White Paper

Is The Power Grid Going To Pot?

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Whether you are a proponent or opponent of legalized marijuana, you are likely to be impacted by the evolution of this controversial topic. But, not in a manner that you'd readily expect.

Media coverage surrounding the topic of weed has been primarily focused on the legalization process itself. Whether we are in agreement or disagreement regarding this controversial issue, we are all very likely to share in at least one of the unintended and unforeseen negative impacts associated with legalizing marijuana.

Power outages risk is exponentially increasing. Uninterrupted power is no longer a customer wish; it is now an expectation. And this is where the real problem begins.

While presently off of mainstream radar, the reality of substantially increased power outages is quickly developing. Unforeseen compounding conditions have led us to this concerning point. Now, serious outages risk within our grids is quietly accelerating as a result of various grid-edge developments. To be clear, legalized marijuana is not the sole cause of this unfolding problem. Rather, the legalization of pot is yet one more of several overlooked compounding elements that are creating substantial, indiscriminately scattered, unplanned loading within our distribution grids.

However, legalized weed not only creates another new grid reliability problem for electricity operators, but it further adds to our costly ongoing power theft problem as well.

Increased Power Outages Are Coming

Today's distribution grids are undergoing a series of simultaneous impacts that are aggregating into serious grid reliability challenges. Unfortunately, this reality is still widely overlooked.

For years, consumers have been encouraged, and financially incentivized to adopt rooftop solar panels. This clean technology has been intended to lessen electricity demand, lower customer bills, reduce Greenhouse Gas emissions, and create conservation of non-renewable energy. That certainly sounds good.

Similarly, Electric Vehicles (EVs) have been encouraged and financially incentivized. This technology is intended to reduce Greenhouse Gas emissions, and create conservation of non-renewable petroleum-based energy. Surely, that all sounds good.

Now, we have the ongoing introduction of legalized marijuana. As many know, pot has been legalized in several U.S. states, and now Canada will nationally legalize weed, with Mexico[1] also taking action. Regardless of your opinion concerning legalization, weed is here to stay. But, growing weed creates substantial unplanned power demands upon our already aged distribution grid infrastructure. Plus, growers can pop up anywhere, thus catching power providers flat-footed.

Furthermore, we have the legacy problem of substantial power theft which in the U.S. alone is suggested to exceed $6 Billion every single year[2]. Illegal marijuana growing operations likely represent a substantial portion of the power theft crisis in most markets. For example, in 2012 British Columbia Hydro (Vancouver, Canada) publicly reported power theft by illegal marijuana growers to be in excess of $100 Million per year just on their grid. Ponder that… just one utility experiencing over $100 Million of power theft per year due entirely to illegal weed production. Virtually every electricity provider on the planet is experiencing some form of power theft; many utilities are enduring theft in the millions or tens of millions of dollars per year. For clarity, the cost of power theft is typically passed directly onto rate payers by amortizing thieve's unmetered power consumption into paying customers' electricity bills. Power theft might seem 'harmless', or be entirely off your radar. But, it's a serious, costly and correctable issue that should matter to you.

So, what do all of these seemingly beneficial grid-edge advancements and ongoing power theft issues have to do with substantially increased power outages risk?

Good question. The answer is not based on rocket science, or complicated algorithms. Nor is the answer too cerebral for most to grasp. Rather, it's as simple as the combination of common sense and basic logic. But, only if you have a general understanding of the distribution grid.

Grid Vulnerability… How Did We Get Here?

Our distribution grids were planned, architected, and deployed decades ago. At that time utility operators positioned and specifically sized millions of transformers within our grids to adequately service the localized then-present, and the reasonably-foreseeable future energy demand. To the defense of utility operators, when our major grid planning and deployment efforts were occurring they had no way of accurately foreseeing or imagining today's rapidly unfolding grid-edge events.

Specifically, decades ago utility operators were unable to predict:

A. Reverse Energy entering our grids through rooftop solar and wind, while also being scattered indiscriminately across our grids. By the way, transformers were never conceived

nor constructed to handle the impacts of Reverse Energy, yet they are now being expected to perform this function wherever Distributed Energy Resources (DER) is deployed.

B. Electric Vehicle (EV) charging stations emerging at the grid-edge in mass quantity; thereby creating substantial unplanned load burden on our transformers, and being indiscriminately scattered throughout our grids.
C. Marijuana being legalized, thus creating substantial unplanned energy loading on transformers to support weed growing; also indiscriminately scattered within our grids.
D. Power Theft continuing to expand throughout our grids; substantially spurred by meth labs, illegal marijuana grow operations, and customers stealing power to operate air conditioners and heat pumps among a list of additional purposes.

Our grids 'might' be fine handling some of these unforeseeable grid-edge impacts, if they were occurring in moderation. But reality clearly indicates that we are simultaneously enduring all of these unforeseen grid-edge impacts. Plus, these impacts are widespread, indiscriminately emerging, and dense. This compounding burden is aggregating onto our existing transformers.

The future is already here, and the distribution grid is beginning to bear the burden of today's unforeseen and unimagined events. If left unattended, these impacts will exceed our grids' architected capability, and that will drive outages, increased operating costs, and a host of issues.

The recipe for substantial outages risk is unfolding; but for how much longer will this escalating outages risk go unnoticed? Some utilities are already seeing 'unexplained' outage increases.

Let's qualify this bold prediction of increased, costly outages. Some mistakenly believe that we can continue to add substantial levels of unplanned, indiscriminately scattered load throughout our grid infrastructure without causing a host of ensuing, adverse consequences. Those misconceptions are predicated upon aged transformers somehow enduring loads for which they weren't intended.

1. **Reverse Energy** – This occurrence results from Distributed Energy Resources (DER). DER typically leverages the sun via rooftop solar, or less commonly the use of wind via windmills. But, transformers were never conceived or manufactured to experience the resulting reverse energy flow. Wherever DER exists, transformer fleets are now expected to handle reverse energy which sometimes causes serious transformer overloading. Perhaps

more concerning, reverse energy also creates a series of unexpected, and unplanned voltage impacts within the grid. The Hawaiian Electric Company presently leads the U.S with its substantial quantities of approved/installed rooftop solar customers. To its credit, Hawaiian Electric has collaborated to release a DER Case Study[3] that will benefit utility peers. As the DER Case Study articulates, utilities must realize there are potentially serious intra-grid impacts via DER. This grid-edge initiative is not a harmless, trivial situation. The pioneering work being performed by Hawaiian Electric is invaluable. But, the punchline is clear; DER may cause transformers and related grid infrastructure to be stressed in an unplanned, and unsafe manner. *This reality sets the stage for increased power outages.*

2. **Electric Vehicles** (EVs) are here, growing in popularity, and will further expand as jurisdictions vow to facilitate this evolution. However, the accompanying EV charging stations represent yet another unplanned grid impact contributor that is often overlooked. Specifically, there are two typical approaches to recharging EVs. The slow process requires about 16-24 hours. The more common process typically recharges EVs within 6-10 hours[4]. The slower charging process requires the equivalent of 1 entire average home[4] worth of added energy demand upon the related transformer. The more common charging process involving 6-10 hours requires energy demand representing the addition of up to 2.5 homes[4] to now be unexpectedly served by the existing corresponding transformer(s). What's the big deal? Well, wherever these energy-intense EV charging stations are deployed inside our grids, each one presents an added, unplanned load burden ranging from 1 to 2.5 homes of energy demand. So, for our millions of transformers that were installed decades ago, it is highly unlikely they were sized to handle this unplanned loading burden spawned by the introduction of one or more EV charging stations. And, perhaps worst of all, EV charging stations are typically used at night. This means that transformers are no longer provided a necessary nightly cool-down period which will now further accelerate transformer life span degradation. *This reality sets the stage for increased power outages.*

3. **Legalized weed** is here, and it's expanding throughout the US, Canada, and even Mexico. Many people are beginning to legally grow their own 'recreational' weed. In certain jurisdictions, individuals are permitted to grow in the range of 2-6 plants for their own use. A recent study[5] documented that a typical home growing operation involving only 4 marijuana plants requires the additional unplanned energy demand of up to 29 refrigerators[5]. So, for each person deciding to grow just 4 plants, the added burden on their existing transformer is equivalent to adding 29 household refrigerators to support the energy demand required for lights, fans, humidity and air conditioning, water pumps, etc. That's for just ONE household growing only 4 plants. Imagine what happens when

thousands, or perhaps millions of households grow just 4 plants. Imagine what happens when thousands or millions of households stretch beyond the legal limit and grow perhaps 10, 20, or more plants; recall that every 4 plants requires up to 29 additional refrigerators of never conceived power demand on the associated transformer.

Figure 1: multiple marijuana plants in residential home

Figure 2: indoor weed growing apparatus

Why would people choose to grow more than 2-6 plants 'legally'? Because the market value PER PLANT harvested ranges around $2500 profit[6]. Using hydroponic growing practices within controlled indoor conditions, weed growers can produce 4 crops per year[6]. Simply, 'recreational' growers can create up to $40,000 of income per year by selling weed.

With regard to the increasing outages risk, think about the immense unplanned loading that is being indiscriminately added onto existing transformers to support the massive energy demand for those who are, or will be legally growing pot. Just like EV charging station impacts, utility operators have no idea where or when homegrown pot-driven energy demands will hit their grid assets. *This reality sets the stage for increased power outages.*

4. **Power theft** is a perpetual problem. Industry experts suggest that U.S. power theft is in excess of $6 Billion PER YEAR[2]. The financial 'loss' of stolen power is a substantial cost; but so too is the overlooked substantial costs associated with remedying the grid damage resulting from ongoing power theft. To be clear, power theft is unplanned energy loss being

stolen from the grid, creating serious unplanned loading impacts on existing grid assets.

Figure 3: underground pre-meter tap

Figure 4: pre-meter tap behind the meter

Beyond all of the proper planning and grid infrastructure placement that utility operators have undergone to build reliable grids, power theft creates unplanned loading pressure. The locations of power theft is typically a mystery. But, when the affected overburdened transformers finally fail, sometimes resulting in fires and additional damage including the periodic loss of life, utility operators then learn where their grid is being abused.

Yet, the real point of this message is to create awareness concerning how much added, unplanned energy demand pressure is accumulating within our grids. Power thieves alone are collectively swiping upwards of 60 Billion kilowatt hours per year from U.S. grids. And, consider the fact that when weed is legalized, it creates a larger consumption interest in the market. This economic principle of supply/demand will undoubtedly fuel additional illegal production, which may likely escalate power theft beyond today's substantial, mind-boggling levels. *This reality sets the stage for increased power outages.*

Power Grids… Up In Smoke?

Will all power grids collapse tomorrow? No.

Are most grids beginning to experience increased levels of indiscriminately placed DER, and/or EV charging stations, and/or legalized weed production, and/or ongoing or expanding power theft? Yes!

Is there anything that we can do? Yes.

Will 'smart transformers' quickly solve our emerging problem. No!

The costs associated with mass purchasing smart transformers will be prohibitive. Installing each new smart transformer will require hours of effort, thus making mass deployment less likely. And, when a smart transformer is being installed, an un-welcomed power outage ensues which may last several hours. If emerging smart transformers happen to cost 'only' $1500 each, the estimated 40 million existing transformers[7] under U.S. utility management will require at least $60 Billion just for the hardware purchase. When additionally factoring the necessary labor costs, and associated truck roll costs to install smart transformers, it is realistic to expect that mass installing smart transformers will likely require in excess of $100 Billion while also causing serious disruptions.

Is the answer to solve our rapidly escalating outages risk going to come from smart meters that have been deployed throughout approximately 55% of the U.S. customer base?[8] No!

Because thieves now commonly tap power lines in front of 'smart meters', and because the mapping association of meters-to-upstream transformers is typically inaccurate due perpetual grid dynamics, there is no way that operators can confidently rely on smart meters to avert our imminent power outages risk. Regardless of the substantial investments already made in Advanced Metering Infrastructure (AMI), this smart meter technology will not solve our existing intra-grid challenges, nor the myriad of grid-edge loading impacts that are rapidly emerging.

*The moral to this story is simple. Upwards of **40 million existing transformers** are the choking point crossroads to be **directly impacted** by the **compounding effects** of **DER**, **EV charging stations**, **legalized weed**, and ongoing **power theft**. Therein resides the justified outages risk concern that utility operators must now address.*

Too Big To Fix?

Are we too far gone to avert substantially increased power outages and the financial pain of related cost burdens, plus the extensive harmful impacts to our economic sector, to public safety, and our expected daily lifestyle conveniences? No.

We do have an available path to help us avoid the emerging, substantial outages risk. The most likely solution enabling utility operators to become proactively aware of intra-grid challenges, indiscriminately emerging unplanned loading, increasing grid reliability risks, and oncoming impacts caused by DER, EVs, legalized pot, and power theft will come from intra-grid sensors.

Intra-grid sensors have proven their ability to proactively identify unsavory grid conditions, provide timely automated grid management alert notices to operators, reduce power outages, and simultaneously drive a series of operations and capital expense savings for electricity providers. Via the aforementioned recent DER Case Study[3], The Hawaiian Electric Company has revealed its 3+ years of successful experience when using intra-grid sensors. Separately, certain utilities are quietly using intra-grid sensors to successfully locate power theft. And, intra-grid sensors are now being used to support an EV charging station impact study conducted by the Utah Smart Energy Lab (i.e., U-Smart) at the University of Utah.

Intra-grid sensors are the necessary technology that will finally provide utility operators with reliable tools and information to avert the otherwise imminent power outages risk that is heading our way. In combination with AMI 'smart meters', intra-grid sensors will create a genuine smart grid experience by enabling utility operators to visualize perpetually dynamic intra-grid conditions. For non-AMI utilities, intra-grid sensors will drive needed intra-grid intelligence. This advanced, proactive understanding of intra-grid conditions will drive a series of benefits; energy efficiency will be meaningfully improved, and operations efficiency gains will also result. When both energy and operations efficiencies are created, utility providers will subsequently improve their financial bottom lines, and will increase energy conservation gains. Collectively, these developments will help operators to meet their emerging GHG mandates/goals, reduce energy waste, increase the longevity of infrastructure assets, facilitate grid resilience, and lower electricity costs for customers.

Intra-grid sensors will help operators to avoid substantial power outages. A massive series of unplanned, indiscriminate loading pressures are now striking our distribution grids. While our grid-edge advancements may fall into the clean tech and/or societal progress buckets, the fact is we cannot overlook an associated resulting impact that must be addressed. We now have an accumulation of grid-edge factors that are rapidly compounding to create a negative side effect.

Increased power outages and associated cost burdens will impact all of us, unless we leverage the unique value provided by cost-effective intra-grid sensors.

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