

**SIEMENS**

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# MineralsFocus

The Magazine for the Mining and Cement Industries



Cover Story:  
**A new way of  
looking at energy**

**Mining:**  
A standard of  
reliability and  
efficiency

**Cement:**  
Automation  
frees up  
resources

Edzard Lübben

*“An energy audit  
performed by experienced  
Siemens engineers  
shows areas with  
potential for **energy**  
savings.”*



## Dear Reader,

In our industry of mining and cement, we provide the essential resources needed for a lot of things that are completely taken for granted in today's developed societies. Examples include cement as the main component for almost all buildings; carbon, iron and copper for the steel and manufacturing industries; and fertilizers to help produce food for the world's growing population. Without the activities of our industry, all those things wouldn't be possible. And that in itself is the reason why the importance of the mining and cement industry in the future is certainly growing – and not declining.

At the same time we are currently seeing some challenges. Commodity prices dropped significantly and are far away from the levels of 2012. Available investment for CAPEX projects is limited; however, it seems that the bottom line has been reached in the meantime.

We at Siemens see these challenges also as opportunities. Siemens offers a complete portfolio of products and solutions that reduces manufacturing and processing costs. One area that is receiving more and more attention in this context is energy efficiency. In fact, studies show that up to 35% of expenditures in mining operations are attributable to energy costs. By increasing energy efficiency, the bottom line is automatically improved.

In this issue, we look at methods to save energy in mining operations. Some measures are quite simple, such as running machinery that is not permanently required at the times of the day when electricity is cheaper. Others, such as the introduction of variable-speed drives for conveyors, pumps, mills and ventilators, are equally simple. An energy audit by experienced Siemens engineers can be performed to detect these and further areas with potential for energy savings. Turn to page 8 to find out more about how Siemens can help operators take a holistic view of their operations to save money.

Another area where Siemens can help lower costs is through the use of Gearless Mill Drives (GMDs). Because GMDs have fewer moving parts and components, they require less maintenance and service and thus lead to lower life-cycle costs. At the same time they are suitable for the highest performance needs. Siemens has a great deal of experience with GMDs: The company first supplied a GMD to the mining industry in 1980, and since then dozens of

orders have been filled for further GMDs. The evolution of GMDs is portrayed starting on page 12. The total operation time of Siemens-supplied GMDs running at sites all over the world comes to over 500 years.

Our GMDs are only one of numerous examples where Integrated Drive Systems (IDS) from Siemens ensure highest customer benefits. A seamless integration of all different elements going into a drive system – including the automation and optimized operations procedures – ensures superior productivity together with highest reliability and performance.

These are just two of the ways that Siemens helps its customers cut costs. Another important area is service. With the remote monitoring tools in our service portfolio, we can help you to continuously monitor your plant, thereby enabling you to detect possible material defects and failures at an early stage – namely, before they can cause expensive downtimes (page 38). And through power monitoring systems, such as those in use at Turkish cement giant Cimsa (page 42), expenditures for energy can be significantly reduced. Furthermore, thanks to advanced software from Siemens, operators at Wonder Cement in India have been able to increase output to keep up with growing demand (page 44).

At the Siemens stand at Expomin in April, we present the solutions mentioned here along with other elements from Siemens' mining portfolio. For visitors it soon becomes apparent that Siemens has everything covered – from design and planning up to engineering, execution and service. If you are at Expomin, stop by and experience for yourself Siemens' entire range of solutions for the mining industry. We will also be at Green Cementech in Hyderabad, India, in mid-May, and we look forward to continuing the discussion with you there.

Sincerely,

**Edzard Lübben**  
Head of Minerals



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## Service performed by experts

Siemens offers a complete portfolio of products and solutions that reduce manufacturing and processing costs in the mining and cement industries. An extensive service portfolio is part of this offering. From on-site inspections by highly trained engineers to remote monitoring tools, Siemens helps operators detect possible defects at an early stage. In the end, this approach contributes to avoiding expensive downtimes.

### Cover Story

#### 08 A new way of looking at energy

In nearly all mining operations, there are motors and compressors and other electrical equipment running around the clock – even when they are not needed. In the face of rising energy costs, operators are starting to question this practice. Audits performed by Siemens engineers show how and where energy can be saved.

#### 12 A standard of reliability and efficiency

In 1980 Siemens installed its first Gearless Mill Drive (GMD) in a mine. Since then, up to 50 further GMDs have been put into service for mining applications. If the hours, days, months and years that all of these drives have been in operation are added up, the result is well over 500 years.

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# The largest drives in the Gobi

Gearless Mill Drives from Siemens were successfully commissioned at Oyu Tolgoi mine in Mongolia.

Two 38 ft SAG mills each with a 20 MW Gearless Mill Drive

## Oyu Tolgoi commissioning



## Thailand



Sinamics drive control and an H-compact PLUS motor from Siemens

# Thai cement producer to increase capacity

TPI Polene has awarded Siemens with a contract for a new clinker production line in Saraburi, Thailand.

In Thailand market demand for cement is growing – so much so that TPI Polene Public Company Limited has decided to increase its production capacities by adding a fourth line with a capacity of 12,000 tons of clinker per day. When operations start in October 2014, TPI Polene's four cement plants will together be able to produce 12 million tons per year. Siemens will design and supply the power distribution equipment and the drive systems for the new line.

The contract includes the drive solutions and the switchgears for high-

medium- and low-voltage power distribution, project management and engineering. In detail, the drive systems consists of 20 slip-ring motors for the main drives, 12 gearboxes, 33 variable-speed drives for fans as well as two multi-drive systems for coolers. For a high level of productivity, efficiency and reliability, all drivetrains are perfectly aligned to one another in the framework of Siemens Integrated Drive Systems (IDS).

Siemens and TPI Polene have already collaborated successfully: Siemens supplied the electrical equipment for


the three other clinker production lines as well as for TPI Polene's cement and coal mills. Furthermore, Siemens also performs maintenance services on the three clinker lines. With all electrical equipment and services for all four production lines coming from one single source, the customer will enjoy trouble-free interfaces and unimpaired operations. ■

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In the southern Gobi desert of Mongolia, around 80 km north of the Chinese border and around 550 km south of the capital Ulaanbaatar, copper and gold are excavated at the Oyu Tolgoi open-pit mine. Jointly operated by Rio Tinto and the Mongolian government, Oyu Tolgoi mine is one of the largest gold and copper deposits in the world.

Siemens equipped the mine with two Gearless Mill Drives, which are the largest drives in the plant and the very heart of the grinding process. The beneficiation plant with a daily throughput capacity of 100,000 tons of ore produces an average of 430,000 tons of copper and 425,000 ounces of gold per year in concentrate. The drives provide a high availability of over 99%, which was an especially important factor for choosing Siemens.

The biggest challenge, both for logistics and installation, was the extreme

weather conditions at the edge of the Gobi desert, where temperatures can fall to -40°C in the winter. To ensure smooth transportation and installation, and to protect the materials used from the weather conditions, special measures were taken including setting up heated enclosures for winding connection work during the winter months.

The integrated drive system from Siemens consists of two ring motors, wrapped around the mill, with a power output of 20 MW each and the new Sinamics SL 150 cycloconverters with improved compactness and diagnostics features. These were installed in the pre-commissioned e-houses together with the associated control and automation equipment, low-voltage distribution, uninterruptible power supply and converter cooling system. Furthermore, the converter transformers, which are specially adapted to the

drive system, are part of the scope of supply. The Gearless Mill Drive system is characterized by high efficiency, which is up to 4% better than conventional drives, saving the customer up to \$1.5 million per year in energy costs.

Siemens was responsible for hardware and software engineering, delivery, installation supervision, commissioning and for training the client's operation and maintenance personnel. Siemens will also accompany the client during operation with the respective services optimized for the plant. These services include operational assistance, remote access and 24/7 on-call support. ■

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## Reliability, ability, commitment

In mid-February Siemens hosted a webcast on the cement business. In an interview setting, Press Officer Stefan Rauscher and Dieter Schletterer, Vice President Cement for the Siemens minerals business, discussed the industry's latest developments and the company's offering. While the webcast was targeted to trade journalists, it held appeal for a wider audience.

After a description of the key challenges facing cement producers all over the world, attention turned to the business in Southeast Asia with descriptions of recent projects in Thailand, Indonesia, Vietnam and Malaysia. Siemens' solutions and services for the industry were also described,

including Cemat, Integrated Drive Systems, the MultipleDrive concept and the Sicement product family.

Schletterer also introduced a new term at Siemens: Cementability. Reliability, ability for continuous optimization and the commitment to the cement industry are at the heart of Cementability.

The complete webcast, background information and photos are available at [www.siemens.com/press/Cement-Webcast](http://www.siemens.com/press/Cement-Webcast). ■

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### Webcast on cement



Press Officer Stefan Rauscher (l.) and Siemens Cement Vice President Dieter Schletterer spoke about the latest industry developments



The business in Southeast Asia was also extensively covered, as well as Siemens' solutions and services for cement manufacturers

## Energy efficiency audit

# A new way of looking at energy

A recent report from the International Energy Agency (IEA), a body founded in 1973 to support governments in achieving energy security, underscores the importance of energy efficiency by describing it as the world's "first fuel."

**T**he IEA had determined that in 2011 investment in energy efficiency had reached levels equivalent to the supply-side investment for energy generation from fossil fuels and renewables. What's more, between 2005 and 2010 investments in energy efficiency have saved its 11 member countries over \$420 billion. But they were also quick to point out that untapped potential still unquestionably exists. Wherever Siemens engineers carried out in-depth analyses on energy efficiency and potential improvement – whether in the company's own plants or together with customers from all different industries – significant potential for savings with typically payback times of less than three years could be identified. Therefore, in a quest to improve the bottom line, more and more mine operators are now turning their attention to inefficiencies and leveraging their own big savings.

In the current situation, mining operators have to face a more and more challenging environment in which rising costs lead to falling profitability. One factor is energy costs that are higher than ever. But there is quite a bit that can be done to get expenditures for energy down. In mining operations up to 35% of costs are for energy, and according to Hans-Jürgen Pelloth, Account Manager for Anglo American, that equals a lot of potential to make cuts.

Each mine is individual, which means in every specific case energy consumption and usage have to be examined in detail. However, one common element in every mine is that there is always something to improve upon. "In a few mines you can still find compressors that have been running 24/7 for 30 years and more. Often they are never switched off," says Pelloth, who with 25 years of experience in the business knows his way around mining operations. ►

The Tumela 1 Shaft at Tumela mine in the South African province of Limpopo



Tumela's life-of-mine (LoM) extends to 2034, although there is indication that it could go beyond 2050





221,800 ounces of refined platinum were produced at the Tumela mine in 2012

**35%** *Up to 35% of costs in mining operations are for energy*

- When less performance is needed from the compressor, pressure is simply let out. And when the compressor is not needed, it is just left to run.

In the face of rising energy costs, Pelloth and his colleagues at Siemens have recognized a new trend: Operators are looking for ways to minimize their energy bills and reduce energy consumption, whether through highly efficient integrated drive systems perfectly tailored to the application, or by turning off compressors and other machinery when they are not needed. Pelloth sees this as a paradigm shift in an industry that until now has been focusing more on mine-related topics and less on energy. Audits performed by Siemens engineers can show mining operators how and where they can save energy.

### Tracking untapped potential

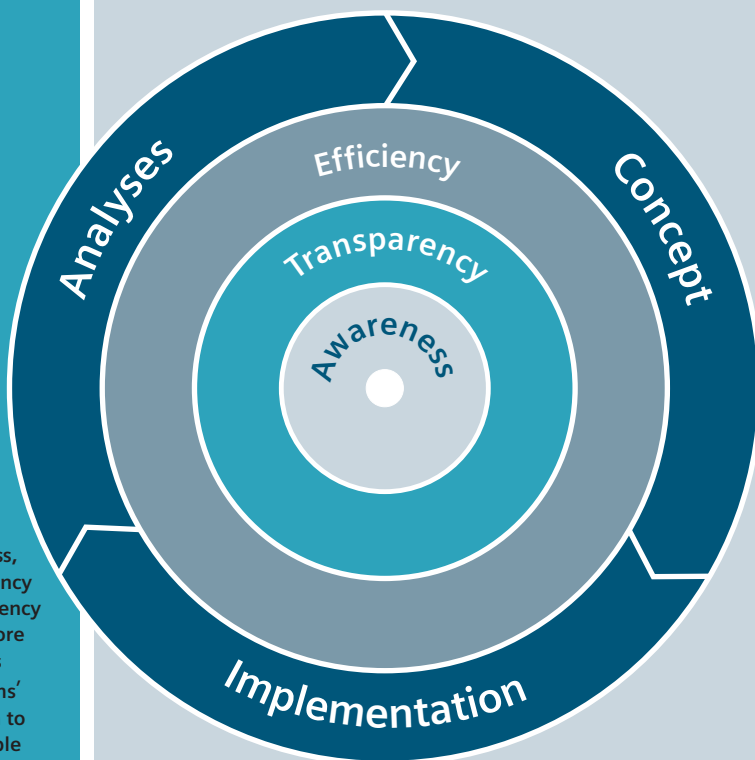
To improve the energy balance, Siemens employs its three-pronged approach to sustainable management. The first step is to create awareness, which is done through an audit. It is here that savings potential is identified – such as machinery left to run even when it is not needed. In the framework of an audit, energy specialists provide operators with a clear and unbiased evaluation of their site. All major energy-saving opportunities are identified with an estimate of the costs and benefits of each potential project. This information helps plant management prioritize the areas most worth tackling.

The next aspect is transparency, which is accomplished through measurements. Therefore, the second phase involves implementing tools, automation and software systems that measure and monitor what's happening on a site, so savings can be validated. The third and final level is efficiency, or the installation of the products and solutions designed to deliver the energy savings.

Over the past 15 years, Siemens has applied this approach in hundreds of industrial sites globally from automotive facilities to petrochemical plants. Furthermore, Siemens introduced the same approach into its own manufacturing plants as part of its corporate sustainability program. The results speak for themselves: Siemens

Awareness, transparency and efficiency are the core elements of Siemens' approach to sustainable management

Lowering energy consumption will also help Anglo American Platinum improve its CO<sub>2</sub> footprint





*In industrial settings energy consumption can be reduced by 10% to*

**30%**

### Anglo American Platinum

Anglo American Platinum Limited is a member of the Anglo American plc Group and is the world's leading primary producer of platinum group metals. The company is listed on the Johannesburg Securities Exchange (JSE). Its mining, smelting and refining operations are based in South Africa. Elsewhere in the world, the Group owns Unki Platinum Mine in Zimbabwe and is actively exploring in Brazil. Anglo American Platinum has a number of joint ventures with several historically disadvantaged South African consortia as part of its commitment to the transformation of the mining industry. Anglo American Platinum is committed to the highest standards of safety and continues to make a meaningful and sustainable difference in the development of the communities around its operations.

Parent company Anglo American and Siemens have collaborated on many projects over the years. The first joint project dates back to about one hundred years ago.

has been able to reduce its primary energy consumption by 26% and greenhouse gas emissions by 22%.

In introducing methods to save energy in the mining sector, Siemens engineers draw on their broad know-how from these and other areas. Take drives, for example: while in an automotive plant a drive has different uses than in a mine, the same principles to save energy apply, such as only operating the drives when they are needed, or running them at times of the day when energy is cheaper. "We at Siemens have over 100 years of experience with mines," says Pelloth. "We know the processes inside and out, and this makes it easy for us to implement energy-saving measures."

### First audit performed

Recently, Anglo American Platinum commissioned Siemens to perform an energy audit at its Rustenburg site in South Africa. Anglo American Platinum management was certain there was potential to cut energy costs and who better than longtime business partner Siemens to perform the audit.

In preparing the audit, the Siemens engineers widened their scope to include all operations at the Rustenburg site. "One of Siemens' strengths is to look at entire systems," comments Pelloth. Everything was investigated in depth: Anglo American Platinum's corporate strategy needed to be understood and, of course, it was necessary to put the company's processes under the magnifying glass, such as hourly production rates and how and when maintenance is carried out. "Basically, we went through everything," says Pelloth.

Concrete steps to lower energy consumption are also included in the audit. These steps are broken down into different phases. For the Rustenburg site, engineers at Siemens came up with a plan to harvest low-hanging fruit in the first phase – such as to shift consumption to times of the day when energy is cheapest, or to introduce small, variable-speed drives for pumps and ventilators. Some of these steps require minor investments; others are completely free, such as taking advantage of more favorable energy pricing mechanisms. In subsequent

phases other areas can be addressed. In all, a period of three to five years would be necessary to implement all suggested measures.

### Fast payback

It is now up to Anglo American Platinum management to decide which measures to implement and when. But whatever is decided, Siemens can take care of everything. As much work as possible is done during running operations, and planned downtimes are used to complete larger projects. Whichever steps are taken, Anglo American Platinum stands to save money.

Nonetheless, it is difficult to say precisely how much. "Calculating exact savings potential is always difficult, because it involves taking so many unknown factors into consideration," says Pelloth. In general, in industrial settings energy consumption can be reduced by 10% to 30%. And depending on the targeted area, the payback period is between four weeks and three years.

Aside from the initial assessment and implementing the suggested measures, Siemens also offers financing assistance. In this case, Siemens pays for the investment costs of the energy-efficiency measures. For the initial period, the financing is structured so that any capital costs are offset against reductions in utility bills, after which the plant owner reaps the full financial benefit.

### The time has come

For the mining industry to remain competitive into the future, something has to be done now to cut energy costs. Also, with regard to CO<sub>2</sub> footprint, saving energy will help mine operators improve their environmental balance and their standing in society. With its rich experience in energy-saving technologies and extensive know-how, Siemens is the right partner for mining operators who want to improve their bottom line – and who want to look at energy in a new light. ■

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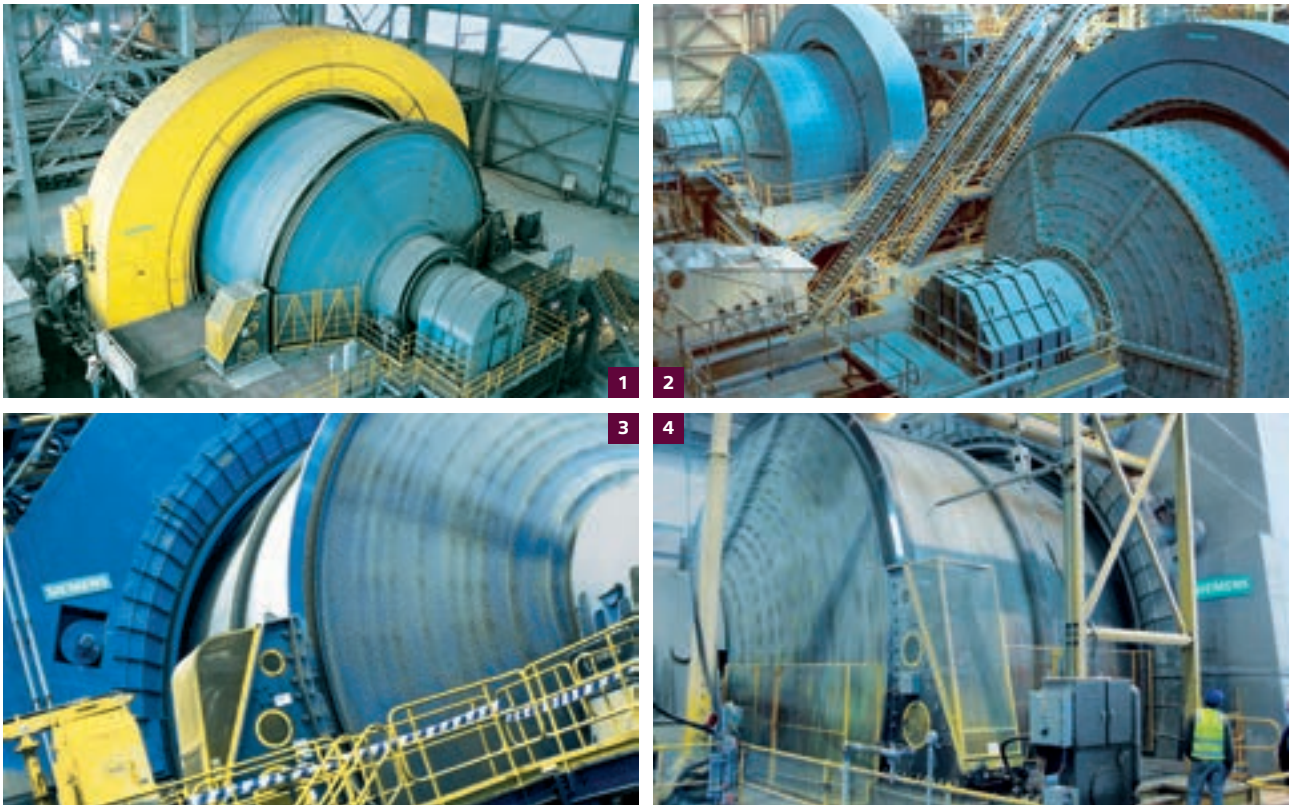
The Gearless Mill Drives in Peñasquito's 38 ft SAG mill

## Gearless Mill Drives

# A standard of reliability and efficiency

Since 1980, Siemens has been supplying Gearless Mill Drives to mining operators all over the world. If the hours, days, months and years that all of these drives have been in operation are added up, the result is well over 500 years. Siemens engineers are able to draw on this experience for further development efforts.

From Norway to Zambia, from Mongolia to Chile – for over 30 years, mining operators all over the world have been counting on Gearless Mill Drives (GMDs) from Siemens. Behind this success is a spirit of innovation that has been integral for the development of GMDs, whose most important features include a small footprint and less weight than conventional drives. And by doing without a range of mechanical and electrical components, the drives' reliability increases and the effectiveness of the entire system increases by 3% to 4%. Maintenance require-



1. Candelaria 1, 36 ft SAG mill   2. Chuquicamata, 32 ft SAG mill   3. El Teniente, 38 ft SAG mill   4. Cadia, 40 ft SAG mill

ments are considerably lower, not least of all because there are no gears that require lubrication and cooling systems.

In 1970, Siemens started up the first GMD for a cement plant. Over the next ten years, seven more GMDs were delivered for cement plants. By the end of the decade, the company received its first order for a GMD for use in the mining industry: the Norwegian mining company Aktieselskabet Sydvaranger ordered a GMD with an output of 8,100 kW of power for an iron ore mill with a 21-foot diameter. The project was completed in 1980, and since then Siemens has started up 50 further GMDs for mining applications.

### Steady development

As output volumes continue to rise in ore mines, the demands on mill drives have kept pace. In 1988, Siemens provided the first GMD for semi-autogenous grinding (SAG) mills in the framework of an order for two 32-foot SAG mills with a performance of 11,200 kW. This project for the Chuquicamata mine in Chile represented a monumental achieve-

ment, as the difference between creating a drive for a 21-foot diameter ring motor and a 32-foot ring motor required significant development effort as well as careful analysis and verification.

Another first came in 1991 when Siemens supplied GMDs for two 36-foot ring motors, developing a 12,000 kW drive for an SAG mill in Kennecott, Utah, and a 11,200 kW drive for an SAG mill at the El Teniente mine in Chile. In a continued call for larger, even more powerful drives, Siemens kept pace. In 1996, Freeport ordered the first GMD for a 38-foot SAG mill located at the company's Grasberg plant in Indonesia. This drive provides an astonishing 20,400 kW of power. In 1998, Siemens supplied the first drive for a 40-foot SAG mill at the Cadia Hill Mine in Australia. The latest development is the sales release of the 42-foot GMD and a draft and confirmed feasibility for a 44-foot GMD.

While the details vary, there is a theme that links these projects – careful development and analysis, timely results and ultimately the delivery of reliable, efficient GMDs.

### Tried and tested design

An advantage of Siemens' integrated design approach is the application of proven system components. For example, the fixation of the laminated iron core in the stator housing is identical to those that have provided fault-free service for decades. The insulation of the stator windings is made of Mica-lastic, a VPI technology Siemens has used in all medium-voltage motors since 1966 and in all GMDs since their market introduction more than four decades ago. What's more, if the service times of all Siemens GMDs in operation worldwide area added up, the result is over 500 operational years. Siemens engineers draw on this experience to come up with innovations.

As the demand for raw materials grows, so too will the need for stronger drives and larger mills. And these mills in turn will enable materials with low ore content to be processed more economically. The foldout shows the history of Siemens GMDs for mining operations – and where the journey is heading.



# Milestones in Siemens Gearless Mill Drives

## 1970: Insulation technology

Beginning in 1970, Vacuum Pressure Impregnation (VPI) was applied for the stator windings of all GMDs.

## 1986: Frozen Charge Protection

Siemens developed and patented its Frozen Charge Protection in 1986, and the first application of this technology appeared in 1988 in the GMDs installed at Chuquicamata, Chile. Frozen Charge Protection uses the torque characteristic of the grinding mill to verify whether the material cascaded. All Siemens GMDs built after 1988 are equipped with Frozen Charge Protection.

## 1988: Cycloconverter, fuseless and short-circuit proof

First applied in 1988, the cycloconverter in Siemens GMDs is both fuseless and short-circuit proof. The over-current protection of the converter detects a short-circuit current and extinguishes it by blocking the gate pulses. The cycloconverter is designed to resist the short-circuit current without damaging thyristors or other components. When a trip by the over-current detection occurs, the GMD can simply be restarted after a required inspection by an electrician. The obvious benefits to this technology are that no additional time is necessary for changing burned fuses, and spares do not have to be stocked. The cycloconverter provides drive availability above 99%.

## 1991: Cooling system

Siemens initially developed a cooling system with cooling elements located at the bottom of the ring motor. Seeing an opportunity for improvement, Siemens engineers redesigned the cooling system in 1991 and developed a satellite cooling system. Fans and heat exchangers are distributed around the motor circumference assuring a continuous and homogenous cooling effect all around the motor. Measurements taken during operation confirm that the maximum difference between the hottest spot and coldest spot is only 4°C in large 38- and 40-foot motors. The excellent distribution of the cooling

effect throughout the motor also allows axial cooling for large and powerful ring motors.

## 1995: Fixation of magnetic core in stator housing

Beginning in 1995, Siemens started using a new fixation method on the magnetic core. The fixation is realized by pressure and by welding: The laminations are stacked on pressure fingers, which are welded to the stator housing. Tension to the pressure finger is applied via tension bolts. Following pressure fixation, the core is fastened additionally by welding to the stator housing

## 1999: Verification with the Finite Element model

Siemens began comprehensive motor design verification using a Finite Element (FE) model in the early 1990s. The FE model placed low demands on the drives and required several simplifications due to the limited calculation capabilities of computers available at that time. The simple model worked for frame sizes up to 38 feet. Siemens delivered the first 40-foot GMD in 1998; however, the FE model could not predict the resonance of the stator in the operating range. As a result of the demands related to larger GMDs, Siemens developed a new FE Model, which also considers the electromagnetic behavior of the air gap. Beginning in 1999, the design on all ring motors was verified by Siemens engineers using this innovative new model. In 2009, further refinements were made to the FE model to ensure the highest efficiency and reliability.

## 2004: Frozen Charge Shaker

In most cases, it is simply not enough to protect a mill by switching it off in the event of cemented charge. The material remains stuck together and glued to the mill body where it must be loosened by mechanical means, for example with jackhammers or water jets. Loosening the material is time consuming and can bring production to a complete standstill. To eliminate this issue, in 2004 Siemens developed and patented a device to loosen the frozen charge and remove the material from the mill body.



1997  
Freeport



1998  
Olympic  
Dam



2008  
Lumwana  
SAG



1990  
Codelco El Teniente



1993  
Candelaria 1

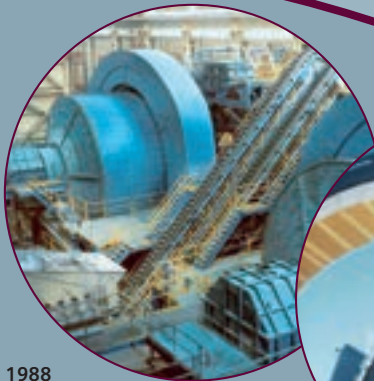


2010  
Pelambres  
expansion



2014  
Toromocho

1988  
Chuquicamata 1



1980  
Sydvaranger



1989  
Chuquicamata 2



21 ft

1980

32 ft

1988

1998  
Cadia



2011  
Los Bronces  
SAG



2012  
Antapaccay  
SAG



2014  
Sentinel



2009  
Peñasquito SAG



2012  
Oyu Tolgoi

36 ft

1990

38 ft

1997

40 ft

1998

## The different sizes of Gearless Mill Drives and the year of their first market introduction

42 ft  
20??

44 ft  
20??

### The future of Gearless Mill Drives: 42 feet and 44 feet

In 2010, Siemens announced the sales release of a 42-foot GMD, and drafted and confirmed feasibility of the 44-foot GMD. The 42-foot drive allows throughput to be nearly doubled compared to the 38-foot mills commonly used in the mining industry.

Siemens employed strict rules in pioneering the groundbreaking 42-foot and 44-foot drives: For one, there would not be any new or unique components and elements used in the drives. Furthermore, new technology components could only be applied to the GMDs if they were already in operation in similar applications, meaning that they had been tested and successfully installed previously. Next, all steps for improvement had to be well engineered and verified with sophisticated design tools. Finally, all engineering and design tools had to be validated with measurements in the field.

The main tool for motor design verification is the Finite Element (FE) model. During the design of the motors, all components were subjected to comprehensive and detailed risk analysis. Siemens validated and refined the FE model with data measurements taken from an operating GMD at Peñasquito, Mexico. To further verify the motor design, a Failure Mode, Effects and Criticality Analysis (FMECA) was also performed to test reliability and availability. The result is a highly reliable design for the 42-foot and 44-foot GMDs, which are intended to provide above 99% drive availability.

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## Gearless drives

# Antapaccay sets the benchmark

**Antapaccay is the first mine that uses world-class gearless drive technology not only for grinding but also for another crucial process step – ore conveying. In both applications, Siemens drives ensure smooth operations.**

**A**ntapaccay is a brownfield expansion of the Tintaya copper mine located at 4,200 meters above sea level in the Cuzco region of the Peruvian Andes. The mine operated by Glencore Xstrata is comprised of new mine facilities, material transport equipment and a new 70,000 ton-per-day concentrator. The mine went into operation in November 2012 and is producing some 160,000 tons of copper in concentrate per year.

The Antapaccay mine is a point of reference for advanced gearless drive systems, which are in use on the overland conveyor as well as in the grinding mills. Both drive systems are provided by Siemens, the market leader for gearless drives in the mining industry. Siemens has also supplied the main electrical distribution equipment, such as the 220 kV gas-insulated high-voltage switchgear, the 33 kV gas-insulated medium-voltage switchgear and the low-voltage distribution equipment.

The growing demand for raw materials means that extraction, transportation and processing require higher throughput, which calls for larger machines and higher drive powers. Demands are equally high in regard to reliability, efficiency and availability of the drive solutions. Gearless drives with low-speed synchronous motors



Antapaccay's 40ft SAG Mill with a 24MW gearless drive from Siemens

are a well-proven solution when more megawatts of drive power are required for mining applications.

### Belt conveyors with gearless drives

In the past few years, gearless drives have become a real alternative to conventional drive solutions with gearboxes when several megawatts of power are required at a drive pulley. In Germany a conveyor belt with gearless drives has been in operation since 1985 at the Prosper Haniel mine. There the driving pulley uses a gearless system with two synchronous motors, each with 3.1 MW of rated

power. According to the operating company, this belt conveyor offers high availability without any significant interruptions or failures attributable to the electrical drive system (synchronous motor, converter), which is an accomplishment after almost 30 years of operation.

This proven success was carried forward when at the end of 2012 two drives were commissioned, each with a nominal power of 3.8 MW, at the conveyor system at the Antapaccay mine. Up to 5,260 tons of copper ore are transported per hour from the mine to a processing plant over a length of 6.5 km on a 1,370 mm wide belt. In 2013, nine additional gearless drives

(4x 4.4 MW and 5x 5.056 MW) were supplied – and they are presently being installed and commissioned in mines in Peru and Chile. The drive system of a belt conveyor has to provide the required speed and torque at any point of operation. This is ensured by using the appropriate converter technology and considering the engineering of the system with an integrated approach. Moreover, ThyssenKrupp as the supplier of the belt conveyor for Antapaccay specified that load peaks have to be avoided. Additionally, a staged starting procedure was required with the objective of minimizing additional forces on the mechanical components, the steel construction and the conveyor belt itself, and to prevent possible oscillations during starting.

Therefore, in the first stage of the starting procedure the belt conveyor is accelerated within 30 seconds to 10% of its rated speed. When the over 12 km of conveyor belt has been set in motion, as is the case for Antapaccay, after approximately 80 seconds the second stage starts – and the belt conveyor is accelerated up to its rated speed within 270 seconds. The load does not influence the starting of the belt conveyor. Special control software integrated in the converter controls and monitors starting and stopping as well as all other operation modes.

When stopping, the belt speed is reduced along a defined ramp and the mechanical brakes are applied shortly before the system comes to a standstill. The control software is also used to implement slip monitoring (between the drive pulley and the conveyor belt) and load balancing control between the two drive pulleys. This facilitates operation with low stress and minimum wear on the mechanical system in all operating conditions.

In addition to this special starting procedure, the overload capability of the synchronous motor also allows extreme operating modes, for example with one failed drive. The drives have been engineered so that the belt can be emptied using just one drive. Moreover, continuous operation is possible with a single drive at 60% of the nominal conveying capacity.

Drive solutions must be reliable and efficient – this is the reason why ►





- ThyssenKrupp and Siemens prefer for these high-power, high-performance applications a straightforward drivetrain design with few components. The gearless drive for the belt conveyor is comprised of just the drive pulley, two bearings, the rotor and stator of the motor. The drive pulley and rotor are arranged on the same shaft. When installing the system, the stator is shifted over the rotor, creating the gearless drive. The shaft of the drive pulley is also the rotor shaft of the synchronous motor.

### A more economical design

A comparison between drive solutions shows that the geared drive requires significantly more components, such as bearings and couplings. The advantage of the gearless drive is obvious, as with an increasing number of components availability and reliability decreases. At the same time, fewer spare parts are required for the gearless solution.

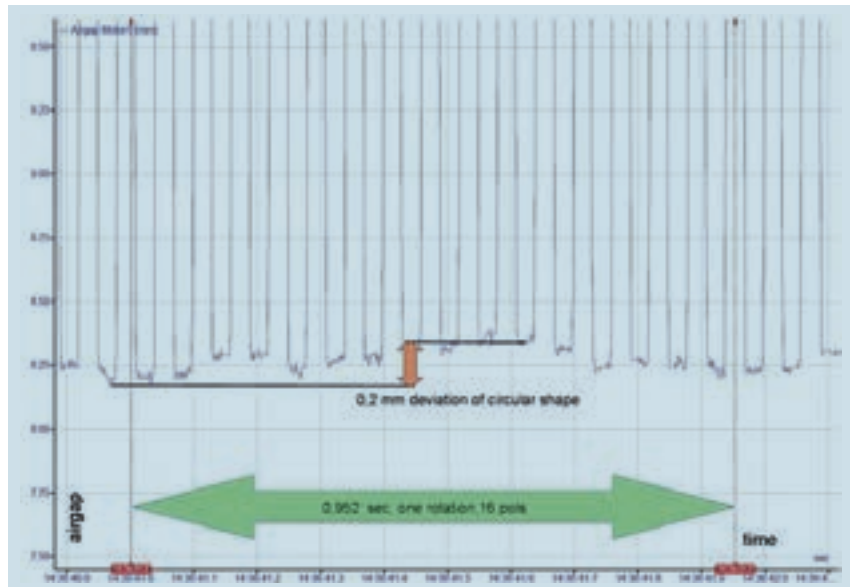
Something similar applies to the efficiency of both drive solutions. As a result of friction, energy is converted into heat in conventional components. This energy is lost and cannot be used to move the drive pulley. As a consequence, for a gearbox generally 2% to 4% power loss must be taken into account (depending on the particular gearbox design). The gearless drive transmits the power directly to the drive pulley.

The statements above are clear arguments for the use of gearless drives, which offer overall economic advantages – especially for demanding, high-power applications. However, both drive solutions are justified, as the break-even point for gearless drives is typically about 2.5 MW per pulley. To master the challenge of plant engineering to select the optimum drive solution for a specific application, Siemens and ThyssenKrupp offer their support.

### Precise air gap monitoring

As in all electric motors, there is an air gap between the rotor and stator. Severe motor damage would occur if the stator and rotor were to come into contact with each other; hence, it is essential to maintain and monitor this air gap.

The air gap is 8 mm for the 3.8 MW machines in service on the conveyor at



Record from the air gap monitoring system for one revolution of the gearless conveyor motor



Drive pulley with the rotor attached on the same shaft and the stator shifted back into maintenance position (picture taken during installation)

Antapaccay. A maximum variation of 20%, in this case 1.6 mm, is permissible in operation. This is a demanding engineering challenge considering the rotor weight of approximately 20 tons and an outer diameter of around 2.5 meters. The figure above shows the results of the air gap measurement at the gearless drive of the Antapaccay belt for one revolution of the rotor. Each of the individual 16 salient poles can be identified. The actual measured values show a radial eccentricity of 0.2 mm at a diameter of around 2.5 meters, which means it is clearly in the acceptable tolerance range of production and assembly.

With additional measurements, the air gap change between an empty and loaded belt conveyor was determined to

be 0.6 mm; hence the actual values are significantly lower than the permissible 20% limit. The air gap between the rotor and stator is permanently monitored to ensure correct operation of the drive. If the variation of the air gap would come out of range, an alarm is issued to the operator and the drive stops.

To ensure continual improvement, Siemens and ThyssenKrupp are using their experience from executed projects and incorporating it into future projects.

### Gearless drives for grinding mills

Gearless drives are well-proven, state-of-the-art technology for large grinding mills. Siemens, the company that introduced Gearless Mill Drives (GMD) to



the mining industry, started up its first GMD on a ball mill in Norway in 1980. The mill and its drive system are still in service. Today, GMDs are mainly used for SAG mills between 36 and 40 feet (10.7 to 12.2 m) and ball mills from 24 to 28 feet (7.3 to 8.5 m). The current size and power limits for GMD's are 42 feet and up to 35,000 kW.

Among the most outstanding GMDs in operation are those in the Antapaccay mine. The SAG mill has an inner diameter (ID) of 40 feet, an effective grinding length (EGL) of 25 feet and 24,000 kW rated power, whereas the two ball mills have an ID of 26 feet, an EGL of 40.5 feet, and 16,400 kW rated power. The GMDs driving these mills are currently the largest in the world in continuous operation at a comparably high altitude of over 4,000 meters above sea level (MASL). In order to serve Glencore Xstrata's project requirements best, the concentrator design has been standardized and hence can be used on other copper projects.

The high altitude of the mine with the low atmospheric pressure and the high solar radiation imposes special requirements for the electrical equipment. Siemens verified the complete gearless drive system and confirmed its suitability up to an altitude of 5,000 MASL. The most critical aspects to guarantee a long lifetime of the gearless drive system in those altitudes are the insulation of the motor windings and an effective cooling system.

Siemens' answer to the challenges on the winding system is the application of Vacuum Pressure Impregnation (VPI) to the windings. VPI was invented by Siemens over 40 years ago, and it is applied to every Siemens GMD. However, in order to meet these demanding requirements, it was necessary to test and demonstrate sustainability in light of the high altitude conditions. A series of trials were performed, such as testing in a pressure chamber simulating up to 5,000 meters, where all the electrical tests have been passed successfully. Additional field tests were conducted at laboratories in Collahuasi, one of the highest installed laboratories (4,250 meters) for this type of simulation in the world. Among other relevant aspects, partial discharges and the dielectric loss factor have been tested with excellent results. Last but not



The drive station of the 6.5 km belt conveyor at the tail of the conveyor toward the stockpile

least, high-voltage tests have been conducted. All tests showed that the key values are considerably better than those stipulated by the relevant standards or, where these do not exist, better than the industrial references of independent laboratories.

To meet the cooling requirements, Siemens provides a homogeneous motor cooling system distributed around the stator to ensure uniform cooling over the entire circumference of the motor. This approach is confirmed by actual measurements, for example at Antapaccay's Ball Mill No. 2 where the mean winding temperature reached 60°C – which is far below the designed limits – with a temperature difference of less than 5°C around the stator. The measurements were taken at 15°C ambient temperature and a continuous power draw of 13,900 kW, or 85% of nominal power.

### Adjustable to current needs

Antapaccay is also making use of the inherent GMD capability to vary speed, as the mill speed can be adapted to the operation requirements at all times. The variable speed allows compensation for throughput changes as well as harder ore, and it significantly reduces wear to the mill liners and ball consumption by optimizing the cascading angle of the mill charge. Reduced wear of the liners increases the maintenance intervals on the mill, which translates to increased productivity.

Generally, increasing production time and productivity are the guidance for Siemens' design objectives. This applies to numerous design features like the fuse-less, short-circuit-proof cycloconverter, the short-circuit-proof

motor as well as to the mill-specific operation modes of the gearless mill drive. The inching, creeping and balancing modes are provided to ease and optimize the normal maintenance measures of the mill. To avoid damage due to frozen charge, the Siemens GMDs feature Frozen Charge Protection that stops the mill safely before a frozen charge incident occurs. Optionally, the frozen charge can be loosened automatically by applying the Frozen Charge Shaker.

Siemens, as a partner for the entire life cycle of the mining project, supports the user with its wide range of services for both gearless systems installed at Antapaccay – the gearless conveyor drives and gearless mill drives. This comprises the joint implementation of an individual and effective service concept including training for users and maintenance personnel, start-up assistance by field-service engineers on site, predictive and preventive maintenance with remote data analysis, 24/7 on-call service assistance with remote diagnostics, monitoring of spare parts, and annual preventive maintenance visits by factory specialists.

In summary, the combination of the design features, the high manufacturing quality and the comprehensive service portfolio leads to incomparable availability of the gearless drive systems and the full satisfaction of the end user with the equipment in operation. ■

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## Haul trucks

# The titans of open-pit mines

In open-pit mines, time is money. The more ore, coal or oil shale that can be transported, the lower the cost for each ton of freight. That's why the trend is toward ever-larger haul trucks. Until recently, the T284 from Liebherr with a loading capacity of 400 tons\* was the largest truck. That position has been taken over by the BelAZ-75710, which boasts a capacity of 500 tons. Siemens has delivered the first drive system for this titan.



Again and again, the size of the excavator bucket has driven the development of the haul truck, and in turn the size of the pit determines the development of the excavator bucket. For economic reasons, it can be assumed that it takes three to a maximum of four loads from the excavator to fill a haul truck. That makes sense and saves time. In the meanwhile, however, the largest excavator buckets have a capacity of 135 tons. This means that it is again time to come up with suitable trucks. The current peak of development is the Russian BelAZ-75710 with a loading capacity of 500 tons.

The dimensions alone are enough to impress: at 20.6 meters (67 ft) it is considerably longer than competitors Komatsu 930E and Cat797, though it has nearly the same profile with a height of 8.16 meters (26 ft) and a width of 9.87 meters (32 ft). As such, it can be easily integrated into existing mine infrastructure. Empty, the colossus weighs 360 tons; charged, 860 tons. Two 16-cylinder diesel motors with 65-liter cylinder capacity and a power rating of 1,715 kW each drive two generators, which via converters transfer the electrical energy to four traction motors.

### Siemens a pioneer in drive technology

For more than 25 years, Siemens has been developing diesel-electric AC drives for haul trucks. The initial prototypes based on GTO technology were developed in 1998 for Hitachi and Liebherr. With the implementation of the water-cooled IGBT in 2005, a truck drive system could be developed capable of transporting between 240 and 400 tons.

"When BelAZ approached us to equip a haul truck with a loading capacity of 500 tons, our first impulse was to simply double the drive system of a 240-ton truck," says Dr. Joy Mazumdar, Business Manager for Mining Trucks at Siemens in

Atlanta, USA. "That seemed like a fairly straight-forward solution, but the amount of real estate on the truck is limited. We needed to fit more power in a finite space."

That's why Siemens engineers started with a 400-ton drive system and optimized it for a 500-ton drive. For this, the power electronics to control the IGBT and the related software had to be newly developed. For the grid box, Siemens modified the 400-ton system for 500 tons, and the cooling system is similar to the 240-ton system, placed on two separate axles.

*The new haul truck is 25 % more productive than the best haul trucks currently available.*

The Siemens AC haul truck platform is a 1,800-volt DC link. The rated voltage is 1,300 to 1,400 volts. The four newly developed inverters (one for each wheel) were IGBTs rated at 1,500 amps, 3,300 volts; the traditional version was 1,200 amps, 3,300 volts. "The increased amperage made it possible to use the same inverter skid, but allowed more current for the increased torque," adds Mazumdar. There were several modifications to the electrical cabinet, since two alternators required more space. There are also two field exciters and extra rectifiers, but all of the additional components could fit into the existing skid. Siemens uses electrical retarding on all of its trucks with IGBT choppers. The grid box is similar to a 400-ton system, but it had to be extended to 24 resistors for modularity; earlier versions have 20. The traction control system SiBAS co-

ordinates the four wheels, two alternators and two engines. It has to have mine-grade robustness and at the same time be operable in "limp" mode if an alternator or engine goes down.

For transaction motors, Siemens uses four motors from the 240-ton concept. These are installed directly behind each wheel hub on the axles and they are each responsible for driving a pair of wheels. The transaction motors are driven by newly developed, higher-performance converters. Thanks to this new addition, a fully independent supply and control of all wheel pairs is possible. With the separately adjustable speed, the vehicle can automatically increase the speed of its outer wheels in curves and lower the speed of the inner wheels (slip/slide control). This protects the extremely expensive tires from unnecessary wear and ensures directional stability by providing the necessary driving force to the individual sets of wheels.

The new 500-ton BelAZ-75710 is expected to be able to travel up a 10% grade with 2% rolling resistance at a speed of 11 km/hr. During retard, it could safely travel downhill at 30 km/hr. Short braking time requires 6 MW, regular braking 5.3 MW.

Siemens has successfully developed a system for BelAZ that allows a 500-ton truck to be powered on the same footprint as a 360-ton truck, which simplifies the design of the truck's power deck layout. The first trucks in the series are currently undergoing factory testing and will be delivered to an open-pit coal mine in Siberia's Kuzbass region. According to BelAZ's calculations, the new haul truck is 25% more productive than the best haul trucks currently available. ■

\*For mining trucks, all ton measurements are in short tons.

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Siemens' biggest mine winder motors

# A future with Siemens

The Chinese minerals market is currently facing increasing pressure as a result of rapidly growing production costs, for example for labor and energy. Further strain has been caused by a fall in the price of coal over the last year. In order to stay competitive in the future, the Chinese mining industry has to become more efficient and reliable. With these targets in mind, important enterprises like Yitai Group are already starting to implement a series of measures.



Inner Mongolia Yitai Group Co., Ltd is a large enterprise whose coal-centered portfolio also extends to railway transportation and coal-related chemical products. A relatively young and dynamic company, Yitai Group puts the spotlight on efficiency and safety. Yitai Group's first order from Siemens is for four shaft-hoisting machines in a new coal mine.

Since its founding in 1997, (Yitai Group Co., Ltd., founded in 1988, and the subsidiary Yitai Coal Co., Ltd, founded in 1997 and listed on the Shanghai B shares) Yitai Coal Group has become the largest coal company in Inner Mongolia – and one of the largest coal enterprises in China. Output from the 13 mines Yitai Group is involved in amounts to 50 million tons annually. And reserves are assessed at 2,954 billion tons.

A point of pride for Yitai Group is its focus on efficiency and safety, with strong performance on both counts. Furthermore, the company's excavated coal typically has a low ash content, a low phosphorous content, a low sulfur content and a medium to high calorific value, making it less environmentally harmful than other coal supplies.

### Quality first

Quality is an important aspect in all of Yitai Group's activities. Operators strive to ensure that customers are 100% satisfied and that no defective products leave company sites. Paying attention to quality and operating according to ISO9001:2008 pays off: by leveraging on its provision of high-quality products and services, Yitai Coal has established long-term, stable and strategic supply-demand partnerships with power and metallurgical customers all over China.

Yitai Group is also making progress in developing a new market, namely in the conversion of coal to synthetic oil. Research activities started in 2006, and by 2009 the company produced the first barrel of qualified oil in China. In 2013, the annual production capacity of synthetic oil was 184,000 tons.

### Plans include expansion

Looking ahead, Yitai Group has ambitious plans, such as to consecutively consolidate the company's existing coal



Cross-section of an integrated machine from Siemens Tecberg

resources, or to carry forward the construction of production systems, such as modern large-scale mining shafts. This is where Siemens comes in with its years of experience with drive systems that boast a high level of efficiency and safety.

Yitai Group recently awarded Siemens with an order in the double-digit million euro range to install four shaft hoisting machines at the company's new coal mine in Inner Mongolia, known as the Hong Qing He project. The project marks a new cooperation between Siemens and Yitai Group.

Of the four machines, two are skip winders, each with integrated 9 MW motors. These mine winder motors are the biggest ever supplied by Siemens – and the hoists are the largest in the world to feature a motor integrated in the drum. The extremely compact design will help Yitai Group to reduce investment costs associated with the new colliery. What's more, the carbon footprint of the integrated machines – with double winding at full load but only at half speed – is smaller than that of a conventionally designed plant thanks to the 0.5% efficiency increase. The space-saving design, comfortable inspection and maintenance, and lower costs for the foundation are some of the many customer benefits of the integrated machine.

The other two machines are used to transport personnel and equipment underground: Siemens is equipping the mine with two service hoists, each powered by conventional 3.8 MW and 355 kW motors, as well as by SM150 and S120 Sinamics converters. The entire automation control and monitoring systems, the medium-voltage and low-voltage control panels, the shaft

signaling equipment, the loading and unloading facilities, spare parts, and commissioning and training are also part of delivery. Operations are scheduled to start in early 2015. This addition will allow Yitai Group to expand production capacity and improve core competitiveness and market presence.

### The right company for the job

High reliability and availability are critical for Yitai Group. And as such, a very short ROI is particularly important. Siemens was able to fulfill this requirement, as proven by excellent references and a very professional team in China. "We were able to convince Yitai Group that Siemens is the only partner able to accompany the installation of the largest mine winder in China," comments Li Xiao Gang, head of Siemens Minerals in China. The entire project is being managed completely by employees at Siemens China; headquarters in Germany is taking on the role of a supplier.

Other future-oriented plans at Yitai Group concentrate on upgrading the company's comprehensive transportation network and infrastructure facilities to ensure that coal reaches the market in a timely manner. And further efforts are focused on the coal-to-oil front. These and other plans to strengthen Yitai Group's position will help the company achieve its vision of 100 million tons of coal production per year and 10 million tons of coal-to-oil production. ■

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New operations center for KUJ 1365

# Below the depths



At the moment, a large industrial project is underway in Kiruna, Sweden – KUJ 1365, whereby “KUJ” stands for Kiruna Underground, and “1365” for the mining activities 1,365 meters under the earth’s surface. The driver behind this project is international mining group Luossavaara-Kiirunavaara AB (LKAB). The Siemens process control system Simatic PCS 7 is an integral part of KUJ 1365, for example in the operation of the unmanned locomotive system that transfers iron ore within the mine.



*“It’s a tough environment and if something breaks, we can’t be dependent on only one communication path”*

Magnus Emanuelsson,  
Project Head at Midroc  
Automation



Peter Hellgren (l.) and Magnus Emanuelsson, both from Midroc Automation, lead the project group of 60 people who work on installation and production commissioning. In total, 95 people work on KUJ 1365

**K**UJ 1365, which started operations in 2012, is expected to secure iron ore mining and processing in Kiruna – Sweden’s northernmost municipality – for a period of at least 20 years. Midroc Automation is responsible for process control and rail transportation as well as general power and lighting for KUJ 1365. For the distributed control system (DCS), engineers at Midroc Automation chose Simatic PCS 7 from Siemens. In addition to controlling 7 locomotives with 21 ore wagons, each sized to manage production of 35 million tons of ore per year, Simatic PC 7 is also connected to large monitors and overhead contact systems, and it controls doors and gates for the process control system. In detail, the scope of delivery from Midroc Automation includes operations centers above and below the ground, ten unloading groups where the ore is loaded onto the locomotive wagon, four drain positions, four crushers, a locomotive control sys-

Magnus Emanuelsson from Midroc Automation (in the foreground) describes to Kent Åkerlund, sales engineer at Siemens, how the ore is loaded onto the locomotive wagons via the unloading groups as seen at the bottom edge of the picture. The strong lights on the cameras help deliver clear video images to the operator who remotely controls the unloading process from the above-ground operations center

tem, on-board equipment for the unmanned locomotives and lighting, outlet centers, and communications cabling for the entire mining level.

Put simply, four networks control KUJ 1365 – two bus systems, one unloading network and a media network. The bus system connects the PCS7 system to computers via terminal buses and to the control system down in the mine via plant buses. The unloading network facilitates communications between the operator’s unloading stations and unloading groups along the track. And the media network is used to communicate with cameras and backup systems.

### Controlled from above

From the newly built operations center located above ground, LKAB process managers and operators monitor and control process and video images presented directly on large monitors and small screens at the operator sites. The loading of the locomotive wagons, for example, is remote controlled from the ground level using a joystick and video image. For this, the signals go from the control center down to KUJ 1365 and back up again to be displayed on the monitors. “A quick and accurate response is a key factor here,” says Peter Hellgren, Project Manager at Midroc Automation. It takes a maximum of 120 milliseconds from when the operator moves the joystick until the movement down in the mine is shown on the screen.

The signals are relayed via WLAN, which is managed by IPCF (industrial point coordination function) rapid roaming. This makes it possible for the clients to quickly move between access points without losing data. In this case the clients keep track of which access points are nearby and switch themselves to the access point with the highest signal strength. This very quick response ensures that no real-time data is lost.

### Reliable connections

The reliable Safety Matrix software from Siemens connects the machines to the PCS 7 system. Safety Matrix itself is connected to the failsafe input and output modules and frequency inverters. “The reason we chose Safety Matrix was because we wanted a single tool that can manage failsafe mode,” says Peter Hellgren. The redundancy is characterized by dual access points in the wireless network, where every access point is connected through a network at track level and every access point is connected through a network in the nearby mine shaft. “The access points are connected in two different rings. If a fault occurs on one ring, this results in redundancy so that the wireless network is still working through the second ring,” says Peter Hellgren.

In fact, all control equipment for process and locomotive transportation uses redundant systems – both at 1,365 meters below ground level and above-ground operations in the control center. “Redundancy permeates ►



The operator controls the unloading groups with local monitors showing process images. In addition, cameras along the tracks show the positions of the locomotives

## Down in the mine

It takes 30 minutes to travel the 13 km down to the level at which the central parts of KUJ 1365 can be reached. LKAB has over 400 km of asphalted roads in the mine – and as many gravel roads. Along the ore body, which is 4 km long, at least 2 km deep and 100 meters thick, there are ten unloading groups where the ore is loaded into locomotive wagons. The 12-km-long railway then transports ore from the unloading to drain using remote-controlled locomotives. The locomotives are controlled via WLAN antennas placed along sections of the tracks. In total, 110 antennas are used to get full coverage. Communication with the engines is through access points at track level and clients on the locomotives.

► the entire facility,” explains Magnus Emanuelsson, Project Head at Midroc Automation. “It’s a tough environment and if something breaks, we can’t be dependent on only one communication path.” Of the six operator stations, one is located in the emergency room, two are in the mine’s control center, and three are in the locomotive and wagon workshop down in the mine. One of the two fixed engineer stations is in the control center and the other is in the emergency room, and the third engineer station is mobile. Of the four unloading stations, three are located in the control center and one is in the emergency room.

## Mining expertise as an export

Experience from KUJ 1365 and using Simatic PS 7 has led to another huge project for Midroc Automation and Siemens, namely the Grasberg mine in Papua, Indonesia. The Indonesian mine, owned by Freeport-McMoRan Copper & Gold Inc., is located at an

altitude of 4,100 meters and is considered to contain the world’s largest deposit of gold. Until now the Grasberg site has been mined as an open-pit mine, but the open-pit mine cannot be made any deeper and operations must now go underground. The mining company wanted a proven concept, so its management selected a similar solution to the LKAB project in Kiruna, but with a larger scope and adapted to local conditions. The first stage in the Indonesian mine is scheduled to be finished in 2016.

“We excel at planning projects and at the same time are also flexible in our approach. Changes happen and we’ve been very good at dealing with them. I think we have a good dynamic in our project setup and we can quickly adapt and manage changes that emerge,” says Magnus Emanuelsson. ■

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## Glossary

**Unloading group:** the area where mined ore is loaded into locomotive wagons

**Unloading station:** operator stations from where the unloading groups are controlled

**Drain mode:** the area where the ore is emptied from the locomotive wagons to the crush

**Mine shaft:** mining tunnel that follows an ore bonanza lode

## Midroc Automation

Midroc Automation is part of Midroc Electro, one of the Sweden’s leading organizations for electrical installation, industrial automation and IT. The company combines expertise in industrial automation, electrical installation, power, switching tools and control cabinets. Midroc Electro has over 1,300 employees in 35 regions around Sweden. The company is part of Midroc Europe Group.

[www.midrocautomation.se](http://www.midrocautomation.se)

## Luossavaara-Kiirunavaara

Luossavaara-Kiirunavaara AB (LKAB) is an international high-tech minerals group and world-leading producer of upgraded iron ore products for the steel industry. LKAB is also a growing supplier of industrial minerals products to other sectors. LKAB

is wholly owned by the Swedish state with headquarters in Luleå and facilities in Malmberget and Kiruna, and in Narvik in Norway. The LKAB Group includes around 30 companies in fifteen countries.

[www.lkab.se](http://www.lkab.se)

**Process control system:** Simatic PCS 7 with 2 Simatic PCS 7-server pairs, 11 Simatic PCS 7 operator clients, 2 servers with Simatic Open PCS 7

**Industrial PC:** Simatic IPC 547 D, Simatic Microbox IPC 427C

**CPUs:** 22 Simatic S7-417 FH, 6 Simatic S7-317F with failsafe functions

**Control system placed in locomotive:** 9 Simatic S7-300

**Wireless communications:** 100 Scalance X100, X200- and X300-switches and 110 Scalance, W700-access points with rapid roaming

**HMI:** 22 Simatic MP 277, 38 Simatic OP 73

**Failsafe frequency inverters:** 100 Sinamics S120 G


**Intelligent engine monitoring system:** Simocode

**Safety life-cycle tool:** Simatic Safety Matrix

**Maintenance software:** Simatic PCS 7 Maintenance Station

**Distributed I/O:** ET 200M

**Timing synchronization:** SiClock TC400



Process instrumentation and control

# Keeping the giant moving

When standing beside a stacker-reclaimer, the small scale of everyday machinery becomes apparent. Cars, buses – even bulldozers – have nothing on this colossus.

Europe's largest dry bulk terminal, EMO Rotterdam, unloads and ships more than 60 million tons of coal and iron ore each year – 24 hours a day, seven days a week. Throughout its 135-hectare stockyard, EMO knows exactly where materials are and how much each stockpile houses. Key to all of EMO's operations are stacker-reclaimers built by ThyssenKrupp Fördertechnik and automated with Siemens process instrumentation

and control systems. At 150 meters in length and a height of 42 meters, each of the seven stacker-reclaimers at EMO houses an entire world of automation.

"Quality is very important to us," says Peter de Klerk, looking out his window at the waiting ships below. de Klerk is Project Manager at EMO, responsible for new builds, conveyor belts, and the renovation and automation of machines. With daily coal and iron ore processing rates of more than

160,000 tons, de Klerk simply states: "Machines have to run."

EMO's operations require precision, from instrumentation on the stacker-reclaimer to EMO's control system monitored in the control room. An inside look into the processes surrounding this impressive piece of machinery shows how automation keeps this busy company moving efficiently, from unloading to storage to load out. ►



## ► Materials on the go

On the stacker-reclaimer's 60-meter belt conveyor, 1.25 tons of coal rush by every second. Belt scales are the heart of the stacker-reclaimer's operation, measuring the amount of coal being pumped from one place to another.

When a ship first arrives at the quayside, EMO's grab unloader lifts up to 50 tons of coal in each scoop, depositing it in a hopper, which then unloads coal onto a conveyor headed for the stockyard. Once deposited, the stacker-reclaimer gets to work. Creating stockpiles reaching 20 meters into the sky, this machine operates around the clock, everyday of the week.

Installing a belt scale onto the stacker-reclaimer can be done the hard way or the easy way: The former is a labor-intensive operation involving a crane to lift and position the three-, four- or six-idler scale. The easy way involves the Siemens Milltronics MMI dual-idler belt scale. Installation at EMO, for example, was simple. The operator hoisted the scale over his shoulder and carried it up about 22 meters to the conveyor belt. Eight bolts secure it to the conveyor frame and existing idler sets are fastened to the dynamic

beams of the scale – no conveyor modification required. With a Siwarex FTC weighing module connecting the belt scale to EMO's control system, the result is an accuracy of  $\pm 0.25\%$ .

Another notable instrumentation solution is the Echomax XPS-30 ultrasonic transducer mounted on the underside of the bucket wheel to measure the stacker-reclaimer's distance from the stockpile. It is connected to

a Sitrans LU01 controller mounted on the bridge. This ultrasonic level system confidently steers the beam and bucket wheel over the varying heights of the coal stockpiles.

## The brains of the operation

If belt scales are the heart of EMO's operations, Siemens Simatic S7 automation system is the brain.

*Standing at the base of the  
350-square-meter hopper,  
the earth moves and a deep  
boom echoes as 65 tons of  
coal pours from the hopper  
into a waiting rail car.*

Automated with Siemens instrumentation and built by ThyssenKrupp Fördertechnik, stacker-reclaimers are at the heart of EMO's operations



All of the process instrumentation and analytic devices monitoring the coal handling process are connected through a Profibus DP network, which sends information to EMO's control room. From their screens operators can tell immediately if a piece of equipment requires maintenance, and they can respond quickly. EMO does all of its engineering on site, so if machinery or a certain process needs repair, a service technician can fix the problem before it can cause a slowdown in operations.

Other control room screens monitor the North Sea ship traffic and the seven stacker-reclaimers. The process control system acts like a car's onboard navigation system for the stacker-reclaimers – finding the best route, for example from ship unloader number one to coal stockpile number six.

Since coal travels to EMO from sources all around the world, mixing different grades and types of coal is necessary. The top suppliers of coal through EMO's facility are South Africa at 40%, Australia at 26% and Columbia at 18% of EMO's total. Coal is mixed in six blending silos, each with a capacity of 6,000 tons and a discharge rate of 3,500 tons per hour.

The process control system knows when and how much coal is being blended, allowing EMO to provide the best quality to its end customers.

### Deep-freeze prevention

EMO uses a great deal of other instrumentation during coal handling. Once coal is ready for shipment, the stacker-reclaimer loads the material onto a conveyor, which transports coal 35 meters upwards into the train load-out hopper. Standing at the base of the 350-square-meter hopper, the earth moves and a deep boom echoes as 65 tons of coal pours from the hopper into a waiting rail car.

Since coal can freeze in the chilly winter temperatures of the North Sea, on cold days EMO sprays railcar loads of coal with a mix of glycol and water. A Siemens Sitrans F M MAG 1100 flowmeter sensor with a Sitrans F M MAG 5000 transmitter measures water supply; another controls the amount of glycol sprayed on coal moving on the conveyor belt; and a third controls the glycol sprayed on coal as it's being loaded into the rail car. A Sitrans FST020 clamp-on flowmeter controls the glycol supply,

which is stored in a vessel monitored by a capacitance level transmitter.

Once coal has been sprayed, it is ready for transport to European centers. Germany and the Netherlands consume the majority of coal that passes through EMO – 62% and 22%, respectively. A nearby coal-fired power plant in Maasvlakte, the Netherlands, uses 12% of this coal to power activities in this industrial area.

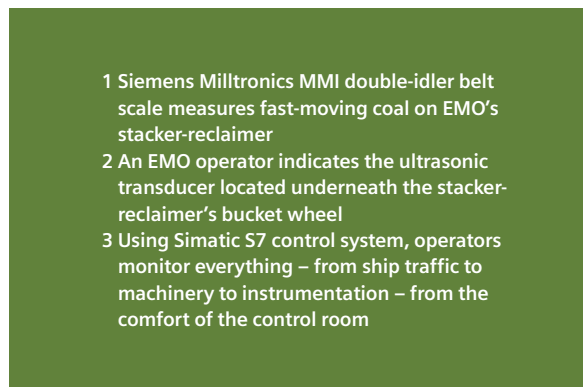
### Machines have to run

After being excavated at sites thousands of kilometers away, coal continues its journey across EMO Rotterdam's coal handling facility: seven stacker-reclaimers, six blending silos and nearly 28 km of belt conveyors, with process instrumentation and control systems linking it all. Complexities of coal handling at a facility of this size are made into a smooth, efficient operation. ■

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## Heavy Duty Rectifier systems

# Pure zinc from the high north

**W**orldwide zinc is used for a broad range of applications. One of the most well known is the galvanizing of vehicle bodies and coating of steel against corrosion. Zinc is primarily extracted from sphalerite (ZnS). Yet aside from zinc, ZnS also contains up to 30% sulfur and different concentrations of iron, lead and silver. To separate these accompanying elements, zinc concentrate is heated to over 900°C so that the ZnS is converted to ZnO and can afterward be dissolved in sulfuric acid. The undissolved by-products remain. The zinc dissolved in acid is transported through pipes to an electrolysis plant. There, as a result of its electrical properties, the high-purity metallic zinc is separated onto polished aluminum plates. The cell voltage in the electrolysis bath measures generally 3.3 V to 3.5 V at a current density of 400 A/m<sup>2</sup> to 600 A/m<sup>2</sup>. The quantity of plates working in parallel and their total surface area define with their current density the total direct current (DC) of the process. With over 50 years of experience in creating very high levels of DC, Siemens developed Siporec, which embodies the most advanced electrical and mechanical engineering available. The compact design ensures high efficiency and an optimal power factor. It consists mainly of diode or thyristor-based heavy-duty rectifiers, the rectifier transformer and the appropriate cooling systems. The whole rectifier group is controlled, monitored and protected by the flexible, digital-control system Siporec CC.

Open communication interfaces like Profibus DP and connections to industry standards like Simatic S7 and Sinamics DCM make the system future-proof and allow it to be quickly integrated into a plant. As a result, the optimally controlled high direct current can flow through large aluminum or copper busbars into the electrolysis baths, which are part of the core process for zinc production.

## High efficiency at Boliden Odda

Odda's zinc smelting plant in Norway was established in 1924, and in 2003 it was acquired by Swedish metals company Boliden. Over 80% of the raw material comes from the company's own mines in Sweden and Ireland; the rest is from mines in Canada and Peru. Ninety-three percent of what is produced is exported, particularly for the steel industry in the UK, France, Germany, the Benelux countries and Scandinavia.

Since electrolysis is a very energy-intensive process, after the acquisition the atmospheric zinc concentrate direct leaching process was introduced in an effort to increase production capacity. The process allows very different qualities of zinc concentrate to be used, and in turn the volumes of zinc fed into the plant can be increased by more than 10%. In 2013 Boliden Odda produced 143,000 tons of zinc metals; for 2016 the target is 200,000 tons.

The modernization of the processing facility was accompanied with

Rectifier type Siporec H



Stacks of zinc bars at Boliden Odda

steps to implement a redundant DC power supply for the electrolyzers that is safe, reliable and open for further plant expansions. In this vein, Boliden Odda commissioned Siemens in 2012 to build a new Heavy Duty Rectifier (HDR) system, which dependably supplies the modernized plant with the necessary direct current.

## Teamwork pays off

This project is an excellent example of international and cross-divisional collaboration between Siemens Norway and different Siemens units. For example, specialists for heavy-duty rectifiers at Siemens Industry Drive Technologies in Erlangen designed and calculated the technical layout of the entire recti-



Siemens realized a Heavy Duty Rectifier group with a 44 MVA rating as well as the associated rectifier control and cooling system for Boliden's Norwegian zinc smelting plant in Odda. Now that commissioning has been completed, the company is in a position to increase its productivity and flexibility – as well as the energy efficiency of its electrolysis plant.



The Boliden Odda site in Norway

fier system including the associated transformer. The result is based on the proven platform Siporec H, designed with diodes forming a 12-pulse system with 110 kA DC at 345 V. The rectifier units were constructed mechanically in a double-tier configuration.

The 66 kV/44 MVA rectifier transformer was produced at the Siemens factory in Dresden. Together in one tank with the regulating transformer and transducers, this power supply unit weighs 165 tons and is more than 7 meters high. Behind the output terminals every transformer section forms a double star system with inter-phase transformer.

As the primary contract partner, Siemens Industry Norway was responsible for the rectifier control system,

the project planning and local project management as well as for construction and commissioning. The German HDR specialists supported Siemens Norway during this project phase.

The system was designed for a 30-year service life running around the clock almost 365 days a year. Siemens performs regular life-cycle services and maintenance services.

The excellent collaboration between Siemens Norway, Siemens units in Germany and Boliden Odda's engineers meant that the complex project could be brought to a close within a very short period of time. Only 15 months after the contract was signed, the test run was successfully completed, and the system could be handed over to the customer. ■



The project team (l. to r.): Arne Uv (Siemens), Sverre Strand (Boliden), Sjur Velure (Boliden), Oddgeir Haug (Siemens), Peter Basen (Siemens), Nils Martinsen (Siemens), Magne Meland (Siemens), Björn Yngve Eriksen (Boliden)

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Performance-based maintenance

# A contract for results

Minera Peñasquito is Mexico's second largest open-pit mine, located in the state of Zacatecas. Operations focus mainly on the production of gold, silver, lead and zinc, a process that is only possible if the overburden is removed quickly and effectively. To complete this task, Goldcorp has entrusted Siemens with the operation and maintenance of the in-pit crushing and conveying system, which starts at the sizer station and passes through the conveyor systems to the belt stackers.





The average output is around 55 million tons per year



**G**oldcorp Inc., headquartered in Vancouver, Canada, is one of the world's fastest-growing gold producers. The company has a total of eleven mines: five in the United States and Canada, three in Central and South America, and three in Mexico.

One of the mines in Mexico is Minera Peñasquito, some 20 km from the municipality of Mazapil in the semi-desert region of Zacatecas. With its extensive ore deposits, Zacatecas has a long tradition in mining work. Exploratory drilling in 2006 at what is today Minera Peñasquito confirmed the presence of gold and silver deposits, and commercial production of the valuable natural resources commenced at the beginning of 2010. The open-pit mine has been in operation since then, with annual production of up to 12 tons of gold, 650 tons of silver, 9,000 tons of zinc and 5,000 tons of lead.

### The production process

Before an open-pit mine is opened up, Mexican law calls for existing flora to be relocated before the fertile soil is removed and placed on earth banks to be used later in remediation. As a final task, the remaining overburden is removed and the land is ready for mineral extraction. During the post-extraction phase, the minerals must pass through a grinding and flotation process (separation) using two sulfide processing lines that have a daily capacity of 50,000 tons, along with a high-pressure grinding roll circuit with a capacity of 30,000 tons per day.

A crucial role in the aforementioned process is played by the ore mills, which reduce the raw material down to the optimum size for the downstream processes. For this purpose, from the start of operations Goldcorp chose Siemens technologies and services, known for their reliability and efficiency.

In 2007, Goldcorp purchased two gearless Simine Mill GD drives, which were installed in two semi-autogenous grinding (SAG) mills. With a diameter of around 11.6 meters (36 ft) and 19.3 MW of rated power, these ore mills are among the largest of their kind. The gearless drives have decisive



**Comprehensive maintenance services ensure the availability of the kilometer-long conveyor belts**

advantages over conventional systems, such as optimum starting and braking that reduces the mills' energy consumption, and their stepless speed control system that enables rapid adjustment to the different properties of the raw material. Having no gear unit means less wear – since there are no mechanical parts between the motor and the mill. In turn, wear and maintenance requirements are reduced, adding up to less downtime.

Goldcorp asked Siemens to handle the servicing and maintenance work on the drive systems and the associated power equipment with the aim of increasing the mills' reliability and availability. These services are comprised of condition-based preventive measures as well as repairs and spare parts management. In addition, stand-by service provides fast repairs and

maintenance whenever they may be required. Remote diagnostics and remote maintenance tools for monitoring the plant are also in use. These detect faults at an early stage and can minimize outage times. The current agreement also includes the corresponding electrical equipment and installations, such as the primary high-voltage supply and all medium- and low-voltage distribution.

The maintenance agreement was designed as a performance-based contract with payment depending on the results achieved. In other words, key performance indicators (KPIs) were defined that have to be met for important operating parameters such as availability. The results impressed the Canadian mining company and laid the foundation for future collaboration between the two companies.

### Fast burden discharge

The Peñasquito operation involved the opening of two extraction areas. To enable quick and efficient transport of the growing amount of overburden, an in-pit crusher and conveyor was installed in 2012 – also known as a sizer station – with a capacity of 10,000 tons per hour. The main advantage is that overburden can be milled close to the site.

The sizer station is located on a connecting strip between the existing pits. It initially crushes the overburden from the two pits to a maximum grain diameter of 35 mm. The overburden then travels on long-distance conveyor systems over a distance of 7 km to the belt stackers. In all, the average output is around 55 million tons per year, resulting in around 1 billion tons over the 17-year life planned for the conveyor system.

The in-pit crushing and conveying system plays a key role in meeting production goals, as the targets for gold, silver, zinc and lead extraction can only be reached if the overburden is removed quickly enough. To ensure this happens, operators at Minera Peñasquito opted for the Siemens Integral Plant Maintenance (IPM) concept. Emiliano Salas, Project Superinten-

dent at Minera Peñasquito, acknowledges the excellent collaboration to date, saying that it was an important reason for entrusting the work to Siemens. He reports on positive experiences with Siemens' Gearless Mill Drives and the company's technical service. In 2012, the Siemens Customer Services Division took over 24-hour service as well as the mechanical and electronic maintenance of the entire system. For this, Customer Services provides both the staff and the necessary equipment.

### The benefits of performance-based pricing

The maintenance order is expected to be worth about €40 million, as with the first version, which is why Goldcorp will benefit from performance-based pricing. Costs will thus be determined during operation based on the system's output (production-based contract) as well as on specified KPIs (performance-based contract). "It was the pricing model based on performance and volume of transported matter that ultimately proved decisive," explains Salas. He also says that some of the key performance indicators include availability, safety and environmental compatibility. It should be noted that for both companies worker safety is paramount – as is environmental protection. For this reason, there is continuous monitoring of the soil, air and water, among other precautionary measures.

A year after the start of the contract, both companies view their collaboration in a very positive light, and there is a clear intention to extend it. ■

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The maintenance agreement for the in-pit crushing and conveying system at Minera Peñasquito was designed as a performance-based contract with payment depending on the results achieved

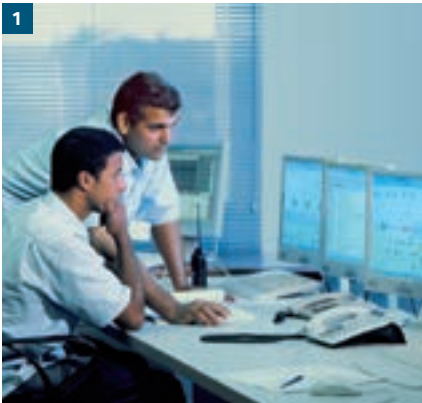


*For both Siemens and Goldcorp, worker safety is paramount – as is environmental protection.*



Optimizing maintenance and service activities

# Condition monitoring – Knowing before it's too late



1. Via remote access the Siemens experts always have an eye on the status of the monitored equipment
2. The Motor Condition Monitoring Box from Siemens measures the vibration and temperatures of the bearings as well as the motor's coil temperature
3. Vertical Loesche mill with Drive Train Condition Monitoring at ANTEA Cement Sh.A.



**For operators of process plants, downtimes are often coupled with substantial economic losses. Monitoring process-critical drive components lowers the risk of downtime, contributes to high availability and, through optimization of the service intervals, increases the cost effectiveness of maintenance and repairs.**

**T**op priority for mining customers is the uninterrupted productivity of production, handling and manufacturing systems. This makes condition-based maintenance of the drivetrain essential. Up to now, machines or parts of the drivetrain have been subject to inspection at defined intervals. This sometimes led to shutdowns only to establish that the machines were actually in good working order. Condition monitoring eliminates the need for this kind of inspection interval and the resulting shutdowns. Continuous monitoring of key components that are critical to the process, especially motors and gearboxes, provides a continuous flow of data about the condition of the machines. Damage can be detected at an early stage and rectified.

Siemens offers condition monitoring for both motors and gearboxes, and the solutions can be scaled individually to match the customer's requirements. Condition monitoring from Siemens reduces the life-cycle costs of the customer's plant, and ensures the availability of the entire drivetrain. All the relevant data flow together in one system. By continuously monitoring the motor and gearbox, Siemens experts can draw conclusions from the interactions between the components of the drivetrain and so intervene at an early stage to prevent damage. The customer receives regular condition reports, and contact is taken up immediately if changes occur, so the customer is always kept up to date on plant status.

### Analyze before an error occurs

"It doesn't help to recognize the condition of a machine after a fault has occurred. We need the data before the fault happens," says Dr. Rainer Ordenewitz, head of Remote Services at Siemens Industry in Erlangen. "Therefore, we don't send people to the machines, but have the machines send data to us. We save the information in a database so that we can analyze it at any time and from anywhere. In this regard, remote access is a powerful tool." Using the Motor Condition Monitoring Box, bearing vibrations and temperatures from large drives in mills, pumps and ventilators and the coil temperature in the motors are monitored. The box is installed directly on the motor. It is decoupled in regard to vibration and temperature, and it is moisture and dust proof according to protection class IP65.

All critical parameters and measured values are available for trend analysis and further evaluation. For example, crucial changes in the trend curves can point to wear or other damage-related causes before significant damage or even a downtime can occur. If a parameter increases too greatly or exceeds a limit value, a message is sent automatically to the specialists at the Siemens Expert Center. They analyze in detail the measured and recorded data and make recommendations for countermeasures. Very often, cost-effective measures

such as a readjustment of the motor orientation are sufficient. If the system runs for a longer time period without any conspicuous issues, the operator receives a quarterly status report and can adjust the maintenance intervals accordingly.

### A package for every drivetrain

Every drivetrain is unique, and for that reason Siemens has compiled different packages, from manual vibration measurements, standardized hardware and service up to completely engineered solutions based on the individual requirements of complex applications.

With that, even several drivetrains can be monitored by one system. Beside the drivetrain, there are also solutions for single motors and gearboxes. Expensive unplanned downtimes and significant damage can thus be avoided.

### Continuous Monitoring in operation

ANTEA Cement Sh.A. is one of the largest industrial greenfield investments by the TITAN Group in Albania. The plant's production capacity is 1.5 million tons of cement a year. The new plant is one of the most technologically advanced in the world with three vertical Loesche mills to grind raw materials. Siemens received the order to equip two vertical mills with Drive Train Condition Monitoring. Vibrations, torque, pressure, temperatures and speed are continuously monitored. The Drive Train Condition Monitoring system is connected remotely to Siemens condition monitoring experts who carry out in-depth analyses regularly, work out action recommendations when required, and generate periodical status reports. In May 2013 the system was successfully put into operation to the customer's full satisfaction. ■

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## Construction materials in the UK

# Expertise + capability =



It's been a very interesting year for the UK minerals sector. While most of the industry has been in the doldrums, or is just beginning to emerge from a very deep recession, in some areas things have been getting pretty lively recently.

**T**here are five main areas of the minerals sector in the UK: quarries, asphalt, building materials, ready-mix concrete and cement production. All areas were badly hit back in 2007, when the recession began in earnest. Often the first to be affected in a downturn (fewer houses being built, fewer sales of building materials, fewer roads being repaired or constructed), and the last to recover due

to economic stimulus coming at the tail end, the industry has certainly had its share of challenges over the last five years.

However, in recent months demand has increased considerably in the minerals sector as the recession finally appears to have bottomed out. The challenge now is for those operators who've mothballed sites and reduced head count to be able to satisfy this

new surge in demand. Technology may provide some of the answers by helping to increase productivity, and investing wisely now could bring significant benefits in the future.

As a major supplier in several areas of this key industry, Siemens UK has seen its market share in the minerals sector more than double in the last couple of years. There are a number of reasons for this spectacular growth:

# = higher efficiency

## Scope of supply

In working with solution partners and SMEs, an increase in demand for energy-efficient technology has been identified, for example through variable speed drives, industrial motors, industrial automation, control equipment and process instrumentation solutions. There is demand for these drivetrain components to better integrate, and for improvements in distribution technologies to increase overall efficiency and potential energy savings for operators.

On the one hand, the quality of Siemens' products convinces the customer. On the other hand, locally available service, support and industry expertise are another major factor. The customer wants to work with someone who knows the business – the operators' drivers, pain points and process flows.

Siemens in the UK has remained dedicated to the minerals business while many other suppliers realigned themselves to other vertical sectors during the recession. For companies both large and small, this serves as proof of Siemens' commitment to the business – even in tough times. Furthermore, the company has increased the scale and scope of what it offers to help companies achieve efficiency improvements.

## Great backup

Some of these trends are more acutely obvious – especially for the large construction materials companies with multiple sites. By partnering with them, Siemens has recognized the need for increased productivity – and has been able to respond to that need. Excellent service and back-up support in addition to energy-efficient technologies are essential elements to this partnership.

In the UK there are approximately 1,300 quarries, with a few of them manufacturing more than 1 million tons construction aggregates annually. Interestingly, these quarries are located remotely, with rail operations,

## *Investments to improve efficiencies can actually help insulate companies from the worst of the energy price rises.*

roads or harbors dedicated solely to transporting their products. These quarries are among the world's most efficient ones, thanks partly to their investment in the best technologies. As such, they are certainly ready for the expected demand upturn.

## Dedication

By staying in the market as long as Siemens has, the company's engineers have a good idea of new trends in the sector and what customers are starting to look at more closely. Silos is a good example. Some of Siemens' newer projects include silo levels for ready-mix plants to prevent over-spillages of milled clinker into the silos. Other projects include level sensors in bitumen supply operations for the asphalt industry to advise via telemetry when tanks are running low and need refilling.

For some of the main players on the market, Siemens did extensive energy consumption audits across multiple sites and identified areas for potential improvements. Currently Siemens is supplying variable speed

drives and control systems at those sites to significantly reduce energy use and improve efficiency.

It should be noted that, despite the market wanting new technologies to become more efficient and to increase productivity, higher energy prices could hold back growth for some. However, investments to improve efficiencies can actually help insulate companies from the worst of the price rises and protect them against future price increases, too. Enhanced capital allowances (ECAs) also offset capital equipment against corporate tax, and leading companies are making substantial investments in these areas that pay off in the long term.

All these are examples of where Siemens is helping companies work smarter and more effectively – two essential strategies for future success. ■

Construction aggregates account for approximately 85% of the non-energy minerals extracted in the UK, and they are critical for the national economy. The market is dominated by four international players: Lafarge-Tarmac, Cemex UK, Hanson (HeidelbergCement) and Aggregate Industries (Holcim).

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## Power monitoring systems

# Energy efficiency through transparency

**Cimsa is one of the leading companies in Turkey's cement and ready-mix concrete industry. Power monitoring systems were introduced to systematically reduce load peaks at all five of Cimsa's Turkish production sites. The result: greater energy efficiency throughout the enterprise.**

**T**he manufacturing process of the world's most widely used building material is very energy intensive. From the crushing of raw material to the grinding of what is known as clinker cement into the finished product, the individual production steps require significant amounts of natural gas and electrical power. These high energy requirements are also reflected in the consumption figures of the five cement plants that Cimsa operates in Turkey: in 2010, they used more than 500 GWh.

As one of the leading companies in the industry, Cimsa also feels it has an obligation to the environment. It has therefore invested a great deal in recent years to significantly reduce emissions, save energy and establish alternative fuels.

### Identifying potential savings

Among the measures that Cimsa has taken to protect human health and the environment is the introduction of precise power monitoring systems in the company's five Turkish cement plants. With such energy-intensive processes, it is important to document and evaluate energy consumption and load peaks, identify potential savings, and take appropriate measures to increase energy efficiency.

The Siemens power monitoring systems in use rely on 7KM PAC measuring devices, 3WL and 3VL communication-capable circuit breakers, and powermanager software. The energy experts developed an individual solution for each production facility.

Power monitoring is part of Siemens Totally Integrated Power (TIP). It's based on a comprehensive range of products, systems and solutions for low and medium voltage, rounded out by Siemens support throughout the entire life cycle – from planning with software tools to installation, operation and services. Smart interfaces allow linking to building or industrial automation, making it possible to fully exploit all the optimization potential of an integrated solution.

### Comprehensive system

In 1975, Cimsa launched cement production at its first plant at the Mersin site. Today, gray and white cement as well as calcium aluminate cement are manufactured there on several production lines. After an extensive modernization in 2010, the production capacity of the largest on-site system is about 4,000 tons of clinker per day. This makes the cement plant in Mersin the company's most important production site,

meaning that it also required the most complex power monitoring system – and first and foremost complete transparency in energy flows. The existing 218 measuring devices were not sufficient for this purpose. To detect all the loads and evaluate the information collected from the crusher plant, conveyor belts, rotary kilns, clinker coolers and storage silos, a significantly more comprehensive system was necessary.

### Flexible architecture

In the newly developed and installed solution, measuring devices from the 7KM PAC series detect the required values. These digital meters are extremely robust and easy to install, thanks to front installation with IP65 sealing class and grid terminals. They also have interfaces for Modbus TCP, Modbus RTU, Profibus IO and Profinet DP, and they can be easily integrated into existing local networks. Thirteen of these measuring devices of type 7KM PAC4200 were already present in Mersin. The number was increased to 25 for the new solution, and they were connected to the Industrial Ethernet network via Modbus TCP and the existing Allen-Bradley PLC. Siemens also connected 206 additional 7KM PAC3100 measuring devices through 11 subordinate



Cimsa is one of the largest cement manufacturers in Turkey.



### Sentron power monitoring – the highlights

- Comprehensive portfolio of complementary hardware and software components
- Individually adaptable to customer requirements
- Transparency of energy flows shows potential savings and thus enables energy savings of up to 20%
- Problems can be detected early and proactively resolved through continuous monitoring, thus enabling the highest-possible availability of power supply

### Cimsa – the company

- Founded in 1975 in Mersin, Turkey
- Today the world's third-largest producer of white cement and calcium aluminate cement
- Producer of high-quality cements and exporter to several countries in Asia, Africa and the Americas

*“The 7KM PAC reliably delivers all the important values – even under harsh conditions.”*

Abdullah Karacilar  
Electrical Engineer, Cimsa



Abdullah Karacilar  
demonstrates the  
7KM PAC

### Totally Integrated Power (TIP)

Siemens products, systems and solutions for low- and medium-voltage make power distribution efficient, reliable and safe – in cities, infrastructure, buildings and industrial plants. They can be linked to building and industrial automation, and are rounded out by comprehensive support throughout the entire life cycle.

Modbus RTU networks to the Industrial Ethernet network via PLC.

The already installed measuring devices from another manufacturer could be integrated into the new solution thanks to the flexible system architecture. The powermanager software allows voltages, currents, power levels and outputs, as well as their variation over time, to be detected, archived and presented as curves. In addition, measured quantities such as power averages are monitored and fed to definable actions, such as signaling. The measured quantities can be derived from a variety of sources, from measuring devices and controllers via Modbus TCP or from more complex units or networks that have an OLE for Process Control (OPC) server interface. This possibility was used twice in this project. In addition, powermanager can be used to generate automated reports according to customer requirements, which are then transferred to an SAP system via File Transfer Protocol (FTP).

### Keeping an eye on consumption

With the new power monitoring solution at the Mersin plant, the energy consumption of the production processes and the corresponding key performance indicators (KPIs) are documented on a daily basis – for example, the energy required for the production of a ton of cement. The powermanager power monitoring system is also being successfully used at the locations in Ankara, Eskisehir, Nigde and Kayseri.

The Distributed System option connects systems across the five sites. The information from the local basic systems is thus available to the experts in the central system for further evaluation and higher-level reporting. This created the required enterprise-wide transparency, making it possible to take measures in each plant to increase energy efficiency or to reduce load peaks. This allows Cimsa to further lower energy consumption across the enterprise. ■

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## Siemens in India

Siemens' first project in India dates back to 1867, when founder Werner von Siemens started building a telegraph line from London to Kolkata. At the time, the 11,000 km line was the one of the fastest and most reliable telegraph links in the world. When the line was completed in 1870, a message could be transmitted between London and Kolkata in 28 minutes instead of the 30 days that mail took to travel between England and India.

A factory was set up in Worli to manufacture switchboards and another was established in 1959 for medical equipment. Production of motors commenced at Kalwa in 1966 and a further switchboard factory was set up in Nashik in 1981.

Today, Siemens in India has a sales and service network that spans across the entire country and includes 23 manufacturing plants, 8 centers of competence and 11 R&D centers.



## Sicement product family

# Automation frees up resources

To enable automatic and hands-free plant operation, Siemens installed an optimization solution for the Wonder Cement factory in Chittorgarh District, in the Indian state of Rajasthan.

In India as in many upcoming economies, cement is in high demand as the housing, infrastructure, commercial and industrial sectors grow. To take advantage of these developments, RK Marble, a leader in the marble industry, established Wonder Cement.

Built as a greenfield project, the Wonder Cement plant is situated in Chittorgarh District, in the Indian state of Rajasthan. An advantage of the location is the plant's proximity to major consumption centers, railway lines and essential infrastructure. In an effort to increase the plant's current production rates of 4.0 million tons per year, operators at Wonder Cement turned to Siemens.

### Simplified operations

"When we first contacted Siemens back in 2011, detailed discussions revealed that what we really needed was an advanced software facility that would enable automatic and hands-free operation of many loops. A good number of loops were controlled by process signal observations and manual interventions by the operators," recalls S.M. Joshi, President of Wonder Cement. The answer was Cemat-based optimization solutions.

Cemat, a part of the Siemens Sicement product family, is based on Simatic PCS 7, a proven distributed control system featuring unique open

architecture for modern, future-proof and economical solutions. The specific Cemat solutions employed at Wonder Cement are KCS for pyro process optimization and MCS to push the mill to its maximum performance. Both KCS and MCS use actual plant data to make precise predictions about quality parameters, and they can be integrated into an existing PCS 7 control system with no additional hardware. The MCS and KCS systems sit on top of the basic automation level and give set points to the already commissioned and fine-tuned PID controllers in the basic automation. Plant process parameters that the operator enters manually result in consistent operation throughout the day. Furthermore, set points can be issued to the already commissioned and fine-tuned PID controllers in the basic automation.

In 2013 during running operations, Cemat MCS and KCS were installed. Thanks to the optimization solutions, operators are freed from monotonous routine work, so they can concentrate on key tasks. Furthermore, at any time the set points in the controllers can be adjusted to achieve stable production conditions at an optimum level. Additional advantages include constant production characteristics for consistent results. The solutions are very user-friendly and they can be easily tuned to ever-changing process conditions to optimally run the loops. The customer

reports major advantages of using the Siemens optimization solutions over those from competitors.

### Results soon apparent

Operators at Wonder Cement are satisfied with the Siemens solution, and almost immediately they recognized benefits from Cemat MCS and KCS: Higher efficiency was recorded as a result of more stable production processes. Quality could also be improved thanks to well-balanced sintering conditions. The lifetime of the refractory and equipment was also extended. A further advantage is that emissions could be lowered.

To keep up with growing demand in India, Wonder Cement is looking to further expand its current capacity of 4.0 million tons annually to 10 million tons. This jump can only be accomplished with the addition of new production lines. Land space has been set aside and the layout for lines 2 and 3 has been drawn up. Plans for implementation have yet to be unveiled. ■

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## Trade fair Expomin, April 21–25



Siemens will have a stand at the German pavilion at this year's Expomin in Santiago de Chile. Press events will be held for trade journalists

Expomin 2014 stands out as a showcase for innovation and technological solutions for the mining industry. This year 70,000 guests from all over the world are expected to attend the trade fair in Santiago de Chile, where 1,300 suppliers will be showing their products and solutions. Siemens will have a stand in the German pavilion. A selection of what will be on display: conveyor systems, air-cooled drives for all altitudes, life-cycle services and Gearless Mill Drives. Descriptions of the portfolio of products and solutions will be supplemented with project references.

Siemens will also use the event to position itself as a future-oriented partner for energy efficiency and environmentally friendly solutions. Gearless drives for mills and conveyors are an important aspect in this regard. Siemens' presence will be complemented with press events, background reports and fact sheets. ■

## Trade fair Green Cementech, May 15–16



Siemens will present its environmentally compatible solutions for the cement industry at Green Cementech in Hyderabad, India

In mid-May Siemens will participate in Green Cementech, an annual international conference and exposition in Hyderabad, India, organized by CII Sohrabji Godrej Green Business Centre and the Cement Manufacturer's Association (CMA). Various business units at Siemens associated with the cement industry will showcase their solutions in areas of green technology and operational excellence.

Once again, Siemens expects a large number of visitors – cement manufacturers, equipment manufacturers, consultants and industry experts – to its stall. Emphasis will be on the concept of a single-stop solution, from source to shaft.

The key objective of Green Cementech is to promote sustainable development of the cement sector and to demonstrate that green makes good business sense. A particular focus is on achieving world-class standards in regard to energy and the environment. Green Cementech is taking place for the tenth time this year. ■





Alexey Svistunov, Chief Editor of the CIS Guinness Book of World Records (between the hostesses), presents a certificate to Alexander Egorov and Oleg Stepuk (2nd and 3rd from left), both from Belarusian Autoworks (BelAZ)

#### Guinness Book of World Records

# Dumper with Siemens technology biggest of its class

**BelAZ-75710, a two-axle all-wheel-drive mining dump truck, is being proposed for the Guinness Book of Records for its weight-carrying capacity of 500 short tons.**

To suit the needs of the gigantic automobile, Siemens traction experts developed reliable and powerful all-wheel driving gear with four electrical motors with a performance rating of 1,200 kW. Furthermore, two traction generators, three blowers, a brake resistor ventilating unit and a control cabinet with two ELFA inverters will be built into the BelAZ-75710. In case of failure of one of the driving gears, an emergency mode can be activated, which

would enable the dumper to get to the service station without being towed.

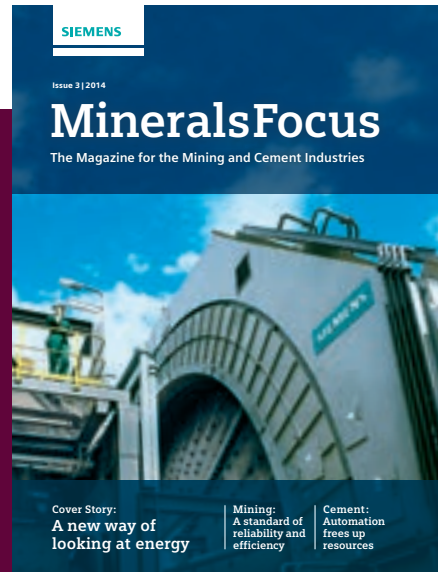
At over 20 meters long, nearly 10 meters wide and 8 meters high, the truck dwarfs anything standing next to it. The maximum speed is 64 km/h. BelAZ-75710, which is now being field tested, is expected to be in high demand in the mines of the Kuzbass region of the Russian Federation, and in certain coal strip mines in Chile and North America. ■

**The world's largest mining dump truck is powered by motors from Siemens**



If you are interested in receiving a sample copy of MineralsFocus, or if you would like to order a free subscription, please send an e-mail to [mining@siemens.com](mailto:mining@siemens.com).

Our magazine is also available as an ePaper. The current version can be accessed at [www.siemens.com/mineralsfocus](http://www.siemens.com/mineralsfocus). You may also order the print version at that link.



## Siemens at Expomin 2014



With over 70,000 expected visitors, Expomin in Santiago de Chile is truly one of the industry's largest trade fairs. This year, Expomin takes place April 21–25. Displays at the Siemens stand in the German pavilion will present among others conveyor systems, air-cooled drives for all altitudes, life-cycle services and Gearless Mill Drives.

[www.siemens.com/expomin](http://www.siemens.com/expomin)

## We've got it covered

Dedicated websites provide a comprehensive overview of Siemens' products and solutions for the mining and cement industries. At the cement site, for example, a new web feature takes a close-up look at Europe's latest and most modern cement plant.

[www.siemens.com/mining](http://www.siemens.com/mining)  
[www.siemens.com/cement](http://www.siemens.com/cement)



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The Siemens logo is displayed in a bold, teal, sans-serif font. It is positioned in the upper left corner of the advertisement, above a white horizontal bar. The background of the entire advertisement is a photograph of a large, curved concrete structure, possibly a cooling tower, with several people climbing it using colorful handholds. The sky is blue with some clouds.

SIEMENS

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[siemens.com/cement](http://siemens.com/cement)

**Integrated Drive  
Systems:**  
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# CEMENTABILITY

**SICEMENT – Reliability that enables you to reach the top**

Companies in the global cement industry are facing major challenges: If they are to improve productivity while simultaneously decreasing costs, they need high-performance products that are also energy-efficient and offer maximum availability and flexibility. These products also need to comply with environmental regulations while providing maximum safety for employees, machines, and material.

In order to tackle all these competing challenges, we have developed SICEMENT – the world's most comprehensive range of products and solutions for the cement industry. Tap into the potential of modern cement production – while maintaining maximum reliability. SICEMENT Drives are best example for Siemens Integrated Drive Systems.

**Opt for CEMENTABILITY.**

**Answers for industry.**



In 1998, the 38-foot Gearless Mill Drive (GMD) from Siemens pictured above started operations at Olympic Dam in Australia. Olympic Dam is a mining center in South Australia where copper, uranium, gold and silver are produced.

Since 1980, Siemens has provided some 50 GMDs to mining operations all over the world. In fact, if the service times of all Siemens GMDs in mines worldwide area added up, the result is over 500 operational years.

One of the most important features of a GMD is its smaller footprint and lower weight compared to conventional drives. And by doing without a range of mechanical and electrical components, the drives' reliability increases and the effectiveness of the entire system grows by 3% to 4%. Maintenance requirements are considerably lower, not least of all because there are no cooling systems and no gears that require lubrication.