

# Implementing Advanced Functions in DMS

Duke Energy Experience and Perspectives

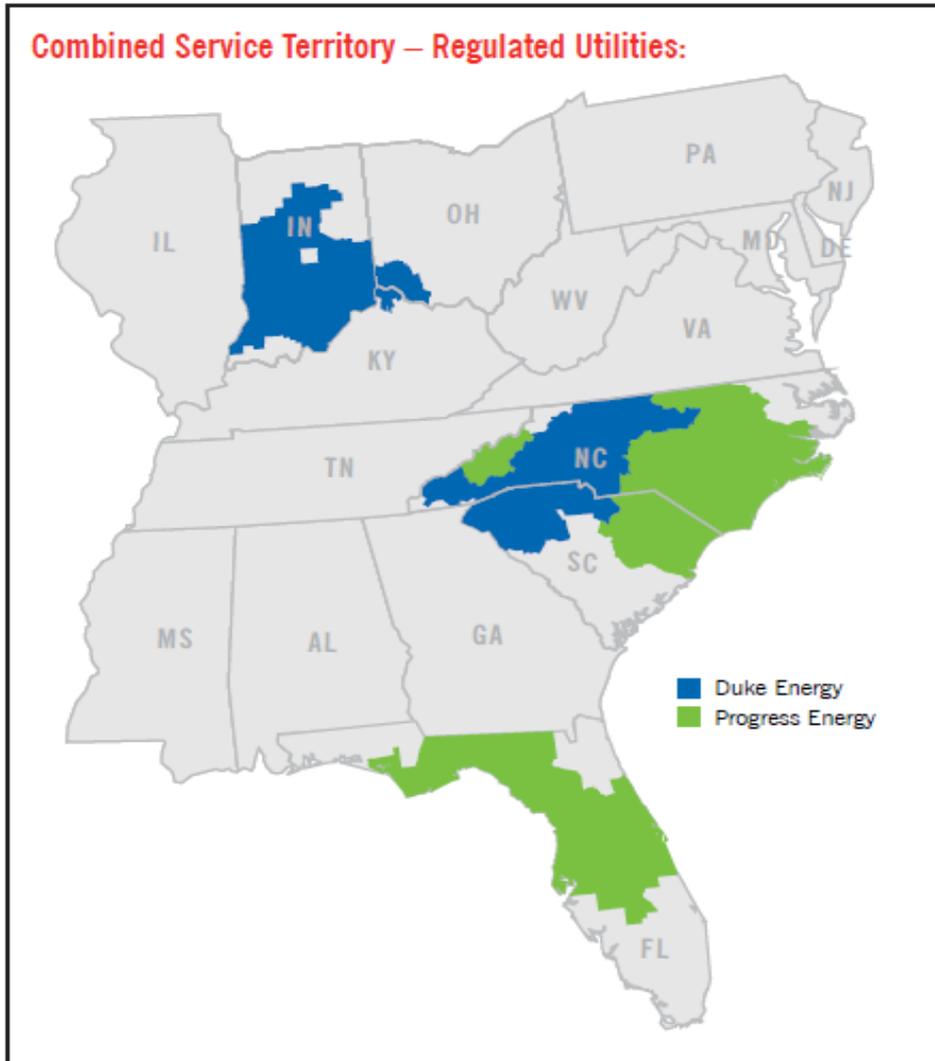
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# Duke Energy - Overview



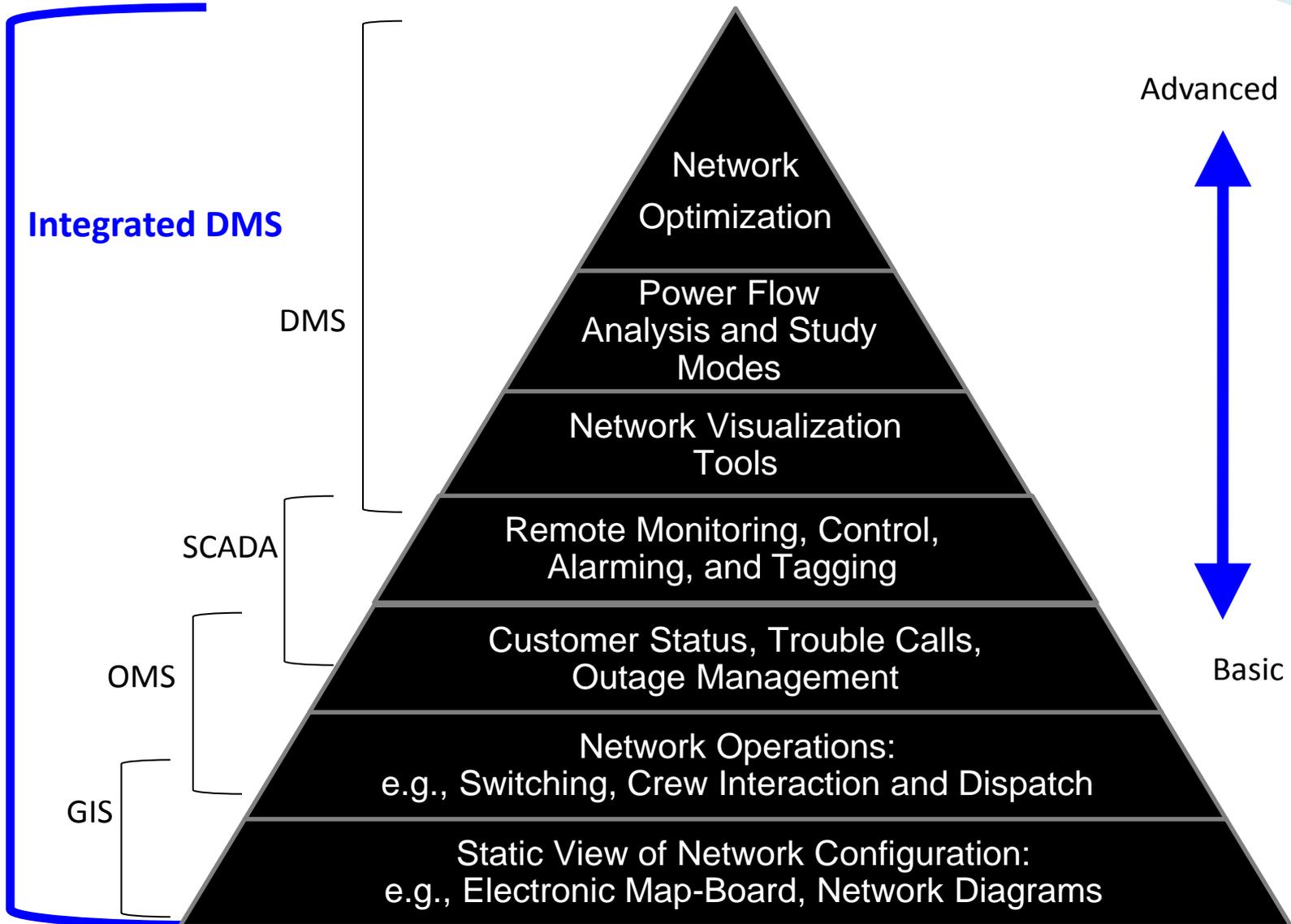
- Electric Retail Customers – 7.2 million
- Gas Customers – 500,000
- Market Cap – \$50.5 billion
- Employees – 27,948
- Service Territory – 104,000 square miles
- Total US Generation Capacity – 49,626 megawatts
- Transmission Lines – 32,200 miles
- Distribution Lines – 261,700 miles
- Duke Energy International owns, operates or has interest in approximately 4,900 MWs of generation



# Agenda

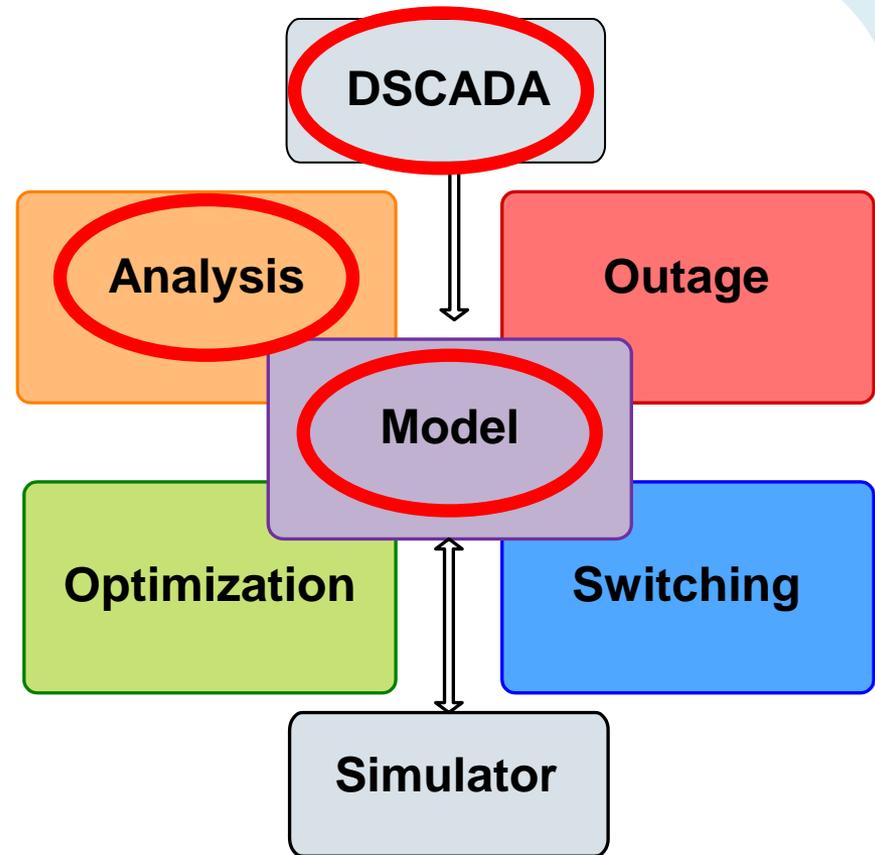
- DMS – brief history
- Integrated Volt/Var Control (IVVC)
  - Objectives
  - Business Case
  - How/What we implemented
  - Next Steps
- Other Advanced Function Initiatives

# Components of an Integrated DMS



# What is Integrated Volt/Var Control?

- IVVC uses an electric distribution model, continuous-near real-time power flows, and measured values to optimize voltage and VAR flow to meet specified optimization objectives
- The optimization algorithm coordinates and manages voltage regulation and capacitor controls to reach the specified optimization objectives
- IVVC is capable of several optimization objectives which include minimize demand, minimize limit violations, minimize circuit losses, and maximize reactive (VAR) support



1. Keep voltage in the service range (Reliability 114-126V)
2. Conserve Energy with Voltage Reduction (Savings during peak)
  - A drop in Voltage ,CVR (Conservation Voltage Reduction), gives a reduction in energy supplied
3. Reduce Losses (Savings)
  - Losses in transmission are driven by two factors – Impedance, Current
  - The conductor is the main source of impedance for a distribution network
  - The impedance of a conductor is driven by the cross sectional area and length of the conductor
  - Those two things are not easily changeable
  - Current, on the other hand, can be changed rather simply
  - By attaining a closer to unity power factor you can reduce the reactive current and achieve less losses

## **Ohio Substation Components (ITF = Inside the Fence)**

- 74 - Breaker Replacements
- 561 - Regulation Controls
- 377 – Microprocessor Relay Upgrades

## **Ohio Distribution Line Components (OTF = Outside the Fence)**

- 126 – Electronic Reclosers
- 1947 – Capacitor Controls
- 4085 – Line Sensors
- 30 – Self Healing Teams

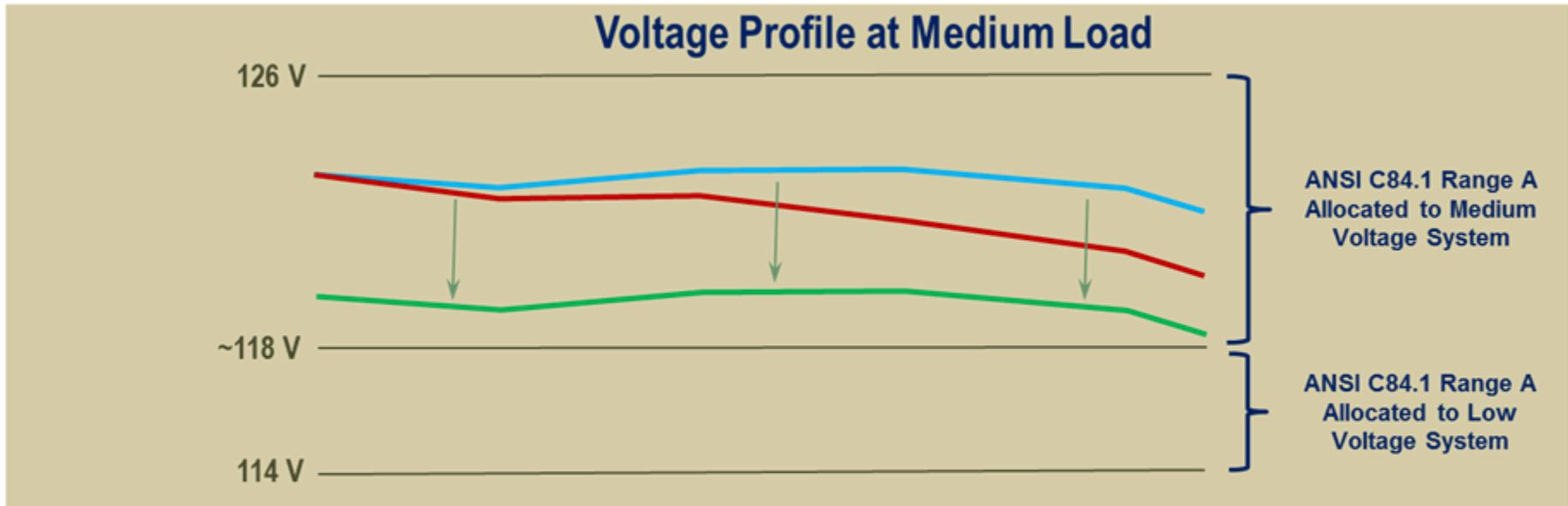
## **Work performed in/on:**

- 148 Substations
- 534 Circuits out of 747

## ■ Ohio VVO Business Case – Energy Reduction

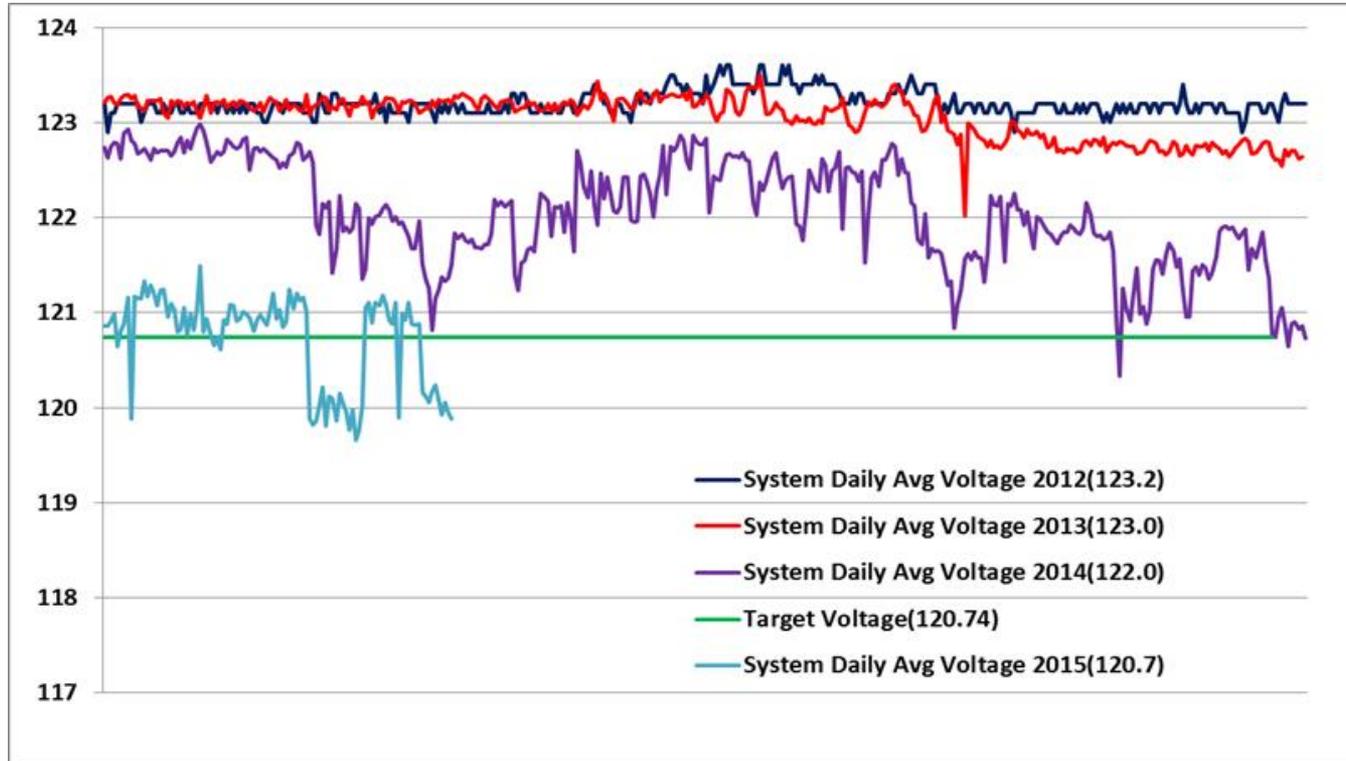
- No prior circuit conditioning work performed
- Assumed there was a 1:1 correlation between demand reduction and energy reduction.
- Commitment to commission of 2% system volt reduction for LVM enabled circuits
- Assumed conservative 0.5-0.79 CVR factor range
- Estimated a system energy reduction of 1.00% - 1.58% with 24/7/365 operation
- Reduced Energy Purchases from the market

# IVVC Before and After Service Voltage



- Lower the voltage profile with substation regulator so that lowest voltage is just above limit

# Average System Voltage Reduction



# Challenges with Current Configuration



- In Ohio there are 511 distribution circuits that are checked out and eligible to run IVVC
- Due to system loading and circuit layout, at any given time 1/3 of our IVVC eligible circuits are not enabled due to switching
- Currently, device heartbeat control is tied to the nominally associated Station and Feeder (SCADA)
- If an IVVC controllable device is switched to a different IVVC enabled feeder, it is not considered eligible on that feeder and will revert to local control.
- The newly configured feeder that now contains both IVVC devices operating in remote mode and in local mode must be disabled for IVVC due to conflicting device operations.

# Next Steps for IVVC

- Alter Heartbeat to use current DMS topology for equipment eligibility
- Integrate AMI meter data into IVVC solutions (voltage readings) for sanity check on secondary voltage buffer
- IVVC pilot in DEC

# Other Advanced Function Initiatives



- Closed Loop FISR pilot in the Carolinas
- Integrate AMI meter data into Distribution Power Flow calculations (kW/kVAR) for solar installations
- Leverage Smart Inverters for control of Distributed Generation
- Integrate Utility-scale Battery Storage for Distribution/Transmission benefits
- Improvements to modeling