

# Utility Distribution Planning 101

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# Webinar Overview

- ▶ Overview of traditional planning
- ▶ Maintaining safety, reliability and cost
- ▶ Planning functions at small vs. large utilities
- ▶ Traditional functions
- ▶ How are investment decisions made?
- ▶ Where does the money go?
- ▶ Overview of distribution planning tools
- ▶ Discussion and questions

- ▶ Distribution planning has traditionally been focused on maintaining:
  - Safety
  - Reliability
  - At reasonable cost
- ▶ At the core distribution planning supports investment decisions
- ▶ As the grid and resource mix are changing, distribution systems are changing and distribution planning is changing
  - In many places, a lot of new gen is connected to the distribution system
  - Distribution system has least amount of utility visibility/control
- ▶ In some states, more detailed distribution plans are being required :
  - Hosting capacity
  - Locational benefits and non-wires alternatives
- ▶ New skill sets may be required as well as coordination across entities within the utility

# Electric Distribution System Planning – An Overview

Electric Distribution Planning is a key utility strategy/function that is used to forecast changes on the grid and modify the system accordingly, all with a focus on;

## Safety

- Design and maintain an electric system that does not place the general public nor utility workers at risk

## Reliability

- Provide the power that the consumers need
- Maintain power quality
  - Maintain stable voltage at point of delivery
  - Support a stable frequency
- Reduce number of outages
  - Frequency (SAIFI) and Duration (SAIDI/CAIDI) are tracked

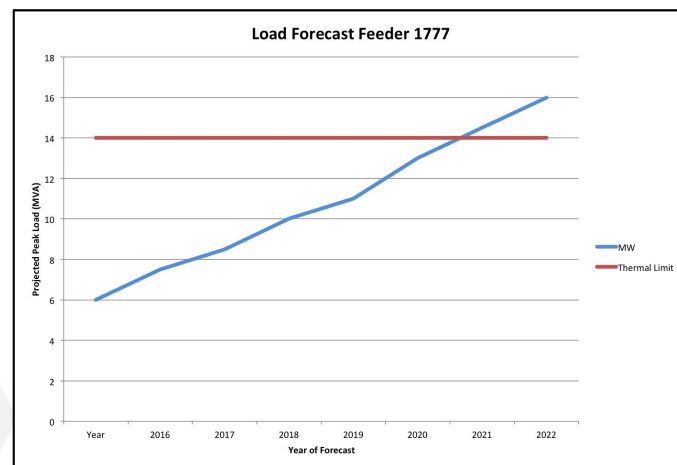
## Cost

- Supply power and energy at an fair and acceptable price

# Traditional Areas of Focus for Larger Utilities\*\*

## Load Forecasting

- Track peak loads (using SCADA data)
- Publish annual long-range forecast
- Evaluate each distribution feeder for annual growth, new loads
- Feeder load forecasts aggregate to show substation status, need for expansion
- Substations may require upgraded transformers, new transformer banks, transmission, distribution equipment
- System Planning (transmission) use this to plan line upgrades (new lines, larger lines, higher voltages)
- Substation departments evaluate the need for larger transformers or additional transformer banks



\*\* Larger utilities often have groups of engineers that focus entirely on distribution planning functions

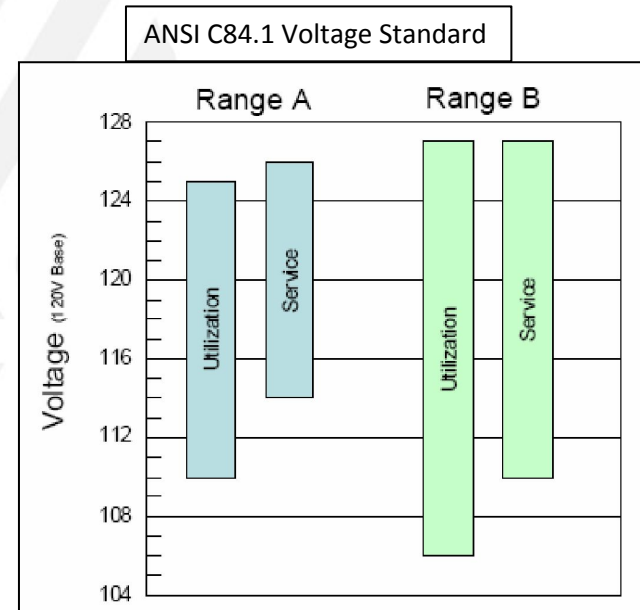
# Traditional Areas of Focus for Larger Utilities

## - Continued

- ▶ Reliability (SAIDI, SAIFI)
  - Feeder-Level protection
  - Under Frequency Load Shedding (UFLS) schedules
  - PUC/customer complaint resolution
- ▶ Power quality support
- ▶ Voltage support (ANSI C84.1)
  - Capacitor placement
  - Voltage regulator placement
- ▶ Evaluation of “special projects” such as large DER systems
- ▶ Large distribution project design
- ▶ These traditional functions remain, while new challenges and opportunities are emerging



Image: NREL Pix 03207



# DISTRIBUTION MODELING TOOLS

## **Question:**

How do utility engineers plan their system changes and upgrades?

## **Answer:**

Sophisticated computerized tools are often utilized by utility engineers, but there are many types of tools available.

# The Foundation for Computer Models - GIS

- ▶ Most utilities have a Geospatial Information System (GIS) in place, where they track their distribution lines, transformers, customers, substations, and sometimes the DER (like PV) systems.
- ▶ GIS departments only update GIS systems to track any system changes
- ▶ Modeling platform users “Extract” the GIS data and then run the model
- ▶ Thus, it is critical to have a high-quality GIS system which is accurate



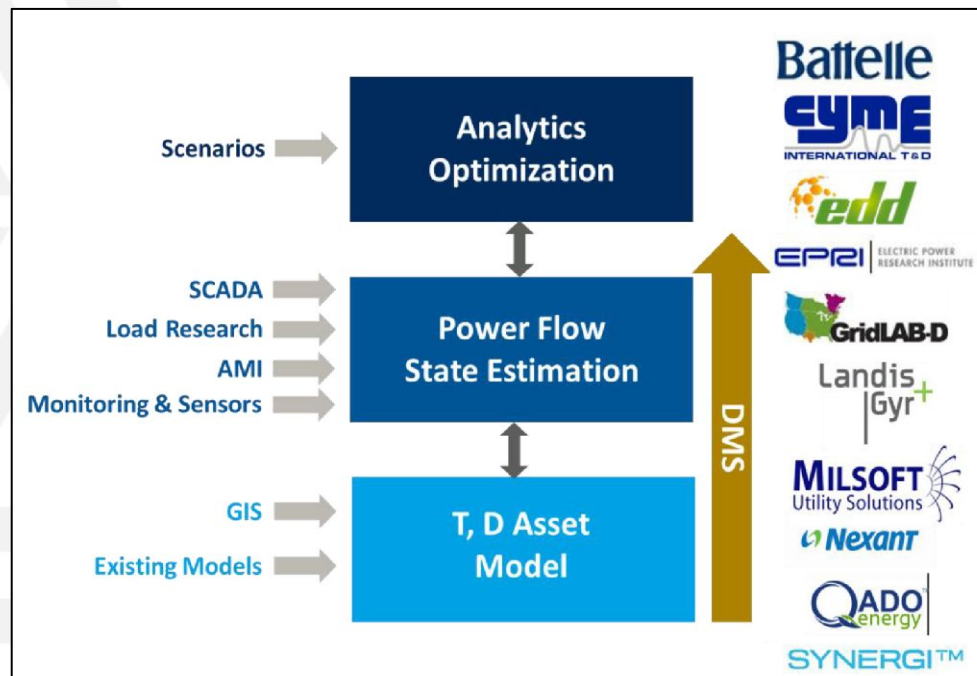
# Distribution Modeling Tools - Observations

Larger utilities typically use the following (with exceptions):

- CYMDIST (power flow)
- Synergi (power flow)
- ASPEN (protection)
- DEW (power flow)
- Others....

Small-Medium utilities typically use

- Milsoft Windmil (power flow)
- Milsoft Light Table (protection)
- Others....
- Consultants



Modeling software is generally a large investment, as is trained staff, thus utilities are quite hesitant to change platforms!

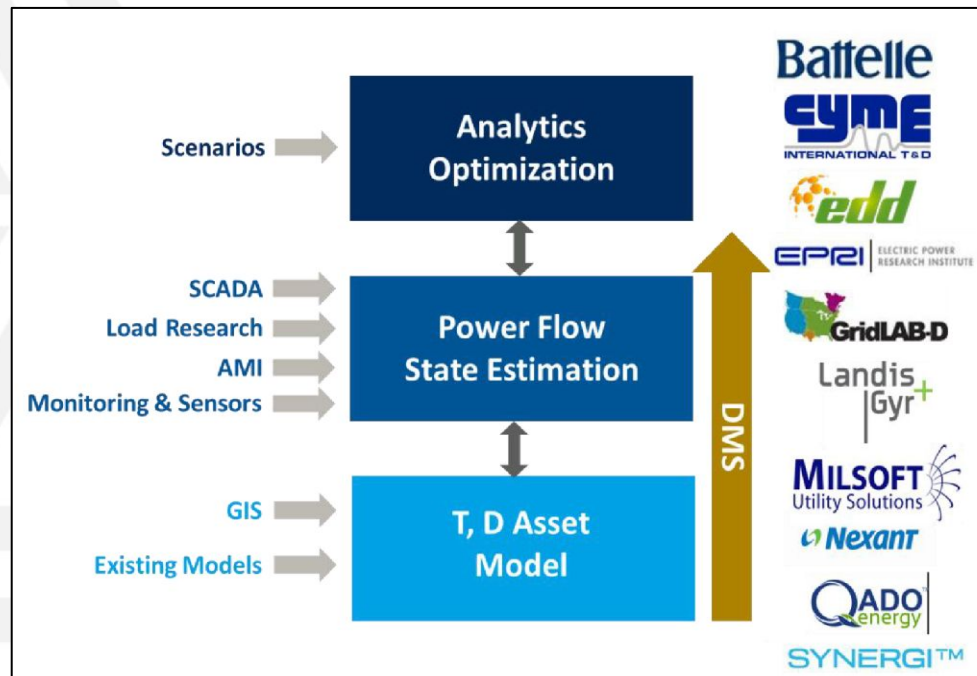
Larger utilities have teams of model experts, while smaller utilities rely on institutional knowledge or third parties

## ► Typically Used Tools

- CymDist
- Milsoft Windmil
- Synergi
- ASPEN

## ► Research Centric Tools

- OpenDSS
- GridLab-D



# Process of Identifying System Risks



# Identify System Risks

- ▶ Determine N-0 (system intact overloads) and N-1 (based on one-point of failure) risks based on the peak demand and available capacity
- ▶ Other considerations
  - Power Quality (low or high voltage)
  - Reliability (line and equipment exposure)
  - Environmental considerations (e.g. line losses)
  - Safety
  - Legal
  - Financial

# Create Risk Mitigation and Projects

- ▶ Traditional poles and wires solutions to mitigate system risks
  - New distribution feeders
  - Reconductoring existing feeders
  - New substations
  - Expanding existing substations



Source: NREL Pix 08216

# Where Does the Money Go?

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# Annual Electric Distribution Budget

## Create Annual Capital Budget

- ▶ Determine funding by program
- ▶ Evaluate Customer Minutes Out and value of service reliability
- ▶ Determine Cost Benefit Ratio
- ▶ Prioritize projects over a 5 year time
- ▶ Budget based on corporate guidelines

Note: This complex planning approach may not be used by small and mid-sized utilities, but is important for larger utilities due to the scale of operations and number of customers

Example Electric Distribution Budget

Program	Percentage
New Service	19.9%
Elec Asset Health	11.2%
Street Lights	2.8%
Elec Capacity	9.6%
Elec Mandates	8.4%
Reliability	16.1%
Sub Capacity	12.4%
Sub Asset Health	5.5%
Equip Purchase	9.7%
Fleet	2.0%
Other	2.4%

# New Load Construction Allowance vs. Customer Paid DER Mitigation

- ▶ Most IOUs have Construction Allowance (CA) for new projects, sometimes results in zero up-front cost for new construction
  - Investments are recovered through tariff design, as investments are generally placed in the “rate base”
- ▶ Distributed Energy Resources (DER) such as PV systems often interconnect without system upgrades, but pay for any upgrades if required to mitigate potential problems



Source: NREL PIX, Coddington



# The Brooklyn Queens Demand Management Project – A Special Case for Distribution Planning



# System Expansion Project: Con Edison's BQDM

## Deferral of ~\$1 billion in traditional network upgrades with distributed solutions

- ▶ Meets capacity shortfall via \$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
- ▶ The effective DER contribution can be located anywhere within the foot print



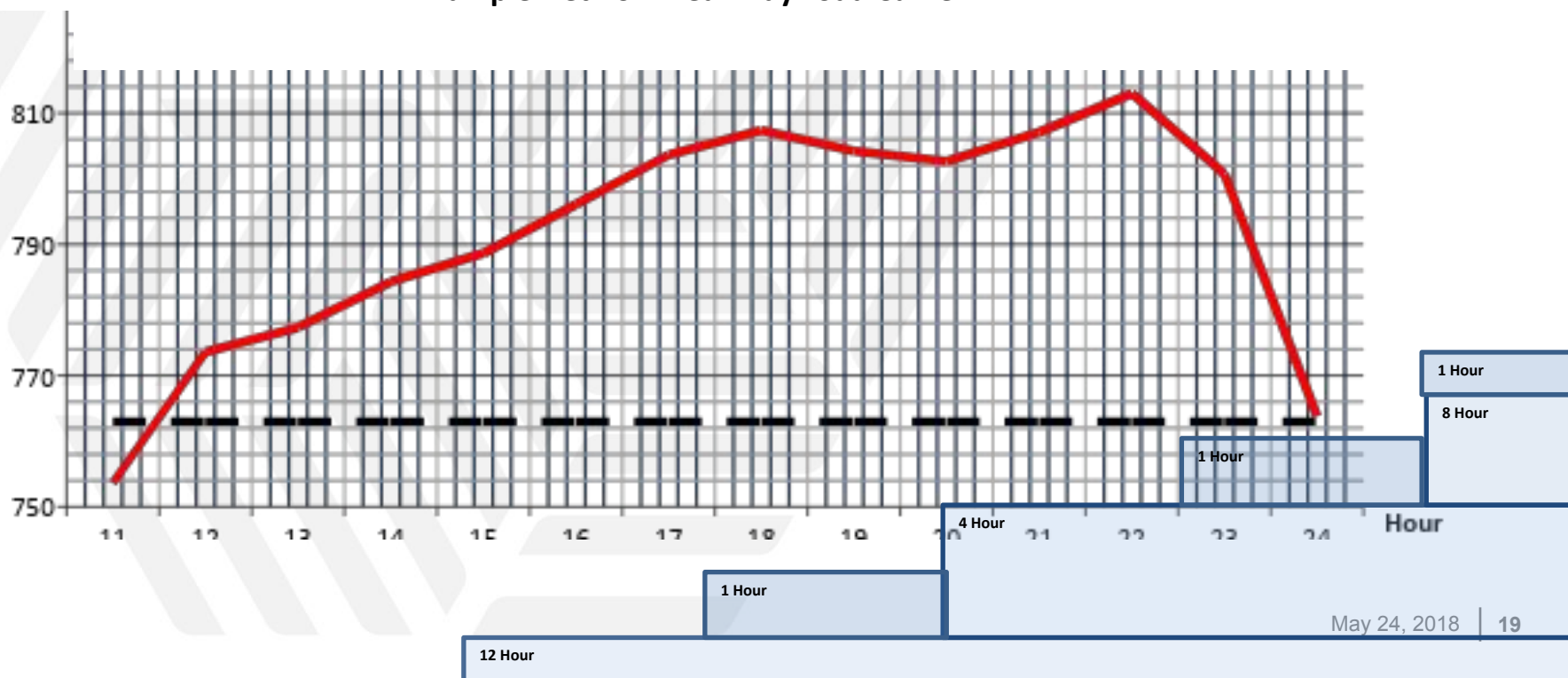
# Brooklyn-Queens Demand Management

## Description

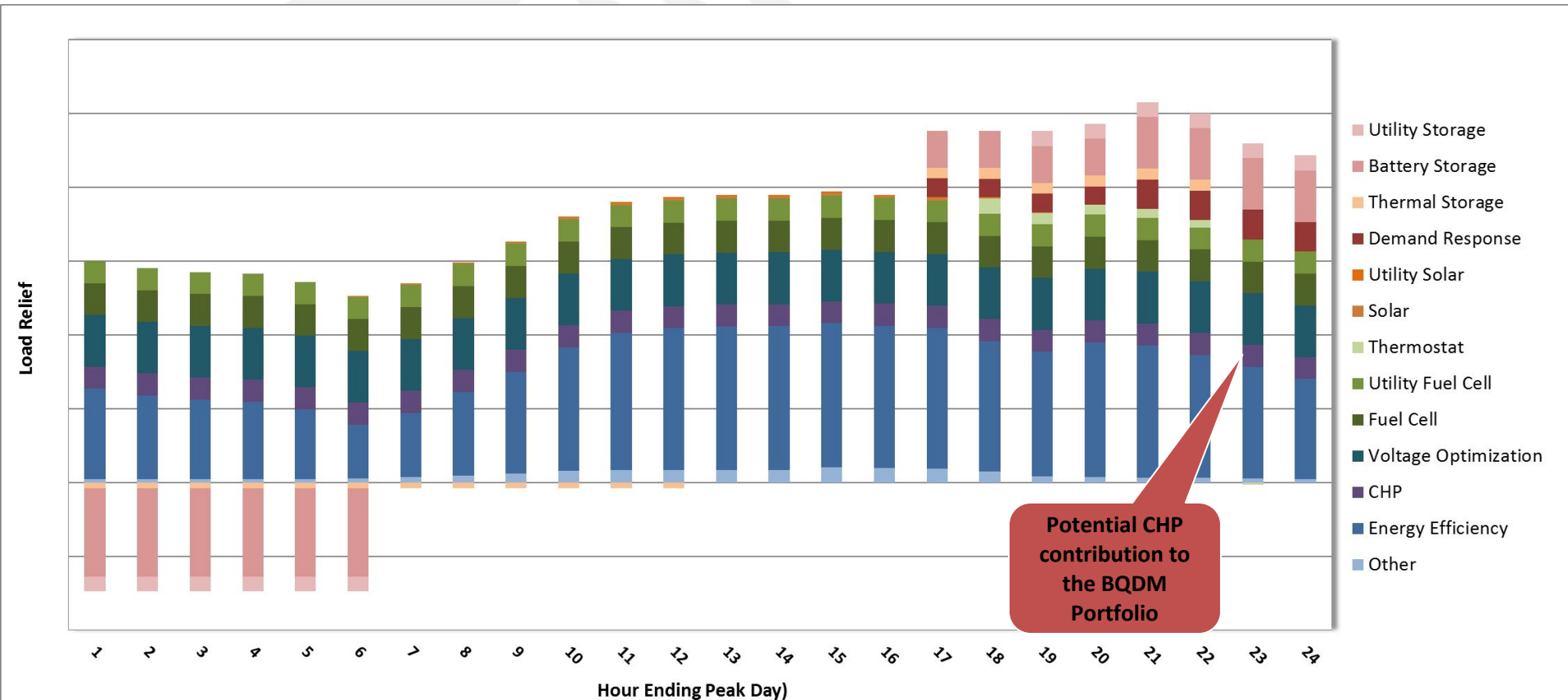


- \$1 billion substation deferral using portfolio of alternative investments in Brownsville network
- Earn rate-of-return plus incentive based on implementation

**Example Network Peak Day Load Curve**



# Illustrative BQDM Portfolio



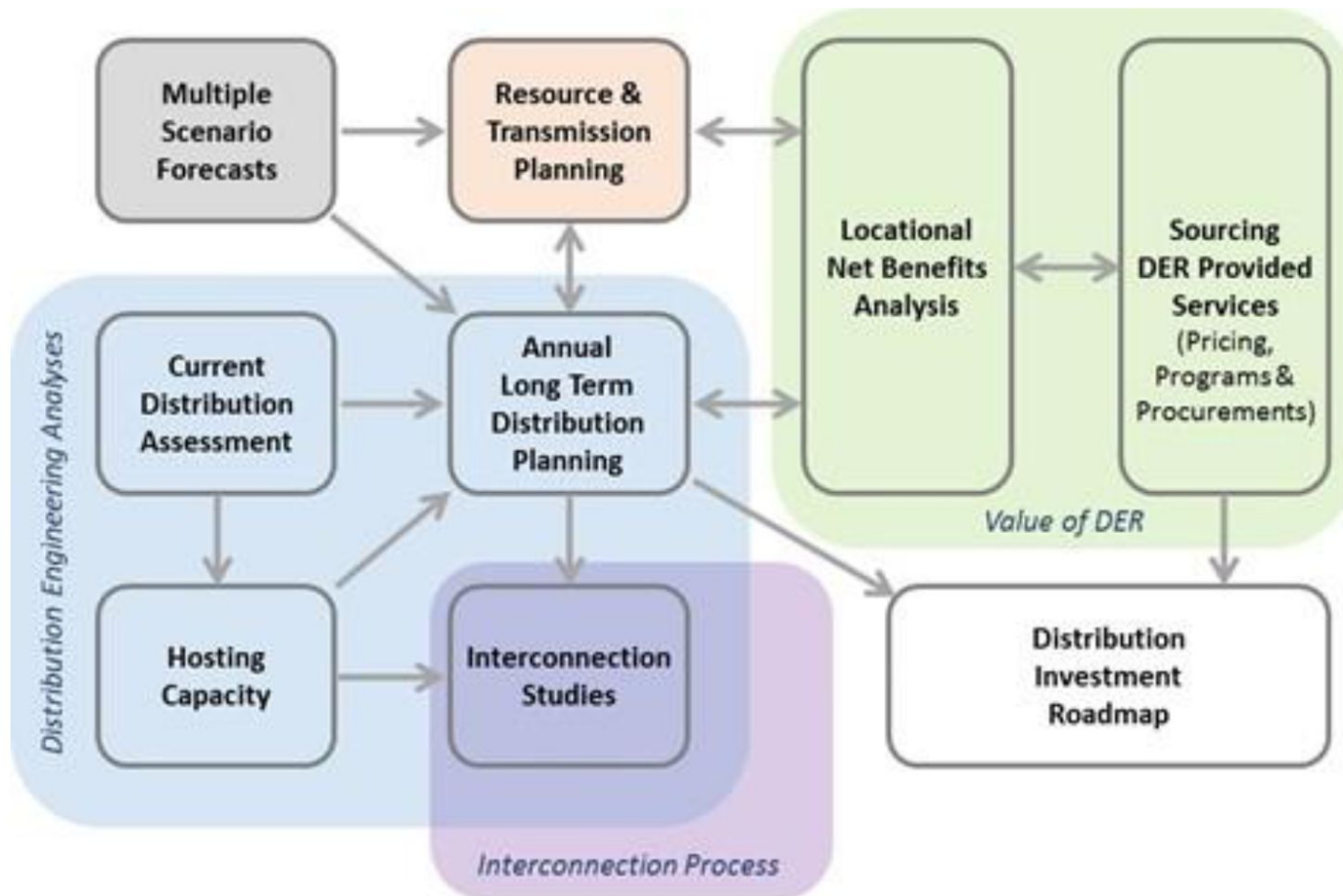
# BQDM - Battery Storage System



12 MW-hours of energy in Lithium Iron Phosphate batteries. Remotely controlled or automated unmanned operation. 1) Charge during off-peak, 2) Discharge for peak-shaving, 3) Repeat as needed. (Note the outdoor installation). Graphic – Con Edison

# Integrated Distribution Planning

## A Means to Plan for DER Integration





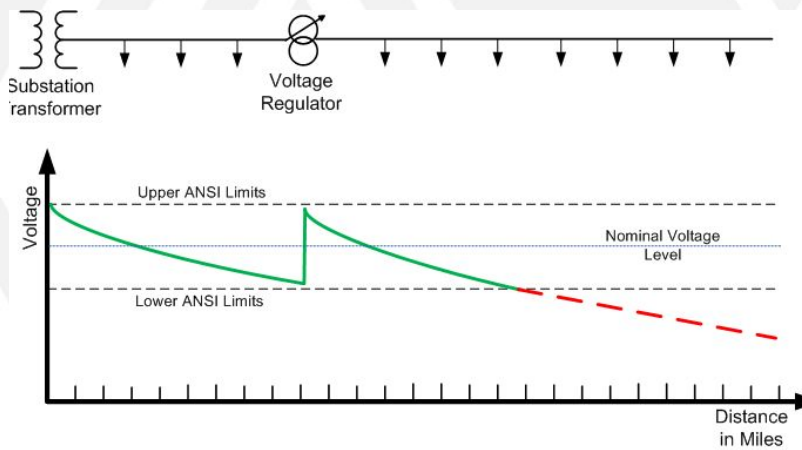
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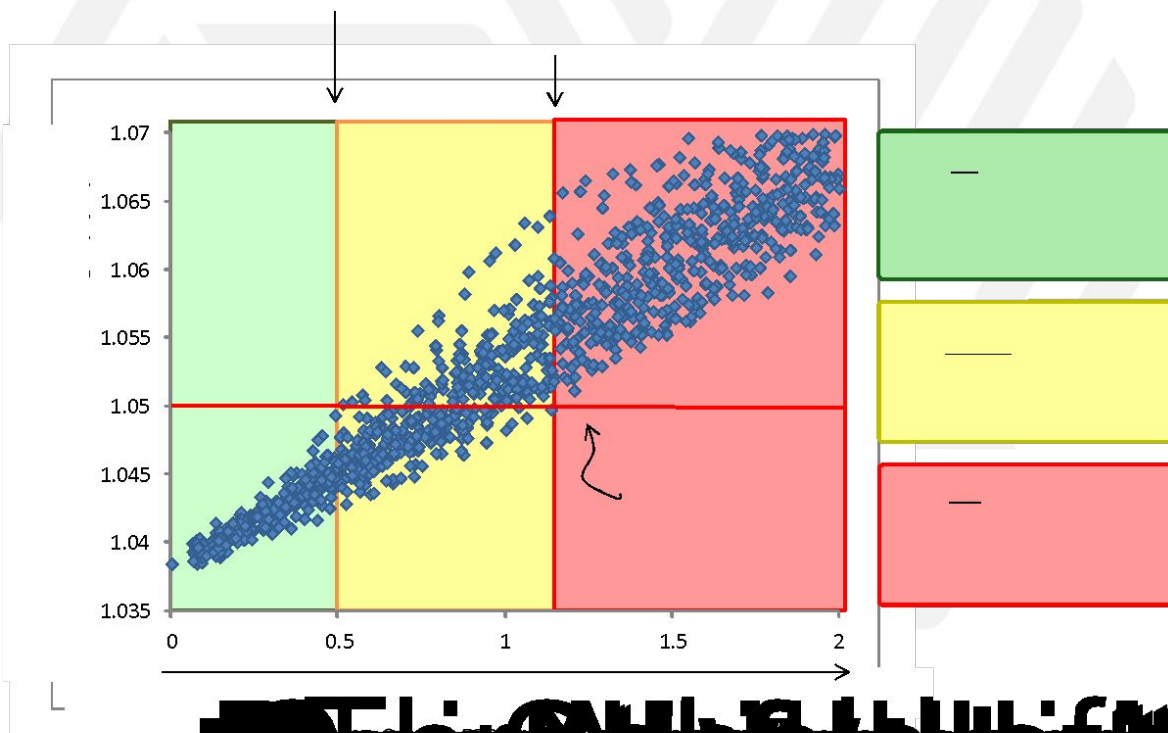
# Basic Questions for PUC Staff Related to Utility Distribution Mapping & Modeling

- ▶ What power flow modeling platform does the utility use?
- ▶ How many staff use this platform?
- ▶ What modeling platform is used for protection coordination? (i.e. fuses, circuit breakers)
- ▶ How often does the power flow model extract data from GIS?
- ▶ Are DERs modeled in power flow?
- ▶ Are DERs tracked for combined analysis?
- ▶ Is the utility prepared to model advanced inverters?



# Other Distribution Modeling Questions

- ▶ Does the utility use any type of “Hosting Capacity” metrics on distribution circuits?
- ▶ Are there defined limits of DER hosting capacity based on location, load, voltage or just policy?



# Other Distribution Modeling Questions

- ▶ Does the utility pursue a Volt-VAR Optimization (VVO) strategy?
  - If so, how do they use power flow models to assist them?
  - Does a VVO strategy impact the operation of other devices such as capacitors, voltage regulators, or substation load tap changers (LTCs)? If so, do the models allow that to be simulated?

