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## Embrace Your Inner Grid

### INSIDE

- Cut Capital & Operating Costs
- Boost Plant Reliability
- Trim Energy Use

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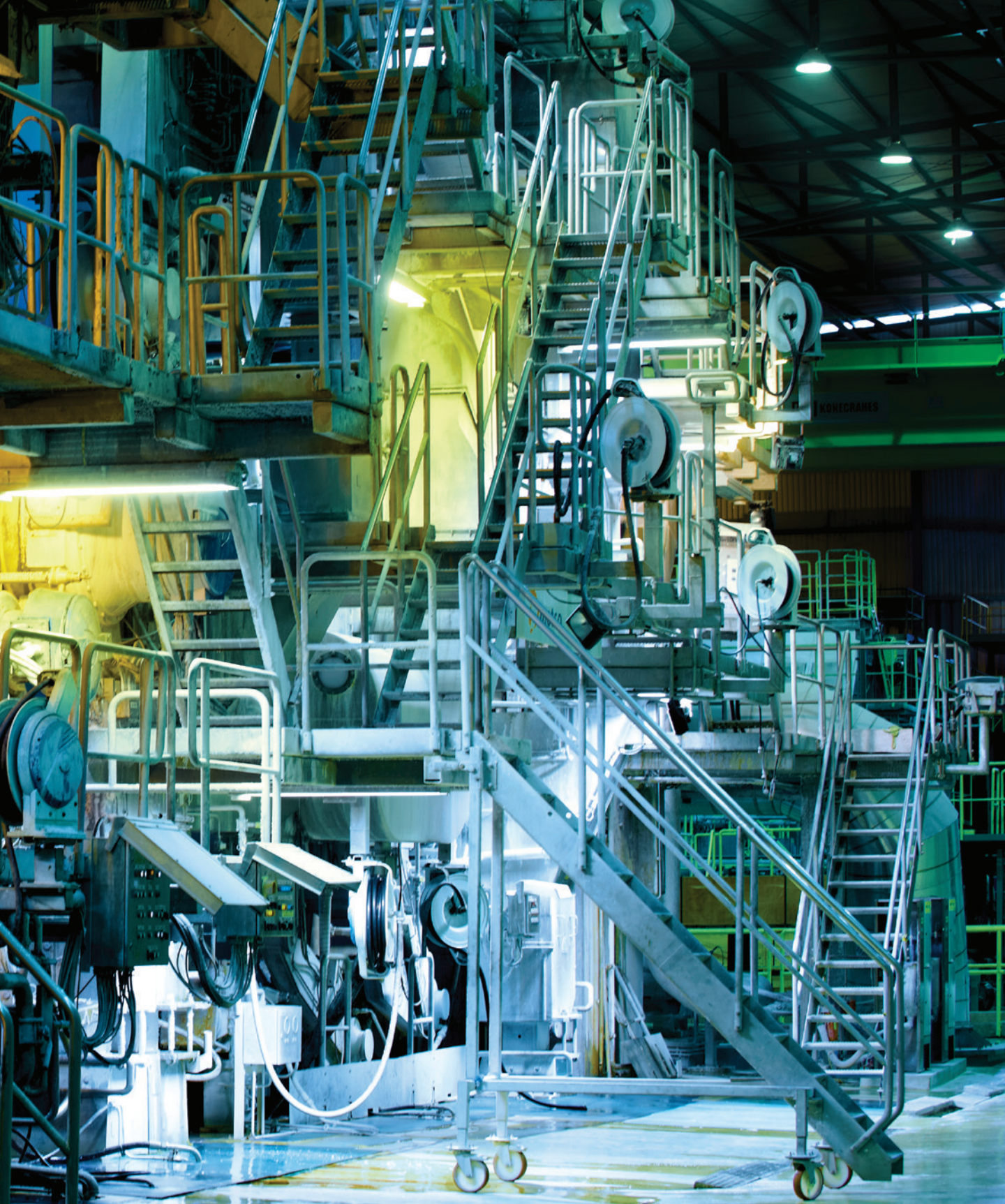
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# Embrace Your Inner Grid

Advancing communication standards, converging platforms make it easier than ever to unify process automation and electrical systems

**I**t's always been difficult to argue against the motherhood and apple pie of integrated systems. A vision of on-demand data flowing freely among formerly isolated information silos is easy. Building and maintaining the custom interfaces often needed to realize the vision is hard.

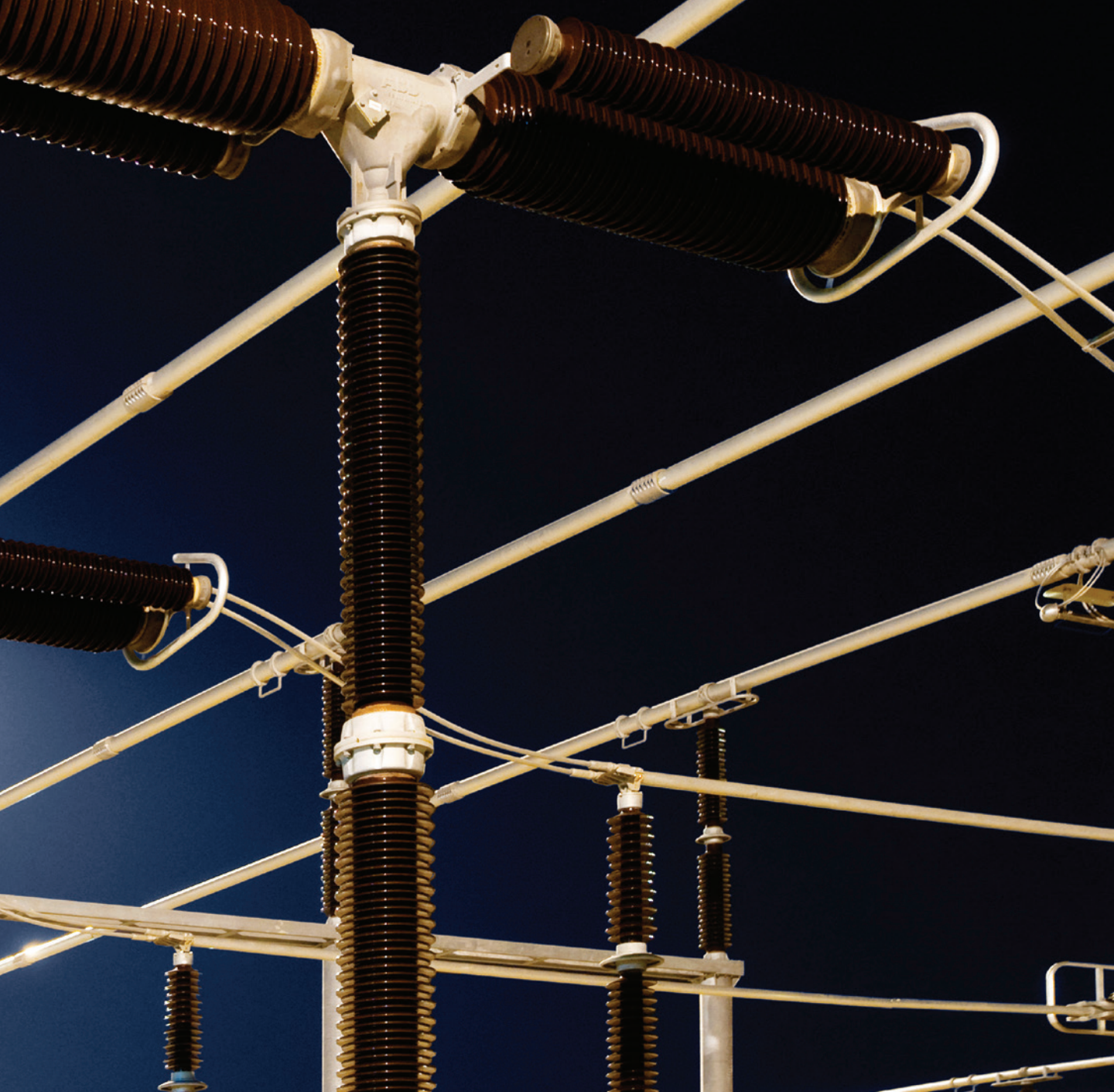
But one by one, the architectural barriers to painless information integration are coming down. In this special report, we'll focus in particular on the convergence of communication protocols and underlying technologies in the arenas of process automation and electrical controls, and how this convergence is allowing a growing number of industrial companies

to reduce capital costs and operating expenses even as they improve overall plant reliability and energy efficiency.

## **TWO WORLDS, TWO SYSTEMS**

Electrical energy is a vital input to process manufacturing operations, often secondary only to raw materials. And, just as the flow of process fluids through pipes, valves and vessels typically is controlled by a dedicated process automation system, the flow of electrons through transformers, circuit breakers and motors is the domain of a dedicated electrical control system.

In a traditional plant, both types of systems work



largely independently to ensure safe, uninterrupted production. Indeed, the differing dynamics of electrical and process phenomena has led over the years to the development of parallel systems, suppliers and support organizations for each type of system.

Typically, the process draws what power it needs according to operational setpoints from the process automation system, and the electrical control system strives to meet those requirements in a safe, stable fashion. If there's any coordination at all between the two systems beyond manual intervention, hard-wired I/O or custom interfaces are used to swap a few key variables or interlocks. Significant effort

and considerable expense are required to establish and maintain even this limited connectivity in good working order.

#### **GRID STANDARDS WITH IN-PLANT IMPLICATIONS**

Even as process industry management demands for improved visibility into real-time energy usage escalated over recent years in response to increasingly volatile energy prices, the electrical power transmission and distribution industry was developing a way for substation automation systems and other intelligent electronic devices (IED) to communicate and interoperate, regardless of manufacturer. The end result, first approved in 2004,



Engineering costs

Training costs

Installation costs

## Petrobras project savings due to integrated process and power systems.

is standard 61850 of the International Electrotechnical Commission (IEC). See sidebar below for more details.

And while transmission and distribution systems were the primary target users of IEC 61850, the standard also has allowed system providers to bring added functionality to their integrated process and power offerings. ABB, for example, a global leader in both process automation and electrical systems, integrated IEC 61850 into its System 800xA to provide a single, unified control and optimization platform for all of a plant's process automation and electrification needs.

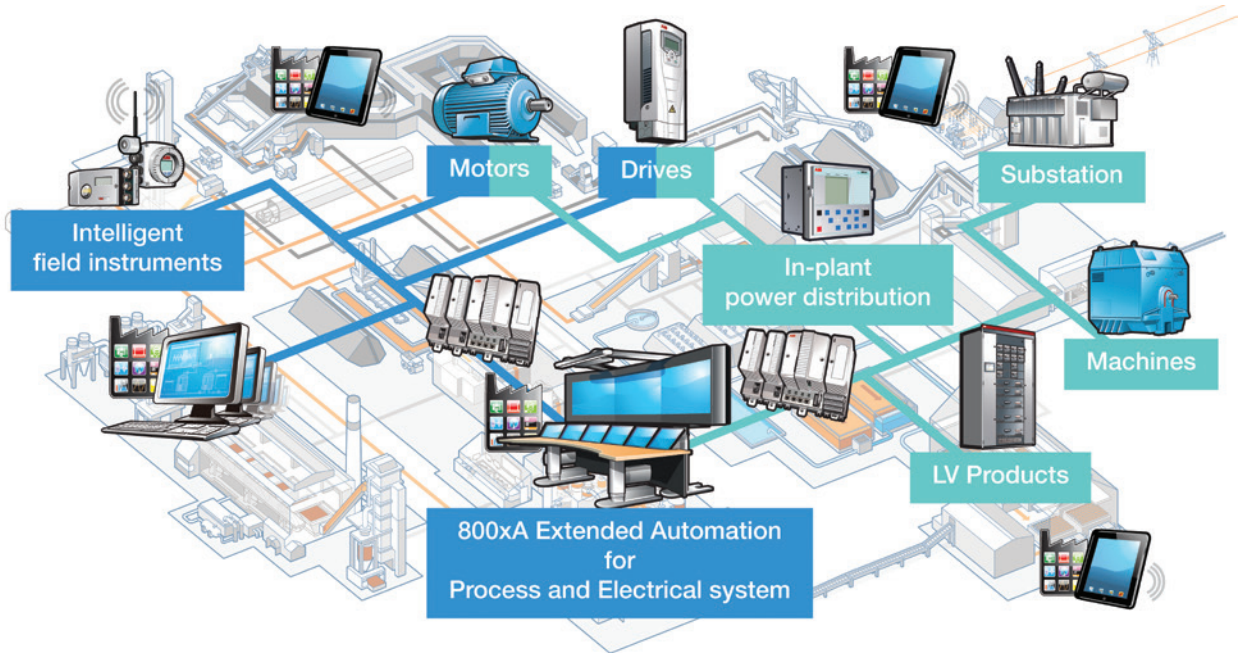
### AN ORIENTATION TO THE POWER INDUSTRY'S IEC 61850 STANDARD

First issued in 2004, standard 61850 of the International Electrotechnical Commission (IEC 61850) was created by the electric power industry to facilitate the communication and interoperability of the intelligent electronic devices (IEDs) that increasingly characterize today's power distribution grid.

At the heart of the standard are object-oriented data models designed to facilitate semantic commonality of essential electrical infrastructure functions among disparate systems and devices. The current edition of 61850 also defines an Ethernet-based, high-speed means of communicating generic object-oriented substation events (GOOSE) horizontally among IEDs for interlocks and protection schemes as well as TCP/IP-based MMS for vertical integration into supervisory systems.

And while transmission and distribution systems were the primary target users of IEC 61850, the standard also has important implications for both power generation facilities and other process manufacturing sites. For starters, it's done much to increase the visibility of operating data and diagnostic information from plant electrical assets. Indeed, the operations of many older in-plant substations are still maintained by blind controllers unable to communicate back to operations. Periodic field observations of transformer temperatures and power meter readings attempt to fill this information gap, but the practice is relatively unsafe, unproductive and untimely as well. Electrical integration via IEC 61850, in contrast, provides seamless, control room access to real-time operational data and diagnostics for all integrated system users.

Regardless of their integration with a plant's process automation infrastructure, IEC 61850 represents significant cost savings relative to the extensive hardwiring for IED communication it replaces. Ethernet connectivity means no I/O—and no hardwiring—is required for communication among IEDs. Fewer wires mean fewer terminations, lower installation costs, and improved organization within substation cubicles. Further, fiber optic networks mean that communication links can run closer to busbars without risk of electromagnetic interference.



ABB's integrated approach to in-plant substation automation and process electrification incorporates both process control level protocols such as PROFIBUS, PROFINET and MODBUS as well as MMS and GOOSE messaging specific to IEC 61850.

## INTEGRATION AS MATTER OF COURSE

System controllers from ABB can now function as controllers in both domains, simultaneously speaking (and translating where appropriate) the languages of both process automation and electrification. This means that operational data from in-plant electrical equipment—ranging from high-voltage substations to low-voltage drives and motors—can transparently feed real-time process control and optimization algorithms as well as other plant information systems. For example, motor data and diagnostic information that once was stranded in the process automation system is now readily accessed by the electrical maintenance technicians charged with their upkeep.

In effect, the company's process automation and electrical control systems are now one and the same. Electrical integration isn't an add-on, it's part and parcel of the System 800xA architecture. And not only is this integration delivered cost effectively, the integrated system actually costs less to acquire, engineer and maintain than two dedicated systems.

Leandro Monaco, ABB global product manager for electrical integration, estimates up to 30% investment cost savings relative to a non-integrated, two-control system approach. And at the Presidente Getúlio Vargas (Repar) refinery of Petrobras in Brazil, engineers credit the refinery's integrated process and power systems from ABB with a 30% savings in engineering costs, 15% savings in installation time, and 20% savings in training costs.

## IT'S ALL ABOUT CONTROL

The improved ability to control capital costs and operational expenses is but one facet of the overall performance improvements made possible by a holistic view of plant data and asset information. A unified platform means users gain better control of overall plant productivity, availability and safety as well. Further, as individual drives, motors, breakers and relays reveal the formerly stranded details of their energy usage in real-time, opportunities to control and conserve energy come to the fore.

ABB's Leandro Monaco relates how at one mining company where energy has come to dominate its variable costs, the "new" key performance indicator (KPI) enabled by integrated process and electrical systems is tons/kWh, replacing the traditional production metric of tons/year. This ability to draw a straight line between production output and energy consumption means that the company can now vary production rate at its various mines based on profitability measured directly in the process automation system. "How powerful is that?" Monaco asks.

In each of the three articles that form the balance of this special report, we'll explore in greater detail the operational advantages of ABB's integrated approach to process automation and electrical controls. We'll explain why embracing your plant's inner grid makes sense from the perspectives of operational and capital expense savings, improved plant performance, and real-time energy management, too. ■

# Consolidate Control Costs with a Unified System

An integrated approach means lower costs for both process and power automation needs



Integration projects most often are justified as investments that pay off over time. Those shiny new communication interfaces and that extra engineering work promise to be worth it because of improvements to come down the line in productivity, visibility and readier decision-making. But sometimes a system supplier's integrated approach can also mean lower initial costs that pay off immediately—in hardware, in software, in engineering hours—compared with the old way of doing things.

With ABB's System 800xA, system designers and end users gain access to an electrical control and process automation system that comes effectively "pre-integrated" and tested. Greenfield plants and brownfield retrofits can both have their cake and eat it too, reducing upfront costs even as operational

savings and performance benefits accrue over time.

As the domain of electrical control has come to rely on Ethernet and other standard, non-proprietary network protocols over recent years, system suppliers such as ABB have in turn been able to eliminate many of the hardwired connections and custom interfaces necessary only a few years ago.

Ethernet-based connectivity means no I/O—and no hardwiring—is required for communication among intelligent electronic devices (IEDs) as well. At one large industrial facility, peer-to-peer networking of IEDs cut an estimated 110 kilometers of cabling. And for a refinery retrofit, 24 marshalling cabinets were eliminated in favor of a single cubicle. Fewer wires also mean fewer terminations, lower installation costs, and improved organization within





substation cubicles. Further, fiber optic networks mean that communication links can run closer to busbars without risk of electromagnetic interference.

### **ENGINEERING, TEST EFFORT STREAMLINED**

All this means reduced hardware, installation and commissioning costs as well as streamlined system engineering effort. Fewer representative configurations, or typicals, can be more safely tested and commissioned back at the switchgear assembler or factory rather than at the plant site. Indeed, adoption of a “bay typical” philosophy can substantially reduce factory acceptance test (FAT) and commissioning time, according to Leandro Monaco, ABB global product manager for electrical integration. “It took perhaps a full day to test a first bay typical,” Monaco says of a

recent project. “But after that we could test eight others of the same typical in a single day.”

Future system flexibility also improves. For example, even after the plant is up and running, IEC 61850 enables GOOSE-based interlocking among switchgear cubicles to be added through software configuration—saving time and keeping workers out of harm’s way. Plus, any late configuration changes can be readily replicated via software across multiple typicals.

ABB’s Monaco relates how in one recent project, the ability of IEC 61850 networks to gracefully accommodate on-the-fly engineering changes helped to avoid a lengthy commissioning delay. The electrical team realized during commissioning that one critical interlock between the transformer and incomer bays was missing, affecting all 30

medium voltage transformers on site. To overcome the problem, engineers simply mapped two GOOSE variables between the transformer IED and incomer IED. The change was tested and then replicated over the network to all of the IEDs involved.

Alternatively, 60 I/O points would have needed to be hardwired (two for each transformer), including the addition of new I/O modules or the changing out of several already tested IEDs that didn't have spare I/O capacity. With IEC 61850 networking, this late change took an hour; without IEC 61850 networking, the delay would likely have run into days.

Meanwhile, most process automation system architectures in use today already use Ethernet for controller communications and for integration with host-level systems. This Ethernet backbone complements automation-specific protocols such as PROFINET, PROFIBUS and FOUNDATION fieldbus for digital field device integration. With both process automation and electrical control systems converging on Ethernet, then, it's not too hard to envision a system like ABB's System 800xA, wherein IEDs and process controllers are part of a common communications infrastructure. And while an Ethernet physical layer is the common thread, network management technology such as virtual local area networks (VLANs) are used to appropriately segment and secure network traffic.

### **SMALLER FOOTPRINT, FEWER SPARES**

Such a unified system yields immediate cost benefits in terms of system footprint. Floor space is often a critically important consideration for space-constrained applications such as off-shore oil and gas platforms, and for plant expansions and retrofits where new equipment may need to abide by the

constraints of pre-existing cabinets and control rooms.

A unified host-level architecture also means that both process and electrical data can be presented on the same engineering, operator and maintenance workstations, possibly reducing the number of consoles necessary while simultaneously boosting the flexibility and capabilities of those that remain.

Inventory costs are reduced, since fewer types of common spare parts are needed. Common engineering and configuration tools mean less training and higher productivity for system designers as well.

### **SPEEDIER PROJECT EXECUTION**

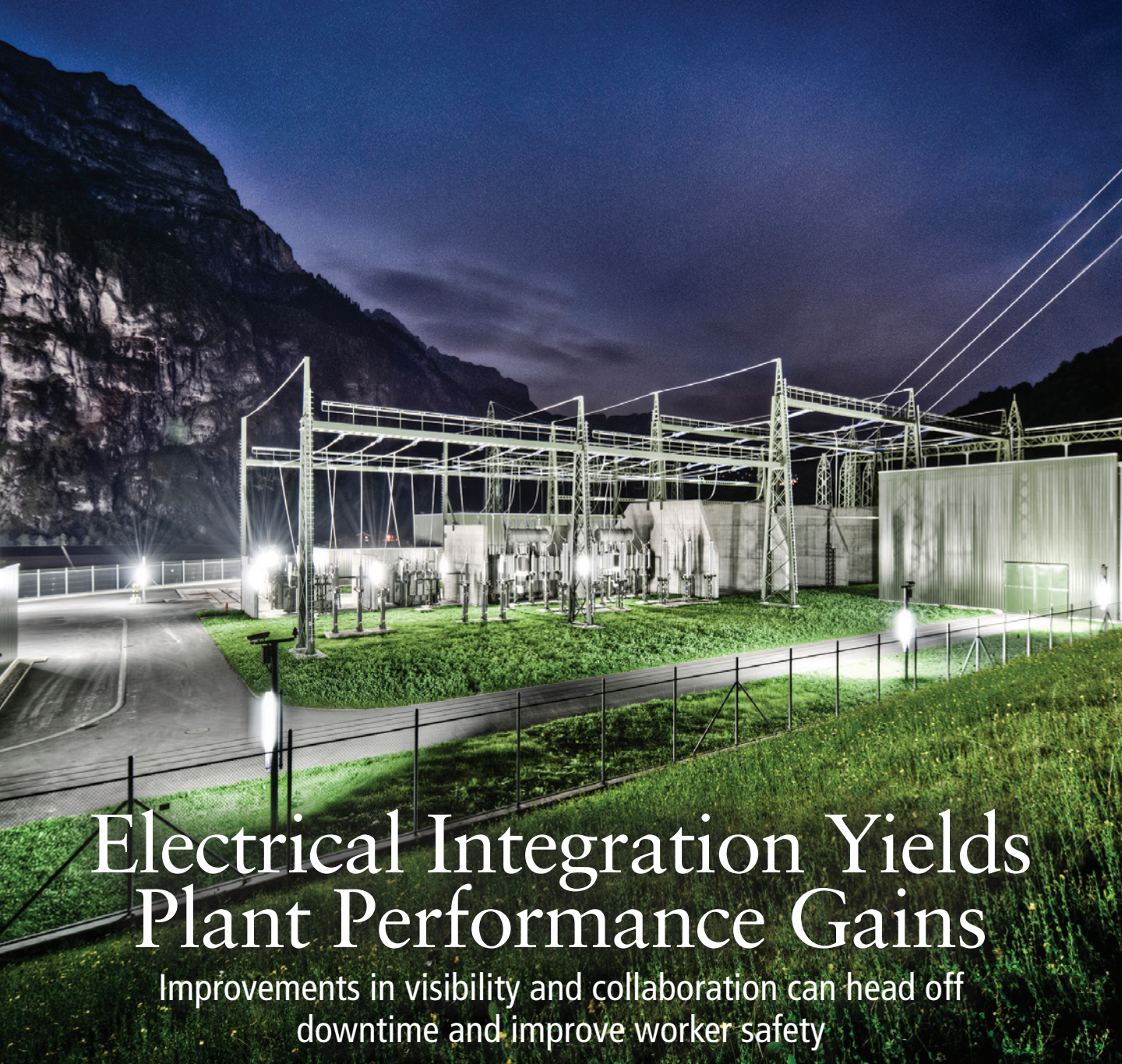
Less engineering, installation and commissioning effort also added up to speedier project execution for E.ON's hydroelectric power plant in Flåsjö, Sweden. The ability to quickly and cost-effectively retrofit the site's aging electrical and process automation systems with an integrated system was key to ABB winning the recent project, the first in a comprehensive overhaul of E.ON's hydroelectric plants along the Ljungan River.

Only six months elapsed from when the contract was signed until the new system was up and running at Flåsjö. Now, the plant's single, integrated system consists of a unified user interface, a common toolset, and a new connection to the company's remote control center in Sundsvall. The unified System 800xA implementation, which among other things handles turbine control and vibration monitoring, now provides remote access to substation data such as reactive power, voltage and current as well. And, when something does need human intervention, maintenance crews arrive equipped with the information, tools, and spare parts they need to effect a complete and rapid fix. ■

### **FIELDBUS: THE ULTIMATE IN I/O FLEXIBILITY**

Over the past several years, the ability to configure analog input/output (I/O) module channels on an individual basis has been promoted in process automation circles as a new way to both increase system flexibility and accommodate late engineering changes in the course of project work. Configurable, single-channel analog I/O is one way of addressing the issue. But if you have the chance, why not do away with old analog I/O altogether?

Fully digital field networks such as FOUNDATION, PROFIBUS/PROFINET and IEC 61850 extend your plant's digital communication infrastructure all the way down to the individual transmitter, motor or protective relay. Indeed, millions of fieldbus nodes have been installed since the late 1980s and, like configurable I/O, digital fieldbuses allow for individual channel assignment at the time of installation—without the need for any additional characterization hardware. Importantly, digital fieldbuses communicate non-process variable information much more quickly than do hybrid analog/digital loops with piggybacked HART signals, significantly improving the ability to implement control strategies that closely coordinate process and electrical system tasks.



# Electrical Integration Yields Plant Performance Gains

Improvements in visibility and collaboration can head off downtime and improve worker safety

**W**hile consolidating electrical control and process automation functions under a single integrated system brings clear cost benefits, it can also deliver significant improvements in overall plant performance. With added visibility into electrical equipment and access to historical data, routine preventive maintenance measures yield to predictive, condition-based activities that take into account the status of both process and electrical assets. And when equipment does need attention, easy access to more complete information means it can be repaired and brought back on line more quickly. Further, remote access to electrical system data enabled by IEC 61850 networks means that many electrical system fixes and configuration changes can be applied and replicated

over the network—keeping workers well clear of potentially hazardous situations.

In addition to providing an expanded and more textured view of a plant's maintenance needs, electrical integration can bring together process operators and electrical power specialists. Together, with a unified set of visualization and system management tools, they can better understand the interdependencies between process and power subsystems and can make more informed, big-picture decisions. In total, improved visibility and collaboration across operations, power and maintenance organizations add up to higher plant availability, improved worker safety and optimized control strategies and procedures that leverage both real-time process and electrical data.



## COORDINATE AND COLLABORATE

In traditional multiple-system plants, operators and maintenance personnel often make critical decisions in silos. They have a limited view of the plant, with knowledge and visibility restricted to just one domain—their own system environment, their own asset database, and their own alarm and event lists with different time synchronization bases. Separate electrical system, maintenance and operations consoles—often in different control rooms—create additional physical and cultural barriers to the common goal of overall plant optimization.

Increasingly though, modern plants are moving to centralized control rooms where process operators, power engineers, and maintenance personnel work together more closely. A common, plant-wide system for process automation and electrical control system tasks helps to further promote collaboration and a consistent operating philosophy across functions. This can help reduce risk, increase uptime and optimize overall decision-making by all.

With one integrated system, all personnel access process and power data through a common interface tailored to that individual's particular role. The process operator's screens default to the flows, temperatures and pressures required to control and interact with the process. The power engineer's displays feature key

parameters of the power distribution system. Meanwhile, maintenance professionals see prioritized lists of work orders for both process and electrical equipment, such as medium- and low-voltage motors, that need their most urgent attention. Underneath the hood, however, each system user has full access to all the same process and electrical data and pertinent alerts, including synchronized lists of alarms and events.

ABB, for example, synchronizes and time-stamps all information from the plant's electrical subsystems to the process system. Time-stamping of process events to this same network clock means that operators and engineers no longer need to try to compare unsynchronized event lists from multiple systems to answer the question of exactly what happened when and in what order. Trouble-shooting, error analysis and even response to plant upsets happen more quickly and easily. Shell Oil, for example, has reported a 20% productivity improvement through better operator visibility of plant assets.

The same shared infrastructure that provides a common time basis for network events also facilitates remote system-wide parameterization and configuration. Disturbance records (DRs), too, are captured on the network, eliminating the need for a substation technician to trek into the field, hook up his laptop to the substation in question, and download the latest DRs. Instead, DRs are automatically uploaded to a system



server, eliminating the potential loss of records due to IED buffer overloads. Technicians are able to remotely access and change parameterization and protection logic from any engineering station; faster analysis means faster root-cause analysis and issue resolution.

### **ASSET MANAGEMENT EXTENDED**

The integration of electrical controls into a unified system architecture also extends the scope of asset management strategies, providing a more holistic view of overall plant health—and the prioritization of corrective interventions. Historically, electrical assets in particular have been difficult to instrument in a cost-effective way. As a result, electrical asset maintenance is often neglected until a previously undetected fault begins to impinge on process operations.

But the integrated information architecture typified by ABB's System 800xA leverages open Ethernet standards such as IEC 61850 and PROFINET to monitor the health of all equipment on a plant-wide basis—from an incoming circuit breaker in a plant substation to a temperature transmitter in a process heat exchanger. With an integrated power and process approach, the entire chain of assets that comprise a particular plant operation can be monitored and viewed, analyzed and diagnosed in the context of an integrated whole.

For example, with System 800xA's integrated Asset Optimization solution, maintenance engineers, process control operators and power engineers all have direct access to the information they need to better predict equipment failures and prevent plant upsets. For example, if a circuit breaker is taking too long to open, an alert is automatically generated and sent to the appropriate person for action. With further integration of the plant's computerized maintenance management system (CMMS), a work order can be generated automatically, streamlining maintenance workflows. The System 800xA Engineering Workplace creates one single view of all types of integrated devices, allowing fast and easy access to device diagnostics as well as configuration and parameterization changes.

One global mining company already has achieved significant asset management advances through electrical integration based on ABB System 800xA. A holistic view of equipment health—notably its medium- and low-voltage motors—has helped improve plant availability as well as worker safety. Next up? They're using the system's inherent energy monitoring capabilities to analyze electrical consumption by plant area and individual load, with the goal of improving overall energy efficiency.

### **WHEN DOWNTIME'S AT A PREMIUM**

Whether deployed separately as part of a larger integrated system, the primary objective of a power management system is to avoid blackouts in industrial plants, especially those with in-house generation, critical loads or unpredictable, insufficient supply from the external grid. Load-shedding, for example, is an essential power management function. In the event of a power shortfall, non-critical areas of the plant are shutdown automatically in order to keep critical parts of the plant in operation. Load-shedding also can help to avoid exceeding peak consumption thresholds, strategically ramping back consumption in non-critical areas to avoid punitive surcharges.

As a longstanding leader in this arena, ABB has delivered standalone power management systems based on System 800xA to many industries around the world. And with IEC 61850, load-shedding applications are now easier to design and maintain. They even respond more quickly than the hard-wired solutions they replace. Indeed, the IEC 61850's GOOSE (generic object oriented substation event) messaging has been proven by independent certifier KEMA to respond 12 to 17ms more quickly than hardwired systems. ■



# A Running Start on Total Energy Management

Electrical integration provides all the infrastructure you need to advance conservation measures

In this special report, we've already examined how an integrated approach to electrical controls and process automation can substantially reduce capital and operating expenses while improving overall plant performance. First, an integrated system costs less to acquire, install, commission and maintain over time relative to two standalone systems. Second, an integrated system tears the blinders from formerly isolated decision-makers, allowing them to collaborate more closely, better understand the big picture, and act more quickly, decisively and correctly. Third, and worthy of standalone treatment in this final article, an integrated system provides a ready platform for implementing energy management strategies that advance plant performance in both economic and environmental terms.

Energy management entails the visibility and control of energy usage from the plant-wide level down to the individual load, with the primary purpose of identifying and addressing sources of inefficiency. With ABB's approach to electrical integration, real-time data from the company's entire portfolio of electrical control system components—from substation automation systems and protective relays down to energy consuming devices such as low-voltage drives and motors—is visible across the entire network.

And while the integration of ABB electrical devices into the company's System 800xA provides uniquely productive synergies—such as through pre-written libraries of asset-specific monitoring applications—electrical devices from other manufacturers that are compliant with the open standards



like PROFINET, PROFIBUS and IEC 61850 can be readily integrated into a System 800xA-based energy monitoring application.

### **ENERGY MANAGEMENT 'ALONG FOR THE RIDE'**

In total, implementation of ABB's electrical integration approach means that detailed, real-time information on power consumption down to the individual load is available at the system level. Analysis down to the individual motor level allows plant personnel to pinpoint and address sources of inefficiency that aren't identifiable in area-wide consumption data. For example, if the data shows an individual motor's energy consumption trending upward, a maintenance call can be scheduled automatically.

Plant personnel can see and understand power usage

in a more coordinated manner, allowing the exploration of new energy-saving opportunities and the validation and extension of existing energy-saving initiatives. Better visibility into power consumption and real-time energy usage and costs also allows for easier energy auditing and benchmarking against industry standards.

### **A COMPLETE PICTURE OF ENERGY USAGE**

In a larger context, the integration of electrical controls within the ABB System 800xA architecture can represent the final element of an integrated, holistic view of all energy flows within a plant. As a process automation system, System 800xA is well equipped to corral the necessary flow rates, temperatures and pressures needed to quantify in real time a plant's consumption of fuel and steam as well as energy-intensive plant utilities such as compressed air and process water. The real-time integration of power consumption—in aggregate and in granular detail—delivers the final brushstrokes required for a complete portrait of energy use.

The primacy of energy as a process input even has some industrial operations redefining their key performance indicators (KPIs) in terms of unit energy consumption, rather than overall production rate: in tons of product per kWhr rather than in tons of product per day or year. This KPI, in turn, sometimes has a more direct correlation with plant profitability than does overall production rate. Energy consumption visibility, enabled by an integrated approach to process automation and electrical controls, is making this approach possible.

The Boliden Minerals Aitik open pit mine in Gällivare, Sweden, is among the increasing number of energy-intensive industrial operations leveraging electrical integration to improve its energy efficiency. The mine produces copper along with silver and gold, and in the process consumes roughly 1.5% of Sweden's total power production.

Needless to say, even small increases in energy efficiency add up quickly. Boliden went with ABB to provide one integrated system for its concentrator plant process control and electrical monitoring systems. Operations and maintenance are centralized in a single control room, and the integrated system provides for them a platform to optimize energy consumption, which they view as a competitive imperative.

"It's self-evident for us to closely follow material throughout the process and optimize it," says Mikael Walther, Boliden system technology manager. "Now we do the same with power. Now we are able to study it, map it out, and analyze the connections between production and power consumption." ■



## Process and power automation Better together

It just makes sense. Every industrial process is dependent on power to operate. In order to provide visibility, it's long been the status quo for information from various electrical components to be brought into the automation system through hardwired I/O signals. Using System 800xA's digital fieldbus technologies (IEC 61850, MODBUS TCP, PROFINET, FOUNDATION Fieldbus, Ethernet IP), users can not only import status information without adding to a project's I/O count, but they are afforded better diagnostic and load information, enabling predictive maintenance and opportunities to save energy.

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