Orchestrating the Grid: Tackling Utilities' Largest Opportunities and Challenges

Microsoft

US Utilities Leaders' Top Concerns

Generation from renewable sources—wind, solar, hydro, biomass, and geothermal—surpassed coal-fired generation in the electric power sector for the first time in 2022. The Federal Energy Regulatory Commission (FERC) 2222 has opened doors for Distributed Energy Resources (DERs) to play a larger role in a more dynamic energy market, and energy storage will continue to rise as a viable resource mix. While these represent significant strides toward electrification and decarbonization, progress is not without challenge.

According to Utility Dive, the US utilities industry faces **top five challenges**:

1. Affordability
2. Electric vehicle (EV) readiness
3. Growth of solar
4. Putting data to good use
5. Partnering with customers

This paper discusses solutions and how Microsoft can help turn industry challenges into opportunities by:

Unleashing innovation and reducing waste with a low-code development platform

Prioritizing and designing system upgrades for EV readiness with digital twins

Harnessing the power of generative AI to supercharge forecasting

Unlocking OT data to enable system insights across the enterprise with an all-in-one AI and analytics platform

Putting customer engagement at the center of the business with a customer data platform and journey orchestration tool

Affordability

Retail electricity prices have increased more than 10% since 2021, largely driven by rising wholesale power supply costs, higher gas prices, and inflation. Although external factors like political, social, and economic changes are beyond direct control of utilities, leaders can make an immediate impact on affordability by improving business processes through digital adoption.

The pandemic accelerated digital adoption out of necessity, but there is still room to further refine and optimize. Most utilities cite outdated, manual processes and siloed operations as key hurdles to operational efficiency. However, emerging technologies like low-code innovation using Microsoft Power Platform are enabling utilities to drive internal innovation and do more with less.

Imagine a scenario where crews are dispatched with precision, avoiding any unnecessary truck rolls, thanks to accurate customer and system records coupled with real-time weather, outages and situational awareness. Imagine another scenario where external crews are seamlessly onboarded to the host utility's job scheduling system before a storm event, creating a unified team to ensure safety and speedy restoration within hours. These process improvements demonstrate how accurate customer data and connected workflow through Microsoft Power Apps can help eliminate operational inefficiencies and position teams for success.

To understand how low code innovation is impacting the industry, we must look at operational gains. Increased digital adoption enhances process efficiencies and streamlines utilities workflows to reduce hand-off friction, leading to cost savings, reduced waste, and ultimately improved affordability.

Through its Digital Productivity Center of Excellence (DPCOE), which started in 2021, PG&E adopted Power Platform and Microsoft 365 to develop over 300 Power Platform solutions, saving them over 527,000 hours in just about four years and enabling over 4,300 Power Platform makers. Using Power Apps and Power Automate, PG&E developed a solution to manage its entire emergency site inventory of over 3,000 pieces of equipment. Even PG&E team members who have no coding experience and are new to digital innovation are now able to develop apps to optimize workflows.

"We felt there was a ton of value to be had throughout our organization in terms of streamlining and automating a lot of low-value work, and re-dedicating people in the organization to doing high-value work. Our entire company is engaged in the success of this as well."

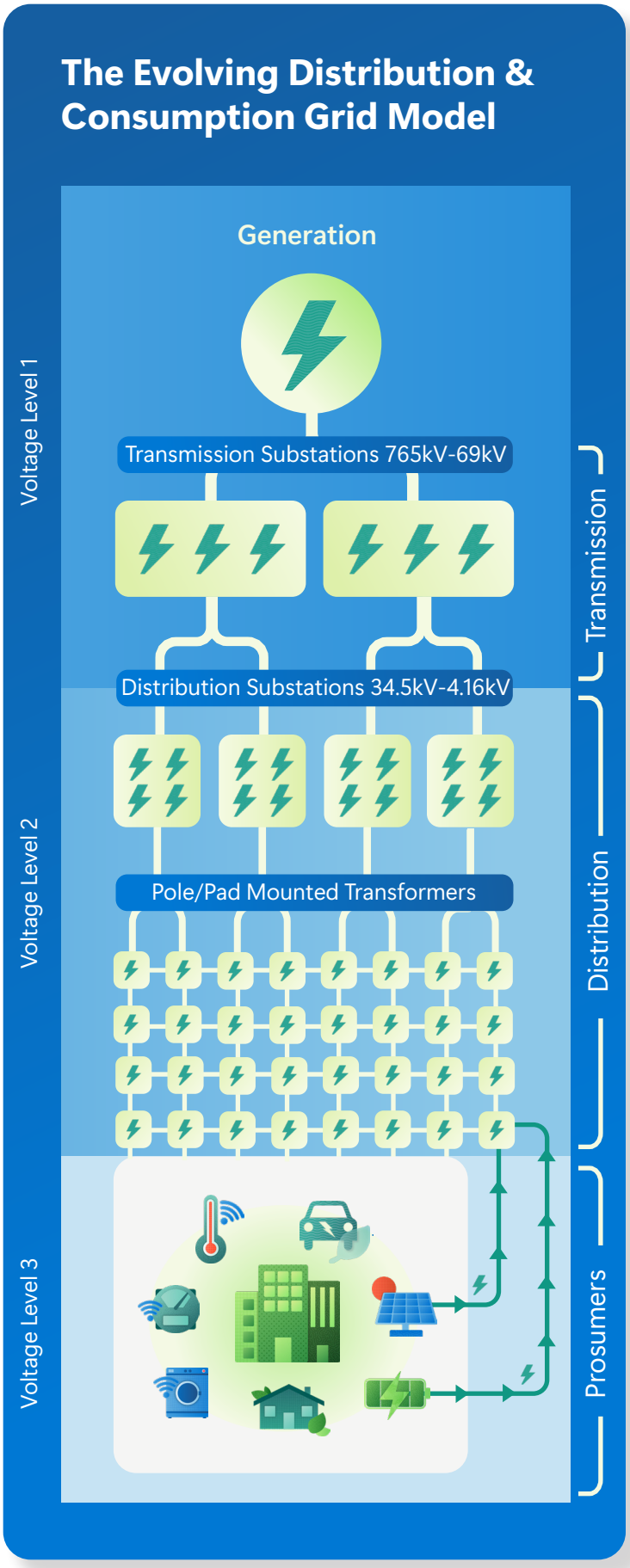
—Mark Seveska, DPCOE Executive Sponsor, PG&E IT Products and Enterprise Solutions.

EV Readiness

Every electric vehicle that connects to the grid is equivalent to the power consumption of a new house on the block. Although EV chargers are local, their impact on the electric network can be broad. As the surge in demand for EVs increases, utilities must take inventory of existing distribution grid conditions and simulate power flow scenarios for reliability, cost, and risk management. Across transmission and distribution, a typical utility has hundreds of transmission substations, thousands of distribution substations, and multiple thousands of feeder circuits mounted on poles and buried underground.

Regardless of system complexity, the need to upgrade the grid and increase visibility is mission critical. To expedite the design, engineering, and approval of substation upgrades to support the EV surge, utilities are leveraging digital twin technology to create digital representations of the grid. But the process isn't always simple; older substations may have drawings containing hard-to-read notes, making the digitization process painstaking. Furthermore, substation upgrades are often multi-disciplinary in nature, necessitating involvement from various engineering disciplines, as well as field operations. Building a digital grid requires a cultural shift from working within siloed, individual departments to collaborating on parallel workstreams across internal and external teams.

In addition to being multi-disciplinary, upgrades are a continual process. Engineering changes must be digitally recorded in real-time, capturing details about when and where the changes occur, by whom, and the methods employed. This ensures that asset data is consistently updated and aligned with what is physically present in the field – commonly referred to as "As-Built" conditions. An existing substation can have up to a hundred engineering revisions during its lifetime.



Modeling the grid is not a new concept but digital twin technology takes current approaches a step further. Although many companies use the terms digital twin and Computer-Aided Design (CAD) modeling interchangeably, CAD typically focuses on representing the wiring of electrical components, as well as the physical arrangement and dimensions of assets.

A digital twin, however, incorporates the behavioral, electrical, and mechanical attributes of the asset. A digital twin also integrates real-time data from IoT devices, like location services, weather conditions, and other sources. These integrations enhance situation awareness and enable near-term scenario planning, revolutionizing utilities asset planning and operations. In this sense, a modern digital twin solution acts as a data integrator, combining rich and complex data from a wide variety of sources into a unified model with a holistic view of assets.

Azure Digital Twin (ADT) provides utilities with a platform to create digital replicas of physical systems to yield insights across operational systems such as network simulation, distribution management, and outage management. It simplifies the creation of comprehensive digital models, tracks the past, simulates the present, and predicts the future by breaking down silos within an intelligent environment. To drive openness and interoperability, ADT comes with an open modeling language, Digital Twins Definition Language (DTDL), providing flexibility, ease of use, and integration into the rest of the Microsoft platform, including Azure IoT operations.

With Azure Digital Twin, physical assets such as a transformer or a breaker can be modeled, and entity relationships can be defined in context. Individual twins can be connected to other twins. The distribution graph above can be digitally described with ADT. These digital models define semantic relationships to connect twins into a knowledge graph to provide a Copilot that allows engineers or operators to interact with OT data through natural language search. Digital twin models help the utilities simulate if-then-else scenarios to produce the optimum design outcome for EV charging and reduce time for EV enablement. With increased visibility and insight, digital twins can help utilities understand what future updates are needed to support the growing demand for EVs.

Kongsberg, a Microsoft partner, has developed Kognitwin, a digital twin software solution built on Azure that enables Distribution System Operators (DSO) with data contextualization and load flow visualization and analysis. Since 2020, Shell has been implementing the solution across its global asset portfolio, using the technology to bring new ways of working by increasing the level of insight and contextual data into asset operations across the landscape of industrial business workflows.

"With the power of Azure and our exciting AI capabilities, we're not just facilitating seamless technological integration but also ensuring the well-being of our workforce. Together, we're optimizing assets, reducing emissions, and advancing towards our shared sustainability goals in a new era of proactive asset management."

-Andy Pratt, CVP Emerging Technologies, Microsoft

Growth of Solar

Traditional grids are characterized by their firm nature, allowing precise control through rotating power generators that start, stop, or speed up. In contrast, generation from wind and solar are heavily influenced by weather conditions, making them more susceptible to variability and difficult to predict and manage. Regardless of generation method, utilities must meet the same customer expectations for power quality and reliability.

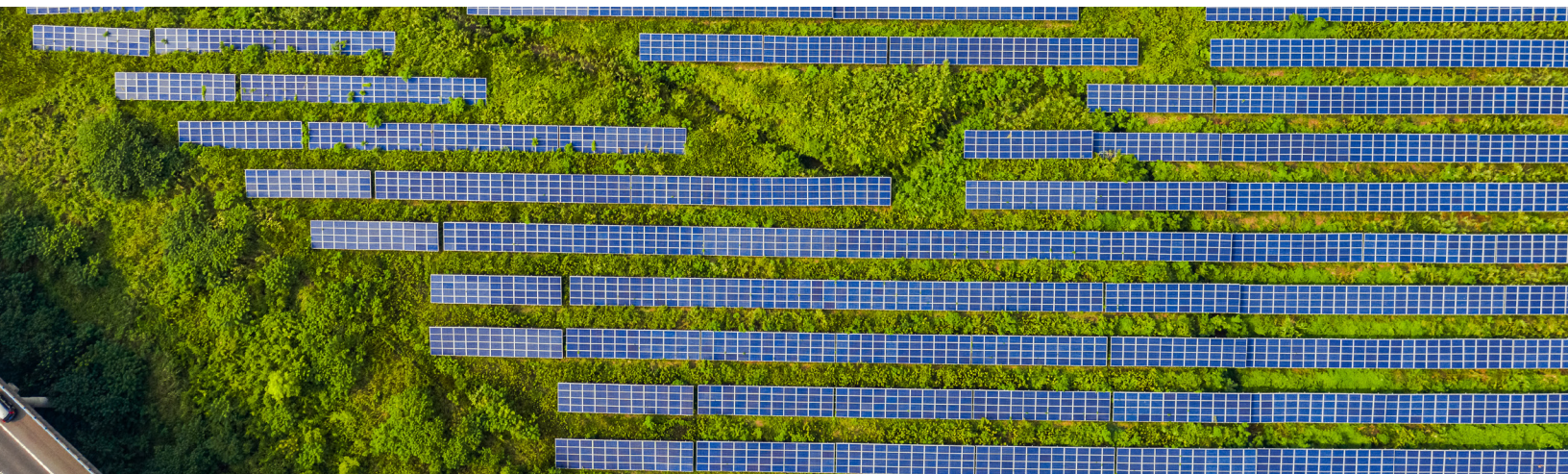
EV adoption adds further complexity, as transformers designed to heat up during the day and cool down at night on a fixed schedule are now operating around the clock. As more EVs come online and charge at night, stress on grid assets increases. This combination of intermittent generation growth and increased EV adoption poses a known risk to grid reliability due to increased thermal stress on transformers.

To help mitigate some of this risk and prepare for the future, utilities turn to forecasting. Forecasting uses a company's internal historical data along with external weather, economic market, and system data to project optimal operational patterns. This enables system operators to spot upcoming congestion and dispatch resources more efficiently and sustainably, both in real-time and over the next 5 to 10 years.

Azure AI's generative AI capabilities are a powerful tool to speed up forecasting. Natural language understanding quickly matches data names, types, and values across systems, accelerating the process of data preparation and curation and facilitating the seamless execution of machine learning tasks. Instead of users reconciling vast amounts of data to match corresponding values between several systems, generative AI can do the matching for us if we train it to build the knowledge graph and to automate remainder data matching, saving time and reducing human error.

To see these powerful capabilities in action, we can look to Ontario Power Generation's (OPG) Energy Markets team that leveraged Microsoft AI to help forecast prices, deliver value, and move a step closer toward a carbon-neutral future. They deployed sophisticated AI models to spot arbitrage opportunities and export excess clean power locally to neighboring markets including to US.

More and more organizations like OPG are looking to invest in emerging technologies as solar generation variability and EV adoption increasingly strain the grid. With powerful generative AI and machine learning capabilities, utilities can more efficiently forecast and dispatch resources.



Putting Data to Good Use

Utilities manage vast amounts of unorganized, disparate data separated by siloed systems. With the adoption of new renewable generation, there's only an increase in complexity. This makes it near impossible to gain operational insights, find value in AI investments, and even coordinate across internal teams. In addition, data that is not organized or out of date can be a liability for utilities and increase compliance risks.

Putting data to good use means extracting insights from existing data through the automation capabilities offered by a modern data platform. Microsoft Fabric is an all-in-one analytics solution for enterprises that offers data lake, data engineering, and data integration, all in one place through OneLake. With Fabric, there is no need to copy data and piece together different services from multiple vendors and systems. Instead, utilities can enjoy a highly integrated, end-to-end, user-centered product that is designed to simplify analytics in support of the industry's toughest challenges, such as scaling DER, EV, and renewable energy integration.

EDP, a global energy company that aims to transform the world through renewable energy sources, is putting data to good use by leveraging Fabric and OneLake to simplify data access across data storage, processing, visualization, and AI workflows. This enables them to fully embrace a data-driven culture where they have access to high-value insights and decisions are made with a comprehensive view of the data environment.

Utilities can also look to Microsoft Data Strategy as a proven method to help put data to good use. It helps an organization centralize data management, bringing together customer and asset data to deliver outcomes such as increased Customer Satisfaction (CSAT), enhanced upselling or cross-selling opportunities, reduced potential downtime, and extended asset life.

Utilities can draw insights from Microsoft's own internal data strategy transformation, which prioritized centralizing data and data management while maintaining flexibility at the edge. Microsoft operates on the principle of being "Disciplined at the Core" and "Flexible at the Edge," offering valuable lessons for utilities in their data management journey leading to developing capabilities to uncovering deep insight from AI.

The data management and governance strategies discussed in this section enable utilities to unlock the true potential of their data, turning disorganized data from siloed, legacy systems into valuable insights and operational efficiencies.

Partnering with Customers

To orchestrate the grid, utilities can leverage customer's onsite generation and demand response to fill in the gap when there is a supply and demand imbalance – creating grid flexibility. This requires a fundamental shift in customer relationship management, since it relies on the capability for utilities to be able to anticipate gaps in supply and demand across time and locations and receive real power support from their customers, all within minutes.

Understanding the nuances of customer energy, onsite resources, and communication preferences is essential to unlock hidden resources on the grid. Microsoft Customer Insights within Dynamics 365 gives utilities the tools to anticipate customer needs and preferences.

One way to see this in action is through Centrica's Boiler IQ. Centrica is an international energy company that develops market-leading energy services and solutions. To monitor boiler conditions in customers' homes, Centrica deployed IoT sensors that monitor conditions and provide alerts ahead of potential equipment failures. Boiler IQ not only enhances customer trust but also showcases the potential for utilities to leverage technology that connects customer needs before they realize.

To better understand and anticipate customer needs and preferences, AEP, a leading U.S.-based utility company, utilizes customer insights and integrates disparate information across their customer relationship management (CRM) and enterprise resource planning (ERP) systems. This gives them a 360-degree view of the customer and establishes a crucial foundation for effective grid management.

Ultimately, grid orchestration requires a fundamental shift in customer relationship management. By treating customers as partners, we can better understand customer energy nuances and leverage customer insights to better support effective grid management.

Summary:
Orchestrating the Grid

To orchestrate a flexible, highly renewable, real-time grid without sacrificing cost reliability quickly, we must be strategic and remember:

1. An essential first step is **unleashing internal innovation** and developing modern, agile processes with low code or no code tools like Power Platform.

2. **Digital twins are more accessible** than ever before, and partners like Kongsberg can support utilities planning for grid upgrades.

3. Forecasting powered by Azure AI and Azure OpenAI is a powerful unlock to **enabling the integration of solar, DER, and EVs at scale.**

4. Data is at the heart of this journey, and a unified data and analytics platform gets teams **out of data integration and into insights.**

5. Finally, Dynamics 365 customer insights can help utilities develop personalized customer experience **turning customers into partners.**

At the heart of this transformation are people and culture. New tools don't create change. Dedicated teams with the right tools, partners, and training will lead us towards a decarbonized, resilient, secure, and accessible power grid. No matter where you are in this journey – our team is ready to help you uncover the opportunities and innovation within each challenge of building the grid of the future.

Learn more at Microsoft for Energy & Resources.