energy Progress, combined



North Carolina's Advanced Energy Economy

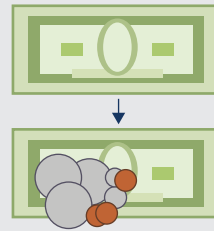
Clean Energy Investments

~\$3.5 billion
invested in clean
energy development
in NC between
2007 and 2014

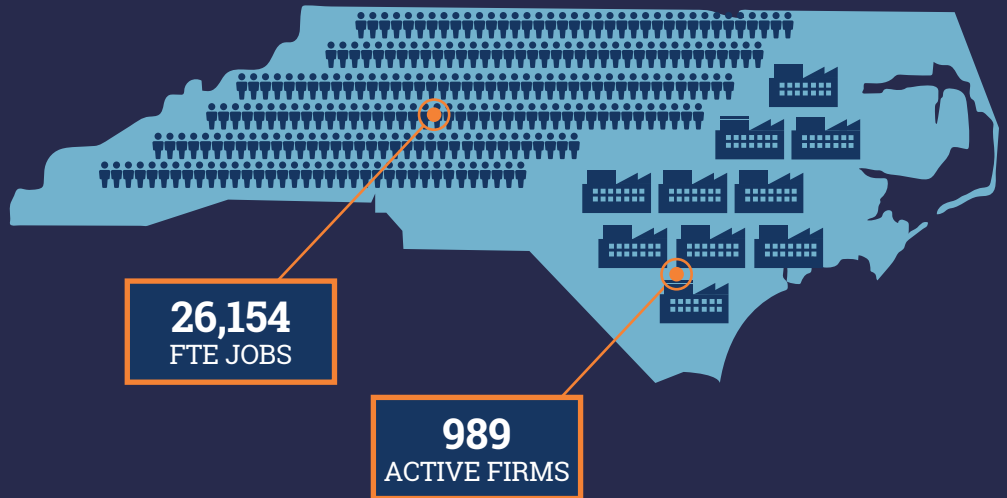
Clean energy
investments were nearly
18 times
the government
incentives for them

\$6.9 billion
annual gross revenues
generated by the NC
clean energy industry

North Carolinians spent
\$27.9 Billion
on imported
fossil fuels in 2013



For each \$1.00
of the Renewable
Energy Investment Tax
Credit utilized, \$1.54
has been returned
to state and local
governments.



2005

Net Metering and
Interconnection
Standards

- Establishing net metering and interconnection standards for distributed generation.

2007

Renewable Energy &
Energy Efficiency
Portfolio Standard

- Requiring investor-owned utilities to supply 12.5% of their electricity from renewable energy or energy efficiency measures by 2021.

2008

Property Tax Abate-
ment for Solar
Energy Electric
Systems

- Exempting 100 percent of the value of a residential solar system from property taxes.

2012

North Carolina
Energy Conservation
Code

- Updates existing code establishing increased energy efficiency standards in state-wide building codes.
- Includes the High Efficiency Residential Option, delivering a 30 percent improvement over N.C.'s previous code.

Chapter 1: Introduction

The American Jobs Project aims to spur job creation in the advanced energy sector by identifying innovative and state-specific policy and technology roadmaps. This national initiative takes advantage of the emerging global demand for advanced energy products and services. The American Jobs Project team analyzed the advanced energy economy in North Carolina and designed recommendations specifically tailored to the state's strengths. These recommendations were informed by extensive research and more than ninety interviews with local stakeholders and experts.

This report identifies opportunities to boost growth in two advanced energy sectors that leverage the state's legacy industries and current investment activities. State and local leaders who seek to leverage the state's resources to create skilled, good-paying jobs can use this report as a foundation for action.

Market Opportunity

Demand for advanced energy has soared in recent years and is poised for continued growth. Since 2004, new investment in the advanced energy sector has totaled \$2.3 trillion worldwide.¹³ In the United States, over \$386 billion was invested in advanced energy between 2007 and 2014; more than \$51 billion was invested in 2014 alone.¹⁴ In nationwide polls, Americans increasingly support renewables over other forms of energy and demand for renewable energy is likely to continue to grow.¹⁵ By 2030, states will need to significantly reduce pollution from power plants, which will make an even stronger case for advanced energy technology, renewable energy resources, and increased energy efficiency.¹⁶ Projections show that renewable energy will be responsible for the vast majority of new generation (69 to 74 percent) between now and 2030.¹⁷ These trends point to a clear market signal: demand for advanced energy will continue to grow over the next 15 years.¹⁸



Economic Clusters

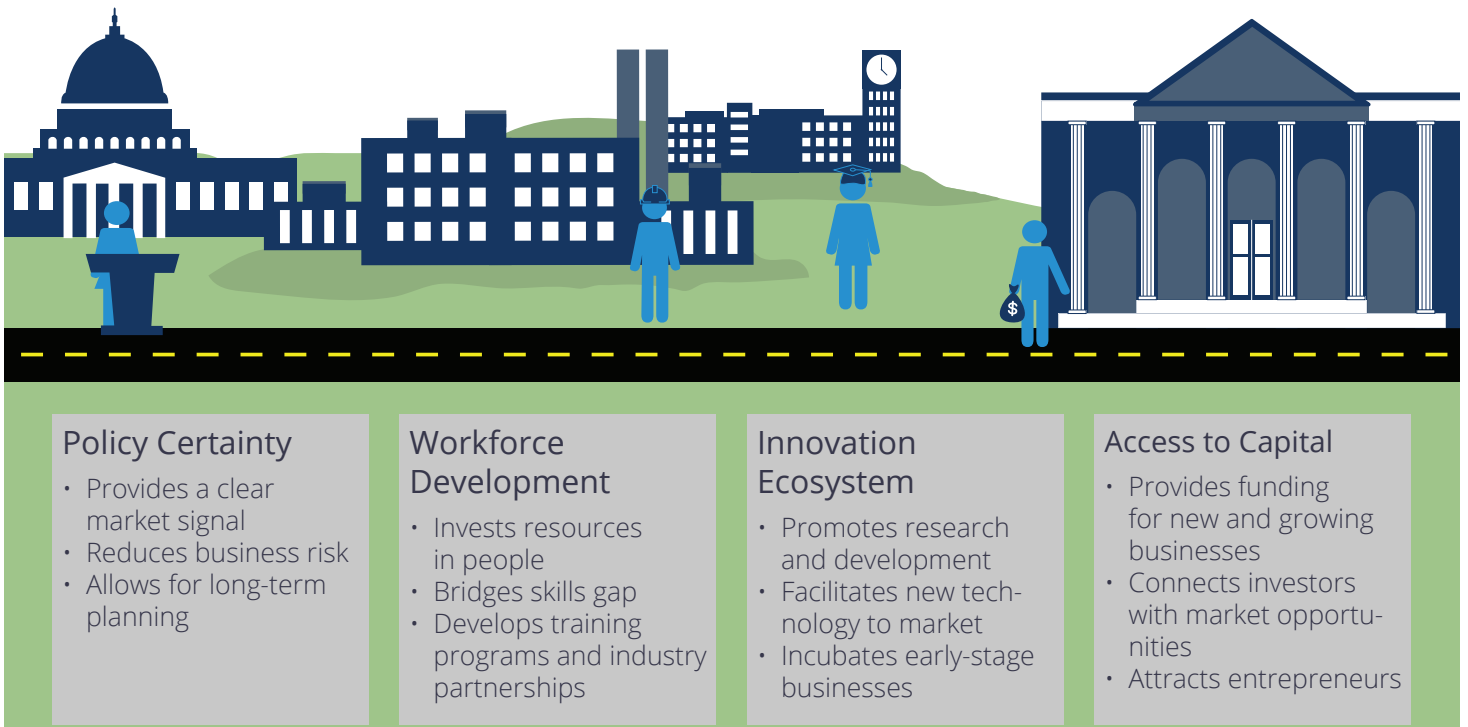
“Clusters are geographic concentrations of interconnected companies and institutions in a particular field.”

– Michael Porter, *Clusters and the New Economics of Competition*¹⁹

Economic clusters encompass a variety of linked industries and institutions—including suppliers of specialized services, machinery, and infrastructure—which form a supply chain.²⁰ Clusters also extend to manufacturers of complementary products and to industries related in skills and technologies. By placing themselves in close proximity to industry allies, companies can benefit from each other’s unique expertise and skilled workers.²¹ Companies in a cluster enjoy closer access to specialized skills and information, which helps increase productivity and efficiency.²²

Economic Cluster

Economic Clusters are created when industries and institutions become linked with suppliers of specialized services, machinery, and infrastructure that are within close proximity, forming a supply chain. Key elements to a successful cluster include Policy Certainty, Workforce Development, Innovation Ecosystem, and Access to Capital.



Geographic proximity and repeated exchanges of information help foster an environment of coordination and cooperation among companies and institutions. Business clusters are shown to increase the productivity of participating companies, drive innovation in the field, and facilitate the commercialization of this innovation by increasing communication, logistical support, and overall interaction between cluster entities.²³ Clusters also help build a strong foundation for creating and retaining employment opportunities.

Jobs Potential

Maximizing job creation in North Carolina is highly dependent on local action. An original equipment manufacturer (OEM) and its local suppliers employ workers from the community. Those employees spend their earnings at businesses in the local economy, such as grocery stores and restaurants. Local businesses also hire employees from within the community, who spend their earnings at other local establishments. This results in a multiplier effect, where a single dollar of spending in a community circulates through local businesses and their employees numerous times. Thus, recruiting advanced energy OEMs and their suppliers to a community can result in increases in local spending that are many times greater than the actual expenses of those companies. Indeed, with the right policies, North Carolina can support over 19,000 jobs per year through 2030.

Report Structure

The analysis presented in this report is divided into four complementary chapters, each covering key elements of growing advanced energy economic clusters in utility-scale batteries and biogas. Chapters 2 and 3 conduct a supply chain analysis for North Carolina's emerging utility-scale battery and biogas clusters. This analysis culminates in an assessment of North Carolina's potential for advanced energy jobs within each cluster and specific policy recommendations tailored to the state's needs. Chapter 4 analyzes North Carolina's innovation ecosystem and access to capital—crucial elements of cluster development—and provides recommendations for further developing the state's innovation pipeline. Chapter 5 provides recommendations for workforce development programs and policies to prepare North Carolinians for advanced energy jobs. The conclusion of the report summarizes key themes.

North Carolina's Military Sector Cluster

State leaders and local stakeholders began growing North Carolina's defense industry cluster in 2006, drawing upon the state's academic strengths, high levels of research and development, and existing strong industry presence.²⁴ North Carolina has since become home to a number of strong defense industry businesses, especially in the Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR); Performance Materials; and RESET Support Activities sectors.²⁵ Due in part to the emphasis on cluster growth, North Carolina has added at least 600 military sector jobs.²⁶



Chapter 2: Utility-Scale Battery Technology

North Carolina's policymakers will play a decisive role in the future of utility-scale batteries in the state. Over the past few years, global utility-scale battery deployment has grown rapidly due to falling prices, technological advancements, favorable government policies, available financing, and increased consumer demand for clean and renewable sources of energy. By targeting the state's emerging utility-scale battery cluster with smart and strategic policy choices, North Carolina's leaders can attract jobs, help improve grid stability, and reduce energy costs for consumers. With policies that encourage growth and technological innovation, North Carolina can create demand for battery products and capitalize on export opportunities in regional, national, and international markets.

What Can Utility-Scale Batteries Do?

Utility-scale batteries provide a wide range of services to the grid and are a fuel-agnostic system optimization tool.¹ If deployed properly, utility-scale batteries save money for electricity customers. Additionally, batteries act as a multipurpose tool for the grid by:²

- Creating efficiencies in grid operation
- Providing ancillary services, such as frequency and voltage regulation and fast demand response
- Reducing investment in transmission upgrades and peaker plants
- Improving reliability of electricity delivery to customers
- Maximizing solar and wind integration, by reducing the intermittency of these resources

This chapter is a guide to develop and strengthen North Carolina's emerging battery economy. After analyzing North Carolina's existing utility-scale battery supply chain and discussing the state's potential for creating good-paying battery jobs, the chapter culminates in policy recommendations for future growth. These recommendations chart a course for North Carolina policymakers to generate and enhance jobs in the utility-scale battery sector.



Photo Credit. Courtesy of Alevio

Utility-Scale Batteries and the Grid

Utility-scale batteries have the potential to restructure our nation's electrical grid. Currently, electricity production and consumption must be precisely balanced. This requires complex control systems and instantaneous backup capacity, also known as spinning reserves.³ Keeping power plants running in order to meet fluctuations in electricity supply and demand burns fuel even though the power is not being used, and that drives up the cost of electricity.⁴ With utility-scale batteries, the grid can "bank" electricity to use when demand is higher. Batteries can play a number of important roles in helping to maintain the balance and control across our electricity system.⁵

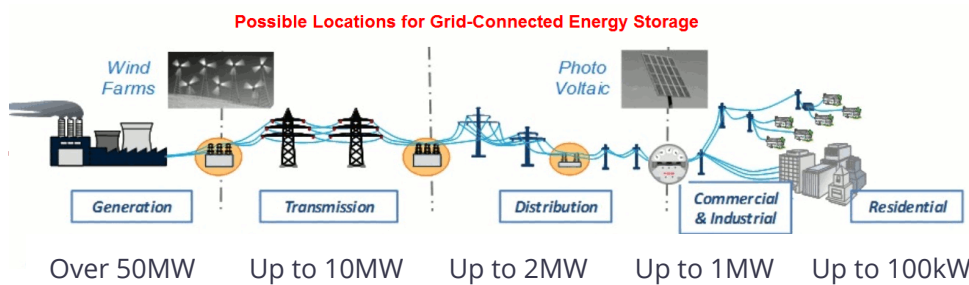


Figure 1. Storage can be used throughout the grid. (Source: Sandia National Laboratories)

Battery Storage Potential

Many technologies can be used for energy storage, including pumped hydroelectric, flywheels, compressed air, and chemical batteries. Battery storage is the most promising of these technologies, because it has several advantages over other technologies. Battery storage:

- does not require extensive land use or maintenance
- can be used for a variety of applications
- has a relatively long storage time
- is easy and fast to activate
- is highly efficient⁶

Additionally, batteries can be located anywhere. They do not pollute the air or make excessive noise, which makes them ideal for dense urban areas where clean, invisible power is needed. Batteries can be applied at different scales, including residential, commercial, and utility. Homeowners are using residential battery systems for back-up power and to complement solar systems, while business owners are using commercial-scale batteries to help reduce energy and demand charges on their electricity bill.⁷ Utilities are being driven toward large-scale battery systems to regulate and stabilize the electric grid through frequency regulation and fast-reacting responses to increased electricity demands.⁸



North Carolina boasts strong anchor companies in the utility-scale battery sector. Well-established battery technology companies in the state include motion and controls manufacturer Parker Hannifin, power and automation manufacturer ABB, lithium battery supplier Celgard, and energy management and automation company Schneider Electric. Alevo, a utility-scale battery company, opened operations in the state in late 2014 with potential to significantly grow employment at its manufacturing facility.⁹

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> • Strong anchor companies • Synergy with existing smart grid cluster • Increases energy resiliency for critical infrastructure facilities • Supports established solar industry • Properly dispatched energy storage lowers costs for customers • Strong university research • Favorable in-state business environment • Success of Research Triangle Park • Strong and well-connected transportation infrastructure • Key component of resilient grid 	<ul style="list-style-type: none"> • Nascent utility-scale battery technology • Lack of specialized workforce in battery technology • Undeveloped regulatory environment • Lack of support for demonstration projects • Energy policy uncertainty • Weak centralized coordination and leadership • Uncompetitive state economic development policy and foreign direct investment strategies
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> • Large in-state market, including data centers, military installations, and hospitals • Export potential in rapidly growing global market • Room for new actors in market • Potential to tap into existing smart grid cluster • Public-private partnerships for economic development 	<ul style="list-style-type: none"> • Questionable policy reliability • Other states acting quickly to dominate the market • Expiration or repeal of policies favoring the advanced energy sector • High capital requirements for advanced energy technologies and rising interest rates

Integrating energy storage is one of the key steps in creating a smart grid—without the ability to store energy, the smart grid system is severely limited in power generation and distribution options.¹¹ Batteries provide the smart grid with the ability to adapt to renewable energy technologies and load variations.¹² Smart grid and utility-scale batteries are complementary technologies. As a result, the two industries could capitalize on shared research, supply chains, and workforce development. There is also overlap in many areas of manufacturing for batteries and smart grid components. North Carolina has a robust smart grid cluster that boasts more than fifty companies in Wake County alone.¹³ North Carolina’s existing battery manufacturing and smart grid companies could join forces to create a thriving economic cluster and bring thousands of jobs to the state.

Utility-scale batteries could also bolster North Carolina’s existing solar photovoltaic (PV) sector by addressing intermittency issues and storing excess generation. North Carolina boasts a robust solar industry—as of 2015, the state ranked second in the United States for new PV installations.¹⁴ Deploying utility-scale batteries in conjunction with solar systems presents a significant growth opportunity in both sectors.

North Carolina is an attractive location for businesses. The state boasts a high quality of life, temperate climate, low cost of living, and good schools. These characteristics translate to the business environment in the form of low-cost labor, advantageous tax policies, low energy costs, and a history of government cooperation. Additionally, North Carolina’s transportation infrastructure is a benefit to in-state manufacturing operations—ports and airports with interconnected rail lines and highways facilitate transport of goods.

Despite strong market incentives and potential overlap with other sectors, expanding North Carolina’s utility-scale battery cluster requires overcoming several barriers. North Carolina must overcome an undeveloped regulatory environment, lack of centralized coordination and leadership, and slow response time to market signals in order to fully capitalize on the economic benefits of utility-scale battery technology. Through smart, strategic policy leadership, North Carolina can eliminate costly energy waste, jumpstart its utility-scale battery sector, and create thousands of good-paying jobs for residents.

Smart Grid

A smart grid harnesses computer-based remote control and automation technology to engage in two-way digital communication with consumers, applications, and devices to quickly respond to changing electricity needs.¹⁰



Utility-Scale Battery Market Trends

Rising Demand

The global utility-scale battery market is experiencing significant growth. North Carolina is well positioned to take advantage of the economic opportunities generated by this market. Innovation, increased understanding of the benefits of the technology, and cost reductions are motivating significant growth in market demand for utility-scale batteries.¹⁵

The utility-scale energy storage market, the residential and commercial energy storage markets, and the electric vehicle (EV) market are all expected to grow over the next decade. Global revenues in the utility-scale battery sector are projected to grow from \$231.9 million in 2016 to \$3.6 billion by 2025.¹⁶ In the global residential and commercial markets, installed energy storage capacity is expected to grow seventy-fold from 2014 to 2024.¹⁷ By 2024, the worldwide market for lithium-ion batteries in electric vehicles is projected to grow from \$7.8 billion to \$30.6 billion per year.¹⁸

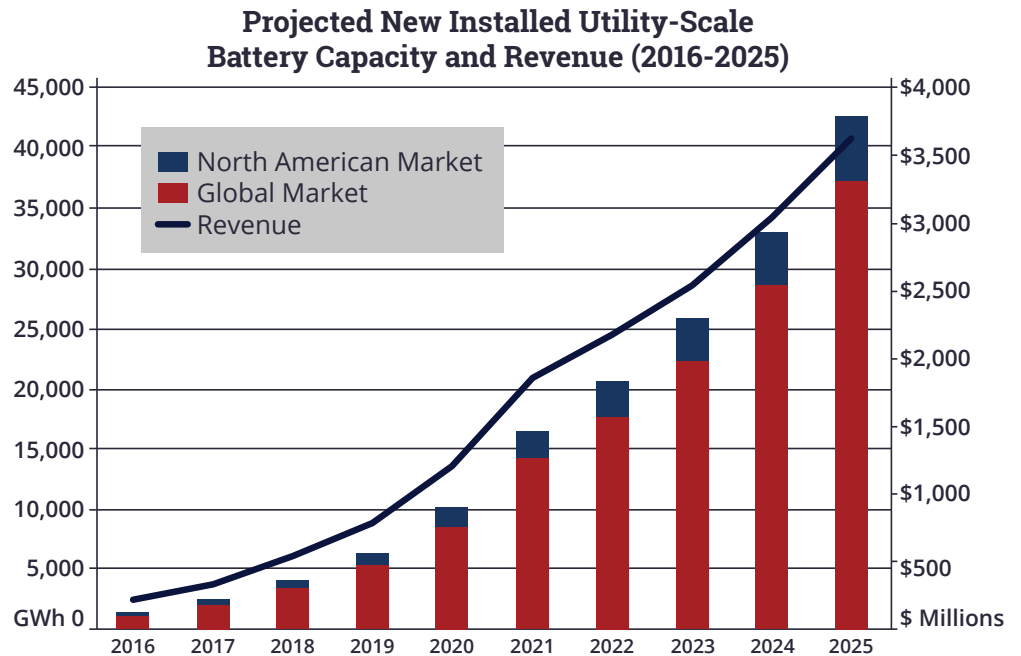


Figure 2. Projected revenue for the global utility-scale battery market could reach \$3.75 billion by 2025.

(Source: Navigant Research)

In the United States, a five-fold increase in the size of the energy storage market is expected in the next half-decade, growing to a \$2 billion market in 2020.¹⁹ Within the United States, Texas, California, and New York are all utilizing forward-thinking policies to expand in-state utility-scale battery markets and become

national leaders in the energy storage sector.²⁰ This trend indicates the potential for significant market growth in states that are able to attract battery manufacturing companies.

U.S. Energy Storage Market to Reach \$2 Billion by 2020

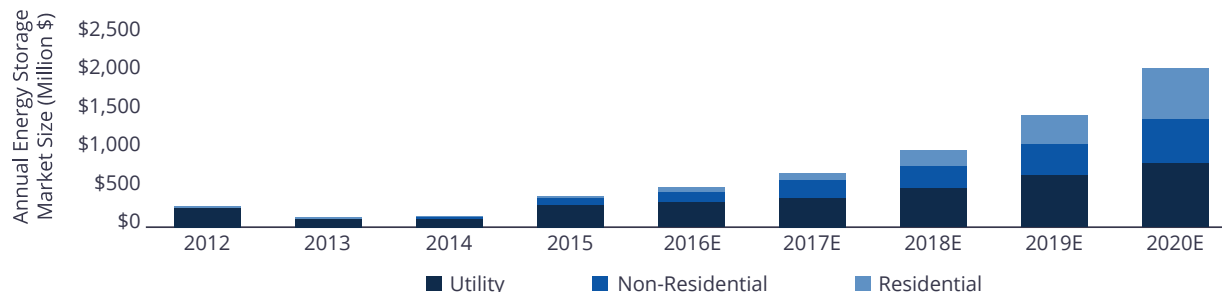


Figure 3. The U.S. market for energy storage is rapidly growing.
(Source: GTM Research)

Falling Costs

Battery costs have been decreasing steadily in recent years, due to advances in manufacturing, technology innovation, economies of scale, and increased competition. Experts estimate that the cost of batteries will decrease by 80 percent of 2014 prices within the next five years.²¹ Technologic breakthroughs and innovations are making utility-scale batteries more effective and cost-efficient every day. Advancements such as the inorganic electrolyte from Alevo are creating incredible leaps in battery capacity—over forty times the life of a traditional battery.²²

"Ultimately, we see battery energy storage for electricity systems as a potential 240GW market by 2030 (excluding car batteries) with system costs potentially dropping to \$230/KWh by early next decade, which would make it cheaper than the average household electricity bill."²³

—Citigroup

While the battery is the most expensive part of a utility-scale storage system, advancements in inverters and other technologies are bringing down overall balance of system costs.²⁴ With system costs decreasing by half every five to ten years, the installation of utility-scale battery systems across the grid is an economic possibility.^{25,26} Increased installations will continue to drive down overall system costs as economies of scale improve.

Decreasing costs and increasing market demand for utility-scale batteries represent an opportunity for North Carolina to become a national leader in battery manufacturing and to attract thousands of good-paying jobs to the state.



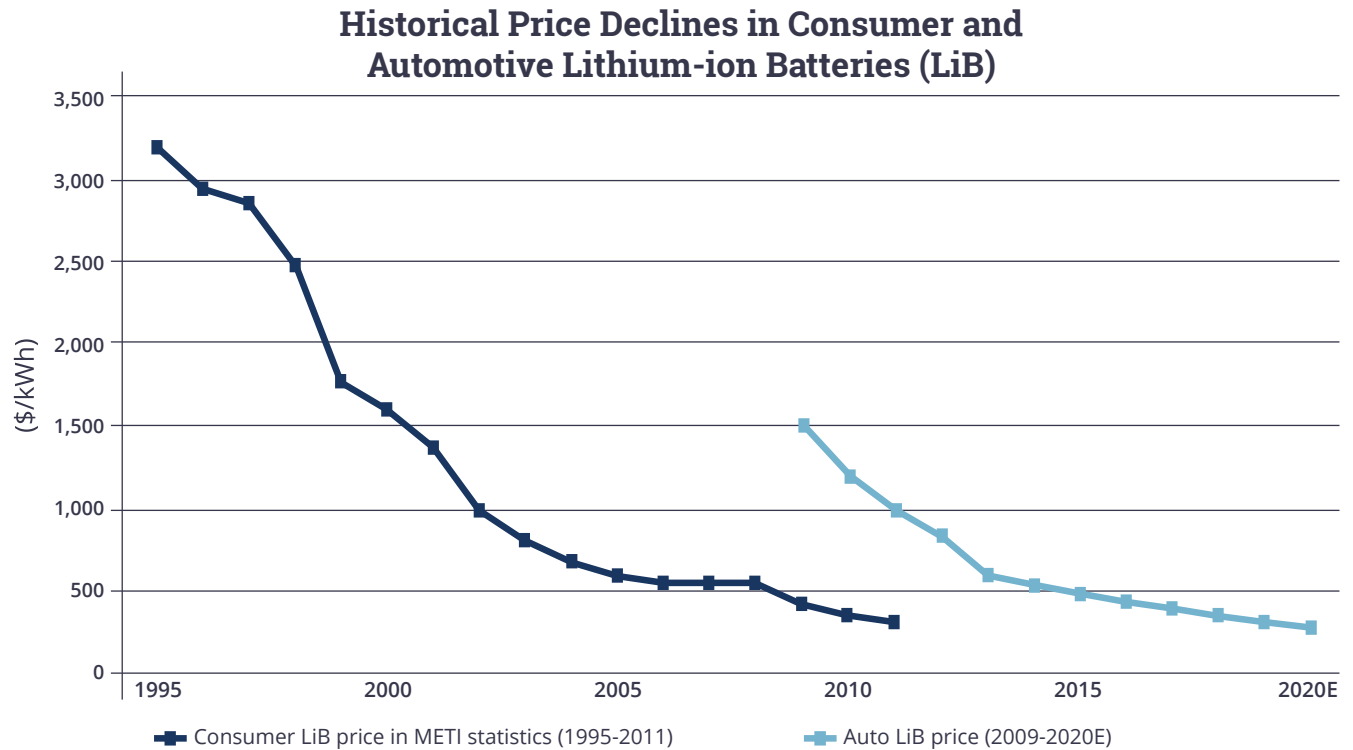


Figure 4. The price per kWh for Lithium-ion batteries is sharply declining.
(Source: Citigroup)

What Does Rising Demand and Falling Cost Mean for North Carolina?

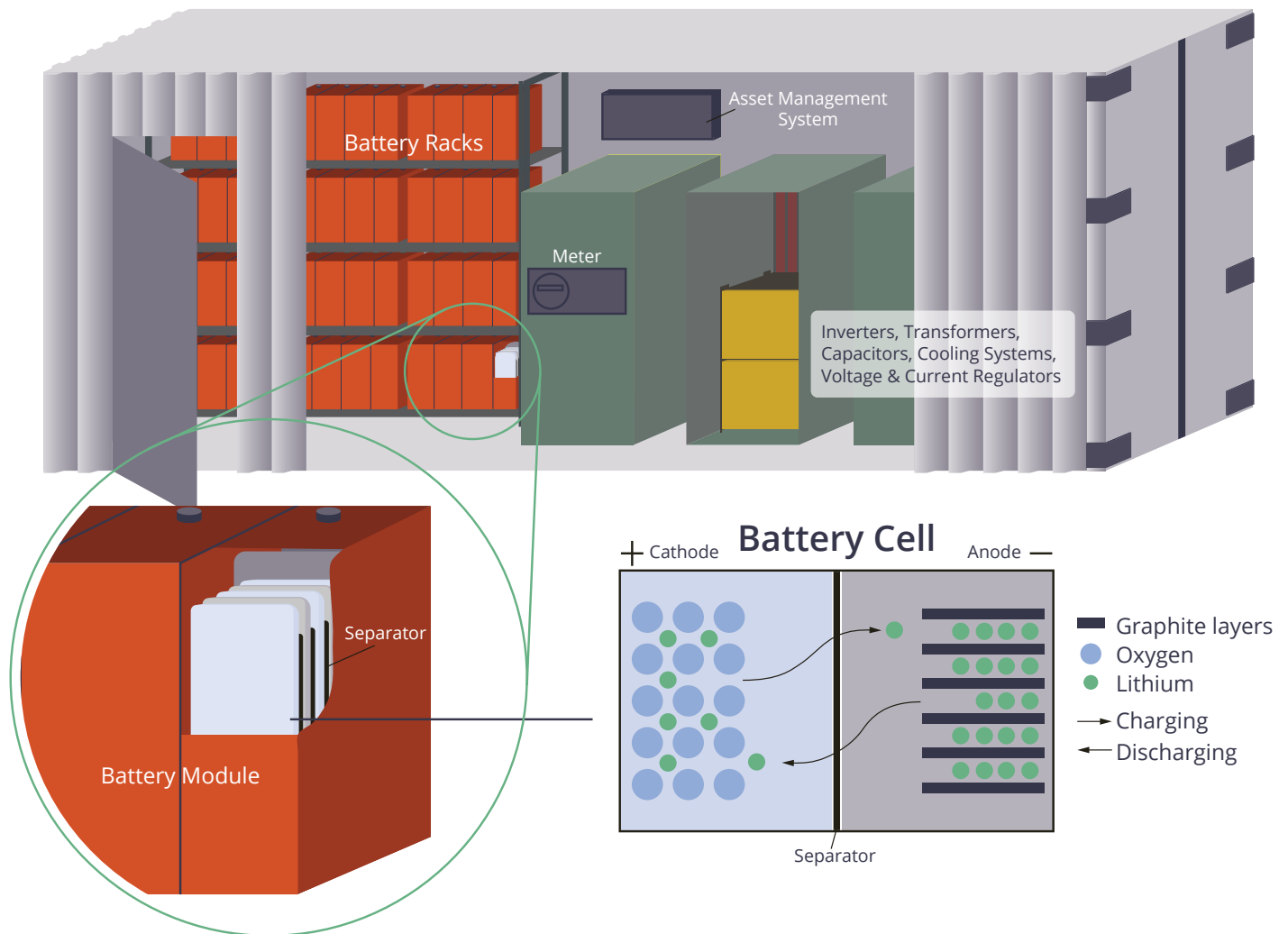
The offshoring of manufacturing jobs was not driven by intrinsic geographic, technological, or cultural factors; rather, aggressive policy and low wages in competitor nations shifted American jobs overseas.²⁷ State policy that fosters a strong market, develops the utility-scale battery supply chain, promotes access to capital, and invests in workforce development will attract manufacturers to the state. With smart policies, North Carolina can be a national and global leader in utility-scale battery manufacturing and deployment.

Many companies in the battery supply chain have already made North Carolina their home and the state possesses the foundation for a strong economic cluster. Many successful anchor companies in North Carolina include Parker Hannifin, Celgard, Eaton, and ABB. Newcomer Alevo invested hundreds of millions of dollars into the vacant Philip Morris building in Concord, and plans to increase production over time from 200 megawatts of battery storage to several gigawatts annually.²⁸ By facilitating local business growth, North Carolina could be the utility-scale battery manufacturing hub of the United States.

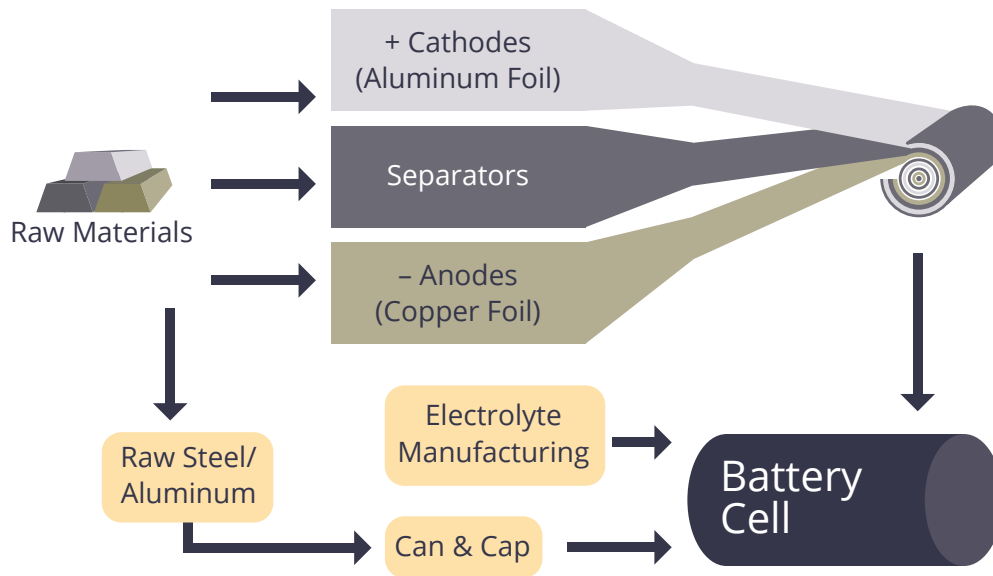
Utility-Scale Battery Manufacturing

There are many types of utility-scale batteries with different manufacturing processes and assembly configurations. In order for North Carolina policymakers and leaders to craft forward-thinking policy that reflects the future of utility-scale battery technology, it is important to understand advances in the space. The graphics below and on the adjacent page show the various stages of battery manufacturing and ongoing trends in battery innovation.

Utility-Scale Batteries



Battery Manufacturing Process



Ongoing Trends in Battery Innovation

Research and innovation in the battery industry is leading to exciting breakthroughs. In the near future, batteries will be smaller, faster, more powerful, safer, and more economical.

Utility-Scale Battery Supply Chain

Batteries are complex systems that offer opportunities for manufacturing at many points throughout the supply chain. The raw materials must be mined, purified, and processed to exacting standards for the battery industry. The battery cell assembly process is technical and requires skilled workers with expertise in electronic and chemical manufacturing processes. The final module assembly—where the battery cells are put together into a product that is sold for use in houses, businesses, or utility systems—requires attention to detail, system knowledge, high levels of quality control, and extensive testing.

Table 1 on the following page describes each of these technology categories and lists the number of in-state companies.

Table 1. Companies in North Carolina's Battery Supply Chain

CATEGORY	SUBCOMPONENT	NUMBER IN-STATE	DESCRIPTION
Full Lithium Ion Battery Energy Storage System Manufacturer		4	Full grid-ready lithium ion battery storage system
	Battery Casing	4	Outside covering of each individual battery cell, including safety features like vents; wiring to connect each cell to the integrated stack
	Graphite	2	High purity graphite for anode
	Lithium Raw Material	2	Raw lithium feedstocks for cathode and electrolyte
	Electrode Supports/ Current Collectors	0	Thin aluminum (anode) and copper (cathode) foil
	Chemical Manufacturing	4	Conversion of lithium compounds to usable forms for specific battery chemistry, additional manufacturing of solvents and additives for battery
	Battery Management System	5	Circuit board control to monitor charging and prevent overcharging
	Separator	2	Semi-permeable membrane to allow lithium to pass from anode to cathode
Power Conversion System		10	Connects energy storage installation to the grid and converts power to the right voltage and frequency to a usable form for the grid and vice versa
	Inverters/Rectifiers	13	Change from DC (battery) to AC (grid)
	Transformers	20	Change AC power voltage
	Monitoring/Analytics	18	Monitor each power conversion system for anomalies and optimize flow of power throughout the day
Total		84	

Key: Strength and Opportunity for recruitment*

*Strengths and opportunities for recruitment were based on the size and strength of companies. For example, several small start-up companies are not as advantageous as a large supplier that has the capital to produce at economies of scale.



Strengths and Opportunities for Growth

North Carolina boasts major strengths throughout the utility-scale battery supply chain, including the presence of ABB. ABB is a global leader in power and automation that has invested in research and development and commercialization of energy storage, smart grid, and microgrid technologies. North Carolina is also home to Celgard, an international company and leader in cell separator technology.²⁹ Saft, a well-established manufacturer of industrial batteries, also has a manufacturing presence in the state.³⁰ Power conversion company Parker Hannifin also plays a critical role in the utility-scale battery industry. Alevo, an emerging utility-scale battery producer and system analytics provider, recently chose North Carolina as its headquarters. Alevo has developed a non-flammable battery that lasts ten times longer than competing technologies without compromising power.³¹

Grid Monitoring Systems

North Carolina's smart grid cluster includes several companies that produce grid monitoring systems and services, such as Eaton and SAS. Grid monitoring systems optimize the power flow to and from batteries making these companies important additions to the utility-scale battery supply chain.

North Carolina is home to several companies that process the raw materials critical to most battery technologies. SGL Carbon processes battery-grade graphite, while FMC Lithium and Rockwood produce downstream lithium compounds used in the battery industry.^{32,33} Asbury Carbon, a global carbon and graphite product supplier, plans to open a graphite processing plant in Lumberton, North Carolina by the end of 2016.³⁴ This new plant will be the first of its kind in the United States.

Building on these strengths, North Carolina's utility-scale battery supply chain provides opportunity for growth, specifically in the full-scale battery system space. EnerSys, a global leader in the utility-scale battery sector, has an office in North Carolina, but does not manufacture in the state.³⁵ Additionally, Dupont, Arkema, and Honeywell each have a presence in North Carolina, but do not currently produce battery materials in the state.^{36,37,38} Incentivizing these companies to expand operations and manufacture in the state would solidify North Carolina's growing battery cluster.

Electrode supports and current collectors present additional growth opportunities in North Carolina. UAJC Corporation, a Japanese company, could potentially fill the state's existing gap in this area. North Carolina leaders could recruit UAJC Corporation and similar companies to attract foreign capital to the state, fill gaps

in the supply chain, expand the emerging utility-scale battery sector, and capitalize on export demand.

North Carolina's Utility-Scale Battery Cluster

As demonstrated in the map below, most of the utility-scale battery industry is concentrated in three geographic regions around the major cities of Charlotte, Greensboro, and Raleigh. Major highways efficiently connect these manufacturing centers. Additionally, many businesses are distributed along major shipping routes. These economic clusters represent opportunities to further strengthen inter-industrial ties within the state and create a robust battery manufacturing sector in North Carolina.

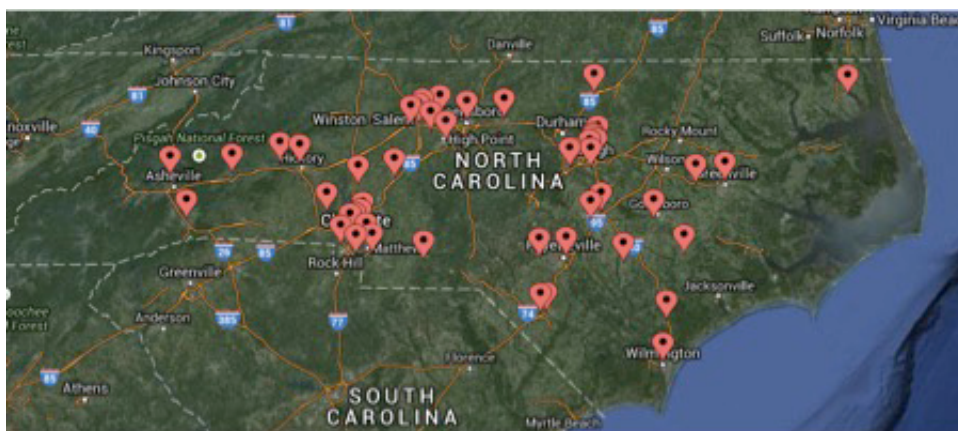


Figure 4. Top 50 Businesses in Battery Manufacturing³⁹

North Carolina's Potential for Battery Jobs

North Carolina's nascent battery cluster is poised for growth. By opening a single large battery manufacturing plant and consolidating the supply chain in North Carolina, the state's battery industry could support up to 17,000 good-paying, skilled jobs annually through 2030. To understand the economic impact of opening a battery manufacturing plant in North Carolina, we looked at an analysis of the Tesla Gigafactory in Nevada. That analysis estimated that the multiplier effect of battery manufacturing could be as low as 1.98 or as high as 3.49.⁴⁰ The high multiplier assumes that a nearly perfect supply chain will form, an optimistic assumption unless forward-thinking policies are implemented by state and local governments.⁴¹ Using the existing analysis done for the Nevada Governor's Office of Economic Development, we analyzed the jobs impact of opening a battery manufacturing plant and consolidating the supply chain in North Carolina.

Multipliers

Multipliers are used to capture the secondary effects of increases in direct job-years. A multiplier of 1.0 signifies that no indirect or induced job-years will be created. A multiplier of 2.0 signifies that, for every one direct job-year, the number of indirect and induced job-years created in the local economy will add up to one full-time equivalent job-year. For example, if rising demand for energy storage creates ten new battery installation job-years and the local multiplier is 2.5, then fifteen new indirect and induced job-years will be created in the local economy.



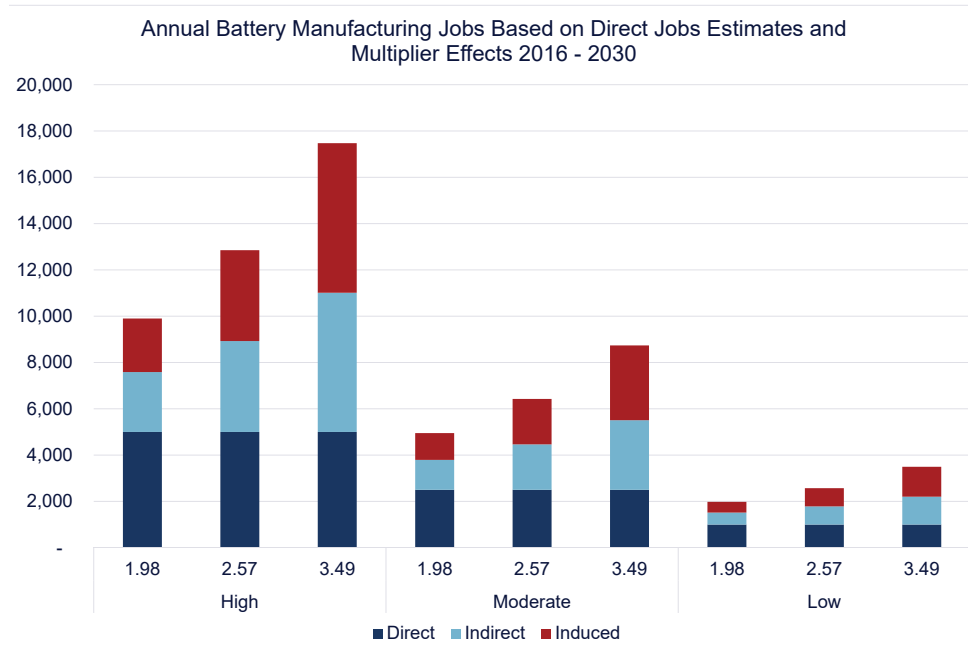


Figure 5. Increasing local spending will result in more jobs for North Carolinians.

To highlight why clustering supply chain businesses in-state is so important, we examined the effects of opening three sizes of battery manufacturing plants using high, medium, and low levels of in-state clustering. To demonstrate how the number of jobs created for each size of factory would change if more supply chain businesses locate in North Carolina, we estimated how the number of indirect and induced jobs changes if the multiplier is increased from 1.98 to 2.57 and 3.49. Additionally, to model battery manufacturing facilities of several sizes, we looked at three scenarios: a high-employment case where a battery manufacturer creates 5,000 direct jobs; a moderate-employment case, where a manufacturer creates 2,500 direct jobs; and a low-employment case, where a manufacturer creates only 1,000 direct jobs.

In all three scenarios, increasing the amount of in-state purchases by the manufacturer would create thousands of jobs. Even in the low-employment scenario, the difference between housing most of the supply chain in state and importing most of those goods is nearly 1,600 North Carolinian jobs. In the high-employment scenario, the difference between consolidating the supply chain in state and failing to do so is over 7,500 North Carolinian jobs.

Because North Carolina already houses several battery supply chain companies, the 2.57 multiplier may best represent the path that the industry is currently on. Under those conditions, a moderate-sized manufacturer would support nearly 4,000 indirect and induced jobs. However, if a concerted effort were made by the state to fill in the supply chain and reach the high

multiplier, that same moderate-sized manufacturer could support an additional 2,300 indirect and induced jobs, bringing the total number of indirect and induced jobs to over 6,200.

Proactive, forward-thinking policies that develop a strong cluster can create many more jobs than are included in the scope of this analysis for two reasons. First, these estimates are limited to the effects of opening a single manufacturing plant. If North Carolina develops a robust cluster by attracting several anchor manufacturers, many more jobs could be created. Second, this analysis only considers supply chain jobs created by selling to a single battery factory. It does not consider jobs that could be created by battery supply chain companies selling to other businesses in the state, in other states, or internationally.

With smart, strategic policies aimed at attracting battery supply chain businesses to the state, North Carolina's leaders can compete aggressively for battery manufacturers and supply chain companies. If a large manufacturing plant opened and enough supply chain businesses were attracted to the state to reach the high multiplier, a single large battery factory could support over 17,000 good-paying, skilled jobs annually through 2030. Building a robust in-state supply chain would make North Carolina a world leader in the battery industry.

Policy Recommendations

Revenues for the utility-scale battery sector are projected to increase fifteen-fold within the next ten years.⁴² Now is the time to take advantage of the market for utility-scale batteries. Battery manufacturers are searching for suitable locations to expand operations and establish factories. Smart, strategic policies are needed to ensure that North Carolina is at the forefront of this emerging market.⁴³ North Carolina has a chance to be a leader in the utility-scale battery sector, but without a targeted effort, other states will reap the benefit of this opportunity.

Policymakers can bolster the state's utility-scale battery cluster by focusing on innovative policies that stimulate demand and make North Carolina irresistible to battery manufacturers. Creating a robust in-state market will attract private investment, strengthen the economy, and create new value chains, which will subsequently stimulate and accelerate new export markets. The state can also strengthen its utility-scale battery cluster by establishing policies that promote advanced manufacturing and innovation within the state. North Carolina can create thousands of skilled, good-paying jobs by stoking competition, eliminating barriers, and encouraging demand.



The following section includes a full discussion of several policy recommendations intended to encourage North Carolina's leaders to find innovative ways to enhance the state's utility-scale battery sector. The recommendations focus on the following actions: 1) defining the value that utility-scale batteries add to the grid, 2) requiring cost of service transparency from utilities, 3) enhancing cost recovery by utilities, and 4) providing tax relief for battery manufacturers and installers in North Carolina.

Policy 1: Properly Define the Value that Utility-scale Batteries Add To the Grid

Grid Resiliency and Reliability

Utility-scale batteries provide an added layer of resiliency and reliability to the grid that is difficult to value and is not often included in modeling tools. Many cities and states are beginning to appreciate the resiliency that energy storage can bring to the grid in the wake of extreme weather events, such as hurricanes.⁴⁶

The most significant barrier for the utility-scale battery industry is accurately valuing the multitude of services that batteries provide to the grid. Utility-scale batteries do not generate electricity or direct revenue. However, the efficiency, resiliency, transmission, and other ancillary services they do offer are not typically assigned a dollar value.⁴⁴ Instead, single metrics are used to determine the value of batteries, which fails to account for the wide array of benefits batteries provide. In the past five years, new federal and regional policies have updated electricity market structures to allow for the monetization of the benefits of energy storage.⁴⁵ As a result, energy storage markets are growing rapidly in some regions.

Energy Storage Valuation through PJM Interconnection

The utilities located in the PJM Interconnection have become national leaders in energy storage due to PJM's early adoption of an energy storage valuation methodology. In 2014, approximately two-thirds of all energy storage installed in the United States was located in the PJM territory.⁴⁷ This success is due to PJM's quick implementation of FERC's Order 755, which creates a market for frequency regulation with a pay for performance premium for storage.⁴⁸ As part of a larger mission to formally define the revenue streams for energy storage at the federal level, FERC has issued several orders to create fair treatment (Orders 1000 and 792) and proper compensation (Orders 755 and 784) for energy storage assets.⁴⁹ Moving forward, utilities within PJM are planning to increase their investments in energy storage: more than 500 megawatts (MW) of storage are in the pipeline, five times the amount currently installed.⁵⁰

Oregon's lawmakers recently passed legislation that requires the utilities commission to create valuation guidelines that include all the benefits of storage. The law states that each of the following parameters should be included: 1) deferred investment in electricity generation, transmission, or distribution, 2) the

reduction in peak demand, 3) improved reliability of transmission systems, 4) improved integration of renewables, 5) reduced greenhouse gas emissions, and 6) reduced portfolio variable power costs.⁵¹ Additionally, public utilities are required to procure at least one energy storage system capable of storing 5 megawatts per hour by 2020. The utilities may recover all costs (including above-market costs) incurred in the procurement through rates.⁵²

Using lessons learned from other states, the North Carolina Utilities Commission (NCUC) could establish a proper valuation method for energy storage. To assign a proper value to energy storage technologies, the utilities commission could use FERC's orders, the PJM Interconnection valuation methodologies, and resources developed by industry experts as guides.⁵³ Given the complexity of energy storage, the commission could actively engage industry experts to assist in this process.

With this new valuation method, the NCUC could determine whether in-state energy storage is economically and technically feasible. If energy storage is deemed feasible, the NCUC could require that utilities include energy storage in their Integrated Resource Plans (IRPs). The IRP process would demonstrate the use-cases where energy storage is a more cost-effective investment than other resources. While some utilities considered lithium-ion batteries in their 2015 IRPs, the NCUC could ensure that the utilities use accurate valuation methodology and metrics in the future.⁵⁴ The NCUC could also issue specific guidelines for utilities to request permission to deploy storage outside of the IRP process. By establishing a valuation model for energy storage, policymakers could send a market signal to utility-scale battery manufacturers that North Carolina is ripe for investment.

Policy 2: Require Cost of Service Transparency

For optimal grid operation, grid assets need to respond quickly, particularly for frequency regulation and demand response.⁵⁵ Technologies that decrease response times provide tremendous value.⁵⁶ Utility-scale batteries can provide the grid with flexibility on a minute-by-minute basis and should be evaluated accordingly. Many utilities currently only offer *hourly* pricing information to the public. Without *sub-hourly* pricing information, utility-scale battery companies cannot prove the full extent of the value of their product. The battery industry needs system-level data in order to prove its commercial case and demonstrate the potential cost-savings for ratepayers.

The public and private sectors have developed modeling tools that evaluate the benefits of utility-scale batteries, across a wide range of parameters. For example, Alevo and E3 have developed



proprietary modeling tools. These tools provide the most accurate results when sub-hourly pricing information is used.

The NCUC could require all in-state utilities to provide cost of service data transparency, which would allow the utility-scale battery industry to demonstrate the feasibility and potential cost savings of deployment. Utilities currently collect this data, but do not make it available to industry players. Armed with full information, the industry could prove its value to ratepayers and the grid as a whole. This requirement would not impact customer-related information or privacy.

Policy 3: Enhance Cost Recovery by Utilities

Utilities generally prefer to demonstrate new technology in small pilot projects before committing to capital-heavy investments. In many cases, utilities conduct a pilot project to test the feasibility and reliability of a new technology. Pilot project capacities are typically small—less than 1 megawatt (MW). However, utility-scale battery pilot projects must be larger in order to truly demonstrate the value of the technology. For example, a 100 MW natural gas plant seeking to invest in utility-scale battery technology would require a 20 MW battery for accurate results from its pilot project. With an estimated cost of over \$30 million, this is an unusually large pilot project. Funding a project of such large magnitude presents a challenge because utilities require regulatory approval to recover the costs of large investments.

Because utility-scale battery installations often need to be deployed at a large scale in order to demonstrate their true value, the large capital expense can present a barrier for utilities. One solution to this problem is to allow on-bill accelerated repayment for cost recovery. This would allow the utility to recover a larger percentage of the overall cost of the installed battery system in a shorter period of time.

Enabling a Leasing Model for Pilot Projects

Leasing utility-scale batteries is an innovative option that could be made available to utilities. Rather than structure the arrangement as a one-time capital expense, the utilities could be authorized by the NCUC to lease the equipment from battery companies during the demonstration phase. If, at the end of the lease period, the batteries have not performed as expected, the equipment is returned to the company. The NCUC could allow cost recovery for the lease, which is a much smaller amount than a one-time capital expense. Additionally, this structure forces battery companies to bear the risk of technology that does not perform as promised.

Another mechanism that could be employed to assist cost recovery for large pilot projects is increasing the amount that utilities are permitted to recover from ratepayers under the Renewable Energy and Energy Efficiency Portfolio Standard (REPS). Under the REPS, North Carolina utilities are permitted to recover up to \$1 million per year for research.⁵⁷ The state legislature could increase this amount specifically for utility-scale battery projects to enable larger demonstrations and pilots.

Policy 4: Provide Refundable and Transferrable Tax Credits for Battery Manufacturers and Installers

Tax credits can provide an important support mechanism to businesses and are valued for their simplicity and immediate availability. Tax credits are a form of co-investment—if the private sector invests, the government will provide a corresponding and measurable level of support. However, income tax credits generally are only valuable to entities that have a tax liability (i.e., taxable profits). Most new companies and startups do not make a profit for several years, leaving them unable to take advantage of tax exemptions. Furthermore, companies in a growth phase use revenue to fund expansion, lowering their profits and their ability to benefit from tax credits.

North Carolina does not provide a tax credit for manufacturing activity in the state. This serves as a disincentive for manufacturers to locate in North Carolina, given that other states grant exemptions to the franchise tax or provide tax credits to local companies. North Carolina charges a franchise tax of 0.15 percent for all companies doing business in the state.⁶⁰

Success of Tax Credits in North Carolina

During the 2013 and 2014 fiscal years, tax credits in North Carolina were “associated with creation of 17,010 jobs, over \$5.8 billion in business property investment, and \$42.1 million in real property investment.”⁵⁸ This generated \$393.9 million in tax credits. The majority of the jobs created were located in the state’s most distressed counties.⁵⁹

Incentives for In-State Manufacturing

Many states have established business incentives that have been beneficial to the advanced energy economy. Texas entities that are solely engaged in manufacturing, selling, or installing specific renewable energy devices are exempted from state franchise taxes.⁶¹ This exemption also applies to certain components of the renewable energy device supply chain.⁶² Similarly, Wisconsin has established a manufacturing and agriculture tax credit that effectively eliminates tax on income generated by manufacturing activity in the state.⁶³

Looking to Texas and Wisconsin as examples, North Carolina could pass similar legislation allowing a franchise tax exemption or an income tax credit for businesses engaged in the manufacturing or installation of utility-scale batteries and related equipment, including any part of the supply chain. The income tax credits



could be refundable and transferable to allow companies that have not yet experienced a tax burden to take advantage of them. Refundable and transferrable tax credits can be sold for cash, allowing companies to benefit from the incentive immediately rather than having to wait to turn a profit. By limiting the exemption to companies manufacturing or installing in the state, the exemption encourages companies to set up manufacturing facilities or installation services in North Carolina and create local jobs.

Chapter Summary

Battery costs are falling as technology improves and manufacturing becomes more cost-effective. Simultaneously, global demand for utility-scale batteries is growing rapidly. Smart, strategic policy choices can help leverage North Carolina's unique strengths and base of anchor companies to create a thriving utility-scale battery cluster. North Carolina's policymakers could consider removing barriers and stoking in-state demand to create a more diverse and robust utility-scale battery sector. Having a strong in-state market will attract private investment and manufacturing to the state, which will create good-paying jobs throughout the supply chain. As clusters coalesce around a nucleus of activity and relationships, North Carolina is well positioned to become a leader in the utility-scale battery industry.



Photo Credit. Courtesy of Alevo

Chapter 3: Biogas

North Carolina's policymakers will play a decisive role in the future of biogas in the state. By targeting the state's emerging biogas sector with smart and strategic policy choices, North Carolina's leaders can attract jobs while meeting a portion of the state's energy needs. With policies that encourage growth and technological innovation, North Carolina can create a strong in-state market and capitalize on export opportunities for biogas technology in regional and national markets.

This chapter provides a guide to developing and strengthening North Carolina's emerging biogas sector. After analyzing North Carolina's existing biogas supply chain and discussing the state's potential for creating good-paying jobs, the chapter culminates in policy recommendations for future growth. These recommendations chart a course for North Carolina policymakers to generate and enhance job-creating clusters in the biogas sector.

What is Biogas?

Biogas is created by converting biological waste into methane gas. Anaerobic digesters break down organic material from agricultural and wastewater treatment facilities, while wells and pipes collect biogas produced naturally in landfills. Anaerobic digesters are air and watertight, which improves air quality and prevents pollutants from contaminating waterways.¹ Once biogas is collected and upgraded, it can be used in various settings to generate heat and electricity, similar to natural gas.² Sometimes called renewable natural gas (RNG), biogas can be used in fuel cells and in place of compressed or liquid natural gas for transportation.³

Benefits of Biogas Production

- Increases farm revenues
- Creates rural employment opportunities
- Reduces offensive manure odors
- Improves water quality
- Provides a consistent source of renewable energy
- Provides a locally-sourced natural gas equivalent without fracking
- Creates digestate, a high-quality fertilizer and the by-product of anaerobic digestion
- Reduces emissions of methane, a greenhouse gas twenty-five times more potent than carbon dioxide⁴



This Revolution Energy Solutions (RES) Duplin County biogas project, in conjunction with another RES digester nearby, processes waste from 10 adjacent farms and nearly 74,000 hogs. The two projects together create enough electricity to power at least 738 homes annually. Photo Credit. Revolution Energy Solutions

Strengths, Weaknesses, Opportunities, and Threats for Biogas in North Carolina

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> • Abundant, renewable, locally-sourced fuel from existing resources, such as swine and landfill waste • Addresses community health and environmental concerns, such as poor air and water quality • Strong university research • Renewable Energy and Energy Efficiency Portfolio Standard (REPS) set-aside for electricity and thermal energy generated from biogas collected from swine and poultry waste 	<ul style="list-style-type: none"> • High capital costs and long development time • Primary actors slow to adopt technology • Lack of understanding of benefits of biogas harvesting by public officials • Risk falls mainly on producers • Lack of clear upfront contracts regarding power and Renewable Energy Credit (REC) pricing • Few anchor companies • Organic wastes owned and managed by many small-scale generators (farmers)
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> • Large untapped local market • Additional revenue stream for agricultural businesses • Potential to export throughout the Southeast United States • Provide energy fuels for more than just energy generation, including transportation and heating homes • Potential uses for local military installations • Provide needed distributed generation resources 	<ul style="list-style-type: none"> • Rollback of REPS set-asides • Attempt by utilities to meet REPS set-asides with out-of-state biogas • Loss of grant funding and incentives • Long development cycles leading to discouraged producers • Subsidized development of conventional energy fuels • Low natural gas prices



Anaerobic Digesters Contribute to Public Health

Using anaerobic digesters for biogas production can be a powerful tool in mitigating the dangerous health risks and high costs associated with waste-contaminated waterways. As of December 2015, North Carolina had 8.8 million hogs creating an average of 116 million tons of manure per year.^{10,11} In-state hog operations and waste are concentrated in five contiguous, low-income counties, putting many residents at risk for health issues.^{12,13} The excess manure in these areas has contaminated both surface and well water through the transmission of pathogens such as *E. coli*.^{14,15,16} The anaerobic digesters used to collect biogas can prevent water pollution by containing contaminants.

North Carolina is well positioned to build a robust biogas technology sector, spur business creation, and stimulate job growth throughout the state. North Carolina is the second largest hog and turkey producer in the United States, meaning there is abundant, renewable, “on-the-ground,” locally-sourced fuel.⁵ North Carolina also ranks in the top five in the country in several other agricultural and livestock sectors, including broilers, sweet potatoes, and cucumbers.^{6,7} Additionally, North Carolina houses numerous food and livestock processing plants, dairy farms, and a variety of cropping systems, all of which produce organic wastes that can be repurposed in advanced energy systems.⁸ Biogas production could provide an additional revenue stream for these businesses. As the ninth most populous state in the country, North Carolina citizens produce a significant amount of organic wastes that are typically landfilled, presenting an additional source of biogas system feedstocks.⁹ These robust industries in North Carolina provide valuable feedstock sources for the biogas sector.

North Carolina State University and Duke University are conducting cutting-edge waste-to-energy research, including work on innovative technology, demonstration projects, and economic analyses.¹⁷ This research contributes to improvements in the value proposition for North Carolina farmers and biogas developers and helps stimulate the industry.

North Carolina’s leaders have already begun efforts to stimulate in-state demand for biogas. The Renewable Energy Portfolio Standard (REPS) requires North Carolina utilities to purchase a percentage of their energy from sources derived from swine and poultry waste.¹⁸ The utilities commission has also allowed a premium price for the electricity generated from these sources. Although this set-aside creates market demand for biogas at a favorable price, enforcement has been delayed and large-scale deployment has not occurred. The NCUC found that compliance was hindered by a number of factors, including project delays, early stage technology, interconnection issues, and reluctance of farmers to sign long-term agreements.¹⁹ Utilities are now attempting to meet the REPS requirements with out-of-state biogas, potentially dampening in-state demand for biogas and fueling the biogas economies of other states.

Several in-state companies providing equipment to the hog and poultry industries could retool their manufacturing processes to produce digester equipment. Currently, most biogas equipment manufacturers are located in the Midwest, making service and maintenance in the Southeast inefficient.²⁰ North Carolina companies could fill this gap in the state’s biogas supply chain and become leading equipment manufacturers in the Southeast.

To achieve its goal of a reliable, affordable energy future, North Carolina must reduce dependence on any single energy source. Increasing in-state biogas production could diversify North Carolina's energy resource mix and reduce dependence on imported fuel. Lack of access to affordable capital, inadequate understanding of biogas benefits by policymakers, and low in-state demand are hindering project development and preventing North Carolina from realizing the full economic benefit of biogas technology investments. Through policy leadership aimed at overcoming these barriers, North Carolina can jumpstart the biogas sector and create good-paying jobs.

Biogas Market Trends

Rising Demand and Cost Competitiveness

The global biogas market is poised for significant growth. Analysts expect the market to reach over \$33 billion by 2022, nearly twice the size of the 2011 market.²¹ Environmental concerns, increased demand for distributed generation, infrastructure build-out for natural gas, and expansion of the compressed natural gas (CNG) vehicle market will all contribute to the biogas industry's future growth.²²

Upgraded biogas, or renewable natural gas (RNG), can be used exactly like natural gas, opening up a broad range of end-uses and markets. RNG can run through a standard natural gas pipeline, generate electricity, heat homes and businesses, and be used for transportation. Demand for natural gas is expected to rise through 2020 at an average rate of 2 percent each year.²³ Much of this future demand could be captured by an expanded biogas industry.

Corporate initiatives and innovative technologies could also increase biogas demand. For example, Bloom Energy, a manufacturer of innovative fuel cells for commercial facilities, uses biogas to provide clean energy to over thirty Walmart installations.²⁴ Other companies such as Google, Coca Cola, IKEA, eBay, and Adobe have installed Bloom's fuel cells, often contracting to purchase biogas as fuel.^{25,26,27} Apple currently purchases biogas to fuel the Bloom Energy Servers at its data center in Maiden, North Carolina.²⁸

While biogas is not yet cost competitive with natural gas, increased investment in RNG technologies could lead to economies of scale that would result in more competitive pricing for biogas. Furthermore, natural gas prices in the United States are expected to rise over the next two years, bringing RNG even closer to market competitiveness.²⁹



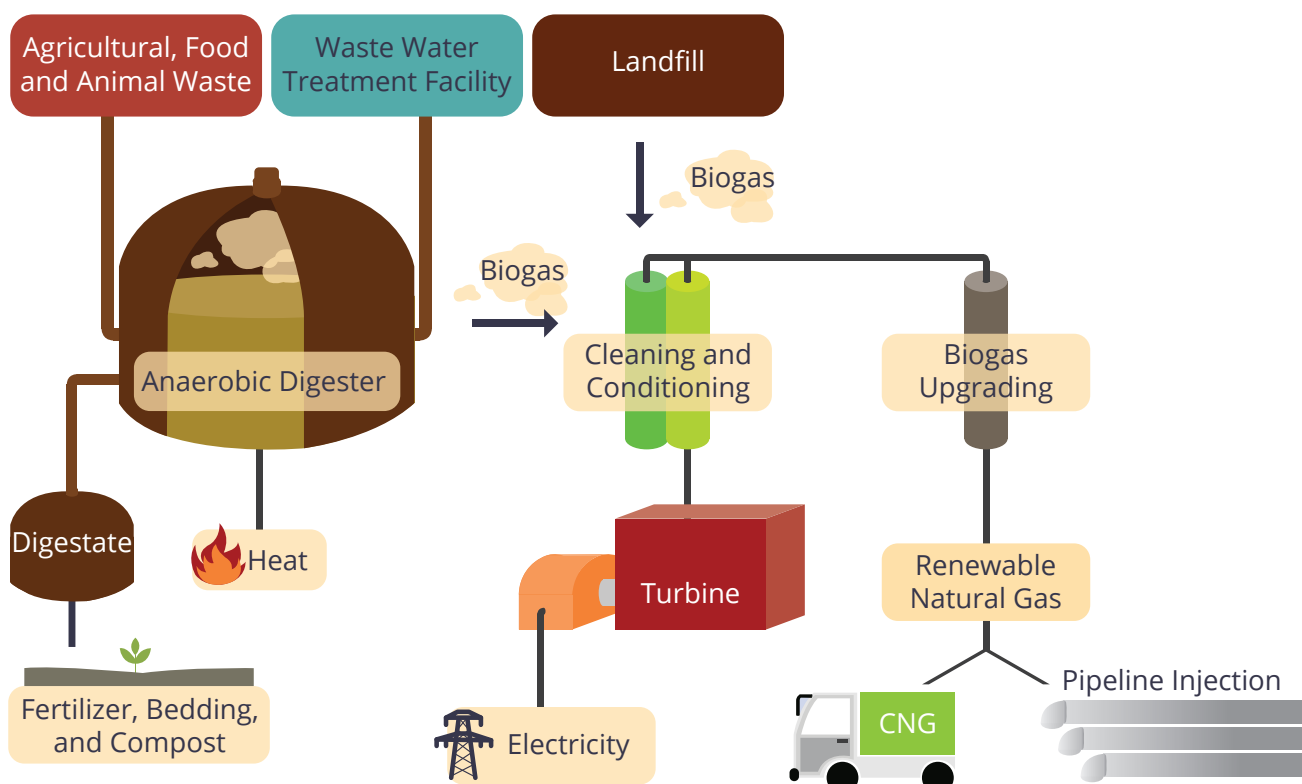
What Does This Mean for North Carolina?

North Carolina's current economy produces an abundance of feedstocks that could be used to meet the demand for biogas. Indeed, North Carolina ranks third in the country for biogas potential.³⁰ The state currently boasts seventy-five biogas production facilities, with the potential for approximately 900 additional projects.³¹

Increasing North Carolina's biogas technology manufacturing could create opportunities for trade with neighboring states. The Southeast does not currently house many biogas equipment manufacturers.³² As a result, North Carolina has the opportunity to become a leader in biogas equipment exports, helping boost economic and job growth in the state. Policies that foster a strong in-state market, develop the biogas technology supply chain, promote access to capital, and invest in workforce development will attract biogas technology manufacturing companies to North Carolina.

Biogas Technology

In order for North Carolina policymakers and leaders to craft forward-thinking policy that reflects the future of the biogas sector, it is important to understand the manufacturing process.



Biogas Technology Supply Chain

The biogas technology supply chain is comprised of companies working across a diverse array of technological fields. Several North Carolina businesses already work in key segments of the biogas industry, such as project development, engineering, and component production. Table 2 describes each of these technological fields, lists the number of North Carolina companies in each field, and identifies areas where the state is especially strong (highlighted in grey), as well as areas with room for growth (highlighted in green).

Table 2. Companies in North Carolina's Biogas Supply Chain

COMPANY TYPE	NUMBER IN STATE	DESCRIPTION
Turnkey Company	3	Develops project, manufactures components, obtains equipment and operates full system
Project Developer	7	Develops project for specific location
Project Consultant	12	Provides outside assistance to either project developers or project owners
Engineering	9	Assists with feasibility studies and project planning
Financial	6	Provides financial assistance to biogas projects in North Carolina
Digester Components	9	Manufactures: tank, mixers, covers, flow sensors, and electrical components contained within the digester unit
End Use Components	6	Manufactures: biogas-compatible electrical generating units, biogas-compatible heat generation units, and means of transporting biogas for end use. Only included companies that have supplied the biogas industry to date
Biogas Conditioning Components	4	Manufactures components used in biogas conditioning services
Research and Development	17	Institutions currently active in biogas research
Total Companies	73	

Key: Strength and Opportunity for recruitment*

*Strengths and opportunities for recruitment were based on the size and strength of companies. For example, several small start-up companies are not as advantageous as a large supplier that has the capital to produce at economies of scale.

The technology used in a biogas project depends on the type of feedstock inputs used. As a result, the supply chain requires different components for each type of feedstock, enabling many different companies to contribute to production. The supply chain includes turnkey companies that design and manufacture full systems, project managers that help get projects off the



Agility Fuel Systems Opens CNG Vehicle Tank Facility in North Carolina³⁵

Agility Fuel Systems is a leading manufacturer of natural gas fuel systems for industrial vehicles in North America. In October 2015, Agility opened a vertically-integrated 204,000-square-foot manufacturing plant in Salisbury, North Carolina. Since locally-produced RNG can be used in these tanks, Agility could serve as an anchor for the state's emerging biogas cluster.

ground, and component manufacturers that contribute to the biogas collection system or the post-processing system. Examining specific components within the supply chain can help North Carolina's policymakers leverage the state's strengths and capitalize on future growth.

Strengths and Opportunities for Growth

North Carolina's robust research and development (R&D) activities, skilled workforce, business-friendly climate, and existing involvement in the biogas sector create a strong foundation for significant future investment. North Carolina houses several biogas consulting, engineering, construction, and project development companies. One of these companies, Cavanaugh & Associates, is active in biogas project research, development, and deployment throughout the state.³³ Crowder Construction, an industrial construction firm based in Charlotte, has built several waste-to-energy projects in the Southeast.³⁴

The state is home to only a few build-own-operate companies in the biogas industry. Enerdyne Power Systems has developed landfill biogas systems throughout the country.³⁶ Charlotte-based Blue Sphere Corporation has several biogas projects in the United States and Italy, including a 5 megawatt (MW) food waste-to-energy plant in Charlotte.^{37,38} Expanding the base of companies developing turnkey projects for all feedstock inputs could facilitate significant expansion of the biogas sector in North Carolina.

North Carolina's policymakers could leverage existing manufacturing operations to fill gaps in the supply chain and help the state become a leader in biogas equipment production. Hog Slat, a leading manufacturer and supplier of swine farm equipment, could be encouraged to expand its operations to include manufacturing liners and piping for digesters.³⁹ Additionally, General Electric could diversify its in-state operations beyond large turbines to include the microturbines used for on-farm electricity generation from biogas. Elster Group, a global leader in metering equipment that currently services North Carolina's smart-grid industry, could expand in-state operations to include the specialized biogas equipment it currently manufactures elsewhere.⁴⁰ Landia, a world leader in biogas components, could grow beyond its in-state sales office to establish a North American manufacturing base in North Carolina.⁴¹

North Carolina could also recruit liner and cover manufacturers to develop its supply chain, as these companies are crucial to the biogas collection process. The majority of North Carolina farms are suitable for covered, lagoon-style digesters. Covered lagoons require liners to separate waste from the land and prevent water

contamination. The state could also look to recruit businesses that manufacture specialized biogas equipment, including conditioning tanks, scrubbers, associated pumps, and other small components. A strong base of companies that manufacture components for the biogas upgrading process would also bring significant value to North Carolina's supply chain.

North Carolina lacks businesses adept at maintaining and repairing biogas systems. Having warehouses to store spare parts would reduce the downtime and repair costs associated with broken digester systems. North Carolina could attract businesses that specialize in systems maintenance, as well as facilities that house spare parts used in digesters.

North Carolina's Biogas Cluster

The American Jobs Project mapped North Carolina's biogas supply chain to show the development of natural clusters in the state. The map below shows that biogas clusters are beginning to form around Charlotte and Raleigh. These early-stage clusters are bolstered by proximity to the agricultural sector.

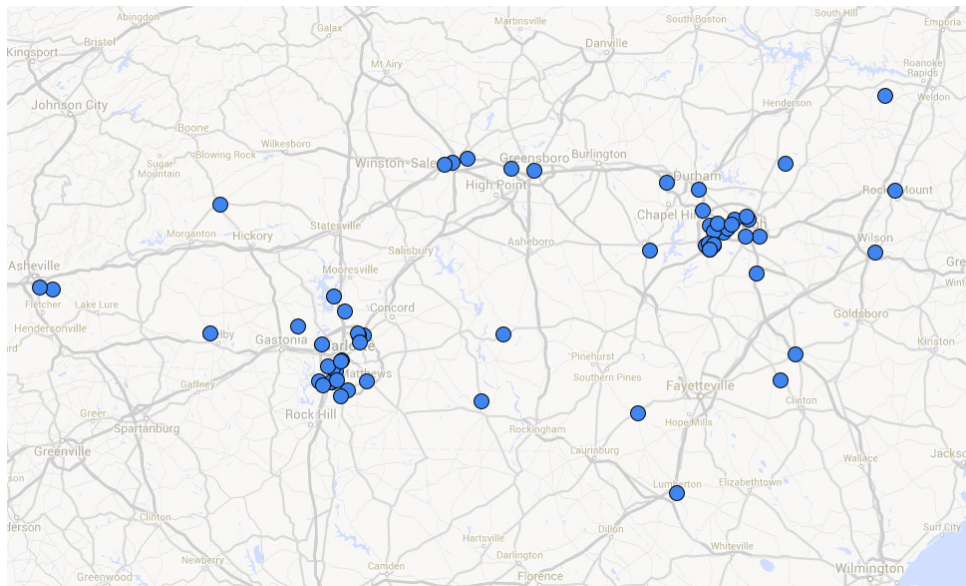


Figure 6. Top businesses in North Carolina's biogas supply chain clusters around Charlotte and Raleigh.



North Carolina has a large number of farms in and around Fayetteville, Kingston, Jacksonville, and Lumberton. Additionally, the state has a dairy farm cluster around Statesville and Hiddenite, and a poultry farm cluster outside of Raleigh. These feedstock sources could encourage growth of biogas manufacturers and maintenance companies nearby. The maps below show swine farms, dairy farms, and landfill sites that are candidates for biogas projects in the state. There are many other candidate sites that are not represented by these maps.

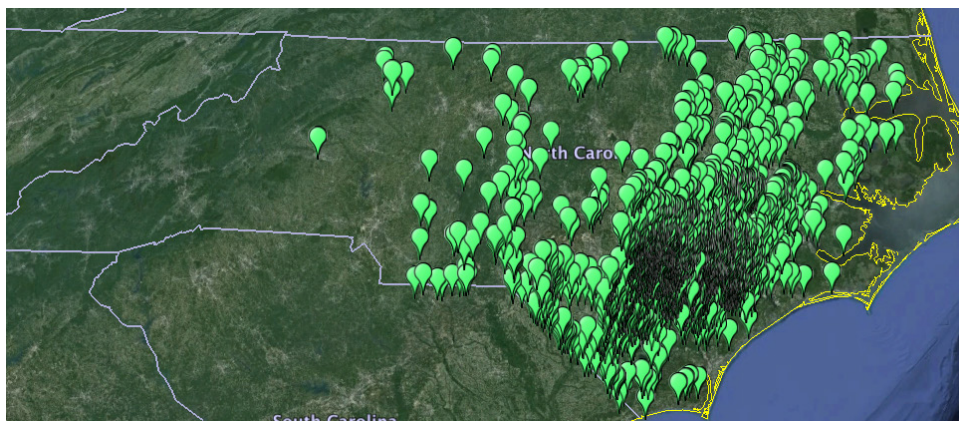


Figure 7. North Carolina's swine farms that are candidates for biogas projects.

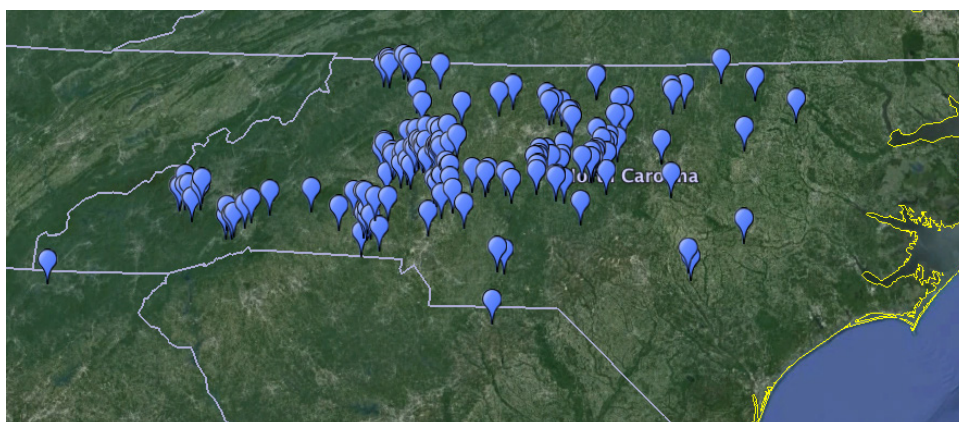


Figure 8. North Carolina's dairy farms that are candidates for biogas projects.



Figure 9. North Carolina's landfills that are candidates for biogas projects.

North Carolina's Potential for Biogas Jobs

As demand for biogas rises, North Carolina has the opportunity to expand the biogas industry, increase in-state spending, and employ an average of over 2,200 North Carolinians annually over the next fifteen years. If North Carolina's biogas companies are able to develop all candidate biogas projects from swine, dairy, and landfill operations, nearly 34,000 direct, indirect, and induced job-years would be supported. While nearly 13,000 of those would be direct job-years in the state's biogas industry, roughly 21,000 indirect and induced job-years would also be supported.

Our analysis begins with estimates for potential biogas projects from the American Biogas Council.⁴² These estimates represent the current technical potential to create biogas projects at existing swine and dairy farms and landfills. We then applied these estimates to IMPLAN models for swine, dairy, and landfill biogas projects from the University of Tennessee's Biobased Energy Analysis Group.⁴³ The IMPLAN models were replicated for three scenarios. First, as a low scenario, we analyzed the indirect and induced jobs created using a multiplier that represents the current state of North Carolina's supply chain. Then, as a high demand scenario, we analyzed the jobs created by using a multiplier for the national economy, representing a near-perfect supply chain. A moderate scenario was created by looking at the mid-point between the high and low multipliers. It should be noted that our analysis did not include all of the potential projects in the state, rendering more conservative estimates. For example, projects involving wastewater treatment facilities, poultry waste, and centralized digestion using aggregated waste from small-to-medium sized farms were not considered.

If a concerted effort were made to consolidate the supply in North Carolina, thousands of job-years could be created. For example, increasing in-state purchases to move from the low scenario to the high scenario would create over 9,400 job-years. Increasing in-state purchases to move from the low scenario to the moderate scenario would create over 4,500 job-years, bringing the number of direct, indirect, and induced job-years to nearly 29,000 through 2030.

If North Carolina is able to develop all candidate biogas projects from swine, dairy, and landfill gases as identified by the American Biogas Council and fill in the supply chain in state, North Carolina's biogas industry could support an average of over 2,200 jobs per year. Increasing the number of supply chain businesses can create good-paying, skilled jobs and make North Carolina a leader in the biogas industry.

What is a Job-Year?

A job-year is one full-time equivalent job for one year (i.e., forty hours per week for fifty-two weeks, which is 2,080 hours per year). If two people each work a part-time job for twenty hours per week for fifty-two weeks, this is counted as one full-time equivalent job for one year, i.e., one job-year. If one person works forty hours per week for ten years, this is counted as ten job-years.

Why Use Job-Years?

By using job-years, our analysis can take into account the length of a job. In energy projects, many construction and installation jobs are short-term, while manufacturing and maintenance jobs may be long-term. Using job-years allows us to accurately count both types of jobs. For example, if ten full-time biogas project construction workers are expected to each spend 208 hours on a landfill biogas gas project, this is measured as one job-year. Alternatively, if one full-time engineer is expected to spend fifteen years operating on that same swine biogas digester project, this is measured as fifteen job-years. In our analysis of North Carolina's biogas supply chain, total job-years are aggregated over the 2016 to 2030 period.



Direct, Indirect, and Induced Job-Years

In order to estimate the potential economic impact of North Carolina's biogas supply chain, direct, indirect, and induced job-years are measured.

- **Direct job-years:** reflect jobs created in the biogas industry to meet demand
- **Indirect job-years:** reflect jobs created at supply chain companies resulting from increased transactions as supplying industries respond to increased demand from North Carolina's biogas industry.
- **Induced job-years:** reflect jobs created throughout the local economy as a result of increased spending by workers and firms in North Carolina's biogas and biogas supply chain industries.

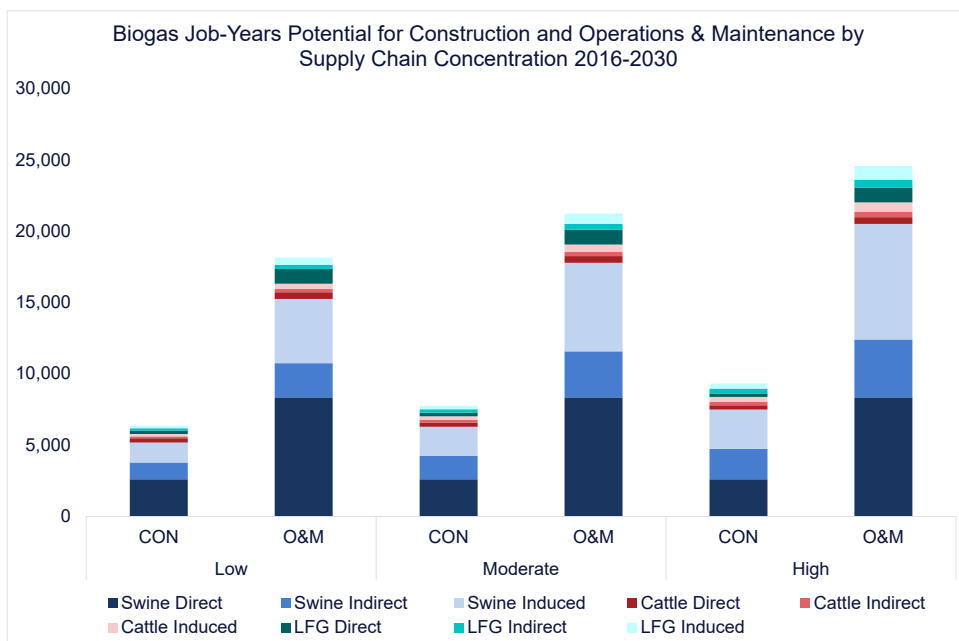


Figure 10. Increasing local spending will increase job-years for North Carolinians.



Inside a Landfill Biogas Facility

Photo Credit. pembina.institute / Foter / CC BY-NC-SA

Policy Recommendations

Policymakers can bolster North Carolina's biogas cluster by focusing on innovative policies that stimulate demand and encourage production within the state. Fostering a robust in-state market will attract private investment, strengthen the economy, and create new value chains. By eliminating barriers placed on local businesses, North Carolina could become a leader in regional and national biogas markets. North Carolina leaders could create good-paying jobs by improving knowledge and understanding of the biogas industry, providing strategic tax relief, increasing project financing options, encouraging the use of biogas fleet vehicles, and improving the economic viability of biogas investments.

Policy 1: Create a North Carolina Biogas Public-Private Partnership

Currently, North Carolina's biogas sector does not have organized leadership. Misinformation and lack of understanding about the costs and benefits of anaerobic digestion hinder market growth in the state. The industry requires strong leadership to bring stakeholders together, provide critical information about costs, and facilitate large-scale deployment throughout the state. Creating a biogas working group would help cultivate strong leadership, educate policymakers, foster strategic public-private relationships, and identify opportunities for growth. North Carolina's policymakers could look to Wisconsin for an example of an effective biogas working group.

Wisconsin Biogas Development Group

The Wisconsin Biogas Development Group is a public-private partnership through the Wisconsin Department of Agriculture, Trade and Consumer Protection. The group convenes the state's energy and agricultural interests and has worked for over a decade to make the state a leader in the U.S. biogas sector.^{44,45}

A North Carolina biogas public-private partnership would help foster relationships and build networks to grow the industry. At the outset, the governor's office could create a biogas task force to spearhead efforts. The Biogas Task Force could begin with a group of representatives from the recently re-launched NC Bioenergy Council, NC Department of Environmental Quality, NC Environmental Protection Agency, Department of Agriculture, the NC Agricultural Finance Authority, Department of Commerce, and private industry. The NC Bioenergy Council is likely to take the lead as its mandate to connect industry stakeholders and



Foreign Direct Investment Opportunities

European companies are currently looking to manufacture their biogas equipment in the United States and cite supportive policies and politics as key factors in where they choose to locate.⁴⁶ North Carolina is a prime destination for these companies, but without a targeted effort, other states will reap the benefits of this opportunity. The Partnership could actively recruit these foreign companies to attract foreign capital, expand the state's biogas sector, and create good-paying jobs for residents. European companies that the Partnership could approach are: BEKON (turnkey), Fickert & Winterling Maschinenbau (turnkey), Klapp & Partners (turnkey), Streisal (mixers), Carbotech (biogas upgrading), Cirmac (upgrading), MT Energie (turnkey), Ros Roca Envirotec (waste collection systems), Dreyer & Bosse Kraftwerke (combined heat and power and upgrading), and Malmberg (upgrading).

encourage bioenergy sector growth closely aligns with the goals stated above. The Governor's Biogas Task Force and the NC Bioenergy Council could enter into a public-private partnership (the "Partnership") with the Economic Development Partnership of NC to pursue clearly identified goals.

Once formed, the Partnership could identify areas in which the state could recruit large-scale developers and support biogas companies as they grow. Additionally, it could work closely with the governor's office to identify and recruit foreign companies in the biogas supply chain to open manufacturing operations in North Carolina. The Partnership could also work with local officials to facilitate and streamline the biogas project development process. The organization could collaborate with utilities and government to create standardized documentation, including a biogas "toolkit" to reduce soft costs; identify financing options; streamline the timing of project development; and improve the regulatory framework for RNG injection into pipelines.

The Partnership could collaborate with the local branches of the NC Natural Resources Conservation Service and North Carolina Cooperative Extension Service to disseminate information and facilitate outreach. Based at North Carolina State University and North Carolina Agricultural and Technical State University, these organizations devote resources to agricultural education and are well-known and trusted by the farming community. Educating farmers about how they can maximize returns from anaerobic digestion—by selling digestate, increasing efficiency by adding additional feedstocks (co-digestion), and tipping fees—is an important means of increasing uptake.

Establishing a biogas public-private partnership with strong support from the governor's office will send a market signal that North Carolina is committed to becoming a leader in the industry and that the state is primed for project development. The Partnership could catalyze significant growth in North Carolina's biogas sector and make the state a regional and national leader in the industry.

Policy 2: Exempt Biogas Projects from Property Tax

North Carolina collects taxes based on the present-use value of farms, rather than the assessed value of the land if it were to be sold for development. This is an incentive for farmers to keep their land in use as a farm and not sell to developers. However, adding significant improvements to the farm, such as an anaerobic digester and associated equipment, would significantly increase the value of the farm and the property tax liability of the farmers. By establishing a property tax exemption for the value added to property by waste-to-energy systems, the state could remove a barrier preventing adoption of the technology on North Carolina farms.

North Carolina offers a property tax abatement for solar photovoltaic (PV) installations. The abatement excludes 80 percent of the value of a residential PV system from property tax assessments.⁴⁷ This tax abatement contributed to the exponential growth of the solar PV industry in North Carolina. Currently, thirty-eight states in the country have renewable energy property tax abatement laws that incentivize growth across multiple industries.⁴⁸

North Carolina policymakers could extend property tax exemptions to include all properties installing new biogas or waste-to-energy equipment. The legislation could provide fifteen to twenty years of abatements in order to give farmers and developers the certainty and stability they need to invest in projects. Policymakers can consider the appropriate percentage of abatement, bearing in mind the needs of both the farmers and tax assessors. By reducing the additional costs of installing this technology, North Carolina can incentivize new investment and remove barriers for adopting biogas technology on farms throughout the state.

Policy 3: Establish a Loan Program for Biogas Projects

Biogas projects require a large upfront capital investment and, in most cases, the use of financing. Low-cost financing is critical to creating favorable economics for biogas projects. In order for the pay-back period for a biogas project to be within an acceptable time frame, the project must be financed at a low interest rate. Due to the perceived high risk of biogas projects, low interest rates are difficult to obtain. Other financing mechanisms intended to provide low-cost financing, such as the Green Community Program, are costly, cumbersome, and state allocation funds are nearly depleted.⁴⁹ Given the economic potential and public health



Earmark Loan Funds for Factory Retooling

Although North Carolina is home to several companies that produce farm equipment and electrical generators, the cost of retooling a factory could be a barrier to expanding these businesses into the biogas sector. North Carolina could overcome this barrier by earmarking a portion of the biogas loan program for North Carolina's manufacturers to purchase machinery and equipment, upgrade or build facilities, or to use as initial operating capital. To receive a loan, firms could be required to meet certain metrics, such as a minimum number of jobs produced in the state. The state could model its factory retooling initiative after a successful program in Wisconsin.

Wisconsin's Clean Energy Manufacturing Revolving Loan Fund

In 2009, Wisconsin established the Clean Energy Manufacturing Revolving Loan Fund (CERLF) to provide low-interest financing (up to \$1 million) to private companies for manufacturing facility upgrades.⁵² For example, Gearbox Express, a Wisconsin-based manufacturer of wind turbine components, utilized CERLF funding to expand and grow its advanced energy operations.⁵³

benefits of capturing methane from waste, North Carolina leaders should consider improving access to low-cost capital for these types of projects. Policymakers could create a dedicated and streamlined loan program for biogas projects. The government could issue bonds at a very low rate using a guarantee under the Clean Water State Revolving Fund program and pass the savings on to consumers in the form of lower borrowing costs.

The New York State Energy Efficiency Research and Development Authority (NYSERDA) issued \$24.3 million in revenue bonds that were guaranteed by the New York Clean Water State Revolving Fund (SRF) program and earned a AAA rating.⁵⁰ NYSERDA successfully petitioned the New York State Environmental Facilities Corporation for assistance with energy efficiency projects under the SRF program due to the fact that energy efficiency programs can reduce fossil fuel consumption and air pollutant deposition in water bodies.⁵¹

Biogas projects protect waterways and drinking water from runoff waste and replace coal-burning generation. As a result, the use of the North Carolina SRF for the biogas industry is justifiable. The revenue bonds could be issued by the North Carolina Department of Environmental Quality (NCDEQ) and backed by a guarantee through a special-purpose vehicle under the North Carolina SRF. The bonds would be sold as taxable Qualified Energy Conservation Bonds which provide a partial federal interest subsidy. NCDEQ, in conjunction with a private partner, could use the revenue from the bonds to establish a loan program dedicated solely to the biogas industry. As loans are repaid, the fund would continue to invest in new projects. Thus, the initial funding would last indefinitely. Public financiers will need to partner with local finance experts and collaborate to streamline the process, improve the availability of data, and standardize documentation.

Establishing a formal biogas loan program will send a signal that North Carolina is serious about cultivating biogas projects, growing its manufacturing base, and attracting good-paying jobs.

Policy 4: Enable the Use of Performance Contracts for Biogas Fleet Vehicles

Alternative Fuel Vehicles (AFVs), powered by renewable natural gas (RNG), are a way for local and state governments to enhance energy security, decrease fuel costs, and stimulate demand for locally-sourced fuels.⁵⁴ Despite these benefits, barriers such as lack of experience with AFVs, inability to accurately predict cost savings, limited budget authority, and lack of access to financing and incentives prevent governments from retooling their fleets to use alternative fuels such as biogas.⁵⁵ To retool public fleets, North Carolina could look to states like Colorado and Pennsylvania for examples of successful fleet vehicle ESCO programs.

What Is an ESCO?

Energy service companies (ESCOs) operate on a performance contract to develop, facilitate financing for, and install energy efficiency projects in buildings. ESCOs traditionally serve governments, hospitals, universities, and schools, saving these end-users a total of \$50 billion in avoided energy costs between 1990 and 2014.^{56,57}

Johnson Controls Inc. and Rose Tree Media School District

The Rose Tree Media School District near Philadelphia, Pennsylvania worked with Johnson Controls Inc., an ESCO, to establish energy efficiency building performance contracts. Johnson identified an additional opportunity for savings—converting the bus fleets to use compressed natural gas. Johnson managed the conversion of diesel buses to natural gas, converted maintenance infrastructure and operations, built fueling stations, and provided staff training and transition assistance. The Rose Tree School District, which operates seventy-four school buses, is projected to save \$6.5 million in fuel costs and \$1 million overall on the project.⁵⁸

North Carolina could use a similar performance contract model to retool municipal fleets and save money. Currently, North Carolina only allows for energy service contracts in public buildings—public fleets are not included.⁵⁹ North Carolina could look to Colorado's 2013 legislation, which allowed vehicle fleet maintenance and fuel cost-savings contracts in public fleets.

Colorado Legislation

In 2013, Colorado amended the state's utility cost-savings measures law, which previously applied only to buildings, to include fleet vehicles. Vehicle fleet maintenance and fuel cost-savings can now be included in public contracts, as long as overall savings are equal to or higher than the contract amount.⁶⁰

By including fleet vehicles in ESCO contracts, North Carolinian municipalities, hospitals, schools, and universities can retool their fleets to save money, capitalize on local resources, create good-paying jobs, and preserve public health in the process.



Policy 5: Create a Carbon Offset Market Aggregator

Biogas projects qualify as carbon offsets because they reduce methane gas emissions. Carbon offsets can improve a project's financial viability and create significant revenue streams for the project developer, but only if they can be sold in the marketplace. Currently, there is no sizeable carbon offset market in North Carolina and participation in other markets is complicated, with high transaction costs for a single player. Carbon offset aggregators pool carbon offsets from multiple projects, reducing the soft costs associated with selling in the marketplace.⁶¹ Aggregators can also serve as project developers, providing the capital needed to finance projects.⁶²

What Is a Carbon Offset?

A carbon offset is a reduction in the emission of a greenhouse gas. Reductions are accomplished by capturing greenhouse gases from the atmosphere or reducing the emissions from a source. An offset is meant to compensate for an emission happening somewhere else. A carbon offset is a tradable commodity. For example, carbon offset producers can sell offsets to companies wishing to reduce their carbon footprint. In North Carolina, swine biogas producers can sell renewable energy credits and carbon offsets separately, which expands revenue streams and increases the economic viability of biogas projects.⁶³

What Is a Carbon Offset Market?

A carbon offset market offers a venue for sellers and buyers of carbon offsets to conduct transactions. Markets exist in many U.S. states and regions, as well as countries around the world. There are two mandatory carbon markets in the United States: the California Cap and Trade Program and the Regional Greenhouse Gas Initiative (RGGI) in the Northeast.^{64,65} The United States also has a voluntary carbon market where companies and people can sell and purchase offsets. Carbon offset standards and verification differ widely across markets.⁶⁶ There are dozens of offset certifiers that qualify under different schemes and have different standards for certification. Working with reputable certifiers helps ensure that offsets are verifiable and can be sold across voluntary and mandatory markets.

Aggregators have been successful in Brazil and North Dakota. Sadia, Brazil's largest exporter of meat products, contracts with farmers to grow hogs but does not actually own the farms. Smithfield Foods, North Carolina's largest hog producer, operates under a similar business model. Sadia formed a nonprofit organization to oversee, finance, operate, maintain, and sell carbon offset credits from its partner farms.⁶⁷ Over the course of seven years, Sadia installed more than 1,100 anaerobic digesters at partner farms.⁶⁸

In North Dakota, the nonprofit North Dakota Farmers Union (NDFU) serves a different role. The NDFU created protocols that were "streamlined, easy to use, and unobtrusive to landowners."⁶⁹ For a small fee, it arranged for verification, registration and sale of carbon offset credits. Over the course of four years, the NDFU aggregated over 3,900 producers from all over the country who collectively earned more than \$7.4 million in offset sales.⁷⁰

A combination of these aggregator models could be successful in North Carolina. A private company such as Smithfield Foods or Prestage Farms could form a public-private partnership with the North Carolina Cooperative Extension or the NC Natural Resources Conservation Services (NRCS). The private company could leverage existing relationships with the farming community to promote the program; provide finance, oversight, and maintenance of the carbon credits; and sell the carbon credits to existing carbon markets. The Cooperative Extension or the NRCS could streamline the process, educate participants, and provide verification services.

Policy 6: Allow Third-Party Sales of Biogas-Generated Electricity

A main barrier to growth in North Carolina's biogas sector is the reluctance of farmers to undertake biogas projects. Farmers cite difficulties obtaining favorable financing, as well as the complicated and time-consuming process of project development—filing for federal and state incentives, arranging interconnection agreements, obtaining permits, and other required paperwork. In some states, third-party ownership of biogas systems alleviates this barrier. North Carolina is one of eight states that disallows third-party sales of electricity to consumers; only regulated utilities can provide that service.⁷¹ The law effectively prohibits third-party ownership models that allow citizens to generate energy on their own property without purchasing the energy system outright.

Third-party Ownership Models

Third-party ownership models allow an investor or project developer to finance, own, and operate a biogas project on a farm. The farmer buys electricity generated on the farm from the third-party at less-than-retail rates and the third-party secures a power purchase agreement (PPA) with a utility or other customers to sell excess electricity. Third-party ownership passes the risk and administrative and management hassles of a biogas project from the farmer to the investor or project developer.

Biogas Project Third-Party Ownership

CH4 Biogas built, owns, and operates a biogas project at Synergy Dairy in Covington, New York.⁷² The 1.4 megawatt (MW) co-digestion project has “diverted more than 1.14 million gallons of food waste from landfills and wastewater treatment facilities” and uses manure from more than 2,000 head of cattle.⁷³ A portion of the electricity generated by the project provides all the electricity needs of the farm and the remainder is sold to the New York Independent System Operator (NYISO) under a power purchase agreement (PPA).^{74,75}

Allowing third parties to develop, own, and sell electricity from biogas projects could help the biogas sector achieve economies of scale to reduce overall system costs and spur in-state demand. Additionally, third-party sales could reduce farmers' risk associated with fuel supply and feedstocks—the threat of herd culls due to illness and equipment maintenance issues often increase risk in biogas projects. Utilities could also benefit from third-party sales of electricity from biogas projects. Rather than negotiating



with individual farmers, PPA and interconnection negotiations would be more efficient with professional counterparties. Additionally, large investors and active biogas developers are better informed of federal grants, tax credits, and subsidies that would optimize capital cost reductions. Opening the market to large investors and project developers by allowing third-party sales of electricity would increase the economic potential of North Carolina's biogas sector.

Chapter Summary

Smart, strategic policy choices can help North Carolina leverage the state's unique resources in order to create a thriving biogas sector. North Carolina has a strong base of biogas research, consultants, and engineers, as well as an abundance of "on the ground" biogas feedstocks. As clusters coalesce around a nucleus of activity and relationships, North Carolina's policymakers could remove barriers and stoke in-state demand to create a more robust biogas sector. By expanding property tax exemptions to include biogas projects, forming a biogas public-private partnership, a dedicated loan program, enabling performance contracts for biogas-powered fleet vehicles, creating a carbon offset market aggregator, and allowing third-party sales of electricity for biogas developers, North Carolina's leaders could strengthen the state's commitment to the advanced energy economy and maximize biogas potential.

Chapter 4: Innovation Ecosystem and Access to Capital

Innovation Ecosystem

- Promotes research and development
- Facilitates new technology to market
- Incubates early-stage businesses

Access to Capital

- Provides funding to new and growing businesses
- Connects investors with market opportunities
- Attracts entrepreneurs

Non-Dilutive Capital

Non-dilutive capital, such as a grant or loan, does not affect ownership of a company. These funding sources may carry interest rates or have restrictions on how they are used, but will not impact the shares of the company.

In today's competitive, globalized economy, businesses are more likely to thrive in cities and states that offer a rich innovative ecosystem and break down barriers to capital. A successful innovation ecosystem bridges the gap between the knowledge economy and the commercial economy, while access to capital programs provide the necessary funds to facilitate commercialization and expansion of businesses. State and local government institutions, as well as private entities, can take action and collaborate to maximize the impact of innovation, support new and expanding businesses, and create good-paying jobs in North Carolina.

Innovation ecosystems promote research and development (R&D), bring new technologies to market, and incubate early-stage businesses. Allowing ideas to be easily transferred from the lab to the marketplace accelerates further entrepreneurship and job creation. Robust innovation ecosystems include efficient intellectual property protection mechanisms, mentoring for entrepreneurs, and engagement of business and venture capital.

Access to capital is critical for the success of advanced energy technologies. New and growing businesses will face severe financial hurdles during technology development, commercialization, and expansion. Having access to investors and non-dilutive capital can be the difference between success and failure. In order to maximize the success of advanced energy businesses that create good-paying jobs, states should consider actively facilitating access to capital.

Seamless connections between researchers, entrepreneurs, investors, and non-dilutive capital are vital for advanced energy technology businesses to thrive. The new energy economy is a race, and only businesses capable of bringing innovative ideas to the marketplace quickly and efficiently will be considered winners.

North Carolina's Innovation Ecosystem

North Carolina supports a robust innovation ecosystem that is anchored by nine prominent academic institutions and a number of strong industrial sectors. However, the state lags

behind others in entrepreneurship, new company formation, and job creation by new companies. According to the 2013 Tracking Innovation report by the North Carolina Department of Commerce, the state ranked twenty-fourth out of fifty states in innovation-related performance.¹

Decreasing venture capital funds and wavering investment activity create barriers to startup activity in North Carolina.² The resulting lag in new high-tech businesses coming to North Carolina negatively impacts the state's reputation as a location for innovation and growth.³ However, North Carolina has an opportunity to attract and retain tech-based businesses through forward-thinking government initiatives, industrial partnerships, and university institutions already present in the state.

Research Institutions and Initiatives

North Carolina boasts a robust higher education system. The Raleigh-Durham area alone is home to three Tier One universities: North Carolina State University (NC State), Duke University, and University of North Carolina (UNC) at Chapel Hill. Six other prominent universities, including UNC Charlotte and Wake Forest University, contribute to the state's strong academic foundation.

North Carolina is home to a number of premier research universities, many of which provide vital resources to the utility-scale batteries and biogas industries. NC State leads PowerAmerica, a \$140 million advanced manufacturing institute sponsored by the U.S. Department of Energy that supports large-scale production of cheap and efficient semiconductors.⁴ Additionally, the FREEDM Systems Center at NC State is one of two National Science Foundation (NSF) Engineering Research Centers at the university. The FREEDM Systems Center's research focuses on the modernization of the U.S. power grid, including the development of advanced storage systems and infrastructure for a more efficient electric system.⁵ NC State also houses the North Carolina Clean Energy Technology Center, a key resource for clean energy education, technology development, and policy creation.

The Energy Production and Infrastructure Center (EPIC) at UNC Charlotte offers top-notch energy-related education and applied research facilities to engineering students. This program partners with industry to offer a collaborative and practical educational experience for students.

North Carolina Agricultural and Technical State University's Center for Energy Research and Technology also contributes leading research on biogas production from animal waste and landfills.⁶ The NCGrowth Initiative at UNC Chapel Hill seeks to help economically distressed communities in North Carolina



The U.S. Department of Energy's Oak Ridge National Laboratory (ORNL) works closely with North Carolina State University and Duke University to conduct vital science and energy research.⁹ Although the laboratory is located in Tennessee, it is an important source of technology innovation in North Carolina. Advanced energy research at ORNL includes developing utility-scale energy storage solutions and smart grid technologies for better system integration, response, and security.¹⁰

grow sustainably.⁷ For example, the initiative's Pig Power project identifies ways to leverage biogas technologies in the market and find opportunities for North Carolina firms across the value chain.⁸

Several other state universities lead research efforts in energy, including the Energy Initiative and the Nicholas Institute's Climate and Energy Program at Duke University, the Energy Center at Appalachian State University, and the Renewable Energy Lab at Cape Fear Community College. The diverse programs at these universities are valuable resources for advanced energy innovation, particularly in the biogas and utility-scale battery sectors.

In the 1960s, North Carolina's leaders established the tech-focused Research Triangle Park (RTP) as an innovation cluster between Raleigh and Durham.¹¹ RTP has since grown to house more than 200 advanced technology companies, including North Carolina's smart grid cluster.^{12,13} RTP also leads the nation in private R&D investments at local universities with over \$296 million per year, more than any other innovation cluster.¹⁴

Innovation hubs such as RTP are key to ensuring coordination between North Carolina's universities for improved economic productivity.¹⁵ InnovateNC is a new partnership between NC State University and nine major public, private, and nonprofit organizations that "supports five North Carolina communities... in expanding their innovation economies."¹⁶ InnovateNC helps local research entities build collaborative relationships and distributes information about state and federal innovation programs.¹⁷

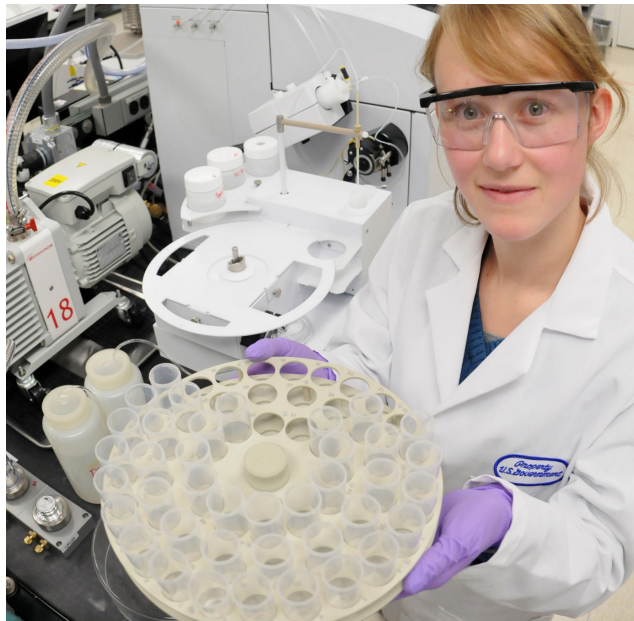


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Resources for Startups

North Carolina boasts numerous incubators and accelerators to support growing companies. North Carolina's startup accelerators include Groundwork Labs, Launch Chapel Hill, and The Startup Factory.^{18,19,20,21} The state is also home to more than thirty business incubators throughout its many research hubs.²² Notably, Charlotte-based incubator CLT Joules focuses on fostering companies in the energy space, assisting companies with business plan design, product development, finance, and pilot projects. Additionally, TheLab in RTP supports twenty-five startup companies at its wet lab space.²³ The Blackstone Entrepreneurs Network, Business Link North Carolina, Small Business and Technology Development Center, and North Carolina Innovative Development for Economic Advancement also support startup companies by providing management counseling and educational services at minimal cost.^{24,25,26,27}

The North Carolina Innovative Development for Economic Advancement (NC IDEA) fosters economic development by assisting startups with commercialization.²⁸ The program also manages a grant program for companies that have demonstrated a technological breakthrough and show high growth potential.²⁹ Awards are given on a semi-annual basis up to the amount of \$50,000.³⁰



Incubators foster collaboration and mentorship.
Photo Credit. vgajic

Incubators and Accelerators

An incubator is designed to provide support services to early-stage startups. Incubator assistance can include office space, professional networks, access to financing, and business skill training. Accelerators assist companies in the later stages of business development, usually addressing short-term needs such as product launches.

Technology Commercialization Carolina (TCC)

The University of North Carolina launched the TCC in August 2015 to support innovation initiatives in the state. TCC engages in entrepreneurship training, intellectual property assistance, market analysis, early-stage venture support, and identifying sources of funding.³¹ The U.S. Economic Development Administration i6 Challenge grant and the Kenan Institute provide funding for TCC.³²



The One North Carolina Small Business Program

The One North Carolina Small Business Fund is a federal fund-matching program. The program matches North Carolina recipients of the federal Small Business Innovative Research and Small Business Technology Transfer with funding opportunities.³⁷

Government Programs

North Carolina's state government has implemented programs to spark investment in new ventures. The state oversees several innovation funds and job training programs that attract new businesses and help retain existing companies.

To address the state's most pressing economic development needs, the North Carolina legislature created the Economic Development Partnership of North Carolina (EDPNC) in 2014.³³ The EDPNC recruits new businesses to North Carolina and supports existing businesses through retention and expansion programs.³⁴ The Department of Commerce also serves as a one-stop-shop for small businesses and startups. Services for small businesses include "assistance in commercializing new technologies and accessing innovation research," and providing access to state funding.^{35,36}

Access to Capital

Access to capital is essential for entrepreneurs to grow their businesses, bring products to market, and create new jobs. Capital pricing can make the bottom-line difference in product affordability and market viability, yet many businesses are unable to secure the necessary capital to survive the commercialization phase. As shown in Figure 11, companies nationwide face funding shortages during the prototyping and commercialization phases, commonly known as the "valleys of death." In 2014, 75 percent of venture capital funding went to companies in California, New York, and Massachusetts; businesses in the other forty-seven states had to compete over the remaining 25 percent, stifling innovation across the country and highlighting the importance of state policies for new venture capital investments.^{38,39}

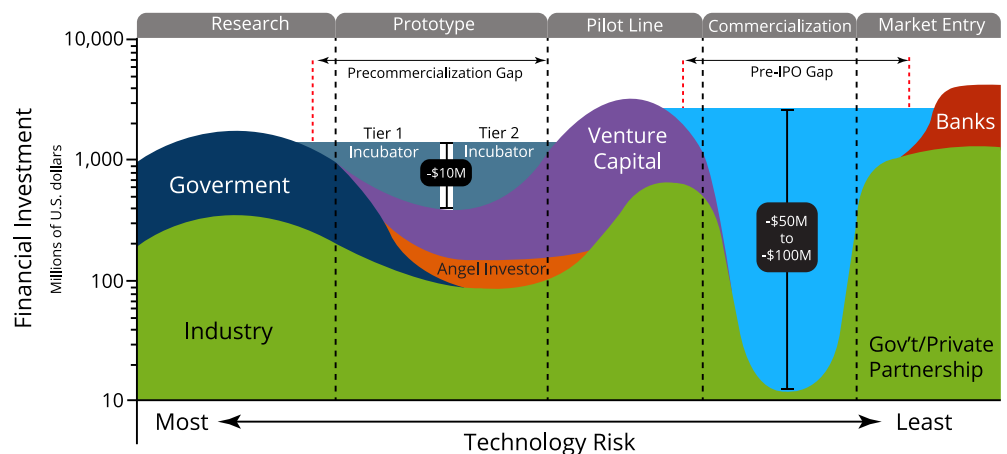


Figure 11. New technologies need help crossing the "valley of death" during the commercialization process. (Source: U.S. Department of Energy)

Advanced energy companies often lose out to more traditional tech-based industries. To ensure the success of as many new and small businesses as possible, North Carolina's lawmakers should consider creating policies to attract more diverse venture capital investments in the state.

Early-Stage Capital

North Carolina is below the U.S. average with respect to the ratio of venture capital dollars to state GDP and the number of venture capital deals as a percentage of high-technology businesses.⁴⁰ The state has a number of public and private initiatives to grow dilutive capital, but it needs strategic policies to rise above the national average.

The Rural Center administers a Fund of Funds Program that invests in venture capital funds to be given to early-stage North Carolina companies.⁴² Since its inception in 2010, the Fund of Funds Program has invested \$10 million in North Carolina venture capital funds.

The North Carolina Innovation Fund is an investment partnership funded partially by the state's pension funds.⁴³ The partnership co-invests in diverse industries based in North Carolina, including advanced energy. Two-thirds of the \$250 million fund is to be used for co-investments, while the remaining third focuses on venture, growth, and mezzanine investments.⁴⁴

Non-Dilutive Capital

There are several grant and loan programs available to entrepreneurs in North Carolina to encourage innovation, startup growth, and corporate expansion.⁴⁵ One example is the Job Maintenance and Capital Development Investment Fund (JMAC). JMAC is a discretionary grant program that targets large employers.⁴⁶ The grant program attempts to retain large-scale capital investment and significant numbers of high-paying, high-quality jobs. Annual payments are allocated based on the amount of taxes a grantee pays. Qualifying taxes are those resulting from investments in new project tools and materials, training programs, and state permitting fees for expansion.

Other examples of non-dilutive capital programs in North Carolina are Industrial Revenue Bonds issued by counties to provide low-cost financing for manufacturing companies, the Industrial Development Fund, which supports infrastructure projects for new industrial facilities in lesser-developed municipalities, and the Farm Ownership Loan Program, which provides loan guarantees for agricultural development.^{47,48,49}

Venture Challenge

The Charlotte Venture Challenge gathers promising early-stage companies to compete for large cash prizes in front of potential investors and first customers.⁴¹ As part of the competition, applicants receive business training, participate in workshops, learn about opportunity investments, and present to an audience of angel investors, venture capitalists, and potential first customers.



The One North Carolina Fund is a program that provides funding for businesses looking to expand or relocate to North Carolina. The funding is meant to support new equipment installation, building expansion, and infrastructure renovation projects.⁵⁰ Job Development Investment Grants are sustained grants provided to new or expanding businesses for up to twelve years. The funded projects must result in increased employment and fulfill economic development goals for the state.⁵¹ Annually, the program can award up to \$15 million in funding.⁵²

Through the Rural Center, the North Carolina Small Business Credit Initiative administers multiple programs that attract new investments. For example, the Capital Access Program is a loan loss reserve program for smaller loans averaging \$100,000, while the Loan Participation Program purchases up to 15 percent of a loan to reduce lender risk. The Rural Center's performance has been very positive for North Carolina, its programs have leveraged over \$400 million of private funding and have created more than 10,700 new jobs.⁵³

The state also houses several non-profit organizations that are working to increase and diversify investment opportunities. The Natural Capital Investment Fund offers loans and equity financing to early-stage companies focused on advanced energy and other sustainable causes.⁵⁴ The Support Center is a non-profit organization providing loans and other forms of support to companies located in underserved communities.⁵⁵

Tax Incentives

North Carolina offers only a few tax credits to help spur business growth. For example, the Technology Development Tax Credit promotes research and development at North Carolina universities by giving small businesses a tax credit equal to 3.25 percent of their research and development expenses.⁵⁶ North Carolina also offers an Interactive Digital Media Tax Credit, which gives substantial support to video game and digital media companies.⁵⁷ This demonstrates the state's willingness to support industrial clusters and innovation ecosystems.

Policy Recommendations

In order to take advantage of North Carolina's strong university research and development activities, the state must invest in commercializing research activities. The following policy recommendations could help incentivize investment in new companies, attract entrepreneurs to the state, and grow existing businesses.

Policy 1: Enable and Promote Equity Crowdfunding

Many states consistently outcompete North Carolina in per capita venture capital investments.⁵⁸ North Carolina's 2014 per capita venture capital spending was only \$35, whereas other states such as Illinois, Colorado, and Utah received \$83, \$148, and \$272, respectively.⁵⁹ Furthermore, North Carolina's businesses benefit from only 1.4 percent of venture capital deals and 1.15 percent of venture capital investment in the U.S.⁶⁰

Equity crowdfunding is an innovative mechanism utilized to attract private funding for new companies. Over the past four years, twenty-five states and the District of Columbia have enacted intrastate securities exemptions that allow equity crowdfunding from non-accredited investors.⁶¹ These exemptions align with updates to the federal exemption for equity crowdfunding under Title III of the JOBS Act.⁶²

Equity Crowdfunding and Enabling Legislation

Equity crowdfunding is a mechanism for early-stage companies to raise money from a large group of investors by issuing ownership shares. By virtue of securities exemption laws, these unlisted companies are not required to register the shares with federal or state securities regulators, reducing the cost and time associated with typical securities offerings. The purpose is to spur innovation, economic activity, and small business growth by easing the regulatory burden faced by entrepreneurs when raising public funds.

To attract private funding for new companies, North Carolina could create a securities exemption for equity crowdfunding for companies located in the state. Intrastate exemption rules allow the state to determine limits on equity offerings and maximum investments by non-accredited investors. For example, the Invest Georgia Equity Crowdfunding Exemption allows non-accredited Georgia investors to invest up to \$10,000 in any company based in the state.⁶⁴ Georgia also allows companies based in the state to raise up to \$5 million per year via equity crowdfunding, one of the

Types of Investors

- Equity Crowdfunders are usually non-accredited investors with restrictions on how much they can invest in companies.
- Accredited Investors are individuals whose incomes exceed \$200,000 (\$300,000 if married) for three consecutive years, or who have a net worth of more than \$1 million dollars, not including home values.⁶³



Crowdfunding Hubs

- Wisconsin offers a licensed crowdfunding hub called CraftFund where Wisconsin investors can browse specialized companies seeking investors.⁷¹
- USEED is a service that helps educational institutions of all sizes develop customized crowdfunding portals. USEED runs the day-to-day operations of the platform for any campus group—whether it is the advancement office, specific departments, or student groups.⁷²
- PennState created a customized platform, PennState Crowdfunding, through USEED and piloted twelve projects.^{73,74}

highest limits in the U.S.⁶⁵ State limits often exceed federal rules, allowing states to compete to become the most attractive place to start a business.^{66,67} In 2015, 102 companies in the country were approved for this exemption and at least one firm relocated from North Carolina to Georgia to become eligible.^{68,69}

North Carolina can look to exemption laws in other states and at the federal level, but should consider some improvements as well. State leaders could allow early-stage companies to benefit from being able to advertise and sell to both accredited and non-accredited investors. The state could also permit “testing the waters,” or allowing an issuer to solicit the general public to determine interest levels in the offering before going to the expense of preparing formal offering documents.⁷⁰ It could also consider allowing aggregate annual equity crowdfunding investments up to \$5 million. These improvements could make North Carolina a leader in equity crowdfunding.

North Carolina could further support equity crowdfunding by creating an online hub. Online equity crowdfunding hubs allow businesses to advertise their companies and ideas to attract small investments, while creating a single source for investors researching and investing in new businesses.

North Carolina’s leaders could establish a new model equity crowdfunding exemption and licensed hub in North Carolina to open up a new pool of investors that could fund local startups and fuel economic growth in the state.

Policy 2: Create Tax Incentives for Investment in Startups

Capital Gains Tax

A capital gains tax is applied to the sale of an asset that was purchased at a lower cost than it was sold. For example, if an individual purchases stock in a company and then sells that stock at a later date when the company is worth more, the profits made on this sale—the capital gains—are taxed.

North Carolina’s capital gains tax is 5.8 percent.⁷⁵ When this rate is combined with the federal capital gains tax, the state is tied for the twentieth highest in the country.⁷⁶ High capital gains taxes are barriers for investors because they cut into the profit investors make from their investments. Investors are often reluctant to invest in early-stage companies because of the high level of risk involved; incentives are needed to encourage investment. A state-wide policy that reduces or eliminates capital gains taxes for investments in specific North Carolina industries could encourage investment and spur economic growth.

Successful Tax Exemption Policies

Similar programs have been successful in the United Kingdom. The Enterprise Investment Scheme (EIS) and Seed Enterprise Investment Scheme (SEIS) are tax-based venture capital schemes that provide tax relief to investors in high-risk companies. The EIS started in 1994 with the aim to help small, high-risk companies build capital by offering tax relief to investors.⁷⁷ In 2012, the government established the complementary SEIS, which offers tax relief at a higher rate for early-stage investment.⁷⁸ Both programs offer complete capital gains tax relief after a three-year investment period.^{79,80} Approximately 22,900 companies have benefited from the EIS, raising over £12.2 billion in funds since the program began in 1994.⁸¹ From 2013 to 2014, SEIS spurred a total of £164 million of investment in 2,000 companies.⁸²

Establishing tax exemptions for investments in targeted early-stage North Carolina companies, such as utility-scale battery or biogas companies, could attract investors to the state. The state could require a three-year minimum investment before qualifying for the exemption and extend the exemption for up to ten years. Access to patient capital provides early-stage companies with more certainty and helps avoid the “valleys of death” during technology development and commercialization. Knowing investors have an incentive to make longer-term investments in the local advanced energy sector could attract startups to North Carolina and grow jobs across the state.

Chapter Summary

North Carolina has demonstrated a strong commitment to the state’s innovation pipeline. The state provides significant support to emerging companies through its public university system, government programs, and partnerships with established innovative companies. However, North Carolina could do more to increase the availability of capital for startups and incentivize investments in local companies. North Carolina’s innovation ecosystem has the capacity to develop and retain firms that will create good-paying jobs for residents and establish the state as a pioneering hub for advanced energy technology solutions.



Chapter 5: Workforce Development

Trained and skilled workers are fundamental to the success of an industrial cluster. Sector-based workforce development goes hand-in-hand with cluster development. If firms in the same cluster are able to coordinate with the government, schools, and related nonprofits on policies and programs to train workers, they will be better equipped to identify employment needs and find qualified workers with the necessary skills to fill available jobs.

With high unemployment and underemployment rates across the country and firms unable to find workers with the right skills, prioritizing workforce development is essential for any emerging or established industry. North Carolina's average unemployment rate in December 2015 ranked thirty-ninth highest in the nation at 5.6 percent, with some rural parts of the state suffering from double-digit unemployment rates.^{1,2} Approximately 83 percent of jobs created in North Carolina since 2009 are either "low-wage" or "ultra-low-wage."³

This graph breaks down the proportion of new jobs created between 2009 and 2013 that pay ultra-low wages, low wages, or above the Living Income Standard (LIS).⁵ The LIS is a measure of how much a worker must earn to afford a basic basket of goods (i.e., food and clothing). For example, a worker with one child must earn \$16.21 per hour to meet the standard.⁶

Jobs By Wage Category As Share of Total Employment Change, 2009-2013

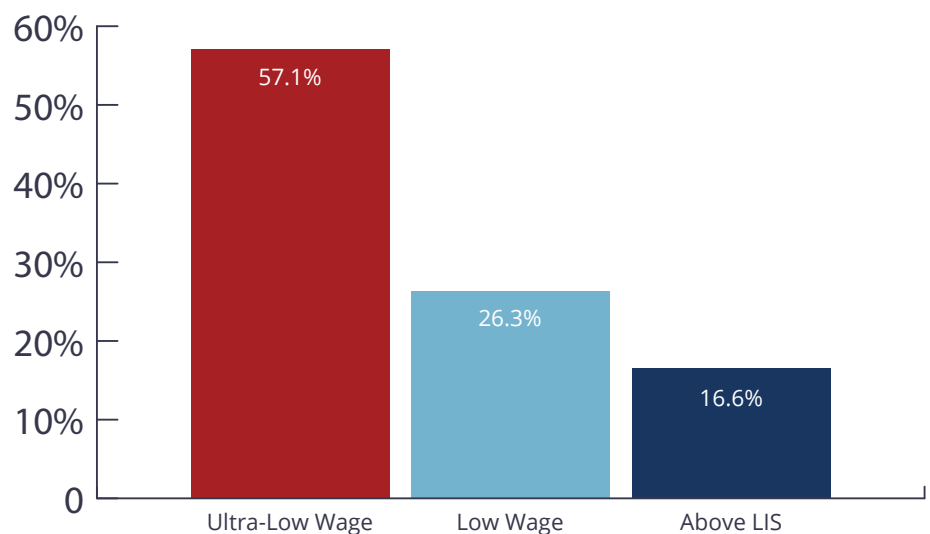


Figure 12. Between 2009 and 2013, most of the jobs created in North Carolina have been ultra-low wage.⁴

(Source: North Carolina Justice Center)

A recent survey of energy and technology companies in the Research Triangle indicates that the sector is growing and expects to hire between 1,500 and 3,300 employees in the next two to five years.⁷ However, these firms also report having difficulty finding qualified candidates to fill certain types of positions. In particular, energy and technology companies are in need of mid-level employees with cross-cutting skills and experiences, with a particular need for software and IT skills.⁸

North Carolina's growing employment in the utility-scale battery sector and strong potential in the biogas space offers an avenue to improve economic prospects for local residents. Global leader in power and battery technologies, ABB, has its North American headquarters in Cary, employing about 30,000 people.⁹ Emerging battery companies are joining ABB in headquartering in the state. Alevo, a utility-scale battery manufacturer, opened its first North American manufacturing facility in North Carolina last year and recently began production at a repurposed Philip Morris facility in Cabarrus County.¹⁰ According to the Cabarrus Economic Development Corporation, Alevo aims to employ up to 6,000 people in the long run.^{11,12} Additionally, North Carolina is well-positioned to capitalize on the growing biogas industry. Hog and poultry farming are significant industrial employers in the state, accounting for approximately 122,000 jobs.^{13,14} Collectively, these farms produce billions of gallons of waste each year.¹⁵ Leveraging this waste by engaging anaerobic digesters could help create jobs in rural North Carolina and establish the state as a regional leader in advanced biogas technology.

In order to capitalize on opportunities in the advanced energy space, North Carolina's policymakers can take proactive steps to address skill gaps and structural challenges in its workforce. A thoughtful sector-based workforce development approach should include industry best practices for recruiting, hiring, training, promotion, and compensation; education and training infrastructure (including community colleges, project-based learning experiences, and apprenticeship programs); and public policy, specifically rules, regulations, and funding streams related to workforce and education.^{16,17} Leaders in North Carolina can focus efforts on regions and populations still experiencing high unemployment.

Workforce Development Strengths

North Carolina's public education system and existing workforce development efforts provide a strong base for professional and technical skill development. Each year, North Carolina's higher education system educates 300,000 students at "16 public universities, 36 private colleges and universities, and 58 community and technical colleges throughout the state."¹⁸



Additionally, the state's education pipeline encompasses K–12 education, retraining efforts targeting displaced workers, middle college, and stackable credentials and certifications. Finally, employers have noted the high quality of life in North Carolina as an asset in recruiting workers from outside the state.¹⁹

Code Green Super Curriculum Improvement Project (CIP)

Stackable Credentials

A system of stackable credentials is an organized sequence of certificates that can be accumulated over time to strengthen individual qualifications and advance a career.²² The sequencing includes short-term skill development blocks that give students a degree of scheduling flexibility, which reduces educational and employment barriers for non-traditional and disadvantaged students.²³

Since 2012, the North Carolina Community College System (NCCCS) has revolutionized its technical curriculum in five major energy-related sectors, including building, energy, engineering, environment, and transportation technologies.²⁰ This curriculum redesign is intended to provide a holistic technical core, while simultaneously allowing for a desired level of specialization based on student and employer needs.²¹ Students can earn multiple “stackable” credentials endorsed by the National Association of Manufacturers while pursuing an associate degree.

K-12 STEM Outreach

North Carolina has expanded STEM outreach through the Kenan Institute of Engineering Technology and Science at North Carolina State University.²⁴ The Kenan Institute offers fifty K–12 STEM teachers year-long fellowship positions that include eighty hours of professional development and a summer internship at a research institution or private company.²⁵ Afterwards, these teachers are able to bring industry knowledge back to their classrooms. Additionally, the National Science Foundation sponsors the North Carolina State Future Renewable Electric Energy Delivery and Management (FREEDM) Systems Center, which connects middle and high school students at thirteen local schools to the advanced energy industry by sponsoring mentorship opportunities, summer camps, hands-on research, science competitions, and teacher training.²⁶

University-Level Initiatives

The Energy Production and Infrastructure Center (EPIC) at University of North Carolina at Charlotte has developed an optional concentration in energy for several undergraduate engineering programs, as well as the MBA and Master of Science programs.^{27,28} EPIC also facilitates internships and cooperative experiential learning opportunities that allow engineering students to commit to three semesters of paid, full-time industry work while also earning academic credits.²⁹ Participants can also apply hours worked towards professional engineering licensing

requirements.³⁰ Furthermore, EPIC offers a graduate certificate in energy analytics, which students can complete in-person or online.^{31,32} Similarly, the North Carolina State FREEDM Systems Center manages an engineering certificate in Renewable Electric Energy Systems (REES), as well as a ten-month master's degree in electric power systems engineering.³³

The North Carolina Clean Energy Technology Center (NCCETC) at NC State offers two programs for training in advanced energy. The Renewable Energy Technologies (RET) Diploma Series consists of five-day workshops that offer nationally awarded training, certification, and continuing education credits in different renewable energy technologies.³⁴ The program can also help professionals meet the continuing education requirements in certain fields. The photovoltaics (REPV) and solar thermal (REST) courses, for example, fulfill the education requirements needed to become a certified PV or Solar Heating installer by offering participants the opportunity to take the North American Board of Energy Practitioners (NABCEP) entry level exams.³⁵ The NCCETC also offers the Certificate in Renewable Energy Management (CREM), a 40-hour program and part of the RET Diploma Series that seeks to help students and professionals make informed decisions in the renewable energy industry by providing them with a foundation of knowledge of existing renewable technologies as well as a targeted understanding of renewable policies and financial options.³⁶



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Utility-Scale Batteries: Jobs and Skills Needed

Types of Jobs

Utility-scale battery deployment and manufacturing requires a variety of professions, including project development, component manufacturing, construction, operations, legal services, data analysis, software development, education, training, and research. As a result, holistic workforce development and education programs are required to ensure all positions—from manufacturers to lawyers—are filled. The table below describes some career opportunities in the battery supply chain.

Table 3. Career Opportunities in the Battery Supply Chain

Job Title	Primary Responsibilities
Sheet Metal Worker	Produce steel racks inside containers
Computer Hardware Engineer and Technician	Design and build computer hardware systems for utility-scale batteries
Electrical Engineer and Technician	Manufacture and assemble battery wiring, electrical circuitry, separators, cooling system, and AC/DC current components
Software Developer	Design, develop, and improve battery software and analytics
Chemical Engineer and Technician	Produce lithium ion phosphate, graphite, and electrolyte compounds for battery
Production Manager and Technician	Manage and assemble final batteries, modules, and racks along the factory production line
Truck Driver	Transport large batteries regionally and to ports or rail stations for national and international shipping
Electrical Power Line Installer and Maintenance Worker	Connect energy storage devices to grid, local utility, and renewable energy generation

Training Ancillary Workers

Training workers for ancillary services in the advanced energy sector is a critical, yet often overlooked, component of workforce development. City planners, accountants, government employees, and lawyers also need additional training to be able to serve growing advanced energy companies.

Biogas: Jobs and Skills Needed

Types of Jobs

Jobs in the biogas industry encompass a wide range of professions, including maintenance workers, manufacturing technicians, project managers, engineers, operators, and consultants. Knowledge in areas such as electrical wiring and technology, mechanics, chemistry, and manufacturing processes are key for industry professionals. The table below describes some career opportunities in the biogas supply chain.

Table 4. Career Opportunities in the Biogas Supply Chain

Job Title	Primary Responsibilities
Sales Representative (Technical and Scientific)	Educate farmers regarding the benefits of purchasing anaerobic digesters as a long-term investment
Biogas Consultant	Make individual determinations on ideal digester type and local grid connectivity based on the characteristics of each farm; assist in determining best application for biogas supply
Engineer (Mechanical, Electrical, Chemical, and Software)	Design digester, turbine, components, processes, metering, and code computer systems for digester automation
Manufacturing/Engineering Technician	Manufacture and assemble digester, turbine, parts, piping, storage cover, etc.
Electrical Technician	Manufacture and assemble electrical circuitry
Laborer	Excavate and cement digester manure collection system and effluent storage pits
Installation Project Manager and Technician	Install digester technology on farm
Biogas Technician/Operator	Conduct day-to-day digester management, clean microturbines, dispose of waste, and resolve minor issues
Digester System Repair Engineer (Mechanical, Electrical, and Chemical)	Identify and resolve digester or system malfunctions if they arise to ensure operating efficiency
Electrical Power Line Installer, Electrician	Connect digester electrical output to the farm's internal energy grid or local utility



Policy Recommendations

North Carolina policymakers can build upon existing job growth and capitalize on opportunities in the advanced energy space through workforce development efforts that target skill gaps and structural challenges.

Policy 1: Improve Industry-Wide Participation in Apprenticeships

A recent survey of energy and technology companies in the Research Triangle found that companies have difficulties finding workers with “highly specific skills that often can only be gained through experience.”³⁷ Apprenticeship programs provide valuable on-the-job skills, making them an important component of career development and workforce training in emerging industries. In 2015, North Carolina ranked last in the country in per capita apprenticeships with only 3,847 active apprentices.³⁸ Experts estimate that reinvigorating and expanding the state’s apprenticeship opportunities would result in as many as 120,000 new jobs in North Carolina.³⁹

Apprenticeship Carolina™

South Carolina’s Apprenticeship Carolina™ program offers a simple model for improving apprenticeship opportunities statewide. After instituting the program, South Carolina’s total apprenticeships increased from 777 in 2007 to more than 11,000 positions in 2014.⁴⁰ These apprenticeships help in-state workers strengthen valuable technical skills in high-wage industries.⁴¹ The program offers a tax credit for companies—\$4,000 for each new apprentice over four years.⁴² This tax credit does more than encourage apprenticeship hiring; it also signals to students and employers that apprenticeships can be a viable alternative to college instruction and provide economic value in STEM industries.⁴³

North Carolina’s Department of Commerce could follow South Carolina’s lead by providing fiscal incentives for companies that hire and train apprentices. Additionally, state leaders could work directly with employers to tailor apprenticeship requirements, wages, and associated curricula to specific technical needs.⁴⁴ By integrating apprenticeship programs with the strong system of stackable credentials available to community college students, the state could help students progress more quickly to good-paying, skilled jobs. Apprenticeship incentives should not only apply to students and recent graduates but also to mid-level and mid-career workers looking to gain specialized experience in the

energy sector. Finally, North Carolina could legitimize industry apprenticeships through endorsements from unions, trade associations, and corporations.

Policy 2: Enable Dislocated Veterans to Get Back to Work

As of 2013, North Carolina's 681,000 veterans represented approximately 9.1 percent of the state's total population.⁴⁵ North Carolina boasts several existing policies and programs that provide pathways for veterans to transition into post-military careers. For example, the state allows veterans to petition their military service towards college credits⁴⁶ and professional licenses.⁴⁷ North Carolina also permits all military veterans—regardless of state origin—to waive the one-year residency requirement and receive in-state college tuition rates.⁴⁸ Additionally, veterans receive private-sector hiring preference through the North Carolina Military Business Center's "I Hire Military" database, which identifies "military-friendly" employers.⁴⁹

Nationally, 42 percent of former military personnel engaged in medium-skill maintenance, machinery, and electrical technician work during their service.⁵⁰ Despite the demand for skilled workers in North Carolina and the strong qualifications of many returning veterans—including technical skills, organizational abilities, and professional maturity—the unemployment rate for veterans is approximately equal to the state average.⁵¹ This presents the state with a significant opportunity to tap into a well-trained and motivated sector of the workforce to contribute to the growth of the advanced energy sector.

New Jersey's upSKILL Initiative

North Carolina could look to the New Jersey Institute of Technology's UpSKILL initiative for a successful example of leveraging the veteran workforce.⁵² Funded by the U.S. Department of Labor, this program provides free job search boot camps.⁵³ The initiative also offers free consulting services to determine the best technical degree or certification program for veterans based on past military duties. UpSKILL then connects veterans with employers based on their technical training and the company's needs.⁵⁴ Finally, this program does not require that participants use their G.I. Bill benefits, allowing veterans to save their funding for future education and workforce training opportunities.⁵⁵



Solar Ready Vets

Solar Ready Vets is a national program that provides soon-to-be discharged U.S. military personnel with training in the solar industry. Training takes place during an intensive four to six week course in solar system sizing and installation, local building codes, and grid connections. The program establishes relationships with employers to facilitate employment following the training. Efforts are underway to establish a Solar Ready Vets program in North Carolina at Fayetteville Technical Community College. Including training in other advanced energy technologies that are synergistic with solar, like batteries, could improve the employment opportunities of participants in the program and provide North Carolina with the trained workers it needs to for its growing battery industry.

North Carolina could adopt the upSKILL model through partnerships with local workforce development boards, community colleges, and the North Carolina Department of Veterans Affairs. Local workforce boards and colleges could help build awareness of high-paying manufacturing and maintenance positions in the advanced energy industry, specifically within the growing battery and digester supply chains. Workforce boards could leverage the strength of North Carolina's solar industry to develop combined training programs in solar and batteries. Workforce boards can help translate veterans' technical work to civilian practice and disseminate information regarding specific technical accreditation and up-and-coming advanced energy jobs. Additionally, North Carolina could offer specialized college orientation for veterans to ensure they are aware of relevant credits and certifications they may have already achieved as a result of their military service.

Policy 3: Expand Public-Private Training Partnerships with Local Community Colleges, Workforce Development Boards, and Employers

Employers in North Carolina are having difficulty finding qualified workers to fill open positions.⁵⁶ Employers report that job candidates lack the required specialized work experience and technical skills.⁵⁷ North Carolina's counties could establish or expand public-private partnerships in the utility-scale battery sector as a mechanism to address the skills gaps in the utility-scale battery sector.

The concept of public-private partnerships is not novel or untested; in 2011, Siemens—a large manufacturing and design firm working in energy, healthcare, transportation, and more—moved into North Carolina and partnered with University of North Carolina and Central Piedmont Community College (CPCC) to offer skill assessments, train prospective workers, and create more than 3,500 new jobs throughout the supply chain.⁵⁸ In 2014, Siemens announced a \$32 million software grant for CPCC's STEM division, which funded the implementation of Siemens' software in classrooms.⁵⁹ The grant also helped create new courses in advanced technology subjects, including mechanical, electrical, civil, and electronics engineering; advanced manufacturing; information technology; mechatronics; and robotics. CPCC and Siemens also established an apprenticeship model that allows students to experience on-the-job applications of the software.⁶⁰

The NCWorks Customized Training Program “provides education, training and support services for new, expanding and existing business and industry in North Carolina.”⁶³ The program operates through its network of community colleges with the goal of supporting job growth, increasing investment in technology, and improving productivity for local businesses.⁶⁴

Employers could coordinate with the local community college system to tap into the existing NCWorks Customized Training scheme and enhance the program to meet employer needs. For example, employers could provide guidance on highly specific modules in existing technician certificate programs based on technical needs. State and local governments could also offer tax rebates to advanced battery technology employers that commit several employees to work as part-time instructors in the program. This would help prospective employees gain valuable insight and skills in order to be competitive in the job market. Additionally, companies and community colleges could collaborate to offer semester-long internships that could lead to full-time employment depending on job performance. Ultimately, strong public-private partnerships between employers and community colleges could help companies target highly trained technical applicants, while also increasing specialized, on-the-job training opportunities for dedicated students.

Alevo’s Partnership with Centralina Workforce Development Board

Battery manufacturer Alevo anticipates hiring up to 6,000 employees for its growing utility-scale battery company in Cabarrus County, North Carolina.⁶¹ In response to a huge influx of employment interest, the local Centralina Workforce Development Board has taken steps to establish a partnership with Alevo by unveiling a job screening website to streamline Alevo’s employment process and sift through qualified job candidates.⁶²



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Policy 4: Enhance Higher Education Programs Relevant to Advanced Energy

Despite a few strong higher education programs in energy—UNC Charlotte’s EPIC, Appalachian State University’s Appropriate Technologies curriculum, and NC State’s Renewable Electric Energy Systems program—employers in the state report difficulty in finding workers with the specific skills needed for the advanced energy industry. By establishing integrated energy-focused courses in ancillary university programs and creating formal degree programs related to batteries, North Carolina’s leaders could provide students with a strong knowledge base in advanced energy systems and prepare them for jobs in the industry.

Encourage Cross- Cutting Energy Education

Business leaders in the energy and technology sectors report difficulties finding workers with cross-cutting skills.⁶⁵ Students studying law, business, public policy, and environmental science would benefit from added courses in advanced energy topics. North Carolina’s universities could enhance existing degree programs throughout the state by incorporating energy-related coursework into the curriculum and providing a means for interdisciplinary collaboration.

Leaders can look to North Carolina’s Duke University Energy Initiative for inspiration to create programs in the North Carolina state educational system. The Duke University Energy Initiative integrates energy curriculum throughout multiple disciplines, supports energy-related research, and engages players throughout the industry.⁶⁶ The program includes students in business, engineering, law, arts and sciences, environmental studies, and public policy and provides energy-focused courses and degree programs.

Enhancing existing degree programs with energy-focused coursework would help provide employers with workers with energy-related knowledge across multiple disciplines.

Expand Formal Degree Programs to Include Battery Technology

The battery industry is a highly-specialized industry and needs specifically-trained workers. In order for North Carolinians to compete for jobs in this emerging industry, they need to have specific training in the technology and industry.

North Carolina could look to San Jose State University (SJSU) for an example of a successful battery education program. SJSU offers a battery technology graduate program, which was designed to increase the number of trained and skilled workers available to the rapidly growing energy storage industry in the San Francisco Bay Area. Coursework covers basic overviews of battery technology and manufacturing, energy market dynamics, and policy considerations. Additionally, students have the opportunity to gain hands-on experience with local companies in the energy storage industry. The program schedule is flexible, allowing students to take classes online, and on nights and weekends so they can continue working while pursuing their degree.⁶⁷

The establishment of a similar degree program at a North Carolina college or university could help increase the pool of skilled workers available for the growing battery and energy storage industries in the state. Additionally, the program could attract manufacturers to the state and create an environment conducive to innovation and advancement in the energy storage industry.

Chapter Summary

North Carolina has the potential to expand the battery and biogas sectors by leveraging the state's higher education system and investing in targeted workforce development initiatives. Coordinated efforts at the state and local levels could spur significant growth in the state's advanced energy economy, attract good-paying jobs, and furnish the workforce with highly trained individuals.



Conclusion

In order to build on North Carolina's success in the advanced energy space and position the state for continued growth, policymakers will need to make advanced energy a priority. The purpose of *The North Carolina Jobs Project: A Guide to Creating Advanced Energy Jobs* is to analyze the state's advanced energy economy in order to create recommendations specifically tailored to the state's needs. The policies recommended in this report are complementary and intended to help the state grow demand for advanced energy technologies, manufacture products within the state, enable entrepreneurship for technological advances, fund innovation with accessible capital, and equip workers with the skills required for the state's future economy.

Policy leadership in the advanced energy space can play an important role in promoting North Carolina's advanced energy clusters and creating quality jobs for North Carolinians. Advanced energy clusters focused on utility-scale batteries and biogas offer great opportunities for the state to grow its economy, create jobs for the state's residents, and become a leader in the production and deployment of advanced energy technology.

If North Carolina's policymakers take swift and purposeful action to grow the utility-scale battery and biogas industries, the state can support over 19,000 jobs per year through 2030.

North Carolina has the right mix of strengths to leverage this opportunity. With smart, forward-thinking policies, the state can diversify its economy and create thousands of middle class jobs for hard-working North Carolinians.

For more information about advanced energy technologies and best practice policies, visit <http://americanjobsproject.us/>.

Appendix: Economic Impact Methodology

The key to job creation lies in local action. Our estimates are intended to start a conversation about how local stakeholders can work together to set their goals and utilize the same tools and data that we have used to estimate potential impacts.

The American Jobs Project combines existing tools, analysis, and projections from several reputable sources to estimate job creation. Rather than providing a specific estimate, we show jobs potential across a range of possible outcomes. All biogas jobs are shown in job-years that exist during the analysis timeline (2016-2030). Battery jobs are shown as an average of annual employment over the analysis timeline.

The biogas jobs analysis used the Impacts for PLANning (IMPLAN) model and evaluated growth potential estimates from the American Biogas Council and used expenditure models from the University of Tennessee's Biobased Energy Analysis Group.^{1,2} The battery jobs analysis is based on an existing IMPLAN analysis for the Tesla Gigafactory and completed for the Nevada Governor's Office of Economic Development (GOED).³

Tools for Economic Impact Analysis

A number of modeling tools are available for estimating economic impacts from advanced energy industry growth. This report employs two of the most common tools available for advanced energy: Jobs and Economic Development Impact (JEDI) and Impacts for PLANning (IMPLAN). Results from the JEDI model only show job gains and do not evaluate losses in other industries. They are based on approximations of industrial input-output relationships, and do not include intangible effects.⁴ The JEDI model is widely used because it estimates construction and other project economic impacts at the local (usually state) levels.⁵ IMPLAN estimates the economic impact of each dollar invested into a sector and the resulting ripple, or multiplier, effects across the economy.⁶ Multipliers are used to generate the economic impacts of the project across three different categories of jobs: direct, indirect, and induced.⁷

It is important to note the limitations of these modeling methods. As mentioned, the estimates shown are only gross job-year creation. Job losses in industries that compete with those in our analysis are not evaluated. Models do not dictate behavior, so



indirect and induced jobs estimates could vary greatly based on the reality of what is actually purchased locally. Also, foreign and domestic competition can play a significant role in limiting the potential for job creation. The estimates presented in this report are highly dependent on sustained local action towards developing and maintaining these industries.

Estimates Used in the North Carolina Report

Biogas

Biogas jobs estimates started with biogas project potential estimates from the American Biogas Council, showing the possible biogas projects from existing landfills, swine farms and dairy farms.⁸ We then created sample projects using existing data from the University of Tennessee's Biobased Energy Analysis Group.⁹ The IMPLAN models were replicated for three scenarios. First, as a low scenario, we analyzed the indirect and induced jobs created using a multiplier that represents the current state of North Carolina's supply chain. Then, as a high demand scenario, we analyzed the jobs created by using a multiplier for the national economy, representing a near-perfect supply chain. A moderate scenario was created by looking at the mid-point between the high and low multipliers. It should be noted that our analysis did not include all of the potential projects in the state, rendering more conservative estimates. For example, projects involving wastewater treatment facilities, poultry waste, and centralized digestion using aggregated waste from small-to-medium sized farms were not considered.

Batteries

The analysis for batteries is based on a report for the Nevada GOED that evaluated economic impacts of the Tesla Gigafactory.¹⁰ We used our own estimates of direct jobs, but grounded them in current jobs estimates from North Carolina-based battery manufacturers. We utilized the range of multipliers specified in the Tesla report, as well as an "in-between" multiplier that represents the mid-point between the high and low multipliers. We show each direct jobs estimate across the range of multipliers to highlight the importance of clustering the supply chain to maximize multiplier effects and hitting the high employment scenario. It is important to note that these jobs numbers are only counting effects from operations and do not include jobs created by construction or retrofitting of new battery manufacturing facilities.

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