Joseph F. DeCarolis
Associate Professor
Department of Civil, Construction, and Environmental Engineering
https://www.ccee.ncsu.edu/people/jfdecaro/

Campus Box 7908
2501 Stinson Drive
Raleigh, NC 27695
P: 919.515.0480

A Proposed Energy Storage Study for North Carolina

North Carolina's power sector faces a rapidly increasing penetration of renewable energy as well as economic and environmental pressures to decrease coal production. Energy storage may present an attractive solution to ensure reliable service, decrease costs to rate payers, and reduce the environmental impacts of electricity production. Given the complexity of grid operations, however, the impacts of using energy storage to achieve these goals should be rigorously evaluated. The NC General Assembly recently passed HB589, titled "Competitive Energy Solutions for NC," and it was signed into law by Gov. Cooper in July 2017. Part XII, Section 12 requires the North Carolina Policy Collaboratory to undertake a study on energy storage technology and its potential benefit to NC consumers. This memo outlines our approach to the study. Our **objective** is to generate a white paper that provides clear policy guidance to the NC General Assembly, NC Utilities Commission, and the NC Energy Policy Council, informed by stakeholder engagement and the application of open and transparent modeling tools.

We propose a five-step approach to evaluate the value of energy storage on North Carolina's grid. We will:

1. Critically review the ongoing deployment of storage capacity in North Carolina and beyond. We will examine the factors driving development within North Carolina, with a focus on assessed cost and benefits, and how they may change in the future. In addition, we will investigate other markets that closely resemble North Carolina, including those with vertically integrated utilities and low prevailing electricity rates. An underlying assumption will be that North Carolina's regulatory structure for utilities remains unchanged. A wide variety of storage technologies will be considered as part of this review, including those listed under Step 3 below.
2. Assess the specific applications and services that can be provided by the energy storage technologies listed below in Step 3, including energy arbitrage, generation capacity deferral, transmission and distribution deferral, ancillary services, and customer demand charge reductions. In addition, the study will also consider integration costs, both physical (e.g., distribution upgrades) and operational (e.g., changes in system dispatch). For each application, we will draw data from existing literature and stakeholder discussions to estimate the range of ratepayer impacts from such use. The examination of stacked services (i.e., meeting the needs of multiple applications) will be limited to applications under utility ownership.
3. Examine a variety of different energy storage technologies and their suitability for each of these services, including mechanical (e.g., flywheels, pumped storage), electrochemical (e.g., lithium ion batteries), thermal (e.g., ice storage), electrical (e.g., supercapacitors), and chemical (e.g., hydrogen fuel cells).
4. Evaluate different ownership models (i.e., utility, third party, site owner/operator) and how each affects the costs and revenue streams associated with storage deployment. Costs and benefits associated with third party ownership will be limited to products available in competitive markets, such as ancillary services and energy arbitrage. We will also consider costs and benefits of behind-the-meter storage from the perspective of customers.
5. Utilize information gathered in the steps above to analyze the costs and benefits of storage-inducing policies over both the short and long term using an appropriate suite of energy models. Focus will be placed on near-term market opportunities, but we will also examine the role of storage in a capacity planning context over the next several decades. We will explore a large number of scenarios that cover a broad range of power system futures. Model outputs will include optimized storage levels, estimated costs and benefits, electricity rates, jobs created, service quality, and emissions.

To help guide and inform our analysis, we will develop a formal process for stakeholder engagement. Early in the project, we will conduct a stakeholder workshop to elicit feedback on challenges and opportunities to the industry. We will hold webinars to keep stakeholders apprised of our progress and solicit feedback. We plan to build on existing partnerships and work closely with Duke Energy, municipal utilities, and electric cooperatives to solicit their input and obtain data in order to conduct the analysis. While stakeholder engagement will help to significantly refine this research effort, we will not materially redraft or redefine the five-step approach defined above.

Wherever possible, the analysis will be conducted with open and transparent models. For example, the team has already developed an open source, publicly available capacity expansion model and input dataset specific to the NC electric sector. Open models allow interested stakeholders to replicate our results, suggest improvements, and serve as the basis for ongoing analysis as technology, market conditions, and policy evolve.

Research Team

We have an assembled team with deep expertise in energy systems modeling, power systems operation, economics, policy evaluation, and energy extension and outreach.

NC State University: Joseph DeCarolis (lead), Jeremiah Johnson, Civil, Construction, and Environmental Engineering; Mesut Baran, Ning Lu, David Lubkeman, Wenyuan Tang, FREEDM Center, Electrical and Computer Engineering; Christopher Galik, Public Administration; Harrison Fell, Agricultural and Resource Economics; Steve Kalland, Autumn Proudlove, Isaac Panzarella, NC Clean Technology Center

NC Central University: Anderson Rodrigo de Queiroz, School of Business