



# Smart Grid Workshop Minnesota Public Utilities Commission

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# What Is Smart Substation?

A demonstration project that retrofitted an existing substation with leading-edge technology

## *Project Objectives:*

- Improve substation operability and reliability
- Improve proactive equipment assessments
- Improve event information and response
- Minimize installation labor and material costs

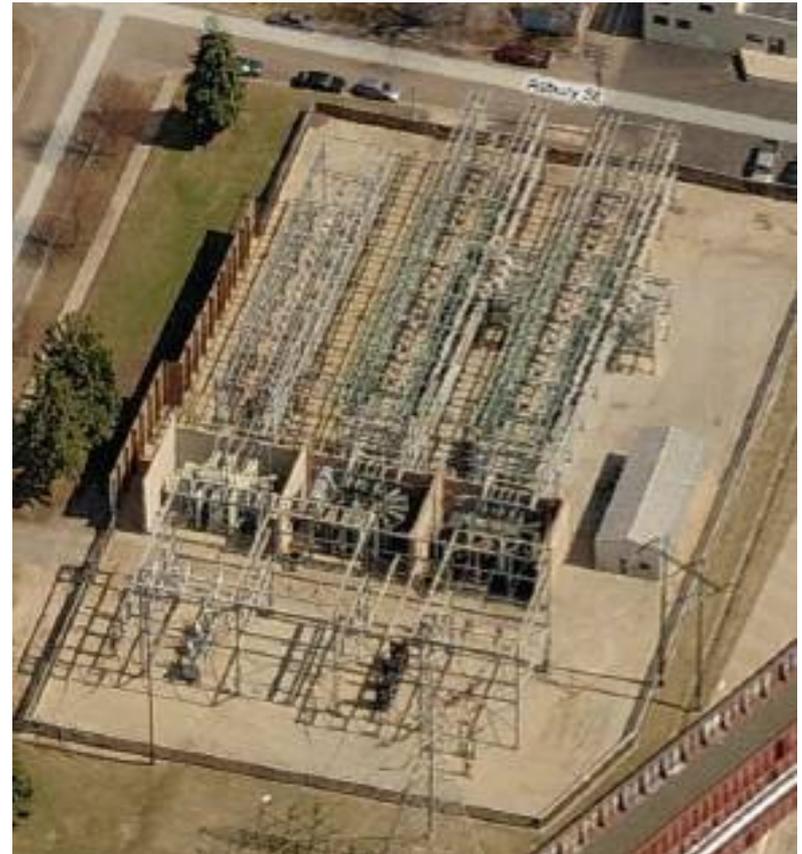
Objectives achieved? **YES**

# Why Merriam Park Sub?

- Located in close proximity to subject-matter experts and field technicians
- Great opportunity for asset renewal!

## *Substation Overview:*

- Located near Snelling and Marshall Ave,  
St. Paul
- Originally constructed in the mid-1950's
- Original protection and controls largely untouched from original installation
- Some replacements completed in the late 1960s to early 1970s

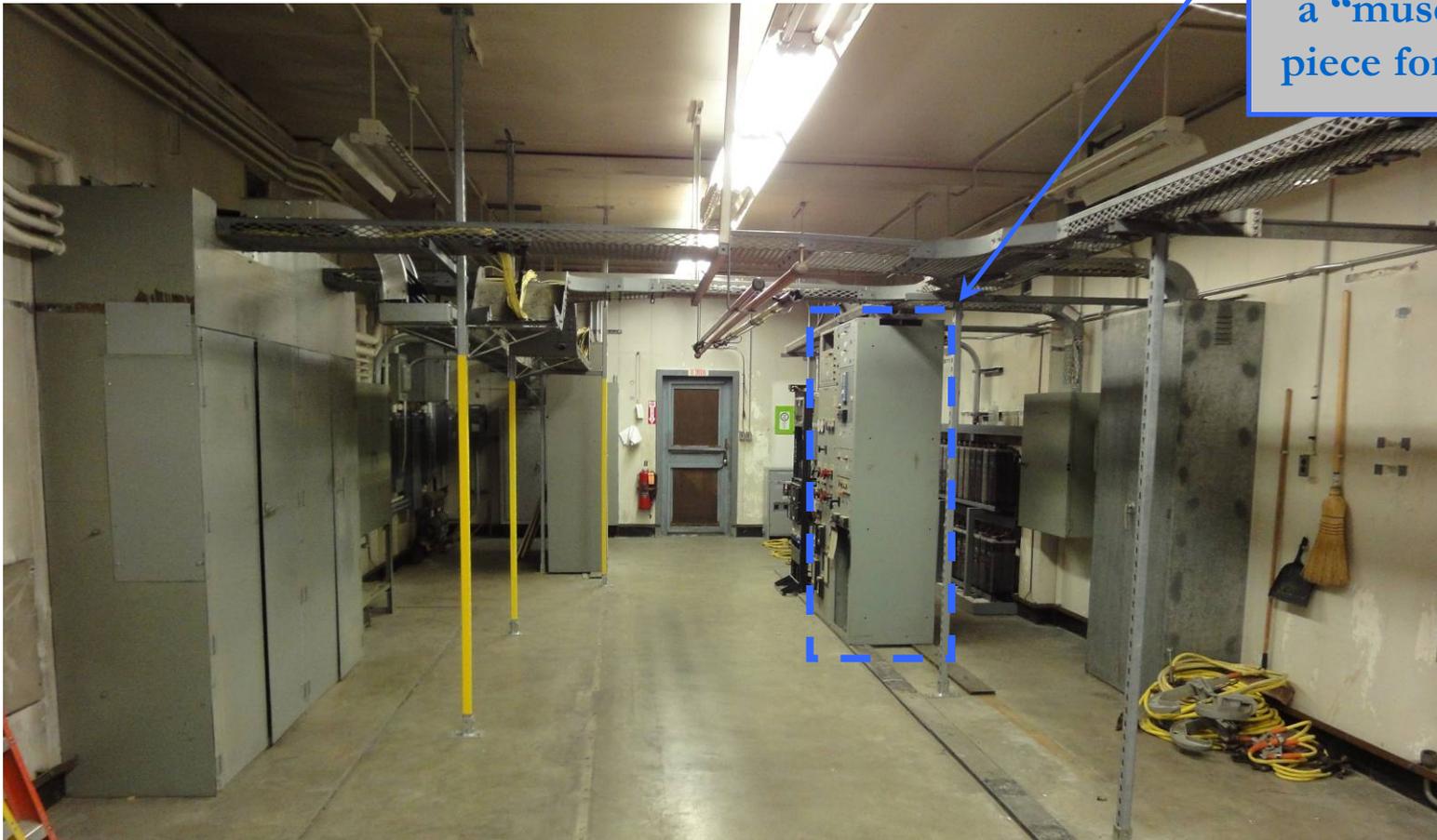


# Merriam Park “v.2”

- In a word... *IEC-61850*... an International Interoperability standard:
  - ◆ Allows peer communication between devices, independent of the manufacturer
  - ◆ Key to equipment integration and reduced wiring complexity
  - ◆ Minimizes hardware and wiring, improving long-term mechanical reliability
  - ◆ Eliminates significant amount of control wiring and complexity
- Two year project duration
- Six vendor partners participated in the project
- At installation time, it was the largest, multi-vendor, complete IEC61850 installation in the U.S.

# How Much Did We Replace?

Left in place as a “museum” piece for tours



# *Features:*

## **“Drop-In” Equipment Enclosure**

- Pre-constructed and pre-wired electrical equipment enclosure
- Minimized required Xcel Energy labor; minimized installation duration and reduced costs
- New enclosure size is 12x32 while original building was 20x50



*Features:*

# Streamlined Equipment Integration



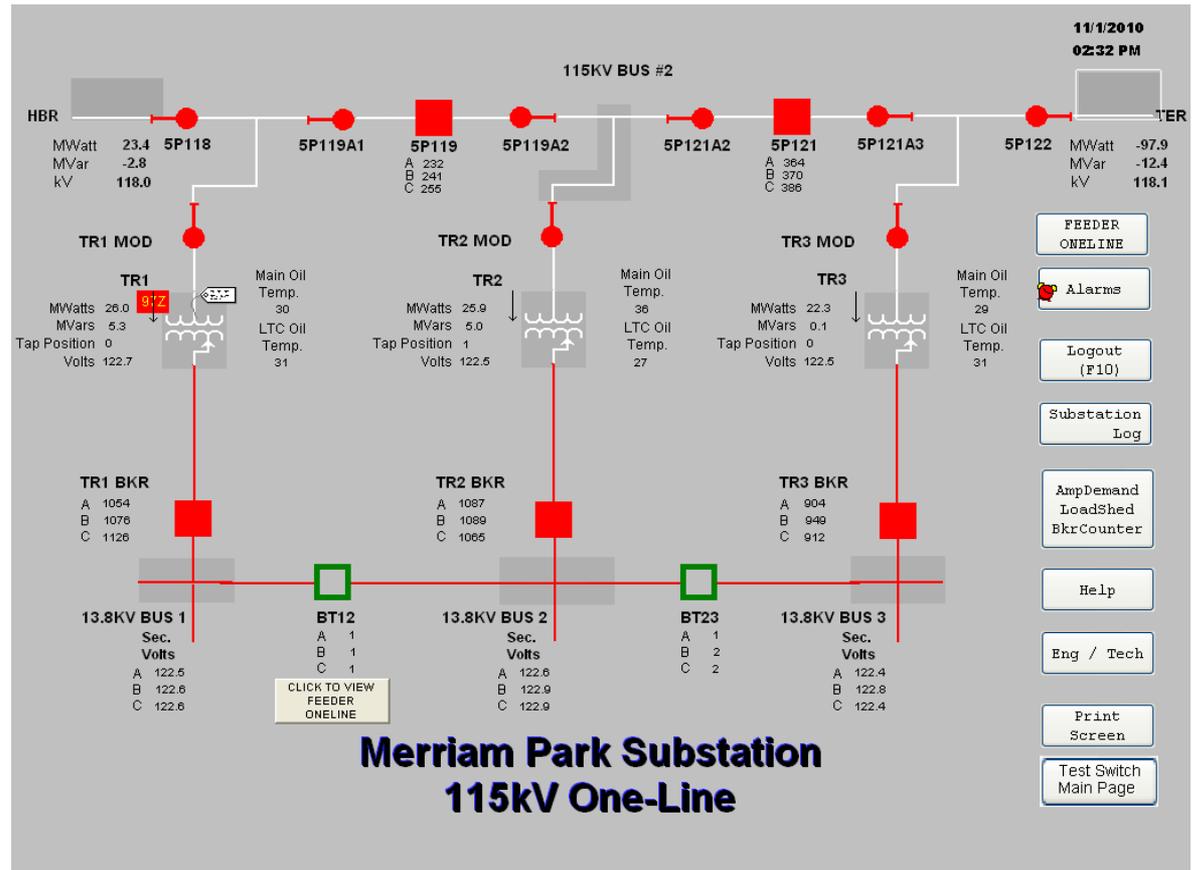
# Comparable Legacy Equipment



# Features:

## Intuitive Operator Controls

- Intuitive and interactive interface to minimize human performance errors



# *Features:*

## Automatic Transformer Analysis

- Dissolved Gas-In-Oil analysis provides indication of imminent transformer failures through gas chromatography
- Previously completed manually on an annual basis in Xcel Energy's chemistry test group
- The DGA equipment provides near continuous sampling and analysis for trending or immediate problem indication



# *Features:*

## Automatic Battery Monitoring

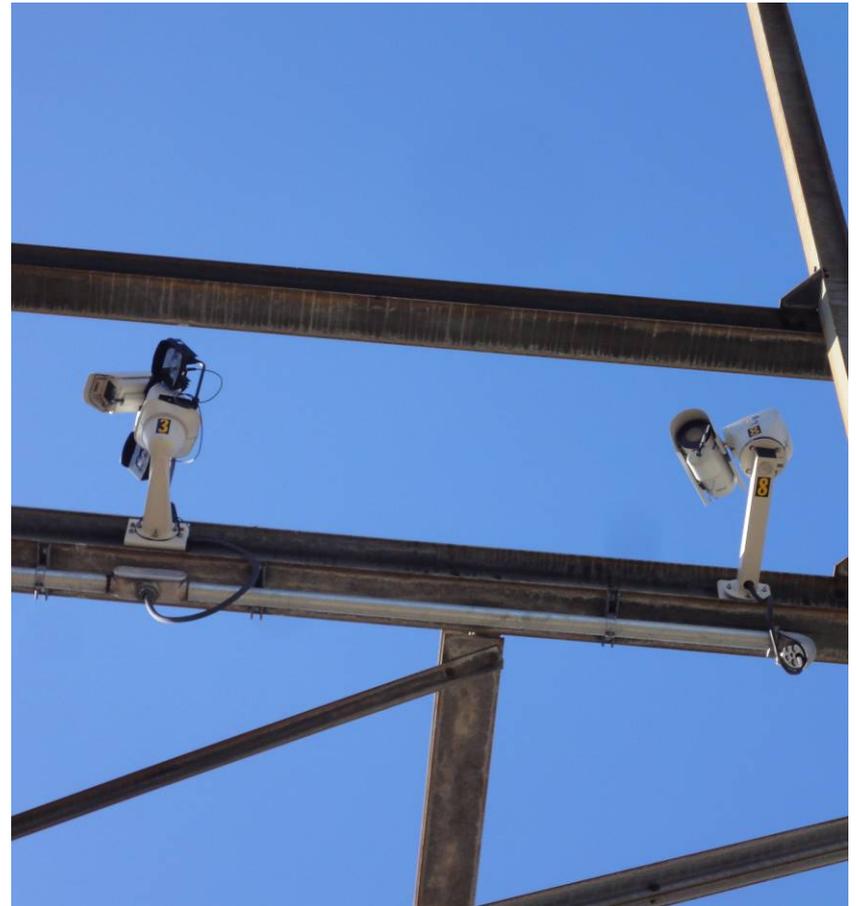
- Battery system critical to reliable operation
- Requires weekly, monthly and annual maintenance checks
- Monitoring system provides continuous monitoring for problems and could eliminate manual maintenance verification



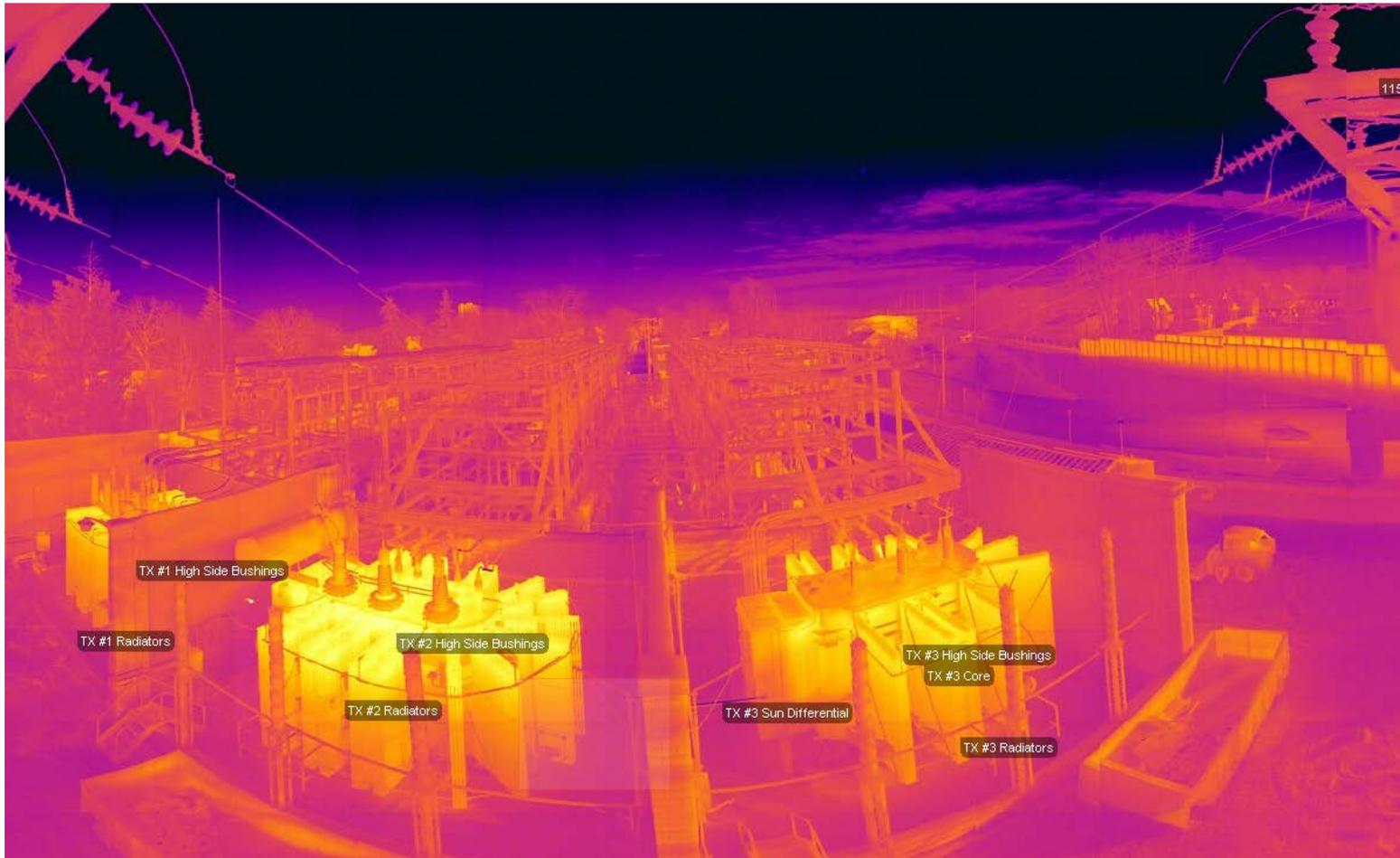
# *Features:*

## Thermal Imaging System

- Provides 360° thermal imaging from an elevated vantage point
- Allows temperature indication at specific image points to help locate “hot spots”
- Pan, Tilt and Zoom capability covers wide area of substation
- In 2011, the system helped provide information of a transformer bushing problem –



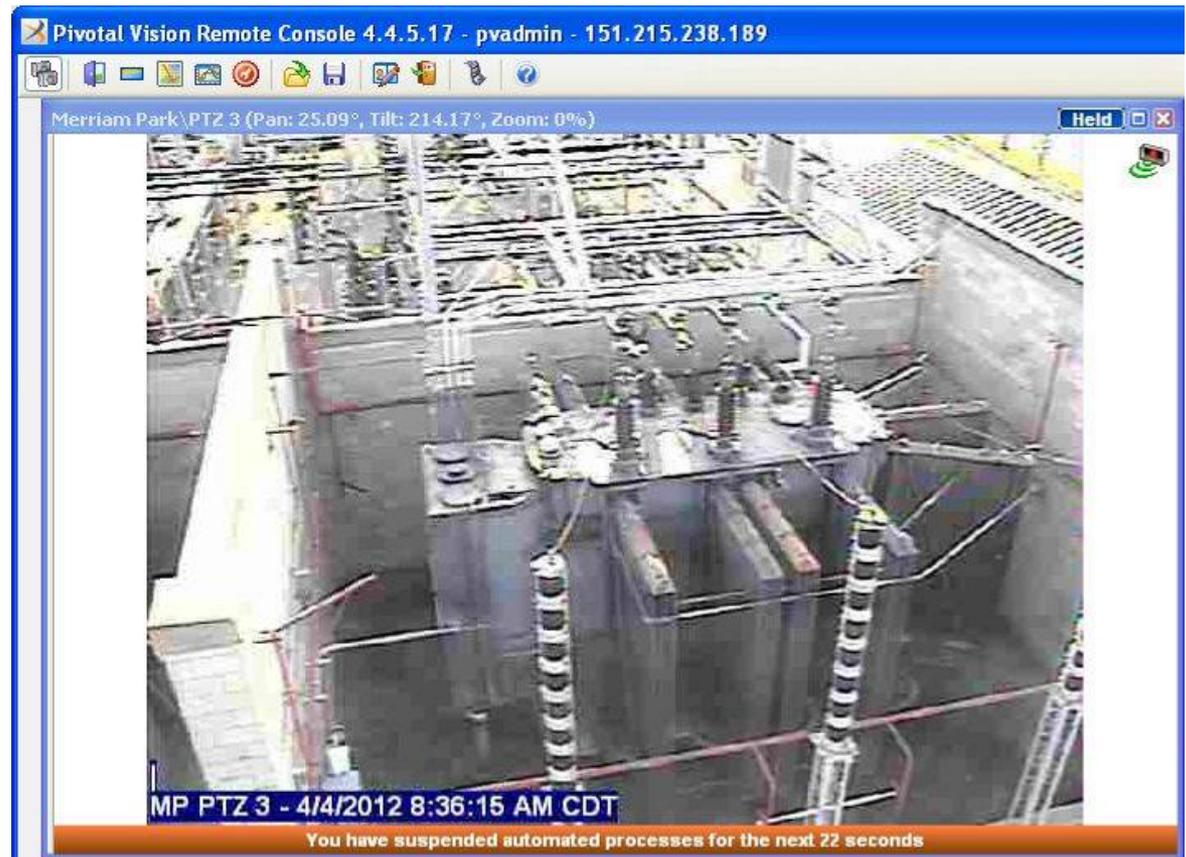
# Thermal Imaging in Practice

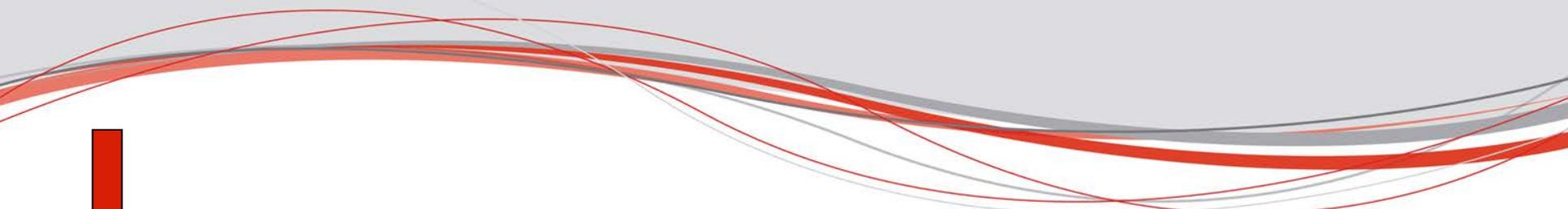


# *Features:*

## Optical Imaging System

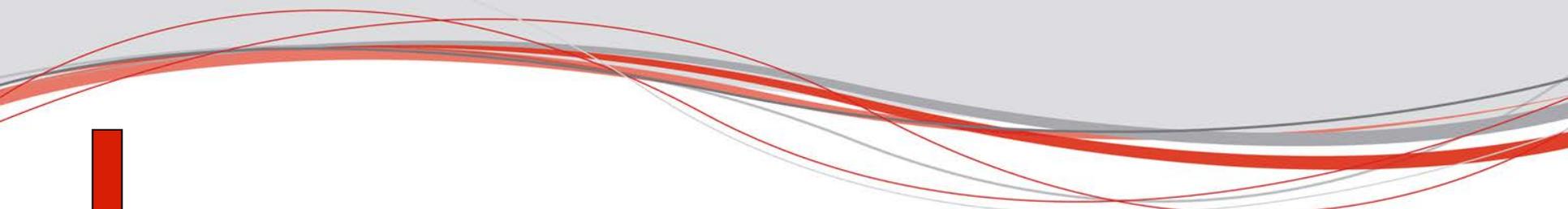
- Pan, Tilt, Zoom and fixed imaging systems
- Cameras process a “guard tour” to scan the site and are also motion-triggered
- Visibility for operators during or after electrical events
- Security for theft (aluminum, copper, etc.)
- System captured one late-night scrap copper theft on camera during construction period





# Smart Substation Future

- We continue to evaluate the cost-benefit of implementing additional monitoring technologies
- We will invest further in IEC-61850 technology when the manufacturing industry develops improved tools to develop, monitor and troubleshoot the system communications



# Lessons Learned

- Total capital investment costs for Merriam Park were on par with a traditional replacement project
- IEC61850 implementation was technologically challenging for engineers and technicians; ensure that vendors are truly experts in the technology
- As an early adopter, Xcel Energy necessarily developed expertise that also benefited the manufacturers

