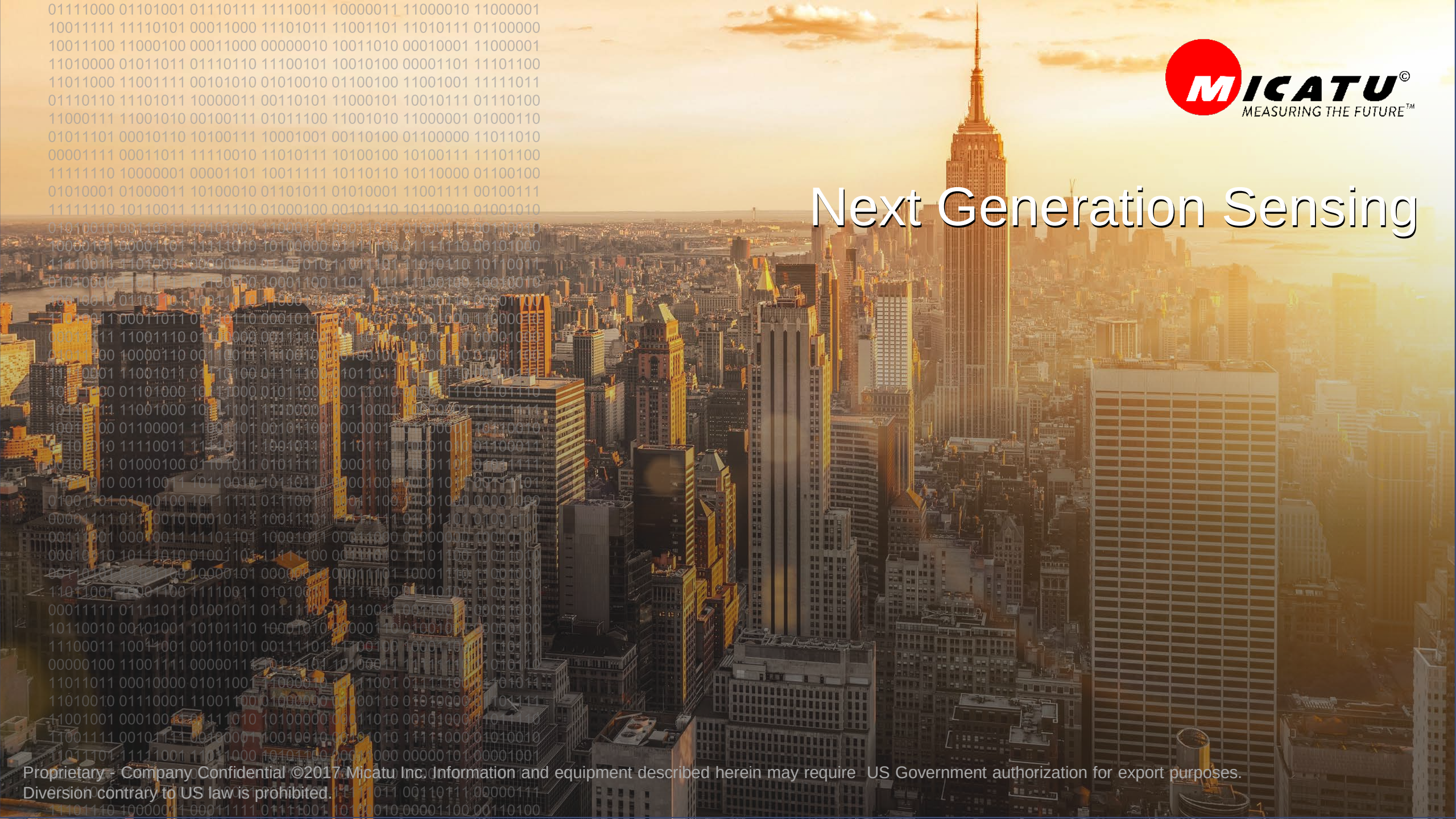


PROBLEMS UTILITIES ARE FACING

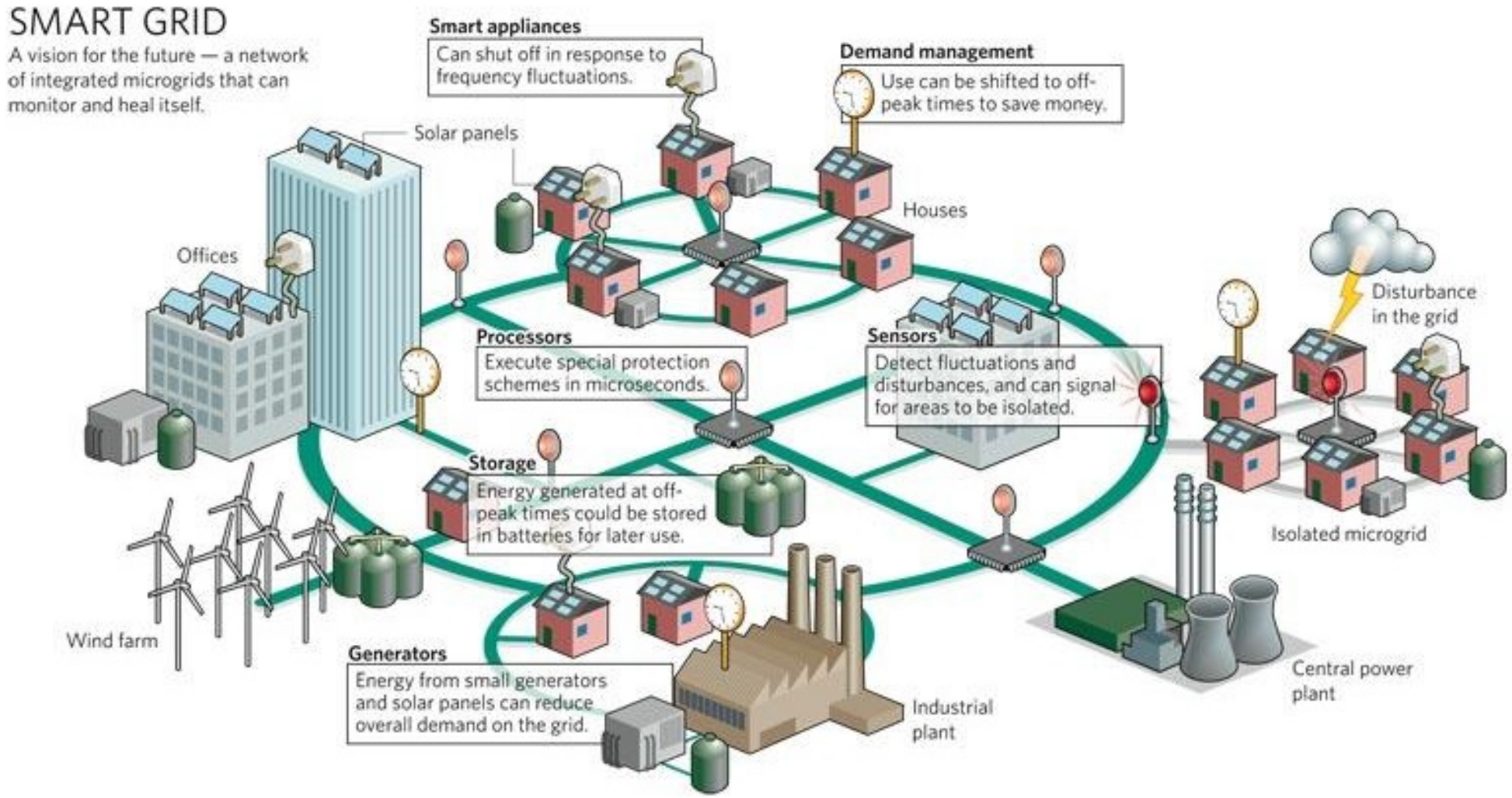
What are the opportunities for utilities?

Problem(s)	*Opportunities*
Utilities are facing a fundamental shift towards renewable energy sources, a changing business model & aging infrastructure.	20 years, $46B to $117B could be saved in the avoided cost of construction of power plants, transmission lines and substations
State legislation is driving US utility industry change, mandating renewable and distributed generation % of total electric generation	Increasing energy efficiency, renewable energy and distributed generation could save an estimated $36 billion annually by 2025
Utilities have started to reach the saturation point, i.e. They have to do something to meet demands.	Distributed generation can significantly reduce transmission congestion costs, currently estimated at $4.8 billion annually

ALL THESE PROBLEMS REQUIRES ADVANCES IN UTILITY OPERATIONAL AWARENESS

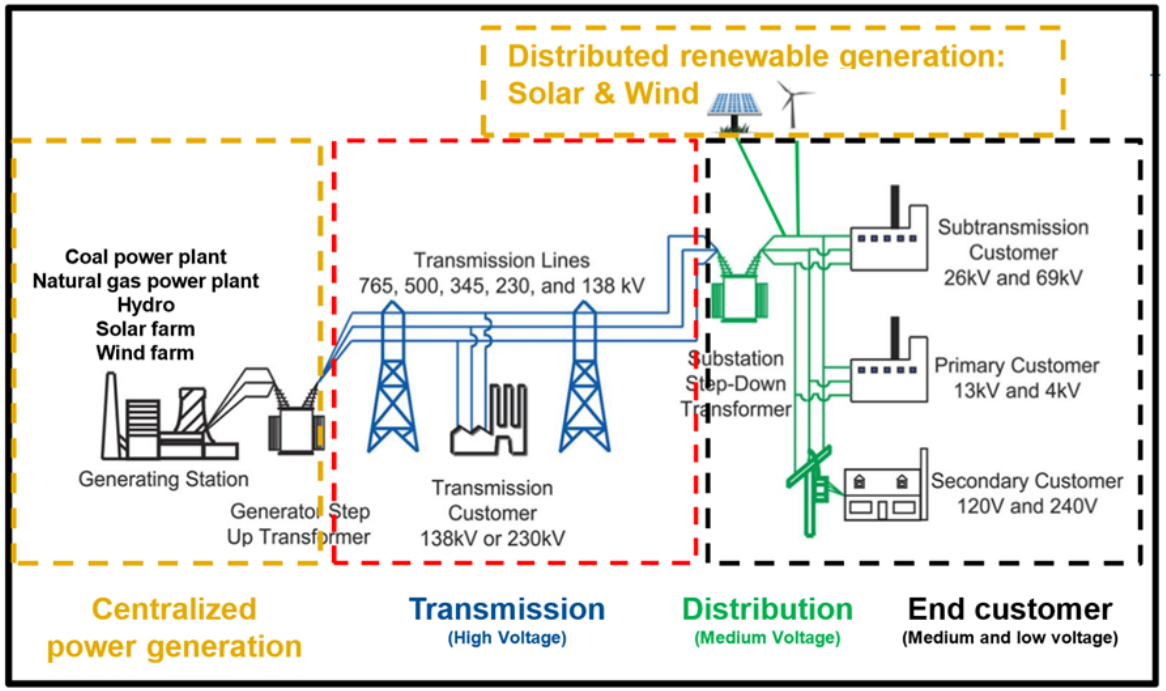
WHERE ARE UTILITIES HEADING

Fundamental change in the grid topology.



HOW IS THE MODEL CHANGING?

What is driving the utilities to invest?



Fully integrated and owned monopoly

Traditional business model

Any combination of:

Power generation supplier - competitive

Wires monopoly

End customer retail monopoly

Evolving business models

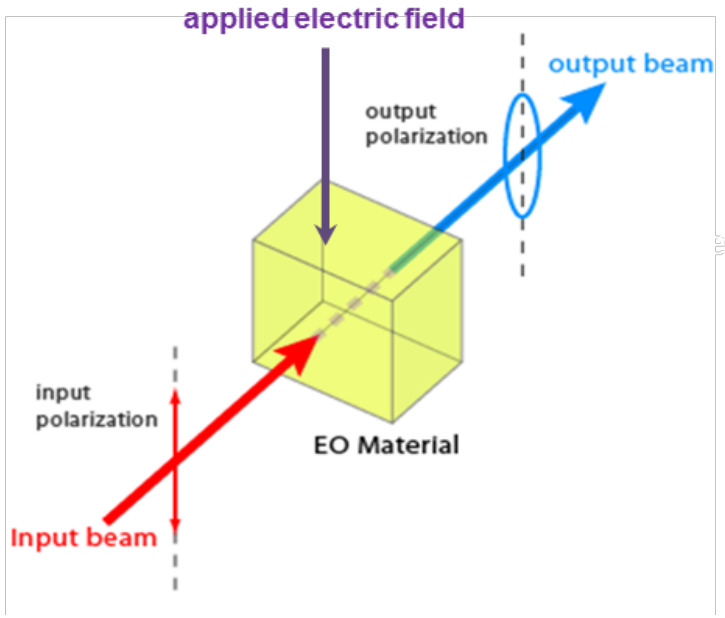
WHAT SOLUTIONS ARE UTILITIES SEEKING?

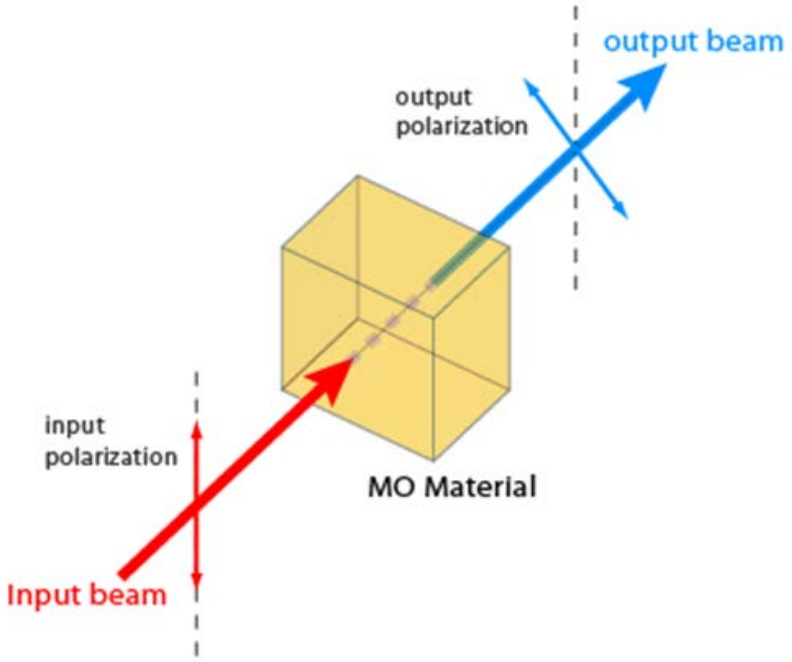
Where are sensing solutions needed?

Challenge	Required Solutions	Required Sensing			
Integrating Renewable Energy Sources	High Fidelity, Low Cost Monitoring of DER Interconnections	Voltage	Current		
IT/OT Integration, AI & IoT	Requires Digitization of the distribution & transmission grids	Voltage	Current	Temperature	Vibration
Equipment Monitoring	Retrofittable sensing solutions	Voltage	Current	Temperature	Vibration
Operations Security	Realtime monitoring of substations and transformer assists	Voltage	Current	Temperature	Vibration
Volts/VAR Implementation	Sensing with proven accuracy and precision	Voltage	Current		
Data Overload	At the "Grid Edge" AI & Analytics	Advanced "Data Collector" & RTU's			

OPTICAL SENSING

The Operating Principle





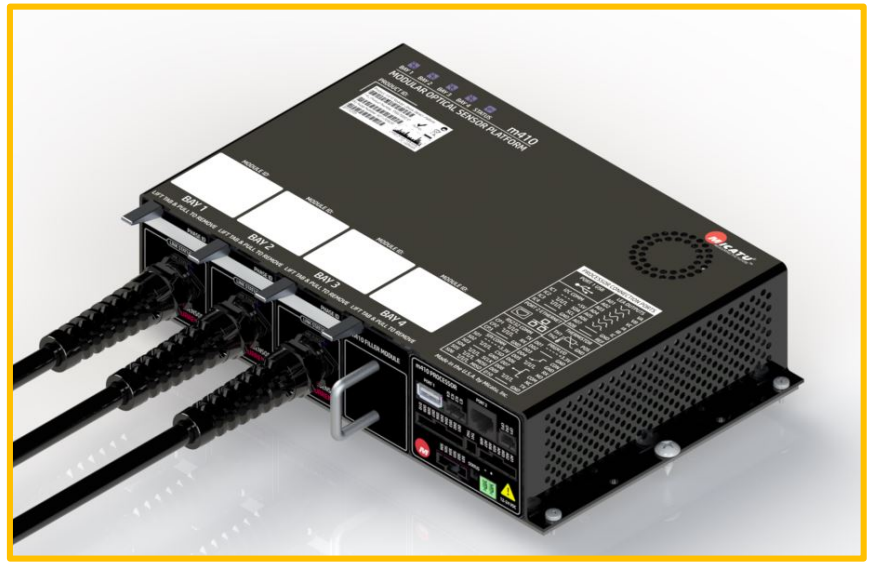
High Accuracy & Precision
± 0.5%

Large Dynamic Range
50th Harmonic, 40dB Response

Digital, Modular & Flexible
Plug & Play, Single SKU

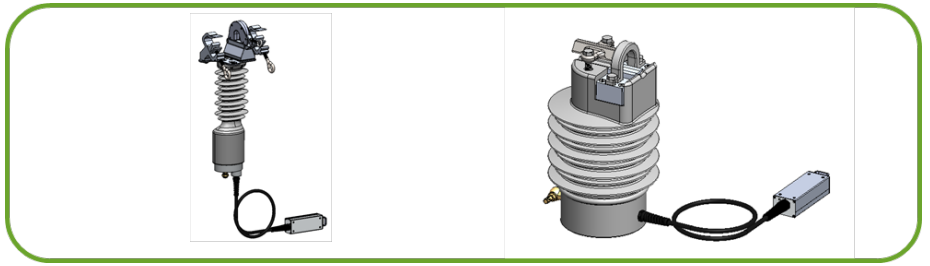
OPTICAL SENSING

Sensing Solutions Overview

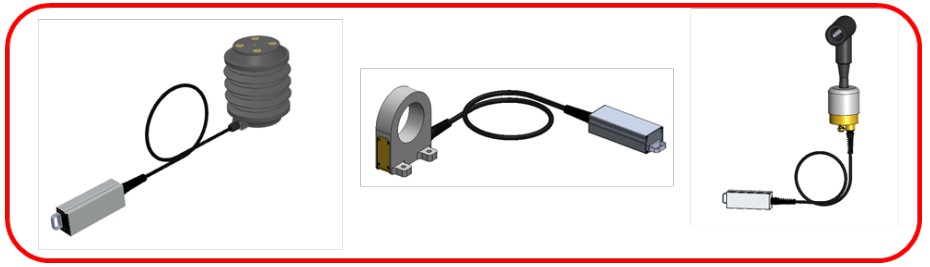


m410 Modular Optical Sensor Platform

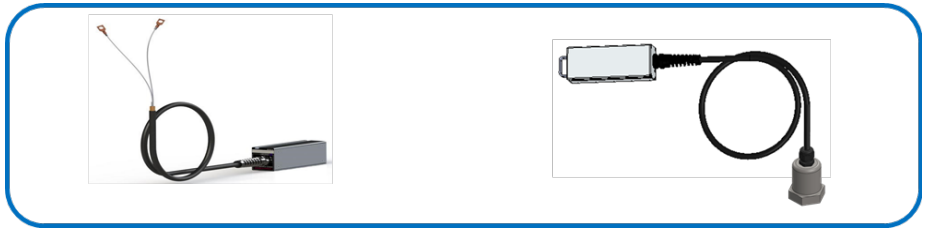
Aboveground Voltage & Current Sensors



Underground Voltage & Current Sensors

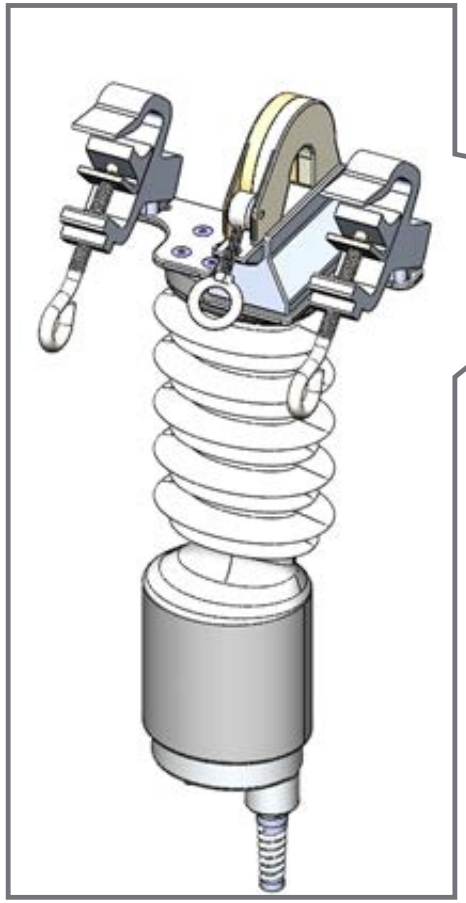


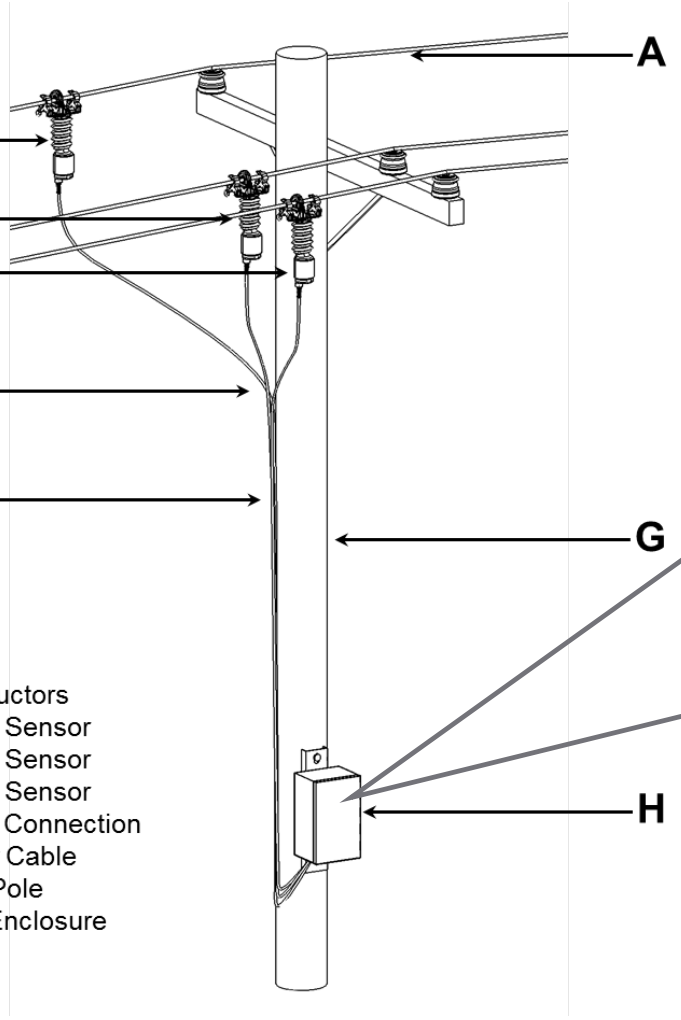
Temperature & Vibration Sensors



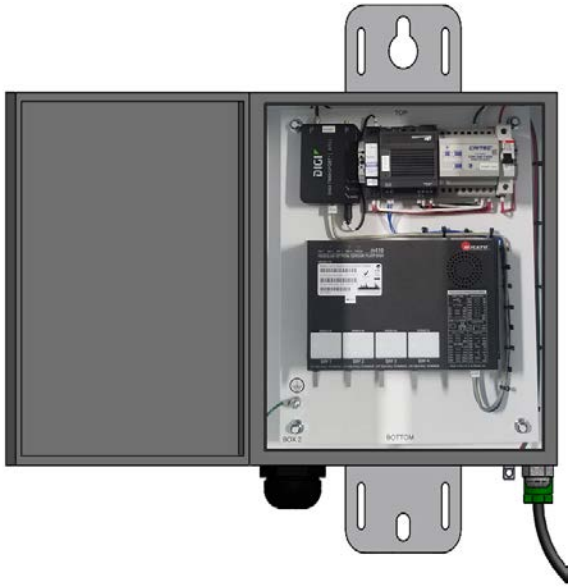
GRIDVIEW™ SYSTEM OVERVIEW

Typical Distribution System Installation





A. Power Conductors
B. Combination Sensor
C. Combination Sensor
D. Combination Sensor
E. Neutral Wire Connection
F. Optical Fiber Cable
G. Power Line Pole
H. Electronics Enclosure



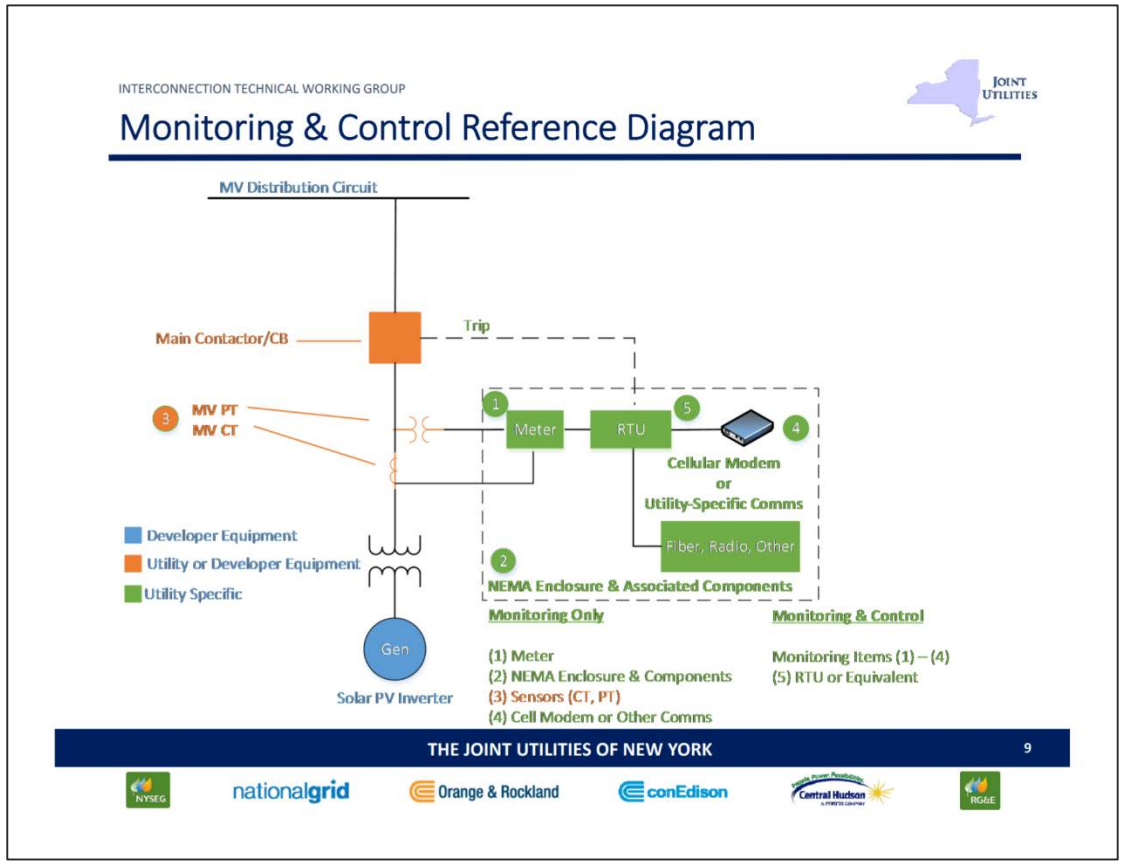
SENSING VALUE

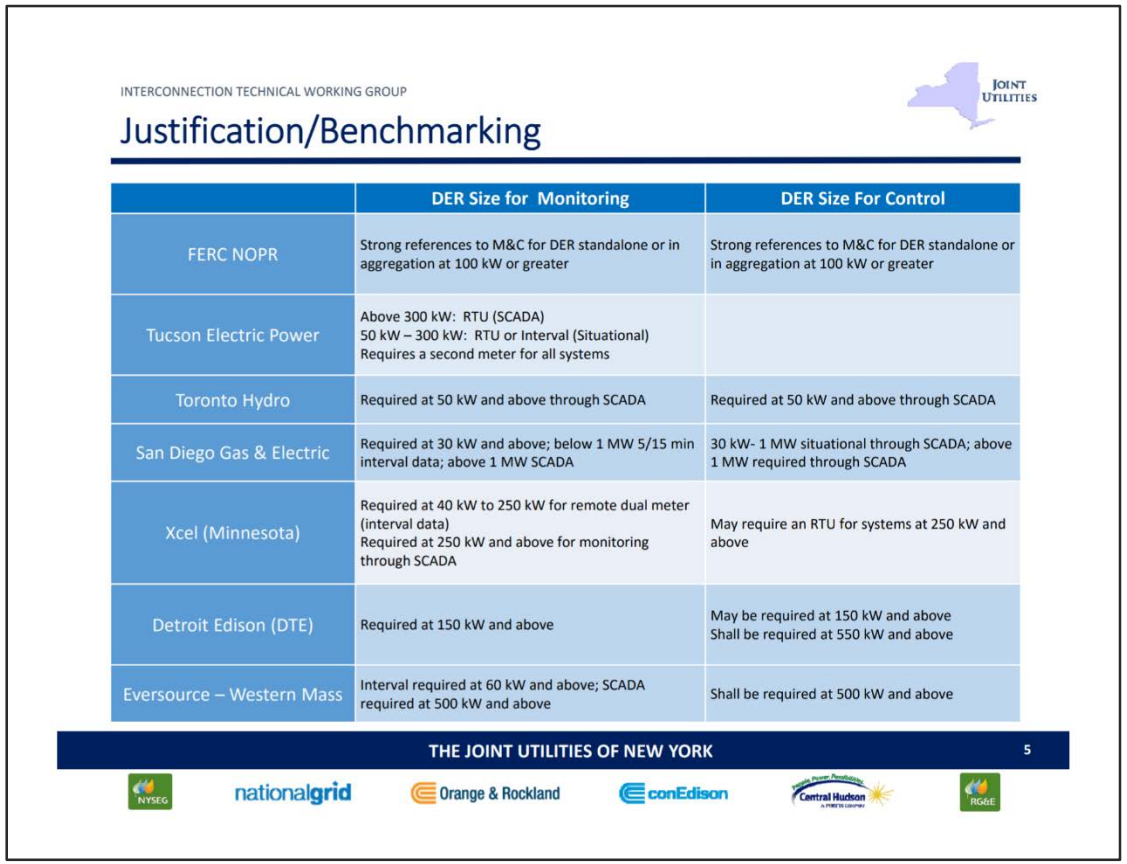
What are key performance metrics?

Customer Needs	Required Sensing
High Fidelity and Low Cost Monitoring	• 70% to 80% Reduction of installation costs • 30% Lower costs of ownership • Highest Performance available in the market • Standardization of all sensing applicatoins
Digitization of the distribution & transmission grids, Retrofittable sensing solution	• Conforms to IEC 61850 Data Communications Standards • Retrofittable and backwards compatible • Only Self-Provisional Sensor System
Realtime monitoring of substations and transformer assists	• Harmonic resolution • Electrical isolation • Tamper evident • Higher accuracy and dynamic range enable higher level of analysis
Sensing with proven accuracy and precision	• Third Party Certification of Performance • Meets all requirements for accuracy, dynamic range, precision
"Grid-Edge" AI & Analytics	• Software enabled AI & Analytics ready solution • Licensable features

OPTICAL SENSOR APPLICATIONS

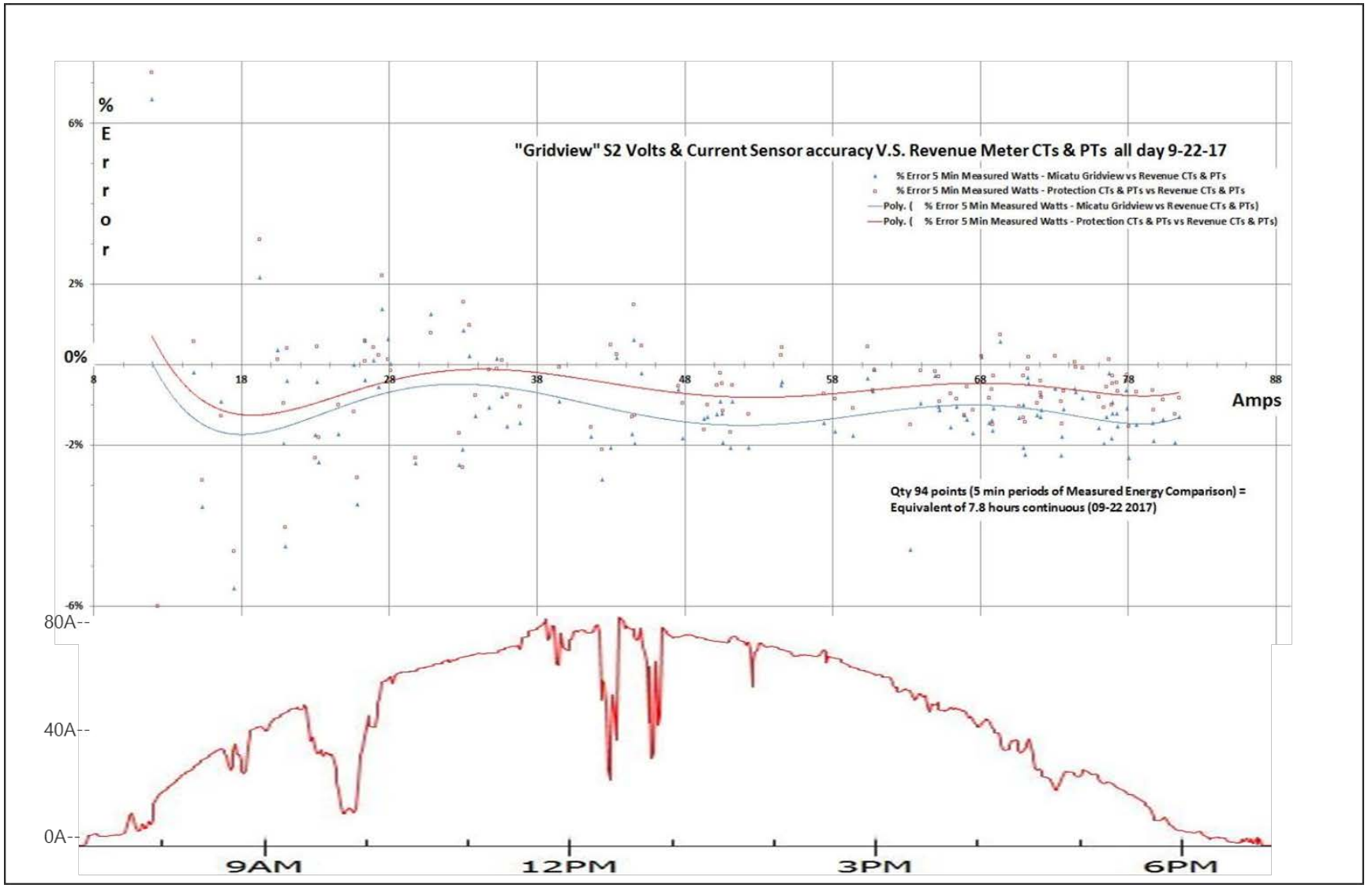
Facilitating Simplified DER Interconnection





	DER Size for Monitoring	DER Size For Control
FERC NOPR	Strong references to M&C for DER standalone or in aggregation at 100 kW or greater	Strong references to M&C for DER standalone or in aggregation at 100 kW or greater
Tucson Electric Power	Above 300 kW: RTU (SCADA) 50 kW – 300 kW: RTU or Interval (Situational) Requires a second meter for all systems	
Toronto Hydro	Required at 50 kW and above through SCADA	Required at 50 kW and above through SCADA
San Diego Gas & Electric	Required at 30 kW and above; below 1 MW 5/15 min interval data; above 1 MW SCADA	30 kW- 1 MW situational through SCADA; above 1 MW required through SCADA
Xcel (Minnesota)	Required at 40 kW to 250 kW for remote dual meter (interval data) Required at 250 kW and above for monitoring through SCADA	May require an RTU for systems at 250 kW and above
Detroit Edison (DTE)	Required at 150 kW and above	May be required at 150 kW and above Shall be required at 550 kW and above
Eversource – Western Mass	Interval required at 60 kW and above; SCADA required at 500 kW and above	Shall be required at 500 kW and above

On-site Test Data Results Example



OPTICAL SENSOR APPLICATIONS

Flexible DER Monitoring Solutions

OPTICAL SENSOR APPLICATIONS

Upgrade Tie Reclosers & Enable Power Quality Measurement

R&D Sensor Testing – Why do we need this?

Lindsey Voltage Sensors, NOVA Frame Mounted

Has 3 External Voltage, 3 Internal Voltage and 3 internal Current sensors

Very "busy" primary connections, even with 6 internal sensors

Performance/accuracy issues of many sensors

Many Tie Reclosers affected in production now (17 in Eastern alone)

3

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R&D Sensor Testing – Project Concept

IMPORTANT: R&D doesn't determine the application specific performance level required;

Simply to thoroughly test and document the performance

Next Generation Sensor Desired Attributes:

- Line suspended, no direct device/pole mounting (line post configuration for certain applications possible)
- Voltage and Current wave forms at 0-10VAC for pole meter connection. (local automation, SCADA use)
- Not fail over test period (will monitor for years), target +/-1% accuracy of Full Scale, but not a disqualifier for Distribution Automation use
- Sensor has factory calibration physically imbedded in attached chip; loads when plugged in
- Other DSIP driven programs to dictate required accuracy of Volts, Amps, Watts, VARs

4

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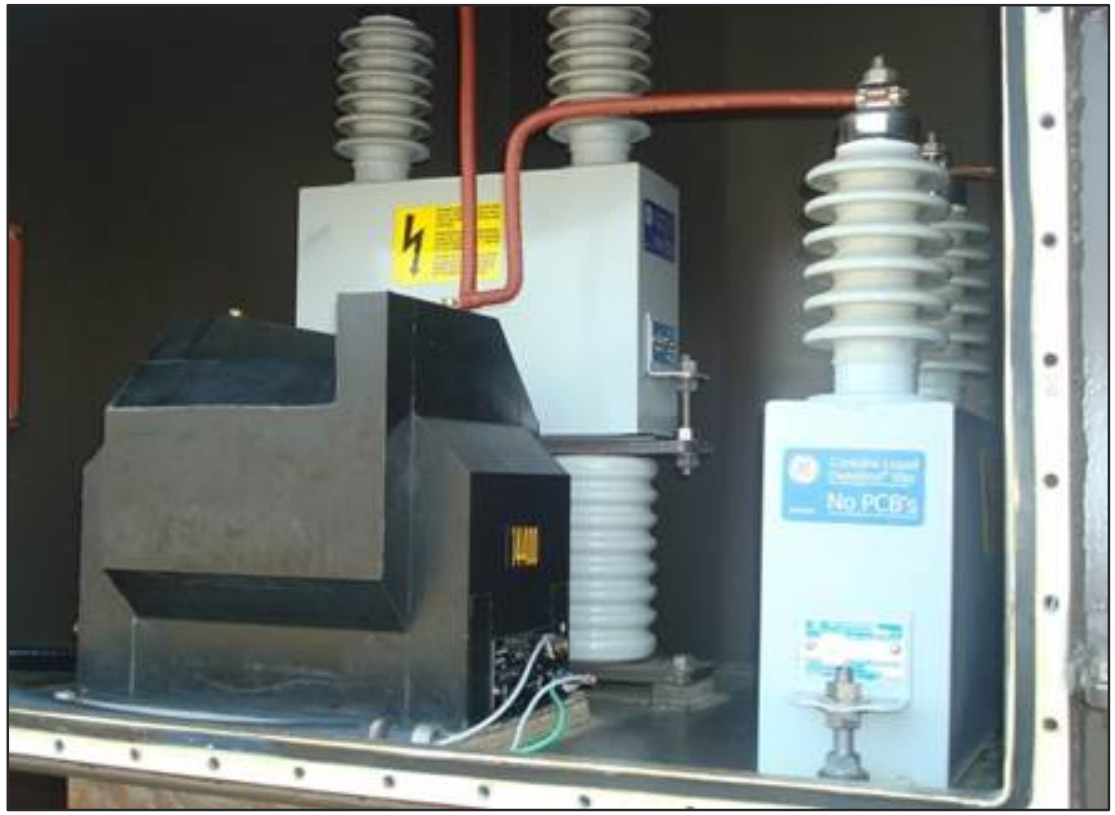
OPTICAL SENSOR APPLICATIONS

High Reliability Sensor Replacements



OPTICAL SENSOR APPLICATIONS

Underground Sensing & Groundless Sensing Solution

HOW DO WE WORK TOGETHER?

CONTACT US:

315 Daniel Zenker

202 IST Center,

Horseheads, NY 14845

+888-715-8836

marketing@micatu.com

www.micatu.com

Micatu GridView Rg235 Sensor