Grid Edge Control

- Grid Optimization (VVO/CVR)
- Grid Integration of Distributed Dynamic Loads (PV)
- Power Quality & Weak Feeders

Presentation to LBNL

February 14, 2014

Deepak Divan, President & CTO, Co-Founder
Grid Edge Control - Summary

• Distributed, decentralized, dynamic control at the grid edge
• Complements existing centralized command & control
• Absorbs dynamics of distributed PV
• Allows many Smart Grid initiatives to deliver on promised value
• Delivers visibility and analytics at edge
Background: Electric Utilities in Transition

Dispatchable Generation

1000 GW peak

- 100’s of generators
- Poor visibility at periphery
- Control is central, slow

Intermittent + Dispatchable Generation

1600 GW peak (@20% RPS)

- 10,000’s of generators
- Visibility to dynamics required
- Dynamic control needed at periphery
CONVENTIONAL Volt VAR Control

Electromechanical Cap Banks / Regulators

- Primary side control
- Centralized & complex
- Slow (5-15 min) response
- Limited switchings per day

Control Center Based Volt/VAR Optimization

Best Practice: Distribution Operations Support

Source: GTM Research
Limitations of Primary Side VVO Control

• Issues

– Voltage drop across distribution transformers 2 - 8 volts, AMI data confirms
– Cannot manage secondary voltage variations using primary side control
– Distributed control required, not possible with central command & control
– Erodes value proposition of CVR/Demand Management systems
– Poor VVO/CVR performance has negative impact on entire market segment
NO GRID EDGE CONTROL

Demand Management / CVR

lower voltage limit - ANSI
ENGO-V: Distributed Grid Control

- Decentralized Volt VAR regulator unit
- Regulation, monitoring, comms all in one box
- Fast, autonomous, variable response
- System analytics & diagnostics

Autonomous Distributed Volt-VAR Control

Voltage Sensing Event Capture

Wireless Comms

Data Manager Diagnostics

Head-end Data Platform

dnp3
“headroom” is maximized

2X greater energy savings possible

lower voltage limit - ANSI
Field Data: 40 Units on a Feeder

| NO GRID EDGE CONTROL | WITH GRID EDGE CONTROL |

$\Delta V = 5$ volts enables 2X demand control
• Voltage instability at PV penetration > 10-15%
• Dispatched slow Cap Banks cannot solve voltage volatility

Source: San Diego Gas & Electric
- Clouds cause voltage volatility and frequent LVR operation
- Dynamic voltage control required at point of problem
- Smart inverters have no VAR reference and can fight
- Utilities cannot dispatch distributed VAR commands
Grid Edge Control Reduces Impact of PV Solar on the Grid

ENGO OFF

ENGO ON

Data for 11/20/13, Setpoint: 0

Data for 11/19/13, Setpoint: 245

Partly Cloudy Days

Voltage (V)

Time

Node
Peak Demand Reduction:
• Peak Demand (Base Case): 3,225 kW
• 5% voltage change at coincident peak: 144 kW reduction
• Cost savings at $15/kW/month: $2,197/mo
• Annual cost savings = $26,300/year

Line loss reduction with power factor control:
• Improving PF from 0.95 to 1.0 reduces line losses by 10%
• Est. line losses 10% of energy delivered = 1900 MWHr/year
• Line losses reduced by 10% = 190 MWHr/year
• Savings by utility at $0.05/kWHR = $9,500/year

24/7 CVR Savings for utility:
• Energy Delivered estimate = 13,700 MWHr/year
• Estimated Energy Savings 420 MWHr/yr reduced (at $0.05/kWHR = $21,000/year)

Power Quality Improvement
• Reduce flicker events
• Reduce dynamics or low voltage location
• Lower cost method compared to reconductoring, new transformer, network re-configure

Fixing low voltage nodes with the ENGO units allows the feeder voltage to be decreased without violating ANSI voltage limits
Live install in 15 minutes
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Grid Integration of Distributed Solar

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