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## **CIGRE US National Committee 2023 Grid of the Future Symposium**

### **How Accelerating Trends in Transmission and Distribution (T&D) Make the Case for Digital Adoption**

**K. MCDERMOTT**  
**Sharper Shape**  
**USA**

#### **SUMMARY**

Under political, environmental, financial, and social pressure, the operation of T&D assets is changing rapidly. Digital technology is no longer “nice to have”. It is fundamental to a utility’s business model to future-proof performance, ensure safety and ultimately manage risk, while delivering reliable power to the communities they serve.

Equally, digital technology is not just a computerized replacement of traditional records or a 3d replicant. It is not a series of SD cards in a drawer or an application only usable by the most advanced software engineers. It adds the fourth dimension – time – to the mix and makes sure that the insights that mix delivers are useful and actionable. A digital twin also has mobile boundaries: remote controlled drones play an essential part in creating the situational awareness that utilities need.

In this paper we will identify the top five trends affecting the T&D utility industry and explain how and why digitization can overcome these challenges.

#### **KEYWORDS**

Aging Industry, Extreme weather, Wildfire mitigation, Energy Transition, Rising cost of energy, Digital Twin, Digitization

Kristy.Mcdermott@sharpershape.com

## **T&D utilities face a simple proposition: do more, with less, in a harsher operating environment.**

Utilities sit at the heart of the decarbonization agenda. They are required to facilitate greater integration of distributed resources, new generation types, and greater electrification in transport, heating, and industrial processes. They must do all this while managing end-of-life infrastructure in a financial climate of tight margins, and an operating environment containing more hazards, threats, and risks than ever before.

However, this evolution in power generation and consumption is accompanied by a revolution in digital technologies. Utilities can have faith in innovations that enable them to future-proof their business, target maintenance effectively, preserve institutional experience and generate cost-efficiencies across the board.

A Living Digital Twin (LDT) is one example. This is, a real-time digital reflection of real-world infrastructure, with the ability to be updated as and when new information is available. Rather than a static snapshot of a piece of infrastructure at a specific moment in time, it is an accurate portrait of the current condition, performance, and maintenance requirements of any aspects of the T&D infrastructure – as well as the history of any work previously undertaken.

Being digital it is accessible to any authorized user from any location at any time. It combines images – that can be gathered by unmanned drones – as well as easily accessible documentation, enabling remote operational teams to get a 360-degree view of their assets and their requirements without driving across country to inspect it for themselves. This allows for early identification of risks, from advanced vegetation management using LiDAR and hyperspectral data, to mapping of ‘what if’ scenarios to be better prepared for disaster events.

As we discuss in this paper, by enabling this kind of situational awareness, digital twins can and should play a vital role in enabling T&D utilities to meet the matrix of risks and interconnected challenges of 2023 and beyond.

## **An aging industry**

The fact that the utility sector as a whole harbors a vast swathe of aging assets, many of which are already beyond the end of their design life, is no secret. Nonetheless, the numbers are eye-opening. For example, the US power grid is made up of 160,000 miles of high-voltage powerlines– but 70 percent of those transmission lines are now more than 25 years old.

Across the Atlantic in Europe, approximately one third of the electricity grid is more than 40 years old, while the average age of substation transformers is 42 – despite them being designed for 40 years of use. The inevitable result is an increase in vulnerabilities and faults, and a greater maintenance requirement to ensure the lights stay on.

This long-term trend is set to continue into 2023 and beyond. There are no signs that historic underinvestment is being reversed, or that T&D utilities have the resources to overhaul their estate. And so more cost-effective ways for inspecting, recording, and maintaining infrastructure are necessary. The need to do more with less is the golden thread running through almost all operations, and technology like a LDT can be part of the solution.

Nonetheless, the problem of aging is becoming more acute because it applies just as much to human assets – and they are starting to leave the industry in significant numbers. Consider that 50 percent of the US utility workforce will retire in the next 5 to 10 years and that 52 percent of the UK electricity sector’s workforce is over the age of 45, and the scale of the problem becomes clear.

As these experienced and deeply knowledgeable individuals leave, they take with them valuable expertise and insight, weakening institutional knowledge. That experience, gained not just from manuals but from years on the job, needs to be recorded and made accessible to incoming teams and a new generation that is inevitably required to join the utility workforce.

One of the major benefits of a LDT is that it supports the remote and complete inspection of these increasingly vulnerable assets. Drone cameras for example can take close-up pictures – without sending a team of linemen in – which can be assessed by expert teams from their offices. Those photos are added to the digital twin to maintain a complete record.

In addition to these kinds of efficiencies, a Living Digital Twin is, uniquely, an inheritor of institutional knowledge, helping to create prioritized action plans that hold and enhance the collective expertise. It also helps improve knowledge sharing through automation, and uses machine learning, artificial intelligence, and advanced analytics to interpret vital asset data and transform it into actionable information for maintenance and other crews.

### **Extreme weather is no longer an outlier**

Flooding, severe storms, tropical cyclones, and wildfires all pose risk to life, infrastructure, and the economy. All are increasing in frequency as the climate changes and are set to be as big a feature of 2023 as they were in 2022.

According to the World Meteorological Organization, extreme weather events have increased by a factor of five in the fifty years since 1971. In 2022 alone, 15 severe weather events accounted for losses worth more than \$1 billion in the US, while 1.63 million acres of European land and more than 7.2 acres of land in the US were ravaged by wildfires. Fatalities are immeasurable.

Powerlines are widely exposed to these events, and in some wildfire cases, can contribute to them. Facing these environmental threats, utilities need to consider ecological and human safety – including that of their employees. With a recent study finding that there is a national trend in the US of people moving away from areas at risk of heatwaves and hurricanes and into areas prone to wildfires, there is a heightened need for technology that can identify wildfire risk and prioritize the level of urgency. Predictive maintenance and vegetation management are critical here, as can ensure the safety of life and infrastructure.

Data-driven and dependency-based mission planning is crucial for mitigating safety, supply, and cost risks. A LDT’s dynamic representation of assets helps utility managers to identify, prepare for, and mitigate risk factors. That includes putting in place the necessary measures for rapid response when disaster strikes.

### **Energy transition picks up pace**

Increasing the input from renewable and nuclear generation, while empowering micro-generation among so-called “prosumers”, and greater use of electric vehicles, demands greater resilience of the grid. T&D utilities will increasingly find themselves at the sharp end of the energy transition as more and more intermittent and non-dispatchable generation is added to the mix. Thus, the energy sector as a whole will play a central role in mitigating environmental damage through decarbonization.

This is clearly a long-term prospect. According to the IEA, 70-80 percent of all new production capacity will come from renewable sources, mainly wind and solar PV, by 2050 – a near 30-year development period. However, events are moving fast. For example, the amount of renewable power capacity to be added in Europe between 2022 and 2027 is now predicted to be twice as high as in the previous five-year period. In fact, renewables are set to account for more than 90 percent of the expansion of global electricity in the next five years.

The changing nature of both power generation and consumption requires stable, flexible, and resilient T&D infrastructure. The holistic overview of assets provided by a digital twin, plus its insights into potential risk and improvement hotspots, helps asset owners stay ahead of the game and build in that resilience where it is needed most.

Importantly, if the data held by a LDT is fed into its analytics engines, the resulting models can help with scenario planning. Utility managers can query the data, ask ‘what if’ questions and visualize the answers to understand how grid loads may change and the impact on infrastructure in a given scenario.

### **Rising cost of energy**

Weather, transition, and aging assets all add to the costs of operating a T&D network and have driven the demand to “do more with less”. Always a key consideration, cost is now top of the agenda, as wholesale prices have shot up in response to geopolitical tensions, including Russia’s invasion of Ukraine and the loss of its vast gas reserves to the European market, which has increased prices across the globe.

For example, wholesale gas prices in Europe rose fourfold in the first half of 2022, while coal saw a threefold year-on-year increase from 2021. The result was that wholesale electricity prices more than tripled in many markets.

Then there is 50 percent rise in global spending that EY predicts will be needed to meet diversifying transmission needs is yet another challenge that will start to be felt in 2023. Finding cost efficiencies across T&D operations is ever more necessary.

One of the biggest cost centers for any utility is maintenance: personnel, travel, logistics, matching the right parts, and the unpredictability of it can rapidly add up. Too much maintenance is inefficient, too little can be catastrophic. By gathering accurate up-to-date data and applying artificial intelligence, machine learning, and analytics, a LDT can help T&D companies achieve the ultimate goal – accurate, safe, and predictive maintenance.

In addition, in many cases, drones can take the place of far more expensive manned helicopters in the gathering of on-site information and data for use in the Living Digital Twin. A LDT modelling capability can also be used to plan and optimize drone missions, analyze their capabilities, and ensure they are the best option for a given scenario. With utilities

striving for cost reductions where possible, the use of drones rather than helicopters or multiple personnel, can be an efficient route.

## **2023 and beyond**

Under political, environmental, financial, and social pressure, the operation of T&D assets is changing rapidly. Digital technology, such as a Living Digital Twin, is no longer “nice to have”. It is fundamental to a utility’s business model in order to future-proof performance, ensure safety and ultimately manage risk, while delivering reliable power to the communities they serve.

Equally, digital technology is not just a computerized replacement of traditional records or a 3d replicant. It is not a series of SD cards in a drawer or an application only usable by the most advanced software engineers. It adds the fourth dimension – time – to the mix and makes sure that the insights that mix delivers are useful and actionable. A digital twin also has mobile boundaries: remote controlled drones play an essential part in creating the situational awareness that utilities need.

As the challenges increase, so do the potential solutions. And in 2023 we will see demand for, and adoption of, those solutions increase.

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