Next-Generation Energy

Report to the North Carolina General Assembly

MARCH 15, 2026

collaboratory
science. policy. solutions.

Contents

Executive Summary

Legislative Mandate

The Next Generation Energy program at the Collaboratory was initiated by Session Law 2023-134, through which the North Carolina General Assembly allocated $15 million in state funds for energy research in North Carolina that supports technology development and catalyzes economic development in the energy sector.

Session Law 2023-134 requires the Collaboratory to submit an annual report to the Joint Legislative Education Oversight Committee by March 15th. The submission of this report is intended to meet the legislative requirement.

Background

North Carolina is continuing to position itself as a leader in the energy transition. NC has a diverse power portfolio, is rich with critical mineral resources, incentivizes economic development and industry growth, and houses efforts to support workforce development and catalyze job growth as energy technologies advance. The State is also home to many excellent universities and colleges, all working on different aspects of the energy transition.

The North Carolina Collaboratory has played a crucial role in advancing North Carolina's energy sector by spurring and supporting research on key topics such as energy storage, critical mineral extraction, grid reliance, and nuclear energy. This report seeks to provide a brief update on the Collaboratory's current projects related to energy issues and outlines future plans to encourage innovation in the energy sector across North Carolina.

Focusing on the state's energy needs, the Collaboratory prioritized several key areas: unlocking North Carolina's critical mineral potential, accelerating energy storage, building a strong nuclear energy workforce, and ensuring grid reliability.

Funding Priorities

In 2025, the NC Collaboratory continued to fund research that extends beyond the lab, delivering tangible benefits to North Carolina's citizens, industries, and policymakers. Focusing on the state's energy needs, the Collaboratory prioritized several key areas: unlocking North Carolina's critical mineral potential, accelerating energy storage, building a strong nuclear energy workforce, and ensuring grid reliability.

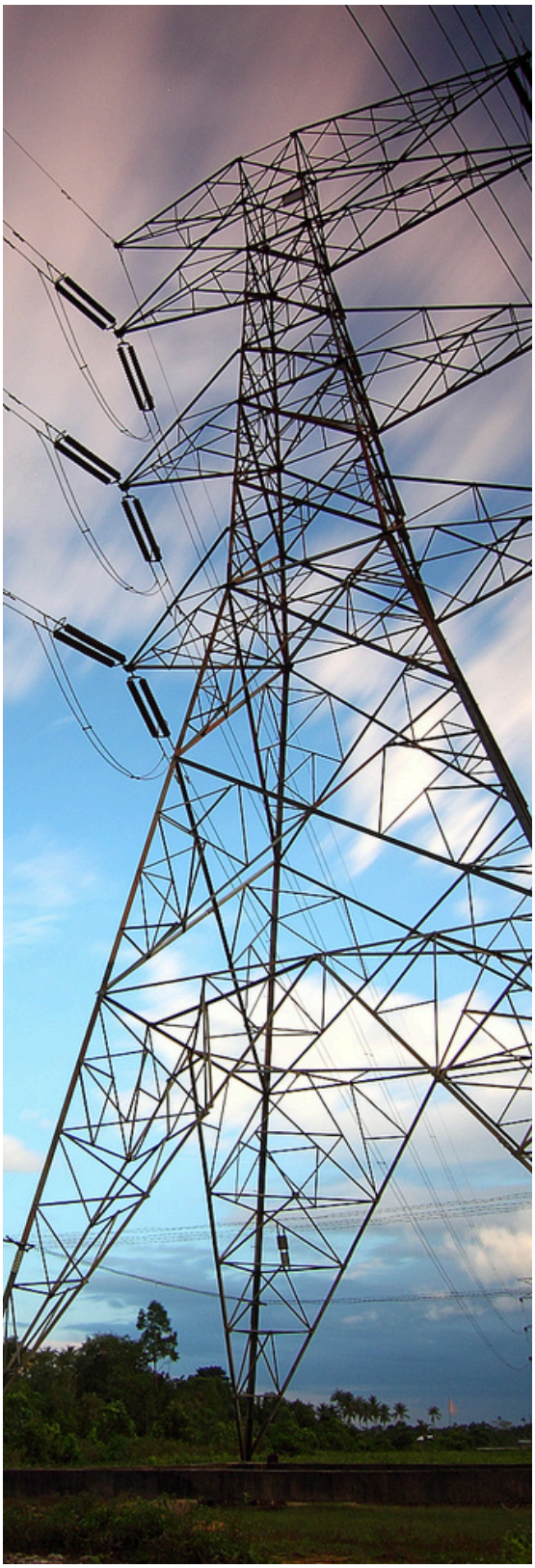
A couple of highlighted projects below provide examples of how Collaboratory-funded research is driving innovation and collaboration:

A team of researchers from UNC-Chapel Hill developed the *Supercharging Energy Storage Report* to assess both the current state of energy storage in North Carolina and ongoing research efforts.

The Appalachian State University-led project, the Battery Industry Partnership, exemplifies this approach, connecting companies, non-profits, academic institutions, and government partners across the entire supply chain to address market, policy, and workforce challenges.

Looking ahead, the NC Collaboratory plans to expand support for critical mineral research, collaborating with the North Carolina Geological Survey, Duke University's Critical Mineral Hub, NC State, UNCG, UNC-Chapel Hill, and other statewide researchers.

The Collaboratory is also working to identify research opportunities related to the potential growth of large data centers in the State and to provide actionable data and recommendations to assist policy-makers in addressing this growing statewide issue.



By the Numbers

8x

Duke Energy projects that electricity demand in the Carolinas will grow at eight times the rate of the previous 15 years over the next 15 years.

80%

The King's Mountain District in Cleveland and Gaston Counties contains more than 80% of the known lithium reserves in the US.

13.9B

Investment by Toyota Battery in its plant in Liberty, NC, creating more than 5,000 jobs.

6x

Clean energy job growth compared to the rest of NC's economy in 2024.

600MW

Duke Energy is exploring a 600-MW Small Modular Reactor at Belews Creek in Stokes County.

85%

Of new load growth in North and South Carolina in the next 15 years will be due to data centers, according to Duke Energy's Carolina's Resource Plan.

140k

EV's and plug-in hybrid vehicles registered in North Carolina as of October, 2025.

#1

NC is the top national producer of high-purity quartz, feldspar, olivine, and pyrophyllite.

New Directions: Launching the NC Critical Minerals Initiative

Critical minerals are the backbone of the U.S. economy, national security, and technological leadership. They power electric vehicle batteries, semiconductors, renewable energy systems, advanced manufacturing, and nearly every major defense platform. Strengthening domestic supply chains for these sectors is now a national priority.

North Carolina is uniquely positioned to meet the rising challenge of the U.S.'s reliance on foreign sources of critical minerals, offering unmatched mineral resources and a robust research ecosystem driven by the Collaboratory. Our state can secure critical supply chains for the nation, strengthen U.S. national security, and drive major economic growth while setting a national standard for responsible, science-based development.

Critical minerals in the state include lithium, high-purity quartz (HPQ), phosphate, and rare-earth elements (REEs). Lithium is essential for producing lithium-ion batteries, which are used in EVs and for renewable energy storage. With an estimated 426,600 metric tons of lithium found in the eastern region of the state, North Carolina is the anchor of the US “Battery Belt” and is poised to become a national leader in lithium production.

HPQ is another crucial mineral that contributes to renewable energy development. HPQ is necessary for solar photovoltaic and semiconductor manufacturing, making it a massively growing industry. In 2024, the global market estimated the industry to be worth $972.9 million, and that is projected to grow to $1.3 billion by 2030.

North Carolina’s Spruce Pine Mining District is estimated to hold about 80% of the world’s HPQ supply, making it a critical part of the solar manufacturing and semiconductor economy. HPQ is widely recognized as a “single point of failure” in the semiconductor supply chain due to its irreplaceable attributes and functions. This was evident following a pause in mining efforts after Hurricane Helene triggered a wave of instability across the semiconductor industry, underscoring the need for greater resilience to natural disasters and further exploration.

Launching the NC Critical Minerals Initiative, cont.

Rare earth elements are essential for the production of electronics such as cameras, hard drives, and speakers. Additionally, REEs are used to produce neodymium-iron-boron magnets, which are employed in wind turbines and electric vehicle motors. There is a great potential for REE mining in North Carolina. The southeastern U.S. contains heavily weathered granite regoliths known for their high REE concentrations, although no REE mining sites are currently active in the Southeast.

Beyond our natural deposits, what further sets North Carolina apart is our research and coordination capacity. The Collaboratory and the UNC System provide a statewide engine for geoscience, environmental research, materials innovation, and policy support in coordination with a variety of universities and industry leaders. Through the new Collaboratory Critical Minerals Initiative, we can integrate mapping, environmental stewardship, processing innovation, and workforce development into a unified statewide strategy.

The Collaboratory is contributing to this initiative and overall supporting our state's ability to responsibly and efficiently leverage its critical mineral resources by funding projects in this space, starting in 2026. The Collaboratory is currently partnering with NC State, Duke, UNC, UNCG, and the NCGS, and project areas currently being considered for funding include:

- Evaluating methods to sustainably extract REEs and critical minerals from waste streams.
- Analyzing global and local critical mineral and downstream supply chain regulatory processes, and identifying value chain vulnerabilities.
- Researching the formation of critical mineral deposits to better inform the exploration of future sources.
- Evaluating the potential for critical mineral resources in under-explored regions across the state.
- Creating comprehensive geologic inventories with insight into critical mineral deposits and their accessibility.
- Developing industry partnerships in the REE and critical mineral space.

This is a generational opportunity. With coordinated leadership and research efforts, North Carolina is fast becoming the nation's center of gravity for critical minerals innovation, production, and manufacturing, all for the betterment of North Carolina citizens.

Critical Minerals Spotlight Project:

UNCG and Minerva Lithium - Nano Mosaic Solid-Phase Extraction Technology

Dr. Rathnayake displays her technology at the Minerva Lithium open house in October.

The initiative outlined above builds on previous work in the critical minerals space that the Collaboratory has supported, including that of Dr. Hemali Rathnayake of UNCG, which was initially funded in 2023. Dr. Rathnayake and her team developed a Nano Mosaic Solid-Phase Extraction (SPE) Technology that extracts lithium from brining solutions more quickly and sustainably than current technologies, shortening the extraction process from weeks or years to just 48 hours and reducing freshwater use by a factor of six.

In October, Dr. Rathnayake demonstrated the technology at an open house hosted by Minerva Lithium in Greensboro, bringing together stakeholders including the Greensboro City Council, Chamber of Commerce, and potential customers such as Rio Tinto, Albemarle Corporation, and Toyota Tsusho.

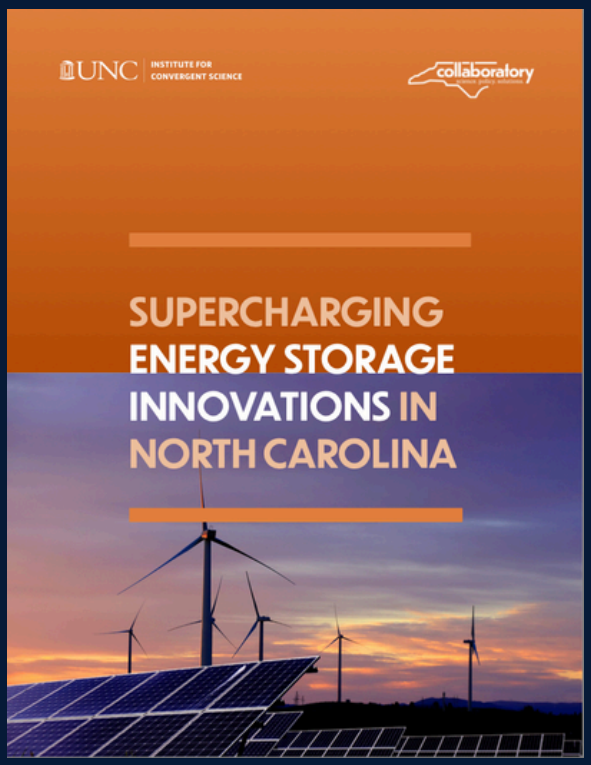
The Collaboratory is following the technology as it shifts from development to commercialization, and will continue to support efforts to increase the technology's market readiness and drive its adoption beyond the lab.

Dr. Hemali Rathnayake, PhD, at UNCG, Professor of Nanoscience and Nanoengineering

2025 Next Generation Energy Project Updates

Catalyzing the Battery Industry

North Carolina faces rising energy demand driven by population growth, the rapid expansion of energy-intensive data centers, and the electrification of transportation and industry. Strategic investment in energy storage innovation and deployment is essential to maintaining grid reliability, balancing variable solar and wind generation, and ultimately lowering energy costs for consumers.



UNC-CH: Supercharging Energy Storage Innovations in NC

To assess North Carolina's energy storage needs and potential, the Collaboratory funded the report Supercharging Energy Storage Innovations in North Carolina, in partnership with the UNC Institute for Convergent Science. Authored by Drs. Alex Miller, Jonathan Williams, and Andrew Yates of UNC Chapel Hill, the report examines the state's energy storage landscape, modeling scenarios that influence the growth of renewable power and storage adoption. It also surveys ongoing energy storage research and development across North Carolina's academic and industry institutions.

The report concludes with recommendations to accelerate R&D and position North Carolina as a leader in energy storage. These recommendations include expanding collaboration between basic and applied scientists, increasing the availability of utility data on storage charging and dispatch, and boosting investment in long-duration storage capable of holding power for more than eight hours.

The full report can be found here: https://innovate.unc.edu/app/uploads/2025/10/nc-energy-report-final.pdf

Appalachian State University Energy Center: Battery Industry Partnership

Kate Bashford, project manager at the Appalachian State University Energy Center, leads the Battery Industry Partnership. Recognizing North Carolina as a leader in battery production, the partnership seeks to strengthen this position by connecting battery and battery-adjacent companies in the state to discuss their needs and develop mutually beneficial relationships. The partnership also engages governmental, academic, and nonprofit partners to improve communication between stakeholders and address challenges related to policy, technology, workforce development, and market growth.

NCBIP Workshop

Kate Bashford, Project Manager at the Appalachian State Energy Center

Project Updates

In collaboration with the North Carolina Department of Commerce, the Partnership has developed a comprehensive map and dashboard detailing the companies involved in the battery value chain. They are also creating a dashboard of battery and critical mineral research centers and initiatives across academic institutions, including faculty specialties, to help companies leverage these resources for R&D. Along these lines, the Battery Industry Partnership's workforce and education working group is convening industry partners, the Governor's workforce agency, the Community College System office, and community colleges across NC to help identify training and certifications needed to create a well-educated workforce. These training programs can then be replicated in other regions with similar needs, creating scalable models that save companies from having to find these contacts on their own.

Looking ahead, the Partnership is establishing a policy and infrastructure working group, which is developing a community safety toolkit to support battery storage siting and permitting through public outreach and education.

Exploring New Nuclear Technologies and Workforce Needs

Access to affordable, reliable, and diverse energy sources will determine whether and how North Carolina captures future economic opportunities, especially as the U.S. races to build more resilient domestic supply chains and maintain its competitive edge in AI. Nuclear energy generation based on advanced technologies, including Small Modular Reactor (SMR) designs, will be an important contributor.

Home to three nuclear power facilities, North Carolina boasts a substantial group of companies with significant experience in nuclear power production. For example, GE Vernova Hitachi Nuclear Energy has headquarters and a manufacturing plant in Wilmington and is a world-leading provider of advanced reactors, fuel, and nuclear services. As older reactors in North Carolina reach the end of their useful lives, new reactor construction must meet or exceed the capacity of the reactors being decommissioned. These advanced reactors will help speed up that process and enhance the power system's resilience in the state. NC is also already planning to deploy small modular reactors at retiring coal plant sites, such as Belews Creek in Stokes County.

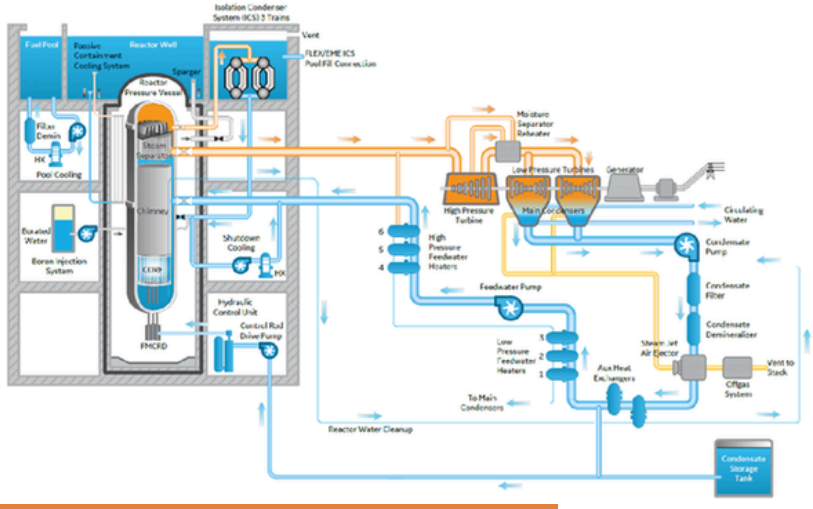
Education and training programs will ensure the state has the talent needed to operate and maintain advanced reactors. The Collaboratory is supporting two projects at NC State that focus on preparing the next workforce generation to meet the changing construction, operation, and maintenance needs.

NCSU: Academic Boiling Water-Small Modular Reactor (BW-SMR) Simulator for Research Development, and Educational Purposes

Dr. Maria Avramova and her team at NC State are currently working with GE Vernova Hitachi Energy to develop a non-export-controlled Boiling Water-SMR (BW-SMR) digital simulator, along with a benchmark to verify its accuracy. The development of a digital simulator effectively communicates SMR capabilities and key technology concepts, serving as an educational resource for universities, research organizations, regulators, and potential customers worldwide. The simulator can also be used to spur STEM development and interest in nuclear power in North Carolina high schools and community college technical programs.

Project Updates

Over the past year, the research team utilized NC State's nuclear and thermal hydraulic capabilities to design a model of the BW-SMR's core, developed a software analysis tool chain, established a Balance-Of-Plant modeling platform, and created interfaces for simulation operators and instructors. Additionally, they developed benchmark specifications to verify the simulation's accuracy. Looking ahead, Dr. Avramova and her team hope to identify areas for improvement in the simulation and to collaborate across different research groups and institutions to promote standardization in SMR modeling.



BWRX-300 Major Systems Reference

Dr. Maria Avramova, PhD, at NCSU, Professor of Nuclear Engineering

NCSU: Assessment to Define Advanced Reactor Workforce Needs

Dr. Kostadin Ivanov and his team have launched a partnership with the non-profit organization, the Electric Power Research Institute (EPRI), to investigate the education and skill requirements for the construction, commissioning, testing, operation, and all other critical functions of an advanced nuclear facility. They are using data from the research reactor (PULSTAR) at NC State, as well as findings from a recently completed state-supported feasibility study on establishing a sodium-cooled advanced research reactor, to identify knowledge gaps and guide the development of comprehensive, effective training programs.

Dr. Kostadin Ivanov, PhD, at NCSU, Professor of Nuclear Engineering

Project Updates

The first year of the project focused on identifying the training gaps associated with nuclear technologies that will most likely be deployed in North Carolina. Some gaps have been identified, such as the need for training programs that cover the increasingly advanced digital systems and automation features possessed by new nuclear technologies. This is becoming a challenge even as legacy nuclear plants are updated to include digital systems, though it is expected to be more significant for advanced reactors. There are also legacy gaps in mathematical aptitude among technician workers, as mathematical competency is a basic requirement among nuclear power plant workers. Another gap concerns behaviors in nuclear safety culture, quality assurance, and human performance tools. The next step in the project is to address and mitigate these gaps through collaboration with K-12 schools, community colleges, universities, and industry partners to strengthen workforce pipelines, thereby enhancing the safety and efficiency of nuclear operations and boosting local economies.

Strengthening Grid Resilience

A resilient electrical grid, equipped with weatherized infrastructure, storage backup, flexible distribution and transmission systems, and proper auxiliary services, is essential to maintaining power during extreme weather events and meeting rapidly growing energy demand. Beyond reinforced infrastructure, resilience requires analytically informed planning and rapid outage response to both prevent and address disruptions. The Collaboratory recognizes the critical importance of a stable, durable grid to daily life and a thriving economy, a need underscored by the devastation caused by Hurricane Helene in 2024. Accordingly, it is committed to advancing research that strengthens North Carolina's grid.

NCSU: North Carolina Power System Restoration Optimization

Dr. Benjamin Rachunok at NCSU is applying optimization tools to identify strategies for pre-positioning repair crews and resources ahead of storms and efficiently reallocating them after outages. This approach reduces response times, minimizes service disruptions, and ensures preparedness for worst-case scenarios.

Project Updates

The team is finalizing a peer-reviewed journal based on this work and presenting the results in two sessions at the Society for Risk Analysis Annual Meeting in December, reaching both researchers and practitioners

NCSU: Assessing the Vulnerability of the Duke Energy Power Grid to Deliberate Attacks on Electrical Substations

Dr. Jordan Kern at NCSU is using machine learning algorithms to predict power outages caused by physical and cybersecurity attacks, helping utilities reduce their vulnerability to targeted attacks. His research, spurred by the 2022 attack on two substations in Moore County, will quantify the costs associated with an attack on each substation on the grid and develop a list of substations to prioritize for added protection.

NCSU: North Carolina Power System Restoration Optimization

Dr. Robert Cox at UNCC and his team are developing an integrated transmission & distribution planning tool to help grid planners model future grid needs in North Carolina. The tool allows users to simulate both the transmission grid and many individual distribution circuits. This will allow users to study cases, including the impacts of large-scale EV adoption, new AI data centers and manufacturing, and increased renewable energy deployment.

Project Updates

Dr. Cox and his team have made significant progress towards developing the tool, collaborating with students from NCSU and Corvid, a high-performance computing provider. Additionally, they have assembled an outside stakeholder group that includes utilities, policymakers, and others to discuss use cases and tool implementation.

Dr. Benjamin Rachunok, PhD, at NCSU, Professor of Industrial and Systems Engineering

Dr. Jordan Kern, PhD, at NCSU, Professor of Industrial and Systems Engineering

Dr. Robert Cox, PhD, at UNCC, Director of the Energy Production and Infrastructure Center

Conclusion

The Collaboratory is spearheading research in energy storage technologies, small modular reactors, and grid resilience to help meet the state's rapidly growing energy demand. It is also building on its momentum in the critical minerals space by collaborating with the North Carolina Geological Survey to launch the NC Critical Minerals Initiative. This initiative connects research efforts across the UNC System to sustainably leverage North Carolina's natural critical mineral deposits and strengthen local and national supply chains. Together, these next-generation energy efforts position North Carolina to responsibly deploy emerging technologies, cultivate resilient industries, and drive long-term economic development.

In addition to the Critical Minerals Initiative, the Collaboratory is expanding research into data center growth. As AI adoption accelerates, these research initiatives will equip policymakers with the data and analysis needed to accommodate increasing energy demand from large-load consumers such as data centers, while maintaining grid reliability and affordability.

North Carolina remains at the forefront of innovation, holding the intellectual, economic, and natural resources necessary to lead the energy transition. The projects outlined in this report will continue to provide decision-makers and industry leaders with the research and tools needed to ensure the state's energy future is both resilient, economically competitive, and socially and environmentally responsible.

Acknowledgments

The North Carolina Collaboratory is a funding agency that partners with academic institutions and state agencies to transform research into practical information for use by State and local governments. Initially focused on natural resources and environmental issues, the Collaboratory has since broadened its portfolio to include research on some of the State's most pressing challenges, including within the public health, education, clean energy, economic recovery, and technology sectors.

Since its authorization in 2016 by the North Carolina General Assembly, the Collaboratory has stewarded over $250 million in appropriations from the legislature, investing in over 700 research projects across all 17 University of North Carolina System campuses and numerous NC-based private colleges and universities. The Collaboratory is committed to developing innovative, evidence-based solutions that serve the state and its constituents.

UNC-Chapel Hill undergraduate students and Collaboratory interns, Carlisle Shore and Perry Holtzclaw, contributed to the drafting and layout of this report.

More information about the Collaboratory can be found at collaboratory.unc.edu