Grid Modernization

The Journey to the Grid Edge

In the last five years, investor-owned utilities (IOU) in the U.S. have filed for $36.4 billion in grid modernization spending, and the pace of investment is accelerating, according to Wood Mackenzie. [1]Utilities are investing in infrastructure hardening, automation and advanced metering infrastructure (AMI) to prepare for an increase in severe weather events and a rapid proliferation of disruptive, consumer-owned energy assets including distributed energy resources (DER) and electric vehicles. But it's unclear how utilities will operationalize these investments with a holistic, technology-driven strategy capable of handling the challenge.

"Utilities are quoting DER integration and market enablement as the primary driver for their grid-modernization investments," Fahimeh Kazempour, head of grid modernization for Wood Mackenzie, said earlier this year. "However, our data suggest that utilities are designing the grid to withstand the scale and variability of DERs rather than integrating more closely with them."

This suggests utilities are busy doing what they know — building out capacity and recovering costs through ratemaking. "Defending the grid" in this manner has been effective for decades, but today's situation requires a next-generation strategy.

MEETING THE DEMAND OF LOAD GROWTH

Grid planners across the U.S. revised their projections for demand growth upwards by 81% between 2022 and 2023, according to data collected by the Federal Energy Regulatory Commission (FERC).[2] In total, grid planners expect electricity demand to grow 4.7% nationwide over the next five years with peak demand increasing by 38 gigawatts (GW).[3]

The convergence of several factors is causing this growth. Commercial and Industrial (C&I) demand is being driven higher by the reshoring of manufacturing and the needs of more powerful data centers, as well as the electrification of transportation. Electric vehicles (EVs) are a major factor in residential demand growth with projections suggesting 53% of U.S. car sales will be electric by 2030.[4] That year, EVs are expected to create 44 terawatt hours (TWh) of new electricity demand before skyrocketing to 107 TWh by 2035.[5] The other big factor in residential demand growth is the switch from gas to electric heating in much of the country's housing stock. This trend, for example, is expected to push winter demand higher than summer demand in the New York ISO around 2040.[6]

Federal agencies and programs are focused on increasing high-voltage transmission to meet demand and bring more utility-scale renewable energy into the mix.[7] But as utilities know, the distribution grid also needs significant attention. Peak demand on a typical residential feeder will increase 30% when just one-quarter of the homes begin charging EVs, according to McKinsey calculations.[8] As demand increases in homes across the U.S., load profiles will change dramatically for millions of service transformers, capacitor banks, circuit breakers and other distribution assets. Even if

[1] https://www.woodmac.com/press-releases/$36.4b-of-grid-modernization-planned-by-investor-owned-utilities/

[2] https://www.utilitydive.com/news/electricity-load-growing-twice-as-fast-as-expected-Grid-Strategies-report/702366/

[3] Ibid.

[4] https://www.recurrentauto.com/research/ev-adoption-us

[5] https://www.statista.com/statistics/952069/electric-vehicle-charging-energy-demand/

[6] https://www.nyiso.com/-/how-winter-energy-use-may-grow-with-electrification

[7] https://www.whitehouse.gov/briefing-room/statements-releases/2022/11/18/fact-sheet-the-biden-harris-administration-advances-transmission-buildout-to-deliver-affordable-clean-electricity/

[8] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-potential-impact-of-electric-vehicles-on-global-energy-systems

regulators allow for unlimited rate recovery, and even if labor market and supply chain constraints continue to ease, most utilities would still be in a race against time—blindly upgrading the oldest assets first, hoping their models match the actual demand that materializes in the years ahead. Capacity constraints are certain to manifest in highly localized fashion first, meaning more targeted mitigations – protection or right-sizing at the distribution transformer level – would be a far more cost-effective approach, but that requires a granularity of information at the grid edge most utilities do not have, today.

But capacity is only part of the challenge at the grid edge, which encompasses millions of devices on the medium- and low-voltage networks forking out from substations to customer meters, and beyond. The increasing complexity introduced by DERs is the other part of the story. EV adoption is also spurring interconnection of distributed energy resources. The residential solar market is expected to quadruple in size over the next decade while adding 95 gigawatts (GW) of generating[9] and residential energy storage is projected to reach 7.5 GW by 2030[10].

Historically, utilities have been hesitant to manage customer loads beyond the meter. But as two-way power flow becomes normal on low-voltage circuits, even the most risk-adverse utilities will need a more proactive strategy for the grid edge. This paper outlines the technological elements required to establish a data-driven, "intelligent" approach for both the build-out and operation of a modern distribution grid.

THE FOUNDATIONS OF A MODERN DISTRIBUTION GRID

To gather and apply data-driven insights to the challenges utilities face on the distribution grid, they need three foundational capabilities, at the grid edge:

1. **Planning:** Augmenting conventional system level supply side forecasting with rapid, high-volume distribution level impact assessments
2. **Visibility:** Real-time, actionable data-driven reporting to support dynamic load growth
3. **Control:** Near real-time, automated distribution level grid management, connecting grid operations (e.g. ADMS, EMS, OMS, etc) down to customer DERs (e.g. HVAC, GIWH, TSTAT, PV, BESS, EV, etc)

The most disconcerting thing about the proliferation of DER's, EVs and other intelligent devices behind the meter, is utilities have very little visibility and situational awareness at the edge of their grids. But the modern grid, with a blanket of sensors and a robust communications network, will shine a light into the dark beyond the substation. With millions, of data points at their disposal, human operators and engineers will be able to investigate what's happening anywhere in their service territory remotely. However, it will be impossible for them to monitor everything happening, which is why analytics, machine learning (ML), and artificial intelligence (AI) will play a key role in aggregating information, flagging emerging issues, and automating operations. The final technological piece utilities require is the interoperability of equipment in the field to receive AI- or human-generated control signals.

The benefits of an intelligent distribution grid will be numerous. Comprehensive data combined with analytical tools will allow utilities to know which circuits are overloaded, prioritize capacity upgrades, and make compelling cases for cost recovery. Operational benefits will include:

- Faster outage restorations and improved SAIDI, CAIFI and SAIFI
- Enhanced employee and customer safety
- Proactive and condition-based maintenance
- Automated and rapid response to severe weather events
- Improved power quality and more efficient power delivery

In addition, leading utilities will also develop a next-generation operational model and mindset. They will use the full potential of grid intelligence to implement proactive load-management strategies and rate structures that optimize capacity on existing distribution equipment. Utilities that embrace the opportunity for customer engagement will employ load-management tools with distributed energy resource management systems (DERMS). This will help to orchestrate EV charging and integrate DERs and grid edge devices, rather than just defending against their impact with equipment upgrades. In doing so they will:

- Become more customer-focused
- Open the door to new service offerings and revenue streams
- Increase the ROI of grid assets by extending/maintaining their lifecycle

[9] https://www.seia.org/research-resources/solar-market-insight-report-2022-year-review
[10] https://about.bnef.com/blog/global-energy-storage-market-to-grow-15-fold-by-2030/

THE CAPABILITIES OF A MODERN DISTRIBUTION GRID

If utilities deploy a comprehensive solution for visibility and command and control on the distribution grid, they will have the foundation to develop numerous advanced capabilities. While interconnected from an outcome's perspective, those capabilities can be divided into three sub-categories:

» Substation automation,

» Distribution automation

» Customer DER management

Substation Automation

The major IOUs already have some level of automation providing protection and measurement capabilities at the substation where high-voltage transmission is converted to medium and low voltage distribution. Substation automation enables the control of substation devices and equipment that can be used to rapidly implement broad-stroke protection and control strategies to maintain reliability and protection of the distribution systems. Substation automation generates datasets that are analyzed for real-time status monitoring, preventative maintenance policies, grid-extension planning and the integration of utility-owned large-scale DERs.

As substation automation becomes more prevalent and visibility into low voltage distribution improves, capabilities will expand. Voltage and current data from distribution circuits, for instance, can be used to automatically adjust tap changes on substation transformers in support of conservation voltage reduction (CVR). Data from the medium voltage network and low-voltage circuits will be fed into advanced distribution management systems (ADMS) and other back-office systems to inform substation voltage control and switching during outages, fire conditions, brownouts or regular day-to-day operations improving safety and reliability.

Distribution Automation

Monitoring of medium voltage networks will provide the data necessary for more granular analysis, decision-making and control. As ADMS vendors restructure their implementations to support medium-voltage data and operational rules, utilities will gain protection over the impact of EVs and other downstream DERs through the ability to monitor and control load on the distribution circuits. By shifting load to off-peak, DERMS can create more hosting capacity for existing infrastructure, reduce transformer overloading and extend operational lifetime of critical transformer assets. Using grid-edge voltage data and load monitoring to better manage and protect vast fleets of service transformers creates more hosting capacity and enhanced operational life, not to mention deferring capital spending for replacement transformers. The same dataset can be used to further refine CVR via capacitor banks and voltage controllers' operational capabilities on medium voltage feeders.

Outage response and safety measures will be dramatically improved with more granular monitoring of medium voltage lines and their control equipment. With machine learning, AI can detect where vegetation encroaches on lines and causes fire hazards. Reclosure schemes will be remotely configurable, and peer-to-peer device communication will allow for automatic rerouting of power during an outage event, instantaneously reducing customer impact.

» Pepco used its AMI to determine accurate, hourly load profiles for 5,400 transformers and to identify over-loading. The improved equipment sizing generated capital savings, avoided customer interruptions and power-quality issues, and protected against safety issues and property damage.

» Avista achieved 2% energy savings from CVR by upgrading substations and distribution feeders with automated voltage controllers capable of receiving feedback from downstream AMI.

» AEP Ohio improved SAIFI by 14% and SAIDI by 9% with automated fault detection and circuit reconfiguration.

Customer DER Management

With visibility and control from the substation to the meter—plus the local area network (LAN) capabilities of advanced meters—utilities will have everything they need to integrate customer EVs, solar and other DERs. These analytics-driven capabilities will dovetail with existing and future demand response (DR) and DER programs to shape demand and time-shift loads, effectively increasing the capacity of existing distribution infrastructure at the level of individual service transformers and, in aggregate, across broader sections of the distribution grid. By providing a standardized pathway to access customer energy resources, costs can be optimized from extending the life of grid assets (secondary transformers) to reducing the need for customers asset upgrades (customer-owned electric distribution panels). Distributed intelligence is being leveraged today to enable automated load management, enabling customer choice to adopt any growing number of electrified resources on the market.

Capabilities will include real-time customer engagement through connections with behind-the-meter devices in homes and businesses. Greater engagement will make it easier for utilities to aggregate and control diverse virtual power plants (VPP) for grid services or to partner with third-party vendors to achieve the same outcomes or other customer-focused innovations.

» Dominion Energy is adding roughly 1,000 new solar panel customers every month. The utility is using its advanced metering infrastructure (AMI) to remotely update net metering configurations and avoid truck rolls. The process is 95% faster and is expected to generate $200 million in operational savings over the next 20 years.

» The State of Michigan requires all utilities to implement energy waste reduction programs. Consumers Energy uses its AMI to generate personalized home energy reports and web portals for each customer and to implement a critical peak pricing program for demand response. The utility also piloted a successful pre-pay program with daily usage feedback and remote disconnection and reconnection functionality.

Integrating Grid Edge Data with Utility OT Systems

In the rapidly evolving landscape of energy distribution and management, the integration of grid edge data into utility Operational Technology (OT) systems has emerged as a critical imperative. The traditional model of centralized energy generation and distribution is giving way to a more dynamic and decentralized paradigm, driven by renewable energy sources, smart grids, and advanced metering infrastructure. At the forefront of this transformation lies the grid edge –the point where consumers, distributed energy resources (DERs), and utility infrastructure converge.

By leveraging real-time insights from the grid edge, utilities can enhance grid reliability, optimize asset utilization, facilitate demand response, and unlock new revenue streams. The integration of grid edge data into utility OT systems assumes paramount importance. Grid edge data encompasses a diverse array of sources, including smart meters, sensors, IoT devices, distributed energy resources, and customer-generated data. By harnessing these data streams, utilities can gain unprecedented visibility into grid conditions, consumer behavior, and asset performance. This visibility, in turn, enables utilities to optimize grid operations, improve service reliability, and meet evolving customer demands.

Benefits of Grid Edge Data Integration:

- Enhanced Grid Resilience and Reliability: Real-time data from the grid edge enables utilities to detect and respond to grid disturbances proactively. By implementing predictive analytics and machine learning algorithms, utilities can anticipate potential issues, preempt outages, and optimize grid restoration efforts.
- Optimized Asset Management: Grid edge data provides utilities with actionable insights into asset health, performance, and utilization. By leveraging asset analytics, utilities can prioritize maintenance activities, extend asset lifecycles, and minimize downtime, thereby maximizing return on investment.
- Empowered Consumer Engagement: Grid edge data empowers consumers by providing them with visibility into their energy usage, costs, and environmental impact. By offering personalized insights and recommendations, utilities can encourage energy conservation, promote demand response initiatives, and foster greater consumer engagement.
- Facilitated Integration of DERs: Distributed energy resources (DERs) such as rooftop solar panels and battery storage systems are proliferating at the grid edge. Integrating DER data into utility OT systems enables utilities to manage these resources effectively and optimize grid stability.

To maximize the value of grid edge data integration, utilities should adopt the following best practices:

Develop a Comprehensive Data Strategy: Establish a clear data strategy aligned with business objectives, regulatory requirements, and technological capabilities. Define data governance policies, data quality standards, and data sharing agreements to ensure consistency, integrity, and reliability of grid edge data.

Invest in Advanced Analytics and AI: Leverage advanced analytics, machine learning, and artificial intelligence (AI) technologies to extract actionable insights from grid edge data.

Implement predictive maintenance algorithms, anomaly detection techniques and optimization models to enhance grid performance and reliability.

Foster Collaboration and Partnerships: Collaborate with industry stakeholders, technology partners, and academic institutions to foster innovation, knowledge sharing, and best practice exchange. Form strategic partnerships with DER aggregators, energy service providers, and technology vendors to accelerate the integration of DERs and grid-edge solutions.

Itron forming strategic partnerships to unify Grid Edge data with utility OT systems

Itron is partnering with industry leaders in ADMS to ease the integration and utilization of data from the edge (behind-the-meter) to the core (grid control room) by connecting the two for real-time data insights for utilities and grid operators. Bringing together grid edge data with operations data will close gaps in visibility that previously prevented utilities from identifying and resolving grid issues quickly and efficiently.

By integrating Itron's Grid Edge Intelligence solutions with leading ADMS technology vendors, the companies will enable utilities to address grid operations challenges brought about by renewable energy generation and behind-the-meter distributed energy resources (DERs), such as customer-owned solar, EV charging infrastructure, or battery storage.

Key benefits expected from the combined solutions include:

- Improved navigation and response to load demands
- Resolve grid constraints
- Real-time automated model accuracy via AI/ML
- Better reliability and more stable power supply

Prioritize Cybersecurity and Privacy: Prioritize cybersecurity and privacy by implementing robust encryption protocols, access controls, and security monitoring mechanisms. Conduct regular security audits, vulnerability assessments, and incident response drills to mitigate cybersecurity risks and safeguard grid-edge data.

The integration of grid edge data into utility OT systems represents a transformative opportunity for the energy industry. By harnessing real-time insights from the grid edge, utilities can enhance grid reliability, optimize asset performance, and empower consumers with personalized energy services. However, realizing the full potential of grid edge data integration requires a strategic approach, collaboration across stakeholders, and investment in advanced analytics and cybersecurity capabilities. As utilities embark on this journey, they must embrace innovation, agility, and a customer-centric mindset to thrive in an increasingly dynamic and interconnected energy landscape.

A SERVICES-FIRST STRATEGY FOR GRID MODERNIZATION

The capabilities gained through grid modernization will allow utilities and their customers to become more engaged in the proactive delivery and use of electricity. Utilities will gain opportunities to deliver new and enhanced services that support customers and the grid, but it will require a shift in operational mind-sets.

Proactive Maintenance Service

Today, most utilities operate under a run-to-fail maintenance policy. Repair of aging infrastructure or failing components doesn't happen until failure occurs, creating an outage or loss of phase. In every case, failure impacts the customers to some degree. Consumer confidence and grid reliability are both reduced, and utilities must report lower SAIDI and CAIFI metrics to regulatory bodies.

Using information from the grid edge, closes the monitoring loop and provides accurate and timely information about equipment that may require replacement or service before it fails. Utilities, for example, could use this information to schedule repairs or replacement of transformers, relays or switching gear in designated service windows, rather than reacting to outages with extraneous truck rolls and overtime. Cloud based services, such as Microsoft Azure, allow utilities to use analytic tools that feed work order systems to create more efficient operations. Using this approach improves SAIDI and CAIFI metrics, customer satisfaction and confidence, while also reducing operational costs.

The Customer Experience

As more prosumers connect to the grid with EVs, solar panels and other DERs, utilities can empower them to use energy more efficiently by providing them with more integrated data and insights. By understanding the value of time shifting their consumption, these customers can lower their bills and help reduce the utilities' needs for additional infrastructure.

Using Itron's DataHub, utilities can feed real-time information about grid-edge events and consumption to Green Button Initiatives or consumer portals, such as Smart Energy Water or Opower, to provide consumers with detailed information about their energy usage. Itron's Grid Edge solutions also enable more direct consumer engagement. For example, by analyzing EV load profiles, the impact of charging on transformer efficiency, and transformer-overload scenarios, utilities can create effective TOU rates to influence consumer behavior. Itron's Grid Edge solutions can allow 100-amp service customers to install level 2 EV chargers without an expensive service upgrade to the home and without having to reconductor and replace the serving transformer. Solutions like this create customer good-will, utility savings and regulatory confidence in grid modernization capabilities.

Business Services

Engagement at the grid edge also brings unique insights that create opportunities for business services that were not available previously. Monetization of the services can help to offset costs associated with the push towards decarbonization, data security, electrification, and sustainability.

Information created by grid-edge devices and the associated analytics enable next-generation business services that have traditionally been provided by laborious spreadsheets, homegrown systems, or specialized software applications. Itron's Grid Edge solutions empower utilities to facilitate these services efficiently. Capabilities like wholesale and retail settlement are available as part of Itron Enterprise Edition™ (IEE). As decarbonization needs grow, IEE will begin to support carbon settlement requirements as well, for the markets that trade carbon credits. Additionally, advanced billing services can accommodate customers who need smart prepaid services, billing discrepancies and net metering needs. With IEE and Itron DataHub, utilities can provide customers customized billing and real-time information on their energy consumption.

As the journey to the grid edge matures, ongoing development of the services Itron provides utilities will continue to evolve. There continues to be a growing need for demand forecasting as weather patterns become more volatile and demand profiles more complex. We've supplied demand forecasting systems to utilities, RTOs and ISOs for the past 30 years, and those are now also enabled by data management systems hosted on Microsoft Azure.

Itron is investing heavily in the evolution of our industry-leading demand response (DR) management and DER management solutions. As the number of DERs continues to grow, these systems will be critical to utility visibility and control to maintain grid stability. Expanded capabilities via the DEO Edge DERMS platform will enable our customers to control and monitor DERs, allowing EV, PV and storage to become resources for maintaining balance of critical infrastructure.

Distributed Intelligence – Delivering value to the Grid Edge

A key aspect of the modern distribution grid will be the location of computing resources performing data analysis and contributing to decision-making. For example, capabilities controlled by ADMS will often function on a centralized intelligence model. In this model, data is polled from across the grid and brought back to headend systems, or the cloud, for analysis. Centralized intelligence has the advantage of developing system-wide insights but can be challenged by the volume of data management, as well as latency and accuracy issues.

In contrast, a distributed intelligence (DI) model uses device-based computing power in meters, gateways and other devices to perform analysis on locally captured information such as voltage and current waveform data. The significant advantage of this approach is the speed, accuracy and localization of the event, which allows distributed intelligence to provide event and anomaly information to ADMS and SCADA control systems that make decisions to avoid outages, safety issues and transformer overloading. This hybrid approach provides closed-loop control feedback that utilizes centralized and distributed intelligence models to ensure significant improvements in grid reliability and safety while reducing the capital spend in infrastructure buildout.

- To limit billing inaccuracies, ComEd needed to ensure that its C&I customers were maintaining a power factor of at least 85%. The utility backhauled the necessary kVArh data for centralized analysis revealing the customers that were falling below the threshold and in need of corrective action.
- CenterPoint Energy (CNP) uploaded an application for detecting high impedance to 150,000 meters with distributed intelligence capabilities. The application had a 93% success rate, identifying more than 250 issues that required equipment replacements, as well as 180 other problems or outdated designs that were referred to engineering.
- Tampa Electric Company (TEC) tested DI applications for meter bypass detection and high impedance detection, and they successfully installed the applications over the air to 200,000 meters already in the field. The trial proved that the DI applications could detect problems at a local level with a high degree of accuracy — greater than 86% on a sample of meter populations that returned DI alarms. The TEC team was able to isolate issues and target meter exchanges, protecting customer safety and reducing field visits.
- FPL has been able to significantly improve its storm response and grid reliability by adding Automated Feeder Switches and Line Sensors to its smart grid network. These devices use the same network infrastructure as FPL's smart meters to communicate with one another and make real-time decisions to minimize outages and reduce outage time. With this grid-side distributed intelligence solution, FPL has eliminated 5.1M minutes of customer interruptions per year and saved an estimated $46M.

THE GRID-EDGE JOURNEY

Advanced metering infrastructure (AMI) introduced solid-state meters with greater resolution, two-way communications, and data management applications that revolutionized utility meter-to-cash operations – and opened the door to consumer-engagement opportunities. The next generation of these connected utility systems has been dubbed AMI 2.0, because they build on the foundations of AMI systems deployed throughout the 2010s. But it's not just an incremental upgrade, as the moniker implies. In fact, it is a necessary solution to the urgent problems utilities now face.

AI, edge computing, cloud services and more robust networking technologies are the foundations of new capabilities that will allow utilities to cost-effectively manage increasing load demand and grid-edge complexity. Intelligent and scalable data-driven solutions are required, because utilities do not have the funds, or the time, to build poles-and-wires solutions for the grid-edge challenges ahead.

Combined with a service-first mindset, leading utilities will use their new capabilities strategically, engaging consumers as partners in the energy/water exchange. Together, they will increase operational insight and visibility throughout distribution systems, deliver real-time data collection, analysis and action where needed, and integrate new consumer-facing technologies like EV's and DERs while ultimately better managing the flow of energy, water and essential services.

There is no single path to reaching these outcomes. Depending on a utility's existing system architecture and business objectives, there are multiple ways to deploy grid-edge management solutions. Itron envisions a grid edge where meters, transformers, and feeders negotiate amongst themselves to achieve localized distribution outcomes, dynamically adapting and configuring sections of the distribution grid, while enabling consumers to participate and benefit from these transactions. Our solutions are designed to meet utilities where they are in developing the real-time orchestration that will ensure grid reliability, enhance consumer experience and automate real-time grid operations, from the low-voltage distribution network all the way up to the substation. The growing challenges utilities face can be overwhelming. Most utilities do not have all the technological expertise, let alone human resources, to manage the scope of grid modernization needed at this moment in time. Itron's mission is to provide utilities a purpose-built path—to help our customers make the best decisions and then operationalize their investments to achieve the greatest impact and value. With the framework and foundations presented in this paper, Itron can assist utilities in drafting their own designs. We can help make the case for modern grid capabilities that achieve short-term objectives while also extending the foundations for a long-term vision. Contact us to get started.

Itron's Grid Edge Solutions Portfolio

Every utility journey is unique, however most utilities are facing the same set of business issues which need to be addressed according to the priority of business objectives, regulatory requirements, and other factors. Itron's solutions designed to be flexible and provide standalone solutions which can also work together; and more importantly, when coupled together their benefits are compounded.

Below are examples of the business issues that can be addressed through one or more solutions in the Itron Grid Edge Solutions Portfolio.

Extreme Weather	The impact of extreme weather events on the grid leads to grid vulnerability, frequent service disruptions and elevated reliability risks, hampering operational resilience and posing substantial barriers to consistent energy supply.
Customer Safety	The safety concerns for customers stemming from grid events, such as downed conductors and other hazards, give rise to risks of injury, property damage, and disrupted daily life, resulting in customer safety anxieties and adverse impacts on well-being.
Resource Sustainability	Over-reliance on legacy carbon-based generation results in escalating carbon emissions, environmental degradation and fossil fuel dependency, creating a critical imperative to reduce carbon footprint and transition towards clean energy solutions.
Enhanced Customer Experience	Lack of focus on customer offering results in customer dissatisfaction, increased complaints and eroded customer trust, leading to adverse public perception, and the risk of eroding market competitiveness.
Secure Data Access	The utility lacks an effective mechanism to provide customers with access to energy consumption data, resulting in regulatory compliance challenges, potential penalties and customer privacy concerns.
Next Generation Services	The utility struggles with wholesale and retail electric settlement processes, resulting in billing inefficiencies, discrepancies and regulatory compliance challenges.
Advanced Billing	Inefficient and inaccurate customer billing arising from manual meter reading and data handling, results in billing discrepancies, delays, customer complaints and operational inefficiencies for the utility.
Transportation Electrification	Electrification of the transportation sector will increase strain on the grid, require infrastructure upgrades, make balancing of energy supply and demand difficult, and jeopardize grid reliability, sustainability goals and customer satisfaction.
Reduce Outage Impact	Inadequate outage management and communications result in suboptimal service restoration, extended downtime and poor customer experience.
Voltage Optimization	The voltage optimization challenges faced by utilities, particularly at the grid edge, result in voltage instabilities, inefficient energy consumption, lack of regulatory compliance and compromised grid reliability.
Asset Management	Lack of holistic asset management within the distribution grid presents significant challenges, leading to inefficient resource allocation, increased risk of equipment failures and hindered reliability.
Increased Operational Costs	Increasing operational costs due to inefficient methods of detecting grid issues.
Revenue Security	The utility faces challenges in detecting power theft and unpaid accounts, resulting in revenue loss, operational inefficiencies and non-compliance with regulatory requirements.

There are some key themes that cross most of these business issues including increasing operational resiliency and reliability, increased operational efficiencies, improved consumer/customer satisfaction and safety and achieving sustainability goals.

Itron's Grid Edge Solutions portfolio is built on the foundational technology necessary to create information and data as it relates to grid edge loads and grid edge use cases. This is the technology that makes doing business at the edge possible. Itron is empowering utilities with new ways of operating the grid edge. With visibility and control spanning from behind the meter out to the substation, Itron engages grid engineers to consumers alike. With Itron's Grid Edge Solutions portfolio, Itron is innovating the way utilities manage the grid edge – at scale. What was previously impossible is now made possible with next-generation grid-edge management.

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