University of the Witwatersrand
School of Mining Engineering
Research Report

Comparing cost implications of renewable energy and grid energy use in the South African mining sector

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A **research report** submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Masters of Science in Engineering.

Declaration

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ABSTRACT

Mining is a significant benefactor to the African continent's economy as mineral exports contribute significantly to the Gross Domestic Product of many countries. While mining is playing a positive developmental role, it is faced with numerous challenges that constrain its performance. Among these are industrial and infrastructure challenges, such as electricity constraints that have proven to be a significant problem facing the mining industry on the continent. South Africa’s development exceeds that of most other African countries but has also been experiencing electricity challenges resulting from infrastructure constraints and the inability of the power system to meet current demands. Looking at the potential of renewable forms of energy (REN) within South Africa, a potential opportunity exists that can contribute towards addressing electricity challenges, and this needs to be explored, especially in the mining industry. This will enable the mining operations to increase the production and beneficiation of minerals without solely depending on a centralised electricity system to provide power.

Electricity is critical for running a mining operation. Relevant surface infrastructure, processing plants, and neighbouring communities also require electricity to support the mining operation and the mining value chain's activities. Mineral extraction and full-scale mining activities in South Africa have fallen short with the erratic and unpredictable supply from Eskom with multiple bouts of, often extended periods of load shedding. South Africa’s 2019’s mining GDP came in at R 226 billion, significantly less than the preceding year (R 351 billion) as a direct consequence of load shedding (Minerals Council of South Africa, 2019).

The energy challenges experienced by South Africa has necessitated the mining industry to look at alternative sources of energy in order to move away from relying solely on electricity supplied by Eskom to ensure feasible and sustainable operations. The objective of the study was to investigate the feasibility of alternative sources of energy by comparing the cost implications of renewable energy and grid energy use in the mining industry. Using quantitative research, this study looked at the capital and operational expenditure of powering a medium to large scale operation on multiple scenarios of REN. Numerous financial models and scenarios were tested to conclude on an independent, feasibly sustainable and practical solution for power supply other than grid-supplied energy from a centralised distributor.

REN proved to be attractive compared to grid-tied energy and offered several solutions depending on the practicality applicable to the relevant operation. The results show that REN options that are currently on the market can power 70ktpm underground operation.

Hydropower had the best return (IRR) and project value (NPV) followed by the solar-only option giving no consideration to back-up power or storage to be utilised after sunset. However, both of these options were found to have practical challenges. Hydropower can only be considered where a consistent flow of a sufficient water mass exists year-round, and the solar-only option can only function during the daytime. To combat this, the analysis looked at alternative scenarios to supply energy during cyclic changes associated with daily or seasonal variations in nature. Lithium-ion batteries (LIB) stood out as an appropriate consideration for the storage of power but proved to be expensive in their current making the solar with battery storage unfeasible.

Based on the results obtained, it is concluded that an opportunity for REN exists and that REN can be feasibly implemented. The installation of REN can reduce and/or eliminate the reliance on a grid-tied source of electricity. However, the cost of storage to ensure stable and undisturbed supply remains a barrier. While the focus of the report was to find a solution away from the grid-tied electricity, under current conditions the feasible option may include considering a hybrid set-up where a mining operation is connected to grid power and supplemented by solar for as long as the daylight allows. This will eliminate the need for expensive power storage and has the potential to realise power cost savings.

As mentioned, some mining companies like Sibanye Stillwater are considering this option. Given the REN landscape in South Africa, clear policy and legislation guidelines are important to encourage investments in REN and as such mining companies should engage with the relevant regulators and government departments to scope out a denser REN future. There is potential for cost savings and for the SA mining industry to become a significant role-player in the REN setup.

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ABBREVIATIONS AND ACRONYMS

Abbreviation	Definition
%	Percent
≥	Bigger than or equal to
°	Degrees
ASG	Advanced Strike Gully
Au	Gold
BP	British Petroleum Company plc
CAPEX	Capital Expenditure
CBE	Cost Based Estimate
cm	Centimetre
CSP	Concentrated Solar Power
Cu	Copper
DPM	Diesel Particulate Matter
DRA	DRA Global
DRC	The Democratic Republic of the Congo
EPS	Enhanced Production Scheduler
Eskom	Electricity Supply Commission of South Africa
FW	Footwall
GA	General Arrangement
GDP	Gross Domestic Product
GW	Gigawatt
Ha	Hectare
HW	Hanging wall
ICMM	International Council on Mining and Minerals
IE	Industry Experts
IEA	International Energy Agency
Implats	Impala Platinum Holdings Limited
Ir	Iridium
IRENA	International Renewable Energy Agency
IRR	Internal Rate of Return
km	Kilometre
kt	Kilo tonne
ktpm	Kilo tonnes per Month
kV	Kilo Volt
kW	Kilowatt
kWh	Kilowatt-hour
LCOE	Levelised cost of energy
LHD	Load Haul Dump (vehicle)
LIB	Lithium-Ion Batteries
LOM	Life of Mine
m	metre

m/s	Meters per Second
m^3/s	Cubic Metres per Second
mbc	metres below collar
mbs	metres below surface
MCSA	Minerals Council of South Africa
MDC	Mine Design Criteria
mm	millimetre
Mpa	Mega Pascal
MRMR	Mining Rock Mass Rating
MSZ	Main sulphide Zone
Mtpa	Million tonnes per annum
MVA	Mega Volt Amperes
MW	Megawatt
NERSA	National Energy Regulator of South Africa
Ni	Nickel
NMD	Notified Maximum Demand
NPV	Net Present Value
NREL	U.S. National Renewable Energy Laboratory
Ø	Diameter
O&M	Operational and maintenance
OHL	Overhead power lines
OPEX	Operating Expenditure
Pd	Palladium
pf	Power factor
PFS	Pre-Feasibility Study
PGE	Platinum Group Elements
PGM	Platinum Group Metal
PPV	Peak Platinum Value
Pt	Platinum
PV	Photovoltaic
PVT	Private
RAW	Return Air Way
REN	Renewable Forms of Energy
Rev	Revision
Rh	Rhodium
ROI	Return on Investment
ROM	Run of Mine
Ru	Ruthenium
SA	South Africa
SI	International Metric System Of Units
SIB	Stay-in-Business Capital
t	Tonne (Metric)
TMM	Trackless Mobile Mining Machines

tpm	Tonnes per month
UG2	Upper Group two
USD	United States Dollar
WBS	Work Breakdown Structure
yrs	Years
ZAR	South African Rand

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1 INTRODUCTION

1.1 Research background and context

In the session discussing Sustainable Development at the 2015 Mining Indaba in Cape Town, mineral exports were identified as the highest contributors to national economies in Africa (African Mining Indaba, 2015). A study from the International Council on Mining and Minerals (ICMM) (2014) shows that African countries represent half of the top 20 countries globally depending on mineral exports (ICMM, 2014). Africa’s contribution to global mining production is significant when looking at both the impact and contribution it has made to the various mineral economies. According to the African Union (2009), several countries on the continent are ranked first in terms of global supply of minerals such as Platinum Group Metals, gold, diamonds and other minerals.

While mining in South Africa (SA) and Africa, in general, contributes significantly to global mineral production, the continent still faces numerous challenges which continue to restrict the mining industry in the different mineral dependent countries from reaching its maximum potential. These challenges include infrastructure constraints (access roads, bridges, rail lines, seaports) and inherent challenges such as an unskilled and illiterate workforce. Most of these challenges are compounded further by governmental red tape, corruption and an unstable political climate (Oosthuizen, et al., 2018). One of the significant challenges facing the African mining sector today is energy sources to power mining operations and all its ancillary operations. A medium to large scale mining operation has a power cost of between 10% and 20% of total expenditure depending on depth, size of operation and mining method (DRA Global Projects, 2019).

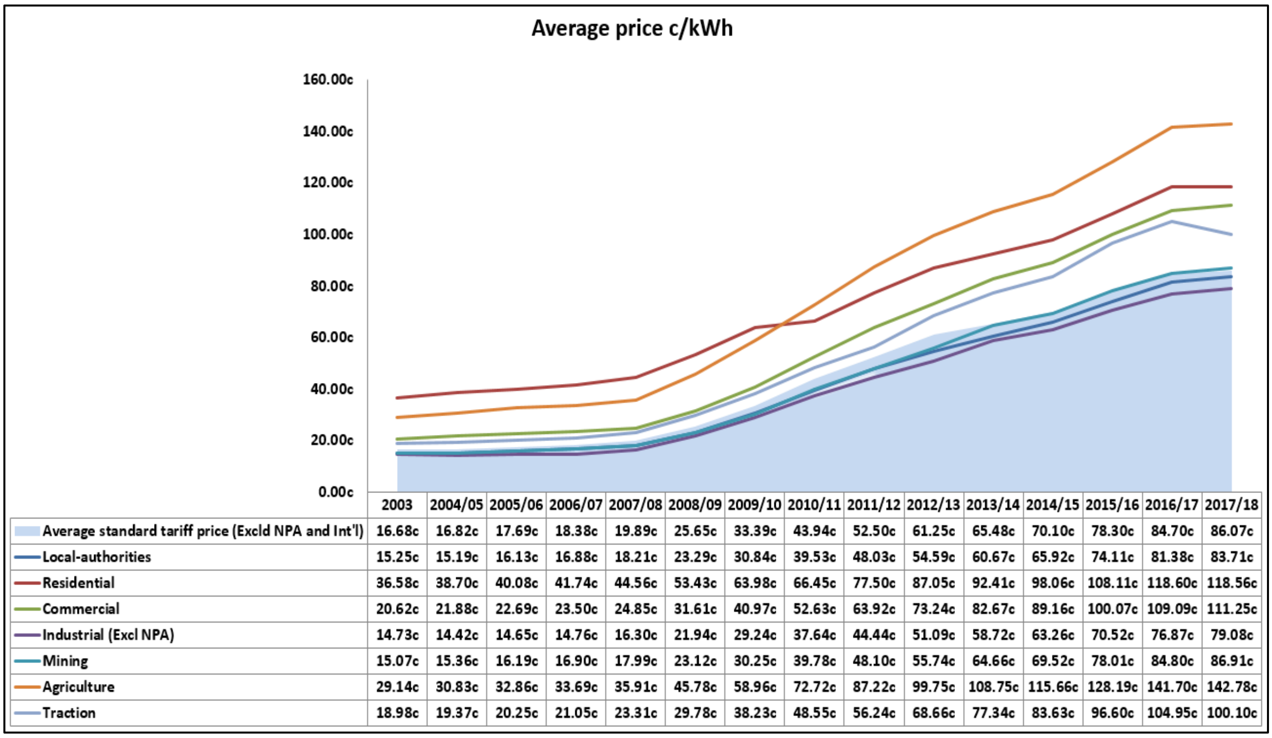
In addition to this cost, there are also operational risks brought by blackouts, load shedding and sole dependence on external suppliers. According to Oostheizen et al. (2018), urbanisation and population growth in many African countries continue to outpace infrastructure delivery. As a result, infrastructure maintenance remains irregular, poorly governed, poorly planned and unsafe. Ageing infrastructure gets compounded by theft, vandalism and lack of funding for maintenance (Oosthuizen, et al., 2018). In addition to the rising cost of electricity, the South African outlook on its ability to generate continuous and reliable power has been pulled into question by the incessant bouts of power outages due to load shedding. The Electricity Supply Commission of South Africa (Eskom) is struggling to keep up with the country’s power demand due to a severe lack of neglect and miss management of its power generating assets (Retief, 2019).

The focus of the research is on South Africa. The research focuses on a medium to large scale mine in the country and compares grid-tied power costs to that of renewable energy. A medium to large scale mining operation in the South African context is defined using the National Small Business Amendment Act No 29 of 2004, which defines this as an “activity that employs more than 200 employees, with an annual turnover of more than R 39 million, with fixed and moveable assets of more than R 23 million” (National Small Business Amendment Act, 2004).

1.2 Problem statement

In December 2019, Eskom had to institute stage six load shedding due to their inability to keep up with national demand. Stage six load shedding refers to 6 000MW that had to be shed from the national grid (Backeberg, 2019). This led to the Minerals Council of South Africa (MCSA) requesting mining companies to decrease their power demand on Eskom’s electricity grid by 20% (Backeberg, 2019). The load shedding implemented during that time had detrimental financial impacts on mining operations. Impala Platinum Holdings Limited (Implats) confirmed a revenue loss of R120 million directly related to stage six load shedding. According to Faku (2019), the overall loss was predicted to be more as the mines were not operating at 100% capacity on the days leading up to the implementation of stage six load shedding (Faku, 2019). Having experienced load shedding events, Implats ranked the impact of load shedding as their third-highest risk for their operations located in both SA and Zimbabwe in 2020 (Impala Platinum Holdings Limited, 2020).

In addition to load shedding, the performance of mining operations is affected by the increasing cost of electricity. Figure 1-1 indicates the average increase in electricity tariffs in South Africa. As can be seen in the figure, the electricity price had increased fivefold from 16.68c/kWh in 2003 to 86.07/kWh in 2018. The dependence of the South African mining industry on the strained power supply and combined with ever-increasing tariffs on the electrical power supply are starting to expose a gap that necessitates the investigation of alternative forms of energy in the mining industry. As discussed above, in addition to increasing tariffs, South Africa has suffered major power outages due to rotational load shedding. Load Shedding presents major challenges to the future prospects of SA’s mining industry as it accounts for 48% of the country’s energy-intensive users (Odendaal, 2020).



	2003	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
Average standard tariff price (Excld NPA and Int'l)	16.68c	16.82c	17.69c	18.38c	19.89c	25.65c	33.39c	43.94c	52.50c	61.25c	65.48c	70.10c	78.30c	84.70c	86.07c
Local-authorities	15.25c	15.19c	16.13c	16.88c	18.21c	23.29c	30.84c	39.53c	48.03c	54.59c	60.67c	65.92c	74.11c	81.38c	83.71c
Residential	36.58c	38.70c	40.08c	41.74c	44.56c	53.43c	63.98c	66.45c	77.50c	87.05c	92.41c	98.06c	108.11c	118.60c	118.56c
Commercial	20.62c	21.88c	22.69c	23.50c	24.85c	31.61c	40.97c	52.63c	63.92c	73.24c	82.67c	89.16c	100.07c	109.09c	111.25c
Industrial (Excl NPA)	14.73c	14.42c	14.65c	14.76c	16.30c	21.94c	29.24c	37.64c	44.44c	51.09c	58.72c	63.26c	70.52c	76.87c	79.08c
Mining	15.07c	15.36c	16.19c	16.90c	17.99c	23.12c	30.25c	39.78c	48.10c	55.74c	64.66c	69.52c	78.01c	84.80c	86.91c
Agriculture	29.14c	30.83c	32.86c	33.69c	35.91c	45.78c	58.96c	72.72c	87.22c	99.75c	108.75c	115.66c	128.19c	141.70c	142.78c
Traction	18.98c	19.37c	20.25c	21.05c	23.31c	29.78c	38.23c	48.55c	56.24c	68.66c	77.34c	83.63c	96.60c	104.95c	100.10c

Figure 1-1: Average price trend (Eskom, 2019)

With the rapid improvement of efficiencies and costs, renewable forms of energy (REN) are presenting a good case as an alternative source of energy for the mining industry. REN presents opportunities for a cheaper power supply (once commissioned). More predictable and clean technology makes for a rapidly evolving landscape as more countries, regions, and corporations are embracing REN (Ellsmoor, 2018). Figure 1-2 below demonstrates the drop in the majority of REN generation costs over the period 2010 to 2018 in USD per Kwh. As can be seen in the figure, solar has the largest drop indicating the steepest improvement trend compared to the rest of the REN shown.

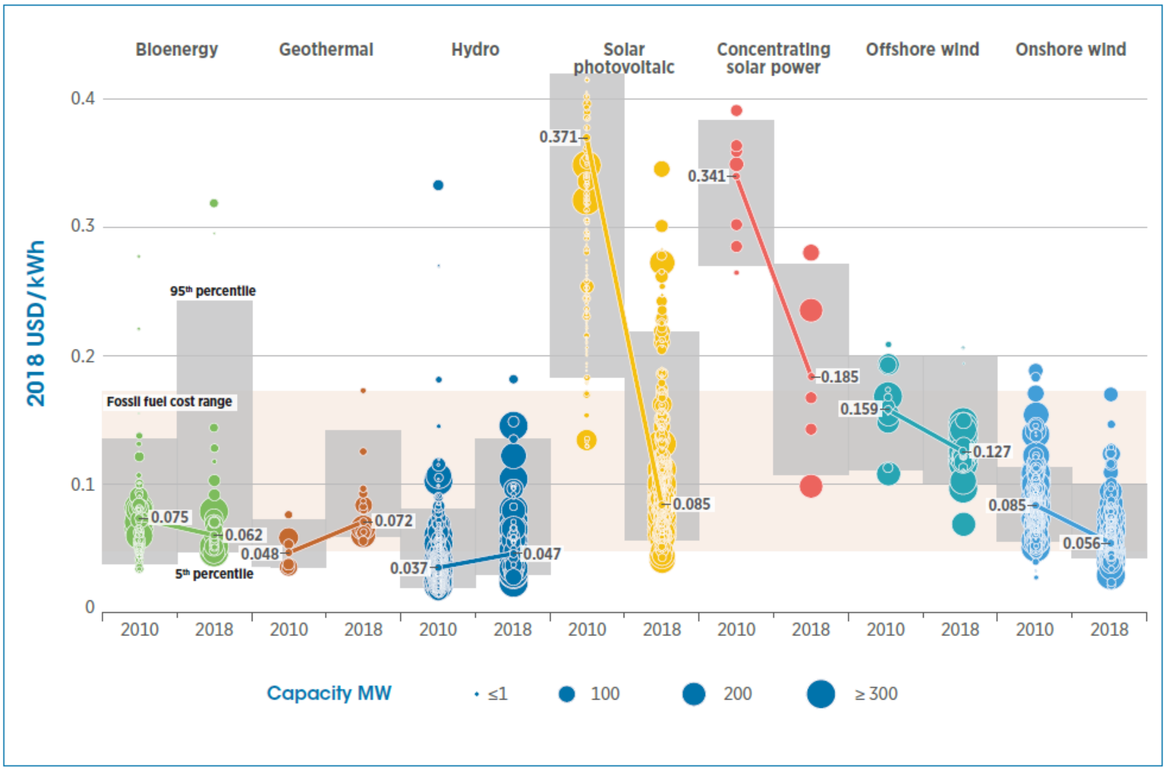


Figure 1-2: Global Costs of utility-scale renewable power generation technologies, 2010–2018 (IRENA, 2019)

Focusing on mining in South Africa, the research concentrates on available and possible on-site REN to compare the costs implications of REN technologies with the costs of overhead power lines (OHL) to service the size of the operation. This will involve a comparison of the total cost of energy supply as done conventionally (grid-tied) by Eskom for the majority of mining operations in SA versus a REN solution. This takes into consideration not only the capital layout required but also the associated operational and maintenance costs. This is mostly a unique mining challenge as mines' locations are determined by the deposit, providing no ability to pre-position any operation. From this research, it is expected that the conclusions reached will be relevant to the situations in other African countries because literature has revealed that a number of mineral-rich countries in Africa face similar energy challenges relating to insufficient infrastructure and unstable power supply and hence REN solutions can become investment options.

1.3 Research aim and objectives

The research aim is to construct a cost model that compares the total costs and trades-off of renewable forms of energy infrastructure against the cost of installing grid-tied overhead lines. The trade-off would be between the total costs of energy supply by means of grid-tied, centrally distributed power (Eskom) versus an on-site renewable form of energy. The cost models highlight Capital Costs (CAPEX), Operating Expenditure (OPEX), maintenance, and tariff costs for both renewable and grid-tied energy. These cost model trade-offs will enable the calculation of an overhead line (OHL) cut-off length or a financial return based on altered capital layouts and operating expenditure. Once analysed, it is expected for the model to show the generated returns and project value.

The focus of the research is not only on the mining component but also takes the power required for the processing and the surface infrastructure into consideration. The required power needs are fully met by any form of energy generation considered allowing for a complete operational solution. Process recoveries, mass pulls and necessary reagents and other miscellaneous processing costs are also considered for a realistic return based on the orebody.

The research addresses the four major questions:

1) How do the initial costs compare setting up infrastructure between renewable forms of energy and grid-tied overhead lines?
2) What is the operating, maintenance and tariff costs of REN compared to grid-tied energy?
3) Will a suitable medium to large-scale underground mining operation (70ktpm) deliver a positive return with current market conditions?
4) What is the OHL distance required to break even with the cheapest REN CAPEX?

1.4 Report structure

The report has six chapters, and each chapter covers the following:

Chapter one gives the background and context of the study. The background discusses the importance of mining on the African continent and South Africa, as well as key challenges facing the mining industry. The background and context are followed by the problem statement, which defines the problem underpinning the research and provides the scope and focus of the study. The chapter also provides the aims and objectives of the research and supporting research questions.

Chapter two provides the literature review of the study. The chapter gives a discussion on mining on the African continent and South Africa. It also provides details on the energy requirements by mining in South Africa. The chapter also gives a review of REN sources, technology and costs, and also discusses the shortfall considerations of the different REN sources. The last section of this chapter takes a look at the global potential for renewable energy production as well as REN potential in Africa and South Africa.

Chapter three outlines the research methodology and design parameters. It details the mine design, resource model, mining method and production schedule created to populate the financial model with real-life data applicable to a 70ktpm operation. It also details the power requirements in megawatt-hours required to run the mine, surface infrastructure and processing plant to support an operation of this magnitude. The chapter further specifies the required financial model inputs. These inputs produce the necessary financial returns used to gauge the various energy options traded-off.

Chapter four breaks down the costing applied to the project. The definition of the term “Levelised Cost of Energy” (LCOE) and comparisons between grid-tied costs and REN costs are provided in the Chapter. The Chapter also provides a detailed write-up on the basis of estimate applied to produce a pre-feasibility level of accuracy, cost-based estimate (CBE). The last section covers the work break down structure (WBS) used to cost and cash flow the CBE. The CBE is then used to populate the financial model.

Chapter five discusses the results from the six financial models and summarises the findings to draw conclusions and recommendations. Chapter six concludes and makes recommendations from the results produced by this study in line with the aim and objectives of the study.

2 LITERATURE REVIEW

2.1 Mining on the African continent

Mining is a considerable contributor to the African continent's Gross Domestic Product (GDP), with a mineral and metals contribution of more than 20% to the continents GDP and over 50% of exports. During 2011, the last commodity cycle boom, mining and petroleum were responsible for the largest share of the continent's USD 42 billion foreign direct investment (Ushie, 2021). Africa ranks either first or second in resource quantity in the following minerals; bauxite, chromite, cobalt, industrial diamonds, manganese, phosphate rock, platinum-group metals, rutile, soda ash, and zirconium (Yager, et al., 2014).

Africa contains 30% of the world's known resources, with the largest share in precious minerals and gemstones (54%), diamonds (78%) and phosphates (60%) (Ushie, 2021). From Figure 2-1 below it is seen that Sub-Saharan Africa produced the majority of global chromium (54%) and cobalt (56%), 50% of diamonds and manganese, 19% of gold and 13% of uranium (Yager, et al., 2015). South Africa (SA) produces the majority of the world's chromium at 52%, 7% of global natural diamonds and 54% of the global manganese stocks. For decades, South Africa was the global leader in gold production, with peak production of 1000 metric tonnes of gold in 1970. Today SA accounts for only 4% of global gold production (Yager, et al., 2015).

Mining also contributes positively to the livelihoods of local communities offering jobs, infrastructure and, if appropriately managed, sustainable development and industrial diversification. Mining also generates significant income to governments in the form of taxes and royalties. These are utilised to improve infrastructure and provide essential service delivery in the form of running water, electricity, sanitation and health care (Gqada, 2012).

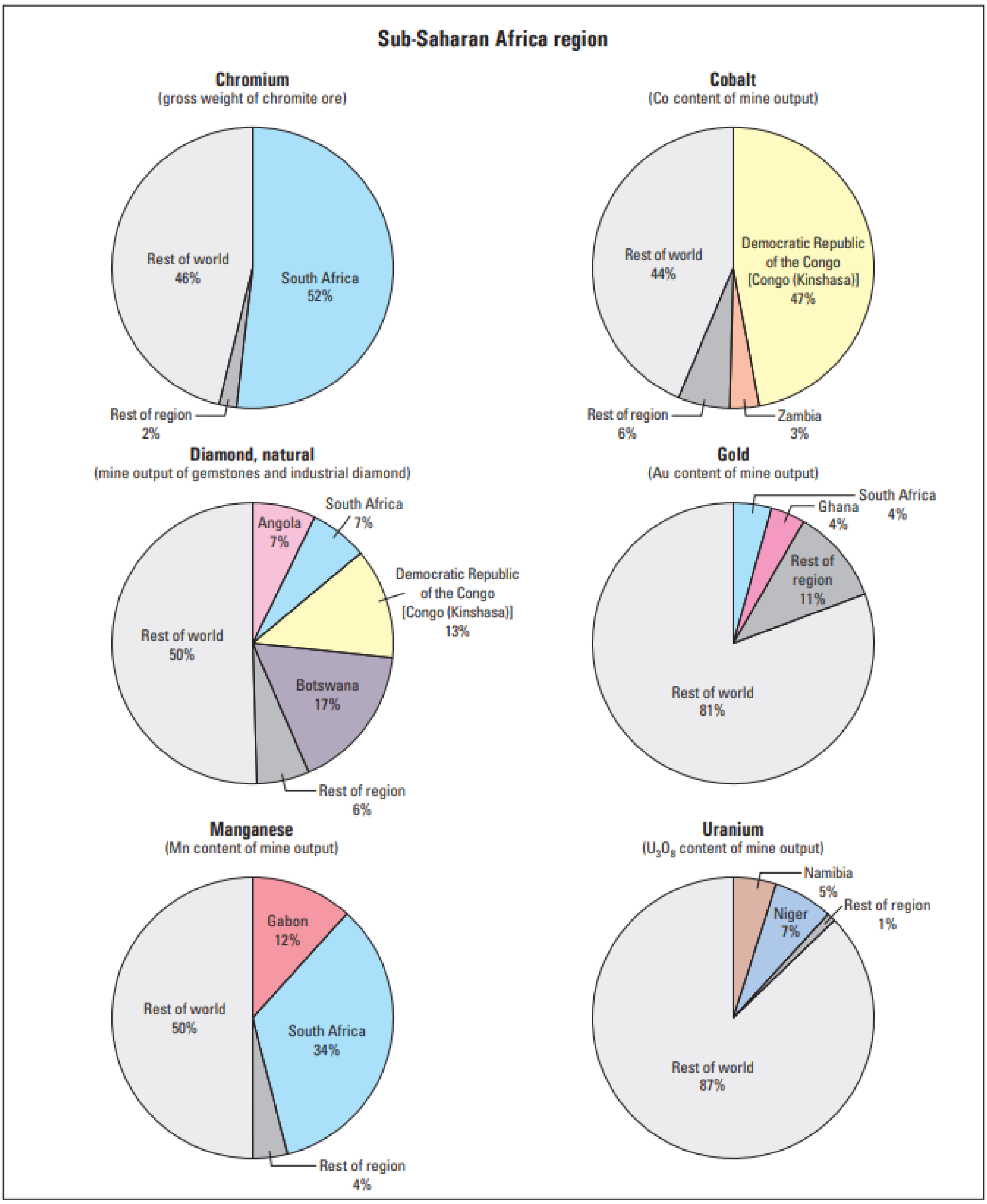


Figure 2-1: Percentage of world production of selected mineral commodities by countries (Yager, et al., 2015)

While the mining industry on the African continent plays an important developmental role, it faces numerous challenges. The mining and processing value chain is very lean, and much of the mined ore is only semi-processed or not at all. A large portion of African minerals is exported as raw materials exposing a gap in the local beneficiation market. This loss of value and further local revenue-generating potential has a downstream impact on local businesses in the minerals value chain (Gqada, 2012). The potential for local skills generation and other sector linkages and economic diversification are severely hindered. These challenges are mainly exacerbated by weak governance structures, policies and management (Gqada, 2012). The other challenges facing the mining industry include infrastructure limitations with ageing infrastructure and poor infrastructure unable to support the expansion of and/or new mining projects. A common challenge facing the African mining sector is a countries' ability to generate the necessary additional megawatts from the already constrained electricity grids required by new start-up mining operations and/or projects.

Figure 2-2 shows the profile of electricity usage in the Democratic Republic of Congo (DRC). As can be seen in the figure, mining is the largest consumer of power at 30%, followed by the private sector at 25% and government at 20%. The DRC's national energy supplier was formed in 1970 by the government. According to Lukamba-Muhiya an Uken (2006), the energy supplier has been underperforming to an extent that the country is calling for reform. This is because less than 10% of the population has access to electricity (Hall, 2018).

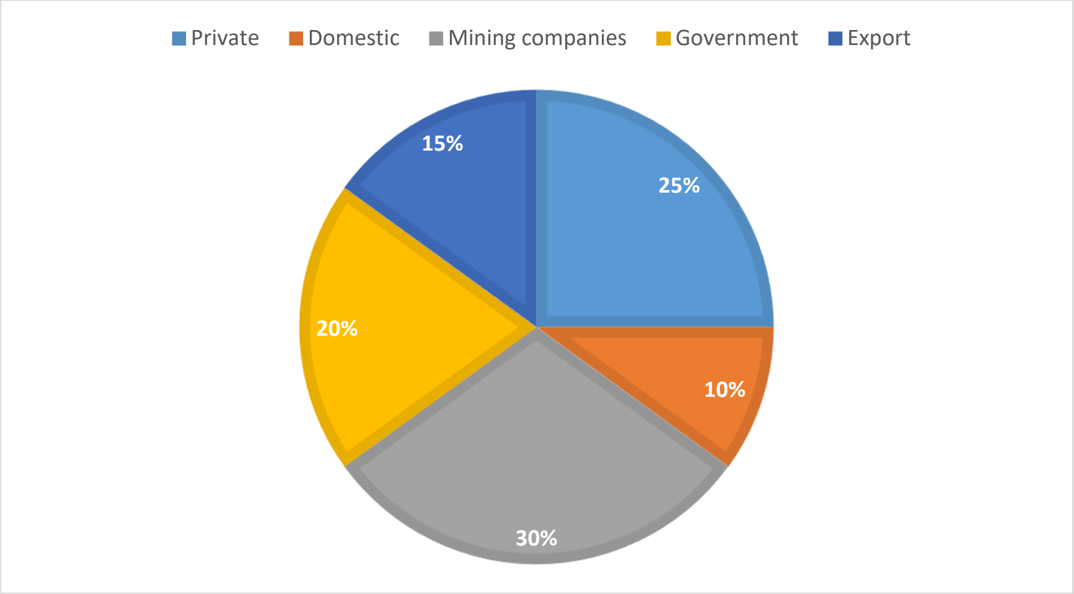


Figure 2-2: Profile of electricity usage in the DRC (Lukamba-Muhiya & Uken, 2006)

Another miner rich country that is facing electricity challenges is Ghana. The country has installed capacity of 4000MW of grid power but is only able to generate 2400MW due to changes in the hydrological conditions, fuel supply shortages and crumbling infrastructure (Newton, 2018). While Ghana is poised to overcome these challenges due to a significant endowment of natural gas and renewable energy sources (hydro and solar) but the country struggles with the poor financial health of the energy sector, limited creditworthiness and lack of transparent procurement framework (Newton, 2018).

2.2 Mining in South Africa

2.2.1 History of mining and power generation

South Africa established its first commercial mine in 1852, a Copper mine in Namaqualand, Northern Cape (Davenport, 2013). Since then, the great diamond and gold discoveries of the 1860s and 1870s played significant roles in defining SA's future. Today, SA holds the world's largest reserves of platinum group metals, chromium, manganese and vanadium (Davenport, 2013). Mining in South Africa started on the surface and as the depth of the deposits increased, extraction became difficult. One of the major challenges was pumping excess mine water to the surface. With several operations experiencing the same problem, mining companies joined forces to build central power stations to keep up with the higher power demand from these deep level pumps. In 1898, the General Electric Power Company Ltd was established (Eskom Heritage, 2021).

After the Anglo-Boer War, with gold mining in the Witwatersrand becoming more prominent and power intense, recommendations led to plans for larger, centralised power stations that could supply cheaper and more reliable electrical power. It was on the back of these mining companies that individual power suppliers in the form of The Rand Central Electric Works Ltd and the General Electric Power Co Ltd was bought out by Victoria Falls and Transvaal Power Company Limited in 1906 (Eskom Heritage, 2021). This amalgamation allowed for the introduction of the Power Act No 15 of 1910 on 28 May 1910 by the Transvaal Colonial Government. The Act allowed the state to place the provision of power under its authority.

In 1919, the SA government requested Charles Hesterman Merz, a universally recognised expert in power generation, to visit the country and recommend on the country's electrical power needs. The recommendations were favourably received and led to the government passing the Electricity Act No 42 of 1922 in September 1922. The establishment of the Electricity Supply Commission (Escom) (known as Eskom today) was announced on 6 March 1923 (Eskom Heritage, 2021).

2.2.2 Contribution and challenges facing SA's mining industry

With mining having shaped the development of SA and Eskom into what it is today, it remains one of the pillars of the local economy and a primary power user (Minerals Council of South Africa, 2019). In 2018, mining contributed R351 billion to the South African GDP and employed 456 438 people. The mining industry has for a long time, been a big source of foreign direct investment into SA (Minerals Council of South Africa, 2019). Although SA's total FDI for 2019 decreased by 15% to USD 4.6 billion, mining continue to attract the bulk of the investments in the country (United Nations Publications, 2020).

The performance of the mining industry has been adversely affected by various challenges including falling commodity prices and the demand for minerals at the global level. Nationally, the mining industry has been affected by labour disputes which have had a significant impact on productivity and mineral outputs (Mineral Council South Africa, 2017). Productivity has also been affected by technical challenges such as declining grades, increasing depth of mining and aging mines. These factors have raised the cost of mining affecting profitability and performance of mining operations. The other concerns are increasing costs of inputs such as water and electricity. According to Mineral Council South Africa (2017), electricity prices have trebled in 7 years. The impacts of the increasing cost of electricity has been exacerbated by power outages as seen in the country.

Eskom's implementation of load shedding in SA has had damaging outcomes on the local mining economy as well as the greater economy. The ongoing Eskom episodes with load shedding are still an ever-present threat and factors responsible for the utility's challenges, represents a threat to a reliable and stable power supply to South Africa's economy (Wright & Calitz, 2019). According to Jan Oberholzer, Eskom chief operations officer, the bouts of load shedding is due to a direct neglect of care and maintenance on the power generating plants from the preceding twelve years (Retief, 2019). According to the Council for Scientific and Industrial Research (CSIR), at 1352 hours, 2019 has seen the longest duration of outages since the power crises started in 2008 (Wright & Calitz, 2019).

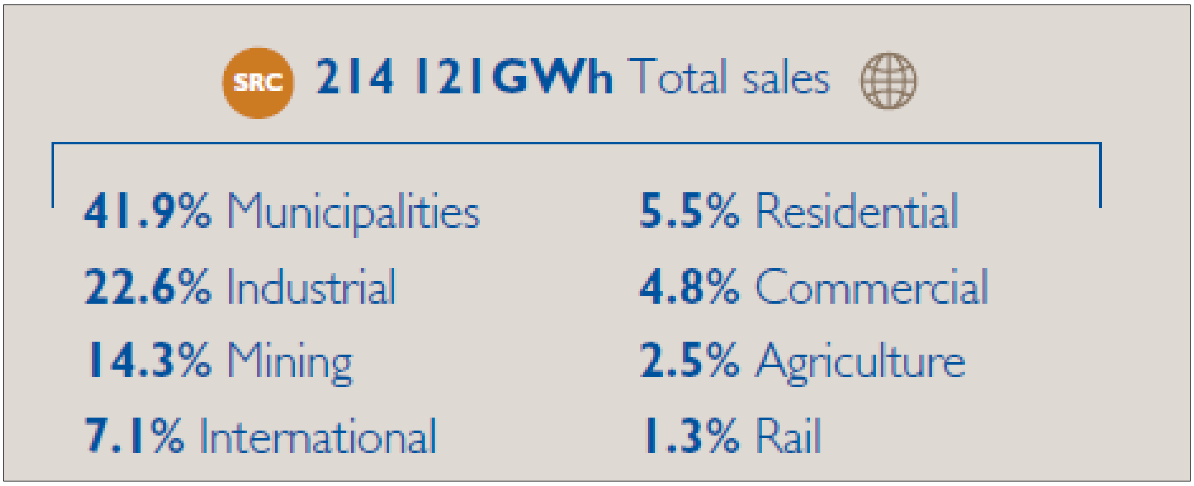
The power outages have had devastating impacts on economic activity including mining operations affecting performance and contribution to the country. As direct consequence of load shedding, in 2019, the mining industry contributed R 226 billion to the country's GDP. This was less than the R 125 billion reported in the preceding year (Minerals Council of South Africa, 2019).

As part of the seeking solutions for the excessive unplanned load shedding, the MCSA asked the SA government to "dramatically streamline" regulatory constraints preventing mining houses from generating their own electricity or to source it from alternative suppliers (Fawthrop, 2019). This, together with Eskom CEO Andre de Ruyter's call for mines to become independent energy producers. These calls are expected to encourage necessary investments from the mining and private equity groups required to setup alternative power generation initiatives (Mungadze, 2020).

2.3 Indicative mining energy requirements and costs

The energy requirements and associated expenditure of mining operations differs according depth, size of operation and mining method. As previously mentioned, a medium to large-scale mining operation has a power cost of between 10% and 20% of total expenditure. Table 2-1 shows the energy used by the mining industry in South Africa.

Table 2-1: Energy used by mining sector in South Africa



214 121GWh Total sales

41.9% Municipalities
22.6% Industrial
14.3% Mining
7.1% International
5.5% Residential
4.8% Commercial
2.5% Agriculture
1.3% Rail

Source: (Eskom, 2017)

The table shows that the largest consumers are municipalities (41.9%), followed by industrial and mining sectors (e.g. at 22.6% and 14.3% respectively). In 2017, South Africa used an estimated 31 000 GWh (14.3% of total sales) energy to power its mining industry. If smelters and refineries are added to the percentage share, the total power consumption rises to more than 30% of total power generated (Minerals Council South Africa, 2018). After the National Energy Regulator of South Africa's (NERSA) approval of the 13.87% tariff increase (effective 1 July 2019). The Eskom tariff increased from ZAR 0.86/kWh in 2018 to ZAR 0.98/kWh in 2019 (Eskom, 2019).

Based on the average charged rate of ZAR 0.98/kWh and 14.3% usage, it follows that approximately ZAR 30.4 Billion was spent to power the mining industry (excluding smelters and refineries) in 2017. This is a considerable amount and justifies looking at alternative sources of energy to improve on mining profits, sustainability and the carbon footprint. The need to explore alternative sources of energy is also motivated by the expected costs that will need to be directed towards the Carbon Tax with the government having signed it into law on the 1st of June 2019. It is expected that the tax will further add to the financial burdens subjected to mining operations affecting performance of the mining industry (Mining Review Africa. 2019). The benefits of alternative sources of power are expected to address power challenges as well as reduce the carbon footprint of mining industry.

2.4 Cost comparisons between South Africa and other countries

Figure 2-3 shows the retail electricity prices in Africa for 2017 in USD/MWh (Statista, 2017). As can be seen in the figure, countries with the highest cost of electricity are Liberia, Sierra Leone, Ghana and Senegal. The countries with the lowest electricity prices are Ethiopia, Zambia, DRC and Botswana. South Africa is ranked number 6 and is amongst the countries with the cheapest price at USD 74.78/MWh or USD 0.075/kWh.

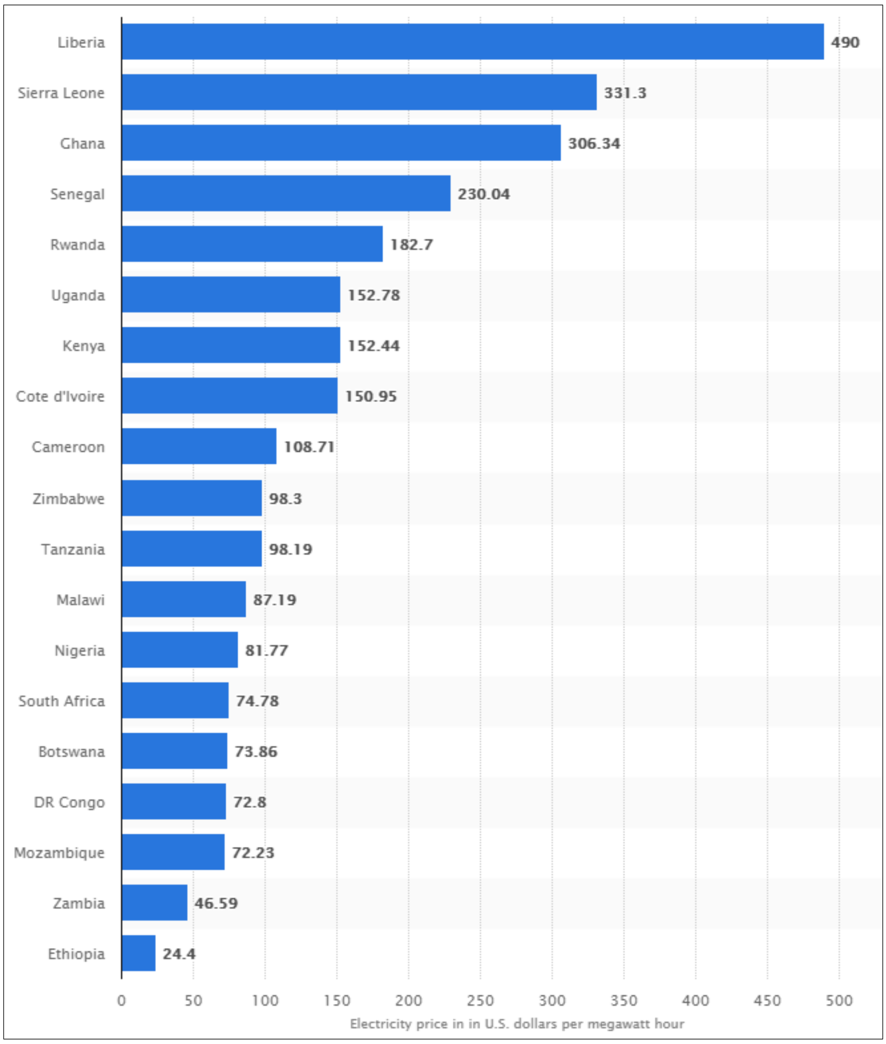


Figure 2-3: Average retail electricity prices in Africa (Statista, 2017)

A more recent global comparisons against SA's electricity pricing can be seen in Figure 2-4. From the figure, the cost of electricity in South Africa is at USD 0.13/kWh. Looking at the global comparisons, SA still ranks amongst the countries situated on the cheaper side of the electricity pricing line. While this is the case, the price of electricity has been increasing in South Africa. Since 2017, SA electricity pricing has overtaken Nigeria, Malawi, Tanzania, Zimbabwe, Cameroon, Ivory Coast and Turkey (Global Petrol Prices , 2020). The key conclusion that can be drawn from comparing SA with other countries both on the African continent and globally, while the cost of electricity in SA remains cheaper compared to other countries, it has been on the increase. From the two figures, it is seen that the price of electricity increased from USD 0.075/kWh in 2017 to USD 0.13/kWh in 2019. This is a substantial increase of 73% in just 3 years.

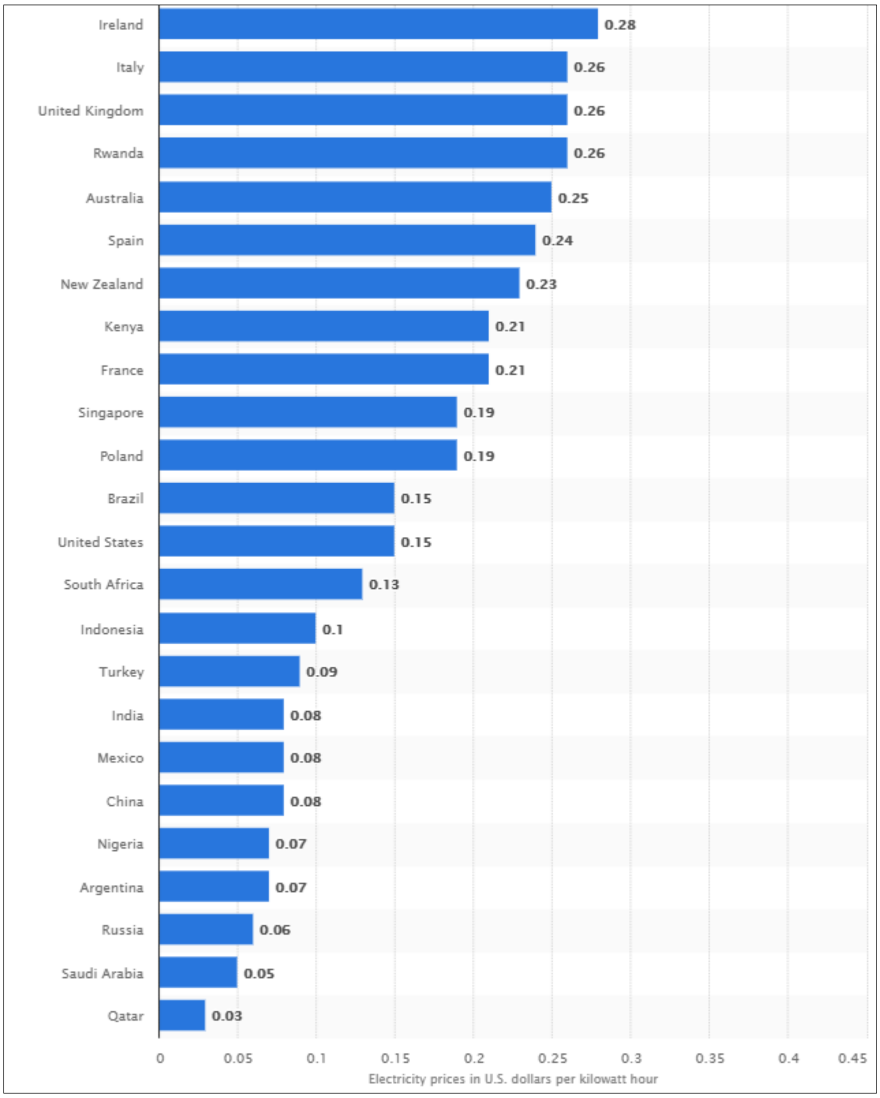


Figure 2-4: Energy pricing in U.S. dollars per kilowatt hour (Statista, 2020)

The other concern relates to the reliability of the power. Although Eskom currently still has fairly low-priced unit rates, the overall spend and reliability of their power supply is what threatens profitability and future prospects of economic activities in the country. Figure 2-5 below shows the average price trend from 1994 to 2020. Historic prices has been inflation adjusted to demonstrate it in today's terms (red line). From the figure, it is seen that South Africa enjoyed some of the lowest energy prices globally, for the period 1994 to 2004 (37 to 38 cents in today's terms). Between 2007 and 2020, the nominal price rose by roughly 460% (± 180% considering inflation). It was in 2007 when the first load shedding was implemented by Eskom.

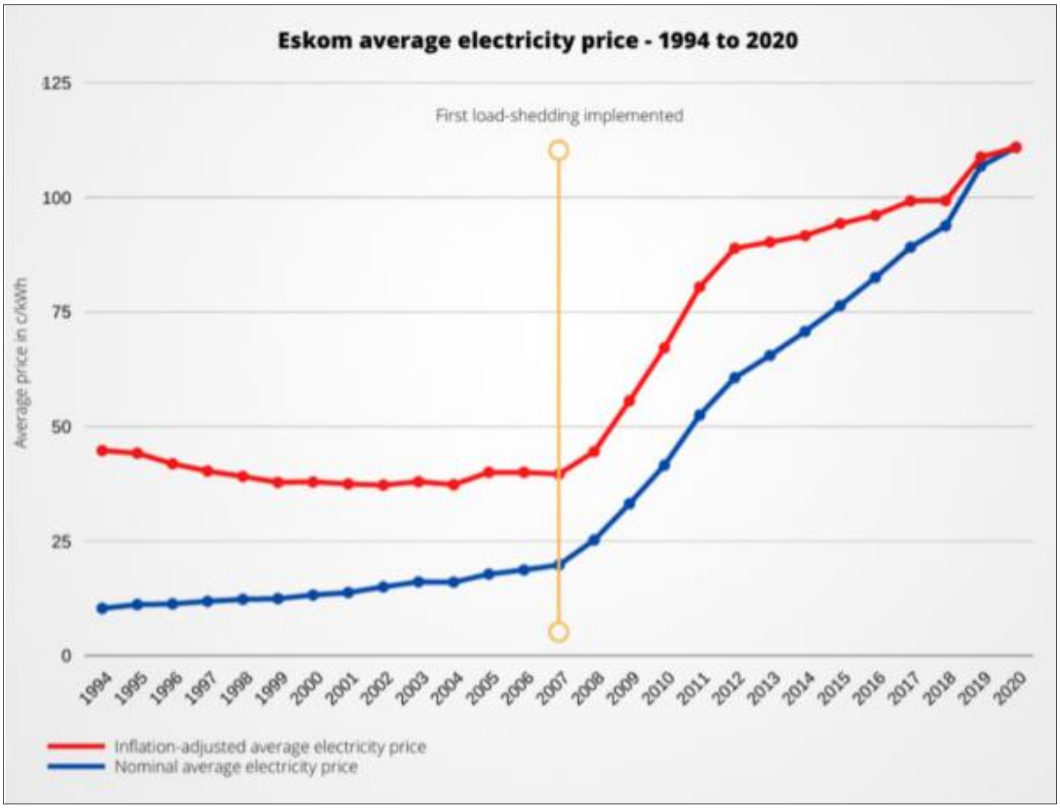


Figure 2-5: Eskom average electricity price – 1994 to 2020(Labuschagne, 2020)

In 2019, Eskom sold 28.7 GWh of electricity to the mining sector at a cost of R 29.9 billion rand. This figure excludes the direct downstream mining linkages such as smelter and refineries of which the bulk is also owned and operated by mining companies (Eskom, 2020). Considering the total spend on powering the mines in SA, and the impacts of load shedding, several mining operations continue to suffer economic losses. Implats reported to have lost R120 million due to irregular power supply. In the company's risk assessment for 2020, the load shedding and constrained electricity supply capacity came out as the third largest risk affecting business operations in South Africa and Zimbabwe (Implats, 2020).

2.5 Current uptake and application of REN in mining operations

As mentioned, energy challenges are not unique to South Africa but are experienced in other minerals rich countries on the continent and globally. The risks associated with energy supply extends from the need for a stable power system, to the pressures relating to the adoption of clean energy with the just transition to the green economies. Globally, the mining industry consumes 6.2% of the total global energy (Aggreko, n.d). The use of fossil fuels in the mining industry has put it under the spotlight with concerns mounting on global warming and impacts on climate change. As a result, attention towards RE source has been increasing with a number of stakeholders exploring the opportunities that exist for the mining industry to ensure its sustainability.

In 2017, the World Bank stated that in order to reduce the carbon footprint, there would be a notable increase in the demand for relevant key minerals and metals to manufacture cleaner energy technologies. These key minerals and metals include, but not limited to, Aluminium, Cobalt, Lead, Lithium, Manganese, Nickel, Iron, Silver, Zinc and Indium (The World Bank, 2017). A clean energy transition is expected to be mineral intensive. The Climate-Smart Mining Facility was launched by the World Bank in 2019. The program aims to help resource-rich developing countries to profit from this growing demand in minerals while ensuring proper management of the mining sector to reduce the carbon footprint. The leading global miners, Rio Tinto, recently joined the World Bank’s Climate-Smart Mining Initiative. The company plans to leverage their experience in order to consult and contribute USD 1 million to the program over the next five years (Reuters, 2019).

There is also an increasing appetite by major mining companies to drive towards renewable energy. BHP Billiton (BHP) partnered with Rocky Mountain Institute to re-purpose its mining sites in North America for renewable energy production (BHP, 2018). In September 2018, gold miner Newmont, deployed a mobile solar power array to its gold mining site in Ghana to generate cheaper electricity and offset the mines energy requirements (McCloy, 2018).

Barrick and AngloGold Ashanti’s joint venture, Kibali operations in the DRC, is 80% powered, on average, by hydroelectricity. Kibali is a large-scale gold mine ranked amongst the largest gold mines in Africa. In 2019, it reported a gold production of 814,027 ounces (Mining Technology, n.d). The operations have achieved this through three hydro plants generating between 10MW and 44MW depending on the season. The load demand for this operation is not constant, and the average consumption is approximately 40MW. As stated above, the hydropower generation plants meet the requirements 80% of the time and are subsidised by a 32MW thermal generator set (Rand Gold, 2017).

The other RE projects that have been implemented have focused on specific activities that consume considerable amounts of energy. Amongst the largest power consumers in underground mining is ventilation. In 2019, DRA completed a study that compared the sum of primary and secondary ventilation power consumption to the use of a battery operated production fleet rather than diesel. Diesel fleets had an overall more significant power demand (DRA Global Projects, 2019). This was mainly due to the increased demand for ventilation as the diesel fleet produced more heat and diesel particulate matter hence required far more ventilation underground. This study was operation specific and applicable only where there is a large concentration of diesel powered equipment, in one spot, for extended periods of time. Although the results are operation specific and cannot be used as a blanket finding, the study showed that savings on power consumption can be recognised with available cleaner power sources.

2.6 A review of renewable energy sources

Omar, et al, (2014) describe renewable energy as energy that is collected from renewable resources, which are naturally replenished on a human timescale. The sources of renewable energy include as sunlight, wind, rain, tides, waves, and geothermal heat. The following discussion provides an overview of the different types of REN sources. It provides definitions, advantages and disadvantages, application and technologies, costs and efficiencies.

2.6.1 Solar energy

Solar power is the most abundant renewable resource (Johnson, 2017). The sun has produced energy for billions of years and naturally energises all the plants on the planet. Scientists have unlocked the secrets of how a plant creates energy through photosynthesis and can duplicate that process using modern technology involving silicone. This process of creating electricity from the sun can power homes, cities and industrial size operations. Photovoltaic (PV) devices, more commonly known as solar cells, change sunlight directly into electricity (Johnson, 2017). These individual cells are joined together to make solar panels. These can be placed on rooftops or large scale fields covering many acres to power large scale operations. Solar energy systems produce no air pollutants or carbon dioxide (Johnson, 2017).

The downside to this technology is that the power only exists as long as the sun is shining. Solar panels also suffer from four major setbacks in the market, which are;

- Efficiency - Typically, manufactured solar cells can reach up to 18% efficiency. This means that only 18% of the sun's rays are effectively converted into usable electricity (International Renewable Energy Agency (IRENA), 2019).
- Capital cost of solar panels – According to a trade-off study done by DRA in 2019, solar panels are expensive to produce and install. Capital construction costs are estimated at $1.8mil/MWh (DRA Global Projects, 2019). This is typically offset by much cheaper generation costs, compared to grid energy, as a solar farm requires very little maintenance with a long production life (DRA Global Projects, 2019).
- Real estate - Solar needs vast amounts of real estate. According to the U.S. National Renewable Energy Laboratory (NREL) as cited in Ong, et al (2013), an average of 3.5 acres/GWh/year is required. Capacity weighted basis averages out at 8.9 acres/MWac. This converts to 3.6 Hectares of land use per one MW capacity (Ong, et al., 2013).
- Daily effective sun exposure – The other downside is the availability of the sun which is estimated to come to only seven hours of adequate sunlight per day.

2.6.2 Wind energy

Wind energy is the process whereby useable electricity is created from the natural flow of air inside the earth's atmosphere. Current wind turbines utilise this flow of air through their blades to create kinetic energy. The internal shaft and gearbox then create mechanical energy. The rotation of this shaft through the gearbox, 100 fold increases the speed of the rotation, spinning the generator to produce electrical energy (American Wind Energy Association, 2019). Three main types of wind energy exist, and these are outline below.

- Utility-scale wind – These are wind turbines that vary in size from 100 kW to onshore wind farms that are able to generate large amounts of electricity. An example is the Jiuquan Wind Power Base in China which is estimated to produce 20 gigawatts (GW) when fully constructed (Power Technology, 2019). They generate electricity for the national grid where it gets distributed to end-users through a centralised power distributor (American Wind Energy Association, 2019).

- Distributed or small wind - This is a turbine of below 100kW in size and is used directly and does not get distributed by a centralised entity but rather powers a small business, farm or home directly (American Wind Energy Association, 2019).
- Offshore wind – These turbines are the largest of the three. They are constructed offshore and can generate more power (American Wind Energy Association, 2019).

A typical 80 meters high, tube-like steel tower elevates a hub with attached blades and a “nacelle,” housing the shaft, gearbox, generator, and controls. The turbine is directed, based on wind readings gathered. These readings help shift the turbine to face the strongest oncoming wind, and the angle or "pitch" of its blades is adjusted to capture the most energy on offer, at that moment, where possible (American Wind Energy Association, 2019). Typically, the modern turbines start producing electricity at a speed of six to nine miles per hour (mph), known as the cut-in speed. Equipment damage is prevented by shutting down turbines at wind speeds of roughly 55mph (American Wind Energy Association, 2019). The current turbines can produce power for roughly 90% of the time through a calendar year. Electricity production increases when wind speed increases (American Wind Energy Association, 2019).

Investment in wind energy is increasing significantly, providing a platform for economies of scale to start playing a role. Wind turbines have become cheaper, offering the benefits of low maintenance costs. Local farmers benefit from the lease of their land required to erect these turbines. It uses a small patch of the earth so the farmer can still farm his land. According to the NREL direct land use can be measured by <0.4 Ha/MW (Denholm, et al., 2009). Wind energy is a significant sector and in 2019, was the 4th largest supplier of employment in renewable energy worldwide with 1.16 million jobs (Renner, et al., 2019). The sector is expecting to employ a further 600,000 people in the next thirty years as the uptake of wind power generation increases. The worldwide energy potential for wind energy is 400 terawatts. Although impressive, the actual generation remains supplemental to the worldwide requirement at this stage needing a significant ramp-up to its potential still (Energy Informative, 2012).

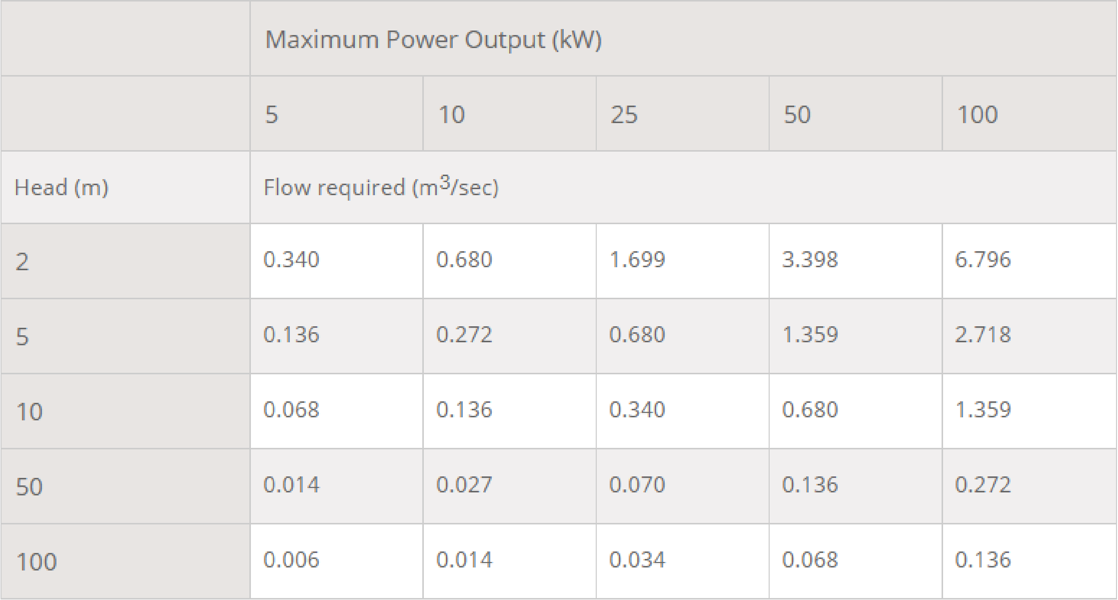
The 400 terawatts mentioned above is not evenly distributed around the globe. It is a summation of geographical wind hotspots that has the potential to generate the required energy. Sub-Saharan Africa has theoretical wind energy potential of 1 300 GW. While this is the case, Africa’s installed capacity was reported to be 5.7 GW in 2018 (Global Wind Energy Council, 2019)

2.6.3 Hydro energy

Hydroelectric power is energy created by the movement of water. There are two forms of hydroelectric power that are small scale and large scale. Small scale involves tidal and wave systems generating electricity as the water flows. Large scale hydroelectric power goes back to 1980 when the United States were the world leaders in the hydroelectric power. It was followed quickly by Canada. Between these two nations nearly 300 billion kilowatt-hours were being produced mostly by dams. The volume of the water flow and the change in elevation (or fall) from one point to another determine the amount of available energy in moving water (U.S. Energy Information Administration, 2019).

Large scale hydroelectric power requires big water reservoirs, normally dams. Depending on the head, a minimum flow rate to generate 100kW of power can be anything from 0.136m^3/s to 6.796m^3/s. Head is defined as, vertical height measured between the change in water levels from the hydro intake to the hydro discharge point (Renewables First, 2015). The table below is a summary of the average flow rates required relevant to a specific head.

Table 2-2: Minimum flow rates required for a range of heads



	Maximum Power Output (kW)				
	5	10	25	50	100
Head (m)	Flow required (m^3/sec)				
2	0.340	0.680	1.699	3.398	6.796
5	0.136	0.272	0.680	1.359	2.718
10	0.068	0.136	0.340	0.680	1.359
50	0.014	0.027	0.070	0.136	0.272
100	0.006	0.014	0.034	0.068	0.136

Source: (Renewables First, 2015)

The water is stored at an elevated level and run through a turbine that generates electricity. It is a very cheap form of REN but requires the correct planning and design work from the beginning of construction (U.S. Department of Energy, 2012). The CAPEX for constructing a 22MWh plant is $120 million and 11MWh is $80 million (DRA Global Projects, 2019). It costs on average, ZAR 0.05/kWh to generate power once capital construction costs are spent (IRENA, 2019). These costs are scenario dependant and can vary significantly considering various inputs such as; location, terrain, materials, civils and all other associated logistics. In the case of hydropower costs, the levelised cost of energy as quoted in the International Renewable Energy Agency’s Renewable Power Generation Costs 2018 report is USD 1490/kW.

2.6.4 Geothermal energy

Geothermal energy is a power source straight from the Earth's natural heat. Geothermal power is clean, abundant and most importantly, sustainable. Geothermal energy occurs naturally in hot rocks, hot liquids or steam beneath the ground and by drilling down into the earth surface the energy to run power plants is harnessed. Power generation entails, in some cases, to drill deep down into geothermal reservoirs, essentially pockets of water under very high pressure and heat (Energy Development Corporation, 2017). To access these, pipes are used where the water can run through under its own pressure. As the water flows upwards, the decreasing pressure causes some of the water to boil and turn into steam. This steam is used to turn a turbine generating energy (Energy Development Corporation, 2017).

Geothermal energy does not offer a significant contribution of energy to the available REN spectrum and is also site-specific due to the requirement of these geothermal reservoirs. Geothermal global energy potential is small (e.g. between 0.3 – 2 terrawatt) compared to other REN sources which provide more opportunities for large scale power generation (Johnson, 2017).

2.7 The downside of REN technologies and adoption considerations

Just as fossil fuels have their challenges, so does REN sources. In most cases, the consideration of alternative energy sources is based on various factors, the main ones being cost implications, reliability, and the ability to be scaled up. In terms of costs, the requirement is that potential energy sources must be cheap compared to traditional sources (e.g. fossil fuels). It is important that the various sources especially, when considered at the large scale must first make economic sense because they are competing with coal and nuclear. And also, that adoption surpasses the point of relying on government subsidies or incentives.

The second consideration is that it must be reliable and provide a long-term solution. Building a coal or nuclear-powered plant, it must last for 20 to 30 years in order to pay off the CAPEX required to build it. An alternative power supply such as a solar plant is expected to last as long. This may be difficult because of the locations of RE and installation. Being out in the desert, dealing with monsoons, hot summers and cold winters among others, for about 20 years, may present challenges. The third consideration is scalability (Sola Decentralised Autonomous Organisation (DAO), 2017). Using the example of solar, the real-estate required to surpass the energy generated by coal, gas, nuclear and oil is enormous. The roof area of a house can only currently supply about 50% of household daily electrical energy needs (Sola Decentralised Autonomous Organisation (DAO), 2017).

Given the standard requirements in terms of the adoption of REN technologies, as outlined above, the figure below shows the investment trends for the various categories of renewables for the period 2013 to 2018. This figure profiles the ranking of different REN sources based on investment appetite. As can be seen in the figure, solar and wind power projects far outrank other REN sources when it comes to financial commitments.

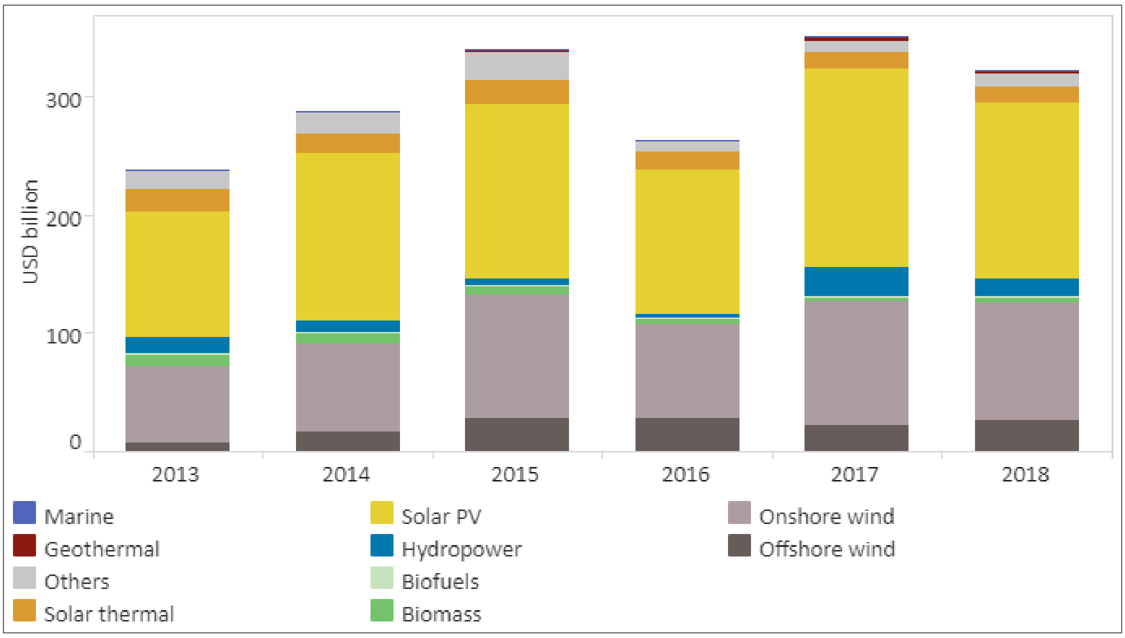


Figure 2-6: Annual Financial Commitments in Renewable Energy(Ferroukhi, et al., 2020)

Given the practicalities that a solar farm cannot generate power at night, a hydro plant needs a consistent water flow and a wind turbine does not generate power in zero wind conditions, power storage is a critical requirement before any of these REN can be independently considered. Storage, transportation and consistency of supply are other significant challenges facing the REN industry today. (Towers-Clark, 2019). Lithium-Ion batteries (LIB) are still clear front runners with a 93% market share in 2018 (excluding pumped hydro storage) for power storage options. There are currently no feasible alternative power storage options when comparing costs and reliability (Gregori, et al., 2020). Although LIB is the leader in energy storage without considering pumped hydro, it is still a major cost at 600/kW/hr, severely affecting the economics of large scale REN projects (DRA Global Projects, 2019).

Due to large power storage cost, alternative hybrid systems have been explored. These rely on using an existing power grid where REN energy could power the operation during peak time power generation and be supplemented with grid power when potential for REN power generation is low. This allows for significant savings on energy storage means and kWhr operational expenditure when REN power is used (Hyder, 2021).

As mentioned, consideration for investment in REN depends on three main factors, being costs, reliability and scalability. The feasibility of alternative power sources depends on set up and working costs compared to coal and nuclear, its ability to be scaled up to provide the required quantity, and also the ability to be mass-produced to offer consistency and reliability (Sola Decentralised Autonomous Organisation (DAO), 2017).

2.8 A global overview of REN

Figure 2-7 shows the amount of energy that is consumed on planet earth every year. This is estimated at 16 terawatts (electricity only) of energy. Each of the spheres shown on the figure represents the potential energy in both non-renewable and renewable resources. This includes total reserves for the finite resources natural gas, oil, and coal on the right hand side and the infinite resources sun, wind, and hydro potential, per annum, on the left hand side. The figure also highlights the size difference between renewable and non-renewable energy sources.

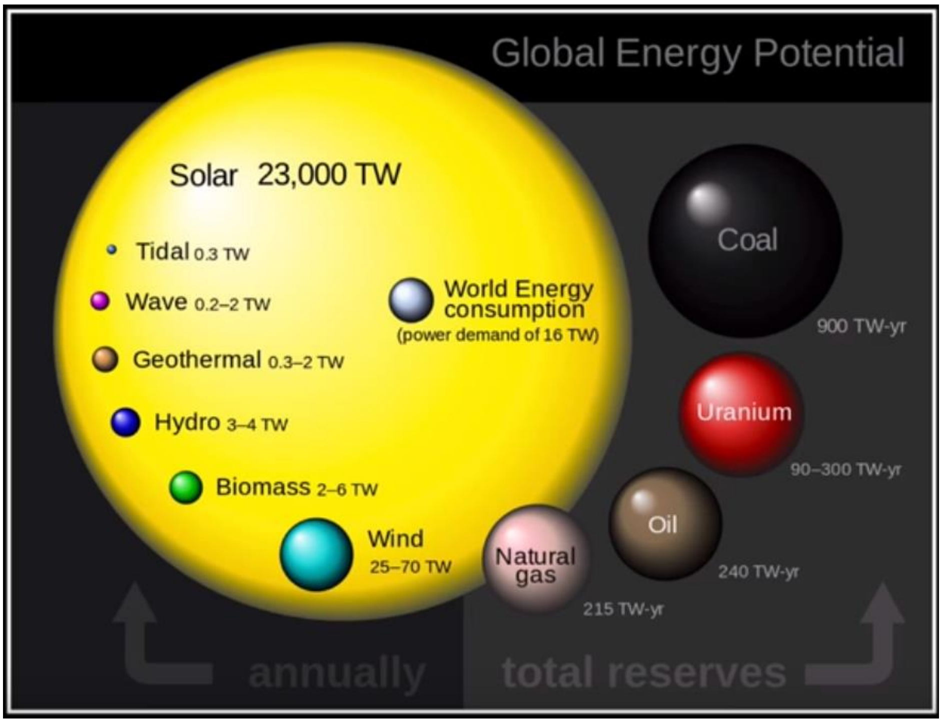


Figure 2-7: Global Energy Potential (Johnson, 2017)

As can be seen in the figure, the largest RE potential is in solar, which is followed by wind. In terms of non-renewable sources, the largest reserves globally, are found in coal and uranium. Figure 2-8 below shows fuel consumption by source and by region worldwide. As can be seen in the figure, the majority of the regions still depends on oil for 40% or more of their fuel requirements. Natural gas also constitutes a significant percentage of fuel consumption. In the Commonwealth of Independent States (CIS) and the Middle East, natural gas contributes over 50% to the total fuel consumption.

The dependency of coal has decreased in most regions, with the Asia Pacific still highly dependent on coal resources. In the case of Africa, there is a high reliance on oil (43%) and natural gas (27%). Coal still plays a significant role in electricity generation in Africa, contributing more than 20% to the energy consumption. While the percentage of REN sources is relatively small across regions, REN is still part of the world’s energy consumption portfolio.

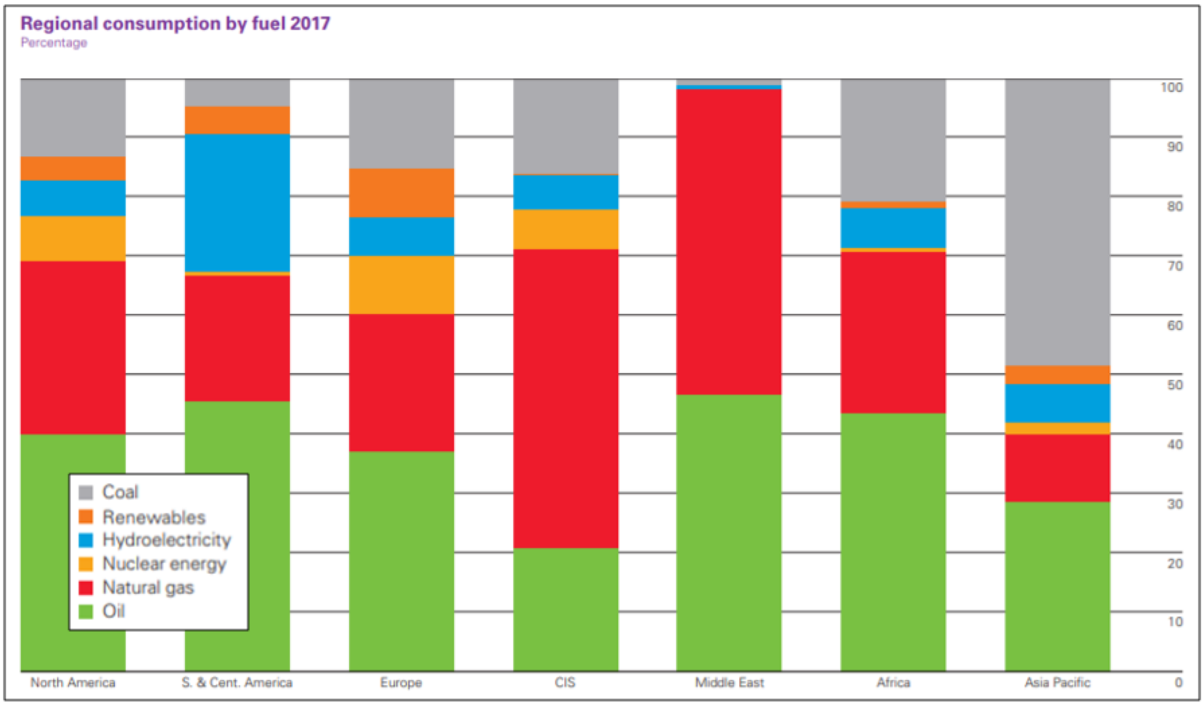


Figure 2-8: Regional consumption by fuel in 2017 (BP Statistical Review of World Energy 2018, 2018)

While RE sources occupy a small percentage of the total energy consumption, there has been increased commitment from different countries across the world to increase REN power generation. On a global front, in support of the just transition to clean energy, Sweden is planning to be the world's first fossil fuel free country by 2040. They have increased investment in suitable forms of REN, electric cars and batteries. Costa Rica has also announced plans to be carbon neutral in 2021, already producing 95% of electricity from REN in the last four years. In the first semester of 2018, Germany produced enough REN electricity to power every home in the country for a year. This excludes industry and business but proves the potential of REN, and how far Germany has come in-line with their 2030 goal of 65% electricity generated from REN (Climate Council, 2019).

Commercially, REN are also showing cost reduction trends with PV solar being the front runner at a utility-scale with cost reduction of 77% from 2010 to 2018 (IRENA, 2019). Figure 2-9 below shows the global utility-scale cost trend from 2009 predicted up to 2025. As can be seen in the figure, there is a strong down trend on costs from almost USD 5000/kW in 2009 to less than USD 1000/kW predicted for 2025 amounting to a cost reduction of 500%. According to IRENA (2016), the forecast is driven by better technologies, improved manufacturing capabilities, economies of scale and decreasing balance of system (BoS) cost. In PV systems, any material required to complete a solar installation other than the

PV modules (panels), is considered the BoS components (U.S. Department of Energy, 2006).

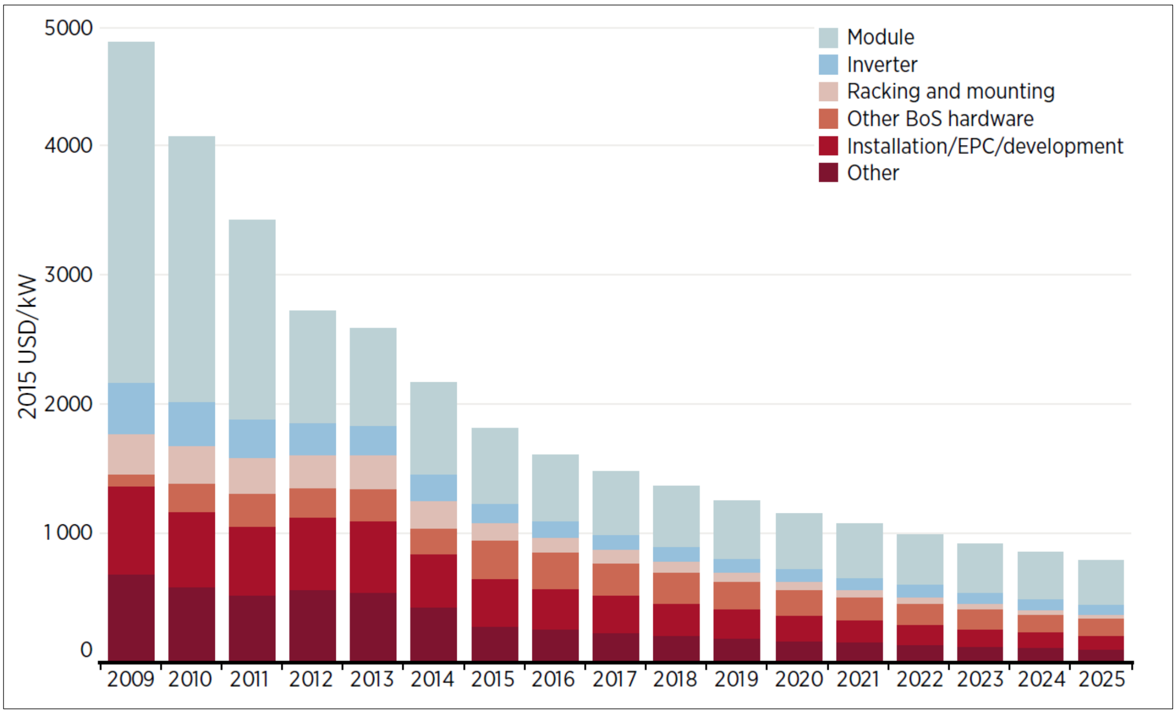


Figure 2-9: Global weighted average utility-scale solar PV total installed costs, 2009-2025 (IRENA, 2016)

Figure 2-10 below shows the levelised cost of electricity for onshore wind from 1995 projected to 2025. As seen in the figure, the overall trend for wind power generation is similar to the PV solar trend as discussed above with a cost of USD 0.2 kWh in 1995 dropping to a predicted median cost of USD 0.075kWh in 2025, a reduction of 266%. According to IRENA (2016), increased market competition in REN projects is forcing tendering companies to streamline and refine their approaches to quality, efficiency and best practice standards. As a result, this competitive market drives down costs, facilitating an increase in REN viability (IRENA, 2016).

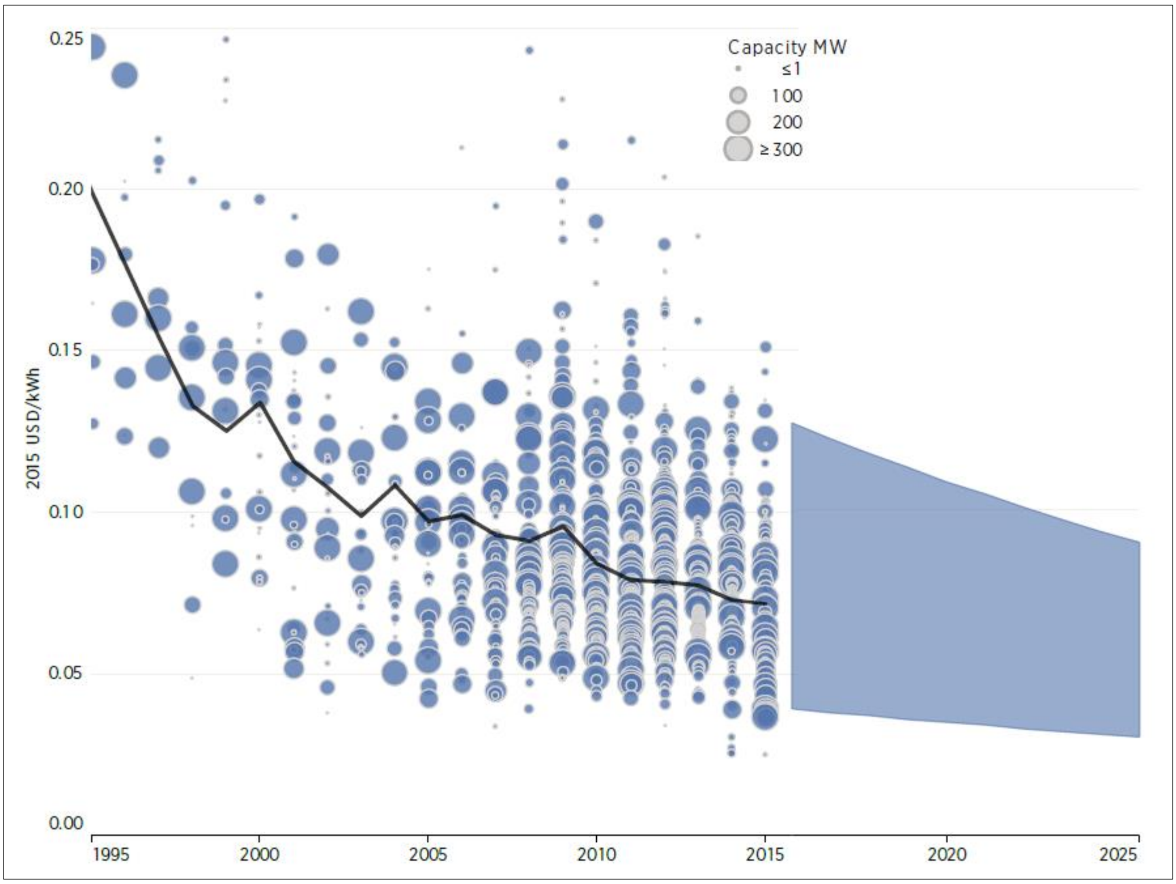


Figure 2-10: Levelised cost of electricity of onshore wind, 1995-2025(IRENA, 2016)

According to IRENA (2018), the world is, slowly moving to the REN with countries like Germany and the United Kingdom already producing above 10% of total power (all forms of power, transport, electricity, cooking, heating) requirements from renewable sources. Iceland is already producing 100% of their electricity requirements from REN (IRENA, 2018). REN is not only more sustainable and environmentally friendly, but is starting to show financial gains over non-renewable sources (Wadhwa & Salkever, 2021).

Figure 2-11 below shows the global electricity generated by REN, per annum, since 2000 to 2018. As shown in the figure, a steady growth has been experienced by the sector during this period. In 2000, there was total global REN power generation of 3 million GWh rising to more than double at almost 7 million GWh 2018. The share of REN power generation is occupied by hydropower. As seen in the figure, the share of wind and solar has ben growing.

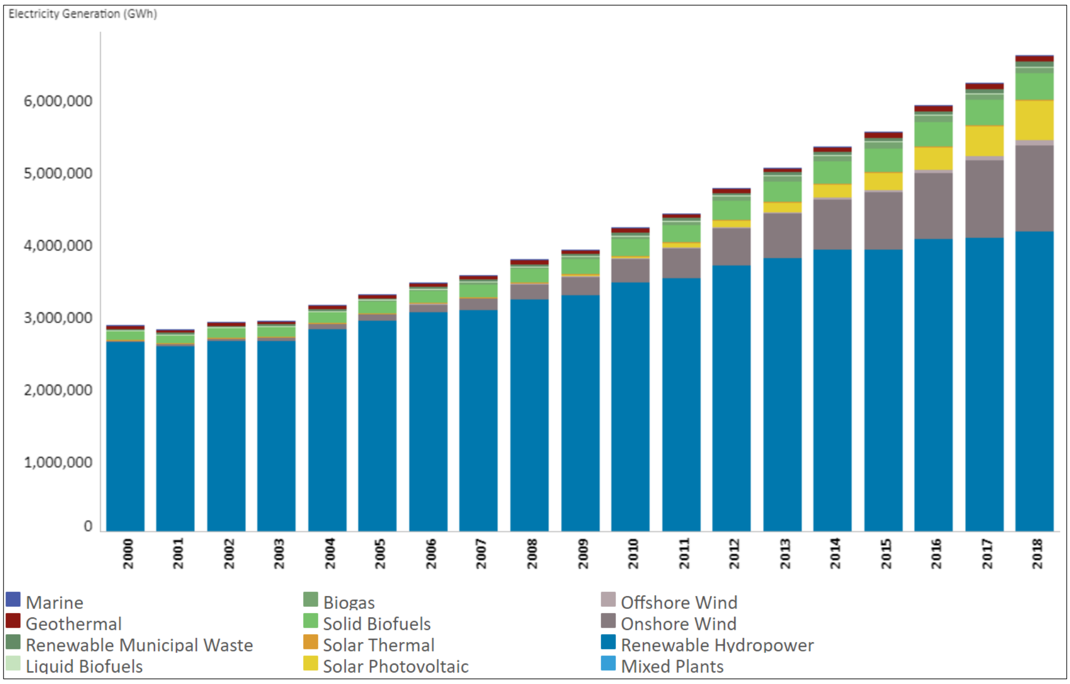


Figure 2-11: Annual electricity generation by renewables, 2000 – 2018 (IRENA, 2018)

2.9 Africa's REN potential

Figure 2-12 below, highlights the relationship between renewables and fossil fuel power generation in Africa. It shows Africa's heavy reliance on fossil fuels compared to renewable energy generation (i.e. coal, oil and gas). About 46% of Africa's energy generation is the primitive burning of bio fuels (wood fires) and waste products (IRENA, 2015). The REN sources account less than 5% of the energy mix on the continent.

While the share of REN sources remains small, the potential of REN in Africa is significant with an estimated 15 GW for geothermal, 110 GW for wind energy, 350 GW for hydropower and 1000 GW for solar (Hafner, et al., 2018). Unfortunately, the vast majority of these resources remain unexploited (Hafner, et al., 2018). By 2014, Africa had tapped into only 8% of this potential with 28 GW of installed power and 17 GW of hydropower projects in the pipeline. In 2017, hydropower produced in Africa reached 32 GW. Even with the underutilisation of potential power, hydropower is still the biggest source of renewable power in Africa (Hafner, et al., 2018).

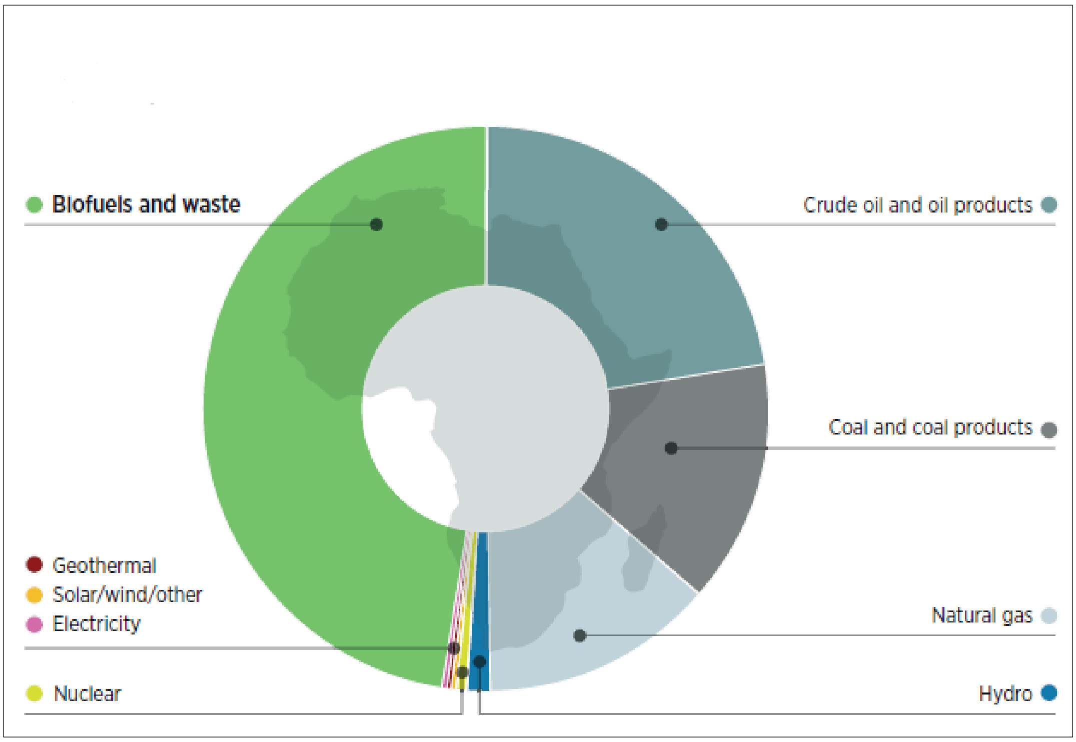


Figure 2-12: Breakdown of total primary energy supply of Africa, 2013 (IRENA, 2015)

Figure 2-13 shows the cumulative growth of installed hydropower over the last ten years in Gigawatts (GW). Installed Hydro power went up from 22 GW in 2007 to 33 GW in 2017. A steady growth of 1.1 GW year on year.

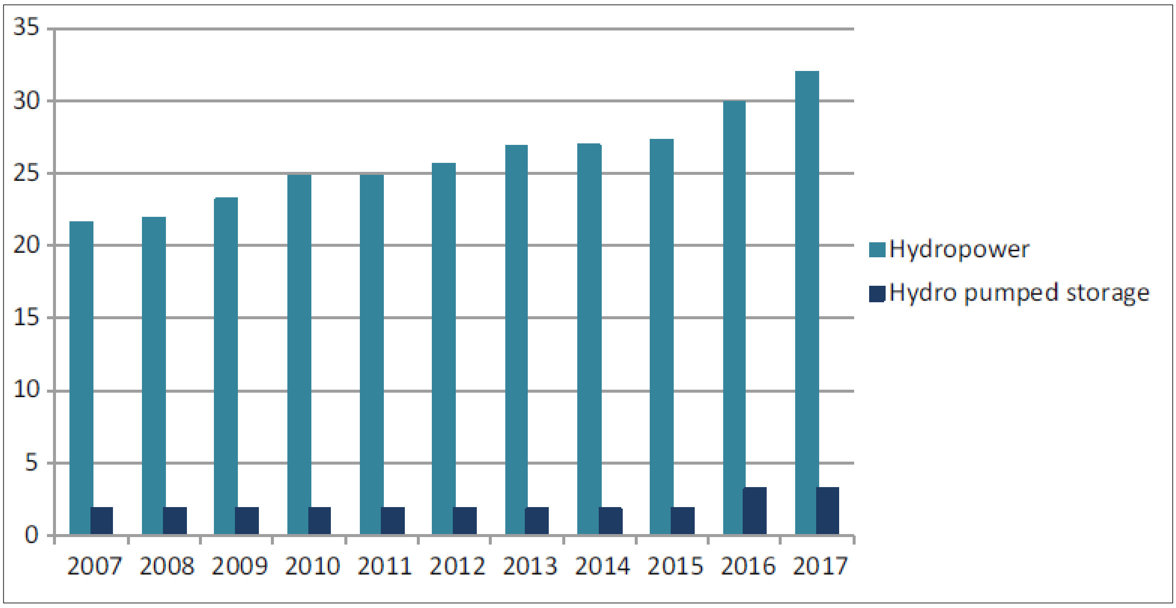


Figure 2-13: Cumulative hydropower capacity installed in Africa (GW) (Hafner, et al., 2018)

Solar and wind energy have also grown exponentially in Africa over the last ten years. This growth is attributed to declining costs and increased competitiveness compared to fossil fuels (Hafner, et al., 2018). Figure 2-14 shows the cumulative growth of installed solar and wind power capacity over the last ten years in Megawatts (MW). Onshore wind capacity increased from 500 MW in 2007 to almost 4700 MW in 2017. This amounts to a massive increase of 940% with total solar seeing an increase of 450 MW/annum over the same ten year period.

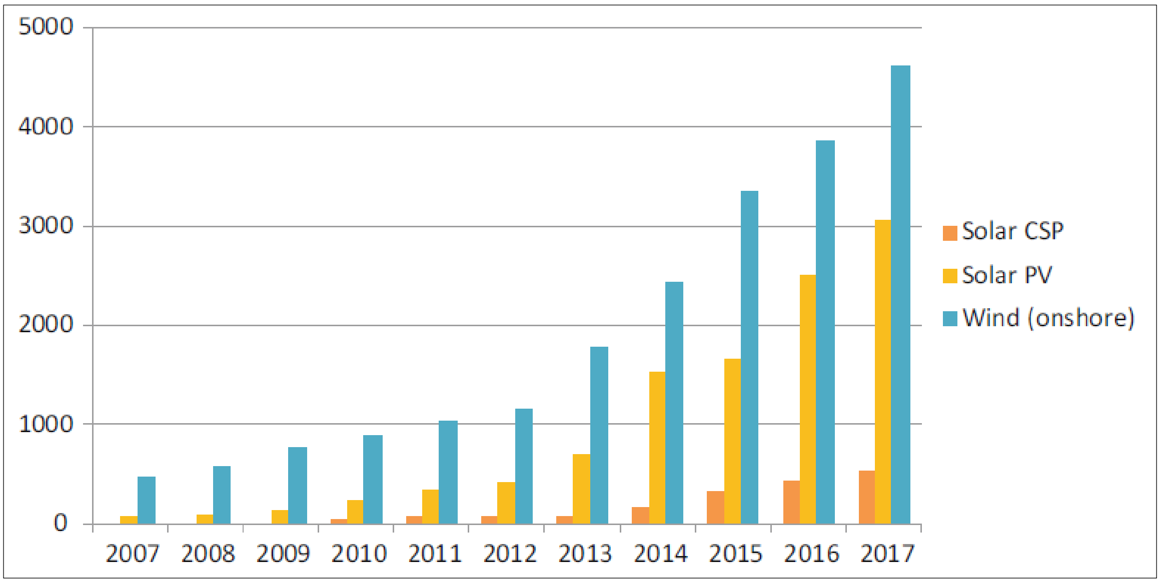


Figure 2-14: Cumulative solar and wind power capacity installed in Africa (MW) (Hafner, et al., 2018)

Table 2-3 below depicts the suitability classes of solar irradiation according to technology and Table 2-4 depicts the suitability classes of the average annual wind speeds at 80 m above ground. Solar potential is measured in two irradiation measures, and these are, Direct Normal Irradiation (DNI) and Global Horizontal Irradiation (GHI). DNI is a better measure for Concentrated Solar Power (CSP) while GHI is preferred for PV. Both solar and wind power are divided into different suitability classes for measurement purposes. The classes vary between, less than 1000 kWh/m²/year to 3000 kWh/m²/year for solar and 0-4 m/s to >9 m/s for wind measured at 80m above ground (Hafner, et al., 2018).

Table 2-3: Suitability classes of solar irradiation according to technology (PV and CSP)

	Limited suitability	Suitable	Highly suitable	Excellent
Photovoltaic (PV)	below 1 000 kWh/m^2/year (GHI)	1 000 –1 500 kWh/m^2/year (GHI)	1 500 – 2 500 kWh/m^2/year (GHI)	2 500 – 3 000 kWh/m^2/year (GHI)
Concentrated Solar Power (CSP)	below 1 800 kWh/m^2/year (DNI)	1 800 – 2 000 kWh/m^2/year (DNI)	2 000 – 2 500 kWh/m^2/year (DNI)	2 500 – 3 000 kWh/m^2/year (DNI)

Source: (Hermann, et al., 2014)

Table 2-4: Suitability classes of average annual wind speeds at 80 m

	Not suitable	Limited suitability	Suitable		Highly suitable / Excellent		
Wind Energy	0-4 m/s	4-5 m/s	5-6 m/s	6-7 m/s	7-8 m/s	8-9 m/s	>9 m/s

Source: (Hermann, et al., 2014)

Figure 2-15 below shows Africa's solar (both PV and CSP) potential based on suitability classes, as outlined in Table 2-3 above. It was calculated on solar irradiation where the red and dark orange areas are the best suited to solar projects (Hermann, et al., 2014). As seen in the figure, the majority of the countries on the African continent have potential for solar power generation both in terms of DNI and GHI.

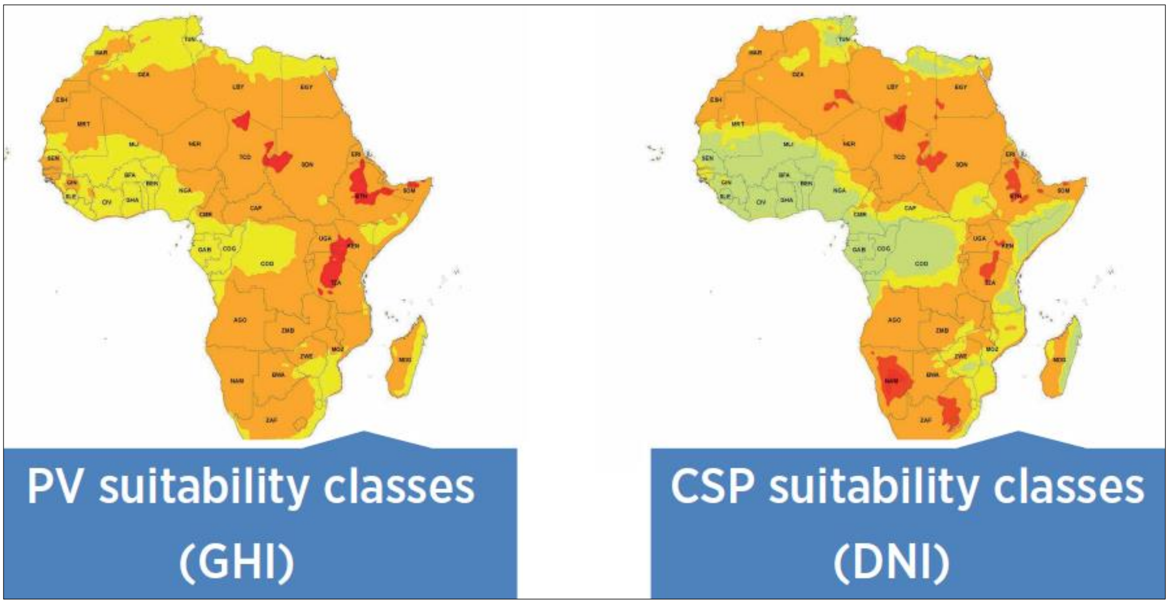


Figure 2-15: Overall resource potential for solar PV and CSP technologies (Hermann, et al., 2014)

Figure 2-16 below shows Africa's wind potential based on the suitability classes as outlined in Table 2-4 above. It was calculated on average wind speed with dark green and blue spots representing the areas that are best suited for wind (Hermann, et al., 2014). Again, a considerable number of countries on the continent have sufficient wind resources to generate power. It is only a few countries in the interior where wind speeds are not sufficient for power generation.

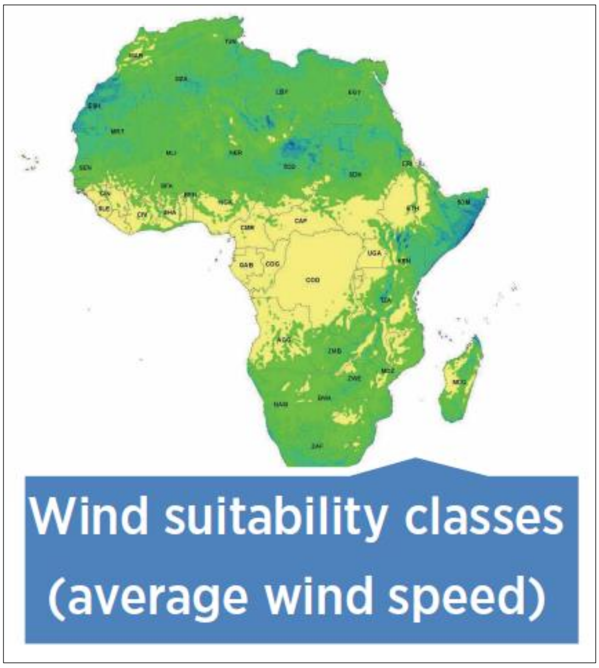


Figure 2-16: Overall resource potential for wind technologies (Hermann, et al., 2014)

2.10 South Africa's REN potential

South Africa ranks at number 15 in the world with regards to the potential for REN generation. In Africa, South Africa is among the top 5 countries with solar and wind energy plants producing only 2.25% of its entire power portfolio from REN (Earl, 2020). Although REN production is only at 2.25% of total power produced, total GWh power production from these sources places South Africa among the leaders in the use of modern REN on the continent (IRENA, 2015). Figure 2-17 below shows the strides made by South Africa since alternative forms of REN (other than Hydro) was introduced starting in 2013. Before 2013, SA was producing 4000 GWh from hydro power only. Post-2013 saw solar PV and wind energy being added to the energy mix. In 2015, Solar thermal was added. SA's REN generation went from 4000 GWh in 2013 to more than 16 000 GWh in 2019. This is a 400% increase in 7 years.

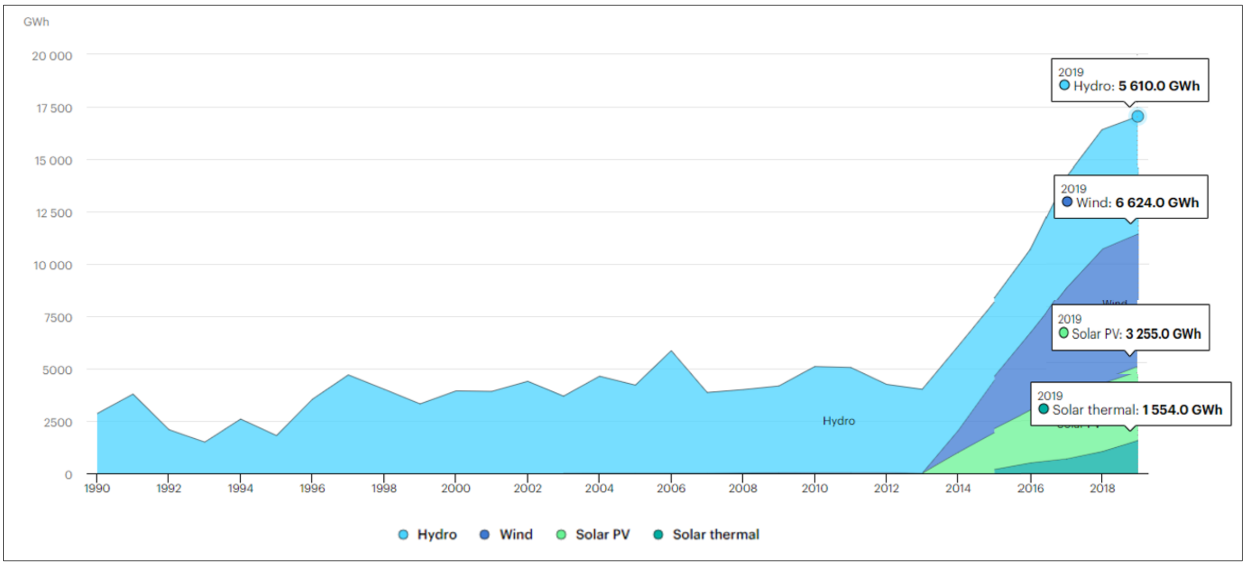


Figure 2-17: REN growth trend for South Africa (International Energy Agency , 2020)

In 2011, the South African government formed the Renewable Energy Independent Power Producer Procurement Program (REIPPPP). The aim of the REIPPPP was to create a competitive procurement program for REN. Since the launch of this program, a combined 5243 MW has been procured through 79 REN projects, equalling USD 16 billion in REN investments (Partnership on Transparency, 2016). The programme brought about marked decreases in the tariff cost for wind and PV. In 2014, South Africa had one of the lowest utility-scale PV costs in the world at USD 0.075/kWh (IRENA, 2015). Figure 2-18 below shows South Africa as one of the cheaper countries with PV module prices together with China and India in the USD 0.5 to 0.55/W bracket. This is based on the average 2015 price as recorded by the countries in the right-hand side box. Looking at the price trend from March 2010 till March 2016, for all solar module types, there was a significant price drop from USD 3/W down to less than USD 1/W. The price margins between various module technologies also shrunk.

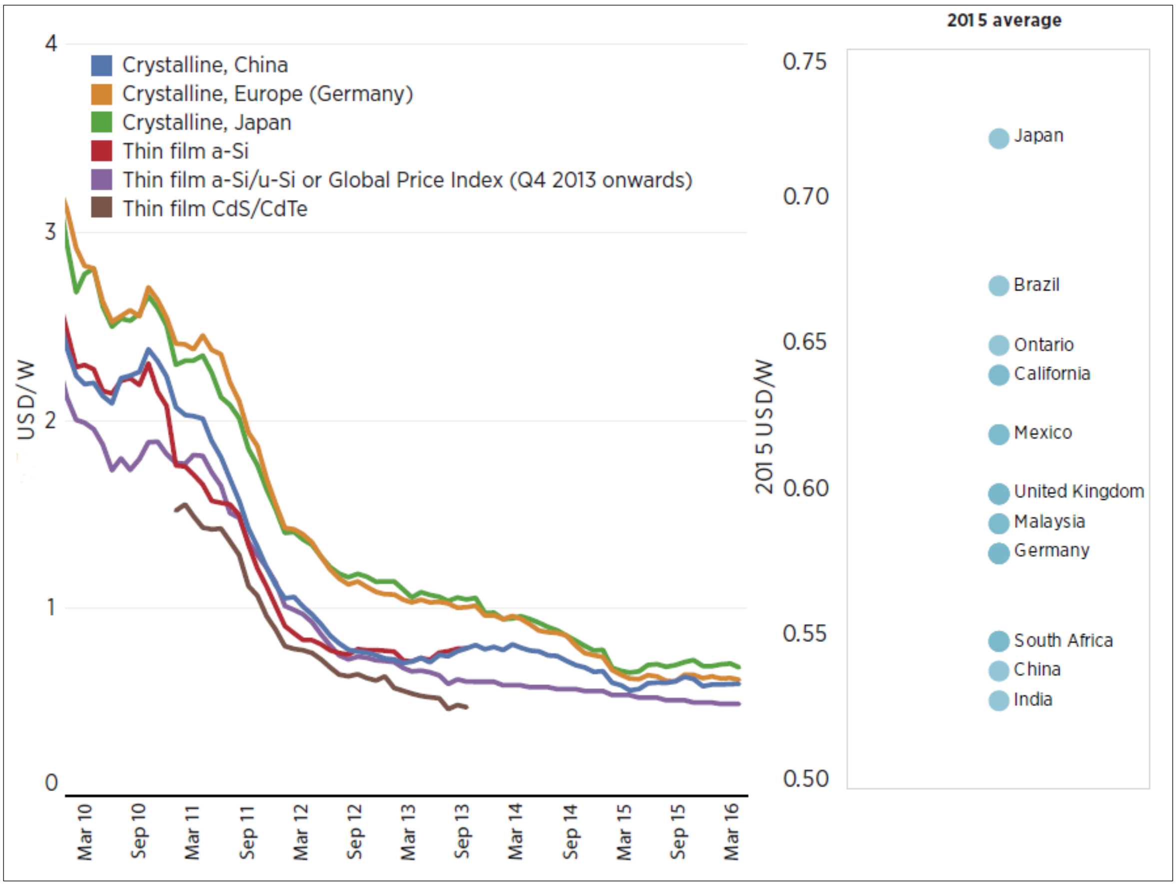


Figure 2-18: Global PV module price trends, 2009-2016 (IRENA, 2016)

On 25 September 2020, the Department of Mineral Resources and Energy announced another 11 813 MW of additional energy to be procured from independent producers (Magoro, 2020). A target of 400 000 new jobs, by 2030, is set through development and establishment of a “green economy” (Río, 2016).

As mentioned above, interest at industry-level to produce own REN power has been noted. Sibanye-Stillwater, the world’s largest producer of platinum and rhodium, second largest producer of palladium and third largest producer of gold, was set to install a 150MW PV Solar plant but pulled the project siting unclear guidance and regulations from the South African government and lack of clarity from Eskom (Sibanye-Stillwater, 2021). According to Sibanye-Stillwater CEO, Neal Froneman, the current legal environment does not represent nor encourage the ideal investment setting for private companies who are looking at self-generation solutions, and is sited as a major risk in South Africa (McKay, 2020). This is another issue that South Africa needs to look at.

2.11 Conclusion

Mining is a significant contributor to mineral economies on the African continent including South Africa. A number of countries on the continent rank amongst the largest producers numerous critical mineral resources required globally. While this is the case, mining in Africa is faced with significant challenges relating to local skills generation, weak governance structures, infrastructure and constrained power grids. The latter challenge continue to adversely affect South Africa's mining sector. The declining performance of SA's mineral sector has been linked to Eskom's inability to guarantee consistent and reliable electricity. Since 2007, power supply in the country has been irregular and unpredictable, with continuous implementation of load shedding caused by severe lack of maintenance. Excluding smelters and refineries, SA's mining sector consumes 30 000 GWh of electricity annually and that is roughly 14% of Eskom's total energy portfolio. In 2020, Eskom's revenue from the mining sector was R 29.9 billion rand and this is expected to continue on the upward trend with increases in electricity tariffs. The price of electricity increased trend 460% between 2007 and 2020.

Given the challenges of power supply and the need for alternative sources of energy, REN presents opportunities to countries. With all power sources, REN sources have advantages and disadvantages. With the cost of power generation being the main factor, over the years, the overall REN costs has seen a very steep decline and this has led to a steady increase in the generation of electricity from REN sources. Annual growth in REN investments projects are also increasing with the largest share going to solar and wind energy. While the share of REN remains small in South Africa, the establishment of the Renewable Energy Independent Power Producer Procurement Program is increasing uptake of REN power generation. On the continent, SA is leading the way with their, having already procured 5243 MW with another 11 813 MW of additional energy to be procured as announced on 25 September 2020 by the Department of Mineral Resources and Energy. As alluded in the discussion, there is also visible interest from mining companies to diversify their energy mix moving away from solely depending on Eskom for power supply. At a global level, several mining companies were noted who have already implemented REN projects.

3 RESEARCH METHODOLOGY AND DESIGN PARAMETERS

3.1 Introduction

As mentioned above, the focus of the study is on the comparisons of financial outcomes of a medium to large scale mining operation powered by variable forms of renewable energy and by a grid tied Eskom power supply. The study aims to investigate the installation of large scale REN, how they measure up against the grid tied equivalent supply, and the costs and the lead time required during the capital investment construction phase. The financial outcomes of the REN and grid tied power supply scenarios are based on earnings before interest, taxation, depreciation and amortisation (EBITDA) for all power producing options considered. EBITDA is used because it provides a fair comparison based on technical findings and eliminates the possibilities from the variations encountered by post earnings taxation. This is because CAPEX allowances, ring-fencing, variable royalty rates applied to diamonds, gold and other metals/minerals all have different corporate tax policies and implications. This chapter provides the research scenario underpinning the study. It discusses study parameters and considerations, as well as the limitations of the study. The chapter also provides a description of resource model and technical parameters important in determining typical power requirements for a medium to large-scale operation.

3.2 Research scenario

The research aims to expose a possibility of unlocking previously inaccessible locations for initial exploration, further exploration and ultimately, potential mining sites. Vastly remote deposits that lack the benefit of nearby infrastructure all over South Africa can benefit from such research. The research involves identifying and locating available and proximate sources of REN to generate cost models for power generation guided by the size of operation and production output. This model is used to determine the feasibility of such operations in terms of mining method, the renewable energy source used and to a certain degree, the effect of the location of deposit to REN sources. The study parameters and limitations of the study are discussed below.

3.2.1 Study parameters

3.2.1.1 Case study location

The focus of the study is on South Africa's mining sector. South Africa provides for a good case study considering the energy challenges that the country has been facing which include rising costs of power and periodic load shedding. Further, South Africa is making strides towards renewable energy with its Independent Power Producer (IPP) policies and implementation. In 2019, the country enacted the Carbon Tax legislation that has been introduced to encourage the use of clean power. South Africa also presents a substantial and diversified mining sector which has been negatively affected by the energy challenges.

3.2.1.2 REN sources considered

In an applied, real world scenario, the choice of a renewable form of energy is a function of the region relative to what is available. For example, a high rainfall area with suitable dam infrastructure will tend towards a hydro energy setup where a desert area with substantial amounts of sunshine will be more in favour of a solar energy setup.

The study focuses on solar and hydro power. Solar energy is the worldwide leader in investments and growth (see Figure 3-1 below) and hydropower is the leader in worldwide total energy production (see Figure 3-2 below) (International Energy Agency (IEA), 2017). The two forms of REN are also best supported with regards to suitability, availability, technology and implementation. As mentioned in Chapter 2, South Africa is amongst the top 5 countries on the African continent with solar and wind energy plants. More so, mining companies like Sibanye-Stillwater have expressed interest in investing in solar plants to complement existing power supply.

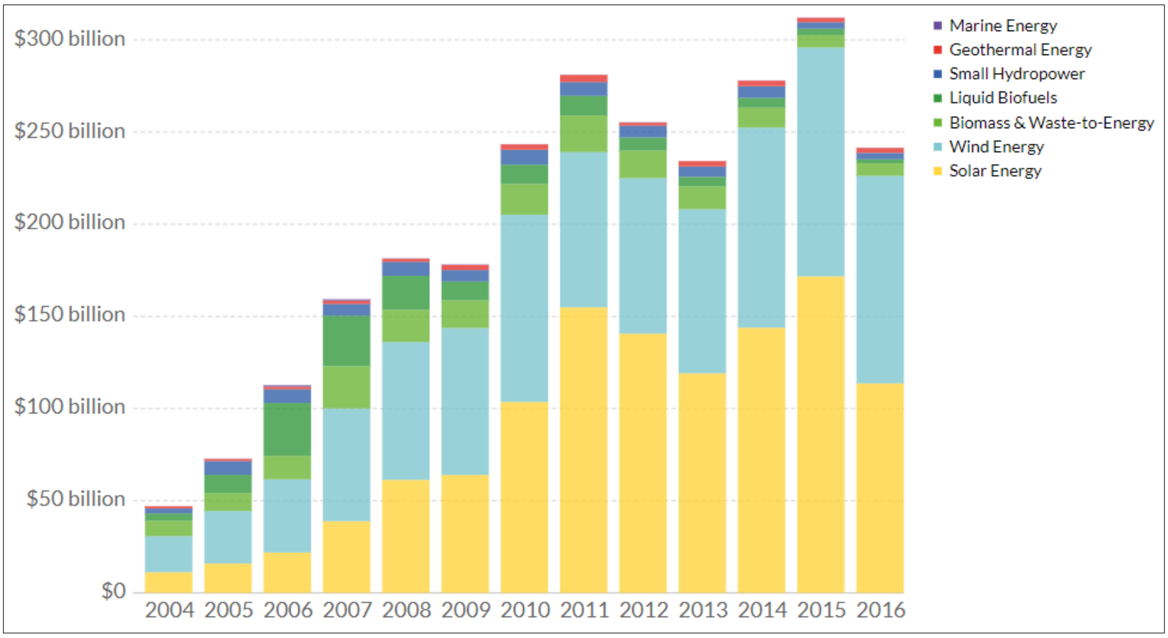


Figure 3-1: Investment of renewable energy by technology (International Energy Agency (IEA), 2017)

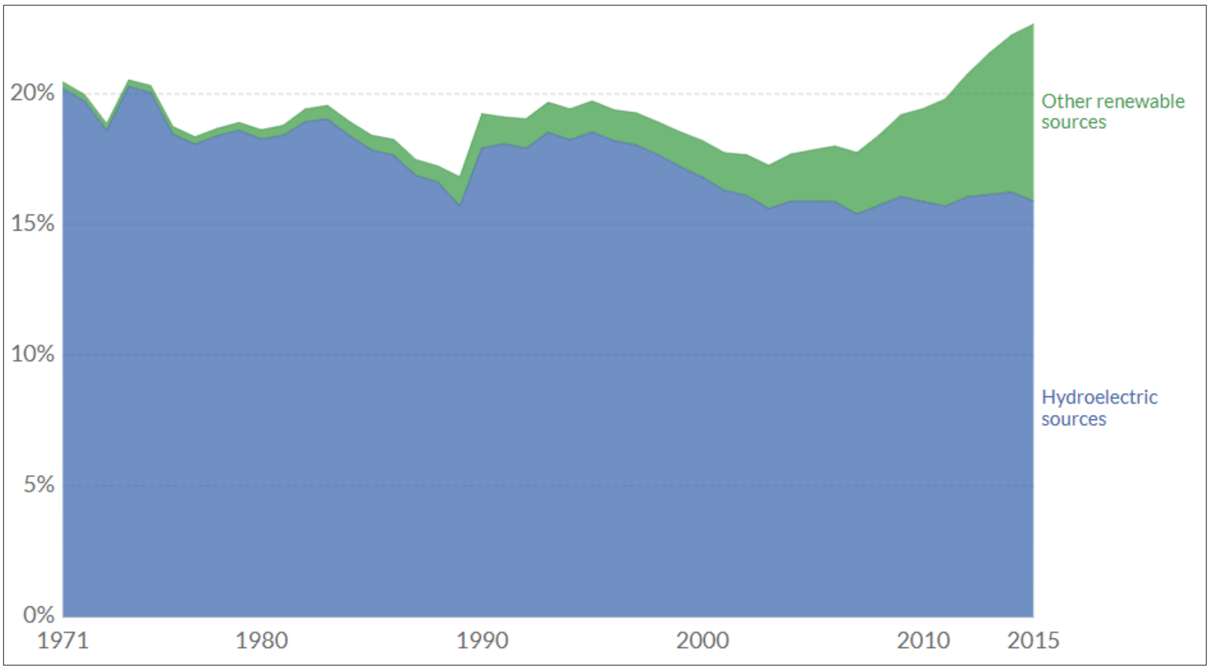


Figure 3-2: Share of electricity production from renewable sources in the world (International Energy Agency (IEA), 2017)

3.2.1.3 Type of operation

The study uses an underground resource capable of producing 70kt ore per month for an approximate life of mine (LOM) of 20 years. An underground mining operation was selected because it has more power requirements compared to surface mining due to the added ventilation, and logistical requirements. The orebody selected for the study was chosen from studied material from an internal project conducted by DRA Global Projects and forms the framework for the basis of producing a financial cost model by means of mine design, sequencing and production scheduling application.

The resource used for the study originates from the Bushveld Complex and is rich in the Platinum Group of Metals (PGMs) such as Platinum, Palladium, Rhodium, Iridium and Ruthenium. These PGMs are often associated with precious metals such as gold, silver, as well as base metals including Chrome, Nickel, Copper and Cobalt (DRA Global Projects, 2019). The Bushveld complex consists of two separate reef horizons, namely; Merensky and the Upper Group two (UG2) reefs. Mining and exploration techniques employed, for this study, are well established in the Bushveld Complex style of mineralisation. This study is done on the high PGM grade, UG2 reef horizon that is also able to contribute significant amounts of chrome (DRA Global Projects, 2019).

The study is based on an underground mine accessed by a decline from surface. A very high-level description of the resource model, mining method, underground layouts and production schedule is provided in Section 3.3 to Section 3.6. Taking from these sections, section 3.7 and 3.8 provides the necessary background to the cost accumulation, power demand and revenue generated in the financial model. The mine design, sequence, schedule, accompanying surface civil works, mechanical components and environmental considerations supporting the mining function, was costed habitually except for the power component.

3.2.1.4 Considerations for grid-tied electricity supply

Electricity supplied from a centrally distributed source requires OHL to be erected to allow the electricity to reach the required site. These OHL vary in sizes, length and ultimately costs. The study assumes multiple distances of these OHL, at a size suited to the power demand, to be installed to investigate the required breakeven OHL distance for this resource. Construction schedules and lead times are also factored in as these are different for dissimilar lengths of OHL and various REN solutions. The latest grid energy cost is used, and the focus is placed on the challenging infrastructure, costs, efficiencies and utilisation (dependency). Both CAPEX and OPEX form an essential part of the equation.

3.2.2 Limitations of the study

The results obtained from the study depend on various parameters including location of the mining site, type of orebody, mining method/s, production outputs, mineral commodity, REN sources that are available, REN technologies, and other parameters. All these factors have a bearing on the energy requirements and the applicability of REN technologies to generate the required power. Different sites will generate different results. In this regard, it is recognised that the results and recommendations emanating from this study may change when applying different study parameters.

While this limitation is recognised, it is worth noting that since the outcome of the study is based on the IRR and NPV generated, previously completed studies can be manipulated to include or replace the energy cost factor with known REN costs in the financial model to test the new financial returns for different sites. This allows for the testing of multiple parameters such as:

- Forms of REN;
- Commodities;
- Scales of operations/tonnage output; and

- Locations.

3.3 Description of resource model used for the study

3.3.1 Geology

The Bushveld Complex, a large layered igneous intrusive body in South Africa, together with the Great Dyke in Zimbabwe and the Stillwater Complex in Montana (United States of America) are good examples of stratified mafic and ultramafic intrusive complexes (DRA Global Projects, 2019). The Bushveld Complex is host to extensive resources of Platinum Group Elements (PGE's). The site is underlain by Main Zone and Critical Zone lithology. Both the Main Zone and Critical Zone outcrop on the mining site (DRA Global Projects, 2019).

The primary economic orebody is the UG2 Reef for this study. The reef outcrops in this area dipping gently at between 10° and 20°. Locally, dips may exceed this. Generally, the reef is oxidised at the surface. The reef can be summarised as laterally and down-dip persistent economic PGE deposits. Both economic units tend to have characteristic vertical grade profiles regarding PGE's, as well as the development of characteristic hanging wall and footwall stratigraphy (DRA Global Projects, 2019).

Geological losses (the absence of reef resulting from a geological feature) in the area have been estimated. The UG2 geological losses have been estimated at 12%, with potholes making up a significant portion of the total loss. See Table 3-1

Table 3-1: Estimated Geological Losses

Geological Loss Type	Merensky Reef	Source	UG2 Reef	Source
Potholes	approx. 14.5%	historically 18.5%	9%	historically 9%
Faults/Shears	1%	historically 1%	1%	historically 1%
Dykes	less than 1%	historically 1%	< 1%	historically 4%
Total Geological Discount	**approx. 16.5**		**Approx. 11%**	

Source: (DRA Global Projects, 2019)

3.3.2 Geotechnical

Local structures such as faults, shear zones and dykes may locally affect the continuity of the layers. The general structural geology of the area is characterised by northeast and east trending dykes and faults with associated conjugated joint sets. Historic mining in the area has been remarkably uncomplicated with faulting. Minor faulting is expected to occur, but, displacements are expected to be less than 1 m. Dykes are being intersected in this area although, no serious problems have been encountered due to these dykes (DRA Global Projects, 2019).

Potholes are generally spherical depressions in the reef where the reef is replaced by waste rock. These features present a considerable challenge in mining by way of dilution and stability. A pothole that is likely to result in a dilution of 20%, i.e. a 6 m diameter pothole in a 31 m panel implies that the panel must be stopped and then redeveloped again. Within the project area, more potholes have been intersected in the Merensky than in the UG2 (DRA Global Projects, 2019).

The UG2 reef consists of a ~ 70cm thick chromitite layer developed within the upper critical zone of the Bushveld Complex. The depth of the ore body ranges from 200m – 600m (DRA Global Projects, 2019).

3.4 Mining method description

The mining method planned for this study is mechanised development for declines and flat ends with conventional reef development and stoping. Due to the combination of mechanised development and conventional stoping, this mining method falls under the category of hybrid mining methods. The mining method is comprised of the following features;

- On-reef mechanised or trackless access development.
- Conventional development in the stopes.
- Scattered breast mining in conventional stopes.
- LHD loading from a draw point filled with broken rock from the stope.
- LHD loading dumping rock onto a dump truck via an ejector bucket, which trams along the strike drives to a tip at the apparent dip declines conveyor.

3.5 Mining layout and method

3.5.1 Development

A triple decline cluster is used for access from the surface in the footwall at an inclination of 9 degrees until it intersects reef. At this point, it turns, and this cluster then continues on-reef (DRA Global Projects, 2019). The three declines are for material, conveyor belt and chairlift and are all developed on reef as apparent dip decline and inclines. The focus is to first mine down-dip from this point to establish a ventilation system with raise bored ventilation holes to surface (DRA Global Projects, 2019). All other development is on-reef with the development end hanging wall on the plane of the reef as per stoping hanging wall. Development ends are designed adequately small to cater for ventilation and suitable mechanised trackless machinery.

The main central decline is developed by trackless mobile machinery. Figure 3-3 shows the apparent dip on-reef decline designs. The main central decline forms the backbone of the mine and serves as the main ingress and egress for men, material and rock. The chairlift is installed in the chairlift decline (DRA Global Projects, 2019). From the central decline, supporting infrastructure is developed to support separate, individual sections for as long as they are economically mined. On either side of the main centre decline, apparent dip reef declines are designed to be developed at every horizontal distance 2,400 m along the strike as illustrated in figure (DRA Global Projects, 2019).

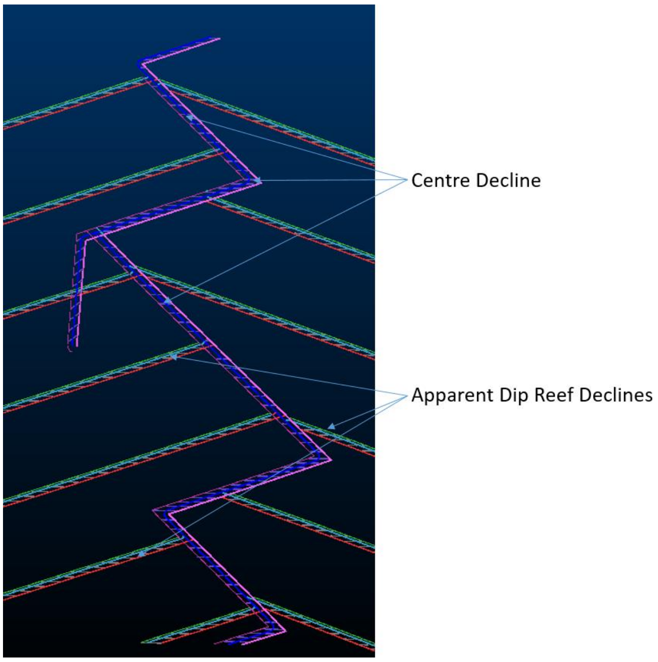


Figure 3-3: Apparent dip on-reef decline designs (DRA Global Projects, 2019)

The primary purpose of these apparent dip declines is to serve as conveyor declines transporting broken rock from lower levels to the main central/access decline. It is from the main centre decline conveyor that the rock is conveyed to surface (DRA Global Projects, 2019). These apparent dip declines are designed to continue, on dip, until the practical length of the conveyor belts is (maximum 5 x conveyor belt lengths of 700 m each) reached and then a new decline is developed. Decline rock is transported utilizing trucks to levels and tipping points above until the conveyor belt is installed (DRA Global Projects, 2019).

Figure 3-4 shows a development mine plan between levels and tipping arrangements. Conveyor belts get installed once the first 360 m decline length has been developed and the strike drive tip and box front gets installed to tip onto the belt. Once the first strike drive tip is commissioned, the decline trucks tip into the strike drive tip (DRA Global Projects, 2019).

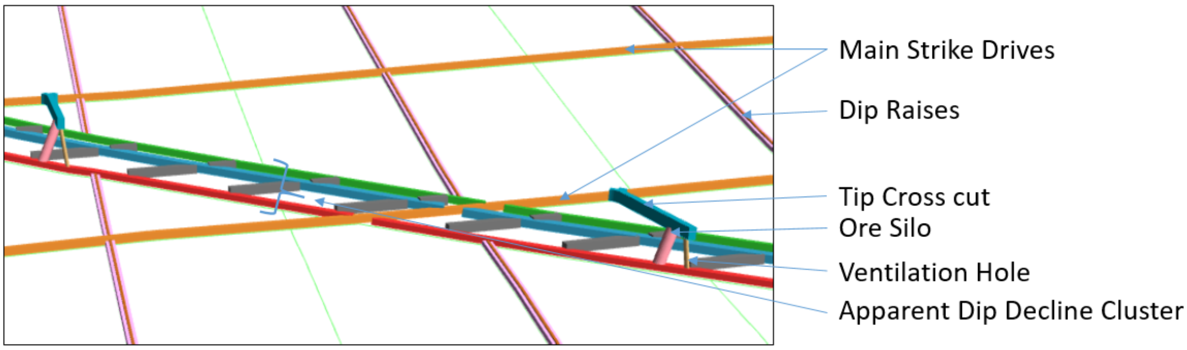


Figure 3-4: Reef Declines, Laterals and tipping cross-cut with silo and ventilation hole (DRA Global Projects, 2019)

From the main strike drive, at every vertical depth of approximately 75 m, along the dip of the UG2 reef, on-reef strike drives are designed. The strike drives serve as the truck tramming/hauling excavations by which broken rock from the stopes is hauled onto the apparent dip decline conveyor belt via gravity feed (DRA Global Projects, 2019).

3.5.2 Stoping

Stoping consists of a raise line with approximately 204 m of back length with six panels per side. After that, ledging and stoping are by means of scattered breast conventional stoping and winch scraping to a muck bay on the side of the centre raise. At every 200 m distance along the strike, an on-reef 204 m long raise line is designed and developed by conventional mining methods for stoping (DRA Global Projects, 2019).

Mining of the panels is designed to start from the base of the raise line. At a panel length of 30m and a stope width of 1.13 m, stoping is planned to advance on either side of the raise line. Within the overall design of the stoping area, each stope typically has twelve standard 30 m long panels as illustrated in Figure 3-5 below.

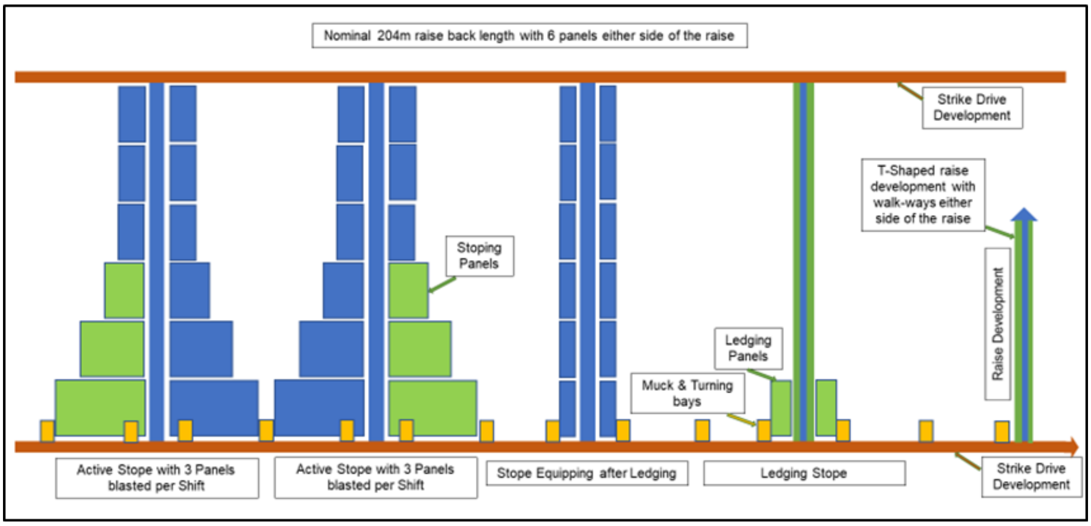


Figure 3-5: Typical Standard Stope Layout (DRA Global Projects, 2019)

3.6 Mine production schedule

In order to achieve the 70 ktpm, four half levels must actively be mined at any given time. This ratio represents the steady-state production to produce a total of 70 ktpm. Table 3-2 shows the assigned rates used in the Enhanced Production Scheduler (EPS) software to generate the 70 ktpm production profile. These rates were determined by modelling production cycles to achieve the predetermined 70 ktpm production requirement. The stope extraction is estimated as illustrated in Table 3-3 below. The table indicates the production required per mine design element, to support one full stope block.

Table 3-2: Maximum Scheduling Parameters for Steady-State Production

Name	Description	Unit	Rate / Tempo per month
Main Decline Cluster	Belt, Mat, Laterals and Level Access (FW)	m	55
App Dip Decline Cluster	Belt, Mat, Ledging and Laterals	m	55
Strike Drive	Strike Drives and Tips	m	55
Reef Raise	Raise	m	30
Stope (Average including ledging)	Stoping - New Design	m^2	420
Waste Drive	Main Strike Waste Drive	m	55
Chairlift Incline	Chairlift Incline	m	30

Note: Initial development is on a 7-day week, after that on an 11-day fortnight

Source: (DRA Global Projects, 2019)

Table 3-3: Stope extraction estimation

Item	Unit	Value	Quantity	Total
Stope block width	m	200	1	200
Stope back length	m	204	1	204
Stope area	m^2	40,800	1	40,800
Ventilation holings width	m	2	1	2
Ventilation Holings Length	m	4.4	1	4.4
Ventilation Holings Area	m^2	8.9	22	195.1
Timber bay Width	m	4.5	1	4.5
Timber bay Length	m	11.5	1	11.5
Timber bay Area	m^2	51.9	1	51.9
Centre Gulley Width	m	1.4	1	1.4
Centre Gulley Length	m	127.3	1	127.3
Centre Gulley Area	m^2	178.2	1	178.2
Travelling Way Width	m	1.8	1	1.8
Travelling Way Length	m	204.0	1	204.0
Travelling Way Area	m^2	367.2	2	734.4
Panel Type 1 Area	m^2	841.2	2	1,682.4
Panel Type 2 Area	m^2	2,681.8	10	26,818.2
Panel Type 3 Area	m^2	1,641.1	2	3,282.2
Mineable Area per Stope	m^2			32,942.6
Pillar Area per Stope	m^2			7,857.4
Extraction estimate	**%**			80.7%

Source: (DRA Global Projects, 2019)

The production estimation at steady state is based on the scheduling parameters outlined in Table 3-4 below. These scheduling parameters are metrics used to define mine design layouts and minimum production requirements to satisfy the 70 ktpm mandate.

Table 3-4: Production estimation per stope

STEADY STATE ESTIMATION		
Mine Design Element	**Unit**	**Calculation / Value**
Stoping		
Level Spacing	m	75
Raise line Spacing	m	200
Mined Panel Length	m	30
In-stope pillars	m	4
Panels per raise line (one-sided)	m	6
Panels per Raise line (two-sided)	unit	12
Mined raise lines per half level	unit	2
Mined raise lines for ledging per half level	unit	1
Production crews per raise line	unit	3
Production Panels per half Level	unit	6
Active Production Panels per Level	unit	12
Panels Blasted per half Level per day	unit	6
Panels Blasted per Half Level per Day	unit	6
Number of Blasts per Panel per Month	unit	15
Stope Height	m	1.13
Stope Utilisation	%	85%
Advance per Blast	m	1
Rock Density	t/m^3	3.886
Face Area per Panel or crew per Month	m^2/mth	450
Tonnes per panel per month	t	1,862
Face Area per Raise per Month	m^2/mth	1,350
Face Area per Half Level per Month	m^2/mth	2,700
Face Area per Crew per month	m^2/mth	450
Stoping Tonnes per Half Level per Month	t	10,831
Average Stope Mining Extraction	%	75
Total Mineable Stope Face Area per raise line	m^2	24,552
Number of Months to mine a raise line	mth	18.2
Gully tonnes	mth	339

Source: (DRA Global Projects, 2019)

The mine production estimation to produce a nominal 70 ktpm is shown in Table 3-5. Stope tonnage is not the sole contributor to the total mine target of 70kt/month, and other excavation tonnages are contributing.

Table 3-5: Mine production estimation to produce a nominal 70 ktpm

Description	Unit	Value
Total Tonnes per Month (Steady State)		
Total tonnes per half level per month	t	16,750
Number of half levels per month	no	4.00
Total tonnes per half levels per month	t	67,000.00
Decline development per mine per month (tonnes)	t	-
Apparent dip declines on reef development per month	no	2.00
Apparent dip decline cluster on reef development per month (tonnes)	t	1,273.05
Apparent dip declines on reef development per month (tonnes)	t	2,546.11
Chairlift development per month (tonnes)	t	3,077.71
Ventilation holes development per month (tonnes)	t	349.74
Total tonnes per mine per month	**t**	**72,974**

Source: (DRA Global Projects, 2019)

Figure 3-6 below is the actual schedule produced and costed. The figure is the representation of the culmination from all areas of the mine contributing to the 70kt/month. The figure is normalised and expressed in tonnage produced annually. It shows the build-up period, a steady state from 2023 to 2042 and a one year tail. This is a generic production schedule and will differ according to the variable power supply scenarios considered. It is influenced by dissimilar lead times and construction periods depending on the power supply scenario considered.

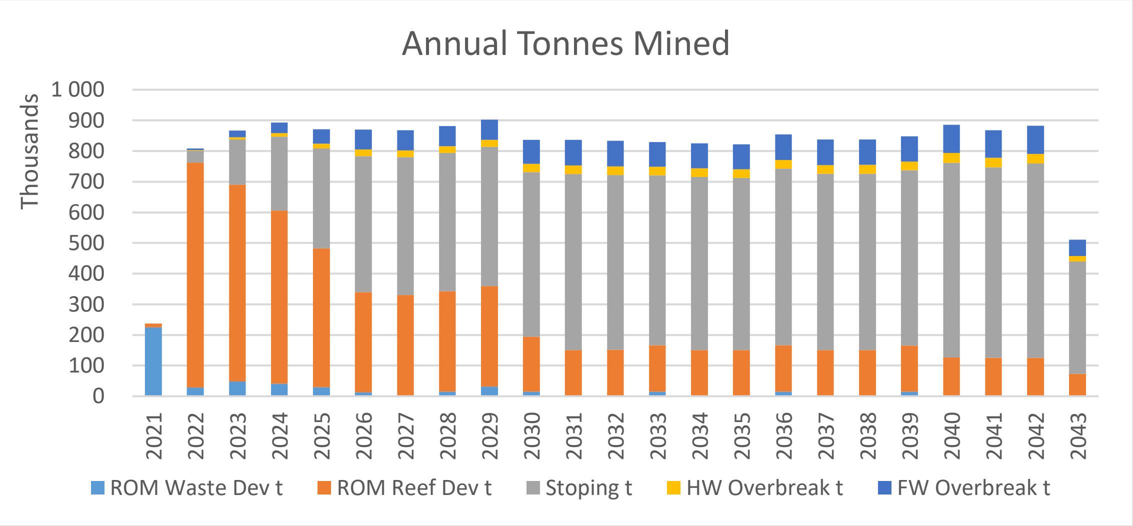


Figure 3-6: Annual Tonnage Production over LoM as Scheduled (DRA Global Projects, 2019)

A reasonable mining grade is achieved but early development tonnes are diluting the initial grade. As stoping increases, and development tonnages drop, the grade trends upwards as can be seen in Figure 3-7 below.

Figure 3-7: LoM Grade as Scheduled below shows the LoM grade for the individual and combined 4E metals. The figure articulates an averaged, annual grade, in grams per tonne (g/t). The 4E grade represents the sum of the platinum, palladium, rhodium and gold grades.

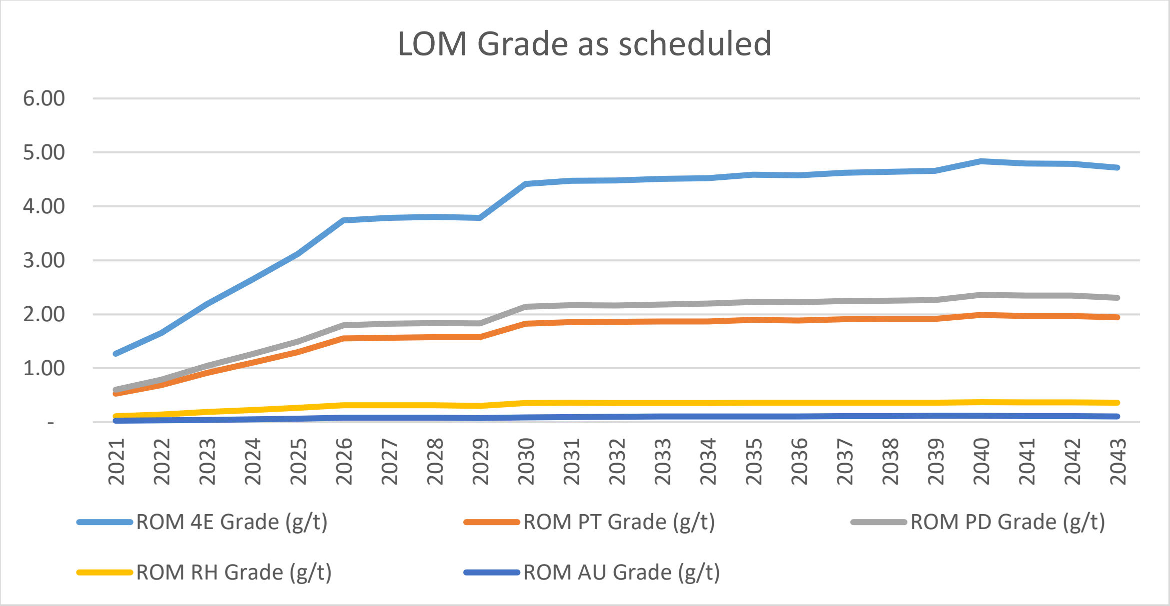


Figure 3-7: LoM Grade as Scheduled (DRA Global Projects, 2019)

Figure 3-8 is a summary of the total reef tonnes represented by the bars and a line graph representing the grade on the secondary axis. The figure clearly shows the impact on grade when development tonnes tapper down while stoping tonnes compensate to produce a steady 70kt/month still. This initial low-grade start and extended wait until maximum grade potential is reached does have a severe impact on the financials with steady state revenue only realised from 2030.

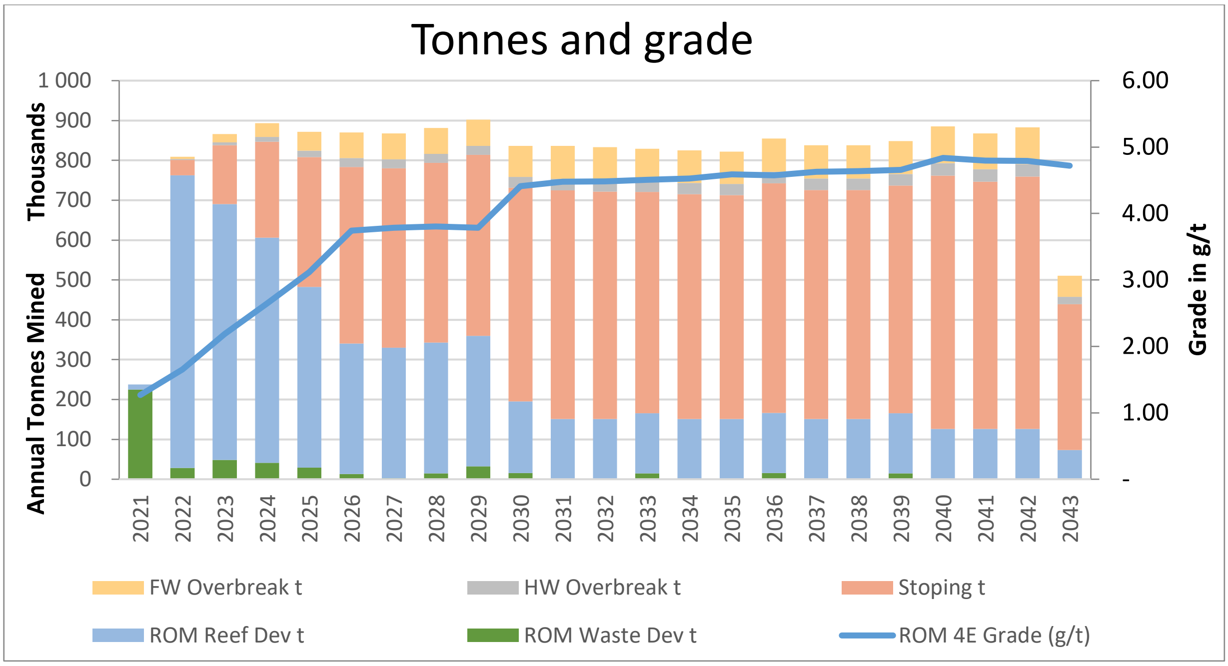


Figure 3-8: LoM Reef Tonnes vs Grade as Scheduled (DRA Global Projects, 2019)

3.7 Power requirements

The mechanical power requirements are subjected to load capacity de-rating factors, diversity and utilisation factors in order to compensate for the operating conditions and to obtain a realistic value for the running power. A load profile was generated for the life of mine (LoM) duration. The additional supply needed for plant and general surface infrastructure puts the total power requirements for the operation at 21.8 MVA (DRA Global Projects, 2019). Figure 3-9 shows the power requirements for the underground operation only, with a steep build-up leading up to the 9.2 MW required for steady state production.

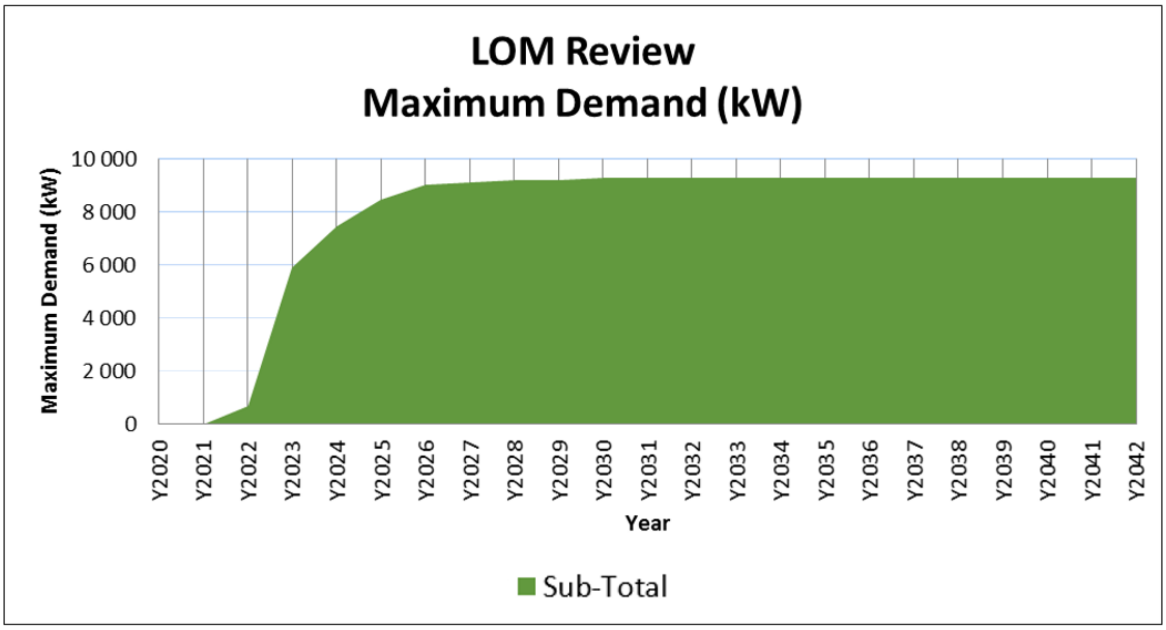


Figure 3-9: Maximum Underground Power Demand for LOM (DRA Global Projects, 2019)

The estimated split in required power is shown in Figure 3-10 below. The estimated load is 4 MW for surface loads and 5.2 MW for underground loads. A maximum load of 9.2 MW is when the mine operates on peak power demand supplying power for ventilation, conveyors, production, pumping and surface requirements. A standard power load factor of 80% is applied to more accurately enable the costing of the realistic power usage.

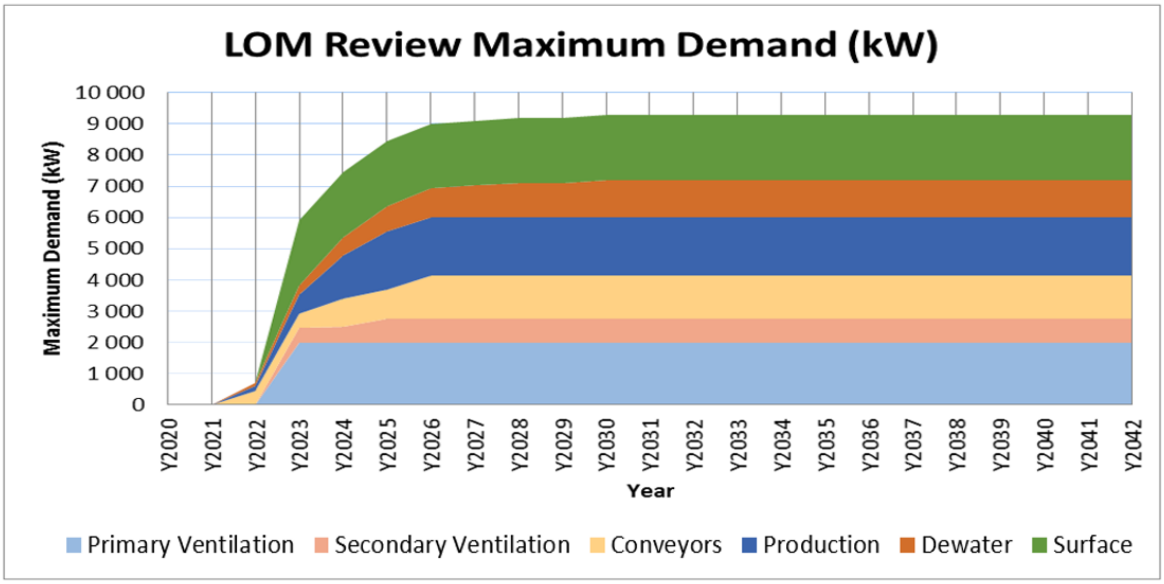


Figure 3-10: Estimated Power Required for the Operation (DRA Global Projects, 2019)

3.7.1 Power distribution

Power is distributed underground from a 6.6 kV substation at 6.6 kV via three 3c x 185mm^2 feeder cables to a UG2 level-0 6.6 kV distribution substation. From the level-0, 6.6 kV distribution substation, dedicated feeders are installed to distribute power to the decline conveyors mini-substations, two apparent dip declines and stopes.

3.7.2 General

In each of the apparent dip declines, power is distributed via a combination of 4-way ring main units, 3-way ring main units and mini-substations to the apparent dip conveyors and stopes. The design is based that, should there be a cable fault in an apparent dip conveyor decline, only one apparent dip conveyor decline is affected. Power is supplied to underground equipment at 525 V via gulley rig panels.

3.7.3 Electrical rate cost

Electrical rate cost (kWh consumption) is based on actual consumption for existing equipment that is required by the future operation and forecast consumption for the new mining equipment. A cost per kWh rate of R 0.98/kWh is used.

3.7.4 Rock handling and other power requirements considered

Blasted UG2 ore is transported from the stope face using face, advanced strike gullies (ASG) and centre gulley scraper winches to a muck bay in the half level strike haulage. An LHD loads the ore onto a 20 t truck to transport it horizontally to the tip above the relevant apparent conveyor decline. At the tip, a hydraulic breaker is used. The breaker reduces the ore size, to pass through a 300 mm grizzly into the ore pass. The short ore pass serves as a surge storage arrangement to enable the ore to be evenly fed onto the apparent dip conveyor via a vibrating feeder. A radial door system is provided to seal the ore pass and prevent mud rushes.

The apparent dip conveyors feed via strike conveyors or directly onto the central dip conveyor system. Four truck tips are feeding two apparent dip conveyors onto the central dip conveyor system. The main dip conveyors transfer the rock to surface and deposit directly into concrete silos. Vibrating feeders in the silo base allow the rock to feed into trucks which then deliver the ore to the plant. The other major power requirements included but not described in detail are:

- Water supply and underground dewatering
- compressed air generation and reticulation

- Maintenance infrastructure (surface and underground)

3.7.5 Mine power consumption forecast

The required total power for the designed and scheduled 70kt operation peaks at 21.8 MVA with a power factor (pf) of 0.8. This requires Eskom to supply 21.8 MVA to accommodate the 17.5 MW total power requirement. The operation sends Eskom a Notified Maximum Demand (NMD) to cover their peak requirements, and Eskom is then responsible for the installation of the capital infrastructure required to supply the NMD. The capital spend by Eskom is amortised over twenty years (or as negotiated) together with the regular monthly usage. According to DRA Projects, 2019, Eskom is failing to commission the required infrastructure on time and within budget. The responsibility has shifted to the operations themselves (DRA Global Projects, 2019). For this study, the responsibility of the commissioning of the capital infrastructure is with the operation. The capital required is costed up front and the supply rate used does not include capital amortisation but a pure per kWh usage.

It is recommended to apply a NMD that is higher than would typically be required in order to provide for contingency should the requirements spike beyond 9.2 MW. Eskom transformers are also sized in increments of 5 MVA, 10 MVA, 20 MVA or 40 MVA. In the case of the current scenario, an NMD of 30 MVA is recommended and would consist of three 10 MVA transformers to allow for emergency power supply should one transformer fail.

If usage remains constant at 17.5 MW, Eskom is only paid for the 21.8 MVA used. The kWh rate of ZAR 0.98/kWh stated above, does not include the capital portion of the supply and, according to DRA Projects, 2019, is an average rate dependant on the following factors:

- Time of day – Peak vs Off-peak rates.
- Seasons – Winter tends to increase tariffs due to more strain on the national grid.
- Length of OHL – The longer the installation of the OHL, the more the cost due to material and increased power loss over longer distances.
- Size of Supply – Bulk supply is cheaper than individual or residential supply.
- Negotiated and Agreed rates – Long term contracts (DRA Global Projects, 2019).

3.8 Financial Modelling

Six full financial models are compiled that complements the mining method, production schedule outputs, metal (product) streams and all associated estimate cost inputs. Table

3-6 below summarises all the financial modelling that was done, and it shows a financial run for every form of power considered.

Table 3-6: Financial Model Summary

Models	Descriptions
Financial Model 1	Solar Only
Financial Model 2	Hydro
Financial Model 3	Solar + Battery Storage
Financial Model 4	Grid - OHL 20km
Financial Model 5	Grid - OHL 50km
Financial Model 6	Break-even OHL km on (Hydro costs)

The different scenarios were tested by lengthening the required overhead line lengths at the previously mentioned cost of R2.5 mil/km. This indicates where a breakeven point is reached based on the length of OHL costs against the REN CAPEX. The economic analysis was carried out using discounted cash flow (DCF) methodologies. As mentioned, the analysis was based on earnings before interest, taxation, depreciation and amortization (EBITDA) and does not consider the effects of inflation, escalation, taxes and other financial charges.

The financial model considered annual revenue, OPEX, initial CAPEX, stay in business (SIB) capital, contingency, environmental rehabilitation financial provisioning, socio-economic development costs and royalties presented on a year-by-year basis. Metals credits have been based on the stated reserve model, and this basis excludes revenue streams from iridium, ruthenium and cobalt. Metal pricing has been based on market pricing dated to July 2019, except for chrome. Chrome concentrate pricing has been based on an internal benchmark and assumes delivery to a domestic buyer within a 100 km radius of the operation. The project start date has been based on the year 2020 and can go up to 2047, depending on the variable lead times for different scenarios. Initial years requires further study work, licencing and environmental challenges and pre-construction depending on the scenario being costed. The production profiles remain constant for all options barring the start time adjustments.

3.9 Conclusion

The research is testing the feasibility of unlocking previously inaccessible ore resources by means of onsite REN power generation. The study is focused on a medium to large scale mining operation and compares REN power generation, against a grid tied power supply. Financial outcomes are expressed in EBITDA. The study is based on a PGM underground mine with production set at 70 ktpm requiring 17.5 MW of power at steady state.

An underground hybrid mining method is used with narrow tabular production stopes serviced by mechanised mobile equipment and conveyor belts. The mining component of the study only, requires 9.2 MW of power but a full operation, including a concentrator plant, was considered. Grid-tied (Eskom)'s CAPEX and OPEX were briefly discussed in the chapter but more details are provided in chapter 4 where project costing is outlined.

4 PROJECT COSTING

4.1 Introduction

The objective of this chapter is to summarise all the costs for the different components of energy. As previously stated, the best estimates to use is the LCOE rates as they include all the OPEX and CAPEX required to predict an accurate ROI for REN. The REN costs used in the financial model carry the necessary accuracy and most recent costs as a worldwide average. The Eskom costs that were used in the analysis are real and up to date with current industry requirements.

4.2 Levelised cost of energy (LCOE)

LCOE is a term which represents the cost incurred to generate energy over a period. This period is usually the life span of the power generating facility studied. By investing in REN, one is making a decision based on other available forms of energy and their associated costs including both CAPEX and OPEX ($/kWh). The costs for other forms of energy increase on a set term basis but REN operational costs are marginal compared to the costs of fossil fuel power plants. By purchasing REN setups, a hedge is essentially created against rising grid energy costs by fixing the per kWh rate at a known cost (UCALC, 2019).

The LCOE can be determined by taking the net present value of the full cost of construction and operation of the energy-producing resource and dividing it by the total kW produced over its lifetime. All the expenses related to the venture typically include the initial cost of investment expenditures, maintenance and operations expenditures and fuel costs (if applicable). The total output of the energy-producing resource is the sum of all electricity generated. The last two critical aspects considered in the calculation are the discount rate of the project and the life expectancy of the arrangement. See equation below.

$$\text{LCOE} = \frac{\text{NPV of total Costs Over Lifetime}}{\text{NPV of Electrical Energy Produced Over Lifetime}}$$

The LCOE is a crucial measurement in deciding whether to push ahead with a new venture or not. The LCOE is the deciding factor whether a project is able to make back the initial investment or not. If it does not, the company will not proceed with building the energy-producing asset and will search for another option. Utilising the LCOE to measure whether an undertaking will be feasible is one of the essential phases in breaking down projects of this nature (Lazard, 2018). The LCOE is an important calculation that allow financial analysts to compare different renewable energy sources such as wind, solar, and nuclear power sources (Lazard, 2018). The parameter allows for these comparisons regardless of unequal life spans, differing CAPEX, size of the projects, as well as the differing risk associated with each of the projects. Figure 4-1 shows the considerations that go into the calculation of the LCOE Rate. The LCOE is taken as a per-unit cost of electricity generated and the risk of each project is an implication of the specific discount rate used for each power-generating asset (Lazard, 2018). For the purpose of the research, LCOE cost is used as far as reasonably possible with the alternative being costs quoted and referenced from DRA's database.

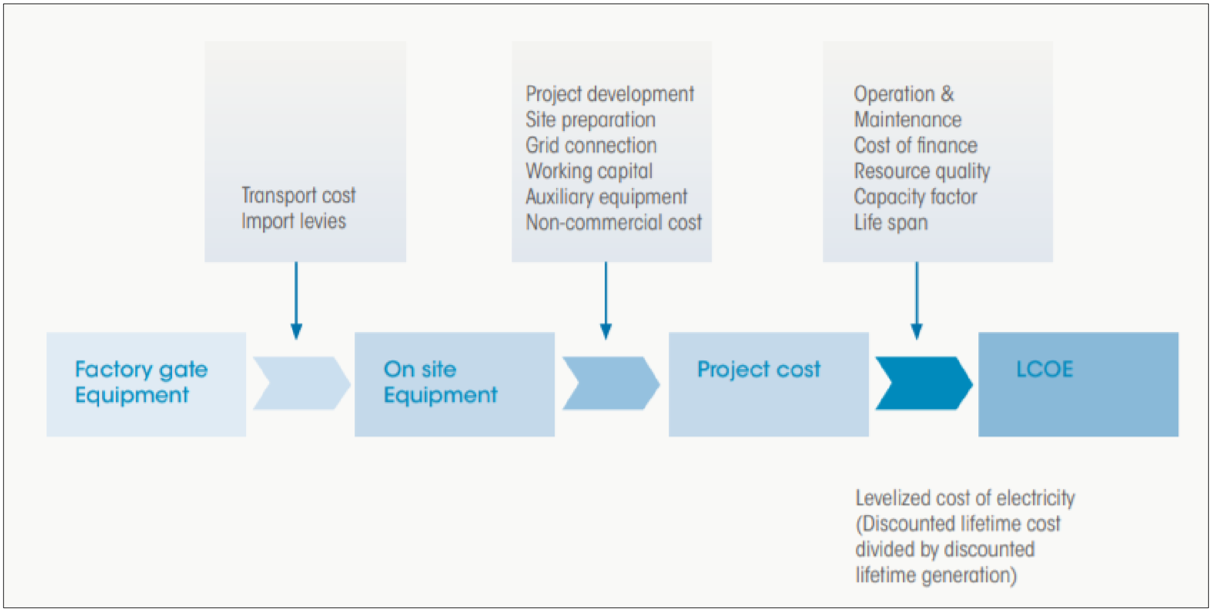


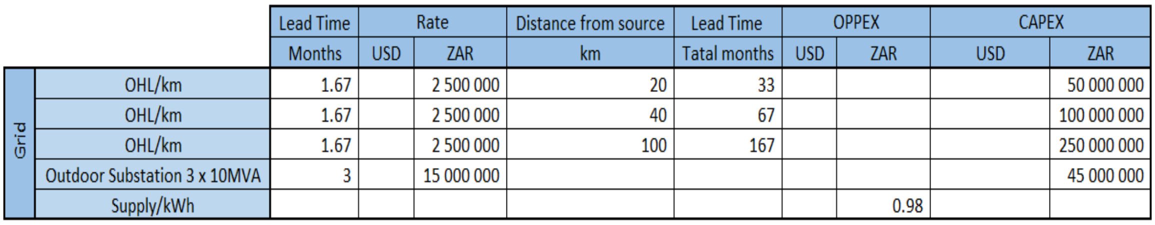
Figure 4-1: LCOE Rate Considerations (IRENA, 2012)

4.3 Grid energy costing

It has been established that the 70kt operation requires a mining power supply of 11.5 MVA with a pf of 0.8, providing a peak supply of 9.2 MW. Considering the plant and general surface, the total supply required is 21.8MVA. This supply is generated through three 10MVA transformers. One 10 MVA transformer including civils, switches, material and labour costs ZAR 15 Million. The Eskom supply rate is ZAR 0.98/kWh, as previously stated, and is an average rate applied for research purpose as Eskom charges different rates during peak and off-peak times (Eskom, 2019).

The lead time on a required 132kV OHL is quoted at three months per 5km, i.e. 1.67months/km. This excludes all the legal and environmental obligations, which adds 24 months to the schedule. The project is costed as a greenfield operation so the power supply must be distributed directly from Eskom. In cases where the newly installed OHL exceeds construction time of 24 months, based on the rate of 3month/5km above, it is assumed that more OHL erecting crews are deployed and, the distance required is completed from multiple sites along the OHL erecting distance. Eskom's distribution network starts OHL supplies at a minimum of 132kV, from there supply lines can join the primary, 132kV OHL, and step down (11kV, 22kV, 33kV etc…) to the client's substation requirement (DRA Global Projects, 2019). Table 4-1 shows the summarised grid cost component used in the financial model comparisons. OHL are priced at R 2.5 million/km with a 1.67 months/km lead time to erect. A 10 MVA, outdoor substation is priced at 15 million each. An Eskom rate of R 0.98/kWh was used.

Table 4-1: Eskom Capital and Operational grid energy supply cost



		Lead Time	Rate		Distance from source	Lead Time	OPPEX		CAPEX	
		Months	USD	ZAR	km	Tatal months	USD	ZAR	USD	ZAR
Grid	OHL/km	1.67		2 500 000	20	33				50 000 000
	OHL/km	1.67		2 500 000	40	67				100 000 000
	OHL/km	1.67		2 500 000	100	167				250 000 000
	Outdoor Substation 3 x 10MVA	3		15 000 000						45 000 000
	Supply/kWh							0.98		

**ZAR: USD 14.13 - Exchange based on 1 July 2019.*

Source: (DRA Global Projects, 2019)

4.4 REN costing

The total installed cost of REN systems can vary widely within individual countries, and between countries and regions. These variations reflect the maturity of domestic markets, local labour and manufacturing costs, incentive levels and structures, and a range of other factors (IRENA, 2012).

Using historical and weighted global averages give the best consistency and accuracy to the financial model inputs. This makes it more suitable to draw conclusions from mining operations in countries other than SA due to the costs being global. When there is a big drive behind a REN project this size (21.8MW), more time and effort is put into the commercial processes. This allows for faster and more efficient sourcing of the necessary equipment required for construction (DRA Global Projects, 2019).

4.4.1 Solar PV Costs

Once the PV solar plant has been built, it needs to be efficiently operated and carefully maintained. Compared to other power generating technologies, solar PV power plants have low maintenance and servicing requirements.

However, as the International Financial Corporation, 2015, p. 125 warns, “proper maintenance of a PV plant is essential to maximise both energy yield and the plant’s useful life (International Finance Corporation, 2015). Optimal operations must strike a balance between maximising production and minimising cost”. Solar energy requires limited maintenance compared to the other generation sources. PV solar plants are investments that are likely to last for 20–25 years or more (Energysage, 2020).

Thus, before turning to the actual process and stages of maintenance and operation, one needs to understand the issues involved in the functioning of a PV solar plant. They can be divided into groups according to the plant’s main components, crystalline solar panels or thin-film solar panels (Sola Decentralised Autonomous Organisation (DAO), 2017). Crystalline solar panels are made from crystalline silicon and depended on the kind of crystal used, they could be monocrystalline or polycrystalline also known as multi-crystalline. Thin-film solar panels mostly consists of cadmium telluride (CdTe), copper indium (gallium) diselenide, cadmium sulphide (CdS) and amorphous silicon (aSi) (Sola Decentralised Autonomous Organisation (DAO), 2017).

Figure 4-2 below gives the average market price for the various forms of solar PV modules from 2010 to 2018. Also shown in the figure is the sharp decline in average prices, by market, from 2013 to 2018. This decline is significant when looking ahead as REN tends to become cheaper and could soon outprice non-renewable energy sources.

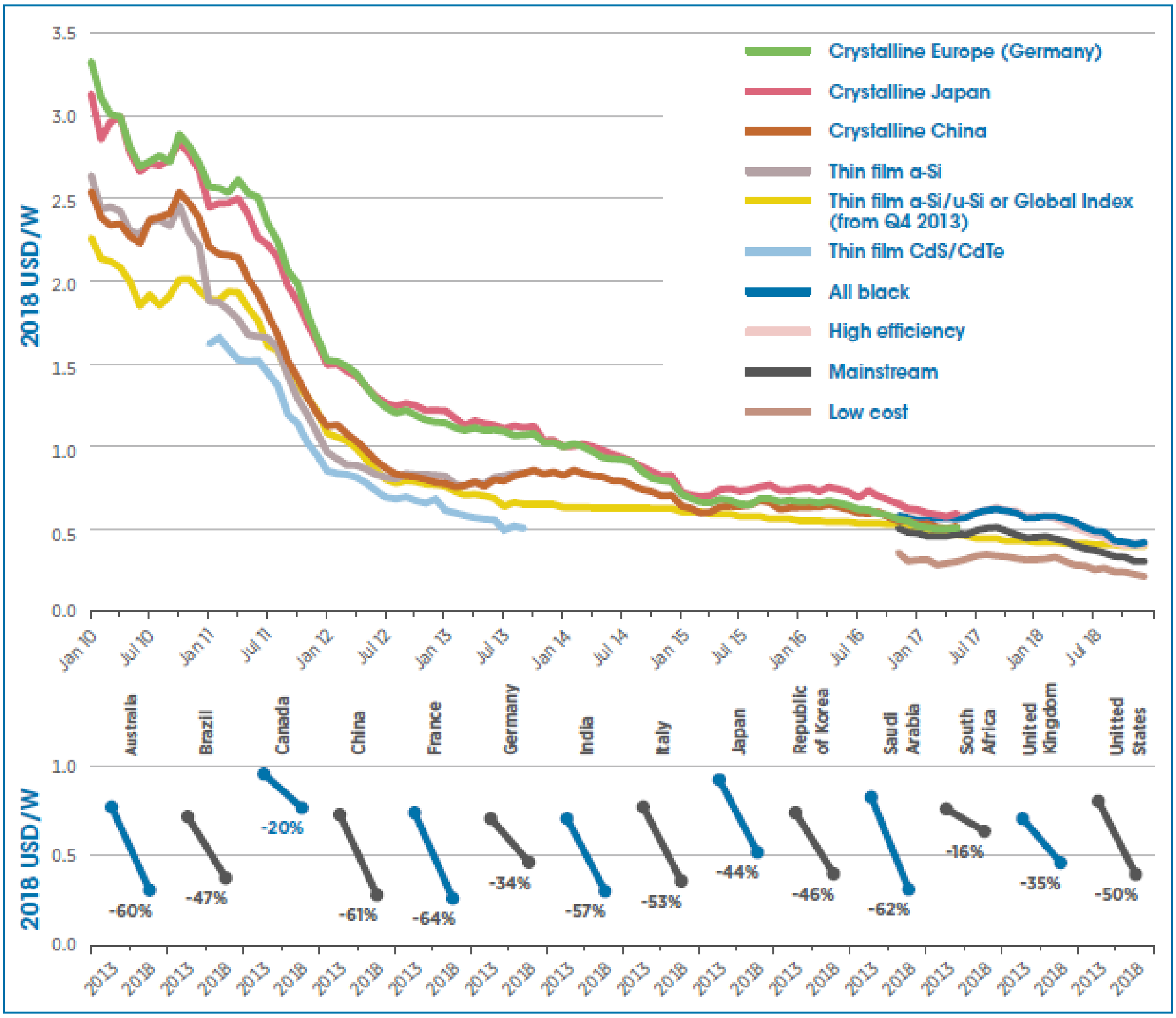


Figure 4-2: Average solar PV module prices by module technology and manufacturer (top) and average module prices by the market in 2013 and 2018 (bottom)(IRENA, 2019)

Figure 4-3 below shows the global weighted average, construction cost trend of industrial sized Solar PV projects between 2010 and 2018. As can be seen the figure, since 2010 the USD/kW rate declined, year on year, from $4 621/kW to $1 210/kW. These declines in costs are the results of improved technologies and increased worldwide adoption of REN. In 2020 the global spent on REN and other clean technologies totalled half a trillion dollars (USD). As the market continues to expand, economies of scale also contribute to falling prices (Wadhwa & Salkever, 2021).

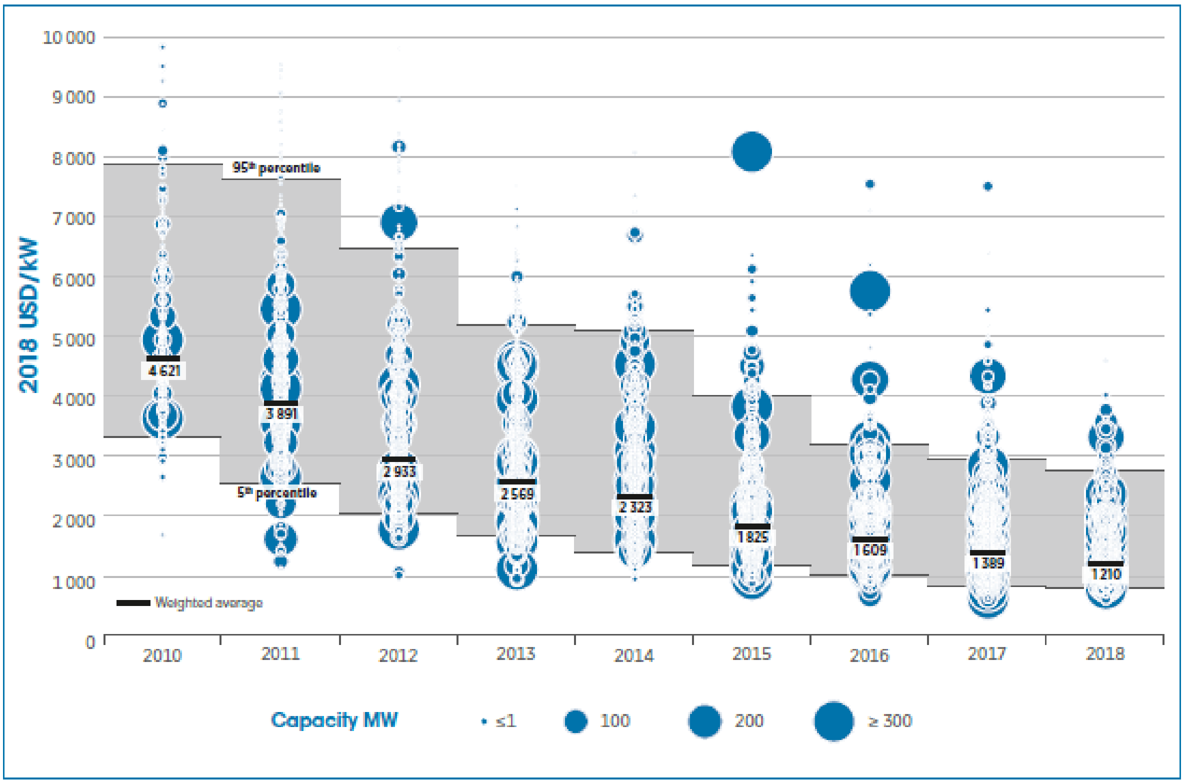


Figure 4-3: Total installed cost (turnkey construction) for utility-scale solar PV projects and the global weighted average, 2010-2018(IRENA, 2019)

Figure 4-4 shows an estimated average, Utility-Scale Solar PV, operational expenditure by technology and different types of trackers with which the panels are equipped. CdTe (cadmium telluride), CIGS (copper indium gallium selenide) and c-Si (crystalline silicon) are the three variants of PV modules (panels) (Enbar, et al., 2015). SAT c-Si (single-axis tracking) and DAT c-Si (dual-axis tracking) are two types of trackers fitted to crystalline silicon panels and CPV (concentrating photovoltaics) is an alternative solar technology (Enbar, et al., 2015).

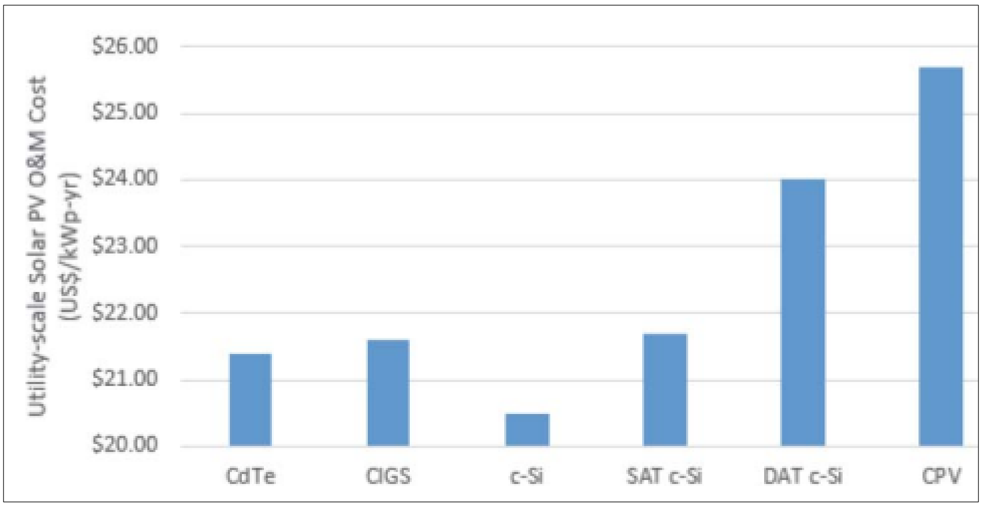


Figure 4-4: Utility-Scale Solar PV operational and maintenance costs (O&M), by Technology (Enbar, et al., 2015)

In order to covert the figures into kilo Watt hour cost, the sum is divided by the forecasted hours in the year. The research is based on an estimated 7 hours of adequate required sunlight per day all year round totalling 365 x 7 = 2 555 hours. From the research an overall average rate of USD 22.5/kWp-yr is assumed as derived from the cost shown in Figure 4-4 (Enbar, et al., 2015). The kWh rate (solar operational expenditure) then is 22.5 / 2555 = USD 0.009/kWh or R 0.12/kWh. Factors that contributing to solar maintenance are natural degradation, grounding and lightning protection, component failures (panels, inverters, trackers), weather conditions (snow, wind, soiling) and general unscheduled maintenance (cable connections, fuses, lightning, structure faults) (Allam, 2018).

4.4.2 Hydro energy costs

Figure 4-5 shows the capital requirement per kW required for different sized hydro operations. For the 70kt operation, the power required was established to be 21.8MVA and hence the 0-50MW cost of USD 1490/kW should apply (IRENA, 2018). This varies from country to country. The estimate provided above is a global weighted average and hence a fair cost to use as an assumption in financial modelling. This cost allows for a comparison at a global level.

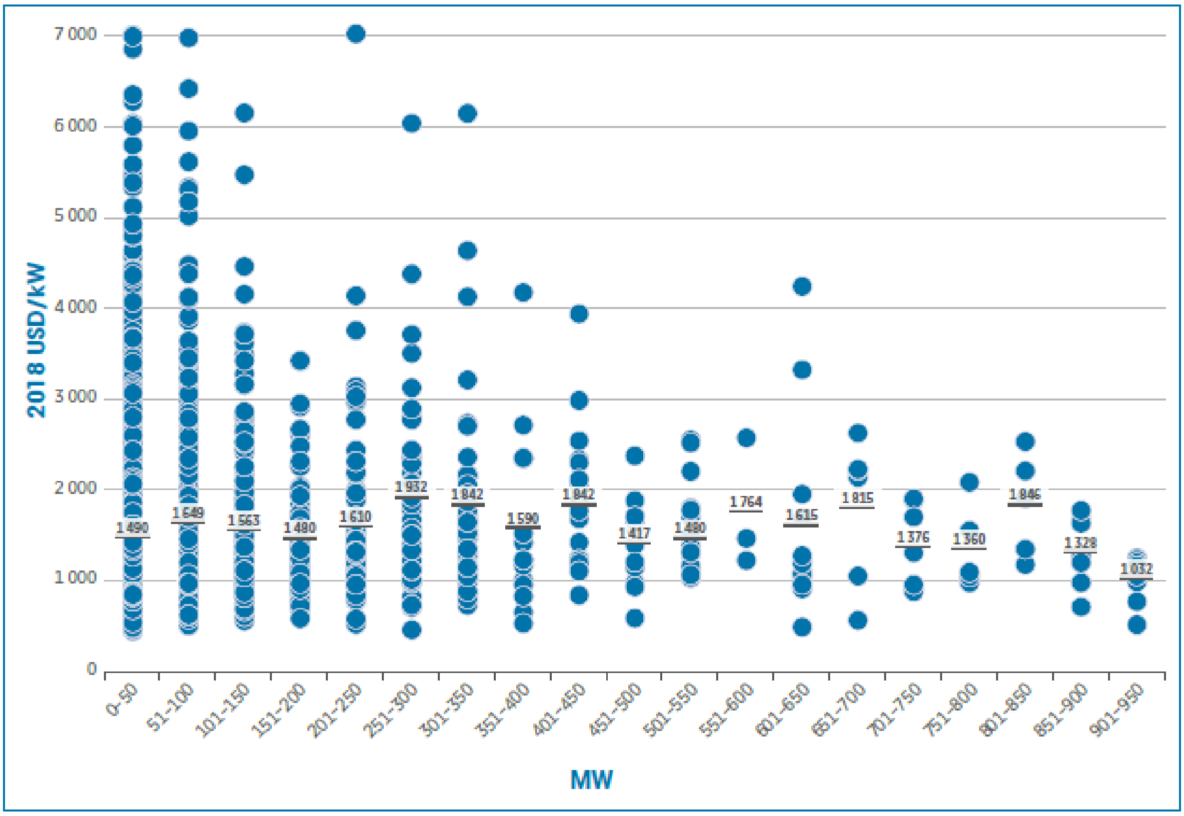


Figure 4-5: Total installed costs (turnkey construction) for hydropower by project and weighted average by capacity range, 2010–2018(IRENA, 2018)

According to IRENA, 2018, there is a relationship between CAPEX and OPEX. Annual operational and maintenance (O&M) costs are often quoted as a percentage of the capital investment cost per kW per year. Typical values range from 1-4%. The International Energy Agency (IEA) assumes 2.2% for large hydropower projects and between 2.2 and 3% for smaller projects, with a global average of around 2.5% (IRENA, 2018). For the purpose of this research a 2% factor will be used to derive the O&M cost from the 1490/kW CAPEX.

With the applicable CAPEX at USD 1490/kW and assuming the required water flow is consistent year-round, the formula for O&M costs is as follows:

$$\frac{\text{USD 1490/kW x 2\%}}{\text{365 days x 24 hours}}$$

This formula equates to USD 0.0034/kWh or ZAR 0.05/kWh for Hydropower OPEX. The LCOE for hydropower is shown in Figure 4-6 below. Africa comes in at USD 0.057/kWh for the period 2014 to 2018.

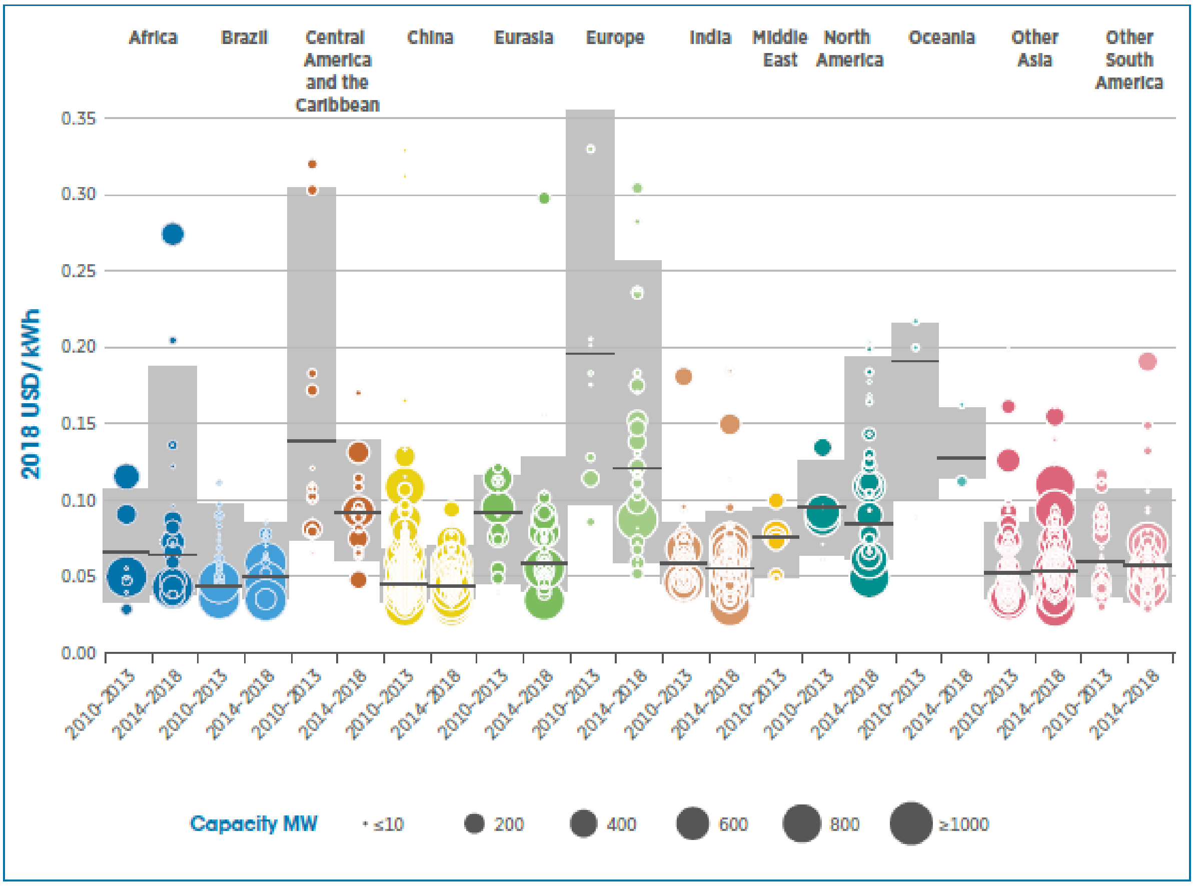


Figure 4-6: Large hydropower project LCOE and capacity weighted averages by country/region (IRENA, 2019)

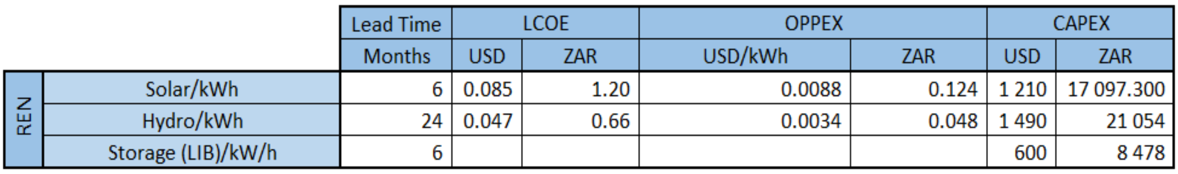
4.4.3 Energy storage costs (Batteries)

Battery storage remains an expensive option. The most widely used batteries are the Lithium-Ion batteries (LIB) which guarantees an efficient operating life cycle of 15 years before they are completely replaced. The cost of the LIB is USD 600/kW/hr. This equates to 1 battery providing 1kW for 1 hour at the cost of USD 600. For a power requirement of 17.5MW, that equates to $600 x 17500kW x 17 Hours (night-time). This comes to178 million USD or ZAR 2.52 billion. This is a significant cost that is required upfront and still excludes the costs of accommodating solar plant required for daytime charging (DRA Global Projects, 2019).

4.4.4 REN cost summary

Table 4-2 below is a summary of the REN CAPEX and OPEX as derived from the research above. The financial modelling will use a CAPEX figure of R 17 097/kW for solar and R 21 054/kW for hydro. Operational expenditure came in at R 0.124/kWh and R 0.048/kWh for solar and hydro, respectively.

Table 4-2: REN costs



		Lead Time	LCOE		OPPEX		CAPEX	
		Months	USD	ZAR	USD/kWh	ZAR	USD	ZAR
REN	Solar/kWh	6	0.085	1.20	0.0088	0.124	1 210	17 097.300
	Hydro/kWh	24	0.047	0.66	0.0034	0.048	1 490	21 054
	Storage (LIB)/kW/h	6					600	8 478

**ZAR: USD 14.13 - Exchange based on 1 July 2019.*

4.5 Basis of estimate

The Basis of Estimate describes the basis, decisions and methodology used to prepare the estimate, which covers the project CAPEX, Replacement and Stay In Business Capital Expenditure (SIB) and OPEX with a base cost date of 31 July 2019.

The cost estimate covers the initial CAPEX requirements and OPEX requirements excluding escalation (Unless otherwise stated), closure costs (rehabilitation costs), project indirect costs and contingencies. Estimating input is provided for the underground mine including associated infrastructure, surface infrastructure and process plant.

The estimate considers planned infrastructure configurations that support mining, processing and general surface areas associated with mining and processing. The estimate quantifies the associated costs for the purchase of infrastructure as required for each relevant area. The product produced is concentrate only and hence the smelting and refining penalties are paid and incorporated in the financial runs. The following considerations were taken into account in determining expenditure:

- Production is from a UG2 orebody.
- The metallurgical plant recoveries are set at historical figures as prescribed by the DRA processing consultant. Plant recoveries are used in the financial model.
- Mining in the first twenty years and beyond is less than 600 m below surface.
- A steady-state milling capacity of 70 ktpm is costed.
- A chrome recovery circuit is costed to capitalise on the chrome content of the UG2 orebody.
- An on-reef mining method has been developed which combines mechanised and conventional mining methods to good effect and which ensures a rapid production build-up with excellent safety features.
- Compressed air in-stope drilling is utilised.

- Diesel trackless equipment is utilised.
- Six different power supply scenarios are cash flowed, i.e. Solar, Solar + Battery Storage, Hydro, 20km OHL Grid-Tied, 50 km Grid-Tied and Breakeven OHL Grid-Tied.

4.5.1 Infrastructure

The surface infrastructure such as workshops, offices, stores, lamp rooms and change houses are costed for the operation. Ventilation raise boreholes with new fans are costed.

An allowance is made for village maintenance as this is an ongoing cost. Shaft overhead costs are calculated over the remaining 23 years, and replacement for winders, pump columns, clear and dirty water pumps, shaft steelwork as well as the power supply for pumping and winders are included. New compressors, as well as their maintenance are catered for in the estimate. Running and/or maintenance costs of main offices, workshops, outside services, ventilation and electrical usage were catered for under surface infrastructure general. Labour associated with Senior Management, Mine Technical Services, Services, Safety Health and Environmental Management, Finance and Human Capital was costed under surface infrastructure general as well.

The cost category for the allocation of costs is as follows:

- Mining
- Civils
- Structural
- Mechanical
- Mechanised
- Plate and Lining
- Pipework and Valves Supply and Installation
- Electrical
- Instrumentation
- Preliminary and General
- Contingency
- Labour
- Consumables

4.5.2 Estimate cost splits

The estimate has been presented in South African Rands (ZAR) in present-day (31 July 2019) terms. The study considered three types of cost to offer the best possible solution for the mining operation, namely CAPEX, SIB Capital and OPEX. These are defined below:

- CAPEX: This includes only the necessary infrastructures, equipment and labour for 70ktpm production; SIB: This includes the necessary infrastructures and equipment to reach "steady-state" production as well as the replacement and repair of infrastructure needed in order to maintain the "steady-state" mine profile; and OPEX: This includes all the necessary labour, maintenance and consumables for the infrastructure and equipment to maintain "steady-state" production at the mine.

4.5.3 Estimate periods

The estimating periods are as follows:

- Earliest CAPEX commenced in 2020 and stretched over different cashflow start dates and periods for different power supply options;
- Earliest SIB commences in 2021 and stretches over different cashflow start dates and periods for different power supply options; and
- Earliest OPEX commences in 2021 and stretches over different cashflow start dates and periods for different power supply options.

4.5.4 Progress plots footprint areas

Figure 4-7 below shows the footprint area that is costed in the Estimates. This footprint size caters for ±20 years of steady-state production at 70ktpm.

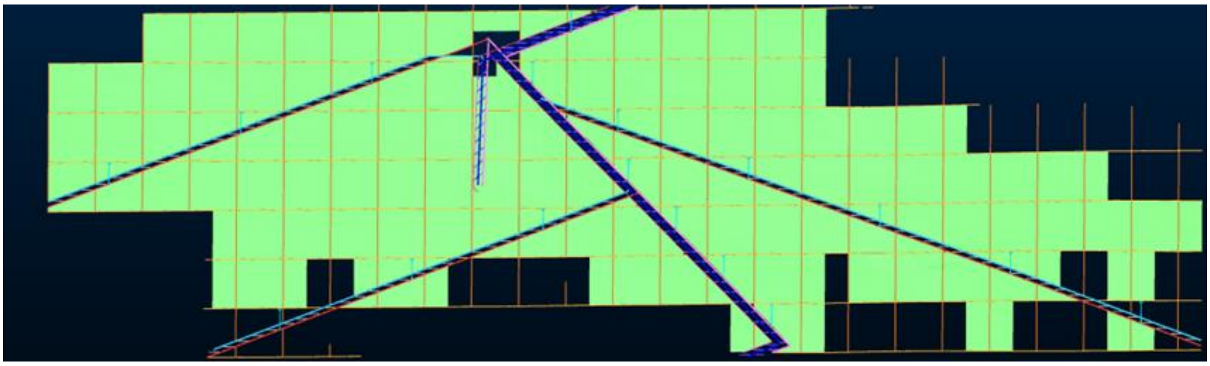


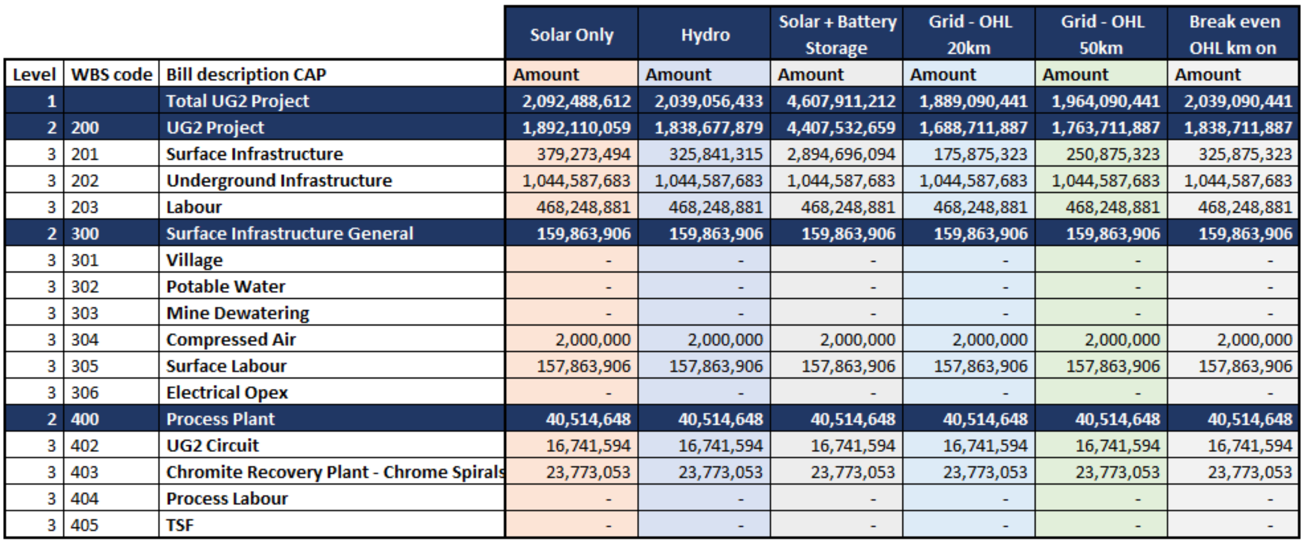
Figure 4-7: Overall mining footprint (DRA Global Projects, 2019)

4.5.5 Cost estimates

A summary of the estimates, for the various power supply options, is shown in the tables 4-3 to table 4-5 below.

Table 4-3 shows the high level breakdown of the CAPEX per WBS area of the study, grouped under Mining (UG2 Project), General Surface Infrastructure and Processing.

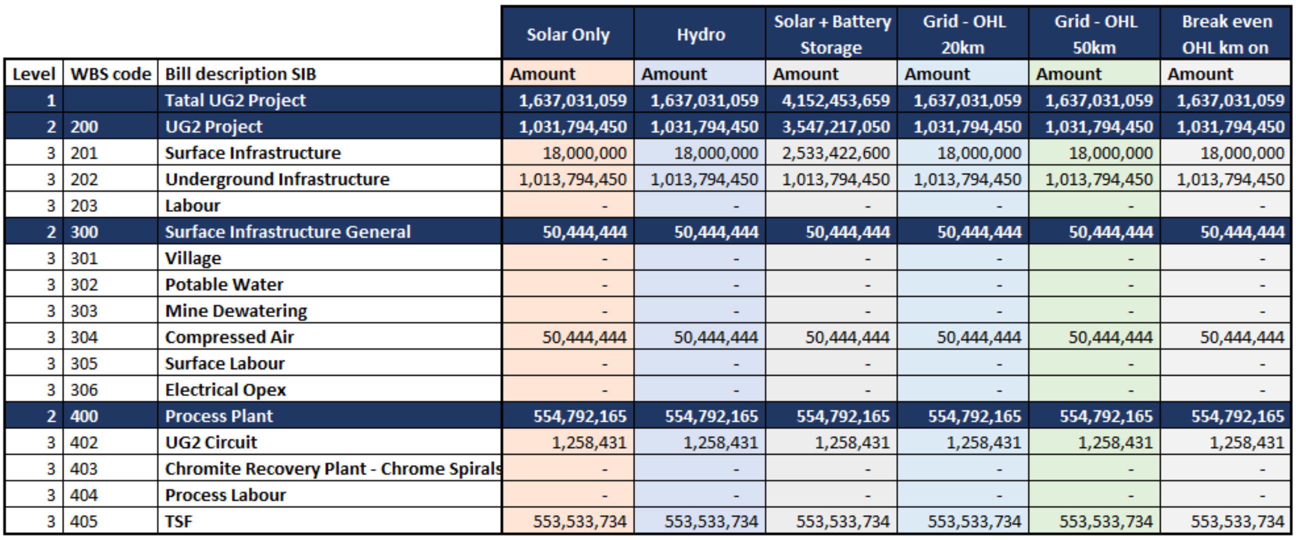
Table 4-3: Estimate breakdown of CAPEX per WBS area per power supply option



			Solar Only	Hydro	Solar + Battery Storage	Grid - OHL 20km	Grid - OHL 50km	Break even OHL km on
Level	WBS code	Bill description CAP	Amount	Amount	Amount	Amount	Amount	Amount
1		Total UG2 Project	2,092,488,612	2,039,056,433	4,607,911,212	1,889,090,441	1,964,090,441	2,039,090,441
2	200	UG2 Project	1,892,110,059	1,838,677,879	4,407,532,659	1,688,711,887	1,763,711,887	1,838,711,887
3	201	Surface Infrastructure	379,273,494	325,841,315	2,894,696,094	175,875,323	250,875,323	325,875,323
3	202	Underground Infrastructure	1,044,587,683	1,044,587,683	1,044,587,683	1,044,587,683	1,044,587,683	1,044,587,683
3	203	Labour	468,248,881	468,248,881	468,248,881	468,248,881	468,248,881	468,248,881
2	300	Surface Infrastructure General	159,863,906	159,863,906	159,863,906	159,863,906	159,863,906	159,863,906
3	301	Village	-	-	-	-	-	-
3	302	Potable Water	-	-	-	-	-	-
3	303	Mine Dewatering	-	-	-	-	-	-
3	304	Compressed Air	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
3	305	Surface Labour	157,863,906	157,863,906	157,863,906	157,863,906	157,863,906	157,863,906
3	306	Electrical Opex	-	-	-	-	-	-
2	400	Process Plant	40,514,648	40,514,648	40,514,648	40,514,648	40,514,648	40,514,648
3	402	UG2 Circuit	16,741,594	16,741,594	16,741,594	16,741,594	16,741,594	16,741,594
3	403	Chromite Recovery Plant - Chrome Spirals	23,773,053	23,773,053	23,773,053	23,773,053	23,773,053	23,773,053
3	404	Process Labour	-	-	-	-	-	-
3	405	TSF	-	-	-	-	-	-

Table 4-4 shows the high level breakdown of the SIB Costs per WBS area of the study, grouped under Mining (UG2 Project), General Surface Infrastructure and Processing.

Table 4-4: Estimate breakdown of SIB costs per WBS area per power supply option



			Solar Only	Hydro	Solar + Battery Storage	Grid - OHL 20km	Grid - OHL 50km	Break even OHL km on
Level	WBS code	Bill description SIB	Amount	Amount	Amount	Amount	Amount	Amount
1		Tatal UG2 Project	1,637,031,059	1,637,031,059	4,152,453,659	1,637,031,059	1,637,031,059	1,637,031,059
2	200	UG2 Project	1,031,794,450	1,031,794,450	3,547,217,050	1,031,794,450	1,031,794,450	1,031,794,450
3	201	Surface Infrastructure	18,000,000	18,000,000	2,533,422,600	18,000,000	18,000,000	18,000,000
3	202	Underground Infrastructure	1,013,794,450	1,013,794,450	1,013,794,450	1,013,794,450	1,013,794,450	1,013,794,450
3	203	Labour	-	-	-	-	-	-
2	300	Surface Infrastructure General	50,444,444	50,444,444	50,444,444	50,444,444	50,444,444	50,444,444
3	301	Village	-	-	-	-	-	-
3	302	Potable Water	-	-	-	-	-	-
3	303	Mine Dewatering	-	-	-	-	-	-
3	304	Compressed Air	50,444,444	50,444,444	50,444,444	50,444,444	50,444,444	50,444,444
3	305	Surface Labour	-	-	-	-	-	-
3	306	Electrical Opex	-	-	-	-	-	-
2	400	Process Plant	554,792,165	554,792,165	554,792,165	554,792,165	554,792,165	554,792,165
3	402	UG2 Circuit	1,258,431	1,258,431	1,258,431	1,258,431	1,258,431	1,258,431
3	403	Chromite Recovery Plant - Chrome Spirals	-	-	-	-	-	-
3	404	Process Labour	-	-	-	-	-	-
3	405	TSF	553,533,734	553,533,734	553,533,734	553,533,734	553,533,734	553,533,734

Table 4-5 shows the high level breakdown of the OPEX Costs per WBS area of the study, grouped under Mining (UG2 Project), General Surface Infrastructure and Processing.

Table 4-5: Estimate breakdown of OPEX costs per WBS area per power supply option

			Solar Only	Hydro	Solar + Battery Storage	Grid - OHL 20km	Grid - OHL 50km	Break even OHL km on
Level	WBS code	Bill description OPEX	Amount	Amount	Amount	Amount	Amount	Amount
1		Tatal UG2 Project	17,016,238,770	16,769,419,565	17,016,238,770	19,901,269,016	19,901,269,016	19,906,050,385
2	200	UG2 Project	12,413,641,967	12,413,641,967	12,413,641,967	12,413,641,967	12,413,641,967	12,413,641,967
3	201	Surface Infrastructure	-	-	-	-	-	-
3	202	Underground Infrastructure	5,384,933,507	5,384,933,507	5,384,933,507	5,384,933,507	5,384,933,507	5,384,933,507
3	203	Labour	7,028,708,460	7,028,708,460	7,028,708,460	7,028,708,460	7,028,708,460	7,028,708,460
2	300	Surface Infrastructure General	2,523,999,693	2,277,180,489	2,523,999,693	5,409,029,939	5,409,029,939	5,413,811,308
3	301	Village	143,111,111	143,111,111	143,111,111	143,111,111	143,111,111	143,111,111
3	302	Potable Water	48,716,085	48,716,085	48,716,085	48,716,085	48,716,085	48,716,085
3	303	Mine Dewatering	105,749,788	105,749,788	105,749,788	105,749,788	105,749,788	105,749,788
3	304	Compressed Air	-	-	-	-	-	-
3	305	Surface Labour	1,721,788,716	1,721,788,716	1,721,788,716	1,721,788,716	1,721,788,716	1,721,788,716
3	306	Electrical Opex	504,633,993	257,814,788	504,633,993	3,389,664,238	3,389,664,238	3,389,664,238
2	400	Process Plant	2,078,597,110	2,078,597,110	2,078,597,110	2,078,597,110	2,078,597,110	2,078,597,110
3	402	UG2 Circuit	1,349,646,941	1,349,646,941	1,349,646,941	1,349,646,941	1,349,646,941	1,349,646,941
3	403	Chromite Recovery Plant - Chrome Spirals	-	-	-	-	-	-
3	404	Process Labour	728,950,169	728,950,169	728,950,169	728,950,169	728,950,169	728,950,169
3	405	TSF	-	-	-	-	-	-

The portion of each significant contribution per costing discipline for the various power supply options are shown in Figure 4-8, Figure 4-9 and Figure 4-10 below. Figure 4-8 below shows the options to have equivalent-sized CAPEX with the exception of the battery storage option. The battery storage option is more than double the capital of the second largest option and is due to the USD 600/kw/hr cost of the LIB.

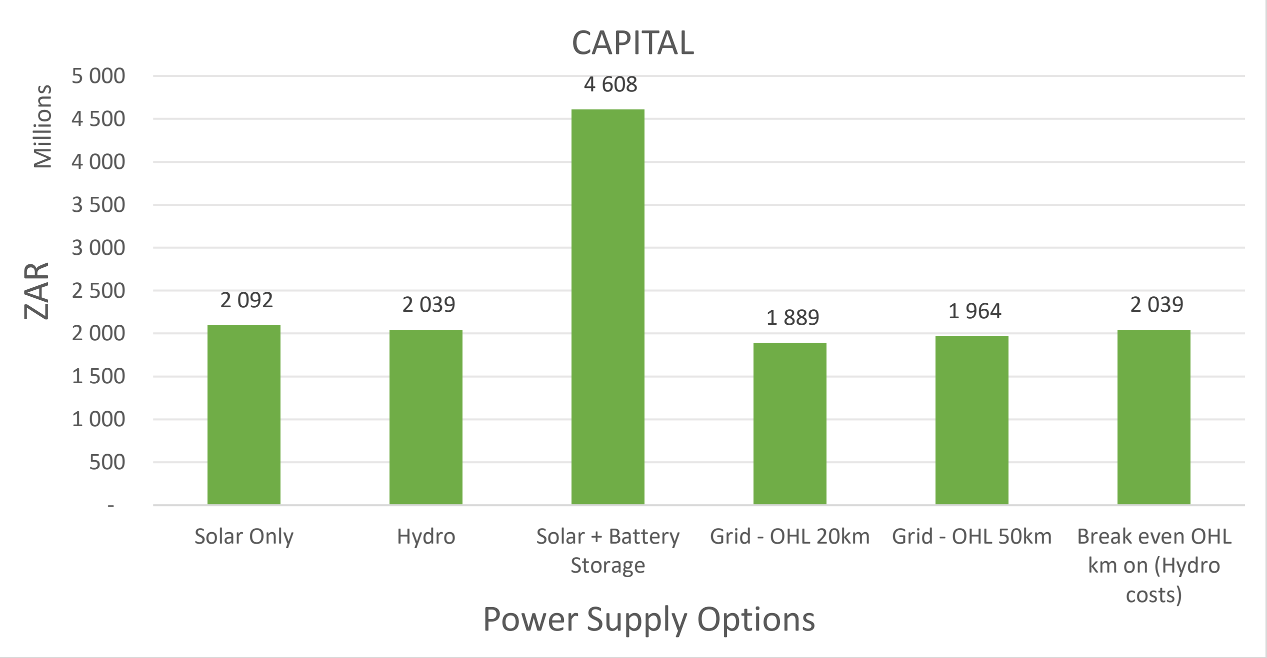


Figure 4-8: Capital cost for individual power supply options

In Figure 4-9 below the SIB costs were kept equal for all the options except for the battery storage component as the batteries are only guaranteed for 15 years and need full replacement in year 16 during the LOM period. This replacement is priced the same as the original priced value. The power demand remains constant throughout the LOM.

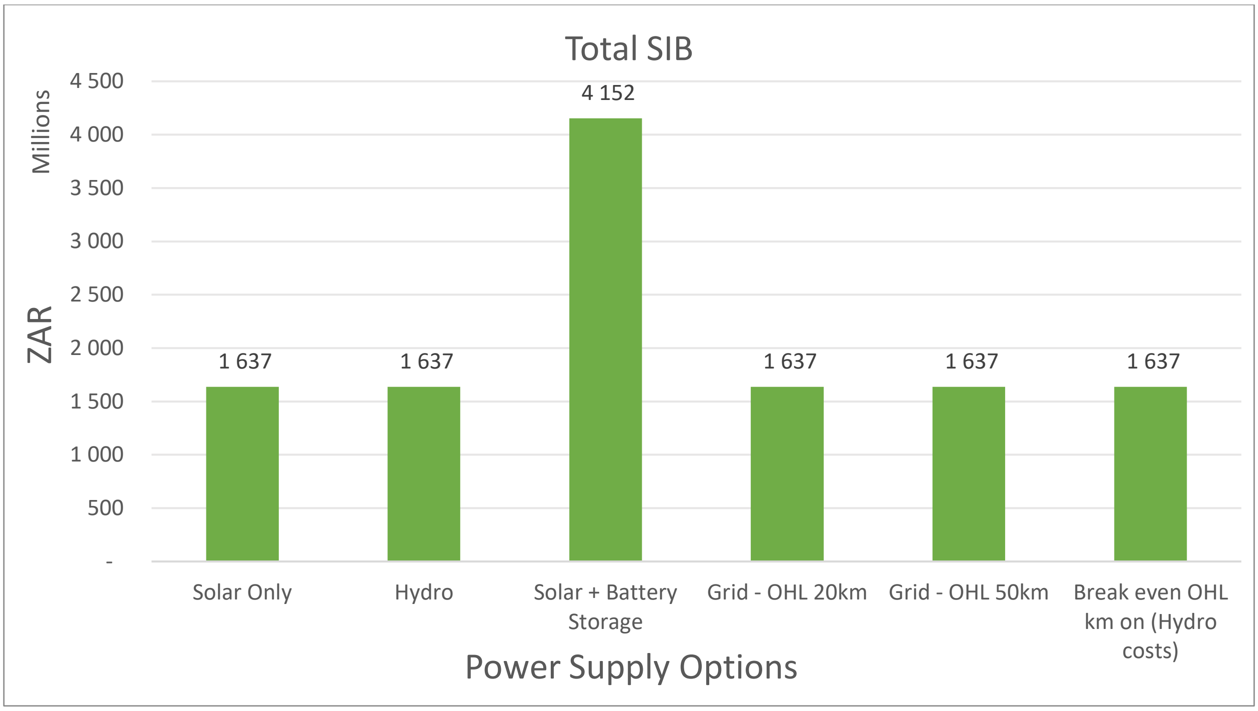


Figure 4-9: SIB cost for individual power supply options

In Figure 4-10 below, as can be expected, the OPEX costs for all 3 OHL options are identical (19.906Bil) as the constant Eskom rate of R0.98/kwh applies to all three the options. The Hydro option is the cheapest with Solar coming second. The magnitude of the impact, exclusively on the electrical OPEX component, is hard to represent visually as the OPEX of all the other contributing costs dilutes the results. Figure 4-11 below represents the OPEX for the electrical component only.

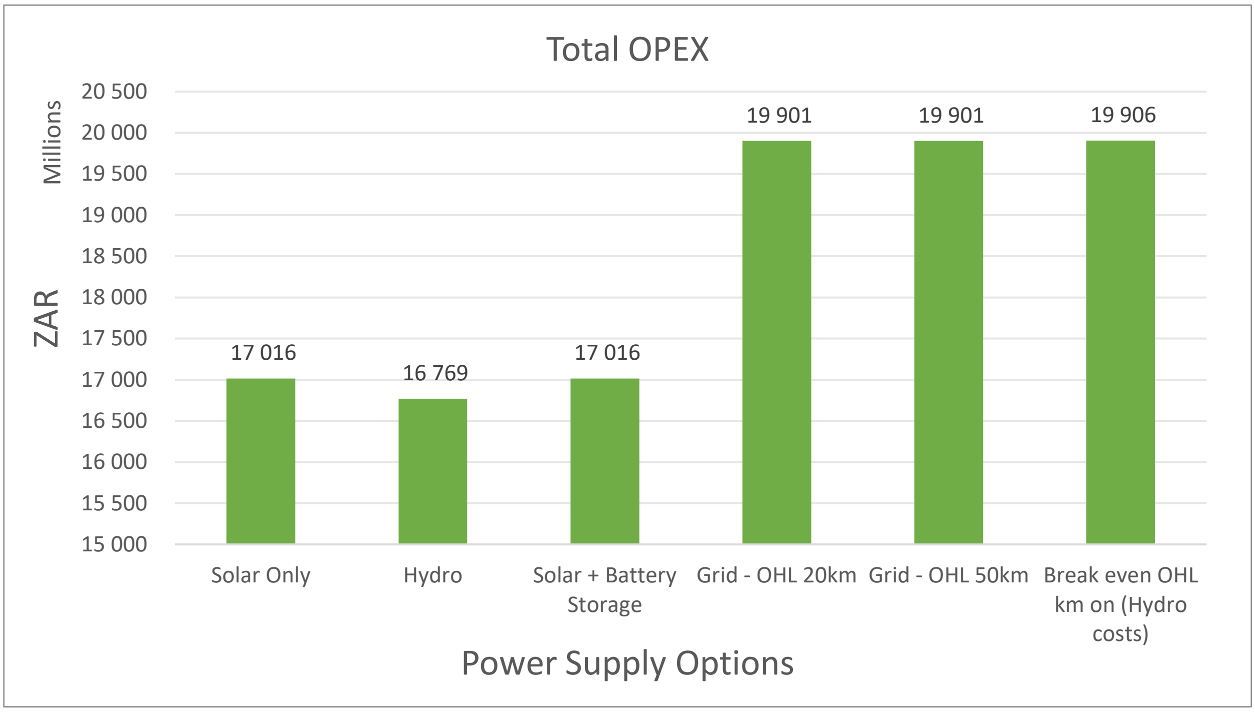


Figure 4-10: OPEX Cost for individual power supply options

Figure 4-11 below offers more resolution on the impact of OPEX based on the electrical component only. Hydro proofs to be the cheapest power supplying option with solar in second place but double the price of Hydropower. Solar with no storage ability, can only provide sufficient power for an average of 7 hours out of 24 hours a day. Grid energy OPEX is 13 times more expensive than hydro and 7 times more expensive than solar.

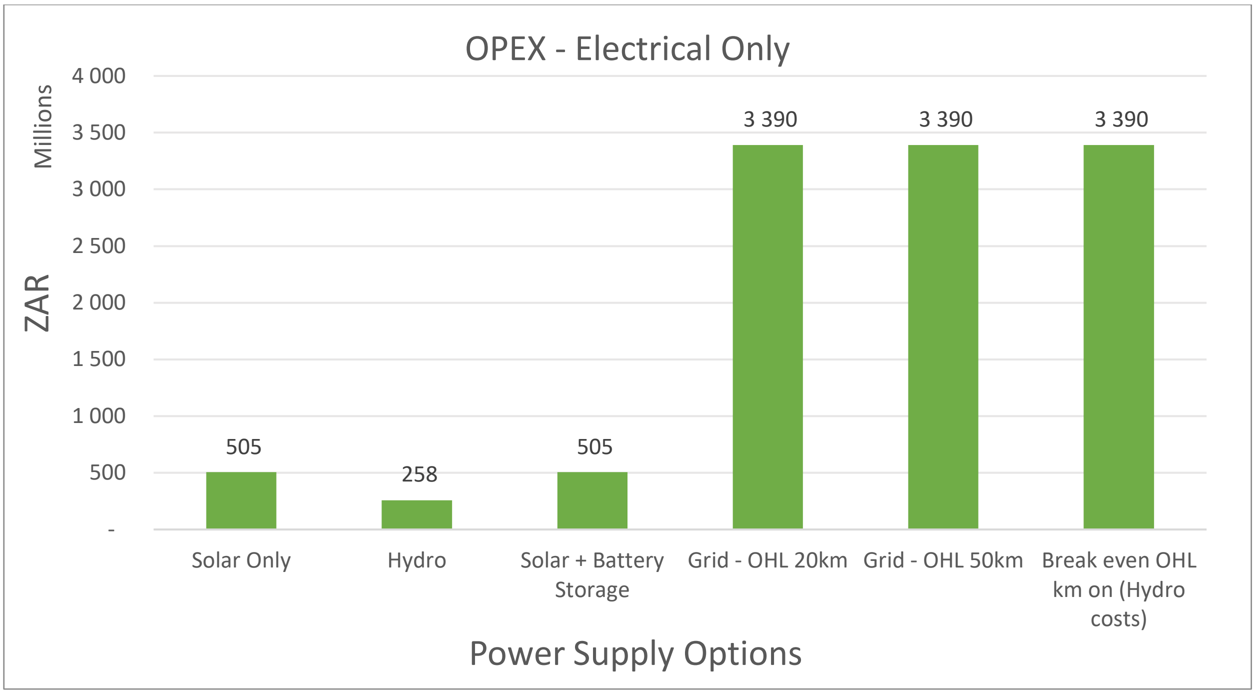


Figure 4-11: OPEX (Electrical only) Cost for individual power supply options

4.5.6 Cash flow

The cash flows for the Estimates were done in alignment with the project execution schedules supporting construction and mine production. Solar and Hydro options were constructed over two years with minimum time allowance for licencing and agreements as the REN is considered as an on-site solution and is constructed on surface footprints, already owned by the operation.

The Grid-tied options consist of a 20km OHL, 50km OHL and a break-even OHL based on the REN with the cheapest capital cost which is Hydro in this case. The break-even option allows for 80km of OHL to be installed based on the rates that were used in Table 4-1 above.

4.6 Work breakdown structure

The Project costing estimate was done according to the Work Breakdown Structure (WBS) as developed for the project by DRA Projects. A level 4 WBS breakdown is given in Table 4-6 below. The level 8 WBS break down, offering further granularity, can be made available on request (DRA Global Projects, 2019).

Table 4-6: WBS Level 4

WBS Level	Bill Description			
1	2	3	4	
	200			UG2 Project
		201		Surface Infrastructure
			01	Equipment
			02	Buildings
			03	Electrical Supply and Reticulation
			04	Fencing and Security
			05	Ventilation / Refrigeration
		202		Underground Infrastructure
			01	App Dip Decline Cluster
			02	Circular
			03	Main Decline Cluster
			04	Strike Drive
			05	Raise
			06	Stope
			07	Mining Equipment
			08	Pipes and Pumping
			09	Ventilation
		203		Labour
			01	Labour
	300			Surface Infrastructure General
		301		Village
			01	Village
		302		Potable Water
			01	Potable Water
			02	Bore Holes
		303		Mine Dewatering
			04	Mine Return Water Treatment Plant
		304		Compressed Air
			01	Vertical Shaft
			02	UM1
		305		Surface Labour
			01	Surface Labour
		306		Opex
			01	Electrical Opex
	400			Process Plant
		402		UG2 Circuit
			01	UG2 Circuit
		403		Chromite Recovery Plant-Chrome Spirals
			01	Chromite Recovery Plant-Chrome Spirals
		404		Process Labour
			01	Process Labour
		405		TSF
			01	TSF

4.6.1 Level of accuracy of the estimate

The level of accuracy adhered to is defined by the requirements needed for a pre-feasibility study. In terms of the DRA study class matrix, a pre-feasibility study's level of accuracy is typically in the order of +25% to -15%.

4.6.2 Sources of data

The following list of documents provided the basis for the CBE:

- Mine Plan and Layouts
- Supplementary sketches as required
- Selected equipment, fabrication and erection rates from DRA database
- Battery limits as set out in the Design Criteria and Scope

The estimate is categorised as a Prefeasibility Study with a combination of detailed, semi-detailed and factored costs. The estimate has been produced from an in-house DRA database. Any changes to the equipment, material or specifications require a modification to the costs.

4.7 Discounted cash flow input parameters

The general inputs are shown in Table 4-7 below per power option. All costs in the model have been reported on a South African Rand basis with a United States Dollar (USD) exchange rate of 14.13 dated 1 July 2019. A discount rate of 10% has been applied for the financial model.

Revenue is delayed suiting the variable lead times required by the different power generating options. The delay of capital positively impacts the returns on the project. This is also countered by the delay of mine production, having the opposite effect.

Table 4-7: Discounted cash flow general inputs

Description	Unit	Value	Reference
Exchange rate			
USD: ZAR	-	14.13	Exchange, based on 1 July 2019 (Currency Live, 2019).
Unit conversions			
Ounces / Grams	-	31.10	Fixed.
Discount rate	%	10	Assumed.

A mass pull of 1.5% has been used and benchmarked to similar operations operating within the project's life of mine (LoM) grade profile. Chrome concentrate produced has been based on a static 12% mass pull and assumes the production of a benchmark metallurgical grade. Table 4-8 below provides a summary of the process inputs.

Table 4-8: Discounted Cash Flow Process Inputs

Description	Unit	Value	Reference
Concentrate Recovery			
Mass pull	%	1.5	Benchmarked to similar operations
Chrome Concentrate			
Grade produced	-	Metallurgical	Assumed
Mass pull	%	12	Benchmarked to similar operations

PGM recoveries have been based on historical operational plant data extrapolated and verified by DRA (DRA Global Projects, 2019). Revenue generated through the sale of metals has been based on pricing sourced from either the public domain or estimated internally from an in-house (DRA) database. There has been no market analysis undertaken as part of this study. The financial model has been based on static metal pricing over the life of mine. The pricing considers a platinum group metal (PGM) concentrate delivered to a local smelter in the region. Chrome concentrate has been based on a delivered cost within a 100 km radius to a domestic buyer.

Revenue has been discounted to account for refining costs, treatment charges, sampling costs and penalties (grade and chrome) applicable to a PGM concentrate (DRA Global Projects, 2019). These are negotiated tariffs applicable for concentrate refining. Inputs for the revenue estimate are shown in Table 4-9 below.

Table 4-9: Discounted Cash Flow Revenue Inputs

Description	Unit	Value	Reference
Purchase of Concentrate Factor			
Pt	-	0.86	(DRA Global Projects, 2019)
Pd	-	0.86	(DRA Global Projects, 2019)
Rh	-	0.86	(DRA Global Projects, 2019)
Au	-	0.86	(DRA Global Projects, 2019)
Ni	-	0.75	(DRA Global Projects, 2019)
Cu	-	0.70	(DRA Global Projects, 2019)
Treatment Charges			
Unit charge rate	ZAR/t conc.	1,693	(DRA Global Projects, 2019)
Sampling Costs			
Unit charge rate	ZAR/t conc.	59	(DRA Global Projects, 2019)
Grade Penalties			
4E threshold	g/t conc.	185	(DRA Global Projects, 2019)
Penalty (below threshold)	ZAR / (5g/t conc)	145	(DRA Global Projects, 2019)
Chrome Penalty			
Chrome content in concentrate	%	2.5	Benchmarked to similar operations.
Penalty	ZAR/t chrome	91,920	(DRA Global Projects, 2019)
Metal Prices			
Pt	USD/Oz	835	(DRA Global Projects, 2019)
Pd	USD/Oz	1,545	(DRA Global Projects, 2019)
Rh	USD/Oz	3,250	(DRA Global Projects, 2019)
Au	USD/Oz	1,360	(DRA Global Projects, 2019)
Ni	USD/t	13,400	(DRA Global Projects, 2019)
Cu	USD/t	5,500	(DRA Global Projects, 2019)
Chrome	USD/t conc.	112	(DRA Global Projects, 2019)

Capital costs have been sourced from the capital cost estimation model on a year-by-year basis, as reported in Chapter 4. Process plant SIB capital has been factored at a rate of 5% relative to the total annual process plant operating costs. In addition to these figures, a contingency allowance for both initial capital, chrome plant capital and SIB capital have been included. According to Stantec's "Hard Rock Miner's Handbook" a prefeasibility study has a level of accuracy of between 20 and 30%. This is determined by "factoring known unit costs and estimated gross dimensions or quantities, once conceptual or preliminary engineering is complete" (Vergne, 2008, p. 77). Based on this, a contingency allowance of 20% for initial capital has been included and the same level of engineering and method was used to derive capital costs for the concentrator plants.

The chrome plant capital has been based on an estimate benchmarked to recent and comparable projects completed by DRA. A higher contingency of 30% has been applied based on this capital estimate method as no level of engineering definition has been conducted for the chrome plant in this project. The contingency allowance falls within a concept study level of accuracy.

Environmental rehabilitation costs have been annualised. Allowance is made for funds already present in a trust, and the anticipated expenditure at the end of LoM. These annual costs consider a bank guarantee fee only for the anticipated capital provision at the end of life of mine. These inputs are shown in Table 4-10 below.

Table 4-10: Cash Flow Inputs

Description	Unit	Value	Reference
CAPEX Contingency Allowance			
Initial capital	%	20	PFS level of confidence.
Chrome plant	%	30	Concept level of confidence.
SIB capital	%	10	PFS level of confidence.
Environmental Rehabilitation Capital Provision			
Annual provision	ZAR	923,091	Calculated.
Capital provision	ZAR	237,275,495	(DRA Global Projects, 2019)
Provision held in trust	ZAR	52,657,284	(DRA Global Projects, 2019)
Guarantee facilities rate	%	0.5	(DRA Global Projects, 2019)
SIB Capital - Process Plant			
% of plant operating cost	%	5	(DRA Global Projects, 2019)

Project royalties are based on South African legislation and was approved by DRA Projects. Royalties payable are a function of gross sales and a royalty percentage. The royalty percentage is limited to a minimum of 0.5% and a maximum of 7%. The formula used to calculate royalty that is payable was as follows:

$$\text{Royalty (ZAR)} = \text{Gross Sales (ZAR)} \times \text{Royalty \%}$$

Where royalty % was calculated as follows:

$$\text{Royalty \%} = 0.5 + \frac{\text{EBITDA}}{\text{Gross Sales x 9}} \times 100$$

(Gazette, 2008)

4.8 Conclusion

The Chapter provided a summary of all the costs components needed for the cash flow and these included grid-energy costs, solar PV costs, hydro energy costs, mining value chain costs and other costs. All these costs are important to inputs to the discounted cash flow. The next chapter presents the results and discusses the findings of the six scenarios that were studied. The results provides cash flows, cost parameters and sensitivity analysis.

5 RESULTS AND DISCUSSIONS

5.1 Introduction

The project is based on a start date of 2020, and the financial models have been limited to a 22-year LOM project cut-off date. The model is based on an artificial tail to ensure all run of mine (ROM) ore is processed once mining activity ceased.

Although the project starts in 2020, LOM production does not start until the lease agreements, environmental impact studies and construction phases are completed. The LOM is 22 years (20 years steady state) for all options costed and does not include the preceding phases as mentioned above. This impacts the start dates of the various production schedules, but the production build-up, steady-state and tail is kept constant a peak RoM capacity of 70 ktpm. During this period, a concentrator plant (UG2 circuit) is operational. The chrome recovery plant will be commissioned and operational as and when required. The plant can treat all tailings from the concentrator plants.

An intermediate stockpile is necessary to balance mined tonnes with plant feed and ensure a blended feed composed of constant grade ore to the 70ktpm plant, thereby maximising metal recoveries. From the mine design and production schedule, revenue drivers include palladium, platinum, rhodium and chrome contributing 48%, 22%, 16% and 8% respectively. This is depicted in Figure 5-1 below.

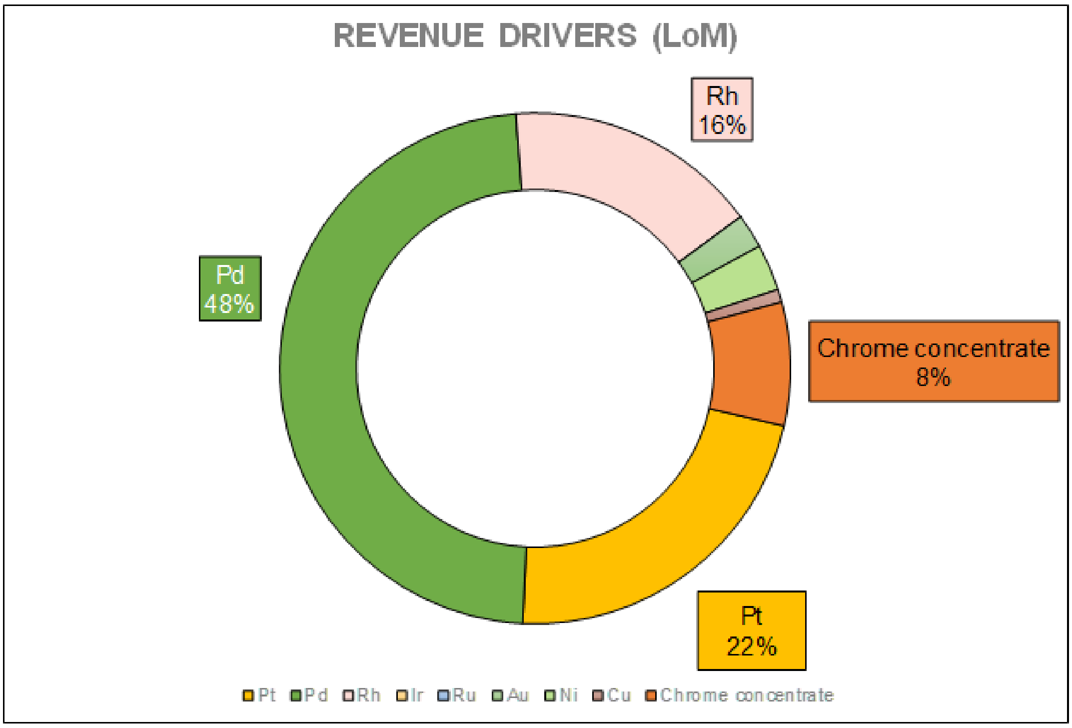


Figure 5-1: Revenue Drivers (DRA Global Projects, 2019)

5.2 Solar power results

A graphical representation of the cash flow is shown in Figure 5-2 below. Positive cash flows (cumulative, undiscounted) are realised in 2037 from project inception with a peak cumulative cash flow requirement of ZAR 3,114,356,759.

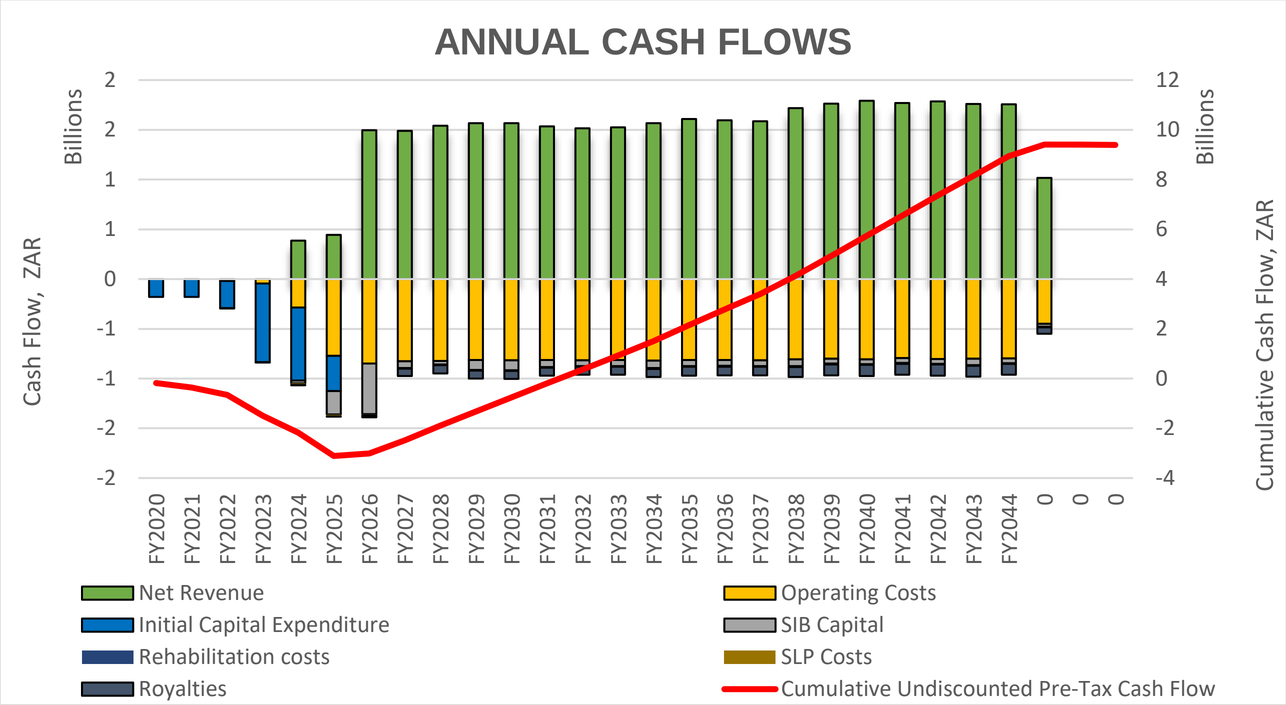


Figure 5-2: Annualised Cash flow - Solar

Initial capital requirements are estimated to be ZAR 2 092 488 612.07 (excl. contingency) over a six-year duration (2020 – 2025). The Net Revenue is the sum of the revenue generated from the sale of metals specified in Figure 5-1 less the costs incurred not specified in Figure 5-2 to Figure 5-12.

These costs, for each individual metals contributing to revenue, are:

- Purchase of concentrate,
- Treatment charges,
- Sampling costs and
- Product penalties

The outcomes from the financial model indicate a pre-tax net present value (NPV) of ZAR 630 217 848 at a 10% discount rate. A corresponding internal rate of return (IRR) of 12.93% is realised with an undiscounted payback period of 18 years. The payback period has been referenced to the project start date of 2020.

Solar has a positive financial result based on the financial model inputs but proves to be impracticable with no form of energy storage. The study is based on year-round availability of power. With an average window of only seven hours of adequate sunshine per day, it makes a solar-only operation effective for only 29% (out of a 24 hour day) of available operational time. Given this shortcoming, the solar only option cannot be considered as a stand-alone solution. This limitation makes it more suitable as a supplementary energy source.

Figure 5-3 below shows the sensitivity analysis parameters in addition to discount rate variability. The main value drivers in NPV and IRR include recovery variance, metal pricing and operating costs. At a 50% reduction in metal selling price, the IRR fails to register due to zero positive income periods realised across the LOM cash flow. It is only at the negative 40% indicator that the lowest IRR, of -6.4% is realised. The IRR peaks at 27.3% with the metal price at 50% higher than the utilised base number. The recovery variance, although a reduced spread at -15% to 10%, follows the exact same trend as the selling price sensitivity. This is true for all six scenarios as both criteria, recovery and selling price, has direct impacts on revenue generation without affecting project costs.

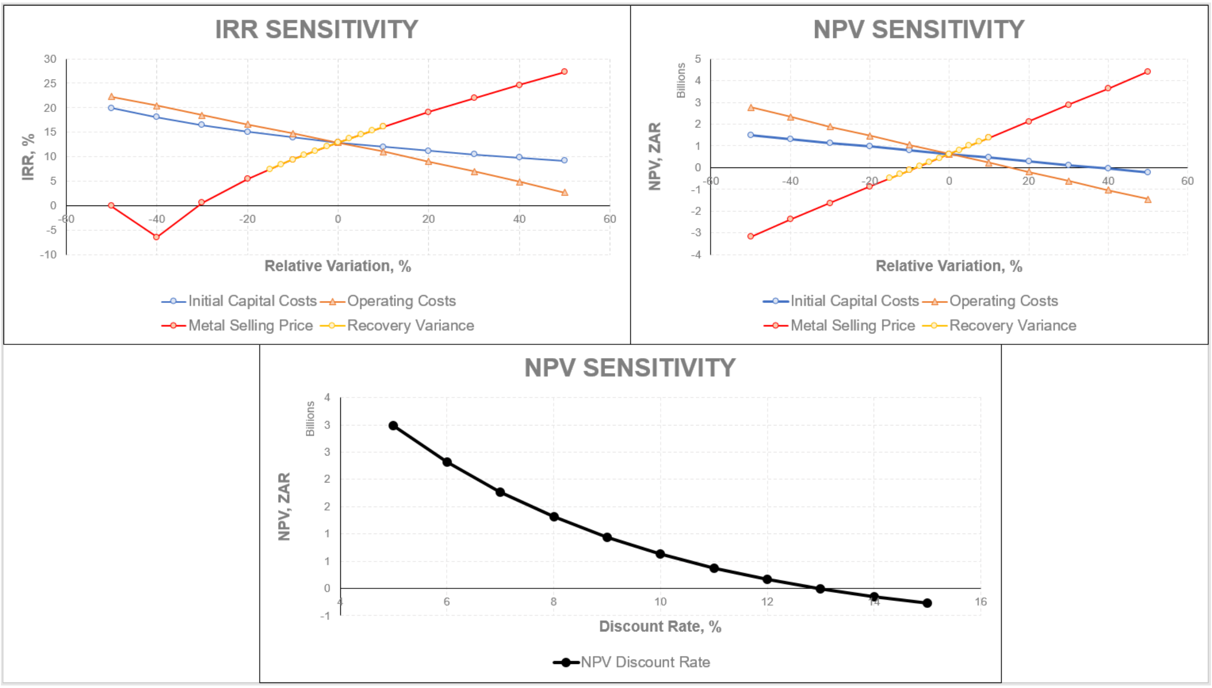


Figure 5-3: Sensitivities on financial returns - Solar only Option

Initial capital cost has a reduced effect on impacting overall project value due to the relatively low requirements in comparison to revenue generated and operating costs over the prescribed life of mine. Operating costs are less sensitive than metal pricing and recovery but has a bigger impact than Initial capital costs. At the utilised base discount rate of 10%, the NPV is ZAR 630 217 848 but remains dependant on the funding strategy and subsequent cost of capital. The impact of the discount rate on NPV, is also shown below on the bottom graph. The first negative NPV is realised at the 13% marker. A detailed discounted cash flow statement, and sensitivity analysis are presented in Appendix A.

5.3 Solar with battery storage results

A graphical representation of the solar with battery storage is shown in Figure 5-4 below. As can be seen in the figure, positive cash flows (cumulative, undiscounted) are realised in 2040 from project inception with a peak cumulative cash flow requirement of ZAR 6,132,863,879. As seen in the figure, in FY2036, the cash flow requirements dip again due to the replacement of the LIB after a 15-year life.

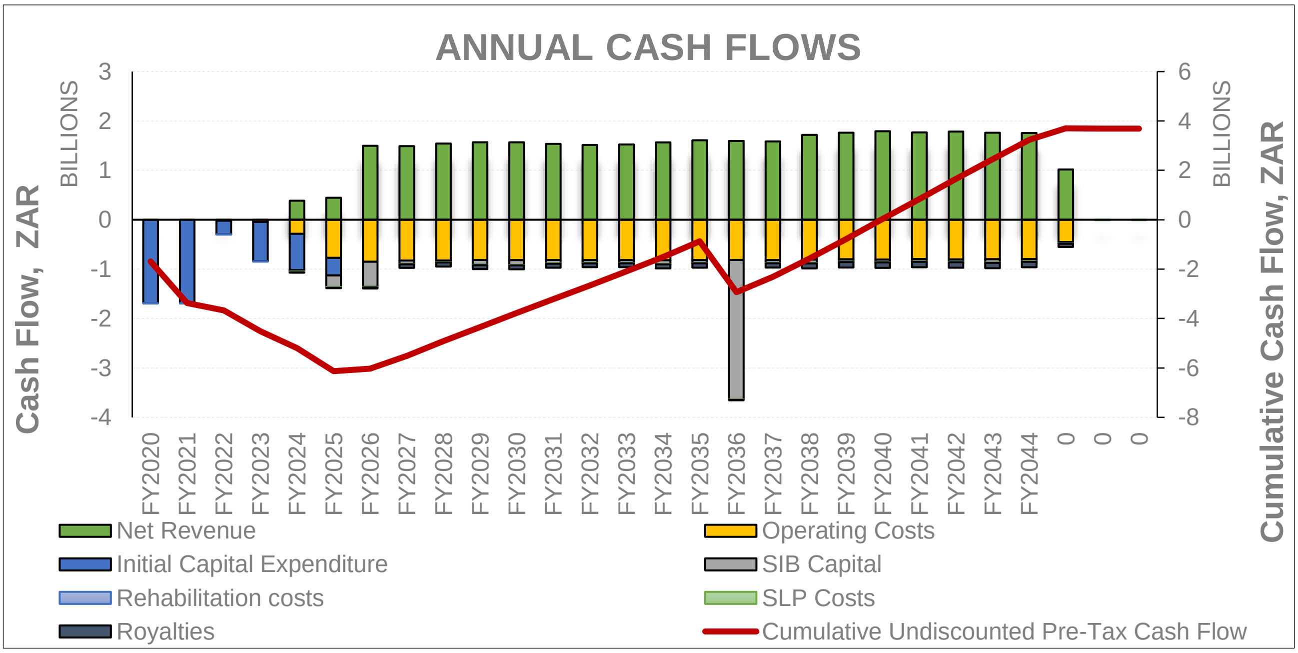


Figure 5-4: Annualised Cash flow - Solar + Battery Storage

Initial capital requirements are estimated to be ZAR 4 607 911 212.07 (excl. contingency) over a six-year duration (2020 – 2025). The outcomes from the financial model indicate a pre-tax net present value (NPV) of ZAR -2 520 886 860 at a 10% discount rate. A corresponding internal rate of return (IRR) of 3.37% is realised with an undiscounted payback period of 21 years. The payback period has been referenced to the project start date of 2020.

As mentioned, the feasibility of solar options is affected by effective daytime (sunlight). The solution to this lies with an economical means of energy storage respectively. If the storage conundrum could be overcome, it will require an oversized solar plant to supply direct power and sufficient reserves, and to charge the batteries or other form of energy storage fully. The solar with battery storage scenario assesses the cost implications of the energy storage. From the results obtain, it is found that battery storage adds an additional upfront capital over and above the direct MW required to power the operation.

Figure 5-5 below shows the sensitivity analysis parameters in addition to discount rate variability. The main value drivers in NPV and IRR include recovery variance and metal pricing. At a 50% reduction in metal selling price, the IRR fails to register due to zero positive income periods realised across the LOM cash flow. It is only at the negative 40% indicator that the lowest IRR, of -16.7% is realised. The IRR peaks at 12.6% with the metal price at 50% higher than the utilised base number.

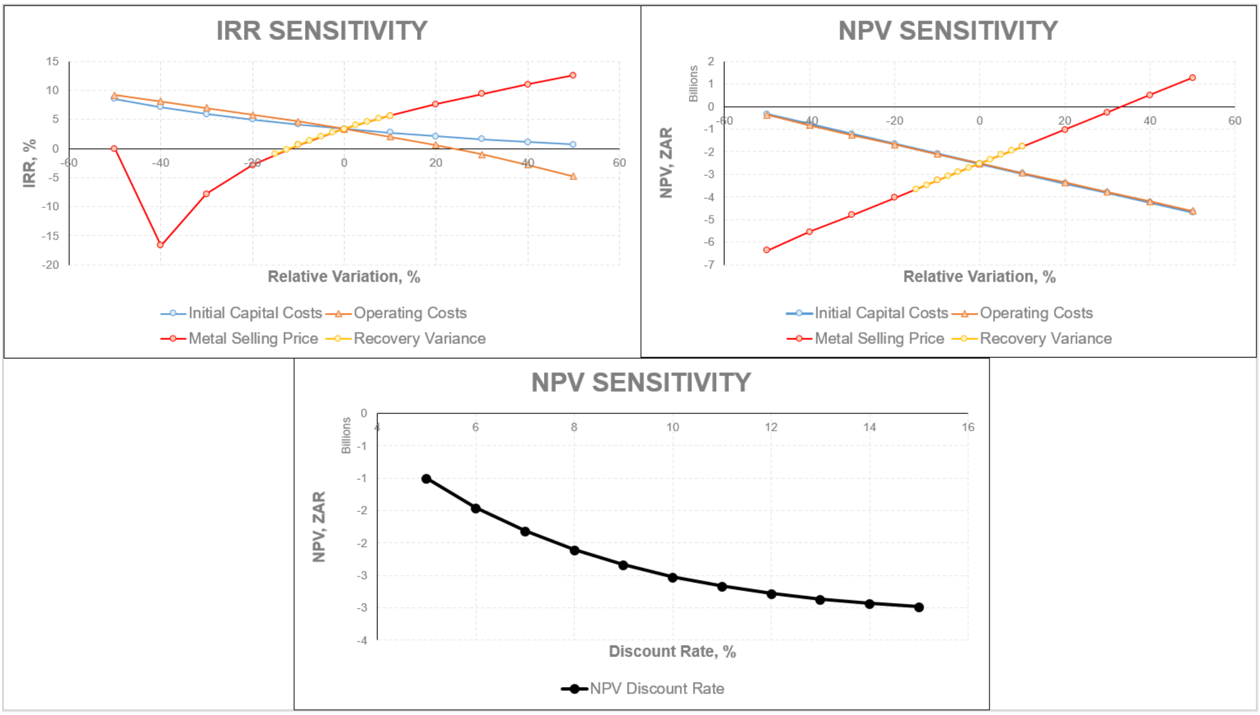


Figure 5-5: Sensitivities on financial returns – Solar + Battery Storage Option

Due to the high cost of battery storage, sensitivities on initial capital causes the biggest deviation compared to all the options considered. A reduction of initial capital and operating cost follows a similar trend but increasing the two sets of costs causes the operating costs to draw away from the initial capital sensitivity graph. This is accredited to the operating costs involvement and exposure over the entire life of mine. Operating costs are less sensitive than metal pricing and recovery but, ultimately, has a bigger impact than Initial capital costs. At the utilised base discount rate of 10%, the NPV is ZAR -2 520 886 860 but remains dependant on the funding strategy and subsequent cost of capital. The impact of the discount rate on NPV, is also shown below on the bottom graph. The NPV never reflects a positive value, even at the lowest tabled discount rate of 5% the NPV is still negative at ZAR -995 924 350. This is the only option to never produce a positive value regardless of the criteria. A detailed discounted cash flow statement, and sensitivity analysis are presented in Appendix B.

5.4 Hydropower results

A graphical representation of the hydropower scenario is shown in Figure 5-6 below. Positive cash flows (cumulative, undiscounted) are realised in 2036 from project inception with a peak cumulative cash flow requirement of ZAR 2, 197,743,322.

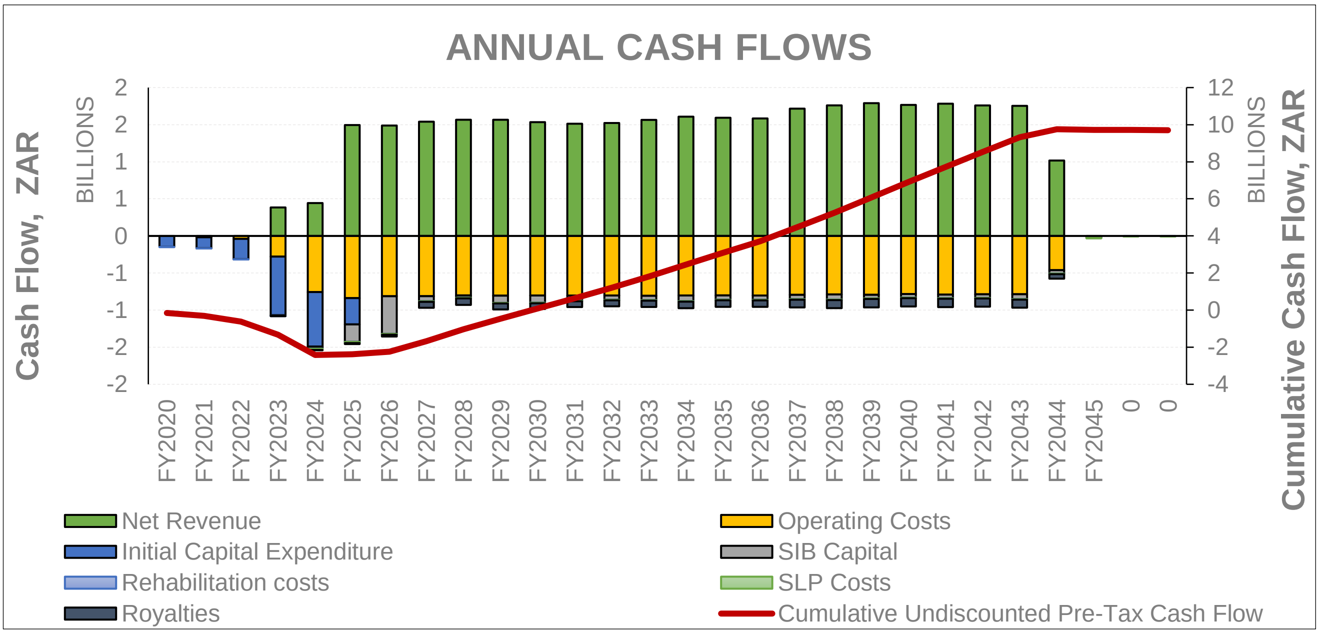


Figure 5-6: Annualised Cash flow - Hydro

Initial capital requirements are estimated to be ZAR 2 039 056 432.7 (excl. contingency) over a six-year duration (2020 – 2025). The outcomes from the financial model indicate a pre-tax net present value (NPV) of ZAR 1 098 758 845 at a 10% discount rate. A corresponding internal rate of return (IRR) of 15.83% is realised with an undiscounted payback period of 19 years.

Hydropower has proven to be the most feasible REN with the Solar-only option unviable at only 29% operability due to day light restriction. Comparing Hydro to the Solar-Battery storage option also heavily favours the Hydro setup with the Solar-Battery Storage only producing a 3.37% IRR and ZAR -2 520 886 860 NPV.

Figure 5-7 below shows the sensitivity analysis parameters in addition to discount rate variability. The main value drivers in NPV and IRR include recovery variance, metal pricing and operating costs. At a 50% reduction in metal selling price, the IRR fails to register due to zero positive income periods realised across the LOM cash flow. It is only at the negative 40% indicator that the lowest IRR, of negative 6.3% is realised. The IRR peaks at 35.7% with the metal price at 50% higher than the utilised base number.

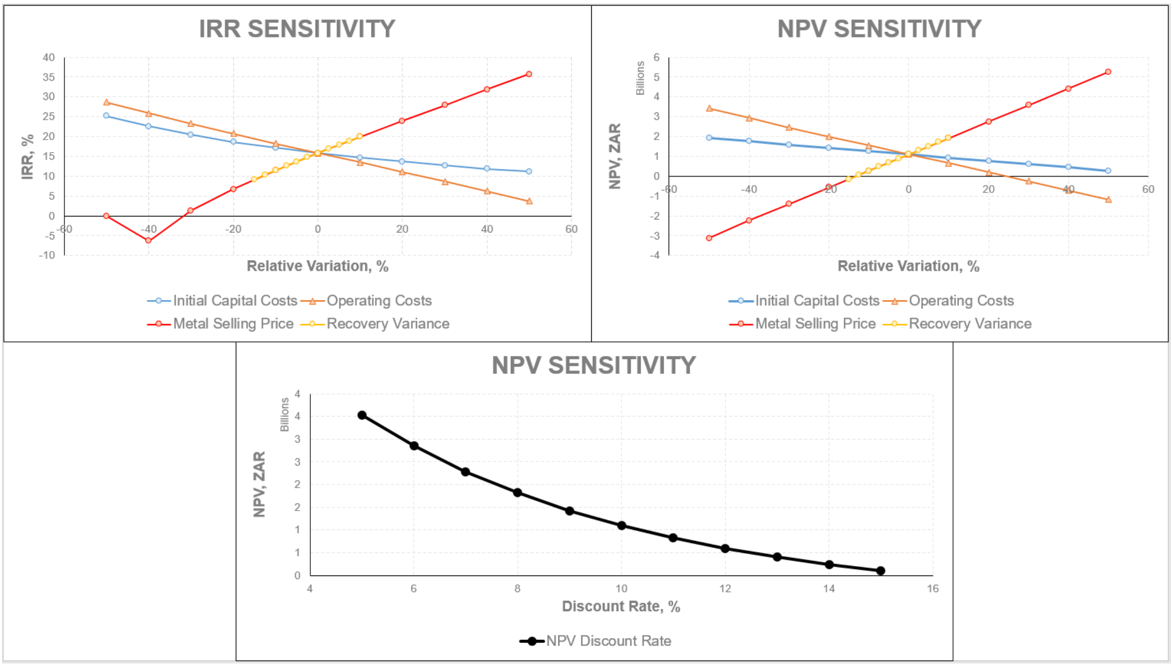


Figure 5-7: Sensitivities on financial returns – Hydropower Option

Initial capital cost has a reduced effect on impacting overall project value due to the relatively low requirements in comparison to revenue generated and operating costs over the prescribed life of mine. Operating costs are less sensitive than metal pricing and recovery but has a bigger impact than Initial capital costs. At the utilised base discount rate of 10%, the NPV is ZAR 1 098 758 845 but remains dependant on the funding strategy and subsequent cost of capital. The impact of the discount rate on NPV, is also shown below on the bottom graph. At a high 15% discount rate, the NPV still produces a positive ZAR 97 588 632 outcome making Hydropower the most robust option out of the six that have been costed. A detailed discounted cash flow statement, and sensitivity analysis are presented in Appendix C.

5.5 Grid – OHL at 20km results

A graphical representation is shown in Figure 5-8 below. Positive cash flows (cumulative, undiscounted) are realised in 2038 from project inception with a peak cumulative cash flow requirement of ZAR 3 085 194 821.

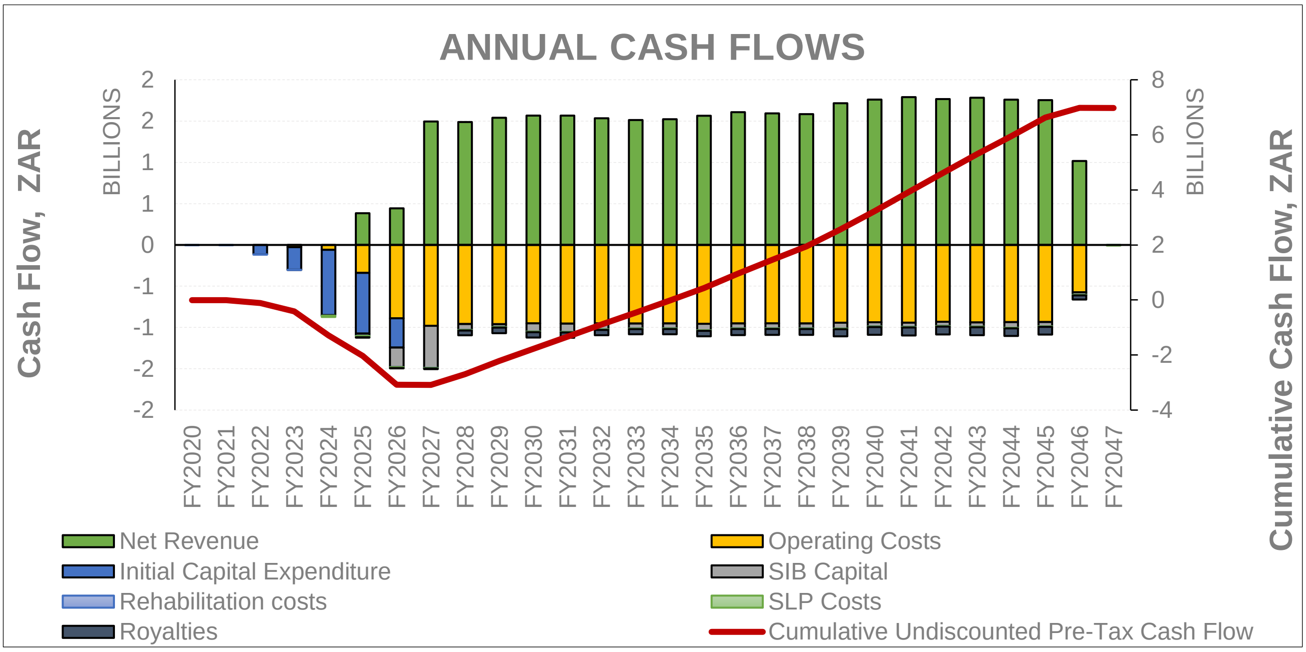


Figure 5-8: Annualised Cash flow - OHL at 20km

Initial capital requirements are estimated to be ZAR 1 889 090 440.9 (excl. contingency) over a seven-year duration (2020 – 2026). The outcomes from the financial model indicate a pre-tax net present value (NPV) of ZAR 128 110 889 at a 10% discount rate. A corresponding internal rate of return (IRR) of 10.74% is realised with an undiscounted payback period of 19 years.

This option has the smallest initial capital amount but the shared highest electrical operational costs. This is the shortest of the OHL options (only 20km) and comes in below the Hydro option in terms of IRR and NPV.

Figure 5-9 below shows the sensitivity analysis parameters in addition to discount rate variability. The main value drivers in NPV and IRR include recovery variance, metal pricing and operating costs. At a 50% and 40% reduction in metal selling price, the IRR fails to register due to zero positive income periods realised across the LOM cash flow. It is only at the negative 30% indicator that the lowest IRR, of -4.8% is realised. The IRR peaks at 27.6% with the metal price at 50% higher than the utilised base number.

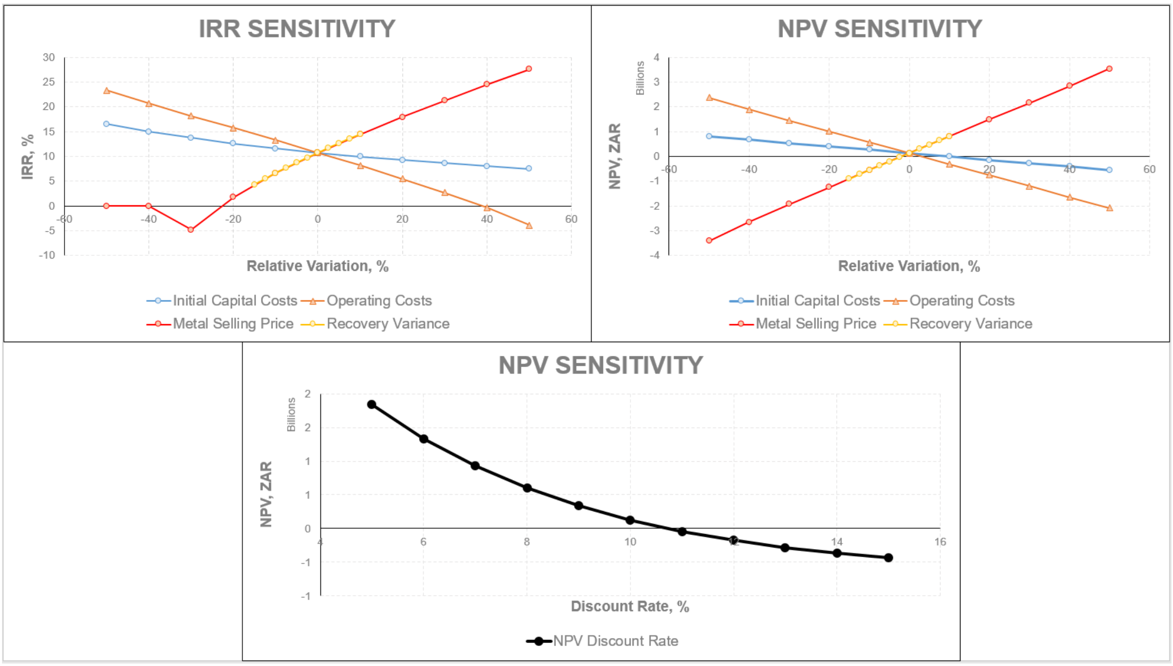


Figure 5-9: Sensitivities on financial returns – OHL 20km Option

Initial capital cost has a reduced effect on impacting overall project value due to the relatively low requirements in comparison to revenue generated and operating costs over the prescribed life of mine. Operating costs are less sensitive than metal pricing and recovery but has a bigger impact than Initial capital costs. At the utilised base discount rate of 10%, the NPV is ZAR 128 110 889 but remains dependant on the funding strategy and subsequent cost of capital. The impact of the discount rate on NPV, is also shown below on the bottom graph. The first negative NPV is realised at the 11% marker. A detailed discounted cash flow statement, and sensitivity analysis are presented in Appendix D.

5.6 Grid - OHL at 50km results

A graphical representation is shown in Figure 5-10 below. Positive cash flows (cumulative, undiscounted) are realised in 2039 from project inception with a peak cumulative cash flow requirement of ZAR 3 114 356 759.

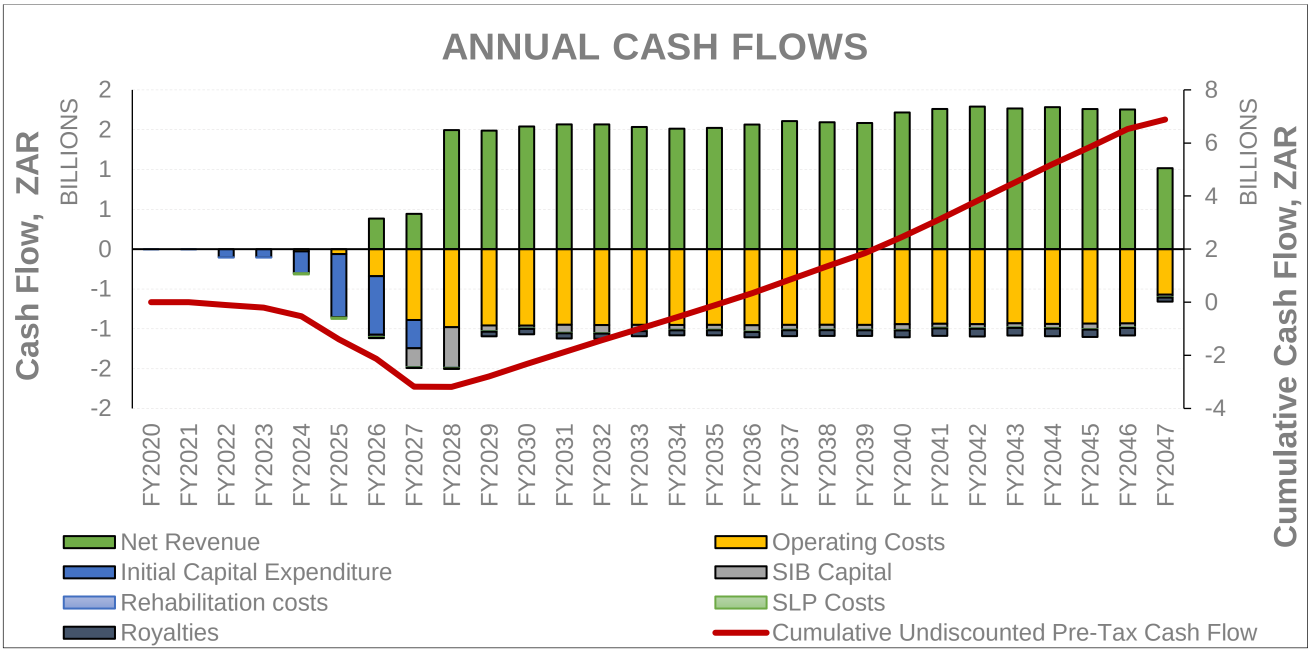


Figure 5-10: Annualised Cash flow - OHL at 50km

Initial capital requirements are estimated to be ZAR 1 964 090 441.9 (excl. contingency) over an eight-year duration (2020 – 2027). With the OHL scenarios, leasing and environmental matters becomes a challenge and delays the kick-off of mine production. The outcomes from the financial model indicate a pre-tax net present value (NPV) of ZAR 40 147 694 at a 10% discount rate. A corresponding internal rate of return (IRR) of 10.24% is realised with an undiscounted payback period of 20 years. The payback period has been referenced to the project start date of 2020.

This 50km OHL option generates a similar return on capital compared to the 20km option but loses significant cash value due to the delay in producing revenue and increased OPEX. Taking into consideration the length of ground to cover, 24 months were afforded to the leasing and environmental requirements to establish a clear route for the OHL to follow during construction. According to DRA Projects, this is within the recommended time but it noticeably pushes out the mine production.

Figure 5-11 below shows the sensitivity analysis parameters in addition to discount rate variability. The main value drivers in NPV and IRR include recovery variance, metal pricing and operating costs. At a 50% and 40% reduction in metal selling price, the IRR fails to register due to zero positive income periods realised across the LOM cash flow. It is only at the negative 30% indicator that the lowest IRR, of -4.9% is realised. The IRR peaks at 26% with the metal price at 50% higher than the utilised base number.

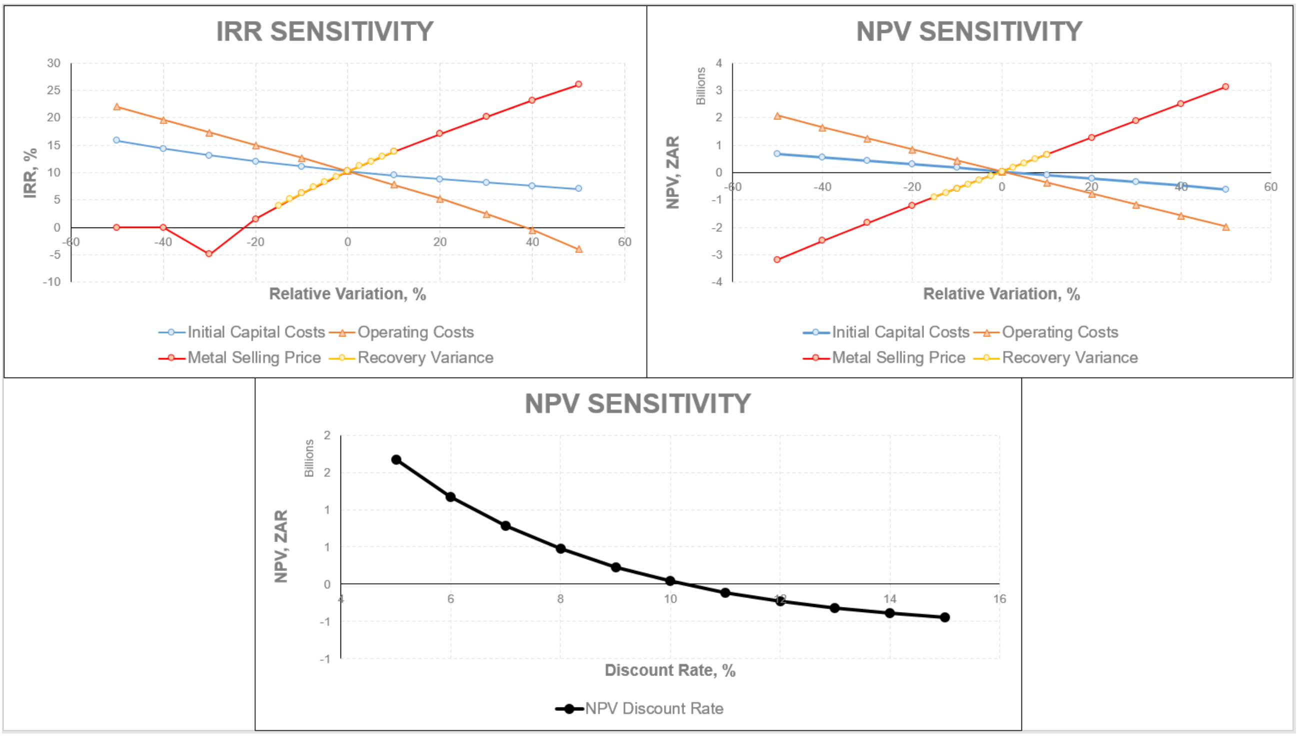


Figure 5-11: Sensitivities on financial returns – OHL 50km Option

Initial capital cost has a reduced effect on impacting overall project value due to the relatively low requirements in comparison to revenue generated and operating costs over the prescribed life of mine. Operating costs are less sensitive than metal pricing and recovery but has a bigger impact than Initial capital costs. At the utilised base discount rate of 10%, the NPV is ZAR 40 147 694 but remains dependant on the funding strategy and subsequent cost of capital. The impact of the discount rate on NPV, is also shown below on the bottom graph. The first negative NPV is realised at the 11% marker. A detailed discounted cash flow statement, and sensitivity analysis are presented in Appendix E.

5.7 Grid – OHL at breakeven results

This option was chosen to compare to the least capital intensive REN option. The reason for this is to compare the two scenarios on a like for like initial capital basis. In this case, it was Hydropower at ZAR 244 965 991.76. The difference between the hydro capital and the outdoor substation required with Grid-tied Energy is ZAR 200 mil. Given the cost of ZAR 2.5 mil/km of OHL, a possible length of 80km of OHLs can be afforded. A graphical representation is shown in Figure 5-12 below. Positive cash flows (cumulative, undiscounted) are realised in 2039 from project inception with a peak cumulative cash flow requirement of ZAR 3,277,272,194.

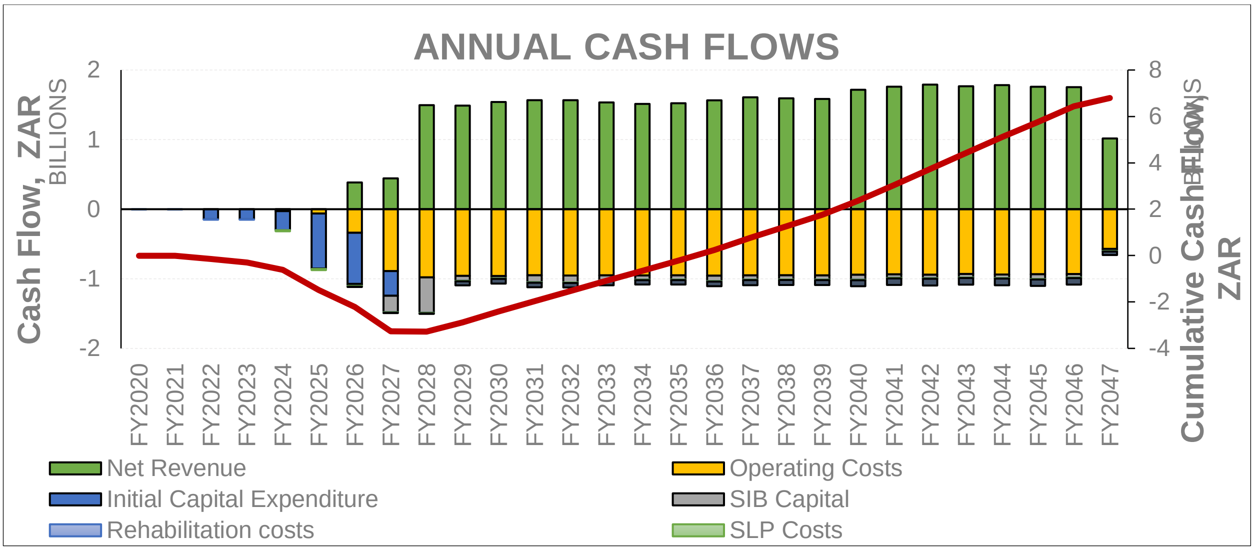


Figure 5-12: Annualised Cash flow - OHL at Breakeven

Initial capital requirements are estimated to be ZAR 2 039 090 440.90 (excl. contingency) over an eight-year duration (2020 – 2027). The outcomes from the financial model indicate a pre-tax net present value (NPV) of ZAR -24 397 077 at a 10% discount rate. A corresponding internal rate of return (IRR) of 9.86% is realised with an undiscounted payback period of 20 years. The payback period has been referenced to the project start date of 2020. OHL's again proves that the long lead times to mine production and an increased electrical power OPEX has a detrimental effect on the project value.

Figure 5-13 below shows the sensitivity analysis parameters in addition to discount rate variability. The main value drivers in NPV and IRR include recovery variance, metal pricing and operating costs. At a 50% and 40% reduction in metal selling price, the IRR fails to register due to zero positive income periods realised across the LOM cash flow. It is only at the negative 30% indicator that the lowest IRR, of negative 5% is realised. The IRR peaks at 25% with the metal price at 50% higher than the utilised base number.

Initial capital cost has a reduced effect on impacting overall project value due to the relatively low requirements in comparison to revenue generated and operating costs over the prescribed life of mine. Operating costs are less sensitive than metal pricing and recovery but has a bigger impact than Initial capital costs. At the utilised base discount rate of 10%, the NPV is ZAR -24 397 077 but remains dependant on the funding strategy and subsequent cost of capital. The impact of the discount rate on NPV, is also shown below on the bottom graph. The first negative NPV is realised at the 10% marker. A detailed discounted cash flow statement, and sensitivity analysis are presented in Appendix F.

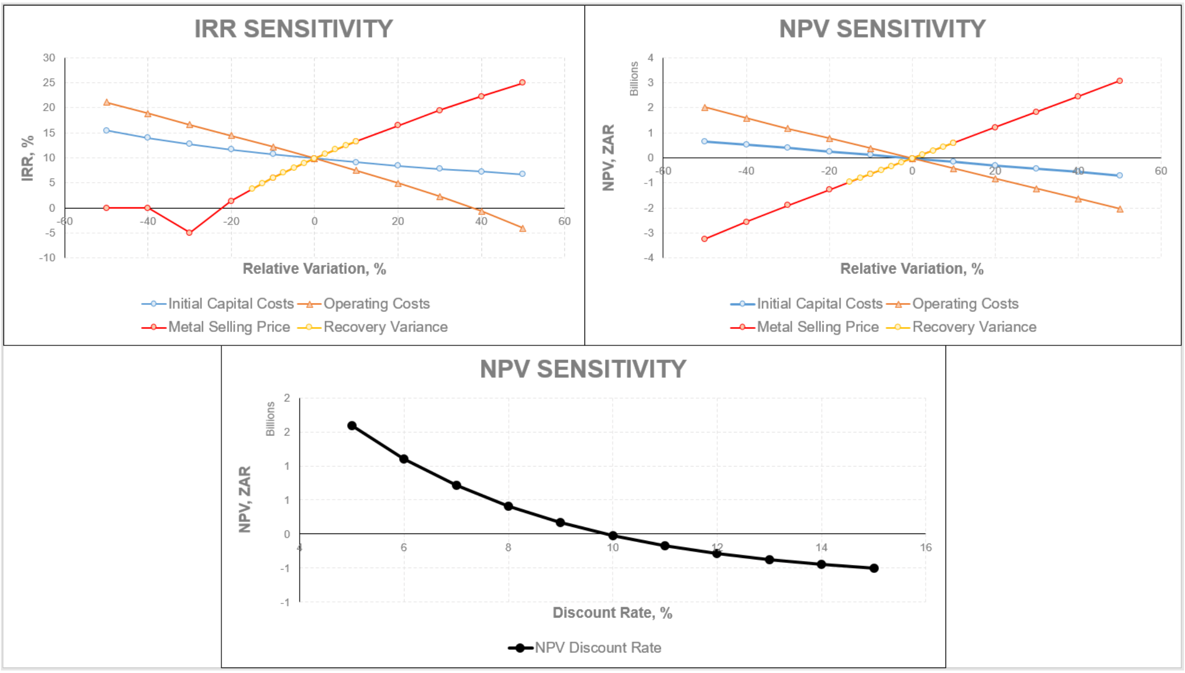
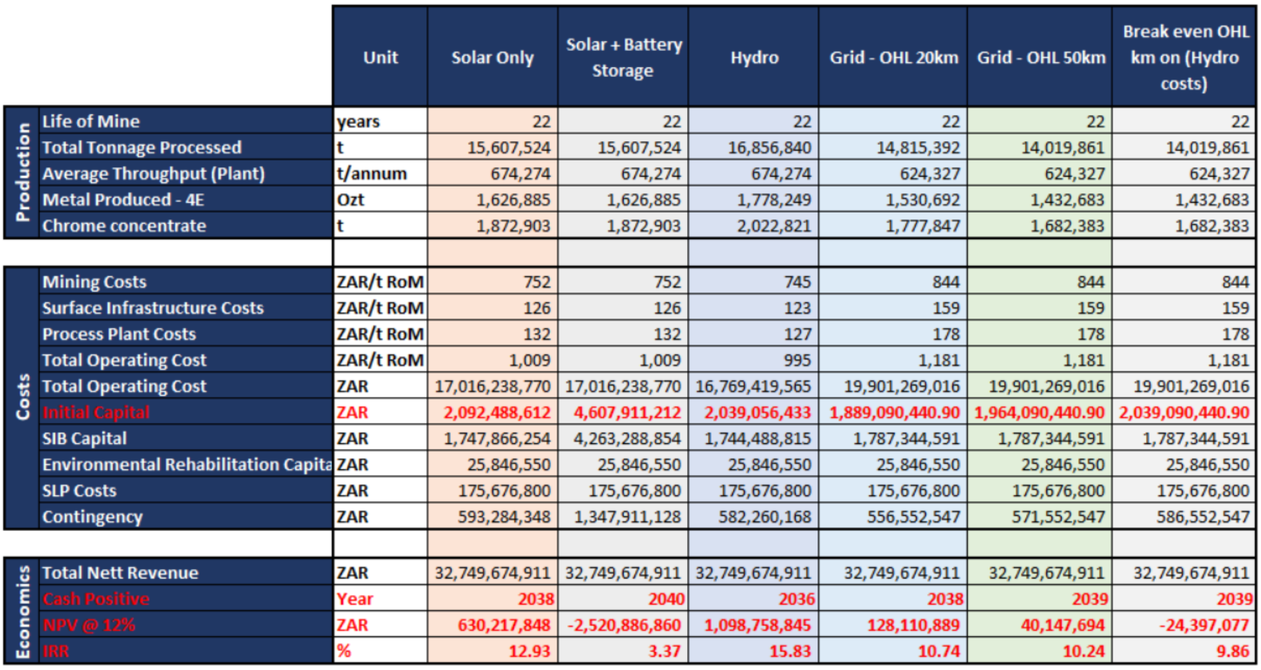


Figure 5-13: Sensitivities on financial returns – OHL Break Even Option

5.8 Results summary

A summary of the comparison is shown in Table 5-1 below. The intent was to investigate numerous potential energy generation options to determine if a possible substitute for Grid-tied energy could be viable.

Table 5-1: Financial Outcomes Comparison



		Unit	Solar Only	Solar + Battery Storage	Hydro	Grid - OHL 20km	Grid - OHL 50km	Break even OHL km on (Hydro costs)
Production	Life of Mine	years	22	22	22	22	22	22
	Total Tonnage Processed	t	15,607,524	15,607,524	16,856,840	14,815,392	14,019,861	14,019,861
	Average Throughput (Plant)	t/annum	674,274	674,274	674,274	624,327	624,327	624,327
	Metal Produced - 4E	Ozt	1,626,885	1,626,885	1,778,249	1,530,692	1,432,683	1,432,683
	Chrome concentrate	t	1,872,903	1,872,903	2,022,821	1,777,847	1,682,383	1,682,383
Costs	Mining Costs	ZAR/t RoM	752	752	745	844	844	844
	Surface Infrastructure Costs	ZAR/t RoM	126	126	123	159	159	159
	Process Plant Costs	ZAR/t RoM	132	132	127	178	178	178
	Total Operating Cost	ZAR/t RoM	1,009	1,009	995	1,181	1,181	1,181
	Total Operating Cost	ZAR	17,016,238,770	17,016,238,770	16,769,419,565	19,901,269,016	19,901,269,016	19,901,269,016
	Initial Capital	ZAR	2,092,488,612	4,607,911,212	2,039,056,433	1,889,090,440.90	1,964,090,440.90	2,039,090,440.90
	SIB Capital	ZAR	1,747,866,254	4,263,288,854	1,744,488,815	1,787,344,591	1,787,344,591	1,787,344,591
	Environmental Rehabilitation Capita	ZAR	25,846,550	25,846,550	25,846,550	25,846,550	25,846,550	25,846,550
	SLP Costs	ZAR	175,676,800	175,676,800	175,676,800	175,676,800	175,676,800	175,676,800
	Contingency	ZAR	593,284,348	1,347,911,128	582,260,168	556,552,547	571,552,547	586,552,547
Economics	Total Nett Revenue	ZAR	32,749,674,911	32,749,674,911	32,749,674,911	32,749,674,911	32,749,674,911	32,749,674,911
	Cash Positive	Year	2038	2040	2036	2038	2039	2039
	NPV @ 12%	ZAR	630,217,848	-2,520,886,860	1,098,758,845	128,110,889	40,147,694	-24,397,077
	IRR	%	12.93	3.37	15.83	10.74	10.24	9.86

As can be seen in the table, the worst performing option is the Solar with Battery Storage option with the NPV of ZAR -2 520 886 860 and IRR of 3.37%. The excessive upfront and 15-year replacement costs of the LIBs are too excessive to make this option viable. The solar-only option compares favourably to the solar and battery storage option and grid-tied options with NPV of R630, 217, 848 and IRR of 12.93%. As mentioned, the main shortcoming is the effective hours of sunlight that takes away the solution of a stable power supply. Of the three REN solutions, Hydropower option as a higher-value option in terms of the NPV (ZAR 1.1 billion) and IRR (15.83%). This option also ranked higher than all the grid options with high NPV and IRR values. Hydro leverages off a lower capital base compared to the other REN options for initial capital and peak capital expenditure.

The grid-tied options all have lower initial capital but has the highest OPEX of all the options. This is mainly due to the ZAR 0.98/kwh Eskom rate compared to the much lower OPEX of the REN. Of the three grid-tied options studied, the Grid-OHL 20km ranked top with more NPV and slightly higher IRR. The major contributor to the lower NPVs calculated for OHL options is the late start in mine production causing a delay in revenue generation.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Africa is a challenging continent, and it has been for years. While it poses enormous potential, Africa is massively underdeveloped in mining and agriculture, natural resources, and other supporting industries. The lack of infrastructure has limited Africa’s economy to expand production industries and tap into existing opportunities. Access to a stable energy supply is amongst the challenges on the continent that is limiting industrialisation.

While the uptake of REN sources remains small compared to other sources of energy, there is recognisable movement towards the integration of REN in power supply. For example, the DRC’s power generation is already dominated by hydropower sources and has a further 100 000 megawatt of potential hydropower capacity able to power its own and surrounding economies (Hall, 2018). The opportunity for REN is there and needs to be assessed against the traditional sources of electricity.

In the case of South Africa, the majority of the mining sector relies solely on the Eskom grid for power to operate. With the recent cycles of load shedding, increase in tariffs and further increases planned, the performance of most marginal mining operations has been negatively affected to a point where some mines had to be closed. This severely impacted production and profitability of mining operations and subsequently contributed to the country’s economic decline and unemployment numbers (Seccombe, 2019).

This study's objectives were to assess the feasibility of pre-determined forms of renewable energy against the traditional grid-tied power options in South Africa to power a medium to a largescale mining operation. With Solar energy being the worldwide leader in investments and growth and Hydropower at the forefront of worldwide total REN production, the two forms of energy production are best supported with regards to suitability, availability, technology and implementation and hence formed the base of the REN studied.

REN can be used alone where there is sufficient storage to ensure a constant supply. A vital consideration in the use of REN is that both solar and hydro options require either a consistent flow of water or some form of energy storage. Storage guarantees an uninterrupted supply of power regardless of environmental, weather or any other external conditions that might impact the ability to generate power. Hydropower storage is in the form of a year-round supply of flowing water. This is achieved by either having a sufficiently strong river that is not seasonally bound or a dam with enough water to supply the required fall to produce the required power demands consistently.

Based on IRENA's LCOE world average, capital cost for a solar and hydropower plant compares relatively even with the total CAPEX component required for 80km of OHL. It is then concluded that 80km of OHL is considered the breakeven capital point where REN starts to require less capital than grid-tied energy. It was found that the 20km and 50km OHL scenarios presented the cheapest CAPEX options. The differences are seen with the IRRs and NPVs between these different financial scenarios. Hydropower generation outweighs all the options financially with the best returns and project value. The solar only option also produced good financial returns, but its adoption is disadvantaged by practicality in terms of the amount of sunshine received daily. With no form of back-up power storage, an operation is only powered for 7 hours a day due to sunlight's requirement to affect daily activities and production outputs.

Overall, the REN options performed well against grid energy options. This is despite the high up-front CAPEX that is required. There are significant differences in the OPEX cost of the power generation options when comparing REN to grid-tied energy. Hydropower was the most economical to generate post capital investment, with solar in at second. The grid-tied total OPEX was significantly higher, coming in at ±18% more than hydro at current Eskom pricing.

LIBs are the front runners when power storage is considered. The study showed LIBs to be expensive and, on an industrial scale, does not make financial sense. The associated costs and the 15 years replacement life of the batteries did not produce a feasible. Until further improvements in LIB storage, efficiency and cost, this option is not viable. Other forms of storage are also available and includes pumped hydro or using solar power only as a supplemental REN during times of sufficient sunlight but staying connected to the grid drawing power during times of insufficient sunlight being available. While the latter option was not part of the investigation, it offer alternatives for low-cost power generation when a grid supply is available considering the costs of battery storage.

The land size required to set up an industrial size solar farm also present a potential problem. In this study, the adopted assumption was that the mine in operation possesses the required size of land to generate sufficient megawatts. Whenever that is not the case, additional land must be purchased and preferably next to the operation. This adds additional capital expenditure and delays in terms of the environmental impact assessments and licensing requirements that will need to be met upfront. If there is no property available next to the operation, further OHL installations will add even more costs to the initial CAPEX. Another real estate challenge is the type of land available. Agricultural land cannot be sacrificed for solar farms but rather arid and un-farmable patches of ground.

Although the solar option modelled in this research proves impracticable, it still offers an opportunity due to its low unit rate cost compared to grid-tied. A hydro setup has even further saving potential on unit rate costs carrying less than 50% of solar cost. Again, should the immediate area provide a suitable water source, hydro proves most feasible. From the completed research, it is concluded that available REN currently on the market, can power a 70ktpm underground mining operation. Ancillary power requirements in the form of additional surface infrastructure and processing plants are also capable of being feasibly powered.

The study shows significant improvements in REN technologies and large SA mining companies like Sibanye-Stillwater, pushing for approval to allow them to generate their own power, independent of the Eskom grid. With the improvements in REN, the continued struggles of Eskom and the launch of the REIPPPP, this study concludes that mining companies should renew and increase their efforts to push for governmental approval to generate their own electricity by means of REN.

6.2 Recommendations

Hydropower had the best financial results, as shown in chapter 6. Hydropower is not always practical as it requires a consistent and predictable flow of water, year-round, in order to ensure the necessary reliability of power supply to run a successful mining operation. If the water flow is seasonal, the infrastructure cannot be utilised to its maximum design potential, and other means of power must be installed as a back-up. It is recommended to invest in hydropower plants whenever the practical requirements allow for it.

When considering a solar-only option, the lack of storage was apparent as solar depends on a daily cycle of available sunlight. LIB storage is still too expensive and does not produce favourable financial results at this stage. It is recommended to invest in the research, development and testing of these forms of storage (batteries) to further improve on its efficiency, cost and longevity.

Considering a hybrid set-up where a mining operation is connected to Eskom grid energy (fossil fuels) and supplemented by solar for as long as daylight allows, should be further investigated. This eliminates the need for expensive power storage options and has the potential to realise power cost savings over and above initial capital spend. It is recommended that hybrid options be given serious consideration for financial valuations on existing operations that still has a 20 year plus LOM. If the real-estate is available and OHLs are present as the primary source of power, this option could have potential to pay for itself over a 20-year life dependant on the outcome of the research. This option has much more potential than just the powering of that operation. This option reduces the strain on the grid during challenging Eskom times. It can supply power to the local communities, especially after the operation shuts down or reaches the end of its production life. It can create new jobs, new skills and finally, it can create a broader platform for further research and testing to improve on the efficiency, cost and durability of these solar farms.

It is further recommended for Eskom to allow “Grid Storage”. This is achieved by allowing industrial operations to feed excess power back into the existing grid to be used at a later stage. This eliminates the need for back-up power and expensive storage solutions. This is a concept that can be used to help Eskom with supplementation of the national demand for power and is an excellent answer to their current shortcomings and challenges faced. The concept will have to be appropriately legislated, and limitations must be applied so that Eskom’s existence and future revenue generation is still guaranteed.

Further studies into the African continent is also recommended. Africa has massive REN potential, and the continent is in a favourable position to make use of this potential. Further studies must look into potential of available locations, types of mining, different commodities and other sources of REN. It will be a massive boost to previous and current African countries facing power supply constraints. This study focused on South Africa only, but there is so much more potential on the rest of the continent.

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APPENDICES

Note: Discounted cashflow appendices will have to be viewed electronically to be able to stretch them to the required size for viewing purposes. Alternatively, A3 landscape prints will also suffice.

Appendix A: Solar-only discounted cash flow statement and sensitivity analysis

Item	Units	Total / Average	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025	FY2026	FY2027	FY2028	FY2029	FY2030	FY2031	FY2032	FY2033	FY2034	FY2035	FY2036	FY2037	FY2038	FY2039	FY2040	FY2041	FY2042	FY2043	FY2044	FY2045
Revenue																												
Pt	ZAR	8 737 452 172	-	-	-	-	95 912 076	109 882 219	396 158 343	393 654 762	408 420 983	415 556 669	416 650 723	408 551 987	402 784 753	406 102 840	416 755 269	428 257 988	425 149 345	423 025 014	461 043 080	472 118 181	481 049 085	476 128 574	481 288 703	473 074 883	471 170 863	274 715 834
Total metal produced	ozt	740 553	-	-	-	-	8 129	9 313	33 577	33 365	34 616	35 221	35 314	34 627	34 138	34 420	35 323	36 298	36 034	35 854	39 076	40 015	40 772	40 355	40 792	40 096	39 935	23 284
Metal sales price	ZAR/ozt	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799
Pd	ZAR	18 807 401 029	-	-	-	-	199 478 694	232 690 623	834 943 449	836 649 357	866 019 401	885 444 401	891 371 599	877 097 352	860 392 231	871 770 867	900 798 168	931 017 359	924 791 296	918 672 962	1 001 243 985	1 030 530 539	1 047 858 448	1 035 984 296	1 043 067 320	1 019 343 015	1 011 624 334	586 611 334
Total metal produced	ozt	861 506	-	-	-	-	9 137	10 659	38 246	38 324	39 670	40 559	40 831	40 177	39 412	39 933	41 263	42 647	42 362	42 081	45 864	47 205	47 999	47 455	47 780	46 693	46 339	26 871
Metal sales price	ZAR/ozt	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831
Rh	ZAR	6 307 421 485	-	-	-	-	75 706 803	84 067 250	306 262 400	300 590 927	312 873 856	314 799 878	307 541 070	296 704 756	292 427 127	289 737 966	296 209 986	303 252 750	297 862 148	295 097 001	320 329 633	331 006 936	338 449 536	329 746 343	334 295 520	340 776 118	342 813 455	196 870 025
Total metal produced	ozt	137 349	-	-	-	-	1 649	1 831	6 669	6 546	6 813	6 855	6 697	6 461	6 368	6 309	6 450	6 604	6 486	6 426	6 975	7 208	7 370	7 180	7 280	7 421	7 465	4 287
Metal sales price	ZAR/ozt	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923
Au	ZAR	746 405 084	-	-	-	-	7 144 280	9 269 165	31 476 353	31 314 113	33 225 115	34 372 748	35 341 256	34 280 395	35 676 891	36 562 393	37 787 480	39 703 555	37 804 879	38 409 985	41 468 338	40 427 872	39 869 479	41 517 006	41 460 688	38 114 410	38 468 600	22 710 083
Total metal produced	ozt	38 841	-	-	-	-	372	482	1 638	1 630	1 729	1 789	1 839	1 784	1 857	1 903	1 966	2 066	1 967	1 999	2 158	2 104	2 075	2 160	2 158	1 983	2 002	1 182
Metal sales price	ZAR/ozt	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217
Ni	ZAR	970 579 809	-	-	-	-	11 511 638	12 743 450	48 073 061	47 409 205	49 164 931	49 670 199	48 330 358	46 014 069	45 807 612	44 464 572	45 479 379	45 582 223	44 775 475	44 503 595	48 488 851	50 279 711	51 945 832	48 103 639	50 198 176	52 964 815	54 315 040	30 753 978
Total metal produced	t	5 126	-	-	-	-	61	67	254	250	260	262	255	243	242	235	240	241	236	235	256	266	274	254	265	280	287	162
Metal sales price	ZAR/t	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342
Cu	ZAR	242 977 588	-	-	-	-	3 043 751	3 325 767	11 844 910	11 605 113	11 920 728	12 120 878	12 023 219	11 735 727	11 928 439	11 630 571	11 942 076	11 722 142	12 570 142	12 285 247	12 794 939	12 597 048	12 451 738	12 494 255	12 425 007	11 869 919	11 842 016	6 803 957
Total metal produced	t	3 127	-	-	-	-	39	43	152	149	153	156	155	151	153	150	154	151	162	158	165	162	160	161	160	153	152	88
Metal sales price	ZAR/t	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715
Chrome concentrate	ZAR	3 195 451 130	-	-	-	-	120 564 613	143 199 253	149 358 320	148 980 996	149 359 418	149 534 625	149 923 015	148 853 121	149 464 663	149 395 168	149 757 636	149 563 397	149 215 186	149 335 840	150 349 029	150 128 349	150 472 488	150 206 843	150 804 002	150 159 757	149 550 352	87 275 060
Metal produced	t	2 022 821	-	-	-	-	76 321	90 650	94 548	94 310	94 549	94 660	94 906	94 229	94 616	94 572	94 801	94 678	94 458	94 534	95 176	95 036	95 254	95 086	95 464	95 056	94 670	55 248
Total metal produced	t	2 022 821	-	-	-	-	76 321	90 650	94 548	94 310	94 549	94 660	94 906	94 229	94 616	94 572	94 801	94 678	94 458	94 534	95 176	95 036	95 254	95 086	95 464	95 056	94 670	55 248
Metal sales price	ZAR/t	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580
Gross Revenue	ZAR	39 007 688 298	-	-	-	-	513 361 855	595 177 726	1 778 116 835	1 770 204 472	1 830 984 432	1 861 499 397	1 861 181 240	1 823 237 408	1 798 481 715	1 809 664 378	1 858 729 995	1 909 099 414	1 892 168 472	1 881 329 643	2 035 717 856	2 087 088 636	2 122 096 605	2 094 180 955	2 113 539 415	2 086 302 915	2 079 784 662	1 205 740 271
Purchase of concentrate cost	ZAR	(5 159 353 397)	-	-	-	-	(56 744 894)	(65 210 888)	(235 209 414)	(234 043 117)	(242 742 961)	(247 078 130)	(246 816 206)	(241 353 064)	(237 809 775)	(239 189 684)	(246 169 594)	(253 224 630)	(250 949 985)	(249 340 168)	(271 332 600)	(278 720 736)	(283 733 696)	(279 446 857)	(282 292 758)	(278 785 359)	(278 102 180)	(161 056 700)
Pt	ZAR	(1 223 243 304)	-	-	-	-	(13 427 691)	(15 383 511)	(55 462 168)	(55 111 667)	(57 178 938)	(58 177 934)	(58 331 101)	(57 197 278)	(56 389 865)	(56 854 398)	(58 345 738)	(59 956 118)	(59 520 908)	(59 223 502)	(64 546 031)	(66 096 545)	(67 346 872)	(66 658 000)	(67 380 418)	(66 230 484)	(65 963 921)	(38 460 217)
Pd	ZAR	(2 633 036 144)	-	-	-	-	(27 927 017)	(32 576 687)	(116 892 083)	(117 130 910)	(121 242 716)	(123 962 216)	(124 792 024)	(122 793 629)	(120 454 912)	(122 047 921)	(126 111 744)	(130 342 430)	(129 470 781)	(128 614 215)	(140 174 158)	(144 274 275)	(146 700 183)	(145 037 801)	(146 029 425)	(142 708 022)	(141 627 407)	(82 125 587)
Rh	ZAR	(883 039 008)	-	-	-	-	(10 598 952)	(11 769 415)	(42 876 736)	(42 082 730)	(43 802 340)	(44 071 983)	(43 055 750)	(41 538 666)	(40 939 798)	(40 563 315)	(41 469 398)	(42 455 385)	(41 700 701)	(41 313 580)	(44 846 149)	(46 340 971)	(47 382 935)	(46 164 488)	(46 801 373)	(47 708 657)	(47 993 884)	(27 561 804)
Au	ZAR	(104 496 712)	-	-	-	-	(1 000 199)	(1 297 683)	(4 406 689)	(4 383 976)	(4 651 516)	(4 812 185)	(4 947 776)	(4 799 255)	(4 994 765)	(5 118 735)	(5 290 247)	(5 558 498)	(5 292 683)	(5 377 398)	(5 805 567)	(5 659 902)	(5 581 727)	(5 812 381)	(5 804 496)	(5 336 017)	(5 385 604)	(3 179 412)
Ni	ZAR	(242 644 952)	-	-	-	-	(2 877 909)	(3 185 862)	(12 018 265)	(11 852 301)	(12 291 233)	(12 417 550)	(12 082 590)	(11 503 517)	(11 451 903)	(11 116 143)	(11 369 845)	(11 395 556)	(11 193 869)	(11 125 899)	(12 122 213)	(12 569 928)	(12 986 458)	(12 025 910)	(12 549 544)	(13 241 204)	(13 578 760)	(7 688 494)
Cu	ZAR	(72 893 276)	-	-	-	-	(913 125)	(997 730)	(3 553 473)	(3 481 534)	(3 576 218)	(3 636 263)	(3 606 966)	(3 520 718)	(3 578 532)	(3 489 171)	(3 582 623)	(3 516 643)	(3 771 042)	(3 685 574)	(3 838 482)	(3 779 114)	(3 735 521)	(3 748 276)	(3 727 502)	(3 560 976)	(3 552 605)	(2 041 187)
Treatment charges	ZAR	(428 145 182)	-	-	-	-	(16 153 950)	(19 186 671)	(20 011 899)	(19 961 343)	(20 012 046)	(20 035 521)	(20 087 560)	(19 944 209)	(20 026 147)	(20 016 836)	(20 065 402)	(20 039 376)	(19 992 721)	(20 008 887)	(20 144 640)	(20 115 072)	(20 161 182)	(20 125 589)	(20 205 600)	(20 119 280)	(20 037 629)	(11 693 622)
Concentrate produced	t	252 853	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
Unit charge rate	ZAR/t conc.	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693
Sampling costs	ZAR	(14 908 505)	-	-	-	-	(562 499)	(668 102)	(696 837)	(695 077)	(696 842)	(697 660)	(699 472)	(694 480)	(697 333)	(697 009)	(698 700)	(697 794)	(696 169)	(696 732)	(701 459)	(700 430)	(702 035)	(700 796)	(703 582)	(700 576)	(697 733)	(407 185)
Concentrate produced	t	252 853	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
Unit charge rate	ZAR/t conc.	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59
Product penalties	ZAR	(655 606 303)	-	-	-	-	(55 744 128)	(66 771 887)	(27 158 923)	(27 090 312)	(27 159 123)	(27 190 982)	(27 261 606)	(27 067 059)	(27 178 260)	(27 165 624)	(27 231 534)	(27 196 214)	(27 132 896)	(27 154 836)	(27 339 071)	(27 298 943)	(27 361 521)	(27 313 217)	(27 421 802)	(27 304 655)	(27 193 842)	(15 869 867)
Grade penalty	ZAR	(74 553 888)	-	-	-	-	(33 820 976)	(40 732 912)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concentrate produced	t	252 853	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
4E grade	g/t conc.	216.14	-	-	-	-	62.88	61.17	210.88	210.71	217.98	221.92	222.02	219.31	215.06	217.24	223.11	230.26	228.78	227.31	245.95	252.74	256.56	254.23	255.46	251.80	251.64	250.52
Unit charge rate (<185g/t conc. @ 5g/t conc. increments)	ZAR/penalty increment	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145
Chrome penalty	ZAR	(581 052 415)	-	-	-	-	(21 923 152)	(26 038 975)	(27 158 923)	(27 090 312)	(27 159 123)	(27 190 982)	(27 261 606)	(27 067 059)	(27 178 260)	(27 165 624)	(27 231 534)	(27 196 214)	(27 132 896)	(27 154 836)	(27 339 071)	(27 298 943)	(27 361 521)	(27 313 217)	(27 421 802)	(27 304 655)	(27 193 842)	(15 869 867)
Chrome in concentrate	t	6 321	-	-	-	-	239	283	295	295	295	296	297	294	296	296	296	296	295	295	297	297	298	297	298	297	296	173
Net Revenue	ZAR	32 749 674 911	-	-	-	-	384 156 384	443 340 178	1 495 039 761	1 488 414 623	1 540 373 460	1 566 497 104	1 566 316 396	1 534 178 594	1 512 770 199	1 522 595 225	1 564 564 765	1 607 941 400	1 593 396 701	1 584 129 021	1 716 200 085	1 760 253 455	1 790 138 171	1 766 594 497	1 782 915 672	1 759 393 045	1 753 753 278	1 016 712 897
Operating Costs																												
Mining costs	ZAR	(12 682 541 981)	-	-	(1 124 652)	(3 157 052)	(172 108 619)	(570 184 545)	(648 073 614)	(622 367 601)	(621 696 528)	(611 445 129)	(614 469 424)	(612 127 242)	(613 446 544)	(612 221 377)	(616 717 065)	(612 282 055)	(611 165 015)	(612 647 318)	(603 622 722)	(598 023 564)	(603 229 494)	(592 297 224)	(600 184 630)	(596 298 708)	(594 259 703)	(339 392 155)
Surface infrastructure costs	ZAR	(2 116 992 904)	-	-	(8 940 991)	(13 945 214)	(49 189 920)	(99 014 010)	(99 333 470)	(99 452 719)	(99 516 331)	(99 526 851)	(99 530 227)	(99 532 214)	(99 532 134)	(99 533 965)	(99 532 499)	(99 532 663)	(99 530 572)	(99 553 715)	(99 557 327)	(99 559 044)	(99 558 679)	(99 563 095)	(99 552 792)	(99 557 728)	(99 153 189)	(55 293 554)
Process plant costs	ZAR	(2 216 703 885)	-	-	(9 668 143)	(26 744 091)	(64 197 931)	(102 333 439)	(102 785 359)	(102 954 052)	(103 044 040)	(103 058 922)	(103 063 698)	(103 066 508)	(103 066 396)	(103 068 985)	(103 066 912)	(103 067 143)	(103 064 186)	(103 096 925)	(103 102 034)	(103 104 463)	(103 103 947)	(103 110 194)	(103 095 619)	(103 102 602)	(102 530 327)	(56 207 972)
Chrome plant costs	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Operating Costs	ZAR	(17 016 238 770)	-	-	(19 733 786)	(43 846 356)	(285 496 470)	(771 531 993)	(850 192 444)	(824 774 372)	(824 256 899)	(814 030 902)	(817 063 349)	(814 725 964)	(816 045 074)	(814 824 326)	(819 316 476)	(814 881 860)	(813 759 774)	(815 297 958)	(806 282 083)	(800 687 070)	(805 892 120)	(794 970 513)	(802 833 042)	(798 959 039)	(795 943 219)	(450 893 681)
Initial Capital Expenditure																												
Mining	ZAR	(1 892 110 059)	(149 199 086)	(149 199 086)	(173 945 096)	(552 983 396)	(571 444 592)	(295 338 803)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Surface infrastructure	ZAR	(159 863 906)	-	-	(46 774 491)	(72 161 736)	(40 927 679)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Process plant	ZAR	(40 514 648)	-	-	(6 339 481)	(34 175 167)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contingency	ZAR	(418 497 722)	(29 839 817)	(29 839 817)	(45 411 814)	(131 864 060)	(122 474 454)	(59 067 761)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital	ZAR	(2 510 986 334)	(179 038 903)	(179 038 903)	(272 470 881)	(791 184 359)	(734 846 726)	(354 406 564)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIB Capital																												
Mining	ZAR	(1 031 794 450)	-	-	-	(1 679 988)	(21 301 515)	(22 899 837)	(85 989 556)	(38 672 267)	(22 899 837)	(82 504 197)	(82 624 244)	(56 651 840)	(46 571 912)	(46 571 912)	(62 464 388)	(46 571 912)	(46 571 912)	(46 571 912)	(56 580 203)	(37 805 438)	(37 805 584)	(37 805 584)	(37 901 651)	(53 578 014)	(37 805 584)	(21 965 160)
Surface infrastructure	ZAR	(50 444 444)	-	-	-	(666 667)	(634 921)	(1 523 810)	(1 523 810)	(19 301 587)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(888 889)
Process plant (incl. chrome recovery)	ZAR	(110 835 194)	-	-	(483 407)	(1 337 205)	(3 209 897)	(5 116 672)	(5 139 268)	(5 147 703)	(5 152 202)	(5 152 946)	(5 153 185)	(5 153 325)	(5 153 320)	(5 153 449)	(5 153 346)	(5 153 357)	(5 153 209)	(5 154 846)	(5 155 102)	(5 155 223)	(5 155 197)	(5 155 510)	(5 154 781)	(5 155 130)	(5 126 516)	(2 810 399)
TSF #3	ZAR	(554 792 165)	-	-	-	(1 258 431)	-	(184 511 245)	(369 022 489)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contingency	ZAR	(174 786 625)	-	-	(48 341)	(494 229)	(2 514 633)	(21 405 156)	(46 167 512)	(6 312 156)	(2 957 585)	(8 918 095)	(8 930 124)	(6 332 897)	(5 324 904)	(5 324 917)	(6 914 154)	(5 324 908)	(5 324 893)	(5 325 057)	(6 325 911)	(4 448 447)	(4 448 459)	(4 448 490)	(4 458 024)	(6 025 695)	(4 445 591)	(2 566 445)
Total SIB Capital	ZAR	(1 922 652 879)	-	-	(531 748)	(5 436 519)	(27 660 965)	(235 456 720)	(507 842 635)	(69 433 712)	(32 533 433)	(98 099 048)	(98 231 362)	(69 661 872)	(58 573 946)	(58 574 088)	(76 055 698)	(58 573 987)	(58 573 824)	(58 575 625)	(69 585 026)	(48 932 918)	(48 933 050)	(48 933 394)	(49 038 266)	(66 282 649)	(48 901 501)	(28 230 892)
Environmental Rehabilitation																												
Rehabilitation costs	ZAR	(25 846 550)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)
SLP Costs																												
SLP Projects 2019	ZAR	(175 676 800)	-	-	-	-	(15 488 200)	(16 008 200)	(10 028 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)
Total SLP Costs	ZAR	(175 676 800)	-	-	-	-	(15 488 200)	(16 008 200)	(10 028 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)
Royalties																												
Net revenue	ZAR	32 749 674 911	-	-	-	-	384 156 384	443 340 178	1 495 039 761	1 488 414 623	1 540 373 460	1 566 497 104	1 566 316 396	1 534 178 594	1 512 770 199	1 522 595 225	1 564 564 765	1 607 941 400	1 593 396 701	1 584 129 021	1 716 200 085	1 760 253 455	1 790 138 171	1 766 594 497	1 782 915 672	1 759 393 045	1 753 753 278	1 016 712 897
Earnings before royalties	ZAR	11 098 273 578	(179 961 994)	(179 961 994)	(293 659 506)	(841 390 325)	(680 259 068)	(934 986 389)	126 053 392	586 895 248	676 271 836	647 055 862	643 710 394	642 479 467	630 839 888	641 885 520	661 881 300	727 174 262	713 751 812	702 944 147	833 021 685	903 322 176	928 001 710	915 379 299	923 733 074	886 840 067	901 597 266	530 277 033
Royalty % (based on net revenue)	%	5.33	0.50	0.50	0.50	0.50	0.50	0.50	1.44	4.88	5.38	5.09	5.07	5.15	5.13	5.18	5.20	5.52	5.48	5.43	5.89	6.20	6.26	6.26	6.26	6.10	6.21	6.30
Royalty	ZAR	(1 744 094 534)	-	-	-	-	(1 920 782)	(2 216 701)	(21 481 131)	(72 652 656)	(82 843 182)	(79 727 581)	(79 354 959)	(79 057 500)	(77 657 172)	(78 933 589)	(81 365 190)	(88 836 847)	(87 272 740)	(86 025 550)	(101 138 965)	(109 170 398)	(112 061 992)	(110 541 783)	(111 551 587)	(107 334 750)	(108 946 240)	(64 003 235)
All-in Sustaining Cost																												
Net revenue (excluding Pt revenue)	ZAR	25 235 466 043	-	-	-	-	301 671 999	348 841 469	1 154 343 586	1 149 871 528	1 189 131 415	1 209 118 368	1 207 996 774	1 182 823 886	1 166 375 311	1 173 346 783	1 206 155 234	1 239 639 530	1 227 768 264	1 220 327 509	1 319 703 037	1 354 231 819	1 376 435 958	1 357 123 923	1 369 007 388	1 352 548 646	1 348 546 335	780 457 280
All costs (OPEX, SIB CAPEX, Rehab and Royalties)	ZAR	(20 708 832 733)	(923 091)	(923 091)	(21 188 625)	(50 205 967)	(316 001 308)	(1 010 128 504)	(1 380 439 300)	(967 783 831)	(940 556 606)	(992 780 623)	(995 572 761)	(964 368 428)	(953 199 283)	(953 255 095)	(977 660 455)	(963 215 785)	(960 529 429)	(960 822 225)	(977 929 165)	(959 713 477)	(967 810 254)	(955 368 781)	(964 345 985)	(973 499 529)	(954 714 052)	(544 050 899)
All-in Sustaining Cost	ZAR	4 526 633 311	(923 091)	(923 091)	(21 188 625)	(50 205 967)	(14 329 310)	(661 287 035)	(226 095 714)	182 087 697	248 574 808	216 337 745	212 424 013	218 455 458	213 176 028	220 091 688	228 494 778	276 423 745	267 238 834	259 505 285	341 773 871	394 518 342	408 625 705	401 755 142	404 661 403	379 049 117	393 832 283	236 406 381
Unit cost (AISC)	USD/ozt Pt	433	-	-	-	-	(125)	(5 025)	(477)	386	508	435	426	446	442	453	458	539	525	512	619	698	709	705	702	669	698	719
Unit cost (AISC)	ZAR/ozt Pt	6 113	-	-	-	-	(1 763)	(71 005)	(6 734)	5 457	7 181	6 142	6 015	6 309	6 244	6 394	6 469	7 616	7 416	7 238	8 746	9 859	10 022	9 956	9 920	9 454	9 862	10 153
Pre-Tax Cash Flow (EBITDA)	ZAR	9 354 179 044	(179 961 994)	(179 961 994)	(293 659 506)	(841 390 325)	(682 179 850)	(937 203 090)	104 572 260	514 242 592	593 428 654	567 328 281	564 355 435	563 421 967	553 182 716	562 951 930	580 516 109	638 337 415	626 479 071	616 918 597	731 882 720	794 151 778	815 939 718	804 837 515	812 181 487	779 505 316	792 651 026	466 273 798
Cumulative Undiscounted Pre-Tax Cash Flow	ZAR	8 109 876 802	(179 961 994)	(359 923 988)	(653 583 493)	(1 494 973 819)	(2 177 153 669)	(3 114 356 759)	(3 009 784 499)	(2 495 541 907)	(1 902 113 253)	(1 334 784 972)	(770 429 537)	(207 007 570)	346 175 146	909 127 076	1 489 643 185	2 127 980 600	2 754 459 671	3 371 378 268	4 103 260 987	4 897 412 765	5 713 352 483	6 518 189 999	7 330 371 486	8 109 876 802	8 902 527 828	9 368 801 626
Discounted Pre-Tax Cash Flow (EBITDA, 10%)	ZAR	965 425 079	(163 601 813)	(148 728 920)	(220 630 733)	(574 680 913)	(423 580 015)	(529 026 711)	53 662 104	239 897 964	251 671 679	218 729 612	197 803 137	179 523 602	160 237 328	148 242 838	138 970 941	138 920 820	123 945 544	110 958 232	119 668 673	118 045 601	110 258 400	98 871 048	90 702 932	79 139 743	73 158 518	385 350 246
Cumulative Discounted Pre-Tax Cash Flow (10%)	ZAR	519 001 094	(163 601 813)	(312 330 733)	(532 961 466)	(1 107 642 380)	(1 531 222 395)	(2 060 249 106)	(2 006 587 002)	(1 766 689 038)	(1 515 017 359)	(1 296 287 747)	(1 098 484 610)	(918 961 008)	(758 723 680)	(610 480 842)	(471 509 901)	(332 589 081)	(208 643 537)	(97 685 304)	21 983 369	140 028 970	250 287 370	349 158 418	439 861 351	519 001 094	592 159 612	977 509 858

NPV @ 10%	ZAR	630 217 848
IRR	%	12.9
Discounted Payback Period	yrs	16.0
Undiscounted Payback Period	yrs	10.0

Sensitivity Tables

Initial Capital Costs

(All Values Reported in ZAR)

Sensitivity Index			1.00

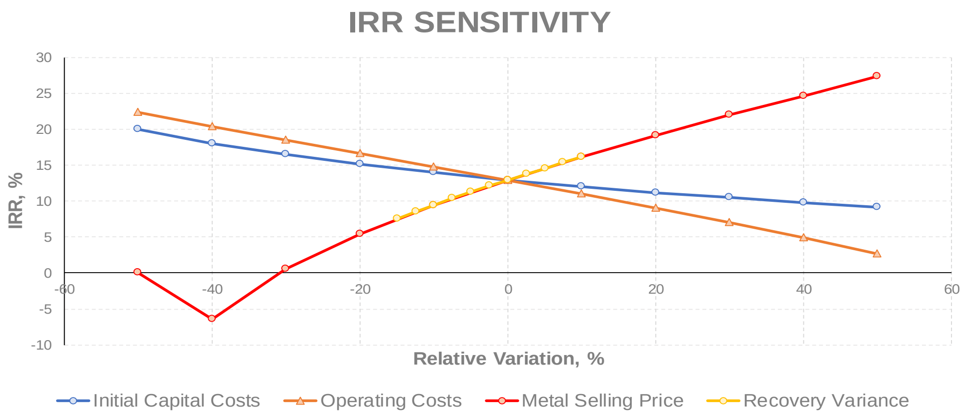
Variation	Index	NPV	IRR
		630 217 848	12.9
(50)	0.50	1 486 300 303	20.0
(40)	0.60	1 315 083 812	18.1
(30)	0.70	1 143 867 321	16.5
(20)	0.80	972 650 830	15.1
(10)	0.90	801 434 339	14.0
-	1.00	630 217 848	12.9
10	1.10	459 001 357	12.0
20	1.20	287 784 866	11.2
30	1.30	116 568 375	10.5
40	1.40	(54 648 116)	9.8
50	1.50	(225 864 607)	9.2

Operating Costs

(All Values Reported in ZAR)

Sensitivity Index			1.00

Variation	Index	NPV	IRR
		630 217 848	12.9
(50)	0.50	2 779 060 623	22.3
(40)	0.60	2 327 955 608	20.4
(30)	0.70	1 881 888 840	18.5
(20)	0.80	1 458 462 911	16.7
(10)	0.90	1 042 815 214	14.8
-	1.00	630 217 848	12.9
10	1.10	217 620 482	11.0
20	1.20	(197 484 807)	9.1
30	1.30	(614 929 763)	7.0
40	1.40	(1 032 374 719)	4.9
50	1.50	(1 449 819 675)	2.7



Metal Selling Price

(All Values Reported in ZAR)

Sensitivity Index			1.00

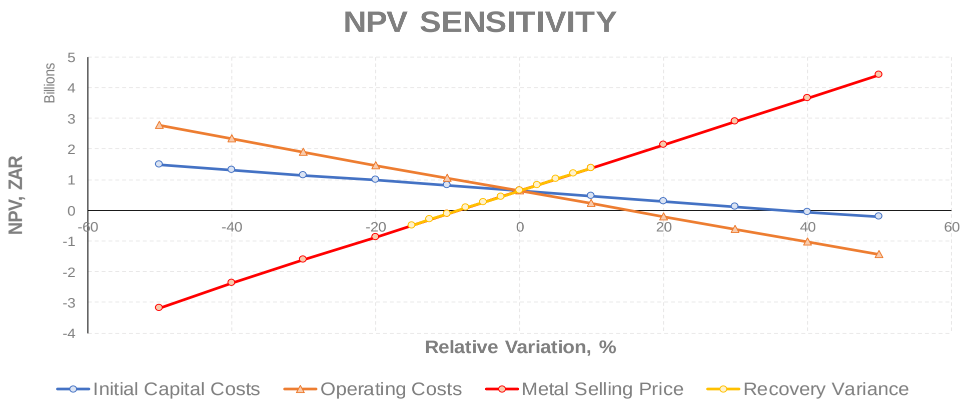
Variation	Index	NPV	IRR
		630 217 848	12.9
(50)	0.50	(3 187 049 367)	#NUM!
(40)	0.60	(2 380 132 490)	(6.4)
(30)	0.70	(1 624 616 862)	0.6
(20)	0.80	(870 609 539)	5.4
(10)	0.90	(116 602 217)	9.4
-	1.00	630 217 848	12.9
10	1.10	1 375 427 888	16.1
20	1.20	2 122 931 219	19.1
30	1.30	2 875 399 303	21.9
40	1.40	3 634 911 017	24.6
50	1.50	4 410 590 990	27.3

Recovery Variance

(All Values Reported in ZAR)

Sensitivity Index			1.00

Variation	Index	NPV	IRR
		630 217 848	12.9
(15.0)	0.85	(493 605 878)	7.5
(12.5)	0.88	(305 104 047)	8.5
(10.0)	0.90	(116 602 217)	9.4
(7.5)	0.93	71 310 318	10.3
(5.0)	0.95	257 612 828	11.2
(2.5)	0.98	443 915 338	12.1
-	1.00	630 217 848	12.9
2.5	1.03	816 520 358	13.8
5.0	1.05	1 002 822 868	14.6
7.5	1.08	1 189 125 378	15.3
10.0	1.10	1 375 427 888	16.1



NPV Discount Rate

(All Values Reported in ZAR)

Sensitivity Value		1

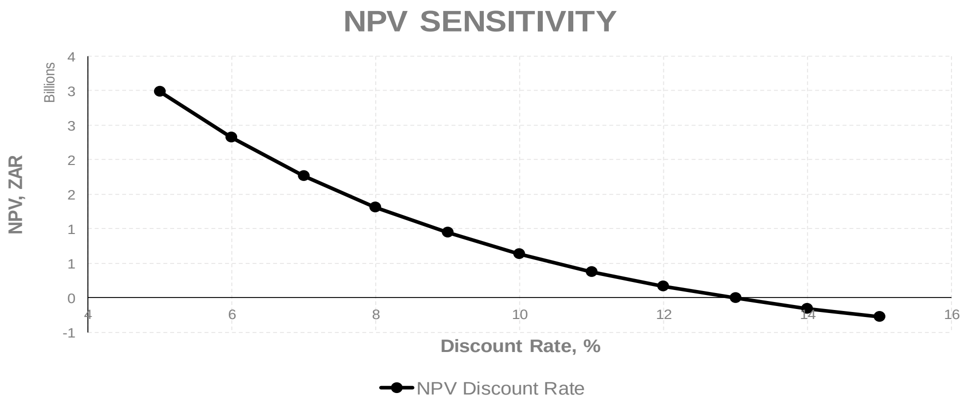
Variation	Value	NPV	Rate
		630 217 848	
(50)	0.50	2 986 014 226	5.0
(40)	0.60	2 317 009 547	6.0
(30)	0.70	1 766 765 624	7.0
(20)	0.80	1 313 388 773	8.0
(10)	0.90	939 274 422	9.0
-	1.00	630 217 848	10.0
10	1.10	374 718 612	11.0
20	1.20	163 434 643	12.0
30	1.30	(11 247 656)	13.0
40	1.40	(155 553 071)	14.0
50	1.50	(274 586 825)	15.0

Contingency Allowance

(All Values Reported in ZAR)

Sensitivity Index			1.00

Variation	Index	NPV	IRR
		630 217 848	12.9
(50)	0.50	801 607 103	13.9
(35)	0.65	750 190 326	13.6
(20)	0.80	698 773 550	13.3
(5)	0.95	647 356 774	13.0
-	1.00	630 217 848	12.9
15	1.15	578 801 072	12.7
30	1.30	527 384 295	12.4
45	1.45	475 967 519	12.1
60	1.60	424 550 742	11.9
75	1.75	373 133 966	11.6
90	1.90	321 717 189	11.4



Appendix B: Solar and battery storage discounted cash flow statement and sensitivity analysis

Item	Units	Total / Average	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025	FY2026	FY2027	FY2028	FY2029	FY2030	FY2031	FY2032	FY2033	FY2034	FY2035	FY2036	FY2037	FY2038	FY2039	FY2040	FY2041	FY2042	FY2043	FY2044	FY2045
Revenue																												
Pt	ZAR	8 737 452 172	-	-	-	-	95 912 076	109 882 219	396 158 343	393 654 762	408 420 983	415 556 669	416 650 723	408 551 987	402 784 753	406 102 840	416 755 269	428 257 988	425 149 345	423 025 014	461 043 080	472 118 181	481 049 085	476 128 574	481 288 703	473 074 883	471 170 863	274 715 834
Total metal produced	ozt	740 553	-	-	-	-	8 129	9 313	33 577	33 365	34 616	35 221	35 314	34 627	34 138	34 420	35 323	36 298	36 034	35 854	39 076	40 015	40 772	40 355	40 792	40 096	39 935	23 284
Metal sales price	ZAR/ozt	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799
Pd	ZAR	18 807 401 029	-	-	-	-	199 478 694	232 690 623	834 943 449	836 649 357	866 019 401	885 444 401	891 371 599	877 097 352	860 392 231	871 770 867	900 798 168	931 017 359	924 791 296	918 672 962	1 001 243 985	1 030 530 539	1 047 858 448	1 035 984 296	1 043 067 320	1 019 343 015	1 011 624 334	586 611 334
Total metal produced	ozt	861 506	-	-	-	-	9 137	10 659	38 246	38 324	39 670	40 559	40 831	40 177	39 412	39 933	41 263	42 647	42 362	42 081	45 864	47 205	47 999	47 455	47 780	46 693	46 339	26 871
Metal sales price	ZAR/ozt	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831
Rh	ZAR	6 307 421 485	-	-	-	-	75 706 803	84 067 250	306 262 400	300 590 927	312 873 856	314 799 878	307 541 070	296 704 756	292 427 127	289 737 966	296 209 986	303 252 750	297 862 148	295 097 001	320 329 633	331 006 936	338 449 536	329 746 343	334 295 520	340 776 118	342 813 455	196 870 025
Total metal produced	ozt	137 349	-	-	-	-	1 649	1 831	6 669	6 546	6 813	6 855	6 697	6 461	6 368	6 309	6 450	6 604	6 486	6 426	6 975	7 208	7 370	7 180	7 280	7 421	7 465	4 287
Metal sales price	ZAR/ozt	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923
Au	ZAR	746 405 084	-	-	-	-	7 144 280	9 269 165	31 476 353	31 314 113	33 225 115	34 372 748	35 341 256	34 280 395	35 676 891	36 562 393	37 787 480	39 703 555	37 804 879	38 409 985	41 468 338	40 427 872	39 869 479	41 517 006	41 460 688	38 114 410	38 468 600	22 710 083
Total metal produced	ozt	38 841	-	-	-	-	372	482	1 638	1 630	1 729	1 789	1 839	1 784	1 857	1 903	1 966	2 066	1 967	1 999	2 158	2 104	2 075	2 160	2 158	1 983	2 002	1 182
Metal sales price	ZAR/ozt	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217
Ni	ZAR	970 579 809	-	-	-	-	11 511 638	12 743 450	48 073 061	47 409 205	49 164 931	49 670 199	48 330 358	46 014 069	45 807 612	44 464 572	45 479 379	45 582 223	44 775 475	44 503 595	48 488 851	50 279 711	51 945 832	48 103 639	50 198 176	52 964 815	54 315 040	30 753 978
Total metal produced	t	5 126	-	-	-	-	61	67	254	250	260	262	255	243	242	235	240	241	236	235	256	266	274	254	265	280	287	162
Metal sales price	ZAR/t	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342
Cu	ZAR	242 977 588	-	-	-	-	3 043 751	3 325 767	11 844 910	11 605 113	11 920 728	12 120 878	12 023 219	11 735 727	11 928 439	11 630 571	11 942 076	11 722 142	12 570 142	12 285 247	12 794 939	12 597 048	12 451 738	12 494 255	12 425 007	11 869 919	11 842 016	6 803 957
Total metal produced	t	3 127	-	-	-	-	39	43	152	149	153	156	155	151	153	150	154	151	162	158	165	162	160	161	160	153	152	88
Metal sales price	ZAR/t	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715
Chrome concentrate	ZAR	3 195 451 130	-	-	-	-	120 564 613	143 199 253	149 358 320	148 980 996	149 359 418	149 534 625	149 923 015	148 853 121	149 464 663	149 395 168	149 757 636	149 563 397	149 215 186	149 335 840	150 349 029	150 128 349	150 472 488	150 206 843	150 804 002	150 159 757	149 550 352	87 275 060
Metal produced	t	2 022 821	-	-	-	-	76 321	90 650	94 548	94 310	94 549	94 660	94 906	94 229	94 616	94 572	94 801	94 678	94 458	94 534	95 176	95 036	95 254	95 086	95 464	95 056	94 670	55 248
Total metal produced	t	2 022 821	-	-	-	-	76 321	90 650	94 548	94 310	94 549	94 660	94 906	94 229	94 616	94 572	94 801	94 678	94 458	94 534	95 176	95 036	95 254	95 086	95 464	95 056	94 670	55 248
Metal sales price	ZAR/t	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580
Gross Revenue	ZAR	39 007 688 298	-	-	-	-	513 361 855	595 177 726	1 778 116 835	1 770 204 472	1 830 984 432	1 861 499 397	1 861 181 240	1 823 237 408	1 798 481 715	1 809 664 378	1 858 729 995	1 909 099 414	1 892 168 472	1 881 329 643	2 035 717 856	2 087 088 636	2 122 096 605	2 094 180 955	2 113 539 415	2 086 302 915	2 079 784 662	1 205 740 271
Purchase of concentrate cost	ZAR	(5 159 353 397)	-	-	-	-	(56 744 894)	(65 210 888)	(235 209 414)	(234 043 117)	(242 742 961)	(247 078 130)	(246 816 206)	(241 353 064)	(237 809 775)	(239 189 684)	(246 169 594)	(253 224 630)	(250 949 985)	(249 340 168)	(271 332 600)	(278 720 736)	(283 733 696)	(279 446 857)	(282 292 758)	(278 785 359)	(278 102 180)	(161 056 700)
Pt	ZAR	(1 223 243 304)	-	-	-	-	(13 427 691)	(15 383 511)	(55 462 168)	(55 111 667)	(57 178 938)	(58 177 934)	(58 331 101)	(57 197 278)	(56 389 865)	(56 854 398)	(58 345 738)	(59 956 118)	(59 520 908)	(59 223 502)	(64 546 031)	(66 096 545)	(67 346 872)	(66 658 000)	(67 380 418)	(66 230 484)	(65 963 921)	(38 460 217)
Pd	ZAR	(2 633 036 144)	-	-	-	-	(27 927 017)	(32 576 687)	(116 892 083)	(117 130 910)	(121 242 716)	(123 962 216)	(124 792 024)	(122 793 629)	(120 454 912)	(122 047 921)	(126 111 744)	(130 342 430)	(129 470 781)	(128 614 215)	(140 174 158)	(144 274 275)	(146 700 183)	(145 037 801)	(146 029 425)	(142 708 022)	(141 627 407)	(82 125 587)
Rh	ZAR	(883 039 008)	-	-	-	-	(10 598 952)	(11 769 415)	(42 876 736)	(42 082 730)	(43 802 340)	(44 071 983)	(43 055 750)	(41 538 666)	(40 939 798)	(40 563 315)	(41 469 398)	(42 455 385)	(41 700 701)	(41 313 580)	(44 846 149)	(46 340 971)	(47 382 935)	(46 164 488)	(46 801 373)	(47 708 657)	(47 993 884)	(27 561 804)
Au	ZAR	(104 496 712)	-	-	-	-	(1 000 199)	(1 297 683)	(4 406 689)	(4 383 976)	(4 651 516)	(4 812 185)	(4 947 776)	(4 799 255)	(4 994 765)	(5 118 735)	(5 290 247)	(5 558 498)	(5 292 683)	(5 377 398)	(5 805 567)	(5 659 902)	(5 581 727)	(5 812 381)	(5 804 496)	(5 336 017)	(5 385 604)	(3 179 412)
Ni	ZAR	(242 644 952)	-	-	-	-	(2 877 909)	(3 185 862)	(12 018 265)	(11 852 301)	(12 291 233)	(12 417 550)	(12 082 590)	(11 503 517)	(11 451 903)	(11 116 143)	(11 369 845)	(11 395 556)	(11 193 869)	(11 125 899)	(12 122 213)	(12 569 928)	(12 986 458)	(12 025 910)	(12 549 544)	(13 241 204)	(13 578 760)	(7 688 494)
Cu	ZAR	(72 893 276)	-	-	-	-	(913 125)	(997 730)	(3 553 473)	(3 481 534)	(3 576 218)	(3 636 263)	(3 606 966)	(3 520 718)	(3 578 532)	(3 489 171)	(3 582 623)	(3 516 643)	(3 771 042)	(3 685 574)	(3 838 482)	(3 779 114)	(3 735 521)	(3 748 276)	(3 727 502)	(3 560 976)	(3 552 605)	(2 041 187)
Treatment charges	ZAR	(428 145 182)	-	-	-	-	(16 153 950)	(19 186 671)	(20 011 899)	(19 961 343)	(20 012 046)	(20 035 521)	(20 087 560)	(19 944 209)	(20 026 147)	(20 016 836)	(20 065 402)	(20 039 376)	(19 992 721)	(20 008 887)	(20 144 640)	(20 115 072)	(20 161 182)	(20 125 589)	(20 205 600)	(20 119 280)	(20 037 629)	(11 693 622)
Concentrate produced	t	252 853	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
Unit charge rate	ZAR/t conc.	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693
Sampling costs	ZAR	(14 908 505)	-	-	-	-	(562 499)	(668 102)	(696 837)	(695 077)	(696 842)	(697 660)	(699 472)	(694 480)	(697 333)	(697 009)	(698 700)	(697 794)	(696 169)	(696 732)	(701 459)	(700 430)	(702 035)	(700 796)	(703 582)	(700 576)	(697 733)	(407 185)
Concentrate produced	t	252 853	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
Unit charge rate	ZAR/t conc.	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59
Product penalties	ZAR	(655 606 303)	-	-	-	-	(55 744 128)	(66 771 887)	(27 158 923)	(27 090 312)	(27 159 123)	(27 190 982)	(27 261 606)	(27 067 059)	(27 178 260)	(27 165 624)	(27 231 534)	(27 196 214)	(27 132 896)	(27 154 836)	(27 339 071)	(27 298 943)	(27 361 521)	(27 313 217)	(27 421 802)	(27 304 655)	(27 193 842)	(15 869 867)
Grade penalty	ZAR	(74 553 888)	-	-	-	-	(33 820 976)	(40 732 912)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concentrate produced	t	252 853	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
4E grade	g/t conc.	216.14	-	-	-	-	62.88	61.17	210.88	210.71	217.98	221.92	222.02	219.31	215.06	217.24	223.11	230.26	228.78	227.31	245.95	252.74	256.56	254.23	255.46	251.80	251.64	250.52
Unit charge rate (<185g/t conc. @ 5g/t conc. increments)	ZAR/penalty increment	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145
Chrome penalty	ZAR	(581 052 415)	-	-	-	-	(21 923 152)	(26 038 975)	(27 158 923)	(27 090 312)	(27 159 123)	(27 190 982)	(27 261 606)	(27 067 059)	(27 178 260)	(27 165 624)	(27 231 534)	(27 196 214)	(27 132 896)	(27 154 836)	(27 339 071)	(27 298 943)	(27 361 521)	(27 313 217)	(27 421 802)	(27 304 655)	(27 193 842)	(15 869 867)
Chrome in concentrate	t	6 321	-	-	-	-	239	283	295	295	295	296	297	294	296	296	296	296	295	295	297	297	298	297	298	297	296	173
Net Revenue	ZAR	32 749 674 911	-	-	-	-	384 156 384	443 340 178	1 495 039 761	1 488 414 623	1 540 373 460	1 566 497 104	1 566 316 396	1 534 178 594	1 512 770 199	1 522 595 225	1 564 564 765	1 607 941 400	1 593 396 701	1 584 129 021	1 716 200 085	1 760 253 455	1 790 138 171	1 766 594 497	1 782 915 672	1 759 393 045	1 753 753 278	1 016 712 897
Operating Costs																												
Mining costs	ZAR	(12 682 541 981)	-	-	(1 124 652)	(3 157 052)	(172 108 619)	(570 184 545)	(648 073 614)	(622 367 601)	(621 696 528)	(611 445 129)	(614 469 424)	(612 127 242)	(613 446 544)	(612 221 377)	(616 717 065)	(612 282 055)	(611 165 015)	(612 647 318)	(603 622 722)	(598 023 564)	(603 229 494)	(592 297 224)	(600 184 630)	(596 298 708)	(594 259 703)	(339 392 155)
Surface infrastructure costs	ZAR	(2 116 992 904)	-	-	(8 940 991)	(13 945 214)	(49 189 920)	(99 014 010)	(99 333 470)	(99 452 719)	(99 516 331)	(99 526 851)	(99 530 227)	(99 532 214)	(99 532 134)	(99 533 965)	(99 532 499)	(99 532 663)	(99 530 572)	(99 553 715)	(99 557 327)	(99 559 044)	(99 558 679)	(99 563 095)	(99 552 792)	(99 557 728)	(99 153 189)	(55 293 554)
Process plant costs	ZAR	(2 216 703 885)	-	-	(9 668 143)	(26 744 091)	(64 197 931)	(102 333 439)	(102 785 359)	(102 954 052)	(103 044 040)	(103 058 922)	(103 063 698)	(103 066 508)	(103 066 396)	(103 068 985)	(103 066 912)	(103 067 143)	(103 064 186)	(103 096 925)	(103 102 034)	(103 104 463)	(103 103 947)	(103 110 194)	(103 095 619)	(103 102 602)	(102 530 327)	(56 207 972)
Chrome plant costs	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Operating Costs	ZAR	(17 016 238 770)	-	-	(19 733 786)	(43 846 356)	(285 496 470)	(771 531 993)	(850 192 444)	(824 774 372)	(824 256 899)	(814 030 902)	(817 063 349)	(814 725 964)	(816 045 074)	(814 824 326)	(819 316 476)	(814 881 860)	(813 759 774)	(815 297 958)	(806 282 083)	(800 687 070)	(805 892 120)	(794 970 513)	(802 833 042)	(798 959 039)	(795 943 219)	(450 893 681)
Initial Capital Expenditure																												
Mining	ZAR	(4 407 532 659)	(1 406 910 386)	(1 406 910 386)	(173 945 096)	(552 983 396)	(571 444 592)	(295 338 803)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Surface infrastructure	ZAR	(159 863 906)	-	-	(46 774 491)	(72 161 736)	(40 927 679)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Process plant	ZAR	(40 514 648)	-	-	(6 339 481)	(34 175 167)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contingency	ZAR	(921 582 242)	(281 382 077)	(281 382 077)	(45 411 814)	(131 864 060)	(122 474 454)	(59 067 761)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital	ZAR	(5 529 493 454)	(1 688 292 463)	(1 688 292 463)	(272 470 881)	(791 184 359)	(734 846 726)	(354 406 564)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIB Capital																												
Mining	ZAR	(3 547 217 050)	-	-	-	(1 679 988)	(21 301 515)	(22 899 837)	(85 989 556)	(38 672 267)	(22 899 837)	(82 504 197)	(82 624 244)	(56 651 840)	(46 571 912)	(46 571 912)	(62 464 388)	(46 571 912)	(2 561 994 512)	(46 571 912)	(56 580 203)	(37 805 438)	(37 805 584)	(37 805 584)	(37 901 651)	(53 578 014)	(37 805 584)	(21 965 160)
Surface infrastructure	ZAR	(50 444 444)	-	-	-	(666 667)	(634 921)	(1 523 810)	(1 523 810)	(19 301 587)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(888 889)
Process plant (incl. chrome recovery)	ZAR	(110 835 194)	-	-	(483 407)	(1 337 205)	(3 209 897)	(5 116 672)	(5 139 268)	(5 147 703)	(5 152 202)	(5 152 946)	(5 153 185)	(5 153 325)	(5 153 320)	(5 153 449)	(5 153 346)	(5 153 357)	(5 153 209)	(5 154 846)	(5 155 102)	(5 155 223)	(5 155 197)	(5 155 510)	(5 154 781)	(5 155 130)	(5 126 516)	(2 810 399)
TSF #3	ZAR	(554 792 165)	-	-	-	(1 258 431)	-	(184 511 245)	(369 022 489)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contingency	ZAR	(426 328 885)	-	-	(48 341)	(494 229)	(2 514 633)	(21 405 156)	(46 167 512)	(6 312 156)	(2 957 585)	(8 918 095)	(8 930 124)	(6 332 897)	(5 324 904)	(5 324 917)	(6 914 154)	(5 324 908)	(256 867 153)	(5 325 057)	(6 325 911)	(4 448 447)	(4 448 459)	(4 448 490)	(4 458 024)	(6 025 695)	(4 445 591)	(2 566 445)
Total SIB Capital	ZAR	(4 689 617 739)	-	-	(531 748)	(5 436 519)	(27 660 965)	(235 456 720)	(507 842 635)	(69 433 712)	(32 533 433)	(98 099 048)	(98 231 362)	(69 661 872)	(58 573 946)	(58 574 088)	(76 055 698)	(58 573 987)	(2 825 538 684)	(58 575 625)	(69 585 026)	(48 932 918)	(48 933 050)	(48 933 394)	(49 038 266)	(66 282 649)	(48 901 501)	(28 230 892)
Environmental Rehabilitation																												
Rehabilitation costs	ZAR	(25 846 550)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)
SLP Costs																												
SLP Projects 2019	ZAR	(175 676 800)	-	-	-	-	(15 488 200)	(16 008 200)	(10 028 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)
Total SLP Costs	ZAR	(175 676 800)	-	-	-	-	(15 488 200)	(16 008 200)	(10 028 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)
Royalties																												
Net revenue	ZAR	32 749 674 911	-	-	-	-	384 156 384	443 340 178	1 495 039 761	1 488 414 623	1 540 373 460	1 566 497 104	1 566 316 396	1 534 178 594	1 512 770 199	1 522 595 225	1 564 564 765	1 607 941 400	1 593 396 701	1 584 129 021	1 716 200 085	1 760 253 455	1 790 138 171	1 766 594 497	1 782 915 672	1 759 393 045	1 753 753 278	1 016 712 897
Earnings before royalties	ZAR	5 312 801 598	(1 689 215 554)	(1 689 215 554)	(293 659 506)	(841 390 325)	(680 259 068)	(934 986 389)	126 053 392	586 895 248	676 271 836	647 055 862	643 710 394	642 479 467	630 839 888	641 885 520	661 881 300	727 174 262	(2 053 213 048)	702 944 147	833 021 685	903 322 176	928 001 710	915 379 299	923 733 074	886 840 067	901 597 266	530 277 033
Royalty % (based on net revenue)	%	5.08	0.50	0.50	0.50	0.50	0.50	0.50	1.44	4.88	5.38	5.09	5.07	5.15	5.13	5.18	5.20	5.52	0.50	5.43	5.89	6.20	6.26	6.26	6.26	6.10	6.21	6.30
Royalty	ZAR	(1 664 788 777)	-	-	-	-	(1 920 782)	(2 216 701)	(21 481 131)	(72 652 656)	(82 843 182)	(79 727 581)	(79 354 959)	(79 057 500)	(77 657 172)	(78 933 589)	(81 365 190)	(88 836 847)	(7 966 984)	(86 025 550)	(101 138 965)	(109 170 398)	(112 061 992)	(110 541 783)	(111 551 587)	(107 334 750)	(108 946 240)	(64 003 235)
All-in Sustaining Cost																												
Net revenue (excluding Pt revenue)	ZAR	25 235 466 043	-	-	-	-	301 671 999	348 841 469	1 154 343 586	1 149 871 528	1 189 131 415	1 209 118 368	1 207 996 774	1 182 823 886	1 166 375 311	1 173 346 783	1 206 155 234	1 239 639 530	1 227 768 264	1 220 327 509	1 319 703 037	1 354 231 819	1 376 435 958	1 357 123 923	1 369 007 388	1 352 548 646	1 348 546 335	780 457 280
All costs (OPEX, SIB CAPEX, Rehab and Royalties)	ZAR	(23 396 491 836)	(923 091)	(923 091)	(21 188 625)	(50 205 967)	(316 001 308)	(1 010 128 504)	(1 380 439 300)	(967 783 831)	(940 556 606)	(992 780 623)	(995 572 761)	(964 368 428)	(953 199 283)	(953 255 095)	(977 660 455)	(963 215 785)	(3 648 188 532)	(960 822 225)	(977 929 165)	(959 713 477)	(967 810 254)	(955 368 781)	(964 345 985)	(973 499 529)	(954 714 052)	(544 050 899)
All-in Sustaining Cost	ZAR	1 838 974 207	(923 091)	(923 091)	(21 188 625)	(50 205 967)	(14 329 310)	(661 287 035)	(226 095 714)	182 087 697	248 574 808	216 337 745	212 424 013	218 455 458	213 176 028	220 091 688	228 494 778	276 423 745	(2 420 420 269)	259 505 285	341 773 871	394 518 342	408 625 705	401 755 142	404 661 403	379 049 117	393 832 283	236 406 381
Unit cost (AISC)	USD/ozt Pt	176	-	-	-	-	(125)	(5 025)	(477)	386	508	435	426	446	442	453	458	539	(4 754)	512	619	698	709	705	702	669	698	719
Unit cost (AISC)	ZAR/ozt Pt	2 483	-	-	-	-	(1 763)	(71 005)	(6 734)	5 457	7 181	6 142	6 015	6 309	6 244	6 394	6 469	7 616	(67 170)	7 238	8 746	9 859	10 022	9 956	9 920	9 454	9 862	10 153
Pre-Tax Cash Flow (EBITDA)	ZAR	3 648 012 821	(1 689 215 554)	(1 689 215 554)	(293 659 506)	(841 390 325)	(682 179 850)	(937 203 090)	104 572 260	514 242 592	593 428 654	567 328 281	564 355 435	563 421 967	553 182 716	562 951 930	580 516 109	638 337 415	(2 061 180 032)	616 918 597	731 882 720	794 151 778	815 939 718	804 837 515	812 181 487	779 505 316	792 651 026	466 273 798
Cumulative Undiscounted Pre-Tax Cash Flow	ZAR	2 403 710 579	(1 689 215 554)	(3 378 431 108)	(3 672 090 613)	(4 513 480 939)	(5 195 660 789)	(6 132 863 879)	(6 028 291 619)	(5 514 049 027)	(4 920 620 373)	(4 353 292 092)	(3 788 936 657)	(3 225 514 690)	(2 672 331 974)	(2 109 380 044)	(1 528 863 935)	(890 526 520)	(2 951 706 552)	(2 334 787 955)	(1 602 905 236)	(808 753 458)	7 186 260	812 023 776	1 624 205 263	2 403 710 579	3 196 361 605	3 662 635 403
Discounted Pre-Tax Cash Flow (EBITDA, 10%)	ZAR	(2 185 679 629)	(1 535 650 503)	(1 396 045 912)	(220 630 733)	(574 680 913)	(423 580 015)	(529 026 711)	53 662 104	239 897 964	251 671 679	218 729 612	197 803 137	179 523 602	160 237 328	148 242 838	138 970 941	138 920 820	(407 793 481)	110 958 232	119 668 673	118 045 601	110 258 400	98 871 048	90 702 932	79 139 743	73 158 518	385 350 246
Cumulative Discounted Pre-Tax Cash Flow (10%)	ZAR	(2 632 103 614)	(1 535 650 503)	(2 931 696 416)	(3 152 327 149)	(3 727 008 062)	(4 150 588 077)	(4 679 614 789)	(4 625 952 684)	(4 386 054 720)	(4 134 383 041)	(3 915 653 430)	(3 717 850 293)	(3 538 326 691)	(3 378 089 362)	(3 229 846 525)	(3 090 875 583)	(2 951 954 764)	(3 359 748 245)	(3 248 790 012)	(3 129 121 339)	(3 011 075 738)	(2 900 817 338)	(2 801 946 290)	(2 711 243 357)	(2 632 103 614)	(2 558 945 096)	(2 173 594 850)

NPV @ 10%	ZAR	-2 520 886 860
IRR	%	3.4
Discounted Payback Period	yrs	26.0
Undiscounted Payback Period	yrs	18.0

Sensitivity Tables

Initial Capital Costs

(All Values Reported in ZAR)

Sensitivity Index 1.00

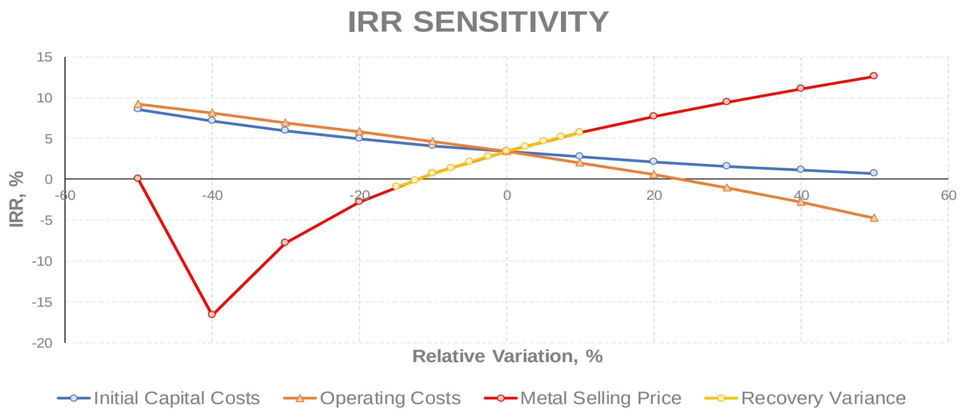
Variation	Index	NPV	IRR
		(2 520 886 860)	3.4
(50)	0.50	(355 121 564)	8.5
(40)	0.60	(788 274 623)	7.1
(30)	0.70	(1 221 427 682)	5.9
(20)	0.80	(1 654 580 742)	5.0
(10)	0.90	(2 087 733 801)	4.1
-	1.00	(2 520 886 860)	3.4
10	1.10	(2 954 039 919)	2.7
20	1.20	(3 387 192 978)	2.1
30	1.30	(3 820 346 038)	1.6
40	1.40	(4 253 499 097)	1.1
50	1.50	(4 686 652 156)	0.6

Operating Costs

(All Values Reported in ZAR)

Sensitivity Index 1.00

Variation	Index	NPV	IRR
		(2 520 886 860)	3.4
(50)	0.50	(367 243 379)	9.2
(40)	0.60	(818 348 393)	8.1
(30)	0.70	(1 264 415 161)	6.9
(20)	0.80	(1 689 064 063)	5.8
(10)	0.90	(2 106 500 627)	4.6
-	1.00	(2 520 886 860)	3.4
10	1.10	(2 935 273 093)	2.0
20	1.20	(3 352 167 249)	0.6
30	1.30	(3 771 401 072)	(1.0)
40	1.40	(4 190 634 895)	(2.8)
50	1.50	(4 609 868 718)	(4.8)



Metal Selling Price

(All Values Reported in ZAR)

Sensitivity Index 1.00

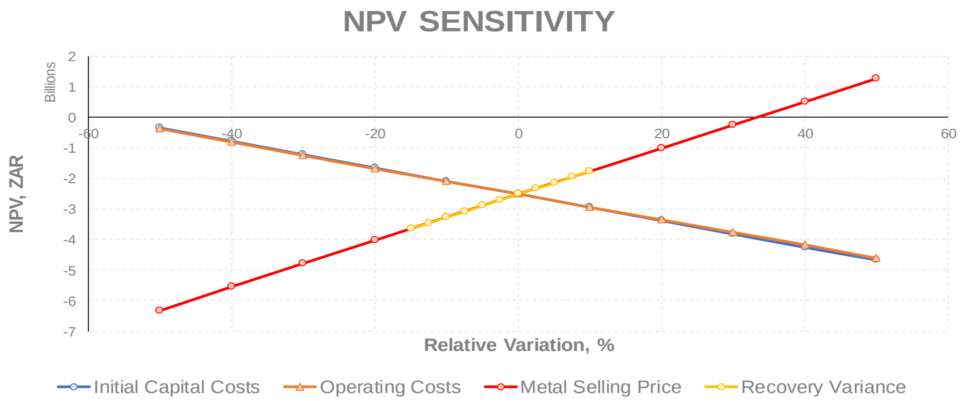
Variation	Index	NPV	IRR
		(2 520 886 860)	3.4
(50)	0.50	(6 353 844 296)	#NUM!
(40)	0.60	(5 545 668 591)	(16.7)
(30)	0.70	(4 786 545 114)	(7.8)
(20)	0.80	(4 028 929 943)	(2.8)
(10)	0.90	(3 271 314 773)	0.6
-	1.00	(2 520 886 860)	3.4
10	1.10	(1 772 068 972)	5.7
20	1.20	(1 020 957 793)	7.6
30	1.30	(264 881 860)	9.4
40	1.40	497 049 380	11.0
50	1.50	1 274 839 944	12.6

Recovery Variance

(All Values Reported in ZAR)

Sensitivity Index 1.00

Variation	Index	NPV	IRR
		(2 520 886 860)	3.4
(15.0)	0.85	(3 650 122 358)	(1.0)
(12.5)	0.88	(3 460 718 565)	(0.1)
(10.0)	0.90	(3 271 314 773)	0.6
(7.5)	0.93	(3 082 500 276)	1.4
(5.0)	0.95	(2 895 295 804)	2.1
(2.5)	0.98	(2 708 091 332)	2.7
-	1.00	(2 520 886 860)	3.4
2.5	1.03	(2 333 682 388)	4.0
5.0	1.05	(2 146 477 916)	4.6
7.5	1.08	(1 959 273 444)	5.1
10.0	1.10	(1 772 068 972)	5.7



NPV Discount Rate

(All Values Reported in ZAR)

Sensitivity Value 1

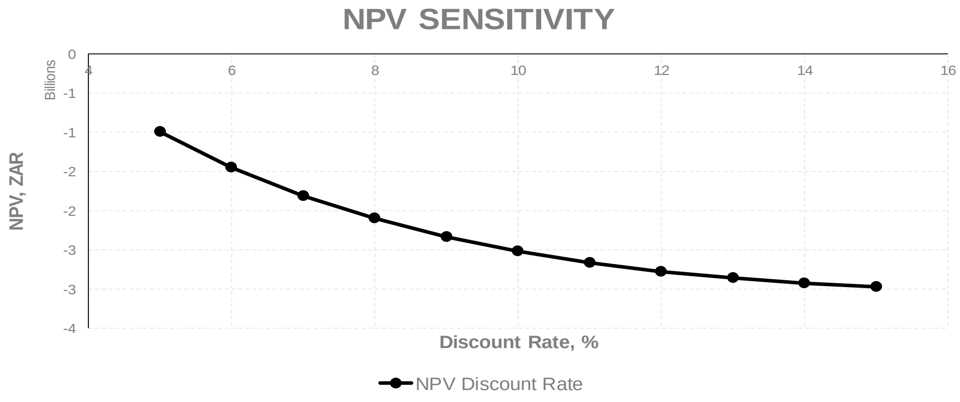
Variation	Value	NPV	Rate
		(2 520 886 860)	
(50)	0.50	(992 924 350)	5.0
(40)	0.60	(1 448 145 822)	6.0
(30)	0.70	(1 812 836 274)	7.0
(20)	0.80	(2 104 400 701)	8.0
(10)	0.90	(2 336 716 325)	9.0
-	1.00	(2 520 886 860)	10.0
10	1.10	(2 665 827 972)	11.0
20	1.20	(2 778 723 215)	12.0
30	1.30	(2 865 380 259)	13.0
40	1.40	(2 930 510 138)	14.0
50	1.50	(2 977 946 852)	15.0

Contingency Allowance

(All Values Reported in ZAR)

Sensitivity Index 1.00

Variation	Index	NPV	IRR
		(2 520 886 860)	3.4
(50)	0.50	(2 106 275 456)	4.2
(35)	0.65	(2 230 658 877)	3.9
(20)	0.80	(2 355 042 298)	3.7
(5)	0.95	(2 479 425 720)	3.4
-	1.00	(2 520 886 860)	3.4
15	1.15	(2 645 270 281)	3.1
30	1.30	(2 769 653 702)	2.9
45	1.45	(2 894 037 124)	2.7
60	1.60	(3 018 420 545)	2.5
75	1.75	(3 142 803 966)	2.3
90	1.90	(3 267 187 387)	2.1



Appendix C: Hydropower discounted cash flow statement and sensitivity analysis

Item	Units	Total / Average	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025	FY2026	FY2027	FY2028	FY2029	FY2030	FY2031	FY2032	FY2033	FY2034	FY2035	FY2036	FY2037	FY2038	FY2039	FY2040	FY2041	FY2042	FY2043	FY2044	FY2045
Revenue																												
Pt	ZAR	8 737 452 172	-	-	-	95 912 076	109 882 219	396 158 343	393 654 762	408 420 983	415 556 669	416 650 723	408 551 987	402 784 753	406 102 840	416 755 269	428 257 988	425 149 345	423 025 014	461 043 080	472 118 181	481 049 085	476 128 574	481 288 703	473 074 883	471 170 863	274 715 834	-
Total metal produced	ozt	740 553	-	-	-	8 129	9 313	33 577	33 365	34 616	35 221	35 314	34 627	34 138	34 420	35 323	36 298	36 034	35 854	39 076	40 015	40 772	40 355	40 792	40 096	39 935	23 284	-
Metal sales price	ZAR/ozt	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799
Pd	ZAR	18 807 401 029	-	-	-	199 478 694	232 690 623	834 943 449	836 649 357	866 019 401	885 444 401	891 371 599	877 097 352	860 392 231	871 770 867	900 798 168	931 017 359	924 791 296	918 672 962	1 001 243 985	1 030 530 539	1 047 858 448	1 035 984 296	1 043 067 320	1 019 343 015	1 011 624 334	586 611 334	-
Total metal produced	ozt	861 506	-	-	-	9 137	10 659	38 246	38 324	39 670	40 559	40 831	40 177	39 412	39 933	41 263	42 647	42 362	42 081	45 864	47 205	47 999	47 455	47 780	46 693	46 339	26 871	-
Metal sales price	ZAR/ozt	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831
Rh	ZAR	6 307 421 485	-	-	-	75 706 803	84 067 250	306 262 400	300 590 927	312 873 856	314 799 878	307 541 070	296 704 756	292 427 127	289 737 966	296 209 986	303 252 750	297 862 148	295 097 001	320 329 633	331 006 936	338 449 536	329 746 343	334 295 520	340 776 118	342 813 455	196 870 025	-
Total metal produced	ozt	137 349	-	-	-	1 649	1 831	6 669	6 546	6 813	6 855	6 697	6 461	6 368	6 309	6 450	6 604	6 486	6 426	6 975	7 208	7 370	7 180	7 280	7 421	7 465	4 287	-
Metal sales price	ZAR/ozt	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923
Au	ZAR	746 405 084	-	-	-	7 144 280	9 269 165	31 476 353	31 314 113	33 225 115	34 372 748	35 341 256	34 280 395	35 676 891	36 562 393	37 787 480	39 703 555	37 804 879	38 409 985	41 468 338	40 427 872	39 869 479	41 517 006	41 460 688	38 114 410	38 468 600	22 710 083	-
Total metal produced	ozt	38 841	-	-	-	372	482	1 638	1 630	1 729	1 789	1 839	1 784	1 857	1 903	1 966	2 066	1 967	1 999	2 158	2 104	2 075	2 160	2 158	1 983	2 002	1 182	-
Metal sales price	ZAR/ozt	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217
Ni	ZAR	970 579 809	-	-	-	11 511 638	12 743 450	48 073 061	47 409 205	49 164 931	49 670 199	48 330 358	46 014 069	45 807 612	44 464 572	45 479 379	45 582 223	44 775 475	44 503 595	48 488 851	50 279 711	51 945 832	48 103 639	50 198 176	52 964 815	54 315 040	30 753 978	-
Total metal produced	t	5 126	-	-	-	61	67	254	250	260	262	255	243	242	235	240	241	236	235	256	266	274	254	265	280	287	162	-
Metal sales price	ZAR/t	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342
Cu	ZAR	242 977 588	-	-	-	3 043 751	3 325 767	11 844 910	11 605 113	11 920 728	12 120 878	12 023 219	11 735 727	11 928 439	11 630 571	11 942 076	11 722 142	12 570 142	12 285 247	12 794 939	12 597 048	12 451 738	12 494 255	12 425 007	11 869 919	11 842 016	6 803 957	-
Total metal produced	t	3 127	-	-	-	39	43	152	149	153	156	155	151	153	150	154	151	162	158	165	162	160	161	160	153	152	88	-
Metal sales price	ZAR/t	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715
Chrome concentrate	ZAR	3 195 451 130	-	-	-	120 564 613	143 199 253	149 358 320	148 980 996	149 359 418	149 534 625	149 923 015	148 853 121	149 464 663	149 395 168	149 757 636	149 563 397	149 215 186	149 335 840	150 349 029	150 128 349	150 472 488	150 206 843	150 804 002	150 159 757	149 550 352	87 275 060	-
Metal produced	t	2 022 821	-	-	-	76 321	90 650	94 548	94 310	94 549	94 660	94 906	94 229	94 616	94 572	94 801	94 678	94 458	94 534	95 176	95 036	95 254	95 086	95 464	95 056	94 670	55 248	-
Total metal produced	t	2 022 821	-	-	-	76 321	90 650	94 548	94 310	94 549	94 660	94 906	94 229	94 616	94 572	94 801	94 678	94 458	94 534	95 176	95 036	95 254	95 086	95 464	95 056	94 670	55 248	-
Metal sales price	ZAR/t	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580
Gross Revenue	ZAR	39 007 688 298	-	-	-	513 361 855	595 177 726	1 778 116 835	1 770 204 472	1 830 984 432	1 861 499 397	1 861 181 240	1 823 237 408	1 798 481 715	1 809 664 378	1 858 729 995	1 909 099 414	1 892 168 472	1 881 329 643	2 035 717 856	2 087 088 636	2 122 096 605	2 094 180 955	2 113 539 415	2 086 302 915	2 079 784 662	1 205 740 271	-
Purchase of concentrate cost	ZAR	(5 159 353 397)	-	-	-	(56 744 894)	(65 210 888)	(235 209 414)	(234 043 117)	(242 742 961)	(247 078 130)	(246 816 206)	(241 353 064)	(237 809 775)	(239 189 684)	(246 169 594)	(253 224 630)	(250 949 985)	(249 340 168)	(271 332 600)	(278 720 736)	(283 733 696)	(279 446 857)	(282 292 758)	(278 785 359)	(278 102 180)	(161 056 700)	-
Pt	ZAR	(1 223 243 304)	-	-	-	(13 427 691)	(15 383 511)	(55 462 168)	(55 111 667)	(57 178 938)	(58 177 934)	(58 331 101)	(57 197 278)	(56 389 865)	(56 854 398)	(58 345 738)	(59 956 118)	(59 520 908)	(59 223 502)	(64 546 031)	(66 096 545)	(67 346 872)	(66 658 000)	(67 380 418)	(66 230 484)	(65 963 921)	(38 460 217)	-
Pd	ZAR	(2 633 036 144)	-	-	-	(27 927 017)	(32 576 687)	(116 892 083)	(117 130 910)	(121 242 716)	(123 962 216)	(124 792 024)	(122 793 629)	(120 454 912)	(122 047 921)	(126 111 744)	(130 342 430)	(129 470 781)	(128 614 215)	(140 174 158)	(144 274 275)	(146 700 183)	(145 037 801)	(146 029 425)	(142 708 022)	(141 627 407)	(82 125 587)	-
Rh	ZAR	(883 039 008)	-	-	-	(10 598 952)	(11 769 415)	(42 876 736)	(42 082 730)	(43 802 340)	(44 071 983)	(43 055 750)	(41 538 666)	(40 939 798)	(40 563 315)	(41 469 398)	(42 455 385)	(41 700 701)	(41 313 580)	(44 846 149)	(46 340 971)	(47 382 935)	(46 164 488)	(46 801 373)	(47 708 657)	(47 993 884)	(27 561 804)	-
Au	ZAR	(104 496 712)	-	-	-	(1 000 199)	(1 297 683)	(4 406 689)	(4 383 976)	(4 651 516)	(4 812 185)	(4 947 776)	(4 799 255)	(4 994 765)	(5 118 735)	(5 290 247)	(5 558 498)	(5 292 683)	(5 377 398)	(5 805 567)	(5 659 902)	(5 581 727)	(5 812 381)	(5 804 496)	(5 336 017)	(5 385 604)	(3 179 412)	-
Ni	ZAR	(242 644 952)	-	-	-	(2 877 909)	(3 185 862)	(12 018 265)	(11 852 301)	(12 291 233)	(12 417 550)	(12 082 590)	(11 503 517)	(11 451 903)	(11 116 143)	(11 369 845)	(11 395 556)	(11 193 869)	(11 125 899)	(12 122 213)	(12 569 928)	(12 986 458)	(12 025 910)	(12 549 544)	(13 241 204)	(13 578 760)	(7 688 494)	-
Cu	ZAR	(72 893 276)	-	-	-	(913 125)	(997 730)	(3 553 473)	(3 481 534)	(3 576 218)	(3 636 263)	(3 606 966)	(3 520 718)	(3 578 532)	(3 489 171)	(3 582 623)	(3 516 643)	(3 771 042)	(3 685 574)	(3 838 482)	(3 779 114)	(3 735 521)	(3 748 276)	(3 727 502)	(3 560 976)	(3 552 605)	(2 041 187)	-
Treatment charges	ZAR	(428 145 182)	-	-	-	(16 153 950)	(19 186 671)	(20 011 899)	(19 961 343)	(20 012 046)	(20 035 521)	(20 087 560)	(19 944 209)	(20 026 147)	(20 016 836)	(20 065 402)	(20 039 376)	(19 992 721)	(20 008 887)	(20 144 640)	(20 115 072)	(20 161 182)	(20 125 589)	(20 205 600)	(20 119 280)	(20 037 629)	(11 693 622)	-
Concentrate produced	t	252 853	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906	-
Unit charge rate	ZAR/t conc.	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693
Sampling costs	ZAR	(14 908 505)	-	-	-	(562 499)	(668 102)	(696 837)	(695 077)	(696 842)	(697 660)	(699 472)	(694 480)	(697 333)	(697 009)	(698 700)	(697 794)	(696 169)	(696 732)	(701 459)	(700 430)	(702 035)	(700 796)	(703 582)	(700 576)	(697 733)	(407 185)	-
Concentrate produced	t	252 853	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906	-
Unit charge rate	ZAR/t conc.	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59
Product penalties	ZAR	(655 606 303)	-	-	-	(55 744 128)	(66 771 887)	(27 158 923)	(27 090 312)	(27 159 123)	(27 190 982)	(27 261 606)	(27 067 059)	(27 178 260)	(27 165 624)	(27 231 534)	(27 196 214)	(27 132 896)	(27 154 836)	(27 339 071)	(27 298 943)	(27 361 521)	(27 313 217)	(27 421 802)	(27 304 655)	(27 193 842)	(15 869 867)	-
Grade penalty	ZAR	(74 553 888)	-	-	-	(33 820 976)	(40 732 912)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concentrate produced	t	252 853	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906	-
4E grade	g/t conc.	218.74	-	-	-	62.88	61.17	210.88	210.71	217.98	221.92	222.02	219.31	215.06	217.24	223.11	230.26	228.78	227.31	245.95	252.74	256.56	254.23	255.46	251.80	251.64	250.52	-
Unit charge rate (<185g/t conc. @ 5g/t conc. increments)	ZAR/penalty increment	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145
Chrome penalty	ZAR	(581 052 415)	-	-	-	(21 923 152)	(26 038 975)	(27 158 923)	(27 090 312)	(27 159 123)	(27 190 982)	(27 261 606)	(27 067 059)	(27 178 260)	(27 165 624)	(27 231 534)	(27 196 214)	(27 132 896)	(27 154 836)	(27 339 071)	(27 298 943)	(27 361 521)	(27 313 217)	(27 421 802)	(27 304 655)	(27 193 842)	(15 869 867)	-
Chrome in concentrate	t	6 321	-	-	-	239	283	295	295	295	296	297	294	296	296	296	296	295	295	297	297	298	297	298	297	296	173	-
Net Revenue	ZAR	32 749 674 911	-	-	-	384 156 384	443 340 178	1 495 039 761	1 488 414 623	1 540 373 460	1 566 497 104	1 566 316 396	1 534 178 594	1 512 770 199	1 522 595 225	1 564 564 765	1 607 941 400	1 593 396 701	1 584 129 021	1 716 200 085	1 760 253 455	1 790 138 171	1 766 594 497	1 782 915 672	1 759 393 045	1 753 753 278	1 016 712 897	-
Operating Costs																												
Mining costs	ZAR	(12 551 021 535)	-	-	(740 017)	(168 285 078)	(562 153 448)	(641 592 191)	(615 892 766)	(615 188 742)	(604 989 349)	(608 019 219)	(605 667 553)	(606 992 545)	(605 762 119)	(610 266 885)	(605 827 387)	(604 716 555)	(606 129 356)	(597 158 556)	(591 564 619)	(596 776 281)	(585 830 843)	(593 758 791)	(589 830 895)	(588 919 731)	(344 958 607)	-
Surface infrastructure costs	ZAR	(2 069 242 913)	-	(8 532 673)	(13 067 682)	(47 801 740)	(96 098 229)	(96 980 316)	(97 101 957)	(97 153 605)	(97 183 007)	(97 188 407)	(97 186 950)	(97 188 937)	(97 188 858)	(97 190 688)	(97 189 222)	(97 189 386)	(97 187 296)	(97 210 439)	(97 214 050)	(97 215 767)	(97 215 402)	(97 219 818)	(97 209 515)	(97 214 452)	(57 314 517)	-
Process plant costs	ZAR	(2 149 155 117)	-	(9 090 522)	(25 502 705)	(62 234 164)	(98 208 675)	(99 456 506)	(99 628 583)	(99 701 647)	(99 743 240)	(99 750 879)	(99 748 818)	(99 751 628)	(99 751 516)	(99 754 106)	(99 752 032)	(99 752 264)	(99 749 307)	(99 782 046)	(99 787 155)	(99 789 583)	(99 789 067)	(99 795 315)	(99 780 740)	(99 787 722)	(59 066 896)	-
Chrome plant costs	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Operating Costs	ZAR	(16 769 419 565)	-	(17 623 196)	(39 310 404)	(278 320 982)	(756 460 352)	(838 029 014)	(812 623 306)	(812 043 994)	(801 915 597)	(804 958 505)	(802 603 321)	(803 933 111)	(802 702 493)	(807 211 678)	(802 768 642)	(801 658 205)	(803 065 959)	(794 151 041)	(788 565 824)	(793 781 631)	(782 835 312)	(790 773 924)	(786 821 150)	(785 921 905)	(461 340 019)	-
Initial Capital Expenditure																												
Mining	ZAR	(1 838 677 879)	(122 482 996)	(122 482 996)	(173 945 096)	(552 983 396)	(571 444 592)	(295 338 803)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Surface infrastructure	ZAR	(159 863 906)	-	-	(46 774 491)	(72 161 736)	(40 927 679)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Process plant	ZAR	(40 514 648)	-	-	(6 339 481)	(34 175 167)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contingency	ZAR	(407 811 287)	(24 496 599)	(24 496 599)	(45 411 814)	(131 864 060)	(122 474 454)	(59 067 761)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital	ZAR	(2 446 867 719)	(146 979 595)	(146 979 595)	(272 470 881)	(791 184 359)	(734 846 726)	(354 406 564)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIB Capital																												
Mining	ZAR	(1 031 794 450)	-	-	-	(1 679 988)	(21 301 515)	(22 899 837)	(85 989 556)	(38 672 267)	(22 899 837)	(82 504 197)	(82 624 244)	(56 651 840)	(46 571 912)	(46 571 912)	(62 464 388)	(46 571 912)	(46 571 912)	(46 571 912)	(56 580 203)	(37 805 438)	(37 805 584)	(37 805 584)	(37 901 651)	(53 578 014)	(37 805 584)	(21 965 160)
Surface infrastructure	ZAR	(50 444 444)	-	-	-	(666 667)	(634 921)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(888 889)
Process plant (incl. chrome recovery)	ZAR	(107 457 756)	-	(454 526)	(1 275 135)	(3 111 708)	(4 910 434)	(4 972 825)	(4 981 429)	(4 985 082)	(4 987 162)	(4 987 544)	(4 987 441)	(4 987 581)	(4 987 576)	(4 987 705)	(4 987 602)	(4 987 613)	(4 987 465)	(4 989 102)	(4 989 358)	(4 989 479)	(4 989 453)	(4 989 766)	(4 989 037)	(4 989 386)	(2 953 345)	-
TSF #3	ZAR	(554 792 165)	-	-	-	(1 258 431)	-	(184 511 245)	(369 022 489)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contingency	ZAR	(174 448 882)	-	(45 453)	(127 514)	(671 679)	(2 684 687)	(21 390 772)	(46 151 728)	(6 295 894)	(2 941 081)	(8 901 555)	(8 913 549)	(6 316 323)	(5 308 330)	(5 308 343)	(6 897 580)	(5 308 333)	(5 308 319)	(5 308 482)	(6 309 337)	(4 431 873)	(4 431 885)	(4 431 916)	(4 441 450)	(6 009 121)	(4 228 274)	(2 285 405)
Total SIB Capital	ZAR	(1 918 937 697)	-	(499 979)	(1 402 649)	(7 388 473)	(29 531 556)	(235 298 488)	(507 669 012)	(69 254 830)	(32 351 890)	(97 917 106)	(98 049 044)	(69 479 554)	(58 391 627)	(58 391 770)	(75 873 379)	(58 391 668)	(58 391 506)	(58 393 306)	(69 402 707)	(48 750 600)	(48 750 732)	(48 751 076)	(48 855 947)	(66 100 331)	(46 511 013)	(25 139 454)
Environmental Rehabilitation																												
Rehabilitation costs	ZAR	(25 846 550)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)
SLP Costs																												
SLP Projects 2019	ZAR	(175 676 800)	-	-	-	-	(15 488 200)	(16 008 200)	(10 028 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)
Total SLP Costs	ZAR	(175 676 800)	-	-	-	-	(15 488 200)	(16 008 200)	(10 028 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)
Royalties																												
Net revenue	ZAR	32 749 674 911	-	-	-	384 156 384	443 340 178	1 495 039 761	1 488 414 623	1 540 373 460	1 566 497 104	1 566 316 396	1 534 178 594	1 512 770 199	1 522 595 225	1 564 564 765	1 607 941 400	1 593 396 701	1 584 129 021	1 716 200 085	1 760 253 455	1 790 138 171	1 766 594 497	1 782 915 672	1 759 393 045	1 753 753 278	1 016 712 897	-
Earnings before royalties	ZAR	11 412 926 580	(147 902 686)	(166 025 861)	(314 107 025)	(693 660 522)	(1 093 909 747)	50 374 404	157 171 014	651 763 345	724 918 326	656 129 494	626 214 938	632 046 243	654 189 814	691 650 025	721 988 088	726 035 536	715 360 266	856 344 447	894 973 632	940 294 649	927 697 161	936 079 381	916 404 657	894 419 751	501 550 574	(32 450 745)
Royalty % (based on net revenue)	%	5.21	0.50	0.50	0.50	0.50	0.50	0.87	1.67	5.20	5.64	5.15	5.04	5.14	5.27	5.41	5.49	5.56	5.52	6.04	6.15	6.34	6.33	6.33	6.29	6.17	5.98	0.50
Royalty	ZAR	(1 705 482 346)	-	-	-	(1 920 782)	(2 216 701)	(13 072 355)	(24 905 519)	(80 120 017)	(88 378 966)	(80 734 859)	(77 250 331)	(77 791 211)	(80 300 733)	(84 672 827)	(88 260 606)	(88 637 599)	(87 405 119)	(103 730 383)	(108 242 782)	(113 427 874)	(111 910 435)	(112 923 399)	(110 619 705)	(108 148 739)	(60 811 406)	-
All-in Sustaining Cost																												
Net revenue (excluding Pt revenue)	ZAR	25 235 466 043	-	-	-	301 671 999	348 841 469	1 154 343 586	1 149 871 528	1 189 131 415	1 209 118 368	1 207 996 774	1 182 823 886	1 166 375 311	1 173 346 783	1 206 155 234	1 239 639 530	1 227 768 264	1 220 327 509	1 319 703 037	1 354 231 819	1 376 435 958	1 357 123 923	1 369 007 388	1 352 548 646	1 348 546 335	780 457 280	-
All costs (OPEX, SIB CAPEX, Rehab and Royalties)	ZAR	(20 419 686 158)	(923 091)	(19 046 266)	(41 636 143)	(288 553 329)	(789 131 700)	(1 087 322 948)	(1 346 120 928)	(962 341 932)	(923 569 544)	(984 533 561)	(978 825 787)	(952 126 967)	(942 317 944)	(951 199 366)	(967 825 718)	(949 610 563)	(949 785 674)	(957 197 822)	(967 134 405)	(956 883 196)	(944 419 570)	(953 371 490)	(947 219 894)	(961 094 066)	(569 585 529)	(26 062 545)
All-in Sustaining Cost	ZAR	4 815 779 885	(923 091)	(19 046 266)	(41 636 143)	13 118 670	(440 290 230)	67 020 638	(196 249 400)	226 789 483	285 548 825	223 463 214	203 998 099	214 248 344	231 028 839	254 955 868	271 813 812	278 157 701	270 541 835	362 505 215	387 097 415	419 552 762	412 704 353	415 635 899	405 328 753	387 452 270	210 871 751	(26 062 545)
Unit cost (AISC)	USD/ozt Pt	460	-	-	-	114	(3 346)	141	(416)	464	574	448	417	444	475	511	530	546	534	657	685	728	724	721	715	687	641	#DIV/0!
Unit cost (AISC)	ZAR/ozt Pt	6 503	-	-	-	1 614	(47 276)	1 996	(5 882)	6 552	8 107	6 328	5 891	6 276	6 712	7 218	7 488	7 719	7 546	9 277	9 674	10 290	10 227	10 189	10 109	9 702	9 057	#DIV/0!
Pre-Tax Cash Flow (EBITDA)	ZAR	9 707 444 234	(147 902 686)	(166 025 861)	(314 107 025)	(695 581 304)	(1 096 126 447)	37 302 049	132 265 495	571 643 328	636 539 360	575 394 635	548 964 608	554 255 032	573 889 081	606 977 199	633 727 482	637 397 938	627 955 147	752 614 064	786 730 850	826 866 775	815 786 726	823 155 983	805 784 952	786 271 012	440 739 168	(32 450 745)
Cumulative Undiscounted Pre-Tax Cash Flow	ZAR	9 313 778 393	(147 902 686)	(313 928 547)	(628 035 571)	(1 323 616 875)	(2 419 743 322)	(2 382 441 273)	(2 250 175 778)	(1 678 532 450)	(1 041 993 090)	(466 598 455)	82 366 153	636 621 185	1 210 510 266	1 817 487 464	2 451 214 946	3 088 612 884	3 716 568 031	4 469 182 094	5 255 912 945	6 082 779 720	6 898 566 446	7 721 722 429	8 527 507 381	9 313 778 393	9 754 517 561	9 722 066 816
Discounted Pre-Tax Cash Flow (EBITDA, 10%)	ZAR	1 087 738 744	(134 456 987)	(137 211 455)	(235 993 257)	(475 091 390)	(680 608 284)	21 056 034	67 873 113	266 675 831	269 954 827	221 839 540	192 408 746	176 602 734	166 235 225	159 836 067	151 709 321	138 716 362	124 237 578	135 364 255	128 636 781	122 908 477	110 237 726	101 121 398	89 988 579	79 826 635	40 678 461	(2 722 794)
Cumulative Discounted Pre-Tax Cash Flow (10%)	ZAR	1 061 867 856	(134 456 987)	(271 668 443)	(507 661 699)	(982 753 089)	(1 663 361 373)	(1 642 305 339)	(1 574 432 226)	(1 307 756 395)	(1 037 801 568)	(815 962 028)	(623 553 282)	(446 950 548)	(280 715 323)	(120 879 256)	30 830 065	169 546 427	293 784 005	429 148 260	557 785 041	680 693 518	790 931 244	892 052 642	982 041 221	1 061 867 856	1 102 546 317	1 099 823 523

NPV @ 10%	ZAR	1 098 758 845
IRR	%	15.8
Discounted Payback Period	yrs	12.0
Undiscounted Payback Period	yrs	8.0

Sensitivity Tables

Initial Capital Costs

(All Values Reported in ZAR)

Sensitivity Index	1.00

Variation	Index	NPV	IRR
		1 098 758 845	15.8
(50)	0.50	1 915 907 169	25.2
(40)	0.60	1 752 477 504	22.6
(30)	0.70	1 589 047 840	20.4
(20)	0.80	1 425 618 175	18.6
(10)	0.90	1 262 188 510	17.1
-	1.00	1 098 758 845	15.8
10	1.10	935 329 180	14.7
20	1.20	770 613 336	13.7
30	1.30	604 960 857	12.7
40	1.40	439 308 378	11.9
50	1.50	273 655 899	11.1

Metal Selling Price

(All Values Reported in ZAR)

Sensitivity Index	1.00

Variation	Index	NPV	IRR
		1 098 758 845	15.8
(50)	0.50	(3 125 205 740)	#NUM!
(40)	0.60	(2 242 042 336)	(6.3)
(30)	0.70	(1 403 620 817)	1.3
(20)	0.80	(565 453 944)	6.8
(10)	0.90	272 510 239	11.5
-	1.00	1 098 758 845	15.8
10	1.10	1 918 489 889	19.9
20	1.20	2 741 206 516	24.0
30	1.30	3 569 768 928	27.9
40	1.40	4 408 900 131	31.8
50	1.50	5 260 079 124	35.7

NPV Discount Rate

(All Values Reported in ZAR)

Sensitivity Value	1

Variation	Value	NPV	Rate
		1 098 758 845	
(50)	0.50	3 522 990 580	5.0
(40)	0.60	2 848 281 700	6.0
(30)	0.70	2 286 716 397	7.0
(20)	0.80	1 818 263 663	8.0
(10)	0.90	1 426 682 011	9.0
-	1.00	1 098 758 845	10.0
10	1.10	823 710 461	11.0
20	1.20	592 707 238	12.0
30	1.30	398 496 695	13.0
40	1.40	235 103 295	14.0
50	1.50	97 588 632	15.0

Operating Costs

(All Values Reported in ZAR)

Sensitivity Index	1.00

Variation	Index	NPV	IRR
		1 098 758 845	15.8
(50)	0.50	3 420 149 936	28.6
(40)	0.60	2 936 618 486	25.9
(30)	0.70	2 455 788 317	23.2
(20)	0.80	1 995 394 109	20.7
(10)	0.90	1 545 176 287	18.2
-	1.00	1 098 758 845	15.8
10	1.10	650 244 790	13.4
20	1.20	198 266 035	11.0
30	1.30	(258 040 849)	8.6
40	1.40	(714 347 734)	6.2
50	1.50	(1 170 654 618)	3.7

Recovery Variance

(All Values Reported in ZAR)

Sensitivity Index	1.00

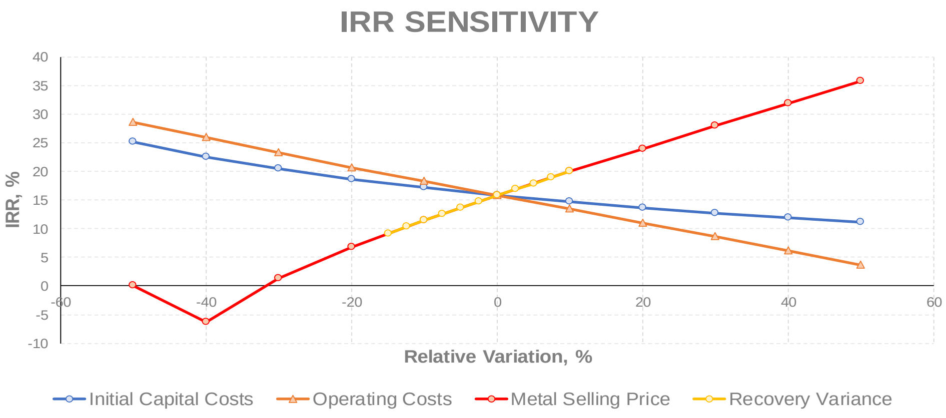
Variation	Index	NPV	IRR
		1 098 758 845	15.8
(15.0)	0.85	(146 370 507)	9.2
(12.5)	0.88	63 171 211	10.3
(10.0)	0.90	272 510 239	11.5
(7.5)	0.93	479 862 253	12.6
(5.0)	0.95	687 214 266	13.7
(2.5)	0.98	893 826 084	14.8
-	1.00	1 098 758 845	15.8
2.5	1.03	1 303 691 606	16.9
5.0	1.05	1 508 624 367	17.9
7.5	1.08	1 713 557 128	18.9
10.0	1.10	1 918 489 889	19.9

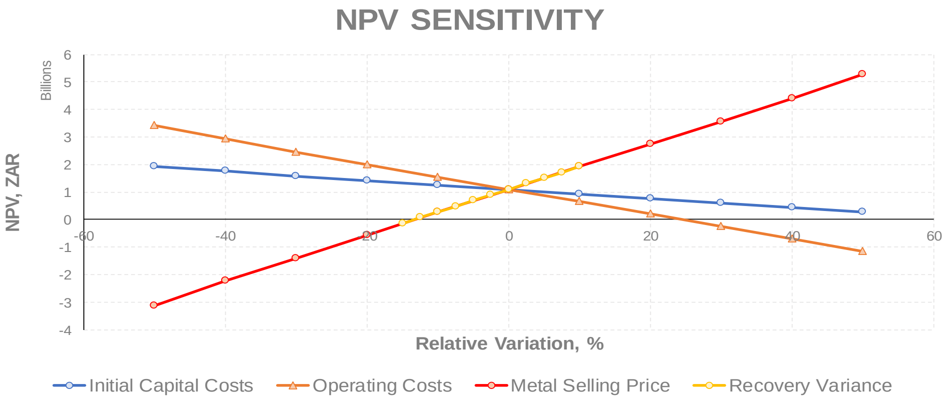
Contingency Allowance

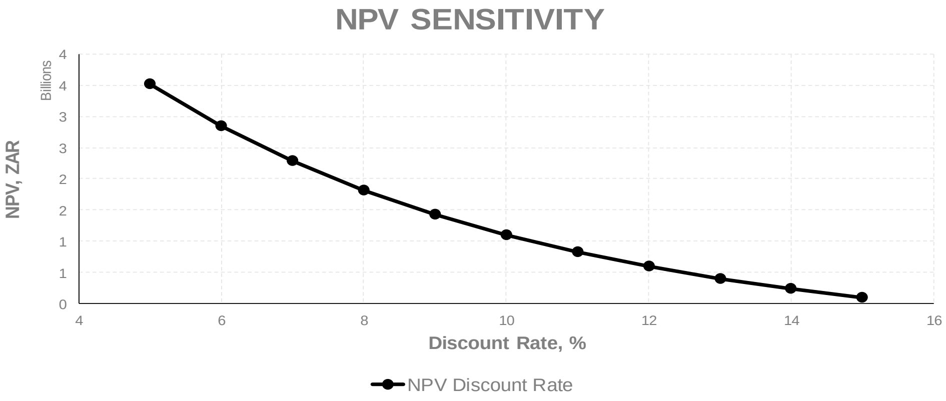
(All Values Reported in ZAR)

Sensitivity Index	1.00

Variation	Index	NPV	IRR
		1 098 758 845	15.8
(50)	0.50	1 263 103 550	17.1
(35)	0.65	1 213 800 139	16.7
(20)	0.80	1 164 496 727	16.3
(5)	0.95	1 115 193 316	16.0
-	1.00	1 098 758 845	15.8
15	1.15	1 049 455 434	15.5
30	1.30	1 000 152 022	15.1
45	1.45	950 848 610	14.8
60	1.60	901 545 199	14.5
75	1.75	851 616 507	14.2
90	1.90	801 556 150	13.9







Appendix D: Grid OHL 20km discounted cash flow statement and sensitivity analysis

Item	Units	Total / Average	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025	FY2026	FY2027	FY2028	FY2029	FY2030	FY2031	FY2032	FY2033	FY2034	FY2035	FY2036	FY2037	FY2038	FY2039	FY2040	FY2041	FY2042	FY2043	FY2044	FY2045	FY2046
Revenue																													
Pt	ZAR	8 737 452 172	-	-	-	-	-	95 912 076	109 882 219	396 158 343	393 654 762	408 420 983	415 556 669	416 650 723	408 551 987	402 784 753	406 102 840	416 755 269	428 257 988	425 149 345	423 025 014	461 043 080	472 118 181	481 049 085	476 128 574	481 288 703	473 074 883	471 170 863	274 715 834
Total metal produced	ozt	740 553	-	-	-	-	-	8 129	9 313	33 577	33 365	34 616	35 221	35 314	34 627	34 138	34 420	35 323	36 298	36 034	35 854	39 076	40 015	40 772	40 355	40 792	40 096	39 935	23 284
Metal sales price	ZAR/ozt	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799
Pd	ZAR	18 807 401 029	-	-	-	-	-	199 478 694	232 690 623	834 943 449	836 649 357	866 019 401	885 444 401	891 371 599	877 097 352	860 392 231	871 770 867	900 798 168	931 017 359	924 791 296	918 672 962	1 001 243 985	1 030 530 539	1 047 858 448	1 035 984 296	1 043 067 320	1 019 343 015	1 011 624 334	586 611 334
Total metal produced	ozt	861 506	-	-	-	-	-	9 137	10 659	38 246	38 324	39 670	40 559	40 831	40 177	39 412	39 933	41 263	42 647	42 362	42 081	45 864	47 205	47 999	47 455	47 780	46 693	46 339	26 871
Metal sales price	ZAR/ozt	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831
Rh	ZAR	6 307 421 485	-	-	-	-	-	75 706 803	84 067 250	306 262 400	300 590 927	312 873 856	314 799 878	307 541 070	296 704 756	292 427 127	289 737 966	296 209 986	303 252 750	297 862 148	295 097 001	320 329 633	331 006 936	338 449 536	329 746 343	334 295 520	340 776 118	342 813 455	196 870 025
Total metal produced	ozt	137 349	-	-	-	-	-	1 649	1 831	6 669	6 546	6 813	6 855	6 697	6 461	6 368	6 309	6 450	6 604	6 486	6 426	6 975	7 208	7 370	7 180	7 280	7 421	7 465	4 287
Metal sales price	ZAR/ozt	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923
Au	ZAR	746 405 084	-	-	-	-	-	7 144 280	9 269 165	31 476 353	31 314 113	33 225 115	34 372 748	35 341 256	34 280 395	35 676 891	36 562 393	37 787 480	39 703 555	37 804 879	38 409 985	41 468 338	40 427 872	39 869 479	41 517 006	41 460 688	38 114 410	38 468 600	22 710 083
Total metal produced	ozt	38 841	-	-	-	-	-	372	482	1 638	1 630	1 729	1 789	1 839	1 784	1 857	1 903	1 966	2 066	1 967	1 999	2 158	2 104	2 075	2 160	2 158	1 983	2 002	1 182
Metal sales price	ZAR/ozt	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217
Ni	ZAR	970 579 809	-	-	-	-	-	11 511 638	12 743 450	48 073 061	47 409 205	49 164 931	49 670 199	48 330 358	46 014 069	45 807 612	44 464 572	45 479 379	45 582 223	44 775 475	44 503 595	48 488 851	50 279 711	51 945 832	48 103 639	50 198 176	52 964 815	54 315 040	30 753 978
Total metal produced	t	5 126	-	-	-	-	-	61	67	254	250	260	262	255	243	242	235	240	241	236	235	256	266	274	254	265	280	287	162
Metal sales price	ZAR/t	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342
Cu	ZAR	242 977 588	-	-	-	-	-	3 043 751	3 325 767	11 844 910	11 605 113	11 920 728	12 120 878	12 023 219	11 735 727	11 928 439	11 630 571	11 942 076	11 722 142	12 570 142	12 285 247	12 794 939	12 597 048	12 451 738	12 494 255	12 425 007	11 869 919	11 842 016	6 803 957
Total metal produced	t	3 127	-	-	-	-	-	39	43	152	149	153	156	155	151	153	150	154	151	162	158	165	162	160	161	160	153	152	88
Metal sales price	ZAR/t	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715
Chrome concentrate	ZAR	3 195 451 130	-	-	-	-	-	120 564 613	143 199 253	149 358 320	148 980 996	149 359 418	149 534 625	149 923 015	148 853 121	149 464 663	149 395 168	149 757 636	149 563 397	149 215 186	149 335 840	150 349 029	150 128 349	150 472 488	150 206 843	150 804 002	150 159 757	149 550 352	87 275 060
Metal produced	t	2 022 821	-	-	-	-	-	76 321	90 650	94 548	94 310	94 549	94 660	94 906	94 229	94 616	94 572	94 801	94 678	94 458	94 534	95 176	95 036	95 254	95 086	95 464	95 056	94 670	55 248
Total metal produced	t	2 022 821	-	-	-	-	-	76 321	90 650	94 548	94 310	94 549	94 660	94 906	94 229	94 616	94 572	94 801	94 678	94 458	94 534	95 176	95 036	95 254	95 086	95 464	95 056	94 670	55 248
Metal sales price	ZAR/t	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580
Gross Revenue	ZAR	39 007 688 298	-	-	-	-	-	513 361 855	595 177 726	1 778 116 835	1 770 204 472	1 830 984 432	1 861 499 397	1 861 181 240	1 823 237 408	1 798 481 715	1 809 664 378	1 858 729 995	1 909 099 414	1 892 168 472	1 881 329 643	2 035 717 856	2 087 088 636	2 122 096 605	2 094 180 955	2 113 539 415	2 086 302 915	2 079 784 662	1 205 740 271
Purchase of concentrate cost	ZAR	(5 159 353 397)	-	-	-	-	-	(56 744 894)	(65 210 888)	(235 209 414)	(234 043 117)	(242 742 961)	(247 078 130)	(246 816 206)	(241 353 064)	(237 809 775)	(239 189 684)	(246 169 594)	(253 224 630)	(250 949 985)	(249 340 168)	(271 332 600)	(278 720 736)	(283 733 696)	(279 446 857)	(282 292 758)	(278 785 359)	(278 102 180)	(161 056 700)
Pt	ZAR	(1 223 243 304)	-	-	-	-	-	(13 427 691)	(15 383 511)	(55 462 168)	(55 111 667)	(57 178 938)	(58 177 934)	(58 331 101)	(57 197 278)	(56 389 865)	(56 854 398)	(58 345 738)	(59 956 118)	(59 520 908)	(59 223 502)	(64 546 031)	(66 096 545)	(67 346 872)	(66 658 000)	(67 380 418)	(66 230 484)	(65 963 921)	(38 460 217)
Pd	ZAR	(2 633 036 144)	-	-	-	-	-	(27 927 017)	(32 576 687)	(116 892 083)	(117 130 910)	(121 242 716)	(123 962 216)	(124 792 024)	(122 793 629)	(120 454 912)	(122 047 921)	(126 111 744)	(130 342 430)	(129 470 781)	(128 614 215)	(140 174 158)	(144 274 275)	(146 700 183)	(145 037 801)	(146 029 425)	(142 708 022)	(141 627 407)	(82 125 587)
Rh	ZAR	(883 039 008)	-	-	-	-	-	(10 598 952)	(11 769 415)	(42 876 736)	(42 082 730)	(43 802 340)	(44 071 983)	(43 055 750)	(41 538 666)	(40 939 798)	(40 563 315)	(41 469 398)	(42 455 385)	(41 700 701)	(41 313 580)	(44 846 149)	(46 340 971)	(47 382 935)	(46 164 488)	(46 801 373)	(47 708 657)	(47 993 884)	(27 561 804)
Au	ZAR	(104 496 712)	-	-	-	-	-	(1 000 199)	(1 297 683)	(4 406 689)	(4 383 976)	(4 651 516)	(4 812 185)	(4 947 776)	(4 799 255)	(4 994 765)	(5 118 735)	(5 290 247)	(5 558 498)	(5 292 683)	(5 377 398)	(5 805 567)	(5 659 902)	(5 581 727)	(5 812 381)	(5 804 496)	(5 336 017)	(5 385 604)	(3 179 412)
Ni	ZAR	(242 644 952)	-	-	-	-	-	(2 877 909)	(3 185 862)	(12 018 265)	(11 852 301)	(12 291 233)	(12 417 550)	(12 082 590)	(11 503 517)	(11 451 903)	(11 116 143)	(11 369 845)	(11 395 556)	(11 193 869)	(11 125 899)	(12 122 213)	(12 569 928)	(12 986 458)	(12 025 910)	(12 549 544)	(13 241 204)	(13 578 760)	(7 688 494)
Cu	ZAR	(72 893 276)	-	-	-	-	-	(913 125)	(997 730)	(3 553 473)	(3 481 534)	(3 576 218)	(3 636 263)	(3 606 966)	(3 520 718)	(3 578 532)	(3 489 171)	(3 582 623)	(3 516 643)	(3 771 042)	(3 685 574)	(3 838 482)	(3 779 114)	(3 735 521)	(3 748 276)	(3 727 502)	(3 560 976)	(3 552 605)	(2 041 187)
Treatment charges	ZAR	(428 145 182)	-	-	-	-	-	(16 153 950)	(19 186 671)	(20 011 899)	(19 961 343)	(20 012 046)	(20 035 521)	(20 087 560)	(19 944 209)	(20 026 147)	(20 016 836)	(20 065 402)	(20 039 376)	(19 992 721)	(20 008 887)	(20 144 640)	(20 115 072)	(20 161 182)	(20 125 589)	(20 205 600)	(20 119 280)	(20 037 629)	(11 693 622)
Concentrate produced	t	252 853	-	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
Unit charge rate	ZAR/t conc.	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693
Sampling costs	ZAR	(14 908 505)	-	-	-	-	-	(562 499)	(668 102)	(696 837)	(695 077)	(696 842)	(697 660)	(699 472)	(694 480)	(697 333)	(697 009)	(698 700)	(697 794)	(696 169)	(696 732)	(701 459)	(700 430)	(702 035)	(700 796)	(703 582)	(700 576)	(697 733)	(407 185)
Concentrate produced	t	252 853	-	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
Unit charge rate	ZAR/t conc.	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59
Product penalties	ZAR	(655 606 303)	-	-	-	-	-	(55 744 128)	(66 771 887)	(27 158 923)	(27 090 312)	(27 159 123)	(27 190 982)	(27 261 606)	(27 067 059)	(27 178 260)	(27 165 624)	(27 231 534)	(27 196 214)	(27 132 896)	(27 154 836)	(27 339 071)	(27 298 943)	(27 361 521)	(27 313 217)	(27 421 802)	(27 304 655)	(27 193 842)	(15 869 867)
Grade penalty	ZAR	(74 553 888)	-	-	-	-	-	(33 820 976)	(40 732 912)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concentrate produced	t	252 853	-	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
4E grade	g/t conc.	214.24	-	-	-	-	-	62.88	61.17	210.88	210.71	217.98	221.92	222.02	219.31	215.06	217.24	223.11	230.26	228.78	227.31	245.95	252.74	256.56	254.23	255.46	251.80	251.64	250.52
Unit charge rate (<185g/t conc. @ 5g/t conc. increments)	ZAR/penalty increment	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145
Chrome penalty	ZAR	(581 052 415)	-	-	-	-	-	(21 923 152)	(26 038 975)	(27 158 923)	(27 090 312)	(27 159 123)	(27 190 982)	(27 261 606)	(27 067 059)	(27 178 260)	(27 165 624)	(27 231 534)	(27 196 214)	(27 132 896)	(27 154 836)	(27 339 071)	(27 298 943)	(27 361 521)	(27 313 217)	(27 421 802)	(27 304 655)	(27 193 842)	(15 869 867)
Chrome in concentrate	t	6 321	-	-	-	-	-	239	283	295	295	295	296	297	294	296	296	296	296	295	295	297	297	298	297	298	297	296	173
Net Revenue	ZAR	32 749 674 911	-	-	-	-	-	384 156 384	443 340 178	1 495 039 761	1 488 414 623	1 540 373 460	1 566 497 104	1 566 316 396	1 534 178 594	1 512 770 199	1 522 595 225	1 564 564 765	1 607 941 400	1 593 396 701	1 584 129 021	1 716 200 085	1 760 253 455	1 790 138 171	1 766 594 497	1 782 915 672	1 759 393 045	1 753 753 278	1 016 712 897
Operating Costs																													
Mining costs	ZAR	(14 219 863 457)	-	-	-	(4 936 079)	(11 312 283)	(200 244 115)	(632 445 000)	(716 943 800)	(693 290 881)	(693 678 880)	(683 601 170)	(686 792 976)	(684 432 932)	(685 757 924)	(684 527 498)	(689 032 264)	(684 592 766)	(683 481 934)	(684 894 735)	(675 923 935)	(670 329 998)	(675 541 660)	(664 596 222)	(672 524 170)	(668 596 274)	(667 685 110)	(404 700 849)
Surface infrastructure costs	ZAR	(2 675 134 920)	-	-	-	(10 324 773)	(16 906 063)	(59 404 831)	(121 618 375)	(124 337 573)	(125 202 221)	(125 650 341)	(125 723 921)	(125 788 114)	(125 783 615)	(125 785 602)	(125 785 523)	(125 787 353)	(125 785 887)	(125 786 051)	(125 783 961)	(125 807 104)	(125 810 716)	(125 812 432)	(125 812 067)	(125 816 484)	(125 806 181)	(125 811 117)	(79 004 616)
Process plant costs	ZAR	(3 006 270 639)	-	-	-	(11 625 687)	(30 932 609)	(78 648 293)	(134 310 346)	(138 157 016)	(139 380 177)	(140 014 103)	(140 118 192)	(140 209 001)	(140 202 637)	(140 205 447)	(140 205 335)	(140 207 924)	(140 205 851)	(140 206 082)	(140 203 126)	(140 235 865)	(140 240 974)	(140 243 402)	(140 242 886)	(140 249 133)	(140 234 559)	(140 241 541)	(89 750 451)
Chrome plant costs	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Operating Costs	ZAR	(19 901 269 016)	-	-	-	(26 886 539)	(59 150 955)	(338 297 240)	(888 373 721)	(979 438 389)	(957 873 279)	(959 343 324)	(949 443 284)	(952 790 091)	(950 419 184)	(951 748 974)	(950 518 356)	(955 027 541)	(950 584 505)	(949 474 068)	(950 881 822)	(941 966 904)	(936 381 687)	(941 597 494)	(930 651 175)	(938 589 787)	(934 637 013)	(933 737 768)	(573 455 916)
Initial Capital Expenditure																													
Mining	ZAR	(1 688 711 887)	-	-	(95 000 000)	(173 945 096)	(552 983 396)	(571 444 592)	(295 338 803)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Surface infrastructure	ZAR	(159 863 906)	-	-	-	(46 774 491)	(72 161 736)	(40 927 679)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Process plant	ZAR	(40 514 648)	-	-	-	(6 339 481)	(34 175 167)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contingency	ZAR	(377 818 088)	-	-	(19 000 000)	(45 411 814)	(131 864 060)	(122 474 454)	(59 067 761)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital	ZAR	(2 266 908 529)	-	-	(114 000 000)	(272 470 881)	(791 184 359)	(734 846 726)	(354 406 564)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIB Capital																													
Mining	ZAR	(1 031 794 450)	-	-	-	-	(1 679 988)	(21 301 515)	(22 899 837)	(85 989 556)	(38 672 267)	(22 899 837)	(82 504 197)	(82 624 244)	(56 651 840)	(46 571 912)	(46 571 912)	(62 464 388)	(46 571 912)	(46 571 912)	(46 571 912)	(56 580 203)	(37 805 438)	(37 805 584)	(37 805 584)	(37 901 651)	(53 578 014)	(37 805 584)	(21 965 160)
Surface infrastructure	ZAR	(50 444 444)	-	-	-	-	(666 667)	(634 921)	(1 523 810)	(1 523 810)	(19 301 587)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(888 889)
Process plant (incl. chrome recovery)	ZAR	(150 313 532)	-	-	-	(581 284)	(1 546 630)	(3 932 415)	(6 715 517)	(6 907 851)	(6 969 009)	(7 000 705)	(7 005 910)	(7 010 450)	(7 010 132)	(7 010 272)	(7 010 267)	(7 010 396)	(7 010 293)	(7 010 304)	(7 010 156)	(7 011 793)	(7 012 049)	(7 012 170)	(7 012 144)	(7 012 457)	(7 011 728)	(7 012 077)	(4 487 523)
TSF #3	ZAR	(554 792 165)	-	-	-	-	(1 258 431)	-	(184 511 245)	(369 022 489)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contingency	ZAR	(178 734 459)	-	-	-	(58 128)	(515 172)	(2 586 885)	(21 565 041)	(46 344 371)	(6 494 286)	(3 142 435)	(9 103 392)	(9 115 850)	(6 518 578)	(5 510 599)	(5 510 599)	(7 099 859)	(5 510 601)	(5 510 603)	(5 510 588)	(6 511 581)	(4 634 130)	(4 634 156)	(4 634 154)	(4 643 792)	(6 211 355)	(4 634 147)	(2 734 157)
Total SIB Capital	ZAR	(1 966 079 050)	-	-	-	(639 413)	(5 666 888)	(28 455 735)	(237 215 449)	(509 788 076)	(71 437 149)	(34 566 787)	(100 137 308)	(100 274 354)	(71 704 360)	(60 616 593)	(60 616 587)	(78 098 454)	(60 616 616)	(60 616 628)	(60 616 466)	(71 627 386)	(50 975 426)	(50 975 721)	(50 975 692)	(51 081 709)	(68 324 907)	(50 975 618)	(30 075 729)
Environmental Rehabilitation																													
Rehabilitation costs	ZAR	(25 846 550)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)
SLP Costs																													
SLP Projects 2019	ZAR	(175 676 800)	-	-	-	-	(15 488 200)	(16 008 200)	(10 028 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)
Total SLP Costs	ZAR	(175 676 800)	-	-	-	-	(15 488 200)	(16 008 200)	(10 028 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)
Royalties																													
Net revenue	ZAR	32 749 674 911	-	-	-	-	-	384 156 384	443 340 178	1 495 039 761	1 488 414 623	1 540 373 460	1 566 497 104	1 566 316 396	1 534 178 594	1 512 770 199	1 522 595 225	1 564 564 765	1 607 941 400	1 593 396 701	1 584 129 021	1 716 200 085	1 760 253 455	1 790 138 171	1 766 594 497	1 782 915 672	1 759 393 045	1 753 753 278	1 016 712 897
Earnings before royalties	ZAR	8 413 894 966	(923 091)	(923 091)	(114 923 091)	(300 919 924)	(872 413 493)	(734 374 607)	(1 047 606 847)	(1 497 995)	451 792 904	539 152 058	509 605 221	505 940 660	504 743 760	493 093 341	504 148 991	524 127 478	589 428 989	575 994 713	565 319 443	695 294 504	765 585 051	790 253 665	777 656 338	785 932 885	749 119 834	761 728 600	405 869 961
Royalty % (based on net revenue)	%	4.40	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	3.87	4.39	4.11	4.09	4.16	4.12	4.18	4.22	4.57	4.52	4.47	5.00	5.33	5.40	5.39	5.40	5.23	5.33	4.94
Royalty	ZAR	(1 440 947 085)	-	-	-	-	-	(1 920 782)	(2 216 701)	(7 475 199)	(57 641 285)	(67 607 651)	(64 455 288)	(64 047 211)	(63 753 533)	(62 352 000)	(63 629 531)	(66 059 210)	(73 531 817)	(71 966 396)	(70 733 917)	(85 835 945)	(93 866 273)	(96 756 654)	(95 239 232)	(96 240 454)	(92 032 502)	(93 405 278)	(50 180 227)
All-in Sustaining Cost																													
Net revenue (excluding Pt revenue)	ZAR	25 235 466 043	-	-	-	-	-	301 671 999	348 841 469	1 154 343 586	1 149 871 528	1 189 131 415	1 209 118 368	1 207 996 774	1 182 823 886	1 166 375 311	1 173 346 783	1 206 155 234	1 239 639 530	1 227 768 264	1 220 327 509	1 319 703 037	1 354 231 819	1 376 435 958	1 357 123 923	1 369 007 388	1 352 548 646	1 348 546 335	780 457 280
All costs (OPEX, SIB CAPEX, Rehab and Royalties)	ZAR	(23 334 141 701)	(923 091)	(923 091)	(923 091)	(28 449 043)	(65 740 934)	(369 596 847)	(1 128 728 962)	(1 497 624 754)	(1 087 874 804)	(1 062 440 854)	(1 114 958 971)	(1 118 034 747)	(1 086 800 168)	(1 075 640 658)	(1 075 687 565)	(1 100 108 296)	(1 085 656 028)	(1 082 980 183)	(1 083 155 295)	(1 100 353 327)	(1 082 146 477)	(1 090 252 960)	(1 077 789 191)	(1 086 835 042)	(1 095 917 514)	(1 079 041 755)	(654 634 963)
All-in Sustaining Cost	ZAR	1 901 324 342	(923 091)	(923 091)	(923 091)	(28 449 043)	(65 740 934)	(67 924 849)	(779 887 493)	(343 281 168)	61 996 724	126 690 561	94 159 397	89 962 028	96 023 718	90 734 653	97 659 218	106 046 937	153 983 502	144 788 080	137 172 214	219 349 710	272 085 342	286 182 999	279 334 732	282 172 346	256 631 133	269 504 580	125 822 317
Unit cost (AISC)	USD/ozt Pt	182	-	-	-	-	-	(591)	(5 926)	(724)	132	259	189	180	196	188	201	212	300	284	271	397	481	497	490	490	453	478	382
Unit cost (AISC)	ZAR/ozt Pt	2 567	-	-	-	-	-	(8 356)	(83 740)	(10 224)	1 858	3 660	2 673	2 548	2 773	2 658	2 837	3 002	4 242	4 018	3 826	5 613	6 800	7 019	6 922	6 917	6 400	6 749	5 404
Pre-Tax Cash Flow (EBITDA)	ZAR	6 972 947 881	(923 091)	(923 091)	(114 923 091)	(300 919 924)	(872 413 493)	(736 295 389)	(1 049 823 548)	(8 973 194)	394 151 619	471 544 406	445 149 933	441 893 450	440 990 227	430 741 341	440 519 461	458 068 268	515 897 172	504 028 317	494 585 526	609 458 559	671 718 778	693 497 012	682 417 106	689 692 431	657 087 332	668 323 323	355 689 734
Cumulative Undiscounted Pre-Tax Cash Flow	ZAR	5 299 158 783	(923 091)	(1 846 182)	(116 769 273)	(417 689 197)	(1 290 102 690)	(2 026 398 079)	(3 076 221 627)	(3 085 194 821)	(2 691 043 201)	(2 219 498 795)	(1 774 348 862)	(1 332 455 413)	(891 465 186)	(460 723 845)	(20 204 385)	437 863 884	953 761 055	1 457 789 373	1 952 374 899	2 561 833 457	3 233 552 235	3 927 049 247	4 609 466 353	5 299 158 783	5 956 246 115	6 624 569 438	6 980 259 172
Discounted Pre-Tax Cash Flow (EBITDA, 10%)	ZAR	128 110 889	(839 174)	(762 885)	(86 343 419)	(205 532 357)	(541 700 140)	(415 619 552)	(538 725 476)	(4 186 061)	167 158 763	181 800 781	156 022 336	140 800 871	127 739 160	113 427 658	105 456 856	99 689 001	102 067 505	90 653 923	80 868 686	90 592 131	90 769 742	85 193 316	76 211 085	70 021 436	60 646 531	56 075 971	27 131 189
Cumulative Discounted Pre-Tax Cash Flow (10%)	ZAR	(15 235 813)	(839 174)	(1 602 059)	(87 945 478)	(293 477 835)	(835 177 975)	(1 250 797 527)	(1 789 523 004)	(1 793 709 065)	(1 626 550 302)	(1 444 749 520)	(1 288 727 184)	(1 147 926 313)	(1 020 187 153)	(906 759 495)	(801 302 639)	(701 613 637)	(599 546 132)	(508 892 209)	(428 023 523)	(337 431 392)	(246 661 650)	(161 468 335)	(85 257 249)	(15 235 813)	45 410 718	101 486 689	128 617 879

NPV @ 10%	ZAR	128 110 889
IRR	%	10.7
Discounted Payback Period	yrs	22.0
Undiscounted Payback Period	yrs	13.0

Sensitivity Tables

Initial Capital Costs

(All Values Reported in ZAR)

Sensitivity Index 1.00

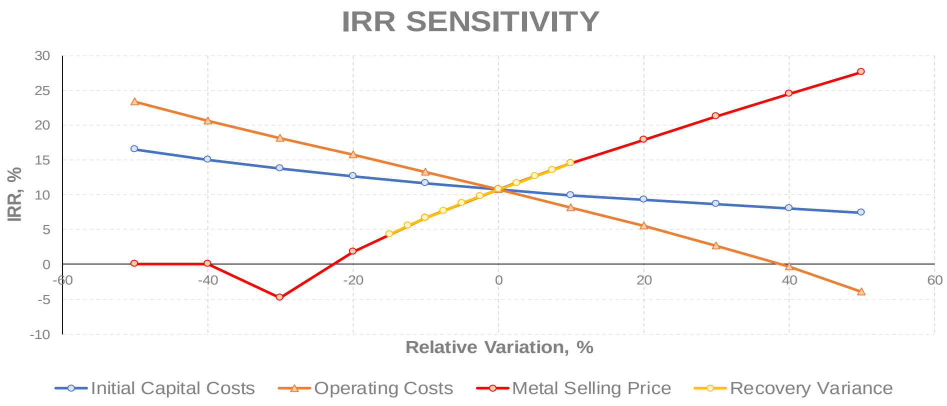
Variation	Index	NPV	IRR
		128 110 889	10.7
(50)	0.50	807 952 304	16.5
(40)	0.60	671 984 021	15.0
(30)	0.70	536 015 738	13.7
(20)	0.80	400 047 455	12.6
(10)	0.90	264 079 172	11.6
-	1.00	128 110 889	10.7
10	1.10	(7 857 394)	10.0
20	1.20	(143 825 676)	9.2
30	1.30	(279 793 959)	8.6
40	1.40	(415 762 242)	8.0
50	1.50	(551 730 525)	7.5

Operating Costs

(All Values Reported in ZAR)

Sensitivity Index 1.00

Variation	Index	NPV	IRR
		128 110 889	10.7
(50)	0.50	2 364 721 386	23.3
(40)	0.60	1 891 020 070	20.7
(30)	0.70	1 442 699 706	18.2
(20)	0.80	1 003 651 106	15.7
(10)	0.90	565 919 821	13.2
-	1.00	128 110 889	10.7
10	1.10	(314 697 232)	8.2
20	1.20	(757 505 352)	5.5
30	1.30	(1 200 313 473)	2.7
40	1.40	(1 643 121 594)	(0.4)
50	1.50	(2 087 208 781)	(3.9)



Metal Selling Price

(All Values Reported in ZAR)

Sensitivity Index 1.00

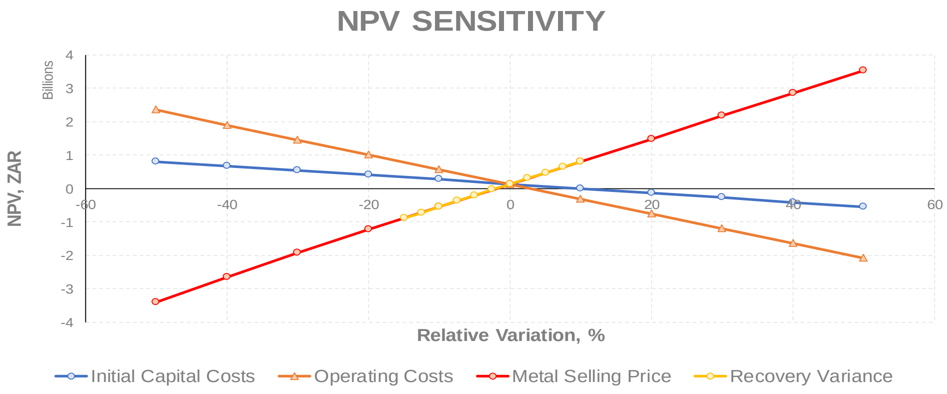
Variation	Index	NPV	IRR
		128 110 889	10.7
(50)	0.50	(3 407 747 338)	#NUM!
(40)	0.60	(2 655 026 427)	#NUM!
(30)	0.70	(1 928 699 431)	(4.8)
(20)	0.80	(1 242 811 516)	1.8
(10)	0.90	(557 350 313)	6.6
-	1.00	128 110 889	10.7
10	1.10	805 652 209	14.5
20	1.20	1 483 115 881	17.9
30	1.30	2 160 579 554	21.3
40	1.40	2 840 864 375	24.5
50	1.50	3 524 938 957	27.6

Recovery Variance

(All Values Reported in ZAR)

Sensitivity Index 1.00

Variation	Index	NPV	IRR
		128 110 889	10.7
(15.0)	0.85	(900 080 914)	4.3
(12.5)	0.88	(728 715 614)	5.5
(10.0)	0.90	(557 350 313)	6.6
(7.5)	0.93	(385 985 013)	7.7
(5.0)	0.95	(214 619 712)	8.7
(2.5)	0.98	(43 254 411)	9.7
-	1.00	128 110 889	10.7
2.5	1.03	297 554 455	11.7
5.0	1.05	466 920 373	12.6
7.5	1.08	636 286 291	13.6
10.0	1.10	805 652 209	14.5



NPV Discount Rate

(All Values Reported in ZAR)

Sensitivity Value 1

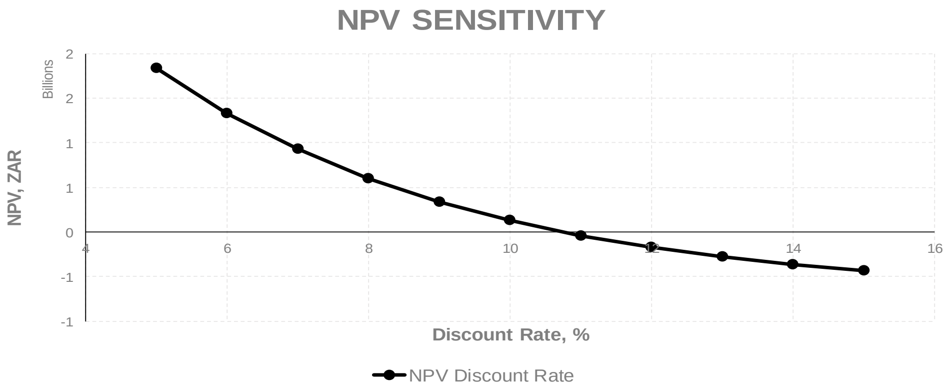
Variation	Value	NPV	Rate
		128 110 889	
(50)	0.50	1 838 895 275	5.0
(40)	0.60	1 333 806 824	6.0
(30)	0.70	927 645 910	7.0
(20)	0.80	601 056 884	8.0
(10)	0.90	338 641 811	9.0
-	1.00	128 110 889	10.0
10	1.10	(40 376 358)	11.0
20	1.20	(174 723 712)	12.0
30	1.30	(281 298 510)	13.0
40	1.40	(365 245 196)	14.0
50	1.50	(430 731 773)	15.0

Contingency Allowance

(All Values Reported in ZAR)

Sensitivity Index 1.00

Variation	Index	NPV	IRR
		128 110 889	10.7
(50)	0.50	268 022 987	11.6
(35)	0.65	226 072 652	11.3
(20)	0.80	184 122 317	11.1
(5)	0.95	142 171 982	10.8
-	1.00	128 110 889	10.7
15	1.15	85 800 221	10.5
30	1.30	43 489 553	10.2
45	1.45	1 178 884	10.0
60	1.60	(41 131 784)	9.8
75	1.75	(83 442 452)	9.6
90	1.90	(125 753 121)	9.3



Appendix E: Grid OHL 50km discounted cash flow statement and sensitivity analysis

Item	Units	Total / Average	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025	FY2026	FY2027	FY2028	FY2029	FY2030	FY2031	FY2032	FY2033	FY2034	FY2035	FY2036	FY2037	FY2038	FY2039	FY2040	FY2041	FY2042	FY2043	FY2044	FY2045	FY2046	FY2047
Revenue																														
Pt	ZAR	8 737 452 172	-	-	-	-	-	-	95 912 076	109 882 219	396 158 343	393 654 762	408 420 983	415 556 669	416 650 723	408 551 987	402 784 753	406 102 840	416 755 269	428 257 988	425 149 345	423 025 014	461 043 080	472 118 181	481 049 085	476 128 574	481 288 703	473 074 883	471 170 863	274 715 834
Total metal produced	ozt	740 553	-	-	-	-	-	-	8 129	9 313	33 577	33 365	34 616	35 221	35 314	34 627	34 138	34 420	35 323	36 298	36 034	35 854	39 076	40 015	40 772	40 355	40 792	40 096	39 935	23 284
Metal sales price	ZAR/ozt	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799
Pd	ZAR	18 807 401 029	-	-	-	-	-	-	199 478 694	232 690 623	834 943 449	836 649 357	866 019 401	885 444 401	891 371 599	877 097 352	860 392 231	871 770 867	900 798 168	931 017 359	924 791 296	918 672 962	1 001 243 985	1 030 530 539	1 047 858 448	1 035 984 296	1 043 067 320	1 019 343 015	1 011 624 334	586 611 334
Total metal produced	ozt	861 506	-	-	-	-	-	-	9 137	10 659	38 246	38 324	39 670	40 559	40 831	40 177	39 412	39 933	41 263	42 647	42 362	42 081	45 864	47 205	47 999	47 455	47 780	46 693	46 339	26 871
Metal sales price	ZAR/ozt	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831
Rh	ZAR	6 307 421 485	-	-	-	-	-	-	75 706 803	84 067 250	306 262 400	300 590 927	312 873 856	314 799 878	307 541 070	296 704 756	292 427 127	289 737 966	296 209 986	303 252 750	297 862 148	295 097 001	320 329 633	331 006 936	338 449 536	329 746 343	334 295 520	340 776 118	342 813 455	196 870 025
Total metal produced	ozt	137 349	-	-	-	-	-	-	1 649	1 831	6 669	6 546	6 813	6 855	6 697	6 461	6 368	6 309	6 450	6 604	6 486	6 426	6 975	7 208	7 370	7 180	7 280	7 421	7 465	4 287
Metal sales price	ZAR/ozt	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923
Au	ZAR	746 405 084	-	-	-	-	-	-	7 144 280	9 269 165	31 476 353	31 314 113	33 225 115	34 372 748	35 341 256	34 280 395	35 676 891	36 562 393	37 787 480	39 703 555	37 804 879	38 409 985	41 468 338	40 427 872	39 869 479	41 517 006	41 460 688	38 114 410	38 468 600	22 710 083
Total metal produced	ozt	38 841	-	-	-	-	-	-	372	482	1 638	1 630	1 729	1 789	1 839	1 784	1 857	1 903	1 966	2 066	1 967	1 999	2 158	2 104	2 075	2 160	2 158	1 983	2 002	1 182
Metal sales price	ZAR/ozt	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217
Ni	ZAR	970 579 809	-	-	-	-	-	-	11 511 638	12 743 450	48 073 061	47 409 205	49 164 931	49 670 199	48 330 358	46 014 069	45 807 612	44 464 572	45 479 379	45 582 223	44 775 475	44 503 595	48 488 851	50 279 711	51 945 832	48 103 639	50 198 176	52 964 815	54 315 040	30 753 978
Total metal produced	t	5 126	-	-	-	-	-	-	61	67	254	250	260	262	255	243	242	235	240	241	236	235	256	266	274	254	265	280	287	162
Metal sales price	ZAR/t	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342
Cu	ZAR	242 977 588	-	-	-	-	-	-	3 043 751	3 325 767	11 844 910	11 605 113	11 920 728	12 120 878	12 023 219	11 735 727	11 928 439	11 630 571	11 942 076	11 722 142	12 570 142	12 285 247	12 794 939	12 597 048	12 451 738	12 494 255	12 425 007	11 869 919	11 842 016	6 803 957
Total metal produced	t	3 127	-	-	-	-	-	-	39	43	152	149	153	156	155	151	153	150	154	151	162	158	165	162	160	161	160	153	152	88
Metal sales price	ZAR/t	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715
Chrome concentrate	ZAR	3 195 451 130	-	-	-	-	-	-	120 564 613	143 199 253	149 358 320	148 980 996	149 359 418	149 534 625	149 923 015	148 853 121	149 464 663	149 395 168	149 757 636	149 563 397	149 215 186	149 335 840	150 349 029	150 128 349	150 472 488	150 206 843	150 804 002	150 159 757	149 550 352	87 275 060
Metal produced	t	2 022 821	-	-	-	-	-	-	76 321	90 650	94 548	94 310	94 549	94 660	94 906	94 229	94 616	94 572	94 801	94 678	94 458	94 534	95 176	95 036	95 254	95 086	95 464	95 056	94 670	55 248
Total metal produced	t	2 022 821	-	-	-	-	-	-	76 321	90 650	94 548	94 310	94 549	94 660	94 906	94 229	94 616	94 572	94 801	94 678	94 458	94 534	95 176	95 036	95 254	95 086	95 464	95 056	94 670	55 248
Metal sales price	ZAR/t	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580
Gross Revenue	ZAR	39 007 688 298	-	-	-	-	-	-	513 361 855	595 177 726	1 778 116 835	1 770 204 472	1 830 984 432	1 861 499 397	1 861 181 240	1 823 237 408	1 798 481 715	1 809 664 378	1 858 729 995	1 909 099 414	1 892 168 472	1 881 329 643	2 035 717 856	2 087 088 636	2 122 096 605	2 094 180 955	2 113 539 415	2 086 302 915	2 079 784 662	1 205 740 271
Purchase of concentrate cost	ZAR	(5 159 353 397)	-	-	-	-	-	-	(56 744 894)	(65 210 888)	(235 209 414)	(234 043 117)	(242 742 961)	(247 078 130)	(246 816 206)	(241 353 064)	(237 809 775)	(239 189 684)	(246 169 594)	(253 224 630)	(250 949 985)	(249 340 168)	(271 332 600)	(278 720 736)	(283 733 696)	(279 446 857)	(282 292 758)	(278 785 359)	(278 102 180)	(161 056 700)
Pt	ZAR	(1 223 243 304)	-	-	-	-	-	-	(13 427 691)	(15 383 511)	(55 462 168)	(55 111 667)	(57 178 938)	(58 177 934)	(58 331 101)	(57 197 278)	(56 389 865)	(56 854 398)	(58 345 738)	(59 956 118)	(59 520 908)	(59 223 502)	(64 546 031)	(66 096 545)	(67 346 872)	(66 658 000)	(67 380 418)	(66 230 484)	(65 963 921)	(38 460 217)
Pd	ZAR	(2 633 036 144)	-	-	-	-	-	-	(27 927 017)	(32 576 687)	(116 892 083)	(117 130 910)	(121 242 716)	(123 962 216)	(124 792 024)	(122 793 629)	(120 454 912)	(122 047 921)	(126 111 744)	(130 342 430)	(129 470 781)	(128 614 215)	(140 174 158)	(144 274 275)	(146 700 183)	(145 037 801)	(146 029 425)	(142 708 022)	(141 627 407)	(82 125 587)
Rh	ZAR	(883 039 008)	-	-	-	-	-	-	(10 598 952)	(11 769 415)	(42 876 736)	(42 082 730)	(43 802 340)	(44 071 983)	(43 055 750)	(41 538 666)	(40 939 798)	(40 563 315)	(41 469 398)	(42 455 385)	(41 700 701)	(41 313 580)	(44 846 149)	(46 340 971)	(47 382 935)	(46 164 488)	(46 801 373)	(47 708 657)	(47 993 884)	(27 561 804)
Au	ZAR	(104 496 712)	-	-	-	-	-	-	(1 000 199)	(1 297 683)	(4 406 689)	(4 383 976)	(4 651 516)	(4 812 185)	(4 947 776)	(4 799 255)	(4 994 765)	(5 118 735)	(5 290 247)	(5 558 498)	(5 292 683)	(5 377 398)	(5 805 567)	(5 659 902)	(5 581 727)	(5 812 381)	(5 804 496)	(5 336 017)	(5 385 604)	(3 179 412)
Ni	ZAR	(242 644 952)	-	-	-	-	-	-	(2 877 909)	(3 185 862)	(12 018 265)	(11 852 301)	(12 291 233)	(12 417 550)	(12 082 590)	(11 503 517)	(11 451 903)	(11 116 143)	(11 369 845)	(11 395 556)	(11 193 869)	(11 125 899)	(12 122 213)	(12 569 928)	(12 986 458)	(12 025 910)	(12 549 544)	(13 241 204)	(13 578 760)	(7 688 494)
Cu	ZAR	(72 893 276)	-	-	-	-	-	-	(913 125)	(997 730)	(3 553 473)	(3 481 534)	(3 576 218)	(3 636 263)	(3 606 966)	(3 520 718)	(3 578 532)	(3 489 171)	(3 582 623)	(3 516 643)	(3 771 042)	(3 685 574)	(3 838 482)	(3 779 114)	(3 735 521)	(3 748 276)	(3 727 502)	(3 560 976)	(3 552 605)	(2 041 187)
Treatment charges	ZAR	(428 145 182)	-	-	-	-	-	-	(16 153 950)	(19 186 671)	(20 011 899)	(19 961 343)	(20 012 046)	(20 035 521)	(20 087 560)	(19 944 209)	(20 026 147)	(20 016 836)	(20 065 402)	(20 039 376)	(19 992 721)	(20 008 887)	(20 144 640)	(20 115 072)	(20 161 182)	(20 125 589)	(20 205 600)	(20 119 280)	(20 037 629)	(11 693 622)
Concentrate produced	t	252 853	-	-	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
Unit charge rate	ZAR/t conc.	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693
Sampling costs	ZAR	(14 908 505)	-	-	-	-	-	-	(562 499)	(668 102)	(696 837)	(695 077)	(696 842)	(697 660)	(699 472)	(694 480)	(697 333)	(697 009)	(698 700)	(697 794)	(696 169)	(696 732)	(701 459)	(700 430)	(702 035)	(700 796)	(703 582)	(700 576)	(697 733)	(407 185)
Concentrate produced	t	252 853	-	-	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
Unit charge rate	ZAR/t conc.	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59
Product penalties	ZAR	(655 606 303)	-	-	-	-	-	-	(55 744 128)	(66 771 887)	(27 158 923)	(27 090 312)	(27 159 123)	(27 190 982)	(27 261 606)	(27 067 059)	(27 178 260)	(27 165 624)	(27 231 534)	(27 196 214)	(27 132 896)	(27 154 836)	(27 339 071)	(27 298 943)	(27 361 521)	(27 313 217)	(27 421 802)	(27 304 655)	(27 193 842)	(15 869 867)
Grade penalty	ZAR	(74 553 888)	-	-	-	-	-	-	(33 820 976)	(40 732 912)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concentrate produced	t	252 853	-	-	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
4E grade	g/t conc.	211.90	-	-	-	-	-	-	62.88	61.17	210.88	210.71	217.98	221.92	222.02	219.31	215.06	217.24	223.11	230.26	228.78	227.31	245.95	252.74	256.56	254.23	255.46	251.80	251.64	250.52
Unit charge rate (<185g/t conc. @ 5g/t conc. increments)	ZAR/penalty increment	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145
Chrome penalty	ZAR	(581 052 415)	-	-	-	-	-	-	(21 923 152)	(26 038 975)	(27 158 923)	(27 090 312)	(27 159 123)	(27 190 982)	(27 261 606)	(27 067 059)	(27 178 260)	(27 165 624)	(27 231 534)	(27 196 214)	(27 132 896)	(27 154 836)	(27 339 071)	(27 298 943)	(27 361 521)	(27 313 217)	(27 421 802)	(27 304 655)	(27 193 842)	(15 869 867)
Chrome in concentrate	t	6 321	-	-	-	-	-	-	239	283	295	295	295	296	297	294	296	296	296	296	295	295	297	297	298	297	298	297	296	173
Net Revenue	ZAR	32 749 674 911	-	-	-	-	-	-	384 156 384	443 340 178	1 495 039 761	1 488 414 623	1 540 373 460	1 566 497 104	1 566 316 396	1 534 178 594	1 512 770 199	1 522 595 225	1 564 564 765	1 607 941 400	1 593 396 701	1 584 129 021	1 716 200 085	1 760 253 455	1 790 138 171	1 766 594 497	1 782 915 672	1 759 393 045	1 753 753 278	1 016 712 897
Operating Costs																														
Mining costs	ZAR	(14 219 863 457)	-	-	-	-	(5 433 987)	(12 598 304)	(200 472 838)	(632 942 274)	(716 935 874)	(693 315 938)	(693 700 553)	(683 607 166)	(686 780 586)	(684 438 404)	(685 757 706)	(684 532 539)	(689 028 227)	(684 593 217)	(683 476 177)	(684 958 480)	(675 933 883)	(670 334 726)	(675 540 656)	(664 608 385)	(672 495 792)	(668 609 870)	(666 570 865)	(403 197 010)
Surface infrastructure costs	ZAR	(2 675 134 920)	-	-	-	-	(10 505 544)	(17 372 967)	(59 487 872)	(121 798 916)	(124 334 696)	(125 211 319)	(125 658 210)	(125 726 098)	(125 783 615)	(125 785 602)	(125 785 523)	(125 787 353)	(125 785 887)	(125 786 051)	(125 783 961)	(125 807 104)	(125 810 716)	(125 812 432)	(125 812 067)	(125 816 484)	(125 806 181)	(125 811 117)	(125 406 577)	(78 458 630)
Process plant costs	ZAR	(3 006 270 639)	-	-	-	-	(11 881 413)	(31 593 109)	(78 765 765)	(134 565 745)	(138 152 946)	(139 393 046)	(140 025 234)	(140 121 271)	(140 202 637)	(140 205 447)	(140 205 335)	(140 207 924)	(140 205 851)	(140 206 082)	(140 203 126)	(140 235 865)	(140 240 974)	(140 243 402)	(140 242 886)	(140 249 133)	(140 234 559)	(140 241 541)	(139 669 266)	(88 978 081)
Chrome plant costs	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Operating Costs	ZAR	(19 901 269 016)	-	-	-	-	(27 820 944)	(61 564 380)	(338 726 474)	(889 306 935)	(979 423 516)	(957 920 303)	(959 383 996)	(949 454 534)	(952 766 838)	(950 429 453)	(951 748 564)	(950 527 816)	(955 019 966)	(950 585 350)	(949 463 263)	(951 001 448)	(941 985 573)	(936 390 560)	(941 595 610)	(930 674 002)	(938 536 531)	(934 662 528)	(931 646 709)	(570 633 721)
Initial Capital Expenditure																														
Mining	ZAR	(1 763 711 887)	-	-	(85 000 000)	(85 000 000)	(173 945 096)	(552 983 396)	(571 444 592)	(295 338 803)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Surface infrastructure	ZAR	(159 863 906)	-	-	-	-	(46 774 491)	(72 161 736)	(40 927 679)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Process plant	ZAR	(40 514 648)	-	-	-	-	(6 339 481)	(34 175 167)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contingency	ZAR	(392 818 088)	-	-	(17 000 000)	(17 000 000)	(45 411 814)	(131 864 060)	(122 474 454)	(59 067 761)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital	ZAR	(2 356 908 529)	-	-	(102 000 000)	(102 000 000)	(272 470 881)	(791 184 359)	(734 846 726)	(354 406 564)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIB Capital																														
Mining	ZAR	(1 031 794 450)	-	-	-	-	-	(1 679 988)	(21 301 515)	(22 899 837)	(85 989 556)	(38 672 267)	(22 899 837)	(82 504 197)	(82 624 244)	(56 651 840)	(46 571 912)	(46 571 912)	(62 464 388)	(46 571 912)	(46 571 912)	(46 571 912)	(56 580 203)	(37 805 438)	(37 805 584)	(37 805 584)	(37 901 651)	(53 578 014)	(37 805 584)	(21 965 160)
Surface infrastructure	ZAR	(50 444 444)	-	-	-	-	-	(666 667)	(634 921)	(1 523 810)	(1 523 810)	(19 301 587)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(888 889)
Process plant (incl. chrome recovery)	ZAR	(150 313 532)	-	-	-	-	(594 071)	(1 579 655)	(3 938 288)	(6 728 287)	(6 907 647)	(6 969 652)	(7 001 262)	(7 006 064)	(7 010 132)	(7 010 272)	(7 010 267)	(7 010 396)	(7 010 293)	(7 010 304)	(7 010 156)	(7 011 793)	(7 012 049)	(7 012 170)	(7 012 144)	(7 012 457)	(7 011 728)	(7 012 077)	(6 983 463)	(4 448 904)
TSF #3	ZAR	(554 792 165)	-	-	-	-	-	(1 258 431)	-	(184 511 245)	(369 022 489)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect	ZAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contingency	ZAR	(178 734 459)	-	-	-	-	(59 407)	(518 474)	(2 587 472)	(21 566 318)	(46 344 350)	(6 494 351)	(3 142 491)	(9 103 407)	(9 115 819)	(6 518 592)	(5 510 599)	(5 510 612)	(7 099 849)	(5 510 603)	(5 510 588)	(5 510 751)	(6 511 606)	(4 634 142)	(4 634 154)	(4 634 185)	(4 643 719)	(6 211 390)	(4 631 286)	(2 730 295)
Total SIB Capital	ZAR	(1 966 079 050)	-	-	-	-	(653 478)	(5 703 215)	(28 462 196)	(237 229 496)	(509 787 852)	(71 437 857)	(34 567 399)	(100 137 478)	(100 274 004)	(71 704 514)	(60 616 587)	(60 616 730)	(78 098 340)	(60 616 628)	(60 616 466)	(60 618 266)	(71 627 668)	(50 975 560)	(50 975 692)	(50 976 036)	(51 080 907)	(68 325 291)	(50 944 143)	(30 033 248)
Environmental Rehabilitation																														
Rehabilitation costs	ZAR	(25 846 550)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)
SLP Costs																														
SLP Projects 2019	ZAR	(175 676 800)	-	-	-	-	(15 488 200)	(16 008 200)	(10 028 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)
Total SLP Costs	ZAR	(175 676 800)	-	-	-	-	(15 488 200)	(16 008 200)	(10 028 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)
Royalties																														
Net revenue	ZAR	32 749 674 911	-	-	-	-	-	-	384 156 384	443 340 178	1 495 039 761	1 488 414 623	1 540 373 460	1 566 497 104	1 566 316 396	1 534 178 594	1 512 770 199	1 522 595 225	1 564 564 765	1 607 941 400	1 593 396 701	1 584 129 021	1 716 200 085	1 760 253 455	1 790 138 171	1 766 594 497	1 782 915 672	1 759 393 045	1 753 753 278	1 016 712 897
Earnings before royalties	ZAR	8 323 894 966	(923 091)	(923 091)	(102 923 091)	(102 923 091)	(317 356 594)	(875 383 245)	(728 830 303)	(1 044 914 108)	(1 482 898)	451 745 172	539 110 774	509 593 801	505 964 263	504 733 336	493 093 756	504 139 388	524 135 168	589 428 131	576 005 680	565 198 015	695 275 554	765 576 045	790 255 578	777 633 168	785 986 943	749 093 935	763 851 135	408 734 636
Royalty % (based on net revenue)	%	4.40	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	3.87	4.39	4.11	4.09	4.16	4.12	4.18	4.22	4.57	4.52	4.46	5.00	5.33	5.40	5.39	5.40	5.23	5.34	4.97
Royalty	ZAR	(1 441 476 650)	-	-	-	-	-	-	(1 920 782)	(2 216 701)	(7 475 199)	(57 635 981)	(67 603 064)	(64 454 019)	(64 049 833)	(63 752 375)	(62 352 046)	(63 628 464)	(66 060 065)	(73 531 722)	(71 967 615)	(70 720 425)	(85 833 840)	(93 865 272)	(96 756 866)	(95 236 658)	(96 246 461)	(92 029 625)	(93 641 115)	(50 498 524)
All-in Sustaining Cost																														
Net revenue (excluding Pt revenue)	ZAR	25 235 466 043	-	-	-	-	-	-	301 671 999	348 841 469	1 154 343 586	1 149 871 528	1 189 131 415	1 209 118 368	1 207 996 774	1 182 823 886	1 166 375 311	1 173 346 783	1 206 155 234	1 239 639 530	1 227 768 264	1 220 327 509	1 319 703 037	1 354 231 819	1 376 435 958	1 357 123 923	1 369 007 388	1 352 548 646	1 348 546 335	780 457 280
All costs (OPEX, SIB CAPEX, Rehab and Royalties)	ZAR	(23 334 671 266)	(923 091)	(923 091)	(923 091)	(923 091)	(29 397 513)	(68 190 686)	(370 032 543)	(1 129 676 223)	(1 497 609 657)	(1 087 917 232)	(1 062 477 551)	(1 114 969 122)	(1 118 013 767)	(1 086 809 433)	(1 075 640 289)	(1 075 696 101)	(1 100 101 461)	(1 085 656 791)	(1 082 970 435)	(1 083 263 230)	(1 100 370 171)	(1 082 154 483)	(1 090 251 259)	(1 077 809 787)	(1 086 786 991)	(1 095 940 535)	(1 077 155 058)	(652 088 585)
All-in Sustaining Cost	ZAR	1 900 794 777	(923 091)	(923 091)	(923 091)	(923 091)	(29 397 513)	(68 190 686)	(68 360 545)	(780 834 754)	(343 266 071)	61 954 296	126 653 864	94 149 246	89 983 008	96 014 452	90 735 023	97 650 682	106 053 773	153 982 739	144 797 829	137 064 279	219 332 866	272 077 337	286 184 699	279 314 136	282 220 398	256 608 112	271 391 278	128 368 695
Unit cost (AISC)	USD/ozt Pt	182	-	-	-	-	-	-	(595)	(5 934)	(724)	131	259	189	180	196	188	201	212	300	284	271	397	481	497	490	490	453	481	390
Unit cost (AISC)	ZAR/ozt Pt	2 567	-	-	-	-	-	-	(8 409)	(83 842)	(10 223)	1 857	3 659	2 673	2 548	2 773	2 658	2 837	3 002	4 242	4 018	3 823	5 613	6 799	7 019	6 921	6 918	6 400	6 796	5 513
Pre-Tax Cash Flow (EBITDA)	ZAR	6 882 418 316	(923 091)	(923 091)	(102 923 091)	(102 923 091)	(317 356 594)	(875 383 245)	(730 751 085)	(1 047 130 809)	(8 958 096)	394 109 191	471 507 709	445 139 782	441 914 429	440 980 961	430 741 710	440 510 925	458 075 104	515 896 409	504 038 066	494 477 591	609 441 714	671 710 772	693 498 712	682 396 510	689 740 482	657 064 311	670 210 020	358 236 112
Cumulative Undiscounted Pre-Tax Cash Flow	ZAR	4 507 167 391	(923 091)	(1 846 182)	(104 769 273)	(207 692 364)	(525 048 959)	(1 400 432 204)	(2 131 183 289)	(3 178 314 097)	(3 187 272 194)	(2 793 163 003)	(2 321 655 293)	(1 876 515 512)	(1 434 601 083)	(993 620 121)	(562 878 411)	(122 367 486)	335 707 617	851 604 026	1 355 642 092	1 850 119 683	2 459 561 397	3 131 272 169	3 824 770 882	4 507 167 391	5 196 907 873	5 853 972 184	6 524 182 204	6 882 418 316
Discounted Pre-Tax Cash Flow (EBITDA, 10%)	ZAR	40 147 694	(839 174)	(762 885)	(77 327 642)	(70 297 856)	(197 053 476)	(494 131 021)	(374 990 852)	(488 494 250)	(3 799 107)	151 946 154	165 260 576	141 835 253	128 006 869	116 124 070	103 116 141	95 868 012	90 627 717	92 788 504	82 414 251	73 500 943	82 354 207	82 516 964	77 448 659	69 280 714	63 660 286	55 131 279	51 122 068	24 841 292
Cumulative Discounted Pre-Tax Cash Flow (10%)	ZAR	(154 607 231)	(839 174)	(1 602 059)	(78 929 701)	(149 227 557)	(346 281 033)	(840 412 054)	(1 215 402 905)	(1 703 897 156)	(1 707 696 263)	(1 555 750 109)	(1 390 489 533)	(1 248 654 281)	(1 120 647 412)	(1 004 523 342)	(901 407 201)	(805 539 190)	(714 911 472)	(622 122 968)	(539 708 717)	(466 207 774)	(383 853 567)	(301 336 603)	(223 887 945)	(154 607 231)	(90 946 945)	(35 815 666)	15 306 402	40 147 694

NPV @ 10%	ZAR	40 147 694
IRR	%	10.2
Discounted Payback Period	yrs	24.0
Undiscounted Payback Period	yrs	14.0

Sensitivity Tables

Initial Capital Costs

(All Values Reported in ZAR)

Sensitivity Index	1.00

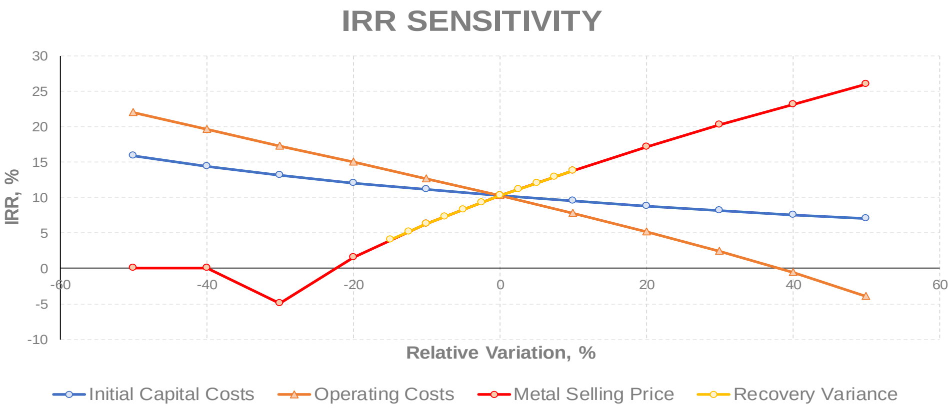
Variation	Index	NPV	IRR
		40 147 694	10.2
(50)	0.50	692 404 318	15.9
(40)	0.60	561 952 993	14.4
(30)	0.70	431 501 668	13.1
(20)	0.80	301 050 344	12.0
(10)	0.90	170 599 019	11.1
-	1.00	40 147 694	10.2
10	1.10	(90 303 631)	9.5
20	1.20	(220 754 955)	8.8
30	1.30	(351 206 280)	8.2
40	1.40	(481 657 605)	7.6
50	1.50	(612 108 929)	7.0

Operating Costs

(All Values Reported in ZAR)

Sensitivity Index	1.00

Variation	Index	NPV	IRR
		40 147 694	10.2
(50)	0.50	2 074 607 918	22.0
(40)	0.60	1 643 742 715	19.6
(30)	0.70	1 235 937 135	17.3
(20)	0.80	836 557 149	15.0
(10)	0.90	438 387 360	12.6
-	1.00	40 147 694	10.2
10	1.10	(362 637 330)	7.8
20	1.20	(765 422 354)	5.2
30	1.30	(1 168 207 378)	2.5
40	1.40	(1 570 992 403)	(0.5)
50	1.50	(1 974 943 266)	(4.0)



Metal Selling Price

(All Values Reported in ZAR)

Sensitivity Index	1.00

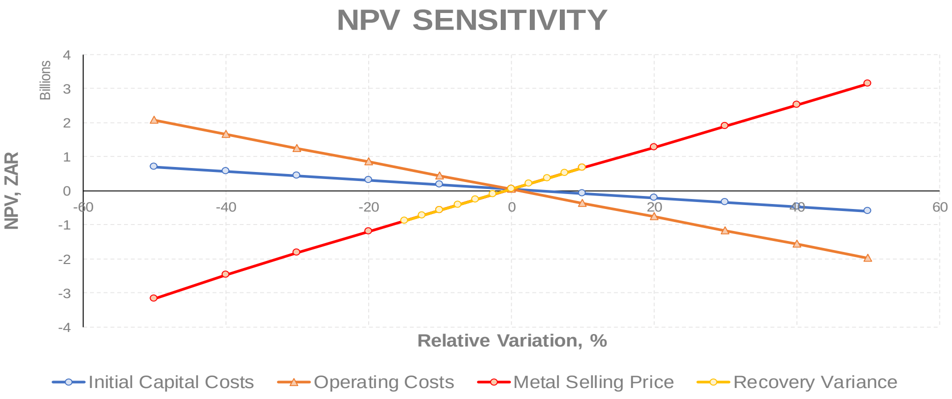
Variation	Index	NPV	IRR
		40 147 694	10.2
(50)	0.50	(3 174 234 625)	#NUM!
(40)	0.60	(2 489 960 829)	#NUM!
(30)	0.70	(1 829 681 914)	(4.9)
(20)	0.80	(1 206 145 401)	1.5
(10)	0.90	(582 998 853)	6.3
-	1.00	40 147 694	10.2
10	1.10	656 093 637	13.8
20	1.20	1 271 969 703	17.1
30	1.30	1 887 845 769	20.2
40	1.40	2 506 304 456	23.2
50	1.50	3 128 212 228	26.0

Recovery Variance

(All Values Reported in ZAR)

Sensitivity Index	1.00

Variation	Index	NPV	IRR
		40 147 694	10.2
(15.0)	0.85	(894 572 127)	4.0
(12.5)	0.88	(738 785 490)	5.2
(10.0)	0.90	(582 998 853)	6.3
(7.5)	0.93	(427 212 217)	7.3
(5.0)	0.95	(271 425 580)	8.3
(2.5)	0.98	(115 638 943)	9.3
-	1.00	40 147 694	10.2
2.5	1.03	194 186 588	11.2
5.0	1.05	348 155 604	12.1
7.5	1.08	502 124 621	12.9
10.0	1.10	656 093 637	13.8



NPV Discount Rate

(All Values Reported in ZAR)

Sensitivity Value	1

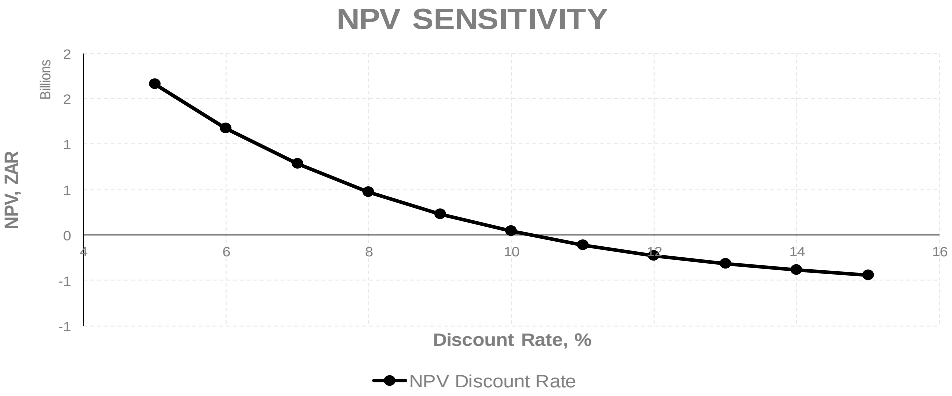
Variation	Value	NPV	Rate
		40 147 694	
(50)	0.50	1 665 728 240	5.0
(40)	0.60	1 174 470 477	6.0
(30)	0.70	784 963 788	7.0
(20)	0.80	476 424 042	8.0
(10)	0.90	232 469 827	9.0
-	1.00	40 147 694	10.0
10	1.10	(110 817 460)	11.0
20	1.20	(228 600 906)	12.0
30	1.30	(319 726 105)	13.0
40	1.40	(389 412 882)	14.0
50	1.50	(441 848 902)	15.0

Contingency Allowance

(All Values Reported in ZAR)

Sensitivity Index	1.00

Variation	Index	NPV	IRR
		40 147 694	10.2
(50)	0.50	173 044 550	11.1
(35)	0.65	133 196 457	10.8
(20)	0.80	93 348 363	10.6
(5)	0.95	53 500 269	10.3
-	1.00	40 147 694	10.2
15	1.15	(27 975)	10.0
30	1.30	(40 203 644)	9.8
45	1.45	(80 379 313)	9.5
60	1.60	(120 554 983)	9.3
75	1.75	(160 730 652)	9.1
90	1.90	(200 906 321)	8.9



Appendix F: Grid OHL breakeven discounted cash flow statement and sensitivity analysis

Item	Units	Total / Average	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025	FY2026	FY2027	FY2028	FY2029	FY2030	FY2031	FY2032	FY2033	FY2034	FY2035	FY2036	FY2037	FY2038	FY2039	FY2040	FY2041	FY2042	FY2043	FY2044	FY2045	FY2046	FY2047
Revenue																														
Pt	ZAR	**8 737 452 172**	-	-	-	-	-	-	95 912 076	109 882 219	396 158 343	393 654 762	408 420 983	415 556 669	416 650 723	408 551 987	402 784 753	406 102 840	416 755 269	428 257 988	425 149 345	423 025 014	461 043 080	472 118 181	481 049 085	476 128 574	481 288 703	473 074 883	471 170 863	274 715 834
Total metal produced	ozt	**740 553**	-	-	-	-	-	-	8 129	9 313	33 577	33 365	34 616	35 221	35 314	34 627	34 138	34 420	35 323	36 298	36 034	35 854	39 076	40 015	40 772	40 355	40 792	40 096	39 935	23 284
Metal sales price	ZAR/ozt	**11 799**	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799	11 799
Pd	ZAR	**18 807 401 029**	-	-	-	-	-	-	199 478 694	232 690 623	834 943 449	836 649 357	866 019 401	885 444 401	891 371 599	877 097 352	860 392 231	871 770 867	900 798 168	931 017 359	924 791 296	918 672 962	1 001 243 985	1 030 530 539	1 047 858 448	1 035 984 296	1 043 067 320	1 019 343 015	1 011 624 334	586 611 334
Total metal produced	ozt	**861 506**	-	-	-	-	-	-	9 137	10 659	38 246	38 324	39 670	40 559	40 831	40 177	39 412	39 933	41 263	42 647	42 362	42 081	45 864	47 205	47 999	47 455	47 780	46 693	46 339	26 871
Metal sales price	ZAR/ozt	**21 831**	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831	21 831
Rh	ZAR	**6 307 421 485**	-	-	-	-	-	-	75 706 803	84 067 250	306 262 400	300 590 927	312 873 856	314 799 878	307 541 070	296 704 756	292 427 127	289 737 966	296 209 986	303 252 750	297 862 148	295 097 001	320 329 633	331 006 936	338 449 536	329 746 343	334 295 520	340 776 118	342 813 455	196 870 025
Total metal produced	ozt	**137 349**	-	-	-	-	-	-	1 649	1 831	6 669	6 546	6 813	6 855	6 697	6 461	6 368	6 309	6 450	6 604	6 486	6 426	6 975	7 208	7 370	7 180	7 280	7 421	7 465	4 287
Metal sales price	ZAR/ozt	**45 923**	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923	45 923
Au	ZAR	**746 405 084**	-	-	-	-	-	-	7 144 280	9 269 165	31 476 353	31 314 113	33 225 115	34 372 748	35 341 256	34 280 395	35 676 891	36 562 393	37 787 480	39 703 555	37 804 879	38 409 985	41 468 338	40 427 872	39 869 479	41 517 006	41 460 688	38 114 410	38 468 600	22 710 083
Total metal produced	ozt	**38 841**	-	-	-	-	-	-	372	482	1 638	1 630	1 729	1 789	1 839	1 784	1 857	1 903	1 966	2 066	1 967	1 999	2 158	2 104	2 075	2 160	2 158	1 983	2 002	1 182
Metal sales price	ZAR/ozt	**19 217**	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217	19 217
Ni	ZAR	**970 579 809**	-	-	-	-	-	-	11 511 638	12 743 450	48 073 061	47 409 205	49 164 931	49 670 199	48 330 358	46 014 069	45 807 612	44 464 572	45 479 379	45 582 223	44 775 475	44 503 595	48 488 851	50 279 711	51 945 832	48 103 639	50 198 176	52 964 815	54 315 040	30 753 978
Total metal produced	t	**5 126**	-	-	-	-	-	-	61	67	254	250	260	262	255	243	242	235	240	241	236	235	256	266	274	254	265	280	287	162
Metal sales price	ZAR/t	**189 342**	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342	189 342
Cu	ZAR	**242 977 588**	-	-	-	-	-	-	3 043 751	3 325 767	11 844 910	11 605 113	11 920 728	12 120 878	12 023 219	11 735 727	11 928 439	11 630 571	11 942 076	11 722 142	12 570 142	12 285 247	12 794 939	12 597 048	12 451 738	12 494 255	12 425 007	11 869 919	11 842 016	6 803 957
Total metal produced	t	**3 127**	-	-	-	-	-	-	39	43	152	149	153	156	155	151	153	150	154	151	162	158	165	162	160	161	160	153	152	88
Metal sales price	ZAR/t	**77 715**	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715	77 715
Chrome concentrate	ZAR	**3 195 451 130**	-	-	-	-	-	-	120 564 613	143 199 253	149 358 320	148 980 996	149 359 418	149 534 625	149 923 015	148 853 121	149 464 663	149 395 168	149 757 636	149 563 397	149 215 186	149 335 840	150 349 029	150 128 349	150 472 488	150 206 843	150 804 002	150 159 757	149 550 352	87 275 060
Metal produced	t	**2 022 821**	-	-	-	-	-	-	76 321	90 650	94 548	94 310	94 549	94 660	94 906	94 229	94 616	94 572	94 801	94 678	94 458	94 534	95 176	95 036	95 254	95 086	95 464	95 056	94 670	55 248
Total metal produced	t	**2 022 821**	-	-	-	-	-	-	76 321	90 650	94 548	94 310	94 549	94 660	94 906	94 229	94 616	94 572	94 801	94 678	94 458	94 534	95 176	95 036	95 254	95 086	95 464	95 056	94 670	55 248
Metal sales price	ZAR/t	**1 580**	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580	1 580
Gross Revenue	ZAR	**39 007 688 298**	-	-	-	-	-	-	513 361 855	595 177 726	1 778 116 835	1 770 204 472	1 830 984 432	1 861 499 397	1 861 181 240	1 823 237 408	1 798 481 715	1 809 664 378	1 858 729 995	1 909 099 414	1 892 168 472	1 881 329 643	2 035 717 856	2 087 088 636	2 122 096 605	2 094 180 955	2 113 539 415	2 086 302 915	2 079 784 662	1 205 740 271
Purchase of concentrate cost	ZAR	**(5 159 353 397)**	-	-	-	-	-	-	(56 744 894)	(65 210 888)	(235 209 414)	(234 043 117)	(242 742 961)	(247 078 130)	(246 816 206)	(241 353 064)	(237 809 775)	(239 189 684)	(246 169 594)	(253 224 630)	(250 949 985)	(249 340 168)	(271 332 600)	(278 720 736)	(283 733 696)	(279 446 857)	(282 292 758)	(278 785 359)	(278 102 180)	(161 056 700)
Pt	ZAR	**(1 223 243 304)**	-	-	-	-	-	-	(13 427 691)	(15 383 511)	(55 462 168)	(55 111 667)	(57 178 938)	(58 177 934)	(58 331 101)	(57 197 278)	(56 389 865)	(56 854 398)	(58 345 738)	(59 956 118)	(59 520 908)	(59 223 502)	(64 546 031)	(66 096 545)	(67 346 872)	(66 658 000)	(67 380 418)	(66 230 484)	(65 963 921)	(38 460 217)
Pd	ZAR	**(2 633 036 144)**	-	-	-	-	-	-	(27 927 017)	(32 576 687)	(116 892 083)	(117 130 910)	(121 242 716)	(123 962 216)	(124 792 024)	(122 793 629)	(120 454 912)	(122 047 921)	(126 111 744)	(130 342 430)	(129 470 781)	(128 614 215)	(140 174 158)	(144 274 275)	(146 700 183)	(145 037 801)	(146 029 425)	(142 708 022)	(141 627 407)	(82 125 587)
Rh	ZAR	**(883 039 008)**	-	-	-	-	-	-	(10 598 952)	(11 769 415)	(42 876 736)	(42 082 730)	(43 802 340)	(44 071 983)	(43 055 750)	(41 538 666)	(40 939 798)	(40 563 315)	(41 469 398)	(42 455 385)	(41 700 701)	(41 313 580)	(44 846 149)	(46 340 971)	(47 382 935)	(46 164 488)	(46 801 373)	(47 708 657)	(47 993 884)	(27 561 804)
Au	ZAR	**(104 496 712)**	-	-	-	-	-	-	(1 000 199)	(1 297 683)	(4 406 689)	(4 383 976)	(4 651 516)	(4 812 185)	(4 947 776)	(4 799 255)	(4 994 765)	(5 118 735)	(5 290 247)	(5 558 498)	(5 292 683)	(5 377 398)	(5 805 567)	(5 659 902)	(5 581 727)	(5 812 381)	(5 804 496)	(5 336 017)	(5 385 604)	(3 179 412)
Ni	ZAR	**(242 644 952)**	-	-	-	-	-	-	(2 877 909)	(3 185 862)	(12 018 265)	(11 852 301)	(12 291 233)	(12 417 550)	(12 082 590)	(11 503 517)	(11 451 903)	(11 116 143)	(11 369 845)	(11 395 556)	(11 193 869)	(11 125 899)	(12 122 213)	(12 569 928)	(12 986 458)	(12 025 910)	(12 549 544)	(13 241 204)	(13 578 760)	(7 688 494)
Cu	ZAR	**(72 893 276)**	-	-	-	-	-	-	(913 125)	(997 730)	(3 553 473)	(3 481 534)	(3 576 218)	(3 636 263)	(3 606 966)	(3 520 718)	(3 578 532)	(3 489 171)	(3 582 623)	(3 516 643)	(3 771 042)	(3 685 574)	(3 838 482)	(3 779 114)	(3 735 521)	(3 748 276)	(3 727 502)	(3 560 976)	(3 552 605)	(2 041 187)
Treatment charges	ZAR	**(428 145 182)**	-	-	-	-	-	-	(16 153 950)	(19 186 671)	(20 011 899)	(19 961 343)	(20 012 046)	(20 035 521)	(20 087 560)	(19 944 209)	(20 026 147)	(20 016 836)	(20 065 402)	(20 039 376)	(19 992 721)	(20 008 887)	(20 144 640)	(20 115 072)	(20 161 182)	(20 125 589)	(20 205 600)	(20 119 280)	(20 037 629)	(11 693 622)
Concentrate produced	t	**252 853**	-	-	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
Unit charge rate	ZAR/t conc.	**1 693**	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693	1 693
Sampling costs	ZAR	**(14 908 505)**	-	-	-	-	-	-	(562 499)	(668 102)	(696 837)	(695 077)	(696 842)	(697 660)	(699 472)	(694 480)	(697 333)	(697 009)	(698 700)	(697 794)	(696 169)	(696 732)	(701 459)	(700 430)	(702 035)	(700 796)	(703 582)	(700 576)	(697 733)	(407 185)
Concentrate produced	t	**252 853**	-	-	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
Unit charge rate	ZAR/t conc.	**59**	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59
Product penalties	ZAR	**(655 606 303)**	-	-	-	-	-	-	(55 744 128)	(66 771 887)	(27 158 923)	(27 090 312)	(27 159 123)	(27 190 982)	(27 261 606)	(27 067 059)	(27 178 260)	(27 165 624)	(27 231 534)	(27 196 214)	(27 132 896)	(27 154 836)	(27 339 071)	(27 298 943)	(27 361 521)	(27 313 217)	(27 421 802)	(27 304 655)	(27 193 842)	(15 869 867)
Grade penalty	ZAR	**(74 553 888)**	-	-	-	-	-	-	(33 820 976)	(40 732 912)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concentrate produced	t	**252 853**	-	-	-	-	-	-	9 540	11 331	11 819	11 789	11 819	11 833	11 863	11 779	11 827	11 821	11 850	11 835	11 807	11 817	11 897	11 879	11 907	11 886	11 933	11 882	11 834	6 906
4E grade	g/t conc.	**211.90**	-	-	-	-	-	-	62.88	61.17	210.88	210.71	217.98	221.92	222.02	219.31	215.06	217.24	223.11	230.26	228.78	227.31	245.95	252.74	256.56	254.23	255.46	251.80	251.64	250.52
Unit charge rate (<185g/t conc. @ 5g/t conc. increments)	ZAR/penalty increment	**145**	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145
Chrome penalty	ZAR	**(581 052 415)**	-	-	-	-	-	-	(21 923 152)	(26 038 975)	(27 158 923)	(27 090 312)	(27 159 123)	(27 190 982)	(27 261 606)	(27 067 059)	(27 178 260)	(27 165 624)	(27 231 534)	(27 196 214)	(27 132 896)	(27 154 836)	(27 339 071)	(27 298 943)	(27 361 521)	(27 313 217)	(27 421 802)	(27 304 655)	(27 193 842)	(15 869 867)
Chrome in concentrate	t	**6 321**	-	-	-	-	-	-	239	283	295	295	295	296	297	294	296	296	296	296	295	295	297	297	298	297	298	297	296	173
Net Revenue	ZAR	**32 749 674 911**	-	-	-	-	-	-	384 156 384	443 340 178	1 495 039 761	1 488 414 623	1 540 373 460	1 566 497 104	1 566 316 396	1 534 178 594	1 512 770 199	1 522 595 225	1 564 564 765	1 607 941 400	1 593 396 701	1 584 129 021	1 716 200 085	1 760 253 455	1 790 138 171	1 766 594 497	1 782 915 672	1 759 393 045	1 753 753 278	1 016 712 897
Operating Costs																														
Mining costs	ZAR	**(14 219 863 457)**	-	-	-	-	(5 433 987)	(12 598 304)	(200 472 838)	(632 942 274)	(716 935 874)	(693 315 938)	(693 700 553)	(683 607 166)	(686 780 586)	(684 438 404)	(685 757 706)	(684 532 539)	(689 028 227)	(684 593 217)	(683 476 177)	(684 958 480)	(675 933 883)	(670 334 726)	(675 540 656)	(664 608 385)	(672 495 792)	(668 609 870)	(666 570 865)	(403 197 010)
Surface infrastructure costs	ZAR	**(2 675 134 920)**	-	-	-	-	(10 505 544)	(17 372 967)	(59 487 872)	(121 798 916)	(124 334 696)	(125 211 319)	(125 658 210)	(125 726 098)	(125 783 615)	(125 785 602)	(125 785 523)	(125 787 353)	(125 785 887)	(125 786 051)	(125 783 961)	(125 807 104)	(125 810 716)	(125 812 432)	(125 812 067)	(125 816 484)	(125 806 181)	(125 811 117)	(125 406 577)	(78 458 630)
Process plant costs	ZAR	**(3 006 270 639)**	-	-	-	-	(11 881 413)	(31 593 109)	(78 765 765)	(134 565 745)	(138 152 946)	(139 393 046)	(140 025 234)	(140 121 271)	(140 202 637)	(140 205 447)	(140 205 335)	(140 207 924)	(140 205 851)	(140 206 082)	(140 203 126)	(140 235 865)	(140 240 974)	(140 243 402)	(140 242 886)	(140 249 133)	(140 234 559)	(140 241 541)	(139 669 266)	(88 978 081)
Chrome plant costs	ZAR	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Operating Costs	ZAR	**(19 901 269 016)**	-	-	-	-	(27 820 944)	(61 564 380)	(338 726 474)	(889 306 935)	(979 423 516)	(957 920 303)	(959 383 996)	(949 454 534)	(952 766 838)	(950 429 453)	(951 748 564)	(950 527 816)	(955 019 966)	(950 585 350)	(949 463 263)	(951 001 448)	(941 985 573)	(936 390 560)	(941 595 610)	(930 674 002)	(938 536 531)	(934 662 528)	(931 646 709)	(570 633 721)
Initial Capital Expenditure																														
Mining	ZAR	**(1 838 711 887)**	-	-	(122 500 000)	(122 500 000)	(173 945 096)	(552 983 396)	(571 444 592)	(295 338 803)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Surface infrastructure	ZAR	**(159 863 906)**	-	-	-	-	(46 774 491)	(72 161 736)	(40 927 679)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Process plant	ZAR	**(40 514 648)**	-	-	-	-	(6 339 481)	(34 175 167)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect	ZAR	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contingency	ZAR	**(407 818 088)**	-	-	(24 500 000)	(24 500 000)	(45 411 814)	(131 864 060)	(122 474 454)	(59 067 761)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital	ZAR	**(2 446 908 529)**	-	-	(147 000 000)	(147 000 000)	(272 470 881)	(791 184 359)	(734 846 726)	(354 406 564)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIB Capital																														
Mining	ZAR	**(1 031 794 450)**	-	-	-	-	-	(1 679 988)	(21 301 515)	(22 899 837)	(85 989 556)	(38 672 267)	(22 899 837)	(82 504 197)	(82 624 244)	(56 651 840)	(46 571 912)	(46 571 912)	(62 464 388)	(46 571 912)	(46 571 912)	(46 571 912)	(56 580 203)	(37 805 438)	(37 805 584)	(37 805 584)	(37 901 651)	(53 578 014)	(37 805 584)	(21 965 160)
Surface infrastructure	ZAR	**(50 444 444)**	-	-	-	-	-	(666 667)	(634 921)	(1 523 810)	(1 523 810)	(19 301 587)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(1 523 810)	(888 889)
Process plant (incl. chrome recovery)	ZAR	**(150 313 532)**	-	-	-	-	(594 071)	(1 579 655)	(3 938 288)	(6 728 287)	(6 907 647)	(6 969 652)	(7 001 262)	(7 006 064)	(7 010 132)	(7 010 272)	(7 010 267)	(7 010 396)	(7 010 293)	(7 010 304)	(7 010 156)	(7 011 793)	(7 012 049)	(7 012 170)	(7 012 144)	(7 012 457)	(7 011 728)	(7 012 077)	(6 983 463)	(4 448 904)
TSF #3	ZAR	**(554 792 165)**	-	-	-	-	-	(1 258 431)	-	(184 511 245)	(369 022 489)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect	ZAR	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contingency	ZAR	**(178 734 459)**	-	-	-	-	(59 407)	(518 474)	(2 587 472)	(21 566 318)	(46 344 350)	(6 494 351)	(3 142 491)	(9 103 407)	(9 115 819)	(6 518 592)	(5 510 599)	(5 510 612)	(7 099 849)	(5 510 603)	(5 510 588)	(5 510 751)	(6 511 606)	(4 634 142)	(4 634 154)	(4 634 185)	(4 643 719)	(6 211 390)	(4 631 286)	(2 730 295)
Total SIB Capital	ZAR	**(1 966 079 050)**	-	-	-	-	(653 478)	(5 703 215)	(28 462 196)	(237 229 496)	(509 787 852)	(71 437 857)	(34 567 399)	(100 137 478)	(100 274 004)	(71 704 514)	(60 616 587)	(60 616 730)	(78 098 340)	(60 616 628)	(60 616 466)	(60 618 266)	(71 627 668)	(50 975 560)	(50 975 692)	(50 976 036)	(51 080 907)	(68 325 291)	(50 944 143)	(30 033 248)
Environmental Rehabilitation																														
Rehabilitation costs	ZAR	**(25 846 550)**	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)	(923 091)
SLP Costs																														
SLP Projects 2019	ZAR	**(175 676 800)**	-	-	-	-	(15 488 200)	(16 008 200)	(10 028 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)
Total SLP Costs	ZAR	**(175 676 800)**	-	-	-	-	(15 488 200)	(16 008 200)	(10 028 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)	(6 388 200)
Royalties																														
Net revenue	ZAR	**32 749 674 911**	-	-	-	-	-	-	384 156 384	443 340 178	1 495 039 761	1 488 414 623	1 540 373 460	1 566 497 104	1 566 316 396	1 534 178 594	1 512 770 199	1 522 595 225	1 564 564 765	1 607 941 400	1 593 396 701	1 584 129 021	1 716 200 085	1 760 253 455	1 790 138 171	1 766 594 497	1 782 915 672	1 759 393 045	1 753 753 278	1 016 712 897
Earnings before royalties	ZAR	**8 233 894 966**	(923 091)	(923 091)	(147 923 091)	(147 923 091)	(317 356 594)	(875 383 245)	(728 830 303)	(1 044 914 108)	(1 482 898)	451 745 172	539 110 774	509 593 801	505 964 263	504 733 336	493 093 756	504 139 388	524 135 168	589 428 131	576 005 680	565 198 015	695 275 554	765 576 045	790 255 578	777 633 168	785 986 943	749 093 935	763 851 135	408 734 636
Royalty % (based on net revenue)	%	**4.40**	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	3.87	4.39	4.11	4.09	4.16	4.12	4.18	4.22	4.57	4.52	4.46	5.00	5.33	5.40	5.39	5.40	5.23	5.34	4.97
Royalty	ZAR	**(1 441 476 650)**	-	-	-	-	-	-	(1 920 782)	(2 216 701)	(7 475 199)	(57 635 981)	(67 603 064)	(64 454 019)	(64 049 833)	(63 752 375)	(62 352 046)	(63 628 464)	(66 060 065)	(73 531 722)	(71 967 615)	(70 720 425)	(85 833 840)	(93 865 272)	(96 756 866)	(95 236 658)	(96 246 461)	(92 029 625)	(93 641 115)	(50 498 524)
All-in Sustaining Cost																														
Net revenue (excluding Pt revenue)	ZAR	**25 235 466 043**	-	-	-	-	-	-	301 671 999	348 841 469	1 154 343 586	1 149 871 528	1 189 131 415	1 209 118 368	1 207 996 774	1 182 823 886	1 166 375 311	1 173 346 783	1 206 155 234	1 239 639 530	1 227 768 264	1 220 327 509	1 319 703 037	1 354 231 819	1 376 435 958	1 357 123 923	1 369 007 388	1 352 548 646	1 348 546 335	780 457 280
All costs (OPEX, SIB CAPEX, Rehab and Royalties)	ZAR	**(23 334 671 266)**	(923 091)	(923 091)	(923 091)	(923 091)	(29 397 513)	(68 190 686)	(370 032 543)	(1 129 676 223)	(1 497 609 657)	(1 087 917 232)	(1 062 477 551)	(1 114 969 122)	(1 118 013 767)	(1 086 809 433)	(1 075 640 289)	(1 075 696 101)	(1 100 101 461)	(1 085 656 791)	(1 082 970 435)	(1 083 263 230)	(1 100 370 171)	(1 082 154 483)	(1 090 251 259)	(1 077 809 787)	(1 086 786 991)	(1 095 940 535)	(1 077 155 058)	(652 088 585)
All-in Sustaining Cost	ZAR	**1 900 794 777**	(923 091)	(923 091)	(923 091)	(923 091)	(29 397 513)	(68 190 686)	(68 360 545)	(780 834 754)	(343 266 071)	61 954 296	126 653 864	94 149 246	89 983 008	96 014 452	90 735 023	97 650 682	106 053 773	153 982 739	144 797 829	137 064 279	219 332 866	272 077 337	286 184 699	279 314 136	282 220 398	256 608 112	271 391 278	128 368 695
Unit cost (AISC)	USD/ozt Pt	**182**	-	-	-	-	-	-	(595)	(5 934)	(724)	131	259	189	180	196	188	201	212	300	284	271	397	481	497	490	490	453	481	390
Unit cost (AISC)	ZAR/ozt Pt	**2 567**	-	-	-	-	-	-	(8 409)	(83 842)	(10 223)	1 857	3 659	2 673	2 548	2 773	2 658	2 837	3 002	4 242	4 018	3 823	5 613	6 799	7 019	6 921	6 918	6 400	6 796	5 513
Pre-Tax Cash Flow (EBITDA)	ZAR	**6 792 418 316**	(923 091)	(923 091)	(147 923 091)	(147 923 091)	(317 356 594)	(875 383 245)	(730 751 085)	(1 047 130 809)	(8 958 096)	394 109 191	471 507 709	445 139 782	441 914 429	440 980 961	430 741 710	440 510 925	458 075 104	515 896 409	504 038 066	494 477 591	609 441 714	671 710 772	693 498 712	682 396 510	689 740 482	657 064 311	670 210 020	358 236 112
Cumulative Undiscounted Pre-Tax Cash Flow	ZAR	**4 417 167 391**	(923 091)	(1 846 182)	(149 769 273)	(297 692 364)	(615 048 959)	(1 490 432 204)	(2 221 183 289)	(3 268 314 097)	(3 277 272 194)	(2 883 163 003)	(2 411 655 293)	(1 966 515 512)	(1 524 601 083)	(1 083 620 121)	(652 878 411)	(212 367 486)	245 707 617	761 604 026	1 265 642 092	1 760 119 683	2 369 561 397	3 041 272 169	3 734 770 882	4 417 167 391	5 106 907 873	5 763 972 184	6 434 182 204	6 792 418 316
Discounted Pre-Tax Cash Flow (EBITDA, 10%)	ZAR	**(24 397 077)**	(839 174)	(762 885)	(111 136 808)	(101 033 462)	(197 053 476)	(494 131 021)	(374 990 852)	(488 494 250)	(3 799 107)	151 946 154	165 260 576	141 835 253	128 006 869	116 124 070	103 116 141	95 868 012	90 627 717	92 788 504	82 414 251	73 500 943	82 354 207	82 516 964	77 448 659	69 280 714	63 660 286	55 131 279	51 122 068	24 841 292
Cumulative Discounted Pre-Tax Cash Flow (10%)	ZAR	**(219 152 003)**	(839 174)	(1 602 059)	(112 738 867)	(213 772 328)	(410 825 805)	(904 956 825)	(1 279 947 677)	(1 768 441 927)	(1 772 241 035)	(1 620 294 881)	(1 455 034 305)	(1 313 199 052)	(1 185 192 183)	(1 069 068 114)	(965 951 973)	(870 083 961)	(779 456 244)	(686 667 740)	(604 253 489)	(530 752 545)	(448 398 339)	(365 881 375)	(288 432 716)	(219 152 003)	(155 491 716)	(100 360 438)	(49 238 369)	(24 397 077)

NPV @ 10%	ZAR	**-24 397 077**
IRR	%	**9.9**
Discounted Payback Period	yrs	**26.0**
Undiscounted Payback Period	yrs	**14.0**

Sensitivity Tables

Initial Capital Costs

(All Values Reported in ZAR)

Sensitivity Index 1.00

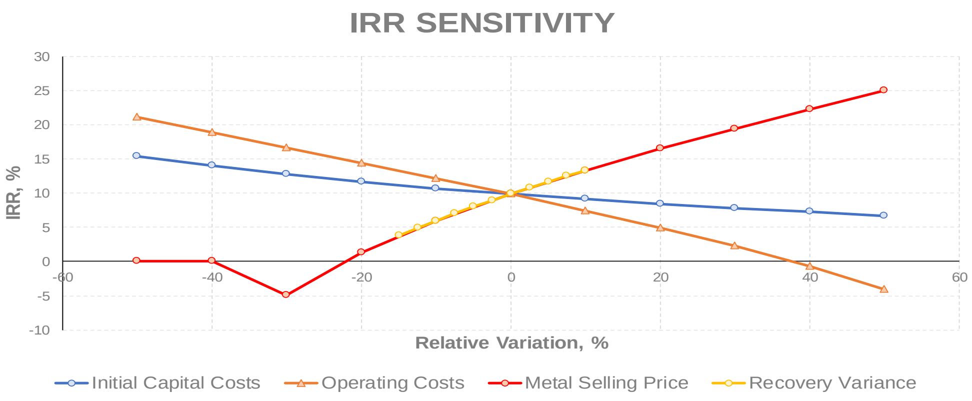
Variation	Index	NPV	IRR
		(24 397 077)	9.9
(50)	0.50	660 131 932	15.4
(40)	0.60	523 226 130	14.0
(30)	0.70	386 320 328	12.7
(20)	0.80	249 414 526	11.6
(10)	0.90	112 508 724	10.7
-	1.00	(24 397 077)	9.9
10	1.10	(161 302 879)	9.1
20	1.20	(298 208 681)	8.4
30	1.30	(435 114 483)	7.8
40	1.40	(572 020 285)	7.2
50	1.50	(708 926 087)	6.7

Operating Costs

(All Values Reported in ZAR)

Sensitivity Index 1.00

Variation	Index	NPV	IRR
		(24 397 077)	9.9
(50)	0.50	2 010 063 146	21.1
(40)	0.60	1 579 197 943	18.8
(30)	0.70	1 171 392 364	16.6
(20)	0.80	772 012 377	14.4
(10)	0.90	373 842 588	12.2
-	1.00	(24 397 077)	9.9
10	1.10	(427 182 102)	7.5
20	1.20	(829 967 126)	5.0
30	1.30	(1 232 752 150)	2.3
40	1.40	(1 635 537 174)	(0.7)
50	1.50	(2 039 488 038)	(4.1)



Metal Selling Price

(All Values Reported in ZAR)

Sensitivity Index 1.00

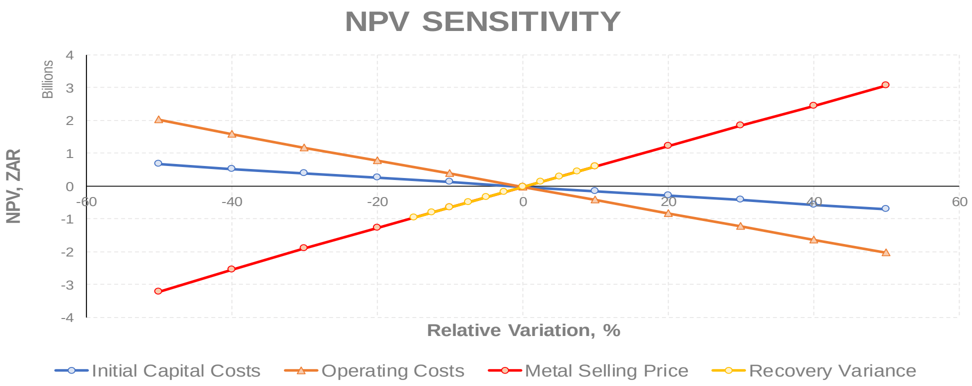
Variation	Index	NPV	IRR
		(24 397 077)	9.9
(50)	0.50	(3 238 779 397)	#NUM!
(40)	0.60	(2 554 505 600)	#NUM!
(30)	0.70	(1 894 226 686)	(5.0)
(20)	0.80	(1 270 690 173)	1.3
(10)	0.90	(647 543 625)	6.0
-	1.00	(24 397 077)	9.9
10	1.10	591 548 865	13.3
20	1.20	1 207 424 931	16.5
30	1.30	1 823 300 997	19.4
40	1.40	2 441 759 685	22.3
50	1.50	3 063 667 456	25.0

Recovery Variance

(All Values Reported in ZAR)

Sensitivity Index 1.00

Variation	Index	NPV	IRR
		(24 397 077)	9.9
(15.0)	0.85	(959 116 899)	3.8
(12.5)	0.88	(803 330 262)	4.9
(10.0)	0.90	(647 543 625)	6.0
(7.5)	0.93	(491 756 988)	7.0
(5.0)	0.95	(335 970 351)	8.0
(2.5)	0.98	(180 183 714)	8.9
-	1.00	(24 397 077)	9.9
2.5	1.03	129 641 816	10.7
5.0	1.05	283 610 833	11.6
7.5	1.08	437 579 849	12.5
10.0	1.10	591 548 865	13.3



NPV Discount Rate

(All Values Reported in ZAR)

Sensitivity Value 1

Variation	Value	NPV	Rate
		(24 397 077)	
(50)	0.50	1 589 833 937	5.0
(40)	0.60	1 101 043 394	6.0
(30)	0.70	713 900 099	7.0
(20)	0.80	407 625 247	8.0
(10)	0.90	165 842 436	9.0
-	1.00	(24 397 077)	10.0
10	1.10	(173 363 966)	11.0
20	1.20	(289 229 330)	12.0
30	1.30	(378 512 705)	13.0
40	1.40	(446 430 212)	14.0
50	1.50	(497 166 028)	15.0

Contingency Allowance

(All Values Reported in ZAR)

Sensitivity Index 1.00

Variation	Index	NPV	IRR
		(24 397 077)	9.9
(50)	0.50	113 878 510	10.7
(35)	0.65	72 416 797	10.4
(20)	0.80	30 955 084	10.2
(5)	0.95	(10 506 629)	9.9
-	1.00	(24 397 077)	9.9
15	1.15	(66 186 366)	9.6
30	1.30	(107 975 654)	9.4
45	1.45	(149 764 943)	9.2
60	1.60	(191 554 231)	8.9
75	1.75	(233 343 520)	8.7
90	1.90	(275 132 808)	8.5