Duke Energy South Carolina Grid Improvement Initiative Workshop Report

September 6, 2018

Prepared by Rocky Mountain Institute

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Executive Summary

Duke Energy[1] hosted a technical workshop on August 14th, 2018 regarding the Company's South Carolina Grid Improvement Initiative to explain the need for and ongoing benefits of grid investments, and to hear feedback from stakeholders in attendance.

Acting as a neutral facilitator, a team from Rocky Mountain Institute (RMI) convened 57 participants (inclusive of 17 Duke Energy and 5 RMI staff) for an afternoon workshop that included content presentations, structured feedback sessions, and facilitated small group breakout sessions. RMI captured detailed notes for all small group and plenary discussions, and conducted an anonymous post-event survey among non-Duke Energy, non-RMI attendees to gather stakeholder feedback.

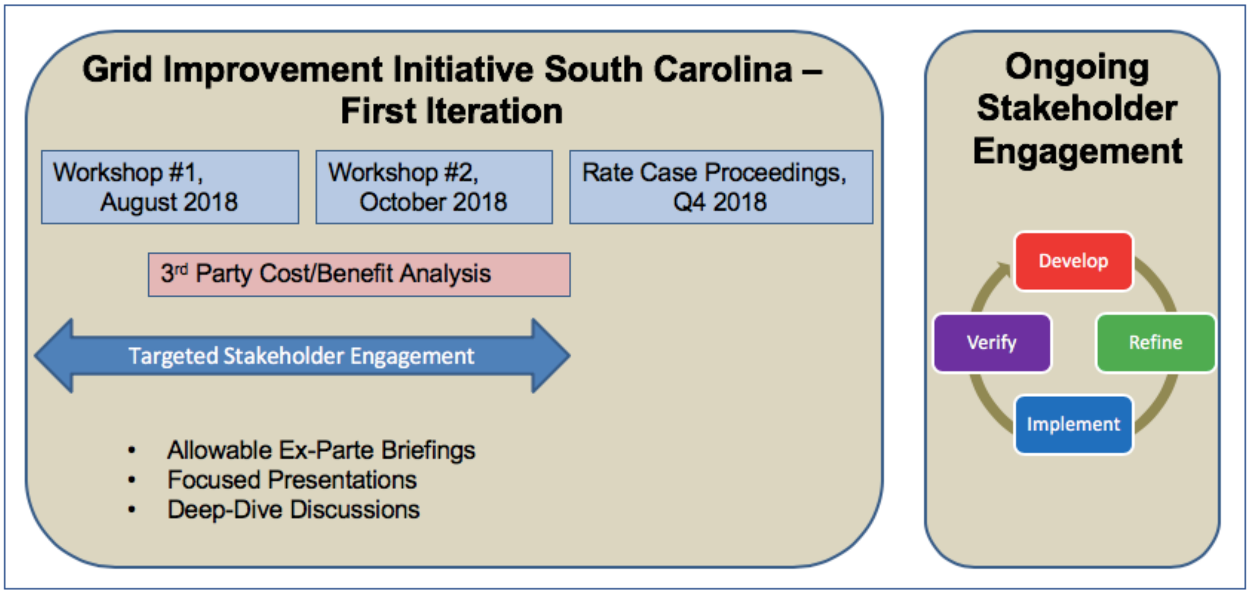
This document provides a record of the day's activities and outcomes, as well as a summary of survey results. This document contains an anonymized synthesis of what was shared by participants, and does not attribute specific comments to specific parties, in order to respect the ground rules agreed to by participants at the beginning of the meeting. Specifically, participants agreed that what was discussed at the workshop could be shared publicly, but specific comments could not be attributed to individuals without their permission.

Workshop Context

This workshop is part of an ongoing stakeholder engagement process for the South Carolina Grid Improvement Initiative. As Duke Energy shared at the beginning of the workshop (see Figure ES-1), Duke Energy intends to file a rate case related to grid improvement, before the end of the fourth quarter in 2018. The feedback collected from this workshop will be incorporated into Duke Energy's subsequent analysis and further development of the grid improvement initiative. In October, Duke Energy will host a second workshop to share any evolved plans for grid improvement, and explain how stakeholder feedback from the first workshop has been incorporated.

[1] References to Duke Energy are intended to describe the joint efforts of the two separate and distinct utilities, Duke Energy Carolinas, LLC and Duke Energy Progress, LLC, both of which operate in South Carolina as well as North Carolina.

Figure ES-1: Stakeholder Engagement Strategy presented by Duke Energy



Workshop Objectives

The workshop was organized around three objectives, as listed below. RMI developed these objectives in consultation with Duke Energy and other participants interviewed in advance of the event.

In order to engage stakeholders in Duke Energy's current plans for grid improvement, the workshop was designed to meet the following objectives:

- **Objective 1:** Develop stakeholder understanding of the initiative;
- **Objective 2:** Listen to and explore stakeholder feedback; and
- **Objective 3:** Lay the groundwork for a collaborative process moving forward.

Key Workshop Outcomes

Several high-level themes emerged from the conversations during the workshop and in the post-event surveys as key outcomes and takeaways for future action. They are described below, with supporting detail in the subsequent sections of this report.

These themes do not necessarily represent the views of RMI, Duke Energy, or any specific attendees, nor do they represent consensus among participants. Rather, we reflect the range of feedback, as well as common themes that arose in multiple conversations during the workshop, for consideration by Duke Energy and other stakeholders as they design a collaborative process moving forward.

- **Familiarity and knowledge about the Grid Improvement Initiative varied widely among stakeholders.**
- **Participants would like to understand more of Duke Energy's quantitative and qualitative goals for grid improvement.** In the Q&A sessions following Duke Energy's presentation and the breakout sessions, participants raised questions around what the performance goals are, in particular beyond reliability. They suggested that Duke Energy conduct further conversations with stakeholders to assess if Duke Energy's goals align with the needs and priorities of customers and understand customer's willingness to pay for reliability.
- **Participants would like to learn more details regarding how Duke Energy is planning to allocate capital among grid improvement investments.** Participants raised questions in both plenary and breakout sessions regarding Duke Energy's plan of prioritizing among various investments.
- **Participants provided input regarding options and considerations they would like Duke Energy to include in the cost-benefit analysis.** Those requests were not all aligned and not all mutually exclusive, but generally include:
    - Compare the relative cost/benefit of different investment options (and share/discuss the rationale around tradeoffs) for each utility.
    - Disaggregate the benefits by each customer class, and allocate cost accordingly for each utility.
    - Be more comprehensive in the options that are being considered in the cost/benefit framework; for example, analyze a baseline scenario of "doing nothing", analyze scenarios with different adoption level of DERs in the distribution system, etc.
    - Maintain flexibility to accommodate additional investment paths or new regulatory frameworks in the future, potentially accommodating performance-based metrics.

Workshop participants discussed a wide range of actions for Duke Energy to take as immediate next steps following the workshop, including:

- **Participants offered to provided analyses/resources to support Duke Energy in developing the Grid Improvement Initiative over the next month.** The offers range from system planning analyses, economic impact studies, to business model reform metrics, and facilitation support. The full list can be found in Appendix 1.

- **Participants recommended Duke Energy continue educating and engaging key stakeholders, with a particular focus on:**
  - Engaging missing or underrepresented perspectives; for example, residential customer representatives and low-income/rural communities.
  - Providing easy-to-access information for stakeholders that are not familiar with the Grid Improvement Initiative.
- **Participants recommended that Duke Energy engage targeted stakeholders in working groups discussions before the end of the year, for the purposes of:**
  - Communicating proposed cost/benefit and trade-off rationales.
  - Understanding and aligning on the methodology and key inputs/assumptions for the cost/benefit analysis.
  - Understanding and aligning on priorities around grid reliability.

Workshop Activities and Attendee List

RMI consulted with both Duke Energy and other participants in pre-workshop discussions; RMI incorporated feedback from these discussions to refine the meeting objectives and design the workshop agenda to best meet these objectives. The workshop agenda as executed is included below in Table 1.

Table 1: Aug 14 Technical Workshop Agenda

Time	Activity	Objectives addressed
12:30	Welcoming remarks	
12:40	Overview of Duke Energy's proposed engagement approach	#1
12:45	Check-in and introductions	
13:10	Activity: Four ways of talking and listening	#3
13:30	Presentation (RMI): National grid modernization context	#1
14:00	Presentation (Duke Energy): Understanding the SC Grid Improvement Initiative, cost/benefit and cost effectiveness framework, and Q&A	#1, #2
15:00	Break	
15:15	Activity: Breakout group discussions for feedback	#1, #2, #3
16:45	Report-out and reflections from breakout groups	#2, #3
17:30	Closing remarks and adjournment	

A total of 57 participants attended the technical workshop, including 17 participants from Duke Energy and 5 from RMI. A full list of attendees is included below in Table 2.

Table 2: August 14 Technical Workshop Attendees

Last Name	First Name	Organization
Barton	Jim	FUJIFILM Manufacturing
Beaufort	Cleve	BMW Manufacturing Co., LLC
Billimoria	Sherri	RMI
Boyt	John	Central Electric Power Cooperative Inc.
Brooks	Jeff	Duke Energy
Burnett	John	Duke Energy
Carter	Ron	North Eastern Strategic Alliance
Chan	Coreina	RMI
Claunch	Chuck	Duke Energy
Culley	Thad	Vote Solar
Cummings	Bill	SCEUC-Chair-Kimberly Clark
Davidson	Hilary	Duke Energy
Davis	Hamilton	Southern Current
Dohn	Steffanie	Southern Current
Dover	Becky	SC Department of Consumer Affairs
Dr. Von Nessen	Joey	University of South Carolina
Echevarria	Sidney	Duke Energy
Elliott	Scott	SCEUC Attorney-Elliott & Elliott
Ferguson	Stinson	SELC
Ghartey-Tagoe	Kodwo	Duke Energy
Gilliam	Joi	SC Department of Commerce
Golin	Caroline	Vote Solar
Hall	Karen	Duke Energy
Haynes	Rebecca	Conservation Voters of South Carolina
Hazzard	Sara	South Carolina Manufacturers Alliance
Hipp	Dawn	South Carolina Office of Regulatory Staff (ORS)
Holeman	Blan	SELC
Jacob	Bryan	Southern Alliance for Clean Energy (SACE)
Jiran	Rick	Duke Energy
Johnson	Sarah	South Carolina Office of Regulatory Staff (ORS)
Knapp	Frank	Small Business Chamber of Commerce
Kruse	Susan	Duke Energy
Lawyer	Robert	South Carolina Office of Regulatory Staff (ORS)
Li	Becky	RMI
Li	Richard	RMI
Martin	Jason	Duke Energy
McKay	Jeff	North Eastern Strategic Alliance
Meyer	Jason	RMI
Moore	Eddy	Coastal Conservation League
Morgan	Willie	South Carolina Office of Regulatory Staff (ORS)
Motsinger	Scott	Central Electric Power Cooperative Inc.
Palmer	Miko	Duke Energy
Preston	Marcus	Duke Energy
Robbins	Shelley	Upstate Forever
Rogers	David	Sierra Club
Ruhe	Mike	Duke Energy
Sandonato	Anthony	South Carolina Office of Regulatory Staff (ORS)

Seaman-Huynh	Michael	South Carolina Office of Regulatory Staff (ORS)
Sharpe	Chris	Duke Energy
Shirley-Smith	Heather	Duke Energy
Simpson	Bobby	Duke Energy
Sipes	Robert	Duke Energy
Smith	Robert	MVA Nucor
Tynan	John	Conservation Voters of South Carolina
Wall	John	South Carolina Manufacturers Alliance
Wislinski	Benton	BGW Solutions
Yawn	George	Resolute Forest Products

Workshop Outcomes

The following sections outline the workshop activities, common themes of discussion, and survey outcomes associated with each of the three workshop objectives. RMI developed these summaries based on notes taken during the workshop as well as on the results of the anonymous survey distributed to participants (excluding Duke Energy and RMI staff) afterwards. Due to the low response rate to the survey (49%), survey outcomes should be interpreted with caution.

The summaries of common themes were not necessarily endorsed by every participant within the workshop, nor are they necessarily the recommendations of RMI or Duke Energy.

Objective 1: Develop stakeholder understanding of the Grid Improvement Initiative in South Carolina

Activities

RMI designed several sections of the agenda to allow for explanation of the need for and benefits of grid investments:

- A presentation from RMI (see Attachment 2) reviewed grid modernization trends across the nation, to contextualize the Grid Improvement Initiative. The presentation outlined both the content of proposals across the country (e.g., specific investment, regulatory, and operational approaches to grid modernization) as well as processes used by utilities, regulators, and other stakeholders to reach alignment.

- Duke Energy provided participants with presentations and handout materials to explain the high-level plans for the Grid Improvement Initiative, including the following:
    - A presentation from Duke Energy (see Attachment 3) covered the unique factors in South Carolina that form the basis for the proposed Grid Improvement Initiative. The presentation was derived from a white paper (see Attachment 4) that Duke Energy developed earlier this year, which was distributed at the workshop before the presentation. After the presentation, participants had a chance to ask clarifying questions that were answered in real time by Duke Energy representatives (see Appendix 2).

- A handout from Duke Energy (see Attachment 5) outlining the process for evaluating cost/benefit and cost effectiveness for a particular course of action.
  - At the workshop, RMI asked participants to spend a few minutes reading through the cost/benefit and cost effectiveness framework; participants also had a chance to ask clarifying questions that were answered in real time by Duke Energy representatives (see Appendix 2).
  - This cost/benefit and cost effectiveness handout also set the stage for the subsequent discussions of the workshop, providing a framework for participants to provide feedback which was summarized in detail as common themes under Objective 2.

Cost/Benefit and Cost Effectiveness Framework

This framework can be conceptualized as a decision tree, summarized as follows:

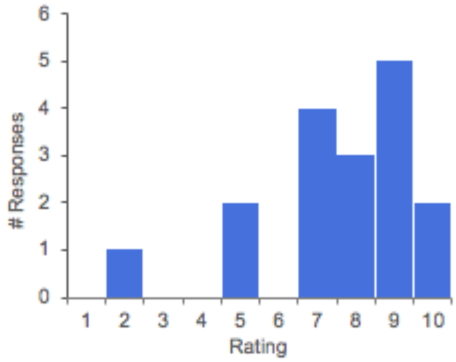
- Cost Benefit Analysis:
  - "Go/No Go" Level: Determine if a course of action should be taken. Proceed if the course of action is either mandatory for compliance, or justified by its clear demonstrated benefit to customers, Duke Energy, or third parties.
  - "Path Selection" Level: Determine if a particular path to achieve this course of action should be taken. Proceed if the chosen path is the only viable option, or more favorable than other paths on a net present value basis, or justified by other qualitative factors that are objective and provable.
- Cost Effectiveness Analysis: Prove that the chosen path will be executed in a reasonable and prudent fashion. Proceed if the execution plan leverages competitive bidding, optimizes work mobilization, identifies risks and contingencies, and implements metrics for evaluating progress.

- A handout from Duke Energy (see Attachment 6) outlining the definition of *maintain base* vs. *incremental* transmission and distribution system work. This handout material was not discussed in detail at the workshop.

Outcomes

Most survey respondents indicated that the workshop improved their understanding of Duke Energy's proposed grid investments, but a few respondents indicated that the workshop did not present substantial new information over what they already understood.

Figure 1: Survey responses: "How well did this workshop enhance your understanding of the proposed Grid Improvement Initiative?"



The post-event survey asked participants "How well did this workshop enhance your understanding of the proposed Grid Improvement Initiative?" Participant answers are shown above in Figure 1. On a scale of one to ten, 82% of respondents answered with a score of seven or higher.

- In comments, one respondent requested more details on Duke Energy's specific analyses, goals, and assumptions of metrics. Another respondent suggested the workshop could incorporate more discussion and fewer formal presentations.
- One of the outliers, who provided a score of 2, indicated in their comments that they already "had a very deep understanding" of the Grid Improvement Initiative.

Objective 2: Listen to and explore stakeholder feedback to the Grid Improvement Initiative in South Carolina

Activities
The agenda was designed to encourage open discussion of participant feedback.

- Following Duke Energy's presentation on the Grid Improvement Initiative, participants asked clarifying questions that were answered directly by Duke Energy's representatives. Participants also asked clarifying questions and provided feedback on the cost/benefit framework, which served to guide the discussion in subsequent activities.
- In addition to the opportunity to share feedback in plenary discussions, breakout sessions provided extensive opportunities for stakeholders to share feedback on the proposed grid investments. Specific discussions hosted in each breakout session, outlined below, allowed participants to raise points of feedback:
  - Breakout question 1: "What criteria or investments are most important to you to include in a modernized grid? How do you define/articulate their values?"
    - Participants shared feedback on the goals of grid improvement and the prioritization of investments to achieve those goals.
  - Breakout question 2: "What key options should be compared in a cost/benefit analysis?"
    - Participants shared feedback on the cost/benefit analysis framework, suggesting additional functionalities, identifying potential scenarios for analysis, and requesting points of clarification.

Common Themes
Key points of feedback from participants centered around the scope and prioritization of grid improvement investments, considerations around the cost/benefit analysis, and customer needs around reliability.

- **Participants suggested Duke Energy first identify clear goals and objectives for the Grid Improvement Initiative before selecting investments.** Key perspectives voiced include:
  - To gauge the success of projects in addressing these goals, Duke Energy should define clear and tangible metrics, such as a certain percentage reduction in SAIDI.
  - Initial stakeholder engagements can serve to vet the goals and objectives, and understand the complementary or competing needs of different customer groups.

- After reaching consensus on a set of goals, Duke Energy should conduct cost/benefit analysis on potential investments to assess and compare the ability of each utility to effectively meet these goals.

- **Participants suggested Duke Energy and stakeholders achieve better mutual understanding of priorities, concerns and willingness to pay for grid investments.**
  - *Understand the prioritization of grid improvement investments from the perspectives of both Duke Energy and each utility's customers*
    Key perspectives voiced include:
    - Participants would like to better understand how Duke Energy will prioritize investments within the Grid Improvement Initiative.
    - Duke Energy should hold focus groups with different customer classes to understand what they want and value.
    - While some participants acknowledge that investments may provide different value to different customers, others stated that investments should benefit all customers.

    Duke's discussion points included:
    - Duke Energy is focusing on projects with clear net present value benefits, such as targeted undergrounding and distribution system hardening.
    - Duke Energy will distinguish grid investments that are indispensable for all customers from those that benefit select customers. Since most investments fall into the latter category, Duke Energy plans to prioritize projects that maximize benefits across the majority of customers.
  - *Cybersecurity, reliability, and foundational data capabilities are among top stakeholder concerns.*
    - There was broad consensus that cybersecurity is one of the top concerns amongst stakeholders.
    - Hardening, resilience, and automation of power restoration can eliminate or reduce the impact of predictable outages, such as those caused by weather.
    - Duke Energy should invest in foundational data capabilities to inform future investments and rate design. This may include smart meters, sensors, and improved grid communications investments.
  - *Duke Energy should assess customers' willingness to pay for reliability.*
    Key perspectives voiced include:
    - Duke Energy should engage customers of all classes to determine their willingness to pay higher rates for reliability.

        - If reliability is the sole goal or desired benefit of grid improvement, Duke Energy should more clearly and transparently convey the goals of grid improvement.
        - One proposed way to gauge consumer interest is through a survey, although there were mixed opinions about how effective this would be.

- **Participants offered diverse suggestions for refinement of the cost/benefit framework.**
    - *Additional functionality of the cost/benefit framework could include:*
        - The cost/benefit framework presented by Duke Energy is only designed to evaluate one single project, and not equipped to compare the relative cost/benefit of different investment options.
            - Duke Energy acknowledged the need to compare benefits of individual investments, as well as take into account the potential stacking of benefits across investments.
        - The current cost/benefit framework appears to be a global analysis, which does not appropriately allocate cost over different customer classes.
            - For example, the 98% of outage costs are borne by businesses (as stated in Duke Energy's white paper), but targeted undergrounding investments primarily benefit residential customers.
            - Duke Energy should fairly allocate costs by benefit for each customer group, and clearly articulate this process in version 2.0.
    - *Potential scenarios by which the cost/benefit framework could be applied include:*
        - Compare the cost/benefit of transmission and distribution-level investments with customer-facing programs such as demand-side management, energy efficiency, demand response, and DERs.
        - Trade-off analysis should be conducted for the seven programs in version 1.0. For example, compare the cost/benefit of targeted undergrounding investments with alternatives that can achieve the same reliability goals, such as self-optimizing grid.
            - Duke Energy should provide clarity on how it is optimizing between different, and potentially competing categories, such as reliability and customer choice.

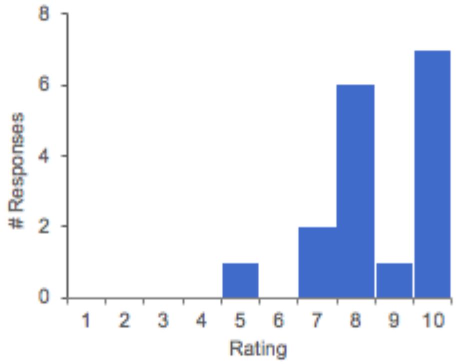
        - Scenario: Identify the cost/benefit of maintaining current reliability metrics, or "doing nothing." This establishes a baseline to establish the need for grid improvement investments.
        - Scenario: Perform cost/benefit analysis assuming 50% of generation will be on the distribution system within 10 years. This projects a future grid scenario with aggressive adoption of non-wire alternatives and customer-owned assets.
    - *Considerations around maintaining flexibility of investment paths include:*
        - Investments should be flexible and support evolution of technology over time. Instead of locking each utility into one course, grid improvement investments should accommodate long-term changes.
        - As states consider alternative regulatory frameworks, cost/benefit analysis should be able to accommodate evolving criteria for the performance of each utility. For example, cost/benefit analysis should be assessed against performance-based metrics, or take into account non-financial benefits such as community and environmental impacts.
    - *Requests for clarification from Duke Energy on the cost/benefit framework include:*
        - Specify the timeline of the cost/benefit analysis. Certain scenarios, such as DER deployment to defer generation investments, may cost more in the short-term but provide cost savings over a longer time horizon.
        - Provide more clarity and transparency around the inputs and assumptions that go into the cost/benefit analyses. This would provide a common foundation for stakeholders to speak/provide input on the technical aspects of cost/benefit analyses.

- **Participants suggested Duke Energy enable more distributed resources through integrated system planning.**
    - Duke Energy should enable more distributed energy resources (DERs) to defer generation investments, reduce carbon emissions, and lower customer bills in the future.
    - Integrated distribution resource planning and hosting capacity analysis can enable more DERs, while also providing more rate options and transparency to customers.

Outcomes

A majority of survey respondents indicated they were satisfied with the opportunity to provide feedback and dialogue with Duke Energy staff and other participants.

Figure 2: Survey responses: "How satisfied are you with the opportunity to provide feedback and dialogue with Duke Energy?"



The post-event survey asked participants, "How satisfied are you with the opportunity to provide feedback and dialogue with Duke Energy?" The average score given was 8.6 out of 10, as shown in Figure 2. Quotes from survey respondents indicate a broad appreciation of the opportunity to provide feedback to and discuss with Duke Energy:

- "Useful to communicate with Duke and other stakeholders in the same room"
- "Small group discussions were good"

The individual who gave a score of 5 did not provide any explanatory comments.

Objective 3: Lay the groundwork for a collaborative process moving forward

Activities

Throughout the workshop, Duke Energy addressed a few topics related to the collaborative stakeholder engagement process, including:

- Timeframe of the next workshop and rate case filing. At the start of the workshop, Duke Energy stated its plan to host a follow-up workshop in October 2018, where Duke Energy representatives will present what they learned from this past workshop and how they incorporated the group's feedback. This subsequent workshop will also precede Duke Energy's rate case filings, which are intended to occur before the end of Q4 2018.
- Lessons learned from the stakeholder engagement process in the North Carolina Power/Forward initiative (see Appendix 2). Duke Energy stated its intent to more clearly communicate the goals of grid improvement, better understand what customers want, demonstrate the value proposition through cost/benefit analysis, and work with stakeholders to gather input prior to filings.
- The RFP process for a third-party to conduct cost/benefit analysis. Duke Energy announced that it is selecting a third-party vendor to conduct cost/benefit analysis on proposed grid improvement investments. Duke Energy emphasized that the consultant is being asked to challenge, not simply validate, Duke Energy's proposals.

Several activities within the agenda focused on considerations for setting up an effective collaborative process, useful both for the upcoming rate case filings and for future collaborative opportunities.

- The workshop started with a "four ways of talking and listening" activity (see Appendix 2), where participants reflected on different ways of communicating for more effective collaboration.
- Two of the breakout group topics also discussed a possible set of next steps to guide a more collaborative planning process moving forward, with summaries below:
  - Breakout question 3: "What analyses or inputs can you provide to Duke Energy to support developing these plans before the end of Q3?"
    - Participants offered to provide analyses to support and complement Duke Energy's own analyses prior to the next stakeholder engagement in October.
  - Breakout question 4: "What kinds of discussions do you suggest Duke Energy host or participate in before the end of Q4?"
    - Participants provided feedback on the timeline, meeting design, and stakeholder representation in future engagements.

- In the long-term, Duke Energy expressed the intent to continue an ongoing stakeholder engagement process, emphasizing that the Grid Improvement Initiative "is a marathon, not a sprint."

Common Themes

Workshop participants proposed a variety of analyses/input for Duke Energy to consider, as well as recommendations for Duke Energy's immediate next steps, including inclusion of more representatives of residential customers and low-income communities, and more targeted engagement with smaller, more functional working groups.

- **Participants offered to provide a wide range of analyses to Duke Energy to inform grid investments.**
    - Several participants offered to provide analyses that their organizations have conducted to support Duke Energy in the Grid Improvement Initiative. These analyses range from system planning analysis, economic impact data, DER integration guidelines, and outage impact studies. The full list of services offered, along with their points of contact, are listed in Appendix 1. By incorporating these analyses from other stakeholders, Duke Energy can validate findings, as well as calibrate the assumptions that go into Duke Energy's analyses.

- **Participants suggested future meetings include representatives of residential customers.**
  Key perspectives voiced include:
    - Future stakeholder engagements should include more residential customers or organizations representing residential customers.
    - In particular, rural and low-income customers should be consulted on targeted undergrounding investments, assuming they would benefit most from distribution system hardening.
    - One survey respondent suggested Duke Energy to "go beyond the usual suspects," and engage organizations such as AARP and the League of Women Voters.
    - While several organizations representing residential customers were invited to this workshop, only a few were able to attend.

- **Participants suggested particular timeline and meeting design for stakeholder engagement.**
  Key perspectives voiced include:
    - Duke Energy should circulate a preliminary set of changes or amendments of the proposed grid investments for comments in

September. That way, participants can offer feedback prior to the subsequent workshop in October.
    - Future stakeholder engagements could be more effective with smaller, more functional working groups. This would allow for more targeted discussion around specific areas of the proposal, with stakeholders actively engaged in the topic.

Outcomes

Survey respondents overwhelmingly indicated interest in continuing to engage with Duke Energy on grid improvement planning, and a majority stated that the workshop provided an effective foundation for future collaboration.

Figure 3: Survey response: "How willing are you to engage in future follow-up conversations with Duke Energy around the proposed Grid Improvement Initiative?"

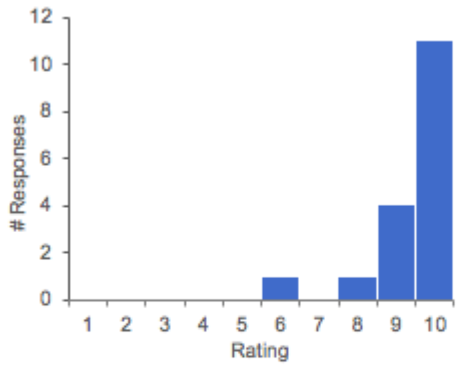
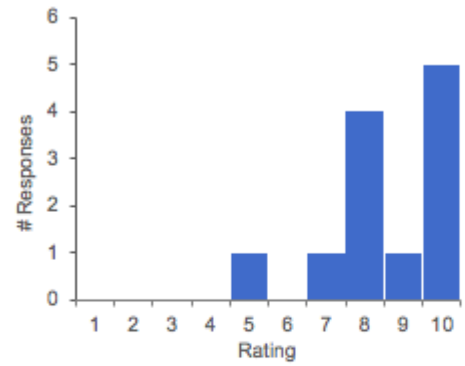


Figure 4: Survey response: "How effective was this workshop in providing a foundation for new kinds of conversation and collaboration going forward?"



The post-event survey asked "How willing are you to engage in future follow-up conversations with Duke Energy around the proposed Grid Improvement Initiative?" Participants responded with an average score of 9.4 out of 10, indicating significant interest in continuing to engage; see Figure 3 above.

- There was one individual who gave a score of 6, but they did not provide comments.

In addition, in response to the question "How effective was this workshop in providing a foundation for new kinds of conversation and collaboration going forward?", respondents gave an average score of 8.6 out of 10; see Figure 4 above.

- The majority of respondents (83%) provided of 8 or higher, sharing comments such as "good starting point, can't wait to see how it moves forward."
- One individual provided a score of 5, requesting "more technical expertise" at future workshops.

Appendix 1: Breakout discussion notes

Participants were instructed to split up into seven small groups to discuss their responses to four breakout questions. The full notes captured from each group's flipcharts are presented below, with annotations for context and clarity in blue. Also included is a summary of common themes that surfaced among different groups. The number of groups in which a particular theme surfaced is recorded in [brackets].

Breakout discussion #1

Question 1: What criteria or investments are most important to you to include in a modernized grid? How do you define/articulate their values?

Common themes from flip chart notes, with number of occurrences in [brackets]:

- Enabling higher DER penetration, to defer new generation [x4]
- Cybersecurity [x3]
- Determine value of investments for different customer groups, and allocate costs accordingly: [x3]
  - Perspective 1: All customers should benefit from investments
  - Perspective 2: Values are different for different customers
- Integrated system planning, which can be more cost-effective and provide more options and transparency [x2]
- Establish foundational data capabilities to inform future investments and rate design. This may include smart meters, sensors, and communications systems. [x2]
- Improve reliability by reducing voltage sag, deploying hardening & resilience measures, and automating power restoration. Eliminate predictable weather-related outages. [x2]
- Investments should be flexible and enable or support evolution of technology. Instead of locking into one course, investments should accommodate long-term changes.
- Provide customer more rate options, value, and transparency and control in managing their bills.

Full notes captured from flipcharts as below, with annotations in blue:

Table A1: Breakout discussion #1 full notes

Group #	Full Notes
1	● Security from cyber threat ● Accommodation and enabling of DER & storage: at the residential, industrial, and utility-scale; leveraging PURPA (Public Utility Regulatory Policies Act) ○ The value of DERs includes non-energy benefits ● Rate equity across customer classes ● Transparency on customer bill; breaking down bill to reflect cost of service, i.e. 50% from generation costs, 50% from transmission costs ● Determine what different customer classes want & value – more customer focus groups across customer classes
2	● EV penetration ● DER penetration ● Integrated system planning ● Customer deliverables: enabling choices, providing value

3	● Invest in strong, integrated distribution resource planning (IDRP) & hosting capacity analysis
	    ○ The value of an IDRP includes:
	        ■ Better tool to plan for the grid
	        ■ Ability to be more cost effective
	        ■ Provides more options with rates
	        ■ Transparency, particularly with regard to rate-based assets
	        ■ Optimize for a more dynamic grid. Data can be used to determine best places for investments.
	● Better define "grid modernization" vs. "routine capital investment"
	    ○ The value of making this distinction includes:
	        ■ Common understanding amongst stakeholders of investment in grid modernization
	        ■ Helpful with cost recovery efforts

4	● Reduction in energy usage and peak demand (to save customers money)
	● Enable customer DERs: distributed generation, demand response, and energy efficiency
	● Cybersecurity
	● Enhanced customer education and engagement on energy usage, to allow customers to better control their energy bills
	● The value of the above investments includes:
	    ○ Reduction in carbon emissions
	    ○ Reduction in customer bills (long-term)
	    ○ Values are different for different stakeholders

5	● Improved reliability, by:
	    ○ Perfect power
	    ○ Reducing voltage sag
	    ○ Hardening & resilience to strengthen against weather-related outages
	● Eliminate repeat/predictable outages (such as those caused by weather)
	● Invest in incremental improvements, not just maintenance:

	○ Smart meter deployment ○ Communication upgrades ○ Self-healing grid ● Better communications to facilitate improved rate design ○ Communication upgrades would provide more data to make decisions ● Make flexible investments that do not lock the Grid Improvement Initiative into one course, but instead accommodate long-term changes ○ An indicator of whether an investment provides flexibility is if it enables/supports evolution of technology. ● Access to cheap, clean energy
6	● Establish appropriate price signals for customers to shift peak system demand ● All customers should benefit from the investments ● Establish foundational data capabilities to support analytics that drive future investments ● Grid investments that enable more clean energy ● Duke SAIFI down, SAIDI up [Duke Energy has experienced a decreased frequency of interruption, but an increased average duration per event] ● Reduce response time to outages ● Reduce truck rolls for outage restoration through system automation – on the transmission system as well as the distribution system ● Cybersecurity: advocate for federal dollars
7	● Transmission improvements, which affect all customer groups ● (Criteria need to be) measurable ● How to enable deferral of new generation

Breakout discussion #2

Question 2: What key options should be compared in a cost/benefit analysis?

Common themes from flip chart notes, with number of occurrences in [brackets]:

- Define cost allocation by benefit for customer classes [x3]
  - Global analysis does not yield accurate cost/benefit analysis because different customers are affected differently
- Perform trade-off analysis of seven programs in version 1.0 [x2]
  - Optimize between different and potentially competing categories, such as reliability & customer choice
- Maintain flexibility to accommodate new technologies in the long-term [x2]
- Provide transparent market-based analysis, and show numbers [x2]
- Define the timeline of cost/benefit analysis. Compare short-term and long-term scenarios, for options such as deferred generation [x2]

- Consider the non-financial benefits, such as benefits to the community and environment
- Participants offered different suggestions for what Duke Energy should prioritize in the cost/benefit analysis:
    - Non-wire alternatives over reliability [x2]
    - Customer-owned resources (solar, EV)
    - PB metrics
    - encourages new market participants,
    - Enable max deployment of renewables/EE
    - Customer options (Nest, TOU, pay as you go).
- Scenarios:
    - 50% generation is on distribution system within 10 yrs
    - Compare with customer programs (DSM, EE, DR, DERs)
    - Alternatives to TUG (expanding redundancy in distribution network)
    - C/B of maintaining current reliability (doing nothing)
- Layered benefits
- Metrics: SAIDI/SAIFI are not sufficient. Cascading impacts

Full notes captured from flipcharts as below, with annotations in blue:

Table A2: Breakout discussion #2 full notes

Group #	Full Notes
1	• C/B analysis should have ability to assign costs accurately between classes ○ For example, PFC has 7 strategic programs but only 1 is transmission-related – how does this benefit wholesale customers? • Compare short-term vs. long-term benefits & costs ○ For example, deferred generation may cost more in the short run but be cheaper and more sustainable in the long run • Identify best bang for the buck • Consider alternatives to targeted undergrounding: i.e. expanding the “spokes” of the grid model and investing in self-optimizing grid to reduce need for undergrounding
2	• Optimize between categories of the Grid Improvement Initiative (using cost/benefit framework) ○ In particular, optimize between reliability and customer choice • Steps (for optimization of investment portfolios): ○ Stabilize patient (maintenance) [Identify the investments categorized as maintenance] ○ Maintain flexibility [Identify the trade-off options] ○ Easy gives (win wins) [Identify the investments that can achieve win-win for Duke Energy and customers] ○ Analyze tail risk exposure [Evaluate the impact of extreme events]

3	• Requirement (that Duke Energy consider) no capital asset that has been depreciated longer than 5 years • Prioritize non-wire alternatives over reliability • Include option that prioritizes performance-based metrics • Include option that prioritizes new market participants to meet grid requirements ○ To implement such a program, Duke Energy can release an RFP with goals and metrics, and potential vendors can explain what new technologies they are employing to meet those requirements • Consider a scenario where 50% generation is on distribution system (within 10 years) • Include trade-off analysis of 7 proposed Power Forward strategic programs in version 1.0 • Utilize customer-owned assets • Rate design changes vs. capital design changes
4	• Employ a transparent, market-based analysis • Compare minimum requirements to Power Forward in North Carolina • Enable an economic return on investment; "TRC-like" [Total Resource Cost] • Compare the cost/benefit of maximum deployment of renewable/EE with current generation portfolio • State economic impact for ratepayers • Perform analysis to maximize fossil fuel cost savings • Assess public health impacts • Perform analysis by customer class • Perform analysis to show cost/benefit of maintaining current reliability metrics

5	This group presented its feedback on the cost/benefit framework mainly in the form of questions for Duke Energy to consider:
	• How are costs allocated fairly for benefit? Duke Energy should articulate this.
	• Global analysis does not yield accurate cost/benefit analysis, since different customer classes are affected differently
	• How does an investment benefit different customer groups, and how much does it cost each group?
	• Is the benefit something we as customers can support, or at least hold us relatively happy?
	• Are these indirect or intangible benefits? Such benefits could include those that benefit the environment, community, or support Duke Energy's core values.
	• How does Duke Energy prioritize projects and choose the best value/benefit for the money?
	• How much optionality does this provide customers?
	    ○ For example, quantify the cost/benefit of electric vehicles, Nest thermostats, TOU (time of use rates), and pay as you go billing options.
	    ○ Quantify the peak lead reduction

	• How does grid improvement achieve a goal most cost-effectively? Duke Energy needs to define goals to drive toward
	• Is the Grid Improvement Initiative worth the investment if no standards are driving or requiring Duke Energy to do so?
	• Whatever you are doing, show us the numbers driving that decision.
	    ○ How does it layer with other benefits?
	• Analyze/quantify more beyond just SAIDI, SAIFI
	    ○ The current cost/benefit framework doesn't consider customer class or cascading impacts
	• Establish a standard way of looking at programs/investments to prioritize and compare them equally
	• How much flexibility does it enable Duke Energy to pivot their initiative in the future?
	• Do policies support the Grid Improvement Initiative?
	    ○ Want to avoid enabling flexibility through technology if policies will deter its benefit
	• What are the near-term impacts? What does near-term mean? What are the long-term impacts?

6	• Consider non-wire alternatives (microgrids, etc) • Consider if customer programs can achieve the same result or better (energy efficiency, demand-side management, demand response, solar, electric vehicles, etc)? • There is a discrepancy between the 1970s grid design and 21st century customer requirements. Consider the following criteria: does the improvement meet a 21st century requirement?
7	• Cost savings from deployment of technology (25%) • Provide customer rate impacts • Consider timing of return on investment

Breakout discussion #3

Question 3: What analyses or inputs can you provide to Duke Energy to support developing these plans before the end of Q3? (include points of contact)

Summary of services offered

Several participants offered to provide analyses that their organizations have conducted to support Duke Energy in developing the Grid Improvement Initiative. Note that these offers are only preliminary, are non-binding, and were made with acceptance of attribution. The full list of services offered, along with their points of contact, are listed below.

- System planning analyses
    - Integrated system operated planning (ISOP) – Caroline Golin, Vote Solar

    - Distribution system planning practices, including storage – Dave Rogers, Sierra Club
    - Renewable resource planning – Mark Dyson, RMI [suggested by other participants]
- Economic impact studies
    - Economic impact data (trade-off analysis) – Steffanie Dohn, Southern Current
    - Upstate growth study and similar data – Shelley Robbins, Upstate Forever
- Distributed resources integration
    - Hosting capacity analysis – Caroline Golin, Vote Solar
    - EV infrastructure information – Dave Rogers, Sierra Club
    - How to use DERs to meet reliability goals – GridLab [suggested by other participants]
- Outage impact studies
    - Business impact and risk analysis of outages – Cleve Beaufort, BMW
- Business model reform
    - Performance-based metrics – Caroline Golin, Vote Solar
- Facilitation support
    - Facilitation of stakeholder meetings – Shelley Robbins, Upstate Forever

The following suggestions were provided without a point of contact:

- Develop a Michigan Consumers Energy-style IRP in support of grid modernization
- Leverage stakeholder involvement to get broader grassroots feedback
- Leverage available data to inform outreach strategy to underrepresented groups
- Develop a rate design that places the cost on the cost causer and not just the rate class
- Example of cost/benefit savings (e.g. AMI meters)
- Speak with other providers that have employed AMI

Breakout discussion #4

Question 4: What kinds of discussions do you suggest Duke Energy host or participate in before the end of Q4?

Common themes from flip chart notes:

- Stakeholder discussions need to include residential customers or organizations representing residential customers. In particular, direct engagement with rural communities that would be benefited by targeted undergrounding.
- Confirm that customers (of all classes) are willing to pay higher rates for reliability. This can be implemented through a customer survey.

- Prior to the October meeting, circulate a preliminary set of changes or amendments for comments in September. Subsequent stakeholder engagements should be targeted, small, and functional.
- Be clear and transparent about the goals of grid improvement, metrics to gauge success, and assumptions in provided analyses. This way, stakeholders can find agreement on the technical aspects of cost/benefit analyses.
- Demonstrate how grid improvements enable more distributed resources.

Full notes captured from flipcharts as below, with annotations in blue:

Table A3: Breakout discussion #4 full notes

Group #	Full Notes
1	• Directly engage with rural communities that would be benefited by TUG • For the "time is now and need is clear" – discuss why *now*? • Engage with customers using focus groups, webpage portal, and surveys. Disseminate via customer bill, media campaign
2	• Host targeted, small, functional stakeholder group discussions
3	• (There is) tension that comes from the average customer not understanding (the fact that) investment in the grid results in improvement of service that substantiates higher rates • Host a discussion on customers' willingness to pay, particularly for reliability • Determine how many solar customers would allow utility to use panel-generated power to supplement grid rather than just receive offsets
4	• Establish agreement/collaboration on technical aspects of cost/benefit analysis • Engage customer-centric groups to get input/feedback • Continue ex parte presentations with PSC, regarding stakeholder engagement and other topics
5	• Host a discussion on the options or scenario (goals) that Duke intends to run • Establish clear goal with clear metrics to drive investments toward • Provide transparency on goals and assumptions • Demonstrate how improvements enable more DER, and compare to other system benchmarks
6	• Involve discussions with residential customers or organizations that represent residential customers. Be sure to include representation for low income customers. • Establish process for evaluating ongoing grid-investment plans in a comprehensive manner (stakeholder, PSC-docket, etc) ○ Ensure the process includes thorough vetting and stakeholder input • Complement October meeting (2.0) with prior redline amendments circulated (and potential meeting) for comments in ~September
7	• Collect customer survey data results, to determine if we are solving the right problem, and prove that customers want it

Appendix 2: Plenary record

Full notes: Duke Energy's presentation on lessons learned from North Carolina

- After fully deploying the Power/Forward initiative in Florida, Duke Energy is now taking a fresh look at South Carolina to address its unique needs for grid improvement.
- Duke Energy learned several lessons from its effort on the Power/Forward initiative in North Carolina, which will guide its process in South Carolina:
    - In North Carolina, Duke Energy unknowingly assumed that since grid modernization was intuitive to the Company, it must be intuitive to stakeholders as well. Duke Energy recognized this disconnect, and as a result, is putting together a two-pager outlining plans and motivations for grid improvement.
    - In North Carolina, Duke Energy assumed that the value proposition spoke for itself. While the value proposition is self-evident to Duke Energy representatives, they have decided to prove it to stakeholders through providing cost/benefit analysis.
    - In North Carolina, Duke Energy believed it knew what customers wanted, but learned after filing that this was not always true. Through this process, Duke Energy discovered that it shares a lot of common ground with stakeholders, and hopes to continue this at the South Carolina workshop.
- Duke Energy pointed out that there are a lot of legislative and regulatory activities in South Carolina, with the net metering issue and renewable policy. Duke Energy indicated that it does not want to talk about grid improvement in a vacuum, but rather in the context of those other activities.
- Duke Energy assured participants that this workshop is not simply just checking boxes, but that Duke Energy is committed to engaging stakeholders to inform the Grid Improvement Initiative.

Activity detail: Four ways of talking and listening

Description

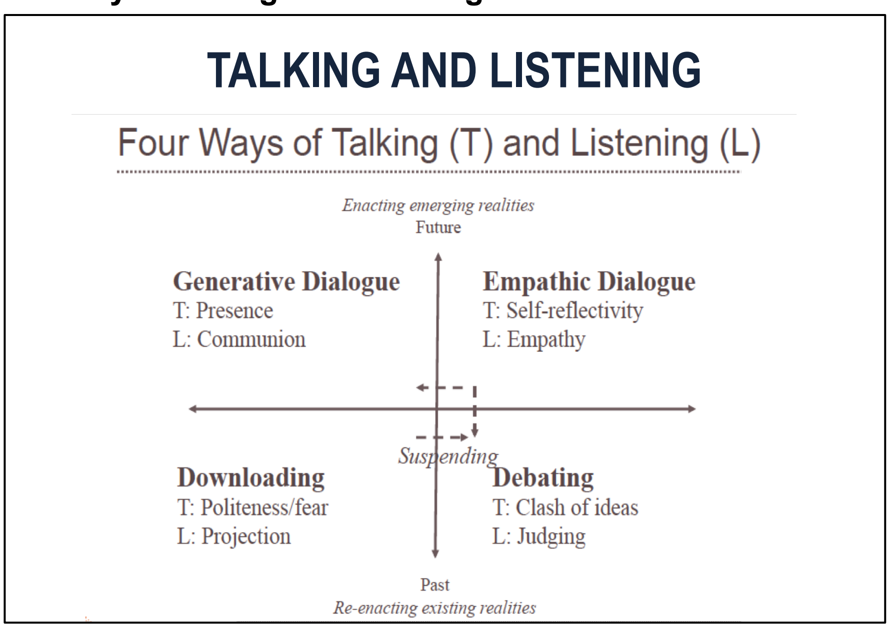
RMI presented a framework to encourage stakeholders to reflect on and practice engaging with one another differently, in order to open up collaboration.

The framework is characterized as four ways of talking and listening, described below:

1) **Downloading**: In downloading, the most common mode, we talk politely, saying what we are expected to say. We download (like from a computer file) or project (like a slide projector) our thoughts and feelings onto the world. This mode maintains the status quo. In this mode, the listener projects his or her own ideas and beliefs.
2) **Debating:** A team shifts from downloading to debating when someone speaks their mind openly, even at the risk of fragmenting the system. Actively searching for alternative facts, perspectives, and options represents a significant leap in the modes of conversation. In this mode, the listener is judging whether or not they agree with the speaker.
3) **Reflective dialogue:** Essential for deep change, reflective dialogue requires empathy and self-reflection. The listener is seeking to understand where the speaker is coming from.
4) **Generative dialogue:** A more rare mode of conversation, generative dialogue allows those who are talking and listening to discover their deeper shared purpose. Fully present, group members appreciate each other's different perspectives and they experience a moment of collective understanding.

Figure A1 illustrates the difference among the four modes.

Figure A1: Four way of talking and listening



Summary
Participants were asked to discuss the following question within their small groups: "What do I need to suspend to support dialogue this afternoon?" Select participants then volunteered to share their responses with the rest of the group in plenary:

- "I come from a legal background, where we're used to fighting. Need to suspend my skepticism."
- "I want to suspend the word 'our'. It can be used and heard in several different ways, and can close or shut down dialogue. It's not just Duke's project – it's everyone's in the room."
- "I am suspending the thought: 'We've had an electrical grid that has worked for 100+ years that's affordable. Why does that need to change? It's worked well.' We should respond to why it needs to change, what customers are wanting, and how Duke is meeting new needs of customers in new generation of electricity."
- "I felt like North Carolina workshop was a band aid or hand-wavy process. I am suspending this assumption for the rest of the day."

Activity detail: Q&A following Duke Energy's presentations

Description
A presentation from Duke Energy covered the unique factors in South Carolina that form the basis for the proposed grid investment initiative. Duke Energy also circulated a handout describing a framework for evaluating the cost-benefit and cost-effectiveness of proposed investments. In response to both the presentation and the handout, participants had a chance to ask clarifying questions that were answered in real-time by Duke Energy representatives. This provides a full record of the questions raised and answers provided in this session.

- *[Question from participant]* The decision tree doesn't point to what project you do first. How does this framework allow Duke to prioritize projects?
    - *[Response from Duke Energy]* The decision tree is for one specific project; need to spread them all out on the "table" to compare projects. Also identify if there are stacking effects.
- What method will we pursue to recover the costs?
    - We do not know yet. In North Carolina, we proposed a rider, deferral as alternative.
        - In South Carolina, we will be having proceedings later this year. Through this workshop, we want to get feedback from you and shape our plans.
- The white paper discussed how 98% of outage costs were for businesses. But targeted undergrounding (TUG) primarily benefits the residential class. How are TUG costs spread amongst customer classes?

- Benefits may be aligned or misaligned with costs for each class.
- If there is subsidization between classes, we have to determine if it is fair.
- Currently, the grid improvement plan is a more traditional cost of service regulation. We are looking at further refinement to that through the rate case.

- Regarding the weather study, there is an aggressive limb trimming program. What is the nature of weather-related outages, given this aggressive trimming? If you underground the lines, you are probably going to take out those trees. Would like more granularity: what % of outages is caused by tree problems?
  - We trim trees on a 5-year schedule. Over 50% of the tree-related outages come from trees outside of the right-of-way. Right-of-way is 30 feet from distribution lines.
  - Tree-related outages account for 30% of outage, so TUG can prevent a total of 15% of outages.
  - We acknowledge that we have not done a great job communicating these details to the public.
- Would TUG necessitate taking down more trees?

  Only if necessary; Duke Energy would seek customer approval.
- Are we looking at the cost benefit analysis for 10 years, or 30 years? Generation assets are for 30-50 years, but this is being assessed for 10 years. Is the cost-benefit framework structured to evaluate capital assets or goals? What is the actual goal and tangible metrics to measure it? For example, "a 30% reduction in SAIDI".
  - Analyses in the near-term will be quantitative, but as we get farther in the future, it's more qualitative. Agree that we should start with a goal, then back out the calculations to identify investments.
  - We are focusing on projects with clear NPV benefits.
  - In our request for proposals for third-party consultants to perform cost-benefit analysis, we encourage applicants not to validate our findings but challenge what we've done.
- I would like to see Duke rank-order grid modernization plans. What is not on customer's priority? Do they care about commercial & industrial customers? How much are they willing to pay to reduce the outage? What if they're okay with current reliability?
  - We are hoping to identify in version 2.0 what are the undeniable truths that all customers want (anticipate this will be a small list), and what is optional? There is a large range of what customers want.
  - Most investments will benefit certain customer classes, but not others.
  - How to capture the sweet spot that benefits a large majority of different customers?

- What are the federal guidelines on grid modernization?
  - NERC is not regulating on the distribution side.
- Are there national standards for cybersecurity?
  - Yes, issued by NERC.
- What % of your spending on cybersecurity relates to what is mandated by NERC?
  - I do not remember the exact numbers, but we go roughly 20-30% beyond NERC standards.
  - I think a large majority of our cybersecurity spending is for mandated requirements. This is all transmission-related. On the distribution side, no requirement exists.
- What about version 1.1, 1.2? This document was written in January. Before we start commenting on 1.0, where are you now?
  - We have not put a stake in the ground for 1.1 – we're moving toward 2.0. We are working on better analytics, and how to scale down the more contentious projects.
  - We are focusing on projects with clear NPV benefits.
  - The moves that's apparent to us include TUG, hardening on the distribution side, transmission hardening and resiliency.
- Are there certain projects that are not up for debate?
  - If there is something that the group wants that is not on that list, please tell us.
- To what degree are these projects your everyday responsibility?
  - We are trying to articulate that through the maintenance vs. modernization document.
  - We are proposing an acceleration on maintenance work.
- Does the proposed rider have to be approved by PSC?
  - There isn't one now. Should there be one, it has to be approved by PSC.

SOUTH CAROLINA GRID IMPROVEMENT PLAN

PRE-READ PACKET

FOR STAKEHOLDER WORKSHOP

10/10/18

INTRODUCTION TO PRE-READ

- This read-ahead packet includes information about the October 10 workshop, including:
  - Workshop objectives, agenda and list of attendees
  - Duke Energy's draft 2018 grid improvement portfolio and detailed information on how it was created.
- Please familiarize yourself with these materials so that you are prepared for the workshop and ready with any questions.
- Rocky Mountain Institute (RMI) will facilitate the October 10 workshop to support a productive discussion among stakeholders and Duke Energy staff.

We look forward to seeing you on October 10!

WORKSHOP OBJECTIVES, AGENDA & PARTICIPANTS

South Carolina University Club. 900 Senate Street ,Columbia, South Carolina 29201

WORKSHOP OBJECTIVES:

- Obtain stakeholder input to Duke's outlook on seven megatrends shaping grid improvement decisions.
- Describe and get feedback on how Duke has used stakeholder input, the impact of megatrends on grid needs and a prioritization methodology to develop a grid improvement portfolio.
- Describe the benefits and risks of the proposed program portfolio and get stakeholder feedback prior to Q4 filing

8:30am	Breakfast and Sign In
9am	PROMPT START and Welcome Objectives, Agenda, Ground Rules Introductions Q4 Executive Summary Megatrends
11:50am	LUNCH
12:35pm	Portfolio Prioritization Methodology Q4 Filing Deep Dive Next Steps Check-Out
3:00pm	ADJOURN

PARTICIPATING ORGANIZATIONS INCLUDE:

- American Association of Retired Persons
- Central Electric Power Cooperative, Inc.
- Coastal Conservation League
- Conservation Voters of South Carolina
- Duke Energy
- Environmental Defense Fund
- HR Workforce Development
- MVA Nucor
- New Alpha Community Development Corporation
- Nucor Steel South Carolina
- Rocky Mountain Institute
- Sierra Club
- South Carolina Appleseed Legal Justice Center
- South Carolina Department of Commerce
- South Carolina Department of Consumer Affairs
- South Carolina Manufacturer's Alliance
- South Carolina Office of Regulatory Staff
- Southern Alliance for Clean Energy
- Southern Environmental Law Center
- Southern Current
- University of South Carolina
- Upstate Forever
- Vote Solar
- Whitney Slater Foundation

THIS WORKSHOP IS PART OF A BROADER STAKEHOLDER ENGAGEMENT PROCESS AROUND DUKE ENERGY'S GRID IMPROVEMENT PLAN IN SC

DUKE ENERGY

August 2018 Workshop → October 10 Workshop → 2018 Q4 Rate Case → Ongoing Stakeholder Engagement 2018 & Beyond

- Stakeholder perspectives are necessary to ensure Duke Energy is making the best decisions possible for South Carolina customers.
- Duke Energy intends for workshops to be accessible to stakeholders with a wide variety of interests, and is working with a 3rd party facilitator to ensure that the process is as effective as possible.
- In this workshop, Duke Energy wishes to inform stakeholders of the status of the draft Q4 filing and get critical feedback that could inform the final Q4 version and plans beyond.
- Stakeholder input has already directionally shaped the draft Q4 filing materially.

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SOUTH CAROLINA GRID IMPROVEMENT PLAN

MEGATRENDS IMPACTING SOUTH CAROLINA

FOR STAKEHOLDER WORKSHOP

10/10/18

TRENDS IN OUR SERVICE TERRITORY

DUKE ENERGY

Oliver Exhibit 11
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In the context of the emerging distributed electric system, Duke Energy has recognized multiple trends and facts that warrant recognition and analysis.

I Threats to grid infrastructure

II Technology advancements – Renewables and DER

III Environmental trends

IV Impact of weather events

V Grid improvement

VI Concentrated population growth

VII Customer expectations

I. THREATS TO GRID INFRASTRUCTURE

Oliver Exhibit 11
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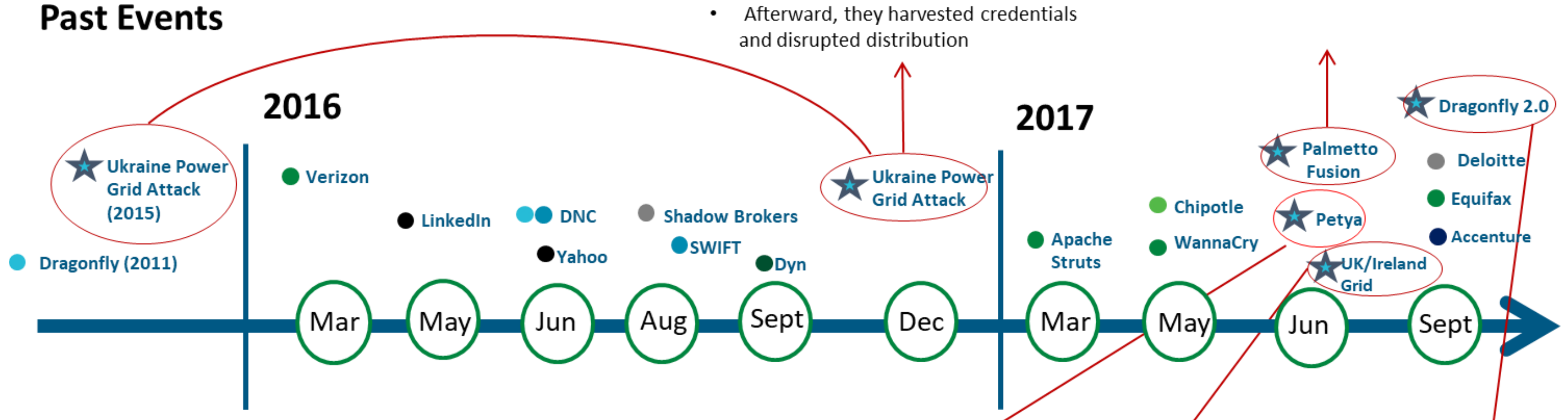
What is happening?

- Purposeful threats, both physical and cyber, to the electric grid are on the rise worldwide

- Attacks started with spear phishing of three energy companies
- The attackers spent months performing recon to learn how those SCADA systems worked
- Afterward, they harvested credentials and disrupted distribution

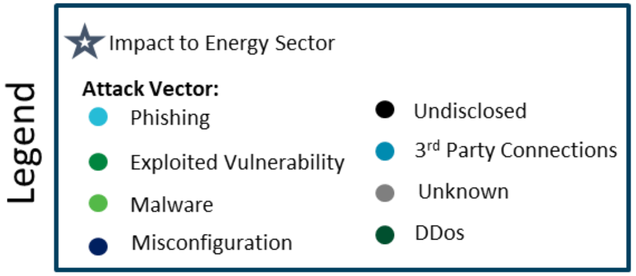
- No impact to Duke Energy
- Sophisticated attack targeting multiple Energy companies



- No impact to Duke Energy
- Similar to WannaCry
- Russian hacking group connected to BlackEnergy believed to be responsible

- Energy Sector Industrial Control System was compromised by the Russian government
- Believed to be connected to cyber attacks in the Energy Sector in the U.S.

- No impact to Duke Energy
- Group has been in operation since 2011
- Switzerland, Turkey, and North America energy sectors were targeted; Turcas Petrol website was compromised
- Email-based attacks; uses tactics and tools from previous campaigns



Source: Duke Energy[1]

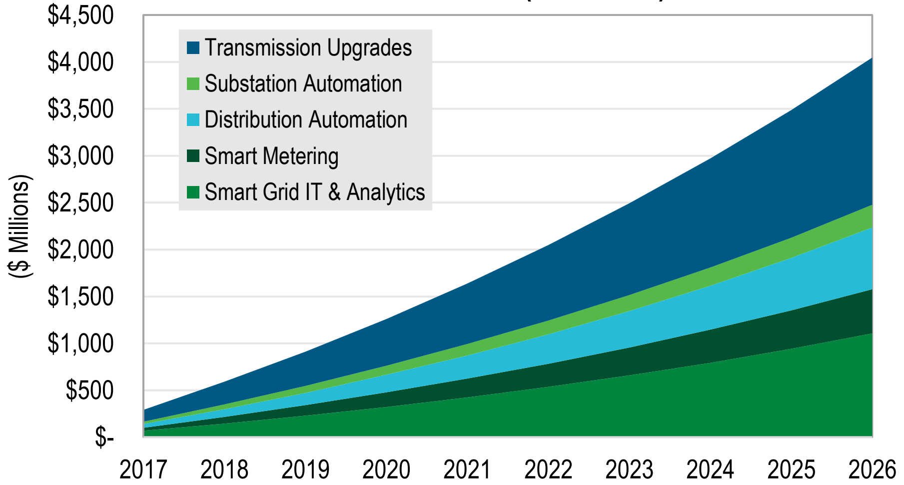
I. THREATS TO GRID INFRASTRUCTURE

DUKE ENERGY

What is happening?

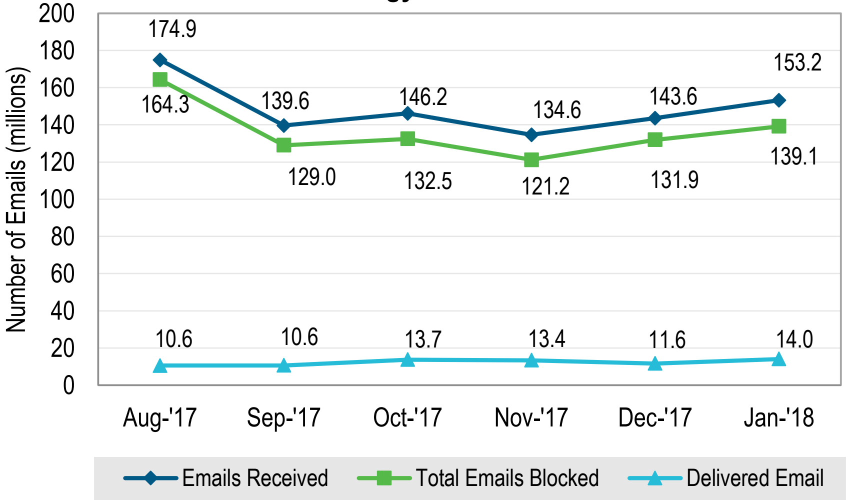
- Grid cybersecurity investment expected to grow from $300 million in 2017 to $4 billion by 2026[2]
- Increasing points of entry: as of November 2017, an estimated 378 million Internet of Things (IoT) devices were vulnerable to hacking[3]
- Ukrainian power grid attacks in 2015 and 2016 and more recent ransomware attacks driving utilities to expand beyond compliance-based management practices[4]
  - Industrial Control Systems Cyber Emergency Response Team estimates a similar incident in the US would result in damages totaling between $243 billion and $1 trillion[5]
- Cyber attacks impacting Southeast municipalities and utilities
  - Ransomware attacks in Mecklenburg County (Charlotte) and Atlanta impacted key government services including bill payments[6]
  - North Carolina fuel distribution company experienced $800,000 cyber heist[7]
  - Duke Energy protection solutions currently blocking +90% of incoming emails[8]

Cumulative Smart Grid Cybersecurity Investment in North America (2017-2026)



Source: Navigant Research Cybersecurity for the Digital Utility[9]

Duke Energy Email Protection

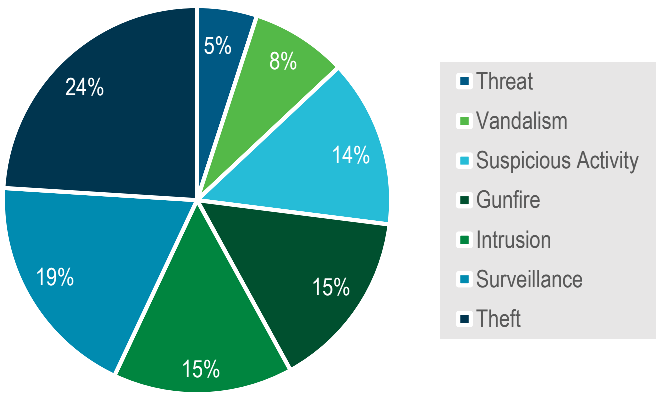


Source: Duke Energy[10]

What is happening?

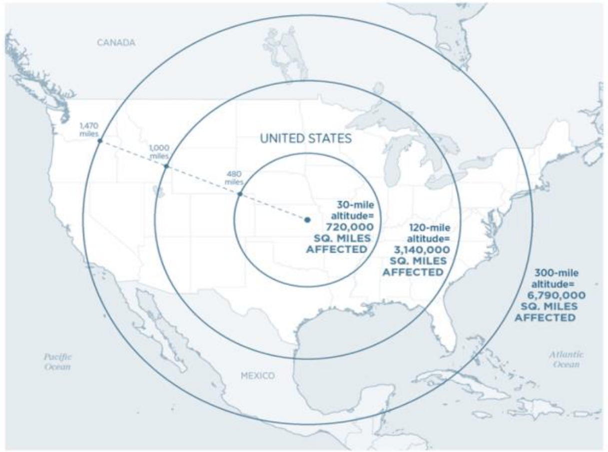
- Electricity Information Sharing and Analysis Center (E-ISAC) assesses that there will be an increase in theft, especially in areas more negatively impacted by socio-economic issues[11]
    - Theft was the top physical threat to the grid in 2017[12]
- The number of terrorist attacks is increasing
    - Physical/sniper attack on PG&E transmission station damaged 17 substation transformers, caused $15 million in damages, and led to $100 million in physical security investments[13]
- Electromagnetic Pulse (EMP) generated at an altitude of 30 miles above the earth can severely damage electronics within an area of about 720,000 square miles[14]
    - Currently there is limited protection to address consequences of EMP-like events[15]
    - Have potential to cause wide-scale long-term losses with economic costs[16]
    - Cost of damage from the most extreme solar event is estimated to cost $1 trillion-$2 trillion with recovery time of 4-10 years[17]

Breakdown of Physical Security Incidents for 2017



Source: NERC[18]

Potential Magnitude of EMP Events

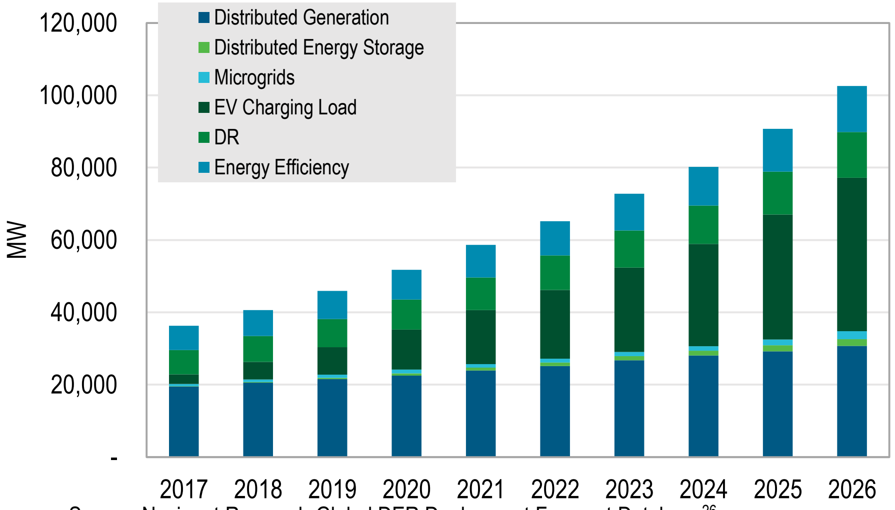


Source: The Heritage Foundation[19]

What is happening?

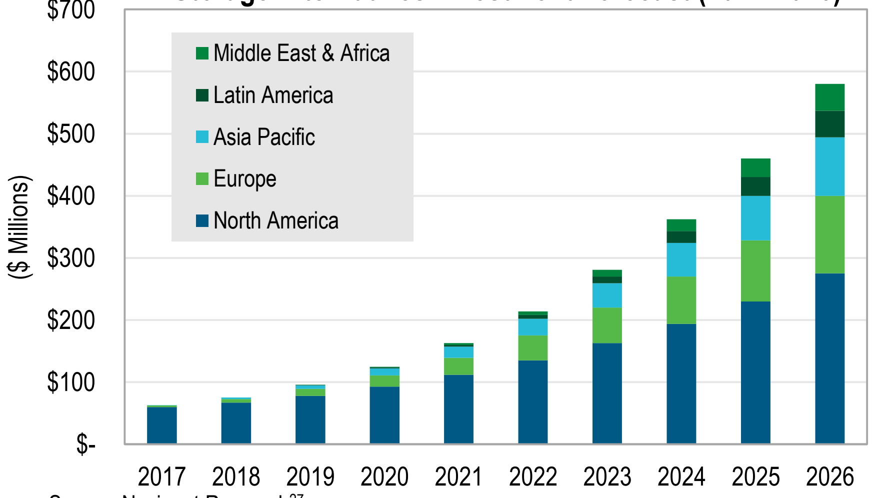
- Distributed energy resources (DER) expected to grow eight times faster than net new centralized generation in the next 10 years globally[20]
  - Distributed generation, including solar PV, remains a dominant contributor to this forecast
  - EVs and EV charging are the fastest growing segments
- Spending on energy storage solutions and alternatives is forecasted to increase at an annual rate of 18% over the next 10 years in North America[21]
- Renewables and DER becoming significant capacity resource for Duke Energy in South Carolina
  - Recent South Carolina Integrated Resource Plan (IRP) includes two times the capacity from renewable resources, energy efficiency, and demand-side management, increasing from 8% in 2019 to 16% in 2033[22]
  - Duke Energy Carolinas (DEC) customer-scale solar program reached 40 MW cap in 13 months (10/15 -11/16)[23]
  - Duke Energy Progress (DEP) customer-scale solar commitments ~60% of 26 MW cap[24]
  - Solar advocates proposing cap increases, DEC has proposed cap increase
  - The Duke Energy South Carolina interconnection queue has +300 requests totalling over 6,300 MW[25]

Global DER Capacity Forecast (2017-2026)



Source: Navigant Research Global DER Deployment Forecast Database[26]

Storage Alternatives Investment Forecast (2017-2026)

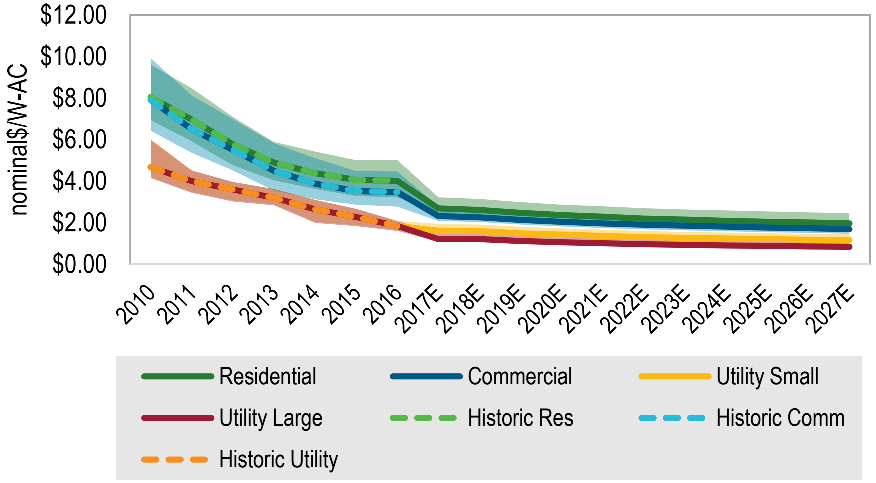


Source: Navigant Research[27]

What is happening?

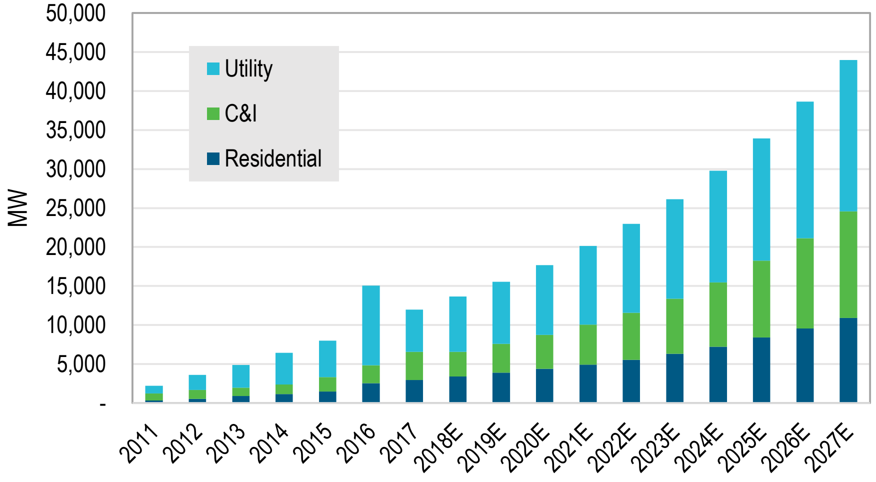
- Solar PV is becoming increasingly competitive[28]
  - Cost of utility-scale solar has dropped 66% since 2010 and is projected to decline by 3.6% per year in the next 10 years[29]
  - Cost of distributed solar has dropped 67% since 2010 and is projected to decline by 3.1% per year in the next 10 years[30]
- Solar PV efficiency has increased which lowers overall installed cost by minimizing the number of panels needed to achieve the same output.
- Module efficiency has increased 2% annually since 2007[31]
  - Manufacturing is shifting to higher efficiency monocrystalline panels
- Distributed solar PV installations are projected to increase in South Carolina
  - South Carolina was ranked 8th in the nation for the most cumulative installed solar capacity in 2017[32]
  - ~6,300 projects totaling ~100 MW have been installed to date[33]
  - Installed capacity in South Carolina is projected to increase 9% per year 2018-2026[34]

Solar PV Cost Declines (2010-2027)



Source: Navigant, NREL[35]

Historical and Forecasted Annual Solar PV Installed Capacity in US (2011-2027)

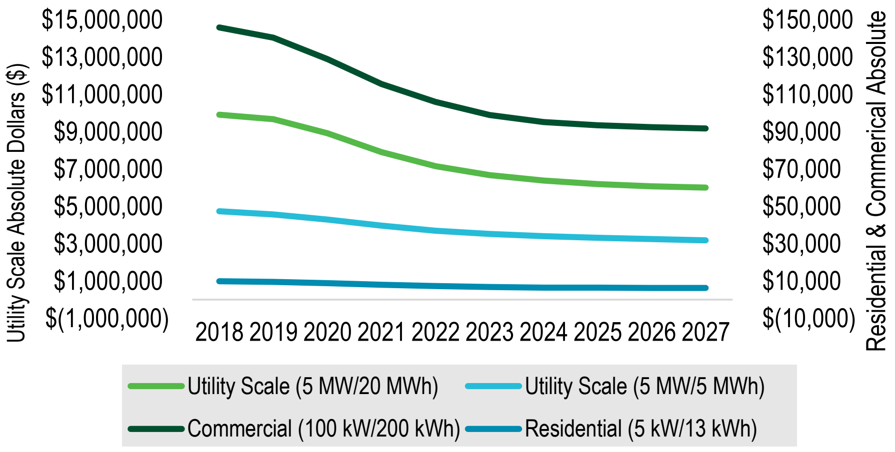


Source: Navigant Research Market Data: Global Distributed Solar PV[36]

What is happening?

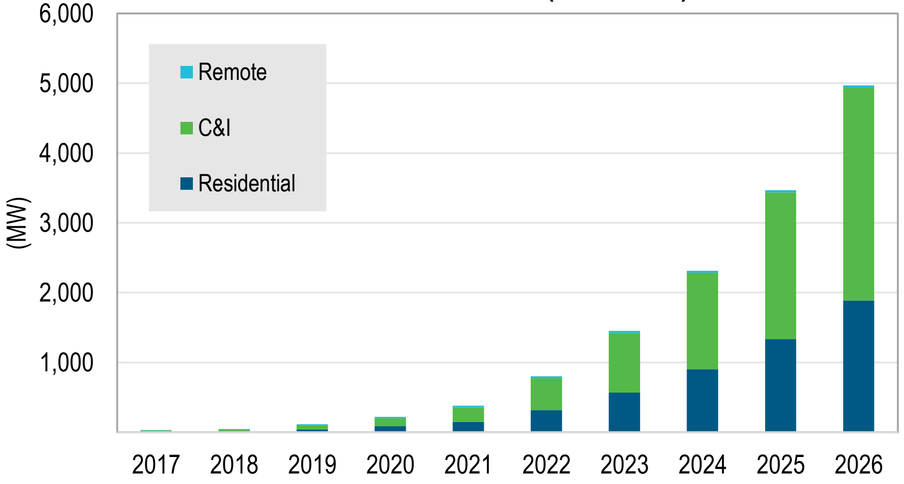
- Battery storage costs expected to decline over the next 10 years in the US
  - Cost of utility-scale storage is projected to decline by 5.4% per year, and utility investment in storage is likely to increase to provide more grid flexibility[37]
  - Cost of distributed storage projected to decline by 5% per year[38]
- Storage installations are projected to increase 2018-2027 in North America:
  - 35% per year for utility-scale[39]
  - 25% per year for distributed storage[40]
- Storage is increasingly installed co-located with renewable energy. Installed capacity of solar plus storage is projected to increase in North America:
  - 57% per year 2018-2026 for utility-scale[41]
  - 76% per year for distributed storage[42]

Li-Ion Battery Storage System Capital Cost Forecast (2018-2027)



Source: Navigant Research Large Commercial and Industrial Energy Storage [43]

Annual Solar PV + Storage Power Capacity and Revenue in North America (2017-2026)

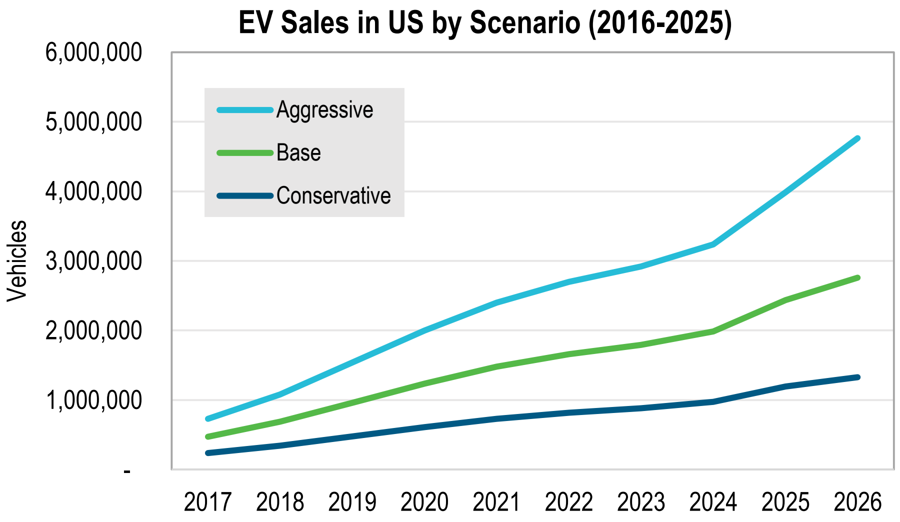


Note: Remote, off-grid solar plus storage typically serves loads of 5 kW or less in remote areas without grid access

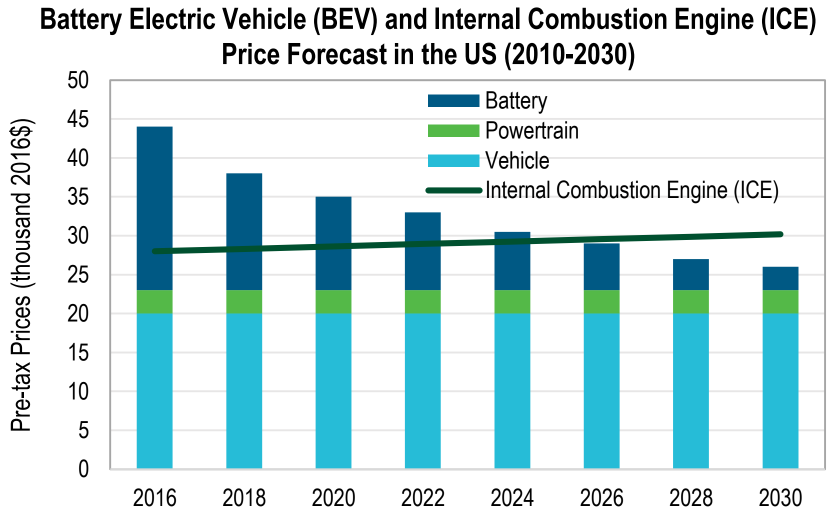
Source: Navigant Research Distributed Solar PV plus Energy Storage Systems[44]

What is happening?

- Cost of EVs has decreased by 80% since 2010[45]
- EVs expected to be competitive with internal combustion engine (ICE) vehicles by 2030[46]
- General Motors announced all-electric, zero emissions future with 20 fully electric models by 2023[47]
    - "General Motors believes electric, self-driving, connected vehicles and shared mobility services will transform how we get around, and we are drawing the blueprint to advance our vision of a world of zero crashes, zero emissions, and zero congestion." – General Motors
- EV adoption is projected to increase
    - By 2027, there will be near 58M PEVs[48]
    - By end of 2018, over 5M PEVs will be on roads globally[49]
    - The number of US residential charging locations is estimated to reach ~6 million by 2025[50]
    - The global market of EVs should see continued sales growth at around 38% through 2020[51]
- Currently, over 2,144 PEVs are on South Carolina's roads today[52]
    - South Carolina recommends in its State Energy Plan to focus on assessing interest in government fleet adoption of alternative fuels and ultimately encourage the development of statewide goals and incentives to promote alternative fuels[53]



Source: Navigant Research EV Geographic Forecasts[54]



Note: Vehicle prices based on medium segment price

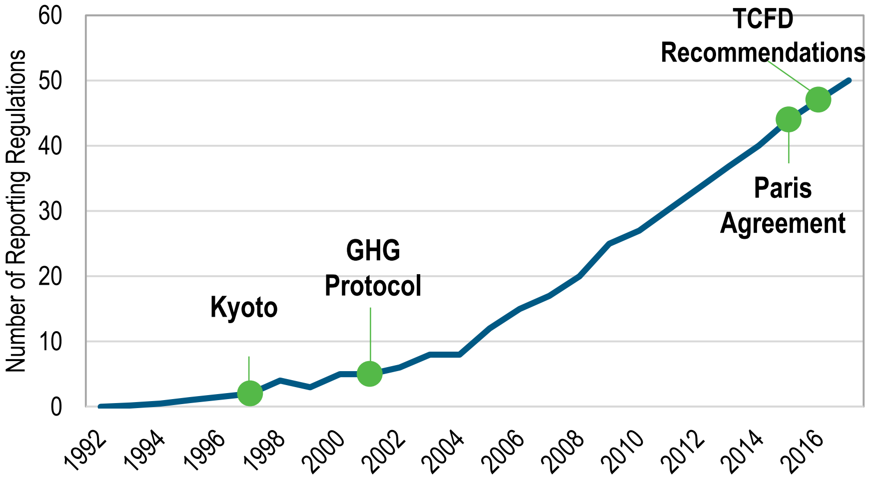
Source: Bloomberg New Energy Finance[55]

DUKE ENERGY

What is happening?

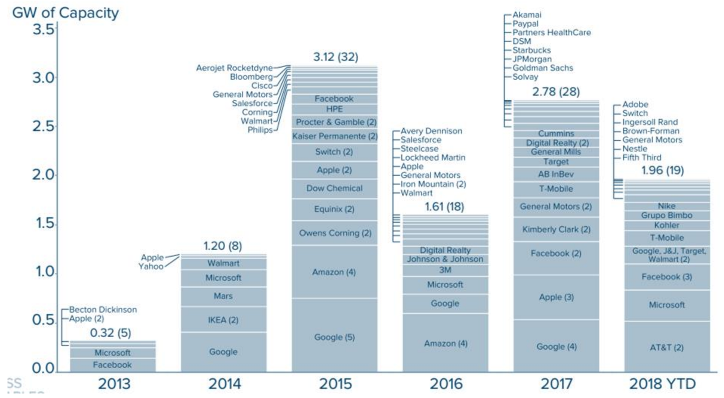
- Broad international commitment and pressure to reduce carbon emissions
- Cyclical federal environmental policy commitments (COP 21, CPP) but implementation of federal energy efficiency standards (transportation, lighting, etc.) underway
- Corporations making commitments and demanding renewable options
  - ~48% of Fortune 500 companies have sustainability and renewable energy commitments[56]
  - Leading SC corporations have set sustainability goals, including BMW, Michelin, Milliken, Walmart, Fujifilm, Ingersoll Rand, Owens Corning, Sealed Air Corporation, and VF Corporation
  - 488 companies taking science-based climate action and 133 have approved targets[57]
  - 75 companies have committed to Corporate Renewable Energy Buyers' Principles with goal to "work with utilities and regulators to expand choices for buying renewable energy"[58]
- States and cities setting goals for renewables, low carbon transportation, and energy efficiency
  - Fifty percent are currently examining one or more of the following topics: (1) smart grid and advanced metering infrastructure (Smart Meters), (2) utility business model reform, (3) regulatory reform, (4) utility rate reform, (5) energy storage, (6) microgrids, and (7) demand response[59]
  - South Carolina established a 36% carbon reduction goal from 2012 emissions[60]
  - South Carolina target of 2% but significant renewables investment underway[61]
  - Stakeholder interest in expanding utility and customer-owned solar in South Carolina
  - South Carolina Technology and Aviation Center is developing a business park in Greenville dedicated to providing a collaborative environment for companies to develop smart city technologies[62]
    - More than 100 new smart technology companies expected to be part of the park

Growth in Reporting Related to Greenhouse Gas Emissions (1992-2017)



Source: World Business Council for Sustainable Development[63]

Contracted Capacity of Corporate Power Purchase Agreements, Green Tariffs, and Outright Project Ownership



Source: Business Renewables Center[64]

What is happening?

- "With climate change and sea-level rise, we'll all be dealing with the issues of water, drainage and extreme weather. That means setting the kind of zoning, planning and building requirements that anticipate living with water."

  - Charleston Mayor John Tecklenburg (9/28/2018)[65]

- South Carolina has faced major weather events in each of the last four years, with Hurricanes Matthew (2016) and Florence (2018) illustrating the magnitude of the challenge the grid faces today from weather
  - Approximately 830,000 people in South Carolina without power during Hurricane Matthew[66]
  - Approximately 1.8 million total Duke Energy customer outages restored across the Carolinas during Hurricane Florence, 178,000 of which were Duke Energy customers in South Carolina[67]
  - Marion and Horry County residents, not yet recovered from Hurricane Matthew, devastated by Hurricane Florence two years later[68]
- Severe ice storms have historically impacted South Carolina's power lines[69]

Hurricane Florence Impacts (2018)

Nichols, SC
Source: The State[70]

Hurricane Irma Impacts (2017)

Source: The Post and Courier[71]

Hurricane Matthew Impacts (2016)

Nichols, SC
Source: CNN[72]

Ice Storm Impacts on Overhead Lines (2015)

Source: Greenville News[73]

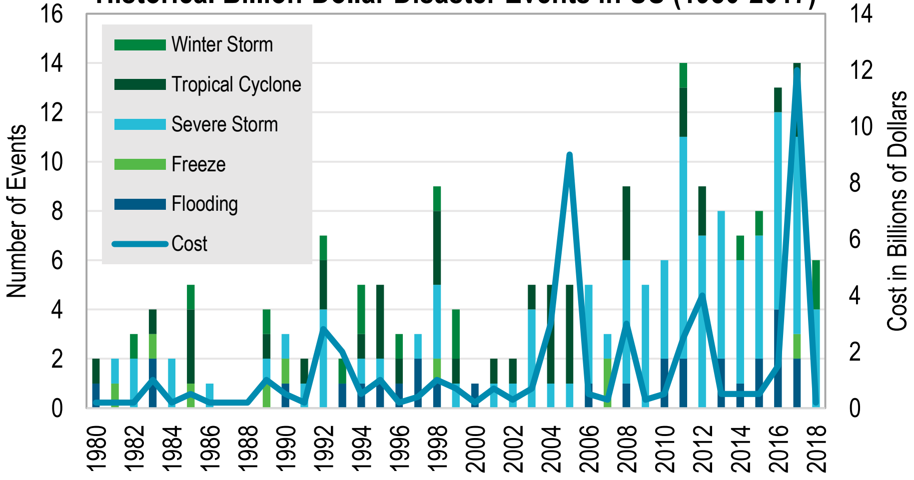
What is happening?

- South Carolina experienced over 170 bulk electric system outages related to weather events (2008-2017) and is part of a larger region that sees the most major storms[74]
- The number of customers impacted by weather events is increasing due to population growth in regions most affected by weather
- The average number of interruptions that a Duke customer would experience (SAIFI) increased by 19% (SC DEC) and 2% (SC DEP) and the average outage duration for each Duke customer served (SAIDI) increased by 28% (SC DEC) and 51% (SC DEP) (2012-2017)[75]
- Number of major event days (MEDs) have increased by 2% per year over the past 25 years[76]
- Number of Duke Energy SC customer outage events increased by 10% since 2012[77]

Temporary Flood Mitigation at 6 Carolinas East Station

Source: Duke Energy[78]

Historical Billion-Dollar Disaster Events in US (1980-2017)



Note: Costs are adjusted for Consumer Price index (inflation)

Source: NOAA[79]

What is happening?

- Grid improvement technology has advanced over the last decade, and has given utilities alternatives to traditional grid infrastructure options.
  - Grid improvement got a boost from $4 billion in Smart Grid Investment Grants under the American Recovery and Reinvestment Act of 2009 (the Stimulus Act) which, combined with industry spending, led to nearly $8 billion in related projects[80]
  - "Smart" grids are expected to increase the grids' efficiencies by 9% by 2030. This is equivalent to saving more than 400 billion kilowatt-hours each year[81]
  - Grid improvement deployments reduce peak demands by 13% to 24%[82]
  - Savings between $46 billion and $117 billion are expected over the next 20 years[83]
  - Smart meters are expected to save more than $150 billion/year by 2020 by reducing the cost of power interruptions by more than 75%[84]
- The global market for smart grid IT and analytics for software and services is expected to grow from approximately $12.8 billion in 2017 to more than $21.4 billion in 2026[85]

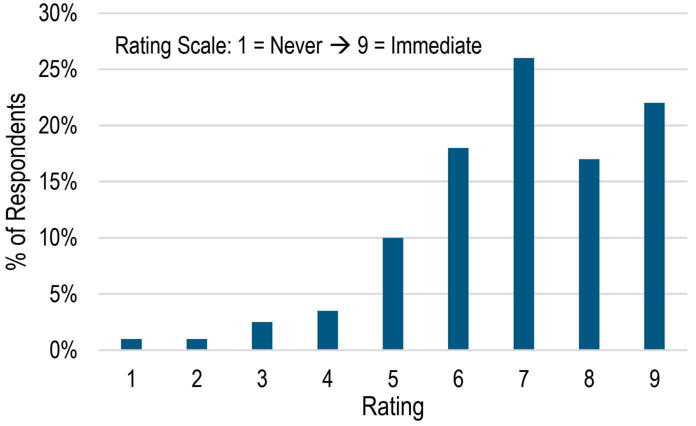
Rapidly Advancing Smart Grid Technologies

Intelligent Devices	Information Technology
• High speed communication networks (fixed and wireless) • Smart Meters • Distribution Automation including intelligent switches, capacitors, and remote fault identification	• Advanced Distribution Management Systems (ADMSs) • Integrated Volt/Volt-ampere reactive Control (IVVC) • Fault, location, isolation, and service restoration (FLISR) • Asset Management Systems (AMSs) • Customer Information Systems (CISs) • Demand Response Management Systems (DRMSs) • Distributed Energy Resources Management Systems (DERMSs) • Energy Management Systems (EMSs) • Geographic Information Systems (GISs) • Meter Data Management Systems (MDMSs) • Advanced Analytics (Asset, Grid Operation, Demand-side, Customer)

Source: Navigant[86]

"Pulse of Power" Survey of Readers

How soon should the power industry adapt to a clean, intelligent, mobile, and distributed grid?

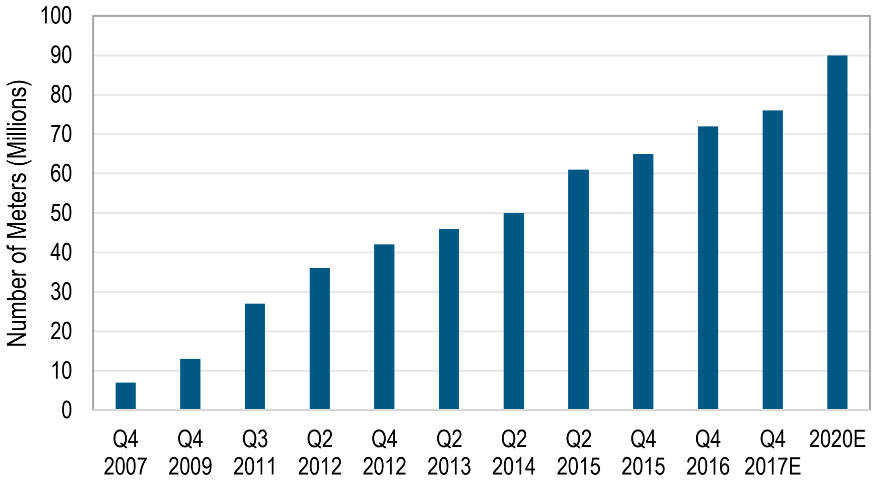


Source: Public Utilities Fortnightly[87]

What is happening?

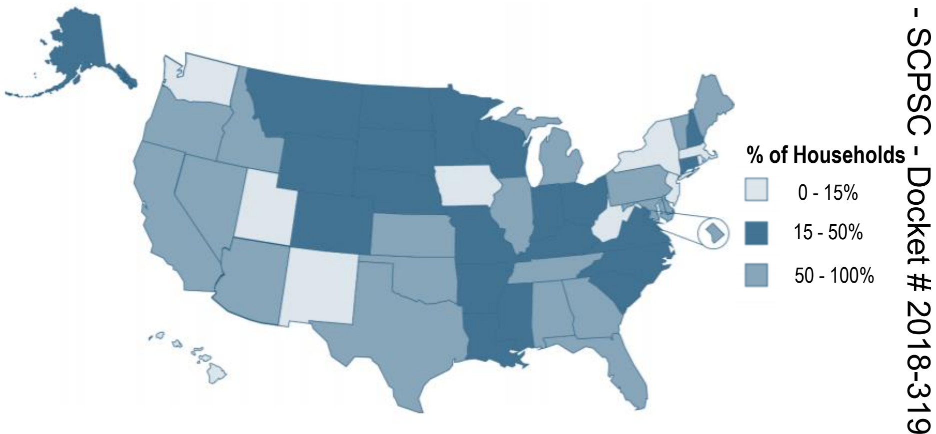
- Deployment of Smart Meters is an indicator of grid modernization adoption by utilities
    - Two-way Smart Meters allow utilities and customers to interact to support smart consumption applications using real-time or near real-time electricity data
    - Smart Meters support demand response and distributed generation, improve reliability, and provide information that consumers use to save money by managing their use of electricity
    - Smart Meter data provides utilities with detailed outage information in the event of a storm or other system disruption, helping utilities restore service to customers more quickly and reducing the overall length of electric system outages
- National Smart Meter installations are approaching 76 million and is projected to reach 90 million by 2020[88]
    - By the end of 2016, there were a total of 855,345 Smart Meters installed in South Carolina[89]
    - Currently, 620,868 Smart Meters (587,707 in South Carolina DEC and 33,161 in South Carolina DEP) are installed in South Carolina areas under Duke Energy's territory[90]

US Smart Meter Installations (2007-2020)



Source: The Edison Foundation[91]

Residential Smart Meter Adoption Rates by State (2016)

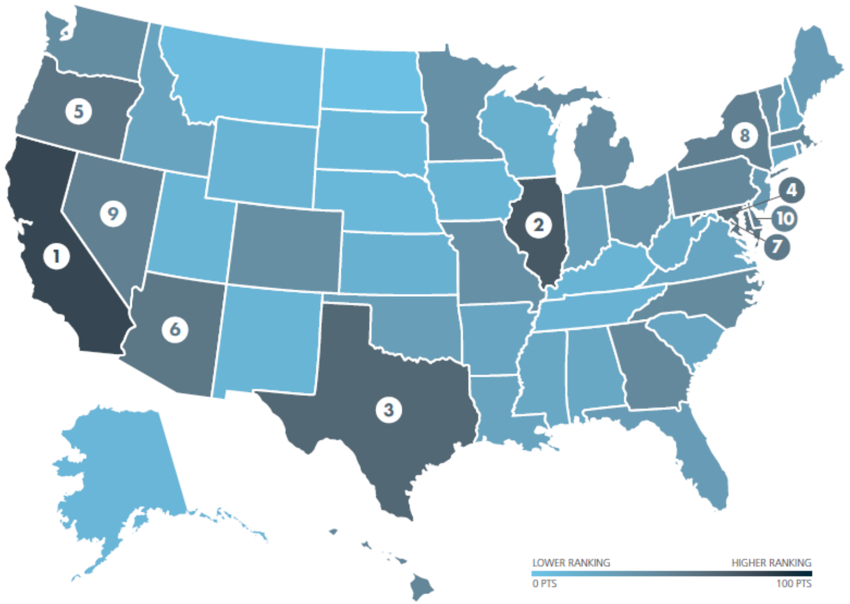


Source: The Edison Foundation[92]

What is happening?

- The SC Energy Plan states that "if South Carolina is to participate in the innovation coming to fruition in the electric sector, (for example, solar panels, wind turbines, EVs, battery storage, and microgrids) then the state will require an advanced, integrated grid to manage and optimize the increasingly dynamic flow of electricity"[93]
- In Q1 2018, 37 US states and the District of Columbia took grid modernization actions involving regulations and legislature. Most of these actions involved Smart Meters, energy storage, and utility business model reforms[94]
- South Carolina was ranked 33rd on the GridWise Alliance's 2017 Grid Modernization Index, which evaluates the leading states using a three-part score based on state support, customer engagement, and grid operations[95]

Grid Modernization Index Across the US



Source: GridWise Alliance[96]

Sample of Targeted Cost Recovery Mechanisms for Grid Modernization Investment

State	Type of Investment
California	Research and technology development
Massachusetts	Grid modernization
Minnesota	Grid modernization
New Jersey	Hardening infrastructure modernization
Ohio	Grid modernization
Pennsylvania	Advanced metering

Source: Navigant[97]

What is happening?

- Utilities are adopting grid technology to support increasing DER penetration
- There are varying types of grid modernization technology, many of which are listed in the table below

Benchmarking of Utility Grid Modernization

Smart Grid Investment	Utility 1	Utility 2	Utility 3	Utility 4	Utility 5	Utility 6	Utility 7
DER Penetration*	5%	25%	32%	55%	4%	<1%	<1%
Smart Meters		●	○	N/A**	○	●	●
Demand Response	○	●	●	◐	◐		◐
Distribution Automation	●	◐	○	●		●	●
Substation Automation	◐	◐	○	◐	◐	●	●
Advanced Communications	●	◐	◐	◐	◐	●	○
Energy Storage	○	◐	◐	◐	○		◐
Electric Vehicle Charging	◐	◐	○	◐	○	○	◐
Volt VAR Optimization	○	○	○		○	◐	◐
Time-of-use Pricing		◐	○	N/A**	◐		●
DERMS/ADMS	○	○	○	○	○	○	○
Microgrids			◐	○			◐
Undergrounding of Circuits	◐		◐	●			◐
Recovery Mechanism	●	●	●	◐	●	●	●

Source: Navigant[98]

*As percentage of peak demand. Note that utilities may define DER resources somewhat differently.
**Utility 4 market structure does not allow them to deploy Smart Meters or TOU rates

● **Large Scale**: utility has deployed technology in majority of its jurisdiction, and has begun evaluating the impacts on its system.

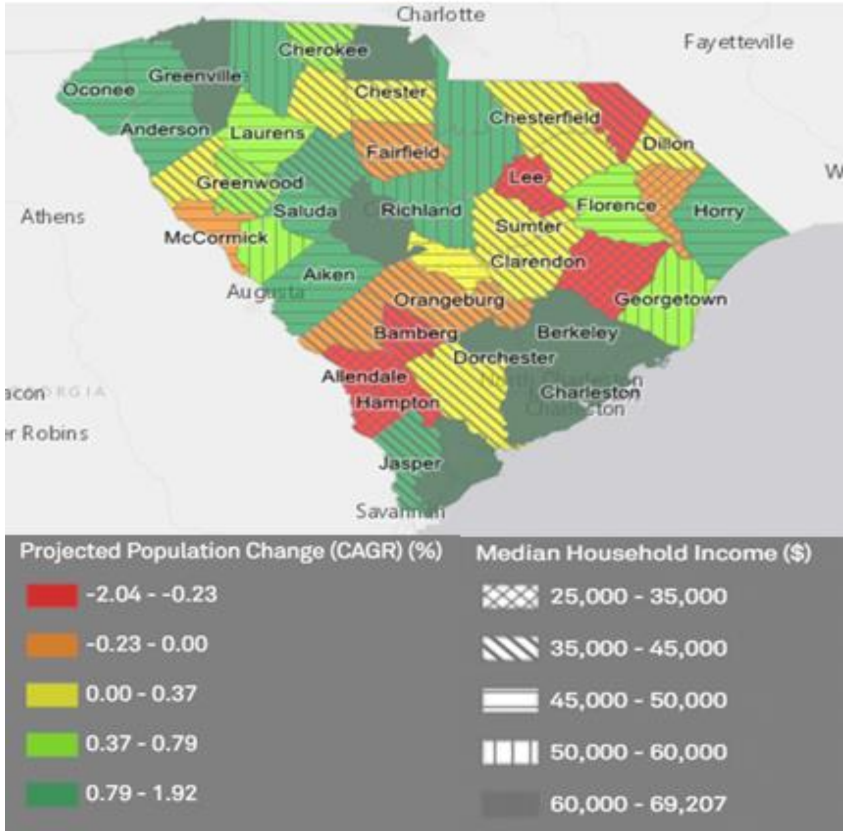
◐ **Pilot/Small Scale**: utility has deployed technology in one to a few locations, and has not been implemented long enough to evaluate its impact.

○ **Planned**: utility has not deployed the technology yet, but has plans for implementation in their most recent smart grid filing.

What is happening?

- People, wealth, and jobs continue to concentrate in urban and suburban areas
  - Movement is being driven by shifting demographics and changing lifestyle preferences
  - Many suburban areas getting an urban makeover with mixed-use development, thoughtful public spaces, transit options, and community-focused street-level development
  - Businesses, industry, and construction are following suit to take advantage of increased population density and connectivity
- South Carolina's population is expected to grow by ~8% (2018-2026)[99]
  - Greenville and Spartanburg counties ("Auto Corridor") accounted for 64% of Upstate's growth[100]
    - BMW currently hiring and training 1,000 additional workers[101]
    - Suppliers have announced $200 million in investment over the past 18 months[102]
  - Charlotte suburbs Fort Mill and Tega Cay experienced ~52% and ~33% growth, respectively[103]
  - Even outside of economic development efforts so prevalent in SC, a significant number of rural counties project stagnant or declining population
- Load is growing with population requiring new infrastructure
  - Load in downtown Spartanburg and Greenville growing 3%-5% per year[104]
  - There are challenges and costs siting new infrastructure in constrained areas

SC Projected Population and Income Demographics

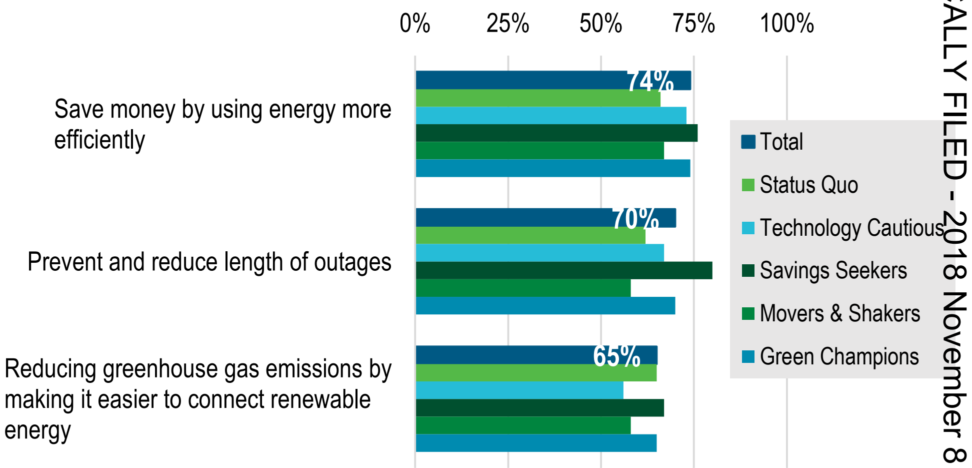


Source: S&P Global[105]

What is happening?

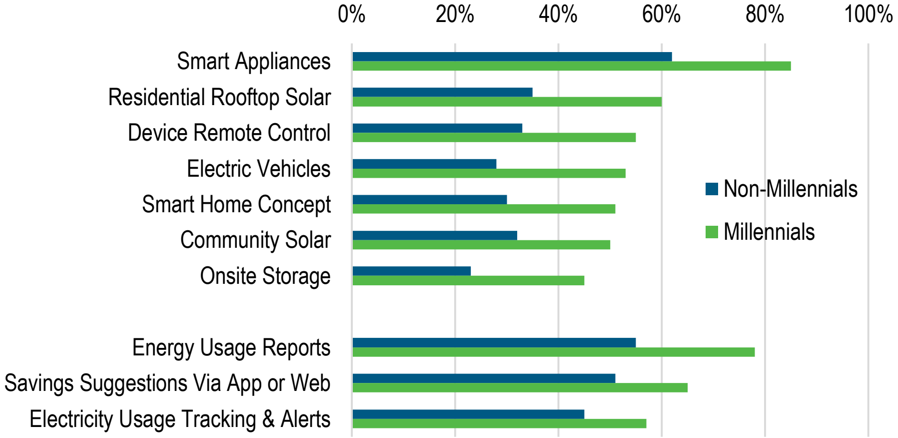
- Customers want to save money and reasonably reduce outages and greenhouse gas emissions[106]
    - Relative importance of these three may vary across customer personas, but they remain consistently the top factors
    - Customers want smart grid investments to reflect these needs
- To address these needs, customers are interested in new technology and increased control over their usage, including (1) smart appliances, (2) rooftop solar, and (3) device remote control[107]
- Millennials are far more interested in energy-related topics than non-millennials[108]
- Duke Energy's high growth business segments (advanced manufacturing, healthcare, data centers) requiring substantial mission-critical electrical infrastructure and cost-effective energy management services
- SC State Energy Plan recognizes that "meeting customer expectations for power and providing immediate restoration when an outage does occur require enhancements and improvements to South Carolina's electric infrastructure"[109]
- Percentage of Customers Experiencing Multiple Interruptions 6 or more times a year (CEMI-6) is projected to increase by 66% by 2028[110]

Factors customer perceive as important for utility supply



Note: These are the top 3 choices for all types of respondents
Source: Smart Energy Consumer Collaborative[111]

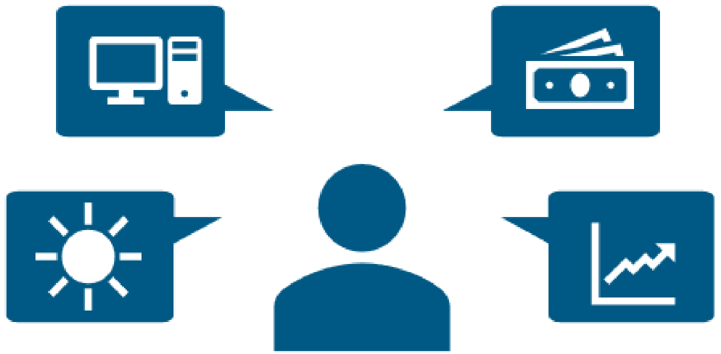
Interest in Energy-related Concepts



Source: Smart Energy Consumer Collaborative[112]

What is happening?

Today, in South Carolina:[113]



- Customers want their power to be on all the time as much as this is reasonably possible
- Customers want their power to be safe
- Customers do not want their power company to harm the environment
- Customers want their power to be as cheap as reasonably possible
- Customers want their interactions with the power company to be as easy and user-friendly as possible
- Customers want increases to their power bills to be minimal, infrequent, and predictable as possible
- Customers want to be informed of problems and issues in advance where possible and want to be updated with status reports as problems are being resolved
- Customers know and accept that there are things beyond our control that will cause power outages no matter what actions we take to prevent them
- Customers are more accepting of power outages when they know what caused the outage and how long it will take to restore power
- The frequency of outages and power quality issues are generally more important to customers than the duration of outages and events
- Most non-residential customers have built the effects of outages and power quality issues in to their business costs and are not willing to pay significantly more to prevent them
- Only some highly power-dependent customers (mostly complex businesses) have taken or are willing to take extraordinary measures to ensure a virtually uninterrupted supply of power

SOUTH CAROLINA GRID IMPROVEMENT PLAN

IMPLICATIONS

FOR STAKEHOLDER WORKSHOP

10/10/18

IMPLICATIONS TO OUR CUSTOMERS FROM THE MEGATRENDS

Our customers are impacted by the megatrends, and, under business as usual (BAU), our customers' expectations will not be met and we will miss the opportunity to optimally use advanced technology.

I	Increased costs
II	Reduced reliability and resiliency
III	Reduced ability to manage and integrate distributed energy resources (DER)
IV	Reduced ability to meet customer expectations and commitments
V	Reduced economic competitiveness for South Carolina
VI	Increased geographic and demographic disparity

I. INCREASED COSTS

Under business as usual, costs to customers may increase as compared to emerging alternatives.

Megatrend	BAU Threat	Opportunity
Concentrated Growth	Costs to build BAU infrastructure in urban and suburban areas with concentrated growth are increasing, and do not provide enhanced capabilities to meet expected future grid needs. These costs will be borne by all customers, including those in rural areas that are unaffected.	Advanced system controls, intelligence, planning, and automation would improve overall system efficiency using existing and new assets and thus lower costs for all customers from what they would otherwise be. Additionally, grid capacity needs and the need for two-way power flow can be addressed proactively.
Technology Advancements – Renewables and DER	Because DER is becoming more cost competitive, customers are installing DER and EVs, which, in turn, require improvements to the grid beyond BAU which increases costs if not done in a proactive and planned manner. The reduced load from DER can also lead to higher bills.	Advanced tools and technologies will enable greater application of DER on the grid. Effectively planning for and optimizing the installation of DER on the grid will lower costs for all customers from what they would otherwise be while maintaining safe and reliable operation of the grid.
Grid modernization	"Like for like" replacement of technology will not lower costs beyond what it is today because capital and operating cost will be unchanged. Further, as the grid is impacted by other trends, existing grid technology may require more rapid replacement, thus increasing costs.	Using advanced grid technologies, system and operational efficiency are increased which lower costs to customers from what they would otherwise be.
Customer Expectations	Customers want to save money and under business as usual, costs will not decline and may go up. As the grid increasingly interconnects DER, interconnection costs of an individual project increase, making it cost prohibitive for customers to have more DER options.	With appropriate grid capabilities, such as ability to manage two-way power flow and intermittent resources, customers will have options that help them manage their costs better, including DER and usage management tools.
Environmental Commitments	Corporations and governments will not be able to meet their environmental goals and commitments if it becomes cost prohibitive to do so. And, in the case where interconnection costs are not incurred, such as with EV, costs to meet these goals and commitments are borne by all customers.	Advanced tools and technologies will enable greater application of DER on the grid, including renewable energy resources. Effectively planning for and optimizing the installation of DER on the grid will lower costs for all customers from what they would otherwise be while maintaining safe and reliable operation of the grid.
Impact of Weather Events	Absent resiliency and reliability improvements, customers will see increased costs from outages as they increase in number and severity. These costs include those incurred by the utility and by customers.	Proactively hardening the system and building advanced monitoring, smart control and grid intelligence can reduce the occurrence and duration of outages, saving customers money compared to business as usual.
Threats to Grid Infrastructure	Absent adequate protection against modern threats, costs to customers will increase due to increased attacks. These costs include those incurred by the utility and by customers.	By building cyber and physical protections that go beyond current compliance requirements to anticipate threats of the future, occurrence and duration of outages can be reduced saving customers money compared to business as usual.

When will implication occur under BAU? 2018 — 2028

Level of severity of implication: = Manageable = Some issue = Many issues

II. REDUCED RELIABILITY AND RESILIENCY

Under business as usual, reliability will not improve and may decrease.

Megatrend	BAU Threat	Opportunity
Concentrated Growth	In concentrated growth areas, reliability will decrease if improvements to the grid don't keep pace with concentrated load increases and DER penetration. Reliability will decrease in rural areas where flat load growth does not support traditional grid strategies.	Advanced system controls, intelligence, planning, and automation can improve overall system efficiency using existing and new assets and thus can improve reliability for all customers. .Additionally, grid capacity needs and the need for two-way power flow can be addressed proactively, which can improve reliability.
Technology Advancements – Renewables and DER	Because DER is becoming more cost competitive, customers are installing DER and EV at an increasing rate, which may decrease reliability due to voltage fluctuation and capacity limitations on the distribution system.	Using rapidly advancing technology and systems, the utility can provide active monitoring and control power flow and improved voltage fluctuation issues using "grid-edge" decision making. Non-traditional applications are also an opportunity to improve reliability.
Grid modernization	"Like for like" replacement of existing grid infrastructure will not improve reliability beyond what it is today because functionality will not have improved. In particular, the number of customers that experience multiple interruption per year will increase (CEMI-6).	Rapidly advancing grid technologies are available to improve grid reliability, including improving visibility to a more granular level of where outages are occurring and enable grid-edge decision making and control.
Customer Expectations	Customer satisfaction will decrease with increased outages, and reduced power quality, as customers are inconvenienced or unable to work. These outages may be caused from voltage or power flow issues from DER, traditional infrastructure, or major events such as weather or cyber attack	Customers expectations of reduced outages (either short- or long-term) and better power quality would be addressed with the use of rapidly advancing grid technology and systems.
Environmental Commitments	Customers with environmental commitments will interconnect DER which could cause voltage and power flow issues on the grid resulting in reduced reliability. Conversely, if DER is curtailed to address the reliability issues, customers will be prevented from meeting their commitments.	Using advanced grid technologies and systems helps customers meet their environmental commitments without sacrificing reliability or resiliency.
Impact of Weather Events	The BAU approach of reacting to damage when storms occur will not improve resiliency. In particular, in concentrated areas, when storms damage equipment, it affects more customers.	Using advanced grid technologies and systems will reduce frequency of short-term outages and reduce time to recover from major storm-induced outages. Undergrounding or hardening the most outage prone lines reduces costs and major event duration for all customers from what they would otherwise be.
Threats to Grid Infrastructure	Cyber and physical threats to grid infrastructure are increasing rapidly. Failure to keep pace with these threats will result in compromised reliability and resiliency of the electric grid.	Aggressive development and implementation of advanced system protections and protocols will help the electric grid remain protected from the ever increasing number and variety of threats it faces every day. Also, in the event that a threat is successful, these measures will help minimize damage/disruption that could impact customers.

When will implication occur under BAU? 2018 — 2028

Level of severity of implication: = Manageable = Some issue = Many issues

Business as usual limits the ability to manage and integrate DER, resulting in the need to curtail or issue moratoriums on customer-owned interconnection.

Megatrend	BAU Threat	Opportunity
Concentrated Growth	The existing constrained grid in urban areas limits the ability to interconnect DER for customers who are interested in renewable energy, storage and electric vehicles.	Advanced tools and technologies that enable two-way power flows will allow for increased application of DER on the grid. Effectively planning for and optimizing the installation of DER's on the grid will lower costs for all customers beyond what they would otherwise be while maintaining safe and reliable operation of the grid.
Technology Advancements – Renewables and DER	As more DER is connected to the grid, hosting capacity available for additional DER diminishes, causing customer interconnection costs to increase for future installations.	If the grid is able to handle two-way power flow by building capacity and using advanced monitoring and automation to manage DER, then DER can become a "tool in the toolbox" for grid operators.
Grid modernization	Current technology on the grid does not enable two-way power flow or voltage and power flow optimization needed to handle customer-sited, intermittent generation. This limits the ability for the grid to handle increasing capacity of DER.	With the use of advanced grid technologies (e.g. microprocessor based equipment), the grid could become a platform to connect and proactively use customer DER.
Customer Expectations	Customer satisfaction will decrease if customers are not given the option to connect DER, particularly renewables or EVs. If DER is not integrated properly, voltage fluctuations will cause DER to be curtailed.	If DER could be integrated, customers will have more energy options and be able to meet their individual needs such as to reduce greenhouse gases and reduce costs from what they would otherwise be.
Environmental Commitments	If customers, particularly corporations and governments, cannot interconnect renewable DER they will not meet their environmental goals.	By allowing customers to interconnect renewable generation, South Carolina will continue to be attractive to businesses with environmental commitments—this includes fast-growing sectors such as data centers, healthcare, and advanced manufacturing.
Impact of Weather Events	Grid-connected microgrids and other DER options for resiliency would not be able to be interconnected and used during severe weather events.	Customers will be able to leverage customer-owned resources in outages to improve resiliency by providing power in an outage at a local level.
Threats to Grid Infrastructure	Without proper protections, new "points of entry" that pose new cyber attack threat points, i.e. hacking a third-party resource, could impact the grid.	Duke Energy can work proactively with customers to build in protections upfront and over time as needs evolve.

When will implication occur under BAU?

Level of severity of implication: = Manageable = Some issue = Many issues

DUKE ENERGY

Business as usual will limit customer options, resulting in higher costs and lower reliability.

Megatrend	BAU Threat	Opportunity
Concentrated Growth	As the demographics of customers in urban and suburban load growth areas evolve they place a higher priority on uninterrupted and personalized energy service. Strained traditional systems in these areas will not be able to meet customer expectations.	Advanced system controls, intelligence, planning, and automation would improve overall system efficiency using existing and new assets and thus improve reliability for all customers. Building capacity for two-way power flow enables options and grid resiliency.
Technology Advancements – Renewables and DER	Under business as usual costs of customer interconnection will increase and curtailment and/or moratoriums will eventually be required which will not meet customer expectations for renewables and DER.	Advanced technologies such as advanced monitoring and controls and solutions that increase hosting capacity will reduce need for curtailment or moratoriums and decrease the cost of interconnection from what they would otherwise be.
Grid modernization	"Like for like" replacement of technology will not lower costs or improve reliability beyond what it is today because capabilities will be unchanged. Further, lack of visibility and control to customer-sited assets and outages will increase cost and reduce reliability.	Distribution automation, grid intelligence and other advanced technologies will minimize outages, accelerate power restoration, and open the opportunity to use DER.
Customer Expectations	Customers will be unhappy if expectations for affordability, reliability, and options are not met.	Access to new capabilities and offerings, as enabled by enhanced grid capabilities, enable customers to meet their expectations, encourage their participation in energy decisions and gives them more control over their energy use.
Environmental Commitments	The grid will increasingly have less ability to integrate DER and renewables which will cause customers to miss meeting their environmental commitments.	With enhanced grid capabilities, such as increased hosting capacity and the ability to integrate two-way power flow and intermittent resources (such as renewables), customers can meet their commitments with DER including solar, storage and EVs.
Impact of Weather Events	Absent resiliency and reliability improvements, customers will see increased costs and outages as storms and major weather events increase in number and severity. Increasing frequency of outages and increased costs lead to lower customer satisfaction.	By proactively hardening the system, undergrounding or hardening the most outage prone lines, and building advanced monitoring, control and grid intelligence, occurrence and duration of outages and associated costs can be reduced from what they would otherwise be.
Threats to Grid Infrastructure	Absent adequate protection against modern threats, customers will see increased costs and outages due to increased attacks. Increasing frequency of outages and increased costs lead to lower customer satisfaction.	By building cyber and physical protections that go beyond current compliance requirements to anticipate threats of the future, customers will be better protected from disruptions and costs of attack.

When will implication occur under BAU? 2018 — 2028

Level of severity of implication: = Manageable = Some issue = Many issues

Business as usual makes South Carolina less attractive for businesses and residents.

Megatrend	BAU Threat	Opportunity
Concentrated Growth	Growth will not be absorbed cost-effectively, thus increasing costs to all customers which drives South Carolina to be a less attractive place to live or do business. Additionally, businesses will be deterred from locating in urban areas (where employees are located) due to reliability issues.	Advanced grid technologies and grid capacity deployed in concentrated growth areas and throughout the system will help to maintain affordability across all customers and encourage business development and relocation to the State.
Technology Advancements – Renewables and DER	Due to the inability of the grid to handle increasing amounts of DER, options will be limited for businesses to deploy renewables and/or DER which will make the State less attractive for businesses that desire these options.	Advanced technologies such as advanced monitoring and controls and solutions that increase hosting capacity will allow more DER and renewables making it an attractive market for certain companies.
Grid modernization	Businesses will not be attracted to do business in South Carolina if the electric grid is not reliable or energy costs are less affordable due to existing equipment and operations. Further, prospective businesses may perceive South Carolina as not embracing rapidly advancing technologies.	A more resilient, reliable and intelligent grid will represent a modern, competitive energy system to current and prospective employers and their employees.
Customer Expectations	Customer satisfaction will decrease if expectations of affordability, reliability and options are not met, which could lead to residents and businesses choosing not to locate in the State.	Programs to protect, modernize and optimize the grid will provide reliable operation and offer customers the options they seek.
Environmental Commitments	The inability to utilize DER to meet environmental goals could inhibit commercial and industrial growth in South Carolina, particularly from large corporations with high renewable energy goals and environmental commitments.	Advanced grid technologies that increase hosting capacity and help to manage intermittency of renewable energy will make it possible for customers to pursue their environmental and sustainability commitments and be interested in South Carolina.
Impact of Weather Events	Absent resiliency and reliability improvements, customers will see increased costs and outages as storms and major weather events increase in number and severity resulting in decreased business and consumer confidence in the ability to stay open during storms.	By proactively hardening the system; undergrounding or hardening the most outage prone lines; and building advanced monitoring, control and grid intelligence; the occurrence and duration of outages and associated costs can be reduced helping customers be confident they can do business in an areas subject to storms.
Threats to Grid Infrastructure	Absent adequate protection against modern threats, customers will see increased costs and potential outages due to increased attacks resulting in decreased business and consumer confidence.	By building cyber and physical protections that go beyond current compliance requirements to anticipate threats of the future, customers will be better protected from disruptions and costs of attack helping customers be confident they can do business despite threats.

When will implication occur under BAU? 2018 — 2028

Level of severity of implication: = Manageable = Some issue = Many issues

Business as usual will not adequately meet the needs of rural customers in the future.

Megatrend	BAU Threat	Opportunity
Concentrated Growth	Capital demands to meet system expansion in high growth areas can undermine investment in rural areas of the state causing disparity between customer demographics and geography.	Advanced system controls, intelligence, planning, and automation would improve overall system efficiency using existing and new assets and thus improve reliability for all customers. Building grid capacity and the ability for two-way power flow enables options and grid resiliency.
Technology Advancements – Renewables and DER	Growth and demographic trends suggest that DER will predominate in urban and suburban centers that have an increasingly younger and higher-wealth demographic, leading to a lesser participation from and cost shifting to lower income or rural customers.	Advanced tools and technologies will enable greater application of DER on the grid. Effectively planning for and optimizing the installation of DER on the grid will lower costs for all customers from what they would otherwise be while maintaining safe and reliable operation of the grid.
Grid modernization	Under business as usual, capital allocated for traditional system improvements necessarily goes to areas where there is highest load and customer count. As a result, rural areas see less timely improvements to the grid under legacy practice using traditional technology.	By optimally implementing new capabilities that reduce costs of improvements and operations in constrained urban areas, additional focus can be given to improvements in rural areas. In addition, grid automation will enhance ability to serve remote areas of the system.
Customer Expectations	Business as usual will not allow all customer classes to equally address their expectations for affordability, reliability and options.	Additional capabilities and programs can be used to proactively address the needs of all customer classes and open new opportunities for all customers.
Environmental Commitments	Under business as usual, only certain customers and businesses will be able to deploy DER or renewables needed to meet their commitments.	Advanced grid technologies that increase hosting capacity and help to manage intermittency of renewable energy will make it possible for all customer to have access to more DER or renewables.
Impact of Weather Events	Absent resiliency and reliability improvements, customers will see increased costs and outages as storms and major weather events increase. This is particularly challenging in rural areas where cost and times for repairs are higher due to longer radials and distance for crews to cover.	By proactively hardening the system, undergrounding or hardening the most outage prone lines, and building advanced monitoring, control and grid intelligence, the occurrence and duration of outages and associated costs can be reduced, particularly in hard-hit rural areas.
Threats to Grid Infrastructure	Absent adequate protection against modern threats, customers may see increased costs and outages due to increased attacks. In particularly, physical attacks will be more detrimental in radial systems, particularly in rural areas, due to singular failure points.	By building cyber and physical protections that go beyond current compliance requirements to anticipate threats of the future, customers will be better protected from disruptions and costs of attack in rural areas.

When will implication occur under BAU? 2018 → 2028

Level of severity of implication: = Manageable = Some issue = Many issues

IMPLICATIONS OF MEGATRENDS

Oliver Exhibit 11
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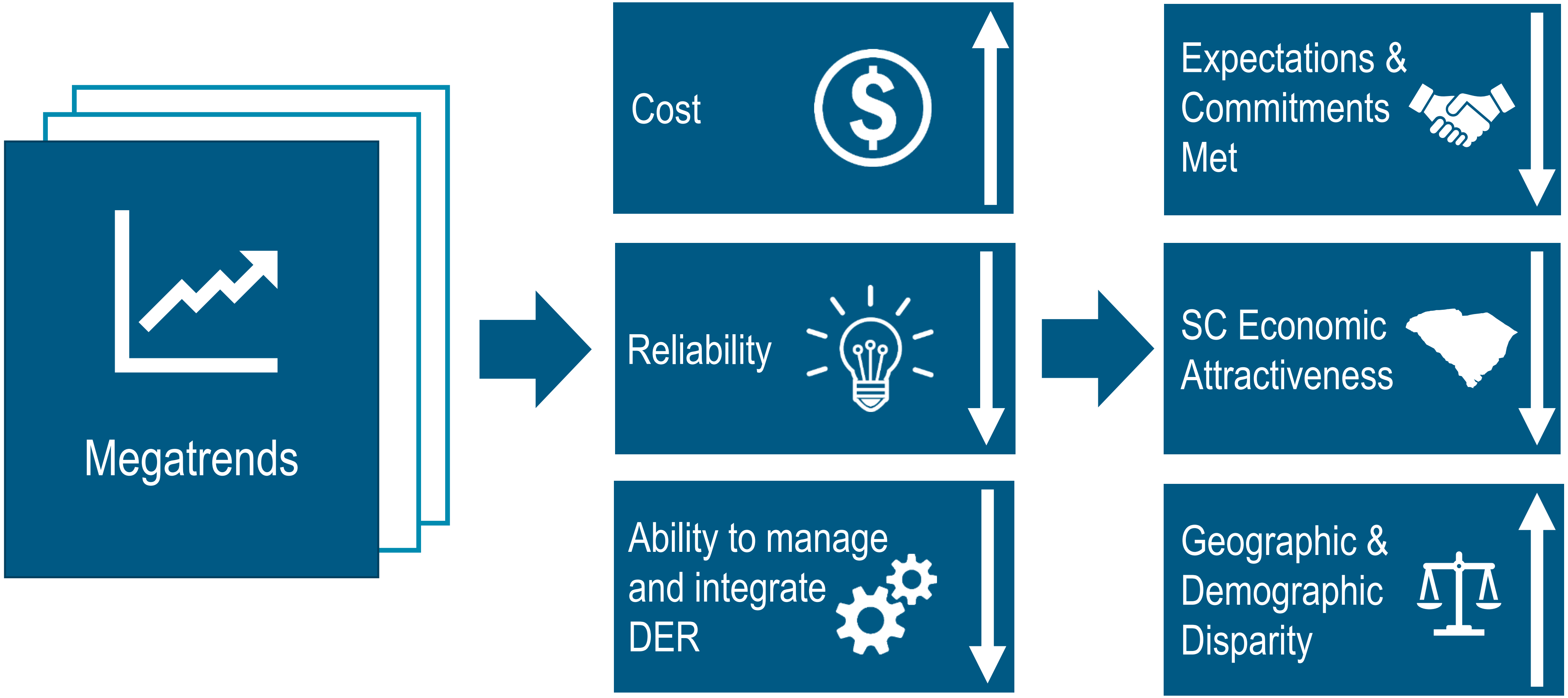
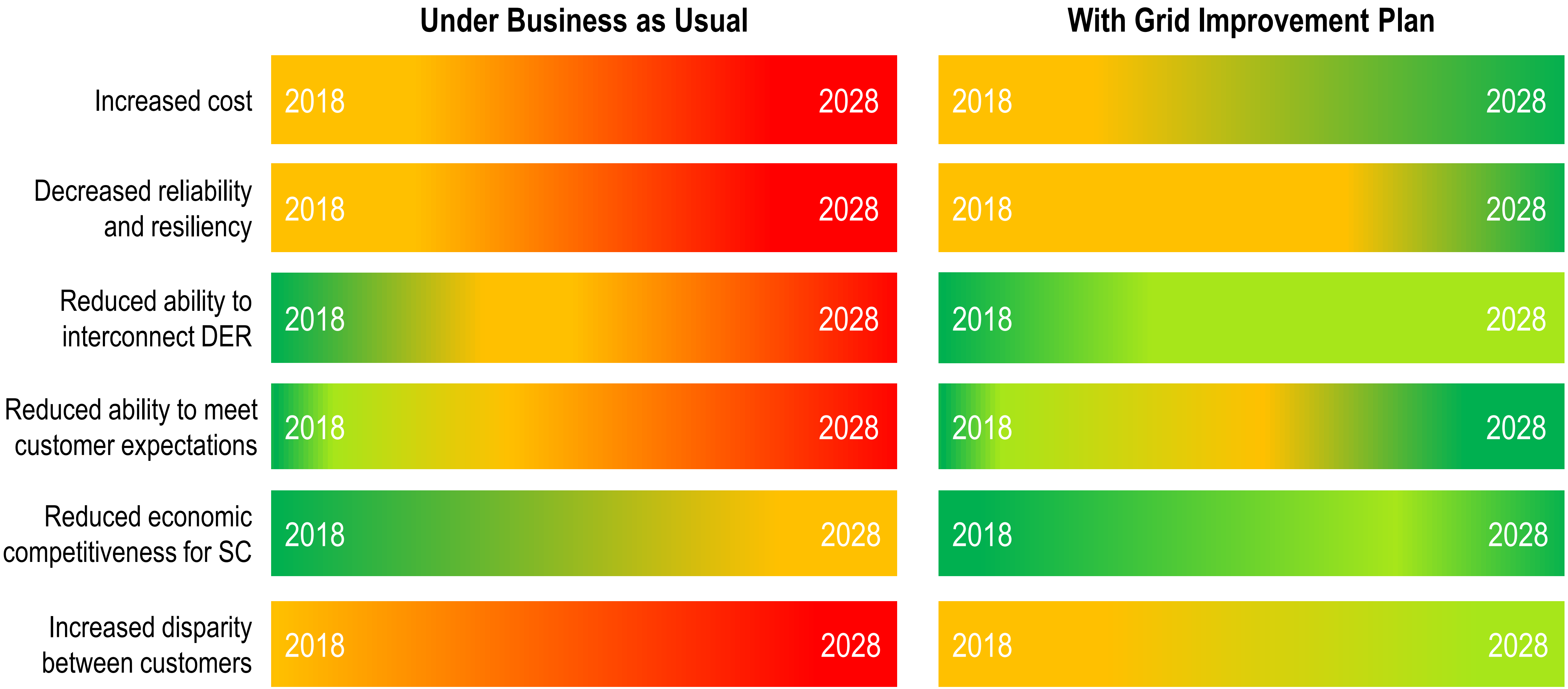
In summary, evolving megatrends will have implications on our **customers and the State.**



IMPACT OF GRID IMPROVEMENT PLAN ON IMPLICATIONS

DUKE ENERGY

Over time, the Grid Improvement Plan will reduce the degree of severity of the implications experienced under business as usual.



SOUTH CAROLINA GRID IMPROVEMENT PLAN

PORTFOLIO PRIORITIZATION METHODOLOGY

FOR STAKEHOLDER WORKSHOP

10/10/18

SOUTH CAROLINA GRID IMPROVEMENT PLAN

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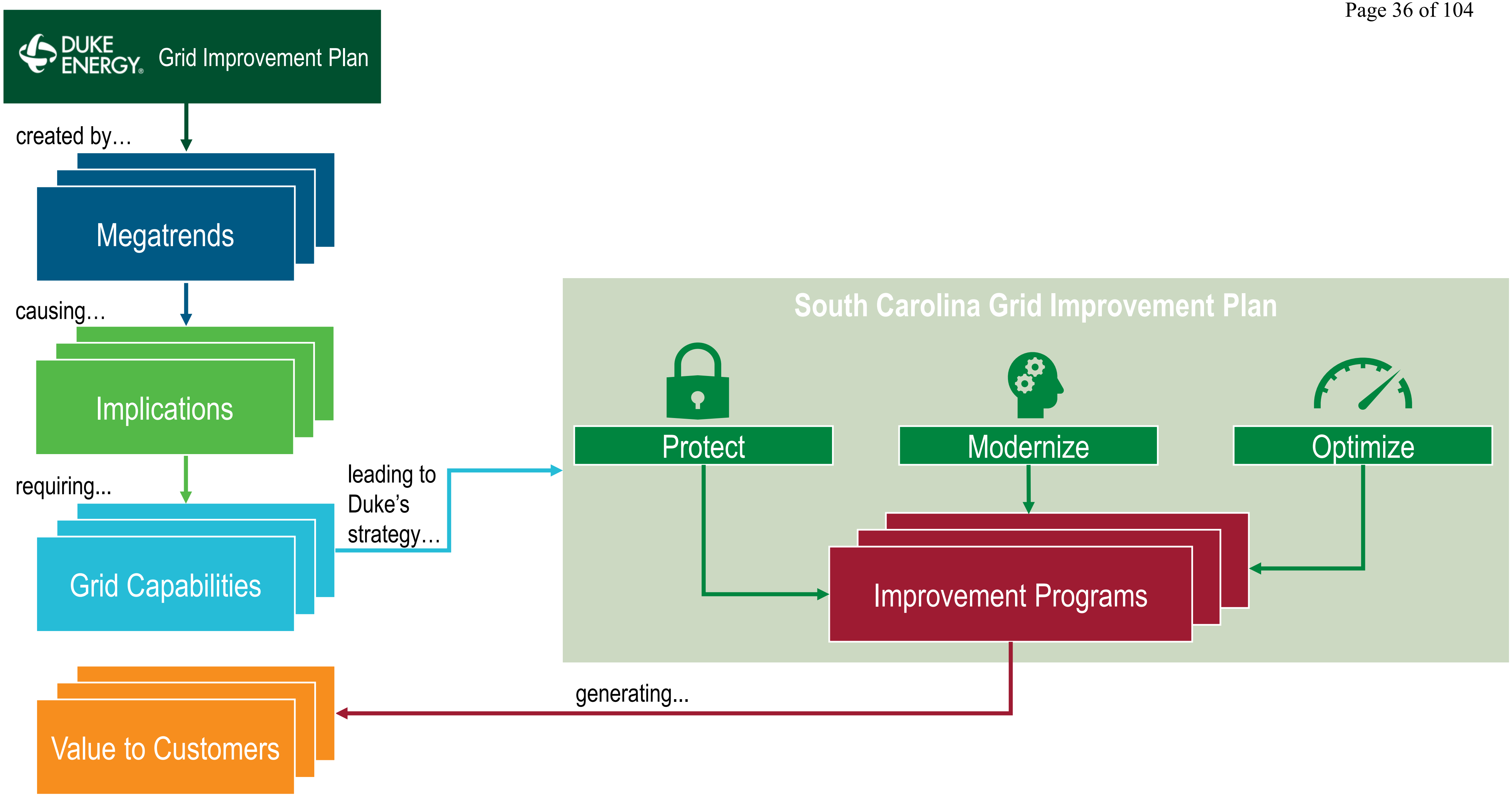


OPTIMIZE

Optimize the total customer experience

MODERNIZE

Leverage enterprise systems and technology advancements

PROTECT

Reduce threats to the grid

MAINTAIN[1]

Serve customers in a manner that meets industry safety, reliability and environmental standards

(1) *Maintain* base work not included in SC Grid Improvement Plan

DUKE ENERGY'S SC GRID IMPROVEMENT PLAN FRAMEWORK

DUKE ENERGY

OPTIMIZE

Optimize the total customer experience

Energy Storage	EV Charging	Hardening and Resiliency [T]	Hardening and Resiliency [D]	Integrated Volt-Var Control	Long Duration Interruptions

Oil Breaker Replacement	Self-Optimizing Grid	Targeted Undergrounding	Transformer Retrofit	Transformer Bank Replacement

MODERNIZE

Leverage enterprise systems and technology advancements

Advanced Metering	DER Dispatch Tool	Distribution Automation	Enterprise Applications	Enterprise Communications

Customer Data Access	Integrated System Operations Planning	Power Electronics	Transmission System Intelligence

PROTECT

Reduce threats to the grid

Physical & Cyber Security

MAINTAIN[1]

Serve customers in a manner that meets industry safety, reliability and environmental standards

Line Extensions	Capacity Expansions	Substation Additions	Outage Follow-up	Pole Replacements

Vegetation Management	End-of-life Asset Replacement	Equipment Inspection & Maintenance	General System Protection

(1) *Maintain* base work not included in SC Grid Improvement Plan

Cost-Benefit and Cost-Effectiveness Justified (Optimize)

Programs and projects in this category provide customers more net benefits than net costs and solve for one or more external "megatrends."

Rapid Technology Advancement-Cost Effectiveness Justified (Modernize)

Equipment, software, hardware, operating systems, and/or accepted system operating practice has advanced at an atypical pace in this category causing the need for rapid and sometimes frequent changes within the utility at a system deployment level. Work in this category is usually related to system communication, automation, and intelligence and must be executed at a deliberate pace while ensuring not to deploy new technology before it has reached operational and price point maturity. While not technically compliance work, work in this category is essential for modern system operations.

Compliance-Cost Effectiveness Justified (Protect)

i. An external law, rule, or regulation applicable to the company requires the work;

ii. A binding legal obligation such as a contract, agency order, or other legal document compels the work; or

iii. The Operations Council has approved the work as being critical and imperative to the Company's operations

Maintain Base (Maintain)

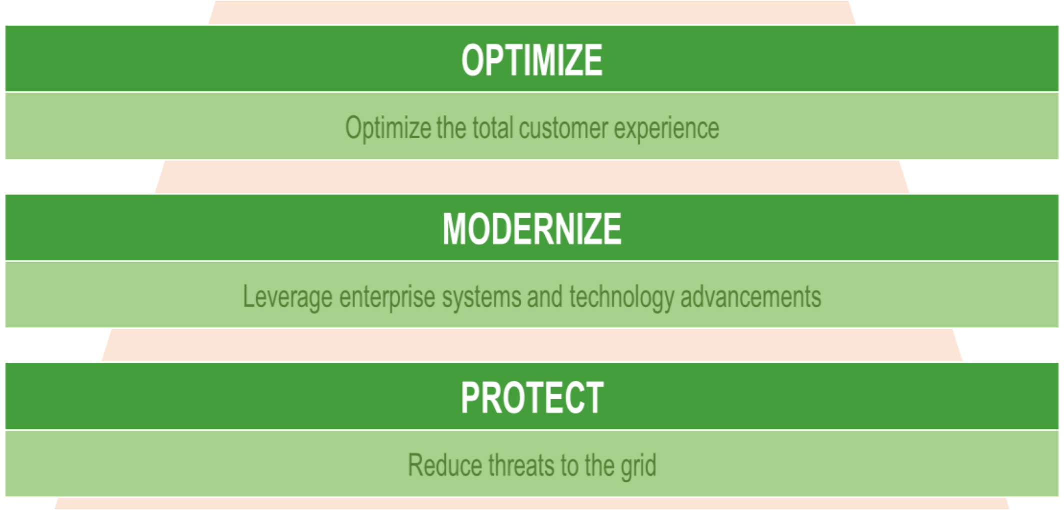
Programs and investments to serve customers in a manner that meets industry safety, reliability, and environmental standards.

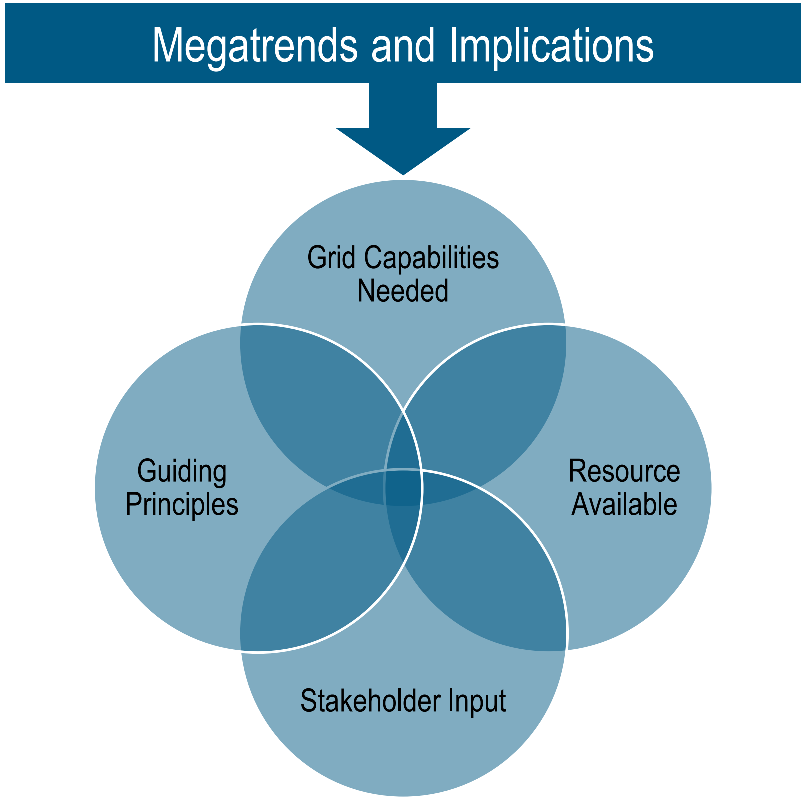
PORTFOLIO PRIORITIZATION METHODOLOGY

DUKE ENERGY

The programs in our portfolio were selected based on alignment with our framework and prioritization criteria.

South Carolina Grid Improvement Plan





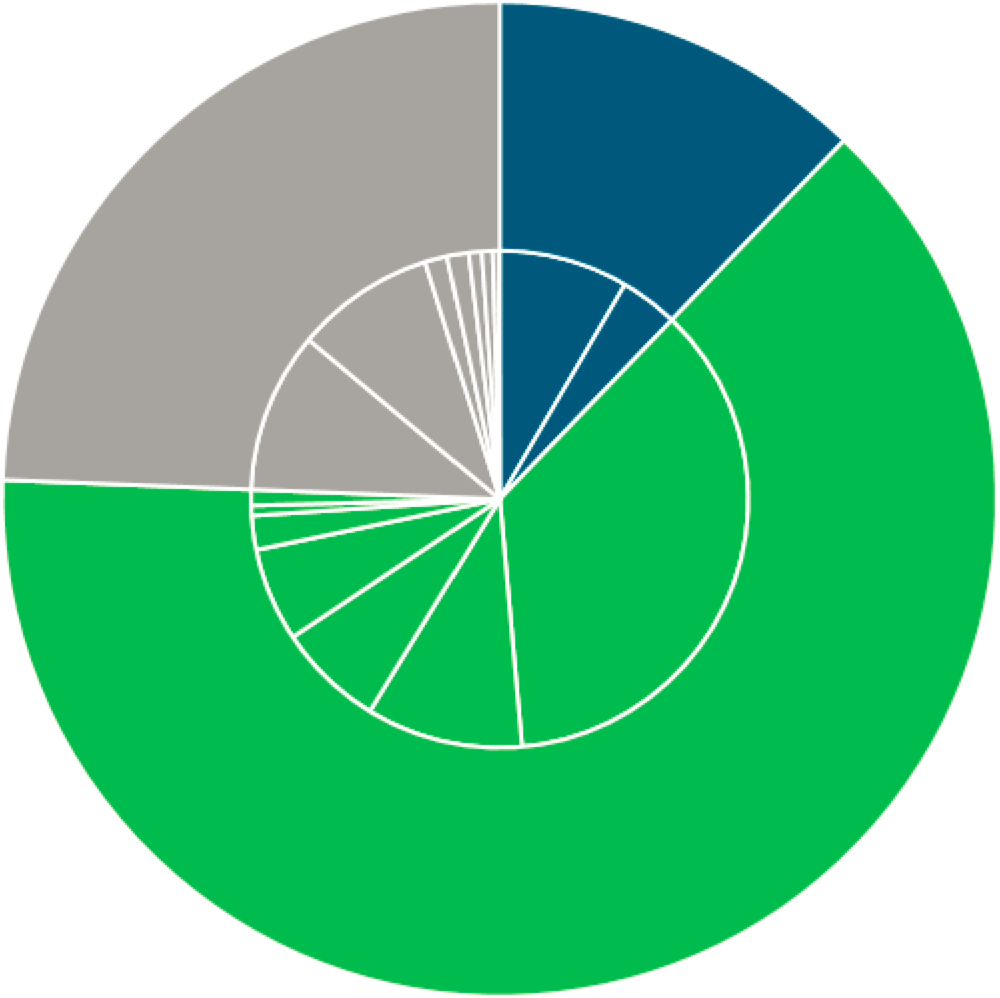
Programs are considered based on fit with framework and justification methodology:

- **Protect**: required for compliance
- **Modernize**: technology has rapidly advanced and is now mature
- **Optimize**: program provides attractive benefits

Customer-Focused Programs are selected and funded based on:

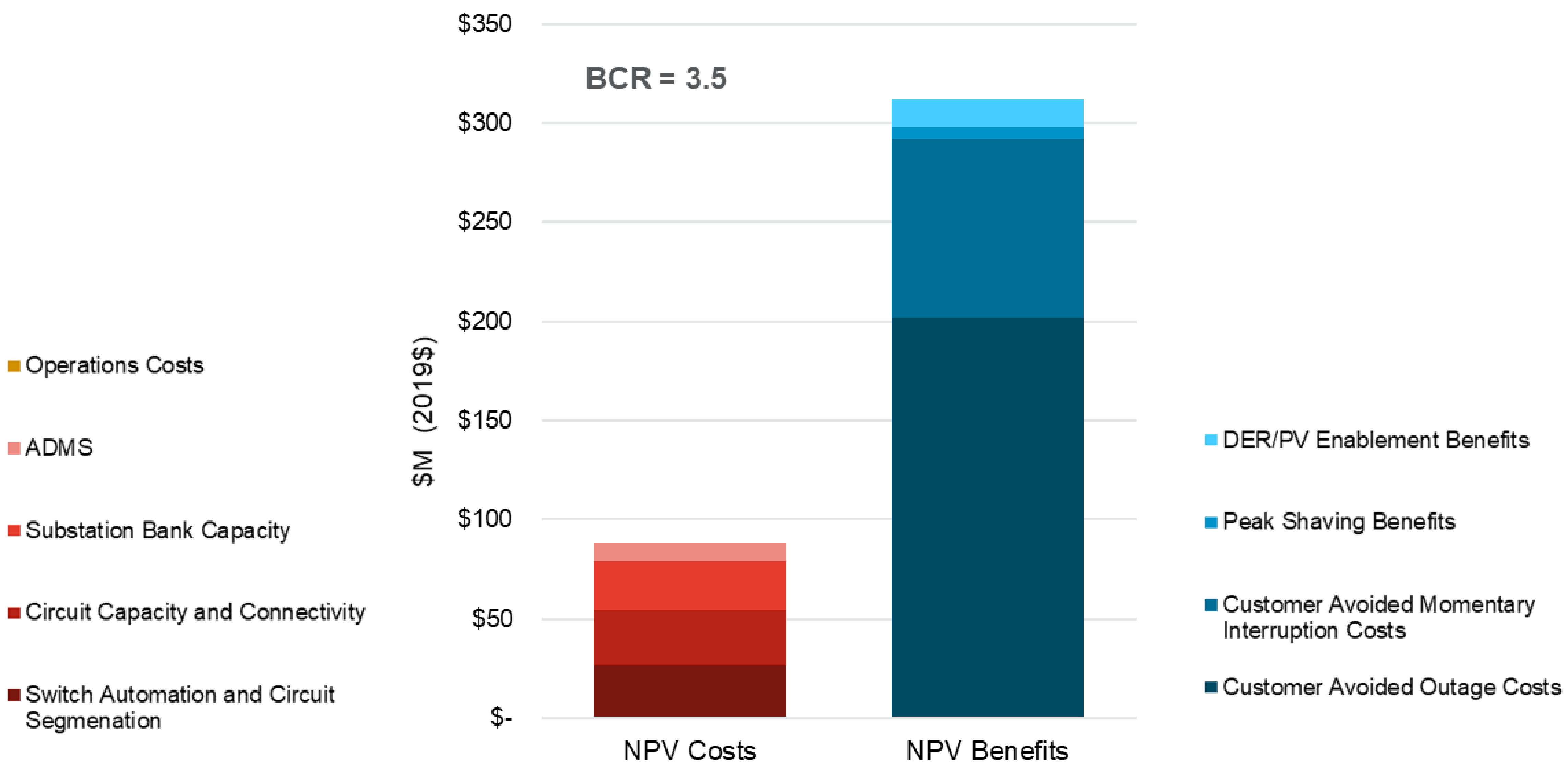
- **Grid capabilities** that are needed to address megatrends
- Scope and budgets right-sized to **available resources**
- **Stakeholder input**
- Alignment with **guiding principles**

PROGRAM PORTFOLIO



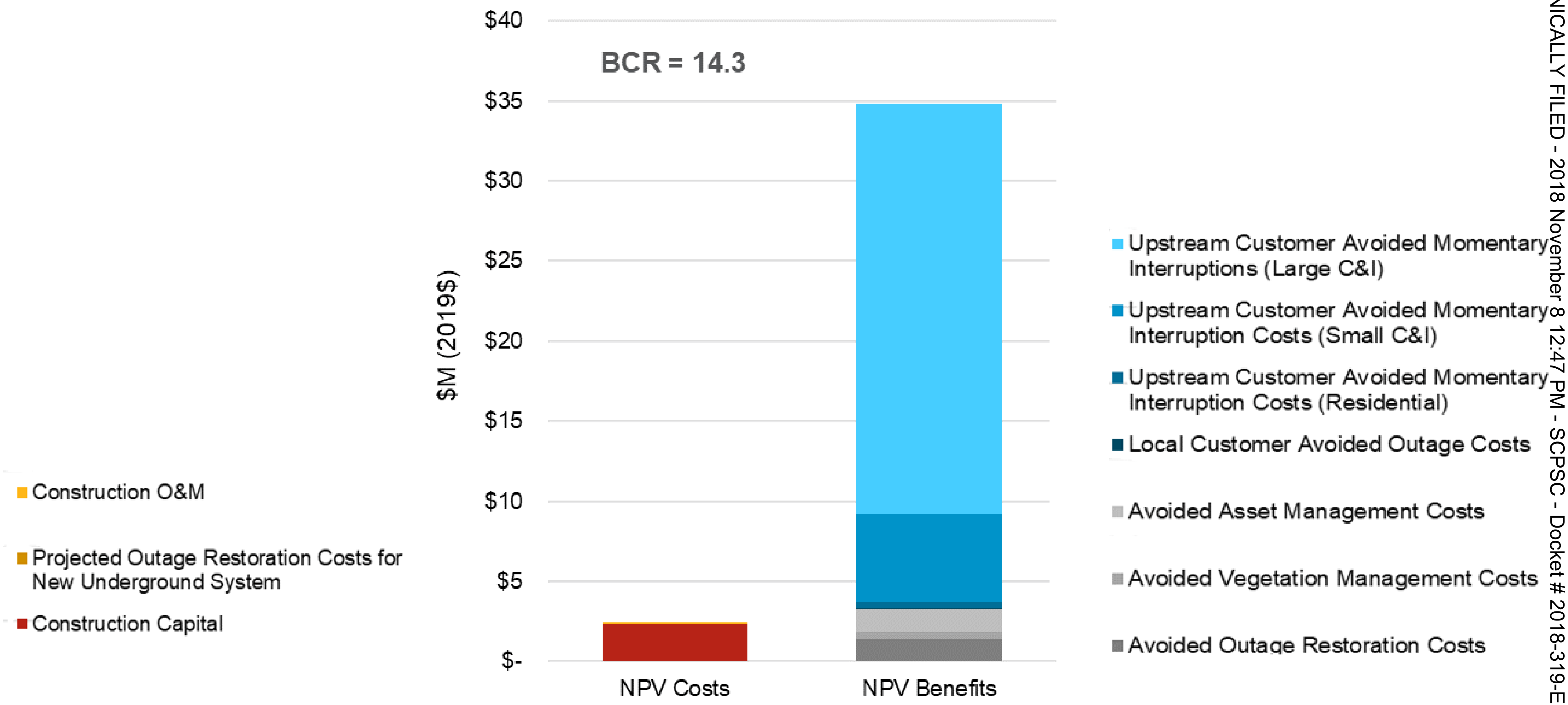
Program
Cost Benefit & Cost Effectiveness Justified (Optimize)
SOG
Incremental Distribution H&R
IVVC DEC
Incremental Transmission H&R
TUG
Energy Storage
Transmission Bank Replacement
D-OIL Breaker Replacements
T-OIL Breaker Replacements
DSDR peak shaving to CVR in DEP
Rapid Technology Advancement: Cost-Effectiveness Justified (Modernize)
T&D Communications
Distribution System Automation
Transmission System Automation
T&D Enterprise Systems
ISOP
DER Dispatch Tool
Electric Vehicle Charging
Power Electronics for volt/var control
Customer Data Access
Compliance: Cost Effectiveness Justified (Protect)
Physical Security
Cyber Security

SOG 3-YEAR DEPLOYMENT – NPV OF BENEFITS AND COSTS



TUG PARK HILLS DEPLOYMENT – NPV OF BENEFITS AND COSTS

DUKE ENERGY



SOUTH CAROLINA GRID IMPROVEMENT PLAN

PROGRAM SUMMARIES

FOR STAKEHOLDER WORKSHOP

10/10/18

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The IVVC program establishes control of distribution equipment in substations and on distribution lines to optimize delivery voltages to customers and power factors on the distribution grid.

DESCRIPTION

IVVC allows the distribution system to optimize voltage and reactive power needs. The program employs remotely operated substation and distribution line devices such as voltage regulators and capacitors. The settings for thousands of these controllable field devices are optimized and dispatched via a distribution management system.

IVVC capabilities enable a grid operator to lower voltage as a way of reducing peak demand (peak shaving), thereby reducing the need to generate or purchase additional power at peak prices, or protecting the system from exceeding its load limitations. The current DEP **Distribution System Demand Response (DSDR)** program uses the peak shaving mode of IVVC to support emergency load reduction.

Another operational mode enabled by IVVC capabilities on the distribution system is **Conservation Voltage Reduction (CVR)**. CVR uses IVVC during periods of more typical electricity demand to reduce overall energy consumption and system losses.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ INCREASE DISTRIBUTED INTELLIGENCE
- ✓ ENABLE VOLTAGE CONTROL
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ INCREASE HOSTING CAPACITY
- ✓ MODERNIZE GRID OPERATIONS & PLANNING

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

MORE ABOUT THE PROGRAM

The Distribution Management System (DMS), which manages the dispatch of IVVC functionality, can be designed to manage distribution circuits such that any impacts to customers with large motors sensitive to voltage control can be reduced. To maximize operational flexibility and value, the IVVC system can also have peak shaving capability and emergency modes of operation. Advanced DMS software upgrades will enable IVVC to operate in various modes to provide further customer benefit in the future.

DSDR to CVR in DEP

In 2014, Duke Energy implemented DSDR in DEP, achieving peak shaving voltage reduction of approximately 3.6% across the DEP distribution system. The DMS in DEP is capable of optimized modes (i.e., DSDR) or non-optimized (i.e., emergency) modes. When in emergency mode, the system can quickly provide a temporary voltage reduction capability of up to 5.0%.

DEP's initial implementation of DSDR also included a significant amount of circuit conditioning to optimize the system for DSDR mode (i.e., the installation of voltage regulating devices and capacitors, balancing of load on distribution circuits, and reconductoring of some distribution lines to larger wire sizes).

Because the substation, distribution, telecommunications, and IT infrastructure were put in place as part of the original DSDR implementation, this sub-program focuses on the deployment of the few additional device installations as well as the DMS upgrades required to support various operational modes, including the current DSDR mode and CVR mode, as well as Self Optimizing Grid and other distribution automation capabilities.

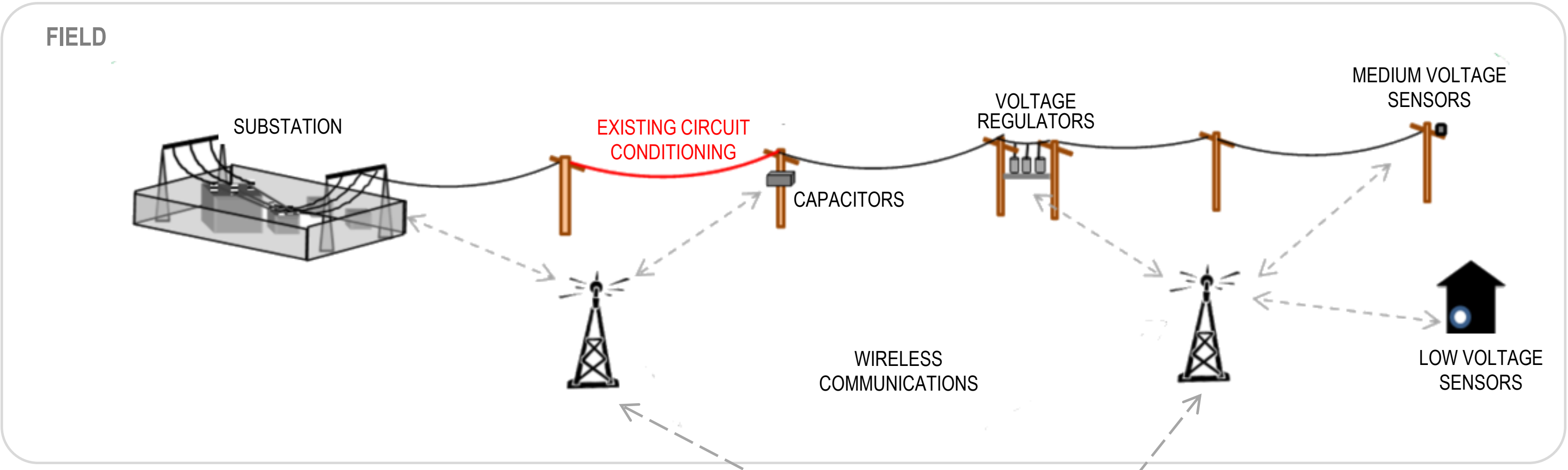
Through this sub-program, Duke Energy will enable 2% voltage reduction for energy conservation (an average of roughly 1.4% load reduction).

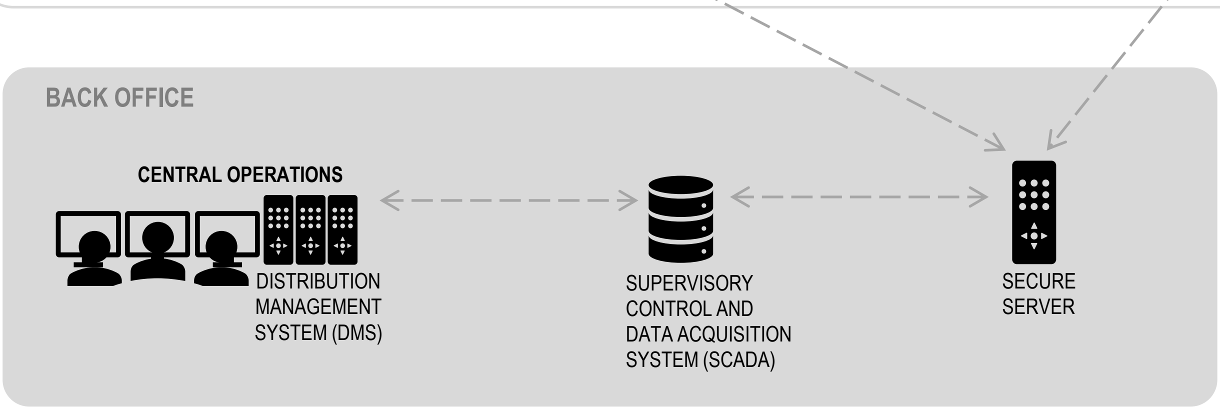
IVVC Project in DEC

The DEC IVVC pre-scale deployment project used real-time field conditions on a small scale to demonstrate the use of IVVC on the DEC system, and validate benefits in advance of its full-scale rollout. The small-scale demonstration validated voltage reductions of approximately 2% are possible with appropriate transmission and distribution system upgrades.

The DEC IVVC project will install communications and voltage control infrastructure at substations and associated distribution lines. The project will also leverage overlaps with efforts like Self Optimized Grid projects that deploy some of the infrastructure and capabilities necessary to enable IVVC.

PROGRAM: INTEGRATED VOLT/VAR CONTROL (IVVC)

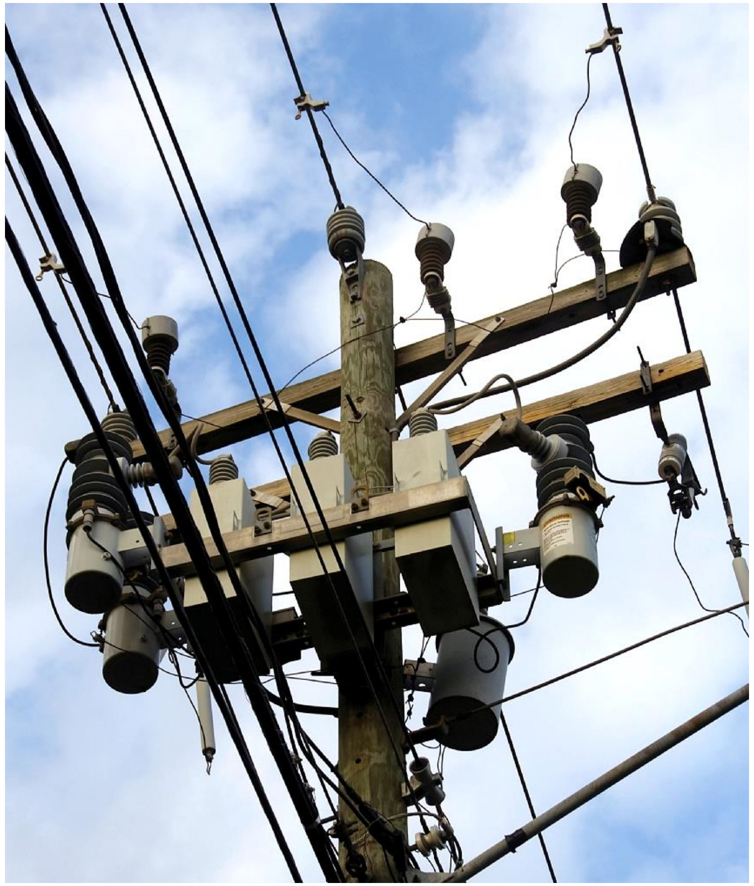




Functionality enabled

- Near real time automated control
- Situational awareness across the system
- Optimized voltage and power factor
- Two-way communication to field devices

SMART CAPACITOR BANK



PROGRAM: SELF-OPTIMIZING GRID (SOG)

DUKE ENERGY

The self-optimizing grid program, also known as the smart-thinking grid, redesigns key portions of the distribution system and transforms it into a dynamic self-healing network.

DESCRIPTION

The current grid has limited ability to reroute or rapidly restore power and limited ability to optimize for the growing penetrations of distributed energy resources (DER). The SOG program is established to address both of these issues.

The SOG program consists of three (3) major components: grid capacity, grid connectivity, and automation and intelligence. The SOG program redesigns key portions of the distribution system and transforms it into a dynamic smart-thinking, self-healing grid. The grid will have the ability to automatically reroute power around trouble areas, like a tree on a power line, to quickly restore power to the maximum number of customers and rapidly dispatch line crews directly to the source of the outage. Self-healing technologies can reduce outage impacts by as much as 75 percent.

The **SOG Capacity projects** focus on expanding substation and distribution line capacity to allow for two-way power flow. **SOG Connectivity projects** create tie points between circuits. **SOG Automation projects** provide intelligence and control for the Self Optimizing Grid. Automation projects enable the grid to dynamically reconfigure around trouble and better mange local DER.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ INCREASE DISTRIBUTED INTELLIGENCE
- ✓ IMPROVE RELIABILITY
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ INCREASE HOSTING CAPACITY

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

MORE ABOUT THE PROGRAM

The SOG program, also known as the smart-thinking or self-healing gird, implements distribution system design guidelines that improve grid reliability and resiliency. SOG circuits will have automated switches to divide the circuit into switchable segments. Each segment is designed to consist of approximately 400 customers, three miles in circuit segment length, or serve 2MW of peak load. This design ensures that any issues on the system can be isolated, and customer impacts are limited. The long term vision is to serve 80% of customers by the Self-Optimizing Grid.

Advanced Distribution Management System (ADMS)

The ADMS subprogram is an enterprise-wide program to deploy a common distribution management system. Consolidating to a single platform for DMS and SCADA systems enables operational efficiency and the ability to integrate future solutions needed as demands on the distribution system evolve. The three main projects are: (1) **SCADA upgrade project** which upgrades the supervisory control and data acquisition system; (2) **DMS common platform project** which deploys a common version of DMS across DEC and DEP; and (3) **Closed loop FLISR project** which deploys DMS functionality that minimizes the area impacted by the resulting outage.

SOG Segmentation & Automation

This subprogram focuses on segmenting circuits in accordance with SOG design guidelines (segments should serve approximately 400 customers, are three miles in length or serve 2 MW of peak load) and equipping those segments with automated switching devices. The purpose is to limit the exposure of customers to power outages associated with faults on a line (e.g., a tree falling or vehicle-power pole collision). This is accomplished by sectionalizing a circuit by adding and/or re-configuring a number of protective devices on tap lines.

Circuit Capacity and Connectivity

This subprogram focuses on upgrading selected circuit feeders and tying them together to meet the SOG design philosophy. The circuit capacity activities involve upgrading the feeder conductor and voltage control devices to enable a circuit to carry its own customer load as well as portions of adjacent circuit customer load, as needed.

Substation Bank Capacity

This subprogram focuses on upgrading selected substations to meet the SOG design philosophy. The substation bank capacity activities involve upgrading existing substation transformers and other associated equipment to allow for a substation to service its normal customer load as well as any additional load it may pick up during a SOG isolation/reconfiguration event.

The Power Electronics program integrates protection and control technology, helps reduce power quality issues associated with high DER penetration, and ultimately improves reliability to customers.

DESCRIPTION

As the adoption of distributed energy resources (DER) (e.g., customer-owned solar and energy storage) reaches critical levels and microgrid technology matures, protective device technology must also advance to appropriately detect and respond to rapid voltage and power fluctuations that often accompany non-dispatchable resources such as solar.

As clouds move across the daytime sky and momentarily block sunlight from reaching solar panels, solar generation immediately ceases. As sunlight peaks through openings in the cloud cover, the solar panels begin generating, creating power spikes and voltage instability on the circuit. These intermittent power impacts occur and then change at rapid rates (in some cases sub-second) and frequently faster than the legacy electro-mechanical voltage management equipment like regulators and capacitors can handle.

Integrating advanced solid-state technologies like power electronics (i.e., static VAR compensators and other solid-state voltage support equipment), better equips the distribution system to manage power quality issues associated with increasing DER penetration.

The program is still in its early stages and current plans are small pre-scale deployments to validate capabilities and benefits.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ IMPROVE RELIABILITY
- ✓ ENABLE VOLTAGE CONTROL
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ INCREASE HOSTING CAPACITY

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

FIRST INSTALLATION OF MINIDVAR IN DEP TERRITORY

COST-EFFECTIVE UPGRADE FOR FEEDERS WITH HIGH SOLAR PV OR DG GROWTH

PROGRAM: DISTRIBUTION SYSTEM AUTOMATION (DA)

The DA program improves how the distribution system protects the public and itself from unsafe voltage and current levels and significantly reduces the impact experienced by customers due to grid issues.

DESCRIPTION

The capabilities offered through DA can transform what may have been an hour-long power outage for hundreds or even thousands of homes and businesses into a momentary outage – or potentially help avoid an outage altogether.

The DA consists of several complementary efforts that work in concert to support dynamic and growing distribution system loads in a more sustainable way while minimizing power quality issues that often accompany a large-scale transition to solar power. One of these projects, **Urban Underground System Automation,** modernizes the protection and control of underground power systems that serve critical high-density areas, such as urban business districts and airports.

The **Fuse Replacement** project focuses on replacing one-time use fuses with automatic operating devices capable of intelligently resetting themselves for reuse, thus eliminating unnecessary use of resources (inventory, time, gasoline, etc.). The **Hydraulic to Electronic Recloser** program replaces obsolete oil-filled (hydraulic) devices with modern, remotely operated reclosing devices that support continuous system health monitoring.

Such digital device upgrades offer further value through efforts like the **System Intelligence and Monitoring** pilot, which develops advanced diagnostic tools that help engineers and technicians address electrical disturbances on the distribution system and improve customer experience.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ INCREASE DISTRIBUTED INTELLIGENCE
- ✓ IMPROVE RELIABILITY
- ✓ MODERNIZE GRID OPERATIONS & PLANNING

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

DUKE ENERGY

MORE ABOUT THE PROGRAM

Through its suite of complementary efforts, the DA Program offers a way to deliver electricity to customers while avoiding preventable service interruption for thousands of customers.

Hydraulic to Electronic Recloser

Phases out existing hydraulic (oil-filled) reclosers to reduce the oil footprint and eliminate maintenance activities. The sub-program has two phases: (1) target all hydraulic reclosers rated 140 amps or greater and replace with electronic, solid-dielectric interrupter devices; and (2) focus on smaller hydraulic reclosers (those rated less than 100 amps) and replace them with similar electronic, solid-dielectric, reclosing devices as this technology becomes mature enough for full scale deployment.

System Intelligence and Monitoring Pre-Scale Effort

Leverages data from digital devices deployed as part of the Self-Optimizing Grid, Smart Meter, and other programs to build a database and system model that monitors electrical disturbances across the distribution system. While each grid device may only monitor a portion of a circuit, advanced analytics creates a larger picture of system activity and an end-to-end blended view of customer experience. When completed, this subprogram will create a new system diagnostic tool for troubleshooting problem areas and mitigating emerging issues as they occur, as well as for managing the integration of DER.

Fuse Replacements with Electronic Reclosers

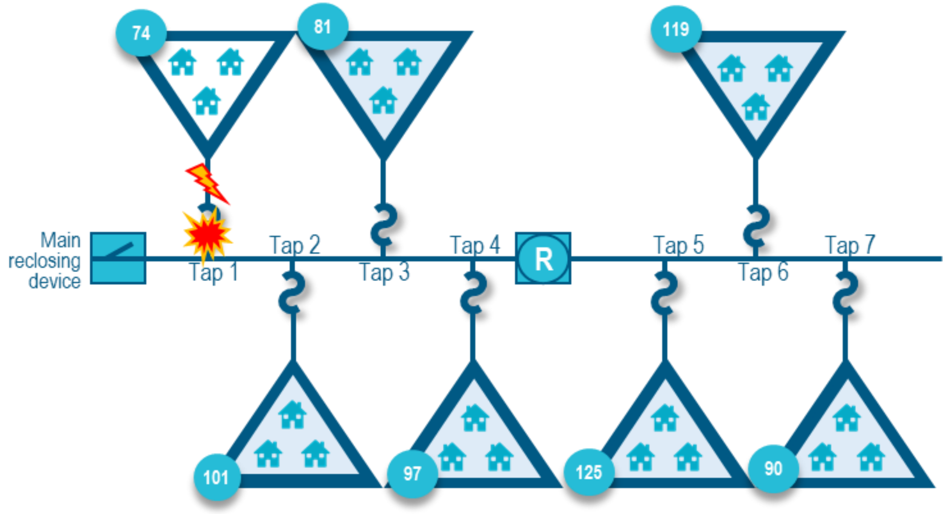
Replaces protective tap line fuses with small electronic sectionalizing devices on segments that can eliminate the most interruptions for customers. The small electronic reclosers serve to prevent customer outages by allowing temporary faults time to clear power lines before operating and initiating sustained outages. A protective fuse in this same tap line configuration is designed to actuate and initiate a sustained line outage at the first sign of a line fault; it must then be replaced before service can be restored. The fuse replacement with electronic recloser eliminates the mainline breaker from operating at all, eliminating unnecessary momentary interruptions and sustained outages.

Underground (UG) System Automation

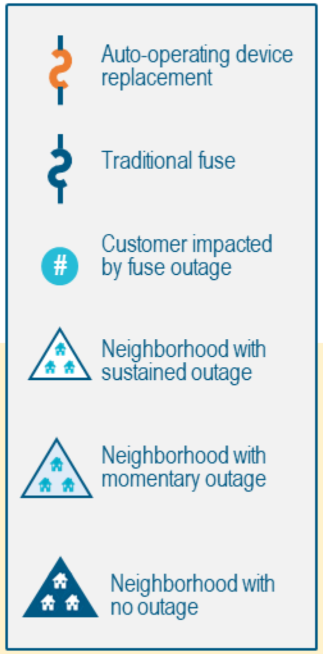
Replaces manually operated underground switchgear with remotely operated automated switchgear and deploys advanced automation schemes in urban downtown areas and other places with high density public use, such as airports and public entertainment areas. UG Automation enables automatic reconfiguration of underground systems for connecting to a new feeder or for isolating downstream system faults to minimize customer outages and impacts to the public. When completed, what might have been hours of service interruption can be reduced down to seconds.

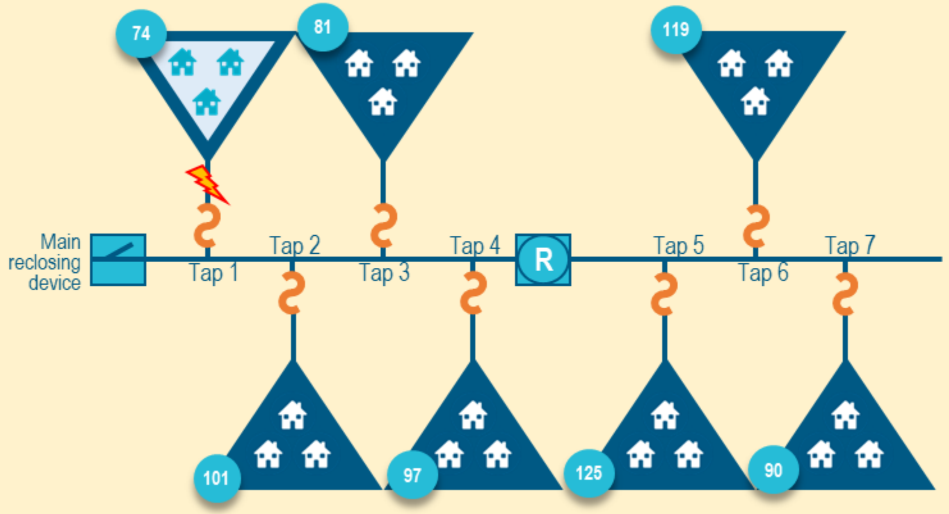
PROGRAM: DISTRIBUTION SYSTEM AUTOMATION (DA)

WITHOUT DEVICE REPLACEMENTS
(687 momentary interruptions, 74 sustained interruptions, one fuse replacement)



- Temporary fault Tap 1
- Main reclosing devices blinks
- All **687** customers experience a **momentary outage**
- The **74** customers of neighborhood 1 experience a **sustained outage** until the Tap 1 fuse is replaced





- Temporary fault Tap 1
- Main reclosing devices blinks
- Only the **74** customers experience a **momentary outage**
- Auto-operating device resets
- **Zero sustained outages**; no fuse replacement needed

WITH AUTOMATICALLY-OPERATING DEVICE REPLACEMENTS
(74 momentary interruptions only)

PROGRAM: ENERGY STORAGE

The Energy Storage program implements battery storage and other related non-traditional measures to defer, mitigate, or eliminate the need for traditional utility investments, such as line capacity upgrades.

DESCRIPTION

The program supports customer and utility initiatives through smart investments in storage for applications that deliver value to customers and the company. These applications include microgrid projects for preventing planned and unplanned outages, as well as long-duration outage projects for providing redundant power sources for vulnerable (rural and remote) communities, and circuit and bank capacity projects using substation-tied energy storage.

Given the multiple applications energy storage technology supports, projects within the Energy Storage program are designed and assessed on a case-by-case basis for the specific challenge being addressed (e.g., long duration outage support, microgrid or emergency power support, auxiliary service needs, etc.).

The Energy Storage program also includes the development and deployment of an energy storage control system to manage the fleet of energy storage resources.

GRID CAPABILITIES ENABLED

- ✓ IMPROVE RELIABILITY
- ✓ INCREASE DISTRIBUTED INTELLIGENCE
- ✓ ENABLE VOLTAGE CONTROL
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ INCREASE HOSTING CAPACITY (DER Enablement)
- ✓ MODERNIZE GRID OPERATIONS & PLANNING
- ✓ EXPAND CUSTOMER OPTIONS AND CONTROL

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

MORE ABOUT THE PROGRAM

Energy storage provides several different forms of value when applied to the distribution grid. It can be used as a tool to improve reliability to remote communities and it can help increase the how much DER in the form of solar energy can be connected to the grid. It can also be used as a way to delay or mitigate the need to invest in more traditional resources to address transmission and distribution capacity needs.

Energy Storage Control System (ESCS)

By enabling grid operators to dispatch batteries, and batteries plus solar, as part of a diverse generation portfolio, the ESCS project creates the means for distributed energy resources to provide a more cost-effective, energy storage solutions for enhancing grid efficiency and reliability, along with bulk power operations effectiveness. The primary ESCS applications include: (1) Frequency regulation services, (2) Energy arbitrage (i.e., shifting to charge off-peak, discharge-on peak), and (3) Microgrid islanding for outage support and peak shaving.

Interrelation with Integrated System Ops Planning (ISOP)

Energy storage is a technology that offers the ability to support many valued requirements across the generation, transmission and distribution systems. The Integrated System Operation Planning (ISOP) effort will enable storage and microgrid projects to be deployed more effectively.

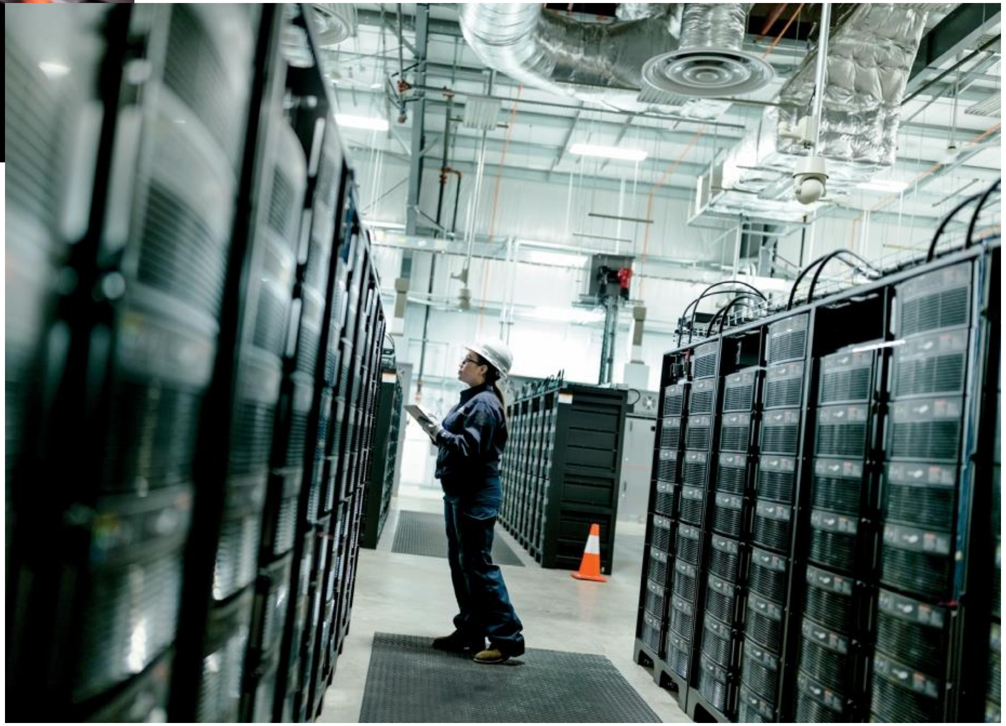
Example: Mt. Sterling Microgrid

The Mt. Sterling Microgrid project was developed to provide electric service to a remote customer in a reliable but more cost-effective way than via a traditional distribution feeder. The microgrid option meets customer needs through use of distributed energy resources, while enhancing both safety and productivity for utility workers by mitigating line maintenance activity in a high-risk, labor-intensive environment. With the maturity of energy storage technology, a microgrid with solar and storage components sized to support customer load for seven consecutive days (without solar generation) was designed, assessed, and determined to be a more reliable and cost effective option for meeting the customer's need for service. The solution, a 10-kW solar PV array, a 95-kWh battery energy storage system and remote monitoring system, offers availability 99.95% of time, with 25-year asset life.

MCALPINE MICROGRID BATTERY SYSTEM

COMMUNITY BATTERY BACKUP SYSTEM

NOTREES BATTERY STORAGE FACILITY



The LDI/HIS program is designed to improve the reliability for parts of the grid with high potential for long duration outages as well as for high-impact customers like airports and hospitals.

DESCRIPTION

The LDI/HIS program is designed to improve the reliability in parts of the grid where the duration of potential outages is expected to be much higher than average. Focus areas for this program are radial feeds to entire communities or large groups of customers as well as inaccessible line segments (i.e. off road, swamps, mountain gorges, extreme terrain, etc.).

Many of the areas served by these long, rural, single-sourced feeders can experience significant impacts to the local economy and to quality of life when the entire town loses power. Further, operational and repair costs are generally higher than average in these areas due to the special equipment required.

While some sites may include extreme hardening, circuit relocations, new circuit ties and undergrounding, energy storage solutions may offer more cost-effective solutions for improving reliability and managing costs.

The LDS/HIS program is designed to improve the reliability of high- impact customers like airports and hospitals, and high-density areas that could require a variety of infrastructure solutions to improve power quality and reliability. Typical projects include substation upgrades, circuit ties, voltage conversions, and reconductoring.

GRID CAPABILITIES ENABLED

- ✓ IMPROVE RELIABILITY
- ✓ HARDEN FOR RESILIENCY

VALUE TO OUR CUSTOMERS

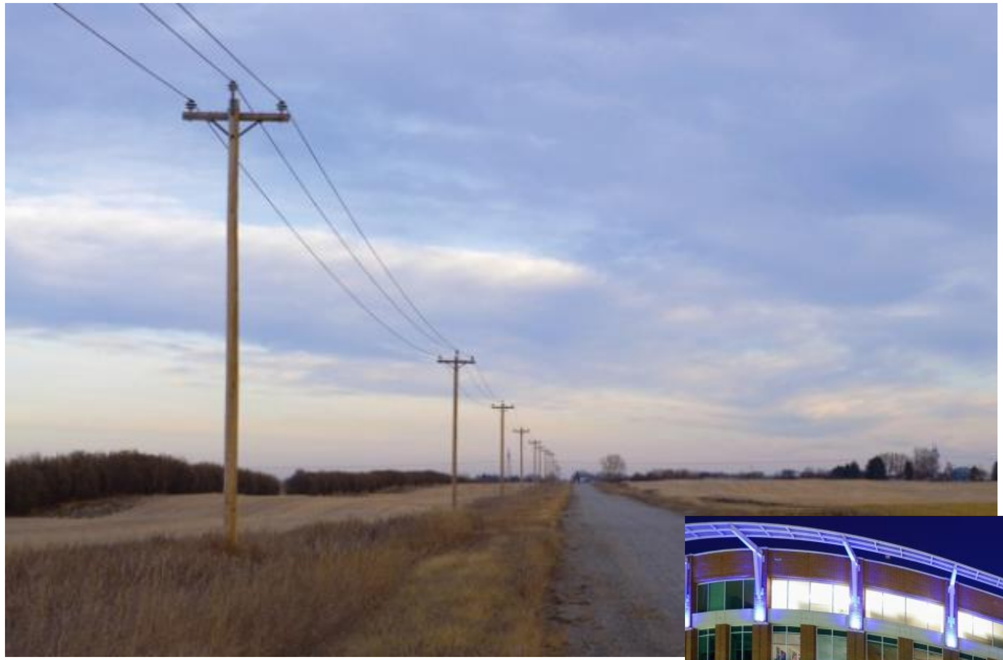
- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

PROGRAM: LONG DURATION INTERRUPTION / HIGH IMPACT SITES (LDI/HIS)

DUKE ENERGY



DOWNTOWN GREENVILLE, SC

The ISOP program integrates utility planning for generation, transmission, distribution, and customer programs to improve the valuation and optimization of energy resources across the system.

DESCRIPTION

Requirements for modern electric utility systems are evolving rapidly with the advent of emerging new energy technologies, changes in policy, and rapid advancements in information exchange and customer needs. Integrated System Operations Planning (ISOP) focuses on the integration of utility planning disciplines for generation, transmission, distribution and customer programs to improve the valuation and optimization of energy resources across all segments of the utility system to best serve electric customers.

The ISOP process addresses key operational and economic considerations across all segments of the system through integration and refinement of existing system planning tools and, in some cases, development of new analytical tools to assess characteristics that have not historically been captured or considered in long-term planning. Some examples include locational values for distributed resources, system ancillaries and reserves needed to support future operations, and energy resource flexibility to support new dynamic operational demands on the system.

ISOP is a multi-year development program to build the tools and processes needed to accommodate an increasingly integrated approach that will be required to optimize planning and operation of the electric utility system of the future.

GRID CAPABILITIES ENABLED

- ✓ INCREASE AUTOMATION
- ✓ INCREASE DISTRIBUTED INTELLIGENCE
- ✓ IMPROVE RELIABILITY
- ✓ ENABLE VOLTAGE CONTROL
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ INCREASE HOSTING CAPACITY

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

PROGRAM: TARGETED UNDERGROUNDING (TUG)

The TUG program strategically identifies Duke Energy's most outage prone overhead power line sections and relocates them underground to reduce the number of outages experienced by customers.

DESCRIPTION

Overhead power line segments with a history of unusually high numbers of outages drive a disproportionate amount of momentary interruptions and outages that affect Duke Energy's customers. When these segments of lines fail, they cause problems for Duke Energy's customers directly served by them as well as customers upstream. Lines targeted to be moved underground are typically the most resource-intensive parts of the grid to repair after a major storm. Equipment on these line segments can experience shortened equipment life and additional equipment-related service interruptions.

The goal of the TUG program is to maximize the number of outage events eliminated. Converting outage prone parts of the system enables Duke Energy to restore service more quickly and cost effectively for all customers. Addressing areas with outlier outage performance improves service while lowering maintenance and restoration costs for all customers.

Criteria for consideration in the selection of targeted communities include:

- Performance of overhead lines
- Age of assets
- Service location (e.g., lines located in backyard where accessibility is limited)
- Vegetation impacts (e.g., heavily vegetated and often costly and difficult to trim)

GRID CAPABILITIES ENABLED

- ✓ IMPROVE RELIABILITY
- ✓ HARDEN FOR RESILIENCY
- ✓ MODERNIZE GRID OPERATIONS & PLANNING

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

PROGRAM: TARGETED UNDERGROUNDING (TUG)

DOWNED POWER POLES

DAMAGE FROM HURRICANE MATTHEW

LINEMAN IN RAIN

IN AREAS INACCESSIBLE BY BUCKET TRUCK, LINEMEN HAVE TO CLIMB POLES TO MAKE REPAIR

PROGRAM: DISTRIBUTION TRANSFORMER RETROFIT

DUKE ENERGY

The Distribution Transformer Retrofit program converts existing overhead distribution transformers to deliver the same reliability benefits as a modern transformer installed today.

DESCRIPTION

Like the Self-Optimizing Grid program, the new sectionalization capability of a retrofitted transformer works to minimize the number of customers impacted by fault or failure on the power line. In addition, similar to the Targeted Undergrounding program, the new protective features that mitigate equipment vulnerabilities work to significantly lower the risk of an outage occurring at the transformer all together.

The core activities of the transformer retrofit program include the installation of a fuse disconnect device on the high-voltage side of every overhead transformer to protect upstream customers from a fault at or downstream of the transformer. In addition, through protective device coordination, the local fused disconnect can be set to prevent any upstream operations of reclosing devices (the source of momentary outages for customers not served by the retrofitted transformer.)

Consistent with modern transformer standards, the program also retrofits transformers with additional protective elements to reduce the risk of external factors such as lightning strikes and animal interference.

GRID CAPABILITIES ENABLED

- ✓ IMPROVE RELIABILITY
- ✓ MODERNIZE GRID OPERATIONS & PLANNING

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

UN-RETROFITTED CSP TRANSFORMER

RETROFITTED TRANSFORMER

FUSED CUTOUT, ANIMAL GUARDS,
COVERED LEAD WIRE, NEW ARRESTER.

The Distribution H&R – Flood Hardening program will be targeted to areas where an overlay of actual outage events from Hurricanes Matthew and Florence intersect with the 100-year flood plan.

DESCRIPTION

In hurricane events like Hurricane Floyd and more recently Hurricanes Matthew and Florence, significant flooding was a major factor impacting restoration. Smart, targeted investments can mitigate the scale of impacts on communities and customers adjacent to these areas prone to extreme flooding. Hardening lines and structures is a balanced approach that can keep power and critical services available to some portion of a community and prevent a widespread outage in an area until flooding recedes.

This program includes the following:

- Alternate power feeds for substations in flood-prone areas, and for radial power lines that cross into and through flood-prone areas
- Hardened river crossings where power lines are vulnerable to elevated water levels during extreme flooding
- Improved guying for at-risk structures within flood zones

GRID CAPABILITIES ENABLED

- ✓ IMPROVE RELIABILITY
- ✓ HARDEN FOR RESILIENCY
- ✓ IMPROVE PHYSICAL SECURITY

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
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WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

MORE ABOUT THE PROGRAM

Data analytics and geo-spatial analysis will assist Duke Energy in identifying patterns of repeat flood impact issues and allow a targeted basis for assessing hardening investments with a cost benefit analysis approach that delivers savings to Duke Energy customers and, at the same time, enhanced reliability for these flood-prone areas.

For a three-year window, this program will focus on hardest hit flood-prone areas from Hurricanes Matthew and Florence, defining opportunities to accomplish the following:

- Event elimination where hardening can demonstrably eliminate future outages events and repair work
- Resiliency options to re-route power and keep many people supplied with power while repairs to damaged facilities are made.

This program will be coordinated with other programs to ensure work scopes do not overlap.

GOLDSBORO FLOODING DURING HURRICANE MATTHEW

FLOODING OF A SUBSTATION IN GOLDSBORO FOLLOWING HURRICANE MATTHEW (2016)

The Smart Meter program is a metering solution (meters, communication devices and networks, and back office systems) used to create two-way communications between customer meters and the utility.

DESCRIPTION

Smart meters are digital electricity meters that have advanced features and capabilities beyond traditional electricity meters. Some of the advanced features include the capability for two-way communications, interval usage measurement, tamper detection, voltage and reactive power measurement, and net metering capability.

Duke Energy's standard smart meter system utilizes a radio frequency ("RF") mesh architecture, which is flexible in that the meters within the mesh network establish an optimized RF communication path to a collection point either through other meters, through network range extenders, or via a direct cellular connection.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ INCREASE DISTRIBUTED INTELLIGENCE
- ✓ ENABLE VOLTAGE CONTROL
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ EXPAND CUSTOMER OPTIONS AND CONTROL

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

PROGRAM: SMART METERING INFRASTRUCTURE

The Electric Transportation effort is a proposed pilot program for South Carolina that will focus on advancing adoption of electric transportation in the State.

DESCRIPTION

The program will establish a foundational level of fast charging infrastructure and determine best practices for cost-effective integration of various electric vehicle types. It will also serve to financially support the deployment of electric school and transit buses in conjunction with the 2016 Volkswagen settlement agreement.

The program will also allow system planners to assess the impacts of charging different types of electric vehicles, as well as impacts that various charging configurations have on the electric system.

In addition to evaluating grid impacts, the Electric Transportation pilot program will assess how all utility customers can benefit from increasing adoption of electric transportation. The pilot program will consist of five components: (1) Residential EV Charging Rebate, (2) Electric Vehicle School Bus Program, (3) Electric Vehicle Transit Bus Program, (4) DC Fast Charging Infrastructure Program, and (5) Education and Outreach.

Another benefit to advancing electric transportation is improved air quality by displacing hydrocarbon based fuels and lowering emissions.

GRID CAPABILITIES ENABLED

- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ INCREASE HOSTING CAPACITY
- ✓ MODERNIZE GRID OPERATIONS & PLANNING
- ✓ EXPAND CUSTOMER OPTIONS AND CONTROL

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

MORE ABOUT THE PROGRAM

In 2011, Duke Energy conducted a plug-in electric vehicle charging station pilot in DEC. This pilot provided charging stations and up to $1,000 credit toward installation for customers who bought or leased a plug-in electric vehicle. Duke Energy analyzed the distribution impact and ways to mitigate those impacts as electric vehicles come into its service territory; the technical capabilities that the charging stations can offer to help mitigate those potential impacts; and when, where, how long, and how often a customer charges their electric vehicle.

Fast Charging Deployment Needed for Market Growth

Electric vehicles are coming to South Carolina as sales growth through the end of 2017 continued with a compound annual growth rate of 43% since 2011. Lack of charging stations is commonly cited as a barrier to purchasing an EV. The program estimates that approximately 1,000 public direct-current fast charging ("DCFC") plugs will be necessary by 2025 to support current forecasts of EV market growth. Currently, there are only 40 open-standard, publicly available DCFC plugs in South Carolina.

Volkswagen Environmental Mitigation Trust

In 2016, Volkswagen agreed to spend up to $14.7 billion to settle allegations of cheating emissions standards. Of that amount, $2.9 billion was used to establish an Environmental Mitigation Trust, which states and U.S. territories may use to invest in transportation projects that will reduce NOx emissions. Of that amount, $34 million was allocated to South Carolina as a beneficiary under the Settlement Trust. In April 2018, the SCDOI announced the release of the first draft of the state's Beneficiary Mitigation Plan ("BMP"). Eligible mitigation actions under the BMP include replacing or repowering diesel school buses, shuttle buses, or transit buses. In addition, beneficiaries may utilize up to 15% of their total allocation on costs relating to light duty, zero-emission vehicle supply equipment.

Other States Are Embracing Electric Vehicles

The Florida PSC approved an EV Infrastructure Pilot proposed by DEF, including public Level 2 and DC Fast Charging; in New York, ConEdison is supporting the deployment of electric school and transit buses, planned fast charging networks, and residential customer charging research. In Orlando, Florida, the Orlando Utilities Commission has deployed one of the largest municipal EV infrastructure programs in the country. Other examples of states that have embraced EVs in a pilot or otherwise include Maryland, Massachusetts, Oregon, Kentucky, Ohio, and California. Georgia Power has installed 25 public fast charging stations, facilitating EV adoption across the state of Georgia. By installing DC Fast Charging stations in South Carolina, the ET Pilot would build on this neighboring network and allow EV drivers to seamlessly traverse South Carolina along the crucial I-85, I-95, and I-26 interstate corridors.

PROGRAM: ELECTRIC TRANSPORTATION

PROGRAM: CUSTOMER DATA ACCESS

The Customer Data Access program focuses on preparing key data systems for sharing data in a manner that aligns with prevailing data access protocols such as the Green Button standard.

DESCRIPTION

Currently, the Company offers a method for customers to download their trailing energy usage data into an XML format. The Customer Data Access program will incorporate modern data access protocols such as the current "**Green Button-Download My Data**" functionality.

"**Green Button-Connect My Data** (CMD)" is a regular automatic transfer of a customer's interval usage data to a third party upon authorization by the customer. The Customer Data Access program will evaluate deployment of CMD or functionality like CMD based on several factors and requirements relevant to South Carolina customers and stakeholders.

GRID CAPABILITIES ENABLED

- ✓ EXPAND CUSTOMER OPTIONS AND CONTROL

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

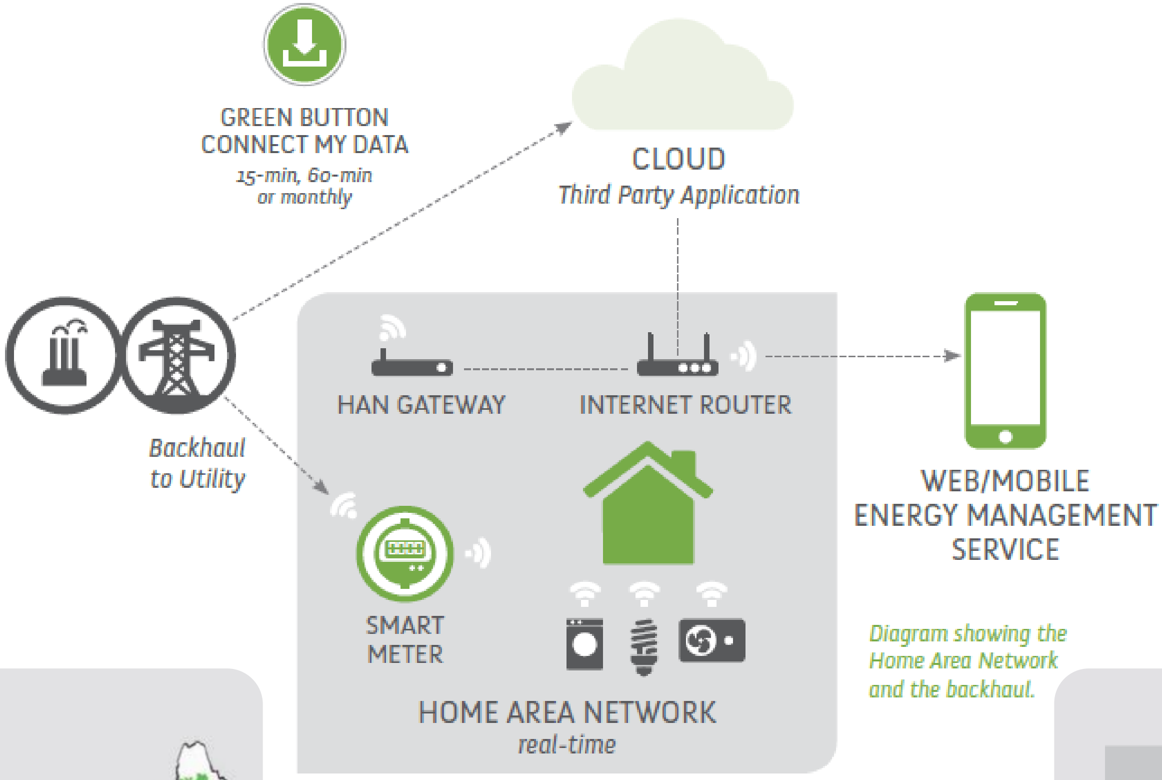
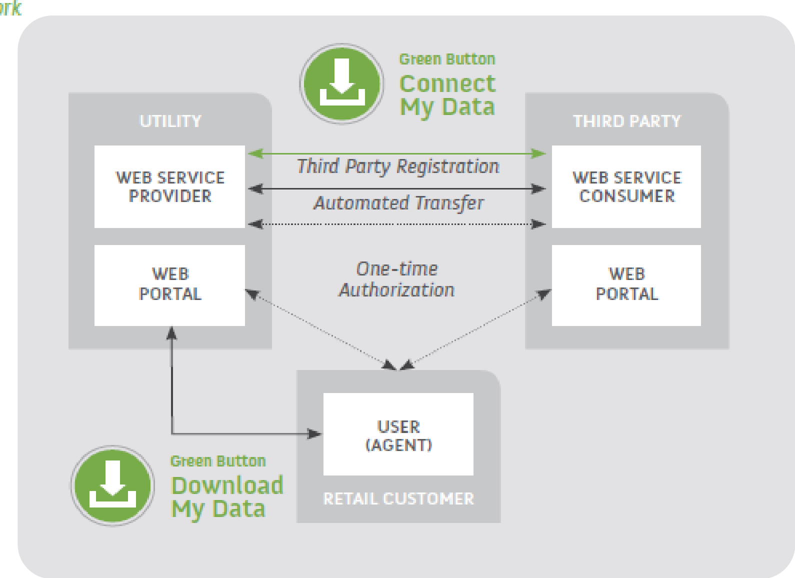


Diagram showing the Home Area Network and the backhaul.

Adoption of Green Button DMD



Source: Murry, M. and Hawley, J., Got Data? The Value of Energy Data Access to Consumers. More Than Smart. January 2016. <Retrieved from http://www.missiondata.org/s/Got-Data-value-of-energy-data-access-to-consumers.pdf>

PROGRAM: TRANSMISSION SYSTEM INTELLIGENCE

DUKE ENERGY.

The Transmission System Intelligence program deploys transformational system monitoring and control equipment to enable faster response to outages and more intelligent analysis of issues on the grid.

DESCRIPTION

Transmission grid automation improvements will reduce the duration and impacts associated with transmission system issues.

Improvements in transmission system device communication capabilities enable better protection and monitoring of system equipment. The data collected from intelligent communication equipment helps better assess and optimize transmission asset health.

The Transmission System Intelligence program includes 1) the **replacement of electromechanical relays** with remotely operated digital relays, 2) the implementation of **intelligence and monitoring technology** capable of providing asset health data and driving predictive maintenance programs, and 3) the deployment of **remote monitoring and control** functionality for substation devices, and rapid service restoration.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ IMPROVE RELIABILITY
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ MODERNIZE GRID OPERATIONS & PLANNING

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

MORE ABOUT THE PROGRAM

System Intelligence and Monitoring

This subprogram focuses on a machine-learning platform that can determine when equipment maintenance or repair is needed. Health and Risk Monitoring (HRM) of the transmission system allows asset managers to proactively address equipment issues before catastrophic equipment failures occur. The HRM platform utilizes Condition Based Monitoring (CBM) – the continuous remote monitoring of asset health data which is used to extend asset life or execute mitigating activities to prevent equipment failures. HRM supplements CBM data with information from Digital Fault Recorders (DFR), which record the details of transmission system faults to support the types of post-fault event analysis that drives future system performance improvements.

Electromechanical to Digital Relays

This subprogram replaces noncommunicating electromechanical and solid state relays with digital relays. Modern relay design with communications capabilities and microprocessor technology enables quicker recovery from events than the design of the existing electromechanical relays. One digital relay is capable of replacing a variety of legacy single-function electromechanical relays. Two-way communications and event recording capabilities allow them to provide device performance information following a system event to support continuous system design and operational improvements. Additionally, they identify line fault locations, which is the ability to use device data to calculate the distance down a line to a line fault, rather than manually assessing and patrolling transmission lines.

Remote Substation Monitoring

This subprogram enables operators to remotely monitor and control substations. This includes the installation or upgrade of supervisory control and data acquisition system (SCADA) interfaces for substation devices, called remote terminal units (RTUs), and upgrades to associated data communication channels. This subprogram is a critical enabler for programs like Integrated Volt/Var Control and Distribution Automation. This subprogram also upgrades serial communication to IP communication for existing RTUs to collect more data and support more devices.

Remote Control Switches

This subprogram replaces non-communicating switches with modern switches enabled with SCADA communication and remote control capabilities. Transmission line switches are currently manually operated in most substations and cannot be remotely monitored or controlled. Switching, a grid operation often used to section off portions of the transmission system in order to perform equipment maintenance or isolate trouble spots to minimize impacts to customers, has historically required a technician to go to a substation and manually operate one or more line switches. This subprogram increases the number of remote controlled switches to support faster isolation of trouble spots on the transmission system and more rapid restoration following line faults.

PROGRAM: TRANSMISSION SYSTEM INTELLIGENCE

Oliver Exhibit 11
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PROGRAM: TRANSMISSION HARDENING & RESILIENCY (H&R)

DUKE ENERGY

The Transmission (H&R) program works to create a stronger and more resilient transmission grid capable of withstanding or quickly recovering from extreme external events, natural or man-made.

DESCRIPTION

Each Transmission H&R sub-program works to address unique challenges in ways that harden the system, and not only minimize impacts to customers, but enhance their electric service experience. The **44-kV System Upgrade** subprogram both protects the 44-kV system from extreme weather, but also paves the way for more DER interconnections by creating additional capacity on the system to transport generation from large scale solar sites. Similarly, the **Targeted Line Rebuild for Extreme Weather** subprogram protects some of the higher voltage transmission lines from extreme weather by addressing vulnerable wooden structures.

The **Networking Radially Served Substations** subprogram builds in more resiliency to the transmission system by creating alternative ways to provide customers with reliable electricity supply in the case of an issue with the primary transmission feed; and, the **Substation Flood Mitigation** subprogram builds in protection for substations most vulnerable to flood damage. Altogether, these H&R efforts not only enhance the functionality of individual assets, but substantially improve the overall functionality of the system, particularly under extreme weather conditions. The long-term plan for hardening and resiliency is to relocate or strengthen at-risk assets or other solutions such as raising the flood plane at that site.

GRID CAPABILITIES ENABLED

- ✓ IMPROVE RELIABILITY
- ✓ HARDEN FOR RESILIENCY
- ✓ IMPROVE PHYSICAL SECURITY

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

MORE ABOUT THE PROGRAM

44kV System Upgrades

Rebuilds and upgrades targeted portions of the 44-kV system to both harden the system against extreme weather, position the system to support DER, and make the overall system more resilient. This will be accomplished in three phases:

- PHASE I (infrastructure upgrades): structurally rebuilds the system, replacing wood structures with taller/stronger steel or concrete structures to better withstand damage in extreme weather conditions. Rebuilding 44-kV lines to 100-kV standards improves performance due to greater elevation and clearance from vegetation. The increased conductor spacing between each of the phases and the addition of basic insulation decreases impacts of lightning events.
- PHASE II (voltage conversions): converts specific circuits of the 44-kV system to 100-kV, making them more capable of supporting large scale solar, storage and other DER. These conversions also require converting the substations served by these lines, which generally involves installing high rated equipment such as transformers and breakers. Portions of the 44-kV system, particularly in rural areas that are prime locations for utility scale solar development, are capacity constrained and unable to support additional interconnections.
- PHASE III (circuit looping): builds in circuit ties between upgraded and converted circuits. This creates a looped circuit design capable of feeding power to these circuits from other sources, as needed, to provide additional system resiliency.

Networking Radially Served Substations

Increases resiliency of radially served substations where outage duration is higher than average, including: networked lines sectionalized into separate radial lines, and lines designed as radial feeders. Networked radial lines can be re-networked by replacing the conductor with higher ampacity and by upgrading the protective relaying. Lines designed as radial feeders will be networked to existing lines into another substation. Substations served by networked transmission lines can be served from either end of the line and the line can be sectionalized to isolate an interruption and restore the majority, if not all, of customers before the full line is restored.

MORE ABOUT THE PROGRAM

Substation Flood Mitigation

Systematically reviewing and prioritizing substations at risk of flooding to determine the proper mitigation solution, which may include elevating or modifying equipment in substations or relocating substations altogether.

Targeted Line Rebuilds for Extreme Weather Events

Specific transmission lines require rebuilding to withstand extreme weather (including wind and ice) and mitigate the risk of unplanned outages. Lines are targeted based on risk-advised decisions along with selection criteria including: tower height, tower condition, and age of asset. Proactive replacement of wooden poles to steel poles that comply with the National Electrical Safety Code (NESC) achieve benefits such as protecting extreme weather and reducing O&M costs.

PROGRAM: TRANSMISSION HARDENING & RESILIENCY (H&R)

DUKE ENERGY

TRANSMISSION POLE REPLACEMENTS

69 KV WOOD POLE CONSTRUCTION

NEW 69 KV STEEL POLE CONSTRUCTION

PROGRAM: TRANSFORMER BANK REPLACEMENT

The Transformer Bank Replacement program leverages new system intelligence capabilities to target transformers before they fail.

DESCRIPTION

Predictive and proactive replacement programs like Transformer Bank Replacement significantly reduce the impacts and costs of replacement when compared to performing the same work following a catastrophic failure.

The objective of this program is to anticipate future transformer failures and replace those transformers in an orderly fashion, avoiding the cost and customer outage minutes associated with these failures. Catastrophic failures often result in significant oil spills, requiring expensive cleanup and other mitigation. Proactive replacement also reduces contingent material inventory needed, since replacements have a 12-24 month manufacturing lead time.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ IMPROVE RELIABILITY
- ✓ MODERNIZE GRID OPERATIONS & PLANNING

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

PROGRAM: OIL BREAKER REPLACEMENT

The Oil Breaker Replacement program identifies and replaces oil-filled circuit breakers on the transmission and distribution systems with modern technology.

DESCRIPTION

The purpose of this program is to replace these legacy assets with breaker technology capable of two-way communications and remote operations.

Transmission level oil breakers will be replaced with the modern sulfur hexafluoride gas (SF_6) circuit breaker technology. The medium voltage distribution level oil-filled breakers will be replaced with modern vacuum circuit breaker technology.

The new communication and control capabilities of this modern technology better positions the transmission and distribution systems to work with grid automation systems to better respond to electric grid events. Looking forward, these fast-response gas and vacuum breakers are better suited for protecting circuits with higher solar and other variable energy resource penetration.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ IMPROVE RELIABILITY
- ✓ MODERNIZE GRID OPERATIONS & PLANNING

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

PROGRAM: PHYSICAL & CYBER SECURITY

The Physical and Cyber Security program protects against the potential risks and impacts of attacks on the electric grid.

DESCRIPTION

The program focuses on hardening above the standard compliance requirements. Transmission elements of the program include:

- **Transmission substation physical security**
- **Windows-based change outs** to address cyber security standards for older Windows-based relays.
- **Cyber security enhancements for non-bulk electric system substations**
- **Electromagnetic Pulse and Intentional Electromagnetic Interference (EMP/IEMI) Protection**

At the distribution system level, much of the focus involves securing and improving risk mitigation of remotely controlled field equipment. An example is enabling door alarms and entry notifications. Programs include:

- **Device Entry Alert System** (DEAS)
- **Distribution Line Device Cyber Protection**
- **Secure Access Device Management** (SADM) - a single tool to remotely and securely perform device management activities and event record retrieval on the entire transmission and distribution device inventory.

GRID CAPABILITIES ENABLED

- ✓ HARDEN FOR RESILIENCY
- ✓ IMPROVE CYBER SECURITY
- ✓ IMPROVE PHYSICAL SECURITY
- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ IMPROVE RELIABILITY

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

PROTECT to reduce threats to the grid

MORE ABOUT THE PROGRAM

Transmission Substation Physical Security

This subprogram enhances the grid resiliency as part of the overall Transmission Security program. Tier 1 site enhancements include high security perimeter fencing and lighting, intrusion detection technology, new security enclosure buildings, hardening of existing control houses, security cameras, and access control. Tier 2 site enhancements include high security perimeter fencing and lighting.

Windows-based Unit Change Outs

The Windows-based Unit Change Outs effort replaces older Windows-based relays that cannot be upgraded due to technology constraints (such as insufficient memory or relay condition). Following these upgrades, the new devices will operate in a Linux environment and be compliant with standards.

Cyber Security Enhancements for non-BES

Cyber Security Enhancements for non-bulk electric system (BES) substations implements protective measures against possible cyber-attacks at those non-BES substations that have Internet-Protocol (IP) routable devices. Such measures include the installation of firewalls and the replacement of vulnerable devices.

EMP/IEMI Protection

Electromagnetic pulses (EMP) and Intentional Electromagnetic Interference (IEMI) can create disruptions for electronic equipment. The measures taken to protect against them focus on hardening and protecting targeted equipment. The electric industry is engaged in significant research, led by the Electric Power Research Institute (EPRI), focused on improving cost-effective and feasible mitigation against EMP/IEMI. This subprogram will focus on pre-scaled implementation of industry research findings.

MORE ABOUT THE PROGRAM

Device Entry Alert System (DEAS)

The Device Entry Alert System (DEAS) project will install an entry door alarm head-end system and deliver processes to enhance physical and cyber security on the distribution systems' intelligent electronic devices (IEDs). This tool will ensure that all physical access of IEDs and related infrastructure in the field are being tracked and monitored.

Secure Access and Device Management (SADM)

SADM provides a tool to remotely and securely perform device management activities and event record retrieval on our entire device inventory in transmission and distribution. The goal of the project is to improve the security of field devices and increase compliance with North American Electric Reliability Corporation critical infrastructure protection (NERC CIP) and other security requirements.

SADM also provides process and labor efficiencies associated with device management, and improves post-event resolution. Within this program, we will standardize systems and processes for secure remote access to field devices, implement device management tasks (including password management, firmware management, configuration management), manage post-fault and other operational event records, and implement a common solution and support model across all jurisdictions within transmission and distribution.

Distribution Line Device Cyber Protection

The Distribution Line Device Cyber Protection projects address physical and cyber security risks for thousands of SCADA-controlled line devices (e.g., regulators, capacitors, reclosers, etc.). The focus of the projects in this workstream is targeted replacement of legacy control equipment with Enterprise Security and Advanced Distribution Management System compliant equipment. The newer installed equipment meets or exceeds Duke Energy Industrial Control System (ICS) enterprise security requirements and also provides a platform for future asset management enhancements, such as remote firmware and device settings management, reducing the need to travel physically to a site to perform a system upgrade. Examples of equipment being replaced include capacitor and distribution (recloser) control devices.

COCHRANE FENCE & MAIN ENTRANCE CRASH GATE

The Enterprise Communications program modernizes and secures the critical communications between intelligent grid management systems, data and controls systems, and sensing and control devices.

DESCRIPTION

The program addresses technology obsolesce, secures vulnerabilities, and provides new workforce-enabling capabilities. This program includes improvement and expansion of the entire communications network from the high-speed, high-capacity backbone fiber optic and microwave networks to the wireless connections at the edge of the grid. These upgrades help build the secure communications required for the increasing number of smart components, sensors, and remotely activated devices on the transmission and distribution systems.

Key communication efforts are: (1) **Mission Critical Transport** which strategically upgrades the infrastructure required for high-speed, reliable, sustainable, interoperable communications for grid devices and personnel; (2) **Grid Wide Area Network (Grid WAN)** which improves network reliability, performance and security for current grid management/control applications; (3) **Mission Critical Voice** which replaces current Land Mobile Radio systems with enhanced, reliable, sustainable, interoperable communications across all service territories; and (4) **Next Generation Cellular** which replaces obsolete 2G/3G cellular technology with the more reliable and secure 4G/5G technology required for modern grid devices in the field.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ IMPROVE RELIABILITY
- ✓ ENABLE VOLTAGE CONTROL
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ IMPROVE CYBER SECURITY

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

MORE ABOUT THE PROGRAM

Mission Critical Transport

Implements the strategic advancements to the backbone of the communication network to ensure reliable, sustainable, interoperable communications for grid devices and personnel. Replaces end-of-life fiber cable, optical systems, and microwave systems; strategically expands high-capacity fiber to new, targeted routes; and investigates alternatives for faster or more cost-effective fiber deployments.

Business Wide Area Network

Updates data network architecture to improve reliability and performance of the core business. Assesses capacity and redundancy requirements and evaluates network options for the core business network and associates area network structures. Supports growing demands for workforce mobility, real-time video capture, data transport needs, and mitigating communication network congestion.

Grid-wide Area Network (Grid WAN)

Improves network reliability, performance and security for grid control, O&M applications by replacing end-of-life data network hardware and converting substations to an IP network architecture. Employs a network redesign, providing capacity and resiliency, and positioning the network to support Field Area Network (FAN) and Neighborhood Area Network (NAN) needed for enabling a smart cities future.

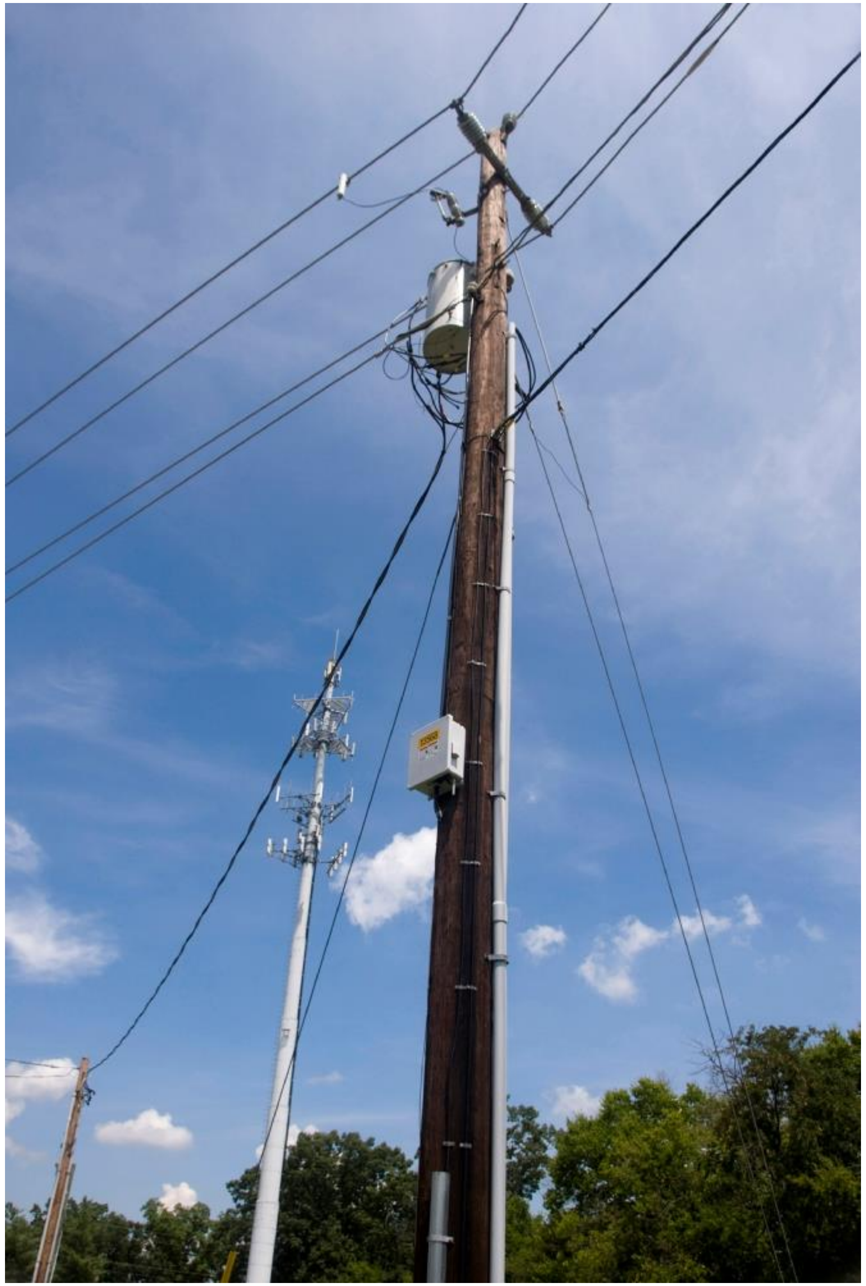
Mission Critical Voice

Strategic replacement and improvement of mission-critical voice (radio) communications to provide reliable, sustainable, interoperable communications for all jurisdictions and businesses. The new radio system will provide increased functionality and interoperability between regions, allowing field workers to use the same radio system to help another region during major storms.

Next Generation Cellular

Addresses the need to migrate 2G/3G communication networks (to be decommissioned by cellular service providers) to updated 4G/5G. Replaces existing network devices located on distribution line devices. In addition to supporting communication continuity through network decommissioning, these upgrades provide greater network bandwidth, lower data latency, and better cybersecurity protection.

PROGRAM: ENTERPRISE COMMUNICATIONS ADVANCED SYSTEMS



The Enterprise Applications program deploys the systems and upgrades needed to monitor the health and security of the grid and analyze data to enable grid automation and optimization technologies.

DESCRIPTION

Upgrades to existing enterprise applications enable system optimization and overall better system performance. Within the program, there are two main components responsible for the delivery of enterprise technology solutions that support transmission, distribution, and other critical lines of business: (1) **Enterprise Systems** and (2) **Grid Analytics**.

This effort focuses on delivering transformative, cross-functional technical solutions to the enterprise in non-disruptive ways. Elements within the portfolio include the Integrated Tools for Outage Applications (iTOA), which works to drive standardization and coordination of grid control center tools and the Targeted Undergrounding (TUG) System, which facilitates efficient workflows via asset management and mapping system upgrades.

Grid Analytics optimizes the electric system health and performance through the deployment of the Health Risk Management (HRM) tool and Enterprise Distribution System Health (EDSH) tool. These tools help to prevent equipment failures and improve asset performance on the transmission and distribution systems, respectively.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ INCREASE DISTRIBUTED INTELLIGENCE
- ✓ IMPROVE RELIABILITY
- ✓ ENABLE VOLTAGE CONTROL
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ IMPROVE PHYSICAL SECURITY

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

MORE ABOUT THE PROGRAM

Integrated Tools for Operations Application (ITOA)

ITOA is a new platform that optimizes current processes and drives standardization regarding system functionality, work processes, and configuration. This project also upgrades and consolidates outage coordination as well as planned switching and logging applications for transmission and distribution control centers.

Targeted Undergrounding (TUG) System

The TUG System automates manual processes and facilitates faster and more efficient workflow by integrating asset management systems. The product enhances the existing enterprise systems for tracking TUG work and creates new mapping capabilities. The mapping enables visualization of the ongoing targeted underground work and consistency in reporting.

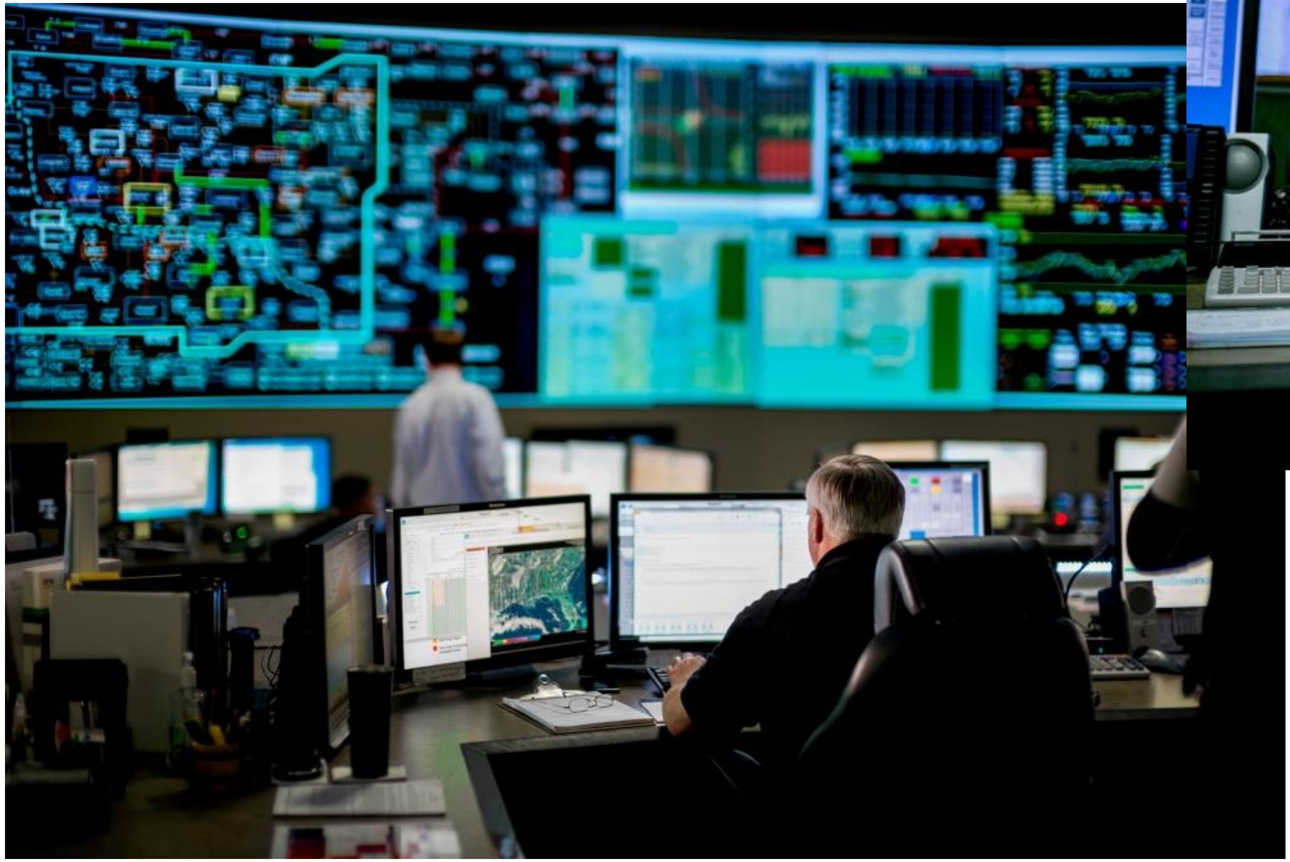
Health and Risk Management (HRM)

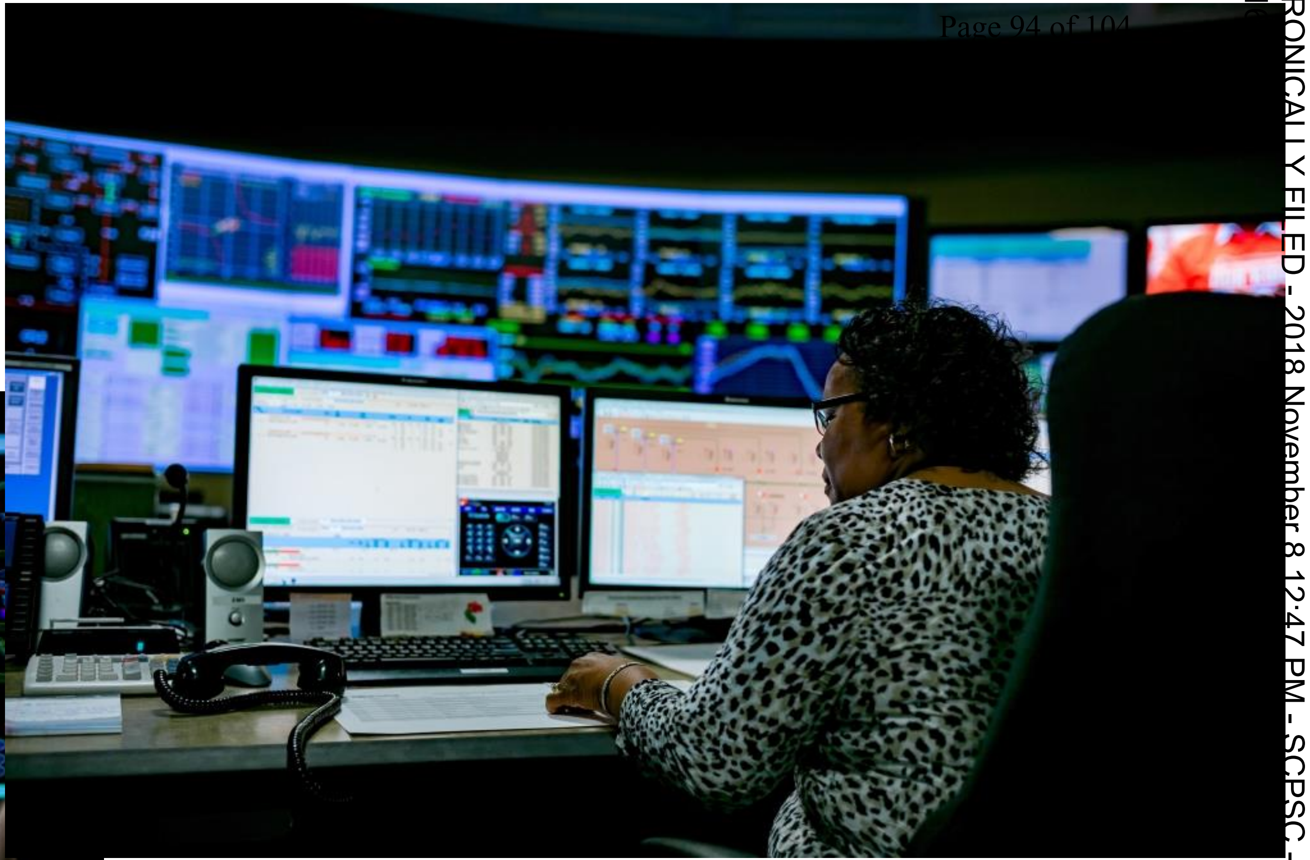
HRM will provide a new platform for collecting data and applying analytics optimization for managing transmission system assets. This sub-program will collect and analyze data to improve the management of assets by using predictive and prescriptive analytics and take proactive steps to prevent or mitigate disruptive events..

Enterprise Distribution System Health (EDSH)

EDSH provides a platform that enables PQR&I Planning, Governance, and Customer Delivery to improve reliability and customer satisfaction. It will enable customer-centric reliability planning and provide a basis for optimizing investments using predictive and prescriptive analytics and allow Duke Energy to take proactive steps to prevent or mitigate disruptive events.

PROGRAM: ENTERPRISE APPLICATIONS





PROGRAM: DER DISPATCH ENTERPRISE TOOL

DUKE ENERGY

The DER Dispatch Enterprise Tool is a software-based solution that provides operators with the ability to monitor and manage both transmission and distribution connected DERs.

DESCRIPTION

This tool will coordinate with the Distribution Management System (DMS) and Energy Management System (EMS) to improve the way DERs are integrated in the energy supply mix, both at the Distribution and the bulk power level.

By providing system-wide visualization and control of large-scale DERs, the DER Dispatch Tool will enable system operators to model, forecast, and dispatch a portfolio of distributed energy resources, like solar generation, biofuel generation and energy storage, based on system conditions and real-time customer demand. This tool will help meet the need to match energy demand with supply, especially in emergency conditions.

Current processes and tools provide system operators with a rudimentary ability to quickly shed large blocks of solar generation in emergency conditions to meet standards for real power control (BAL-001-2). The proposed solution will provide operators with a more automated and refined toolset to optimize management of both utility and customer owned DERs to meet system stability requirements.

This system will replace an existing tool in DEP that is used to dispatch distribution connected solar in 50 MW increments

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE DISTRIBUTED INTELLIGENCE
- ✓ ENABLE VOLTAGE CONTROL
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ EXPAND CUSTOMER OPTIONS AND CONTROL

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

SOUTH CAROLINA GRID IMPROVEMENT PLAN

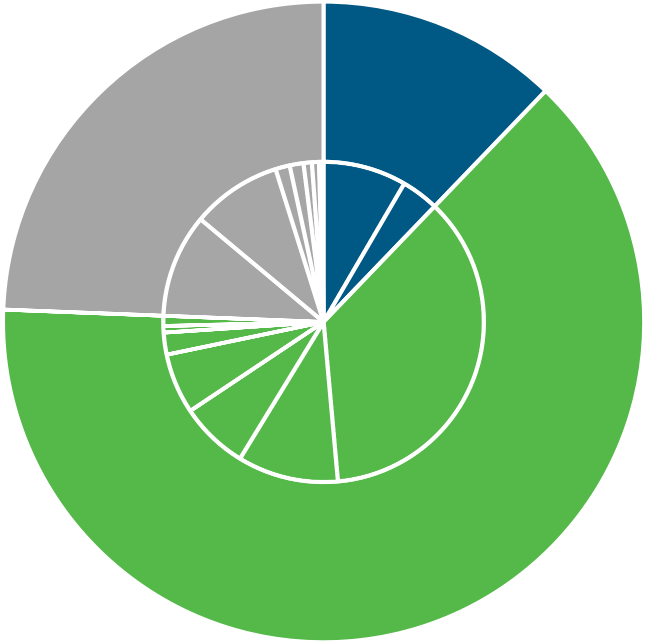
PORTFOLIO SUMMARY

FOR STAKEHOLDER WORKSHOP

10/10/18

SC GRID IMPROVEMENT PLAN PORTFOLIO SUMMARY

DUKE ENERGY



Program	3 Year Range
Cost Benefit & Cost Effectiveness Justified (Optimize)	**$228-373M**
SOG	$75-122M
Incremental Distribution H&R	$35-60M
IVVC DEC	$35-57M
Incremental Transmission H&R	$25-40M
TUG	$22-36M
Energy Storage	$20-32M
Transmission Bank Replacement	$8-13M
D-OIL Breaker Replacements	$2-4M
T-OIL Breaker Replacements	$4-6M
DSDR peak shaving to CVR in DEP	$2-3M
Rapid Technology Advancement: Cost-Effectiveness Justified (Modernize)	**$87-141M**
T&D Communications	$33-53M
Distribution System Automation	$20-33M
Transmission System Automation	$17-28M
T&D Enterprise Systems	$5-8M
ISOP	$5-8M
DER Dispatch Tool	$3-5M
Electric Vehicle Charging	$3-4M
Power Electronics for volt/var control	$1-2M
Customer Data Access	$0.2-0.4M
Compliance: Cost Effectiveness Justified (Protect)	**$44-72M**
Physical Security	$30-50M
Cyber Security	$14-22M

- **Cost-Benefit and Cost-Effectiveness Justified (Optimize)**

Programs and projects in this category provide customers more net benefits than net costs and solve for one or more external "megatrends."

- **Rapid Technology Advancement-Cost Effectiveness Justified (Modernize)**

Equipment, software, hardware, operating systems, and/or accepted system operating practice has advanced at an atypical pace in this category causing the need for rapid and sometimes frequent changes within the utility at a system deployment level. Work in this category is usually related to system communication, automation, and intelligence and must be executed at a deliberate pace while ensuring not to deploy new technology before it has reached operational and price point maturity. While not technically compliance work, work in this category is essential for modern system operations.

- **Compliance-Cost Effectiveness Justified (Protect)**

i. An external law, rule, or regulation applicable to the company requires the work;
ii. A binding legal obligation such as a contract, agency order, or other legal document compels the work; or
iii. The Operations Counsel has approved the work as being critical and imperative to the Company's operations.

SOUTH CAROLINA GRID IMPROVEMENT PLAN

APPENDIX

FOR STAKEHOLDER WORKSHOP

10/10/18

[1] Duke Energy
[2] Navigant Research. *Cybersecurity for the Digital Utility*. 2017. https://www.navigantresearch.com/reports/cybersecurity-for-the-digital-utility.
[3] Navigant Research. *Managing the IoT Cybersecurity Threats in the Energy Cloud Ecosystem.* 2018. https://www.navigantresearch.com/reports/managing-iot-cybersecurity-threats-in-the-energy-cloud-ecosystem.
[4] North American Electric Reliability Corporation. *State of Reliability 2018.* 2018. https://www.nerc.com/pa/RAPA/PA/Performance%20Analysis%20DL/NERC_2018_SOR_06202018_Final.pdf.
[5] Lloyd's. *Business Blackout: Emerging Risk Report*. 2015. https://www.lloyds.com/news-and-risk-insight/risk-reports/library/society-and-security/business-blackout.
[6] Charlotte Observer. *Fake email, stolen log-ins opened door to widespread hack on Mecklenburg County*. 2017. https://www.charlotteobserver.com/news/politics-government/article189428824.html.
[7] Symantec. *Targeted Attacks Against the Energy Sector*. 2014. http://www.symantec.com/content/en/us/enterprise/media/security_response/whitepapers/targeted_attacks_against_the_energy_sector.pdf.
[8] Duke Energy
[9] Navigant Research. *Cybersecurity for the Digital Utility*. 2017. https://www.navigantresearch.com/reports/cybersecurity-for-the-digital-utility.
[10] Duke Energy
[11] North American Electric Reliability Corporation. *State of Reliability 2018.* 2018. https://www.nerc.com/pa/RAPA/PA/Performance%20Analysis%20DL/NERC_2018_SOR_06202018_Final.pdf.
[12] North American Electric Reliability Corporation. *State of Reliability 2018.* 2018. https://www.nerc.com/pa/RAPA/PA/Performance%20Analysis%20DL/NERC_2018_SOR_06202018_Final.pdf.
[13] LA Times. *Sophisticated but low-tech power grid attack baffles authorities*. 2014. http://www.latimes.com/nation/la-na-grid-attack-20140211-story.html#.
[13] The Mercury News. *PG&E upgrading substation security after San Jose sniper attack*. 2014. https://www.mercurynews.com/2014/06/18/pge-upgrading-substation-security-after-san-jose-sniper-attack/.
[14] The Heritage Foundation. *The Danger of EMP Requires Innovative and Strategic Action*. 2018. https://www.heritage.org/homeland-security/report/the-danger-emp-requires-innovative-and-strategic-action.
[15] The Heritage Foundation. *The Danger of EMP Requires Innovative and Strategic Action*. 2018. https://www.heritage.org/homeland-security/report/the-danger-emp-requires-innovative-and-strategic-action.
[16] Federal Energy Regulatory Commission. *Electromagnetic Pulse: Effects on the U.S. Power Grid Executive Summary*. https://www.ferc.gov/industries/electric/indus-act/reliability/cybersecurity/ferc_executive_summary.pdf.
[17] Federal Energy Regulatory Commission. *Electromagnetic Pulse: Effects on the U.S. Power Grid Executive Summary*. https://www.ferc.gov/industries/electric/indus-act/reliability/cybersecurity/ferc_executive_summary.pdf.
[18] North American Electric Reliability Corporation. *State of Reliability 2018.* 2018. https://www.nerc.com/pa/RAPA/PA/Performance%20Analysis%20DL/NERC_2018_SOR_06202018_Final.pdf.
[19] The Heritage Foundation. *The Danger of EMP Requires Innovative and Strategic Action*. 2018. https://www.heritage.org/homeland-security/report/the-danger-emp-requires-innovative-and-strategic-action.
[20] Navigant Research. *Global DER Deployment Forecast Database.* 2017. https://www.navigantresearch.com/reports/global-der-deployment-forecast-database.
[21] Navigant Research. *Non-Wires Alternatives.* 2017. https://www.navigantresearch.com/reports/non-wires-alternatives.
[22] Duke Energy. *South Carolina Integrated Resource Plan*. 2018. http://www.energy.sc.gov/node/3048.
[23] Duke Energy
[24] Duke Energy. *South Carolina Integrated Resource Plan*. 2018. http://www.energy.sc.gov/node/3048.
[25] Duke Energy
[26] Navigant Research. *Global DER Deployment Forecast Database.* 2017. https://www.navigantresearch.com/reports/global-der-deployment-forecast-database.
[27] Navigant Research. *Non-Wires Alternatives.* 2017. https://www.navigantresearch.com/reports/non-wires-alternatives.
[28] Duke Energy
[29] Navigant. *Duke Energy 10-year Renewable Price Forecast.* 2018.
[30] Navigant. *Duke Energy 10-year Renewable Price Forecast.* 2018.
[31] PV Insights. http://pvinsights.com/.
[32] Solar Energy Industries Association. *South Carolina Solar*. 2018. https://www.seia.org/state-solar-policy/south-carolina-solar.
[33] Navigant Research. *Market Data: Global Distributed Solar PV.* 2017. https://www.navigantresearch.com/reports/market-data-global-distributed-solar-pv.
[34] Navigant Research. *Market Data: Global Distributed Solar PV.* 2017. https://www.navigantresearch.com/reports/market-data-global-distributed-solar-pv.

"The information and data cited in this document from sources other than Duke Energy are the assertions of the independent third parties that created them and while Duke Energy has no reason to doubt the accuracy of the third-party information and data cited in this document, Duke Energy has not independently verified the accuracy of such information and data, nor does Duke Energy adopt or espouse any conclusions or recommendations that the independent third parties may have drawn from that information and data."

[35] Navigant. *Duke Energy 10-year Renewable Price Forecast.* 2018.
[36] Navigant Research. *Market Data: Global Distributed Solar PV.* 2017. https://www.navigantresearch.com/reports/market-data-global-distributed-solar-pv.
[37] Navigant Research. *Innovations in Power Conversion Technology for Grid Storage.* 2018. https://www.navigantresearch.com/reports/innovations-in-power-conversion-technology-for-grid-storage.
[38] Navigant Research. *Market Data: Large Commercial and Industrial Energy Storage.* 2018. https://www.navigantresearch.com/reports/market-data-large-commercial-and-industrial-energy-storage.
[39] Navigant Research. *Innovations in Power Conversion Technology for Grid Storage.* 2018. https://www.navigantresearch.com/reports/innovations-in-power-conversion-technology-for-grid-storage.
[40] Navigant Research. *Market Data: Large Commercial and Industrial Energy Storage.* 2018. https://www.navigantresearch.com/reports/market-data-large-commercial-and-industrial-energy-storage.
[41] Navigant Research. *Energy Storage for Renewables Integration.* 2017. https://www.navigantresearch.com/reports/energy-storage-for-renewables-integration.
[42] Navigant Research. *Distributed Solar PV plus energy storage systems.* 2017. https://www.navigantresearch.com/reports/distributed-solar-pv-plus-energy-storage-systems.
[43] Navigant Research. *Market Data: Large Commercial and Industrial Energy Storage.* 2018. https://www.navigantresearch.com/reports/market-data-large-commercial-and-industrial-energy-storage.
[44] Navigant Research. *Distributed Solar PV plus energy storage systems.* 2017. https://www.navigantresearch.com/reports/distributed-solar-pv-plus-energy-storage-systems.
[45] NC Department of Environmental Quality. *Energy Policy Council Biennial Report*. 2018. https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Energy/Energy%20Policy%20Council/2018%20EPC%20Biennial%20Report%20-%20FINAL.pdf.
[46] Navigant Research. *Market Data: EV Market Forecasts.* 2017. https://www.navigantresearch.com/reports/market-data-ev-market-forecasts.
[47] Wired. *General Motors is going all electric*. 2017. https://www.wired.com/story/general-motors-electric-cars-plan-gm/.
[48] Navigant Research. *EV Charging Equipment Market Overview.* 2018. https://www.navigantresearch.com/reports/ev-charging-equipment-market-overview.
[49] Navigant Research. *EV Charging Equipment Market Overview.* 2018. https://www.navigantresearch.com/reports/ev-charging-equipment-market-overview.
[50] Utility Dive. *EV charging providers scale up amid a 'revolution in transportation.'* 2018. https://www.utilitydive.com/news/ev-charging-providers-scale-up-amid-a-revolution-in-transportation/532530/.
[51] Navigant Research. *Market Data: EV Geographic Forecasts.* 2017. https://www.navigantresearch.com/reports/market-data-ev-geographic-forecasts.
[52] Plug In America. *Electric Vehicles in South Carolina*. 2017. https://pluginamerica.org/wp-content/uploads/2017/04/South_Carolina_Electric_Vehicle_Factsheet_May_2017.pdf.
[53] SC Office of Regulatory Staff. *State Energy Plan*. 2018. http://energy.sc.gov/energyplan.
[54] Navigant Research. *Market Data: EV Geographic Forecasts.* 2017. https://www.navigantresearch.com/reports/market-data-ev-geographic-forecasts.
[55] Bloomberg New Energy Finance. *Lithium-ion Battery Costs and Market. 2017*. https://data.bloomberglp.com/bnef/sites/14/2017/07/BNEF-Lithium-ion-battery-costs-and-market.pdf.
[56] World Wildlife Fund. *Power Forward 3.0*. 2017. https://c402277.ssl.cf1.rackcdn.com/publications/1049/files/original/Power_Forward_3.0_-_April_2017_-_Digital_Second_Final.pdf?1493325339.
[57] Science Based Targets. 2018. https://sciencebasedtargets.org/companies-taking-action/.
[58] World Resources Institute & WWF. *Corporate Renewable Energy Buyers' Principles*. 2018. https://buyersprinciples.org/.
[59] Duke Energy
[60] SC Office of Regulatory Staff. *State Energy Plan*. 2018. http://energy.sc.gov/energyplan.
[61] SC Office of Regulatory Staff. *State Energy Plan*. 2018. http://energy.sc.gov/energyplan.
[62] Smart Cities Dive. *Smart city tech campus planned for Greenville, SC*. 2017. https://www.smartcitiesdive.com/news/smart-city-tech-campus-planned-for-greenville-sc/513517/.
[63] World Business Council for Sustainable Development. *Stepping up climate ambition: a business perspective*. 2018. https://www.wbcsd.org/Programs/Energy-Circular-Economy/Climate-Energy/Climate-Action-and-Policy/News/Stepping-up-climate-ambition-a-business-perspective.
[64] Business Renewables Center. *State of the Market Report*. 2018. https://www.rmi.org/our-work/electricity/brc-business-renewables-center/.
[65] The Post and Courier. *After Florence flooded SC, mayors across smarter disaster prevention*. 2018. https://www.postandcourier.com/news/after-florence-flooded-sc-mayors-across-us-urge-smarter-disaster/article_20839d0c-c32d-11e8-acce-cfbe53cf5fd9.html.
[66] The Summerville Journal Scene. *Remembering Hurricane Matthew.* 2018. https://www.journalscene.com/news/remembering-hurricane-matthew/collection_65baac68-b51c-11e8-b514-9316bcc16db7.html.

"The information and data cited in this document from sources other than Duke Energy are the assertions of the independent third parties that created them and while Duke Energy has no reason to doubt the accuracy of the third-party information and data cited in this document, Duke Energy has not independently verified the accuracy of such information and data, nor does Duke Energy adopt or espouse any conclusions or recommendations that the independent third parties may have drawn from that information and data."

[67] Duke Energy
[68] The State. *'Everybody is very nervous:' SC town rocked by Matthew braces for Hurricane Florence*. 2018. https://www.thestate.com/news/state/south-carolina/article218182285.html.
[69] Duke Energy
[70] The State. *How you can help tiny SC town flooded once again, this time by Florence.* 2018. https://www.thestate.com/news/politics-government/politics-columns-blogs/the-buzz/article218988830.html.
[71] The Post and Courier. *Irma punished parts of South Carolina: Here's the region-by-region impact*. 2017. https://www.postandcourier.com/news/irma-punished-parts-of-south-carolina-here-s-the-region/article_f37a8ca4-96f4-11e7-90b8-0b18db922a09.html.
[72] CNN. *Hurricane Matthew creates 'record-breaking' flooding*. 2016. https://www.cnn.com/2016/10/08/us/hurricane-matthew-florida/index.html.
[73] Greenville News. *How the ice storm impacted the Upstate's power lines*. 2015. https://www.greenvilleonline.com/story/news/local/2015/02/16/ice-poses-threat-power-lines/23522359/.
[74] Eaton. *Blackout Tracker*. 2017. http://powerquality.eaton.com/blackouttracker/default.asp.
[75] Duke Energy
[76] Duke Energy
[77] Duke Energy
[78] Duke Energy
[79] NOAA. *Billion Dollar Weather and Climate Disasters*. https://www.ncdc.noaa.gov/billions/time-series.
[80] Congressional Research Service. *The Smart Grid: Status and Outlook*. 2018. https://fas.org/sgp/crs/misc/R45156.pdf.
[81] Smart Grid. *Smart Grid 101*. http://www.whatissmartgrid.org/smart-grid-101.
[82] IEA. *Technology Roadmap: Smart Grids*. 2011. https://www.iea.org/publications/freepublications/publication/smartgrids_roadmap.pdf.
[83] UCR & DOE. *The Future of Smart Grid Technologies*. 2017. https://engineeringonline.ucr.edu/blog/the-future-of-smart-grid-technologies/.
[84] Smart Energy Consumer Collaborative. *Smart Grid 101*. 2018. https://smartenergycc.org/smartgrid101/.
[85] Navigant. *From Smart Grid to Neural Grid.* 2018. https://www.navigant.com/insights/energy/2018/from-smart-grid-to-neural-grid.
[86] Navigant Research. *Market Data: Smart Grid IT Systems*. 2017. https://www.navigantresearch.com/reports/market-data-smart-grid-it-systems.
[87] Public Utilities Fortnightly. *PUF Annual Pulse of Power Survey*. 2018. https://www.fortnightly.com/sites/default/files/article_uploads/180615-2018-survey-results-doc.pdf.
[88] The Edison Foundation. *Electric Company Smart Meter Deployments: Foundation for a Smart Grid*. 2017. http://www.edisonfoundation.net/iei/publications/Documents/IEI_Smart%20Meter%20Report%202017_FINAL.pdf.
[89] SC Office of Regulatory Staff. *State Energy Plan*. 2018. http://energy.sc.gov/energyplan.
[90] Duke Energy
[91] The Edison Foundation. *Electric Company Smart Meter Deployments: Foundation for a Smart Grid*. 2017. http://www.edisonfoundation.net/iei/publications/Documents/IEI_Smart%20Meter%20Report%202017_FINAL.pdf.
[92] The Edison Foundation. *Electric Company Smart Meter Deployments: Foundation for a Smart Grid*. 2017. http://www.edisonfoundation.net/iei/publications/Documents/IEI_Smart%20Meter%20Report%202017_FINAL.pdf.
[93] SC Office of Regulatory Staff. *State Energy Plan*. 2018. http://energy.sc.gov/energyplan.
[94] NC Clean Tech Energy Technology Center. *50 States of Grid Modernization*. 2018. https://nccleantech.ncsu.edu/wp-content/uploads/Q12018_gridmod_exec_final.pdf.
[95] Grid Wise Alliance. *Grid Modernization Index 4*. 2017. https://gridwise.org/grid-modernization-index/.
[96] Grid Wise Alliance. *Grid Modernization Index 4*. 2017. https://gridwise.org/grid-modernization-index/.
[97] Navigant
[98] Navigant
[99] SC Revenue and Fiscal Affairs Office. *South Carolina State and County Population Projections 2000-2030.* http://sccommunityprofiles.org/census/projections_2010.html.
[100] Appalachian Council of Governments. *Rural Long-Range Transportation Plan 2040*. http://www.scacog.org/Portals/9/Transportation/1%20Demographic%20Trends%20and%20Projections.pdf.

"The information and data cited in this document from sources other than Duke Energy are the assertions of the independent third parties that created them and while Duke Energy has no reason to doubt the accuracy of the third-party information and data cited in this document, Duke Energy has not independently verified the accuracy of such information and data, nor does Duke Energy adopt or espouse any conclusions or recommendations that the independent third parties may have drawn from that information and data."

[101] Automotive News. *How BMW energized an entire state*. 2018. http://www.autonews.com/article/20180908/OEM01/180919996/bmw-spartanburg-south-carolina-investment.
[102] Automotive News. *How BMW energized an entire state*. 2018. http://www.autonews.com/article/20180908/OEM01/180919996/bmw-spartanburg-south-carolina-investment.
[103] US Census Bureau. *American Fact Finder*. https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.
[104] Duke Energy
[105] S&P Global Market Intelligence. https://www.spglobal.com/en/.
[106] Smart Energy Consumer Collaborative. *Consumer Pulse and Market Segmentation Study – Wave 6*. 2017. https://smartenergycc.org/consumer-pulse-wave-6-report/.
[107] Smart Energy Consumer Collaborative. *2018 State of the Consumer*. 2018. https://smartenergycc.org/2018-state-of-the-consumer-report/.
[108] Smart Energy Consumer Collaborative. *2018 State of the Consumer*. 2018. https://smartenergycc.org/2018-state-of-the-consumer-report/.
[109] SC Office of Regulatory Staff. *State Energy Plan*. 2018. http://energy.sc.gov/energyplan.
[110] Duke Energy
[111] Smart Energy Consumer Collaborative. *Consumer Pulse and Market Segmentation Study – Wave 6*. 2017. https://smartenergycc.org/consumer-pulse-wave-6-report/.
[112] Smart Energy Consumer Collaborative. *2018 State of the Consumer*. 2018. https://smartenergycc.org/2018-state-of-the-consumer-report/.
[113] Duke Energy

SOUTH CAROLINA GRID IMPROVEMENT PLAN

DUKE ENERGY

Megatrends

- Concentrated Growth
- Technology Advancements
- Grid Modernization
- Customer Expectations
- Environmental Commitments
- Impact of Weather Events
- Threats to Grid Infrastructure

Implications

- Increased Cost
- Decreased Reliability
- Inability to Interconnect DER
- Decreased Customer Satisfaction
- Decreased Economic Attractiveness for South Carolina
- Decreased Demographic Fairness

Grid Capabilities

- Increase monitoring and visibility
- Increase automation
- Increase distributed intelligence
- Improve reliability
- Harden for resiliency
- Enable voltage control
- Accommodate two-way power flows
- Modernize grid operations
- Improve cyber security
- Improve physical security
- Expand customer options and capabilities
- Increase hosting capacity

Plan

- Protect
- Modernize
- Optimize

Programs

- IVVC
- SOG
- TUG
- Power Electronics
- Energy Storage
- Distribution Automation
- Transformer Retrofit
- LDI/HI
- EV Charging
- ISOP
- Customer Data Access
- Transmission System Intelligence
- Transmission H&R
- Transformer Bank Replacement
- Physical & Cyber Security
- Oil Breaker Replacement
- Enterprise Communications Improvement
- Enterprise Apps
- DER Dispatch Tool
- Advanced Metering
- Distribution H&R

Value to Customers

- Maintain reasonable rates
- Improve reliability, safety, resiliency
- Meet or exceed customer expectations

Summary Report of South Carolina Duke Energy Grid Improvement Workshop

Table of Contents

Prepared by Rocky Mountain Institute
Rocky Mountain Institute Contact: Coreina Chan, cchan@rmi.org

Executive Summary

Duke Energy hosted a technical workshop on October 10, 2018 regarding the Company's South Carolina Grid Improvement Initiative to explain the need for and ongoing benefits of grid investments, and to hear feedback from stakeholders in attendance. This workshop was specifically designed to focus on the grid improvement plan and did not address (1) what cost recovery would be used to pay for the plan, or (2) interrelated topics such as regulatory reform or integrated resource planning.

Acting as a neutral facilitator, a team from Rocky Mountain Institute (RMI) convened 57 participants (inclusive of 20 Duke Energy and four RMI staff) for a workshop that included content presentations, structured feedback sessions, and facilitated small group breakout sessions. RMI captured detailed notes for all small group and plenary discussions and conducted an anonymous post-event survey among non-Duke, non-RMI attendees to gather stakeholder feedback.

This document provides a summary of the day's discussions and outcomes, as well as a summary of survey results. This document contains an anonymized synthesis of what was shared by participants, and does not attribute specific comments to specific parties, to respect the ground rules agreed to by participants at the beginning of the meeting. Specifically, participants agreed that what was discussed at the workshop could be shared publicly, but specific comments could not be attributed to individuals without their permission.

The Appendix contains detailed notes from breakout discussions and question and answer sessions.

Workshop objectives

The workshop was organized around three objectives, listed below. RMI defined these objectives in consultation with Duke Energy and other participants interviewed in advance of the event.

- **Objective 1:** Obtain stakeholder input to Duke's outlook on seven megatrends shaping grid improvement decisions.
- **Objective 2:** Describe and get feedback on how Duke Energy has used stakeholder input, the impact of megatrends on grid needs and a prioritization methodology to develop a grid improvement portfolio.
- **Objective 3:** Describe the benefits and risks of the proposed program portfolio and get stakeholder feedback prior to Q4 filing.

Key workshop outcomes and takeaways

As described below, and supported by the rest of this report, there were a number of key workshop insights and outcomes.

1. **Participants generally viewed the pre-read materials and workshop as well-structured and informative, and felt the engagement provided insight into**

Duke Energy's priorities and decision-making processes. Survey and Poll Everywhere results suggest that nearly all stakeholders found this opportunity to review Duke's thinking and process valuable.

2. **Stakeholders were especially interested in further quantitative information about the megatrends and implications portion of the workshop.** For example, several expressed an interest in "seeing numbers" to provide additional detail to the heat maps on slide 34 of the pre-read.
3. **Several stakeholders stated the new plan reflected that Duke Energy had listened to stakeholder feedback.** Stakeholder feedback during the plenary question and answer sessions, online polling and survey indicated that many generally agreed the revised grid improvement filing plan had improved since the first plan.
4. **Generally, stakeholders aligned with Duke Energy on the utility's outlook on megatrends and their implications, but did have key feedback including:**
    a. Costs: several discussion groups pointed out their concerns and questions about how the grid improvement plan would result in rate impacts across different customer groups
    b. Environmental factors: almost all groups mentioned the increasing importance of climate change and how climate change urgency should be given more focus in the megatrends and implications
    c. Technology: general consensus was that the megatrends and implications may be underestimating the impacts of rapid adoption of technologies like solar, storage and electric vehicles
5. **Generally, stakeholders had a positive impression of the Q4 filing but did have key questions and concerns, including**:
    a. What cost recovery mechanism would be used to pay for this plan?
    b. How would benefits/costs be shared equitably by South Carolinians?
    c. What is the quantified vision for renewables penetration and distributed energy resources (DER) hosting capacity?
6. **Stakeholders expressed interest in continued engagement with Duke Energy, both related to the Q4 filing and other future efforts.** Feedback from the plenary, online polling and survey indicated a strong interest in continued engagement.

We obtained stakeholder feedback throughout the workshop via online polling, table discussions, and plenary question and answer sessions. Themes emerging from the conversations during the workshop and in the post-event surveys are summarized in the report, with supporting detail in the Appendix.

Workshop Activities and Attendee List

RMI consulted with both Duke Energy and other participants in pre-workshop meetings and heeded calls to design the workshop agenda to best meet the objectives. The workshop agenda as executed is included below in Table 1.

Table 1: October 10 Technical Workshop Agenda

Time	Activity	Objectives addressed
9:00	Welcome remarks	
9:15	Check-in and introductions	
9:30	Presentation (Duke Energy) Executive Summary: Q4 Filing	#1, #2, #3
9:45	Activity: Polling, feedback and questions	#1
10:25	Presentation (Duke Energy): Megatrends and Implications	#1, #2
11:30	Lunch	
12:15	Presentation (Duke Energy): Portfolio Prioritization Method	#2, #3
12:35	Activity: Polling, feedback and questions	#1, #2, #3
1:15	Presentation (Duke Energy): Q4 Filing Overview	#2, #3
2:15	Next steps for stakeholders	#3
2:30	Closing remarks and adjournment	

A total of 54 participants attended the technical workshop, including 20 participants from Duke Energy and four from RMI. A full list of attendees is included below in Table 2.

Table 2: October 10 Technical Workshop Attendees

Last Name	First Name	Organization Name
Allsbrook	Wes	CEPCI
Blade	Paul	Conservation Voters of South Carolina
Boyt	John	Central Electric Power Cooperative Inc.
Brooks	Jeff	Duke Energy
Brown	Justin	Duke Energy
Burnett	John	Duke Energy
Chan	Coreina	RMI
Claunch	Chuck	Duke Energy
Coppola	Barbara	Duke Energy
Culley	Thad	Vote Solar
Davidson	Hilary	Duke Energy
Dover	Becky	SC Department of Consumer Affairs
Von Nessen	Joey	University of South Carolina
Dyson	Mark	RMI
Ferguson	Stinson	SELC
Finnigan	John	EDF
Fitch	Tyler	Vote Solar
Glenn	Alex	Duke Energy
Hall	Karen	Duke Energy
Hancock	Alan	SC Coastal Conservation League
Hartman	Beth	RMI
Hipp	Dawn	South Carolina Office of Regulatory Staff (ORS)
Hutchison	Nikki	AARP
Jacob	Bryan	Southern Alliance for Clean Energy (SACE)
Jiran	Rick	Duke Energy
Johnson	Sarah	South Carolina Office of Regulatory Staff (ORS)
King	Trip	Audubon South Carolina
Kruse	Susan	Duke Energy
Lawyer	Robert	South Carolina Office of Regulatory Staff (ORS)
Maley	Daniel	Duke Energy
Martin	Jason	Duke Energy
McLawhorn	James T.	Columbia Urban League
Mitchell	William	Conservation Voters of South Carolina
Moore	Eddy	Coastal Conservation League
Morgan	Willie	South Carolina Office of Regulatory Staff (ORS)
Mosier	Ryan	Duke Energy

Oliver	Jay	Duke Energy
Preston	Marcus	Duke Energy
Rice	Chris	Nucor Steel South Carolina
Rivers	Hope	Executive Vice President
Robbins	Shelley	Upstate Forever
Rogers	David	Sierra Club
Ruhe	Mike	Duke Energy
Ruoff	John	SC Appleseed Legal Justice Center
Sandonato	Anthony	South Carolina Office of Regulatory Staff (ORS)
Sharpe	Chris	Duke Energy
Shirley-Smith	Heather	Duke Energy
Simpson	Bobby	Duke Energy
Sipes	Robert	Duke Energy
Slater	Loretta	Whitney Slater Foundation
Smith	Robert	MVA Nucor
Teplin	Chaz	RMI
Wilkerson	Brandon	South Carolina Department of Commerce
Woodberry	Leo	New Alpha Community Development Corporation

Workshop Outcomes

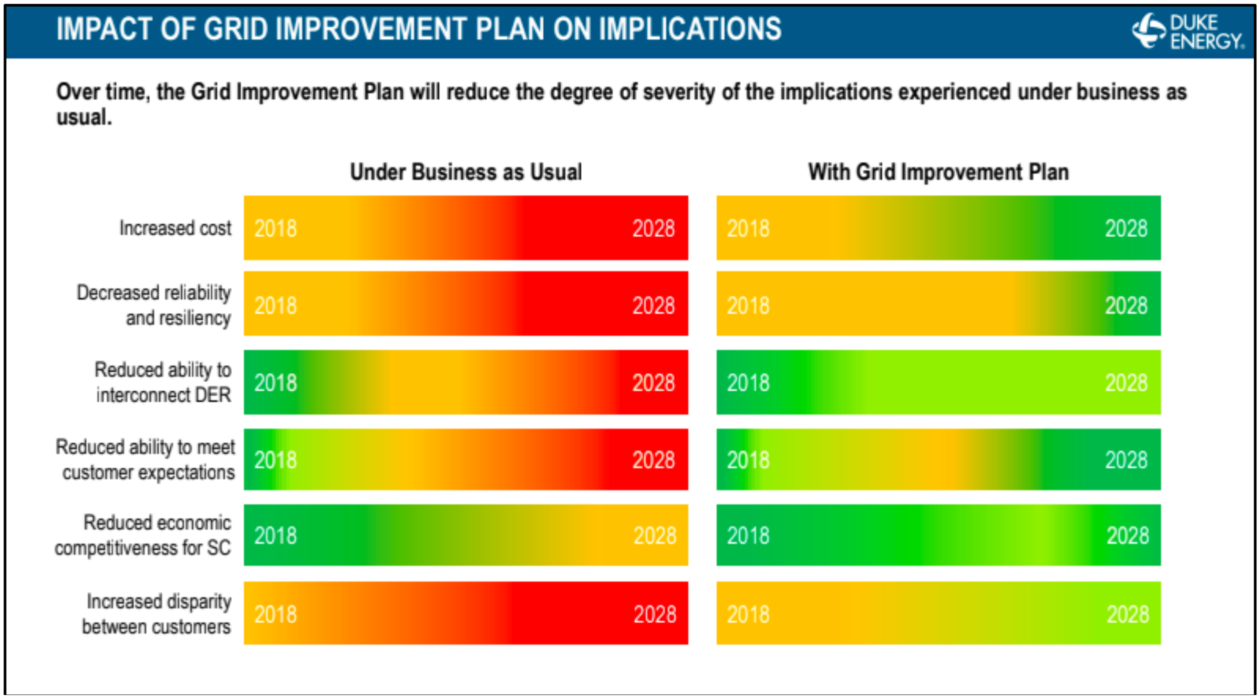
The following sections outline the workshop activities, common themes of discussion, and outcomes associated with each of the three workshop objectives. RMI developed these summaries based on notes taken during the workshop as well as online polling during the workshop and the results of the anonymous survey distributed to participants (excluding Duke Energy and RMI staff) afterwards. There was a 60% response rate to the survey.

Objective 1

Obtain stakeholder input to Duke Energy's outlook on seven megatrends shaping grid improvement decisions.

Supporting Activities

- **Pre-Read**: In the pre-read sent to participants, Duke Energy identified seven megatrends shaping near and long-term grid improvement needs, and the potential implications of these megatrends on customer service under a business-as-usual scenario (no grid improvement). Duke Energy compared the outlook for grid performance under business-as-usual vs. grid improvement plan scenarios, using the following qualitative summary slide:



- **Workshop Presentations**: The fourth quarter filing executive summary at the beginning of the workshop touched on all three main objectives including describing the megatrends and implications for grid improvement decisions. Next, a more detailed presentation from Duke Energy (see Attachments for all presentations) reviewed the seven megatrends impacting the energy industry overall, to explain the rationale for grid improvement investments.
- **Workshop Discussion**: Following the presentation on megatrends and their implications, several feedback activities collected input from stakeholders including a plenary rapid-fire question and answer session, plenary real-time online polling, and facilitated dialogues at tables. Five tables reported out to the room on the key takeaways from their discussions. These discussions were not designed to reach consensus but rather to highlight areas of common interest and concern.

Summary of discussion points

- Costs: several discussion groups pointed out their concerns and questions about how the grid improvement plan would result in rate impacts across different customer groups
- Environmental factors: almost all discussion groups mentioned the increasing importance of climate change and how climate change urgency should be given more focus in the megatrends and implications

- Reliability: several discussion groups mentioned the risk of power interruptions (e.g., during future storms) and the importance of improving reliability in future, especially for industrial customers.
- Technology: several stakeholders voiced that the megatrends and implications may be underestimating the impacts of rapid adoption of technologies like solar, storage and electric vehicles
- Additional key trends identified by participants included (1) flattening load growth, and (2) quickly evolving customer expectations, especially from the next generation(s) of customers.

Gauging Stakeholder Alignment

Real-time polling questions indicated that participants were directionally aligned with how Duke Energy views megatrends. Polling responses indicated similar levels of participant alignment with Duke Energy on potential megatrend implications on customer service and need for a grid improvement strategy:

Figure 1: Real-time online polling responses – "How aligned are you with how Duke Energy views these 7 megatrends?"

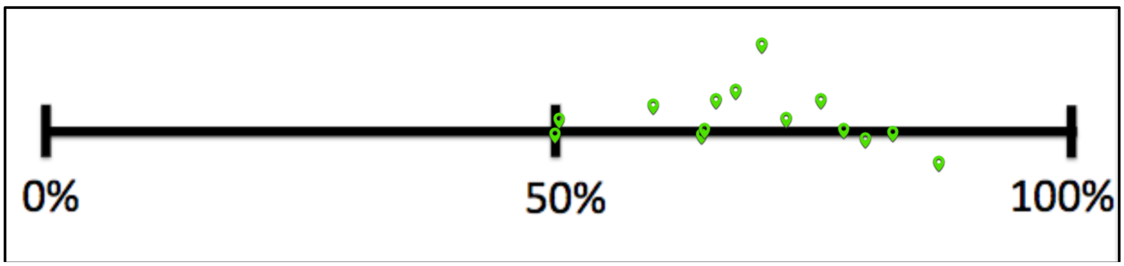
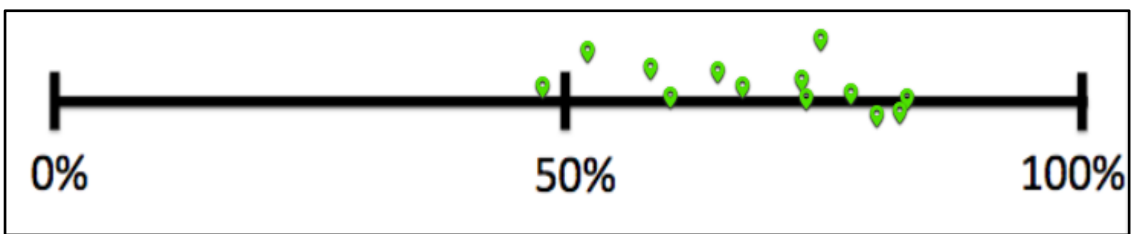
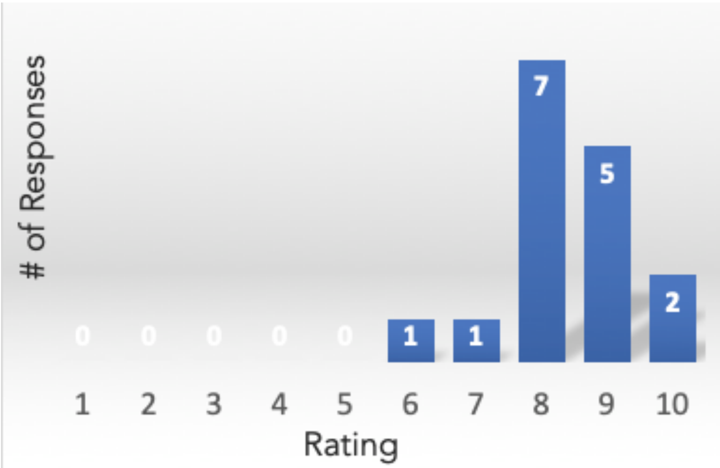


Figure 2: Real-time online polling responses - "How aligned are you with how Duke Energy views the implications to these 7 megatrends?"



In addition to real-time online polling, RMI asked participants to fill out a post-event survey to better understand stakeholder feedback. All participants indicated in the survey that the workshop improved their understanding of Duke Energy's framing of grid improvement in the context of megatrends and implications, with everyone giving a score over 5 out of 10 and the majority of respondents at 8 or above.

Figure 3: Post-event survey responses - "On a scale of 1 to 10, How well did this workshop enhance your understanding of the proposed grid improvement plan?"

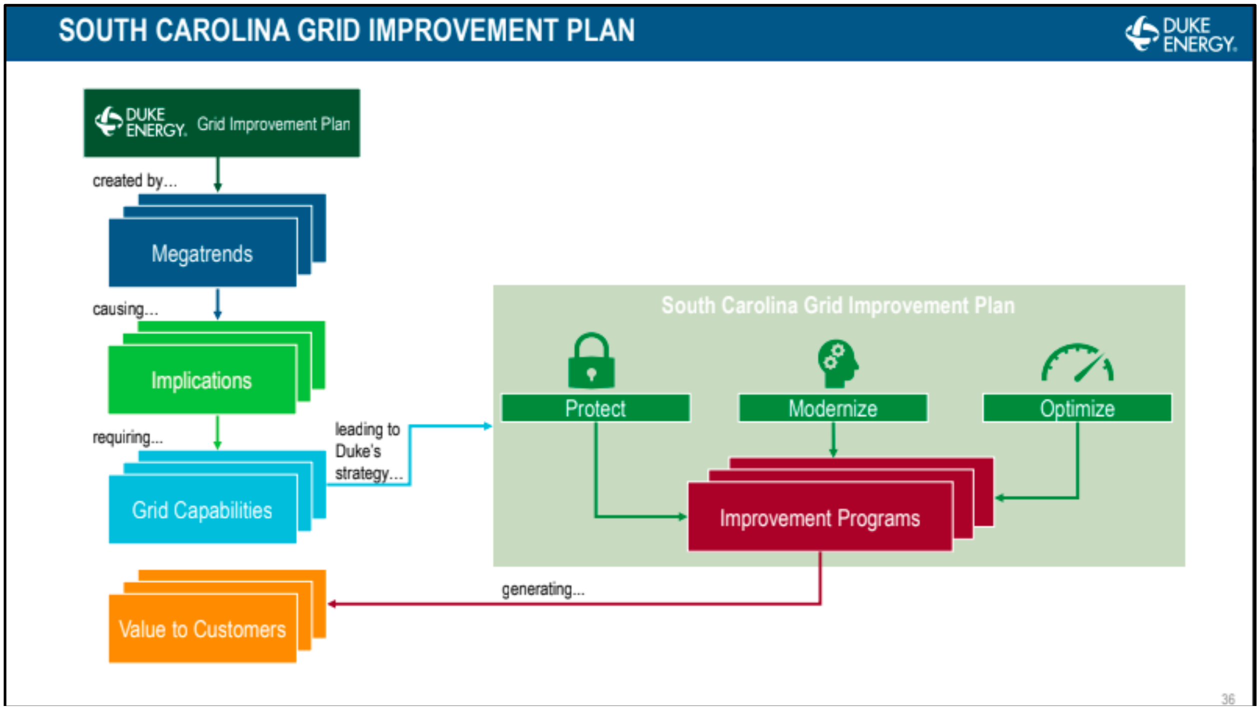


Objective 2

Describe and get feedback on how Duke Energy has used stakeholder input, the impact of megatrends on grid needs and a prioritization methodology to develop a grid improvement portfolio.

<u>Supporting Activities</u>

- **Pre-Read:** In the pre-read sent to participants, Duke Energy outlined their process for using stakeholder input, megatrends and grid needs to create a Grid Improvement Plan. The summary slide is included below.



- **Presentations**: In the first session after lunch, Duke Energy summarized the company's analytic process, including more details on the interruption cost estimate (ICE) model developed by the Department of Energy (DOE) to value the cost of outages. The presentation explained how the company categorizes grid needs as "Optimize," "Modernize," or "Protect" and showed two examples of cost–benefit analysis, one at the program level for self-optimizing grid and one at the project level for targeted undergrounding.
- **Discussion**: After this Duke Energy presentation, participants grouped themselves into pairs to discuss 'What questions, if any, do you have about what was presented?' After 10 minutes, participants were asked to record their questions and the questions were answered in plenary by Duke Energy executives to help raise the overall level of understanding in the room. The questions are listed here:

1) How are environmental benefits calculated?
2) Specifically, what is the formula for DER enablement?
3) What is the discount rate for net present value?
4) Can you provide more detail on ICE, i.e., is it proprietary?
5) How will Duke Energy allocate costs between C&I versus residential customers to reflect benefits?
6) How does Duke Energy distinguish between "maintain" and "improve" for targeted undergrounding?

7) How will you consider the option for microgrids as an alternative to targeted underground more broadly?

Question and Answer Summary

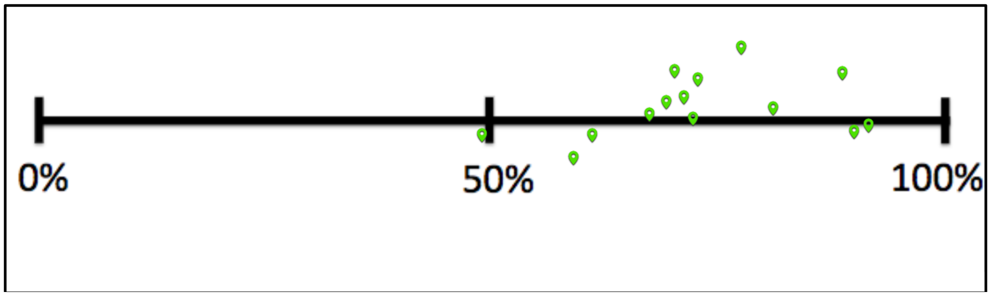
Duke staff answered questions in plenary. Discussion focused largely on environmental benefits and the models used to calculate cost-benefit for different types of programs and projects. These questions and answers were not intended to reach consensus with stakeholders but rather to explain Duke Energy's analytic approach or perspective. Answers are summarized below:

- Environmental benefits were calculated by considering benefits like additional capacity for peak shaving and reduced SO_2, NO_X, and CO_2 emissions. Other benefits of interest to stakeholders included enablement of DER and electric vehicle (EV) charging, and flexibility for other future technologies.
- Net present value calculation uses the appropriate Duke discount rate for the service territory (approximately 7%).
- The ICE model is not proprietary and was created with a DOE-sponsored study to analyze typical costs of service interruptions for various customers including residential, small commercial, and large industrial.
- Targeted undergrounding addresses several megatrends, and projects will be deployed based on cost-benefit analysis to demonstrate value.
- There are many opportunities to use storage and microgrids in ways Duke Energy hasn't before. The focus is on having a positive net present value for storage such as a capacity need or a need to address a community that is underserved. Once you have storage you can use it to island or microgrid during peak demand, or support frequency regulation—the core value is deferring investment.
- All cost savings eventually go to the customer. Grid improvement programs that initially bring savings to Duke Energy will result in those savings being passed along to customers in the form of rates that increase less than under the base case of business as usual.

Gauging Stakeholder Alignment

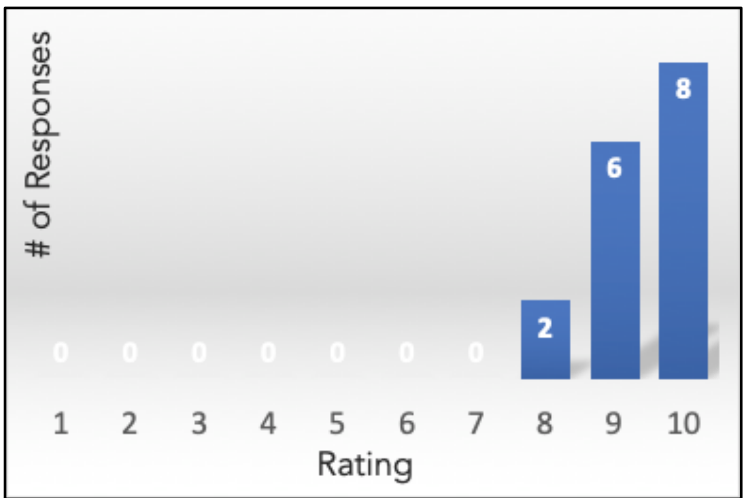
After the plenary question and answer session, participants were asked using real-time polling the following question that is relevant to the second objective: "To what extent do you believe this plan addresses the megatrends discussed earlier today?" The results, below, show that responding participants generally felt the plan addresses the megatrends described by Duke Energy.

Figure 4: Online polling: "To what extent do you believe this plan addresses the megatrends discussed earlier today?"



In addition to the real-time polling, the post-event survey asked participants, "On a scale of 1–10, How satisfied are you with the opportunity to provide feedback and dialogue with Duke Energy?" As shown in Figure 5 below, all 16 completed surveys indicated a score of 8 or higher.

Figure 5: Post-event survey: How satisfied are you with the opportunity to provide feedback to Duke Energy at this workshop?



Objective 3

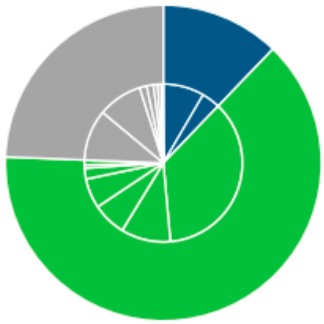
Describe the benefits and risks of the proposed program portfolio and get stakeholder feedback prior to Q4 filing.

Supporting Activities

- **Pre-read**: In the pre-read sent to participants, Duke Energy outlined their Grid Improvement Plan in more detail, including cost ranges for each program area. The summary slide is included below.

SC GRID IMPROVEMENT PLAN PORTFOLIO SUMMARY

DUKE ENERGY



Cost-Benefit and Cost-Effectiveness Justified (Optimize)
Programs and projects in this category provide customers more net benefits than net costs and solve for one or more external "megatrends."

Rapid Technology Advancement-Cost Effectiveness Justified (Modernize)
Equipment, software, hardware, operating systems, and/or accepted system operating practice has advanced at an atypical pace in this category causing the need for rapid and sometimes frequent changes within the utility at a system deployment level. Work in this category is usually related to system communication, automation, and intelligence and must be executed at a deliberate pace while ensuring not to deploy new technology before it has reached operational and price point maturity. While not technically compliance work, work in this category is essential for modern system operations.

Compliance-Cost Effectiveness Justified (Protect)
i. An external law, rule, or regulation applicable to the company requires the work;
ii. A binding legal obligation such as a contract, agency order, or other legal document compels the work; or
iii. The Operations Counsel has approved the work as being critical and imperative to the Company's operations.

Program	3 Year Range
Cost Benefit & Cost Effectiveness Justified (Optimize)	**$228-373M**
SOG	$75-122M
Incremental Distribution H&R	$35-60M
IVVC DEC	$35-57M
Incremental Transmission H&R	$25-40M
TUG	$22-36M
Energy Storage	$20-32M
Transmission Bank Replacement	$8-13M
D-OIL Breaker Replacements	$2-4M
T-OIL Breaker Replacements	$4-6M
DSDR peak shaving to CVR in DEP	$2-3M
Rapid Technology Advancement: Cost-Effectiveness Justified (Modernize)	**$87-141M**
T&D Communications	$33-53M
Distribution System Automation	$20-33M
Transmission System Automation	$17-28M
T&D Enterprise Systems	$5-8M
ISOP	$5-8M
DER Dispatch Tool	$3-5M
Electric Vehicle Charging	$3-4M
Power Electronics for volt/var control	$1-2M
Customer Data Access	$0.2-0.4M
Compliance: Cost Effectiveness Justified (Protect)	**$44-72M**
Physical Security	$30-50M
Cyber Security	$14-22M

- **Presentations:** Several presentations focused on describing the benefits and risks of the proposed program portfolio and getting stakeholder feedback prior to the Q4 filing. Specifically, the workshop started with a Q4 executive summary presentation and concluded with a more detailed overview of the filing. This detailed overview included a breakdown of the costs by program as well as a discussion of the heatmaps developed to explain the implications of megatrends and grid impacts.
- **Questions:** Following the detailed filing overview presentation, the workshop transitioned to an open question and answer session in plenary with several members of the Duke Energy staff. Many of the questions focused on the heat maps and addressed uncertainties in factors like renewable integration, EV adoption, and more. Costs and issues of customer equity also continued to be areas of focus.

  <u>Summary of Q&A</u>
  - Why is the heat map showing reduced ability to meet customer expectations with the orange in the middle? Duke Energy's response: There is uncertainty with factors like EVs and batteries and what will happen with expectations quickly changing around adoption of these new technologies.
  - With regards to the reduced ability to connect DER in the improvement plan, what is the plan missing that would enable this to go from yellow to green? Duke Energy's response: The lighter shade of yellow represents an effort to optimize what we are doing to address the impacts in the most

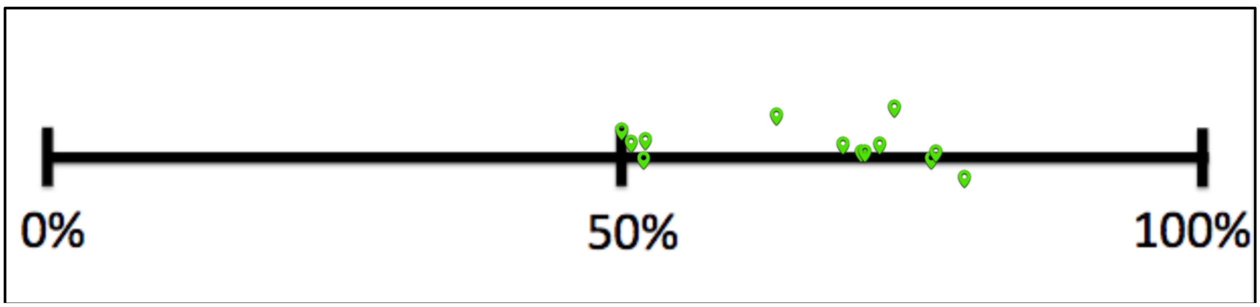
cost effective way and also reveals uncertainty about trends in electric cars or batteries.

  - Why is the heat map showing increased disparity between customers? Duke Energy's response: urban areas are growing and rural populations are declining—the traditional utility model is to serve the most load, which in this case would mean greater investments in urban areas, and fewer in rural. This plan includes deploying some electronics on the rural lines to reduce outages, easing the disparity between the self-optimizing urban grid and the rural service.
  - With grid improvement, are you predicting costs will eventually be lower and will this correlate to a decrease in rates? Duke Energy's response: Yes, over the base case. When these programs kick in they will be more valuable than not. To do this cost-benefit analysis Duke Energy erred on the conservative side of only capturing the hard costs.

Gauging Stakeholder Feedback

Finally, the workshop transitioned to real-time polling questions to gather data from the entire room on overall support for the fourth quarter grid improvement filing plan. Overall, stakeholders were clustered in groups of around 50% support for the plan and closer to 75% support as described in Figure 6 below:

Figure 6: Online polling responses: "Based on what you've heard today, how supportive are you of this plan at this time?"



- **Final Discussion:** Following the plenary presentation, question and answer session, and online polling, the group separated into final table discussions around two questions: what are the strengths of this plan, and what issues and concerns do you have? Feedback from these discussions was captured by a Duke Energy representative taking notes at each table.

Summary of Table Discussion Points: Overall, workshop participants were supportive of Duke Energy's efforts to incorporate stakeholder feedback, and felt that the updated grid improvement plan was better than the first version. The ability to incorporate more

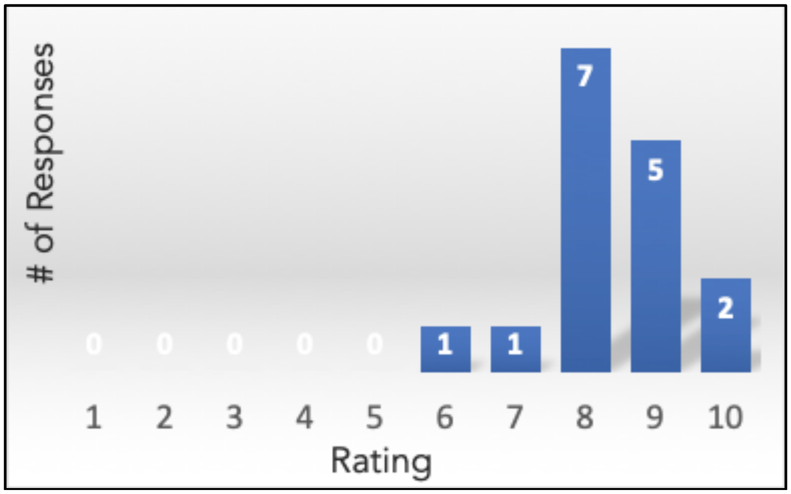
DERs along with increased amounts of storage, reduced targeted undergrounding, and a stronger focus on optimizing technologies like integrated volt/VAR control (IVVC) were all highlighted as positive elements of the plan. Concerns focused on cost and rate impacts along with more details on metrics and goals for DER integration and reduced centralized generation. Outside of plenary discussions, breakout groups discussed feedback on the filing and three tables reported back in plenary:

1. Participants at this table felt that Duke Energy had focused on listening to stakeholder feedback to revise the grid improvement plan. Specifically, stakeholders appreciated the inclusion of more storage, ability to accommodate increased renewables, and the focus on a self-optimizing grid. Their main issues and concerns focused on the unknown costs and rate impacts, along with an interest in learning more about how the plan would impact the transmission system in addition to the distribution system.
2. Participants were similarly supportive of Duke's focus on listening to and incorporating stakeholder feedback, specifically mentioning the use of a neutral third-party facilitator as a positive element of the input process. Concerns were also focused on cost impacts in addition to workforce development plans. There was also an interest in better understanding the differences between the first and second version of the filing plan, specifically asking why IVVC wasn't included in the first plan.
3. Along with incorporating stakeholder feedback, this group highlighted specific positive elements of the plan including flexibility, viewing DER as an opportunity rather than a threat, scaled back undergrounding efforts, and more robust cost-benefit analysis efforts. Concerns focused on costs, metrics and goals for DER integration, and more planning for less centralized generation.

Final Stakeholder Feedback

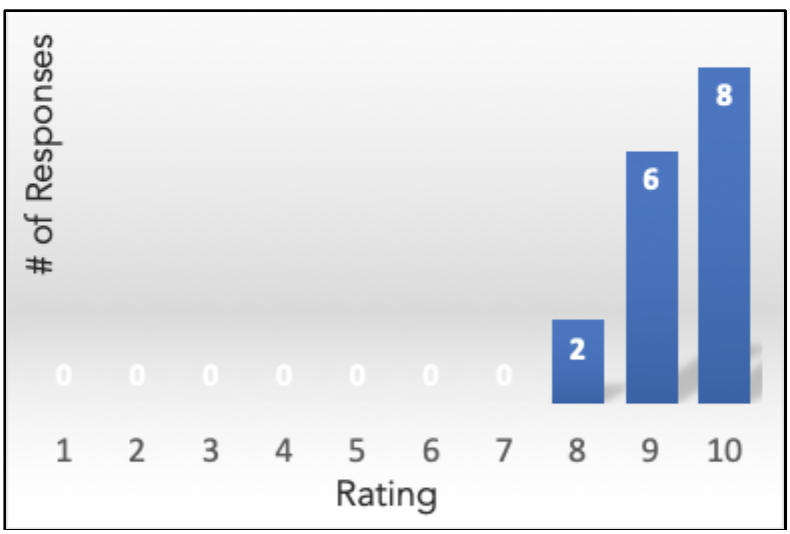
After this final round of discussion, Duke Energy collected a final round of feedback with survey responses. Based on these responses, participants overall indicated interest in continuing to engage with Duke Energy on grid improvement planning, and a majority stated that the workshop provided an effective foundation for future collaboration. Responses to each final survey question are summarized below:

Figure 7: Survey Question 1: "On a scale of 1–10, how well did this workshop enhance your understanding of the proposed grid improvement plan?



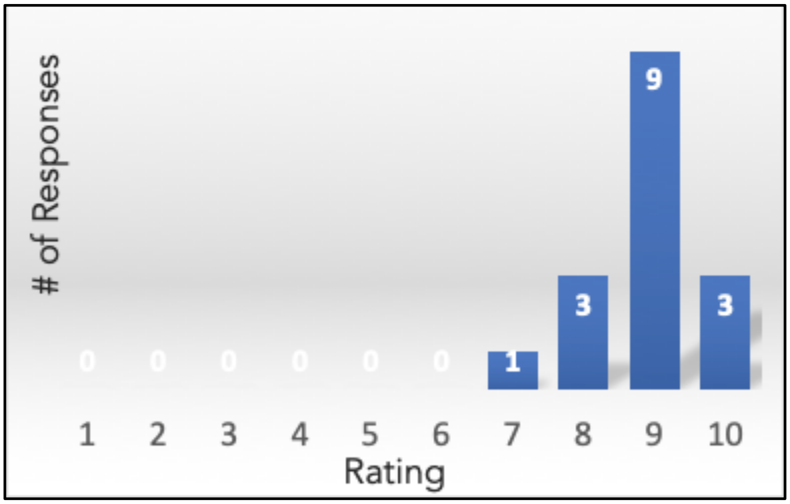
The first post-workshop survey questions asked attendees to assess how well the workshop improved their understanding of Duke Energy's grid improvement plan. The chart above shows the number of respondents that rated the workshop with a given rating. The 16 responses suggested that the workshop did improve their understanding of the plan: no responses rated the workshop less than 6 and 14 of the 16 responses rated the workshop greater than 7 on this question.

Figure 8: Survey Question 2: "On a scale of 1–10, how satisfied are you with the opportunity to provide feedback to Duke Energy at this workshop?



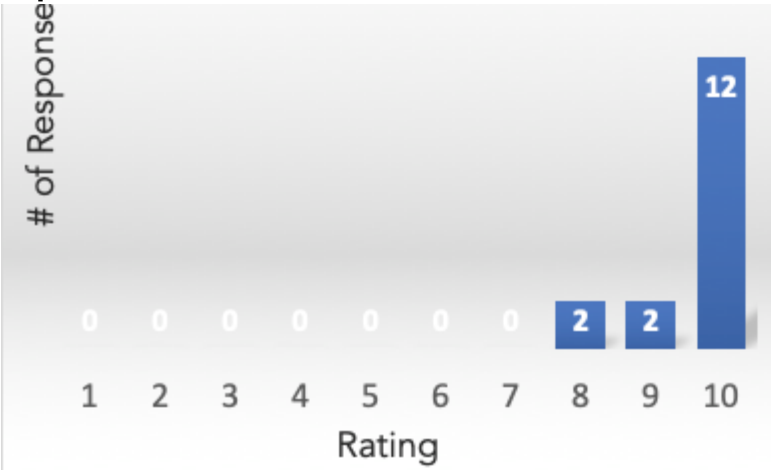
The second post-workshop survey question asked attendees to assess how well the workshop allowed them to provide feedback to Duke Energy. The chart above shows the number of respondents that rated the workshop with a given rating. The 16 responses indicate that attendees did feel that they had a chance to give Duke Energy feedback: no responses rated the workshop less than 8 and 14 of the 16 responses rated the workshop greater than 8 on this question.

Figure 9: Survey Question 3: "On a scale of 1–10, how well did this workshop enhance your understanding about other stakeholders' points of view?



The third post-workshop survey question asked attendees to assess how well the workshop allowed attendees to improve their understanding of other stakeholders' point of view. The chart above shows the number of respondents that rated the workshop with a given rating. The 16 responses suggested that the workshop did allow attendees to hear the perspective of other workshop attendees: no responses rated the workshop less than 7 and 12 of the 16 responses rated the workshop greater than 8 on this question.

Figure 10: Survey Question 4: "On a scale of 1–10, how willing are you to engage in potential future follow-up conversations with Duke around proposed grid improvement initiative?



The last post-workshop survey questions asked attendees if they were willing to engage in a future conversation with Duke around grid improvement. The chart above shows the number of respondents that rated the workshop with a given rating. The 16 responses suggested that the workshop attendees are overwhelmingly willing to engage with Duke on grid improvement going forward: all responses were an '8', '9' or '10' and 12 of the 16 responses were '10.'

Appendix 1: Executive Summary

After Duke Energy presented an initial executive summary of their view on the future of the grid, their process for creating an improvement plan and their Q4 filing plan, participants were asked "Based on what you just heard, what are the most urgent questions you have for Duke Energy about the Q4 filing?" RMI staff documented stakeholder questions posed on post-it notes below, grouped into the following categories:

- **Cost, Rate Impacts, Cost Recovery and Equity**, focused on plan costs and how those costs would be balanced among ratepayers:
    - What are the total cost and rate impacts?
    - What is the impact on the customer's cost and bill?
    - What are the rate impact and how will allocations and rate design be done?
    - What are you doing to protect consumers from a rate payer perspective (stabilizing costs)?
- **Distributed Energy and Renewables Integration**, focused on the extent to which grid improvements would enable future grid hosting capacity, and timeline, and on what timeline.
    - What assumptions is the preparing-for-renewables-section based on?
    - How will the proposed grid improvements increase opportunities for renewable energy especially solar?
    - How will this second proposal increase DER integration compared to the first proposal?
    - At what total level will DER be integrated and on what timeline?
- **Cost-benefit** focused on detailed cost-benefit analysis of the proposed grid improvements.
    - Where is the detailed cost-benefit study?
    - What is the real value to each customer class?
    - When can we see the cost-benefit analysis for specific programs?
    - How is the value to customers balanced across classes?
- **Workforce Development**, focused on how and whether the plan opens up new opportunities for local jobs, and constraints on local trained worker capacity.
    - What is the community education plan?
    - Can you provide more information on the workforce development component and the role that the technical college system can play?
    - What is the impact on workforce development?
- **Others**
    - What is the grid improvement plan for the 44 KV transmission system in the DEC area?
    - What are you doing to protect the grid against artificial intelligence and cyberthreats?
    - What are the net environmental impacts?

Appendix 2: Megatrends and Implications

<u>Q&A:</u>

After Duke Energy's Megatrends and Implications presentation, participants had a chance to ask clarifying questions that were answered in real-time by Duke Energy representatives. This section provides a summary of the questions posed by stakeholders to Duke Energy staff, and notes from staff's real-time responses.

- "Why would you not add as an implication increased reliance on fossil fuels and environmental and cost implications of that?"
  - Cost risks of fossil fuels under business as usual are carried through as an understanding in all the implications presented. Under a business as usual where DER would not be enabled to as great a degree, baseload generation using fossil fuels would continue.
  - In certain programs we quantify base capacity avoidance and fuel implications from the grid improvement plan.
- "Do you foresee the plan addressing some of the transmission issues that are affecting some areas?"
  - Yes, various programs address these issues, including the program for the 44 kV DEC area, programs that impact intermittency and power quality, programs for volt-VAR control, and the DER dispatch tool that would address potential needs to curtail solar.
- "When I think about demographics I think about social and economic demographics. Can we focus on social and economic demographics rather than typical demographics like age, etc.?"
  - Yes, Duke Energy is thinking about all our customers for this plan.
  - For the low-income example, the fuel savings and energy usage savings from IVVC will create automatic efficiency and avoid capacity payment for future generation.
- "Could you tell us about the math behind the heat maps?"
  - At this point the heat maps are highly qualitative — in the nearer term we have more confidence in our data but moving out farther in time we get less quantitative and more qualitative.
- "[When will this plan cause...] increased customer options for rates?"
  - The impact to customer rates will occur as programs are implemented and new rates are approved by the Commission.
- "If avoiding increased costs is one of the primary goals (which should mean savings for consumers), do you have a sense of the balance between when you have to capture costs in order to implement, and when we as consumers will see those savings?"
  - The answer to that question is program dependent.

- For example, the DEP volt-VAR control program has a high potential payback of around 30 to 1; you will spend money over 4 years and that money will "come back quickly."

Polling Questions

Following the Q&A, participants answered polling questions and engaged in table discussion on those questions.

"How aligned are you with how Duke Energy views these seven megatrends?"

Several stakeholders offered explanations for why they responded as they did:

- 75%: One stakeholder agreed with Duke Energy on the megatrends but felt they don't sufficiently capture the full importance of climate change. The stakeholder referred to the Intergovernmental Panel on Climate Change report released the same week as the workshop to underscore the importance of climate change.
- 75%: Another stakeholder also largely agreed with Duke Energy and mentioned that his organization gets involved with grid modernization programs around the country to help ensure they are implemented in a cost-effective way. The stakeholder was involved in the grid modernization plan in North Carolina and had an opportunity to present recommendations. Looking at the megatrends that were identified here it appears that Duke Energy adopted many of the suggestions.
- 50%: Another stakeholder was closer to halfway agreement, not because he disagreed that those are the megatrends we are seeing today, but because having worked on utility issues for 40 years, he recognizes the large degree of uncertainty around trends. Part of the challenge in developing trend outlooks is building in flexibility and sharing risk around "who pays for inaccurate projections."
- 50%: Another stakeholder was at 50% or lower agreement because of the need for greater emphasis on weather impacts. This stakeholder also highlighted and expressed support for the trend NGOs have for looking for energy solutions that are more community based.
- 50%: A final stakeholder was also at 50% or lower because she felt that the plan gave insufficient focus to impacts on the environment.

"How aligned are you with how Duke Energy views the implications for South Carolina?"

Stakeholders offered explanations for why they responded as they did:

- Stakeholders indicated that their answers to this polling question were largely reflected in their responses to the previous question on megatrends.
- One stakeholder added that environmental factors should be a larger component of the implications.

<u>Table discussions</u>

Stakeholders were asked to discuss the following question: "Where do you share common ground with Duke Energy? What's missing? Where do you differ? Why?

<u>Common themes among the responses included:</u>

- <u>Costs:</u> Several discussion groups raised concerns and questions about how the grid improvement plan would result in rate impacts across different customer groups.
- <u>Environmental factors:</u> Almost all groups mentioned the increasing importance of climate change and how climate change urgency should be given more focus in the megatrends and implications.
- <u>Reliability:</u> Several groups mentioned the risk of power interruptions (e.g., during future storms) and the importance of improving reliability in future, especially for industrial customers.
- <u>Technology:</u> Several stakeholders voiced that Duke Energy's megatrends and implications presentation may be underestimating the impacts of rapid adoption of technologies like solar, storage and electric vehicles
- <u>Additional key trends</u> identified by participants included (1) flattening load growth, and (2) quickly evolving customer expectations, especially from the next generation(s) of customers.

Detailed documentation of table discussion post-its follows:

<u>Megatrends</u>

- "Where do you share common ground with Duke Energy?"
  - "All"
  - "All"
  - "General Agreement"
  - "All, with some more focus on uncertainties"
  - "Generally, acknowledge listed trends but …"
  - Customer Expectations
  - Changing Customer Expectations
  - "Protecting Consumers from Cyber Threats"
  - "Physical Threats"
  - "Threats to Infrastructure"
  - "Cyber threats are real concerns to many customers – including seniors"
  - "Weather Events (incr. Frequency, severity, duration)"
  - "Agree that the grid needs improvement"
  - "Technology Advancement – EV adoption, storage prices"
  - "Environmental Trends"

- "Top 3 Trends: (1) Technology Advancements/Grid Improvements, (2) Environmental, (3) Weather Events (dependent on data). Trends need emphasis"
- "What's missing? Where do you differ?"
    - "Different 'customer of tomorrow'
    - "Aging Line workforce"
    - "Grid reliability and improvement (transmission) is essential for serving a growing state (and growing state industry)"
    - "Missing: Is there an added service such as high-speed internet"
    - "More electric: More connected appliances/homes"
    - "Rate of change is ramping up"
    - "'Electrify Everything' scenario (as another megatrend? – or supplement on technology advancement [in addition to EVs])"
    - "Climate change driving fossil fuel use"
    - "More emphasis on climate"
    - "Enough weight on EV Budgets?"
    - "Declining Load Growth"
    - "Detach from utility (going off grid)"
    - "Flat load growth missing"

Implications of Megatrends

- "Where do you share common ground with Duke Energy?"
    - "All"
    - "Can't stand still and can't go backward (Business as Usual won't work)"
    - "Agree on identification of implications"
    - "How can you break down the language for low-income people in a form to understand better."
    - "How will the company show how, in low-income communities, grid improvement will be used in their home?"
- "What's missing? Where do you differ?"
    - "Big Policy $wings – Impact of corporate tax structure. Hit on customer bills. Climate Δ/energy policy. Deregulation (especially transmission & distribution)"
    - "Disproportionately Impact low income"
    - "Missing: customer affects / behavior modification"
    - "Cost must be considered and remain reasonable"
    - "What does this mean for solar non-utility size (solar) solutions? Rooftop/Community."
    - "How do we integrate NGO solar (DER) solutions into the grid (Interchange)
    - "How much job growth?"
    - "How can low income people participate in job growth?"

- "How can we develop more resilience (security) with storms?"
  - "Cost may actually decline – missing: business model"
  - "Updated regulatory construct and business model to take advantage of markets"
  - "Optimize response to megatrends"
  - "How are these weighted?"
  - "Unanticipated catastrophic events"
  - "But maybe not degree of harm under business as usual (BAU)"
  - "Fossil Fuel Environmental and price implications w/ BAU"
  - "Does Grid Mod give both NC/SC an economic development advantage?"
  - "Disparity on who can own an EV"
  - "Load implications of younger generation"
  - "Equity w/respect to rates or benefits of service, especially for low income"

Appendix 3: Program Prioritization Method

Full notes: Duke Analytic Process Questions

Description of process: Following the Duke Energy presentation on the company's analytic process for developing the grid improvement plan, stakeholders asked questions in plenary. This section provides a summary of the questions posed by stakeholders to Duke Energy staff, and notes from staff's real-time responses.

- "How do you calculate the environmental benefits – using [data or reports from the] EPA or some other data?"
  - For self-optimizing grid, we tried to quantify benefits from additional capacity to address peak shaving. Another environmental benefit is the enablement of future DER capacity like rooftop solar and EVs. These technologies have a range of potential adoption penetration and growth, and also range in resources required to prepare for that. We used an external consultant to help with these estimations.
- "We would love to see more detail on the environmental benefits analysis."
  - The company makes assumptions around inputs such as how much EVs and battery storage are going to grow—we can share these assumptions and we are open to feedback.
- "For the net present value calculation, what discount rate was used?"
  - We used the appropriate company discount rate for the service territory, approximately 7%. We've seen other cost benefit analysis which didn't use our rate; however, we felt it would be more conservative to use our rate.
- "Can you provide more info on the ICE model [and how it is used to quantify the] value of lost service, and whether this is a proprietary methodology?
  - ICE is not a proprietary model. It is based on a DOE-sponsored study to analyze typical costs of service interruptions for various customers including residential, small commercial, and large industrial. The model

assigns an average for momentary interruptions and different lengths of hours, and we've seen it is the best tool available to value what "being without power" really means.
    - The ICE model does not take into account outages longer than 16 hours, so it does not give you the value of major events like hurricanes. That is a whole different analysis that the ICE tool is not designed for.
- "With these examples, it seems that a lot of benefits flow to commercial customers. How are you going to allocate costs to ensure they pay? As a second question, for Targeted Undergrounding, how are you differentiating between maintain TUG [programs] and grid mod TUG [programs]?
    - The TUG programs address several of the megatrends. Based on stakeholder feedback to the initial plan, we have scaled back the amount of TUG and focused the current plan on individual projects.
    - Using these initial individual projects, we plan to prove the value of TUG and how it addresses megatrends...and then complete more projects more based on this value.
    - For the question on how costs are allocated, we looked at programs that address momentary interruptions. This TUG project was unusual because of the number of commercial customers near a line also serving residential customers.
- "For the cost/benefit of targeted undergrounding, are you also considering how to enable a microgrid to [be integrated into those geographies]?"
    - There is a lot of opportunity to use storage in ways we haven't used it before. The important focus for Duke Energy is to have a positive net present value for storage, e.g., it meets a capacity need or a need to address a community that is underserved.
    - Then, once you have the storage, you can use it to island or microgrid during peak demand, or support frequency variation. But the core value is deferring investment.
- "How do you handle the differences between customer and utility benefits when calculating net present value? "
    - All costs eventually go to the customer — savings for the utility goes to the customer in the end, so it's beneficial if the utility saves.
    - Regarding direct customer benefits around the self-optimizing grid, in addition to going around outages, the program also enables two-way power flow through automated switches controlled by a central hub that allows us to change configurations and manage more DER on the system.

Appendix 4: Q4 Filing Overview

Q&A:

Following the Duke Energy overview presentation on the company's proposed near final fourth quarter filing for grid improvements, company staff took questions in plenary from participants. This section provides a summary of the questions posed by stakeholders to Duke Energy staff, and notes from staff's real-time responses.

- "For the heat map showing reduced ability to meeting customer expectations, what is going on with the orange in the middle?"
  - The orange reflects uncertainty around factors like EVs and batteries, and around expectations about the adoption of these new technologies. In the near term future we aren't sure how these will be immediately managed, but in the long run we are confident we can support these technologies (reflected by the green shown further out in time in the heat map).
- "With regards to the Implication titled "reduced ability to connect DER," the improvement plan is better than BAU but still seems like a slow demise.[...] What is the plan missing that would enable it to [actually improve]?"
  - The lighter shade of yellow reflects uncertainty from and around addressing impacts "in the most cost-effective way."
  - This includes uncertainty around technologies like electric cars or batteries.
- "What's going on with the increased disparity between customers on the bottom [heat map]?"
  - The traditional utility model is to serve the most load, which in the case of South Carolina would imply investing more in urban areas, and less in rural. If we can deploy some electronics on the rural lines to reduce outages, this would ease the disparity between the self-optimizing urban grid and the rural service.
- "Costs are a dire picture under business as usual. With grid improvement, are you predicting costs will eventually be lower, and will this correlate to a decrease in rates?"
  - Yes, over the base case. When these programs kick in they will create relative value, resulting in a decrease in rates compared to business as usual. IVVC is a great example in the short term; by better managing the voltage, we will help lower costs to customers.
  - It's more effective to do something proactively and well planned than reactively when the system has reached a breaking point.
  - For any of these programs, are we going to see bill returns? We think so. We've erred on the more conservative side of capturing only the benefits to hard costs; we have not included valuation of holistic benefits..

- “Is this plan [being created under existing planning processes and methods for grid improvement relative to integrated resource planning] or would a new process be developed integrated planning?”
    - We are looking at planning as both an enterprise process and as a system, so it could be used across jurisdictions.
    - A phased approach will be used for a few principle things like software, analytics, and integration of that into the global plan for the utility.
    - We continue to reach out for best practices, stakeholder engagement, and lessons learned.
- “Do you have any more insight on hosting capacity?”
    - We have discussed hosting capacity in North Carolina, which takes over a year or two or work to do correctly. We are working with a new software package that will help us work on hosting capacity more efficiently than we are today.
    - We are aiming to focus on solving for enterprise level infrastructure and functionality.

Polling Questions

Several stakeholders offered to provide an explanation to the plenary on where they placed their cursor on the real-time polling question about overall alignment with the filing plan, and why:

- 75%: One stakeholder was uncertain investments in grid improvement will actually create opportunities for DER and skepticism on how the investments lead to future decreased costs.
- 50%: Another stakeholder was unsure the implications of the grid improvement plan on rates and total revenue requirement, which customers will pay. Without knowing this, this individual found it hard to say, ‘Thumbs up.’
- 50%: This stakeholder stated that uncertainty in costs make it difficult to fully support the plan.
- 75%: One stakeholder stated this plan is better than the original version that was introduced in North Carolina, but there is some remaining skepticism around if certain programs fit as grid modernization.
- 75%: Another stakeholder is supportive of setting the foundation for and building data analytics capability for future DER integration.
- 60%: This stakeholder stated that grid improvement is necessary, but it’s still unclear how the plan will result in benefits and costs. Additionally: we need a diversified approach to solving the energy problems in South Carolina, balanced with the need for renewables and energy efficiency. We also need to be investing in other things as well — this is a lot of money that could be supporting other efforts.

Table Discussions

Participants were asked to discuss and document "What are the strengths of this plan? What issues, concerns, or questions do you need to raise?" For this activity, RMI tasked Duke Energy representatives with documenting what they heard from stakeholders on post it notes.

Report out in plenary:

Three tables presented out on the highlights of their discussion

1. Table 1: Participants felt that Duke Energy had focused on listening to stakeholder feedback during the revision process for the grid improvement filing plan. Specifically, stakeholders appreciated the inclusion of more storage, ability to accommodate increased renewables, and the focus on a self-optimizing grid. Their main issues and concerns focused on the unknown costs and rate impacts, along with an interest in learning more about how the plan would impact the transmission system in addition to the distribution system.
2. Table 2: Participants were also observed that Duke Energy had incorporated stakeholder feedback into the plan and identified the use of a neutral third party facilitator as a positive element of the input process. Concerns focused on cost impacts and opportunities for workforce development. Participants expressed an interest to better understand the difference between the first and second version of the filing plan, and specifically queried why IVVC didn't seem to be included in the first plan.
3. Table 3: The following aspects of the plan resonated as positive among this group: flexibility in design of the plan, reduced undergrounding investments, and improved cost-benefit analysis and report out. Some participants expressed they view DER as an opportunity rather than a threat. Concerns focused on costs, metrics and goals for DER integration, and their desire for planning to focus more on decentralized generation.

The follow section captures digitally the detailed notes from Duke Energy staff at discussion tables:

What are the strengths of this plan?

- Stakeholder involvement and listening/responding
- Self-optimizing grid
- Outage updates via text
- DER dispatch tool
- Battery storage is starting to show up in grid plan
- Accommodates small solar and battery
- Starting to capture costs experienced by customers
- Refreshing to hear ability to deal with DER being taken into consideration
- More EVs and storage

- Reliability improvement is key component
- Refreshing to hear stakeholder feedback will be integrated
- Responsiveness of version 1 to feedback
- Big improvement over NC approach
- Stakeholder process with neutral 3rd party expert
- Narrowed focus to relevant trends compared to last time
- Provided good distinction between BAU and GIP with clear options for future
- Stakeholder input reflected
- Flexibility of plan
- 3 years more feasible than 10 years
- More user friendly
- More national views
- Tone more receptive to DER—not painted as a problem but a solution
- Better definition of projects
- Cost benefit by project better than last version
- Scaled back TUG to prove benefit

<u>What issues, concerns, or questions do you need to raise?</u>

- Why wasn't IVVC in the original plan?
- What are the differences between the first and second plans?
- Important to lay out as much of the future plan as possible
- Important to communicate how these investments facilitate efficiency and behavior decisions
- Re: 44 kV lines where? How? When?
- Not much info on cost stabilization over time
- Want more info on workforce development plans
- Want more info on future assumptions related to solar penetration
- Want more info on which programs contribute to which grid capabilities
- How long will this investment and cost increase last? Not clear
- Looking for how costs and budget will be allocated, i.e., EV vs. transmission
- Generation planning: need less centralized generation, impacts to IRP
- IRP not showing retirements related to grid improvements
- Securitization for stranded assets: effective, efficient retirement of assets
- Making the most of the potential—Biggest DER is EE, may not need grid improvement for leveraging EE, what's the true customer value?
- Cost allocation
- Implementation execution risk
- More project by project details
- Cost overruns and timelines lengthening
- More info on macro view of megatrends vs. individual trends
- Opportunities to mitigate rate impacts to low income needs more discussion
- More definition around how stakeholder process continues over 10-year life of plan

- Metrics and goals for DER integration
- Does grid mod improvement provide “perfect power” or markedly improved at plant site?
- Integrated VAR level with Grid Mod—does this help at plant level and can plant be relieved of their VAR control?
- Are there synergies with customer and utility? Customer operating characteristics paired with utility costs
- Rate impact TBD
- Need more info on transmission (not just distribution)
- Need more on hardening the transmission system
- Transmission capacity impacting economic development
- Reliability not as big an issue for some groups, varies by types of customer class (e.g., hospitals)
- Aligning who pays for benefit
- Cost and who pays?
- Need to capture customer outage costs greater than 16 hours
- Need to plug into non-profit groups as partners and education
- More community involvement to understand benefits