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Digitalization and power generation

Evolve, adapt and thrive during the
Energy and Fourth Industrial
Revolutions

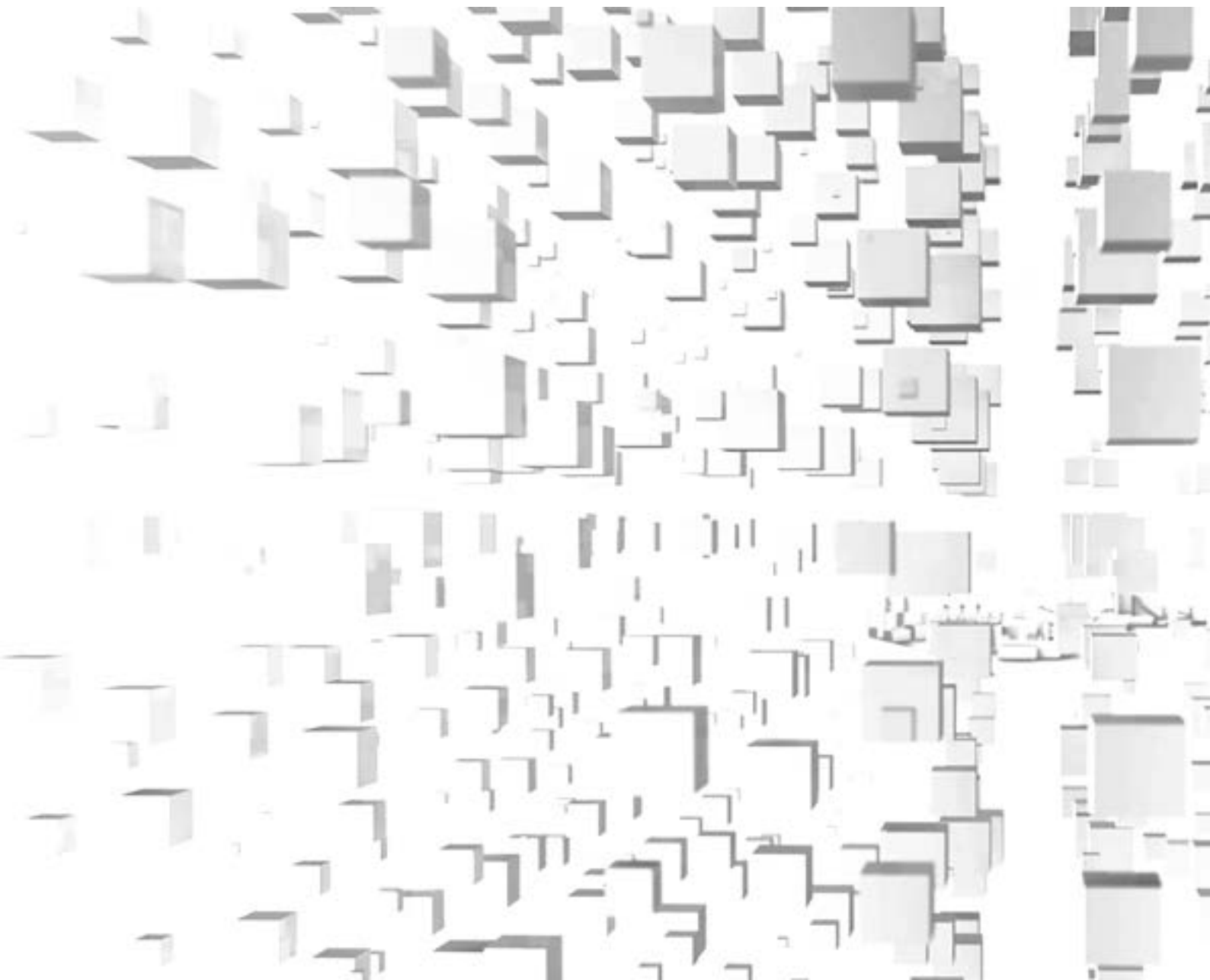


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Introduction

The power industry is in a state of transformation due to the substantive changes that have taken place over the past 20 years, such as deregulation, stricter emissions requirements and the significant addition of renewable capacity into the generation mix.

The increasing complexity that these changes make to the business environment is most effectively managed through the adoption of advanced digital solutions that best engage with the people, processes and technologies involved.

Digital technologies allow power generators to better manage process and automation know-how; gain visibility and insights into the performance of equipment, plants and fleets to enhance decision-making; and ultimately, to find new ways to operate more competitively in the changing power market.

From conventional power generation, including coal, gas, combined cycle, nuclear, hydro and waste-to-energy, to renewables like biomass, solar, tidal and wave, each sector and business has its own priorities and challenges. These include heavy investment in improving the performance of legacy equipment, gaining greater access to expertise in remote geographies and automating compliance reporting.

Power generators need digital solutions to solve specific business challenges in a scalable way - eg, that can be extended across fleets or assets - to deliver real and measurable benefits, sustainable over both the short and long term.

There is no 'one size fits all' approach to implementing digital solutions. It takes significant industry expertise, a deep knowledge of the market context and understanding of the power generation process.

Sustainable progress for the power generation industry can only be achieved through a close, collaborative relationship between technology partners and decision-makers.

At ABB we work hand in hand with our customers to understand both their current situation and

their future needs in evolving market conditions. This provides us with the insights necessary to apply our leading industry, technology and digital expertise and solutions.

Our customers have diverse technology stacks, combining equipment from OEMs, integrators and existing plant, often dating back many decades. In addition, each customer will develop rich digital ecosystems involving many partners and solution providers.

To be able to securely connect and leverage both existing and new investments in equipment and partner technologies requires digital solutions to be adaptable, open and agnostic.

Our belief in this approach means that ABB can provide the products and services that best meet the needs of each customer and deliver sustainable progress for power generation operators, owners, investors, end users and society more broadly.

ABB is already a global leader in delivering sustainable progress for power generation through digitalization. We have been incredibly privileged to have worked with the world's leading power companies, partnering to leverage digital solutions to solve their real-world problems.

ABB has been at the forefront of digital for more than 40 years and a leader in power generation for almost 130 years. We have the largest installed base of control systems in the industry, with more than 7,000 distributed control systems currently running in power generation worldwide.

Our cross-industry digital portfolio extends from device to edge to cloud — with devices, systems, solutions, services and a platform that enable our customers to know more, do more, do better, together.

Digitalization of power generation in times of transition

Digitalization holds great promise for the power generation industry. However, a range of internal and market challenges can constrain its effective uptake and implementation for those in the early stages of their digital journey.

Innovative companies that approach digitalization strategically, balancing the short and longer term objectives of the business, will gain a significant competitive advantage, improving their ability to adapt and thrive.

Industry transformed

We are in the middle of two separate but closely related revolutions that are reshaping the entire value chain of power generation.

The first is the Energy Revolution. The industry is moving from conventional, centralized and well-controlled bulk generation to one that includes distributed and weather-dependent production; from stable, well-defined load profiles to more volatile and reverse power flows.

Since 2010, global renewables capacity has increased by 8-10 percent year on year, with more than 150 GW added annually (equivalent to more than two-thirds of all capacity addition). In Europe, 27 percent of energy generation already comes from renewables.

The second is an industrial revolution. This involves the move from isolated, underutilized assets and people to dynamic, globally connected operational models that enable real-time insight, optimized decision-making and automated processes.

These revolutions bring both challenges and opportunities for the power generation industry.

On the one hand, there is increased market and operational complexity, knowledge retention and acquisition challenges in developed and developing markets respectively, regulatory compliance burdens and dynamic pricing pressures.

At the same time, there is a range of new digital solutions available, designed to address these very

challenges and enable flexible new business models. In these times of volatility and change, the one certainty is that standing still is not an option. Digitalization needs to be embraced strategically to sustain long-term competitive advantage, while delivering immediate tactical requirements.

Approaching digitalization

Digital solutions have become powerful tools to manage the complexity of the current business environment. Rapid advances in sensors, control systems, industrial software and artificial intelligence are opening new ways of driving efficiency gains from existing operations and enabling new, more flexible business models with extensive opportunities for growth.

Utilities, including power generation, are recognizing that industrial Internet of things (IIoT) technologies can yield significant benefits and many are actively planning for future investment over the next 12-18 months. According to digitalization analysts LNS Research, over half are planning to invest in their analytics capabilities, while more than a third plan to invest in sensing and smart grids, as well as their operations, automation and business systems.

The challenge, however, is when, how and why to approach digitalization. The context of change and volatility in the power industry has constrained the full utilization of digital and the significant benefits it can bring.

For power generation companies, the decision to invest in digitalization is often tactical and weighted against multiple short-term demands on cash flow, such as aging infrastructure, rising compliance costs and workforce replacement.

Compared to these immediate needs, realizing the profound benefits of digital transformation can often appear long term, uncertain and ultimately an issue for tomorrow.

It can also be a challenge to identify the right partner to work with. Aside from their technical capability, there are key considerations that need to be addressed:

- What happens to our intellectual property?
- How do we know our data is secure?
- How do we know we won't be locked in to a proprietary system with significant cost implications in the future?

As a result, where digital solutions have been implemented, the approach has often been tactical, narrow and focused on short-term objectives. Rather than achieving the full benefits of digitalization, siloed digital initiatives have proliferated and in some cases contributed to the very complexity they were designed to solve.

Achieving the promise of digitalization

Digitalization is a business initiative. It impacts the people, processes and technology inside a company, its operational model, competitive advantage and ultimately the sustainability of its business. Implemented effectively, it delivers both immediate tactical benefits and supports the long-term strategy.

To achieve the full benefits it promises, digitalization needs to be approached in a way that is focused on a company's strategic priorities and avoids the hype of a specific technology or solution. Each sector and business has its own operational priorities and challenges. These include heavy investment in legacy equipment, working in remote geographies or a shortage of necessary skills.

This means that there is no 'one size fits all' solution. Instead, a tailored solution is required that looks at the people, processes and technology involved in the company and how they operate together.

A close, collaborative relationship is required with partners who understand both the industrial and business context, and have expertise in industrial digital connectivity.

Digitalization can already offer a significant range of immediate operational and financial benefits. Sensors, devices and software can enable operators to utilize a wide range of data in real time and improve decision-making; control systems enable improved performance and maintenance of vital infrastructure and equipment either on-site or remotely; advanced analytics enables predictive maintenance and simulation to optimize asset performance; remote monitoring and external support can address key human resource and knowledge retention issues.

The longer-term promise of digitalization is also starting to be realized. New, more agile operational

and business models are now possible based on connectivity, optimized decision-making and automated processes.

Cloud technology and secured remote services also enable a closer relationship with partners. They allow expertise to be accessed securely from outside the plant and they free up company personnel to focus on strategic areas, such as the adoption of new business models.

Evolve, adapt and thrive

Digitalization of the power generation industry is already under way and gathering momentum. More and more companies are launching digital initiatives that encompass not only critical assets such as turbines, boilers and generators, but also smaller balance of plant systems that can significantly influence plant operation.

The benefits of digitalization are already measurable – according to LNS research, gains of more than 10 percent for productivity, maintenance and reliability are being achieved, compared to 1-2 percent for companies that don't embrace digitalization.

Longer term, standing still is not an option. As competitors and new players rapidly embrace new solutions and technologies, the risk of falling too far behind to catch up becomes a real business risk.

Challenges such as skills shortages and cyber security are also going to become more acute with implications for safety, efficiency, margins and ultimately operational viability.

For pioneering companies, there is the opportunity not just to survive the current challenges, but to use digitalization to adapt and thrive.

For example, with an IIoT platform in place, the cost of digitalizing an additional asset or process becomes marginal.

The key to success is to approach digitalization as a business issue with strategic implications. It requires solutions that provide tactical operational advantages in the short term, while simultaneously allowing evolution without obsolescence and the full transformation potential that digitalization promises.

For those companies that embrace it effectively, the opportunity is sustained competitive advantage, a reimagined business model and new opportunities for growth.

The Energy and Fourth Industrial Revolutions

The power industry has a long history of embracing the benefits of digital technology. For decades, power companies have used remote sensing, networked communication, data aggregation, monitoring and control systems to optimize their generation, transmission and distribution systems.

The new level of digitalization ushered in by the Fourth Industrial Revolution is enabling power generators to be more competitive and dramatically improve performance and flexibility through access to more meaningful analytics and insights. Digitalization is perhaps most significantly giving power generation companies the ability to adopt new business models and improve business processes in light of new market conditions and greater regulatory demands.

Naturally, many utilities focus on the threat these revolutions pose to their business model, but substantial opportunities are available for those able to embrace this transformation.

The challenges and opportunities of the Fourth Industrial Revolution

The Fourth Industrial Revolution is transforming businesses worldwide, adding sensing and communication technologies to turn machines and equipment into smart assets.

Through secure connectivity, smart assets and systems can communicate and cooperate not only with each other but also with humans in real time, improving performance through the entire value chain.

This revolution is making profound changes to the power industry. Renewables, distributed generation and smart grids require entirely new capabilities and are reshaping the way that the energy market works.

The exponential increase in the number of sensors and the amount of data that they must collect, manage and exchange is delivering new understanding and insight, but also an increasing need to convert information into action from the volumes of data extracted.

There are further challenges, with entrants from the digital economy disrupting the industrial landscape, while governments and regulatory bodies impose stricter standards and reporting measures.

The digital world will continue to evolve - mass data storage, secure remote access, artificial intelligence, decision support systems and predictive analytics will become mainstream. The current and next generation of power assets will have a number of life cycle advantages when compared to older assets.

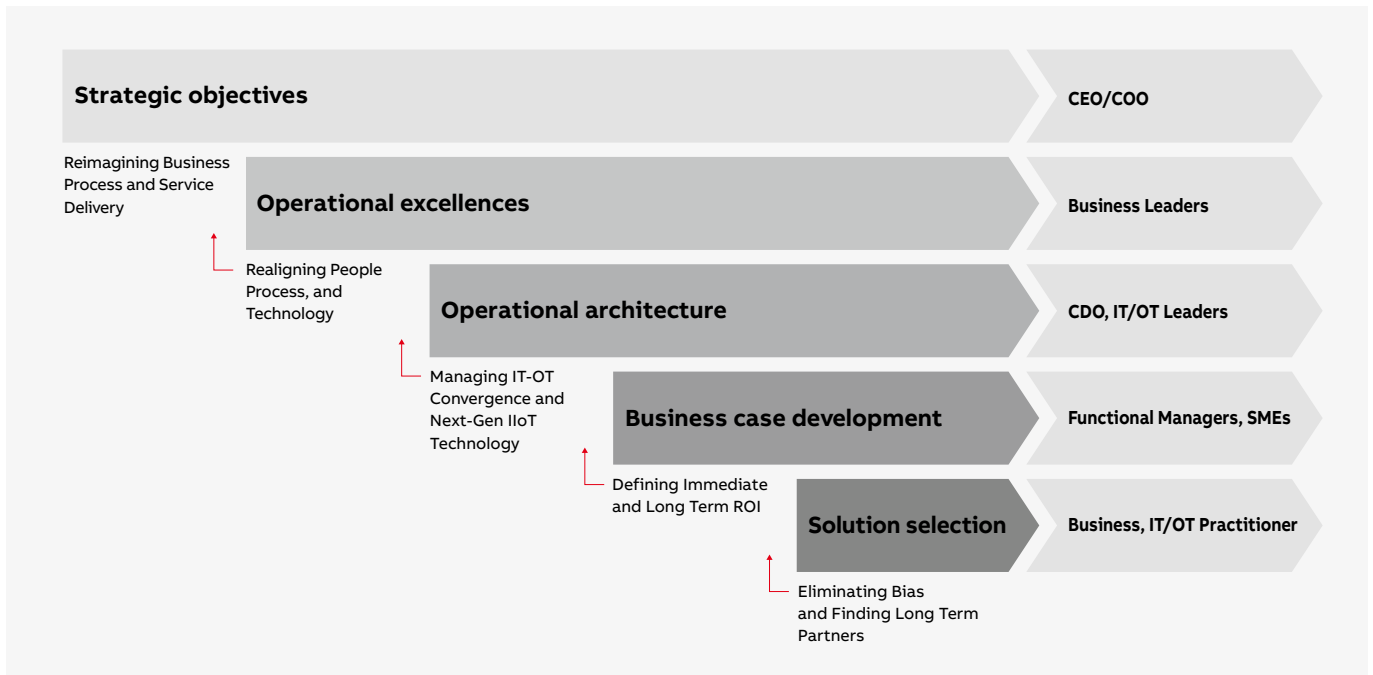
To thrive amid these challenges, the utility of the future will need to embrace digitalization to compete and evolve business models as the power market transforms. As with previous industrial revolutions, there are huge opportunities for those who place themselves ahead of the curve. Equally, there will be significant consequences for organizations that are unprepared for the revolution and get left behind as former accepted practices grow less relevant.

Real value is being delivered today

There is a lot of hype about the future value of IIoT, but many companies are already reaping the benefits from the additional insight and flexibility that digitalization delivers.

ABB is proud to have been trusted with helping some of the world's largest and best operated power companies make their digital transformations – unlocking real and significant value for energy businesses, such as:

- Reducing the cost of modernizing a coal-fired power plant DCS by 72 percent - a saving of more than \$3 million - thanks to our 'Evolution through obsolescence' commitment to protect the customer's investment
- Improving efficiency and reducing greenhouse gas emissions in a 10-year-old lignite-fired plant
- Enabling thousands of small distributed generating units to form a virtual power pool and trade energy on a demand-response basis, thanks to an ABB central control and optimization solution



01 Digital transformation framework.
Source: LNS Research

- Improving operations and increasing revenues at a fleet of coal-fired power plants with closed loop optimization and control of the combustion process. This plant reduced boiler start-up costs by 15 percent, improved thermal efficiency by 1 percent and reduced NO_x emissions by 10 percent.

And in the water industry:

- Helping one of Asia's largest cities provide clean drinking water for its booming population and reduce leakage in its water distribution network from 30 percent to 10 percent over a five-year period

Digitalization brings together tools, processes and people to close the loop between data, insight and action. This helps asset intensive industries like power generation not just to survive, but adapt, evolve and thrive.

Getting digitalization right

In many industries, businesses have not seen the returns they expect from digital transformation projects. Some studies estimate between 66 and 84 percent of digital transformation projects fail to deliver. Typically, this is due to lack of vision, mismatched expectations, failure to communicate or effectively manage change.

To be successful, digital transformation has to be more than a technology project – it has to be a business initiative. It requires a structured framework to drive organizational structure and decision-making that impacts all levels of the business. Digital transformation really needs a CEO vision for how these next-generation technologies will impact strategy.

Digitalization is more a matter of people and mindset than technology. Communication, change management and training are equally as important as technology. It requires a strong multifunctional approach, bringing all key stakeholders on the journey.

Transformation needs to build on existing operational excellence initiatives to ensure people, process and technology capabilities are aligned; it needs technologies to ensure there is an architecture in place to bring together both IT and OT; and it needs business leaders to build local business cases and select the right technology solutions and partners that meet requirements.

Established power plants may already have connected systems in place, but often in silos, and the ability to access the information needed to inform better decisions across the value chain could be missing. One approach to manage this is to begin with small projects to improve efficiency and adopt digital transformation in short, speedily implemented phases, while keeping an outcome-based approach for each phase. As the transformation builds momentum, it should open deeper digital opportunities and enable such plants to achieve overall digital transformation.

Crucially, successful digital transformation relies on finding the right partner. Some technology companies might develop fascinating solutions, but often without an understanding of the customer's specific business problems or with a 'one size fit all' attitude. If the solutions don't engage with the customer's people, processes and technologies, they will fail.

Key digitalization terms

Sensors and devices

These are the 'things' where information originates, such as a vibration, pressure or temperature sensor, but also radio frequency identification (RFID) technology that uniquely identifies an object. These may be attached to existing equipment or sometimes plant equipment will have the sensors and connections built in.

The cloud

The cloud is a secure but open central repository where all information is stored and accessible to users and applications of many types. In other architectures, this was called a 'historian', a 'SCADA database' or a 'central database'.

Edge computing

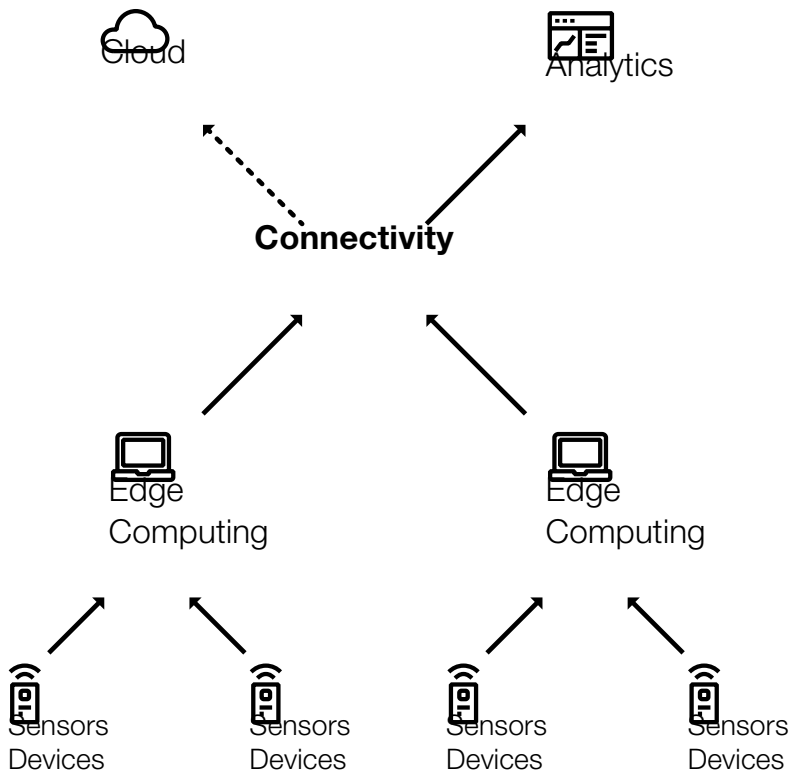
Often data needs to be processed without going to the cloud to achieve required response speeds or for safety integrity. As this means dealing with the data at the 'edge' of the cloud network, it is called 'edge computing' and may be required for situations such as safety integrity levels (SIL) 2 and 3, control loops or electronic locks. Edge computing may take place in the device itself or across multiple devices. In process control this is the distributed control system.

Connectivity

Connectivity ties the devices, edge and the cloud together across many standards and systems to create one homogeneous system.

Analytics

Analytics, or 'big data analytics', are the many applications that process data in the cloud to deliver information about equipment diagnostics, logistics and inventory, trends and analysis. Examples include, "this type of equipment from manufacturer X has an excessive failure rate when used for Y" or "use of consumable A is particularly high on B so we need to stock up before ..."



Challenges and customer needs

Digitalization can play an important role in solving a range of operational and business challenges for power generation companies. In this section we outline four key challenges.

Driving operational excellence

The market disruptions, increasing complexity, emerging technologies, regulatory changes and new supply-demand dynamics of electricity mean that many power generators are increasingly focused on operational flexibility to improve the availability and efficiency of their plants.

Operational excellence for plants covers not only supplying reliable, affordable power and optimizing uptime, but also managing physical and cyber security, disasters and emergencies, public safety and environmental performance.

There is not always a direct link between the areas that operational excellence initiatives need to focus on and available key performance indicators (KPIs). Additionally, many plants have multiple systems in place but often with different database schemas, reporting schedules and protocols, so aggregated reporting of new operational KPIs around flexibility, profitability and better use of resources can be difficult.

A challenge for those operating fleets of power plants is to ensure that best practices at one plant are applied across the fleet and lessons learned are effectively shared. A further challenge is that successful operational excellence initiatives rely on cooperation and transparency across power plants, and especially across divisions – something that may need cultural transformation and breaking down traditional departmental silos to be realized.

The most crucial aspect of any operational excellence program is to define what success looks like. This means understanding what factors will drive business growth, enable optimal

asset performance for current market conditions, while producing power in a safe and sustainable fashion, and delivering the profits that stakeholders demand.

It also means defining the right metrics that indicate success in these areas, while ensuring that appropriate measurements are made and information is visible and shared for more rapid and effective decision-making.

People, processes and technology are the underpinnings of operational excellence initiatives. These initiatives must be owned by the most senior business function leaders to ensure the correct buy-in and commitment and make sure the program is delivered.

Moving forward, power generation companies must continue to evolve operational excellence initiatives as the continuous improvement engine of the company and the driving force for innovation. Big data and artificial intelligence are increasingly a feature of these innovations and one of the greatest opportunities is to use machine learning to provide plant owners with guidance on how to achieve operational excellence.

Big data also has a role for fleets of power plants. It can enhance operational visibility of KPIs across the fleet and provide the ability to 'double click' into individual plants or specific classes of equipment across the fleet.

Knowledge and workforce management

The energy industry has a shortage of skilled and experienced workers. For emerging markets, there is often the need to attract and im-

port experienced workers; in developed markets, the issue is compounded by a high proportion of the workforce nearing retirement. In the United States, for example, 40 percent of the workforce at electric and natural gas utilities will be eligible for retirement in the next five years. This 'generational shift', driven by a retiring workforce presents a significant challenge for the energy industry.

A further challenge to those operating in mature power markets is the cost-effective attraction and retention of skilled and seasoned operations personnel, in the face of increasing competition for talent from other technical and process industries.

Even when new talent is obtained, there is still a need for education and training. As an industry that has long relied on knowledge being passed via 'on-the-job training' and the individual know-how of experienced workers, many companies are having to deal with capturing this implicit knowledge and systemizing it for effective succession planning and knowledge transfer

Due to the need to move away from reliance on individual knowledge while retaining the necessary skills and competence, the ability to securely access both remote internal and external expertise is a huge enabler for these markets. Partnering with experts in power generation can bridge this gap and enable cost-effective, innovative solutions for the industry.

Regulatory compliance

Power generators are caught in a difficult situation. The increasing cost of complying with environmental, labor and other regulations is creating additional operational complexity and straining operating margins. These may involve meeting ever more challenging emissions limits, evolving the power generation capacity mix towards natural gas and renewable sources or updating aging infrastructure. At the same time, failure to comply can result in substantial fines or the closing of plants.

The financial burden of compliance is resulting in a cost squeeze on operating margins. This therefore involves an investment trade-off in other areas, such as human resources. The result is that power generators increasingly need to achieve more with less – they need to make continuous improvements in

operational efficiency to sustain their existing margins. For example, a recent study by consultants Capgemini showed that more than a quarter of power generation executive respondents targeted investment in the areas of reducing selling, general and administrative expenses or direct labor costs.

Digital solutions are required to support and facilitate this transition. This includes asset optimization strategies that take into account emissions, abatement costs and equipment life. It involves data visibility, ensuring that crucial regulatory data can be easily collected and are accurate and visible in real time to ensure cost-effective compliance.

Cyber security

With the increasing digitalization of assets and the exponential rise of cyberattacks around the world and across all sectors, the power generation industry is no exception in facing heightening cyber risks. The 2015 attack on the Ukrainian power grid is a cautionary tale for the entire industry.

However, finding solutions to these risks is not easy. For one, IT and OT, both of which are critical in creating a secured environment for assets, have different priorities. IT systems are usually renewed after four or five years, OT systems after 10, 15 or even 20 years. IT may wish to introduce new measures to improve security, which OT sees as an imposition that could disrupt operations.

Secondly, successful and resilient cyber security programs require not only investment in technology, but also in acquiring skilled resources and evolving business processes to address new risks. Cyber security requires a defense in depth approach that relies on disparate security controls to span the spectrum of industrial cyber security risks.

Finding the right security partners can also be challenging. While there are many potential partners who do many things well, and some do one thing expertly, few have the know-how in all the relevant domains – power generation and transmission, distributed control systems and automation, digitalization and the cloud, and cyber security. By 2018, an astonishing 50 percent of IIoT device manufacturers will not be able to address threats due to weak authentication practices.

Making a meaningful argument to a company's leadership to justify investments in cyber security is not easy. It is almost impossible to put a value on things we avoid without knowing if we have avoided them. Instead of thinking about the investment in cyber security from a value perspective, companies should think about it as an insurance policy – a way to avoid potential costs and unacceptable risks that could be incurred through a disruption to operations brought on by a cyberattack.

Committing to a long-term strategy beyond a quick fix is key. Many companies buy an off-the-shelf solution that will help them through compliance. Others seek help from consultancies to make security assessments and close the gaps they find, but fail to put in place a long-term, sustained security program. Or they miss the critical step of providing continuous training and keeping their staff motivated, and risk losing talent and knowledge in a market where skilled cyber security personnel are in short supply.

Ultimately, a sound cyber security strategy needs to be a long-term commitment. Working with the right partners, companies should consider the entire life cycle of the program, and not just the initial design, focusing equally on processes, people and technology.

How to approach digitalization in power generation

ABB has been chosen by some of the world's largest and best operated power companies to partner them on their digital journeys. We value the trust our customers place in us, and we work closely with our partners to ensure that we deliver on strategic priorities.

ABB is keenly aware of the trade-offs the customer is making and has built a portfolio of tested products to facilitate digital transformation. Together with our ABB Ability™ digital solutions, we have helped our customers achieve astounding results for their plants and businesses.

Digital leaders in power generation

ABB has one of the largest installed bases of power and automation hardware and software globally. Our expertise and portfolio of products, systems and solutions cover the entire plant: from automation and instrumentation to electrical balance of plant, turbine control, excitation, condition monitoring, plant and process optimization, and preventive maintenance.

Over the past decade alone, ABB has deployed digital solutions to address our customers' greatest challenges at more than 300 units with an installed generating capacity of 72 GW around the globe.

This knowledge of the power generation process, installed base, proximity to customers and ability to cover the whole plant has enabled ABB to partner with customers and apply digital solutions to some of their greatest challenges in a power market in transformation. These solutions include:

1. Virtual power plants

A central control and optimization solution for a VPP operator with more than 4,500 producing and consuming units in eight countries in Europe, generating and trading 3,200 MW of energy.

2. Power plants and boilers

An ABB Ability™ remote services solution that

reduced boiler start-up costs by 15 percent, saving up to \$176,000 annually, improved efficiency by up to 1 percent and reduced NO_x emissions by 5-15 percent.

3. Power plants and automation

ABB collaborative operations solutions that significantly reduce unplanned downtime.

4. Power plants and automation

Solutions that optimize processes, reduce risk, increase operator efficiency and plant availability by reducing abnormal events by 40 percent.

An early adopter

ABB has developed automation and control technologies that have paved the way for digitalization in computing and cloud technologies today.

The Bailey Boiler Meter, created by ABB in 1917, enabled operators to safely measure boiler pressure, steam and fuel consumption to control emissions for the first time ever.

This breakthrough event was followed by many other digital milestones such as the first automated control system, the first use of a digital computer, the first automation system with simultaneous and real-time access to business and process data, and the first Web service for process control.

ABB applied these innovations with one single purpose in mind: to improve the productivity, efficiency and reliability of our customers' assets in the power generation, water and process industries.

Through close relationships and deep understanding of our customers' challenges, we have been entrusted with helping these companies through their digital transformation. Our portfolio is a direct output of this – road-tested solutions built to solve real-world problems.

Partnering with leading technology providers

Today, ABB is further advancing digitalization and data analytics with ABB Ability™ digital solutions. By partnering with Microsoft and IBM, ABB is able to drive digitalization across the power generation industry.

Evolution without obsolescence

With power generation being such an asset-intensive business, maximizing the return and lifetime of these investments is essential. Plants make significant investment not just in the system hardware, engineering tools and application software but also in developing valuable intellectual property in the form of data, processes, site-specific strategies and the knowledge of their engineers, technicians and operators.

Plant owners' investments can be highly compromised if their control system vendor forces them down a 'rip-and-replace' route for upgrade. This route typically requires massive replacement of system hardware, process re-engineering and retraining of personnel. The long commissioning and start-up periods, lost generation and inherent risks result in serious cash flow impact.

An evolution approach allows system owners to maximize the useful life of their control systems and the intellectual assets built on them. Through stepwise system evolution, the risk associated with system change is mitigated – minimizing downtime and protecting the owner's long-term investments in control applications, process graphics and historical data.

By adopting a stepwise approach in which components or process areas are upgraded individually as required during either normal operation or as part of scheduled maintenance activities, the rest of the system can be left undisturbed.

Evolution without obsolescence offers plant owners the flexibility to upgrade their control systems to fit their business and plant operational needs rather than due to component obsolescence. This lowers the cost of ownership, increases the value the system provides, and extends the life of the system - maximizing system investments and assets, both physical and intellectual.

A collaborative approach

We believe that sustainable progress for power generation can only be achieved through collaboration – within the plant, fleet and company, and with valued partners and suppliers, who support decision-making through insights and information.

At ABB we work hand in hand with our customers to better understand their specific requirements and the challenges they face. As each customer has a highly diverse technology stack and will develop a rich digital ecosystem involving many partners, we believe that an open and adaptable approach best meets their needs.

This enables us to provide the products and services that maximize the return on their existing investments, and plan for both short and long term optimization. We also partner with customers to provide new operational flexibility and ways of working.

As we engage with customers on digital solutions to drive specific outcomes, we will often initiate pilot projects to demonstrate tangible results that can be scaled - following a four step model:

Plan

The first step of the process is to understand the customer's business, their strategic priorities and key initiatives. This frames the context and desired outcomes of the project and ensures alignment of the customer and all the partners involved.

Design

The next step is to design for purpose. This involves looking at the people, processes and technology involved, capturing the requirements from each of the different stakeholder groups, defining success criteria and developing a proof of concept. This is also a great opportunity to engage with the customer's employees and ensure they are included in the digital journey.

Build

Once a solution has been designed, we move on to installation and testing. It is fundamental that the test meets the site requirements, is executed to plan and the case results are captured accurately.

Evaluate

After the test is completed, the results are presented for discussion. We then review the strategic, operational and financial case for scaling the pilot and present a set of recommendations for moving forward.

Security is fundamental

Cyber security is not a destination but an evolving target. Cyber security is about finding the right balance by taking a defense in depth approach to ensure operations are protected and secure.

ABB has helped many utilities assess the security position of their critical assets, identify vulnerabilities and potential threats, develop a plan to protect the assets and comply with international standards, national regulations and corporate policies. ABB approaches cyber security throughout the life cycle of both systems and data.

Customers can rest assured that their data is protected through contractual commitment with ABB, meaning their data is shared only with consent. Furthermore, customers' data is protected through restricted access for use only for specific services.

Data ownership and data accessibility are key issues for our customers. With ABB, the data is always owned by the customer - it is their intellectual property. Data integrity follows ABB cyber security rules and standards, as does data accessibility, but with the option that ABB will integrate any additional requirements the customer may have.

As cyber attacks increase and digitalization expands, close collaboration between IT and OT is essential. ABB understands both departments and their roles and responsibilities. We help them come together, communicate with each other and understand one another. We can explain to OT why the new measures are needed, but we can also explain why OT is concerned about the disruptions those measures may cause.

ABB Ability™ solutions for power generation

ABB has a wide range of digital solutions that are designed to meet the current and future needs of the power generation industry.

Our portfolio of digital solutions, ABB Ability™, includes secure devices, systems, solutions, services and a platform that enable our customers to know more, do more, do better, together.

Expert support for operations

ABB Ability™ solutions include infrastructure as a service, connecting plants, processes and people with ABB's deep domain expertise in real time.

- Collaborative operations
- Loop tuning optimization
- Alarm management and rationalization
- Control system health check
- Sootblowing advisory

Monitoring

Utilizes process and system data through sensors, devices and software to know more about the plant or fleet in real time.

Condition-based and predictive maintenance:

- Cycling impact (thermal gradients causing stress to thick bodies)
- Boiler and turbine stress evaluator
- Vibration monitoring
- Sensor diagnostic/Failure identification
- Continuous emissions monitoring

Performance monitoring:

- Equipment, plant and fleet (actual efficiency vs. expected)

Performance optimization

ABB Ability™ solutions for power generation improve operational efficiency for both an individual plant and across an entire fleet. Our deep knowledge of the industry enables us to recommend solutions and close the loop. This lowers variable costs, increases output, reduces emissions, lowers operator variability and enables greater operational flexibility.

Plant

- Load response: primary/secondary frequency and black start
- Fast start: boiler and steam turbines
- Efficiency: combustion coal/fuel oil/gas
- Output: fuel flow and turbine control valve and HPP power
- Emissions abatement: monitoring and NO_x /SO_x control

Fleet

- Virtual power plant - load coordination across fleet

Summary

As the Energy and Fourth Industrial Revolutions continue to gather momentum, digitalization will become an increasingly important tool for sustaining operational efficiency and competitive advantage.

Challenges such as skills shortages and cyber security will only become more acute with implications for safety, efficiency, margins and, ultimately, operational viability.

Through decades of industrial and technological leadership, we know how to execute digital projects for a power generation industry going through a time of volatility, uncertainty and transformation.

Our commitment to evolution without obsolescence and building close, collaborative relationships with our customers enables us to provide solutions that solve real operational and business challenges at the scale of asset, plant and fleet.

The ABB Ability™ portfolio of digital solutions includes secure devices, systems, solutions and services that enable operators to utilize data in real time, improve decision-making, manage critical infrastructure either on-site or remotely, simulate and predict maintenance issues and optimize operational efficiency. Close collaboration also enables a new, more flexible way of working that connects plants, processes and people with ABB's deep domain expertise in real time.

At ABB, we help our customers adapt, evolve and thrive in times of change.

ABB is a leading provider of integrated power and automation solutions with unparalleled experience in partnering with the energy and water industries, bringing them improved operations and sustainable progress. We deliver integrated and secure digital systems, services and solutions to automate and optimize the performance of conventional and renewable power plants and water facilities.

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