



# ABB drives and motors for improving energy efficiency

“Improving energy efficiency worldwide is the fastest, the most sustainable and the cheapest way to reduce greenhouse gas emissions and enhance energy security.”

(Final statement of G-8 summit, Germany, June 2007)



## ABB drives and motors help to solve the energy challenge

Today industry and commerce are facing an energy challenge. Pressures to reduce energy consumption, lower carbon dioxide (CO<sub>2</sub>) emissions and provide secure power supplies are coming from governments, consumers, legislators and shareholders alike. All of these pressures are against a background of ever-rising energy prices and the dramatic effects climate change is having on the environment. As a result, industry and their consumers are demanding ever more energy efficient products.

### Improved efficiency key to energy goals

The world's demand for energy is rising steadily. Today, it is nearly twice what it was 30 years ago. By 2030, it may have risen by over 50 percent again, according to estimates by the International Energy Agency (IEA). The organization estimates that global consumption of electricity will grow nearly twice as fast as the energy demand overall and that it will almost double by 2030.



### **Helping industries and utilities improve energy efficiency**

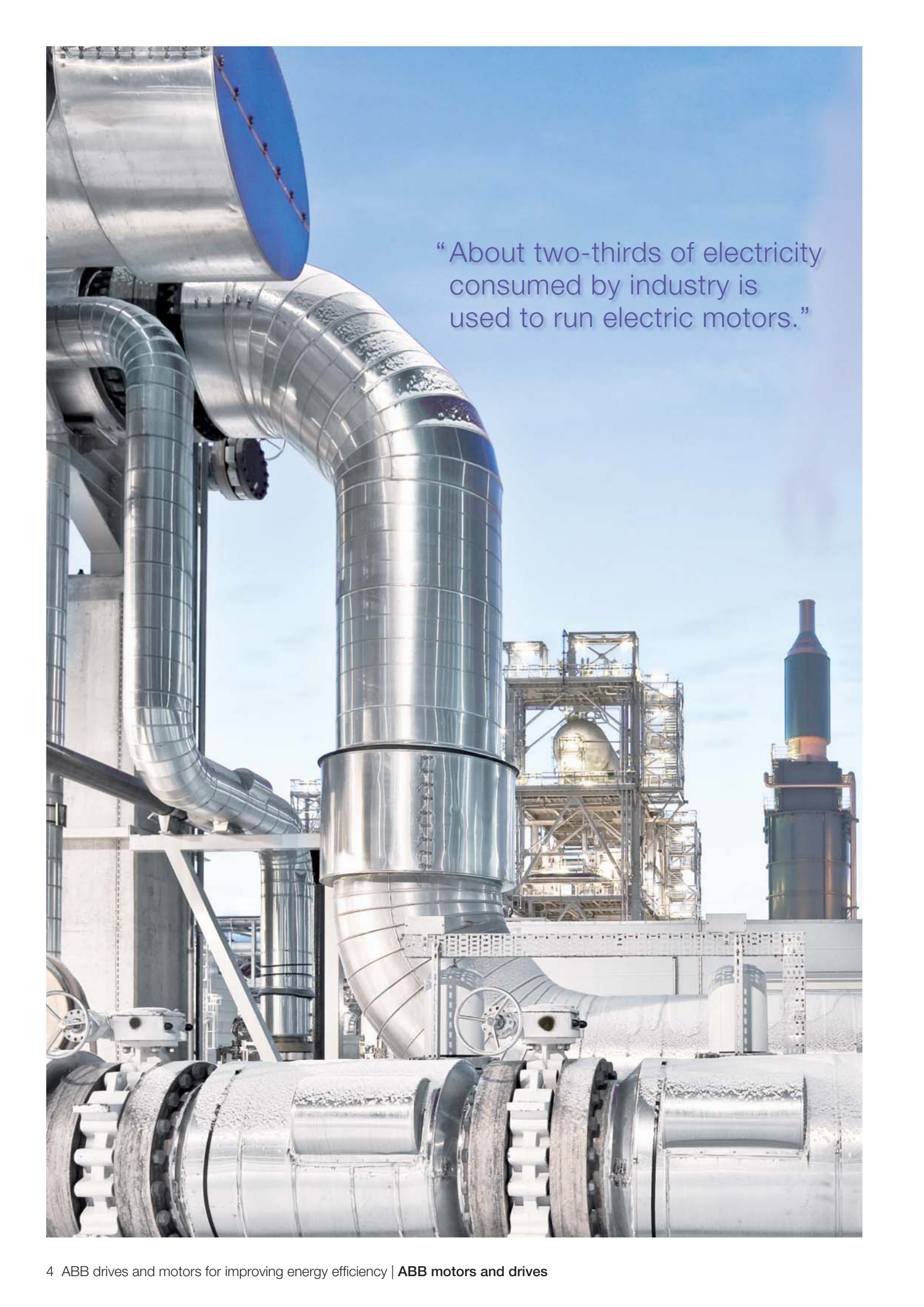
Industry consumes about 42 percent of all electricity generated, according to the IEA. The most energy-intensive industries are cement, chemical, iron and steel.

The energy saving potential in industry is enormous just in motor-driven applications alone: hundreds of millions of electric motors driving machines, compressors, fans, pumps or conveyors in virtually every sector account for about 67 percent of all the electricity that industry uses. More than 90 percent of industrial motors either cannot adjust their power consumption or use very crude methods to do so.

Many always run at full speed, regardless of the actual output needed. In many applications, energy use can be cut to one-eighth just by reducing the motor speed by half.

The most immediate, cost-effective and practical way to address the energy challenge is to grasp the opportunities for energy reduction that comes from using energy more efficiently with available and proven technology.

ABB's drives, motors and other technologies can help lower energy use, either by reducing power consumption and losses, improving productivity or through better management of equipment.

A photograph of an industrial facility, likely a refinery or chemical plant. The image is dominated by large, complex piping systems. In the foreground, there are several large, horizontal pipes with visible flanges and bolts. A prominent feature is a large, vertical pipe that curves from the left side towards the center. The pipes are made of a light-colored metal, possibly aluminum or stainless steel, and are surrounded by a network of steel support structures. In the background, there are more industrial structures, including a tall, cylindrical tower with a blue top section and a complex of scaffolding and platforms. The sky is a clear, pale blue. The overall scene conveys a sense of large-scale industrial operations.

“About two-thirds of electricity consumed by industry is used to run electric motors.”

# Reduce energy, increase productivity and safeguard quality

**ABB is the world's largest manufacturer of electric motors and drives. Drives adjust the speed of electric motors to match the actual demand of the application thereby reducing motor energy consumption by typically 20 to 50 percent.**

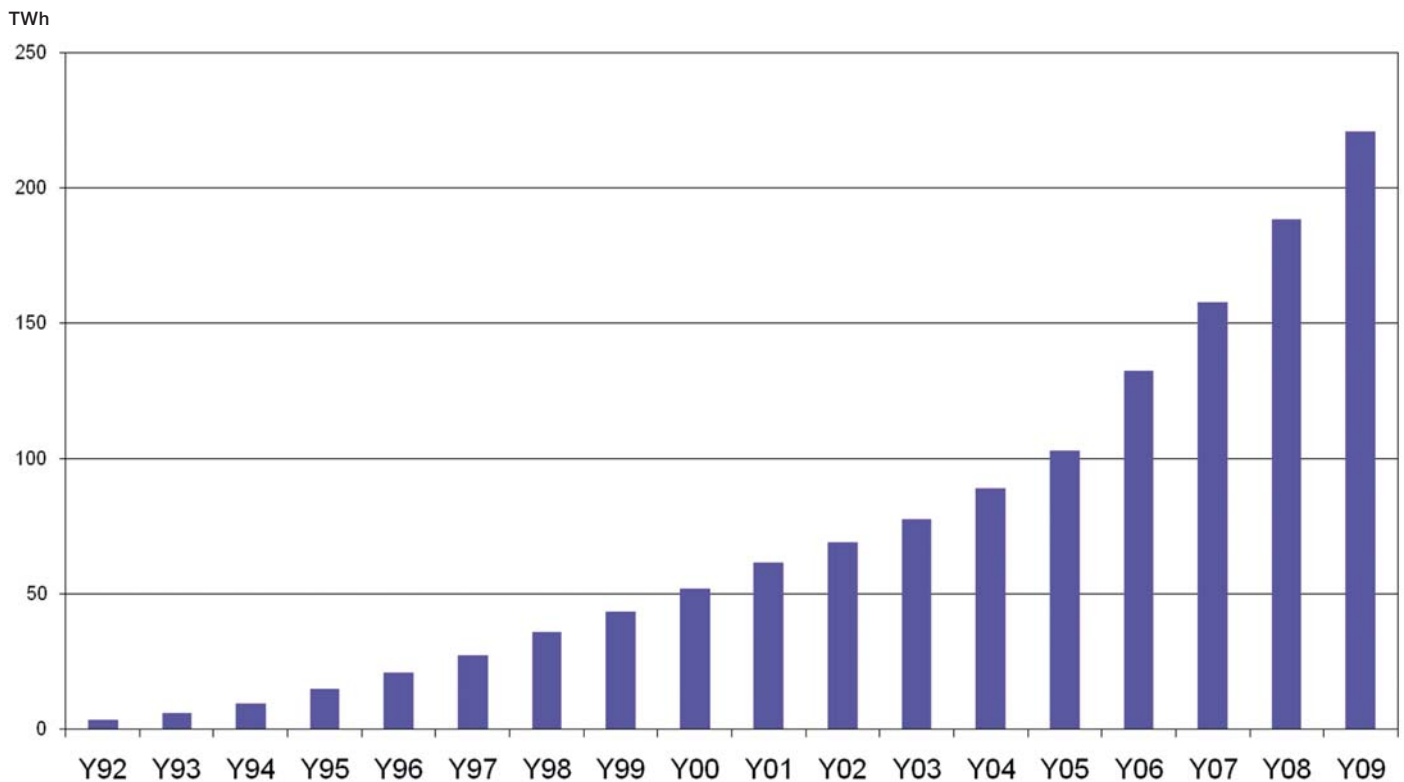
## **Biggest energy saving potential in industry**

There is great potential to save energy and costs in industry. Nearly 70 percent of all electrical energy consumed by industry is used by the millions of electrical motors installed worldwide. Every year, several more millions of motors are added. These motors are the workhorses of industry, driving machines, compressors, fans, pumps and conveyors in virtually all industrial sectors. Not only are pumps and fans numerous, they also have the greatest energy saving potential. Therefore, targeting pump and fan applications is a great way to begin an energy saving initiative.

ABB supplies virtually every industry with a broad range of electric motors and drives to reduce energy consumption, increase productivity and safeguard quality. Among the industries served are cement, minerals, metals, oil and gas, chemicals, pharmaceuticals, pulp and paper, water, and marine.

In fact, during the 40 years or so since the first drives appeared, ABB has delivered millions of units across the globe to every type of application in all industries. During this time, vast experience has been gained of how industry can save energy in the most effective ways. The installed base of ABB drives saved 220 million megawatt-hours (MWh) in 2009, equivalent to the yearly consumption of about 54 million EU households. In terms of CO<sub>2</sub> reduction, these savings equate to 180 million tonnes, more than the yearly emissions of more than 45 million cars.

## **Energy saved with ABB drives**



- The installed base of ABB AC drives saved about 220 TWh in 2009, equivalent to the consumption per year of more than 54 million EU households.
- If that 220 TWh would have been generated by fossil fuel powered electricity plants, ABB drives reduced CO<sub>2</sub> emissions in 2009 by about 180 million tonnes, corresponding with the yearly emission of more than 45 million cars.

# Energy-saving drives for every need



**Drives reduce the output of an application, such as a pump or a fan, by controlling the speed of the motor, ensuring it runs no faster than it needs. Many motors are oversized to cope with a maximum demand that rarely or never occurs. The drive brings the motor speed down to match the actual demand needed by the application. This often cuts energy consumption by 50 percent and in extreme cases by as much as 90 percent.**

When other control methods are used, such as dampers, vanes or valves, the motor runs at full speed and the flow of the output is mechanically restricted. For instance, the flow through a pipeline may be reduced by a valve. This is wasteful, because the motor keeps running at its nominal speed regardless of the demand. The pump delivers maximum output and the excess is reduced at the valve, where the surplus energy is wasted through friction.

The relationship between a pump or fan's speed and its energy need is known as the cube law, because the demand for power increases with the cube of the speed. This means that a small increase in speed requires a lot more power, but also that a modest speed reduction can give significant energy savings. A pump or a fan running at half speed consumes only one-eighth of the power compared to one running at full speed.

In addition to the energy savings, the drive delivers accurate control and less mechanical wear, reducing maintenance and extending the life expectancy of the system. Payback is often less than six months on energy alone. ABB's product range, from 0.18 kW to 72 MW, is the widest available from any manufacturer, offering drives for every need.

## **Measuring for efficiency**

Not only does the drive offer substantial potential energy savings, but the savings are also easy to control and to quantify. Many of ABB's drives have built-in energy calculators to monitor energy used and energy saved by the motor in kWh, € and \$ and CO<sub>2</sub>.

ABB also has two easy-to-use energy saving calculation tools, PumpSave and FanSave, which are used to make a reasonably accurate estimate of the potential savings of an application. The estimates are used to check the viability of installing a drive against other alternatives. The drive's built-in energy calculators show actual results that can be compared with the estimates of the calculation tools and can be used as a basis for future energy saving projects.

# Safe, reliable and efficient motors

**ABB has long supported the need for efficiency in motors, and high efficiency products have formed the core of its portfolio for many years. Today ABB is at the forefront of efforts to reduce global energy consumption and carbon dioxide emissions by supplying safe, reliable and efficient motors. ABB has a full range of motors in IE2 class; premium efficiency motors in IE3 class; and super premium motors in IE4 class.**

The International Electrotechnical Commission (IEC) has introduced new standards relating to energy efficient motors. IEC/EN 60034-2-1 specifies new rules concerning efficiency testing methods and IEC 60034-30 defines new efficiency classes IE1, IE2 and IE3 for DOL (Direct-On-Line) motors. In addition, standard IEC/TS60034-31 defines super premium efficiency class IE4 for both DOL and driven motors.

These standards provide major energy and cost savings to industrial and commercial motor users, while helping to moderate the growth in the world's electricity demand. More accurate measuring of motor efficiency benefits both manufacturers and end users. A level playing field is introduced, enabling manufacturers to compete on equal terms and users to easily compare the efficiency of different motors.

ABB has calculated the efficiency values under the efficiency testing standard IEC 60034-2-1: 2007 according to the indirect method, with additional losses determined from measuring. The company is taking steps to ensure that its products comply with the requirements set nationwide and worldwide.

## **ABB's portfolio of high efficiency motors**

ABB offers three different low voltage standard motor ranges, enabling users to select the right motor for each application. Comprehensive ranges of low voltage motors are available, ranging from 0.055 to 1000 kW. In addition to low voltage standard motor ranges, ABB also offers a wide range of motors and generators for hazardous areas, marine and special applications as well as high voltage and synchronous motors and generators.



# Managing savings throughout the life cycle

One of the quickest ways for industries and utilities to lower energy consumption and therefore reduce their bills is to employ high efficiency motors and drives. In many instances the return on investment can be within months. While such payback can have a significant effect on the profitability of an organization, other benefits come from reducing carbon dioxide emissions and contributing to the environmental objectives of the community.

## Life cycle approach

To achieve the best return on investment, users of production equipment need to apply a life cycle approach when considering investing in major equipment. The life cycle cost (LCC) is the total cost for purchasing, installing, operating, maintaining and disposing of an item of machinery.

There is a need to raise awareness of the financial benefits of energy efficiency. Payback times of an item of machinery can be extremely short but many businesses still focus on the purchase price when buying equipment, instead of considering running costs over the lifespan.

The purchase price of an electric motor and drive, for instance, is just 1-3 percent of what the owner will spend on energy to run the equipment over its lifetime.

LCC should be calculated not only on new installations, but also existing ones. Existing systems provide much greater scope for efficiency improvements than new installations. The volume of systems in use exceeds the volume of annual new installations many times over. Additionally, many existing installations can offer considerable scope for improvement if the duty has changed since the system was first installed.

## Additional benefits throughout the life cycle

Installing high efficiency motors and drives not only reduces energy costs but can significantly contribute to improving process control and reliability, increasing production capacity, reducing maintenance costs and lowering reactive power.

### Benefits of drives include:

- Accurate process control by infinitely variable stepless speed control
- Fault protection of the motor and cables
- Soft starting and stopping to avoid mechanical damage to the process
- Reduced maintenance through smooth starting
- Wide speed, torque and power range gives accurate speed control, resulting in process optimization and better product quality
- Improved power factor helps maintain motor efficiency at reduced load
- EMC protection against interference with other sensitive equipment
- Production increase through more appropriate motor speed




### Benefits of using high efficiency motors include:

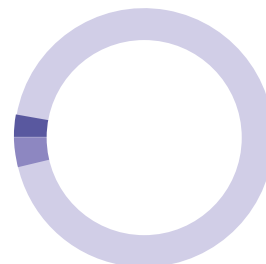
- Reduced maintenance through cooler running
- Reduced bearing and winding temperatures thereby extending the lubrication intervals and increasing motor's useful life
- Very stiff basic structure achieved by optimization of cutting-edge design, quality materials and advanced manufacturing techniques
- Less noise generated and subjected to lower mechanical stresses

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## Main elements of life cycle costs for a motor and drive \*

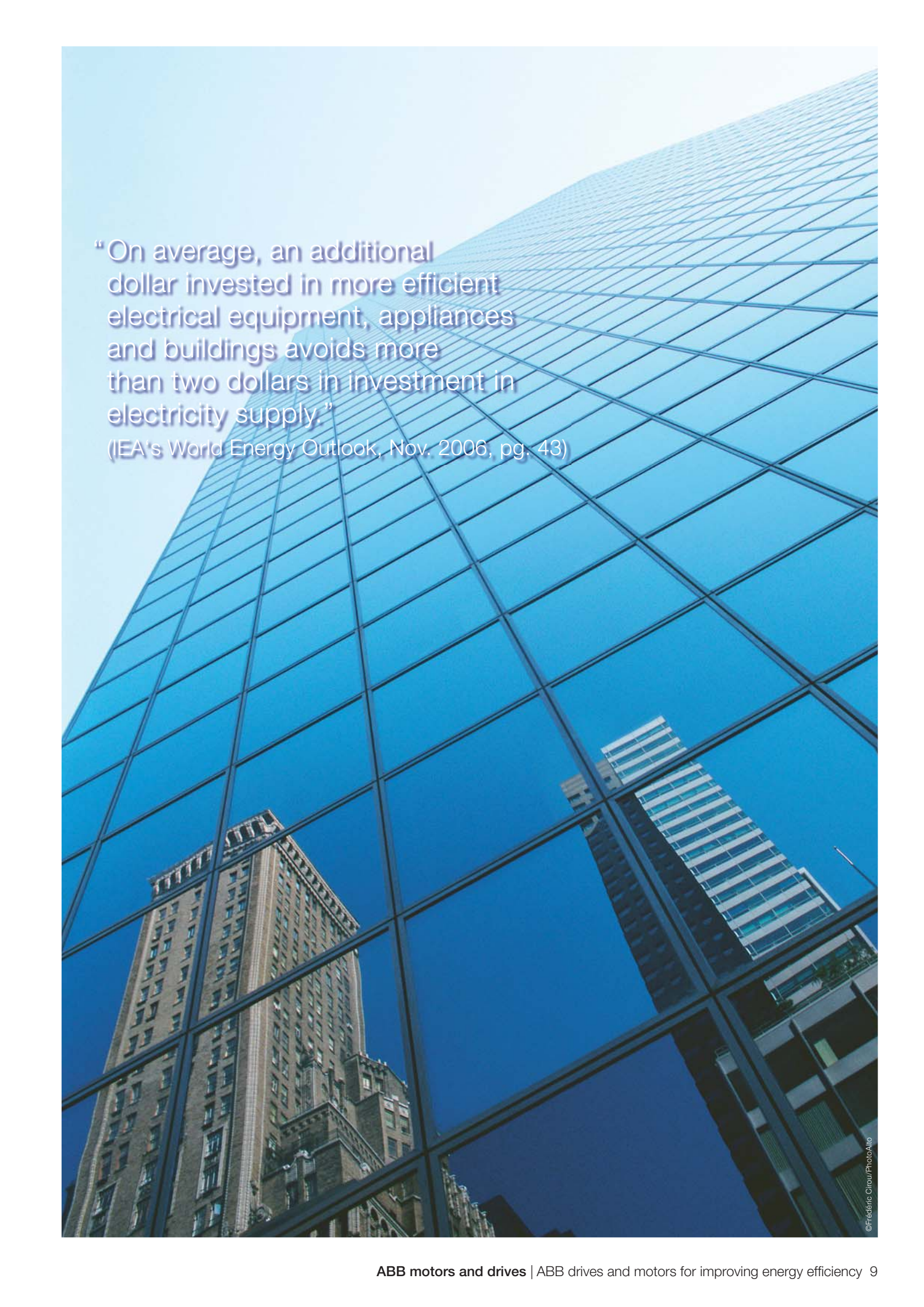
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-  Purchase 5 %
-  Energy 92 %
-  Maintenance 3 %



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\* Typical life cycle cost when retrofitting a new motor and drive to an existing system



“On average, an additional dollar invested in more efficient electrical equipment, appliances and buildings avoids more than two dollars in investment in electricity supply.”

(IEA's World Energy Outlook, Nov. 2006, pg. 43)

“The installed base of  
ABB drives saved 220 million  
megawatt-hours in 2009.”



# Fast and efficient energy appraisal for lowering energy use

**ABB has devised a simple and methodical energy appraisal process that presents the energy saving potential of selected applications to the end users. The starting point for a successful energy appraisal is to identify applications where energy can be saved immediately by using ABB drives and motors.**

An energy appraisal is normally carried by an ABB engineer or one of ABB's authorized local channel partners who can identify relevant applications that will generate energy saving results. This identification helps the end user target their investment so that it generates the highest possible savings and delivers the best return on investment.

Energy appraisals are most suitable for processes with variable torque applications that obey the cube law, running continuously and where flow is controlled by a mechanical means such as valves or dampers. This is where the savings from installing a drive really start to look good compared to the investment cost.

ABB's experience is captured in its energy appraisal scheme:

## **There are six steps to an efficient energy appraisal:**

1. Outlining the appraisal's scope
2. Monitoring and data collection
3. Data analysis
4. Recommendations
5. Implementation
6. Verification and follow-up

### **1. Outlining the appraisal's scope**

An ABB engineer or one of ABB's authorized channel partners visits the end-user to get an understanding of their facility. This includes location of the applications, an inventory of motors, any health and safety restrictions as well as anything unusual that might affect the energy profile.

### **2. Monitoring and data collection**

During a walk around the facility, the engineer will spot typical applications that may be running inefficiently. The engineer looks not only at fixed speed motors but also any drives currently used, to see if the application is running at maximum efficiency.

The selected applications may be monitored in order to accurately determine which applications are consuming the most energy. If this stage is necessary then it may be performed over a seven-day period, to gain a complete picture of the plant's typical energy use.

### **3. Data analysis**

Following the collection of the data, the findings are analyzed and potential savings identified. The findings are methodically presented, with tables and graphs being created to help identify where savings are likely to arise. Among the data available includes an estimation of present energy usage, areas of potential savings, payback time if an investment is made in drives and/or motors, carbon dioxide emission reduction, along with many other key facts and analysis.

### **4. Recommendations**

An action plan is prepared, usually comprising a report, highlighting applications that can save the most. The figures will be normally translated into monthly savings, and there will be detailed recommendations for fitting drives or motors.

### **5. Implementation**

Using the recommendations from the energy appraisal, ABB identifies the correct drive and motor for the respective application. In many instances, it can help with the installation and start-up or commissioning of the drive and motor. This includes setting the correct parameters to ensure that the drive or motor is operating at its optimum energy efficiency.

### **6. Verification and follow-up**

Once new equipment is fitted, it is normal to track the actual savings against the predictions shown in the report. This will also help justify the investment in drives and electric motors. ABB provides life cycle services to ensure that the drive or motor is looked after throughout its working life.



## Life cycle services for improving energy efficiency

For a high efficiency motor and a drive to maintain their energy saving potential it is important that they are looked after throughout their life cycle. To make sure this happens, ABB has devised a series of energy-related services and tools that can be used throughout the entire life cycle value chain.

### **Installation and commissioning**

For fast and efficient drive and motor commissioning, ABB offers its professional commissioning service. ABB certified engineers adjust the drive parameters to meet the precise demands of the application. All start-up information with process parameters are saved, should the engineer need to recall any information at a later date.

### **Operation and maintenance**

A maintenance assessment carried out by ABB or an authorized ABB channel partner provides the foundation for developing a long-term drive and motor maintenance and improvement plan. The purpose of the assessment is to define measures to be taken for lowering operational costs, improving productivity, reducing environmental impact and enhancing safety.



During operation and maintenance, tuning of the drive maximizes its energy savings. Not only does the drive offer substantial potential energy savings, but the savings are also easy to control and to quantify. Many of ABB's drives have built-in energy calculators to monitor energy used and energy saved by the motor in kWh, € and \$ and CO<sub>2</sub>.

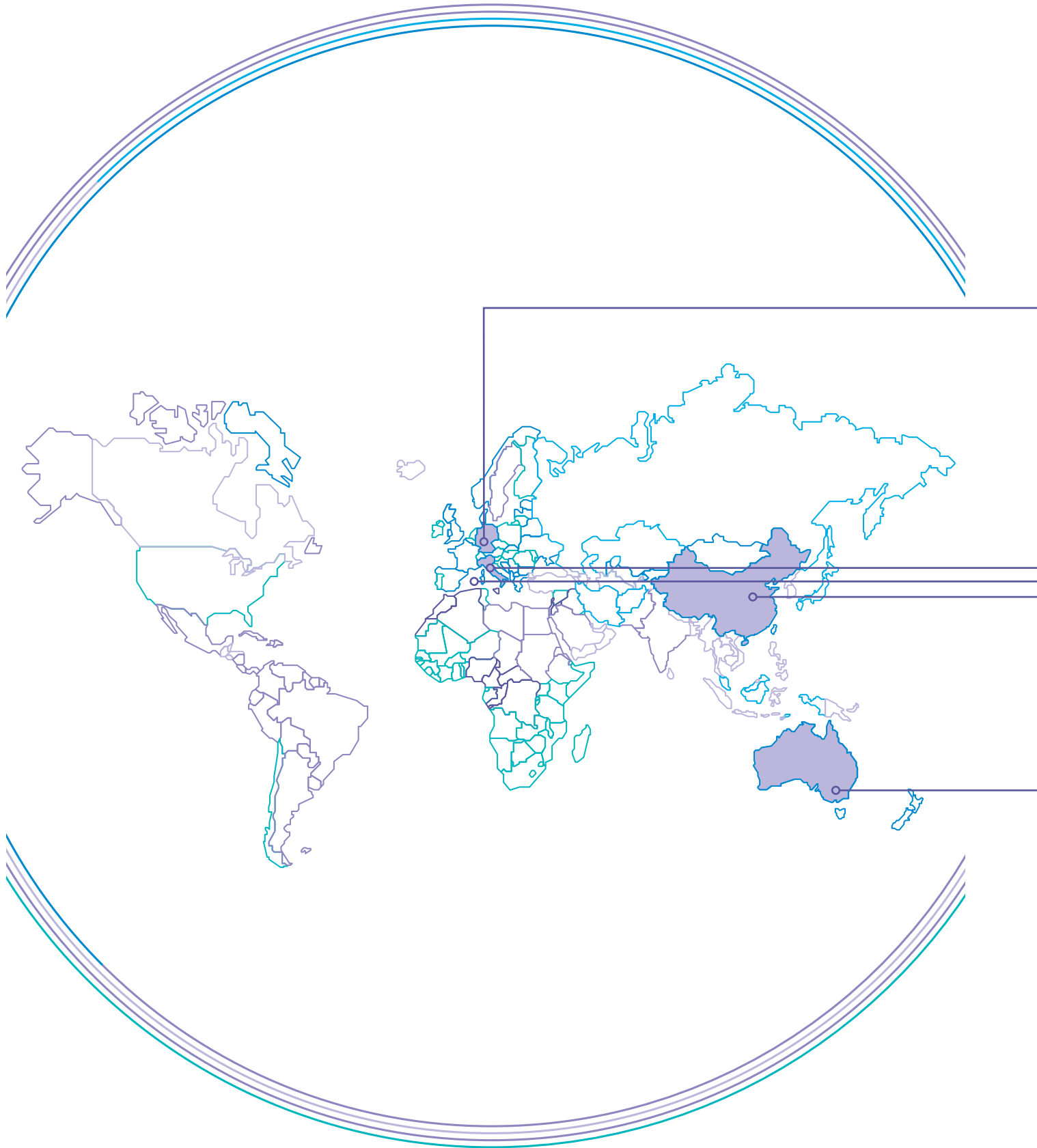
#### **Upgrade and retrofit**

Drive upgrades are designed for improving the performance and extending the functionality and the lifetime of the drive to provide end users with the best possible return on their investments while maximizing the energy saving potential. Upgrade services comprise hardware and software updates. Benefits of upgrading a drive typically include lower maintenance costs and reduced energy consumption.

#### **Replacement and recycling**

When the drive and motor life cycle is complete ABB encourages recycling whenever equipment is replaced at end user sites. ABB can advise on the appropriate replacement drive and motor for an application. Depending on the country, ABB aims to remove and dispose of any ABB or non-ABB drive and associated equipment in line with the environmental regulations enforced within that country.

# References





#### **Energy consumption and CO<sub>2</sub> emissions reduced at German coal-fired power plant**

The Grosskraftwerk Mannheim Aktiengesellschaft (GKM) operating in Mannheim is one of the most efficient coal-fired power plants in Europe. In the course of restructuring the boiler plant, two of the three boiler feed pumps were fitted with ABB drives. The result is a 25 percent energy saving and a short three years return on investment. The annual energy saving is 300,000 € per boiler feed pump.



#### **Drives and motors make impact at Italian food and beverage production plant**

The Pomezia plant (Rome) is the largest production plant of Cesare Fiorucci S.p.A and one of the biggest cold meat and salami production companies. ABB carried out an energy appraisal in order to optimize the energy consumption. Improvements were identified in the areas of refrigeration, water purification and heat production. Altogether the replacement of 23 motors with high efficiency motors rated between 5.5 to 75 kW, and the installation of 15 ABB drives, ensures energy saving of about 572,000 kWh and CO<sub>2</sub> emission reduction equivalent to 317,000 kg/year.



#### **Energy appraisal leads to cruise ship fuel saving**

Costa Serena is a luxurious cruise ship which produces all electricity using its on-board diesel generators. The large fans and extractors in the ship's engine room were analyzed during an energy appraisal. An analysis carried out by ABB technicians led to the decision to make the plant more flexible, allowing it to work optimally according to actual needs. After analysis, 37 ABB drives were installed allowing a saving of about 1,270 tons of fuel a year, with a consequent reduction of CO<sub>2</sub> emissions of some 4,000 tons per year.



#### **Chinese water utility identifies pump as main energy saving opportunity**

A water utility in Xinxiang, China carried out an energy appraisal in order to optimize the energy consumption of its water treatment plant. Results concluded that significant energy savings could be made in a water treatment pump by replacing the existing constant speed flow control method with ABB drives. One 400 kW pump was retrofitted with an ABB drive, resulting in savings of about 660,000 kWh per year.



#### **Australian heritage building halves energy costs**

The State Library of Victoria, Australia, founded in 1854, is a research library with over one million visitors a year. An energy appraisal concluded that significant energy savings could be made in an existing HVAC system by replacing the flow control of chillers and cooling towers, which used throttling valves, with ABB drives. Using 15 ABB drives, from 5.5 to 55 kW, energy saving between 30 to 60 percent is achieved across the various applications. The total energy consumption is reduced by 1,800 MWh annually.

# Contact us

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