Advanced Sensor Development

GRID MODERNIZATION INITIATIVE
U.S. Department of Energy

Project Description

Focus on key challenges previously identified in industry roadmaps and DOE programs that are critical to increased visibility throughout the energy system. The project is organized around three major segments: end-use, transmission and distribution (T&D), and asset monitoring.

Expected Outcomes

End-use: (1) develop low-cost sensors, exploiting additive manufacturing techniques, to monitor the building environment and electrical characteristics of HVAC equipment, and (2) develop algorithms to use building-level data to provide utility-scale visibility of grid reliability and localized weather monitoring.

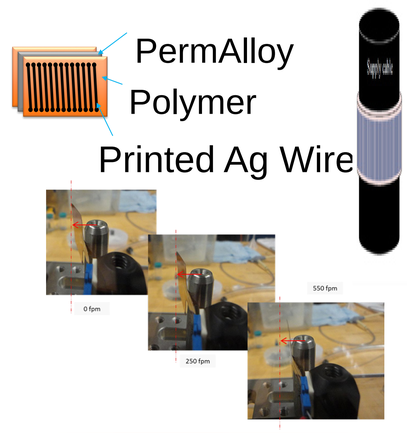
T&D: extend the resolution of transmission grid visibility orders of magnitude higher than current technologies. Focus is on dynamic response and data resolution as well as innovative ways to estimate electrical parameters from optical sources.

Asset Monitoring: sensing platforms with attributes that are best-suited for broad applicability across the entire grid asset monitoring application areas. Focus is on very low cost gas and current sensors for asset monitoring.

Significant Milestones	Date
(1) Draft requirements specification document. (2) Develop Ultra-PMU Algorithms for Transient Capture and Prediction, including adaptive zero-crossing algorithm and phase-locked loop algorithm. (3) Develop Optical CT/PT Integrated PMU Monitoring System: Tailor ORNL high-accuracy phasor and frequency measurement algorithms for optical CT/PT. (4) Develop CoFe electrodeposition process for integrated biasing magnets.	**11/30/2016**
(1) Draft specification of sensor development to measure airflow at an accuracy > 90% and current at >95% accuracy.	**2/28/2017**
(1) Document describing an algorithm to identify power outages based on Internet disconnects. Demonstrate >90% recognition accuracy of power outages based on real streams of Internet communications from typical homes. (2) Develop Ultra-PMU Algorithms for Transient Capture and Prediction: Experiment with adaptive window size for optimal performance. Ensure the algorithms be able to detect the transients in one cycle or less. (3) Validation of repeatable electrodeposition process which is capable of providing repeatable material stack of required thickness (variable thickness range for detecting currents in the 1A - 1000A range , while current state-of-the-art solutions detect currents on the order of 10A).	**5/31/17**
(1) Draft design document for physical and data-driven sensors incorporating functional and deployment requirements. The document will describe the sensor designs, in particular, airflow measurement at >90% accuracy, current at >95% accuracy, and outage detection >90% accuracy	**8/30/17**

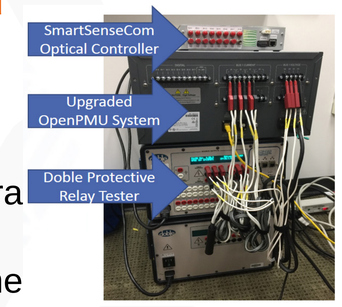
End-Use

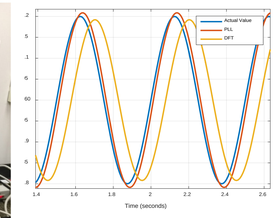
- A thin film low-cost sensor for improving building energy efficiency.
- Data-driven outage map in partnership with a network company.
- Open-source package in R for load shape estimation and forecasting

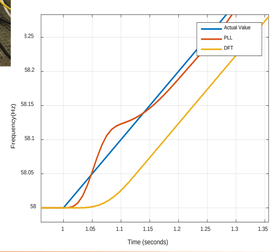


T&D: Ultra PMU and optical sensors

- Built PMU testing system.
- Developed multiple ultra fast PMU algorithms.
- Ultra fast response time of one cycle. (Compared to 6 cycles DFT algorithm)





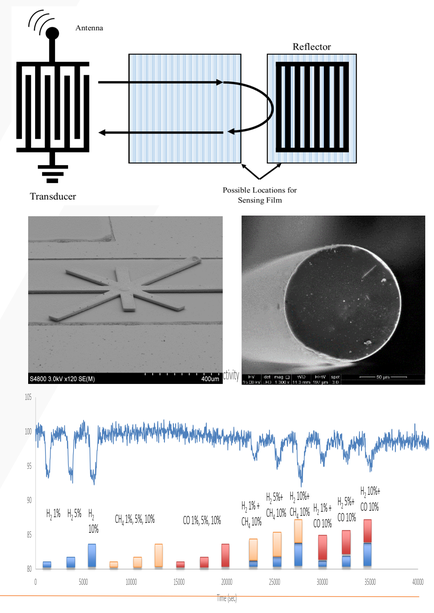


Asset Health Monitoring

Magneto-elastic sensor (MagSense): a first-of-its-kind ECD CoFe alloy with a high degree of magnetostriction.

Surface-Acoustic Wave (SAW) sensor: for methane detection. promising selectivity and sensitivity.

Nano-Enabled Optical Fiber sensor: for selective H2 chemical sensing. demonstrated temperature monitoring for transformer core.



Progress to Date

All milestones completed
3 Patent applications
3 Patent disclosures
2 Journal Papers under review

- Utilization of Optical Sensors for Phasor Measurements Units, IEEE Power Energy Society (PES) letter
- Clustering of Residential Load Patterns Based on an Improved Gravitational Search Algorithm, IEEE Transactions on Smart Grid