PRODUCTION ENERGY OPTIMIZATION IN MINING

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ABSTRACT

In these times of increasing costs and diminished returns, energy consumption is one source of savings that remains relatively untapped in the mining sector. Typically, 15% to 40% of operational costs can be attributed to energy in mining operations. This “process variable” is a complex, multi-faceted variable that involves government regulations, societal pressures, cost and competitiveness. A mining company able to successfully embrace an energy efficiency program is more often than not a successful mining company.

Production optimization programs, relatively common today, provide increased production, increased availability of assets and, in many cases, improved quality. They generally ignore the energy question altogether.

Production Energy Optimization combines reductions in energy consumption with production improvements to reduce the cost per unit of production while improving emissions reporting.

An energy strategy in mining and mineral processing operations is a critical component of Production Energy Optimization. This strategy must support the financial and operational integrity of the business. Developing a successful energy strategy requires a well structured approach such as following:

- Understanding where energy is being used and why,
- Recommending and implementing energy conservation measures,
- Driving visibility to targets and results,
- Re-evaluating continuously.

The objective of this paper is to help you better understand the process, tools and technologies that enable mining organizations today to address energy and sustainability issues more tactically and proactively.

KEYWORDS

Energy, Optimization, Efficiency, Mining, Production

THE SCOPE OF AN ENERGY EFFICIENCY PROGRAM

Before implementing a program to target and execute opportunities for energy efficiency, it is important to understand the company's current energy efficiency environment through self assessment.

What is an energy efficiency company strategy?

A corporate energy efficiency strategy typically evolves over time (Fig. 1), it matures. In its infancy the strategy is rather rudimentary – measuring and analyzing energy consumption while increasing staff awareness of energy issues. This may include workshops or audits which could identify potential energy efficiency opportunities (EEOs).

The strategy will then begin to embrace technology and become "system enabled" where automation can provide active energy management. This may even include programs to optimize the energy procurement process.

Often, an Energy Management System (EMS) is used to extract energy data automatically from various sources such as Enterprise Resource Planning (ERP) systems, data servers or historians, etc. The EMS will convert this data into information, information which will facilitate energy consumption analysis.

And finally, a fully mature strategy will embark on continuous improvement plans throughout the operations and corporate organization. At this point energy data is monitored over time, best practices are identified then adopted and continuous improvement programs become commonplace. The energy efficiency team is working side-by-side with mine managers and engineers to prioritize a list of energy efficiency projects and execute these projects in a timely fashion.

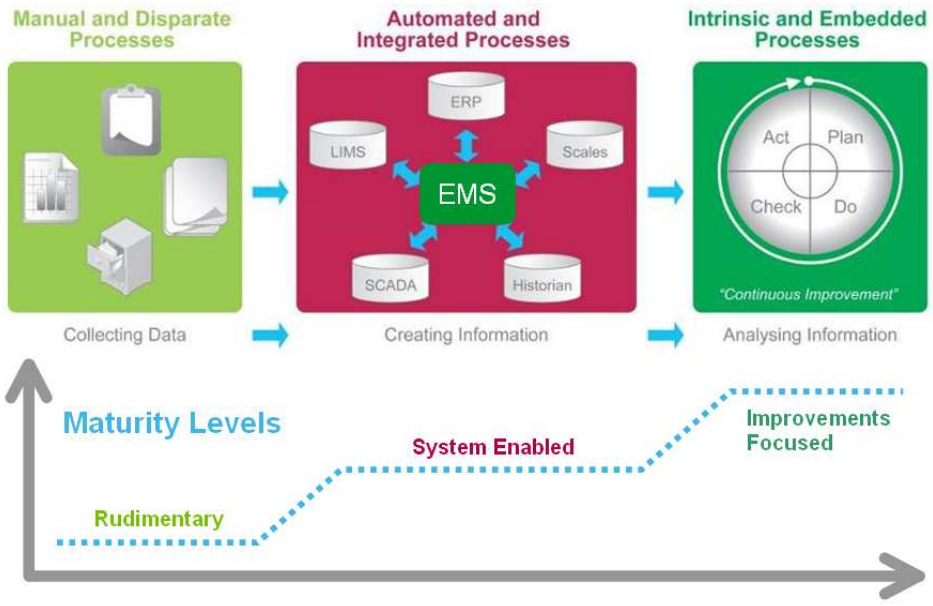

Figure 1: Evolution of Energy Strategies over Time

How is energy information collected from the field?

An energy efficiency approach requires continuous measurement with an appropriate degree of granularity - precise information about where energy is consumed - from main feeders to main loads. This is obtained with power and energy measurements, power quality analysis, and often measurement of water, air, gas or steam (Fig. 2). In most cases the data from these measurements are stored in a data server or historian.

Figure 2: Smart meters and relays: Intelligent protection relays, power meter, flow meter,

How is energy purchased?

An important concept is to understand how energy is purchased by the company. This is done through bill verification, rate structure analysis, energy risk management and/or demand response. Mining and mineral processing companies often struggle with the prediction of energy use, and are sometimes penalized for under or over forecasting. It is the lack of timely information that makes this prediction difficult.

Energy rate structure analysis and optimization has proven in numerous cases to be an important source of savings. In some cases it has allowed the company to avoid costly capacity increases through scheduling and “smart consumption”.

Reducing Emissions and Reporting Carbon Footprint

With today's emphasis on carbon, mining organizations can become overwhelmed juggling carbon management projects. There's an endless list of options including buying carbon offsets, selling emission credits, hedging carbon-market risk, reporting on greenhouse gas emissions and spearheading various carbon-reduction projects.

Carbon footprint calculation and reporting is only one piece of the sustainability puzzle, but it is one that companies struggle with implementing successfully. Building an accurate carbon footprint requires a wide array of data, typically pulled from various sites and requiring coordination across several internal departments.

In fact, most sustainability teams significantly underestimate the time and effort required to gather this data. Summit Energy Services has indicated that energy use typically constitutes over 90% of an organization’s greenhouse gas emissions; therefore, to calculate a carbon footprint, it is necessary to have access to energy usage data. Beyond energy, the carbon footprint may include: Water, Steam, Refrigerants, Kerosene, Tires, Crude Oil, Waste Water, Waste Oil, etc…

Renewable Energy Sources

The introduction of renewable energy sources is also playing a role in reducing energy costs for mining operations. The Australian government believes, as stated in their 2011 report *Securing a Clean Energy Future*, the mining sector will invest close to $10 billion by 2016 in developing these alternative sources of energy. Integrating these sources as part of an overall energy program requires careful analysis and forecasting. Local incentives are more often than not a major factor in the decision to adopt renewable energy sources.

Effective Management of Energy Projects

Operations teams play a major role in mature strategies for energy reduction. Operations teams are challenged to achieve target recoveries at the lowest energy consumption. Prioritize the best projects, action plans, and identify no cost / low cost opportunities.

Monitoring improvements over time is critical to success. Both equipment improvements and system improvements will combine over time to achieve the target energy/production performance (Fig. 3). The so-called “low hanging fruit” will generate significant early gains but ultimate success will be through a continuous improvement program that management supports.

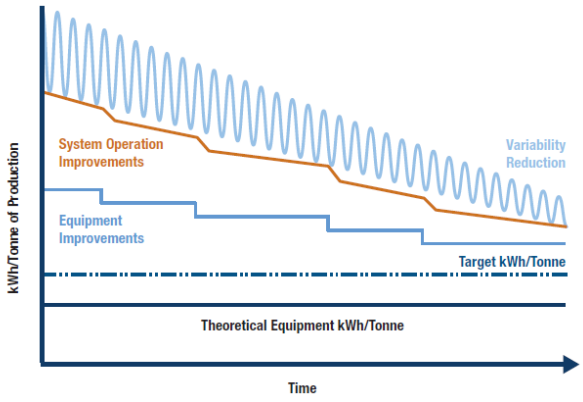

Figure 3: Energy efficiency gains over time

THE FOUR STEP APPROACH

After understanding the company's overall energy efficiency status, it is recommended to follow a four step approach for continuous improvement. This method is a common sense, iterative process which can be adapted to all organizations whether in their energy efficiency infancy or already quite mature.

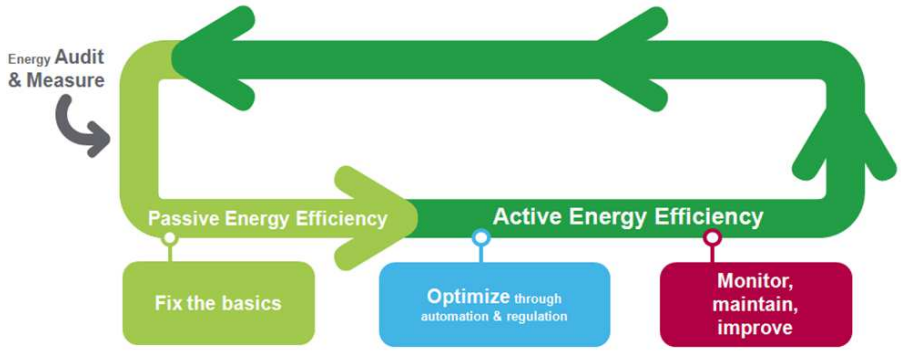

Figure 4: The four step Energy Efficiency Method adopted by Schneider Electric

Step 1: Audit & Measure

The first step of the approach involves completing an energy analysis, identifying the major points of measurement, collecting energy information and determining the energy drivers. This measurement can be manually performed, but the installation of metering systems is recommended for the most critical loads.

Before starting an improvement program, measurement and benchmarking helps to determine where and to what degree energy is wasted. It also provides a baseline for future comparison. Measurement during the monitoring stage helps identify deviations that need to be corrected in order to sustain the savings.

In addition to metering systems, modern motor protection relays and advanced circuit breakers are also able to deliver energy information, allowing more load granularity to obtain energy consumption data.

Multi-site mining operations using centralized energy monitoring (Figures 5 and 6). The benefits provided and results which could be obtained are:

- Real time energy consumption data by plant and by area
- Confirmation of correct utility billing
- Optimized energy procurement

Step 2: Fix the basics

The initial results typically reveal areas that can be addressed and remedied without external help. Often, basic house-keeping improvements to process can reduce waste and trim utilization to meet basic energy efficiency targets.

High-efficiency motors, power factor correction, lighting, and compressed air leaks are common starting places that can benefit from the introduction of passive devices which consume less energy "by design".

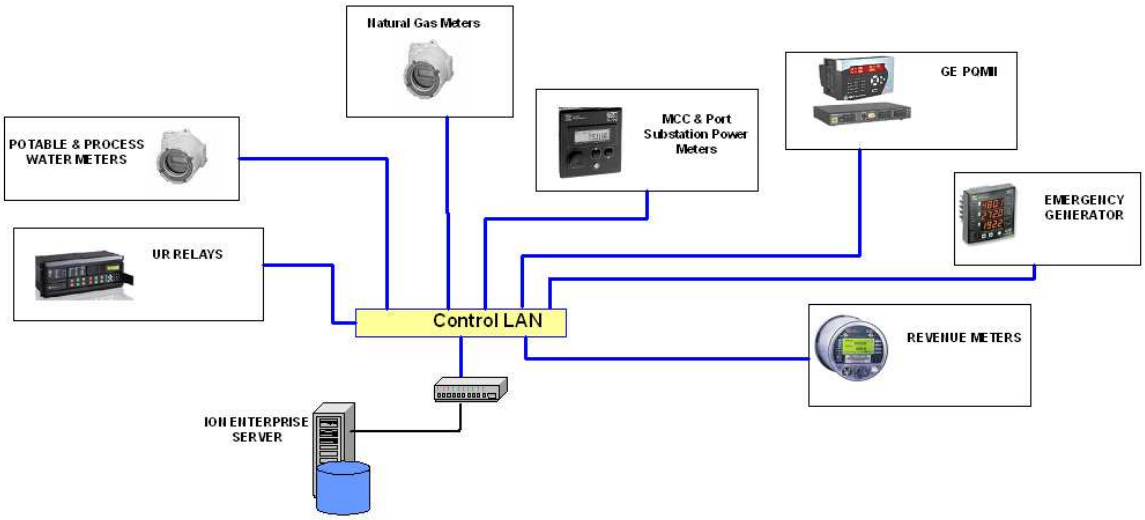

Figure 5: Site-wide energy tracking for an Ontario mining company (Schneider Electric)

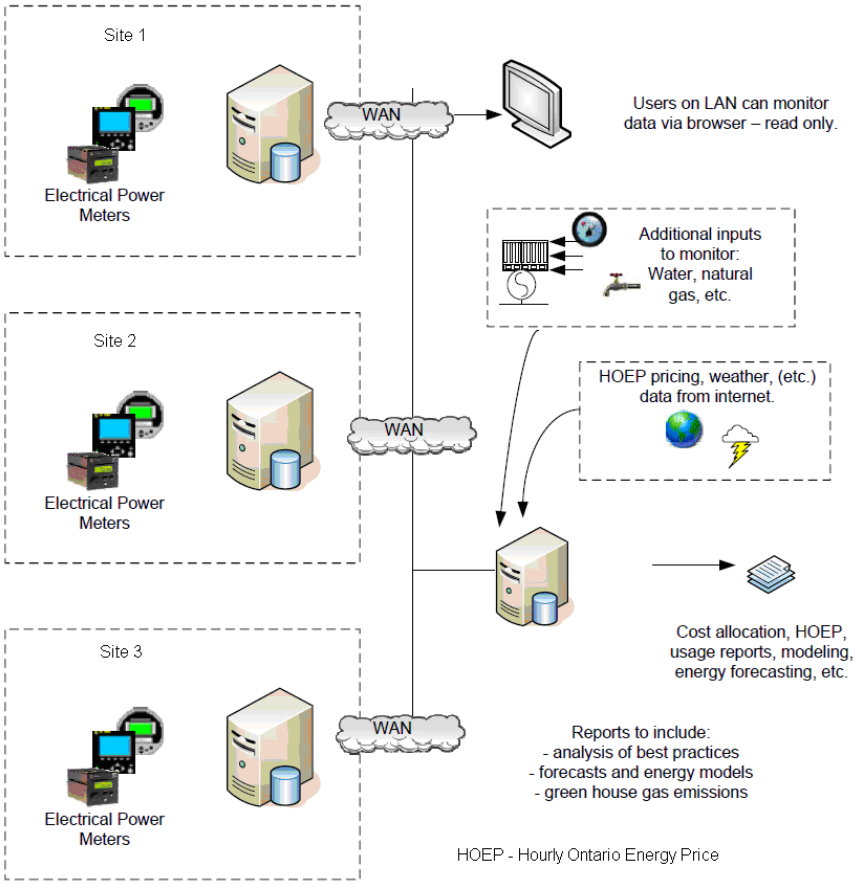

Figure 6: Real-time, multi-site energy tracking for an Ontario mining company (Schneider Electric)

Step 3: Automate and Optimize

This step implies the use of active elements, which control processes to achieve energy efficiency, such as automation systems to regulate energy usage. Mining operations requiring ventilation, pumping and heating/cooling are always candidates for automated optimization.

Automated ventilation of underground mines has proven to be a source of savings while improving air quality and quantity where needed. Closely linked to ventilation is the heating and/or cooling of air.

Some mineral operations can't be optimized using conventional control solutions. These processes are too complex and have multivariable characteristics that require a different approach besides conventional control strategies. For example, grinding circuits are a primary focus point for energy savings but require very specialized studies and systems.

Advanced process control (APC) & optimization techniques using neural networks, fuzzy logic and expert systems are strong allies for energy efficiency, since they deliver the optimum particle size for grinding while avoiding over grinding and energy waste. Modern APC strategies can be relatively easy to implement, often embedded within the control systems, and after completion require little maintenance.

As illustrated in Figure 7, an example of a mine site using basic automated detection and reaction to context benefited in several ways:

- Reduction in energy use per ton of production,
- Corresponding reduction in GHG,
- $250,000 saved in the crusher area during first 12 months.

A plant-wide program of reducing power or shutting down power in areas not in active production was all that was required.

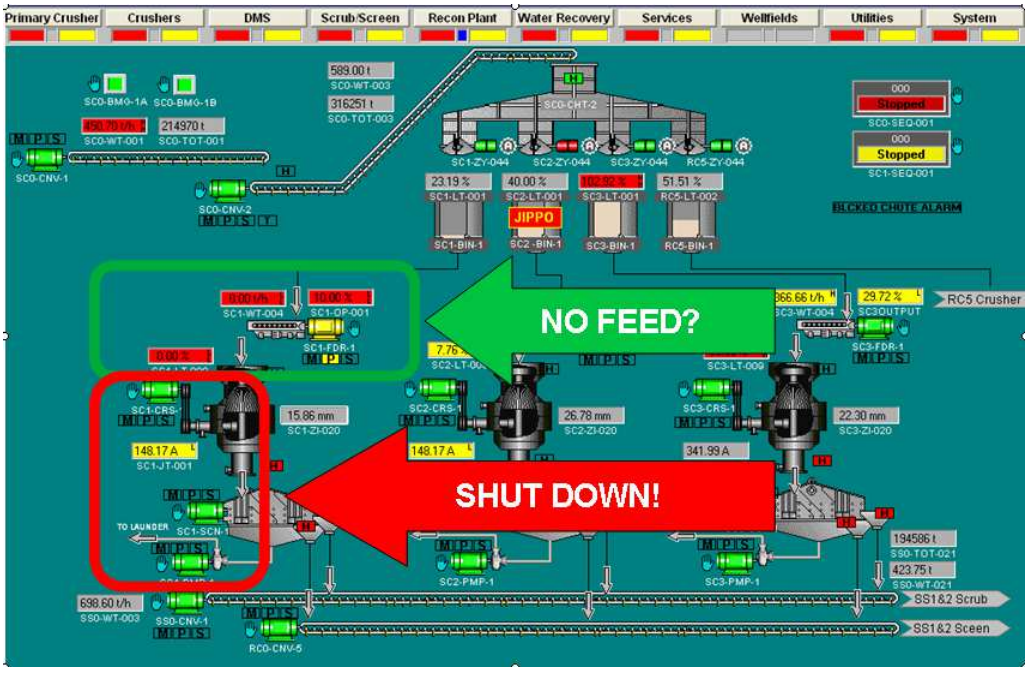

Figure 7: Automated contextual energy savings measures (Schneider Electric)

Step 4: Monitor, Maintain and Improve

Continuous improvement is necessary over time. Achievements can be lost if a systematic approach isn't implemented and doesn't have the support of the entire company.

As mentioned previously, Energy Management Systems are strong allies for constant energy monitoring. A mining operations information system, combined with an Energy Management System (EMS), provide the ability to optimize energy utilization. This approach combines the best of two worlds. Mining intelligence tools such as Production, Maintenance, Downtime, and financials with data contextualized to understand energy intensity.

This gives users real-time data production information associated with energy drivers and allows them to forecast energy usage since it generates an energy model against production scenarios.

In parallel, such technology drives dynamic objectives, where the new energy target is compatible with new production scenarios. Fixed objectives aren't always appropriate if production has new characteristics.

Dashboards displaying site energy performance (Fig. 8) at a mine site using an advanced Production Energy Optimization solution track real-time energy use and plant performance. Plant managers, operations and maintenance often monitor religiously Overall Equipment Effectiveness (OEE) as well.

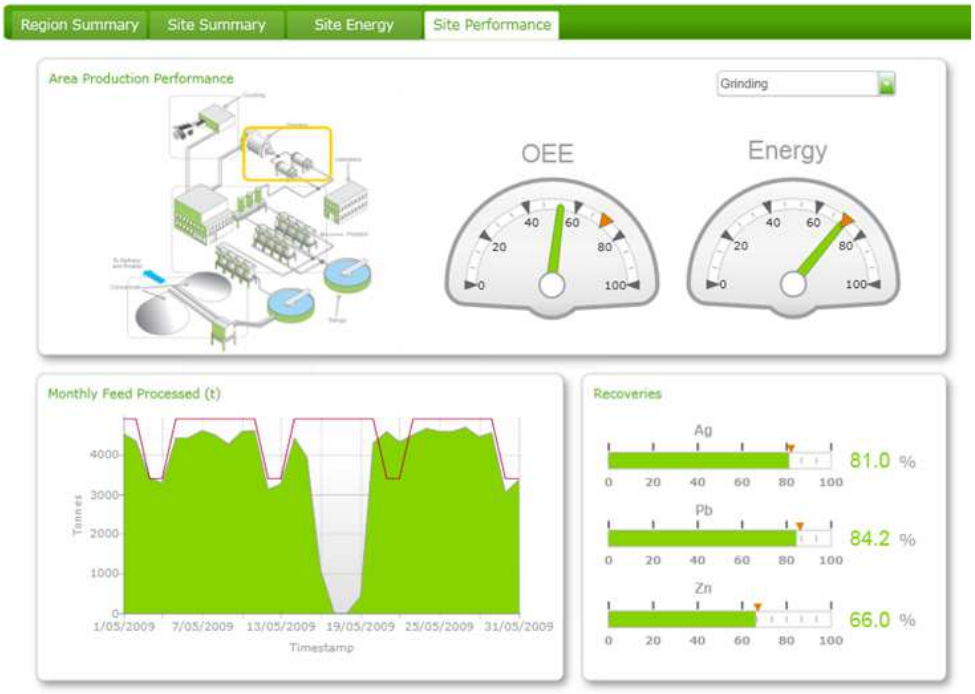

Figure 8: Mine site Production/Energy Performance dashboard (Schneider Electric)

WHERE ARE THE EEO's IN MINING?

There is sufficient evidence to support the capacity for mining and mineral processing operations to reduce their energy use. A 2005 report by Natural Resources Canada, Benchmarking the Energy Consumption of Canadian Open-Pit Mines, studied the energy consumption of open cut iron ore and gold mines. In investigating iron ore in an open cut mine, it was reported that there was potential to reduce the mining costs, based on energy savings, by 36% and milling costs by 47%. For gold mining this estimate was a staggering 53% for milling.

The US Department of Energy, in their 2007 Mining Energy Bandwidth Study, offers the following analysis of EEOs in mining (Fig. 9):

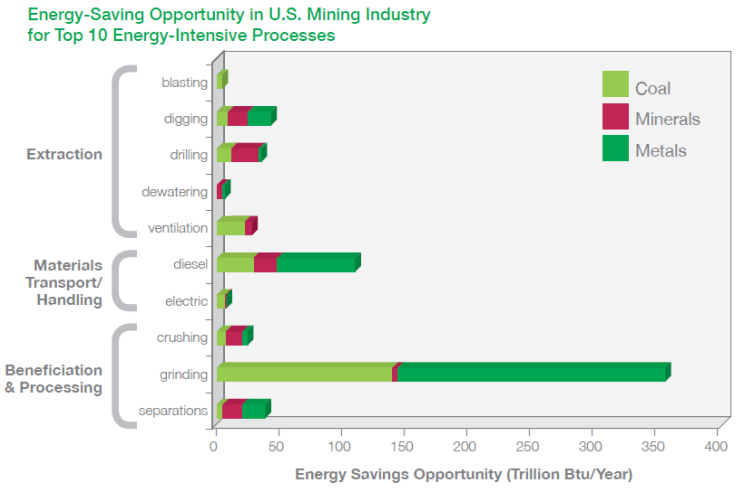

Figure 9: Energy Efficiency Opportunities in Mining as estimated by US Dept. of Energy

In the 2011 CIM paper "Improving Energy Efficiency in Barrick Grinding Circuits", Barrick Gold was able to achieve up to 20% improvement on some grinding circuits. The effort in this case required comprehensive sampling and modeling of the individual grinding circuits to achieve optimal energy/production performance.

As mentioned earlier, energy efficiency programs in ventilation are beginning to reap significant benefits. Pilot projects under way at a mine in Finland is currently showing 10-15% savings on the cost of heating supply air using a waste heat recovery system. Other pilot projects are ongoing at mine sites in Northern Ontario, see K Lagowski's article in CIM Magazine Mar/Apr 2013 "*Air Supply on Demand*". In this article, Cheryl Allen of Vale states "Ventilation on Demand (VOD) is the ability to have the right amount of air where you need it, when you need it". The energy savings potential is obvious.

In all cases a reliable, preferably automated system for data acquisition significantly improves the ability to track the effects of improvements over time. "Permanent" gains are the long-term goal.

PERFORMANCE AND RESULTS MEASUREMENT

A key success factor in any energy program is implementing the right tools for the right people within the corporation. Below we are presenting three software tools that can be used according to the level of information and type of analysis required.

Energy Management Software

This software, sometimes referred to as an Energy Management Information System (EMIS), helps to view energy in financial terms and gain insight into the impact of power quality and reliability. It benchmarks performance to reveal inefficiencies and risks and then tracks the progress of the energy efficiency initiatives, verifying the results of equipment upgrades or other improvements. Emissions reporting help to meet environmental goals. Trend analysis supports strategies to avoid demand or power factor penalties and reveals unused electrical system capacity.

In addition, the software helps optimize procurement by forecasting needs, comparing rates, identifying billing errors and validating contract compliance. Furthermore, it can accurately allocate costs to departments or processes.

The example screen shot in Figure 10 is a typical trend analysis for water, air, gas and steam. Water and gas consumption is shown against temperature. This type of analysis is the first step in the 4-step method – audit and measure.

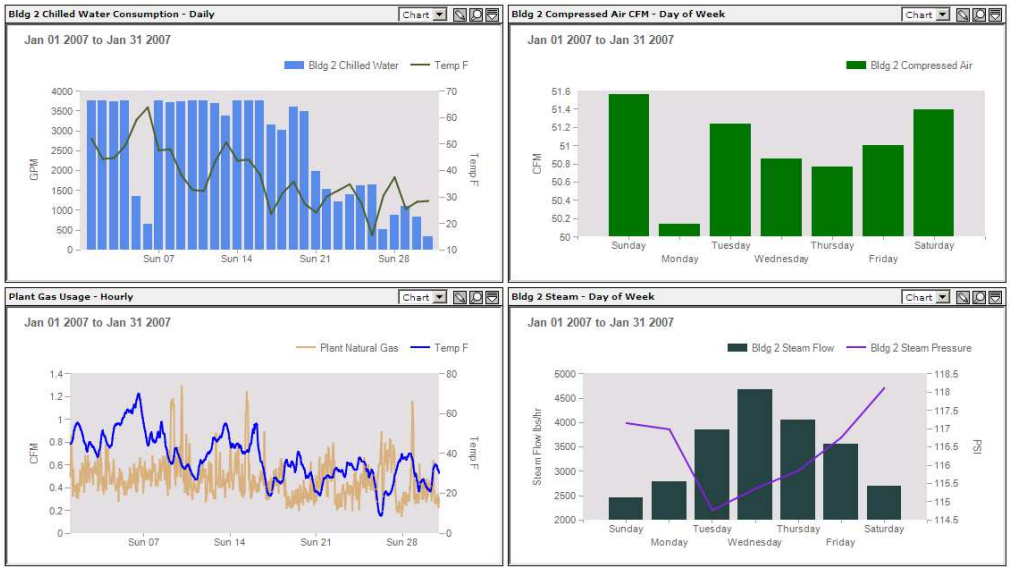

Figure 10: WAGES trends over time - Enterprise Energy Management software by Schneider Electric

Operations Management Software

Mining Operations Information Systems, or Operations Management Systems, provide advanced operations information in real-time. The ability to track energy use within the plant production context is an advanced means of achieving "smart" energy use.

These modern systems provide up-to-the-minute:

- Production reports with variances to targets;
- Energy use during "down" time (Fig. 11).This is essentially an analysis to identify "non-productive" energy consumption in operations. Clearly an item to be reduced to strict minimum.
- Energy "overconsumption" events (Fig. 12). An overconsumption event is very similar to a downtime event. This time the event is automatically triggered when a certain energy use (or water etc) is exceeded, instead of an asset stopping. The system automatically captures:
    - Start time of the overconsumption event
    - End time of the overconsumption event
    - Duration of the event
    - Amount of overconsumption (MWh, water, gas)

  Like downtime, an energy overconsumption event can have classifications and causes associated with it.

Classification	Total kWh	Total Hours	kWh / minute
Scheduled Equipment Downtime	115,339	154.08	12.48
Scheduled Process Downtime	989	1.25	13.15
Standby Time	205	0.10	35.45
Unscheduled Electrical Downtime	289	0.40	12.02
Unscheduled Mechanical Downtime	5,703	7.17	13.26
Unscheduled Process Downtime	1,130	1.35	13.96

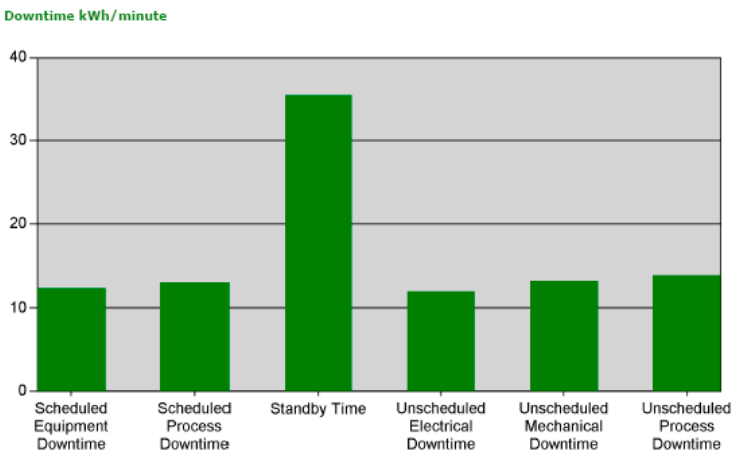

Figure 11: An example of tracking energy use during downtime - Schneider Electric Ampla Software

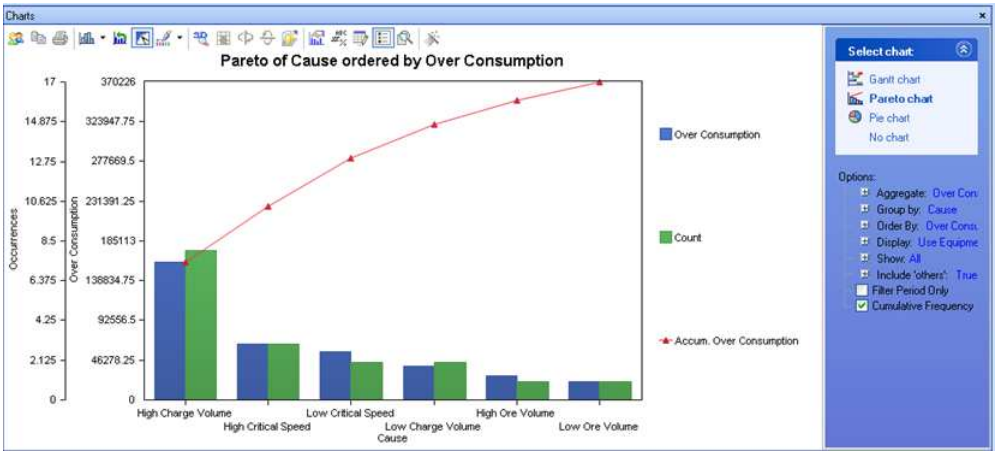

Figure 12: Energy "Overconsumption" Events - Schneider Electric Ampla Software

Corporate sustainability dashboards

These corporate dashboards (Fig. 13) track the corporate energy performance, monitor markets (from commodities process to raw materials) and environmental impacts.

The information contained in these dashboards has the advantage of being automatically generated and updated as opposed to manual reports. An internet web-based system allows worldwide tracking in close to real-time.

Typical content for proprietary online energy management and reporting portals include:

- Real-time access to key energy information
- Cost and usage data
- Carbon reporting
- Program goals and progress
- Forward looking price forecasts
- Custom reporting

Figure 13: Corporate dashboards – Summit Energy's DashboarDView

CONCLUSIONS

The global mining industry has begun to embrace energy efficiency as a means of improving overall company performance. Energy efficiency strategies evolve over time and generally begin with basic tasks such as measurement and progressively expand to include advanced optimization tools and techniques tied to continuous improvement plans.

Using modern measurement, communications and data acquisition systems, a vast amount of data is now available for analysis. Analysis using various software tools provides real-time information on where energy is being consumed and under what conditions. In this way potential Energy Efficiency Opportunities are identified, improvement plans are established and progress is monitored over time.

Potential savings at any given mine will depend on many factors but the method presented in this paper can help achieve significant savings for all mining operations. These savings and advantages come in many forms and are clear indications of a successful mining company.

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