TECHNOLOGIES FOR ADVANCED VOLT/VAR CONTROL IMPLEMENTATION

Integration of Advanced Metering Data

2014 IEEE PES T&D CONFERENCE & EXPOSITION
CHICAGO
APRIL 14-17
Objective: Safely move the customer into the lower 5% of the allowed voltage band to save energy

- Minimum allowed voltage at the meter is 114V
- Actual meter voltage is typically around 120+V
- Consumer devices are designed to operate with 108V input voltage
- Excess voltage results in energy waste!

95% of voltage optimization savings are in the customer’s home
Why AMI Measurement?

The only way to know the customer voltage is to measure it!

Customer voltage variation…
• is not always furthest from the substation,
• can move around seasonally,
• can move around due to new loads, and
• is affected by intermittent distributed generation.

Roughly half of the voltage drop from the substation to the customer occurs between the service transformer and the meter.

Use of AMI voltage data along with existing SCADA controls to optimize voltage levels on the network provides a comprehensive view from the customer to the control center and enables management of load variability due to deployment of distributed energy resources.
A FLEXIBLE APPROACH TO OPTIMIZATION

AMI based CVR is a flexible solution that adapts not only to your grid but also to your business case.

<table>
<thead>
<tr>
<th>Energy Efficiency - CVR</th>
<th>Demand Voltage Reduction</th>
<th>Volt/VAR Optimization</th>
</tr>
</thead>
<tbody>
<tr>
<td>When run 24/7 it can deliver significant energy savings to your customers through Conservation Voltage Reduction.</td>
<td>Turned on just prior to peak, it can reduce peak demand charges while at the same time ensuring reliable service.</td>
<td>It flattens the voltage profile and improves power factor while at the same time increasing the opportunity for additional demand and energy savings.</td>
</tr>
</tbody>
</table>
Edge of Network Applications

- Calculates circuit-by-circuit savings potential
- Checks for errors and voltage outliers
- Enables a continuous improvement process
- Generates initial bellwether meter set

- Provides real-time voltage optimization
- Uses customer voltage measurement
- Responds dynamically to grid changes
- Achieves sustainable savings
- Provides circuit by circuit management

- Measures actual energy and demand savings
- Integrates weather and economics into validation
- Leverages EPRI validated statistical methods
- Provides feedback into grid efficiency planning
1. Target worst outliers with best fix
2. Fixing the additional points below 116 V would give additional range for CVR.
Planner: Integrate AMI Data into Planning Software
Distributed Energy Resource Compatibility

Linear Prediction of Customer Voltage

\[ V = IR + B \]
Advanced Voltage Optimization: Adding DVR to CVR and Volt/Var

- Water Heater Energy Storage Affect
- Sequential Circuit Voltage Switching
- Return to VVO level with no secondary peaks
- No Customer impact
- Combined Energy & DSM VVO
SECURE OPERATION

EDGE Optimizes setpoint for LTCs and Voltage Regulators

Local Control for LTCS and VRs make Raise/Lower decisions

Optimized High and Low Voltage settings for Capacitor Banks

Local Control for Capacitors make Open/Close decisions
GENERATING SAVINGS AND A CVR FACTOR

Method 1
Historical data used for off records
OFF
ON

CVR turned on and left on

Method 2
CVR turned on and off to create data (Can be scheduled in EDGE Manager)
OFF
ON
OFF
ON
OFF
ON
OFF
ON
OFF
ON
OFF
ON

CVR/VAR OFF
CVR/VAR ON

Record 1
TX #1 =
Status
Day Type
CDD
HDD
Humidity
Volts
kW/Customer

Record 2
TX #1 =
Status
Day Type
CDD
HDD
Humidity
Volts
kW/Customer

Δ Volts
Δ kW
HIGH VARIATION LOAD AND GENERATION STABILIZATION

Stabilizer

1. EDGE Stabilizer will manage the integration of high-variable loads/generation into the Voltage Optimization process
2. Final version will optimize the circuit capacity for allowing high variation loads and generation to be compatible.
3. EDGE Stabilizer will be built to work with existing EDGE CVR and various Volt/VAR schemes (override mode)

Using real-time AMI voltage data, and substation data, manage the integration of high-variable loads into the voltage optimization process.
CASE STUDY – MIDLOTHIAN VIRGINIA

Pilot at Dominion Virginia Power
✓ Precise voltage control on two circuits
✓ 6,697 AMI meters
✓ Suburban Setting
✓ Mix of Residential and Commercial
✓ Average of 2.8% savings

Dominion Virginia Power Pilot Performance
✓ 5 Years of CVR Operation
✓ Initial Pilot area yielding $292,000 (5,144 MWh) in annualized energy savings for 6,697 customers.
✓ Pilot extended to 11 additional sites (80K meters under CVR control)
✓ Piloting in rural and dense urban settings.
Total CVR benefits increase as the Program is implemented across each circuit.

Not just a “one and done”, ensures achieved benefits are sustained & new benefits are added as your grid grows.