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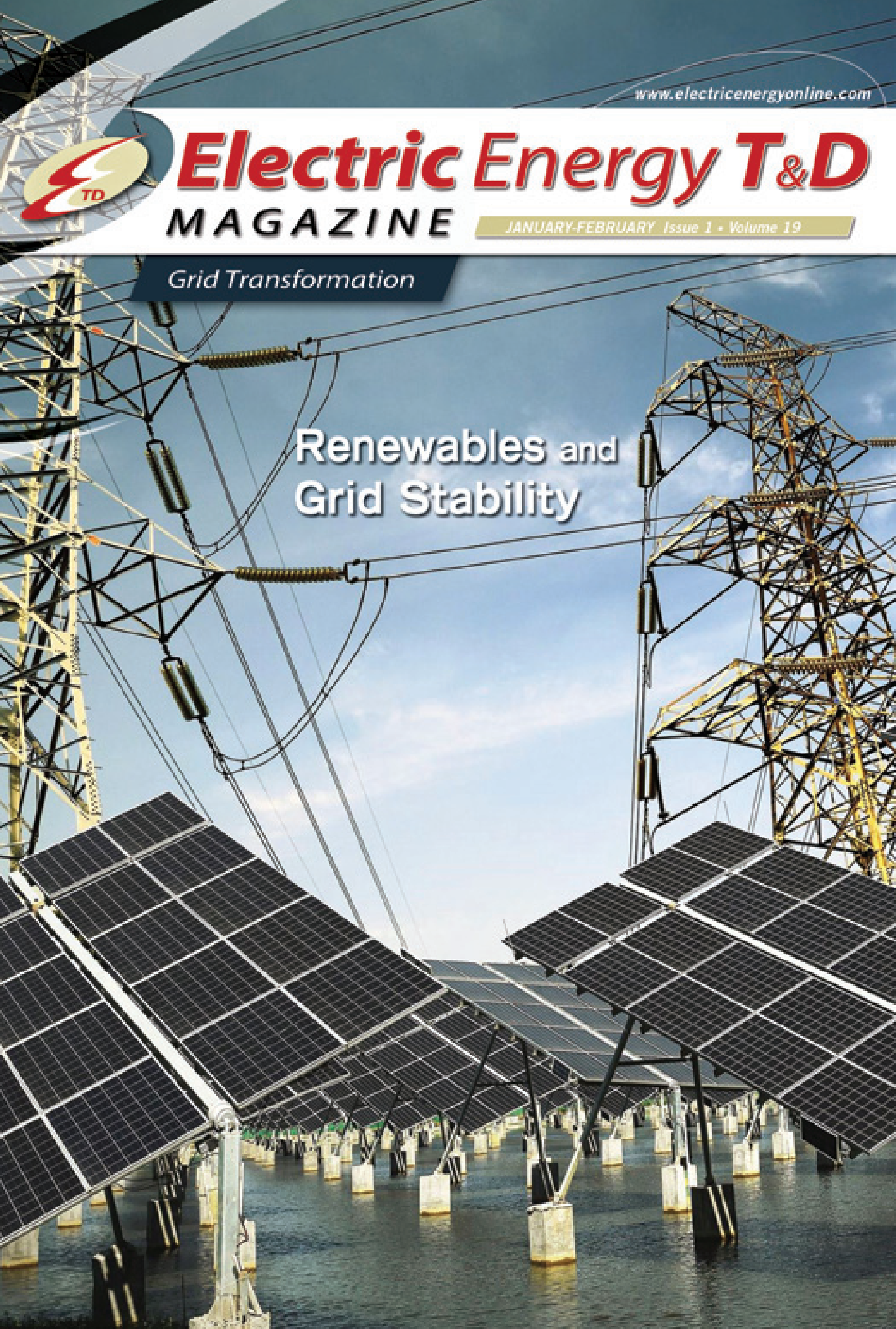
Grid Transformation

Renewables and Grid Stability



Is Inserting Renewables into the Electric Grid Stable?

By Takafumi Arai

In a time driven by the adoption of renewable energy resources, we're also experiencing new challenges with the way that power is supplied. Electric utilities and grid operators are tasked with integrating distributed energy into the mix without compromising the steady flow of the electric power that we need. Any interruption is an inconvenience. Utilities recognize this, but they also acknowledge the need for change within the commercial distribution of electrical power. In fact, the U.S. Energy Information Administration estimates[1] that national electricity transmission and distribution loses an average of 6 percent of the electricity annually from being transmitted and distributed throughout the U.S. With the rise of renewable energy sources – accounting for at least 19.5 percent of global electricity[2] – we must find a way to integrate these renewables into our T&D systems as soon as possible.

But first we must ask...what is the real potential of renewables in electric energy?

The Department of Energy was formed in the 70s, and the organization immediately put the Natural Gas Policy Act[3] into place. But, today's need for renewable energy is different than it was at that time. The current resurgence of renewable energy stems from the need to reduce the high environmental impact that we've put on our grids over the last few decades. The environment is affected by the major sources of pollution which originate from coal-fired plants that release gases into the air.[4] Numerous policy acts have been put into place, but we need to a find a solution to replace the continuous need to build such plants. Today's energy systems demand efficiency, reliability, and security – and the integration of renewables into our electric grid must support those needs.

Renewables are already saving time and cost for utilities. For example, in 2013, Idaho Power Company (IPC) received a $94 million grant from the U.S. Department of Energy to modernize the grid, including the development of renewable energy integration tools. As part of the grant, IPC was able to improve its forecasting, using 15 percent of natural gas-fired reserves instead of 100 percent. This alone resulted in savings of approximately $50,000 for the utility and its customers, and IPC is seeing similar results on a consistent basis.[5]

Previous challenges of using renewables in electric power

To be clear, renewables have not always been efficient, reliable, and secure. For example, basic weather conditions have often hampered the ability to collect this energy. This is not surprising if we consider the fact that the three most important things used for renewable energy are the sun, the wind, and rain. All of these elements provide energy, but they also create challenges for the utilities. Farms and ranches are great locations for wind turbines, but these remote areas make it difficult for transmission lines to reach, creating long lines with a high potential for energy loss. There are also the more simple challenges, such as regions that have a very dark winter where the solar panels are untouched by the sun.

Another challenge is the injection of reactive power into the electric grid from outside power sources, such as solar energy. The utility controls the voltage levels of its system, and injects energy into the grid when necessary to smooth out the natural swings in usage and keep the voltage at an acceptable level. But by renewable energies being injected into the grid, it can throw off a utility's synchronous generator, making it so they can't track where the power is coming from.

Today's electric grid can overcome these challenges

These types of challenges are being overcome, however. The electric utility industry has plans to invest $1.5-2 trillion in infrastructure by 2030 to support renewables in the system.[6] In the U.S., this initiative is connected to the belief that 'distributed energy offers solutions to many of the nation's most pressing energy and electric power problems, including blackouts, brownouts, energy security concerns, power quality issues, tighter emissions standards, transmission bottlenecks and the desire for greater control over energy costs.'[7]

In order to incorporate renewable energies into their existing infrastructures, companies must address several primary issues that can make the system unstable:

Voltage management: This is especially important to control, and companies are looking to options such as Secondary and Tertiary Voltage Regulators; reactive power compensators such as the STATCOM (Static Synchronous Compensator); battery systems for storing energy reserves; and pole transformers for remote tap control.

Frequency control: A power system often has inconsistent frequencies when adding renewable energy. Companies are searching for solutions that can adjust frequency variations within a specified range by using a faster regulated response.

Controlling output fluctuations: Absorbing excess energy in cases of excessive output fluctuations will help companies maintain a smooth power curve.

Managing electric vehicle charging: This is an increasingly complex problem as electric vehicles become more widely adopted, as rapid charging can cause a sudden increase in load to the system. Batteries can be used to store excess power, minimizing the negative effects of rapid charging on the grid.

Demand response: This is one of the more commonly known solutions for managing energy, and is increasingly being applied to renewables as well. DR allows for the system to automatically request that users suppress power consumption during peak hours, and can automatically shift any surplus power load to a later time.

As more and more companies begin using these types of tools, the entire industry is getting closer to the promise of renewables in the grid.

Technology and policy will move the industry forward

It is reported that 30 U.S. states and the District of Columbia are currently implementing Renewable Portfolio Standards that mandate a certain percentage of electricity generated by a particular technology, such as solar or biomass.[8] These types of laws and standards, plus technologies that enable the collection, transmission and distribution of renewables, are driving the global electric energy ecosystem into a much healthier place.

About the author

Takafumi Arai is the digital marketing supervisor for Toshiba's global smart community projects, which include a variety of renewable energy solutions that the company is implementing and testing in a dozen countries. Follow the community at www.toshiba-smartcommunity.com/EN.

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Facing the New Energy Future

How One Major Electric Utility Improved Business Agility

By Jay Mishra

Today's utilities are facing a lot of uncertainty about the future direction of their business and industry.

Will energy be more democratized, with advanced distributed energy resources such as solar panels changing how electricity is sourced? Are there other distributed energy technologies in development that will have a significant impact on the industry? What will be the impact of the decarbonization of energy? What about changing demand patterns caused by electric cars and fluctuating gas prices?

The ramifications of these market forces could mean new business models or regulatory environments for electric utilities.

Staying Competitive Through Business Agility

With all of these challenges, utilities need to find a way to remain competitive. Enter the growing concept of business agility. Analyst firm Forrester Research defines business agility as 'the quality that allows an enterprise to embrace market and operational changes as a matter of routine.' In other words, a utility can only be as successful as its ability to quickly adapt to changing market and customer needs.

A key component of business agility in this environment is partner relations. Utilities will need new technology and energy acquisition partners and will need to manage those relationships well to improve their business agility and keep pace with industry changes.

Data is a Bottleneck

But here's a situation that happens all too frequently. A company wants to do business with another company, executives do the negotiations, promises are made, a deal is struck. Then it comes time to integrate data and the process slows to a halt.

That's because oftentimes data formats are different. With record sizes and data sets being very large, bringing this third-party data into a business system gets very complex. If the business analyst can't do it using a spreadsheet and macros, then the IT team is called in to manipulate the data. All the while, the clock is ticking and the partnership is not moving forward. This can upset the partner and they may choose to go elsewhere.

Data integration is a growing solution to this problem that allows utilities to more smoothly and quickly – sometimes within hours – to integrate external data files into a business system.

What is Data Integration?

Data integration takes data from multiple sources and in multiple formats and transforms that data to be viewed within an existing business process. The result is that users have a unified view of multiple data sets. This process can be difficult because it often requires different coding for different data sets depending on the data type and source.

Data integration is powerful, but it's no easy task and therefore has historically been in the realm of IT. But as utilities seek to expand their agility, there has been a movement to simplify this technology in order to provide software that can be used by the data analysts or customer integration teams that are close to the customers.

Data integration has been seen by utilities as a way to transform data for regulatory purposes. In these situations, the mission critical nature of the data meant that IT needed to ensure data accuracy after the transformation.

What is ETL?

Extract, transform, and load (ETL) is an industry term used to describe data movement and transformation across or within systems involving high data volumes and complex business rules. ETL processes are widely used in data integration, data migration, and master data management initiatives, as well as for loading data from the source systems into data warehouses, operational data stores, and data marts.

ETL processes are critical components for feeding a data warehouse, a business intelligence system, or a big data platform by retrieving data from operational systems and pre-processing it for further analysis by reporting and analytics tools. The accuracy and timeliness of the entire business intelligence platform rely on ETL processes.

Energy Acquisition Partnership Example

Acquiring electric energy assets is a great example of the data integration challenge facing utilities.

This transaction is collaboration between an energy company and other energy vendors with a heavy need to integrate each vendor's uniquely formatted data into the main system in order to finalize an acquisition.

Too often, energy companies have home-grown or manual systems for this data integration that dramatically increase the time involved in onboarding a new acquisition. However, they also carry the risk of inaccurate information.

This was the case for one major regional energy corporation with nearly 400,000 ratepayers. The company received information formatted according to each of its energy vendors' own systems, which meant manually copying that data into the company spreadsheet. Macros then had to be run in order to produce an output file sufficient for the company's current acquisition system. The inefficient process was consuming valuable time and resources.

The company's IT staff wanted to build a uniform process that would import vendor data directly into the acquisition system. The solution had to be able to handle each vendor's file format, as well as translate some of the vendor-specific terms. The new system would have to be flexible and scalable, because new vendors and their proprietary formats are added all the time.

After evaluating available technologies on the market, the energy company chose an ETL-based data integration software solution because it provided an easy-to-use interface that enabled users to quickly map the vendor fields to the company's own fields.

The software the utility selected allowed its partner team to convert the data taking a project off of the plate of IT without sacrificing the flexibility, scalability, and functionality required for the energy company's complex application. At the same time, the team was able to quickly and easily map new vendor data to the main system. The company was also able to take advantage of the software's static lookup functionality to translate vendor-specific codes.

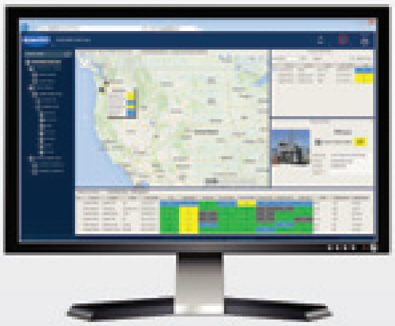
Now, any time data needs to be integrated from an existing vendor (or a vendor who uses a familiar system), the energy company can open up the transfer setting corresponding to that specific vendor file format. For new vendors, a new transfer setting can be created in a matter of minutes and saved for reuse.

Business agility is a macro solution for many of the challenges that face utilities, but data and data integration are the foundations for making the whole effort successful. Data integration technology is a major step forward and should play a key role in the data processing infrastructure of all utilities.

About the author

Jay Mishra is the Vice President of Product Development at Astera Software. Mishra leads the product vision and development for Astera's data integration products and has over 12 years of experience in software engineering with over 8 years of experience in managing mid-sized, fast-paced and dynamic software engineering teams. Mishra holds a Master of Science degree in Computer Science from the Virginia Tech and a Bachelor of Science in Mathematics and Computing from the Indian Institute of Technology.

Supporting Tough Decisions with doblePRIME™ and dobleARMS™



Transformer owners need to make tactical and strategic decisions when it comes to managing their assets. This requires the right data, which comes from having the appropriate tools for data collection and analysis. Doble Engineering Company has nearly a century of practical field experience and associated asset management of transformers. This expertise has been the basis for the development of key tools including the doblePRIME™ Condition Monitoring Platform and the dobleARMS™ Asset Risk Management System.

Monitoring at the Asset or Station Level

The doblePRIME Condition Monitoring Platform is a state-of-the-art, scalable and flexible system for gathering and analyzing condition data. It can be used to monitor one transformer or all transformers at a single station. It is a tactical tool giving alerts and alarms that allow you to make targeted responses in a timely manner.

The customizable platform is built for your program requirements and can include the monitoring of dissolved gas, moisture in oil, partial discharge, bushing health and tap changer condition – while integrating all types of diagnostic indicators, IEDs and sensor data.

doblePRIME can link to an asset risk management system such as dobleARMS for the advanced analytics, root cause and financial analysis needed to justify capital decisions and long-term strategic asset plans.

Strategic Planning and Intervention

dobleARMS is a comprehensive system for managing risk across a fleet of assets. It takes all available condition, asset, operational, test and maintenance data and generates transformer health indices for a single unit or an entire fleet. dobleARMS integrates transformer criticality (consequence/impact) to give a view of risk, based on user specified dimensions, and identifies both short and long term priorities and variations to operational and capital plans.

dobleARMS accepts criticality metrics for safety, environmental impact, business interruption and financial loss, calibrated through a common denominator to ensure cohesion of analysis and results. By ensuring that we keep track of the original risk quantities, transformer owners, managers and operators can address risks as they develop and manage plans for intervention: what, when and where

dobleARMS Dashboard Features

- The top concern transformer is shown in detail and subject matter experts can drill down to the available monitoring, SCADA and asset data for further review
- The Smart WatchList tracks those units which are in the plan for action
- The fleet summary is a filterable and sortable list which identifies vulnerable transformers at key locations
- The individual transformer health scores and criticality are listed in an interactive manner

Within an ISO 55000 framework, dobleARMS provides both short term tactical support for a rapidly changing operational environment, and long term strategic support for financial considerations and replacement and contingency planning. In addition, it leverages ISO best practice failure mode analysis methods that provide the most reliable asset health index in the industry.

Conclusions

As individual tools, doblePRIME and dobleARMS are leading-edge and world-class products. Together, doblePRIME and dobleARMS underpin smart decisions for an intelligent grid and can provide value from day one of their deployment.

Doble Engineering Company
Worldwide Headquarters
85 Walnut Street, Watertown, MA 02472 USA
www.doble.com

Out of the Box Thinking for Home Energy Management

By Dean Schiller

Not so long ago, setting up a new computer was a hassle. Thankfully, technology companies have largely remedied this complexity, and customers now expect products, from smart phones to computers, to work right out of the box.

In the utility world, Home Energy Management System (HEMS) devices like smart thermostats, electric vehicle chargers, solar panels, lighting controls, water heater controls, and pool pump controls are at the center of residential utility efficiency and demand response programs. These connected energy technologies promise to create a tightly integrated smart home, where residents can control their comfort and energy use with a few taps of their mobile devices or clicks on their web app.

Unfortunately, installing and provisioning HEMS devices to smart meters is still as painful as setting up those old computers. From my experience working with pioneering utilities like National Grid and Glendale Water & Power, I've seen this process unnecessarily slow HEMS customer adoption and make it all too difficult for utilities to meet their goals. The challenge is figuring out how to make HEMS devices a snap to install, while ensuring they are secure and reliable for both the homeowner and utility.

So what's the problem?

Let's take a look at the HEMS installation process. Right now, the utility-deployed installer starts by finding and writing down the 12-digit MAC address and 16-digit installation code for every HEMs device: from smart thermostats and in-home displays to electric vehicle charging stations and smart plugs. The installer then calls the utility operations center and reads each MAC/installation code combination aloud.

Like any manual process, there's ample room for error. It's amazing how 8's look like B's, and the number zero can be confused with the letter 'o.' Over the course of thousands of HEMS installations, we've seen that more than 25 percent of MAC addresses and install codes are read and entered incorrectly. Worse yet, when the installation fails, diagnosing the issue can consume frustrating hours of manpower, all while a customer (that has taken time out of their busy schedule) stands by watching. This entire process could take up to an hour and a half to complete.

In short: we're a long way from meeting today's 'out of the box' technology standard. And that's a shame. Engineers have designed and built elegant technological solutions. HEMS devices are specifically meant to engage customers and improve their experience with energy, but that labor of love is undermined by complex system installation.

It's a critical design flaw – and it's time to hold ourselves accountable.

The HEMS is poised to create a magical customer experience that fundamentally changes how we use energy at home. Yes, there will be a few bumps along the way, but like with all new things this technology will evolve and improve. We just need to keep thinking 'out of the box.'

Designing for speed

The experts who solved the computer setup problem did so with smart technology, and my company, CEIVA Energy, did the same. We developed a mobile HEMS provisioning tool called HANs-On that runs on an iPhone and allows installers to scan barcodes on HEMS devices and automatically sync MAC addresses with utility servers. This brings the HEMS online far faster. Since it's fully automated, utility employees eliminate long searches for install codes, garbled voice calls, bad handwriting, data entry or transposed numbers. Staff can log jobs and track their day, perform installation surveys to track feedback, and take installation pictures directly within the app to better track problems and successes. The HANs-On app also verifies the customer account and provides a map to the house. We're even bypassing those tedious manuals altogether.

A new installation app may sound minor, but this pioneering approach solves a significant problem that nobody else has addressed, translating into instant joy for utilities. Several utilities that have deployed HANs-On, including National Grid, found that the technology slashed installation time from half an hour per device to less than a minute – delivering a real 'wow' factor to utility workers accustomed to the old, painful way. Since most installers and operations center staff bill hourly, this translates into impressive utility savings that scales with the growth of efficiency programs. Utilities can also test HEMS devices immediately and fix them on the spot, rather than having to return in a separate trip. These benefits are transforming the bottom line for utilities, helping to meet goals far more efficiently while engaging customers around new technology.

About the author

Dean Schiller is the founder and CEO of CEIVA Energy, a comprehensive, flexible utility-controlled Home Energy Management System (HEMS) provider. CEIVA partners with utilities across North America--from Glendale Water & Power to SDG&E and National Grid--to engage with residential customers and meet goals. Schiller is a former Walt Disney executive and guided the technology behind numerous classics such as Beauty and the Beast, Pocahontas, Aladdin and The Lion King.

Transformer Truth or Dare

How to Make Decisions on the Health and Reliability of Transformers

By Tony McGrail

Tough Decisions – Tactical and Strategic

Owning a transformer means making many big-money decisions, but those decisions aren't always clear or straightforward.

Assessing Your Transformer: Questions to Ask

1. How do I determine if my transformer is healthy? What criteria should I use?
2. How do I interpret each reading?
3. What's most important for me to monitor?
4. How do I determine which transformer is the most critical to replace this year? The oldest, unhealthiest or the one with the irritating fill-in-the-blank alarm?

Transformer owners need to consider two types of questions: tactical and strategic. Without a harmonious approach to these questions, it's impossible to understand the true health of a transformer, and whether or not it's meeting the needs and demands your organization requires. Tactical goals may include questions such as, 'can I return a transformer for service after a fault, or do I need to schedule an immediate corrective or verification action?' Strategic goals revolve around lifespan, capacity, budgeting and monitoring equipment.

Figure 1: 650 MVA GSU

Online testing, monitoring and evaluation tools are still new to the industry when you consider transformers have been used for over a century, but these tools have slowly become mainstream over the past 10 years. Without discounting the value of off-line testing, power organizations and testing equipment companies have recognized one very critical issue that needs a solution: Things change more rapidly than off-line only testing allows us to detect.

In the early years of transformer application, transformers were bigger and more substantial than they are currently. Put simply, transformers were generally overdesigned, resulting in low transformer failure rates and the expectation that units would last decades. With advances in transformer manufacturing, the margin of overdesign has reduced to the point where it is almost non-existent. Now, thanks to tighter tolerances, the old school approach to letting transformers stay in service indefinitely is fraught with peril. The built-in insurance of overdesign is simply gone.

The political and economic environment has also changed. Regulators now require utilities to prove their worth when it comes to financial rate changes, environmental impact, customer up-time, reliability and public safety. Utilities need to use tools that are much faster, more tactical and that constantly generate data through online systems to meet these requirements.

Transformer owners are working hard to ascertain and digest the right data to make critical decisions confidently, but the volume of data is overwhelming and is complicating matters. What looks like a critical piece of information at first glance could easily be a diversion with no real importance. Having the appropriate tools and solutions in place to help navigate all the available data is the best way to simplify the process and ensure the real red flags are addressed quickly.

Figure 2: Poor Condition Transformer

Facing (and Preventing) your Fears: Catastrophic Failure

Figure 2 shows a catastrophic bushing failure – in other words, one of a transformer owner's biggest fears. In this case, the explosion resulted in additional collateral damage – the adjacent bushing was lost and shock waves were sent through the main transformer tank. This bushing could have been saved with appropriate condition monitoring, as part of an asset management program.

Let's now take a look at the benefits and applications of risk and condition monitoring tools.

The Case of the GSU Bushing

To better understand how to simultaneously tackle both strategic and tactical goals, let's review a real-world example of a Generator Step Up (GSU) transformer and see if the right questions were asked and if the decisions made were correct.

The GSU transformer in Figure 1 looked to be in good condition based on off-line tests prior to 2003, but performance outside those tests was largely a mystery… until the company adjusted its transformer health strategy.

In this case, a 345/26 kV 968 MVA GSU, manufactured in 1984, supplied power via a DC link to a large city in the United States. The bushings were known to have a design flaw that led to a specific failure mode with characteristic changes in leakage current and online power factor. If monitored online, these symptoms can be identified before a catastrophic failure occurs. For this GSU, a bushing monitor was installed in order to record the raw current and derive the required parameters, and provide notifications of bushing deterioration.

After several months of normal operation, the monitor showed a small but significant change in the relative phase angle associated with the H3 bushing over a period of three days. This was followed by a further variation of over 2 degrees in seven hours, along with a rise in leakage current magnitude of over 8 percent.

These may seem like small variations, but they are actually huge changes in a very short amount of time. High level alerts were received by system operations from the monitor and previously planned and agreed upon actions were taken: the transformer was removed from service and the bushings tested off-line, validating the online results. The leakage current data is summarized in normalized form in Figure 3. The rapidly deteriorating situation is clear.

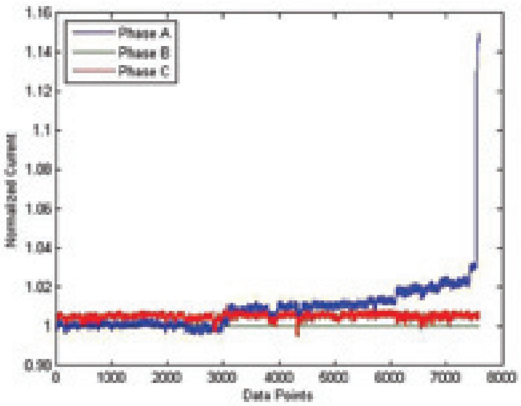


Figure 3: Rising leakage current data

A subsequent forensic analysis of the bushing showed advanced deterioration and punctures in the insulation. Though impossible to say how long the bushing had before failure, this bushing had obviously moved away from 'normal' and was heading toward the same catastrophic failure seen with similar units. Appropriate condition monitoring provided data for a tactical asset management decision. The bushing was replaced, and the GSU likely saved from destruction.

The Benefits of Online Monitoring

Condition monitoring should be based on a simple initial question: *What problem are we trying to solve?*

If we are looking to monitor the general health of a transformer, then general use monitoring, including DGA (Dissolved Gas Analysis) and temperatures may be sufficient. This will not detect all potential problems, and there is still the risk that certain failure modes can occur without warning.

When it comes to more comprehensive monitoring, you will need a bushing PF/TanDelta, operational (SCADA), Partial Discharge (PD) and a means to correlate data and develop an asset health index (AHI) for a transformer. An AHI, if developed and used properly, can be a valuable guide to tactical intervention and action. If there are particular issues with a transformer – suspect bushings or a tap changer prone to rapid thermal deterioration – targeted condition monitoring would be included in the application of an advanced suite of tools.

The best approach for condition monitoring is to use a flexible monitoring platform that can gather and analyze data at an individual station, while also providing a comprehensive view of all transformers. A platform that aggregates data across different transformers to data-mine the larger data set and seek out anomalous behaviour is a powerful approach to data collation and analysis. However, there also needs to be a degree of understanding on the part of the user. Otherwise, the whole system falls apart and it's just another protocol that collects dust on the shelf. Agreed response and action plans should be in place before a monitoring platform provides alerts, alarms or notifications: working out what to do in the middle of an event is always more difficult!

By implementing a cost-effective, targeted and financially justified system, an organization enables technicians, engineers and managers to better understand their assets, manage asset condition and prevent unplanned outages.

The Case of the Aging Fleet – Where to Concentrate?

Managing a fleet of transformers is a challenge – it really means managing a lot of transformers individually, but simultaneously using the statistics of the population and financial limitations to help drive priorities and decisions. A population may have a historic failure rate – One percent of the population fails annually, for example – but that statistic applies to the population as a whole and is only an indication for a particular transformer.

Aging implications for any given transformer population is key to effective analysis. With all assets aging nominally at the rate of one year per year, some may be ageing more quickly due to higher impact of through-faults or through more tap changer operations or by having more thermal deterioration of paper insulation. This information should be factored into the health analysis for individual transformers and also used to prioritize and identify candidates for replacement. Figure 4 shows a predicted failure rate rising with transformer age, based on statistics shared by Hartford Steam Boiler Insurance Company.

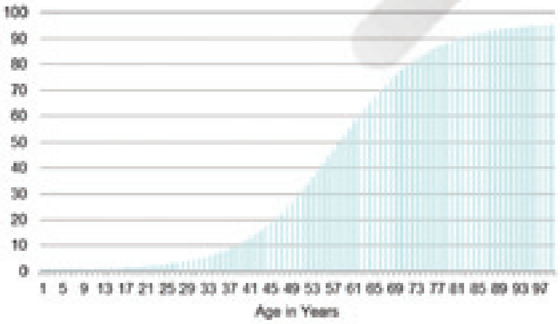


Figure 4: Cumulative Failure Rate for Power Transformers in North America. (Data presented at the 2012 International Conference of Doble Clients).

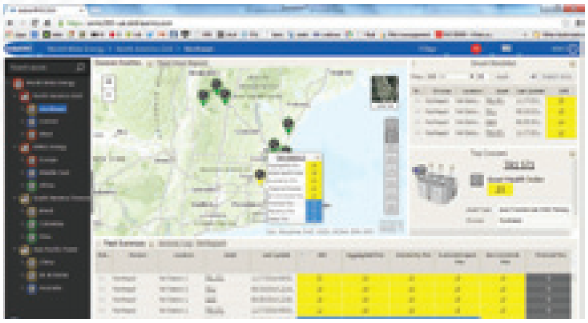
There is a predicted rise in failure rate as transformers reach about 50 years of age – the age which many in-use transformers are currently approaching -- but the statistics available vary between organizations and on a year to year basis.

A large fleet allows for *statistically relevant analysis*. Looking at 1,000 transformers with a historic failure rate of 0.5 percent, we can expect, over the coming year, five failures. Regardless, determining which transformers will fail remains a very difficult question to answer. It is important to review the manufacturer, design and data from industry sources to understand all possible contributing factors.

Considering off-line bushing power factor tests, we can see that in 2012, North America alone tested over 45 thousand bushing C1 insulations systems. Of these, over 1.5 percent were in bad condition and required replacement – where the power factor was above 1 percent or had doubled since installation. It is more difficult to replace a whole power transformer, as the capital costs are high and the lead time is long.

Case Study in Online Monitoring

To obtain a deeper understanding of asset health, a large investor owned utility, located in the Midwest of the United States, recently undertook a project of installing online monitors to improve their tactical awareness of asset condition. This initiative was coupled with an implementation of the platform dobleARMS to integrate their offline testing data, their online monitoring data and their SCADA data into one centralized system that will monitor the risk associated with their assets. This automated process provided new data points, generated from the online bushing monitoring and online DGA monitoring, and integrated the existing SCADA points into the risk management system.



Snapshot of dobleARMS AHI Fleet View Report, map view

This continuous process, in parallel with available offline test results, were automatically supplied to the system as they became available in the test database. The system was able to monitor the assets in real time and update the utility's asset management and operations management as to changes in the health and risk of an asset. Understanding asset health and risk is very important to the utility, as well as having a system powerful enough to warn them when something needs their attention, with an indication of the timescale and intervention planned.

Tools for Strategic Planning and Intervention

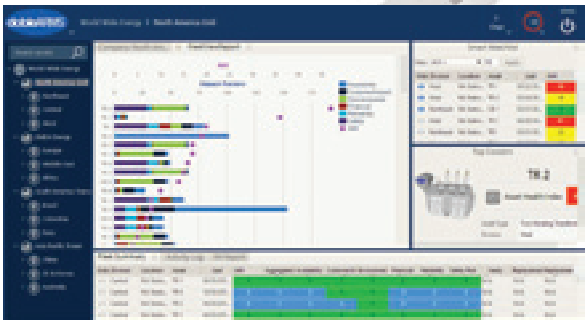
An asset risk management system is critical to showing an entire fleet's health and risk at-a-glance. In the case provided above, ranked asset health scores allowed for the utility to identify work priority and subsequent critical analysis helped to identify the consequences of failure and aided in scheduling work to mitigate the risk. Bringing data together - and making it readily available - is a key to enabling tactical and strategic decision making.

So – the tough decisions:

- Which transformers should be targeted for replacement, in what timescale, and with what justification?
- How do we manage the risk associated with those units before they are replaced?

Managing a population is best achieved through a consistent and standards based approach, reflecting the priorities of the standard for Asset Management ISO 55000 and the needs of the organization.

There are a number of purported asset risk management tools available, but a comprehensive tool that accepts criticality metrics for safety, environmental impact, business interruption and financial loss, and is calibrated through a common denominator to ensure cohesion of analysis and results, is imperative. By ensuring that we keep track of the original risk quantities, transformer owners, managers and operators, we can address risks as they develop and manage plans for intervention.



Snapshot of dobleARMS AHI Fleet View Report, Impact Factors

Conclusions

There are tough decisions to be made for short term individual transformer reliability and transformer population management for the long term.

Condition monitoring is applied at the station level to generate decision supporting data with respect to transformer health and viability – an asset health index and anomaly identification. It's imperative to utilize available tools to make decisions with confidence in the face of operational contingencies and target responses in a timely manner.

Asset management of a population is a complex activity, and requires a view of the individual transformers within the context of the fleet and individual business requirements of each transformer. Combining both tactical and strategic tools optimizes an organization's use of critical and expensive assets, allowing for timely and cost effective intervention, improving understanding of asset health and providing consequent grid reliability improvement.

About the author

Tony McGrail is Doble Engineering Company's Solutions Director for Asset Management & Monitoring Technology, providing condition, criticality, and risk analysis for utility companies. Previously Tony spent over 10 years with National Grid in the UK and the US; he has been both a substation equipment specialist, with a focus on power transformers, circuit breakers and integrated condition monitoring, and has also taken on the role of substation asset manager and distribution asset manager, identifying risks and opportunities for investment in an ageing infrastructure. Tony is a Fellow of the IET, a member of the IEEE and the IAM, is currently chair of the Doble Client Committee on Asset and Maintenance Management and a contributor to SFRA and other standards at IEEE, IEC and CIGRE. His initial degree was in Physics, supplemented by an MS and a PhD in EE and an MBA. Tony is an Adjunct Professor at Worcester Polytechnic Institute, MA, leading courses in power systems analysis.