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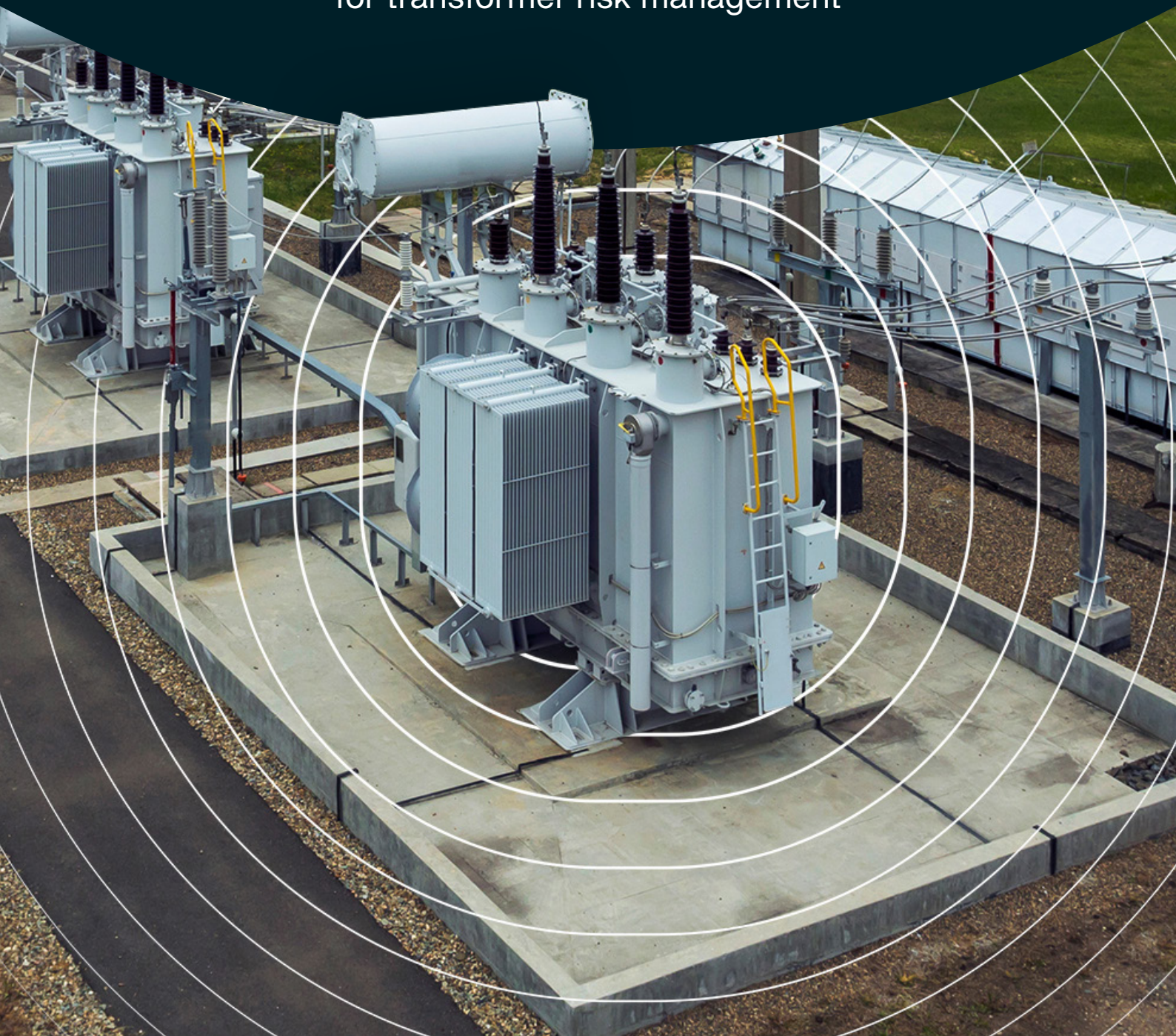
eBook

If Your Monitoring System Isn't Giving You Answers, It's Giving You Risk

Discover a complete end-to-end solution for transformer risk management



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Introduction

In today's grid, transformers are under more pressure than ever from overloaded assets, ageing fleets, fewer experts on the ground, and higher expectations for reliability. Monitoring alone isn't a strategy. To really improve performance and extend asset life, utilities need a holistic approach that combines data, diagnostics, and expertise.

This eBook shows how to move from alarms and data streams to a proactive, predictive, and strategic transformer management model. It introduces a three-part solution, Camlin Energy's TOTUS (complete condition visibility), Asset Insights (turning data into decisions), and Expert Services (human insight where it matters). Together, they create a closed loop from sensing to action that reduces risk, cuts OPEX, and strengthens regulatory and commercial performance.

If the outcome isn't a decision or an intervention, it's just data.

Chapter

01

Why monitoring alone isn't a strategy

As capacity and network complexity continue to grow, asset owners face increasing pressure to maintain high availability while controlling operating costs and managing risk. Asset Managers across generation, transmission, and distribution systems must now identify and invest in technologies that provide meaningful insight into asset health to optimise both performance and lifecycle management.

A key critical asset across all power systems is the transformer, which enables the efficient transfer of electrical energy between voltage levels and acts as a critical link between generation, transmission, and distribution networks. In many installations, transformers represent a single point of failure an undetected fault can lead to catastrophic failure, prolonged outages, and significant financial and reputational damage.

Transformer fleets are ageing faster than they can be replaced. Meanwhile, demand is rising, capital is constrained, skilled resources are scarce, supply chains are tight, and regulatory demands are intensifying. In that context, a transformer failure isn't just a maintenance problem; it's a business risk with safety, reliability, regulatory, and reputational implications.

What utility leaders need is not more dashboards, but actionable intelligence that drives timely, proportionate interventions and measurable outcomes.

In practice, that looks like:

- **Clear fleet health visibility** (not just asset by asset noise)
- **Early warning** of developing faults, before they become events
- **Prioritised actions** by risk and criticality (where to act first, and why and what to do)
- **Evidence** that stands up to regulators, insurers, and the board

Utility leaders don't need more dashboards - they need actionable intelligence.

Chapter

02

1 TOTUS

2 Asset Insights

3 Expert Services

An integrated system: data + intelligence + action

A modern monitoring strategy must do more than collect data. Data without interpretation simply creates noise, false alarms, and operational inefficiencies. Today's utilities need systems that **translate raw data into clarity, reduce uncertainty,** and **support confident decisions** at every level of the organisation, from operators to asset managers.

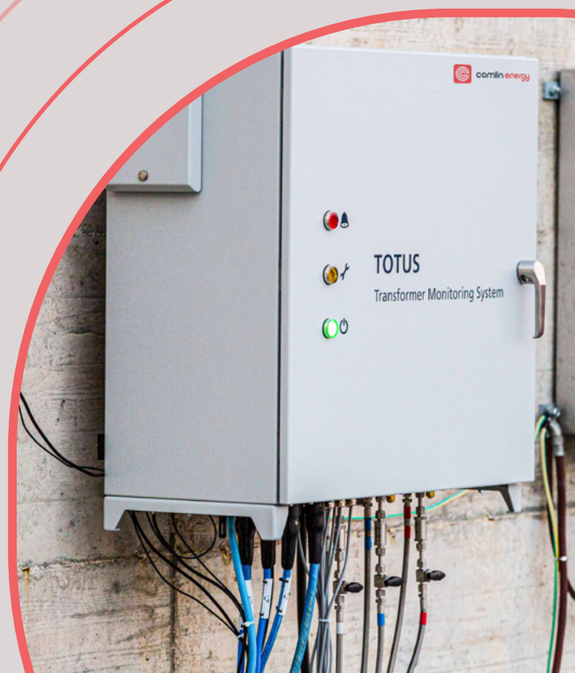
This is why Camlin Energy's approach goes beyond traditional monitoring. Instead of treating each device, sensor, or dashboard as a standalone source of information, we deliver a **holistic, full-loop framework** that connects data, analytics, and expertise into one continuous cycle of improvement. The outcome is not just better visibility, but **meaningful, actionable intelligence** that directly shapes risk posture, maintenance strategy, operational availability, and long-term asset planning.

At the centre of this approach are three critical components, each strong individually, but transformative when combined. It must provide actionable intelligence, reduce risk exposure, and support confident planning and decision making. That's why a holistic solution from Camlin Energy delivers a **complete solution for transformer risk management**.

1 TOTUS:
gives a complete condition visibility

A foundation of trustworthy, real-time intelligence that helps teams see what matters, understand what it means, and respond with confidence. It monitors all key components on the transformer, giving a full picture of transformer health and is the only unit to integrate DGA, Partial Discharge (PD), Bushing Monitoring (BM), Through Fault Currents (TFC) and Transformer Analytics into a single system.

Outcome: Sensors deliver real-time condition data that highlights early signs of faults, overloads, deterioration, and safety risks.



2 Asset Insights:

interprets the continuous data stream to **detect patterns, predict failures,** and highlight exactly what your teams **need to act on, when and where** it matters.

Raw data, even high-quality correlated data, is only half the equation. The next step is enabling the organisation to act on it with confidence.

Asset Insights is Camlin's analytics and decision-support layer: an intelligence engine that transforms condition signals into **fleet-wide risk scores, remaining useful life forecasts, and clear, prescriptive actions.** Instead of operators or engineers manually interpreting trends, the system continuously updates health indices, learns from new data, and links each insight to a recommended response, whether that's a diagnostic test, a controlled derating, heightened monitoring, or a planned intervention.

Where TOTUS answers what is happening, Asset Insights answers:

- **How serious is this?**
- **What is the likely progression?**
- **What is the impact if we do nothing?**
- **What action delivers the best risk-to-cost outcome?**

This turns monitoring from a technical activity into a business-aligned capability that supports maintenance, finance, operations, and planning simultaneously.

Outcome: It turns raw data into confident operational and investment decisions that prevent outages and avoid unnecessary capital spend.

2 Expert Services:

human insight where it matters, with experts who **diagnose, interpret, and guide** interventions to support your team.

Finally, even the best analytics benefit from expert interpretation. Camlin's Expert Services team bridges the gap between data and real-world action: experts who validate anomalies, correlate changes across multiple parameters, and guide interventions, to support your team 24/7.

The service includes diagnostic deep dives, failure forensics, monitoring strategy design, on-site commissioning, and 24/7 support. This human layer ensures that the organisation never overreacts, or worse, underreacts, to critical signals. Every alert is verified, contextualised, and translated into clear guidance.

In a landscape where skills are scarce and experienced specialists are retiring faster than they can be replaced, this expert partnership becomes a force multiplier for utilities.

Outcome: Giving you the confidence to act at the right time, with the right evidence, and with the right operational plan.

Chapter

03

TOTUS: complete condition visibility

Transformers rarely fail without warning, yet those warnings are often scattered, subtle, and easily missed when monitoring relies on isolated sensors or siloed systems. **TOTUS changes that**. As Camlin Energy's integrated condition monitoring platform, TOTUS provides a single, unified view of transformer health, designed to catch issues early, interpret them accurately, and give utilities the clarity they need to act with confidence.

Instead of juggling multiple devices, dashboards, and data streams from different vendors, TOTUS brings every critical parameter together into one correlated, alwayson source of truth. Dissolved gas analysis (DGA) reveals incipient thermal and electrical faults; partial discharge monitoring detects insulation stress long before it becomes a failure; bushing monitoring (capacitance and power factor/tanδ) tracks deterioration that could lead to catastrophic outages; and comprehensive thermal, electrical, and environmental data, oil and winding temperatures, load, voltage, ambient conditions, builds a real time picture of how the asset is truly performing. Even vibration and event signatures, including through faults and OLTC mechanism indicators, are captured and interpreted in context.

This continuous, multi-parameter visibility is far more than a convenience; it is a strategic advantage. By correlating signals across different channels, TOTUS dramatically reduces the noise that typically overwhelms operational teams. False alarms diminish, genuine anomalies stand out sooner, and patterns that would be invisible in isolated systems become clear indicators of emerging risk. Operators don't just receive alerts; they receive **alerts in context**, grounded by what happened and why it matters. That context transforms a generic "warning" into a meaningful, prioritised decision point: whether to intervene, increase monitoring, run diagnostics, or plan a controlled maintenance window.

And this is why TOTUS matters. Most transformer failures don't announce themselves on a single channel, and they don't escalate in ways that traditional monitoring can easily detect. But when data is correlated, when gas changes align with PD activity, when thermal shifts coincide with loading behaviour, when bushing trends match vibration signatures, teams can see the full picture early, understand the risk, and act decisively.

TOTUS isn't just a monitoring device. It is the foundation of a strategic, predictive, intelligence driven transformer management strategy.

By giving organisations the complete condition visibility they've been missing, TOTUS makes early intervention possible, supports confident planning, and becomes the first link in the closed loop that transforms data into real, measurable outcomes.

TOTUS saves five 130 kV bushings in Canada

Evidence:

TOTUS detected a rising Power Factor (Tan Delta) in two bushings, increasing by ~0.7%

Partial Discharge activity increased at the same time, and TOTUS identified the PD source as coming from the bushings

PRPD (Phase Resolved Partial Discharge) analysis indicated PD likely caused by metallic particles in oil

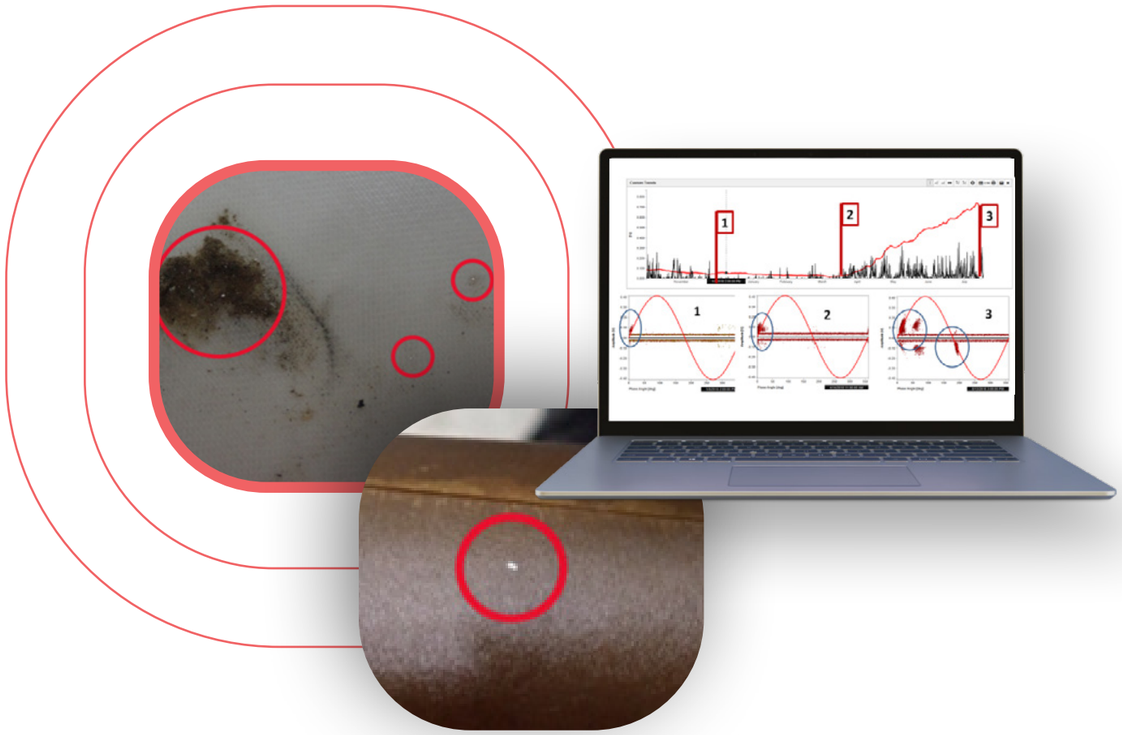
Action:

Utility de energized the transformer and completed

offline testing (DGA + oil quality)

Results showed poor oil condition and H_2 above 9,700 ppm, confirming deterioration

Two bushings replaced immediately. Offline screening revealed three additional defective bushings → total of five bushings replaced, preventing a catastrophic failure



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When data is correlated, teams can see the full picture early, understand the risk, and act decisively.

Chapter

04

Asset Insights: turning data into decisions

Data, on its own, doesn't create clarity, reduce risk, or change outcomes. It only becomes valuable when it drives action. That is why Asset Insights sits at the heart of a modern transformer-management programme: it converts raw condition signals from various sources into decision-ready intelligence, enabling teams to understand what is happening, how serious it is, **and what to do next.**

Asset Insights continuously transforms incoming field data into fleet-wide health indices and dynamic risk scores, updating these as new data arrives so utilities always have a current, defensible view of asset condition and criticality.

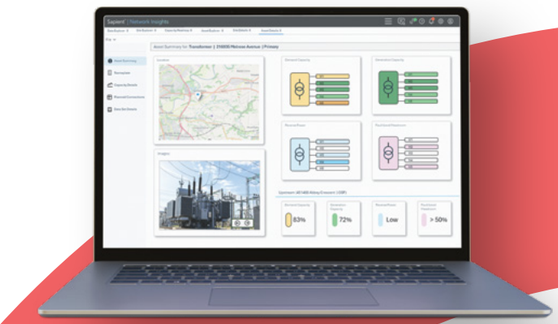
Beyond assessing the present, Asset Insights projects forward. Its uses true operating conditions, load behaviour, thermal history, environmental exposure, and duty cycle to forecast degradation trajectories and help operators understand how long assets can safely and economically remain in service. This forward-looking ability allows utilities to plan interventions, capital allocation, and maintenance windows with far greater confidence, reducing the uncertainty that typically surrounds large transformer fleets.

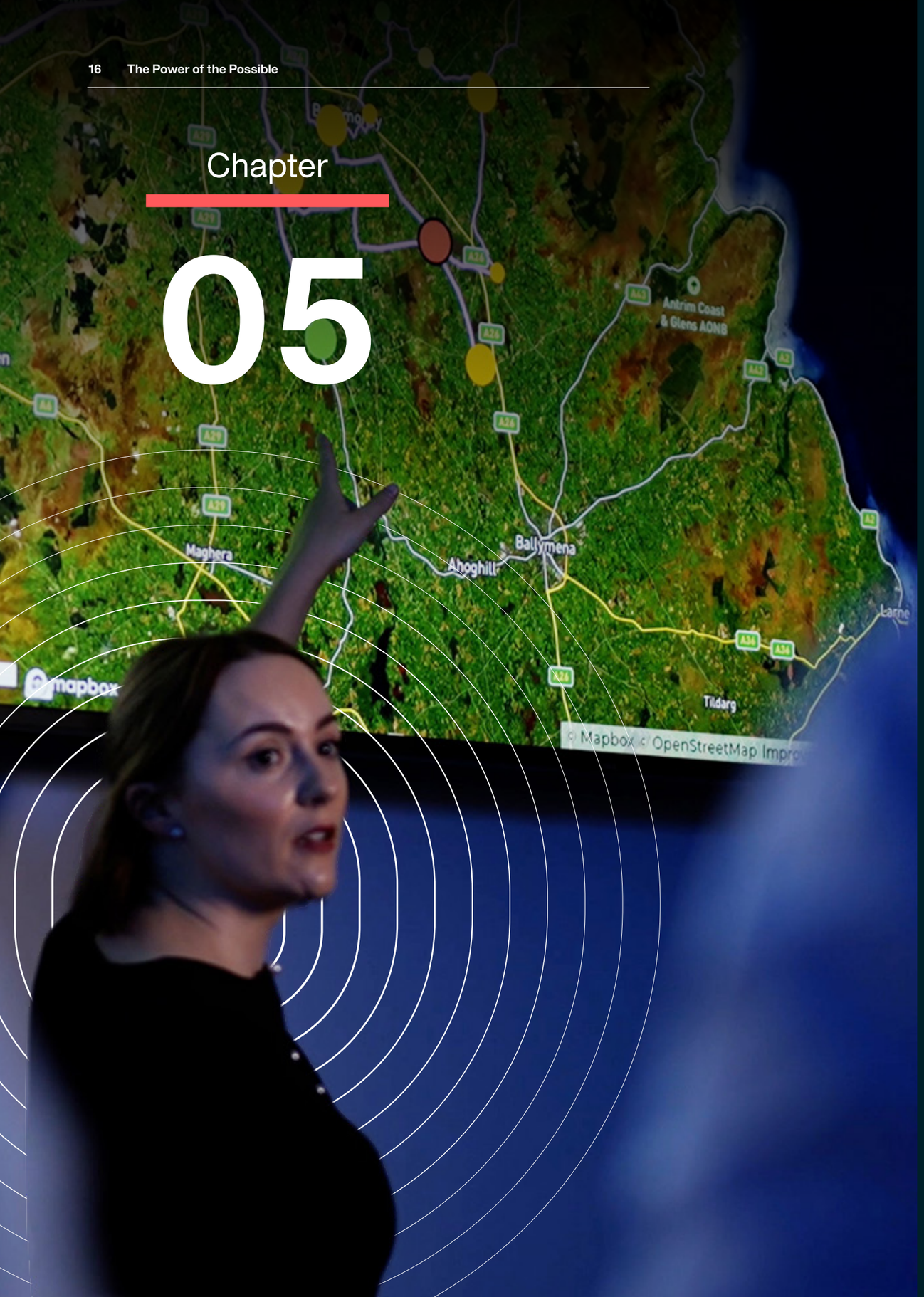
Asset Insights also provides a structured understanding of failure impact and **translates complex condition data into clear, prescriptive actions,** from diagnostic tests and targeted inspections to controlled operational adjustments that mitigate risk while maintaining availability. Its visual dashboards, trend views, and intelligent alerts are designed for both engineers and operators, presenting the right information at the right depth so that decision-makers can respond quickly, consistently, and with the necessary context.

Because real-world decision-making doesn't happen in isolation, software provides open integration with third-party tools and business asset-management systems, ensuring that actions are based on a full available data picture.

The impact is measurable. Asset Insights directly reduces the need for manual inspections and dramatically shortens the time between a signal emerging and a decision being made. It drives consistent risk-based prioritisation across the fleet, critical for organisations managing ageing assets, constrained budgets, and increasing regulatory pressure. Importantly, it gives utilities transparent, traceable evidence to demonstrate diligence to regulators, insurers, and internal governance teams. This documented chain of insight-to-action strengthens the organisation's risk posture and reduces exposure across both operational and financial dimensions.

Asset Insights is the intelligence layer that brings together monitoring and confident asset-management decisions. It transforms data into clarity, clarity into action, and action into outcomes. Without it, fleets are left with raw signals, scattered alarms, and growing uncertainty. With it, utilities gain complete visibility of transformer health and strategic risk management.





Expert Services: human insight where it matters (Interpretation and assurance)

Even with the most advanced monitoring systems and intelligent analytics, some decisions require the judgment of experienced experts. **Camlin Energy's Expert Services bridge the critical gap between measurement and action.** As your transformer fleet ages, and as seasoned specialists retire faster than the industry can replace them, this layer of expert oversight becomes not just valuable, but essential.

Experts bring real-world context to every insight coming from TOTUS and Asset Insights. They validate anomalies, correlate multiparameter changes, and distinguish between noise, nuisance alerts or alarms, and genuine warning signs that require proportionate action. This correlation work is essential: a single signal rarely tells the full story, but when gas trends shift alongside PD activity, when thermal patterns coincide with loading behaviour, or when bushing parameters change in step with vibration signatures, Camlin's experts' piece together the complete narrative of what is happening within the transformer. **Their analysis transforms data into clear, prioritised guidance**, ensuring operational teams always know what should be done, when, and why.

Camlin's Expert Services provides a comprehensive support that strengthen every phase of the monitoring programme. This includes **deepdive diagnostics and condition assessment,** where our experts analyse complex cases, review historical patterns, and validate whether developing indicators indicate early-stage deterioration or harmless variation. They also conduct failure analysis, helping utilities understand root causes and prevent repeat events. Their expertise extends to **monitoring strategy design,** ensuring monitoring investments align with asset criticality, operational objectives, and long-term risk posture.

Camlin provides a **monitoring service**, meaning that every alert is not only detected but actively evaluated around the clock. This **'always on' oversight** ensures that teams never miss a critical signal, and equally, optimise resources responding to false alarms. When action is required, Expert Services give field teams the steps needed to execute interventions consistently and safely.

The value of the expertise provided cannot be overstated. In today's environment, marked by staff shortages, increasing equipment stress, and intensifying regulatory scrutiny, **the right guidance at the right time, can prevent costly failures and enable proactive interventions that save time, money, and reputational risk.**

Expert guidance ensures that decisions are evidence based and aligned with both technical standards and commercial realities.

The power of expert intervention is best illustrated through real cases.

Large utility partnership spotlight

What was the large utility looking for in a partner?

A clear vision for the Grid Of the Future, which is safe, highly reliable and resilient, low cost to operate and maintain, and environmentally harmless.

Value Delivery

- **Insights & reliability:** Bushing saved due to insights provided by Sapient Insights & Camlin Experts
- **Reduced O&M costs:** Transition from time based to condition-based maintenance.
- **Asset replacement strategies:** Ability to plan CAPEX for asset replacement backed by real-time data.
- **Health & safety maximised:** Protecting the utilities people and the local community

Timeline

Summer 2022

Alarm raised > data reviewed by Camlin Team > report created about potential bushing issue (only appears during hot weather)

January 2023

Reports presented to senior leading US utility team

Summer 2023

Same alarm appears as summer 2022 ? additional report created by the Camlin Team > prescriptive actions updated (must be tested during summer) > bushings test in August by independent party which confirmed problematic issues

2023 Result

Utility advised to replace bushing

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What this example reveals, Expert Services completes the full loop. Where TOTUS delivers visibility and Asset Insights delivers intelligence, Expert Services helps deliver **action, the human decision-making capability that ensures the right actions are taken, at the right time, for the right reasons.** It is this combination of technology and expertise that transforms a monitoring programme into a truly strategic asset management capability.

The right actions, at the right time, for the right reasons.

Chapter

06

Building the business case: outcomes, not alarms

Why invest beyond the monitor? Investing in a modern transformermonitoring programme is not about collecting more data, it is about **reducing business risk,** improving operational performance, and protecting assets that are more expensive and more difficult to replace than ever. As your network becomes more complex and the consequences of failure intensify, value can no longer be justified by data volume alone. **Business risk, not terabytes, determines the return on investment.** A unified monitoring and analytics stack materially reduces operational complexity and the total cost of risk while simultaneously improving availability, reliability, and safety.

One of the immediate advantages is the reduction in operational friction. Instead of dealing with multiple vendors, disconnected devices, fragmented dashboards, and competing data sources, utilities gain a streamlined ecosystem: **one integrated supplier, one architecture, fewer interfaces, fewer contracts, and fewer updates to manage.** This consolidation lowers OPEX and enables operational teams to work faster, with greater clarity and confidence. The impact extends directly to network performance. By revealing emerging risks before they escalate, the unified stack reduces unplanned downtime and shortens outage durations, two of the most costly and reputation-sensitive dimensions of utility operations.

Beyond immediate operational gains, the business case strengthens further when maintenance strategy shifts from reactive or time-based tasks to **evidence-based interventions.** With clearer insight into asset health and risk, teams can focus resources where they deliver the greatest value, eliminating unnecessary inspections and prioritising the transformers that genuinely need attention. Over a fleet, this targeted approach has a compounding effect: as uncertainties decrease and the understanding of condition patterns improves, failure risk declines and intervention timing becomes far more precise.

This unified approach extends transformer life at a time when replacement cycles are increasingly constrained. With aged fleets and long lead times becoming the norm, the ability to safely stretch asset life, supported by credible diagnostics and risk assessment, is a significant financial advantage. At the same time, improved visibility into thermal behaviour, loading patterns, and degradation dynamics enables utilities to **operate closer to true limits with confidence,** unlocking additional capacity without compromising safety.

For CFOs and executive leaders, the numbers speak louder than the technology. The financial case for investing beyond traditional monitoring is built on **quantifiable outcomes:** avoided failures, reduced truck rolls and emergency callouts, stronger insurance positioning, and deferred capital expenditure made possible by life extension and Remaining Useful Life (RUL)informed planning. Unlike simple alarms or isolated data streams, a closed-loop monitoring and analytics system produces traceable, defensible evidence that supports not just maintenance and operations, but regulatory reporting, risk governance, and strategic planning.

A modern monitoring strategy is not an operational luxury, it is a business critical capability. It delivers tangible financial returns, reduces enterpriselevel exposure, strengthens regulatory posture, and ensures the resilience of the most essential, and most vulnerable, assets in the power system. The organisations that adopt this approach position themselves at a strategic advantage; those that delay remain exposed to rising risk, aging infrastructure, and avoidable cost.

Chapter

07

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How to build your transformer monitoring programme

1 Leverage Proven Industry Experience

Partner with organisations that offer the right depth of expertise, particularly those with extensive experience in transformer monitoring, transformer health, and the sector-specific challenges faced by modern utilities. It is important to choose a partner with a complete, end-to-end offering rather than a provider focused solely on sensors to collect data. When hardware, software, and expert insight are all delivered together, the result is seamless integration and a holistic view of asset performance and health.

Look for partners who can incorporate offline, historic, and third-party data to build a comprehensive understanding of the condition and behaviour of your asset fleet. It is important you instruct organisations that understand the technical, operational, and commercial pressures asset owners face and can support informed decision-making.

2 Begin with a Comprehensive Asset Assessment

Every engagement should start with a structured review of asset criticality, operating conditions, existing data, and organisational objectives. This assessment forms the foundation for defining monitoring priorities and tailoring the programme to the specific needs and context of your operations.

3 Implement Holistic Monitoring and Analytics Solutions

The monitoring programme should be designed as an endtoend solution that integrates seamlessly with existing systems and data sources. It must also include ongoing expert interpretation and support to ensure that insight and value are maintained throughout the entire asset lifecycle. Monitoring data only becomes meaningful when it is continuously reviewed, contextualised, and translated into actionable insight. By embedding expert analysis throughout the asset lifecycle, you ensure that the system remains aligned with evolving operational needs, emerging risks, and changes in asset behaviour over time.

4 Transition from Reactive to Predictive Asset Management

Move toward predictive asset management by building a structured, insightdriven approach to understanding asset condition and behaviour. Begin by establishing continuous monitoring across critical assets, ensuring data is captured consistently and in real time. Combine this with advanced analytics to identify emerging patterns, early warning indicators, and deviations from normal operating behaviour. Integrate historic, offline, and thirdparty data to strengthen trend analysis and improve diagnostic accuracy. Finally, embed these insights into your operational processes so maintenance planning, intervention decisions, and resource allocation are guided by evidence rather than fixed schedules or reactive responses.

5 Maximise the Value of Existing Data

Whether you are starting from scratch or building on existing systems, it is important to evaluate how current, historic, and thirdparty data can be better utilised, analysed, and interpreted to reveal meaningful trends and a broader operational context. This review should also highlight opportunities to unlock deeper insights through enhanced analytics, improved diagnostics, or more effective system integration.

6 Engage a Partner Who Can Support You LongTerm

Choose a provider who can support you throughout the entire journey, from the initial asset assessment through deployment and into ongoing value optimisation. It is equally important to work with a partner who takes a collaborative approach and ensures that the monitoring strategy remains aligned with your wider business objectives.

7 Initiate a Strategic Review

Begin by arranging an initial discussion or asset review to clarify your monitoring goals and determine the most impactful next steps. This early review provides the foundation for shaping a monitoring strategy that delivers reliable insight, supports confident decisionmaking, and creates longterm organisational value.

Conclusion: from monitoring to proactive management

Transformers will continue to carry more load, face harsher duty cycles, and be harder to replace. **Monitoring alone won't change that. Action will.**

By combining **TOTUS, Asset Insights,** and **Expert Services,** Camlin Energy delivers a practical, **full loop programme** that turns data into decisions and decisions into outcomes, s**afer, more reliable, and more costeffective** operation across the fleet.

But the deeper shift happening here is bigger than technology. Utilities are entering an era where uncertainty, complexity, and financial pressure demand a different approach, one built not on isolated measurements or reactive maintenance, but on **predictive insight, strategic foresight, and evidence based decision making**. Camlin's full loop solution empowers organisations to regain control over their ageing fleets, reduce exposure to operational and financial risk, and create a repeatable, scalable framework for longterm asset management. This is not simply an upgrade to monitoring; it is a fundamental shift in how infrastructure is managed.

As networks become more dynamic, as electrification accelerates, and as regulatory expectations intensify, the utilities that thrive will be those that replace guesswork with clarity and replace alarms with action.

Camlin Energy exists to enable exactly that transformation, to give operators the confidence to act early, the intelligence to act correctly, and the evidence to demonstrate impact. The message is simple: **with the right visibility, intelligence, and expertise, you don't just monitor the grid, you manage it with confidence and action,** that is how you build a futureready, resilient, monitoring programme.

Ready to build a holistic transformer monitoring programme?

Contact the team for more information.

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Group Headquarters

31 Ferguson Drive
Knockmore Hill Industrial Park
Lisburn BT28 2EX
Northern Ireland