GE Energy

RELIABLY
SAFELY
SUSTAINABLY

Electrical Solutions For Mining

imagination at work


"It's estimated that energy usage accounts for more than 15% of total mining production costs."

GE Electrical Solutions For Mining

Across the world, regional energy shortages have compelled some mines to sharply curtail their power consumption. In the U.S., it's estimated that energy usage accounts for more than 15 percent of total mining production costs and that mines use 3 percent of all industrial energy. These realities have become part of a powerful set of factors that, along with economic challenges, the accompanying fall in commodity prices, and the growing awareness of climate change is driving the mining industry to become more energy-efficient and find cost-effective ways to perform their operations.

Accordingly, the mining community is being challenged to find electrical equipment and systems solutions that make mining operations: 1) reliable, efficient, and continuous; 2) safer and protected; and 3) sustainable. GE's portfolio of electrical solutions embraces and achieves each of those priorities.

Cleantech Magazine, www.cleantechinvestor.com, Mining and Energy Article, Sep/Oct 2010

Reliable, Efficient, and Continuous Operation

Deloitte, the international consulting and advisory giant, reported that three of the top 10 issues on the minds of global mining leaders in 2009 were the impact of electricity shortages on mining operations, commodity price volatility, and the squeeze play created when the miners' operating costs are higher and their raw materials prices are lower. When it revisited industry trends 18 months later, Deloitte found that the issues were largely unchanged.

Clearly, the mining industry wants to establish a consistently reliable operation that optimizes production. Mincom's 2010 annual survey of executives at the leading North American mining companies found that 67 percent of them are concerned about improving performance and operational effectiveness, and 56 percent are trying to ensure that their production data accurately reflects mine productivity and efficiency. A significant portion of the respondents (42 percent) are modeling ways to measure how their operations are improving and what opportunities exist to reduce costs.

Mining companies are looking at cutting costs by, among other things, using more efficient equipment to ease energy demand. That challenges mines to maintain a delicate balance which maximizes productivity and quality and minimizes energy consumption and environmental impact. To get the best of both of those worlds, mining operators need product suppliers to furnish them with the integrated process control systems that can make their plants more reliable and efficient. They also need tools that tell them why downtime is occurring at the time of the outage so it can be prevented.

Reliability and efficiency depend on solutions that let mines effectively gauge and control all aspects of their production—including how much energy they use. They demand technologies that accelerate and simplify access to information, alert operators to potential problems, give a real-time, big-picture view of the whole mining value chain in action, and reduce maintenance with extended equipment life cycles.

Continuity as a function of energy management requires secure, dependable distribution of power—and technology that stabilizes power supply by compensating for voltage fluctuations. Uninterruptible power systems (UPS) can guarantee that the most mission-critical processes function at all times. Redundant, bypass-equipped systems also are essential to continuity.

In a nutshell, the industry wants the most availability and production it can get for the lowest cost and amount of energy—and solutions providers who can help make that happen.

Deloitte, Tracking the Trends 2009, The Top Global Mining Issues, 2008
Mincom Annual Study, Mining Executive Insights North America, 2010

Safety and Protection

Mining is a physically hazardous business, and – since mining accidents hurt people, process continuity, production and the bottom line – it's not surprising that ensuring workplace safety is a major concern of 71 percent of the Mincom survey respondents. Workplace safety is operational safety, and that covers mechanical, physical, and electrical processes. Electricity is especially challenging, as it poses three major mining hazards to both personnel and equipment: shock, arc-flash, and arc-blast. By law, only people skilled in building and operating the equipment in a mine's major electrical installations and who have given safety training on electrical hazards can work in those installations.

Solutions to prevent arc-flash injuries, which can occur if arc temperature or radiant energy is excessive, include: equipment that can contain or properly vent arc-flash and blast pressure; current limiting reactors or fuses to restrict available short-circuit current; remote operating controls for circuit breakers that let operators open and close equipment at a safe working distance; and circuit breaker racking mechanisms that extend through safely closed cubicle doors. The arc-blast issues that have to be addressed are blast pressures and the impacts of fragmented, molten, and vaporized metal; the flash suits that will protect against arc-flash may not necessarily work against arc-blast.

Mincom Annual Study, Mining Executive Insights North America, 2010

Sustainability

Mining processes typically impact land, water, and energy utilization. That's why mining companies, like other good corporate citizens, have the desire and obligation to contribute to the greater public good by limiting the effects of their operations upon people and natural resources. One way the industry can do this is to cultivate renewable resource strategies that conserve— and preserve—the environment. As ever-more-stringent environmental regulations are enacted, this approach becomes increasingly attractive.

There is also a demand for solutions that don't compromise on production quality in order to meet environmental mandates – i.e., beneficiation processes (where extracted ore is separated into mineral and commercially-worthless gangue, or extraneous material) that hold down energy consumption and waste gas emissions.

The ultimate sustainability challenge for mine operators is how to control energy, emissions, and water use.

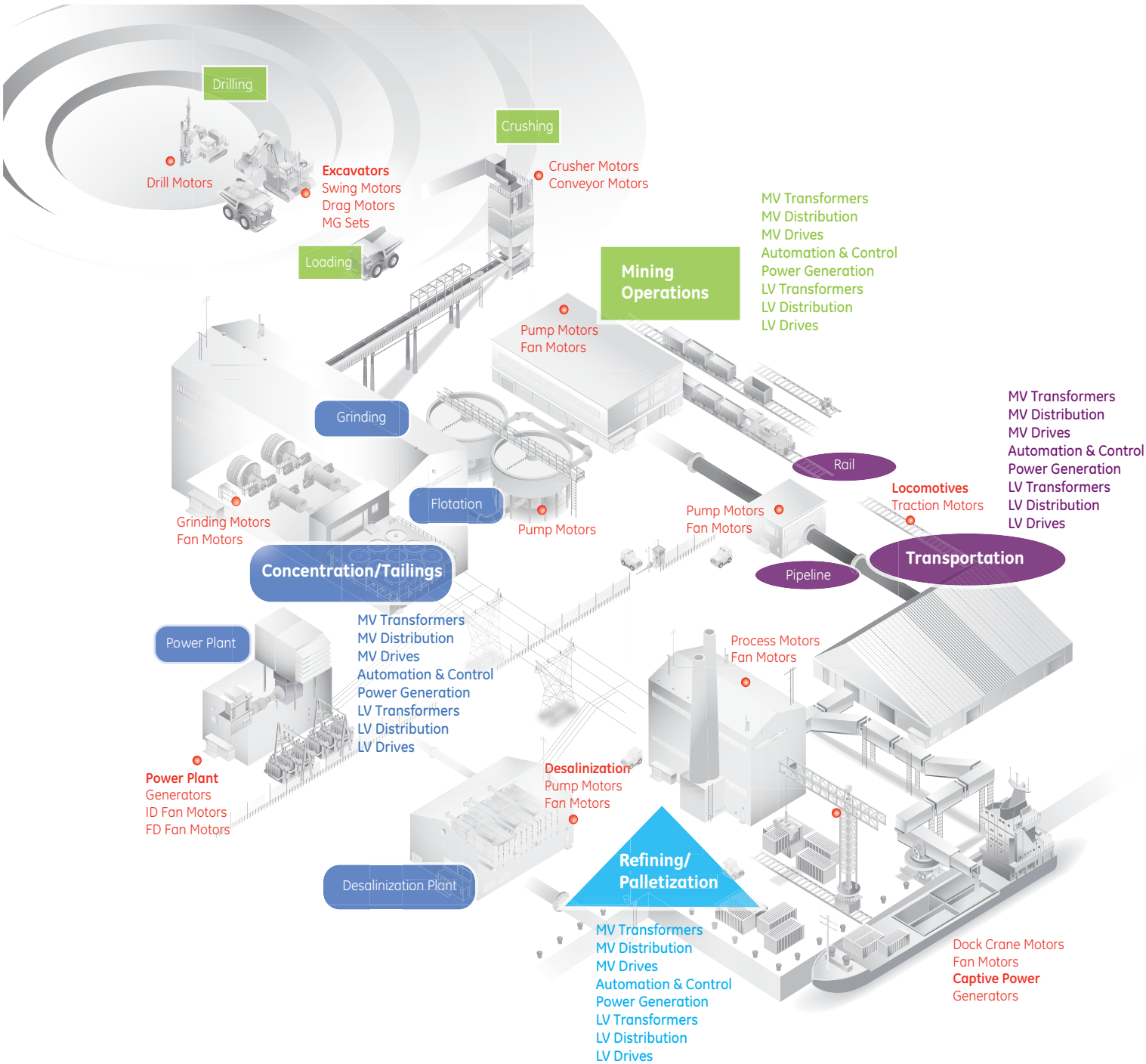
Our Electrical Solutions For Mining: An Overview

Reliability. Safety. Performance excellence. Those are the consistent hallmarks of the diverse portfolio of electrical solutions that GE has developed, installed, and maintained for the mining industry for more than eight decades. We are uniquely positioned to meet the process requirements of our customers with an immense foundation of expertise, including the longest-running installed base of rotating machines in the world and the largest installed base of power circuit breakers in North America.

Energy is essential to every aspect of mining, and mining companies look to GE for the innovative and proven technologies that help assure precise, dependable energy supply, distribution and control. Power that is delivered efficiently, cost-effectively, and sustainably is indispensable to effective mining operations; GE electrical distribution products deliver it**. Reliably. Safely.** When you need it.

Our comprehensive offerings have cross-functional applications throughout the mine site. Systems and equipment for power generation, automation and control, medium-voltage (MV) and low-voltage (LV) equipment, transformers, distribution equipment and drives work in all the key mining functions—operations, concentration and tailings, refining and pelletization, and transportation. Synchronous generators and more than a dozen types of motors also keep the mining infrastructure running along smoothly. However harsh the mining environment, no matter where it is in the world, GE's breadth and depth of experience in electrical distribution, digital energy, and motors gives our mining customers a production flow, **reliably and safely.**

GE Solutions Cross Mining Value Chain



GE Electrical Solutions Cross Mining Value Chain

Product Reference

Category	Products	Description	Challenge
Power Generation	Synchronous Generators	Generators - 3.3 kV to 13.8 kV - medium to large sized	Sustainability
	Generator Excitation System	Static and Brushless Excitation System for Voltage Regulation and PF Control	Sustainability
	Generator Synchronizing System	Synchronizing Systems	Sustainability
	e-House	Electrical Equipment and Auxiliary Devices	Reliable, efficient and continuous operation
MV System	Air Insulated Switchgear (Secogear)	Medium Voltage Distribution and Control	Reliable, efficient and continuous operation
	PowerVac	Medium Voltage Distribution and Control	Reliable, efficient and continuous operation
	Gas Insulated Switchgear (SecoCube)	Medium Voltage Distribution and Control, SF6 insulated	Reliable, efficient and continuous operation
	LimitAmp MV MCC /Contactor	Medium Voltage Motor Control Center, with fused contactor	Safety & protection
	MV/LV Dry Power Transformer	Medium Voltage Transformers	Reliable, efficient and continuous operation
	MV Variable Speed Drives (MV700 -Converteam)	Variable Speed Drives for MV Induction Motors	Sustainability
	MV Motors	Wound rotor, Induction and Synchronous Motors	Sustainability
	DC Motors	Large DC Motors for special applications	Sustainability
	DC Drives	Converters for DC Motors	Reliable, efficient and continuous operation
	Reactive Compensation	Equipment for power factor correction and harmonic filters	Reliable, efficient and continuous operation
LV System	LV Switchgear (SEN Plus)	Low Voltage Distribution and Control	Safety & protection
	MCC (SEN Plus)	Low Voltage Motor Control Center	Reliable, efficient and continuous operation
	Evolution 9000	Low Voltage Motor Control Center	Reliable, efficient and continuous operation
	IMM (Entellipro)	Intelligent Motor Management Relay	Reliable, efficient and continuous operation
	Sofstarters (ASTAT XT)	Softstarters for LV Induction Motors	Sustainability
	Busway (Spectra)	Busbar Trunking System	Reliable, efficient and continuous operation
	Variable Speed Drives (AF 600)	Variable Speed Drives for LV Induction Motors	Sustainability (ecomagination)
	LV Motors	Low Voltage Motors	Sustainability
	ACB (Entelliguard G)	Air Circuit Breakers	Reliable, efficient and continuous operation
	MCCB (Record Plus)	Molded Case Circuit Breaker	Reliable, efficient and continuous operation
	MCB	Mini Circuit Breaker	Reliable, efficient and continuous operation
	AKD 20	Low voltage switch gear	Reliable, efficient and continuous operation
	Entellisys	Low voltage switch gear	Reliable, efficient and continuous operation
	Arc Vault	Arc Flash protection system	Safety & protection
	Lighting Panels	Lighting Panels for non-hazardous or hazardous areas	Sustainability
	Automatic Transfer Switches	Automatic Transfer Switches	Reliable, efficient and continuous operation
	LV Drives	Low voltage variable speed drives, AFE Technology	Reliable, efficient and continuous operation
High Voltage	High Voltage	Power Transformers	Reliable, efficient and continuous operation

GE Electrical Solutions Cross Mining Value Chain

Product Reference

Category	Products	Description	Challenge
Automation & Control	Protection Relays (Multilin)	Micro processor based multifunction protection relays	Reliable, efficient and continuous operation
	UPS Power Quality	Uninterruptible Power System	Reliable, efficient and continuous operation
	PLCs	Programmable Logic Controllers	Reliable, efficient and continuous operation
	Power Management System	Software for real-time management, monitoring and control of electrical distribution networks	Sustainability
	Fiber Optic Multiplexers	Fiber Optic Multiplexers	Reliable, efficient and continuous operation
	Software Proficy	Manufacturing automation system	Reliable, efficient and continuous operation
	Ethernet Switches & Converters	Ethernet Switches & Converters	Reliable, efficient and continuous operation
Industrial Services	Power system studies	• Short circuit • Protective device coordination • Motor starting • Load flow • Harmonics • Conceptual design • Dynamic and transient stability • Update one line diagrams • Arc flash hazard	Reliable, efficient and continuous operation
	Field Engineering	• Additions & modernization • Repairs • Upgrades/Uprates • Add communications • Remote monitoring • Testing • Failure analysis • Replacement parts • Maintenance services	Reliable, efficient and continuous operation
	Field Services	• Installation • Comissioning • Startup • Planned & Unplanned Maintenance	Reliable, efficient and continuous operation
	Mechanical Services	Mechanical equipment services for refiners, blowers, crushers, compressors, gear boxes and centrifuges: • Inspections of rotors, shafts, bearings, hydraulic systems and housing • NDT • Weld repairs • Re-machining • Balancing • Upgrades • Complete machine rebuilds • Sleeving and boring of bearing fits • Re-machining shaft fits • Casing repairs, welding or metal-stitch • Shaft replacements • Impeller repair and lobe repair • High speed balance • ETC	Reliable, efficient and continuous operation
Project Management	Project Management	Project definition, planning, coordination, administration and controlling orchestrated to assure successful implementation	Reliable, efficient and continuous operation

How We Solve the Challenges

There are clear reasons why mining companies want their operations to become more efficient and available today. Commodity price volatility has created uncertainty, and governments are continuing their regulatory pressure for cleaner, more renewable energy generation and reduced energy demand. With these conditions in place, mining companies need solutions providers to develop more automated and innovative technologies that can improve operational efficiency—and help them cut costs.

For instance, to get a better view of inefficiencies in their production cycle, mine operators need integrated systems to consolidate and communicate the mountain of data that all of their processes generate.

One of the design parameters for new solutions is industry customization. Since mines have unique production environments, they can't always accommodate technology that works for other sectors, such as manufacturing. As a result, efficiency-based research and development efforts must focus on technologies that are mining-specific.

It is energy, however, that presents miners with the greatest efficiency challenge—and the greatest opportunity to reduce overall operations costs.

Efficiency and reliability are more than concepts; they can be measured and quantified. Unplanned downtime costs $100,000 an hour, on average, and a safety incident is 28 percent more likely if maintenance is after-the-fact, rather than planned.

The kind of predictive maintenance and remote monitoring and diagnostics that GE applies to our electrical distribution and control equipment and systems lowers maintenance costs while increasing productivity. It lessens the odds of an unscheduled outage and lets you plan downtime when it has a minimal effect on productivity. Equipment life expectancy grows, while the operating expense per production unit, the need for spares, and the risk of catastrophic equipment failure all decline. The upshot is that operating efficiency improves by 10 to 15 percent.*

*Results my vary depending on customer operation.

Solutions For Reliable Mining Operations

SecoGear™ air-insulated, metal clad switchgears assure control and protection for power plant and substation transformers, capacitors, and motors with a compact design that is the world leader in vacuum technology. The unit is arc-proof, with an easy-to-operate, low-maintenance front panel and a reliable interlocking system that reduces accident risk by preventing several malfunctions related to the circuit breaker.

Reliability and safety are engineered into the complete SecoGear unit.

All components have been carefully selected and qualified during a 40-year lifetime accelerated thermal durability test, and because they require little maintenance, they save on operational and capital costs, keep downtime to a minimum, and stretch out the switchgear life cycle. The compartments are self-contained and separate from one another, so an arc-fault can't spread between them, and there's less chance of any one compartment damaging the equipment within another.

The safety design includes pressure relief flaps, so if an arc-fault happens inside a compartment, the flaps automatically open and route the pressurized gas to the rear side. That protects both equipment and personnel. SecoGear's grounded metal enclosure protects operators from live and moving parts within the switchgear, and since the enclosure is sealed, external objects that could short circuit the system cannot penetrate. An automatic shutter system keeps operators from opening the shutter by mistake and exposing themselves to injury during maintenance.

Rated voltage is 12 kV to 40.5 kV, while rated current is between 630 A and 4,000 A.

Evolution Series E9000® motor control centers provide safe and flexible configurations for protecting and controlling motors in a wide variety of applications, from very complex auxiliary drive systems to very basic fan and pump motors. Now, the E9000 features the first 600 A plug-in units and the first snap-in low-voltage vertical barriers.

With the simpler, more flexible design that original equipment manufacturers (OEMs) had requested over previous iterations, the E9000 has 20 percent more density, so customers can add more buckets and feeders in a single section; 30 percent more wire space; and 60 percent fewer parts, for easier installation. It can handle the high workload necessary to run critical round-the-clock operations. Besides being simpler, the E9000 has a smaller footprint, too, so it needs less electrical room space—a big consideration in the tight confines of underground mines.

Several key parts create significant advantages for you. The Minimum 65 KAIC Bus Bracing Standard lets customers expand the motor control center to meet new system requirements, such as increased power demand. Its IBC-2006 Seismic Standard equips the motor control center to operate reliably in earthquake zones.

A large selection of plug-in feeder circuit breakers make it possible to move buckets quickly. Drives that are rated to 100 KAIC save on space and costs. Multilin Motor Management Relays afford process application versatility for different levels of diagnostics and control along with remote monitoring of critical applications.

The **PQM II,** designed to advanced industry specifications, is an accurate, reliable, and compact three-phase power meter with an optional Ethernet and fiber communications module. It is suitable for a variety of continuous metering applications, including distribution feeders, transformers, motors, and generators. This is a robust tool that meters current, voltage, real and reactive power, energy use, power cost, power factor and frequency.

Because it can be connected to a DCS or SCADA system, a PQM II meter can integrate the process, instrumentation and electrical requirements of a plant automation infrastructure. Ultimately, PQM II can be integrated into a total plant-wide system for overall process monitoring and control. Continuous monitoring immediately spots problems created by faults or changes, so it minimizes process downtime. Any of the assignable outputs can trigger the dispatch of specific alarm messages about application-specific conditions.

The **EntelliPro** Intelligent Motor Management (IMM) system for motor protection and control has benefits-laden features during all life cycle stages.

The system is engineered for fast initialization and low risk, is easily adapted to special requirements, adjusts to customer needs, and has fully free programmable logic. There's also a demonstration kit available to pre-test the SCADA system and drive application settings.

At commissioning, the system is I/O configurable, and trouble shooting of fully flexible logic is easy.

During the operations phase, all information is available at switchgear level through a touch control panel, and it's possible to achieve redundant communication with two independent field bus interfaces. Advanced trouble-shooting capability lets you log analog values and events in a field log.

Maintenance is easy, with simple, plug-and-play spare parts, a service plug in each switchgear section and full EPOS system compatibility.

Power transformers used within the primary substation, as well as secondary substation transformers used within the plant, provide reliable and continuous operation for mining applications within harsh, challenging environments.

Transformer coatings, including paintings, are specially designed to withstand the effects of high humidity content, ultraviolet radiation, and chemical pollution or saline fog. Designs have been adapted for strip mines located at high elevations of up to 4,500 meters over mean sea level, and for uneven surfaces so that bushings remain immersed in oil on a tilted area. In seismic regions, our Seismic Certified Transformers (IBC) will operate successfully in the event of an earthquake.

For more than a century, GE has furnished the mining industry with comprehensive **services** support for drive, control and power delivery systems; field engineering; motor, generator and mechanical repair; and equipment parts. We have the expertise to maximize the life and performance of your critical equipment assets and a broad network of service hubs to provide support when and where you need it.

Having the right parts in place and in sync is imperative for the efficient and continuous performance of your mining equipment. GE makes this the norm with a full suite of parts services that runs the gamut, from testing and certification, to repair and return, to exchange and new parts. And we have all the parts you need, with a standing drives and control systems inventory of 75,000 component parts units and $20 million worth of new factory parts.

The **Proficy Software** suite of time-tested, commercial-off-the-shelf software solutions offers multi-faceted, versatile process control systems to improve plant efficiency and productivity and integrate flawlessly with your existing infrastructure while providing value-added enhancements.

With improved interoperability and composite systems that leverage a cross-system, real-time data and services bus and repository, this software gives users the power to consolidate and simplify systems, lower operating costs, respond nimbly to changing conditions and simplify training.

The Proficy architecture's modularity and expandability can handle one or many machines and grows at your own pace to meet your evolving process control needs. The software coordinates all enterprise data and traces the convoluted histories of batches, continuous processes, sub-assemblies, components or byproducts. This provides a clear view of the origin and destination of the raw materials that enter the plant and the finished goods that leave it – and also boosts quality, productivity, and control.

Besides Proficy Software, we can offer Proficy Process System, which combines the best of DCS and PLC process control through PACSYSTEMS, PAC8000 and 8000 Process I/O. Proficy Process Systems is our advanced, scalable, fully integrated system that leverages the latest hardware and software technologies for complete process automation and control. Based on contemporary, yet well-proven technologies, Proficy Process System combines the power of traditional DCS systems with the flexibility, freedom, and affordability of a PLC-based approach.

Ensuring Workplace Safety

Mining operations depend on power that is delivered safely, as well as efficiently and reliably. They require solutions to lessen the risk of electric shock and arc-flash and arc-blast incidents for personnel operating or working near live electrical equipment.

While the odds of an arc-flash event are low—there are eight such accidents daily across all industries—the costs, in human and dollar terms are high: Those events cause one to two deaths every day, cost an average of $16 million each, and inflict burns, temporary blindness, hearing loss, concussions and/or shrapnel wounds on injured survivors.

An arc-flash hazard analysis, including a calculation of how much incident energy the hazard can generate and a labeling system that tells personnel the proper protective equipment to wear, can make workers safer and lessen the risk of an incident. That analysis is one of several studies that can drive safety by identifying reasons why outages or failures could happen, reviewing the impact and ratings of new add-on equipment, and ensuring cost-effective, stable, and efficient power-system operation.

Several solutions from GE can limit exposure to arc-flash and arc-blast. Incident energy can be minimized with sensitive protective settings and fast interruption and fault diversion mechanisms. Advanced diagnostics can prevent events from happening. Arc-resistant equipment and barriers can protect personnel. Operating and diagnostic software can operate equipment remotely.

Safety and Protection Solutions

The **Limitamp®** AR arc-resistant MV motor control meets the IEEEC37.20.7 standard and provides Type 2B protection for personnel during an arc-flash, so less personal protective equipment (PPE) is required. The Limitamp control's heavy-duty design contains and redirects arc-flash gases and energy through advanced vent flaps at the top of the enclosure. A multiple interlocking mechanical and electrical system safeguards personnel from energy released in an arc-flash incident, so no energized device is exposed.

The low voltage box that holds the meter, relays, lights, and switches is sealed to protect it from exhaust gases and other materials. A visual disconnect safety feature is accessible through a window in the outer high voltage door. ANSI NEMA compliant.

The **SEN Plus** LV distribution and control switchgear offers unprecedented user safety while meeting the demand for a broad current range from a few kW for motor control up to 6,300 A. The SEN Plus switchgear can be safely modified under energized conditions, and its design and epoxy powder coating make it shock-resistant. Its degree of protection is IP30 p to IP54.

The pairing of SEN Plus with the EntelliGuard™ air circuit breaker establishes excellent personnel and system protection. Independent testing has verified that functional areas of the unit are compartmentalized to limit internal arc-faults to their point of origin. The system's 100 kA withstand rating equips it to handle large faults.

A special mechanism allows the operator to fully operate the module with the door closed, for maximum safety. Short-circuit, certified, self-aligning stabs provide a high level of operational safety. IEC compliant.

EntelliGuard™ products, GE's newest line of LV circuit breakers, has advanced trip units that deliver superior circuit protection and protect personnel against high-energy arc-flash incidents while preserving system reliability. Entelliguard's waveform recognition (WFR) sensing technology uses an algorithm that can consider a combination of peak current and time to determine if the fault current exhibits the characteristic wave shape of a current and energy-limiting, fault-current interruption. Due to its ability to detect that the waveform is truly energy limiting, it can be set more sensitively (at a lower pickup) than one that only considers peak current.

The EntelliGuard product line stands out by lowering the risk of worker exposure to the dangerously high heat and energy levels, concussive power and equipment explosion debris that accompany an arc-flash incident while maintaining electrical power to mission-critical loads. For a wide range of situations, there is no falloff in the selectivity needed to coordinate the sequence of operations and interlocking required for the highest possible power system availability. EntelliGuard circuit breakers have a Reduced Energy Let-Through (RELT) setting that—when enabled—temporarily lowers the instantaneous pickup setting of the breaker so it can trip faster. Thus, less energy is released during an arc-flash incident.

Safety and Protection Solutions

Entellisys™ LV switchgear is more than just basic over current and relay protection. It has no peer in providing efficient, advanced multiple-source ground-fault protection, zone-based protection and settings that can be changed according to the power sources that are active at any given time. This integrated system delivers power distribution protection, control, monitoring and diagnostics through synchronized, simultaneously-processed, real-time information from each circuit breaker.

Features that create comprehensive, arc-flash energy safety include near-gear and remote user interface options outside the arc energy zone; RELT settings that let minimum time-delay settings operate at the main bus on command; and a remote racking device for breakers that keeps users away from the arc energy. The advanced zone-base protection achieves ground fault interruption in systems with multiple solidly ground sources, as well as selective protection without the need for cascaded time delays. This increases mining operation uptime.

Bus differential protection quickly detects lower magnitude faults that could be missed by the main breaker settings. Zone-selective interlocking provides fast selective protection, depending on fault location, not fault magnitude. The multi-source ground fault capability can identify a fault within a zone and trip all source breakers simultaneously. All of these options minimize arc-flash risk and equipment damage and can be programmed into the CPU in the field with minimal effort or equipment modification. You get a powerful combination of attributes: system-wide visibility with advanced display of all data and activity—including metering, historic trends, and waveform capture—for easy troubleshooting and fail detection; and increased safety from the ability to segregate all control and monitoring away from the arc-flash boundary.

In just eight milliseconds, the **Arc Vault™** arc-flash protection system can stop an arcing fault. By halting the fault in its tracks so quickly—at a fraction of the time needed by traditional containment technology—the Arc Vault system saps much of the energy released by the flash. That makes serious injury much less likely; minimizes stress on transformers, circuit breakers and other equipment; and drastically limits downtime, often to just one working day.

Unlike typical arc-resistant switchgear, the Arc Vault system doesn't manage the outsized energy of the arc-fault, it extinguishes it. Unlike other options, it can reduce work-related injuries even when panel doors are left open during routine maintenance, and it can be retrofitted on most low-voltage applications. Compared to a bolted fault that would happen with a crow bar system, Arc Vault cuts the energy released from a fault by 63 percent or more, to less than 1.2 cal/cm^2.

Since the incident energy is limited so greatly and dissipated so quickly, the exhaust chimneys and plenums you would need to install and the bulky PPE your maintenance workers would have to wear in anticipation of an explosion are unnecessary. The contained and abruptly snuffed arc-fault never gets to the point of a destructive blast.

Sustainability

Like other industries, mining is challenged to become more sustainable while decreasing energy consumption and greenhouse gas (GHG) emissions. Much of the impetus for this is coming from the marketplace: Companies in the Dow Jones Sustainability Index outperform the general stock market, and 70 percent of customers are likely to increase their business with companies that demonstrate good corporate citizenship. Academia reflects that emerging reality as well: 54 percent of business schools require courses on sustainability.

GE's ecomagination initiative helps customers innovate with solutions that make their businesses significantly more sustainable—and more efficient and profitable. In 2010, we doubled our investment in cleaner technology and renewable energy research and development to $1.8 billion, and we intend to grow that investment to $10 billion by 2015. Since we launched the initiative in 2005, 110 GE products and solutions have been ecomagination qualified.

How can ecomagination impact mining? Consider a customer's experience with the AF-600 variable speed drives that are used in mining operations. The customer's installation of just 10 of those drives cut annual kWh consumption by 78 percent, produced $30,472 in annual energy savings, and eliminated 17 million metric tons of CO emissions per year. The project also paid for itself within nine months.

Solutions That Drive Sustainability

Our **motors** drive equipment at every part of the mining site. In mine drilling, motors are used in pumps and fans for ventilation, hydraulics, and fluid cooling. We are the world design and manufacturing leader of electrical drive systems for the draglines and shovels needed for surface mining and have motors powering vehicles that move soil, ore, coal, tools, equipment, and personnel. A full range of our vertical and horizontal motors handle primary, tertiary and secondary crushing operations, as well as synchronous and asynchronous motors for fixed and variable-speed processes in grinding applications. At the point where electrolytic and chemical processes separate the metal from the ore, high-efficiency motors are involved in transporting materials; pumping, reducing, and purifying chemicals; rotating mixing machinery and driving sorting systems. Traction and crane motors support the heavy-duty, heavy-load lifting and transport operations at the end of the cycle.

Series 9000 large synchronous motors and generators up to 100,000 horsepower (HP) have several key advantages: best-in-class efficiency for lower operating costs; low starting current for better starting capability; the leading power factor that reduces utility penalties associated with lagging power factor; and reduced current pulsations for non-steady-state loads, which improve electrical-system stability.

Our solutions are aligned with customer needs. The 4- and 6-pole rotor design has the strength and stiffness for maximum reliability. With a 30-year record of operational performance excellence, **Quadramatic™** load-sharing motors have unmatched efficiency for fixed-speed grinding mill applications and have the only technology that provides leading volt-amperes reactive (VARs) without needing additional equipment. That can make the generating plant and the energy purchase smaller. The **Rotector II™** solution continuously monitors and protects large machines from potentially catastrophic failures with real-time readings and direct measurements that optimize performance. A low-maintenance, sturdy product that is well-suited for hazardous environments, the **Brushless Excitation System's** solid-state components can endure high mechanical and electrical stresses in the most challenging applications. Meanwhile, the **Collector Ring Excitation System,** with its grooved surface rings for effective cooling and proper current sharing among brushes, is reliably used in high-performance, variable-speed motor applications that may require a very fast response.

**X$D Ultra®** extra-severe-duty motors are made of rugged, corrosion-resistant hardware with grease fittings and plugs that provide re-lubrication access to extend bearing life. A product of ecomagination, the X$D Ultra has low vibration, is economical to maintain, uses minimal electricity, and reduces annual CO emissions.

Two new **Pegasus™MHV** (medium and high voltage) induction motor lines serve the mining industry. The MHV Horizontal has more horsepower per frame and improved efficiency and power factor over previous MHV induction designs, even though the overall weight of the motor is less. The high-reliability, low-maintenance MHV Wound Rotor also is more efficient than earlier offerings because it has an optimized electromagnetic design and a new ventilation/cooling system. A third line of induction and synchronous motors, the **Custom 8000** offering, has three sets of products that are pertinent to mining. Squirrel cage induction motors to drive pumps, fans, and compressors have inherently simple motor construction and control with lower initial cost—especially in smaller ratings—and adaptability to the toughest environments. Wound rotor induction motors are applicable for hard-to-start, high-inertia fans, and where power system requirements call for a soft start and a limited-range adjustable speed. Higher-efficiency synchronous motors, which can provide a system power factor improvement, have an advantage in high-voltage, high-power applications. The new **Quantum™LMV** line of MV totally enclosed, fan-cooled (TEFC) induction motors has innovative D-duct heat transfer technology that allows for the maximum airflow, resulting in more motor output per frame. The Quantum LMV offering has an improved efficiency and power factor, a more compact design, and is suitable for pumps, blowers, compressors, and conveyors.

The **MV7000's** innovative large-drive technology offers performance efficiency above 99 percent and reliability with fuseless protection and press-pack insulated gate bipolar transistor (IGBT) power semi-conductors (PPI). The front-access MV7000 variable-speed drives are compact and modular, and they have low operating costs. They also have a low component count, requiring only 12 PPIs per drive up to 8.4 MW, compared to other drives that require 18 to 36 power switches.

These drives can feed induction and synchronous machines with high-performance vector control, in all speed ranges from marine low-speed propulsion drives to high-speed compressor drives without a gearbox. Since the advanced power electronic controller (PEC) for each drive is an adaptable Versa Module Europa (VME) bus controller that uses the most advanced processor technologies, it can cover a wide range of drive applications and configuration options.

The **ASTAT® XT** soft starter delivers reliability and smooth acceleration to standard AC motors ranging from 8 A to 1,400 A and from 230 V to 690 V. Since it controls acceleration and deceleration from full speed, the ASTAT XT offering does a better job of reducing wear and tear on motors than typical line starting methods. That's especially true for pumps, fans, compressors, and conveyors.

The energy-efficient soft starter has powerful features to handle demanding applications. Motor protection is IEC Class 10 or 20 and NEMA Class 10, 20, and 30 overload. Extra power terminals come standard, so it's easy to install an external bypass contactor. Pump control avoids overpressure when acceleration ends and suppresses hammering at the stopping phase.

AF600

As the example cited earlier in this brochure demonstrated, these ecomagination-qualified variable speed drives significantly reduce energy consumption and have a very quick return on investment. Ranging in size from 1/3 to 1,350 HP, and with the wide voltage ratings to meet your application needs, the AF 6 series drives improve performance, simplify installation, are space-efficient, and make costly add-ons unnecessary. Their energy-monitoring features track and measure the amount of power that each drive uses.

The AF-60 LP and AF-650 GP drives within the series are ideally suited for low-power and general-purpose constant-torque applications.

A-Series Lighting Control Panels

These panels, which can stand alone or be networked into a building automation system, reduce energy costs by providing programmable control of the breaker, so you can manage lighting usage during non-peak hours by switching lights on and off remotely. The optional remote-operated circuit breaker software allows users to program the panels with a PC-based application that makes it easy to establish lighting zones and on/off schedules, and compile data on burn hours.

Integrating the controller into the panel reduces installation costs, saves time, and creates a smaller footprint than traditional external relay panels. The units come fully pre-wired to customer specifications, and they can be expanded or contracted to fit your needs.

PMCS

This energy management system from GE's Multilin product line lets you track the energy use and power quality of your facility's electrical network on a real-time and an historical basis by the day, hour, and minute. PMCS is a fully integrated solution, complete with site evaluation and consultation, overall project management, thorough device integration, communications setup and testing, site-specific graphical interfaces, and hands-on training. It will cut your energy costs by optimizing process and equipment control methods, so energy use is more economical and efficient.

As a customized solution, the PMCS offering can be as simple as a remote monitoring system or as comprehensive as a completely engineered automated control system—or anything in between. You can combine any or all of four functional models—monitoring, power quality, cost allocation, and control and automation. Integrated with HMI client software, this solution shows graphical representations of substation equipment status, energy trends, remote control of devices, and automated responses to system conditions.

Implementing the PMCS energy management system gives you the big picture of your energy flow continually, and the ultimate benefits of that are substantial: less downtime, better predictive and faster corrective maintenance, more safety, higher productivity, a smaller power bill, and protection of critical production equipment and other loads from identified sources of "dirty" power.

Project-Specific Support Capabilities

GE can support your specific mining project needs globally and locally with a projects team that combines domain expertise with application/technical, commercial, project management and site services resources. These broad capabilities provide our mining clients and their EPC (Engineering, Procurement and Construction) contractors with wing-to-wing engagement and support early on in the project; the team assists with the pre-FEED/design stage, models various solutions, develops value-engineered alternates and transfers the expertise from these activities onto the execution phase, which concludes with site sustaining services for greenfield and brownfield applications.

The list below contains a select number of mining projects that our projects team has executed successfully on a global basis. For more details on these specific projects or the capabilities applied to them, please contact your GE Industrial Solutions lead.

GE's Role in Key Mining Projects

Location	Mineral	Application	Scope
Dominican Republic	Gold/Copper	Refining	Electrical distribution, motors, drives, power management, site installation services
Canada	Potash	Excavation	Hoist motors, drives, transformers, electrical distribution, automation
Brazil	Copper	Excavation	Conveyer motors, drives, automation
Canada	Molybdenum	Concentration	Ball & SAG mill motors and drives, project management, site services
Australia	Coal	Excavation	Dragline rebuild engineering, motors, drives & site services
USA	Rare Earth	Excavation	HV substation transformers, e-houses, electrical distribution, site services
Chile	Copper	Excavation	Grinding circuit motors/ drives package, electrical distribution, site services
South Africa	Gold	Excavation	Hoist motors, drives and automation

About GE Industrial Solutions

Leading the future of electrification around the globe, GE Energy's Industrial Solutions business forges strong relationships with customers, identifies and solves challenges and invests in innovative technologies that help create a cleaner, smarter and more efficient electrical infrastructure. Operating in more than 60 countries, GE's dedicated teams from electrical distribution, industrial services and power electronics manufacture and service products for residential, commercial and industrial applications.

About GE

GE (NYSE: GE) works on things that matter. The best people and the best technologies taking on the toughest challenges. Finding solutions in energy, health and home, transportation and finance. Building, powering, moving and curing the world. Not just imagining. Doing. GE works. For more information, visit the company's website at **www.ge.com.**

GE Energy works connecting people and ideas everywhere to create advanced technologies for powering a cleaner, more productive world. With more than 100,000 employees in over 100 countries, our diverse portfolio of product and service solutions and deep industry expertise help our customers solve their challenges locally. We serve the energy sector with technologies in such areas as natural gas, oil, coal and nuclear energy; wind, solar, biogas and water processing; energy management; and grid modernization. We also offer integrated solutions to serve energy- and water-intensive industries such as mining, metals, marine, petrochemical, food & beverage and unconventional fuels.

Follow GE Energy on Twitter **@GE_Energy.**

GE Energy
41 Woodford Avenue
Plainville, CT 06062
http://www.geindustrial.com/mining

GEA19658 (02/2012)