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It's Time to Listen to Transformers

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A transformer fire at Heathrow Airport earlier this year triggered cascading power outages, cutting electricity to more than 66,000 homes, grounding more than 1,300 flights, and causing losses of up to £100 million. According to a recent report, the fire started because of a fault in a 50-year-old asset that subsequently led to short circuiting and arcing, setting the transformer alight.

This wasn't an isolated accident but the third transformer-related blaze in less than a month in the UK. In fact, across the UK, eight transformer-related incidents were recorded over a span of just 10 weeks. The Heathrow fire and these seven other incidents are the inevitable consequences of aging infrastructure, rising demand, and insufficient systems to effectively monitor these critical assets.

The Pressure on the Grid

In the UK, about 40% of all transmission infrastructure assets were installed before 1975. In the U.S., more than 50% of power transformers are over 40 years old. Many of these were designed with a 40-year life expectancy, yet they have been stretched to operate 50 to 60 years or more.

This might not have been an issue when energy demand was flat, but it isn't anymore. Today, the electrification of transport, data centers, artificial intelligence (AI) infrastructure, and green heating solutions is driving a dramatic surge in electricity consumption. The UK alone expects a 30% increase in electricity demand by 2030.

The U.S. is also seeing an increase in electricity demand, particularly in high-load urban areas. Yet, the manufacturing pipeline for large transformers is under strain. Right now, the average lead time for a large transformer in the U.S. is about 200 weeks. In the UK, where domestic manufacturing capacity is limited, it's even harder to source new units. Supply chain bottlenecks, skilled labor shortages, and rising material costs all make it a slow and expensive process.

Add to that the backlog caused by natural disasters. Every hurricane, wildfire, or flood-struck region diverts transformer stock away from planned replacements and expansion toward emergency repair. Utilities are constantly on the defensive, struggling to maintain service levels with limited equipment.

Even if supply wasn't an issue, replacing transformers is not just plug-and-play. These are enormous, heavy, and often custom-built components. Installation requires careful planning, specialized expertise, and planned shut-downs. That means outages and risk. It also means that, in many cases, utilities delay replacement until there is no other choice. And even if companies had the means to replace them all, you simply can't. The grid is too vast, the access windows too narrow, and the disruption too costly.

First Line of Defense: The Role of Hydrogen in Transformer Monitoring

Extremely common, but often overlooked, transformers are the workhorses of our power grids. They convert high-voltage electricity from power plants and generating stations, to lower voltages for distribution to our homes and businesses. They are primarily the same designs that were first deployed more than 100 years ago. They include coils of wire (windings), a metal core, and bushings to connect the transformer to the grid. They are often filled with oil to increase electrical insulation between the closely wound coils and to help cool the coils by conducting away heat.

It is tempting to think of failures of these critical assets as rare, but they are not. Over the past year, transformer-related fires and explosions have shut down power stations, stadiums, subway lines, and airports. Some incidents have involved suspected vandalism, but in most cases, investigations point to aging infrastructure and inadequate monitoring and maintenance.

Transformers rarely fail without warning. They whisper before they scream. And the first whisper of an issue is often the production of hydrogen gas from the oil in their main tank.

When an incipient fault occurs, whether due to overheating, arcing, or other mechanical faults, for example, when the coil winding insulation inside a transformer breaks down, hydrogen is the first fault gas released. The presence of hydrogen is an early and reliable indicator of a developing problem. If left unchecked, these faults can worsen, resulting in transformer failures, which could include rupturing and fire, that almost always leads to prolonged outages.

Unfortunately, in most medium- and low-voltage substations around the world, this critical early warning is not being effectively monitored. Transformer monitoring has traditionally relied on laboratory-based dissolved gas analysis (DGA) of periodic manual transformer oil samples. While important, it requires access to the transformer, and the sampling is infrequent (12 to 48 months), meaning issues can arise and escalate between test intervals without detection.

Compared to this manual sampling, continuous hydrogen monitoring offers a smarter, faster, and more cost-effective solution Installed conveniently on the transformer, these sensors continuously monitor hydrogen levels inside the transformer.

This kind of early warning matters. The presence of hydrogen at the onset of a fault gives operators valuable insight and the lead time needed to respond and prevent a potential failure. With continuous monitoring, the risk of missing warning signs between manual DGA tests drops significantly.

So, by deploying these sensors across a fleet, utilities can better prioritize maintenance, reduce unplanned outages, and extend the useful life of aging transformers.

This capability is transforming how utilities manage aging infrastructure. It's like going from waiting for a check-engine light to having real-time engine diagnostics in your car. Operators can now catch problems in their infancy, long before they threaten to become a Heathrow-level event. Protecting existing assets is both smart and essential in a world where replacement transformers are scarce, expensive, and slow to source.

Economic and Operational Benefits

Some might ask: is this just about safety? Is it a nice-to-have or a must-have? Looking back to the Heathrow incident, the cost of that one failure was up to £100 million, before counting reputational damage, security risk, and customer frustration.

Now, consider that a hydrogen monitor costs just a few thousand dollars, a fraction of a percent of the Heathrow losses. So, this is not just good engineering but good economics, because we don't always get a second chance.

Since aging transformers can't be swapped out overnight, there are many steps that can be taken to avoid premature failure in the meantime. One such measure is early fault detection, particularly through hydrogen monitoring, that gives utilities and infrastructure managers a powerful tool to safeguard their assets and stay ahead of potential failures.

By detecting issues early, operators can also extend the life of transformers by as much as 20%, thanks to better maintenance planning and timely interventions. This shift from reactive to predictive maintenance dramatically reduces the risk of unplanned outages, helping to avoid costly disruptions like the one we saw at Heathrow.

But the benefits go beyond preventing failures. Real-time hydrogen monitoring also plays a key role in strengthening overall grid reliability, a crucial advantage as power demand grows and climate-related stresses increase. And unlike full-scale replacements, hydrogen sensors offer a cost-effective solution.

This is why leading utilities in the U.S. are already investing in this approach, rolling out real-time hydrogen monitoring across critical infrastructure, including at major airports. These forward-thinking organizations recognize that waiting for something to break is no longer affordable, practical, or wise. More than just a technical upgrade, hydrogen monitoring is fast becoming a cornerstone of the broader digital transformation reshaping today's power grids.

As we push toward net-zero goals and the electrification of everything from transport to heating, the grid can no longer operate as it did in the past. It needs to become smarter, more automated, and far more resilient. Technologies like sensors, data analytics, and AI-driven decision-making are central to this evolution.

Within this digital ecosystem, hydrogen sensors play an important role by delivering real-time, actionable insights from one of the grid's most critical assets. They enable a shift from reactive repairs to proactive maintenance, helping operators make better decisions and optimize assets in a world where both time and resources are limited. In essence, they transform transformers from passive, high-risk equipment into intelligent, connected assets that support a more reliable and efficient energy future.

Avoiding The Next 'Heathrow'

The warning signs for the Heathrow fire were there. The transformer was more than 50 years old and monitoring was either outdated or missing altogether. The result was a chain reaction of economic, operational, and reputational damage that rippled across the country and beyond.

But it does not have to be this way. By adopting hydrogen monitoring, utilities, airports, stadiums, and other critical infrastructure operators can get ahead of the problem. Real-time data makes it possible to spot issues early, prioritize maintenance, and prevent disaster before it strikes. It is a simple, cost-effective tool that extends the life of essential equipment, reduces downtime, and safeguards the public.

Sensor manufacturers are already partnering with forward-thinking energy leaders to roll out this technology at scale, but others need to follow. Because the next failure might not be an isolated fire; it could mean grounded flights, a dark city block, or a hospital left without power. The question for all of us is: what can we do to stop the next big blackout before it starts.

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