ABB review

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The corporate technical journal

Innovation

Imagine a robot with the dexterity of a human, using two arms to manipulate workpieces precisely and that can safely work alongside humans. That vision is now a reality. The front cover of this edition of ABB Review features ABB's new YuMi® robot, which is also highlighted on page 6.

The present page shows busbars at the Outaouais (Canada) HVDC converter station. This back-to-back 1,250 MW installation permits power to be interchanged between the grids of Québec and Ontario.

Innovation

Claes Rytoft

Dear Reader,

The front cover of this issue of ABB Review depicts ABB's new dual-armed YuMi robot. You may be wondering whether ABB's engineers have looked too much at the robots of popular culture, but there is a very sound reason to produce a robot with two arms. Humans can position an object with one hand while working on it with the other. They do this for countless tasks ranging from peeling a potato to using apps on smartphones – and there are numerous assembly and handling tasks for which this robot presents similar advantages.

Advanced robots are just one example of the co-development of software and hardware and the increasing role of such products in industry. Further articles look at how the ever-increasing flood of data from the myriad sensors across a plant can be harnessed to deliver real gains in productivity and how this is redefining the automation pyramid. Continuing with this automation focus, ABB Review discusses how emulation can reduce system testing and how service tools can leverage productivity.

But it is not only industrial automation systems that can look forward to improvements in efficiency and productivity. An article on building automation highlights some of the impressive innovations this area is seeing. The journal also looks at a smarter scheduling for process heat to reduce peak power demand.

Not all intelligent solutions have software at their core. ABB's new QCap capacitor introduces several design features that assure higher reliability, longer life and a safe mode of failure.

Last year, ABB Review celebrated the centenary of one of its predecessor journals, BBC Review. The present issue looks at the publication's other predecessor magazine, ASEA Journal (which traces its origins to 1909), and presents some early gems from the archives. But it is not only on the occasion of anniversaries that ABB Review looks at the past. The journal publishes history articles on a regular basis, frequently using the perspective of the past to explain present and future trends. Twenty-two such articles have been published since 2007. Readers can explore these and other past articles (going back to 1996) by visiting ABB Review's web page www.abb.com/abbreview. The web page also provides readers with an option to sign up for ABB Review's email alert and be informed of new editions. In addition to the print and pdf versions, ABB Review is also available as a tablet app, which is also accessed from the above web page.

Enjoy your reading.

Claes Rytoft
Chief Technology Officer and
Group Senior Vice President
ABB Group

Innovation highlights

ABB's top innovations for 2015

Innovation comes in many forms. Sometimes it takes the shape of radical new concepts applied to real-life problems, and at other times, it appears as new ways to utilize existing technologies. Always striving to lead through innovation, ABB is continuously advancing its product portfolio and developing technologies to better meet the changing needs of its customers. Here, ABB Review presents the highlights for 2015, some of which are discussed at greater length in this and forthcoming issues of the journal.

YuMi®, creating an automated future

ABB's new dual-arm robot – YuMi – is the world's first truly collaborative robot designed for a new era of industrial automation. The robot is inherently safe, allowing for barrier-free collaboration with humans in a more productive, side-by-side working environment.

YuMi's control software, precision and innovative design are key to its operation. To further enhance safety, it has lightweight components padding to absorb energy upon impact, and eliminates pinch points.

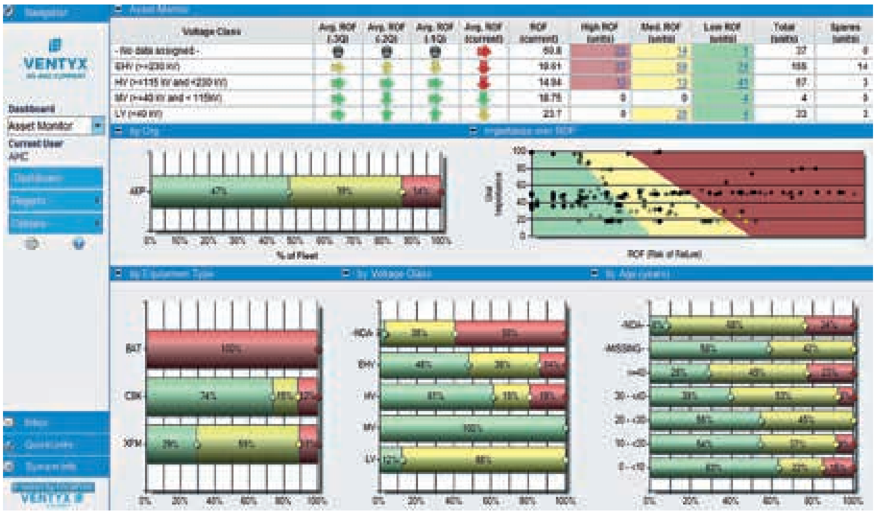
Designed for small-parts assembly, ABB's dual-arm robot meets the ever-changing production requirements of the consumer electronics industry, but can be used in any process with similar delicate demands.

YuMi is part of an overall system, featuring adaptable hands, flexible parts feeders, vision guidance and state-of-the-art control software. Its small size minimizes factory floor footprint and enables installation in work stations currently only occupied by people. Additional features include an integrated robot controller and two 7-axis arms, as well as sufficient payload, speed and protection for capable operation in most small parts assembly environments.

The name YuMi is derived from "you" and "me" – implying robot and human partnership. More details will be available when the dual-arm robot is introduced to the market at the Hanover Fair in Germany in April 2015.

A full-length article on YuMi will appear in an upcoming edition of ABB Review.

The real world: Maximizing reliability on a budget



Company maintenance budgets are never large enough to take care of all the issues that arise in old electrical equipment. ABB's Asset Health Center™ (AHC) is the key to moving from time-based maintenance activities to condition-based management of high-voltage assets. ABB's expert-developed algorithms convert analytical data into information that allows informed decisions to be made when prioritizing maintenance actions to improve equipment reliability.

Whether by using only occasional observations, annual dissolved gas analysis (DGA) data, sophisticated monitoring systems or structured inspections by an equipment expert, AHC takes all available data and provides actionable information, thus maximizing the value gained from each and every maintenance dollar.

AHC provides timely notifications when abnormal asset behavior is detected and provides an immediate view of equipment condition long before the substation gate is unlocked.

This allows sending the right people, with the right equipment, and at the right time to take actions that improve asset reliability. The flexible ABB performance models behind AHC can also be integrated with other asset management solutions to provide a perfect answer for equipment reliability needs.

New release: System 800xA v6

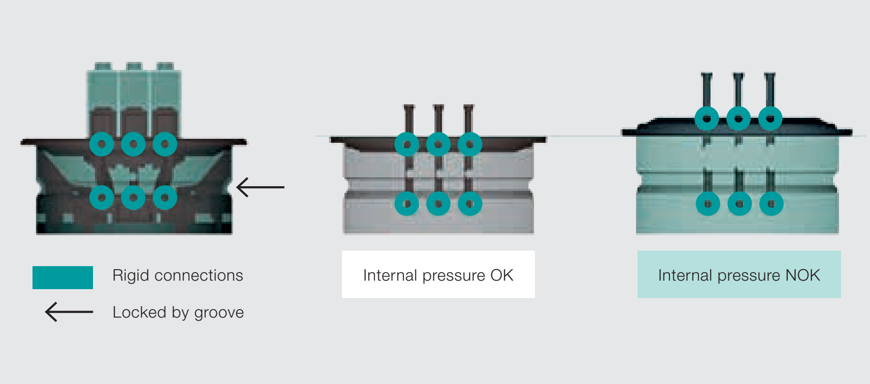
Since its introduction in 2004, ABB's distributed control system (DCS), Extended Automation System 800xA, has been enabling productivity by consolidating process, electrical, safety and telecommunications in one automation platform.

System 800xA's sixth-generation release has been specially developed to support upgrades of older DCSs running on unsupported operating systems such as Microsoft Windows XP® and simultaneously helps customers reduce operational costs associated with maintaining the automation system.

In addition to the adoption and implementation of technologies such as virtualization, System 800xA v6 includes an innovative software installer that harnesses the power of multicore technology found in today's servers and workstations to significantly reduce the required automation infrastructure. The number of machines in an automation system can be reduced by as much as 50 percent, and more importantly, capital and life-cycle costs are reduced.

Other additions to v6 include:
- Wireless routers enabling the safe and secure deployment of mobile operator clients.
- New, more secure means to provide much needed data to the enterprise from the control layer.
- A list of operator effectiveness improvements including trend and alarm list enhancements, an embedded public address system, and a KNX interface that more closely connects an operator's physical environment to the overall automation solution.

Putting a cap on reactive power



Capacitors may have been around for more than 250 years, becoming irreplaceable in countless applications, but this does not mean that their development is over. ABB's newest QCap low-voltage capacitor sets new standards in terms of reliability, quality and safety.

One of the major challenges in power capacitor design is heat. Overall, electrical losses within a capacitor are low, but as low thermal conductivity is intrinsic to the materials used, temperatures can build up and degrade the capacitor. The QCap design is optimized for low losses, increasing its operating lifetime and reliability.

The QCap excels in more than just optimal thermal performance however. The capacitor is also self-healing, meaning that when an electrical fault occurs, the resulting arc burns a hole isolating the faulty area. Such an occurrence reduces the capacity by about one part in a million while avoiding a potentially destructive spread of the fault.

But QCap's innovative approach doesn't stop there either. Each self-healing event emits a small amount of gas. Over time and as the capacitor ages, the gas accumulates. When the gas pressure surpasses a threshold, it causes the can's lid to pop upwards, severing the connecting cables and hence isolating the faulty device.

Read more about QCap on pages 53–59 of this edition of ABB Review.

PASS hybrid technology steps up

For many, high-voltage equipment has always been divided between air-insulated switchgear (AIS) and the more compact, but more expensive, gas-insulated switchgear (GIS). This picture changed dramatically some 20 years ago when ABB introduced PASS (plug and switch system). PASS combines the best of the AIS and GIS worlds to create mixed technology switchgear (MTS). Even if basic equipment costs are higher than for AIS, MTS delivers a lower cost of ownership.

In 2013, ABB announced the launch of a 420 kV high-voltage hybrid switchgear known as PASS M0S 420 kV. This means the PASS product family now covers voltages from 72.5 to 420 kV with breaking currents from 31.5 to 63 kA.

In addition to standard modules, a special solution called the PASS M0H offers a complete high-voltage switchyard with an "H" configuration as a single transportable unit. The 420 kV PASS hybrid module retains all of the PASS family benefits and each PASS module is equivalent to a complete switchgear bay. The preassembled and factory-tested PASS M0S 420 kV can be easily transported and quickly installed, without the need to assemble any active parts. In order to transport the fully assembled product, the (3.6 m, 350 kg) insulators are rotated into a compact position in the factory and returned to the in-service position on-site. This key feature is unique to PASS technology.

Increasing the capacity of distribution grids

The distribution grids that soak up power from photovoltaic (PV) and wind installations were designed to cope with a certain energy flow – and the power generated by PV and wind installations can be a multiple of that design limit. In many cases, the limiting factor is not even the transmission capability as such, but voltage range compliance.

Conventional solutions involve network upgrades – but a line voltage regulator (LVR) can easily solve the problem at far less expense. An LVR is able to automatically adjust a voltage, within a certain range, to a desired value.

ABB has introduced a new LVR for the low-voltage (LV) distribution grid. It is available in standard ratings of 250 kVA, 125 kVA or 63 kVA and allows voltage adjustment of +/- 6 percent in steps of 1.2 percent of the voltage. The LVR can be mounted in a standard cable distribution cabinet and placed anywhere along the LV line, including at the output of a distribution transformer. A typical cabinet location would be in the vicinity of a roof-mounted PV installation. For applications in the medium-voltage (MV) grid, a corresponding regulator has just been developed. The MV LVR can handle power up to 8 MVA, at voltages of up to 24 kV, with a regulation range of +/- 10 percent.

DS1: Transient-free, diode-based capacitor switching

With DS1, ABB has reached a milestone with the first capacitor switch based on semiconductor technology that allows synchronized switching. DS1 is the first indoor medium-voltage apparatus of its kind in terms of innovation and performance. The switch, fully dry-air insulated, is able to perform opening and closing operations on capacitor banks without causing any transient voltage or inrush current and eliminating the probability of restrike occurrence.

This is made possible by the embedded control unit, which enables optimized switching that is precisely synchronized with the AC network parameters. The product connects the capacitors at zero voltage crossing and disconnects them at zero current – with a precision of a few microseconds.

Thanks to DS1, capacitor bank switching will no longer be a delicate operation since any side effects on the distribution network and the capacitors are avoided. This prolongs component product life and eliminates the need for additional equipment such as inrush reactors.

Moreover, this new capacitor switch can perform up to 50,000 operations with a switching frequency of more than one operation per second. It is rated at up to 17.5 kV and 630 A.

Industrial customers will benefit from DS1's power factor correction capabilities, and utilities will get the most out of it for reactive power compensation.

Something new under the sun

Operating a photovoltaic (PV) installation at the top of the low-voltage range – defined by IEC standards to be 1,500 VDC – reduces equipment and labor costs. However, running devices at this voltage level can be problematic. For instance, interruption can be difficult due to so-called critical currents that cannot be interrupted. ABB's new T7D PV-E hybrid breaker not only works effortlessly at voltages up to 1,500 VDC but it also avoids the critical current issue.

In the T7D PV-E, the critical current problem is counteracted by using power electronics for low-current interruption. Because the power electronics are not in the main current path, power losses are as low as in normal electromechanical breakers and there is thus no need for cooling. Once higher currents flow, the power electronics are no longer required and they are switched off. Very small components are used – even at the device's 1,600 A rating – making the power electronic unit extremely compact.

As a further bonus, the electronics are powered through an energy harvesting unit that exploits the energy of the contact arc. In addition, the electronics sleep (and are isolated) when the breaker rests in the closed or open position.

Laying the groundwork for tomorrow's electricity grids

Supporting the European Union's 2020 climate and energy targets is the largest EU-funded smart grid initiative – Grid4EU – a "large-scale demonstration of advanced smart grid solutions with wide replication and scalability potential for Europe." ABB is collaborating with three of the six European energy distributors who make up the Grid4EU consortium, to build and test the scalability and replicability of new and innovative solutions for large-scale distribution networks.

The first demonstration project – Demo 1 – is in partnership with RWE in Reken, Germany. Fully integrated grid automation technology monitors the network condition and reconfigures the network topology to minimize the impacts of faults, avoid overload situations and reduce network losses using a distributed software system.

Demo 2, in collaboration with Vattenfall in Uppsala, Sweden, focuses on how to monitor and control the low-voltage (LV) network based on existing advanced metering management technology for the Nordic region. ABB provided measuring equipment in secondary substations and visualization tools for alarm and event management and statistical evaluation.

In conjunction with CEZ Distribuce in Vrchlabi, Czech Republic, Demo 5 focuses on designing, implementing and testing automation in medium-voltage and LV grids that are newly equipped with remote controlled devices, fast communication infrastructure and local SCADA (supervisory control and data acquisition) systems to support automated and islanding operations.

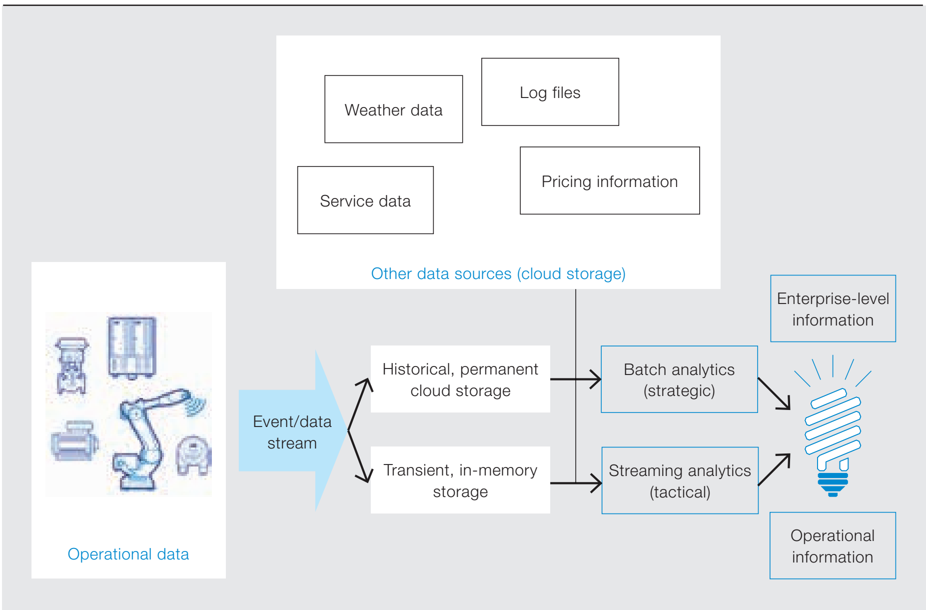
The Grid4EU program drives the development of cost-effective and scalable solutions for supervision and control in parts of distribution networks that previously did not have this capability. Such far-reaching management capability is essential for the safe integration and increased hosting of distributed renewable resources, enabling the reduction of carbon emissions while maintaining grid reliability.

Information exploitation

New data techniques to improve plant service

CHRISTOPHER GANZ, ROLAND WEISS, ALF ISAKSSON – Data is on everybody's agenda – and no more so than in the industrial world. Taglines such as the Internet of Things, Industry 4.0, Industrial Internet and other related topics repeatedly show up in technology publications around the world. The digitalization of the industrial world involves the collection and analysis of data from a large number of sensors with the aim of aiding the people responsible for plant operations, maintenance and management. Handling this flood of data in an intelligent way holds the key to greater plant efficiency. New techniques developed by ABB that process plant information in innovative ways can have a major positive impact on service offerings.

1 Many sources of data in the industrial environment can be accessed to help make efficiency improvements.



Immense quantities of data are becoming available in many industrial settings. Only when this data results in actions will efficiency gains be made.

Data flow is the lifeblood of an industrial plant. Is this the picture of the future? Partly it is, but, to a large extent, intelligent devices in plants are already communicating with each other. For example, in a typical control loop, in which sensor data is analyzed in real time by the controller and then fed back to the actuator, all the devices involved are intelligent and all of them exchange information in some form or another.

So is the future just about rearranging what already exists in a more productive way? Again, partly it is, but technologies now available allow information to be processed in new ways that can have a significant impact on service offerings.

Firstly, storing massive amounts of data has become affordable due to cloud storage offerings from several major providers. In the industrial domain, this will allow more extensive analysis of product and system behavior than ever before. Data from multiple devices can be stored over an extended period and used to improve operations and maintenance in industrial plants – for example, by reducing asset downtime or allowing a more efficient utilization of the service workforce. Depending on the data contracts with customers, benchmark information can be shared to highlight performance deficits.

For non-real-time-critical parts of the system, this can be done now – but the quest for algorithms to uncover the most relevant insights has just begun.

Secondly, the traditional automation pyramid – with its mainly hierarchical system architecture – is being rearranged. More intelligent sensors and controllers that are more flexible exist in a meshed network that now connects to the Industrial Internet [1]. Further, all information has to be available immediately and everywhere. Production managers want to be able to check key performance indicators (KPIs) in real time and have state-of-the-art visualization of this information on all form factors – from big-screen, fixed installations to mobile devices like smartphones and tablets. Isolated subsystems will exist only in special cases and will suffer from reduced functionality as they will not be able to participate in the data and service ecosystem.

Flexibility

Flexibility is a key aspect in the new world of maximum data exploitation. One key driver of flexible systems is the need to be able to customize each and every product – rarely are two cars with the same configuration ordered during a given production cycle. This is also true for smaller, significantly cheaper products, eg, Apple Watch. Therefore, the production facilities of the future have to be able to create products with high variability and be reconfigurable in a very short time. Further, product cycle times are getting shorter – months for smaller consumer goods and just a few years for complex goods such as cars. Such cycle times require production

> Technologies now available allow information to be processed in new ways that can have a significant impact on service offerings.

Title picture
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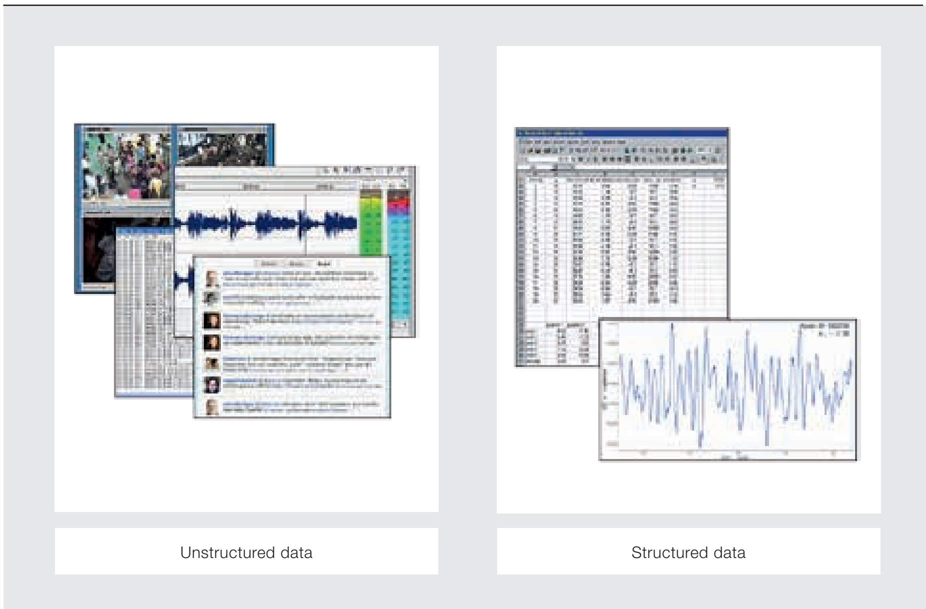
2 The structuring of data is an important step in turning it into actions that will improve efficiency.



devices that can be plugged into the existing facility with minimal engineering. Finally, virtual engineering will need to start with early simulation models, based both on historical data and real-time data from virtual and real devices.

Accessible data platforms

Data will no longer reside in information silos, but will be accessible for advanced analysis in cloud platforms. The analysis will access data gathered over long periods of time as well as high-frequency data streaming into the analytics engine in almost real time. A huge bonus is that these services can be scaled according to customer needs – there is no need for precautionary over-provisioning for each customer. Modern analytics platforms like Google Cloud Dataflow [2], Amazon Kinesis [3], or Spark [4] can provide the foundation for such advanced offerings.

Of course, the main role of automation suppliers is to produce the applications that are built on these platforms. These applications can be used internally or externally. Internal applications include automated analysis of customer feedback – eg, service requests or failure reports – that improve internal processes and optimize products. External applications give customers access to advanced information – for example, operational KPIs that allow monitoring of plant productivity.

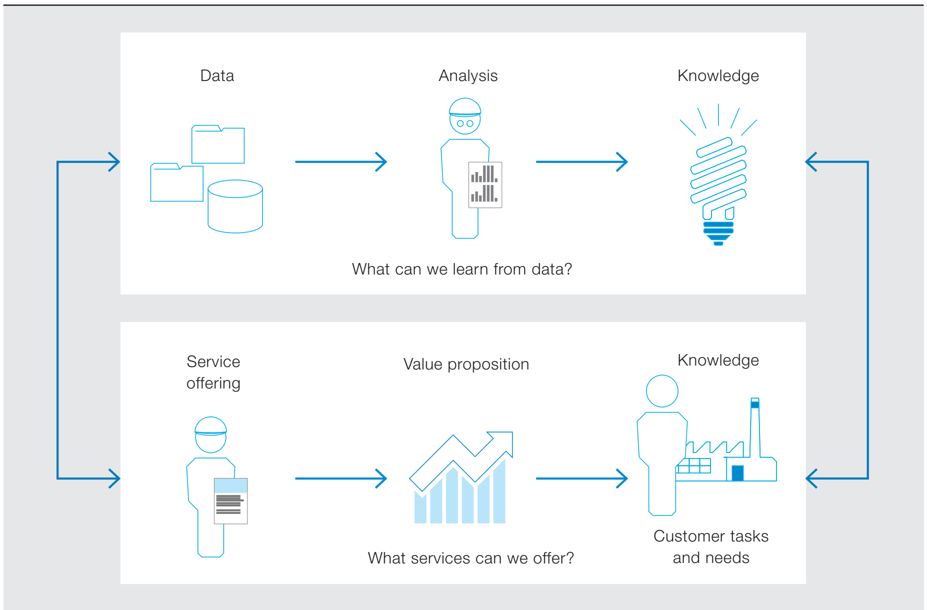
Storing massive amounts of data has become affordable due to cloud storage offerings from several major providers. In the industrial domain, this will allow more extensive analysis of product and system behavior than ever before.

Device- and plant-level analytics versus fleet-level analytics

As already mentioned, data analysis is not new. However, many monitoring and diagnostics solutions focus on individual devices – to detect a failing sensor or to analyze vibrations from rotating machinery like motors and generators, for example. In some cases, this has been extended to entire plants or at least sections of a plant – eg, to monitor

Data will no longer reside in information silos, but will be accessible for advanced analysis in cloud platforms.

3 Remote, data-driven services increase plant performance and operational efficiency.



a complete shaft line with drive, motor, gearbox and load (a compressor, for instance) or to use flow sensors, pressure sensors and mass measurements to carry out leakage detection on a pipeline or water network.

The increased availability of data will enable comparisons across multiple plants – so-called fleet analytics. The fleet can be devices within one enterprise – for example, all electrical motors of a particular type. Here, a supplier like ABB potentially has access to a much larger fleet, namely the entire installed base of the motor in question. A fleet is also understood to mean the set of all complete plants of a particular type inside one corporation; all the vessels in a shipping company; or all paper machines in a paper company.

Like a Web search, there are many textual data sources in the industrial environment that may be searched to yield useful results – eg, service reports, operator logs and alarm lists.

Homogeneous versus heterogeneous data

So far, data analysis has mainly involved signal analysis of conventional numerical process data originating from sensors. Today, there are numerous other sources of data that are waiting to be tapped. For example, search engines are extensively used to find data on the Web, but there are many textual data sources in the industrial environment that can also be searched to yield useful results – eg, service reports, operator logs and alarm lists. Other sources include images or video files. It is usually not obvious what features to look for as the use of the data will be context- and application-dependent and this must be accommodated on a case-by-case basis. One challenge is to time-synchronize data from all these sources in order to fuse the information together → 1–2.

Edge versus cloud computing

Another interesting challenge is to identify where the data analytics should take place. The previous discussion largely assumes that the relevant data will be stored centrally, eg, in the cloud. However, devices are becoming more intelligent so there is more computational

The traditional automation pyramid with its mainly hierarchical system architecture is being rearranged. More intelligent sensors and controllers that are more flexible exist in a meshed network that now connects to the Industrial Internet.

power closer to where the data is generated. To perform the computing close to the source is sometimes called edge [5] or fog [6] computing. It is already the case that not all data is sent to a data historian. For example, when using a medium-voltage drive to control the roll speed in a rolling mill, only the speed and torque are collected at the control system level, while the current is typically only available inside the drive.

With intelligent sensors and actuators, it may be that only information that has already been analyzed is available in the cloud storage. An important trade-off here, then, is to decide which signals to process locally and exactly what information to transmit to the central storage, since at the edge there is usually no historian and hence the local data may not be available for later analysis. An important factor in that consideration is that data storage costs are declining, thus reducing the need for the historian to employ compression and potentially destroy information that could be useful later.

New insights into advanced service offerings

None of the technologies and trends described so far provides direct value to a customer. Data collection and data analysis may increase knowledge and enable predictions, but unless someone acts on these, there will be no effect on the plant performance. Only when the knowledge is turned into actions and issues are resolved will there be a benefit from analyzing more data. In other words, knowing what is faulty is one part of the equation, but fixing it is another part.

Providing remote access to data and analytics to service experts will close the loop of continued improvement. Online availability of support from a device or process expert is essential for a quick resolution of unwanted situations. Coupling remote access with the new technologies now available enables earlier detection and better diagnostics, and therefore facilitates faster service – resulting in better planning and an increase in plant and operational efficiency ➔ 3.

Christopher Ganz
ABB Technology Ltd.
Zurich, Switzerland
christopher.ganz@ch.abb.com

Roland Weiss
ABB Corporate Research
Ladenburg, Germany
roland.weiss@de.abb.com

Alf Isaksson
ABB Corporate Research
Västerås, Sweden
alf.isaksson@se.abb.com

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Emulation to the rescue

The virtual emulator framework simplifies process control system testing

MARIO HOERNICKE, RIKARD HANSSON – When process control systems are going through their final test phases, a software simulation of the process is often used to test the control system response. However, this simulation is usually focused on the functional part of the process control system – namely, the centralized control applications. Distributed control functions, located within subsystems or field devices, are often neglected. ABB's virtual emulator framework (VEF) integrates and automatically configures subsystem emulators and so enhances functional testing. The networks of emulators that VEF's virtualization-based technology enables the user to configure appear and behave like the actual automation system, subsystems and networks.

To tackle the emulation complexity encountered in the integration and factory acceptance tests, ABB has developed the virtual emulator framework.

Traditional process control systems (PCSs) commonly consisted of a single subsystem – the distributed control system (DCS) – that interacted with sensors and actuators, and displayed process states or alarms and events on an operator control station. In contrast, the modern PCS is a high-performance product that incorporates – alongside the still-dominant DCS – fieldbuses, intelligent devices and other subsystems in order to provide more flexible and intelligent functionality.

The Foundation Fieldbus (FF) is one of the most prevalent fieldbuses found in modern PCSs [1].

Title picture
ABB's virtual emulator framework greatly simplifies process control system testing by including distributed control elements in the overall simulation. Shown is part of an oil and gas plant in Hammerfest, Norway.

The FF distributes control functions for execution in field devices. In some cases, cascaded loops are used where the inner cascade is located in field devices and the outer cascade is located in the DCS controllers. In other words, the FF can embody an entity that is altogether more complex than the DCS.

Another important example of a DCS-connected subsystem is the electrical control system. The IEC 61850 standard, for instance, describes a fieldbus used for substation automation. The intelligent electronic devices (IEDs) with which it deals are comparable to the controllers of a traditional DCS.

However, there is a price to be paid for the increased functionality these subsystems bring: For each subsystem integrated into the PCS, different engineering methods are required and highly complex interfaces have to be created.

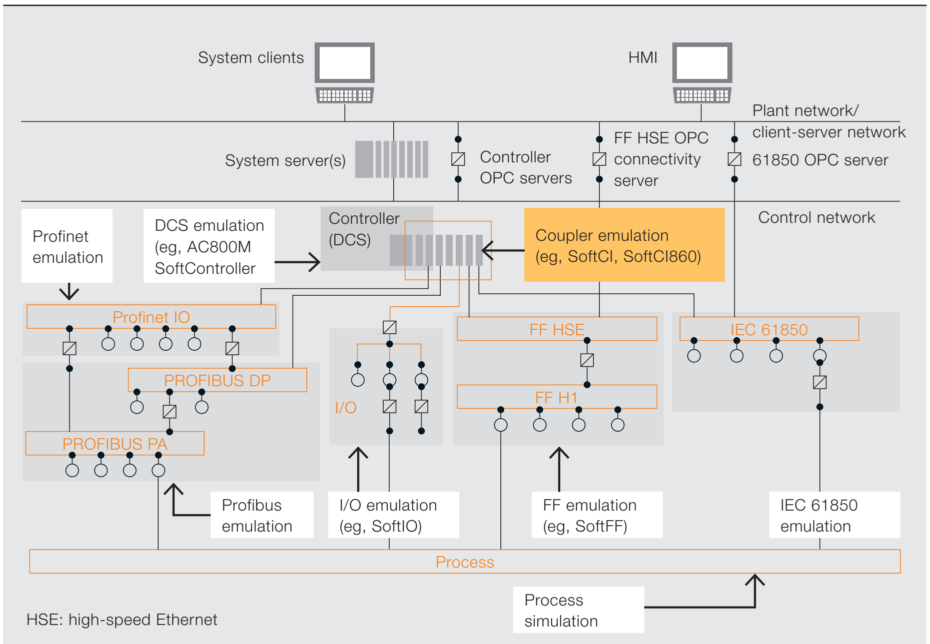
Alongside this increasing sophistication – and, consequently, greater engineering effort – customers also demand a shorter time to market. When the shrinking number of engineers is factored in, it becomes clear that today's PCS engineering world faces a daunting task. Nevertheless, engineers must guarantee acceptable quality, so efficient and complete tests are essential.

Challenges in testing process control systems

The more complex the automation, the better testing has to be. As is the case in most software projects, testing is usually done throughout the development phase of a PCS. But there are two test stages at the end of the engineering effort considerably more important than the rest: The factory acceptance test (FAT), where the PCS engineers test critical parts in cooperation with, and in the presence of, the customer, in order to validate engi-

The modern PCS is a high-performance product that incorporates fieldbuses, intelligent devices and other subsystems in order to provide more flexible and intelligent functionality.

1 The virtual “hardware-in-the-loop” test bed can replace large parts of the automation hardware.



neering results (“Is it the right product?”); and the integration test, which checks the entire PCS functionality, including, for example, controller parameters or subsystem interfaces. The integration test is performed before the FAT to verify engineering results according to the specification (“Is the product right?”). Both of these stages require the control system

The VEF is able to plan and deploy entire emulation networks for the automation system in question with just a few mouse clicks.

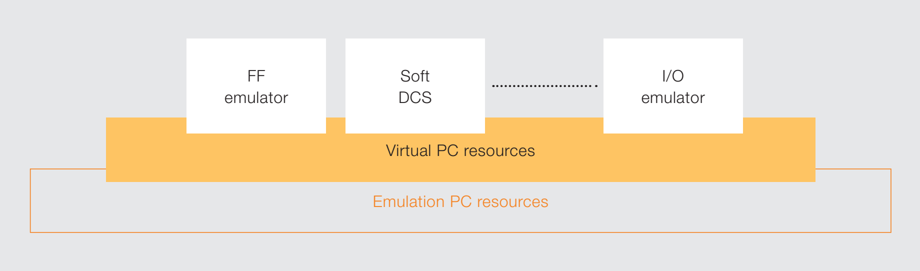
hardware to be staged on the shop floor – so servers, field devices, etc. need to be present, configured and administrated. This is a complex and time-consuming task.

An important aspect of the integration test is the testing of the connections between control functions located in the DCS and the subsystems (eg, FF or IEC 61850). Since the field components are regularly sent directly to the site in order to save shipping and staging costs, this testing is often not possible [2]. Recent initiatives have developed imitations of the automation system hardware to replace the hardware missing at integration test and FAT time → 1.

To stimulate the automation system emulators and to provoke reactions to process states, a process simulation is often used. For the integration test and FAT, lightweight simulation models are usually accurate enough, but in case operator training simulation or virtual commissioning is required for the plant, high-fidelity models can be used for these two tests. The connection between the PCS and the process simulation model, as well as the orchestration of the simulation environment and higher-level simulation functionality, can be performed using software such as the Extended Automation System 800xA Simulator [3].

Although the plant can be completely imitated and tested using process simulation combined with automation emulation and subsystem emulation, emulation is still not well established in the integration test and FAT. Investigations showed that this is due to the immense configuration effort required for the separate tools, combined with the high administration effort for the emulation PCs and the impracticalities involved in engineers mastering a large variety of emulation tools.

2 Virtual-machine template with installed emulators



3 Parameters for emulator integration

Parameter	Usage
Number of Ethernet interfaces	Each emulator requires a defined number of Ethernet interfaces for each instance in which it is executed. The VEF uses this to configure the virtual hardware.
Number of simultaneously executable emulator instances	Depending on the implementation of the emulator, it is capable of executing a defined number of instances on a single PC or VM. This number is used to calculate how many VMs are required.
Number of simultaneously executable subsystem instances per emulator instance	Some emulators can emulate a number of subsystem instances within a single instance of the emulator. VEM needs this number, as well, to create the instances of the emulators and assign a subsystem instance to each.
RAM required per emulator instance	Indicates whether an emulator instance can be executed within a given PC environment and is used to configure the RAM of the VMs.
Object type of the emulated subsystem	Each subsystem (or each emulated object) has an object type. The object type is used to identify the required emulation tool.

To tackle this complexity, ABB has developed the virtual emulator framework (VEF).

The virtual emulator framework

The VEF is able to plan and deploy entire emulation networks for the automation system in question with just a few mouse clicks. Since it uses virtualization to automatically create the emulation networks, the virtual hardware can also be automatically created and configured, according to the automation system and PCS topology.

Integration of emulators into the VEF

As a prerequisite for the automatic generation of emulation networks, the emulation tools need to be tightly integrated into the VEF. Conceptually, the VEF uses virtual machine (VM) infrastructure to integrate emulators and to automatically generate the virtual appliances and the virtual networks for the emulation. The emulators are installed on a VM template in the same way as on a physical PC → 2.

The advantage of the virtual infrastructure is that the template can be easily duplicated – allowing many instances to be created without user interaction and without staging new physical PCs.

Since the emulators have different capabilities, depending on their implementation and the emulated subsystem type, a few parameters have to be provided to the VEF for each emulator type. The VEF uses these parameters to plan the virtual network topology and virtual hardware for each emulator type → 3.

Besides the emulator-type-specific parameters – that have to be specified just once for each emulator type – the IP addresses for each object to be emulated are required. This parameter is instance-specific and therefore needs to be separately configured for each instance of an emulatable object.

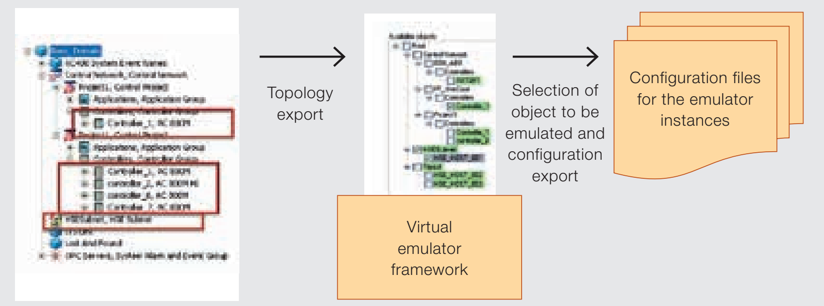
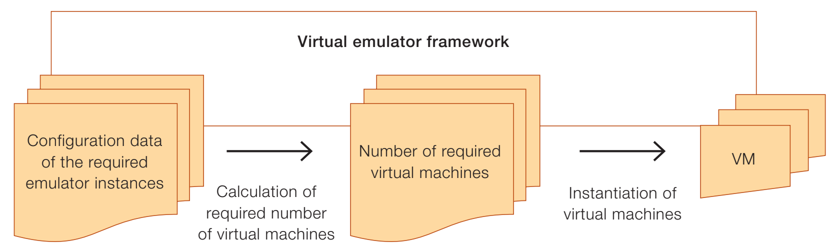
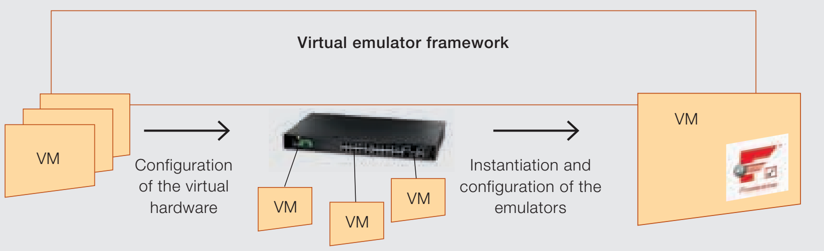
Finally, the VEF uses this information to automatically configure the virtual networks and automatically establish communication between the emulator instances and the plant network.

Algorithm to generate a virtual emulator network

Based on the VM template, the VEF is able to apply a multistage algorithm. With this algorithm, the VEF is able to generate the required VMs, configure the virtual hardware according to the requirements of the emulator instances, configure the network interfaces and execute the emu-

The user is able to monitor and debug the configuration of the selected subsystems and the automation system. The network behaves like – and appears to be – the original automation hardware and subsystem hardware.

4 Algorithm to create the virtual emulation network

Step No.	Description	Illustration
1	**Export of the automation system topology** In the first step, the topology of the automation system is exported from the PCS engineering system. The engineered topology within the PCS contains the automation system components, eg, controllers. Based on the object type, emulatable components can be identified and highlighted.	
2	**Selection of parts that need to be emulated** Usually, only certain parts of the plant are tested at the same time and the user can select these. The configuration files for these instances are then created. Those files are later used to automatically configure the emulator instances.	
3	**Calculation of required number of VMs** Based on the parts selected for emulation, the required number of VMs can be evaluated, whereby some rules have to be adhered to: – The maximum number of Ethernet cards per VM may not be exceeded. – The maximum number of executable instances on one VM may not be exceeded for any emulator. – The maximum number of emulatable objects per emulator instance may not be exceeded. – Virtual RAM may not exceed physical RAM.	
4	**Instantiation of virtual machines** Based on the calculated number of required VMs, the VM instances are created from the template.	
5	**Configuration of virtual hardware** Based on the parameters of the emulator types, the hardware of the specific VM instances is configured. The required number of Ethernet interfaces and the required RAM for each individual instance are configured.	
6	**Configuration and execution of emulator instances** In the last step, the VM instances are started, the configuration files created in step 2 are used to configure the emulator instances, and the emulator instances are executed.	

The VEF automatically configures the virtual network and automatically establishes communication between the emulator instances and the plant network.

lator instances with the instance-specific configuration → 4.

When the algorithm has been successfully executed, the user is able to monitor and debug the configuration of the selected subsystems and the automation system. The network behaves like – and appears to be – the original automation hardware and subsystem hardware.

VEF system architecture

To evaluate the developed algorithm, a prototype was developed for the PCS System 800xA. Two emulators, the AC 800M SoftController [4] and SoftFF [2] – including SoftCI [5] – were integrated into the prototype.

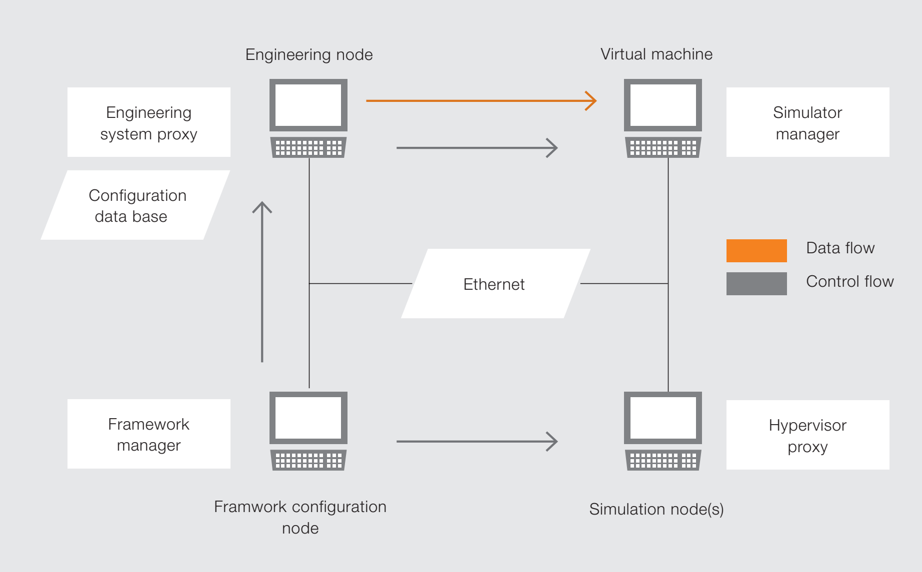
Since System 800xA has a distributed system architecture and the focus has been on large system emulations, the architecture of the VEF is also of a distributed nature. As a base for the communication between the different nodes within the VEF and System 800xA, TCP/IP was chosen.

The VEF consists of four node types that can be installed on the same physical PC or in VMS or it can be distributed – just as in

5 System architecture: virtual-emulator-framework nodes

Node type name	Usage	Residence
Configuration node	The configuration node is used to select the parts that will be emulated.	A PC inside the System 800xA network; not necessarily a System 800xA node.
Engineering system access node	This node type consists of a single service that is used to interface with the engineering system of System 800xA. It is used to export the automation system topology and the configuration files for the emulator instances.	A System 800xA node that contains the required engineering tools for exporting the configuration and that has access to the aspect directory.
Orchestration node for the hypervisor	Orchestration of the hypervisor controlling the VMs is required as well. This node makes the connection to the hypervisor (eg, VMware vSphere) and to start, stop, create, etc. the VMs.	This node needs to be installed and executed on a PC that has access to the hypervisor (eg, PC with vSphere Client installed). It must be located in the same networks, like the other nodes.
Virtual machine node	The VM node configures the emulator instances and starting and stopping the emulator instances inside the VMs.	This node is installed in the VM template and executed automatically on every VM instance.

6 Virtual-emulator-framework communication structure



System 800xA → 5-6. Except for the configuration node, the VEF consists only of MS Windows services that do not require user interaction.

As a base for the prototype, the VMware platform was chosen. The prototype has been evaluated using VMware Workstation for small emulation networks that can be deployed on a single PC and VMware vSphere Hypervisor for large virtual emulation networks, based on the VMware ESXi platform. Both scenarios have been tested with positive results.

Fast FAT

The VEF was developed to enable an efficient integration test and FAT preparation, with little manual intervention, and it has been successful in this.

The VEF requires only two user interactions to deploy an entire virtual emulation network: The selection of the objects to be emulated and the configuration of the private cloud/virtualization PCs. The purchase, staging and configuration of special emulation PC hardware is no longer necessary.

By using virtualization, the configuration of the hardware interfaces required for the emulator instances also becomes unnecessary. Now, the configuration can be performed automatically in accordance with engineering data exported from the engineering tools.

The prototype demonstrates the feasibility of implementing this solution for a complex PCS. Hence, the VEF is a scalable solution to efficiently configure and deploy heterogeneous emulation networks for process control systems.

Mario Hoernicke
ABB Corporate Research
Ladenburg, Germany
mario.hoernicke@de.abb.com

Rikard Hansson
ABB Process Automation, Simulator Solutions
Oslo, Norway
rikard.hansson@no.abb.com

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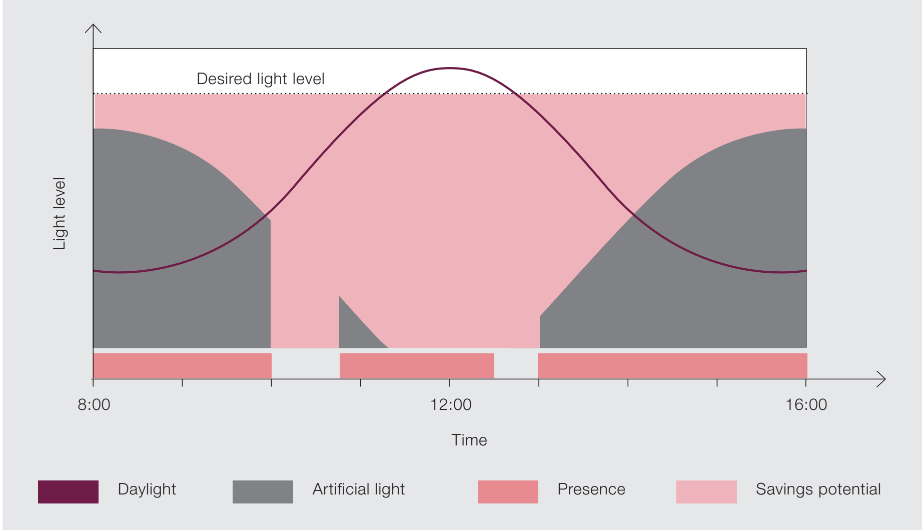
Building better

Technology to make buildings intelligent

THOMAS RODENBUSCH-MOHR, ANTHONY BYATT – Constant IT advances, rapid urbanization, climate changes and the rise of alternative energy technologies are four major trends that are driving a furious development of building automation technology. While intelligent buildings and smart homes were until comparatively recently the stuff of science fiction, they are now a reality and are well-placed to offer the energy efficiency, comfort and security people seek. ABB's KNX line of products helps make the intelligent building a reality.

1 Savings potential of occupancy-controlled constant lighting control in an office



The world is undergoing change of a magnitude hitherto unseen. And in 2008 a landmark was passed: For the first time in history, more people were living in cities than in rural areas. This trend toward urbanization is accelerating: In the 20th century the population of cities grew more than 10-fold and the United Nations predicts that two out of three people born in the next 30 years will live in cities [1]. This rapid urbanization is a major driver of building automation evolution. Climate change, energy policies and the rise of alternative energy technologies are three further drivers. The intelligent building, or smart home, is the result of this evolution.

Intelligent buildings – once futuristic concepts – are now a reality and are becoming big business. As an illustration of this, Google, one of the biggest data companies on the planet, recently paid over $3 billion for Nest Labs, a specialist in indoor heating control. The building automation business as a whole is already worth tens of billions of dollars worldwide – and should turn over $50 billion by 2018 [2].

Building automation can deliver many benefits – for example, energy efficiency, flexibility, comfort and security. For private residences, the latter two usually are the most important, whereas for commercial buildings, energy efficiency and flexibility usually have priority.

Automation saves energy

Buildings, commercial and residential, are responsible for a significant portion of the world's energy consumption. Fortunately, savings of 20 percent or more can be relatively easily unlocked by making the continuous monitoring of energy usage an integral part of a building's automation system. Experts in the field see a particular potential for savings in commercial buildings because the users of these often feel detached from the management of systems such as heating and lighting, and are thus less motivated to intervene to save energy; a comprehensive automation of such buildings circumvents the effects of this disinterest.

> KNX-based installations can make dramatic savings in energy consumption, resulting in payback times of typically three to five years – a much shorter time than other energy-saving measures such as insulation or insulated glazing.

Connects via KNX

"If you want to control it you have to measure it," is an old adage that is very applicable to energy use in buildings. In order to have any sort of energy optimization, the energy flows in a building have to be understood. ABB's i-bus® KNX devices do just that. KNX Association created KNX technology, which is a worldwide standard for all applications in home and building control. This technology finds use in applications ranging from lighting and shutter control to various security systems, heating, ventilation, air conditioning, monitoring, alarming, water control, energy management, metering as well as household appliances and audio.

ABB has developed a range of devices for intelligent building control applications that interface via the KNX bus. The ABB i-bus KNX energy module, for example, is used to measure the electrical current consumed by various devices directly at the point of use and report the readings to a visualization system.

Title picture
The Contemporary and Modern Art Museum of Trento and Rovereto, Italy, has made significant energy savings using ABB's i-bus KNX.

In 2008 a landmark was passed: For the first time in human history, more people were living in cities than in rural areas.

2 Rebuilt after a disastrous fire, ABB's i-bus KNX helped this school reduce its energy bills by almost a third.

This and other ABB i-bus KNX devices – such as light controllers, switch actuators, dimmer actuators, blind/shutter actuators, fan coil actuators and controllers, gateways and so on – provide the muscles and nervous systems necessary for fine-grained monitoring, control and actuation throughout the building.

Such installations can help make dramatic savings in energy consumption, resulting in payback times of typically three to five years – a much shorter time than other energy-saving measures, such as insulation or insulated glazing. Further, ABB i-bus KNX technology allows rapid reconfiguration of the building if requirements change or the room layout needs to be modified.

The potential for energy savings in intelligent buildings can be well illustrated in the area of heating and lighting.

Lighting is usually one of the single biggest consumer of energy in commercial buildings. However, constant light schemes can reduce lighting bills considerably. In such a scheme, a light sensor measures the natural light level so the controller can top this up with the amount of light needed to achieve the desired lighting level and no more → 1.

Further, a presence detector can be used to minimize the illumination (and heating) in unoccupied spaces. Such schemes can result in an energy consumption 30 to 40 percent below that of a manual light control setup. Similar savings are to be found when shutters or blinds are automatically controlled to reduce heating and cooling costs.

Regulation regulations

In many jurisdictions, minimizing the energy footprint of a building is no longer just an option: Building automation systems are rapidly becoming a key element in allowing various energy aims to be achieved – whether they are national or supranational targets, or building-code related – and are therefore becoming written into law. Germany, for instance, has new laws related to energy savings that reference DIN V 18599, which explicitly includes building automation. In addition, some countries insist on an energy performance evaluation and certification when a property is bought or sold.

Further standards – like DIN EN 15232, which handles the energy efficiency of buildings and the influence of automation on it – provide a good guide for architects and planners.

The rapidly-evolving regulatory framework, coupled with an ongoing boom in the building automation sector provides fertile ground for ABB's i-bus KNX, which has already enabled high energy

3 The Busch-priOn

4 The Busch-ComfortTouch

efficiencies to be achieved in multiple sites.

Cutting bills

ABB is executing its own sustainability program to optimize the energy efficiency and ecological quality of complete industrial sites. ABB's sites in Germany, for instance, have reduced energy consumption by 35,000 MWh compared with 2007 levels. The initiative is being copied by other ABB sites in Europe: In the ABB plant in Odense, Denmark, for example, a three-story building has been equipped with 645 KNX components to regulate heating and cooling and to provide constant lighting. In the larger offices, a reduction of 13 percent in electrical energy consumption has been achieved.

In the Museum of Modern and Contemporary Art of Trento and Rovereto, in Italy, a KNX system reduced the annual power consumption by 456 MWh – which translates into 28 percent, or some $100,000 – in its first year of operation. In a school in Neckargemünd, Germany, a 525-component KNX setup reduced the energy bill by close to one-third → 2.

Smart and comfortable

In residential buildings, comfort and security assume a significance at least as great as energy efficiency does in commercial buildings. Bedrooms should be cool, but the living quarters comfortably warm; lighting levels should always be appropriate; blinds and shutters should open and close according to the weather or time of day; security cameras should be convenient, discreet and easy to operate; and so on. Busch-Jaeger, a member of the ABB Group, has a range of ABB i-bus KNX products to help realize this vision of the smart house.

Because most of ABB's products are not aimed at the domestic market, it is unusual for them to be visible in homes, so special care has been given to the optical design of the Busch-Jaeger devices as well as to their functionality. The Busch-priOn®, for example, is an ergonomically designed central control unit residents can use to monitor and control an entire living area: Light scenes, timer, blind and heating control – all these functions can be performed intuitively using a rotary control element and a display → 3. The Busch-ComfortTouch® combines the functions of a building control system with those of an information and entertainment center – light dimming and switching, blind control, temperature regulation, security camera viewing, music playing, video viewing, etc. are all combined in one unit → 4-5. The integrated audio and video players are enhanced by a connection to the Internet, which also allows control of the entire system from a remote location via smartphone and tablet apps.

ABB has developed a range of KNX-compatible devices that interface via the KNX network to the building automation system.

Intelligent buildings were once futuristic concepts but are now a reality – and are becoming big business.

5 The ABB i-bus KNX DALI Light Controller for constant lighting control

Smart homes in the smart grid

In the future, smart homes will be part of the smart grid, which will allow ABB i-bus KNX devices to communicate with the utility and display, for example, the current electricity tariff. Depending on the particular tariff in operation, domestic devices could be programmed to switch on or off, or a decision could be made about feeding power back into the grid – from a domestic photovoltaic installation or electric car battery, for example. ABB already offers products that do this automatically.

Global drivers

The coming decades will see buildings increase in technological sophistication: They may be made from concrete that can sequester carbon dioxide; their sides may be covered in photovoltaic films; automated vertical mini farms on their roofs will deliver fresh, local produce to those living below; solar installations will provide the zero-emission building's power and hot water; rainwater reuse, perhaps coupled with insulating green roofs, will be part of a city-wide smart water, sewage and irrigation system. All this has to be connected, monitored and controlled by smart technology.

It is clear, then, that cities, and the buildings in them, are at the start of a dramatic period of evolution. As the world becomes more urbanized and more densely populated, intelligent building technology will become ever more important to enable the demands of society to be balanced against the need to conserve energy, reduce greenhouse gases and house billions of people with the energy efficiency, comfort and security they seek.

Thomas Rodenbusch-Mohr
ABB Stotz-Kontakt GmbH
Heidelberg, Germany
thomas.rodenbusch-mohr@de.abb.com

Anthony Byatt
Editorial consultant
Louth Village, Ireland

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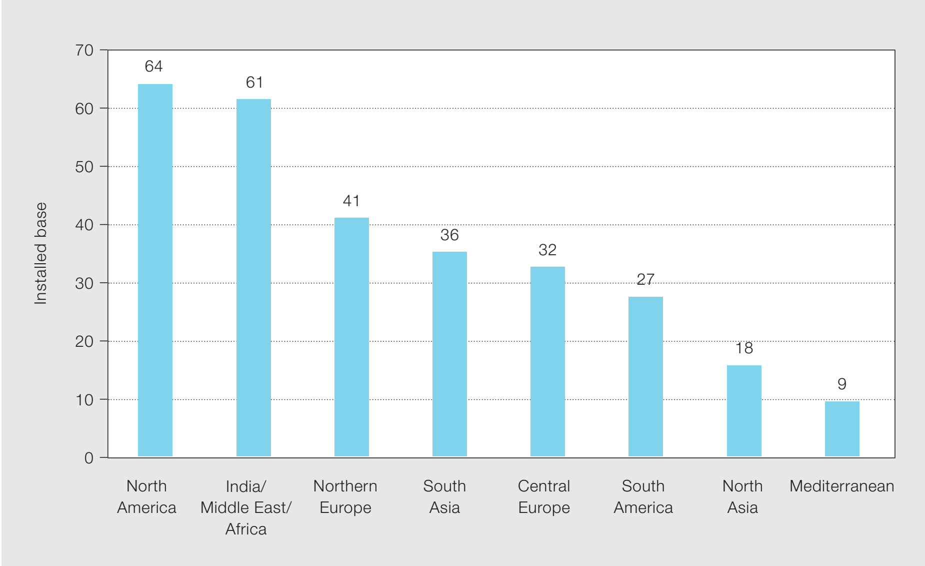
A service tool grows up

ABB's ServicePort™ is now delivering advanced services to a wide range of customers worldwide

PATRIK BOO – When the ABB ServicePort™ Service Delivery Platform was launched in 2012 as a tool to support ABB engineers in delivering service, developers hoped they had a tool that would be embraced by the engineers and, more importantly, ABB customers. Now their tool has been validated. ServicePort is being successfully used at more than 200 sites, by hundreds of customers and ABB personnel, and all indicators point to continued growth.

1 Installed customer ServicePorts by region



Whether a company refines oil, recycles wastewater, produces packaging, mines minerals or engages in any industrial processing, repeatability and smoothly running processes are central to a successful operation. With today's intense global competition, companies are faced with reducing production interruptions as much as possible.

Most plant managers work to prevent problems or catch them early before they have an adverse effect. But proactive service to maintain maximum uptime isn't always easy to deploy.

Finding people highly experienced in the areas of process diagnostics is challenging in both developed and developing economies. Clearly it is difficult to transfer entire teams of experts to developing economies. In developed economies difficulties in finding and keeping the required expertise in the midst of baby boomer retirements means companies must expand their search for this expertise, so that when production issues arise, they have an approach for how to address the issues.

For access to the service expertise needed to keep production moving, many customers turn to outside providers. This option can save time and costs while providing the help needed to address specific issues. After managers make the decision to work with an outside provider the challenge is finding a company with the right experience and technology to meet the needs of the company's equipment, process and industry.

ABB is often called upon to supplement a plant's service engineers for two very important reasons: because it has extensive expertise in process automation, and because it has the tools needed to deliver that expertise quickly and effectively.

As a world leader in process automation, ABB has a deep bench of experts who have a broad range of knowledge, experience and skills in customer processes and equipment.

Demand for advanced services has grown in recent years, and the question for ABB has become how best to deliver advanced services to more customers, such as those in remote locations.

To meet this need, ABB created ServicePort, which brings top expertise directly into customer sites worldwide through a secure, remote connection specially designed to help deliver advanced services. ServicePort provides the means for ABB engineers to swiftly diagnose a customer's equipment and process problems. Wherever an industrial company is located, whenever process expertise is needed, a site can have direct access to ABB's depth of knowledge and abilities.

ABB has taken the concept of ServicePort and made it a reality. But more than that, ABB has turned ServicePort into a growing success.

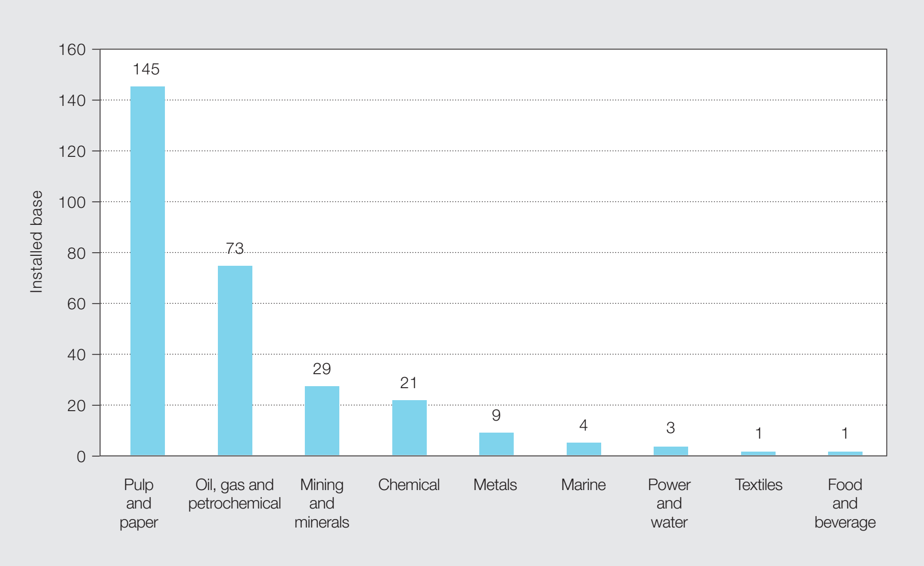
The beginning

ServicePort started as a promising idea for making high-quality ABB expertise directly available to process industry companies in a way that was fast and flexible. While the first prototype was used to deliver advanced services to a customer in 2008, in 2011 the concept gelled into the robust design now known as ServicePort. As a service delivery platform, ServicePort makes it possible to quickly and consistently capture data from control systems and analyze the data so that the customer or ABB advanced services personnel can make sound recommendations about improvement actions.

> ServicePort provides the means for ABB engineers to swiftly diagnose a customer's equipment and process problems.

Title picture
The ABB ServicePort Service Delivery Platform facilitates secure, remote-enabled execution of advanced services from ABB experts.

2 Installed customer ServicePorts by industry



Wherever an industrial company is located, whenever process expertise is needed, a site can have direct access to ABB's depth of knowledge and abilities.

Customers were initially cautious about installing ServicePort because they perceived it, with its remote connection, as a potential cyber security risk. However, ServicePort is designed to be secure, with customer data protected at every stage, and customers have grown to trust this.

As customers realized that through secure remote delivery they could obtain the needed high-level process analysis and troubleshooting at a lower cost, more and more sites opted for ServicePort. It has become an expeditious way for process industry customers to connect with ABB advanced services.

After just two years, more than 200 ServicePorts are now in use worldwide, with customer sites in India, the Middle East, Africa, northern and central Europe, the Mediterranean, north and south Asia, South America and North America – and its use is expected to grow ➔ 1. Based on 2013 and 2014 sales figures, the expected compound annual growth rate for advanced services powered by ServicePort is 41 percent.

When ServicePort was first introduced, its implementation began primarily in the pulp and paper industry. It quickly expanded into many industries. Today, the service is used in chemicals, food, gas, marine, metals, minerals, mining, oil, paper, power, textiles and water ➔ 2.

There are significant reasons why the service has gained traction. As a remote-enabled service delivery platform, ServicePort allows customers and ABB experts to view, scan and track important key performance indicators (KPIs) that impact equipment and process performance. This gives engineers the ability to take actions to solve problems and improve performance. Customers and ABB personnel have local or remote access to clear, frequently updated views of KPIs.

By automatically collecting, analyzing and monitoring selected KPIs, ServicePort helps engineers make better informed decisions, giving sites improved availability, process performance and product quality, while reducing raw material use and energy costs ➔ 3.

Because the automated service tools used to capture and analyze data are so effective, they can be used by less experienced engineers. This expands ABB's ability to support global customers.

Branching out

To ensure that an enterprise's specific needs are met, ABB developed a way for ServicePort to provide the exact advanced services that a site chooses. Like a smartphone, ServicePort can host multiple apps, called Performance Service Channels, which deliver specific ABB advanced services.

The channels fall into three categories:
– Equipment performance services monitor the use and performance of ABB products, such as control systems and drives.
– Process performance services diagnose and improve production or

All ABB advanced services powered by ServicePort use an effective three-part methodology – diagnose, implement and sustain – to close performance gaps and assure higher performance.

3 Using ServicePort enables customers and ABB personnel to have clear views of equipment and process key performance indicators with which to make decisions.

business processes, such as loop performance and cyber security.
- Industry performance services diagnose and improve equipment or processes specific to certain industries, such as mining, and pulp and paper.

Performance Service Channels currently available are:
- Equipment (ABB Extended Automation System 800xA, ABB Harmony system)
- Process (cyber security, control loop performance)
- Industry (ABB mine hoists, ABB quality control systems)

New Performance Service Channels continue to be developed.

To further meet a site's individual needs, ServicePort installation options have also grown. Although ServicePort began as a single on-site hardware station, customers can now choose between workstation, rack-mount, mobile, mini or virtual options → 4.

Comprehensive analysis

All ABB advanced services powered by ServicePort use an effective three-part methodology – diagnose, implement and sustain – to close performance gaps and assure higher performance.

ABB advanced services are differentiated by the engineering designed into their delivery. This engineering ranges from automating data collection and analysis; through designing repeatable processes; to establishing secure, remote-enabled interaction between the tools, processes and experts the customers want.

One example of ABB's advanced services powered by ServicePort is System Performance Service. Using System Performance Service, ABB control system customers can obtain an automated control system checkup that provides a benchmark for system performance and configuration. Comprehensive diagnostic analysis can be used to assess a control system's operation and implement improvements. Through ServicePort, System Performance Service identifies, classifies, and helps prioritize opportunities to improve system performance.

Case studies

One ABB customer, a large natural gas processing facility in the Middle East that utilizes the world's largest ABB Harmony Distributed Control System, used ABB's Harmony and Loop Performance Service to identify and troubleshoot potential process problems. The plant needed uninterrupted operation to process large volumes of product and obtain top performance from its process control systems. However, production expansions and upgrades had created uneven performance at the site's eight processing trains.

The customer asked ABB to provide a single monitoring method to identify existing and potential process problems, as well as a standard method for trouble-

4 To meet customer demand, ServicePort is offered in a range of options including workstation, rack-mount, mobile, mini or virtual.

shooting these problems. ABB Harmony and Loop Performance Service, powered by ABB ServicePort, provided the data gathering, analysis and troubleshooting methodology the plant needed.

Performance Service software tools quickly identified a faulty bridge controller. By monitoring CPU use rates, the customer found a controller out of normal range, identified the cause and resolved the issue. Today, the plant continues to use these performance services to diagnose and resolve system and process issues, and to monitor system and process performance.

ServicePort can host multiple apps, called Performance Service Channels, which deliver specific ABB advanced services.

Another customer, a large chemical plant in the United States, produces numerous chemicals for consumer products that must be accurately processed for quality, efficiency and safety. In this complex operation the control system must perform optimally, making it critical that system settings and parameters are configured according to industry best practices and standards. Since the chemicals could be problematic or even hazardous if not used as intended, it is essential that each is correctly processed and tracked. To maintain needed accuracy, control system settings must be monitored often and compared with ABB best practices and standards. Additionally, system software has to be continuously updated with new releases.

The plant managers decided to take preventive actions to ensure that system configuration and parameters are accurately monitored by investing in ABB System 800xA Performance Services powered by ServicePort. Customer personnel immediately began using the channel daily to monitor system software, and were able to make more informed decisions relative to configuration changes.

Plant managers use System 800xA Performance Service to ensure system software is continuously updated with the newest releases. The ABB service team provides remote and on-site services to help the customer maintain software updates. Customer and ABB personnel use ServicePort Explorer in the plant to view data and trends to address issues and can even view data off-site.

After just two months of use, the customer decided that the ABB System 800xA Performance Service powered by ServicePort were so effective that company managers asked ABB to provide additional services to help them ensure product quality.

ServicePort spreads

As ServicePort appears at more customer sites, those who obtain it have a tool that can provide them with the level of service needed to maintain performance throughout the process automation life cycle.

Patrik Boo
ABB Process Automation Service
Westerville, OH, United States
patrik.boo@us.abb.com

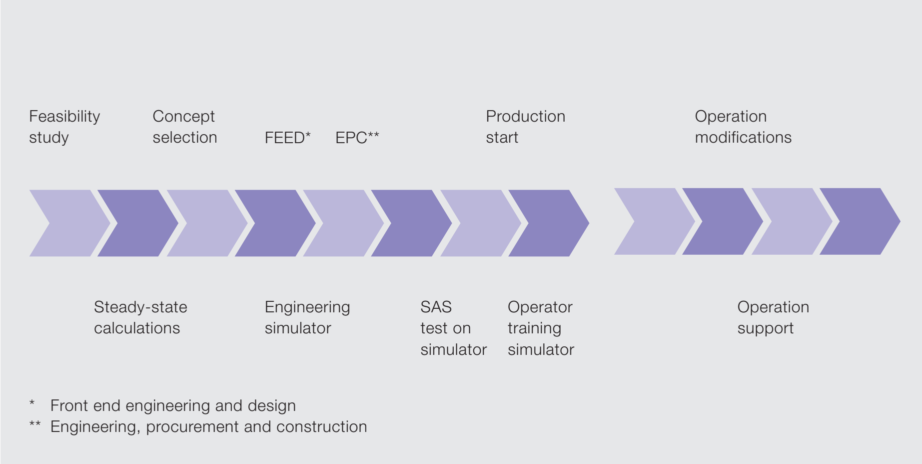
An expanded role

ABB's 800xA Simulator is now being used throughout the complete life cycle of an automation system

LARS LEDUNG, RIKARD HANSSON, ELISE THORUD – The combination of stringent safety demands and complex processes in industrial plants has led to the increased use of simulator solutions in recent years. Oil and gas producers as well as nuclear power plants have used simulators for decades, but now also other segments such as fossil power and minerals and mining are using simulators [1]. ABB's 800xA Simulator continues to improve safety and productivity in automated industrial processes and yet it can now be used for a great deal more, generating benefits during the complete life cycle of the automation system. One customer in particular is benefiting from the 800xA Simulator as operators master processes in a safe and realistic environment and engineers test control modifications before transferring to the actual plant environment.

Title picture
ABB's 800xA Simulator is playing a key role in the development and operation of Ormen Lange, one of Europe's largest and most technologically advanced natural gas projects.

1 800xA Simulator life cycle



The simulator's first stage of use with ABB's Extended Automation System 800xA is as a simulator for engineering, design and testing. It can then follow up with control system checkouts to verify and if necessary modify the control logic before the commissioning. Then the 800xA Simulator becomes part of an operator training simulator for training on an identical control system interface for plant familiarization, safety system operation, startup, shutdown, response on malfunction, emergencies and safety procedures. Finally, plant modification and optimization studies can be done on the simulator before costly installation.

As simulators are now being used throughout the complete life cycle of an automation system the expression "life-cycle simulator" is being used as well.

As simulators are now being used throughout the complete life cycle of an automation system the expression "life-cycle simulator" is being used as well.

Stimulated simulation

Two different types of process simulators exist. With stimulated simulators, the control system and its human machine interface (HMI) are identical to the real control system, and only the process and instrumentation are modeled. With emulated simulators the control system and instrumentation as well as the process itself are modeled. The look and feel of an emulated simulator may be similar to the real system, which may be good enough in some training situations. However, for life-cycle purposes the stimulated simulator is the only choice since an identical control system is needed. Also certain parts of System 800xA are too complex to emulate correctly, eg, sequences and advanced Alarm Management.

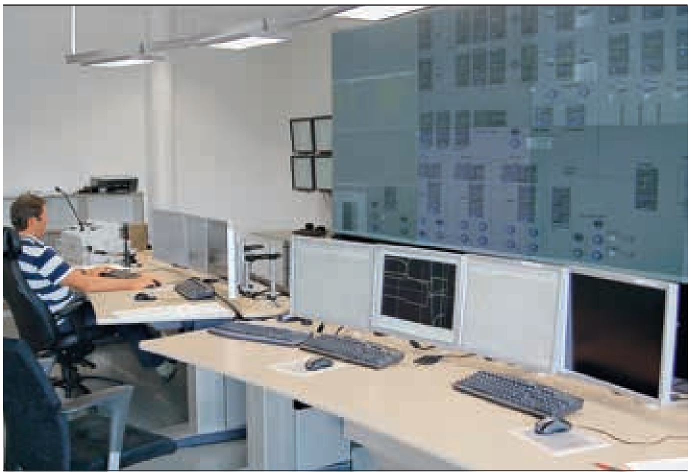
With 800xA Simulator, it is possible to create a simulator system with the same view and logic as the safety and automation system (SAS) of the running plant. The plant's System 800xA configuration can be copied to an identical operator training simulator environment for both testing and training, and the operator interactions with the control system become equal to the running plant.

800xA Simulator is the SAS part of a stimulated simulator system. Linked to a plant-tailored dynamic process model, it becomes a powerful life-cycle simulator system.

2 Life-cycle concept of 800xA Simulator

Life-cycle phase	Usage	Benefits
Planning and design	Design and engineering simulator	Improved and verified design through dynamic simulator model
Engineering	Safety and automation system test simulator	Integration of the model with SAS; verification of process control and operator dialogs
Virtual commissioning	Test plant design and SAS functionality in real scenarios	Validation of plant; reduced commissioning time
Production start	Operator training simulator	Operators prepared with training before plant startup
Operation	Training of new operators, hazard training, new operation strategies	Well-trained operators who can handle upsets in the process; verification of SAS changes and training operators before implementation on plant

3 Ormen Lange 800xA Simulator



The concept of the life-cycle simulator is to enable the customer to benefit from the investment throughout the complete life cycle of the automation system [2]. Therefore the simulator can easily be maintained to follow the plant life-cycle changes from beginning to end → 1–2.

Life-cycle concept

800xA Simulator supports each phase of the plant system life cycle, beginning with the design and engineering phase. A dynamic process model is developed in parallel with process design and used for verification. By doing this the quality of design is verified, major rework during the construction period is avoided, and control and safety philosophy is tested.

The SAS is developed in the engineering phase. The simulator is sequentially updated with process parts that are ready for control and operator dialog testing and integration with the model. The control strategy is verified. Using the simulator for realistic testing reduces commissioning time and increases safety during the commissioning phase. At this point the testing continues after the real control system is shipped to site for commissioning.

With the next phase the simulator is used for a wide range of realistic training purposes before plant startup to increase safety and reduce the number of unplanned shutdowns. Hazard and critical training can be repeatedly performed in a safe environment. Without the simulator option, this type of training is very expensive or not even possible. Training activities can include plant familiarization, operating and maintenance procedures, plant startup and shutdown, SAS operation, response on malfunction and emergency situations, as well as safety procedures.

Training can be for either new operators or for operators in new process areas. The simulator can be used in a certification program for production operators or technicians within new process areas or production lines. Also the simulator can be used for recertification to assure that operators retain and improve their skills.

The simulator can be used to study the modification impact of updating control logic and libraries, including the impact of applying updates while the process is in a producing state. It can also be used to verify changes to new or modified process areas, and to train operators accordingly. Testing software updates of System 800xA and control system firmware is also possible.

Process and control system optimization can also be simulated. With the simulator, optimization studies can be done by running scenarios and then applying improvements to the running plant. "What if" engineering analysis can be performed where required to optimize unit design.

Due to overlapping engineering and training activities customers often request more than one simulator system. This can often be the case before plant startup and in modification phases. For these occasions additional simulators can either be purchased or leased.

800xA Simulator uses the process graphics and control logic of the site's safety and automation system to provide an identical operator environment and identical process.

In an extensive study looking at the use of training simulators, over 90 percent of respondents evaluated the simulator use at their plant as successful or very successful, none as unsuccessful.

Ormen Lange project

800xA Simulator is playing a key role in the development and operation of Ormen Lange, one of Europe's largest and most technologically advanced natural gas projects → 3. The simulators were instrumental to production starting three weeks ahead of schedule in 2007 and are central to the continuous improvement and expansion of the field.

The field is located in the Norwegian Sea 120 km off the coast of Norway. The reservoir lies some 3,000 m below the seabed and contains recoverable gas reserves of some 400 billion m^3. The gas wells are located on the seafloor at depths of 800 to 1,100 m and are the world's largest wellheads to date. The gas is transported from the reservoir through two multiphase pipelines to an onshore processing plant at Nyhamna, Norway, where it is dried and compressed.

ABB process control, safety and information management systems monitor and control the gas processing plant. The plant subsea installations and the flow of gas through the pipeline are also monitored and controlled with ABB process control, safety and information management systems.

800xA Simulator uses the process graphics and control logic of the site's safety and automation system to provide an identical operator environment and identical process control. The dynamic process model is delivered by Kongsberg Oil & Gas Technologies.

From the very beginning of the Ormen Lange project, emphasis was made on training the operators and performing final testing of the control logic in parallel with construction of the onshore and offshore production facilities. Each of the many process sections was analyzed and tested in the simulator before construction was completed. One engineering and two operator training simulators were used in parallel.

The Ormen Lange project is under constant development and expansion. 800xA Simulator is playing a key role in its growth and evolution by enabling new processes and subsystems to be designed, engineered, corrected and tested before they are integrated into the plant control system.

In 2011 ABB delivered a fourth 800xA Simulator for the site's groundbreaking subsea compression project. The purpose of this full-scale pilot project is to determine the feasibility of using subsea compression rather than topside compression to maintain a stable flow of gas when the natural pressure in the field begins to drop.

This is the largest subsea compression development and qualification project ever undertaken. The control system for the full-scale subsea compression project is being designed and tested in 800xA Simulator and is expected to be fully operational in 2015.

Customer experiences and achieved benefits

The Ormen Lange project is not the only project reporting such positive results from actively using simulator systems. In an extensive study evaluating the use of training simulators among major oil companies on the Norwegian shelf, conducted by Oslo and Akershus University College of Applied Sciences [3], some major results were:

- Ninety-seven percent of the respondents used plant-specific simulator systems, ie, no generic simulators
- Eighty-nine percent used the simulator systems also for engineering purposes
- Over 90 percent of the respondents evaluated the simulator use at their plant as successful or very successful – none as unsuccessful.

Other noteworthy findings from the survey include a 31 percent estimated increase in operator effectiveness and a reduced time for commissioning and startup by 18 days for a new facility and 2.2 days after modifications. Simulator training can help avoid an average of three unplanned shutdowns per year. The average total estimated annual savings in the study were $15.3 million per plant.

Lars Ledung

Rikard Hansson

Elise Thorud

ABB Process Automation, Simulator Solutions

Oslo, Norway

lars.ledung@no.abb.com

rikard.hansson@no.abb.com

elise.thorud@no.abb.com

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Switching gears

Moving to smart switchgear for primary and secondary substations

VINCENZO BALZANO, MARTIN CELKO – Medium-voltage (MV) distribution systems are undergoing a revolution: Gone are the days when they merely distributed power of consistent quality from some far-off generator and performed basic switching and protection duties. Now, intermittent local generators, such as wind and solar sources, present a more complex energy flow for the distribution equipment to handle. Further, there are heightened quality and reliability expectations from operators and consumers. This puts the onus on utilities to make sure their often aging grids become safer, smarter, more efficient, more reliable and more environmentally friendly, and in addition, easier to engineer, install and operate. This is why MV distribution networks are becoming "smart." To address the demand for smart switchgear, ABB has developed the UniGear Digital concept for primary substations and the SafeRing, SafePlus and UniSec products for secondary substations.

1 SafeRing GIS RMU for smart grids

Major changes are running through the power industry: On top of industry-mandated indices like the system average interruption duration index (SAIDI) and system average interruption frequency index (SAIFI), many states are introducing a range of other grid efficiency regulations. Further, the energy generator and consumer landscape is becoming more mixed and more sophisticated with intermittent generators like solar and wind sources jostling for grid access and major new consumers, like data centers, placing stringent demands on power providers.

All this is happening to an infrastructure that has changed little since its inception in the early 1900s. This situation has led to the genesis of the so-called smart grid. At the power distribution level, the smart grid offers an intelligent way to approach grid efficiency and reliability, and provides a solid foundation for the automation, and remote monitoring and control of switching. But smart distribution needs smart products, at both the primary and secondary substation levels.

Title picture

Improved levels of automation and communication in substations give central operators the ability to optimize grid operation. ABB's smart switchgear enables this optimization at the primary and secondary substation levels.

ABB UniGear Digital

ABB's UniGear Digital is not just the next version of an established product. Rather, it is a new concept – a new way of going about MV switchgear. The concept combines well-proven switchgear design with an innovative approach to protection, control, measurement and digital communication. It is based on an optimized integration of current and voltage sensors into MV switchgear, combined with the latest intelligent electronic devices (IEDs) and IEC 61850 communication. The concept is embodied in the UniGear ZS1, an ABB MV air-insulated switchgear (AIS) for primary substations.

This switchgear is produced locally around the world and more than 200,000 UniGear panels have already been installed in more than 100 countries. The UniGear ZS1 is used in demanding locations such as offshore platforms, container or cruise ships and mines, as well as in the more common applications, like utility substations, power plants, chemical plants, etc.

Lower cost and easier setup

With the UniGear Digital concept, "one size fits all," so there is no need to change primary MV components, for example, instrument transformers, if the load changes. This saves time and money during project planning and execution.

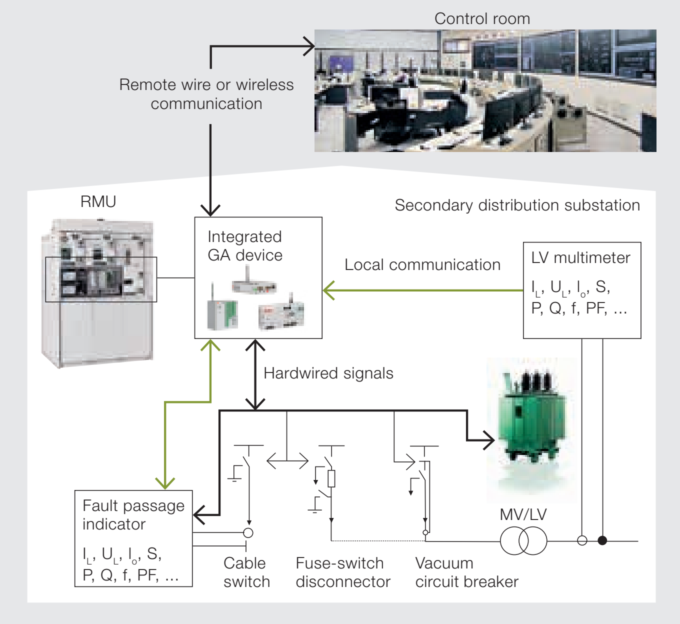
> The smart grid offers an intelligent way to approach grid efficiency and reliability, and provides a solid foundation for the automation, and remote monitoring and control of switching.

Energy losses during operation are lower with the UniGear Digital than with equivalent devices: Instrument transformer losses are eliminated and this can save around 250 MWh over the 30-year life of a typical substation. This represents a reduction of about 150t of CO_2 emissions.

Costs are also reduced because the UniGear Digital has fewer live parts, so outages are less frequent and troubleshooting effort is reduced. UniGear Digital takes up less space in the substation – a real cost-saver where real estate is expensive or limited.

2 UniSec for smart grids

3 Whole system overview



Setup is easier too. The streamlined setup procedure eliminates the necessity, in many cases, to define details such as relay parameters, current transformer (CT) data and voltage transformer (VT) data. CT/VT data does not have to be calculated, checked and approved, and last-minute changes can be realized in the IED logic. IEDs are perfectly suited to protection, control, measurement and supervision duties concerning utility and industrial power distribution – including radial, looped and meshed networks.

Using the IEC 61850 standard, the international standard for electrical system automation, further simplifies things. Protection and control IEDs publish signals for interlocking, blocking and tripping between panels via horizontal GOOSE communication. GOOSE (generic object-oriented substation events) – defined under the IEC 61850 standard – is a control model mechanism in which any format of data (status, value) is grouped into a data set and transmitted. GOOSE communication is becoming popular in substations as it offers simplicity, functionality, flexibility, easy scalability, improved diagnostics and faster performance.

The IEC 61850-9-2 LE process bus is also used by IEDs for transmitting sampled measured values (SMVs). UniGear Digital uses it for sharing busbar voltages, for example.

UniGear Digital combines well-proven switchgear design with an innovative approach to protection, control, measurement and digital communication.

Secondary substation automation products

Two elements are essential to enable the smart grid at the secondary substation level: automation of the secondary substation switchgear itself and the ability to communicate with the remote SCADA (supervisory control and data acquisition) system. ABB has products that address these: gas-insulated SafeRing and SafePlus ring main units (RMUs) and UniSec air-insulated switchgear.

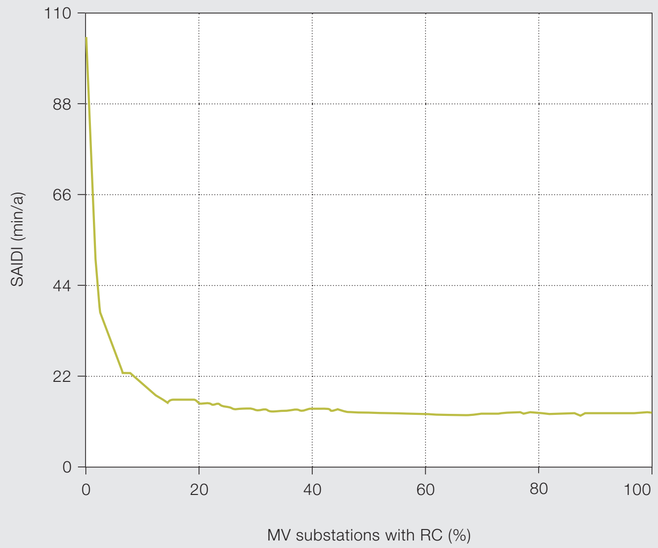
SafeRing and SafePlus RMU gas-insulated switchgear (GIS) is designed with flexibility and compactness in mind → 1. Each consists of a completely sealed system with a stainless steel tank containing all the live parts.

4 Typical automation level features

Feature	Level name: Monitoring	Control	Measurement	Protection
MV network switches position monitoring	x	x	x	x
MV network fault monitoring (including fault direction)	x	x	x	x
Distribution transformer feeders fault monitoring	x	x	x	x
MV network switches position control	n/a	x	x	x
MV network analog values measurement	n/a	n/a	x	x
Protection functions (including autorecloser)	n/a	n/a	n/a	x
MV network faults indication reset command	o	o	o	o
LV network analog values measurement	o	o	o	o
Distribution transformer feeders emergency trip command	o	o	o	o
Customer-specific signals (LV network faults, water intrusion, etc.)	x	x	x	x

x – available o – option n/a – not available/applicable

5 Nonavailability (SAIDI) of a network against number of MV substations equipped with remote control (RC) technology



This virtually maintenance-free system ensures a high level of reliability and personnel safety.

UniSec AIS is based on a highly flexible, modular concept that can be readily configured to meet the specific needs of each application → 2. UniSec is used in secondary substations where normal environmental conditions prevail, no severe space restrictions apply and complex configurations and accessories – with, for example, MV instrument transformers or surge arresters – are required.

Secondary substation automation

To enable automation, MV switchgear is equipped with an advanced grid automation (GA) controller. This device collects data available within the substation, puts it into a standard communication protocol and transfers it to the remote control center for evaluation → 3.

This improved level of automation and communication in substations gives the remote operator the ability to adjust different operations in order to:
– Provide high-quality power at all times
– Reduce energy transport losses
– Enhance network stability
– Avoid (or shorten) outages
– Avoid overloading network components
– Improve maintenance planning
– Enhance field crew efficiency
– Optimize asset management

Different levels of remote automation are available for ABB secondary switchgear and the user can select the one that best suits his needs → 4. Each level comes with a predefined IED standard package, which, in some cases, can even be integrated into the MV switchgear, thus eliminating the need for additional mounting space. Customization of these standard packages is also possible. All standard packages include:
– Power supply backup source for IEDs (24 V DC batteries)
– Wired and/or wireless (GSM/GPRS) communication interfaces
– Preconfigured IEC 60870-5-104 remote protocol signals

> The streamlined setup procedure eliminates the necessity, in many cases, to define details such as CT/VT data, and last minute changes can be realized in the IED logic.

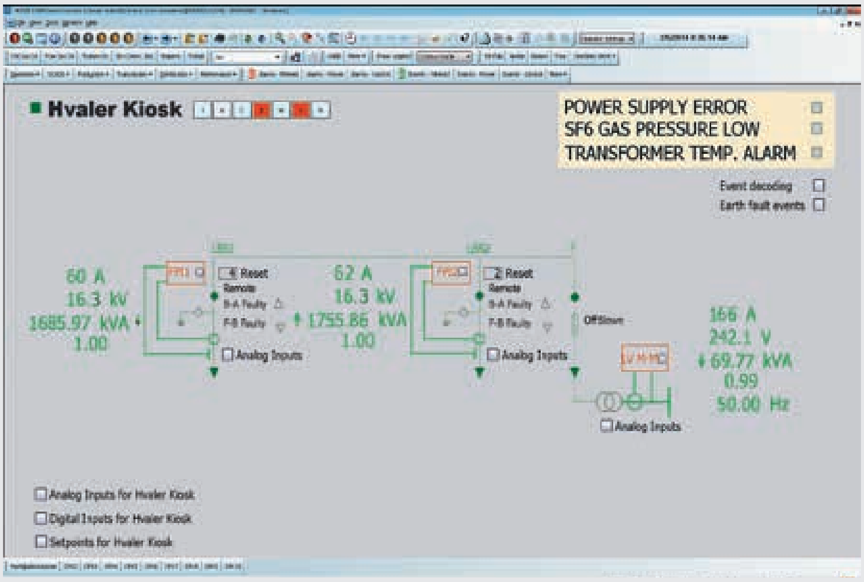
6 Smart grid in Rome

Acea Distribution, an Italian utility, is committed to making electricity distribution in the MV and LV networks more intelligent, with the aim of making Rome a smarter city. Acea started with a pilot project – one of eight pilot projects in Italy approved and partially financed by the Authority for Electricity and Gas. For Acea, ABB is a partner in this venture, rather than just a supplier – indeed, a cooperation agreement was signed in this regard.

In the experimentation phase, ABB provided UniSec switchgear, current sensors, voltage sensors and IEDs for the secondary substations. The logic employed is based on IEC 61850 protocol. Inter-substation and control system communication use GOOSE, over a private wireless network.

The system is installed on a new portion of the Rome electrical distribution grid and will allow Acea to substantially reduce the number and average duration of service interruptions, with a consequent reduction in restoration times and penalties.

7 Norwegian Smart Grid Centre



The island municipality of Hvaler in Østfold, Norway, was chosen to be the test laboratory for smart technology in MV and low-voltage (LV) distribution networks. This project is called DeVID (Demonstration and Verification of Intelligent Distribution networks) and is part of the Norwegian Smart Grid Centre.

The archipelago has a mix of homes that are occupied year-round, vacation condominiums, and commercial activity that provide the opportunity to study different electricity usage profiles.

Hvaler has 3,000 houses and 4,300 condominiums. The population increases from 4,000 in winter to 30,000 in summer, presenting a challenge for the entire infrastructure, including the power network.

ABB is one of several participants in DeVID and ABB's contribution is a Magnum compact secondary substation (CSS) with a SafeRing 24 kV switchgear that allows the local utility, Fredrikstad Energi, to locate any faults quickly and to monitor power quality and load in this part of the network.

The CSS is monitored via ABB's Network Manager SCADA, part of the company's Ventyx (enterprise) software portfolio; communication between SCADA and the CSS is via GSM. The two load break switches in the RMU can be controlled from the SCADA system and approximately 200 measurement parameters are monitored.

Energy losses during operation are lower with the UniGear Digital than with equivalent devices.

All IEDs installed within the switchgear or kiosk are factory preconfigured based on the standard package specification. The communication system details (IP addresses, access point name, SIM card PIN, etc.) and MV network parameters (fault pickup current, fault current pickup time, etc.) are usually configured on-site.

GA effectiveness

For a quick evaluation of the effectiveness of a particular GA solution, ABB uses an activity-based costing (ABC) calculation tool developed in cooperation with the National Technical University in Aachen, Germany. This allows calculation of, for example, the impact of a SafeRing installation and standard GA package on SAIDI → 5.

Smart switchgear is already making a big impression → 6–7. The smart grid is still in its infancy. Renewable sources, distributed generation and an increasingly complex and demanding network of power consumers are just some of the factors that will drive future product development in smart distribution switchgear.

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Vincenzo Balzano
ABB Power Products
Dalmine, Italy
vincenzo.balzano@it.abb.com

Martin Celko
ABB Power Products, Medium Voltage Products
Brno, Czech Republic
martin.celko@cz.abb.com

Smoothing the peak

Integrated optimization algorithms save heating costs

HOLGER KRÖHLER, ANDREAS SCHADER, REINHARD BAUER, SILKE KLOSE, SUBANATARAJAN SUBBIAH – Many industrial processes use large amounts of heat generated by electricity. This can be expensive, and even more so if significant quantities of peak power are consumed. ABB's new DCT880 is a thyristor power controller for heating applications whose integrated power optimization algorithms reduce costs by reducing peak power demand. This is done fully automatically without affecting the production process or schedule. The main component is an optimization suite that runs on the DCT880 without the need for further supervisory equipment like additional programmable logic controllers. The key to optimization is a microtime energy scheduling algorithm. This shifts the periods in which energy is consumed by amounts small enough that the heating process is not affected. However, by cleverly applying those changes, the peak power demand can, in many cases, be greatly reduced.

1 The DCT880's power optimization algorithms help users avoid expensive peaks in their power consumption.

A significant cost factor in all heating applications is energy. When heating electrically, the total energy cost is often greatly increased by the extra cost of power peaks. Such cost penalties are very common for larger customers as it helps to keep the grid and power production stable. This penalization strategy is becoming more prevalent as more renewable power generators join the grid.

One way to decrease the peak consumption would be to distribute energy-intensive process tasks evenly over the day. However, this approach would not prevent peaks that occur over a smaller timescale. The DCT880 offers a different solution – it distributes the load to maximize peak reduction → 1. In this way, the DCT880 can cost-optimize thyristor control of resistive, inductive and infrared heaters in annealing, drying and melting, and of heating in the glass, plastics and metal industries.

Title picture
Peaks in any sense set a challenge. A mountain peak is simply there and must be scaled. However, the sophisticated power optimization algorithms in ABB's DCT880 help users avoid expensive power consumption peaks in the first place.
Photo credit: Michelle Kiener.

General setup

Many industrial heating applications consist of numerous heating elements at the same site. These heating devices may have different energy consumptions when switched on; some may operate in a coupled manner; and they could all be controlled by one supervisory control or independently by local PID controllers.

Regardless of which setup is actually used, one requirement is ubiquitous: good power quality. This can be achieved by using full-wave burst firing, ie, by either letting full sine waves pass or by completely blocking them to switch the device fully on or off → 2. When doing power optimization, the DCT880 uses full-wave burst firing. Besides this mode, the DCT880 also offers other control methods like half-wave control, soft starts and soft downs as well as phase-angle control → 3.

The challenge with the DCT880 was to bring high-quality discrete optimization routines to a unit with relatively little computational power.

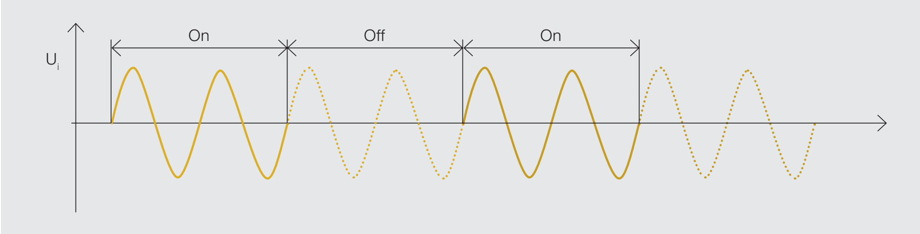
A heating application is often subdivided into cycles that are between 2 and 20 s long, with each cycle controlled independently. Directly before the start of a new cycle, sensor measurements are made and – for each heating device – the amount of energy to be distributed throughout the next cycle is calculated. Knowing the operating power of the heating device, it then is easy to calculate the length of the next cycle. The overall heating process is slow enough that it does not matter exactly when during the cycle the energy is distributed (ie, when the heating device is switched on).

Depending on the load type, each DCT880 can control up to three loads that are independent of each other. Many configurations are possible, such as several single-phase, delta, star, multi-tap, open delta, etc. If more than three loads are to be controlled, one (standard) DCT880 will act as master and will be responsible for the power optimization calculations. Any DCT880 can be made master by setting a software switch. However, there may be only one master per system → 4.

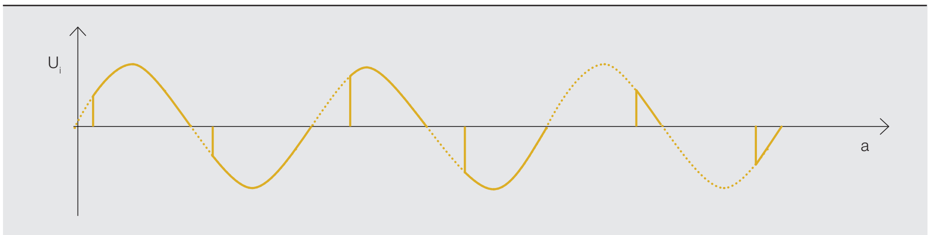
After a DCT880 receives the information on the energy demand of its load for the next cycle, it passes that information to the master.

When heating electrically, the total energy cost is often greatly increased by the extra cost of power peaks.

2 Full-wave burst firing



3 Phase-angle control



When the master has received this information from all its slave DCT880s, it performs the optimization step – ie, calculating when to switch each heating device on and off so as not to negatively affect the heating process. The results are then passed to the slave DCT880s so they can control their heating devices in the next cycle.

How is optimization done?

The diagram in ➔ 5 demonstrates the dramatic difference power optimization makes. When the DCT880's optimization takes charge, the curve volatility disappears and the curve becomes much smoother, never exceeding 50 percent of the installed capacity. How can this be achieved?

The principle is illustrated in ➔ 6. In ➔ 6a eight heat consumers are shown that have 100 kW and 200 kW operating powers and a utilization between 30 percent and 70 percent over the 1 s cycle time. ➔ 6b shows that the accumulated power consumption is uneven, with a peak after 300 ms.

➔ 7 shows the same situation, but with a mathematically optimal solution. The periods in which the consumers are switched on are perfectly distributed across the cycle ➔ 7a. No peak exists in the overall demand ➔ 7b.

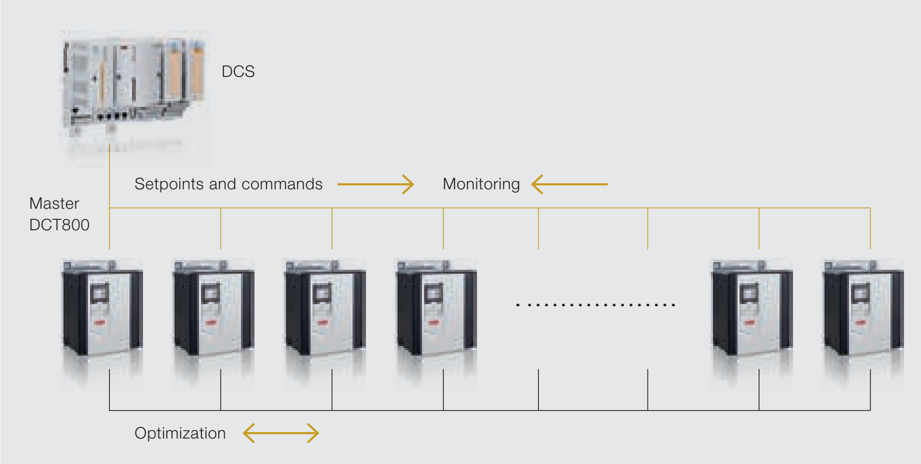
A special feature of DCT880's power optimization is its handling of mid-load situations. In ➔ 8a all devices are working at 60 percent utilization of the cycle time so no matter which consumer switching strategy is chosen, there will be a peak somewhere ➔ 8b. The problem can be overcome by splitting – ie, switching a consumer on and off twice during the cycle ➔ 9. Splitting is the only way to achieve this perfect solution.

To save cost, the approach should be able to run on a DCT880 alone – without any additional equipment. It also has to be fast enough to service small cycle times and accommodate different types of input.

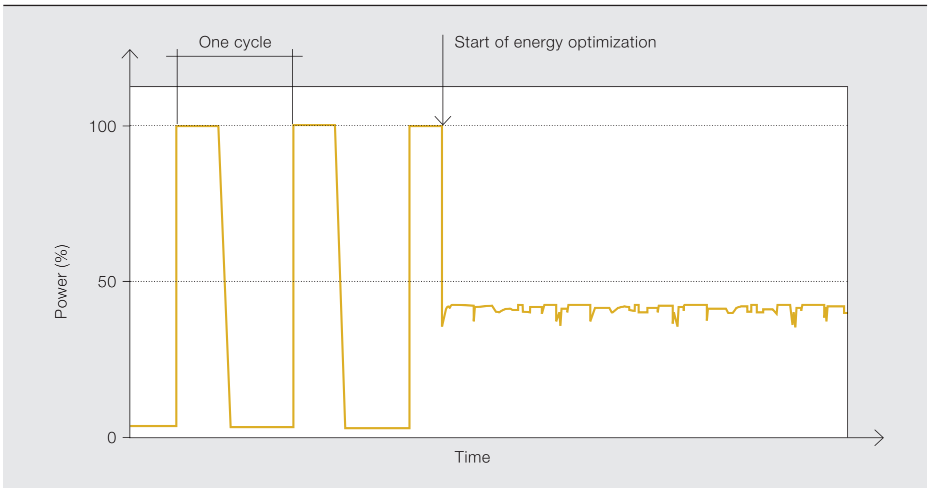
The approach: algorithm engineering

From a mathematical perspective, the underlying problem belongs to the field of discrete mathematical optimization. This is a very mature field of research, already offering a rich toolbox to support the algorithm development, in which ABB has extensive expertise.

4 Communication architecture of the DCT880



5 Energy consumption (relative to the sum of the power of all heaters) of an installation with 14 consumers without (left half of graph) and with (right half) power optimization.



The DCT880 distributes the loads to reduce peak consumption.

Mathematical optimization is often performed on dedicated high-performance computers. The challenge in the case of the DCT880 power optimization was to bring high-quality discrete optimization routines to a unit with relatively little computational power. The decision was made to apply the methodology of algorithm engineering: In a cycle consisting of design, analysis, implementation and experimental evaluation, custom-tailored, practicable and very efficient algorithms were developed that perfectly fit the available capabilities. Each algorithm considered was tested on data originating from a real-world installation.

Algorithm engineering is an iterative approach. After a new algorithm has been evaluated, it can become the new base for further development, can be discarded or can be revisited, depending on the measured quality of the approach. A sequence of solution algorithms with increasing quality is thus obtained.

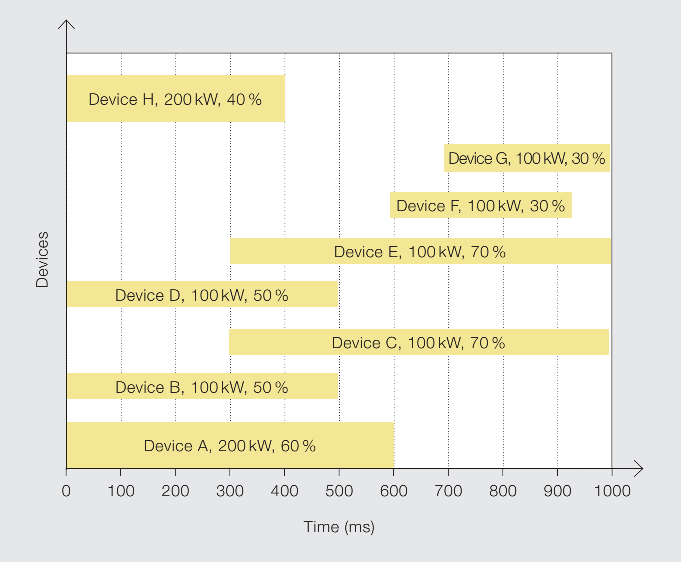
However, after reaching a satisfactory quality level only half the work is done. The next step is to make the algorithms simple and easy to work with. Again, using an iterative approach, the existing algorithms are improved.

Solution quality is not allowed to deteriorate. However, new algorithms should be simpler and easier to maintain than their predecessors. This way it is possible to satisfy the two, often conflicting aims of solution quality and maintainability.

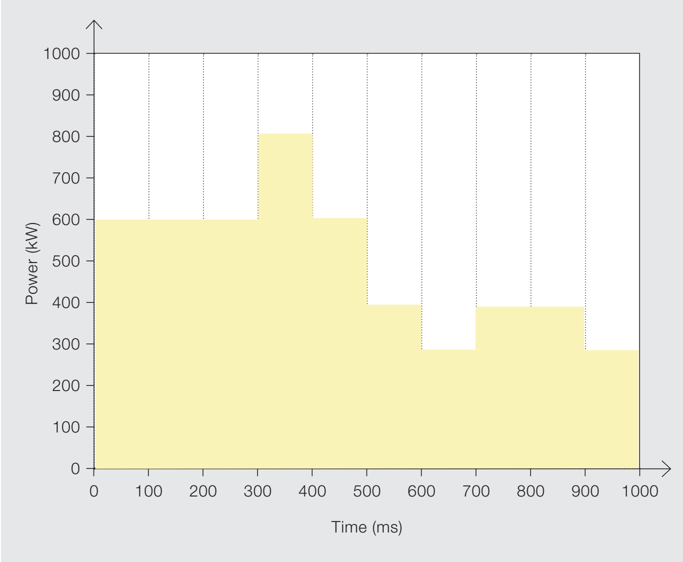
Making algorithms for the real world

In order to develop a solution that succeeds in a real-world setting, many additional requirements have to be met. Technical restrictions may lay down a minimum operating duration for a heating device. The number of switching actions within one cycle may also be limited. Further, a restricted grid connection may necessitate load shedding: If the

6 Nonoptimized power consumption

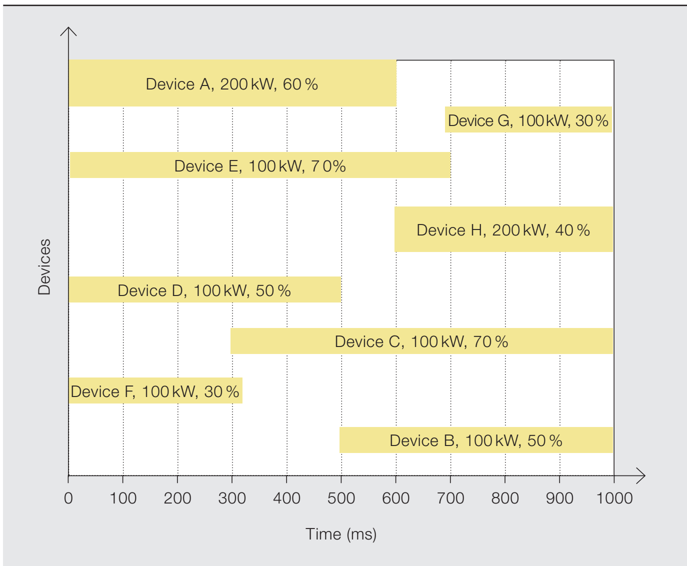


6a Eight consumers spread over a 1 s cycle

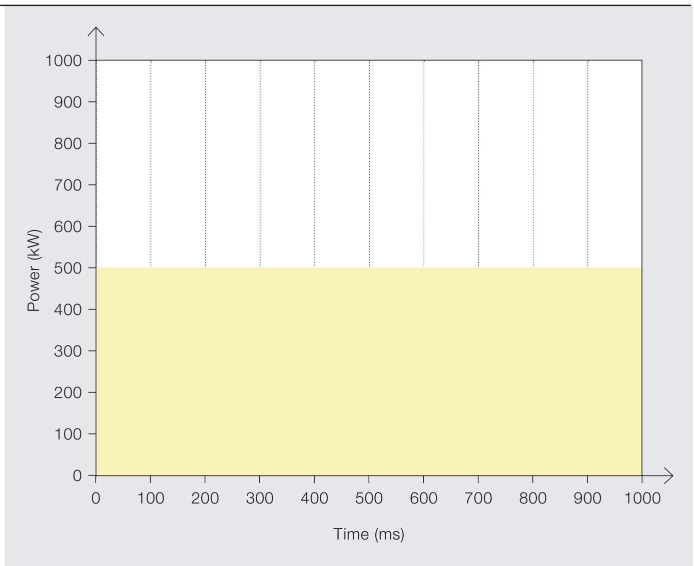


6b After 300 ms, power consumption peaks

7 Optimized solution

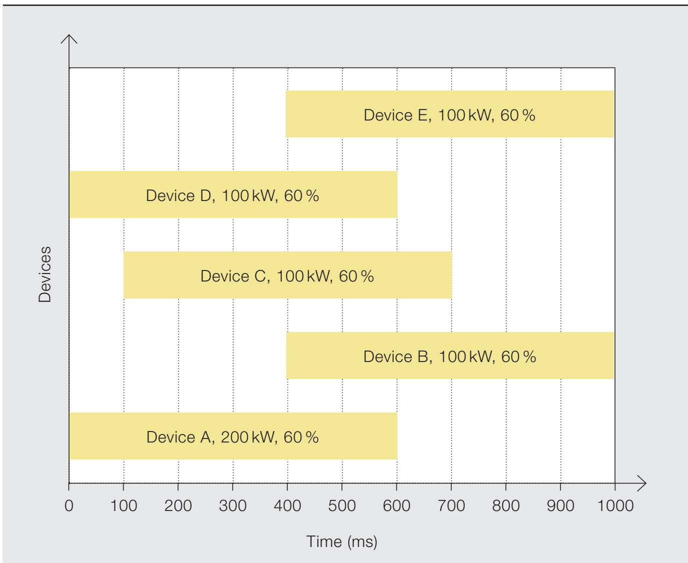


7a Consumers are distributed across the cycle.

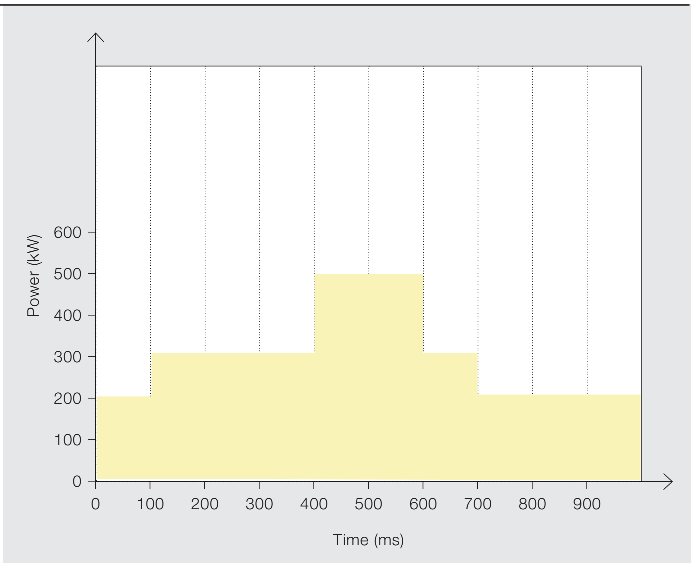


7b The optimal distribution of the consumers means that no power peaks are present.

8 Mid-load situation

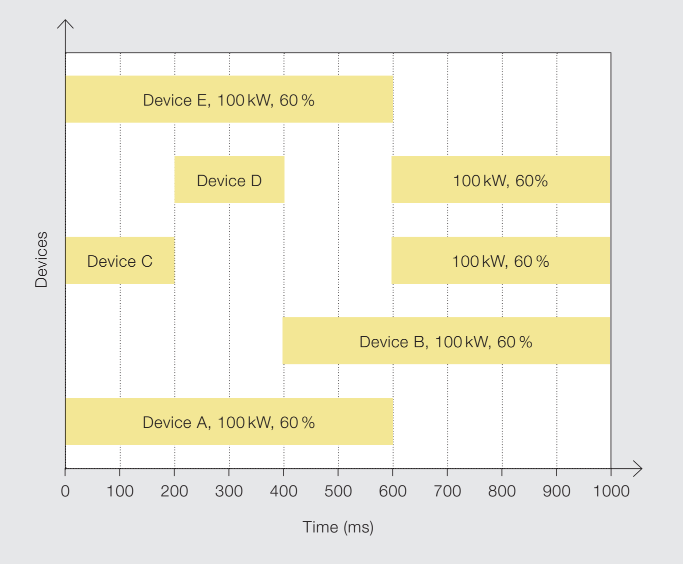


8a Loads may occupy a large portion of the cycle.

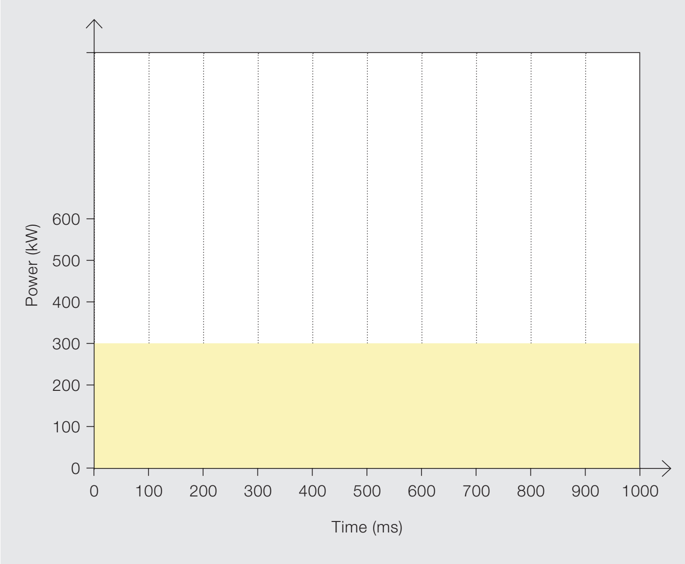


8b A peak somewhere is inevitable in mid-load situations.

9 Load splitting



9a During the cycle some consumers can be switched on and off twice.



9b Splitting is the only way to reach a perfect solution.

In a cycle consisting of design, analysis, implementation and experimental evaluation, custom-tailored, practicable and very efficient algorithms were developed.

heating devices' collective power demand exceeds the power the grid connection can provide, emergency shutdowns should be performed by some devices.

Further, to reduce costs for the customer, the approach should be able to run on a DCT880 alone – without any additional equipment. It also has to be fast enough to service small cycle times and accommodate different types of input.

With all these constraints, the solution should still be easy to handle and maintain. To that end, a solution was developed that does not need a mass of tuning parameters and options understood only by experts.

Benefits of the new solution

The DCT880 optimization solution reduces the customer's process energy costs. It also helps to enforce grid stability and power quality. It is easy to use as it dispenses with hard-to-understand tuning parameters, which means commissioning and maintenance can be done without the aid of specialists.

A further significant advantage of the solution is its architecture: The optimization is performed completely separately from the rest of the setup – ie, all units report their set points to the master unit and receive optimized commands in return. Hence, the optimization can be integrated into any setting – it does not matter if there is a supervisory control programmable logic controller (PLC) or if each DCT880 is controlled locally by a separate controller.

Further, the production process is not affected by the optimization routine so there is no need to adapt operational planning.

On the market

Development of the DCT880 – which is based on proven and reliable ABB DCS DC drive technology utilizing ABB's new control platforms, ACS880 and ACS580 – started in early 2013. The product and the power optimization algorithms were launched in late 2014.

Holger Kröhler
Andreas Schader
ABB Discrete Automation and Motion
Ladenburg, Germany
holger.kroehler@de.abb.com
andreas.schader@de.abb.com

Reinhard Bauer
Silke Klose
Subanatarajan Subbiah
ABB Corporate Research
Ladenburg, Germany
reinhard.bauer@de.abb.com
silke.klose@de.abb.com
subanatarajan.subbiah@de.abb.com

Wind window

An effective user interface for wind farm operations

MARIA RALPH, SUSANNE TIMSJÖ, ADRIAN TIMBUS, STEFANO DOGA – Wind farm operations often involve remote interactions with off-site control rooms. This poses a challenge because every wind turbine generates a large amount of information related to running conditions and power production. When the sheer number of turbines in some farms is taken into account, it becomes clear that the operators have to handle a much larger amount of data than their counterparts in installations such as hydropower or thermal plants. Further, it is critical that the remote operator is able to easily and effectively assess situations, access the right information, and react quickly and appropriately. Therefore, the design of the interface that provides operators with the information they need, while bridging the distance to the installation, is very important. This is where ABB's wind farm automation comes into play.

Wind farm operators have to handle a relatively large amount of data compared to other, similar installations, such as hydropower plants.

Wind farms are often monitored and controlled by operators sitting in off-site control rooms. As with any control room, it is essential that the operator has timely access to the right information so that the installation can be kept running smoothly. Furthermore, it is of the utmost importance that the information is presented in an intuitive way as this will enable the operator to perceive, interpret and react appropriately. In order to do this effectively, it is necessary to understand the needs of the operators.

Title picture
Wind farms produce a lot of data. Filtering, decluttering and presenting this information to operators in an effective way is essential to ensure they are not overwhelmed and can act quickly and appropriately.

Every wind turbine generates large amounts of data – such as wind speed, wind direction, ambient temperature, bearing temperature, rotor speed, nacelle direction and hydraulic pressure. Add in production data such as active power, reactive power and daily production, and multiply this all by the large number of turbines found in many farms and it becomes clear that operators have to handle a relatively large amount of data compared with other, similar installations, such as hydropower plants.

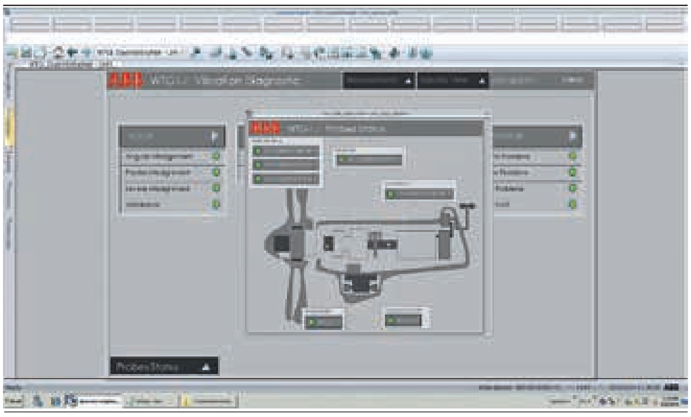
By interviewing and observing users in their real working environments, valuable insights can be gained into the key HMI design considerations.

By interviewing and observing users in their real working environments, valuable insights can be gained into the key human-machine interface (HMI) design considerations that relate to how all this data can be best presented. From a series of interviews and observation sessions with control center personnel who deal with renewable plants, in particular wind farms, various high-level operator requirements have been identified.

The requirements include the need to:
– Understand and interpret the layout of the wind farm.

1 Farm view with one tower selected, showing recent alarm history and power output

2 Wind turbine vibration diagnostics



The solution provides customers with an intuitive interaction experience. The design philosophy centers on improving situation awareness and thus improving support for decision making.

- Detect, comprehend and resolve alarms quickly.
- Get support for planning ahead (eg, maintenance).
- Be aware of the current situation.
- Quickly navigate between different parts of the system to access the right information – energy produced, trend data, alarm data, nacelle information, etc.
- Be informed about the status of the electrical substation linked to the wind farm.

Design concepts

With these considerations in mind, ABB has developed two prototypes. The first prototype used 2-D visualization to display wind farm information. This design focused on a PC-based user interface integrated into the Symphony® Plus system (ABB's automation platform for the power generation and water industries).

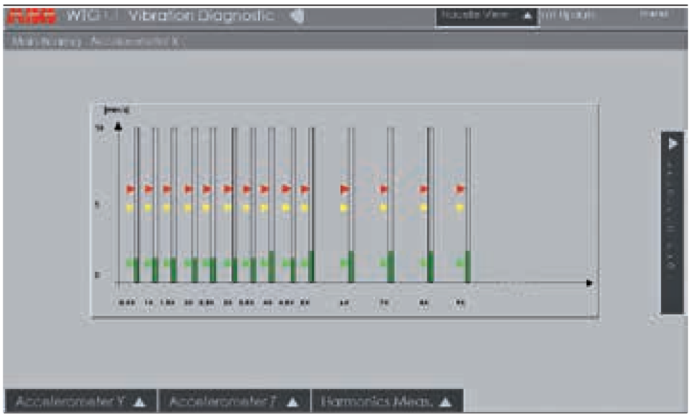
A first phase of the prototype was made available to customers at the end of 2014 and the remaining features are scheduled to be released in 2015.

Features of this prototype are based, in part, on the ASM (abnormal situation management) Consortium Guidelines for Effective Operator Display Design 2008 [1] and include the ability for operators to:

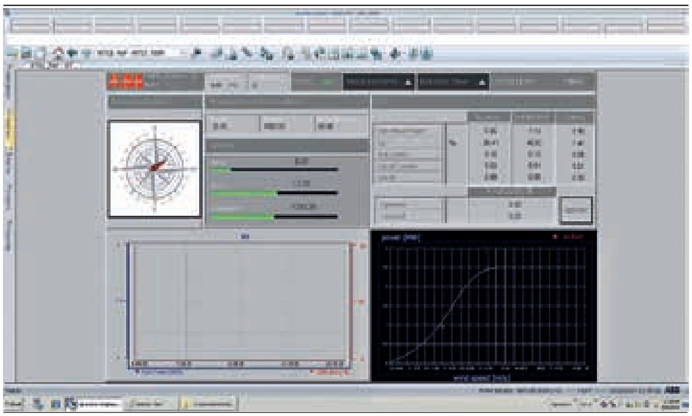
- Easily navigate between different information levels (eg, nacelle view, trends, alarm list, diagnostics) → 1-3.
- Access details (eg, wind speed, wind direction, target values, generation performance) of individual wind towers by using hovering interactions → 4.
- Switch between different views of the entire wind farm. This could be a representation of the wind turbines in a straight-line, schematic fashion, for example, or a view reflecting the actual farm topology and turbine separation → 5.
- Navigate to a more detailed view of the nacelle for a selected tower → 6.
- See desired information on a single screen (eg, wind farm overview, single nacelle view, alarm list).
- Compare certain parameters for several nacelles on the same screen.
- Save a wind tower's data in a "safe area" in order to analyze its behavior later.

The second prototype investigated if three-dimensional techniques could be applied to visualize wind farm information and thus improve the operator's understanding of weather data and the relationships between towers. A 3-D representation can be more intuitive and

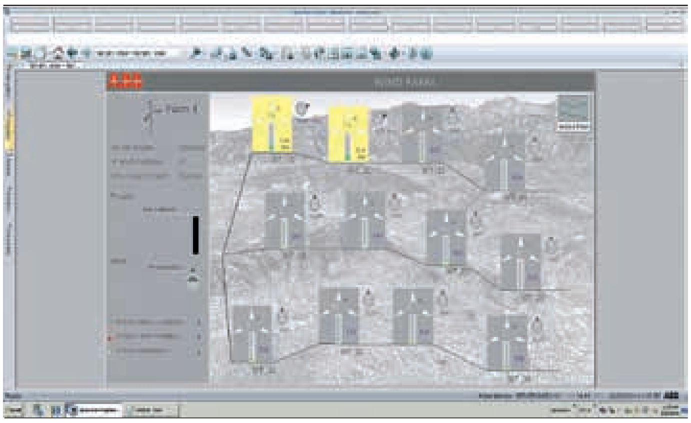
3 Harmonics diagnostic data



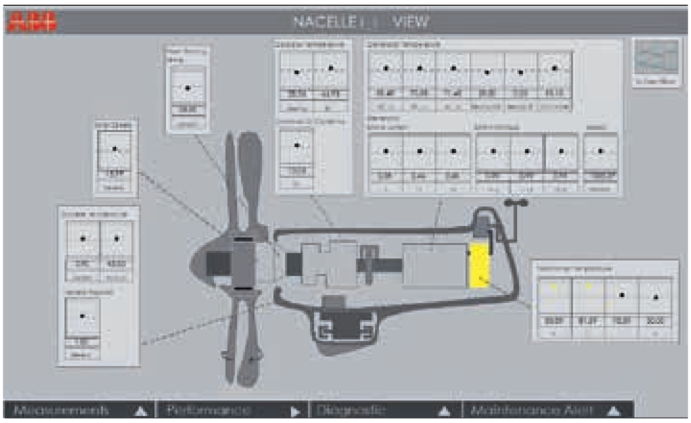
4 Performance data



5 Wind farm topology



6 Detailed nacelle information



effective when linking specific wind farm data with the physical turbines → 7-9.

Both approaches have been well received by customers and efforts are underway to provide hydropower plants and solar plants with a comparable product that has the same look and feel, and a similar type of support for decision making and monitoring.

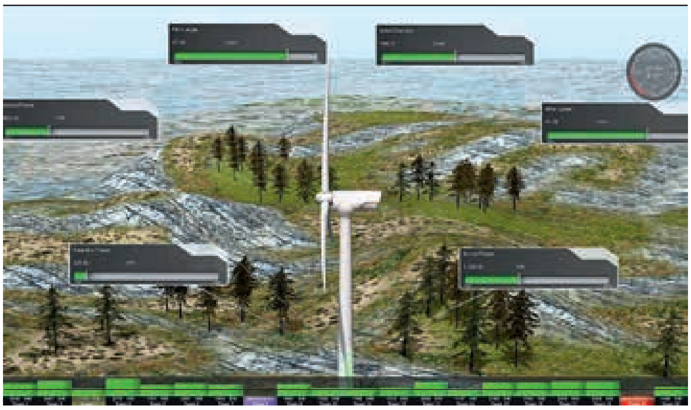
> By providing enhanced navigation and information visualization to operators, the application presents what they need, when they need it – and in a way that makes sense to them.

Operators benefits

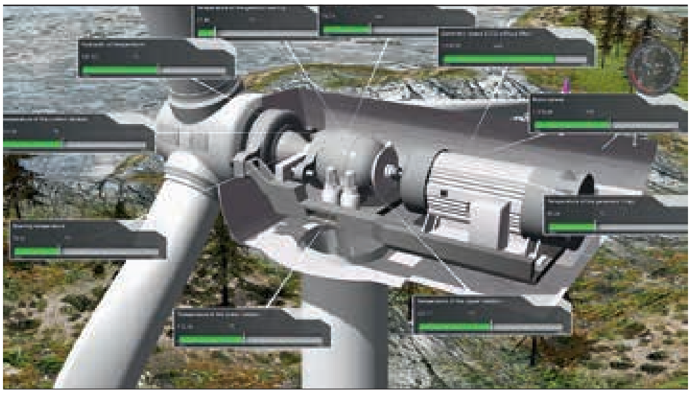
Following the completion of the initial designs and prototypes, the step-wise implementation into the Symphony Plus platform was continued. Further displays have been realized that help operators to more effectively manage their wind assets, from high-level, map-based presentations of the generation portfolio to dedicated displays for each wind farm, wind turbine and individual components. The implementations closely follow the design criteria and guidelines defined in the prototypes and also use a new color palette. The information is presented to the operator in a more structured way and the ability to smoothly navigate between various parts of the system – such as trend displays, faceplates and alarm management systems – allows operators to react to events in the field more efficiently.

7 3-D overview of wind farm

8 Wind turbine parameters in 3-D



9 Nacelle detail in 3-D



Situation awareness is further improved by the powerful alarm management system, which helps guide the operator's attention toward the important events in the field.

For the 3-D design, a connection between the application, which resides on a mobile device or desktop PC, and the database containing the plant data was implemented. This real-time connection allows field personnel to instantaneously obtain information about the asset while they are performing repair and maintenance work.

Customer benefits

This automation solution provides customers with an intuitive interaction experience. The design philosophy centers on improving situation awareness and thus improving support for decision making. By providing operators with enhanced navigation and better information visualization, the application presents the information they need, when they need it – and in a way that makes sense to them. This has a direct positive impact on the effectiveness and productivity of operators working within this domain.

With the new HMI concept, customers can see the relevant information at the portfolio level – split into country, region and plant type. Effective navigation allows a quick transition to the important details of every component – crucial when these details are needed to support informed decision making. Situation awareness is further improved by the powerful alarm management system, which helps guide the operator's attention toward the important events in the field.

Productivity and operations efficiency are boosted by an innovative way of displaying data. Instead of just showing the relevant numbers onscreen, their relation to lower and upper allowed margins is also displayed. This helps operators to more effectively detect inconsistencies or problems at first glance, thus reducing the effort required to understand abnormalities in the system's behavior.

This ABB offering for the wind power domain helps remote operators connect more directly and effectively with the process they are meant to control. With it, operators are able to make sense of the large quantity of data generated by wind farms and are in a position to easily and effectively assess situations, access the right information and act quickly and appropriately.

Maria Ralph
Susanne Timsjö
ABB Corporate Research
Västerås, Sweden
maria.ralph@se.abb.com
susanne.timsjo@se.abb.com

Adrian Timbus
ABB Power Systems
Zurich, Switzerland
adrian.timbus@ch.abb.com

Stefano Doga
ABB Power Systems
Genoa, Italy
stefano.doga@it.abb.com

Reference

[1] ASM Consortium Guidelines: Effective Operator Display Design. Available: http://www.asmconsortium.net/Documents/ASM_Handout_Display.pdf

Caps unlocked

ABB's new QCap cylindrical capacitor improves power factors

RAYMOND MA-SHULUN, CYRILLE LENDERS, FRANCOIS DELINCÉ, MARIE PILLIEZ – Reactive power is a major concern for both industries and utilities. It impacts energy costs and CO_2 emissions and causes equipment malfunction and failure as well as reducing equipment lifetime and adding to maintenance costs. There are many ways to mitigate reactive power – and virtually all involve capacitors. The capacitor may have been around for about 250 years, but with it playing such an important role there is always a case to be made for seeking additional improvements, especially in terms of further reducing losses and enhancing safety and reliability – and this is exactly what ABB has done with its new QCap. But what exactly is it that sets this new capacitor apart?

Design parameters range over several orders of magnitude within a capacitor element ranging from about 10 nm for the thickness of the metal layer to about 100 m for the electrode length.

As 45 percent of electricity generated is consumed by motors, and the inductive nature of motors makes them a consumer of reactive power, measures to keep this reactive power out of the grid have immediate benefits. One way to achieve this is to compensate the reactive power locally. There is nothing novel about using capacitors in such applications, but ABB's QCap capacitor breaks new ground in terms of reliability, quality and safety → 1.

ABB's QCap is designed to be the ultimate safe and reliable capacitor with unbeatable quality.

After more than 250 years of progress (the Leyden jar was invented in 1746) capacitors have developed into a commodity product. However, especially for metallized film power capacitors, their design and manufacture remains a highly challenging field – a poorly designed capacitor can fail in a catastrophic manner.

The power capacitor is the electrical component that deals with the highest electrical fields → 2. Design parameters range over several orders of magnitude within a capacitor element ranging from about 10 nm for the thickness of the metal layer to about 100 m for the electrode length: Key dimensions needing to be controlled during manufacturing span 10 orders of magnitude → 3. Furthermore, mechanical stress during winding plays a key role on the capacitor's performance. The production of a good capacitor element requires a deep understanding of all process parameters.

Building on its long history of manufacturing power factor capacitors, ABB adheres to the following seven imperatives:
- Know-how in R&D and production
- In-house design
- Material selection
- In-house manufacturing
- Stringent test criteria
- 100 percent testing of capacitor elements and units
- Continuous improvement of manufacturing process

Title picture
ABB's new QCap cylindrical capacitor features an advanced protection system and other innovative features.

1 The challenge of reactive power

When a pure AC voltage (containing only one frequency) is applied to a reactive load, the current will lag (if the load is inductive) or lead (if it is capacitive) with respect to the voltage by a phase angle φ. The cosine of this angle is defined as power factor (PF) of this reactive load → a.

The cos(φ) of a reactive load can also be defined as the ratio of its active power to its apparent power. Most reactive loads are inductive for the simple reason that most electrical power is consumed by inductive motors. According to IEA (International Energy Agency), around 45 percent of global electricity is consumed by electric motors of all kinds [1]. A motor's power factor varies from 0.7 to 0.9 at its nominal power. If the load decreases, so does the power factor. For instance, a motor with a power factor of 0.7 at its nominal load will have a power factor of 0.3 at a quarter of its nominal load [2]. As the load decreases to zero, the motor runs as a nearly pure inductive load (power factor approaching zero). Since few electric motors continuously run at their full load, low power factors are a major concern.

The delivery of reactive power causes losses in transmission and distribution networks (and CO_2 emissions). High levels of reactive power can even threaten grid stability. Therefore, most utilities around the world impose a minimal power factor for customers, and charge penalties if it is not met.

A common practice used to mitigate the inductive power factor is to install capacitor banks (switched or fixed) close to the loads. The reactive power required by the motor is then supplied locally by the capacitors rather than drawn from the grid. As shown in the phase diagram → b, adding a capacitor to an inductive load reduces the inductive (kvar) and apparent power (kVA) consumed, without the motor's active power being affected.

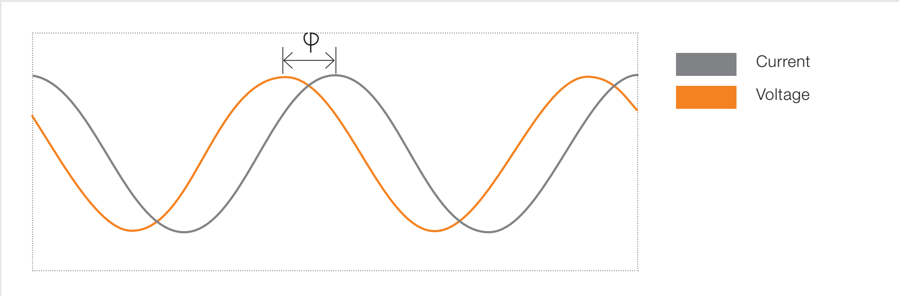
For many decades, capacitors have been a cost-effective solution to the reactive power challenge. However, the increasing use of variable-speed drives (VSDs) has opened an alternative method of operating electric motors while minimizing grid-side reactive power. But VSDs introduce a new challenge: grid-side harmonics. Harmonics are detrimental to other electrical equipment as they can cause overheating in cables, transformers and motors, or interfere with sensitive devices. The two main solutions used to mitigate harmonics are passive and active filters. Low-harmonic drives are also available but they are largely not cost competitive with passive and active filters. Thanks to their simple structure and low cost, passive filters are a common choice for suppressing harmonics. A passive filter is basically an LC filter, and thus requires a capacitor. With or without VSDs, capacitors continue to play an important role in connecting motors to the grid.

ABB has been a pioneer in developing and manufacturing power capacitors, catering for power factor correction (PFC) across the whole delivery chain of electricity, including high-, medium- and low-voltage applications.

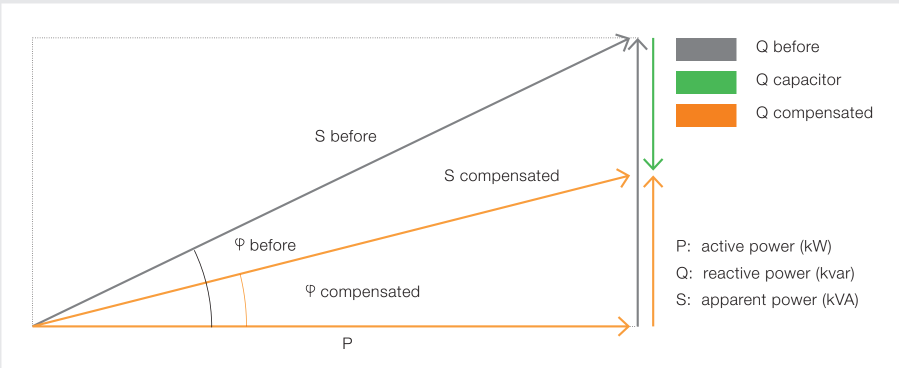
PFC solutions available on the market today can be divided into two categories: capacitor- and IGBT-based technologies → c.

In contrast to discrete step switching, IGBT-based technology can achieve stepless compensation. Active filters and stepless reactive compensators are two emerging products that improve the power factor by injecting compensating reactive current into the installation. Capacitor-based technology is the dominant solution in today's market.

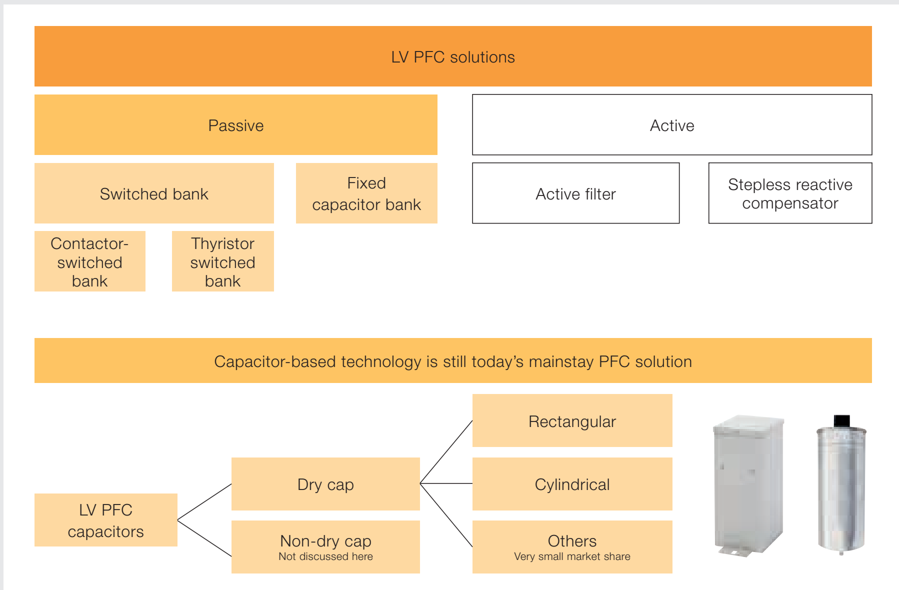
Capacitor banks today use mainly dry capacitors, with rectangular and cylindrical units being the most common. Some manufacturers also make other shapes but the market share of these is small.



a Reactive power is caused by the phase shift between current and voltage.



b Capacitors can be used to compensate the phase shift caused by electric motors.



c Power factor correction solutions

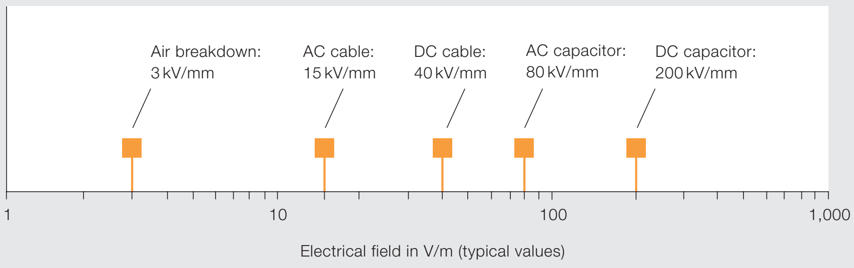
References

[1] Energy-Efficiency Policy Opportunities for Electric Motor-Driven System, P. Waide, C.U. Brunner, p. 35, OECD/IEA, Paris, 2011.

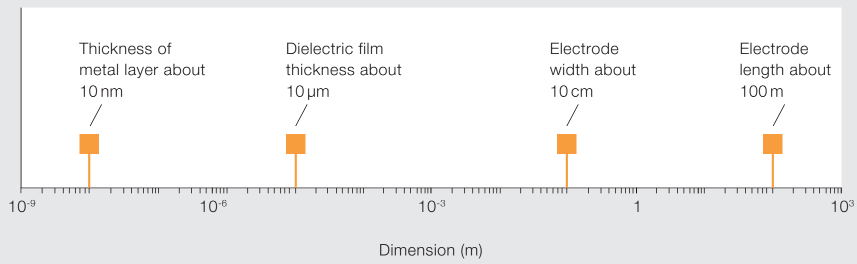
[2] Low voltage motors – Motor guide (ABB document 9AKK105285), p. 64, Feb. 2014.

Low power losses are a key requirement for a capacitor. High internal temperature is one of the primary causes of premature capacitor failures.

2 The power capacitor is the electrical component that deals with the highest electrical fields.



3 The major design parameters of a capacitor span 10 orders of magnitude.



A cool capacitor

As the newly developed low-voltage power capacitor for power factor correction, ABB's QCap complements the company's existing LV CLMD-type capacitor (rectangular type). It delivers value to customers by providing three enhanced technical merits:

– Low power losses
– Good heat dissipation
– Advanced safety features

Low power losses are a key requirement for a capacitor. Even if losses are relatively low compared with the reactive power available (typically 0.2 to 0.3 W/kvar), the heat generated is difficult to extract due to the plastic nature of the dielectric. The metallic electrodes are so thin that they barely contribute to heat transfer.

Losses are generated by dielectric polarization and by the Joule effect in the conductive parts, especially the electrodes. To optimize conduction losses, the thickness of the metal deposit can be varied according to its location. Using a thick metal layer throughout is not a good approach as it would in fact deteriorate dielectric performance. Temperature also has a fundamental impact on dielectric performance, leading to breakdown and aging. Consequently, high internal temperature is one of the primary causes of premature capacitor failures.

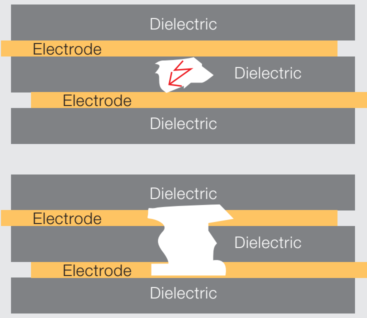
A holistic design perspective has been adopted to minimize losses. QCap uses optimized film width and device diameter to ensure a very low temperature rise. Film widths either too small or too large cause unnecessary temperature rises.

A metallized dry capacitor is able to isolate a small localized dielectric breakdown through a self-healing process.

QCap's low losses are achieved through:

– Use of the highest-class dielectric film

4 Self-healing process of QCap



4a Electric arc isolates short circuit

4b Self-healed dielectric

- ABB's unique metallization profile, minimizing electrode losses without compromising dielectric performance
- Optimized geometry, ensuring better thermal behavior

A safe capacitor

QCap's extremely safe design not only ensures the customer's peace of mind during the capacitor's entire operating lifetime, but also guarantees that when the device finally reaches the end of its lifespan (be it through failure or age) that it will do so safely. The principle of QCap's safety mechanism consists of two features:
- Self-healing technology
- Overpressure disconnection

Self-healing technology

A metallized dry capacitor is able to isolate a small localized dielectric breakdown through a self-healing process. Self-healing is a unique feature of capacitors with metallized dielectric.

Moisture or dust trapped inside the device, or some other type of defect, can cause a local dielectric breakdown. The resulting short circuit between two electrodes will emit plasma, vaporizing the dielectric material and the surrounding metal and leave a hole. The breakdown area is thus isolated and the capacitor self healed → 4.

Besides preventing the breakdown from spreading, the self-healing process leads to the loss of a small part of the capacitance (typically 1 part per million). It also releases a small amount of gas.

Overpressure disconnection

The usual way to protect a circuit against device failure is to use a fuse. However, a

> A high-impedance fault cannot be protected by a fuse.

capacitor (especially a metallized film one) can fail in both a low and high impedance mode. A low-impedance fault leads to a short circuit and can be protected by a fuse. However, a high impedance fault will not lead to a current increase, but to resistive behavior creating a local hotspot in the dielectric material and ultimately its meltdown. This kind of failure cannot be protected by a fuse[1], since the current through the capacitor is not necessarily larger than its nominal current (only the phase would shift from reactive to active).

The gas accumulation from self-healing actions slowly increases the pressure in a sealed can. This phenomenon can be used to protect the capacitor in the event of a failure.

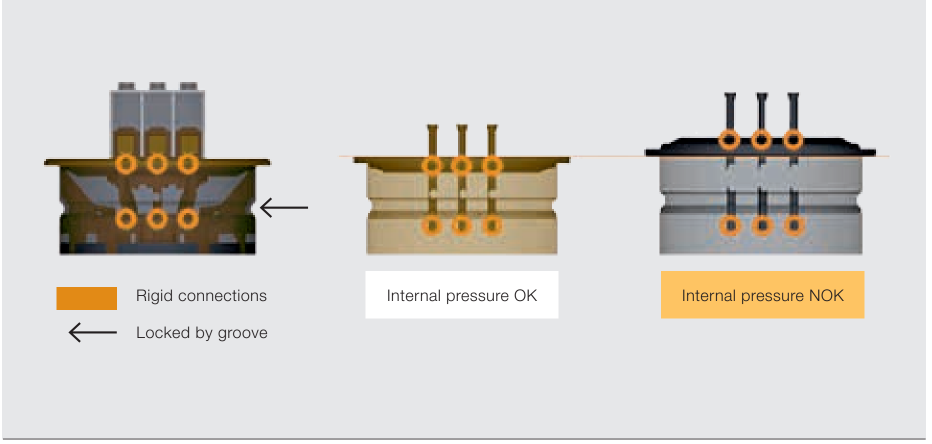
QCap features a protection system based on overpressure. The device terminals are internally connected using three notched wires that break when the

Footnote

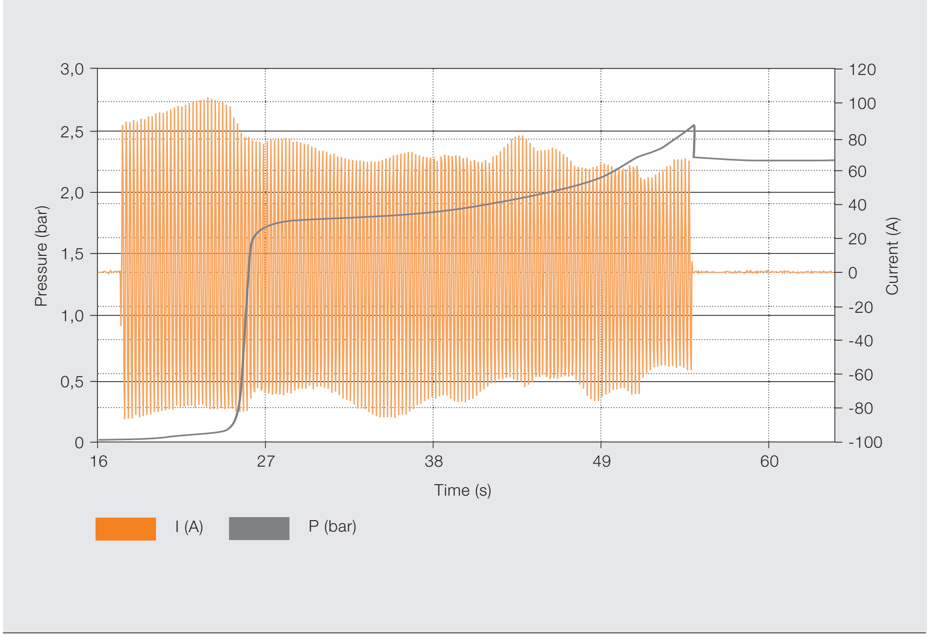
1 With the CLMD type, the strategy is to turn the high-impedance fault into a low-impedance fault by using a small parallel non self-healing capacitor, which upon failure will operate an internal fuse.

The gas accumulation from self-healing actions slowly increases the pressure in a sealed can. This phenomenon can be used to protect the capacitor in case of failure.

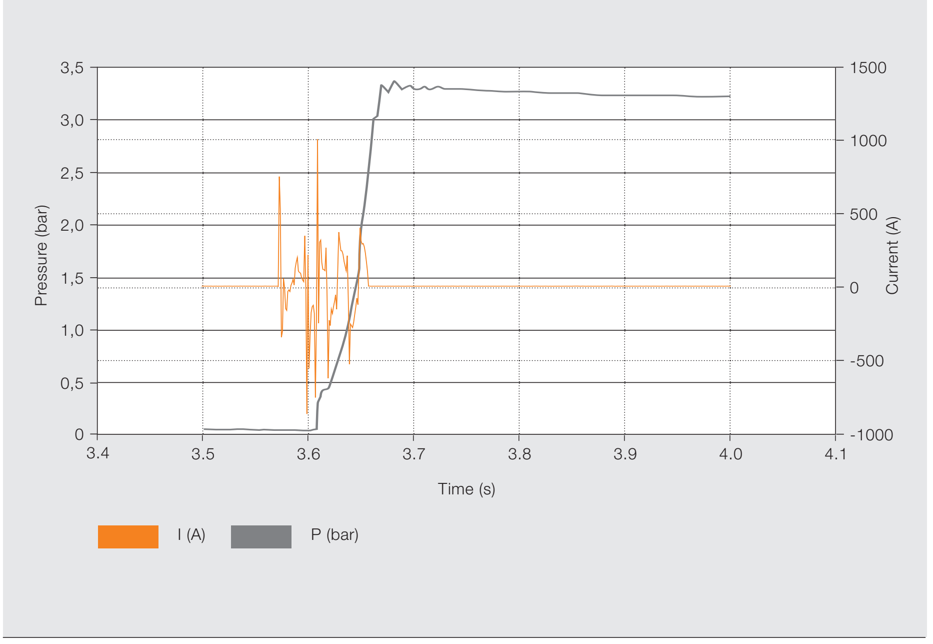
5 One of the safety features of the QCap capacitor is that it is disconnected by the buildup of pressure.



6 QCap self-disconnection in an overpressure scenario

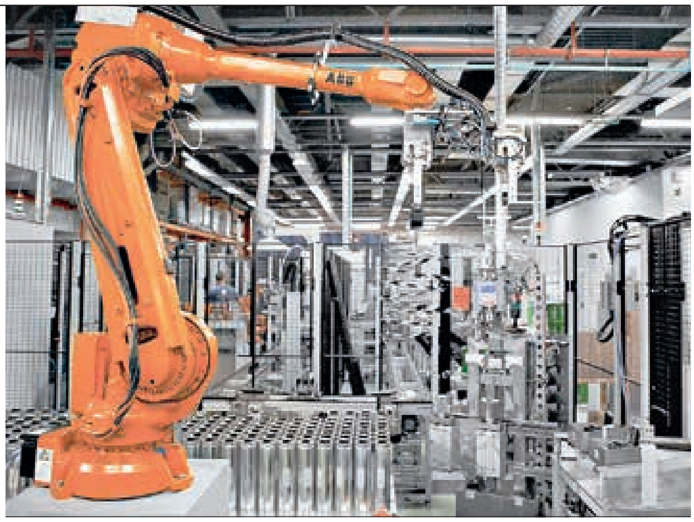


6a Pressure and current over time during detruction test – slow pressure rise



6b Pressure and current over time during destruction test – fast pressure rise

7a QCap capacitors



7b On the production line

ABB's QCap capacitor breaks new ground in terms of reliability, quality and safety.

lid rises due to gas pressure. To make sure the disconnection works reliably, the wires are indirectly anchored to the lid at one end and to the can at the other. The groove shown in ➔ 5 is designed to support this. The lid is manufactured to have two stable positions (normal and expanded). When pressure pushes up the lid, all three wires break and the capacitor is isolated from the grid.

The pressure threshold can be reached either by the long-term accumulation of gas released by self-healings (normal end of life) or by a high-impedance fault as described above.

Two recordings of the pressure rise and current during a destruction test are shown in ➔ 6. The elements were previously intentionally damaged by applying a DC voltage that was ramped up until a fault current limited to 300 mA was reached. Full AC power was subsequently applied.

The overpressure disconnection mechanism only works when the containing can is sealed, but this feature also has other advantages such as providing a barrier against electrode damage due to oxidation and moisture.

QCap: the ABB quality cylindrical capacitor

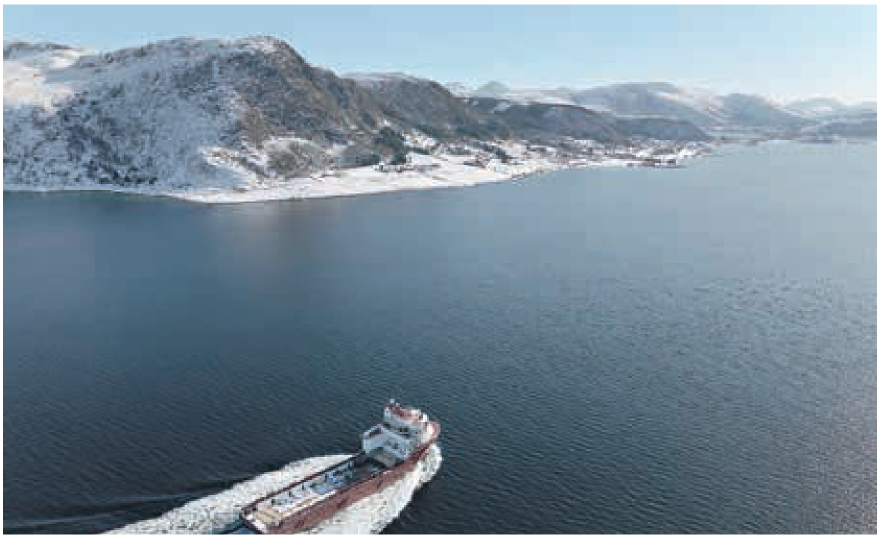
ABB's QCap is designed to be the ultimate safe and reliable capacitor with unbeatable quality. In summary, its six distinct features are:
- Reduced losses (minimizing premature failures)
- Best quality film (ensuring operating quality)
- Unique disconnection system in case of failure (ensuring safety)
- Optimized thermal dissipation (optimizing reliability)
- Manufactured on an automated production line (ensuring quality consistency) ➔ 7
- Elements and capacitor units 100 percent tested with stringent criteria

Raymond Ma-Shulun
Cyrille Lenders
Francois Delincé
Marie Pilliez
ABB Power Products
Jumet, Belgium
raymond.ma-shulun@be.abb.com
cyrille.lenders@be.abb.com
francois.delince@be.abb.com
marie.pilliez@be.abb.com

ABB in brief

Real-life performance of ABB's onboard DC grid technology

A few years ago ABB presented the concept of an onboard DC grid as a revolutionary solution that uses DC to transmit electric power between the prime movers, thrusters and propulsors, and other onboard consumers (see ABB Review 2/2012, "Onboard DC grid," pp. 28–33). Test results now substantiate the success of this solution.



The onboard DC grid is an extension of the multiple DC links that exist in all propulsion and thruster drives, meaning that all the proven electrical products used in today's ships remain-like AC generators, inverter modules, AC motors, etc.

However, the main AC switchboard and thruster transformers are no longer needed and the result is a more flexible power and propulsion system.

The expected improved fuel efficiency has been substantiated by the real-life performance of ABB's first onboard DC grid installation on the MS Dina Star, a multipurpose offshore supply and construction vessel owned by Myklebusthaug Management in Norway. One year after installation the MS Dina Star showed fuel savings of up to 27 percent during low load conditions and a decrease in sound pressure level of 5 dB from 1,800 to 1,200 RPM, which equates to a reduction in engine noise loudness of around 30 percent.

The results will be presented in more detail in an upcoming issue of ABB Review.

Connecting the canals

Venice is a UNESCO World Heritage Site, famous for its canals, majestic buildings and narrow winding streets. While proud to preserve its heritage, Venice is also a modern city. Residents and businesses now enjoy free Internet access. For a small fee this is also offered to the 22 million tourists visiting the city every year.

The network that handles more than 200 GB of data and 40,000 subscribers a day is equipped with 200 wireless mesh routers supplied by ABB Tropos Wireless Communications Systems.

The routers are deployed in discreet enclosures that blend aesthetically with the city's historical architecture and can switch automatically between two frequency bands (2.4 and 5 GHz), ensuring high connectivity, even in narrow and winding alleys. As Venice residents typically travel 30 minutes a day by boat, the water buses have also been equipped.

The Venice Wi-Fi project is part of the "Free Italia Wifi" initiative, whose objective is to create a national network of free wireless broadband networks.

Wind down the windows

On April 8, 2014 Microsoft ceased support for their hugely successful Windows XP operating system. This means there will be no new security updates, no new patches and no active support. The effect of this is that XP will become insecure, unreliable and incompatible with most newly released IT hardware.

Security issues are the most urgent consideration: The target-rich landscape of industrial IT is already under an unprecedented and sustained assault from malicious agents, so the cessation of XP security updates is a very serious matter.

Further, most hardware manufacturers have already stopped supporting Windows XP, so there will be no XP drivers for new hard disks, printers, graphics cards, network equipment, etc.

There are compliance issues too: Businesses that are governed by regulatory obligations may find that they are no longer able to satisfy compliance requirements. With so much personal and private data now stored on servers, this is a very significant concern. The recommendation made by Microsoft and all cyber security companies is to upgrade to Windows 7 or 8. ABB offers solutions to the XP situation that help customers better protect their plants and personnel while ensuring safe operations and continuous production.

Decathlon® for Data Centers turns cost centers into profit centers

Insight into data center performance helps businesses better understand their profitability. Because a modern data center resembles a small town in terms of its energy budget, monitoring and control requirements, understanding when, where and at what rate energy is consumed from data center assets has become a key performance indicator of business health.

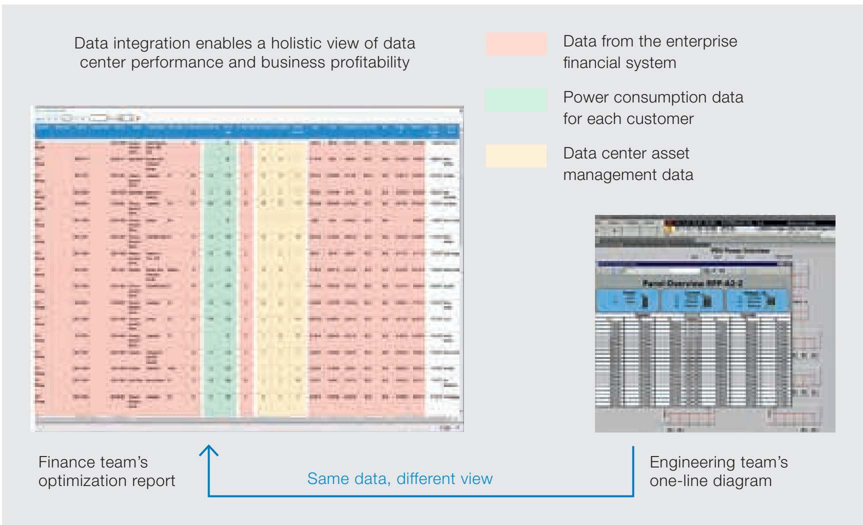
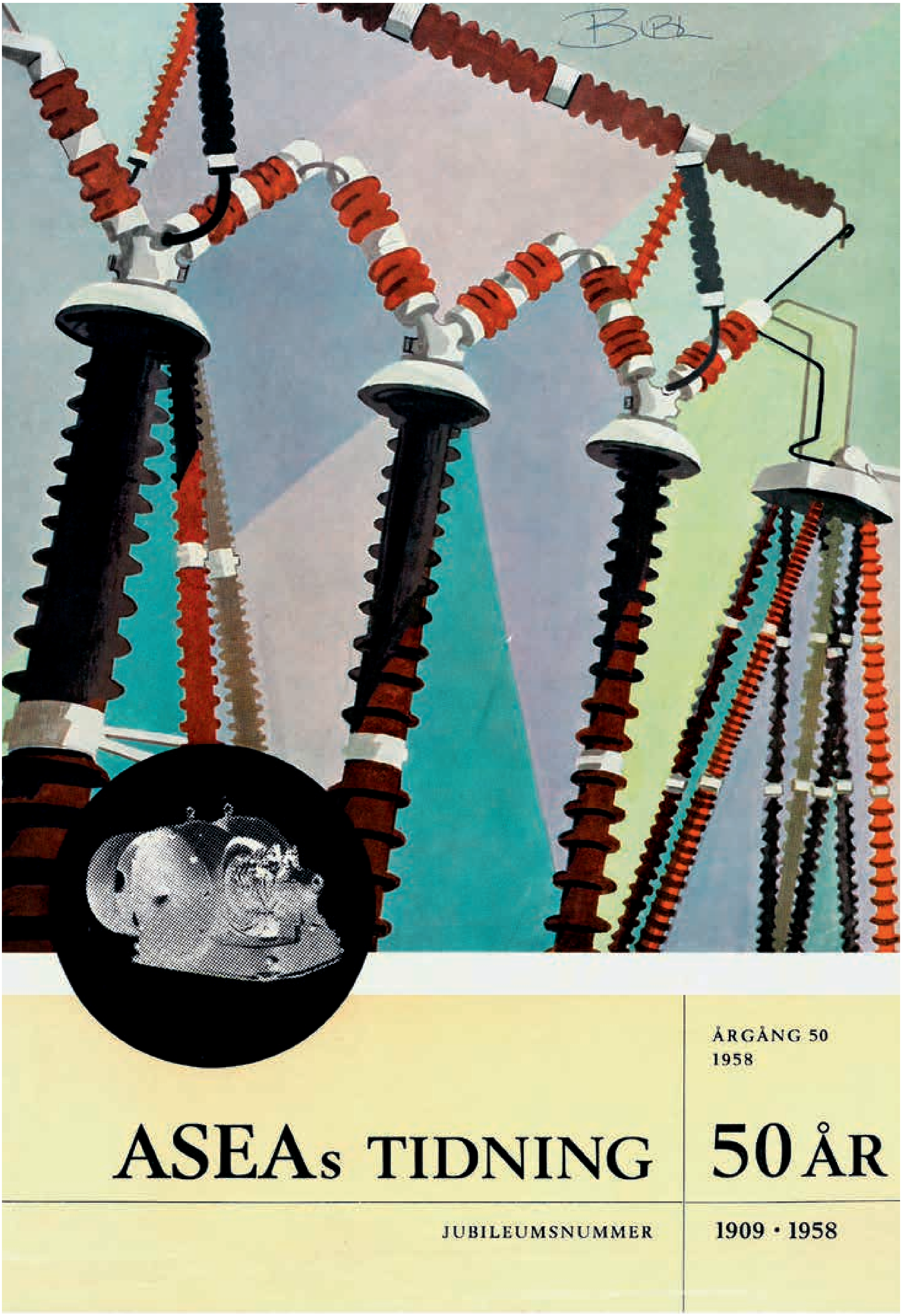


ABB Decathlon for Data Centers provides the visibility, decision support and controls for capabilities – like energy management and capacity planning – that these behemoths of the IT industry need in order to run efficiently. Telx, a major provider of data center colocation services across the United States, has delivered an exceptional example of how Decathlon can transform operations. Telx uses Decathlon for Data Centers to optimize energy consumption and cooling, and in a sophisticated approach unique in the data center business, they also exploit data center performance metrics to help other business functions. For example, the finance department incorporates power consumption data to more accurately analyze profit; the sales department uses data center operational costs to adjust pricing when it's time for contract renewals; and the product marketing department uses data center performance information to better understand how products and services are sold to and used by customers. Moreover, because they are using a single data source, there is less room for error in business and operational analyses. The ease with which Decathlon enables data to be integrated, normalized and fed into all the company's business tools means that business profitability can be analyzed from a power and energy standpoint. With this integrated approach and focus on both business and operational metrics, even enterprise data centers – which are often viewed as a cost centers – can become profit centers, too.


ÅRGÅNG 50
1958
ASEAs TIDNING
50 ÅR
JUBILEUMSNUMMER
1909 • 1958

From the ASEA archives

Looking back on more than a century in print

ANDREAS MOGLESTUE – The year 2014 saw a prominent focus on history in the pages of ABB Review. Several articles explored the history of different ABB technologies and issue 2/2014 featured a large section dedicated to the history of the journal itself, presenting many gems from the archives.

ABB Review revisited its history in 2014 because that year marked the anniversary of the first publication of one of its predecessor journals, BBC Review. The centenary edition was produced as a collectible issue → 1. The lead article of that issue pointed out that ABB Review has another – even older – predecessor journal. This article takes a closer look at that journal.

ASEA, one of ABB's predecessor companies, launched the magazine ASEAs Tidning in 1909.

In 1909 ASEA launched a magazine called ASEAs Egen Tidning [1] (later ASEAs Tidning), which had a mixture of technical papers and more general articles intended for external and internal readerships and was published in Swedish. In 1924 it was joined by a second publication aimed at an external readership. This was ASEA Journal, which was published in English from the beginning.

When ASEA and BBC merged in 1988, the editorial activities of ASEA Journal and BBC Review were also combined and the journal was renamed ABB Review. The following pages present a selection of items from the pages of ASEA Tidning and ASEA Journal → 2–6.

ABB Review's celebration of its history is not confined to the centenary. For many years now, the journal has been publishing articles with a history perspective in its "Perpetual Pioneering" series → 7. The editors intend to continue this series in the future by exploring further aspects of the company's rich history.

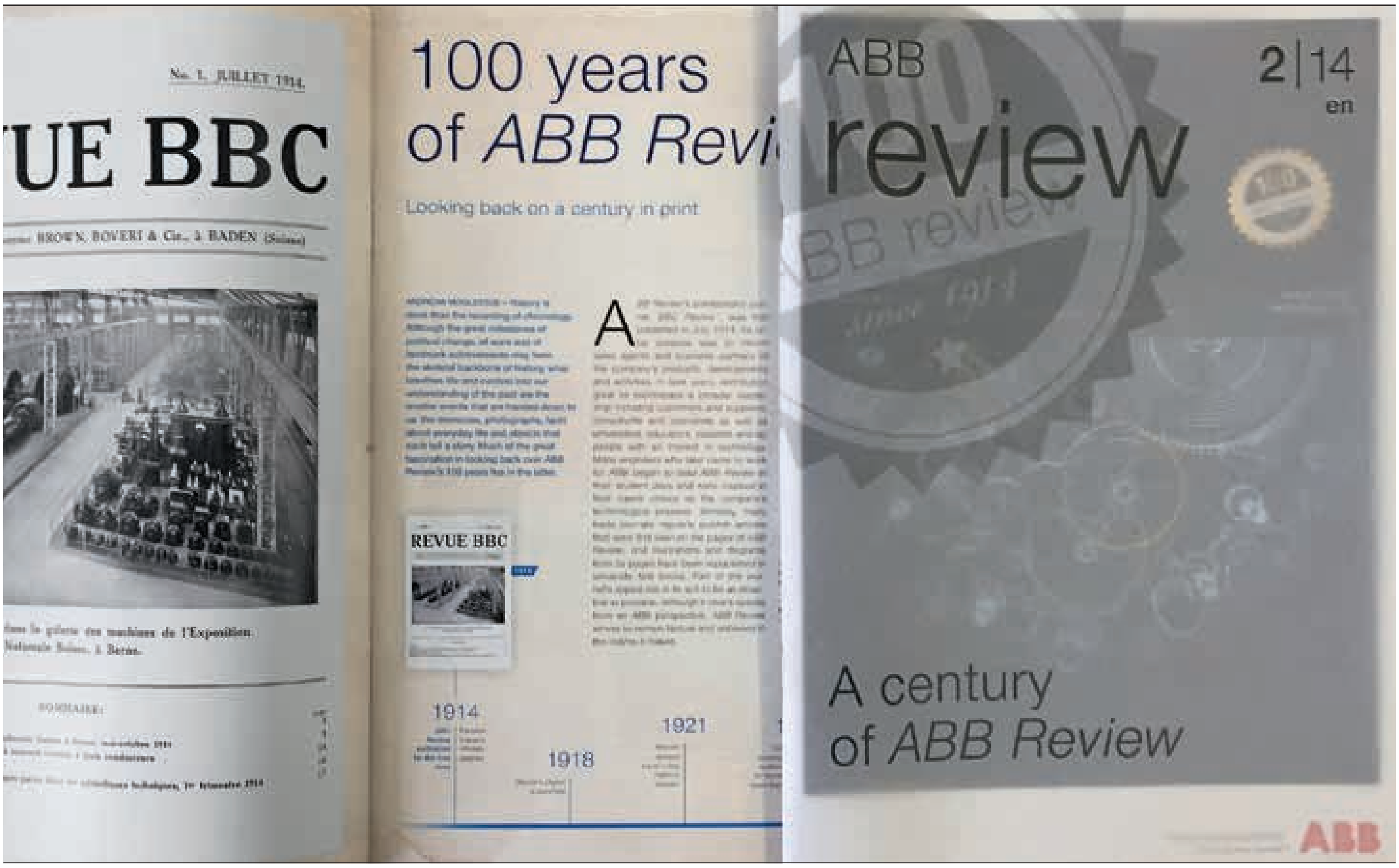
Many thanks to Mikael Dahlgren for searching for this material in the ASEA archives.

Andreas Moglestue
ABB Review
Zurich, Switzerland
andreas.moglestue@ch.abb.com

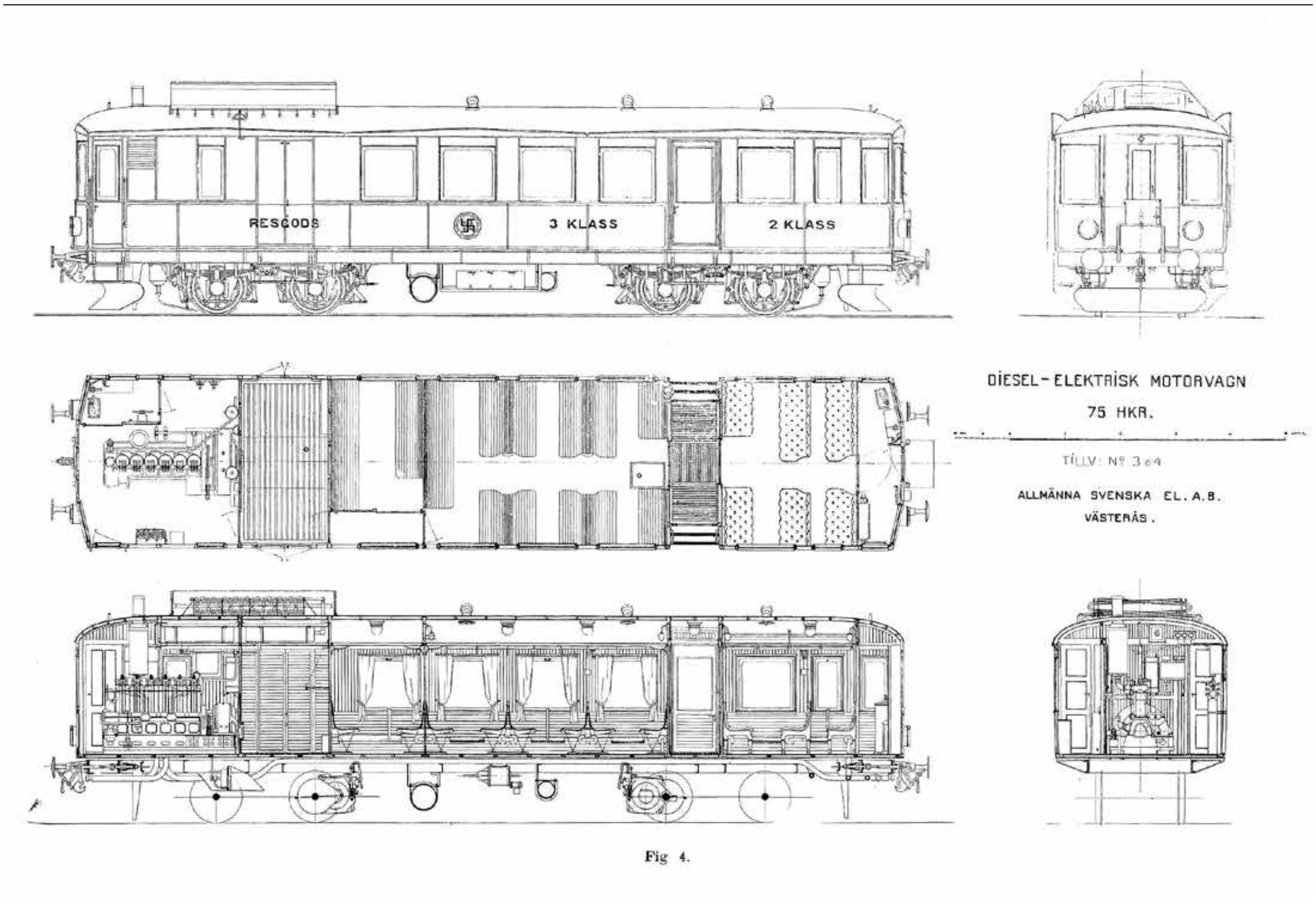
Title picture
Cover of the 50th anniversary issue of ASEAs Tidning (1958)

Footnote
1 Translation: ASEA's Own Journal

1 The print edition of ABB Review’s 2014 collectible centenary edition

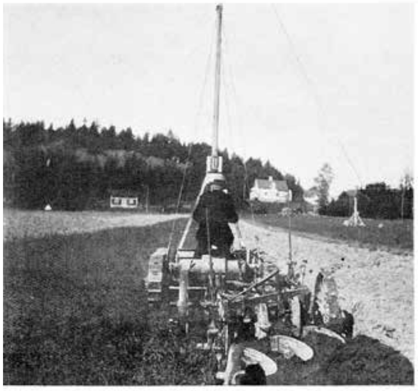


2 Diesel-powered motor coach for Swedish Railways, published in ASEAs Egen Tidning, June 1914



3 Electric tractor with overhead cable, ASEA Tidning, December 1920

ELEKTRISK PLÖJNING MED ASEA-MOTOR.



Från plöjningsarbetet å Hamra gård.

Utnyttjandet av den elektriska kraften för utförande av lantbrukets fältarbeten är ett problem, som i samband med lantbrukets elektrifiering länge varit och ännu är föremål för många försök och experiment.

I det system för elektrisk kraftöverföring till rörlig traktor, som Electro-Agricultur A. B. i Stockholm under de senaste åren utarbetat, äro tre huvudelement erforderliga: a) transformatorn, som medelst en vanlig stolpkontakt står i förbindelse med högspänningsledningen, b) kabelvagnen, som medelst isolerad kabel mottager strömmen från transformatorn, samt genom reglerbar blank luftledning överför den vidare till c) traktorn eller "Electro-tanken", som bogserar jordbearbetningsmaskinen (plog, harv, gödselspridare etc.).

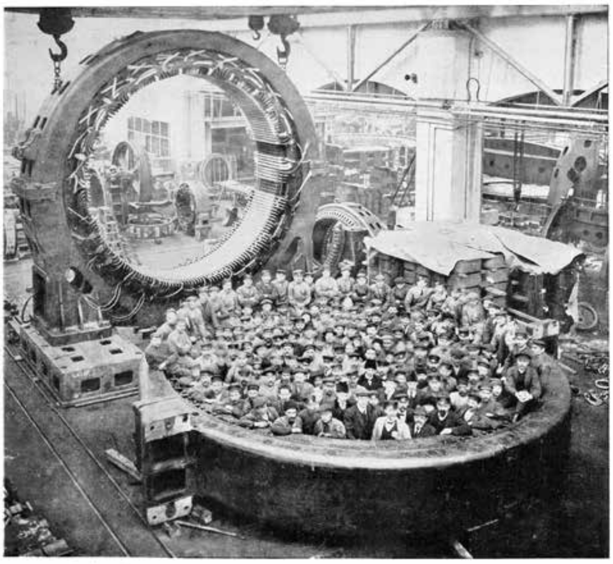
Vår bild är tagen vid plöjningsarbete å Hamra gård utanför Stockholm med en dylik traktor av tanktyp, försedd med motor- o. apparatutrustning av Aseas tillverkning.

4 Generator stator for Oxelösunds Järnverks A.-B.

Utkommer varannan månad. Prenumeration hos redaktionen.

ÅRGÅNG 9. 1917.	Ansvarig utgivare: J. S. EDSTRÖM. Redaktör: A. W. HENNING.	APRIL N:o 2.

ETT PAR AV ASEA:s MASKINJÄTTAR I EMAUSVERKSTADEN.



Den liggande statorn, som rymmer 153 personer, är för en av generatorerna till Untraverken.
Den stående statorn för Trollhättans kraftverk.

5 Advertisement for ASEA radio receiver (1924)

Önskar Ni en färdig radiomottagare, erhåller Ni den komplett uppsatt med antenn och tillbehör fortast och bäst genom oss.

Bygger Ni själv Eder mottagare, följ då våra kopplingsschemor och anvisningar.

Vill Ni utbygga Eder lamp- eller kristallmottagare, använd Eder då av våra speciella förstärkare.

Ämnar Ni anordna radiomottagning i en samlingslokal eller utomhus, vänd Eder då till vår radioavdelning för att få lämpligaste apparat och högtalare.

Kataloger och upplysningar erhåller Ni antingen direkt från oss eller från våra filialer.

ASEA

AVDELNING FÖR INSTALLATIONSMATERIEL
KLARABERGSGATAN 21, STOCKHOLM

Västerås 1924. Västmanlands Allehandas A.-B:s Tryckeri

6 Presenting the world's first commercial HVDC link (Gotland)

ASEA JOURNAL 1954

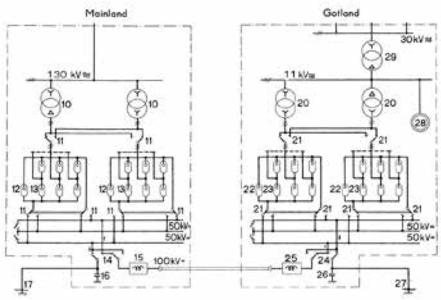


Fig. 1. Main circuits for high voltage D.C. transmission. (Tkh 7321)

10, 20. Three-phase transformers
11, 21. Double-throw isolating switches
12, 22. By-pass valve
13, 23. Six single-phase mercury arc valves
14, 24. Change-over switch
15, 25. Smoothing devices
16, 26. Capacitors for absorbing lightning surges
17, 27. Earth electrodes
28. Synchronous condenser
29. 11/33 kV three-phase transformer

The Convertor Transformers

As in the case of the other plant components which are connected to the high voltage direct current, the valve windings of the convertor transformers are insulated according to an A.C. standard for 80 kV nominal voltage. The clearance between the A.C. phases belonging to the same valve group is however designed according to an A.C. standard for 40 kV.

The convertor transformers in Västervik station are three-winding transformers (1 and 3 in *fig. 3*). The windings for connecting to the 130 kV network are star-connected with isolated star-point. The valve winding on transformer 1 is delta-connected, and on transformer 3 it is star-connected. As a consequence of this phase shifting of the valve windings by 30 degrees, the two series-connected six-pulse convertors thus affect the A.C. and D.C. networks in a similar manner to that of a twelve-pulse convertor. The third transformer winding is supplied with an on-load tap-changer and feeds a series transformer (2 and 4 in fig. 3), the secondary winding

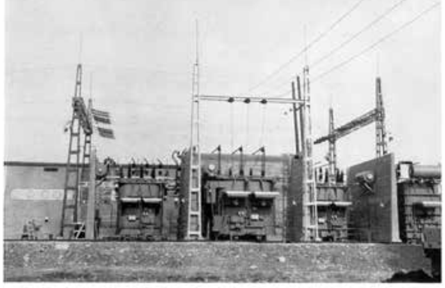


Fig. 2. The convertor station on Gotland. From left to right: Convertor transformer for valve group 2, network transformer, convertor transformer for valve group 1, D.C. reactor. (44012)

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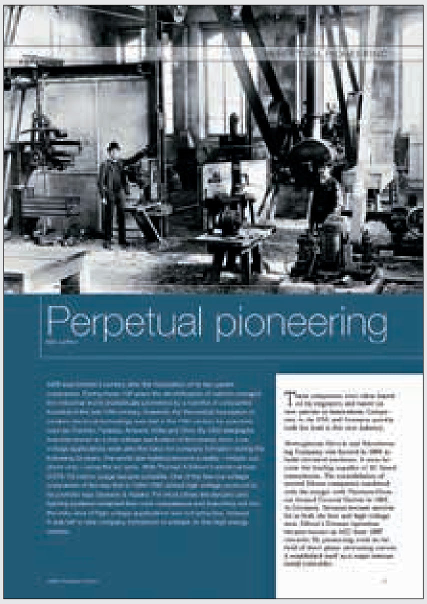

Most articles in ABB Review look at present, emerging or future products, technologies and trends. But the journal has not forgotten the company's past. It is often through the exploration of history that present developments are explained and achievements placed in context. For many years, ABB Review has published its ongoing history series, "Perpetual pioneering," which is dedicated to the histories and background stories of ABB technologies or fields of activity. An overview of articles published so far is provided below.

PDFs of these articles are also available for download from www.abb.com/abbreview

Perpetual pioneering
(lead article of series)
Nils Leffler, ABB Review 1/2007, pages 73–74

Thirty years in robotics
Brian Rooks, ABB Review Special Report Robotics, 2005, pages 6–9

The circuit breaker
A showcase of industrial product development
Fritz Pinnekamp, ABB Review 1/2007, pages 75–78

ABB turbochargers – history and milestones
Malcolm Summers, ABB Review 2/2007, pages 85–90

Transforming history
The ABB power transformer story
Thomas Fogelberg, Åke Carlsson, ABB Review 3/2007, pages 80–86

100 years
ABB celebrates a century of presence in China
Franklin-Qi Wang, ABB Review 4/2007, pages 74–77

125 years running
From the very beginning, ABB has been a pioneer in electrical motors and machines
Sture Eriksson, ABB Review 1/2008, pages 81–86

Success story
Looking back at ABB's contribution to industrial robotics
David Marshall, Christina Bredin, ABB Review 2/2008, pages 56–62

The winning chips
History of power semiconductors at ABB
Hansruedi Zeller, ABB Review 3/2008, pages 72–78

HVDC
ABB – from pioneer to world leader
Gunnar Asplund, Lennart Carlsson, ABB Review 4/2008, pages 59–64

Compact and reliable
Decades of benefits: Gas-insulated switchgear from 52 to 1,100 kV
Lothar Heinemann, Franz Besold, ABB Review 1/2009, pages 92–98

High-voltage bushings
100 years of technical advancement
Lars Jonsson, Rutger Johansson, ABB Review 3/2009, pages 66–70

Electrifying history
A long tradition in electric railway engineering
Norbert Lang, ABB Review 2/2010, pages 88–94

From mercury arc to hybrid breaker
100 years in power electronics
Andreas Moglestue, ABB Review 2/2013, pages 70–78

The world of high-voltage power
A concise history
Fredi Stucki, ABB Review Special Report High-voltage products, 2013, pages 6–10

In harmony
Looking back on a fruitful history of co-development of high power rectifiers and semiconductors
ABB Review 1/2014, pages 65–70

100 years of ABB Review
Looking back on a century in print
Andreas Moglestue, ABB Review 2/2014, pages 7–23

Rise of the robot
Celebrating 40 years of industrial robotics at ABB
David Marshall, Nick Chambers, ABB Review 2/2014, pages 24–31

60 years of HVDC
ABB's road from pioneer to market leader
Andreas Moglestue, ABB Review 2/2014, pages 32–41

Semiconductor generations
ABB looks back on 60 years of progress in semiconductors
Christoph Holtmann, Sven Klaka, Munaf Rahimo, Andreas Moglestue, ABB Review 3/2014, pages 84–90

Entering a new epoch
A brief history of the electric power supply
Jochen Kreusel, ABB Review 4/2014, pages 46–53

Distribution evolution
Medium-voltage distribution technology is a key part of the power network
Gerhard Salge, ABB Review Special Report Medium-voltage products, 2014, pages 7–10

High impact
60 years of HVDC has changed the power landscape
Bo Pääjärvi, Mie-Lotte Bohl, ABB Review Special Report 60 years of HVDC, 2014, pages 12–17

From the ASEA archives
Looking back on more than a century in print
Andreas Moglestue, ABB Review 1/2015, pages 63–66

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Preview 2|15

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Errata

The names of several authors were omitted from the article "Advanced 3-D windings: GMD 3-D windings with just a few clicks" on pages 18 to 23 in ABB Review 3/2014. The correct authors are Macarena Montenegro-Urtasun (macarena.montenegro-urtasun@ch.abb.com), Giovanni Canal (giovanni.canal@ch.abb.com), Jan Poland (jan.poland@ch.abb.com) and Axel Fuerst (formerly with ABB Process Automation).

On page 51 of the article "Entering a new epoch: A brief history of the electric power supply" in ABB Review 4/2014, it is stated that Cahora Bassa is in South Africa. This should read southern Africa. Cahora Bassa is in Mozambique. Furthermore in figure 4 on page 50, Finland should be in the ENTSO-E (NORDEL) synchronous grid.

ABB Review apologizes for these errors.

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