

# CHAPTER 1

## INTRODUCTION

### 1.1 BACKGROUND

#### 1.1.1 A brief history of the mining sector in South Africa

According to MiningIQ (2013) the mining sector contributed to the establishment of the Johannesburg Stock Exchange (JSE) in the late 19<sup>th</sup> century. Associated wealth from some of the richest gold deposits globally found in the Witwatersrand area caused a gold rush that would ultimately transpire into the South African War, also known as the Anglo Boer War and the country's leadership under the British Empire until 1961. Although mining techniques at the time was considered somewhat hostile, the British Empire paved the way for what is today known as the Mine Health and Safety Act (No. 29 of 1996) (SA, 1996) and Mineral Act (No. 50 of 1991) (SA, 1991) that governs the day-to-day mineral processing activities (South Africa – Mining History, 2013). In the annual report from the Chamber of Mines (Chamber of Mines of South Africa, 2012) it is stated that mining's contribution in the past 130 years has made South Africa the most industrialized country in Africa. International sales of gold peaked in the 1970s with South Africa contributing towards 68% of global production and in 2001, 51% of all global Platinum production (MiningIQ, 2013).

Today, the country has some of largest mineral resource deposits in the world with accolades of leaders in Platinum, Magnesium and Chrome reserves and the third largest producer of Gold (Mining and Minerals, 2012). In an uncertain world economy the price of Gold soared to a record high at \$1900/ounce in September 2011 (Reuters, 2012) and has dropped back to a low of below \$1200/ounce as markets respond to the proposed stimulus from the United States Federal Reserve (Rankin, 2013). Currently the sector provides solutions to unemployment rates that are at 25% with year on year growth within mining at 6.9% equating to 21000 jobs created for the past year (Statistics South Africa, 2012:8). This is all somewhat aligned with Governments National Growth Path in creating 5 million jobs by 2020 (Dube, 2011) and the required contribution from mining and industry. Taborda (2013) stated that mining during the second quarter of 2013 was the single biggest cause for movement on the Balance of Trade account reducing the average deficit due to commodities exports.

Mining as a sector in the South African economy directly contributed towards 8% and 9.7% of Gross Domestic Product (GDP) in 2010 and 2011 respectively, 18% and 20% if we consider indirect and induced effect (Baxter, 2011:6). With this in mind total GDP quarterly

growth increased to 3.35% from a mere 1.725% in 2010 (GDP, 2012). Much of the economic activity in the input industries is attributable to the mining sector. The industry uses significant amounts of transport, consulting and financial services, steel and material inputs, electricity and water inputs (Chamber of Mines of South Africa, 2012).

Key economic factors of mining in SA is listed below and indicated in figure 1.1:

- *Job creation – Created 1.35 million jobs in 2010.*
- *Employment – Highest dependency ratio of 10:1 meaning that 13.5 million are indirectly relying on mining for food and livelihood.*
- *Energy – Provides 72% of SA’s primary energy needs via coal, liquid fuels and calculated on the 2012 consumption figures, R 88 billion would be required to import energy that would have a negative effect on the trade of balances account.*
- *Income – Spent R 437 billion in 2011 and of this an estimated 89% was in the SA economy.*
- *GDP Corporate Tax – 17.2% of all corporate taxes paid and more than double is the contribution to the GDP as measured against any other industry.*
- *Foreign Exchange – Earned 38% of total merchandise exports in 2011 at R 282 billion.*

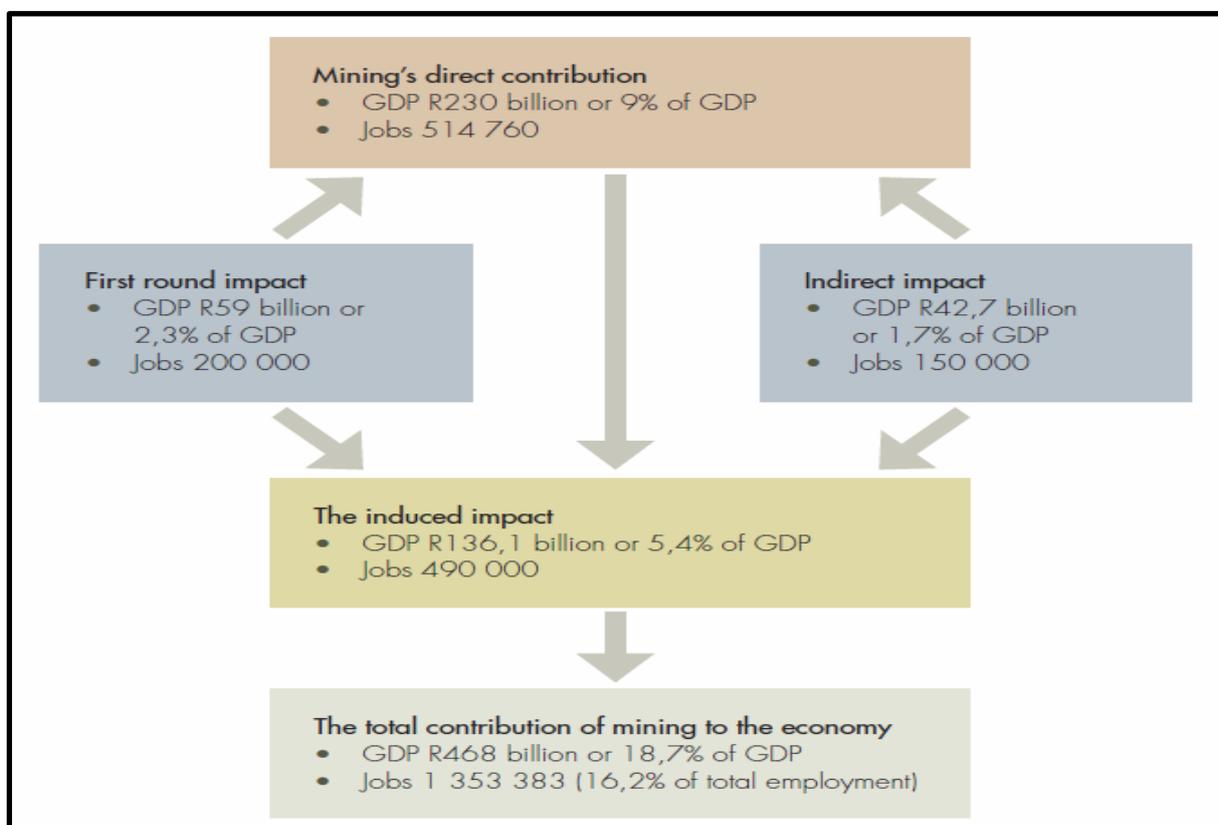


Figure 1.1: Mining Contribution towards GDP in 2010 (Chamber of Mines of South Africa, 2012)

Work from the Energy Intensive User Group (EIUG), Chamber of Mines along with the Industry Task Team on Climate Change (ITTCC) during 2012 in preparation for public representation at the Multi Year Price Determination (MYPD 3) on energy increases for the period 2013 to 2018, showed that industry and predominantly mining will contribute over and above the current economic allocations an additional R 450 billion to infrastructure development (EIUG, 2012). Given that Eskom under its new building program will spend about R 300 billion on power stations like Medupi and Kusile and Transnet some R 100 billion on rail upgrades, and that these are government institutions under control of the Department of Public Enterprises (DPE) with primarily a revenue based system. The infrastructure development cost will fall predominantly on mining as a sector as it utilizes about 40% of generated electricity and 50% of rail transport in South Africa (Unlimited Energy, 2013).

### **1.1.2 Current situation and policy constraint on energy**

In the past the industry had to overcome serious cost constraints to make it profitable as infrastructure and maintenance costs increased at higher inflation rates than that of the final product (Baxter, 2011:9). This was overcome to some extent by limiting the cost per unit in the production of each ounce (R/ounce) and high product volumes. One of the biggest contributors to low unit costs came from Eskom with the cost of energy; they were and still are among the cheapest suppliers of electricity in the world (Solidarity, 2011). This directly lead to turmoil for the utilities supplier, Free Cash Flow (FCF) was limited and the lack of Government policies allowed for aging infrastructure and generating reserve margins to deplete and the country experienced rolling black outs in 2008 (van der Merwe, 2008). The total net effect to the economy is still undetermined but some gold and platinum mining companies had substantial losses during the period according to Flak (2012). In the past decade industry therefore has seen the rise of energy tariffs far exceeding the Consumer Price Index (CPI) and cumulatively from 2003 to 2018 based on the National Energy Regulator of South Africa (NERSA) approval unit cost of energy has risen from R0.2 /kWh to R1.02 /kWh (Camco, 2013). Calculated annually the increase averages about 20% year on year from a direct line method.

Free Cash Flow (FCF) is the amount of cash flow available to investors who are the providers of debt and equity capital. It represents the net amount of cash flow remaining after the firm has met all operating needs and paid for investments, both long and short term (Megginson, Smart & Graham, 2010:34). Shareholder wealth is influenced by the usage of this FCF.

Government soon realized the constraints of being an emerging economy with limited supply capacity and what effect that would have in reaching the goals set out in the National Growth Plan. In 2010 the Department of Energy (DoE) published the Medium Term Risk Mitigation Plan (MTRM) and its full Integrated Resource Plan (IRP) working with NERSA (DoE, 2010: 8). The IRP looks at what the requirement for economic growth on the demand side is and estimates how the electrical supply should grow in order to sustain a balance of supply (IRP, 2011:6-10). Based on the forecast the generation mix (coal fired, nuclear and renewables) of power stations were planned for future implementation (IRP, 2011:22-31). One of the driving factors in decision-making on what technology would be used is the associated carbon emissions that are caused directly from generation (DoE, 2011:37). Eskom currently produces electricity at 1.02 kg/kWh; this in turn is one of the highest emission factors in the world (Letete, Guma & Marquard 2010:4). To offset the carbon, Government should focus on more renewable technology and less coal (Langridge, 2010:7). By moving to an electricity supply grid that is mostly renewable the costs per unit of energy will escalate to approximately 300% of current costs (NERSA, 2010:25). At the same time new policies like Carbon Tax (Carbon Tax, 2013) and the National Energy Efficiency Strategy (NEES) require reduced consumption levels from mining to set targets (DoE, 2013). Figure 1.2 below illustrates the current cross functional and policy constraints within Government and the obvious challenges there will be to Industry, Mining and the Commercial sectors that will add additional cost pressures.

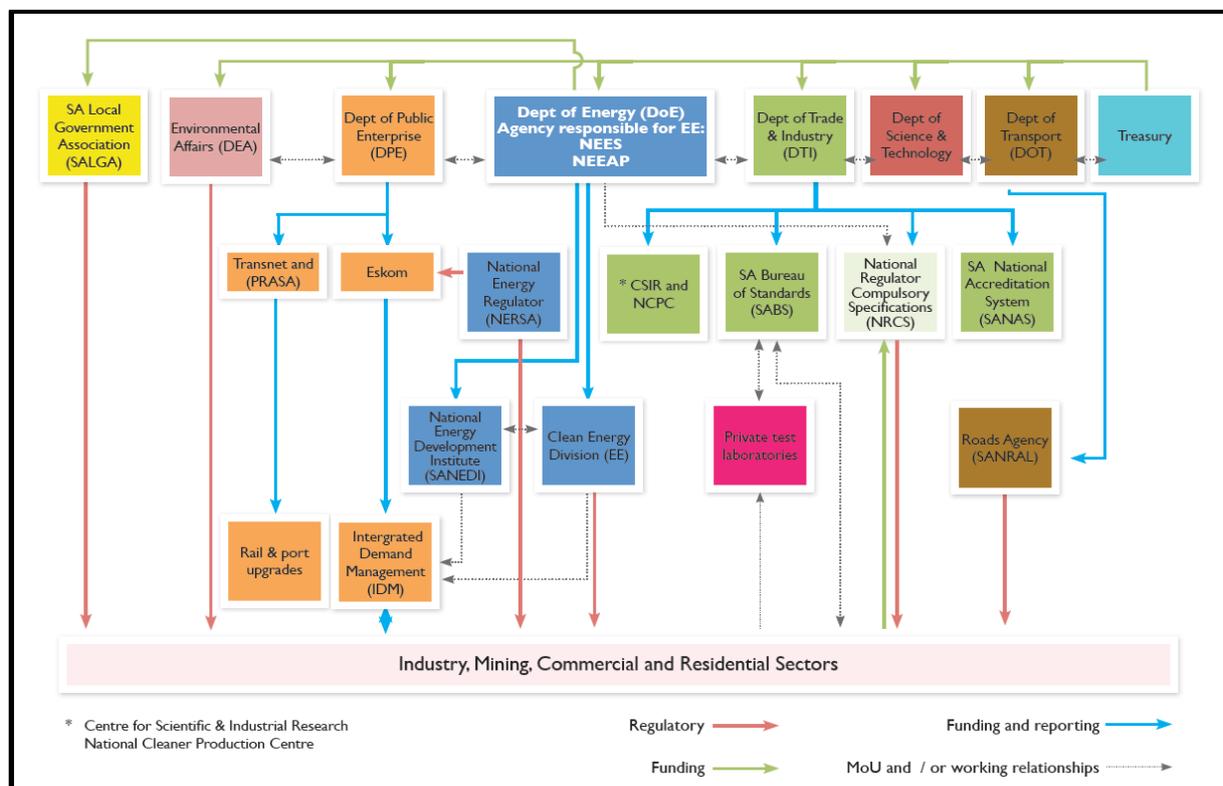


Figure 1.2: Cross functional roadmap and policy delivery from Government (Unlimited Energy, 2013)

### **1.1.3 What message does it send to markets**

In international markets this poses a substantial threat to current platinum, chrome and gold production figures and investor confidence. The majority of metallurgical processes require substantial heat to extract the precious metals (Roussow, 2011:17). Some of the biggest smelters in the world like the Lion Smelter at Xstrata use kilns that run on high electrical consumption electrodes. Looking at direct operational expenditure (OPEX) costs at some companies will increase to approximately 40 percent from current levels of between 12 and 20% if costs are to increase as indicated in the Multi-Year Price Determination (MYPD2) (NERSA, 2010:18). Also Government still needs to decide how carbon taxes should be introduced and at what level of year on year growth it will escalate. According to the Energy Intensive User Group (EIUG) current forecasts indicate price escalations that will exceed inflation figures if applied and this in turn makes no economic sense (Roussow, 2011:24). Business is trying to illustrate what possible alternatives to proposed Government applications are with carbon abatement curves (Camco, 2013).

No exact estimates are available as to what the actual annual growth of associated electrical cost and its contribution to OPEX would be. Very important though is when prices of electricity contribute increases; accurate models for forecasting are required to ensure that cash flow won't be depleted as part of operational costs. Corporates with annual electrical budgets that range in billions of Rands cannot allow for excessive percentage errors on their prediction as it limits capital availability. This in turn snowballs to quarterly performance indicators where budgets and actual numbers differ and available cash is not utilized and could influence investor confidence. The need in industry is for accurate and simplistic modelling solutions to limit the error percentage between budget and actual numbers. Also Government via the National Energy Efficiency Action Plan (NEEAP, 2013) driven from the DoE requires companies to provide annual energy forecasts that enable them to track consumption variations and a method of benchmarking industries to efficiency targets.

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## **1.2 PROBLEM STATEMENT**

Mining is an ever changing production environment that has a vast magnitude of variables that influence energy consumption. Electrical base load calculation and forecasting is influenced by depth, speed of face advance, equipment used and environmental temperature constraints among others. No single solution package enables the analysis of all these variables and their contribution to the base and variable load conditions. This makes accurate predictions on the consumption profiles difficult. The process of annual

budgeting is also limited in the sense that the mechanism used to predict should be simplistic in nature to ensure that the forecasting is done within certain parameters and boundary conditions that make sense with installed infrastructure.

Very important also is that forecasting is site dependent; no single processes between any mining operations are identical due to reef deformation and extraction volumes. It is of essence that models are simplistic and understandable but should limit error percentages.

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## **1.3 RESEARCH OBJECTIVES**

### **1.3.1 Primary objectives**

The main objective of this study is to determine if a single equation per mine or per process can be established that will actively predict electrical consumption and how much error is made for forecasting. Also what the influential factors are to actively predict base and variable load conditions.

### **1.3.2 Secondary objectives**

The sub-objectives of the study are the following:

- The system should be simplistic in nature for use in management forecasting.
  - What the effect of the error have on cash flow and capital availability.
  - If the model could be spread to different operations that include open pit and deep level mining operations.
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## **1.4 RESEARCH METHODOLOGY**

The research methods used in this study are the following:

### **1.4.1 Literature study and theoretical review**

A literature study will be done to evaluate the best method to accurately (within a certain percentage) predict base and variable load conditions within a deep level mine. The literature study will focus on the following for applicable energy models:

- Current forecasting methodology;
- Monte Carlo Analysis; and
- Regression Analysis.

### **1.4.2 Empirical research**

The empirical research was done by means of a quantitative study including a statistical data analysis.

The quantitative study was done on data provided by AngloGold Ashanti energy department. The methods above will be tested on selected processes that make up the mine energy consumption. From the data a prediction on variable and base load conditions will be established.

Statistical data analysis will be used to determine the impact of changes in these variables on changes in the dependent variable which is a variable that tells us how much more/less value the particular process contributes. The method that is most accurate will be applied to a forecast model and tested as to the accuracy of the prediction.

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### **1.5 SCOPE OF THE STUDY**

The field of study for this research is statistics in management of electrical forecasting within the mining environment. The research focuses on what the potential and best practice is for a forecasting model within mining and the application thereof.

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### **1.6 LIMITATIONS OF THE STUDY**

Research will show that there is only a limited amount of publications available and that this study is a first of a kind for mining. The biggest limitation will be that we are focussing on the deep level mining environment. As mentioned, each mine is unique and the study may provide multiple solutions for energy modelling that are highly complicated. The study will also only focus on gold production and within deep level mining it is different from other mineral extraction processes.

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### **1.7 LAYOUT OF THE STUDY**

The rest of the dissertation is as follows: Chapter 2 presents the literature study of the different methodologies as mentioned under 1.4.1. Chapter 3 will be the empirical research; looking to identify variable and base load conditions and also what percentages the forecast models obtained. Chapter 4 will present the results of the analysis along with the conclusions and recommendations.