T&DWorld EnergyTech

Sponsored by NEXTera 360 Energy Management Software

RESILIENCY IS TOP OF MIND

Data is the Energy Industry's Best Defense

Introduction

Resiliency has been top of mind for grid operators, electricity suppliers, and consumers alike as escalating climate change-driven extreme weather is stretching the reliability of our electrical infrastructure. In the summer of 2023 alone, widespread flooding in the Northeast forced utilities to shut down power while extreme heat in the Southwest and Southeast perpetually taxed the electric grid's ability to meet peak demand records.

As extreme weather causes increasing outages, energy infrastructure owners must invest in resilient and diverse electricity solutions to mitigate these hazards before they leave important customers scrambling in the dark for reliable solutions. Similarly, commercial and industrial (C&I) customers who depend on a reliable grid are seeking solutions to overcome increasingly common outages that severely impact operations.

This white paper, presented together with NextEra Analytics (NEA), explores how improved data collection and analytics help a diverse array of energy infrastructure companies better predict and manage extreme grid conditions due to events like wildfires and extreme weather, helping ensure better reliability for the grid and for large commercial and industrial (C&I) customers. Ensuring resiliency doesn't necessarily mean increased costs, as many of the models that require a robust understanding of grid risks and energy market fluctuations come with co-benefits that can help the bottom line, regardless of whether you are a large utility, commercial entity, or large industrial facility.

An Imperative to Upgrade

Energy infrastructure and large C&I companies have used technology and internal processes to ensure reliability for decades. But risks to reliability are now evolving and intensifying rapidly thanks to climate change driving more extreme weather, while the digitalization of energy infrastructure is simultaneously creating countless new entry points for cyberattacks. These unprecedented 21st century risks to the grid require a 21st century approach to risk management.

Electric grid outages have recently become more frequent, providing ample proof that old approaches are falling short. On average, Americans spent eight hours without power in both 2020 and 2021 — more than double the rates seen in any year from 2013 to 2015. Major blackout events increased by more than 60% from 2015 to 2020.

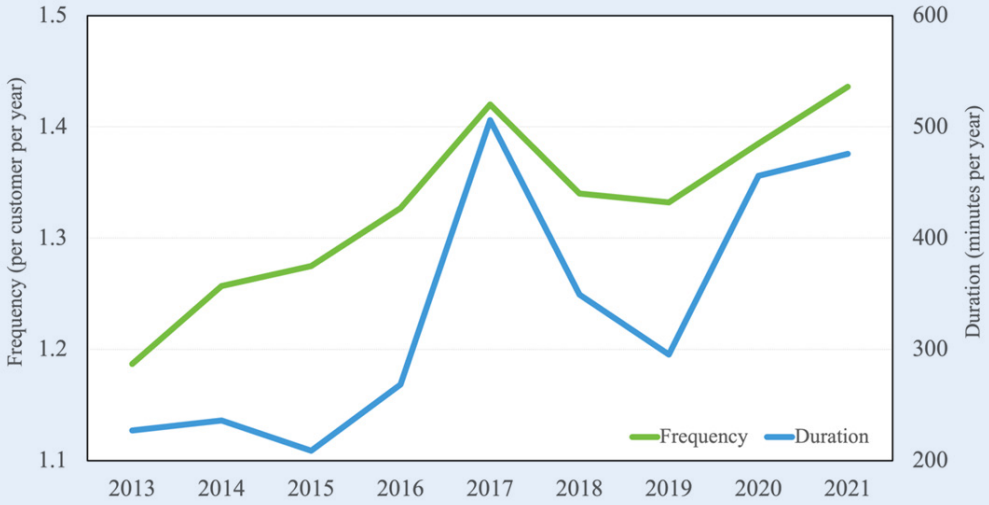
Extreme heat, long-term drought, and wildfires severely impacted California electric grid operations and energy markets in the summer of 2022, a threat that climate experts expect to accelerate. Winter Storm Uri in 2021, which caused the Texas power grid to fail for multiple days amid freezing temperatures, has become the poster child for America's fragile grid.

There is no silver bullet to defend against all sorts of reliability risks. Energy companies must develop robust strategies that protect the system along with a myriad of physical and digital parameters. But utilities and C&I companies can't implement robust strategies to address the problem without better predicting the impacts of extreme weather or market conditions on the real-time performance of their systems.

Advanced data and analytics help solve that foundational visibility challenge, paving the way for energy companies to develop effective risk mitigation strategies and operating plans.

2013-2021 Frequency and Duration of Outages

Frequency (System Average Interruption Frequency Index; events per year per customer) and duration (System Average Interruption Duration Index; minutes per year per customer) of all outage events in the United States. Source: EIA Reliability Metrics of U.S. Distribution System



How to Make Data Analytics the Foundation of Ensuring Reliability

Energy and C&I companies can harness reams of data from today's increasingly digital electric system to achieve the full potential of analytics to improve resiliency planning and decision-making. Improving resiliency means using robust data and sophisticated analytics at a multitude of timescales that stretch from long-term planning to real-time alerting and awareness. Such data-driven analytics can include:

- **Integrated resource design** to analyze and develop resilience pathways that are sustainable and cost-effective. Long-term planning is an ongoing process that takes a utility or C&I company's current energy picture and then roadmaps how to achieve objectives such as energy security and reliability through carbon-free, sustainable resources.
- **Asset performance monitoring** to track, predict, and optimize individual asset performance and improve preventative maintenance. For distributed energy resourcing, this monitoring becomes a key component of reliability management for an enterprise that has equipment and business processes heavily reliant on localized power resources.
- **Energy management** to optimize energy resource performance, such as the charging and discharging of battery energy storage systems (BESSs), or to participate in revenue-generating demand response programs. Often C&I customers procure their power from a mix of power purchase agreements (PPAs), wholesale or retail market transactions, and on-site power facilities which require active, portfolio-level management to reduce emissions. Not only can energy management improve reliability, but proper algorithms that are attuned to market fluctuations can improve the bottom line.
- **Meter analytics** to track water and electric meter and sub-meter facility data for actionable insights. For utilities and many C&I companies, grid analytics can help detect equipment outages, identify process inefficiencies, improve reliability, and reduce operating and maintenance costs.

These capabilities can be implemented for almost any operation with a combination of proven, effective software and hardware. Leading energy management and optimization solutions produce actionable analytics that improve an organization's ability to make plans and execute those plans most cost-effectively.

Analytics-Backed Resiliency in Action

Using data and analytics to better predict, manage, and recover from outages isn't the stuff of some advanced AI-powered future. It's happening now and getting better every day. Recent cases in point demonstrate the value advanced data and analytics capabilities bring to operational effectiveness and the bottom line.

Built on 15+ years of experience in energy optimization, data science, forecasting, and analytics, NEA analyzes ~23 billion data points daily across ~30 GW of renewables in operations with ~$160 billion in total assets. NEA, a wholly owned independent subsidiary of NextEra Energy Resources, developed NextEra 360™ – comprehensive energy management software to reduce energy costs and carbon emissions, manage risk, optimize asset performance, and improve returns on investment.

ENHANCE DATA RESOLUTION, ELIMINATE GAPS, AND IDENTIFY OPPORTUNITIES TO REDUCE ENERGY SPEND

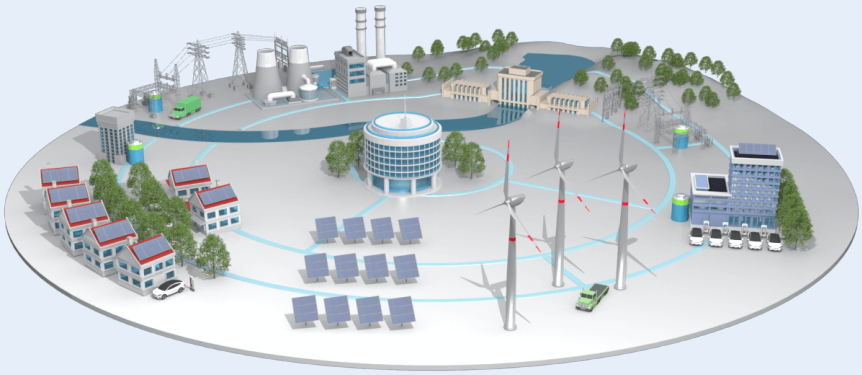
The ability to instrument, measure, and transfer information from physical assets in the field is critical to operating reliable electric grids. As datasets grow, modern analytical methods are being applied to enhance power resiliency for utilities and C&I customers. In practice, many of today's analytical methods require exemplar data sets for training and real-time monitoring for final validation. Existing SCADA solutions can provide monitoring and historization of field device telemetry data but often at a cost point and complexity that is a barrier to more widespread application. However, NEA believes a software solution that enables distributed, secure data collection from remote sensors need not be expensive, complex, or restricted to a single hardware platform.

NextEra 360 Connect (Connect) is a robust, hardware-agnostic software package that simplifies the process of data collection. The proprietary software can run on edge devices provided by NEA or on existing site infrastructure. Edge devices can utilize secure cellular connections or wired communication methods to transfer device telemetry data to cloud-based applications and data repositories. The software also supports use cases where edge compute is needed to control important processes locally, increasing system reliability. Additionally, the distributed nature of the Connect solution increases data availability by providing local historization in the event communication to a central database is disrupted. The low cost of entry with this technology can enable more sites to be instrumented and measured at higher resolution, thereby enabling better situational awareness and faster response to adverse events.

Since the Connect software is hardware agnostic, it allows data collection systems to interface with most common electrical systems, sensors, and controllers. This solution is currently deployed across hundreds of sites supporting efforts that improve grid resilience. The Connect solution allows customers to monitor real-time electricity use, thus understanding the relationship of device performance characteristics to critical operational outcomes. Connect's real-time data collection from site generation assets enables fault detection, response to DR events, and ongoing asset performance evaluation. Finally, Connect enables dispatch of generation assets that utilize energy management algorithms mentioned throughout this paper.

DESIGNING A SUSTAINABLE AND RELIABLE INTEGRATED RESOURCE PLAN

Utilities have long engaged in system resource planning to ensure future load demand can be met with appropriate contingency. Existing generator operating characteristics, weather, and fuel costs



Integrated Resource Plan Schematic
Many different sources of energy generation that can make up an integrated resource plan along with a simplified supply and demand equation.

along with future load projections, market prices, and system constraints all inform a complex optimization problem to ensure a cost-effective, sustainable, and reliable future generation stack. C&I customers face a similar quandary when trying to source electricity to achieve their decarbonization and reliability goals. Should they source from a traditional electric utility alone? Should they contract with renewable energy developers on a long-term PPA? Or is it best to invest in on-site distributed generation and storage solutions to reduce tariff exposure? What is the best combination of interventions that avail of the national or local renewable energy or tax incentives?

NextEra 360 helps utility and C&I customers alike decide exactly which scenario is the most optimal, sustainable, and cost-effective integrated resource design using an all-of-the-above approach to achieve a specified level of reliability. The software considers existing generation, annual energy costs, and future load to run thousands of simulations to minimize the cost of energy generation and procurement.

MANAGING BATTERY ENERGY STORAGE SYSTEMS (BESSs) DURING THE CALIFORNIA HEAT DOME

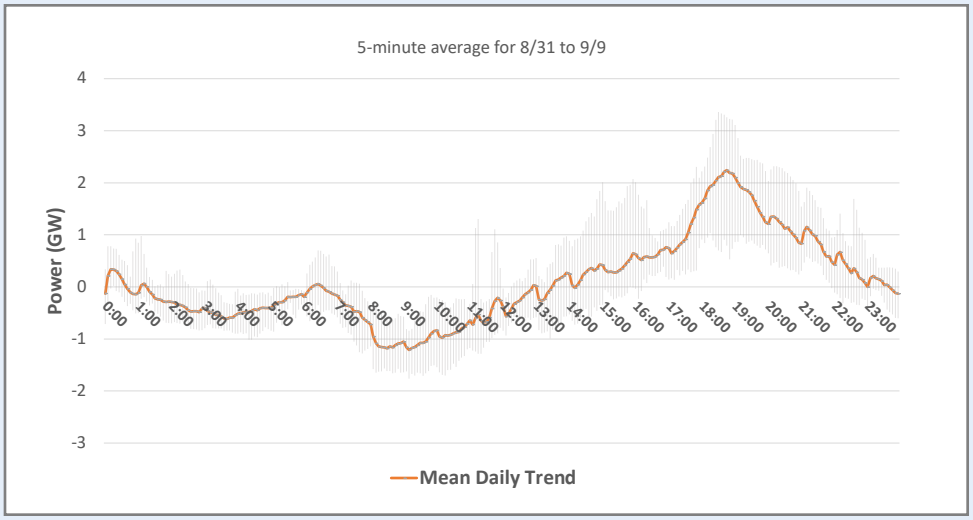
The California heat dome event from Aug. 31, 2022 to Sept. 9, 2022 resulted in the worst heat wave in state history. Excess air conditioning demand drove power consumption to record high levels, resulting in numerous power supply shortages. The evening peak hours during this timeframe required CAISO, California's primary grid operator, to manage the emergency with vigilance via a full week of "flex alerts" that called on residents to conserve energy in the late afternoon and early evening.

In addition to leveraging emergency energy supply, much of the CAISO battery fleet (~3.5 GW) was queued up to discharge power to the grid to minimize rotating outages. While many of the batteries discharged too early to fully stabilize the grid, the NextEra 360 controlled battery was able to fully hold its charge and then send power to the grid during the flex alert (4 – 9 p.m.) when it was needed most. Not only did the battery more effectively stabilize the grid by properly

discharging during critical flex alerts, but the improved timing enabled more revenue by selling energy during higher price periods. To achieve these kinds of outcomes, NEA utilizes advanced site telemetry, electricity market analysis, and battery optimization methodologies in its trading algorithms to more effectively trade batteries in the wholesale electricity markets while maintaining regulatory compliance.

LOAD FORECASTING FOR SHORT-TERM SYSTEM PLANNING

Utilities have several mechanisms to balance supply and demand including, but not limited to, demand response programs, bringing online low-utilization generators, and procurement of energy in day-ahead and real-time markets to serve increased load. Bringing additional generators online or procuring energy in the

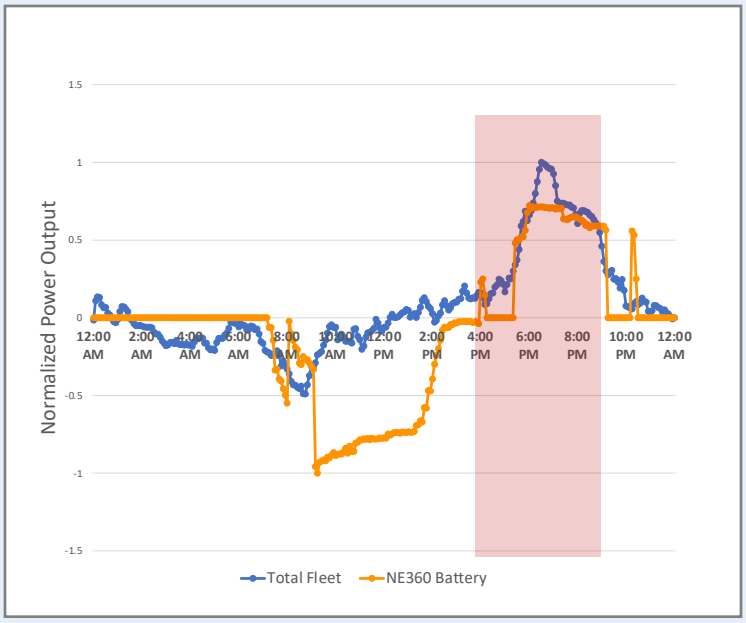


Main Daily Trend

Depiction of Battery Fleet Power Response. The mean daily trend is the 5-minute average for 8/31/22 through 9/9/22 where the candlesticks indicate price volatility and variation in operations and energy availability (cycling) of the battery fleet.

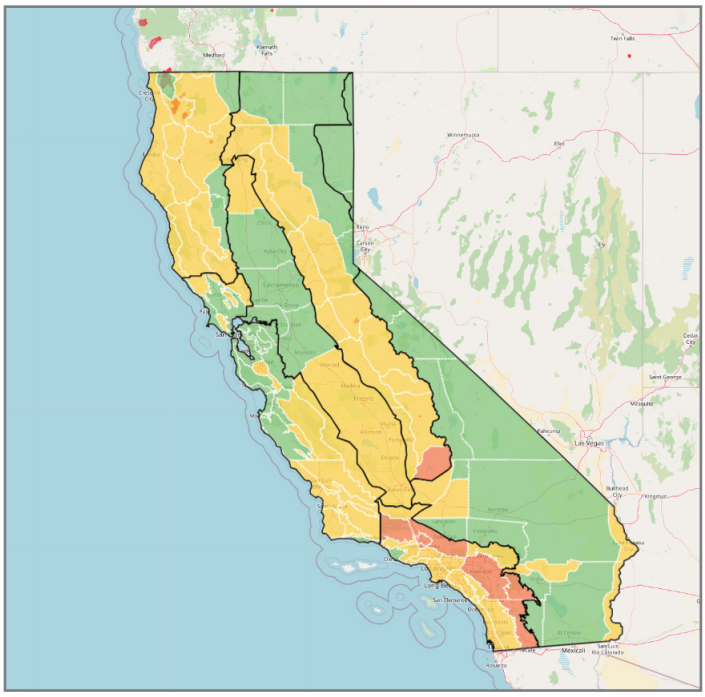
Normal Power Output

Depiction of a NextEra 360 Battery Profile on 9/6/2022, which illustrates NextEra 360's ability to charge up the battery from co-located solar production and then discharge primarily during the flex alert window (4 – 9 p.m.) to deter rotating outages when residents were asked to prepare for possible rolling blackouts.



real-time market can be costly for load-serving entities, while not having enough generators or load-shedding capabilities can result in electric service interruptions. As such, accurate forecasting of the short-term (one to seven days) load diurnal pattern, magnitude, and peak is critical for utilities and system operators to plan, schedule, and dispatch generators to meet customer demand while having enough system contingency.

Load forecasting typically involves the application of machine-learning algorithms to infer relationships between historical usage and weather conditions, along with their lagged effects, to predict future demand based upon forecasted weather. Producing robust load forecasts can also help understand potential load-shedding events or price spikes, which can have serious impacts on the operations and bottom line for large C&I companies that are large power users. Similarly, incorporating better load forecasts into battery management algorithms can enable C&I customers to be aware of potential grid disruptions while also implementing strategies to reduce their energy costs via more strategic energy management.



QUANTIFYING AND MITIGATING WILDFIRE RISK

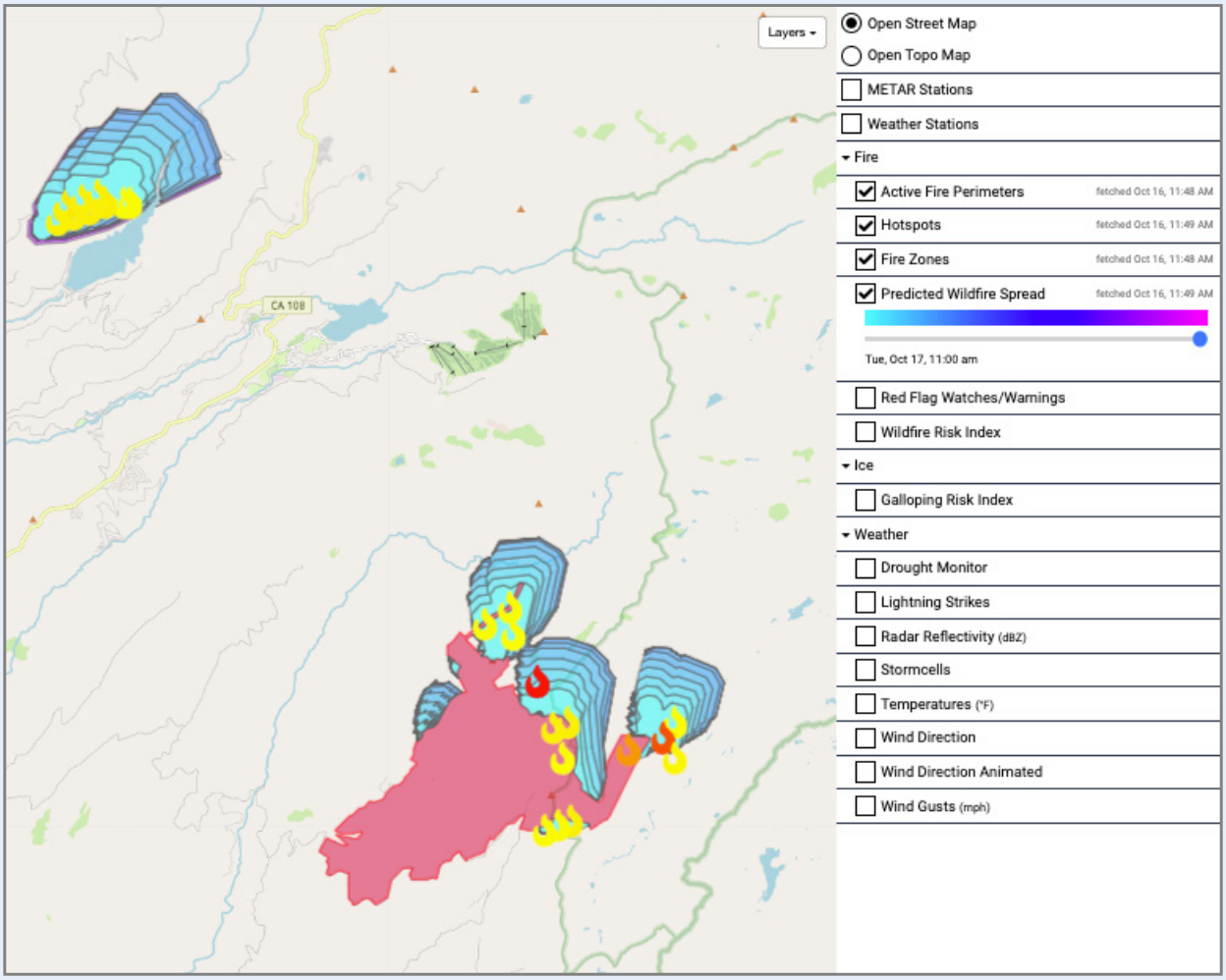
Threats from wildfires are on the rise due to the expansion of the urban-wildland interface, historical fire suppression, and the increase in extreme weather fueled by climate change. As a result, many electric utilities/producers are required to enact robust wildfire mitigation programs to strategically plan and adjust operations in real time to ensure system resiliency. C&I companies know they need to source reliable power to sustain their production through short outages, and having situational awareness of imminent wildfire risks can help them protect their people and facilities.

NEA has developed automated tools that quantify the near-term (one to seven days) and real-time wildfire risk

Wildfire Risk Index Table

Zone	**Mon** / Oct 16	**Tue** / Oct 17	**Wed** / Oct 18	**Thu** / Oct 19	**Fri** / Oct 20	**Sat** / Oct 21	**Sun** / Oct 22
North Coast	Low	Elevated	Elevated	Elevated	Elevated	Elevated	Elevated
Central Coast	Elevated	Elevated	Elevated	Elevated	Elevated	Elevated	Elevated
South Coast	Elevated	Elevated	Elevated	Elevated	Elevated	Elevated	Elevated
Central Valley	Elevated	Elevated	Elevated	Elevated	Elevated	Elevated	Low
Sierra Nevada	Elevated	Elevated	Elevated	Elevated	Elevated	Elevated	Elevated
Desert	Low	Low	Low	Low	Low	Low	Low

Depiction of a Wildfire Risk Index forecast across the state of California. The Wildfire Risk Index considers both meteorological and vegetative data to quantify the categorical risk of explosive wildfire growth potential.



Depiction of a Wildfire Spread Model forecast. The Wildfire Spread Model predicts the spread of active wildfire hotspots using information about forecasted weather, vegetation, and land cover.

(0-24 hours). NEA's wildfire risk index (WRI) quantifies the short-term risk of wildfires based upon vegetation/fuel, soil, and weather data for the next seven days, with forecasts communicated via email alerts and a sophisticated user interface. The WRI model was developed and validated using historical wildfire, weather, and vegetative data coupled with sophisticated data analytics.

While near-term wildfire risk is critical for planning purposes, NEA's Wildfire Spread Model (WFSM) provides automated real-time email alerting of potentially damaging wildfires to control center stakeholders. Once a wildfire is detected from filtered real-time satellite hot spot observations, the WFSM uses weather forecast data, vegetation data, land cover information, current fire perimeters, and WRI fire spread risk to quickly predict the future fire trajectory and alert users of any imminent risk to assets.

Conclusion

Stakeholders across the power sector agree that the risks to reliability will only continue to grow. These hazards threaten the reputations, performance, customer satisfaction, and bottom lines of energy companies as well as those of any large C&I companies that are directly affected by them. Even more, energy leaders are keenly aware that the resilience of the electric system in the face of increasing risks to the grid is a matter of life or death for many in the communities they serve. Managing the change is hard, but it could be made easier by being able to gather and analyze relevant data at the right time.

Improving an organization's data and analytics capabilities provides foundational information to build effective strategies for utilities to plan for and prevent outages, while also enabling large factories/offices to ride through outages with little to no impact on performance. Once these capabilities are developed, energy companies can automate processes to improve performance before, during, and after extreme events. And when events escalate, leaders will have real-time analytics at their fingertips to know if hands-on interventions are needed.

Many energy and C&I companies could benefit from working with a trusted expert to help them build the necessary data and analytics capacity. NextEra Analytics could be the expert to provide help collecting the right analytics and then putting them to use for improved decision-making. With experience serving regulated utilities and merchant power operations within the NextEra Energy corporate family and experience ensuring reliability for C&I customers like South Sioux City and merchant Independent Power Producer (IPP) operations, NEA understands the core concerns and requirements of its customers, from the need to limit market exposure for utilities to the need to ensure reliable, inexpensive, and renewable electricity for C&I companies.

CONTACT
Richard Walker, Senior Director
Science and Asset Performance
NextEra Analytics
NextEra360@NextEraAnalytics.com