

“Digitalization is the only way to manage this complexity and deliver the necessary visibility, agility, and fast data-driven decision-making across an entire business. This is becoming crucial to transformers due to their pivotal role in managing power quality, flow control and enabling efficient and safe electricity networks that are fit for the needs of today and tomorrow.”



Digital transformation in action: A deep dive into the next generation of TXpert™ Hub

Discover how to digitalize your transformer with TXpert™ Hub and turn data into actionable insights for optimizing transformer performance.

Decarbonization is driving an accelerated shift from fossil-based to renewable power generation, as well as a substantial increase in the electrification of transportation, industry, and buildings. Hitachi Energy estimates that by 2050, we will need four times the current power generation capacity, and our electrical power systems will need to transfer three times more electrical energy.

We must strengthen the power system, making it more reliable and secure; expand it in both reach and scalability; and evolve it to be more sustainable and resilient. At Hitachi Energy, our purpose is to advance a sustainable energy future for all, and we are delivering this through our pioneering innovation combined with our strong belief in the value of collaboration and tackling the challenge together.

We are seeing specific impacts throughout the power system, from generation to transmission and distribution. The

integration of around 20 times the current renewable capacity is leading to dynamic and even reverse power flows, where systems may become increasingly overloaded due to the changing generation mix. These new distributed energy sources may demand digitalization for monitoring, controlling, and securing remote assets, which are often in hard-to-reach locations. In parallel, the increasing dependency on electricity for industrial and transportation usage creates more dynamic load profiles and a growing risk of outages.

This is creating the need to optimize energy both locally and system-wide leading to a complex “system of systems” that must be integrated and managed. Digitalization is the only way to manage this complexity and deliver the necessary visibility, agility, and fast data-driven decision-making across an entire business. This is becoming crucial to transformers due to their pivotal role in managing power quality and flow control and en-

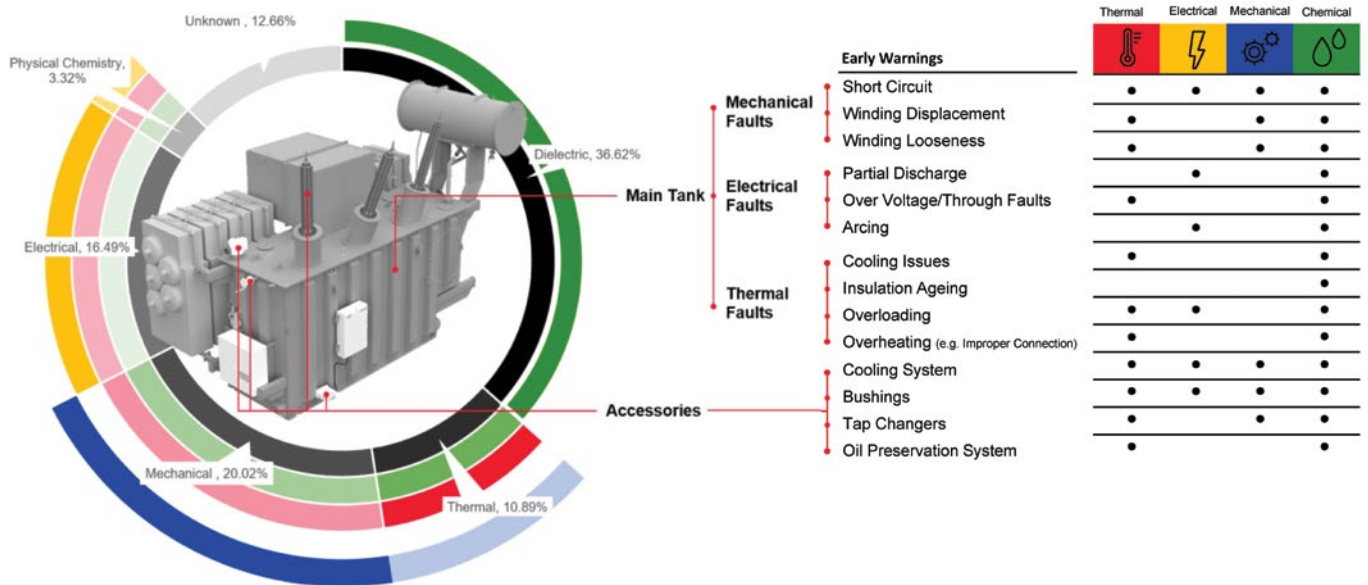


Figure 1. The overlay of failure modes and early indicators

A CIGRE study has shown that transformer monitoring can reduce the risk of catastrophic failures by 50 percent

abling efficient and safe electricity networks that are fit for the needs of today and tomorrow.

A CIGRE study [1] showed that in 964 transformer failures, online monitoring can detect up to 80 % of failures. Figure 1 shows the overlay of failure modes and early indicators that would detect them.

There are overlaps in early warnings and many signals to monitor, so the application criticality and transformer value should be considered when choosing the best monitoring system. This goes beyond simply adding sensors to generate more data – it requires connecting all the relevant data across many devices to gain insights for fast, data-driven decisions. These insights drive efficient utilization

of assets, extended operating life, and cost-effective maintenance and operation. All of these allow transformers to further contribute to sustainability and provide savings that can be invested in supporting the energy transition.

Also, achieving accelerated and meaningful change, with the context of today's mixed-technology installations, needs a vendor-agnostic, scalable, and configurable modular approach that can work with and bring together all makes / brands and models of transformers, new or old. This is why we have developed our fully customizable and open ecosystem for transformer digitalization.

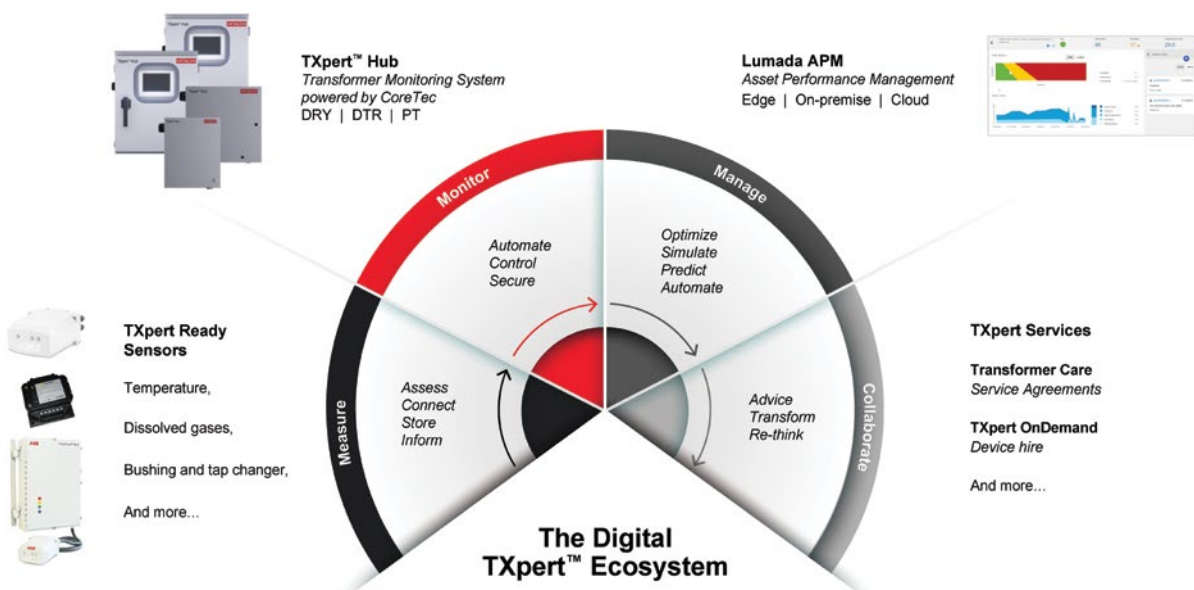
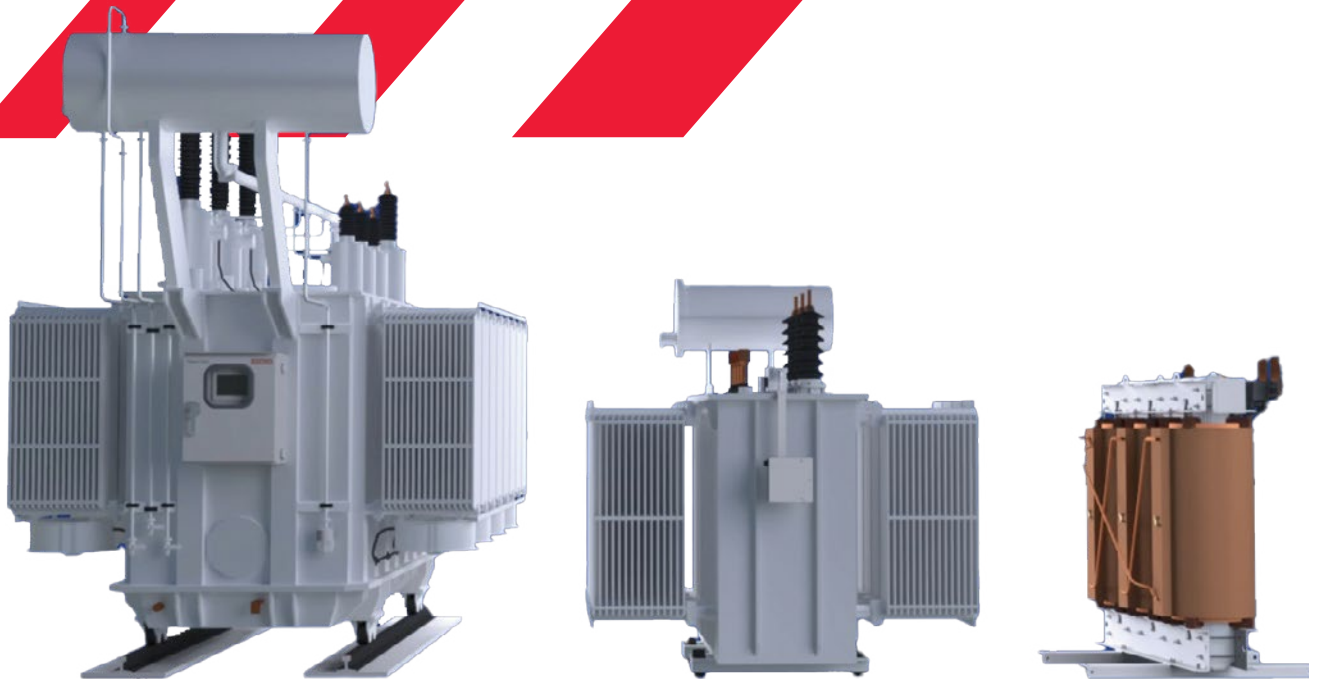


Figure 2. The TXpert ecosystem



TXpert™ Hub

Digitalization for every transformer

Figure 3. TXpert Hub with all three applications

TXpert Hub allows monitoring of sensors from different manufacturers and in any transformer, regardless of who is manufacturing it or if it is new or already in service

Introducing the new generation of TXpert Hub, the heart of the TXpert Ecosystem

TXpert Hub is the heart of Hitachi En-

ergy's TXpert Ecosystem. It enables the user to take simple steps to digitalize a transformer; liquid-filled or dry; new or retrofitted; regardless of its brand.

TXpert Hub collects data from sensors, monitors interdependencies,

and trends their evolution based on configurable thresholds. It acts as the cyber-secure bridge for upstream communication going up from or downstream to the transformer, allowing safe and remote monitoring.



Transformers in wind farms are usually not sized for peak production. When wind speeds are high, transformers are overloaded momentarily.

TXpert Hub analyzes transformer ageing due to repetitive fluctuations in wind conditions and warns the operator.



During peak climate days in summer/winter, transformers feeding HVAC systems operate with forced air cooling engaged for additional emergency loading.

TXpert Hub can monitor fan conditions and harmonics to avoid unplanned outages during peak season.

The new generation of TXpert Hub, powered by the latest CoreTec technology, enables a transformer operator to:

1. Maximize the lifecycle value and operating efficiency of your transformer

Maximizing the lifecycle value of a transformer starts with making sure the transformer fulfills its function without unexpected degradation or unplanned outage. TXpert Hub monitors thermal, chemical, electrical, and mechanical early warnings to catch fast-forming faults. A CIGRE study has shown that transformer monitoring can **reduce the risk of catastrophic failures by 50 percent** [2].

Additionally, monitoring allows you to squeeze more operating efficiency out of a transformer while keeping any overloading at safe levels. TXpert Hub allows its user to understand the overload capability to unlock a momentary increase in production while keeping an eye on the resulting accelerated ageing rate.

2. Access knowledge remotely

Transformer sensors are often designed to be only used with a specific combination of devices or for a specific type of transformer from a certain manufacturer. This makes it difficult for our customers to integrate better and more advanced technologies if they are not already using components from the same manufacturer or product line, thus limiting the scope of digitalization for their transformers.

TXpert Hub allows monitoring of sensors from different manufacturers and in any transformer, regardless of who is manufacturing it or if it is new or already in service. Its interface is customizable to track and check health KPIs and access them remotely, either through standard industrial protocols, WI-FI, or cellular connectivity, so an operator can know of an issue and dispatch service as and when required.

At its core, both industry-leading hardware and software improvements enable a cyber-secure connection. Our company, the development team, and the product were certified by third-party agencies to comply with ISO, IEC, and IEEE cyber-security standards. While our processes continuously screen for potential new threats and warn our customers of the issue and the remediation.

A CIGRE study showed that early problem detection could reduce repair costs by 75 percent and loss of revenue by 60 percent



Avoid dispatching personnel to the site, reducing associated costs and risks.

TXpert is equipped with cyber-secure cellular communication avoiding added cabling costs during installations and allowing for remote monitoring.



Municipalities are embracing electrical vehicles, making charging station parks progressively common.

TXpert Hub can explain the effects of the increasing number of charging stations on the grid while visualizing it all remotely.



Reliability is key in data centers; monitoring transformer health parameters as well as the network harmonics can ensure uptime.

By monitoring voltage harmonic distortion, TXpert Hub can warn of any excessive voltage harmonics that can affect electrical equipment, especially sensitive loads like servers. It can be coupled with consultancy and corrective maintenance plans in a service agreement for better uptime.

3. Optimize your operations

A significant maintenance optimization strategy is to replace simple time-based maintenance that mitigates risk by doing everything, every year, for all transformers, with a more sophisticated, condition-based maintenance strategy – i.e., focusing maintenance on high-risk transformers. It is estimated that a **life extension of 5 to 15 years can be achieved** with properly focused preventive maintenance programs.

A CIGRE study showed that early problem detection could **reduce repair costs by 75 percent and loss of revenue by 60 percent**. Furthermore, **annual cost savings can amount to 2 percent of the price of a new transformer – i.e., approximately \$40,000 to \$80,000** for a power transformer [3].

When TXpert Hub communicates multiple transformers data to Lumada APM, each asset is categorized according to its current health condition and expected life. Grouping offline historical and real-time data with decades of subject-matter expertise in transformer manufacturing and maintenance, Lumada APM will provide the recommended fix to the problem and the timeline. With all this actionable intelligence, the operator can optimize the operational and maintenance spending to maximize the capabilities of their assets and budgets and build business cases for repair/replacement decisions.



Tap into OEM and service expertise to plan and execute adequate maintenance.

TXpert Hub can warn of forming issues, our service teams can provide reports interpreting the data and support with corrective maintenance if required.

4. Extend the useful life of transformers

With an average age in industrial plants of 30 years and in utilities of 40 years, the world's transformer fleet is ageing – and is incurring increasing replacement and repair costs, as well as the risk of failure. Many transformers are now also operated beyond their recommended life span to smooth investment peaks or deal with long lead times for new transformers.

Once TXpert Hub triggers an alarm or APM recommends action for specific corrective service, Hitachi Energy experts can help make good use of the data collected and the output of asset management software to analyze the condition of a specific transformer or complete transformer fleets. The combination of this data with the design data, the information in Hitachi Energy's installed base system, the results of oil analysis, condition assessments, and the maintenance history provide Hitachi Energy with a 360-degree view of a transformer fleet. This insight plays a pivotal role for Hitachi Energy in the condition assessment process.

For the short term, the operator can make sure that a sick transformer is “nursed,” with the TXpert Hub monitoring critical development of a failure mode, balancing operational needs against risk whilst planning for a shutdown.

On a long-term and strategic level, a condition assessment study gives top management a clear picture of the maintenance and renewal investments that are required over the next 20 to 30 years. Our service team in over 30 countries can carry out these corrective actions to extend the lifetime of the problematic asset.



Delay an unplanned shutdown to suit your established schedule.

With long delivery times for replacement units and reducing CAPEX budget, TXpert Hub can support extending the lifetime of a transformer until it becomes possible to replace or to service.

We provide pre-packaged units for Distribution DRY, Distribution Oil, and Power Transformers with a variety of options customizable from entry-level to advanced systems using uniform software and configurable hardware modules



Monitoring the bushings on your transformer can provide early warning that the end of life is approaching. This allows adequate planning of an outage to replace the bushing before it fails. Timely bushing replacement extends the life of your transformer maximizing operational life.



		Thermal	Electrical	Chemical	Mechanical
Distribution Dry	Basic	●			
	Basic +	●	●		
Distribution Oil	Basic	●			
	Basic +	●	●	●	
Power	Basic	●		○	
	Basic +	●	●	○	
	Advanced/ Custom	●	●	○	●

● Standard ○ Optional



Summary

By installing the latest version of TXpert Hub, the operator gets:

- Actionable insights: advanced algorithms (depending on the data available and the transformer type)
- Remote monitoring: alarm setting, industrial protocols, and Wi-Fi and cellular communication options
- Scalable and manufacturer agnostic: connect any sensor, apply to any type of transformer (dry, distribution, or power), and digitalize at any age (new or old)
- Cyber Secure: TXpert Hub acts as a cyber-secure funnel above all installed sensors, creating a single secure link to the outside. (Hitachi

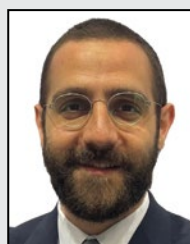
Energy is certified for ISO27001, the development team is certified IEC 64443-4-1, and the product is certified IEC 64443-4-2 and complies with IEEE1686).

We offer pre-packaged units for Distribution DRY, Distribution Oil, and Power Transformers. By using uniform software and configurable hardware modules, we are able to offer entry-level to advanced customized systems.

Bibliography

- [1] CIGRE Technical Brochure 642/2015
- [2] L. Cheim et al., *Transformer Reliability Taking Predictive Maintenance Program to the Next Level*, CIGRE Study Committee A2 COLLOQUIUM, October 2017
- [3] *Economics of transformer management*, CIGRE Technical Brochure 248, June 2004

Author



Lony Tehini is the Global Product Manager of Transformer Accessories at Hitachi Energy.

Lony holds a bachelor's degree in electrical engineering from McGill University. He joined Hitachi Energy in 2015 from ABB Automation. He has held various sales and product management positions and is currently responsible for transformer accessories. He is currently based in Montreal, Canada.