Joint Utilities

Stakeholder Engagement Information Session

February 29th, 2016

Agenda

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- 10:00 – 10:15 Welcome and Opening Remarks
- 10:15 – 10:45 Transmission Planning Overview
- 10:45 – 11:15 Overhead System Planning Overview
- 11:15 – 12:00 Underground System Overview
- 12:00 – 1:30 Lunch and Tours
- 1:30 – 2:00 System Planning and Forecasting Overview
- 2:00 – 2:30 Capital Investment Planning Overview
- 2:30 – 3:00 Stakeholder Engagement Process and Next Steps
- 3:00 – 3:10 Stakeholder Survey

Welcome

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- Stakeholder Engagement Information Session
- Focus today is Transmission and Distribution Planning Process and Capital Investment Plan
- Enabling Distributed Energy Resources (DER) to meet state goals and Reforming the Energy Vision (REV)

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Transmission Planning

John Borchert

Senior Director , Energy Policy and Transmission Development
Central Hudson Gas and Electric Corporation

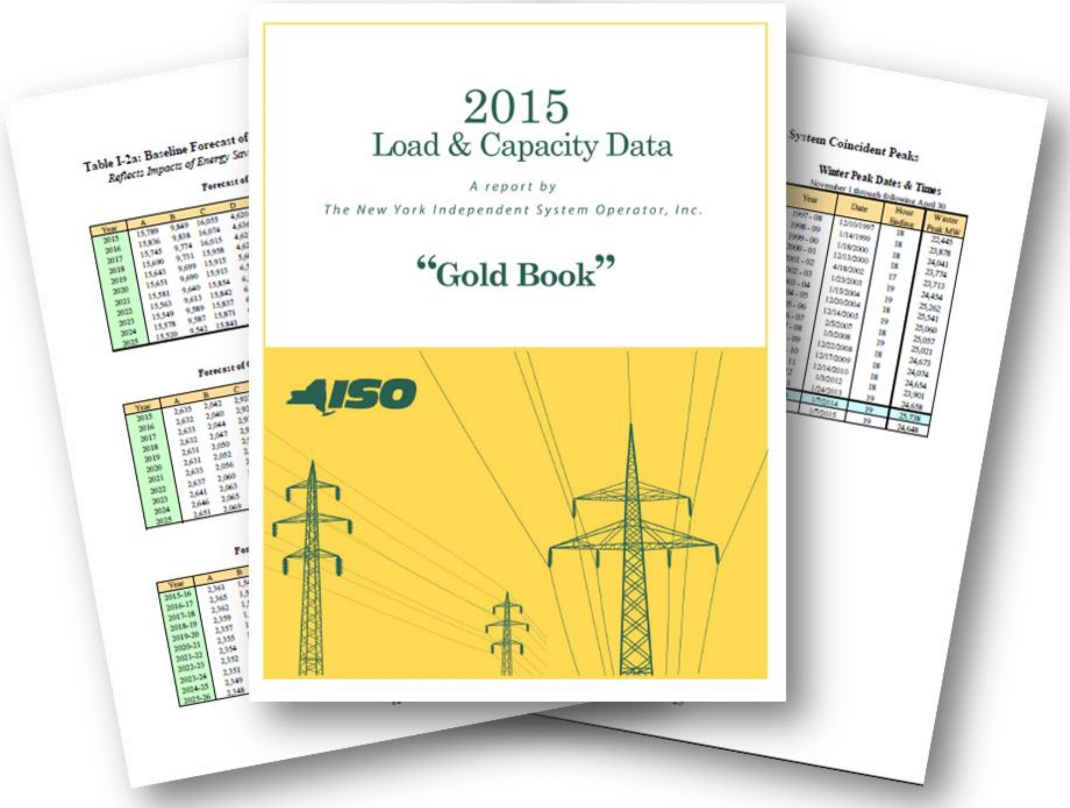
Overview
A Stakeholder Perspective

- Transmission System Data and Fundamentals
- NYISO and Utility Transmission Planning Process
- Transmission Planning Drivers and Assumptions
- Changes that Affect Transmission Operation and/or Planning
- Relevance to REV, the DSIP and Stakeholders

Transmission System and Design Practice

- Electric Transmission System is a large sophisticated machine
  - Evolving over 100 years
- Network Design to Allow Flow from Generators to Loads
  - Flows can move in either direction on a line
  - Flows can move over many paths
  - Allows flow following loss of a network path
- Operated using sophisticated controls
  - Computer models
  - High Speed Communications
- Operated to deliver lowest cost to consumers while maintaining reliability
  - Operated based on market efficiency
  - Must abide by reliability rules

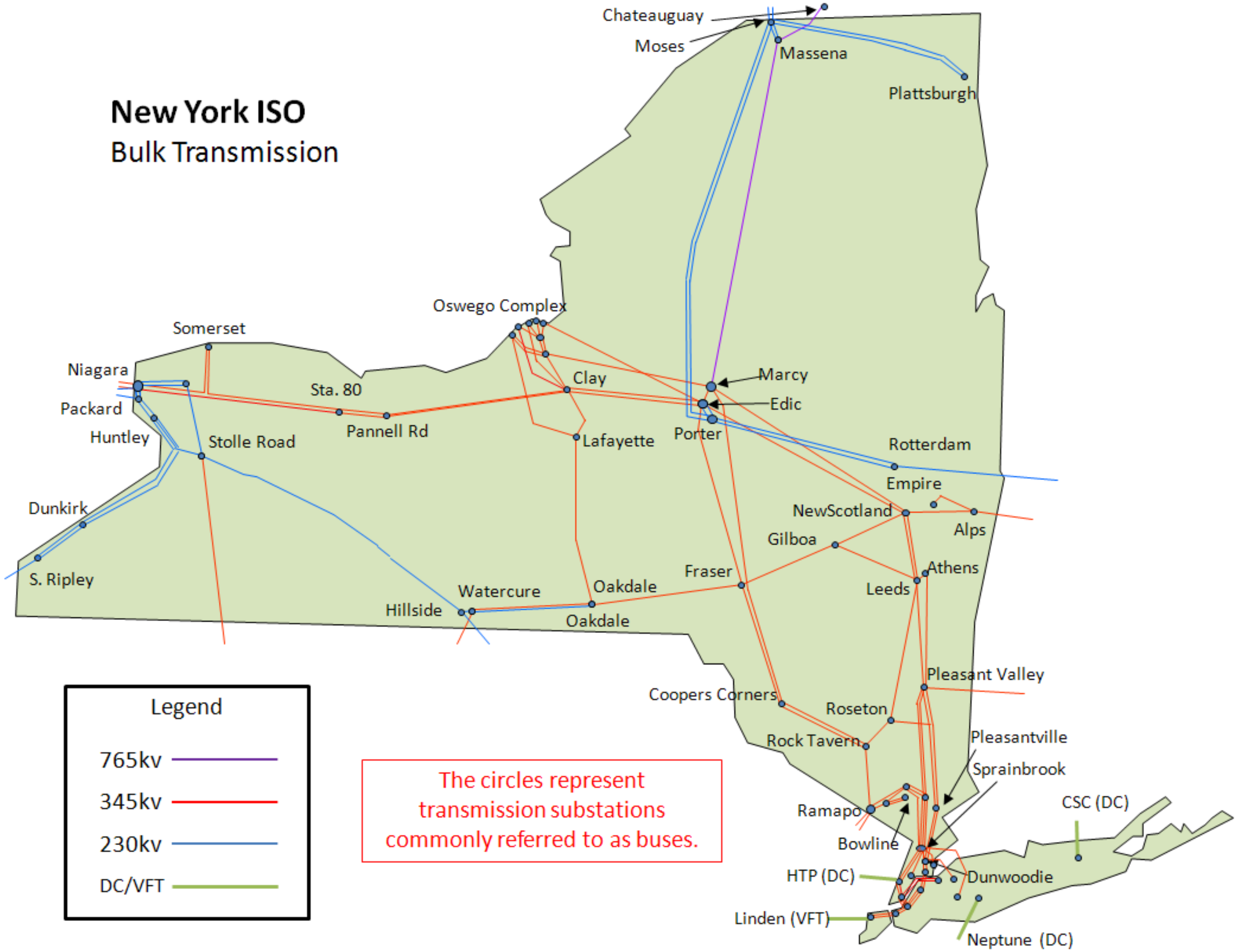
NYISO by the Numbers



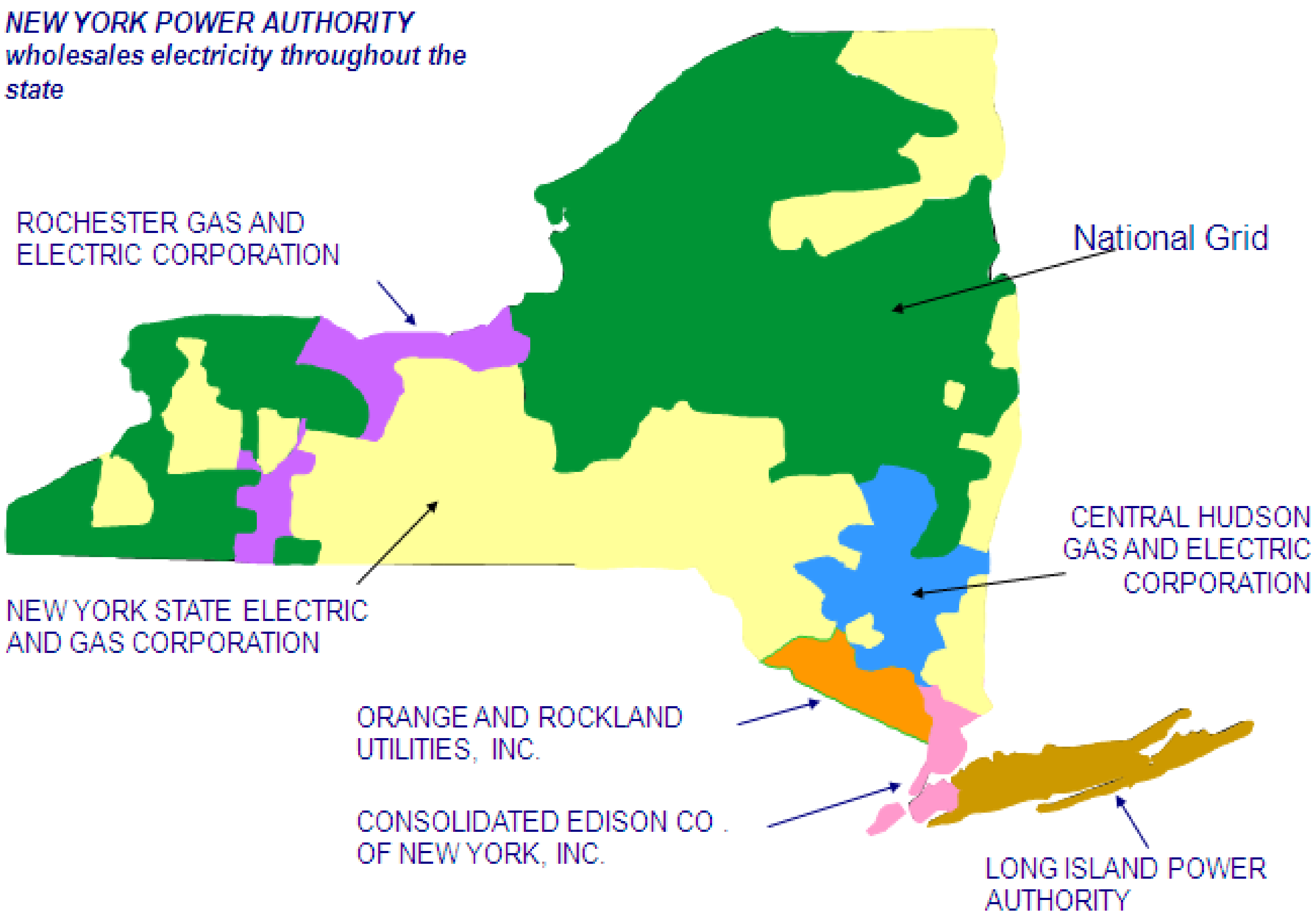
The NYISO manages the flow of electricity for the Bulk Electric System in New York State, which encompasses the service territories of all the investor-owned electric utilities, public power authorities and municipal electric systems.

- **39,039** MW of power plant capacity **(net dependable capacity)**
- **33,956** MW record peak demand (July 19, 2013)
- **1,124** MW Demand response resources (Summer 2014)
- **6,124** MW Renewable resources
- **11,086** circuit-miles of transmission lines

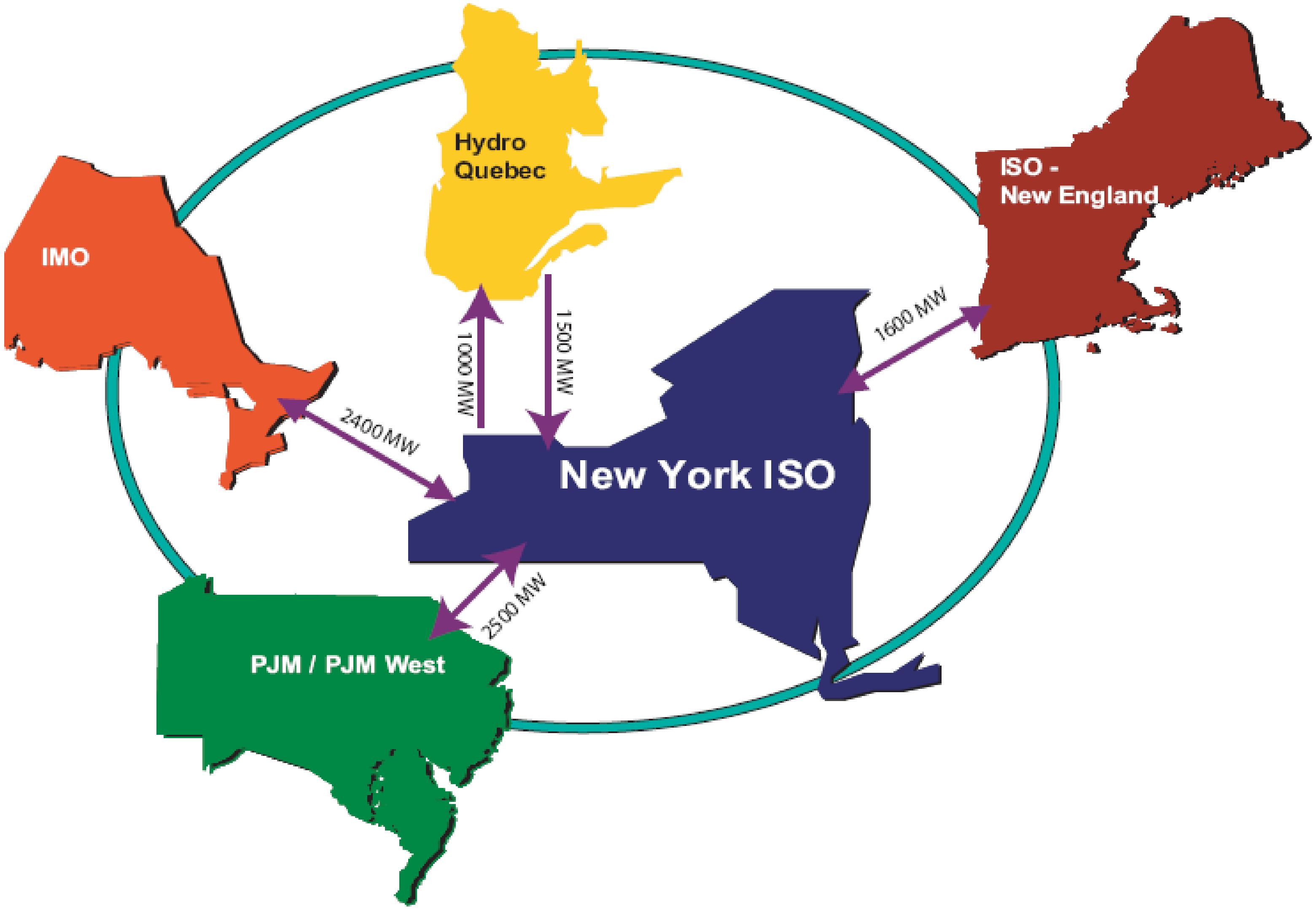
Bulk Transmission System



Local Area Transmission Systems



Neighboring Transmission Systems



Typical Transmission Power Flow

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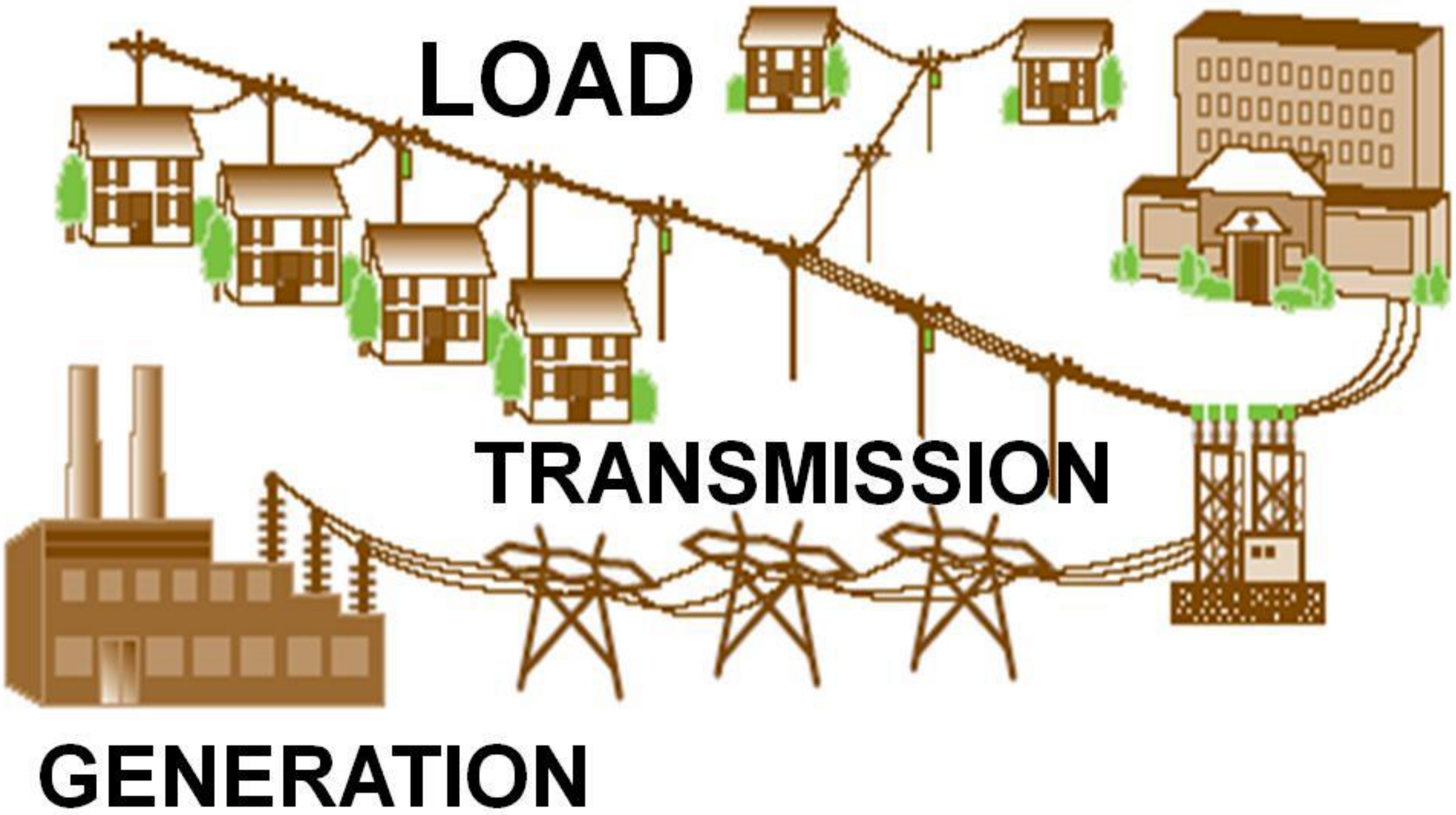
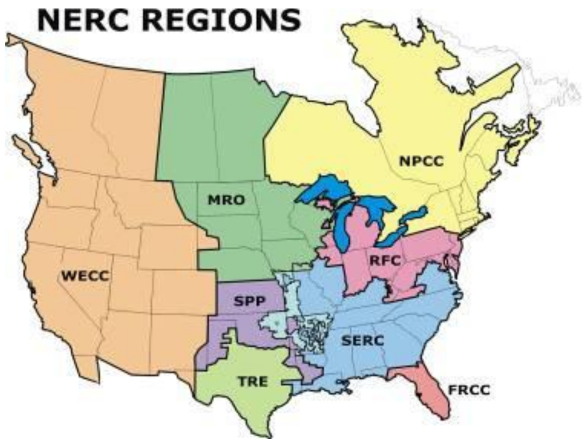


The Bulk and Local Transmission Systems are a network for reliability of supply to load

General Transmission Planning Objectives and Considerations

- To plan and maintain **safe, reliable and efficient** service
  - Sufficient capacity and transmission security
    - Proper operating voltage and power quality
    - Ability to restore system capability
  - Market efficiency and flexibility
  - Able to allow interconnection of new resources
- Planning processes are routinely performed to ensure system reliability and efficiency (every 2 years with a 10 year look ahead)
- Additional studies to test scenarios or other system changes
  - Announced retirements
  - New regulations or policy goals
  - Aging infrastructure

Three Sets of Reliability Standards Apply



North American Electric Reliability Corporation (NERC)

- Independent, not-for-profit organization with mission to improve the reliability and security of the bulk power system in the U.S., Canada and part of Mexico
- Compliance with NERC Reliability Standards became mandatory and enforceable in the U.S. in 2007

Northeast Power Coordinating Council (NPCC)

- Includes New York, New England, Ontario, Québec and the Maritimes
- Formed as voluntary, not-for-profit, regional reliability organization in 1966 in response to the blackout in 1965
- NPCC is our Regional Reliability Organization (RRO) for northeast North America

New York State Reliability Council (NYSRC)

- Not-for-profit organization established in 1999
- Responsible for Reliability Rules specific to the New York State Bulk Power System
- U.S. law authorizes New York State to impose more stringent reliability standards

Transmission Planning

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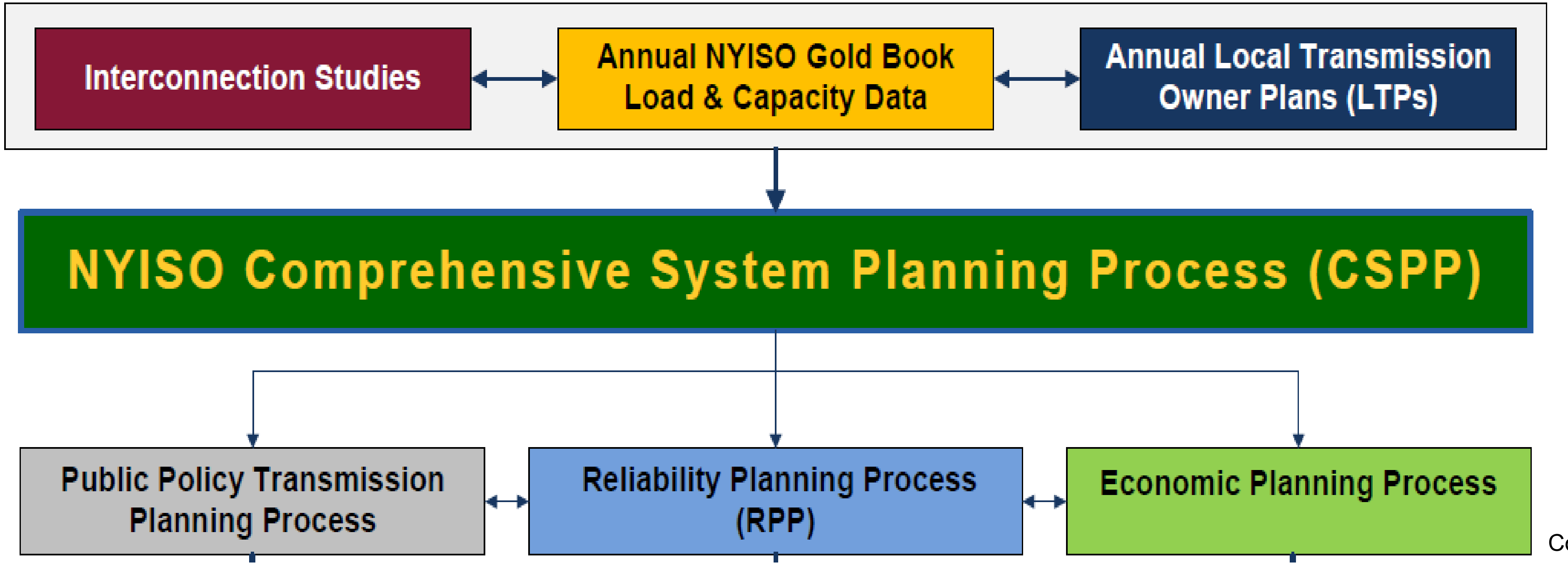
NEW YORK INDEPENDENT SYSTEM OPERATOR

NYISO Planning



Courtesy of the NYISO

NYISO Transmission Planning Processes
Reliability

Reliability Planning Process

- Identify reliability needs of the New York Bulk Power Transmission System
  - Assess both transmission security and adequacy
  - Assess resource adequacy
- Solicits solutions for identified needs
  - Backstop solutions from Transmission Owners
  - Market or regulated solutions from Developers
- Develop comprehensive reliability plan
  - Ties planning processes together

NYISO Transmission Planning Processes
Economic

Economic Planning Process

- Two Phases
  - Study Phase
    - Identify congestion on the New York Bulk Power Transmission System
    - Identify generic solutions
  - Project Phase
    - Developers propose projects for review
    - Must be cost/beneficial and pass voting process

NYISO Transmission Planning Processes
Policy

Public Policy Planning Process

- Address public policy needs of the New York Bulk Power Transmission System
  - NY PSC solicits transmission needs and determines transmission needs driven by public policy
  - NYISO solicits projects to meet transmission needs
  - NYISO assesses proposed solutions and projects
  - NYISO evaluates and selects solution(s) and project(s)
- There are currently two public policy transmission needs driving projects today
  - Western New York – release bottled Renewable Generation
  - AC Transmission – relieve bottled upstate generation to serve downstate load

Local Transmission Planning

- Local transmission plans
  - Non-Bulk transmission
  - Utilize similar studies to the reliability planning process
    - Maintain operation after contingencies
    - Maintain voltage and stability
    - Able to operate with loss of a generator
- Projects are developed to
  - Replace Infrastructure
  - Address Compliance Issues
  - Maintain Operating capability
  - Improve both System & Local Load Serving capability
- Projects typically address multiple issues
- These projects feed into the NYISO Comprehensive Plan

Transmission Planning Assumptions

- Demand forecast
  - Forecast modifiers – DR and DER
  - Reserve margin
- Generation, both existing and forecast
  - Availability and variability
  - Forecast modifiers – SCR and DER
  - Retirements
  - Resource dispatch
- Transmission Topology
- Seasonality of loads and resources
- Reliability Criteria

Definitions:

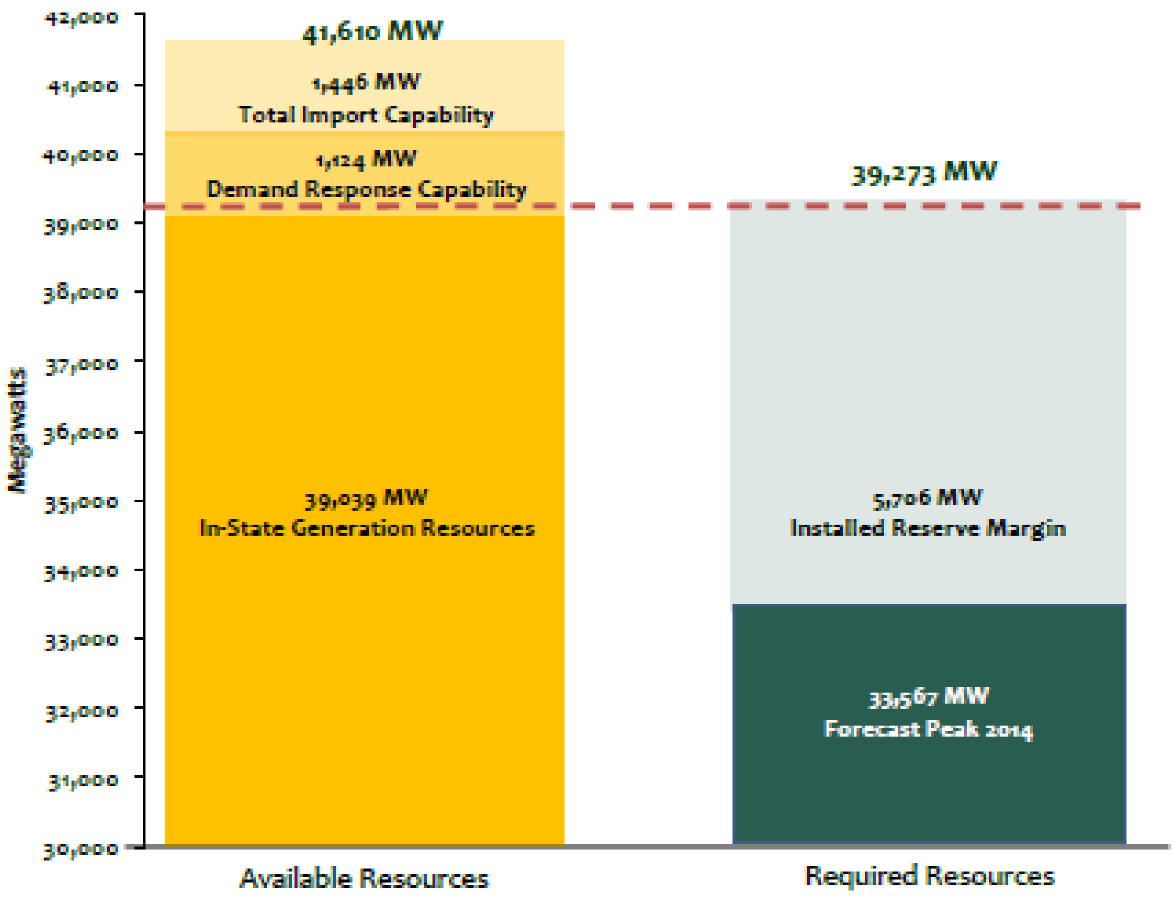
DR – Demand Response

DER – Distributed Energy Resources

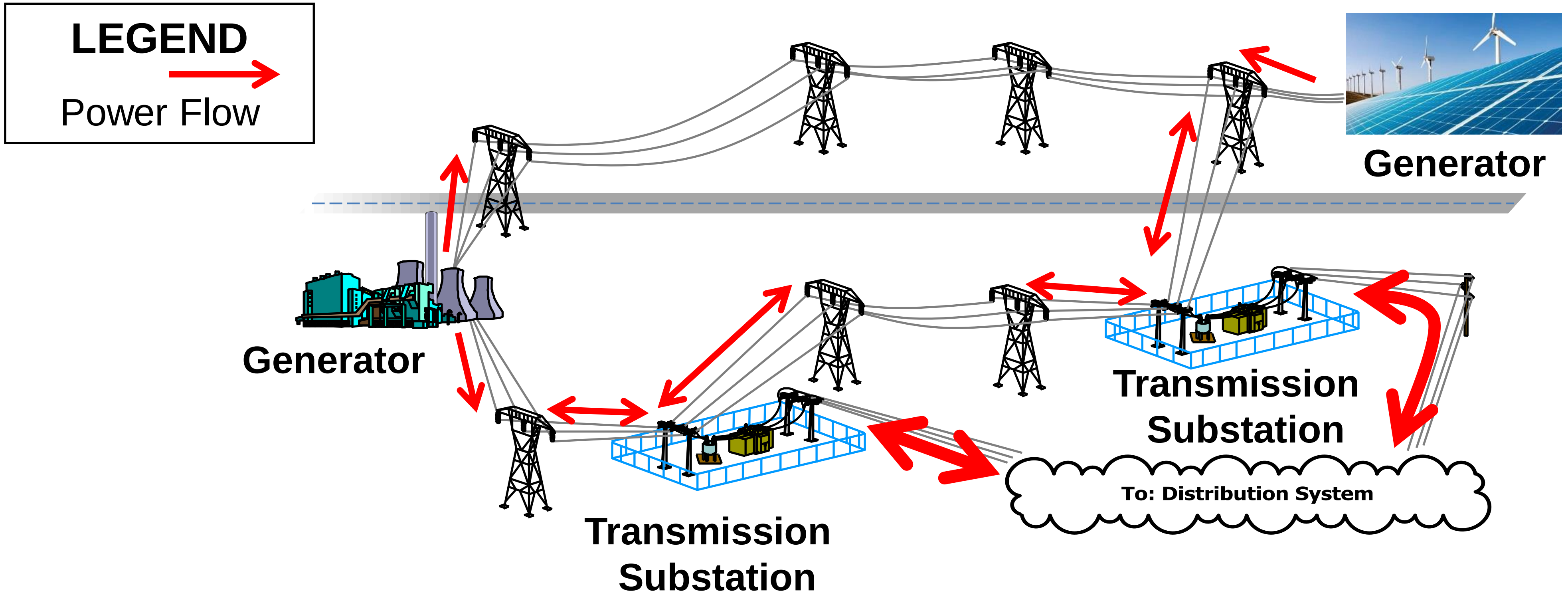
SCR – Special Case Resources

Forecast Modifiers
Impact of SCR, DR and DER

- Wholesale DR (SCR) as a resource
- Local DR as a load modifier
- DER as both a resource and load modifier



Typical Transmission Power Flow
With High Penetration of DER



Potential for flow in both directions at the Transmission and Distribution Interface

Impact of Increased DER on Transmission System Operation and Planning

- Operation
  - Reversal of power flow at T&D Interface
  - Voltage profile and control
  - Voltage and transient system analysis
  - Changes in flow patterns on transmission system
  - Changes to critical system conditions typically assessed
- Planning
  - Forecast DER impacts on Load & Resources
  - Need to model DER in base case models
    - Previously load at T&D Interface was net

Transmission Planning Take Away Thoughts

- Transmission planning today is a complicated multi jurisdictional process
  - Processes prescribed by FERC
  - Criteria dictated by Reliability Organization
  - Influenced by PSC (siting and rate cases)
  - Other stakeholders
- Many drivers beyond load growth
  - Generator resources
  - Aging infrastructure
  - Market access and technology
- DER is currently not a huge system impact
- Planning for DER and integrating DER into the transmission system is adding a layer of complexity

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Questions?

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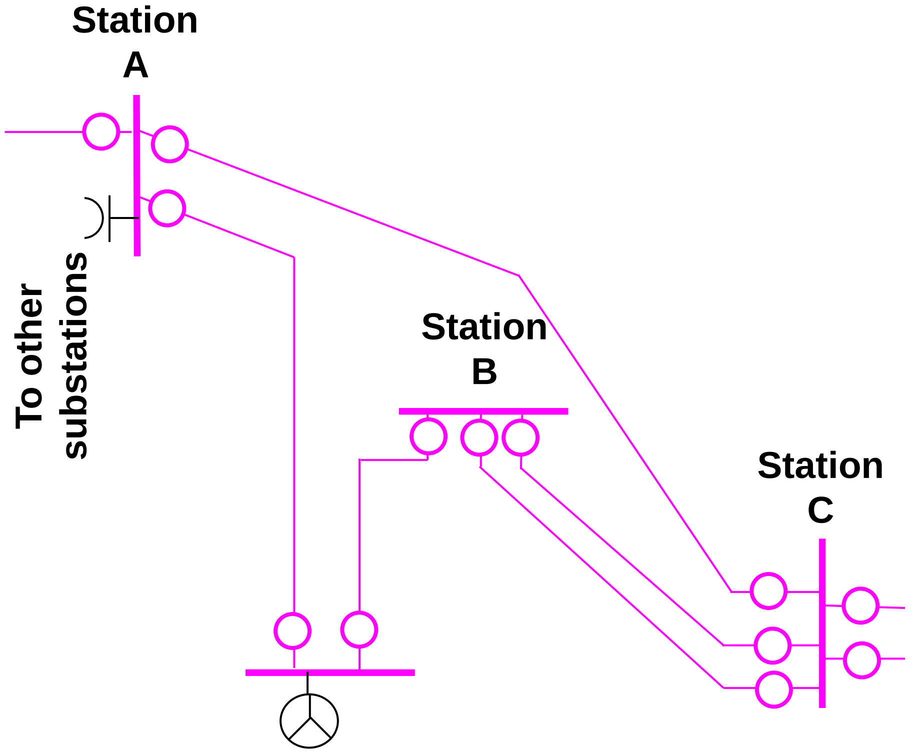
Overhead Distribution Planning

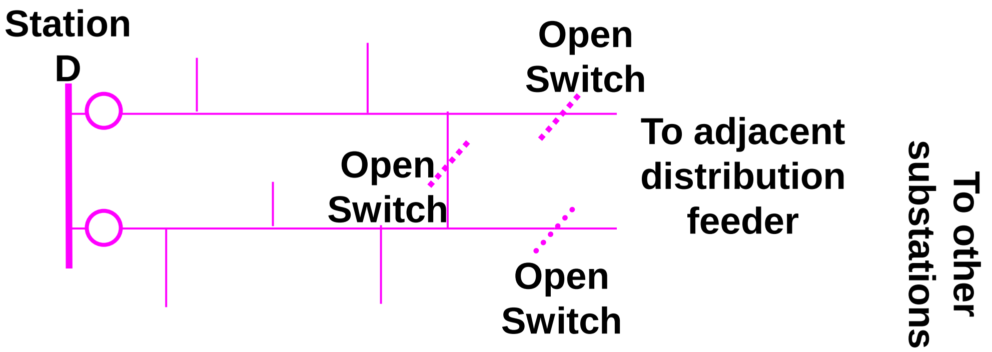
Dave Conroy – Director, AVANGRID
Angelo Regan – Director, Orange & Rockland

Transmission and Distribution Planning
Different Objectives

Transmission Planning

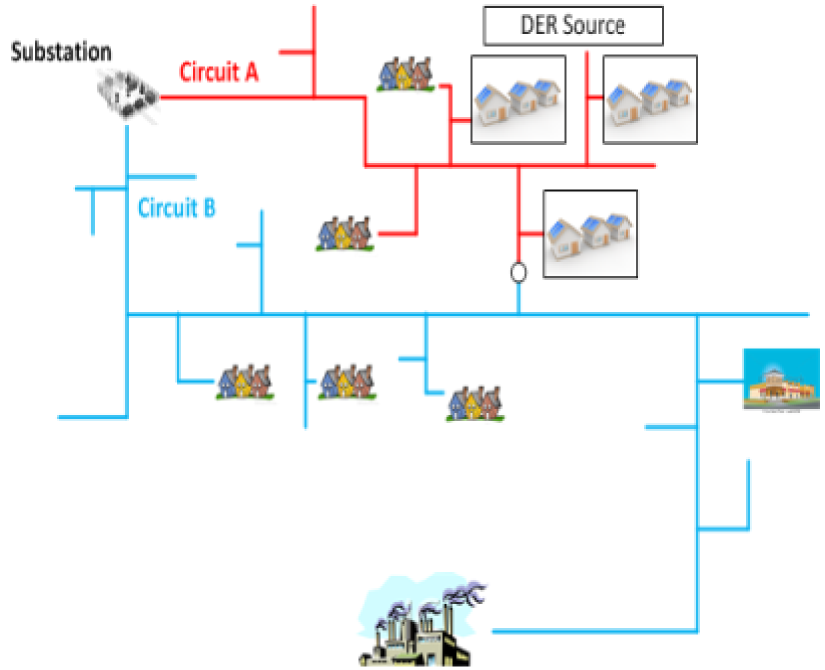


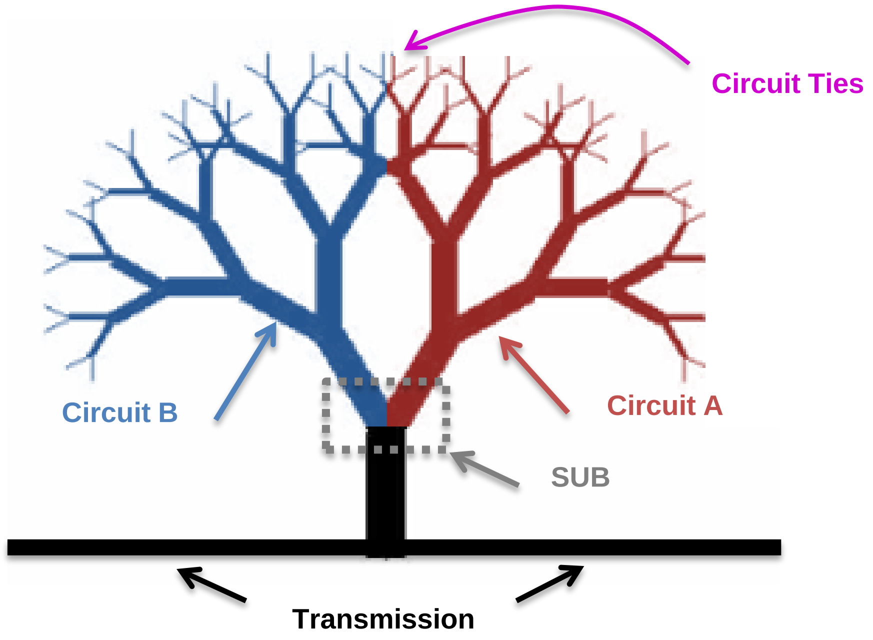
Overhead Distribution Planning



- Transmission planning addresses a mesh network and addresses grid stability and bulk power imports and exports
- Distribution planning is radial and granular, addressing thermal capacity, power quality and restoration times

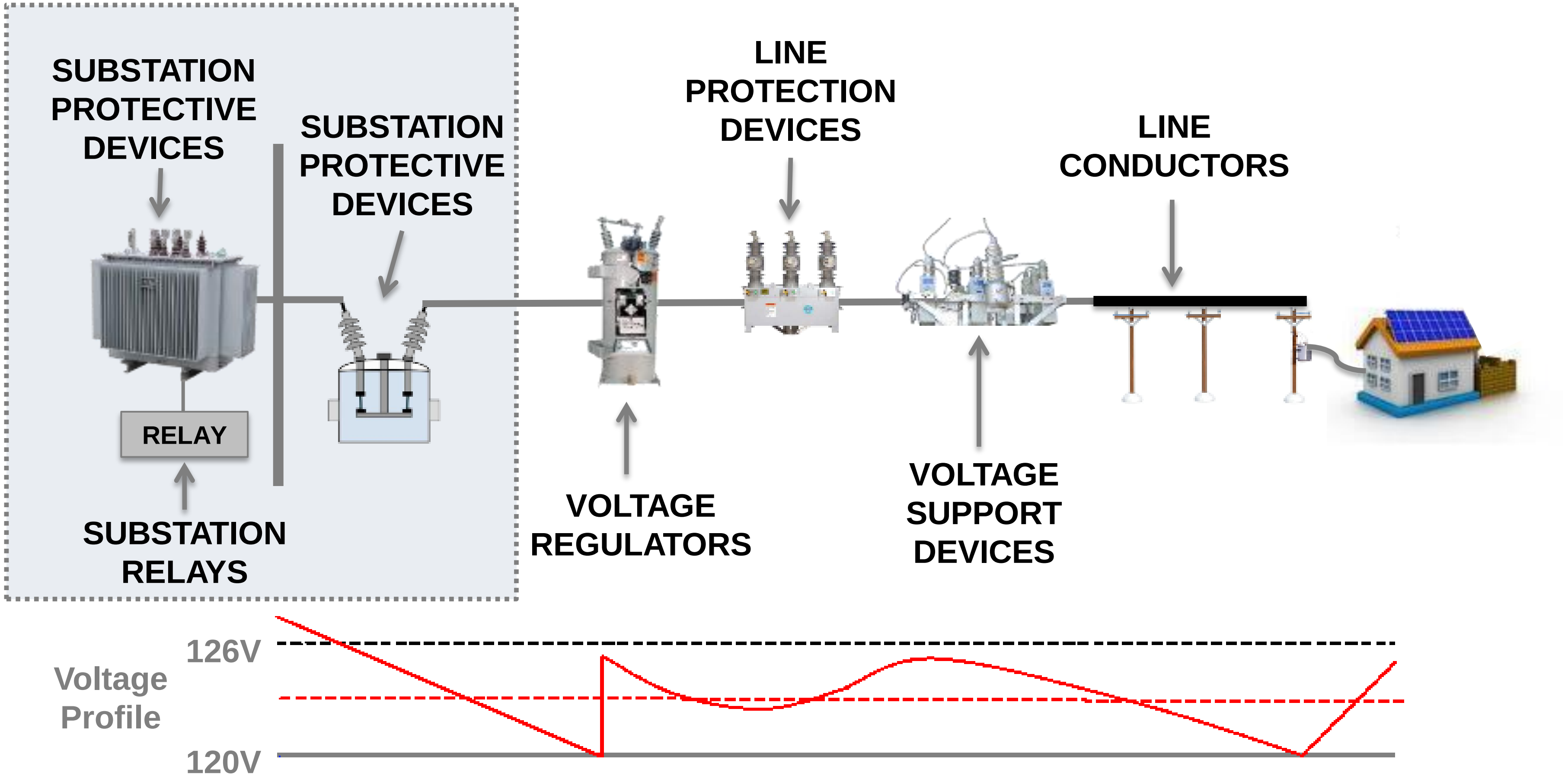
Distribution System is Tailored to Meet Localized Needs





- Design of distribution circuits is driven by topology, customer mix and load and available resources
- Distribution circuits are often switched into abnormal configurations for planned and unplanned situations

Typical Distribution System Design



Distribution systems comprised of radial distribution feeders that include various devices to ensure safe and reliably service for end users.

General Distribution Planning Objectives and Considerations

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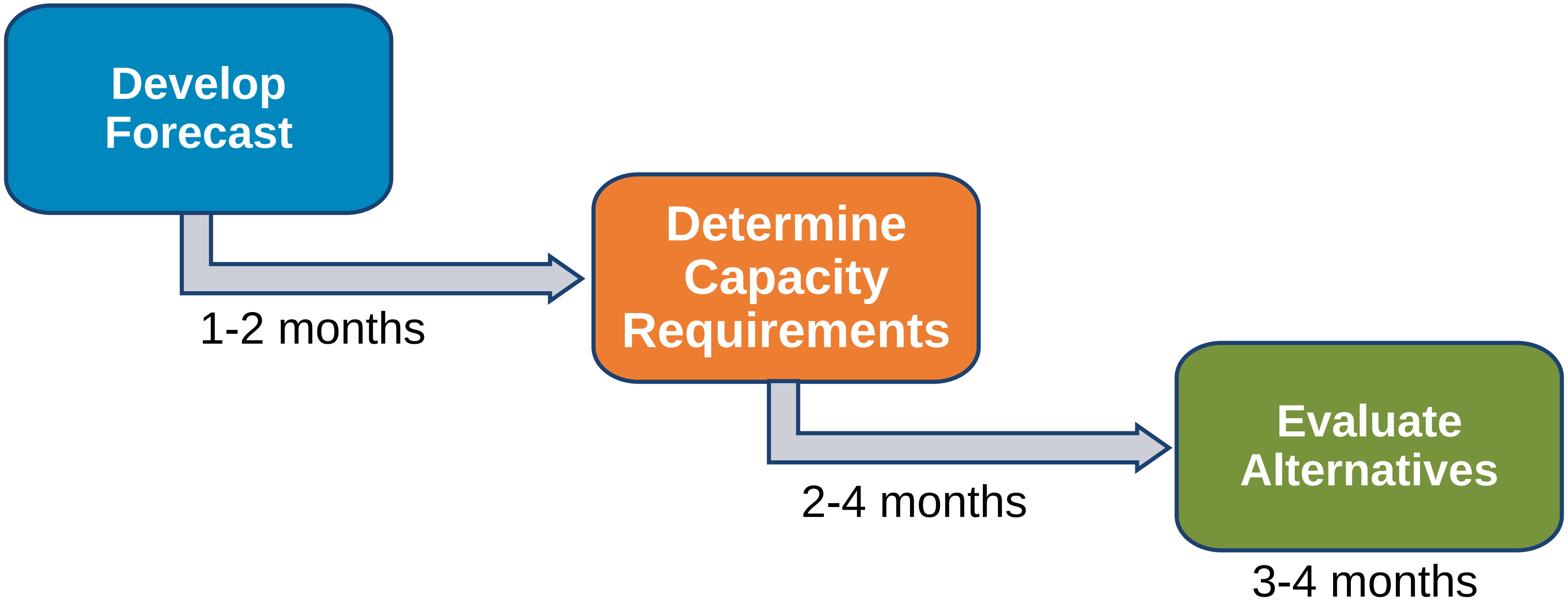
- All utilities plan to maintain safe and reliable service as a priority
  - Sufficient capacity
  - Proper voltage and power quality
  - Operational flexibility and restoration
- Detailed analysis of the current and projected future operating states of the electric distribution system are regularly completed with respect to
  - Company specific design standards and risk analysis, capability and geography/topology
  - Specific industry (e.g., IEEE/ANSI) operating criteria and guidelines
- Analysis routinely performed to review both short-term requirements, as well as long term scenarios

Overview of Distribution Planning Process



The Distribution Planning Process (DPP) is an annual process that last approximately 8-10 months and identifies projected distribution capacity and operating deficiencies and determines mitigation plans to address those projected deficiencies.

Short-Term Planning Process

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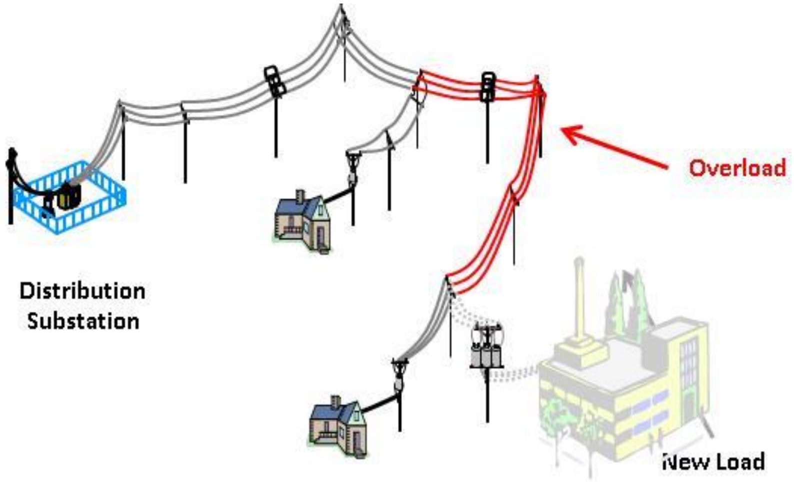
- Review of most recent summer operating conditions on all substation transformer banks
  - Actual loading vs. weather normalized loading
    - Performed on distribution circuits and feeders when possible
  - Voltage and VAR profiles
  - Power factor conditions
- Perform analysis of areas that experienced operating issues to determine short-term solutions
  - Voltage problems
  - Equipment approaching or exceeding operating limits
  - Contingencies



Short-Term Planning Process
Cont'd

- Solutions are typically more localized, smaller and lower cost
  - Capacitor and Regulator installations
  - Install additional switching capability for system reconfiguration
  - Stepdown transformer upgrades, line re-conductor or extensions, voltage conversions
- Determine near-term equipment operating conditions
  - Weather normalized load forecasts for banks and circuits
    - Anticipated near-term customer growth and block load additions

Short-Term Planning Process
Cont'd

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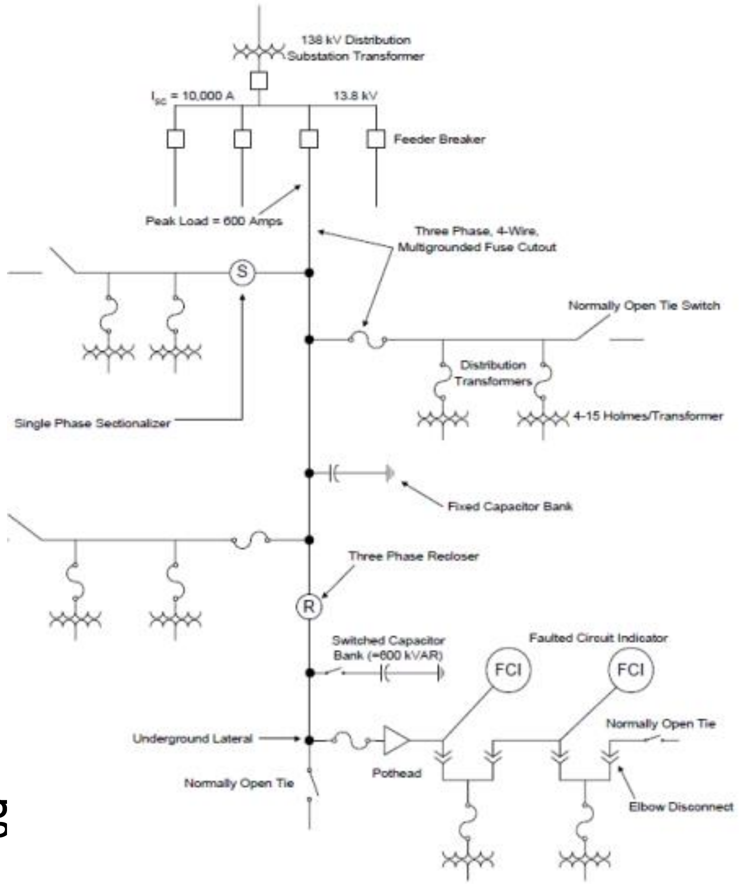
- Detailed modeling of entire distribution system under both normal operating conditions and prescribed contingency conditions to project for and analyze appropriate operating conditions
  - Loading, phase balancing, voltage coordination, power factor, protection coordination
- Analysis of distribution automation and auto-loop scheme operation
- Determination of NYISO under-frequency/manual load shed requirements
  - Combined function of Planning, Protection, Engineering and Operations
- Analysis of the effects of DG/DER on all of the above



Long-Term Planning Process

- Builds off of all work completed as part of the short-term planning review
  - Most Companies perform an annual detailed analysis for the upcoming 5 to 10 year period
  - Can be performed periodically extending to a 20 year period
- Determine long-term equipment operating conditions
  - Weather normalized load forecasts for substation transformer banks
    - Anticipated long-term customer growth and block load additions
- Detailed modeling of entire distribution system under both normal operating and prescribed contingency conditions (loss of a circuit, substation bank or entire substation)
  - Loading, backup capability and restoration to meet planning standards
- Analysis of the effects of DG/DER on all of the above

Long-Term Planning Process
Cont'd

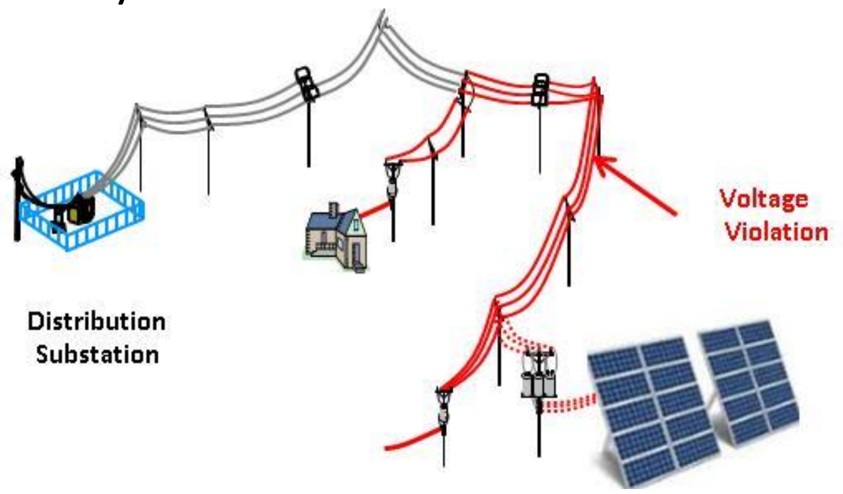
- Substantial analysis completed to determine lowest cost solutions
  - Permanent switching / system reconfigurations to optimize capacity utilization
  - Addition of distribution automation/smart grid technologies to further optimize asset utilization and capacity sharing through temporary system reconfiguration
  - Installation of new circuits prior to the need to build higher cost substation solutions
  - Constructing lower cost infrastructure alternatives to defer higher cost solutions

Long-Term Planning Process
Cont'd

- Solutions are typically implemented for a broader geographic area, have more electric system and customer impact, take longer to permit and construct and are higher cost
  - Additional distribution circuits
  - Adding substation transformers to existing substations
  - Upgrading existing substations (increased capacity or different operating voltage)
  - Adding new substations

Planning Challenges with Significant DER Penetration

- Forecast accuracy – an inexact science becomes significantly more complex
  - Required coincidental readings per circuit significantly increases for the entire load profile of operating conditions
    - Sudden changes in weather (cloud cover) requires very flexible system
  - Contingency planning scenarios increases and is more complex
- Voltage and VAR profile and control – T&D
- Protection and coordination – T&D
- Reverse power flow – T&D
- Need for improved analysis tools and systems
  - Capability of modeling high penetration DER
  - Capability of modeling combined T&D effects
  - Collect significantly increased and new data for modeling
  - Real world operating data to improved assumptions, forecasts and modeling data
- Determination of radial distribution system hosting capacity
  - A priority for all stakeholders to be addressed in the supplemental process



Conclusion

- Distribution Planning requires substantial levels of granularity
  - Obligation to reliably serve end-users in service territory
  - Agile planning process
  - Substation, transformer bank, feeder, feeder devices planning
  - Significant amounts of data and analysis
- Distribution Planning is complex and requires high degree of granular coordination to ensure cost effective solutions are deployed while planning for the future
  - Asset infrastructure replacement plans
  - Distribution operational switching capabilities, voltage/power quality and protection
  - Local area understanding of electric system performance
  - Integration of high penetration DG / DER adds substantial complexity to an already detailed and complicated process

The Joint Utilities are committed to expand the planning tools and techniques to integrate DER into the distribution system.

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Questions?

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Underground Distribution Networks

Christopher G. Jones

Department Manager - Distribution Engineering/System Design, conEdison

Topics

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- Con Edison overview
- Underground secondary network overview
- DER integration into secondary networks
  - Targeting load relief with DER
  - Reliability considerations
  - Technology updates allowing two-way flow
- Secondary network DG hosting capacity

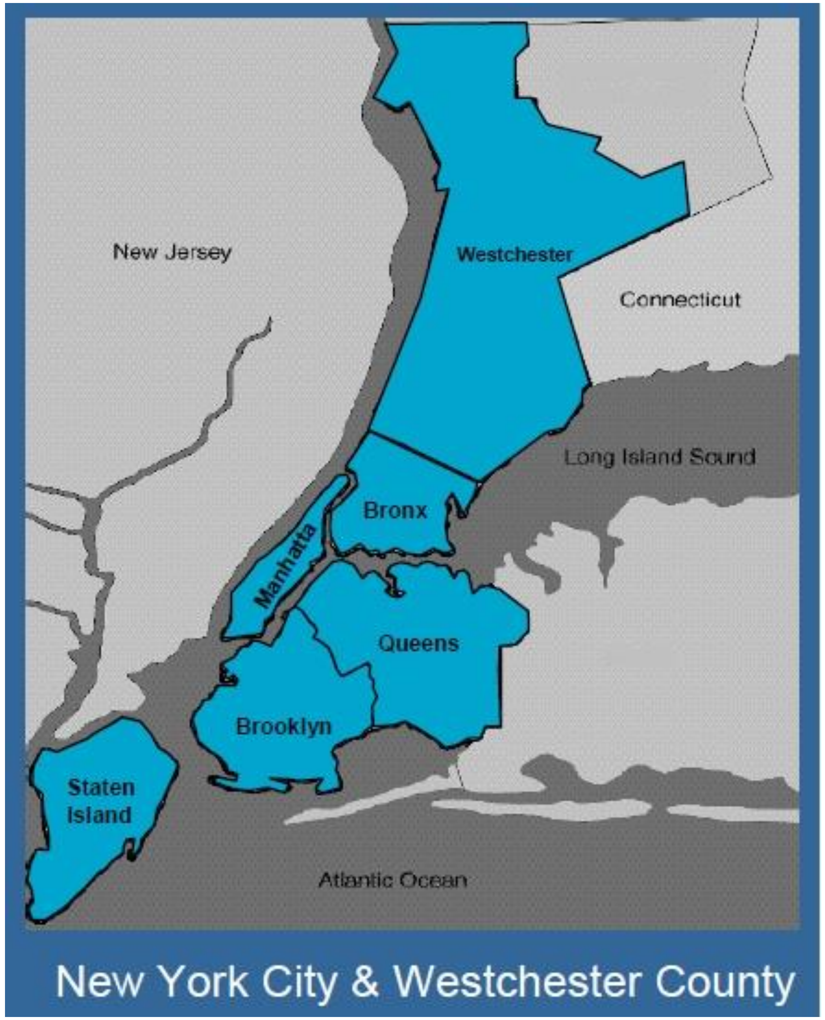
Con Edison Overview

- Service Territory

Customers	3,300,000
Population	9,200,000
Area	604 mi^2
Peak Demand	13,241 MW
Con Ed Load Density	21.9 MW/mi^2

- Service Voltages

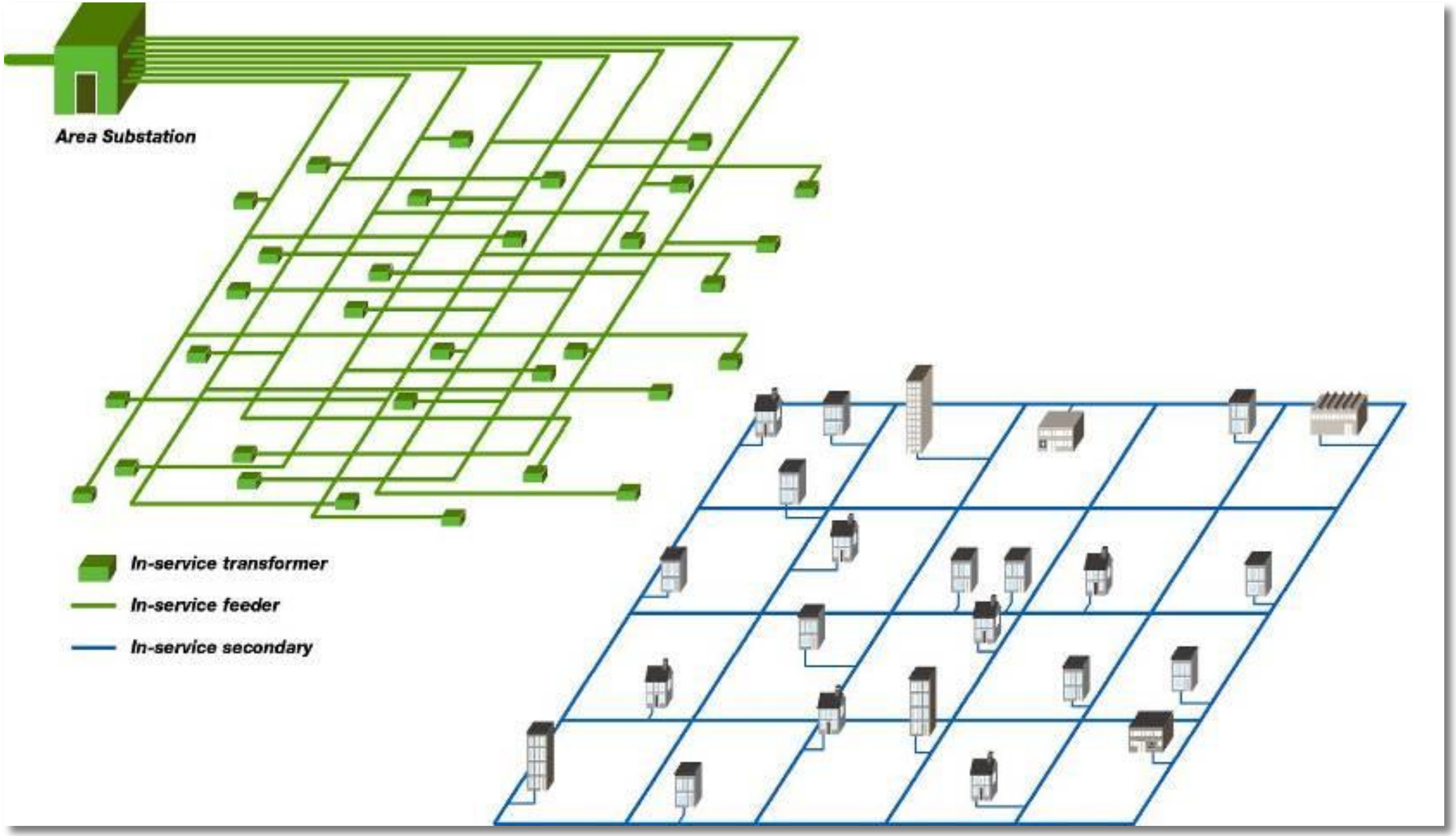
Transmission	345kV, 500kV, 230kV, 138kV, 69kV
Primary Distribution	33kV, 27kV, 13kV, 4kV
Secondary Distribution	120/208V,265/460V



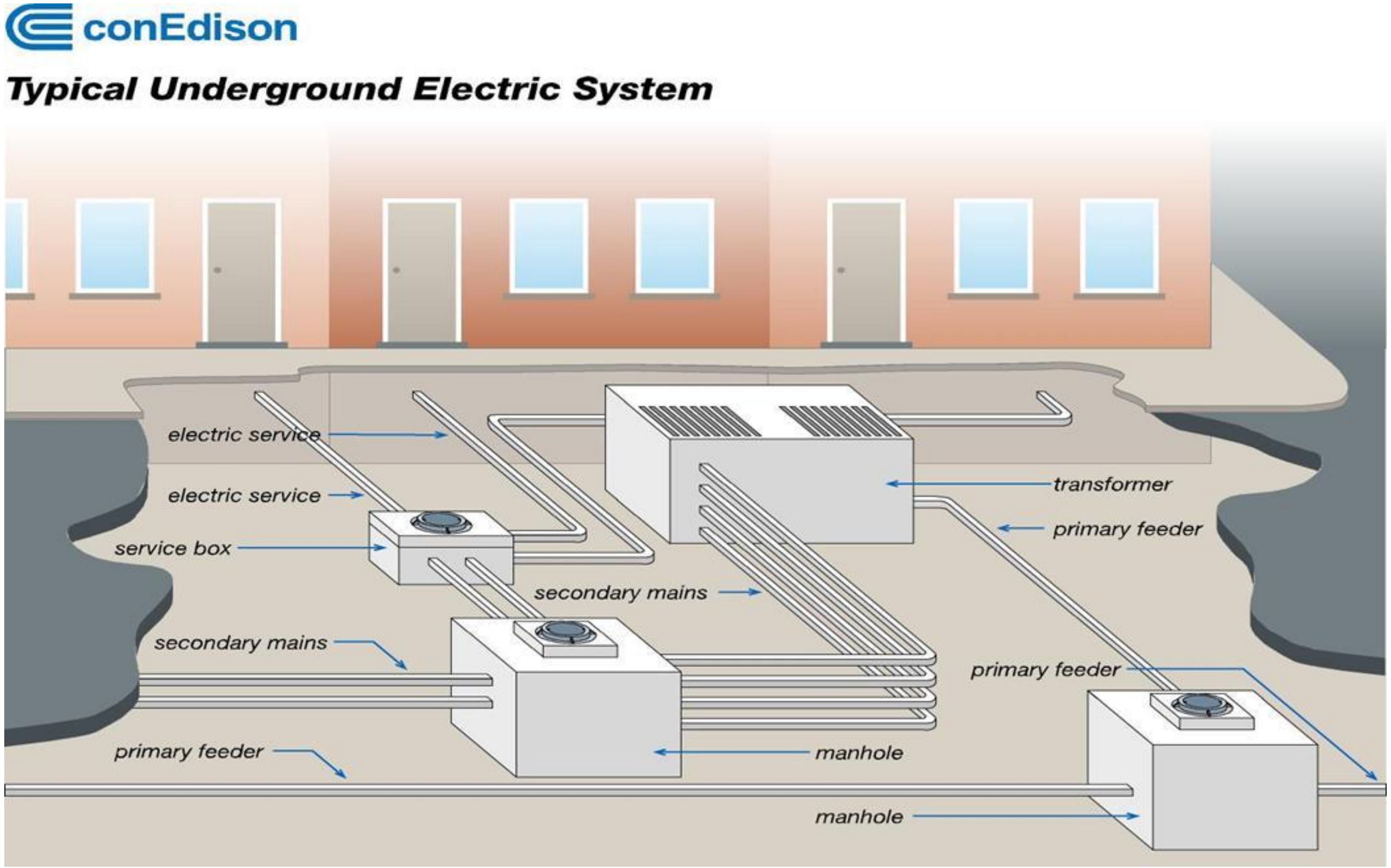
Secondary Network Design and Operation

- Covers 85% of Con Edison's territory
- **Multiple primary (MV) distribution feeders and transformers provide parallel paths to common secondary (LV) grid**
- Primarily a **2nd Contingency** design
- Diversity – Substation and Field
- Design allows for
  - Reliability at peak loads
  - Fault repairs and scheduled work to be performed without interruption of service to customers

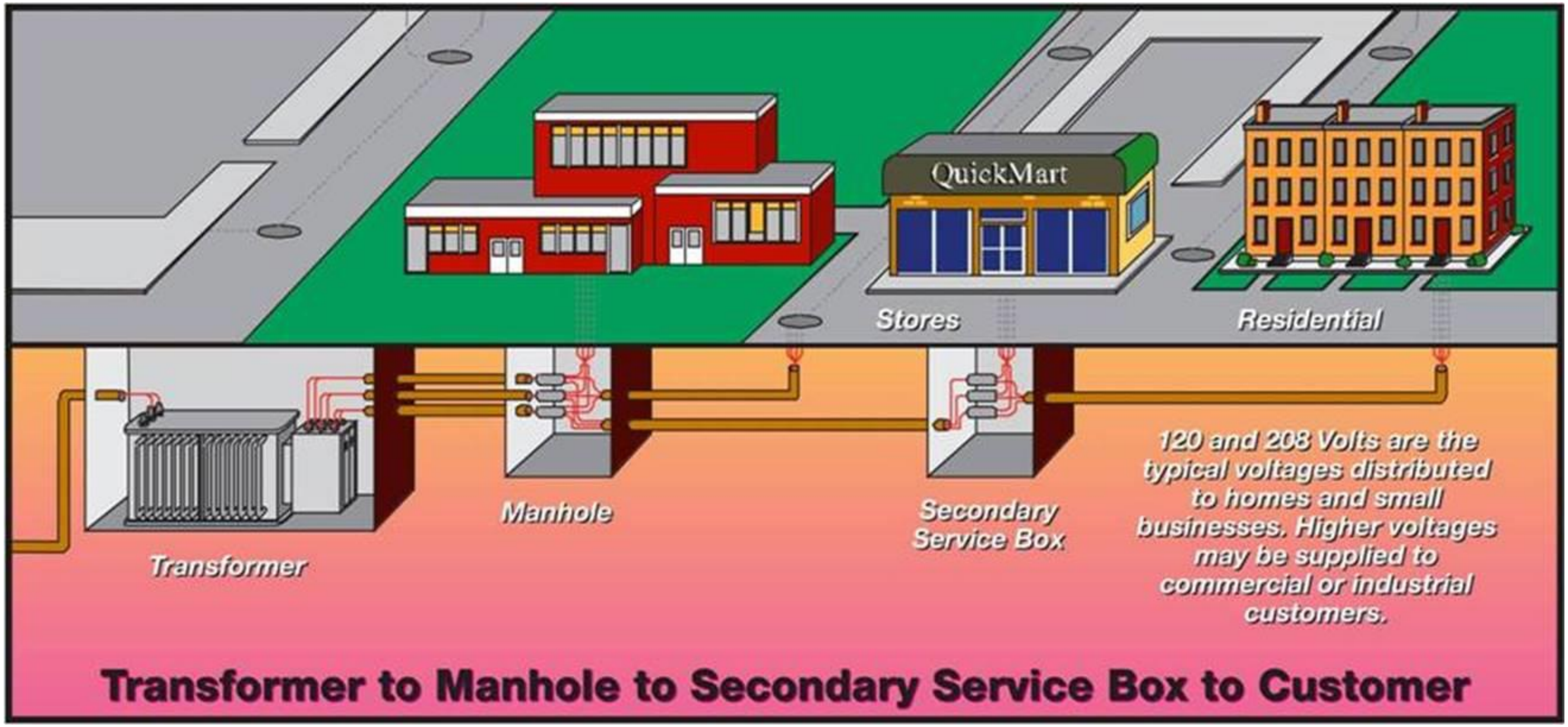
Network System
Overview



Network System



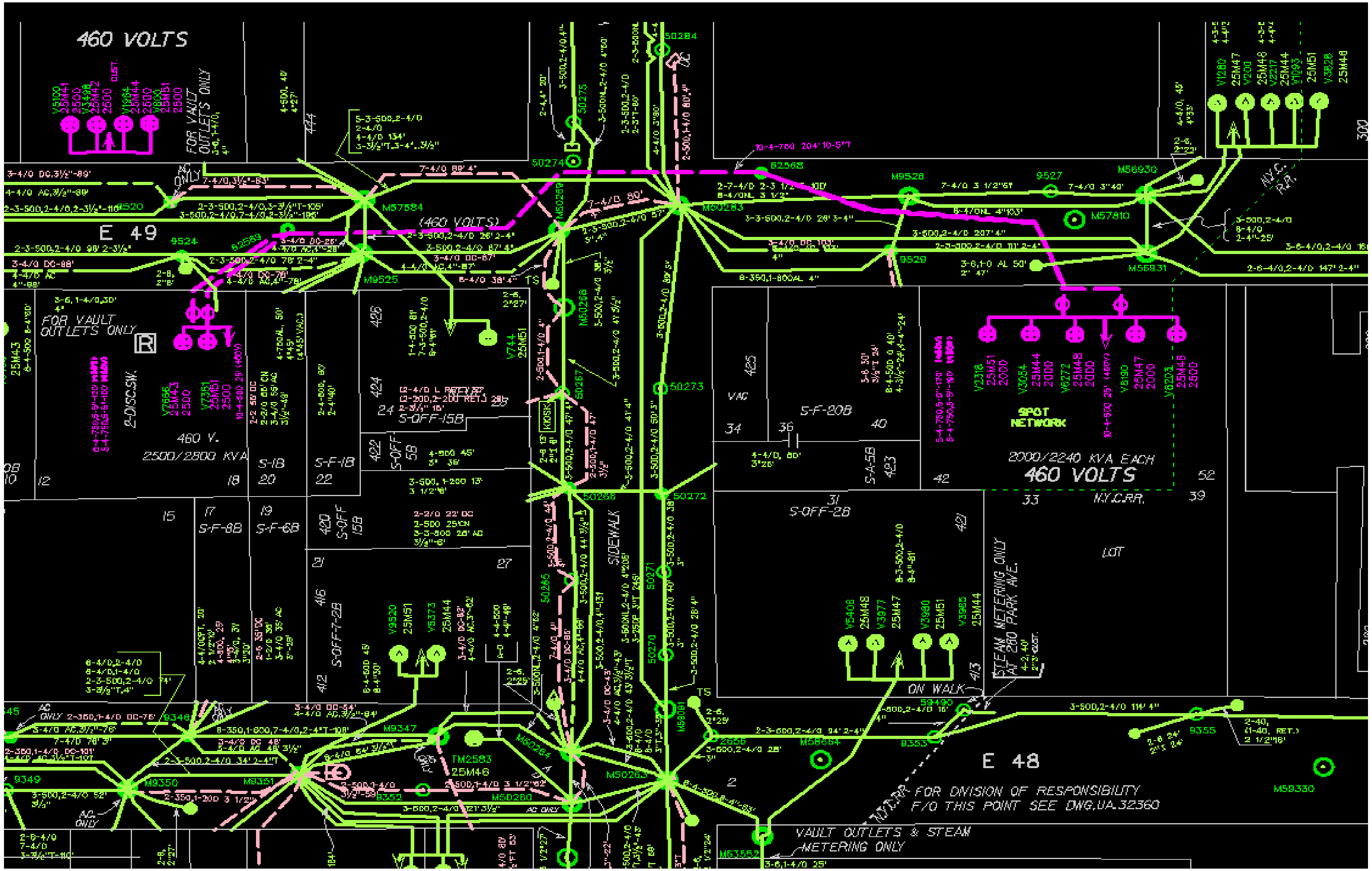
Network System



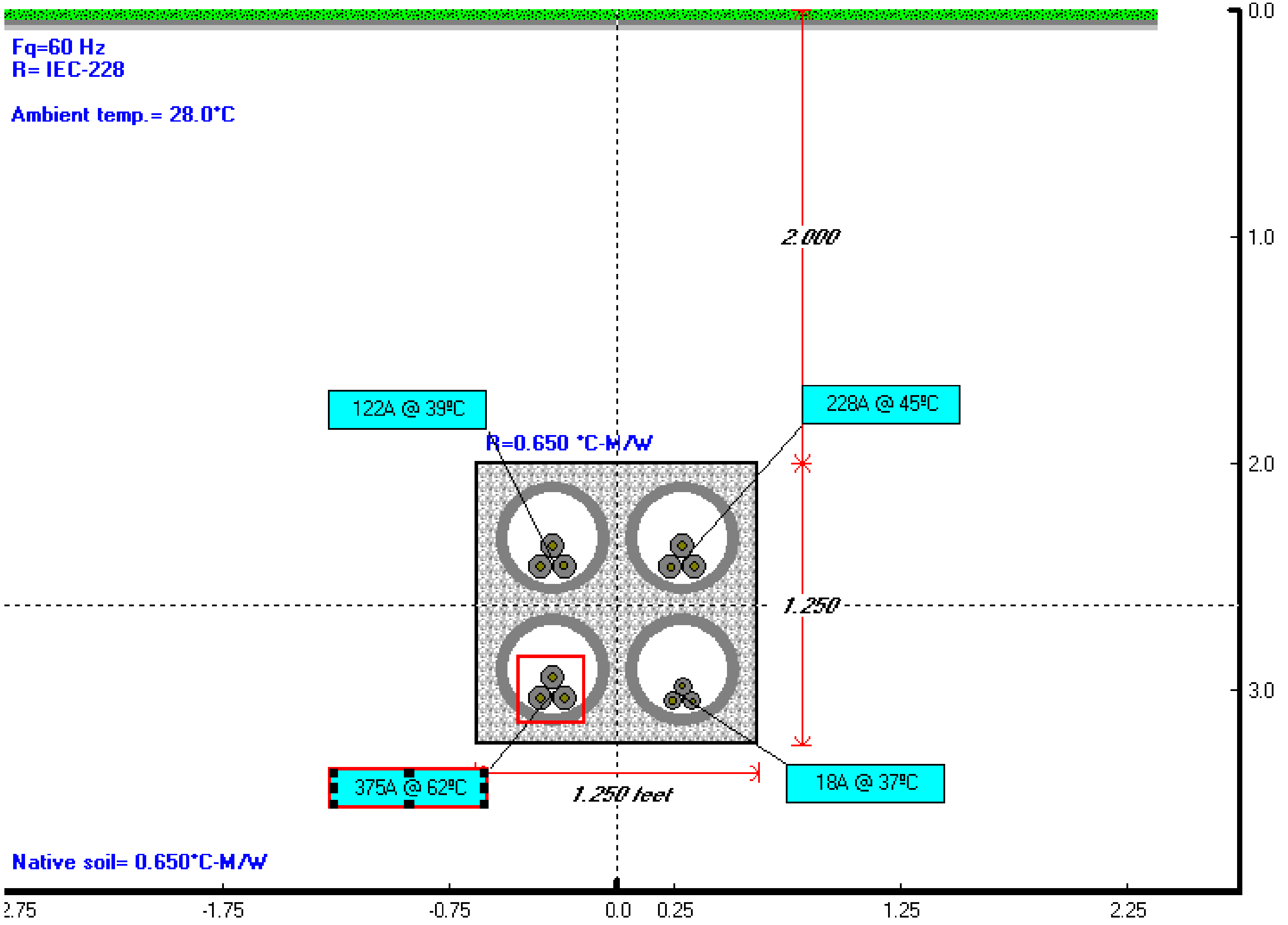
Network Equipment

Network Equipment

Secondary (120/280V and 460V) Mains Map

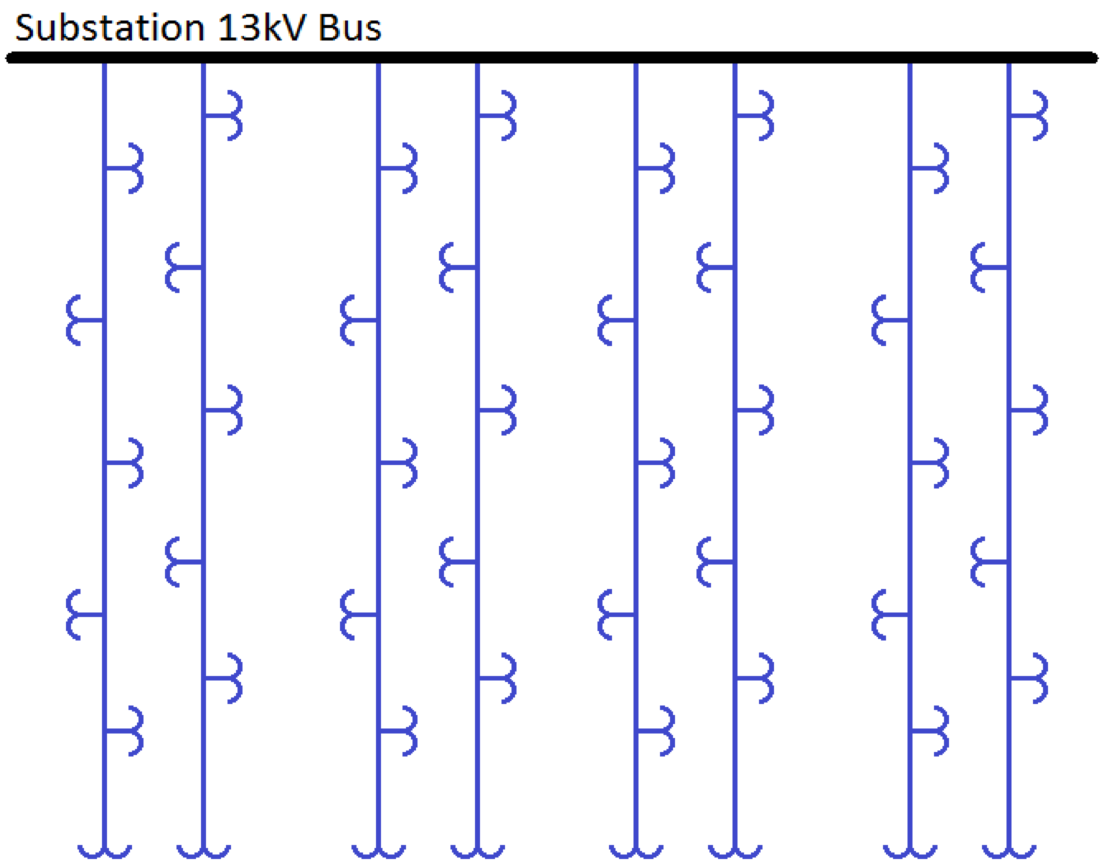


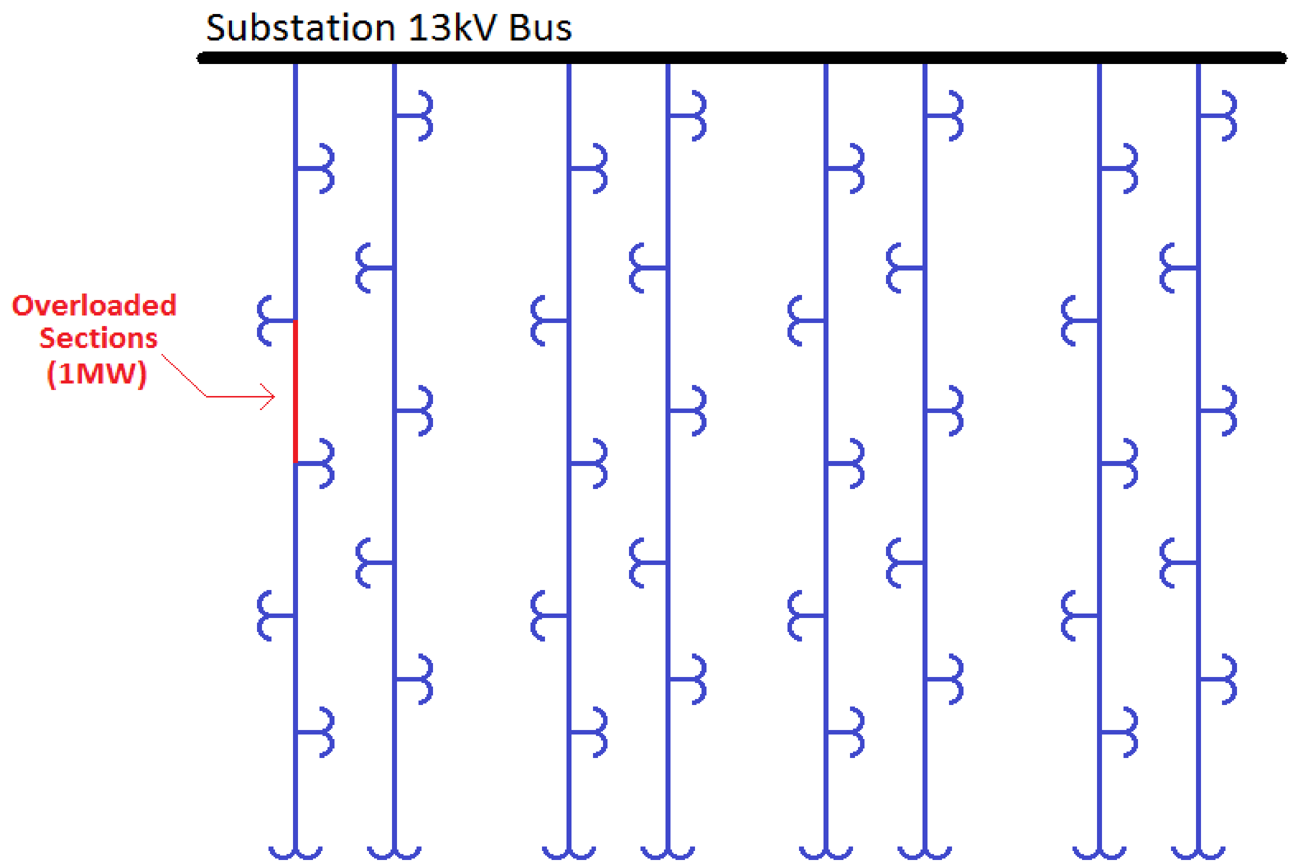
Equipment Rating
Rate Feeder Section Using the CYMCAP Module

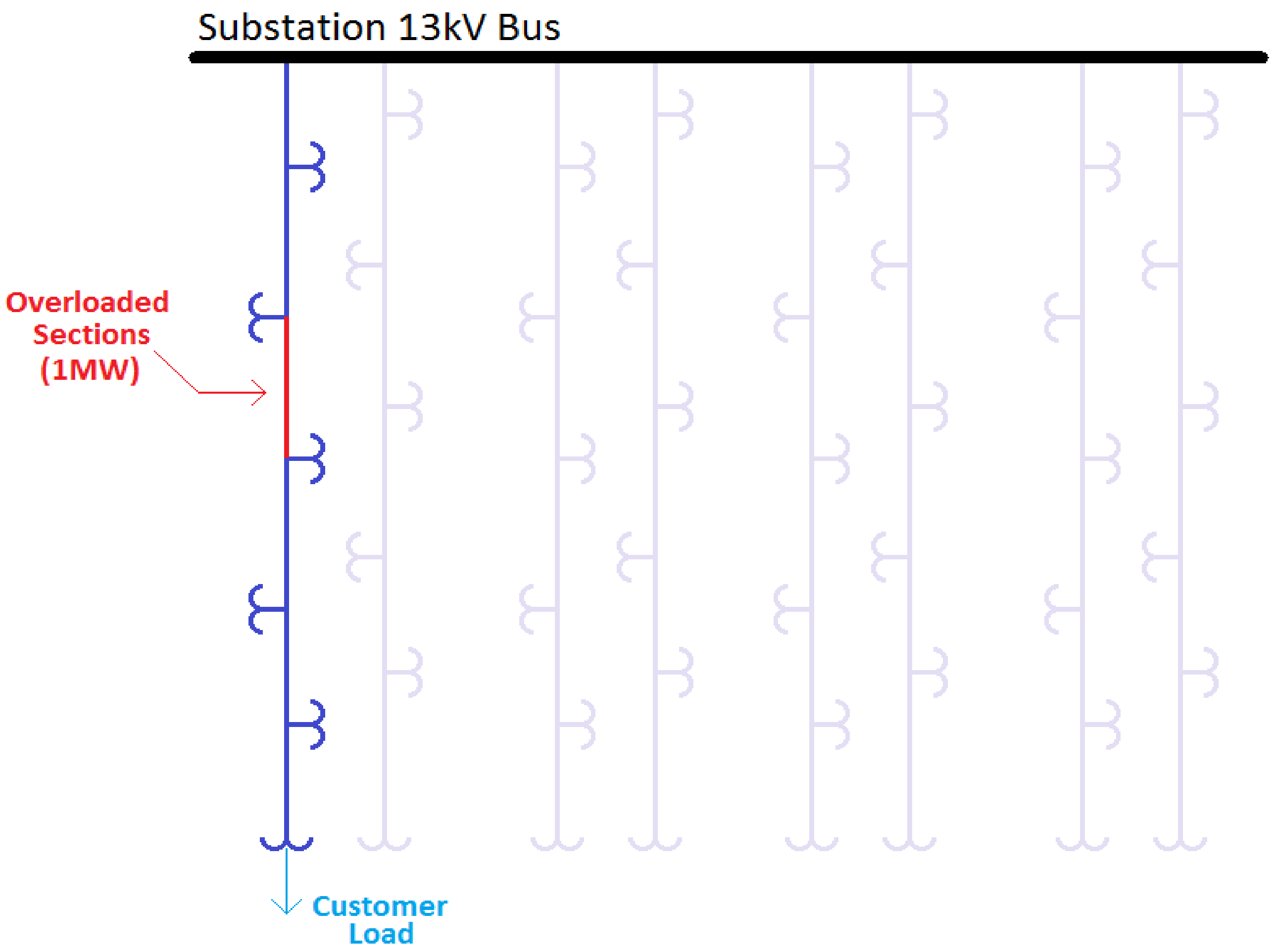


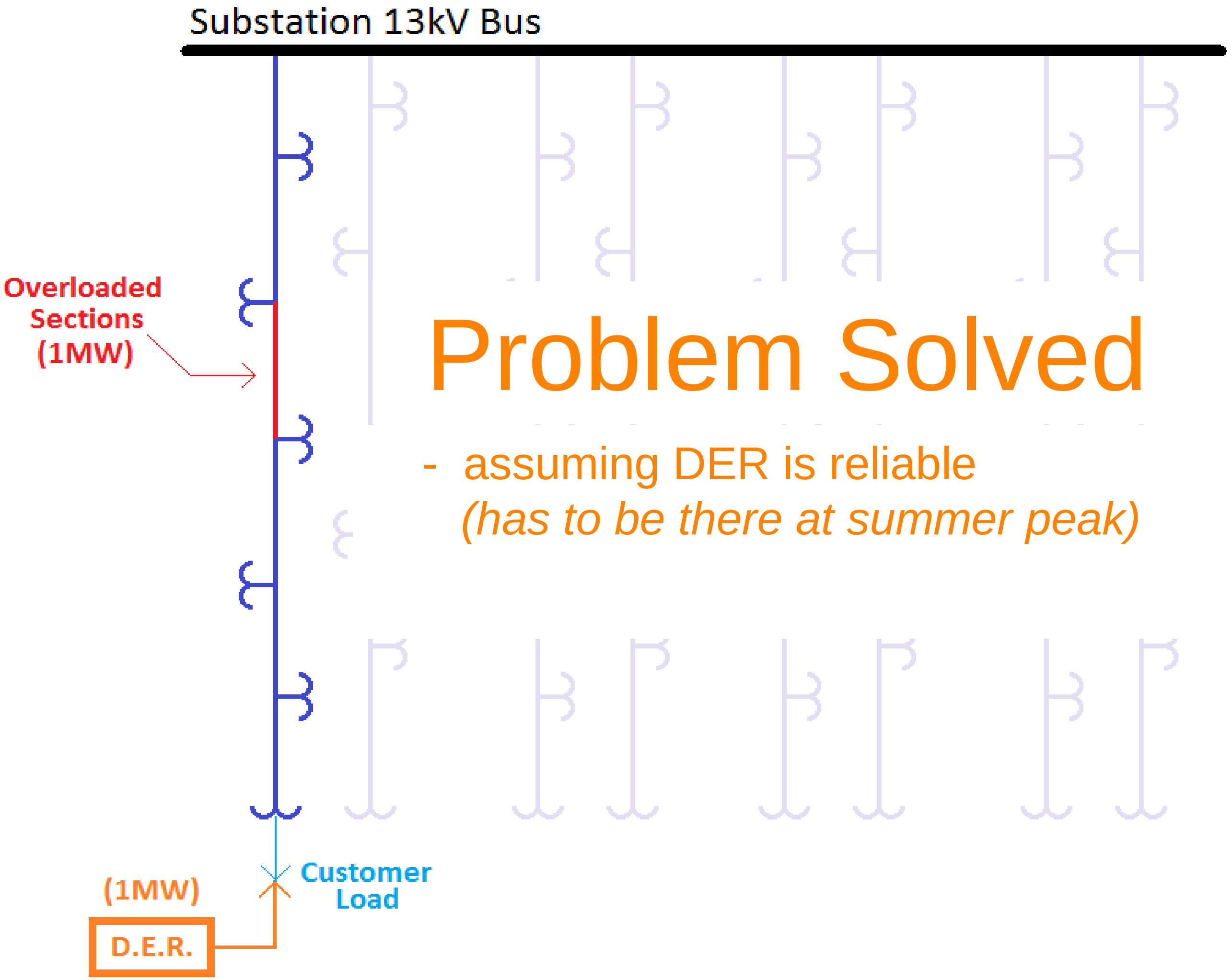
Integration of DER in a Secondary Network
Using DER's for Load Relief

- Contrasting with a radial circuit
- Reliability issues
- Considers a single DER


Substation 13kV Bus

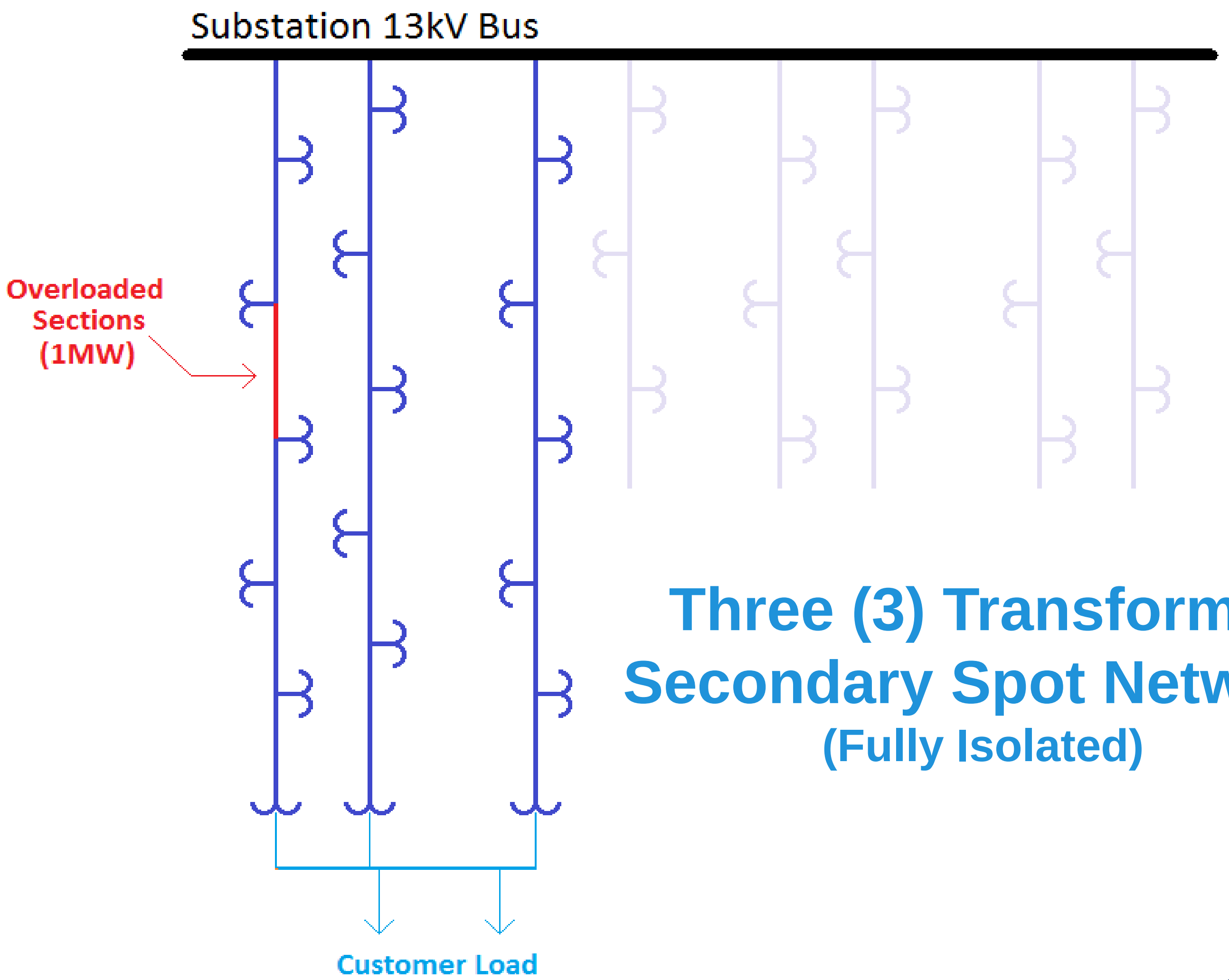

Substation 13kV Bus
Overloaded Sections (1MW)


Substation 13kV Bus
Overloaded Sections (1MW)
Customer Load



Problem Solved

- assuming DER is reliable
  (has to be there at summer peak)



Three (3) Transformer Secondary Spot Network

(Fully Isolated)

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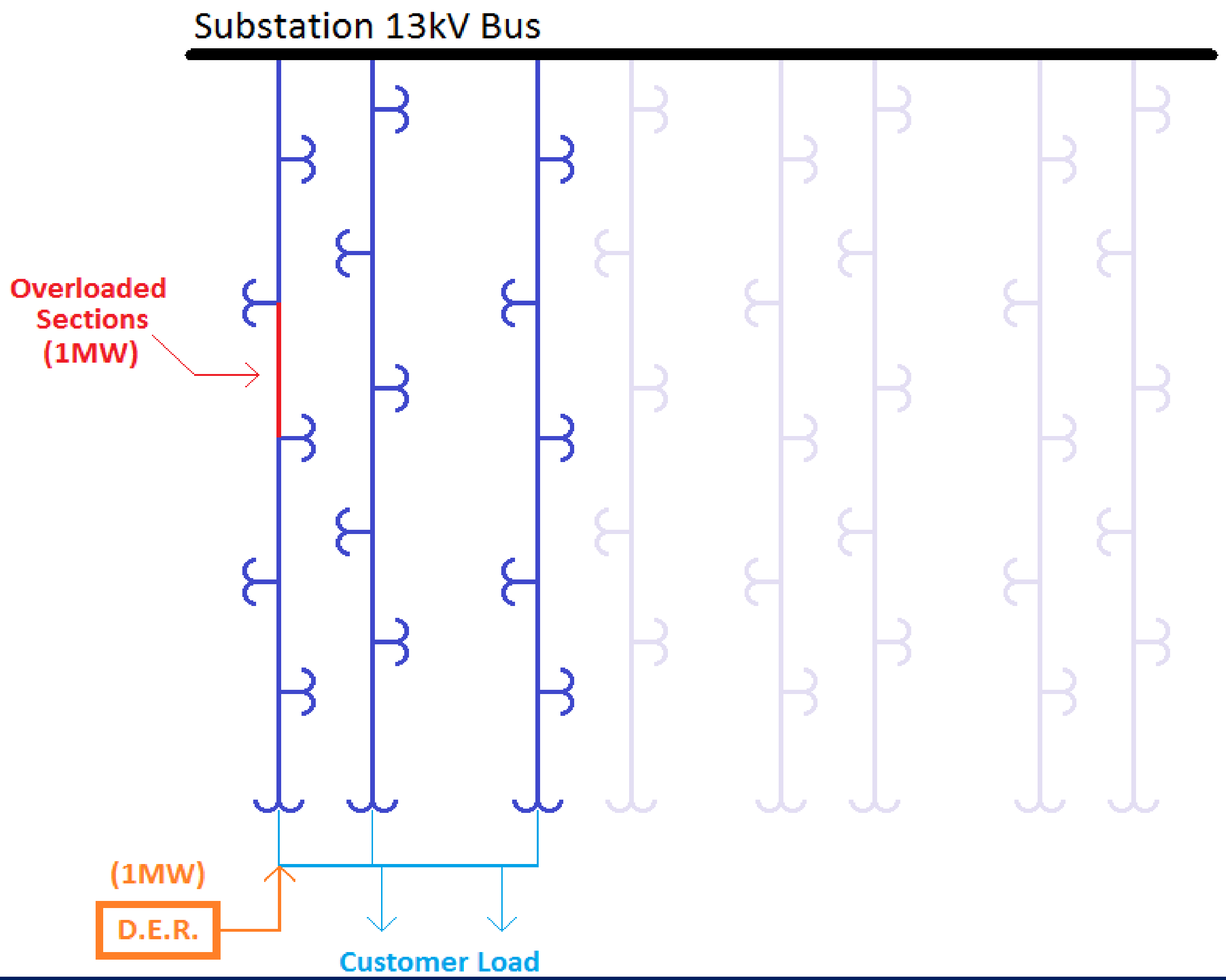
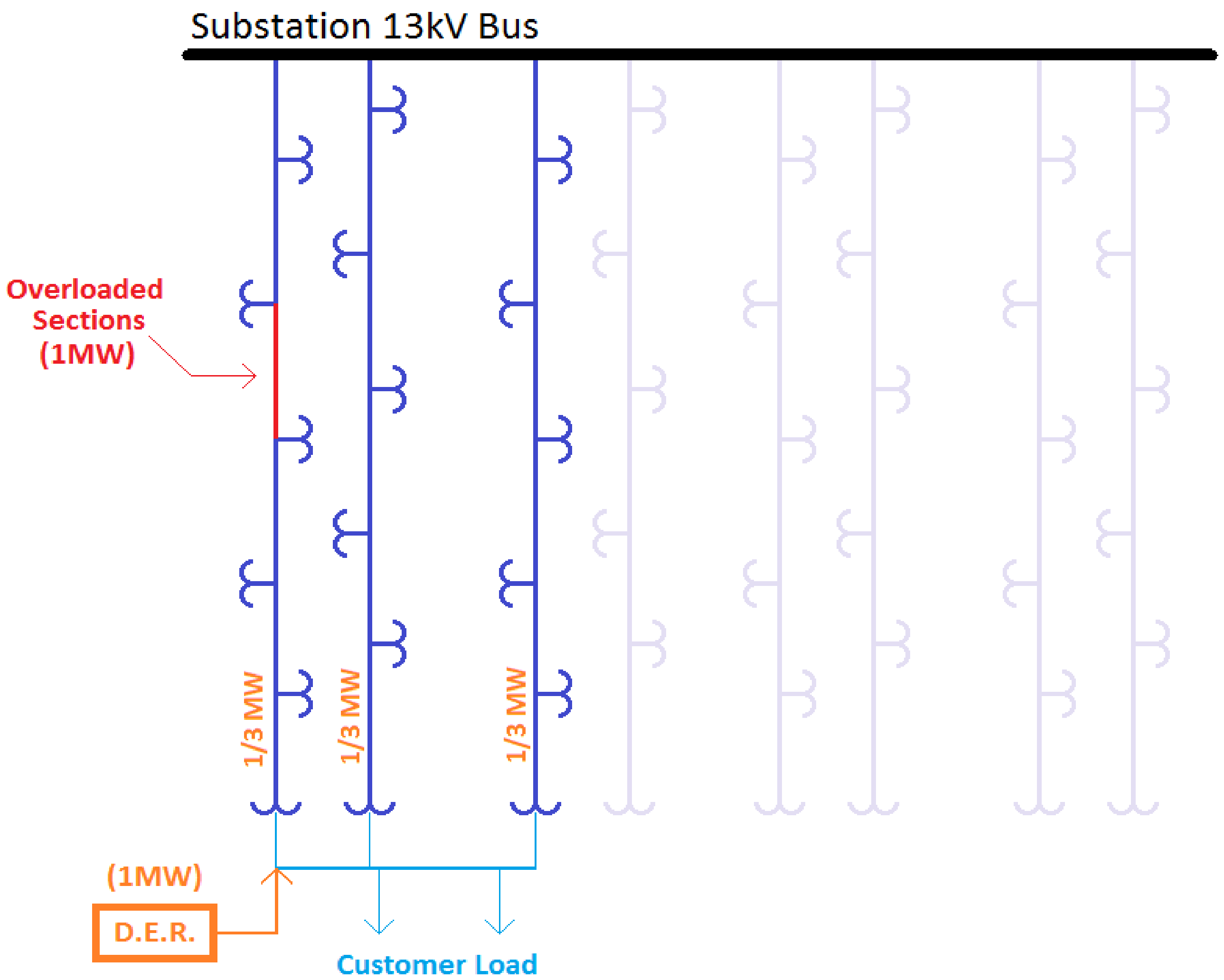
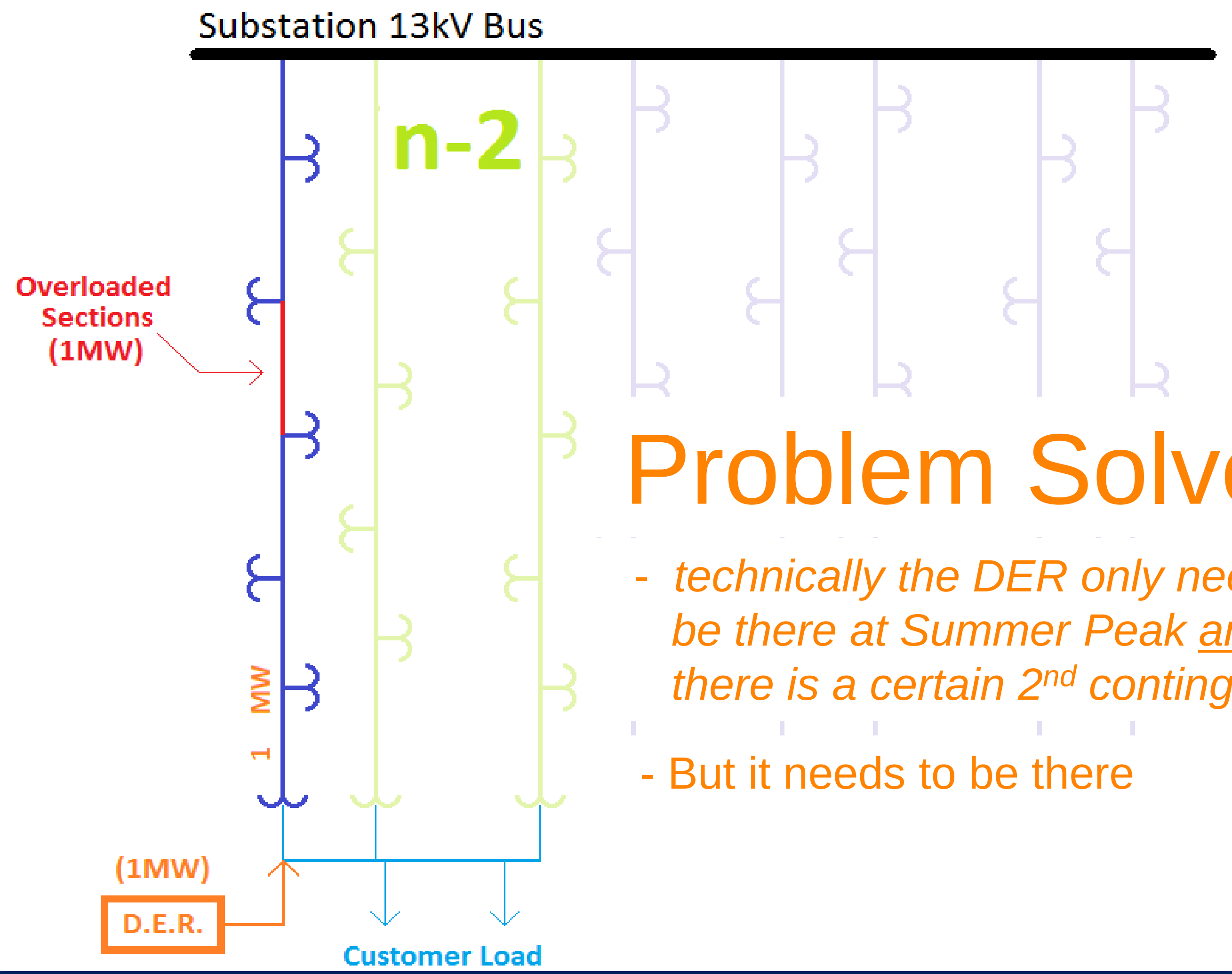


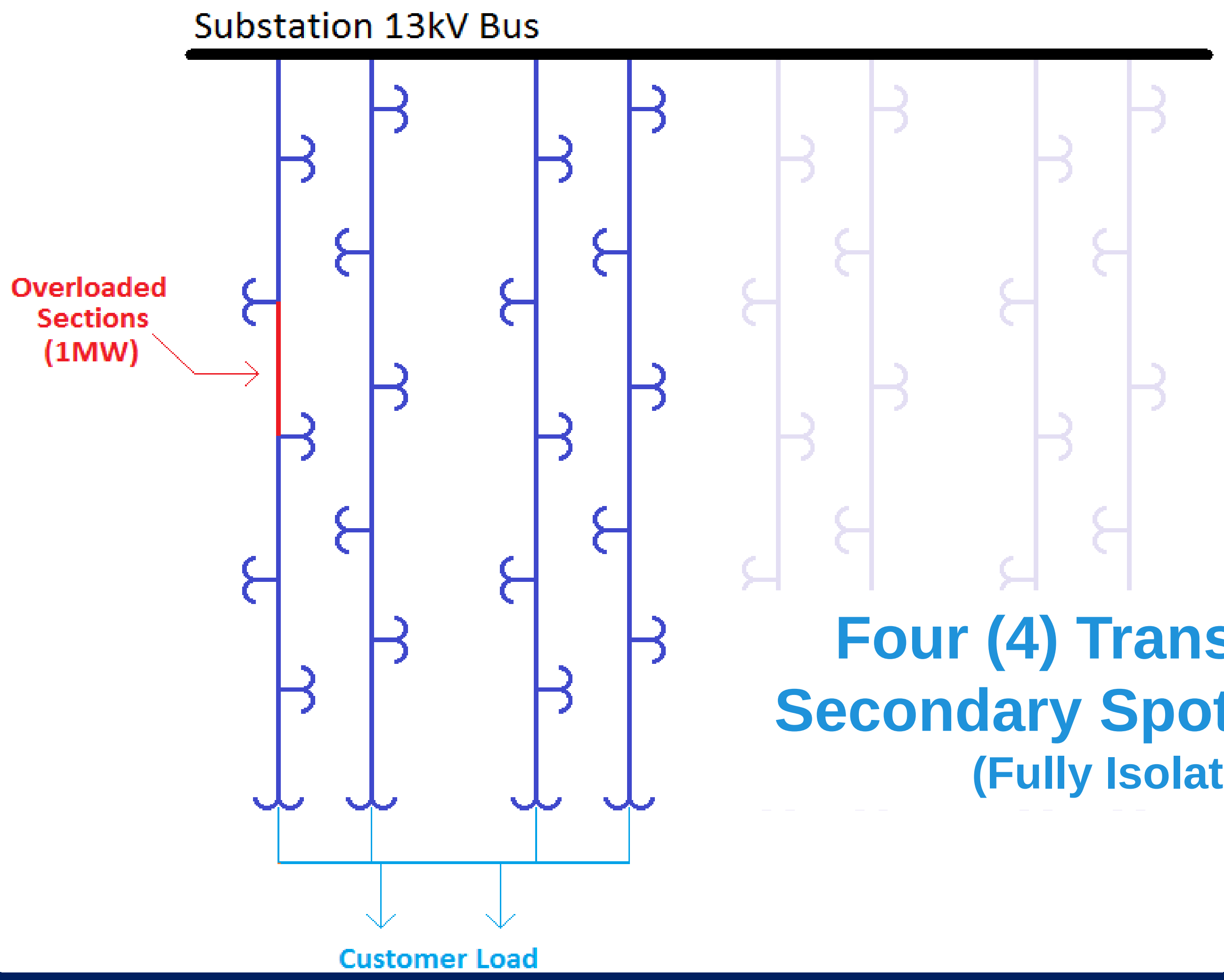

Substation 13kV Bus
Overloaded Sections (1MW)
1/3 MW
1/3 MW
1/3 MW
(1MW)
D.E.R.
Customer Load



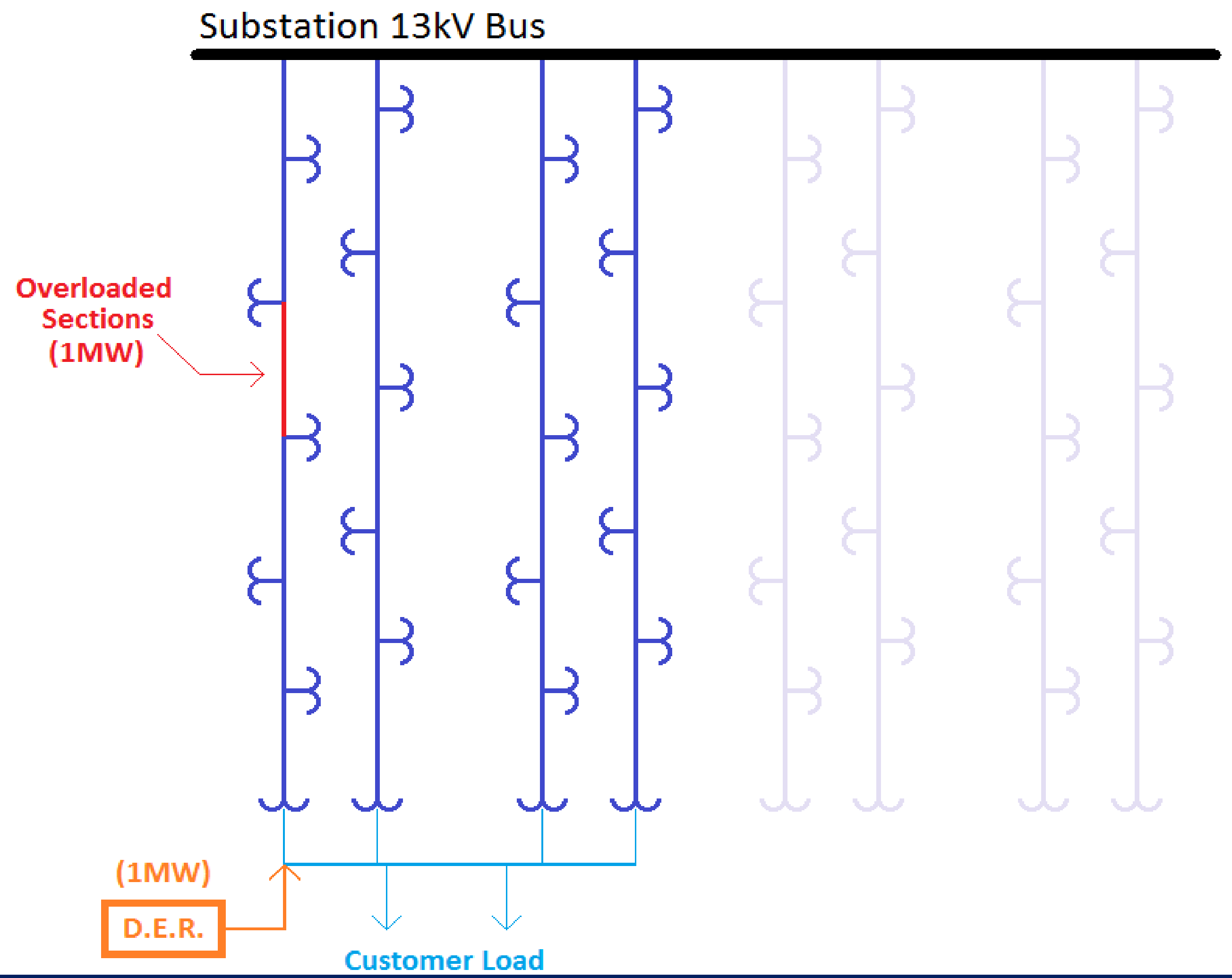
Problem Solved

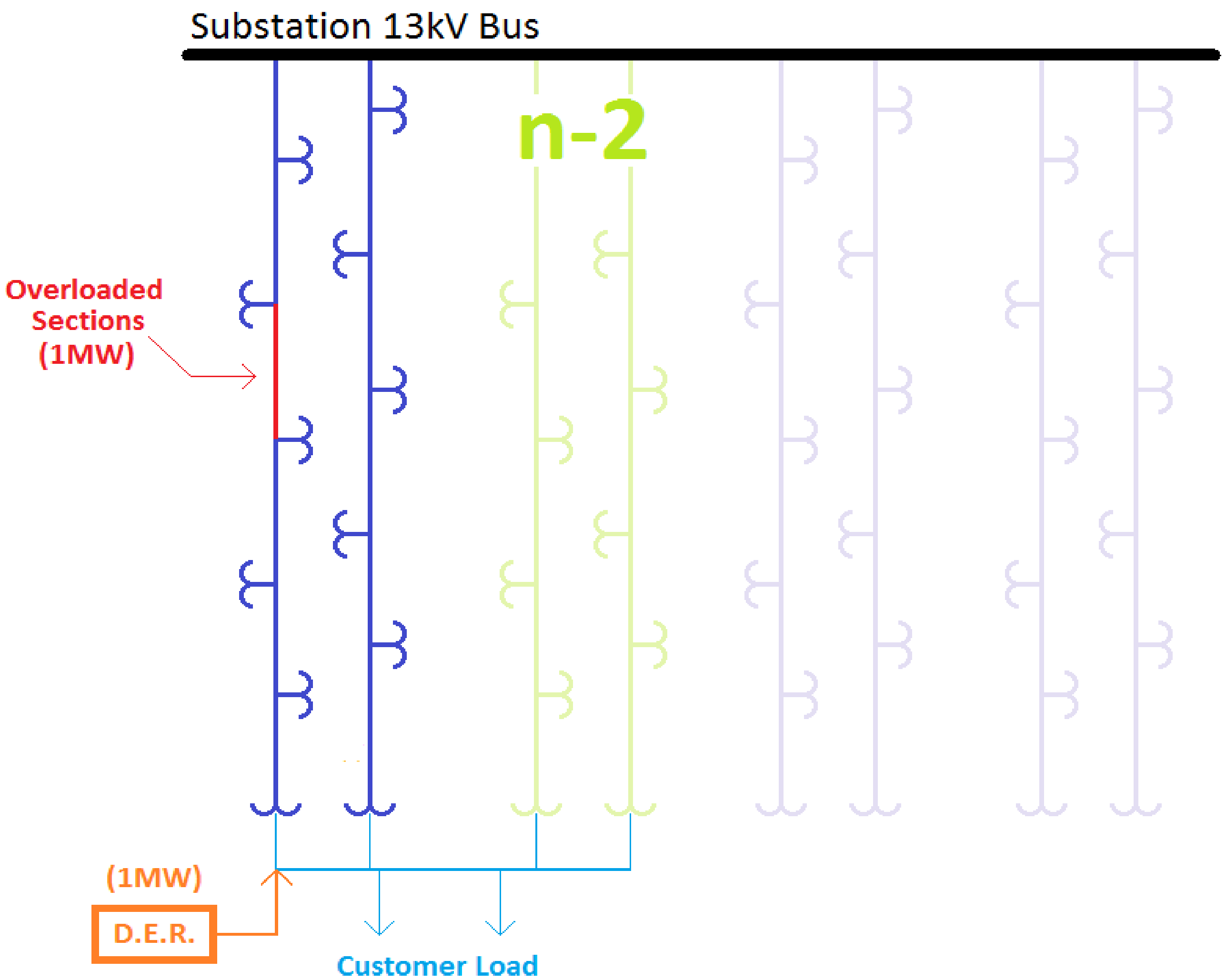
- *technically the DER only needs to be there at Summer Peak and when there is a certain 2nd contingency)*

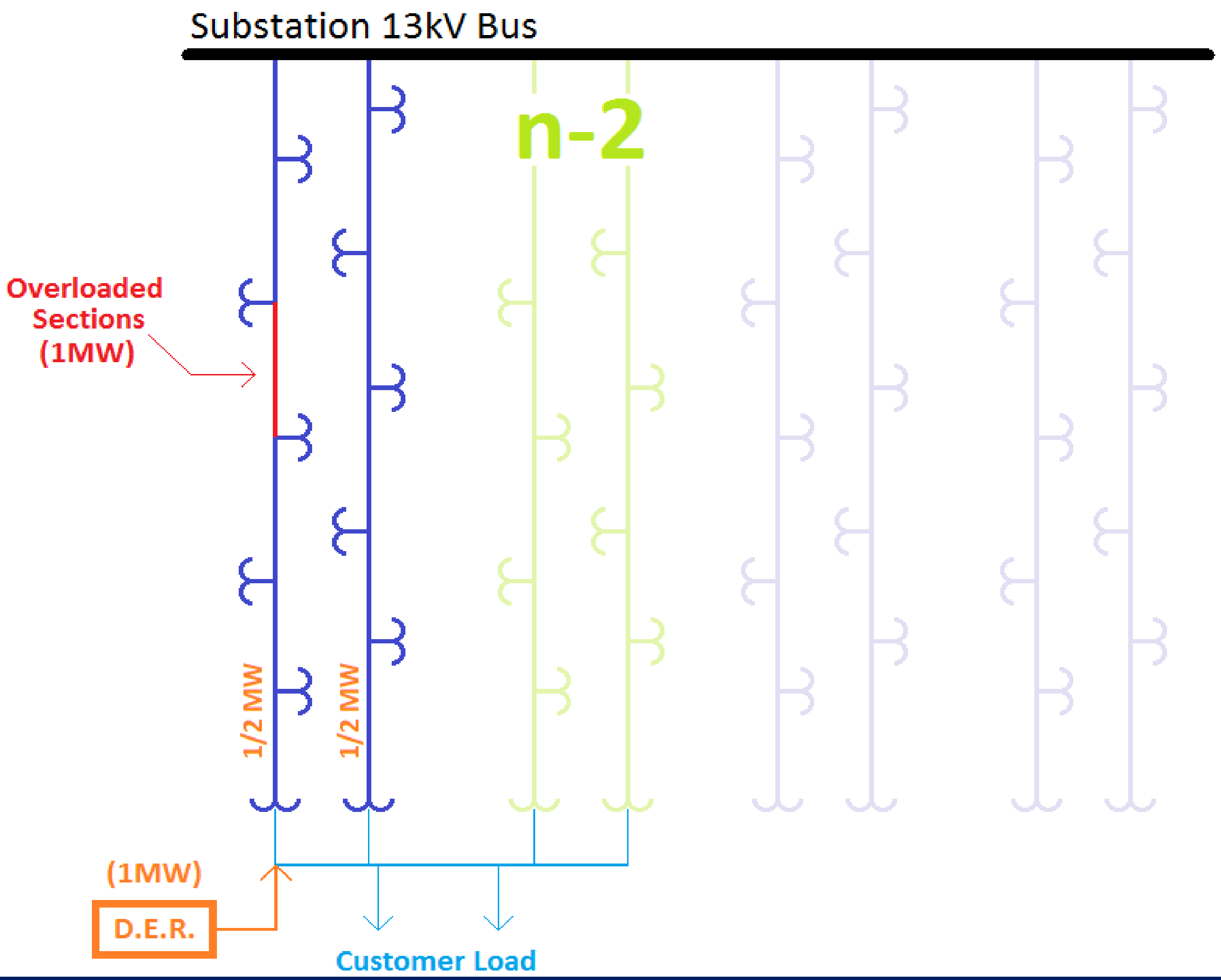
- But it needs to be there



Four (4) Transformer Secondary Spot Network
(Fully Isolated)

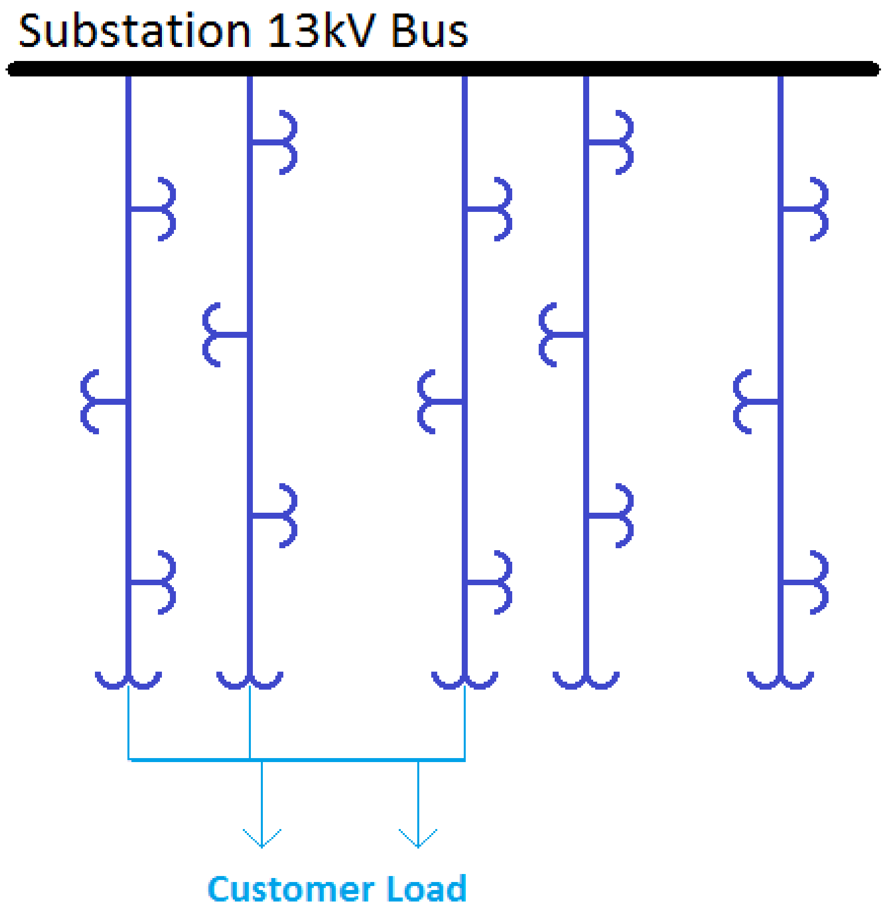

Substation 13kV Bus
Overloaded
Sections
(1MW)
(1MW)
D.E.R.
Customer Load

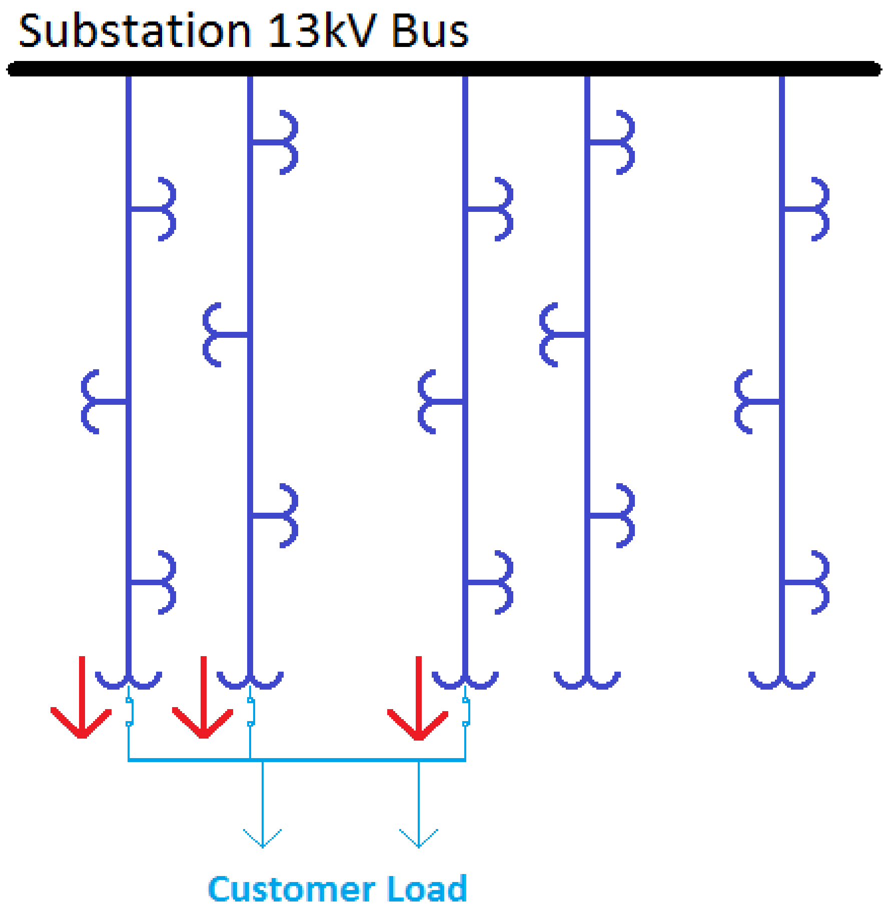

Substation 13kV Bus
n-2
Overloaded Sections (1MW)
(1MW)
D.E.R.
Customer Load


Substation 13kV Bus
n-2
Overloaded Sections (1MW)
1/2 MW
1/2 MW
(1MW)
D.E.R.
Customer Load

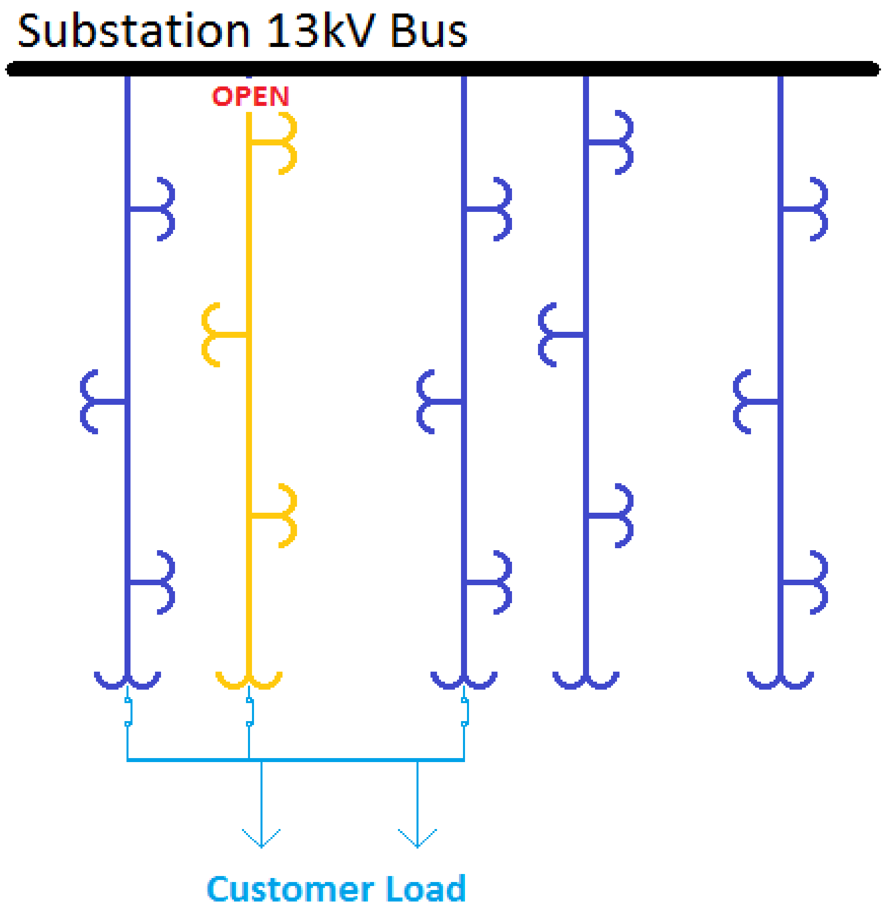
Integration of DER in a Secondary Network

Technology changes to allow two-way power flow on a network

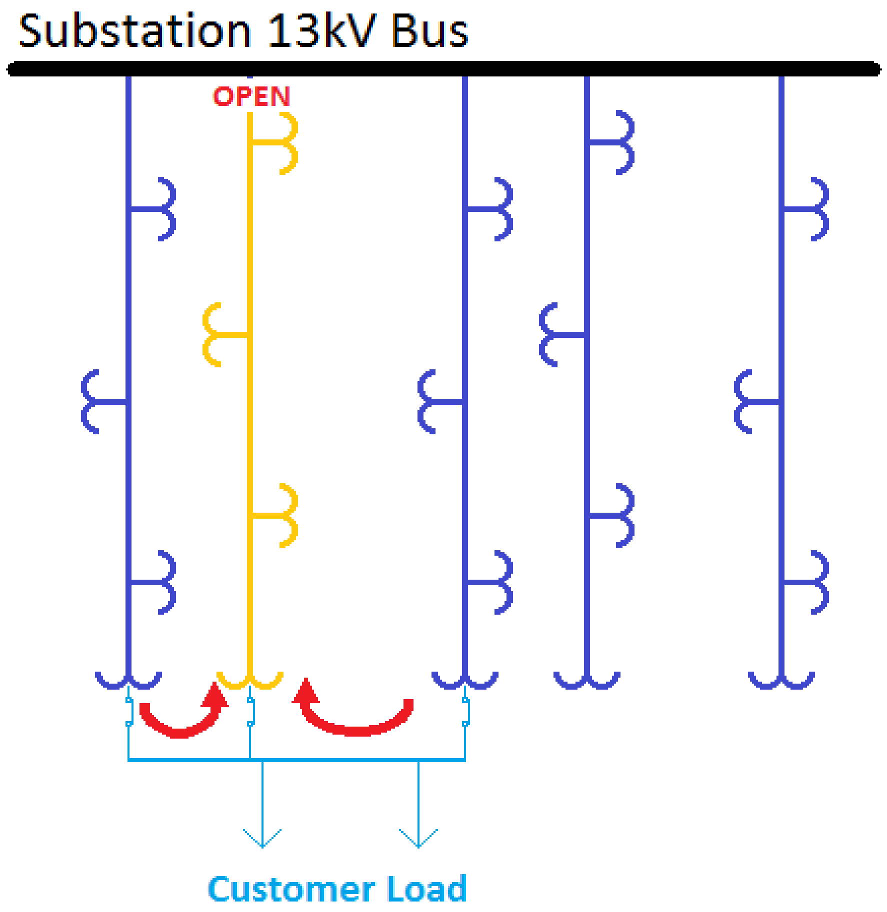

Substation 13kV Bus
Customer Load



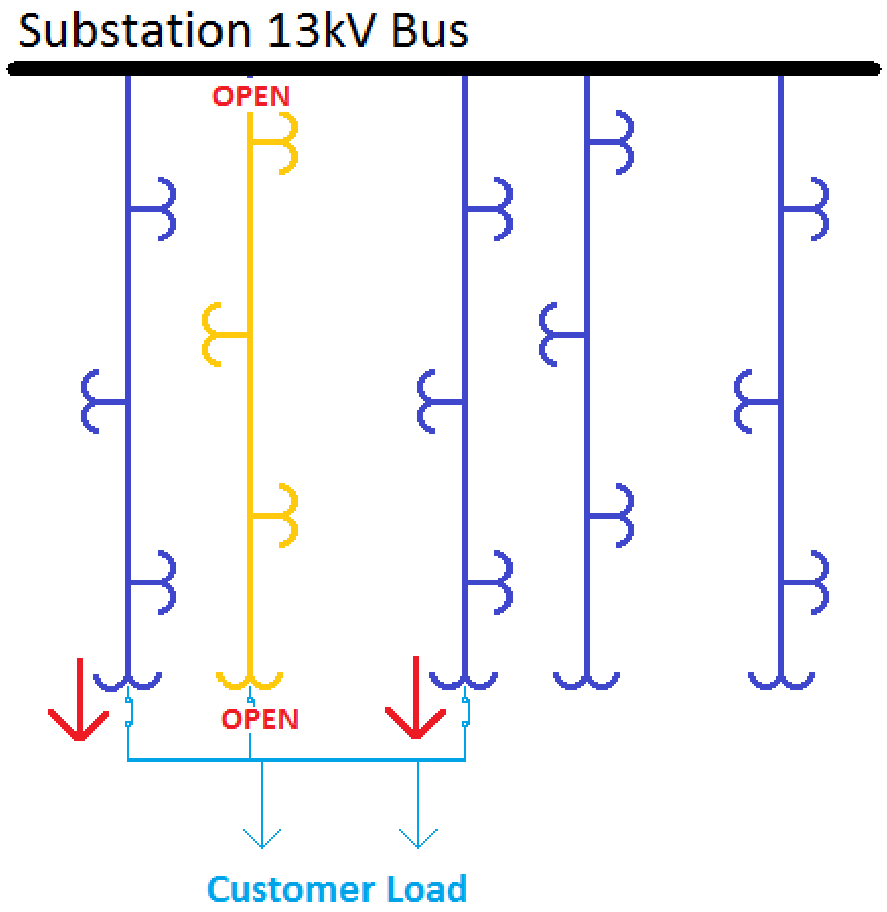
Normal Operation



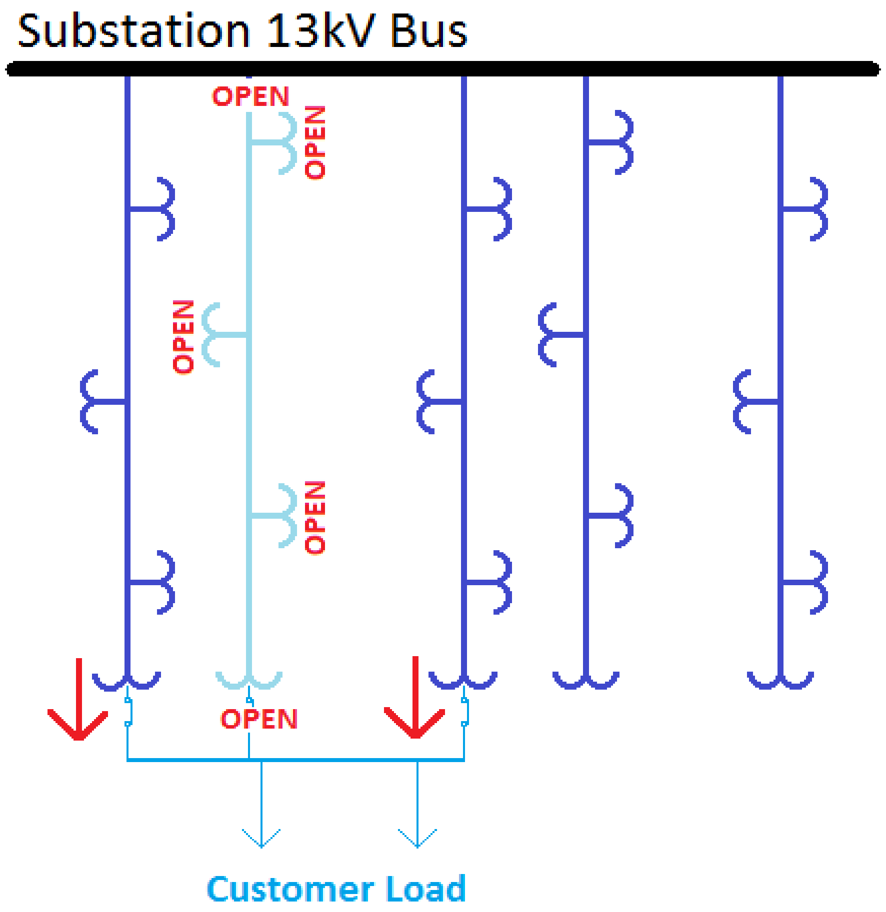
Normal Operation



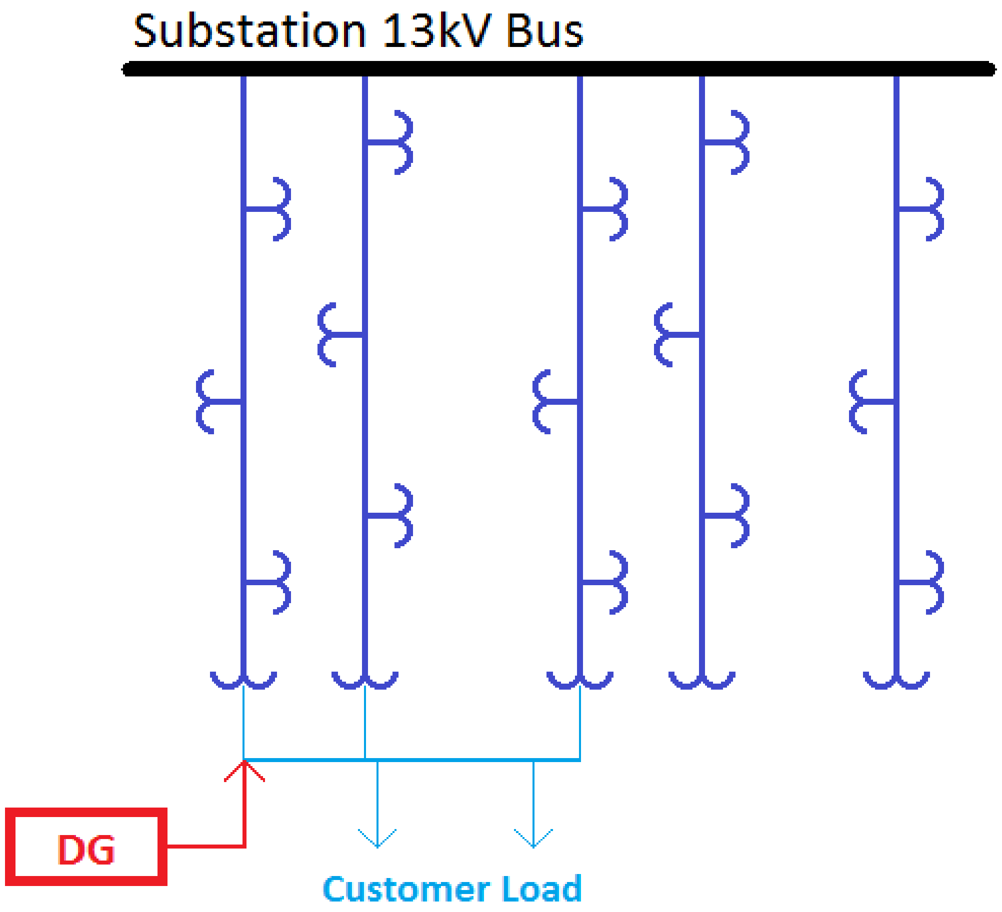
Normal Operation



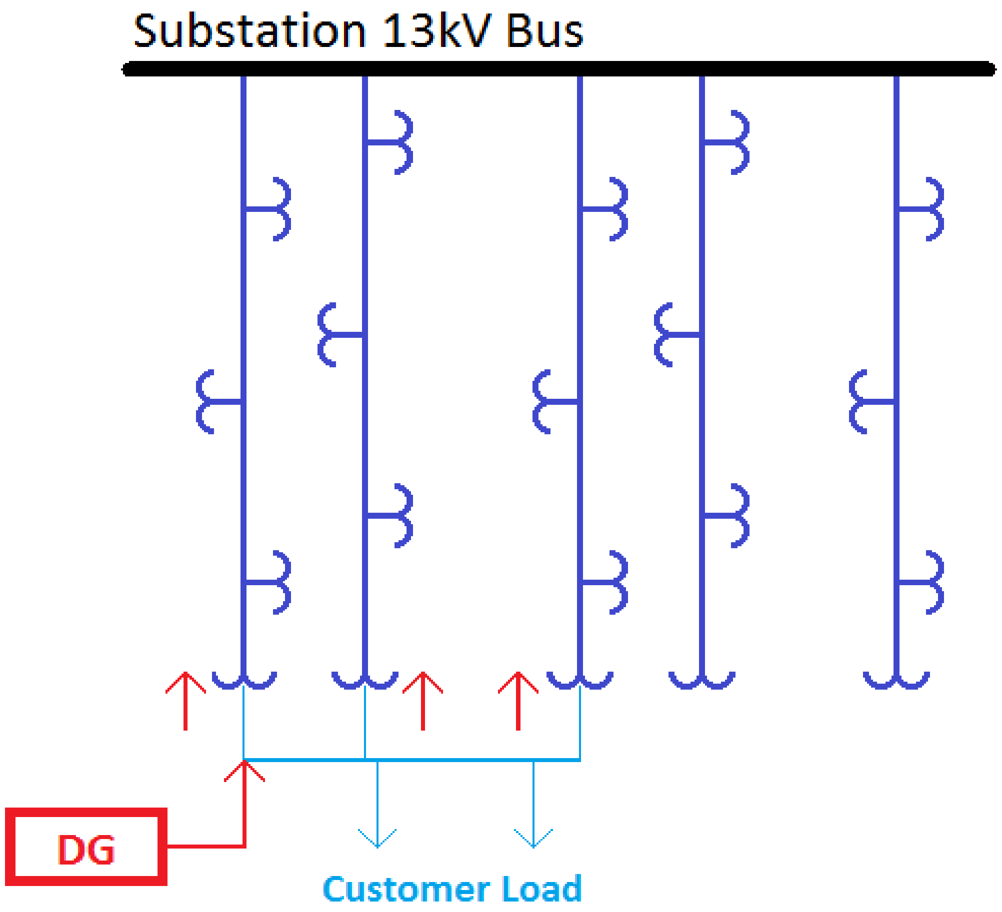
Normal Operation



Normal Operation

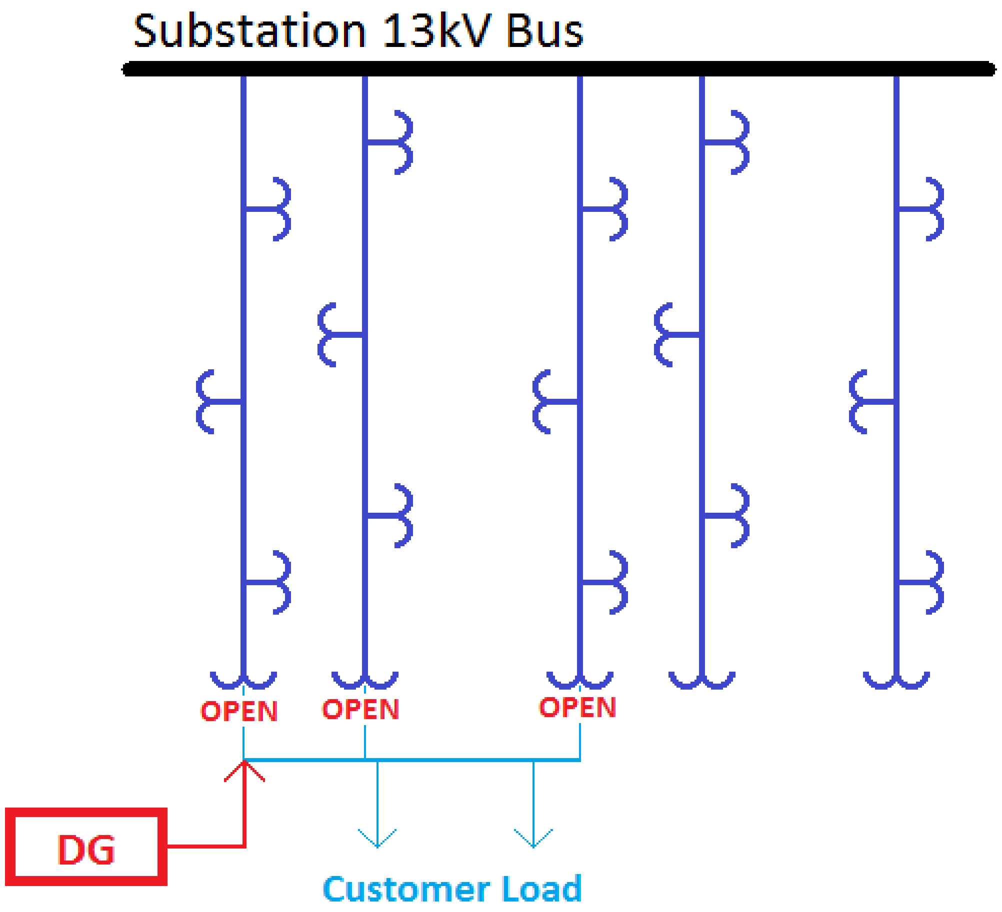


Normal Operation
(with DG)



Normal Operation
(with DG)

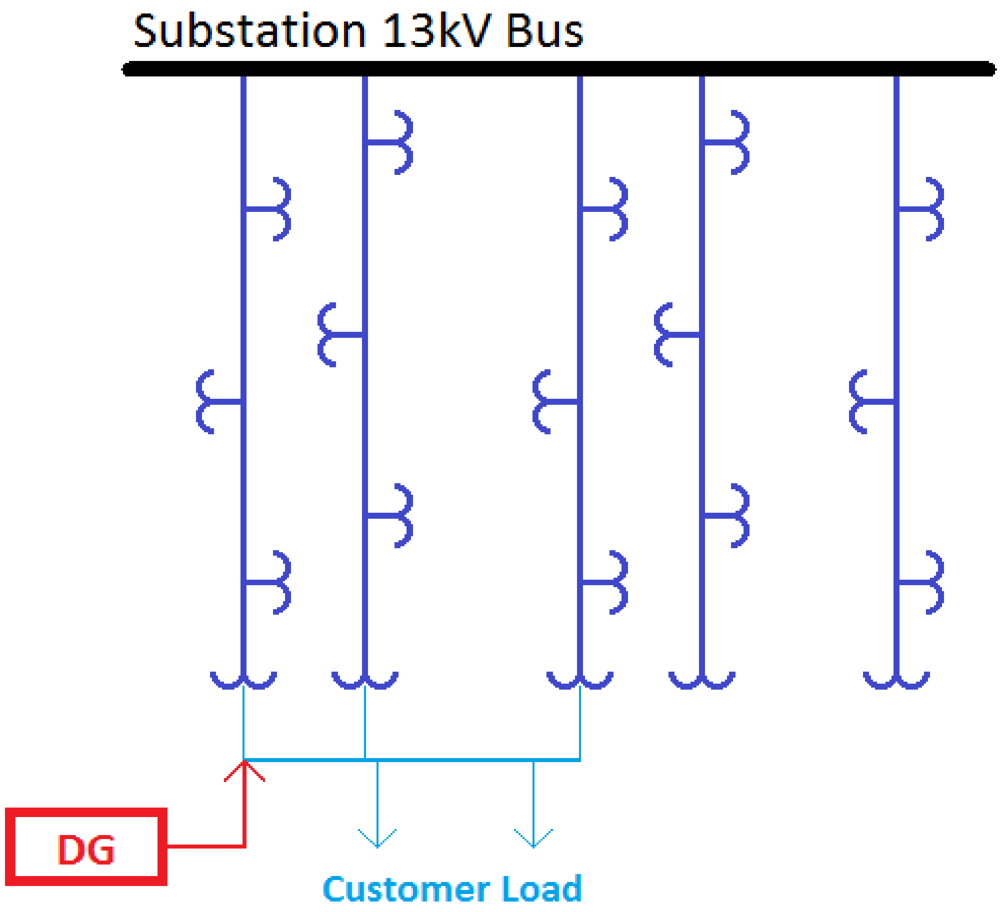
JOINT UTILITIES



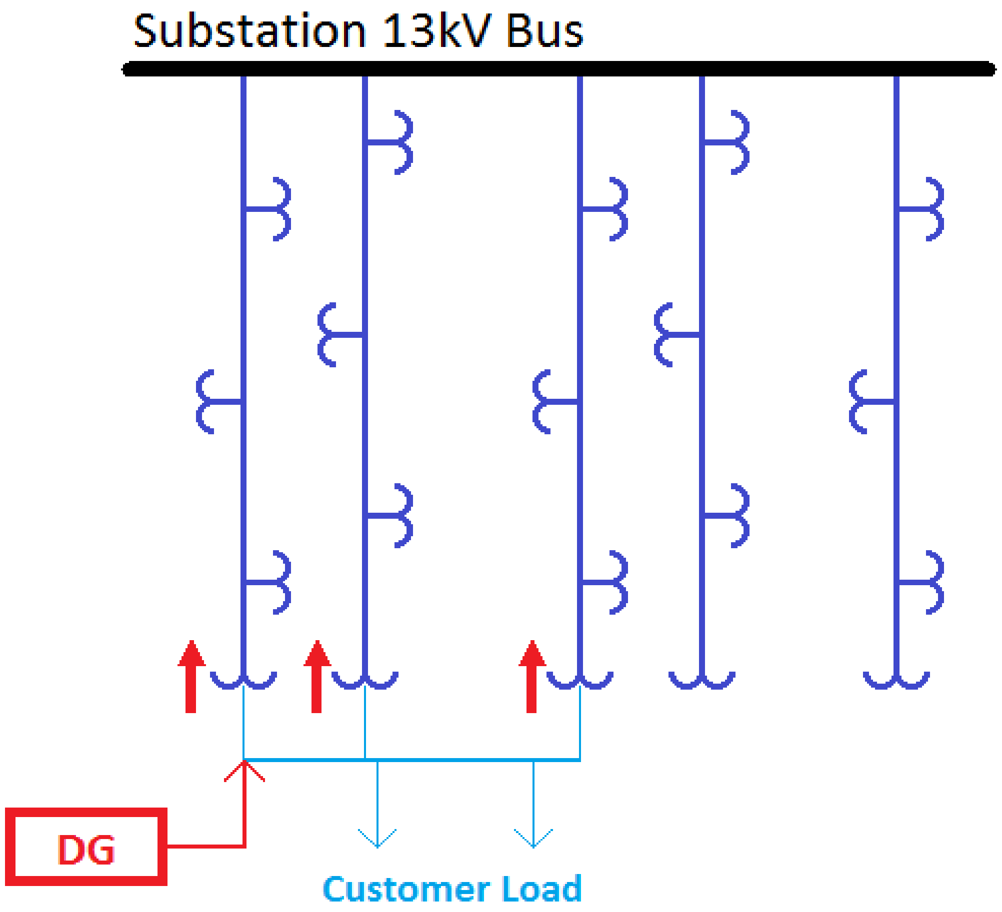
- **Load Dropped** or
- Island Condition

Normal Operation
(with DG)

Joint Utilities

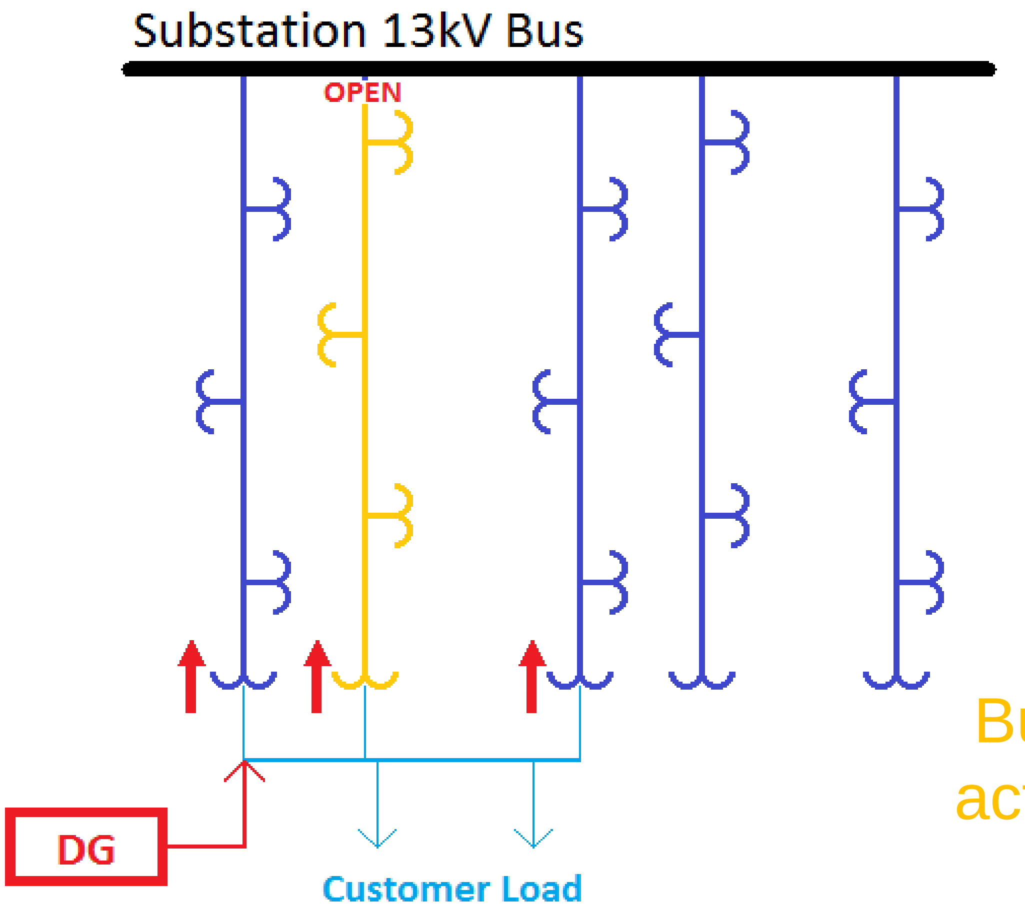


New Scheme to allow reverse flow at an Isolated Network



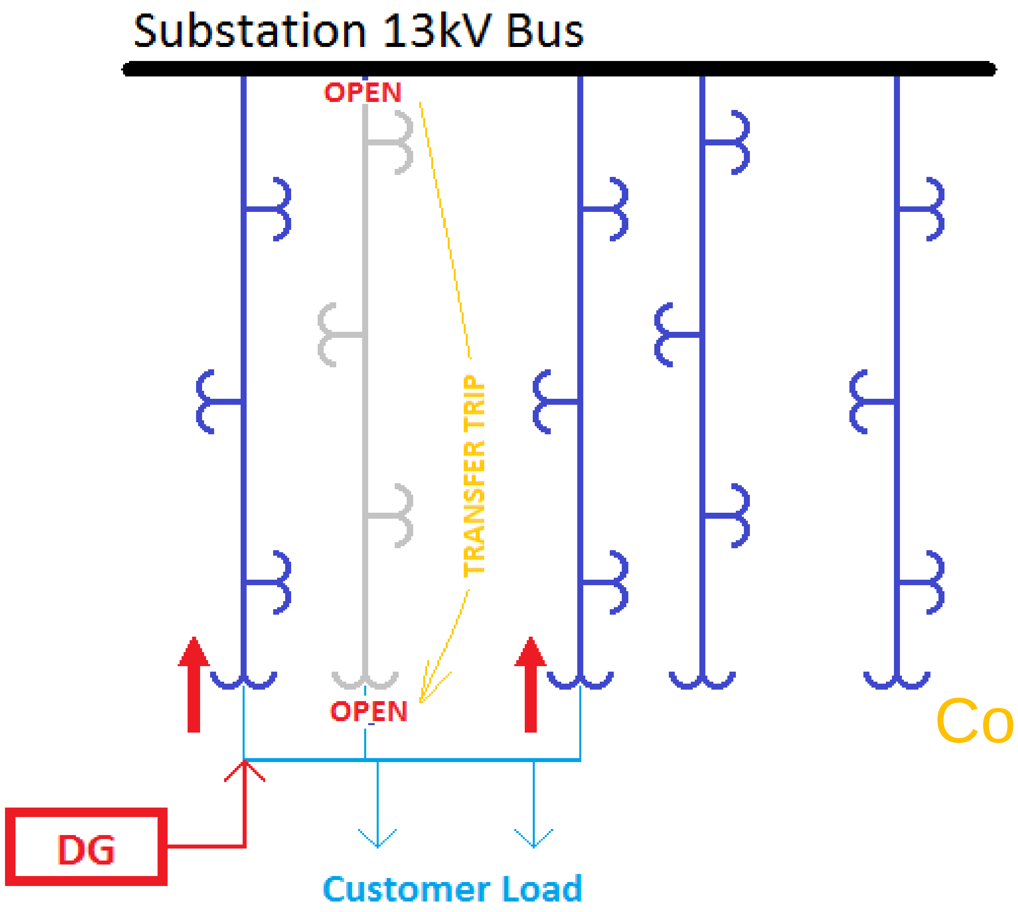
New Scheme to allow reverse flow at an Isolated Network

Effectively Disables the Sensitive Reverse Element



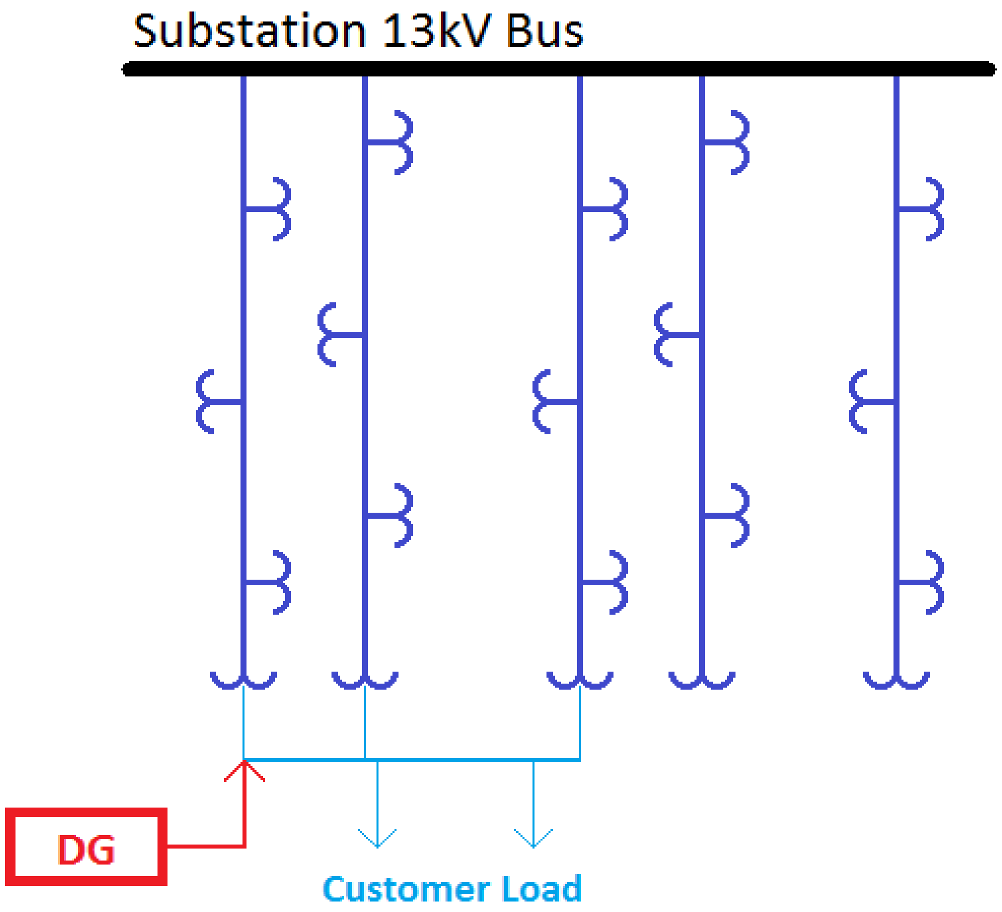
New Scheme to allow reverse flow at an Isolated Network

But what happens when you actually really do want to trip?

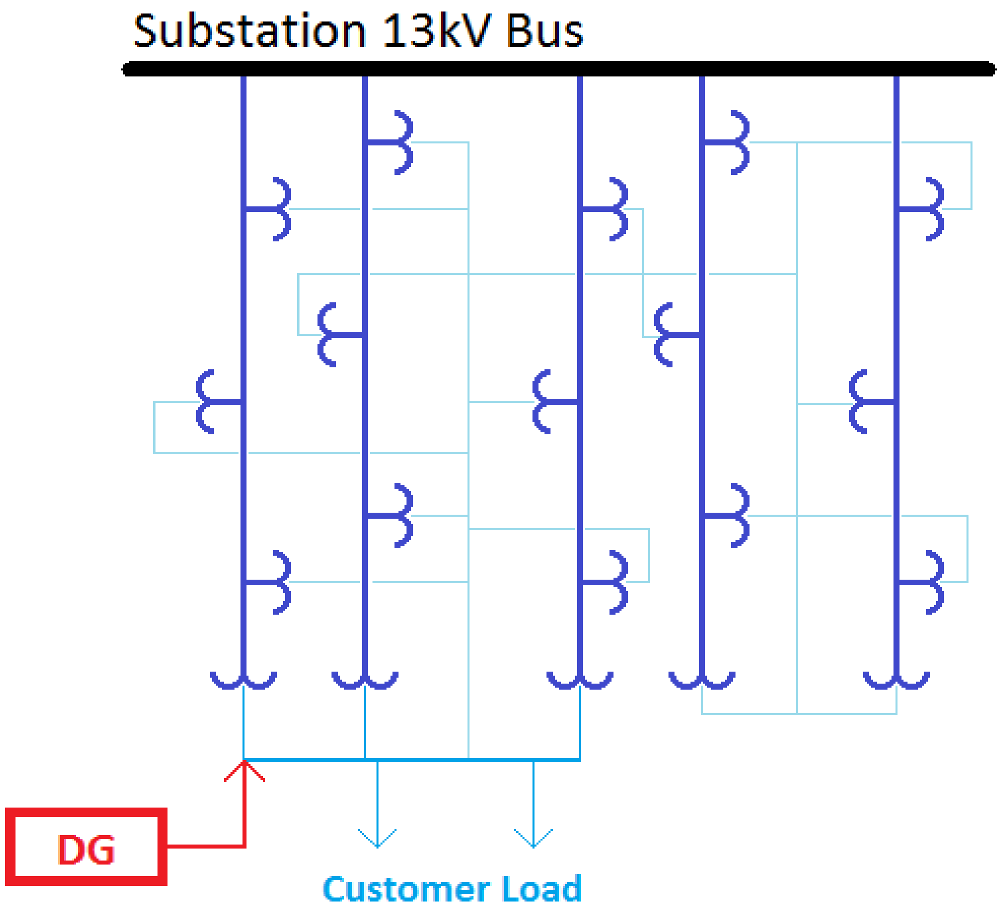


New Scheme to allow reverse flow at an Isolated Network

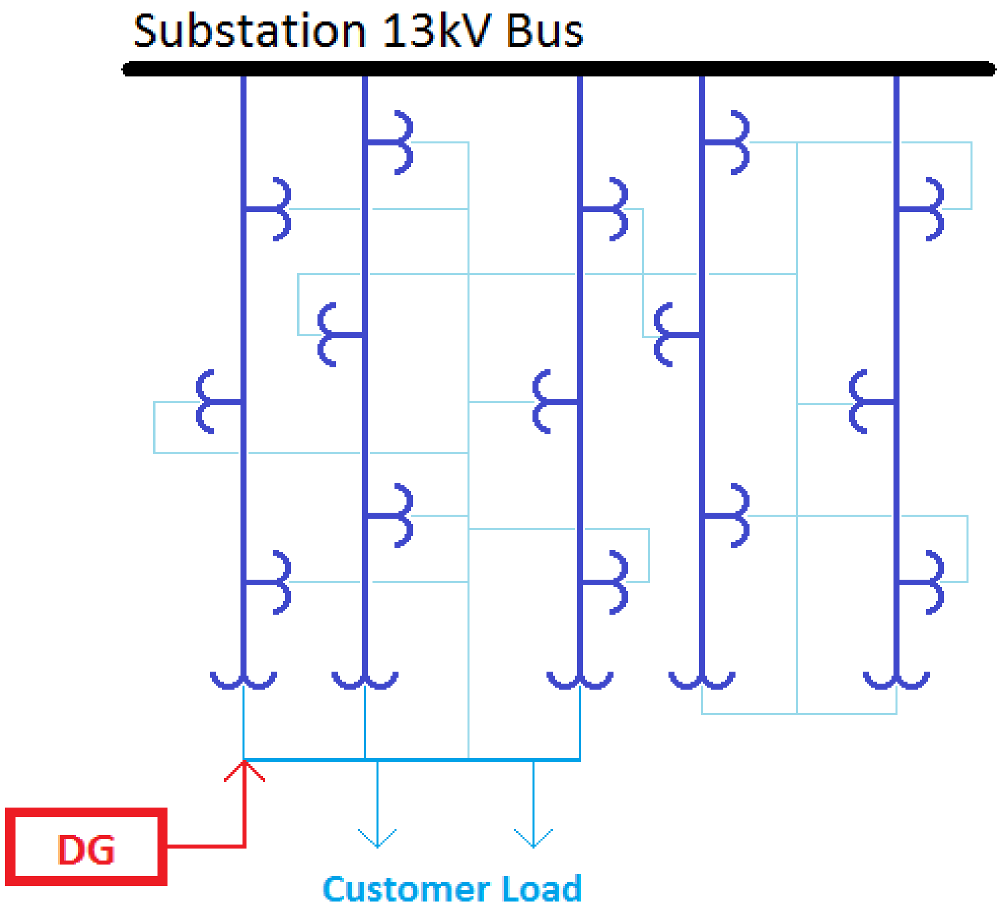
Communication Aided Tripping



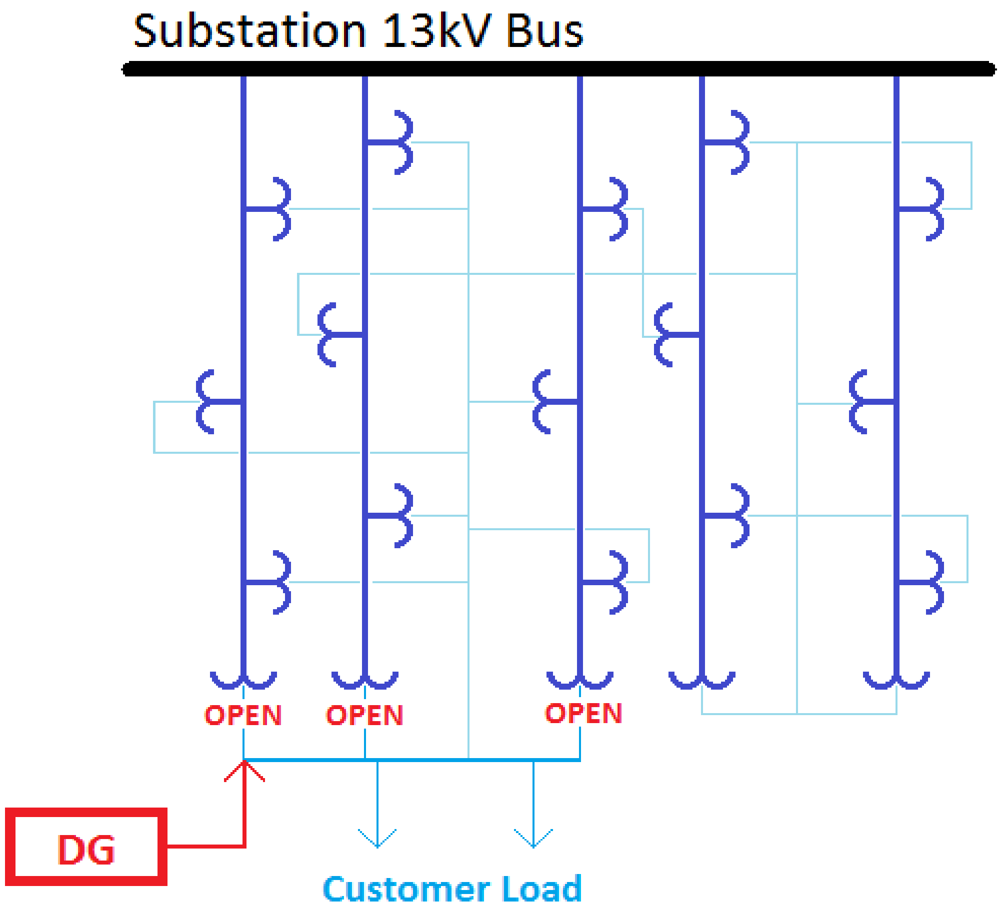
So the last scheme discussed Isolated Networks



Here we are connected to the distributed Network

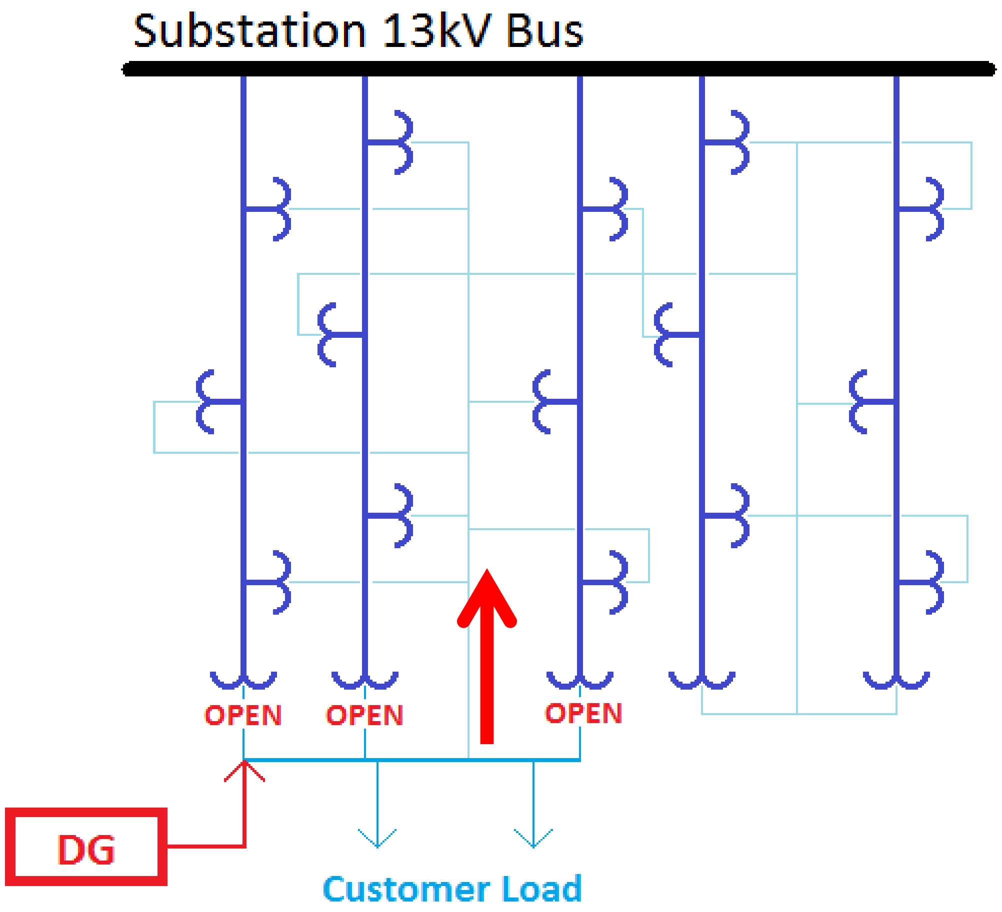


If too much DG gives us reverse power flow



Normal Operation
(with DG)

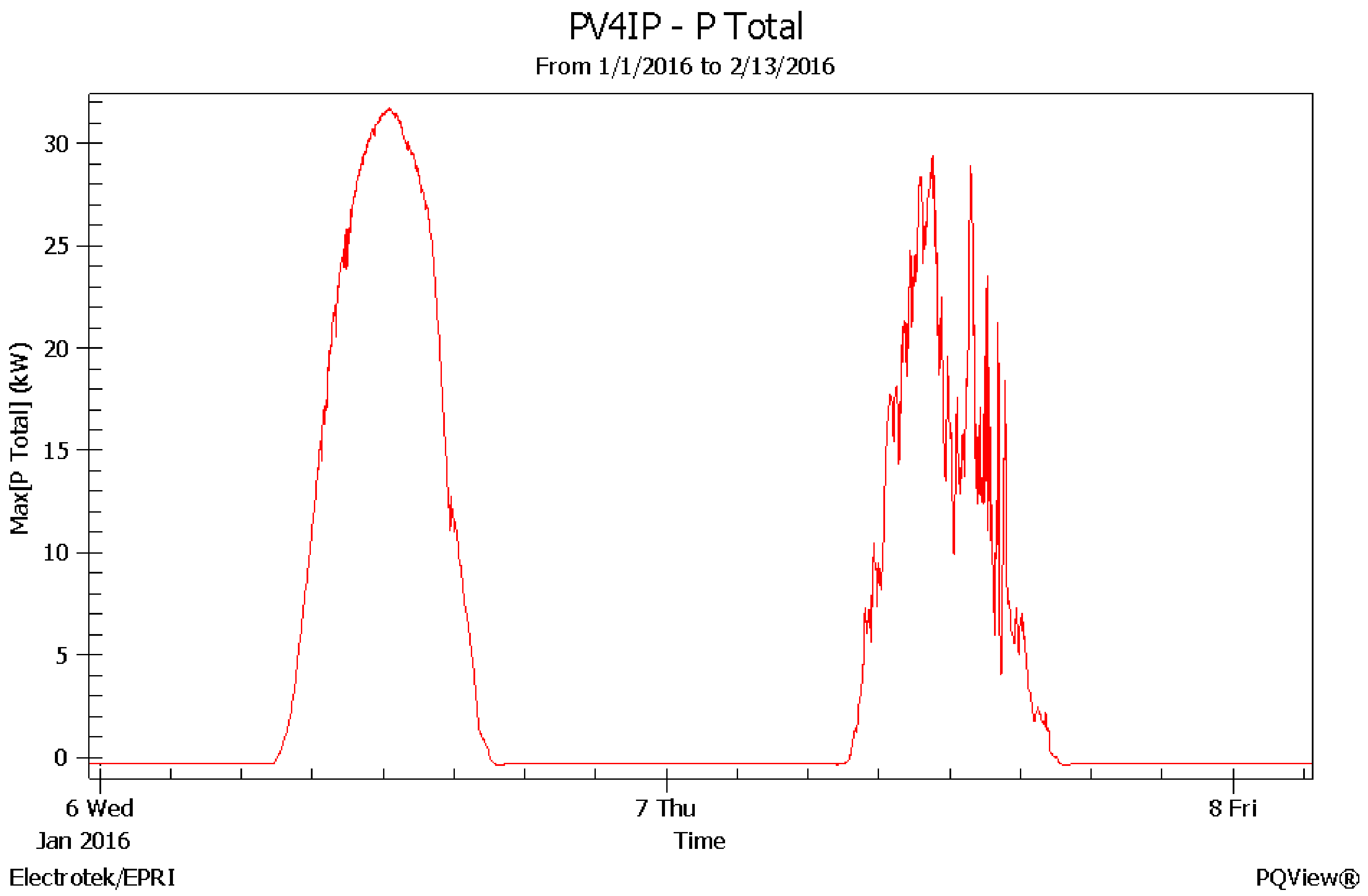
The local Network Protectors will open

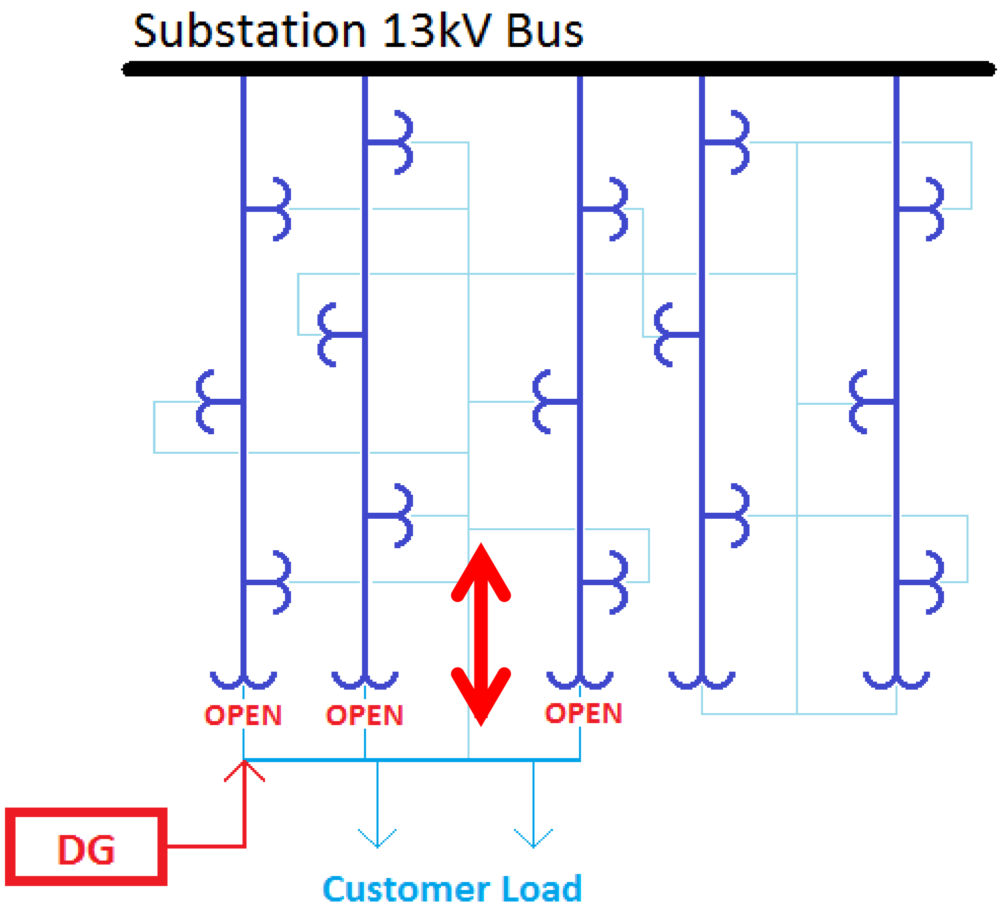


Normal Operation
(with DG)

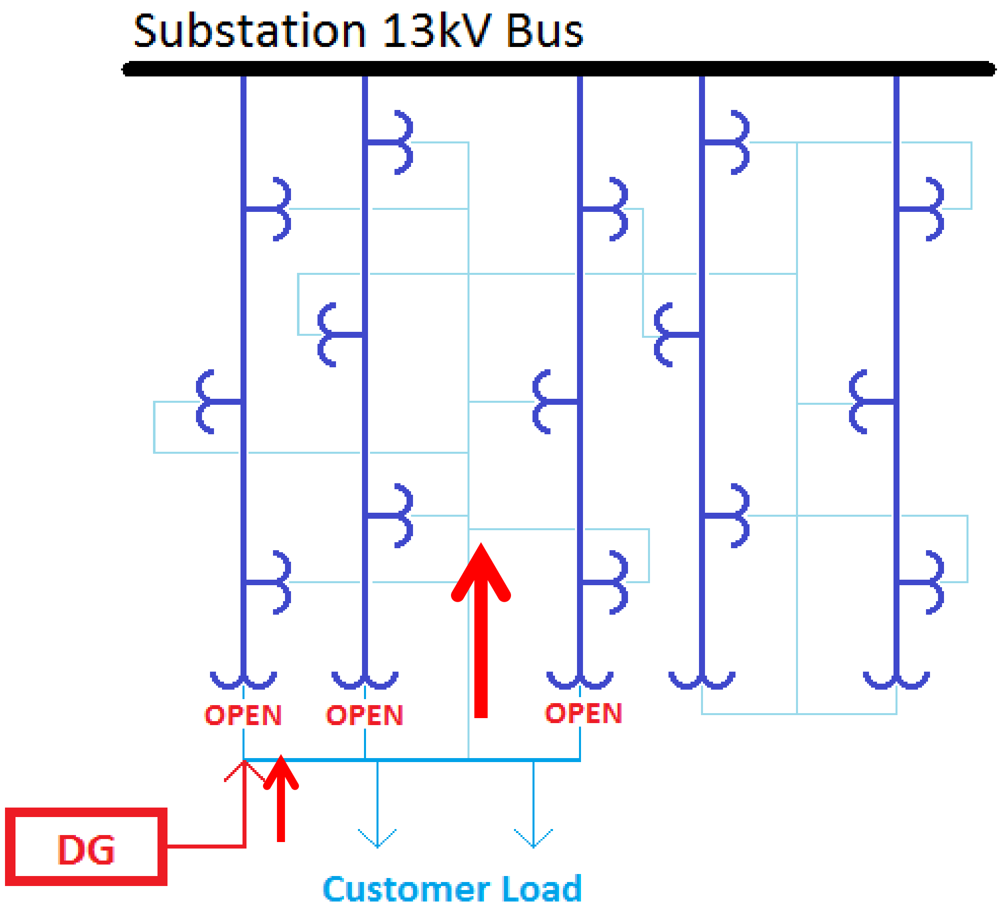
… and all is OK.

… except

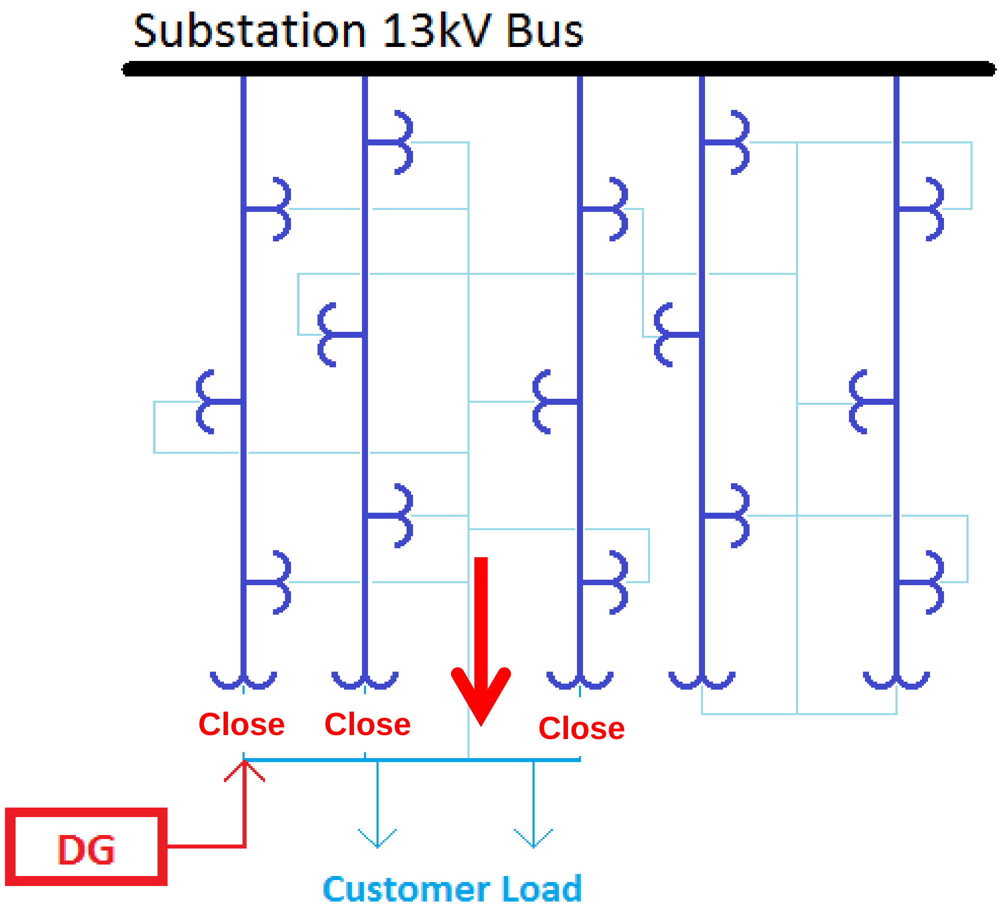

PV4IP - P Total
From 1/1/2016 to 2/13/2016
Max[P Total] (kW)
30
25
20
15
10
5
0
6 Wed
Jan 2016
7 Thu
8 Fri
Time
Electrotek/EPRI
PQView®



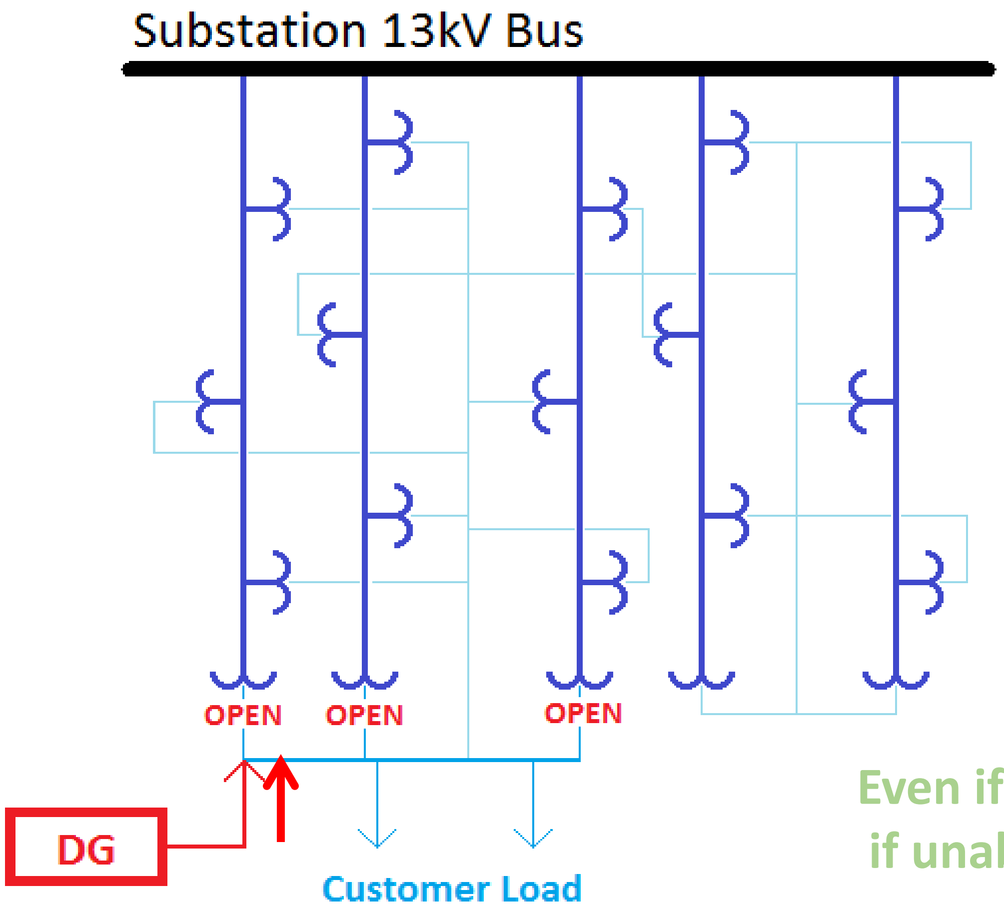
Normal Operation
(with DG)



Normal Operation
(with DG)

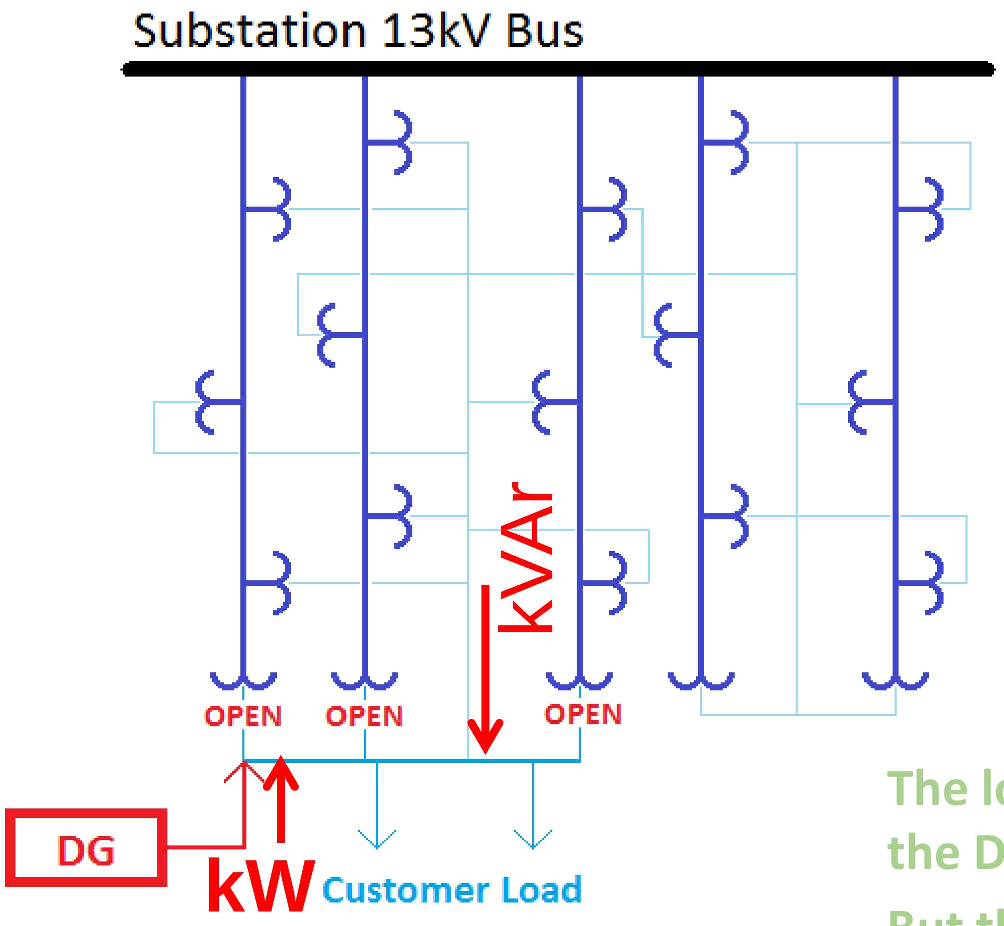


Normal Operation
(with DG)



Normal Operation
(with DG)

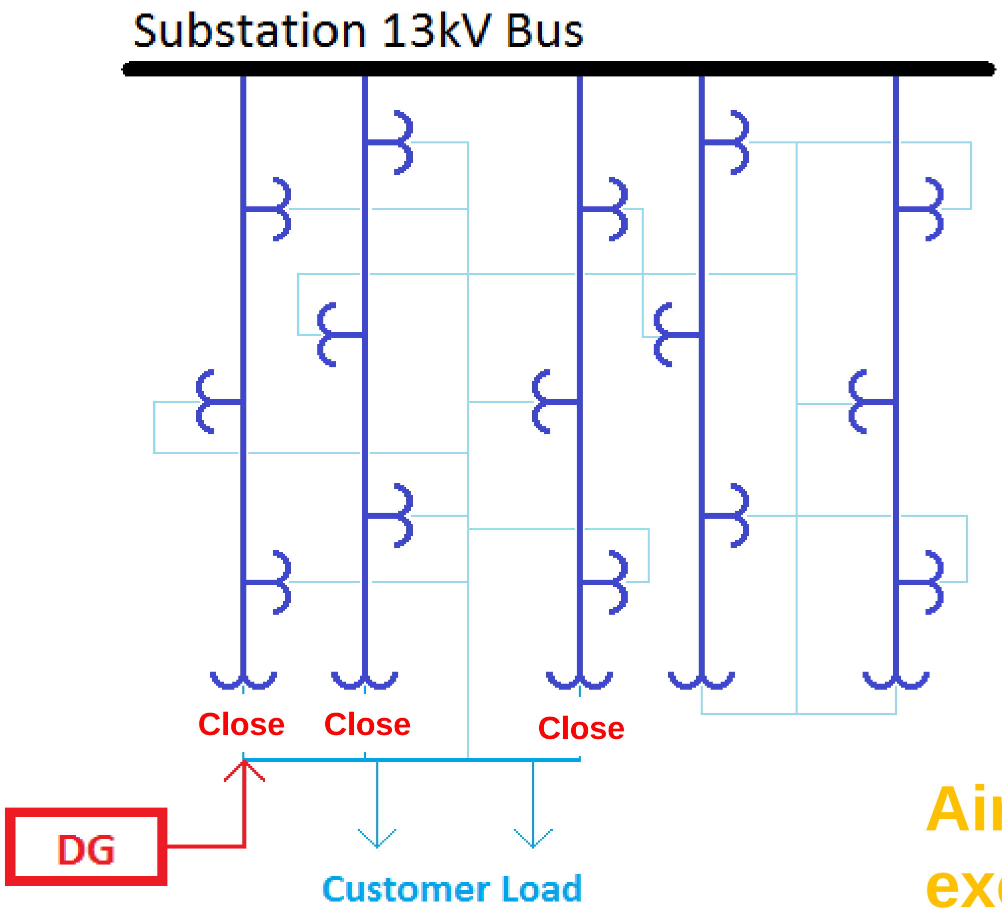
Even if DG Output is relatively constant ...
if unable to produce kVArs



Normal Operation
(with DG)

The local customer kW's will come from the DG (e.g., PV)

But the kVAr's will come from the network



So solutions involve:

"Anti-Pumping"

- detects multiple operations

"Rate-of-Change"

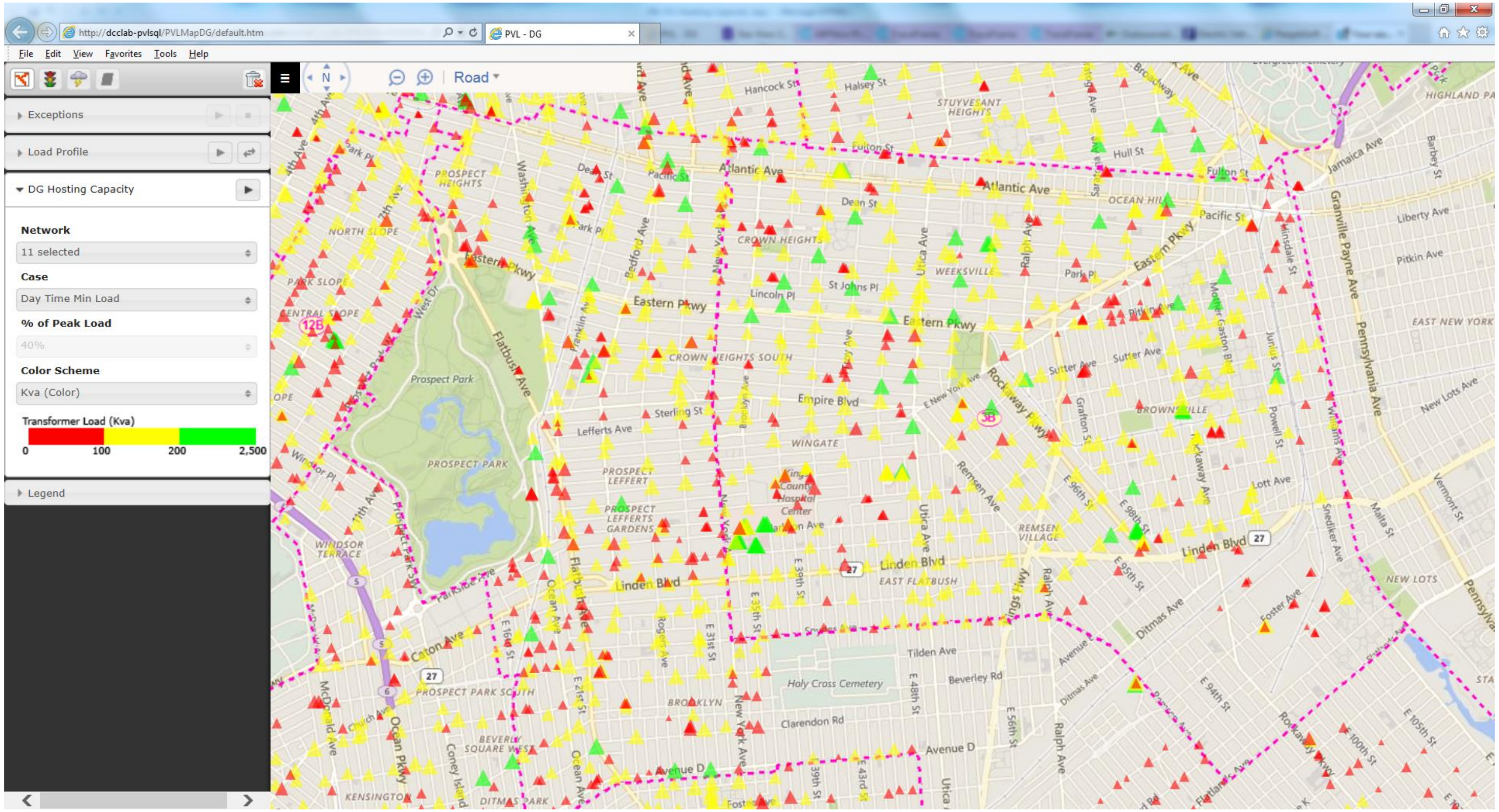
- detects "slow" moving power swings

Aim is too keep NWP closed except for Fdr Outages

Integration of DER in a Secondary Network

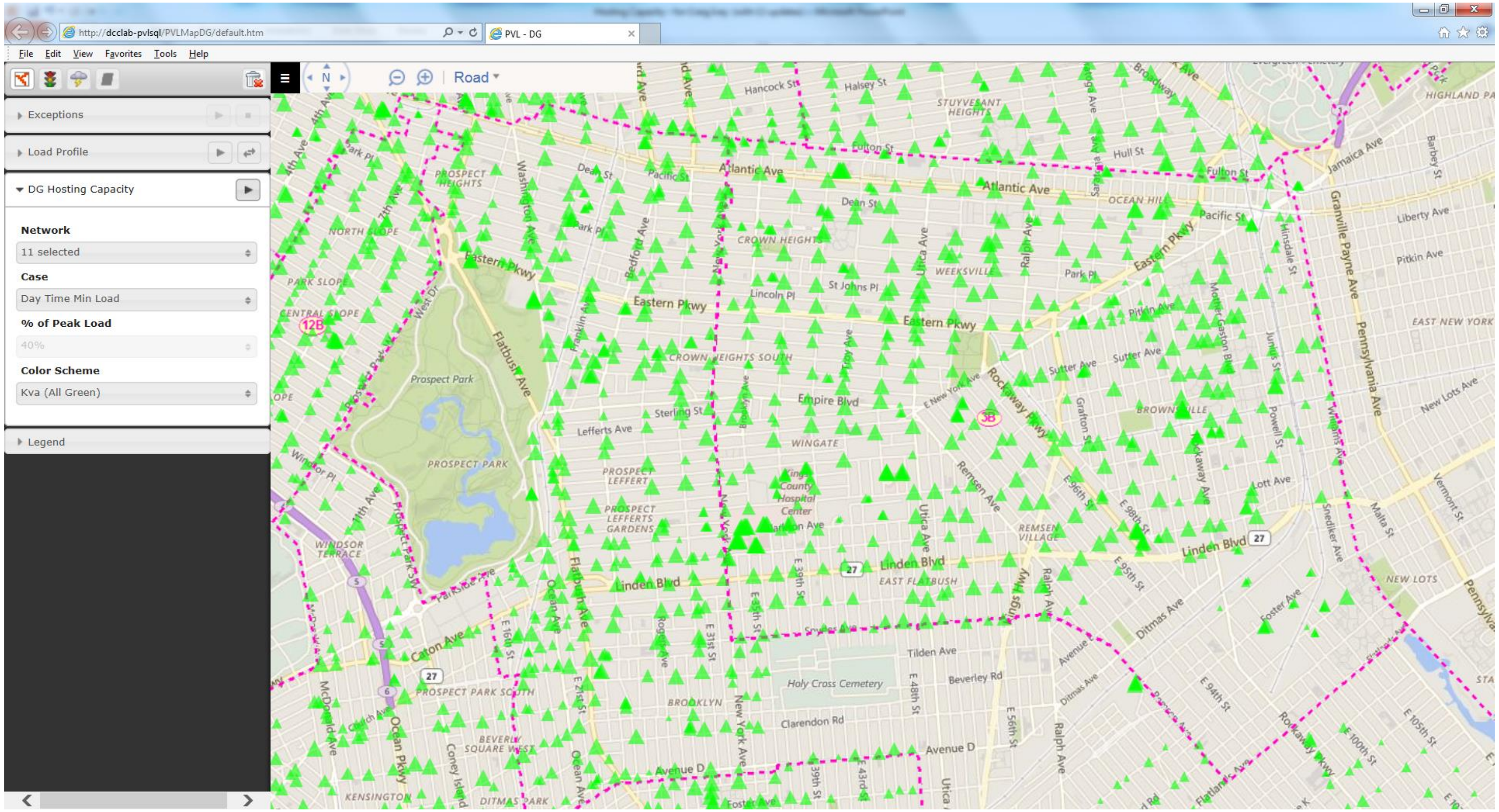
Hosting Capacity

DER Hosting Capacity



http://dcclab-pvlsql/PVLMapDG/default.htm

DER Hosting Application



http://dcclab-pvlsql/PVLMapDG/default.htm

Conclusion

- There are significant differences in the design and operation of overhead radial distribution versus underground network distribution
- Consolidated Edison is in the process of developing tools to evaluate hosting capacity for DER on network distribution systems
- The techniques for evaluating hosting capacity on radial distribution are complex and can't be transposed from the network analysis

JOINT UTILITIES

Questions?

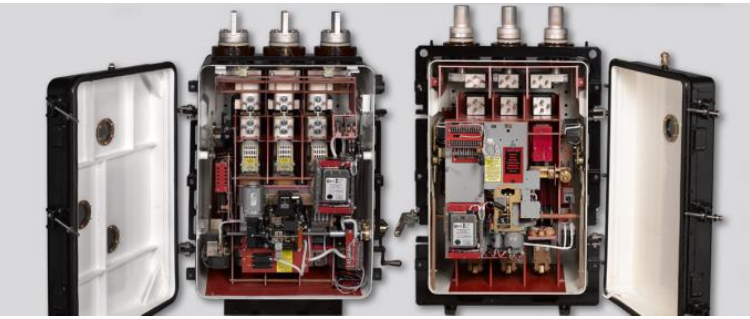
Lunch and Tours

JOINT UTILITIES

Logistics

- Lunch outside of the auditorium to the left
- Three groups that signed up during registration
- Meet tour leaders in the lobby where you signed up and received your pass
- Tours start every 10 minutes and will be complete within 45 minutes
- Back in the auditorium at 1:30 for afternoon sessions

Tours Areas



Lunch and Tours

Tour Groups

1. Green 12:00
   - Dave MacRae/ Eugene De Simone
2. Blue 12:10
   - Andy Bishun/ Angie Mazzella
3. Red 12:20
   - Balvinder Deonarine/ Diana Cabrera

Sample Schedule

Topic	Schedule
Meet in Lobby	12:00
Network Lab (205)	12:15
Overhead Training Area	12:30
Secondary Splicing	12:45

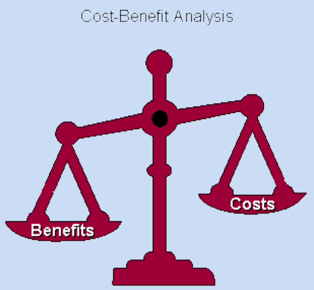
JOINT UTILITIES

Planning and Forecasting for the Distribution Grid

Rob Sheridan - PE, Director, New Energy Solutions, National Grid

Mark Domino - PE, Manager, Distribution & Subtransmission Planning, National Grid

Planning Objectives



Safety

- Public
- Employee

Compliance

- Obligation to Serve
- Standards and Codes
- Licenses and Contracts

Reliability

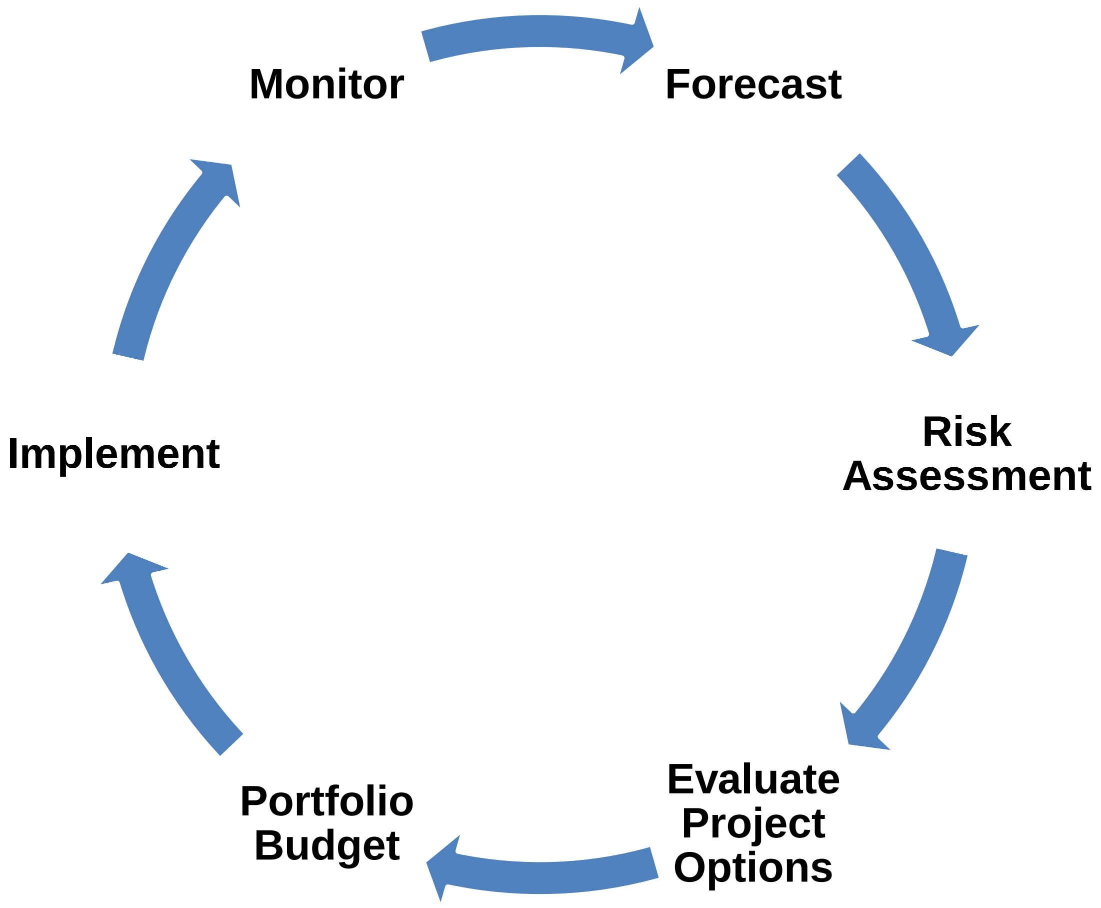
- Prevent Failures
- Respond to Failures

Cost Effective

- Initial
- Lifetime
- Capital
- O&M

Planning Cycle is a Continuous Process

- Annual cycle
- Integrates wide breath of considerations, data sources and stakeholders
- Risk based prioritization
- Leads to multi-year work plan



Forecasting
Many Inputs

JOINT UTILITIES

Capacity
- Load vs Rating
- Voltage and Power Factor

Reliability
- Frequency of Interruption
- Duration of Interruption

Asset Condition
- Inspections
- Maintainability

Resilience
- Ability to recover from a Major Event

Operability
- Standard Equipment and Procedures
- Systems Integration
- Skills and Training

Cost
- Installation
- Operation & Maintenance

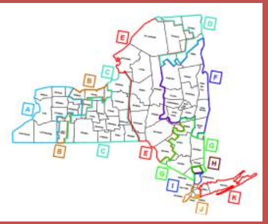
Need Date
- Lead Time
- Longevity

Project Synergies
- Project Implementation
- Long Term Plan

Forecasting Draws from a Diverse Set of Inputs

JOINT UTILITIES

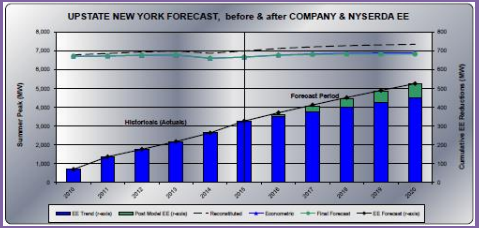
Historic Loads



Weather Normalization

- Heating Degree Days
- Temperature-Humidity Indexes

Energy Efficiency



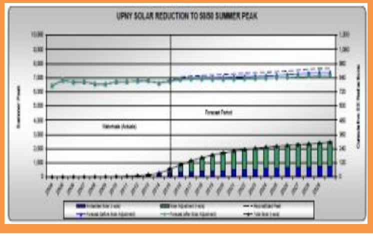
Demand Response

- NYISO Programs

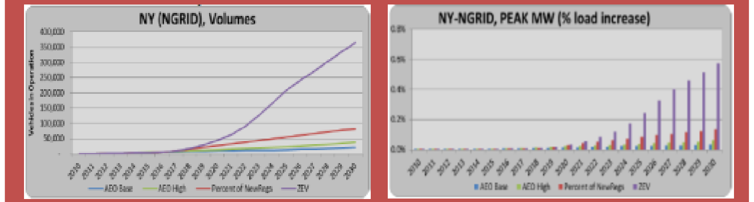
Year	Date	Zones	Hour BEG Start Time	Hour END End Time	ICAP Assigned TOTAL	A	B	C	D	E	F	comment
2013	19-Jul	A-F	13:00	18:00	366.0	202.0	12.0	48.0	1.0	20.0	83.0	per NYISO
	18-Jul	A-F	13:00	18:00	311.1	171.7	10.2	40.8	0.9	17.0	70.6	assume 85% of July 19th, 2013
2012	17-Jul	B-only	14:00	18:00	2.0	-	2.0	-	-	-	-	per NYISO
	21-Jun	A-F	13:00	18:00	183.0	101.0	6.0	24.0	0.5	10.0	41.5	assume 50% of July 19th, 2013
	20-Jun	C-only	14:00	18:00	24.0	-	-	24.0	-	-	-	assume 50% of July 19th, 2013
	29-May	A-F	13:00	18:00	183.0	101.0	6.0	24.0	0.5	10.0	41.5	assume 50% of July 19th, 2013
2011	22-Jul	A-C, E-F	13:00	18:00	485.0	283.8	14.2	39.9	-	28.5	119.6	per NYISO
2006	02-Aug	A-C	14:00	19:00	202.0	161.6	10.1	30.3	-	-	-	total per NYISO; zones inferred

Distributed Generation

- PV
- Wind
- CHP



Electric Vehicles



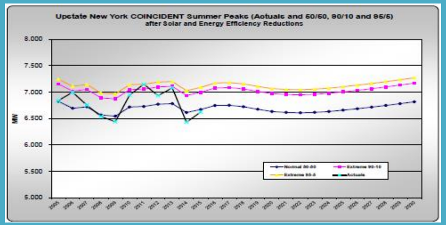
Regional Economic Drivers

- Real Personal Income
- GDP
- Employment

Approach

- Weather Normalized Historic Loads
- Energy Growth
- Trends in Load Factor
- County Growth Rates
- Then apply EE,DR,DG

Forecasts



NG Works with NYISO

1. Fall following Summer
2. Load Forecasting Task Force
3. NG Supplies 50/50 Forecast Value
4. NYISO Applies Criteria
5. NYISO uses Company Forecast if Within Criteria
6. Forecast Produced for Following Summer

Long Term Forecast Interaction with NYISO

JOINT UTILITIES

NYISO Receives Long Term Forecast

NYISO Does not do Company Level Forecast

Same Economic Indicators Service

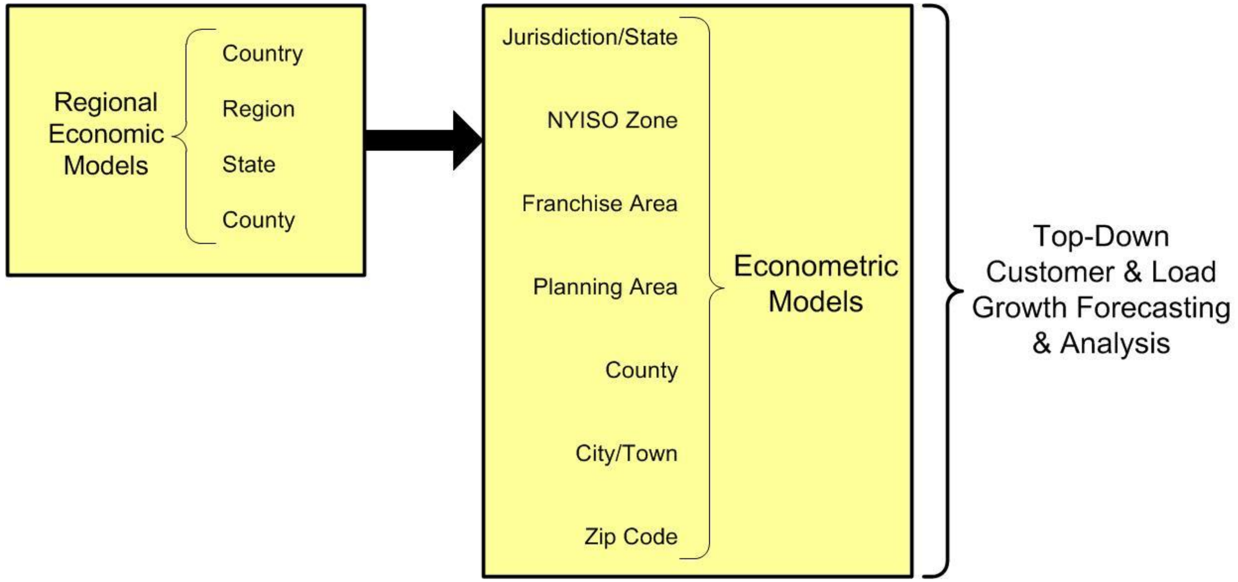
Similar Approach to EE

Similar Approach to DG

Similar Approach to Weather Normalization & Extreme Work

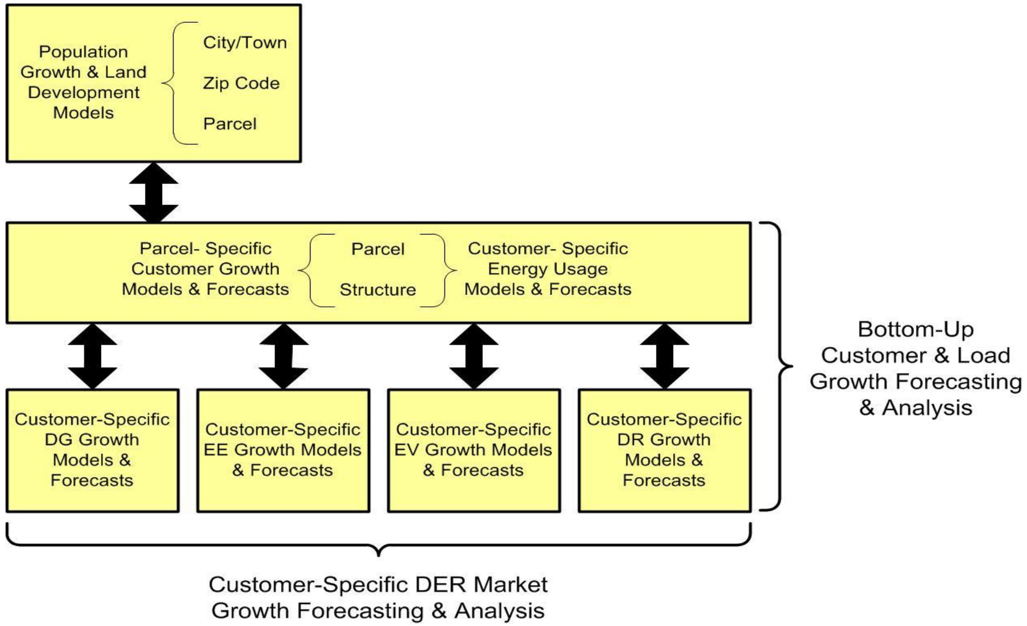
NG Uses NYISO DG Programs in Forecasting

“Top-Down” Forecasting Framework



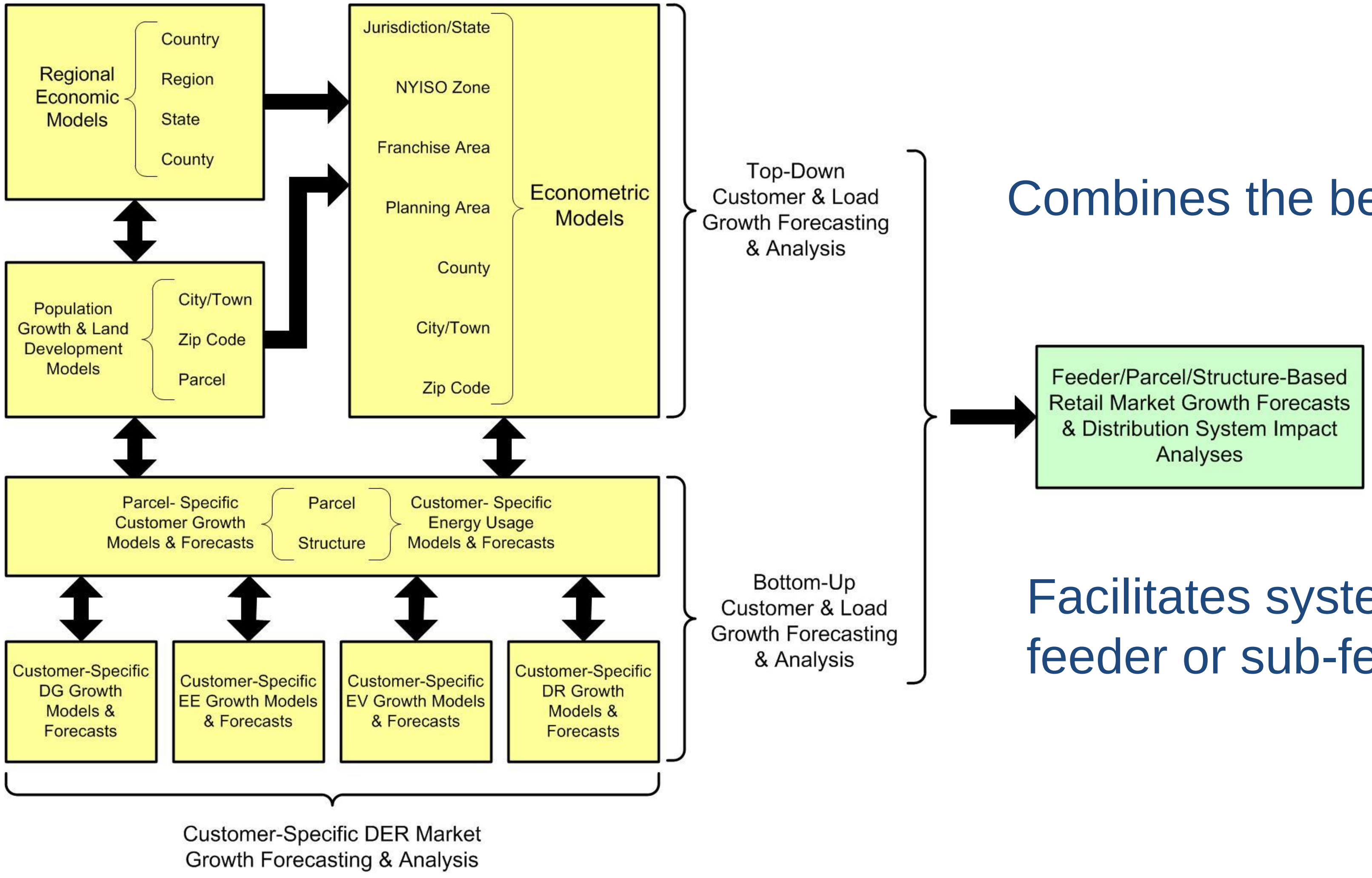
- Accurately represents the impact on growth of policy and economic factors
- Very limited spatial accuracy
- Customer class aggregations – does not deal directly with heterogeneity of our customers, their energy usage or their energy decisions

"Bottom-Up" Forecasting Framework



- Focuses on the factors that directly influence and drive customer energy usage behavior and decisions
- Maximum spatial accuracy at the individual parcel/structure/customer level
- Deals directly with the significant heterogeneity of our customers, their energy usage or their energy decisions

Integrated "Top-Down" and "Bottom-Up" Forecasting Framework



Combines the benefits of both methodologies

Facilitates system impact analyses at the feeder or sub-feeder level

Bottom-Up Models

Customer Specific

- Components Usage
- Structure and End-Use Energy Usage
- Energy Usage Behavior
- Energy Investment Decision Making

Customer-Specific Retail Market Growth Models

- Distributed Generation
- Electric Vehicles
- Energy Usage Behavior
- Demand Response
- Energy Efficiency
- Storage

Analytics

JOINT UTILITIES

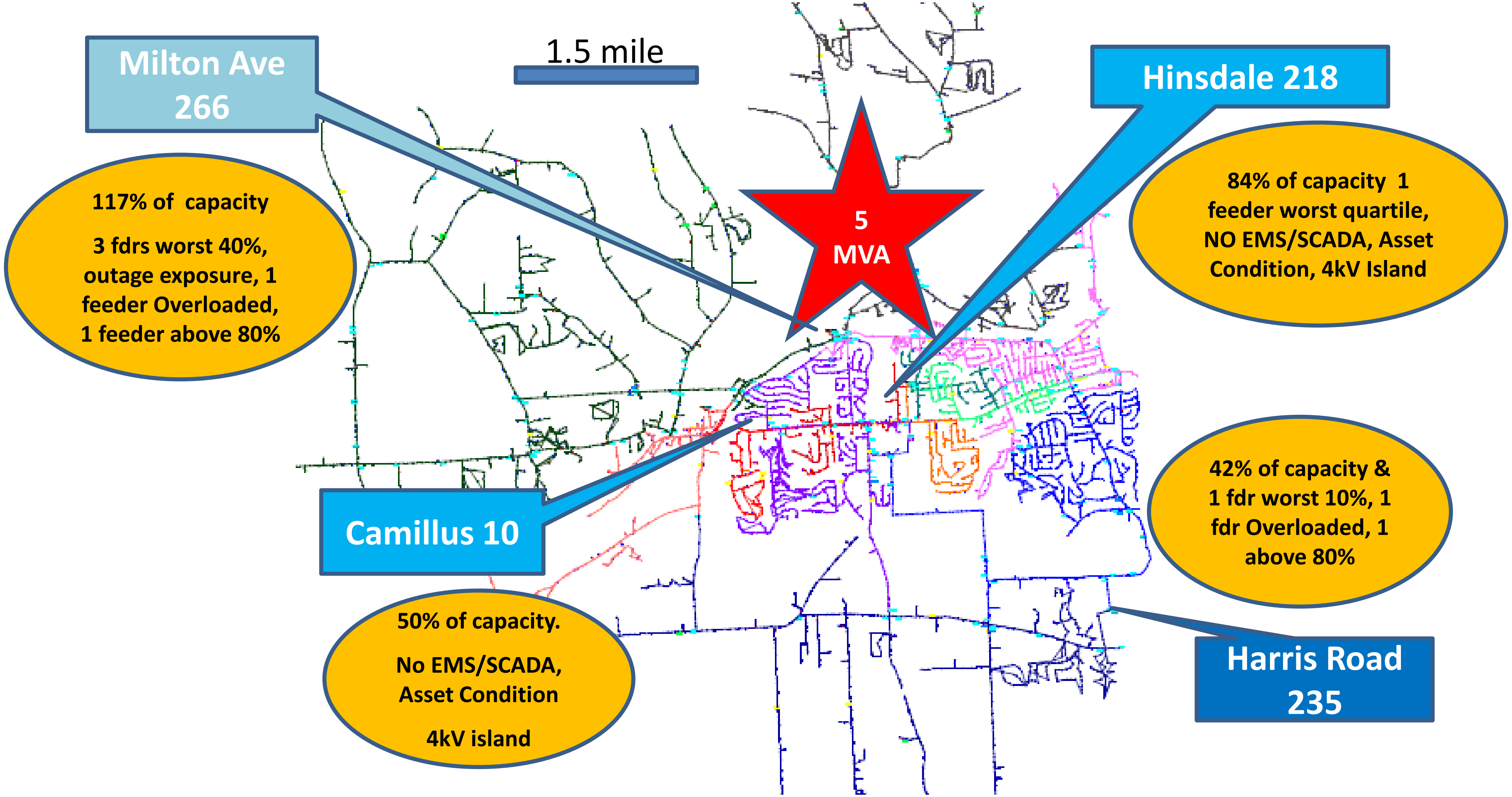
Distribution Model

- Detailed individual feeder model down to services
- Power Flow Solutions
- Multiple Analyses Supported

Holistic Analysis

- Integration of all customers, markets and components
- Wide and Deep set of factors, constraints, interactions and behaviors

Typical Study
Multiple Challenges



Study Process

Joint Utilities

2 months
- Gather and Scrub Peak Loads

0.5 months
- Apply Forecast and Compare to Ratings

0.5 months
- Gather Study Team

1-2 months
- Gather Asset Condition Information and Stakeholder Input

5 months
- Solution Development and Evaluation

1 month
- Technical Review

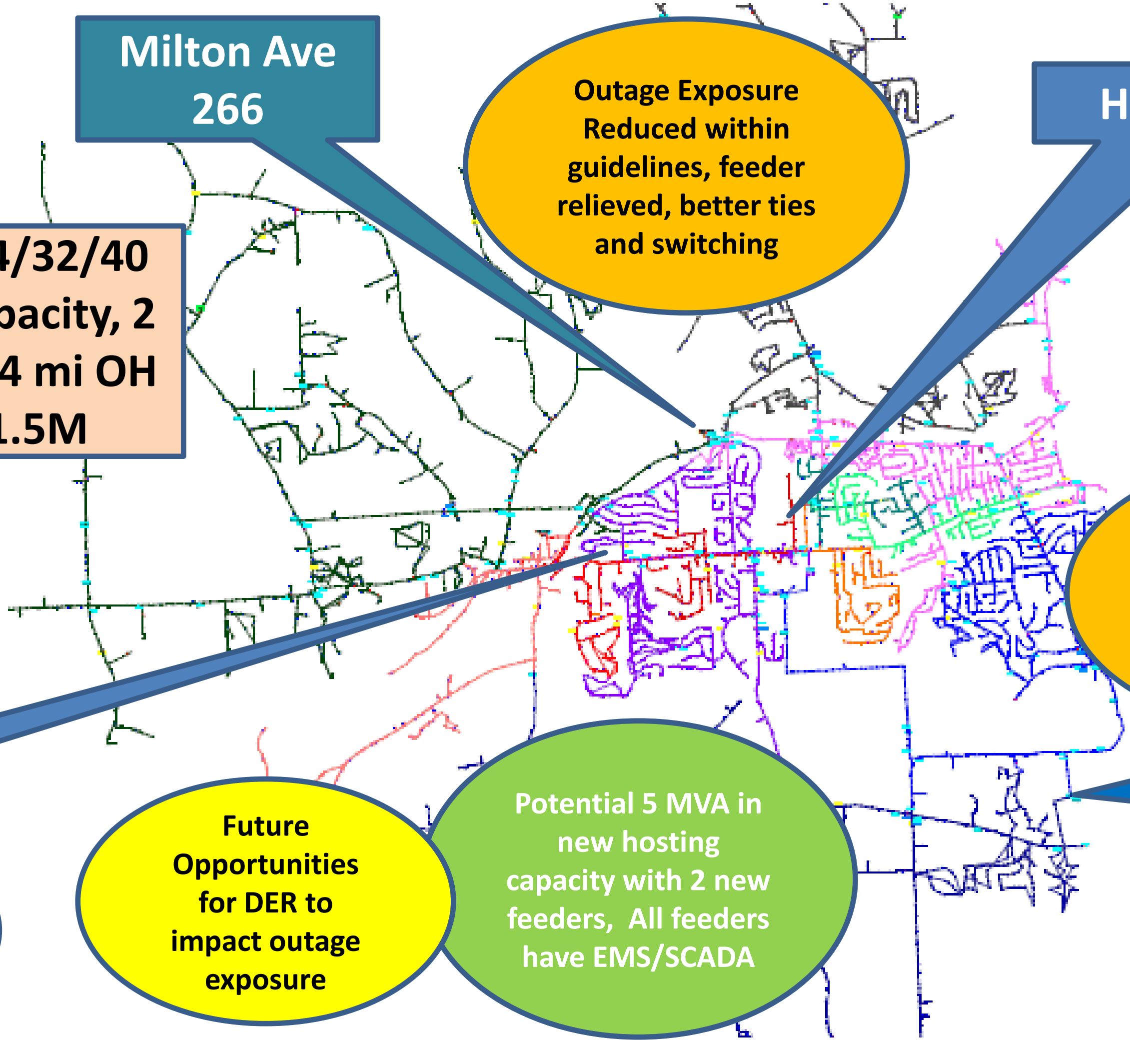
2 month
- Authority to Spend

1-4 Years
- Support team engineering, permitting and licensing, procurement, construction, records

Monitor
- Monitor Results and Repeat

Results
Multiple Challenges Addressed

JOINT UTILITIES



Milton Ave 266

Outage Exposure Reduced within guidelines, feeder relieved, better ties and switching

Hinsdale 218

Station Retired, Feeder Rebuilds/ Conversions

Expanded substation with 24/32/40 transformer, 28 MVA firm capacity, 2 new feeders+2 spare feeder, 4 mi OH Line, 0.6 mi UG cable, $11.5M

Reduced outage exposure, increased feeder tie capability. Other concerns outside the scope

Camillus 10

Station Retired Feeder Rebuilds / Conversions

Future Opportunities for DER to impact outage exposure

Potential 5 MVA in new hosting capacity with 2 new feeders, All feeders have EMS/SCADA

Harris Road 235

Summary

JOINT UTILITIES

- Our inputs do not come in at the same time nor have the same quality
- There is hourly data for about 50% of substations and distribution circuits
- Data needs to be scrubbed for abnormal configurations
- Zone Forecasts are applied to substation transformers and distribution circuits
- Market Intelligence can alter forecasts
- Asset Condition is an important consideration
- Developed solutions can be short term and/or long term projects
- Infrastructure projects may increase DER opportunities
- DER can augment the solution toolbox
- We are looking forward to working with the DER Community to support the goals of REV

JOINT UTILITIES

Questions?

JOINT UTILITIES

Capital Investment Planning

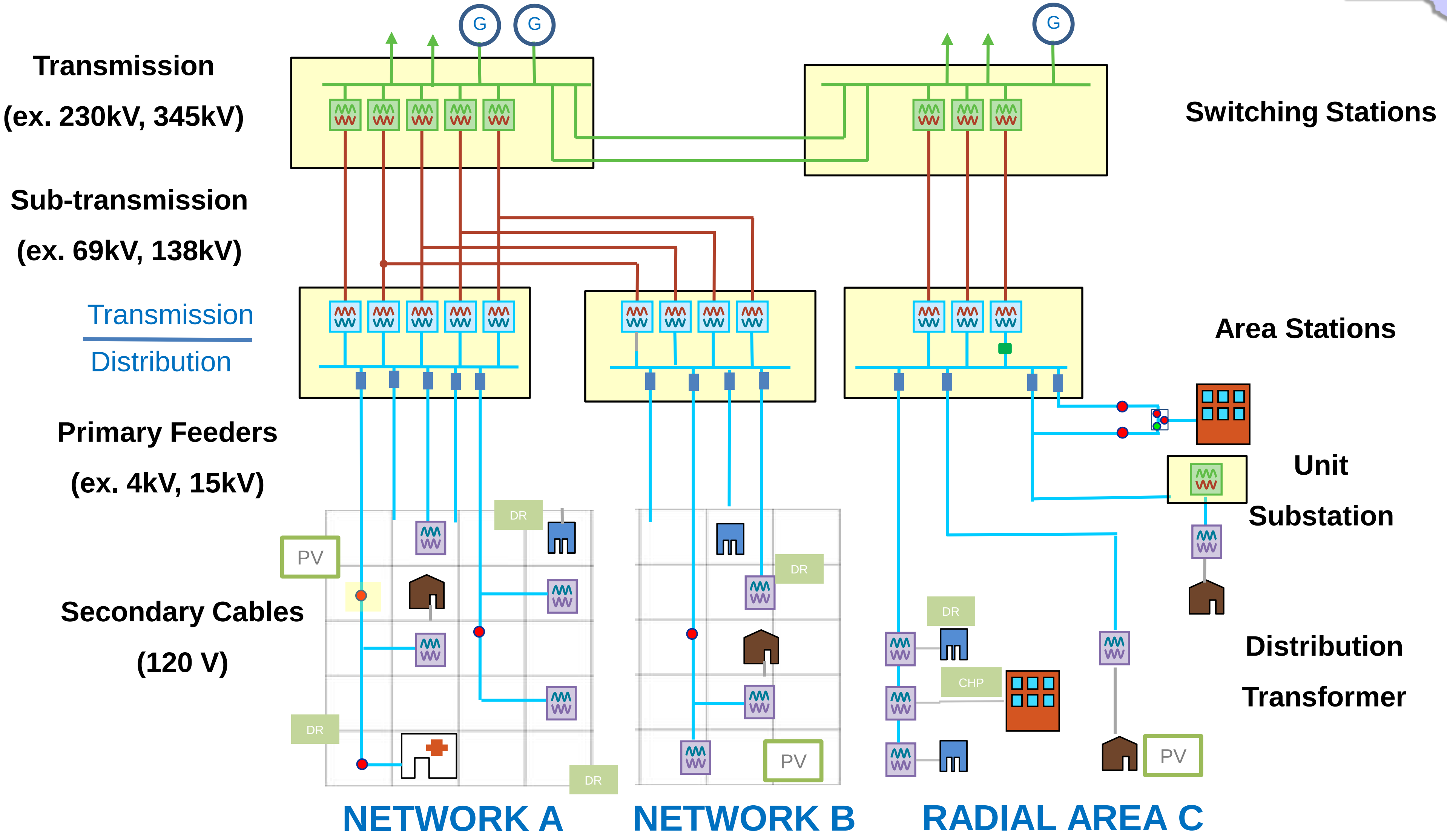
Damian Sciano

Director - Distributed Resource Integration, conEdison

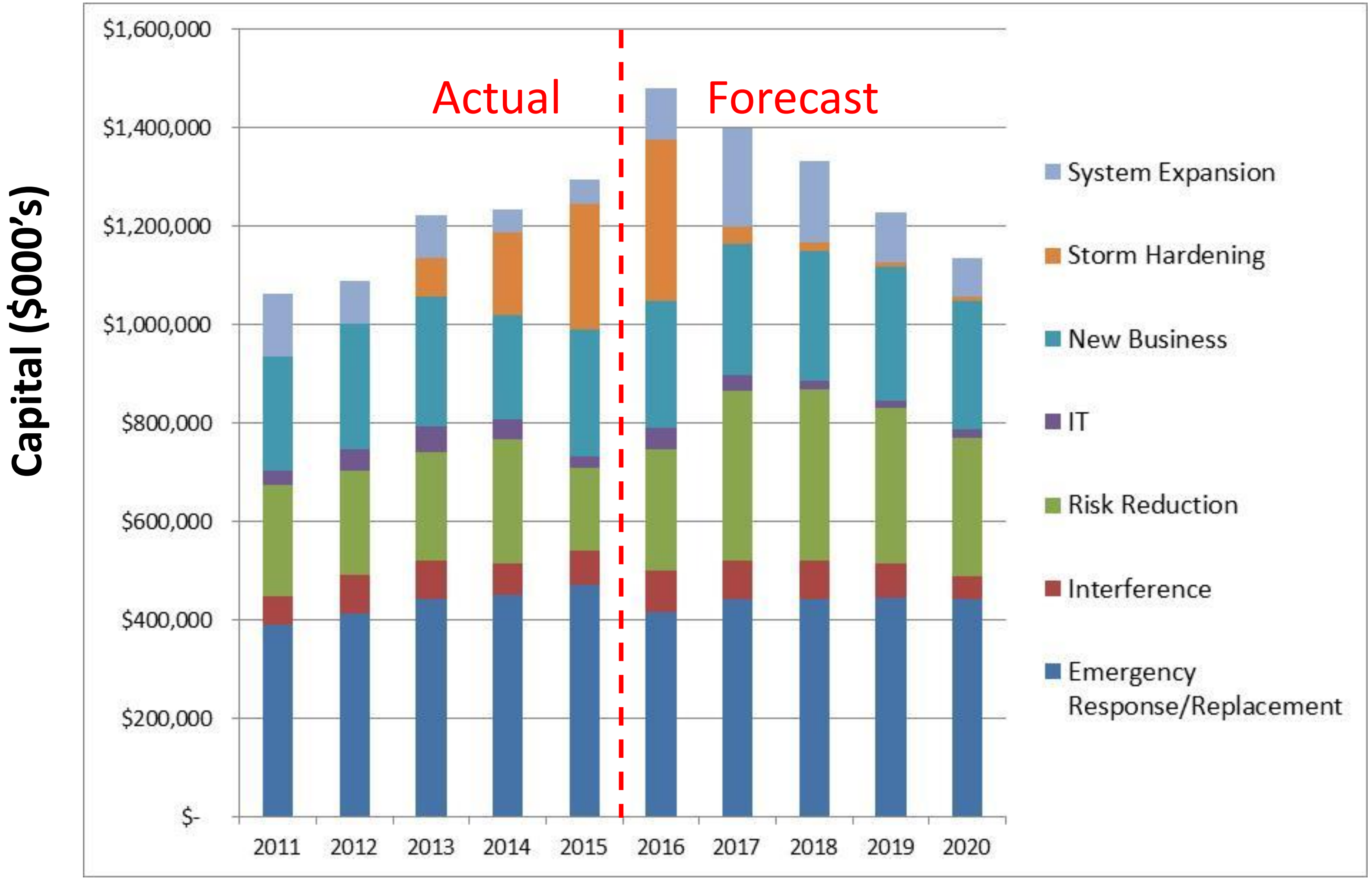
Topics

- Overview of capital expenditures (Con Ed)
- Timing considerations
- Illustrative utility comparison
- Sample capital investment projects

Overview of Electric System Components



Distribution Capital Expenditures



Emergency Response/Replacement

JOINT UTILITIES

- Replacement of failed equipment due to
  - Age
  - Environment
  - Loading
- Includes
  - Lights out conditions
  - Temporary “shunts” and
  - Repairs to restore design criteria
- Limited predictability
- Geographically sparse

Emergency Response/Replacement

JOINT UTILITIES

Interference

- Same physical location occupied by existing utility facility and proposed municipal facility

Interference
Cont'd

JOINT UTILITIES

Risk Reduction

- Compliance programs (e.g., secondary inspection program)
- Targeted programs and components
- System resiliency

Information Technologies (IT)

- Specific to operations capital
- Does not include common plant
- Captured in both T&D

New Business

Joint Utilities

- New buildings and developments
- Modified services
- **Does not** include “organic” growth due to increased usage

Storm Hardening

Joint Utilities

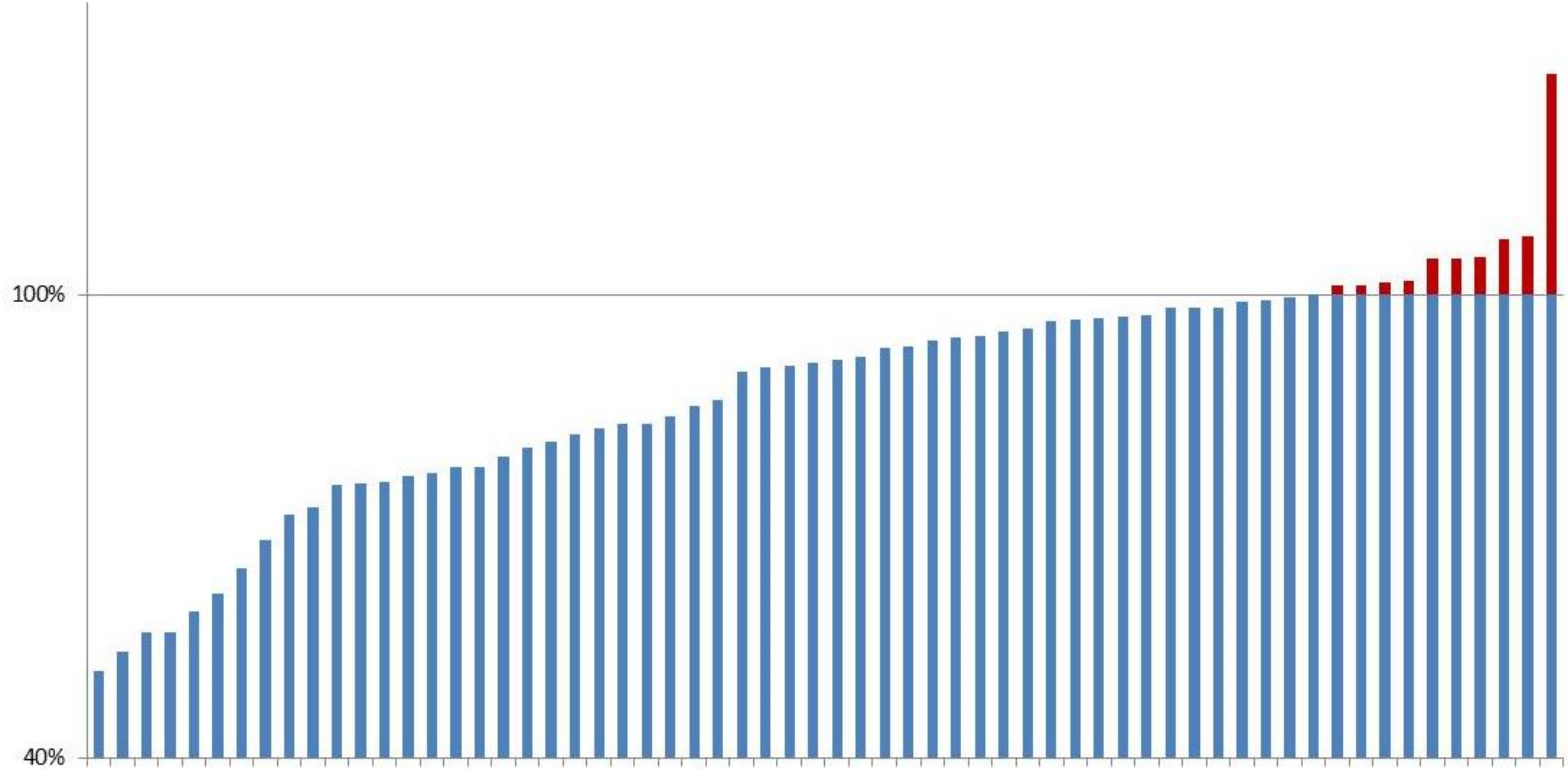
- Targeted programs
- Increase system resiliency
- Respond to increased flooding standards

System Expansion

- Due to organic load growth
- Several categories
  - Area substation
  - Feeder relief
  - Transformer and secondary relief
- Varying implementation times
  - Several years for substations
  - Nine months for feeders and transformers

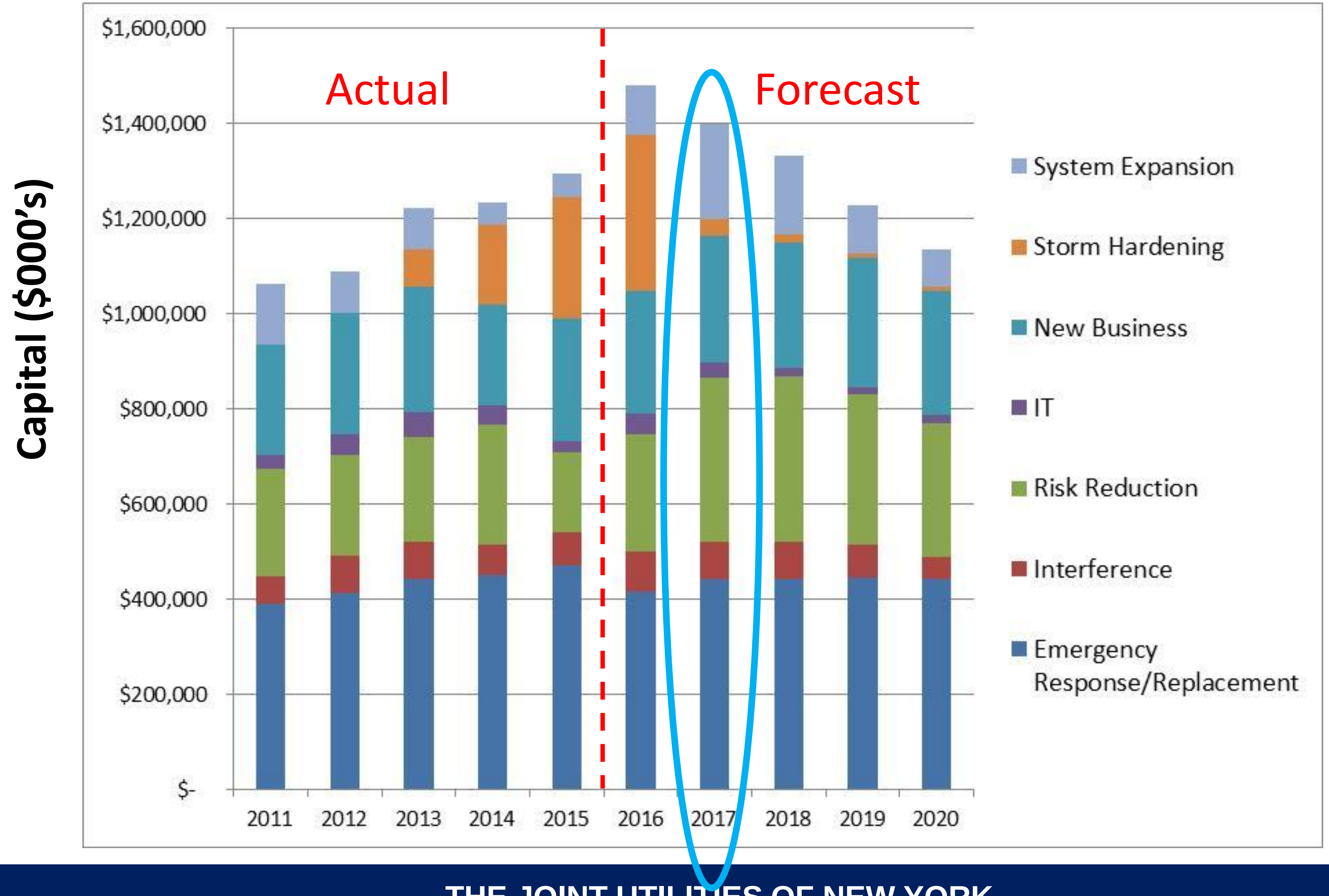
System Expansion
Cont'd

Ten Year Substation Loading as % of Capability



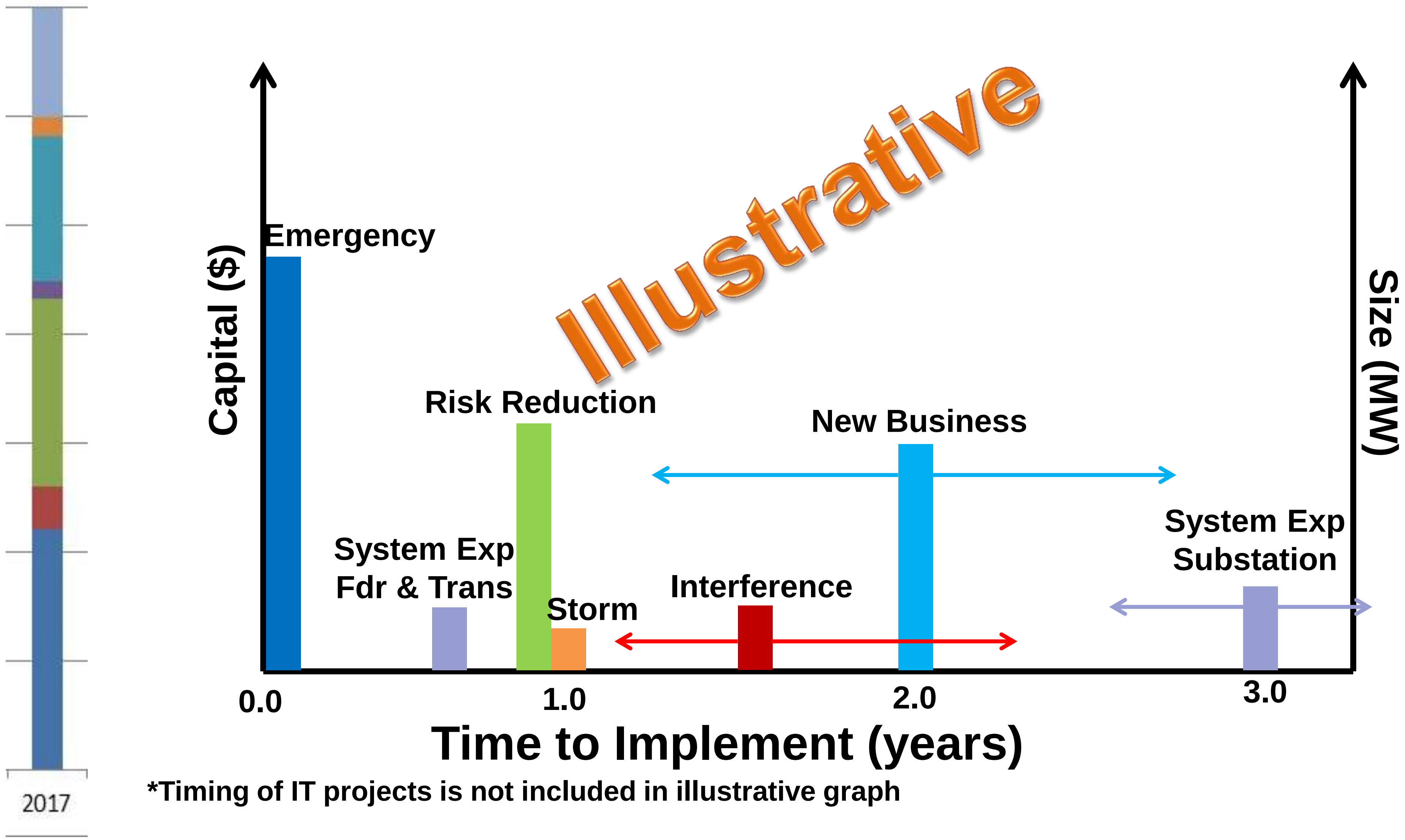
Deeper Look at 2017 Spend

Joint Utilities



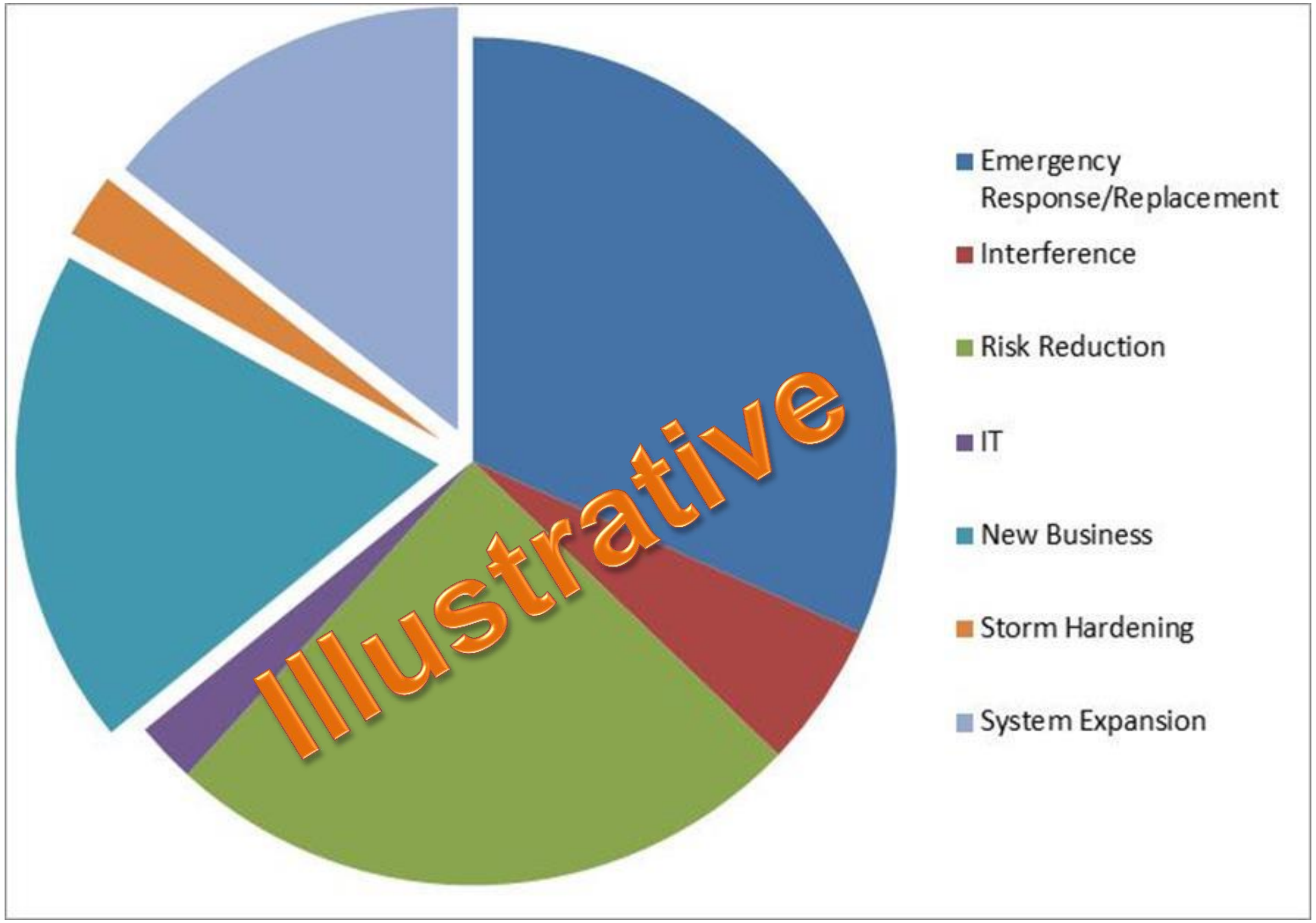
Timing of Distribution Capital Implementation*

JOINT UTILITIES



*Timing of IT projects is not included in illustrative graph

Snapshot of 2017 Spend



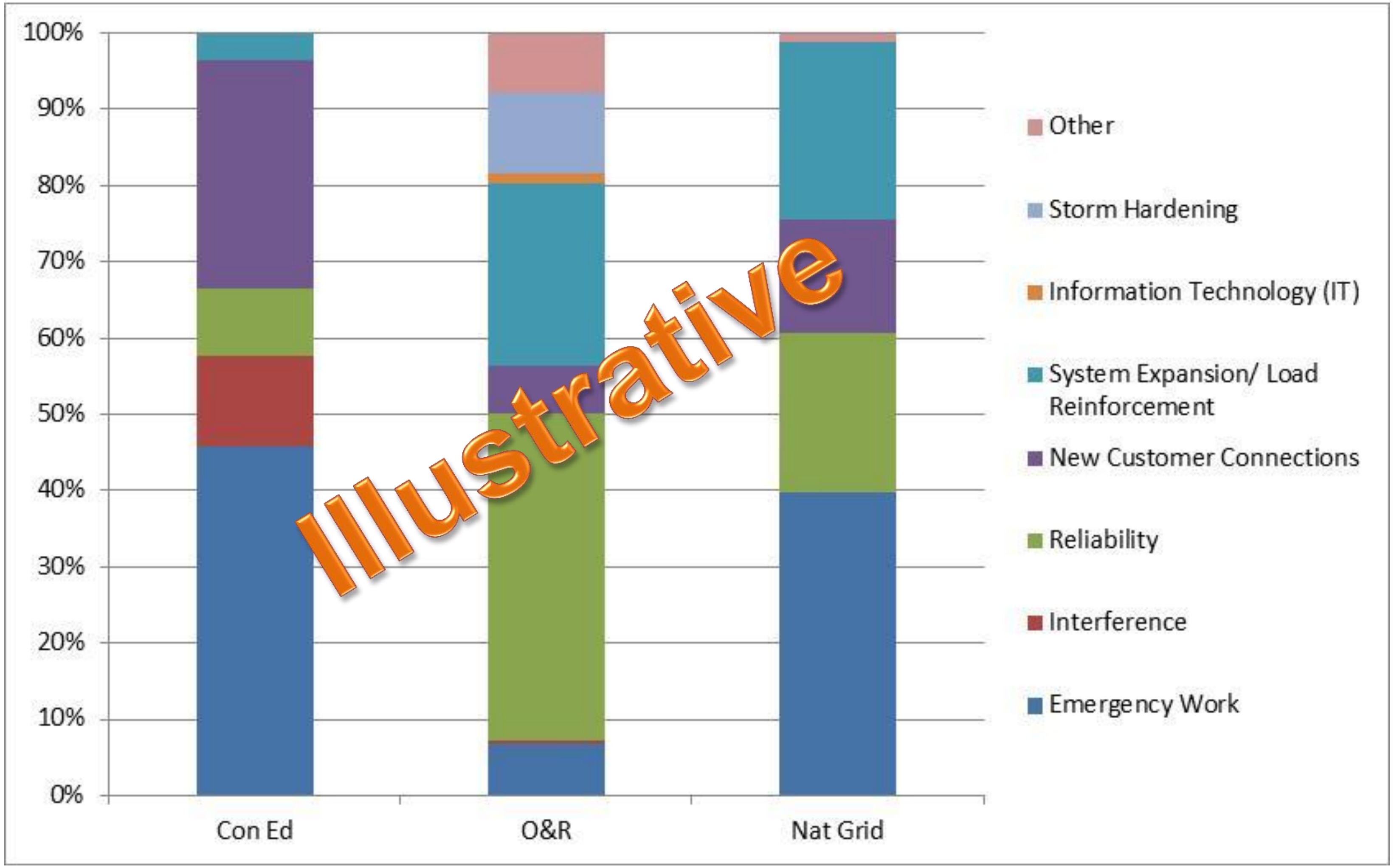
Category Nomenclature across Other Utilities

JOINT UTILITIES

Illustrative

Description	Con Ed	O&R	Nat Grid
Emergency Work	Emergency	Replacement	Damage/Failure
Interference	Interference	"See Line 7"	"See Line 4"
Reliability	Risk Reduction	Risk Reduction	Asset Condition
New Customer Connections	New Business	New Business	Customer Requests/ Public Requirements
System Expansion/ Load Reinforcement	System Expansion	System Expansion	System Capacity and Performance
Information Technology (	IT	"See Line 7"	"See Line 8"
Storm Hardening*	Storm Hardening	Storm Hardening	
Other	N/A	Other	Non-Infrastructure

Category Comparison across Other Utilities



Current Feeder and Transformer Annual Planning Cycle

Aug 2015

- Actual peak data (summer experience)
- Scale models to design criteria (86 temp variable)
- Overlay load forecast
- Evaluate models
- Evaluate alternatives and pick best solution
- Create load relief job
- Construct load relief job

May 2016

NWA Planning Cycle

JOINT UTILITIES

Aug 2015

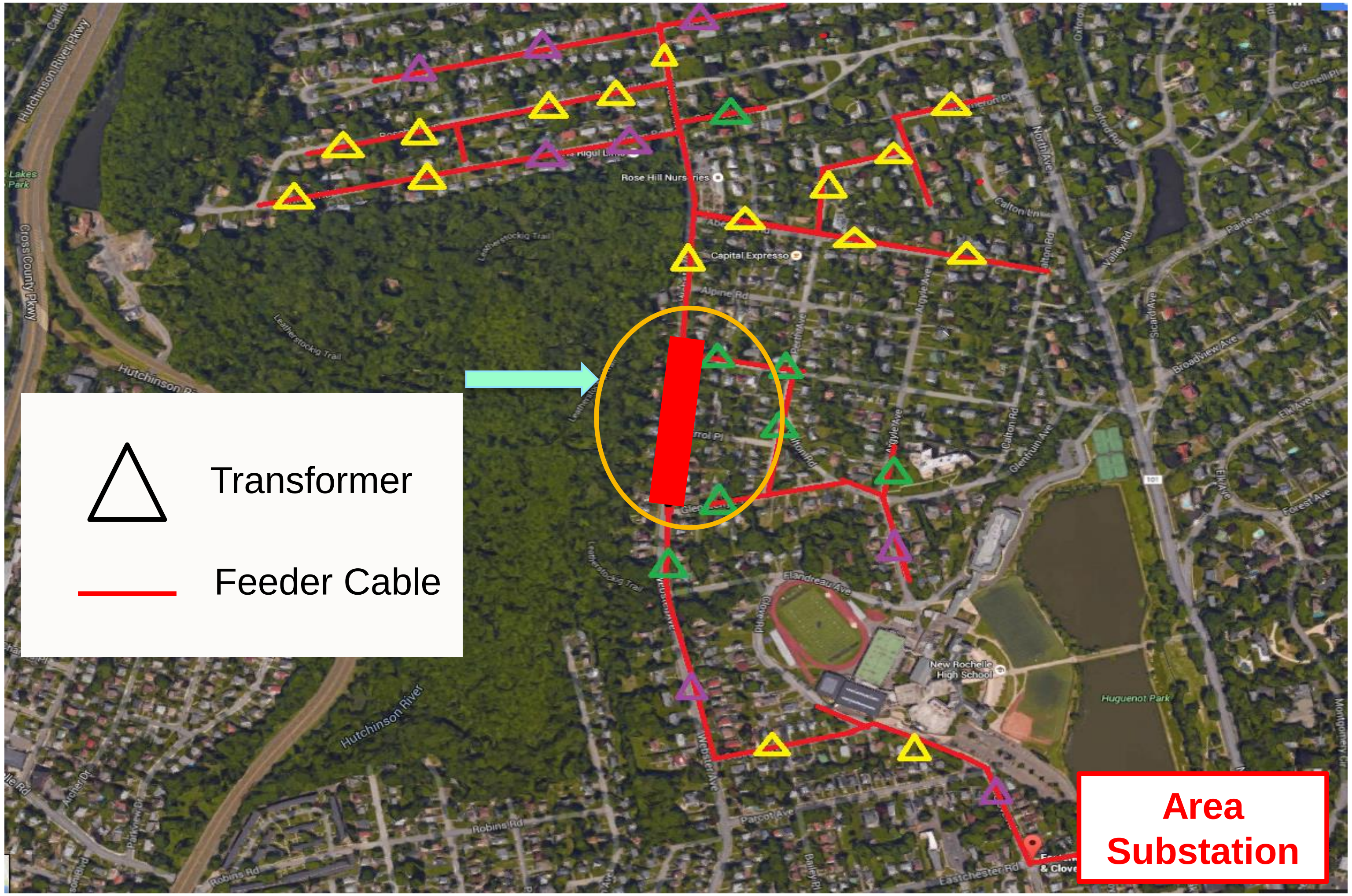
May 2018

- New multiple year approach
- Create models for 2-3 years
- Load forecast for 2-3 years (load and loss factors)
- Evaluate models
- Evaluate alternatives and pick best solution
- Combination of load relief job and NWA solution

Examples of Primary Load Relief

- Swap load
  - Transformers
  - ATS
  - Loops
  - 4 kV unit substation
- Replace limiting section (NWA possible)
  - Vacant conduit
  - Existing conduit
  - New conduit
- Remediation plan (NWA possible)
  - Spec change to tolerate for multiple years

Cable Overload Condition
Location



Load Relief Cable Section Solution

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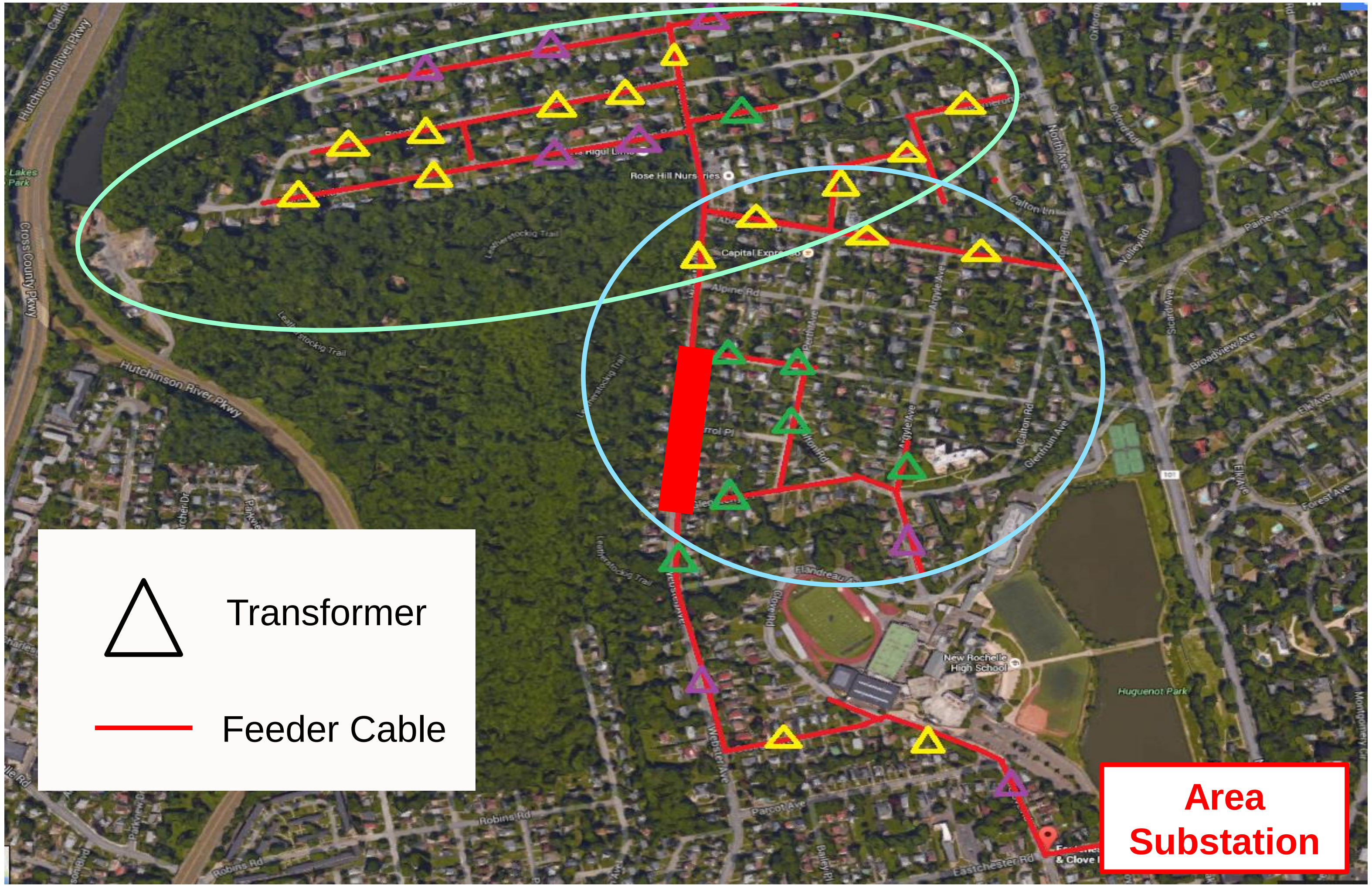
3-500 EPR NL Emergency Overload (Current cable installed)		
Actual Loading (Overload Condition)	Normal Summer Emergency Rating	% Overload
610 Amps	560 Amps	109% (50 amps)

Install new 3-750 EPR NL Cable Ratings		
Actual Loading	Normal Summer Emergency Rating	% Loading
610 Amps	700 Amps	87% (90 amps capacity)

Project Costs

Load Relief Price Range	
Remedy	**Cost**
Replacing 1 Cable Section (250 ft)	$38,000
Replacing 1 Cable Section & Conduit (250 ft section typically)	$188,000
DER Solution – Solar example (50 amps approximately 1 MW)	Estimated $2 million (assumes $2.00 per watt)

Overload Condition
Customers to Target



Transformer Load Relief

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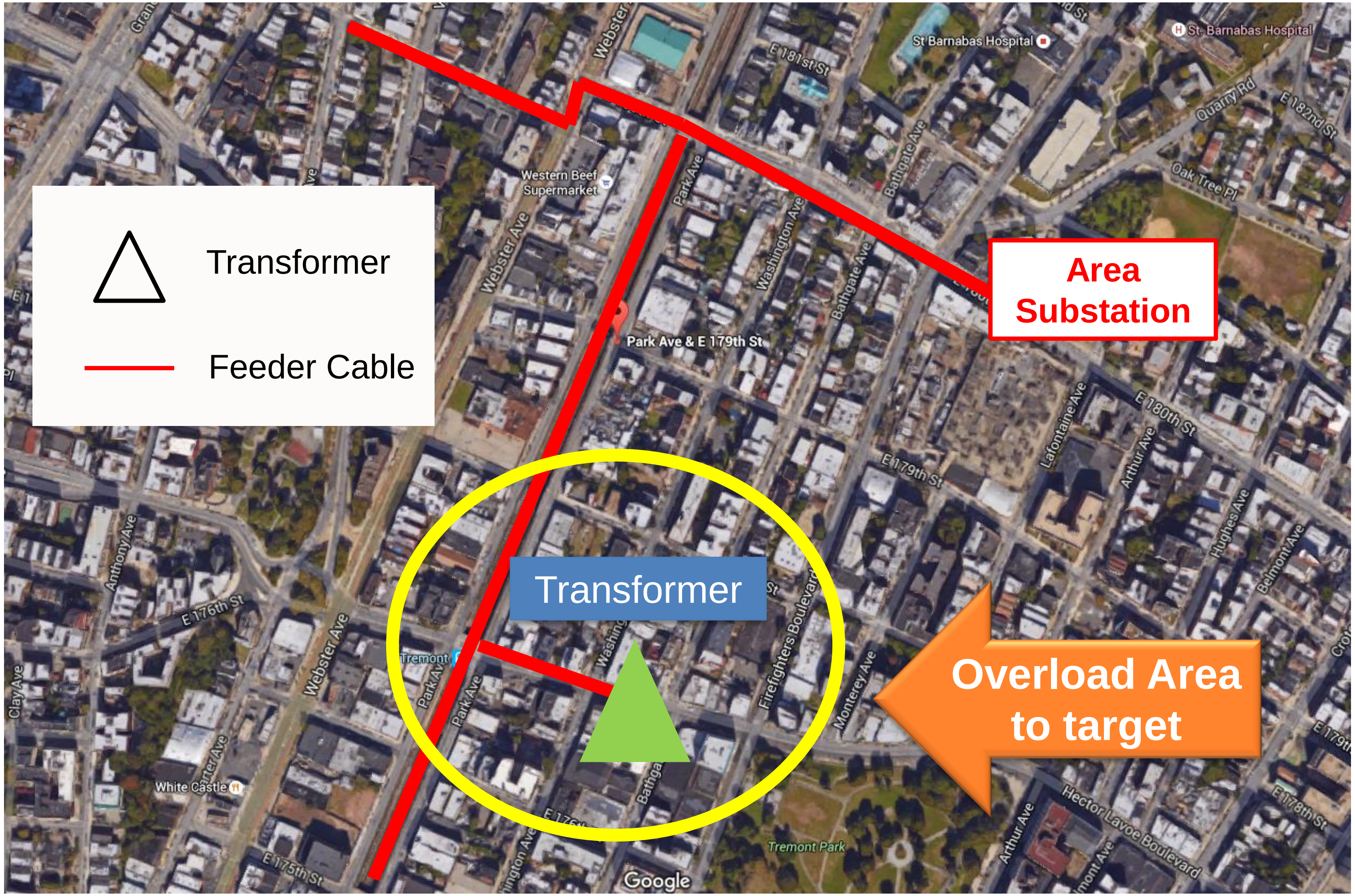
- Swap/divert load
- Upgrade existing transformer
  - New NWP
  - Same size higher rating
  - Increased capacity in same structure (rare)
- Install additional secondary cable (NWA possible)
- Install new vault and transformer (NWA possible)

Transformer Overload Scenario

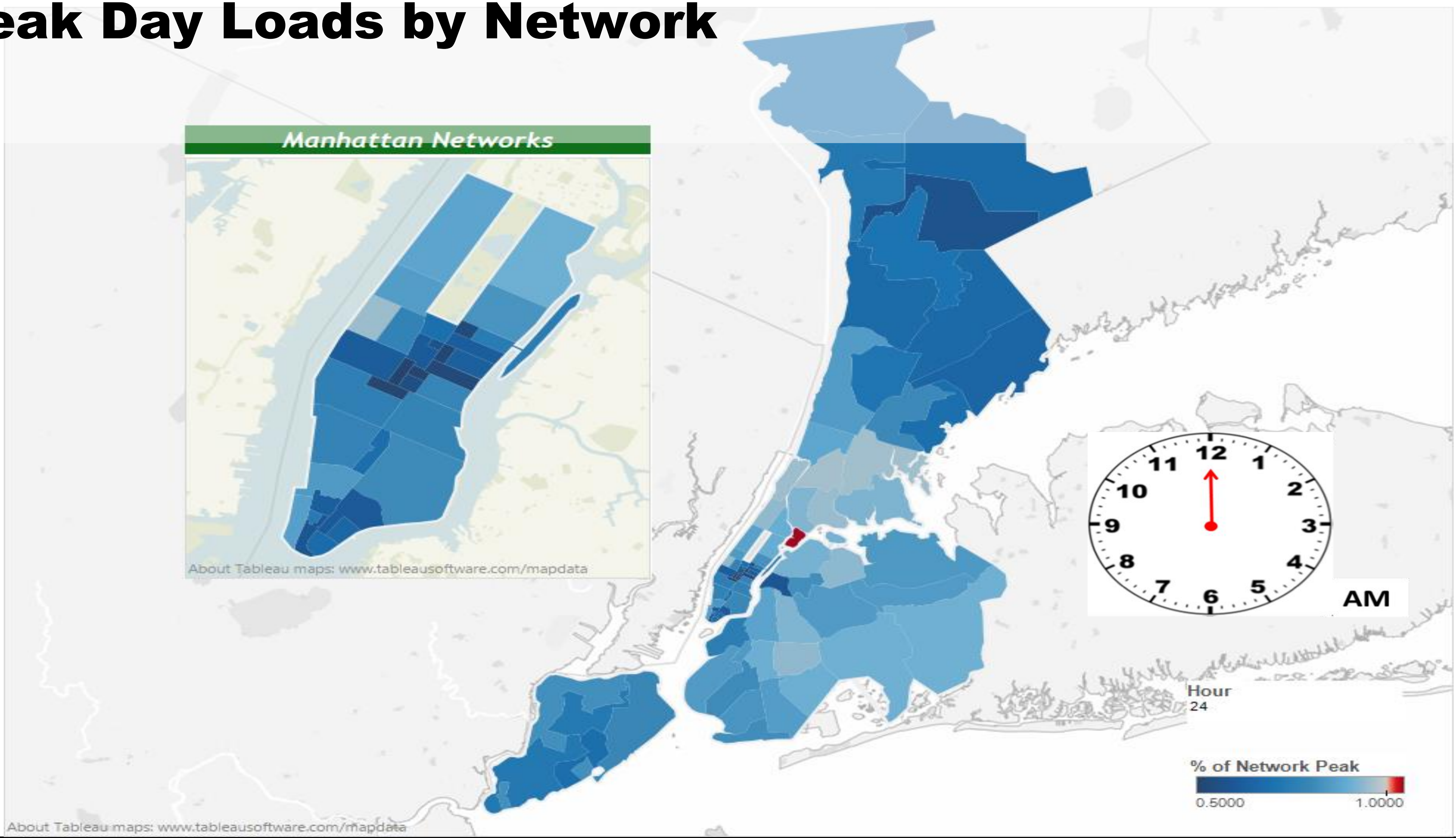


Project Scope
Goal and Costs

Load Relief Price Range	
Remedy	**Cost**
Estimated Capital Cost	$350,300 - $700,000 (typical range)
DER Solution - Solar example (0.6 MW*)	Estimated $1,200,000 at $2.00 per watt
* Realize only 25% to 50% of solar addition due to network configuration ** In addition, solar must be discounted for time of transformer peak loading (34% at 5PM)	

Possibly more expensive, but employing the societal cost benefit test (SCT) may result in a higher benefit cost for solar

Peak Day Loads by Network



System Expansion Project
Brooklyn-Queens Demand Management Program (BQDM)

Deferral of $1.2 billion in traditional network upgrades with distributed solutions

- Meets capacity shortfall through a $200 million program
  - Non-traditional customer-sided 41 MW ($150 m)
  - Utility-sided solutions 11 MW ($50 m)
- Long duration, night peaking network requires a portfolio of solution and an understanding of appropriate discount rates for various DER
- Ultimately, the effective DER contribution can be located anywhere within the foot print

Brooklyn-Queens Demand Management

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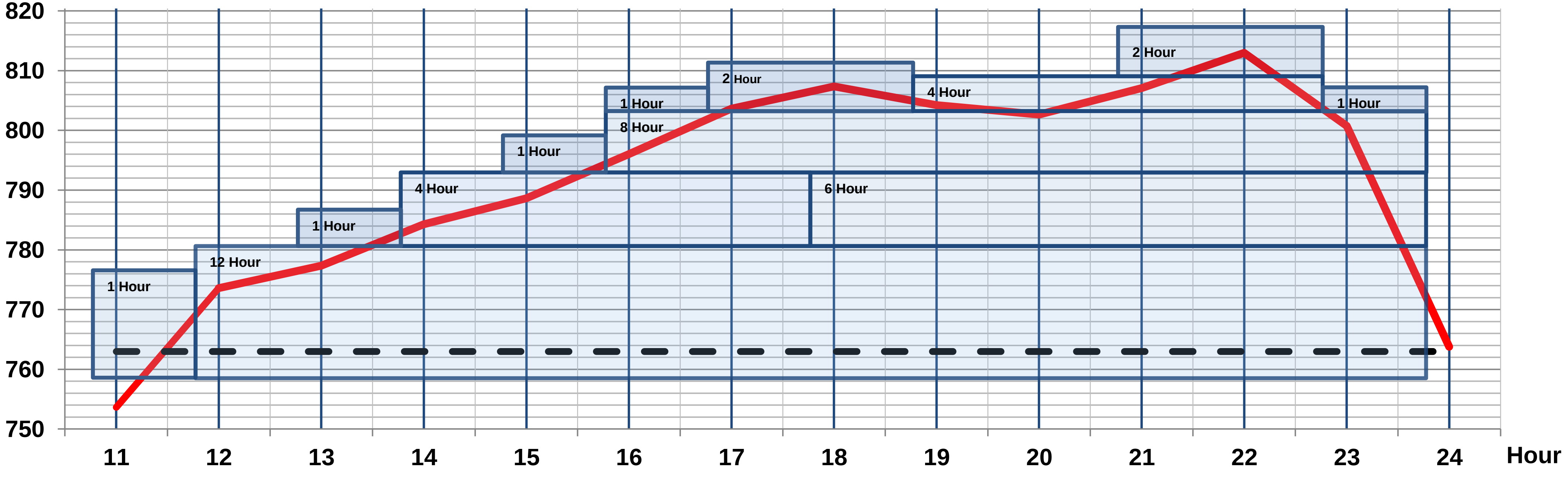
Description

- $1.2 billion substation deferral using portfolio of alternative investments in Brownsville network
- Earn rate-of-return plus incentive based on implementation



Recap

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- Capital expenditures meet a variety of needs and require varying amounts of time to implement
- Utilities are reviewing planning processes to identify best opportunities to integrate DER; this will be coupled with stakeholder engagement
- Additional work needs to be done to standardize capital investment plan categorization among utilities
- We are working to evaluate multiple types of capital projects for NWA solutions versus traditional solutions and share these results so everyone can learn from them
- A robust Benefit Cost Analysis process is a key enabler to best integrate DER into the utility planning process

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Questions?

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Next Steps

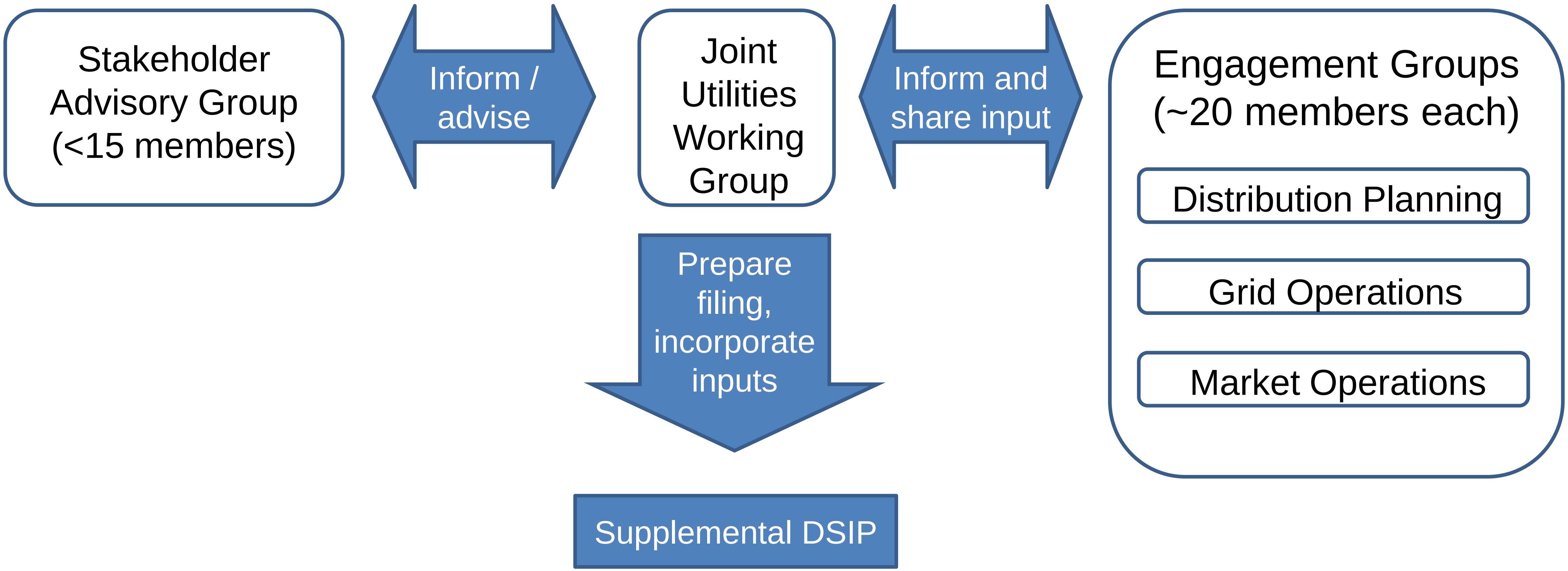
Tom Mimnagh

Department Manager - Utility of the Future, conEdison

Next Steps

- Distributed System Implementation Plan – filing 6/30/2016
- Supplemental Joint Utility DSIP – filing 9/01/2016
- Incorporate DSIP Guidance – March 2016
- Expanded Stakeholder Engagement – ongoing

Next Steps
Stakeholder Engagement



Next Steps
Supplemental DSIP Topics

Working Groups	Distribution System Planning		Grid Operations		Market Operations	
Topics	Improved Interconnection Process	Hosting Capacity Methodology	System Data	Monitoring & Control	Customer Data	DER Procurement Approaches (Tariff, NWAs)
	Demand Forecasting	BCA Screening	Joint System Planning and System Operations	Cyber Security	Market Participant Rules	Measurement / Verification
	DER Forecasting	Probabilistic Planning Methodology	Coordinated Dispatch and Tools – Other DER	NYISO, Coordinated DER Dispatch - DR	Granular Pricing	Settlement Procedures
	Storage Methodology	Load Flow Analysis Process	ISO Roles and Responsibilities	Coordination at T&D interfaces		

Thank You

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Your Opinion Matters

The Joint Utilities of NYS are committed to engaging stakeholders in working towards meeting the REV goals . Surveys are now being distributed to you. Please take a few minutes and let us know your thoughts about today's events and ideas for the future.

NYSEG nationalgrid Orange & Rockland conEdison Central Hudson RG&E