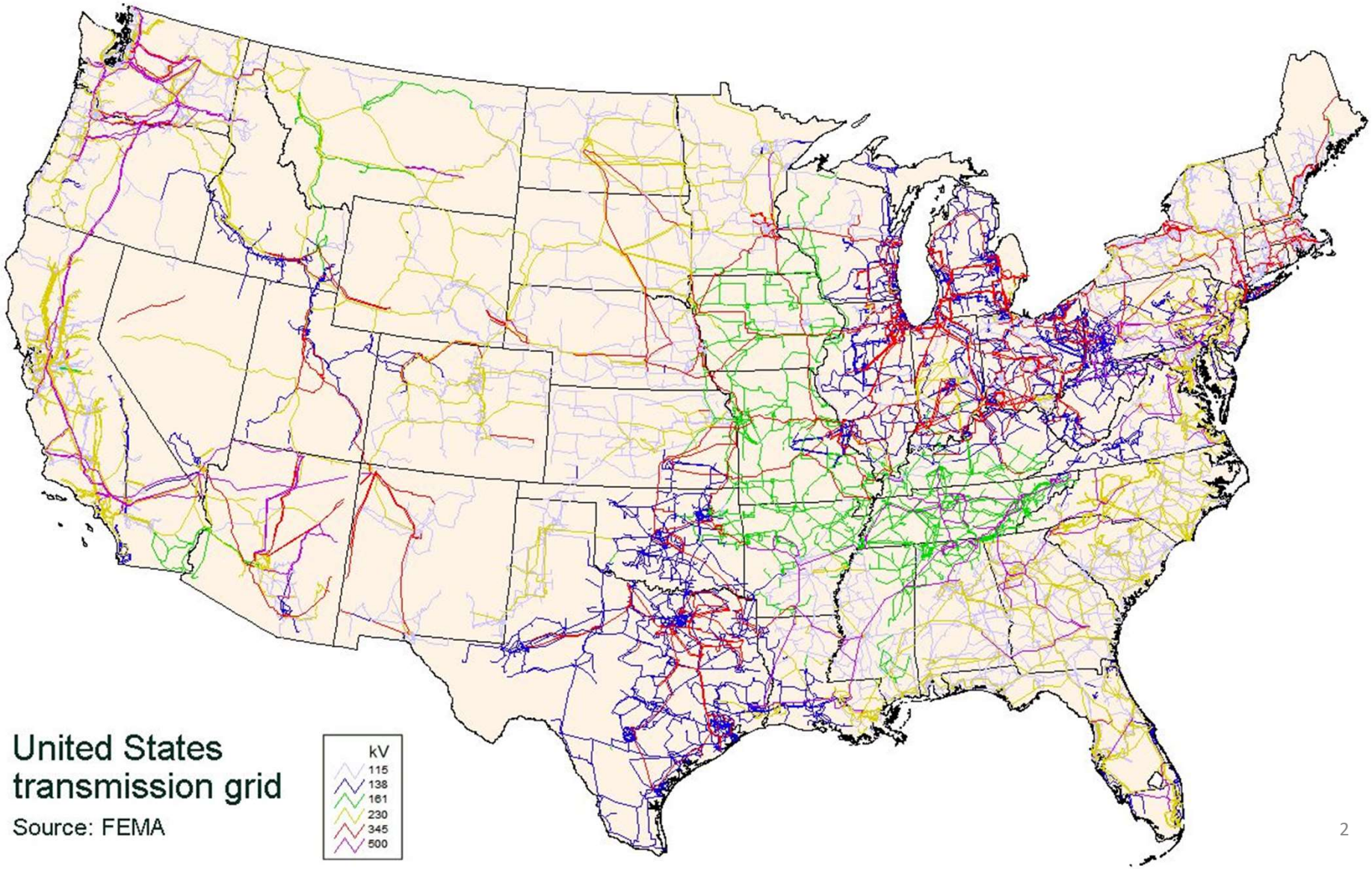
Ohio's Electric Cooperatives
2024 Summer Conference

PJM Transmission Planning Process Overview

Presented by:

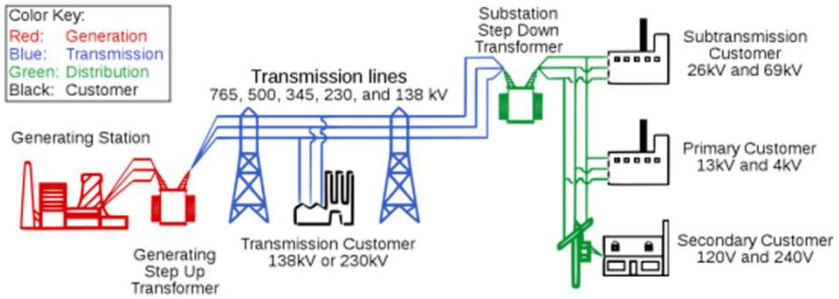
Tom Schmidt – Principal Planning Engineer, Buckeye Power

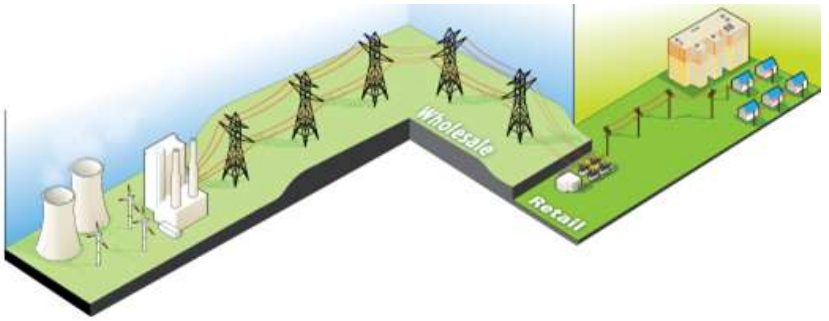
August 13, 2024

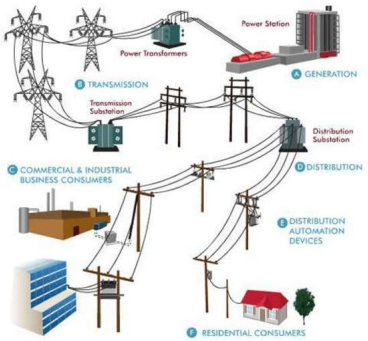


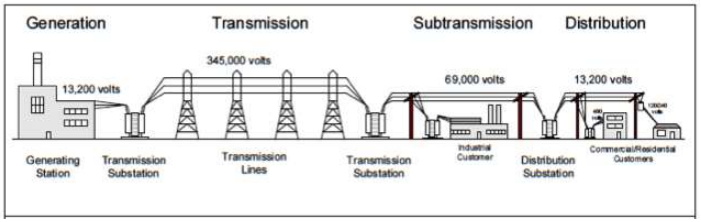
United States transmission grid

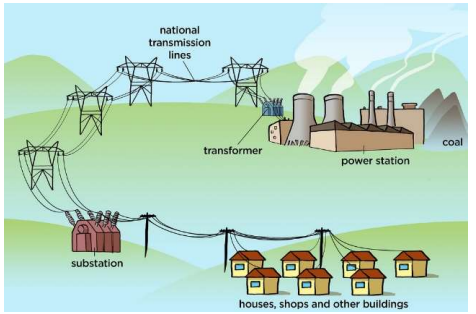
Source: FEMA

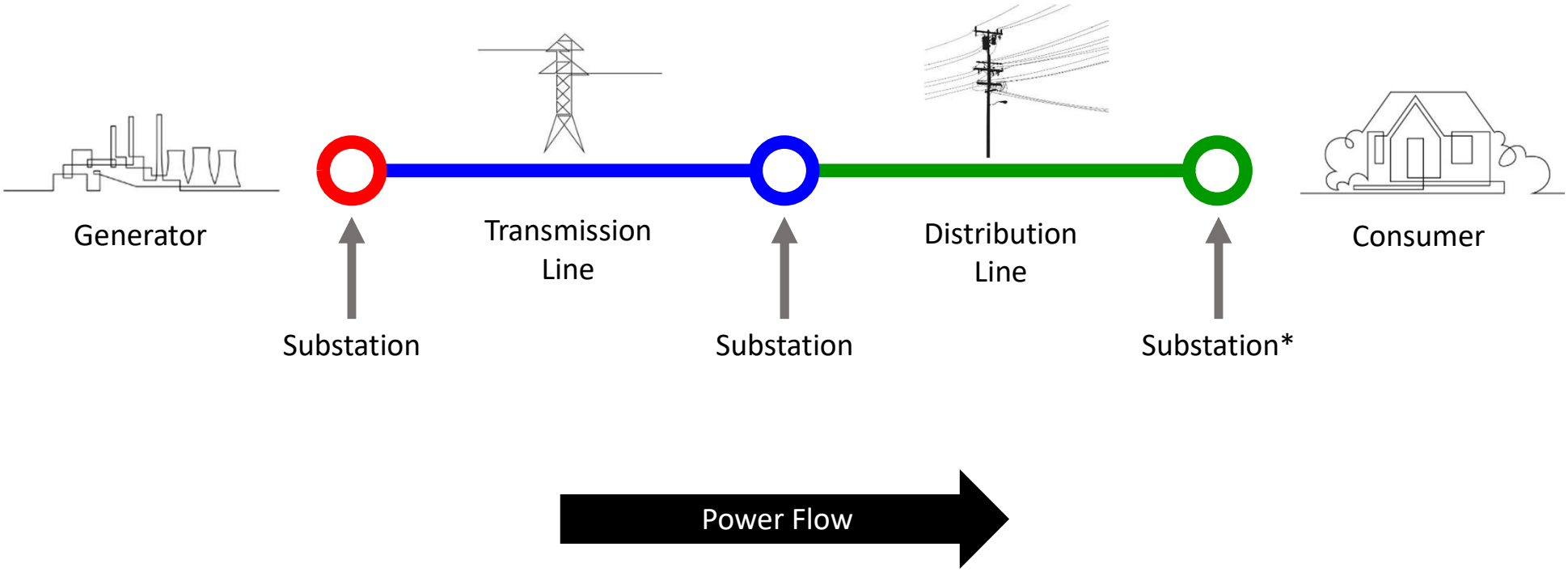

Color Key:
Red: Generation
Blue: Transmission
Green: Distribution
Black: Customer
Generating Station
Generating Step Up Transformer
Transmission lines
765, 500, 345, 230, and 138 kV
Transmission Customer
138kV or 230kV
Substation Step Down Transformer
Subtransmission Customer
26kV and 69kV
Primary Customer
13kV and 4kV
Secondary Customer
120V and 240V

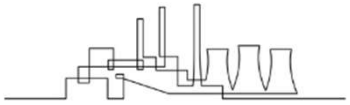

Wholesale
Retail


Power Station
Power Transformers
A GENERATION
B TRANSMISSION
Transmission Substation
Distribution Substation
C COMMERCIAL & INDUSTRIAL BUSINESS CONSUMERS
D DISTRIBUTION
E DISTRIBUTION AUTOMATION DEVICES
F RESIDENTIAL CONSUMERS

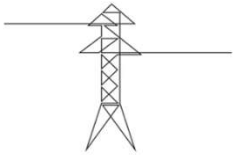

Generation
Transmission
Subtransmission
Distribution
13,200 volts
345,000 volts
69,000 volts
13,200 volts
Generating Station
Transmission Substation
Transmission Lines
Transmission Substation
Industrial Customer
Distribution Substation
Commercial/Residential Customers


national transmission lines
transformer
power station
coal
substation
houses, shops and other buildings

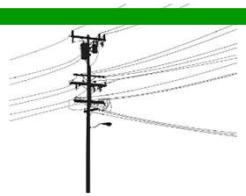

Generator
Substation
Transmission Line
Substation
Distribution Line
Substation*
Consumer
Power Flow



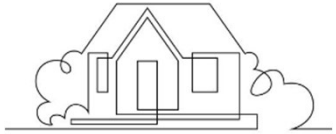
Generators



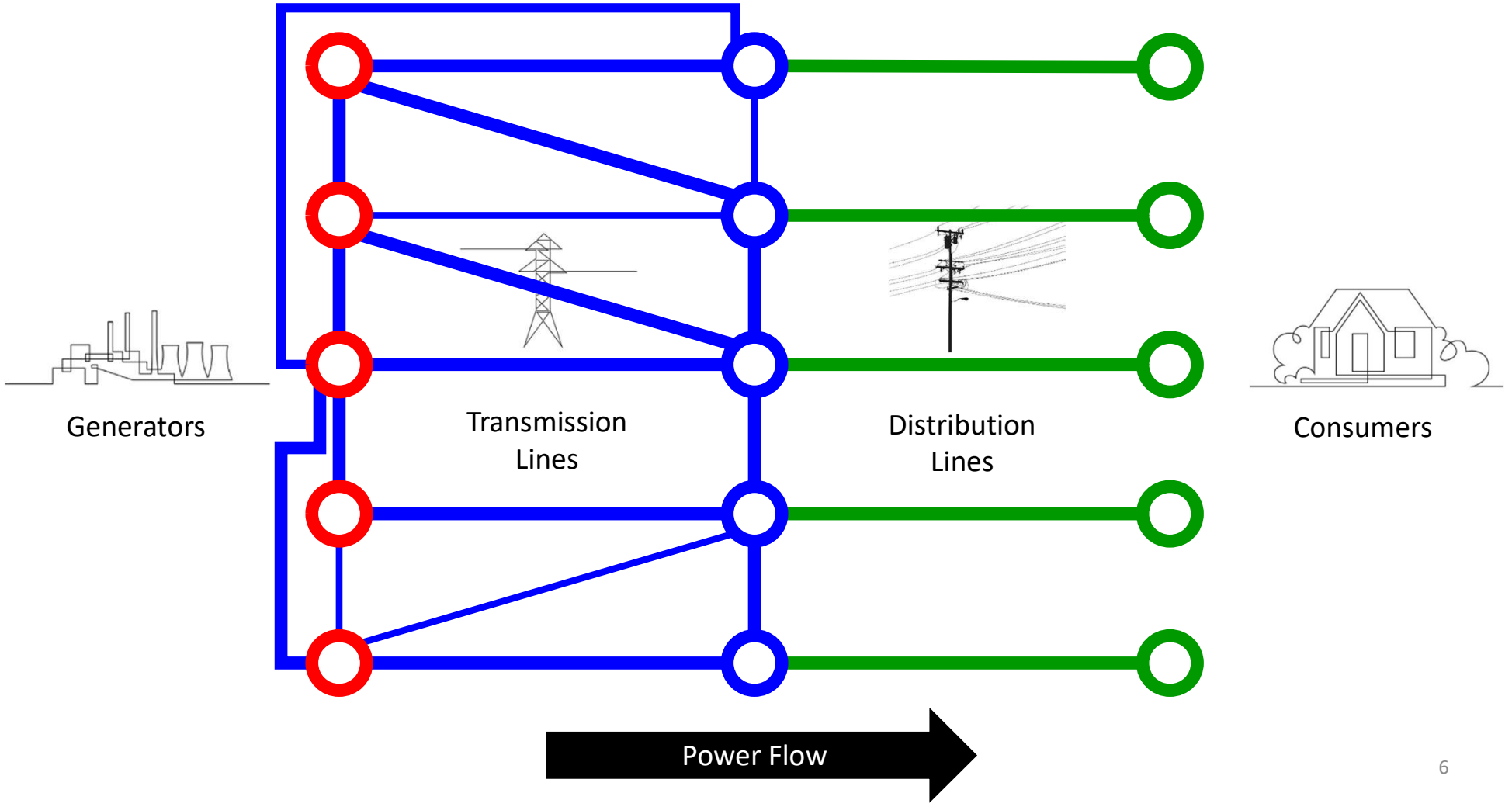
Transmission Lines



Distribution Lines



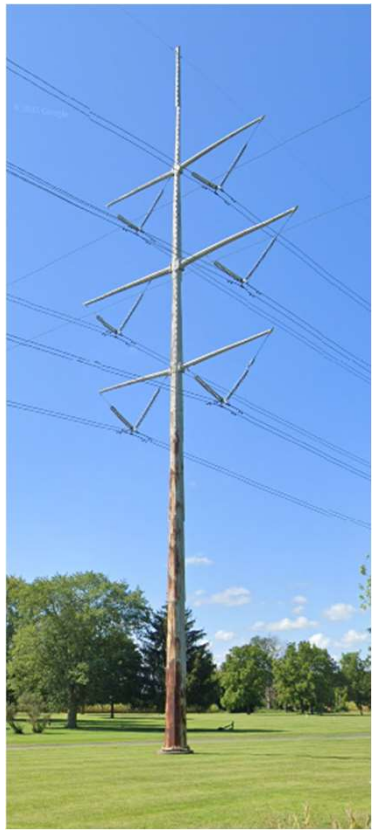
Consumers


Generators
Transmission Lines
Distribution Lines
Consumers
Power Flow

Types of Extra High Voltage (EHV) Transmission Lines

765kV Single-Circuit Steel Lattice Structure with 4-Bundle Conductor

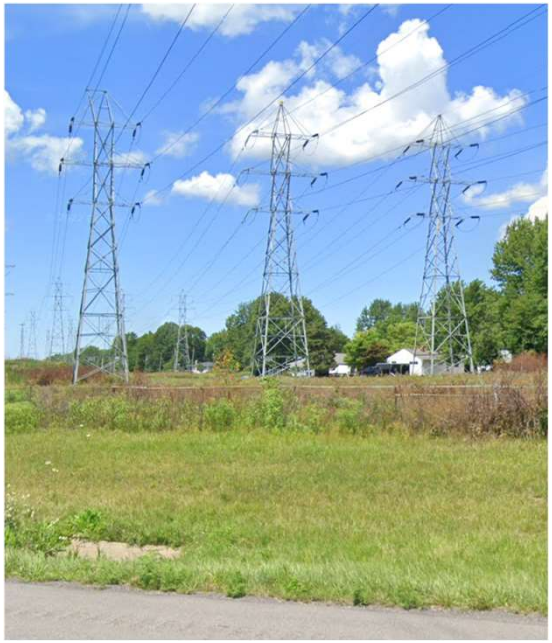
345kV Double-Circuit Steel Lattice Structure with 2-Bundle Conductor



345kV Double-Circuit Steel Monopole Structure with 2-Bundle Conductor

345kV Single-Circuit Guyed-V Structure with 2-Bundle Conductor

Types of Transmission Lines



138kV Double-Circuit Steel Lattice Structures

138kV Double-Circuit Monopole Structure

138kV Single-Circuit H-Frame Structure

138kV Single-Circuit Monopole Structure

Types of Sub-Transmission Lines

69kV Double-Circuit
Monopole Structure

69kV Single-Circuit
H-Frame Structure

69kV Single-Circuit
Monopole Structure

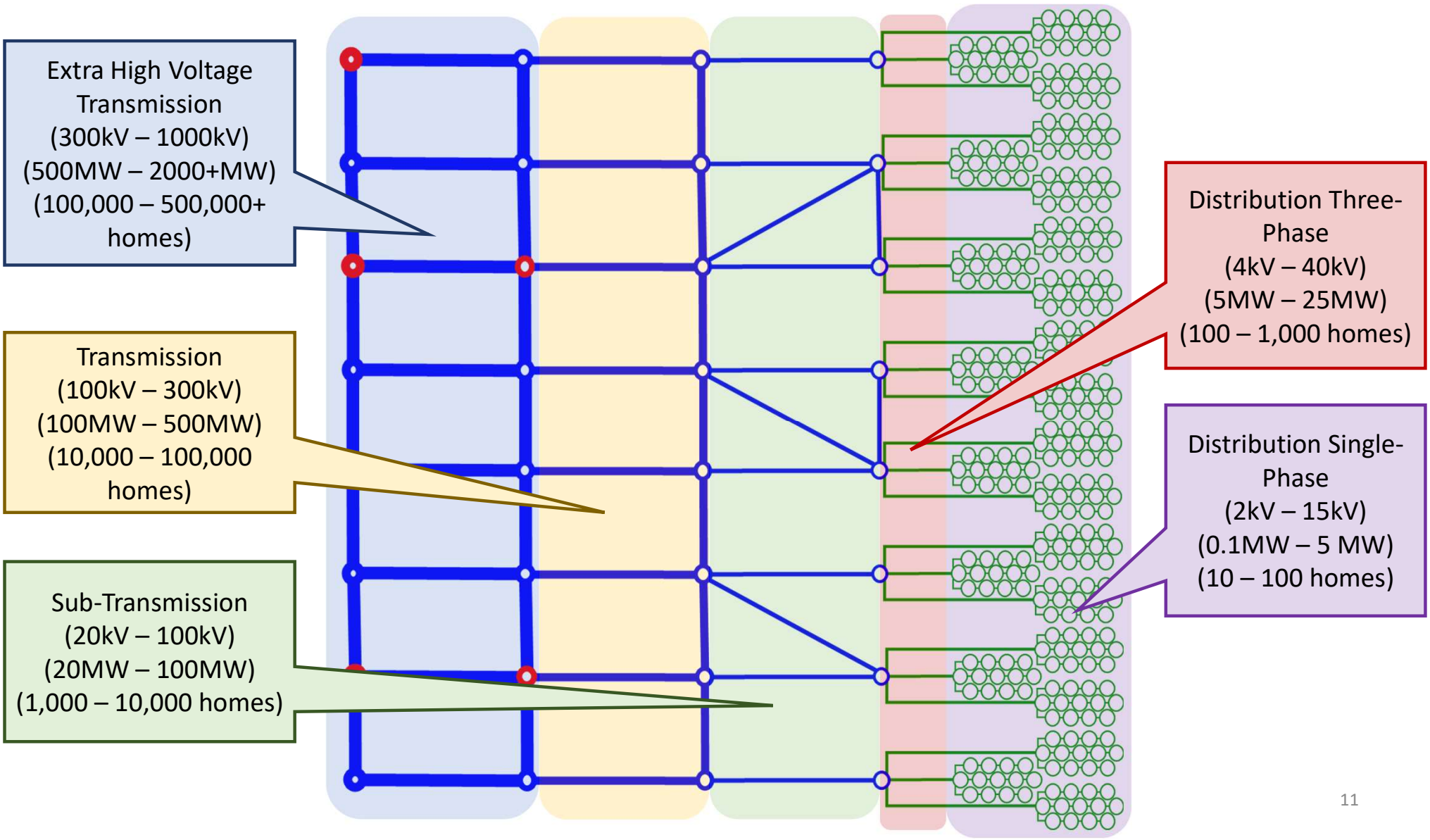
Types of Distribution Lines

25kV Double-Circuit
Three-Phase Distribution Line

12kV Single-Circuit
Three-Phase Distribution Line

7.2kV Single-Phase
Distribution Line

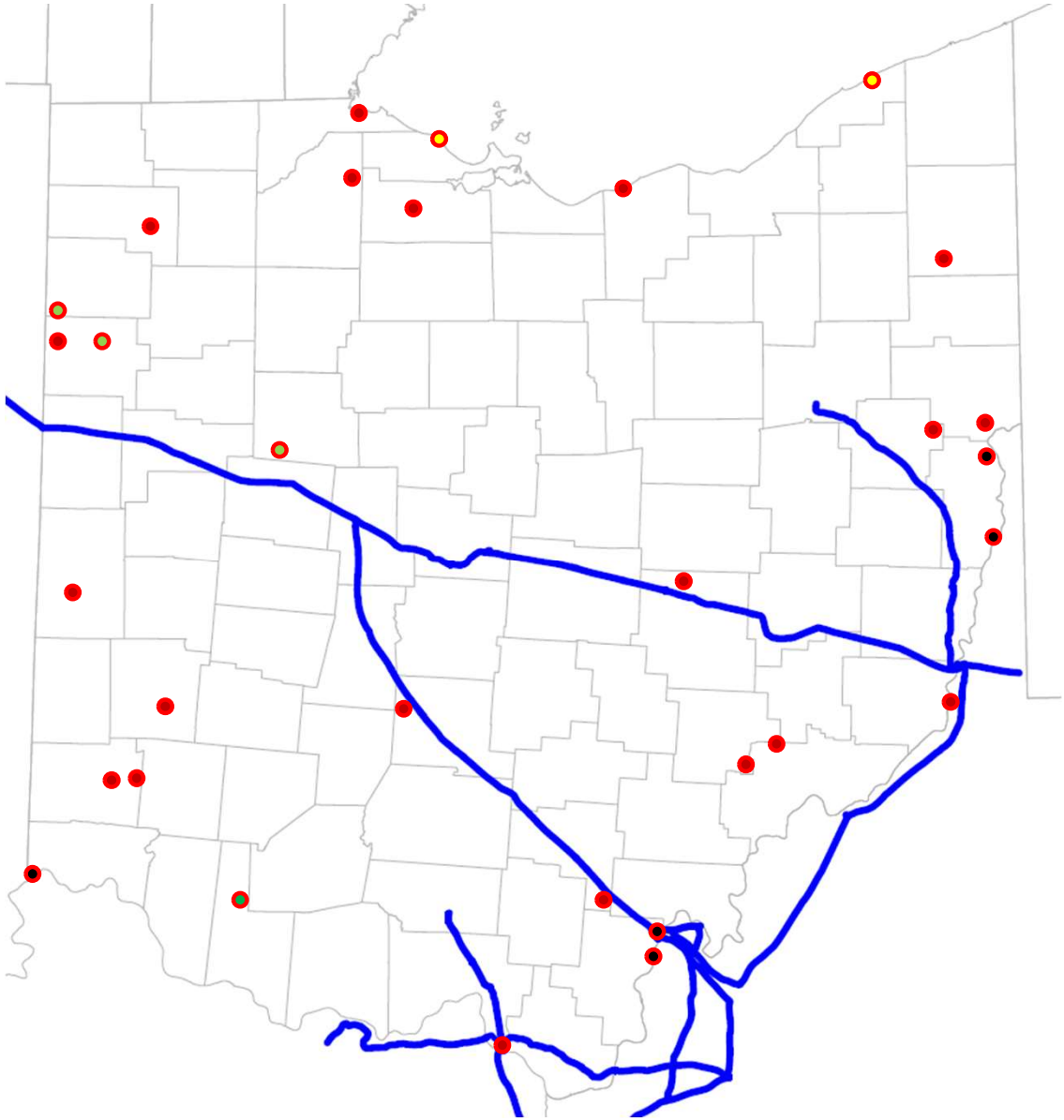
120/240V Single-Phase
Distribution Service


Extra High Voltage Transmission
(300kV – 1000kV)
(500MW – 2000+MW)
(100,000 – 500,000+ homes)
Transmission
(100kV – 300kV)
(100MW – 500MW)
(10,000 – 100,000 homes)
Sub-Transmission
(20kV – 100kV)
(20MW – 100MW)
(1,000 – 10,000 homes)
Distribution Three-Phase
(4kV – 40kV)
(5MW – 25MW)
(100 – 1,000 homes)
Distribution Single-Phase
(2kV – 15kV)
(0.1MW – 5 MW)
(10 – 100 homes)

Generators (Output > 200 MW):

- Natural Gas
- Coal
- Nuclear
- Wind
- Solar

EHV Transmission (> 500 kV)

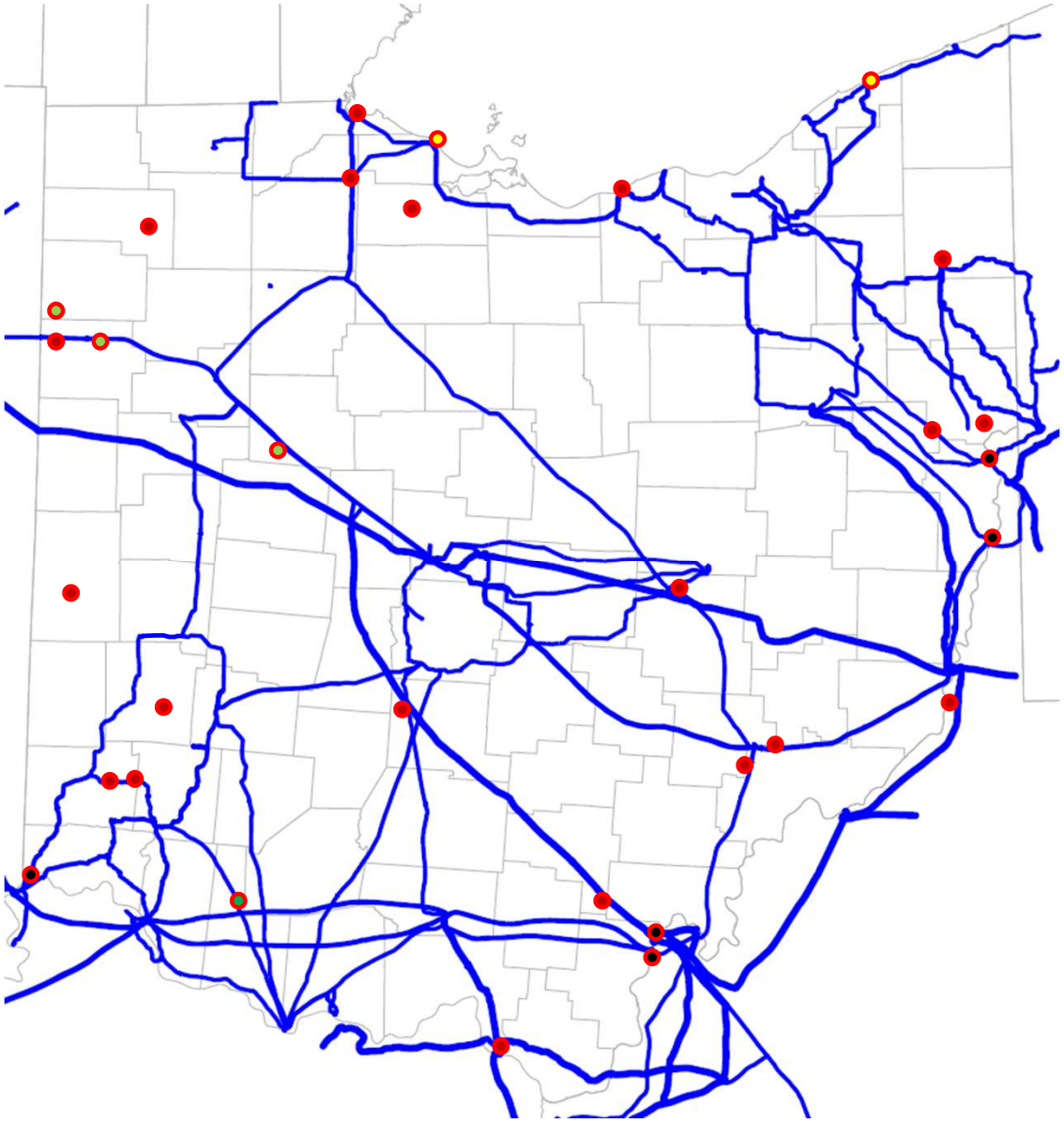


Generators (Output > 200 MW):

- Natural Gas
- Coal
- Nuclear
- Wind
- Solar

EHV Transmission (> 500 kV)

EHV Transmission (> 300 kV)



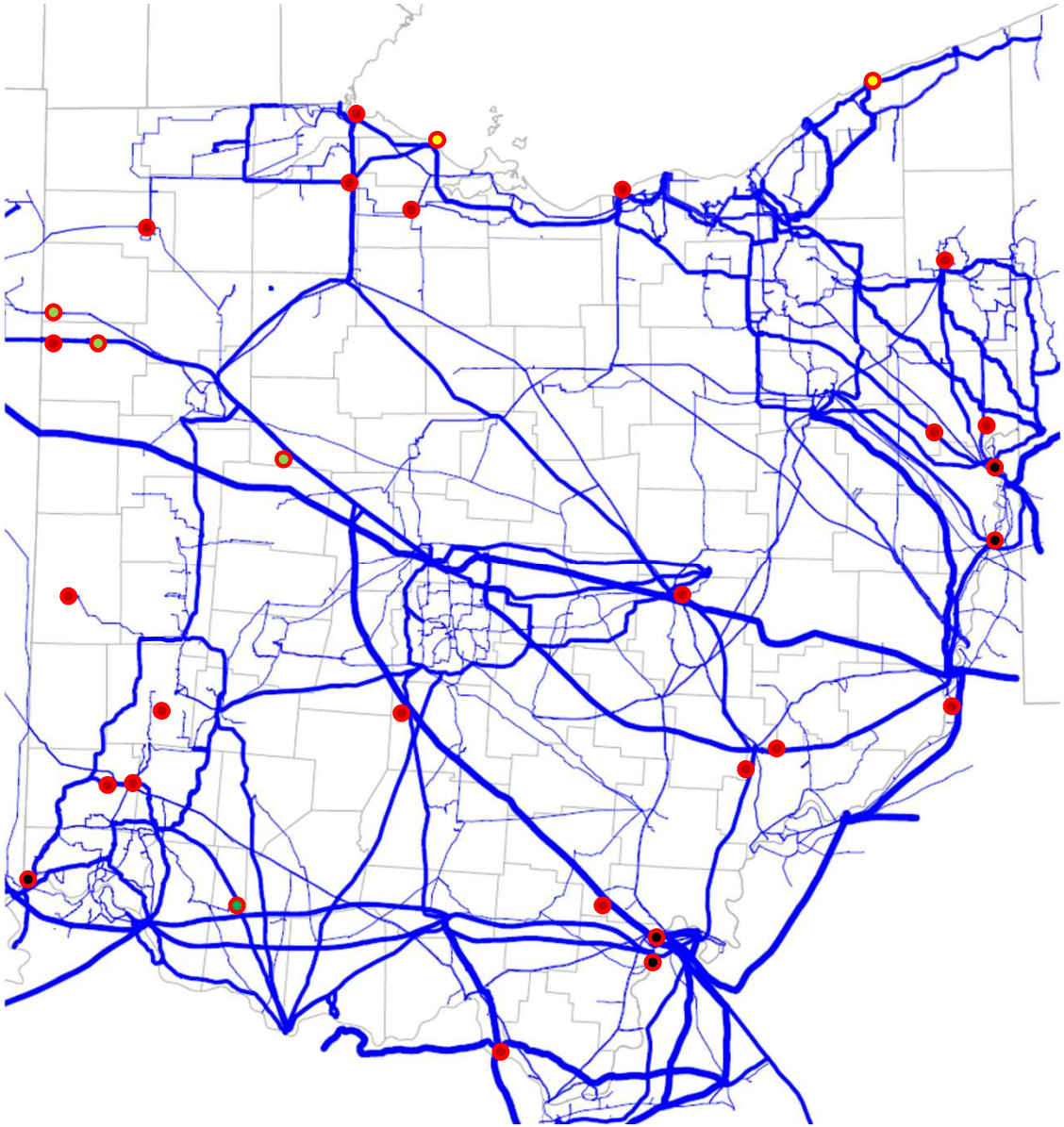
Generators (Output > 200 MW):

- Natural Gas
- Coal
- Nuclear
- Wind
- Solar

EHV Transmission (> 500 kV)

EHV Transmission (> 300 kV)

Transmission (> 100 kV)



Generators (Output > 200 MW):

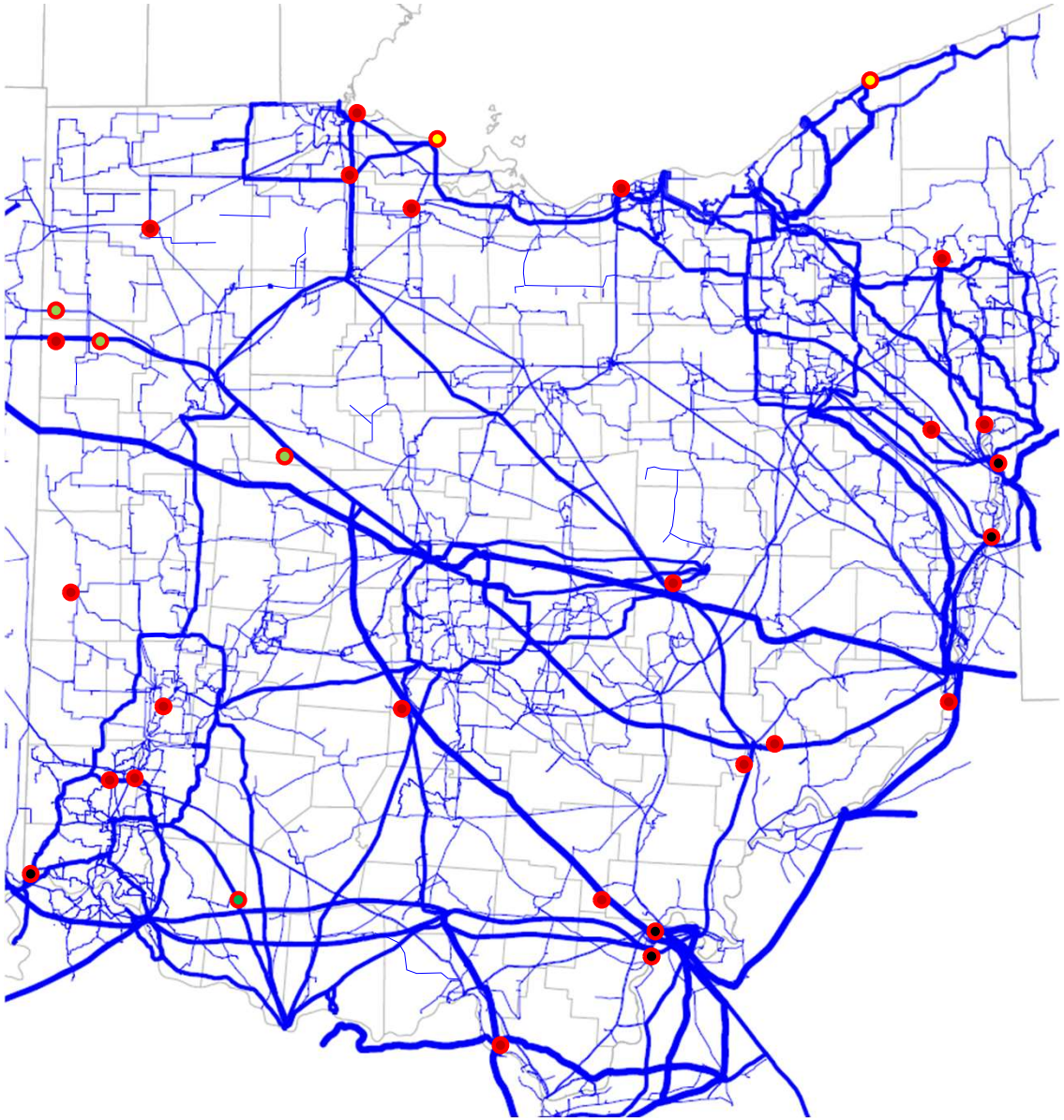
- Natural Gas
- Coal
- Nuclear
- Wind
- Solar

EHV Transmission (> 500 kV)

EHV Transmission (> 300 kV)

Transmission (> 100 kV)

Sub-Transmission (< 100 kV)



Generators (Output > 200 MW):

- Natural Gas
- Coal
- Nuclear
- Wind
- Solar

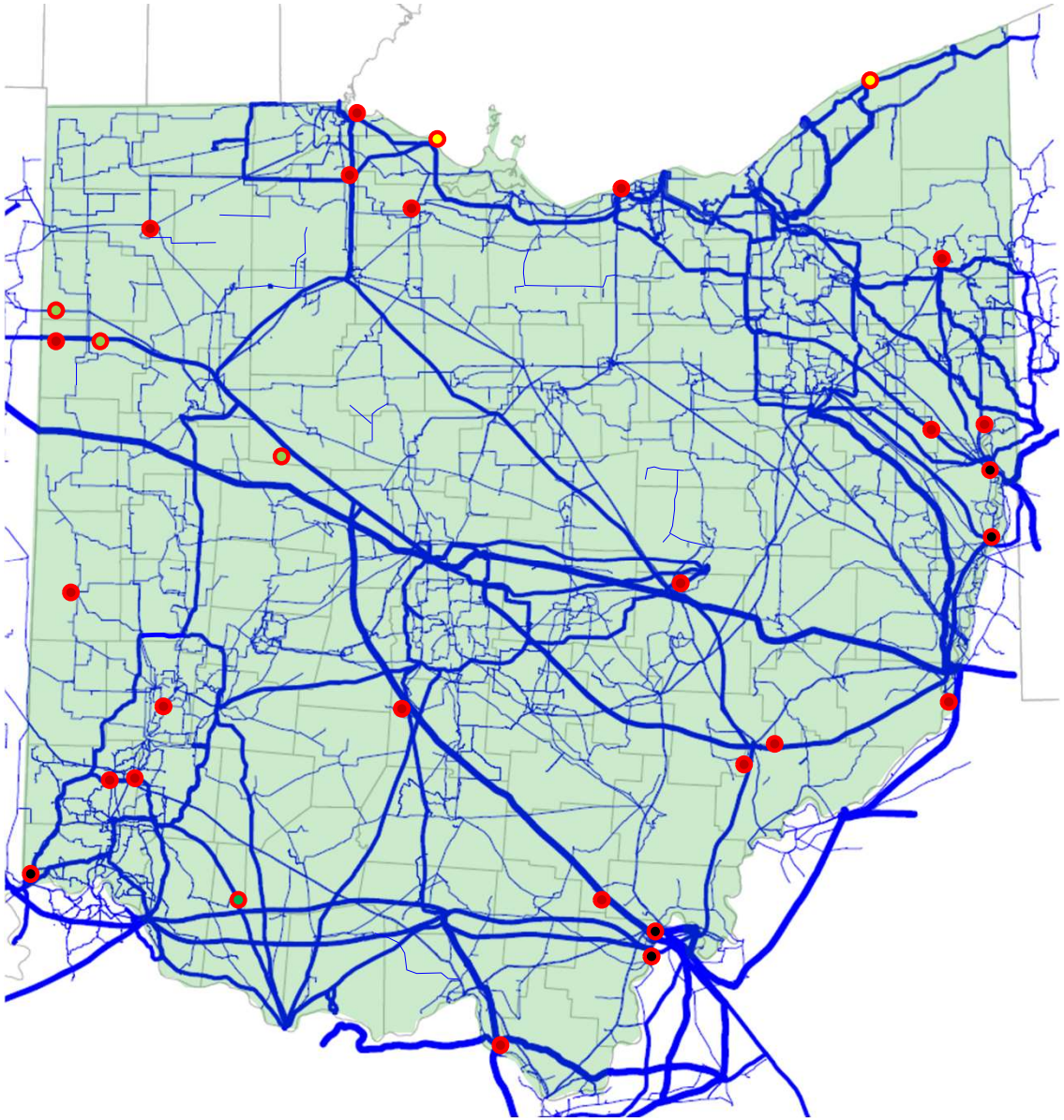
EHV Transmission (> 500 kV)

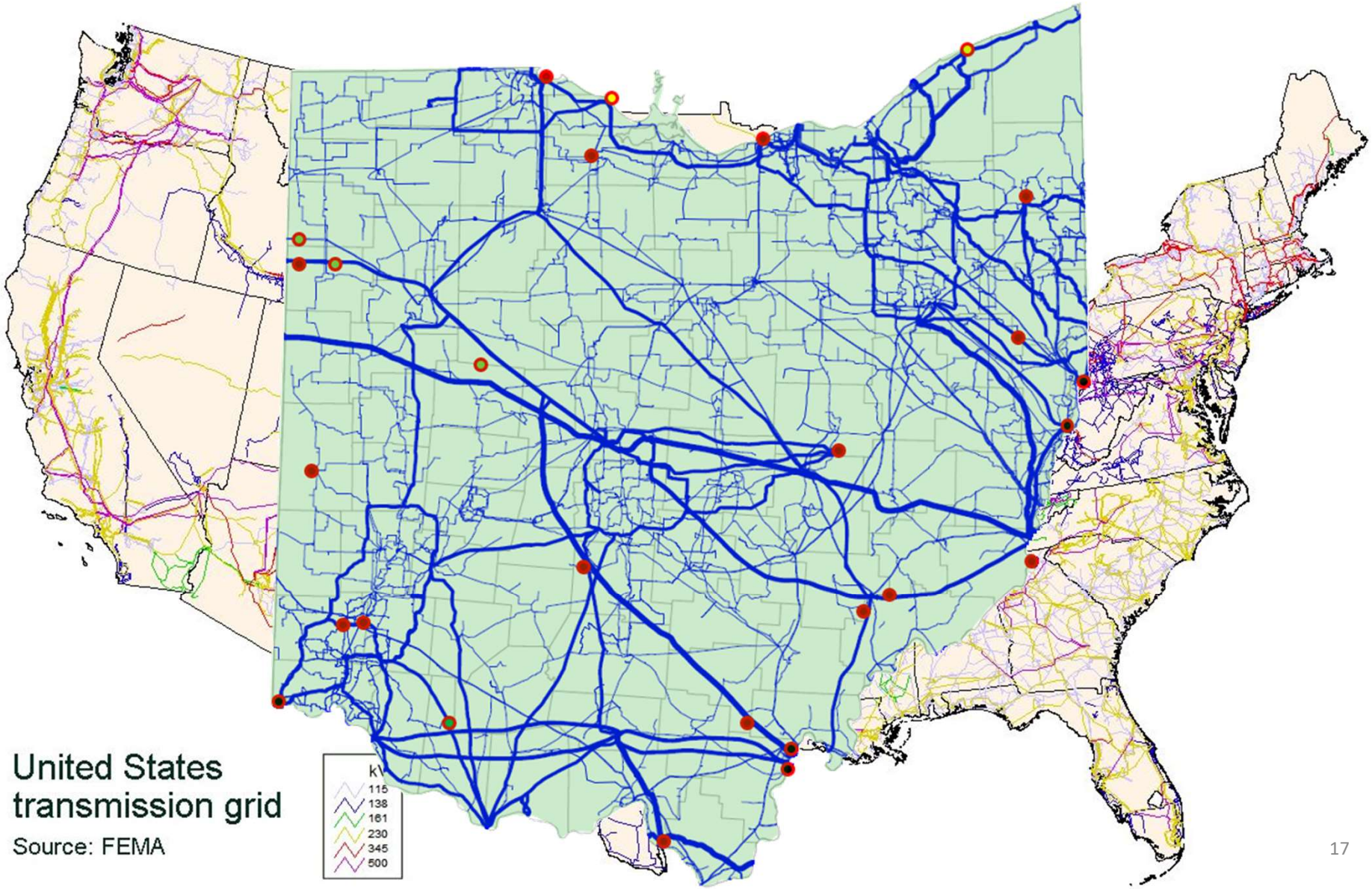
EHV Transmission (> 300 kV)

Transmission (> 100 kV)

Sub-Transmission (< 100 kV)

Distribution (< 40 kV)



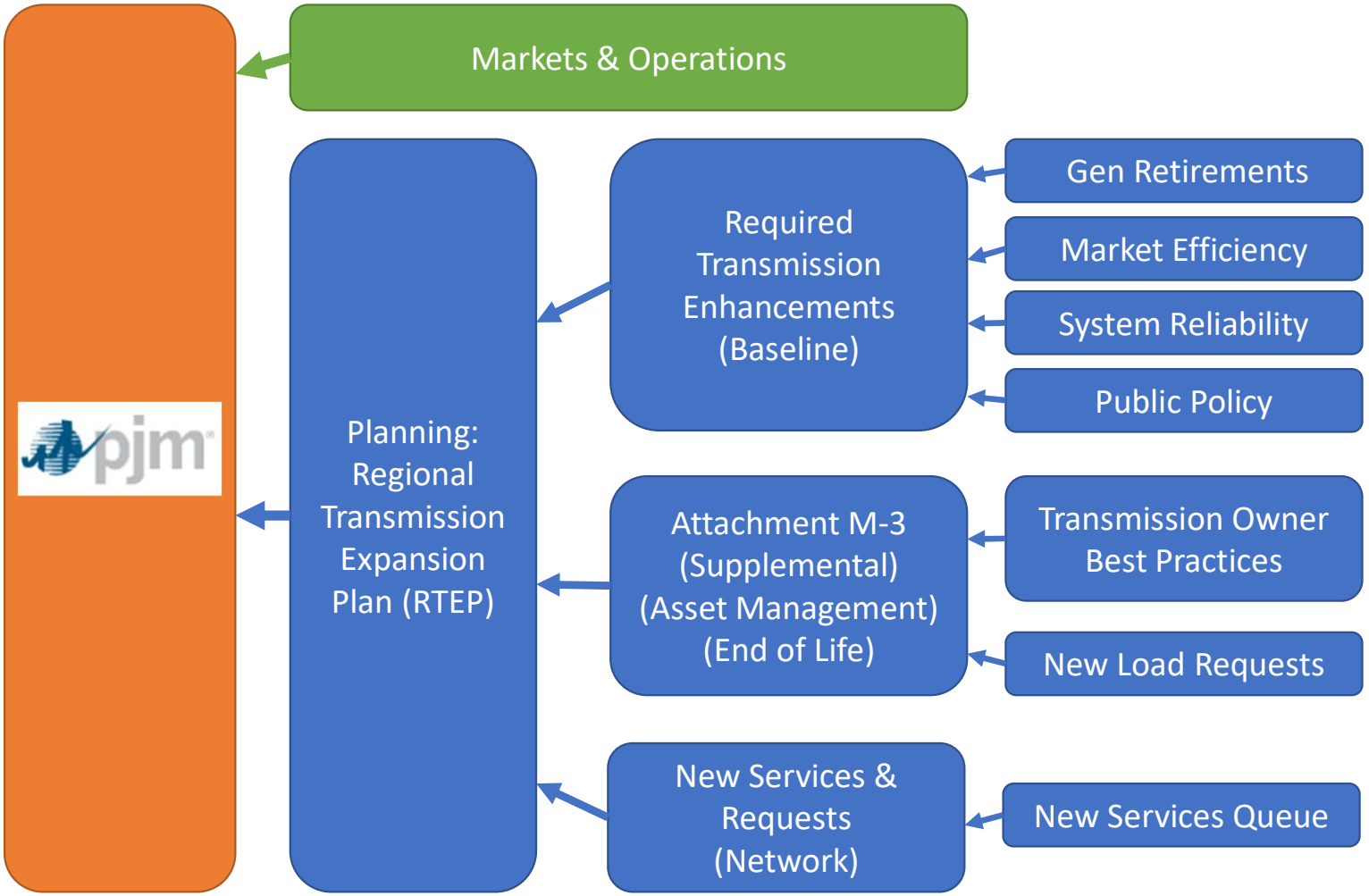


United States transmission grid

Source: FEMA

PJM Transmission Planning

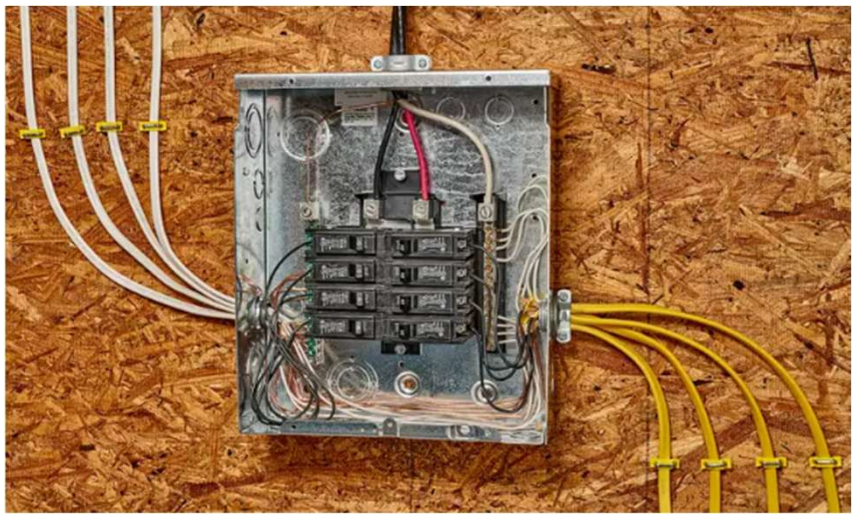
- Incredibly Dry
- Exceedingly Expansive
- Survival is Not Guaranteed


Markets & Operations
pjm
Planning: Regional Transmission Expansion Plan (RTEP)
Required Transmission Enhancements (Baseline)
Gen Retirements
Market Efficiency
System Reliability
Public Policy
Attachment M-3 (Supplemental) (Asset Management) (End of Life)
Transmission Owner Best Practices
New Load Requests
New Services & Requests (Network)
New Services Queue

Reading the Instruction Manual

- Once a year, Transmission Owners are required to present their planning assumptions to PJM stakeholders.
- These assumptions describe how Transmission Owners will perform their system planning responsibilities, and include:
  - A description of the system model used when planning:
    - All transmission line, transformer, generator, load, and shunt device ratings and impedances.
    - Listing of contingencies to be studied by PJM.
  - A description of their planning criteria for system reliability:
    - NERC planning criteria for >100kV, FERC Form 715 for <100kV.
  - A description of their planning criteria for the development of supplemental projects:
    - Much more subjective than NERC planning criteria.
    - Used to help justify replacement of aged infrastructure.

Development of Required Transmission Enhancements (Baseline Projects)



Development of Required Transmission Enhancements (Baseline Projects)

Step 1: Analysis

- PJM gathers all system model data from Transmission Owners and creates a model of the entire PJM system five years in the future.
- PJM has models for peak loading periods in summer and winter as well as a light load model.
- PJM applies contingencies* to the system model to identify violations of Planning Criteria.
- PJM publishes violations and modeling data as part of a Competitive Planning "window". This is a 60- or 120-day period for any Transmission Owner or Non-Incumbent Transmission Developer to download the data published by PJM and develop proposals.

* Contingencies are simply planned or unplanned outages to parts of the transmission system. Transmission lines (measured breaker to breaker), power transformers, generators, or shunt devices are examples of single elements of the transmission system. Often, a contingency may involve several of these single elements.

Development of Required Transmission Enhancements (Baseline Projects)

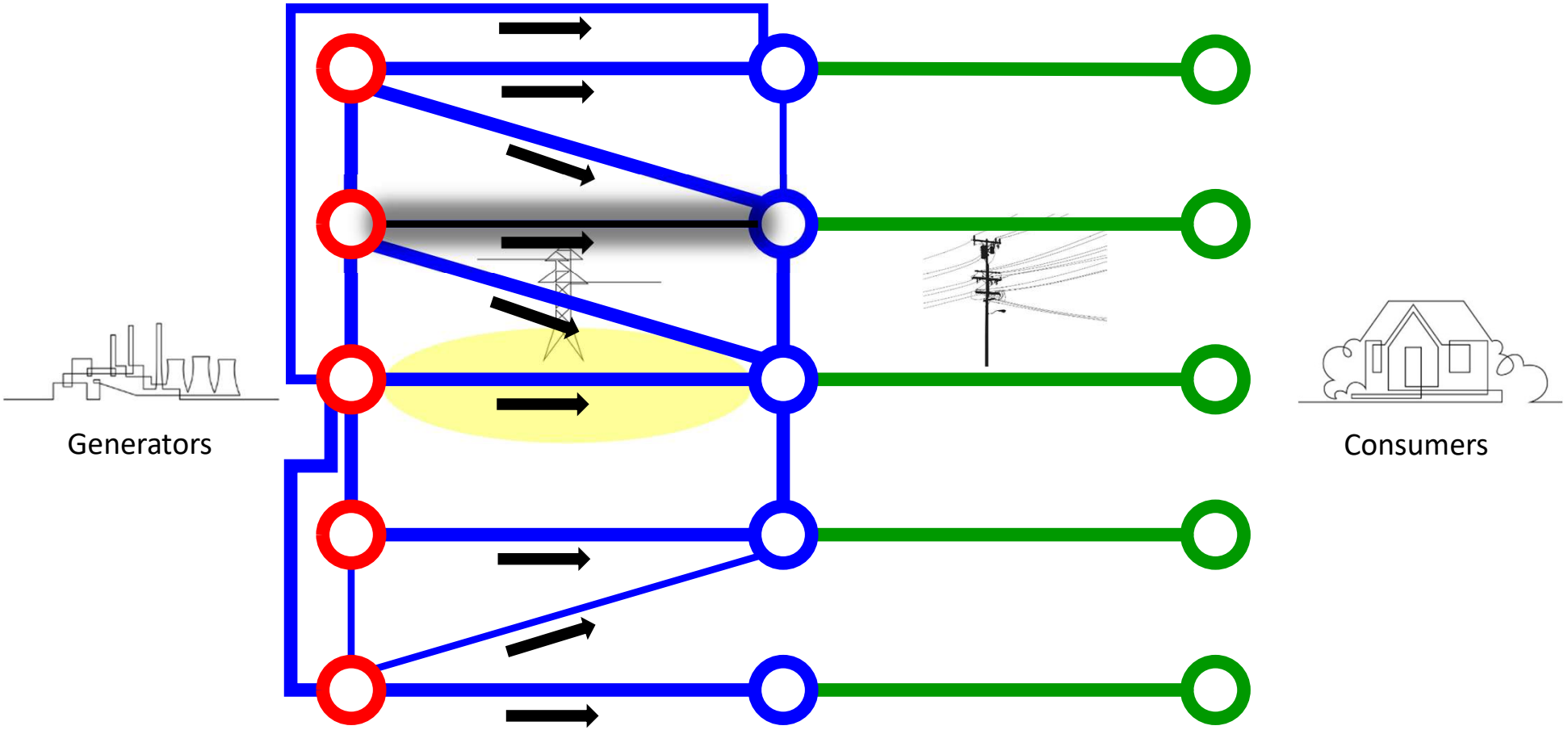
Step 2: Soliciting Input

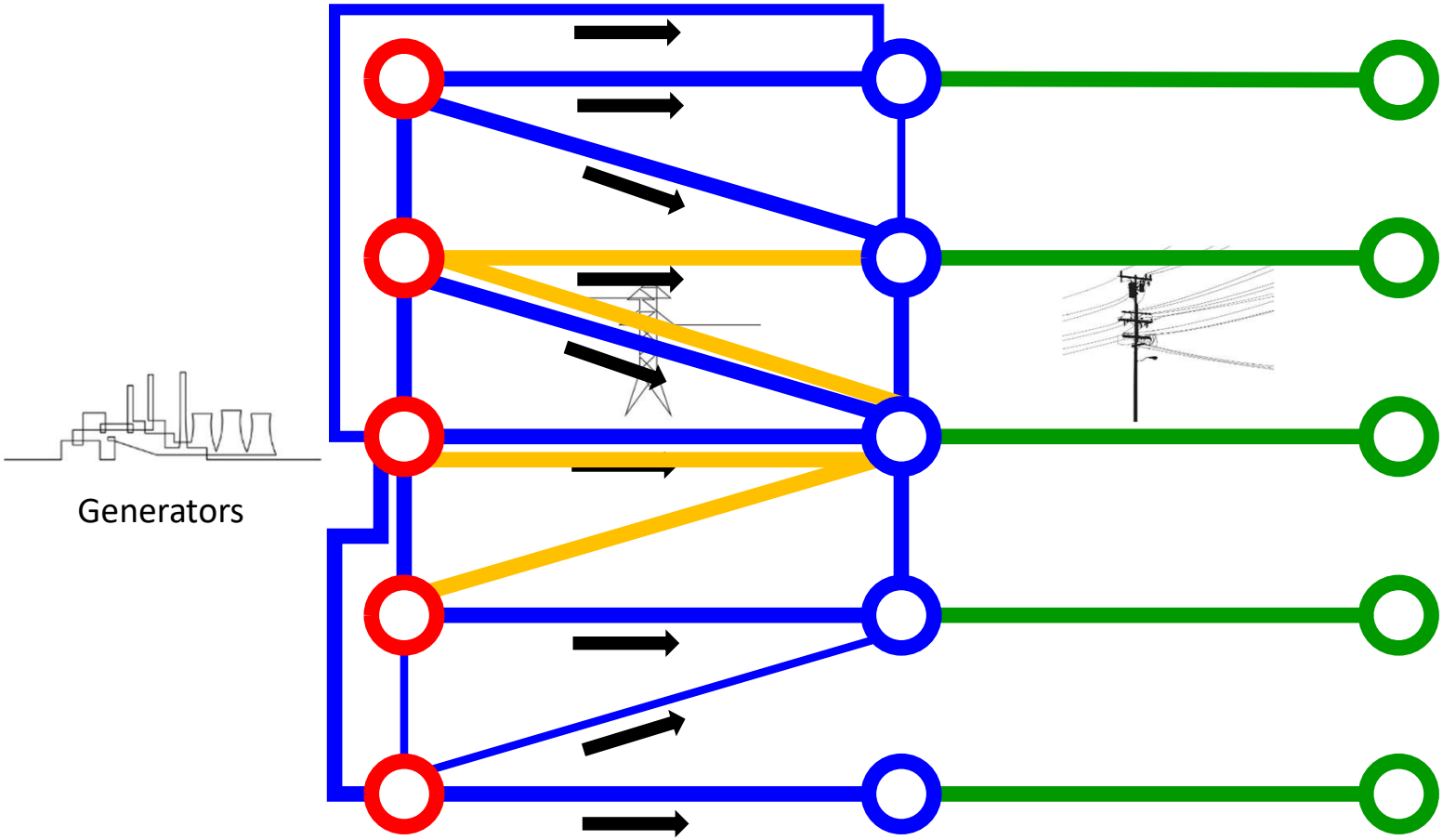
- Any registered entity may review the data published by PJM and submit proposals to resolve violations eligible for Competitive Planning.
- Violations not eligible for Competitive Planning are assigned to the incumbent Transmission Owner.
- Reasons for exemption include:
  - Immediate Need – project is required in 3 years or less,
  - Lower Voltage Facilities – violation is restricted to a single facility < 200kV,
  - Transmission Substation Equipment – violation can be solved by an upgrade to and existing substation facility (excluding power transformers).

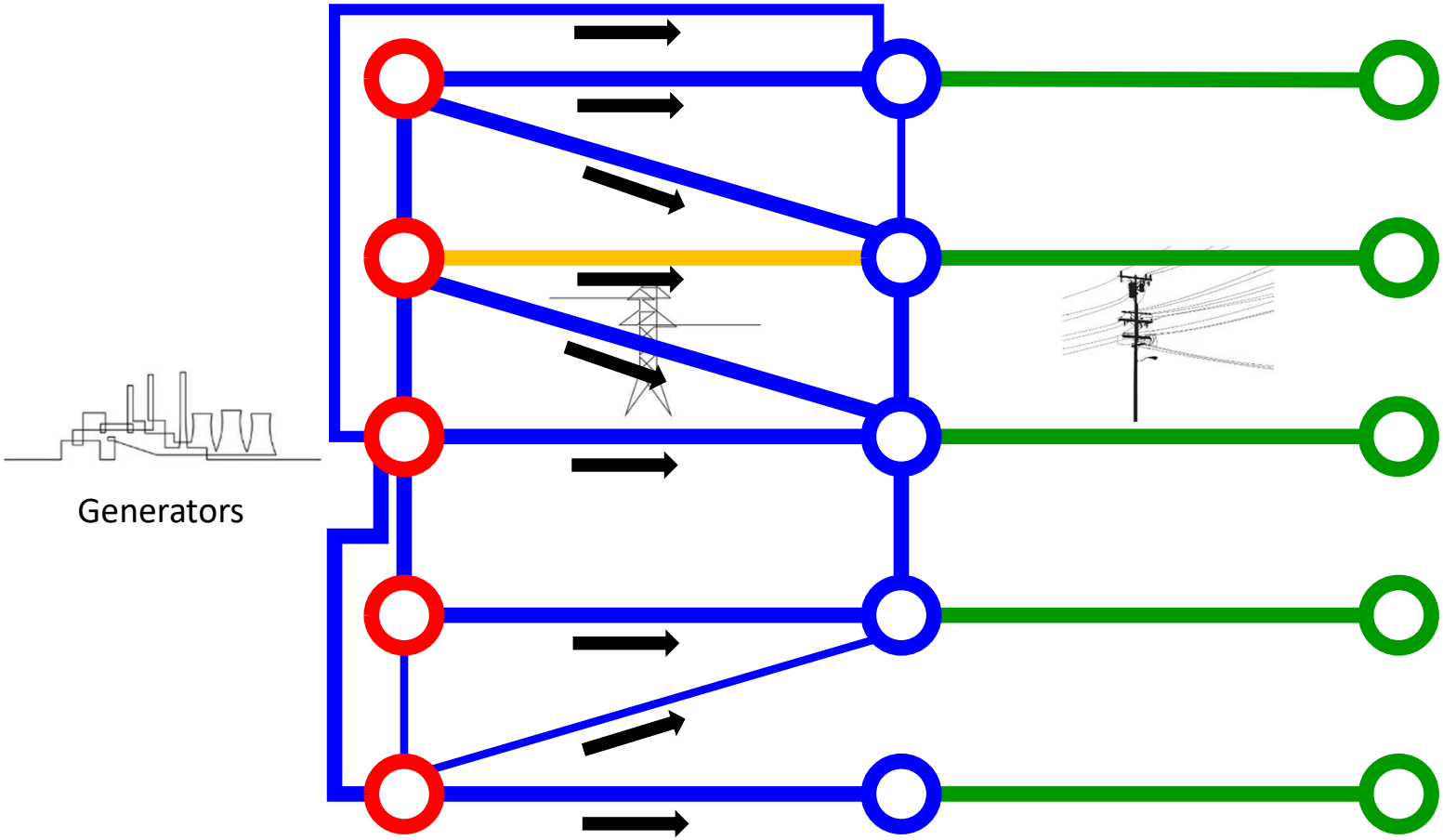
Development of Required Transmission Enhancements (Baseline Projects)

Step 3: Choosing the Best Solution

- PJM gathers all proposals and presents them to stakeholders for review and selection of a winning proposal.
- Winning proposals are reviewed and approved by the PJM Board of Managers.
- Upon approval from the PJM board, the winning proposal is now considered a Required Transmission Enhancement, or Baseline Project, and included in the Regional Transmission Expansion Plan.
- PJM calculates the applicable cost allocation and divides the project costs across transmission zones.


Generators
Consumers


Generators
Consumers


Generators
Consumers

Development of Attachment M-3 Projects
(Supplemental Projects)

Development of Attachment M-3 Projects (Supplemental Projects)

Step 1: Statement of System Needs

- Transmission Owners present materials to PJM stakeholders to illustrate a system deficiency* that would not otherwise be addressed by planning criteria (NERC, FERC Form 715).
- These Need Statements can include:
  - A description of a new load request
  - Description of aged infrastructure
  - Description of poor local reliability

* This term does not appear in any PJM tariff and is intentionally ambiguous. Supplemental Projects are not driven by system reliability planning criteria, but these metrics do not account for unplanned outage frequency or duration. Supplemental Projects allow for transmission owners to improve the quality of service to end use customers.

Development of Attachment M-3 Projects (Supplemental Projects)

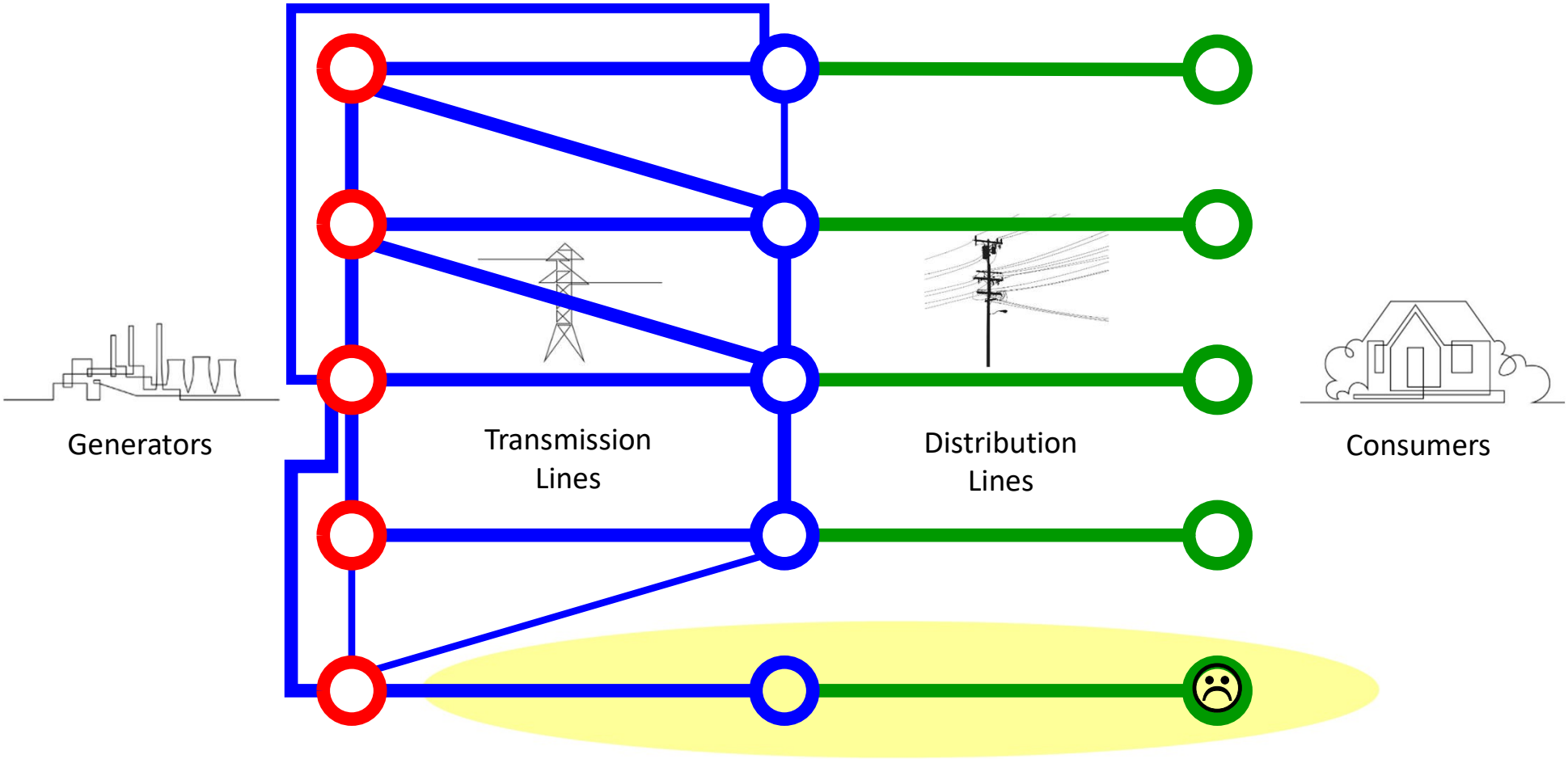
Step 2: Presentation of Solution

- After a minimum of 30 days, Transmission Owners present solutions to Need Statements.
- The solution statement includes:
  - A description of the proposed improvements
  - A review of alternative solutions
  - Cost estimates
  - Planned in-service date

Development of Attachment M-3 Projects (Supplemental Projects)

Step 3: PJM Analysis and Inclusion in Local Plan

- Following the presentation of solutions, PJM performs a “do no harm” analysis to ensure the proposed solution does not result in planning criteria violations on the greater transmission system.
- The solution is then included in the local plan and incorporated into the Regional Transmission Expansion Plan.
- Costs for Supplemental Projects are allocated 100% to the local transmission zone.


Generators
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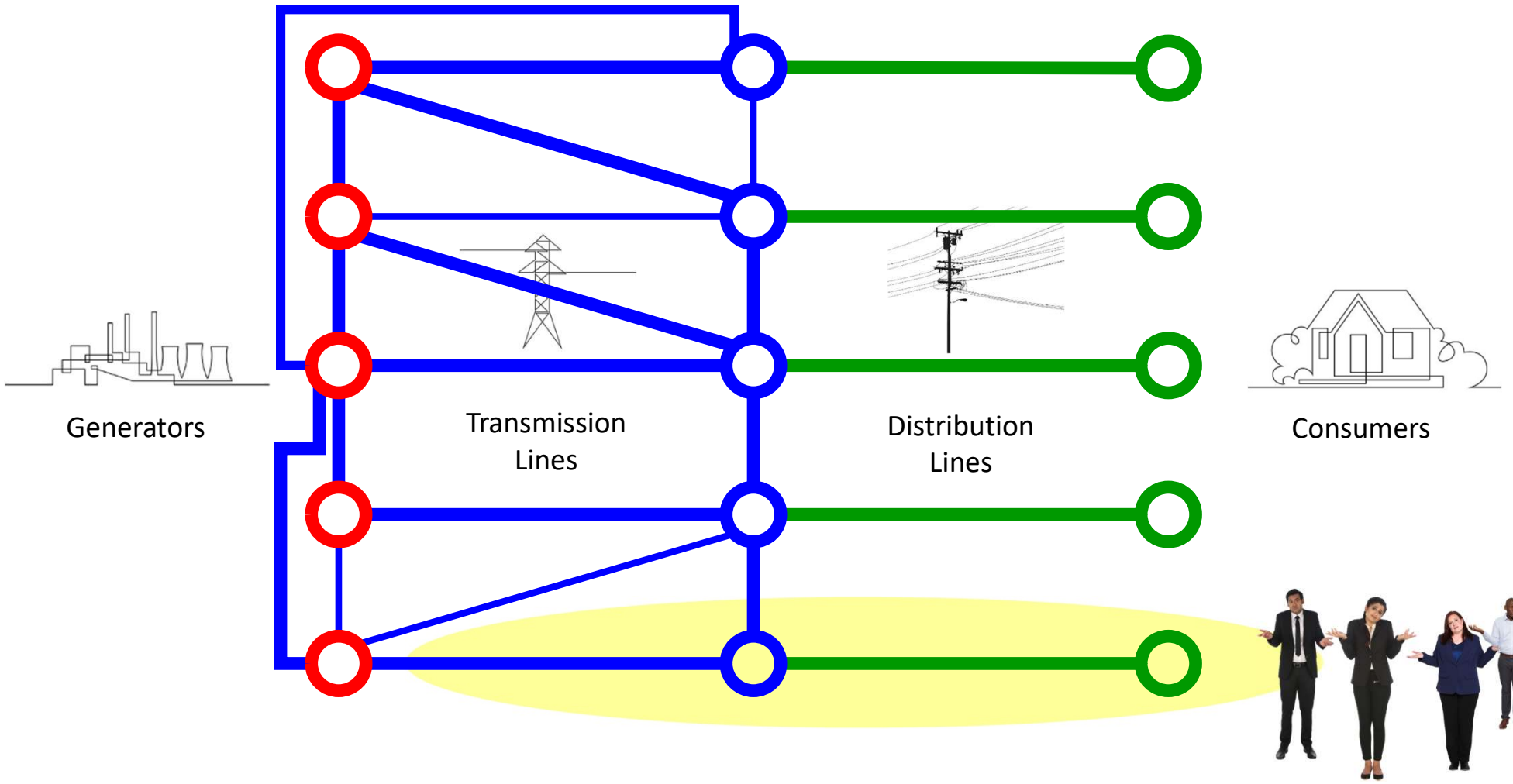
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Development of Generation Interconnections (Network Projects)

Development of Generation Interconnections (Network Projects)

Step 1: New Services Queue

- Applications for new generation interconnection (or increases at existing facilities) are processed by PJM and assigned a sequential Queue Position identifier on a first-come, first-served basis.
- Twice a calendar year, PJM compiles all new generation interconnection requests from the past six months for to form the New Services Queue.
- PJM coordinates with local transmission owners to conduct impact studies to evaluate the impact of new generation on the system, identify any violations to applicable planning criteria, and determine what system upgrades are required to accommodate the request.

Development of Generation Interconnections (Network Projects)

Step 2: Additional Study

- Upon issuance of the Impact Study, the interconnecting customer has a period of 30 days to choose to proceed to the Facilities Study or forfeit their queue position.
- Facilities Studies include the following:
  - Summary of all identified criteria violations
  - Scope and costs for all upgrades required for interconnection
  - Summary of system constraints
- Upon issuance of the Facilities Study, the interconnecting customer has a period of 60 days to execute an Interconnection Service Agreement.

Development of Generation Interconnections (Network Projects)

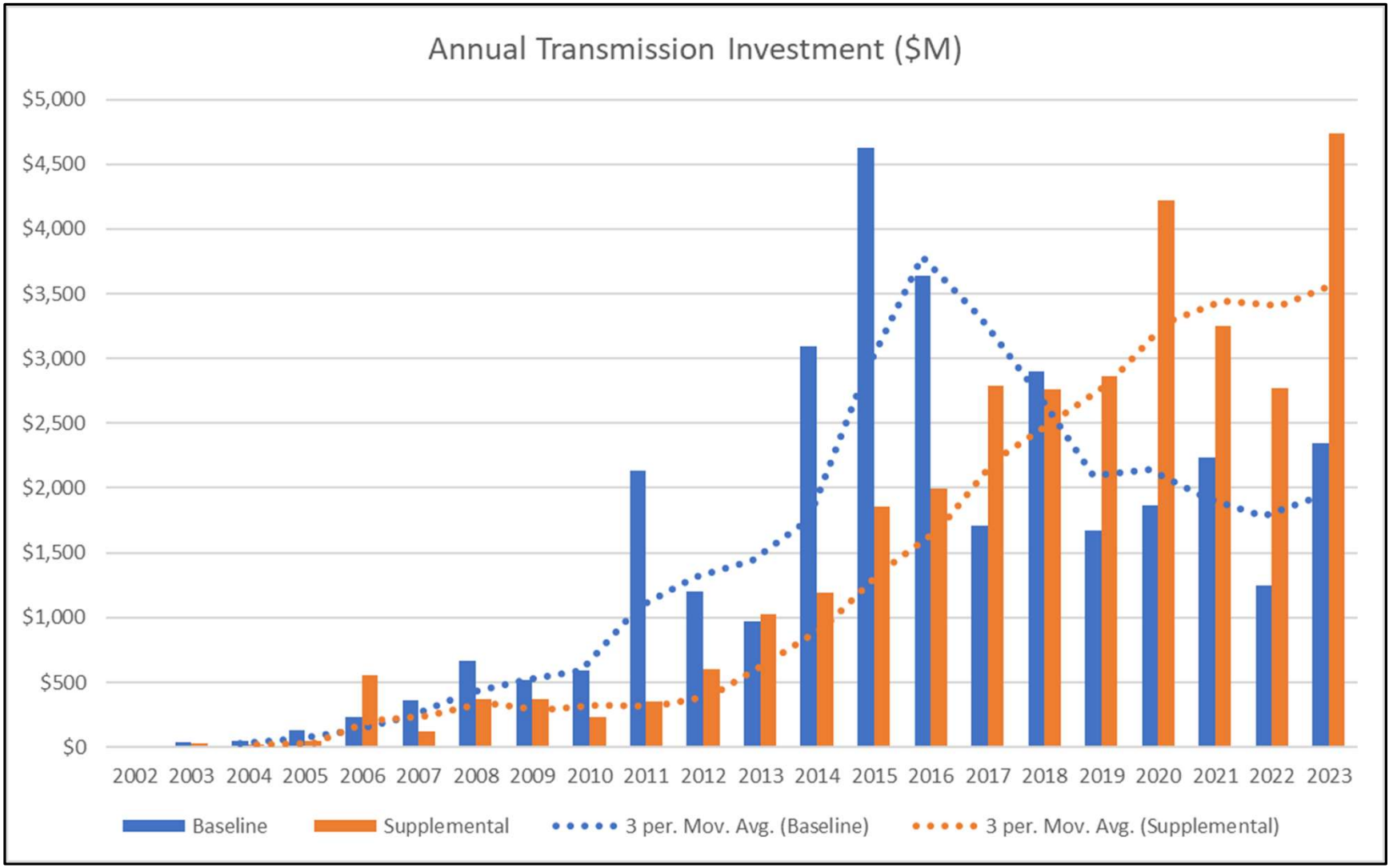
Step 3: Even More Agreements

- Interconnection request will be terminated if customer fails to execute ISA or fails to meet milestones (unless extended) described in PJM Tariff (right of way, permitting, equipment procurement, etc.).
- Upon issuance of the ISA, the interconnecting customer has a period of 90 days to execute a Construction Service Agreement.
- Once all agreements are executed and filed at FERC, all upgrades required for interconnection are included in the Regional Transmission Expansion Plan.
- The costs of all network upgrades are assigned 100% to the interconnecting customer.

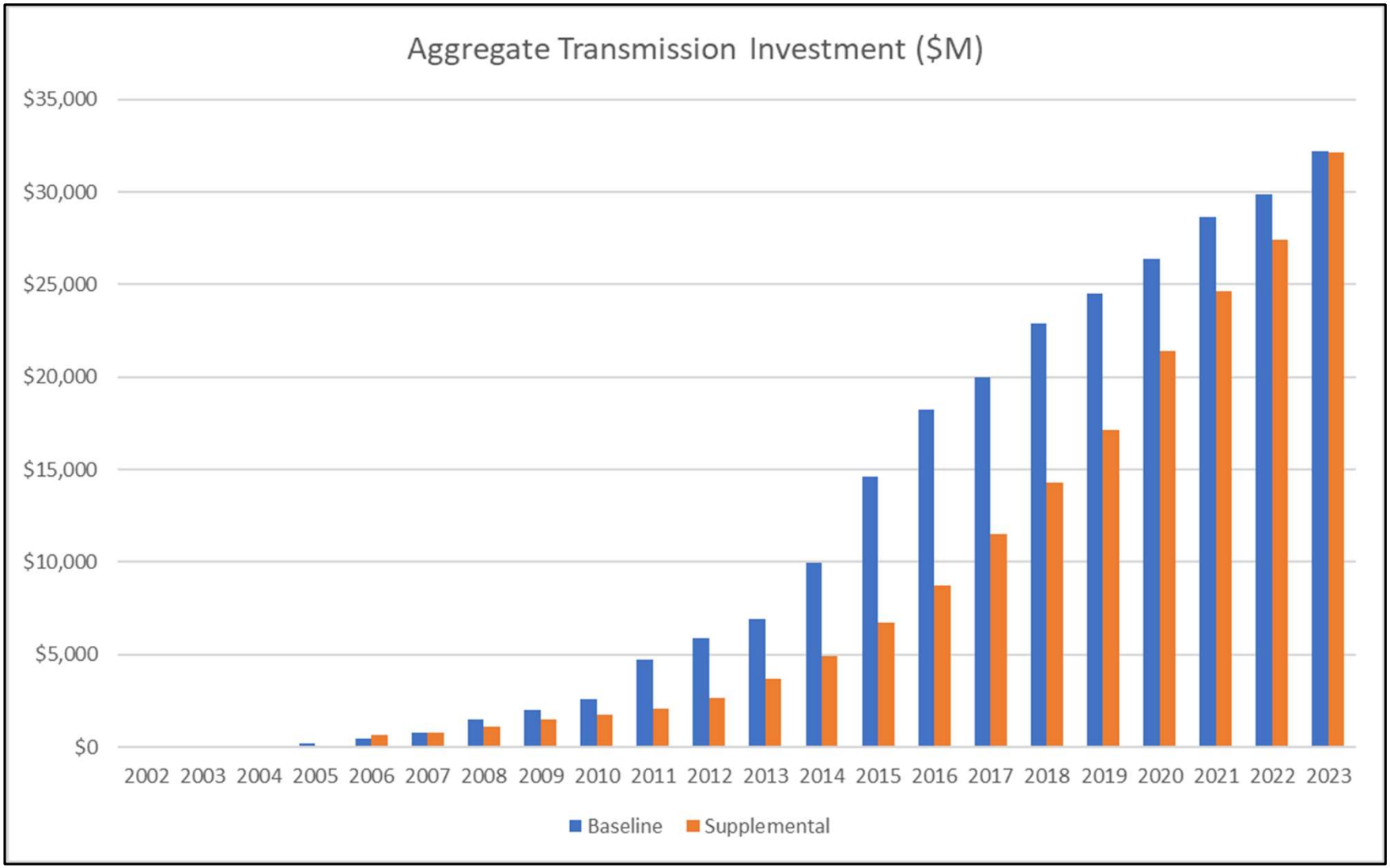
Cost Allocation and Transmission Investment

Costs for Upgrades Included in the RTEP are Recovered as Follows:

- Baseline Projects can be socialized across all transmission zones in PJM, divided across two or more benefitting zones based on DFAX, or assigned to a single zone if only one zone benefits.
- Supplemental Projects are 100% assigned to consumers within the transmission zone. This appears on Buckeye's bill as Network Integration Transmission Service (NITS).
- Network Upgrades are 100% assigned to the interconnecting customer.



Source: PJM Transmission Cost Information Center (Version 14, 7/11/23)



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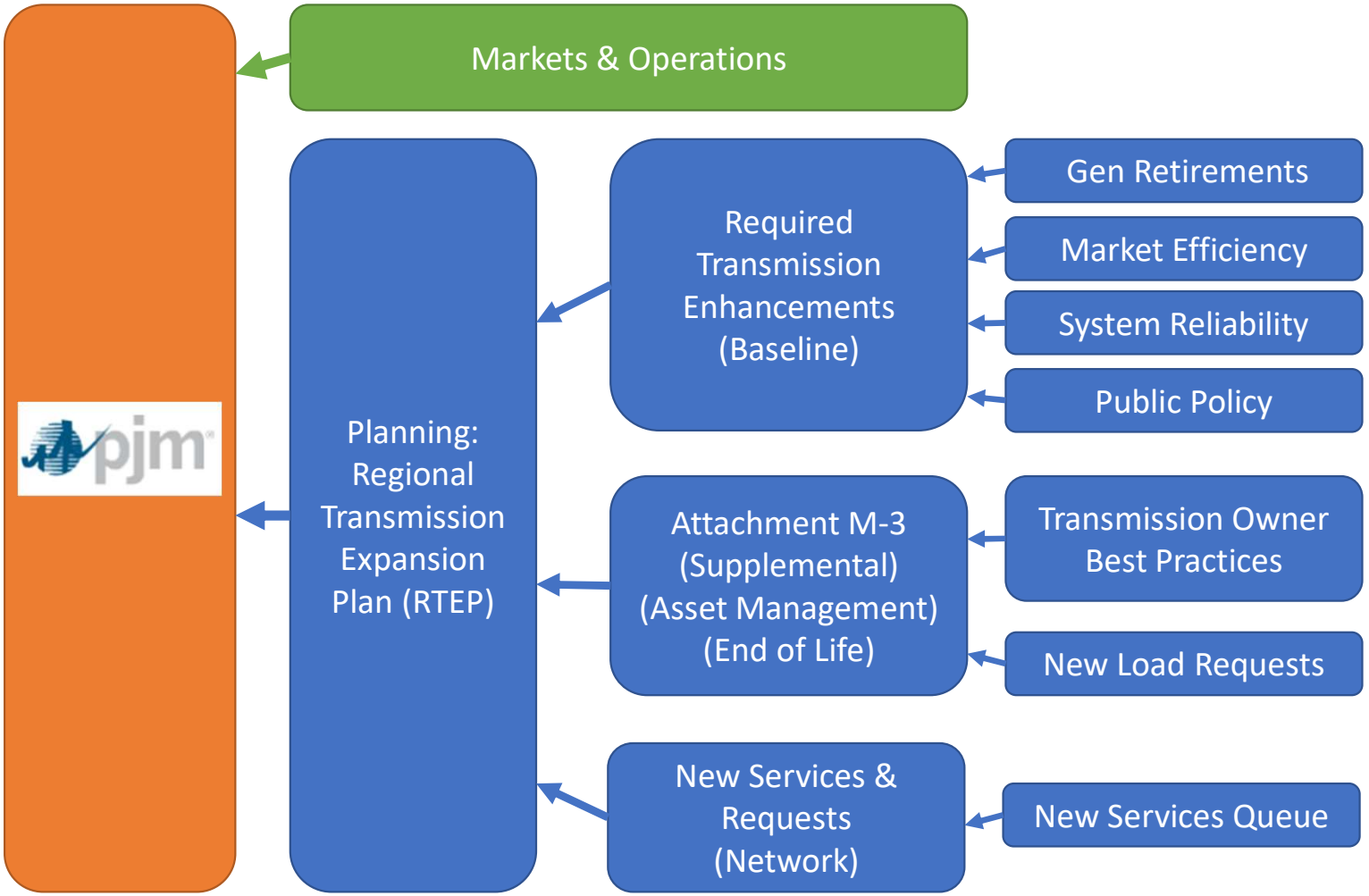
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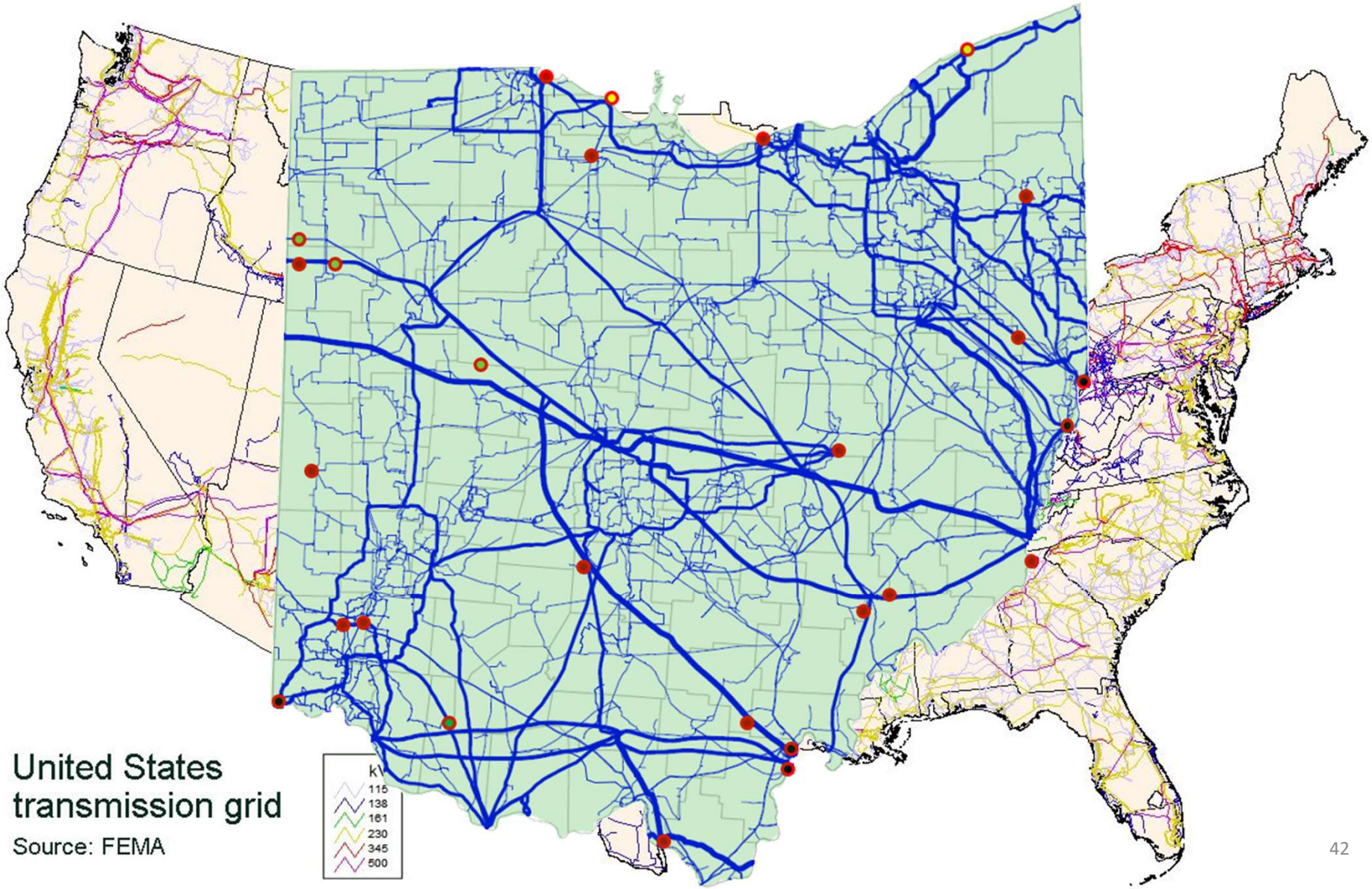

United States transmission grid

Source: FEMA