Resilience for Regulators #1

Climate Resilience Frameworks to Improve Risk Management: Exploring Lessons Learned from North Carolina

January 26, 2022
NARUC Center for Partnerships & Innovation
Welcome & Agenda

1. Opening remarks & Introductions
   (Commissioner Kimberley Duffley)
2. Panelist Presentations
3. Q&A (all participants)
Opening Remarks & Introductions

**Moderator:** Hon. Kimberly Duffley  
Commissioner, North Carolina Public Utilities Commission

**Panelists:**

**Jim Fox,** Senior Resilience Associate, NEMAC+Fernleaf, US Climate Resilience Toolkit Team

**Sushma Masemore,** Assistant Secretary for the Environment, North Carolina Department of Environmental Quality

**Robert Cox,** Associate Director, University of North Carolina Charlotte’s Energy Production & Infrastructure Center (EPIC)

**Nelson Peeler,** Senior Vice-President of Transmission, Fuels Strategy, and Policy, Duke Energy
Climate Resilience Frameworks to Improve risk management – Lessons learned from North Carolina

January 26, 2022
• Jim Fox jfox@nemacfernleaf.com, Ned Gardiner ned.gardiner@noaa.gov
Changes in flooding, wildfire, heat, power, population, and other realities are stressing our communities, landscapes, and livelihoods.
What is resilience?

IPCC – “Resilience is the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identify and structure, while also mainlining the capacity of adaptation, learning and transformation.”
NC EO80 Directives

Department of Environmental Quality & Designees

• **N.C. Climate Risk Assessment and Resiliency Plan** - provide a scientific assessment of current and projected climate impacts on North Carolina and prioritize effective resilience strategies.

**All Cabinet Agencies** - **Assess and Address Climate Change**

• Evaluate the impacts of climate change on agency programs and operations
• Integrate climate change mitigation and adaptation practices into agency programs and operations
• Support communities and sectors vulnerable to climate change impacts
US Climate Resilience Toolkit launched in 2014

Assist decision makers in building resilience
Did you know?

- Sectors (Energy, others)
- Case Studies
- Regional Data
- Hundreds of Tools
- Links to experts
Climate Explorer

- Historical temperature and precipitation observations at hundreds of climate stations,
- Interactive graphs and maps showing climate projections and observations for any county in the contiguous United States.
Steps to Resilience

✓ Risk framework
✓ Transparent and defensible priorities
✓ Comparable to other communities nationwide
✓ Moves from the data to decisions - from “Did you know?” to “What can we do about it?”
✓ Scalable to handle small communities, large metro areas, and states

1. Explore Hazards
2. Assess Vulnerability & Risk
3. Investigate Options
4. Prioritize & Plan
5. Take Action
US Dept of Energy VARP

1. Identify VARP planning team
2. Identify Critical Assets and Infrastructure
3. Characterize Climate Trends and Events
4. Characterize Likelihood of Climate Change Hazards
5. Characterize Current and Projected Impacts
6. Characterize Vulnerabilities with a Risk Matrix
7. Identify and Assess Resilience Solutions
8. Develop and Implement a Portfolio of Solutions
9. Monitor, evaluate, and reassess the Resilience Plan

Steps to Resilience
1. Explore Hazards
2. Assess Vulnerability & Risk
3. Investigate Options
4. Prioritize & Plan
5. Take Action
NC Climate Risk Assessment
Using the Steps to Resilience
From Data to Decisions

- Temperature Variability and Change
- Extreme Precipitation
- Sea Level Rise and Tidal Effects

- Development
- Impervious surfaces
- Population growth
- Energy and water demand

- Flooding (Riverine, Coastal, Other)
- Water shortage due to drought
- Wildfire
- Extreme Heat

- People
- Programs
- Property
- Infrastructure

NC EO80 – 2019/2020
Framing comments
- Energy reality is rapidly changing, this provides an opportunity to build resilience as we are modernizing the infrastructure to handle 21st century fuel and power needs.
- Energy drives commerce, transportation, housing sectors and therefore solutions must be integrated across these sectors

Critical Impacts and Potential Options
- Electric Grid/Increased Storm Intensity causes power outages and related disruptions cascade through the local and state economy
- Power Plant Cooling/Water shortage due to drought puts stress on water quantity and quality
- Fuel supply chain disruption/increased storm intensity affects evacuation routes and critical infrastructure
Develop a systematic vulnerability-based approach to assess needs for equitable energy resilience investments across the state of North Carolina

- using New Hanover County as a case study
- and New Bern as a test case for replicability of the analytical approach.

vulnerability-based assessment, 2 sequential parts:
- assessment of potential consequences on the community
- informs energy resilience investments
Energy Resilience with an Equity Lens

- Who is being most impacted?
- How is that impact being experienced?
- What unique vulnerabilities, risks, assets and barriers exist?
- What additional resources are necessary?

<table>
<thead>
<tr>
<th>Energy System</th>
<th>Emergency Mgmt</th>
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<tbody>
<tr>
<td>Reduce the number of customers impacted and duration of outages</td>
<td>Efficiently address immediate life safety concerns</td>
</tr>
<tr>
<td>Reduce future losses, risks and vulnerabilities to life and property</td>
<td>Increase speed to recovery</td>
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<tr>
<th>Community Resilience</th>
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<tbody>
<tr>
<td>Trust, transparency, community input, and context</td>
</tr>
<tr>
<td>Improved health, economic and social well-being outcomes</td>
</tr>
<tr>
<td>Full participation, equitable access, availability, and benefit</td>
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Beth Schrader, Office of Recovery and Resilience  5/19/21
Vulnerability analysis framework for the pilot project

Power System Assets (Distribution)

Energy Asset Vulnerability (and Risk) to Hurricanes

Potential for Power Outages during Hurricanes

Community Assets and People

Community Vulnerability (and Risk) to Power Outages

DEQ
UNC Asheville
NEMAC+FernLeaf
Resilience for Regulators

Climate Resilience Frameworks to Improve Risk Management
Collaborative Efforts and Lessons Learned

January 26, 2022

Sushma Masemore, P.E.
Assistant Secretary for Environment
Problem Statement

North Carolina experiences frequent extreme weather events that disrupt essential operations, energy infrastructure, and threatens the health and safety of citizens.
Florence was the largest mobilization in Duke Energy storm history.

Flooding and wind damage were unprecedented.

Generator failures at a WWTP released partially-treated water into the Cape Fear River.

9 Duke Energy substations were flooded.

What are we trying to prevent?

Carolina’s Grid Disturbance types
Source: Advanced Energy

$17 billion in estimated damages statewide

51 counties FEMA declared for Individual and/or Public Assistance

5,000+ people rescued by air, water and land

21,272 people sheltered on night of Sept. 15

Distribution Summary

<table>
<thead>
<tr>
<th>Restored</th>
<th>Events</th>
<th>Outages</th>
</tr>
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<tbody>
<tr>
<td>NC</td>
<td>22,604</td>
<td>1,643,762</td>
</tr>
<tr>
<td>SC</td>
<td>3,806</td>
<td>177,984</td>
</tr>
<tr>
<td>Total</td>
<td>26,410</td>
<td>1,821,746</td>
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</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>DEP</th>
<th>DEP System Outage Information</th>
<th>Lines</th>
<th>Substations</th>
<th>Wholesale PODs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Storm (183)</td>
<td>45</td>
<td>90</td>
<td>48</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Weather Related 67%
Widespread impacts: Matthew, Michael, Florence

- Matthew Only
- Florence Only
- Michael Only
- Michael/Florence
- Matthew/Florence
- Matthew/Michael/Florence

Total Counties Under Presidential Disaster Declaration:
- Hurricane Matthew: 50
- Hurricane Florence: 52
- Tropical Storm Michael: 21

77 of 100 Counties impacted between 2016-2018
“Large changes in North Carolina’s climate — much larger than at any time in the state’s history — are very likely by the end of this century under both the lower and higher scenarios.”

Source: North Carolina Climate Science Report, https://ncics.org/nccsr
Crosscutting Priorities

Energy Resilience & Equity

Vulnerable Sectors & Nature Based Solutions

Distributed Energy Resources, Community Solutions, and Microgrids
NC Clean Energy Plan Recommendations

1. Require comprehensive utility system planning
   - Establish planning processes that connects generation, transmission, and distribution planning in a holistic, iterative, and transparent process

2. Modernize the grid to support clean energy resources
   - Create accountability by requiring transparency, setting targets, timelines and metrics of progress made toward grid modernization goals.

3. Strengthen the resilience and flexibility of the grid
   - Require utilities to develop projects focused on DERs, community solutions, and microgrids at state facilities and critical infrastructure locations to enhance resilience.
   - Develop a method to quantify the human costs of power outages and integrate these costs when evaluating grid modernization plan components related to resiliency.
How does resilient distribution planning align with transmission and resource planning?

Do “T”, “D”, and “G” planning integrate resilience independently?

Or is it better to address resilient planning as an overlay across “T”, “D” and “G”?
North Carolina Resilience Plan

North Carolina
Climate Risk Assessment and Resilience Plan
Impacts, Vulnerability, Risks, and Preliminary Actions
A Comprehensive Strategy for Reducing North Carolina's Vulnerability to Climate Change

June 2020

Sector Strategy
Developers: 200+
Community Workshops
Participants: 300+
Stakeholders:
100+

Executive Summary
1. Key Findings and Recommendations
2. Resilience Plan Development Process
3. NC Climate Science Report Summary
4. Climate and Environmental Justice
5. Vulnerability, Risk, and Potential Options for Addressing Climate-Related Hazards
6. Nature-Based Solutions to Resilience
7. Path Forward
Vision of Resilience

• A resilient North Carolina is a state where our communities, economies, and ecosystems are better able to rebound, positively adapt to, and thrive amid changing conditions and challenges, including disasters and climate change; to maintain and improve quality of life, healthy growth, and durable systems; and to conserve resources for present and future generations.
Community Energy Resiliency Planning

Energy assets

Community critical infrastructure

Climate threats

Virtually Certain
- Sea Level will continue to rise

Very Likely
- Summer Heat Index Values will increase
- Severe droughts will become more intense
- Annual Total precipitation will increase

Likely
- Hurricane intensity will increase
- Increase in precipitation will lead to an increase in inland flooding
1. Planning an Affordable, Resilient, and Sustainable Grid (PARSG)

**Partners**: UNCC EPIC, NC CETC, Duke Energy, New Hanover County, NC DEQ SEO

**Benefit**: New metrics (e.g., economic losses experienced by customers from outages due to hurricanes) to help the state, utilities, and stakeholders evaluate resiliency options.

2. Community Energy Resilience Planning in New Hanover County (FEMA BRIC)

**Partners**: New Hanover County, NC DEQ SEO, UNCC EPIC, Duke Energy, EPRI, NCUC Public Staff

**Benefit**: Engage community/businesses/government to mitigate risk, increase resiliency, and promote a culture of preparedness via energy infrastructure, EE measures, and distributed energy resilience solutions.

3. New Hanover Community Vulnerability and Resilience Mapping

**Partners**: UNC-Asheville NEMAC, FernLeaf Interactive, New Hanover County, NC DEQ SEO

**Benefit**: Novel systematic method to identify resilience solutions for community assets in disadvantaged communities at risk of extreme flooding and heat events.
4. Community Microgrids
   **Partners:** UNCC, Duke Energy, NCEMC, NREL, Quanta Technology, Southern Methodist University, Clemson University, NC CETC, NC DEQ SEO
   **Benefit:** First-of-the-kind assessment of advanced algorithms compared to a baseline of control algorithms in fielded utility scale community microgrids.

5. Alternative Fuels Corridor Planning
   **Partners:** E4Carolinas, Savannah River National Lab, SACE, NCCETC, Centralina Clean Fuels, Triangle Clean Cities, Duke Energy Piedmont Natural Gas, Advanced Energy, Electric Cooperatives of SC, ONEH2, NC DEQ SEO
   **Benefit:** Post disaster emergency response plan/roadmap that will reduce the impact to infrastructure disruption, transportation, utility restoration and recovery operations.

   **Partners:** State agencies, NCORR, USCA, NASEO, USDOE, utility providers, NC DEQ SEO
   **Benefit:** Cohesive strategy for incorporating key state-owned infrastructure into broader vulnerability, energy efficiency, and resilience planning processes.
What’s Ahead
In Electricity System Resilience

• Divisions in DEQ are working with community, government, and business partners to plan and implement actions that can be taken to increase resilience
• Muni & Coop electricity providers are looking at resilience as well
• Significant questions:
  1. How the current regulatory process is able to adapt to this new concept of system community energy planning?
  2. Could investments in new infrastructure include some of these community benefits?
Planning an Affordable, Resilient, and Sustainable Grid in North Carolina

Dr. Robert Cox
Associate Director, Energy Production and Infrastructure Center
Professor of Electrical and Computer Engineering
UNC Charlotte
Project Approach

• Project was developed following two major events
  • Difficulty with a major $13B grid modernization effort in NC
  • Impact of Hurricane Florence

• Guiding questions:
  • What are the consequences of recent and expected events?
  • How do we view both traditional and advanced investments through the lens of mitigating those consequences
**Key Findings**

- **Finding #1**: Significant past storm impacts occur on the distribution system, often because of issues outside of expected utility control.

- **Finding #2**: Need for greater engagement between local stakeholders & utilities.

- **Finding #3**: Need for new metrics that recognize the shared need for hardening & DERs:
  - Must value the necessity of hardening to enable greater penetration of DERs.
  - Must find a way to rate-base and/or cost-share resilient back-up power, considering the full stacked benefits.
Holistic Benefits of Grid Resilience

- Many impacts to critical infrastructure discussed in project
- One common impact is the effect on customers in areas with high Social Vulnerability Index
Holistic Benefits of Grid Resilience

• Example:
  • Food contents damaged (D-SNAP) benefits
  • Sheltering costs

• Assumptions:
  • Outpost can protect 100 customers with an average family of 4
  • Outpost can provide ice
  • Outpost can keep residents in home
  • 2-day outage, 1x per year

**Benefits of Shelter With Resilient Power**

*2 Day Use, 1X per year*

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Food damage</td>
<td>$64,000 / event</td>
</tr>
<tr>
<td>Sheltering cost</td>
<td>$23,800 / event</td>
</tr>
<tr>
<td>Self food preparation</td>
<td>$4,800 / event</td>
</tr>
<tr>
<td>Total Annual Benefit</td>
<td>$92,680 / event</td>
</tr>
<tr>
<td>20-Year Benefit</td>
<td>$1.85M</td>
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NARUC Panel Discussion

Climate Resilience Frameworks to Improve Risk Management: Exploring Lessons Learned from North Carolina

Assessment Key Findings

Extreme weather events, including extended durations of colder than normal weather, pose a risk to the uninterrupted power delivery.

Natural gas supply disruptions in infrastructure-limited areas can affect winter reliability.

Continuing drought in the west can cause low hydro conditions for the upcoming winter and reduce the available supply of electricity.

Generator Owners are facing challenges to obtain fuels as many supply chains are stressed.

Responses to NERC’s Level 2 Alert — Cold Weather Preparations for Extreme Weather Events

- Indicate that operating plans for winter are in place, but
- Generator resource availability could again suffer as a result of
  - equipment failure or lack of fuel under severe winter conditions
Winter and Summer Preparedness Reviews
- Effective weatherization practices
- Coordinated generation planning

On-site fuel backup, dual fuel capability

Integrated gas and electric coordination

Culture of self-criticality and lessons learned
- Root cause analysis and learning from events
- Evaluation of events across industry, all regions

Vertical integration provides benefit for Duke Energy customers:
- Enhances resiliency as distribution, transmission and generation can easily coordinate respective operations
- Supports resiliency needed with the introduction of significant levels of renewable energy

Figure 1: Solar Real Time 7-Day Profile

Large daily variation in renewable energy output during winter months highlights need to advance system resiliency
Duke Energy Actions to Advance Resiliency

Transmission Grid Modernization Programs

- System Intelligence
  - Smart field devices and infrastructure to improve grid operator system awareness
  - Remotely sectionalize circuits
  - Locate system faults

- Substation Hardening & Resiliency
  - Flood mitigation
  - Replacing oil filled circuit breakers

- Line Hardening & Resiliency
  - Rebuilding vulnerable line segments to reduce threats: high winds, lightning and vegetation

- Cyber and Physical Security
  - Electronic detection
  - Fences and Intrusion Detection

Grifton Station after Hurricane Mathew 2016
Grifton Station with Tiger Dam Before Hurricane Florence 2018
Grifton Station Flood Wall 2020
Duke Energy Actions to Advance Resiliency

Distribution Grid Modernization Programs

- Self-Optimizing Grid
  - Ability to automatically reroute power
  - Rapidly dispatch line crews directly to the source of the outage

- Targeted Underground
  - Underground most outage prone overhead power line sections

- Long Duration Outage/High Impact Sites
  - Radial feeds to entire communities or large groups of customers
  - Inaccessible line segments

- Integrated Volt-Var Control (IVVC)
  - Optimize voltage and reactive power