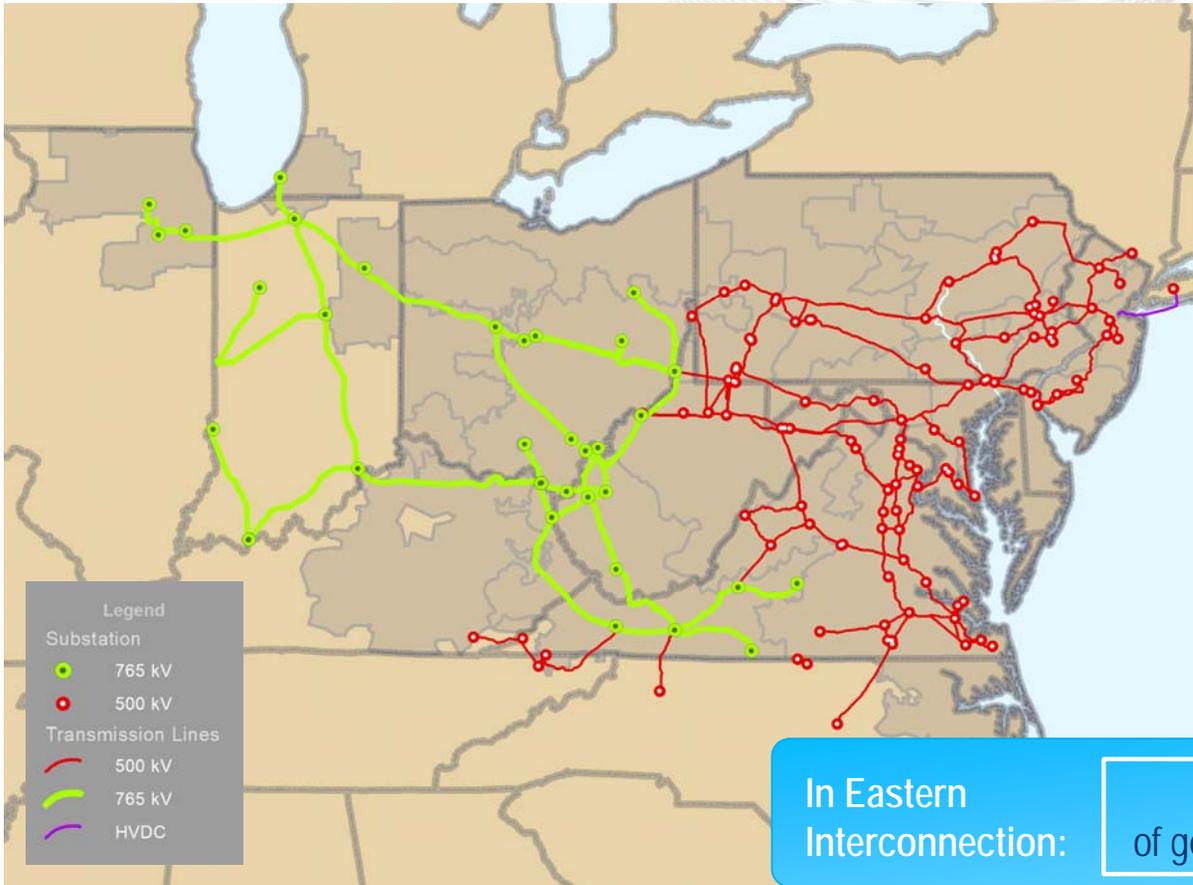




PJM Generation and Transmission in Ohio

Ken Seiler
Vice President – Planning
PJM Interconnection

Ohio Energy Savings & Management Conference
Feb. 18, 2021



Key Statistics

Member companies	1,040+
Millions of people served	65
Peak load in megawatts	165,563
Megawatts of generating capacity	186,788
Miles of transmission lines	84,236
2019 gigawatt hours of annual energy	787,307
Generation sources	1,446
Square miles of territory	369,089
States served	13 + DC

In Eastern Interconnection:

27%
of generation

26%
of load

20%
of transmission assets

- “Highway” across which electricity is delivered
 - Economy, security and societal well-being
- Tie lines link PJM zones and neighboring systems together:
 - Sharing generation
 - Leveraging load diversity
 - Emergency condition mutual assistance
- New transmission assets:
 - Enabling historic generation shift
 - Aging infrastructure
 - Market efficiency





Ensuring
reliability:
Keeping the lights on

- Reliability: compliance with NERC and regional criteria
- Resilience: continuous delivery under extreme events



Keeping costs low:
Delivering lowest-cost
power to customers

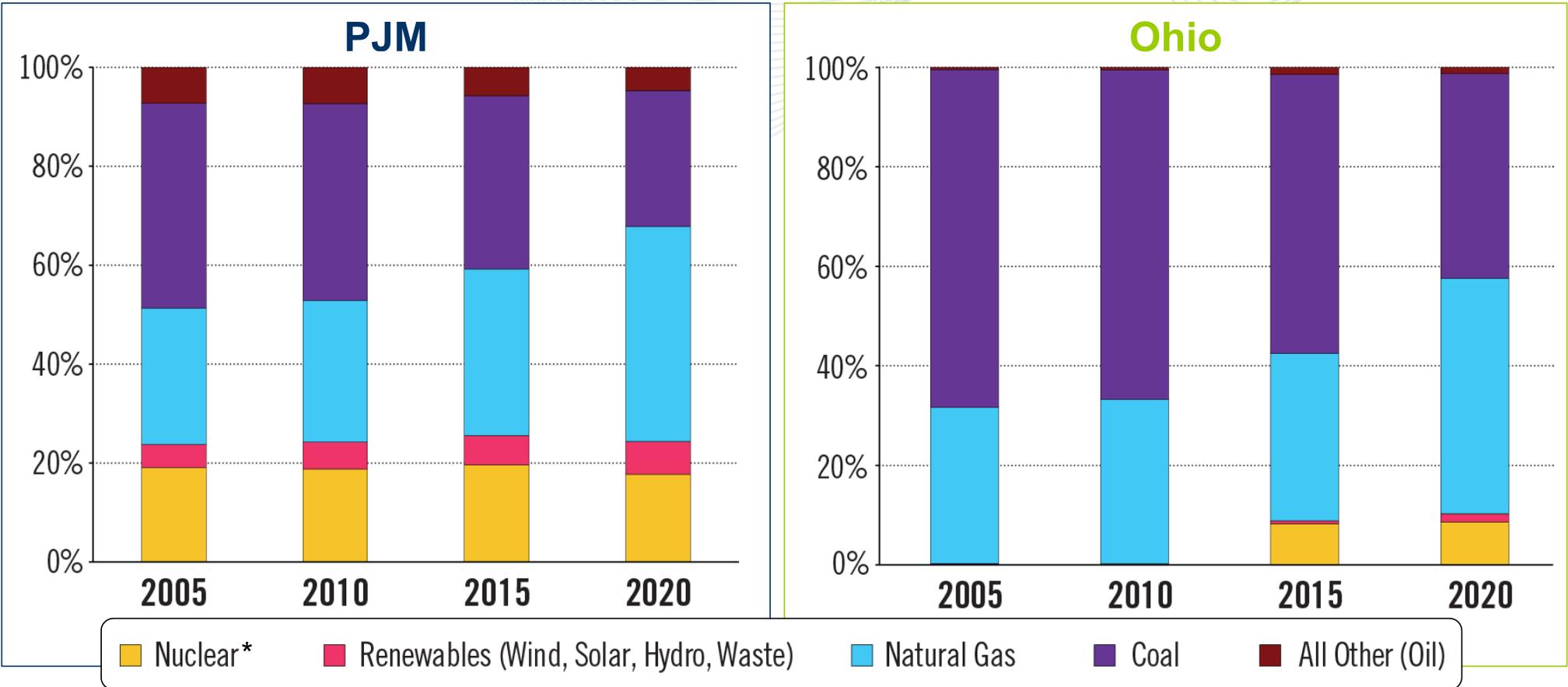
- Wholesale energy and capacity markets



Supporting public policy:
Enabling state renewable mandates and federal emission mandates



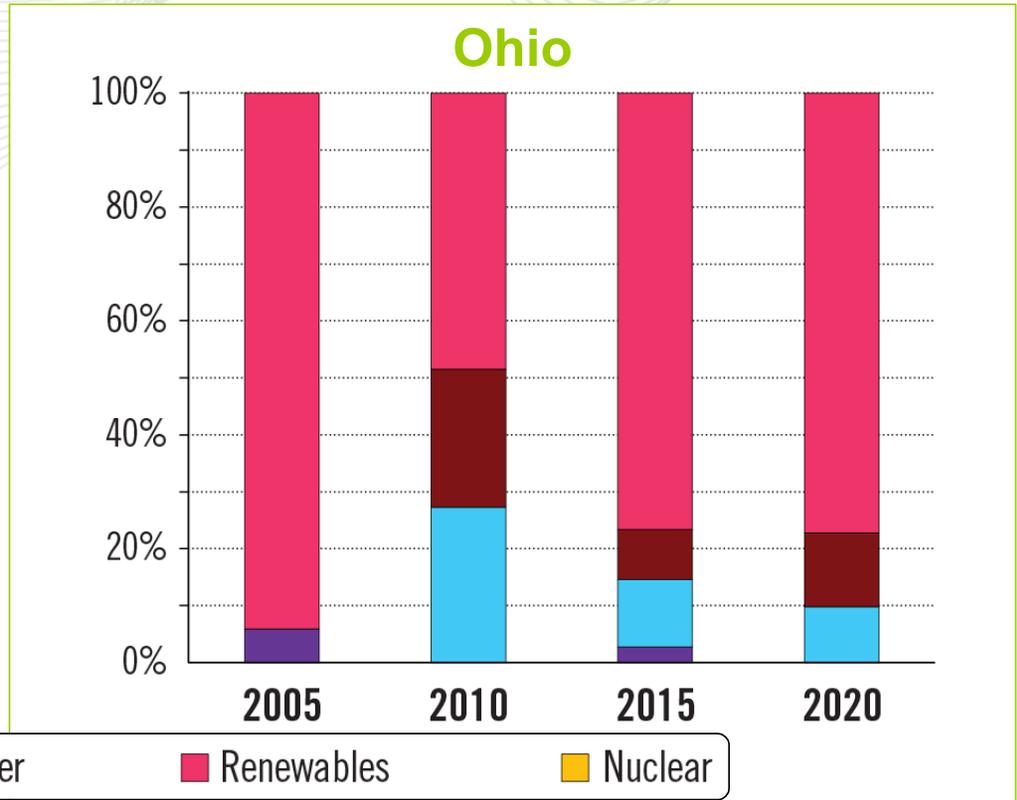
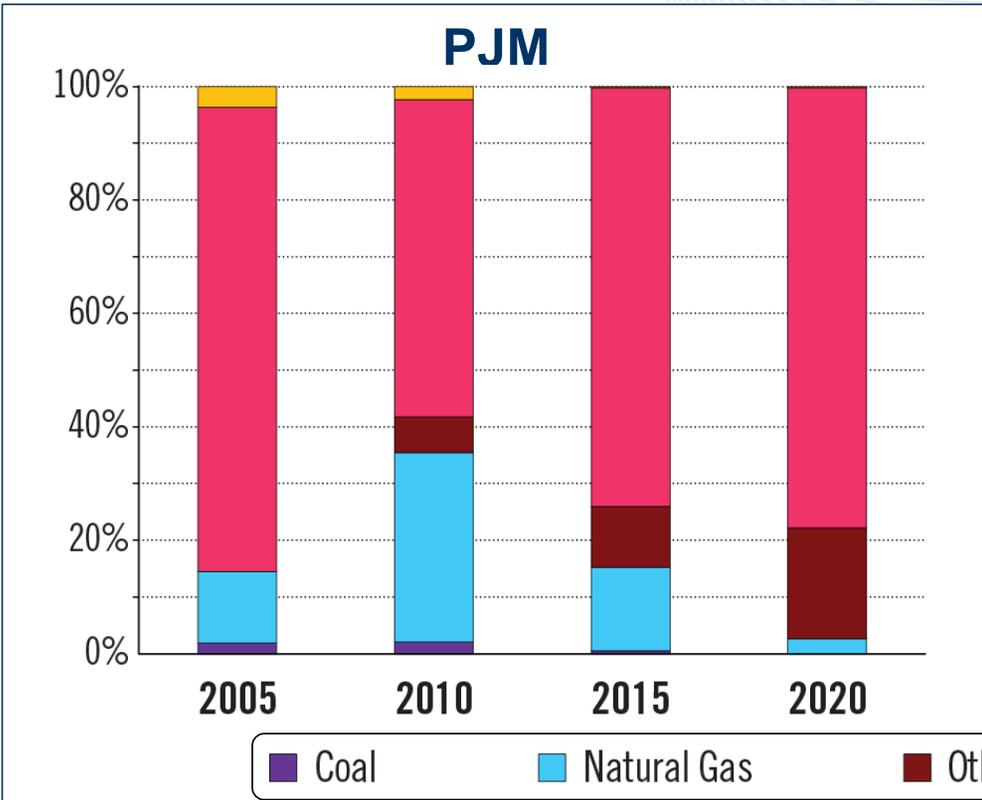
Installed Capacity Trend: Historic Generation Shift



*No nuclear units in Ohio in PJM until the ATSI integration (David Besse and Perry in 2011)



Queued Capacity Trend: Fuel Mix Shift Continues



Renewables include: hydro, solar, wind, biomass, wood and methane.

Other includes: diesel, storage and oil.

Note: Figures include all queued generation requests that are actively under study, under construction or in suspension.

Historic generation shift continues –
renewables, natural gas

Offshore wind –
interconnection rights

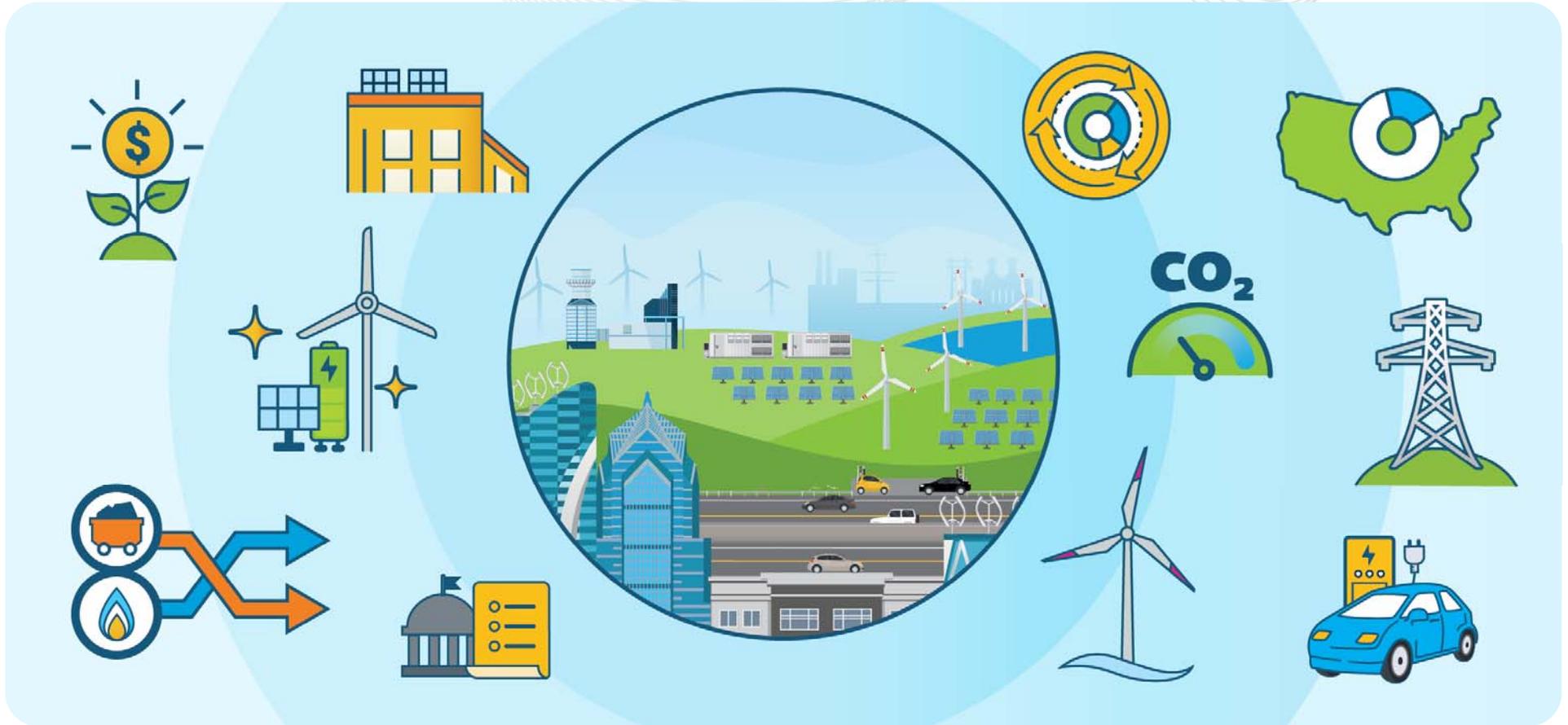
Aging infrastructure –
Two-thirds over 40 years old

Grid resilience –
weather, cyber and physical attacks; fuel delivery

Public policy – RPS mandates, environmental regulations

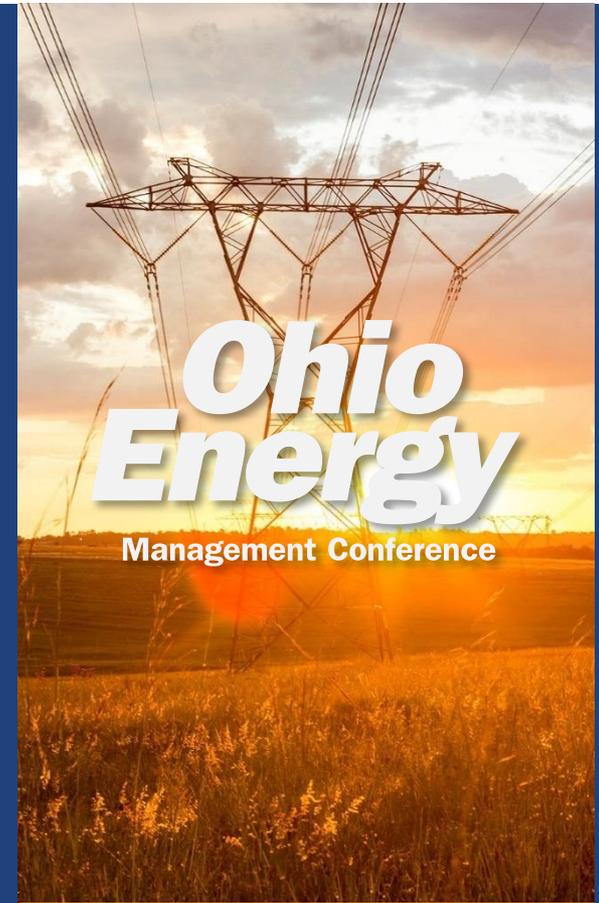
Customer expectations –
24/7/365 reliability at lowest cost

Integrating new technologies – DLR, storage, microgrids, electric vehicles, DER/Order 2222



FirstEnergy Ohio: Planning for an Evolving Transmission System

February 17, 2021



WE HAVE
THE POWER

FirstEnergy Transmission System

- **Approximately 7,200 miles of transmission lines in Ohio**
- **Always evolving to adapt to changes in generation and demand**
- **Reliability, resiliency and flexibility help handle planned and unplanned events**
- **Essential to meeting customer energy needs and delivering the power quality they expect – safely and reliably**

Toledo Edison
A FirstEnergy Company

The Illuminating Company
A FirstEnergy Company

Ohio Edison
A FirstEnergy Company

Reliability and Resilience



■ Resiliency:

- Necessary for uncontrollable events
- Includes storms, physical or cyber security threats, even pandemics

■ Robust, integrated transmission network:

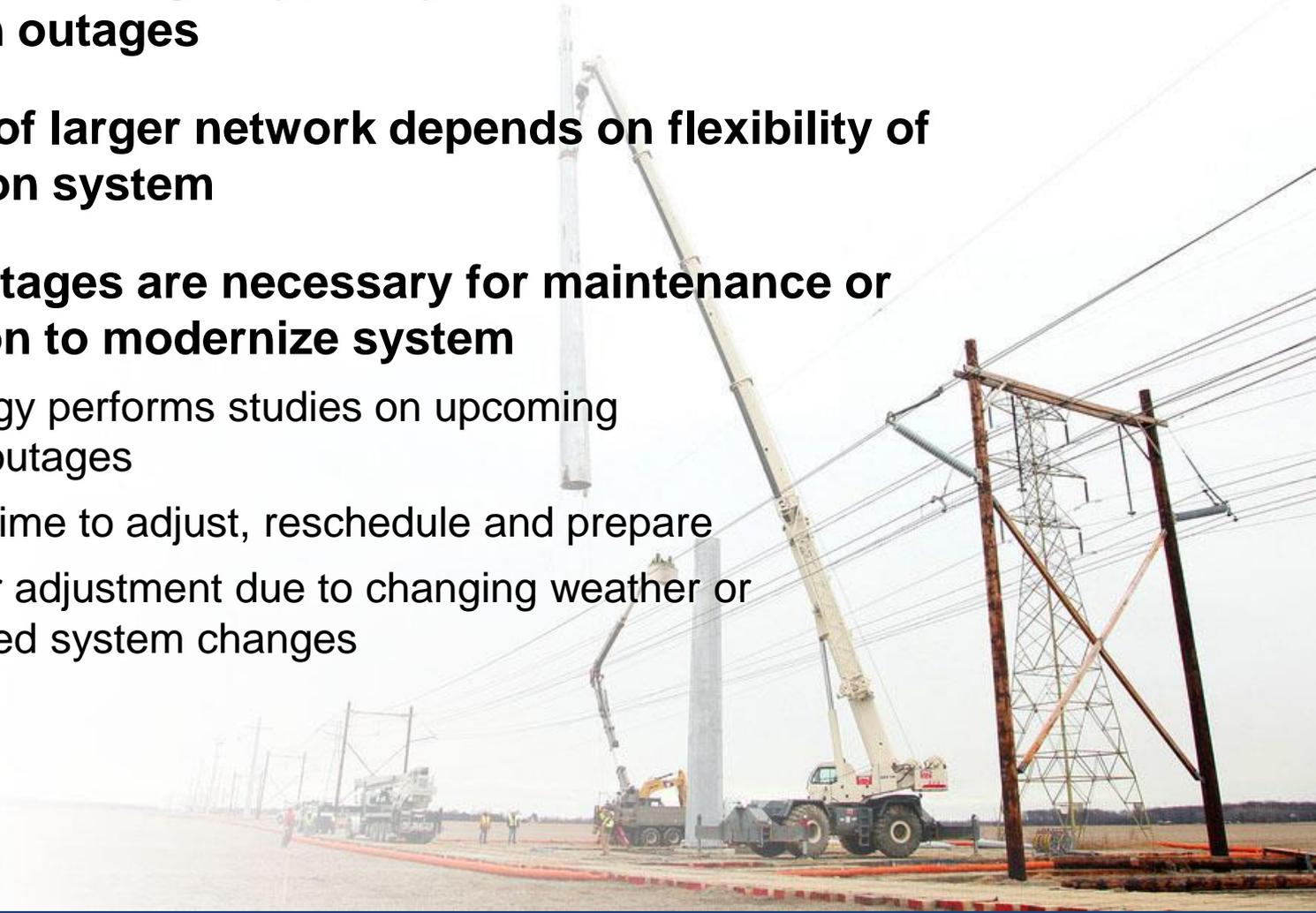
- Multiple paths from generation and to customers
- Helps prevent service interruptions

■ Flexibility:

- Helps meet industrial customers' needs
- Manages planned outages for maintenance and construction months in advance

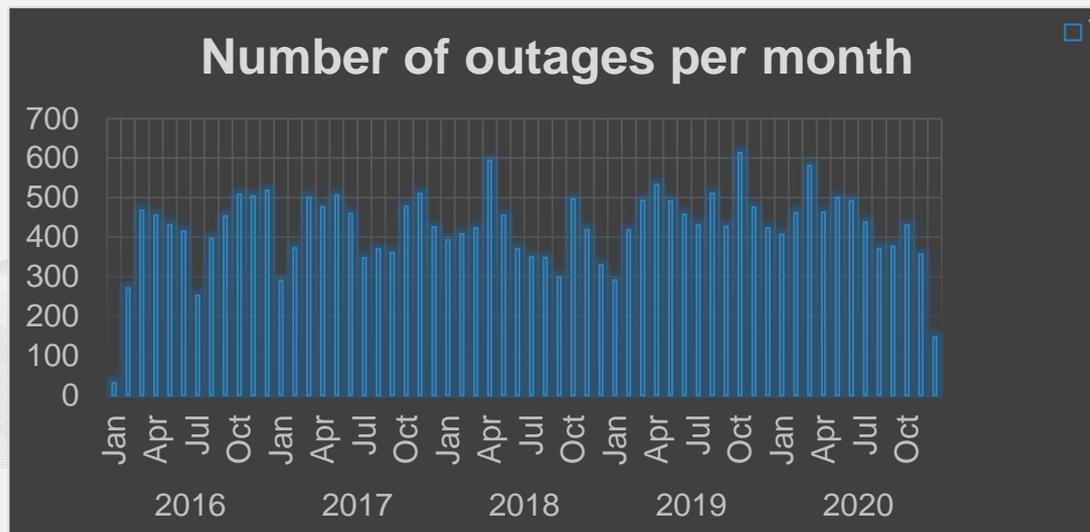
Reliability and Resilience: Planning Ahead

- **Transmission outages typically affect more customers than distribution outages**
- **Resilience of larger network depends on flexibility of transmission system**
- **Planned outages are necessary for maintenance or construction to modernize system**
 - FirstEnergy performs studies on upcoming planned outages
 - Ensures time to adjust, reschedule and prepare
 - Allows for adjustment due to changing weather or unexpected system changes



Reliability and Resilience: Planning Ahead

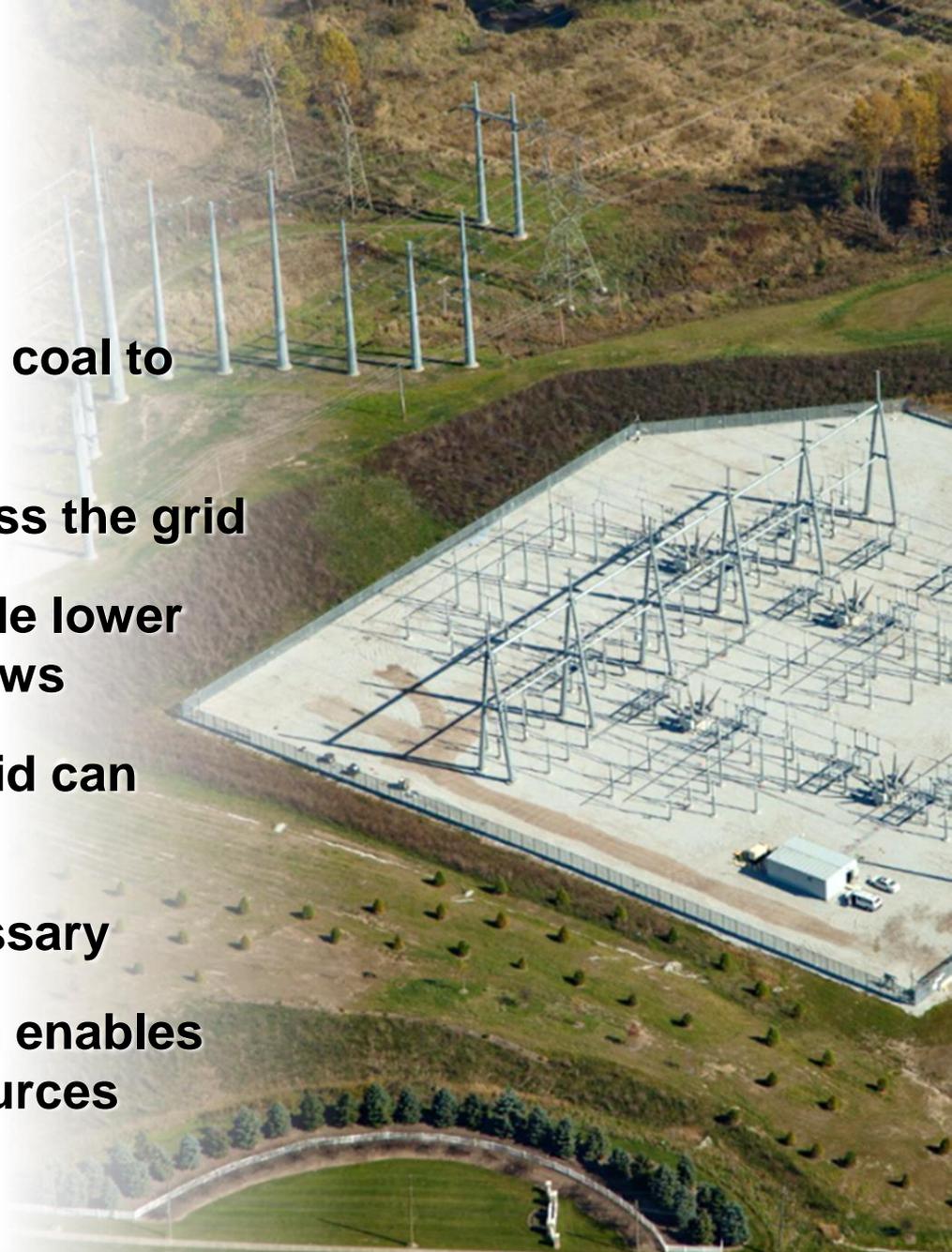
- **Average of 400 outages a month over last 5 years** *
 - Planned outages facilitate necessary maintenance and construction
- **Flexible system helps prepare for outages**
 - Planning happens months in advance
 - Must be flexible based on available generation that day



* The vast majority of these are planned outages, with a small number of unplanned outages.

Evolving Generation

- **Generation mix is changing**
- **Includes significant shift from coal to natural gas**
- **Affects how power flows across the grid**
- **Power lines that used to handle lower flows may now have larger flows**
- **Flexibility helps ensure the grid can handle changes**
- **Voltage support may be necessary**
- **A robust transmission system enables integration of renewable resources**



Evolving Generation: **Generation Patterns**

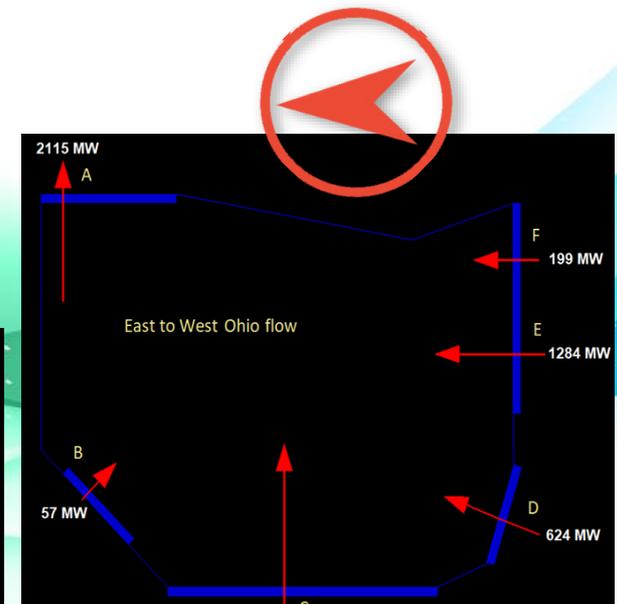
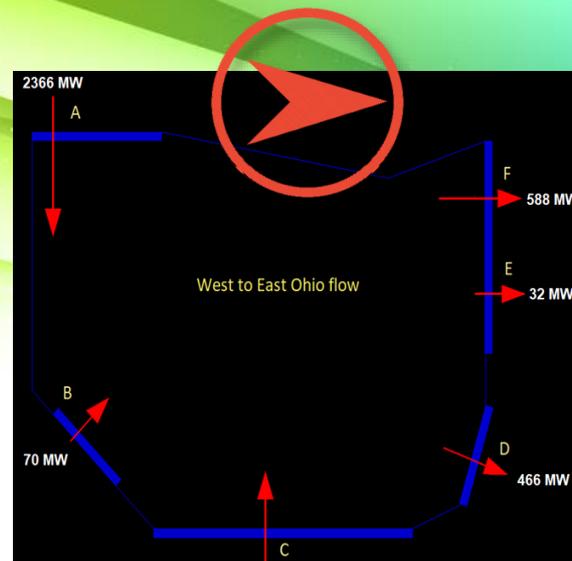
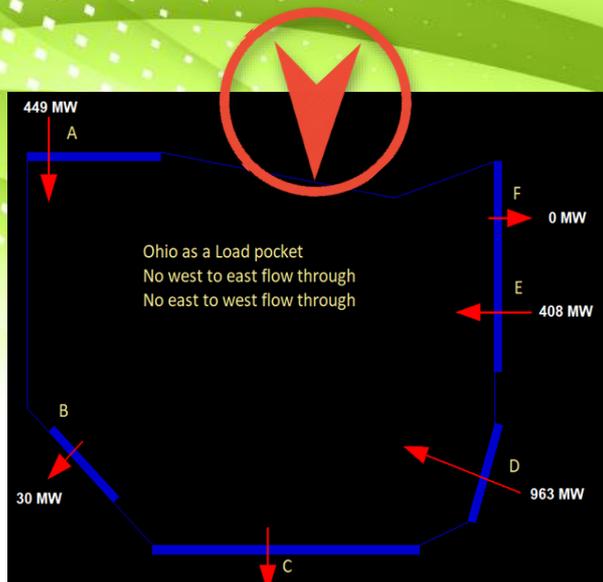
- **Generation across the system varies daily**
- **Generation shifts can cause issues for the transmission system**
- **System must be flexible to prepare for changes**
- **Power flows like a highway – in more than one direction**



Transmission: Changing Power Flows

■ Power typically flows through in one of three ways:

- West to East
- East to West
- No distinct and routine flow pattern



Transmission System: Customer Value

- **The interconnection between FirstEnergy and other utilities helps create robust and reliable network**
- **Generation mix requires system flexibility**
- **Ensures safe, reliable power**
- **Delivers quality power under changing conditions**
- **Helps provide quality power across Ohio and throughout the region**



Thank You



QA



Ohio Energy Conference

February 18– Columbus, Ohio

Dayton Power & Light Overview

520,000

Customers across
6,000 square miles

155

Substations

310 Miles

Of 345kV line

\$60 Million

Invested in economic
development, community
priorities and charitable
partners

380 Miles

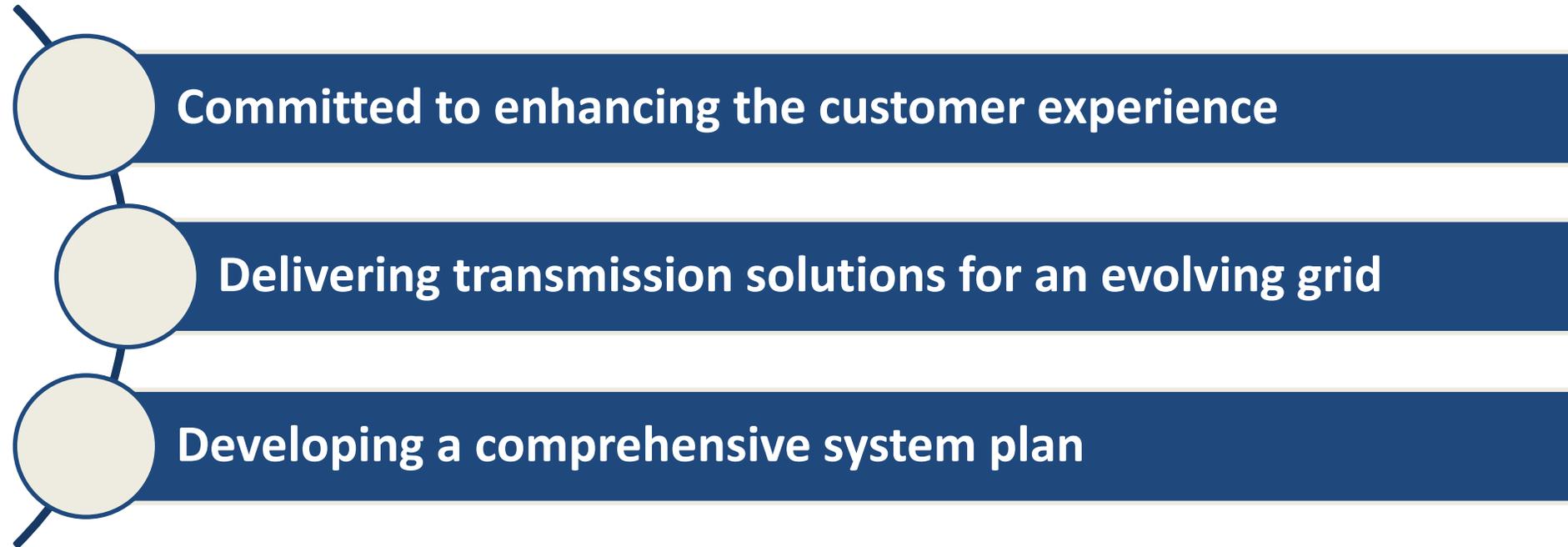
Of 138kV line

992 Miles

Of 69kV line



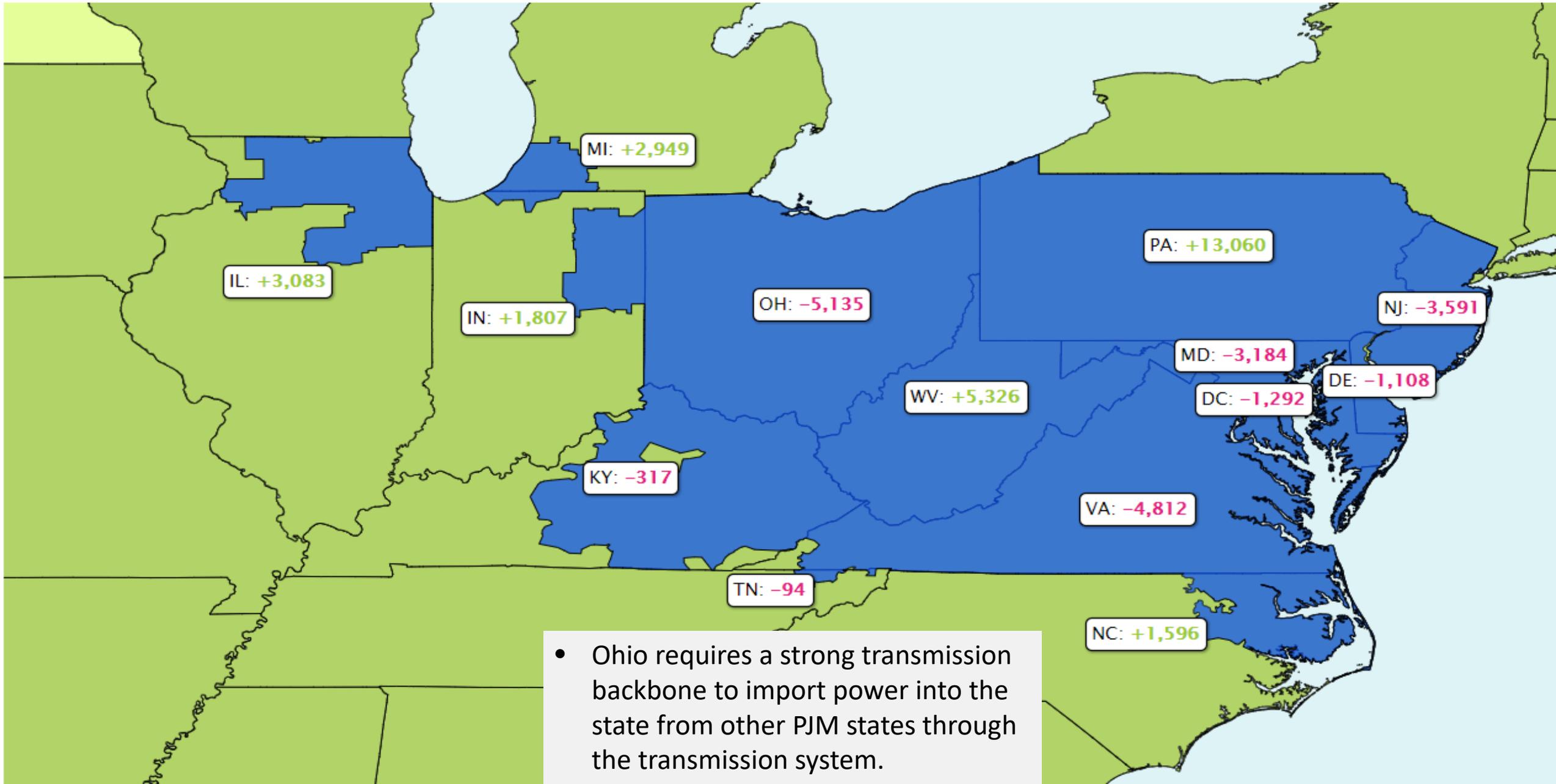
DP&L Transmission Planning



*Transmission planning based on affordability, reliability
and sustainability*

PJM State Net Import/Export Map

(2.8.2021 3:00PM)



- Ohio requires a strong transmission backbone to import power into the state from other PJM states through the transmission system.

DP&L Customer Experience

PJM M-3 Process

- Committed to proactively collecting input.
- Establishing direct paths for constant and consistent communication.
- Better communication equates to transparency.
- In it together, lets keep working together

FERC approved process

DP&L Community Ambassador Program

- Monthly community meetings
- Understand what is happening in and with the community while collecting feedback

DP&L Customer Stakeholder Meetings

- Regular meetings with customer stakeholders
- Discussions enhance real-time operations and help bring customer needs forward

Local Communities

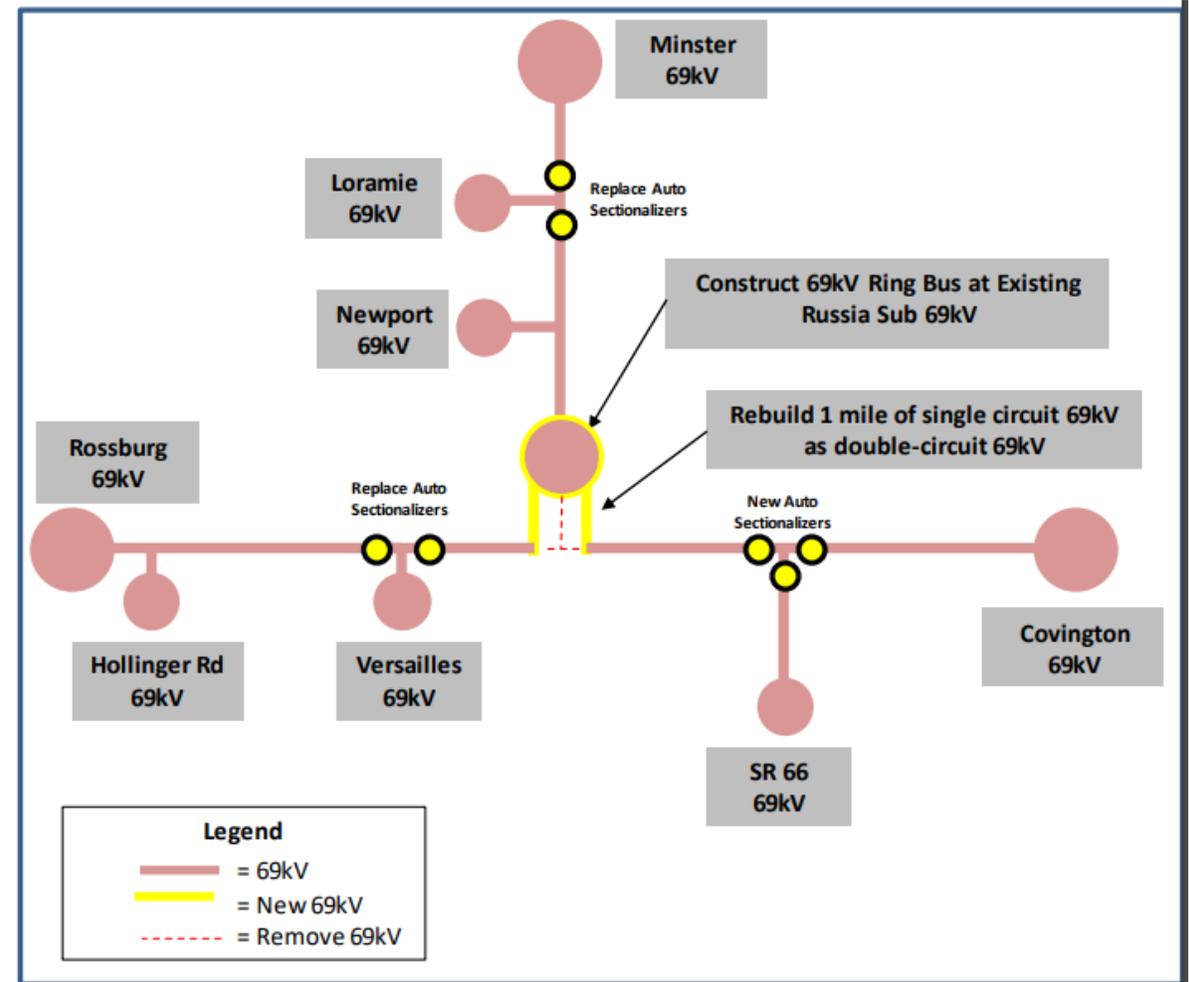
- Partner with PUCO & OPSB in power siting and customer outreach
- Partner with several local economic development orgs to recognize their needs

Feedback from a DP&L Customer after Recent Supplemental Project Upgrades:

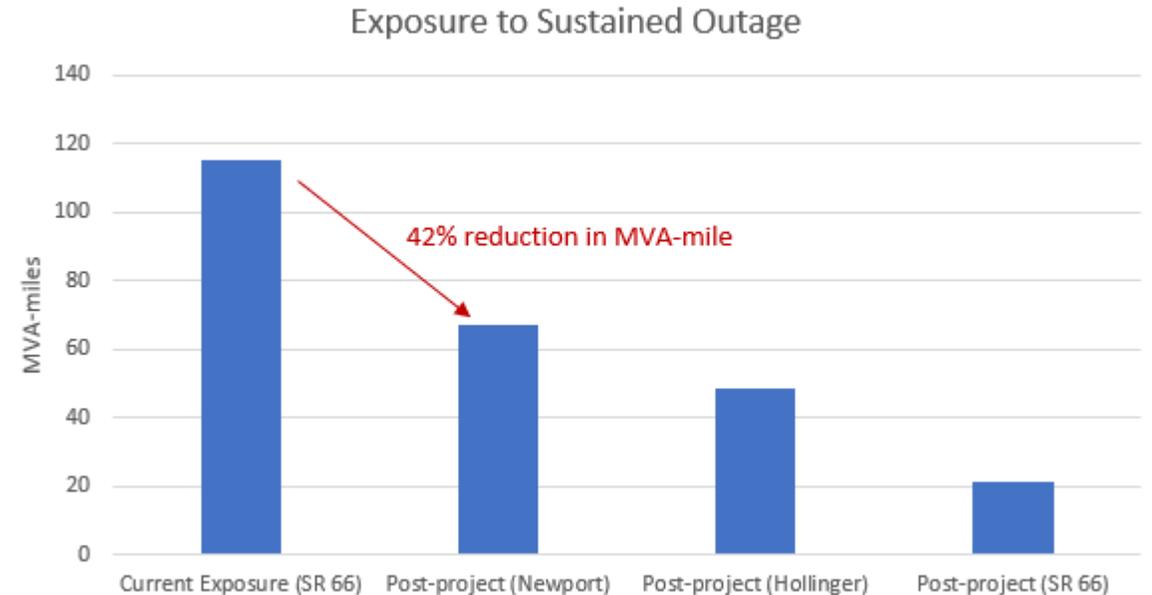
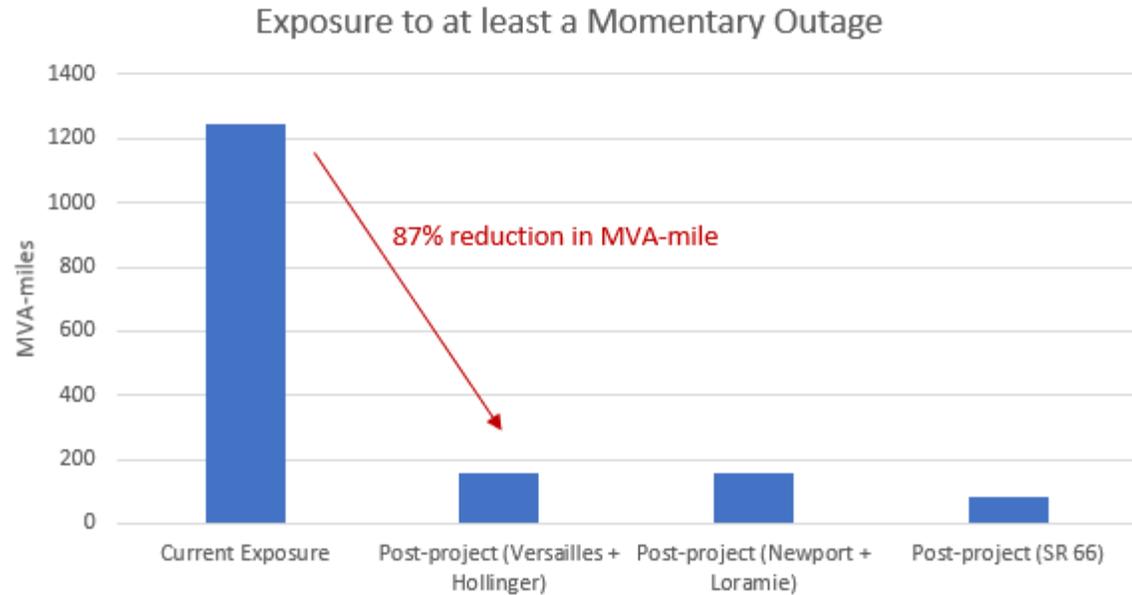
“DP&L did a wonderful job installing the substation and providing power to the new plant. The project went very well with no issues related to safety or deliverables. The DP&L team was very professional and worked well with the construction groups and delivered the service as specified in the allotted timeframe.”

Cost-Effective Transmission Solution Example 1

- DP&L has a 42-mile 69kV transmission line located in the northwest part of our service territory.
- This line has been one of the worst performing circuits on the DP&L System, experiencing over 30 outages in the last 5 years.
- A fault occurring anywhere on the 42-mile line results in at least a temporary outage of 6 complete substations and 7,000 customers.
- **DP&L developed a holistic and cost-effective solution that will solve the root cause issue of exposure to improve reliability and will be able to defer a costly line rebuild project.**
 - The selected breaker solution and sectionalizing improvement project will cost approximately \$5M.
 - The alternative to rebuild the complete line would have been \$42M and can be deferred.



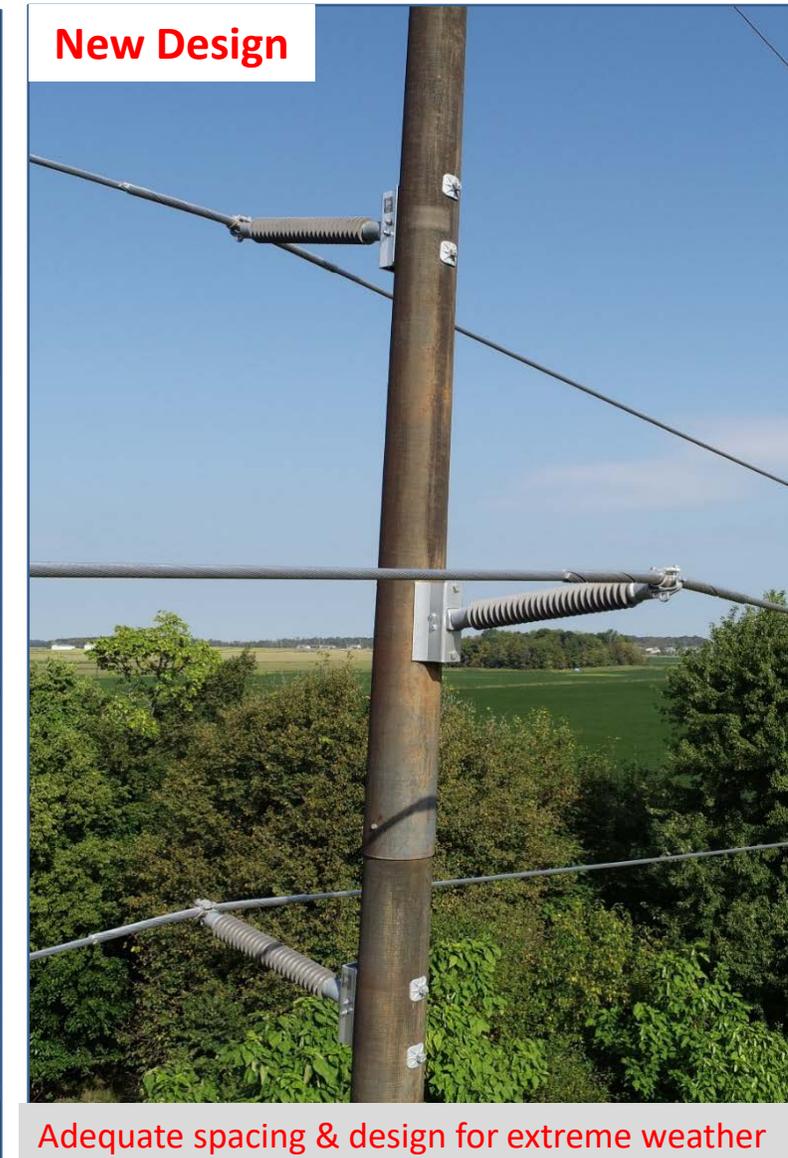
Key Reductions in System Exposure



Experience in Operations > Understanding Customer Needs > Improved Designs = Improved System Reliability

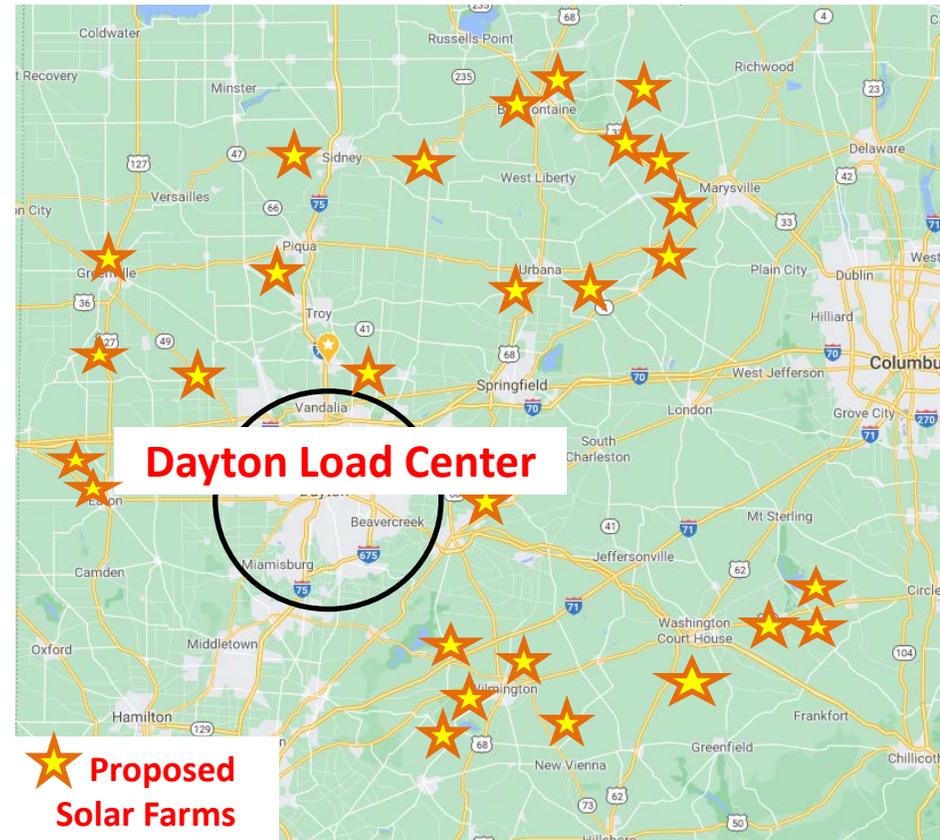
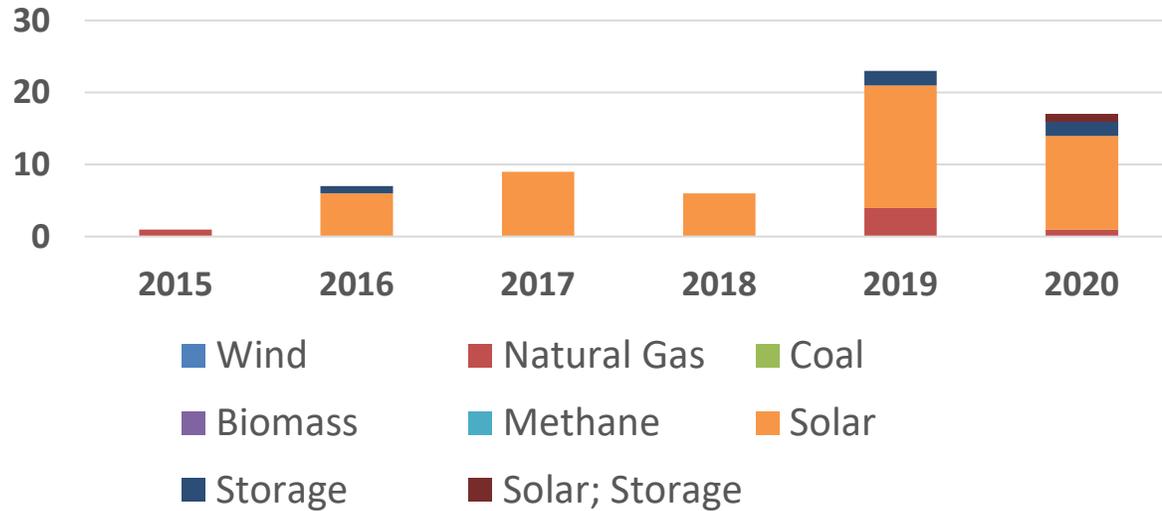
Effective Transmission Solution Example 2

- DP&L recently completed a 69kV transmission line rebuild just north of Sidney, Ohio, leading the way for a collection of reliability improvements for residential, commercial, and industrial customers in Auglaize, Logan, and Shelby counties.
- Prior to the line rebuild, the line experienced 19 outages in a 4-year period.
- After the line rebuild was complete in late 2019, the line has only experienced 1 outage.
- In this specific example, DP&L knew the root cause of the issue (equipment) and scoped the correct form of a solution to solve the problem.



Planning for the Evolving Grid

Dayton Interconnection Queue - # of New Generators by Year/Fuel



The DP&L transmission system is in transition from a few large central generation stations injections. Transmission resiliency must be maintained or improved to accommodate many more injection points and increasing dependence on renewable generation supply.

DP&L is Moving Forward



Enhancing the
customer
experience



Complete system
planning



Reliable transmission for
DP&L customers
OHIO Wins

DP&L is successfully meeting affordability & reliability needs today and looks forward to working together to ensure continued sustainability

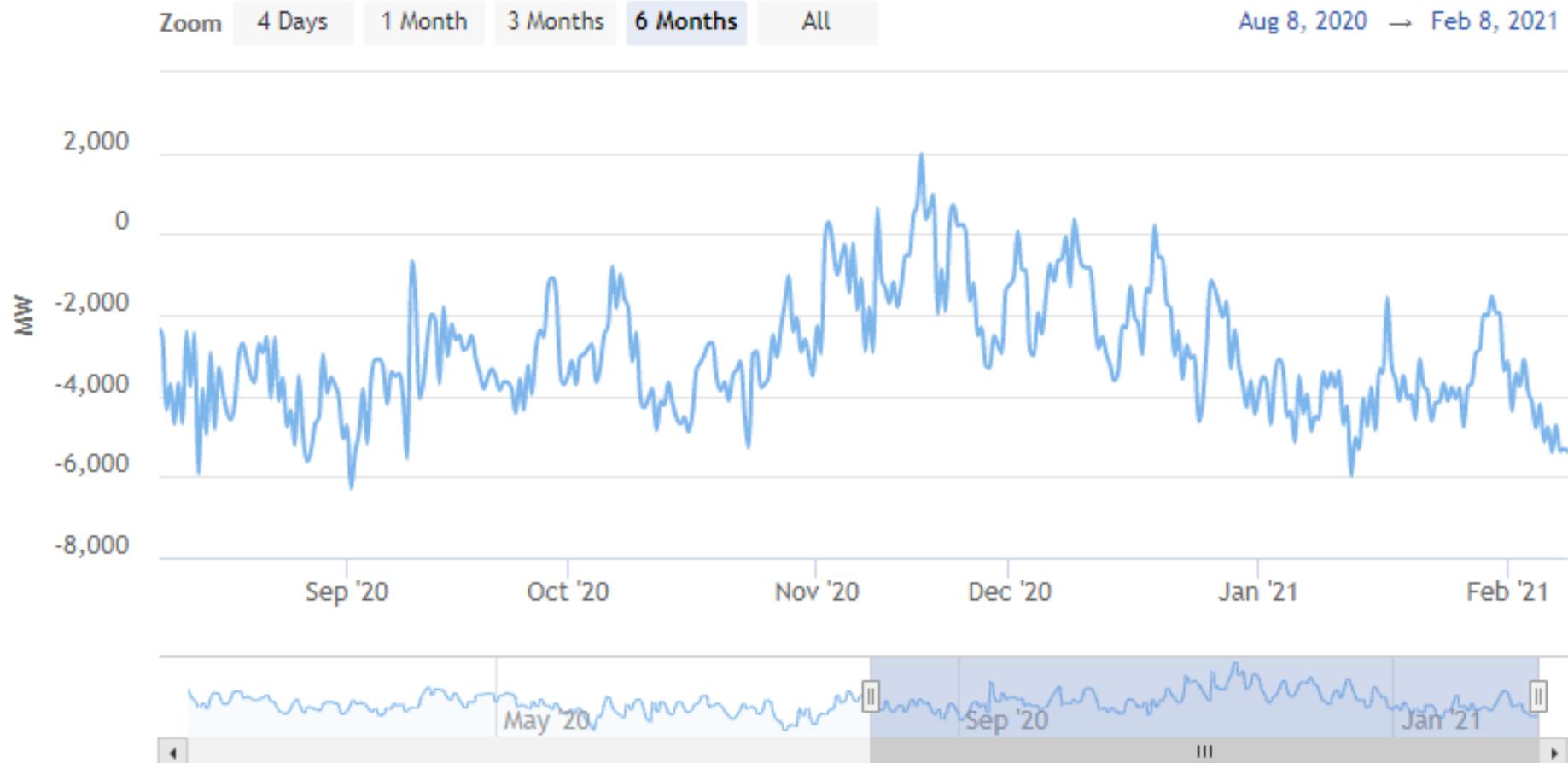
Appendix

Ohio Import/Export Trend – 6 Months

Ohio

Import/Export Trend

As of 2.8.2021 3:00 pm EPT



PJM Generation Reliability Attribute Table

- As the generation fuel mix changes, the new resources and transmission system will need to fill in the voids left by retired generation types.
- Shift from generators providing essential reliability attributes to a more flexible, sustainable resource mix.
- The new evolved transmission system with more penetration of faster inverters might need additional support from storage to fill the void of traditional generators to provide short circuit current support.

Resource Type	Essential Reliability Services (Frequency, Voltage, Ramp Capability)					Fuel Assurance		Flexibility			Other		
	Frequency Response (Inertia & Primary)	Voltage Control	Ramp			Not Fuel Limited (> 72 hours at Eco. Max Output)	On-site Fuel Inventory	Cycle	Short Min. Run Time (< 2 hrs./ Multiple Starts Per Day)	Startup/ Notification Time < 30 Minutes	Black Start Capable	No Environmental Restrictions (That Would Limit Run Hours)	Equivalent Availability Factor
			Regulation	Contingency Reserve	Load Following								
Hydro	●	●	●	●	●	○	◐	●	●	●	●	◐	●
Natural Gas - Combustion Turbine	●	●	◐	●	◐	●	○	●	●	●	●	◐	◐
Oil - Steam	●	●	●	●	●	●	●	●	○	○	○	○	◐
Coal - Steam	●	●	●	●	●	●	●	◐	○	○	○	◐	◐
Natural Gas - Steam	●	●	●	●	●	●	○	●	○	○	●	◐	◐
Oil/ Diesel - Combustion Turbine	●	●	○	●	○	○	●	●	●	●	●	○	◐
Nuclear	◐	●	○	○	◐	●	●	○	○	○	○	◐	●
Battery/ Storage	◐	◐	●	●	○	○	○	●	●	●	◐	●	●
Demand Response	○	○	◐	◐	◐	◐	◐	●	●	◐	○	●	●
Solar	◐	◐	○	○	◐	○	○	●	●	●	○	●	●
Wind	◐	◐	○	○	◐	○	○	●	●	●	○	◐	●

● = Exhibits Attribute
 ◐ = Partially Exhibits Attribute
 ○ = Does Not Exhibit Attribute



Duke Energy

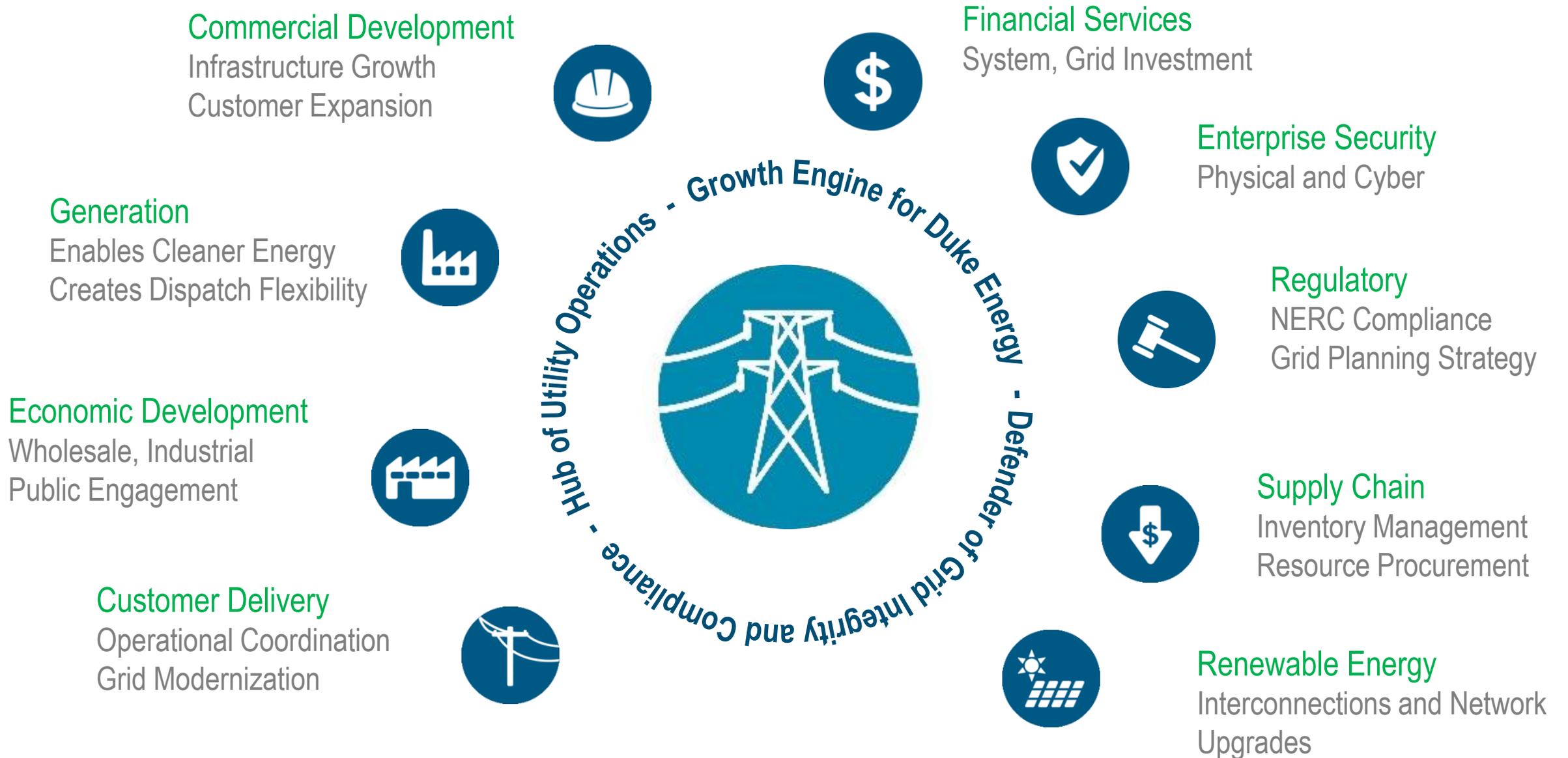
Presentation for OH Energy Management Council Conference
February 18, 2021



BUILDING A SMARTER ENERGY FUTURESM

Ohio Transmission Strategy

Transmission Powering the Lives of Our Communities



- Duke Energy Ohio (OH)
 - Transmission Circuit Miles
 - 66-69kV – 488 miles
 - 100-199kV – 508 miles
 - 345kV – 407 miles
 - No Duke Energy OH owned generation

Key Strategic Objectives

- Maintain Electric Grid Reliability
- Transform System Operations
- Support Queue Effectiveness
- Accommodate Renewable Resources

Midwest Service Territory



Transmission backbone to utility infrastructure



- Assures effective and efficient reduction of risks to Grid reliability and security and sets the guiding principles for Grid operations

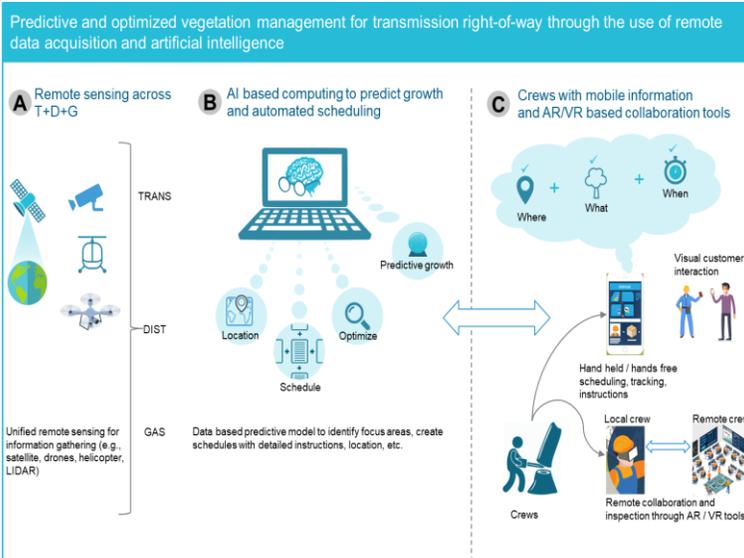
- Moving toward net zero carbon to meet customer demands and respond to federal and regional policy changes

- Critical to reliability and stability of electric infrastructure
- Backbone between Generation and Distribution and needs flexibility in infrastructure to support stakeholder interest in net zero carbon

- Delivers product to end-use customers
- Additional work to accommodate distributed renewables

Proactive programs to support reliability and system operations

Program Transformation



Light Detection and Ranging (LiDAR)

- Capture proximity of tree threat to power lines
- Height striking distance, tree segments & proximity of the vegetation to the line
- Hyperspectral imagery used to identify different tree species and health from spectral signatures



Data Acquisition

Asset Data



System Performance



Health & Risk Management (HRM)

- Leverages machine learning and artificial intelligence
- Manage assets statistically rather than by time and failure

Emerald Ash Bore

- Program to address ash trees that pose risk to transmission system

Grid Improvement

- Modernizing grid infrastructure to harden from weather impacts and enable renewables

Transmission – Grid Improvements

Baseline Transmission System Produces Value

- Vital to maintain real time operations
- Provides for future expansion and enhancement planning

Benefits of the Transmission System

- Functional design remains valid, and valuable for decades
- Replace or upgrade without fundamentally changing the functional aspects of a facility when needs arise

Transmission Facility Improvements

- Implemented without changing the original function if required
- Key components in supporting changing needs and functions over time

Grid Hardening and Resiliency Improvements

- Contribute greatly to operational flexibility and customer restorations
- Demonstrated quicker restoration efforts after major storms

Road to Net Zero

Evolving Industry Direction

2020 ————— 2030 ————— 2040 ————— 2050 ▶



Decarbonize energy

- Retire and improve reliability at remaining coal stations
- Invest in new gas and renewables

Duke Energy Response

- *Responding to changing customer preferences, growing levels of engagement*
- *Making company and system adjustments as regional policy and RTO guidance develops*
- *Building Transmission infrastructure to accept growing Midwest renewable assets*



Decarbonize capacity

- Complete remaining coal retirements
- Scale wind, solar, storage, DR/EE
- Introduce new technology



Drive to Net Zero

- Continue to enable available solar, storage and wind resources
- Scale new technology
- Carbon capture / offset

Transmission Key Takeaways

- A properly planned and maintained transmission system
 - Provides interregional, regional, and localized benefits.
 - Facilitates the efficient delivery of resources to load.
- Interconnected Transmission
 - Provides tremendous system benefit, including stability and resilience
 - Allows for the retirement of coal generating units, without causing supply disruptions or instability
- Transmission
 - A key component supporting the transition to a low carbon energy supply, and to new technologies such as microgrids
 - Readily facilitates the interconnection of new resources, and customers

Key Strategic Objectives

- Maintain Electric Grid Reliability
- Transform System Operations
- Support Queue Effectiveness
- Accommodate Renewable Resources



BOUNDLESS ENERGYSM

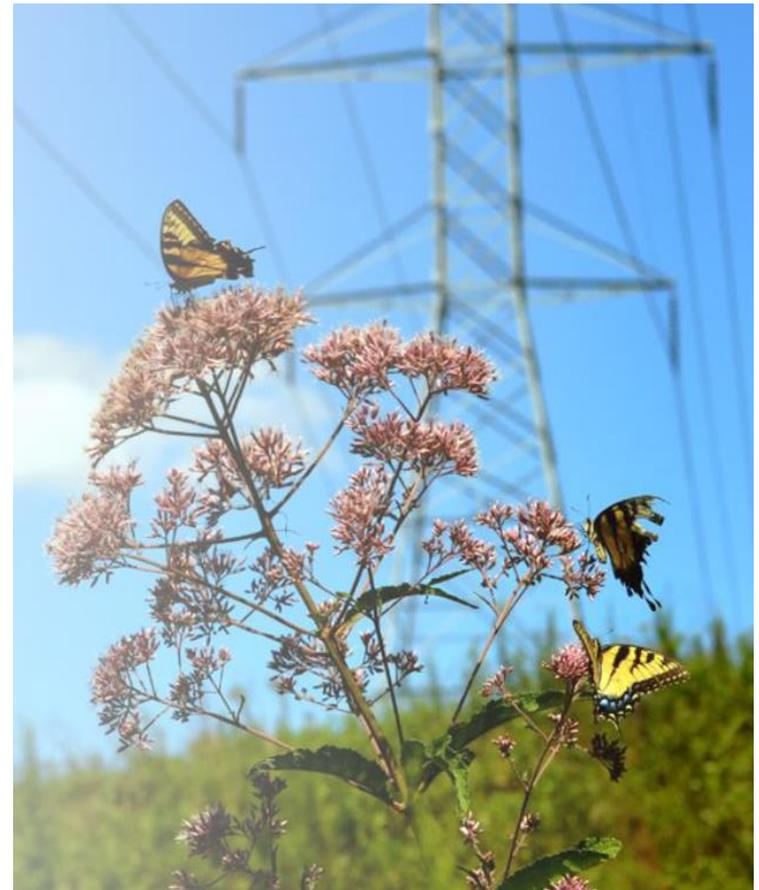
The Value and Benefits of AEP Transmission Investments



presented at the

25th Annual Ohio Energy Savings & Management Conference and Virtual Institute

February 18, 2021



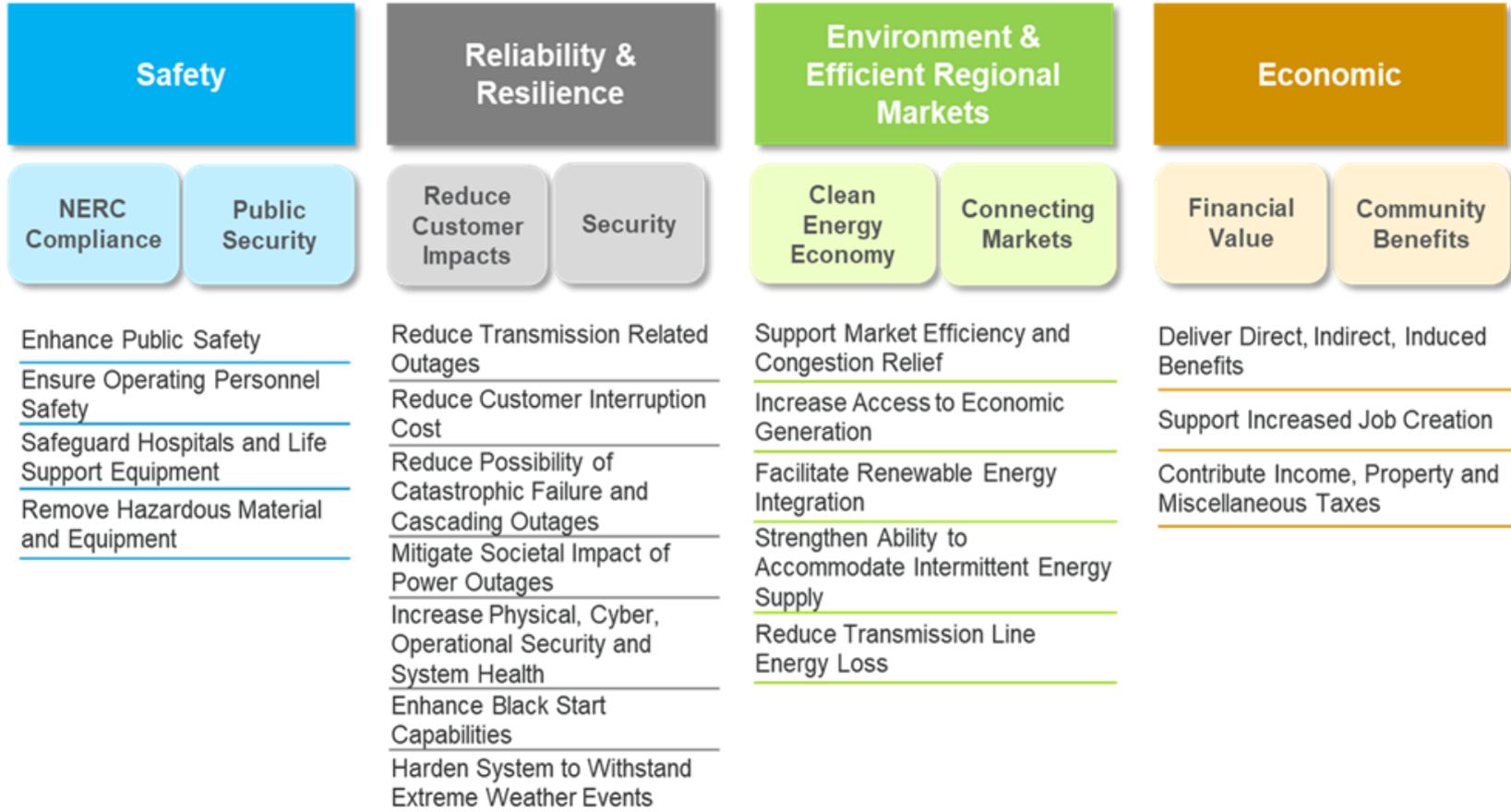
The North American Pollinator Protection Campaign, managed by Pollinator Partnership, has awarded its first 2020 Pollinator Electric Power Award to American Electric Power for its leadership in pollinator-friendly projects.

The recognition includes a collaboration with Dawes Arboretum (near Newark, Ohio) to create a biodiverse prairie habitat along a transmission line right-of-way.



BOUNDLESS ENERGY™

Value Proposition of AEP Transmission Investments





BOUNDLESS ENERGYSM

Safety

NERC
Compliance

Public
Security



**Reliability &
Resilience**

Reduce
Customer
Impacts

Security

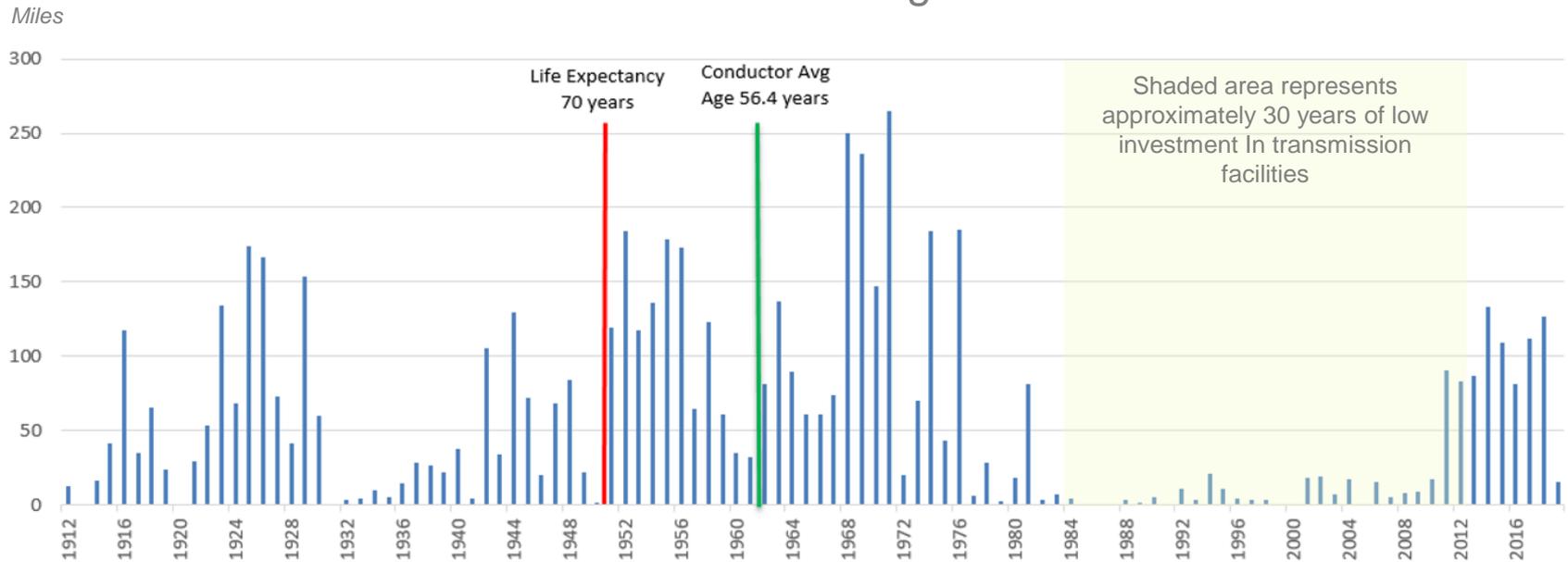
Rotting Wood and Failing Brace Arm



Excessive Hardware Rust



AEP Ohio Transmission Line Age based on Conductor



Transmission lines in operation today identified by year the line was first placed in-service

AEP owns, operates and maintains about 7,346 miles of transmission lines across Ohio



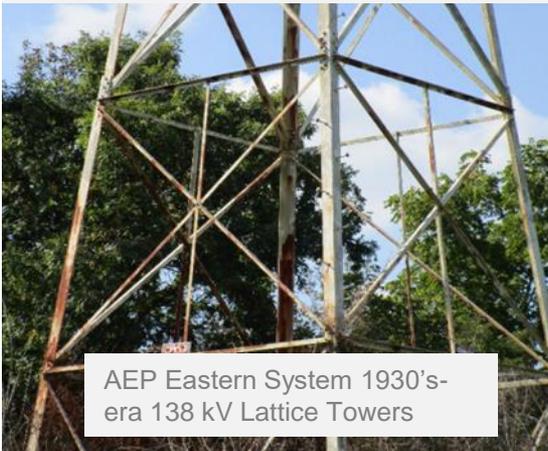
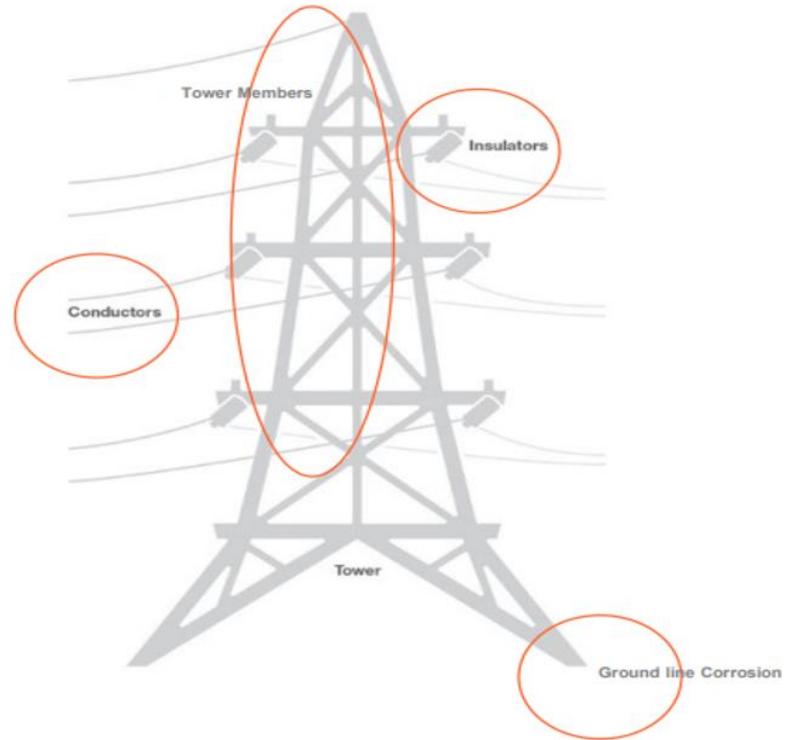
An AEP Company

BOUNDLESS ENERGY™

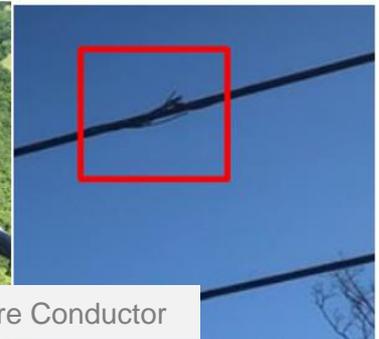
Explaining How We Evaluate the Performance, Condition and Risk of Failure of our Assets



Equipment on Transmission Towers with Potential for Condition-Based Failure



AEP Eastern System 1930's-era 138 kV Lattice Towers



Broken Wire Strands on Steel Core Conductor



BOUNDLESS ENERGY™

Reliability & Resilience

Reduce Customer Impacts

Security

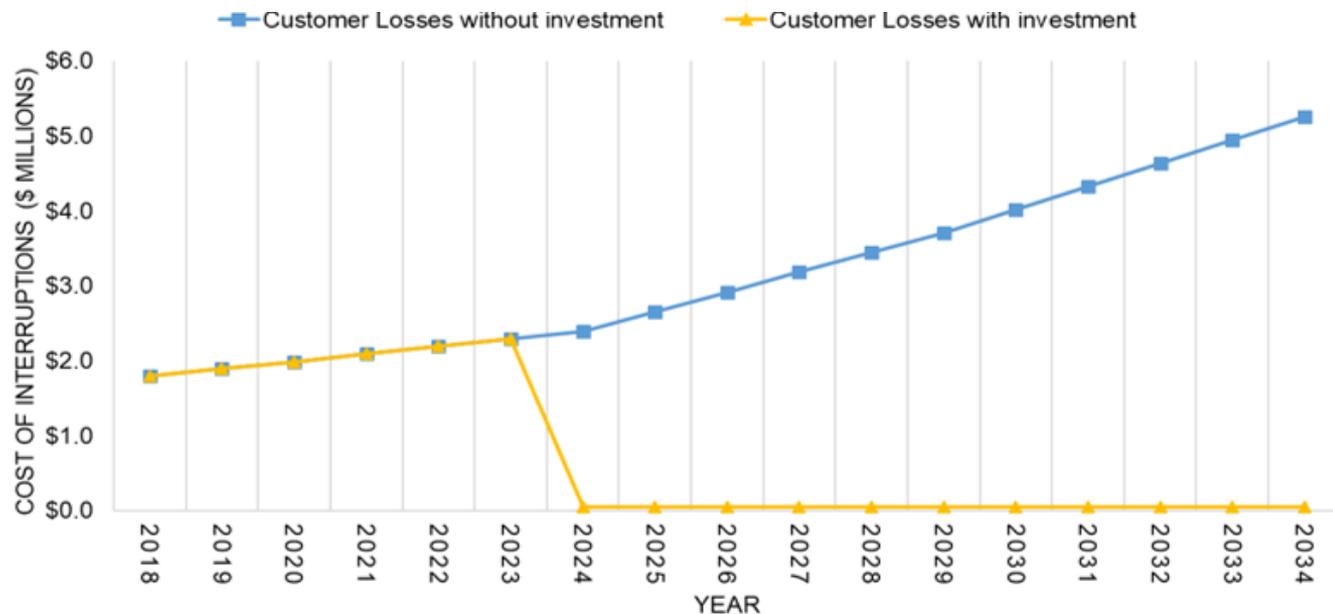
For this circuit, annual CMI minutes without investment are forecasted to **increase 2.3 million in 2018** to almost **7.3 million by 2035** or **315%**

Once completed the planned transmission project is expected to **reduce** CMI based on 2018, to 115K

Replacing one of the transmission lines with the highest number Customer Minutes of Interruptions(CMI) delivers benefits and value by greatly reducing outages.

The planned transmission project to replace this line means **avoided economic losses for Ohio customers** of about **\$2.3 Million** in 2024 and **\$4.0 Million** by 2030 for a total of **\$46.5 Million** by **2035**

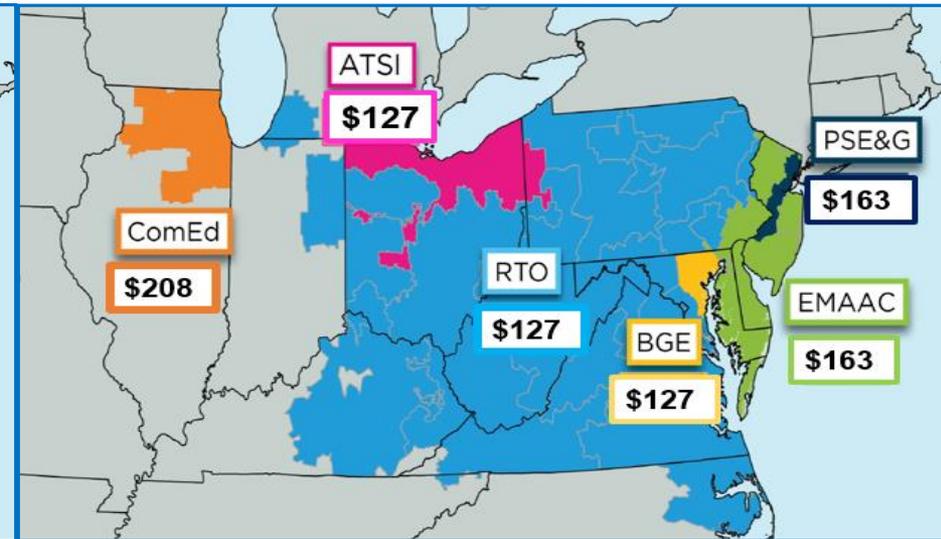
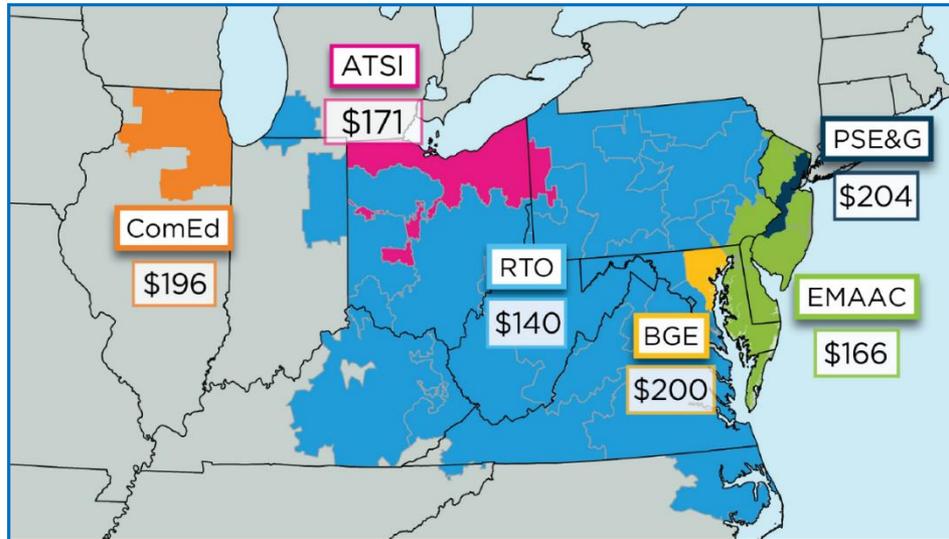
Customer Minutes of Interruption by Cost and Reduction With and Without Investment East Logan - South Lancaster Circuit



Capacity Market Pricing

2018 Calendar Year
Weighted Average Clearing Price

2019 Calendar Year
Weighted Average Clearing Price



2018

- As much as **\$64/MW-Day Savings** in the capacity market when compared to higher cost PJM zones

~\$280 Million in annual savings for
AEP Ohio connected demand

2019

- As much as **\$81/MW-Day Savings** in the capacity market when compared to higher cost PJM zones

~\$355 Million in annual savings for
AEP Ohio connected demand

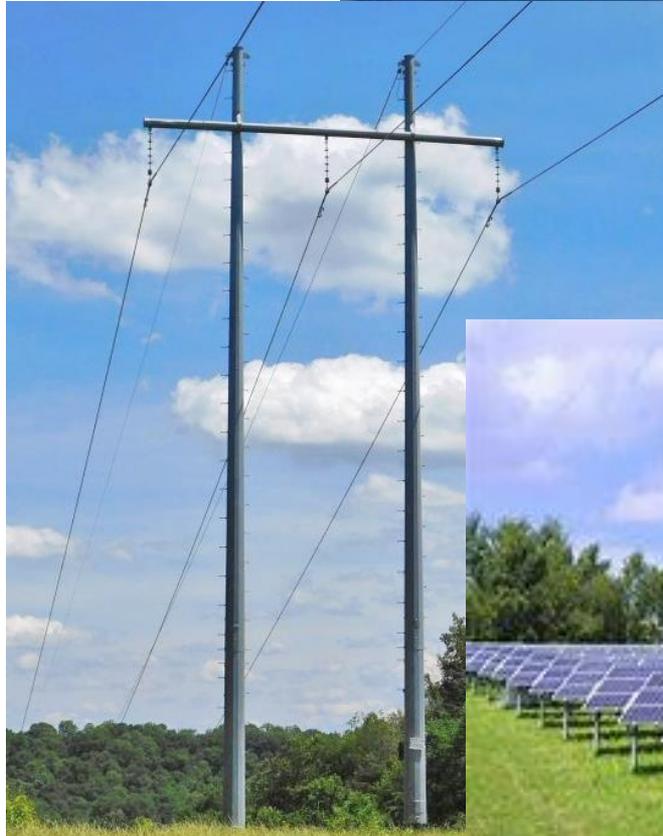


BOUNDLESS ENERGYSM

Environment &
Efficient Regional
Markets

Clean
Energy
Economy

Connecting
Markets



The Value and Benefits of AEP Transmission Investments 2020-2022

Additional Economic Benefits for Ohio

Economic

Financial
Value

Community
Benefits



Supports 5,070 Jobs

each year with an annual
compensation of \$50,000



Stimulates nearly \$2.9 Billion

in economic activities across Ohio



Contributes \$861 Million

in total taxes paid to state and local
governments from 2020-2022

CONSTRUCTION PROJECTS CREATE A BOOST IN ECONOMIC ACTIVITY THAT:

Attracts New Businesses • Provides Local Income • Generates Tax Revenue



