RURAL ENERGY STORAGE DEPLOYMENT PROGRAM (RESDP) CASE STUDY:

North Carolina's Electric Cooperatives

Cooperative Partnership to Develop Utility-Scale Energy Storage and Renewable Power on A North Carolina Egg Farm

RESDP Project

This is the second in a series of case studies on the deployment of battery energy storage systems (BESS) projects at electric cooperatives through NRECA's Rural Energy Storage Deployment Program (RESDP). RESDP's goal is to successfully deploy BESS at rural critical infrastructure served by electric cooperatives to increase resiliency, improve system efficiency, and to collect best practices and lessons learned from these deployments with electric cooperatives across the country. For more information on the project and additional resources, please visit the project landing page at www.cooperative.com/RESDP.

The project profiled in this case study is an effort led by North Carolina's Electric Cooperatives to install and own a solar photovoltaic and BESS system on land leased from a local farm and share the system benefits between the farm and their distribution cooperative, Tideland EMC.

This material is based upon work supported by the DOE Office of Electricity Stationary Energy Storage Program, directed by Dr. Imre Gyuk.

Project Background

In 2017, Rose Acre Farms, a 3.5 MW commercial and industrial (C&I) load at peak, informed its distribution cooperative, Tideland EMC, that it sought a substantial supply of renewable energy – to be located on its property – for its large egg-laying facility as a part of its sustainability goals. This led to discussions of a novel cooperative-member partnership to meet the member's needs while adding value to the greater cooperative system.

Under the partnership, Tideland EMC's power supplier, North Carolina Electric Membership Corporation (NCEMC), would build and own a solar photovoltaic system on land leased from Rose Acre Farms and allocate all renewable energy credits (RECs) from the solar installation to the farm. With financial and advisory assistance from NRECA, NCEMC added a battery energy storage system to provide system benefits, such as peak shaving and efficient integration of the power from the solar farm into the grid. The project fits into NCEMC's long-term energy innovation strategy, which includes developing microgrids and solar-plus-energy storage for resiliency and economic enhancements.

Adding resiliency was not a focus for Rose Acre Farms – it already owned and operated on-site diesel generation for that purpose. But resiliency is a major goal for Tideland EMC and North Carolina's Electric Cooperatives, and the cooperatives worked together with Rose Acres Farms to accomplish a project that went beyond traditional renewable generation. The innovative project incorporates the solar photovoltaic and BESS system into a microgrid that will be completed in a second phase and operated in the event of weather-related outages or grid disturbances in order to maintain reliable service to the farm. Tideland EMC and NCEMC leaned on the demonstrated success of their four prior microgrid projects, including one deployed by the two cooperatives in 2017 to serve Ocracoke Island in the nearby Outer Banks.

To Paul Spruill, Tideland EMC's CEO, the project is part of the evolution of an electric cooperative's mission of service to its members. "We've spent decades working with our members on economic development and to meet their needs for energy efficiency," he says. "It's natural now to use our existing member relationships to not only host projects that meet goals of environmental sustainability, but also to deliver to our membership the kinds of technologies and solutions that were not available in the past."

Project Partners
• Rose Acre Farms, a large egg-laying poultry operation in Hyde County, North Carolina • North Carolina's Electric Cooperatives and its generation and transmission entity, North Carolina Electric Membership Corporation (NCEMC) • Tideland Electric Membership Corporation (Tideland EMC) • NRECA's Rural Energy Storage Development Program (RESDP)

What the Project Tests

The following details the various aspects of the arrangement between the participating entities and the technology that this project aimed to test:

- Partnership between a cooperative and a large C&I member to meet the member's goals for access to renewable energy while preserving the cooperative-member relationship, with the cooperative continuing as the supplier of energy and energy services.
- The efficacy of a utility-scale battery energy storage system that not only efficiently integrates a variable renewable resource into the cooperative distribution grid, but also utilizes that BESS as a generation and transmission (G&T) asset to deliver technical and economic benefits to all members.
- Execution of a contract between a cooperative and a member, which allows the cooperative to build, own, and manage generation and storage assets located on the member-owned property.

- The expansion of the solar-plus-energy storage project in phase 2 (2022) to a fully-functioning microgrid that can provide enhanced energy security and resiliency to the commercial member while operating as an asset delivering "edge of the grid" benefits to the cooperative's electric power infrastructure.

Project Details
Solar • 2 MW of solar photovoltaics from 6,300 ET solar modules • 36 string inverters from Sungrow
Battery energy storage • Two 1,257 kVA/2,514 kWh Tesla Megapacks • Lithium Nickel-Cobalt-Aluminum Oxide (NCA) battery chemistry • Energy Storage System Size: 5,028 kWh • Bi-Directional Converter System Size: 2,514 kVA
Other technical details • DC Nominal System Voltage: 1,000 VDC • AC Nominal System Voltage: 277Y/480 VAC • O&M for the energy storage system provided by Tesla under a long-term contract
Rose Acre Farms commercial load • 3.5 MW summertime load (2.7 MW in coolest months) • 1.25 million kWh monthly average consumption • Excellent load factor and power factor relative to other Tideland EMC C&I members

Images of the Rose Acre Farm Solar Project

Images courtesy of NCEMC and Rose Acre Farms.

Ownership and Financing

NCEMC, a tax-exempt organization, established a taxable LLC to construct and operate the solar system, energy storage, and associated system hardware. The project was financed using a sale/leaseback transaction with Farm Credit Leasing (FCL) to monetize the tax credits associated with the project. FCL retains ownership of the physical system throughout the lease term, and there is an option for the LLC to purchase the system at the end of the lease term for a predetermined residual value. The LLC operates the system and sells the associated energy output to NCEMC under the terms of a purchased power agreement.

Project Procurement and Construction

The solar-plus-energy storage installation at Rose Acre Farms was developed as part of a group of five similar solar-plus-storage projects initiated by NCEMC. A Request for Offers was issued, and Azimuth Energy was selected as the engineering, procurement, and construction (EPC) entity to build each project. NCEMC, with its recent experience in utility-scale battery storage through its development of solar plus storage and microgrid projects, chose to procure the battery energy storage system directly. Funding provided by NRECA through its RESDP project substantially reduced the cost of the energy storage system and connected NCEMC to technical experts at Pacific Northwest National Laboratory and Sandia National Laboratories.

BESS Procurement

NCEMC chose to purchase its battery storage system from Tesla based upon a Request for Information sent to multiple suppliers and its prior experience with the vendor on NCEMC's Ocracoke Microgrid project.

Project Timeline

Dates	Activity
2017 - 2019	Discussions were initiated between Tideland EMC and Rose Acre Farms regarding the commercial member's interest in sourcing renewable energy and a proposed solution located on the member property
November 2019	Contract finalized between NCEMC, Tideland EMC, and Rose Acre Farms on the project
January 2021	Contract with EPC for Rose Acre Farms signed, and procurement initiated
April 2021	Construction of Rose Acre Farms solar-plus-energy storage project begins
July 2022 (anticipated)	Commissioning of Rose Acre Farms project

The solar-plus-energy storage project is one of 13 such projects built or under development by NCEMC as of the fourth quarter of 2021. In the case of Rose Acre Farms, there will be a second phase in 2022 to further build the project into a microgrid with two additional reclosers and additional controller programming and testing. These upgrades will allow the farm to be islanded during a grid outage, utilizing the solar-plus-energy storage asset.

Benefits, Challenges, and Next Steps

RESDP Benefits
$250k in grant funding from the U.S. Department of Energy through NRECA
Technical training on fire safety from the Pacific Northwest National Laboratory
Technical expertise in battery storage from Sandia National Laboratories
Information exchange and lessons learned shared through NRECA and its members

Key Project Challenges
A final contract on the overall project structure and the land lease agreement was achieved after several years of talks between the cooperatives and the C&I member.
Determining the optimal size and capacity of the solar PV system. The co-ops and farm worked together and after extended discussions decided on on-site solar that meets slightly more than half of the facility's peak demand.
Competing land uses (agriculture versus energy production)
Remote project location
Avoiding impacts on the facility's daily operations

Next Steps for 2022
Finalize construction (anticipated by July)
Commissioning and testing
Commercial operation
Commence Phase 2: microgrid operation (with additional reclosers and controller programming)

Preparing for the Possibility of a Battery Fire

An important feature of NRECA's RESDP is training and education on fire safety and batteries. The project taps the expertise from the Pacific Northwest National Laboratory to address fire safety from the initial stages of project concept and design to the information emergency responders need to contain a battery fire.

Matt Paiss, technical advisor for battery materials and systems from PNNL, leads fire safety training for NRECA's RESDP projects. Paiss' background includes 23 years with the San Jose, California Fire Department, followed by work consulting on safety training and code reviews on solar photovoltaic installations and battery systems. In 2021, he conducted a lithium-ion battery fire safety training session at the Rose Acre Farms for approximately 30 participants representing local fire departments, county emergency staff, and employees from Tideland EMC and NCEMC.

Utility-scale battery fires are relatively rare, but given the high temperatures, explosive gases and size of the systems, a battery fire has the potential to be catastrophic if preparations have not been made.

For electric cooperatives and other utilities, Paiss says the most important decisions are made when writing the Request for Proposals (RFP). Project requirements must accurately reference the fire safety codes and standards the project must meet. If these are not spelled out up front, "it's hard to hold an awardee to something that's not included in the RFP," says Paiss.

Utilities should be aware that the adoptive fire codes for energy storage systems changed significantly between 2015 and 2021, as deployments of utility-scale lithium-ion batteries grew sharply. By 2021, the National Fire Protection Association 855 became the national standard delineating the minimum requirements for mitigating hazards associated with energy storage systems. NFPA 855 (2020 Edition) describes the safety standards that must be followed during commissioning and decommissioning, during operation and maintenance, and for emergency responders. While local codes may vary, Paiss recommends compliance with NFPA 855 as the appropriate standard for a utility battery project.

An additional and related key requirement for energy storage systems is to meet the UL 9540 (2020 Edition) product safety standard for installation, power conversion, and communications and controls. Siting a project is another important fire safety consideration. In an area where there is a risk for wildfires, a significant non-vegetative barrier should be created. In general, an ESS should be installed away from other buildings or combustible structures.

For emergency responders, Paiss says the increasingly common response to a lithium-ion fire is to employ a defensive strategy where no exposures are directly threatened. The focus then becomes on preventing any spread of the fire, while letting the ESS burn itself out. Ideally, a fire can be contained within an isolated outdoor cabinet, while ensuring an explosion can be prevented from the flammable gases.

Paiss says that to date, there is not a proven and effective fire suppression system for lithium-ion batteries. He adds that, in the case of a fire, the UL9540 listed Tesla Megapack installed in the Rose Acre Farms project is designed to avoid explosions by igniting and burning away flammable gases using a spark plug in the plenum.

How the Project Fits into Greater Co-op Operations and Goals

The Rose Acre Farms project is an example of NCEMC's strategic effort to maximize the value of distributed energy resources to benefit North Carolina's cooperative utility system. By pairing distributed generation resources with battery energy storage, the G&T and its member distribution cooperatives can improve reliability and reduce the intermittency of renewable energy while also increasing the resilience for Tideland’s C&I member. While there is a direct benefit to cooperative consumer-members (the end-users), the value is amplified as part of the G&T’s role as a Distribution Operator (DO) for its members, providing visibility and coordination of DER upstream to the Transmission Provider and downstream to the distribution system. This coordination is accomplished by employing a Distributed Energy Resource Management System (DERMS) and allowing NCEMC to leverage this DER for reliability purposes and grid benefit.

Grid and Community Benefits of NCEMC’s DO Role

Battery energy storage is one of the key elements in NCEMC’s coordinated deployment of distributed resources. The long-term benefits of this effort will include:

- Increased grid flexibility and stability
- Improved power reliability and resiliency
- Enhanced environmental sustainability through lower carbon emissions
- Reduced power supply costs
- Deferred investment in new power plants and other traditional assets

The Current Role of North Carolina's Electric Cooperatives

NCEMC provides project development, financing, and operational services to distribution electric co-ops for solar-plus-battery storage projects, including:

- Leasing and contract agreements
- Project management from design through construction
- Control and integration of the various solar-plus-battery storage components to optimize the electric grid

As of the end of 2020, NCEMC’s portfolio of distributed and renewable energy resource programs (operational or in development) includes:

- 260 MW of utility-scale solar and other renewables
- 2.15 MW of community solar
- 35 MW of battery energy storage

Takeaways and Lessons Learned

1. **Project delays due to contract negotiations and supply chain issues**

   a. The project partners took time for education and understanding to reach an agreement on the structure and nature of a cooperatively owned energy project sited on a C&I member property (in order to deliver access to renewable energy sought by the member).

      Kagen DelRio, NCEMC's manager of project development and engineering, notes that the cooperatives and Rose Acre Farms engaged in extensive talks over many months. These talks included education on the energy technology being deployed and the physical nature of the facilities being constructed on its property, how the project would affect the company's profitability, and how the RECs would be exchanged. "[Energy] is not their core business, so we held a lot of discussions to make sure they are comfortable with who we are as a cooperative and the details of the project," he says.

   b. Another challenge was that selecting and coming to an agreement with an EPC included a time-consuming RFP process with extensive technical reviews and then lengthy negotiations with the EPC selected for the project. Construction was delayed due to supply chain disruptions, which contributed to a jump in the costs of raw materials in a three-month span (February through April) during the first half of 2021. For example, aluminum and conduit prices increased approximately 23% in this three-month span, while copper increased 27%.

2. **Delays due to technology issues**

   a. There were no delays involved in battery storage procurement – NCEMC procured the Tesla Megapack system ahead of time, and it was warehoused and ready for installation before construction commenced. However, once the battery system was installed, Tesla was called upon to assist in resolving performance issues. "Any time you are deploying a new technology, you need to expect to spend additional time getting everything working up to spec," says DelRio.

   b. NCEMC experienced a high failure rate with the string inverters in other solar-plus-storage projects and changed the inverter vendor for Rose Acre Farms. However, DelRio says that there was a challenge in establishing a stable, high-speed communications path with the alternate string inverters due to the use of RS-485 serial communications versus the ethernet protocol used on prior projects. Despite extensive hardware in the loop lab testing, determining whether reliable communications have been achieved will not be confirmed until the project has gone through the final commissioning.

   c. The need to develop a customized controller required extra time and effort. While DelRio says that 'off the shelf' solutions for stand-alone solar systems are fairly mature, that is not the case for solar-plus-storage projects. "And in our case, we want reactive power support and other ancillary services capabilities to support grid operations. All of the features and functionality we required were not found in existing off-the-shelf products," says DelRio.

3. Energy storage economies of scale

a. Given the overall demand for battery storage, DelRio says, "if you don't have a 25 MW or larger project, it's not as attractive to manufacturers or EPCs." One way to achieve negotiating power and economies of scale for smaller projects is to group multiple projects under one contract.

b. However, multiple projects create logistical challenges, as each project has separate constraints and time schedules.

4. Human resource requirements

a. It is easy to underestimate the time required to manage an energy storage project, particularly if the utility has limited experience in deploying the technology.

b. It is highly recommended that a cooperative designate a dedicated project manager for an energy storage project. It is reasonable to expect that a seasoned project manager will be able to oversee two or three concurrent projects. Any project manager should expect to encounter unexpected delays, but those without experience may also need to spend additional time becoming familiar with the unique requirements of energy storage procurement, construction, and commissioning.

5. Evaluating project economics and anticipated value

a. NCEMC's Portfolio and Resource Optimization group performed an analysis that looked at the estimated capital cost and the portfolio value in avoided demand, transmission, and energy expenses. Risk factors, such as changes in market prices, execution risk, and regulatory uncertainty, were included in the evaluation. The overall value stream was then reviewed to determine the NPV benefit to the G&T's power supply portfolio over the asset life.

b. The returns for investment in a project like Rose Acre Farms depend on the project specifics and any upgrades required for the interconnection. Adding energy storage makes the returns dependent upon the marginal demand rate. In the case of NCEMC, the demand response use case from energy storage provided a clear net benefit for the portfolio.

Contact for Questions

Lauren Khair
Director, Business Transformation
Business and Technology Strategies
Lauren.Khair@nreca.coop
o: 703-907-6845 m: 571-424-0978

This case study was written by Bob Gibson, Consultant & Technical Writer (Gibson Energy Insights: gibsonenergyinsights@gmail.com).