# Full speed ahead
## ABB technology briefing

## Power Technologies

Contents



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# Who, what and why?

Developing new technology is a direct investment in ABB's future. We invested roughly 4.5 percent of revenues, or US$ 799 million, in R&D and order-related development in 2002.

ABB runs ten research programs which are geared to making the company and its customers more competitive. The programs, managed by strategic technology teams that cut across the businesses and corporate headquarters, are aligned in two core areas: power technologies and automation technologies.

Each global laboratory combines research units in the U.S., Europe and Asia. ABB is building up its R&D activities in India, Singapore and China.

To find out more visit:
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## Power Technologies

ABB Power Technologies serves electric, gas and water utilities as well as industrial and commercial customers, with a broad range of products, systems and services for power transmission, distribution and power plant control.

### Who?

Researchers and engineers in the laboratories for power technologies largely develop products and systems used by electric, water and gas utilities, as well as industrial and commercial customers.

### What?

Insulation technologies, current interruption and limitation, power electronics and flow control and protection of electrical energy from large transmission systems to household applications.

### Why?

Availability, reliability and safety of electrical energy are challenges, especially with regard to ageing infrastructure and deregulated markets. Modernization and the buildup of new capacity must be provided in the shortest of delivery times.

### Outlook

Combining new materials with process research and the connectivity of Industrial IT will help ABB's customers improve the safety and reliability of their power supply – from grid to plants and factories.

**Ten research programs**

- Control and optimization
- Software architecture and processes
- Sensors and microsystems
- Power electronics
- Advanced industrial communication
- Mechatronics and robotics automation
- Power device technologies
- Power transmission and distribution applications
- Manufacturing technologies
- Nanotechnologies

# No more blackouts

Massive power blackouts in the U.S. and Europe are stark reminders that reliable power is not a right or privilege, but an infrastructure which is too often taken for granted.

If you don't invest in power transmission infrastructure, the lights will go out. It's that simple. ABB has proven technology that can quickly and effectively remedy power outages created by congested grids, and bottlenecked cross-border power exchanges.

Increased power trading has put great stress on power networks in Europe, because grids were built to satisfy power demands within a single or a few connected countries, and not as cross-border power exchanges.

The same applies to the U.S. – grids originally designed to move power within small utility service territories are now being stretched to their limits as massive blocks of wholesale power crisscross from one region of the country to another.

These grids need to be carefully monitored in wider areas, upgraded and expanded, and quickly. ABB has a portfolio of technologies and products to stabilize unreliable grids. We effectively analyze the network to identify critical links, and deliver with short installation times because we can use modularized components. ABB's well-established High-Voltage Direct Current (HVDC) transmission technology, for example, helps solve two problems at the same time: increasing grid reliability and allowing power exchange across grids.

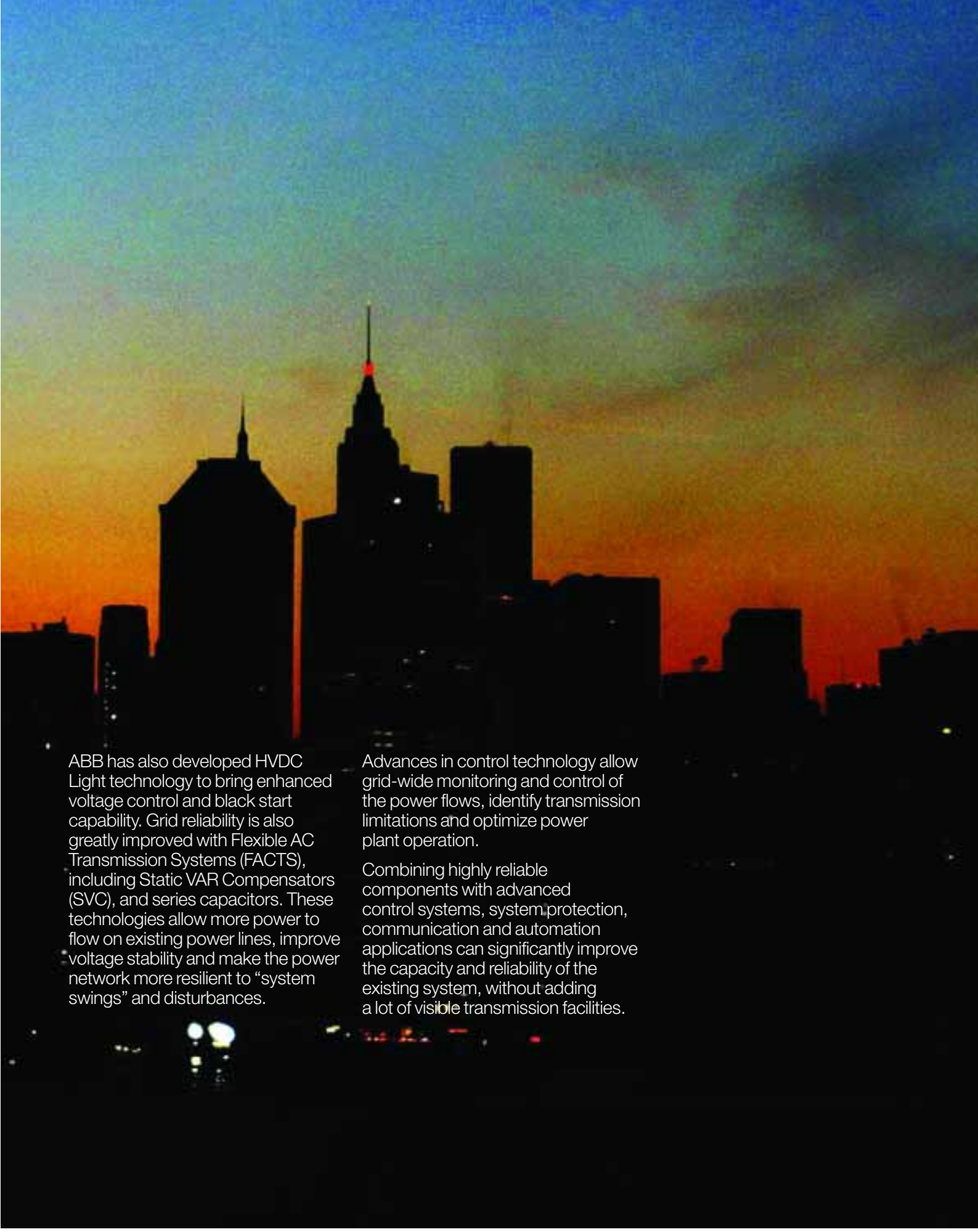


ABB has also developed HVDC Light technology to bring enhanced voltage control and black start capability. Grid reliability is also greatly improved with Flexible AC Transmission Systems (FACTS), including Static VAR Compensators (SVC), and series capacitors. These technologies allow more power to flow on existing power lines, improve voltage stability and make the power network more resilient to “system swings” and disturbances.

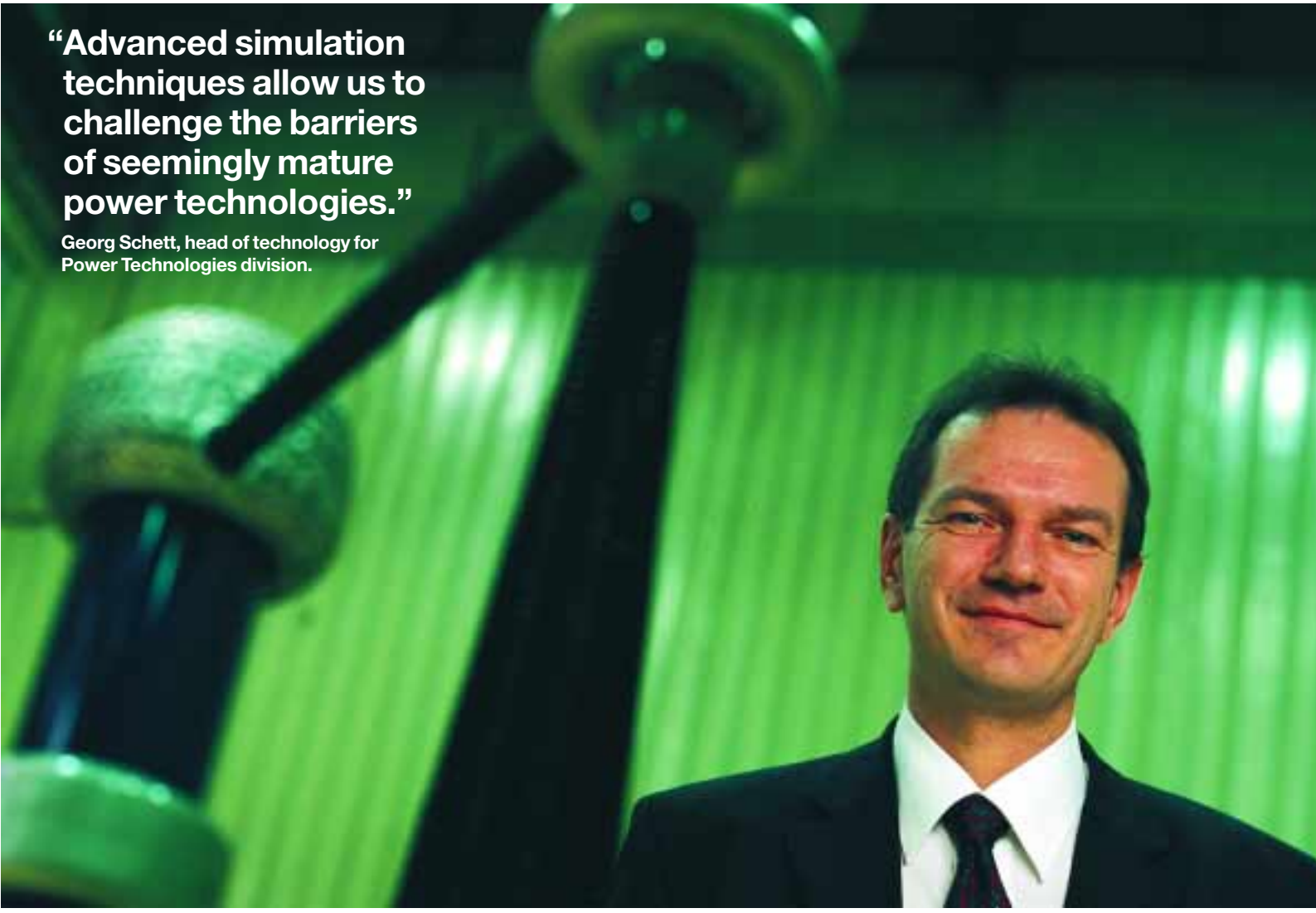
Advances in control technology allow grid-wide monitoring and control of the power flows, identify transmission limitations and optimize power plant operation.

Combining highly reliable components with advanced control systems, system protection, communication and automation applications can significantly improve the capacity and reliability of the existing system, without adding a lot of visible transmission facilities.

# Full speed ahead

ABB is the recognized leader in power technologies. Research and development in this area is focused on better serving electric, gas and water utilities, as well as industrial and commercial customers, with a focused range of products, systems and services for power transmission, distribution and power plant control.

To find out more visit: www.abb.com/ptd



## Market characteristics

Demand for power technologies in China, India and the Middle East is growing substantially. Europe and the U.S. are growing at a more moderate rate, though the recent power outages in North America foreshadow solid growth in the U.S. and Canada. The ongoing consolidation and cross-border operation of utilities and power networks is increasing the need for interconnectivity equipment and products that can be delivered quickly.

## Technology areas

Technology already exists to increase the reliability and performance of power networks. To do that, customers need to build faster high-voltage power-electronic devices into vulnerable sections of the grid. ABB has focused on the development of equipment like high-voltage direct current (HVDC) links and flexible alternating current transmission systems (FACTS). The power industry term FACTS covers a range of technologies that enhance the security, capacity and flexibility of power transmission systems. All of these systems can be installed without the need for new overhead transmission lines. Where new lines are needed, oil-free cables can be put underground. We have also developed power devices with better insulation and self-blasting current interruption technology.

## Research programs

ABB works on electrical insulation, current interruption and the system aspects of complete power grids to enhance reliability and interconnectivity. We also focus research on improving our manufacturing processes for products ranging from transformers to switchgear to improve product quality and delivery times. Nanotechnology is an emerging area with high potential.

## Industrial IT

Most of ABB's power technology products have been Industrial IT-enabled in the last two years, which means they have a standard format for data and the exchange of information with other products and within larger systems. For example, by building in intelligent components, a power transformer can be linked into a larger control system for easy monitoring and maintenance. The vision is to link the entire power grid all the way down to its component parts – a boon to operators. Industrial IT is also used in ABB factories to boost performance (for example in Poland and Germany).

## Strategic initiatives

Fast deliveries, quality products and efficient service are at the top of every customer's list. To meet these needs, ABB is modernizing all of its own factories, complete with Internet ordering. We are also pushing for International Electrotechnical Commission (IEC) standardization in substations, which will allow different systems to be linked together by common protocols. In addition, we are further enhancing communication by adding even more intelligent components to our products and systems.

## Outlook

Advanced simulation techniques allow us to challenge the barriers of seemingly mature power technologies. By coupling new materials with process research and the connectivity of Industrial IT, we are confident we will stay ahead of the competition.

## Shipping power in bulk

Did you know? ABB is building two of the world's largest high-voltage direct current (HVDC) transmission links to transfer 50 TWh (50 trillion watthours) of hydroelectric power from the Three Gorges dam to the industrialized coastal areas of Shanghai and Guangdong more than 900 kilometers away.

Recently, the power transmission link between the Three Gorges dam and Changzhou passed all trials and is ready to set a new world record for power levels of 3,300 megawatts. ABB's next HVDC link, from Three Gorges to Guangdong, is scheduled for completion in mid-2004.

"China's power policy is to transmit power from the west to the east," said Yuan Qing-yun, division director of HVDC division 1, department of engineering and construction, State Grid Corporation. "I believe ABB has the best technology for HVDC, and I'm very satisfied with the progress we've made so far."

ABB's environmentally-friendly HVDC technology is used in many different parts of the world to strengthen power supply.

# Fast growth in United Arab Emirates

The government in the United Arab Emirates has increased spending on job creation and infrastructure expansion and is opening up its utilities to greater private sector involvement.

As the infrastructure expands, demand for power increases. Reflecting this upswing, ABB won more than US$ 100 million in orders for power technologies from the Abu Dhabi Water and Electricity Authority (ADWEA) last year.

Over the past 30 years, the UAE has undergone a profound transformation from an impoverished region of small desert principalities to a modern state with a high standard of living.

The ABB orders reflect this transformation – and the sense of urgency of the authorities in the emirates. One of the contracts awarded to ABB includes the supply of around 50 pre-engineered and self-contained 33/11KV distribution substations, which will dramatically speed up delivery time, and 386 medium-voltage switchgear panels and 20 transformers.

Another five 33/11KV distribution substations incorporate the latest technology in control, protection and monitoring systems, as well as 250 air and gas-insulated switchgear panels, and 25 distribution transformers.

The UAE has an open economy with a high per capita income and a sizable annual trade surplus. Its wealth is primarily based on oil and gas output (about 33 percent of GDP).

ABB's pre-engineered and self-contained distribution substations will dramatically speed up delivery time.

With eight million bicycles on its streets and the number of autos growing by 40 percent a year, good public transportation in Beijing is essential.

# Racing to meet deadlines for 2008 Olympic Games

Authorities in Beijing turned to ABB to help them cope with the anticipated massive influx of people that will swell the city's metro system during the 2008 summer Olympic Games.

Beijing's metro system consists of 100 kilometers of track which can only handle around ten percent of the city's 12 million inhabitants. In advance of the Olympics, city planners are tripling its length.

"We have to get a lot of people from point A to point B," says Wu Youyou, vice director and senior engineer. "ABB's technology is environmentally sound, of high quality and very reliable."

The Beijing Metro Group hired ABB to provide medium-voltage switchgear to power the new Beijing light rail running from Xizhimen to Dongzhimen.

The new light rail is part of the Beijing municipal government's ongoing ten-year plan to meet the needs of the 2008 games. Wu Youyou says eight metro lines are currently under construction or slated for construction this year. "Many electrical products will be used in these projects, from control systems to transformers and medium and low-voltage products."

"The most advanced line in terms of construction is the one where we've partnered with ABB," says Wu Youyou.

In a city with eight million bikes and 1.3 million motorcycles – and the number of autos growing by 40 percent a year – public transportation is paramount. "In addition, Beijing as a city is expanding quickly," he says. "Which means there is more and more pressure to have low impact, safe, quiet and reliable rails and trains."

ABB earlier in the year won a US$ 18 million order for medium-voltage gas-insulated switchgear (GIS) for Guangzhou metro line 3 and Shenzhen metro line 1. It was ABB in China's largest-ever medium-voltage order.

# Talkin' about a new generation

Interrupting current in a power station requires the most powerful circuit breakers known. They must handle huge loads, withstand enormous forces and operate reliably within milliseconds for many years.

With an 80 percent market share, ABB is the world's largest producer of generator circuit breaker systems. It has built this leading position with innovative technology like the proprietary self-blast breaker system which captures energy from the powerful electric arc produced when a circuit is interrupted, which in turn creates sufficient gas pressure to blow out the arc.

Demand for these breaker systems is growing fast on the back of new power stations.

ABB established a world record in switching high currents with self-blast technology.

But customers increasingly want the specification, ordering, building and delivery of the equipment to be faster and more efficient.

So ABB created a new range of generator circuit breaker systems that over time will replace almost 90 percent of its current offering in this market. Called HECS, or high energy current system, it's a family of seven highly modular systems covering the full range of different power station applications, including gas turbine, steam, nuclear or hydro, and power ratings.

The systems are compact, yet offer extraordinarily high breaking power for their size. They have established a world record in switching high currents with self-blast technology. Performance levels have also improved, with the breaker itself guaranteed for 20,000 close/open operations compared with 15,000 in the systems being replaced.

Each of the HECS variants has a large number of common high performance components, but each one can also be customized in the late stages of manufacturing according to the rating of the power station and the transformer that connects it to the grid.

Modular design also means ABB can guarantee greater reliability from the point of delivery and that maintenance is simplified over the many years that these systems will be in operation.

The HECS family of products is aimed initially at the new power station market. Two systems have already been delivered, and a further 30 are being deployed in new projects around the world.

The annual market for generator circuit breaker systems is expected to total more than US$ 100 million a year by 2005.

## Taming a tidal wave

Deregulated electricity markets have turned the complex tasks of buying and selling power cheaply and securely into a daily challenge for power operators.

ABB is already a leader in power network management technology, with a range of software tools giving operators reliable mechanisms to negotiate prices and find economical distribution options.

But as power markets grow and diversify, the mathematical challenge to integrate these enormous streams of information increases exponentially.

ABB is tackling these complicated market dynamics with sophisticated mathematical formulas and new software – called Resource Manager – that in effect tames the information tidal wave.

ABB's focus is a range of IT-based scheduling technologies which forecast energy availability and consumption, with emphasis on resource optimization.

Operators need fast, accurate, custom-made products, fair and efficient market pricing systems, as well as tools to analyze supply and demand, price-quoting mechanisms, availability and scheduling.

They need to communicate constantly with each other and with central markets.

ABB's new system is designed to give them that but is also adaptable, so power operators can optimize forecasting, buying and selling according to their specific circumstances.

The new process is expected on the market in 2004.

## Live wires

When power lines crash to the ground it's a devastating and dangerous event – electricity is often cut and live wires pose hazards to anyone passing nearby or touching the line.

Power companies must quickly identify and analyze these so-called high impedance faults (HIF). But under certain conditions – dry, desert climates, for instance – remote detection from a substation is difficult because the fault current is actually very low and indistinguishable from normal power consumption.

In the U.S. alone – where there are more than a million miles of distribution lines – this problem has plagued scientists for more than 30 years.

Fortunately, ABB is releasing its new Distribution Protection Unit, the DPU2000R, which will incorporate HIF detection. It is first aimed at the U.S. utility market.

The key to the new system is a series of three complex algorithms that measure current in different ways against pre-determined thresholds to identify the weight, wave shape and energy of the current and match it to typical HIF behavior.

The algorithms then "vote" to see if a fault is likely to have occurred. If more than two algorithms indicate a fault, the utility can take action with confidence.

Power companies can respond swiftly to potential faults, locate a fallen line, and also decide whether a line should be tripped or simply alarmed while it waits to be repaired.

# Preventing clear and present danger

## Controlling power distribution is a huge and complex undertaking.

Grid operators schedule routine maintenance, plan outages, deploy emergency engineering teams in the teeth of a storm and inform customers when a blackout strikes, and when the lights will go on again. All of these tasks – and many others besides – can only be done if operators have accurate information and analysis.

Securing the grid is so important to modern power utilities, they can spend up to US$ 10 million installing the right control system, and up to US$ 1 million per year keeping the system up to date.

The third generation of ABB's computer-aided distribution operations system (CADOPS) now provides the control information that utilities need in real time.

It delivers up-to-the-minute, as-operated information and analysis of the entire grid, versus the as-built view offered by many other distribution control systems.

The CADOPS moment-by-moment view is mounted on a single software platform, accessible to company intranets and displayed in a simple graphical format that can be easily used by different operators.

It includes engines to track and analyze outages, pinpoint key customers and help deploy recovery teams.

CADOPS can also be used to create a database of operations within the utility, so that optimal operating conditions may be analyzed, crew performance checked and improved and customer inquiries efficiently handled.

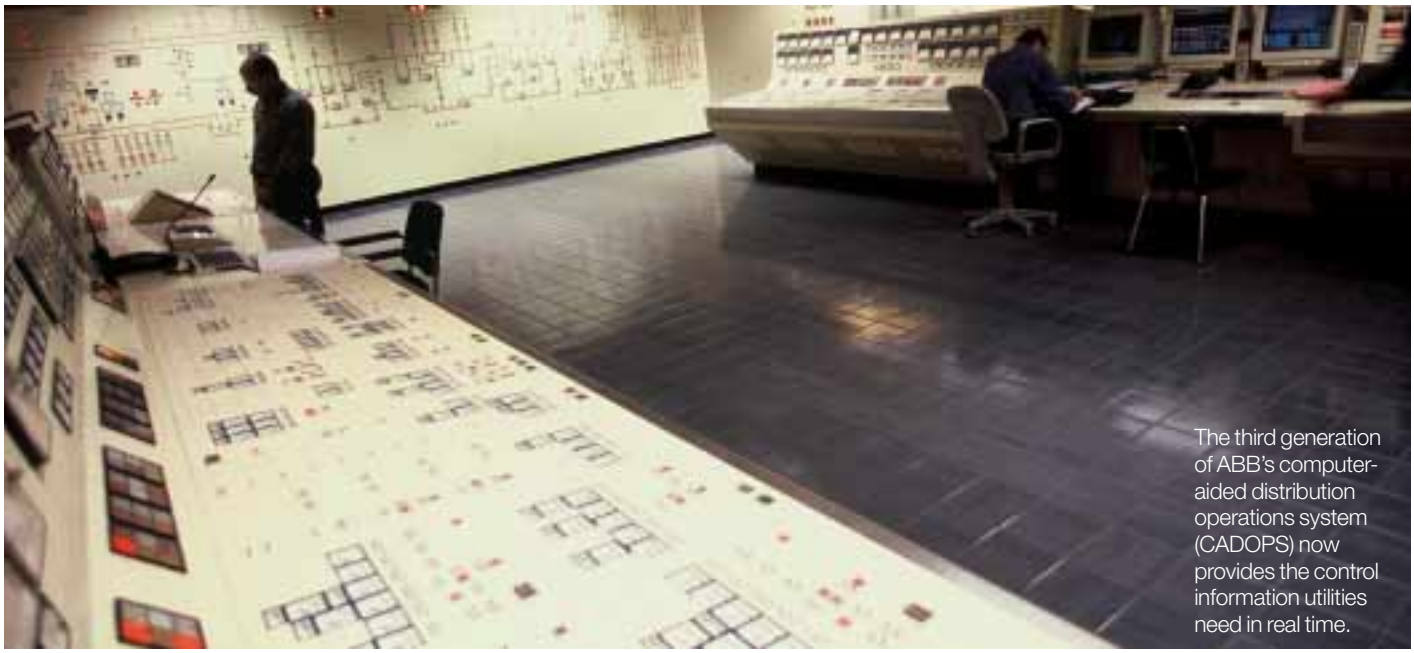
When Commonwealth Edison (ComEd), in northern Illinois, put the latest version of CADOPS through its paces last year, the system proved its reliability in the most severe of simulated storm conditions.

Over a 12-hour period it handled 320,000 trouble calls, including 40,000 an hour at peak, and it allowed 240 dispatchers, including 180 connecting to the system via the Internet, to deploy 500 field crews.

The Supervisory Control and Data Acquisition (SCADA) system integrated with CADOPS monitored the activity of the network, handling a circuit breaker operation every three seconds and delivering network situation reports every 15 minutes.

ComEd – with 3.6 million customers, 5,000 feeder lines and 2.5 million electrical nodes – is a very large utility, but by no means the largest. However, the test represents the most detailed and rigorous trial of CADOPS ever undertaken.

Already, 22 other customers are using the system or are having it installed, including Pacific Gas and Electric and Pacificorp in the U.S., the Spanish utility Ibedrolla, and Israel Electrical.



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ABB's wide-area monitoring system (WAMS) improves power transmission capacity by up to 20 percent.

## Grid watch

Power distribution grids are highly complex systems composed of hundreds of energy inputs, a vast array of intricate electrical components and millions of users, often spread over huge areas.

Operators urgently need ways to measure, monitor and control the instability that reduces a grid's performance.

The challenge is to stabilize grid operation while running the network as close to its limits as possible. Until recently, the technology to do this simply didn't exist.

ABB has developed a wide-area monitoring system (WAMS) that improves power transmission capacity by up to 20 percent.

For the first time, it gives operators accurate early warning signals by monitoring any developing instability precisely and in real time, even when the grid is operating at high loads.

ABB's breakthrough is a set of advanced, patented algorithms, or mathematical procedures, that quickly calculate the status of energy flowing across the grid and feed signals back to the control center.

The dynamic monitoring system alerts operators to the exact nature of instability problems, so grids can run closer to full capacity. The hardware comes in compact units that can be deployed around the grid in substations and linked to a central PC for online monitoring.

ABB is combining its wide-area monitoring system with its Flexibile AC Transmission Systems, or FACTS, to create a large-scale warning and control system and help operators accurately identify and correct problems across an entire power network.

Pilot testing is under way in the widely spread Norwegian grid, and is backed by joint research and development work at Imperial College, University of London and the Swiss Federal Institute of Technology.

## With Industrial IT,

ABB standardizes information formats and organizes them into user-defined architectures, which cuts waiting time and introduces customers to cost-efficient, copy-and-paste engineering. They get the right information, in the right form, at the right time.

**On our own shop floor**

Production of crucial vacuum current interrupters at ABB's medium-voltage factory in Ratingen, Germany will reach a record 165,000 units by the end of 2003, compared to 140,000 in 2002.

An essential factor improving efficiency at the plant is ABB's Industrial IT systems and software, which integrates production information and gets it to the right person at the right time.

The Industrial IT application in Ratingen is being copied for use in ABB's other discrete manufacturing operations worldwide.

**End of the paper chase**

The age of folders and paper documents is over.

It's simply too time-consuming to search for data about a component from various bookshelves in different offices.

Around 36,000 ABB products come with complete electronic documentation in the unique structure of AspectObjects, so information is instantly and easily accessible.

**Helping power components speak**

Circuit breakers can now analyze themselves in a power grid and exchange data with other breakers to coordinate action.

The common language they speak is Industrial IT, and the information is structured so other components in a substation can join in the conversation.

This link can vastly improve maintenance and overall asset management at a utility.

## Boiling point

Before automated engine systems, cars needed chokes to start efficiently. Huge power station boilers also need special devices and controls to start up efficiently.

Full of complex piping, countless burners and thousands of tons of fuel, power boilers typically shut down at least once a week to match dips in energy demand.

Firing them back up to peak power generating capacity is a never-ending challenge that can take several hours, so cutting downtime would generate big savings.

That's where ABB's Boiler Startup comes in – a computerized system that predicts optimal conditions for starting a boiler from a mass of variables, including fuel oil and coal, auxiliary steam and electricity, and wear of the wall components.

ABB estimates that Boiler Startup can save 15 percent of the time it takes to start up – a saving of around US$ 100,000 per year. Boiler Startup software builds an analytical model consisting of thousands of equations representing a boiler's complex inner workings, then applies a mathematical recipe to determine the cheapest, fastest way to fire up.

The model can predict conditions and costs up to two hours ahead of time, and manages the entire startup process automatically. Both a regular startup and an emergency startup to meet a sudden surge in power demand can be managed.

The first ABB Boiler Startup system was installed at the beginning of 2003.

## Lightning strikes

If a bolt of lightning or a downed tree damages a power line, a circuit breaker immediately kicks in to handle the sudden surge of electrical power.

These vital components protect power grids from short circuits and consumers from blackouts.

Circuit breakers isolate faults in a power grid by mechanically separating electrical contacts, temporarily stopping the flow of electricity in a circuit until the fault can be repaired.

Traditional circuit breakers use spring, hydraulic or pneumatic systems that are noisy and easily worn out, to separate the breaker contacts.

ABB is taking a totally different approach with a new generation of modularized breaker systems that for the first time use motor drives for this operation.

A motor drive circuit breaker is much quieter than a conventional breaker, making it a very attractive alternative in urban substations. It's also more reliable, operating up to three times longer than traditional spring systems before needing maintenance.

ABB's motor drive circuit breaker is activated by a high current pulse that starts the motor and separates the breaker contacts in milliseconds. It's also computer-controlled, so utilities can supervise their operations and detect component faults remotely.

ABB believes motor drive circuit breakers could eventually replace the spring and hydraulic drive application completely.

## Cut tender times by 80%

ABB has developed a faster way of modeling power equipment on a computer, so new substations or power transformers can be configured within minutes, rather than weeks.

The accurate computer model can provide detailed equipment requirements. For example, a utility can compare using an air-insulated substation with a more compact gas-insulated unit. New transmission lines can be modeled as single or double lines, at low or high voltages, in AC or DC power.

This means utilities can assess a number of options at the same time and make more informed decisions faster.

Based on modularized power equipment, ABB's power configurator cut tendering times by 80 percent. ABB also uses a common configurator platform (CCP), which combines all of our power products in a common configuring and order system. Users can complete a quotation in less than five minutes.

Once manufacturing begins, modularization and the use of product data management systems mean ABB can pre-engineer base equipment, and customize it to individual specifications.

This speeds up the manufacturing process and reduces cost. Equipment can be factory pretested before delivery, reducing on-site construction and testing time.

Behind this is a detailed knowledge of how existing grids and networks work.

For example, ABB has a complete map of the North American grid that collapsed during the summer of 2003. An understanding of grid bottlenecks and vulnerabilities can be brought into ABB's modeling to help utilities strengthen their grids and prevent future blackouts.

## The lifeblood of a power network

Utilities often lack the quality data they need to effectively manage their electricity networks, which are vulnerable as a result. Typically, a network control center receives data from equipment and parts of the grid that have been developed independently of each other.

For example, different network computer systems are often incompatible and can't trade data, particularly on-line and off-line systems.

To fix this flaw and improve the quality and consistency of data pulled from the grid, ABB has developed a System Integration Option (SIO) that combines innovative software with its power network control systems.

It's an important development, because power managers with incomplete knowledge of network and equipment conditions may not be operating the grid at its peak potential.

The SIO uses open computing standards to uniformly model a utility's assets in different systems, including SCADA (Supervisory Control and Data Acquisition) systems and maintenance management and geographical information systems.

The key is to synchronize the data and build an integrated system model that produces consistent, reliable information to help utilities manage their assets effectively.

ABB already leads the market in supervisory power control systems, and its SCADA system has captured 20 percent of this US$ 1 billion market.

## Shrinking the heart of a power grid

In modern power markets, smaller is better.

Fierce competition means power companies need compact and efficient power grids, made up of parts that don't cost much to operate and are easy to integrate and fix.

Aware of the need to reduce and simplify, ABB has designed more features into a central component of a power substation – the circuit breaker.

The resulting hybrid – called PASS M00 – integrates the functions of circuit breaker, earthing, disconnection and measurement in one insulated module, eliminating separate pieces of equipment for each function.

PASS M00 is designed for the 72.5 kilovolt market commonly found in Australia, Latin America, North Africa and parts of Europe, which is worth an estimated US$ 5 billion a year.

ABB developed a similar module in the late 1990s for the 145 –170 KV range. The compact, modular design of PASS M00 offers better protection from weathering and pollution, and lowers energy loss.

A unique rotating breaking chamber is key to its compact size. All competing circuit breakers use a linear breaking system which requires much more space.

PASS M00's current measurement system works in harmony with other protection equipment, activating the system when a fault occurs. And the rotating chamber is an easy way to connect a line to earth, so repairs can be made safely.

## Take a break

A modern car and the first car ever made still have one thing in common – a mechanical drive system. Of course, today's automobile is also a high-tech machine, filled with control electronics, navigation systems and communication devices.

In the same way, circuit breakers – the devices used for interrupting an electric current to prevent short circuits – have evolved into multifunctional, multipurpose devices, even though the mechanical operation of disconnecting contacts remains the same.

ABB pioneered breaker technology, launching the first intelligent switchgear for medium voltage in the 1990s. More than 40,000 units are in successful operation.

The next step is a big one – and involves a product we call the e-breaker. Highly sophisticated, it works within power grids to pass information over a high-speed communication link to a web-based operator.

The Industrial IT "plug and produce" concept provides real-time access to information, and allows grid operators to engineer intelligent breakers on a system level. This is what they need to reconfigure their grids as fast as possible in order to prevent large area blackouts.

Adding physical components like measuring devices or control panels to an integrated protection and control technology results in very compact circuit breaker design.

This also reduces the engineering and installation workload for customers and increases the reliability of their systems, since they have to deal with fewer cables and parts.

# Power on the horizon

ABB is a world leader in power technologies, with more than US$ 7 billion in revenues in this area alone. In our labs and in cooperation with leading universities, this is what we see for the future of power.

### Smart materials

The gradual implementation of nanotechnology, a set of technologies that allows for individual molecules or atoms to be handled – will enable the design of “smart” materials. Nano-designed dielectrics will be able to react better to changes in electric fields. This opens a number of possibilities for cables, bushings, surge arresters and insulating materials. Further developed super-conductive materials will be used in power grids to limit currents and aid transmission of electricity. Using new technology to design the surfaces of insulators will help increase the reliability of those components.

## Shrinking power devices

Remember how big the first mobile phones were? Components and in turn products will continue to shrink over time. As we explore the physical limits of circuit breakers, the interrelation of the electric arcs within the walls of the breaking chamber and the thermal management of the breaker devices become critical areas of development. Power electronics, already considered state-of-the-art in terms of power conversion, will use hybrid circuit breakers in more applications. Substations will shrink as current and voltage sensors are increasingly integrated. Improved power electronics and motor drives will support this trend.

## Wireless world

Wireless devices will be used more to help products communicate with control systems. Substations will automatically supply status reports and call for service if needed. Self-monitored products like transformers will exchange information with enterprise management systems, thanks to Industrial IT.

## Lower environmental impact

More power transmission will go underground. As this happens, transmission and distribution lines will disappear. More high-voltage direct current (HVDC) light technology will reduce losses and new materials will make equipment last longer with less maintenance, lessening life cycle impact. Where establishing a right of way is not possible, more HVDC Light point-to-point connections will be made.

## Safer power grids

Grids will be stabilized with flexible alternating current transmission systems (FACTS), which will build in existing HVAC systems to boost capacity. Real-time control systems will manage larger areas and often cut across borders. They will be helped by satellite-based monitoring devices, allowing more energy to be transported through power lines with higher safety margins.

## Deregulation as a business

In deregulated markets, energy will increasingly be traded as a commodity. New technology will simplify connectivity between disparate power supply systems, provide a better overview of available power, and in turn ease this trading.

# www.abb.com/technology

The Internet is a playground for most – a place to get more information, download music, order books or investigate individual areas of interest.

Of course, the Internet is also something more. It is an idea incubator.

Suppose you are a student working on a project at university. ABB's technology Web pages can help you find an expert in your area of interest. You can exchange information and download specific drawings or mathematical calculations. Moreover, you can find the configuration data for a substation or get condition-monitoring statistics for preventive maintenance on motors and machines.

We have global research and development labs working together on large projects on the Internet. You can watch streaming video interviews with ABB's technology gurus – and listen to them discuss strategy and the future direction of research and development.


There is a section devoted to emerging technologies. It chronicles the historical development of nanotechnology, software, wireless applications and Micro-Electro Mechanical Systems (MEMS), and provides some guidance on where ABB will take these technologies in the future.

One of the most valuable parts of ABB's technology site is devoted to publications. It is no secret that ABB has been in the power and automation business for more than 100 years. What isn't widely known is that research papers, periodicals and technology reviews, accumulated during that time, have made their way to the Web.

ABB's products and services are already configured by customers on the Internet, helping the company glean important information about buying decisions and trends in the market.

The technology team wants to apply this learning to future research. One new idea is to create a technology forum, where an engineering problem is made public on ABB's sites. Independent researchers, scientists and students can submit their ideas or findings to the forum and help ABB solve the problem.

From these beginnings, it is possible to see collaborative research – technology experts working around the clock, all over the world – which will spawn an entirely new generation of technology solutions.

# Glossary

**Air-Insulated Switchgear (AIS):** a system of circuit breakers, measuring and control devices to switch electric currents using air as the insulating gas for high voltage applications.

**Algorithm:** a set of mathematical formulas to describe a process.

**Capacitor:** a system used to store electrical energy.

**CCP:** common configurator platform; a device used to create accurate computer models of power networks.

**CCPP:** combined cycle power plant; plants with gas turbines and steam cycles.

**.com and .net:** specifications and run-time environments for Microsoft component architecture and programming models to promote software interoperability.

**Circuit breaker:** a switching device capable of making, carrying and breaking electrical currents under normal and abnormal conditions.

**Computer-Aided Distribution and Operations System (CADOPS):** a control system which delivers up-to-the-minute, as-operated information and analysis of the entire power grid.

**Deregulated electricity markets:** markets in which the provision and trading of electrical power is regulated by market forces, rather than state legislation.

**Dielectric fluid:** a fluid with electric properties.

**FACTS:** Flexible AC Transmission Systems; a term describing technologies that enhance the security, capacity and flexibility of power transmission systems.

**Field bus:** communication line between instruments and controllers.

**Generator:** a rotating machine that produces electric power.

**Gas-Insulated Switchgear (GIS):** a system of circuit breakers, measuring and control devices to switch electric currents; GIS use high-pressure gas as an insulating medium for high voltage applications.

**Greenhouse gases:** gases that contribute to the greenhouse effect and global warming. The most significant are carbon dioxide ($CO_2$), water vapor, methane ($CH_4$), nitrous oxide ($N_2O$), chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride ($SF_6$).

**High Energy Current System (HECS):** systems that interrupt high electric currents in the100 kA range; used as generator circuit breakers.

**High Impedence Faults (HIF):** electric faults causing power leaks in power networks; difficult to detect.

**High-Voltage Direct Current (HVDC) Light:** an economical technology solution for converting and transporting electrical energy with a direct current at high voltage.

**Industrial IT:** Industrial IT is ABB's patented concept for linking products and services together with the information needed to run, monitor and maintain them.

**Micro-Electro Mechanical Systems (MEMS):** mechanical systems in the micrometer range for which the electrical supply is integrated on the same silicon chip.

**Microvaristor:** tiny ceramic particles which become conductive in high electrical fields; widely used in over-current protection devices.

**Network Modeling:** a method to describe a network with mathematical formulas in order to find optimal solutions for its design.

**PASS M00:** a compact ABB switchgear which integrates switching and measuring functionality in a modular design.

**Phase-shifting transformer:** a controlled transformer shifting the phase angle between input and output voltage in order to improve the power flow in the grid.

**Polyethylene:** material with excellent properties for electrical insulation.

**Power transmission and distribution:** shortened to T&D by engineers, refers to lines which provide the physical transport infrastructure to transmit electricity from generation source to customers.

**Preventive maintenance:** a method of forecasting when to begin maintenance on a machine or system before a failure occurs.

**Supervisory Control and Data Acquisition (SCADA):** a control system which allows the power network operator to view and control the status of many aspects of the power network.

**Transformer:** a machine that uses magnetic fields to change the voltage and current levels of electric power.

**Wide Area Monitoring System (WAMS):** technology created to detect and identify instabilities in power systems and reduce the chance of large area and cascading blackouts.

**Web-based:** software programs that incorporate the Internet for successful operation.

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