Grid modernization to support clean energy	*What are the key grid upgrades or investments needed to enable greater adoption of clean energy by customers and utilities while maintaining affordability for ratepayers and reliability?*

Summary:

There is potential debate about how to define grid modernization, this group chose to focus on the technologies, upgrades and investments that are required to enable greater adoption of clean energy and did not address the definition of grid modernization. We are suggesting upgrades and investments that will work towards creating a “lean grid,” that maximizes power output, while minimizing resources and CO_2 emissions.

The implementation of these key upgrades and investments should be done using a transparent evaluation process that considers the stacked benefits that result. The cost recoupment and the impact of that recoupment on low income individuals and small businesses should also be considered.

Establishing different segment goals (i.e. CO_2 reduction, DER integration, pricing targets, reduction of outage time, etc.) and setting reasonable timelines is a good way to provide accountability on the progress made toward grid modernization and inform all stakeholders as to where more resources or attention must be paid.

High level upgrade and investment recommendations include:

- Regionally appropriate DERs that harness the natural energy producing environment to maximize the DER
- Energy storage that provides localized power that offsets demand
- Smart inverters, transformers and power controllers that facilitate the bidirectional flow of power
- Capacity improving investments to aid in faster, more stable redirection of power when needed

More detailed areas for innovation and improvement are outlined in the body of this paper.

1. Briefly describe the nature of this policy tension/question - What is happening?

Transformation of the electric power system to a system powered by high levels of clean fuels requires integrated planning of technology adoption so as to occur at high speed and in a way that exploits demand flexibility, high potential for energy efficiency, and the low cost of renewables to offset costs of equipment modernization. Whereas supply and load balancing already are executed as a system level function, traditional power system management structures do not provide

- a mechanism for successful management of a rapid and extensive grid technology transformation
- pricing signals that reflect environmental costs
- incentive structures that could drive participants to choose efficient transformational actions

Optimal engagement of renewables and complementary grid and usage technology will require transparency in planning. Likewise, operational effectiveness under conditions of 2-way power-flow will require a significant increase in availability of transmission and distribution data to enable monitoring, control, and system protection.

Challenges for grid modernization include decisions about the scale (utility or smaller scale) of renewable generation most efficiently supported while meeting goals for resilience and determining who pays and who benefits from necessary investments.

2. To what extent does this policy tension exist in NC + why is it relevant to the state?

The challenges outlined in question 1 are relevant to us. However, relative to states with high levels of consumer level renewables, NC has the capacity to move forward with consumer-level assets but is faced with the challenge in short order of adopting a strategy for successfully exploiting significant availability of large, utility scale solar deployment. This scale of deployment is more readily known and amenable to central management than DERS, which in general requires distributed control. However, NC also needs policies that encourage implementation of distributed resource management, so that communities in monopoly territory, as well as large corporate campuses, and communities in coops can benefit from stable implementations of smaller scale DER. Distributed resource management will be facilitated by the establishment of incentives, such as pricing signals that encourage distributed producers to match load profiles.

3. What policy or regulatory action might be required to address the tradeoffs you see? What entity would need to take the action you've identified?

- We recommend creation of a working group to evaluate:
    - Feasibility of new incentive structures for suppliers, consumers, and technology providers
    - Framework for transparent analysis and decision making
    - Technical framework for real time asset management and situational awareness
    - Alternate cost recovery and/or incentives for utilities and third parties to invest in grid upgrades and renewable sources
    - Interconnection rules to facilitate higher levels of distributed resources

Ultimately the balance between affordability and ensuring grid reliability in the face of increased clean energy adoption will likely come before the North Carolina Utilities Commission (NCUC) as it considers cost recovery for investments made by utilities or requirements for interconnection that involve new grid upgrades or investments needed to manage grid instability. Many states have created incentive structures for utilities or interconnected resources to deliver solutions to the grid instability problems resulting from incompletely managed intermittent generation, so as to enable high levels of renewable generation. While there are no fully established frameworks for assessing the appropriateness of stability solutions, our utility commission could be charged with requesting proposals for solutions and having them evaluated by independent industry professionals.

4. How are people in other places responding to this tension? What are the most innovative and promising solutions? Do they seem feasible in NC?

According to the NC Clean Energy Technology Center's The 50 States of Grid Modernization: Q1 2019 Quarterly Report: "Over half of U.S. states are currently examining these regulatory frameworks or actively working to deploy advanced grid technologies. This activity is expected to continue, as states and utilities conduct studies, try new approaches, and learn from one another about how best to achieve the many benefits of a more modern grid."

In terms of incentives to encourage clean energy developers to invest in storage or other technologies to address clean energy intermittency, California Rule 21 is the ruling from the CA PUC that covers distributed energy resources interconnection requirements for utilities including technical standards and tariffs. Each of the IOU's in CA have their own tariff to cover the implementation of Rule 21 in their territory. The latest updates have included requiring smart inverters and communication standards to better enable the integration of DER's.

5. Are there ways you think NC should consider responding to this tension? What entity would need to take the action you've identified?

Beyond the policy or regulatory actions mentioned above, NC should be aware of all the technologies available today to ensure grid reliability in the face of increased clean energy adoption. While this is not an exhaustive list, some current technologies include battery storage, electric vehicles, demand response, energy efficiency, smart inverters, and system-wide grid investments. System-wide grid investments were noted in NC DEQ's 2018 *Energy Policy Council Biennial Report* as "distribution automation, which is the addition of smart switches that enable fault location, isolation, and restoration; new distribution monitoring and data gathering systems (e.g., Supervisor Control and Data Acquisition) (SCADA)); and two-way communications to intelligent energy devices (IED) on the distribution grid." The Biennial Report also noted, "Each new system generates orders of magnitudes of new data that can be analyzed and interpreted."

Upgrades supporting grid-beneficial distributed renewable generation adoption						
Upgrade	Capability facilitated					
	Monitoring and Visibility	Local intelligence/ Automation	Efficiency	Matching load and supply	Increased capacity of solar per unit energy	Low emission electrification
Advanced metering infrastructure	x	x			x	x
Power electronics	x	x	x	x	x	x
Energy storage				x	x	x
EV charging infrastructure				x	x	x
Demand side management tools				x	x	x
Price signal communications				x	x	x

The chart below highlights areas of opportunity that were identified recently in a study by Duke Energy and were deemed most critical to driving innovation and improvement in the integration of DER to the grid

Utility Side Upgrades						
Program	Capabilities Enabled					
	Monitoring & Visibility	Automation	Distributed Intelligence	Voltage Control	Two-way Power Flows	Increase Hosting Capacity
Advanced Metering Infrastructure	X	X	X		X	
Integrated Volt/VAR Control (IVVC)	X	X	X	X	X	X
Self-Optimizing Grid (SOG)	X	X	X	X	X	X
Power Electronics for Volt/VAR	X	X	X	X	X	X
Distribution Automation	X	X	X	X		
Energy Storage			X	X	X	X
DER Dispatch Enterprise Tool	X	X	X		X	
Enterprise Communications	X	X	X	X	X	
Cyber Security	X	X	X			

NC also has world-class research institutions, which can be leveraged to push for new technological solutions that are increasingly affordable. Private companies in the Research Triangle Park, Charlotte and elsewhere throughout the state can also be consulted for technical solutions to these challenges.

APPENDIX: References

"The Future of Solar Energy: An Interdisciplinary MIT Study," Energy Initiative, Massachusetts Institute of Technology, ISBN (978-0-928008-9-8), 2015, 334 pages.

NC DEQ's 2018 *Energy Policy Council Biennial Report, https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Energy/Energy%20Policy%20Council/2018%20EPC%20Biennial%20Report%20-%20FINAL.pdf*

Peter Fox-Penner, "Smart Power - Climate change, the smart grid, and the future of electric utilities", 2014, Island Press, ISBN 978 -1- 59726-705-2 or -706-9

Feedback from Workshop Discussions 5-22-19

Ideas in the presentation I did not understand:

We need real time data: Who is "we"? Distributed Generators? Devices?
The utility would argue that as the grid operator they are the only ones that need the data
Are we envisioning that e.g. a behind-the-meter solar inverter could bid ancillary services
Explanation of grid instability. What does this mean exactly?
Concept of cost recovery as a problem; Oh I think you meant worry about adequate usage of new generating sources
What's the tension between affordability and grid reliability?
The feasibility of getting the real-time asset management
Examples of incentive structures from other states
What categories of data could be shared with consumers/made public
What distinguishes "grid modernization" between traditional utility investment? What is the core distinction?
Role of NCUC influence
Exactly what grid mod includes
How integrating large scale solar projects is more of an immediate challenge than is DER when it comes to grid mod

Ideas that were missing from the presentation, but should be included:

Is this distribution or transmission grid mod
Addressing the urgency to agree on a policy for grid mod
Dukes proposal of if and to do maintenance, storm hardening and instability Vs. need for greater grid capacity to handle more renewables in Eastern NC to load center in central/western NC
Tension - Grid operation is designed to bring supply to demand. With electrification comes implicit scheduling/storage and the need/opportunity to bring demand to supply. That is flexible demand provides for integration of renewables → Electrification?
Duke does not compete strongly with independent producers in building and operating renewables. Does duke lack opportunity to rate base new renewable investments? Does this affect incentives for the company's technology pathway?
Definition of data availability and what could be used
Policy to require smart metering
Policy to set communication protocols for grid equipment such as smart meters
    related to the above, making the grid ready for transportation electrification
What is capacity potential for residential and commercial PV?
Have you explained smart inverters emphasis EQ7 & EQ8
What should/could "working group" for grid mod look like?
Separate docket for Grid Mod at NCUC
What are the key upgrades/investments needed?
What truly counts as grid mod vs. business as usual/necessary for reliability
Better distinction between this group and the interconnection group; What is each group distinctly trying to address between the interconnection issues?
Burden of cost → who bears the brunt
GDPR - Data protection
Community solar
Opportunities to partner with customers (i.e. private sector) on projects that would be beneficial to the grid as well as to that customer (ex. energy storage)
How this is taking into account equity issues, als ratepayer impacts generally

Ideas that emerged from this presentation that may be in tension with my/another group's topic area:
What happens when there is a tension between the grid the utility wants and the grid customers with DER want?
More transparency needed in all utility silos
Duke wants more investment opportunity- why not grid mod to support more clean energy capacity?
Faster interconnection - can we really achieve this faster?
Our entire group was silent on the topic of environmental justice
Fits with "resilience" at the consumer/distribution level
How does "grid modernization" interact with the traditional resource planning process
Interconnection: Another group handles this. Maybe save space and focus elsewhere here?
Transparency
How does duke energy define grid modernization
Interconnection of new assets

Ideas that I am excited about and would like to explore more:
Ideas that I am unexcited about - another working group. There have been many in recent years and duke energy has walked away from what has been
Queue for storage vs solar or creative ways to manage interconnection
Transparency emphasis
Data availability
Increase in residentially produced energy (rooftop solar) clean
What data is available publicly in other states or RTOs that is not available in NC - we should be able to access such data
Working group for grid modernization
New incentive structures (performance based rate?) to encourage grid and 2-tier queue for centralized/decentralized generation
Rhode Island PBR example!
Setting criteria (a rate base?) for evaluating investments in grid mod
Access to data and real time access
Resiliency of grid
Looking at what other states are doing and implementing in where it makes sense (i.e. for data sharing/transparency, interconnection, etc.)