How intelligent MV switchgear transforms downtime, maintenance and operations

White Paper

By

Bilal Arif
Terry Fei
Benoit Mougenot
Leandro Costa
Natasha Nelson
Anne Laure Jallon
Florent Nocodie
Jean-Eudes Vautherin

Executive summary

Data from digitalized MV electrical equipment is enabling businesses to transform the way they manage and maintain their power systems. This paper explains how digitalization supports businesses to thrive in the power distribution networks of the future and sets out practical steps to implement it.

- Electric power is growing in importance. Rising demand and complexity, amid ongoing skills shortages, are creating unprecedented challenges.
- Businesses can take a strategic approach to power system management, using data, trends and AI to meet rising demand and reduce downtime through smart and efficient ways of working.
- Data from intelligent switchgear is a foundation, enabling early detection, condition monitoring and predictive maintenance with increased visibility.
- Adopting such technology results in an impressive ROI. Combined from downtime risks avoided, operational maintenance reduced and asset lifetimes extended.

Public

The hourly cost of downtime in the New Electric World

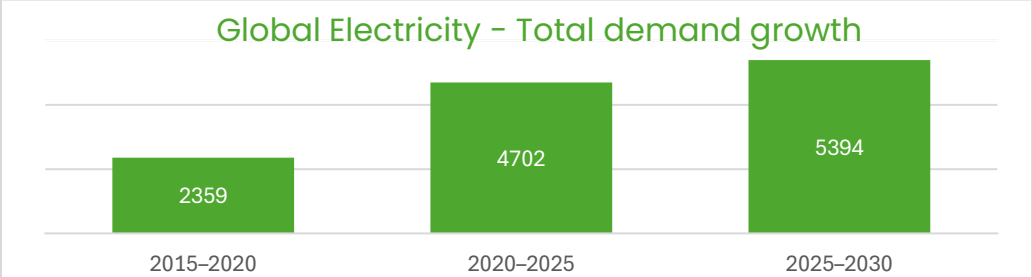
The rise of electricity is creating unprecedented challenges.

Electricity is increasingly central to the global economy, with annual growth in demand over the next five years expected to be 50% higher than in the previous decade, driven by dynamic growth in AI, EV Infrastructure and decarbonization.

With this rise in demand expected to outpace economic growth, ensuring a sufficient and reliable supply of power is a crucial concern across industries where 24/7 operations are increasingly expected.

Figure 1

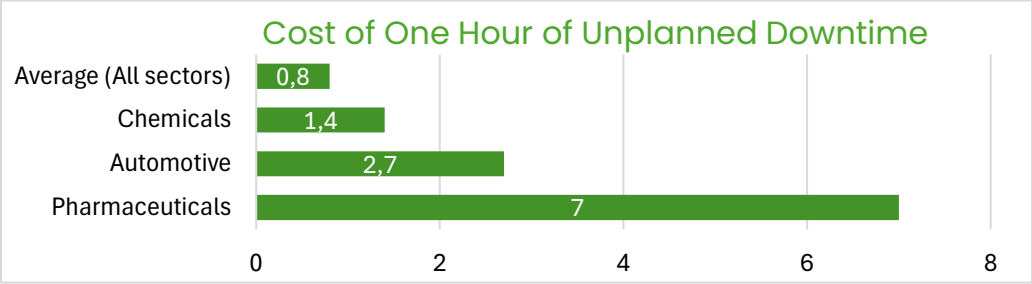
Global electricity demand has doubled in 10 years to nearly 5400 TWh International Energy Agency (IEA), Electricity



Unplanned downtime is common, experienced by 80% of industrial businesses. It's also increasingly expensive. The cost of every hour doubled between 2019 and 2024 (automotive segment data), amounting to billions of dollars in some sectors.

Figure 2

2026 Estimated cost per hour. Top 3 Manufacturing sectors + average (MUS$) Sources: IDS Indata



$1.4 trillion: Estimated annual cost to the world's 500 biggest companies

Power-related issues are regularly reported as the biggest cause in unplanned downtime. Businesses must not only ensure access to more electricity but be able to do so dependably amid challenges such as rising complexity from integrating renewable sources, and the higher resilience needed to withstand extreme weather.

Why the current approach is no longer good enough

Faced with these challenges, many organizations are responding reactively, dealing with problems as and when they emerge. But this approach is inefficient and risky. It creates a spiral of shutdowns and short-term fixes that can eventually push equipment or operational teams beyond their limits.

The need to transform working practices is particularly important given the increasing shortage of electrical engineers. More than half of energy related businesses and organizations are already experiencing critical hiring bottlenecks. And the need for workers is increasing, with the US and EU power industries alone expected to have to fill 750,000 new jobs by 2030. To mitigate these huge risks and complexities, organizations must find ways to make their power systems work

"This system has definitely paid for itself… Within the first week or so, we were getting insights that we had no idea about." ***Lee Perry, Electrical Design Engineer, BASF*** *Watch the video*

harder for them, which typically involves moving from reactive to more predictive approaches.
Many have already begun using condition monitoring and predictive maintenance to adopt a more strategic way of working, where data and AI support proactive operations. When implemented effectively, this approach provides the efficiency and clarity needed to meet future demands. This paper will explore how businesses can make this change and avoid getting left behind.

When chemical manufacturer BASF set up digital sensors and analytics, the data showed that the company was overloading some of its drives.

How to quantify the ROI payback of intelligent switchgear

As we'll explore later**, intelligent medium voltage (MV) switchgear delivers a return on investment (ROI) in three clear ways:**

1. Reduced maintenance spending
2. Downtime costs avoided
3. Longer asset lifespans

These advantages combine to meaningfully reduce the total cost of ownership of intelligent equipment compared to older models. The savings typically exceed the small shift from OpEx to CapEx required to invest in new devices, leading to a significant financial return.

What changes? How to digitalize MV operations

Intelligent MV switchgear provides clear visibility of a power system's health through accurate data. This means that rather than tackling unpredictable issues as they arise, system managers can make informed interventions through reliable detection, alerts and forecasts.

Embedded IoT sensors build a reservoir of data, laying strong foundations for future digital transformation. In the first phase bringing visibility to remove the guesswork, and the second includes predictive operations with AI driven capacities, some of which we are still yet to imagine.

"…. saves us time and money on the maintenance and operations of our installations amounting to around 30 to 35%." ***Roland Francey, Head of Power Supply Installations, UCB Farchim, Bulle***
Watch the video

Phase one: From analogue guesswork to informed intervention

Data from intelligent switchgear brings advantages from day one, alerting system managers to anomalies which can emerge any time from the point of installation. This allows them to detect otherwise invisible problems before they cause serious disruption. Studies into MV switchgear performance suggest the biggest impact can come from continuous monitoring of circuit breaker, cable and busbar compartments.

"Without lifecycle data, you're forced to make assumptions."

Anne-Laure Jallon

The evolving sensing capabilities of digitalized electrical equipment are allowing businesses to do this with increasing confidence. In addition to core metrics such as temperature and humidity, new models are now providing advanced granularity by measuring variables such as the alignment and wear of circuit breakers, that are only possible through manufacturer-embedded designs.
Data also supports a more efficient overall approach to maintenance, allowing businesses to monitor the condition of equipment over time. In contrast to legacy equipment, which must be maintained at fixed, time-based intervals, data trends

"By monitoring the health of the equipment in real time… I can anticipate failures and perform maintenance only when needed" ***Luis Gilberto Lopez Paez, Electrical Specialist, Nestlé Toluca Cafés*** *Watch the video*

from intelligent devices provide an ongoing, accurate picture of the system's health. This gives system managers the confidence to arrange maintenance more strategically. **In many cases, they can extend the time between routine maintenance shutdowns,** and when these do take place, engineers have a better idea of what needs to be done.

As businesses make use of these growing capacities, and learn more about trends over time, on-site maintenance interventions become fewer, more targeted, and better informed.

At Nestlé's Nescafé plant in Toluca, Mexico, alerts allowed the facility to avoid five major stoppages (2020-2024), saving around USD $2m.

Phase two: From data to AI-powered transformation

Data drives new efficiencies, but it's just the start of what's possible. Layering insights from different sensors and components allows teams to understand their systems in ever greater depth, supported by the growing capacities of AI to power new condition-based maintenance strategies.

"The size of the data pool is vitally important. AI must learn from many applications and from day one of energization." ***Anne-Laure Jallon***

As data builds, cloud-based analytics highlight trends and patterns which are combined with expert-led insights into actionable quarterly health reports. This enables system managers to progress from monitoring equipment's current condition to accurately predicting its maintenance needs and lifespan. Understanding how a device is ageing, and anticipating its likely trajectory, allows a business to asset manage much more efficiently.

With increasingly sophisticated digital analytics and AI learning, the **focus is shifting from individual asset-level management to a system-wide vision**. Insights from each device are synthesized into a comprehensive and holistic picture. This allows resources to be directed to the highest priority at any given time. Whether that's a long-planned circuit breaker replacement, or a sudden deterioration in the health of a motor, t**he system compares indexes and assesses risks to identify the best approach,** even integrating control and maintenance systems (SCADA, CMMS, EMS etc.) to highlight maintenance decisions and create work orders.

"we're able to have insights at a level that's never been seen before in our industry" and *"the ability to make sure we have the longest useful life out of all of our assets."* ***Chris Crosby, CEO and Founder, Compass*** *Watch the video*

Through condition-based maintenance, Compass reduced intrusive on-site maintenance by 40% and cut OpEx spending by 20%.

In the coming years, AI technologies will continue to transform electrical systems with smart, efficient decision making. Current developments point to AI agents, which can reason and act autonomously, playing an increasingly important role in managing power system health. These digest a vast amount of diverse data from segregated systems, condition monitoring updates, alerts, operational metrics, procedures, contracts and technical documentation, and interact with experienced technicians to pinpoint issues and recommend solutions.

Tackling the skills shortage: move from daily reactivity to intelligent planning

Digitalization also offers a solution to current skills shortages, driving a shift from daily reactivity to intelligent forward planning. It allows engineers to diagnose issues more precisely, train colleagues faster, and deploy their expertise where it really matters. In this way, they can meet rising demand amid ongoing capacity challenges, while always keeping people in control.

Table 1

Moving from reactive to predictive maintenance, summary of changes

	Time-based	Condition-based
Maintenance	Reactive Intrusive Costly Disruptive Snapshot of health	Predictive Remote checks Efficient Minimal disruption Continuous health trend
Costs	Inefficient Day-to-day pressure	Optimized Strategic planning
Operations	On-site interventions Accident risk Short-term troubleshooting Skills dependent	Remote monitoring + operation Increased safety Quarterly planning

How to get there: five steps to transform your MV operations

"With remote data, we can generate a maintenance report for dozens of cubicles in one click without even visiting the electrical room."
Benoit Mougenot

Digitalization is a journey, leading to compounding benefits and empowering engineers and managers. Here's how it progresses:

Step 1: How to lay strong foundations for digitalization

To thrive in the new world of energy, businesses need systems designed for it, intelligent, robust and more sustainable.

Modern electrical equipment is supporting increasingly power-dense applications and better asset optimization. Driven by electrification and AI, some sectors see a 4x increase in electrical power consumption. So new equipment must lay resilient foundations in addition to digital transformation.

One such example is Schneider Electrics' new MCSeT MV switchgear, which uses EvoPacT circuit breakers at the heart to withstand up to 50,000 operations, with a service life up to 5x longer than the industry standard (for 12kV) cutting average lifetime carbon emissions and maintenance downtime. It's also an example where both switchgear and circuit breakers are **embedded with a comprehensive package of intelligence and connectivity** needed to provide visibility of today's complex electrical systems.

All components must also be designed for cybersecurity compliance, using a secure- and embedded-by-design approach aligned with IEC 62443 to suit the preferred edge or cloud architecture.

"If we detect partial discharge, being able to overlay humidity or thermal data tells a much deeper story… we didn't even need an interruption or site visit"
Florent Nocodie

Step 2: What parameters are needed to monitor MV switchgear comprehensively?

The efficient management of electrical systems relies on receiving accurate readings of key health metrics, many of which would be impossible to monitor without embedded sensing. These advanced inputs are each valuable in their own right, but the real advantages come when they're combined for richer insights.

The example MCSeT equipment monitors 7 different variables to provide an accurate and comprehensive picture of switchgear health.

Monitoring Location	Why it matters
Switchgear cubicle	**Temperature:** Thermal hotspots on busbars and cables **Humidity:** Excessive moisture inside the equipment **Partial Discharge:** Insulation breakdown (cables, bushings etc.)
Circuit breaker	**Electrical wear:** Erosion of Vacuum Interrupter contacts **Mechanical wear:** Operating speed of mechanisms **Alignment:** Breaker position within the panel **Thermal:** Hotspots on circuit breaker connections **Auxiliaries:** Degradation of coils and motors

Combining multiple monitoring sensors allows much deeper insight into common issues like circuit breaker misalignment. This can prevent a site visit, or an intrusive inspection requiring downtime.

"what's great is a live, constant stream of data on switchgear health. …. moving away from snapshots and getting the full picture in real time."
Bilal Arif

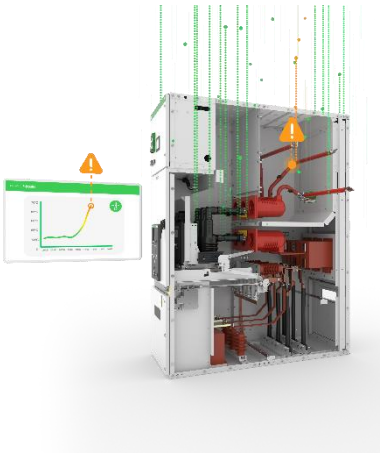
Step 3: How detecting issues early cuts downtime risks

Through continuous data and timely alerts, AI and analytics make it possible for businesses to identify emerging issues early and address them proactively, before they develop into serious problems.
Together, the seven types of monitoring enable the detection of the biggest risks in medium voltage equipment (affecting both operator safety and business uptime):

- fire, short circuit or arc flash
- deterioration of insulation and accelerated ageing
- wear of circuit breakers

Monitoring circuit breaker wear allows engineers to intervene, if necessary, before safety risks increase. Other irregularities such as thermal hotspots and partial discharge (which may be due to installation issues), can occur from day one.

The ability to identify and tackle these issues promptly helps businesses avoid unplanned shutdowns. Detecting early cuts downtime by up to 75%.



Step 4: Does predictive maintenance bring new levels of efficiency?

Looking at the bigger picture, visibility from AI and analytics gives engineers the capacity to adopt a more strategic approach to managing their power systems.

Continuous data from sensors creates trends, aggregated and analyzed through advanced digital service plans such as Schneider Electric's EcoCare. These inform a maintenance index detailing the condition of the individual parts of an electrical device, as well as an overall health index for each piece of equipment. Trends of data across time also kickstart the development of lifetime ageing models. This supports businesses to plan and target maintenance activities efficiently, and if the

"AI is going to act like a pair of eyes that never sleeps… will tell us the likely cause and the most efficient way to fix it before we arrive on site" ***Benoit Mougenot***

system is healthy, increase the time between routine intervals. This could, for instance, mean extending the time between specific maintenance inspections* **from three to five years.**

When system managers move from fixed, time-based schedules to arrangements based on the actual condition of equipment, they gain a huge potential saving*. Intelligent MV switchgear with embedded sensors can reduce maintenance activity by up to 40%.

Step 5: How AI helps power system managers lead with vision?

The clearer the view a business has of its electrical system, the more precisely it can manage it. With granular data, trends and AI-powered input accurately predict which actions will keep it in operation for longer.

We can compare this to the way technology is helping us live more healthily. Using wearable devices, we now monitor metrics such as heart rates and blood glucose. This creates the visibility needed to manage our health better, and healthy bodies lead to longer lifespans. The same principle applies to energy intelligence in electrical equipment. Through accurate data, condition-based insights and trends, system managers can make their investments work harder, for longer. By keeping their devices in good health*, some businesses have **extended equipment lifespans by up to a decade, allowing future CapEx spending deferrals.**

As advances in AI technology continue, data-fueled learning and prediction offer huge possibilities for power systems, from hyper-efficient maintenance schedules to AI assistants and completely new paradigms. Supported by rich data and deep intelligence, your electrical infrastructure can become a beacon of stability in an increasingly complex power landscape, where resilient distribution and predictive maintenance make downtime a distant memory.

*Based on real examples. Maintenance schedules or extensions vary by equipment type and condition. Savings and estimates are based on Schneider Electric experience and are non-contractual. For proof and to learn more about customer reactions, please visit se.com/ecocare

Conclusion: What digitalization means for decision makers

How	Why it matters
Risk Reduction	Electricity powered businesses face an important strategic choice: continue with high-risk reactive operations, or switch to proactive power system management to take control of business uptime.
ROI Payback	A small investment in intelligent, digital-ready equipment creates the efficiency needed to meet rising demands amid a growing skills shortage.
Operational Efficiency	Early detection, condition monitoring and predictive maintenance can radically reduce costs and downtime.

How	Why it matters
Workforce Optimization	Data and AI are transforming day-to-day work practices, empowering engineers to make fewer, smarter interventions.
Asset Longevity	With better maintained equipment, current lifetime estimates of 30 years (IEC specifications) can be lengthened, and CapEx spending deferred.

"The future includes an army of AI agents that can reason and act across this entire system. Helping engineers to be more informed and hyper efficient." ***Natasha Nelson***

Join the digital revolution, start laying foundations today!

To learn more about how you can transform power system management through intelligent medium voltage equipment, visit our website.

About the authors

Bilal Arif is the Global Launch Leader in the field of Medium Voltage Distribution for Air-Insulated Switchgear having smart condition-based monitoring capabilities and digitalization. He holds a Ph.D. in the subject of Predictive Control for Grid Connected Applications from the University of Nottingham, UK.

Natasha Nelson is the Chief Technical Offer for Services and Vice President of EcoStruxure Power solutions for End-Users. She has with leading expertise in IoT, AI and connected systems and is a Fellow of Massachusetts Institute of Technology, USA.

Anne-Laure Jallon is AI and Analytics Director with focus on data transformation within EcoStruxure Solutions. She was educated at Institut National Polytechnique in Grenoble, France.

Terry Fei is Global MV Components Marketing Leader, specializing in innovation in Circuit Breakers. Terry was educated with a Master's degree from Donghua University, China.

Florent Nocodie is a Services Innovation Leader with focus on incubation of new concepts. With over 20 years' experience in the Energy Management field, he holds a Master's degree in Marketing from Burgundy School of Business, France.

Leandro Costa leads the Global Launch Team in Schneider Electric's Medium Voltage business. Leandro holds a degree in Electrical Engineering from UNISAL University, Sao Paulo, Brazil.

Jean Eudes Vautherin is the Leader of Marketing for Recurring Services, Energy Management. He holds an Engineering degree from ESTP, France and Masters in Management from IEA, France.

Benoit Mougenot is Marketing Leader in Digital MV Offers. Benoit studied Marketing and Sales for Industrial and Engineering at ESTA Belfort, France.

Resources

- Electricity 2026 - The international Energy Agency
- The Real Cost of Manufacturing Downtime 2026
- The True Cost of (Industrial) Downtime 2024
- Four ways new medium voltage circuit breakers help increase uptime
- The invisible threat in MV switchgear: Detecting Partial Discharge
- Why condition-based maintenance is a turning point for electrical distribution
- Transforming Data Center Services: AI-Driven Condition Based Maintenance
- Benefits of Shifting to Condition-based Maintenance in Electrical Distribution

Appendix: FAQ

What business problem does MV digitalization solve? Unplanned downtime is the core issue, with power-related failures a major cause. Intelligent MV switchgear provides continuous condition monitoring and visibility, enabling early fault detection and proactive maintenance—reducing outage risks and business disruption.

How should we justify the ROI of predictive maintenance in MV switchgear? ROI comes from three measurable areas. Downtime avoided (high-cost outages prevented), Maintenance reduction (up to 40%), Extended asset life (defers CapEx). Together, this lowers Total Cost of Ownership (TCO) while improving uptime and operational efficiency.

How does predictive maintenance change maintenance strategy in practice? It shifts maintenance from time-based and reactive to condition-based and predictive. Continuous monitoring replaces periodic inspections, maintenance becomes targeted and planned, fewer shutdowns mean better prioritization and improved safety. The Result: more efficient operations with less disruption.

What are the tangible outcomes of MV condition monitoring? Digital condition monitoring delivers measurable results: Up to 75% reduction in unplanned downtime, up to 40% reduction in maintenance costs, Extended maintenance intervals (e.g. 3 to 5 years). These outcomes improve reliability, reduce costs, and optimize asset performance.

Which parameters should be monitored in MV switchgear? Effective predictive maintenance relies on key variables: Temperature (thermal hotspots), Humidity (moisture risk), Partial discharge (insulation breakdown), Circuit breaker wear (electrical & mechanical), Alignment and auxiliary condition. Combining these provides a comprehensive view of equipment health.

How does digitalization address the engineering skills shortage? Digital insights shift teams from reactive firefighting to planned operations: Faster fault diagnosis, better task prioritization, reduced manual inspections. This enables engineers to focus on high value work and increases workforce efficiency.

How does MV digitalization support resilience and future system demands? With increasing electrification and complexity, continuous monitoring improves resilience by: Maintaining asset health proactively, providing real-time alerts and predictive insights, enabling smarter, risk-based decisions, this ensures reliable power systems even under higher loads and evolving demands.

Part Number 998-25777200 © 2026 Schneider Electric. All rights reserved.