



Consideration of Adding AMI to Distribution Transformers

Prepared by John Kretzschmar, SAMSCO
Spartan Armstrong Metering Supply Company

*For North Carolina Electric Meter School
Management Session
Tuesday, June 14, 2022 at 8:45 am.*



Intra-Grid Sensors and ATI for Distribution Transformers

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What is an Intra-Grid Sensor?

A sensor used to provide detailed information about conditions that exist between the distribution transformer and the meter.



Why do we need Intra-Grid Sensors?

We are now stressing grid assets with increased unplanned burden and never previously conceived pressures.

Yet operators are still without comprehensive data that will accurately reveal the intra-grid dynamics created by these changes.



Distributed Energy Resources (DER)

Through solar and wind renewables, we are introducing Reverse Energy onto the distribution grids.

The millions of existing transformers were not designed to handle this impact.

While renewables are beneficial, Reverse Energy can produce unstable, and unsafe grid conditions.



Distributed Energy Resources (DER)

Intra-grid sensors accurately measure and report Reverse Energy, and its impacts on the grid.

Utilities without AMI, or “smart meters” need intra-grid sensors to understand the Reverse Energy impacts inside their grid.

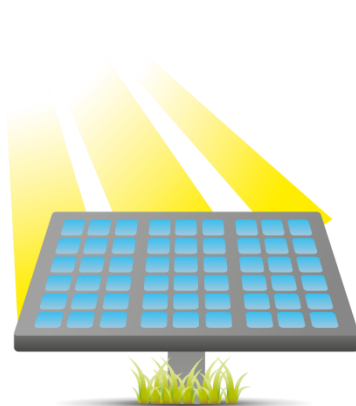
Utilities with AMI need intra-grid sensors to understand Reverse Energy impacts on transformers.



Distributed Energy Resources (DER)

The reality is that AMI generated Reverse Energy data does not accurately indicate impacts on transformers or the resulting grid impacts.

AMI data is typically not accurately aligned to the upstream transformers due to pervasive GIS mapping errors, thus causing aggregated AMI data to be unreliable.



Distributed Energy Resources (DER)

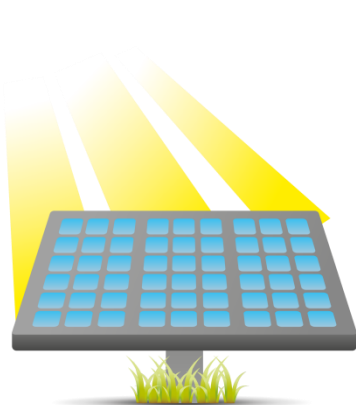
Even though utilities are pre-notified of Distributed Energy Resources installations, operators are still uncertain of potentially serious and/or dangerous impacts on upstream assets since AMI intra-grid data is unreliable.



Reverse Energy

Reverse Energy creates new instances of unknown and unplanned voltage fluctuations/conditions. This contributes to potentially unstable and unsafe grid conditions.

Safety for the public at-large is key, but so too is the safety of utility linemen who are increasingly at risk due to the unanticipated voltage levels being created by Distributed Energy Resources (DER).



Reverse Energy

AMI-deployed utilities might think they know Reverse Energy impacts, the truth is they typically do not possess accurate AMI-to-transformer information.

This can leave linemen in a position of not knowing what to expect when they approach DER-active transformers.



Electric Vehicles

Electric Vehicle charging stations create a new, unplanned load on transformers. Each charging station has the capability of adding up to one additional home worth of power load on a transformer.

This unplanned loading impacts transformers and may exceed a transformer's designed capacity causing major problems.



Illegal Marijuana Production

Illegal marijuana grow houses commonly steal significant levels of power from the grid.

Theft occurs simply by tapping power lines in front of the meters.

No endpoint meter (including AMI smart meters) can effectively detect pre-meter power theft.

This means thieves steal as much power as they want, and they steal it indefinitely without fear of detection.



Legalized Marijuana

When jurisdictions legalize marijuana, significant unplanned loading hits the respective transformers and the grid.

Legalization permits, in some ways encourages residents to grow marijuana using power-intense hydroponic resources. This unanticipated reality then causes additional strain on the existing transformers and the grid.



Aging Assets

According to the US Department of Energy, the average age of existing distribution grid transformer is presently in the range of 38-42 years.

The average projected life span of transformers is typically 40 years so many transformers are nearing or have already eclipsed their intended life span, yet we demand more performance, reliability, and various unintended service capabilities.



Aging Assets

Intra-grid sensors proactively reveal over-burdened and failing transformer assets allowing operators to effectively enable preventive maintenance efforts.

This approach enables operators to transition away from costly and disruptive, reactive grid management practices.



Power Theft

Despite significant Smart Meter penetration, power theft is a perpetual problem. Industry experts suggest that U.S. power theft is in excess of \$6 Billion per year.

The locations of power theft is typically a mystery. If the affected overburdened transformers finally fail, utility operators then learn where the theft is occurring.



Power Theft

Smart Meters claim to lessen power theft but the reality is that power theft has increased.

Thieves have discovered that since utility personnel are no longer coming onto their property, they can tap power lines ahead of the meter and the diversion will go undetected indefinitely.



Meter Programming Issues

An incorrectly programmed meter can result in significant errors.

For example: a meter programmed for a 200:5 transformer but has a 400:5 transformer will significantly misreport usage.



What are system losses?

Energy generated by Power Station does not match energy distributed to the consumers.

The difference between generated and distributed energy is known as Transmission and Distribution loss; aka system loss.

System loss is the energy that is generated but not paid for by users.



Line Loss

According to US Energy Information Administration reports, nearly 200 Billion unmetered kWh's are 'leaked' from US distribution grids annually.

This loss represents nearly \$21 Billion that was unmetered but was amortized as electricity cost across US rate payer's bills.

All of this while our government, utilities, and rate payers have been investing billions of dollars in 'smart meters', and other energy efficiency efforts.



Line Loss

- Electricity is '*leaking*' from within the US distribution grid in front of the AMI/AMR meters at costly levels.
- To a large extent, electricity providers have been unable to accurately identify where power leaks have been occurring within the grid.
- Intra-grid power loss is substantial and is occurring daily.

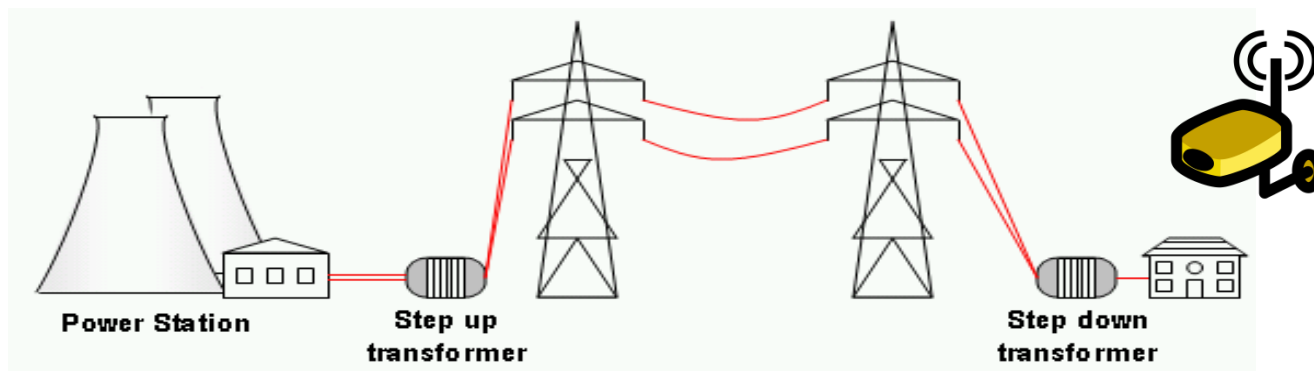


Line Loss

Electric distribution grids do not have adequate sensor technology and analytic capabilities to allow operators to directly reduce system losses.

As a result, a blind spot exists between the substation SCADA and the AMI meter.

Intra-Grid Sensors can provide visibility into this critical area.



The Next Step in Grid Modernization

Advanced Transformer Infrastructure (ATI)

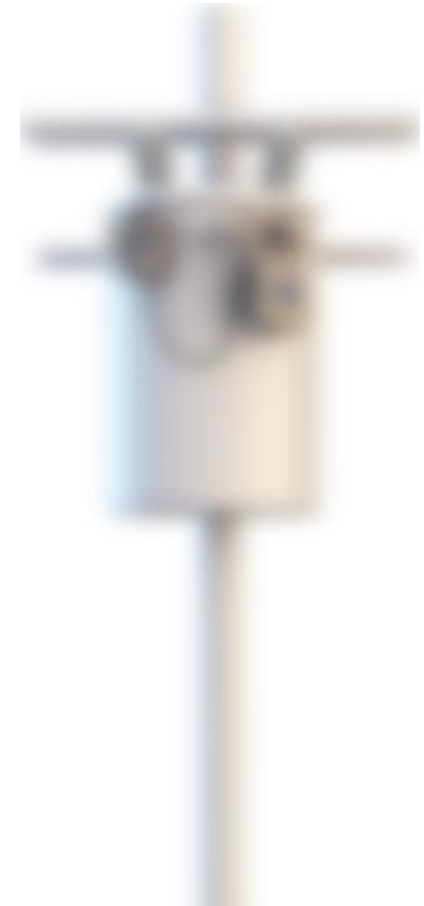
Reliability Improvements

DER & EV Integration

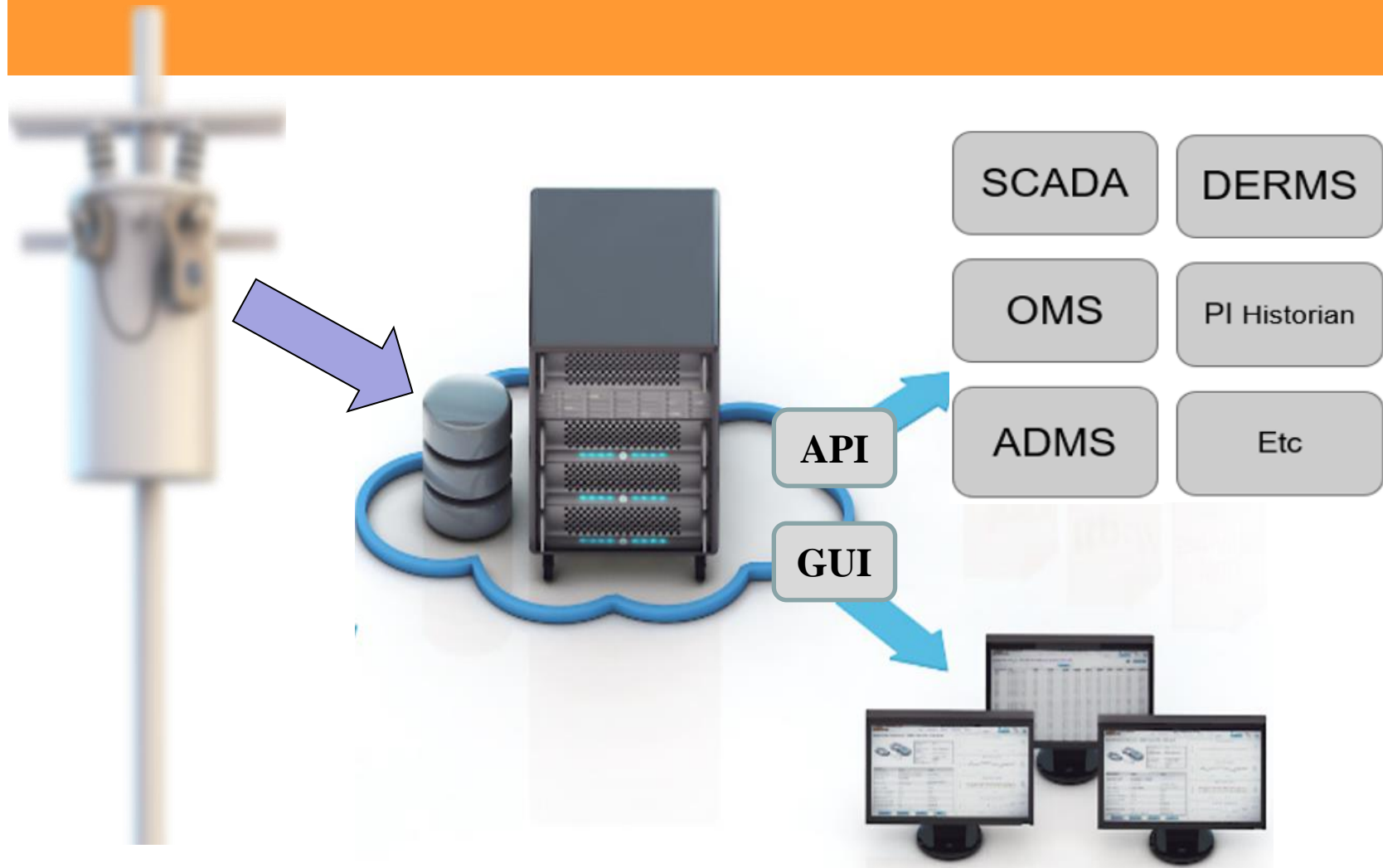
Fire Mitigation

Outage Notification

Voltage Optimization



Advanced Transformer Infrastructure



Advanced Transformer Infrastructure

Critical DATA:

unique

TIMELY

Granular

Accurate

RELIABLE

Data points (per phase where applicable)



Energy

Delivered Total Active Energy [KWh]
Received Total Active Energy [KWh]
Delivered Total Apparent Energy [KVAh]
Received Total Apparent Energy [KVAh]
Delivered Interval Active
Received Interval Active
Delivered Interval
Received Interval
Delivered Interval
Received Interval
Delivered Interval
Received Interval
Delivered Interval
Received Interval

RMS Voltage

Instantaneous [V]
Maximum per interval [V]
Minimum per interval [V]
Average per interval [V]
Standard Deviation [V]

Automated Alerts
&
Outage
Notifications

Temperature [°C]

Wireless Cellular Signal RSSI

Outage Notification

Power Factor

Phase Angle

Advanced Transformer Infrastructure

ATI Data Value: HECO User Groups

ATI Head-End



GUI

Graphical User Interface

API

Application Programming Interface

Presently Available API Calls:

1. Transformer Asset Information
2. Transformer Historic Data
3. Outage Notification Data
4. Active Alerts Data
5. Critical Alerts Data



**Hawaiian
Electric**

1. Operations Planning
2. Customer Service – small accounts
3. Customer Service – large accounts
4. Systems Operations
5. Asset Management
6. Distribution Planning
7. T&D Engineering
8. Primary Trouble Calls
9. Standards & Conceptual Engineering



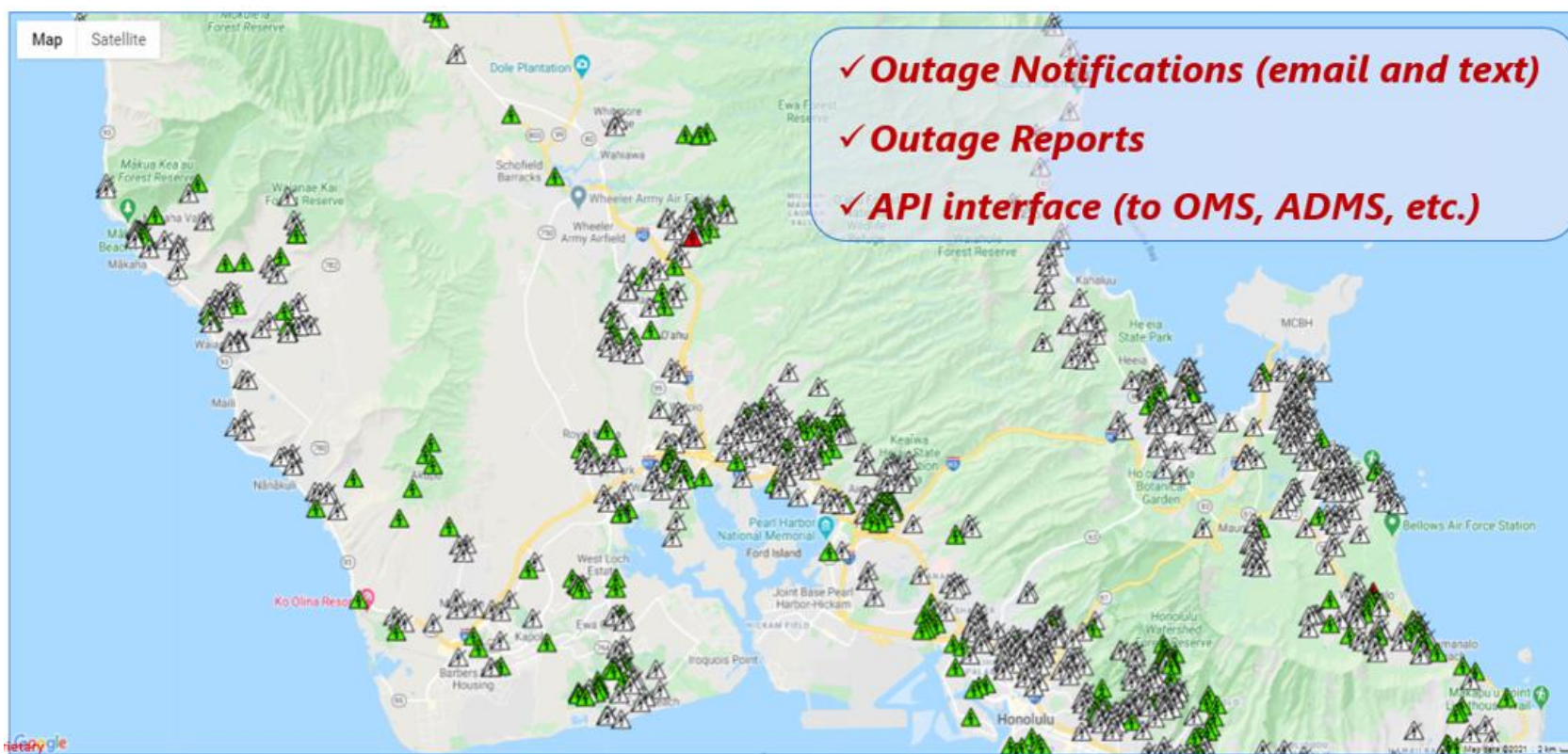
Advanced Transformer Infrastructure

ATI Data:



**Hawaiian
Electric**

Outage Notification



Advanced Transformer Infrastructure

Forward & Reverse Energy Impacts

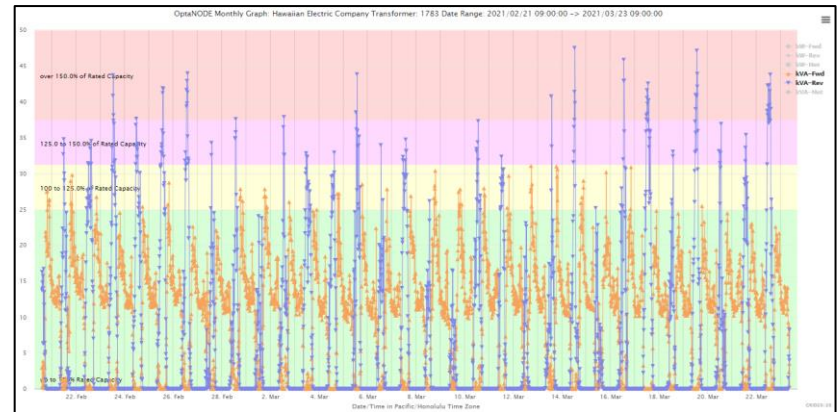
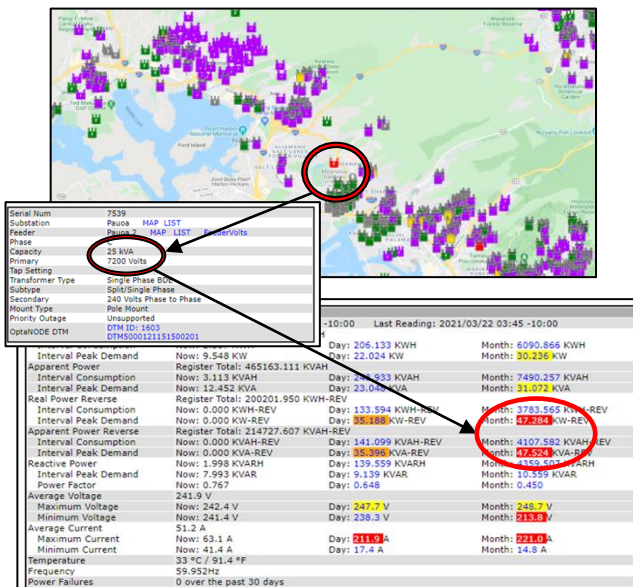
The combination of excessive Delivered & Received Energy can cause Transformer Overload and Premature Failure (i.e., accelerated End of Life & potential Asset Fires)

ATI Systems can also deliver:

Transformer Overload Awareness = Preventive Intervention

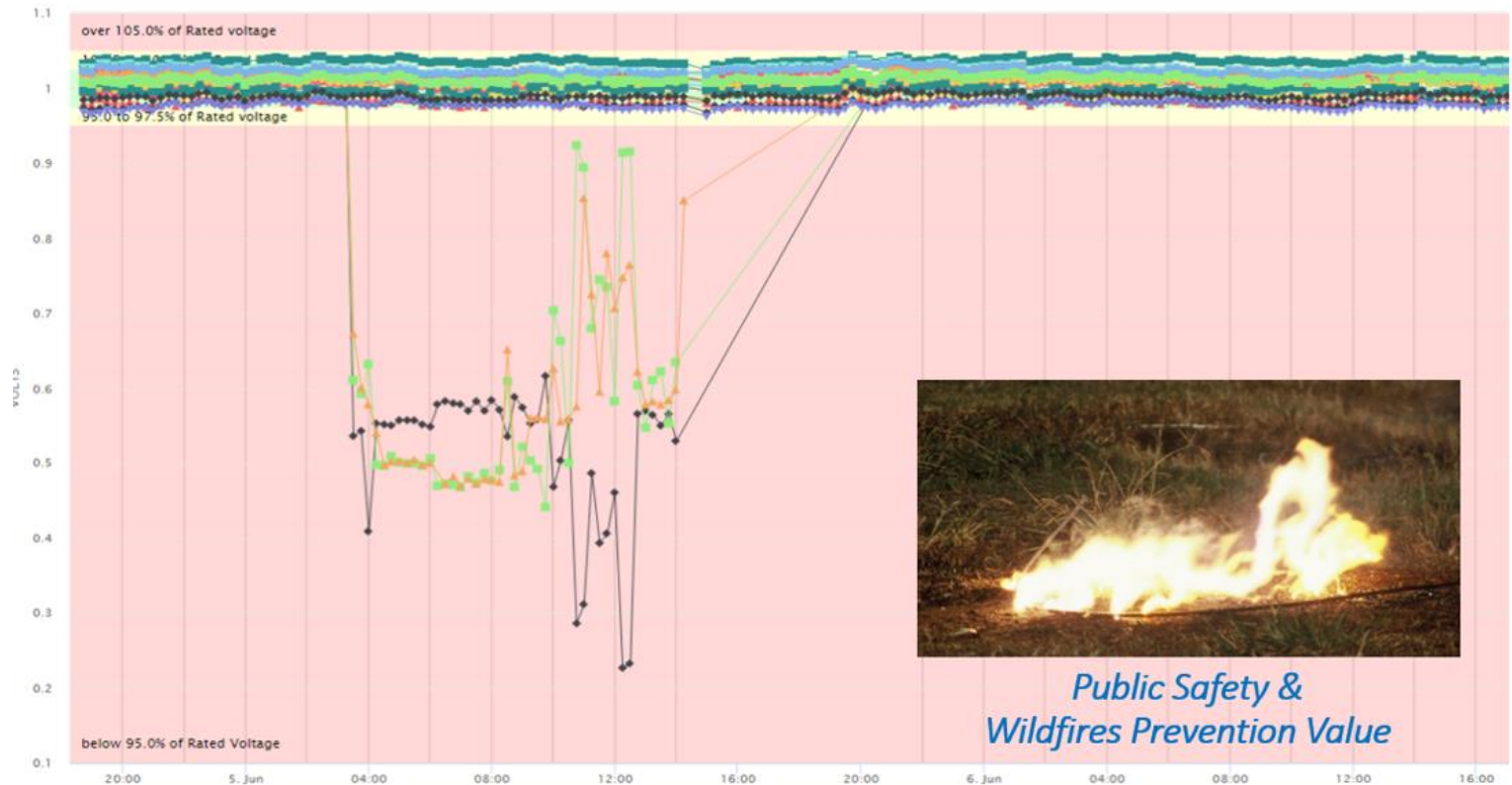
Asset Fires/Wildfires Prevention = Reduces Liability Risk

Improved Lineman & Public Safety = Reduces Liability Risk

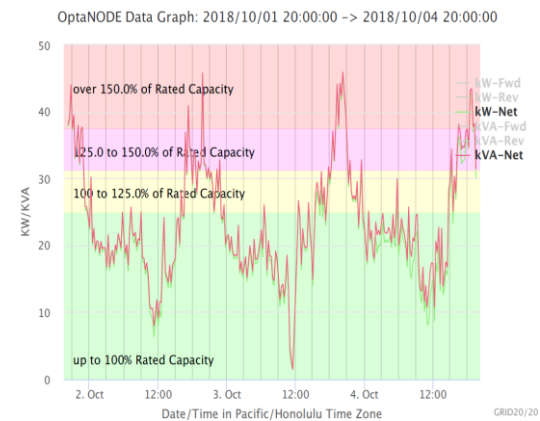
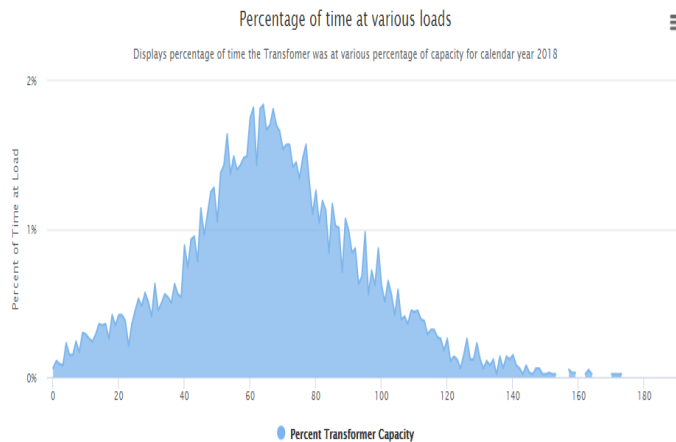
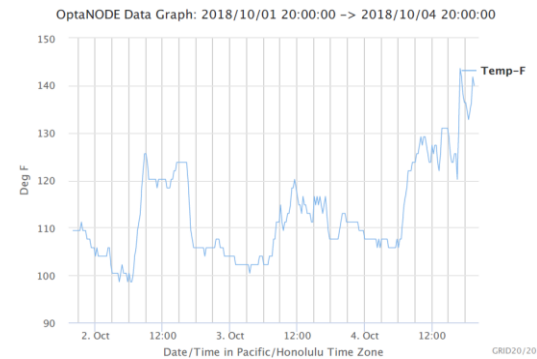
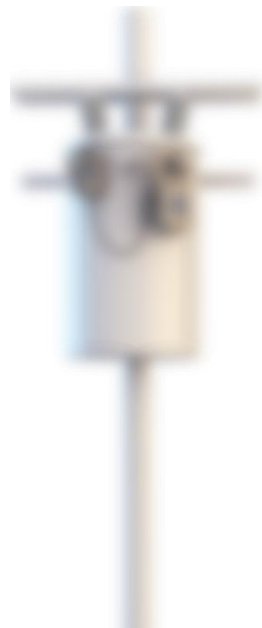


Advanced Transformer Infrastructure

Primary-side **Downed Conductor Detection**



Advanced Transformer Infrastructure



Advanced Transformer Infrastructure



- *Achieve Reliability Improvement**
- *Provide Outage Notifications to Accelerate Restoration**
- *Reveal Unplanned Loading/Overloading**
- *Facilitate Improved Fire/Wildfire Mitigation**
- *Identify Downed Conductor Events**
- *Proactively Identify Failing Assets**
- *Reveal DER-Induced Voltage Fluctuations**
- *Reveal & Document Reverse Energy Entering the Grid**
- *Facilitate Conservation Voltage Reduction**
- *Identify Power Theft, Meter Inaccuracies & Bad Multipliers**
- *Facilitate Safe EV Charging Station & DER Adoption**
- *Identify Improper Tap Settings**

Advanced Transformer Infrastructure

- *Identify Harmful Phase Imbalances**
- *Identify Energy Inefficiencies**
- *Assist with Clean Energy/Battery Storage Planning**
- *Reveal GIS Mapping Errors**
- *Provide Automated Alerts = Hands Free Remote Grid Monitoring**
- *Support API Calls**
- *Enhance Microgrids Monitoring**
- *Facilitate Clean Energy Mandates = Reduce GHG Emissions**
- *Reduce Corporate Liability Risk**



Questions?



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