SUBSTATION RELIABILITY: ACHIEVING OPERATIONAL EXCELLENCE WITH A DIGITAL PARTNERSHIP

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Substation Reliability: Achieving Operational Excellence with a Digital Partnership

A Reference Solution in the Perennial Quest for Reliability Improvement

The commissioning of many of the currently operational utility assets often dates back to times of explosive growth in the developed world, such as the 1960s and 1970s. Long life cycles are a primary requirement for capital-intensive investments and an inherent characteristic of large-scale assets across generation, transmission, and distribution.

Over the years, not only have these assets grown older but the environment in which they operate has also changed drastically. Macroeconomic factors are leading to a different set of decisions. In large parts of the world, population growth is slowing down and so will energy demand growth, which has largely stagnated in recent years. Investment levels have not always kept up with the need to replace the existing asset base.

Looking ahead, however, the further electrification of energy demand looks inevitable. Transportation and to a lesser extent heating will abandon fossil fuels, albeit at a significantly different pace across geographies. Rising living standards and stable growth in the developing world, meanwhile, can only be achieved with a reliable grid.

With the electrical asset sector's transformation accelerating, optimizing cost, performance, and risk is becoming increasingly complex. Customers, shareholders, regulators, and the wider stakeholder community expect asset owners to demonstrate a convincing return on investment — even if this means doing more with less.

Asset owners will have to unlock the value of their investments and achieve operational excellence by leveraging new technologies and carefully selecting expert partners. Data, once the purview of IT, is now ubiquitous and has long reached the operational side of asset management. Equipment and machinery, on the other hand, once exclusively monitored and controlled by operational technology (OT), is becoming hyperconnected. The IT and OT worlds are coming together, and bridging the expertise gap between the two is vital when asset reliability is at stake.

Substations' Evolving Landscape

While these considerations are pertinent to electrical assets in general, they could not be more applicable to substations specifically. A core component of every grid, substations enable the transformation of voltage from high to low or vice versa, acting as intermediaries between power generation and consumption. Their good functioning is critical to ensuring the quality of supply, be it in consumers' homes, at commercial premises, or for industrial loads.

From analog to microprocessor relays and from early SCADA systems to IEC 61850-based communication, substations have changed significantly in many ways. A move toward SF_6-free

equipment, for example, would have been considered unfeasible until a few years ago. However, regardless of the motivation behind change, the need for reliability is constant.

We could ask what would really happen in the absence of this reliability. If recent history were to teach us a lesson, it would, for example, point to the power system separation in continental Europe in January 2021, caused by the tripping of a single busbar coupler in a substation in Croatia. Or the blackout affecting parts of Athens in February of the same year, due to a circuit breaker failure at a substation owned by the transmission system operator. Or a similar event that left midtown Manhattan in the dark in July 2019.

A Holistic Approach to Substation Life-Cycle Management

While substations evolve, so should the approach to their maintenance. Moving away from heavy current and voltage sensors toward distributed intelligent electronic devices (IEDs) and from signaling copper wires toward fiber optic communication brings significant improvements. However, it requires a more sophisticated maintenance approach that can benefit old and new substations alike.

This new approach to substation maintenance is made possible by the growing convergence of IT and OT. New technology used at substations generates a wealth of information that was unavailable in the past. If age and service life alone do not suffice as indicators, then all sorts of information must be captured, from the asset's operating environment and maintenance history to real-time information on the asset's health status. Against this backdrop of aging assets and a retiring technical workforce, this new approach will need to be holistic, encompassing all available tools and techniques. Alternatives to human-based activity will need to embed the accumulated experience of these skilled, experienced, and hence invaluable workers.

Going Beyond Software (or Hardware) Only

It should be clear by now how challenging substation maintenance has become due to diverse underlying factors. Traditional break-fix maintenance is not only obsolete but also tremendously costly given the advances in technology. High upfront costs act as a deterrent to new investments, so deferring them by optimizing the reliability of the existing assets is even more necessary now than in the past. The questions that asset owners face have largely remained the same over time, even though the answers could now look very different: How can a fault be prevented? What can be done to extend the life cycle of my asset?

These questions may not be easy to answer. The disruptive events related to substation failures perfectly demonstrate that current approaches are far from optimal. They also show that simply arming asset owners with a piece of software for asset performance management (APM) may not be enough when setting out to implement a truly resilient maintenance strategy.

In this context, substation owners should acknowledge the need for expert support. The stakes are too high for them to blindly put all their hopes on internal know-how. This is not always available, especially among datacenter operators or small industrial players, for example, and often fails to address the long-term needs of maintenance planning.

A long-term partnership with a specialized provider can remedy these shortcomings. Taking the necessary steps to move from a corrective to a preventive or even predictive and (ideally) prescriptive maintenance strategy is a great example of how human expertise is still core. This paradigm shift requires more than just the use of advanced analytics and AI. It requires a detailed risk assessment based not only on the evaluation of a substation's current health but also factors like its criticality and the cost of an outage. And it should lead to the structuring of a targeted maintenance plan prioritizing actions and assigning them to those executing them.

Considering Wipro's Grid Modernization Services

Wipro's expertise in the electricity transmission and distribution domain, utilities' IT/OT systems, and connected network/asset framework helps its customers to build low-cost solutions to bring distributed asset and network data into one single digital information platform.

The Next Phase of Substation Maintenance

There is an even greater need now for advanced asset maintenance capabilities to efficiently operate substations. To achieve operational excellence, substation owners will need to continue to ensure safety and service standards while "sweating" assets has become more and more common. On their way to designing a comprehensive approach that goes beyond assets only, substation owners must consider all processes, tools, and people involved in maintenance. The following approach summarizes how Wipro helps its clients optimize the reliability of their substations via a comprehensive solution working closely with its platform partnership ecosystem.

Accumulated Experience at the Service of the Clients

Wipro's solution approach combines a platform partnership contract with APM software for OEMs. The goal is to enable the asset and O&M managers to improve substation performance throughout the asset life cycle. The process starts with modeling the substations and their surrounding network by applying a reliability-centered maintenance methodology and by using advanced analytics. Next, the maintenance policies are tailored to the client's needs, taking into account budget planning and resource allocation. Wipro's solution approach also enables the substation owners to continuously improve maintenance processes thanks to a systematic process of data collection. Access to remote application support by an expert is provided by the platform OEM, while Wipro subject-matter experts (SMEs) are available to build up the competency of the client's workforce via training.

A Strong Technical Foundation

As far as the different solution deployment models are concerned, APM systems can be implemented on the client's infrastructure or by using platform services hosted by OEMs as SaaS (or even in a hybrid deployment). These can interface with the ERP and SCADA, which enriches the risk profiling of the substation, based on asset technology, maintenance records, and operational aspects. Adding to the mix a failure modes and effects analysis (FMEA) to assess the impact of the potential unavailability of the asset enables the creation of a risk matrix of failure severity versus occurrence. This is the starting point for outlining a proactive and predictive/

prescriptive, reliability-centered maintenance strategy. APM system users are typically empowered by customizable dashboards and periodical reporting as well as a maintenance process that is completely paperless.

Meeting the Challenges

Historically, grid operators have kept the competence and responsibility for grid maintenance within the organization, rather than outsourcing it. These companies have developed internal know-how that third parties cannot always match. To penetrate the utility market, Wipro is prioritizing companies that are particularly affected by competence attrition or those that never had a strong track record of in-house, reliable substation operation. The entry of non-utilities in the renewable energy space, for example, indirectly expands Wipro's addressable market.

Wipro has invested considerably to build homegrown platforms (such as Looking Glass [LG], Cognitive Energy Intelligence [CEI], and i-Connect), invest in or acquire firms with relevant products and expertise (such as Designit, Artizon, Appirio, and Capco), and develop a global partner ecosystem with platform and solution providers (such as Microsoft, Amazon, Hitachi Energy, Siemens, GE, Oracle, and Schneider Electric). This strongly positions the company with customers, who can leverage these end-to-end products and services to build their next-generation digital asset management capabilities.

IDC Recommendations for Tech Buyers

Substation owners (such as grid operators, industrial entities, or datacenters) should consider the following recommendations when designing their maintenance strategies:

- **Ensure substation maintenance becomes part of a larger IT/OT convergence initiative.** Issues with legacy technology and its compatibility with newer applications, as well as security, are major concerns for utilities (and beyond) when it comes to bringing together the two worlds. But the improvements in operational performance more than make up for any disadvantages you might encounter. In that regard, substation maintenance should be part of a broader program that includes all your assets.
- **Invest in maintenance early to avoid high costs later.** Early complacency usually results in costs down the road, as your asset grows older. A well-designed maintenance strategy helps reduce and discount future costly interventions, enabling better planning.
- **Distinguish ongoing from targeted maintenance.** The substitution of a component (e.g., a protective relay) after a routine check is not to be confused with the targeted maintenance of the transformer's insulation, the breakdown of which can lead to damages in the winding. Assessing the severity of a potential failure requires a thorough FMEA. While this can be carried out by software, deciding whether an upgrade or replacement is due requires human expertise. In any case, your maintenance strategy should not be reactive, but proactive.

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About the Analyst

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Jean-François Segalotto is associate research director for IDC Energy Insights in Europe. His research provides full coverage of the utility value chain, covering a wide range of industry-specific themes, including smart grids, the Internet of Things, connectivity and networks, emobility, and business systems supporting smart customer operations and digital transformation.

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