Session 2:
Conservation and Optimization Via Volt/Var Control

The Smart Grid Experience:

Applying Results,

Reaching Beyond

ELECTRIC POWER RESEARCH INSTITUTE

U.S. DEPARTMENT OF ENERGY

Conservation and Optimization Via Volt/var Control

Tuesday, October 28, 2014

8:00 a.m. Session

Moderators

Jared Green, EPRI

Joe Paladino, DOE

The Smart Grid Experience: Applying Results, Reaching Beyond

October 27-29, 2014

Session Agenda

- (8:05-8:20 AM) Brian Schell – American Electric Power
- (8:20-8:35 AM) Bruce Lovelin – Central Lincoln
- (8:35-8:50 AM) Daniel Fournier - Hydro-Québec

- (8:50-9:00 AM) 5-10 minute break for Q&A

- (9:00-9:15 AM) Jim Parks – SMUD
- (9:15-9:30 AM) Jay Oliver – Duke Energy
- (9:30-9:40 AM) Jeff Roark – EPRI
- (9:40-9:50 AM) Joe Paladino – DOE

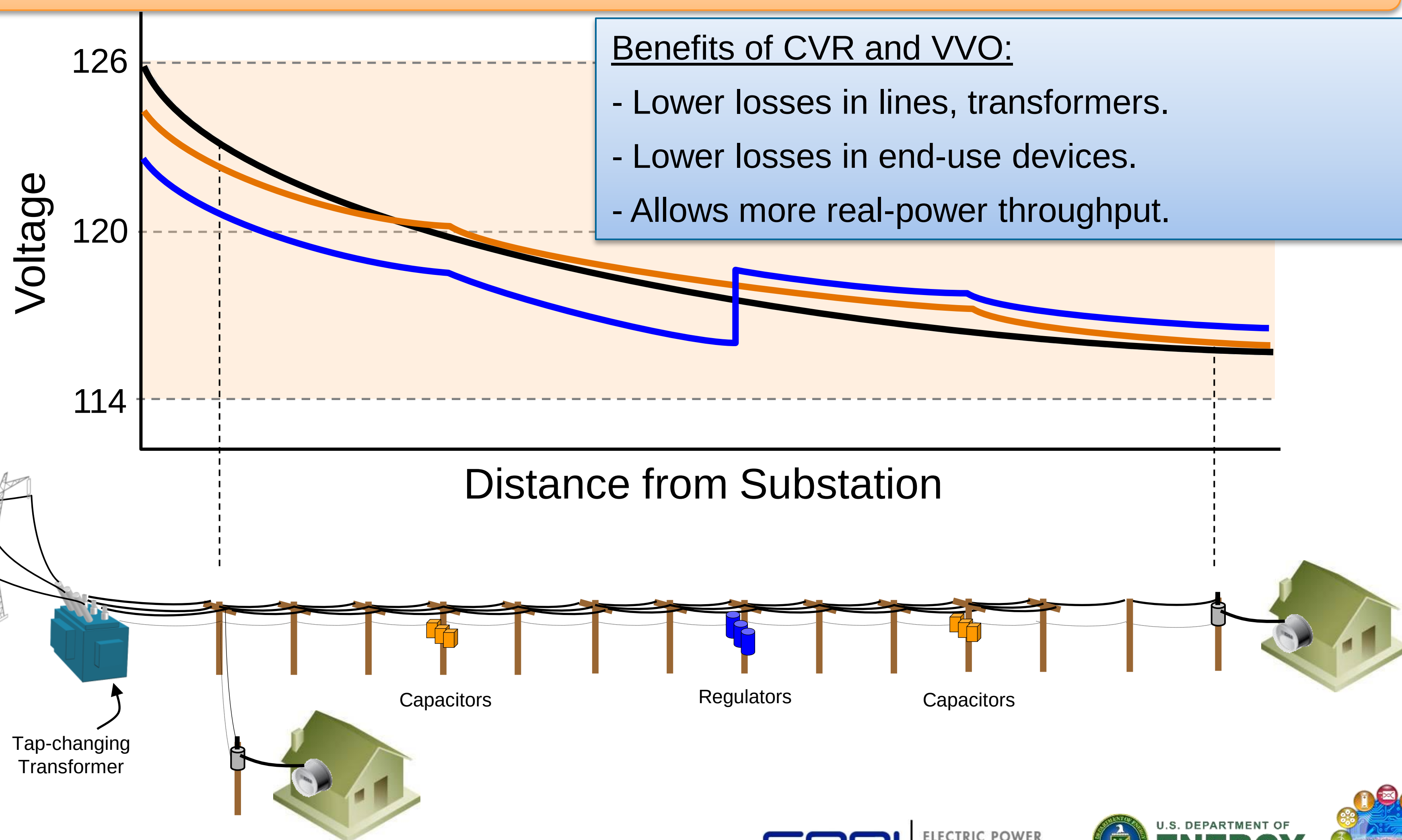
- (9:50-10:00 AM) 5-10 minute break for Q&A

CVR and VVO Basics

CVR factor (CVRf) = % change in load ÷ % change in voltage

<ins>Benefits of CVR and VVO:</ins>

- Lower losses in lines, transformers.
- Lower losses in end-use devices.
- Allows more real-power throughput.



Brian Schell, American Electric Power

Email: beschell@aep.com

- Brian received his B.S.E.E. degree from West Virginia University in 1988 and has been a licensed Professional Engineer in the State of Ohio since 1995.
- Principal Engineer employed with American Electric Power for 25 years.
- Worked first 5 years in the Region Engineering Organization in Columbus, Ohio.
- Worked for 15 years in the Distribution Planning organization and was supervisor for Ohio the last few years.
- Since 2010 worked in the Grid Management Deployment organization for American Electric Power.

Volt VAR Optimization at AEP

Experience with three vendors:

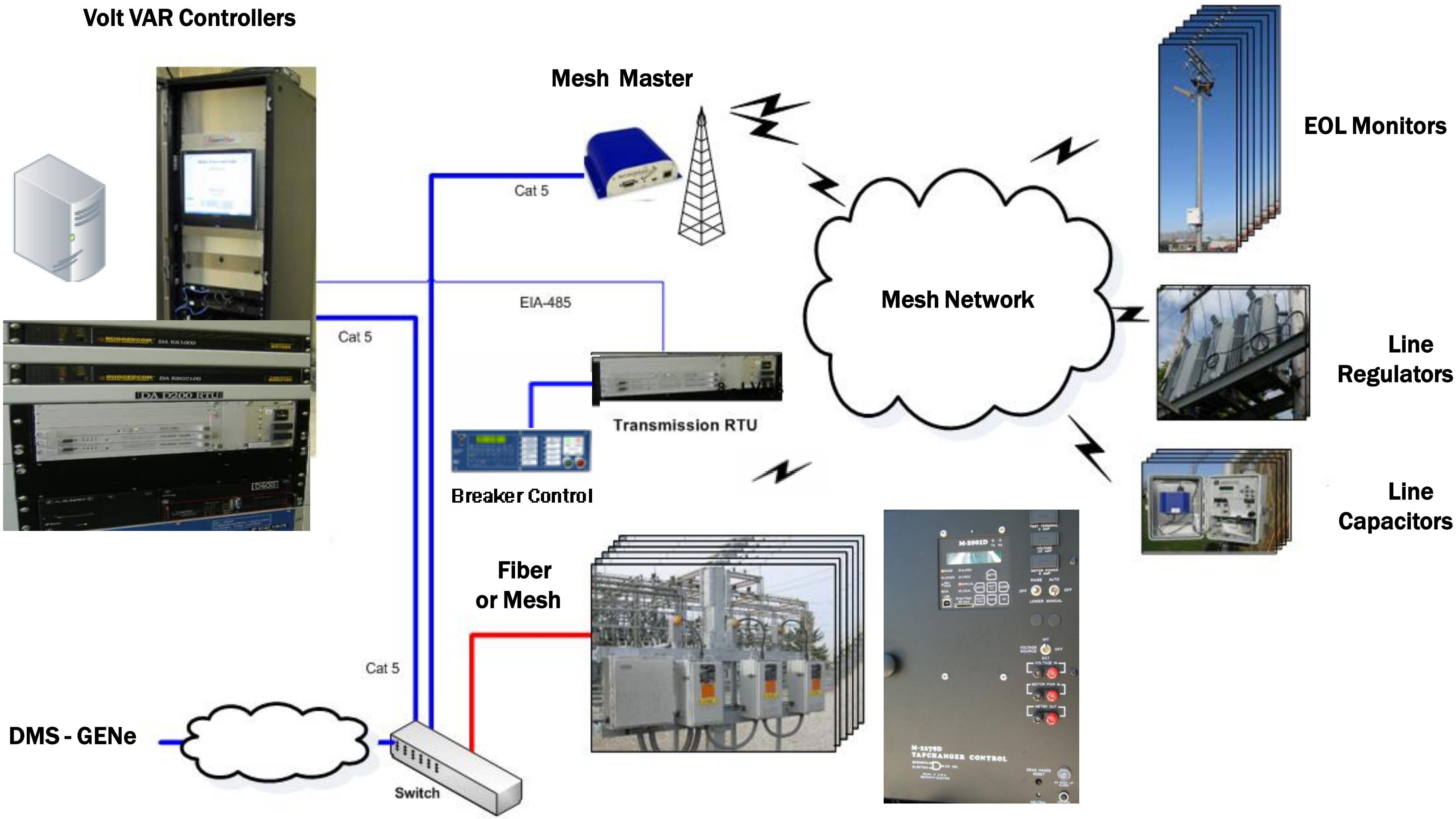
(alphabetical order)

- **Cooper Yukon VVO**
- **GE VVO**
- **Utilidata AdaptiVolt™ VVO**

Volt VAR Optimization at AEP

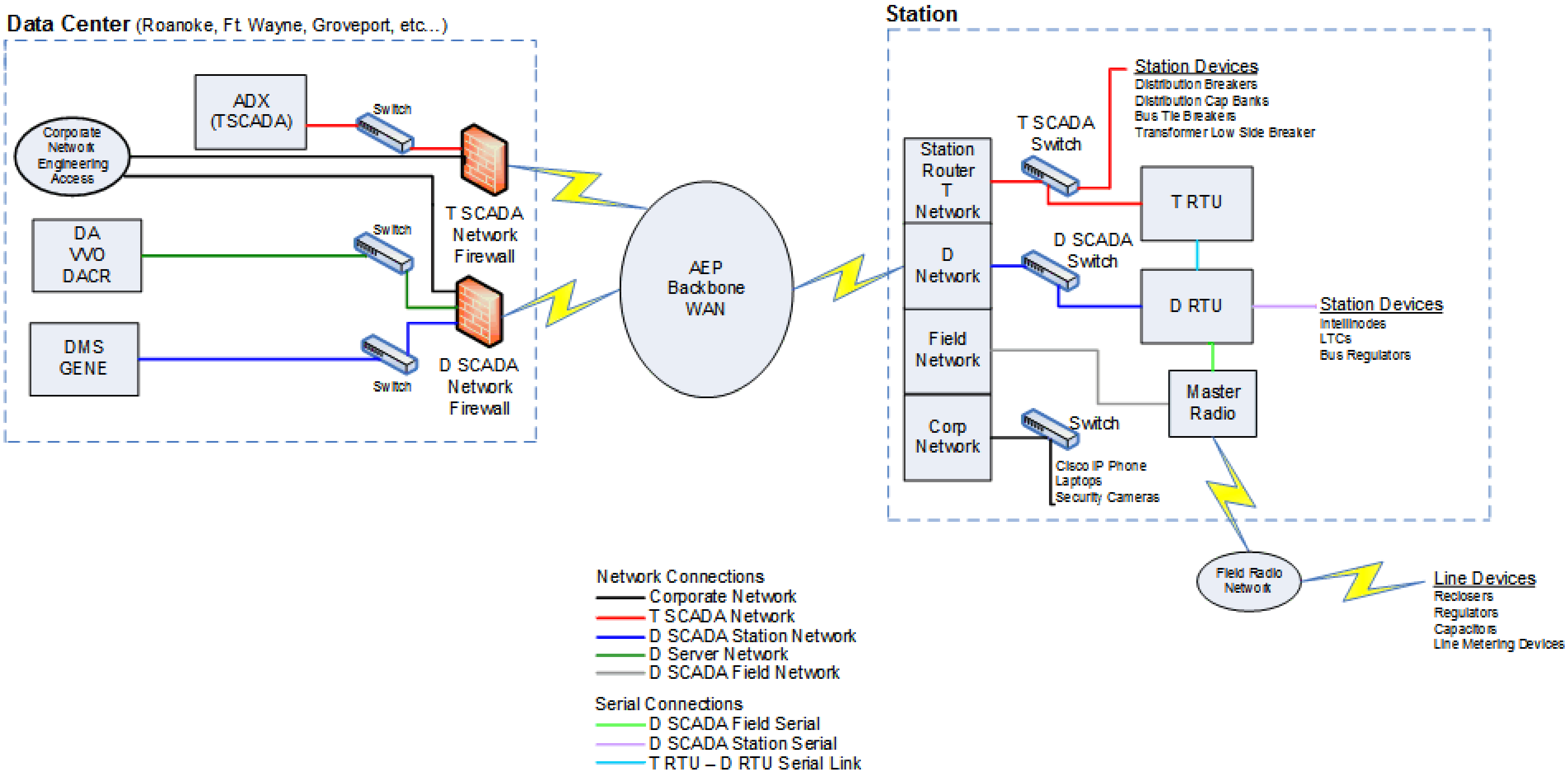
- In Service
  - 17 circuits in Ohio
  - 13 circuits in Oklahoma
  - 9 circuits in Indiana
- In Progress
  - 25 circuits in Kentucky
  - 25 circuits in Indiana
  - 3 circuits in Michigan
- In Planning
  - 80 Circuits in Ohio
  - 25 Circuits in Indiana
- Approximately 200 circuits in the growing VVO Plan

Volt VAR Optimization Architecture

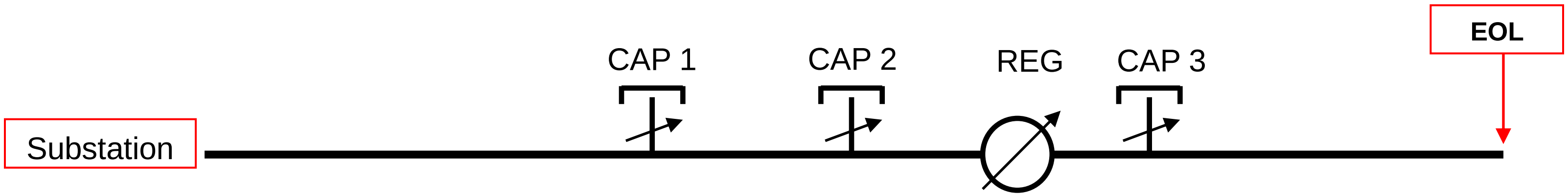


Volt VAR Optimization Architecture

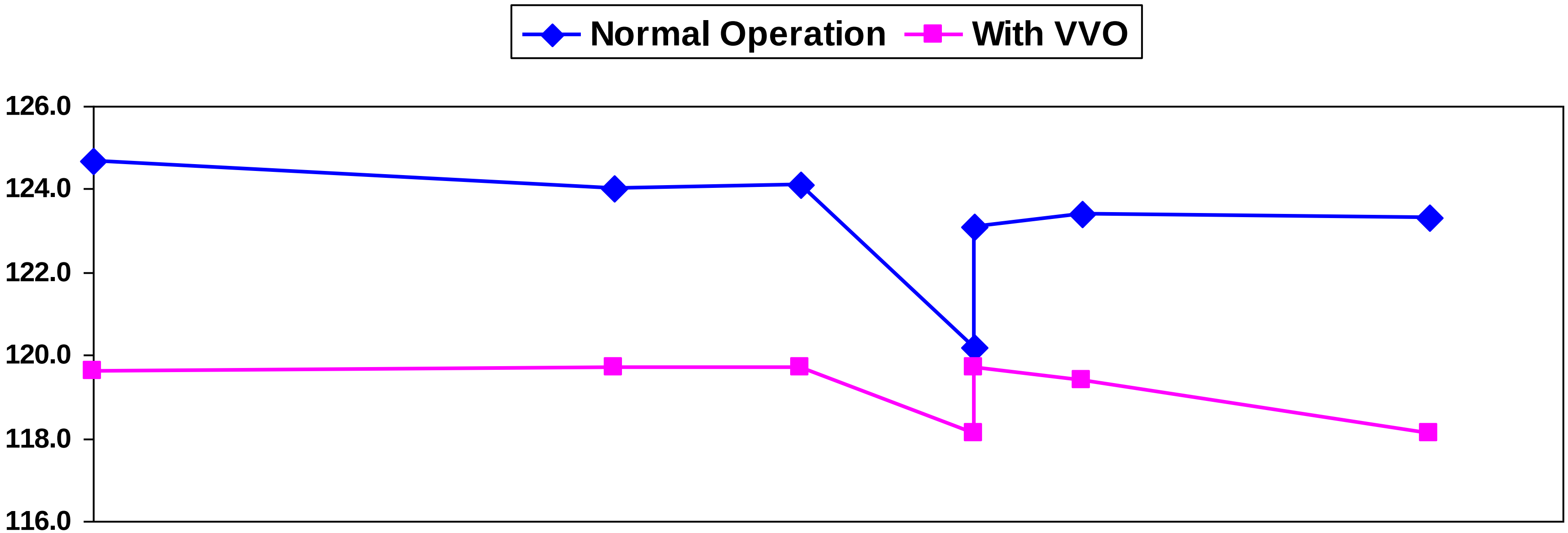
DRAFT



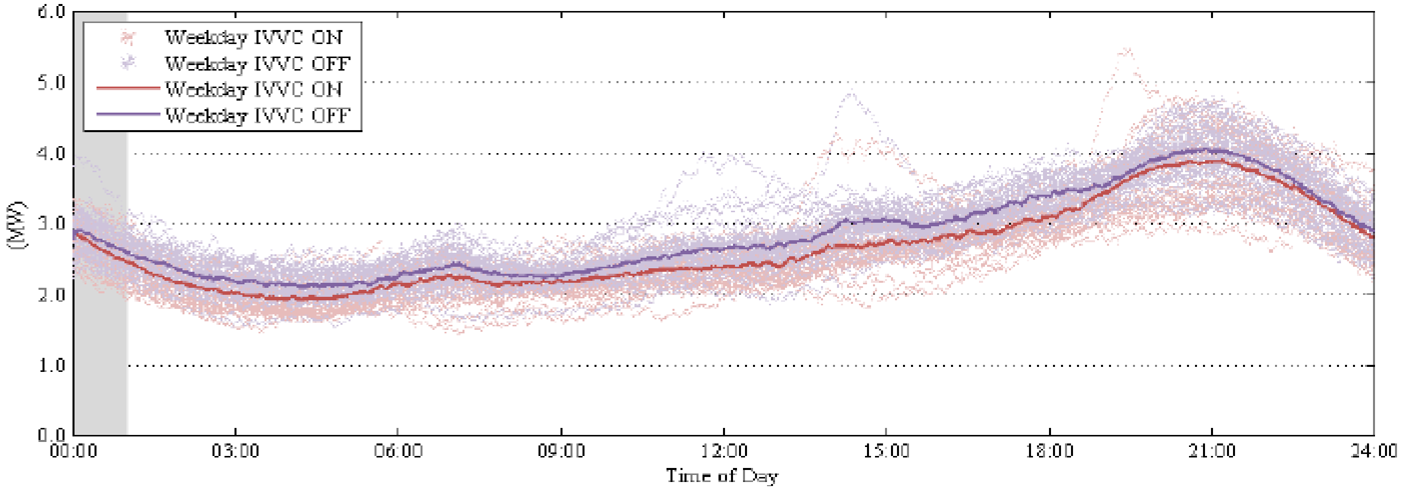
AEP Ohio: Gahanna – 4504 (13 KV) Voltage Profile

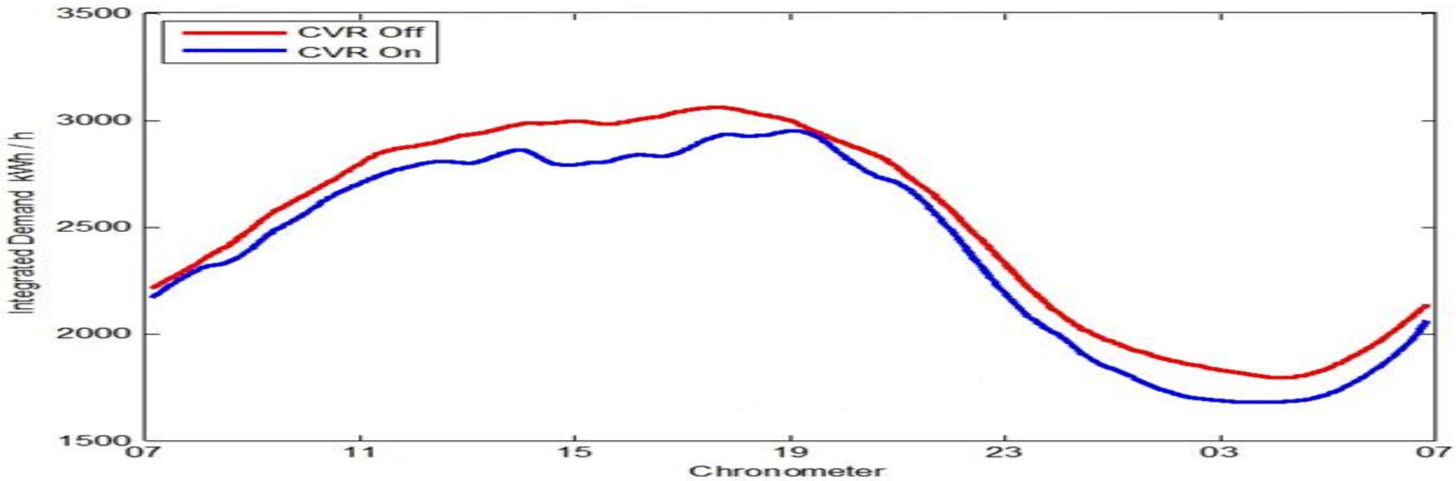


Without *VVO* = 6-7-11 @ 4:30pm
With *VVO* = 6-6-11 @ 4:30pm

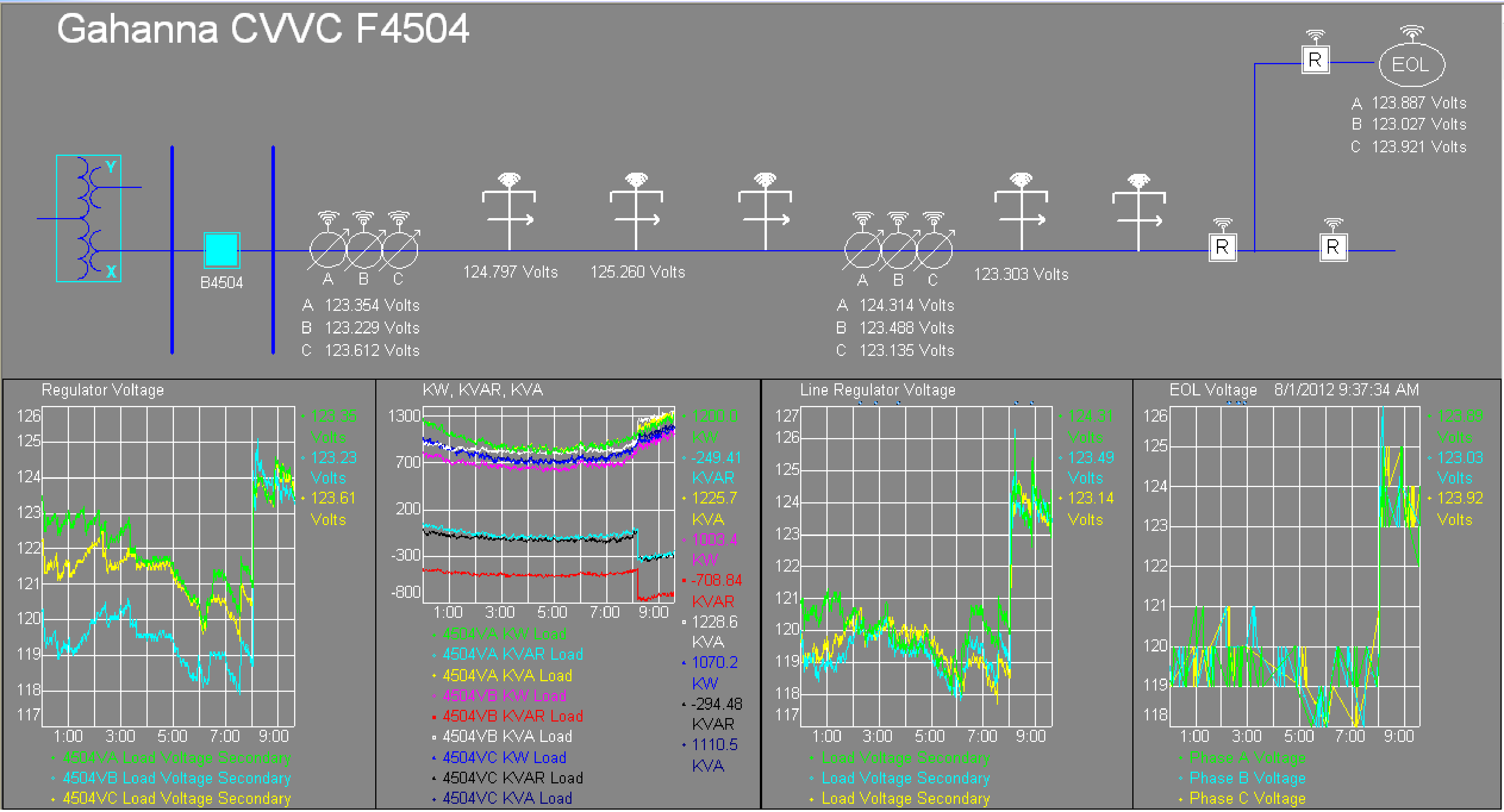


Circuit Performance In Multiple States





SCADA PI Process Book View



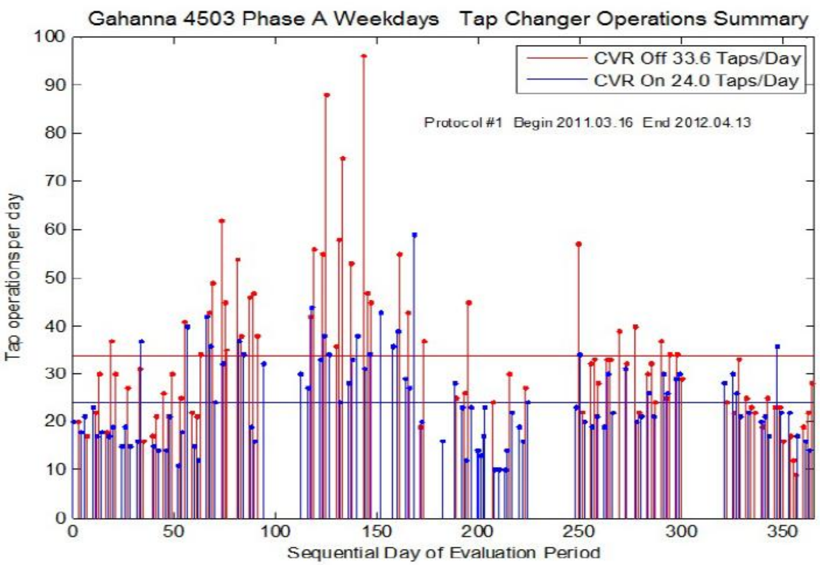
Volt VAR Optimization at AEP

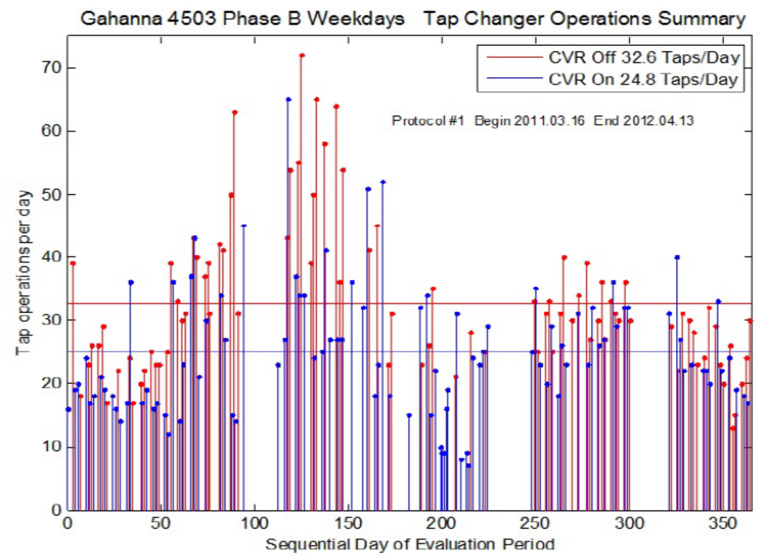
- **Volt Var Optimization technology works as expected**
  - Testing validates that ~2-4% energy and demand reduction is achievable.

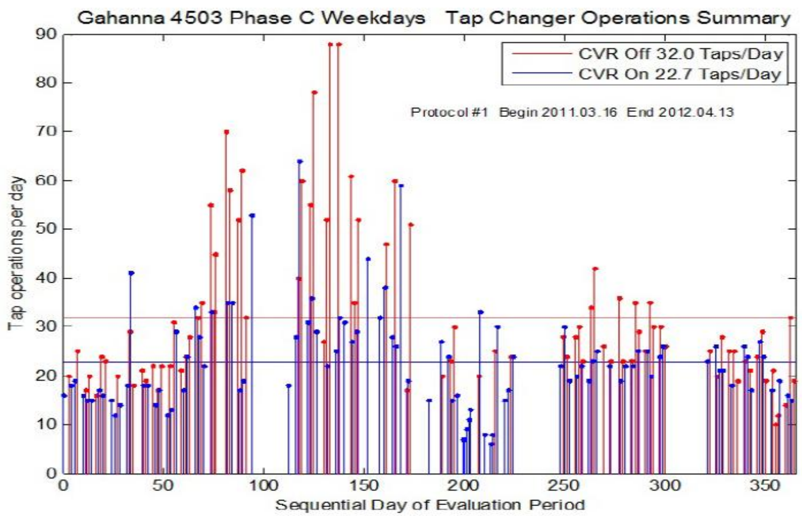
Demand and Energy Reduction Results

- **Measurement &Verification (M&V) Analysis Methods**
  - Requires Day On Day Off Testing
  - Battelle/PNNL Third Party Analysis
  - Protocol #1
  - How do we improve M&V methodology?

Reduced Tap Operations using Utilidata AdaptiVolt System







Tap Operation Reduction Summary

Average / Day over a year

Phase A – 33.6 reduced to 24.0 (28.6%)

Phase B – 32.6 reduced to 24.8 (23.9%)

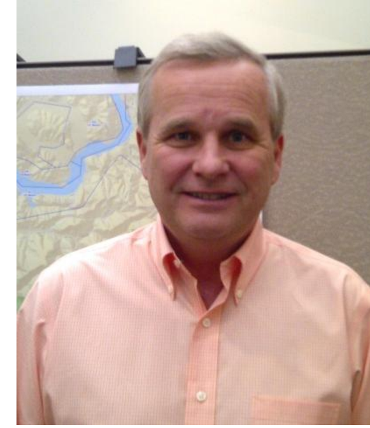
Phase B – 32.0 reduced to 22.7 (29.1%)

Volt VAR Optimization at AEP

- Standards (Architecture, Addressing, Regs, CAPs, LTCs, Sensors, RTUs, etc.)
- Processes (Alarms, Vendor Updates, Equipment Failures, Circuit Modeling, etc.)
- Day 2 Support (Resources, Monitoring, Commitment, Costs, Service Level Agreements, etc.)
- Documentation (Version Control, Updates, Central Repository, etc.)
- Resource Plan (GMD, Telecommunications, Station Engineering, Distribution Engineering, etc.)
- Testing

Bruce J. Lovelin, Central Lincoln PUD

blovelin@cencoast.com



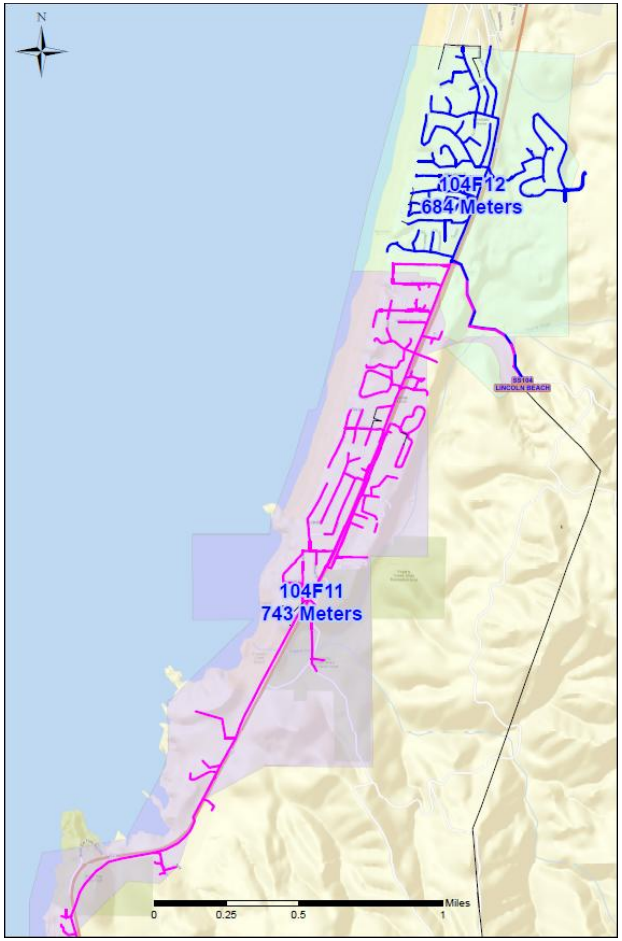
- Chief Engineer and Systems Engineering Manager
- 30 years experience in electric utility industry
- Electrical Engineering Degree from Oregon State University
- Smart Grid Project Program Manager

Central Lincoln PUD

- 270 MW Peak load, 39,000 Customers
- 130 employees
- 120 miles of Oregon Coastline

Could a AMI System be used to Manage Customers' Voltage real time?

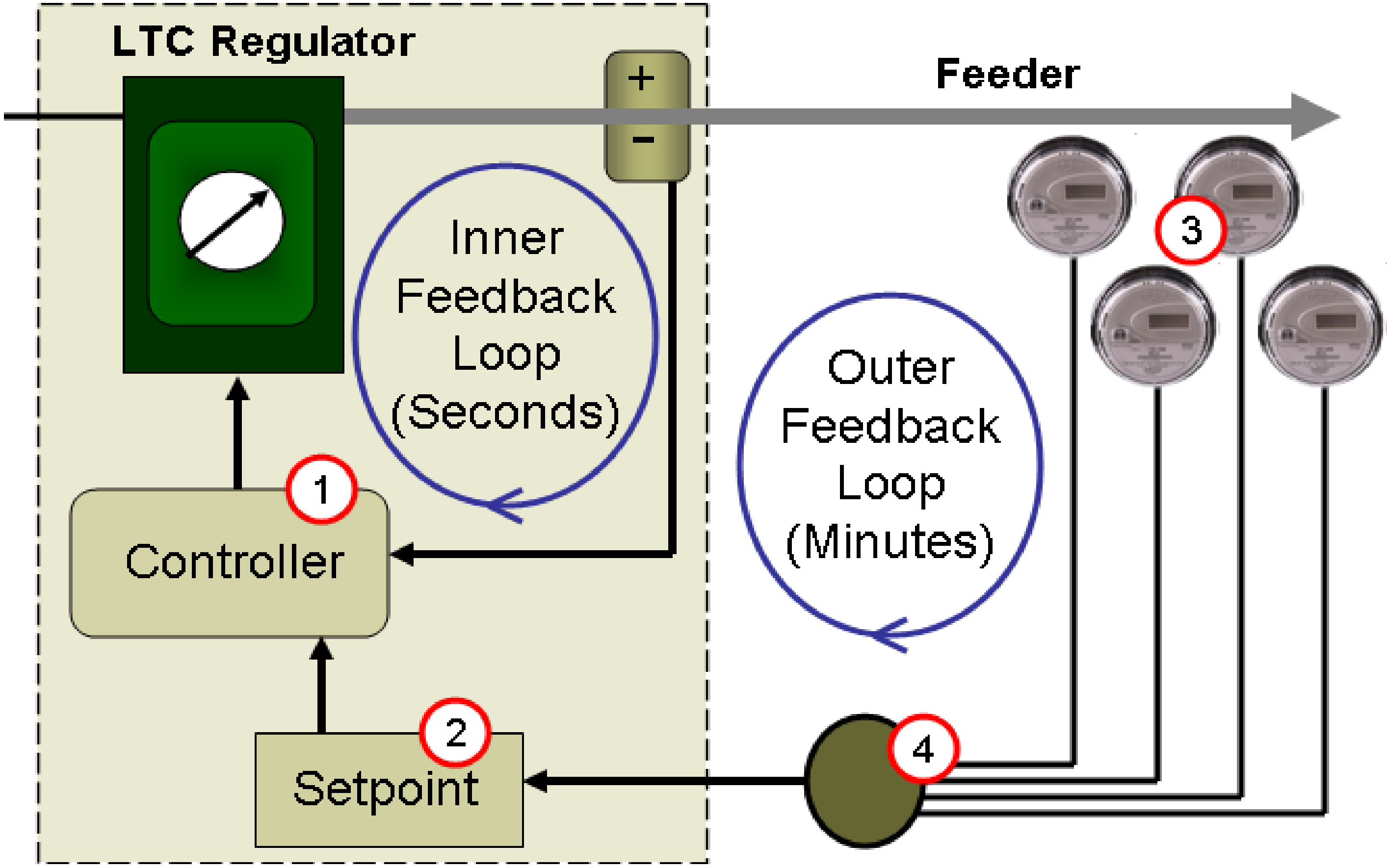
Pilot Project



Lincoln Beach Substation

- One LTC transformer
- Two feeders
- 1400 meters
- Coastal community
- High percentage of vacation homes
- 8 months heating annually
- No A/C

System Operation



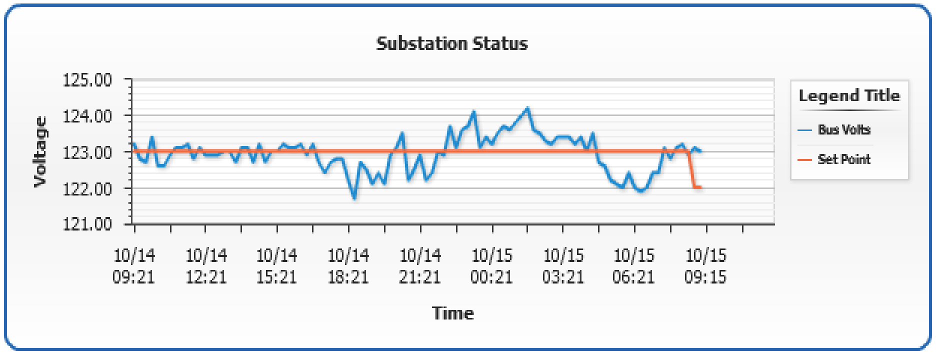
System Operation

Node CentralLincoln/SS104

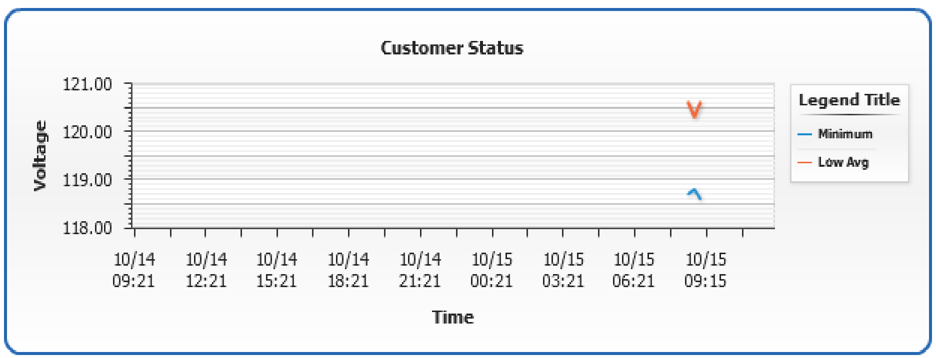
CentralLincoln/SS104

Status | Map | AMI Data | SCADA Data | Messages

SS104

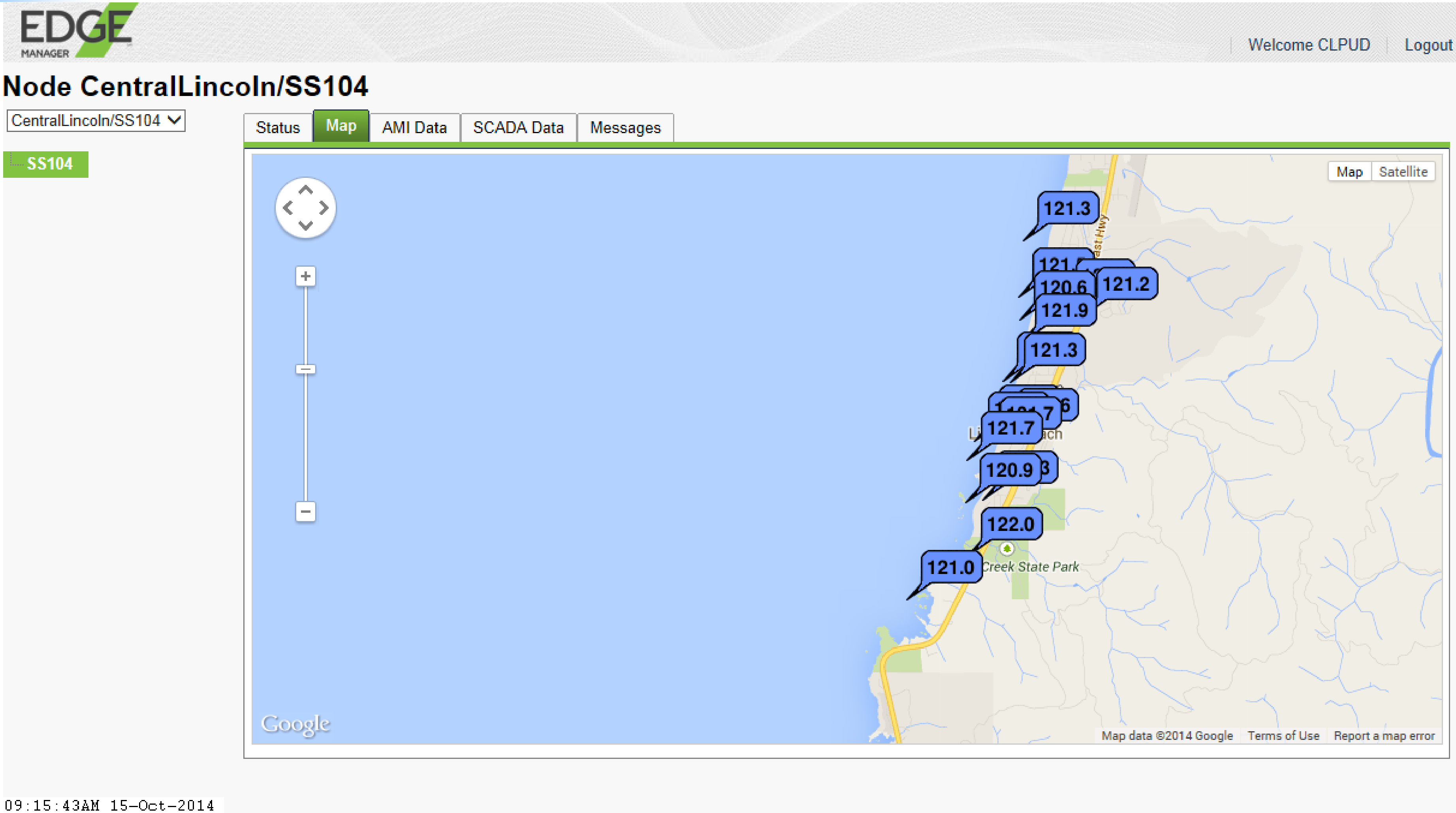


Device	SS104
Type	LTC/VR
Time	2014-10-15 09:06:08
Health	Good
Set point	122.0
Bus Voltage	123.0
Customer Low Avg	120.6
Customer Minimum	118.6

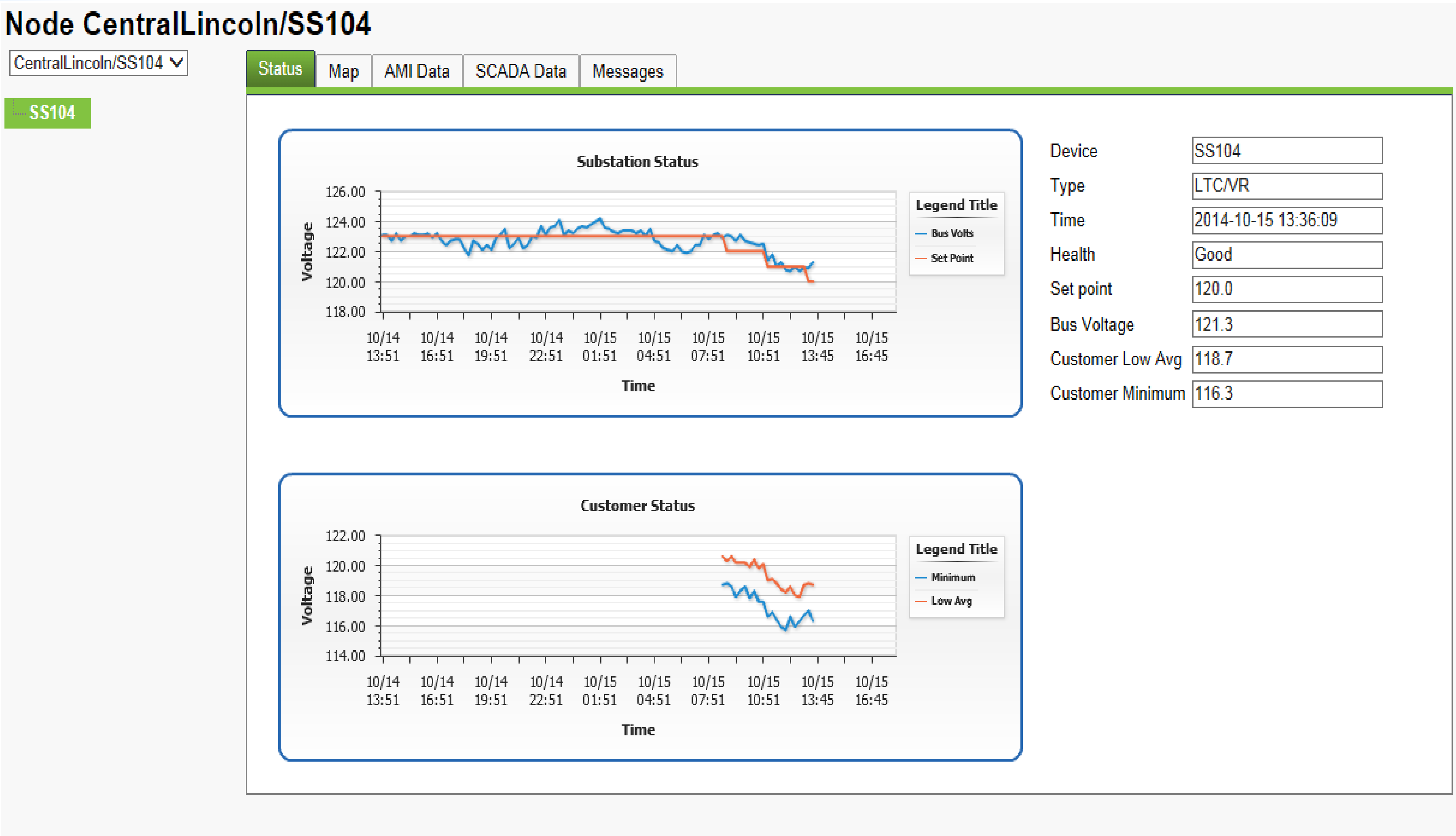


09:14:56AM 15-Oct-2014

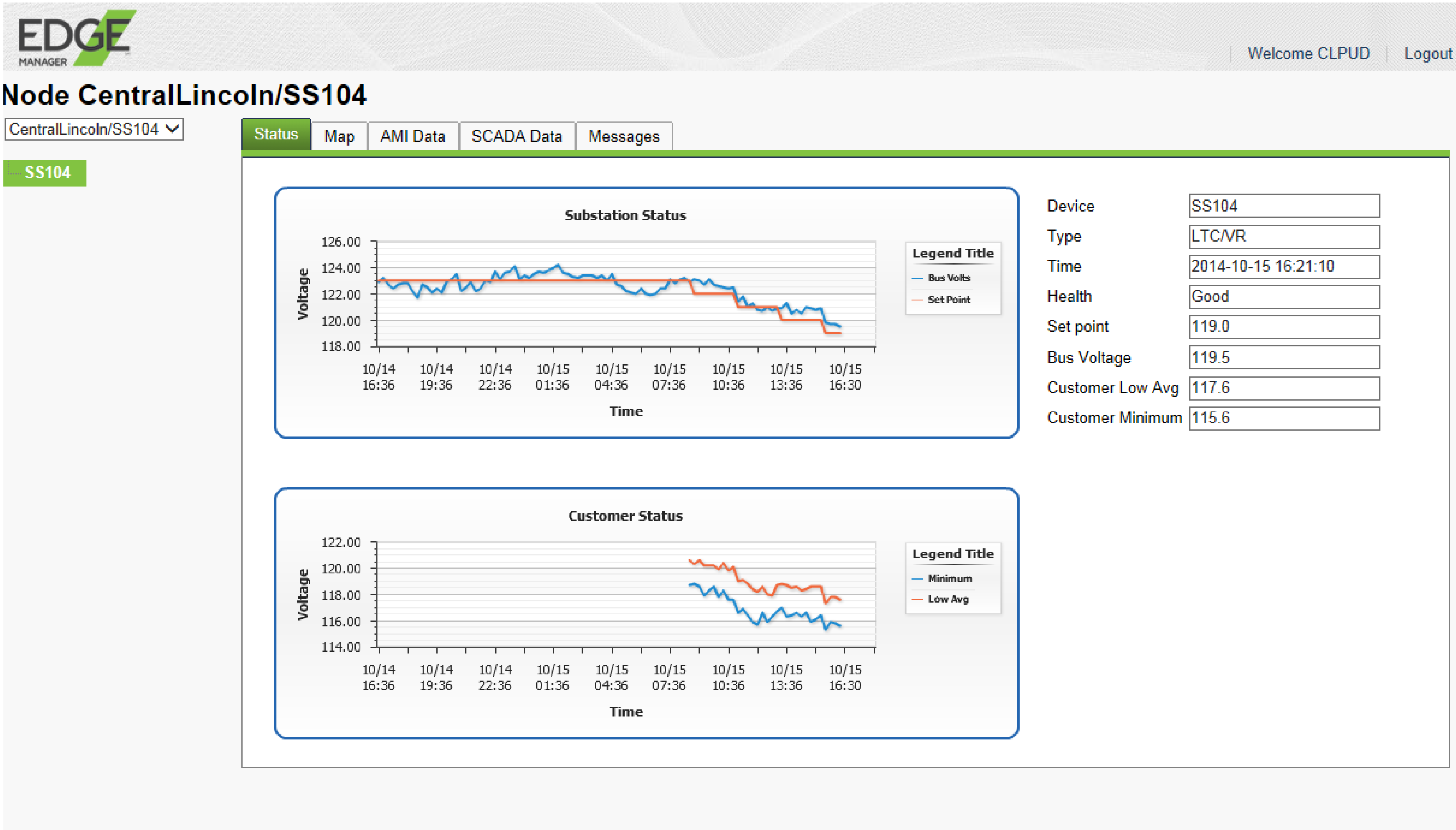
System Operation



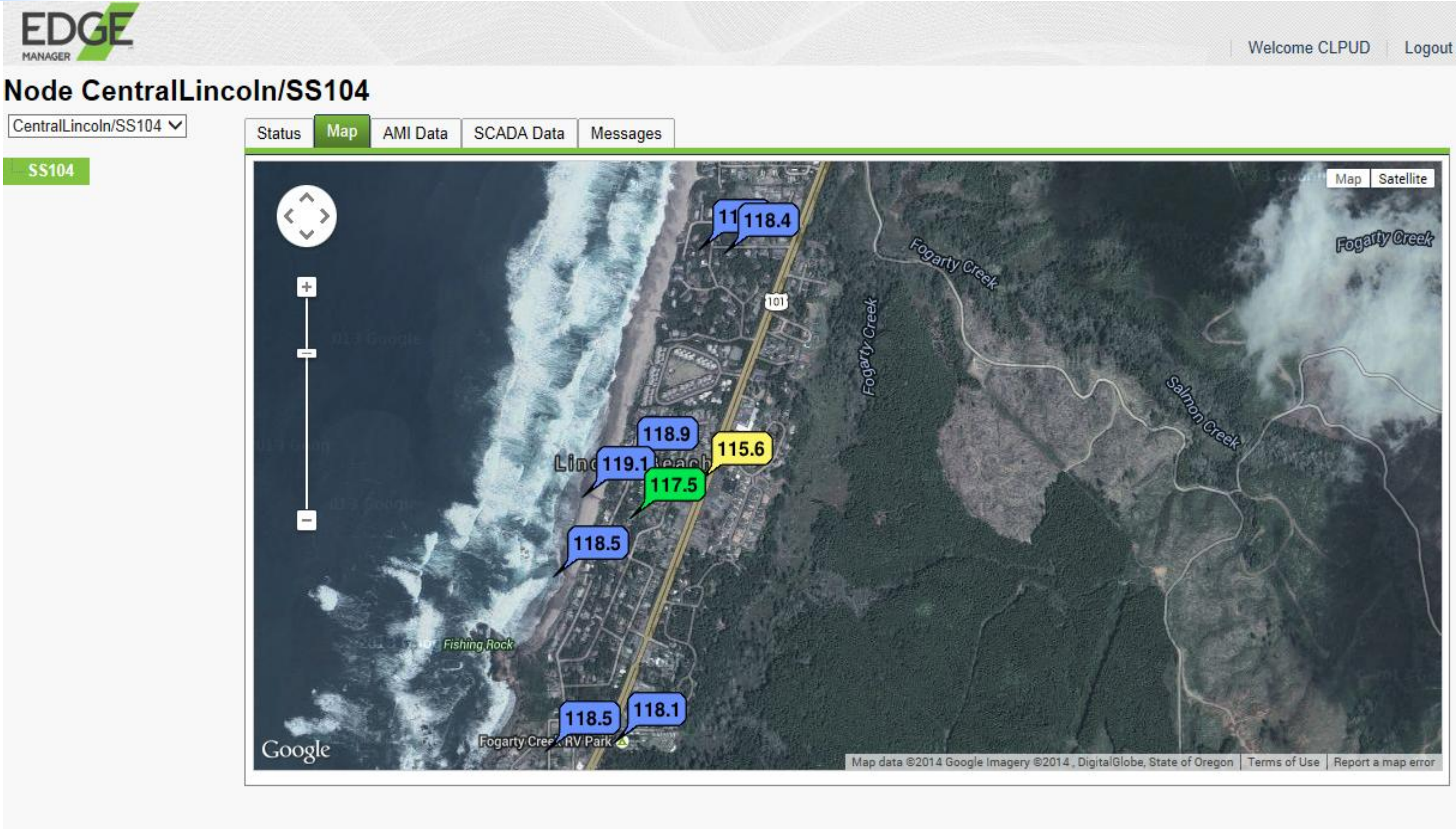
System Operation



System Operation



System Operation



Project Results

	Voltage Reduction	CVR Factor	Energy Savings
Summer	3.46%	0.63	2.18%
Fall	3.18%	0.63	2.00%
Winter	2.35%	0.69	1.62%
Annual	**2.95%**	**0.65**	**1.92%**

- EDGE Validator uses hourly data
  - Bus voltage, MW
  - Temperature, relative humidity
  - CVR on/off
- ON hours paired with similar OFF hours

Lessons Learned

- Great Tool for Finding Service Issues
- Operational Changes
- LTC Operation Unchanged
- SCADA and AMI Integration Went Well
- Did not impact AMI Meter Reading Performance
- No Customer Issues

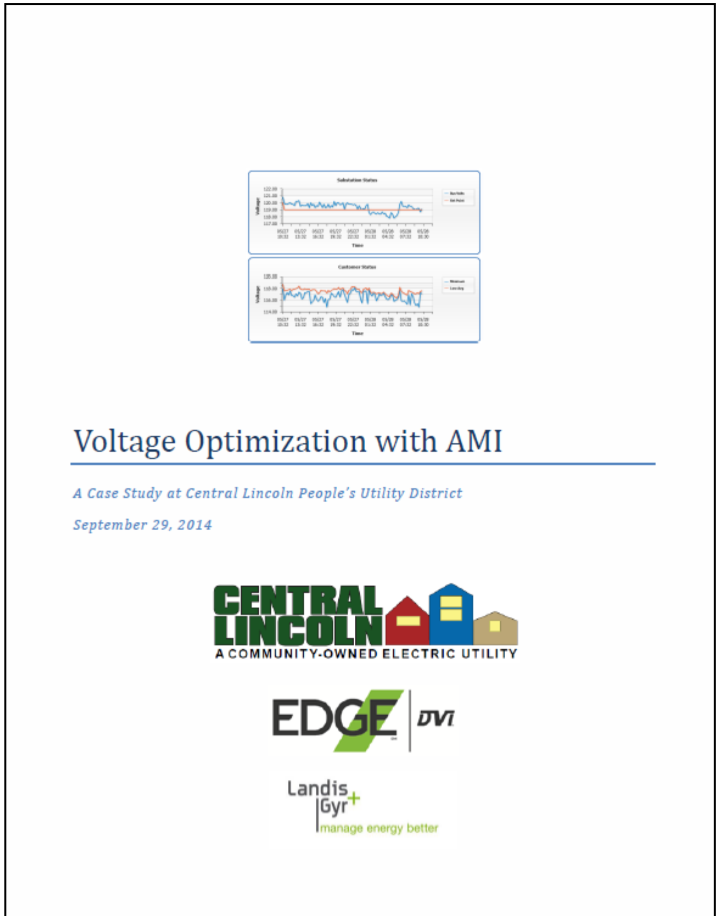
Project Assessment

- Saved Customers about 2% Energy Consumption
- Operational Positives
- Easy to Implement
- SCADA and AMI Integration Went Well
- Robust Measurement and Verification
- Cost-Effective Resource – 1 cent/kwh

Next Steps

- Full System Implementation
- Up to 25 Substations
- 3 Year Project
- Begins Winter 2015

Thank You!


Voltage Optimization with AMI

A Case Study at Central Lincoln People's Utility District

September 29, 2014

CENTRAL LINCOLN
A COMMUNITY-OWNED ELECTRIC UTILITY

EDGE DVI

Landis Gyr+
manage energy better

For a copy of our case study

please contact:

Bruce J Lovelin

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Daniel Fournier, Hydro Quebec

Email: Fournier.Daniel.3@hydro.qc.ca

- Daniel Fournier received a Bachelor in Engineering Physics from the Ecole Polytechnique de Montreal in 1980. He later earned a M.Sc. and Ph.D. in Energy INRS Energy in 1985 and 1988 respectively
- He worked at the Institut de recherche d'Hydro-Québec (IREQ) from 1990 to 2004 and was involved in various research and development related to expert diagnostic systems (infrared thermography and partial discharges) for Distribution equipments
- Since 2004, he worked for Hydro-Québec Distribution as a senior engineer in the field of smart grid applications.
- Since 2010, he has been representing Hydro-Québec Distribution as advisor for the EPRI Smart Grid Demo Host Site Project.
- He is also in charge of the Distribution Automation Telecom modernization project.
- He is a member of the Order of Engineers of Quebec.

VVC at Hydro-Québec Distribution

by: Daniel Fournier, Eng.
Jordi Drouin, Eng
Laurier Demers, Eng.

The Smart Grid Experience: Applying Results, Reaching Beyond

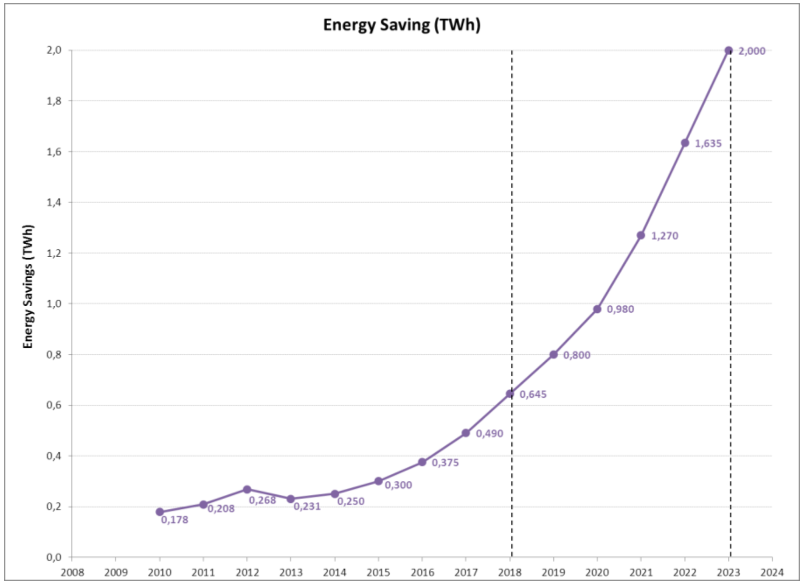
October 27-29, 2014
Charlotte, NC

Project Description

- Goal: by 2023, 2 TWh savings (annual energy consumption)

- 2008-2010 (7.3M$ invest.) Pilot phase completed

- 2011-2023 (152.4M$ invest.)
    - 150 substations and 2,000 distribution lines
    - 1,000 remotely monitored voltage transformers
    - 865 remote-controlled capacitor banks
    - Infrastructure upgrades



VVC Project Status

- Voltage control on 17 substations (10 more to come in 2014)
- 195 TTT (medium voltage sensors) installed
- 865 remote controlled capacitors banks installed

Reactive Power Control System status

Overview of system components

- 865 capacitors at 1.2 Mvar each – total capacity 1038 Mvar
- Remote control capacitors are controlled by the distribution control system
- 576 capacitors currently remote controlled

Objectives

- Switching of the shunt distribution capacitors by remote control in order to
  - improve voltage profile (distribution)
  - reduce losses (transmission and distribution)
  - increase stability limits (transmission)
  - increase the transit of power (transmission)
- Consider the real time needs and constraints of the transmission provider
- Increase the energy gains if the substation has both volt & var control

Reactive Power Control System

Observations:

- Pilot project: ~1800 capacitor switching operations
- Some issues with capacitor bank operations: mechanical or remote control related deficiencies (approx. 5% total)
- Important to use integrated measurements in the algorithm as opposed to instantaneous measurements
- No customer complaints related to the reactive power control system observed during the pilot project

Next steps:

- Improve the algorithm to optimise the number of capacitor operations
- Reduce maintenance cycles on the equipment
- Increase capacitors being managed by the VAR control system from 576 capacitors to 865 capacitors
- Develop indicators to determine the frequency in which each capacitor is used. (less frequently operated units could be moved to another location)
- Integrate a VVO system in order to maximize the energy gains

Voltage reduction techniques

Static setpoint

1. Permanent setpoint modification
2. Seasonal setpoint modification

Dynamic setpoint
Normal modes

3. Dynamic voltage control
4. Dynamic Volt-Var control (VVC)

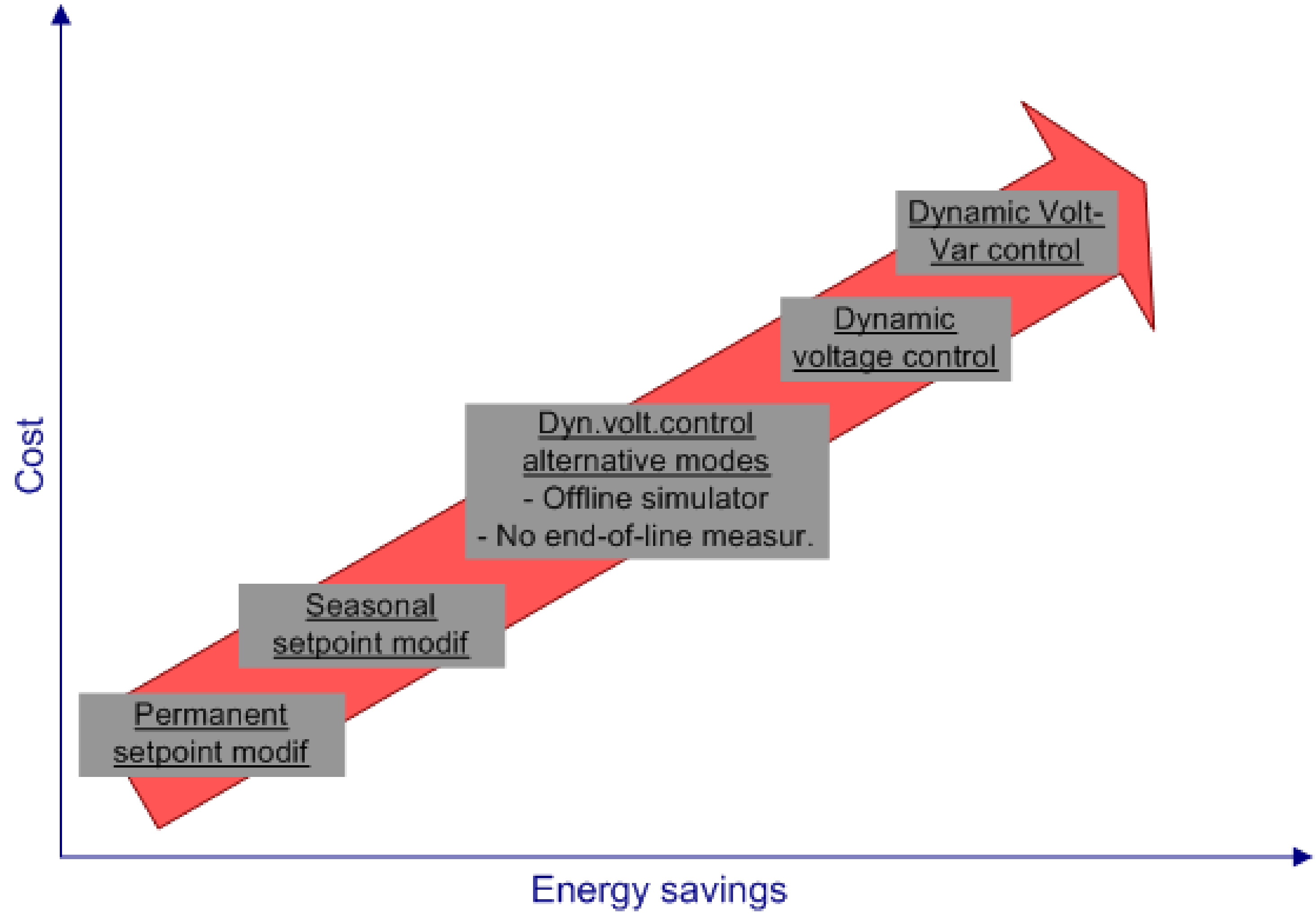
Dynamic setpoint
Alternative modes

5. Dynamic voltage control – No online simulator static voltage targets only
6. Dynamic voltage control – No end-of-line voltage measurements (simulator only)

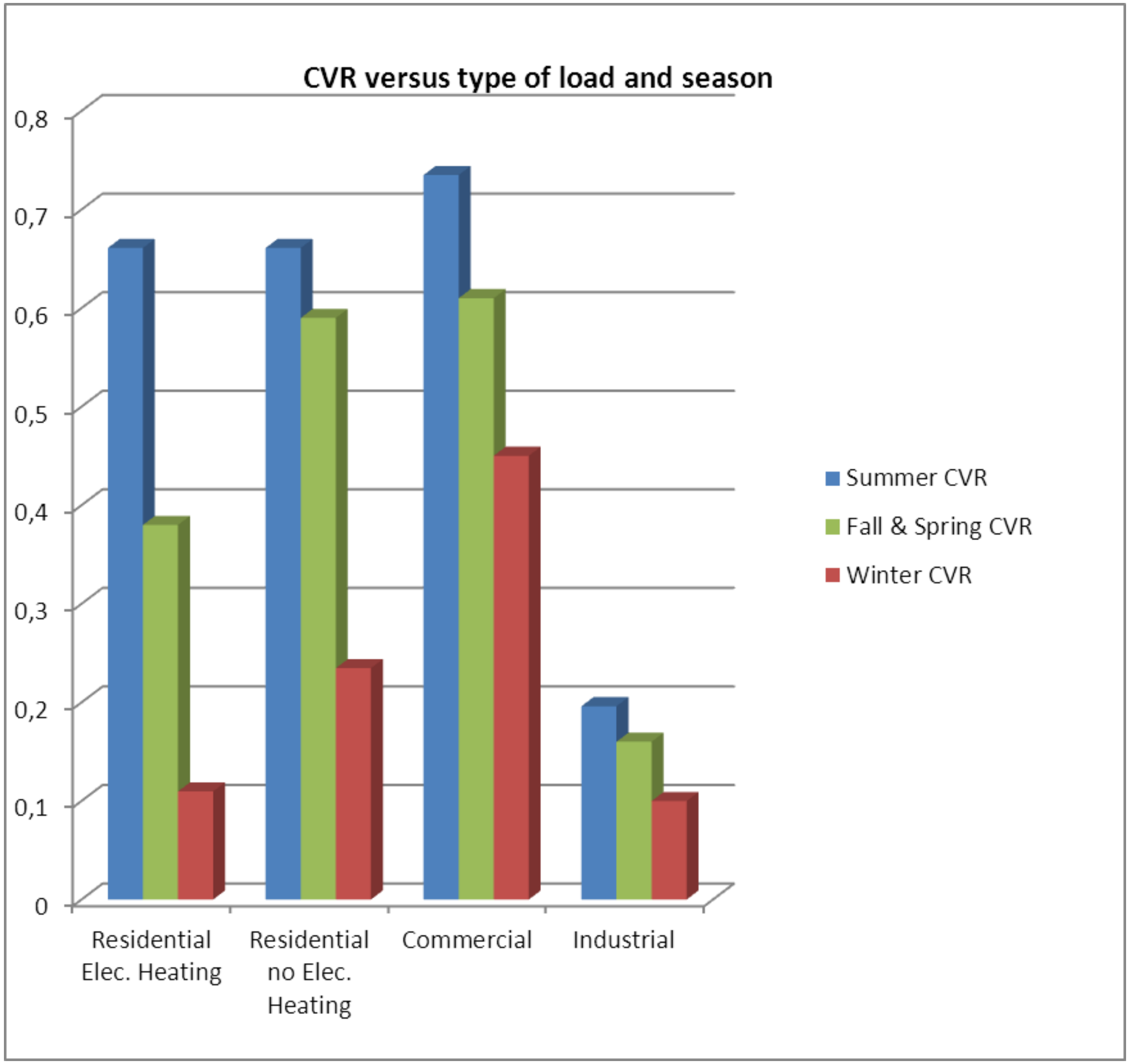
Voltage reduction techniques
Summary of requirements

Requirements	Voltage reduction techniques					
	Perman. setpoint modif	Seasonal setpoint modif	Dynamic voltage control - Offline simulator	Dynamic voltage control - No meas.	Dynamic voltage control	Dynamic volt-var control
Offline Simulator (planning tool)	X	X	X			
Online Simulator (real time load flow)				X	X	X
Substation data acquisition			X	X	X	X
Remotely controlled voltage regulator at substation			X	X	X	X
Real time voltage measurement at critical locations			X		X	X
Remotely controlled capacitor banks						X

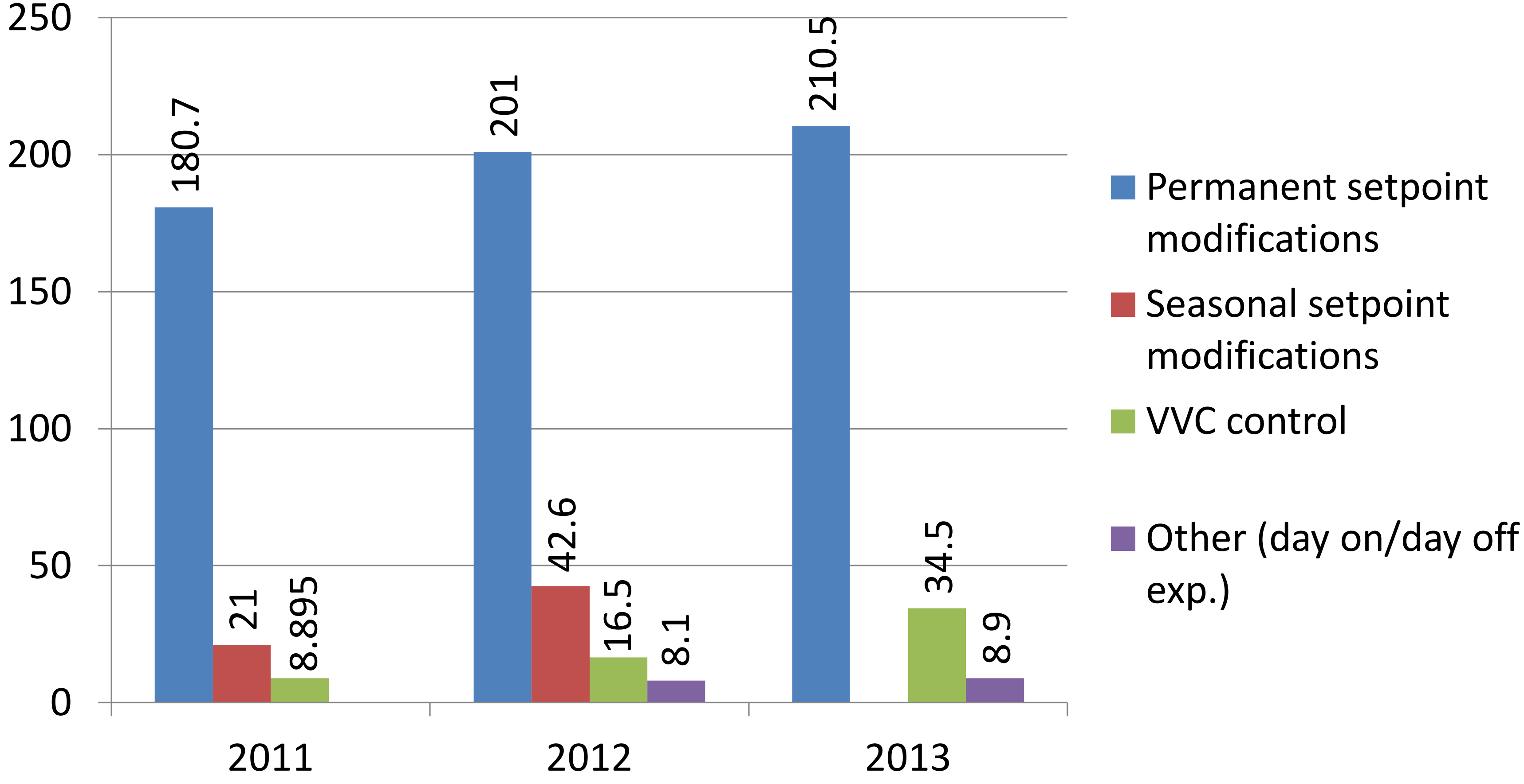
Voltage reduction techniques
Summary of cost-effectiveness analysis



CVR study on 4 substations (37 lines)



Energy gains (GWh)



Lessons learned

– Low voltage on substation's distribution panel:
  in certain substations, because of a design flaw, lowering the voltage creates a risk of affecting the operation of the substation itself. Take that into account.

– During planning, two limitations are often overlooked :
  - Regulation dead band (tap changer)
  - Voltage unbalance (greater than expected). Must use the lowest phase voltage

– Some customers need an adaptation period even though the reduced voltage stays within the standard limits. (ex. hospitals with sensitive equipment).

Conclusion

- It is not realistic to implement VVC in all substations. Still, there are several other ways of minimizing energy consumption through voltage reduction.

- Benefits are :
  - Allows to minimize cost and/or maximize energy saved
  - Could reveal issues before wasting investments.

Next steps:

- Adjust our communication process to keep sensitive customers informed of every voltage reduction as soon as planned (often one year ahead)
- Evaluate the cost of fixing the low voltage issue in each problematic substations
- Evaluate the use of the AMI for voltage measurements
- With the gained knowledge, refine our deployment strategy and our business case

Reference

- Hydro-Québec Smart Grid Host Site Progress Report For the Period Ending October 2013 (Technical Update, February 2014)

  EPRI Report: 300200144 (members only report)

Jim Parks,
Sacramento Municipal Utility District

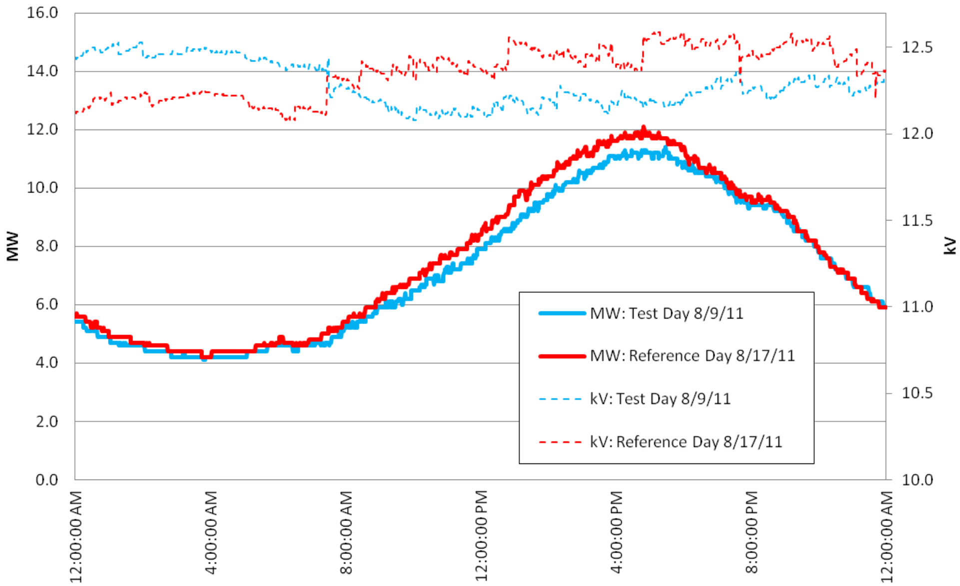
Email: Jim.Parks@smud.org

- Program manager in the Energy Research and Development department at SMUD.
- Completing a $308 million smart grid initiative, SmartSacramento®.
- SmartSacramento has over 40 individual projects.
- Projects include distribution automation, smart meters, demand response, dynamic pricing and more.
- Past work includes transmission planning, energy efficiency, electric transportation and emerging technologies.
- Over 25 years' experience in the energy industry.

CVR Pilot Project

- Automated 118, 12 kV feeders
- Began summer 2011 on two substations.
  - Retrofit of sub controls
  - Addition of switched capacitor banks
  - Utilization of existing Capcon control system
- Goal of initial phase:
  - Test both CVR and VVO.
- Hypothesized that an industry average CVRf (0.5 – 0.7) could be achieved.
- Expanded project in 2014 to 14 substations.
  - Wanted to determine operational strategy--peak-period/emergency or 24/7 operation.

Substation A 2% CVR Analysis



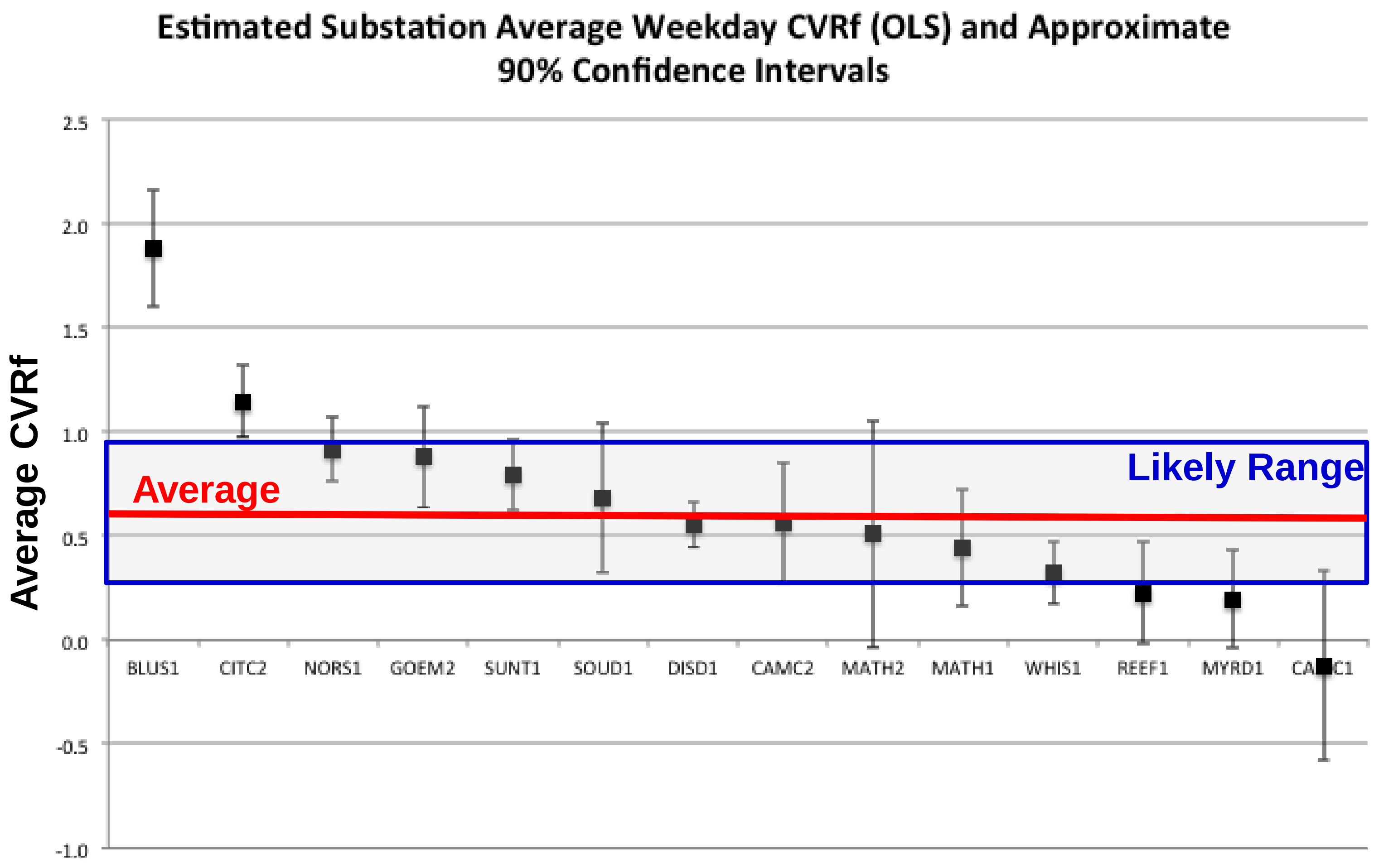
Early Results

Substation	Approximate Avg. Percentage Demand Reduction (2% V reduction)
Substation A	2.5%
Substation B	1.0%

Project Successes - Overview

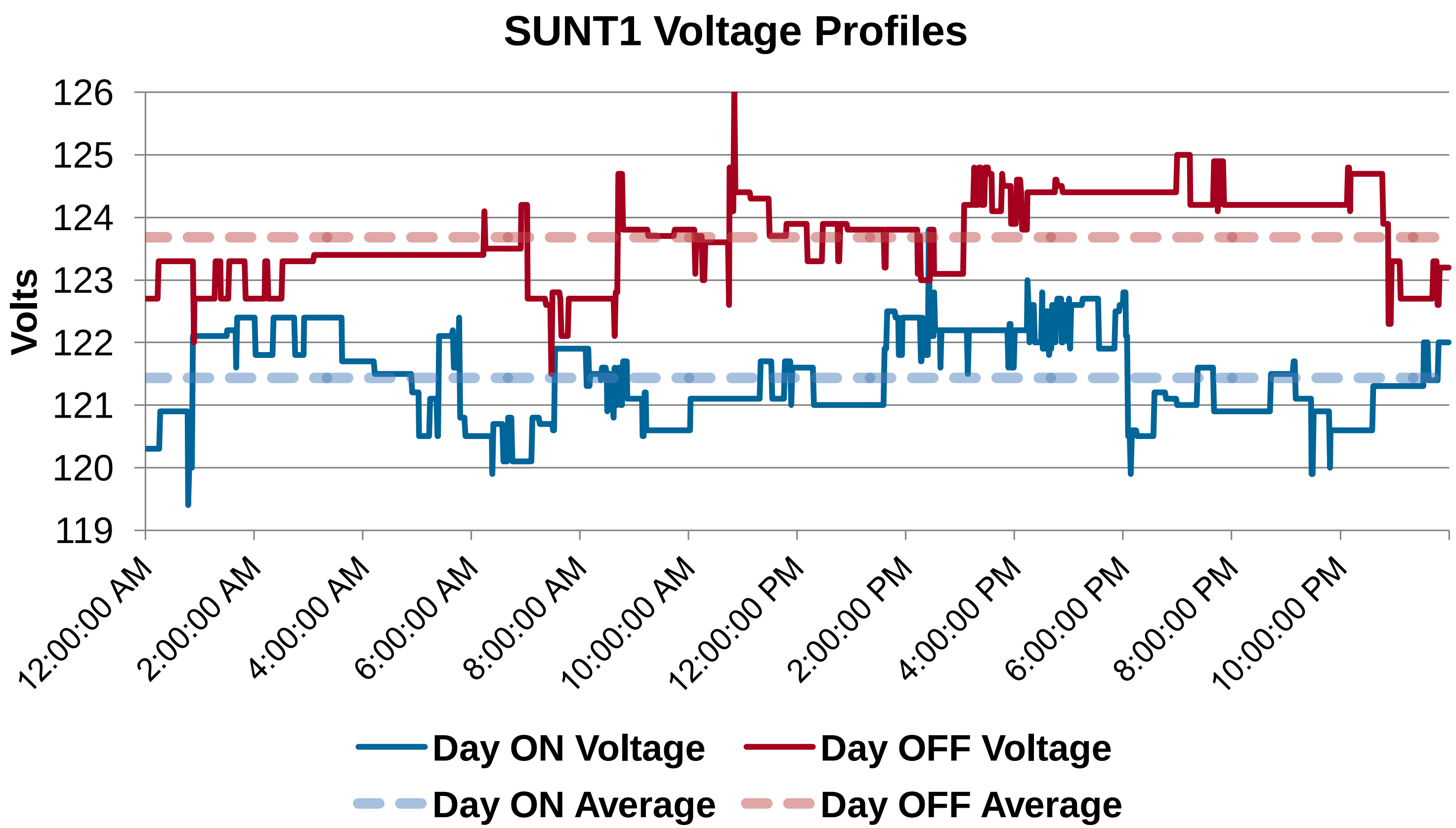
- Modified control system worked as designed.
- Conducted three years of CVR testing.
- Developed a statistical model to predict CVR impacts.
  - Used a variety of variables, including PV.
  - Two separate regression methods produced similar results.
    - 1.8% average voltage reduction ≈
      - 2% average daily energy (MWh) reduction
      - 1.1 % average load (MW) reduction

Project Successes – 2013 Analysis



Surprises Related to the Project

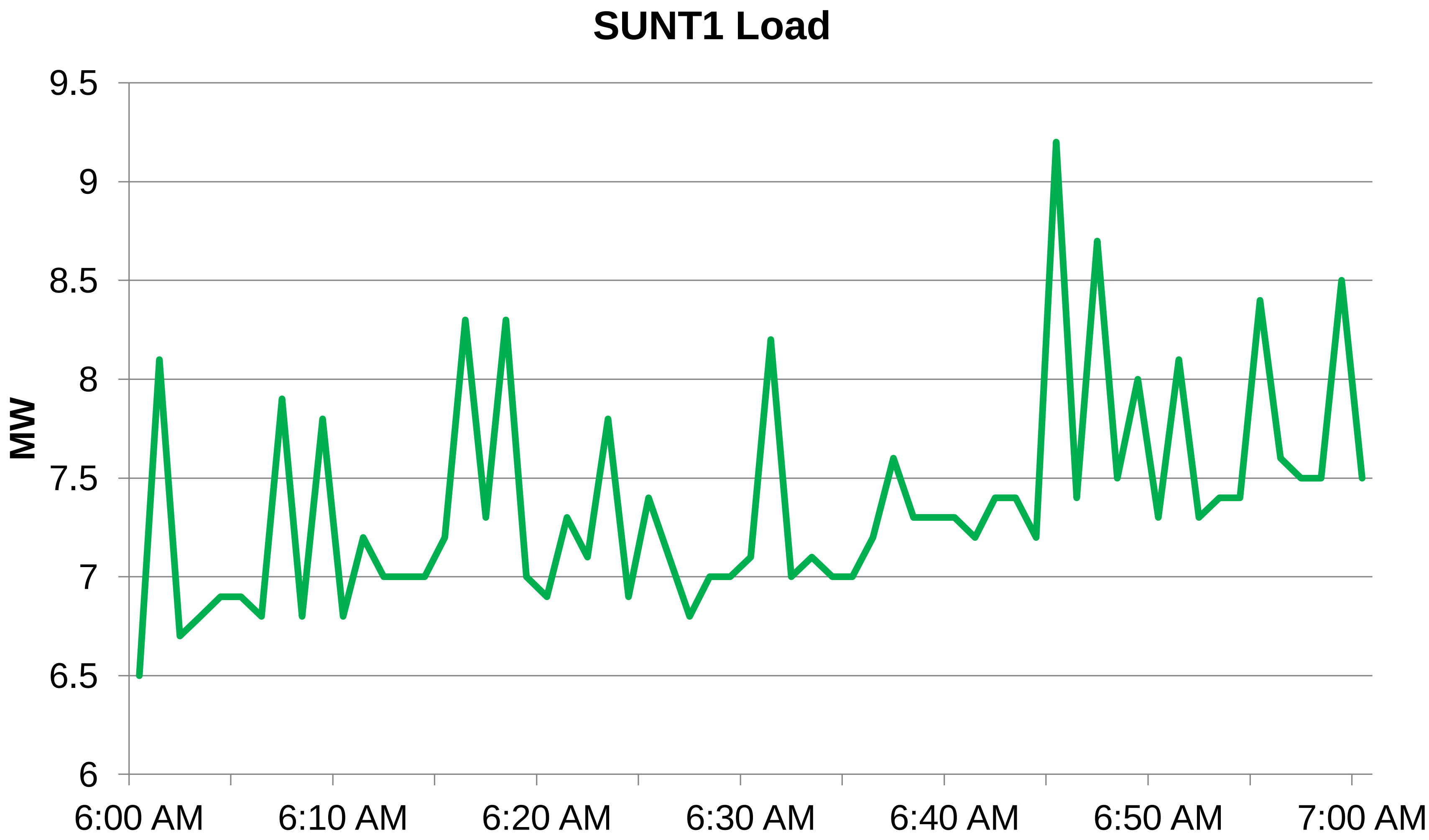
- Goal was to test CVR at 3% voltage reduction.
  - Limited target to 2% (actual average reduction was 1.7%).



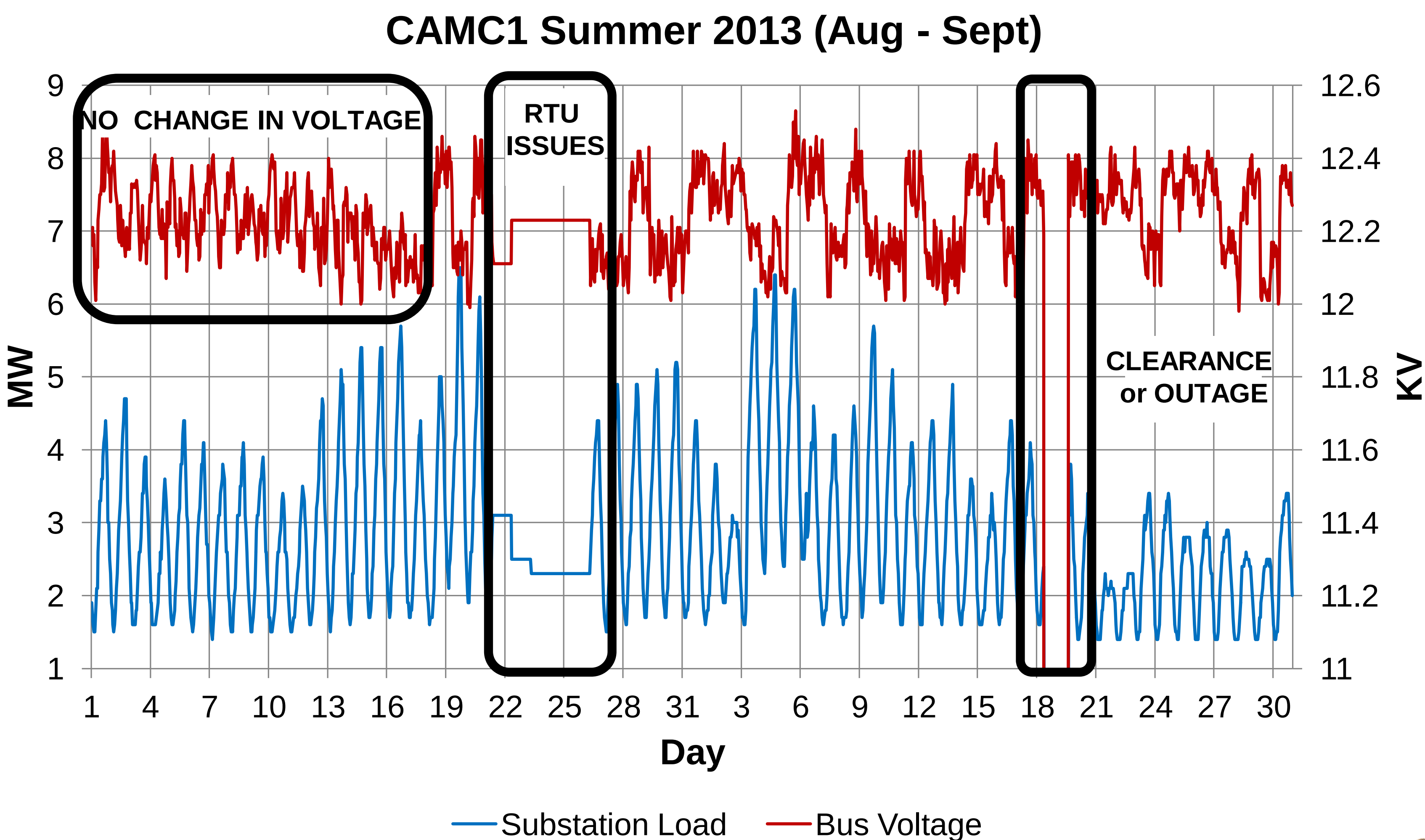
Surprises Related to the Project

- Goal was to test CVR at 3% voltage reduction.
  - Limited target to 2% (actual average reduction was 1.7%).
- “Distribution data is MESSY!”

MESSY Data - Episodic Loads



MESSY Data – Clearances and Outages



Surprises Related to the Project

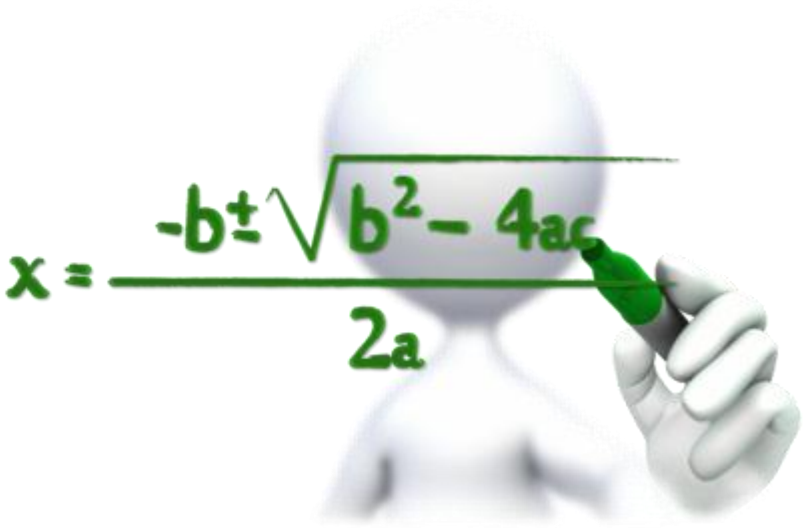
- Goal was to test CVR at 3% voltage reduction.
  - Limited target to 2% (actual average reduction was 1.7%).
- "Distribution data is MESSY!"
  - Episodic loads
  - Power transformer clearance for maintenance.
  - Communication failures
- Difficulty explaining the CVRf outliers.
- No known customer complaints.

Reaching Beyond

- Challenge is accurately measuring CVR impacts
  - Impact of voltage reduction is small and variable.
  - Normal variation in load is comparatively large.
  - Small moment-to-moment variations may be larger than CVR impact.

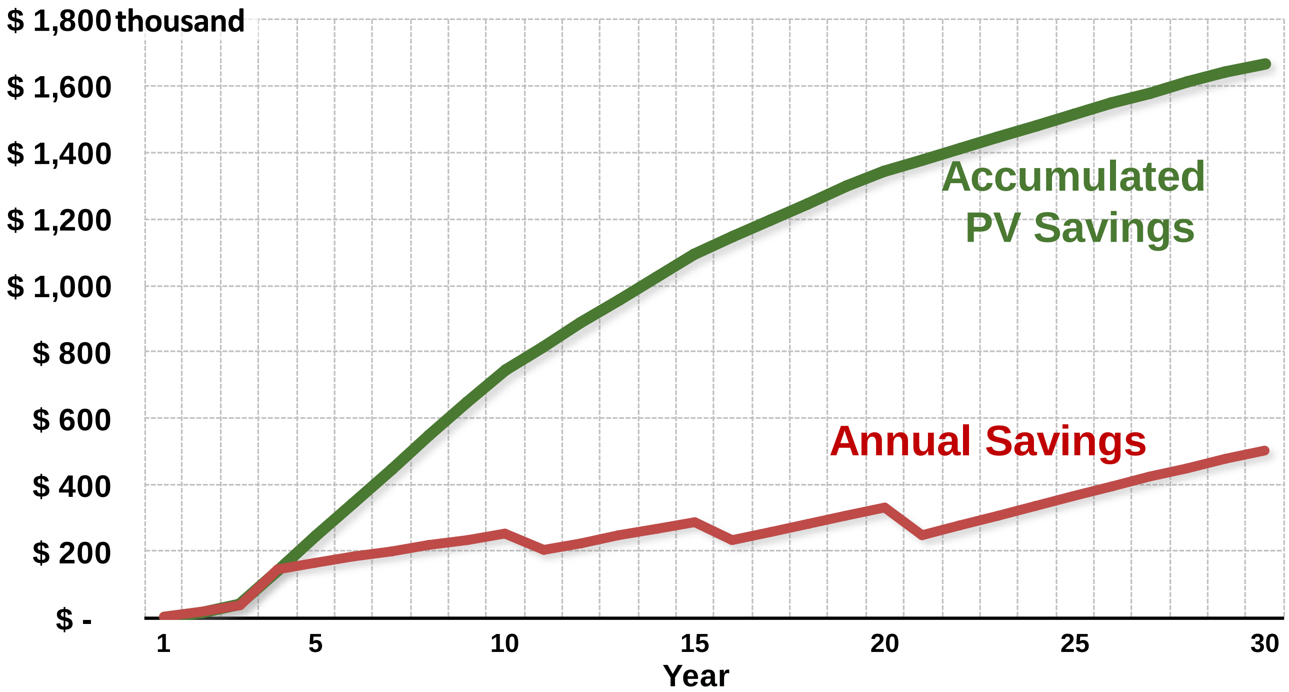
Reaching Beyond

- Challenge is accurately measuring CVR impacts
  - Impact of voltage reduction is small and variable.
  - Normal variation in load is comparatively large.
  - Small moment-to-moment variations may be larger than CVR impact.
- Model provides good approximation.



Reaching Beyond

- Challenge is accurately measuring CVR impacts
- Model provides good approximation.
- Performed a CBA on the 14 substations in the project.



Reaching Beyond – Next Steps

- Challenge is accurately measuring CVR impacts
- Developed model provides good approximation.
- Performed a CBA on the 14 substations in the project.
- Developing a business case for peak-time and full-time CVR.
- Present findings to management.

Jay Oliver, Duke Energy

Email: Jay.Oliver@duke-energy.com

- Held Director of Grid Automation role since Fall 2012
- Prior to this, served as
  - Major Projects Manager, Distribution System Demand Response, Progress Energy Florida
  - Director, Distribution Services, Progress Energy Florida
  - General Manager, South Coastal Region, Progress Energy Florida
- Received bachelor's degree in electrical engineering from the Georgia Institute of Technology
- Earned his master's degree in business administration from the University of South Florida.
- Licensed Professional Engineer in Florida.

IVVC Projects at Duke Energy

Duke Energy Ohio

- IVVC designed to operate 24/7
- Targets an average 2% voltage reduction on approx. 500 circuits
- Included gaining control of voltage regulating devices (in substations and on distribution circuits) through DMS

Duke Energy Progress

- Distribution System Demand Response (DSDR) targeted 310MW of peak demand reduction capability to avoid new CT plant construction
- Peak shaving voltage reduction currently approaches 4%
- North Carolina Utility Commission classified DSDR as an *Energy Efficiency* program with rider recovery
- Included significant circuit conditioning and automation of voltage regulating devices through DMS

IVVC Projects at Duke Energy

Other Jurisdictions

(Carolinas, Florida, Indiana and Kentucky)

- Evaluating Volt/VAR control opportunities to determine appropriate methodologies and optimal design for each area
- Applying lessons learned and best practices from IVVC and DSDR projects

IVVC Business Rationale for Duke Energy

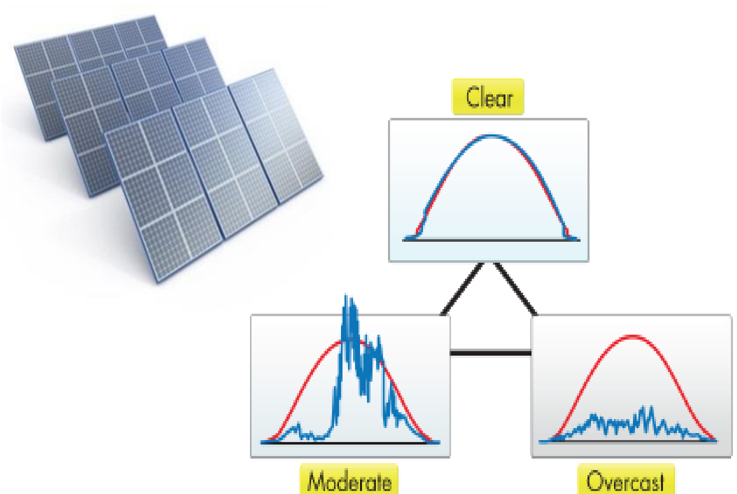
IVVC Value Proposition

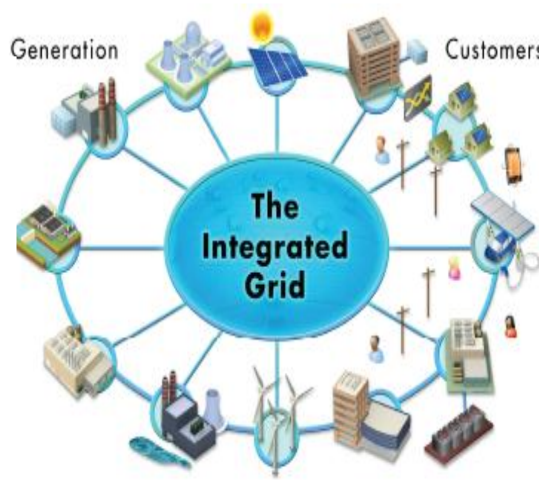
- Capital investments in IVVC leads to ***net reduction*** in customer bills through fuel savings
- Customers win through fuel savings and net lower bill
- Shareholders win through increased earnings on investment capital

IVVC Business Rationale for Duke Energy

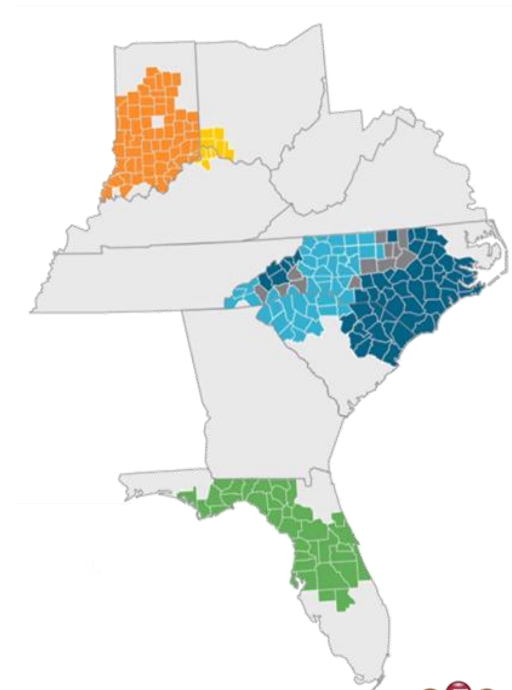
Key Observation

- IVVC pays for itself today
- IVVC also has multi-purpose capability as a Grid Management tool that positions the utility for the complexities of the future





Source: EPRI



IVVC Project Results and Benefits - DEP

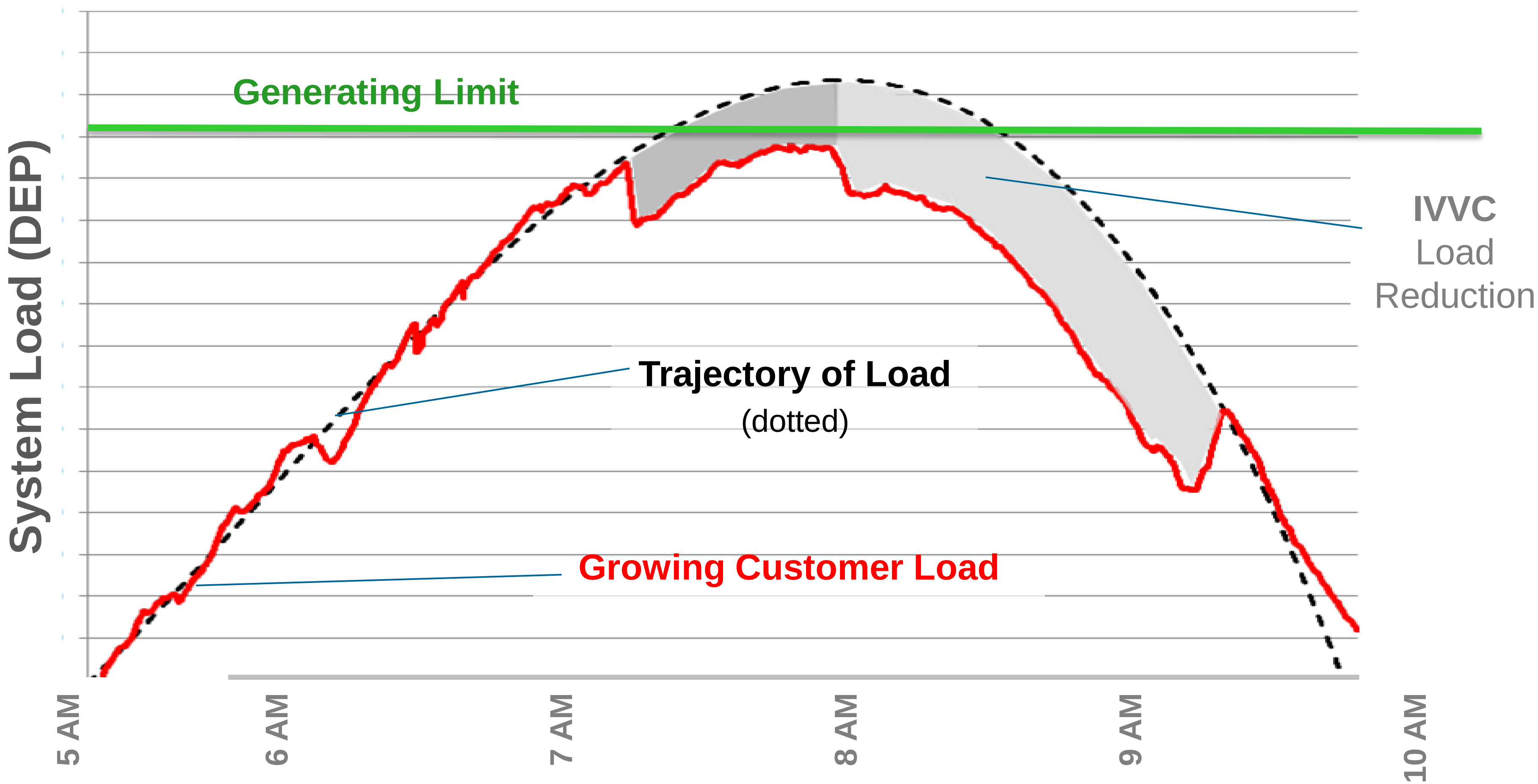
Integrated Volt/VAR Control – Duke Energy Progress DSDR

- Completed in July 2014
- Load Reduction Capabilities - 310 MW
- Peak shaving benefit confirmed
- Realizing back stand and spinning reserve benefit
- Comparable to dispatching a CT plant*

* DSDR load reduction capabilities nearly match the generation capabilities of Units 3 and 4 of DE's Asheville Plant which are capable of producing a total of 324 megawatts of peaking power

IVVC Project Results and Benefits - DEP

System Load for 4 Hours During 2014 Polar Vortex



88 Thousand Customer Outages Avoided

during extreme cold weather event

IVVC Project Results and Benefits – DEO

Distribution System Efficiency Metrics - IVVC

Average System Voltage Baseline (2012) 123.2 V

IVVC Operation (as of 8/31/14)	*Avg Circ Volt w/ IVVC*	*Avg Circ Volt Red % w/ IVVC*	*MWh Red w/ IVVC*	*Assumed CVR Factor*	*# of Cir w/ IVVC*
	121.1 V	1.75%	33,241	0.5	319

IVVC Circuit Commissioning Plan/Actuals

Number of Circuits Complete with IVVC by Year						
	2013		**2014**		**2015**	
	Planned	Actual	Planned	Actual	Planned	Actual
August	*50*	50	*125*	162	*122*	-
EOY	*100*	87	*275*	20	*-*	-
Total	*150*	**137**	*412*	**319**	*534*	**-**
Total %	*28%*	26%	*77%*	60%	*100%*	

As of 8/31/14

Successes, Surprises, and Next Steps

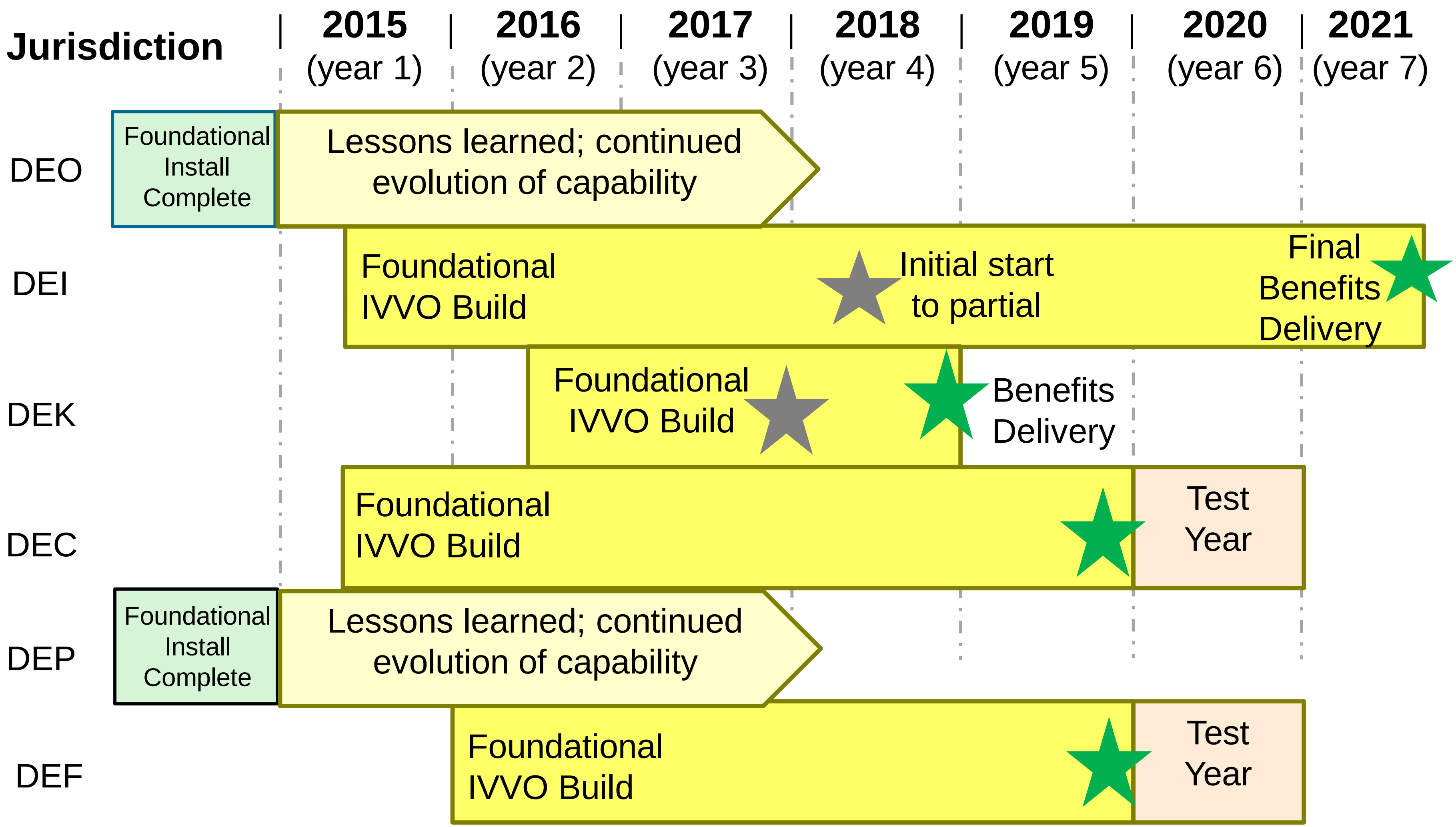
Lessons Learned

- IVVC projects require dedicated and cross functional project team
- Somebody needs to be “in charge” of delivering the benefit
- Do not underestimate efforts for DMS configuration and testing
- Legacy data accuracy is critical to DMS system model
- Utility and vendor senior management sponsorship is critical
- Received higher level of regulatory oversight than we expected

Next Steps

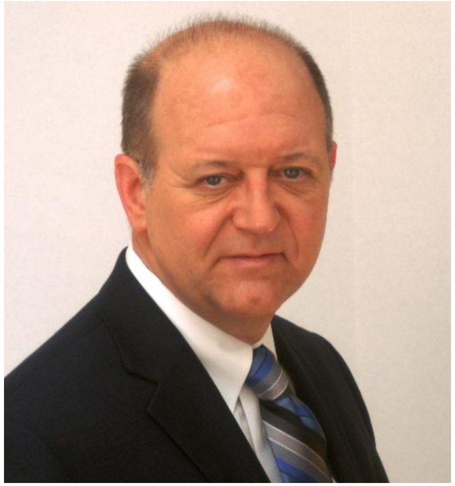
- Will consider a combination of 24/7 and peak shaving modes
- Developing Duke Energy IVVC road map

IVVC Conceptual Deployment Timeline



Jeffrey D. Roark, EPRI

Email: jroark@epri.com



- 34 years experience in regulated, unregulated, and government utilities
  - transmission and generation system planning,
  - strategic planning
  - bulk power contracts
  - power market analysis
  - wholesale deal structuring
  - trading and marketing research
  - regulatory analysis (as both regulator and regulated)
- With EPRI since 2011, responsible for cost/benefit analysis in the Smart Grid Demonstrations program
- BEE, MSEE Auburn University
  MBA, University of Alabama at Birmingham

Project: Cost/Benefit Analysis tool

- Developed an Excel-based cost/benefit analysis screening tool for CVR and DA/FLISR.
- Helps analysis of prospective designs; but not a design tool.
- Provides platform for calculating sensitivities to major project variables.

Software: Distribution Cost Benefit Analysis Calculator

Acronym: CBACalc

Version: 1.1

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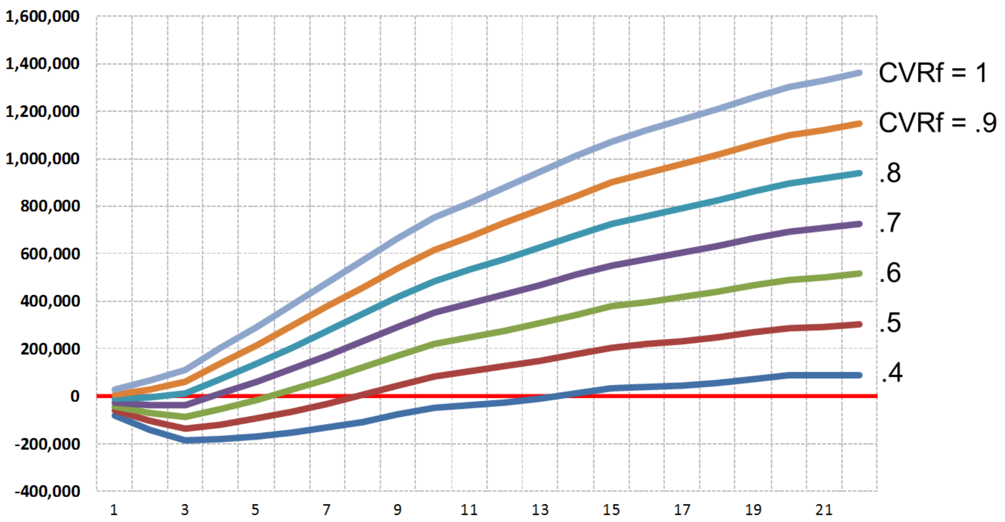
Software Information | Volt Var CVR | Distribution Automation | Inflation ...

Project Successes

- Applied prototype in distribution automation system build-out study
- Used tool to analyze a number of CVR projects
- Version 1.1 published and available on Epri.com Product ID 3002001294

Accumulated PV Savings for Various Values of CVRf @ $60/MWh Energy



Cost/Benefit Analysis for VVC/CVR

- CBA for CVR is mostly straightforward.
  - Utility Costs: Capital for VVC equipment & systems
  - Utility Savings: energy, GT&D capital deferrals

- Capacity and energy impacts are easily monetized.

- The tool handles the largest cost and impact components.

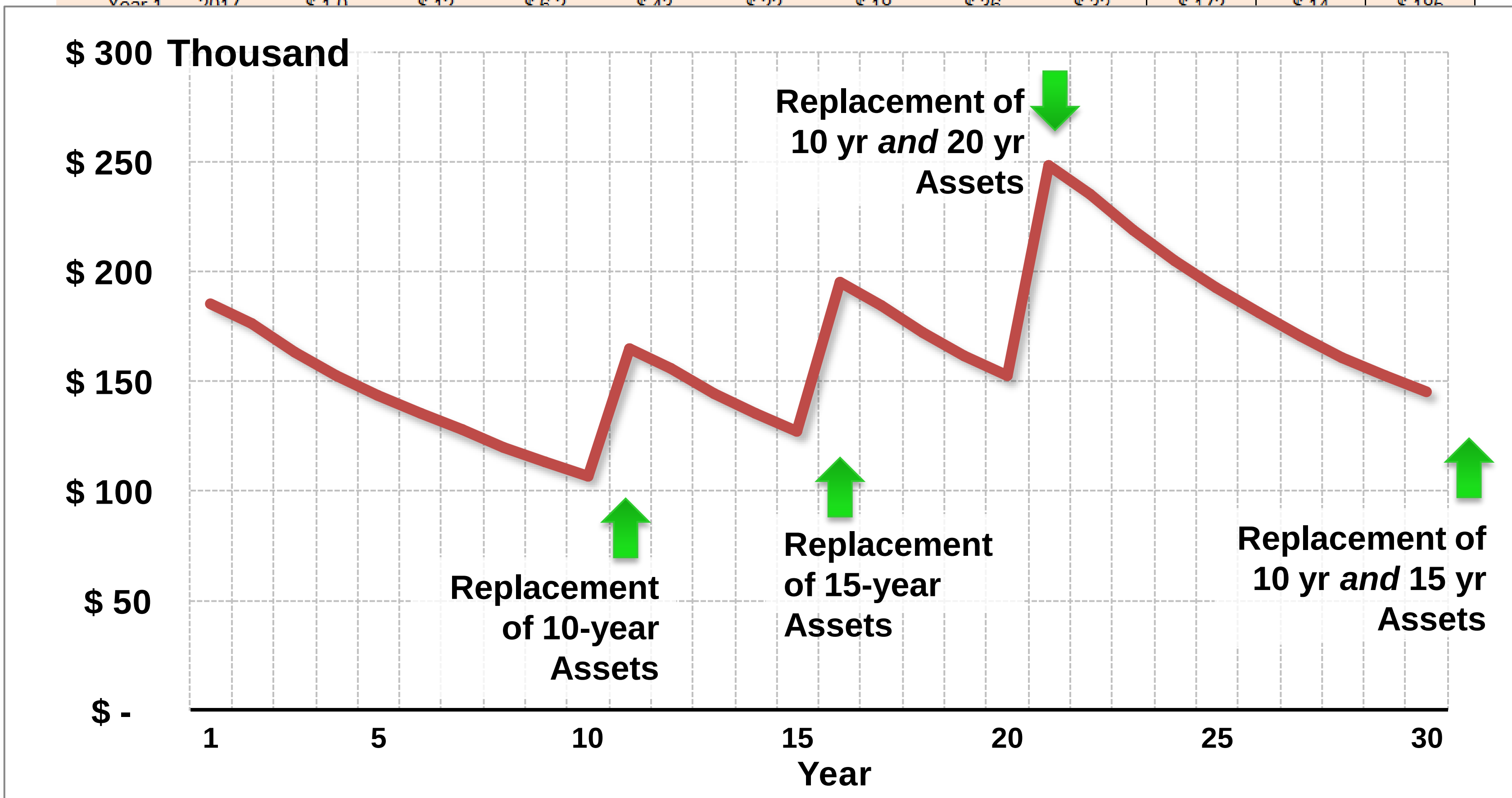
Inputs: Equipment Capital & O&M
(Example Numbers)

Device Data ($ in Cost Base Year)								
	Capacitor Fixed	Capacitor Switched	Regulators	Radio	Substation Equipment	Control System	Sensors	Other Controls
Equipment Cost	$ 4,000	$ 8,000	$ 30,000	$ 2,000	$ 100,000	$ 4,000	$ 5,000	$ 150,000
Installation Cost	$ 1,000	$ 1,000	$ 2,000	$ 500	$ 5,000	$ 500	$ 1,000	$ -
Base O&M	$ 80	$ 160	$ 600	$ 40	$ 2,000	$ 80	$ 100	$ 3,000
Life (years)	20 years	20 years	20 years	10 years	15 years	15 years	10 years	15 years

Project Design Data ($ in Project Year)					
.	Number	Devices	Installation	Total Initial Capital	O&M Base
Capacitors Fixed	1	$ 4,626	$ 1,157	$ 5,783	$ 93
Capacitors Switched	7	$ 64,769	$ 8,096	$ 72,865	$ 1,295
Regulators	1	$ 34,698	$ 2,313	$ 37,011	$ 694
Radios	43	$ 99,467	$ 99,467	$ 198,934	$ 1,989
Substation Equipment	1	$ 115,659	$ 5,783	$ 121,442	$ 2,313
Controls	19	$ 87,901	$ 10,988	$ 98,889	$ 1,758
Sensors	24	$ 138,791	$ 27,758	$ 166,549	$ 2,776
Other Controls	1	$ 173,489	$ -	$ 173,489	$ 2,776
Total				$ 874,962	$ 13,694

Calculates Revenue Requirements For CVR Equipment

		Revenue Requirements k$										
		Equipment Ownership Costs								Total	Expenses	Total
		Fixed Caps	SwitchCaps	Regulators	Radios	Sub Costs	Controls	Sensors	Other Controls	Ownership	O&M	Rev Reqs
Year 1	2017	$ 1.0	$ 12	$ 6.2	$ 43	$ 22	$ 18	$ 36	$ 32	$ 172	$ 14	$ 185
Present Value		$ 7	$ 92	$ 47	$ 347	$ 165	$ 134	$ 291	$ 235	$ 1,317	$ 155	$ 1,472



Inputs: System and CVR-Impact Data
(Example Numbers)

Feeder/Substation Data		
Annual MWh at Sub	130,000	MWh
Annual Peak MW at Sub	30	MW
Year of reported MWh	2012	
Annual Growth Rate	0.9%	
Average Loss Percent	4%	

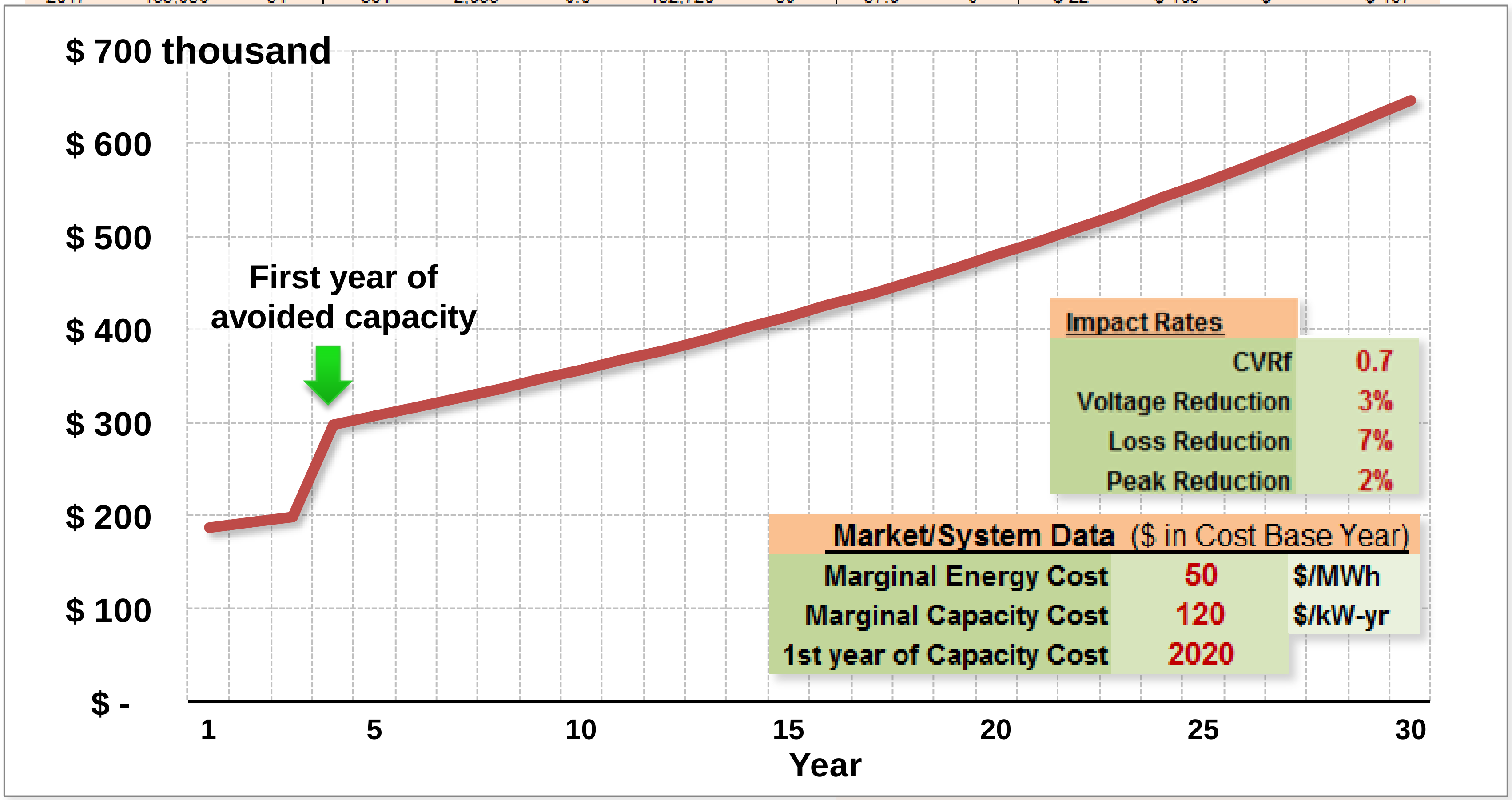
Load Factor = 50.3%

Market/System Data ($ in Cost Base Year)		
Marginal Energy Cost	50	$/MWh
Marginal Capacity Cost	120	$/kW-yr
1st year of Capacity Cost	2020	

Impact Rates	
CVRf	0.7
Voltage Reduction	3%
Loss Reduction	7%
Peak Reduction	2%

Example Case: Impacts and Avoided Costs

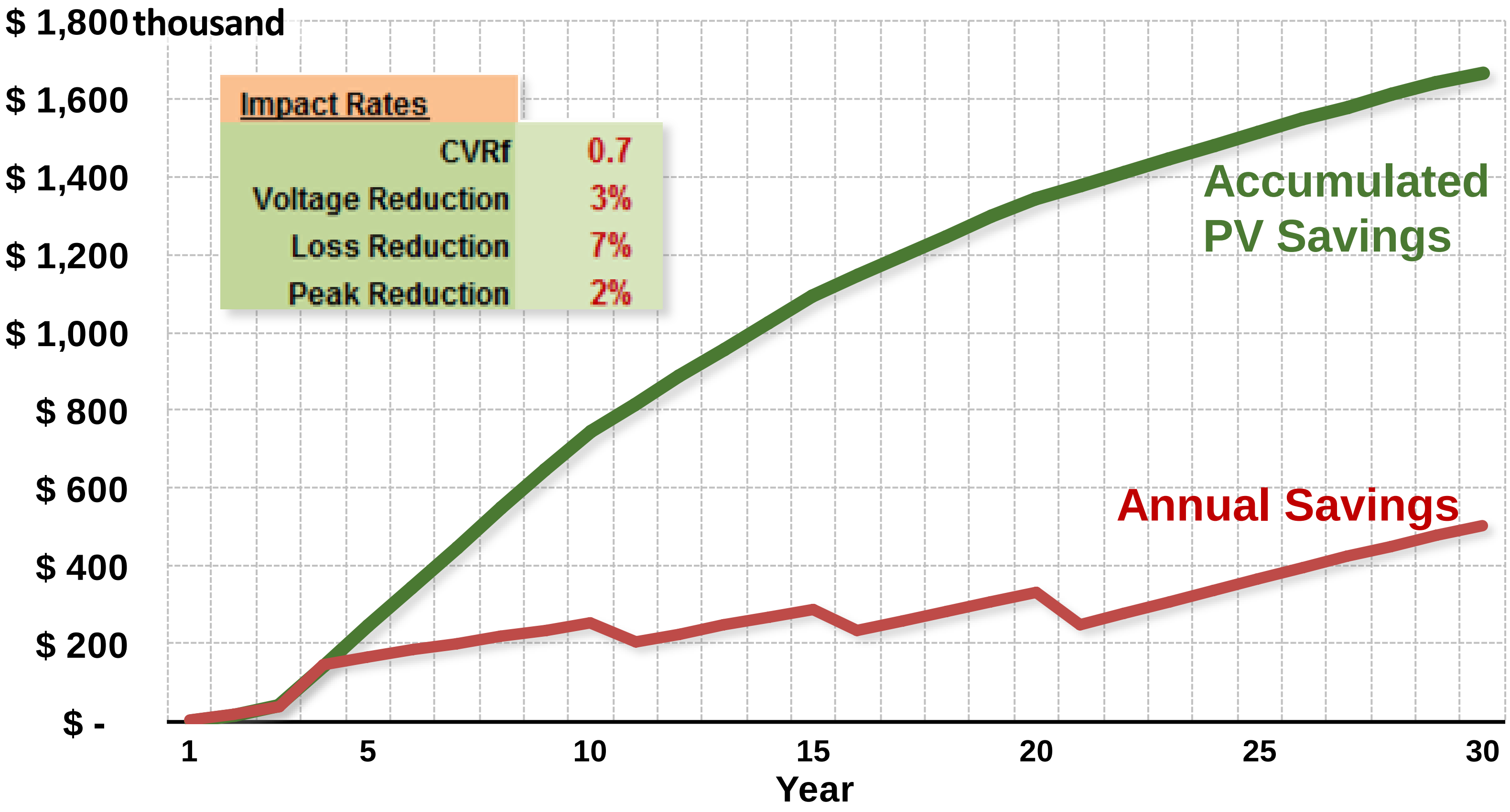
			Impacts							Avoided Costs in k$			
	Base Load MWh	Base Peak MW	Loss Reduction	Load Reduction	Peak Reduction	Resultant Load MWh	Resultant Peak MW	Energy Cost $/MWh	Capacity Cost $/kW-yr	Loss Reduction	Load Reduction	Peak Reduction	Total
2017	135,956	31	381	2,855	0.6	132,720	30	57.8	0	$ 22	$ 165	$ -	$ 187
								Present Value		$ 271	$ 2,034	$ 836	$ 3,142



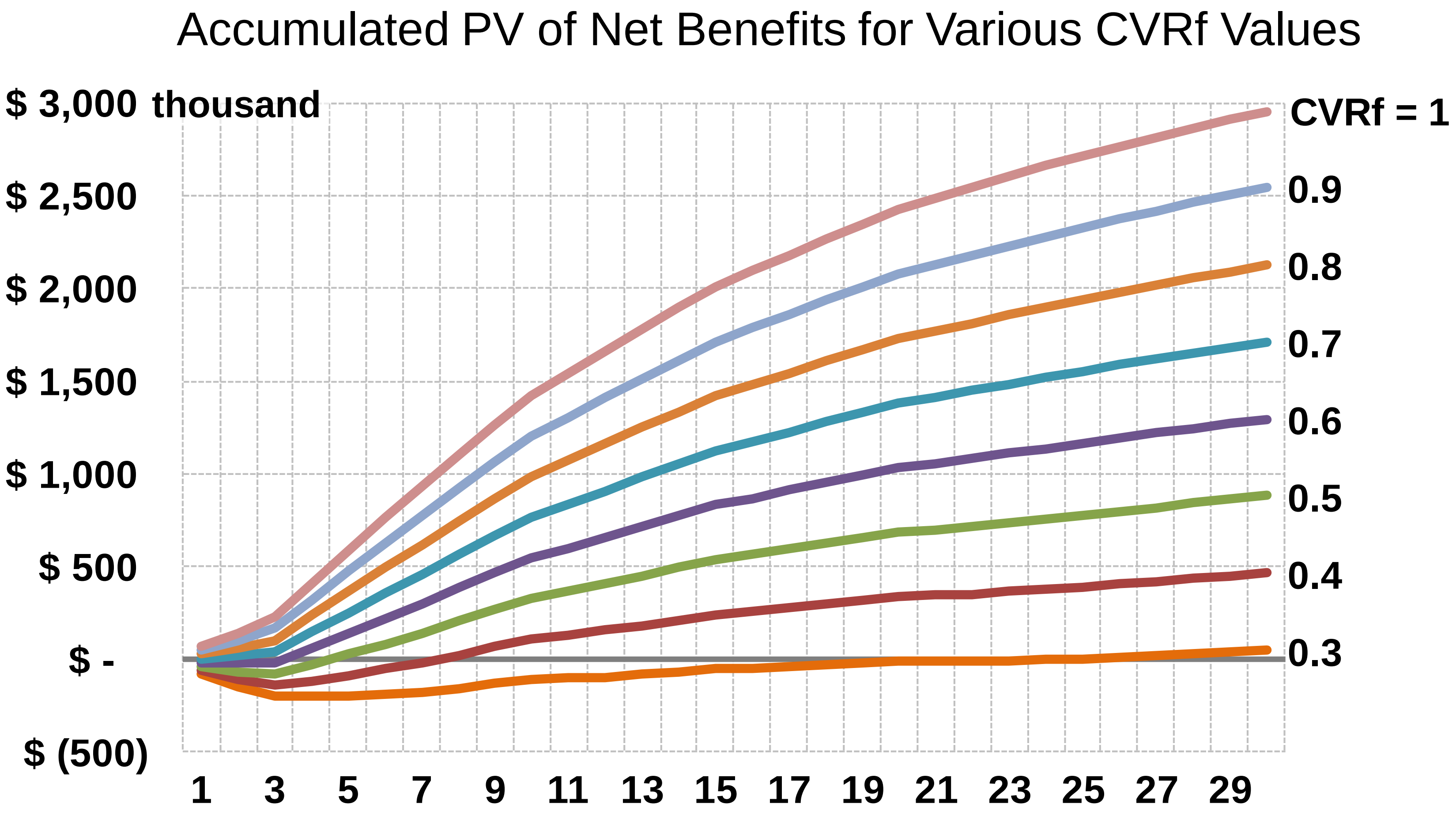
Impact Rates	
CVRf	0.7
Voltage Reduction	3%
Loss Reduction	7%
Peak Reduction	2%

Market/System Data ($ in Cost Base Year)		
Marginal Energy Cost	50	$/MWh
Marginal Capacity Cost	120	$/kW-yr
1st year of Capacity Cost	2020	

Example Case: Net Benefits



Example Case: CVRf Sensitivity



Surprises Related to the Project

Not so surprising:

- Utilities’ monetization assumptions (marginal energy and capacity) may not fit simple inflation scheme.
  - Used modified version to incorporate custom marginal energy and marginal capacity values
- Sensitivities provide sense of assumption importance.
  - CVRf variation low to high
  - CVRf decay to a lower value

A Few Comments on M&V for CVR

- Low or nonsensical results from day-on/off regression analysis does not *necessarily* mean that CVR is not effective on a particular circuit.

- Large, non-conforming loads or singular events can mask the CVR effect.

- Evaluate statistical significance of all results, including high and "expected" results.

- Given M&V issues, *nothing* is precise.
  Look at a range of possibilities.

Questions / Discussion