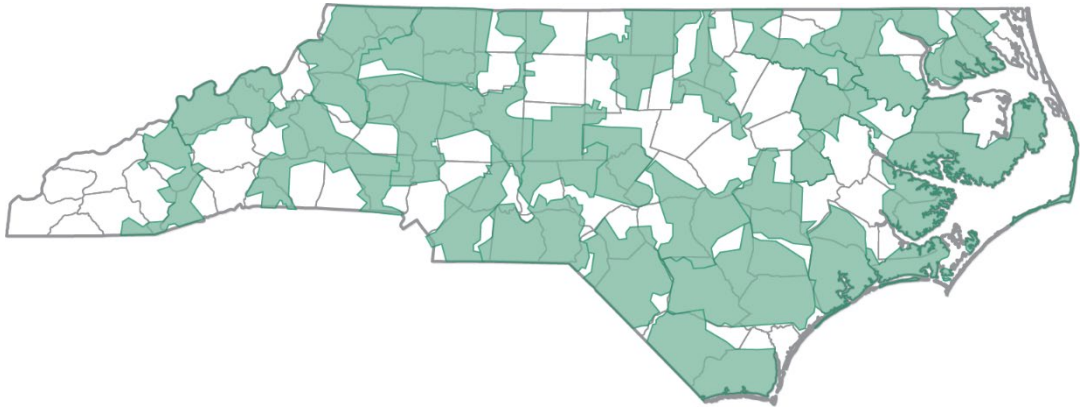
Microgrids
Pilots to Programs and Lesson Learned

John Lemire - Director, Grid Management

NC Electric Cooperatives

Your Touchstone Energy® Cooperatives



Summary

- Who are the NC Electric Cooperatives
- Pilots to Programs
- Program Opportunities with Customers (Coops or C&I Customers) and Developers

1 M

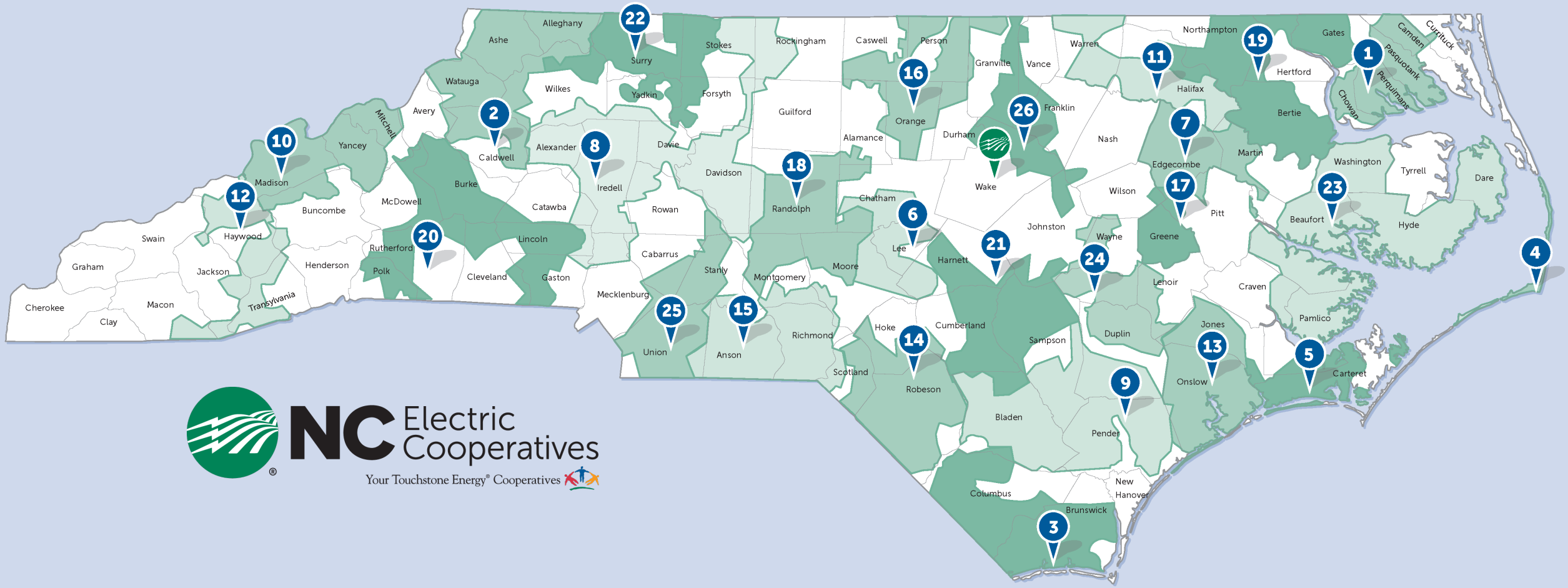
Households and businesses served by NC Electric Cooperatives

93

Counties we work in around the state of North Carolina

26

Distinct member-owned, not-for-profit cooperatives



NC Electric Cooperatives

Your Touchstone Energy® Cooperatives

Lessons Learned

Focus on communications, implementation of use cases, and ongoing support after commissioning

Requirements for success

- Collaboration with local engineering and operations staff
- Clearly defined and documented operational agreements and procedures
- Distribution systems are not perfectly balanced at all levels

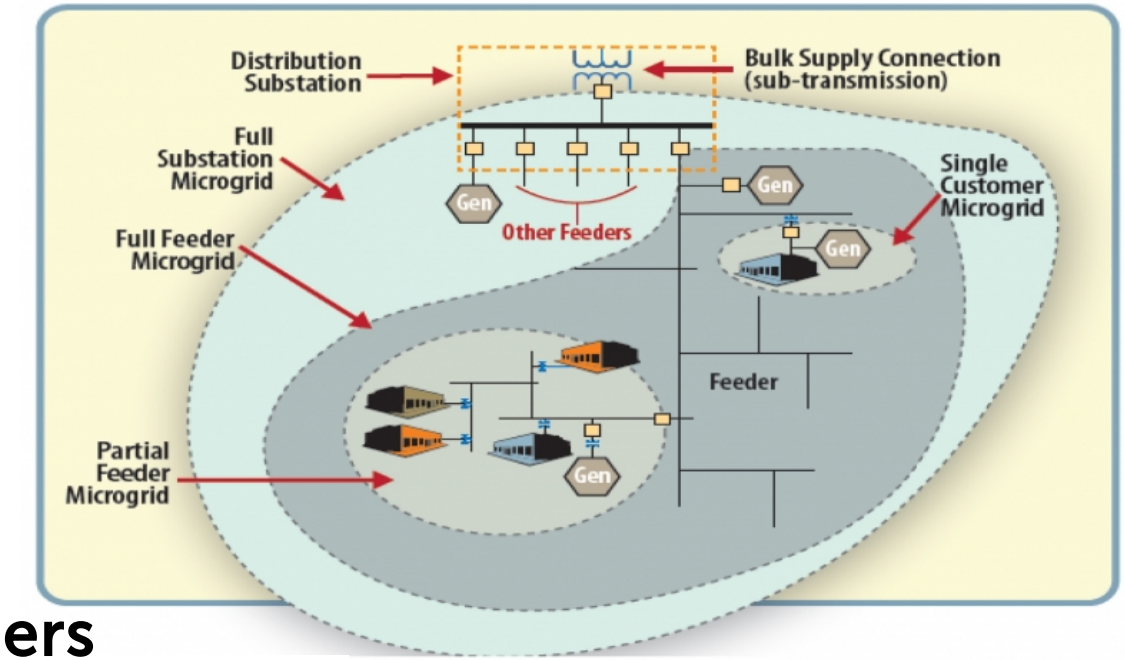
Pilot Concept to Implementation

- Innovation team developed the project concept
- Project received Board approval
- R&D budget funded by all NC Cooperatives
- Entity that invests receives the benefit
  - NCEMC
  - Distribution Cooperative
  - Member-consumer

Preserves the regulatory structure of electric service to the member-consumers

Microgrids

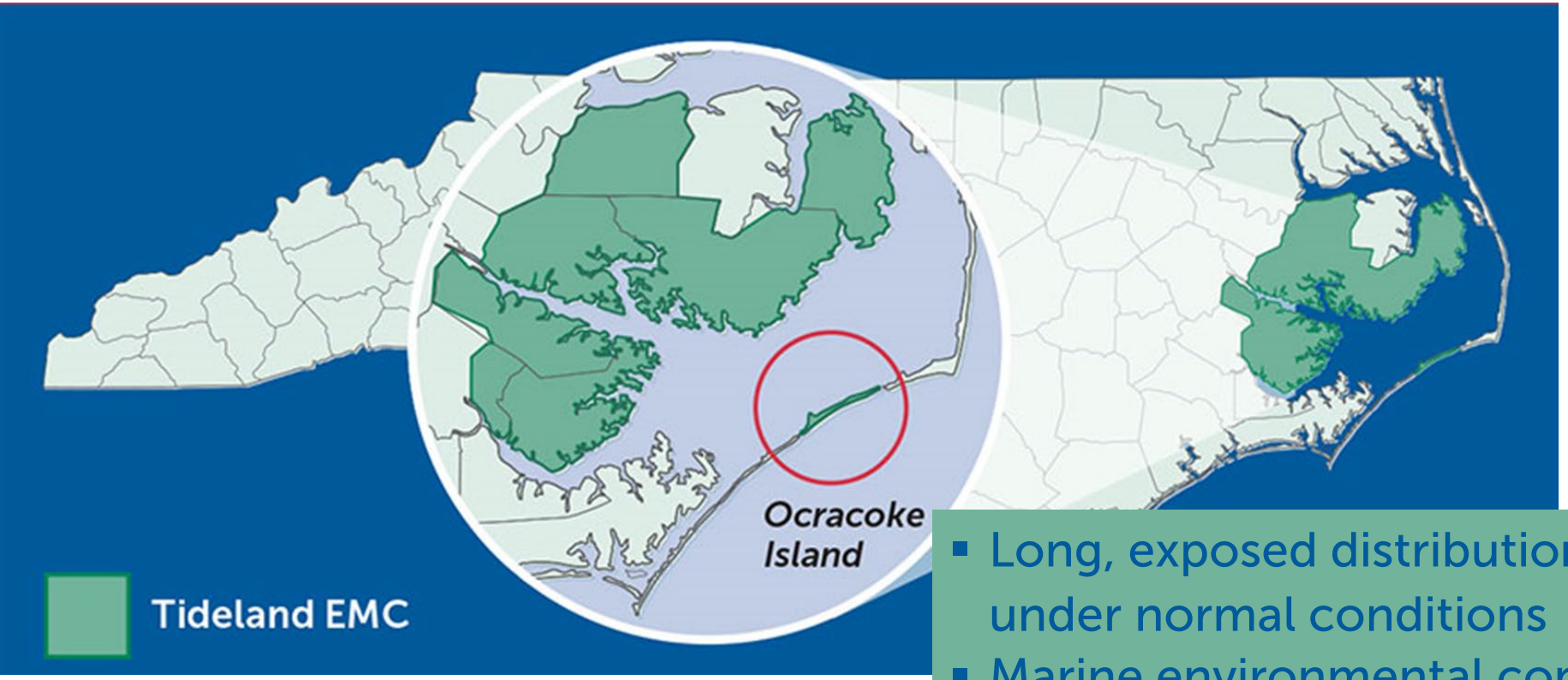
- Four operational
  - Ocracoke Island – Feb 2017
  - Butler Farms – Mar 2018
  - Heron's Nest – June 2020
  - Eagle Chase – March 2021
- One in development
  - Rose Acre Farms – Q4 2021
- Objectives
  - Demand Response
  - Resilience
  - Sustainability



Partners

EPRI ELECTRIC POWER RESEARCH INSTITUTE
NRECA America's Electric Cooperatives
Business & Technology Strategies
AESI
Power Secure
OATI
TESLA
NRCO NATIONAL RENEWABLES COOPERATIVE ORGANIZATION

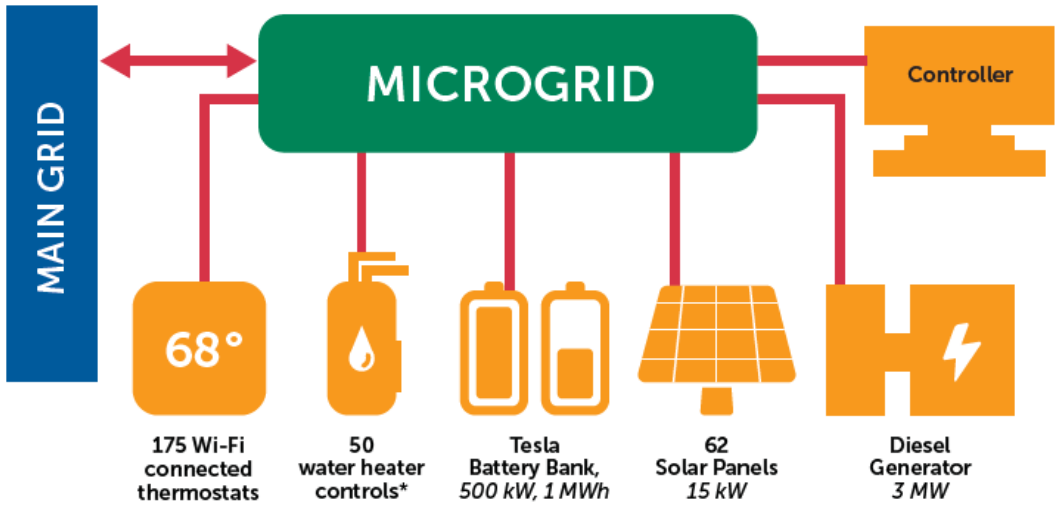
Ocracoke Microgrid



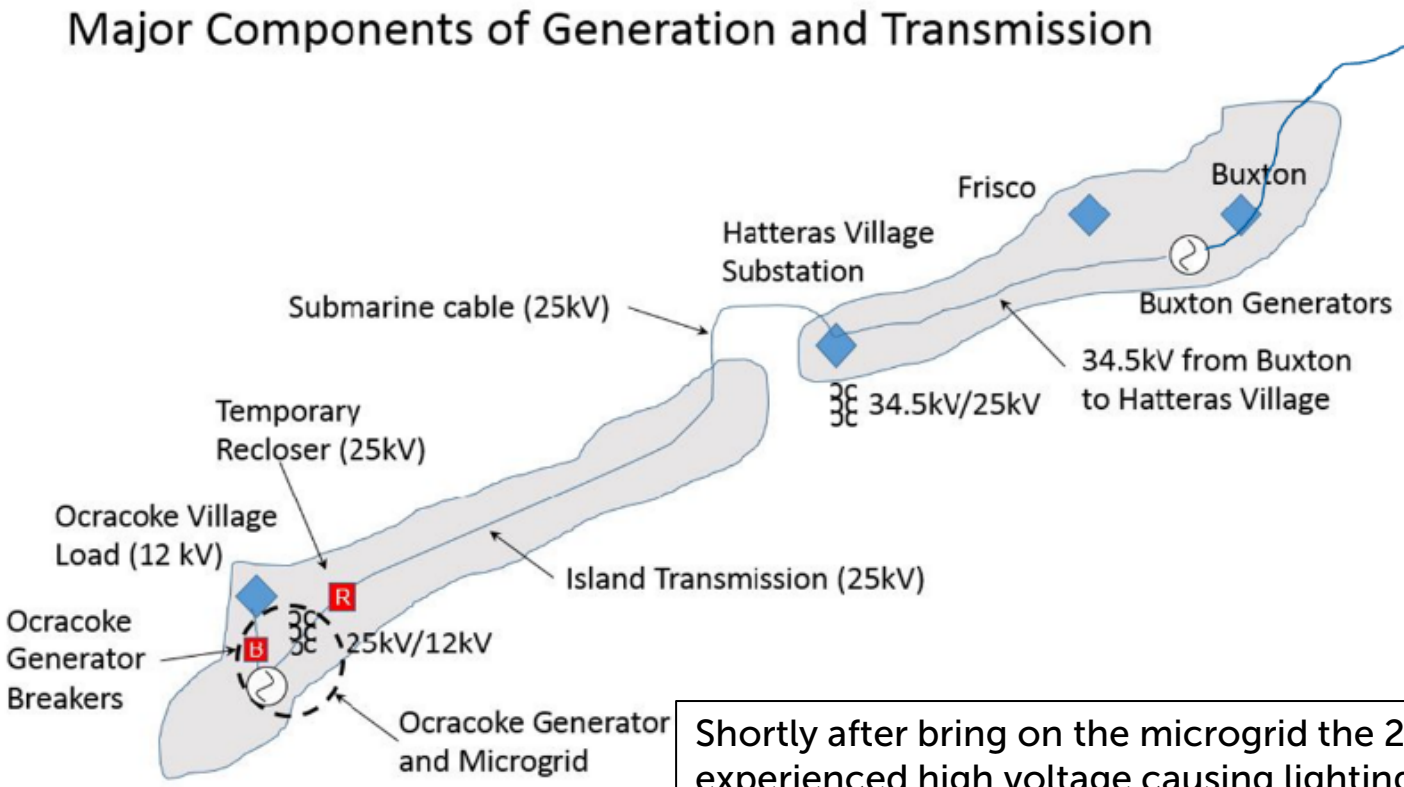
- Part of NC Coastal Outer Bank Region
- Population: 948
- Area: 9.6 square miles

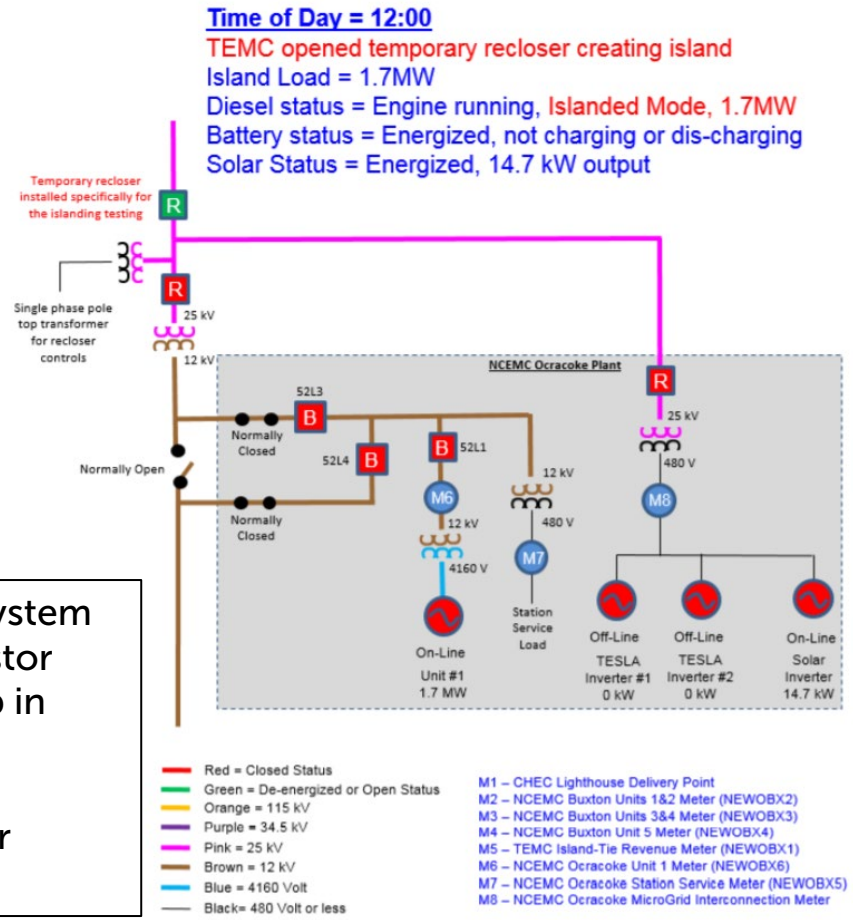
- Long, exposed distribution feeder serving the area under normal conditions
- Marine environmental conditions, high wind and storms
- Peak seasonal load coincides with costly demand peaks
- Generation capacity well below peak loads

Ocracoke Microgrid Components



Ocracoke Islanding Test – 10/25/17

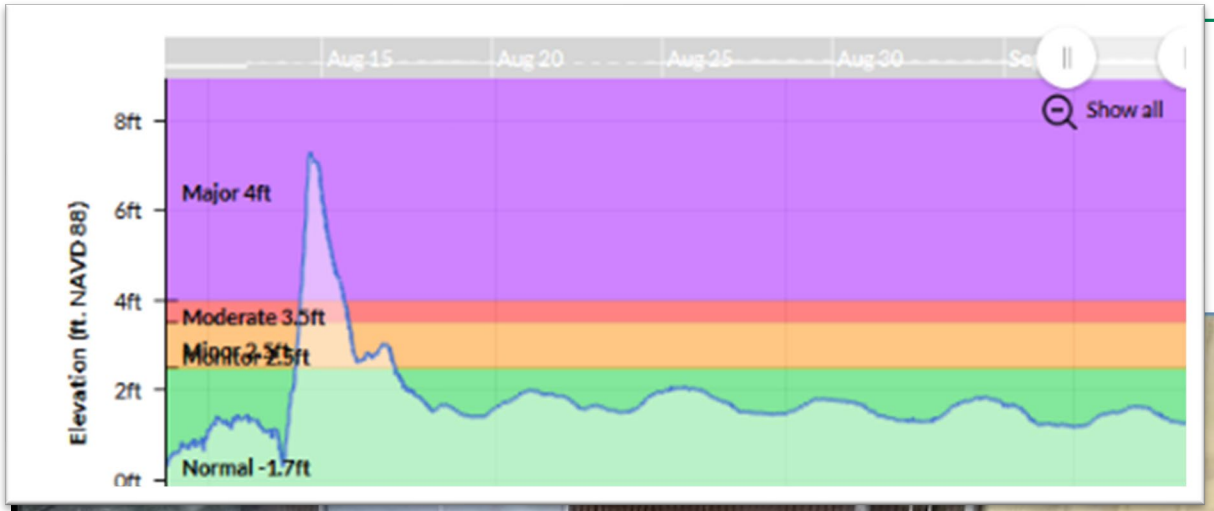


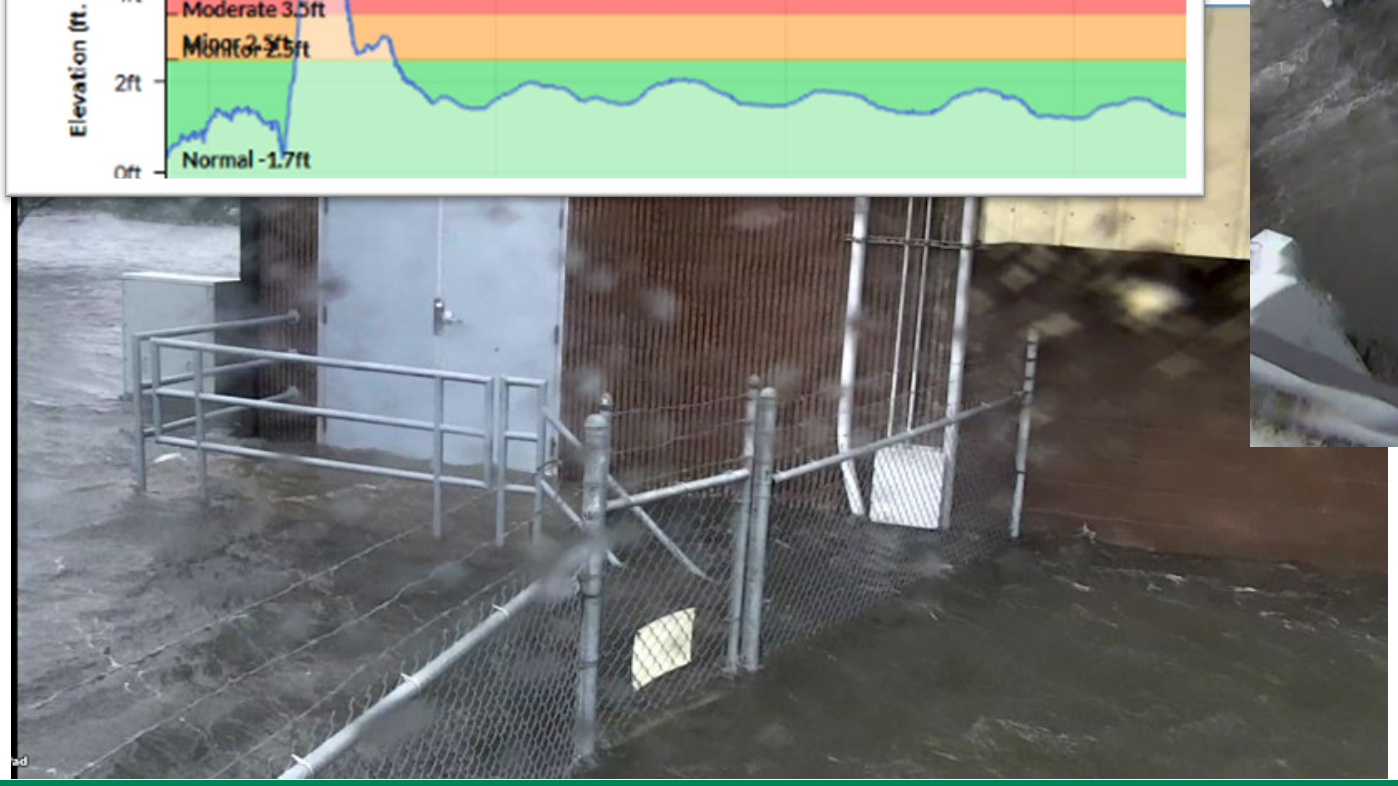


Shortly after bring on the microgrid the 25kV system experienced high voltage causing lighting arrestor failure on the 25 kV system. This caused a drop in voltage and all generation was removed.

Later during an attempted re-test the generator breaker opened due to high voltage.

Hurricane Dorian – Ocracoke Plant & Microgrid





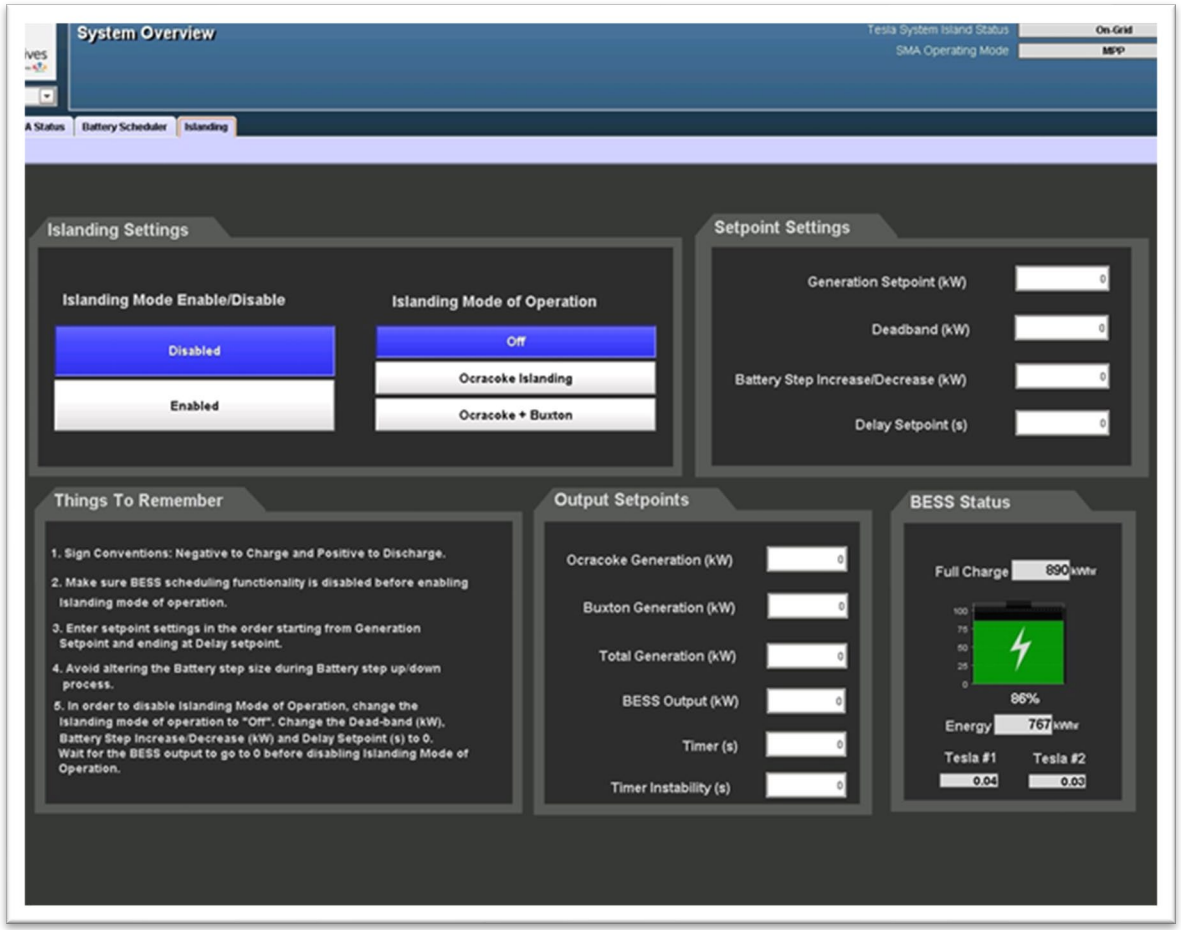
Ocracoke Controller Enhancement

Future Schedule Capability

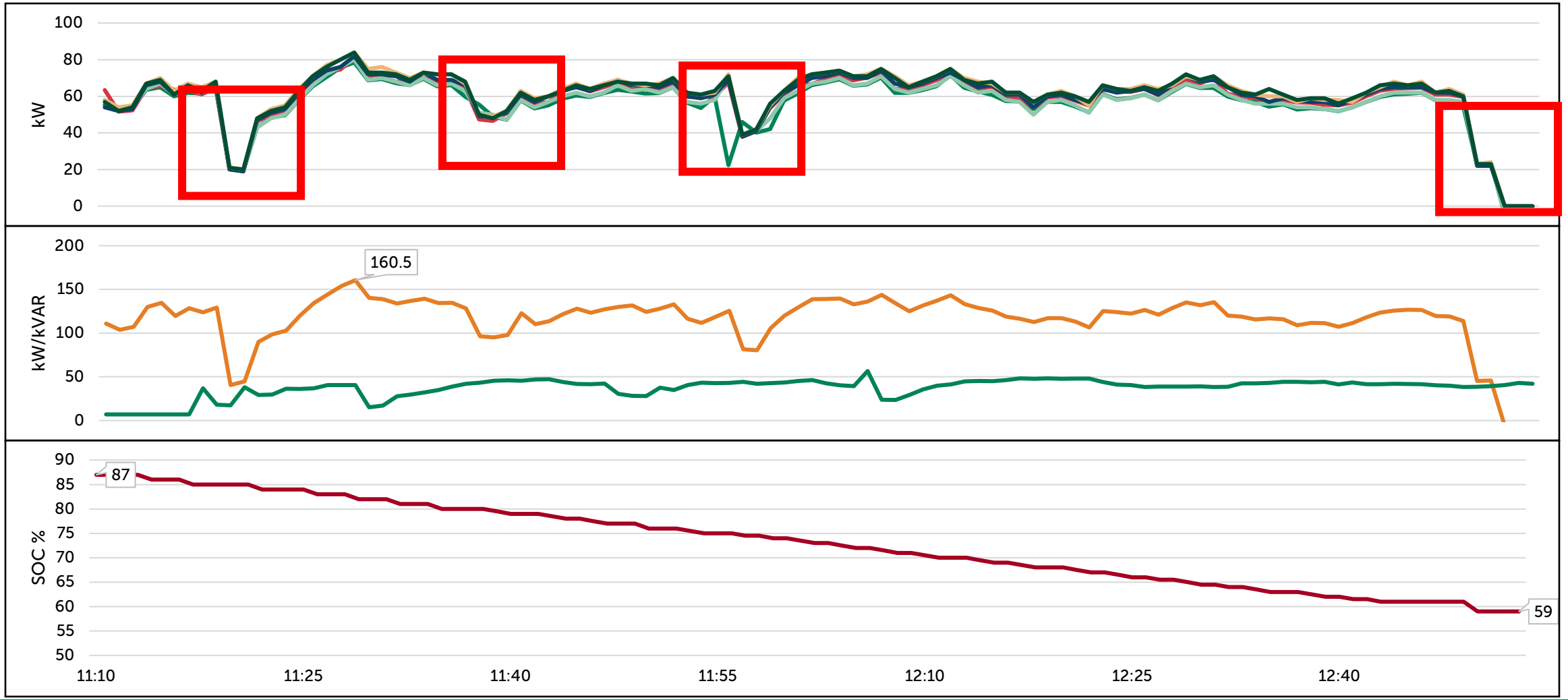
- Now conforms to standard controller design criteria

Dynamic Battery Shaping in Island Mode

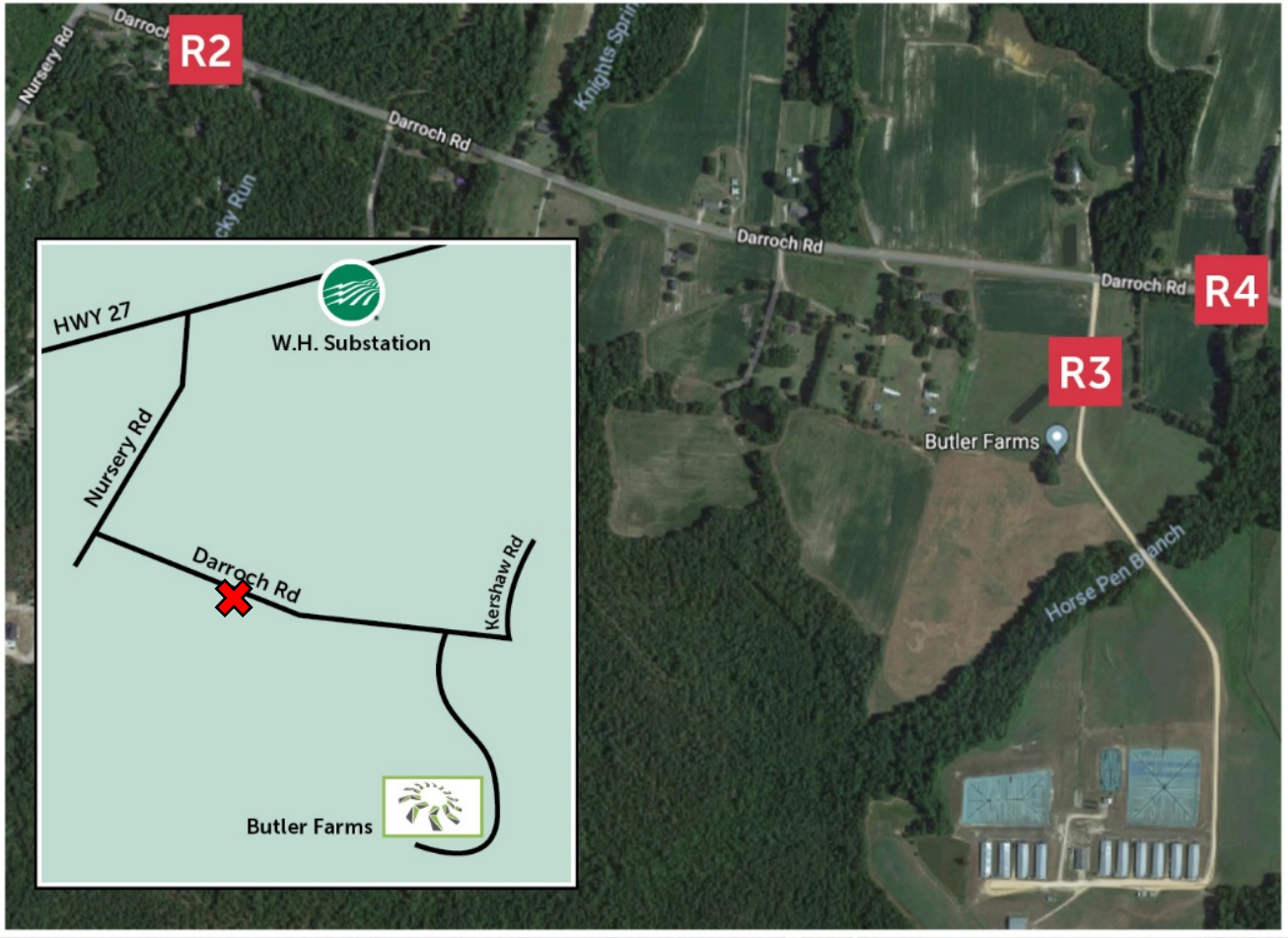
- Monitor & Respond to stability
- Defer start or enable shut down of diesel plant
- Optimize current diesel output



Butler Farms Phase 2 Test Results – Feeder Island



Butler Farms Unsuccessful Transition – 9/14/18



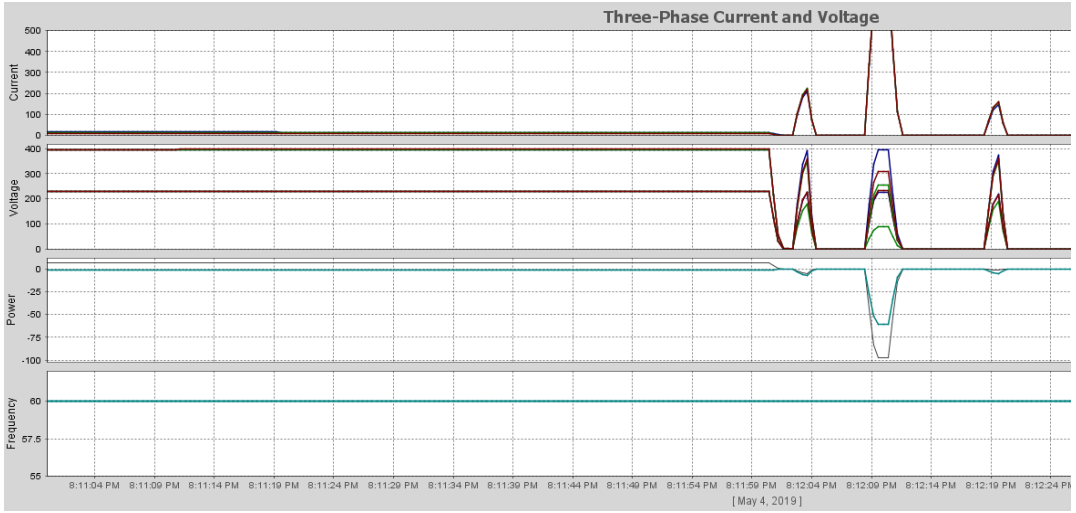
Event	Time
September 14	
Feeder Out	05:13:00
Mode Change Blocked	05:14:00
Shutdown (R3 open)	06:35:00
September 16	
Power Restored	22:50:00

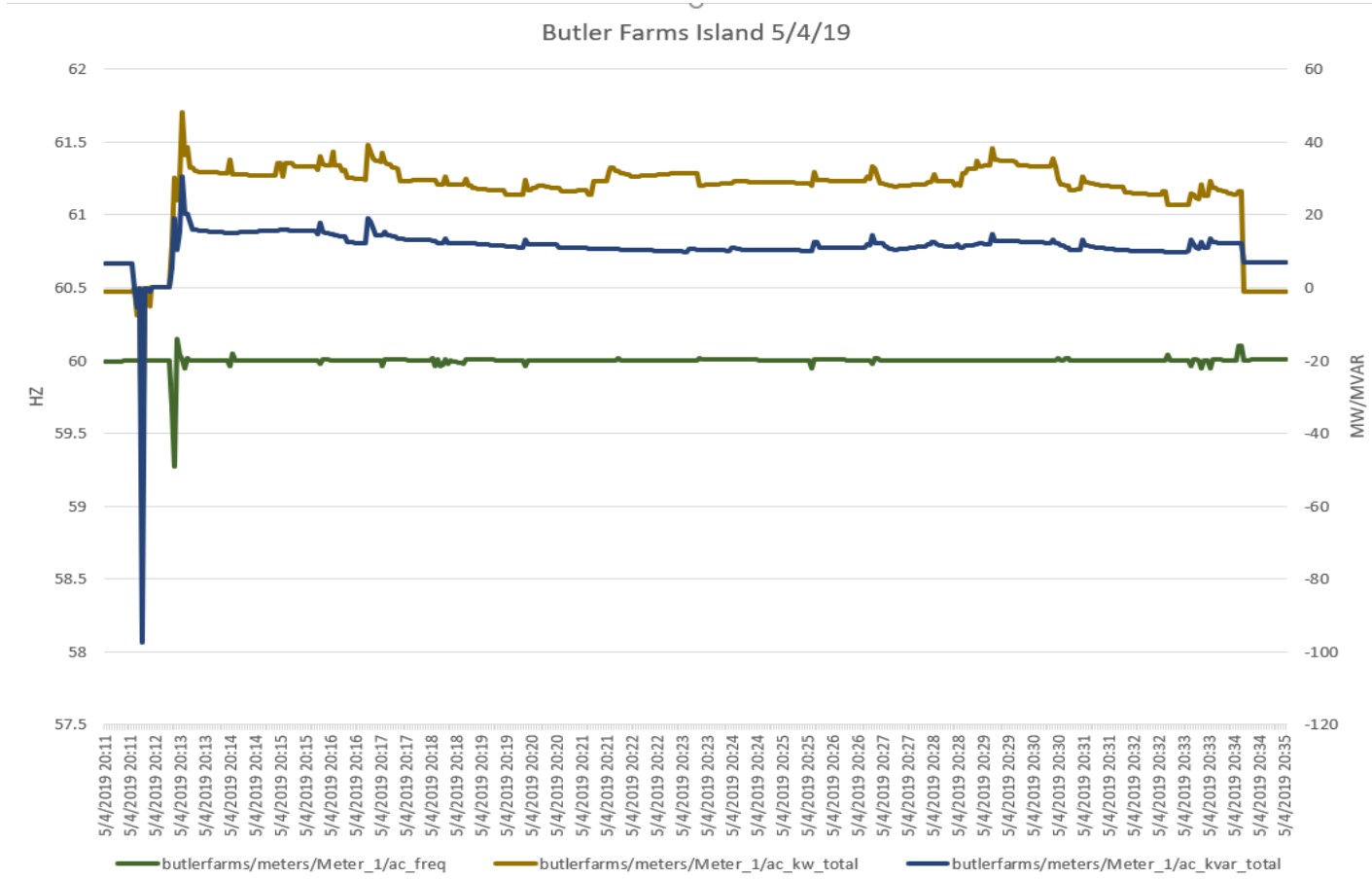
- Catch-all alarm point used in Cooper recloser scheme that included “loss of AC”
- Shutdown mode opened R3 isolating the farm

Butler Farms – Farm Island Event 5/4/19

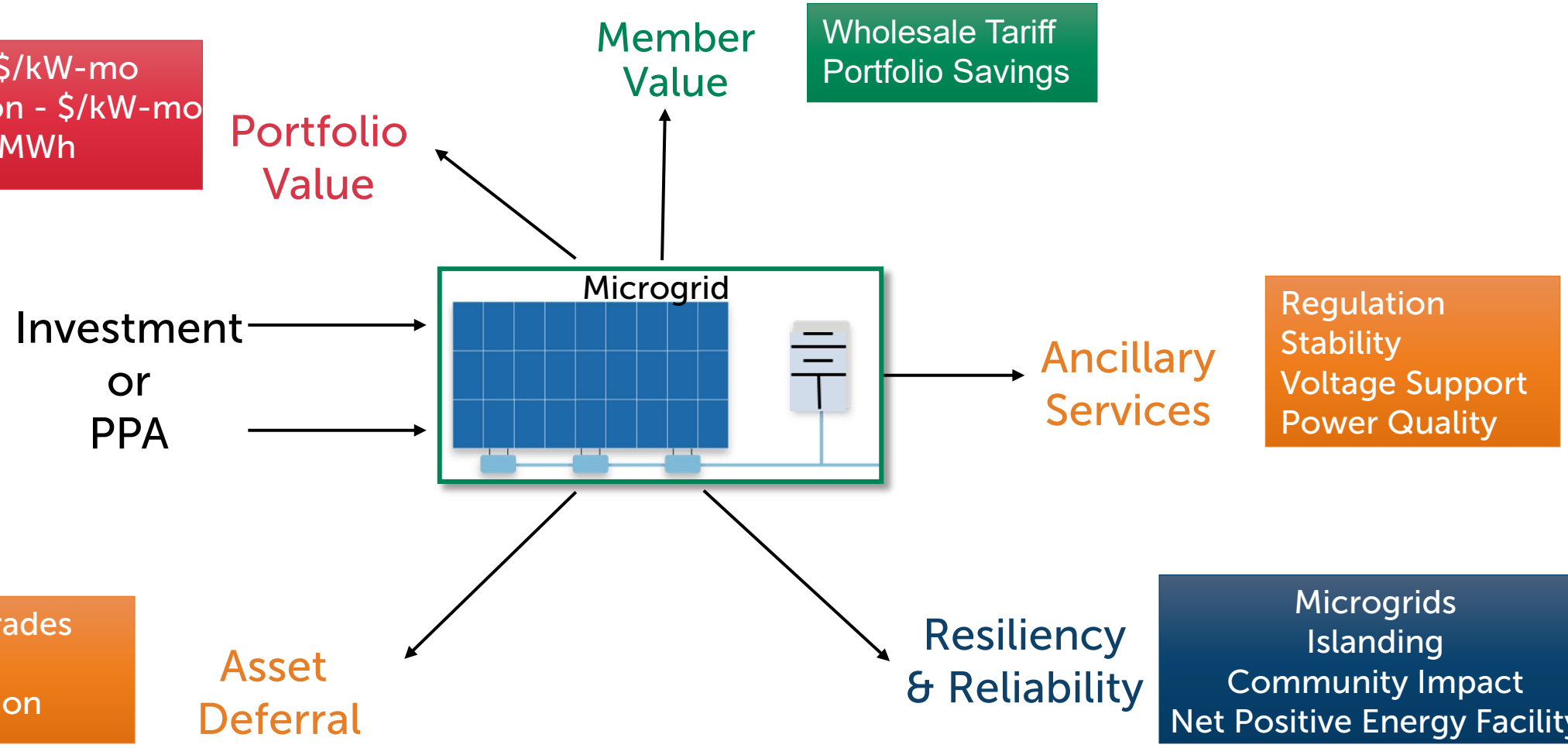
Saturday, May 4, 2019, a tree caused an outage on the 12kV feeder that serves Butler Farms.

The Butler Farms Microgrid successfully recognized the outage and transitioned into Farm Island mode to support the farm during the 20-minute outage event.





Microgrids: Use Cases and Value

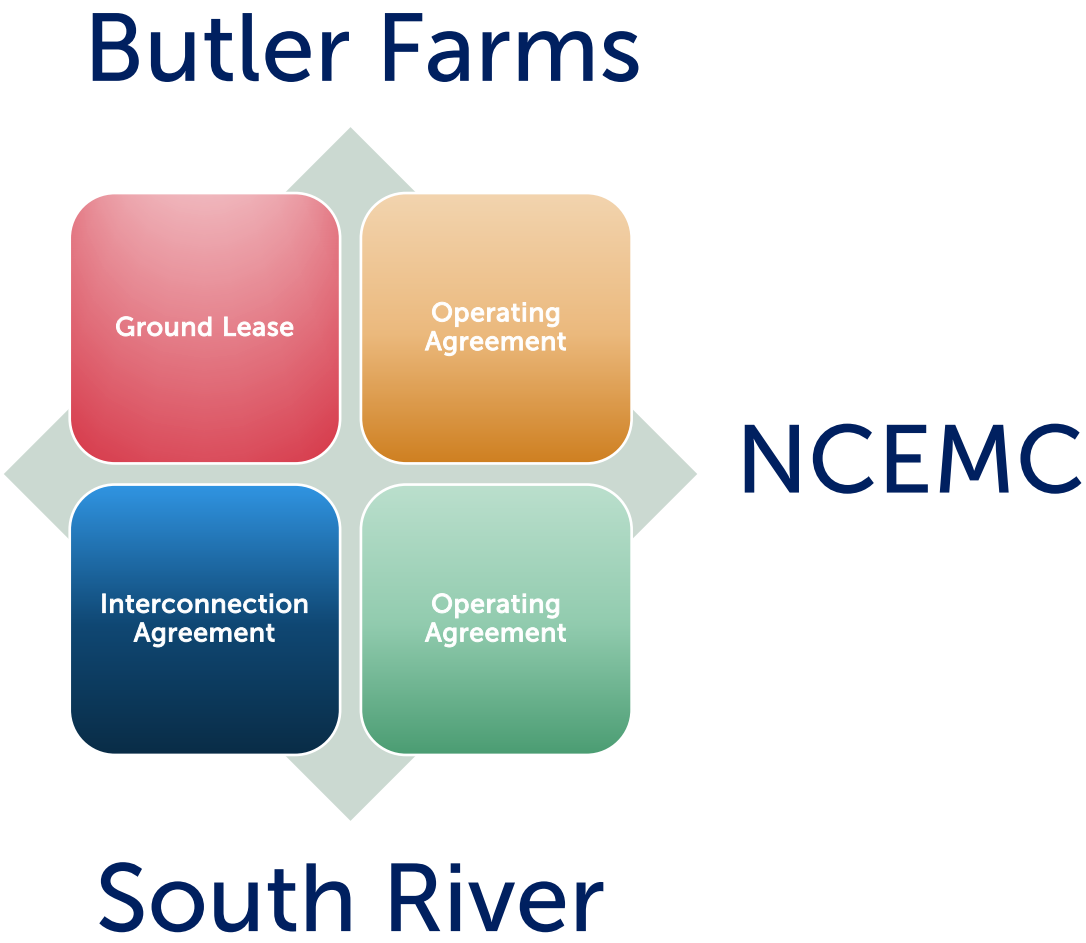


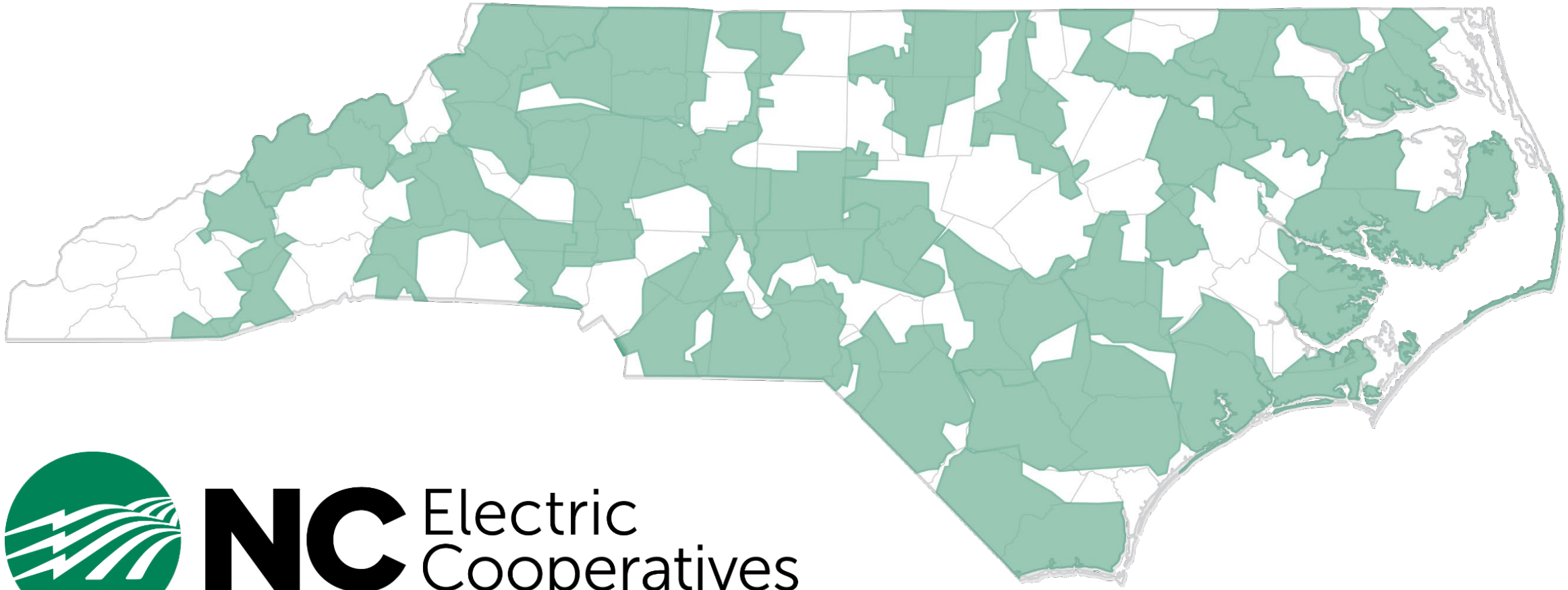
Contractual Arrangements and Agreements

Subordination Agreement – Farm Lender and NCEMC

Preserves the regulatory structure of electric service to the member-consumers

Solar and Biogas PPA– Butler Farms and South River





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Appendix

Butler Farms Community Microgrid

- North Carolina is the nation's second leading pork producer
- Lillington, NC
  - 28 miles southwest of Raleigh, NC
  - Population of 3,581

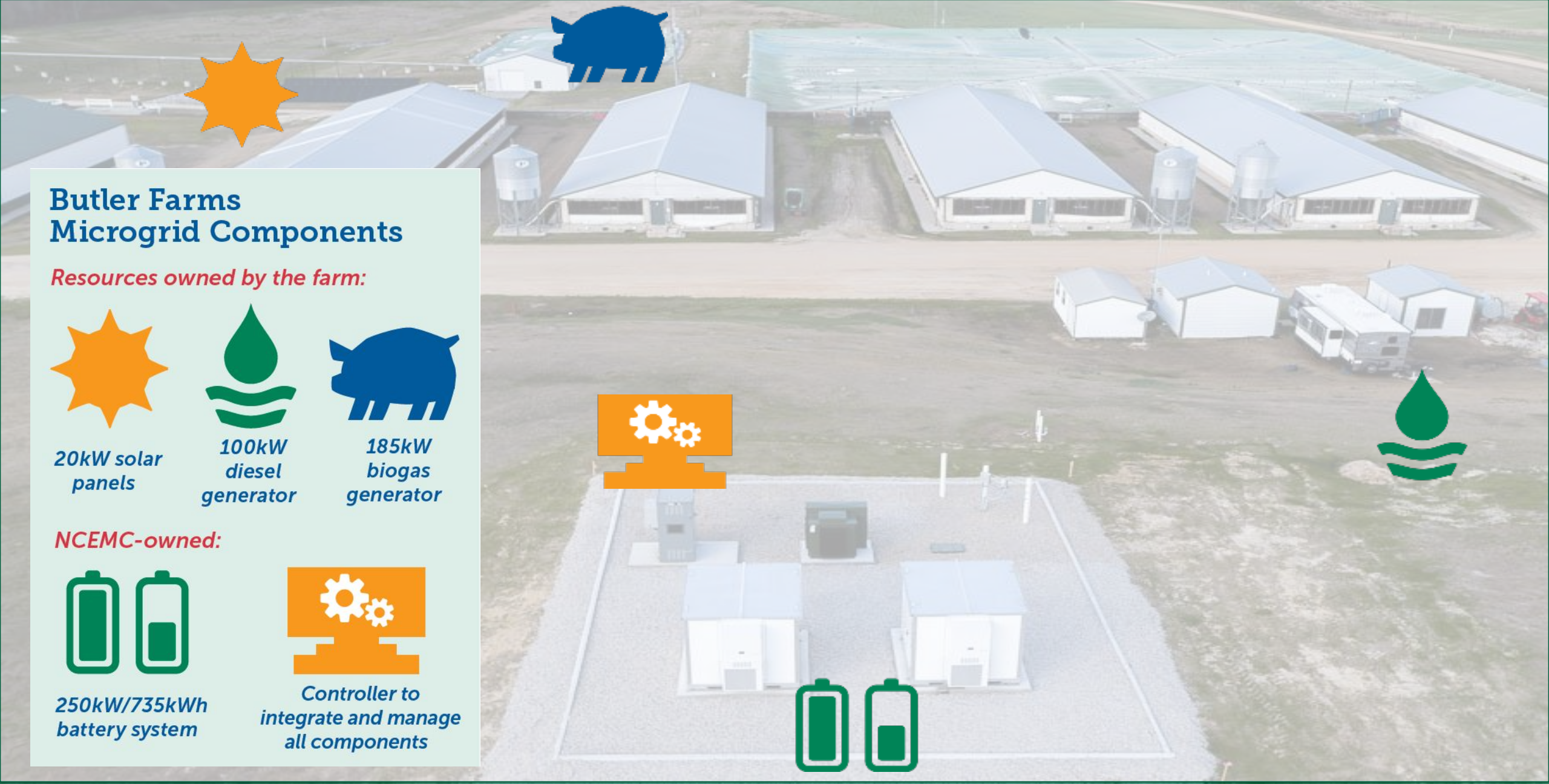
NCEMC assets

- Battery: 250 kW – 735 kWh
  Samsung / PowerSecure system

On-site generation owned by customer

- 185 kW swine-waste generator
- 20 kW solar
- 100 kW diesel

Controller and infrastructure to provide community resilience



Butler Farms Microgrid Components

Resources owned by the farm:

- *20kW solar panels*
- *100kW diesel generator*
- *185kW biogas generator*

NCEMC-owned:

- *250kW/735kWh battery system*
- *Controller to integrate and manage all components*

Butler Farms Microgrid Phases and Objectives

Phase 1
February 2018

Grid-Tie mode and autonomously operate in Farm Island mode to power Butler Farms using solar and batteries for a minimum of four (4) hours

Phase 2
June 2018

Expand to switched operation in Feeder Island mode to power 28 surrounding homes for a minimum of four (4) hours

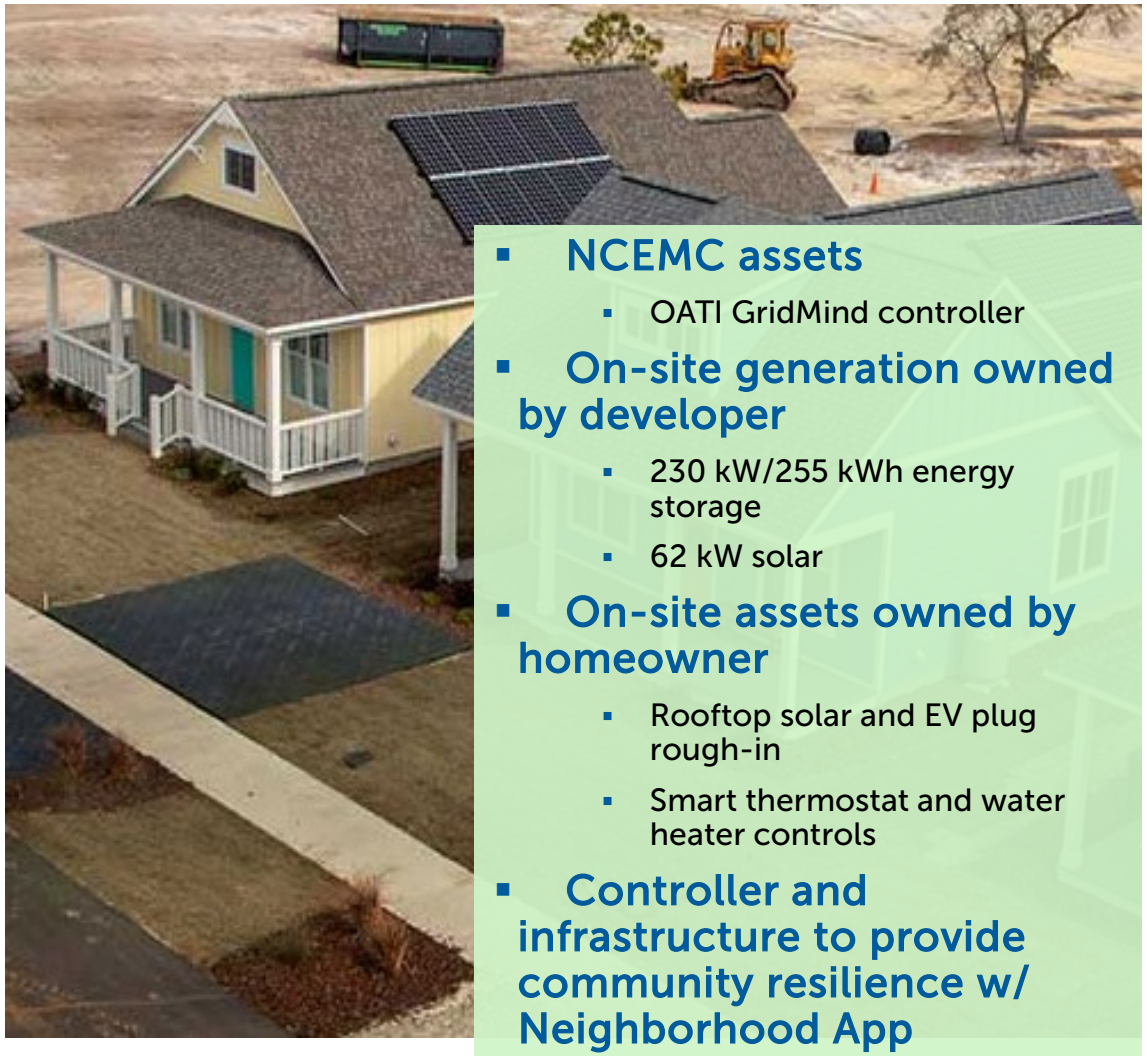
Phase 3
February 2020

Incorporate the operation of the biogas and diesel generator & expand footprint of surrounding homes

Heron's Nest Project: Brunswick EMC

What's New

- Sustainable neighborhood
- OATI GridMind (site controller) will integrate with DERMS
- GridPort (distributed sensor) on individual devices

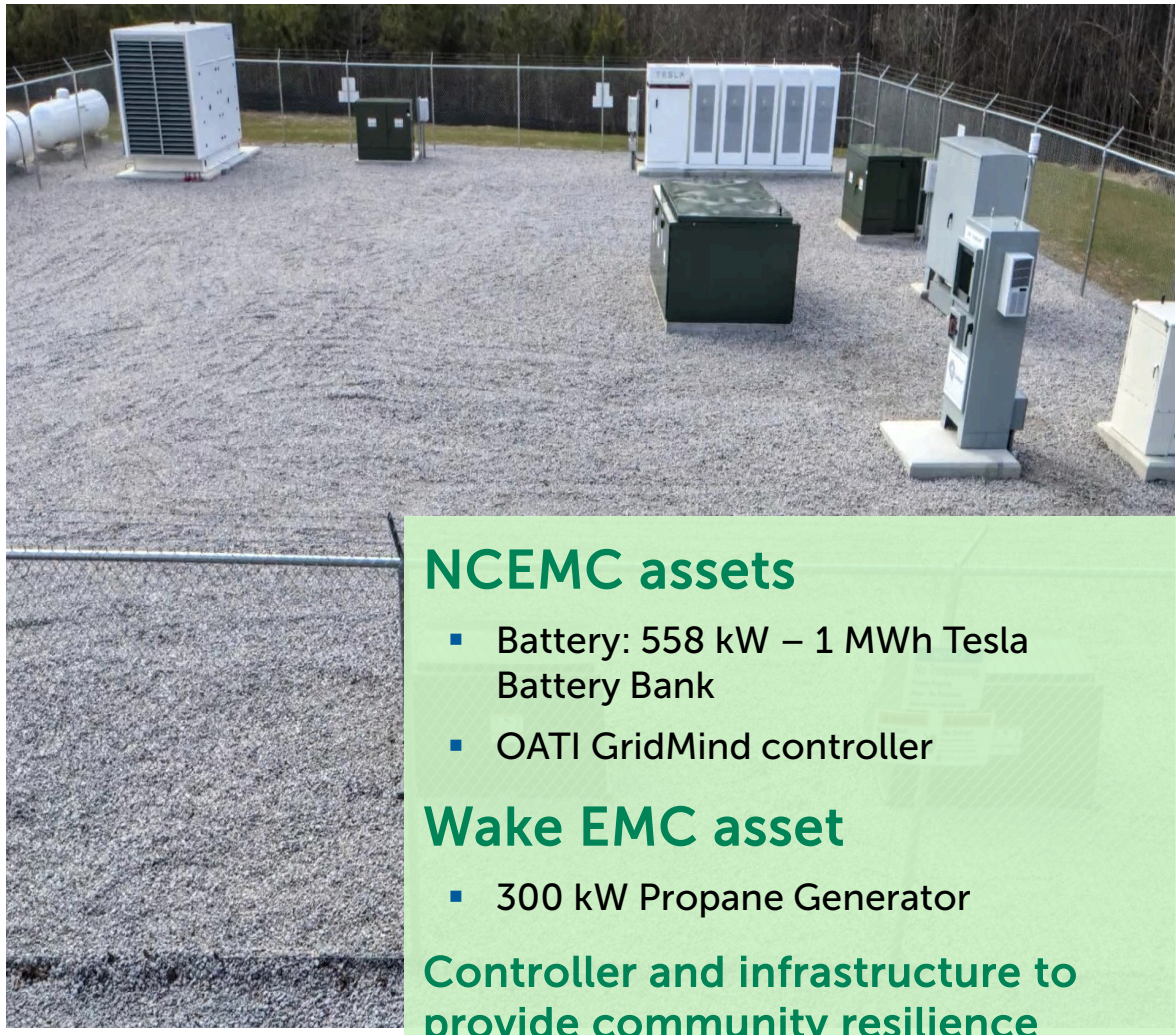


- **NCEMC assets**
  - OATI GridMind controller
- **On-site generation owned by developer**
  - 230 kW/255 kWh energy storage
  - 62 kW solar
- **On-site assets owned by homeowner**
  - Rooftop solar and EV plug rough-in
  - Smart thermostat and water heater controls
- **Controller and infrastructure to provide community resilience w/ Neighborhood App**

Eagle Chase: Wake EMC

What's New

- Resilient neighborhood w/ 36-hour backup power
- OATI GridMind (site controller) will integrate with DERMS



NCEMC assets

- Battery: 558 kW – 1 MWh Tesla Battery Bank
- OATI GridMind controller

Wake EMC asset

- 300 kW Propane Generator

Controller and infrastructure to provide community resilience

Rose Acre Farms: Tideland EMC

What's New

- Designing optimal control of distributed, back-up diesel generation to balance against solar + storage

On-site generation by NCEMC

- 2.0 MW solar
- 2.5 MW / 5 MWh Battery

Controller and infrastructure to provide resilience by NCEMC