Instant Smart Transformers

Transformers…The Red-headed Stepchild, or Ugly Duckling?

Throughout the history of electricity grids, distribution transformers have been regarded as low-level assets. To some, transformers have been the asset we can overload as much as desired, and then simply replace it when it finally fails. In essence, although commonly purchased and deployed with an estimated 40 year life expectancy, many operators have considered transformers to merely be a 'throw-away' asset; akin to the reference of a red-headed step child's inappropriate treatment.

Oh, how times are now changing.

Today, we now read of transformer manufactures, and even governments investing millions of dollars to create new 'smart transformers'. Most of this interest has been caused by the ongoing growth of solar rooftop deployments which drive never previously conceived reverse energy into our distribution grids--something for which transformers were never designed to handle. In essence, the electricity grid and its infrastructure assets were designed to deliver electricity in one direction; from left to right, if you will. But, with the explosion of interest and rate of adoption regarding Distributed Energy Resources (e.g., solar power, and wind), electricity operators are now faced with a genuine challenge when managing our distribution grids – aka, unexpected reverse energy, voltage impacts and unplanned loading caused by DER. There are other reasons that drive the present interest to develop new 'smart transformers' such as Electric Vehicle charging station impacts, although DER is certainly a major catalyst.

But, let's truly take a moment to think about what we are doing.

We are seeing the distribution grid evolve right in front of our eyes. Our distribution grids are rapidly being asked to handle never conceived reverse energy, and significant unplanned load for which the entire grid, and its infrastructure assets were truly never designed to handle. And, interestingly, the forces of change presently impacting our grids are actually outpacing utility operators' ability to safely and efficiently handle these growing impacts (e.g., extensive solar rooftop penetration, unplanned loading from legalized marijuana and Electric Vehicle (EV) charging stations, aging infrastructure, etc). Resulting outages due to substantial unplanned loading are costly, and disruptive.

Let's build new 'smart transformers'; surely that will solve our problems! Right? Well….not so fast.

There seems to be a few major oversights as it relates to 'smart transformers'. In essence, while it may make logical sense to develop new 'smart transformers', what we aren't yet considering is how long it takes to get them to market, and more importantly, how long it truly takes and what it costs to appropriately deploy a substantial 'smart transformer' fleet into the field.

Many utilities use an annual 'change out' program to retire their oldest transformers and replace with new. Budgets are set aside to achieve this annual practice which may represent up to 1% - 2% of the respective utility's transformer fleet. Conversely, many utilities do not subscribe to an annual 'change out' program, and simply replace transformers only as they fail.

So, let's get real when it comes to new 'smart transformers'.

When are new 'smart transformers' going to truly create meaningful help with regard to managing our rapidly changing grids in the US, and globally?

The US grids collectively contain approximately 40 million distribution transformers under utility management. If each 'smart transformer' bears an estimated retail price of just $1500.00 each (likely to be a conservative estimate), the US utilities will need to spend at least $60 Billion just for the new hardware to 'change out' existing transformers with new 'smart transformers'. Then we have to physically install the 'smart transformers' using crews and equipment. If we estimate the necessary truck roll costs to achieve 'smart transformer' installations by using a conservative amount of $500 each, we add yet another $20 Billion to the new 'smart transformer' initiative. Of course, we still have not factored in the planned power outages required to install every new 'smart transformer' which results in more lost revenue by utilities, more operating costs to execute the installations, and significant customer impact to make the switch from existing to new 'smart transformers'.

It's not unreasonable to conclude that US grid operators would need to spend in excess of $100 Billion to install new 'smart transformers'. And, we haven't yet contemplated how long that effort

"SMART TRANSFORMER" INSTALLATIONS MAY EASILY COST US RATEPAYERS OVER $100 BILLION, WILL CAUSE MAJOR POWER DISRUPTIONS, AND WILL NOT TRULY BE HELPFUL TO GRID OPERATORS FOR YEARS OR EVEN DECADES TO COME.

truly would take to replace 40 Million transformers; many years or even decades is not unreasonable to assume.

The reality is that we will not see a mass 'change out' of existing transformers to embrace new 'smart transformer' installations due to unbearable cost, extensive power disruptions, and the massive amount of time to execute. Rather, we will more likely see a trickle deployment over the course of decades for 'smart transformer' penetration. Eventually, new 'smart transformers' may permeate the US grids, but that will be long after operators have to deal with serious grid management challenges.

Our distribution grids are under serious pressures NOW, and those pressures are escalating exponentially faster than new 'smart transformers' will ever be able to address our immediate, near and mid- term needs which are in full swing, and endlessly increasing upon US grid operators.

Now what?

One of our industry's best kept secrets is the emergence of intra-grid sensors which are quickly retrofit onto existing distribution transformers. These pioneering sensors are now proven assets within the industry that will dramatically change the entire distribution grid management paradigm; once the industry at-large chooses to embrace them



The transformer manufacturers may not want to hear about intra-grid sensors retrofitting onto existing transformers. When intra-gird sensors are deployed, they immediately allow utilities to understand not only which transformer assets do not need replaced, or those that do need replaced, but more importantly they actually convert EVERY transformer into a 'smart transformer' within mere minutes, and likely for less than half the cost of a new 'smart transformer'. And unlike new 'smart transformers', intra-grid sensors do not require a power outage to install. To this end, transformer manufacturers know that intra-grid sensors actually diminish the need for new 'smart

transformers'. Clearly, the use of intra-grid sensors is FAR more practical than new 'smart transformers' concerning the key areas of cost, time to deploy, and power interruption.

UNLIKE "SMART TRANSFORMERS", INTRA-GRID SENSORS REQUIRE NO DISRUPTIVE POWER OUTAGES, THEY INSTALL IN MERE MINUTES, AND COST LESS --PERHAPS ONLY ½ THE PRICE – MAKING INTRA-GRID SENSORS INSTALLED ON EXISTING TRANSFORMERS THE CLEAR CHOICE.

From yet another important view, utilities are learning that AMI meters ("smart meters") are unable to reliably produce valuable intra-grid information as once was imagined. This is due to the quiet fact that utility asset mapping sources are commonly inaccurate, to no fault of the utility since the distribution grid is the most dynamic and most volatile segment of the entire grid space. That means that while a utility asset map shows certain meters are tied to a specific transformer, the actual association of assets is commonly no longer correct. Rather, there are commonly different meters tied to different transformers than the antiquated utility mapping suggests, thus causing AMI meter-level data regarding the intra-grid to be grossly flawed.

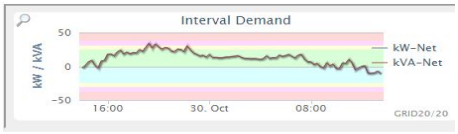
Therefore, utilities cannot rely upon AMI intra-grid data to make necessary, intra-grid assessments, adjustments, etc. Additionally, power thieves have learned that AMI deployment means utility meter reader personnel will never visit their property again. This enables power thieves of all levels to simply tap their service line in front of the AMI meters (a common practice), and steal as much power as they desire in perpetuity without fear of detection. AMI "smart meters' cannot effectively detect pre-meter taps, and therefor AMI cannot report this added, unplanned load burden caused by stolen power which is being served by the respective transformers. To put this into perspective, the US power theft estimate is $6 Billion PER YEAR. Pre-meter tapping is not rare.

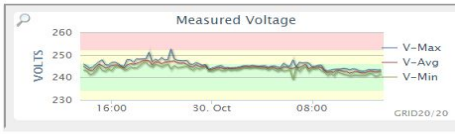


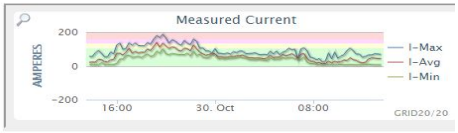
For utility operators to truly make a swift enough grid management adjustment to serve today's rapidly changing demands of DER impacts, EV charging station impacts, legalized marijuana impacts, etc…, the fastest, most economical, and most practical approach requires the use of intra-grid sensors to gain desperately needed insights into the grid.

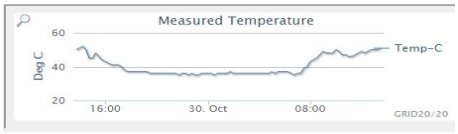
Serial Num	29028
Substation	Waimanalo Beach
Feeder	Beach Lots
Phase	C
Capacity	25 kVA
Primary	7200 Volts
Transformer Type	Single Phase BDE
Subtype	Split/Single Phase
Secondary	240 Volts Phase to Phase
Mount Type	Pole Mount
Priority Outage	No
OptaNODE DTM	DTM ID: 1515 DTM5000121151500018

Parameter	Value		
Reading Time	Last Comms:2017/10/30 13:30 HST	Last Reading: 2017/10/30 13:30 HST	
Real Power	Register Total: 286532.580 KWH		
Interval Consumption	Now: 0.009 KWH	Day: 316.491 KWH	Month: 10232.256 KWH
Interval Peak Demand	Now: 0.036 KW	Day: 34.144 KW	Month: 41.588 KW
Apparent Power	Register Total: 291209.170 KVAH		
Interval Consumption	Now: 0.013 KVAH	Day: 321.247 KVAH	Month: 10371.597 KVAH
Interval Peak Demand	Now: 0.052 KVA	Day: 34.292 KVA	Month: 41.728 KVA
Real Power Reverse	Register Total: 31078.271 KWH-REV		
Interval Consumption	Now: 2.638 KWH-REV	Day: 23.938 KWH-REV	Month: 750.924 KWH-REV
Interval Peak Demand	Now: 10.552 KW-REV	Day: 10.576 KW-REV	Month: 18.688 KW-REV
Apparent Power Reverse	Register Total: 33016.757 KVAH-REV		
Interval Consumption	Now: 2.688 KVAH-REV	Day: 26.398 KVAH-REV	Month: 798.711 KVAH-REV
Interval Peak Demand	Now: 10.752 KVA-REV	Day: 10.764 KVA-REV	Month: 18.776 KVA-REV
Reactive Power	Now: --- KVARH	Day: 55.073 KVARH	Month: 1694.391 KVARH
Interval Peak Demand	Now: --- KVAR	Day: 3.513 KVAR	Month: 4.621 KVAR
Power Factor	Now: ---	Day: 0.880	Month: 0.832
Average Voltage	242.8 V		
Maximum Voltage	Now: 243.4 V	Day: 252.6 V	Month: 254.8 V
Minimum Voltage	Now: 241.7 V	Day: 239.0 V	Month: 214.8 V









As noted above, distribution transformers have been considered a lowly, cheap, “red-headed step child” asset. They have been commonly misused, then discarded for a new transformer upon (premature) failure. But, many utility operators are now beginning to realize that these simple workhorse assets are actually the “Ugly Duckling” in disguise.

Intra-grid sensors install on existing single phase and poly phase transformers in mere minutes—for both pole and pad mount applications--- typically under 10 total minutes for a pole mount or pad mount single phase, and under 25 minutes for a pole mount or pad mount poly phase. AND, no power outages are necessary to install intra-grid sensors on existing transformers which means the meter revenue continues, and ratepayers are not saddled with inconvenient and costly power outages.

Via intra-grid sensors, in just minutes an existing ‘lowly’ transformer is efficiently converted into a valuable intelligent node…yes, an “instant ‘smart transformer”….which then serves as an invaluable ‘crystal ball’ resource for operators to receive unique data, and truly understand critical intra-grid conditions for many years to come. Future proof intra-grid sensors report information to operators at desired intervals creating clear vision into the heart of the grid for the first time in the history of distribution grid management. This is indeed a disruptive technology that favorably flips our historic reactive grid management approach into a cost-effective, energy efficient, proactive process.

Think about this… intra-grid sensors will likely cost less than half of new ‘smart transformers’, and unlike new ‘smart transformers’ they will not require power outages to be experienced during installation, they deploy in only minutes versus many hours like new ‘smart transformers’ require,

and they will give us immediate insight into the most misunderstood segment of our entire distribution grid architecture. Plus, they are future proof, and deliver automated alerts to operators thereby creating a 'hands-free' distribution grid management solution. Ponder that reality!

Intra-grid sensors provide unique, timely, accurate, granular information from within the heart of the grid that other assets cannot deliver, and they do it right now for less cost and less interruption!

The adage of 'information is power' has not changed or become obsolete. Intra-grid sensors will deliver massive amounts of data that can be segregated into 'exception reporting' and 'big data' to drive a series of distribution grid management and planning value propositions for operators. And, intra-gird sensors now offer automated alerts which notify utility personnel of outages, and undesirable intra-grid conditions. This feature creates a revolutionary 'hands-free' grid management solution for utility operators, creating the path for a genuine smart grid experience.

Let's get practical. Let's take action now to solve our rapidly escalating distribution grid challenges. We do not have the luxury of years or decades to address our present-day and rapidly emerging grid challenges with the false hope of new 'smart transformers' saving the day. Intra-grid sensors applied to existing transformers provide the missing link to solving the woes of today's rapidly morphing grid.

INTRA-GRID SENSORS CREATE THE CRYSTAL BALL SOURCE OF INFORMATION NEEDED FOR ELECTRICITY OPERATORS TO SAFELY AND EFFICIENTLY MANAGE TODAY'S RAPIDLY CHANGING DISTRIBUTION GRIDS.

Let's turn our once perceived lowly transformers into valuable crystal balls that continue advising operators of what is truly occurring inside the most dynamic, most vulnerable and most volatile segment of the entire grid architecture; rather than operators continuing to be nearly blind to this critical space. Waiting years for new 'smart transformers' to address our present woes is impractical, let alone also dealing with the enormous unnecessary 'smart transformer' costs and installation outage impacts.

Now is the time to embrace intra-grid sensors for the genuine value they provide.

Rather than being perceived as the red-headed stepchildren of our distribution grids, "Ugly duckling" transformers which are swiftly retrofit with intra-grid sensors will immediately become the beautiful swans of our distribution grids. Intra-grid sensors retro-fit onto transformers will soon create an energy efficient, cost effective, proactive, genuine smart grid experience for US, and global electricity operators.