

An analysis of the sustainable mining of selected minerals and metals in South Africa

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ABSTRACT

The study was done to understand the direction in which South Africa's mining model is developed and the changes required for South Africa to take its rightful place in the mainstream spheres of economic and commercial affairs. The huge demand for African commodities is creating new opportunities for African governments to realise the hopes of their people for a better life. The objective of this study is to analyse the South African mining model to determine the sustainability of mining in South Africa. It was done by analysing Chrome, Coal and Platinum as selected minerals and metals. A literature study was conducted and the focus was on the reserves and resources that South Africa has in these minerals and metals, the current supply and demand factors and estimates were done on the future demand. The last part was to determine the state of and planned expansions of infrastructure like Electricity supply, Shipping Ports, Rail transport, Road transport and Water supply that mining operations require. Following the literature study, a survey was conducted in order to support the findings of the literature study and to determine the most important factors that can influence investment decisions in the mining sector by evaluating the investor's acceptability of South Africa's mineral and resource industry.

It was concluded that the South Africa mining module is well developed with the required skills and knowledge for sustainable mining in the future. It was determined that there would be a future market to maintain a sustainable mining module. The major risk for the sustainable mining module is the reliance on infrastructures required in the mining environment, which is under governmental management. Survey results concluded that South Africa is not an investor-friendly country mainly because of its ineffective administration processes to perform mining. Investors are also seeking for independence of regulatory institutions.

A recommendation for future research would be to determine the optimum South African Governmental needs of the investment in infrastructure capital to ensure that the country's economy will be able to grow.

Key words: Sustainable mining, mining infrastructure, South Africa mining, mining investment, Platinum, Chrome, Coal, markets and uses.

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LIST OF ABBREVIATIONS

AIDC	Automotive Industry Development Centre
BIC	Bushveld Igneous Complex
BRIC	Brazilian, Russian, Indian and Chinese countries
BRICS	Brazilian, Russian, Indian and Chinese countries, with South Africa added
CEO	Chief Executive Officer
CIS	Commonwealth of Independent States
DMR	Department of Mineral Recourses
DWA	Department of Water Affairs
GDP	Gross domestic product
IFC	The International Finance Corporation
OECD	Organisation for Economic Co-Operation and Development
PGMs	Platinum Group Metals
PPP	Purchasing power parity
Prasa	Passenger Rail Agency of South Africa
SA	South African
SANRAL	South African National Roads Agency
UG2	Upper Group 2

CHAPTER 1: NATURE AND SCOPE OF THE STUDY

1.1 INTRODUCTION

South Africa is in the spotlight of mining investors as mining is labelled as a money making business, and individuals, mining companies as well as government benefit from mining and mining related revenues (Nkala, 2009:48). Mining is the extraction of valuable minerals, metals and other geological materials from the earth and can also be defined as the extraction of any non-renewable resource. Materials recovered by mining include base metals, precious metals, iron, uranium, coal, diamonds, limestone and oil (Mintek, 1994:6). In the metal industry it is known that all roads should lead to Africa, yet after a century of active mining it is still the poorest continent in the world and all the countries are heavily in debt to the G8 countries and the World Bank (Nkala, 2009:48). The study will be done to understand the direction in which South Africa's mining model is developed and the changes required for South Africa to take its rightful place in the mainstream spheres of economic and commercial affairs.

1.2 BACKGROUND OF THE STUDY

Mining of rocks and metal has been done since pre-historic times. The mining processes involve prospecting for ore bodies, analysis of the profit potential of the proposed mine, extraction of the desired materials, and disposal of materials and the rehabilitation of the land to repair it to its natural state once the mine is closed. The impact of surging oil and metal prices on Sub-Saharan African economic growth mirrors a trend to the region's Gross Domestic Product (GDP) growth. As commodity prices took off from 2003, so the Sub-Saharan countries' growth rate accelerated from an average of 2.2 per cent annually during the 1990s to 5.9 per cent a year since 2000. This growth is much higher compared to the developed countries like the United Kingdom (-0.2%) and United States (0.4%) and significantly lower than the developing countries like China (9.6%) and India (6.9%). This trend is expected to return from 2010 to 2020 and will be the ignition for the South Africa economy to grow (Rossouw, 2010).

In the last few decades Africa's rich natural resources and raw materials have provided investment opportunities for foreign companies like Xstrata Alloys to grow from a \$500 million company to a \$8 billion international company in over 10 years (Rossouw, 2010). It is the continent with the largest quantity of unexploited arable land, where climate conditions are perfect and water is sufficient. With virtually every Sub-Saharan Africa country endowed with considerable mineral resources, Africa produces more than sixty metal and mineral products and is a major producer of gold, Platinum Group Metals (PGMs), diamonds, uranium, manganese, chrome, nickel, bauxite cobalt and also a major player in the coal market (James, 2009:38). With all the minerals in the ground, Africa is yet to rise economically to take its rightful place in the mainstream spheres of economic and commercial affairs. China, another economical giant who rose in the last decade became an alternative to G8 countries, and trading is made easy as it is not overcomplicated with the concept of good governance procedures. The huge demand for African commodities is creating new opportunities for African governments to realise the hopes of their people for a better life.

Africa has numerous factors favouring investors, the negative factors that cannot be ignored are the disunity and the distrust among political groups fuelled by fear that their economics would be dominated by neighbours and foreigners (James, 2009:38). Not many African people are benefiting from the wealth created by mines. It is not generally known that in Africa, with its population approaching nine hundred million, only two million people are employed in the mining sector (James, 2009:38). Africa with its enormous mineral wealth is viewed as an investor's opportunity, the truth is that the continent has a history of strife, turmoil, starvation, unemployment and is a violator of human rights. When evaluating the current financial powers of continents, the Anglo-Saxon development model also known as the free market capitalistic model for Africa has failed to encourage any measure of sustainable growth on the continent.

1.3 PROBLEM STATEMENT

With the rise in demand for minerals and metals from China, expected economical growth in India next decade and limited resources in the rest of the world, it is still

undetermined if the African countries will receive the benefit that is due to them for mining these precious minerals. In past decades, it was determined that Africa has the minerals and resources to feed the growth of the rest of the world; to optimise on this, one will need to understand the lifecycle of the mining process (From reserve in the ground, mining of reserve, process and beneficiate the mined material and sell it to the capital market) .

1.4 OBJECTIVE OF THE STUDY

1.4.1 Primary objective

The primary objective of this study is to analyse the South African mining model to determine the sustainability of mining in South Africa. It was done by evaluating Chrome, Coal and Platinum as selected minerals and metals. To ensure that South African mining is sustainable, profitable and beneficial to the country, the following issues will be addressed in the study:

- Market overview on supply and demand for selected minerals and metals and the uses thereof.
- Determine the next commodity demand cycle with our knowledge of the growth of the developing world, namely the Brazilian, Russian, Indian and Chinese (BRIC) countries.
- Evaluate South Africa's infrastructure that would be required in the mining process and trade of mined products by means of questionnaires, interviews and market research.

1.4.2 Secondary objectives

The secondary objective of the study will be determined by doing interviews with mining stakeholders and administer questionnaires to key mining stakeholders to:

- Determine the most important factors that can influence investment decisions in the mining sector.
- Evaluate the investors' friendliness of South Africa's mineral and resource industry.

1.5 SCOPE OF THE STUDY

The main focus of the study, analysing sustainable mining of selected minerals and metal in South Africa, will be measured in terms of the attractiveness of investing in mining in South Africa and also evaluating all influences and stakeholders in the mining industry.

The geographical demarcation of the research will be in South Africa. The industry focus will be mining specific and focus on chrome, coal and platinum. The organisational data to be investigated will be Anglo American, BHP Billiton, Sasol and Xstrata, with their associate companies, as they are the major companies operating in the South Africa mining environment, mining the minerals being researched.

1.6 RESEARCH METHODOLOGY

1.6.1 Literature study

The study was based on comprehensive literature studies. The bulk of the research was focused on information that already exists and included mediums such as:

- Research articles
- Marketing analysis
- Statistical publications
- Internet search results
- Magazines
- Mining related policies

The study goal was to gather information to understand the major forces and factors influencing the lifecycle of the mineral and metals markets.

1.6.2 Empirical study

The study was conducted and data were collected by means of questionnaires and interviews and the process was as follows:

- The target population was Mining Houses based in South Africa who have been operating in the mining environment. A total of 249 mining houses were listed by

Mbendia Information Services of which 97 were qualifying because of the minerals they mine (Mbendia Information Services (Pty) Ltd, 2005).

- Statistical analysis of data was conducted in co-operation with data and statistical consultants on the supply and demand factors of minerals, the infrastructure requirement of the mining industry and determines the investment friendliness of mining in South Africa.
- Questionnaires were developed to gather data and were discussed with senior managers and directors of the Mining Houses selected.
- Informal interviews with senior mining executives and consultants were held to discuss the role and vision they have for Mining Houses.

1.7 LIMITATIONS OF THE STUDY

As mining companies and mining stakeholders will all benefit from such a research study, it was a challenge to determine if responses received are a politically correct response, an own view or opinion and not the view of the directors or shareholders of the company and to align uninformed stakeholders' views with the views of the actively involved stakeholders.

Furthermore, the research proposal is a very sensitive matter for all stakeholders, as mining houses/investors are profit driven and want to create wealth. Government stakeholders focus more on development and upliftment of the communities. Surrounding communities rely on the mining houses to do development in the mining areas and create work opportunities. The challenge was to find the balance between the stakeholders' needs as stated above.

When analysing the infrastructure requirements of the South Africa Mining Houses, the challenge was to find the correct status of pipelines, ports and shipping, power supply, water supply, rail transport and road transport. The Mining Houses highlighted the negative experiences and the public sector only reported the positives in their annual results.

1.8 LAYOUT OF THE STUDY

The dissertation will consist of five chapters.

Chapter 1: Scope and nature of the study

Chapter 2: Mineral and metal market

1. Selected minerals and metals

- Chrome
- Coal
- Platinum

2. The next mineral and metal driving mining growth.

Chapter 3: Factors required ensuring sustainable mining growth

1. Infrastructure requirements for mining growth.

- Electricity provision
- Pipelines
- Ports and Shipping
- Rails
- Roads
- Water

Chapter 4: Research methodology

1. Questionnaire and statistical data

2. Conclusion of the survey

Chapter 5: Conclusion and recommendations for future studies

1.9 SUMMARY

The chapter outlined the background of the research, the problem statement, the scope of the study, the framework of the study, methodology, limitation and layout of the study.

CHAPTER 2: MINERAL AND METAL MARKET

2.1 INTRODUCTION

Mineral markets by definition would be broken up into mineral (a substance that occurs naturally in rock and in the ground and has its own characteristic appearance and chemical composition) and market (a gathering in a public place for buying and selling goods) (Atwood, 1985).

The mineral markets that drive the Southern Africa economy are Chrome, Coal, Diamonds, Gas and Oil, Gold, Iron and Platinum Group metals. Of these metals, Chrome, Coal, and Platinum will be studied, as they are the minerals that relay the most of the country's infrastructures like: pipelines, ports and harbours, power, rail, road and water. Iron ore was also considered, but requires the same infrastructure as Chrome and Coal. This chapter will establish if the fundamentals of the South Africa mineral market will still exist and be sustainable for future years.

The major growing economies are the BRIC countries, namely Brazil, Russia, India and China. In 2010, South Africa was added to form the BRICS countries but as it is the country being studied, it will not be studied in the same manner as the original BRIC countries in the second part of chapter 2. They are deemed to all be at a similar stage of newly advanced economic development and responsible for the economic growth in the world.

2.2 SELECTED MINERAL AND METALS IN SOUTH AFRICA

2.2.1 Chrome

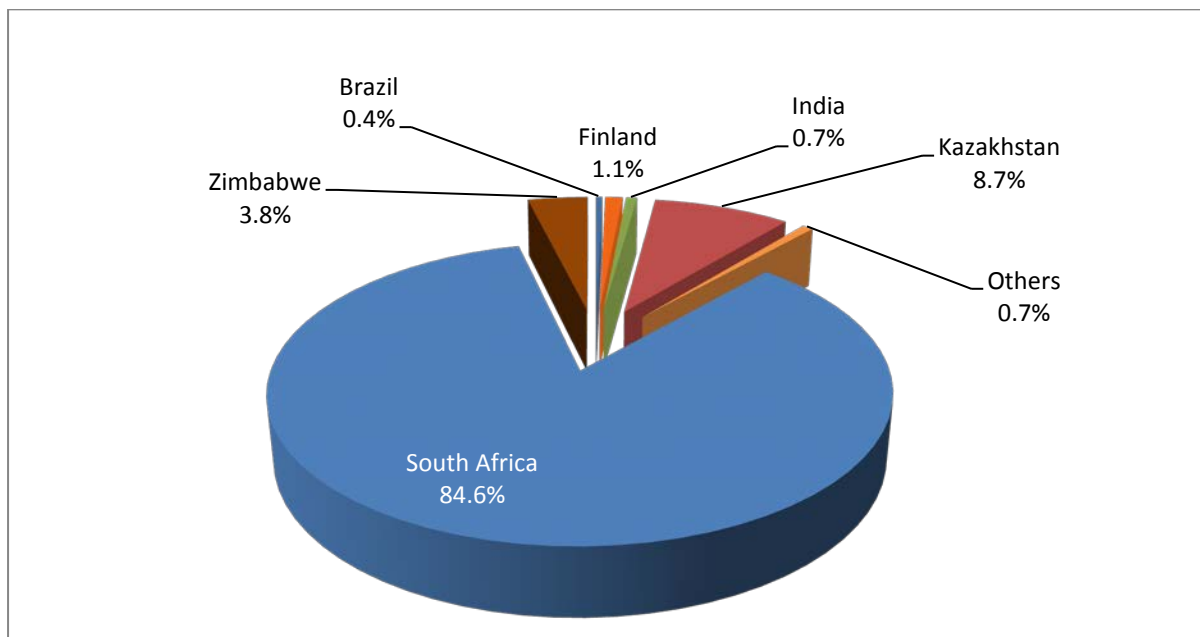
Chrome ore reserves in the world are abundant, but highly concentrated in South Africa, Zimbabwe, Kazakhstan and India. These four countries accounted for an estimated 70% of world chromite production in 2008 (Roskill, 2009:41). Around 90% of the world's chrome ore reserves and resources are located in South Africa, forming on the Bushveld Igneous Complex, and in Zimbabwe, on the Great Dyke. The uneven distribution of reserves has resulted in a continued shift of Ferro-chrome

production from stainless steel-producing countries to chromites-producing countries.

Chromium mining started in earnest only in 1921, and by the start of the Second World War, production had reached 180 000 tons per year. Until the 1970s, the greater part of South Africa's chromite ore was exported. From 1970 onwards local industry gave increasing attention to the manufacture of ferrochromium and stainless steel in South Africa.

The South African reserve base for chrome ore is estimated to be at 85% of the world total as indicated in figure 2.1. Reserves occur in the Bushveld Igneous Complex, a layered igneous intrusion that stretches across North West, Gauteng, Mpumalanga and Limpopo provinces. Stratiform ore seems to occur within layers of mafic to ultramafic rocks which formed as a result of differential crystallisation in a cooling magma. The complex is oval-shaped, measuring over 300km east to west and 100km north to south and the layers dip gently towards the centre. The chrome ore seams vary in thickness from below 1cm to over 2m and can be continuous along a strike for over 100km.

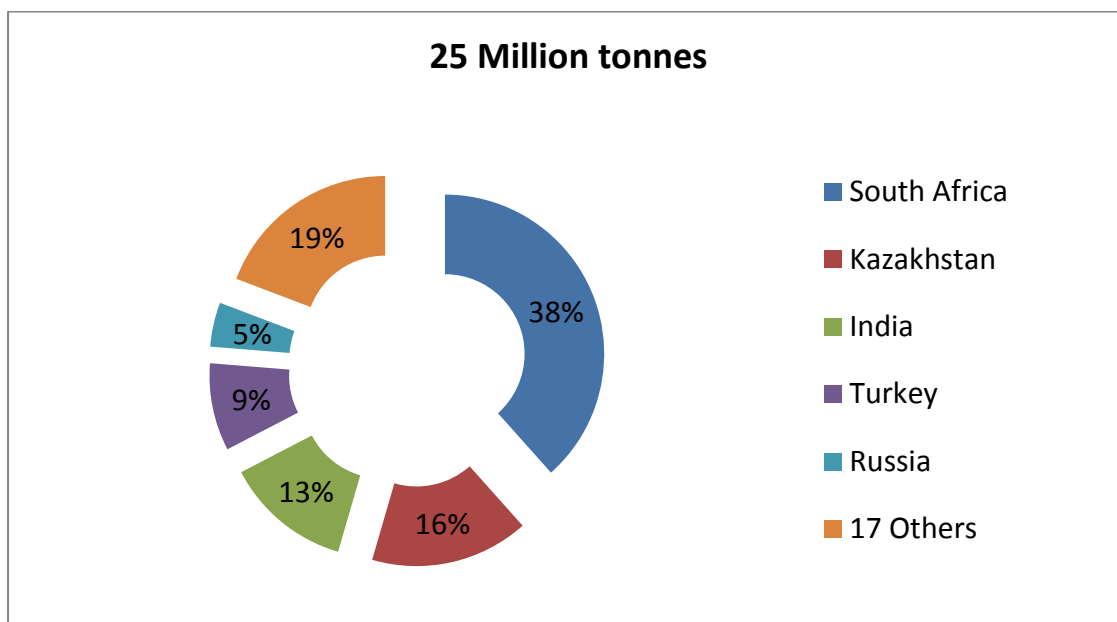
Figure 2.1: Chromite reserves represented by country



Source: (Roskill, 2009:14)

Chrome ores are mined on both the Eastern and Western Belt of the Bushveld Igneous Complex. The ores are lower in grade than those mined in many other countries, with a Cr_2O_3 content of 40-48% and a Cr:Fe ratio of below 2:1. Reserves are close to the surface; however, low mining costs compensate for lower ore grades. The Bushveld ores are suitable for the production of charge chrome, and for foundry and chemical uses, because the silica content of friable ores can be easily reduced. With South Africa as the major producer at 38% of the world production as indicated in figure 2.2, it is clear that South Africa is not using the advantage of being the mineral rich country with 84.6% as shown in figure 2.1, of the world's chromite reserves. Zimbabwe with 3.8% of the Chromite reserves, being 3rd largest in the world, is not even ranked under the top 5 producers and is currently producing less than 1% of the production.

Figure 2.2: World Chromite Production



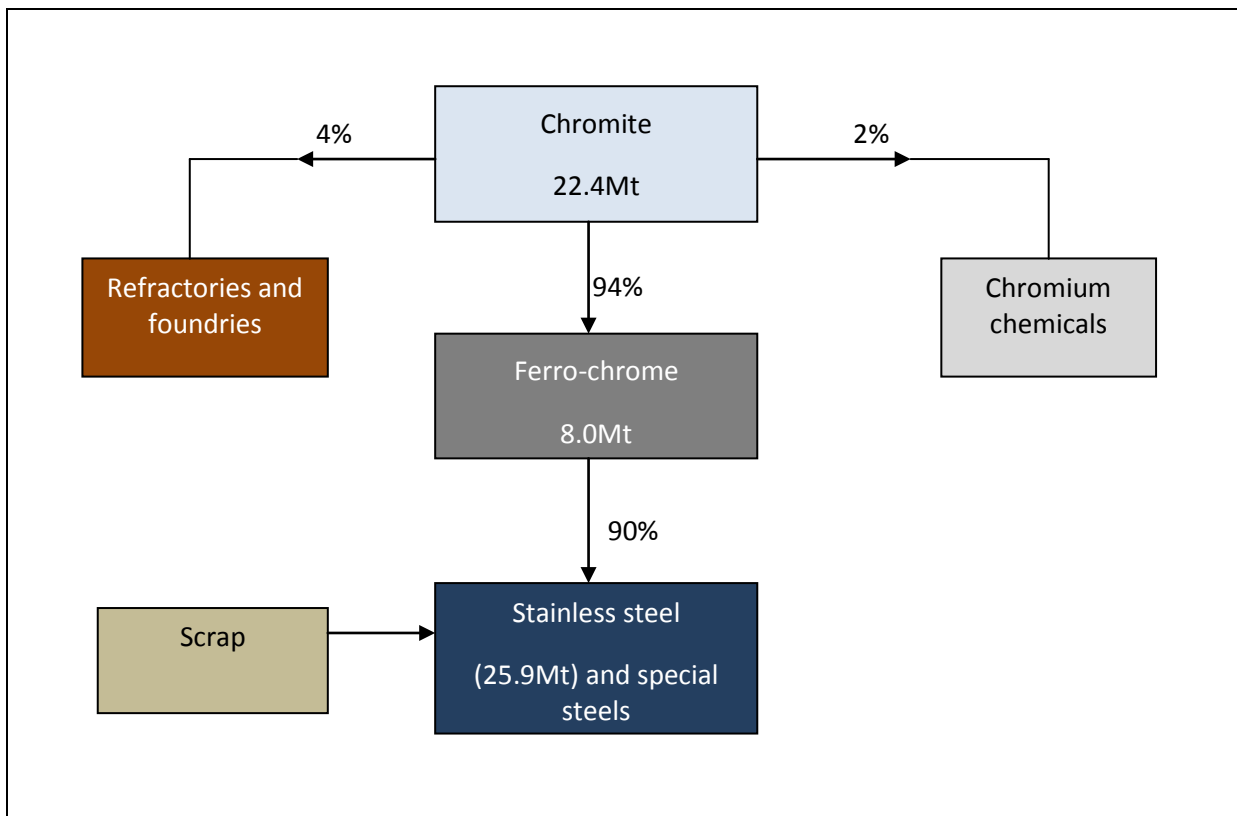
Source: (Roskill, 2009:41) (Calculated)

In the Chrome market as shown in figure 2.3, Chromites are supplied to the metallurgical industry for use in the production of Ferro-chrome and 94% of Chromite is consumed in the process. Highlighted in figure 2.3, around 90% of Ferro-chrome is consumed in the production of stainless steel, where it is used to impart corrosion and oxidation resistance and to enhance hardened ability, creep and impact strength. Metallurgy uses for Chromite accounts for 94% as shown in figure 2.4. Trends in the stainless steel market are therefore the main determinant of demand

for both Chromites and Ferro-chrome. Chromium metal is also added to high-performance and non-ferrous alloys and sputtering targets to increase hardness and strength.

A further 2% is consumed in the production of sodium dichromate and other chromium chemicals used in metal surface treatment, leather tanning, wood preservation and pigments. The remaining 4% is used in basic refractories and as foundry sand.

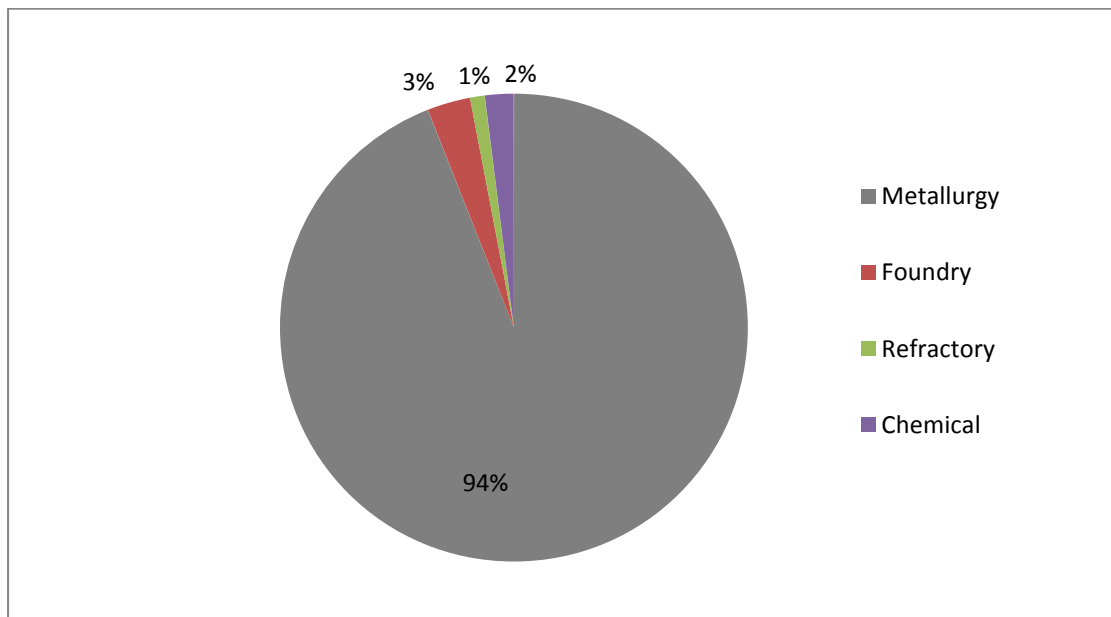
Figure 2.3: The 2008 World Chromium market



Source: (Roskill, 2009:8)

The metallurgical use of Chromite requires beneficiation processes like smelting and refining which is very energy intensive. Other end-uses for chromium are foundry products, chemicals and refractory goods. The stainless steel industry is by far the largest consumer of Ferro-chrome, without which stainless steel cannot be produced.

Figure 2.4: World Chromite production by end-use



Source: (Roskill, 2009:4)

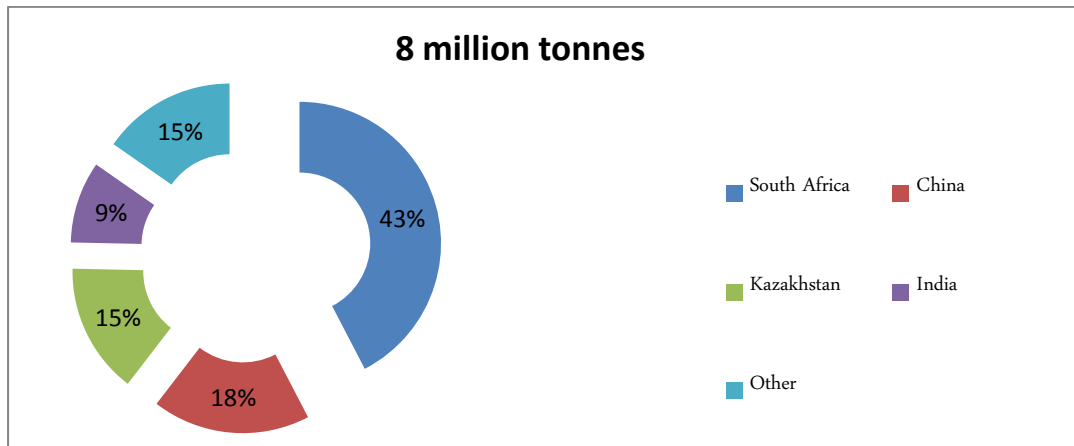
Until the beginning of the downturn in the global economy in mid-2007, stainless steel production had shown large increases. Demand in developing countries such as China and India helped global output increase at an annual average rate of 5.4% for the period 2000 to 2007, with China alone accounting for over 60% of the rise in global stainless production (Roskill, 2009:4). This sharp rise in the manufacture of stainless steel has seen demand for Ferro-chrome increase at a similar rate.

The largest markets for Chromite containing refractories are the Commonwealth of Independent States (CIS), mainly the Ukraine, Russia and some parts of China, where steelmaking technology is less advanced and environmental regulations are less stringent than in developed economies.

Leather tanning is the largest end-use for chromium chemicals, accounting for around 32% for total consumption (Roskill, 2009:4). The fact that leather production is largely labour intensive has meant there is a low degree of automation in the industry. As a result of the amount of labour required, tanning activity has moved to hide producing countries, notably USA, Brazil, Argentina and Australia, or to countries with low labour costs, such as India and China (Roskill, 2009:5).

Ferro-chrome is the downstream product of the Chromite mined and figure 2.5 will highlight the role South Africa play in the ferro-chrome market.

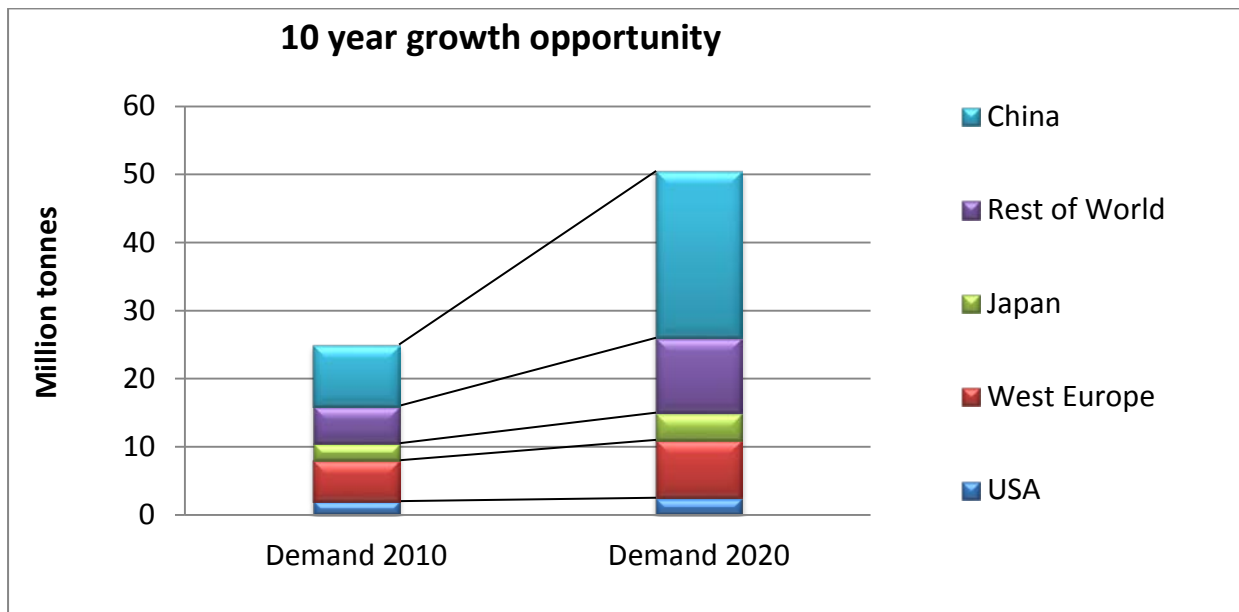
Figure 2.5: Ferro-chrome supply



Source: (Roskill, 2009:50) (Calculated)

South Africa is the major producer of Ferro-chrome, with 43%. China with no reserves and no mining activities in Chromite is the second largest supplier with 18%. The 18% China represents is the opportunity that was lost by South Africa, as it is the country with 84.6% of the reserves as shown in figure 2.1. The growth of the Chinese market is the result of their government's assistance to the beneficiating side of mining in their quest to increase economical growth. Current demand and the projected increase for demand in Ferro-chrome market is shown in figure 2.6. Should a double in demand for Ferro-chrome realise within ten years, mainly expected from China, a supply opportunity would have to be filled by the producing countries. For every 10% increase in world demand for Chromite ore, South Africa's output in Chromite ore have the potential to increase 26% to the supply side and will have to increase with year on year by 13%. The main factor to take up the growth opportunity or economical benefit would be the countries willing to beneficiate these metals. Beneficiating functions smelting and refining is very energy intensive and the country must have sufficient electricity supply.

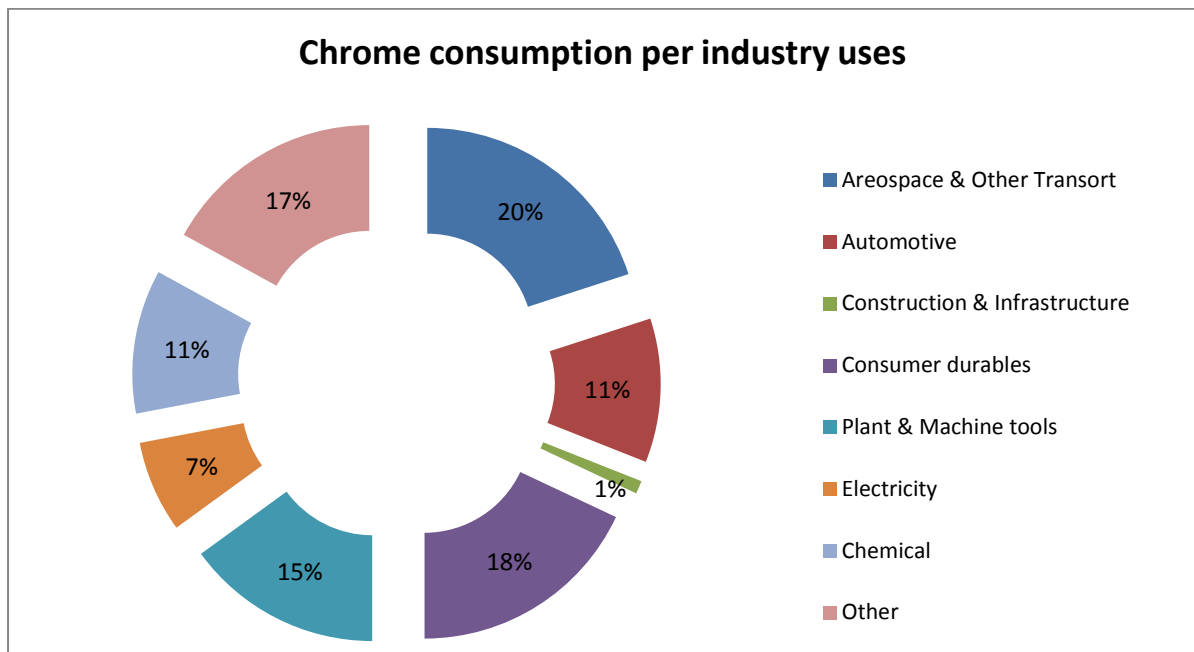
Figure 2.6: Chrome demand and expected growth



Source: (Xstrata Marketing Department, 2010) (Calculated)

Chrome as a mineral and metal have a relatively big distribution in uses as shown in figure 2.7. The bigger the distribution of uses, the more risk adverse the metal is as it is represented and used in a variety of markets. The expected growth was also discussed in section 2.3.2 and shown in figure 2.6.

Figure 2.7: Chrome Consumption



Source: (WBMS, BAS - ML Research Estimates, 2009)

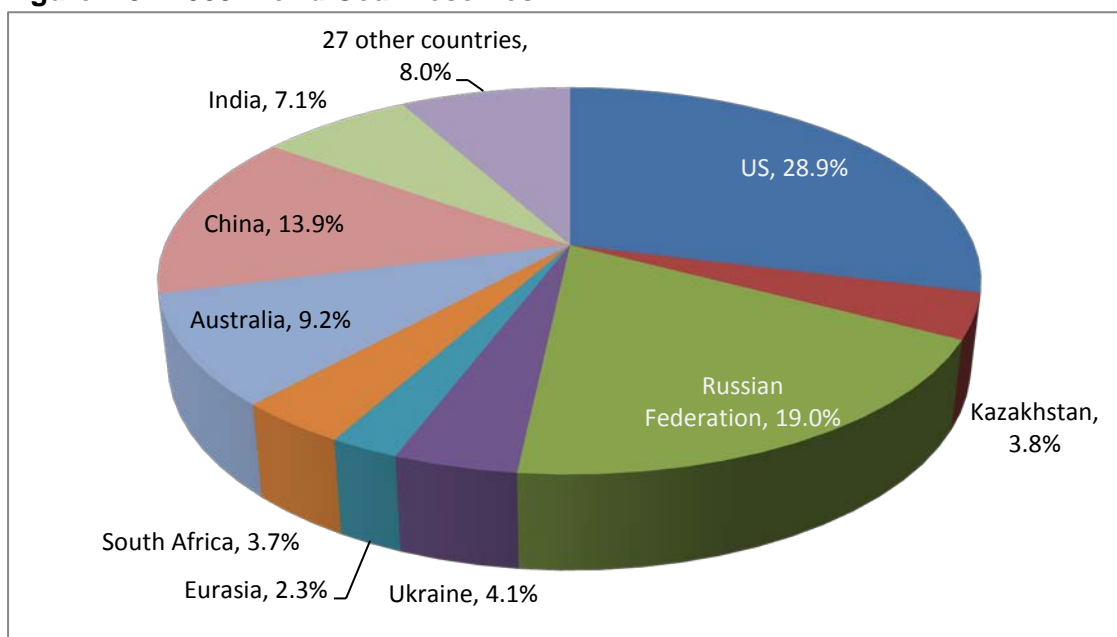
According to Nienaber, Chief Executive Officer of Xstrata Alloys, the world's biggest Chrome producer and referring to figure 2.7, the main uses of chrome are in the aerospace and transport, the automotive, consumer durables and plant and machinery tools industry. The wide variety of uses of the metal will take a really brave man to state that these markets will stop to expand and this makes a continuous investment in Chrome quite attractive.

2.2.2 Coal

Coal is a global industry, with coal mined commercially in over fifty countries and used in over seventy countries. There are mainly two types of coal and they have different uses. Steam coal, also known as thermal coal is mainly used in power generations and Coking coal, better known as metallurgical coal, is mainly used in steel production. Coal is readily available from a wide variety of sources and can be transported to demand centres quickly, safely and easily by ship and rail. The big supply base of produces ensure a very competitive and efficient market (World Coal Association, 2010).

Latest estimations are that that there are over 826 billion tonnes of proven coal reserves worldwide at the end of 2009. This means that there is enough coal to last world around 119 years at current rates of production. In contrast, proven oil and gas reserves are equivalent to around 46 and 63 years at current production levels (BP, 2010:32).

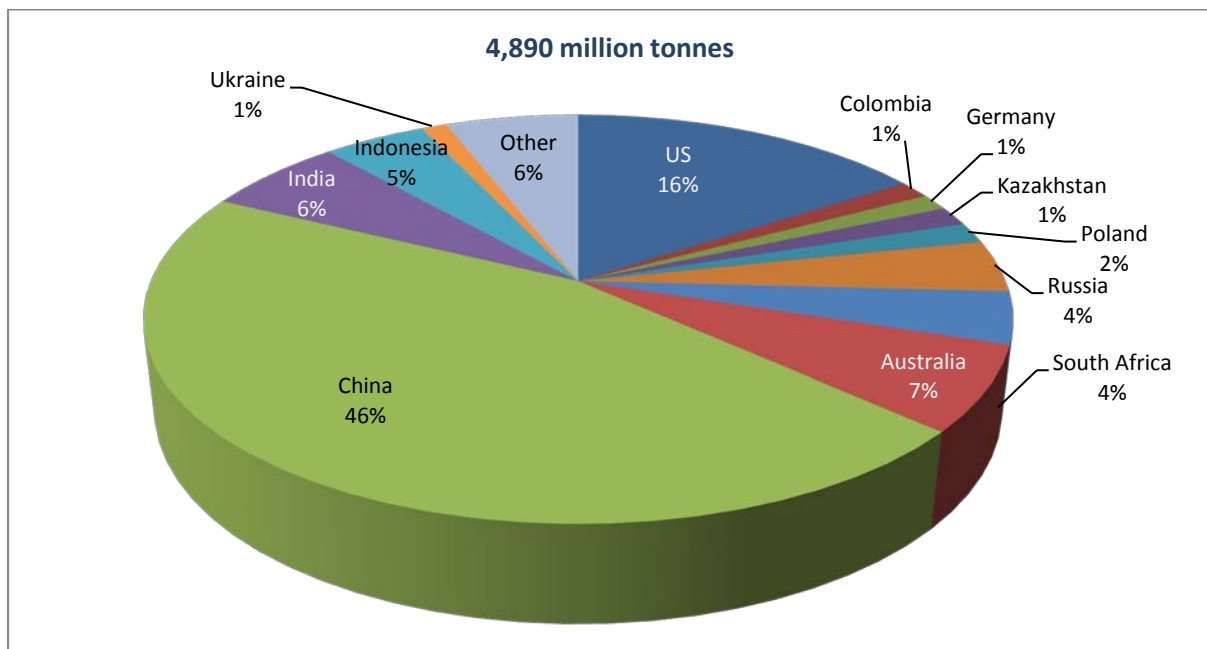
Figure 2.8: 2009 World Coal Reserves



Source: BP (2010:32)

According to the 2010 BP Statistical Review of World Energy – June 2010 survey (BP, 2010), South Africa had at the end of 2009 coal reserves amounting to 30,408 million tonnes, 3.7% of the world total as illustrated per in figure 2.8. South Africa has Africa's only significant coal reserves. South Africa had 2009 coal production of 250.02 million tonnes, 4% shown in figure 2.9 of the world total, and enough to last South Africa 120 years at the current production rate.

Figure 2.9: World coal producers



Source: BP (2010:34)

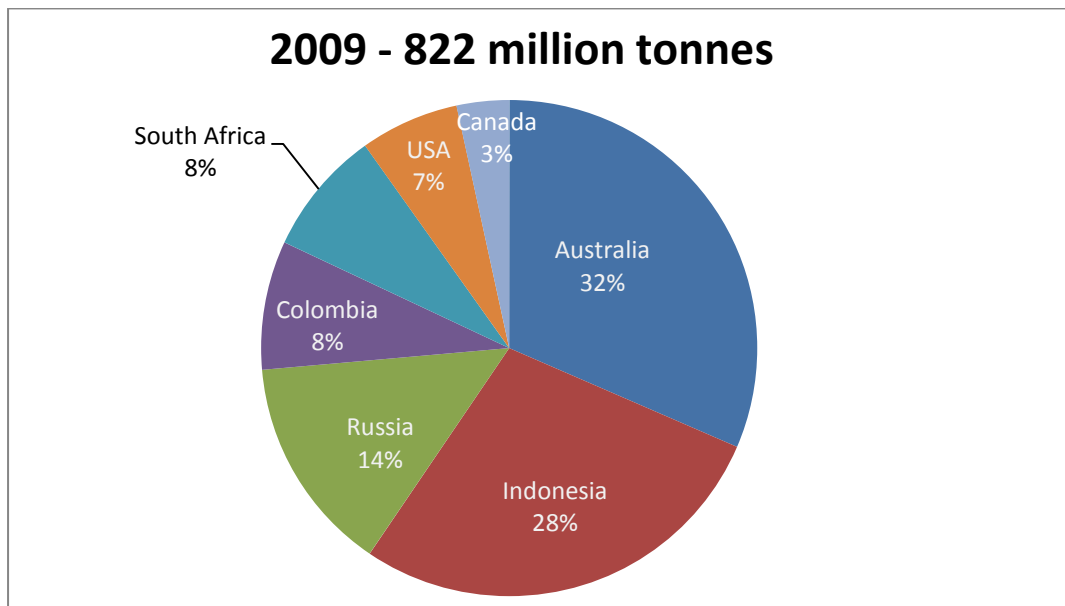
South Africa's coal production was valued at approximately R60 billion in 2009. The world's major producers are China, the USA, India, Australia, Russia, Indonesia and South Africa. South Africa had 2009 coal consumption of 99.43 million tonnes, equivalent to 3.03% of the world total. South Africa is Africa's only significant coal consuming nation. South Africa is currently the fifth largest coal producing country in the world, producing around 224 million ton of marketable coal each year (World Coal Association, 2010). With the small percentage market share, South African production will have a marginal effect on world coal markets should supply and demand markets be reviewed. The more important fact is that coal is needed for power generation to assist the country to maintain its position as market leaders in Ferro-chrome and Platinum Group Metals. Currently, about 93% (World Coal

Association, 2010) of South Africa's primary energy needs are provided by coal and delivered by Eskom. Due to the relative lack of suitable alternatives, this situation is unlikely to change over the next 10 years. Coal's role as a fossil fuel is likely to become increasingly important in a world in which concerns over energy security are rising and demand for energy is growing strongly (World Coal Association, 2009).

Eskom is a state owned electricity provider and is South Africa's sole provider of energy and for the review of electricity provision Eskom as a company was reviewed. Eskom is the 11th largest electricity generator in the world, while Sasol is the largest coal-to-chemicals producer. The main challenge to the ongoing use of coal as an energy source is environmental concerns. About 51% of South African coal mining is performed underground, with the balance produced by open cast methods. The industry is highly concentrated; with the top five producers namely Anglo American Coal (23.4%), Exxaro (15.6%), BHP Billiton (17.5%), Sasol Coal (13.7%) and Xstrata Coal (13.6%) in total produce 84% of the commercial coal. More than 70 000 workers are employed in the coal industry (Chamber of Mines, 2009:18). The majority of the country's coal is currently mined in the Highveld, Witbank and Ermelo coalfields located in Mpumalanga province. Witbank coalfield is by far the most important source of South Africa's mined coal at present. Current environmental factors like water and air pollutions are raising the concerns of the sustainability in mining of this deposit; however, the future of South Africa's coal industry depends on the development of the Waterberg deposits, which extend into Botswana.

Overall international trade in coal reached 822 million tons in 2009; while this is a significant amount of coal it still only accounts for about 16% of total coal consumed. Most coal is used in the country in which it is produced. True supply for coal would be to refer to the net exporters as illustrated in figure 2.10, where South Africa accounts for 8% of total world exports in 2009 (World Coal Association, 2009).

Figure 2.10: Coal supply by world coal exporters



Source: (BP, 2010:34)

Access to modern energy services not only contributes to economic growth and household incomes but also to the improved quality of life that comes with better education and health services. All sources of energy will be needed to meet future energy demand, including coal.

Coal has many important uses worldwide. The most significant uses for steam or thermal coal is in electricity generation and coking coal used for steel production, cement manufacturing and also converted to liquid fuel. Around 5.8 billion tonnes of hard coal were used worldwide during 2009 and 953 million tonnes of brown coal. Since 2000, global coal consumption has grown faster than any other fuel. The five largest coal users - China, USA, India, Japan and Russia - account for 72% of total global coal use (World Coal Association, 2009).

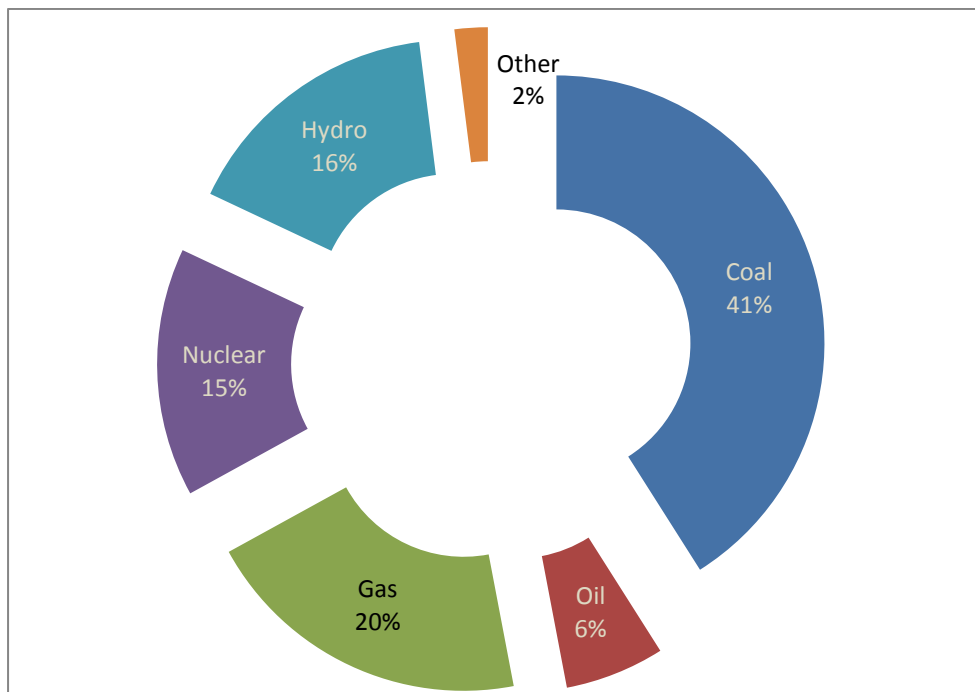
Coal is traded all over the world, with coal shipped huge distances by sea to reach markets. Over the last twenty years:

- seaborne trade in steam coal has increased on average by about 7% each year
- seaborne coking coal trade has increased by 1.6% a year (World Coal Association, 2010).

The biggest market for coal is Asia, which currently accounts for 56% of global coal consumption; although China is responsible for a significant proportion of the Asian market share. Many countries do not have natural energy resources sufficient to cover their energy needs, and therefore need to import energy to help meet their requirements. Japan, Chinese Taipei and Korea, for example, import significant quantities of steam coal for electricity generation and coking coal for steel production.

Coal plays a vital role in electricity generation worldwide. Coal-fired power plants currently fuel 41% of global electricity and gas the second most significant source as shown in figure 2.11.

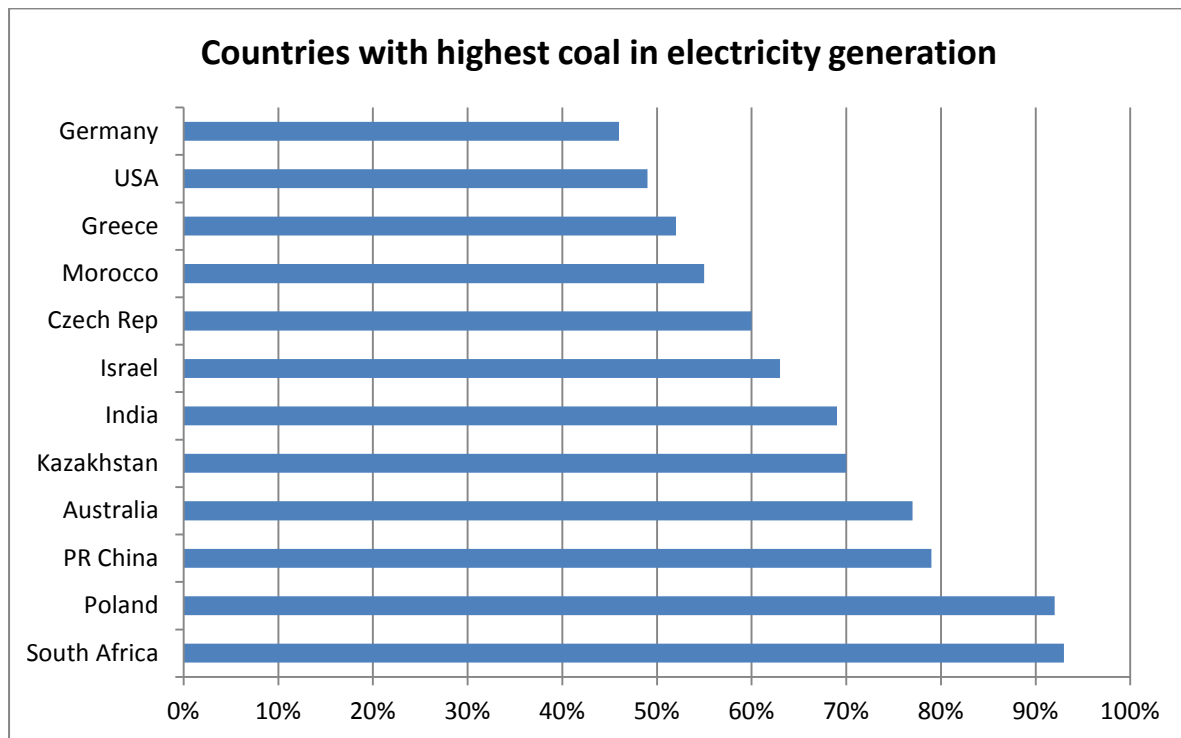
Figure 2.11: Total World Electricity Generation by Fuel (2009)



Source: (World Coal Association, 2010)

The countries with the highest percentage coal fuels are demonstrated in figure 2.12. These countries will be the highest coal dependents and will also have a great risk of air pollution. The importance of coal to electricity generation worldwide is set to continue, with coal fuelling 44% of global electricity in 2030 (World Coal Association, 2009).

Figure 2.12: Coal in electricity generation



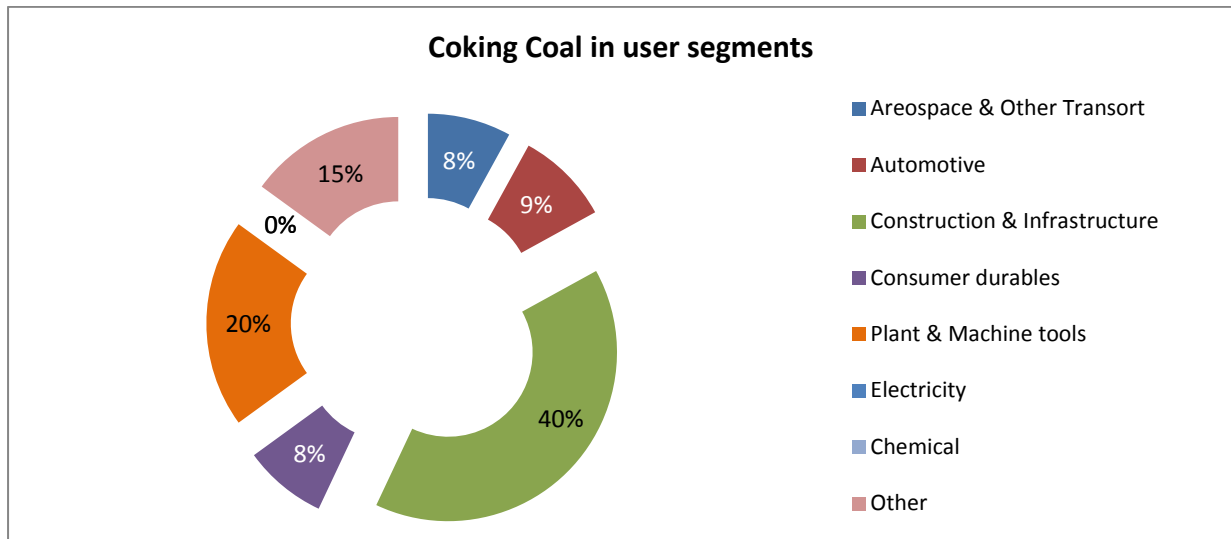
Source: (World Coal Association, 2009)

Other important users of coal include alumina refineries, paper manufacturers, and the chemical and pharmaceutical industries. Several chemical products can be produced from the by-products of coal. Refined coal tar is used in the manufacture of chemicals, such as creosote oil, naphthalene, phenol, and benzene. Ammonia gas recovered from coke ovens is used to manufacture ammonia salts, nitric acid and agricultural fertilisers. Thousands of different products have coal or coal by-products as components. The products are everyday products like soap, aspirins, solvents, dyes, plastics and fibres, such as rayon and nylon. Coal is also an essential ingredient in the production of specialist products like:

- **Activated carbon** - used in filters for water and air purification and in kidney dialysis machines.
- **Carbon fibre** - an extremely strong but light weight reinforcement material used in construction, mountain bikes and tennis rackets.
- **Silicon metal** - used to produce silicones and silanes, which are in turn used to make lubricants, water repellents, resins, cosmetics, hair shampoos and toothpastes (MBendi Information Services (Pty) Ltd, 2005).

Coking coal as stated in figure 2.13 is relatively diversified and mainly used in the construction and infrastructure and the manufacturing of plant and machine tools. These user segments are the key to all growth areas for developing countries and will continue to grow. The expected growth of coal is discussed in section 2.3.2 and shown in figure 2.13.

Figure 2.13: Coking Coal Consumption



(WBMS, BAS - ML Research Estimates, 2009)

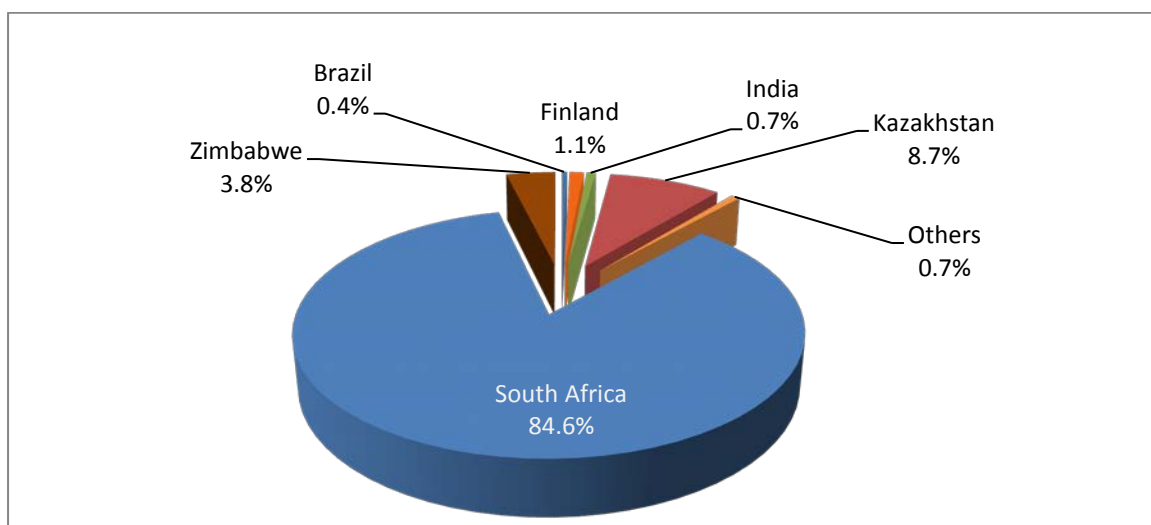
With thermal coal 100% consumed in the electricity sector with a hyper-inflated demand to be analysed as part of electricity supply, as long as no feasible alternative is available, that substantial growth opportunities exist for South Africa to grow its thermal coal output. Thermal coal can also directly be linked to electricity supply, on which the growth of Chromite, Platinum Group Metals and Iron is dependant, as they are all energy intensive due to smelting and refining processes required to produce the final product.

2.2.3 Platinum Group Metals

Platinum is the most important of the group of elements called the “platinum group metals or PGMs”, the other members of which are ruthenium, rhodium, palladium, osmium, and iridium. Platinum supply is highly concentrated with more than 75% of the global primary platinum supply that comes from South Africa, which equates to 63% of the total supply as indicated in figure 2.15. The PGMs occur within a volcanic intrusion called the Bushveld Igneous Complex (BIC). The BIC is a basin-shaped intrusion of some 370 kilometres across, with only its rim exposed. The intrusion

contains numerous distinct layers (magmatically differentiated), three of which contain economic concentrations of PGMs. The main PGM bearing layers, often referred to as 'reefs', are called the Merensky Reef, the Upper Group 2 (UG2) Reef and the Platreef. The Merensky Reef is located on the Western and Eastern Limbs of the BIC and is presently the primary target for exploitation, providing some 54% of the world's platinum. The Upper Group 2 (UG2) layer is also located on the Western and Eastern Limbs and currently yields 21% of the world's platinum supply (Terblance, 2010). UG2 is fast becoming an increasingly important source for PGMs as shallow Merensky ore bodies deplete. Numerous Merensky generation shafts now exploit the UG2 along with several new mines and projects in ramp-up. Both layers contain valuable copper and nickel by-products, but base metal concentrations are generally minor in the UG2 Reef. On the Northern Limb of the BIC the third reef, known as the Platreef, accounts for 4% of the world's platinum, with only one mine in operation at present. The Platreef has a number of exploration projects and a relatively high concentration of base metal credits of nickel and copper. As per figure 2.14, South Africa represents 84.6% of the total proven platinum reserves in the world. With 75% of primary platinum supplied by South Africa equating to 63% of the total supply of 2009 shown in figure 2.15, the bulk of the beneficiating happens in South Africa and the process is highly dependent on electricity to run the base metal and precious metal refineries.

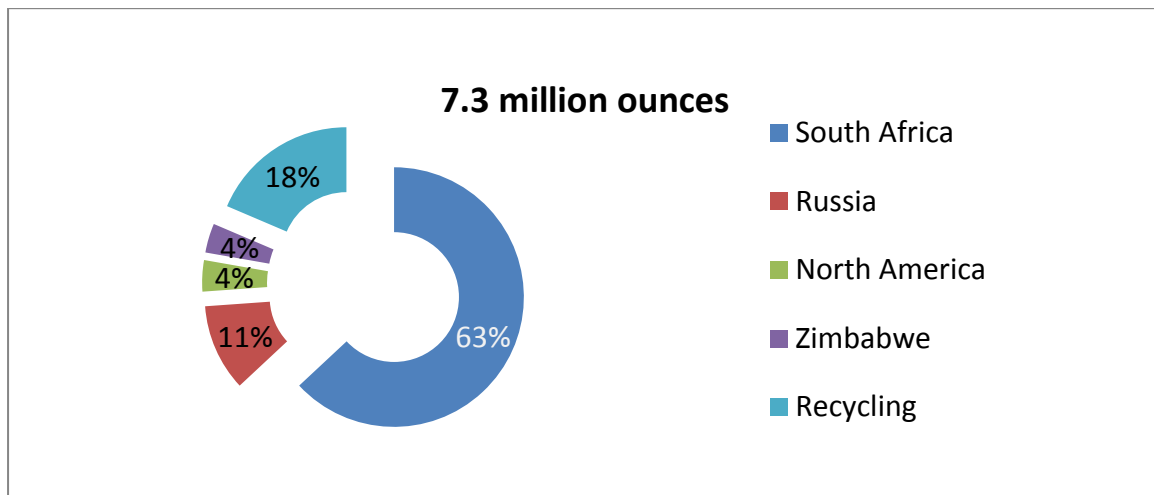
Figure 2.14: Platinum reserves represented in the world



Source: (Terblance, 2010)

The world's main supplier of platinum is South Africa with 63% during 2009 indicated in figure 2.15; should recycling be ignored, this amounts to 75% of the primary supply. Other than Chrome, South Africa have the biggest resource, and is also the primary supplier for platinum on a similar basis. The challenge for the Platinum sector is to retain the market position they have.

Figure 2.15: Platinum supply



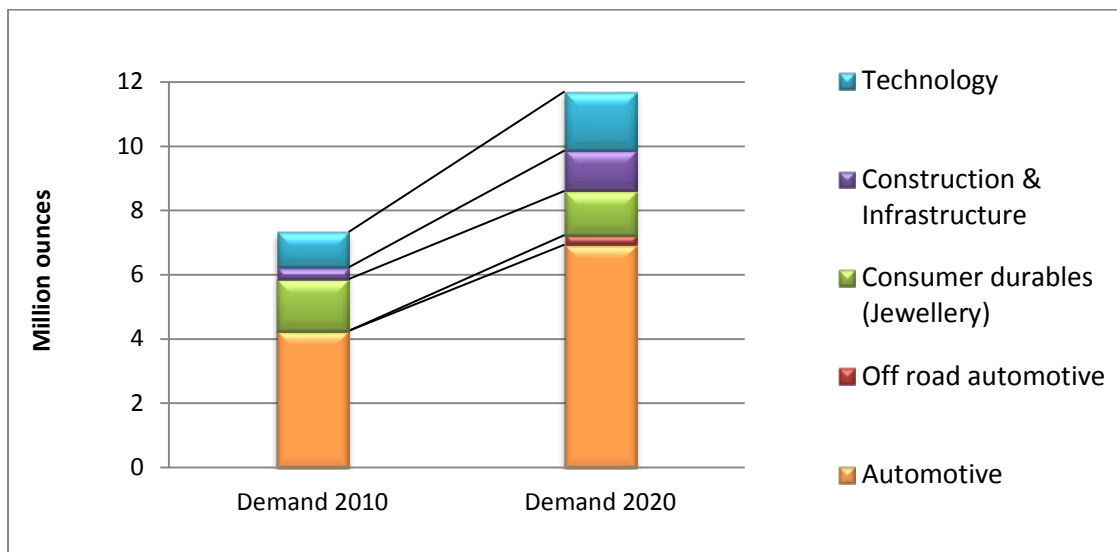
Source: (Johnson Matthey Public Limited Company, 2010)

Platinum demand is mainly in the automotive sector as shown in figure 2.16, with a substantial portion being used in the jewellery and technology sector. The leading demand sector for PGMs will continued to be catalyst for air-pollution abatement in both light-and heavy duty vehicles. Platinum alloys in cast or wrought form, are commonly used for jewellery. It was always marketed as the preferred metal for engagement rings in the United States of America, but as a result of its scarcity and high prices compared to gold, soon became a signature of exclusivity. In India where arranged marriages are still custom and traditional gold rings are passed down from generation to generation, PGM rings are marketed as the signal that true love was found within the arranged marriage. In Japan and China, platinum jewellery is marketed as a signature of pureness once a man declares his love to a woman. PGMs are also used in the chemical sector as catalyst for manufacturing bulk chemicals such as nitric acid in the petroleum refining sector and in the fabrication of laboratory equipment. In the technology sector, PGMs are used in computer hard disks, multilayer ceramic capacitors, liquid crystal displays, flat-panel displays (television) and hybridized integrated circuits. PGMs are used in the construction

sector in the production of fibreglass. Platinum is also becoming an investment tool in the form of Exchange Traded Fund, where on invest in the PGM metals bars.

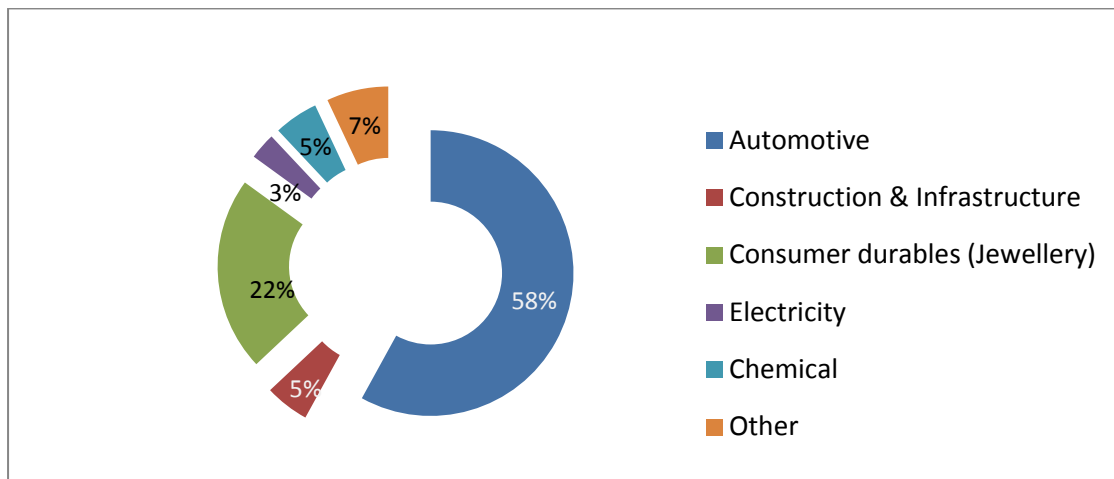
Platinum is the key to a greener environment, which is currently on of the world's most talked about challenges in the form of global warming. This is supported by the Global emission standards; during 2010, Europe was already adopting the Euro 5 standard and China and Russia the Euro 4 Standard. India is currently on the Euro 3 standard. According to the Global Emission Standards Timeline, all countries must adopt the Euro 5 standard by 2016. This will put additional pressure on the supply sector which is good for South Africa as this legislation enforces the use of catalytic convertors in the automotive sector. It is expected that the demand for PGMs is the automotive sector to increase with 50% as indicated in figure 2.16 of platinum demand.

Figure 2.16: Sector demand for platinum



Source: (Steve Forrest Associates, 2009:46) (Calculated)

Figure 2.17: PGM Consumption in the end user sector



Source: (WBMS, BAS - ML Research Estimates, 2009)

Although Platinum is mainly driven by the automotive sector, it is relatively diversified and is essential to everyday use as illustrated in figure 2.17. The issue to address is to determine what feasible alternatives or reasons would exist that would hamper the growth of platinum as the markets exist. The growth of platinum is discussed in section 2.3.2 and figure 2.16.

2.3 THE NEXT MINERAL AND METAL DRIVING SUSTAINABLE MINING GROWTH

As determined in Chapter 2.2, South Africa has the mineral reserves, knowledge to process the minerals and metals to sell it to the rest of the world to stimulate the current and expected demand. America is one of the oldest economies to keep data on their commodity consumptions (WBMS, BAS - ML Research Estimates, 2009). To model demand and consumption trends, the United States of America is used as a benchmark due to unique data on commodity consumption back to 1900 that will highlight the use of commodities during the period of United States industrial development and plot Brazil, India and China, three of the BRIC countries, on the commodity trends. By determining the historical demand and consumption of commodities, a projection will be made on which commodities will have a consistent or growth demand over the next few decades.

Projecting consumption trends for specific commodities will enable the determination for the minerals and metals mined in South Africa that will have a sustainable market

and also serve as an indication on what commodities the country can expand on. Russia has very little supply, demand and consumption data available to analyse and is assumed to follow the same trend as the other three countries as part of the BRIC demand, which is expected to be the same trend as the United States industrial trend.

2.3.1 Commodity demand from developing markets

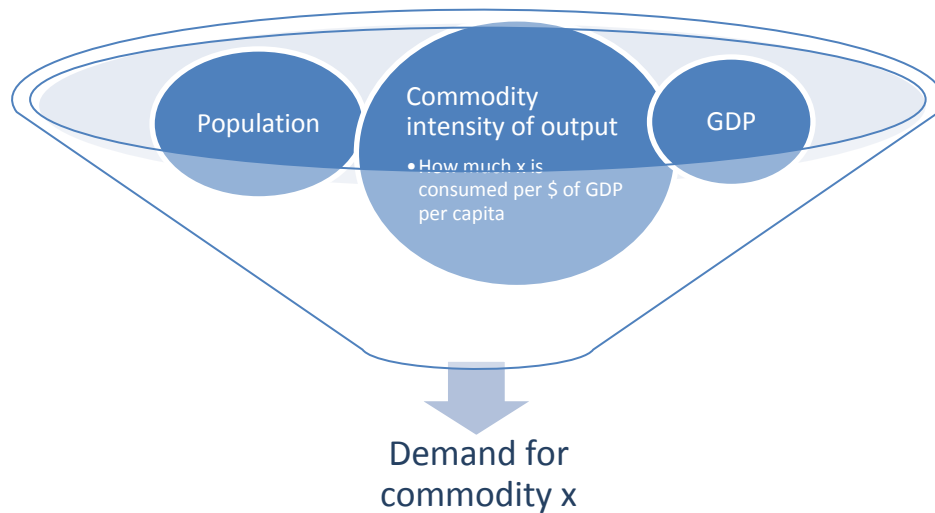
The last decade saw the BRICS make their mark on the global economic landscape. Over the past 10 years they have contributed over a third of world Gross Domestic Product (GDP) growth and have grown from one-sixth of the world economy to almost a quarter as measured in purchasing power parity terms (PPP). Looking forward to the coming decade, this trend will be continuing and become even more pronounced (Goldman Sachs Group Inc, 2010).

2.3.2 Commodity demand in Brazil, India and China

The following salient features were taken into account in determining the demand:

- Commodity demand or consumption in a given country typically varies with population, GDP and average wealth.
- Typically, as population and GDP rise, commodity demand will also rise; however, as average wealth rises the commodity use per \$ of GDP per capita, or commodity intensity, may rise or fall depending on a country's stage of development.
- The Long run model in figure 2.18 links these three factors with the Brazilian, Chinese and Indian economies using forecasts for population, GDP and wealth – along with analysis of how commodity intensity varies with wealth based on benchmarking.

Figure 2.18: Three sources of growth in long run demand



The data in Table 2.1 for the population % growth and GDP % growth will be used as part of the calculation showed in figure 2.18 to determine the demand for the commodities.

Table 2.1: Actual and expected growth rates of BIC economies

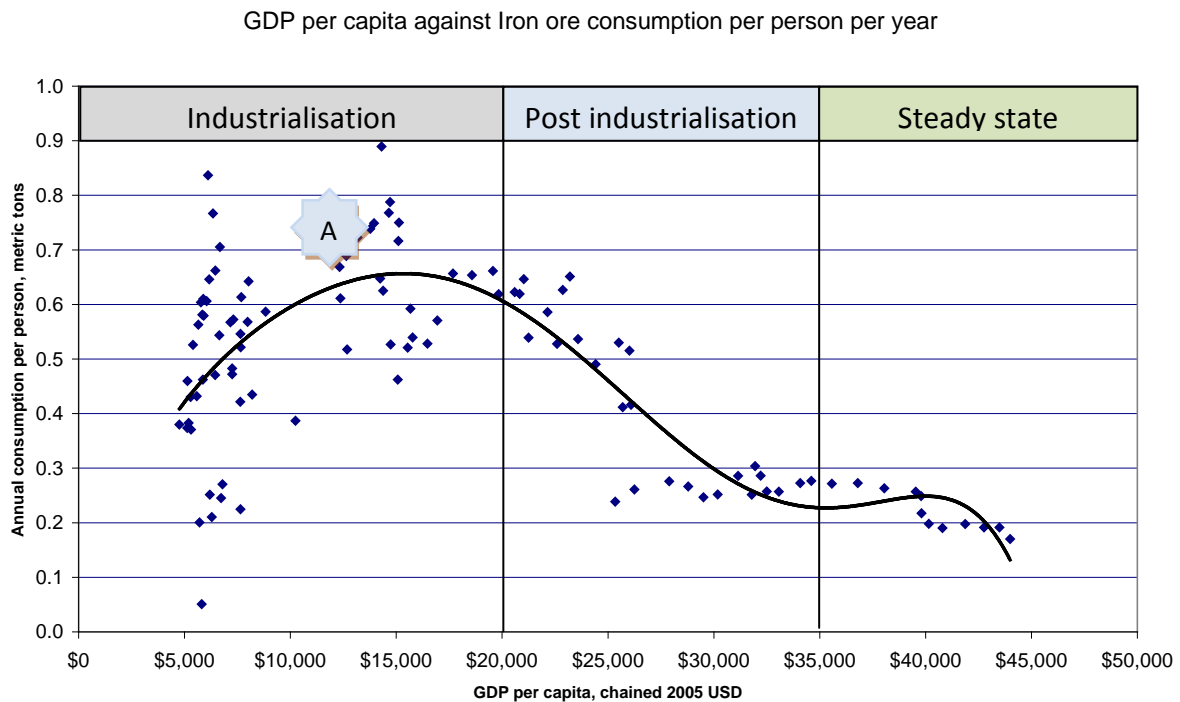
	China, GDP growth	India, GDP growth	Brazil, GDP growth	China, population growth	India, population growth	Brazil, population growth
2009	6.52%	4.52%	-1.30%	0.50%	1.43%	1.30%
2010	7.51%	5.61%	2.16%	1.50%	1.40%	1.27%
2011	10.25%	6.89%	3.04%	1.50%	1.37%	1.23%
2012	10.67%	7.59%	3.43%	1.50%	1.34%	1.19%
2013	10.33%	7.95%	3.78%	1.5%	1.32%	1.19%
Trend (2014-2020)	9.00%	7.00%	4.00%	1.20%	1.30%	1.10%
Source:	Cebr	Cebr	Cebr	IMF/UN	IMF/UN	IMF/UN

(WBMS, BAS - ML Research Estimates, 2009)

The main goal will be to calculate the commodity intensity as this will highlight the annual consumption per person measured in metric tons consumed. Calculating commodity intensity one of the key inputs to the modelling process is to determine how commodity intensity varies with wealth. Typically as an economy moves from substance agriculture to an industrial economy (moving from approximately \$5,000 to \$15,000 GDP per capita) commodity use per head will rise as the country invests in infrastructure and buildings; and consumption and production of manufacturers rise. Figure 2.19 contains a worked example with a scatter-plot of GDP per capita

against iron ore consumption and production per person along with a trend line, based on the USA historical data. The stages of industrialization, post industrialization and steady state are marked on the chart. Steady state is the phase when a country are developed and well developed.

Figure 2.19: Iron ore intensity, USA 1900-2007



Source: (WBMS, BAS - ML Research Estimates, 2009)

The industrial cycle are split into three stages:

Stage one: Industrialisation

Manufacturing base broadens; consumption of durables rises, much infrastructure and public works are undertaken. This is indicated per figure 2.19 of the Iron ore consumption, from the start-up to \$20,000 spent per capita. Over a time scale this would be roughly the first 40 years when the industrialisation started.

Stage two: Post-Industrialisation

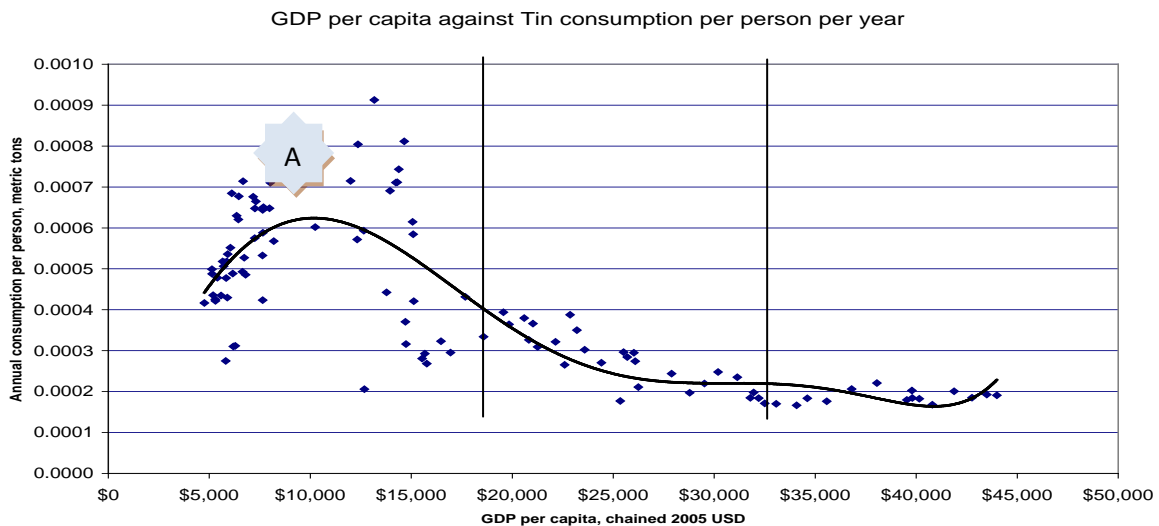
During stage two some manufacturing is outsourced to lower cost economies; infrastructure is now in place with consumption per capita primarily for maintenance. This was calculated for the years between 40 and 70 and is known as the post-industrialisation period.

Stage three: Steady State

Consumption per person remains roughly constant in order to meet the required level of consumption and maintenance. This was calculated over the last thirty years of the period measured and would be between years 70 and 100.

The consumption of Iron in Brazil, China and India is at a current as indicated in figure 2.19, is at point A. Should the consumption trend continue as previously in the US, the assumption can be made that there will be a demand increase in Iron for the next 20 years. This is a positive for the South-African mining module on sustainability, with South-Africa being a net exporter of Iron.

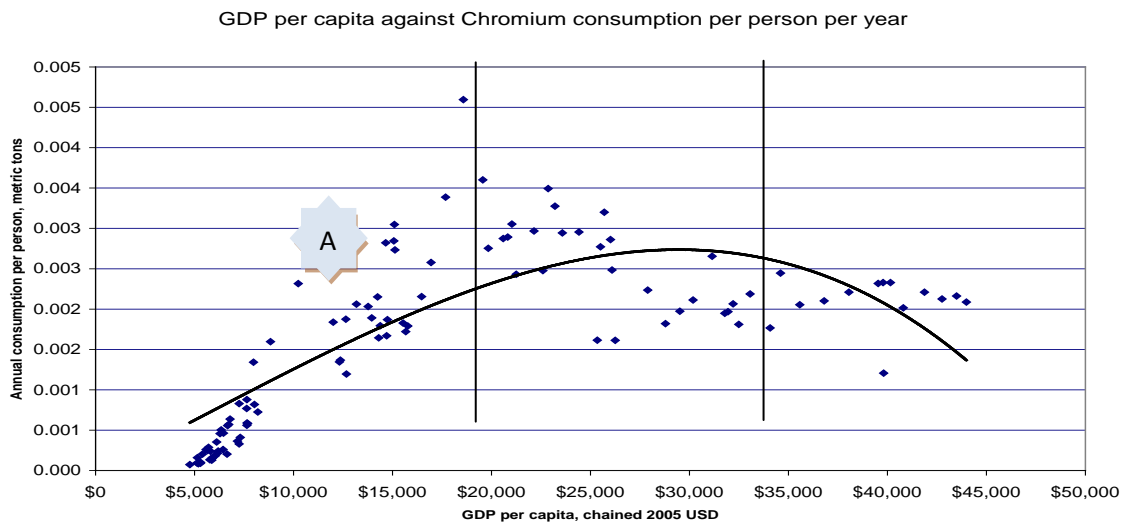
Figure 2.20: Tin intensity, USA 1900 – 2006



Source: (WBMS, BAS - ML Research Estimates, 2009)

On the same assumption as with iron ore, it can be assumed that the BRICS countries will have a few years of constant demand for Tin before it would be declining sharply as indicated in figure 2.20. South Africa is not a major role-player in Tin production and would not be that affected.

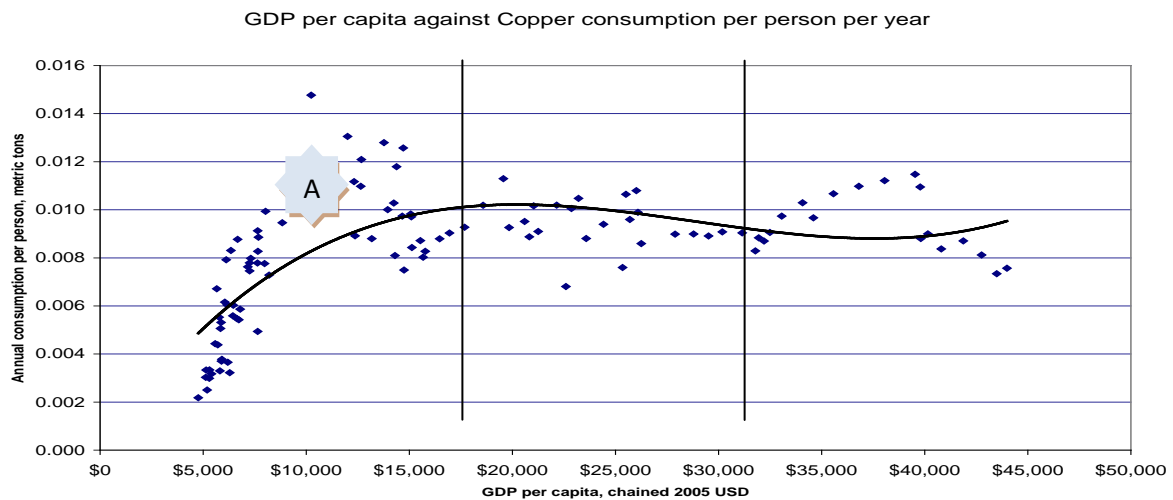
Figure 2.21: Chromium intensity, USA 1900 - 2006



Source: (WBMS, BAS - ML Research Estimates, 2009)

As determined in Chapter 2 (section 2.2), South Africa has ample chrome reserves and is a major player in the production of Ferro-chrome at 45% shown in figure 2.5. With the industrial phase still showing significant increases for growth in figure 2.21, South Africa definitely has an opportunity to grow its market share and capitalise on the growth opportunity at hand.

Figure 2.22: Copper intensity, USA 1900 to 2007

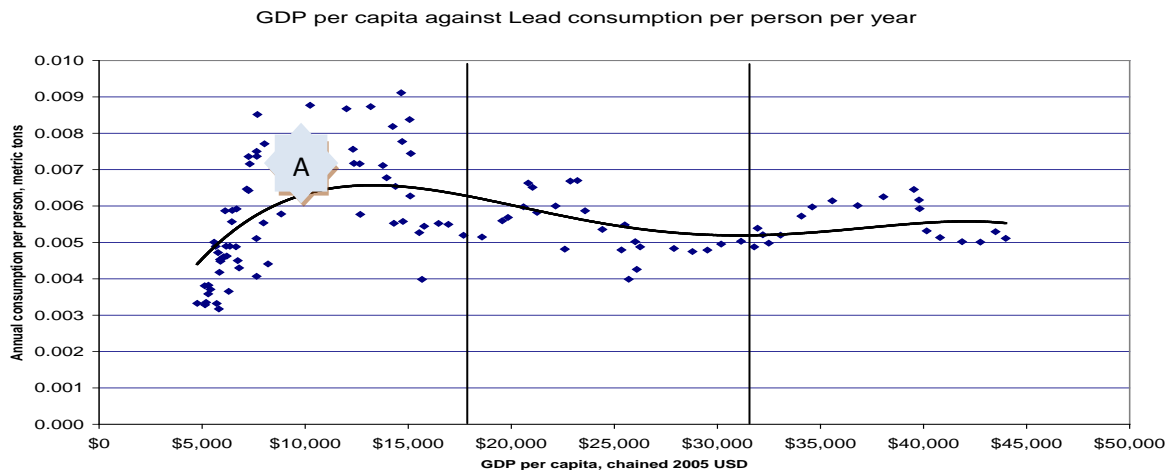


Source: (WBMS, BAS - ML Research Estimates, 2009)

Analysing the copper consumption per person in figure 2.22, it seems that the growth in the copper production levels for the BRICS countries are at a sustainable demand level. South Africa is not a major supplier of the world copper market, but approximately 20,000 people are directly employed and 80,000 indirectly in the

copper sector (Chamber of Mines, 2009). Copper has the same infrastructure requirements as platinum and the one is usually a by-product of the other and by mining both, South Africa will definitely benefit from mining copper.

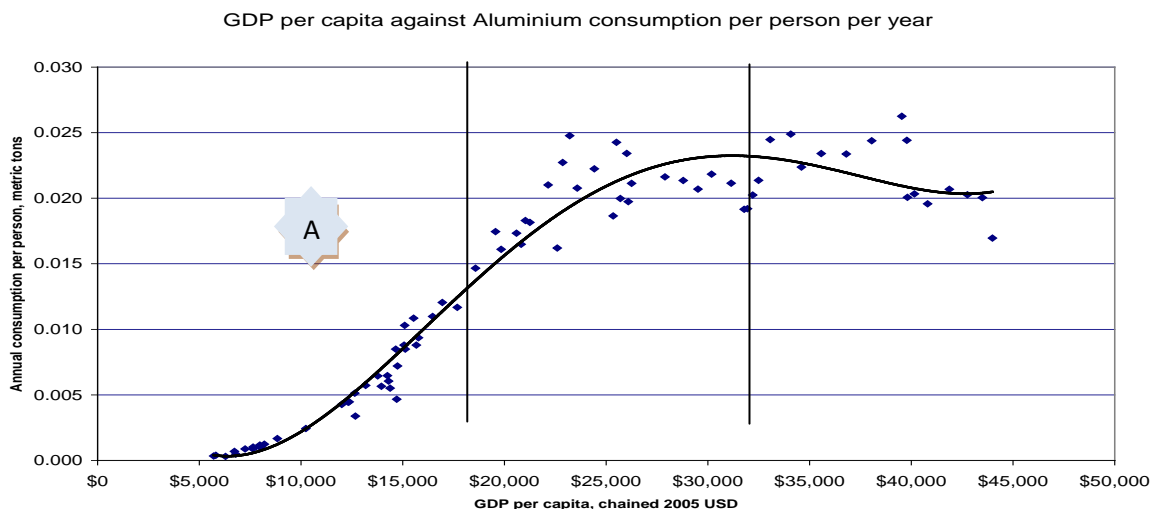
Figure 2.23: Lead intensity, USA 1900 - 2006



Source: (WBMS, BAS - ML Research Estimates, 2009)

The BRICS countries shown in figure 2.23 have reached a level that their demand for lead will stay stable. South Africa is not a major lead producer and will not be affected by growth in demand for lead at the current levels.

Figure 2.24: Aluminium intensity, USA 1900 - 2006

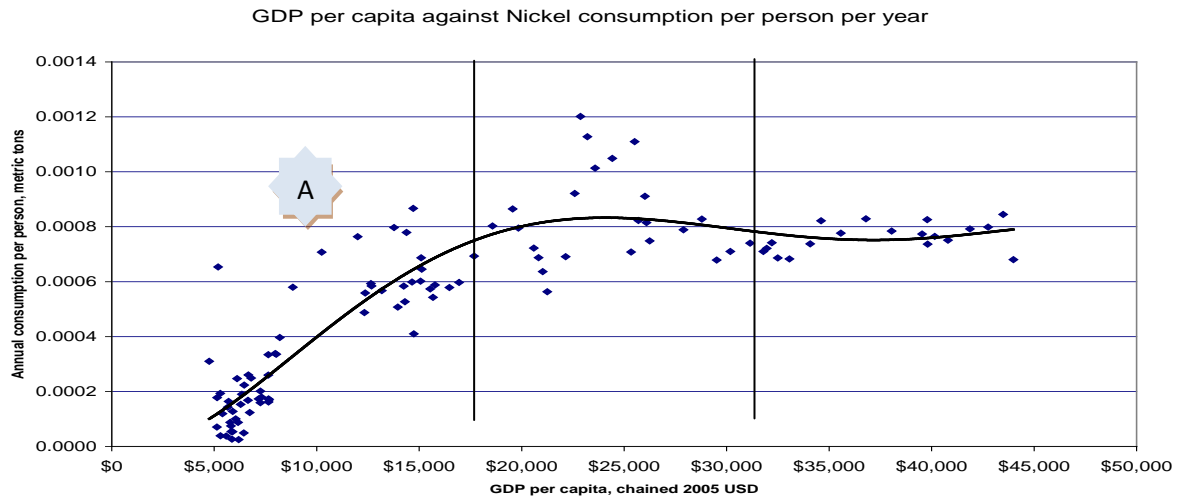


Source: (WBMS, BAS - ML Research Estimates, 2009)

South Africa has major aluminium smelters and accounts for about 3.5% of the world aluminium supply. During 2008, BHP cancelled their aluminium expansion projects due to the fact that they were unable to receive electricity or power allocation required for the smelting and refining processes. As shown in figure 2.24 it is clear

that there is still a big demand upside to come in the next forty years for the BRICS countries' aluminium demand and South Africa will not share in the economical benefit if capacity building for aluminium smelting is not done.

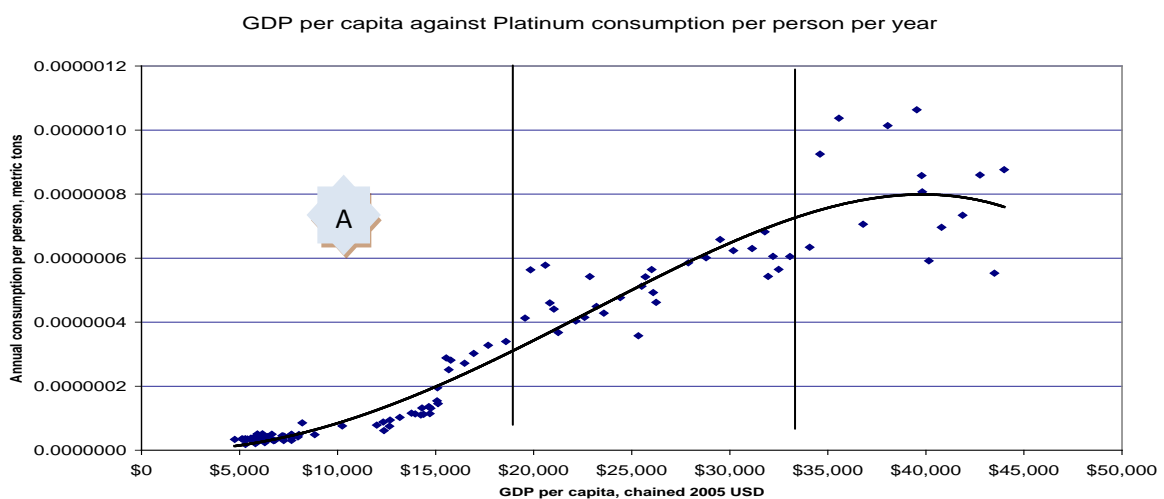
Figure 2.25: Nickel intensity, USA 1900 - 2006



Source: (WBMS, BAS - ML Research Estimates, 2009)

South Africa accounts for about 2% of the world nickel supply and have 8% of the world's nickel reserves (Chamber of Mines, 2009:8). Nickel, copper and platinum have the same infrastructure requirements and as per graph 2.25, the BRICS countries will have the potential to increase its 2% world supply to at least 8%. Figure 2.25 shows a demand increase for nickel in the next twenty years before it will stabilise. South Africa is ideally positioned to expand in the nickel commodity.

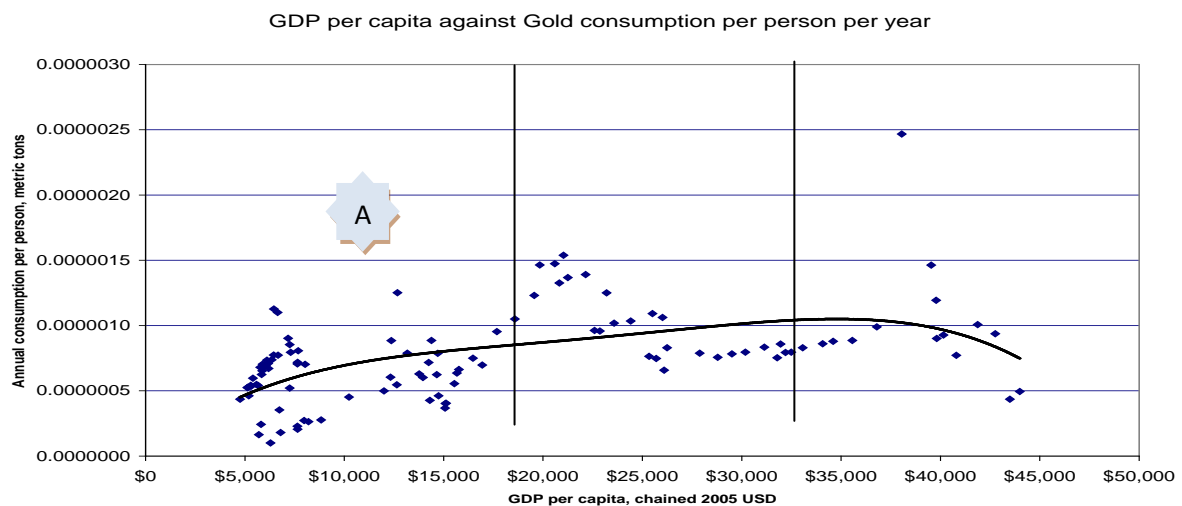
Figure 2.26: Platinum intensity, USA 1900 - 2006



Source: (WBMS, BAS - ML Research Estimates, 2009)

As determined earlier in chapter 2, South-Africa has ample Platinum reserves (Graph 2.9 - 85%) and is the main player in the production of Platinum Group Metal ounces with 75% of the world's primary supply (Johnson Matthey Public Limited Company, 2010). With the industrial phase in figure 2.26 still showing significant increases for growth, South Africa definitely has an opportunity to grow its market share and capitalise on the growth opportunity at hand. With all the environmental legislation like carbon taxes, Euro emission regulations coming into act, South-Africa must ensure that they capitalise on the opportunity as a definite growth opportunity is highlighted for the platinum industry.

Figure 2.27: Gold intensity, USA 1900 - 2006

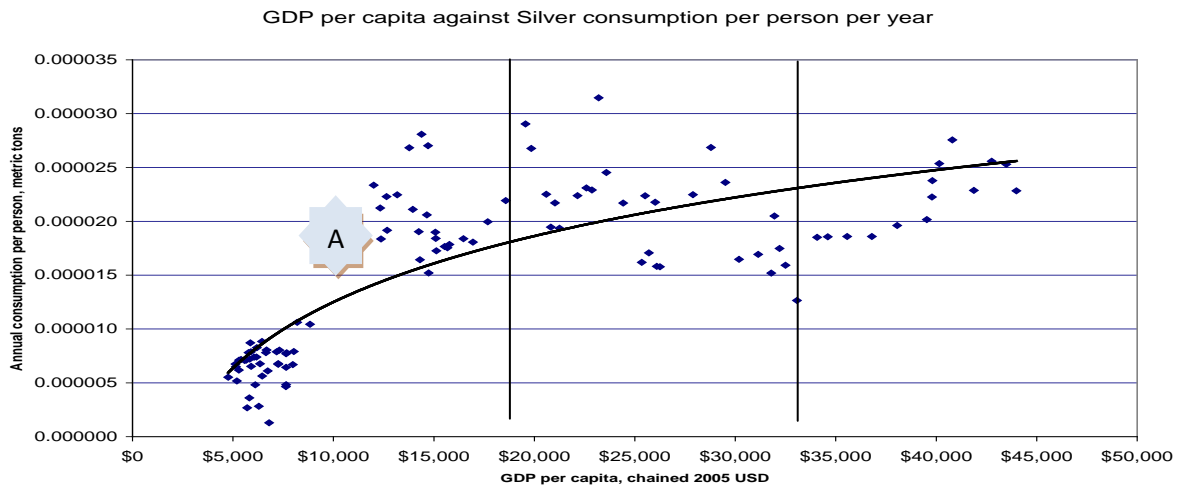


Source: (WBMS, BAS - ML Research Estimates, 2009)

Gold is mostly seen as an investment asset and with a constant demand as shown in figure 2.27, no major changes are expected. Gold is a currency that is measured in physical metal; every time that a financial crisis occurs or any uncertainty in a specific market exists, people invest in gold to see in what direction the markets would turn. South-Africa used to be the major producer of gold in the period from 1940 – 1990. South-Africa has 30% of world gold reserves and currently produces 8.8% of world production (Chamber of Mines, 2009:8). South Africa's remaining gold reserves are very deep and expensive compared to the rest of the world. Demand for gold is not driven by development requirements and, therefore, the BRIC

countries' demand would not have a major impact on South-Africa supply and economy.

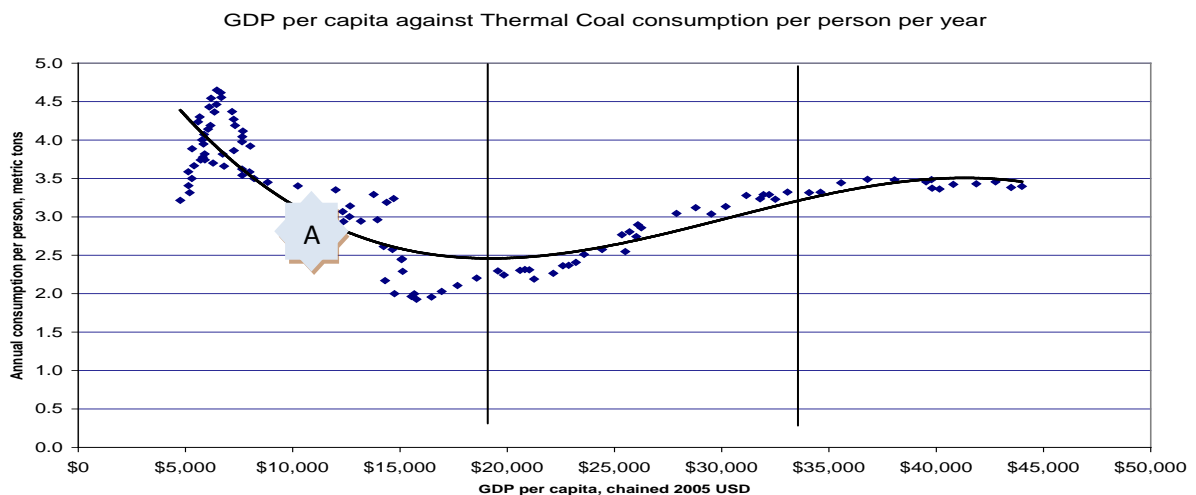
Figure 2.28: Silver intensity, USA 1900 - 2006



Source: (WBMS, BAS - ML Research Estimates, 2009)

The BRICS countries will show a strong demand for silver as shown in figure 2.28, but South Africa is not a major silver producer with less than 0.4% of world supply (Chamber of Mines, 2009:8) and will not be affected by growth in demand for silver.

Figure 2.29: Thermal Coal intensity, USA 1900 - 2006



Source: (WBMS, BAS - ML Research Estimates, 2009)

With thermal coal 100% consumed in the electricity sector it is safe to state that as long as no feasible alternative is available, that substantial growth opportunities exist for South Africa to grow its thermal coal output. As the trend in Figure 2.29 indicate that the demand will decrease, it must be taken into account that thermal coal can

also directly be linked to electricity supply, on which the growth of Chromite, Platinum Group Metals and Iron is dependant, as they are all energy intensive due to smelting and refining processes required to produce the final product, their demand will ensure that the demand for thermal coal continues to grow, as long as no feasible alternative exists for coal in electricity generation.

Types of intensity trends

The intensity trends from figure 2.19 to figure 2.29 were analysed and classified into three types and classified below:

- *Type one: Rise and Fall*, commodities of iron and steel, iron ore and tin have seen raw material consumption per person rise with wealth up to around \$15,000 GDP per capita. Beyond this, consumption per person tends to fall as manufacturing is outsourced and the country begins to import finished goods rather than raw materials. Also, in the post-industrialisation period, much infrastructure work will already be in place.
- *Type two: Rise and Plateau* commodities of copper, lead, nickel, aluminium and platinum have experienced the same period of industrialisation with rising consumption per person. However, raw material consumption levels tended to plateau rather than decline beyond \$20,000 with some activities such as construction that cannot be outsourced easily.
- *Type three: Technology shift*, thermal coal has experienced a unique trend during the period examined primarily due to the major changes in usage – notably the decline of coal as a fuel for transportation and home energy – due to substitution towards oil and gas.

Table 2.2 shows the growth expected in commodity demand from the BIC economies by linking the three factors shown in figure 2.18 and data in table 2.1 to give a % demand growth for the selected minerals and metals that are relevant to South Africa and is referred to as the Long run module.

Limitations of Long run module to be taken note of and not taken into account in the table are:

- **The benchmarking** approach used did not anticipate a technological innovation – such as the substitution of coal for oil and gas as a fuel in transportation. In addition, the benchmarking approach assumes that the commodity intensity to

development relationship in the BIC economies will follow the shape of the US during its industrialisation phase.

- **Forecasting error** may lead to inaccuracies in commodity demand growth projections as economic forecasts turn out to be incorrect (WBMS, BAS - ML Research Estimates, 2009).

Table 2.2: Results – Forecast annual growth in commodity demand in BIC economies

	Scenario	Iron ore	Copper	Chromium*	Nickel	Zinc	Platinum*	Thermal coal*	Gold and Silver
Medium run (2009-2012)	Base case	4.5%	8.2%	12.9%	11.6%	7.1%	8.1%	5.1%	8.3%
Long run (2013-2020)	Base case	5.1%	9.9%	20.5%	16.0%	8.4%	9.7%	5.9%	10.9%

Source: (Centre for Economics and Business Research Ltd, 2010)

* Minerals and metals analysed in chapter 2.2

2.4 SUMMARY

South Africa has the reserves, the experience and knowledge to produce Chrome, Coal and PGMs. With reference to table 2.2, strong demand for Chromium, Copper, Nickel, Platinum, Gold and Silver is expected to feed the growth of the BRICS countries. A constant growth in demand for coal is projected as it is needed to supply electricity to the different beneficiating processes of metals like chrome and platinum which is depending on the availability of electricity supply and the unique characteristics of platinum required in catalyst for the automotive sector to fight air pollution.

South Africa has a major role to play in the growth of the BRICS countries. With the expected demand South Africa will have a sustainable mining industry if the demand as projected in table 2.2 realises. With ample reserves of Iron ore, Chromite, Copper, Aluminium, Nickel, Platinum and Thermal Coal, and a rising demand expected from the BRICS countries, the pressure will be on the supply side, and the countries best prepared for the next commodity boom, will be the countries to capitalise on the financial benefit to be created by supplying the minerals and metals.

In Chapter three and four it will be determined if South Africa has the infrastructure to grow and support the growth of the supply side for a sustainable mining industry.

CHAPTER 3: INFRASTRUCTURE REQUIRED TO ENSURE SUSTAINABLE MINING GROWTH

3.1 INTRODUCTION - INFRASTRUCTURE

To keep pace with the mineral and metal market growth, infrastructure is a major role player. Infrastructure is an integral part on the mine to market process with South Africa's mining situated inland and not on the coastal areas; transport of mined products that need to be exported, is being dependent on Government infrastructures like roads and railways. The cost of capital and cost of utilising the infrastructure is one of the main cost determinants that will form part of the operational profitability and sustainability of mining in South Africa.

South Africa had a modern and well developed transport infrastructure. The roads were world-class. South Africa's main export with 50% foreign income from minerals and metals which is derived from mining activities are all based inland, thus the mining sector is heavily dependent on transport modes like road and rail to move the products to the ports (Rossouw, 2010). The air and rail networks are the largest on the African continent and the country's ports provide a natural stop-over for shipping to and from Europe, the Americas, Asia, Australasia and both coasts of Africa. The enormous distance between South Africa and its major trading partners in Asia, Europe and the Americas contributes to high cost, and Africa infrastructure networks are inadequate and poorly maintained, with rising cost that is hindering trade.

One of the critical success factors to the growth of the South African economy is infrastructure investment. South Africa has to expand infrastructure to suit mining and other traditional activities while at the same time investing in the facilities required for a more labour-absorbing, knowledge-intensive economy, of which sustainable mining forms a major part of. The engines of economic growth is electricity generation, pipelines, ports, rail and road transport and water supply, and they will be evaluated to determine if South Africa will be able to run a sustainable mining operation in the future, based on the current status and future expansion plans.

3.1.1 Electricity provision

Over the past decade South Africa has experienced significant growth across the whole economy. This growth came at a price as it placed increased pressure on South Africa limiting power supply. Warning signs that the growing economy was putting pressure on SA's electricity supply were first evident in 2006, ultimately culminating in rolling blackouts in 2008. The energy crisis has since stabilised as a result of the slowdown in economic growth and the subsequent reduction in demand for electricity (Rossouw, 2010).

Electricity is one of the key growth pillars for mining. In the mining process, electricity will play a key role in the following areas where electricity is required for:

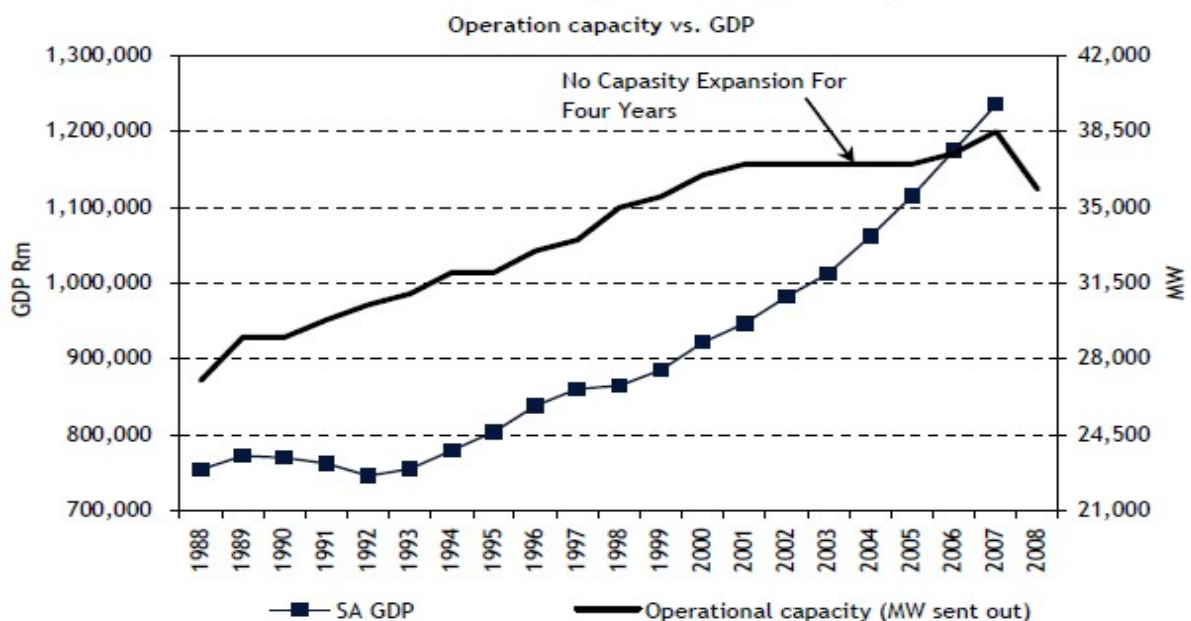
- powering the ventilation fans to ensure that breathable air is available underground
- powering pumps to ensure that underground mining shafts are not flooded
- engineering machinery and lights to operate underground
- powering conveyor systems or electric trains to transport mined ore to the surface
- powering processing plants like platinum concentrators, chrome spiral plants, coal washing plants
- powering the smelters and refineries processes in the form of furnaces, where the most electricity is consumed. In the chrome mining process 80% of electricity is consumed in this area (Rossouw, 2010)
- general use for day-to-day operations in offices and automated processes.

Eskom is a state-owned electricity provider and is South Africa's sole provider of energy and for the review of electricity provision "Eskom" as a company was reviewed.

South Africa experienced the effects of insufficient energy infrastructure during the devastating rolling blackouts of 2008. The two questions to be answered would be to determine if Eskom will be able to supply enough electricity to the mining industry to ensure that mining will be able to meet its planned growth plans and will it still be able to supply electricity to the industrial industry at competitive prices to ensure that

South Africa will still be cost competitive in the mining sector. With review of figure 3.1, it is clear that Eskom's capacity grew with the growth in South Africa's Gross Domestic Product (GDP growth). 2001 was the start of a booming economical growth and it is clear that Eskom had fallen behind in its required replacement and expansion investment. It had been running up against the peak reserve margin threshold for much of the past five years (The peak reserve margin is the difference between generating capacity and peak demand). The internationally accepted norm for this measure is a minimum of 15%. Once the reserve declines below 15%, the network is at risk of failing as a result of too little flexibility being available for maintenance, dealing with breakdowns, allowing for phasing in and out of new and old infrastructure, and also simply to allow for faster-than-expected growth in demand (mainly a function of economic growth) (Rossouw, 2010).

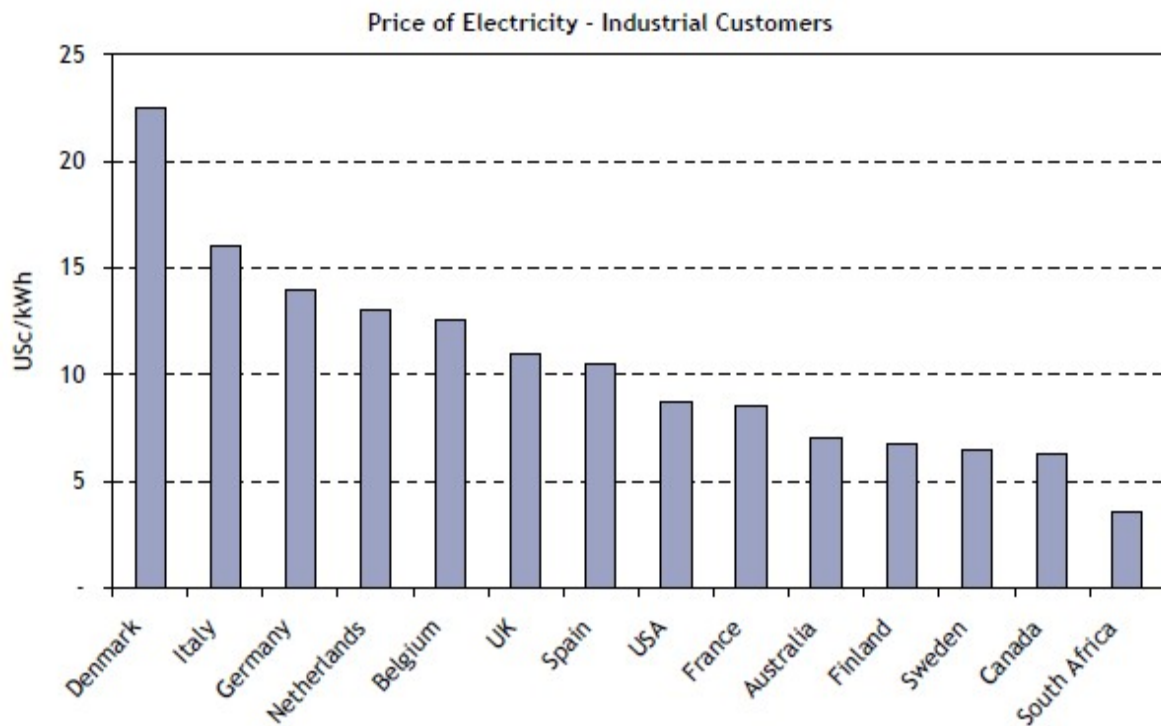
Figure 3.1: Eskom stalled from 2001 to 2006 while economy was booming



Source: (Esterhuizen, 2008)

As illustrated in figure 3.2, South Africa during 2008 was still amongst the lowest-cost suppliers of electricity in the world. This comparison illustrates a 74% lower price for South Africa compared to Canada, the next cheapest supplier of power. It must be highlighted, that this situation has change dramatically from 2008 to 2010.

Figure 3.2: Eskom's supply of low cost electricity is changing dramatically



Source: (Esterhuizen, 2008)

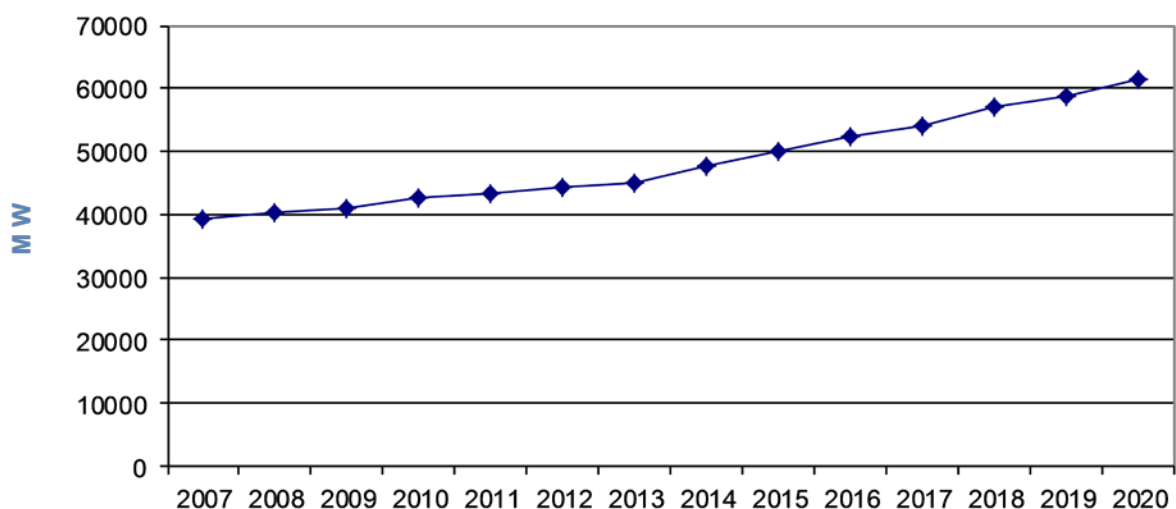
Eskom has also increased prices with 25% (Inflation rate of 4.5%) for 2009 and 25% for 2010 (inflation of 5%) and 28% for 2011 (inflation of 5%) (Meiring, Jacolize, 2011), citing the sharp increase in input costs as the major reason. High increases like that must be a clear sign that Eskom is not at all healthy.

There can be no doubt that the excessive increases experienced from 2009 to 2011 will impact the Chrome and PGM industry negatively when it comes to production costs. Regardless of this clear threat to profitability and stability in the mining industry, the sharply rising cost profile of electricity supply from Eskom will force mining companies to find alternative ways to reduce production cost, as South Africa will no longer enjoy the benefit of the cheapest electricity in the beneficiation industry and will also no longer be the preferred investment destination relating to the lowest electricity cost in the world for smelting and beneficiating processes (Esterhuizen, Leon, 2008). Harmony Gold CEO Graham Briggs says the tariff increases affected operations; during 2009 electricity accounted for 13% of operational cost, and this increased to 20% during 2011, directly having a negative impact on the company's

profitability. He confirmed that for decades South Africa boasted the lowest electricity prices in the world and that era has ended. South Africa used to attract megaprojects like Rio Tinto’s aluminium smelter at Coega, which was cancelled due to the uncertainty over high electricity tariffs and reliability of power supply. Harmony Gold, a major gold mining company in South Africa, is forced to target higher paying mining areas which are shortening the operational lifespan of the mines in order to be still competitive internationally (Briggs, 2011).

In the past, large industry investment into the country was largely driven by the promise of cheap electricity. Increasing tariffs are expected to decrease the attractiveness of the South African market for industrial development, particularly in the mining and manufacturing sector. Due to current funding constraints for capacity development, tariff increases are expected to continue to 2015. Eskom’s 20 year power generation build program is expected to cost between R800 billion and R1.2 trillion (Frost and Sullivan Economic Research and Analytics, 2011). This is 100 times the annual profit the company made during the 2010 financial year and it won’t be possible for Eskom to fund these expansions out of operating profits. The growth plan will increase capacity as shown in figure 3.3, that the installed grid integrated capacity will increase from 42,000MW in 2010 to 61,563MW in 2020 (42% increase over 10 years or 3,74% year on year).

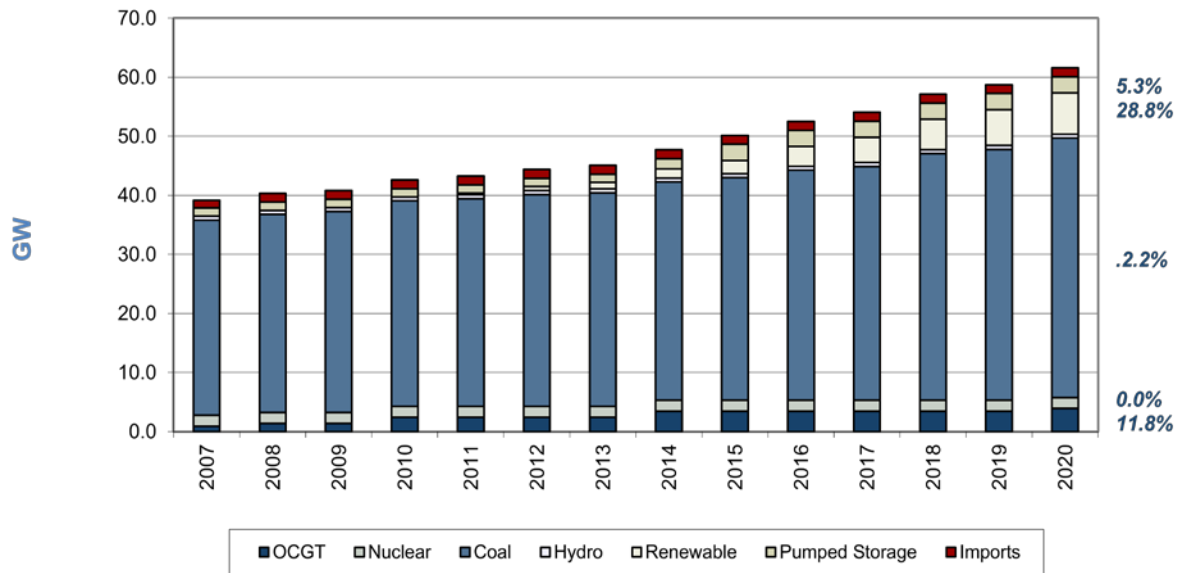
Figure 3.3 : South Africa forecast installed electricity capacity (2007 – 2020)



Source: (Frost and Sullivan Economic Research and Analytics, 2011:325)

Figure 3.4 indicates that coal power generation is still expected to represent the dominant form of electricity generation to South Africa over the next ten years, significant growth in renewable energy is expected from 2015 to 2020.

Figure 3.4: South Africa forecasted installed electricity capacity by type (2007 – 2020e)



Source: (Frost and Sullivan Economic Research and Analytics, 2011:326)

Eskom does not currently have the available funding to meet the development targets up to 2020. Funding constraints have been a significant restraint to the timely development of the Medupi and Kusile power projects and funding is expected to be provided through private investment, equity investment and debt (Frost and Sullivan Economic Research and Analytics, 2011).

Taking the installed electricity capacity plan into account all indications show that Eskom will be able to supply the mining sector with electricity for sustainable mining. The cost for electricity and capital for expansion is the main risk identified for the delivery of the growth projects that can impact the delivery of the capacity growth plans.

3.1.2 Pipeline

Chrome, Platinum Group metals and Coal never make use of the pipeline structure as transport medium, which is mainly used as a transport medium for fuel, gas and oil. Due to the fact that the mining of Chrome, Coal and Platinum is not directly

dependent on pipelines, it was decided by the researcher to not investigate pipelines as a mode of transport in the study.

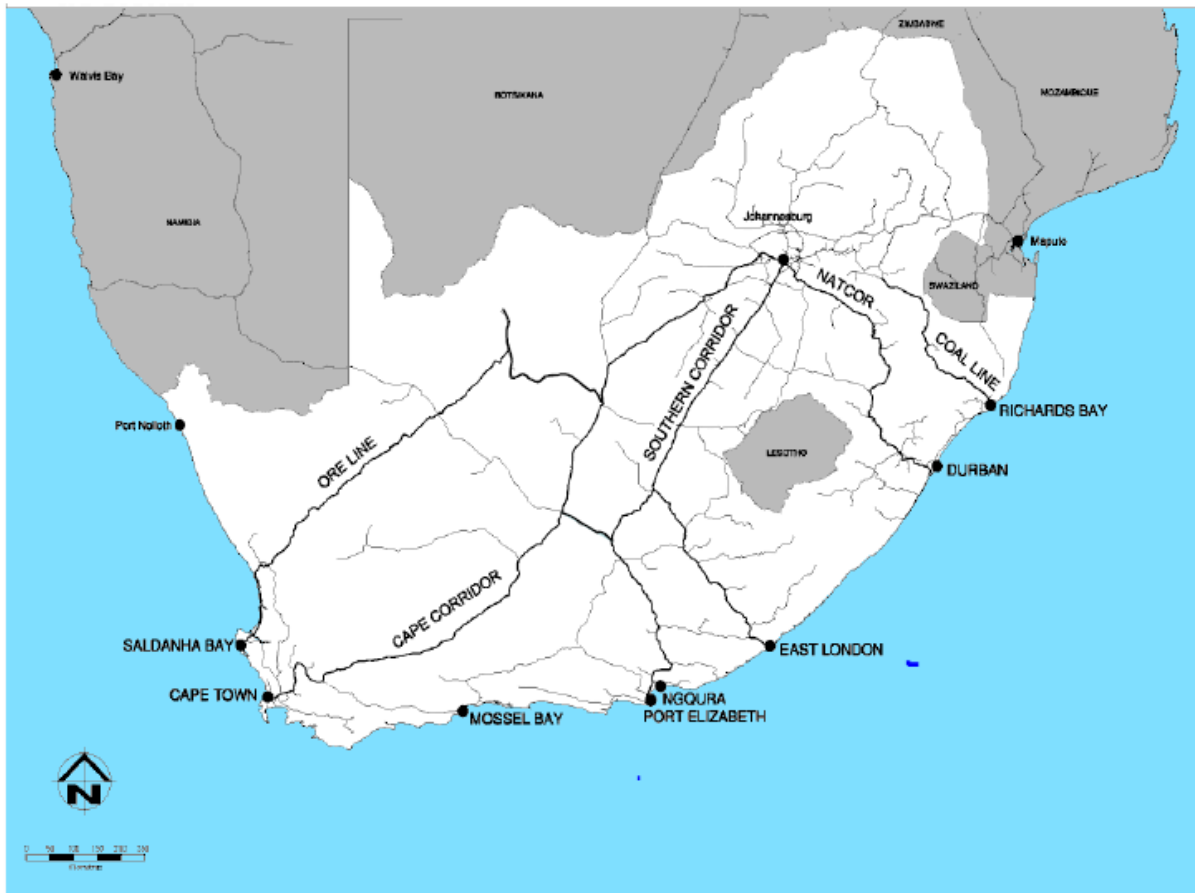
3.1.3 Ports and shipping

Major shipping lanes pass along the South African coastline in the south Atlantic and Indian oceans. Approximately 96% of the country's exports are conveyed by sea, and the seven commercial ports are the conduits for trade between South Africa and its Southern African partners as well as hubs for traffic to and from Europe, Asia, the Americas and the east and west coasts of Africa (South Africa Transport Network, 2011).

The state-owned Transnet National Ports Authority manages the country's ports. As highlighted in figure 3.5 these ports are: Richards Bay and Durban in KwaZulu-Natal, East London and Port Elizabeth in the Eastern Cape, and Mossel Bay, Cape Town and Saldanha in the Western Cape. An eighth commercial port, the Port of Ngqura, was developed off the coast from Port Elizabeth in the Eastern Cape, with the first commercial ships docked at the end of 2009, and the completion of the port is expected during 2012. Ngqura is set to be the deepest container terminal in Africa. It is a crucial part of Coega, one of South Africa's strategic industrial development zones (Transnet Group Planning, 2009).

Minerals and metals like Iron ore, Thermal Coal, Chromite and Manganese are mainly exported by tanker boats; these metals account for huge volumes and are always of substantial weight. Due to the volumes, big storing areas are also associated with these minerals, and South Africa harbours are designed for the capacity to mining ore storage.

Figure 3.5: South Africa Rail and Port Corridors



Source: (Transnet Group Planning, 2009:95)

Durban is Africa's busiest port and the largest container facility in Southern Africa, while Richard's Bay is the world's largest bulk coal terminal. Taken together, South Africa's ports handled 183-million tons of cargo in 2007, and major upgrades are under way to increase handling capacity further (Transnet Group Planning, 2009).

Richard's Bay, currently the world's largest bulk coal terminal, truly caters for tankers, and with current estimates, it will have to double in size, to cater for the mining growth plans. The 2008 economic crisis gave some breathing time to the ports, the volumes that were shipped in 2008 is only expected during 2012 again (Transnet Group Planning, 2009). Research by the Automotive Industry Development Centre (AIDC), which promotes vehicle manufacturers global competitiveness, has found SA ports to be among the world's most expensive to use. Terminal charges at Durban, South Africa's largest port is between 80% to 170% higher than costs at major European ports and eight times more than those charged by Latin America's most expensive port, Buenos Aires. Grindrod Freight Service Division Managing

Director, Dave Rennie confirms these high costs and states that it would be acceptable if they were accompanied by high efficiency, and commended that there is nothing wrong with Transnet's strategies and plans, but to work they need everyone to pull in the same direction. The International Finance Corporation (IFC) study, "Doing Business 2010" ranks South Africa at 148th in cross-border trade efficiency. The Organisation for Economic Co-operation and Development (OECD) notes that South Africa's ports' efficiency levels are 50% to 70% of similar ports. In 2009 the Durban container terminal achieved an average of 23 units/crane hour compared to an international norm of 35 units/crane hour, being only 66% efficient of the norm (Thomas, 2010).

Transnet's growth plan is aligned with the growth of mining, and the expected demand for ports, is based on the sectors requirement. A well laid out plan with capital and capacity requirements up to 2037 are in place and Transnet is working towards that path (Transnet Group Planning, 2009:164) that will cater for a sustaining mining module. The concern relating to mining growth is the inefficiencies and high operating cost. These can be overcome by optimisation and automation, education and behaviour changes.

3.1.4 Rail

South Africa has an extensive rail network – the 14th longest in the world – connecting with networks in the sub-Saharan region. The country's rail infrastructure, which connects the ports with the rest of South Africa, represents about 80% of Africa's total. State-owned Transnet Freight Rail is the largest railroad and heavy haulier in Southern Africa, with about 21,000km of rail network, of which about 1,500km are heavy haul lines. Just over 8,200km of the lines are electrified. South Africa has also opened the door to private rail operators, with Transnet calling for expressions of interest from private sector companies to operate branch railway lines, or feeder lines, which comprise some 35% of the country's national rail network. In his 2011 national budget speech, Finance Minister Pravin Gordhan announced an 18-year, R86-billion programme to upgrade the country's rail transport infrastructure. Metrorail commuter services can be found in Cape Town, the Eastern Cape Province, Durban, and greater Johannesburg and Pretoria, focusing mainly on poorer South Africans. Tourists and well-heeled passengers can travel on the Blue

Train, one of the world's most famous luxury trains, while Shosholoza Meyl transports passengers between the country's major cities. The government has taken the safety of passengers seriously, increasing the number of railway police officers to over 2 500 by the end of 2009 and building rail police stations in several stations in the Western Cape, KwaZulu-Natal and Gauteng. Police mobile coaches were also introduced to facilitate the arrest and charging of criminals on board trains on long-distance routes, instead of waiting for the train to reach the next station. The government also created a new rail and bus operator, the Passenger Rail Agency of South Africa (Prasa), by merging the operations of the South African Rail Commuter Corporation, Metrorail, Shosholoza Meyl, and Autopax, the company that runs the Translux and City to City buses. The Gautrain, an 80km rapid rail network, connects Johannesburg, Pretoria and OR Tambo International Airport from mid-2011, easing congestion on the Johannesburg-Pretoria highway by offering commuters a safe and viable alternative to road travel. Gautrain's 24 train sets of four rail cars each (96 rail cars in total) will travel at maximum speeds of 160km/hour, 18 hours a day, together making around 135 000 passenger trips a day. Secondary transport to and from stations and nearby destinations will be provided by luxury buses. There will be 10 stations, three of which will be underground. The underground tunnel section will be about 14km long and up to 96 metres below the surface in some places. The first phase, the section between the airport, Sandton and Midrand, was completed in mid-2010, and by the end of September 2010, the Gautrain had already transported a million passengers. The second phase, the line from Johannesburg to Pretoria, is set to be complete and was ready for commercial use by June 2011. (South Africa Transport Network, 2011). The transport of the passengers by rail, make more road transport available for trucks.

On the mining side with the transport of mined products, requiring rail is a key mode of transport. Coal producers in South Africa have been eager to export more coal to meet rising demand from India and China but have been limited by infrastructure bottlenecks. Below is a breakdown of port and rail infrastructure hurdles and some of the expansion plans in South Africa.

1. State owned logistics group Transnet operates South Africa's entire rail network. The company transported 62.2 million tonnes of coal to the export

terminal at Richards Bay in its last financial year, far short of an expanded capacity of 91 million tonnes at the port. The group has said it plans to raise capacity on the coal export line to 81 million tonnes by 2015, and it is studying the possibility of freeing up some 14 million tonnes of capacity on the coal line in two to three years by moving non coal cargo to a new line via Swaziland (Transnet Group Planning, 2009).

2. Coal producers have said they would be willing to participate in an attempt to accelerate Transnet's expansion and have been discussing possible deals for years. Transnet Chief Executive Officer (CEO) Brian Molefe in June 2010 dampened expectations that a private-public partnership will realise, saying many such private-public deals had turned out to be disasters. Mr Molefe said possible deals could include a partnership in which a private player would build and operate a line or Transnet would give privately owned locomotives and wagons access to its rail lines or lease them. Transnet has repeatedly questioned companies' ability to produce the amounts they have said they would like to export (Transnet Group Planning, 2009).
3. Transnet is discussing the option of building a new line linking the Richard's Bay terminal with the Waterberg coalfield, touted to become South Africa's next major coal region, although the line is unlikely to materialise soon. Transkalahari Rail Line is busy with construction of a railway line connecting Botswana's Mmamabula coal field with the Namibian port of Walvis Bay, with an estimate cost of R75 billion is expected to start in late 2012 and take some five years. The line, to be built in a private-public partnership, should have capacity of around 50 million tonnes to be economically viable and robust. According to Namibia's government the rail line may be extended to the Zambian border to facilitate exports of Zambian minerals via Walvis Bay, including copper (Transnet Group Planning, 2009).
4. Richard's Bay Coal Terminal is the world's single largest export coal terminal, with an expanded capacity of 91-million tonnes. It has said it could increase capacity to beyond 110 million tonnes once volumes on the rail lines have been improved (Transnet Group Planning, 2009).
5. South Dunes Coal Terminal has an allocation of 6 million tonnes half of which belongs to state owned power utility Eskom. Eskom said in November 2010 it

was seeking proposals from coal producers for the use of its 3 million tonne stake (Transnet Group Planning, 2009).

6. Logistics group Grindrod stated in June 2009 that an expansion of available coal capacity at its dry bulk terminal in Richard's Bay to 3,2 million tonnes from 1,5 million should be completed during 2011. It said it would like to increase the terminal's capacity by 10 million tonnes or more. Durban Bulk Connections is the company that operates a 3.5 million tonne export terminal from Durban. Around a million of that capacity is dedicated to coal. The company had plans to increase that capacity to 5 million tonnes and to build a new 3 million tonne coal export operation at Richards Bay but has so far failed to secure environmental and building permits to do so.

To conclude on the rail network infrastructure, which is after electricity the biggest infrastructure role player for sustainable mining in South Africa, as per Transnet CEO Strategy presentation in conjunction with Transnet's group planning report is (Transnet Group Planning, 2009):

- The condition of the rail network is fair.
- Due to increased demand on the main corridors, significant capacity improvements will be needed within 10-12 years.
- A major challenge will be the impact of inadequate electricity supply, theft and vandalism and the availability of rolling stock – all impacting operating capacity.
- The 30 year plan will accommodate large scale capacity expansions in line with economic and industrial policy development.

The above is also in line with personal interviews with Mr. Jeff McLachlan, Logistics Director of Xstrata South Africa (Mclachlan, 2010) and Mr Gerrie De Wet, General Manager of Imperial Logistics (De Wet, 2010). They both commented that the problem with rail transport is not the capacity but the efficiency and reliability of deliveries from the mines to the ports. They further stated that road transport was a reliable alternative, resulting on more pressure being put on roads. Mined products to be exported need to be in the ports to be loaded on the big tankers. Should a deadline for loading be missed, the mining house needs to incur cancelation cost,

incur storage cost in the harbour yards and also need to wait for the next available ship, which might be up to a month for specific destinations, meaning dead working capital and also required to give discounts to customers for late deliveries because of non performance. In situations like the above, road transport is then more feasible than rail.

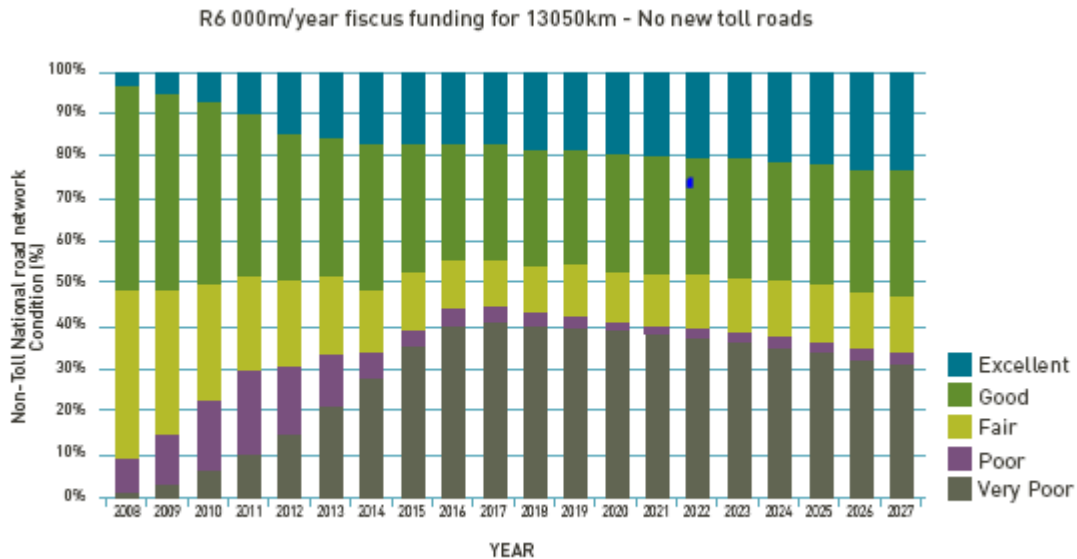
3.1.5 Roads

With the rail sector as mode of transport of minerals and metals being exported under pressure, the alternative transport would be road transport. It is in many instances more reliable, less time consuming and more flexible than railways.

The Department of Transport is responsible for overall policy, road-building and maintenance is the responsibility of the South African National Roads Agency (SANRAL) as well as the nine provinces and local governments. Established in 1998 in accordance with the South African National Roads Agency Limited and National Roads Act 1998, the Agency is an independent, statutory company registered in terms of the Companies Act. The South African government, represented by the Minister of Transport, is the sole shareholder and owner of the Agency. The mandate of the Agency is to develop, maintain and manage South Africa's 16,170 kilometre national road networks comprising over R30 billion in assets, excluding land (Van Greve, 2009:21).

As per figure 3.6, the 2011 year indicate that 10% of South Africa's road is classified as very poor, increasing from only 3% four years earlier and if no urgent attention in the form of funding for the repair and building new roads, the "very poor" roads will increase to 40% within five years. This has come about because of underfunding of road maintenance, overloading of heavy vehicles, and increased volumes of road freight vehicles. Also to be considered is that much of South Africa's rail system is underutilised and considered by many to be outmoded. The issue of road or rail degradation must not be considered in isolation, since the two are related and this relationship must be better understood (Van Greve, 2009:21).

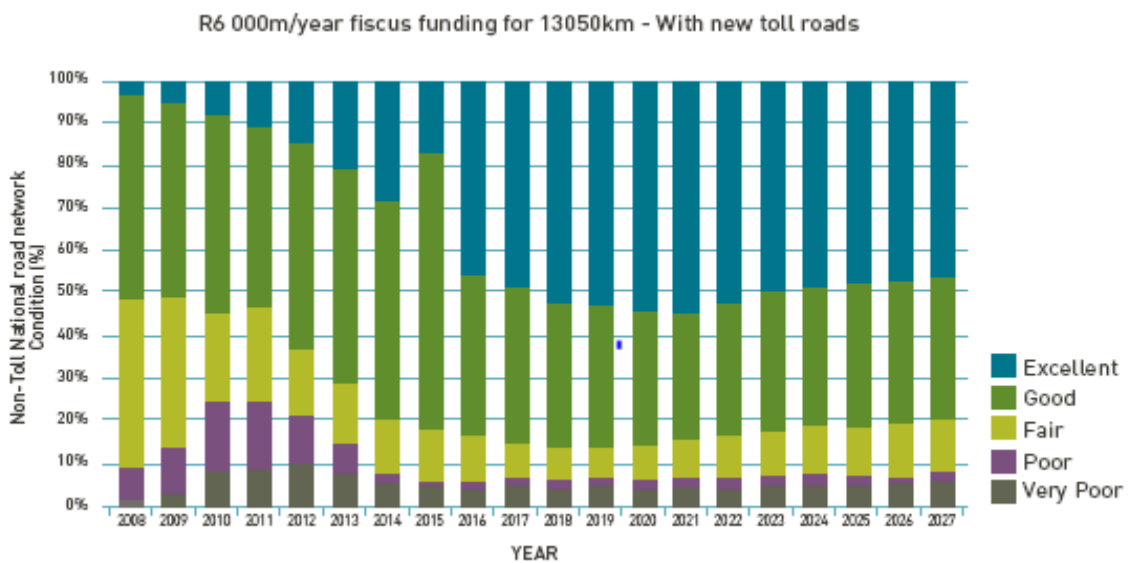
Figure 3.6: Condition of SA roads with no new toll roads



Source: (Van Greve, 2009:21)

Figure 3.7 shows the results expected should the planned new toll roads be built, as per the SANRAL long-term plan. It shows in 2011 that the 10% “Very poor” roads will decrease to 5% of the road structure within five years and the most promising part is the “Excellent” classified road to increase from only 10% to 50% of the road structure.

Figure 3.7: Condition of SA road with new toll roads



Source: (Van Greve, 2009:21)

The SA Bitumen Association has stated, “Motorists now face twice as many operating costs. This applies to all forms of transport, including commercial, freight and industrial, as well as public transport and emergency vehicles. South African motorists contributed R26-billion in fuel taxes to the government exchequer but only about R 6-billion was spent on road maintenance, of which R600 million of these maintenance cost is a direct result of overloading of freight vehicles (Corporate Services SANRAL, 2010). The South African Government is presently spending only about the equivalent of six cents, from each litre of petrol and diesel sold, on road maintenance. Another question is whether the heavy vehicle operators’ 50 cent contribution is enough; even if the entire amount were put back to maintenance it is substantially less than toll roads with an average heavy vehicle user charge of 128 cents per kilometre. Mr Nazir Alli , Chief Executive Officer of SANRAL stated that there is no road maintenance backlog and the next phase for the next five to seven years is to strengthen the roads carrying capacity that will support freight and mining transport (Venter, 2010).

With personal interviews with Mr. Jeff McLachlan, Logistics Director of Xstrata South Africa (Mclachlan, 2010) and Mr Gerrie De Wet, General Manager of Imperial Logistics (De Wet, 2010) both agree that an efficient rail transport system would be the best suited mode of transport for the mining industry, due to the large and heavy volumes to be moved. They both commented that the South Africa road transport system is currently the preferred alternative to rail transport and is the most reliable and efficiency mode of transport for deliveries from the mines to the ports, via toll roads. The main concern they both echoed was the fact that for roads to be kept in good condition, more than the current planned capital will need to be invested in road maintenance which will in its turn make it very expensive and as the cost will be transferred to the road users, the South Africa mining business will incur un-completive transport cost that will put the South African mining sector under more pressure.

3.1.6 Water

The role that water plays is fundamental to food and energy security, economical growth, maintaining health, sustaining the livelihoods of the poorest and is considered a condition for alleviating poverty. The purpose of investigating the

availability of water now and for future use is the fact that it forms an essential part of mining operations, on top of the need for human consumption. It is used underground as part of the drilling process: it is used in concentrator plants in flotation processes, in smelter and refineries as coolants and is also the key part when tailings being pumped to tailings dams, opposed to being trucked. South Africa is not a water rich country but have ample water. The main concern with the South Africa water infrastructure is the supply of clean water that is suitable for human consumption and industrial uses. Around 98% of the water resources in South Africa have already been developed and allocated. Agriculture via Irrigation soaks up 62% while only contributing 3% to the South Africa Gross Domestic Product (GDP) (Pretorius, 2011:45), Mining and Bulk Industrial companies utilised 6% (Sonjica, 2004:29) of the water requirements and contribute in total directly and indirectly to 19% of the South African GDP (Chamber of Mines, 2009:2).

The Minerals and Petroleum Resources Development Act no. 28 of 2002 lays down conditions for obtaining a permit to mine or prospect, which includes submitting an environmental management plan showing the impact the operation will have on the environment and how that will be rehabilitated. Miners and prospectors have to set aside funds for rehabilitation based on expert advice, and review this sum every year. The permit holder is responsible for any environmental pollution until the minister issues a closure certificate. New legislation also require the Department of Mineral resource (DMR) to audit these licences on an annual basis and companies face the threat of losing their mining licences should they not comply with the rules of the South African Water Affairs Board. This was only enforced after the water nightmare arose with the determining that acid water rising from old un-rehabilitated mining shafts will be polluting some of South Africa's main rivers and make billions of litres of water polluted (Mathews, 2010:7). South Africa has almost fully exploited existing fresh water resources and are challenged by quality-based scarcity as water pollution and other activities such as over pumping of aquifers have turned available water unusable without extensive treatment. As much as 77% of South African drinking water is provided by groundwater resources (Pretorius, 2011:45). Rapid population growth and economic development is expected to place considerable reliance upon this resource in future, as rainfall and freshwater from rivers and lakes becomes more variable and as a result, less reliable owing to climate change. The

increase in demand for water is not only being pressured by the growing population, but also by issues such as poor city planning and water sanitation management (Barradas, 2011:40).

If proper investments and management decisions are not made at the appropriate time, water crises may develop. This could see jobs and livelihoods affected, taps running dry and needless spread of diseases (Sonjica, 2004).

Notwithstanding the great strides made in improving access to basic drinking water and sanitation in South Africa, the quality and availability of water in South Africa has become a complicated challenge. This is largely the outcome of higher industrial and mining activity, as well as from a sharp increase in urbanisation, which has added to the historical backlog, placing access to municipal services under pressure and highlighting the desperate need for additional infrastructure (Barradas, 2011:42).

A Department of Water Affairs (DWA) report stated that investigations showed an unacceptably high incidence of poor drinking water quality in rural South Africa.

The report cited a number of reasons for the poor quality of drinking water standards:

- A lack of understanding by Water Services Authorities, regarding the requirements for successful drinking water quality management
- Poor management including monitoring of drinking water services
- Poor infrastructure management
- Insufficient Water Service Authorities institutional capacity and
- Inadequate interventions to tackle poor drinking water quality when identifies (Sonjica, 2004).

During 2005 a drinking water regulator programme was launched with the aim of ensuring the improvement of tap water quality through compliance monitoring, this leading to two incentive-based regulation programs being launched, namely Blue and Green Drop Certifications.

Blue Drop Certification aims to test the quality of drinking water provided by South African municipalities and water authorities. The average Blue Drop Score for 2010 was 70.75%, a general improvement from 53% in 2009. Only a mere 5% or 38 out of

787 municipal water authority obtained a Blue Drop status of 95% or higher compliance.

Green Drop Certificate investigates and audits wastewater treatment and compliance with relevant legislation on water. In April only 32 (3.8%) of the 852 water plants received a green drop status, 203 (24%) scored better than 50% and most concerning is that the other 403 (47%) were not considered to be in a state to be assessed (Barradas, 2011:42). The green drop findings imply that millions of litres of untreated or poorly treated sewage are being discharged into rivers and streams each day (Barradas, 2011:43).

Minister of Water and Environmental Affairs Bulyelwa Sonjica raised further serious concerns regarding South Africa's water affairs when she launched the Green Drop report in April 2010 by stating that South Africa would need about R23 billion to prevent the country's water treatment works from collapsing. The DWA has since reported in its Strategic Plan 2011/12 to 2013/14 that a huge backlog had developed in the regional bulk water and sanitation infrastructure owned by municipalities, including water treatment and wastewater treatment plants. Surveys done jointly with local government estimate the backlog at R110 billion. The department has budgeted R5.4 billion over the next four years to reduce this backlog. This amount excludes the funds that have been allocated in the budgets of local governments (Barradas, 2011:43). The mining industry would have to cater for capital investment cost for its own water supply, as it is clear that the DWA will not be able to supply more water to the mining's industry's demand as determined in chapter two.

3.2 SUMMARY

The engines of economic growth are electricity generation, pipelines, ports, rail, road transport and water supply. Only pipelines were not studied in the chapter as it is not playing a direct role in the sustainable mining of selected minerals and metals selected namely Chrome, Coal and Platinum Group metals.

The conclusions for each section are as follow:

- Electricity provision namely Eskom is currently under cost and supply pressure. It has a strong strategy based on the expected future demand required and the main risk is raising capital to deliver the set long-term strategy. In Chapter 2 it was also determined that South Africa have enough coal reserves to be mined, which will ensure enough coal for energy generation.
- Ports currently have capacity to support mining processes. It has a strong strategy based on future demands required to support mining growth. The major risk under ports is the current high operating cost and inefficiencies compared to international standards.
- The Rail network that transports the mining minerals and metals are in a fair condition with the required capacity to support current mining activities. It is the preferred mode of transport for Coal, Iron Ore, Manganese and Chrome Ore. Inefficiencies let major users like the mining sector use the more expensive road as mode of transport. Capacity improvements that would be capital intensive would be required within the next ten years to support mining growth. The current strategy plan caters for a 30 year expansion. The major risk for rail expansions identified is the reliance on available electricity to power the railways.
- Road transport is currently the preferred mode of transport as it is more effective, efficient and flexible than rail. Roads are being more pressured by the rail sector's inefficiency and funding required for maintaining roads will drastically increase road transport cost.
- Water supply for domestic and mining usage is a major risk in South Africa's quest for sustainable mining as the Department of Water Affairs reported that they don't have the funds and 98% of South Africa's water have already been developed and allocated. Industrial demand for water will always be behind domestic demand as access to water is a human right. South Africa's Department of Water Affairs will need to develop a strategic plan to ensure that water managed by Municipalities are improved and ensure that wastewater and sanitation management are improved to ensure that less polluted water are discharged into rivers; this will increase water quality and availability of drinking water. The government will also have to review which

sectors contribute most to the growth of the country and allocate water accordingly. Agriculture via irrigation uses 62% of South Africa's water compared to mining usage of 6% and contribution 3% to the country's GDP, significantly less than the mining sector's 19%. Should mining be allowed a bigger portion and more focus being placed on water management in the agriculture sector, there will be enough water for mining demand but the mining sector will still have to cater for its own funding for major capital outlays.

CHAPTER 4: EMPIRICAL RESEARCH

4.1 QUESTIONNAIRE AND STATISTICAL DATA

The chapter addresses the data analysed in the study. It provides an explanation of the data collection, samples and the statistical analysis.

4.1.1 Methodology

The survey establishes a baseline for the current status of the 2010 mining module and formulates the perceptions of companies currently active in the mining environment and other stakeholders in the mining environment.

a) How the sample group was selected

A list of companies that are currently actively involved in mining and beneficiating minerals and metals in Southern Africa was compiled. The focus was placed on companies that currently deal with all stakeholders in the mining environment and related stakeholders on a daily basis. The individuals were selected for the leadership roles they play in their organisation.

b) How the survey was administered

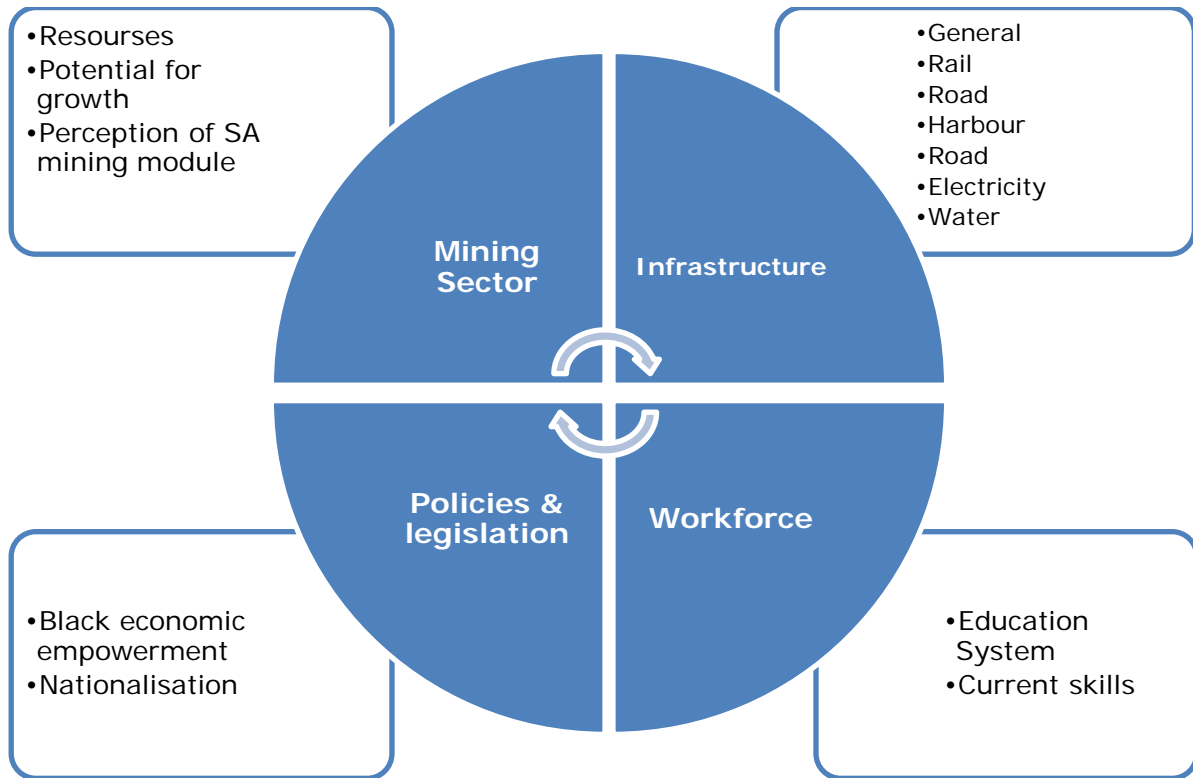
Companies were contacted individually and the survey was either faxed or emailed to them or discussed with them in person or telephonically. Where necessary, follow-up calls were made to respondents in order to obtain explanations of survey responses. Individual responses will remain confidential.

c) How the survey questionnaire was designed

The survey questionnaire (*Annexure 1*) was designed by the researcher with guidance of the study leader. The outlay of the survey questionnaire was based on the prescribed guidance from the Potchefstroom Business School at the North-West University. The scope and methodology of the survey questionnaire was based on the experience gained of working in the mining environment. The scope was to gauge the current perceptions that exist in the mining environment in South Africa and ascertain the challenges they experience when dealing with expansion and growth strategies, satisfying stakeholders and shareholders and attracting new investors. Representatives were requested to give their views on each statement

based on their knowledge of the industry. The survey results will be evaluated in the four focusing areas of Part 1 of the questionnaire as set out on figure 4.1.

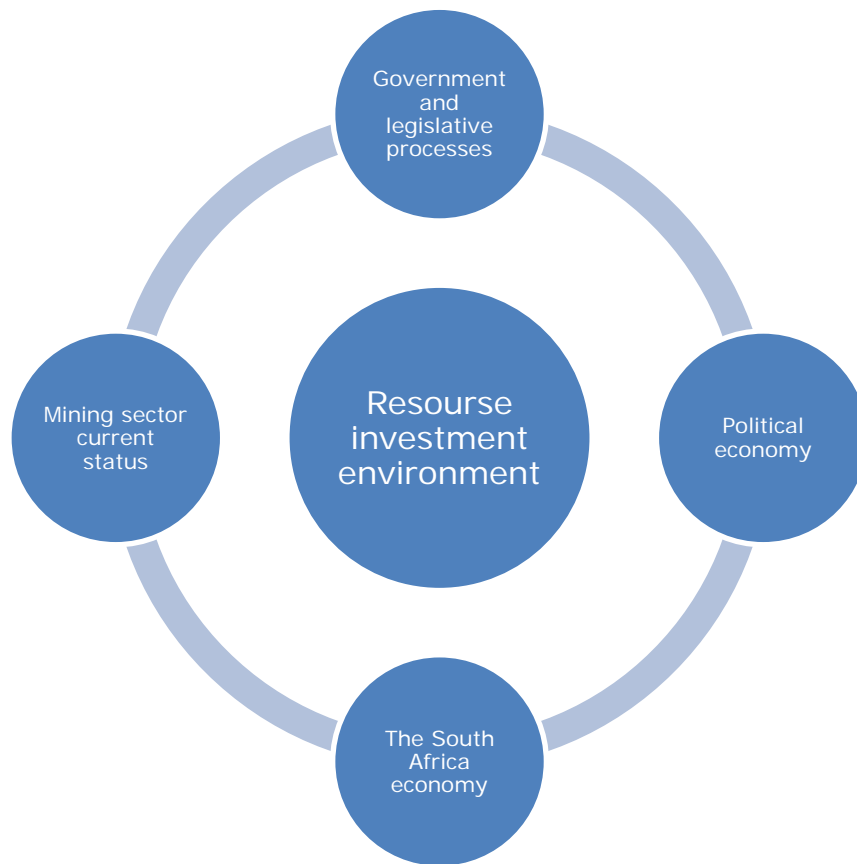
Figure 4.1: Summary of part one of study survey



Source: Own compilation

Part two of the survey questionnaire was designed to do ratings based on the highest means and not to test for the reliability. Each answer will be evaluated and addressed on its own. The results after the factors had been evaluated will be used to determine the most important factors investors use, to do investment and give guidance to stakeholder in the mining sector to develop a strategy to ensure a sustainable growth module for South Africa mining. The second half of the survey was designed to assess the general sentiment regarding investment in mining and resources department. Each representative was asked to rate 16 factors also in four focus areas laid out in figure 4.2, namely: governmental and legislative processes, the mining sector's current status, the political economy and the economy in general as laid out in figure 4.2.

Figure 4.2: Summary of part two of the survey



Source: Own compilation

d) How the list of respondents was compiled

The student inspected a list of registered mining companies issued by the publication, *Mining Weekly*. All exploration companies and paper companies (non producers) were removed from the list. Of the remaining 42 companies 5 majors were selected. Only active market participants and companies mining Chrome, Platinum group metals, Coal and Iron and that also do beneficiation and further processing of the ore were considered. The student contacted their public liaison officers, explained the purpose of the call and followed up with the people to whom they referred to. Participants had to follow the instructions on the questionnaire, complete the survey by highlighting or marking the appropriate box they selected with an X and return to the sender via e-mail, facsimile or in hard copy format.

e) How perceptions about the mining module and stakeholders were captured

The survey elicited information on investors' perceptions of the current mining environment from two angles. Firstly, it asked investors to give their own views of and experience of the environment and government support in which they currently operate. Then, based on the results, an interpretation was formed by the researcher of an operating environment. Each question was evaluated individually and discussed.

Representatives were asked to rate each factor according to a 1 to 5 point Likert-type scale with the results forming the data base:

- 1 = strongly disagree,
- 2 = disagree,
- 3 = neutral,
- 4 = agree and
- 5 = strongly agree

*Calculations for the **first** part were performed as per the following statistical methods:*

- Descriptive statistics, calculating the mean, standard deviation (trend explorative)
- Reliability testing

Secondly, investors were asked to indicate the most important factors for investing in the mining environment and this provided greater insight into the reasons for the successes in and failures of investments in the resource sector.

*Calculations for the **second** part were performed as per the following statistical methods:*

- Descriptive statistics, calculating the mean, standard deviation

Where representatives were asked to rate each factor according to a 1 to 5 Likert-type scale:

- 1 = not a factor,

- 2 = minor factor,
- 3 = definite factor,
- 4 = major factor and
- 5 = a critical factor/deal breaking factor.

Factor ratings and rankings were calculated as follows:

Factor ratings - A mean of all respondents' ratings was then calculated for each factor. This mean was the rating for that factor shown in table 4.7.

Factor rankings – After the mean of all respondents' rankings was calculated for each factor, these means were sorted and assigned ordinals from the highest value to the lowest. These ordinals, the relative rankings of the factors, were used to determine the most important factors from an investor's point of view for investing in the resource environment and shown in figure 4.7.

Deal breaker – As another indication of how important respondents considered a factor, the percentage of respondents considering that factor as “a deal breaker” was calculated by dividing the number of respondents rating the factor “a critical factor of deal breaker” by the number of those giving the factor any rating as shown in table 4.7

Confidentiality

Assurance was given to each participant that all opinions supplied will be kept confidential and that no results were or will be made available, to ensure anonymity.

Reliability of data

To test the reliability of the set of measures, Cronbach's Alpha was used to measure the internal consistency and reliability. The definition for reliability is the extent to which the measurements are repeatable and that any random influence which tends to make measurements different from occasion to occasion is a source of measurement error that occurs. (Nunnally, 1967). Interrelated items may be summed to obtain an overall score for each participant. Alpha can take on any value less than equal to 1, including negative values, although only positive values make sense. Higher values of alpha are more desirable at levels above 0.70 that is needed for the statistics to be reliable.

4.1.2 Statistical data

Data collected for the survey was analysed by the North-West University's Statistical Consultation Services at Potchefstroom Campus using SPSS 2005.

- Frequency distributions will be portrayed graphically by means of tables in the study.
- The mean will be used as a measure to determine the central tendency and the standard deviation to indicate spreading of data ranges.
- Reliability testing according to Cronbach's Alpha coefficient which is based on the average correlation of variables within a test.

In Table 4.1 a summary is given of the responses to the survey.

Table 4.1: Response to the survey

RESPONSE TYPE	FREQUENCY	PERCENTAGE
Number of questionnaires distributed	35	100%
Number of questionnaires returned	23	66%
Number of questionnaires discarded	0	0
Number of questionnaires analysed	23	66%
Number of questionnaires analysed as percentage of returned	23	100%
Number of questions in analysed questionnaires (61 x 23)	1,403	100%
Number of valid answers received in analysed questionnaires	1,403	100%

A total of 35 questionnaires were sent to respondents in the mining sector to the 5 companies selected as per 5.1.1 (d) and 23 were returned by the cut-off date of 15 November 2010. The 23 represent a response rate of 66% of which 100% of the received questionnaires were able to be analysed.

Gender, racial group and age of the group were not analysed, as the responders were selected on the position and responsibility they carry in their organisation. Informal notes were made on the race group classification of the respondents and are presented in table 4.2, as per the South African racial group classification.

Table 4.2: Race group classification of respondents

Racial group	FREQUENCY	PERCENTAGE
Black	6	26%
Coloured	0	0%
Indian	2	9%
White	15	65%
Total	23	100%

The majority of the respondents were white (65%), while 26% were black and 9% were Indian.

4.1.3 Research findings

The structure of the questionnaire was designed to group findings so that they can easily be converted to conclusions per section with a high or acceptable Cronbach Alpha coefficient. The questionnaire was not designed to obtain different views for different cultures and ethnic groups. Investigating the reason for the unexpected deviation can be concluded as followed:

- Different ethnic groups experience the changes in infrastructure and economical growth differently. (Example – white responders feel that electricity supply is weakening because they personally experience power interruptions at home, and bad service delivery should they deal with municipalities where black respondents were positive as they see that there is a lot more individuals who have access to electricity compared to twenty years earlier)
- Grouping of different facets allowed for too big variety of answers that also affected the reliability. (Example – the findings for road and water as infrastructure was grouped together in the questionnaire, answers were not aligned and the Cronbach Alpha was distorted.)
- Time of uncertainty in the South Africa mining industry resulted in mixed results received from the respondents.

The final results did not produce the desired Cronbach Alpha coefficient. Grouping of the data for formulating conclusions is thus unreliable and the planned path on how the conclusions have been formed needed to be adjusted and each question with a meaningful finding was reviewed on an individual basis. The acceptable level for the standard deviation has also been increased to a level of 1 from the prescribed 0.5.

A) PART ONE

Data in question 1 to 4 forms part of the descriptive statistics of the survey. The questionnaire was designed in four sections.

Part 1 will determine resources, potential for growth and current perception that exist for the South African mining module and individual results will be addressed.

As previously discussed a Likert scale was used for Part one of the questionnaire. In a normal distribution the majority of values lie within an interval of plus and minus one standard deviation above and below the mean. The more dispersed the data, the larger the standard deviation (Levine, Stephan, Krehbiel, & Berenson, 2008).

The mean and standard deviations will be presented in table 4.3 to table 4.5 for the for pillar section of Part one, and discussed on an individual basis. For questions in table 4.3 to 4.5 refer to survey questionnaire (ANNEXURE 1).

Table 4.3: Mining sector review

Descriptive statistics						
Resources	N	Valid answers	Minimum	Maximum	Mean (\bar{x})	Std. Deviation (s)
q1.1.1	23	23	1.000	5.000	3.217	1.204
q1.1.2	23	23	1.000	4.000	2.391	.783
q1.1.3	23	23	1.000	4.000	2.609	1.033
q1.1.4	23	23	1.000	2.000	1.348	.487
Potential for growth						
q1.2.1	23	23	1.000	4.000	3.000	1.000
q1.2.2	23	23	1.000	4.000	2.652	1.027
q1.2.3	23	23	1.000	5.000	2.870	1.014
SA mining module						
q1.3.1	23	23	4.000	5.000	4.348	.487
q1.3.2	23	23	3.000	5.000	4.739	.541
q1.3.3	23	23	1.000	5.000	3.435	1.121
q1.3.4	23	23	3.000	5.000	4.261	.541

Question 1.1.4 has a very small standard deviation of $s = 0.487$ and a mean of $\bar{x} = 1.348$, indicating an area of concern for the sector with all of the respondents strongly disagreeing or disagreeing that the Department of Mineral Resources manages mineral resources in a well controlled environment.

The Potential of growth section has an average mean of $\bar{x} = 2.841$. The $s = 1.014$ showing that the perception for the growth is also much more distorted and is not able to make a valid statement from the findings.

The current South Africa mining module section has a $\bar{x} = 4.196$ and the $s = 0.672$ also shows that the data is mostly centred on the mean, with question 1.3.3 distorting the reliability of the section; question 1.3.3 highlighted the uncertainty whether the Chamber of Mines is performing the duties for which it was created for.

Question 1.3.1 has one of the highest means of $\bar{x} = 4.348$ and the smallest $s = 0.487$ indicating that all the participants feel that mining plays a major role in South Africa's growth but receive very little attention and assistance from government. Question 1.3.2 has the highest mean in the questionnaire at $\bar{x} = 4.739$ and a small standard deviation of $s = 0.541$. As much as 18 of the 23 participants strongly agreed that a strong and enforceable legal framework is required for the mining industry that can serve as a basis for investors to base decisions on.

Question 1.3.4 has a high mean of $\bar{x} = 4.261$ and also a small $s = 0.541$ indicating that the participants also feel that the mines currently incur huge cost to satisfy its direct stakeholders.

Table 4.4: Infrastructure

Descriptive statistics						
General & Logistics	N	Valid answers	Minimum	Maximum	Mean (\bar{x})	Std. Deviation (s)
q2.1.1	23	23	2.000	5.000	4.130	.694
q2.1.2	23	23	1.000	5.000	3.348	1.402
q2.1.3	23	23	1.000	5.000	2.522	.994
q2.1.4	23	23	1.000	3.000	2.130	.626
q2.1.5	23	23	1.000	5.000	3.043	1.224
q2.1.6	23	23	1.000	4.000	2.217	.795
q2.1.7	23	23	1.000	5.000	2.957	1.107
q2.1.8	23	23	1.000	4.000	1.913	.848
q2.1.9	23	23	1.000	5.000	2.826	1.370
Electricity (Eskom)						
q2.2.1	23	23	1.000	4.000	2.174	.887
q2.2.2	23	23	1.000	5.000	3.087	1.083
q2.2.3	23	23	1.000	5.000	2.957	1.065
q2.2.4	23	23	1.000	4.000	2.348	1.071
Water						
q2.3.1	23	23	1.000	4.000	1.522	.790
q2.3.2	23	23	1.000	3.000	1.522	.593
q2.3.3	23	23	1.000	4.000	1.957	.825

Under the general review and logistical part of the review the following were highlighted: Question 2.1.1 has a relative high mean of $\bar{x} = 4.130$ and a small standard deviation of $s = 0.694$, indicating that all the participants feel strong that South Africa is the best equipped country in the Southern Africa area where mining mostly occurs.

Question 2.1.2 with a $\bar{x} = 3.348$, the average feeling is that assistance from and development by government is required for South Africa to be competitive. The concern is that it has the highest $s = 1.402$ in the questionnaire, highlighting the distortion of data from the respondents. This also raised another question, is the data so distorted that the respondents don't think government is capable to fill the required need nor will South Africa mines be taking over the responsibility to ensure that they are as competitive as they always were?

Question 2.1.4 with a $\bar{x} = 2.130$ and a $s = 0.626$ highlighted that the respondents feel that Transnet's growth won't support the anticipated growth of mining in South Africa.

Question 2.1.6 with a $\bar{x} = 2.217$ and an $s = 0.795$ highlighted the same concern that South Africa's harbour capacity will also not support the growth of mining in South Africa.

Question 2.1.8 with $\bar{x} = 1.913$ and a $s = 0.848$ raised further concerns in respect of infrastructure growth as the data show that the respondents feel that road infrastructure is currently not well managed in South Africa.

The Electricity supply section of question 2.2 with $\bar{x} = 2.641$ and a $s = 1.027$ supported a finding that there is a lot of uncertainty with respondents, and although Eskom (State owned enterprise for electricity supply in South Africa) has a full development plan to ensure sufficient electricity, the respondents are uninformed or just don't have faith that the government controlled entity will ensure that these targets are met.

The Water supply section of question 2.3 with $\bar{x} = 1.667$ and a $s = 0.736$ and question 2.3.1 with $\bar{x} = 1.522$ and a $s = 0.593$ highlighting the fact the respondents feel very strongly that South Africa do not have sufficient storage dams to supply water for the current activities such as human consumption, agriculture and industrial uses such as mining.

Table 4.5: Education system and workforce

Descriptive statistics						
Education	N	Valid answers	Minimum	Maximum	Mean (\bar{x})	Std. Deviation (s)
q3.1.1	23	23	1.000	4.000	1.826	.778
q3.1.2	23	23	1.000	4.000	1.652	.714
q3.1.3	23	23	1.000	4.000	2.696	.974
Workforce						
q3.2.1	23	23	1.000	5.000	1.870	1.217
q3.2.2	23	23	1.000	5.000	3.043	1.022
q3.2.3	23	23	3.000	5.000	4.174	.650

Table 4.5 supplies the data for the education system and the current workforce in the South Africa mining sector. Under the education review question 3.1.1 highlighted that participants feel that the current education system does not support the development of skilled labour. Question 3.1.2 also highlighted that participants feel that the quality of education between public schools, following the South Africa curriculum and private schools with an international curriculum are not on the same level of quality education.

The workforce section question 3.2.1 with $\bar{x} = 1.870$ and a $s = 1.217$ the mean shows that participants mostly disagree with the statement that South Africa currently have enough skilled labour to support rapid growth in the mining sector, but with a standard deviation of 1.217 the assumption is mostly distorted, another fact highlighting the multiple perceptions that exist.

Question 3.2.3 is a perception of a past event and with $\bar{x} = 4.174$ and an $s = 0.650$, most of the participants' answers are aligned and most agree that South Africa used to produce some of the best skilled engineers in the world.

Table 4.6: Policies and legislation

Descriptive statistics						
Black economic empowerment	N	Valid answers	Minimum	Maximum	Mean (\bar{x})	Std. Deviation (s)
q4.1.1	23	23	2.000	5.000	3.826	.834
q4.1.2	23	23	1.000	5.000	3.391	1.033
q4.1.3	23	23	1.000	5.000	2.826	1.114
q4.1.4	23	23	1.000	5.000	3.174	1.154
Nationalisation						
q4.2.1	23	23	1.000	4.000	3.217	.850
q4.2.2	23	23	1.000	5.000	2.652	.982
q4.2.3	23	23	1.000	4.000	1.565	1.080
q4.2.4	23	23	1.000	5.000	1.870	1.217
q4.2.5	23	23	2.000	5.000	3.435	.992
q4.2.6	23	23	2.000	5.000	3.348	.832
Investors						
q4.3.1	23	23	2.000	5.000	3.261	.915
q4.3.2	23	23	2.000	5.000	3.174	1.072

Table 4.6 supplies the data for the Policy and Legislation framework in the South Africa Mining environment.

With Question 4.1.1 with $\bar{x} = 3.826$ and a standard deviation (s) $s = 0.834$ participants feel that Broad Based Black Economic Empowerment is failing because of political interference.

Questions 4.1.2 question 4.1.3 and 4.1.4 are all close to a neutral average $\bar{x} = 3.000$ and an $s = 1$ which can be seen as distorted data. This is further supported as these questions all have answers of a minimum of 1 (strongly disagree) to a maximum of 5 (strongly agree), another fact highlighting the multiple perceptions that exist.

With Question 4.2.3 with $\bar{x} = 1.565$ and $s = 1.080$ the responders feel strongly that nationalisation of mines will not distribute wealth to the public of South Africa. Question 4.2.4 with $\bar{x} = 1.870$ and $s = 1.217$ further support the previous finding in the form that the respondents do not feel that nationalisation worked successfully in other countries.

For the investors question, the average is $\bar{x} = 3.217$ and $s = 0.994$. This further highlights the fact that the respondents are in a neutral position about investing in South Africa.

For the questions in table 4.9 refer to survey questionnaire (Annexure 1, Part II). The data in table 4.9 indicate that all the questions have a standard deviation smaller than 1, indicating that the data is not distorted. The average mean (\bar{x}) for the survey is $\bar{x} = 3.690$ and $s = 0.824$. The second part of the questionnaire was designed to highlight the most important factors per individual rating and reliability was not tested.

Table 4.7 follows on next page

PART TWO

Table 4.7: Investors view on investing in South Africa

Descriptive statistics								
	N	Valid answers	Minimum	Maximum	Mean (\bar{x})	Std. dev (s)	Critical / deal breaker	Critical / deal breaker %
Government and legislative processes								
Q 1	23	23	2	5	4.217	.850	10	43%
Q 2	23	23	1	5	4.087	.848	6	26%
Q 3	23	23	2	5	3.870	.694	3	13%
Q 4	23	23	1	5	3.391	.988	2	9%
Q 5	23	23	2	5	4.000	.853	7	30%
The mining sector's current status								
Q 6	23	23	2	5	3.739	.864	4	17%
Q 7	23	23	1	4	3.304	.765	0	0%
Q 8	23	23	2	5	3.696	.926	5	22%
Q 9	23	23	3	5	3.957	.706	5	22%
Q 10	23	23	3	5	4.261	.689	9	39%
Q 11	23	23	1	4	2.826	.887	0	0%
The political economy								
Q 12	23	23	1	5	3.522	.846	1	4%
Q 13	23	23	1	5	3.609	.891	3	13%
The economy								
Q 14	23	23	2	5	3.391	.722	1	4%
Q 15	23	23	2	5	3.217	.951	3	13%
Q 16	23	23	3	5	3.957	.706	5	22%

Question 1 – 5 dealing with government and legislative processes has a mean \bar{x} = 3.913 and a standard deviation s = 0.847. It also highlights the important role the participants feel government and legislation play when investing decisions need to be made opposed to the status of the mining sector and the stance of the general and political economy.

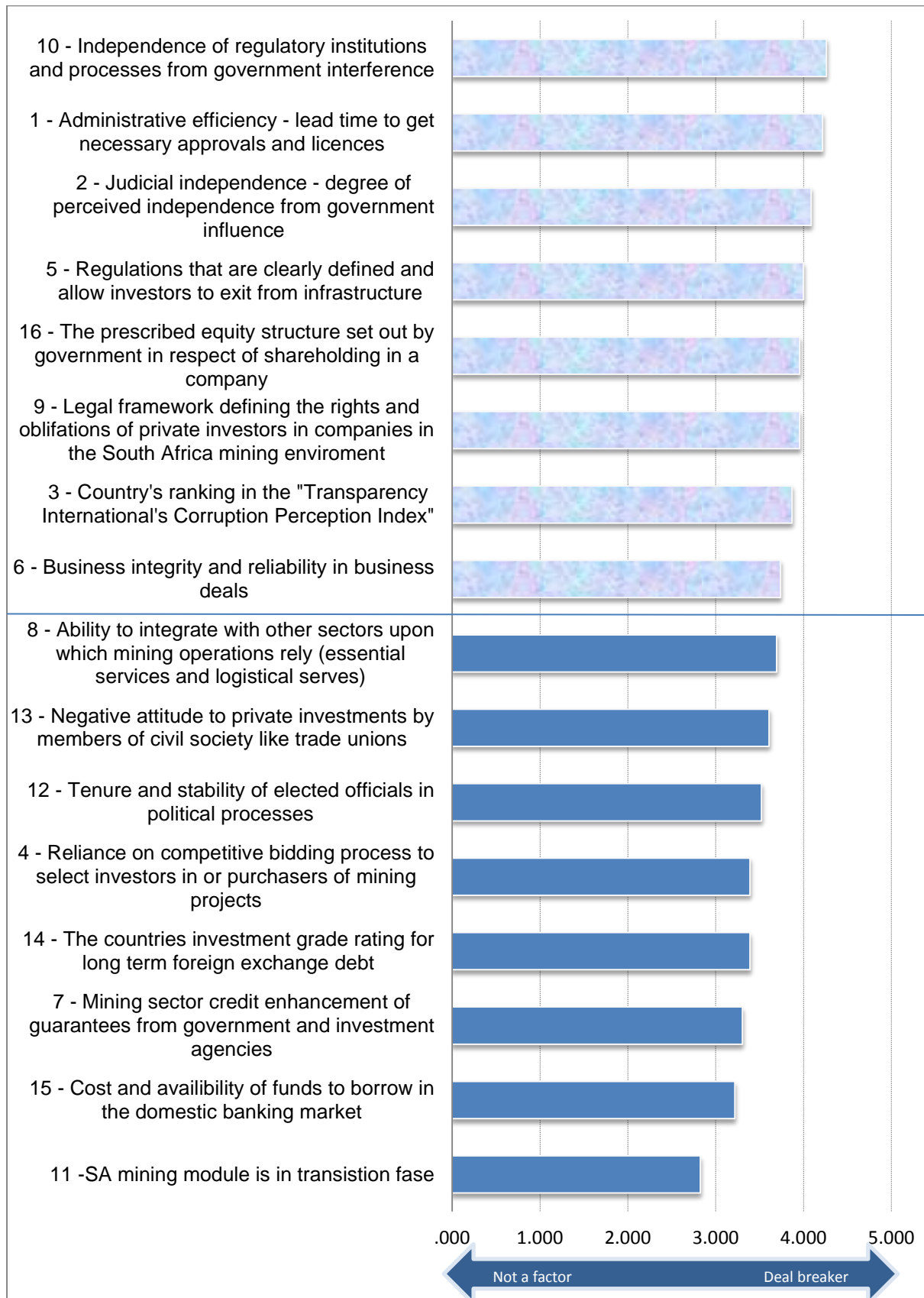
Questions 1 also have the most selections (10 / 23 or 40%) of the critical or deal breakers' selections. It highlights that investors will not put up with cost of delays because of administrative inefficiency.

Question 10 has the second highest (9 / 23 of 39%) of the critical or deal breakers selections. This indicates that investors base decisions on the independence of the controlling administration of the resources and mining sector, free from government interference.

Question 5 has the third highest (7/23 or 30%) of the critical or deal breakers' selections, stating that clearly defined regulations are required for investing in the South Africa mining and resource sector.

Figure 4.3 follows on next page

Figure 4.3: How investors rank priorities when investing in mining and resources in South Africa



Source: Own compilation

From the survey results shown in figure 4.3 the following conclusions were made:

Question 10's data suggest that government can increase the chances of investor attractiveness by ensuring that the mining and resource sector are managed independently of regulatory institutions and processes from government interference.

Question 1's data showed that the administrative efficiency and effectiveness to get approvals and licences is the second most important factor, highlighting that investors will not put up with cost of delays because of administrative inefficiency.

Question 2's data, the third most important factor is the judicial independence, free from government interference. This factor ensures that should trouble arise in the investing country, that there will be a justice system to protect the investment made.

Question 5's data, the fourth most important factor, the quest for regulations that are clearly defined and allow exit for investors in infrastructure, strongly support the previous point and are also about protecting the investments to be made.

Question 16's data, the fifth most important factor for investing in South Africa's mining and resource sector is the prescribed equity structure set out by government in respect of shareholding in the company. Most investors will be willing to fund investment in operations as *question 15's* data show that the availability of funds in the domestic banking market is the second last on the list but with the investment also comes the requirement of management and control over the investing asset, as they feel that it is their hard earned money that needs to be protected, and used to generate profits.

4.2 CONCLUSION OF THE SURVEY

The findings of the empirical research had been divided in two parts, part one is the evaluation of the mining environment with the challenges experienced when dealing with expansions, growth strategies, satisfying stakeholders and attracting new investors. Part two is analysing the most important factors for investing in the mining and resource environment.

Part one

As set out visually in Figure 4.4 the following can be concluded:

The mining sector highlighted that the South African mining sector scored average with a lot of cost and administrative concerns.

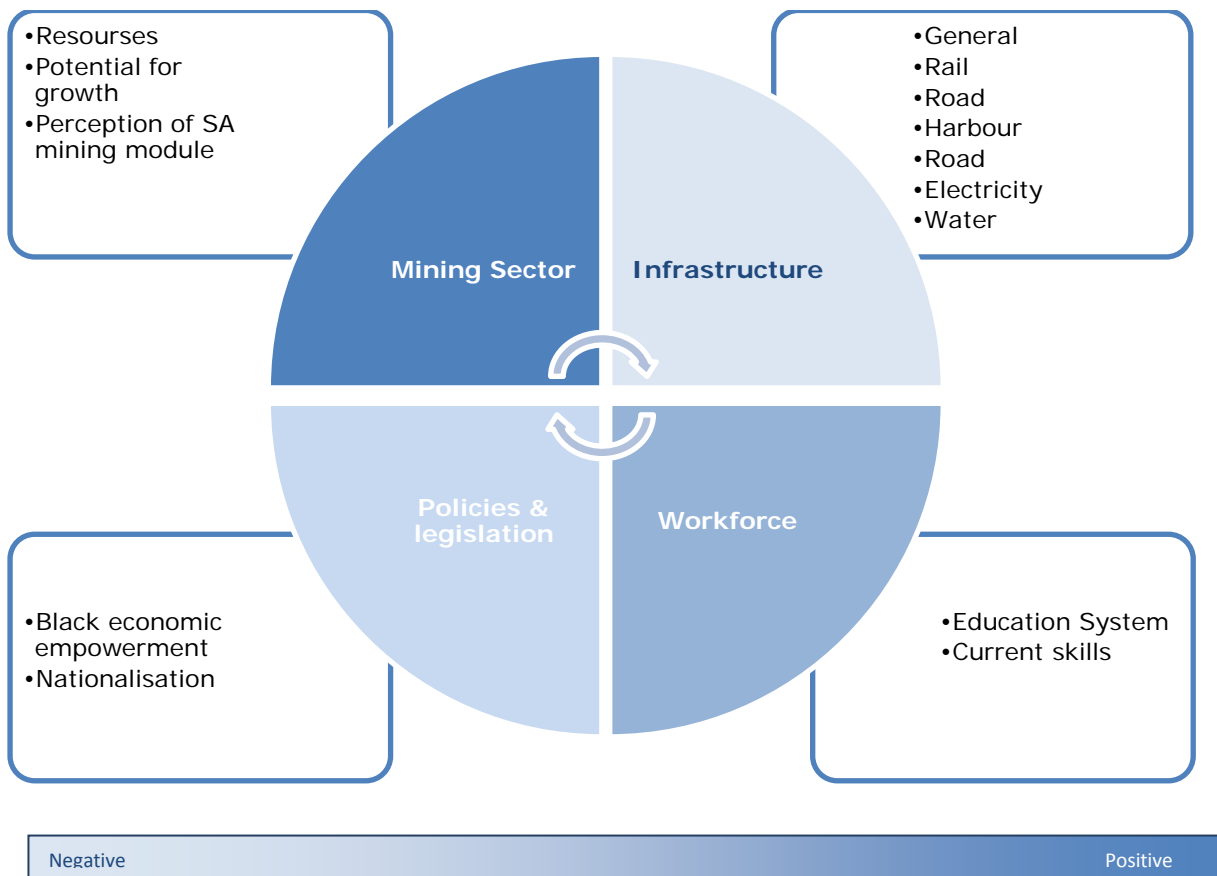
The infrastructure results show that South Africa is the best equipped country in resource rich Africa, but the survey also highlighted that the participants feel that infrastructure is not well managed in South Africa and that it will not be able to support rapid growth in the mining sector.

Under workforce it is clear that the participants highlighted that South Africa used to produce some of the best engineers in the world. The participants feel that South Africa currently do not have a capable workforce to support rapid growth in the mining sector and further concerns are raised that the current education system is not improving.

With the policies and legislation sector participants agreed that Black Economic Empowerment is failing because of government interference. It is also highlighted that nationalisation will not create wealth for the people and is also failing in other countries.

Figure 4.4 follows on next page

Figure 4.4: Part one of survey summary



Source: Own compilation

Part two

The goal of part two of the survey is to determine the important factors for investing in the mining environment and to provide greater insight into the reasons for the successes in and failures of investments in the resource sector.

An **investor** is a party that makes an investment into one or more categories of assets such as equity, debt securities, real estate, currency, commodity, derivatives such as put and call options with the objective of making a profit (Oxford University Press, 2005).

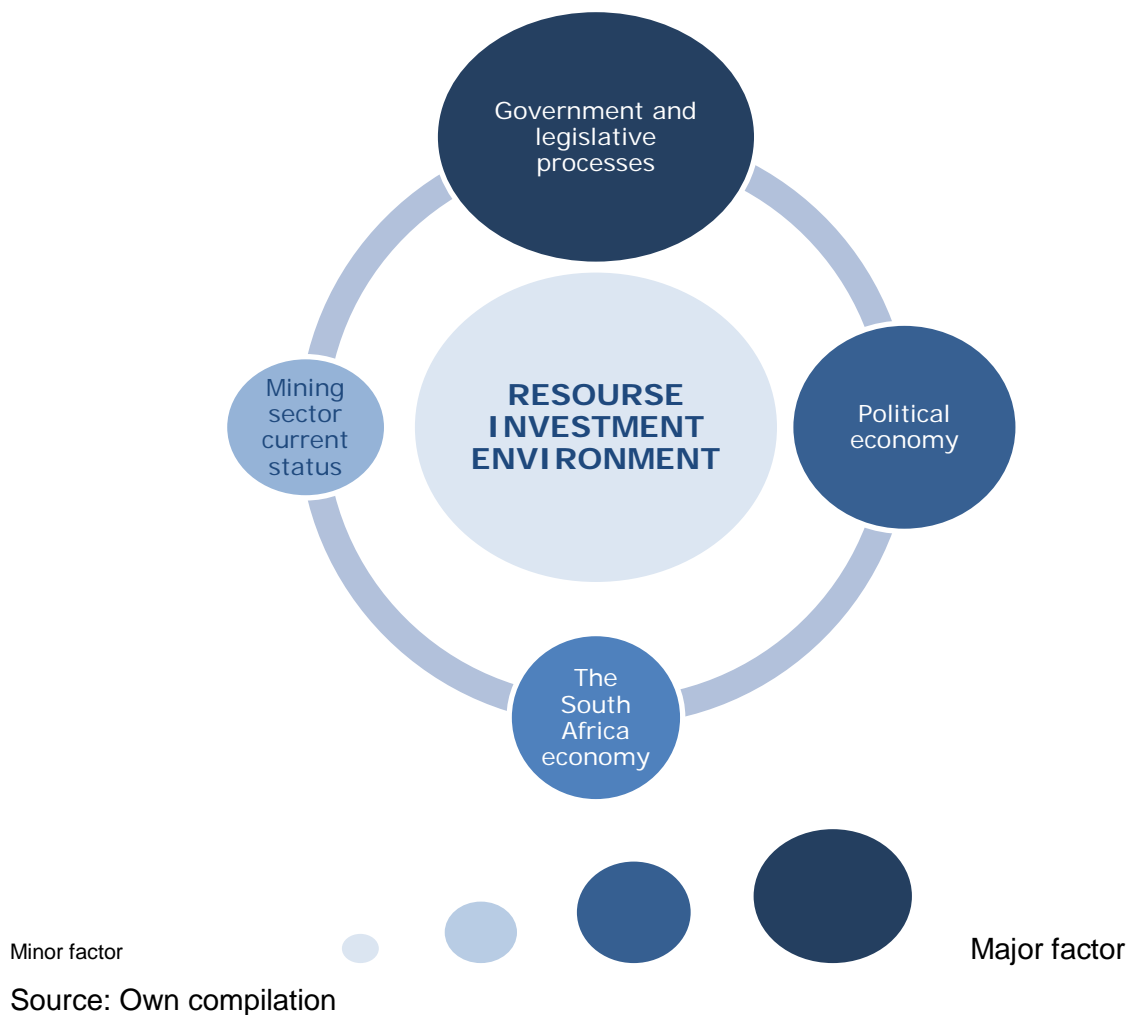
Investment is putting money into something with the expectation of gain that upon thorough analysis has a high degree of security of principle, as well as security of return, within an expected period of time. In contrast putting money into something with an expectation of gain without thorough analysis, without security of principal,

and without security of return is speculation or gambling (Oxford University Press, 2005).

As summarised visually in Figure 4.5, it can be concluded that government and legislative processes are the most important factors for investors to make investment decisions. The second most important factor is the stability of the political economy and environment and then the general economy of the country to invest in.

It was highlighted that the status of the current mining sector is the least important factor for investing decisions.

Figure 4.5: Summary of part two of the survey



CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

The primary objective of the study to analyse the South African mining model to determine the sustainability of mining in South Africa, was completed and evaluated on the selected minerals and metals namely Chrome, Coal and Platinum group metals. The primary objective was achieved and the following concluding statements can be made with the knowledge gained:

- Through a market overview on supply and demand for selected minerals and metals it was determined that there will be a demand upside for Chrome, Coal and Platinum group metals for the next twenty years. South Africa is ideally positioned to fill future demands as the country has the reserves and resources to grow its market share. South Africa has 84% of chrome reserves and only delivers 43% of the final product of Ferro-chrome; this highlighted that South Africa is already not optimising the full benefit of a reserve and resource-rich country.
- It was determined that the next commodity demand cycle will be driven by the BRIC countries and South Africa have ample reserves of Iron ore, Chromite, Coal, Copper, Aluminium, Nickel and Platinum group metals. South Africa must ensure that it will be in a position having the required infrastructure to mine these mineral and metals.
- South Africa's infrastructure required in the mining process and trade of mined products was evaluated and found to be the key risk area in the current and future of the sustainable mining process by both the literature and empirical studies and can be concluded as follow:
 - Electricity provision is currently under cost and supply pressure and in need of funding for future capital for capacity expansions. South Africa has sufficient coal to be supplied to electricity generators.
 - Ports have the capacity to support the mining growth, but high operating cost and operation inefficiencies were identified as the major problem to be addressed.

- The Rail network is in a fair condition but seen as unreliable. Funding for future capital for capacity expansions is required and also dependent of the availability of electricity to power the required rail lines.
- Road transport is under pressure because of rail networks' unreliability and is cost intensive. In the next decade road transport cost will drastically increase because of toll systems being implemented to fund capital for road expansions and maintenance cost.
- South Africa is in desperate need of water for the mining sector. Mining houses will in the future have to cater and plan for its own water supply and water treatment plants. This will be an added capital cost for new mine developments and cost of water is also expected to significantly increase.

The secondary objectives were also achieved and the study highlighted the following:

- South Africa is not an investor friendly country with timely and effective administration processes to do mining.
- Independence of regulatory institutions from government interference are the most important factor for investors in the mining sector and the second most important factor is administrative efficiency from regulatory institutions.

South Africa has the reserves and metals in the ground to be mined. The South African mining module is well developed with the required skills and knowledge for sustainable mining in the future. It was determined that there would be a future market to maintain a sustainable mining module. The major risk for the sustainable mining module is the reliance on infrastructures required in the mining environment, which is under governmental management.

5.2 RECOMMENDATION FOR FUTURE STUDIES

The study highlights that infrastructure required in the mining process is the major risk for South Africa to have a sustainable mining module. A proposed study would be to determine the optimum the South African government needs to invest in infrastructure capital to ensure that the country's economy will be able to grow. With mining impacting a wide variety of stakeholders a proposed study would also be to

develop a stakeholder management strategy for mining houses and the role stakeholders play in the mining process.

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Annexure A

MBA Research Study

Conducted by: **Zach Engelbrecht**

Field of study: **Master in Business Administration (MBAIII)**

Supervisor: **Prof Dr Ronnie Lotriet**

Institution: **North West Business School at the University of the North West**

Campus: **Potchefstroom**

As a representative of your company, you have been selected to participate in the above study by answering this questionnaire. This survey questionnaire is anonymous and the sole purpose of the information gathered is to support my research proposal. The completed questionnaire will assist me in evaluating whether or not South Africa is in a position to benefit from the next commodity boom.



S U R V E Y

Please remember there are no right or wrong answers – simply answer the questions based on your knowledge and experience.

To determine the current view and perception of the South Africa mining module please complete the following questions

- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neutral
- 4 = Agree
- 5 = Strongly agree

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
MINING SECTOR VIEW AND PRESEPTION						
1.1	South Africa has sufficient mineral resources to supply double the demand for metals and minerals	①	②	③	④	⑤
	South Africa’s mineral resources have been fully explored	①	②	③	④	⑤
	Mineral resources information is openly reported in South Africa	①	②	③	④	⑤
	The Department of Mineral Resources manages mineral rights in a well-controlled environment	①	②	③	④	⑤
1.2	South African mining companies are able to scale up production to meet demand	①	②	③	④	⑤
	My company’s growth strategies enable it to double supply upon demand	①	②	③	④	⑤
	Mining currently contributes 16% to South Africa’s gross domestic product (GDP) and has the potential to double.	①	②	③	④	⑤
1.3	Mining plays a major role in Southern Africa’s economic growth, but does not receive the attention and assistance it deserves from government. (Contribution to the “Gross Domestic Product” growth and job creation).	①	②	③	④	⑤
	Investors in the mining industry want a clear and enforceable legal framework. The regulatory “rules of the game” must be clear and remain credible and enforceable and not be altered by the government once investors have made decisions based on those regulations.	①	②	③	④	⑤
	The Chamber of Mines in South Africa has failed as spokesperson of the major mining houses and those companies have to engage with government themselves.	①	②	③	④	⑤

- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neutral
- 4 = Agree
- 5 = Strongly agree

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
①	②	③	④	⑤

	<p>Mining houses incur huge costs to satisfy stakeholders. (Trade unions, government departments such as the Department of Mineral Resources and communities)</p>
	<p>My companies most important stakeholder is</p> <p>.....</p> <p>.....</p> <p>Because:</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>

- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neutral
- 4 = Agree
- 5 = Strongly agree

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
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PRESEPTION ON SOUTH AFRICA'S INFRASTRUCTURE						
2.1	South Africa has the best infrastructure of all Southern African countries.	①	②	③	④	⑤
	Without assistance from and development by government, Southern Africa countries would be ill-equipped to compete for investment with mining and beneficiating companies in South America, Australia and China.	①	②	③	④	⑤
	The current logistical infrastructure (modes of transportation) in South Africa can support rapid growth in the country.	①	②	③	④	⑤
	Through Transnet (the South African supplier of transport and rail infrastructure) Government's growth strategy supports the anticipated growth in mining to 2020.	①	②	③	④	⑤
	Rail transport is currently the most cost competitive form of transport for mining activities in South Africa.	①	②	③	④	⑤
	South Africa has harbour capacity to support the growth of increased mining activities to 2020.	①	②	③	④	⑤
	South Africa's road network currently supports mining activities.	①	②	③	④	⑤
	Road infrastructure is well managed in South Africa.	①	②	③	④	⑤
2.2	The use of road transport is the preferred method of transport in South Africa for mining activities.	①	②	③	④	⑤
	Through Eskom (the South African supplier of electricity) government's growth strategy supports the anticipated growth in mining to 2020	①	②	③	④	⑤
	If the government fails to increase power supply to support the anticipated growth in mining, the private sector and non-government businesses will fulfil the demand.	①	②	③	④	⑤
	South Africa currently has sufficient research and development capacity in the field of power supply.	①	②	③	④	⑤
	Coal fired power stations are currently the only feasible solution for power supply as opposed to hydro and nuclear power stations.	①	②	③	④	⑤

- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neutral
- 4 = Agree
- 5 = Strongly agree

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
2.3	South Africa is a water rich country.	①	②	③	④	⑤
	South Africa has sufficient storage dams to supply water for human consumption, agriculture and industrial uses such as mining.	①	②	③	④	⑤
	Global warming is a sales pitch used by environmental consultants for job creation.	①	②	③	④	⑤
PERSEPTRION OF SOUTH AFRICA'S EDUCATION SYSTEM						
3.1	Current educational systems in South Africa support the development of skilled labour.	①	②	③	④	⑤
	The quality of education in private and public school are on par.	①	②	③	④	⑤
	Education in South Africa is affordable for the average South African	①	②	③	④	⑤
3.2	South Africa has enough skilled labour to support rapid growth in the mining industry.	①	②	③	④	⑤
	South Africa universities deliver the same quality of students as internationally universities.	①	②	③	④	⑤
	In former years South Africa produced some of the best skilled engineers in the world.	①	②	③	④	⑤
PERSEPTION OF POLICIES AND LEGISLATION RELATING TO MINING						
4.1	Broad Base Black Economic Empowerment (BBBEE) in South Africa has noble intentions but is failing because of political interference	①	②	③	④	⑤
	Government moves targets relating to BBBEE requirements and mining companies therefore struggle to achieve the government goals	①	②	③	④	⑤
	Mining companies that meet the BBBEE requirements benefit from government support when applying for and obtaining prospecting, mining and water licences.	①	②	③	④	⑤
	The prescribed equity structure prescribed by government in respect of shareholding in a South African company (26% black empowered) is daunting for international investors.	①	②	③	④	⑤

- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neutral
- 4 = Agree
- 5 = Strongly agree

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
4.2	The mining industry's sustainable development strategies are not sufficient to ensure the survival of future generations	①	②	③	④	⑤
	Governments in South Africa need to subsidise power and water usage to ensure that their countries' mining operations can compete effectively in the international arena	①	②	③	④	⑤
	Nationalisation of mines will distribute wealth to the public of South-African.	①	②	③	④	⑤
	Nationalisation of mines is successful in other countries.	①	②	③	④	⑤
	Mining companies pay taxes and royalties, basic services such as access to water, electricity, housing, sanitation and health care should be the government's responsibility in communities surrounding mining areas	①	②	③	④	⑤
	The "use it or lose legislation" in respect mineral reserves tarnishes the image of investing in reserves in South Africa.	①	②	③	④	⑤
4.3	I invest my own money in resource companies operating in Southern Africa in the form of shares and ETFs because I believe that it is a secure market when compared to other indices such as food, property and technology.	①	②	③	④	⑤
	South Africa has a positive investment environment	①	②	③	④	⑤
<p>In my opinion the 3 most positive aspects of mining in South Africa are: 1)..... 2)..... 3)..... and the 3 major risk would be: 1)..... 2)..... 3).....</p>						
<p>What do you evaluate as the best and worst aspects of mining in South Africa?</p>						

Part II

As an independent investor in a South Africa, please rate the following factors.

1 = Not a factor

2 = Minor factor

3 = Definite factor

4 = Major factor

5 = Critical / deal breaking factor

		Not a factor	Minor factor	Definite factor	Major factor	Critical / deal breaking factor
Government and legislative processes						
1	Administrative efficiency – lead time to get necessary approvals and licences.	①	②	③	④	⑤
2	Judicial independence – degree of perceived independence from government influence.	①	②	③	④	⑤
3	Country's ranking in the "Transparency International's Corruption Perception Index"	①	②	③	④	⑤
4	Reliance on a competitive bidding process to select investors in or purchasers of mining projects.	①	②	③	④	⑤
5	Regulations that are clearly defined and allow investors to exit from infrastructure.	①	②	③	④	⑤
The mining sector's current status						
6	Business integrity and reliability in business deals.	①	②	③	④	⑤
7	Mining sector credit enhancement of guarantees from government and investment agencies.	①	②	③	④	⑤
8	Ability to integrate with other sectors upon which mining operations rely (supply of essential services and logistic serves)	①	②	③	④	⑤
9	Legal framework defining the rights and obligations of private investors in companies operating in the Southern African mining environment.	①	②	③	④	⑤
10	Independence of regulatory institutions and processes from government interference.	①	②	③	④	⑤
11	The South Africa mining model is in a transitional phase when compared to competitive market structures in other countries, like Australia.	①	②	③	④	⑤
The political economy						
12	Tenure and stability of elected officials in political processes.	①	②	③	④	⑤
13	Negative attitude to private investment by members of civil society (trade unions, press and non- government organisations)	①	②	③	④	⑤

- 1 = Not a factor
- 2 = Minor factor
- 3 = Definite factor
- 4 = Major factor
- 5 = Critical / deal breaking factor

		Not a factor	Minor factor	Definite factor	Major factor	Critical / deal breaking factor
The economy						
14	The countries' investment grade ratings for long-term foreign exchange debt.	①	②	③	④	⑤
15	Cost and availability of funds to borrow in the domestic banking market.	①	②	③	④	⑤
16	The prescribed equity structure set out by government in respect of shareholding in a company.	①	②	③	④	⑤

A note on privacy.

This survey questionnaire is anonymous and the sole purpose of the information gathered is to support my research proposal “An analysis of the sustainable mining of selected minerals and metals in South Africa”.

Any records which I keep of your responses do not contain any identifying information unless specifically stated to the contrary.