

Making power plants energy efficient
ABB, integrated power and automation
solutions

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ABB has a singularly broad and comprehensive offering in power generation. It covers the complete scope of supply in power plant instrumentation, control and electrical equipment, which ABB integrates into a plant-wide solution called integrated ICE.

Integrated ICE is a capability unique to ABB. It builds on the company's vast product and systems portfolio in power and automation technologies, and on 125 years of expertise and innovation in power generation.

It extends across all types of power generation (from fossilfuel and nuclear to hydro and solar), and includes the full scope of ICE products and systems in a power plant (from power transformers and generator excitation systems to distributed control systems and field instrumentation).

And it incorporates an unrivaled track record in plant optimization, power management, system integration, and lifecycle service.

Improving power plant energy efficiency

Around 70 percent of the world's power plants use coal, natural gas, oil, biomass or solid waste to generate electrical energy. Between 7 and 15 percent of the power generated at fossil-fuel plants is consumed by the plant's auxiliary systems. Much of this energy could be saved or sold to generate higher plant revenues.

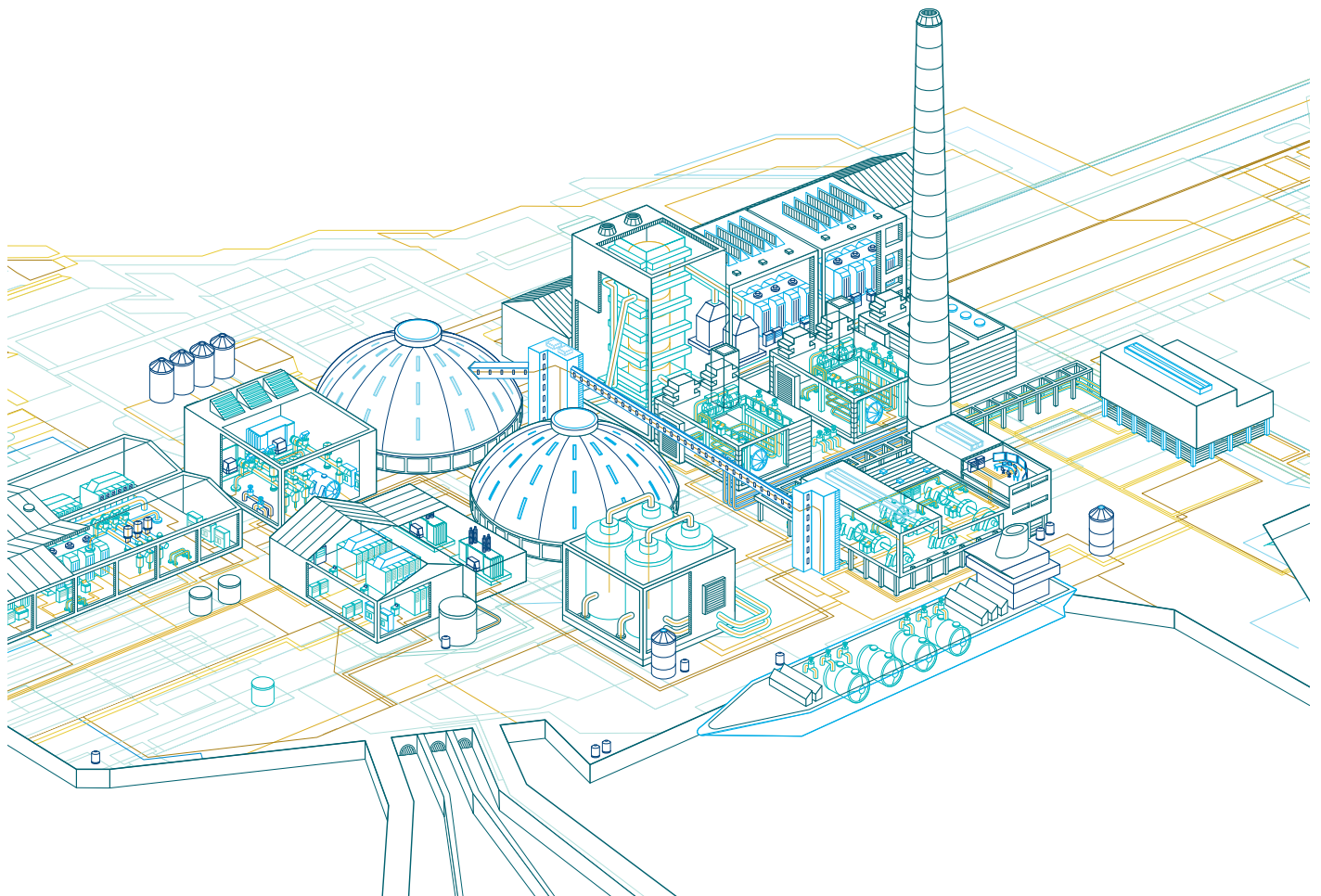
Auxiliary systems are a major part of a power generation facility. Their purpose is to power the plant using a minimum of input energy to achieve maximum output and availability.

They include all the drive power applications (pumps, fans, motors, drives), electrical balance of plant and instrumentation, control and optimization systems.

ABB is the market and technology leader in the majority of the products and systems that make up the auxiliary systems of a power plant and the scope of supply in an integrated instrumentation, control and electrical solution.

By improving the efficiency of each auxiliary, ABB can reduce the energy consumption of an existing facility by 10-30 percent. Added together – system by system, saving by saving – the reductions in energy consumption and associated CO₂ emissions are considerable. Output and availability are also improved, as are equipment and system reliability.

The Italian utility Enel has transformed its Torrefaldis Nord thermal power plant from heavy fuel to “clean coal” with the help of ABB power and automation technologies, increasing the electricity generated from each ton of fuel by 15 percent. ABB’s central control system connects 3,500 instruments across the plant, gathering and analyzing data that enables Enel to operate the plant at maximum efficiency – and to reduce the plant’s emissions of nitrogen oxide, sulfur dioxide and dust by more than half.



Manual and methodology

In a recently published manual “Power Generation: Energy Efficient Design of Fossil-Fuel Power Plants”, ABB describes how these savings can be achieved in an existing power plant. Step by step, the handbook describes how ABB can achieve improvements in energy efficiency, output and reliability.

Among other things it details how improvements can be obtained from correct-sizing motors, equipping fans and pumps with variable speed drives, increasing plant capacity with power factor improvements, as well as enhancing the performance of turbines, generators, distributed control systems and field instrumentation.

1. Reducing the energy consumption of boiler feed pumps by 25 percent

ABB medium-voltage drives have slashed the energy consumption of two boiler feed pumps at a coal-fired power plant in Germany by 25 percent. The solution increases plant revenues by \$800,000 a year and reduces annual CO₂ emissions by 10,200 tons. The two ABB high-efficiency ACS 1000 medium-voltage drives control two boiler feed pumps at unit 6 of the 1,675 megawatt GKM coal-fired power plant at Mannheim, Germany.

The pumps each have a rated output of 5.8 megawatts and were installed in the mid-1970s when unit 6 was constructed. Prior to the ABB solution the pumps were controlled by hydraulic clutches, which were operating with an efficiency of only 72 percent and were losing more than 1 megawatt of energy per pump.

When unit 6 was revamped in 2006, GKM concluded that the poor efficiency and high energy losses of the pumps and clutches were no longer sustainable. GKM turned to ABB for a solution.

ABB proposed a modernization package for each pump comprising an ACS 1000 medium-voltage variable speed drive, an ABB RESIBLOC® dry-type transformer, and a complete overhaul of the pumps.

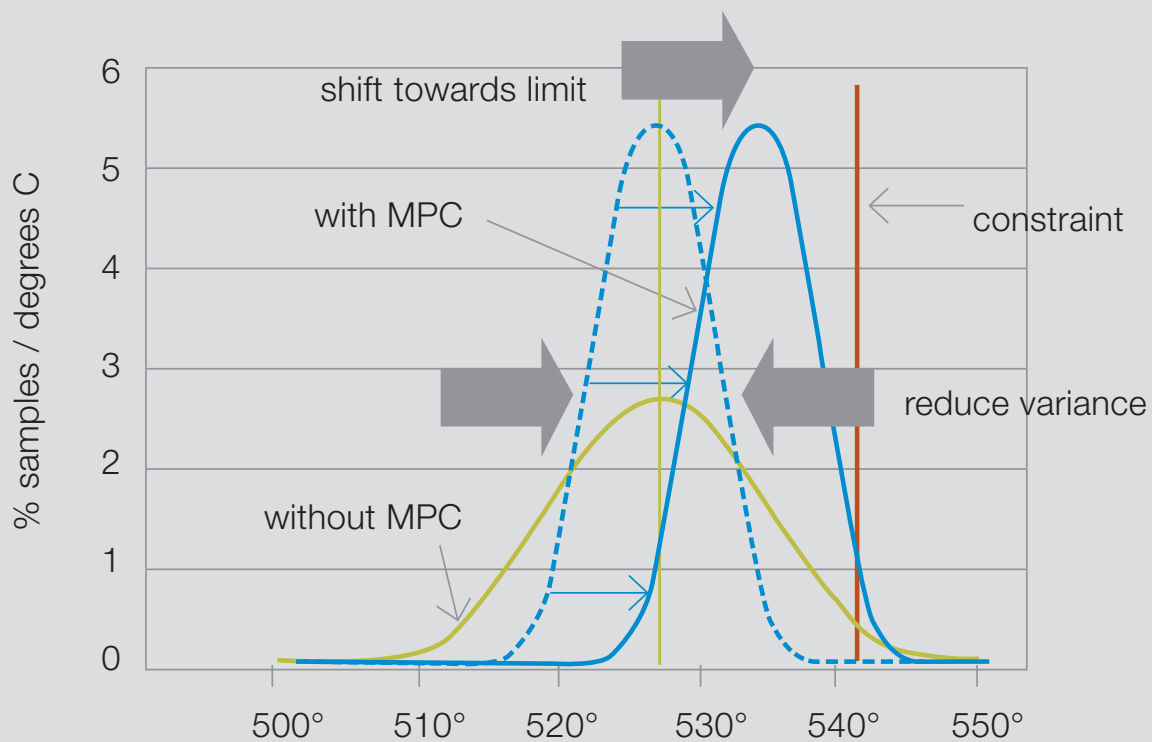
After two years of trouble-free operation GKM could confirm a reduction in pump energy consumption of 25 percent, energy that the plant can sell instead of consuming and which is worth \$400,000 per pump per year in revenues.

The improvement in energy efficiency has had a corresponding impact on the plant's carbon footprint, lowering its carbon dioxide emissions by 10,200 tons a year – a significant reduction for a fossil-fuel power plant. And the overall efficiency of the new pump drive system is a near-perfect 98.5 percent, compared to the inefficient 72 percent of the previous system.

The installation has been so successful that GKM subsequently awarded ABB an additional two contracts to install medium-voltage drive systems for the feeder pumps and water circulation pumps at two of the plant's other generating and district heating units.

1 GKM power plant, Mannheim, Germany | 2 The water-cooled ACS 1000 medium-voltage AC drives were installed ready for connection in special, fully air-conditioned containers





Reduced variance of steam temperature allows operation closer to the limit

2. Reducing the fuel consumption of boiler startups by 10-20 percent

An ABB BoilerMax optimization solution has cut the cost of boiler startups by between 10 and 20 percent at five fossil-fuel power plants in Germany and Ireland, savings worth several hundred thousand dollars a year in reduced fuel costs.

BoilerMax has been successfully operating for several years at seven generating units and five power plants owned by E.ON, GDF Suez and ESB, where it has achieved some remarkable reductions in fuel consumption.

Savings of between 10 and 20 percent in the cost of each startup have been consistently recorded since installation. This equates to annual savings of between € 80,000-160,000 (\$100,000-200,000) for the approximately 100 startups a year that a typical average-capacity power generating unit performs.

The installations cover coal, gas, and oil-fired generating units with capacities of between 420 and 950 MW. They include units at Staudinger, Ingolstadt, and Heyden (all owned by E.ON in Germany), Zolling (owned by GDF SUEZ in Germany) and Aghada (owned by ESB in Ireland).

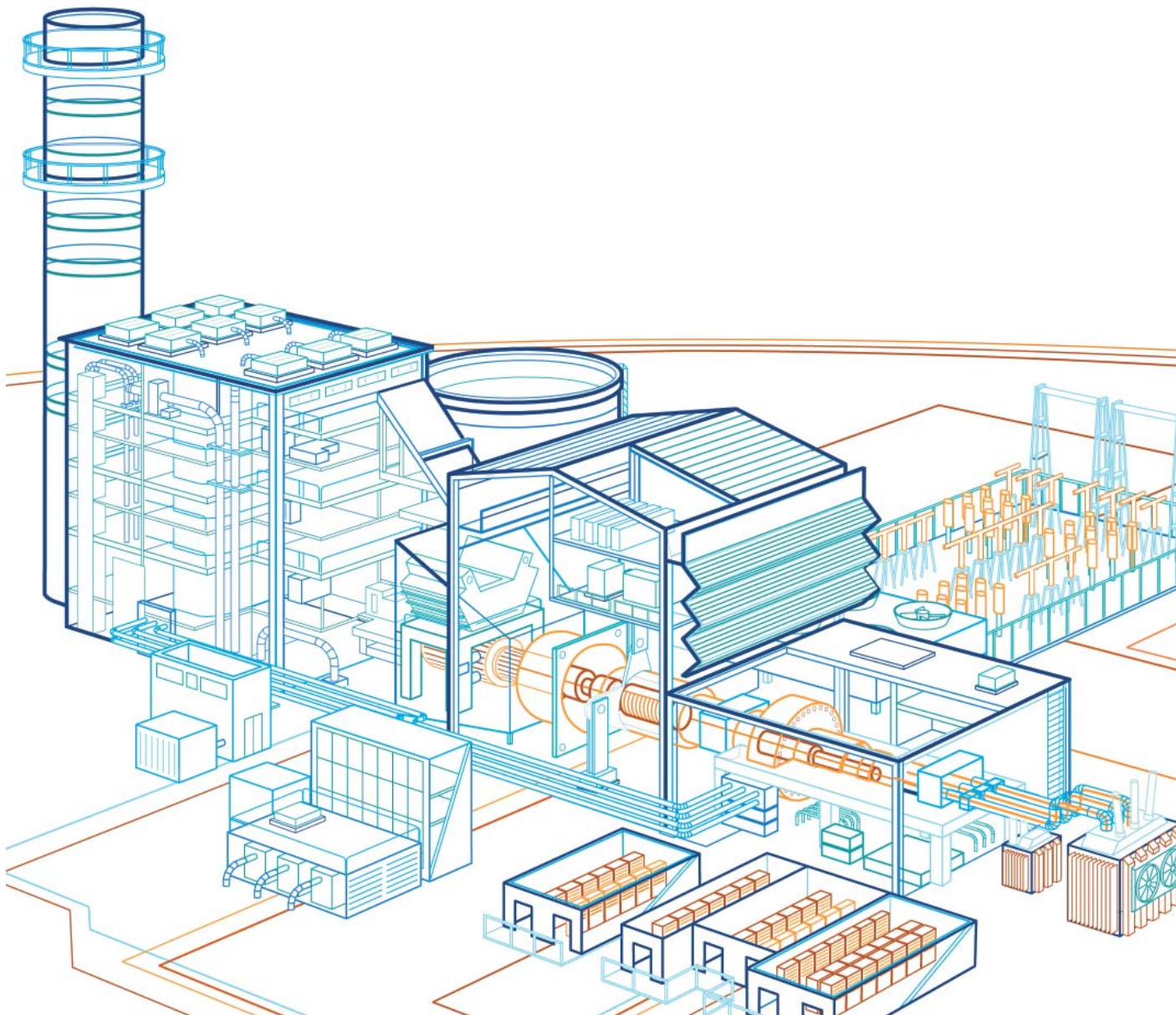
BoilerMax is integrated with ABB's System 800xA control system at Ingolstadt and Zolling, and with ABB's earlier Procontrol P unit control system at Staudinger and Heyden.

Power plant optimization usually focuses on extracting as much energy from the fuel as possible during normal operation.

BoilerMax, on the other hand, improves operating efficiency by optimizing startup procedures. This is particularly important as the fuel used at startup is of a higher grade and more costly than that used in normal operation.

BoilerMax optimizes boiler startup times by determining optimal control actions based on thermal and dynamic constraints. It computes fuel costs and thermal stress in critical components and uses the data to calculate the optimal set-points for fuel supply and the operation of the high pressure bypass station.

The predictive horizon of BoilerMax covers the entire duration of the boiler startup to ensure that the most cost-effective operating mode is computed. The startup costs minimized are in fuel (heavy fuel oil), auxiliary power (light oil and electrical auxiliary power) and auxiliary steam.



3. Generating 25,000 MWh more power from the same fuel input

Advanced ABB process control technology has reduced NO_x emissions by 15 percent at a large U.S. power plant, while generating 25,000 MWh a year of additional electrical energy at the same fuel input.

The technology, Combustion Optimizer, is part of ABB's comprehensive OPTIMAX® portfolio of optimization tools that continuously assess power plant performance and provide root-cause analysis of any deviation from optimal efficiency levels.

Within the first few months of operation at two of the four units of a 2,000 MW coal-fired power plant in the United States, Combustion Optimizer achieved some remarkable improvements in plant efficiency and substantial reductions in greenhouse gas emissions.

Nitrogen oxide (NO_x) emissions were reduced by 15 percent and reheat spray flow by 40 percent. The resultant improvement in boiler efficiency enables the plant to generate some 25,000 megawatt hours of additional power a year with the same fuel consumption, enough to power thousands of U.S. homes.

Part of the ABB OPTIMAX suite of optimization software for industrial and utility power plants, Combustion Optimizer uses multivariable model predictive control (MPC) to minimize process variations and enable power plants to operate closer to their optimum without violating process constraints.

The benefits of running the plant closer to its operating limits include improved heat rate, higher generating capacity and lower greenhouse gas emissions. Multivariable model predictive control also facilitates faster ramp rates.

Although MPC is used widely in the process industries it is only recently that computers have become sufficiently powerful and cost-effective for it to be applied in the more demanding applications of large, complex power plants.

ABB's OPTIMAX portfolio of optimization software and tools is installed at industrial and utility power plants in more than 50 countries.

4. ABB concept delivers under budget and ahead of schedule

An ABB integrated ICE solution has helped a U.S. electric utility to open a new power plant three months earlier and for \$8 million less than originally planned. Benchmark levels of plant optimization, energy efficiency and reliability were the customer's requirements.

Black Hills Power started production at its new 100-megawatt Wygen III coal-fired power plant in Wyoming in April 2010, three months ahead of schedule.

The achievement is the result of a successful collaboration between ABB and Black Hills Power to adopt a fresh approach to engineering and identify new and innovative solutions that would reduce costs and enhance plant performance.

The improvements include a redesigned plant grounding system, a new approach to running underground cables through duct banks using a more robust yet less costly material, and the integration of I/O cards directly into the electrical equipment or in the field.

These improvements significantly reduced construction and material costs and shortened the overall installation time of the solution. The third improvement alone (integration of the I/O cards) eliminated the need for more than 16,500 meters of control cable.

ABB's integrated instrumentation, control and electrical solution for Wygen III encompasses the full scope of power and automation products and systems. The concept ranges from performing system studies to properly sizing the equipment and then integrating everything into the most efficient, reliable and optimized solution possible.

For BHP it brought the additional benefits and savings of shorter delivery time, faster generation of revenues, and lower capital expenditure.

ABB Power Generation

ABB is a leading provider of integrated power and automation solutions for all types of power generation plants. With an extensive offering that includes electrical balance of plant, automation, instrumentation and control systems, and service – along with more than 125 years of expertise and innovation and a presence in over 100 countries – ABB solutions help optimize performance, improve reliability, enhance efficiency and minimize environmental impact throughout the plant lifecycle.

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