# Energy Efficiency in a Sustainable Mining Industry

Bessie Monchusi [1] & Marek Makowski [2] – co-supervisors

[1] CSIR; [2] IIASA

## Background and motivation

Energy efficiency, as well as investment and operational costs are important factors in designing and implementation of the most suitable industrial systems and technology. This also applies to the mining industry, an important part of the South African economy. The Deep-mine Collaborative Research Program 1998-2002 defined the energy profile of a typical ultra-deep mine, and thus provided the basis for exploring ways of reducing energy costs. It also demonstrated the complexity of modelling the energy needs of an ultra-deep mining that are dominated by power requirements of ventilation, cooling, refrigeration and pumping. The reports from this program can be used as a guideline for development of an efficient and sustainable mining production system. Sustainability, however, requires further research focused on quantifying environmental and social impacts of the mining industry, modelling effectiveness of technological innovations, as well as providing methods and tools for integrated analysis of the underlying mathematical models aimed at exploring synergies and trade-offs between indicators characterizing diverse aspects of mining and its impacts.

## Research theme

The research will focus on model-based analysis of current and future mining technologies, in particular: energy efficiency and use, environmental impacts (especially emissions and waste), capital and operating costs, and the system wide impacts of technological innovations. The main aim is to provide support for development of energy efficient systems that shall provide the desired level of productivity with reduced energy consumption, lower costs, and smaller environmental impact.

The current electrical energy consumption, carbon emissions and waste production data for mines shall be sourced and analysed. Indicators characterizing the important attributes of the system (such as diverse costs, efficiency, environmental and social impacts) shall be defined and computed. Then, a mathematical model relating the decision variables (e.g., chosen technology, production level, and available resources) and the indicators will be developed. Finally, methods for integrated model analysis will be adapted to enable use of such a model for supporting the design and implementation processes in the mining industry. Such a decision-making support system will be available for the consulting services for mines that assist in development of demand side management programmes, connecting the components of complex energy management for building models customized for specific cases. Finally, such a decision-making support can also be used for building the skills and capabilities of professionals in the mining industry.

## Relevant skills

A successful candidate shall have keen interest in applied system analysis and proven skills in at least one of the following areas: operations research (in particular methods and tools for mathematical modeling, integrated model analysis, data analysis), energy systems, energy efficiency, and mining industry.

**Recommended reading**


1. Deepmine, 1998-2008, Task Definition, Task 6.5.1, Task 13.11, Task 16.1.2.
2. Govender, S. 2008 Energy Saving Mechanisms In The Mining Industry: A Case Study Of Switching Off Non-Essential Power, 44-60.
3. LCG Energy Management Group Investigation of Current Research Related to the Reduction of Energy Usage in Mines Through Recycling, Reuse, and Other Means, 23-38.
4. Wierzbicki, A., Makowski, M., Wessels, J., 2000, Model-Based Decision Support Methodology with Environmental Applications, Mathematical Modeling and Applications, Kluwer Academic Publishers, Dordrecht, ISBN-0-7923-6327-2.
5. Makowski, M, 2009, Management of Attainable Tradeoffs between Conflicting Goals, Mathematical Modeling and Applications, Journal of Computers, Vol 4, No 10 (2009), 1033-1042, ISSN-1796-203X.


More reading suggestions are posted at https://github.com/iiasa-ime/SAYSSP.