PART 1

RESILIENCY AND RELIABILITY

UTILITIES TODAY FACE DAUNTING TECHNOLOGICAL challenges. At a time of higher customer demand and need for greater capacity, utilities are confronted with aging infrastructure that increases the risk of outages and requires more upgrades and repairs to maintain. The US Energy Information Administration (EIA) leaves no doubt in its reports that the duration and frequency of outages are increasing. The American Society of Civil Engineers scores American energy infrastructure at just slightly above failure (D+). Additionally, extreme weather-driven events, such as hurricanes and wildfires, occur more frequently, creating further hazards that have wreaked havoc on utility infrastructure. At the same time, the renewable energy market is growing fast. EIA projects that renewable energy will grow to 31 percent of the total US power generation mix by 2050. Renewable energy and market pressures, such as deregulation, have created business uncertainty for utilities.

As they face these great challenges, utilities increasingly rely on GIS and location intelligence to modernize their approach to data and analysis. GIS helps utilities visualize and analyze data as a real-world model of their infrastructure, map their networks in incredible detail, and develop a deeper understanding of their business and operations. When utilities incorporate location in

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their decision-making, they improve risk assessment and strengthen resiliency. Maps and spatial analysis help utility managers see and understand the patterns for better investments, security, and operational decisions. GIS provides immediate situational awareness of grid operations when integrated with grid sensors and devices. It includes productivity tools that lower costs and help utilities understand customer behavior.

More importantly, GIS allows utility operators to investigate and respond to a large set of questions:

- Where are the most pressing resiliency and reliability issues?
- Where are the critical security and environmental vulnerabilities that threaten the grid?
- Where can they improve customer service and productivity?
- Where are the best locations to apply conservation and renewable resource programs?

Your first step in answering these questions is to learn how utilities use GIS today. Part 1 of this book includes four case studies that illustrate how different types of utilities incorporate location intelligence and spatial thinking to make their networks more resilient and reliable.

Case studies

Electric, gas, and water utilities have traditionally worked in two worlds. In one world, they maintain, repair, and extend their current resource networks to keep up with the growing demand for electricity, gas, and water. In the other world, utilities innovate and adopt new technologies to modernize their networks so that they can run more efficiently, become more reliable, and provide faster customer

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service. But nowadays, utilities are finding that these two worlds are blending together so that maintenance and innovation are part of the same strategy.

Today, utilities increasingly integrate GIS with smart, wireless sensor technology. They use live, interactive maps on mobile devices to streamline work in the field and convert computer-aided design (CAD) data into GIS map layers. These technologies allow utilities to perform spatial analysis and support programs and initiatives, including keeping their customers informed.

The four real-life stories in this section show how utilities integrate GIS with real-time sensors to prevent outages and create better customer experiences. Utilities are transitioning from CAD to GIS to move to a more efficient and far more capable future. They are engaging with their customers using GIS dashboards, surveys, and stories built on ArcGIS StoryMaps and related applications. And they are using GIS to address the challenges of delivering safe drinking water and protecting public health.

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ACCELERATING A DIGITAL FUTURE

Elvia

ELVIA IS ONE OF THE LARGEST ELECTRICITY NETWORK COMpanies in Norway, providing power to nearly 2 million people. It does so by operating approximately 28,000 distribution transformers while maintaining all overhead lines and cables that span the region. Elvia's vision for the future centers on digitally transforming those distribution transformers, which will ensure a more stable power supply and help keep grid costs as low as possible. Elvia constantly tests new, smart technologies to achieve its future vision. Creating a modern primary grid involves expanding the utility's use of smart sensors, which it is doing with the support of the Centre for Intelligent Energy Distribution (CINELDI), one of Europe's largest research centers for intelligent electricity distribution.

Elvia manages a wide range of diverse power grid assets that are naturally subject to excessive loads, challenging environmental conditions, and normal wear and tear. Risk factors such as thermal or electrical breakdown, or even fires caused by overheating, can cause widespread power failures and outages for customers. Regular and comprehensive monitoring of all power equipment across the grid is critical. Routine inspections can find and document serious issues, such as frayed conductors, degraded insulation, moisture, and evidence of overheated components. However, utilities normally do not have a real-time view of equipment temperature. Ad hoc temperature checks are often expensive and time-consuming. As a result, these checks sometimes are not performed on a regular, consistent basis, as may be needed.

"The standard tools we have in our toolbox only measure the temperature in one location, at a single point in time," said Åshild Vatne, research and development adviser of the smart grid initiative at Elvia.

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Elvia has created a new solution that integrates location data from smart, wireless sensors into ArcGIS mapping and analytics.

Wireless sensors the size of postage stamps are placed on Elvia power equipment to continuously monitor their heat signatures in real time. These sensors can be strategically positioned on small surface areas that are normally difficult to access, and they do not require a direct line of sight. With a battery life of up to 15 years, the sensors do not require manual maintenance and yearly calibration. This new system helps establish baseline asset performance indicators, alerting inspectors and managers when temperatures reach a predetermined variance outside of standard operating levels.

"The strategic focus on a new smart grid is bringing together all kinds of sensor data," said Kjetil Nymoen, solution architect, IT strategies for energy technology at Elvia.

The real-time data feeds directly into ArcGIS, where it is aggregated, synced, and visually presented in context with other location-based information, providing a comprehensive common operating picture of activity across the power grid.

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"With the new, integrated GIS system, people don't have to use ten different applications. They now have one map and can visualize what's going on right there and then," said Vatne. If unexpected temperature changes occur in any of the grid components, the new system triggers alerts to the service team for further investigation. For example, a temperature increase without an accompanying load increase indicates a problem that the utility can respond to and fix immediately, Nymoen said.

Elvia has expanded its rollout of smart sensors from an initial plan of 20 up to 2,000. The company is adding them to transformers and switches at more than 100 different power substations. In addition to temperature sensing, the Elvia team also tests the sensors for a variety of use cases.

One important use case is leak detection, which provides an early warning of underground flooding to avoid the need for pumping, which can be expensive and dangerous for workers. Another important case is proximity sensors on transformers, which indicate when transformers must be cleaned, and on entryways, which ensure that doors stay closed, effectively lowering security risks.

Almost immediately, the new smart-sensor solution offered Elvia impressive results. Its new location intelligence capabilities have strengthened the company's communication, collaboration, and distribution of real-time asset data with its teams in the field.

"Consistent service is always the ultimate goal. With GIS, we are creating a better customer experience, and if we're able to prevent an outage, that's huge," said Nymoen.

In one example, a service team used traditional manual assessment methods to determine that a circuit breaker wasn't in critical need of repair. However, after reenergizing it, sensors indicated that the temperature was increasing more so than anticipated, and the breaker was in danger of failing. The new remote monitoring

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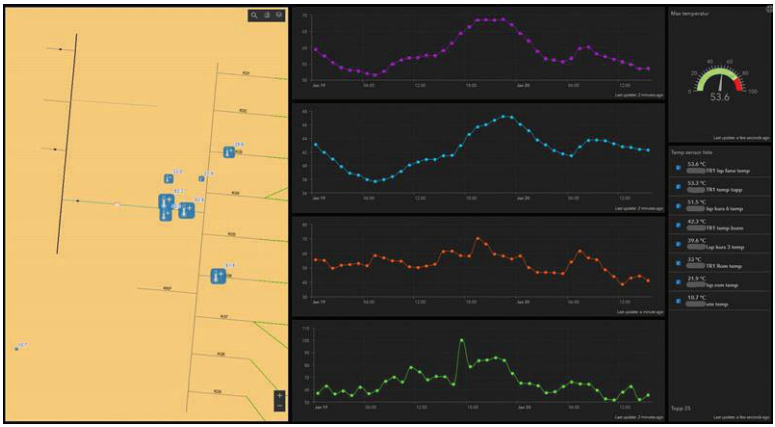

The combination of wireless smart sensors and ArcGIS enables Elvia to visualize and analyze all conditions in real time using GIS dashboards. Staff can quickly identify unexpected changes in baseline asset performance indicators before they evolve into more serious problems. This new, proactive approach has significantly reduced previously required emergency repairs, which are typically more expensive than the routine, planned maintenance.

system triggered an immediate alert to members of the operations team. With this information, the team quickly focused on the part of the equipment generating the spike in temperature and easily identified the root cause. Although the breaker initially passed the manual service check, the team changed the entire breaker based on the new insights that the network of smart sensors provided.

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