

The customer newsletter of
ABB Power Generation

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in control



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Power and productivity
for a better world™



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Massimo Danieli
Head of ABB Power Generation

Dear Reader,

The vast majority of the world's power plants use thermal sources of energy to generate power. These thermal applications are the bedrock of ABB's power generation business. Thermal is where we started 130 years ago, and to this day it remains a core ABB competence. As one of the articles in this issue of In Control points out, there are not many thermal power plants in the world that do not rely on ABB products and solutions to generate their energy.

ABB's portfolio for thermal power plants is firmly based on our power and automation expertise. Our offering consists of integrated instrumentation, control and electrical solutions, or ICE as we also refer to them. These solutions encompass the plant's electrical balance of plant, the substation or high voltage grid connection, the plant's distributed control system, and its instrumentation and measurement systems. And they consist of products, systems and equipment made by ABB.

The key word is 'integrated.' Our expertise as a global leader in power and automation allows us to integrate our ICE packages into optimized solutions. This is a unique ABB differentiator. It provides benefits for the contractor during project execution and for the end user during plant operation. And it is supported by our extensive global network of dedicated service engineers and a comprehensive service program that covers the full life cycle of the plant.

In this issue of In Control we take a more detailed look at our offering for thermal power plants and how our integrated ICE solutions have

made a difference for our customers. To illustrate this we are delighted to feature an interview with Dr. Qader, the director of Mass Group Holding's power sector business. In the past few years MGH has built several power plants in Iraqi Kurdistan and added 3,000 MW of much-needed generating capacity to the local power supply. ABB has provided turnkey ICE solutions for all MGH's plants and has formed a close and collaborative working relationship with the company, which Dr. Qader generously describes.

Other impressive projects that we highlight in this issue include a comprehensive electrical solution for a mega power generation and desalination project at the Ras Laffan industrial complex in Qatar; an advanced control solution for one of Germany's largest coal-fired power plants; and a cogeneration upgrade at the largest manufacturing facility of automotive company Daimler. We've also included a few examples of recent ABB solutions for pumped storage plants in Europe, Asia and the United States, including the huge 1,000 MW Limmern pumped storage plant in Switzerland.

We trust this issue of In Control will provide you with insights into the many different ways in which ABB is delivering excellence in thermal power generation. Enjoy your reading.

With kind regards,

A handwritten signature in blue ink, appearing to read 'Massimo Danieli'.

Massimo Danieli
Head of ABB Power Generation



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The perfect power plant solution

Integrated instrumentation, control and electrical packages for thermal power plants

ABB has been in the power industry since 1883 – that's a few years longer than the world's first commercially operated power plants. At the time, we were pioneers in a new and revolutionary industry. Now – 130 years later - we have been in the power generation industry longer than just about any other company. There are few power plants in the world that do not rely on ABB solutions to generate their power and deliver it safely, reliably and efficiently to their customers.

ABB is a market and technology leader in power and automation technologies. We design and manufacture products, systems and solutions for the power and process industries. For the power industry we deliver complete solutions for transmission grids and distribution networks. We are the number one supplier in many electrical and control technologies – generator circuit breakers, transformers, substations, motors, drives, gas analyzers, and distributed control systems, to name but a few.

For the power generation sector we integrate these high-performance products into complete instrumentation, control and electrical (ICE) packages for all types of greenfield and brownfield thermal power plants – from supercritical and ultra-supercritical coal-fired plants, to gas- and oil-fired plants, biomass and waste-to-energy plants, and geothermal power plants.

Our scope of supply extends across the entire delivery chain. It begins with system studies and includes detailed design, engineering, project management, installation and commissioning. And it incorporates all the electrical, control and instrumentation equipment – from the electrical balance of plant to the substation and grid connection, and from the instrumentation and field devices to the distributed control system.

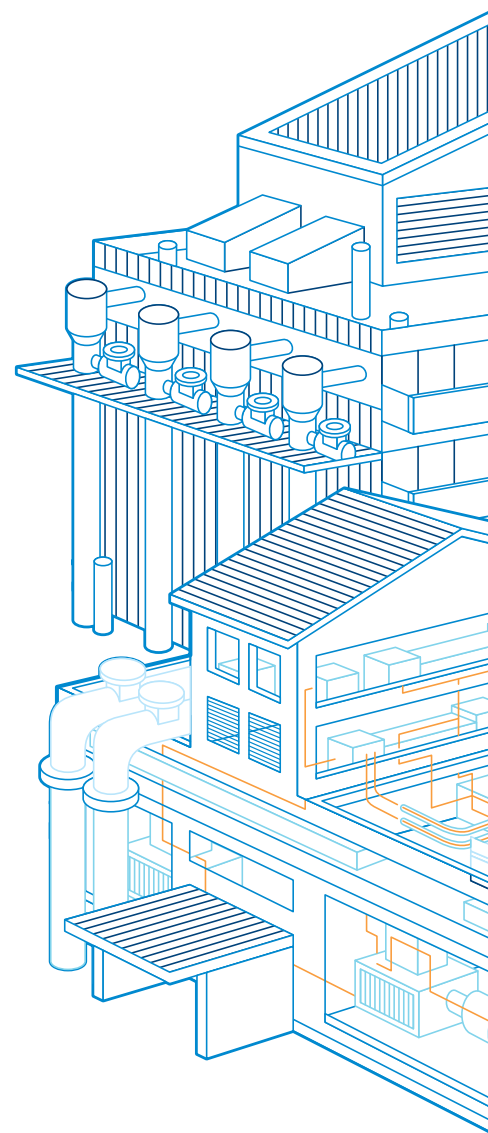
Integration makes a difference

An integrated solution comprised of products made by ABB has many benefits. The key word is 'integrated.' This is where our long and in-depth expertise really does make a difference – both for the EPC (engineering, procurement and construction) contractor and the power plant owner.

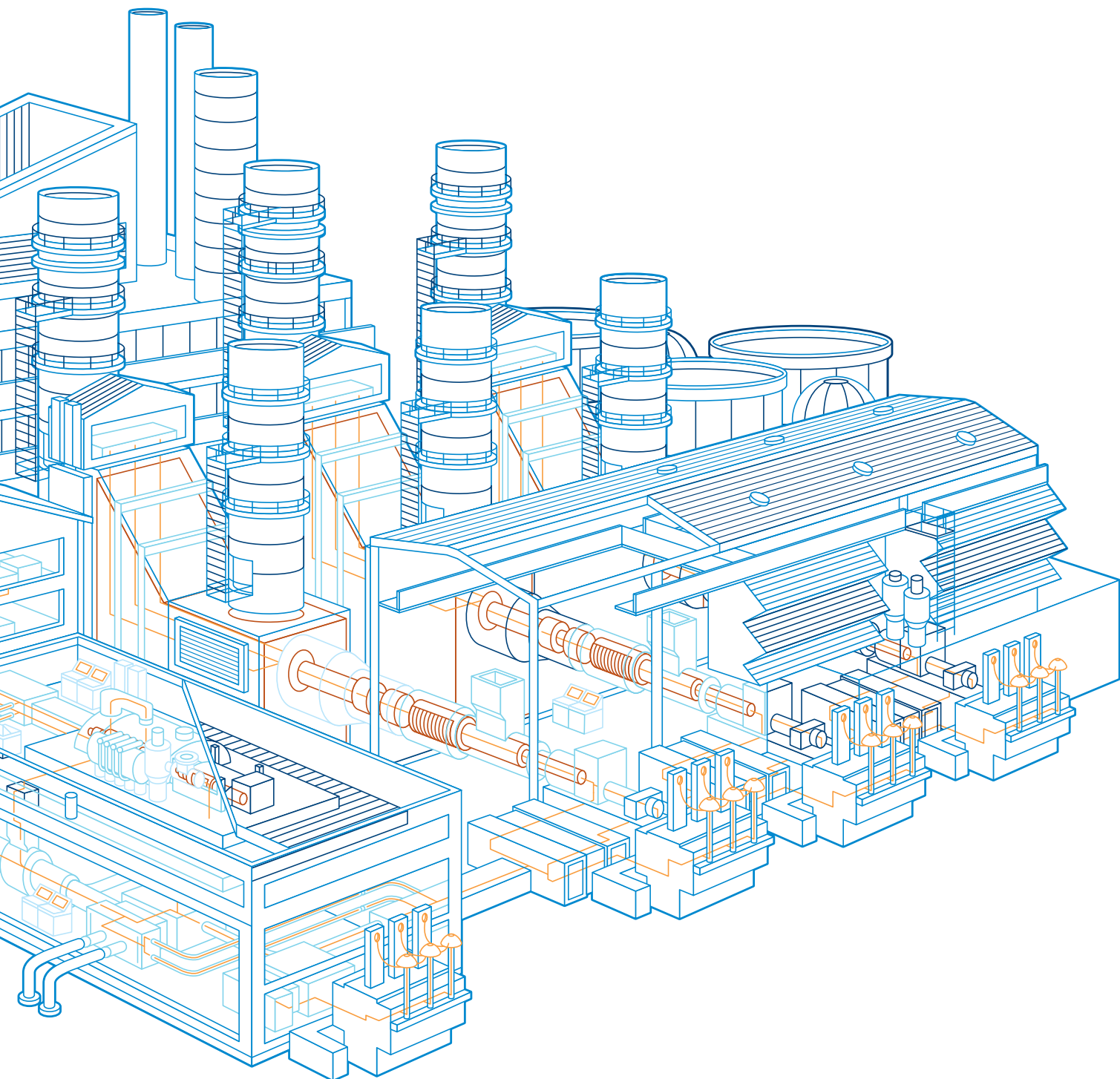
For the EPC it means a single interface with a single vendor, thereby minimizing project risk. It reduces the amount of engineering required and makes it significantly more cost effective. For the end user it means a more efficient and optimized solution that meets their requirements for availability, redundancy and performance.

These benefits are not restricted to any one region. Our global footprint is unsurpassed. ABB operates in around 100 countries worldwide, and has dedicated power generation resources in more than half of those countries. This, and our extensive process know-how and experience of local grid codes, gives us a unique capability to help our customers meet their production objectives in whichever country or region they operate.

For instance, in Europe thermal power plant owners require a high level of operational flexibility to enable power grids to integrate large-scale wind and solar power plants. In India, China and Asia, cost is a market driver – one that ABB is able to meet thanks to its numerous local manufacturing facilities and engineering centers. In the Middle East, our power plant solutions meet the high technical standards and specifications that are required for the region's demanding climate and operating conditions. And in the Americas, our products and solutions are manufactured locally at ABB factories to meet regional requirements and standards.



The heart of ABB's integrated ICE solutions is the Symphony™ Plus total automation system. This industry-leading control platform integrates all areas of the plant in a simple, scalable, seamless and secure manner. It provides users with the broadest possible view of the plant by integrating data from all plant areas and systems. Through its open architecture, Symphony Plus seamlessly consolidates and visualizes plant data to improve operator response to changing conditions, resulting in improved plant safety and availability.



Complete service offering

Our service offering covers the complete scope of the plant's power and automation systems, from the distributed control and plant optimization systems to the instrumentation and emission monitoring systems. On the electrical side it covers the entire energy path, from electrical balance of plant to the substation and grid connection.

We offer a full portfolio of life cycle management services. It extends from repairs and spare parts to complete plant upgrades and equipment retrofits. And, it covers each phase of the

plant life cycle, from first concept to decommissioning.

Energy efficiency and plant optimization are two of our specialties. We perform energy efficiency assessments and use our unique process, product and application expertise to identify savings that can reduce plant energy consumption by between 5 and 20 percent.

And we use that same expertise to optimize plant operations with a broad range of solutions, from computer-based maintenance management systems (CMMS) to online optimization

tools and online lifetime assessment monitoring for turbines and boilers.

To learn more about ABB's offering for thermal power plants, contact your local ABB power generation office or go to www.abb.com/powergeneration.

Delivering excellence in project execution



Delivering integrated instrumentation, control and electrical solutions for power generation and water plants – on time, within budget, and with strict compliance with health and safety regulations – is one of ABB's defining strengths.

ABB has a long and distinguished track record in project execution. It is one of our defining characteristics, a competitive strength that differentiates us from the competition.

There are many factors that contribute to this – from our integrated solutions and engineering expertise, to our global footprint and resources, and our project execution professionalism.

Integrated solutions

ABB has been in the power business since the days of Edison and the world's first commercially operated power plants in the 1880s. During those 130 years we have built up a vast bank of expertise that extends across all power and water plant applications – from thermal power plants and renewables to water processing and distribution.

In that time our installed base of power and automation products and systems in the power and water industries has become one of the biggest in the industry. There are few power or water plants in the world that do not rely on ABB solutions to secure production and plant efficiency.

Our offering of integrated instrumentation, control and electrical (ICE)

packages builds on this heritage of leadership in power and automation technologies. These packages consist almost exclusively of ABB products and systems – from the generator circuit breaker to the substation and grid connection, from the gas analyzers and flow meters to the distributed control system and plant optimization software. We also take full responsibility for system studies, design, engineering, installation and commissioning, and we support the plant over its entire life cycle with a comprehensive program of service products and solutions.

Most importantly, our integrated ICE solutions simplify the project execution process and deliver substantial savings to the customer. For the contractor they eliminate the risk of working with multiple vendors and of integrating multiple interfaces into a single system. With ABB, there is just one vendor and one interface. This reduces the need for engineering and speeds up project execution. The potential savings in capital expenditure for a greenfield project are significant.

For the end customer, the ABB single vendor/single interface solution delivers operational benefits in the form of significantly reduced cost of ownership. An integrated electrical and control solution maximizes production and efficiency. It also reduces life cycle costs by minimizing the need for spare parts, maintenance and staff training.

Global resources

ABB operates in about 100 countries and employs around 145,000 people. Of these power and automation specialists, around 4,500 are dedicated power generation experts, engineers and project execution professionals. They know the global and regional power markets, and they know the market drivers and customer preferences for each market. They, and our global footprint, enable us to serve our customers in whichever markets they operate worldwide.

Much of our project execution expertise is channeled via our network of competence centers. These serve as centers of excellence for a broad range of applications: thermal and water, photovoltaic power plants, hydropower, hydro generator service, nuclear, energy efficiency, cyber security, and Symphony Plus automation.

Our global service network is probably the largest and most decentralized in the power and water business. We have more than 1,300 dedicated power generation and water service specialists in 56 countries worldwide, ready to respond quickly and proactively to customers' needs.

For all our products and systems, we offer low-risk evolution strategies that ensure maximum return on investment while enhancing equipment availability and performance. Our service philosophy is simple: We protect your investment through the stepwise evolution and upgrading of your electrical, control and instrumentation systems to minimize the consumption of energy, prolong asset operating life, and reduce the cost of ownership.

Project execution expertise

ABB prides itself on its ability to deliver each project on time, within budget, to the correct specifications and in compliance with health and safety regulations.

Each ICE project is led by a certified ABB project manager. He is ABB's face to the customer and his role is to ensure smooth and consistent project execution, from the first kick-off meeting to completion and hand-over of the plant.

Behind each ABB project manager stands a team and an organization with vast experience and proven procedures for managing complex supply chains of ABB and third-party manufacturers. Our extensive worldwide network of power and automation manufacturing partners enables us to deliver the solution on or ahead of schedule and at the best price.

Installation is always supervised by an experienced ABB site manager, and commissioning is always performed by ABB engineers. This approach ensures that the equipment is installed to ABB's standards and the solution optimized to achieve the best possible plant performance.

Compliance with health, safety and environment (HSE) regulations is a crucial part of ABB's project execution activities. Our objective is simple: to instill a zero-incident culture throughout the workforce and design HSE into all site activities.

Our zero-incident policy extends to legal compliance as well. All ABB managers are trained to comply with the laws, ordinances and regulations

that apply to the project and country in question. Our employees are required to follow the values and principles of the company as set out in the ABB Code of Conduct, which is based on ABB's business principles of responsibility, respect and determination.

Following the successful completion of the project, ABB offers a comprehensive service portfolio for the entire solution – with dedicated service professionals and fast response times from our global network of power generation and water service centers.

Our global service network is probably the largest and most decentralized in the power and water business.

Building a nation's power plants

Interview with Dr. Qader, Director of Power Sector, Mass Group Holding Ltd.

Over the past six years, ABB has supplied integrated instrumentation, control and electrical solutions for six new 500 MW power plant units in Iraqi Kurdistan.

ABB's partner and customer is Mass Group Holding (MGH), a locally based multi-industry company that produces electricity, cement, steel and fertilizer.

Dr. Qader, director of MGH's power sector business, describes his company's working relationship with ABB.

How would you describe the electricity situation in Iraq and Iraqi Kurdistan today?

The power situation in Iraq has been in very bad shape for the past 10-12 years. When we signed the contract for our first power plant in 2006, there were only 1-2 hours of power a day in Kurdistan. This was interrupted supply, not continuous. Now the power is on 23-24 hours a day in Iraqi Kurdistan, and by the end of May (2013) we will have another three units online that will increase the supply to almost 24 hours a day. That's a magnificent achievement.

Why did MGH decide to invest in the power generation business in Iraqi Kurdistan? What are the investment drivers?

Let me start with the last part of the question. The basic driver is that we – the company - are from Kurdistan. So we knew there was a huge need for power. Our people were really suffering from the lack of electricity. It was really very, very sad. The second driver was that we saw a very good opportunity to invest. And the end result has been good for everyone.

MGH now has a large portfolio of power plants and is a leading independent power producer (IPP) in Iraqi Kurdistan. How would you describe this journey and the growth of your portfolio?

When we started we were the first IPP in Iraq, and I believe we still are the only IPP in the country. That in itself was a big adventure. Nobody knew how it would go and we were not sure that we would get a return on our investment. When I look back on those years, I consider them the most rewarding of my life. We've provided power for millions of people and have helped improve their daily lives. I feel we have done something valuable for the people of Kurdistan.

What sort of relationship do you have with ABB?

When we started the first project with ABB, no one had heard of our company. So ABB, just like the other suppliers we spoke to, was sceptical. They (ABB) thought they were taking a big risk with the first project. During the second project, things began to run smoothly. And by the time we started our third plant, a very satisfying working relationship had developed. Our teams realized that they were in the same boat together. If they fail, they fail together; and if they succeed, they succeed together. Now we think and act as one company. That includes everybody - from management to the project execution team.

Your business model is to work with two suppliers – GE for turbines and ABB for the electrical, control, instrumentation and balance of

plant. Why did MGH choose this particular model and why did you select these two companies as your partners?

This is a very important question that goes deep into our modular way of thinking. In all six projects we have taken a modular approach. For instance, our first plant, Erbil, started with a 500 MW phase 1. We then added a 500 MW phase 2, and in time we will add a 500 MW combined cycle unit. This will take its capacity up to 1,500 MW. The same concept applies to the other plants.

The second part of our modular approach was to use one top supplier for the turbine and generator (GE) and one top supplier for the rest of the plant (ABB). This has enabled us to build a strong foundation of shared experience and of working as a single team. This modular approach not only works well, it saves us time and money. It takes only two days to agree a contract with ABB and GE. We just call each other, arrange to meet and agree on just two things – time and price. The rest is modular. I think that our modular approach has been the essential factor in the success of these projects.

What are the benefits for your company in working this way?

I have already mentioned time, money and modular approach. Our relationship now extends to the highest level of management in both companies – that in itself is a benefit. We take a 'one team approach' when tackling a problem, which saves us a lot of money and makes life easier for ABB and GE. As a result of these projects, both ABB and GE



Dr. Qader
Director of Power Sector, Mass Group Holding Ltd.

“We’ve provided power for millions of people and have helped improve their daily lives. I feel we have done something valuable for the people of Kurdistan.”

are now well-known to the Kurdistan government and renowned for their supplier reliability.

this need, and I think that will be the next field we enter. We are also thinking of going into wind and renewables.

How would you describe ABB’s performance in the six projects, both in project execution and in the performance of its electrical and control solutions?

One of the things we are proud of is that in all six projects there has not been a single variation in the original order. That proves that we discussed everything properly in the beginning and that we got everything right at the start and all through project engineering, execution and commissioning. To this day – six projects and 3,000 MW – there has been no variation in any order. I consider that to be a big achievement.

What would be your advice to other companies who are considering ABB as a power generation partner?

Don’t hesitate. That would be my recommendation. The results on the ground in Kurdistan speak for themselves, and so my recommendation would be don’t hesitate.

What does the future hold for MGH’s power generation business?

If you allow me to speak for all three parties - MGH, ABB and GE - we are ready and have the experience to build power plants anywhere. In the south of Iraq there is a big need for power plants. We are well equipped to meet

Powering up northern Iraq

ABB has delivered integrated instrumentation, control and electrical solutions for six power plant projects in Iraqi Kurdistan. The plants have added 3,000 MW of much-needed electricity to the autonomous region's power supply.

Iraq's need for electrical energy is huge. The country currently generates around 8,500 MW but requires around 20,000 MW of electricity to meet daily demand. As a result of this shortfall, supply is limited to 4-5 hours a day in much of the country. This creates hardship for the people and hinders the growth of the economy.

In Iraqi Kurdistan, an autonomous region of northern Iraq, the situation is much different. There, over the past few years, power supply has increased from 2-4 hours a day in 2003 to almost continuous round-the-clock supply today. During the same 10-year period, demand for electricity has quadrupled as a result of the region's booming economy.

One company that has contributed perhaps more than any other to the improvement in power supply is Mass Global Holding. MGH, as it is also known, was the first independent power producer in Iraqi Kurdistan. In just seven years, between 2006 and 2013, MGH has completed six units at three power plants and added 3,000 MW of generating capacity to the region's power network. This has increased capacity manyfold compared to what was available in 2006, when the first of the six projects was initiated.

Two partners

MGH has selected the same two partners for all six power plant projects. GE supplies the gas turbines and

generators, and ABB provides an integrated instrumentation, control and electrical (ICE) solution including balance of plant and a high voltage substation. MGH has developed a modular concept whereby it can build and expand each plant in 500 MW units. The concept enables MGH to manage and control each project itself – and in close working relationship with ABB and GE – rather than simply handing the project over to a single turnkey contractor.

"The three companies work truly as a single team," says Dr. Qader, director of MGH's power sector business. "This approach has enabled us to build a strong foundation of shared experience and a robust work ethic. It not only works well, it saves us time and money and makes life easier for everyone."

As a result of this proven approach, the team has completed all six fast-track projects either on time or ahead of schedule, thereby enabling MGH to increase the supply of power to the region's power grid.

ABB's scope of supply for each project includes the electrical balance of plant, distributed control system and instrumentation, high voltage substation, balance of plant, telecommunications and fire detection systems, and water treatment system. ABB was also responsible for plant design, procurement, logistics, erection and commissioning in all six projects.

"We have reached the stage where we work so efficiently as a team that it takes us only two days to agree a contract with ABB and GE," says Dr. Qader. "This enables us to start and execute projects faster than would otherwise be possible. All we need to do when we meet to discuss a new project is set a price and a delivery date. The rest is modular."



“This approach has enabled us to build a strong foundation of shared experience and a robust work ethic. It not only works well, it saves us time and money and makes life easier for everyone.” Dr. Qader, Director of Power Sector, Mass Group Holding

Safety and control in the mountains of Missouri

The generators and turbines lower down are each capable of generating 225 megawatts of power. They are also reversible, so at night excess electricity from the grid is used to pump water back to the high reservoir.

The upper reservoir suffered a catastrophic failure in December 2005, and was out of operation until April 2010. A faulty water level reading caused the reservoir to accidentally overfill and a retaining wall to give way. Four million cubic meters of water breached into a nearby river in less than 12 minutes. In the process of returning to commercial operation, control and protection systems were improved to enhance operational safety and reliability.

ABB provided an integrated ICE (instrumentation, control and electrical) solution for the entire project, including medium- and low-voltage switchgear, motor control centers, protection system, inverters, governor system, and a state-of-the-art distributed control system. ABB was also responsible for engineering, installation supervision, commissioning and training.

This included installation in the upper reservoir of the most advanced level of monitoring, control and protection system in the US, which significantly improves the plant's safety and reliability.

ABB began with a full audit of the existing equipment at the 40-year old plant, drawing on its vast experience in pumped storage and hydropower. The audit included comparing and evaluating the plant against modern designs, and making recommendations to improve reliability, operations, maintainability and personnel safety.

This exhaustive process resulted in many new features rarely seen in hydro plants. All functional areas of the plant have redundant controllers, with redundant power supplies fed from independent primary sources of power.

The Taum Sauk pumped storage hydroelectric plant in the US state of Missouri helps the region meet peak power demands during the day. Electrical generators are turned by water from a high reservoir flowing through a 2,100-meter long tunnel to a hydropower plant and lower reservoir 210 meters below.



The control network also provides redundant data communication highways following independent routing paths.

A new hardwired protection system for the unit mechanical protection and level measurement and protection system for the upper and lower reservoirs is backed up by software implementation of the protection functions. The backup software implementation is located in the unit controller, the new digital governor controller or the upper reservoir controller as appropriate.

These and other new features will keep the plant operating with a vastly improved degree of dependability and safety for many years to come.

Large and fast-track solution for combined cycle power plant in Ras Laffan

ABB has supplied highly complex electrical systems and grid connections for a mega power generation and water desalination project in Qatar. The combined cycle power plant in the industrial city of Ras Laffan, Qatar, has a generating capacity of 2,730 MW, and can produce more than 238,000 cubic meters of potable water daily. This equates to 20 percent of Qatar's water consumption and 30 percent of its electricity generation.

ABB's German and Swiss operations provided the design, supply, installation and commissioning of the plant's electrical systems, including substations rated at 400 kilovolts (kV), 220 kV and 132 kV; two 800 megavolt ampere MVA interbus transformers; eight generator circuit breakers for the gas turbines; the isolated phase ducts, the direct current (DC) supply and uninterruptible power supply (UPS); transformer protection system, 75 medium- and low-voltage switchgears, and cable systems with a total length of more than 1,000 km.

ABB was responsible for complete engineering services, construction supervision and commissioning of the electrical systems, as well as for staff training. A consortium comprising Suez Energy International, Mitsui, Ras Girtas Power Company, and Qatar Petroleum developed the plant, which sells water and electricity to the local utility, Kahramaa.

Very early in the tendering stage the EPC Hyundai Engineering and Construction supported by Suez/Mitsui signed a cooperation agreement with ABB, due to the highly complex nature of the electrical systems in the project. This was to limit their risk and was a direct result of ABB's excellent track record in Qatar with Kahramaa. Ras Laffan was the third large project ABB has successfully completed in the country, after Ras Abu Fontas B2 in 2008 and Quatalum in 2009.

ABB products make up 71 percent of the hardware scope of supply, and ABB resources constitute 67 percent of the services. Total investment for the power and

desalination plant amounts to \$3.7 billion. ABB's project management was based in Mannheim (Germany), which during the engineering phase had to coordinate design offices in Abu Dhabi, Kosice (Slovakia), Baden (Switzerland) and the general basic design with offices in Seoul (Korea). A total of 41 factory acceptance tests held in the span of 94 days were successfully completed. Logistical challenges included 28,700 square meters of freight managed in some 61 shipments.

ABB's Swiss operations supplied some of the largest substations in the Middle East region for this project, including 31 bays of 400 kV gas-insulated switchgear (GIS), 12 bays of 220 kV GIS and 12 bays of 132 kV GIS, as well as associated systems, such as IEC 61850 substation automation, control, protection, telecommunication and auxiliary systems. ABB and its subcontractors performed 200,000

man-hours of work within the three years between go-ahead and hand-over.

ABB engineers and technicians from around the globe, including Germany, Switzerland, the USA, Canada, the Philippines and Korea helped complete this demanding project.

Following the hand-over, Hyundai project management commented: "Hyundai and ABB have pulled together to achieve the common targets for this project. Most of our plans have been completed successfully. We have mastered difficult and serious risks with the help of our strong cooperation and proper coordination, in spite of many unexpected obstacles and interruptions from the start-up until now, the finish. We are grateful to ABB and ABB staff for the positive cooperation and assistance, which proves ABB's reputation and capability as a highly qualified company in the field of power systems worldwide."



Large-scale pumped storage in Switzerland

ABB is supplying a complete package of electrical equipment for the new 1,000 MW Limmern pumped storage power plant in Switzerland.

Kraftwerke Lint-Limmern (KLL), a member of the Swiss power producer AXPO, is overseeing the project, with the first unit expected to be operational by 2015.

Pumped storage power plants are an efficient means of large-scale energy storage, and an important part of the strategy to add renewable energy such as wind and solar generation to the power mix, because they can quickly balance power fluctuations caused by sudden wind gusts or cloud cover.

The Limmern pumped storage hydropower station is being installed in an underground cavern. It will have four generating units with a total capacity of 1,000 MW in generating and pumping mode. Each unit consists of a pump-turbine and a doubly-fed asynchronous motor/generator, allowing them to operate with variable speed and enhancing the plant's overall performance.

In generation mode water will flow from the upper reservoir, Muttsee, 600 m down to the generation units and further on into the lower reservoir, Limmernsee. From there it will be pumped back up again for storage and released when needed.

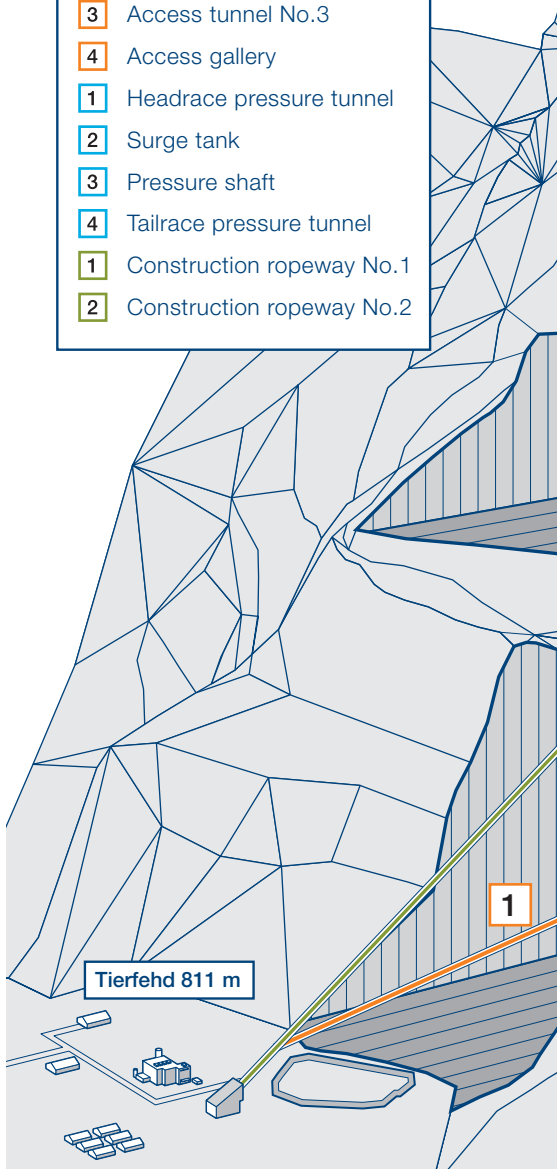
ABB is providing electrical equipment and a control system based not only on price and technical characteristics, but also on outstanding references and experience in comparable projects, specifically in control systems for large-scale pumped

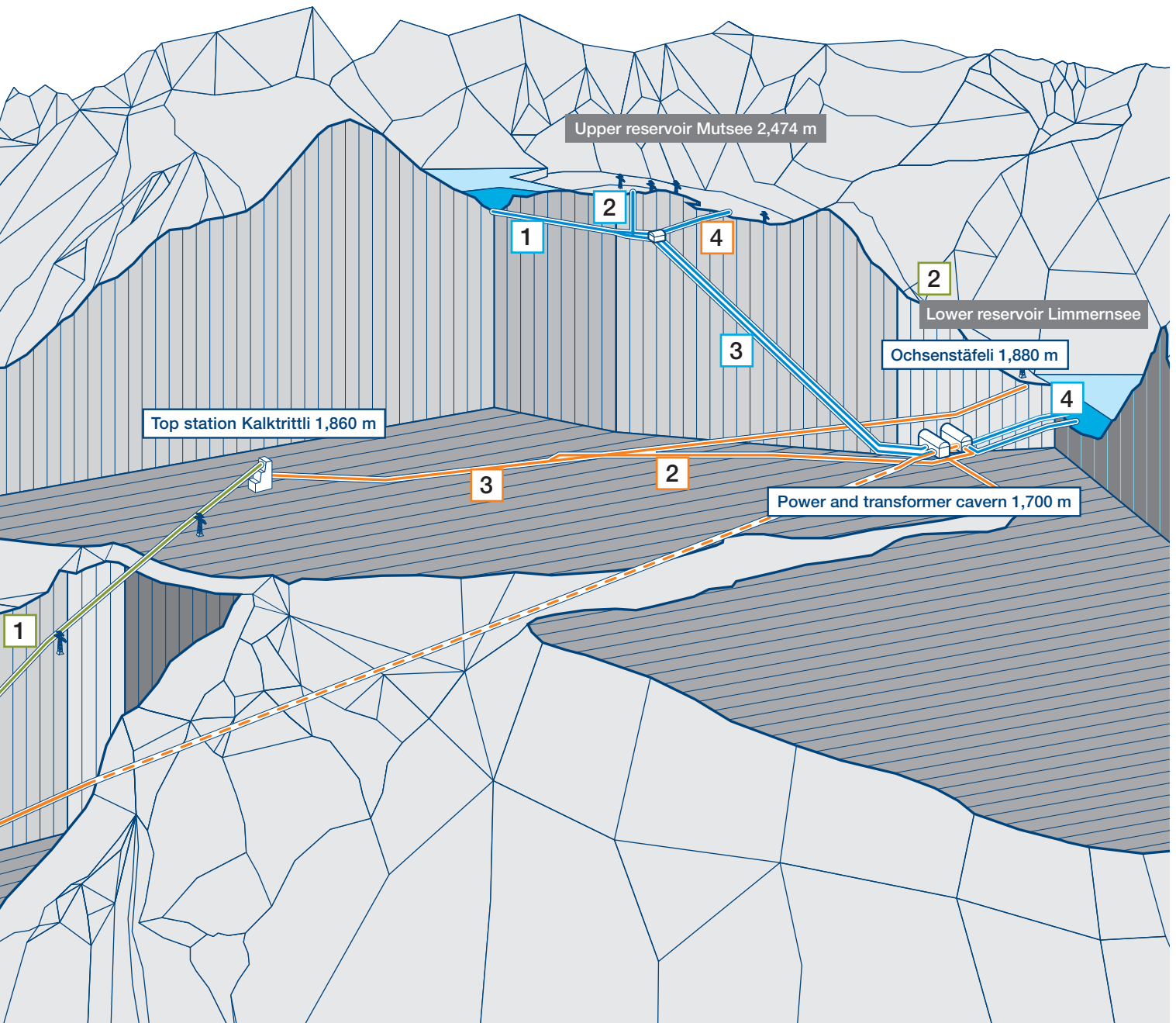
storage plants. ABB's responsibility extends from design to engineering, manufacturing, delivery and commissioning of components and systems.

The equipment list from ABB includes main and auxiliary transformers, medium- and low-voltage switchgear, instrumentation and automation systems. ABB will also provide a 380 kilovolt (kV) GIS (gas-insulated switchgear) substation to feed power from the plant to the Swiss national grid.

The finished plant will help KLL generate clean energy to meet future peak load and ancillary services demand across Switzerland, contributing to the stable operation of an interconnected European grid.

In addition to operating efficiency, technical solutions, terms, conditions and references, a key factor in ABB winning this contract was its ability to demonstrate how the new plant could be seamlessly integrated into the existing infrastructure - a matter of great importance for KLL, says Emil Bieri, Axpo Power AG's project manager in charge of electrical. A reference visit to a similar ABB pumped storage installation in Austria helped seal the deal.

- 
- 1 Access tunnel No.1 with funicular
 - 2 Access tunnel No.2
 - 3 Access tunnel No.3
 - 4 Access gallery
 - 1 Headrace pressure tunnel
 - 2 Surge tank
 - 3 Pressure shaft
 - 4 Tailrace pressure tunnel
 - 1 Construction ropeway No.1
 - 2 Construction ropeway No.2



Kraftwerke Linth-Limmern AG (KLL) is a joint venture between Canton Glarus (15%) and Axpo Power AG (85%). KLL generates about 480 MW of power from four existing hydropower plants. The expansion project Linth 2015 will add another 1,000 MW of pumped storage capacity to secure the efficient and flexible operation of KLL's assets.

Approximately \$2 billion will be invested until 2016, the year the plant will reach full operational capacity. Up to 500 people will be working on site during its construction.

The project area encompasses different sites at altitudes between 800 and 2,400 meters above sea level (MASL), which is a logistical challenge. Two new high capacity transport ropeways had to be built, capable of carrying up to 40 tons of equipment.

The 4-km long access tunnel has been excavated by means of a tunnel boring machine (TBM), weighing about 1,600 tons, measuring 160 m in length and with a drill head diameter of 8 m. Never before has a TBM of that size been used in a tunnel with up to 24 de-

grees incline. When completed, the access tunnel will be equipped with a 200-ton funicular, for transporting heavy equipment to the power cavern (including the four main transformers).

About 500,000 tons of rock, from the excavation of the tunnels and the power cavern, will be used for a new gravity dam that increases the storage capacity of the existing Mutsee (upper reservoir) from 9 to 24 million m³.

Supporting Daimler's cogeneration upgrade



Mercedes-Benz Sindelfingen

The Mercedes-Benz plant in Sindelfingen is Daimler's largest production facility, serving as the center of competence for upper range and luxury vehicles in the company's global production network. At the plant, some 26,000 employees produce about 500,000 vehicles a year.

A new gas turbine in the cogeneration plant of the giant Sindelfingen Mercedes-Benz assembly facility near Stuttgart, Germany, has doubled electrical output and significantly reduced CO₂ emissions. ABB delivered the 44 megavolt ampere (MVA) generator and transformer, gas compressor and pipeline, recooling systems, power cables and ensured the smooth integration of the new system into the existing 20-kilovolt (kV) distribution grid.

Daimler AG has operated a cogeneration power plant at Sindelfingen, its largest production facility, since 1960. The plant supplies all of the site's heat and about one-third of its electricity. The fuel source has been more than 99 percent natural gas since the mid-1980s, which keeps greenhouse gas emissions very low.

Daimler has modernized and expanded the cogeneration system, installing a modern gas turbine and waste heat boiler to replace the steam

boiler. With an electrical output of 31 megawatts (MW) and a thermal output of 42 MW, the system's fuel efficiency rating is more than 80 percent. Future installations are expected to more than double the plant's power generation capacity.

The ABB project team put the experience gained from other projects to good use; for instance, the construction of 16 gas turbine blocks rated 125 MW each for thermal power plant projects in Iraq. "During planning and

installation, the space conditions on site were a particular challenge," says Vela. "The situation was challenging due to the fact that the assembly of the components took place below the heat recovery steam generator, which was still under construction, imposing a significant logistical challenge as the various suppliers had to be managed." A major contribution of the project success can be accredited to MTU Onsite Energy, who is leading the consortium with ABB.

Switchgear protection and control for the future

ABB has supplied a state-of-the-art control system for auxiliary power equipment at the Jänschwalde Lignite Power Plant in eastern Germany. Nearly 700 Relion 615 protection devices will be deployed and integrated into the new control system by 2015, using the IEC 61850 communication standard.



The Jänschwalde Power Station is one of the largest lignite-fired power plants in Germany. Located near the German-Polish border, its total installed capacity of 3,000 megawatts (MW) is supplied by six 500 MW power generating units.

The power plant generates an average of 22,000 gigawatt hours (GWh) of power annually, and supplies electricity to about 4.4 million homes in the region. Some of the heat produced during electricity generation is fed into a district heating system that serves the plant itself and the nearby cities of Cottbus and Peitz.

Since Jänschwalde was commissioned in 1981, standards of environmental protection and safety have risen dramatically. The owner, Vattenfall, one of Europe's largest electricity generators, has regularly upgraded the plant since 1991 to keep it compliant with the latest environmental legislation. All 12

station boilers are fitted with low NO_x combustion technology, the turbines and electrostatic precipitators have been modernized, and a flue gas desulfurization system installed. This has not only reduced pollution, but improved efficiency to 36 percent – an excellent result for a power plant that has been in operation for 30-plus years.

In recent years, more frequent control malfunctions, the unavailability of some spare parts and the need to replace analog protection devices with digital units made modernization necessary. Vattenfall decided to replace the existing control system of the auxiliary power equipment to maintain the plant's availability, profitability and technical safety up to and beyond 2020, which will support the future planned renewal of the power plant's operating license.

ABB and Emis Electrics GmbH installed an open, independent, state-of-the-art operating and monitoring

control system, including an AC 870P automation system and S800 I/O modules. Analog protection was replaced with 694 cutting-edge Relion 615 protection devices, while 32 SUE 3000 high-speed transfer devices were also installed. These were integrated into the control system according to the IEC 61850 standard. In addition, 694 medium-voltage switchboards and 680 low-voltage switchgears were retrofitted and integrated with the operating and monitoring system. When the project is completed, every component of the new control system will be an ABB product or system.

On completion of the project, Vattenfall will obtain a consistent, modern and future-proof control and protection system for the switchgear. The solution will ensure easy operation of the plant.

The ambitious schedule represents the biggest challenge of the project. The retrofits are scheduled for completion by 2015, and must be installed during planned maintenance outages. The tight time schedule requires extensive preparation, so the units can promptly resume operation after maintenance. This way, the overall project schedule can be met.

Power for PKN Orlen chemical plant

ABB is providing the electrical systems and grid connections for a 460 MW combined cycle power plant in Wloclawek, Poland for PKN Orlen, one of central Europe's largest crude oil refiners and fuel retailers. A GE-SNC Lavalin consortium is building the plant, which will provide reliable and efficient power to a chemical facility operated by Anwil, a PKN Orlen subsidiary.

ABB provided full technical support to the customer, GE-SNC Lavalin, from the start of this project. The power plant concept will be single shaft and consist of a gas turbine, a heat recovery steam generator (HRSG), and a steam turbine complemented by related electrical and mechanical balance of plant. The power generated will be used by the chemical plant's 110 kV grid and the 220 kV national grid.

ABB will supply a customized solution that connects the plant to both grids, internal and external. The interconnection of the 110 kV and the 220 kV grid consists of two step-up transformers in combination with a phase shifting transformer and the related high voltage switchgear bays.

ABB's early work with GE-SNC Lavalin on this project and the customer's belief in the ABB team's execution capabilities were instrumental in winning the order. ABB's solution enables a very flexible power flow to the 110 kV and the 220 kV grid, and provides PKN Orlen with optimized, economical power generation for its production plant while enhancing the security of the energy supply.

The future power plant was modeled using the ABB electrical system analysis tool NEPLAN®, which enables ABB to analyze, plan, optimize and simulate electrical networks with a very high de-

gree of accuracy, for steady state as well as dynamic calculations.

The phase shifting transformer makes control of the active power flow possible. It will compensate for the phase angle shift as a consequence of the different impedances. This economical solution to active power control provided SNC Lavalin with a unique selling point and was a key factor in the project's success.

In addition to the transformer package, ABB's scope of supply also includes the complete electrical balance of plant, the generator circuit breakers, isolated phase bus ducts, medium voltage and low voltage switchgear, emergency power supply and cable systems.

A project management team from ABB Poland and ABB Germany is responsible for the execution of the project. ABB Poland brings deep knowledge of local requirements in support of the design team from Mannheim, Germany, and is responsible for all site activities.

ABB combines robust project execution capabilities in large and complex projects with careful attention to fulfilling local requirements. This core



expertise and ABB's best-in-class technology provide major advantages for customers, compared to our competitors.

ABB's installed base of power and automation products and systems in the power and water industries has become one of the largest in the industry, due to factors like integrated solutions and engineering expertise, global footprint and resources and project execution professionalism.

During the signing ceremony of the 30 million Euro ABB project, the SNC Lavalin Polska representative thanked ABB for its excellent technical contribution to the project's success.

Integrated ICE solution for new Czech power plant

ABB is supplying a turnkey instrumentation, control and electrical solution for a new 135 megawatt combined heat and power unit in the Czech Republic.

ABB has won three separate contracts from the German-based general contractor, Kraftanlagen München, to supply turnkey instrumentation, control and electrical (ICE) packages for a new combined heat and power (CHP) unit at the Kladno 1 power plant in the Czech Republic. The plant is owned by Alpiq Generation, a subsidiary of Alpiq, the Swiss-based energy company.

Currently under construction and scheduled to start production in January 2014, the new CHP unit will provide 135 megawatts (MW) of electric power and 105 MW of thermal energy. The electricity will be fed into the local power grid and the thermal energy will provide district heating for Kladno, a city with a population of 110,000 located close to the capital, Prague.

The new CHP unit replaces an obsolete coal-fired unit from the 1970s, which no longer meets emission regu-

combined cycle unit and a 43 MW peaking power unit. The existing units were built between 1998 and 2000.

ABB was selected by Kraftanlagen München for its ability to supply a fully integrated ICE solution for the entire unit including grid connection and integration of the CHP control system with the plant-wide Kladno 1 control system. ABB is also responsible for design, engineering, project management, installation and commissioning.

On the electrical side the solution includes 110 kV gas insulated switchgear, power transformer, generator circuit breaker and protection system to ensure reliable and uninterrupted power supply to the power grid. And for the plant electrical system it includes distribution and auxiliary transformers, low and medium voltage switchgear, and low and medium voltage drives to maximize reliability and safety and minimize the plant's own energy consumption.



prehensive package of cyber security features and operating procedures to ensure that the distributed control system, control room and critical electrical equipment will be secure against unauthorized access or attack.

Equipping Kladno 1 with integrated ICE solutions is only part of ABB's commitment to Alpiq Generation. For the past 12 years, ABB has been providing the plant with extensive life cycle management services for the whole ABB installed base – distributed control systems, electrical balance of plant, variable speed drive systems, instrumentation, switchgear and transformers.

The extent of the service agreement includes software evolution, maintenance and support for the distributed control systems, as well as upgrades, repairs, remote monitoring and preventive maintenance of the electrical systems to ensure that the plant continuously meets the high performance and environmental standards that Alpiq Generation demands.

“We are more than satisfied with the ABB control system, in particular with its reliability. With regard to our choice of service provider, the most important factor is the availability of technical personnel with the appropriate skills and knowledge to solve our problems – requirements that ABB consistently meets.”

Stanislav Klanduch, Operations and Maintenance Director, Alpiq Generation

lations. Using a combination of lignite and biomass as fuel, the new unit will be significantly more efficient and environmentally friendly than the old unit, and will increase the generating capacity of the entire plant.

ABB has provided similar turnkey ICE solutions for all the existing units at Kladno 1, which currently comprises two 135 MW generating units, a 67 MW

The instrumentation package covers the boiler house (including the Foster Wheeler boiler), machine house (including the Skoda Power turbine) and common facilities. The unit will be controlled by an ABB distributed control system, which will be integrated with the existing ABB distributed control system that controls all the existing units at the plant.

ABB will equip the unit with a com-

Highest safety guarantees for pumped storage power plant

Vattenfall, one of Europe's largest generators of electricity and largest producer of heat, has invested several million dollars to completely overhaul the Wendefurth pumped storage power plant in eastern Germany. ABB modernized the control system and installed new switchgear.



Pumped storage power plants are an important part of a strategy to add renewable energy such as wind and solar generation to the power mix, because they can quickly balance power fluctuations caused by sudden wind gusts or cloud cover.

But to fulfill this role, it is essential that the technology is updated regularly, especially if it has been in use for several decades. The Wendefurth plant commenced operations in 1967/68. It has two pumped storage units and a total rated output of 80 MW. Operator Vatten-

fall recently ordered an extensive overhaul and modernization of the plant's facilities and technical equipment.

ABB modernized all instrumentation and control equipment, installed the new 110 kilovolt (kV) components in the outdoor high-voltage switchgear, the new machine switchgear, the electrical protection of the synchronous machine with a power output of 40 megavolt ampere (MVA) and voltage of 10.5 kV, as well as the transformer used for the first pumped storage unit. The second unit is scheduled for overhaul in 2014.

The old system did not include a generator circuit breaker in the generator lead, a configuration which enabled synchronization on the 110 kV side only, making the island mode of the system impossible. The measuring cells and the outgoing feeder for auxiliary power were designed as open air and were not enclosed.

The new system now meets the most stringent safety requirements. State-of-the-art enclosed ABB's UniGear ZS1 switchgear takes over the task of a generator circuit breaker, and ensures electrical braking of the pumped storage units by means of a special braking disconnector. ABB's VM1 vacuum circuit breaker with magnetic drive is used as a circuit breaker. It is a vacuum circuit breaker with vacuum interrupter embedded in epoxy resin and a magnetic actuator. It is completely maintenance-free, and has a life expectancy of approximately 30,000 electrical operation cycles. The complete system is now absolutely internal arc proof, with pressure relief duct cast-resin insulated bus duct leads and an ultra-fast earthing switch for internal arc limiting.

The power plant operator also attached great importance to personal safety and equipment protection in case of short-circuits. In order to meet these requirements, ABB used the ultra-fast earthing switch. The system's arc sensors detect any short-circuit as it occurs and switches it off within milliseconds. This considerably increases plant availability and personal protection, particularly during maintenance work.

Plug-and-play EBoP solution for new gas power plant in Thailand

ABB is delivering a modular, pre-engineered electrical balance of plant solution for a new gas turbine combined cycle power plant that will help Thailand meet increasing demand for power with more efficient and environmentally sustainable technology.

ABB has been awarded a contract from Mitsubishi Heavy Industries (MHI) to design and engineer a complete electrical solution for the 1,600 megawatt (MW) U-Thai gas turbine combined cycle power plant in Thailand. The power plant will be located in the U-Thai district of Ayutthaya Province, about 70 km north of Bangkok.

As part of the solution, ABB is supplying distribution transformers, low- and medium-voltage switchgear as well as direct current (DC) systems. The solution includes a modular and customized E-house to store the electrical equipment that will integrate MHI's turbine control system.

ABB's modular, pre-engineered approach is a cost-effective plug-and-play solution that ensures faster overall delivery. Containers are pretested in the factory, helping customers to reduce operational and execution risks, while maintaining the traditional ABB standard of high-quality products and installation.

The U-Thai plant is owned and operated by Gulf JP UT Company, a leading independent power producer in Thailand and a subsidiary of Gulf JP Company Limited. Under a 25-year power purchase agreement, the generated electricity will be sold to the Electricity Generating Authority of Thailand (EGAT), and the steam to users in Rojana Industrial Park, serving mainly the electronics and automotive industries.

The plant is part of Thailand's effort to provide reliable and cost-effective power generation by promoting the use of more efficient and environmentally sustainable technology. More than 80



percent of the country's power capacity comes from traditional fossil-fuel generation. This project supports Thailand's public-private partnerships (PPP) program by enhancing the efficiency of its power generation infrastructure, and is in line with the national plan to use such partnerships to add an additional 22 gigawatts (GW) to the country's current 34 GW generating capacity within the decade.

ABB is scheduled to complete its part of the project in the second quarter of 2014.

ABB is also currently working with MHI to supply similar electrical equip-

ment and an E-house for the Nong Saeng 1,600 MW gas turbine combined cycle power plant in Thailand's Saraburi province. This plant is also owned and operated by Gulf JP Company Limited, through its subsidiary, Gulf JP NS Company Limited. The project is currently under construction and scheduled for completion in 2014.

Stable and reliable electrical supply in industrial applications

Industrial electrical supply systems have a range of specific requirements in response to an assortment of different processes and associated process requirements. This article briefly examines the technical challenges and diversity of interactions caused by specific requirements in the power sector and all adjacent electrical subsystems, which form part of the industrial electricity supply.

Captive power plants mainly provide electrical energy to industrial complexes and industrial parks. Electrical generation is mostly provided by combined heat and power plants because of their efficiency and other significant advantages, such as:

- Meeting both electrical and thermal energy requirements
- Enabling high usage times
- Providing secure additional and reserve supplies of electrical energy
- High system availability and maintainability (high MTBF, low MTTR figures)
- High degree of flexibility for modification and adaptation of process characteristics
- Robust operational characteristics of installed components and systems

The basic structure of the energy supply in different industrial complexes is influenced by the actual processes at work in them. For example, the requirements of the chemical industry are still dominated by the generation of process heat. This fact defines the comprehensive energy supply, including the supply of steam. As a result of simultaneous electrical power requirements, the use of economical back-pressure power plants with high energy utilization will be mandatory for these types of processes, because

these systems are able to exploit 90 percent of primary energy and belong to the wide range of so-called combined heat and power plants (CHP). In some countries this highly efficient form of energy receives considerable subsidies, making CHP technology doubly attractive.

In steel or aluminum melting plants using an electric arc furnace, it is clear that in addition to the specific procedures and requirements of automation and control, meeting the challenges of electrical system design is crucial to the efficient and economic operation of the plant. The large and sudden variations in electrical load as a result of the metallurgic process create extreme voltage and frequency fluctuations. This occurs periodically during normal operation, and thus has to be considered a part of normal plant operation.

Plant and grid requirements

The special requirements of power plants and the power supply of industrial plants are quite specific and vary according to process, as described in the preceding examples of the chemical and metallurgic sectors.

The electricity supply of industrial plants is not completely self-sufficient, nor can it be rebuilt for the sake of a plant's security and availability. For this reason, and because of more stable and reliable conditions in island networks, other factors must be considered, including:

- Boundary conditions of the main supply, maximum performance
- Protection and control of overall system behavior



- Compliance with stability criteria, static and transient stability, frequency overload
- Reactive power and voltage support
- Interception security and compliance with protection criteria

Any disturbance of the active power balance by large and sudden changes in frequency makes the entire synchronously coupled composite system or the island grid vulnerable. All generating units at its disposal and connected part-



ners in the composite system must participate in adjusting the turbine control. In exceptional cases, it may be permissible to switch off consumers if a sound power management and load shedding system is available, which does not harm the process or the environment. The usable frequency range is limited by the resonance frequency of the turbo generators to about 45 Hz in a 50 Hz system. Deviations of the frequency above or below the nominal value are in the range of

+/- 1-2 Hz while in the public electrical grid these values are only one-tenth of this size. The criteria for protection under frequency is usually set at 47.5 Hz. The constant frequency deviation is obtained from the following equation:

$$\Delta f = sN * f_n * \frac{\Delta P}{PN}$$

Where,

Δf = Frequency deviation

SN = Static figure of the electrical grid as relative value in % ~12-16%, the result of all primary frequency controlled power plants and frequency dependent loads

fN = Nominal frequency value 50 Hz

ΔP = Load step / drop

PN = Load of the adequate grid / island grid



Frequency deviation is corrected in the short time range (<30 seconds) of the primary performance of the turbine governor control involved. The basic procedure is specified in an article about a major field test in the chemical industry.¹

Stability criteria

Each power plant connected to the electrical grid is an oscillatory system whose natural frequency is determined primarily by network short-circuit power and the moment of inertia of the turbine set. Many different factors must be considered in order to ensure stable, reliable and safe operation of complete electrical systems. The most important include enquiries about static and transient stability, voltage stability by handling reactive power requirements, and frequency stability as mentioned before.

ABB's integrated solution

ABB's approach is to provide an integrated, comprehensive solution primarily based on solid process know-how of all relevant plant types. Starting from there, the logical engineering steps include system analysis and feasibility studies to enable optimized electrical grid integration. An excellent

example of this is the PKN Orlen project on page 18, where ABB supported the customer to find the best solution for the future plant by performing modeling and professional electrical system analysis. ABB's proposal to couple the two high voltage grids of 110 kV and 220kV with two step-up transformers and one phase shifting transformer convinced the customer.

A variety of state-of-the-art products support ABB's competencies and capabilities, enabling it to meet and surpass all of the requirements for a highly efficient, stable and reliable industrial power supply. ABB manufactures the majority of the entire instrumentation, control and electrical (ICE) equipment chain in its own factories, which are located all over the world. The equipment includes field instruments, distributed control systems (DCS), generator circuit breakers, step-up and phase shift transformers, high-, medium-, and low-voltage switchgear (air- and gas-insulated), emergency power systems, generator excitation systems, including power factor control and power system stabilizer, starting frequency converters for gas turbine generators, and synchronization and protection devices. To meet the need for harmonic filtering and flicker control in electric arc furnaces and other applications, ABB has developed outstanding static var compensation products like thyristor valves including control and auxiliary devices.

¹ M.Lösing RWE, W.Magin ABB, R.Stolle BASF. Reliable and Efficient Energy Supply for Industrial Plants with Combined-Cycle Power Plants. VGB 6/2001, 57-61.

Flexible power generation

The increase in renewable power and direct power trading requires power generation providers to become more flexible. ABB OPTIMAX PowerFit is a product that helps power and water utilities to optimize load / unit commitment, with modules that may be used for operations and scheduling, plant management and system control, independently or in combination, online and offline.

Utilities need to continuously minimize operation and maintenance costs and improve their commitments for bidding in their markets. They need decision-support tools to determine their optimal operation strategy. Minimizing cost can be carried by operations scheduling (unit commitment).

ABB OPTIMAX® PowerFit helps utilities handle the needs of interconnected cogeneration networks and deregulated markets. Its features include:

- Frequent updates during the day that complement traditional day-ahead plans for conventional power generation
- Combined heat and power generation scheduling, from heat-driven to electricity-driven
- Exploits storage capacities on the heat side
- Increased controllability of renewable generation units

A new version of OPTIMAX PowerFit, now available in the ABB Dynamic Optimization platform, provides a new optimization method for real-time power plant control. It enables the pooling and combined management of individual power generation units, as if they were one large plant. Real-time optimization distributes overall set points to each individual power generation unit, considering actual efficiencies, process constraints and temporary limitations. The introduced hierarchy reduces overall complexity, increases flexibility, and provides the best power generation solution for each unit.

Load optimization traditionally focuses on day-ahead plans for power production and trading. In an OPTIMAX PowerFit system, an automation network - either a physical network or a virtual private network (VPN) - connects multiple production units. This new sys-



tem layout addresses four new trends:

- The number of power production units significantly increases with the use of renewable energy
- Power production needs to be re-planned frequently during the day to account for fluctuations
- The required optimization cycle times are reduced from daily planning cycles to seconds, eg, for the pooling of secondary frequency control
- The role of human operators changes from being part of the loop to supervision

The new trends in power generation are driving the switch to automated optimization in real-time control systems. OPTIMAX PowerFit directly accesses the automation network via the scanner, supplementing fast, reliable communications with sophisticated numerical optimization, reliably handling large optimization programs in fractions of seconds.

For large conventional power plants, the idea is to pool and optimize multiple

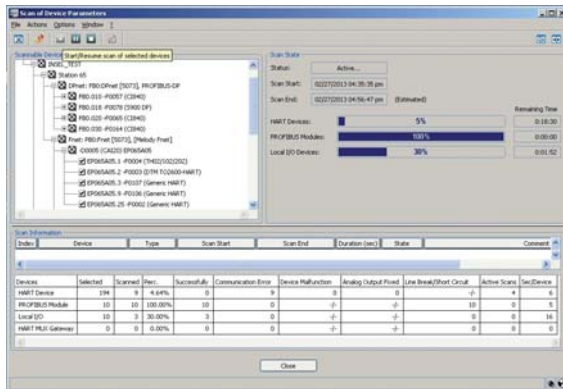
units per plant locally, automating communication from the load dispatcher to the control systems of the power generation units, enabling responses to increasingly frequent updates. It ensures the appropriate provision of primary frequency control, secondary frequency control and required load ramps.

Pooling small renewable power plants can achieve an overall capacity that is sufficient for participation in the electricity market. Many renewable production units, like wind and solar, do not participate in direct trading. Instead, they supply an increasing amount of unmanaged power to the grid. This can harm grid operation and stability. Renewable supply management controls the amount of renewable power fed to particular distribution networks. Online optimization offers proven technology to break down overall set points to individual power generation units, fulfilling legal requirements and meeting plant constraints. As a result, the renewable generation units receive limits for their supply to the grid.

Symphony Plus Melody

HART LifeCycle Tracker

Reduced project costs with HART LifeCycle Tracker for S+ Control Melody



HART LifeCycle Tracker enables users to access and display the latest updated project status with a single mouse click. They can view the whole project chain – from the engineering phase to commissioning, start-up and current operation. Progress and status are displayed in a simple and intuitive manner. With just one mouse click the entire plant is documented and its status compared with the previous version. To facilitate the assignment of maintenance personnel, the plant can be easily divided into separate maintenance categories or areas - for single devices, functional units, plant areas or the entire plant, regardless of whether Melody I/O, PROFIBUS remote I/O or HART Multiplexers are used.



Advantages

- All-in-one solution: one tool for S+ Melody I/O as well
- Optimized commissioning of HART field devices
- System-wide connection verification of HART devices
- System-wide health check of HART devices
- Remote I/O and HART Multiplexer
- Automatic detection of damaged or replaced devices
- Easy capture and visualization of device status

ABB is a leading provider of integrated power and automation solutions for conventional and renewable-based power generation plants and water applications. The company's extensive offering includes turnkey electrical, automation, instrumentation and control systems supported by a comprehensive service portfolio to optimize performance, reliability and efficiency while minimizing environmental impact.

Application focus in the next issue:

Service



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