IDENTIFYING OPPORTUNITIES TO REDUCE THE CONSUMPTION OF ENERGY ACROSS MINING AND PROCESSING PLANTS

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ABSTRACT

In addition to meeting Government Policy on Energy Efficiency Opportunities (EEOs), mining and mineral processing companies are increasing energy efficiency to reduce costs in the current financial conditions. One of the major issues with EEOs is the lack of data available on energy use, and more importantly the energy use linked to production data, that identify energy reduction opportunities.

As well as energy reduction, mining and mineral processing companies often struggle with the prediction of energy use, and are often penalised for under or over forecasting. Once again it is the lack of timely information that makes this prediction difficult.

This paper looks at expanding the use of a Manufacturing Execution Systems by integrating with Energy Solutions. This will provide automatic, timely information, at a granularity that makes it easier to identify EEOs, reduce energy costs, and better predict energy use in a mining and mineral processing operation.

INTRODUCTION

Both the financial and atmospheric climate are key discussion points in 2009. Mining and mineral processing companies are looking at both reducing energy use to lower costs, and to reduce emissions, particularly in light of any carbon emissions scheme that may be introduced. To achieve this, companies must have a clear understanding of their current energy use, and therefore require tools that will empower people to make decisions.

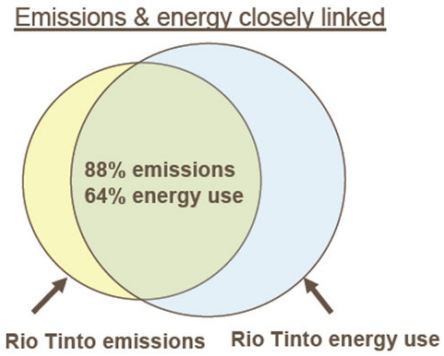
Governments are recognising the potential for energy efficiency, particularly in the mining sector. Many are introducing Energy Efficiency Opportunity (EEO) programs, which encourage large energy-using businesses to improve their energy efficiency by identifying, evaluating, and reporting publicly on cost effective energy savings opportunities.

Many governments are making participation in Energy Efficiency Opportunities mandatory for corporations that use more than 0.5 petajoules (PJ) of energy per year.

One of the reasons behind the EEO program is that Governments believe that increased uptake of cost-effective energy efficiency technologies and process, will help businesses maintain competitiveness under a carbon pollution reduction schemes as globally we move towards a low carbon economy.

As shown below in the Rio Tinto Diagram (from a Rio Tinto presentation at an EEO forum) there is a close relationship between emissions and energy use.

Figure 1: Rio Tinto's link between Energy and Emissions (How Rio Tinto Addresses Energy Management. Energy efficiency opportunities –22nd May, Melbourne, 2008.)



Current Examples of EEOs in Australian Mining and Minerals Processing

As part of EEO programs, large energy users must complete EEO reports. These are posted publically on the company web sites and also government energy web sites.

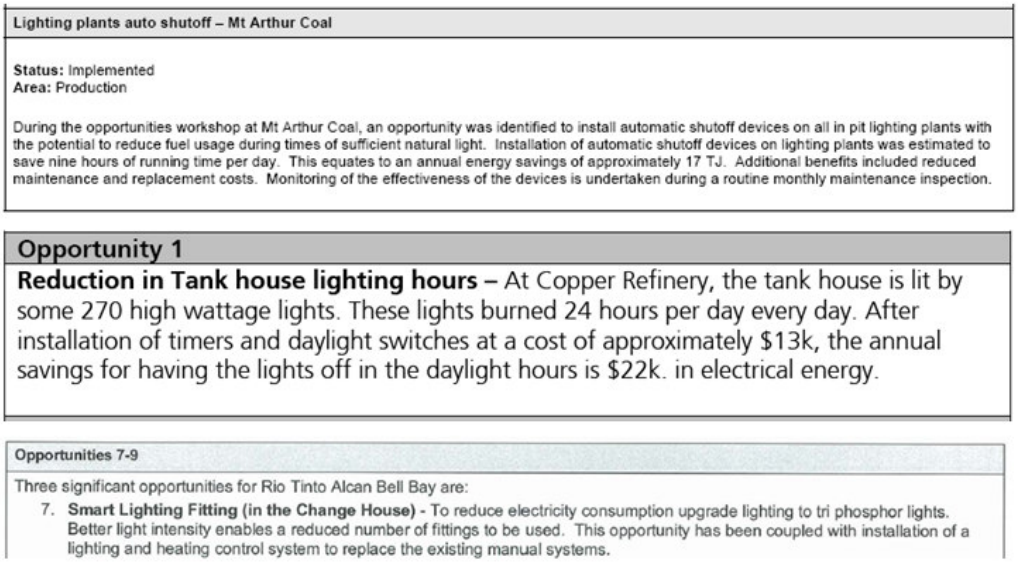
One of the issues with EEO reporting is that there is an increasing "sameness" about the type of EEOs that mining companies are starting to identify in their operations.

For example common EEOs are:

- Reducing the lighting (lighting control systems)
- Reducing the energy used in air conditioning by changing the type of airconditioning
- Changing to variable speed drives to reduce energy
- Reducing energy related to compressed air leaks

The suggestions above provide savings, indeed quick win opportunities in the mining and mineral processing environment. The question in the next few years will be where to go next to reduce energy use.

Figure 2: Extracts from BHPB, Xstrata and Rio EEO reports showing "lighting reductions" as a possible EEO.



Lighting plants auto shutoff – Mt Arthur Coal

Status: Implemented
Area: Production

During the opportunities workshop at Mt Arthur Coal, an opportunity was identified to install automatic shutoff devices on all in pit lighting plants with the potential to reduce fuel usage during times of sufficient natural light. Installation of automatic shutoff devices on lighting plants was estimated to save nine hours of running time per day. This equates to an annual energy savings of approximately 17 TJ. Additional benefits included reduced maintenance and replacement costs. Monitoring of the effectiveness of the devices is undertaken during a routine monthly maintenance inspection.

Opportunity 1

Reduction in Tank house lighting hours – At Copper Refinery, the tank house is lit by some 270 high wattage lights. These lights burned 24 hours per day every day. After installation of timers and daylight switches at a cost of approximately $13k, the annual savings for having the lights off in the daylight hours is $22k. in electrical energy.

Opportunities 7-9

Three significant opportunities for Rio Tinto Alcan Bell Bay are:

7. **Smart Lighting Fitting (in the Change House) -** To reduce electricity consumption upgrade lighting to tri phosphor lights. Better light intensity enables a reduced number of fittings to be used. This opportunity has been coupled with installation of a lighting and heating control system to replace the existing manual systems.

We believe that operation teams will play a major role in the next level of energy reduction. Operations teams will be challenged to achieve target recoveries at the lowest energy consumption. The next level of energy savings will come from process and operations management changes, rather than more energy efficient drives or lighting changes.

DESIGN & SET-UP

Energy Forecasting and Events of Excess Energy Use

In discussions with mining and mineral processing companies it became apparent that they are facing common problems as they attempt to do more using less energy. The challenge for mining and mineral processing companies is that they currently don't have sufficient information to make decisions to reduce energy (identify EEOs), or forecast energy use accurately.

Complex energy forecasting tools are available to better forecast energy use, but don't take into account the context of excess energy use, or the historical and future production data, therefore not delivery accurate forecasts.

Mining and mineral processing companies are investing in meters and enterprise Energy Management (EM) software to monitor and visualise/report on energy use. Providing information on energy use is only partially solving the problem of determining new opportunities to reduce energy use, and in turn comply with EEOs. Along with energy use, information's required on what is actually happening in the plant at the time, in other words there has to be context supporting the energy use. For example near real time information like kWh/tonne or kWh/ounce of production.

Mining and mineral processing companies tend to have information systems that provide production and delay accounting (downtime) information, but do not combine or integrate with energy systems to provide more useful information. This level of information provides accurate forecast models and perhaps new EEOs. Production and downtime are obviously key factors in energy use, therefore integrating production and energy systems have potential benefits.

The integration of Energy Management (EM) with Manufacturing Execution Systems (MES) can be given the general term Production Energy Optimisation (PEO).

The key problem that these companies face is timely access to accurate energy information. They either:

- do not have the information available at all
  (example: either it is not captured, or a manual process and not available to everyone)
- the information is not granular enough, or
  (example: there is insufficient power information for the entire facility)
- provide information that is isolated and has no context in with which it was used.
  (example: energy figures do not link to what was actually happening in the plant)

Added to this, is the lack of ability to accurately forecast energy use. Both under and over forecasting energy use often results in financial penalties from utility companies or dedicated energy providers.

There is sufficient evidence to support the capacity for mining and mineral processing operations to reduce their energy use. The two following graphs from the US Department of Energy certainly indicate the opportunity exists.

Figure 3 looks at the top 10 energy intensive processes in coal, minerals and metals. It is no surprise that grinding is the largest energy intensive process.

Figure 4 is interesting in that it looks at the potential for energy savings for the coal, metals and mineral industries within the USA. The key observation from the graph is that where coal and metals have the potential to reduce their energy use by 17% and 21% respectively due to best practice, minerals has the potential to reduce it by 27%.

Figure 3: Energy-Savings Opportunity in US Mining Industry for Top 10 Energy-Intensive Processes

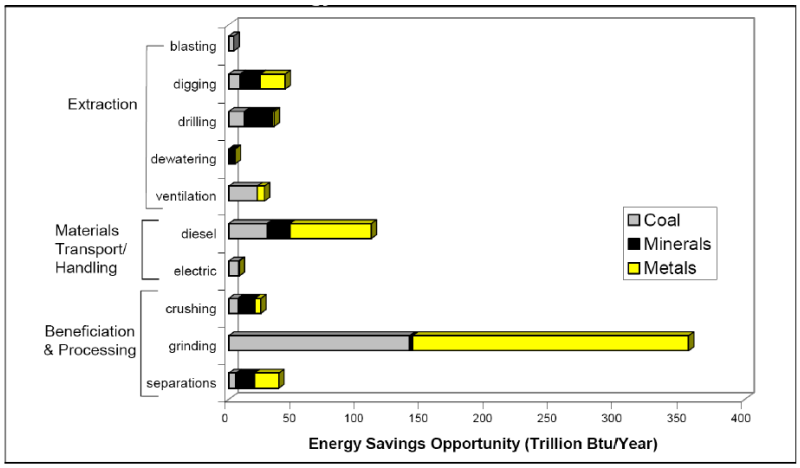
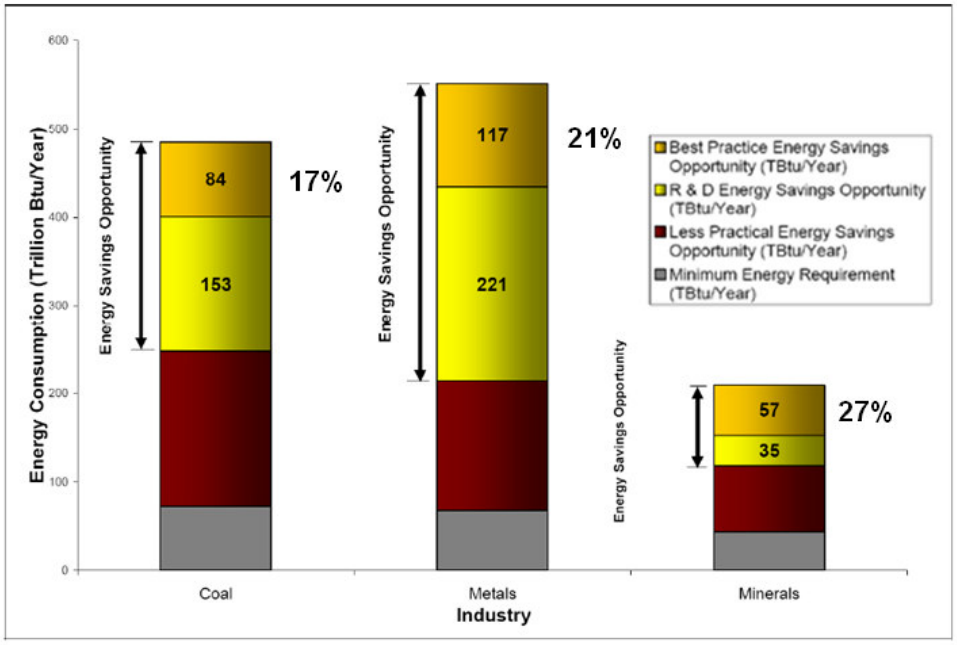


Figure 4: U.S. Mining Industry Energy Bandwidth for Coal, Metal, and Mineral Mining (Source: Mining Industry Energy Bandwidth Study, June 2007 by the U.S. Department of Energy)



A similar conclusion was made in a 2005 report by the Natural Resources of Canada where they benchmarked 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 reduced to a staggering 53% for milling.

Examples of Energy Events

If an MES is already collecting downtime information of large mining assets, along with production figures, it is efficient to integrate this with energy information to provide useful "energy eventing" information. This data can then be easily reported and visualised together. See figure 5.

There are many reasons why an increase in mill energy use could spike. For example, if the same throughput is required within a mill, and the feed material is a harder or more competent ore, energy use can increase by over 10%. This information about ore competency could be available historically in the MES.

Similarly if the grind size had to reduce by half to maintain recovery rates during flotation (due to liberation issues with an ore), energy will increase in excess of 10%, more likely to be a factor of four. Once again this information about liberation changes could be available historically in the MES.

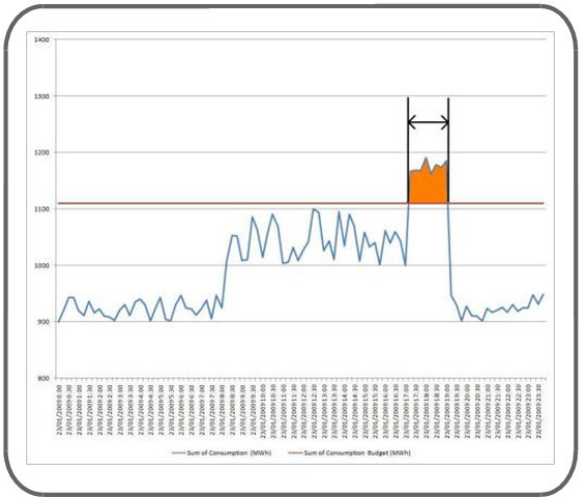
In both these cases the integration of existing data into a Production Energy Optimisation (PEO), could provide visualisation in near real time with such parameters as energy/tonne, cost/tonne. PEO visualises downtime with energy information through drill down functionality to identify context with energy use.

The real advantage comes with energy events; events where more or less than normal energy is used, without a reason.

Production Energy Optimisation systems support:

1. Automatically capturing events:
    a. Start and end time, duration, excess energy used
    b. Plus context information – material, product, grade, crew, shift,
    c. Automatically or manually split events
2. Knowing when your equipment is consuming too much energy and by how much
    a. When demand (kW) is over a target
    b. When kWh/ton is over target

Figure 5: Energy Events Graph



Start Time	End Time	Duration (mins)	Over (MWh)	Classification	Cause	Shift	Crew
23/1/09 17:15	23/1/09 19:00	105	514	Process	Poor Feed	Afternoon	Crew C

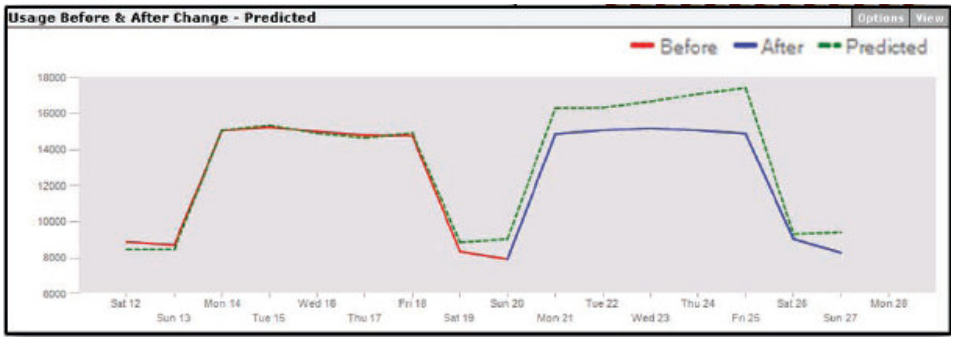
Figure 5 illustrates an "energy event" where over consumption of energy occurred. The MES captured context around this event and poor feed was attributed to the over consumption of energy.

Energy Forecasting

When failing to meet a forecast (either over or under) incurs monetary fines, tracking energy consumption against forecasts becomes very important. Mining and mineral processing companies need to accurately forecast energy consumption and have timely access to actual energy consumption so that decisions can be made.

Sophisticated mechanisms for modeling energy consumption are needed to generate a forecast. These models are available as part of an Energy Management solution and use regression and correlation based on ASHRAE Guideline 14. They assist in identifying the factors/drivers that affect energy consumption, and then develop algorithms that can forecast energy consumption. To do this type of modeling more effectively requires the production and downtime data that an MES provides.

Figure 6: Predicted Energy Use using Regression and Correlation Model



By integrating MES and EM systems, the energy model can easily be derived from historical process data, with the MES providing future process data like production plans, shift targets, and upstream feed grade.

RESULTS AND RECOMMENDED SOLUTION

Importance of Operations Data (already captured in MES)

The importance of the data already captured in the MES cannot be under estimated. The value lies in linking it with energy data. Many vendors are looking at providing energy solutions; however the improved value proposition is not having an MES and an EM system, but an integrated Production Energy Optimisation solution.

Recommended Approach

By combining automatically captured data on production and downtime in the MES, and energy use in the EM system, energy efficiency benefits can be realised. To maximise the benefits it is suggested that the information be not only combined but also displayed together. This type of integrated solution we have already referred to as Production Energy Optimisation.

The best approach would be for the Production Optimisation Solution to enable:

- Real time Energy Consumption Reporting
- Forecasting of energy consumption based on certain parameters
- Establishment of optimal energy consumption target for each section of an operation
- Identification and quantification of all consumption above the target
- Discovery of root causes of over consumption
- Report on shift or daily consumption and over consumption events
- Real time calculation of sustainability KPIs such as kWh/tonne
- The provision of validated actual data to justify future capital expense and/or process changes

To systematically, reduce energy consumption in the minerals processing environment we recommend the following process:

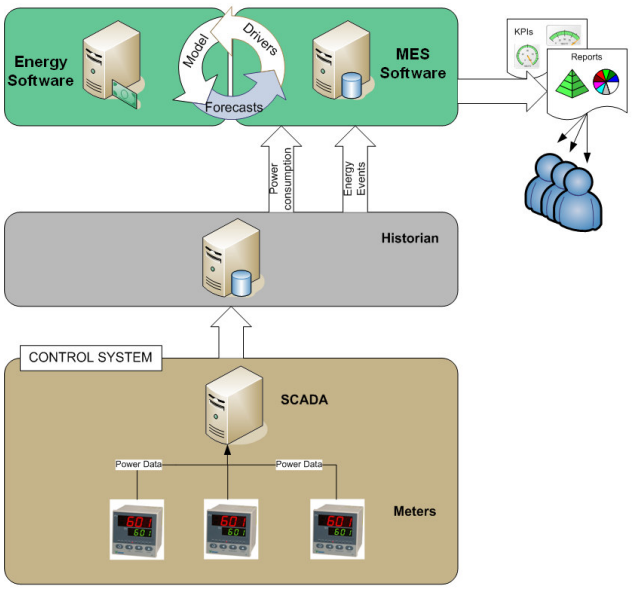
- Identify the energy drives for your plant. E.g. material grades, recovery rates etc
- Report in real –time the energy consumption as well as the energy drivers
- Use an energy model to forecast the energy consumption based on the forecasts of your energy drivers
- Use this forecast to determine an energy target
- Identify and qualify all consumption above the target
- Analyse results to determine root causes of overconsumption

Over consumption may be caused by failing equipment and could be another trigger used to optimise maintenance programs.

Real-time metrics can also help to drive behavior. KWh/ounce can be easily calculated and displayed so that operators know how the plant is performing in terms of production and energy.

By collecting accurate records on the causes of energy consumption above target, this data can be used to support capital expenditure required to change process equipment.

Figure 7: Proposed architecture for integration of MES with Enterprise Energy solution.



Potential Energy Savings

In mining operations there is a need for real-time reporting and analysis. As with delay accounting, there is a requirement to empower operations people by providing the information in a form that they can easy interpret and act upon on a daily basis. Operations people know their plant and can help identify EEOs if they have timely information.

In looking at Production Energy Optimisation in the MMM industries, accurate, timely information is needed to create opportunities to reduce energy use. The US research illustrated graphically in Figures 3 and 4, is a great place to start to identify areas for energy savings through best practice.

Better information will make it easier for mining companies to identify these potential savings.

Forecasting Energy Use

Improved forecasting of energy use can provide two advantages:

1. Reduction in penalties for over or under forecast (usually based upon a shared grid)
2. Reduction in the gap between the provided power from a power plant, and the actual used (dedicated power plant), often called the “spinning excess”

1. Improved Energy Forecasting to Reduce Costs

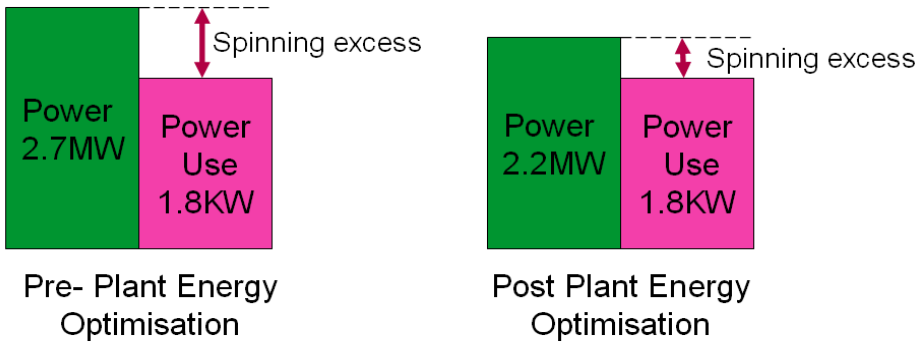
- Using forecasting algorithms, and by combining the energy information with production or downtime information, produces more accurate forecasts of energy use. This supports reductions in penalties for under or over forecasting.

- Maximise the use of existing power infrastructure capacity and avoid overbuilding power infrastructure by having more accurate information.

2. Forecasting and Understanding Energy Use to Reduce the Spinning Excess Created by the Power Plant

The example of a mining and mineral processing site that requires approximately 1.8 MW of power, where the dedicated power plant (run by a 3rd party) produces 2.7MW and therefore a spinning excess of 0.9 MW. The company only pays for the 1.8MW but has to pay for maintenance and fuel for the 2.7MW.

Figure 8: Reducing Spinning Excess Using Plant Energy Optimisation Example



If sufficient information was known about why the peak loads occur (for example the starting sequence for the mills) the spinning excess could be reduced, therefore reducing the fuel and maintenance costs.

Energy events may also be the reason for the size of the spinning excess. A better understanding of their root cause and prevention may also support the reduction of costs associated with spinning excess.

CONCLUSION

Manufacturing Execution Systems (MES) are commonly used in mining and mineral processing companies, reporting key data and KPIs around production and downtime. Their information empowers managers to make decisions that may improve business excellence.

Energy Management (EM) solutions are increasingly being installed in mining and minerals processing companies to provide information for tracking operational consumption, forecasting consumption and providing information around energy quality. Like MES, the information provided is useful for better understanding energy consumption. The information empowers people to make decisions that may improve business outcomes by reducing energy use or better forecasting energy use.

Both MES and EM systems have their use in mining, by providing automated, accurate information in a timely manner. It is however the integration of both systems that will provide more value when endeavors are made to better understand energy use, and therefore potentially reduce energy use. The integration of MES and EM solution to form a Production Energy Optimisation (PEO) provides added value.

Using PEO energy events can be identified, the reasons for them understood, and perhaps preventative action put in place to reduce or stop them recurring as frequently.

PEO providing context with abnormal energy events are critical to understanding energy use and over/under performance. It is also useful in providing better forecasting in the high energy mining and mineral processing environments. In isolated mining environments a potential quick win on reducing energy could be found by using better forecasting and understanding of energy use to reduce the spinning excess of a power plant.

References

[1] *How Rio Tinto Addresses Energy Management.* Energy efficiency opportunities –22nd May, Melbourne, 2008.

[2] *EEO Public Report 2007 Rio Tinto Ltd.*

[3] *Xstrata Holding Pty Ltd Energy Efficiency Opportunities, Annual Public Report, December 2008.*

[4] *BHPB EEO Report 2008*.

[5] *EEO Public Report Gold Fields Australia Pty Ltd, 2008*.

[6] *Mining Industry Energy Bandwidth Study, June 200.* The U.S. Department of Energy: Industrial Technologies Program

[7] *Benchmarking the Energy Consumption of Canadian Open-Pit Mines.* Natural Resources of Canada, 2005.

[8] *Benchmarking the Energy Consumption of Canadian Underground Bulk Mines.* Natural Resources of Canada, 2005.