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POWER SYSTEMS TECHNOLOGY

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TRANSFORMER TECHNOLOGY MAG

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BETTER DATA TODAY, A SMARTER GRID TOMORROW

GRID MODERNIZATION AND ADVANCES IN ENERGY STORAGE

What Leaders are Saying:
Mike Sheppard
CEO of PTR Inc.

Smart Grid:
Success Formula for Industrial AI

Integration of DGA Monitors
to More Comprehensive Transformer Monitoring Systems

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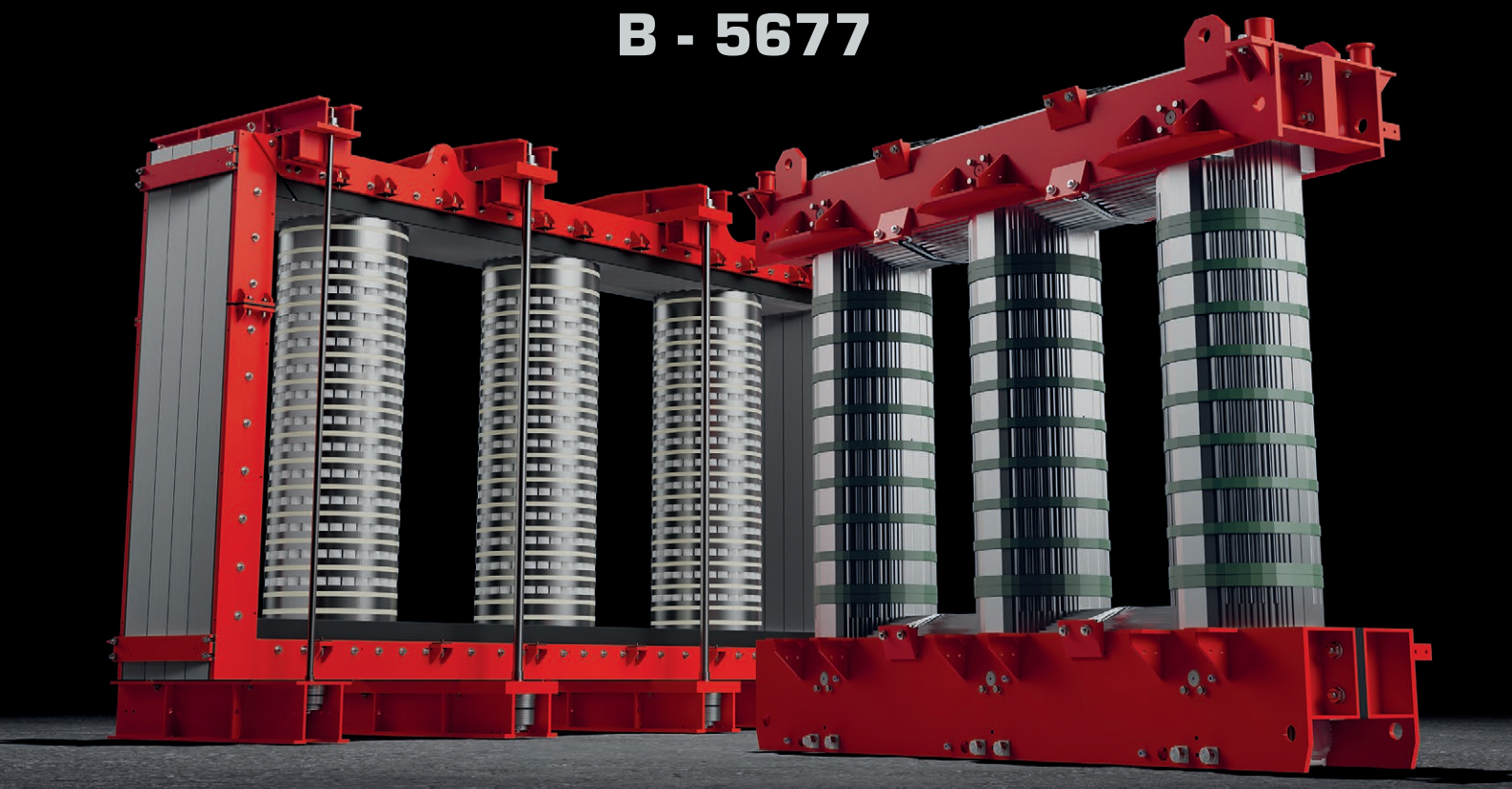

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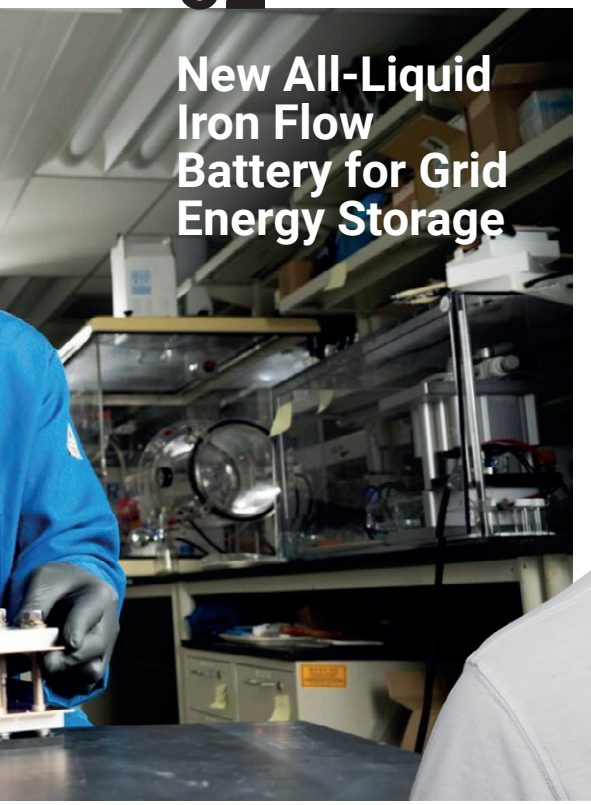

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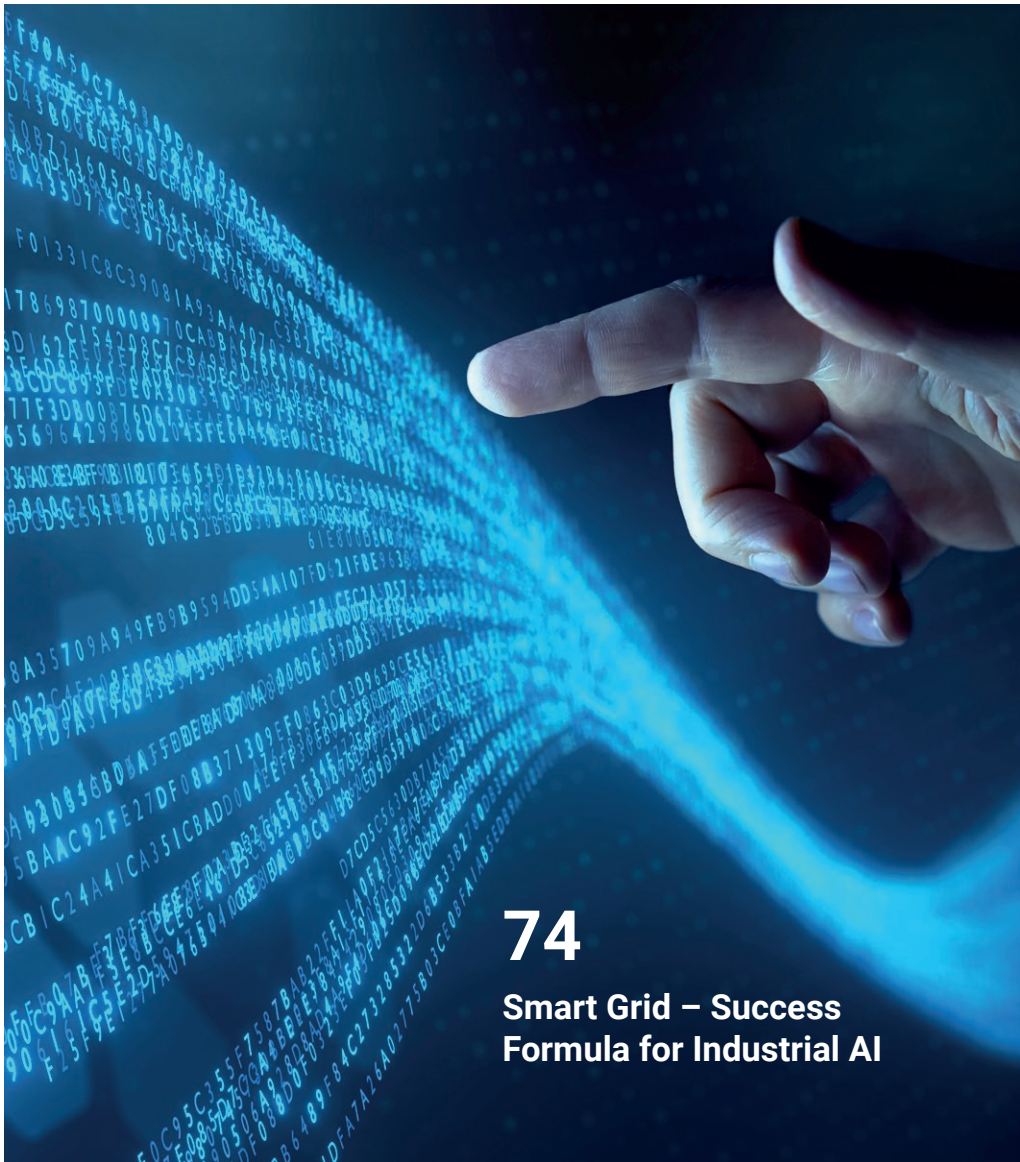

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Smart Grid – Success Formula for Industrial AI

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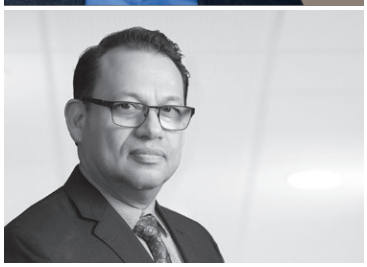

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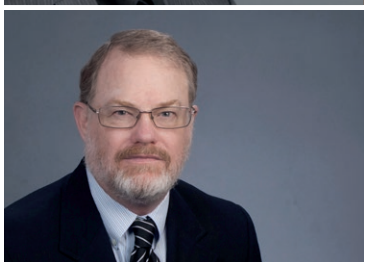

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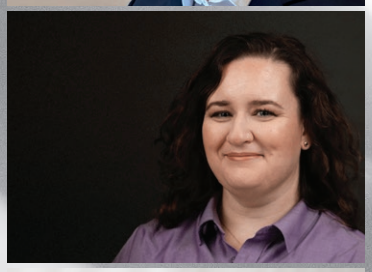

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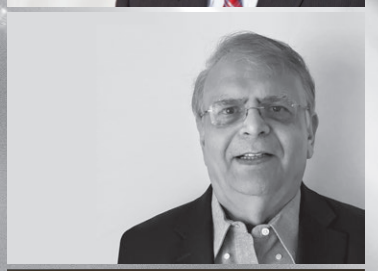

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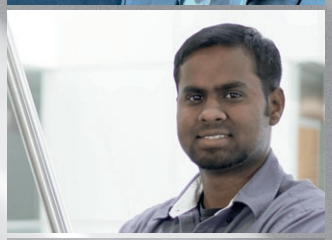

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Challenges and Opportunities in Building an Electric Energy-Based Society

As exciting as transitioning to an electrical energy-based society is, as it holds immense potential for sustainability and environmental benefits, it's not without its challenges. Here are some key hurdles to consider:

Technical Challenges: Intermittency and Storage: renewable energy sources like solar and wind are variable, depending on weather conditions. This creates challenges in grid stability and requires efficient energy storage solutions, which are still under development.

Is hydrogen a future fuel that in abundance, as new reserves of "white hydrogen" are discovered? Will it create technologic challenges for building this potential market?

Grid Modernization: Integrating renewable sources into existing grids requires significant upgrades to handle fluctuations and accommodate distributed generation. This can be expensive and time-consuming.

Interoperability is the buzzword we are using for making sure everything connects with everything. We have moved form a well defined "step down" grid to a more complex "step everywhere" grid.

Raw Material Availability and Supply Chain Issues: The production of solar panels, wind turbines, and batteries relies on specific raw materials that could face potential supply chain constraints. The technology development required to use more abundant and available raw material is underway, but still not fully capable of replacing rare earth materials, like lithium, for example.

Why are transformers in such a short supply with ever expanding lead times? Yes, demand has caused the existing supply issue, but there is another issue for OEM's and that is the supply of some materials and component parts, and the supply of skilled and even unskilled labor.

Supply chain issues are not related to transformer supply, but to almost everything required for the modern grid. As an example, Printed Circuit Boards (PCBs) are required throughout the modern grid as we move from an electromechanical system to a solid state one and they are also in short supply.

Photo: Shutterstock

Supply chain issues are not related to transformer supply, but to almost everything required for the modern grid.

Economic Challenges: High upfront costs: While long-term savings are significant, renewable energy technologies often have higher upfront costs compared to traditional fossil fuels, deterring investment. Currently governments are covering much of this shortfall, but that support is surely going to dwindle, if not dry up completely.

Job displacement and labor shortages: The shift away from fossil fuels could lead to job losses in certain sectors, requiring targeted policies for workforce retraining and transition. But right now, we have almost every job function from electrician to electrical engineer is in short supply, with estimates of the need growing, while the boomer retirement phenomenon continues.

Ensuring equitable access to affordable electricity remains a challenge, especially as governmental investment to support this transition begins to end and the cost of operating this new system falls on consumers.

Energy access and affordability: Ensuring equitable access to affordable electricity remains a challenge, especially as governmental investment to support this transition begins to end and the cost of operating this new system falls on consumers. Low income and third world/ developing countries will bear a disproportionate cost of operating the modern grids.

Conclusion: Great gain will require some measure of pain, and we need to be realistic, yet bold, as we forge ahead with grid modernization.

Alan M Ross
CRL, CMRP
Managing Editor
APC Media
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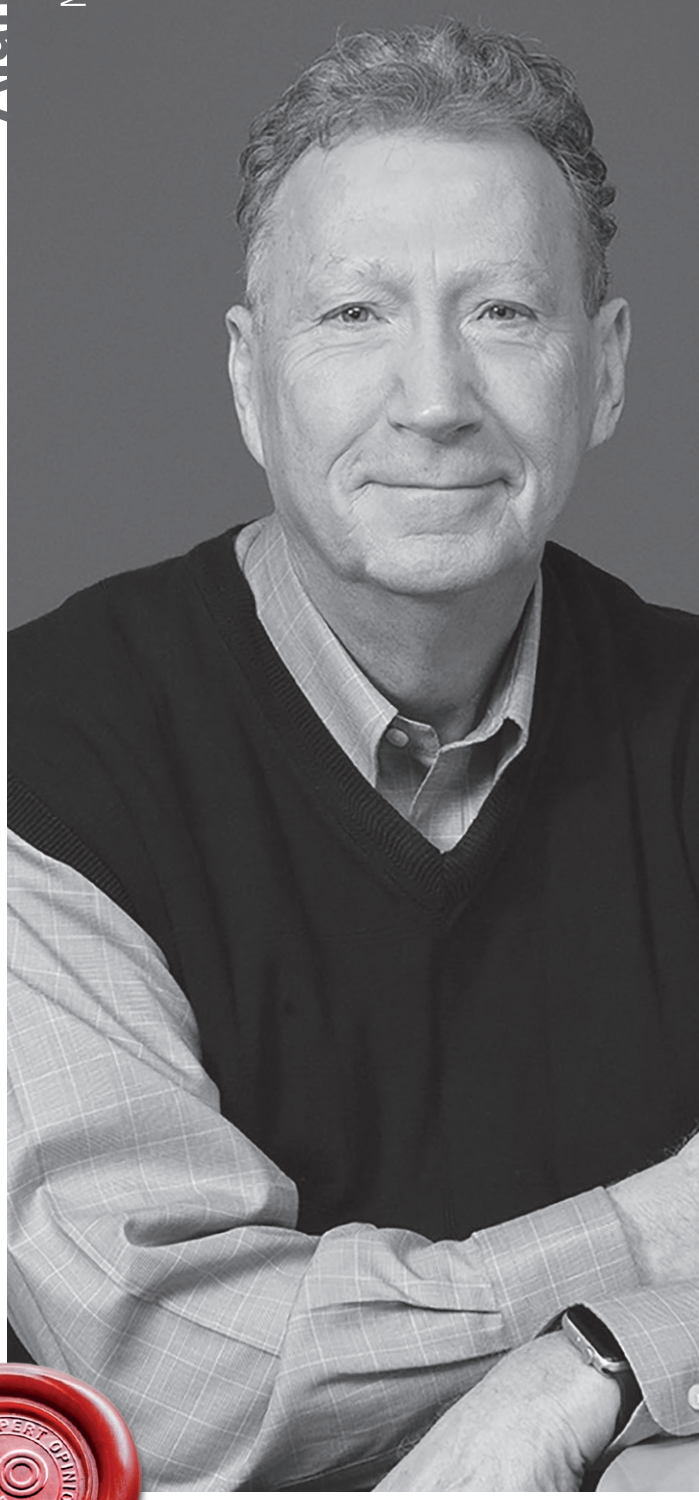
Alan has decades of experience in the power systems industry and is one of the greatest reliability experts out there.



Robert Brusetti

Vice President of Professional Services
at Doble Engineering Company

Interview with **Robert Brusetti**

> I think the industry has to do a better job of attracting talent... We have to bring renewables into the industry, which is introducing challenges to moving power from generation to where it's needed... A lot of utilities are becoming more and more dependent on outside talent.

Photo: Doble Engineering Company

Alan Ross: My guest today is Robert Brusetti, Vice President of Professional Services for North America at Doble. We're at the Doble Client Conference 2024.

I understand it's the largest attendance you've ever had.

Robert Brusetti: Yes, it is. It's a very impressive attendance that we have this year. It covers a lot of the North American client base.

AR I've been in the industry about 20 years. This industry has gone through more change in the last five to seven years than it has in a hundred years beforehand.

Where are we now? Where do you think it's brought us to?

RB It's brought us to a point where we're in a bit of a panic mode. During COVID, things shut down. We weren't doing a lot of stuff. I saw it in our professional services business, where we weren't doing as much visits to clients. Clients weren't engaging with a lot of training. We were trying to do training through virtual means, which doesn't really replicate being on site. Right now, we are making up for that time during which we were in a lockdown period. Add to that this drive to electrify the system, going with EVs, pushing renewables. It's causing the utility industry to do a lot of catching up, introducing new technologies, and a lot of scrambling to get the assets they need to support this growth in the electrical footprint.

AR Assets like transformers are now two, three, sometimes four years out, and you're not going to change that dynamic. That means the assets that you do have in place are more critical than ever. And there is the idea of good data to do good maintenance, etc.

You mentioned the difference between COVID and the non-COVID is we thought we could do everything digitally online. What we found is we can't. I know you got some incredible engineers that go out and help solve problems for people, but having that professional out there having that training hands-on, being at the at the utility at the site is incredibly important, right? Talk to me a little bit about what you learned coming out of COVID.

RB It has made us more willing to accept work remoting to begin with, and having the tools. I'm not going to plug one tool over another, but the tools we have today allow us to do things that, before, we were reluctant to use. They might have been there, but we weren't using them as much. We had webinars, yes, we did things, but we didn't do a lot of things like we do today. We might have a meeting in the office, but we all stay in our offices because it's just easier than going to a conference room. It has made me more accepting to having key people remote. I always felt that people needed to be at the office, and I still feel that way, but the ability to communicate, to give remote people the ability to feel like they are in the office is much better today than it was.

I think the tools we have today are better to accomplish that, to see who's available, a little green or red light shows up, and sometimes people play game the system though, they're always red. There's that ability to also do some level of management. We've implemented the tools now that, if somebody calls the main number, that automatically goes to an available engineer. It also doesn't just go to the first available engineer just because his last name it begins with an A. It keeps track of who we gave the call to so that we make sure we evenly distribute stuff.

One of the things people were always concerned with, primarily before COVID, was finding contact information. Post-COVID, here's the number. When you call the number, press one, you're going to get an engineer. We've really learned to utilize those tools much better.

AR Excellent, because what comes to mind for me is, we've learned how to collaborate differently, remotely, to bring in experts to do the kind of thing.
Before we started this, you brought up that the deregulation that we went through is similar to what the airline industry went through.

RB To some extent. When Ronald Reagan deregulated the airline industry, some airlines fared poorly because they were serving markets where they were guaranteed a certain price, and a number of airlines went out of the business. But overall, with the exception of COVID, flights have become more cost effective. People will complain about the services, but we're getting great value in a seat on a plane.

When we deregulated the utility industry, I used that as a model to see how it was faring, but I was quickly corrected that the difference between the airline industry and the utility industry is the airline can decide to fly into a city and not fly into a city, whereas the utility has to serve that person. They have to invest no matter what, but I think the utility industry overall has become far more efficient due to deregulation. But deregulation for the utility industry is a very different model than the airline industry. They have certain restrictions.

Photo: Shutterstock

DURING COVID, THINGS SHUT DOWN. WE WEREN'T DOING A LOT OF STUFF... ADD TO THAT THIS DRIVE TO ELECTRIFY THE SYSTEM, GOING WITH EVS, PUSHING RENEWABLES. IT'S CAUSING THE UTILITY INDUSTRY TO DO A LOT OF CATCHING UP, INTRODUCING NEW TECHNOLOGIES, AND A LOT OF SCRAMBLING TO GET THE ASSETS THEY NEED TO SUPPORT THIS GROWTH IN THE ELECTRICAL FOOTPRINT.

I THINK SOME OF THE HEADWINDS WE'RE FACING TODAY IN TERMS OF OUR TALENT BASE AND TRAINING IS A RESULT OF LACK OF INVESTMENTS WE MADE AS WE TRANSITIONED OUT OF DEREGULATION, WHICH WAS ALMOST 30 YEARS AGO... UTILITIES ARE REALIZING THAT THEY WEREN'T DOING THE ADEQUATE TRAINING... IF YOU WANT TO BE A KNOWLEDGEABLE, VALUABLE TRANSFORMER ENGINEER, YOU EITHER GOT TO HAVE A UTILITY THAT'S WILLING TO INVEST A LOT IN YOU TO GET UP TO SPEED, OR YOU GO WORK FOR AN OEM.

When they want to raise rates, they have to go to a committee or a council, and they decide if the rates go up.

I think some of the headwinds we're facing today in terms of our talent base and training is a result of lack of investments we made as we transitioned out of deregulation, which was almost 30 years ago. We're dealing with assets with long life cycles, you're not seeing the immediate effect of not investing in certain things. A lot of what we're seeing today, such as these rooms packed with people, is because they finally realize there's so much to learn, and the utility industry doesn't have a lot of avenues to get trained.

Transformers are much more complicated than what you learn in a textbook. The world has only a couple hundred true transformer experts that understand transformers very well. That's an extremely limited pool. Utilities are realizing that they weren't doing the adequate training. Essentially, if you want to be a knowledgeable, valuable transformer engineer, you either got to have a utility that's willing to invest a lot in you to get up to speed, or you go work for an OEM.

AR That number of experts is decreasing every year because most of them are over 60.

RB Unfortunately, in the last six months, we've lost two of them in our industry. When it happens, everybody knows, it's not like a Vice President of Professional Services, they're a dime a dozen [laughter].

AR We've now got up to where we are now. What are the challenges, the opportunities on front of us? What do you think the next five to seven years look like in the power industry?

RB It's a steep learning curve, and I hope that people understand it. I think the industry has to do a better job of attracting talent. We're competing with a lot of glamorous technologies. The kids come out of college and they are going to these industries, and we compete with them, because we need engineers as well.

If you look at the utility industry, a lot of people that are in the field, trained by the utilities, move up. Not having the tools of an engineer, or somebody who's been trained in the discipline, you're going to struggle adapting to some of the technologies that come along.

We have to bring renewables into the industry, which is introducing challenges to moving power from generation to where it's needed, because we don't have the various components in the grid that would naturally allow the power to flow to the load, so things have to be done to the grid to push the power in the direction you want it to go, something we never dealt with much in the past. The systems are quite complicated, and I find utilities that require this technology or this service have to outsource it, because they lack the talent in-house to do it. A lot of utilities are becoming more and more dependent on outside talent.

I don't want to criticize it too much, because that's how I make a living too. But that's the reality, that's where Doble is positioned nicely, because we don't build the product that is used to generate, transmit, and distribute the power. We can step back and be an independent view of the whole thing, because we don't really have skin in the game.

That's why there are a lot of people at these events, because we stress and review every presentation before it's made to make sure it is technically solid. We don't allow commercials, though something sneaks in here and there, but it is 99% pure technical experience here. We don't allow certain parties to come to certain meetings, because we know they have a vested interest in the discussion, so the people that have issues with these assets can speak freely.

AR I've got two points I want to follow up on. One of them is this open architecture. Nobody's going to have a solution that a utility can buy and say, hey, that's the whole solution, because they have equipment from so many different manufacturers. They don't want to rely on any one vendor. They want to make sure they can take data from all of the different assets.

The second theme is power quality. When we look at the system, we have this step-down system, down to the rate payers. Now the rate payers are becoming not just consumers, they're becoming prosumers. Power comes back up.

Some of the utilities' ratepayers are now their vendors, which complicates things, and it introduces an enormous amount of harmonics and transients into a system that we're still trying to grapple with.

RB Let's touch on the ubiquitous system. From a data perspective, you're absolutely right, they want data from all the sensors they put out there to come back on a platform into a database.

The problem is, you got all the data. What are you doing with it? There's a lot of value

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in there; how are you going to digest all that information? This is where you're hoping that some sort of intelligence or mechanism can help you. Right now, we're really taking advantage of 1% of the data we have out there. Having a mechanism gets us beyond that, even doubling and tripling it.

The biggest problem with that is first digesting. Is it good information or is it just noise? We have a couple million data points just on a particular test done on a transformer. That's a lot of data that's easy to digest because we already understand where good or legitimate numbers exist. You get a million data points; you throw out 10,000 data points because you know it's garbage because it doesn't fall within this window. It's not that easy in a lot of other areas. We don't have that expertise.

It's a two-part answer because the people at the level that have to design the system will say, No, I need a transformer that meets my specifications. I can't buy a transformer from just anybody. Yes, if I'm buying a little pad mount that feeds a small building, you can buy those off the shelf. If I'm buying a big transformer that's going to be gigawatts of power, I need a very customized design for my system, because in America we didn't develop all our systems that behave the same way. That's why transformer manufacturers are out three, four years, because it takes a long time to build a custom thing.

The second question is power quality. The biggest problem with power quality is, the prosumer has to understand that what he pays for the power coming into the house is not what he's selling the power for. The utility has a cost in moving it.

You're absolutely right that the utility needs to maintain a certain amount of power on the grid, because nobody wants to flip their switch and the lights not go on. We want 100% reliable power. The utility has to plan for how much power they have on the system, so they don't have a really good feel when all these very small power producers are pushing power onto it. And then a cloud comes by and things change.

They're doing a very, very good job, by the way, using modeling, using weather type information to kind of predict what short-term power they have on their system. It's still a problem because you're down at the distribution level.

They're used to their power being at a different part of the system where they could control it much better. At the end of the day, utilities

still have to keep their generators or sources of power available, even though they don't need it, because they have to maintain what's called a spinning reserve, because you don't know when something's going to come off, but you got to keep the lights on.

The other problem they're having is power is going in the other direction now, and the system was designed to go in one direction. It's adding another level of complexity.

You mentioned harmonics. There's a lot of harmonics, and some equipment is very sensitive to that. At a high voltage level, harmonics do a lot of damage to power equipment.

AR Thank you for that feedback.

I've got one last thing for you. We're here at the Doble Client Conference 2024 in Boston. Largest conference you've ever had, right? Over 1,300 people here.

You're the guy that needs to make sure all of those different presentations, all of the collaboration goes well, and you already said it, this is a no-sale zone, right? Getting all of these utilities to share with each other and capturing that, that's great.

Talk a little bit about what your expectations were, and how you are feeling right now that you're in the middle of it.

RB It seems to be going smooth. I kind of set the tone, but there is a group of engineers, which I refer to as our client services engineers, that are dedicated to this. They understand they serve a role in this industry, and they are the people who have to capture the information and then distribute it out.

I've been at this company, it'll be 35 years in August, and it was instilled in me from the very beginning that we are the stewards of this information. People are entrusting us in capturing the information and then turning around and making it available to them. You can go back and look at the first conference from 1934. We have books on that information. We've converted everything from 1958 to now electronically, so you can get access to it very quickly. If you want something before then, we'll help you get it.

This fall we have a smaller meeting with about a hundred and fifty people, primarily managers and asset managers, engineers. We get together and decide on the program. It's a full week of, let's see what your issues are. What do you have going on? What have you learned? What's working for you? We put that all together, and it ends up creating this program. We have 51 technical papers throughout the week, along with other things going on, and people are presenting it. I'd say maybe a third of them are Doble papers. Another third are papers that Doble help a client write, and the other third are clients that do it, or an OEM that has addressed an issue and wants to present the solution.

It all goes back to why it is so successful this time. There's been an appreciation that there's not a lot of avenues for power engineers to continue to evolve in their profession. The people in the industry and the managers have realized that. We're co

AR It has been a delight, Robert.

Thank you for putting this conference on and thank you for inviting us to come here and be a part of it.

RB Thank you for the opportunity to present our point of view.

Grid Modernization, Enabled by Data

by **John McDonald**

Photo: Shutterstock

We live in a data-driven world. For power utilities engaged in grid modernization, however, basic questions remain pertinent to their mission: What is the underlying philosophy supporting big data for power systems? What grid modernization goals can be realized by applying big data? And, perhaps most importantly, what concrete steps can be taken to achieve these goals?

The foundational thinking on grid modernization, in my view, relies on three philosophical points. First, the entire effort must be approached in a holistic manner. Second, data should drive improvements in a power utility's ability to meet consumer expectations for safe, efficient, reliable and affordable power. Third, data is an enabler of value, and to survive upheavals in technology, markets and regulatory models, utilities must embrace data-driven opportunities.

The foundational thinking on grid modernization relies on three philosophical points: a holistic approach, data-driven improvements, and embracing data-driven opportunities.

John McDonald, P.E. serves as a consultant in the electric utility transmission and distribution industry. With 50 years of experience, John holds B.S.E.E. and M.S.E.E. degrees from Purdue University, and an M.B.A. from the University of California-Berkeley. He is a Life Fellow of IEEE, recipient of numerous awards including the IEEE Millennium Medal, and has served in leadership roles including Past President of IEEE PES. John is also a member of the US National Academy of Engineering. He continues to contribute to the field through teaching and publications, and has received recognition such as the 2009 Outstanding Electrical and Computer Engineer Award from Purdue University.

The Journey to Digital Transformation (see Figure 1) requires changes in instrumentation, data collection and analysis, and automation to enable situational awareness. Understandably, many power utilities remain in reactive mode. Moving forward will require a complete inventory and review of all assets on the power network, as well as reviewing each asset's criticality to create a business case for prioritized investments.

Moving from Level 2, a responsive mode, to Level 3, a predictive mode, involves modeling – data will provide the network's actual balance of demand and generation, enable predicting the impact of weather, and understanding the subsequent risk of asset failure. At Level 3, a utility improves its readiness for extreme weather – the leading cause of outages – and applies those insights to assessing asset fleet risk.

A significant advancement that supports Level 3's predictive posture is the concept and application of a "digital twin," – a software representation of a physical asset, system, or process that harnesses real-time analytics to detect or predict operational issues and avoid fix-on-fail scenarios.

Today, enabling Level 4 and Level 5 capabilities is dependent on technological advancements. In Level 4, artificial intelligence (AI) drives application optimization and orchestration from the network's edge to the cloud to prevent or limit outages. At Level 5, the network becomes self-healing, with autonomous operations and limited human intervention. If your utility begins digital transformation today, it will be positioned to take advantage of technology that enables Levels 4 and 5 when it becomes available.

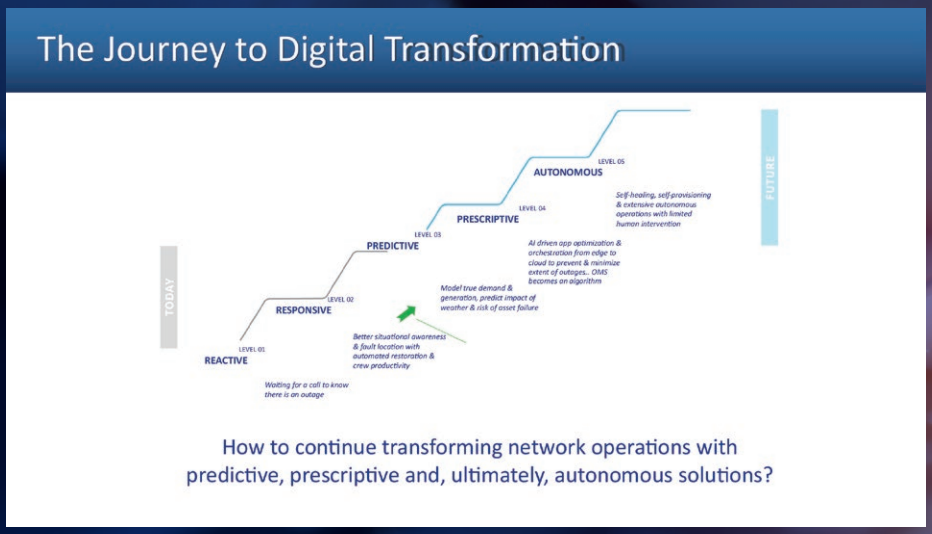

Figure 1. The Journey to Digital Transformation.

Concrete steps

The first step – taking a holistic approach – is conceptual, but it requires heavy lifting.

A utility must view transmission and distribution (T&D) as a single, integrated entity. Its Operations Technology (OT) group must be seamlessly integrated with the Information Technology (IT) group for operational and enterprise data management. (Executive leadership is critical.) The shared goal of all departments must focus on consumer engagement and satisfaction based on improved system reliability, resiliency, and efficiency. A holistic approach requires interoperability

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between devices, systems, and databases, based on open architecture and standards.

This means that all data-producing devices in a T&D system are mapped to communication channels and networks with the necessary response requirements and the result is routed to both operations and enterprise sides of the organization. This will enable every authorized, internal stakeholder to have secure and timely access to that data for value creation. This should align consumer needs with utility operational business drivers. That alignment should illuminate how to approach data generation, collection, storage, and presentation or access – and how actionable intelligence is applied.

"Strong" before "smart"

Developing a "strong" grid before pursuing a "smarter" grid begins with establishing an information and communications technologies (ICT) foundation based on open architecture and industry standards. Initially, IT and communications groups together determine the functional requirements (response requirements, bandwidth, latency) of every data path – from sensor to end-user – for current and future systems and applications. Having established a "strong" ICT foundation, a utility can proceed to develop a "smart" grid, and map data from sensor to end user.

"Strong" before "smart" also refers to enabling pan-organizational cooperation in pursuit of utility-wide goals; cultural shifts accompany technological advancements.

Observability Strategy

Control room operators must be able to "see" the status and performance of all key elements of the power network and eliminate "blind spots." Pursuing this goal means adopting an "observability strategy." Blind spots should be addressed based on their criticality to the network. Are the right sensors providing the pertinent data for analytical applications that provide visibility? The business case for sensor and application should be evaluated to produce an enterprise-wide total return on investment (ROI). Today, data-producing sensors and devices known as intelligent electronic devices (IEDs) are proliferating on the "D" side of "T&D." IEDs may be standalone sensors, or they can be data-producing substation protection and control equipment such as protective relays, load tap changers, etc. IEDs produce two streams of data – operational and non-operational – that must be fully exploited to create visibility with a solid ROI.

Non-operational data can inform enterprise goals for energy efficiency, load shaping and capital deferral. For example, metering data is non-operational data, which can support energy efficiency and reliability programs such as demand response and dynamic pricing (see Figure 4).

To take us one level deeper, each IED has multiple "points" that produce either operational or non-operational data. All the points in a specific IED may be conceived of as a "data map". Each IED and its data map

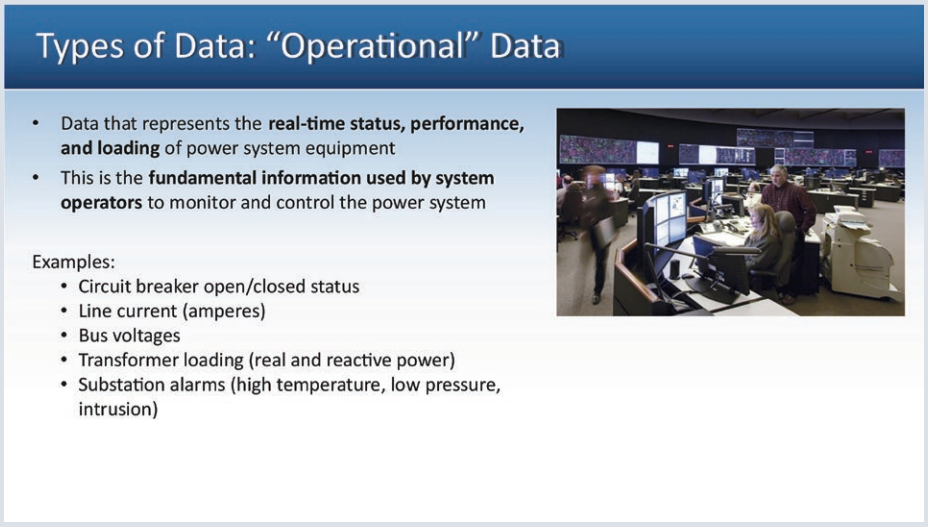

Figure 2. Operational data is routed in real time to operators in control centers for monitoring and control purposes.

Operational & Nonoperational data

These two data sources require different routing and enable myriad means of value creation. Operational data is routed in real time to operators in control centers for monitoring and control purposes (see Figure 2). Non-operational data is routed, stored, processed and made accessible on-demand to both operations personnel and enterprise units for use with their applications (see Figure 3).

Network response requirements

Because various data streams rely on a variety of response requirements, a utility may rely on a variety

should be matched with one or more communication network(s) that provide the response requirements appropriate to transmitting that data. Operational and non-operational data each have their own communication network response requirements.

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Types of Data: "Non-Operational" Data

Data items for which the **primary user is someone other than the system operators** (engineering, maintenance, etc.)

Note that operators are usually interested in some data that is classified as non-operational

Examples of "Non-Operational" data:

- Digital fault recorder records (waveforms) (protection engineer)
- Circuit breaker contact wear indicator (maintenance)
- Dissolved gas/moisture content in oil (maintenance)

Figure 3. Non-operational data is routed, stored, processed and made accessible on-demand to both operations personnel and enterprise units for use with their applications.

Characteristics of Operational & Non-Operational Data

Characteristic	Operational Data	Non-Operational Data
Data Format	Usually limited to **individual time-sequenced data items**	**Usually a data file** that consists of a collection of related data elements
Real Time vs Historical	Usually consists of **real-time or near real-time** quantities	Mostly **historical** data: trends over time
Data Integration	Easily transportable by conventional SCADA RTUs using **standard (non-proprietary) protocols**	Typically use **vendor specific (proprietary) formats** that are not easily transported by SCADA communication protocols

Figure 4. These two data sources require different routing and enable myriad means of value creation.

of communication networks to achieve the desired, cost-effective functionalities. Time synchronization of data is an essential requirement. Data often must be time-tagged to reliably determine correlations or sequence of events.

The real-time operational data generated by IEDs typically demand the most stringent response requirements, whether the medium is redundant fiber optic cable ringing a service territory, wireless microwave or UHF.

Yet, operational data is heterogeneous and a utility can take a mix-and-match approach to the communication networks it rides on. Examples include "smart" interval meters that record data every 15 minutes, integrated Volt/VAr Control (IVVC) that requires only 30-60 seconds to switch on distribution feeder-based capacitor banks and, in contrast, Fault Detection, Isolation and service Restoration (FDIR), which requires a 2-second response.

The bandwidth of non-operational data is determinative in selecting a communication network, because a digitized waveform, for example, may require a "fat pipe" to reach the enterprise uncorrupted. Speed, latency, and other metrics of the communication path are less crucial because non-operational data is often used for forensic analyses. Non-operational data is also heterogeneous, so it too can also benefit from a mix-and-match approach to communication networks.

Integration before automation

Integrating IEDs across the substation and on distribution feeders requires assigning each data stream to the appropriate communication network and routing those data streams to the control center and/or the enterprise. Remember, now that IEDs are synonymous with nearly every piece of power system equipment, including protective relays, meters, transformers, etc., visibility depends on operators seeing their behavior (operational data) and understanding their condition (non-operational data).

The integration challenge can be visualized as a series of layers. At the bottom, transformers and circuit breakers represent the foundation. The next levels "up" include IED implementation, IED integration, and substation automation (SA) applications. The enterprise comprises the fifth and highest level.

Historically, IED integration has often focused only on operational data – for example, instantaneous values of voltage and current. This often ignored the value of non-operational data, which can be, for example, on-demand or event-triggered data of logs of events and oscillography that aids diagnostics and forensics on conditions that lead to outages or equipment failures.

Integration can be complex and costly because it requires that the utility to tie together protection, control and data acquisition

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functions. To control capital and O&M costs, a utility should use the fewest possible number of platforms and avoid redundant equipment and databases.

The integration of data-producing devices and systems precedes SA. (SA refers to implementing SCADA, alarm processing, and other functions to optimize asset management and operational efficiencies without human intervention.) Determining SA applications initially requires observing the behavior of data over time (daily, seasonally) and diverse conditions (weather patterns) to establish data-based threshold values that can trigger automated responses. In order of importance, the three crucial elements are: data, software analytics, and the user experience. Note the tell-tale shift from emphasis on the "user interface" (a passive notion of how data is presented) to the "user experience." As utilities become data-driven, how data is presented or accessed must become intuitive to support operators in making beneficial, timely decisions.

Integrating IEDs across the substation and on distribution feeders requires assigning each data stream to the appropriate communication network... visibility depends on operators seeing their behavior and understanding their condition.

Connecting sensor to data user

The routing and use of operational data is likely old hat to readers, so let's drill down on the routing and availability of non-operational data. This challenge has a technical component, yet I must reiterate the accompanying cultural shift in which formerly autonomous personnel must work across legacy silos, for the greater good. Grid modernization will not happen without integrating and modernizing the utility workforce into an interactive, cohesive unit. This workforce evolution will lead to organizational and business process changes, so it's a fundamentally transformative, irreversible process. It is the first step from a reactive utility to a proactive utility on The Journey to Digital Transformation (see Figure 1).

Coupling organizational change with technology advances, if properly understood and implemented, will unlock significant value in resolving business challenges. Operationally, the step I'll now outline will enable a utility to shift to a more effective and less costly condition-based maintenance approach and support future functionalities.

Functional data paths

Fasten your seatbelt! The design and information architecture that can deliver non-operational data to the authorized enterprise individual or unit for value creation requires the creation of an enterprise-wide "data requirements matrix." The first step in this process involves querying business unit managers on who in their bailiwick needs non-operational data. The process must specify the precise type of data, its form, and at the specific time intervals for documenting that data.

Those being queried should be supported by a presentation on the inventory of IEDs and their data maps (the collection of data-producing points in each IED). This will enable business managers and their personnel to understand what's available to serve their needs. The affected personnel will also need technical assistance to properly understand how they can create value from this potentially new source of data, as well as how to use processing, applications, and presentation technology to achieve that value.

The purpose of the exercise must be clear: enterprise-centric value creation is the goal, not the use of data to support individual or business unit goals. Silo walls must crumble, both culturally and technically.

An inventory of distribution system IEDs must include their data maps and attributes. The next step is complex – to determine which points in each data map can serve value creation by enterprise stakeholders.

The attributes associated with each IED data point might differ among devices by different vendors; they must be accurately documented.

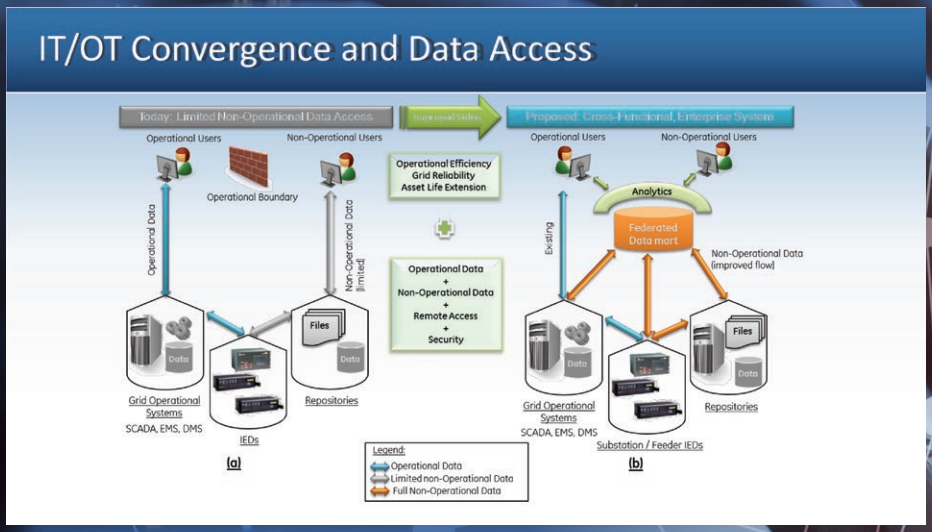

Figure 5. The siloed arrangement, left, typifies many utilities' suboptimal approach to data management, limiting access to non-operational data. On right, all devices, systems and data repositories feed into a federated data mart (FDM), enabling organization-wide access to both operational and non-operational data for improved decision making and value creation.

Examples abound. The data sampling rate in one device might vary from another. An end-user might seek a peak value or an average value for each hour of data retrieved. These attributes are referred to as the "aspect of value." It is crucial in this step to determine what data each IED produces and the "aspect of value" to the end user.

Once the IED template (the sensors and their data maps) and the data requirements matrix (who needs which data and its attributes) are established, the project turns to

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mapping the data source to the end user. And that, in turn, informs the network architecture that delivers non-operational data across the corporate firewall into a data repository/warehouse, where it can be accessed on demand by authorized users. From experience, I can state that rigor and accuracy in this phase are critical to a successful outcome. To extract full value from IEDs implemented in the future, they are simply added to the existing template, matrix, and map. Utilities often rely on a number of physical data repositories, which remain useful in the data mart scenario described here.

on-demand from a virtual data mart, which has received the data from the operations (SCADA) historian. A data mart also guarantees that users across the enterprise all access data possessing a single, precise value. The data mart user interface should be designed to allow a user to report suspicious data that may reflect sensor, system or process errors or even a cybersecurity breach. Figure 6 illustrates how myriad data sources feed both a control center and an enterprise information management center. On the enterprise side, data in a federated data mart (FDM) can be readily accessed for value creation by diverse, authorized end-users.

perceptions, and motivations, which requires an understanding of market segmentation.

All the points made in this article may seem quite distant from our historical notion of "grid modernization," but The Journey to Digital Transformation, coupled with seizing the day on prosumer market segmentation will indeed pave the way to cost-effective, secure, future-oriented grid modernization that is every utility's goal.

Author's note: This topic deserves to be explored at greater depth and I do so in my Chapter 1 in Big Data Application for Power Systems (Elsevier). The book's 2nd edition is in press.)

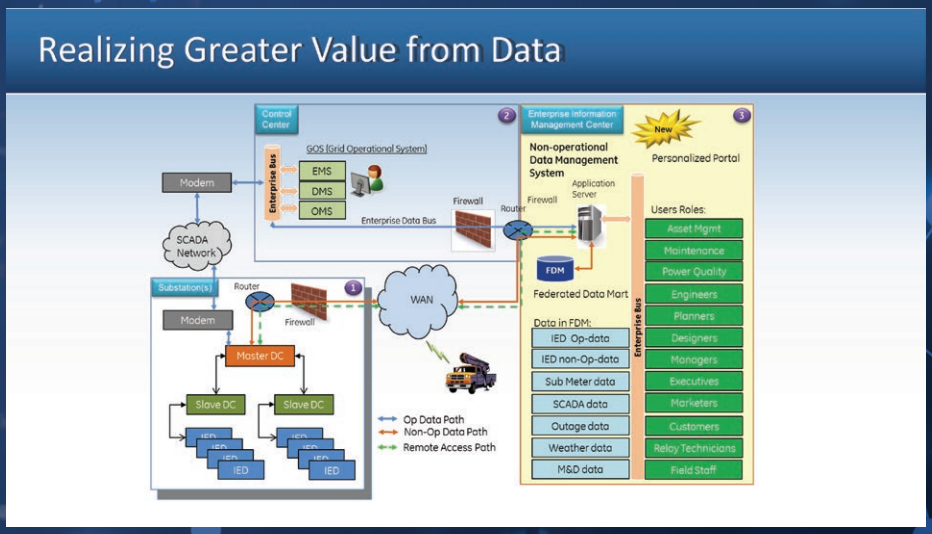

Figure 6. This illustration depicts how myriad data sources ideally feed both a control center and an enterprise information management center. On the enterprise side, data in a federated data mart (FDM) can be readily accessed for value creation by diverse end-users (user roles in horizontal green boxes at far right.

A federated data server can sit atop and access these potentially disparate, legacy repositories, creating a "virtual data mart," which includes both operational and non-operational data. Figure 5 illustrates a typical, siloed approach to data management (left) and how that can be transformed (right) so that authorized users across the utility organization can access both operational and non-operational data.

If this painstaking process is carefully followed, an enterprise end-user can access non-operational data

The consumer

Readers must surely be aware that "customers" – energy users with their name on the bill – have evolved to become "consumers" (all energy users) and even "prosumers" who own their usage data and expect value for allowing a utility to use it. Ultimately, prosumers will likely shape a utility's business model and how its operations and enterprise staff successfully deliver value. Prosumers, however, are not homogenous and, thus, they must be engaged and that requires understanding their diversity of needs,

Readers must surely be aware that "customers" – energy users with their name on the bill – have evolved to become "consumers" (all energy users) and even "prosumers" who own their usage data and expect value for allowing a utility to use it.

INTEGRATION OF DGA MONITORS

FOR MORE COMPREHENSIVE TRANSFORMER MONITORING SYSTEMS

VAISALA

The wait for new transformers means that operators of old units may need to extend their operational lifetime further than originally planned.

The current situation with transformer procurement lead times has increased the criticality and importance of transformers in operation, while heightening the relevance and usefulness of continuous monitoring as a tool for asset management. At the same time, the growing pool of assets in need of condition monitoring continues to increase as early indication against failures is essential to grid uptime.

The wait for new transformers means that operators of old units may need to extend their operational lifetime further than originally planned. Dissolved Gas Analysis (DGA) can be part of the solution, and especially when done continuously with a dedicated monitor, it is one of the best and more comprehensive transformer condition monitoring tools available.

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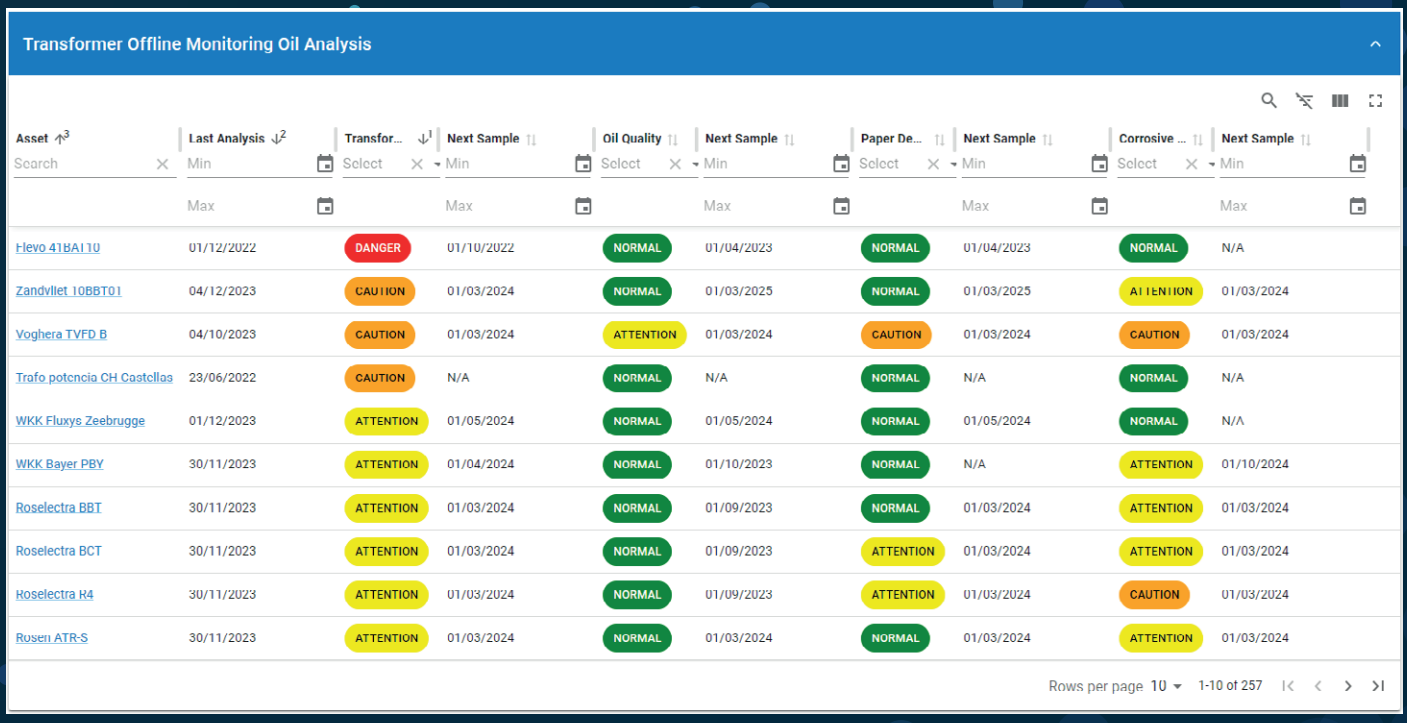

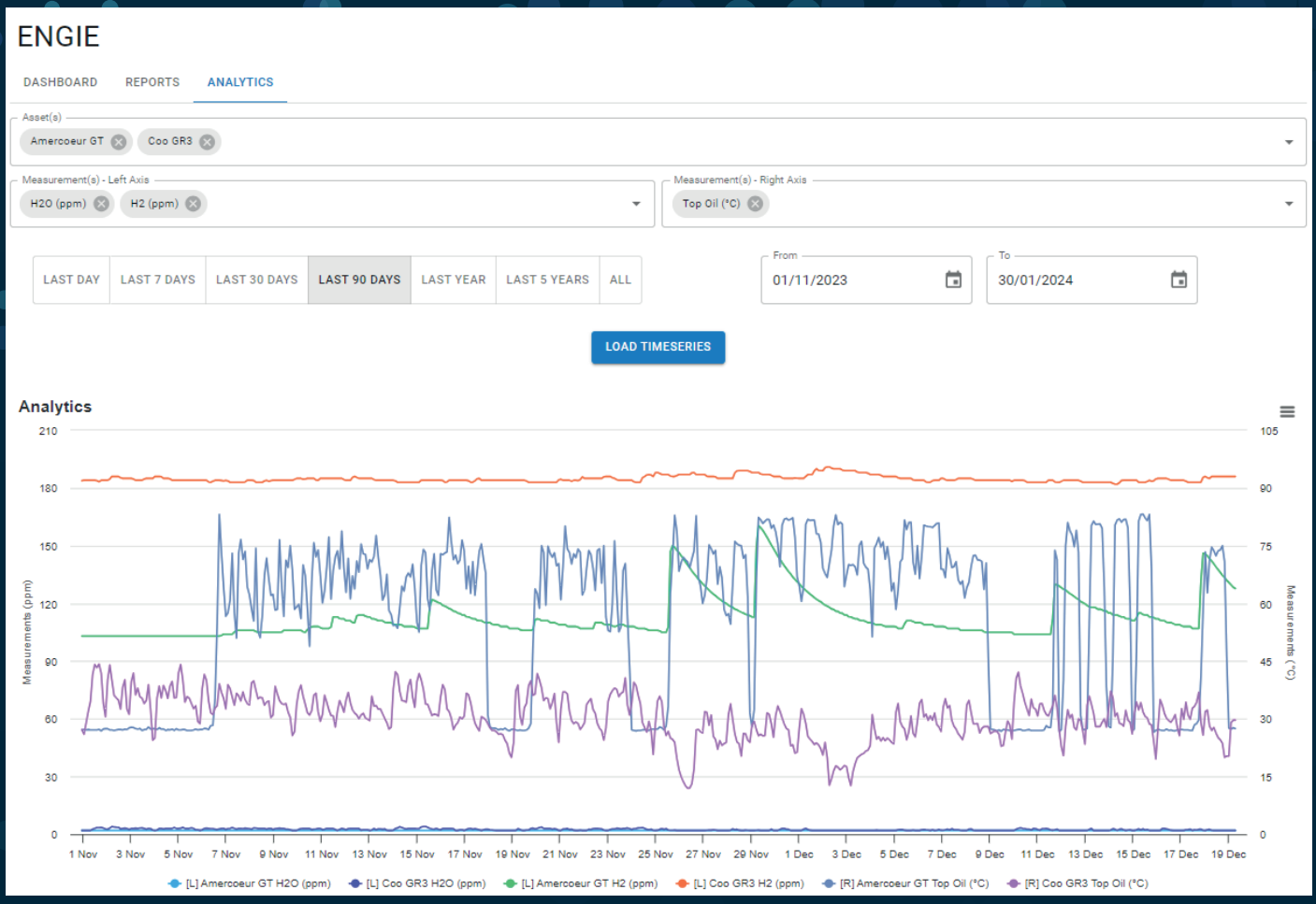

Figure 1: ENGIE Laborelec OneBoard platform, fleet overview and analytics tool
Photo Credit: ENGIE, ENGIE Laborelec OneBoard platform

Critical integration testing must be done for multi-gas DGA monitors with multiple transformer monitoring systems to make sure that the communication protocol implementation is compatible with other systems.

One of the main difficulties reported by utilities in adopting continuous DGA monitoring is handling of the data monitors produce and making sure that alarms and notifications from the monitors are relayed to correct recipients. Many transformer owners are turning toward transformer monitoring systems to improve the collection of data and analytics for the transformer condition assessment as a whole. The systems can also ease generating alerts of issues and directing them to the correct people, whom have the necessary skills and knowledge to react to these situations.

Handling transformer monitoring on a large scale with immense transformer fleets is also driving this interest. Integration of DGA monitors to these systems is one effective way to increase the systems monitoring coverage and implement quick responses to any developing faults detectable by DGA. Correlating the DGA data with transformer loading, oil temperatures and other information complements the analysis and detection of issues. Another advantage of these systems, depending on the implementation, is that the condition monitoring data can be routed separate from operationally critical SCADA data, thus allowing separation of these networks for better cybersecurity.

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Contrary to the belief that transformer monitoring systems are closed and only accept certain inputs, many of them allow different DGA monitor manufacturers' units to be integrated fully into the system. As there is no standard or certified way that monitors should communicate with a transformer monitoring system, there can be slight differences between common protocol implementations (Modbus, DNP3 & IEC 61850) that could cause issues transmitting data. The only way to be certain of inter-compatibility is through testing.

DGA monitor manufacturers can perform integration tests with monitor system makers to verify the compatibility of the monitor and transformer monitoring systems beforehand. This ensures that no surprises of data transmission or data format incompatibility exists between the system and monitor, and that the system can be taken into use without issues.

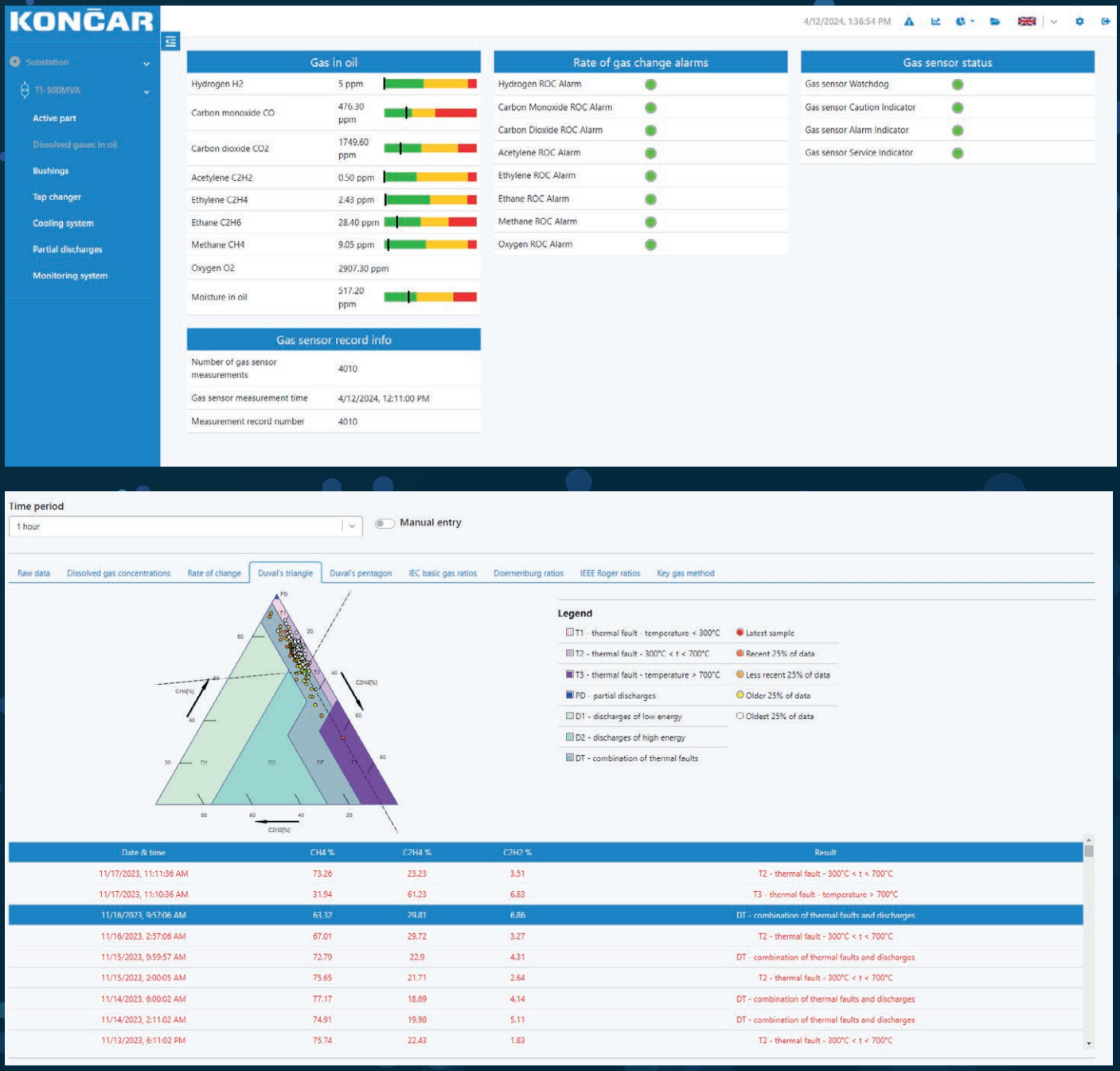

Figure 2: Koncar TMS, DGA measurement screen and diagnostics view
Photo Credit: Končar Group

Critical integration testing must be done for multi-gas DGA monitors with multiple transformer monitoring systems to make sure that the communication protocol implementation is compatible with other systems. This promotes the attitude toward more open systems and ensures that users can utilize DGA monitors, and that data is produced with ease, in the monitoring system of their choice.

There are numerous commercial monitoring systems available for this purpose and each have their own specialties and strengths, so not all compatible systems can be covered, but a few systems and screenshots are presented here.

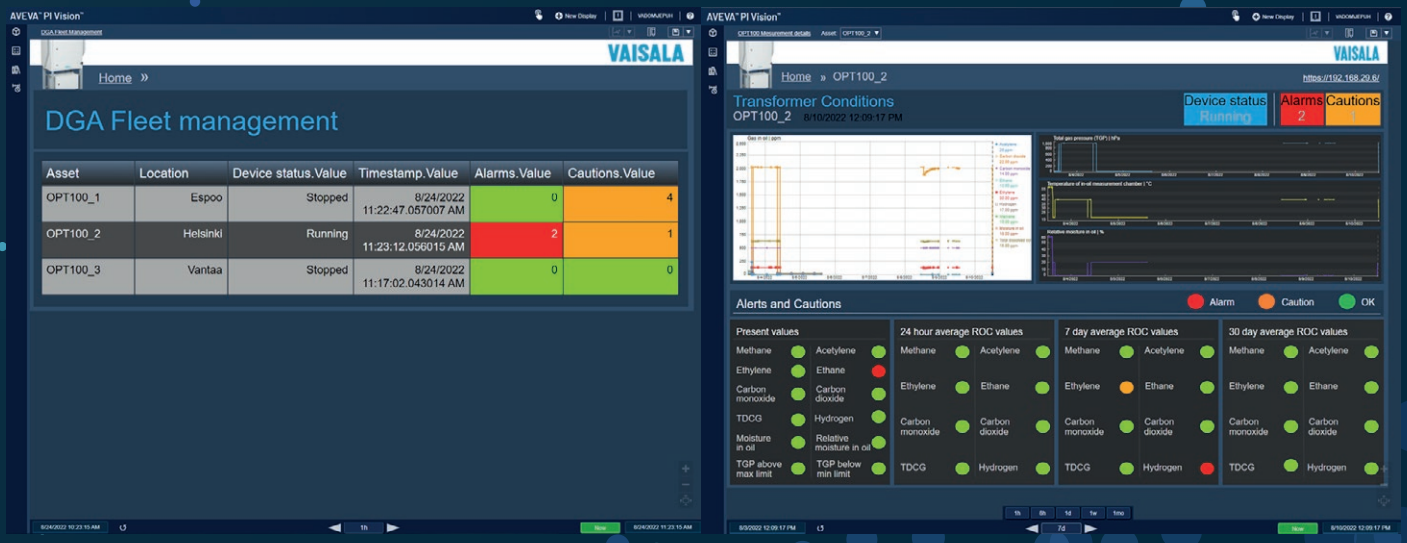

Figure 3: AVEVA PI System (formerly OSIsoft PI System), implementation of fleet overview and monitor data view by Vaisala with OPT100 Optimus™

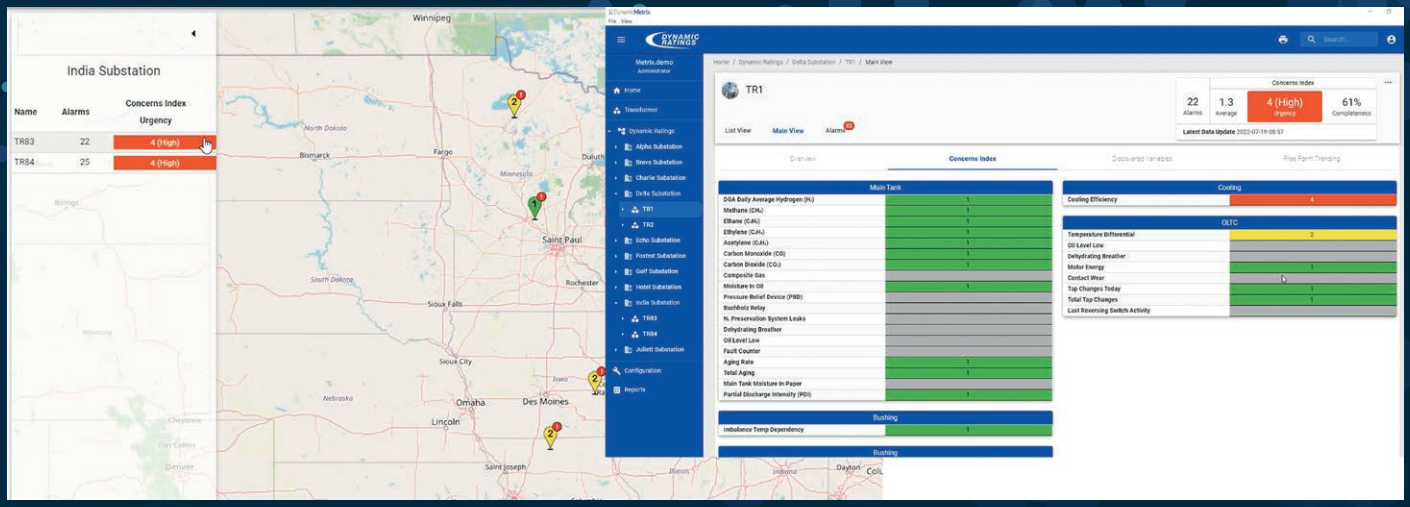

Figure 4: Dynamic Ratings DynamicMetrix®, map view and transformer condition view
Photo Credit: Dynamic Ratings

Toni Mellin is an Application Manager at Vaisala and actively working in Cigre, IEC & IEEE collaborating with other experts. His 9 years of experience in transformer condition monitoring enable him to support research and development, sales, and other functions to understand customer needs and drive innovative solutions. Toni holds a Master of Science degree in Electrical Engineering.

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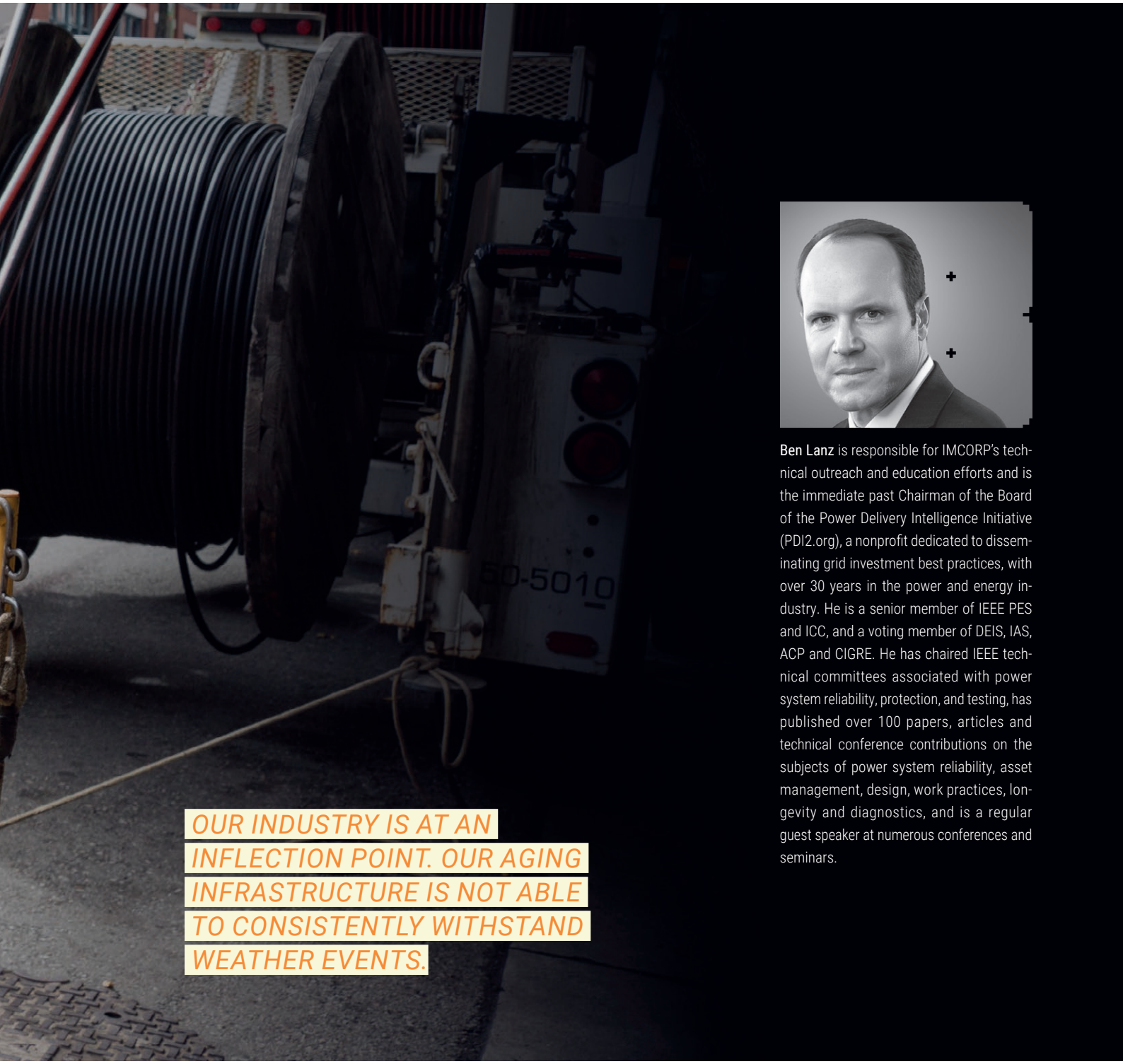
Grid infrastructure investment: A societal decision?

By **Ben Lanz** Director of Solutions Consulting at Osmose, IMCORP

Photo: IMCORP



OUR INDUSTRY IS AT AN INFLECTION POINT. OUR AGING INFRASTRUCTURE IS NOT ABLE TO CONSISTENTLY WITHSTAND WEATHER EVENTS.

Ben Lanz is responsible for IMCORP's technical outreach and education efforts and is the immediate past Chairman of the Board of the Power Delivery Intelligence Initiative (PDI2.org), a nonprofit dedicated to disseminating grid investment best practices, with over 30 years in the power and energy industry. He is a senior member of IEEE PES and ICC, and a voting member of DEIS, IAS, ACP and CIGRE. He has chaired IEEE technical committees associated with power system reliability, protection, and testing, has published over 100 papers, articles and technical conference contributions on the subjects of power system reliability, asset management, design, work practices, longevity and diagnostics, and is a regular guest speaker at numerous conferences and seminars.

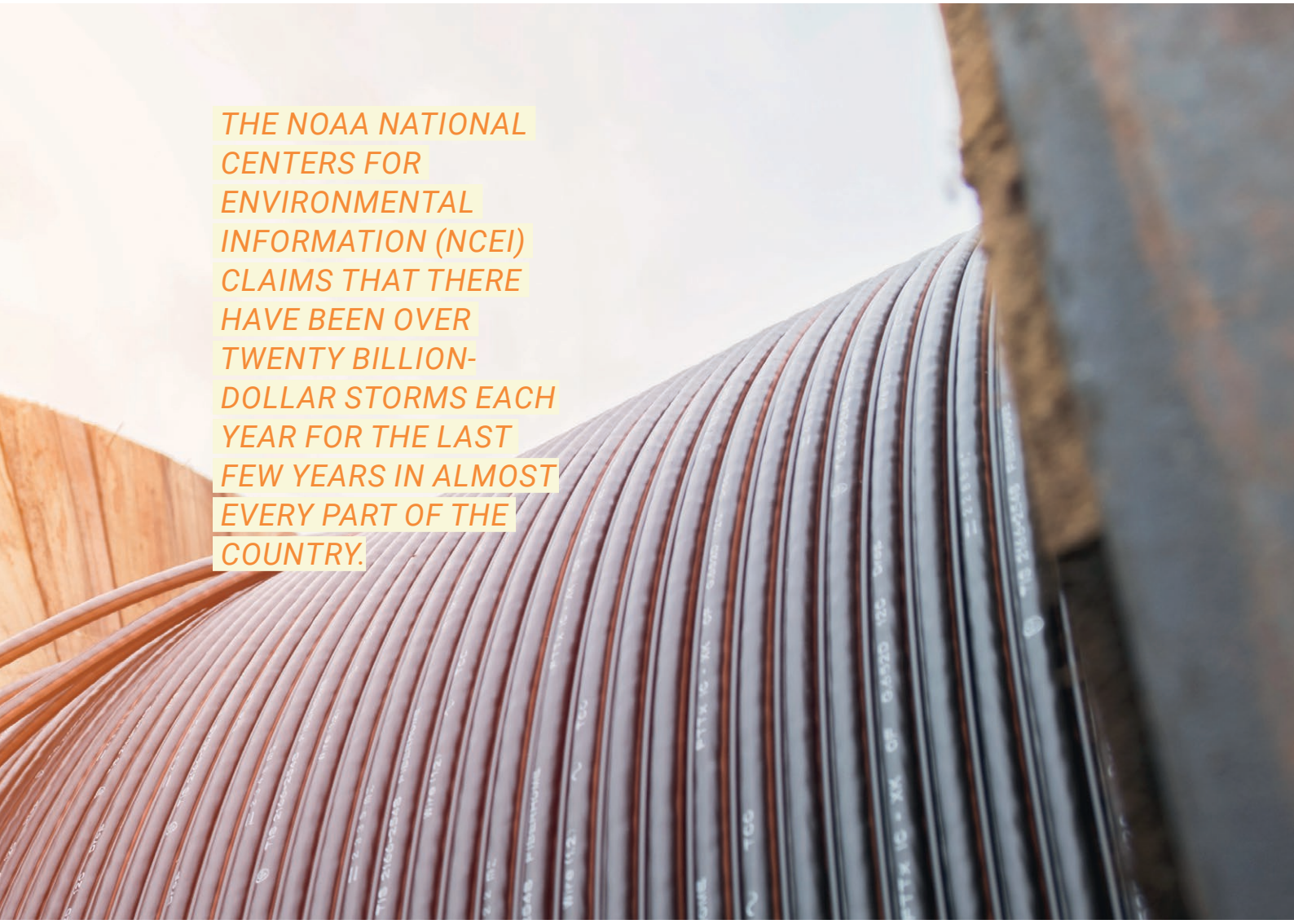
Grid infrastructure investment needs to be a societal decision. I believe utilities have an amazing opportunity in this new era of electrification to make the case to society, their rate payers, to get support for capital investments which achieve the reliable, resilient, and sustainable grid we need.

Our industry is at an inflection point. Our aging infrastructure is not able to consistently withstand weather events. At the same time electric power is needed to support more of our critical tasks than ever before. According to the US Energy Information Administration (EIA),

the average American withstands seven hours of electric service outage per year. Obviously, this means that some of us experience no outages for years, while others are out for days or longer. According to the US Census, an increasing percentage of us are choosing to live in beautiful areas with high risk of fire or storm damage; places our ancestors never would have dreamed of living. As we journey to electrify a larger portion of our residential energy needs, and extreme weather, like storm Uri, takes out our power, many of us cannot maintain safe temperatures in our homes, protect our houses from damage, support in-home medical care devices, cook and preserve food, do our job, communicate with loved ones and emergency personnel, or drive our electric vehicles (EV), or even evacuate in our EVs during emergency situations!

If the power goes out for a couple days due to storms, what's the economic impact? The local utility will need to make significant investments to rebuild and often asks regulators for some relief on the shoulders of rate payers. But that is just the tip of the iceberg! Take the state of Florida for instance. The state GDP is estimated at over three billion dollars per day. If one third of the state can't do business, that's one billion dollars of loss per day. One billion of GDP worth loss including wages paid, commerce not transacted, and taxable revenues that will never be realized. And in case you think your area is exempt, the NOAA National Centers for Environmental Information (NCEI) claims that there have been over twenty billion-dollar storms each year for the last few years in almost every part of the country.

According to EIA, seventy-two percent of us are supplied by investor-owned utilities (IOU). This model has been nothing short of amazing in bringing safe, reliable and affordable electricity to the masses with minimal government investment during the first wave of national electrification. However, now that most of our significantly aged grid exists, who should make the decision to invest in upgrades to support new sustainability and resilience goals? Who decides to make the infrastructure upgrades that can withstand high impact low probability (HILP) events with little or no customer outage? Is it the IOU, an appointed government regulator, Wall Street, or a specific consumer advocacy group? I applaud bellwether utilities like Florida Power and Light, WEC Energy, and PG&E. These utilities have made the case to their rate payers for large proactive capital investments to their existing infrastructure spread out over years to achieve a more sustainable, reliable and resilient grid.



THE NOAA NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION (NCEI) CLAIMS THAT THERE HAVE BEEN OVER TWENTY BILLION-DOLLAR STORMS EACH YEAR FOR THE LAST FEW YEARS IN ALMOST EVERY PART OF THE COUNTRY.

Photo: IMCORP, Shutterstock

FPL is hardening their overhead feeder cable systems and undergrounding the rest of their 27,000 miles of residential circuits. WEC Energy Group surveyed their rate payers and found strong support for a reasonable increase to monthly bills to get upgraded resilient infrastructure. They have now undergrounded two thousand miles of their worst-performing overhead lines and achieved over 95% improvement. PG&E stated they are planning to underground ten thousand miles and have called it the ultimate sustainable solution for their high wildfire risk areas.

What if more utilities see themselves as long term capital investment institutions for society's benefit? What if they could get the publics' support to invest billions in proactive capital investment measures that could guarantee sustainability and resiliency? Reports indicate rate payers are willing to pay for sustainable reliability and resiliency, regulators want predictable rate growth and avoid frequent requests for storm relief, Wall Street wants a steady rate of return on investments, politicians want local investment with good jobs and protection for future tax revenues, and the utilities would be happy to avoid the storm fire drills that put their employees in harms way and reactive operations and maintenance costs that negatively impact their bottom line and stock price. Have I left anyone out? I believe utilities have an amazing opportunity in this new era of electrification to make the case to society, their rate payers, and get their support for large capital investments spread out over decades that achieves the reliable, resilient, and sustainable grid we need at the lowest total cost of ownership. I think grid infrastructure investment needs to be a societal decision. Do you agree?

Denis Phares

dragonfly® ENERGY

> From a downstream perspective, we need to have the energy delivered when it's needed. From an upstream perspective, the energy is delivered only when the sun is shining and the wind is blowing. That's what needs to be matched up.

CEO at Dragonfly Energy

Interview with **Denis Phares**

Photo: Dragonfly Energy

Alan Ross: We are here at the RE+ 2023 event in Las Vegas. My guest is someone that I've had interviews with before, and he's a delightful interviewee. Denis Phares is the founder and CEO of Dragonfly Energy. And you've got your pulse on the marketplace. First of all, we are going to talk about what changed since the last time you and I had an interview.

Denis Phares: It's great to be back. Alan, thanks for having me back. It is a rapidly evolving industry, obviously. There's so much that is happening because we're in the middle of this major global transition. If I were to, say, identify what has been changing lately over the last half year, over the last year, a lot of it has to do with just exposure in terms of understanding what needs to change over the next decade, next couple of decades. If you look at RE+ here today, what I've noticed, it's all batteries.

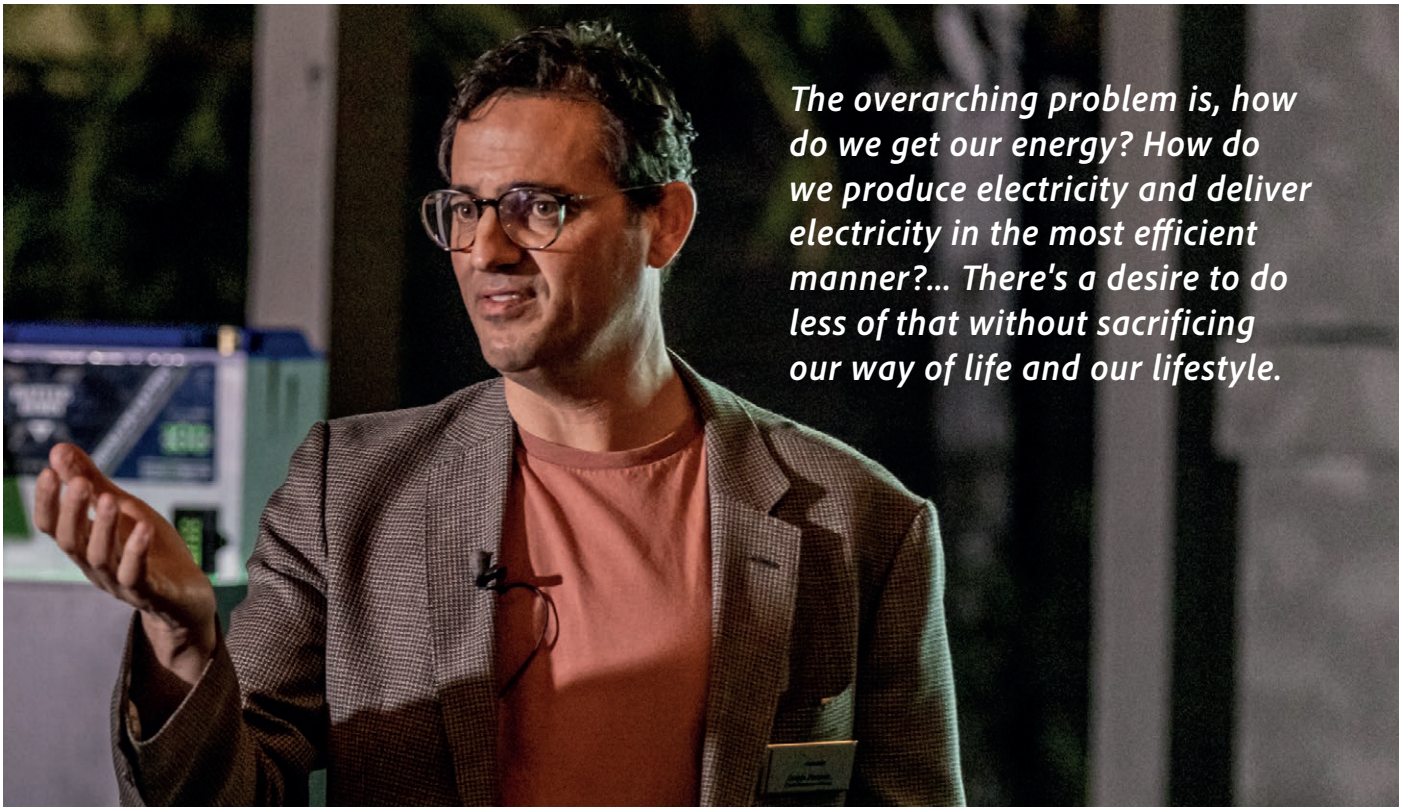
AR There's a lot of batteries here. Batteries, batteries, batteries. You said something about it evolving, but we're still identifying the problems and still trying to figure out how to merge a thousand solutions into the problems. And there'll be winners and losers. The people that figure it out will be the winners. But a lot of it comes about to collaboration of the overall problem. Define the problem a little bit more clearly today than maybe it was a year ago.

DP Well, the overarching problem is, *how do we get our energy?* How do we produce electricity and deliver electricity in the most efficient manner? And one thing that we are recognizing, especially over the last year or two, is that there are tangible effects on climate that we have seen from burning fossil fuels. There's a desire to do less of that without sacrificing our way of life and our lifestyle. It is now a very interesting mix of technology and money and financing and politics and just general public perception.

AR Where does storage fit in the midst of all of that? From a generation standpoint, we're moving to much more wind and solar. That's part of this. They're trying to say, *Okay, let's move to that.* We'll get some geothermal in there. People are still trying to build a nuclear plant. It's not going to happen in the United States, in my opinion. But let's assume that the generation is working. Now, on the other end, you have electrification of everything, especially transportation. That creates a whole storage problem of where things are. I know Dragonfly has a very unique solution we're going to talk about because you've applied it, you're out there in the marketplace. But talk about the gap between the transmission, generation transmission, let's assume that the politics will figure it out, but really the distribution and the electrification of society, because that's what we're really about, electrification of society. Talk a little bit about where storage as a part of that.

DP Well, you've got the downstream aspect, which is the electrification of things like transportation, and you've got

Photo: Dragonfly Energy



the upstream aspect, which is the solar and wind that you talk about. From a downstream perspective, we need to have the energy delivered when it's needed. From an upstream perspective, the energy is delivered only when the sun is shining and the wind is blowing. That's what needs to be matched up. You need storage to basically create that and it has to be large enough to be able to take in the energy when it's being produced and deliver it when it's needed.

AR That's not necessarily what Dragonfly does, but talk about some of the technologies that seem to be more promising in terms of large energy storage, that may be, for example, in large cars. Talk a little bit about what's happening in that space.

DP There are so many ways to store energy. You can store energy as electrochemical energy, like in a battery. You can store it as gravimetric energy, like pump hydro. You can store it in kinetic energy, like fly wheels. There's just so many ways to do it. And ultimately, what technology needs to is whatever you're doing, it has to be cheap. It's all about bringing the cost down, whether you're making new batteries, whether it's flow batteries or lithium batteries or fly wheels or whatever you're doing. It's got to be inexpensive enough that it makes sense for our application, either by end users if you're off-grade or by utility companies if you're on-grade.

AR Excellent. I want to go specifically to Dragonfly. Talk a little bit about your particular technology in this space, because you've invented it, correct? And then let's talk about what you're experiencing as one of the solution providers to the marketplace.

DP We have been working on cost reduction. The way that we've done it is by changing the way lithium cells, in particular, are manufactured. We've reduced the cost of manufacturing. Now, we haven't done that in our current core business, our current marketplace, where we are assembling battery for things like RVs and boats and industrial solar applications. In that regard, we're competing with lead-acid batteries, so from a cost perspective, we're already there in that arena. But when we want to revolutionize the grid, the cost has to be much, much lower. That's where we need to deploy our cell manufacturing technology, the dry electrode process we've developed. We just completed our pilot line. That's what happened since the last time we talked. We've begun to produce anode. The next step is to produce cathode, and then by the end of the year, we expect to produce full cells.

AR When you say the pilot project that happened, talk a little bit about that. How did you decide to do it? Did you get financing and funding for it? Because it's not cheap to do everything that you're doing.

DP It's actually a pilot line. We built a pilot line to produce on the order of about 150 megawatt-hours a year. It's not a very large scale gigafactory, but it applies our innovative


Photo: Dragonfly Energy

dry electrode process. And how did we finance it? Well, that's why we went public last year. We had to raise the capital to do that.

AR I hope we help get the message out about you going public last year. That's good. I want to talk about that scale up. You got to go now from the anode to the cathode to the scale up. The plan for doing that, and you talk about 150 megawatt-hour. Is that what you're trying to Scale, what does that mean? Does that run a city? Does that run my house? Talk about what you're trying to scale it to.

MS A 150 megawatt-hours annually for a lithium cell manufacturing plant is small. You're talking niche applications there, maybe a consumer electronics application by scale. Not that we're making those types of batteries, but if you want to make enough batteries to make a dent on the grid, then you need many gigawatt hours. We need to be in the terawatt hour range to really make a dent there. So everything's going to help. We're doing our bit. We're doing what we can to apply one technology and lower the cost. But I think everything is going to contribute.

AR Is that a proprietary technology?

DP It is.

AR Do you think you will scale? You'll just be able to scale, or are there certain size factors? Size matters, right? You get to a certain point where you say the technology won't work at this level or not.

DP No, I know we will scale. The point of the pilot line was to demonstrate that we can scale.

AR Denis, you got to save the world. That's what we need. We need technology that fits, that works because your technology has been applied before. It's not like it's a new technology, and it works in boats, RVs. Does it work in automotive?

DP I want to be clear. The technology that we've deployed in terms of our battery pack assembly is not the same as the cell manufacturing that we've completed the pilot line for. We will make the cells and then put them in the packs that we're already assembling and putting it out in the marketplace. Can the process be applied to EVs and car batteries? The answer is yes, it can. It's a chemistry agnostic process. We can make lithium iron phosphate cells, LCO cells, NMC cells. It is very versatile.

Photo: Dragonfly Energy

AR Excellent. You're part of the future.

DP We're working on it.

AR I appreciate that. Last question for you. You're here at RE+. This is what? Your third, fourth? What are you trying to say to the market from being here at RE+? What's your message?

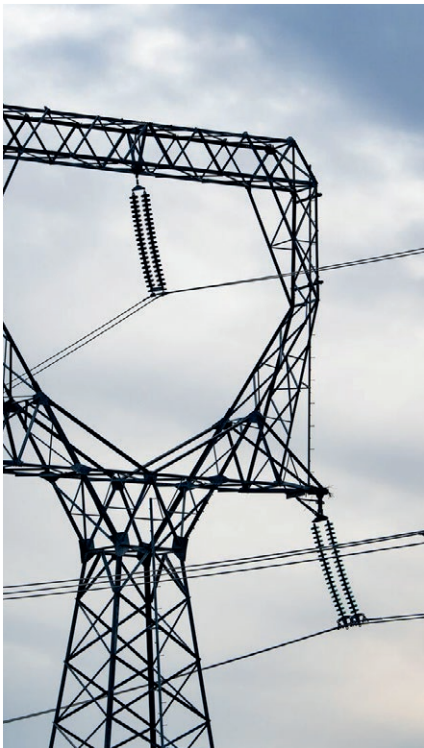
DP This show used to be the SPI show, the Solar Power International. Now it's the Renewable Energy Show. It highlights the fact that it's more than solar. Now you've got the issues associated with the storage and the transmission and all that stuff. The reason that we're here and what we hope to get out of it is we want to form collaborations. We want to form partnerships, potentially find investors, potentially find customers. This is the place to be. I mean, my goodness. You have to be here. Everybody's here.

AR I hope this will convince investors to say, you got to put your money where it's going to make the biggest impact for the longest period of time that can scale. And I absolutely believe in what you're doing at Dragonfly. Thank you for meeting me again. Thank you for being here.

DP It was my pleasure. Thank you, Alan.

New All-Liquid Iron Flow Battery for Grid Energy Storage

as reported by **Karyn Hede**



A commonplace chemical used in water treatment facilities has been repurposed for large-scale energy storage in a new battery design by researchers at the Department of Energy's Pacific Northwest National Laboratory. The design provides a pathway to a safe, economical, water-based, flow battery made with Earth-abundant materials. It provides another pathway in the quest to incorporate intermittent energy sources such as wind and solar energy into the nation's electric grid.

The researchers report in Nature Communications that their lab-scale, iron-based battery exhibited remarkable cycling stability over one thousand consecutive charging cycles, while maintaining 98.7 percent of its maximum capacity.

Karyn Hede is an experienced science and medical communicator, author, and university instructor. She has worked both as a science journalist and as a media relations specialist. Karyn's published work has appeared in Science, Nature, Scientific American, MIT's Technology Review, Journal of the National Cancer Institute, and other media outlets. She has authored more than 70 published articles in the scientific and technical literature. She has also been an invited lecturer on science communication. She is passionate about making science and technology advances accessible to anyone curious about how scientists figure things out. At PNNL, she covers the physical and computational sciences, quantum information sciences, waste to fuel conversion, and vehicle technologies. Find out more about Karyn on LinkedIn.

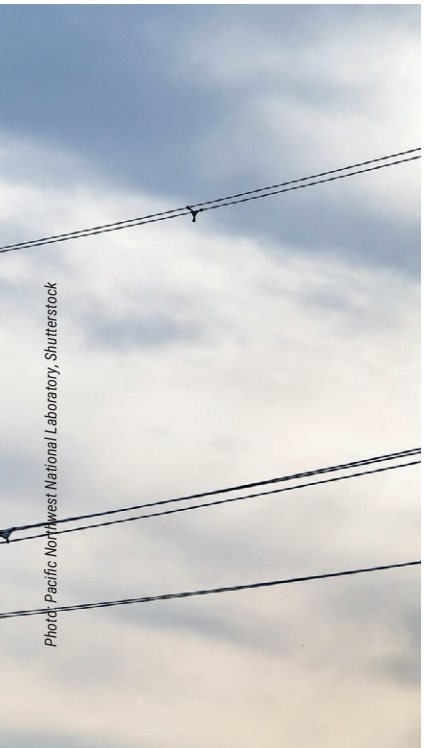


Photo: Pacific Northwest National Laboratory, Shutterstock

What makes this battery different is that it stores energy in a unique liquid chemical formula that combines charged iron with a neutral-pH phosphate-based liquid electrolyte, or energy carrier.

Crucially, the chemical, called nitrogenous triphosphonate, nitrilotri-methylphosphonic acid or NTMPA, is commercially available in industrial quantities because it is typically used to inhibit corrosion in water treatment plants.

For comparison, previous studies of similar iron-based batteries reported degradation of the charge capacity two orders of magnitude higher, over fewer charging cycles.

Iron-based flow batteries designed for large-scale energy storage have been around since the 1980s, and some are now commercially available. What makes this battery different is that it stores energy in a unique liquid chemical formula that combines charged iron with a neutral-pH phosphate-based liquid electrolyte, or energy carrier. Crucially, the chemical, called nitrogenous triphosphonate, nitrilotri-methylphosphonic acid or NTMPA, is commercially available in industrial quantities, because it is typically used to inhibit corrosion in water treatment plants.

In the near term, grid operators are looking to locate battery energy storage systems (BESS) in urban or suburban areas near energy consumers.

Often, city planners must grapple with consumer safety concerns. The type of aqueous flow battery reported here could help alleviate safety concerns.

Phosphonates, including NTMPA, are a broad chemical family based on the element phosphorus. Many phosphonates dissolve well in water and are nontoxic chemicals used in fertilizers and detergents, among other uses.

"We were looking for an electrolyte that could bind and store charged iron in a liquid complex at room temperature and mild operating conditions with neutral pH," said senior author Guosheng Li, a senior scientist at PNNL who leads materials development for rechargeable energy storage devices.

"We are motivated to develop battery materials that are Earth-abundant and can be sourced domestically."

What is a flow battery?

As their name suggests, flow batteries consist of two chambers, each filled with a different liquid. The batteries charge through an electrochemical reaction and store energy in chemical bonds. When connected to an external circuit, they release that energy, which can power electrical devices. Unlike other conventional batteries, flow batteries feature two external supply

Photo: Shutterstock

tanks of liquid constantly circulating through them to supply the electrolyte, serving as the battery system's "blood supply." The larger the electrolyte supply tank, the more energy the flow battery can store.

Flow batteries can serve as backup generators for the electric grid. Flow batteries are one of the key pillars of a decarbonization strategy to store energy from renewable energy resources. Their advantage is that they can be built at any scale, from the lab-bench scale, as in the PNNL study, to the size of a city block.

In the near term, grid operators are looking to locate battery energy storage systems (BESS) in urban or suburban areas near energy consumers.

Often, city planners must grapple with consumer safety concerns. The type of aqueous flow battery reported here could help alleviate safety concerns.

"A BESS facility using the chemistry similar to what we have developed here would have the advantage of operating in water at neutral pH," said Aaron Hollas, a study author and team leader in PNNL's Battery Materials and Systems Group. "In addition, our system uses commercially available reagents that haven't been previously investigated for use in flow batteries."

The research team reported that their initial design can reach energy density, a key design feature, up to 9 watt-hours per liter (Wh/L). In comparison, commercialized vanadium-based systems are more than twice as energy dense, at 25 Wh/L. Higher energy density batteries can store more energy in a smaller square footage, but a system built with Earth-abundant materials could be scaled to provide the same energy output.

Future development of aqueous redox flow batteries

"Our next step is to improve battery performance by focusing on aspects such as voltage output and electrolyte concentration, which will help to increase the energy density," said Li. "Our voltage output is lower than the typical vanadium flow battery output. We are working on ways to improve that."

PNNL researchers plan to scale-up this and other new battery technologies at a new facility called the Grid Storage Launchpad (GSL) opening at PNNL in 2024.

The GSL, funded by the Department of Energy's Office of Electricity, which also funded the current study, will help accelerate the development of future flow battery technology and strategies so that new energy storage systems can be deployed safely.

Study contributors included co-lead authors Gabriel S. Nambafu and Hollas, as well as Peter S. Rice, Daria Boglaienko, John L. Fulton, Miller Li, Qian Huang, David M. Reed, Vincent L. Sprenkle, and G. Li from PNNL. Shuyuan Zhang and Yu Zhu from the University of Akron in Akron, Ohio, also participated in the research.

Photo: Shutterstock

THE H-J FAMILY OF COMPANIES

HOW WOMEN EXECUTIVES ARE ENERGIZING THE TRANSFORMERS COMPONENTS SECTOR

Diana Diaz
Director of Sales in Latin America
Cinthya Alcaras
Supply Chain Manager
Stephanie Sherrill
Production Manager
Carolina Bermudez
Head of Latin America Inside Sales

The H-J Family of Companies is a global leader in the manufacturing and supply of products and solutions to the heavy electrical industry. These components support the transformer, switchgear, regulator, recloser and breaker industries, along with specialties in the utility market.

Founded in 1969, H-J is headquartered outside of St. Louis, Missouri, USA. The company maintains a global presence with offices operating in Brazil, Canada, China, Colombia, India, Mexico, the Philippines, Spain, Germany, the Netherlands and throughout the United States, all of which allow H-J to serve domestic and international customers. The H-J Family of Companies conducts business in more than 70 countries across all continents.

In this article, *Women in Power Systems* Magazine is proud to feature four exceptional women leading the world of components for transformers and switchgear in The H-J Family of Companies. Through their roles as directors and managers, these four women have demonstrated their ability to lead teams, make strategic decisions and make a difference in the industry. In this article, we will explore the stories of Diana Diaz, Cinthya Alcaras, Stephanie Sherrill and Carolina Bermudez, highlighting their achievements and impact on the electrical components and solutions industry.

Diana Diaz

Director of Sales in Latin America

Diana is an inspirational leader in the world of sales of solutions and components for the transformer sector in Latin America. As sales director for The H-J Family of Companies, she has played a vital role in expanding her company's presence in the region. Her ability to understand customer needs and her commitment to excellence in customer service has made her a reference in the industry.

Cinthya Alcaras

Supply Chain Manager

Cinthya is an expert in supply chain management in the electrical industry. Her leadership has optimized logistics and ensured on-time delivery of critical components in an era where lead times are a crucial issue for many industry players. Cinthya believes in the importance of operational efficiency and cross-departmental collaboration to achieve success.

Stephanie Sherrill

Production Manager

Stephanie is a visionary in managing the production of bushings, connectors, terminals and other in-house-manufactured products at The H-J Family of Companies. With more than 30 years in the industry with The H-J Family of Companies, her focus on automation and continuous improvement has increased the efficiency and quality of the company's products. Stephanie is an advocate for investing in innovative technologies to drive manufacturing excellence.

Carolina Bermudez

Head of Latin America Inside Sales

Carolina leads the Latin America Inside Sales team with passion and dedication. Her ability to coordinate strategies and maintain effective communication with her service teams in each region has significantly improved order management, claims, and ultimately, customer satisfaction. Carolina believes in empowering her team to achieve bold goals.

Diana Diaz, Cinthya Alcaras, Stephanie Sherrill, and Carolina Bermudez are extraordinary examples of female leadership in The H-J Family of Companies and the electrical components industry. Their achievements and contributions demonstrate that women are critical in driving innovation and excellence in this essential industry. Through their vision, dedication, and commitment to excellence, these leaders are paving the way for future generations of women in power systems.

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Diana Diaz: I started my career with a power transformer company 26 years ago, where I worked as a purchasing manager. I spent my time there perfecting my role and learning about each area of the organization. It was there that I came to understand that the more knowledge I could learn about the company and industry, the more quickly I could advance my career. I was able to grow with the company, learn from its challenges, and contribute to its successes.

After ten years in my purchasing role, I had a thorough grasp of how I wanted to advance my career. It was then I made the decision to move to the other side of the desk and explore the sales world. I wanted to become the kind of salesperson I hoped to find when I was in my purchasing role. I based my principles of service on understanding the customers' needs and providing quality responses in a timely manner. This decision was a turning point in my career and opened my mind to a great deal of new experiences and successes.

> When I visit with customers in person, I can learn about not only their business needs, but about their cultures, lifestyles, and families. Creating these relationships and collaborating with them to find solutions is what motivates me to continue improving even in the face of everyday challenges.
>
> **Diana Diaz**

When I became the Director of Sales, I was most challenged with defining my leadership style. I learned that leading a team is not only giving direction but giving my team a voice to build solutions by creative thinking. Together we develop & implement their strategies. I strive to continuously expand upon their talents and together we improve as a team. My sales team in Latin America is not limited by a position or title. They are encouraged to contribute to the improvement and growth of the company overall. I am also conscious of my personal comfort zone. I actively seek to challenge it daily. By doing this, I am practicing what I teach to my team.

I am proud to be a part of a company that deeply respects our cultural differences and believes in our talents. I consider it a big responsibility to guide the new generation of The H-J team to work and live with passion while striving every day to be the best version of themselves.

Photo: The H-J Family of Companies

Cinthya Alcaras: In November 2022, I joined The H-J Family of Companies as Supply Chain Manager, bringing a background in supply chain management from my previous experience in the electrical sector. Throughout my career, I've consistently worked in supply chain roles, starting as an MRO buyer with no prior experience. The initial challenges were immense, and the resulting stress was substantial, but overcoming these hurdles provided valuable lessons in the processes of understanding and prevention.

My educational background includes a degree in business administration from the Queretaro International University and a master's in supply chain and logistics from the Mondragon University. I have always been passionate about my work, finding joy in the constant learning and problem-solving it entails.

Having had the opportunity to work in various companies and sectors, I've gained a broad perspective on managing different teams, organizations, ERPs, suppliers, and problem-solving strategies. However, nothing has been as transformative as navigating the challenges brought by the pandemic, reshaping the world of supply chain management.

In this ever-changing landscape, the pandemic emphasized the importance of working harder and faster, diversifying sources, and maintaining flexibility. It highlighted the necessity of having alternative sources from different countries to ensure resilience in the supply chain. Beyond professional impacts, it also led to a shift in personal values, emphasizing the importance of relationships with family, friends, and colleagues.

> Navigating these changes [brought by the pandemic] has further honed my adaptability and strategic thinking, making me a more resilient and forward-thinking Supply Chain Manager.
>
> **Cinthya Alcaras**

Navigating these changes has further honed my adaptability and strategic thinking, making me a more resilient and forward-thinking Supply Chain Manager.

As challenging as it may be, this is a job that I truly enjoy and am passionate about. I wouldn't exchange this for anything else. I consider myself fortunate to work in a field that I love, with a company that shares my passion.

Working with H-J is a genuine pleasure. While experiencing the typical ups and downs of any company, the people here form one big family, and that's something I greatly appreciate.

Since joining H-J, I have enjoyed new challenges and opportunities, all of which have contributed to my personal and professional growth. To work within a company culture that aligns so well with my own principles is a wonderful opportunity that I am thoroughly enjoying and learning from every day.

Stephanie Sherrill: In January of 1994, I started working for H-J Enterprises, Inc. as a Machine Operator with no background in manufacturing. I always focused on clerical and business classes in my education and had goals of becoming a Real Estate Broker. However, when I experienced the world of manufacturing, I knew this would become my career path, and even more so, one I wanted to excel in.

During my time as a Machine Operator, I became familiar with different machining operations and techniques. This includes quality expectations and inspections, production quotas, and the importance of standard operating procedures.

Shortly into my career, I became a Lead in our Machine Shop which introduced me to the leadership role. This experience taught me the importance of teamwork and how to manage people. I attended several different leadership and managerial classes and eventually worked in a production supervisor role.

As a supervisor, I began to work closer with our engineering, sales, and process improvement groups. In this role, I was introduced to a more technical side of our industry, the need for constant improvement and customer relationships. After a few years, I became the Assistant Plant Manager. This role had many of the same responsibilities as the supervisor position, but also expanded into Scheduling I was not involved in before.

> This experience has not only taught me the world of manufacturing but has also taught me the importance of leading by example, developing relationships, and working as a team with people from every walk of life.
>
> **Stephanie Sherrill**

Photo: The H-J Family of Companies

Now as Director of U.S. Manufacturing, I work very closely with our teams making sure our production goals are met. This is achievable through continuous improvements and while maintaining our commitment quality products.

Each one of these roles was a steppingstone to the next level. This experience has not only taught me the world of manufacturing but has also taught me the importance of leading by example, developing relationships, and working as a team with people from every walk of life.

It's been a wild ride and I've enjoyed it!

Carolina Bermudez: I started working for The H-J Family of Companies in 2010 as a sales assistant in the Bogota, Colombia, office. Holding a bachelor's degree in international business administration from the Andean University of Pereira Colombia and specializing in customs and international trade from the Externado University of Colombia, my career trajectory had previously centered on foreign trade and supply chain, so delving into the commercial and customer service arena was a new adventure for me.

I come from a small city in the heart of the Colombian coffee axis and joining a multinational company with a global presence was a challenge that I still enjoy intensely to this day. In my new professional role, I transitioned from a very local scope to being part of an internationally dynamic business with an impact at the Latin American level. A whole world of cultures, languages, and processes unfolded before me! My challenge: understanding the needs of our customers in their cultural language and translating them into our own.

In this process of managing our customers' needs, I started to develop a different leadership style and became deeply involved in our internal processes of quality, manufacturing, logistics, and continuous improvement. This resulted in creating a synergy of connections between processes that, far from being independent, are fully complementary to each other. I firmly believe that connecting all these links makes a different and more effective experience for the end customer.

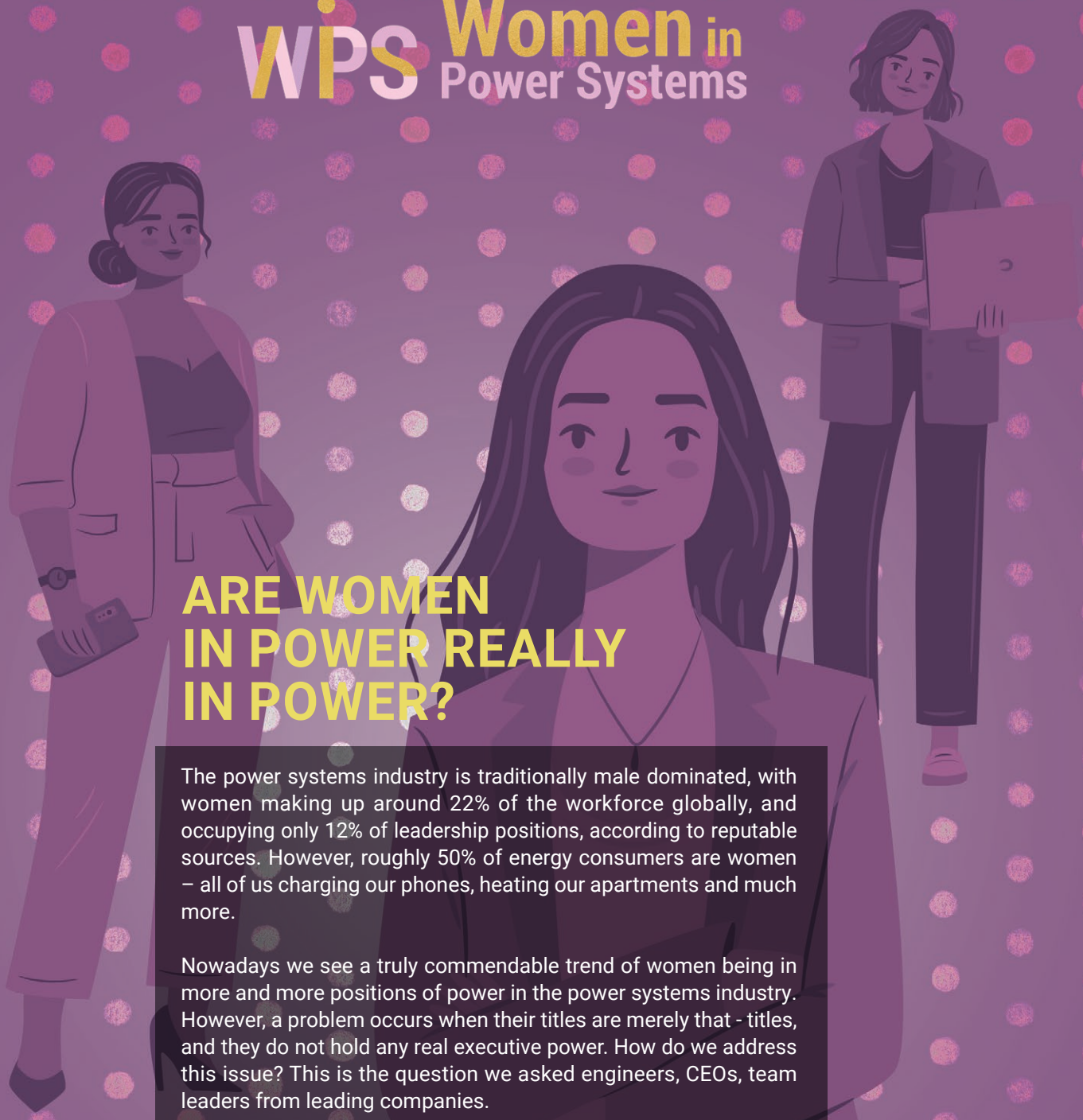
In this ever-changing landscape, the pandemic emphasized the importance of working harder and faster, diversifying sources, and maintaining flexibility. It highlighted the necessity of having alternative sources from different countries to ensure resilience in the supply chain. Beyond professional impacts, it also led to a shift in personal values, emphasizing the importance of relationships with family, friends, and colleagues.

> In my new professional role, I transitioned from a very local scope to being part of an internationally dynamic business with an impact at the Latin American level.
>
> **Carolina Bermudez**

Now, as the Inside Sales Manager for the Latin American region and with a new base of operations in Leon, Guanajuato, Mexico, I expand my scope not only to take care of our customers but also to create strategic commercial actions aiming to enhance the customer experience and achieve a level of excellence that allows us to continue maintaining long-term relationships.

Each step I've taken has shaped me as a professional with interdisciplinary skills, as I like to define myself. This experience of being a Latina woman leader in the commercial field of the electrical industry has been a fascinating world of experiences and learning.

WPS Women in Power Systems



ARE WOMEN IN POWER REALLY IN POWER?

The power systems industry is traditionally male dominated, with women making up around 22% of the workforce globally, and occupying only 12% of leadership positions, according to reputable sources. However, roughly 50% of energy consumers are women – all of us charging our phones, heating our apartments and much more.

Nowadays we see a truly commendable trend of women being in more and more positions of power in the power systems industry. However, a problem occurs when their titles are merely that - titles, and they do not hold any real executive power. How do we address this issue? This is the question we asked engineers, CEOs, team leaders from leading companies.

The road towards a more equal representation is long, but we want to be a part of the change by encouraging discussion and giving a platform to women's voices in the industry.

Support the voices of women in power systems - be the voice of women in power systems!

Contact Managing Editor: Paula Čivrak paula.civrak@apc.media
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WOMEN IN POWER SYSTEMS
SPRING 2024

camlin energy

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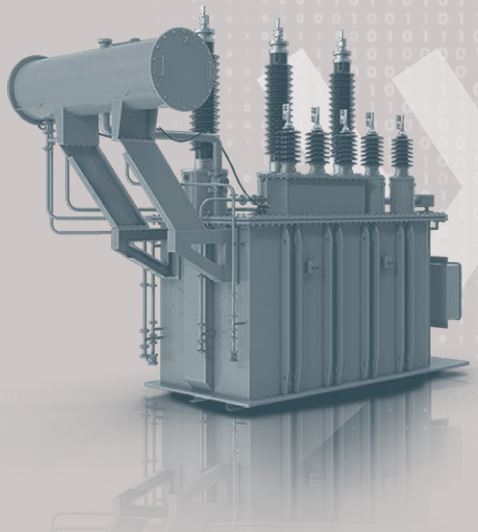


Navigate the future with insights

Empowering utilities with the insights to predict asset behaviour, maximising reliability, protecting people, reducing O&M costs and driving operational efficiency

See beyond the surface

Impact of Failure

Users can configure asset criticality and assess the impact and cost of failure by combining probability of failure with asset classes

Predictive Analytics

Leverages data from multiple sources and harness machine learning to predict asset performance enabling proactive maintenance

Prescriptive Actions

Provides prescriptive actions based on asset health to automate and prioritize maintenance activities

Michael Sheppard

Photo: PTR Inc.

> That's an entirely new level of flexibility that's required from solution providers. The real change is that solutions that are being provided also have to be flexible.

CEO at PTR Inc.

Interview with **Michael Sheppard**

Alan Ross: Hi, I'm Alan Ross. I'm the Managing Editor of APC Media. Today at Distributech International 2024, I'm joined by Michael Sheppard, CEO of PTR Inc., our esteemed research partner.

How did you get into this whole industry as it relates to PTR?

Michael Sheppard: I graduated 2008, finance degree. I had done my thesis on collateralized debt obligations at the time. If I believed what I was actually writing, then maybe I should consider, at least temporarily, some alternatives.

Fortunately, my father had co-founded a market research company. I thought I should use a financial analyst perspective and apply it to market research - the same core philosophy of trying to figure out what's going on and try to create models to predict the future.

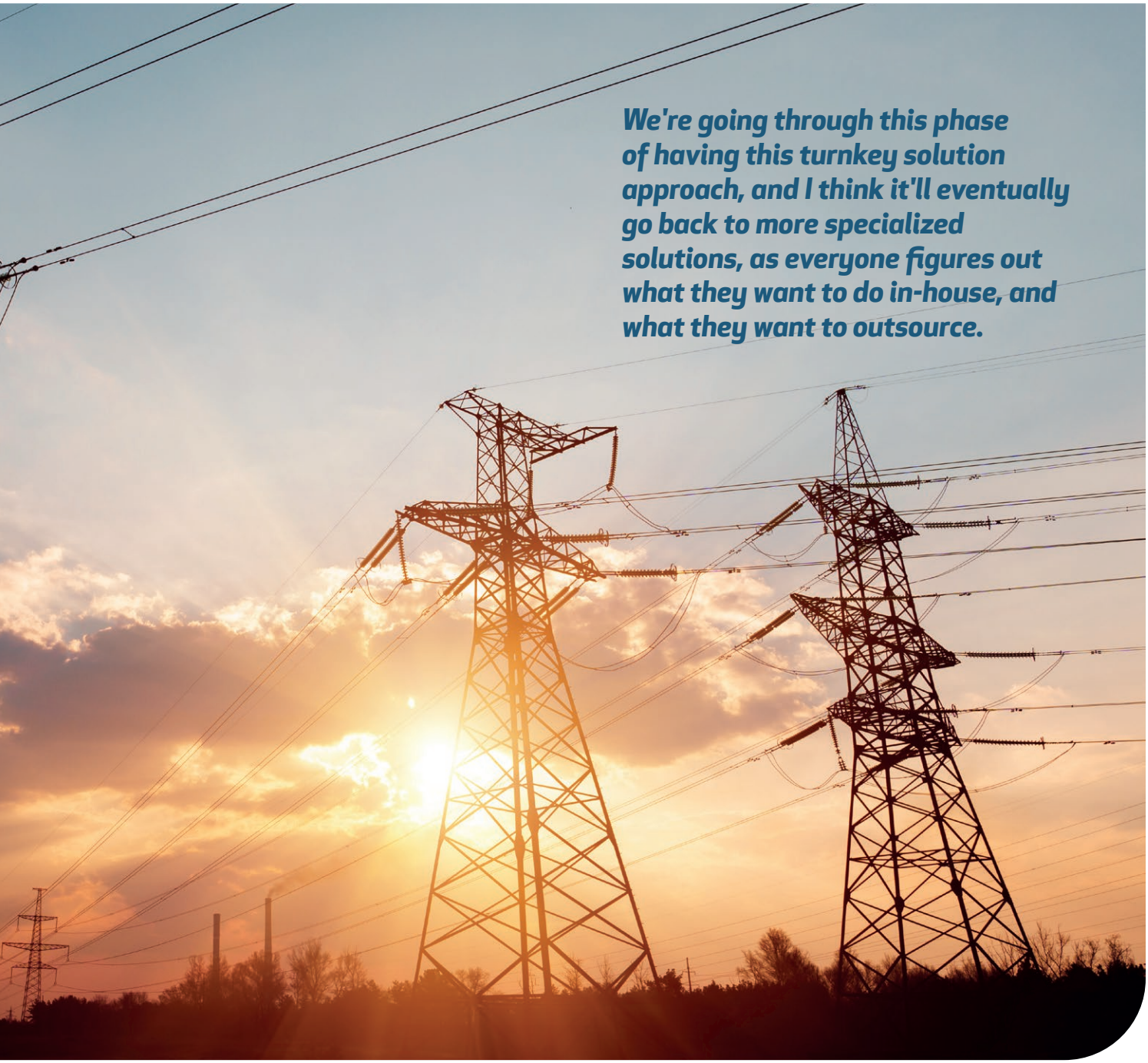
I got into the company, and the company was a fast-growth company, traditionally known for semi-conductor coverage. That's where I learned how to become an analyst doing semiconductor research. Through acquisitions, the company ended up as part of IHS, which is now part of S&P Global. Throughout my journey at that organization, I got into solar photovoltaic research. That actually got me into the energy and eventually the power industry. I ended up managing a consulting group there. The request we were getting all the time was to help people figure out the power grid. Separately, we were doing consumer and industrial research. We were asked to connect these two. That was all custom, and I thought that this knowledge, the methodology requires you to invest a lot of time and effort. Every electricity network is independent and unique. Therefore, we created PTR Inc. with the goal to really understand the networks in each country around the world.

That was 2016. We're almost at our eight-year anniversary.

AR You've been doing research on the industry even before PTR. You've seen it like the rest of us have seen it. Static, not a lot of dynamism, decades of not changing, very closed systems we don't share with anybody. All of a sudden in the last five years, we've seen some pretty dramatic change to the point where we're at right now. In your perspective, what does that look like to where we are right now in the industry?

MS Even as an outside observer, you could say it's very surprising, because in my background with solar, change is constant in that industry. I am familiar with a regulatory-driven or incentivized environment. But in terms of established norms and traditions and what operating metrics drive these companies, that's all changing. We're having conversations with our customers and prospects about things that are still in development. For instance, supply chains around EV charging. What are the standards there? How are procurement decisions being made? These are the questions we're helping our customers answer. Though the things being sold are the same, they're being applied in new ways. It's involving new characters, like the *Googles* and *Microsofts* of the world, in an intimate way, not just on the fringe, but in the core within the networks, with all that sensing, measuring, and processing of that information, the new generative AI; it's all being applied to this legacy network.

Photo: Shutterstock



We're now unlocking a lot of this new potential in terms of business models and revenue streams. One of the research practices we've done for a few years at PTR is around storage. When doing storage research, I was always thinking there quite a few things you can do in ancillary services that storage can provide to the grid. Why is it only one-at-a-time thing? Why is it only you can have an agreement on one aspect? That concept around multiple revenue streams, I had first encountered, at least in the electric network side of things, that's unlocking right now, in real time.

AR One of the reasons storage is coming up so much is one of the big buzzwords in the industry right now. I was the President of the Electric Power Reliability Alliance where I retired. I felt like 15 years ago, I invented the idea of *reliability* in the power industry, because we were talking about it back then. Today, the new word is *resilience*. Reliability means keeping the lights on. Resilience means turning the lights back on once they go off. And because of weather events, bad physical and cyber actors, all of the different things that are going on, resiliency has taken a front seat, and that's what utilities are looking for. How do I become resilient in the face of so many unknown factors?

MS Going back to these new actors that are being involved, one of the major new actors are data centers. We won't call them bad, because they provide a lot of revenue. Their philosophy about how they do business

is very iterative. You have these new players that are okay with, I won't quote directly, *the move fast and break things mentality*, which obviously goes against the electric network and how that was built.

This is where the solution providers really have to step up their game. They need to be able to provide an iterative solution to their customers while maintaining the same standards and support that they had done with the owners and operators of the grid simultaneously. That's where we're hearing stories about providing flexible solutions. It's not just about anticipating the needs, it's also about understanding what someone really means, interpreting what they're saying, even if it is not explicit.
To some degree, that was always true. At the same time, there was a narrow tolerance there. Now you're deploying stuff into a job site being ready to reconfigure. That's an entirely new level of flexibility that's required from solution providers. The real change is that solutions that are being provided also have to be flexible.

AR You just hit another point, solutions providers. 10 years ago, but even five years ago, at an event like this you'd see somebody selling bucket trucks, big fans and such. You don't see that anymore. You see IBM, Google, Microsoft, Dell, and a lot of different suppliers in the industry than have been there in the past. We had a lot of asset suppliers. We don't have asset suppliers as much anymore, as we have people coming in and helping utilities make a change.

MS It's not different than what I've seen within the industry. 10 years ago, this was happening in the industry in a big way. Living in Germany for many years, there are conferences like Hannover Messe where you see deployments of things like automation solutions into factories. It is basically replacing pure asset providers with asset plus software, plus consulting, plus analytics, plus privacy, storage, cybersecurity. You're adding to the stack of value that you're providing. Now, it's a stack of value that wasn't valued in the past. There's a big education effort required there in order to get those customers and prospects familiar with, *Hey, you do need additional solutions.* Instead of you organically building it and having to build new teams inside your own organization to facilitate this, people should take this turnkey solution.

Even though it is a well-established industry, there are all these changes taking place.

We're going through this phase of having this turnkey solution approach, and I think it'll eventually go back to more specialized solutions, as everyone figures out what they want to do in-house, and what they want to outsource. I think that's also why you're seeing a lot of providers offering all-encompassing solutions. Everything is new and moving, and people are just trying to focus on the core value proposition, or the highest value proposition, outsourcing everything else, and then figuring out where everyone's play is.

As a third party looking at the market, one of the things that I mentioned before is we're doing a lot of supply chain research on things like data centers. The challenge we have is deciding who goes in what box. Now a lot of people are doing a lot of different things. Typically, you would be able to type-cast people: this is an OEM, this is an EPC, these guys are in this area or this region of the country. Over here, they're doing something else. It's all based on capabilities, perceived value, and access to the customer. It is very dynamic right now.

AR This is an industry, in my opinion, that likes to be first to be second. People want something both new and proven. No, you get new, or you get proven. I see more collaborative effort than I've ever seen, where utilities, in particular, are open to multiple parties coming in to work together to provide a solution. A little bit more hesitance to do one, because nobody wants to make a mistake to pick the wrong one. Now, if it's proven and you're the right one, they're going to be a winner. But right now, there's openness to collaboration, multiple people, even competing companies, they seem to be working together more than ever. Is that going to be the new future or what is the new future? What does it look like in the utility industry a decade from now?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MS Before I go forward, I'll go back a couple of years where we were all talking about the DERMS implementation and seeing utilities work with 10 different providers. The question I always ask is, how much of their network is under your coverage? They usually have one conductor or whatever. They're still in this trial mode, it satisfies the regulators. They are checking it out, doing their diligence. Moving forward, we're going to see less of that work with everybody. I don't want to think too much about consortiums and going down that road. I saw a lot of that when looking inside industries - you had to pick a camp. I don't think that would be healthy either.

I think the technology is there - the concepts of things like bi-directionality for EV charging or the home. We've had it figured out for decades.

In my mind, the bottlenecks are the business models, the public perception, and therefore the regulatory environment. These are the real challenges right now - to not trip ourselves up along the way of the technology being involved with these other hurdles.

We look at technologies like silicon carbide penetrating into the networks. In some isolated places, we see that as a potential bottleneck. But by far and away, the majority is, yeah, you could stack two of those together and still get the problem solved. Maybe it's a bit less efficient, but the point is that you move forward and you progress. If that involves increasing your computational power - you can do that with twice as many data centers right now. But how do you solve getting transmission to those? If you expand that, how do you then procure all the right equipment there? If we have procurement shortages in things like transformers right now, how are we supposed to do that in an efficient way? Are we going to, in the US, lose about half of the current market? Data centers are in the US. Is that going to maintain if we have supply shortages?

There's an interesting trend we're seeing right now: re-localization of production. We see that almost across the board with different products. We're going to go through an iteration here. It's going to be a 10, 15-year cycle. But I think that's going to improve. By doing that, that's going to improve the understanding of the true cost of things. We'll also be able to more quickly react to things, like scaling up of data centers and such. It's probably going to be five years before we can really unlock some of these things. I'm hoping in the interim, we can unlock that other bottleneck, which is around the policy side, and make sure we don't get in our own way.

AR Talk to me about PTR, because we do rely on you very much. It's Power Technology Research. I can vouch for the quality of the articles we get from you. You do a lot of very complex consultative type of research for people. Talk to me a little bit about that aspect of the company and why you can be trusted in that area.

MS Thanks, Alan. As I said, my background is finance. I'm an outlier in the company. We are a mostly electrical engineering company. We could have been an EPC, but we decided what we wanted to do was help people understand these market trends, because it was not well understood. I worked for a company of 15,000 people, and we didn't know how it worked, even though we were experts in generation and consumption of energy. I felt like it would be really great to be able to answer questions like, what is the capacity of the grid to absorb things like renewable energy on a region-by-region basis? What about new things like electric vehicles? How are we going to be able to adopt that? Are we going to be able to proactively inform the market? This includes informing policymakers about what's going on here, so that new policies are not a knee-jerk reaction to something after it happens, and there's a lot of inefficiency loss along the way. We truly see ourselves as a participant in the industry in terms of helping the broader audience understand what's going on.

If you're new to the industry, we work with and train people to get them up to speed on what's going on and transition from another sector. We really see our role in the training education of even the broader sector. That's our core mission. In terms of what we're doing that's new – we're always trying to make sure that we can quantify whatever we're doing. Now we do a lot around web scraping of maps, trying to get where the EV installations are happening, where the ports are being electrified for powering ships. We are using more and more those actual data centers to help us do that. We're trying to make sure we stay on top of trends. We are more and more automating ourselves and trying to keep our core time focused on the actual analytics and analyzing, talking with our customers. We really want to maximize that and not get bogged down as much as possible in all the research side of what we're doing.

We truly see ourselves as a participant in the industry in terms of helping the broader audience understand what's going on.

AR It's hard to do future research on an industry that's changing so rapidly. You can do that in micro steps, but trying to do a macro step, you're too prone to being wrong because things change. I didn't know about the training and education part. We need to do more about that. We need to publicize that more as the power of what you do, because

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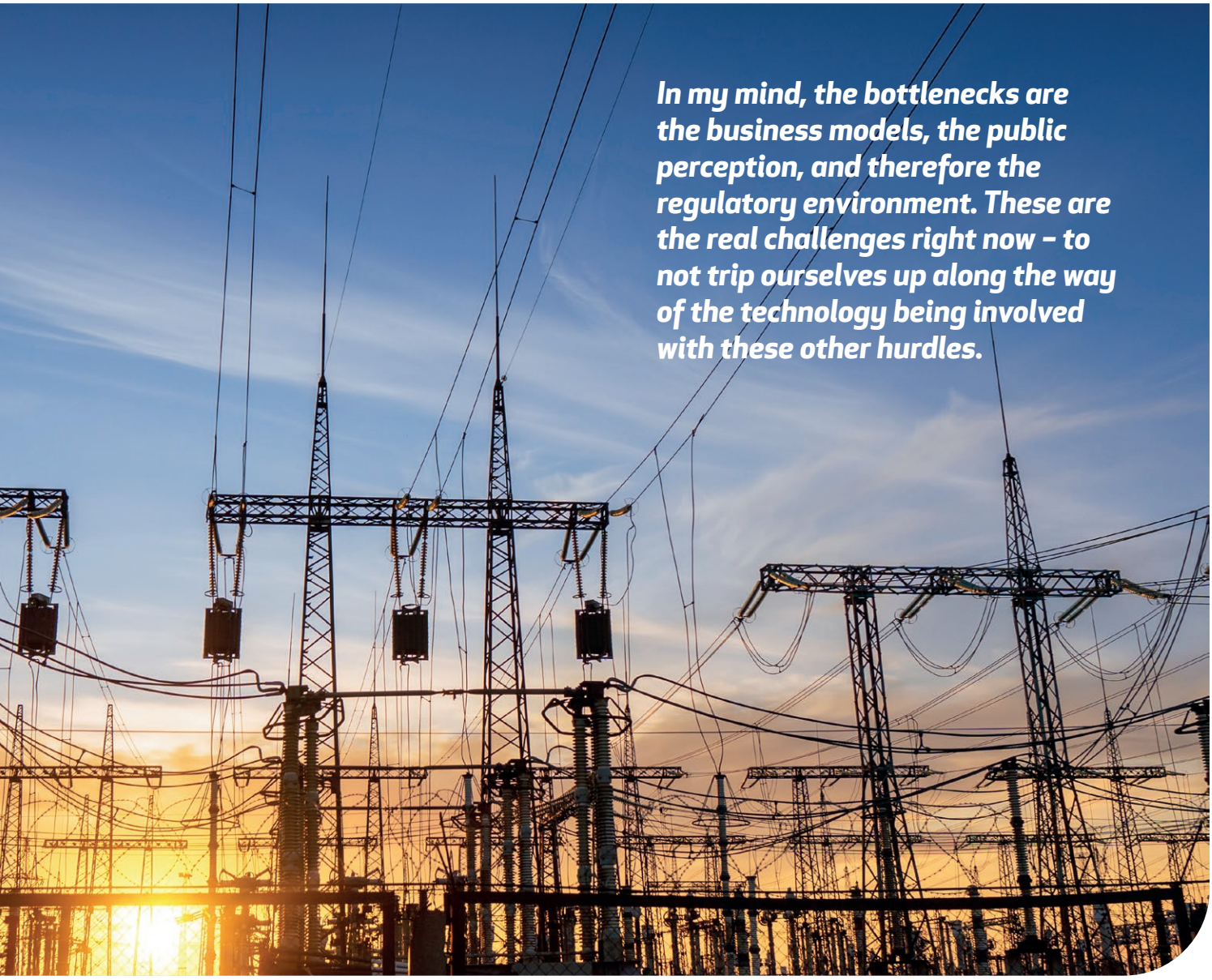
having the research behind the training and education is really important.

MS It makes it more digestible. You can trust it when you know that there was a proper methodology in place to say something about the market. We use that to build rapport, and then in order to help get people up to speed



that may not have that background. In our projects, usually one of the first things we do is get a bunch of pictures. Then we create pages and pages of definitions. *This is what we define as a switch gear. These are the functions that we include*. It is, you could say, an alignment that's required. It also helps us demonstrate to our customers that we understand the complexities here. One company may call it one thing, another company may call it something different, but we need to make sure we're really defined on those definitions.

That's a big part of what we see as education, because maybe multiple stakeholders in that same project and the customer have different understandings. We see ourselves also as a standard, if you will.

AR You're becoming the Webster Dictionary of the power industry. You got a definition for everything. The other thing you mentioned, words we use differently. One person will have an acronym for something, somebody else might have a different acronym.

MS Especially as we're entering this data center realm and we're talking about semiconductors and things like that, it's very interesting when those acronyms collide.

AR I use this term a lot because I really believe in it, and I think this industry likes that. The word is trusted advisors. Utility industries want trusted advisors, and they are very loyal in that regard. PTR is a trusted advisor for us. Thank you very much, Michael.

Smart Grid – Success Formula for Industrial AI

By **Steve Pfrenzinger** AI Transition Strategist | Corp Comm Specialist
MIT AI Certified | Professional Services Sector Veteran | Business Development Specialist

In today's fast-paced industrial landscape, including Smart Power Grids, the deployment of modern Artificial Intelligence (AI) systems is reshaping how the industry approaches efficiency, predictability, sustainability, and risk avoidance.

All involving major infrastructure and encompassing the monitoring and management of assets where catastrophic events can be massively expensive, disruptive, and dangerous.

To demystify the complex orchestration behind these modern systems, we can simplify the AI process into this easily digestible formula.

Data + IoT + ML = AI

…or **DIMA** for short. Let's delve into this formula, designed to empower

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IMAGINE THE VAST AMOUNT OF HISTORICAL OPERATIONAL DATA AS THE LIFEBLOOD OF AI PROCESSES. THIS DATA, DRAWN FROM PAST EXPERIENCES OF INDUSTRIAL OPERATIONS, FORMS THE FOUNDATION UPON WHICH AI IS BUILT. IT'S AKIN TO THE WISDOM ACCUMULATED OVER YEARS OF WORK—A RICH REPOSITORY THAT INFORMS AND ALERTS US TO FUTURE ACTIONS.

non-AI-expert business leaders with the core knowledge to ask insightful questions and make informed decisions (a list of suggested questions is included at the end):

1. Data: The Historical Backbone
Imagine the vast amount of historical operational data as the lifeblood of AI processes. This data, drawn from past experiences of industrial operations, forms the foundation upon which AI is built. It's akin to the wisdom accumulated over years of work—a rich repository that informs and alerts us to future actions.

And, in the power industry it appears significant amounts of data is being collected.

2. IoT: The Real-time Network
The Internet of Things (IoT) is a web of interconnected devices (e.g., sensors, data gathering machines, …),

BY EMPOWERING KEY BUSINESS LEADERS WITH THE STANDARDIZED DIMA FRAMEWORK, ALL CAN FOSTER A DEEPER UNDERSTANDING AND CULTIVATE A PROACTIVE CULTURE OF INQUIRY. THIS SIMPLE, YET STRATEGIC APPROACH ENSURES THAT WHEN IT COMES TO INTEGRATING AI INTO LARGE-SCALE INDUSTRIAL SYSTEMS, EVERY DECISION IS DATA-DRIVEN, EVERY KEY POSSIBILITY IS CONSIDERED, AND EVERY INVESTMENT IS MADE WITH EYES WIDE OPEN TO THE FUTURE.

each acting as a nerve ending in the vast expanse of an industrial body. These edge devices (e.g.. hydrogen, moister and temperature sensors) continually relay new operational data back to a central, cloud-based system—data captured in the throes of the industrial process, offering a real-time pulse on operations.

3. ML: The Training Regimen
Machine Learning (ML) is the rigorous training ground where AI learns to make sense of massive amounts of historical data. Like a massive datastore or a Large Language Model (LLM), ML algorithms digest past patterns to predict and optimize future outcomes. It's where data transforms into wisdom.

4. AI: The Intelligent Output
AI is the embodiment of a computer's ability to mimic human intelligence. It's the sophisticated offspring of the ML process above, operating on what's called a "neural network" (human-mind-like) structure. AI takes the baton from ML, running with the insights gleaned to steer industrial operations towards greater, more intelligent, and predictable heights.

Now, let's consider how this formula aids non-AI-experts in the industrial sector, particularly in evaluating a potential Smart Grid project. By breaking down the DIMA components, stakeholders can ask pivotal questions to ascertain the viability, affordability, and potential success of a major industrial AI implementation:

1. **Data Quality:** Do we possess historical data of sufficient quantity and quality to train the AI model in the machine learning (ML) process?
2. **Business Justification:** Is there a compelling business need for this project, and can the costs be justified? Do we have any build or buy options to consider?
3. *** Real-time Data Acquisition:** Are our systems capable of capturing new data as it emerges from the multitude of sensor-laden edge devices?

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4. **Data Labeling:** Can we ensure historical data can be accurately labeled (identified) for effective use in ML training specific to our domain?
5. **** AI's Role:** What positions (roles) do we envision for AI in our cloud dashboards, comparing real-time data with historical data—assistant, peer, or manager?
6. **AI Autonomy:** Should our AI be empowered to autonomously respond to alerts, or will human oversight be necessary?
7. **AI in the Real World:** Will our AI be confined to computers, or will it take physical actions in response to alerts (e.g., using robots, drones, turn dials, flip switches, etc.)?
8. **Extending Asset Life:** Can we expect to extend the asset life of our major equipment to better meet our sustainability goals? Can you estimate by how much?
9. **Project Risk Assessment:** Considering the high stakes, how do we mitigate the risk that up to half of major DIMA projects may not meet expectations?
10. **AI's Internal Decision Making:** Warning! Today's AI systems repeatedly generate different outputs (answers) for the same inputs (questions) via what are called "non-deterministic" processes. Does AI's unpredictability and lack of transparency (i.e., its sources) in decision making create issues for our systems that require precision and repeatability?

    Note:
    In such cases (above), a hybrid approach that combines the repeatability and transparency of rule-based systems with the adaptability and variability of AI might be most effective.

By empowering key business leaders (managers, engineers, and utility professionals) with the standardized DIMA framework, all can foster a deeper understanding and cultivate a proactive culture of inquiry. This simple, yet strategic approach ensures that when it comes to integrating AI into large-scale industrial systems, every decision is data-driven, every key possibility is considered, and every investment is made with eyes wide open to the future.

** End-to-end IoT ecosystems are a DIMA requirement and available from numerous well-known providers, connecting remote edge devices (data gathering sensors) to cellular gateways to cloud databases to AI predictive analysis and appropriate action. Familiar providers here are CISCO Systems, GE Digital, Samsara, Sensata and Montage Connect.*

*** Beyond human talent, AI development needs tools, libraries, and platforms to speed development and deployment. Familiar platform providers are MS Azure and Amazon's AWS. PyTorch and TensorFlow are two of the most popular open-source libraries for machine learning and artificial intelligence projects.*

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ADVANCED TRANSFORMER TESTING AND TECHNOLOGIES

In the upcoming June issue, we delve into the dynamic realm of transformer technology, where innovation is key to building a robust and dependable grid infrastructure. Beyond mere monitoring, significant strides in transformer testing methodologies, coupled with cutting-edge manufacturing processes and the integration of novel materials and technologies, are poised to revolutionize the landscape. For procurement professionals, this heralds a shift towards sourcing components that align with these advancements, ensuring optimal performance and longevity. Meanwhile, asset management professionals face the challenge of incorporating these transformative elements into their strategies to uphold grid reliability and resilience. Embracing these changes is paramount as we navigate towards a future where adaptability is synonymous with grid sustainability.

Intrigued by the transformative potential of these advancements? Don't miss out on the next issue as we unravel the intricate interplay between innovation and reliability in the realm of transformer technology. Stay ahead of the curve with insightful analyses, expert perspectives, and groundbreaking insights that are set to redefine the future of grid infrastructure.

COMING IN JUNE ISSUE