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Smart Grid

Mike Born

Principal Engineer, Capacity Planning

Agenda

- ✓ Smart Grid – Brief Overview
- ✓ ComEd’s Smart Grid Vision and Building Blocks
- ✓ Customer Relations Game Changer
- ✓ The Illinois Smart Grid Journey
- ✓ Federal Stimulus (Matching Grant)
- ✓ Overview of ComEd Stimulus Proposal
- ✓ Conservation Voltage Reduction & IVVC

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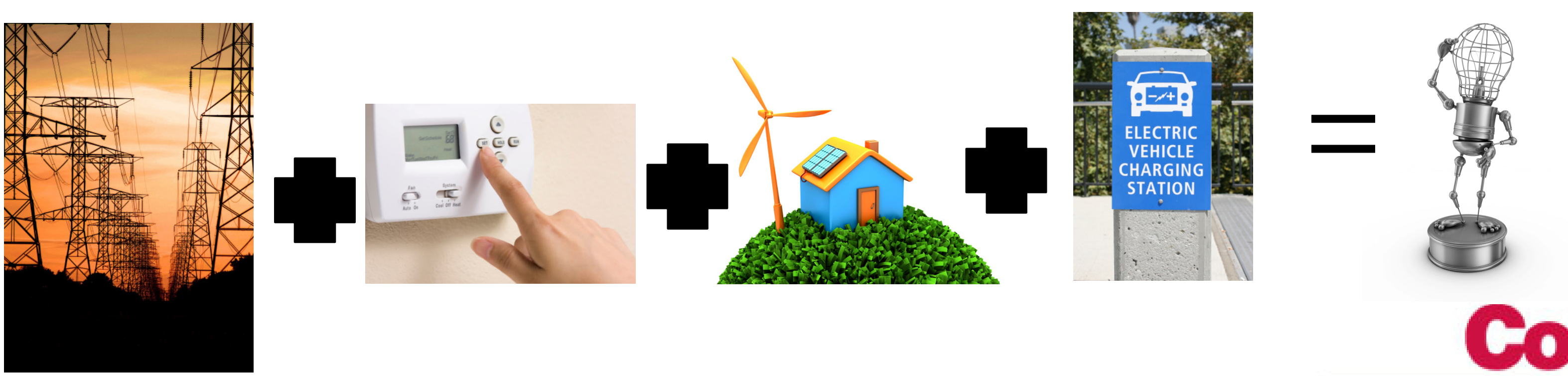
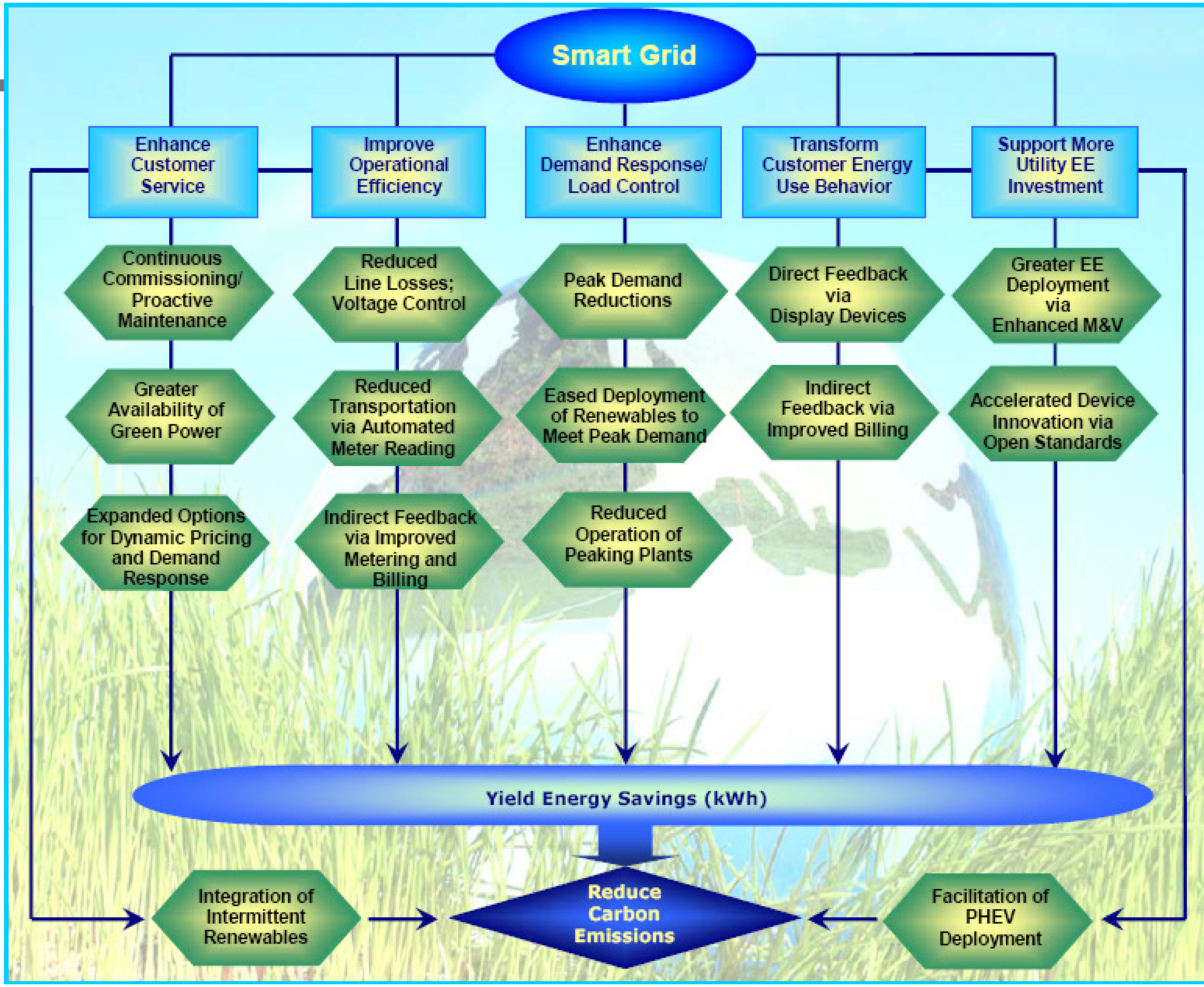
Background

- ✓ National Academy of Science declared the electrification of the nation as the "most significant engineering achievement of the 20th century"
  - Driver to achieving global economic leadership position
  - Carries over 1,000,000 megawatts of energy over 300,000 miles of transmission lines managed by 3,100 electric utilities
- ✓ Convergence of aging infrastructure, significant technological advancements, rising customer expectations, and social issues create the catalyst for the next stage in the evolution of the grid
- ✓ In December, 2007, Title XIII of the Energy Independence and Security Act endorsed the modernization of the nation's electric grid and characterized the "smart grid"
  - Provides incentives to transform the existing infrastructure to a smart grid

A Transformational Leap

- ✓ Poles, wires, cables, circuit breakers and transformers still form the backbone of the electric grid
- ✓ Advances in communication technologies and information processing can enable a highly automated integrated intelligent network that:
  - Will empower customers with increased information, flexibility, and control over their service
  - Improved service reliability
- ✓ Smart Grid concept represents a renaissance for the distribution company
  - Defining the utility of the future – more responsive to the needs of customer





Slide Credit: EPRI – The Green Grid

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The Smart Grid Vision

Enhancing customer value with cost-effective technological advancements that empower customers in ways that lead to:

- More efficient utilization of electricity
- Reductions in future demand growth
- Improvements in the environment
- A more reliable and secure system

Key Building Blocks

- ✓ Integrated communication systems
  - Foundational and required to enable the other key building blocks

- ✓ Information processing
  - Enhanced operator controls, decision support, peak load response, equipment condition monitoring
- ✓ Advanced components
  - Automated switches, intelligent meters, microprocessor relays, distributed resources (wind, solar, etc.), superconductors, power electronics, etc.
- ✓ Advanced sensing and measurement
  - Time of use pricing, outage detection and notification, energy management systems, phasor measurements, power quality monitoring, etc.

- ✓ Advanced control
  - Automatic restoration and isolation, control of distributed resources, etc.

Integration of these building blocks is key to creating enhanced intelligence and thus enhanced service

What might the Smart Grid 'look like'?

Home area network

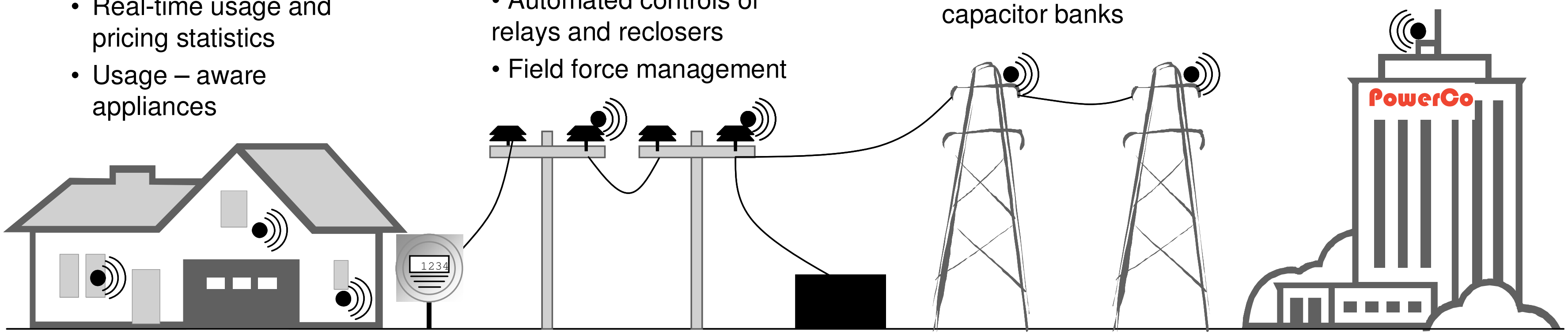
- Real-time usage and pricing statistics
- Usage – aware appliances

Delivery Automation, Sensors and Controls

- Real-time reporting of status and outages
- Automated controls of relays and reclosers
- Field force management

Transmission Sensors and Automation

- Power factor monitoring
- Optimized switching of capacitor banks



Smart Meter

- Report usage by time
- Report outages in real-time
- Remote disconnect
- HAN gateway

Distributed Generation

- Micro-generation
- Solar
- Wind
- Net metering

Data collection, processing and back office

- Automated billing
- Disconnection of unoccupied / unpaid
- Daily usage stats
- Time of Use pricing

Smart Grid will deliver enhanced reliability and create new opportunity for customer control of energy usage and spend

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Game Changer to Customer Relations

- ✓ Automatic Meter Infrastructure (AMI) is the "on ramp" to the smart grid journey because it unlocks new opportunities for the customer
- ✓ Smart meters empower customers
  - Real time information on electrical usage
  - Real time pricing
  - Demand response
- ✓ Smart Grid improves customer service
  - Improved outage detection and response
    - Less dependence on customer reporting outages
  - Real time meter information available to customer service representative for customer inquiries
  - Optimize utilization of existing infrastructure
  - Accommodates and adaptable to distributed resources (wind, solar, etc.)
  - Improved reliability – fewer and shorter interruptions

The Illinois Smart Grid Journey

- ✓ The ICC has established the stakeholder workshop process as the method to creating the Illinois smart grid roadmap
  - Six-month Advanced Metering Infrastructure (AMI) Workshop concluded in May
  - Two-year Illinois Statewide Smart Grid Collaborative Workshop is in progress
- ✓ American Recovery and Reinvestment Act of 2009 (ARRA) included funds to implement Smart Grid Investment Grants under Title XIII of the Energy Independence and Security Act of 2007
  - ComEd submitted proposal to invest $350 million in smart grid technologies
    - AMI
    - Customer Applications
    - Enhanced Substation
    - Distribution Automation
    - Communication Support Systems

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Stimulus Analysis

✓ $3.4B Allotted for Stimulus

- 18M smart meters
- 1M In-Home-Displays
- 200,000 advanced transformers
- 175,000 load management devices
- 170,000 smart thermostats
- 700 automated substations

✓ 70% of proposals contained AMI projects

ComEd's ARRA Stimulus Proposal

AMI

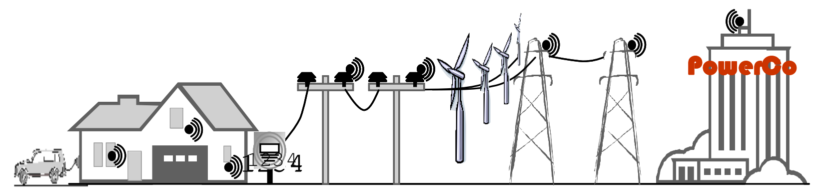
- A total of **320,000 AMI meters** are proposed
  - 220,000 in the Maywood Operating Center
  - 89,000 in the City of Chicago
  - 10,000 in Elgin
  - 500 in Tinley Park
  - 500 in Chicago High Rises

Distribution Automation

- Approximately 700 automated switches and reclosers
- Dynamic Voltage Management pilot on 21 distribution lines
- Upgrade of existing distribution radio control system to a new secure interoperable network

Customer Applications

- 60,000 In Home Devices
- Community Outreach
- 17,000 additional air condition cycling
- 2000 advanced meters for BOMA downtown building pilot program



Enhanced Substation

- 4 Intelligent Substation conversions, which includes 371 microprocessor upgrades
- 875 microprocessor relay upgrades
- 57 transformer monitoring devices
- 3 digital disturbance monitoring data recorders

Communication Support Systems

- Approximately 370 miles of fiber optic cable
- IP Enabled SCADA WAN
- 200 RTU upgrades
- Analog to digital phone line upgrades
- SCADA Master Control upgrade and expansion
- SCADA Monitoring of underground fluid filled transmission lines

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Conservation Voltage Reduction (CVR) and Integrated Volt-VAr Control (IVVC) Pilot

CVR Pilot Objectives

- ✓ Reduce peak demand and annual energy consumption by reducing the delivery voltage.
- ✓ Reduce feeder and substation transformer losses by maintaining near unity power factor at all times.
- ✓ Improve capacitor bank availability and eliminate annual preventative maintenance inspections through real time monitoring of bank status.
- ✓ Evaluate the effectiveness of CVR to reduce energy and practical limits to the amount of voltage reduction

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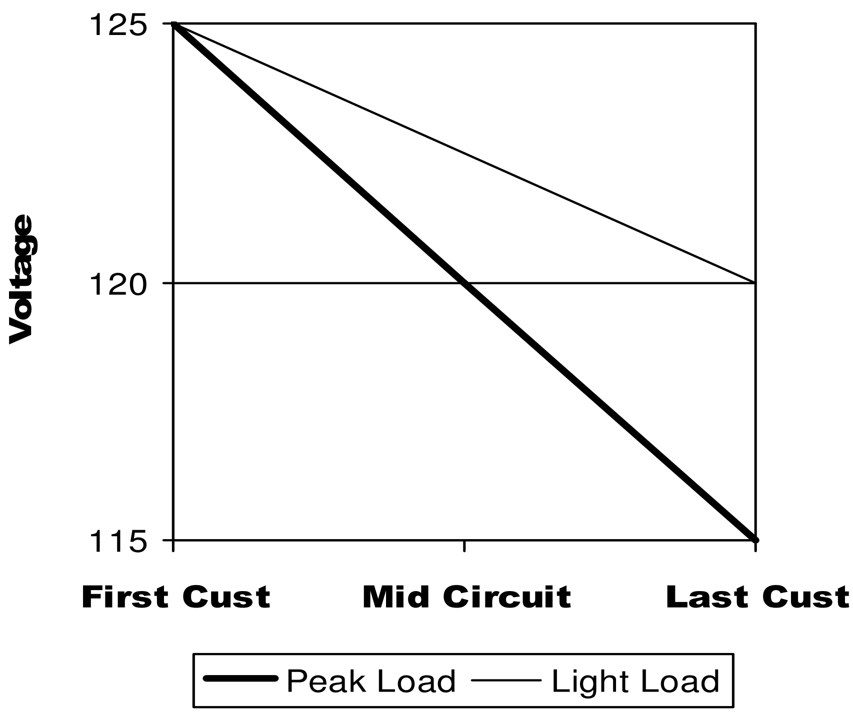
Voltage Reduction Impact on Consumption

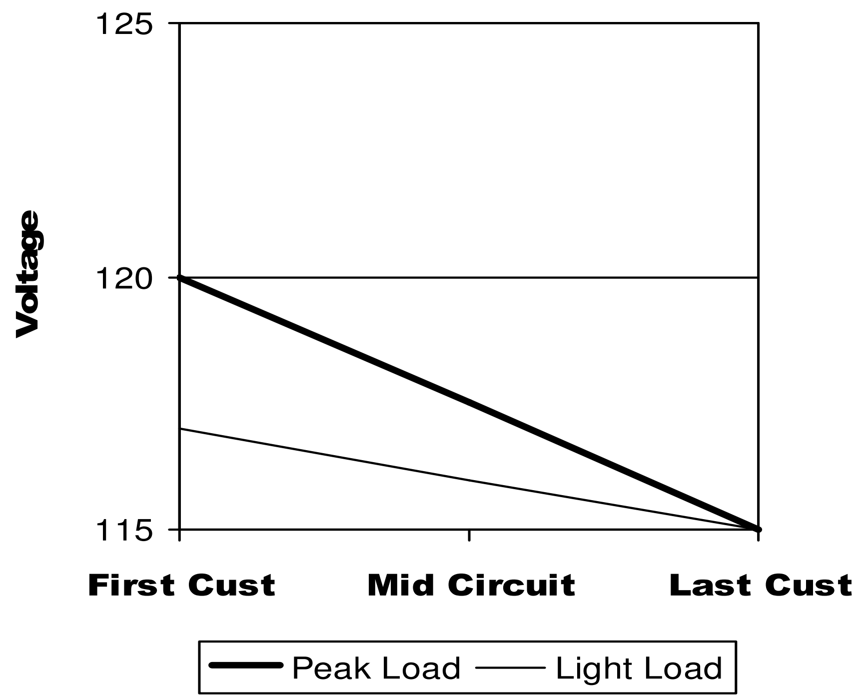
- ✓ Electric utilization equipment requires less real and reactive power when the applied voltage is in the range of 95-100% of the nominal voltage compared to the 105% voltage typical for ComEd.
- ✓ Industry experience indicates that a 0.75% reduction in energy occurs for a 1.0% reduction in voltage.

Voltage Regulation Philosophy Change

- ✓ Current – 125V at substation, up to 10V primary voltage drop



- ✓ With CVR – 120V at substation, flat (2V) primary voltage profile



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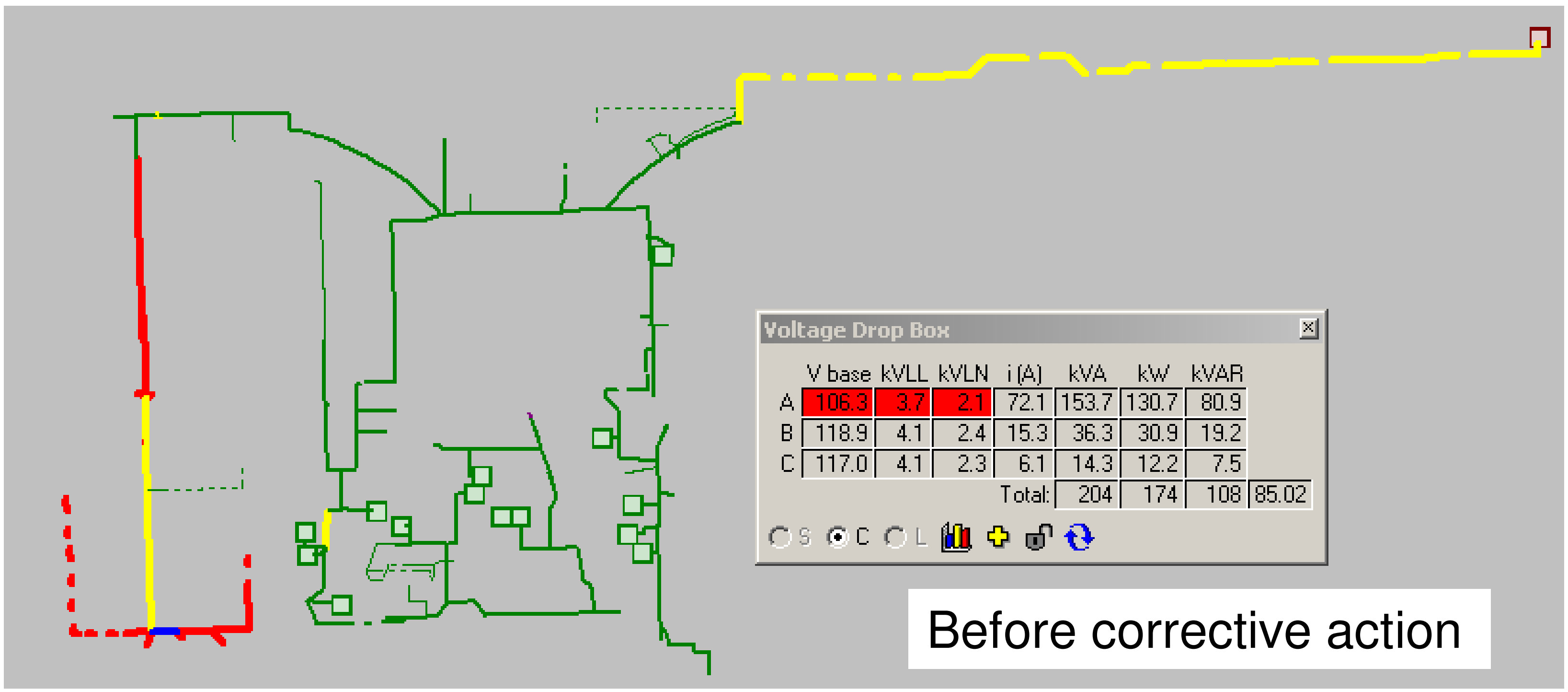
Development of Implementation Plan

✓ Capacity Planning will analyze pilot area feeders to determine reinforcement required to flatten voltage drop. D0504 requires additional caps.



Before corrective action

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Current ComEd Capacitor Applications

- ✓ Capacitors are applied to reduce substation and feeder load at peak. Loss minimization and flat voltage profiles are not generally considered. Voltage switched capacitors are applied in areas with low voltage violations. Voltage override is generally applied to avoid voltage violations, but may prevent capacitors being on at peak if high voltage occurred prior to the peak load. Excess capacitor output is typical during light loads which results in increased losses and substation transformer tap changers in the “buck” range.

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Conceptual Integrated Volt/VAr Capacitor Control Plan

- ✓ In an integrated Volt/VAr system, capacitors are controlled based on measurement of kW, kVAr at the feeder breaker, primary voltage at capacitor locations and secondary voltage from AMI customer locations. Control of capacitors and the substation LTC is optimized to result in a flat feeder voltage profile and unity power factor. This result reduces customer demand, energy usage and energy losses.

Preliminary System Architecture