Automation in Electricity Grid

The first rule of any technology used in a business is that automation applied to an efficient operation will magnify the efficiency. The second is that automation applied to an inefficient operation will magnify the inefficiency.
- Bill Gates

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What is Automation

The General understanding is that Automation is the use of technology to perform tasks with reduced human assistance. Automation is the application of technology, programs, robotics or process to achieve outcomes with minimal human input as IBM defines it.

With respect to Automation in the Electricity Grid we can define Automation as "the creation and application of technology to monitor and control the production and delivery of electricity and related services, with minimal human intervention."

Why Automation

This question has been one of the most debated between Conventional operators who managed the legacy systems efficiently and planners and technologists who look to the growth of this vital infrastructure, and into the future. A simple answer would be that Automation reduces time, effort and cost, whilst reducing manual errors, giving our business more time to focus on our primary objectives.

Accomplish processes that can't be done manually

Operational technology (OT) automation tools allow us to do a wide variety of things that simply can't be done manually. For example, isolating a fault in the electricity network and resuming power in the rest of the network, can be time-consuming and requires highly skilled, hands-on knowledge.

Keep pace with increasing infrastructure scale

Infrastructure needs tend to grow more quickly than the organisation or the sector, who have to create and maintain it, so it's often a struggle to manage new requirements with existing staffing levels. Automation tools such as Sub-station Automation Systems, Generation Management systems, Energy Management systems (Transmission) and Distribution Management Systems (DMS) will help our existing teams handle increasing infrastructure and operational requirements by streamlining information and control through a vast array of tasks, reports and processes.

Integrate and deploy power with zero tending downtime

Fast and reliable operations is increasingly important as the sector dives deeper into more complex and dense networks. Isolation of faults in the Transmission network using intelligent Electronic Devices, and SAS coupled with intelligence from SCADA systems, Isolation of faults in Distribution network using the function Fault location, isolation, and service restoration (FLISR) as a part of the Distribution Management system are a few which reduce downtime. Integrated operations of Generation, transmission and Distribution will be the need of the future and more so with integration to decentralized generation, micorgrids and EVs.

Streamline power restoration processes

When system faults happen, it's vital to detect and contain those as quickly as possible. Remediation can be complicated with complex networks and time-consuming and applying fixes manually can be error-prone. Automation functions will help reduce the downtime, maintain Grid security and increase revenue

Make more time to focus on high-value initiatives

Automating a few of Generation, Transmission and Distribution processes can help reduce the amount of time, operational teams have to spend on repetitive, tedious, manual processes which has a bearing both on customer service as well as revenue earned. Automating these tasks, give them more time to focus on higher value strategic processes and operations to move towards more effective and efficient operations.

Stay ahead of operational complexities and costs

Automation helps us streamline and manage complex environments in Generation, Transmission and Distribution, while also providing operational analytics that can help us better understand and reduce the costs involved. With an end-to-end integrated platform, we can also reduce complexity by delivering new automation consistently, and by sharing best practices and content across the organization.

Transform our organization into a highly agile, instantly scalable, future-proof success story

Organizations that embrace and adopt an "automation-first" culture can save time, save money, and have more time to focus on higher impact strategic initiatives. When Operational technology automation becomes second nature within our organization, our teams will be able to handle operational and security issues faster, scale up to take advantage of new opportunities more quickly, and experiment more efficiently.

Simply put, an automation-first culture saves time and money while fostering continuous learning, experimentation and innovation

Automation in Power sector

The legacy grid, based on a central generation, transmission and distribution model, was not architected to support modern-day electricity needs—whether accommodating peak demands for unpredictable renewable energy sources like wind and solar, or driving the burgeoning market for electric vehicles (EVs)

At the same time, there is growing worldwide attention to extending electricity access to a much larger population. Global electricity generation is forecasted to grow by 2.3 percent annually over the next decade at the same time as global electricity use is rising by 26 percent.

There are other factors at play as well. Technology innovation in areas like miniaturization, digitalization, energy storage and pervasive networking are enabling a shift away from centrally located power generation to a decentralized model. Power generation needs would be distributed and handled much closer to where demand is, at the edge of networks, helping to increase efficiency and optimize energy usage. New offerings in areas like microgrids, Distributed Energy Management Software and IIoT-enabled predictive analytics are leading a sustained and protracted effort to transform the legacy grid into something that is smarter, more resilient and more sustainable in an effort to meet next-generation electricity needs.

Being able to accommodate energy created in a more decentralized fashion is the story of a more complex grid. ***And Automation is the key to unlocking the ability to operate in this world of more complexity."***

Limitation of today's grid

The traditional Grid architecture is a large-scale centralized generation that operates remotely from consumers with limited energy storage, passive loads and no ability for two-way communications.
A modern grid, in contrast, requires the ability to dynamically optimize operations and energy sources, rapidly detect and mitigate any disruptions or disturbances, and integrate hybrid energy sources. At the same time, the modern grid should enable consumers to manage their own electricity use so they can play a part in energy optimization and reduction of costs.

There could be a ton of energy towards the edge of the grid, so the ability to flow that back to a substation and on to a larger transmission grid used in another location is a huge opportunity.
But the grid was never designed to do this— it's all about centralized generation and transmission, never a multi- or bi-directional flow."

The Technology pieces

Transformation of the electric grid starts with digitization, retrofitting or replacing components such as transformers or meters with sensors and greater network connectivity to add situational awareness to the asset to better understand its operation.

Next step is implementing automation technology—everything from predictive analytics and smart controls—to optimize the asset and enable a proactive response to avert potential downtime or maximize performance. A host of GMS and EMS functions will help achieve this.

"As the world becomes more digitalized, it has a profound effect on how we think about electricity and creates a layer of knowledge that allows us to think about energy in new ways,"

Distribution management systems (DMS) will play key roles in grid modernization. They combined with SCADA provide the desired visibility, identify and isolate faults, managing switching, facility outage management and bring the required customer connect.

Microgrids are considered a more efficient way to distribute energy to local sources and can also function as a backup "island mode" source in case of a power outage or disruption on the larger grid. An array of Automation technology services that includes advanced edge controls and remote connected optimization services, help to implement microgrids by utilities, government facilities and manufacturers to enhance resiliency and gain energy independence and efficiency.

"As you begin to digitize the energy value chain, consumers can think about how much resiliency, sustainability and cost matters to them, and solve for outcomes."

Challenges to Grid automation

Today, utility companies can invest in several types of technologies, including equipment-health-monitoring sensors, smart capacitor banks, and new grid-scale storage projects. common pitfalls utilities face when determining where to make these investments:

- A quantified value proposition is not clearly articulated. Evolving grid outcomes (such as flexibility, resiliency, and security) have yet to be defined in power sector-accepted terms, which are necessary for fact-based discussions on value. Many utilities either over plan or under plan which affects the system either way
- Investments are not linked to specific use cases. Without working on a used case, utilities tend to invest in automation assets. The ability to target demonstrated needs is critical to avoid investing in stranded assets.
- Investment programs are siloed. Many stakeholders—such as customer-facing teams, operational units, regulatory bodies, and OT companies—are frequently not involved in the development of investment programs. Grid investments and other business areas are substantially interdependent; failure to document and consider these interdependencies can result in poor implementation plans.
- Insufficient resources are allocated to development and execution of grid-modernization plans. Investments that contribute to strategic-capability goals must be prioritized, and necessary resources allocated, whereas those that are irrelevant should be scrubbed from the capital plan.
- Enterprise IT and OT systems and platforms are rigid and monolithic. While hardware such as digital relays and smart meters are widely deployed, underlying software systems are frequently not designed to handle the volume of data streamed from the field. The SAMAST programme may address this. However, SCADA systems deployed without planned information storage and retrieval, inadequate situational awareness functions, and inability to utilise cross functional data is something which the utilities fail to notice.

Approach to Automation

1. Utilities to set top-down priorities

Utilities have previously used simple and well-understood compacts to justify their grid investments: in exchange for building a reliable electric grid, utilities' stakeholders would approve their projects and guarantee a return on the capital invested. Utilities have specific metrics to track reliability (such as SAIDI/SAIFI), and stakeholder expectations centered on a continual improvement in these metrics. In other words, more capital investment meant greater reliability for their customers and communities.

Today, a safe electric grid continues to be table stakes, but customers' expectations around resilience, security, and flexibility have changed. This evolution represents not only an opportunity for utilities to deliver expanded outcomes and benefits to their customers but also a challenge to define the relationship between investments and what customers can expect.

Utilities have struggled both to explain new value propositions and to clearly link them to customer demands and needs. As a starting point, they should sharpen their articulation of what outcomes their proposed programs will provide. "Grid modernization" or "Grid Automation" is an imprecise term that can mean different things to different stakeholders; the first step for utility companies to get regulators and consumers on board is to pin down exactly what utilities mean by "modernization" or "Automation".

2. Define foundational investments

Capabilities are not binary. Some may become more mature and widespread across the grid over time. Monitoring and control (SCADA) for example, are universally foundational. Thus, most utilities must have basic monitoring and control capabilities already in place, but many seek to grow maturity over time

Utilities must determine how advanced these capabilities need to become, but they must also consider timing. Doing so can ensure utilities invest at an appropriate pace to build their capabilities as needed. How mature each capability should be—and how comprehensively deployed across the grid—depends on the specific characteristics of the grid and the customer segment it serves. For example, utilities with significant amounts of commercial and industrial customers with EVs and distributed generation might require probabilistic, scenario-based planning for each distribution circuit. For others, such a capability might not be needed in the next five to ten years.

Understanding the foundational investments required can be difficult, as they are often not tied to a specific grid circuit or asset. Utilities should work with subject-matter experts and line leaders to diagnose weaknesses in existing foundational workflows—such as grid planning, asset design, control-room operations, and field and emergency operations.

3. Size and prioritize physical-device investments

Grid-modernization and automation programs tend to cover the deployment of millions of field devices. These monitoring and control devices include smart digital substations, next-generation smart meters, and distribution automation devices (reclosers or sectionalizers). What goes unmentioned, however, is that other programs focus on retrofitting obsolete designs, such as upgrading substations and feeders to higher voltage levels and or line improvement programmes.

Regardless of the type of investment, our research shows that the best approach is bundling investments in packages that achieve a common outcome. For example, feeder undergrounding can serve higher levels of resilience, while sectionalizing feeders achieves higher reliability. An investment package can therefore be sized based on a target level of device penetration and subsequently prioritized based on quantifiable outcomes achieved for the customer versus the cost of each package.

4. Articulate the plan's value

Most plan rejections across the country are rooted in insufficient documentation of ratepayer benefits, as compared with cost implications. This trend will likely persist—unless utilities articulate the value of all ratepayer outcomes and, if necessary, commit to targets enabled by their plans.

Grid-Automation plans are frequently more than the sum of their parts. ... Painting the whole picture can make utilities more successful, and frequently more accountable, for regulators and stakeholders alike.

Automation components

Automation components vary with the need, plan and approach towards modernization. Essentially, the power system field equipment should be automation ready. This necessitates the switchgear and line and underground cable in case of Distribution networks and the Receiving stations or sub-stations of respective voltage levels of Transmission network to be adaptable to automation requirements.

Primarily the Automation system is placed on the field system with monitoring and control devices like sensors and related devices, which gather the data and extend control. A reliable two way communication system is necessary to connect these devices to Control system (in a broader sense). The control system would be a set of hardware housing relevant software to gather, display, process and provide data, information and wisdom for all stakeholders would be the last bit. A number of such Automation systems could be integrated to form a comprehensive system.

Final word

Given the scope of what's required, the electricity grid's makeover is going to be a slow-moving transformation. Beyond the obvious technology challenges, there is the question of where the capital comes from to fund these massive upgrades and retrofits—a hurdle underscoring the importance of public/private partnerships.

"This is not a world where you can rip and replace everything out there," "The grid will be upgraded in a piecemeal fashion as it is fortified for the future."

"It's not possible to codify in rules all the possible scenarios on a second-by-second basis, "Managing all the data in real time is increasingly complicated. And, ultimately, machine learning is the only way to deliver models that govern all scenarios effectively."