

## Issues to Consider when addressing CVR as an EE Resource

### Defining costs and benefits

- ▲ Costs – incremental, overlap w/ other SmartGrid investments, etc.
- ▲ Benefits – energy, peak, power quality, line losses, etc.

### Incentive mechanisms to capture maximum savings potential

- ▲ Deep penetration per circuit
- ▲ Persistence of savings.

### Funding mechanisms

- ▲ SBC, Ratebase, other?

### M&V

- ▲ There are no formally established M&V protocols.

### Ensuring persistence of savings

### Interaction with DG

- ▲ Voltage regulation on high penetration DG circuits



**Thank-you!**

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Ameren Illinois Voltage Optimization  
Pilot Test Plan Presentation  
Citizens Utility Board  
October 1, 2013



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## Ameren Illinois Voltage Optimization Pilot Test Plan



### Project Review – Test Circuit Locations

- University Substation, Peoria – Feeders 1, 3, 4 (15.9 MVA Peak), Comparable Feeder Hines Transformer 1
- Route 121 Substation, Mt. Zion – Feeder 173 (7.3 MVA Peak), Comparable Feeder Mt. Zion – Feeder 174

### Test Plan Description

- Reference Day (No Conservation Voltage Reduction) for 24 hour periods.
- Test Day constitutes lowering voltage set points for all Regulators and LTC's by either 2% or 4%.
- Testing will occur seven days a week where the feeder voltage level will be varied between reference day, 2% voltage reduction and 4% voltage reductions. The cycle of Reference day, 2% voltage reduction, 4% voltage reduction will be repeated for the duration of the pilot.
- Measure KW, KVAR, Voltage & Current components at substation feeder locations.

## University – Manual Testing Process



- Lack of automated control equipment created need to operate substation Load Tap-changer (LTC) manually.
- Monday and Wednesday's 2% CVR.
- Tuesday and Thursday's 4% CVR.
- Friday-Saturday-Sunday were reference days (No conservation voltage reduction applied)
- Instituted 7 day rotation similar to Mt. Zion test plan on January 17, 2013

## Electric Power Research Institute support



- Ameren Illinois would like to recognize EPRI for their significant contribution to Ameren Illinois Conservation Voltage Pilot Project
- The Electric Power Research Institute (EPRI) has provided Ameren Illinois significant guidance on its CVR pilot project.
  - EPRI provided training to Ameren Illinois on the various analysis methodologies that have been performed across the utility industry.
  - EPRI has analyzed all of the data that Ameren Illinois provided from this CVR pilot project and created many of the slides that are depicted in this presentation.

## Data Collection/Retention Issues



- ADMS Implementation
  - Data for Mt. Zion from April 30 through May 24<sup>th</sup> was deleted
- Communication Issues
  - Loss of communication path between field & dispatch
  - Communications cable at Decatur Distribution Dispatch was severed inadvertently
- Data not acquired due to process issues
  - Testing Calendar was not updated for University pilot from August 2<sup>nd</sup> through Aug 25<sup>th</sup>
  - Late implementation of CVR occurred on a few days during pilot.
- Test Calendar Results on next slide depict data issues

# Test Calendar Results

**Mt. Zion Substation**

Month	Su	M	Tu	W	Th	F	Sa
May	29	30	1	2	3	4	5
Jun	10	11	12	13	14	15	16
Jul	1	2	3	4	5	6	7
Aug	5	6	7	8	9	10	11
Sep	2	3	4	5	6	7	8
Oct	30	31	1	2	3	4	5
Nov	4	5	6	7	8	9	10
Dec	2	3	4	5	6	7	8

**University Substation**

Month	Su	M	Tu	W	Th	F	Sa
May	6	7	8	9	10	11	12
Jun	3	4	5	6	7	8	9
Jul	1	2	3	4	5	6	7
Aug	5	6	7	8	9	10	11
Sep	2	3	4	5	6	7	8
Oct	30	31	1	2	3	4	5
Nov	4	5	6	7	8	9	10
Dec	2	3	4	5	6	7	8

- Normal V
- 1.7% reduction
- 3.2% reduction
- Irregular V
- Missing Data
- Some Missing
- Camp Missing
- ADMS Issues
- Communications
- Process Issues



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## Statistical Model Development Methodology

- To estimate the sensitivity of load to voltage, regression analysis can be used to estimate a linear model of the hourly feeder load.
- The model attempts to reproduce the feeder load from a set of variables that includes the %-change in voltage,  $\% \Delta V(t)$ .

$$\text{Feeder load}(t) = k \cdot \% \Delta V(t) + (\text{other terms}^*)$$

- The coefficient of the voltage change is the average sensitivity of the feeder load to the change in voltage.  
$$k \approx \frac{\text{Change in Feeder Load}}{\% \text{ Change in Voltage}}$$
- Results are often expressed normalized for comparability, i.e., as the Conservation Voltage Reduction Factor, CVRF.

$$\text{CVRF} = \frac{\% \text{ Change in Feeder Load}}{\% \text{ Change in Voltage}} = k / \text{Average feeder kW}$$

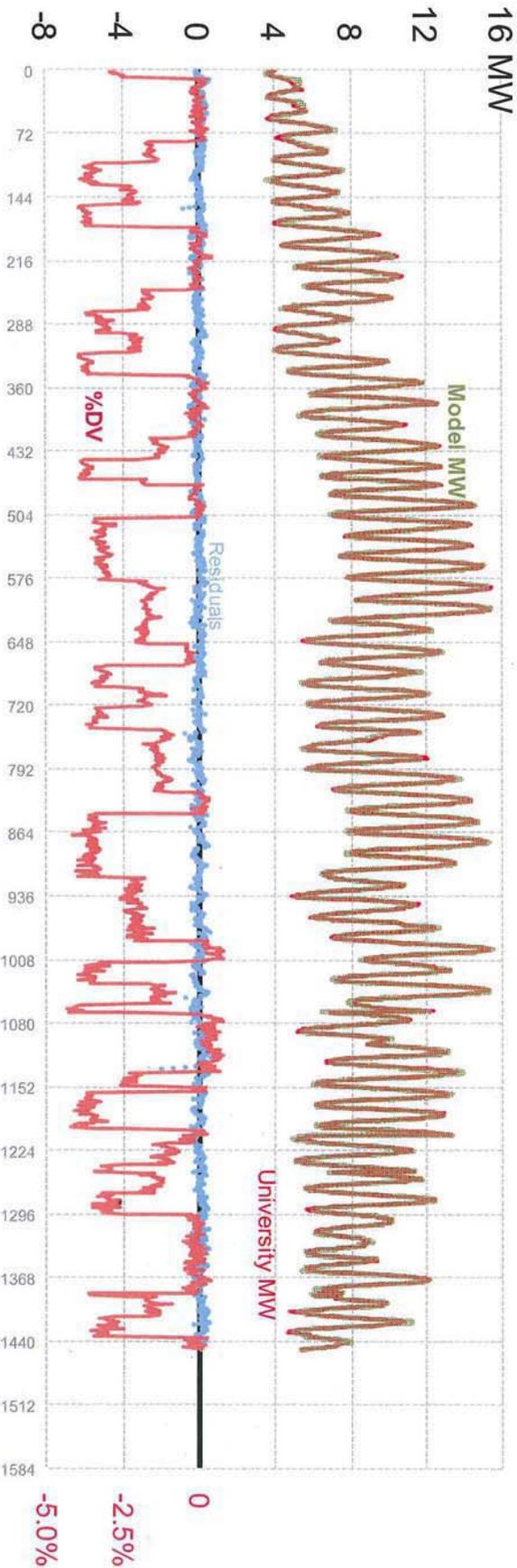
(for the calculation period)

\* "other terms" includes day-of-week, time-of-day, holidays, and temperature data or the load on a comparable feeder



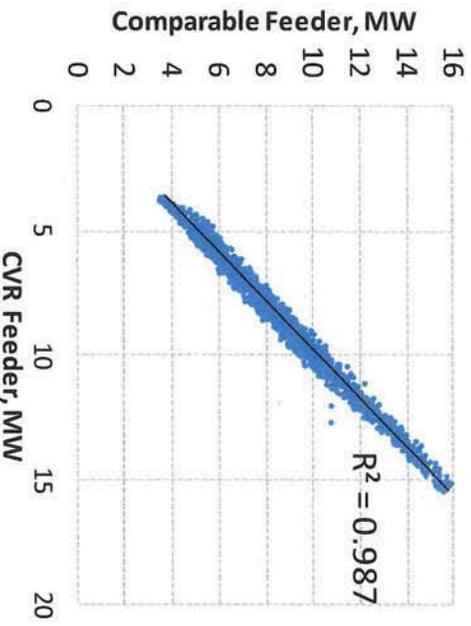
# University, Jun-Sep 7

65 days from Jun 1, 2012 to Sep 7, 2012

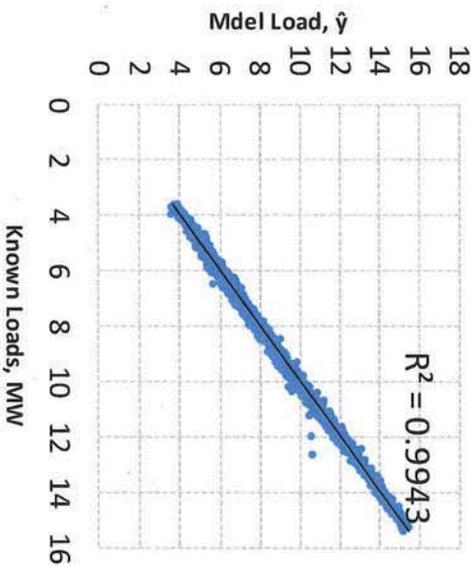


Note: Some days have fewer than 24 hours of data.  
 Gaps in data are collapsed on the horizontal axis.

Correlation to Comparable Circuit



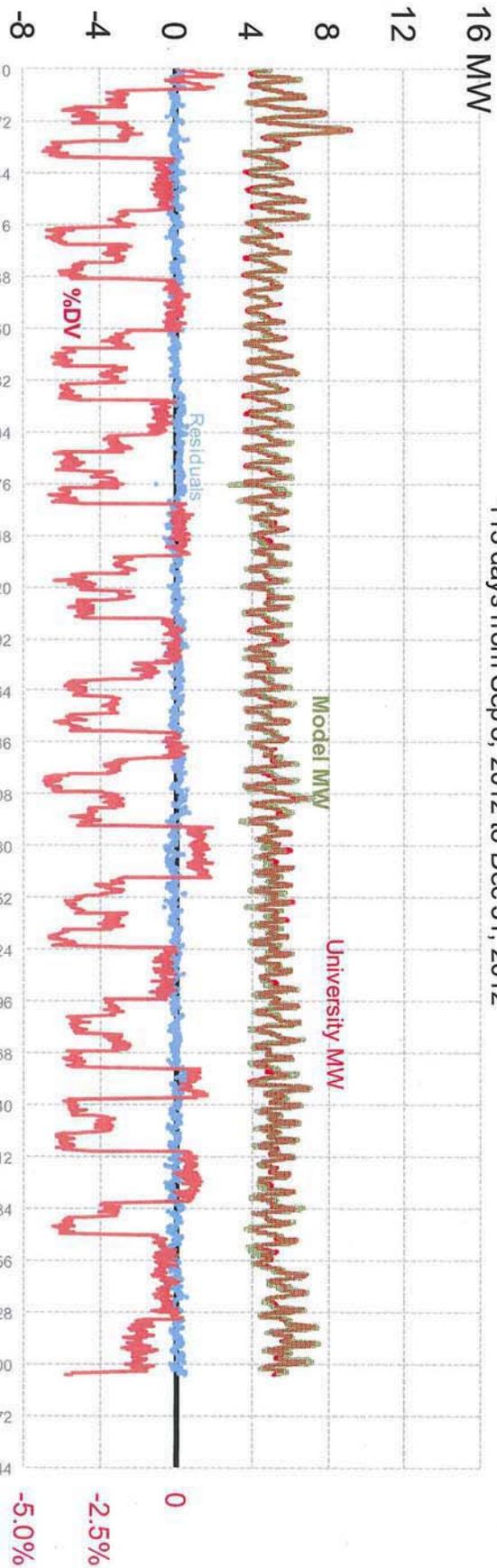
Model to Actual



$\Delta\%V$  Coefficient = 68.8 kW/%  
 Average Load, as is = 8.69 MW  
 Avg load at normal V = 8.81 MW  
 $\% \Delta MW / \% \Delta V$   
**CVRf = .78**

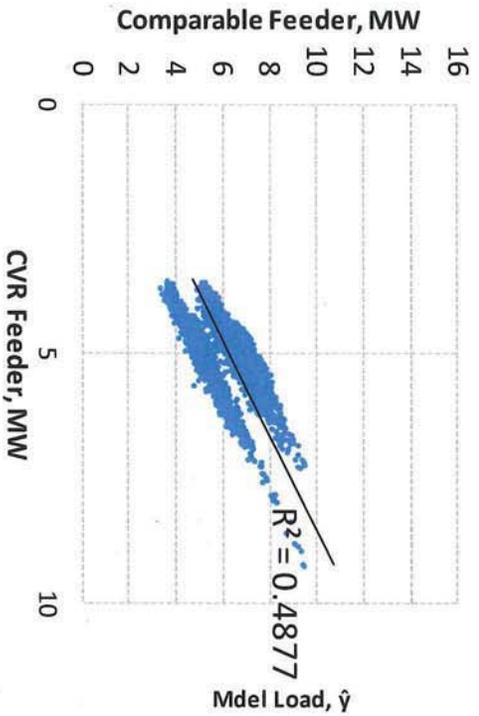
# University, Sep 8-Dec 31

113 days from Sep 8, 2012 to Dec 31, 2012

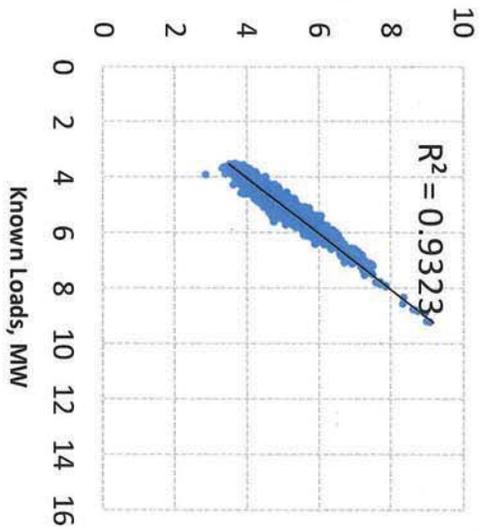


Note: Some days have fewer than 24 hours of data.  
 Gaps in data are collapsed on the horizontal axis.

Correlation to Comparable Circuit



Model to Actual



$\Delta\%V$  Coefficient = 66.6 kW/%  
 Average Load, as is = 5.26 MW  
 Avg load at normal V = 5.35 MW

$\% \Delta MW / \% \Delta V$   
**CVRf = 1.24**

# Chronological Plot of University and Hines Loads showing Offset from Late September to Late November

