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Structure™

Smart Grid Technologies
Demand Reduction: Conservation Voltage Reduction

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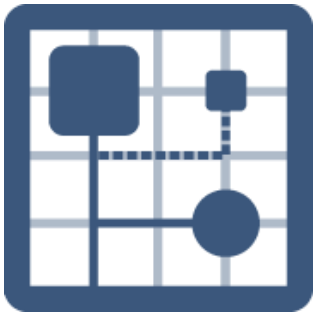

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Smart Grid: Business Drivers

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Intelligent (Smart) Grid
[Smart integration of systems]

Improving Operating Point
[Self healing / control / automation]

Technology Improvements
[More system visibility & more data]

- Paradigm change in Distribution Operations
- Need to revise strategies & roadmaps
- Wide-scale Distribution Automation deployments
- Integrated Distribution Management Platform (iDMP)
- Convergence of real-time & traditionally planning-type applications

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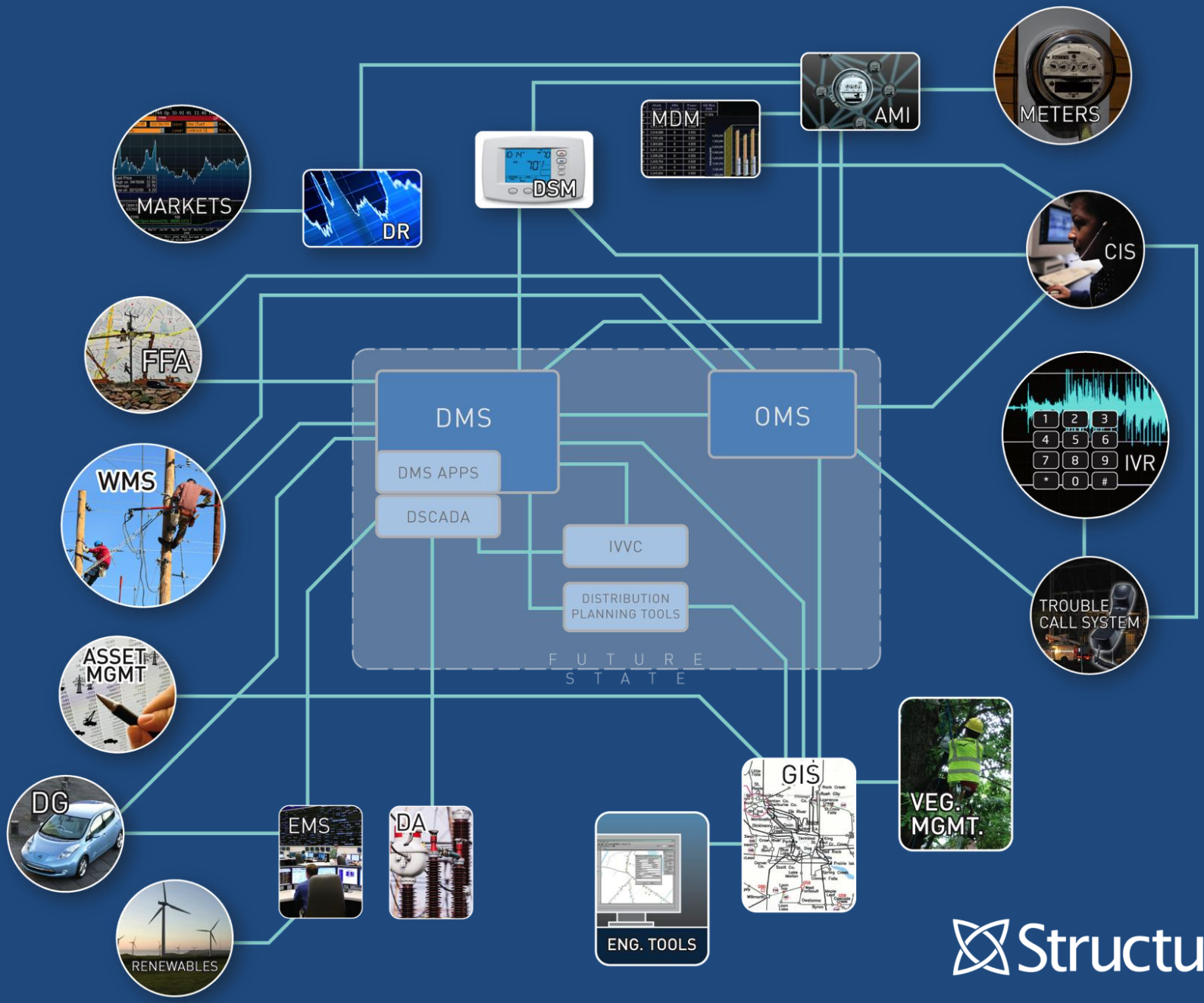

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Operational-Driven Smart Grid: Business Objectives

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- Provide a holistic/integrated Network Control Center that includes automation and optimization
- Reduce outage time & minimize outage foot print
- Upgrade legacy systems and add advanced functionality
- Improve system operation efficiency and system operating point
- Reduce peak demand when, and if, required
- Efficient management of field personnel
- Centralized or Distributed Control of DA devices
- Improve operations and improve customer experience
- Delay new generation or avoid use of expensive generation

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Smart Grid Trend: Self "Healing" Networks

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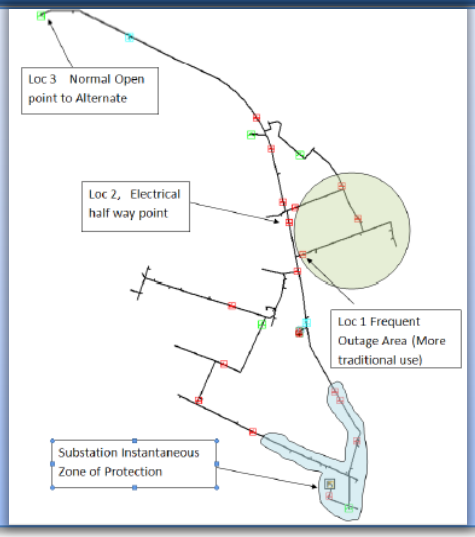
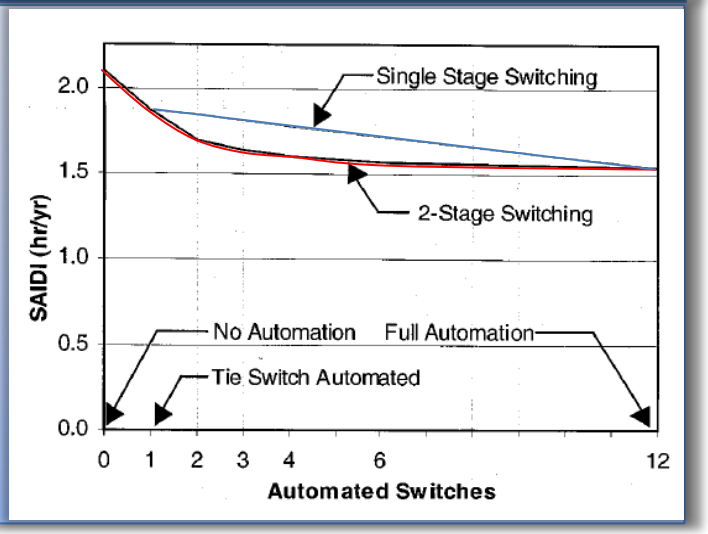
Long envisioned distribution automation for "self healing" being implemented on utility-wide scales…

- Automatic restoration of feeder sections limits interruption impacts
- 20+% main line feeder SAIDI improvements possible and promised
- Centralized (DMS/DSCADA) and local (peer-to-peer) control systems being used

"Self Healing" Network Example – Automated Switch Deployments Reduce SAIDI





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Smart Grid Trend: DSM & DR

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Multiple approaches have evolved for managing demand…

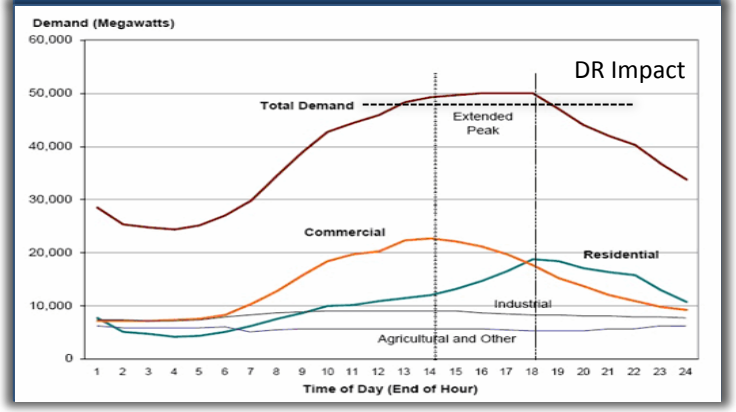
- Demand Side Management: Energy efficiency and energy conservation
- DSM Objectives: Peak shaving, valley filling, load shifting, strategic conservation
- Demand Response: Load reduction as response to price or system condition
- DRMS Solutions: Direct load control, critical peak pricing, real-time pricing

Demand Side Management

ASK ABOUT ENERGY STAR State Appliance Rebate Program

SMARTHOME™

Demand Response



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Smart Grid Trend: CVR or IVVC

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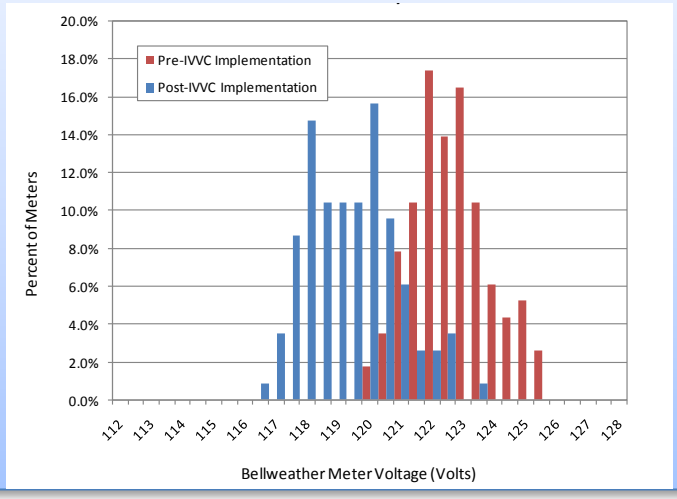
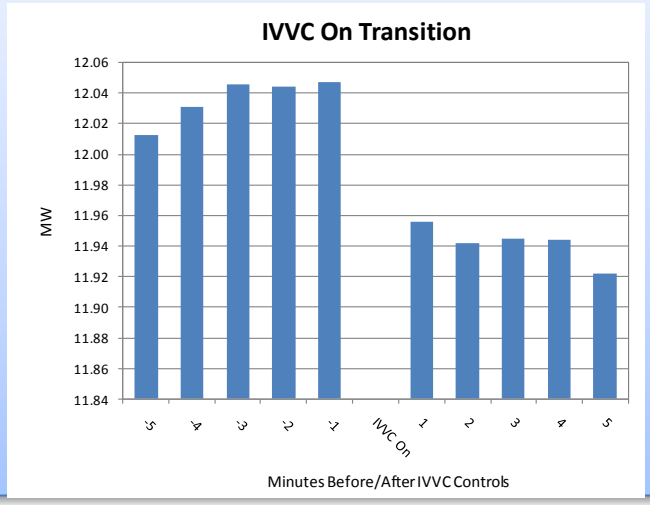
Capacitor and LTC control to minimize losses and manage peak demand…

- Real time management of feeder voltage profile to reduce peak demand
- One for one reduction typical – 1% voltage reduction gives 1% demand reduction
- Near real-time monitoring required to prevent voltage violations

IVVC Example –Average Customer Voltage Reduction Yields Demand Reduction





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CVR / IVVC: Capability & Objectives

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- Consists of substation control and distribution VAr dispatch
  - Substation Control – the “rough” substation-level adjustments
  - Distribution VAr Dispatch – the “fine” feeder-level adjustment
  - The two functions are coordinated to the same targets
- Objective: to flatten the voltage profile “curve”
- Conservation Voltage Reduction (CVR) objective functions:
  - Reduce customer demand at system peaks
  - Lower system losses
  - Improve power factor
  - Improve voltage profiles

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IVVC: Reduction of Demand @ Peak Times

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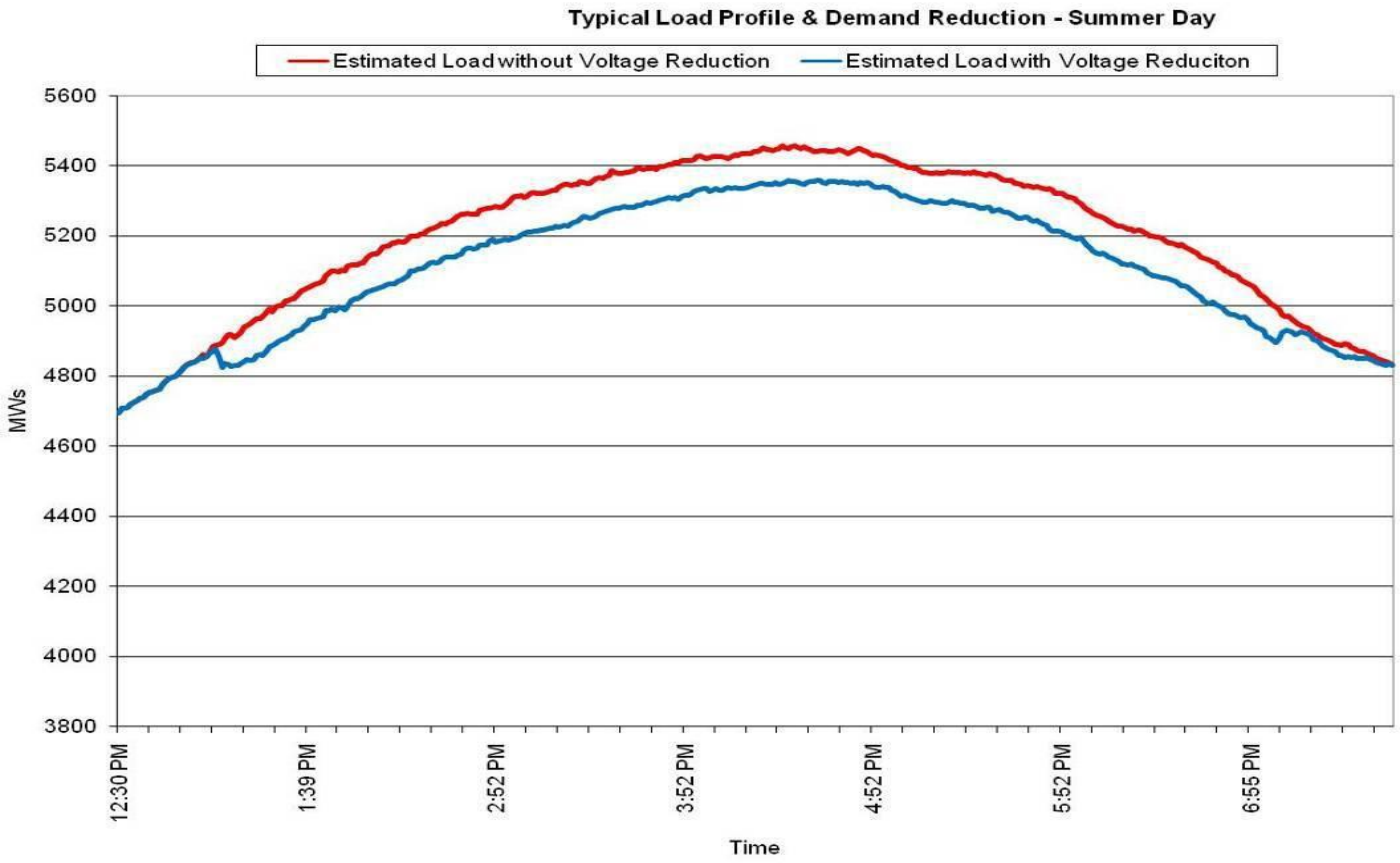

It is expected that 1% drop in voltage will result in 0.5 to 1% drop in demand

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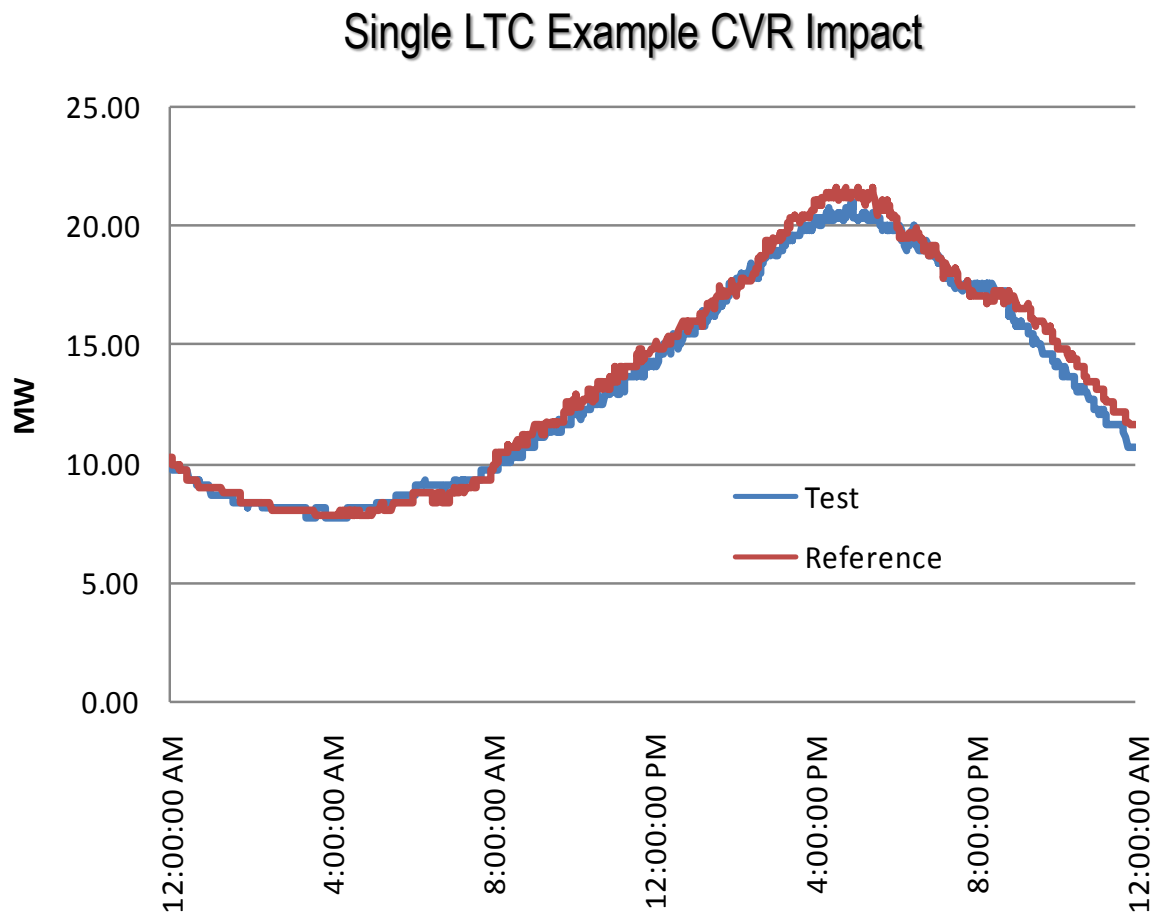
CVR: Relative Magnitude



- CVR involves small voltage reductions (1-5%) on distribution circuits
- Corresponding (0.5-5% reductions in demand can be achieved
- Aggregation across a large number of distribution circuits can result in useful overall reduction in demand.

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CVR / IVVC: Operational Benefits

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- Lower demand on peak hours & improve power factor on off-peak
- A 1% in voltage reduction yields a reduction of about 0.5 – 1%
  - Load-type dependent
- For example, for a peak demand of 6 GW:
  - If voltage is reduced 1.2V, load would be reduced 45 to 60 MW
  - For a 4.8V reduction, load is lowered 180 to 240 MW
  - For a 2-hr peak load duration, a 4.8V reduction yields a demand reduction of 360 to 480 MW-hr
- Involves advanced analytics & coordinated real-time control of devices
- An Issue: constant power vs. constant impedance load
- Theoretically feasible – being deployed as pilots and some large scale

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CVR/IVVC: Equipment Requirements

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Successful CVR/IVVC implementations include several key components …

Automated Capacitor Banks

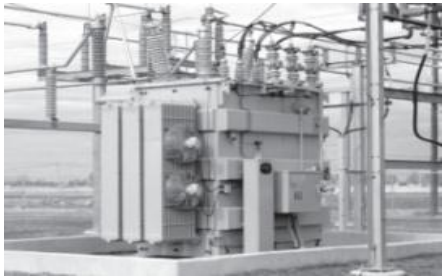
For voltage control and reactive power support on lines

Distribution Management System (DMS) with CVR/IVVC Application

Includes control logic for optimization

Communication System

(Substation) Load Tap Changers



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CVR: Challenges & Opportunities

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- Challenges
  - Ensuring acceptable end user voltage (monitor bellwether AMI meters)
  - "Failsafe" remote LTC control (use band center control rather than adjusting tap positions directly)
  - Timing/triggering of control actions (utilize change thresholds for implementation of control actions)
- Opportunities
  - "Dispatch" CVR/IVVC load reduction to postpone generation purchase/plant investment
  - Delay substation/distribution system expansion

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Thank you!