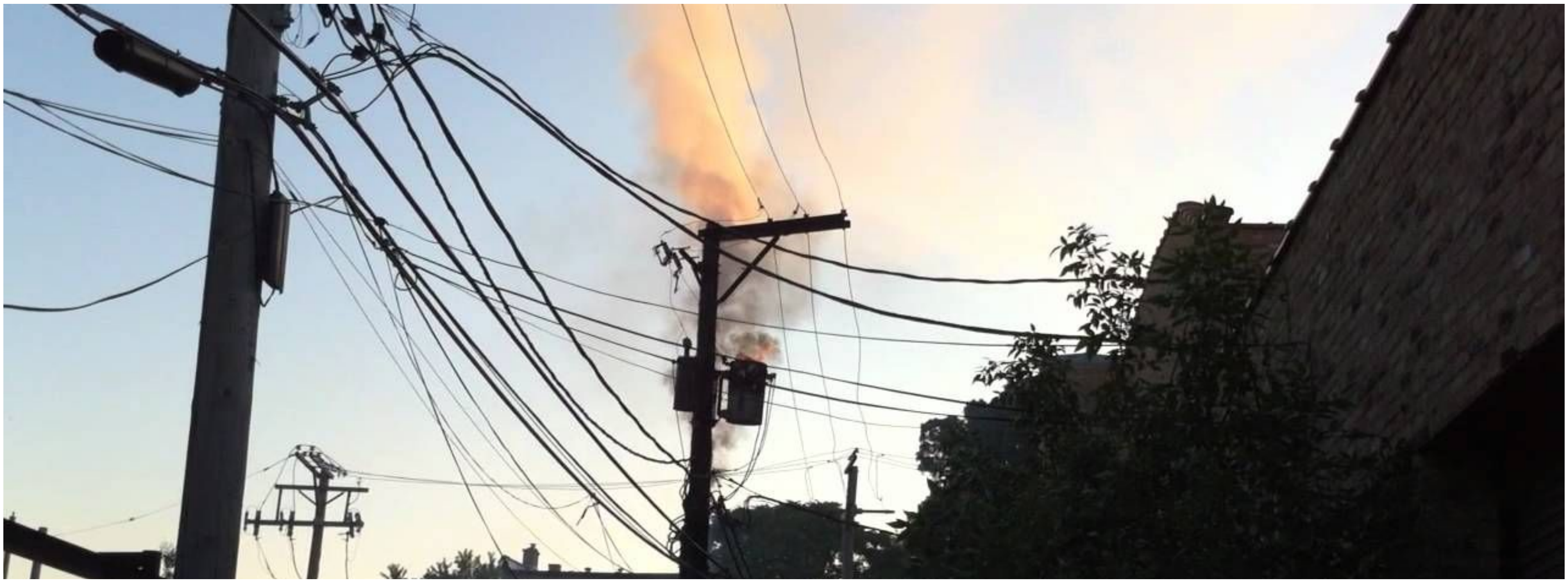
White Paper



# Reliability and Fire Risk

GRID20/20®
Optimize Energy Efficiency

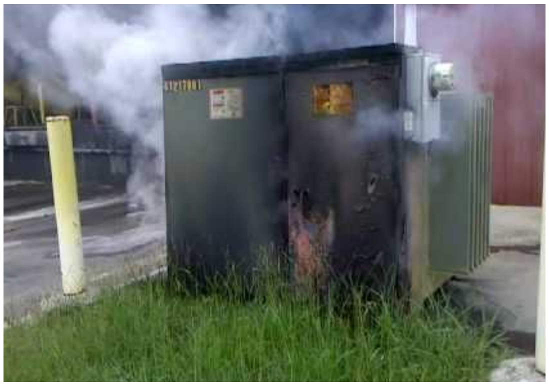
*August 2018*

# Grid-edge Reliability Challenges and Fire Risk… Go Hand in Hand

The US has experienced instances of catastrophic fire damage created by failed electricity assets.

The US utility operators have performed deliberate brown-outs, and black-outs to protect grid reliability during periods of significant energy demand, leaving customers temporarily in the dark.

Today's distribution grids are being taxed by ever-increasing, unplanned grid-edge challenges.



While Advanced Metering Infrastructure (AMI) presents a valuable role in the smart grid evolution, it has been expected to perform beyond its capability. Prior to the emergence of intra-grid sensors, operators had no source of intra-grid information other than what AMI inaccurately produced. But, as time has passed, the real limitations of AMI have surfaced. Simultaneously, the release of pioneering intra-grid sensor technology has entered the marketplace thereby presenting a viable solution for accurate intra-grid management. When coupled with AMI, intra-grid sensors yield a genuine smart grid. When coupled with Artificial Intelligence, grid control exponentially increases.

But first, we need to face some sobering facts concerning the progression of ongoing, accelerating, compounding "advancements" now occurring within our distribution grids. Quietly, but undeniably, there is a rapidly increasing risk of grid asset-related fires. It's time that all stakeholders take notice, and take action to avoid substantial grid Reliability degradation.

## Reliability Challenges = Escalated Fire Risk

Reliability, or the measure of how consistently electricity operators deliver power to customers, is a key metric. Regulators have legally ensured that utility operators are required to provide a minimum level of Reliability performance (i.e., SAIDI, SAIFI, etc.). In essence, operators are held accountable to meet electricity delivery performance standards. Or, operators face potential penalties for malperformance.

To this end, power outages are monitored for both "frequency" of occurrence (i.e., SAIFI), and also for the "duration" of occurrence (i.e., SAIDI). Operators must minimize the frequency of permitted outages within their grid, and they must similarly minimize the duration of each outage. If operators fall below these legal requirements, they are subject not only to penalty, but also to painful press coverage, and unhappy customers. The larger and/or longer the outage, the worse the situation.

It is clear that Reliability is a very important focus for operators. Not only do they risk undesirable optics among stakeholders, but they also lose revenue when outages occur. Operators lose revenue by not distributing energy to meters during the outages. Whenever power outages occur, the public and industrial/commercial sectors pay their own costly price; via the loss of perishables, economic downtime, lack of lighting/heating/cooling, nearby traffic and street light outages, and a host of additional safety and comfort-related impositions.  Every power outage causes painful negative impacts to everyone.  Very simply, electricity is a crucial element of our daily existence.

Throughout recent years, the electricity industry has witnessed an accelerated rate of technology advancement occurring at the grid-edge. These grid-edge developments have been quietly aggregating. However, the compounding impacts of these various grid-edge "advancements" are continuously setting the stage for serious increased Reliability challenges, or worse.

*Increased fire risk is growing due to a series of problems that are collectively presenting an unplanned, never-conceived burden on the most vulnerable asset class within the distribution grid.*

## Problem #1

### Electric Vehicles (EVs)

Greenhouse Gas (GHG) emissions reduction is an ongoing desire. The increasing commitment by governments to 'electrify' roadway systems is designed to perpetuate EV adoption. While this may yield positive improvements for our environment, the fact is that most EVs require an EV charging station to be installed at the owner's residence. Every EV charging station represents an unplanned load on the respective transformer serving the owner's home. Each EV charging station commonly introduces the equivalent of 1 home up to 2.5 homes of unplanned loading demand on a transformer. When multiple EV owners are served by the same transformer, the unplanned loading burden upon the related transformer escalates commensurately, and therefore substantially; perhaps well beyond the transformer's intended capacity given that it was likely deployed decades ago. To further exacerbate this serious unplanned loading issue, most EV charging occurs at night. Nighttime is historically when utility operators count on transformer loading to be decreasing, thus allowing a necessary cooling down period for transformers. To further add to this growing risk, most residential EV charging stations are installed without the utility's knowledge. EV charging stations clearly add substantial unplanned loading, plus nighttime loading, and oftentimes are installed throughout the grid with no awareness by the utility. This ever-increasing, grid-edge EV charging station reality is helping to rapidly set the stage for transformer failures, and fires.

## Problem #2

### Distributed Energy Resources (DER)

Rooftop solar penetration is growing as ratepayers search for ways to lower their electricity bills. By harvesting energy produced by the sun, homeowners can power their homes. This concept of leveraging grid-edge power generation (e.g., solar, wind) is known as Distributed Energy Resources (DER). Oftentimes, homeowner's rooftop solar panels actually produce more power than their home consumes. This results in unplanned energy being driven in a reverse fashion --- from the home upward to the transformer. This 'reverse energy' can create overloading on the transformer, just as forward energy demand can similarly cause transformer overloading. Interestingly, transformers were never conceived nor built to handle 'reverse energy', and certainly not at the overloading level. No one knows what transformers will do when being burdened by reverse energy, and/or excessive reverse energy, day in and day out. But, logic would tell anyone that if a transformer was never designed or manufactured to handle this two-way flow of enregy, and we are presenting repeated reverse energy including reverse overloading levels to the transformer, then it's unlikely that good things will result. This ever-increasing DER reality occurring at the grid-edge is yet another rapidly developing risk factor for increasing transformer failures and fires.

## Problem #3

### Legalized Marijuana

A recent study performed in Colorado USA indicates that an indoor hydroponic marijuana growing system for just 4 plants will create the unplanned load equivalency of up to 29 refrigerators. That means that for every household choosing to hydroponically grow just 4 plants, they will instantly create an unplanned loading burden of 29 refrigerators on their respective transformer. If several people who are served by the same transformer each grow just 4 plants, you can easily see the substantial, compounding unplanned loading impact on the upstream transformer. If people choose to grow more than 4 plants, the loading burden increases further. Utilities are/will be unaware of the locations where legal marijuana growing occurs at the residential level. Imagine, everyone who chooses to hydroponically grow just 4 marijuana plants introduces a new loading burden of 29 refrigerators on their transformer. As the legalization of marijuana continues to expand, how many millions of residential growers will continue emerging to create a compounding, seriously burdensome impact on our transformer fleet? How many people will choose to hydroponically grow more than just 4 plants? This reality of Legalized Marijuana introducing serious unplanned loading at the grid-edge is another substantial risk factor for rapidly increasing transformer failures and fires.

## Problem #4

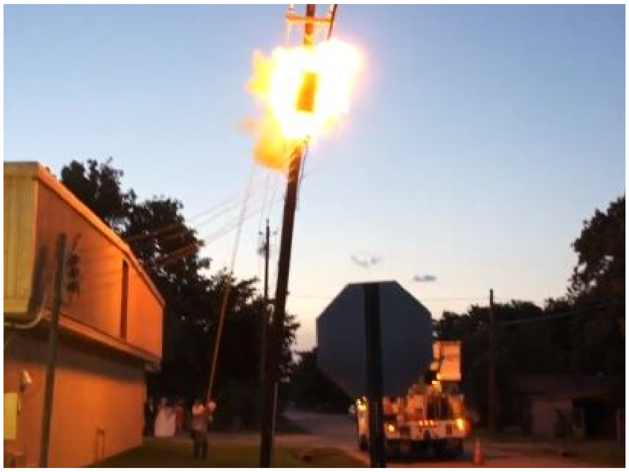
### Ongoing Power Theft

Power theft has been in process for decades. The US alone reports between $6 Billion - $9 Billion of power theft EVERY year. This creates unplanned loading on the respective transformers, and utilities are unaware of the location of power theft instances. Countless cases of fire, and loss of life have resulted from power theft cases. With the ongoing introduction of Advanced Metering

Infrastructure (AMI), power theft is prone to increasing without detection. As power rates increase, as cryptocurrency mining expands, as meth labs continue to emerge, and as heating and cooling costs rise, power theft increases. All power theft causes unplanned loading pressure on the related transformers; oftentimes causing transformer overloading that AMI is simply unable to ever detect. This sobering reality of ongoing, ever-increasing grid-edge Power Theft is another substantial risk factor for increasing transformer failures and fires.

## The Compounding Effect

Any of the aforementioned problems alone can cause costly transformer failures and fires. In fact, that reality is already occurring throughout our grids. However, as we continue to see an uptake in EVs, DER, legalized marijuana growing, cryptocurrency mining, and ongoing theft, the recipe for disaster is percolating right under our noses, and right in front of our eyes.



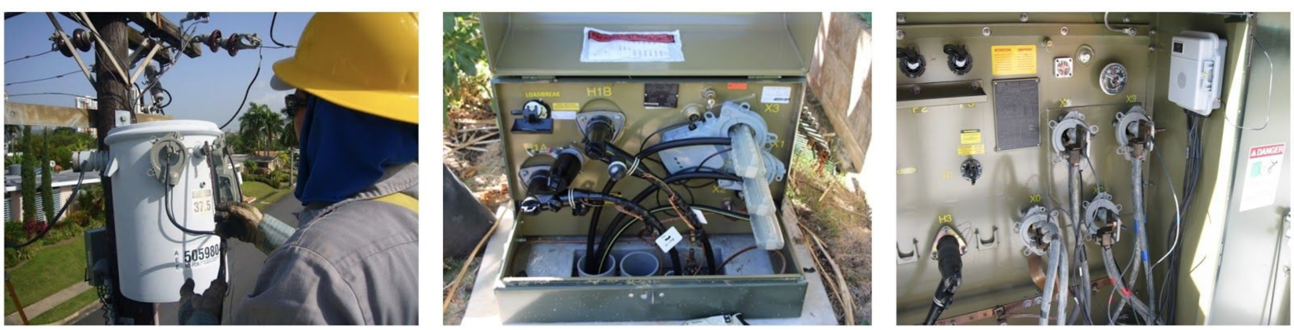
Stakeholders may not yet have the necessary awareness, or concern over this rapidly evolving situation. But, as the transformer failures and related fires continue to increase, there will indeed be some costly 'consequences' that will ensue. Clearly, we can expect to see Reliability metrics beginning to decline. Substantially increasing outages frequency is now imminent. The sobering news regarding transformer fires is that it takes only one instance to cause massive liability impacts for the utility operator, and the public at large. Transformer fires can be costly, and sometimes fatal. This may not be news. But, actually recognizing the magnitude of impact that we are creating at the grid-edge is indeed news for most. The compounding effects of our ongoing grid-edge developments is brewing a multitude of unintended negative outcomes, unless we take action to get in front of this developing situation.

While this may sound dramatic, the fact is that we are now pointing a series of grid-edge 'advancements' directly toward the most vulnerable asset class within the entire grid (i.e, transformers). Ignoring this reality, or hoping that things will somehow be ok is not a solution. Oversight, willful ignorance, or inaction does not sound like a good plan for the well-being of our communities, our citizens, our infrastructure, our economic interests, nor our environment.

## The Solution

Before the release of intra-grid sensors, playing this game of “Russian Roulette”, or “let’s just wait until something fails, then we can go repair it”, may have been the only options. But, with the pioneering class of cost-effective intra-sensors now being released into the market, utility operators no longer have to be blind to the stressed health condition of transformer assets. And, operators no longer have to be ‘blind’ to the dynamic, volatile intra-grid conditions that occur routinely within the electric distribution network.

Transformer manufacturers have worked to develop ‘smart transformers’. While replacing our aging fleet of 40 million US transformers with new ‘smart transformers’ may sound great, it is a flawed strategy. The installation of smart transformers will require upwards of $100 billion, or more. Plus, we basically do not have the massive quantities of line crews available to tackle this monumental, time-consuming deployment challenge. And, all smart transformer installations will require lengthy, negative-impacting planned power outage impacts upon our societies and our economic productivity. Perhaps most notably, new smart transformer installations will require years, if not decades to deploy. Yet, our grid-edge pressures, increasing outages, and escalating fire risks are occurring NOW, and are compounding rapidly. We do not have the luxury of time to install new smart transformers to address our serious present-day, near and midterm grid-edge induced Reliability and fire risk issues; even if cost was not an issue. We need action to be taken now!



*OptaNODE® DTM and PDTM intra-grid sensors installed on Distribution Transformers*

Intra-grid sensors commonly deploy in less than 10 minutes, they require NO power outage inconveniences, and will cost significantly less to deploy throughout our grids. In approximately 10 minutes we can now convert most existing transformers into suedo ‘smart transformers’ by quickly and cost-effectively retrofitting intra-grid sensors without inconvenience to customers.

Now, operators can actually be proactively notified by Automated Alerts delivered by intra-grid sensors whenever unsavory grid conditions are detected at the transformer level. This feature now allows operators to foresee developing issues and take corrective action in advance of failures or disasters. Using intra-grid sensor data, both operations and planning engineers can now forecast emerging issues, and provision their grid assets suitably to reduce asset failures, costly outages, and serious fire risks.

While there is a series of additional value propositions delivered by intra-grid sensors, a clear winner is their unique ability to deliver unparalleled, timely, granular, and accurate insight into the distribution grid. When combined with the unparalleled predictive capability of Artificial Intelligence, this cutting-edge technology gain enables operators to avoid the imminent grid Reliability challenges, and escalating fire risks that are rapidly, and otherwise unavoidably heading our way.

We can either wait for more disasters to occur, or we can avoid them by deploying intra-grid sensors on our transformers, coupled with emerging Artificial Intelligence (AI) capability.

How many costly, catastrophic, and/or fatal instances must occur before the electricity industry will be encouraged and supported by stakeholders to leverage the unparalleled values provided by time proven intra-grid sensors, and game-changing AI?

Our increasing grid-edge “Reliability Challenges and Fire Risk”… do indeed go hand-in-hand.

*A solution to this genuine concern has already been developed, tested, and proven. Now the industry simply needs to adopt and deploy; or just continue to experience unnecessary costs, and unnecessary risks of disaster related to our distribution grids.*