2022 DEC MYRP T&D Technical Conference

November 2, 2022

Today's speakers

Brent Guyton

Director, Distribution Asset Management

Dan Maley

Director, Transmission Compliance

Laurel Meeks

Director, Renewable Business Development

Agenda

Topic	Presenter
Context and external trends	**Brent Guyton**
Distribution projects	Brent Guyton
Transmission projects	Dan Maley
Energy Storage projects	Laurel Meeks
Closing remarks	Brent Guyton

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Plan for today

Plan for the day

- Update on context and external trends that impact grid improvement planning
- Share summary of planned work and expected benefits for Distribution, Transmission, and Energy Storage
- Give examples of planned work during the Multiyear Rate Plan ("MYRP") period
- Q & A

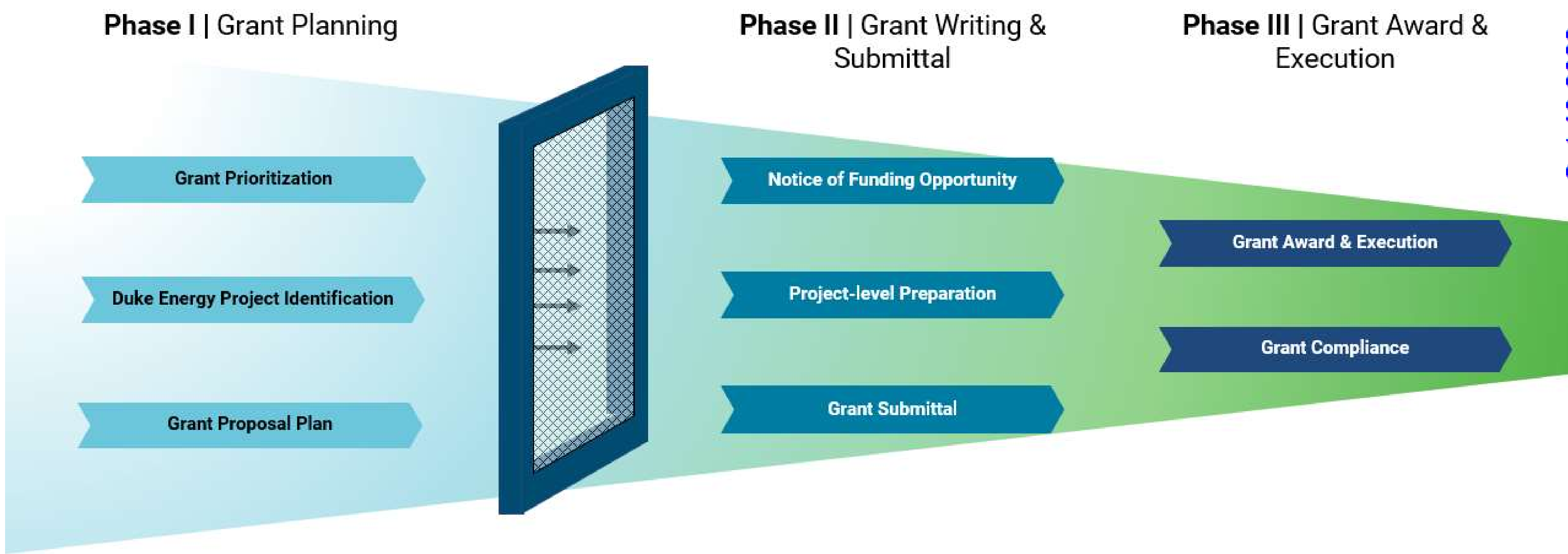
Documents shared in advance

✓ Detailed description for each planned improvement program and/or project, including:
  – Purpose and description of work to be completed
  – Summary of expected benefits
  – Estimated total costs across all work

✓ Complete list of all planned projects, including:
  – Projected in-service dates
  – Estimated total cost for each project
  – Expected benefits for each project

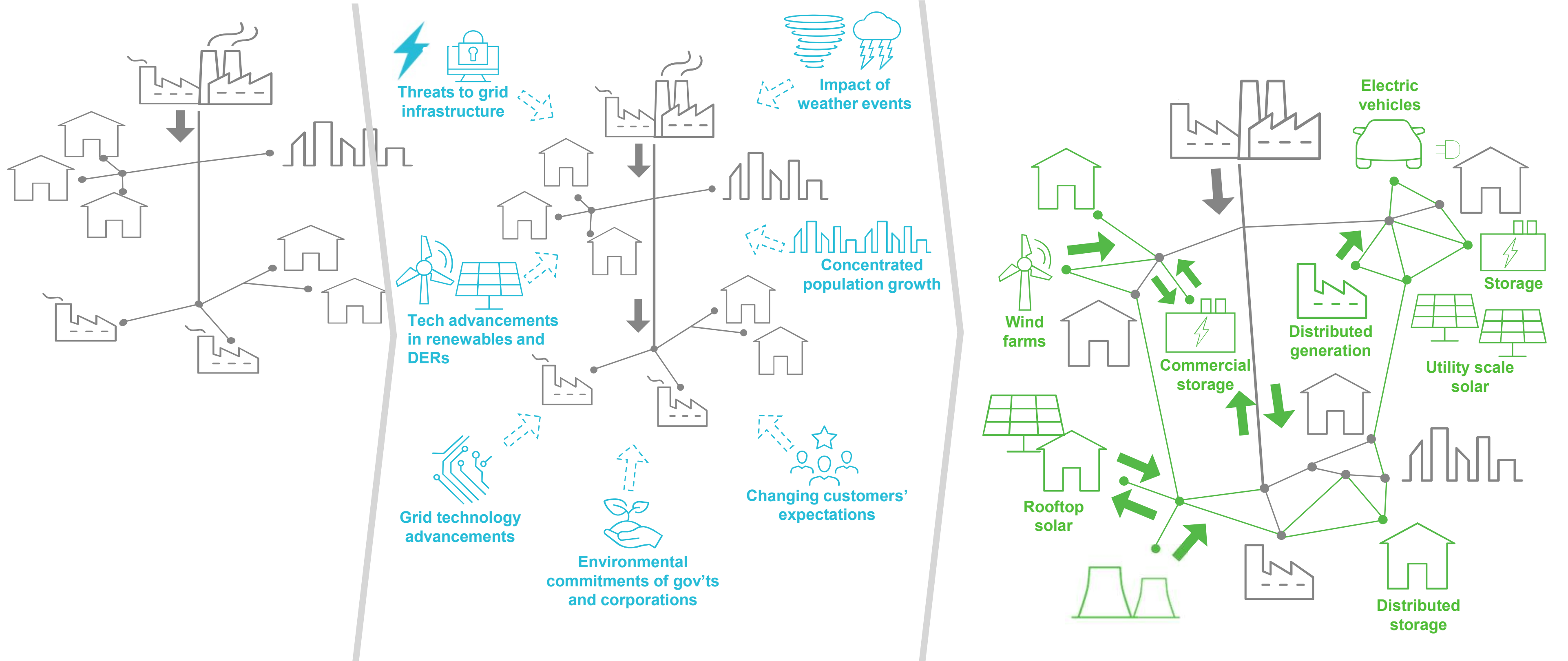
✓ Cost-benefit analyses

Infrastructure Investment Jobs Act (IIJA) grant process

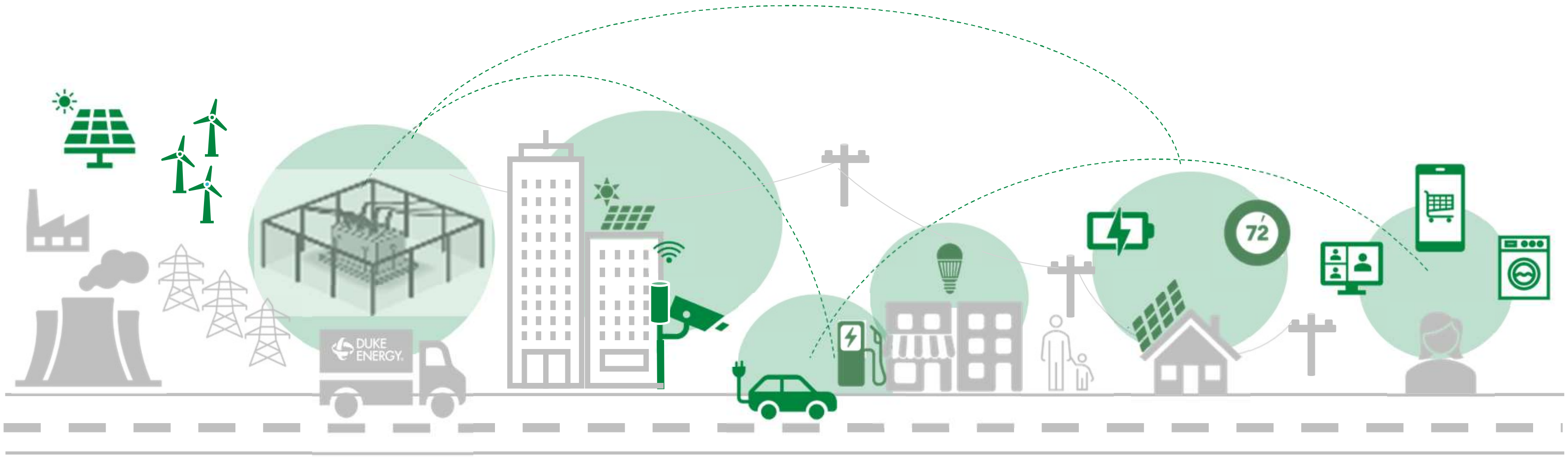


Journey to develop the grid of the future

The past	The present	The future
The grid as a supplier	*Increasing impact of Megatrends*	*The grid as an enabler*



Three objectives for improvement work to address the megatrends and ready the grid for the future



Grid resiliency

Increase the grid's ability to withstand and recover from more frequent intense weather and external events

Expanded renewables and DERs

Enable the grid to meet customer demand for DERs while maintaining reliable service

Equitable access to benefits

Achieve balanced outcomes for customers across geographies, promoting access to emerging technologies and energy solutions

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Planned work will result in significant customer benefits

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Significant customer benefits expected from projects

- Maintain **reliable power** with **fewer and shorter outages**
- Protect against **physical and cyber attacks and severe weather events** to drive resiliency
- Expand **access to renewables and distributed energy resources (“DERs”)**
- Enable the grid to **support future technologies**
- Operate **efficiently** and support programs that give **energy control** and **affordability**
- Provide **equitable access** to benefits

Our strategy will serve customers into the future

- Add **flexible capabilities** that can adapt to changes in technology, population, external threats, and DERs
- Continue to **improve decision-making** with advanced **data analytics tools**
- Integrate **new solutions** to address changing customer needs

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Customer benefits based on building several critical grid capabilities

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Reliability

Improve resiliency by increasing grid strength and ability to rapidly restore power

Promote DER adoption by providing consistent power flow

Capacity

Promote DER adoption by enabling 2-way power flow capability in more circuits

Address changing demand by outfitting circuits to meet increasing load

Automation & Communication

Improve resiliency by detecting faults and rerouting power to self-heal, reducing impact from outages

Promote DER adoption by enabling more efficient resource management

Voltage Regulation

Promote DER adoption by optimizing voltage levels to protect customers from disruptive supply spikes or sags

Improve resiliency by better managing dynamic power flows from distributed resources

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Planned distribution improvements

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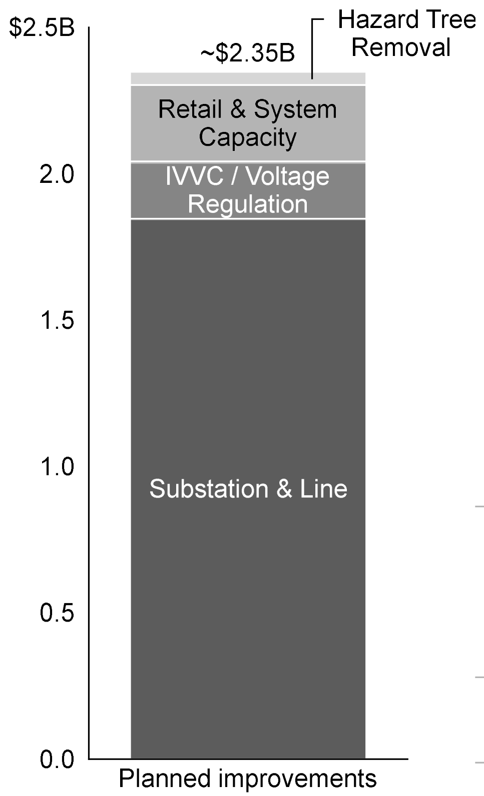
Planned grid improvements*
Aug. '23 - Dec. '26
DEC NC (in $B)



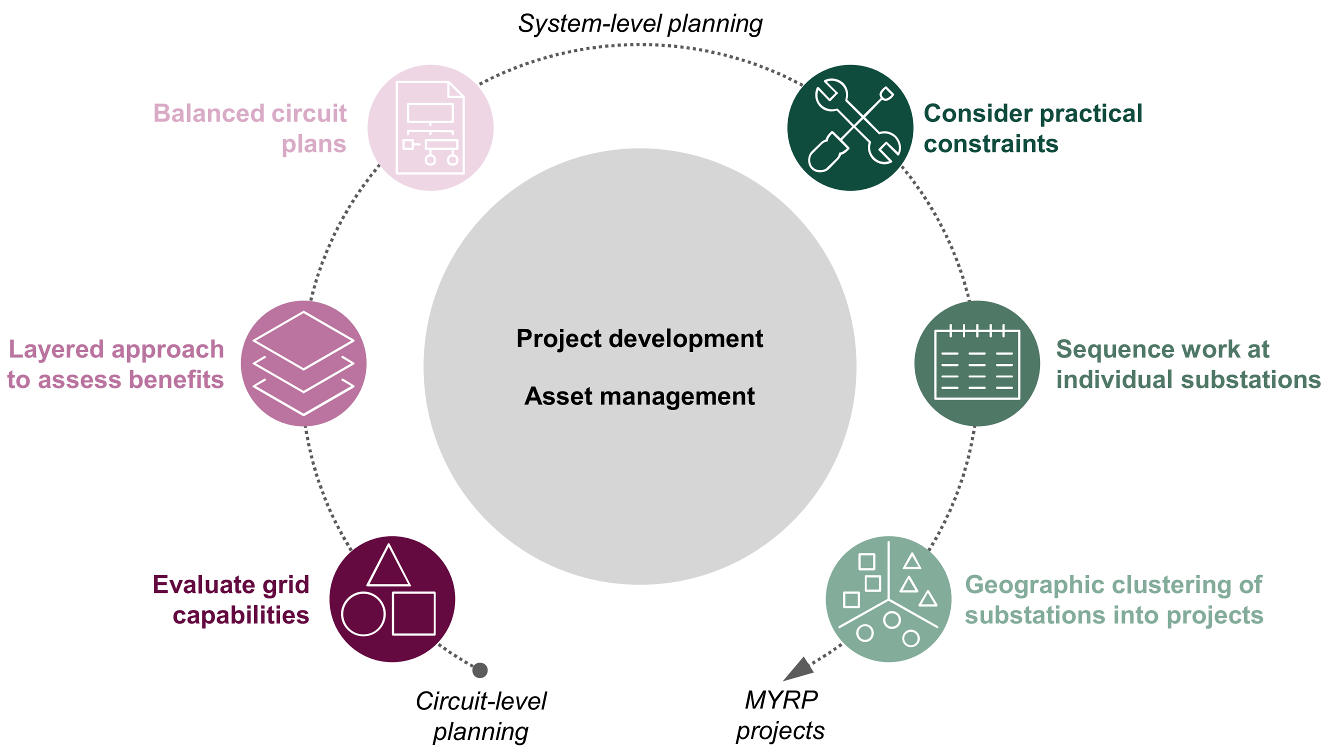
Improvement category	Improvement program details
Substation and Line	**Capacity:** Increase line capacity to support DERs and EVs and traditional loads
	Self-Optimizing Grid ("SOG"): Build new ties, install sectionalizing / automation devices
	Hardening & Resiliency ("H&R"): Upgrade, strengthen, and underground event-prone infrastructure
	Distribution Automation: Add automated restoration capabilities
	Long Duration Interruption: Re-route feeder / bring to road to increase accessibility
	Targeted Undergrounding: Place outage-prone line segments underground to improve performance
	Hazard Tree Removal: Take down at-risk trees outside of right of ways
	Infrastructure Integrity: Review, identify, and complete work for existing infrastructure
IVVC / Voltage Regulation	**Integrated Volt-VAR Control ("IVVC"):** Establish control of distribution equipment to optimize delivery voltages and power factors
	Voltage regulation & management: Add/upgrade devices to support DG, EVs, and PVs
Retail & System Capacity	Expand capacity to support load growth and increased system functionality
Hazard Tree Removal	Take down at-risk trees outside of right of ways

Note: Costs as shown include capital expenditure, AFUDC, and contingency; additional costs for one-time O&M associated with installation are not included

Distribution project planning approach to maximize customer benefits

DISTRIBUTION

Project planning approach



Process overview

- Circuit-level planning used to identify optimal mix of improvement programs to be deployed
- At system level, practical constraints and sequencing requirements considered for selection of circuit plans to implement
- MYRP project plans compiled to include work at geographically clustered substations

Sample Distribution MYRP project

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Project-based approach

- For Distribution system, projects are planned for a set of substations in a clustered geographic region
- Select improvement programs are deployed across each substation in the project, based on its specific needs
- Improvement programs at individual substations are executed geographically to maximize resource efficiency, minimize disruption and deliver customer benefits across a broad customer footprint/area

Sample Distribution MYRP project: Triad-251 Area Project

Project includes work at 18 geographically clustered substations

Substations included	Improvement programs deployed within the project							
	Capacity	SOG	Hardening & Resiliency	Distribution Automation	Long Duration Interruption	Targeted Undergrounding	Hazard Tree Removal	Infrastructure Integrity
Bannertown	✓	✓	✓	✓			✓	✓
Brookwood	✓		✓	✓			✓	✓
Buck Island		✓					✓	✓
Buxton St	✓		✓	✓				✓
Dobson	✓	✓	✓	✓				✓
Flat Shoal		✓						✓
Goodwill Church Rd		✓	✓	✓			✓	✓
Key St	✓	✓	✓	✓		✓	✓	✓
Level Cross		✓		✓		✓	✓	✓
Mt Airy	✓	✓	✓	✓		✓	✓	✓
Oak Ridge		✓		✓	✓			✓
Sedge Garden			✓	✓			✓	✓
Seward	✓						✓	✓
Southbound	✓		✓	✓			✓	✓
Toast				✓			✓	✓
Walnut Cove	✓		✓	✓		✓	✓	✓
Welcome			✓	✓			✓	✓
White Plains	✓			✓			✓	✓

Example: Planned work at Key St. substation includes Capacity, SOG, H&R, Dist. Automation, Targeted Underground, Hazard Tree Removal, and Infrastructure Integrity

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Financial cost-benefit analyses methodology

Overall methodology

- Benefits calculation and cost-benefits analysis completed using methodology from previous rate case filings
- Expected financial benefits based primarily on customer (e.g., reliability improvements) and operational savings (e.g., avoided O&M)
- Cost-benefit analyses completed at the improvement program level; similar to analysis for SOG in previous rate case filings

Data inputs

- **Aggregate resource / input** requirements determined based on:
  - Substation characteristics
  - Historical project data: average requirements for completion of work
- **Expected reliability improvements** determined based on:
  - Historical performance for identified circuits
  - Historical project data: average improvements associated with program

Methodology for benefits and costs

- **Program costs** calculated using aggregate resource / input requirements and projected unit costs (based on historic project data)
- **Program benefits** calculated as financial value of:
  - Customer savings (expected reliability improvements, using the Interruption Cost Estimate (ICE) Calculator used for data input)
  - Operational savings (e.g., avoided O&M)
  - Other savings (e.g., fuel costs, environmental)
- Timing of costs and benefits determined from expected project schedules

Excel-based cost-benefit analysis (CBA)

- Projected schedule of **program costs and benefits** tabulated in Excel
  - Benefits segmented by outage avoidance (sustained and momentary) and operational savings
  - Costs segmented by capital (including contingency) and O&M (implementation and ongoing)
- Present value (as of current year) calculated for costs and benefits
- Net present value and benefit-cost ratio calculated
- Sensitivity analysis tab included for variance on key inputs

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Integrated Volt-VAR Control
Program overview

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Program purpose:

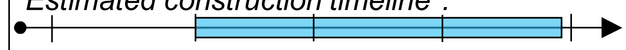
Integrated Volt-Var Control ("IVVC") establishes control of distribution equipment in substations and on distribution lines to optimize delivery voltages and power factors on the distribution grid. DEC will dynamically operate IVVC in the form of Conservation Voltage Reduction ("CVR") which reduces energy (MWh's) and saves fuel, while reducing Duke Energy's carbon footprint. By installing modern sensing and control devices, as well as integrating them into the Distribution Management System, IVVC helps improve distribution system operational efficiency.

Program description:

- Coordinated control of distribution equipment in substations and on distribution lines to optimize voltages and power factors on the distribution grid
- Installs communications and control infrastructure including substation voltage regulator control replacement, substation capacitor control replacement, distribution line voltage regulator control replacement, distribution line capacitor replacement, medium voltage sensors, and two-way communications implementation into these substation and distribution line devices
- Dynamically optimizes the control of substation and distribution devices, resulting in a flattening of the voltage profile across an entire circuit
- Provides increased visibility into the status and condition of substation and field devices such as capacitor banks, voltage regulators, and transformer load-tap changers. This added visibility and enhanced voltage control will help manage the integration of distributed energy resources (i.e., solar) by improving the grid's ability to respond to intermittency
- Lowering the circuit voltage, through conservation voltage reduction (CVR), at the substation results in a reduction of system loading, creating the benefit of decreased generation. CVR supports voltage reduction and energy conservation

Key details:

Estimated construction timeline:*



Estimated in-service dates:*

Projected costs:

DEC NC	Jan'24 – Dec'24	Jan'25 – Dec'25	Jan'26 – Dec'26
Capital costs**	$25.5M	$37.2M	$33.7M
Installation O&M**	$.5M	$.7M	$.6M

Grid capabilities enabled:

- **Voltage Regulation:** reduced distribution line losses due to lower overall voltage; more efficient grid due to lower line losses and reduced reactive power; less generation fuel consumed and lower emissions due to grid efficiencies; integrated control of capacitor banks provides greater ability to reduce reactive power

HB951 Policy Considerations addressed:

- Encourages peak load reduction or efficient use of the system
- Encourages utility-scale renewable energy and storage
- Encourages DERs
- Encourages beneficial electrification, including electric vehicles;
- Promotes resilience and security of the electric grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for discrete and identifiable projects proposed to be included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

Integrated Volt-VAR Control
Program benefits

DISTRIBUTION

Fuel Savings

- IVVC reduces energy (MWh's) consumption and saves fuel. Fuel savings are passed directly to customers

Carbon reduction

- Lower carbon emissions from reduced generation due to reduced energy (MWh's) consumption and improved grid efficiencies

Improved voltage experience for customers

- Integrated Volt-VAR Control maintains proper voltage levels to customers by keeping voltages in the proper range

Expands solar and renewables

- Optimized control of Volt/VAR devices improves the grid's ability to respond to intermittency

Improve Grid Efficiency

- More efficient grid due to lower line losses and reduced reactive power
- Integrated sensing and control deployed in IVVC helps improve distribution system operation efficiency

Quantitative Cost-Benefit Analysis

Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$842.6M	$540.2M	1.6

Note: Work is required as pat of honoring obligation to serve through prudent and safe utility practice

Voltage Regulation Management

Program overview

DISTRIBUTION

Program purpose:

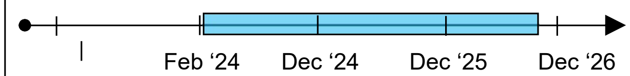
The Voltage Regulation and Management ("VRM") improvement program will modernize the grid by installing devices that will improve voltage management and power quality for all customers, while supporting the growth of distributed energy resources ("DERs").

Program description:

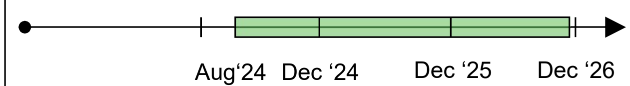
- Establishes control of equipment on the distribution grid to optimize delivery voltages to customers and to prepare for two-way power flows on the grid
- Improves the grid's ability to address intermittency and fluctuations caused by DERs, enable DER adoption and improve power quality to customers
- Three levels to the program
  - Installation of new voltage regulators on circuits help maintain a constant voltage level by creating "regulation zones". Improves voltage management on the circuit by adjusting voltage conditions and reducing intermittency caused by solar DER sites
  - Installation of new capacitors on circuits. Improves voltage management and allows electricity to be efficiently distributed across the distribution circuits by automatically adjusting the reactive power on the circuits
  - Installation of new specialized equipment like power electronics in areas of higher levels of DER penetration. These devices better equip the distribution system to manage power quality issues associated with increasing DER penetration

Key details:

Estimated construction timeline:*



Estimated in-service dates:*



Projected costs:

DEC NC	Jan'24 – Dec'24	Jan'25 – Dec'25	Jan'26 – Dec-26
Capital costs**	$26.2M	$40.6M	$32.9
Installation O&M**	$.5M	$.8M	$.6M

Grid capabilities enabled:

- **Voltage Regulation:** promote DER adoption by optimizing voltage levels to protect customers from voltage deviation due to disruptive supply spikes or sags and improve resiliency by reducing intermittency/fluctuations from DER power supply

HB951 Policy Considerations addressed:

- Encourages peak load reduction or efficient use of the system
- Encourages utility-scale renewable energy and storage
- Encourages DERs
- Encourages beneficial electrification, including electric vehicles;
- Promotes resilience and security of the electric grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for discrete and identifiable projects proposed to be included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

Voltage Regulation Management
Program benefits

DISTRIBUTION

Improved voltage experience for customers

- Advanced technologies will help maintain proper voltage levels to customers by keeping voltages in the proper range
- Integrating advanced equipment on the grid helps reduce power quality issues associated with increasing DER penetration

Expands solar and renewables

- Increasing the level of distributed energy resources that can be accommodated on the distribution grid reduces the need to curtail or issue moratoriums on customer-owned interconnections

Gives customers more options and control

- Increasing the grid's ability to integrate more renewables and electric vehicles provides customers more options to meet their individual needs

Transforms the grid to prepare for a cleaner, lower-carbon future

- Technologies that enable two-way power flows for increased DER on the grid will allow more customers to interconnect clean forms of renewable generation. This helps North Carolina continue to be attractive to businesses with environmental commitments

Note: Work is required as part of honoring obligation to serve through prudent and safe utility practice

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Capacity
Program overview

DISTRIBUTION

Program purpose:

Capacity upgrades and improvements enhance reliability of service for our new and existing customers, and support load growth from traditional loads. Additionally, the upgrades support transportation electrification and integration of distributed energy resources ("DERs"), such as rooftop solar and battery storage.

Program description:

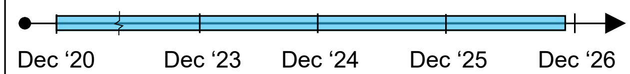
Capacity work is driven by customer load growth, including the expansion of electric vehicles and other distributed technologies.

Retail substation upgrades focus on work needed within the retail substations that serve distribution customers. Work includes installation of transformers, substation upgrades, and extension of transmission lines to new substation property. Improvements like transformer upgrades increase the capacity available at that substation to meet current and future customer demand for electricity.

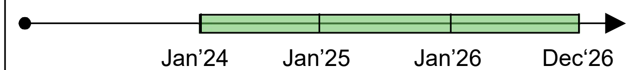
Distribution system capacity upgrades focus on work needed to add capacity on distribution lines. Improvements include new distribution lines and equipment (e.g., regulators, reclosers) or upgrades to existing equipment to increase the maximum current that can be delivered. The use of advanced data analysis, like Morecast and the Advanced Distribution Planning ("ADP") toolsets, help to forecast locations where capacity upgrades are most needed. As demand for electricity increases, either from customer growth or installation of large quantities of distributed energy resources, it increases pressure on the system from the points of use upstream to the substation. Upgrading the lines to a larger conductor by replacing conductors, adding a new circuit, or transferring some load to an adjacent circuit, can help better distribute electricity and provide a reliable experience for all customer needs. This improvement program will drive planners to choose the best and most cost-effective solution for targeted line upgrades to enable sustainable customer load growth and expansion of distributed resources.

Key details:

Estimated construction timeline:*



Estimated in-service dates:*



Projected costs:

DEC NC	Jan'24 - Dec'24	Jan'25 - Dec'25	Jan'26 - Dec'26
Capital costs**	$157.4M	$205.9M	$164.5M
Installation O&M**	$3.1M	$2.6M	$2.5M

Grid capabilities enabled:

- **Capacity**: promote DER adoption by enabling 2-way power flow and address changing demand by equipping circuits with capacity needed to meet increasing load

HB951 Policy Considerations addressed:

- Encourages utility-scale renewable energy and storage
- Encourages DERs
- Encourages beneficial electrification including electric vehicles
- Promotes resilience and security of the grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for discrete and identifiable projects proposed to be included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

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Capacity
Program benefits

DISTRIBUTION

Improved reliability

- Reduce potential outages due to overloaded conductors and equipment associated with DER penetration and customer load growth. Upgrades will also help improve resiliency by allowing for additional switching scenarios to address outages and high demand scenarios

Improved resiliency

- Higher capacity lines improve voltage quality and make it easier to address outages and restore service. Additional capacity and connectivity can also support self-healing networks in the area to lessen the duration and impact of outages on the system

Expands solar and renewables

- Strategically upgrading capacity supports more efficient DER connections

Note: Work is required as part of honoring obligation to serve through prudent and safe utility practice

Self-Optimizing Grid
Program overview

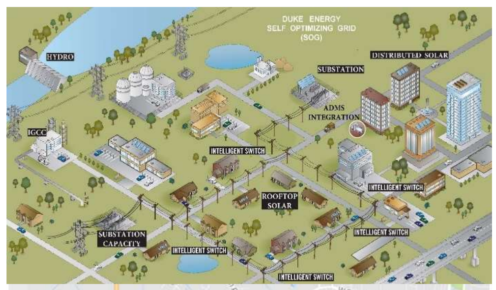
DISTRIBUTION

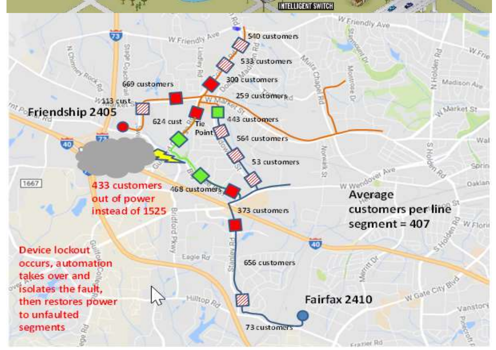
Program purpose:

The Self-Optimizing Grid (SOG) program, also known as the smart-thinking grid, redesigns key portions of the distribution system and transforms it into a dynamic self-healing network with the purpose of improving system reliability.

Program description:

- Consists of three major components:
  - **Capacity:** expands line capacity
  - **Connectivity:** creates tie points between circuits to allow for automatic reconfiguration
  - **Automation:** provides intelligence and control
- Converts circuits into switchable segments to minimize number of customers affected by outages, expands capacity to support an integrated grid, and ensures the necessary connectivity to allow for rerouting options
- Detects potential faults and fixes power outages in real time using sensors, switches, and controls to recognize power outages, automatically isolate the faulted portions, and reconfigure to minimize customer impact
- Reduces number of outages, decreases duration of outages, and restores power in minutes
- Once installed, incremental annual savings of 127,000 customer interruptions (CI) and over 25 million customer minutes interrupted (CMI) are expected





Key details:

Estimated construction timeline:*

Dec '20 — Dec '23 — Dec '24 — Dec '25 — Dec '26

Estimated in-service dates:*

Jan'24 — Jan'25 — Jan'26 — Dec'26

Projected costs: DEC NC	Jan'24 - Dec'24	Jan'25 – Dec'25	Jan'26 – Dec'26
Capital costs**	$127.8M	$58.4M	$84.6M
Installation O&M**	$1.8M	$0.8M	$1.2M

Grid capabilities enabled:

- **Reliability:** improve resiliency to increase grid strength and ability to rapidly restore power
- **Capacity:** promote DER adoption by enabling 2-way power flow and address changing demand by increasing capacity;
- **Automation & Communication:** improve resiliency by detecting faults and rerouting power; promote DER adoption with efficient resource management

HB951 Policy Considerations addressed:

- Encourages DERs
- Encourages beneficial electrification including electric vehicles
- Promotes resilience and security of the grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for discrete and identifiable projects proposed to be included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

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Self-Optimizing Grid
Program benefits

Improve reliability and resiliency

- SOG creates a network of interconnected circuits that are split into smaller automatically switchable segments that can isolate faults and reconfigure, thus greatly reducing the number of customers affected by sustained outages; the program also reduces the number of outages and decreases the duration of those outages if they do occur

Expand solar and renewables

- SOG creates a network of interconnected circuits with more capacity and two-way power flow which is more accommodative to renewable energy resources including rooftop solar, battery storage, electric vehicles, and microgrids

Quantitative Cost-Benefit Analysis

Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$1,348.5M	$238.4M	5.7

Distribution Hardening & Resiliency: Laterals

Program overview

DISTRIBUTION

Project purpose:

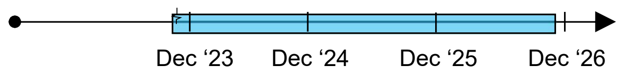
Duke Energy has an obligation to provide reliable service to customers in every community that we serve. Proactively replacing and upgrading damaged, deteriorated or at-risk lateral distribution lines that can lead to unplanned outages is essential for providing safe and reliable service to customers and supports the reliable expansion of distributed resources.

Project description:

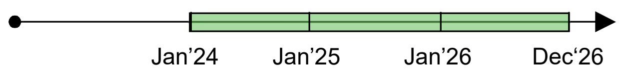
- This work is focused on the lateral sections, also known as tap lines, which branch from the main feeder lines and feed neighborhoods, businesses, industrial customers
- Targeted work is identified through a data-driven approach based on factors such as historical data and observed condition of the line. Risk factors that are considered when identifying candidates for this program are:
  - power lines that have a history of prior outages due to deteriorated wire,
  - evidence of prior damage (fraying, multiple splices, pitting etc.), and
  - small wire that has been identified with a steel core that presents a risk of deterioration
- This work includes replacing at-risk steel core conductor with new all-aluminum segments of conductor, which is extremely corrosion resistant, and increasing the size in some cases, to accommodate more load. These improvements will help to improve reliability on the line, deliver a better experience for customers and support the high level of performance needed to grow distributed technologies in the area

Key details:

Estimated construction timeline:*



Estimated in-service dates:*



Projected costs:

DEC NC	Jan’24 – Dec’24	Jan’25 - Dec’25	Jan’26 – Dec’26
Capital costs**	$70.0M	$135.6M	$230.9M
Installation O&M**	$1.3M	$2.5M	$4.2M

Grid capabilities enabled:

- **Reliability:** Improve resiliency by increasing grid strength and ability to rapidly restore power and promote DER adoption by providing consistent power flow

HB951 Policy Considerations addressed:

- Encourages DERs
- Encourages beneficial electrification including electric vehicles
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for discrete and identifiable projects proposed to be included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

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Distribution Hardening & Resiliency: Laterals

Program benefits

DISTRIBUTION

Improved reliability

- Eliminate the risk of overhead conductor failures by upgrading the size and quality of the wire. This improvement will help increase reliability for customers served by the line

Improved resiliency

- More robust design and construction standards can help to avoid outages, but also help crews restore power faster in these areas
- Upgrades that help shorten outages can also free up line and tree crews sooner to help with outage restoration in other areas

Outage cost avoidance

- Fewer and shorter outages resulting from grid strengthening work helps avoid recurring trips to the same locations to restore power after severe weather and can also make line and tree crews available faster to assist with power restoration in other areas

Improved customer experience

- Improving the overall reliability of the line, increasing the resiliency of the line and decreasing restoration times improves the overall customer experience and establishes an operational environment that is more resilient and more conducive to distributed technologies in that area

Quantitative Cost-Benefit Analysis

Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$898.5M	$361.6M	2.5

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Distribution H&R: Public Interference
Program overview

DISTRIBUTION

Project purpose:

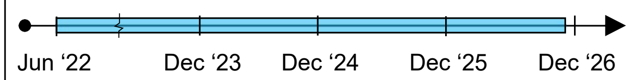
This distribution work improves reliability by targeting the Company's most outage prone overhead backbone power line sections greatly impacted by vehicle accidents and determining the proper hardening & resiliency solution to reduce the number of outages experienced by customers.

Project description:

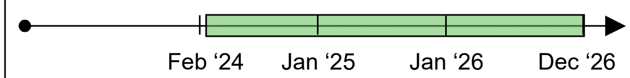
- Public interference outages, typically cars hitting overhead power line poles, are outside of the company's control. When these accidents occur, it often results in a long-duration outage due to the severity of the damage caused by the incident
- Historical outage data is used to identify the locations where vehicles have been prone to strike poles. Criteria for consideration in the selection of targeted communities include:
  - Service location (i.e., lines must be located on three-phase portions of the circuit)
  - Frequency of outages from vehicle accidents
- Lines targeted to be hardened will receive a custom solution which may include undergrounding of the overhead line, relocating the line, or changing the design of the infrastructure at the location of the repeat occurrences

Key details:

Estimated construction timeline:*



Estimated in-service dates:*



Projected costs:

DEC NC	Jan'24 – Dec'24	Jan'25 – Dec'25	Jan'26 – Dec'26
Capital costs**	$11.8M	$39.7M	$44.6M
Installation O&M**	$.2M	$.7M	$.8M

Grid capabilities enabled:
- **Reliability:** Improve resiliency by increasing grid strength and ability to rapidly restore power and promote DER adoption by providing consistent power flow

HB951 Policy Considerations addressed:
- Encourages DERs
- Encourages beneficial electrification including electric vehicles
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for discrete and identifiable projects proposed to be included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

Distribution H&R: Public Interference
Program benefits

DISTRIBUTION

Improved reliability

- A stronger grid is more resistant to outage from public interference. Reducing the risk of outages on overhead lines improves reliability and provides a better experience for customers

Improved resiliency

- More robust design and construction standards in outage prone areas helps avoid outages and reduces the need for crews to return to the same outage prone areas, freeing up line and tree crews sooner to help with outage restoration in other areas

Outage cost avoidance

- Fewer and shorter outages resulting from grid strengthening work helps avoid recurring trips to the same locations to restore power

Improved customer experience

- Improving the overall reliability of the line, increasing the resiliency of the line and decreasing restoration times improves the overall customer experience and establishes an operational environment that is more resilient and more conducive to distributed technologies in that area

Quantitative Cost-Benefit Analysis

Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$99.9M	$80.3M	1.2

Distribution Hardening & Resiliency: Storm
Program overview

DISTRIBUTION

Project purpose:

These distribution improvements strengthen the grid in areas vulnerable to severe weather, and in other high-impact areas. Assets will be engineered to better withstand high winds and impacts from snow and ice to help reduce outages and restoration time in areas prone to physical damage during severe storms. Strengthening the grid in these areas improves reliability and can also help free up resources faster to assist with outage restoration in other areas.

Project description:

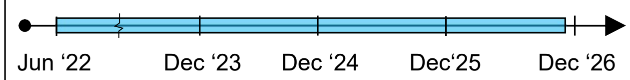
- Distribution hardening and resiliency improvements are targeted to locations of the distribution grid that have been identified, through analysis of historical outage data, as being more vulnerable to outage impacts from extreme weather events. Examples are poles and wires in heavily vegetated areas that experience impacts from downed trees, or areas where an outage could potentially impact essential services or large numbers of customers for an extended period

- Poles and wires in these areas are being replaced with an upgraded, more robust standard that includes larger poles, shorter spans, and additional guy wiring which helps provide a hardened, more reliable grid during extreme weather events.
  - A construction comparable to Grade B & NESC 250B-D loading for solutioning will be applied to the targeted circuit segments. The grades of construction (B/C/N) determine the different safety factors for design, with Grade B providing the highest margin of safety. For example, Grade B is required for spans crossing limited access highways, railroads, and waterways. NESC 250B-D defines required wind and ice loading for design

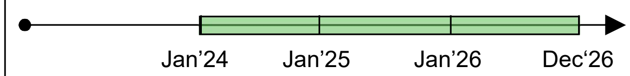
- The distribution grid across North Carolina was historically built to withstand the typical weather types that are most commonly experienced in the state (e.g., winter storms, an occasional tropical system, summer afternoon thunderstorms). Increasingly, though, we are seeing a rise in frequency and severity of outages in many parts of the state. This trend can become even more pronounced in areas that are more exposed to these extreme conditions

Key details:

Estimated construction timeline:*



Estimated in-service dates:*



Projected costs:

DEC NC	Jan'24 – Dec'24	Jan'25 – Dec'25	Jan'26 – Dec'26
Capital costs**	$3.4M	$16.3M	$31.6M
Installation O&M**	$.06M	$.3M	$.6M

Grid capabilities enabled:
- **Reliability:** Improve resiliency by increasing grid strength and ability to rapidly restore power and promote DER adoption by providing consistent power flow

HB951 Policy Considerations addressed:
- Encourages DERs
- Encourages beneficial electrification including electric vehicles
- Promotes resilience and security of the electric grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for discrete and identifiable projects proposed to be included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

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Distribution Hardening & Resiliency: Storm
Program benefits

DISTRIBUTION

Improved reliability

- A stronger grid is more resistant to power outages from severe weather. This helps reduce the frequency of long-duration power outages caused by storms

Improved hardening & resiliency

- More robust design and construction standards in storm-vulnerable areas can help to avoid outages, but also help crews restore power faster in these areas. Upgrades that help shorten outages can also free up line and tree crews sooner to help with outage restoration in other areas

Outage cost avoidance

- Fewer and shorter outages resulting from grid strengthening work helps avoid recurring trips to the same locations to restore power after severe weather and can also make line and tree crews available faster to assist with power restoration in other areas

Improved customer experience

- Improving the overall reliability of the line, increasing the resiliency of the line and decreasing restoration times improves the overall customer experience and establishes an operational environment that is more resilient and more conducive to distributed technologies in that area

Quantitative Cost-Benefit Analysis

Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$167.9M	$41.8M	4.0

Distribution Automation
Program overview

Program purpose:

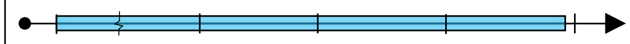
The Distribution Automation program focuses on modernizing single-use fuses with devices capable of intelligently resetting themselves for reuse, restoring power faster for customers and eliminating unnecessary use of resources (labor, fuel, inventory etc.) to reset them. The program seeks to improve reliability and minimize customer interruption when an outage occurs, turning what would have been a sustained outage into a momentary blink.

Program description:

- Replaces single use fuses on a distribution line with automated lateral devices (ALD) like small reclosers. Currently, distribution line fuses are designed to open in the event of a fault, resulting in a sustained outage. Line fuses are one-operation devices, meaning that once a fuse interrupts a fault, the fuse melts and must be manually replaced. Most interruptions on the distribution grid are temporary, such as a tree limb falling on a power line before falling to the ground. But due to the use of fuses, those temporary faults often become sustained outages
- ALD opens during a temporary fault, resetting and attempting to close and restore power after a short period of time. If the fault source is cleared, power is restored without manual intervention
- ALD are capable of attempting self-restoration multiple times. If the fault source is sustained, the ALD opens to protect the circuit until a manual intervention is completed
- Larger reclosing devices sense faults downstream of line fuses and open and reclose in an attempt to clear faults without a sustained outage. By introducing the ALD, the remaining customers on the circuit will not experience a momentary outage
- Reclosing capability can be applied to smaller segments of the circuit traditionally protected by fuses
- Focuses on segments of the distribution system where line protections are less robust and where it is likely that even a temporary fault will result in a fuse melting and a sustained outage

Key details:

Estimated construction timeline:*



Estimated in-service dates:*

Projected costs:

DEC NC	Jan'24 – Dec'24	Jan'25 – Dec'25	Jan'26 – Dec'26
Capital costs**	$15.0M	$8.1M	$5.3M
Installation O&M**	$.3M	$.1M	$.1M

Grid capabilities enabled:
- **Reliability:** Improve resiliency by increasing grid strength and ability to rapidly restore power and promote DER adoption by providing consistent power flow

HB951 Policy Considerations addressed:
- Encourages DERs
- Encourages beneficial electrification including electric vehicles
- Promotes resilience and security of the electric grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for discrete and identifiable projects proposed to be included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

Distribution Automation
Program benefits

DISTRIBUTION

Improved reliability and resiliency

- Reduction in customer interruptions that benefit all customers where applied, including potential critical need customers

Quantitative Cost-Benefit Analysis

Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$67M	$24.9M	2.7

Long Duration Interruption (LDI)
Program overview

DISTRIBUTION

Project purpose:

This distribution work relocates segments of main overhead feeder lines in hard-to-access areas to improve accessibility for utility trucks. Improving crew accessibility reduces restoration time for outages in difficult to reach areas and increases worker safety. Moving these line segments to road-accessible locations that are more easily maintained can also help reduce the risk of an outage, improving overall reliability for customers in these areas and can also help free up resources faster to assist with outage restoration in other areas..

Project description:

- Targeted areas for this program are radial distribution lines that serve entire communities or large groups of customers, as well as inaccessible line segments (i.e., off road, swamps, mountain gorges, extreme terrain, etc.)
- The areas targeted for improvement experience consistently higher-than-average outage durations and reduced power reliability and customer satisfaction
- During extreme weather events, vegetation, erosion, and flooding can create challenges and potentially unsafe conditions for restoration crews trying to restore power, resulting in longer outage times
- Addressing these challenges typically involves relocating the lines to road right of way. Road accessibility helps improve the customer experience and provides positive benefits to the overall power restoration process as it allows more efficient access to lines and equipment from the road right of way

Key details:

Estimated construction timeline:*

Jul '22 | Dec '23 | Dec '24 | Dec '25 | Dec '26

Estimated in-service dates:*

Jan'24 | Jan'25 | Jan'26 | Dec'26

Projected costs:

DEC NC	Jan'24 - Dec'24	Jan'25 - Dec'25	Jan'26 - Dec'26
Capital costs**	$6.4M	$5.0M	$11.7M
Installation O&M**	$0.2M	$0.2M	$0.4M

Grid capabilities enabled:

- **Reliability:** Improve resiliency by increasing grid strength and ability to rapidly restore power and promote DER adoption by providing consistent power flow

HB951 Policy Considerations addressed:

- Encourages DERs
- Encourages beneficial electrification including electric vehicles
- Promotes resilience and security of the grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for discrete and identifiable projects proposed to be included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

Long Duration Interruption (LDI)
Program benefits

DISTRIBUTION

Improved reliability

- Strategically relocating outage-prone line segments to more accessible and maintainable locations helps reduce outage risk

Improved resiliency

- Relocating the feeder segment to a more accessible and maintainable right of way helps improve resiliency by reducing outages and promoting faster responses when outages do occur

Reduced outage costs

- Relocating these feeder segments from hard-to-reach locations to more maintainable areas helps reduce outages and avoids the need for more specialized and expensive equipment and crew labor needed to repair outages

Improved customer experience

- Improving the overall reliability of the line, increasing the resiliency of the line and decreasing restoration times improves the overall customer experience and establishes an operational environment that is more resilient and more conducive to distributed technologies in that area

Quantitative Cost-Benefit Analysis

Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$320.2M	$19.7M	16.3

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Targeted Undergrounding
Program overview

DISTRIBUTION

Project purpose:

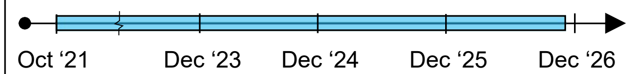
The Targeted Undergrounding (TUG) program improves reliability by strategically identifying the company's most outage prone overhead power line sections and relocating them underground to reduce the number of outages experienced by customers.

Project description:

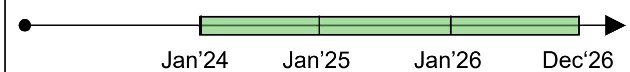
- This program uses data analytics to identify overhead line segments with an unusually high frequency of historical outages and places those segments underground.
- Criteria for consideration in the selection of targeted communities include:
  - Performance of overhead lines
  - Age of assets
  - Service location (e.g., lines located in backyard where accessibility is limited)
  - Vegetation impacts (e.g., heavily vegetated are often costly and difficult to trim)

Key details:

Estimated construction timeline:*



Estimated in-service dates:*



Projected costs:

DEC NC	Jan’24 - Dec’24	Jan’25 - Dec’25	Jan’26 - Dec’26
Capital costs**	$38.4M	$67.1M	$88.2M
Installation O&M**	$0.02M	$0.05M	$0.06M

Grid capabilities enabled:
- **Reliability:** Improve resiliency by increasing grid strength and ability to rapidly restore power and promote DER adoption by providing consistent power flow

HB951 Policy Considerations addressed:
- Encourages DERs
- Encourages beneficial electrification including electric vehicles
- Promotes resilience and security of the grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for discrete and identifiable projects proposed to be included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

Targeted Undergrounding
Program benefits

DISTRIBUTION

Improved reliability

- By undergrounding the overhead wires, the exposure to failures above ground will be eliminated and will lead to an improved reliability experience for customers on that line

Improved hardening and resiliency

- Improved system resiliency by reducing repeated trips to the same line segments during storms and outage events, freeing up resources faster to restore power to other customers

Reduced outage costs

- Overhead conductor that is converted to underground will not require vegetation maintenance costs to maintain the right of way

Expands solar and renewables

- Improving the overall reliability of the line, increasing the resiliency of the line and decreasing restoration times improves the overall customer experience and establishes an operational environment that is more resilient and more conducive to distributed technologies in that area

Quantitative Cost-Benefit Analysis

Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$487.0M	$159.1M	3.1

Hazard Tree Removal
Program overview

DISTRIBUTION

/DRAFT

Program purpose:

The purpose of the program is to maintain or improve reliability by identifying and taking down dead, structurally unsound, dying, diseased, leaning, or otherwise defective trees from outside the maintained right-of-way that could strike electrical lines or equipment of the distribution system. Reliability is maintained or improved by minimizing interruptions from tree-caused outages.

Program description:

- All hazard trees are identified by a qualified Duke Energy representative per industry best management practices
- Any tree found to present an imminent risk to infrastructure is assigned to a supplier immediately to be taken down
- A Duke Energy Program Manager assigns remaining identified trees to a supplier for property owner/customer notification of pending work
- As schedule and mobilization allows, suppliers cut down trees following property owner/customer notification

Key details:

Estimated construction timeline:*

Estimated in-service dates:*

Projected costs:

DEC NC	Aug’23 - Dec’24	Jan’25 - Dec’25	Jan’26 - Dec’26
Capital costs**	$35.8M	$21.5M	$19.5M
Installation O&M**	$0M	$0M	$0M

Grid capabilities enabled:

- **Reliability:** Improve reliability through a better protected grid, improve resiliency by removing hazard trees that result in longer outage restorations, and improve power flow consistency and efficiency which supports promotion of DERs

HB951 Policy Considerations addressed:

- Encourages DERs
- Encourages beneficial electrification including electric vehicles
- Promotes resilience and security of the electric grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for discrete and identifiable projects proposed to be included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

Hazard Tree Removal
Program benefits

DISTRIBUTION

Improved reliability and resiliency

- Managing trees and other vegetation to improve reliability and make the grid more resistant to vegetation-related outages

Note: Work is required as part of honoring obligation to serve through prudent and safe utility practice

Infrastructure Integrity
Program overview

DISTRIBUTION

Project purpose:

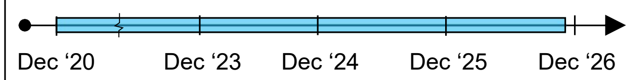
This infrastructure Integrity initiative seeks to continually improve and ensure a safe reliable electrical energy delivery system through identification and mitigation of risk factors such as end-of-service equipment, technology obsolescence, and removal of damaged in-service distribution equipment such as capacitors, regulators, reclosers, and other line equipment. Proactively identifying and planning these improvement opportunities can minimize impacts to customers, turn potential emergency outage response into a planned replacement, strengthen the overall grid against unplanned interruptions of service, and support the increased grid capabilities being implemented to promote DER adoption..

Project description:

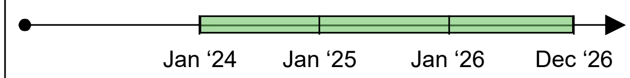
- As more automation is added to the system from grid improvements to improve reliability and support DER, the historical system integrity norms are changing to consider the dependency of distribution customer reliability on two-way power flow. Programs that were historically in place to address known risk factors now are evolving to support more devices on the system, changes in device operations due to power intermittency, and newer technologies that deliver new capabilities and challenges for the grid
- Examples of infrastructure integrity work include:
  - Asset replacement – Inspection-based programs including poles
  - Oil mitigation – hydraulic-to-solid dielectric replacement, and replacement of live-front/end-of-life transformers
  - Greenhouse gas mitigation – replacement of SF6 switchgear with solid dielectric
  - Technological obsolescence – replacement of recloser control panels nearing end of life
  - System operability to serve dynamic power flows – replacing non-communicating hydraulic reclosers with new remote-accessible solid dielectric units
  - Major outage root cause studies
- This work coincides with other distribution improvement work scheduled at the substation or circuit to optimize crew travel, maximize switching procedure utilization, and improve traffic control zone utilization

Key details:

Estimated construction timeline:*



Estimated in-service dates:*



Projected costs:

DEC NC	Jan'24 - Dec'24	Jan'25 - Dec'25	Jan'26 - Dec'26
Capital costs**	$222.9M	$121.5M	$103M
Installation O&M**	$4.0M	$2.2M	$1.9M

Grid capabilities enabled:
- **Reliability:** Improve resiliency by increasing grid strength and ability to rapidly restore power and promote DER adoption by providing consistent power flow

HB951 Policy Considerations addressed:
- Encourages DERs
- Encourages beneficial electrification including electric vehicles
- Promotes resilience and security of the electric grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for discrete and identifiable projects proposed to be included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

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Infrastructure Integrity
Program benefits

Improved reliability

- Sustaining the integrity of the infrastructure through data-informed replacements will lead to a more reliable power quality experience for customers

Improved resiliency

- Sustaining the integrity of the infrastructure makes it easier to troubleshoot outages and restore service quicker

Improved customer experience

- Coordinating infrastructure improvements with other planned work helps optimize crew travel, maximizes planned outage and switching procedures, and improves traffic control zone utilization on substation projects

Note: Work is required as part of honoring obligation to serve through prudent and safe utility practice

Agenda

Topic	Presenter
Context and external trends	Brent Guyton
Distribution projects	Brent Guyton
Transmission projects	**Dan Maley**
Energy Storage projects	Laurel Meeks
Closing remarks	Brent Guyton

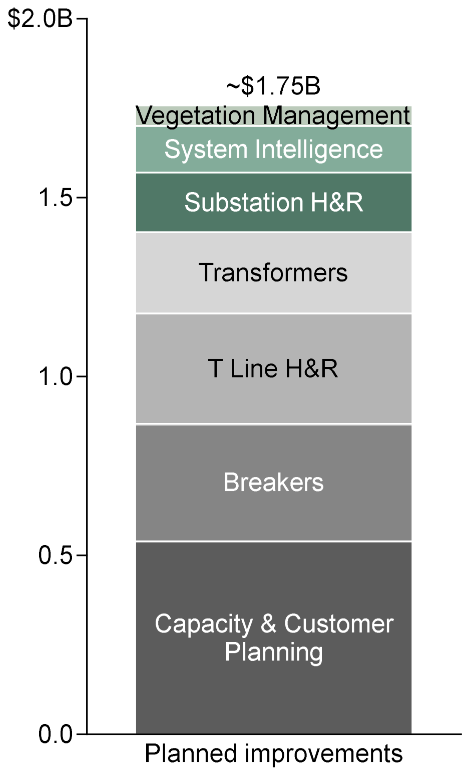
Transmission capabilities and customer benefits

	Characteristics enabled	Customer benefits created
System Intelligence	**Improved grid awareness** from modernized transmission system communication capabilities that increase operator and engineer visibility to system conditions	• Reduced risk of long duration outages • Reduced outage frequency
Hardening and Resiliency	**Stronger and more resilient** transmission grid by upgrading lines and substations	• Reduced system impact from external threats • Reduced outages caused by line component failures • Reduced / avoided emergency repairs
Transformer & Breaker Upgrades	**Improved reliability** and **increased renewables facilitation** from upgrades to transformers and circuit breakers that are beyond their useful life	• Reduced risk of long duration outages • Mitigation of potential environmental impact • Improved accommodation of variable energy sources
Capacity & Customer Planning	**Meeting customer** and **compliance obligations** as demand grows and renewable energy sources are added to the system	• Ensuring grid reliability and stability • Ability to meet evolving customer demand • Sustainable growth of renewable generation

Planned transmission improvements

TRANSMISSION

Planned transmission improvements*
Aug. '23 - Dec. '26
DEC System (in $B)



Improvement category	Improvement project areas
System Intelligence	**Intelligent Equipment** and upgrades that enhance system monitoring and response ability
Hardening & Resiliency	**Transmission Line Hardening & Resiliency**: Transmission line upgrades that mitigate the effects of external events and extreme weather
	Substation Hardening & Resiliency: Substation upgrades that mitigate the effects of external events and extreme weather
	Vegetation Management: Targeted removal of hazard trees that could cause interruptions
Transformer & Breaker Upgrades	**Breakers:** Upgrading end-of-life circuit breakers
	Transformers: Upgrading end-of-life transformer banks
Capacity & Customer Planning	**Planning** for changing demand, new delivery points for customers, and transmission expansion for utility scale renewables

Note: Costs as shown include capital expenditure, AFUDC, and contingency; additional costs for one-time O&M associated with installation are not included

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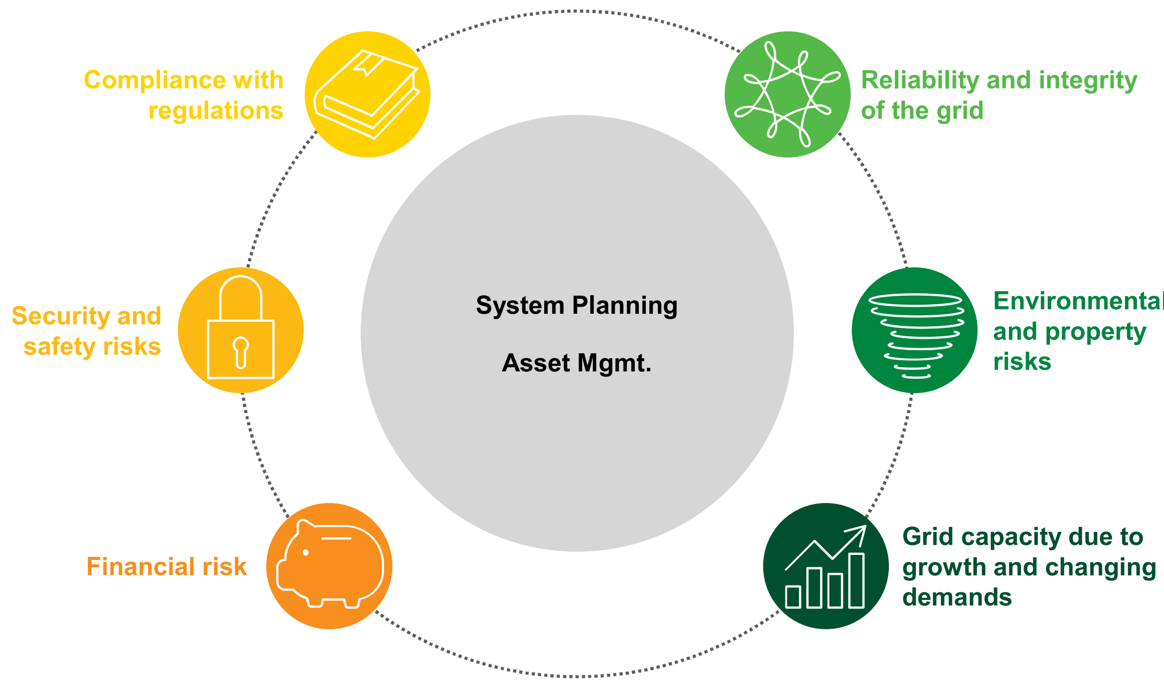
Systematic, value based approach to prioritize opportunities

TRANSMISSION

Value based approach

- Improvement opportunities are prioritized based on **avoided risks, benefits, and cost**
- **Environmental, safety, compliance, and financial risks** are considered
- **Impact modelling** is used to inform decision-making including:
  - Avoided customer outages
  - Improved redundancies / networking
  - Equipment failure probability / consequences

Project prioritization framework



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Financial cost-benefit analyses methodology

Overall methodology

- Benefits calculation and cost-benefits analysis completed using methodology from previous rate case filings
- Expected financial benefits based primarily on outage risk reduction
- Cost-benefit analyses completed for individual project locations, in line with previous filings

Data inputs

- **Cost Estimate** based on historical project data (i.e., average requirements for completion of work, materials)
- **Asset Condition** based on field assessments, inspections (probability of failure for end of life assets)
- **Risk of Overload** based on system planning studies and analysis (for capacity projects)
- **Consequence of Failure** based on voltage level, circuit configuration, customer mix

Methodology for benefits and costs

- Total **Project costs** including costs outside of the MYRP project in-service window
- **Project benefits** calculated based on outage risk reduction
  - Financial value of outage risk reduction (reliability improvements) calculated using Interruption Cost Estimate (ICE) Calculator
- Timing of costs and benefits determined from expected project schedules

Copperleaf cost-benefit analyses (CBA)

- Third party software used to assess project benefits
- Annual avoided outage benefits summed for 30-year life following project in-service
- Net present value and benefit-cost ratio calculated for each project location
- Excel sensitivity analysis included for variance on key inputs

Source: ICE Calculator

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System Intelligence
Project overview

TRANSMISSION

Project purpose:

This system intelligence project is critical to provide grid operators and engineers with enhanced information to respond to changing conditions that challenge reliability. Remote asset monitoring allows proactive decisions to be made when equipment health is threatened, and remote operated switches play a vital part in sectionalizing transmission lines to limit the customer impact of faults from external causes and equipment failures.

Project description:

The system intelligence project improves reliability for customers by helping avoid unplanned outages and reduce duration / impacts when outages occur. The scope of work includes:

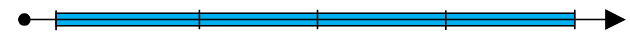
- **Electromechanical to digital relays** replace noncommunicating electromechanical and solid-state relays with digital relays
- **Remote substation and asset monitoring** enables operators to remotely control equipment as well as monitor the health of equipment
- **Remote control line switches** replaces manually operated switches with modern switches enabled with SCADA communication and remote-control capabilities

Digital relays

Remote operated line switch

Key details:

Estimated construction timeline:*



Estimated in-service dates:*

Projected costs:

DEC System	Aug’23 – Dec’24	Jan’25 - Dec’25	Jan’26 - Dec’26
Capital costs**	$45.9M	$35.4M	$49.9M

Grid capabilities enabled:

- Strengthened grid against outages
- Increased resiliency to recover from outages including during extreme weather & storm events
- Increased Grid operator visibility to system conditions
- Improved reliability
- Optimized ability to monitor the grid for variable conditions associated with DER deployments

HB951 Policy Considerations addressed:

- Encourages peak load reduction or efficient use of the system
- Encourages utility-scale renewable energy & storage
- Promotes resilience & security of the electric grid
- Maintains adequate levels of reliability & customer service

Note: * Timelines are for identified locations included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

DUKE ENERGY

System Intelligence
Project benefits

TRANSMISSION

Improve reliability

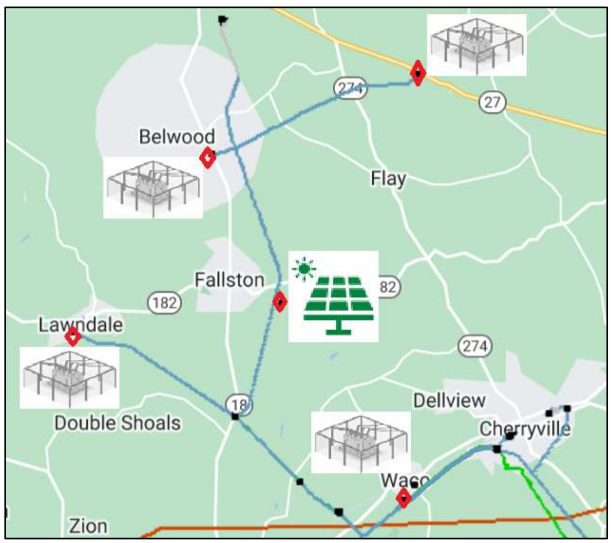
- Reduce outage duration and number of customers impacted from vegetation and line component failure events

Increase operational efficiency

- Improve grid operator and engineer visibility to system events and equipment health

Quantitative Cost-Benefit Analysis

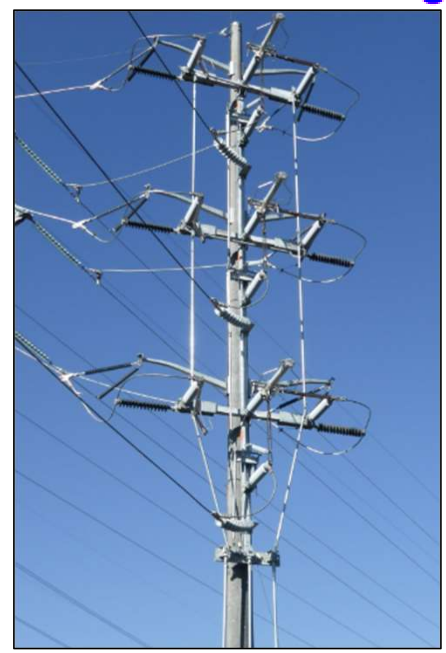
Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$2,681.4M	$120.5M	22.3



Waco 44kV Line

Example: Waco 44kV Remote Operated Sectionalizing Switch

- Multi-tapped 44kV line in rural area with 24 miles of exposure
- Improves the ability to sectionalize and restore; more than 6,000 customers served on this line, from four separate retail customer substations
- 30MW Solar Plant interconnection planned; sectionalizing capability improves renewable generation availability



Multi-Way Remote Operated Line Switch

Line Hardening & Resiliency
Project overview

TRANSMISSION

Project purpose:

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

Project description:

Each of the Transmission H&R scopes of work address unique challenges in ways that harden the system, and not only minimize impacts to customers, but enhance their electric service experience.

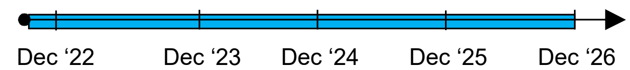
- **Cathodic Protection** scope extends the life of the existing lattice towers that support power transmission from generation sources to substations. Corrosion protection is installed at tower legs to mitigate future corrosion and improve strength which is particularly beneficial under extreme weather condition
- **Targeted Line Strengthening for Extreme Weather** scope replaces vulnerable wooden structures and lattice steel towers and rebuilds transmission line segments. 44kV lines are rebuilt to 100kV structural and electrical standards to improve reliability and enable future capacity needs including renewable generation interconnections. Degraded 100kV and 230kV lattice towers are redesigned to updated standards that harden against storm impacts

44kV Line with Wooden Structures

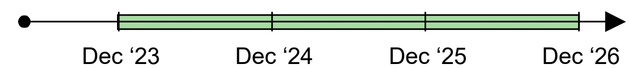
Line Rebuilt to 100kV Standard

Key details:

Estimated construction timeline:*



Estimated in-service dates:*



Projected costs:

DEC System	Aug’23 - Dec’24	Jan’25 - Dec’25	Jan’26 - Dec’26
Capital costs**	$98.8M	$92.5M	$117.4M
O&M costs**	$0.6M	$0.6M	$0.5M

Grid capabilities enabled:

- Strengthened grid against outages from extreme weather and storm events, as well as other threats
- Increased resiliency to recover from outages
- Improved reliability

HB951 Policy Considerations addressed:

- Promotes resilience and security of the electric grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for identified locations included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

Line Hardening & Resiliency
Project benefits

TRANSMISSION

Improve reliability

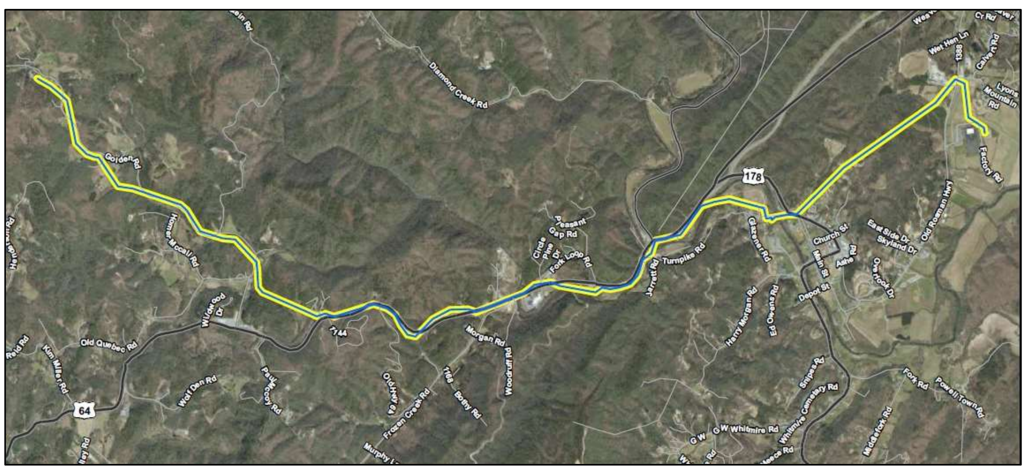
- Reduced outages caused by line component failures
- Reduced voltage spikes, sags, and momentary interruptions

Increase operational efficiency

- Reduce or avoid emergency repair or replacement or after-hours work

Quantitative Cost-Benefit Analysis

Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$6,879.2M	$289.8M	23.7



Example: Quebec 44kV Line Rebuild

- Scope: Rebuild approx. 6.5 miles of deteriorated line structures within the Pisgah National Forest
- In the last 5 years outages on the Quebec 44kV have put thousands residential customers plus commercial/industrial out of power
- One of the top two lines with repeat outages impacting customers

Substation Hardening & Resiliency
Project overview

TRANSMISSION

Project purpose:

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

Project description:

- **Substation Reliability Upgrade** scope includes replacing a combination of major station equipment such as transformers, breakers, regulators, circuit switchers, and ancillary equipment such as instrument transformers and disconnect switches. This work is typically executed in conjunction with System Intelligence upgrades
- **Air-Break Switch** scope replaces the existing motor and spring-operated air-break switches with more reliable circuit switcher. The upgraded circuit switcher will provide better fault protection for adjacent power transformers along with being safer to operate from a remote location in the station
- **Animal Mitigation** scope installs equipment specifically designed to prevent animal induced events from impacting customers directly through an outage or indirectly through a system perturbation such as a voltage depression

Animal Resistant Fence

Air-Break Switch

Key details:

Estimated construction timeline:*

Dec '22 — Dec '23 — Dec '24 — Dec '25 — Dec '26

Estimated in-service dates:*

Dec '23 — Dec '24 — Dec '25 — Dec '26

Projected costs:

DEC System	Aug'23 - Dec'24	Jan'25 - Dec'25	Jan'26 - Dec'26
Capital costs**	$94.1M	$32.9M	$38.9M

Grid capabilities enabled:
- Strengthened grid against outages including during extreme weather and storm events
- Increased resiliency to recover from outages
- Improved physical security

HB951 Policy Considerations addressed:
- Promotes resilience and security of the electric grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for identified locations included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

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Substation Hardening & Resiliency
Project benefits

TRANSMISSION

Improve reliability

- Reduced outages caused by substation component failures; reduce impacts of extreme weather and external events

Increase operational efficiency

- Reduce or avoid emergency repair or replacement or after-hours work

Quantitative Cost- Benefit Analysis

Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$5,757.6M	$197.9M	29.1

Substation Transformer

Example: Winston Tie Reliability Upgrade

- Important tie station just south of Winston-Salem, connects 13 100kV transmission circuits and includes 4 retail customer circuits serving ~4,000 customers
- Project Scope splits retail load from a single transformer bank to two separate banks to reduce customer impacts from events on the bank/bus
- Installation of new 100kV/12kV Transformers, circuit switchers, addition of low voltage bus, upgrade of 12kV breakers, addition of bus-tie capability, animal mitigation upgrades

Substation Oil Breaker

DUKE ENERGY

Vegetation Management
Project overview

TRANSMISSION

Project purpose:

The Transmission vegetation management project works to create a hardened transmission grid capable of withstanding extreme weather events and reduce the frequency of outages impacting customers.

Project description:

- The Transmission Integrated Vegetation Management ("IVM") program is focused on ensuring the safe and reliable operation of the transmission system by minimizing vegetation-related interruptions and maintaining adequate conductor-to vegetation clearances, while maintaining compliance with regulatory, environmental, and safety requirements and standards. Program activities focus on the removal of hazard trees along and outside of the right of way to minimize the risk of vegetation-related outages

Removal of incompatible vegetation along Transmission ROW

230kV Transmission Circuit

Key details:

Estimated construction timeline:*

Estimated in-service dates:*

Projected costs:

DEC System	Aug'24 - Dec'24	Jan'25 - Dec'25	Jan'26 – Dec'26
Capital costs**	$17.3M	$20.2M	$19.5M

Grid capabilities enabled:
- Strengthened grid against outages including during extreme weather and storm events
- Improved reliability

HB951 Policy Considerations addressed:
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for identified locations included in MYRP filing ; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

Vegetation Management
Project benefits

TRANSMISSION

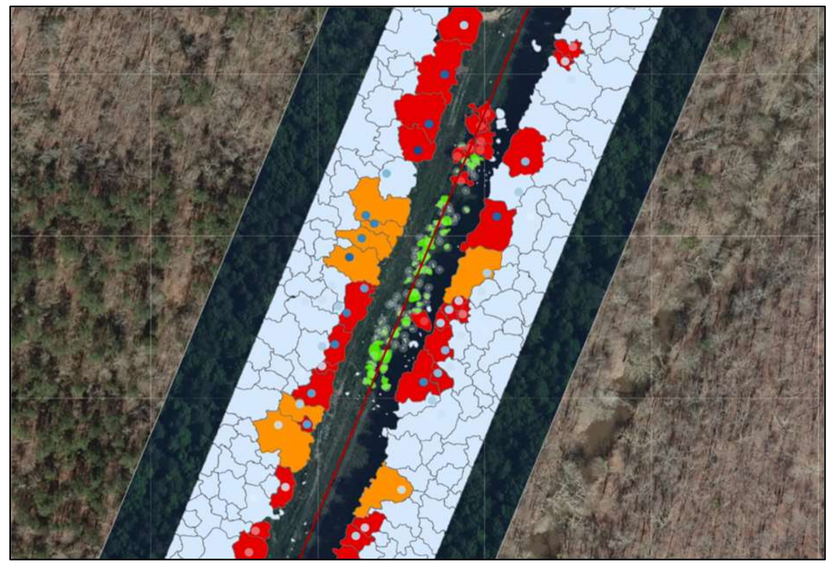
Reduced customer interruptions
- Reduced customer outages; vegetation is one of the leading cause of outages

Operational savings
- Proactive tree removal leads to less emergency work and less collateral equipment damage

Storm Hardening
- Reduce impact to the grid and customers during extreme weather/storms

Example: High Point 100kV Lines

- 37-mile line connecting a hydro-electric plant to multiple substations, supporting over 24,000 residential customers
- Shared ROW with multiple 100kV lines
- LiDAR has identified danger tree fall-in threats up to 30 feet outside ROW
- Vegetation falling from outside the ROW results in ~17% of transmission customer minutes interrupted



High Point 100kV Tree canopy risk model

Note: Work is required as part of honoring obligation to serve through prudent and safe utility practice

Breaker Upgrades
Project overview

TRANSMISSION

Project purpose:

The Breaker Replacement project involves replacing degraded transmission circuit breakers, including oil circuit breakers (“OCBs”), typically in conjunction with upgrading the associated protection and control relays. The new communication and control capabilities of this modern technology better positions the transmission and distribution systems to effectively respond to electric grid events. These reliable gas and vacuum breakers are also better suited for protecting circuits during high-frequency fault events such as winter storms and hurricanes.

Project description:

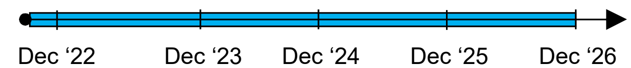
- The breaker replacement project ensures reliable equipment; this keeps electric faults isolated to the smallest section of the system to minimize customer impacts
- Circuit breaker technologies are being transitioned from OCB to SF6 Gas Circuit Breakers (“GCBs”) for 44 kV and higher applications, and Vacuum Circuit Breakers (“VCB”) for 35 kV and lower

Transmission Gas Circuit Breaker (GCB)

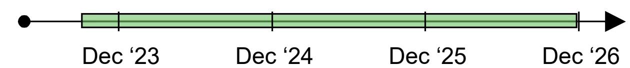
Distribution Vacuum Circuit Breaker (VCB)

Key details:

Estimated construction timeline:*



Estimated in-service dates:*



Projected costs:

DEC System	Aug’23 - Dec’24	Jan’25 - Dec’25	Jan’26 - Dec’26
Capital costs**	$97.9M	$108.3M	$121.8M

Grid capabilities enabled:
- Allowed for additional capacity on the system
- Enhanced reliable fault interrupt capability
- Reduced environmental footprint
- Improved reliability
- Strengthened grid against outages
- Increased resiliency to recover from outages

HB951 Policy Considerations addressed:
- Promotes resilience and security of the electric grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for identified locations included in MYRP filing ; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

Breaker Upgrades
Project benefits

TRANSMISSION

Improve reliability

- Minimize the number of customers impacted from an outage event, component failures, or slow to operate circuit breaker

Strengthen the grid and manage risk

- Reduce risk of a more extensive grid outage resulting from breaker mis-operation or failure

Increase operational efficiency

- Reduce or avoid emergency repair or replacement or after-hours work

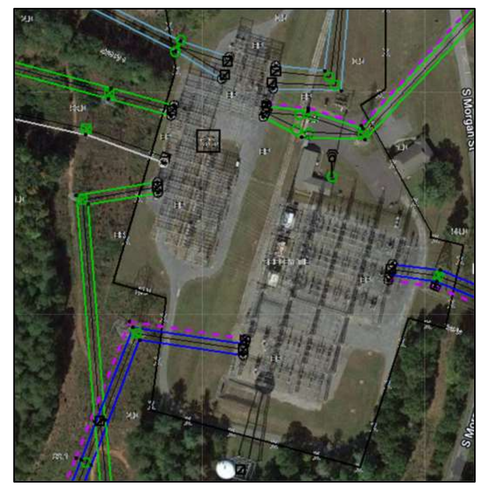
Quantitative Cost- Benefit Analysis

Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$8,645.4M	$282.4M	30.6

Shelby Tie 100kV Oil Circuit Breaker

Example: Shelby Tie Transmission Oil Breakers

- Scope: Replace fourteen (14) circuit breakers including 44kV, 100kV, and 230kV
- Station is critical to serving reliability needs of customers in the greater Shelby area
- Five (5) lines connect to station, potential for over 11,000 customers to be affected by events.



Shelby Tie

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Transformer Upgrades
Project overview

TRANSMISSION

Project purpose:

The objective of the Transformer Upgrade project is to anticipate future transformer failures and replace those transformers in a proactive manner, avoiding the cost and customer outages associated with these failures. Failures can result in significant customer outages, collateral damage, and oil release requiring environmental mitigation.

Project description:

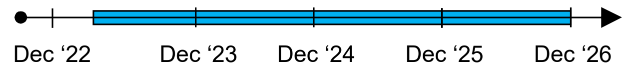
- The Transformer Upgrade project involves replacing degraded transmission transformers and regulators, typically in conjunction with upgrading the associated protection and control relays
- Improved reliability and response to variable energy resources through the elimination of arc-in-oil load tap changers

Typical T/D Transformer

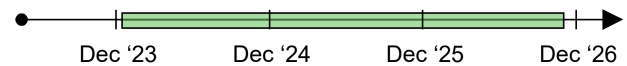
Transmission transformer

Key details:

Estimated construction timeline:*



Estimated in-service dates:*



Projected costs:

DEC System	Aug'24 - Dec'24	Jan'25 - Dec'25	Jan'26 - Dec'26
Capital costs**	$116.0M	$73.2M	$37.7M

Grid capabilities enabled:
- Strengthened grid against outages including during extreme weather and storm events
- Increased resiliency to recover from outages
- Improved reliability when accommodating variable conditions associated with DER deployments
- Improved performance from vacuum load tap changer (LTC) technology

HB951 Policy Considerations addressed:
- Encourages DERs
- Promotes resilience and security of the electric grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for identified locations included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

Transformer Upgrades
Project benefits

TRANSMISSION

Improve reliability
- Reduced outages caused by transformer and regulator failures

Increase operational efficiency
- Avoid system loading contingencies due to loss of capacity from failed transformer

Strengthen the grid and manage risk
- Reduce risk of unplanned events, collateral damage from failed transformers, and environmental threats from oil spills

Quantitative Cost-Benefit Analysis

Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$4,637.6M	$213.4M	21.7

Example: Concord Main - Replace 100kV Transformers

- Scope: Replace two transformers that are identified in poor health through testing and condition monitoring; each asset is over 50 years old
- Project scope also uprates current limiting components to enable future capacity uprates to accommodate renewable resources coming onto the grid
- Improves reliability for approximately 7,500 customers

Concord Mn 100/13kV Transformer

Capacity and Customer Planning
Project overview

TRANSMISSION

Project purpose:

As demand on the transmission system grows and changes over time, new transmission projects and upgrades are needed to serve retail customer and keep the grid reliable and in compliance with North American Electric Reliability Corporation (“NERC”) Standards. Transmission expansion projects also facilitate the connection of additional utility scale renewable generation sources.

Project description:

The Transmission System is required to meet NERC Standards and reliably serve customers. NERC and local standards set requirements for transmission system power flows, voltages, stability, and breaker capability to maintain a safe and reliable transmission grid and avoid widespread grid blackouts.

- After Transmission Planning identifies future overloads and network upgrades, the plan is screened by ISOP to identify projects that have the potential to be deferred or avoided by a non-traditional solution (“NTS”), such as energy storage
- Red Zone Expansion Plan projects uprate areas of the grid that are limited for additional generation interconnections, preparing the grid for the clean energy transition. Projects are presented/approved through the NC Transmission Planning Collaborative


500kV Breaker


230/100kV Autotransformer

Key details:

Estimated construction timeline:*

Dec ‘22 Dec ‘23 Dec ‘24 Dec ‘25 Dec ‘26

Estimated in-service dates:*

Dec ‘23 Dec ‘24 Dec ‘25 Dec ‘26

Projected costs:

DEC System	Aug’23 - Dec’24	Jan’25 - Dec’25	Jan’26 - Dec’26
Capital costs**	$78.4M	$173.9M	$287.2M

Grid capabilities enabled:
- Served increased customer demand
- Maintained reliability
- Enabled connection of more solar generation

HB951 Policy Considerations addressed:
- Encourages utility-scale renewable energy and storage
- Encourage DERs
- Encourages beneficial electrification, including electric vehicles
- Promotes resilience and security of the electric grid
- Maintains adequate levels of reliability and customer service

Note: * Timelines are for identified locations included in MYRP filing; **Capital and Installation O&M costs based on in-service dates and include AFUDC and contingency

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Capacity and Customer Planning
Project benefits

TRANSMISSION

Improve reliability

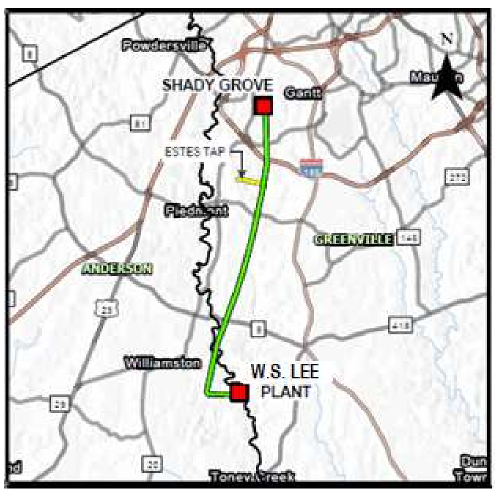
- Meet federal compliance mandates for grid reliability
- Maintain grid reliability and stability
- Provide capacity upgrades and new connections to serve customer needs

Societal benefit

- Facilitate clean energy transition

Quantitative Cost-Benefit Analysis

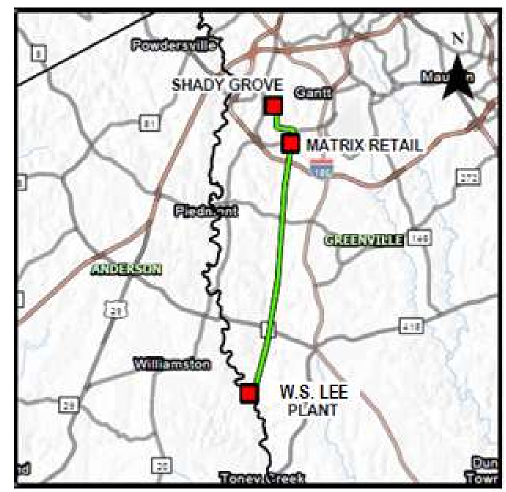
Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$6,495.1M	$496.4M	13.1



Piedmont 100kV Line

Example: Lee and Piedmont 100 kV – Line Uprate

- 24 miles of double circuit line will be rebuilt and uprated to strengthen power flow between the W.S. Lee Combined Cycle Plant and Shady Grove Tie
- Aged conductor, structures, and static wire replacements will reduce the chance of failures resulting in grid and customer impacts
- Work is located in Greenville & Anderson Counties, SC and improves reliability for more than 7,000 customers directly served from these lines as well as several large industrial customers
- Capacity uprate allows additional renewable generation resources to connect to the grid in this high solar-viability region



Lee 100kV Line

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Agenda

Topic	Presenter
Context and external trends	Brent Guyton
Distribution projects	Brent Guyton
Transmission projects	Dan Maley
Energy Storage projects	**Laurel Meeks**
Closing remarks	Brent Guyton

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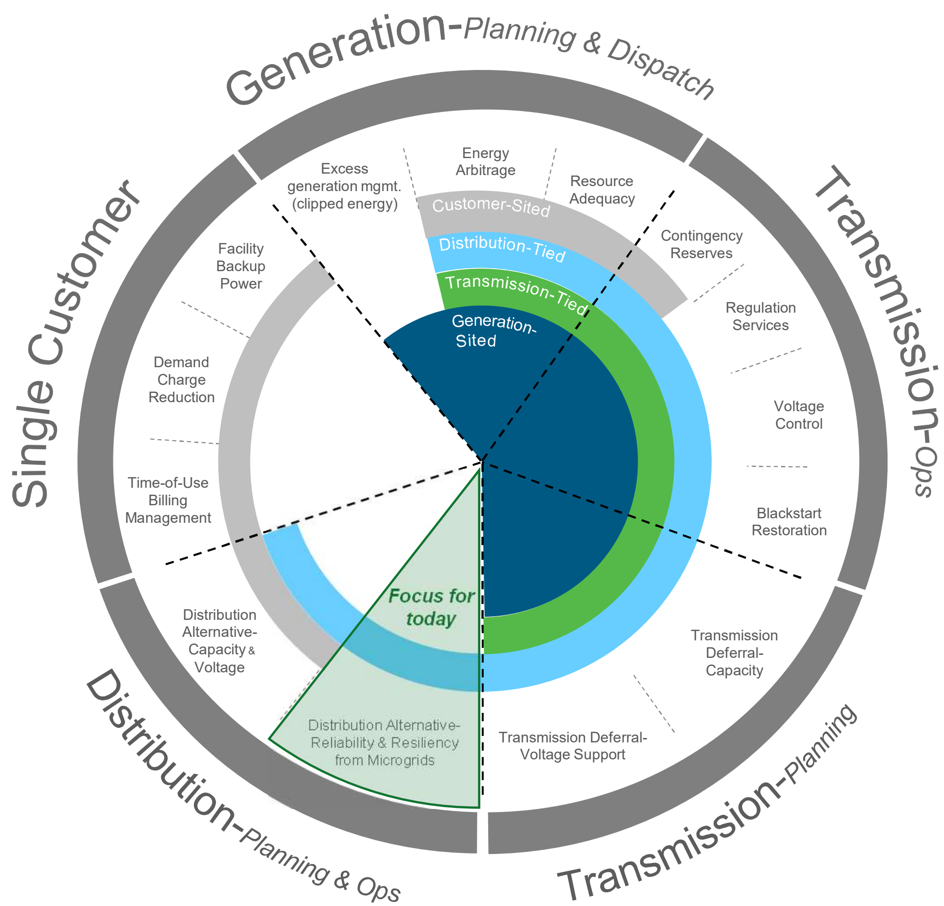
Energy Storage projects can serve multiple functions



Customer and grid services from energy storage

- **Enablement of increased renewable penetration** by managing 'swings' from intermittent sources to maintain reliability and resilience of the grid
- **Increased reliability and resiliency** for communities fed by isolated distribution feeders
- **Economic operation** by time-shifting stored energy from low-cost to high-cost periods*
- **Optimized value** by strategically siting projects to "stack" use cases which demonstrate customer value
- **Flexibility for future needs**, as assets can be adapted as system demand changes

Note: *Storage will charge from the grid with a mix of carbon free and carbon-emitting resources

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Energy Storage
Program benefits for customers

Sustainability

- Benefits to the bulk electric system such as capacity, regulation and contingency reserves have traditionally been performed by carbon-emitting generation resources. Replacing carbon-emitting resources with assets that can store and redeploy clean energy resources helps reduce emissions and deliver positive environmental benefits to the system

Interconnection Study Process Improvement

- Engineering assessments of the projects' impacts to the existing transmission and distribution systems are constantly being improved across the Carolinas. Challenges solved during execution of these initial projects will enable faster, more efficient, more predictable outcomes when studies are performed for future projects

Organizational Experience (Design/Ops)

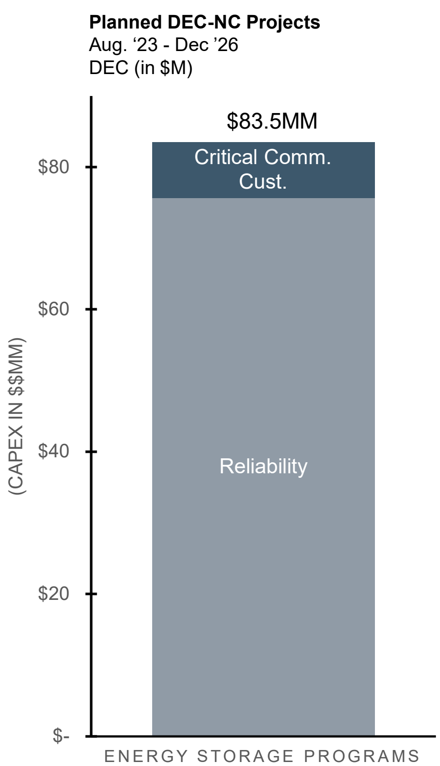
- Battery energy storage has not yet been operated by Duke Energy teams in the Carolinas at scale. Battery use cases included in the DEC MYRP energy storage portfolio will refine future ideation/construction/operation processes and enable more effective designs and more efficient operations when repeated for future similar projects

Cost-effective implementation

- Sourcing of materials and labor for battery engineering, procurement, and construction is more effective when a group of projects can be solicited rather than individual/single projects. Treatment of efforts in a programmatic fashion is likely to result in better outcomes in terms of cost, material certainty, and schedule predictability. These outcomes can help improve service and deliver cost savings to customers

Planned energy storage improvements

ENERGY STORAGE



• Improvement category	• Improvement program details
• Reliability	• Energy storage and microgrid equipment improving reliability for geographically isolated feeder sections
• Critical community customer	• Energy storage and microgrid equipment improving reliability for critical community services

- Managing the energy transition and meeting clean energy goals requires new technology and a new way of operating the grid. Energy storage will be a critical resource for balancing the bulk system as well as serving traditional T&D needs
- *The energy storage projects presented in the technical conference are those that serve a distribution function. As such they are a portion of the energy storage fleet planned to achieve the energy transition*

Project Identification Approach

ENERGY STORAGE

Project lifecycle:

Origination → Development → Execution → Operation

Initial identification

- Reliability batteries are identified as potential solutions on remote distribution feeders with load pockets at the tail end of the feeder
- Critical customer batteries are identified as solutions on feeders with critical community assets needing increased resiliency, such as hospitals, emergency shelters, or public safety institutions

Project screening

- Evaluate whether battery is best solution to the problem
- A preliminary and detailed engineering analysis which identifies ideal solution sizing and siting

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Financial cost-benefit analyses methodology

ENERGY STORAGE

Overall methodology

- Cost-benefit analysis completed using methodology similar to prior Commission filing (Hot Springs CPCN)
- Expected financial benefits based on avoided T&D costs and ISOP bulk system values (e.g., capacity, energy arbitrage, ancillary services)
- Cost-benefit analyses performed on revenue requirement basis in order to reflect standalone storage Investment Tax Credit (ITC) impact

Data inputs

- **Battery sizing and siting** to address reliability need:
  - Power (MW) and Energy (MWh) determined to provide power during outage
  - Bounds of microgrid defined
- **T&D alternatives analysis** performed to determine "theoretical T&D alternative" to a battery:
  - Most sites surrounded by non-Duke utility
  - Distribution Planners used expertise to determine costs for theoretical alternative; however, these solutions are likely infeasible
- **ISOP bulk system benefits** developed from approved 2020 IRPs

Methodology for benefits and costs

- **Initial deployment costs** calculated using aggregated vendor responses for battery pack costs and historic project data for construction costs
- **Battery refresh costs** calculated using proprietary industry forecasts for costs to replace battery cells after 15 years
- **Program benefits** calculated as financial value of:
  - Revenue requirement of avoided cost for theoretical T&D alternative to a battery, not including easement acquisition costs
  - Bulk system services the specific battery project can be expected to provide

Excel-based cost-benefit analysis (CBA)

- Projected schedule of **program costs and benefits** tabulated in excel
- Present value (as of current year) calculated for costs and benefits
- Battery costs and theoretical T&D alternative benefits calculated on revenue requirement basis in order to reflect ITC impact on battery costs
- Net present value and benefit-cost ratio calculated for each program
- Sensitivity analysis tab included for variance on key inputs

Energy Storage – Reliability
Program overview

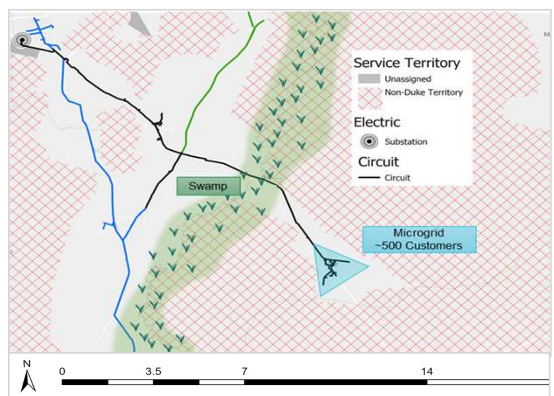
ENERGY STORAGE

Program purpose:

The Reliability category of the Battery Energy Storage Program improves reliability and resiliency to avoid outages and speed restoration, while at the same time enable cleaner energy options by providing benefits to the bulk electric system in support of the energy transition as legacy generation types are replaced with more renewable resources.

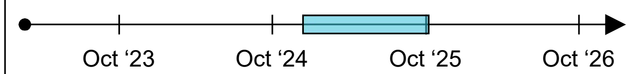
Program description:

- Geographic features and service territory assignment boundaries have created enclaves of customers with lower-than-average reliability
- Upon unplanned loss of utility service, the battery will form a microgrid area and serve customers until repairs are made to restore normal service.
- When not performing a reliability function, batteries may provide benefits such as capacity or energy arbitrage to the bulk electric system
- Designs are optimized to economically mitigate a significant number of outages each particular microgrid area has historically experienced
- Each project consists of the battery itself, and network upgrades both on-site and off-site

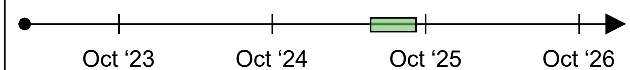


Key details:

Estimated construction timeline:*



Estimated in-service dates:*



Projected costs:

DEC NC	Jan'24 - Dec'24	Jan'25 - Dec'25	Jan'26 - Dec-'26
Total costs**	$21M	$55M	$0M

Grid capabilities enabled:
- Service Reliability Improvement
- Green-Enabled Supply of Bulk System Needs (generation capacity, regulation services, etc.)
- Promote Adoption of Renewable Resources

HB951 Policy Considerations addressed:
- Encourages utility-scale renewable energy and storage
- Encourages DERs
- Improves levels of reliability and customer service

Note: * Timelines are for discrete and identifiable projects proposed to be included in MYRP filing; **Capital costs based on in-service dates and include AFUDC and contingency

Energy Storage – Reliability
Program benefits

ENERGY STORAGE

Improved reliability and resiliency

- Improving reliability of service will result in saved customer expenses which are a direct result of unplanned utility interruptions caused by natural or man-made external events. Improving resiliency makes it easier to restore service quicker

Basic Services

- Distribution microgrids include volunteer fire departments, TV broadcasting stations, cell towers, gas stations, medical practice, schools, and grocery sales. Improving reliability of these customers from service outages increases the safety of the communities they serve

Solution Scaling

- Deployment of multiple projects builds confidence in microgrids as an available "tool in the toolbox" to solve other/future operational and engineering challenges to providing service which meets customers' expectations

Quantifiable Cost-Benefit Analysis

Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$62.9M **	$66.8M	0.94

** All comparable alternatives used as the basis for benefit calculations would present significant execution-related challenges, including land permitting, real estate encumbrances, and territorial assignment issues. Easement acquisition costs are not included.

Energy Storage – Critical Community Customer

Program overview

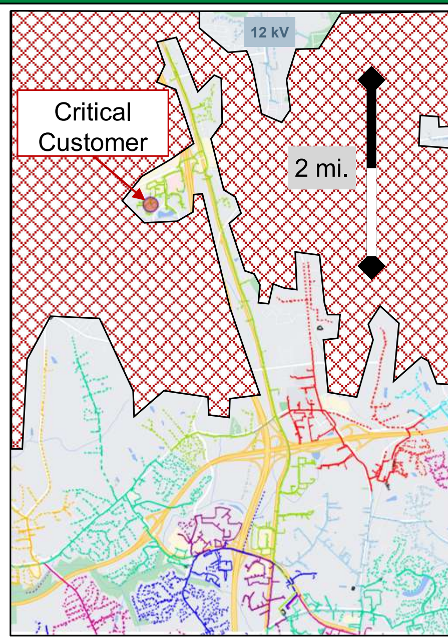
ENERGY STORAGE

Program purpose:

The Critical Community Customer category of the Battery Energy Storage Program improves reliability and resiliency to avoid outages and speed restoration for a community critical customer, while at the same time enable cleaner energy options by providing benefits to the bulk electric system in support of the energy transition as legacy generation types are replaced with more renewable resources.

Program description:

- Distribution voltage and service territory assignment boundaries have created enclaves of customers for whom self-healing grid installation is challenging
- Upon loss of utility service, the battery will form a microgrid area and serve the critical customer until repairs are made to restore normal service
- When not performing reliability function, batteries may provide benefits such as capacity or energy arbitrage to the bulk electric system
- Designs are optimized to economically mitigate a significant number of outages the critical customer has historically experienced
- Each project consists of the battery itself, and network upgrades both on-site and off-site



Non-Duke Service Territory

Key details:

Estimated construction timeline:*

Oct '23 | Oct '24 | Oct '25 | Oct '26

Estimated in-service dates:*

Oct '23 | Oct '24 | Oct '25 | Oct '26

Projected costs:

DEC NC	Jan'24 - Dec'24	Jan'25 - Dec'25	Jan'26 - Dec-'26
Total costs**	$7.5M	$M	$M

Grid capabilities enabled:

- Service Reliability Improvement
- Green-Enabled Supply of Bulk System Needs (generation capacity, regulation services, etc.)
- Promote Adoption of Renewable Resources

HB951 Policy Considerations addressed:

- Encourages utility-scale renewable energy and storage
- Encourages DERs
- Improves levels of reliability and customer service

Note: * Timelines are for discrete and identifiable projects proposed to be included in MYRP filing; **Capital costs based on in-service dates and include AFUDC and contingency

Energy Storage – Critical Customer
Program benefits

ENERGY STORAGE

Community Safety

- Critical customer microgrids help ensure the continuation of fundamental community services provided by organizations such as hospitals. As such, the benefits created by electric service reliability improvements are enjoyed by a large variety and number of customers in the utility service territory

New Customer Solution

- Deployment of early critical customer reliability microgrid projects provides a new solution for customers with a need for high electric service reliability and ability to share costs while at the same time providing bulk system benefits to the grid and valuable operating experience to Duke Energy

Quantifiable Cost-Benefit Analysis

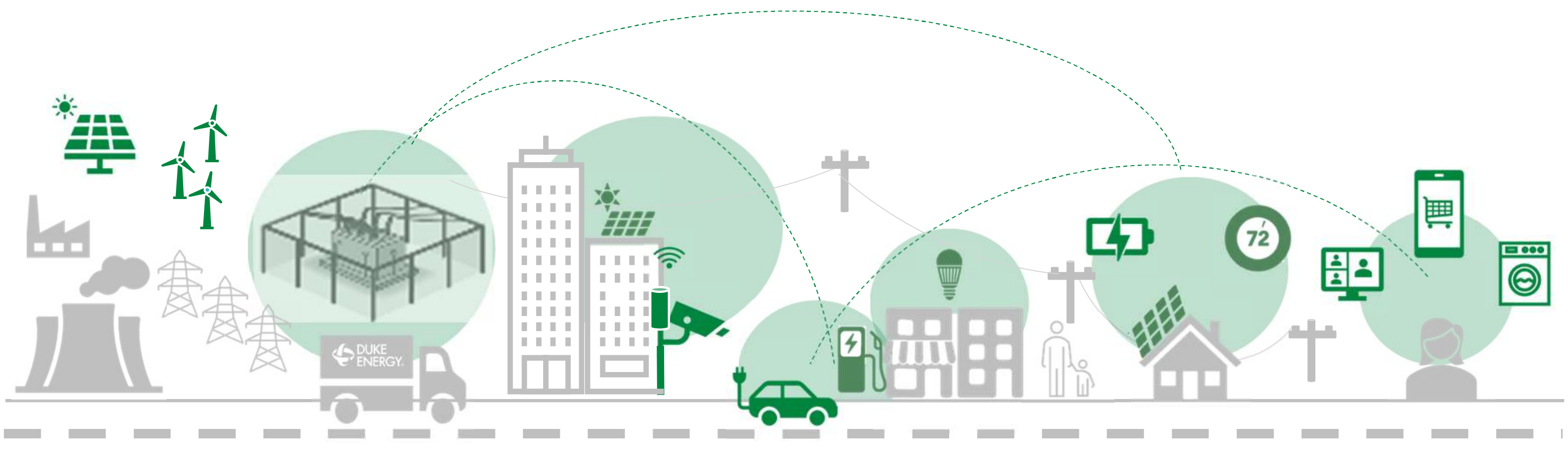
Total NPV benefits	Total NPV costs	Benefit-Cost ratio
$7.0M **	$7.2M	0.98

** All comparable alternatives used as the basis for benefit calculations would present significant execution-related challenges, including land permitting, real estate encumbrances, and territorial assignment issues. Easement acquisition costs are not included.

Agenda

Topic	Presenter
Context and external trends	Brent Guyton
Distribution projects	Brent Guyton
Transmission projects	Dan Maley
Energy Storage projects	Laurel Meeks
Closing remarks	**Brent Guyton**

Improvement work is designed to enable the grid for the future



Grid resiliency

Increase the grid's ability to withstand and recover from more frequent and intense weather

Expanded renewables and DERs

Enable the grid to meet customer demand for DERs while maintaining reliable service

Equitable access to benefits

Achieve balanced outcomes for customers across geographies, promoting access to emerging technologies and energy solutions

Appendix

DUKE ENERGY

Overview of ICE Calculator

DISTRIBUTION

ICE CALCULATOR

Nexant

- **Interruption Cost Estimate (ICE) Calculator is an electric reliability online planning tool** developed by Lawrence Berkeley National Laboratory (LBNL) and Nexant, Inc. with funding from the U.S. Dept. of Energy (DoE)
- Tool is **designed for electric reliability planners at utilities, government organizations, and other entities** that are interested in estimating interruption costs and/or the benefits associated with reliability improvements in the United States
- **Translates reliability improvements into value** by using data from 34 previous Customer Interruption Cost studies from 10 utilities between 1989-2012

Data inputs to ICE

- State
- Customers
  - Non-residential
  - Residential
- Reliability metrics
  - SAIDI
  - SAIFI

Analytical model run

Outputs from ICE / inputs to CBA

- **Cost data by customer sector** (Residential, Small C&I, Med./Large C&I)
  - Cost per Outage Event
  - Cost per Average kW
  - Cost per Unserved kWh

Generalized CBA Calculated Reliability Improvement Value:

Number of Events Eliminated * Average Number of Customers Impacted * ICE Cost per Outage Event (Based on Duration)

Source: ICE Calculator