UtilityWeek Intelligence EXPLAINS

Electricity North West targets improved safety and resilience with LineSIGHT

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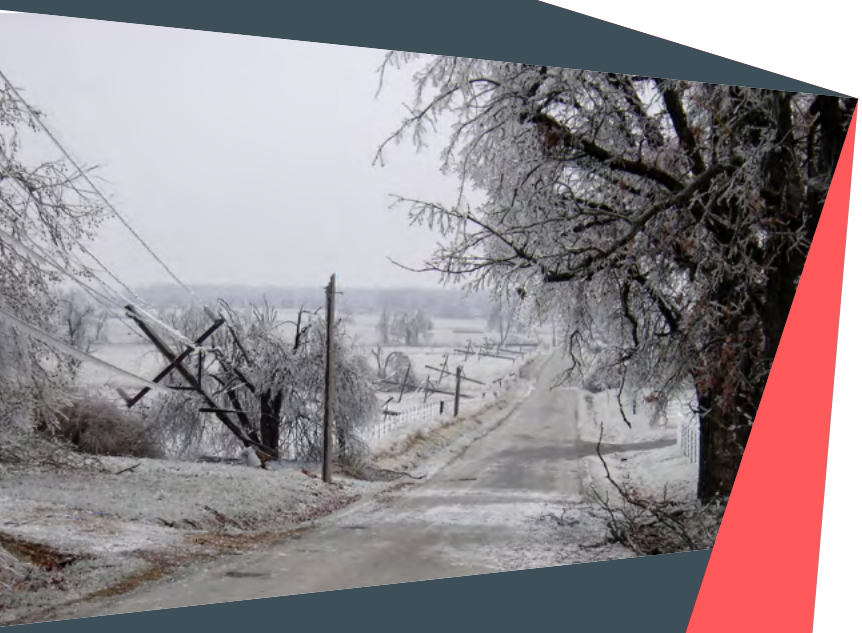
Utility Week, in association with Kelvatek



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The devastating power of Storm Arwen

Kelvatek's technology is expected to be widely adopted by networks to meet safety commitments and get power back up and running quickly in the event of a storm.

In November 2021, Storm Arwen brought chaos to the UK. The fallout from the extratropical cyclone included three fatalities due to falling trees, rail passengers stuck on trains overnight, snow across the Pennines, and vehicles overturned by high winds.

Then there's the serious matter of the one million homes that experienced a loss of power because of strong winds, or trees falling on overhead lines, with more than 100,000 experiencing an outage that lasted several days.

Storm Arwen was the most powerful winter storm of the past 10 years. Analysis of the disruption found the duration of the outages was due to sensors on overhead lines failing to detect fresh damage because they were without power while the initial faults were repaired. There were also difficulties coordinating and resourcing field teams in major storm conditions.

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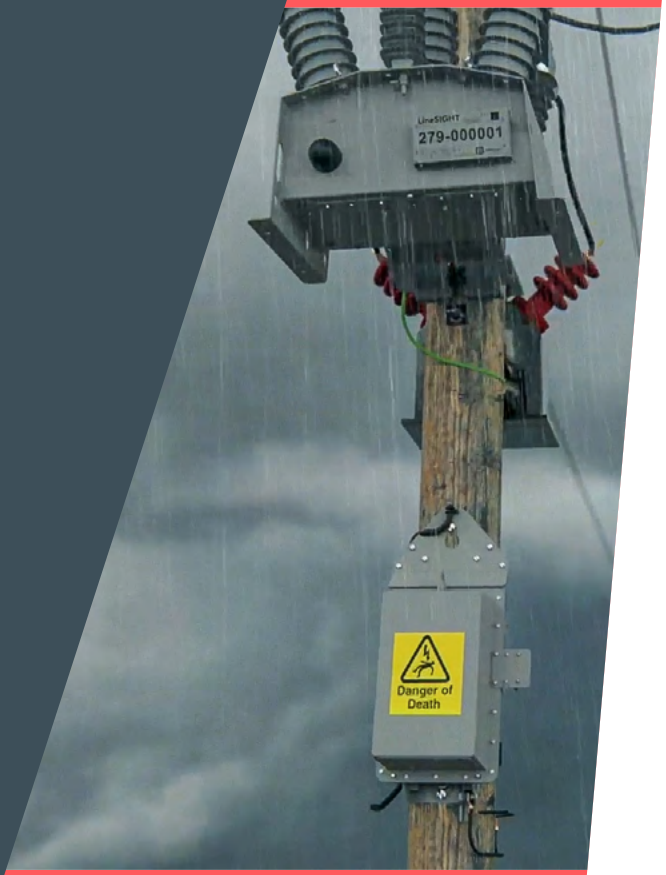

People were without power for so long because networks would get a report of an initial fault, teams would address it, and in the intervening period the storm would inflict even more damage while circuits were deenergised. Sensors on the network didn't reflect the damage because there was no power flowing through them.

Enter LineSIGHT, Kelvatek's monitoring and fault management system for overhead lines, which is being rolled out by the regulator and Electricity North West (ENWL). The technology offers the capability to accurately locate major outage issues such as faults, downed lines, and low-hanging conductors.

Paul Killilea, asset and investment director at ENWL, explains more. "When there are storm conditions and severe weather, the overhead line network can fault due to trees falling, or heavy wind causing clashing of conductors, and it can be quite devastating. Storm Arwen demonstrated that."

ENWL has a complicated network. It includes 160,000 wood poles across 1,000 circuits. An individual circuit could be tens of kilometres long. Some parts of the network are in rural or mountainous areas where reporting of damage by the public is unlikely.

That's why the DNO has a sophisticated digital network management system that automatically starts to restore supplies in the event of a fault, opening and closing circuits to determine where it is.

> "When there are storm conditions and severe weather, the overhead line network can fault due to trees falling, or heavy wind causing clashing of conductors, and it can be quite devastating."
>
> **Paul Killilea,** asset and investment director at ENWL

But that could still be in the range of several kilometres of line, Killilea explains. "We also check all customer calls that come in and group the calls and faults to try and pinpoint an area." Patrolling the line to look for an exact location could take several hours, he adds.

The key benefit of LineSIGHT's predecessor project Sentinel was the ability to locate faults within plus or minus 500 metres. "That means with we were able to target several spans' length of line with resources.

"With LineSIGHT we are now able to pinpoint faults within 250 metres or less, so it's a much more accurate and efficient way of locating a fault and starting the restoration and repair process."

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LineSIGHT can also sense very small fluctuations in voltage and current which indicate a piece of equipment such as an insulator is starting to fail. "This will mean that we can proactively repair rather than wait for a complete fault and the disruption it causes. Our existing capability isn't sensitive enough to detect some of the fault conditions LineSIGHT can find."

Because LineSIGHT is capable of sensing that there is something unusual on a circuit before a fault causes an outage, it will help enable predictive maintenance, Killilea explains. "We can be proactive: looking for the fault that hasn't occurred yet."

Other DNOs are now planning to install LineSIGHT, he says, with some of these deployments being funded through Storm Arwen-related allowances.

Meanwhile ENWL is also using Kelvatek technology on low-voltage networks to improve storm response. Kelvatek's PERCH solution (pole-mounted reclosers) sits on low-voltage lines and detects faults that cause fuses to blow and interrupt supply, and then will attempt to restore power.

> "Our existing capability isn't sensitive enough to detect some of the fault conditions LineSIGHT can find."

Paul Killilea, asset and investment director, **ENWL**

This is particularly useful because faults are often transient in storm conditions. Debris or birds can strike the line, for example, and trip out the circuit. The network is seeking a wider roll-out of PERCH on its low-voltage networks, also as part of the Storm Arwen re-opener. "Restoring faults is a very resource-intensive process, so PERCH is a big win," Killilea says.

For its part, LineSIGHT currently covers 23 circuits at ENWL. This has enabled the detection of many incidents including broken insulators, de-stranded conductors, and locations with burn damage, and provided the opportunity to make faster repairs. This is making the network more resilient and efficient, resulting in easier maintenance.

"But ultimately, for us, with LineSIGHT, the safety case is everything," Killilea says.

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Robert Friel, a chartered electrical engineer who runs Apteno Consulting, and was formerly emergency planning manager for EDF Energy Networks, explains that a number of DNOs have seen incidents where line conductors on the ground have caused fatalities. "It's mercifully rare, but it happens. The resistance on the ground is often high, which means the circuit doesn't always trip.

"The ability to monitor those faults that could be a danger to life is vital, and you couldn't always do it before. Storms generate reputational damage, but LineSIGHT will also help networks fulfil their responsibilities under the Electricity, Safety, Quality and Continuity Regulations.

"That's why it's so important."

The combination of LineSIGHT with Kelvatek's Sapient data management platform provides an overview of the topology of the network that helps make it safer, Killilea adds.

Sapient receives a host of data points from sensors in the field and monitors the health of the network. It features algorithms that analyse network conditions based on its knowledge of how the network is structured. The platform is also integrated with the ENW network management system, so it doesn't record intentional changes to the network configuration as faults.

The more fault detection and resolution is automated and digitalised, the better, Killilea explains. In storm conditions and high winds, people can't work at height. "Systems that can re-close automatically and get power systems back on without human intervention are ideal.

"And automating as much as you can around the fault means less disruption for customers."

As climate change worsens and extreme weather becomes more frequent, this resiliency will be crucial. "In 2023, we had a 20% increase in high-voltage faults on our network. It was a heavy year for us.

"But overall, our network performed at the best level it's ever performed at, and that's because we have invested in technologies and integrated them to our digitised network management system."

> "The combination of LineSIGHT with Kelvatek's Sapient data management platform provides an overview of the topology of the network that helps make it safer."
>
> **Robert Friel,** a chartered electrical engineer, **Apteno Consulting**

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History lesson: A storm from another decade

"It was a car crash." Robert Friel is recalling the aftermath of the 90mph+ gales that battered the UK and northwestern Europe in the autumn of 2002. Friel was drafted in while working for EDF Energy to help with the clean-up from the storm.

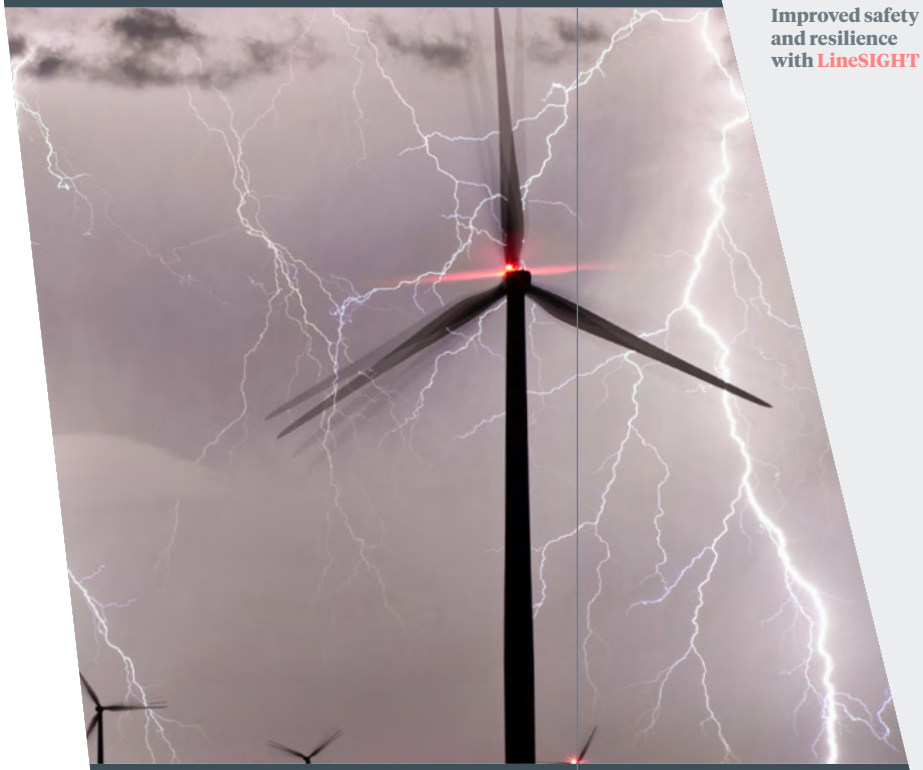
"In some areas it took eight days to get the lights back on," he remembers. "Telephony was lost as well. In the aftermath, we saw a marked change in Ofgem and DNO storm performance [requirements], to aiming to get power back on in 24 hours or 48 hours. But in Storm Arwen, we saw some of the same downsides as in 2002.

"If we had had technology such as LineSIGHT back then we would have it deployed on high-risk areas of the network and known where we might need to respond to network issues ahead of time."

LineSIGHT is not reliant on the network for power supply and doesn't require deviations in current to detect faults. That means it can pinpoint secondary damage ('nested faults') on a network in the event of a storm, enabling engineers to react to the situation.

LineSIGHT enables focus on specific areas. "If primary protection trips, you may be looking at patrolling a large section of the line. With LineSIGHT, you can often pinpoint it within 250m or less. That saves time."

Saving time means improved customer satisfaction ratings for the DNOs, and lower financial penalties, helping make the business case for LineSIGHT attractive. The technology may also mean teams do not have to be sent to site, or helicopters sent up to detect a fault. This has both health and safety and financial benefits, Friel explains.



Sentinel prepares ground for enhanced fault detection

Improved safety and resilience with LineSIGHT

The origins of LineSIGHT are in Sentinel, an innovation launched in ED1 and researched as part of Ofgem's Network Innovation Allowance, in which Electricity Northwest (ENWL) and Kelvatek developed a solution to locate faults quickly on overhead line networks.

These faults included broken overhead line conductors which could be low-hanging or in direct contact with the ground.

The research platform was initially designed to provide a fault location within 500m of the actual position. Sentinel was intended to inform engineering policy for the application of high-voltage distance-to-fault systems on distribution networks for the whole of the UK and led directly to the development of LineSIGHT.

Under the Sentinel projects, which started in 2015, different types of equipment were initially deployed on the line for research purposes. Roll on nine years to ED2, and ENWL is deploying 3,200 LineSIGHT units to cover 80% of the overhead network. A typical circuit might feature five to eight monitoring units covering about 25km.

Network protection typically relies on overcurrent or earth current to detect that something has failed. In the case of the line detaching and just hanging, there is nothing in the normal set-up to detect it. Kelvatek wanted to develop a technology that could use other detection means in addition to current. Because LineSIGHT measures capacitance and impedance, it's able to observe and report the changes when a line sags low.

LineSIGHT offers improved resilience to storms but also, crucially, safety benefits. There are hazards where overhead lines have come down from or been loosened from pylons or poles for lots of reasons, including storms or hazards which are often difficult to detect unless spotted and reported by a member of the public.

The risks are huge. Hazards include people, vehicles (or farm animals in rural areas) encountering the downed line when it is still live. The line could be on the street or crossing, a playground. Or a low-hanging wire has the potential to electrify a post with a person walking by.

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LineSIGHT boosts storm performance at Electricity Northwest

The network has been using the technology with Kelvatek's Sapient data management platform to improve safety and performance in extreme weather.

Objectives

The core objective behind Electricity North West's investment in LineSIGHT was to improve public and staff safety. However, it became apparent there would be secondary benefits in terms of enhanced storm performance, and many more network performance advantages.

Faults on rural networks can cause overhead power lines to hang low while remaining live, which creates a serious public safety hazard. This can be a particular issue during storm events with multiple occurrences. LineSIGHT technology helps detect and locate these hazards.

The prompt detection of damaged equipment and pinpointing the location of faults enables the more efficient despatch of repair crews. End customers benefit from the faster removal of safety hazards caused by network faults as well as the reduced likelihood of power cuts. LineSIGHT also allows the identification of issues more quickly in storm situations where multiple faults can occur at the same time.

Solution

The LineSIGHT system consists of multiple sensors deployed across the overhead network which communicate with the Sapient data management platform over the GSM standard. This enables near-real time detection and reporting of anomalies such as clashing conductors or downed lines. The automated analysis tool produces notifications that are sent directly into the network management system used by staff in the control room, making the insights available to engineers and dispatch managers.

This ensures accurate and timely delivery of alerts to enable an efficient and effective response to faults and developing fault conditions.

The notification types, including the triggering event and accuracy, are shown in the table above.

Triggers	Location accuracy with 95% confidence	
Current anomaly	Phase-phase between units (on branches) Phase-earth between units Cable faults	+/-300 m (+/-500 m) +/-750 m Switchable section
Zero-sequence anomaly	Phase-earth on branches Sub-sensitive earth faults	+/-1 km Switchable section
Open circuit fault	Open circuit fault	+/-100 m
Nested fault	Nested open circuit fault	+/-100 m
Lowered line condition	Lowered line	Switchable section

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Kelvatek has developed a set of tools and processes to assist Electricity North West with the selection of circuits to achieve the maximum desired coverage by detection type. Several key factors were considered when helping the network prioritise which circuits should be equipped with LineSIGHT, including:

- **Proportion of overhead line versus underground cable.**
- **Length of circuits –** the longer the amount of overhead line the greater the risk of damage.
- **Safety considerations regarding clearances, public buildings and footfall in the area and potential risk of harm due to lowered lines.**
- **Number of customers served –** circuits with higher numbers of customers were typically prioritised, but other factors such as types of communities affected (remote, for example) were also considered.
- **Propensity to storm/weather damage (for example high ground) –** networks on higher ground or in highly wooded areas may be at greater risk of multiple areas of damage.
- **Geographic location and access –** impact on scouting, damage identification and repair access. Networks crossing remote areas away from roads are problematic to access and assess.

Using these parameters, an optimal deployment plan was produced per circuit for Electricity North West. This helped achieve a balance between the advantages of additional coverage against cost. Typical considerations include:

- **How well the circuit should be covered for overcurrent and zero-sequence anomalies.**
- **Increased accuracy on branches further down the circuit.**
- **Are all the perceived high-risk areas monitored for lowered line and open circuit faults?**
- **How well the overhead section of the circuit should be covered for open circuit and nested faults.**
- **On average a circuit would contain between five to eight monitoring units.**

LineSIGHT observed 67 anomalies in the period between the end of January and the end of April this year, sending notifications to Electricity North West at a rate of roughly 5.6 per week. The average time from onsite fault to an estimated location is just 11 minutes.

"The initial results from LineSIGHT have been highly encouraging, accurately identifying numerous defects and faults across our network," says Paul Kililea, asset and investment director, Electricity North West. "We plan to extend its deployment to a wider area of our 11 kV overhead network over the remainder of ED2."

Conclusion

As the rollout of LineSIGHT continues, new circuits are being commissioned. It has become increasingly apparent that LineSIGHT will provide opportunities for early intervention in developing fault conditions to prevent interruptions before they occur.

All these capabilities will be of significant value in maximising network performance during storm conditions. Kelvatek is continuing to work in partnership with Electricity North West to further develop the LineSIGHT service.

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Our team consists of network experts, data scientists, and technology specialists who work together seamlessly to deliver exceptional results for our customers. With over 30 years of experience, we have a deep understanding of our customers' challenges and business needs. We leverage this expertise to create customised solutions involving hardware, software, and specialised services to ensure optimal network performance.

Our history and culture of innovation, along with our numerous successful customer collaborations, demonstrate our track record of delivering research and development into business-as-usual operations.

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