A brief from THE PEW CHARITABLE TRUSTS | Oct 2014


North Carolina State University


Altrendo Images


Adam Kazmierski

Clean Economy Rising
Solar shines in North Carolina

Overview

North Carolina has emerged as a clean energy leader in the Southeast because of its high-caliber academic institutions, robust public and private investments, and policies such as the renewable energy and energy efficiency portfolio standard. The state has climbed nationwide rankings in the solar industry and attracted companies working in smart grid technologies, which use digital communications to allow electricity providers to detect and react to changes in usage. This brief examines the reasons for North Carolina's success in clean energy innovation and its resulting economic growth.


North Carolina State University

Clean energy policies

North Carolina has emphasized the use of clean and efficient power sources to keep pace with its growing population and energy-intensive industries.[1]

In 2007, the state became the first in the Southeast to adopt a renewable energy and energy efficiency portfolio standard. The standard requires electric cooperatives and municipal utilities to obtain 10 percent of their electricity from renewable sources or efficiency improvements by 2018, and investor-owned utilities to obtain 12.5 percent of sales from such clean sources by 2021.[2] Legislation to roll back the requirements failed in 2013 because state lawmakers were concerned about losing the economic benefits of these emerging industries.[3]

The state also offers owners of renewable energy projects a 35 percent investment tax credit and other financing opportunities, complementing federal tax incentives.[4] These have spurred distributed energy projects—the generation of power on-site at homes or businesses.

Key State Policies					
✓	Renewable portfolio standard	✓	Tax incentives		Green power purchasing
✓	Net metering and interconnection standards	✓	Bonds/loans/rebates/other financing		Nonutility sales of renewable electricity allowed

Source: North Carolina State University, Database of State Incentives for Renewables and Efficiency

Sources of power and economic growth

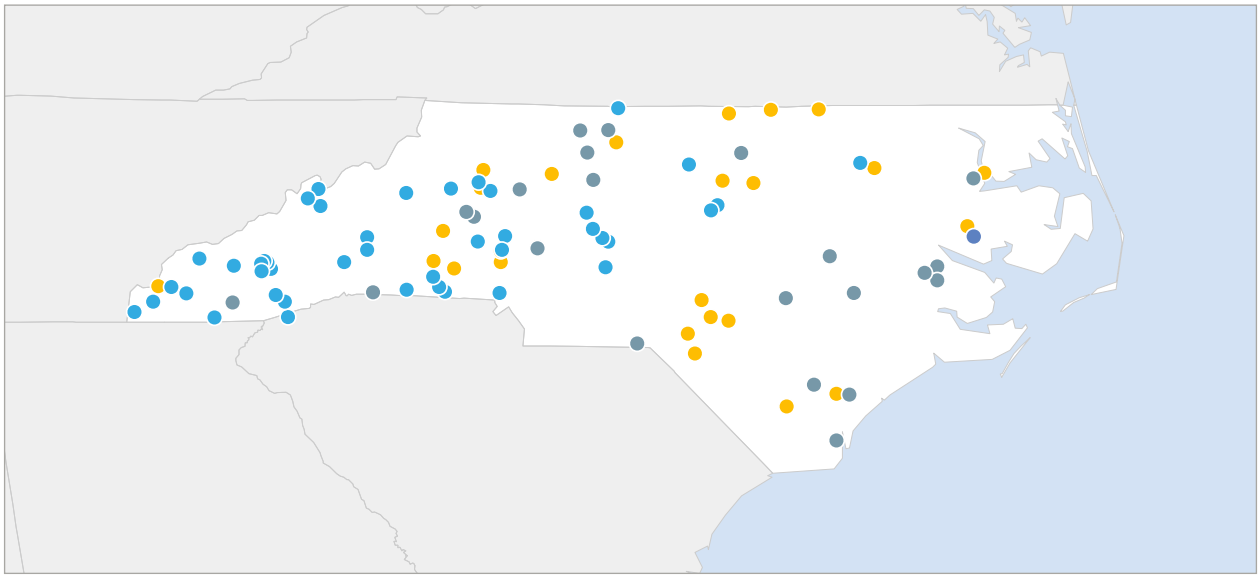
North Carolina's clean energy policies support the growth of new industries. Statewide, private investment in clean energy totaled $2.6 billion from 2009 to 2013 and will generate an additional $8.1 billion over the next decade, according to Navigant Research.

North Carolina reaped revenue from clean energy projects of $2.67 billion from 2007 to 2013, a figure nearly 20 times greater than the state incentives of $135.2 million, according to an analysis prepared by RTI International for the North Carolina Sustainable Energy Association.[5] In 2010, the Brookings Institution ranked three North Carolina metropolitan areas within the top 100 U.S. cities for jobs in the clean energy and environmental fields: Raleigh-Cary, Charlotte-Gastonia-Rock Hill, and Greensboro-High Point.[6]

Hydropower accounts for the largest installed capacity of renewable energy in North Carolina.[7] Solar, however, represented 98 percent of capacity added in 2013 and is likely to continue dominating future installations. Solar energy's relative success may stem from its strong resource potential in North Carolina, the rapid decline in photovoltaic panel prices nationwide, and state policies such as the renewable portfolio standard and tax incentives that encourage both utility-scale and distributed projects.[8] New solar capacity additions and investment will slow in 2016 due to the looming expiration of the federal investment tax credit, but the sector will nevertheless continue to generate an average of $523 million in annual revenue from 2017 to 2023.

North Carolina has significant onshore wind potential, concentrated along the coast and in the western part of the state.[9] It also has the most offshore wind potential of all the Atlantic states, so further growth is possible in this emerging sector.[10]

Renewable Electricity Power Plants, > 1 Megawatt Capacity



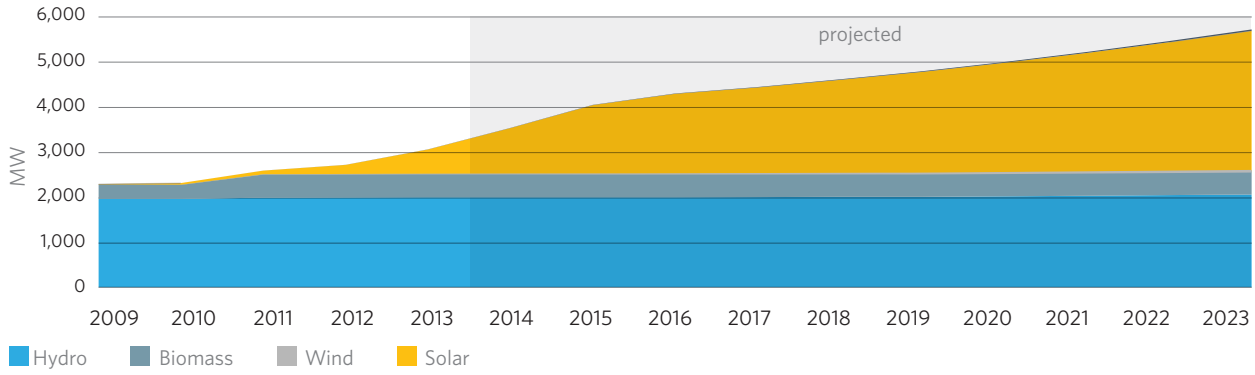
Solar Hydro Biomass Combined heat and power

Source: Energy Information Administration

Snapshot: North Carolina's clean energy economy

Clean Energy Capacity, by Sector and Year

Actual (2009-13) and projected (2014-23) growth in cumulative capacity

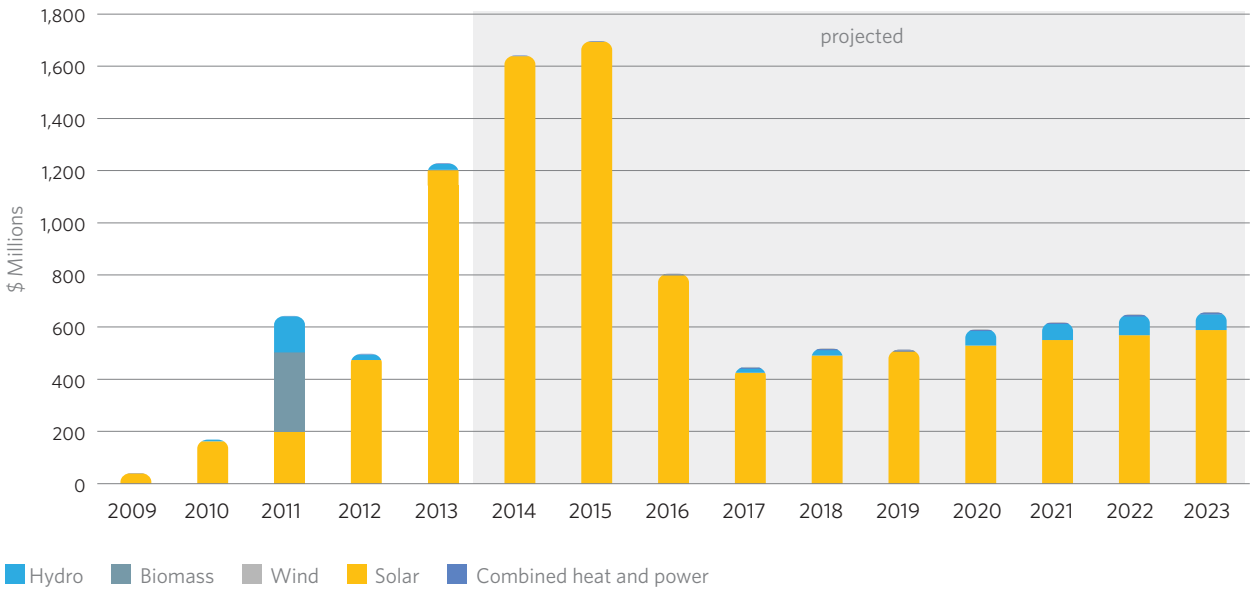


Note: Navigant Research provided data and projections of annual capacity additions from 2009 to 2023. These figures were added to baseline 2008 cumulative capacity data from the Energy Information Administration (except for wind and solar, for which cumulative data were available from Navigant Research). Navigant Research's methodology is described at the end of this brief, and that of the Energy Information Administration is detailed in Table 3, available at http://www.eia.gov/renewable/state/northcarolina/.

Sources: Navigant Research, Energy Information Administration

Clean Energy Investment, by Sector and Year

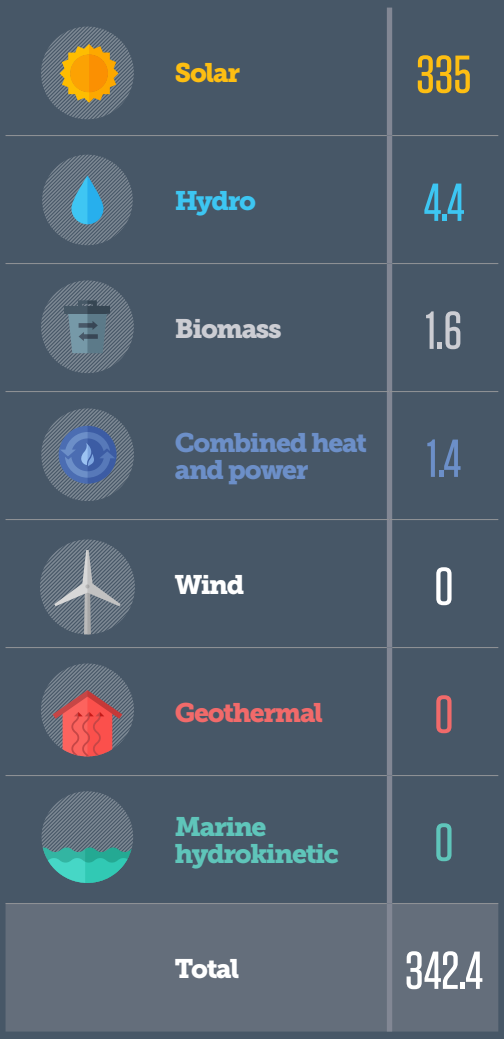
Actual (2009-13) and projected (2014-23) annual investment



Source: Navigant Research

New Clean Energy Capacity Installed in 2013 (MW)

Solar accounted for majority of new projects



Source: Navigant Research

> To remain competitive, North Carolina must continue to invest in new, efficient energy sources."
>
> —2011 North Carolina Economic Index

National Rankings

Rank	
3rd	in new renewable capacity installations, 2013 (342 MW)
3rd	in private investment, 2013 ($1.2 billion)
8th	in energy- and environment-related jobs, 2011 (83,017)

Sources: Navigant Research, Bureau of Labor Statistics

Geographic Spotlight

North Carolina's Research Triangle

The Research Triangle spans more than 10 counties and houses 12 academic institutions, anchored by Duke University, North Carolina State University, and the University of North Carolina, Chapel Hill. The region attracts more than $2 billion annually in research and development, often featuring collaboration among businesses, government institutions, and universities.*

Research Commons in The Research Triangle Park.

The area includes The Research Triangle Park, a nearly 7,000-acre campus housing 170 companies. It has received national recognition for mentoring in science, technology, engineering, and math.† In addition, the Research Triangle Region Cleantech Cluster, a nonprofit organization, provides technological and business support for more than 500 companies working on renewable power, energy efficiency, smart grids, and advanced transportation.‡

Triangle entities include some of North Carolina's most notable successes and top recipients of U.S. Department of Energy research funds.§ Four that recently received federal Advanced Research Projects Agency-Energy (ARPA-E) grants have shown early promise and attracted additional investment. Details about some of these recipients, including Phononic, ABB, Cree, and the Research Triangle Institute,** will appear later in this document.

* Research Triangle Regional Partnership, "Education," last updated 2014, http://www.researchtriangle.org/assets/education/universities-colleges; and Research Triangle Regional Partnership, "Regions," last updated 2014, http://www.researchtriangle.org/regions/research-triangle-region.

† Holly Trippett, "Responding to President's Call to Action, US2020 Announces 7 Cities as Winners of Its STEM Mentoring Competition at the White House Science Fair," *Citizen Schools*, May 2014, http://www.citizenschools.org/blog/us2020-press-release-us2020-announces-7-cities-winners-stem-mentoring-competition-white-house-science-fair.

‡ Research Triangle Regional Partnership, "Cleantech," last updated 2014, http://www.researchtriangle.org/clusters/cleantech.

§ USA Spending.gov, "Prime Award Spending Data," accessed March 11, 2014, http://www.usaspending.gov/. Based on top five recipients of funding from the Energy Department's Office of Energy Efficiency and Renewable Energy and the Advanced Research Projects Agency-Energy, fiscal years 2004-13.

** Advanced Research Projects Agency-Energy, "Select ARPA-E Projects Demonstrating Market Engagement" (Feb. 2, 2014), http://www.arpa-e.energy.gov/sites/default/files/documents/files/2014_Summit_Press_Release_Addendum_022314_0.pdf.

Solar industry highlights

North Carolina's renewable portfolio standard has encouraged the solar industry's growth. The state has built or started planning approximately 100 solar farms since adopting the rules in 2007. None previously existed.[11] According to projections from Navigant Research, this growth is likely to continue. North Carolina installed 537 MW of utility-scale, commercial, and residential solar from 2009 to 2013. Navigant Research forecasts the addition of nearly 2.6 gigawatts over the next decade (2014 to 2023). The state now ranks fifth nationwide in the number of homes powered by solar.[12]

98% Solar's share of the clean energy capacity added in North Carolina in 2013

Source: Navigant Research

The economic benefits are clear. Private investment in North Carolina solar projects totaled $2.1 billion over the past five years (2009 to 2013), and will generate another $7.8 billion over the next decade (2014 to 2023), according to data from Navigant Research. Furthermore, North Carolina added 1,700 solar jobs in 2013—bumping it up eight spots from the prior year to 10th place nationwide.[13]

The state's strength in solar also has attracted companies with energy-intensive data centers. American Express chose North Carolina for a $400 million data center because of the state's robust clean energy policy, and Apple built the largest privately owned solar facility in the nation at its data center in Maiden.[14]

North Carolina Solar
National rankings, 2013

Rank	
3rd	in new capacity (335 MW)
3rd	in private investment ($1.2 billion)
4th	in total capacity (557 MW)
5th	in homes powered by solar (36,771)
10th	in jobs (3,100)

Sources: Navigant Research, Solar Energy Industries Association, and Solar Foundation

North Carolina's net metering policy allows residential and industrial customers to offset their energy costs by returning electricity from on-site distributed systems, such as solar panels, to the grid. Despite this success, continued growth could be hindered by the limitations of North Carolina's current rules and restrictions on third-party sales of electricity by independent power producers (nonutilities).

For example, the state allows net metering only for projects smaller than 1 MW and gives the utility, not the consumer, ownership of the marketable renewable energy credits.[15] In addition, the project owner cannot sell excess electricity without being regulated as a utility.[16] The state could make clean energy projects more economical and improve the electrical system's stability by removing these barriers to small-scale residential and commercial power generation.

Geographic Spotlight

Solar Power: The New Cash Crop

Across North Carolina, sunlight is being soaked up by solar panels alongside crops. Utility-scale projects are particularly concentrated in the eastern part of the state, providing supplemental income on farmland and former industrial sites.[*] Some examples:

- Strata Solar is developing several projects in this area. The 75-MW Wiggins Mill solar farm in Wilson County will generate enough electricity for Duke Energy to power 11,000 homes on days with optimal sunlight.[†] A planned 100-MW solar farm in Duplin County will provide electricity to Duke Energy and create approximately 400 construction jobs.[‡]
- Innovative Solar Systems is developing an 80-MW solar farm on property leased from Barker Gallberry Farms in Cumberland County.[§]

The economic benefits of these projects motivated some rural lawmakers to reject a 2013 effort to roll back the renewable portfolio standard.[**]

[*] Sammy Fretwell, "Farmers Grow Profits With a New Crop: Solar Panels," *News & Observer*, Nov. 11, 2012, http://www.newsobserver.com/2012/11/11/2478266/farmers-grow-profits-with-a-new.html.

[†] John Murawski, "Chapel Hill's Strata Solar Plans Third 75-Megawatt Solar Farm in N.C.," *News & Observer,* Nov. 19, 2013, http://www.newsobserver.com/2013/11/19/3387289/chapel-hills-strata-solar-plans.html.

[‡] John Downey, "Strata Solar Plans 100-Megawatt Solar Project in NC," *Charlotte Business Journal*, Feb. 12, 2013, http://www.bizjournals.com/charlotte/blog/power_city/2013/02/strata-solar-plans-100-megawatt-solar.html?page=all.

[§] John Murawski, "Proposed 80-Megawatt Solar Farm Would Be NC's Biggest," *News & Observer*, April 29, 2014, http://www.newsobserver.com/2014/04/29/3821008/proposed-80-megawatt-solar-farm.html.

[**] John Murawski, "Push to End NC's Renewable Energy Program Dies in Committee," *News & Observer,* April 24, 2013, http://www.newsobserver.com/2013/04/24/2847114/nc-house-committee-defeats-proposal.html.

Project Spotlight

Powering Up Camp Lejeune and Fort Bragg

Asheville-based FLS Energy has installed solar panels on approximately 2,200 homes at Marine Corps Base Camp Lejeune. FLS owns and operates the project, which provides up to 75 percent of each housing unit's water-heating needs and reduces associated costs by approximately 20 percent. Federal and state tax incentives were instrumental in financing the project.[*]

Camp Lejeune also is installing solar panels on rooftops, unused fields, parking lots, and other surfaces throughout the base. Collectively, these projects are expected to save approximately $500,000 per year in energy costs.[†]

Elsewhere in North Carolina, Fort Bragg, the Army's largest base in the world by population, also installed solar power and efficiency technologies such as combined heat and power, which generates heat and electricity from a single fuel source. The Army thus will save taxpayers an estimated $13 million per year.[‡]

FLS Energy owns and operates solar panels that power water heating on Camp Lejeune's housing units.

[*] Solar Energy Industries Association, "Enlisting the Sun: Powering the U.S. Military With Solar Energy 2013" (May 17, 2013), 16, http://www.seia.org/sites/default/files/Enlisting%20the%20Sun-Final-5.14.13-R6.pdf; and Frank Marshall, FLS Energy, pers. comm.

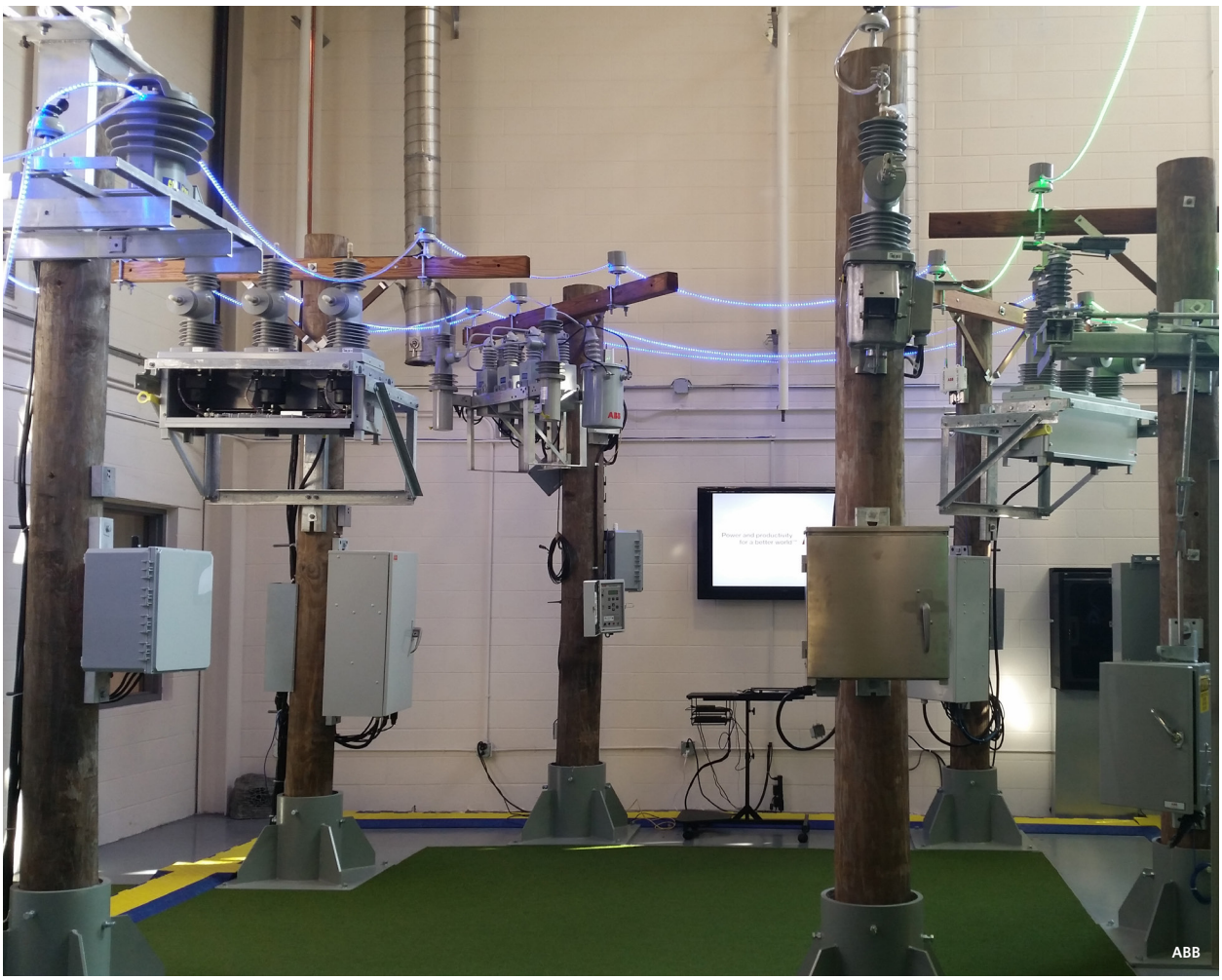
[†] Associated Press, "Camp Lejeune Adding Solar Farms to Cut Costs," *The Virginian-Pilot,* Aug. 21, 2012, http://hamptonroads.com/2012/08/camp-lejeune-adding-solar-farms-cut-costs.

[‡] Drew Brooks, "Fort Bragg at the Forefront of Clean Energy, Report Says," *The Fayetteville Observer*, Feb. 3, 2013, http://www.fayobserver.com/military/article_ef05fee9-9d54-5901-b30e-a32911a3a295.html.

Smart grid highlights

In 2011, two Duke University studies showed that North Carolina is a hot spot for smart grid technology.[17] The U.S. Department of Energy describes a smart grid as "digital technology that allows for two-way communication between the utility and its customers" through a system of "controls, computers, automation, and new technologies and equipment working together."[18] Smart grids allow power producers to respond more rapidly to changing electricity demand, which enhances reliability and efficiency. The technology can also facilitate the connection of technologies such as solar, wind, and electric vehicles, which are considered intermittent energy sources because they do not supply power continuously, as traditional fuels do.

The Research Triangle houses nearly 60 core firms spanning the entire value chain (including inventors, vendors, power providers, and others) of the technology, with five headquartered in Raleigh alone, the second-largest cluster in the country. Its strength relies partly on academic institutions and a large concentration of clean energy companies. It also depends on supportive government policies, such as the renewable portfolio standard, and on robust utility investments in grid modernization.[19]

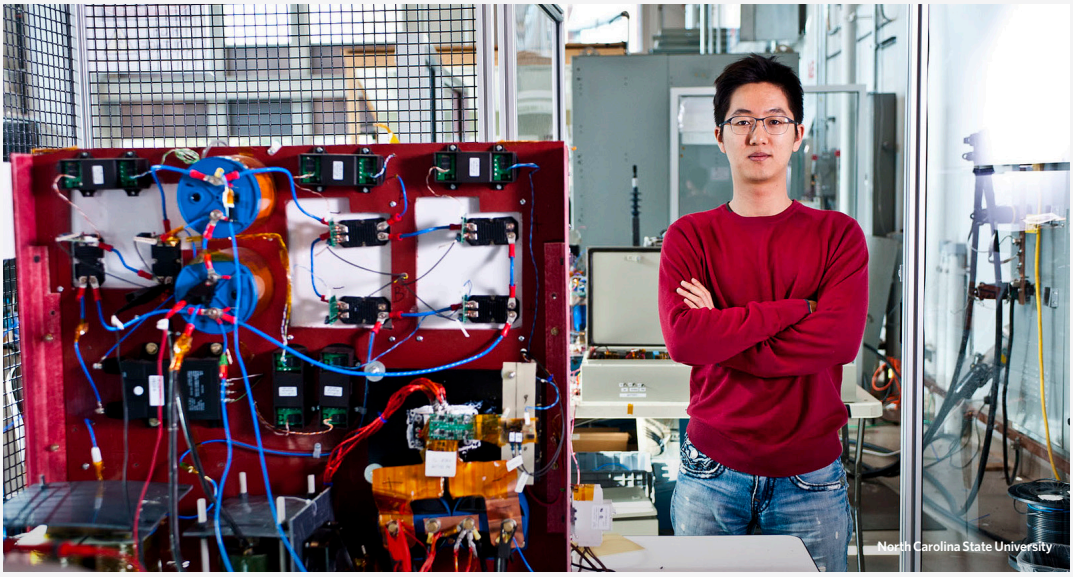


Smart grid testing in the Research Triangle.

Institution Spotlight

Leading the Pack: North Carolina State University

Strategic public and private investments at North Carolina State University's top-notch engineering program have propelled the school to the forefront of energy innovation.



The Next Generation Power Electronics Innovation Institute at North Carolina State University.

North Carolina State University's Future Renewable Electric Energy Delivery and Management (FREEDM) Systems Center, supported by an $18.5 million National Science Foundation grant, is working on smart grid technologies to enable distributed energy generation and storage.[*] The school's Centennial Campus houses a North Carolina State Technology Incubator, which in 2007 contributed an estimated $76 million in gross state product and helped create 900 jobs.[†]

In 2014, the Department of Energy selected the school to coordinate the Next Generation Power Electronics Innovation Institute. The $140 million manufacturing hub is a public-private partnership with federal and state funding, including five universities, two federal laboratories, and 18 companies. The institute focuses on wide bandgap semiconductors—a smaller, faster, more-efficient alternative to the ubiquitous silicon-based devices found in smart grids, solar panels, and other electronic devices.[‡]

[*] North Carolina State University, "Smart Grid Central" (June 12, 2011), http://www.ncsu.edu/features/2011/06/smart-grid-central; and North Carolina State University, "FREEDM Systems Center: About," http://www.freedm.ncsu.edu/index.php?s=1.

[†] RTI International, "Report: Startups Supported by NC State Technology Incubator Boost the Local Knowledge-Based Economy" (Feb. 25, 2008), http://www.rti.org/newsroom/news.cfm?obj=E7BB6BCD-B4E5-467B-8312353AF1CA91A1.

[‡] North Carolina State University, "Manufacturing Innovation," http://www.ncsu.edu/power.

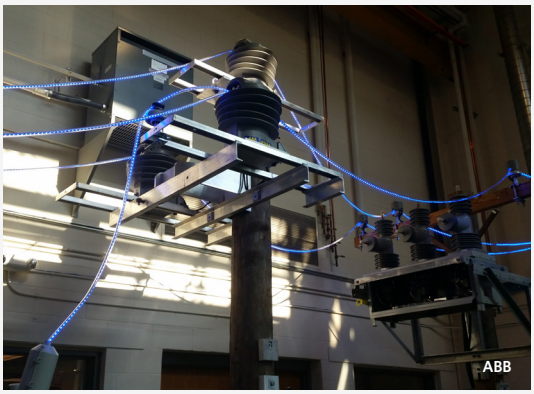
Company Spotlights

A Network of Innovation

The importance of work at both North Carolina State University (NCSU) and the federal Advanced Research Projects Agency-Energy (ARPA-E) is illustrated by the trio of companies below, which stand at different stages of development but exemplify some of the region's engines of innovation.

ABB: Global power giant comes to North Carolina

Swiss power and automation systems company ABB moved its North American headquarters to Cary in 2009 and now employs 2,000 people statewide.* NCSU's Centennial Campus houses one of ABB's seven global research and development centers. In 2012, the partnership launched its Smart Grid Center for Excellence to develop technologies capable of improving resiliency in extreme weather.† ABB participates in the Next Generation Power Electronics Innovation Institute.‡ Furthermore, the company received a $4.85 million ARPA-E grant in 2010 to develop a superconducting magnetic energy storage system to incorporate renewable power into the grid.§



Smart grid technology testing at ABB.

Durham-based Phononic builds high-efficiency devices to reuse waste heat in electronics.

Cree: A homegrown success

Founded by NCSU graduates and based on research conducted in the school's engineering lab, Cree has grown to more than 6,000 employees worldwide. It has emerged as a leading provider of light emitting diode (LED) and semiconductor technologies. Its accomplishments have paved the way for full-color displays on billboards, more efficient light bulbs, and silicon-carbide wafers capable of powering personal electronics and power inverters—which transform solar energy into usable electricity—with less energy.** Cree is part of the Next Generation Power Electronics Innovation Institute.†† In 2010, it received a $5.6 million ARPA-E grant for its silicon-carbide research .‡‡

Continued on next page

Phononic: Startup became early success story

Durham-based Phononic is an NCSU spinoff working to recycle waste heat in electronics and appliances into usable power through advanced thermoelectric devices. Four years after receiving $3 million from ARPA-E, the startup raised an additional $36.4 million in venture capital. The 50-employee company plans to grow its engineering team and expand its manufacturing capacity in The Research Triangle Park.[***]

[*] ABB, "ABB Relocates Its North American Corporate Headquarters to Cary, North Carolina" (April 14, 2009), http://www.abb.com/cawp/seitp202/58e9202283c7c5fe852575990047ff53.aspx.

[†] PennEnergy, "New Technology From ABB Helps Cities Keep the Power 'On' Despite Severe Weather," March 5, 2012, http://www.pennenergy.com/articles/pennenergy/2012/03/new-technology-from.html.

[‡] John Murawski, "Obama Picks NCSU to Lead $140 Million National Research Consortium." News & Observer, Jan. 15, 2014, http://www.newsobserver.com/2014/01/15/3532737/obama-to-name-ncsu-home-to-new.html#.

[§] Advanced Research Projects Agency-Energy, "Magnetic Energy Storage System," http://www.arpa-e.energy.gov/?q=slick-sheet-project/magnetic-energy-storage-system.

** North Carolina State University, "Creating Cree," NC State Engineering (spring 2010), http://www.engr.ncsu.edu/magazine/spring2010/cree.php.

[††] John Murawski, "Obama Picks NCSU to Lead $140 Million National Research Consortium," *News & Observer*, Jan. 15, 2014, http://www.newsobserver.com/2014/01/15/3532737/obama-to-name-ncsu-home-to-new.html#.

[‡‡] Advanced Research Projects Agency-Energy, "Utility-Scale Silicon Carbide Power Transistors," http://arpa-e.energy.gov/?q=slick-sheet-project/utility-scale-silicon-carbide-power-transistors.

*** Advanced Research Projects Agency-Energy, "Improved Thermoelectric Devices," http://arpa-e.energy.gov/?q=slick-sheet-project/improved-thermoelectric-devices; David Bracken, "RTP-Based Phononic Devices Raises $21 Million," *News & Observer*, Dec. 12, 2013, http://www.newsobserver.com/2013/12/12/3455632/rtp-based-phononic-devices-raises.html; and Cleantech Group, "i3 Market Intelligence Program," accessed July 7, 2014, www.i3connect.com.

Emerging opportunities

Advanced vehicle technology shows potential

In addition to North Carolina's growing strength in solar and smart grid technologies, other opportunities include advanced transportation and bioenergy. The state's manufacturing sector ranks fourth nationwide, at $88 billion, or 19 percent of gross domestic product.[20] Manufacturers also employ 11.2 percent of the state's workforce.[21] With its highly skilled labor force, the state hopes to attract advanced vehicle manufacturing facilities to spur economic development.[22]

- Volvo Trucks, with corporate headquarters in Greensboro, is one of only four manufacturers participating in the Energy Department's SuperTruck initiative, a nationwide pilot program to develop highly efficient heavy-duty trucks.[23]
- After receiving a large Energy Department award, battery manufacturer Celgard opened a lithium-ion battery separator facility in the Charlotte area and employs 440 people.[24]

Institution Spotlight

Taking Charge on Electric Vehicles

The North Carolina Plug-in Electric Vehicle Taskforce began in 2011 under the leadership of Advanced Energy—a nonprofit corporation established by the public utilities commission to assist utilities with clean energy projects—and the state Department of Commerce, with government, industry, utility, and nonprofit partners. The task force received funding from the U.S. Energy Department's Clean Cities Program to create a plan for plug-in electric vehicle implementation. More than 1,600 such vehicles were registered in the state as of 2013, more than double the first year of sales.*

* North Carolina Plug-in Electric Vehicle Taskforce, "About Us," http://www.advancedenergy.org/portal/ncpev/about.php.

Biomaterials build on agricultural heritage

A strong agricultural legacy also creates potential to harness waste materials for advanced biomass power generation and liquid biofuel production.[25] Several companies that produce enzymes or feedstocks for biofuels—including BASF, Bayer CropScience, Novozymes, and Syngenta—are headquartered in North Carolina and recently announced expansions in the state.[26]

To catalyze further growth of the biofuels industry, the state Legislature established the North Carolina Center for Biofuels in 2007 with a $4 million annual appropriation. Although the center has since been closed because of budget cuts, it contributed business support services and $10.1 million in grants to 71 projects.[27] Among them:

- U.S.-Israeli biofuels company Virdia (formerly HCL CleanTech) established its first pilot facility in Durham in 2010.[28] The company since has received $6 million in funding from the U.S. Department of Energy, attracted at least $30 million in private investment, and added other facilities throughout the Southeast.[29]
- Biochemtex, an Italian company, selected Clinton in 2013 for its $200 million cellulosic biofuels plant. The project, which will create an estimated 65 jobs, received a $300,000 One North Carolina Fund grant and includes several federal, state, and local partners.[30]

Conclusion

Given North Carolina's ample renewable resources and skilled technical workers, the state is well-situated to continue growing its clean energy economy. The state will be able to capitalize fully on these assets by preserving and strengthening state policies, such as the renewable portfolio standard; leveraging federal policies such as tax incentives; and continuing strong public and private investments in research and development.

Endnotes

1 Kristin Bunn and Derek Ramirez, *2011 North Carolina Economic* Index, North Carolina Department of Commerce (June 2011): 2, 28–30, http://www.nccommerce.com/Portals/0/Research/EconIndex/2011%20Economic%20Index.pdf.

2 Energy Information Administration, "North Carolina: State Profile and Energy Estimates," last modified Dec. 18, 2013, http://www.eia.gov/state/analysis.cfm?sid=NC.

3 John Murawski, "Push to End NC's Renewable Energy Program Dies in Committee," *News & Observer*, April 24, 2013, http://www.newsobserver.com/2013/04/24/2847114/nc-house-committee-defeats-proposal.html.

4 North Carolina State University, Database of State Incentives for Renewables and Efficiency, "North Carolina Incentives/Policies for Renewables and Efficiency," http://www.dsireusa.org/incentives/index.cfm?re=0&ee=0&spv=0&st=0&srp=1&state=NC.

5 RTI International, "Report: Startups Supported by NC State Technology Incubator Boost the Local Knowledge-Based Economy" (Feb. 25, 2008), http://www.rti.org/newsroom/news.cfm?obj=E7BB6BCD-B4E5-467B-8312353AF1CA91A1.

6 Brookings Institution, "Sizing the Clean Economy" (July 2013), http://www.brookings.edu/research/interactives/aggregate-clean economy#/?ind=1&geo=2&vis=0&dt=1&z=4&x=847&y=545.

7 Energy Information Administration, "North Carolina Renewable Electricity Profile 2010" (March 8, 2012), Table 3, http://www.eia.gov/renewable/state/northcarolina; and Energy Information Administration, "Electric Power Annual" (Dec. 12, 2013), Table 4.7B, http://www.eia.gov/electricity/annual. Data are for net summer capacity, which is the maximum output that generating equipment can supply to system load at the time of summer peak demand, after accounting for electricity demand for station service or auxiliaries.

8 National Renewable Energy Laboratory, "Renewable Energy Technical Potential," last updated Oct. 17, 2013; U.S. Department of Energy, "Revolution Now: The Future Arrives for Four Clean Energy Technologies" (Sept. 17, 2013), http://energy.gov/sites/prod/files/2013/09/f2/200130917-revolution-now.pdf; and Energy Information Administration, "North Carolina: State Profile and Energy Estimates."

9 U.S. Department of Energy, "WINDExchange: North Carolina 50-Meter Wind Map," last updated May 1, 2014, http://apps2.eere.energy.gov/wind/windexchange/maps_template.asp?stateab=nc.

10 Marc Schwartz et al., *Assessment of Offshore Wind Energy Resources for the United States,* National Renewable Energy Laboratory (June 2010), http://www.nrel.gov/docs/fy10osti/45889.pdf.

11 Sammy Fretwell, "Farmers Grow Profits With a New Crop: Solar Panels," *News & Observer,* Nov. 11, 2012, http://www.newsobserver.com/2012/11/11/2478266/farmers-grow-profits-with-a-new.html.

12 Solar Foundation, "State Solar Jobs: North Carolina," last updated November 2013, http://thesolarfoundation.org/solarstates/north-carolina.

13 Ibid.

14 Bryn Baker et al., "Power Forward 2.0: How American Companies Are Setting Clean Energy Targets and Capturing Greater Business Value," Calvert Investments, Ceres, David Gardiner & Associates, and World Wildlife Fund (July 2014): 13, https://www.worldwildlife.org/publications/power-forward-2-0-how-american-companies-are-setting-clean-energy-targets-and-capturing-greater-business-value.

15 North Carolina State University, Database of State Incentives for Renewables and Efficiency, "North Carolina Incentives/Policies for Renewables and Efficiency."

16 U.S. Department of Energy, Clean Energy Application Center Southeast, "Barriers to Military Installations Utilizing Distributed Generation From Renewable Energy Resources: Third Party Power Purchase Agreements" (May 2011), http://www.southeastchptap.org/resources/reports/SERAC_3rd_Party_PPA_Whitepaper_%20110518.pdf.

17 Marcy Lowe, Hua Fan, and Gary Gereffi, "U.S. Smart Grid: Finding New Ways to Cut Carbon and Create Jobs," Duke University Center on Globalization, Governance & Competitiveness (April 19, 2011), 22, http://cggc.duke.edu/pdfs/Lowe_US_Smart_Grid_CGGC_04-19-2011.pdf; and Marcy Lowe, Hua Fan, and Gary Gereffi, "Smart Grid: Core Firms in the Research Triangle Region, NC, 2011," Duke University Center on Globalization, Governance & Competitiveness (May 24, 2011), 8-15, http://www.cggc.duke.edu/pdfs/Lowe_Research-Triangle-Smart-Grid_CGGC_05-24-2011.pdf.

18 U.S. Department of Energy, "What Is the Smart Grid?" https://www.smartgrid.gov/the_smart_grid.

19 Lowe, Fan, and Gereffi, "U.S. Smart Grid: Finding New Ways to Cut Carbon and Create Jobs"; and Lowe, Fan, and Gereffi, "Smart Grid: Core Firms in the Research Triangle Region."

20 North Carolina State University, "Industrial Extension Service: Importance to North Carolina," last updated 2014, http://www.ies.ncsu.edu/industries/manufacturing/manufacturing-matters/importance-of-manufacturing-to-nc.

21 National Association of Manufacturers, "North Carolina Manufacturing Facts," http://www.nam.org/~/media/CF1950ABFCF64735BF8B2C14976CEE88.ashx.

22 Catherine Carlock, "Which Automakers Need More Manufacturing Capacity and Could the Triad Help?" *Triad Business Journal* (March 6, 2014), http://www.bizjournals.com/triad/blog/2014/03/which-automakers-need-more-capacity.html.

23 White House, "Fact Sheet: Opportunity for All: Improving the Fuel Efficiency of American Trucks—Bolstering Energy Security, Cutting Carbon Pollution, Saving Money and Supporting Manufacturing Innovation" (Feb. 18, 2014), http://www.whitehouse.gov/the-press-office/2014/02/18/fact-sheet-opportunity-all-improving-fuel-efficiency-american-trucks-bol.

24 U.S. Department of Energy, "Secretary Chu Celebrates Expansion of Lithium-Ion Battery Production in North Carolina" (July 26, 2011), http://energy.gov/articles/secretary-chu-celebrates-expansion-lithium-ion-battery-production-north-carolina.

25 Energy Information Administration, "North Carolina: State Profile."

26 Robin Deacle, "Agbio a Fast-Growing Sector in N.C.'s Life Science Industry," WRAL TechWire (June 24, 2014), http://wraltechwire.com/agbio-a-fast-growing-sector-in-n-c-s-life-science-industry/13759067.

27 Amanda Peterka, "After GOP Eliminates Funding, Nascent Industry Wonders if It Has a Place in N.C.," *E&E* (July 17, 2014).

28 Virdia, "HCL CleanTech Establishes Administrative and Pilot Plant Facilities" (April 1, 2010), http://www.virdia.com/news-and-events/news-and-events/33-hcl-cleantech-establishes-administrative-and-pilot-plant-facilities-in-north-carolina.

29 Bryan Sims, "Virdia Embarks on New, Improved Commercialization Trajectory," *Ethanol Producer* (March 14, 2012), http://ethanolproducer.com/articles/8649/virdia-embarks-on-new-improved-commercialization-trajectory.

30 Area Development Online, "Biochemtex Invests $200 Million in North Carolina Cellulosic Biofuels Facility" (Dec. 2, 2013), http://www.areadevelopment.com/newsItems/12-2-2013/biochemtex-production-center-sampson-county-north-carolina378923.shtml.

Notes

Notes

Acknowledgments

This policy brief is one of a collection examining state clean energy economies. The states selected have demonstrated leadership in clean energy policies, installations, and economies, or are at a crossroads in their energy futures. The brief was prepared by The Pew Charitable Trusts' clean energy initiative, with Lynn Abramson as lead author. This research was funded in part by The 11th Hour Project.

Unless otherwise specified, data on capacity additions and investment were provided by Navigant Research, an energy market research firm, and include solar photovoltaics, industrial sector combined heat and power, geothermal power (excluding heat pumps), biomass power (excluding landfill-gas, anaerobic digesters, and biogas recovery), hydropower projects, permanently installed (not pilot) marine and hydrokinetic projects, and wind projects greater than 1 megawatt.

The Clean Energy Business Network

Pew's Clean Energy Business Network seeks to inform and engage clean energy business leaders in policy issues affecting the industry. For more information or to sign up for this free resource, visit pewtrusts.org/businessnetwork.

For further information, please visit:

pewtrusts.org/cleanenergy

Contact: Lynn Abramson, senior associate, clean energy
Email: labramson@pewtrusts.org
Phone: 202-540-6474