How Advanced Data Historians Help Keep Up with a Changing Grid

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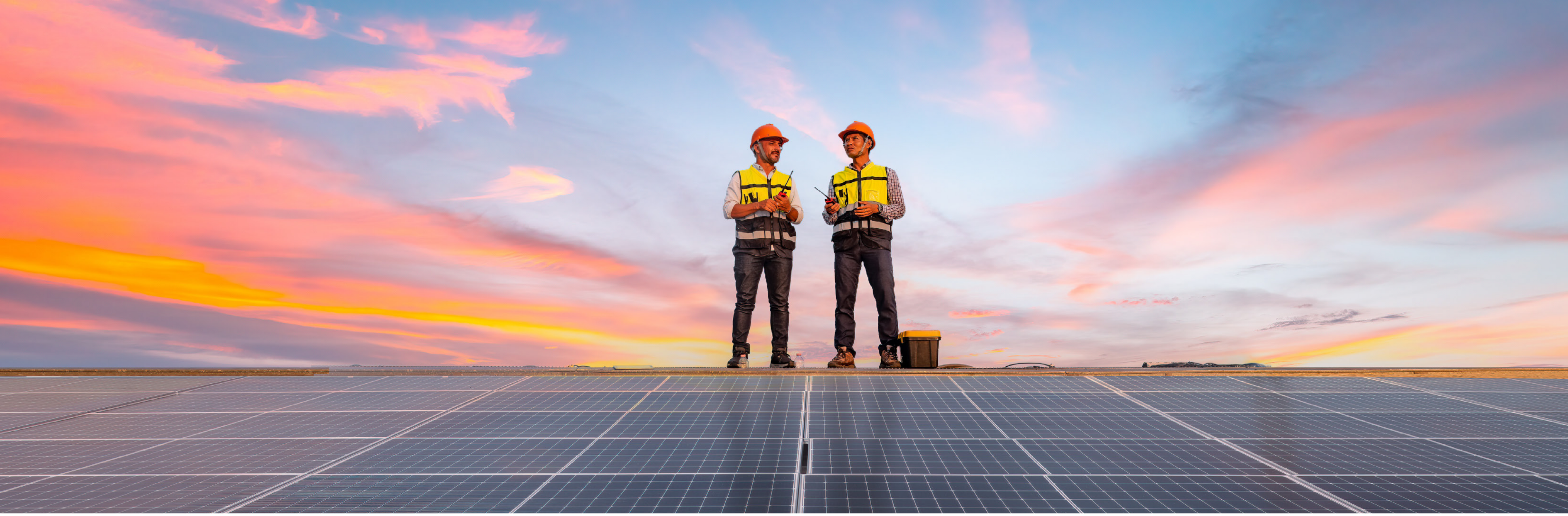

Introduction—Exploding DER Growth Calls for New Digital Tools

The clean energy transition currently reshaping the electric power utility system requires intelligent management of unprecedented amounts of new and changing grid asset data. For the past century, the grid consisted primarily of large fossil fuel power plants generating power that was sent in one direction to the homes and businesses that consumed them.

That hub-and-spoke model has been remarkably resilient, but with the emergence of new technologies and the imperative to reduce greenhouse gas emissions, electric grid dynamics are rapidly changing. The growth of renewables and Distributed Energy Resources (DER) like rooftop solar, energy storage and electric vehicle (EV) charging infrastructure—coupled with significant load growth and new load patterns—is posing unprecedented operational challenges to grid operators.

In its first-ever DER outlook in 2020, the consultancy Wood Mackenzie projected DER capacity in the Unites States would reach 387 gigawatts by 2025. The same report projected that over $110B would be invested in DERs between 2020 and 2025. By 2023, Wood Mackenzie's projection had changed to nearly $70B in annual capital investments between 2022 and 2027. The clean energy transition is accelerating beyond initial estimates. This requires utilities to accelerate investment in modern digital technologies to maintain grid reliability and resiliency in the face of changing grid dynamics.

A Grid with Greater Complexity and Dependence on Data

The growth of renewables and DER has many benefits. The integration of large amounts of energy storage, including solar, helps utilities and corporate electricity customers that purchase DERs achieve ambitious greenhouse gas emission reductions. DERs can also deliver financial savings to residential and commercial customers and help utilities and grid operators reliably deliver electricity during times of peak demand. The addition of DERs in strategic locations on the power system can delay or eliminate the need for grid operators to make expensive infrastructure upgrades to accommodate rising electricity demand.

Realizing the significant upsides of an increasingly renewable and distributed electricity system can only be achieved by navigating the complexities introduced by these new assets. In addition, the emergence of millions of so-called prosumers—DER owners who both consume and generate electricity—introduces bidirectional power flows that have the potential to cause power outages and even damage grid infrastructure.

The increasing amount of data available to monitor the grid represents both an opportunity and a challenge for utilities. The stakes for leveraging data to optimize a reliable grid are high because electricity is increasingly relied upon to heat and cool buildings, power industrial processes and fuel transportation. For example, the EIA forecasts that electricity demand from transportation alone could rise from 12 billion kilowatt-hours in 2021 to over 145 billion kilowatt-hours by 2050.

> **The electricity demand for EVs and the transportation industry in general could increase from 12 billion kilowatt-hours in 2021 to 145+ billion in 2050.**
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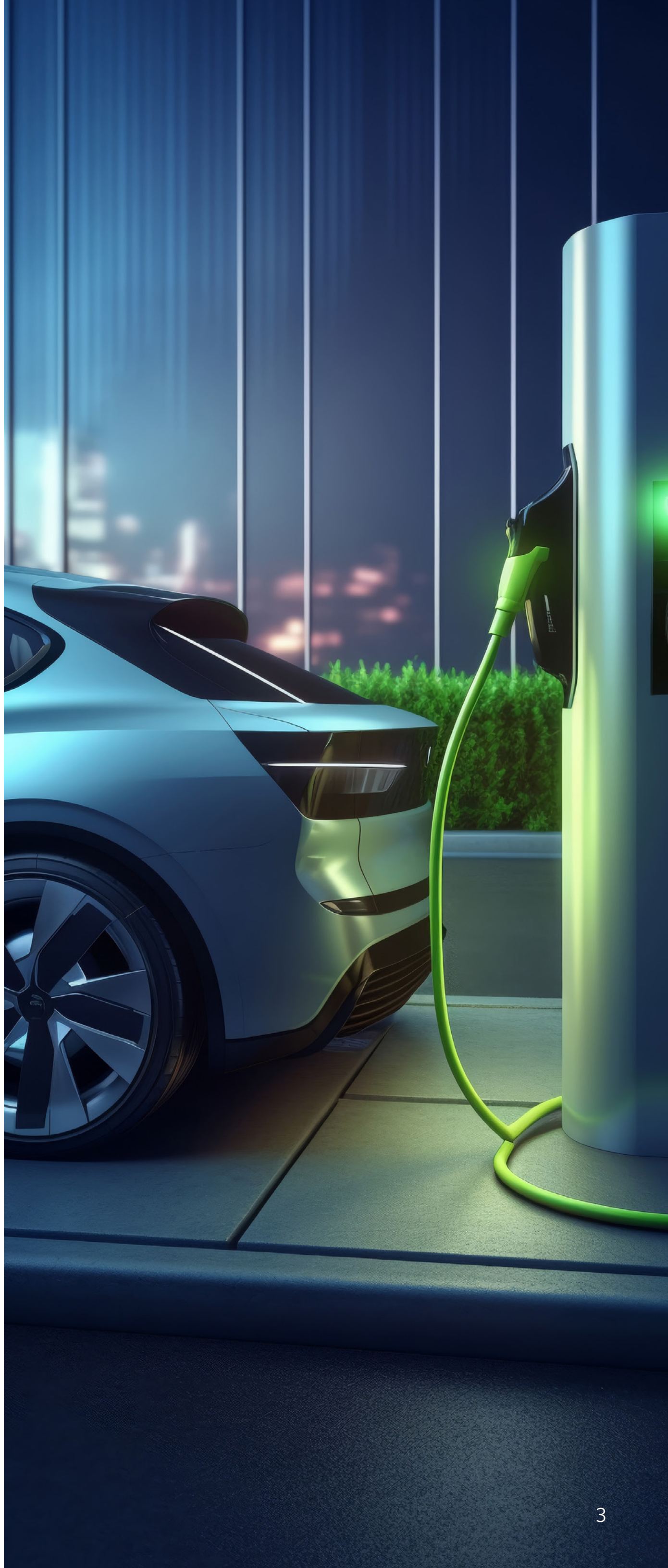
> **– U.S. Energy Information Administration**



The challenge of maintaining grid reliability is also growing due to an influx of DERs and variable renewable generation. The increasing frequency and severity of climate change-fueled extreme weather are putting pressure on the electric grid at a time when reliability is tantamount. These strains are having a negative impact. For example, the average annual number of weather-related power outages increased by roughly 78% during 2011-2021, compared to 2000-2010.

The Crucial Role of Data Historians in Achieving Utility Objectives

Data has a potentially transformative role in helping utilities achieve their most mission-critical objectives. Consider the value that data can deliver in maintaining grid reliability. As equipment ages, the capacity to analyze historical and real-time data to pinpoint possible failures before they happen and trigger an outage becomes increasingly important.

Predictive maintenance that prevents an unplanned outage is the best-case scenario. But data is also essential to help utilities quickly respond to grid problems. Data collection and analysis can help utilities detect and precisely locate grid faults, which is a vital first step in resolving an outage. Data is also a key ingredient in the grid modeling and scenario planning that utilities need to do to prepare a response to overloads or back feeds from renewables.

It's not just grid reliability that depends on data. Data about the electricity consumption of individual, commercial and industrial customers provide utilities with the insight to suggest rate options that save customers money and relieve pressure on the grid during times of peak demand. Data is also the foundation of any utility's effort to establish a greenhouse gas emissions baseline and measure progress towards net zero and other emissions reduction targets.

The value of these and other uses of data is inextricably linked to it being secure, validated and timely. Leveraging data for better decisions and investments ultimately means relying on a data historian. A longtime utility tool, data historians collect, store and manage a massive volume of data related to a utility's operations and the performance of its generation, transmission and distribution assets. Among the most common features of a data historian are:

- **Data collection.** All the sensors, AMI and other devices that generate data across the utility grid can send their information to a data historian. This is an important first step towards using the information to guide insights and decisions.
- **Data storage.** Data historians store data in structured ways that allow the information to be accessed rapidly. This includes organizing information with timestamps so that changes over time in equipment health and other metrics can be noted.
- **Data retrieval.** In order to identify and understand trends, users of data historians need to have access to the data in ways that make the information usable. This means providing them with tools to quickly query and retrieve the specific data they need.
- **Monitoring.** Data historians play a role in helping utilities monitor grid conditions in real time. This helps identify faults and other threats to reliability so they can be addressed in a timely fashion.
- **Analytics and reporting.** Trend analysis, predictive modeling and other data analytics supported by data historians provide insights that support investment and other decisions aimed at improving both grid resilience and reliability, as well as customer satisfaction.
- **Integration.** To deliver optimal value, data historians must support easy integration to a wide variety of enterprise systems, including operating technologies such as Supervisory Control and Data Acquisition (SCADA) and Energy Management Systems (EMS), business intelligence and other utility tools.
- **Cybersecurity.** Data historians provide robust cybersecurity measures that ensure confidentiality and integrity, and provide a foundation for any analytics, insights, monitoring or decision support.

Challenges Facing Data Historians

Used properly, secure, accurate and real-time data can translate into a more reliable, decarbonized and customer-centric grid. However, many traditional data historians are not equipped to reliably transform the information generated by meters, sensors and other equipment into tangible benefits for utilities, the grid and society.

Cybersecurity is a weak point for traditional data historians. This is significant because the prevalence of sensors, DERs, telecommunication equipment and other infrastructure in today's digital grid has vastly expanded the area that cybercriminals can attack and exploit.

According to a recent report by the International Energy Agency (IEA), cyberattacks on the energy industry are both significantly underreported and on a dramatic upswing. According to the IEA, recorded attacks include the disablement of controls at European wind farms, the disruption of prepaid meters due to the unavailability of information technology (IT) systems, and ransomware and data breach attacks. According to IBM's most recent report on the cost of data breaches, the average price tag for an energy sector breach was nearly $5M in 2022.

> **The average cost for an energy sector breach was nearly $5M in 2022.**
>
> **– IBM Report**

The challenge of securing data will likely only increase. Nation-states use cyberwarfare as a strategic geopolitical weapon and are devoting significant financial and human resources to improving their capabilities. This is making it more complex and harder to defend against attacks, which include the use of artificial intelligence (AI), than when cybercriminals worked alone or in small groups. The increased sophistication of attackers is also aided by a more distributed grid with a large and growing number of connected devices and resulting vulnerabilities.

Traditional data historians safeguard data on the IT side. But the convergence of IT and OT (operational technology) systems is part of the grid's evolution, and is necessary to enable utilities to perform data analysis for improving grid monitoring and planning. Traditional data historians struggle to ensure security when they must push data from IT to the OT layer, as opposed to outbound data passing through the electronic security perimeter to IT. Securely accessing important data from the IT side is limited by bandwidth constraints, which is further exacerbated when utilities have a large geographic footprint.

Another limitation of traditional data historians is their reliance on compression algorithms. Data compression was a necessity when hard drives were both extremely expensive and limited in their storage capacity. As a result, traditional data historians relied on compression algorithms to deliver an approximation of grid conditions, equipment performance and other metrics. The downside to this approach is that it does not provide the granular data needed for predictive analytics, billing, grid reliability and other utility priorities. While data historians do not have to compress data, ceasing compression can introduce new challenges, like slow data retrieval.

Other limitations of traditional data historians include:

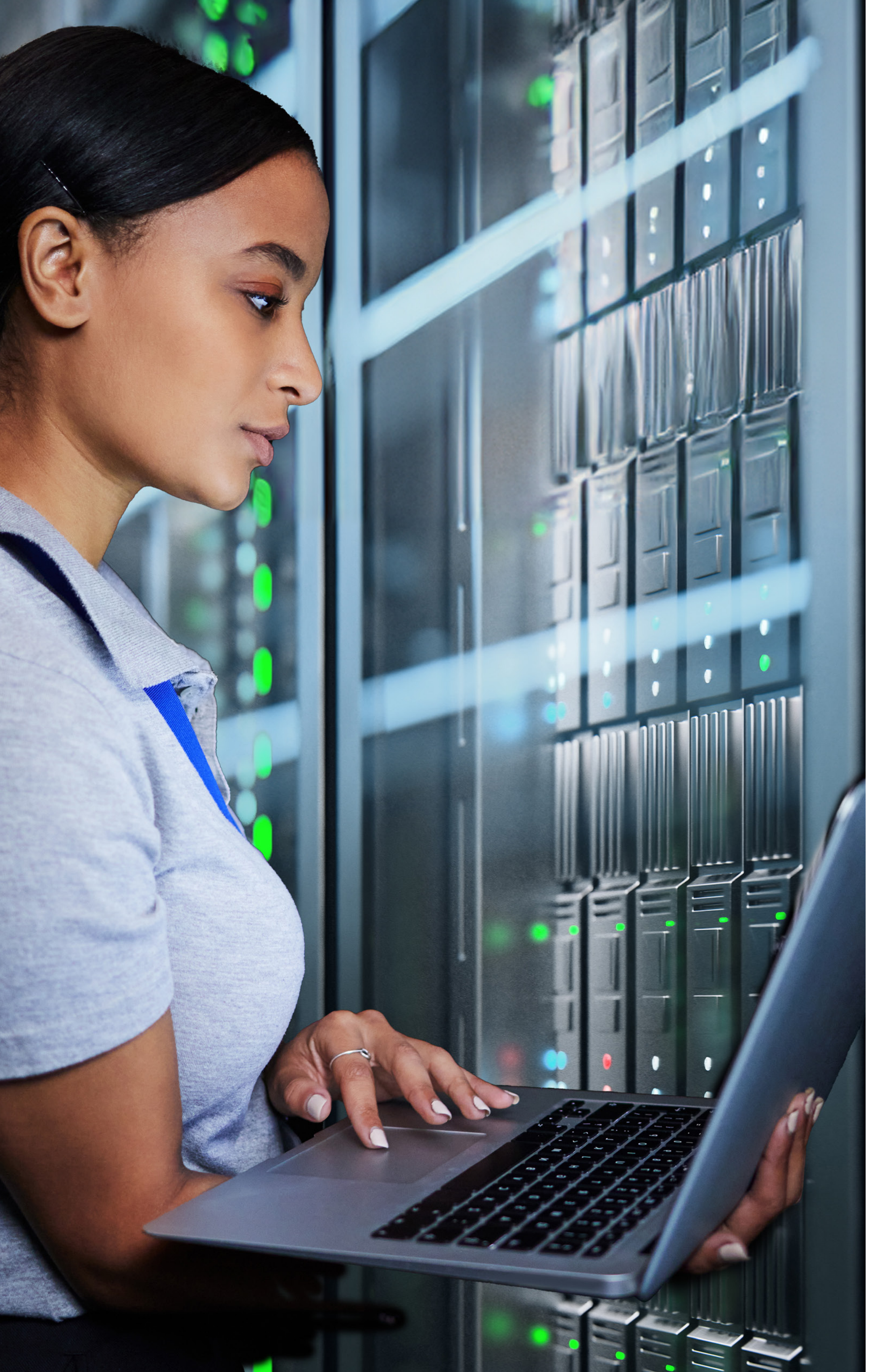
- **Limited time resolution.** Where the timescale of the data is not sufficiently granular to differentiate values that occur almost simultaneously.
- **Limited quality states for a value.** This may mask the actual nature of a data value. For example, was the value modified or does it consume additional points to capture the value and its actual quality state?
- **Fail to provide a holistic view of data in a single repository.** Maintaining different types of data, including analog, status and multifield string-based data like alarms in a common repository simplifies data access and governance.
- **Lack of integration with asset management platform.** Combining operational data with metadata (including information about the brand of a transformer, its location, and when it was put in service) allows users to analyze grid operations in ways that are impossible when using SCADA point data only.

Modern Data Historians Keep Up with a Changing Grid

The distributed, decarbonized and digitized grids that are emerging today are enabled by advances in a wide range of technologies—from energy storage systems and solar panels to electric vehicles, smart meters and grid monitoring sensors.

Data historians need to evolve as well. Today's data historians must be able to accommodate the unique data needs of utilities and grid operators with Big Data features and capabilities. These need to fully leverage the secure, granular, real-time data required by utilities to operate resilient, reliable, decarbonized and customer-centric grids. Among the most important capabilities are input-output, backup, redundancy, performance and recovery of Big Data.

Expanded computing power is the foundation of better data historian performance. Traditional data historians bolster their compute power by replacing an existing server. This approach can improve performance, but it comes at a very high cost and can take time to complete.

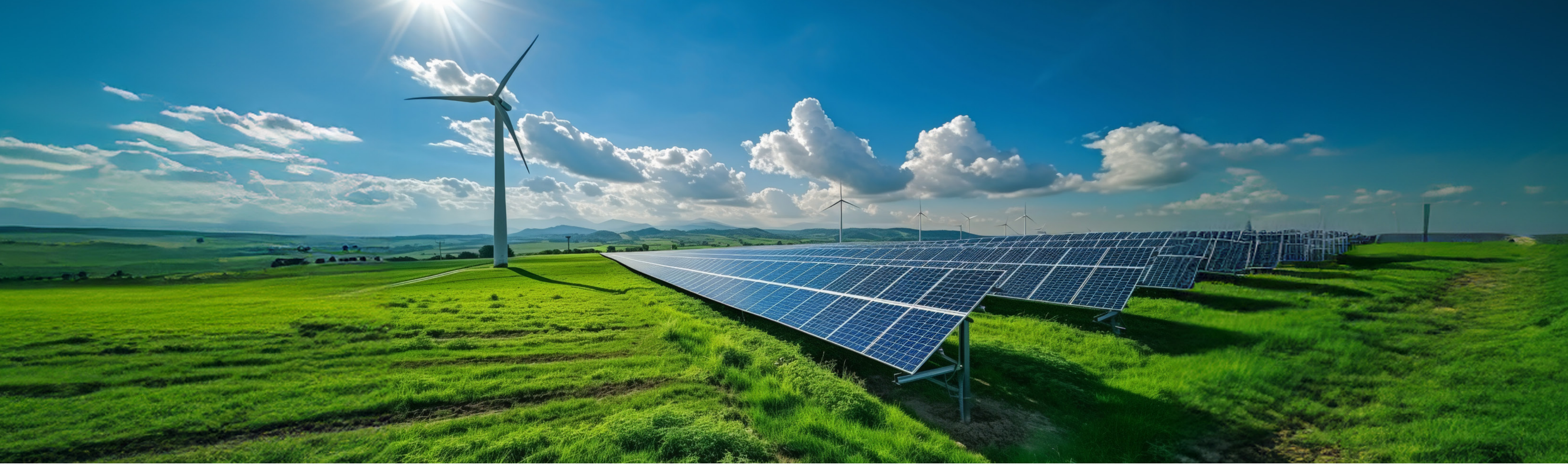


Today's newer approaches use a network of servers instead of a single server, and quickly add compute power by simply adding a node to the cluster of servers. Access to a cluster has other advantages as well, including data integrity. The increasing frequency and severity of extreme weather increases the risk of servers being damaged and becoming inoperable. Utilizing a cluster of servers means that data replication and backup are assured.

With new data historian technologies, operators can easily **compare current real-time data to previous periods** to determine if the system is operating within established norms. Based on real-time events, reports can be generated and automatically sent to the appropriate teams for notification and follow-up.

The new systems enable asset management teams to **better plan equipment maintenance** or replacement. Confident planned maintenance eliminates the risk of expensive and disruptive unplanned asset-related outages. Using modern data historian applications, utilities can schedule asset preventative maintenance and ensure adequate backup is in place, avoiding a disruption in service.

An additional benefit of the new technologies is that they enable utility executives to **monitor and report on important strategic objectives**, including sustainability. According to the Smart Electric Power Alliance (SEPA), 80 percent of U.S. electricity customers are served by utilities with a 100 percent carbon-reduction target. Additionally, over 20 U.S. states have enacted legislation or executive orders mandating or targeting 100 percent clean energy. Reliance on reliable data helps utility executives monitor and report progress towards decarbonization goals, as well as identify cost-efficient investments and strategies to drive decarbonization, including expanded use of virtual power plants (VPPs).



Conclusion—It's All About the Data

The clean energy transition currently reshaping the electric power utility system requires intelligent management of unprecedented amounts of new and changing grid asset data. Data historians play a crucial role in helping utilities leverage data for better decision-making, including preventing unplanned outages, responding to grid problems, and relieving pressure grid at peak demand times. However, traditional data historians are not equipped to efficiently transform such huge amounts of data, and suffer from issues of grid reliability, cybersecurity and failure to provide a holistic view of the collected data.

The expanded compute power of modern data historians, together with their ability to efficiently handle Big Data, enables utilities to operate resilient, sustainable and intelligent utility networks. These new capabilities preserve data integrity and eliminate the risk of expensive and disruptive unplanned asset-related outages while helping corporations advance towards their decarbonization goals.

AspenTech OSI Chronus™ Data Historian Supports a Secure, Resilient and Sustainable Grid in The Netherlands

A Netherlands-based distribution utility deployed the AspenTech OSI CHRONUS data historian to help it translate the increasing amounts of grid asset data collected into operational insights for use in real-time operations. The solution's scalable data historian platform was able to store millions of data points at millisecond frequencies. Advanced visualization and built-in reporting and analytics provided added value. Computing power and storage were added as the need arose. Support by multiple servers provided reliable data redundancy and cybersecurity, enabling the company to exploit the opportunities provided by the clean energy transition.

About Aspen Technology

Aspen Technology, Inc. (NASDAQ: AZPN) is a global software leader helping industries at the forefront of the world's dual challenge meet the increasing demand for resources from a rapidly growing population in a profitable and sustainable manner. AspenTech solutions address complex environments where it is critical to optimize the asset design, operation and maintenance lifecycle. Through our unique combination of deep domain expertise and innovation, customers in asset-intensive industries can run their assets safer, greener, longer and faster to improve their operational excellence.

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