

Mine energy budget forecasting: The value of statistical models in predicting consumption profiles for management systems

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Abstract

The mining industry in South Africa has long been a crucial contributor to the Gross Domestic Product (GDP) starting in the 18th century. In 2010, the direct contribution towards the GDP from the mining industry was 10% and 19.8% indirect. During the last decade global financial uncertainty resulted in commodity prices hitting record numbers when Gold soared to a high at \$1900/ounce in September 2011, and thereafter the dismal decline to a low of \$1200/ounce in July 2013. Executives in these markets have reacted strongly to reduce operational costs and focussing on better production efficiencies. One such a cost for mining within South Africa is the Operational Expenditure (OPEX) associated with electrical energy that has steadily grown on the back of higher than inflation rate escalations. Companies from the Energy Intensive User Group (EIUG) witnessed energy unit prices (c/kWh) and their percentage of OPEX grow to 20% from 7% in 2008. The requirement therefore is for more accurate energy budget forecasting models to predict what energy unit price escalations (c/kWh) occur along with the required units (kWh) at mines or new projects and their impact on OPEX.

Research on statistical models for energy forecasting within the mining industry indicated that the historical low unit price and its notable insignificant impact on OPEX never required accurate forecasting to be done and thus a lack of available information occurred. AngloGold Ashanti (AGA) however approached Deloitte in 2011 to conclude a study for such a statistical model to forecast energy loads on one of its operations. The model selected for the project was the Monte Carlo analysis and the rationale made sense as research indicated that it had common uses in energy forecasting at process utility level within other industries. For the purpose of evaluation a second regression model was selected as it is well-known within the statistical fraternity and should be able to provide high level comparison to the Monte Carlo model. Finally these were compared to an internal model used within AGA.

Investigations into the variables that influence the energy requirement of a typical deep level mine indicated that via a process of statistical elimination tonnes broken and year are the best variables applicable in a mine energy model for conventional mining methods. Mines plan on a tonnage profile over the Life of Mine (LOM) so the variables were known for the given evaluation and were therefore used in both the Monte Carlo Analysis that worked on tonnes and Regression Analysis that worked on years. The models were executed to 2040 and then compared to the mine energy departments' model in future evaluations along with current actuals as measured on a monthly basis. The best comparison against current

actuals came from the mine energy departments' model with the lowest error percentage at 6% with the Regression model at 11% and the Monte Carlo at 20% for the past 21 months. This, when calculated along with the unit price path studies from the EIUG for different unit cost scenarios gave the Net Present Value (NPV) reduction that each model has due to energy. A financial analysis with the Capital Asset Pricing Model (CAPM) and the Security Market Line (SML) indicated that the required rate of return that investors of AGA shares have is 11.92%. Using this value the NPV analysis showed that the mine energy model has the best or lowest NPV impact and that the regression model was totally out of line with expectations.

Investors that provide funding for large capital projects require a higher return as the associated risk with their money increases. The models discussed in this research all work on an extrapolation principle and if investors are satisfied with 6% error for the historical 2 years and not to mention the outlook deviations, then there is significance and a contribution from the work done. This statement is made as no clear evidence of any similar or applicable statistical model could be found in research that pertains to deep level mining.

Mining has been taking place since the 18th century, shallow ore resources are depleted and most mining companies would therefore look towards deeper deposits. The research indicates that to some extent there exist the opportunity and some rationale in predicting energy requirements for deep level mining applications. Especially when considering the legislative and operational cost implications for the mining houses within the South African economy and with the requirements from government to ensure sustainable work and job creation from industry in alignment with the National Growth Path (NGP). For this, these models should provide an energy outlook guideline but not exact values, and must be considered along with the impact on financial figures.

List of Key Terms

Energy Modelling

Energy Price Path

Monte Carlo Analysis

Regression Analysis

Mine Energy Model

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List of Abbreviations

AGA: AngloGold Ashanti

AGM: Annual General Meeting

AMCU: Association of Metal and Construction Union

B&TD: Business and Technical Development

BME: Basic Mining Equation

Bn: Billion

c/kWh: cents per Kilowatt Hour

CAPM: Capital Asset Price Model

CDM: Clean Development Mechanism

CDP: Carbon Disclosure Project

CER: Certified Emission Reduction

CPI: Consumer Price Index

DEA: Department of Environmental Affairs

DoE: Department of Energy

DPE: Department of Public Enterprises

EIUG: Energy Intensive User Group

ESCO's: Energy Saving Companies

FCF: Free Cash Flow

GDP: Gross Domestic Product

IDM: Integrated Demand Management

IPAP: Integrated Policy Action Plan

IPCC: Intergovernmental Panel on Climate Change

IPP: Independent Power Producers

IRP: Integrated Resource Plan

ITTCC: Industry Task Team for Climate Change

JSE: Johannesburg Stock Exchange

kWh: Kilowatt Hour

kWh/t: Kilowatt Hour per tonne

LPG: Liquids, Petroleum and Gas

LOM: Life of Mine

m: millions

MIT: Massachusetts Institute of Technology

MTRMP: Medium Term Risk Mitigation Plan

MYPD: Multi Year Price Determination

Mtoe/a: Million tonnes of energy per annum

NEEAP: National Energy Efficiency Action Plan

NEES: National Energy Efficiency Strategy

NERSA: National Energy Regulator of South Africa

NGP: National Growth Path also known as the NDP: National Development Plan

NOPAT: Net Operating Profit After Tax

NUM: National Union of Mine Workers

NWU: North West University

OCF: Operating Cash Flow

OPEX: Operational Expenditure

P2V: Pathway to Value

R: Rands

ROE: Return on Equity

ROIC: Return on Invested Capital

RPP: Revenue Price Path

SA: South Africa

SAR: South African Region

SML: Security Market Line

SPP: Strategic Project Planning

tCo2-e: tonnes of CO2 gas emitted

TWh: Terawatt Hour ‘

UN: United Nations

USA: United States of America

VRT: Virgin Rock Temperature

YTD: Year to Date