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Engineering efficiency in mining

Enhancing safety, reliability
and sustainability

Tackling mining's diverse challenges

The machines and equipment used in mining must provide reliable, safe and efficient operation in challenging and hostile environments. Together with extensive mining experience and a wide portfolio of life cycle services, ABB is well positioned to tackle the industry's most demanding situations.



Maintenance managers



"We need the most reliable products and systems to avoid unplanned shutdowns."

Lower operational overheads...

- Operational costs must be controlled without compromising safety of plant, personnel or end product.
- All production machinery across all applications must have higher reliability than previous generations to provide increased production time. Breakdown is not an option so unplanned downtime must be eliminated.

... through advanced maintenance regimes

- Soft starting and accurate torque control prevents shock loading, leading to less wear and tear on gears, belts and driven machines. Variable speed drive (VSD) modernization services offer a new life to old aging assets while economically ensuring lowest life cycle cost.
- ABB Ability™ Condition Monitoring services deliver accurate, real-time information about VSD, motor and mechanical equipment conditions, to ensure equipment is available, reliable and serviceable.
- ABB's global service network and service agreements relieve pressure on in-house teams and increase speed of response to critical issues.
- ABB Ability™ Smart Sensor's condition monitoring functionality warns of impending failures, long before they happen, reducing unplanned downtime.



Engineering managers



"We need to increase mine sustainability and reduce our impact on the environment."

Becoming more competitive...

- Operations must remain profitable even in tough market conditions. Increasing production efficiency by digitizing with ABB Ability™ helps that happen.
- Personnel safety increases when people are removed from harm's way by using remote or autonomously operated equipment.
- Improving air quality by reducing contaminants and increasing the quality of ventilation improves employee health.
- Providing a modern, technology supported work place that is competitive with other industries helps attract the most talented employees.

... through better stewardship of our mineral resources

- A smaller CO₂ footprint through more efficient energy use and management. ABB Ability™ Energy Optimization services reduce CO₂ emissions and help gain cost savings through reduced electricity consumption.
- Increased use of electrically driven machines reduces diesel emissions and the potential for fuel spills.
- Reduce waste heat entering the atmosphere by using more efficient digitally controlled processes.



Health and safety managers



"The presence of hazardous areas requires the safest and most reliable products to decrease the risk of fire or gas ignition."

Meeting global safety regulations...

- International standards for hazardous areas such as IEC, MA, MSHA, ATEX and others, together with regional certifications, improves safety in mining.

... demands the best-in-class technology

- VSDs and electric motors need to be rugged and reliable, with systems protecting against arc flash.
- VSDs must have safety enhancing features like the integrated functional safety modules complying with the highest machinery safety requirements.
- An AC motor and drive combination certified for explosive atmospheres gives safe, economical and effective control of any motor-driven application.

"We see technology as key to improving safety levels in mines."

Overseeing diverse application safety needs...

- Using diesel engines underground presents safety, health and ventilation challenges.

... with the safest and most reliable solutions...

- VSDs play a key role in ventilation on demand (VOD) by ensuring that the right amount of fresh air is available in the right area without increasing flow in areas that do not need it.
- The latest technology in underground drills, load haul and dump machines (LHDs) and personnel transport, uses VSDs and battery powered electric motors to replace diesel engines, greatly reducing ventilation demands and increasing safety.



Production managers



"Our production targets must meet the high-quality specifications our customers demand: on-time, efficiently and safely."

From production efficiency to quality output to operational targets...

- Operational efficiency can be improved by controlling costs such as energy use and peak penalty charges to introducing more automation and reducing manpower.
- To meet ever stricter production targets, mining equipment cannot break down. Any risk of application failure must be anticipated using real-time data gathered from the process.
- Customers demand the highest quality end-product, which calls for automated, on-line sampling systems that give instant and accurate feedback.

... digitalization and automation bring better intelligence

- Multiple inputs and outputs (I/Os) allow a variety of process information to be extracted from VSDs, motors and mechanical products and adds intelligence to the motor-driven application.
- Easy drive integration with a PLC or control system increases site digitalization, providing greater insight, reduced maintenance and better production control.
- Accurate torque control and rotational speed regulation eliminate process interruptions and contribute towards high end product quality across all applications, while saving energy.
- ABB Ability™ Life Cycle Assessment services help to maintain a high quality, performance and availability of operations, in a predictable manner.

Tuning the mining process

From surface to underground mining, there are hundreds of motor-driven applications that benefit from speed and torque control. Benefits include energy saving, higher uptime, extended machinery lifetime and improved safety.

1 OPEN PIT MINING

Applications:

- Drill rigs
- Track-mounted electric shovels
- Dozers and rubber-tired front-end loaders
- Haul trucks
- Stackers and reclaimers
- Primary crushers: fixed and mobile types
- Conveyor systems

1a DRILLING AND BLASTING

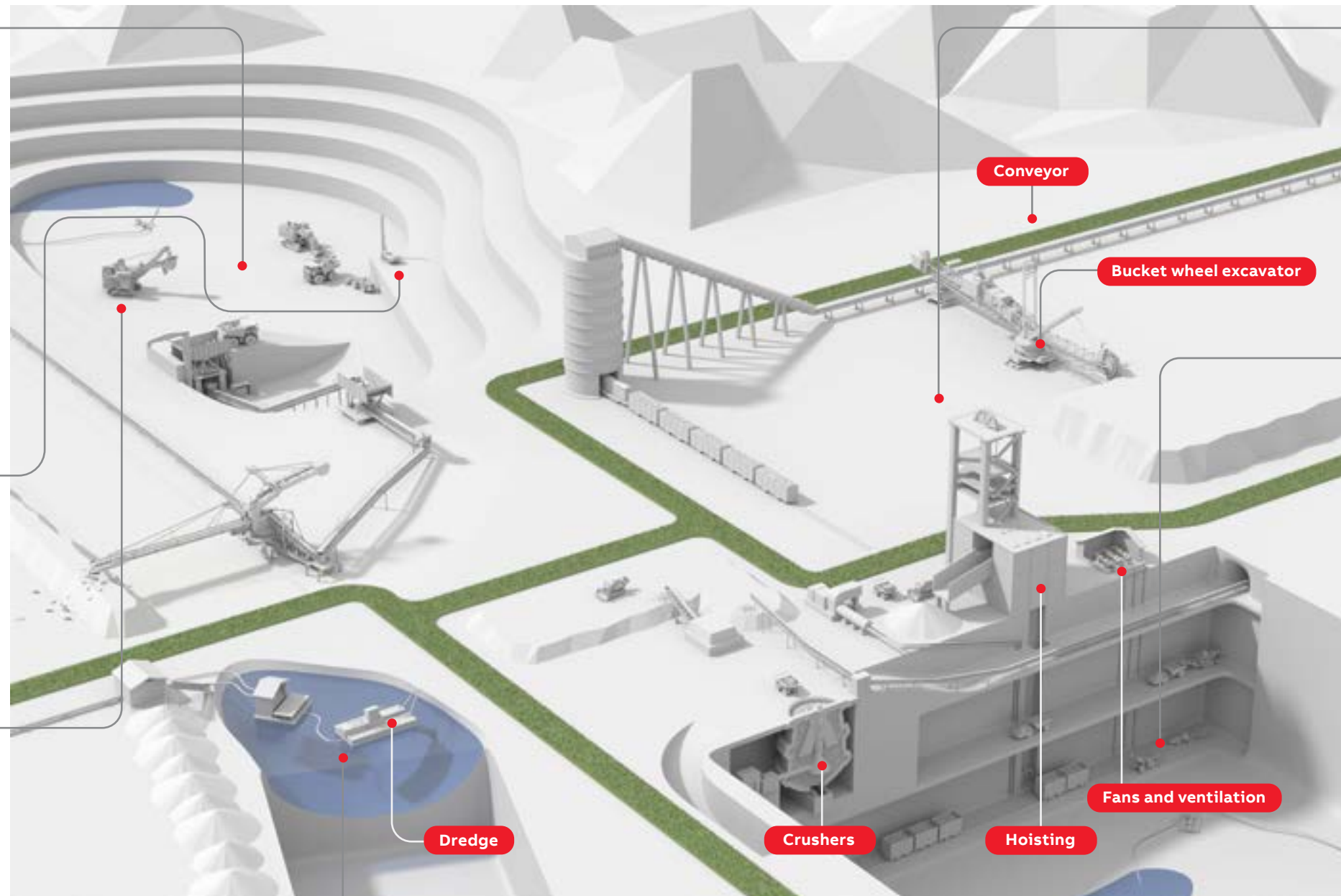
Applications:

- Drilling machines

1b REMOVING ORE

Applications:

- Large electric shovels
- Diesel powered haulage trucks
- Electric trolley assisted diesel trucks



2 STRIP MINING

Applications:

- Drill rigs
- Shovels
- Trucks
- Dozers
- Draglines
- Bucket-wheel excavators
- Crushers
- Conveyors

3 UNDERGROUND MINING

Applications:

- Drilling and cutting machines
- LHDs and trucks
- Crushers
- Feeders and conveyors
- Tunnel boring machines
- Mine hoists
- Ventilation fans
- Pumps





4 DREDGING

Applications:





- Pumps
- Bucket line
- Dragline







Improving the efficiency of mining operations

Mine operators, machine builders and equipment suppliers need to select a motor-drive package that increases productivity, lowers energy consumption and maximizes equipment lifetime.

	Challenge	Solution	Benefit
	Surface and underground drills <ul style="list-style-type: none">• Strict environmental regulations demand more energy-efficient and environmentally friendlier drilling techniques.• Varying ground conditions requires a drill motor that can adjust its speed continuously.	<ul style="list-style-type: none">• Motor-drive package regulates drill motor speed to ensure optimum performance based on ground conditions, bit pressures and percussion rates.• Electric motor used instead of hydraulic or pneumatic motor.• Varying motor speed, depending on conditions, uses less energy compared to hydraulic or pneumatic drilling systems.	<ul style="list-style-type: none">• Extends drill lifetime and reliability with lower energy use and environmental impact.• Reduces the use of hydraulic liquids or compressed air, lowering environmental impact and increasing safety.• Reduces overall cost of ownership.
	Compressors <ul style="list-style-type: none">• Pipe bursts caused by variations in air pressure and wasted energy through air leakages.• High current demand when starting a compressor can cause disturbance in the power network.	<ul style="list-style-type: none">• Drive controls compressor motor speed and maintains constant air pressure in the pipeline, with significant reduction in air leakages.• Drive controls the compressor ramp up and motor in-rush current, which reduces power network disturbances.	<ul style="list-style-type: none">• Maintains air pressure at desired level with high energy efficiency and minimal maintenance.• Reduces air leakages by eliminating pressure peaks.• Reduces mechanical stresses and prolongs lifetime of compressor and entire air pipeline system.
	Crushers <ul style="list-style-type: none">• Huge mechanical stress on crusher and motor caused by crushing large rocks.	<ul style="list-style-type: none">• Crusher motor speed and torque control prolongs lifetime of machine.• Direct torque control (DTC) detects heavy loads and limits applied torque to safe levels.• Drive smoothly reverses direction of crusher, rotating back and forth to break down hard rock without jamming the crusher.• Drive provides nominal torque in entire operating speed range, assisting in starting crushers in weak network.	<ul style="list-style-type: none">• Uninterrupted throughput with reduced mechanical stress, maximizes uptime.• Reliability and high efficiency of ABB induction, slip ring and synchronous motors reduce downtime and operating costs, minimizing total cost of ownership.• Reduces load and disturbances on the grid.• Reduces wear and tear, improves reliability and prolongs crusher lifetime.
	Draglines <ul style="list-style-type: none">• Varying quality of overburden affects operation of dragline.• Voltage fluctuations in weak supply networks can jeopardize dragline's operation, leading to unplanned production downtime.	<ul style="list-style-type: none">• Drives control the dragline's travel, slew, dragging, conveying and hoisting, enabling entire operation to match the overburden requirements.• Soft starting of various motors eliminates high starting currents and helps increase productivity of machine and other mine site equipment.• Regenerative drives in draglines recover braking energy when reducing slewing speed.	<ul style="list-style-type: none">• Lower energy use and less wear on draglines motors and mechanical parts.• Reduces mechanical stresses on motors and machines, reducing maintenance needs.



	Challenge	Solution	Benefit
	Conveyors and feeders <ul style="list-style-type: none">• Risk of belts slipping or breaking.• Loads are variable with frequent stops and starts leading to power grid experiencing voltage drops when starting large motors.• Downhill conveyors may require regenerative braking.	<ul style="list-style-type: none">• Drive protects belts and other mechanical equipment through smooth and accurate motor speed and torque control.• Drive controls starting acceleration to prevent belt slippage, reduce peak belt tensions and provides accurate and fast load sharing when multiple drives are located on a single conveyor.• Braking energy generated by motors and drives on regenerative conveyors is fed back into electrical network where it is available for use by other equipment.• Conveyors can be run at low speeds for maintenance, belt changes or avoidance of ice build-up.	<ul style="list-style-type: none">• Prolonged belt lifetime and reduced stress on belt splices, resulting in higher availability.• Power grid is protected from voltage drops by regulating inrush current when starting motors
	Stacker-reclaimers and spreaders <ul style="list-style-type: none">• Continuous pressure to reduce stacking and reclaiming times, lower operational and maintenance costs and maximize plant uptime.	<ul style="list-style-type: none">• Drives for motor speed control ensures efficient stacking and reclaiming, substantially lowering energy consumption, reducing wear and tear and prolonging machine lifetime with improved uptime.	<ul style="list-style-type: none">• Improved productivity through lower energy use and reduced downtime.
	Pumps <ul style="list-style-type: none">• Water hammer must be avoided.• Up to 20 percent of a mine's total energy consumption is used by pumps.• High-density, abrasive and corrosive substances in slurry means pump parts wear out quickly and maintenance and energy costs are high.	<ul style="list-style-type: none">• Slow starts of pump systems eliminate water hammer pressure spikes and resulting damage.• Controlling pump motor speed with a drive brings substantial energy savings compared to on/off control, throttling or any other control method.• Pump speed can be adjusted to match fluctuations in system parameters such as flow rate, static head and settling velocity.	<ul style="list-style-type: none">• Eliminates pressure peaks in pipelines due to soft starting.• Efficient operation of pumps, pipes, joints and valves.• Reduces noise and increases motor and pump life.• A drive adjusts pump speed so that the flow is above critical velocity preventing blockages and avoiding a shutdown of the plant.
	Fans <ul style="list-style-type: none">• Underground mines demand control of air flow for fresh air and removal of emissions, dust, heat and gases produced during mining.• Main and secondary ventilation fans are among largest consumers of electric power, having a direct impact on cost of production.• Critical resonance frequencies cause wear and tear to fans.	<ul style="list-style-type: none">• Accurate control of air flow is achieved by controlling speed of fan motors with drives.• Drives are most energy-efficient control method, ensuring significant energy savings compared to any other control technique.• To eliminate critical resonance frequencies, drives programmed to jump over them.	<ul style="list-style-type: none">• Better control of air flow with minimized energy consumption.

	Challenge	Solution	Benefit
	Winches <ul style="list-style-type: none">• Belt slipping and breaking causes considerable downtime.• Constant rope tension is essential for keeping dredger firmly in desired position.• Dredger is moving continually and requires ease of control to maximize efficient operation.	<ul style="list-style-type: none">• Winch drives control belt tension, avoiding breakages.• Drives replace costly hydraulic winch controllers, eliminating high maintenance costs, pollution risk and energy inefficiency while improving overall system reliability.• Drives enable easy and accurate manoeuvrability of dredger.	<ul style="list-style-type: none">• Constant belt and rope tension for prolonged equipment lifetime.• Reduced noise levels, lower energy and maintenance costs plus elimination of hydraulic liquid leakages.• Ease of dredger positioning increases operating efficiency.
	Mine hoists <ul style="list-style-type: none">• Uninterrupted operation is critical to allow movement of miners and material and as evacuation route in emergencies.• Gearbox failures, wear and tear of ropes and hoist mechanics as well as energy inefficiency have a negative impact on mine's profitability and safety.	<ul style="list-style-type: none">• Drives vary speed of hoist motors providing smooth and accurate hoist operation throughout the entire speed range.• ABB motors, drives and mechanical power transmission products have intelligent remote monitoring and diagnostics system which delivers important information on equipment status and possible maintenance tasks needed.• Drives feature redundancy which makes it possible to continue hoist operation at half speed with full load in case of a failure in the drive system.	<ul style="list-style-type: none">• Enhanced safety and high reliability for improving mine productivity.• Excellent energy efficiency, prolonged equipment lifetime and reduced maintenance cost.• Monitoring mine hoist equipment allows personnel to schedule preventive maintenance, thus increasing safety and reliability of operations.
	Mills <ul style="list-style-type: none">• To sustain production, mills must operate continuously.• With dual pinion mills, the load must be shared equally between the two pinions.• Torque pulsations and peak torques during startup create high stresses on network and mechanical equipment.	<ul style="list-style-type: none">• Drive control lets mills easily react to changes in ore characteristics and throughput. Speed of mill can be tuned for optimal grinding and maximum throughput.• Drives ensure an accurate and coordinated load sharing.• Drives provide a smooth ramp up and deliver high starting torque for current drawn.	<ul style="list-style-type: none">• There is no need to change mechanical components if ore characteristics change. More efficient use of the grinding power.• Accurate load sharing reduces component wear and increases reliability.• Low starting currents and high starting torque enable a smooth startup of mill, even when fully loaded.
	Trucks and loaders <ul style="list-style-type: none">• Increasing fuel prices, pressures to limit exhaust gas emissions and underground ventilation costs are leading to alternatives for conventional trucks and loaders with mechanical transmission systems.	<ul style="list-style-type: none">• Drives and motors can propel trucks and loaders and control the movement of truck beds and loader buckets.• Offer higher efficiencies than diesel engines and eliminate heat and exhaust generated by diesel engines, thereby reducing ventilation needs.• E-mobility drivelines for heavy working machinery have IP 67 enclosure and can tolerate 4 g vibrations and 30 g shocks.	<ul style="list-style-type: none">• Faster driving speed, lower fuel consumption, minimized need for maintenance and reduced noise and gas emissions.
	Locomotives and trains <ul style="list-style-type: none">• Stringent safety requirements, type of transported material, amount of load, driving conditions and track profile set different challenges on operating mine trains.	<ul style="list-style-type: none">• Controlling locomotive and train motors using drives brings flexible train operation irrespective of load and environmental factors.	<ul style="list-style-type: none">• Safe and environmentally friendly materials transportation.• Safe and comfortable working conditions, lower energy bill and reduced maintenance costs.
	Flotation cells <ul style="list-style-type: none">• Mineral recovery and cleaning of flotation concentrates.• Corrosive operating conditions require robust motors to increase uptime and reliability.• Vibration due to belt slipping or misalignment condition causes downtime.	<ul style="list-style-type: none">• Severe duty premium efficient motors designed for belt driven or coupled to a gear reducer, vertical or horizontal mounting.• ABB Ability™ Smart Sensor technology installed on the motor frame for condition monitoring.	<ul style="list-style-type: none">• Increased uptime and reliability with industrial severe duty motors.• Premium efficient severe duty motors deliver lower energy consumption.• Remote monitoring of electric motor condition with ABB Ability™ Smart Sensor technology.



Features and functions benefiting mining applications

ABB offers an extensive range of devices for motor control, including soft starters and programmable drives, as well as synchronous, induction and permanent magnet motors. Choosing the right products and features is essential to combat extreme working conditions, such as high temperature variations, humidity, vibration, high altitude, dust, corrosives and weak network conditions.



Variable speed drives

Soft starting and stopping and reversing of motor

- Eliminates voltage fluctuations in supply network, high starting currents and reduces mechanical stress during starting and reversing.
- Savings through smaller cables and supply switchgear.
- Improves reliability and prolongs application lifetime.

Accurate speed regulation

- From running at crawling speed to smooth change of direction of rotation to synchronizing all motor speeds.
- Reduces energy consumption, prolongs lifetime, lowers operational and maintenance costs.

Dynamic torque regulation

- Full torque precisely controlled throughout entire speed range.
- Enables high starting torque and eliminates torque peaks.
- Less maintenance, lower costs, high uptime and increased productivity.

High power factor

- Lower reactive power consumption and no compensation equipment needed.
- Lower installation costs and substantial energy savings.

PID control

- No need for external PID controller.
- Avoids costs for additional components.

Flexible user interface

- Easy connection to any automation system through multiple fieldbus adapters.
- Reduces installation and programming costs.

Regenerative braking

- Braking energy is fed back into electrical network.
- Lower energy bill.

Synchronizing of multiple motors

- Equal distribution of load between motors and elimination of undesirable dynamic effects.
- Less wear and tear, lower maintenance costs.

Flying start

- Motor can be started when spinning.
- Time savings through immediate starting and no need for braking.

Power-loss ride through

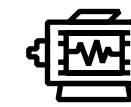
- Uninterrupted operation of drive and motor in power failure situations.

Torque memory

- Avoid load jerk when starting motor and releasing brake.
- Minimal wear of gearbox and other mechanics.

Functional safety

- Safely stop applications using built-in safe torque off (safety level SIL 3).



Motors

ABB offers a comprehensive range of high efficiency motors designed for the demanding environment of mining operations.

Designed for harsh environments

- Designed for use in surface and underground applications, in hard rock and coal mines
- Certified for explosive atmospheres
- Protection ratings up to IP69 against wet and corrosive environments
- Wide range of surface treatment and corrosion protection solutions available

Energy efficiency

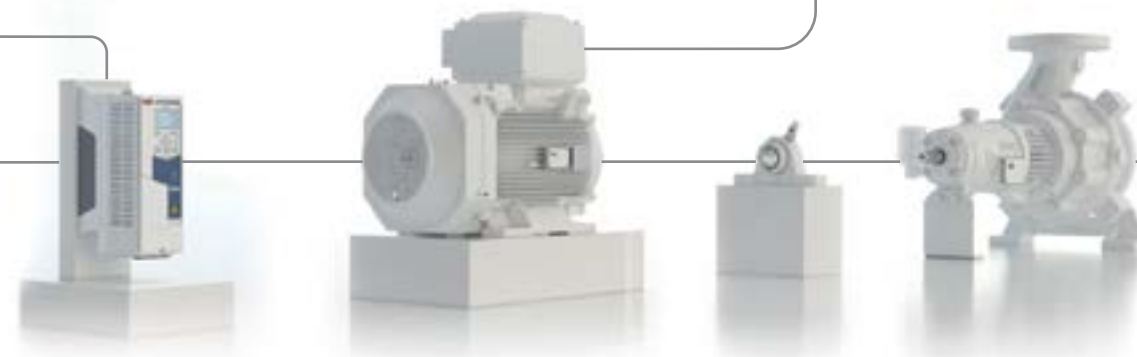
- High efficiency up to IE5 to reduce energy costs and emissions
- Reduced heat rejection increases bearing life
- Suitable for frequency converter operation

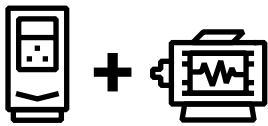
High reliability and compact design

- High power density provides the same output power with a smaller frame size or higher power with the same frame size
- Bearing locked at D-end to avoid axial play
- Bearings greased for life or regreasable, fitted with grease relief systems

Easy installation

- Oversized terminal box as standard for ease of installation
- Flexible cabling solutions
- Horizontal or vertical mounting





Packages

ABB offers motor-drive packages that exactly match the customer’s process requirements. They provide the following advantages:

- Optimized system design
- Reduced commissioning time
- Integrated manufacturing and delivery schedules
- Verification of the functionality and the load performance of the motor-drive package

Drivelines for electric working machines
ABB offers complete electric drivelines for heavy working machines – optimized for each machine’s actual working cycle.

Conveyor packages

- Pre-packaged solutions including pulleys, bearings, coupling, reducers and other components
- Engineered projects including drives, motors and mechanical products

Synchronous reluctance motor and drive (SynRM)

- Save energy with IE5 synchronous reluctance motors and drive packages



Softstarters

Easy to use

- Ensures low stress start every time, either with a normal voltage ramp or with more advanced torque control for linear torque acceleration.

Harsh environment use

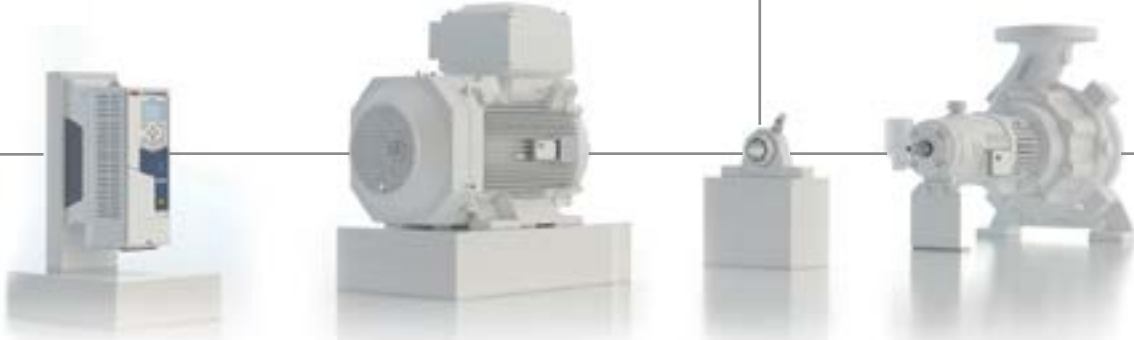
- Ensure uninterrupted production in dusty or wet environments with IP66 keypad and coated electronics.

Variable speed

- Run motor in three different speeds - helpful during maintenance inspections.
- Reduces inrush current compared to a DOL start.

Motor protections

- Built-in electronic overload (EOL) protection.
- Locked rotor protection.
- Standstill brake function - gives motor a braking force to be able to withstand external forces.



Mechanical power transmission products

Mounted bearings

- Patented shaft attachment designs that provide faster and safer installation and removal.
- Industry-leading seal technology.
- ABB Ability™ Smart Sensor for mounted bearings provides an option to wirelessly monitor temperature and vibration.
- End covers are available to increase safety by preventing injury during operation.

Couplings

- Complete line of couplings for all bulk material handling applications including grid, gear, tire, sleeve, moment and fluid.

Controlled Start Transmission (CST)

- Reliable and rugged gear reducer with multi-plate wet clutch located on low speed side of gearbox, transmitting motor torque to driven load.
- Acts like a shock absorber and dampens belt tension spikes.
- Gearbox, motor, conveyor components and belt splices are protected.
- Clutch is PLC controlled so soft starting with long acceleration ramps are standard and load sharing between multiple motors are included.

Enclosed gearing

- Heavy duty gearboxes utilize AGMA bearing specifications with industry leading seal technology to withstand shock loads and provide increased service life.
- Torque Arm II and MTA feature the patented twin tapered bushing shaft attachment design that provide faster installation and removal while minimizing vibration and eliminating fretting corrosion as seen with competitive designs.
- Torque-Arm II and Magnagear XTR® backstops are compatible with lubricants containing extreme pressure (EP) additives.

Pulleys

- Drum and wing pulley constructions available in heavy duty, mine duty extra, or engineered class. Engineered class includes an extended two year warranty.
- Tapered bushed and keyless shaft locking devices available.
- Integral hub, profiled, turbine, and T-section end discs designs.
- All common lagging materials available (SBR, DLAG, neoprene, FOS, ceramic, EPDM, and others).
- Proprietary DLAG lagging compound provides 73 percent higher abrasion resistance than SBR.



From the mine to the cloud and beyond

ABB Ability™ Condition Monitoring for powertrains optimizes the performance and efficiency of rotating equipment. It enables full transparency on all parameters for drives, motors, mounted bearings, gearing and pumps.

1 Intelligent powertrain

The powertrain is equipped with sensors and cloud connectivity and can comprise motors, drives, mechanical components including bearings, couplings and gearboxes – and also pumps.

2 Turning data into valuable information

Data gathered from VSDs' built-in sensors and loggers together with that collected from ABB Ability™ Smart Sensors fitted to motors, bearings, gearing and pumps, can be collated, stored and further accessed via the cloud. The ability to gather and analyze this data can reveal information on the status and condition of your equipment, so that you can schedule service activities more effectively.

3 Accessing data for analytics

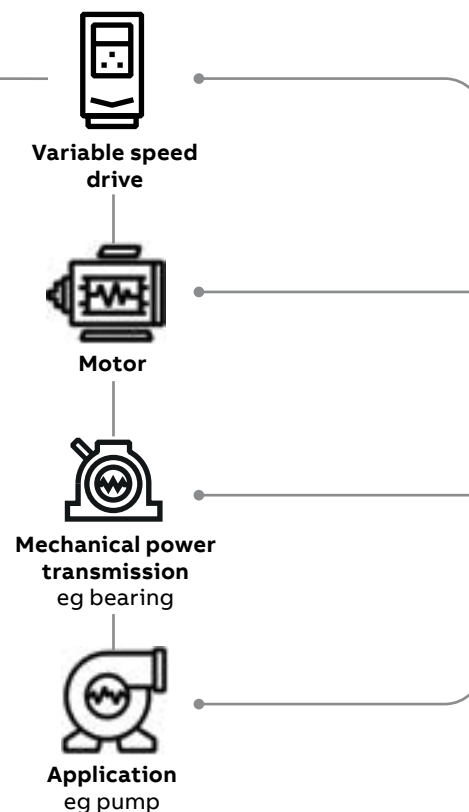
Detailed information can be extracted into a company's own portal and systems. Information on many aspects of the mining and minerals process is available, including the ability to know exactly when and how production equipment is maintained.

Detailed dashboards give full transparency so that you can take actions that lead to less downtime, extended equipment lifetime, lower costs, safer operations and increased profitability.

4 Gain a digital advantage

Ensuring that the right person is exposed to the right information at the right time brings:

- Appropriate response to production challenges, minimizing operating costs and wastage of products.
- Greater insight into various aspects of the mining production process, thereby improving quality and reducing variations, errors and waste.
- Lower risk of production failure and change the maintenance from reactive to predictive.



Keeping your production running

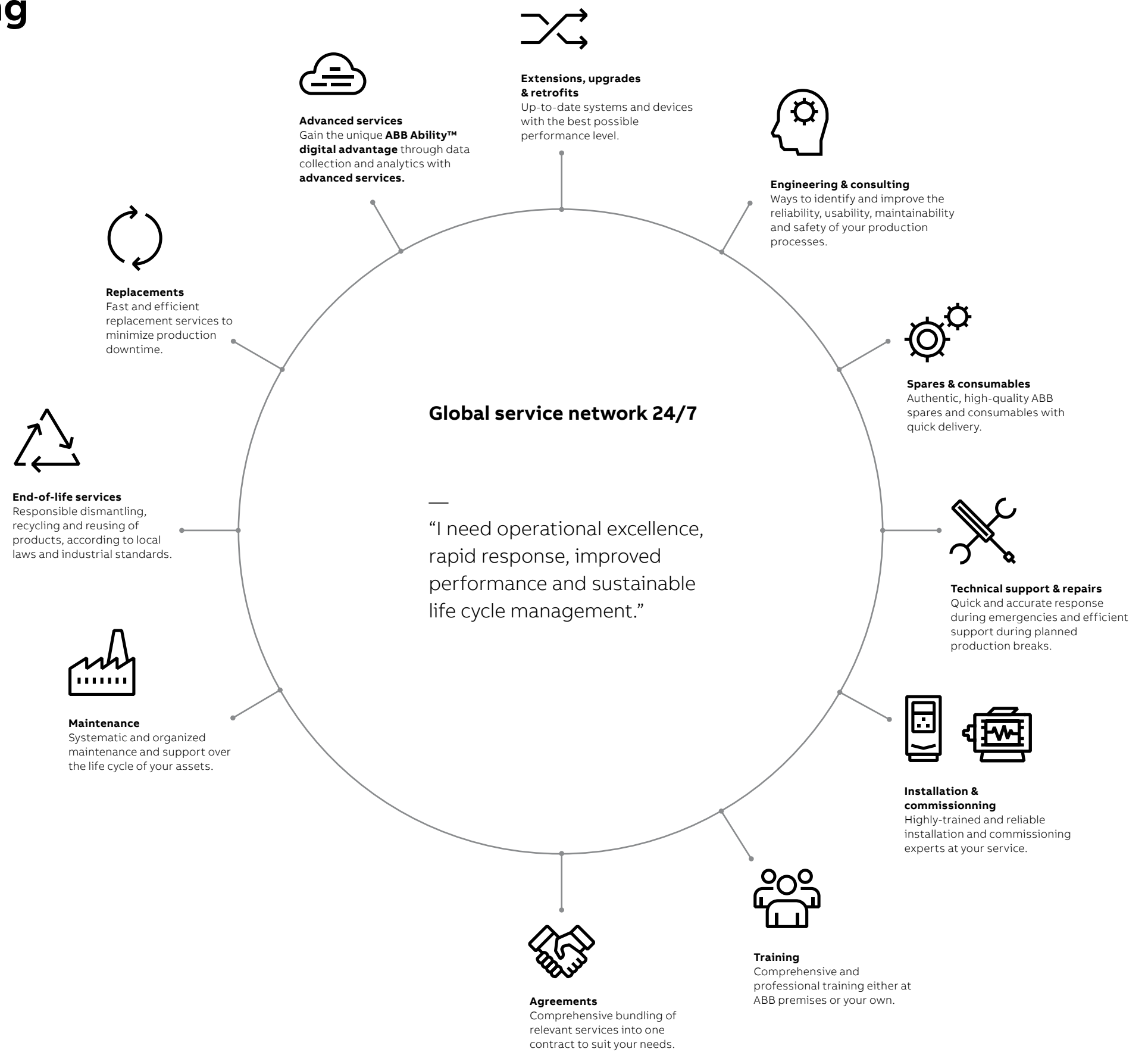
From spare parts and technical support to cloud-based remote monitoring solutions, ABB offers the most extensive service offering to fit your needs. The global ABB service units complemented by external ABB Value Providers form a service network on your doorstep. Maximize performance, uptime and efficiency throughout the life cycle of your assets.

With you every step of the way

Even before you buy a drive, motor, bearing or softstarter, ABB's experts are on hand to offer technical advice from dimensioning through to potential energy saving.

When you've decided on the right product, ABB and its global network of ABB Value Providers can help with installation and commissioning. They are also on hand to support you throughout the operations and maintenance phases of the products life cycle, providing preventive maintenance programs tailored to your operational needs.

ABB will ensure you are aware of any upgrades, retrofit or replacement opportunities. If you've registered your drives and motors with us, then our experts will contact you advising on your best service advice. All of which helps maximize performance, uptime and efficiency throughout the lifetime of your powertrain.



With you, wherever you are in the world

Partnering with ABB gives you access to some of the world's most innovative technology and thinking.

Global reach

ABB operates in over 100 countries with its own manufacturing, logistics and sales operations together with a wide network of local ABB Value Providers that can quickly respond to your needs. Stock availability is good, with short delivery times for many products backed by 24-hour spare parts delivery.

In addition, we work closely with the mining and minerals sector to develop custom products, services and solutions to help standardize processes across multiple sites and streamline your supply chain.

We have seven global R&D centers with more than 8,000 technologists and invest \$1.5 billion annually on innovation.

End-to-end product portfolio

Alongside its variable speed drives, motors, softstarters, bearings and couplings, ABB's automation offering includes a wide range of scalable PLCs, a selection of HMIs, instrumentation and robotics. With functional safety options, from built-in safe torque off to safety PLCs, you can readily implement bespoke safety requirements.

ABB's offering includes:

- End-to-end **power and automation solutions**, from power distribution, raw material receipt, to process and machine control, to end of line packaging.
- **Power protection and power quality solutions** to safeguard equipment and processes.
- Industry leading **robotic automation solutions** that improve your speed-to-market.
- A complete range of **protection, connection and wire management solutions** that withstand harsh environments and extreme

temperature swings, and provide the reliability needed for continuous operations.

Streamline sourcing

ABB's end-to-end product and services portfolio streamlines your sourcing and purchasing activities and standardizes production across multiple sites, saving you money on spare part inventories while reducing maintenance costs.

