

Power System
Engineering, Inc.

New York Association of Public Power

Otsego Electric Cooperative, Inc.

Innovations in Energy Efficiency

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Otsego's Energy Efficiency Measures

- LED Lighting – All MV (~800 lights) to be changed out to Evluma over next 3 months

Light	Wattage	Avg Hourly Demand (kW)	Estimated Annual Usage (kWh)	Estimated Savings Per Light Switched to Evluma LED: Est Demand Savings (kW)	Estimated Savings Per Light Switched to Evluma LED: Est Annual Usage Savings (kWh)	Estimated Total Savings IF Switched ALL MV to Evluma LED: Est Demand Savings (kW)	Estimated Total Savings IF Switched ALL MV to Evluma LED: Est Demand Savings ($)	Estimated Total Savings IF Switched ALL MV to Evluma LED: Est Annual Energy Savings (kWh)	Estimated Total Savings IF Switched ALL MV to Evluma LED: Est Annual Energy Savings ($)
Evluma LED	40	0.040	149	-	-	-		-	-
Beta LED	40	0.043	159	-	-	-		-	-
Metal Halide	100	0.134	499	0.094	351	-		-	-
Mercury Vapor	175	0.203	759	0.164	610	139	$4,939	518,635	$9,766

- ETS
  - 2 whole house Comfort Plus systems installed
  - System being installed at Otsego's office
- Distribution system loss mitigation

System Losses

System Losses = Energy purchased – Energy sold

As % of Energy purchased:

$$\frac{\textit{System losses}}{\textit{Energy purchased}}$$

CAUTION!!!

Difference in time and load when consumer meters are read compared to when substation meters are read can lead to errors in loss calculations.

Otsego's Efforts

- Tracking monthly distribution system losses by substation
  - Utilizing data from deployed Canon AMI system
  - Better alignment of time period for purchases and sales
- Discovered that the Richfield substation has a higher percentage of losses
  - Where are these losses coming from?
  - What cost effective measures can be implemented to reduce the losses?

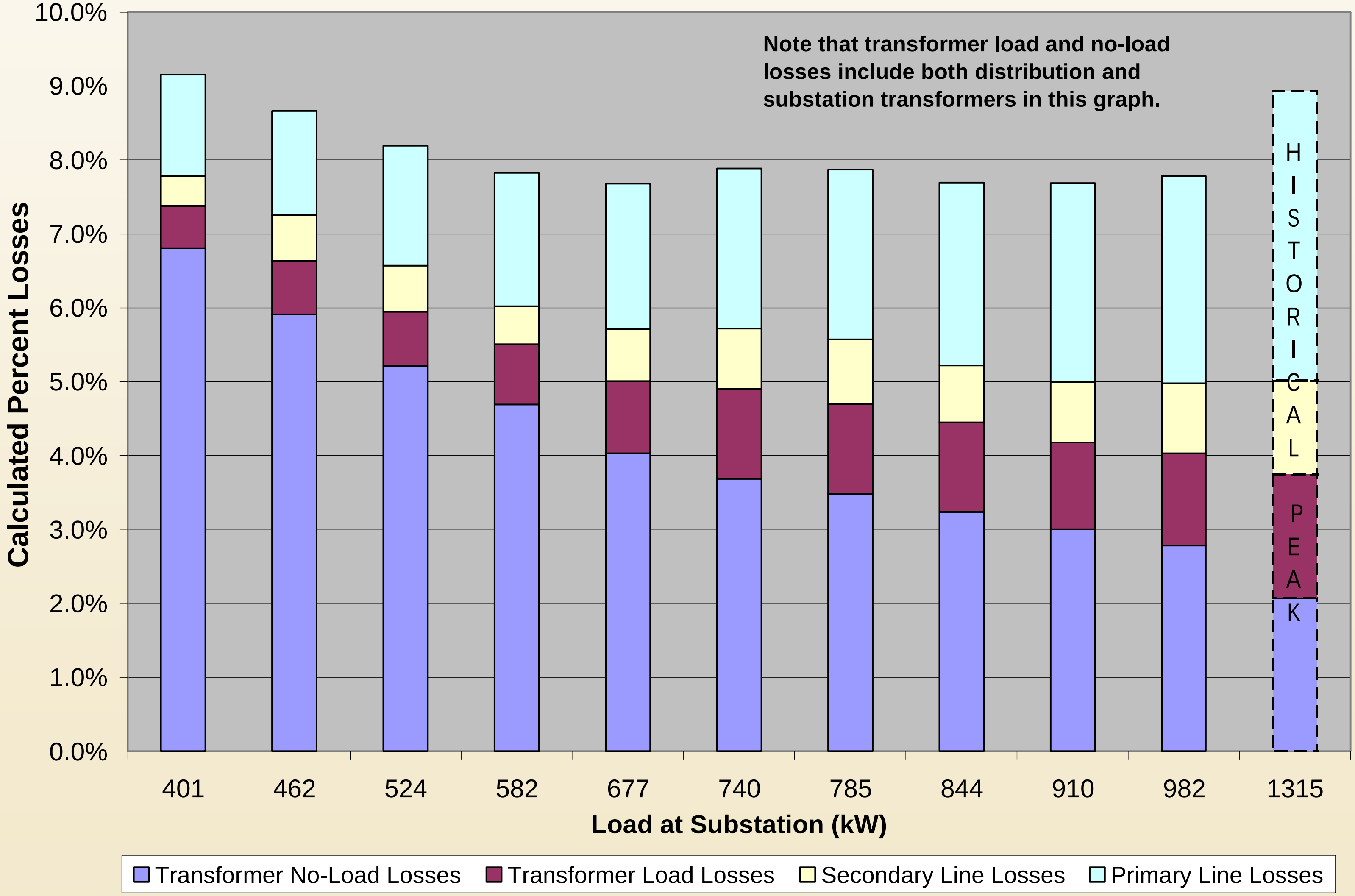
Sources of Losses

LOSS COMPONENT	FUNCTION OF	NOTES
Substation Power Transformers		
No-Load (core) losses	Voltage	Magnetizing transformer core. Contributes significantly to energy losses.
Load (winding) losses	I^2R	Greater than no-load losses @ rated capacity
Auxiliary losses	I^2R	Primarily from fans - small compared to windings
Voltage regulators		Located at Subs and on Dist Line
No-Load (core) losses	Voltage	Magnetizing transformer core. Contributes significantly to energy losses.
Load (winding) losses	I^2R	Affected by amount of time and distance off neutral
Distribution lines (12.47/7.2 kV)	I^2R	Three-phase, vee-phase, and single-phase lines
Distribution transformers		
No-Load (core) losses	Voltage	Magnetizing transformer core. Contributes significantly to energy losses.
Load (winding) losses	I^2R	Greater than no-load losses @ rated capacity
Secondary / service conductors	I^2R	End of the system. Therefore need to consider effects of increased losses at this level causing increased current and losses on all other components
Consumer Metering		Defective meters, miswired meters, meter reading errors, data entry errors, theft. More of a testing, verification, and policy issue.

Innovative Look at Losses

- Leveraging of technology
  - Collected hourly interval load data from AMI system for every meter on Richfield substation
  - Database behind GIS system used to create a detailed engineering model of the Richfield area down to the individual meter level
- Applied load data to engineering model to calculate hourly losses by system component
  - Determine <u>where</u> losses are being incurred
  - Determine <u>when</u> losses are being incurred

Summary of Results



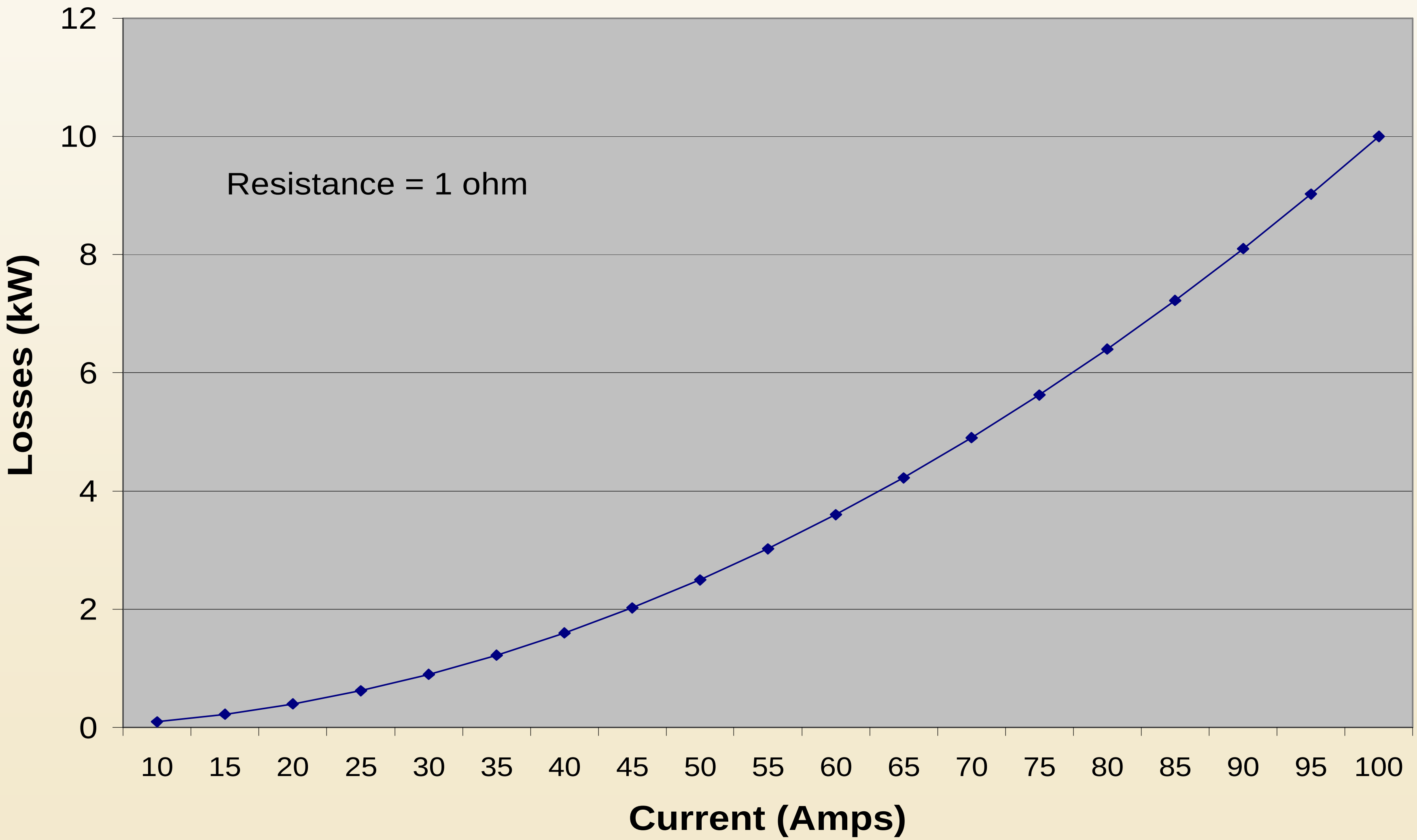
What Was Learned

- Dominant contributors to losses
  - Transformer no-load losses
  - Primary distribution system losses – “line losses”
- Size and lengths of secondary conductors generally appropriate, thus losses are minimal
- Transformers generally size sufficiently large enough, thus load losses are minimized

Primary Distribution System Loss Mitigation

- Ways to lower line losses
  - Reduce current flow
  - Reduce resistance of conductors
- The largest benefit is derived by reducing current flow since losses are a function of current squared
- Reducing resistance of conductors is very capital intensive (requires upgrading lines)
  - Generally not cost justified to only reduce losses
  - Otsego considers benefit of loss reduction in normal planning process – identified 12.3 mi of line to upgrade

Load Losses as a Function of Current



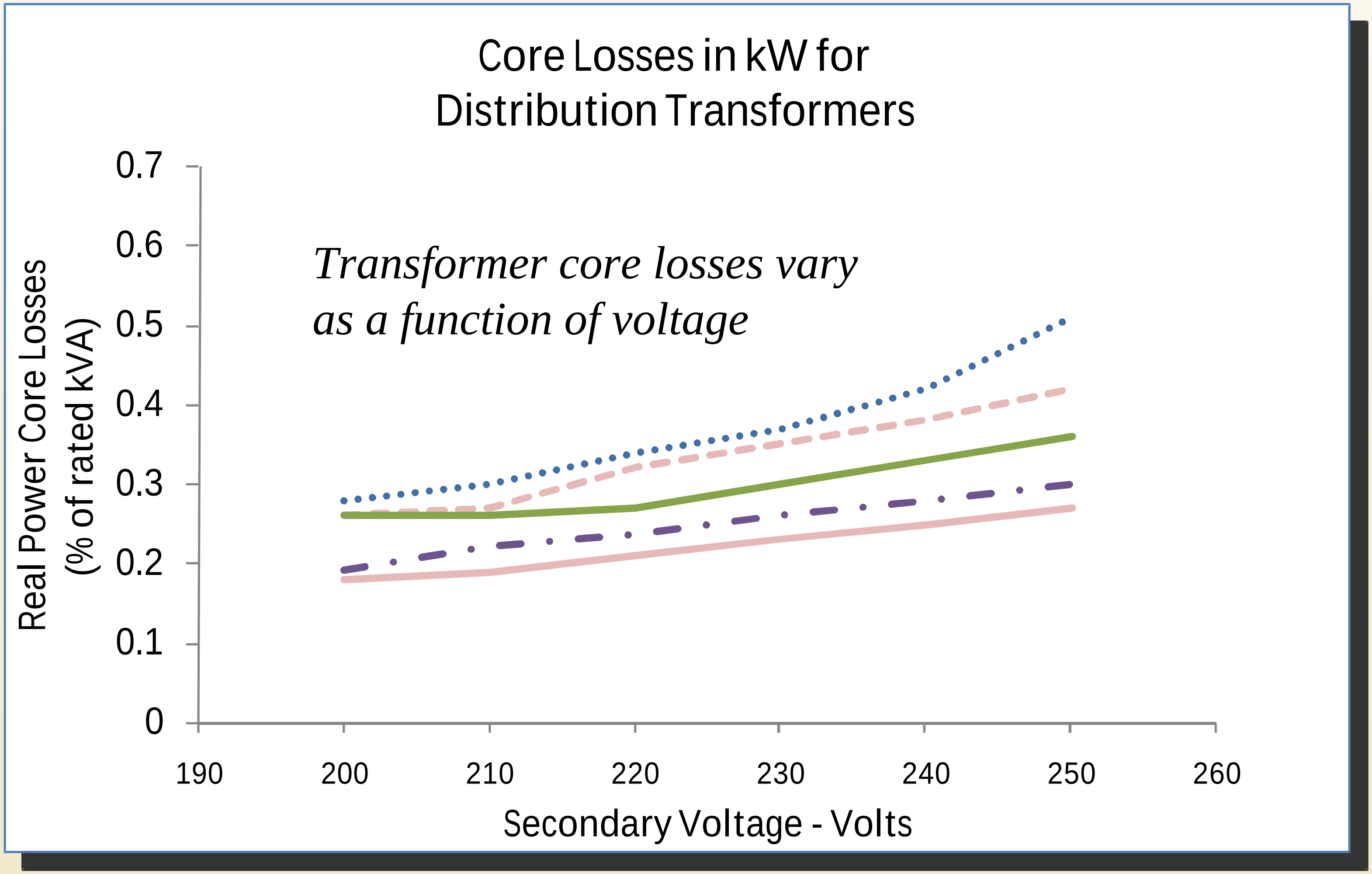
Ways Otsego is Reducing Current Flow

- Balancing loads along three-phase line
- Reducing reactive power flows through installation of capacitors
- Converting one single-phase line to vee-phase

Transformer No-Load Loss Mitigation

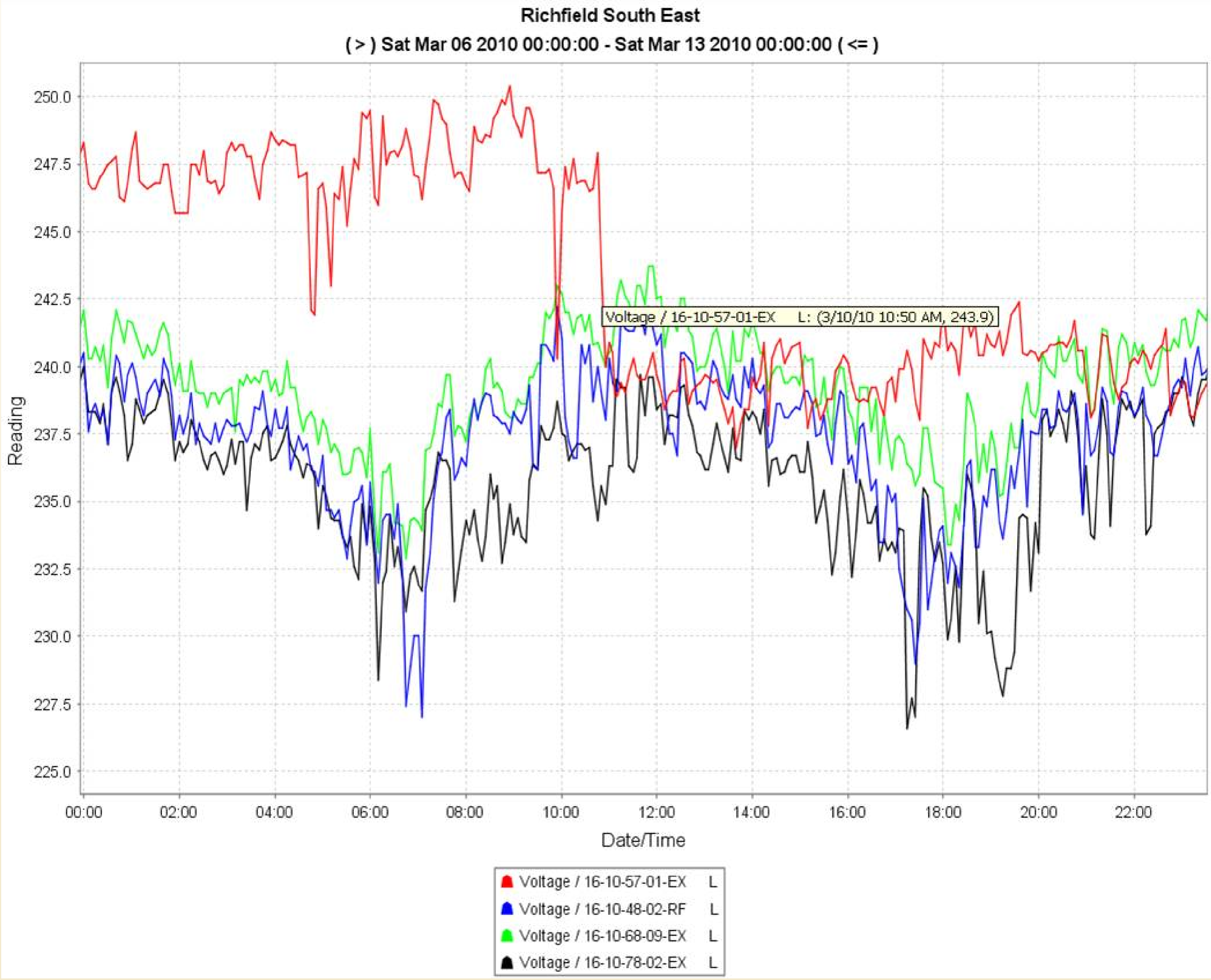
- De-energize transformers on inactive services
- Install more efficient transformers
  - New DOE standards require new transformer purchases meet certain efficiency levels
- Install smaller transformers
  - Installing smaller transformers will increase load losses, voltage drop across transformer, and potentially cause premature transformer failure due to overloading
- Reduce voltage

Transformer No-Load (Core) Losses



Voltage Optimization

- System is designed to maintain ANSI required voltage levels during peak load times
- During non-peak times, voltage across system is higher than required and can be reduced
- Substation bus regulators at Richfield substation programmed with Line Drop Compensation (LDC) settings
  - Effectively reduce voltage during lower loading periods
  - Maintain adequate voltage support during peak loading periods



Richfield South East
(>) Sat Mar 06 2010 00:00:00 - Sat Mar 13 2010 00:00:00 (<=)
Reading
250.0
247.5
245.0
242.5
240.0
237.5
235.0
232.5
230.0
227.5
225.0
Voltage / 16-10-57-01-EX L: (3/10/10 10:50 AM, 243.9)
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Date/Time
Voltage / 16-10-57-01-EX L
Voltage / 16-10-48-02-RF L
Voltage / 16-10-68-09-EX L
Voltage / 16-10-78-02-EX L

Benefits of Reduced Voltage

- Lower transformer core losses
- The current (and associated demand) of constant impedance and partial constant impedance loads will decrease
  - Amp draw of these devices are proportional to the voltage used to energize the device
  - Reduced current = reduced line losses
  - Improved energy efficiency

Issues With Voltage Reduction

- Ensuring adequate voltage is maintained during peak loading times
- Reduced energy usage = lost billing revenue
- Negative impact to certain devices output and efficiency
  - Light foot candles
  - Motor speed / torque
  - Heat / Cooling output
- Constant power loads will see an increase in current to maintain required output

Next Steps

- Monitor effects of regulator LDC settings
  - Adjust LDC settings as needed
  - Quantify benefits
- Continue monitoring load balance and reactive power flow, adjusting as needed
- Continue with work plan projects to upgrade identified lines
- Apply lessons learned to other areas of the system

Thank You!

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