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Beneficiation in Namibia:

Impacts, Constraints and Options

INSTITUTE FOR PUBLIC POLICY RESEARCH

Hanns Seidel Foundation

The compilation and publication of this report were funded by the Hanns Seidel Foundation.

Design and layout: Caroline de Meersseman
Printed by John Meinert Printing, Windhoek

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IPPR Research Report

November 2017

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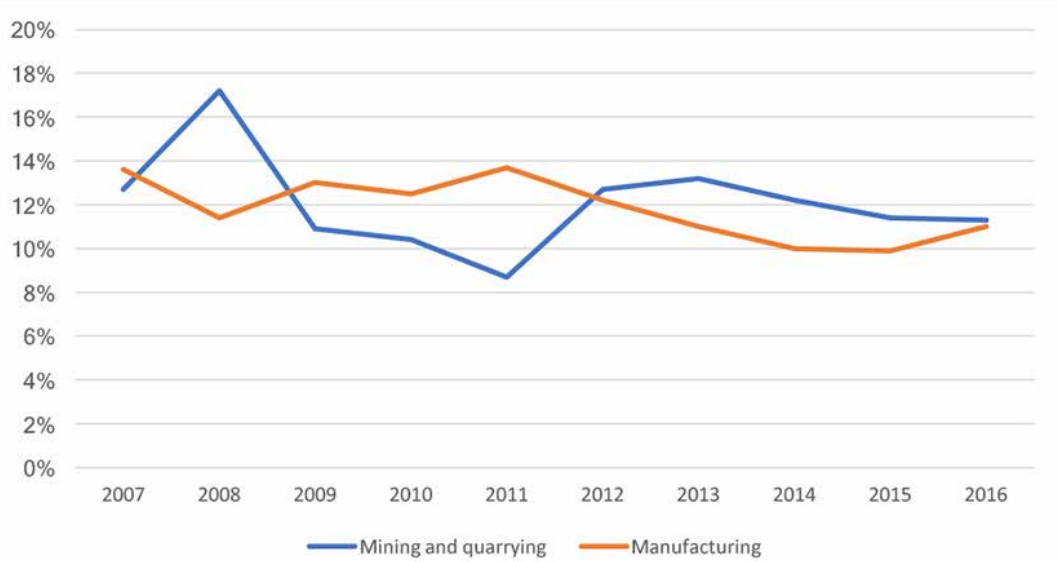
Rowland Brown holds a Master's degree in Economics from the University of Aberdeen, Scotland. He has worked as an economist for the National Planning Commission, Capricorn Investment Holdings, the Bank of Namibia and IJG Securities. He was the Founding Chairperson of the Economic Association of Namibia, is a graduate of the US State Department's International Visitor Leadership Programme to the United States, and a technical expert on financial stability for the IMF. In 2017 he co-founded Namibian financial services company Cirrus Capital. He works primarily on budget analysis and business climate assessments for the IPPR.

MINING IN NAMIBIA

Overview

The mining sector has been and remains a foundational sector for the economy of Southern Africa, and its role in the Namibian economy is no exception. Since independence it has consistently been one of the main contributors to Namibian GDP, contributing approximately 13% on average over the past 10 years. It therefore comes as no surprise that over the last 27 years, the Government of Namibia has kept a strong focus on the mining sector as a strategic economic asset.

CONTRIBUTION TO GDP



Source: Namibia Statistics Agency

At independence, the government inherited a well-developed mining industry. This industry represented a core of technical expertise, a source of hard currency earnings and a strong employment and tax base for the country. The industry, at the time, focused on Namibia's world-class diamond and uranium reserves. Other smaller mineral and metal deposits such as gold, zinc, lead, copper and salt are also observable but did not perform on the same scale.

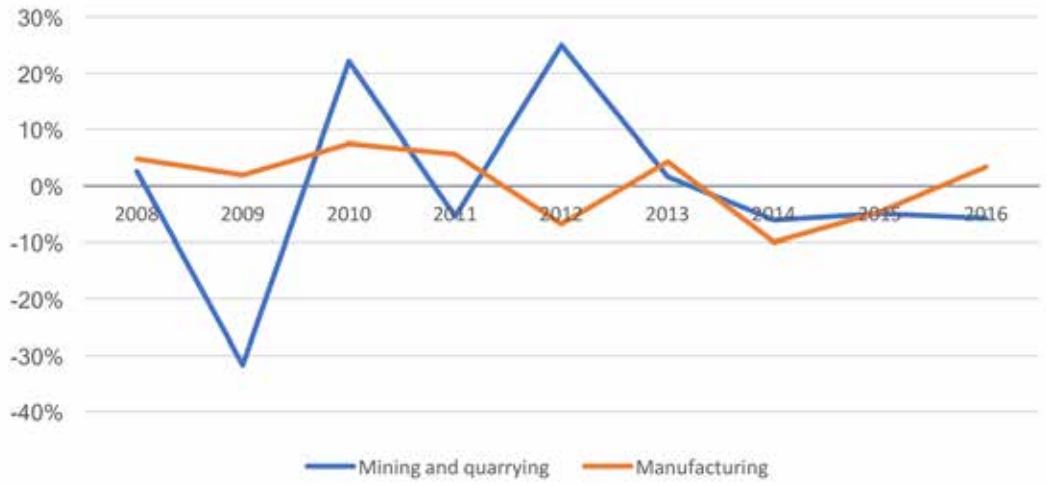
However, at the time, the bulk of the local mining industry was purely extractive, with very limited value addition of these raw commodities taking place in country, as well as little up-stream value chain capture.

In the period following independence, the focus of government turned to increasing both up and down-stream value capture in country, on the basis that such value addition could develop the local manufacturing sector, create jobs and boost export earnings, a mantra that had become prominent across the continent. In 2013, the then Minister of Trade and Industry, Calle Schlettwein, stated "We need a paradigm shift and transformation from being an economy that largely produces what it does not consume and consumes what it does not produce". This issue has repeatedly been raised as a priority as a significant portion of minerals and metals are claimed to leave Namibia's borders with minimal or no value added.

Despite the assumed self-evidence of the value-addition focus of government, very few success stories have so-far been witnessed, resulting in efforts to conduct further studies into the likely feasibility and success of downstream operations, particularly, and whether these can, in fact, be profitable. As a result, the Joint Value Addition Committee was established under the Fourth National development plan, encompassing representatives from the National Planning Commission, the Ministry of Finance, the Ministry of Trade and Industry (as it was then called), the Ministry of Mines and Energy, and the Chamber of Mines. The Committee hired consultants who completed two studies on the beneficiation possibilities for Namibia's mineral, the first completed in 2014 and the second in 2015. The final deliverable for the Committee under NDP4 (the fourth National Development Plan) was the development of a mineral beneficiation

strategy for Namibia. The Committee continued its work in 2015 and 2016, although planned field visits to downstream operations in neighbouring South Africa and Zambia for 2016 were cancelled as a result of government's financial constraints.

SECTOR GROWTH



Source: Namibia Statistics Agency

The political nature of the drive for beneficiation has led to the implementation of various successful (and unsuccessful) policies. In particular, beneficiation in the diamond industry has attracted the specific attention of government.

Policy and Tax Regimes

Before assessing the beneficiation opportunities for Namibian minerals and metals, it is imperative to examine the regulatory framework that they fall under. To do this it is necessary to examine the policies that facilitate the extraction, movement and regulation of these commodities. Beyond this, it is also necessary to look at the policies that impact the investment climate not only around extraction, but also the wider economy, as they have a bearing on investment in beneficiation activities.
Further, mining and exploration companies in Namibia are subject to a plethora of direct and indirect taxes, and many of the proposals surrounding beneficiation to date have in effect resulted in an increased indirect tax on miners.

Policy and Legislation

Policy Environment:

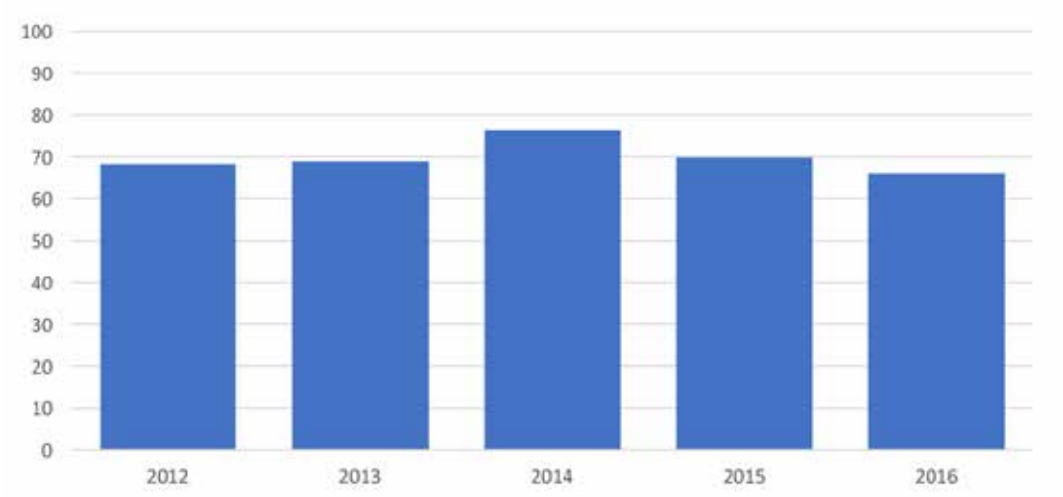
While Namibia has historically been viewed as a relatively attractive mining investment destination, three policy and/or legislative proposals have rocked the industry and the positive investment image of the country during the past decade. Firstly, in 2011 in an effort to increase "value addition" for Namibian minerals, the Ministry of Finance proposed draconian taxes on the export of "unprocessed minerals", including 15% VAT, a 5% export duty and an increase in the mining (income) tax rate on profits. This combination of both top and bottom line tax threatened the viability of much of the local mining sector, causing a number of mining entities to consider ceasing operations in Namibia. The threat to viability, coupled with the policy uncertainty that was created when the taxes were introduced without warning, resulted in Namibia sliding in ranking from a mining investment perspective.

Through 2015 and 2016, Namibia's score and ranking on the Fraser Institute Annual Survey of Mining Companies fell consecutively. These surveys attempt to assess the impact of mineral endowments and policy climate on exploration investment, and rank territories according to the extent to which these policy factors encourage (or discourage) investment. The three key areas of the survey look at investment attractiveness, policy perception, and best practices.

The rating slide over these two years was largely driven by two pieces of legislation, one proposed, and one enacted. These were the New Equitable Economic Empowerment Bill (NEEEB) and the Investment Promotion Act. Both pieces of legislation have been poorly received by domestic and foreign investors in the country for various reasons, largely centred around the policy and implementation uncertainty that they introduce, as well as the effect on companies' ability to operate, manage and control their affairs in the best interest of their shareholders.

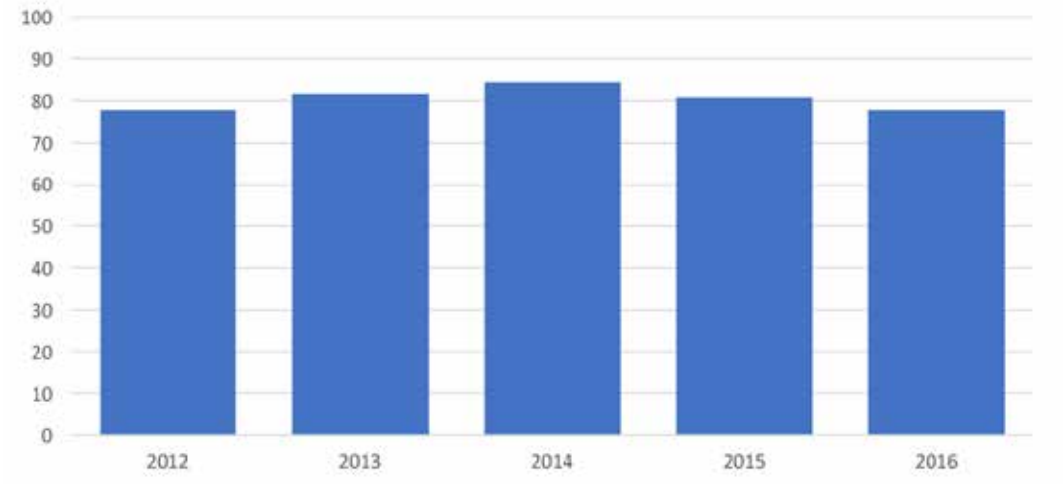
Prior to the 2015 and 2016 slide in the ranking, in 2014, Namibia was ranked as the 19th most attractive jurisdiction in the world when only policies were considered. The country fell to 29th in 2015, and this trend continued in 2016 when it fell to a rank of 38th. After the latest decline Namibia no longer ranks as the second most attractive jurisdiction in Africa based on policy. The reasons for the latest deteriorations were cited as increased concern over uncertainty regarding the administration, interpretation, or enforcement of existing regulations, the taxation regime, and barriers to trade.[1]

NAMIBIA: INVESTMENT ATTRACTIVENESS INDEX



Source: Fraser Institute

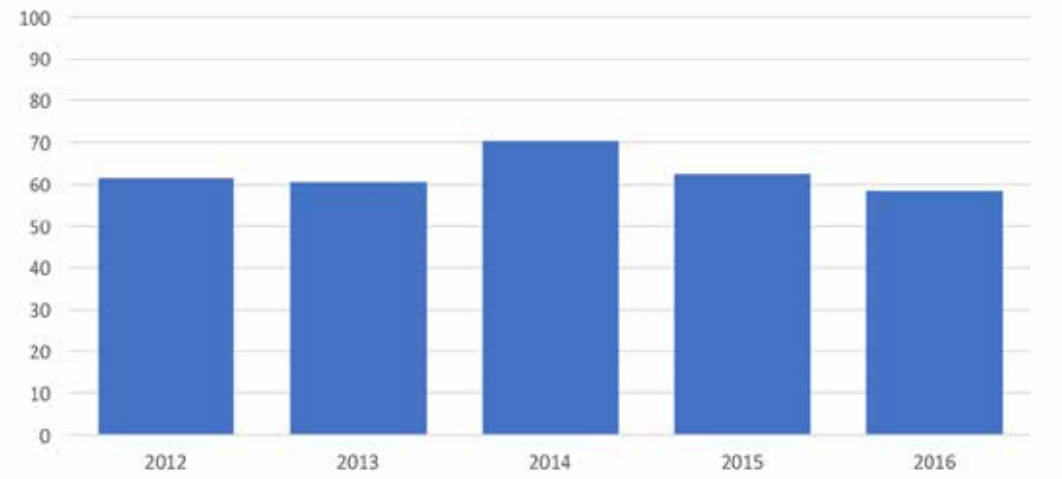
NAMIBIA: POLICY PERCEPTION INDEX



Source: Fraser Institute

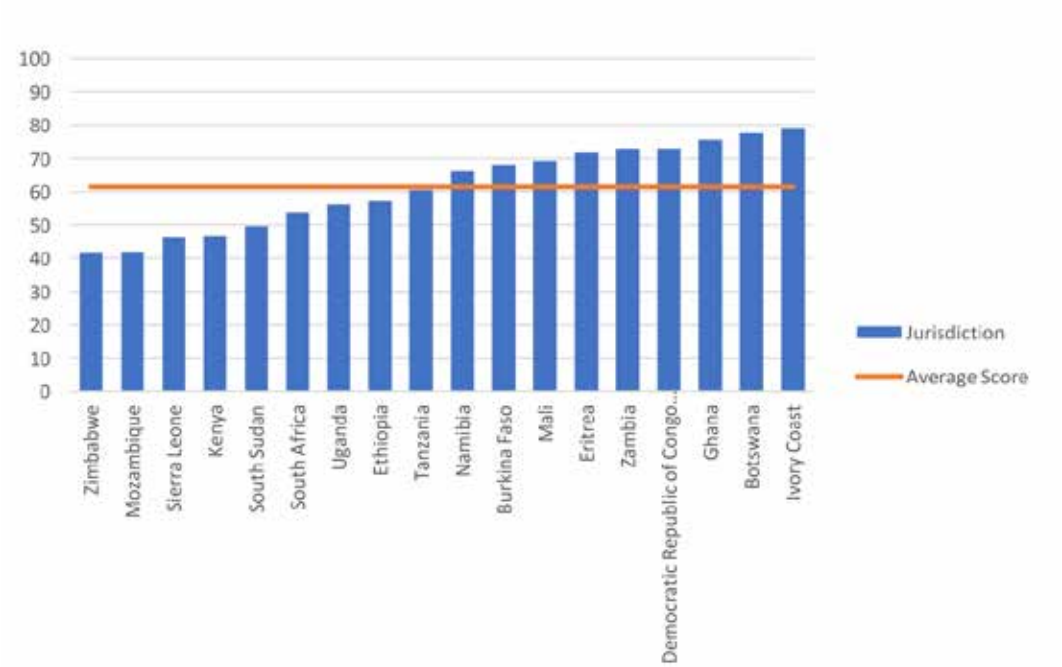
[1] Fraser Institute Annual Survey of Mining Companies, 2016

NAMIBIA: BEST PRACTICES MINERAL POTENTIAL INDEX



Source: Fraser Institute

AFRICA INVESTMENT ATTRACTIVENES



Source: Fraser Institute

Successful value addition requires the development of and investment in the manufacturing sector, from both the public and private sectors. Currently the perception that Namibian New Equitable Economic Empowerment Framework Bill and the Namibia Investment Promotion Act have created have been anti-investment. Although not specifically named, companies in the 2016 Fraser Survey raised concern over a Namibian policy that targets previously disadvantaged person. To promote policy to entice investment in a new sector in Namibia it is imperative that a positive investment climate is created in Namibia. This will not only attract investment, but by removing perceived bottlenecks will allow businesses to operate at their peak capacity.

Legislative Space:

Legislation with regards to "facilitating and regulation the responsible development and sustainable utilisation of Namibia's rich endowment of mineral, geological and energy resources for the benefit of all Namibians" falls under the authority of the Ministry of Mines and Energy (MME). With guidance from the MME, Parliament has passed three major pieces of legislation regarding minerals and mining, namely the Minerals

Act, the Minerals Development Fund Act and the Diamond Act. However, only two of these are of much relevance today as the drive around Mineral Development Fund Act has died out, with the Mineral Development Fund stating it is currently investigating and reviewing additional sources of funding that would ensure long-term financial sustainability.[2] The acts are used as a guide to ensure the sustainable contribution of minerals to the socio-economic development in Namibia. This is further iterated in the Minerals Policy of Namibia where the policy structures are listed.

Firstly, the Minerals Act serves as the backbone of the treatment of minerals in the country and delegates rights and responsibilities of stakeholders regarding mining claims and various licences. It endorses the fact that all prospecting and exploitation rights of Namibia's mineral resources are vested in the State. The Act advocates the creation of certain roles and bodies, such as the Mining Commissioner – whose job is to grant all licences and to inspect mining operations – and the Minerals Board, which is made up of important stakeholders in the sector (MME representatives, the Chamber of Mines, small-scale-prospectors and miners) to advise the Minister.

Due to the world-class nature of Namibia's diamond resource, the government created a specific mandate to regulate the resource. The Diamond Act mirrored several clauses present in the Mineral Act, such as allocating a Diamond Commissioner and a Diamond Board.

With regards to beneficiation, Section 58 of the act affords authority to the MME to oblige producers of rough diamonds to sell their output to Namibian diamond cutters and polishers under terms and conditions that the Minister may deem appropriate. Section 59, in attempt to encourage domestic cutting and polishing, attaches an export levy on unpolished diamonds.

Taxation

Over the past 27 years, mining activity in Namibian has made a substantial contribution to government revenue, both directly and to a greater extent, indirectly. However, while the overall contribution of the sector to the economy and government revenue is sizable, the direct contribution is relatively small, at approximately 6% of revenue? per year, the bulk of which is made up of diamond taxes and royalties. The income tax rates charged on mining entities is segmented into two groups: diamond mining and non-diamond mining companies. Diamond mining companies pay a significantly higher corporate tax rate than non-mining and non-diamond mining companies, of 55% whereas the non-diamond mining companies corporate tax rate is 37.5% – higher than the non-mining company tax rate of 32%.

Over and above the higher tax rates, both diamond and non-diamond mining companies are subject to a 10% Non-Resident Shareholders Tax (NRST) on dividends where more than 25% of shares are held by a non-resident company and 20% in all other cases.

Further, mineral producers pay a top-line tax to government in the form of a royalty. These payments are made irrespective of whether the company makes a profit or not, and are varied per mineral as follows:

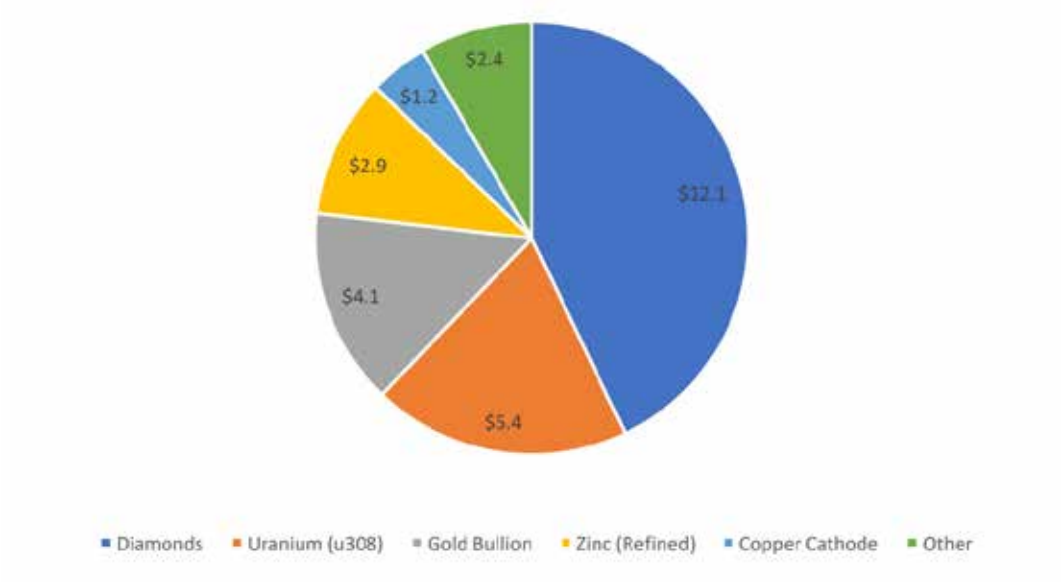
Rough diamonds	10%
Rough emeralds, rubies and sapphires	10%
Unprocessed dimension stone	5%
Gold, copper, zinc & other based metals	3%
Semi-precious stones	2%
Nuclear fuel minerals	3%
Industrial minerals (fluorspar, salt, etc)	2%
Non-nuclear fuel materials	2%
Oil and gas	2%

Source: Chamber of Mines

Royalties received from the mining industry amounted to N$1.6 billion in 2014/15 and are estimated at N$1.2 billion for the financial year of 2016/17.

[2] Guide to The Namibian Economy 2017 by Robin Sherbourne

MINERALS PRODUCTION BY VALUE (2016) – N$ BILLION



Source: Ministry of Mines and Energy

Employment

The mining sector's contribution to employment is relatively small in terms of employment numbers, representing just 2.2% of the total 676,885 employed persons in the country in 2016?. However, the sector pays the fifth highest average wage in the country, well over 200% of the national average wage.

Furthermore, according to the Namibia Statistics Agency (NSA), the working conditions presented in the mining sector are favourable in comparison to other sectors. Mining is second only to public administration and defence, with regard to the percentage of employees that receive paid leave and fifth with regard to percentage of employees that receive paid sick leave.

Beneficiation of Namibian commodities, it is believed, will go further in addressing unemployment. Downstream value addition requires processing and manufacturing of the raw materials, which in turn requires labour as an input. However, downstream beneficiation will not necessarily have the impact on unemployment that many believe it will. Namibia's struggle with unemployment is not necessarily just an issue of a shortage of work, but rather a combination of a shortage of unskilled work and a surplus of unskilled labour. Processing raw materials and manufacturing will absorb minimal amounts of unskilled labour. As is addressed further on this document, many of the downstream beneficiation processes will not require significant amounts of labour, and much of the employment created will require skilled labour, dependent on the resource and processes.

Exports

Although mining only accounts for a small portion of employment created, it contributes significantly to reserves thereby narrowing the current account deficit. In 2015, goods from the mining sector accounted for nearly half of all exports, settling at 47%. However, with weaker commodity prices seen in 2016, this figure dropped to 41%.

EXPORTS AGAINST MINING EXPORTS

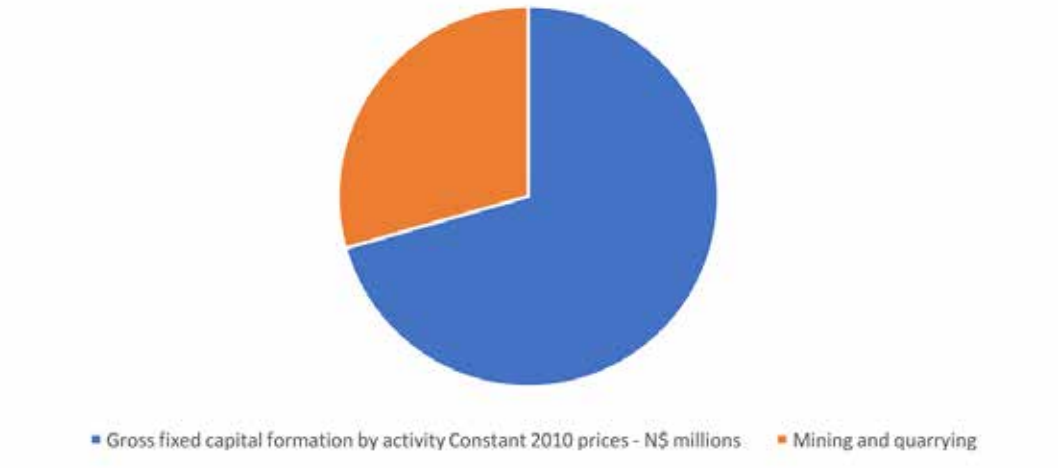
Fixed Investment

Historically, mining has been one of the largest contributors to gross fixed capital formation. Over the last four years, mining and quarrying contributed on average 38% to gross fixed capital formation. However, this decreased in 2016 to just 24% in real terms. This is by far the lowest contribution over the last four years. The formation of capital has an inherent upstream effect since mineral exploration is not the exclusive contributor to the aggregated value.

One should also consider the added value to several assets from other industries the mining industry displays as investment in Property, Plant and Equipment is required for the continuation of the mine. Never has this been more salient than in 2017 when the construction industry was impacted dramatically due to the completion of construction of several mines in Namibia.

The relationship between mining and construction was exemplified by the construction boom seen from 2013-2015, with the construction of the Husab, Otjikoto and Tschudi mines which contributed about 45% towards fixed capital investment.

GROSS FIXED CAPITAL FORMATION 2007-2016



Beneficiation

The focus of this report is on beneficiation and mineral resources, and so is not concerned with beneficiation in other contexts such as agriculture. The South African Department of Mineral Resources defines beneficiation as the "transformation of a primary material (produced by mining and extraction processes) to a more finished product, which has a higher export sales value".[3] The Chamber of Mines of Namibia has a similar perspective, describing beneficiation as the "further processing of mineral products into more refined and sophisticated products that generate greater value added within the domestic economy".[4] The Minerals Policy of Namibia takes a similar approach, explaining that it can cover an array of processes "from basic ore dressing, such as handpicking or crushing and screening, through to the manufacturing of final consumer goods, such as automobiles".[5] However, this definition goes one step further, and excludes any mineral that needs to "undergo initial processing in order to make it saleable", such as producing yellow cake from uranium ore or gold bullion from gold ore. These processes, in the eyes of the Namibian government, do not add value in the national economic sense. All these definitions are based on the same principle: taking raw materials and processing them as far as possible, rather than exporting them and losing out on the possible value that could be added. These policies can go by different names, such as beneficiation, increasing value addition, promoting downstream processes or completing value chains.[6] Beneficiation has been a topic of discussion since independence, finding its way into policy and strategy documents throughout Namibia's 27 years.

Beneficiation is a logical process; it seems natural that countries would progress from exporting their raw materials to processing these materials. This progression is believed to promote industrialisation and generate significant economic growth, which in turn should reduce poverty and inequality in developing economies.[7] Beneficiation is an attempt to diversify away from simple commodities, foster industrialisation (a driver of growth) through structural transformation, and reduce high unemployment[8] as result of the creation of new local industries.

The bulky raw mining exports, stagnant returns, commodity and foreign currency volatility, and the possibility of creating a secondary sector through manufacturing have all moved policymakers to focus on the opportunities beneficiation should bring. It is argued that the magnitude of value added to domestically produced minerals does not fall within the high value brackets; public perception is that very little to no beneficiation is done to the raw materials. This is often justified by reference to Namibia's balance of payments. Once cut and polished diamonds, refined copper and refined zinc (more beneficiated products) are excluded, calculations indicate that other, more raw minerals and metals – such as uranium, gold, and manganese – amount to roughly 80% of Namibian mining exports. The perception is that Namibia is exporting its mineral wealth only to repurchase it once it has been processed, at a premium. This has raised the concern of government and the general population. The concern is that by doing this we not only lose out on the monetary value added to our resources, but also lose out on the nominal effect it can play on our economy – in terms of employment, growth in secondary industries and the multiplier effect. This perception has been challenged and refuted by the Chamber of Mines and many mines themselves, arguing that many operations carry out some sophisticated beneficiation which results in refined mineral products for export.[9] Examples of these are the processing of uranium ore into yellow cake (which does not satisfy the government's definition of beneficiation, as indicated above), production of copper cathodes, and zinc refining.

Initially it was suggested that the current players in the mining sector should take on the task of beneficiation. This notion, however, was met with much resistance from the industry and representatives. Downstream beneficiation is not a task that mining companies would like to take on as they are specialised in the extraction and limited processing of natural resources. The Chamber of Mines, one of the bodies protesting against mines having to take responsibility for further beneficiation, proclaims that "miners are not manufacturers and manufacturers are not miners".[10] Rather, government should adopt a model that creates incentives for and attracts specialised manufacturing companies.

[3] http://www.dmr.gov.za/beneficiation-economics.html
[4] CoM "Beneficiation of Mineral Products in Namibia" 2011 pg 2
[5] Minerals Policy of Namibia pg 19
[6] "Examining Beneficiation" – Hausmann, Klinger & Lawrence – 2008, pg 1
[7] "Examining Beneficiation" – Hausmann, Klinger & Lawrence – 2008, pg 1-2
[8] "Examining Beneficiation" – Hausmann, Klinger & Lawrence – 2008, pg 17
[9] CoM "Beneficiation of Namibian Mineral Products" 2011 pg 8
[10] CoM Beneficiation of Namibian Mineral Products 2011 pg 9

Thus, to attract investment in this sector it is imperative that the government attract individuals that have the necessary expertise to create beneficiation. To do this Namibia needs to display an investment-friendly climate to attract ventures in the opportunities that exist for beneficiation.

Much emphasis is placed on downstream beneficiation, so much so that upstream beneficiation is often overlooked. Upstream value addition concerns the supply side of production, and therefore concentrates on the procurement of goods used in the production of minerals and metals. Thus, any industry that relies on the extraction of raw materials commonly has an upstream stage in its production process. Some upstream beneficiation already exists in Namibia, with further opportunities discussed below.

Although opportunities for upstream beneficiation exist, the focus on Namibian commodities is generally with regard to downstream value addition, i.e. the ordinary understanding of value addition being the processing and refining the raw material, intermediate goods and final products. This is mostly achieved by cultivating the manufacturing sector and thus it would be essential that Namibia has a positive investment climate in order to attract specialist investors.

Investment in downstream processes has already been seen to some extent in the diamond industry, with diamond polishing and cutting. Through the establishment of NamGem, other cutting and polishing companies have sprung up. This has been a catalyst in creating the Namibia Diamond Trading Company (NDTC) which was mandated to allocate all Namdeb rough stones that are sold to local cutters and polishers or exported to different global diamond trading companies. Local entities are currently allotted 10% of rough diamonds mined in Namibia. However, the success of this effort is met with scepticism as several of these companies are running at a loss. Currently the NDTC has 12 sightholders, listed below:

- Almod Diamonds Ltd
- Laurelton-Reign Diamonds
- Hard Stone Processing
- Nu Diamond Manufacturing
- Namgem Diamond Manufacturing
- Schachter and Namdar
- Pluczenik Diamond Namibia
- Ankit Gems
- NamCot Diamonds
- Julius Klein Diamonds Namibia
- Trau Bros
- Diminco Diamond Manufacturing Namibia

With the popular desire to see that more is done to our raw resources by “manufacturing Namibian minerals” there are mammoth misperceptions of what can be achieved currently but, more importantly, what could be achieved with adjustments in our current policy.

Commodities

This section details the potential downstream beneficiation possibilities for key commodities that are produced in Namibia. As a result of globalisation and international trade, competitive advantage rather than endowment of natural resources drives mineral value addition. Factors such as a skilled workforce, competitive input costs (for instance cheap labour and electricity), as well as access to markets and low transport costs are the forces that drive investment in mineral beneficiation. Downstream beneficiation can be separated into four distinct stages:

- **Mining**: this includes the process of extraction, crushing and/or grinding and the eventual production of the ore or concentrate (i.e. the raw product)
- **Smelting:** this process involves the transformation of the concentrate or ore into an intermediate product, such as alloys or refined metals
- **Refining or fabrication:** this is the conversion of the product into an even more refined product that is suitable for purchase by both small and more advanced industries. These are products such as wire rods.
- **Manufacturing:** this is the final stage, and the one most touted for domestic beneficiation to drive growth. This is the use of intermediate and refined products to manufacture final products for sale, such as vehicles, jewellery, cables, etc.

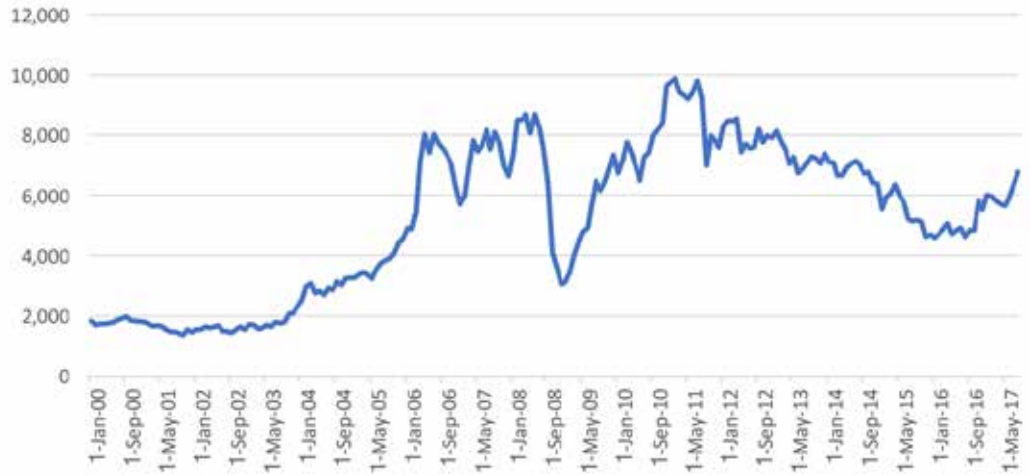
Downstream beneficiation encompasses a broad range of activities, ranging from capital-intensive activities such as refining, through to labour-intensive activities such as manufacturing.

Copper

Despite Namibia's long history of copper mining and smelting, domestic production is relatively insignificant when compared to the rest of the continent. The largest producers of copper include countries such as the US, Chile, China, the DRC, and Peru. Namibia's output forms around 1% of global supply.

Copper has a host of applications, from use in construction and plumbing, through to power generation and transmission, electronic product manufacturing, wiring and to form alloys. Declining construction activity in China reduced demand for copper, causing the price to fall to a six year low in August 2015. Since then, however, both demand in China and the price have recovered and posted significant gains in 2016 and 2017.

COPPER PRICES (US$/METRIC TONNE)



Source: Bloomberg

Operations:

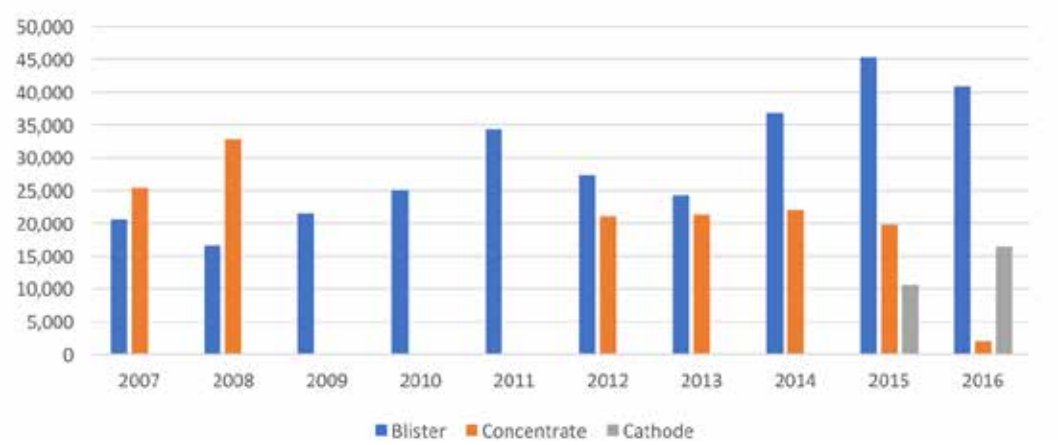
In 2013 Weatherly International announced that it had managed to secure a loan to the value of US$91 million in order to fund the development of its Namibian subsidiary's Tschudi copper operation. The Tschudi copper mine became operational in 2015 and produces refined copper. The operation is expected to have a life of around 11 years and is the first in Namibia to produce pure refined copper on-site. With the mine ramping up production in 2015 it was able to produce 10,659 tonnes of copper cathode, well above

its target for the year. Despite some setbacks caused by groundwater at the open pit mine, copper cathode production increased to 16,391 tonnes in 2016.

Weatherly International also owns two other copper operations in Namibia, namely the Otjihase copper mine and the Matchless mine. These operations were restarted in 2011 and ran through to 2015, when the drop in copper prices resulted in these operations being suspended and put into 'project development' status.[11] Weatherly has stated its intention to reopen both operations once the copper price reahes an acceptable level, with increased output and reduced unit costs, but as yet have not indicated a copper price that would support the resumption of activities.

In late 2013, Australia-based International Base Metals released results of a feasibility study conducted at its Omitiomire copper project. The results indicated that a small oxide processing plant and mine would be economically feasible, with copper at a price of US$7,276 per metric tonne or higher. The copper price is still well below this, so it remains to be seen if this operation will start up. An estimated 3.1 million tonnes of 0.93% copper-containing ore can be extracted, producing about 25,570 tonnes. This is not a significant amount by global standards.

COPPER PRODUCTION (TONNES)



Source: MME

Smelter:

The Dundee Precious Metals Tsumeb smelter (previously Namibia Custom Smelter) uses copper concentrate to produce blister copper which is 98% pure. This can be further refined through electrolysis to produce refined copper cathode which is 99.9% pure. Blister copper produced here is exported for further refining. With insufficient copper mining operations in Namibia, domestic sources are supplemented with imports from neighbouring countries such as Zambia to make the small smelting operation feasible. Dundee Precious Metals Tsumeb operates the smelter, which was upgraded to expand its capacity to handle approximately 240,000 tonnes of concentrate per year. Although it is a high-cost smelter, it is one of few worldwide that accepts copper concentrates with deleterious elements such as arsenic or other impurities, and so the Tsumeb smelter makes use of concentrate sourced from mines in Bulgaria and Peru. By being able to smelt what are referred to as 'dirty' or 'complex' copper concentrates, Dundee has created a niche and there is significant potential for increasing smelting through importing 'dirty' copper concentrates from other regions such as Chile. The smelter ran at a loss in 2012 and 2013, attributed to high electricity costs, old technology and low-quality feed. The smelter's capacity was subsequently expanded with the expectation that this would lower unit operating costs. The blister copper produced here is exported to various destinations where the gold and silver are extracted and highly-refined copper cathode is produced.

In 2016 Dundee completed an acid plant which captures the sulphur dioxide by-product of the copper refinement process and converts this to sulphuric acid. This is a positive move in domestic beneficiation, as sulphuric acid is used in the leaching process by various mines such as the uranium mines in the Erongo region. As such, the Tsumeb smelter has an off-take agreement to produce sulphuric for one of the uranium mines, providing a portion of what they require. Should it be possible to increase production of sulphuric

[11] CoM AR 2015 pg 15

acid, this provides an opportunity for expansion of domestic production and reduces the need to import this chemical from international producers.

Beneficiation:

Further downstream beneficiation of the Tsumeb Smelter's blister copper is possible. Currently it is exported as blister copper to be refined elsewhere. A refinery plant, although requiring significant capital investment, would be able to convert the blister copper into copper cathode thereby adding value. Constructing a refinery of this nature is associated with a long payback period, and so is in part determined by domestic demand for refined copper products that can be produced more cost effectively than imports. The smelter is mostly fed by imported copper ore, and so the expected life of local operations is not a concern. The short life of mine and relatively small sizes of Weatherly's projects make investment in further downstream beneficiation, such as a cable or wire rod plants, unattractive.

DIAMOND ROUGH PRICE INDEX

Source: Bloomberg

Diamonds

Namibia consistently produces gem-quality diamonds while ranking ninth globally in terms of volume. Based on carat value, however, Namibia consistently ranks highly, coming in at second by dollar per carat.[12] In the diamond industry there is a fundamental division between mining and beneficiation. Diamond companies generally do not have significant cutting and polishing operations, just as cutting and polishing companies are not much involved in mining. However, some exceptions have arisen when governments encourage mining companies to get involved in cutting and polishing as part of a larger deal. This is the case in Namibia, with Namdeb's involvement in NamGem. But this is the exception to the rule, as is the case in other types of mining. For instance, one does not see companies involved in iron ore mining setting up car manufacturing plants. The route that the Namibian government has taken is not to force the involvement of diamond mines in downstream activities, but rather to encourage diamond cutting and polishing through access to Namdeb diamonds and favourable Export Processing Zone status.

Operations:

There are two key rough diamond operations in Namibia. The first is Namdeb Diamond Corporation, a 50:50 venture between the Namibian government and diamond giant De Beers.[13] Namdeb focuses on land-based exploration, mining and then rehabilitation. It has three main areas of operation.

i. Northern Coastal Mines finds itself south of the port town of Lüderitz, the most noteworthy operation being the Elizabeth Bay mine.
ii. Southern Coastal Mines, formerly known as Mining Area 1, stretches approximately 100km from just above the mouth of the Orange River to Chameis Bay.
iii. Orange River Mines extends for about 50km along the Orange River, from the eastern boundary of Southern Coastal Mines to Sendelingsdrif. Orange River Mines is home to the Daberas and Sendelingsdrif mines, renowned for the high value stones they produce.

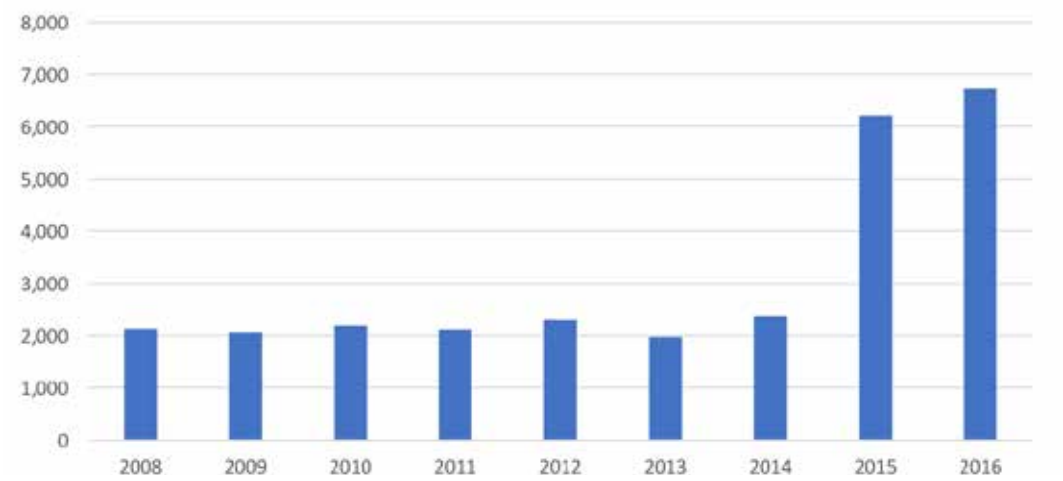
In late 2017 it was reported that Namdeb intended to slowdown and eventually cease operations at its

[12] Debmarinenamibia.com
[13] http://www.namdeb.com/

land-based mines.[14] The first to be shutdown would likely be the Elizabeth Bay mine near Lüderitz, followed by the Daberas mine along the Orange River. This is not entirely surprising as land-based operations have been contributing less and less to Namibia's total production over recent years.

Marine diamond mining has more than made up for dwindling land-based reserves. Debmarine Namibia is the largest diamond producer in the country, by both value and volume, contributing approximately 70% of total diamond production.[15] Similarly to Namdeb, Debmarine Namibia is a joint venture operation between the Namibian government and De Beers, mining the offshore mining licence area along the southern coast of the country. The company operates a number of exploration and mining vessels, and in 2017 inaugurated the most advanced marine diamond exploration and sampling vessel in the world – the SS Nujoma.

DIAMOND PRODUCTION (CARATS)



Source: Chamber of Mines

Beneficiation:

In 2008 De Beers and the Government of the Republic of Botswana created the Diamond Trading Company Botswana, another 50/50 joint venture. This is one of the largest rough diamond sorting and valuation facilities in the world, and is capable of handling 45 million carats per year. This is more than enough to handle the output of Angola, Botswana, Namibia and South Africa. It is said to be cheaper and more efficient to expand the current facilities in Botswana than developing new centres elsewhere, and so this is not a viable option for Namibia especially as De Beers is unlikely to develop another centre within the region. The focus should remain on cutting, polishing and jewellery manufacturing. The price per carat from rough diamond to polished gem-quality diamond increases about eightfold. This represents significant value that can be captured within Namibia. The industry argues that limited supply is stifling them, and there are calls for the 10% of locally-mined diamonds allocated to domestic factories to be pushed to 20%. The 10% allocation to domestic firms is not enough for these firms to realise economies of scale, and with high associated costs, many do not run at a profit. Increasing their allocation, both in terms of quantity and quality of diamonds made available to them, should boost the profitability of downstream beneficiation currently active in Namibia.

In order to boost further beneficiation of cut and polished diamonds into jewellery, significant investment is required. The challenges this undertaking faces are upfront costs in equipment purchases, finding skills in a country that is new to the industry and saddled with a majority-unskilled workforce, as well as competing with other nations that have lower labour costs (such as India) or more expertise (such as Europe).

Gold

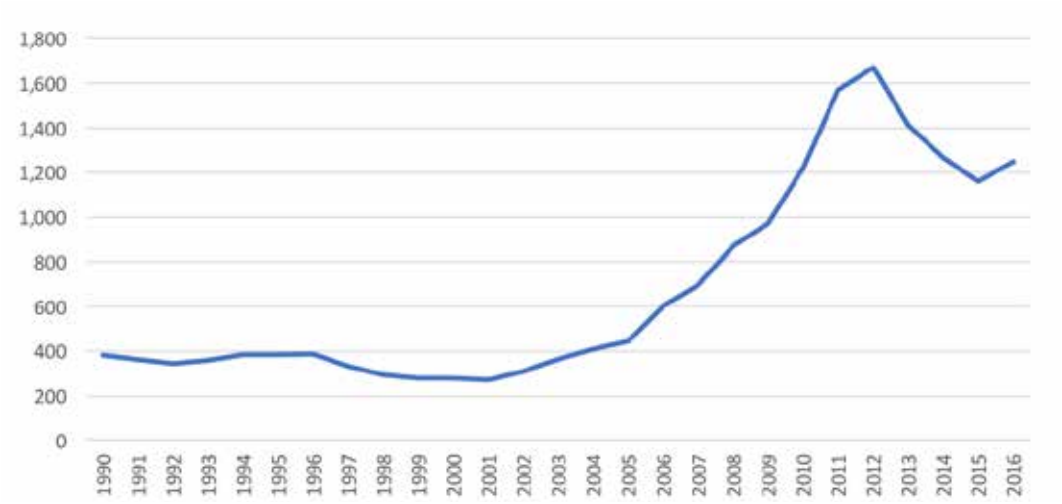
Even though gold was discovered in Namibia as far back as 1899, it remained relatively ignored due to the ores generally being of low value and the focus being on diamond mining. The most prominent gold mine in Namibia is the Navachab gold mine, having been in operation since 1989. Namibia's gold output is negligible in comparison to the rest of the world, especially when compared to the largest producers such as Australia, China and Russia. Gold prices have seen increased volatility over the past years, mainly as a result of an increasingly unpredictable global economic climate and quantitative easing policies being

[14] Namibian Sun. Wed 30 Aug 2017. Front page. "diamonds aren't forever"
[15] http://debmarinenamibia.com/main/whoweare

implemented by central banks in developed economies.

GOLD PRICES (US$/TROY OZ)

Source: World Bank

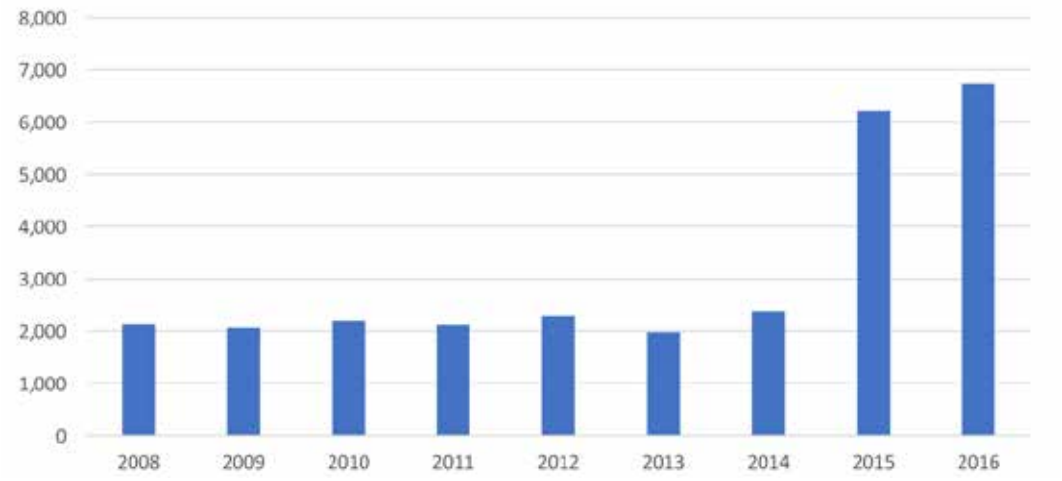


Operations:

Namibia is now home to two commercial gold mines, the first being Navachab with B2Gold's Otjikoto project coming into operation in 2015. The output from both mines is exported to a gold refinery for further processing.

Navachab is an open pit mining operation with a life of mine expected to take it to 2036. Further exploration may yield viable deposits. Otjikoto is projected to potentially be a larger operation than Navachab and in 2015 was estimated to have a life of mine of 12 years.

GOLD BULLION PRODUCTION (KG)



Source: Ministry of Mines and Energy

Beneficiation:

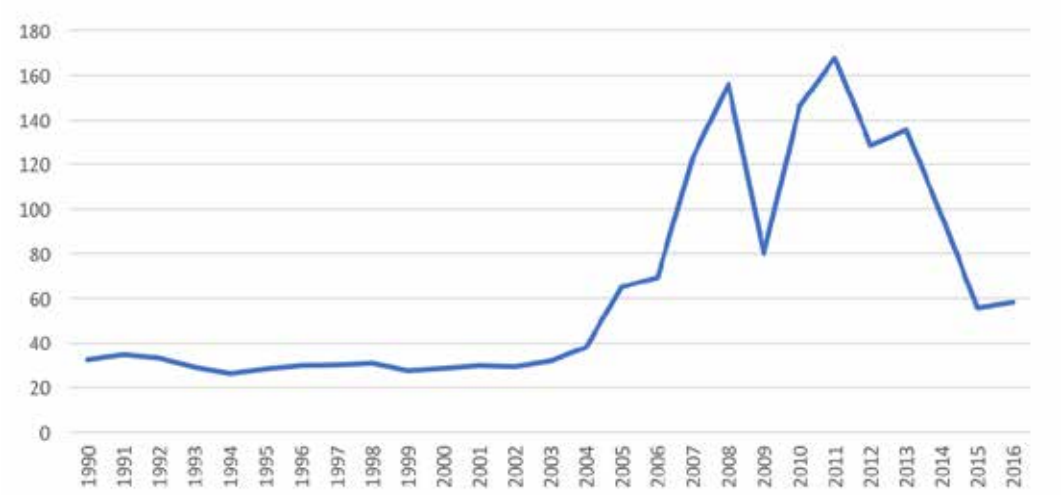
Downstream beneficiation of gold includes refining and further manufacturing. Gold mines generally do not refine gold directly, as it is often a low margin operation when compared to mining. There is a global excess of gold refining capacity, with many international refineries suffering from input shortfalls. South Africa is home to the third largest refinery, the Rand Refinery. A gold refinery requires economies of scale in order to remain competitive, considering the high operating costs and low profit margins involved. Gold refineries are rather energy intensive, with regional electricity supply constraints and high (as well as increasing) costs posing a barrier. Beyond this, many of the chemical inputs required are not produced in Namibia and come at a high cost. With the long payback period associated with a refinery, the current expected life of mine and small comparative output of Namibian operations do not make a refinery commercially viable.

This is exacerbated by the relatively close proximity of the Rand Refinery, which has excess capacity. The conclusion is that downstream beneficiation of gold is not viable, considering the excess worldwide refining capacity, high operating costs and life of mines in the area not being long enough to offer secure supply.

Iron Ore

Iron ore mining is very new to Namibia with the first sizeable commercial operation established in 2015. This is attributed to historical explorations that showed Namibia had sizeable iron ore resources, but that they were of a low grade that did not warrant commercial interest. Iron ore is mined and then refined to produce 'pig iron', one of the primary raw materials used to make steel. Iron itself is usually found in magnetite, hematite, goethite, limonite or siderite (ranging from highest to lowest iron content). Because iron ore is the key ingredient for steel, the price of iron ore is heavily dependent on the steel market. Steel is one of the most commonly used metals in the world, with applications ranging from construction to vehicle and appliance manufacturing.

IRON ORE PRICES (US$/DRY METRIC TONNE UNIT)



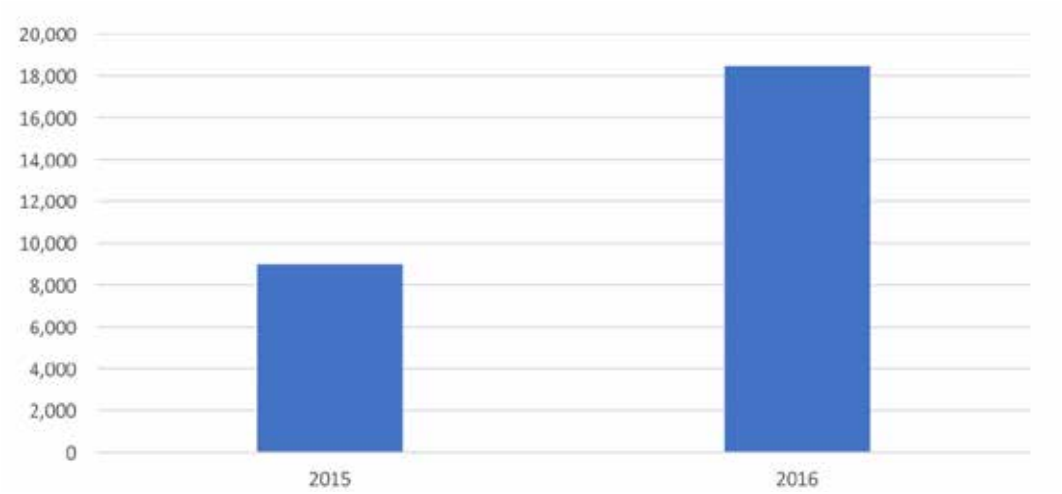
Source: World Bank

Operations:

Lodestone's Dordabis iron mine is the first iron mine in Namibia. Production commenced in July 2015 and the mine went on to produce 4,000 tonnes of iron ore that year, doubling to 8,878 tonnes in 2016. The initial life of mine is estimated at 20 years, with ongoing exploration expected to expand the proven reserves. The magnetite produced by Lodestone is used by Ohorongo in their cement manufacturing, which exemplifies upstream value addition through the use of locally produced inputs.

Other projects include the Eastern China Non-Ferrous Metals Investment Holding exploration of a substantial iron ore project south of Opuwo in the Kunene region, the AVZ Minerals Ltd magnetite project at Ondjou, as well as the Deep Yellow Ltd prospect of the Shiyela iron project. Although studies and explorations of these projects purportedly yielded encouraging results, no further information on any of these has been made available since 2013. It is therefore reasonable to assume that nothing has yet come of these.

IRON ORE PRODUCTION (TONNES)



Source: Ministry of Mines and Energy

Beneficiation:

Iron ore mining in Namibia is still in its infancy and requires substantial investment in order for Namibia to become an exporting nation. For the time being, domestic production from Dordabis is used in upstream value addition, such as the Ohorongo cement making process or as inputs in the uranium mining process. Downstream value addition of iron ore into steel is possible; however this requires planning, access to capital, cheap electricity, coking coal and natural gas.

Turning iron ore into steel involves many processes that can be done in a variety of manners, depending on the product mix, raw materials available, energy supply, and capital available. The three main processes available are:

- **Blast Furnace/Basic Oxygen Furnace:** crude iron is made by using mostly iron ore and coke in a blast furnace. This is then turned into steel in a basic oxygen furnace. The inclusion of coke making and sintering operations make this an extremely energy intensive route.
- **Scrap/Electric Arc Furnace:** this route relies primarily on scrap for iron input, and has a remarkably lower energy requirement as it omits the coke making and iron making processes.
- **Direct Reduced Iron:** based on iron ore, and often scrap for the iron input. This process can be less energy intensive than the blast furnace route, but this depends on the size, as well as the fuel used and ore characteristics.

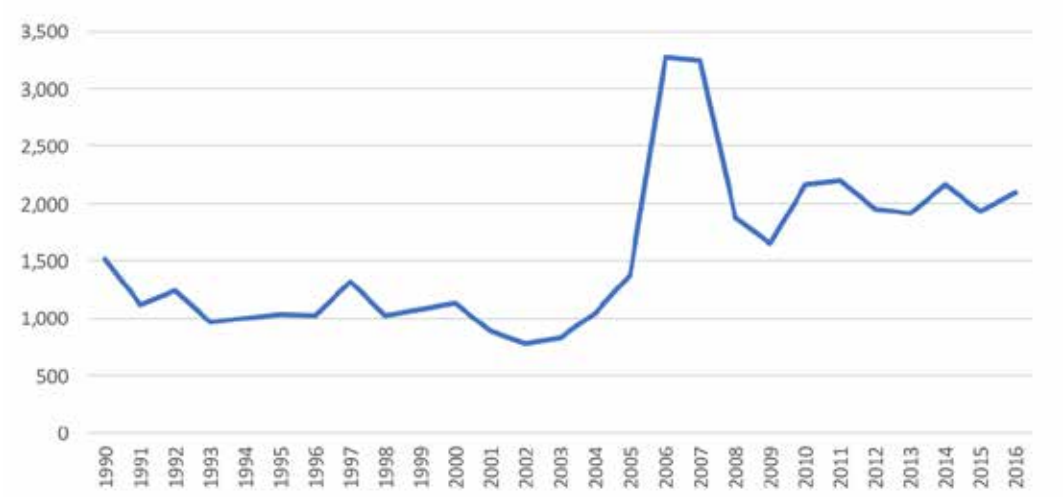
Over the past few years there has been excess global steel smelting capacity, much of which is attributed to China (the world's largest producer), with capacity utilisation estimated at just below 70%.[16] Beyond the issues posed by the excess global capacity, steel manufacturing in Namibia would be challenged by international cost competitiveness, especially in terms of inputs such as labour and energy. This is a lesson to be learnt from South Africa's struggling steel industry which also has excess capacity. Following the trend of many other commodities, the majority of countries that produce iron ore produce very small quantities of steel. South Africa is not a significant steel producer, ranking 24th in the world in 2016 according to the World Steel Association.[17] The majority of its steel operations since 2011 have been either making losses or are only marginally profitable, being under pressure from persistently low steel prices, increasing energy costs, and distance from major export markets. If Namibia were to develop this sector it would require low electricity prices, a domestic supply of scrap, coking coal, manganese and a plentiful supply of consistent-quality iron ore. Furthermore, the potential gains from developing further steel downstream beneficiation do not seem that great. In many industries that require steel as an input, the total costs of steel as an input are not significant. For example, in vehicle manufacturing steel only accounts for about 3% of the entire cost of the final product.

[16] http://www.hellenicshippingnews.com/tackling-excess-steel-capacity-the-chinese-way/
[17] https://www.worldsteel.org/en/dam/jcr:0474d208-9108-4927-ace8-4ac5445c5df8/World+Steel+in+Figures+2017.

Lead and Zinc

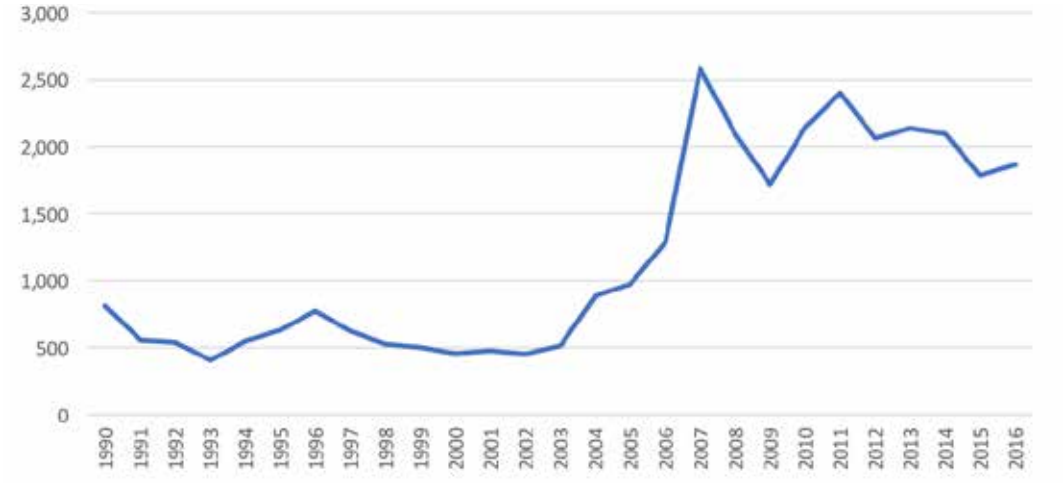
Similar to diamonds, zinc and lead operations are fairly concentrated in the south west region of Namibia. Zinc has a variety of uses. Most of the global supply is used to galvanise steel, protecting it from corrosion, while the remainder is used for processes such as producing zinc alloys (brass and bronze), some is converted to produce semi-manufactured products, and some is used in the making of oxides and chemicals. Lead does not attract much focus, as it is often produced as a by-product (or co-product) of zinc mining because their ores occur together naturally. As such, most mines end up producing zinc concentrate and lead concentrate by separating the two through smelting. From there the concentrates tend to be sent off to relevant lead or zinc smelters for further beneficiation.

ZINC PRICES (US$/MT)



Source: Ministry of Mines and Energy

LEAD PRICES (US$/METRIC TONNE)



Source: Ministry of Mines and Energy

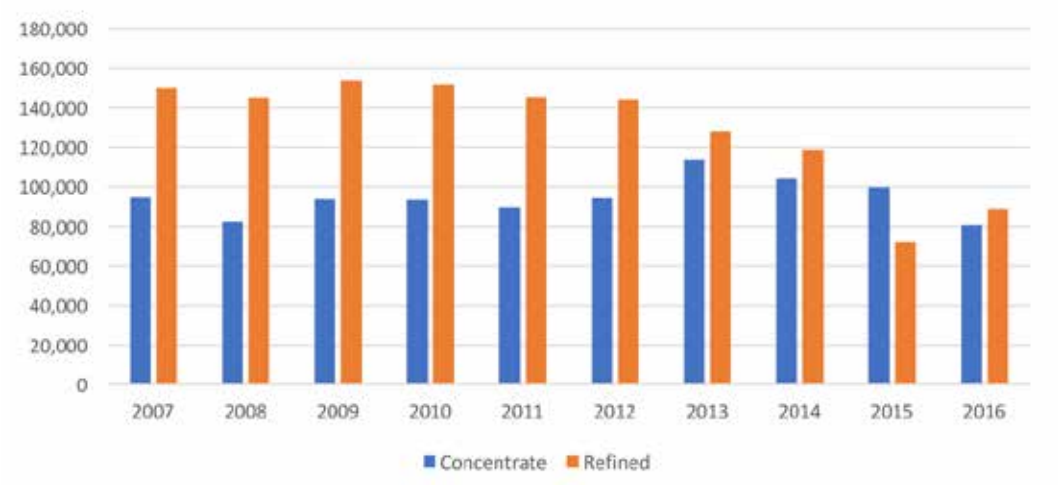
Operations:

Namibia currently has two active zinc operations, Rosh Pinah Zinc Corp and Skorpion Zinc. Rosh Pinah Zinc Corp has lead and zinc operations, producing 80,560 tonnes of zinc concentrate and 14,862 tonnes of lead concentrate in 2016. Skorpion Zinc managed to produce 85,427 tonnes during its 2016/17 financial year. The Skorpion life of mine has been extended by three years from 2017 to 2020. Skorpion's operation is somewhat unusual as it produces its refined zinc from oxide ores through solvent extraction and electrowinning, a process more commonly restricted to copper mining. Where Skorpion mines zinc sulphide in an open pit mine, Rosh Pinah Zinc Corp produces a zinc concentrate from zinc oxide mined underground. Rosh Pinah Zinc Corp sent its zinc concentrate to a refinery in Springs, South Africa, until it was closed in 2011. Since then, both Rosh Pinah Zinc Corp's zinc and lead concentrates are exported overseas to be smelted, the majority of it being sent to China. It is theoretically possible for Rosh Pinah Zinc Corp's zinc

sulphide to be roasted into oxides, and then to be fed into Skorpion's plant to produce special high grade zinc of the same quality. However, this is entirely dependent on Rosh Pinah Zinc Corp's life of mine and the preferences of Glencore, which owns Rosh Pinah Zinc Corp. Glencore has excess smelting capacity overseas, and so is likely to continue exporting its zinc concentrate to be refined elsewhere.

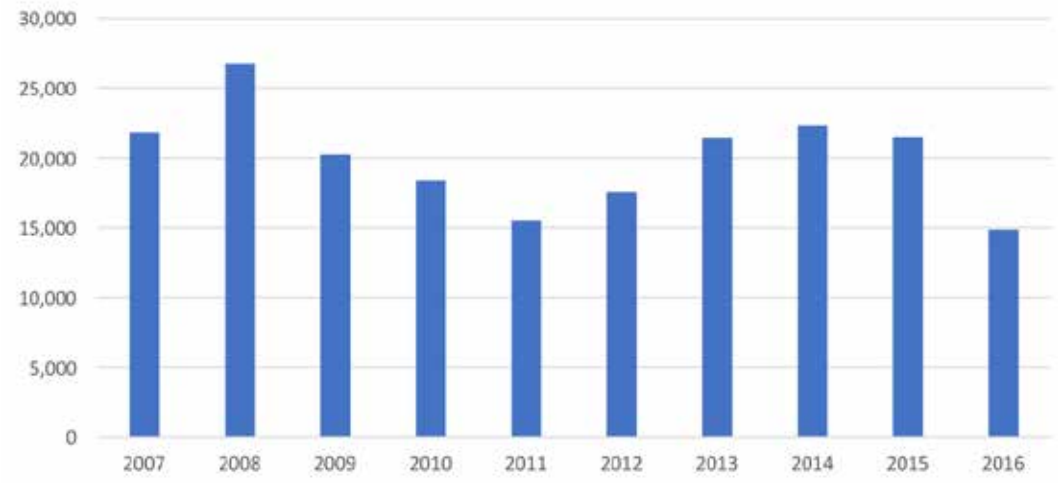
Vedanta (the owner of Skorpion) and GlencoreXstrata (the owner of Rosh Pinah) have been in dispute over the significant Gergarub zinc sulphide deposit near their current operations. The mines initially signed an agreement in 2005, but since then both have come under new ownership and arguments arose as to the interpretation of this original agreement. Both owners agreed to arbitration in South Africa, which awarded Vedanta's Skorpion a controlling 51% and Rosh Pinah the remaining 49%. Glencore allegedly lodged an appeal against this, but since then very little public information has been forthcoming.

ZINC PRODUCTION (TONNES)



Source: Ministry of Mines and Energy

LEAD CONCENTRATE PRODUCTION (TONNES)



Source: Ministry of Mines and Energy

Beneficiation:

As mentioned earlier, there is already excess steel capacity (such as in South Africa) and so even with domestic zinc supply, forging ahead with steel manufacturing in Namibia is not likely to yield positive results. Brass is an alloy of zinc and copper (generally more copper than zinc), a high-value product that is relatively straightforward and cheap to produce. Brass is a highly-recyclable metal, retaining around 80% of its intrinsic metal value, and so it is unusual for primary refined zinc to be used in its production. As such, this

would not be a suitable use for Namibia's zinc output.

With regard to zinc, the majority of profits are captured in producing zinc concentrate, rather than smelting zinc. This suggests that mining and producing zinc concentrate should be encouraged, and upstream integration should be the focus for this commodity as this would benefit more from exposure to the commodity price. In terms of government collecting royalties, it would make sense to focus on zinc mine development rather than stressing downstream value addition.

Exploration and studies conducted thus far indicate that Namibia's lead production could peak at around 60,000 tonnes a year – a quantity that does not justify the construction of a dedicated lead smelter. It would be possible to further beneficiate domestic sources of metals such gold bullion, zinc, lead and copper concentrate. However, the key issue remains with economies of scale. Due to the low profit margins from smelting and refining, downstream beneficiation like this requires significant economies of scale. Unfortunately, the relatively small quantities mined in Namibia, as well as short-term life of mine outlook for some operations, does not make establishing smelting and refining process an attractive investment option in Namibia. Investment could be encouraged if Namibia is able to demonstrate that such activities are more economically viable here than other countries in the region. This could be due to lower input costs, such as transport or energy, although Namibia is not yet in a position to offer anything of the sort, especially as it is still heavily reliant on imports. In order to benefit from further downstream zinc beneficiation, a domestic steel industry will need to be developed, along with the associated iron ore, manganese and coking coal processes. These industries could be developed and the products beneficiated, but significant economies of scale are required in order for this to be cost competitive and compete on the international market.

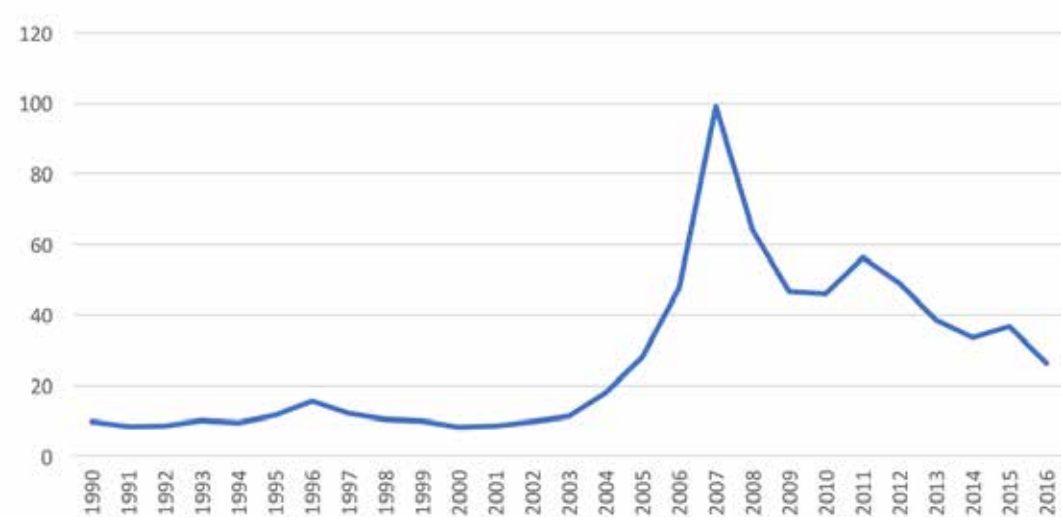
Uranium

Until recently, Namibia was home to two significant uranium mines that are purportedly capable of providing around 10% of world uranium output.[18] This has now increased, with Swakop Uranium's Husab mining starting production on 30 December 2016. Husab is reported to be the second largest uranium mine in the world and the largest open-pit mine in Africa, with the mine's total potential production exceeding Namibia's total production prior to its operation.[19] This should propel Namibia to third place on the ladder of world uranium producers. Uranium prices hit a high in 2007, but have been on a constant downward trajectory attributed to declining demand ever since the global financial crisis in 2008 and the Fukushima Daiichi nuclear disaster in 2011. The World Nuclear Association forecasts that nuclear power generation worldwide will increase 30% by 2030, and 41% by 2035.[20] This is because many existing generation facilities will need to be replaced as they reach the end of their lifespan, as well as the shift away from fossil fuel generation which will create gaps in generation which can be taken up by 'cleaner' generation through nuclear.

Namibia is one of few nations with special permission to mine and export yellow cake (viz. uranium oxide). International agreements exist between uranium importing and exporting countries in order to limit and regulate the transfer, transport and use of nuclear material. Namibia is one of these countries with the safeguards in place to ensure that exported uranium is used strictly for peaceful purposes (such as energy generation), and is not diverted for weaponisation or other military use. This allows easier development of uranium and nuclear resources in Namibia than in many other nations, creating an incentive for exploration and further development.

[18] http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/namibia.aspx
[19] http://www.swakopuranium.com/n948920/n948981/index.html
[20] http://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx

URANIUM PRICES (US$/POUND)



Source: International Monetary Fund

Operations:

The Husab body has been considered as one of the most important uranium discoveries in recent times. This recent discovery is the largest granite-hosted uranium deposit in Namibia, and the third largest uranium-only deposit in the world so far. The mine has a potential total uranium oxide output of 6,800 metric tonnes per year. The world's second largest uranium mine came into operation on 30 December 2016 when Husab produced its first barrel of uranium oxide. With a gradual ramp up, the mine is expected to reach nameplate capacity by 2019.

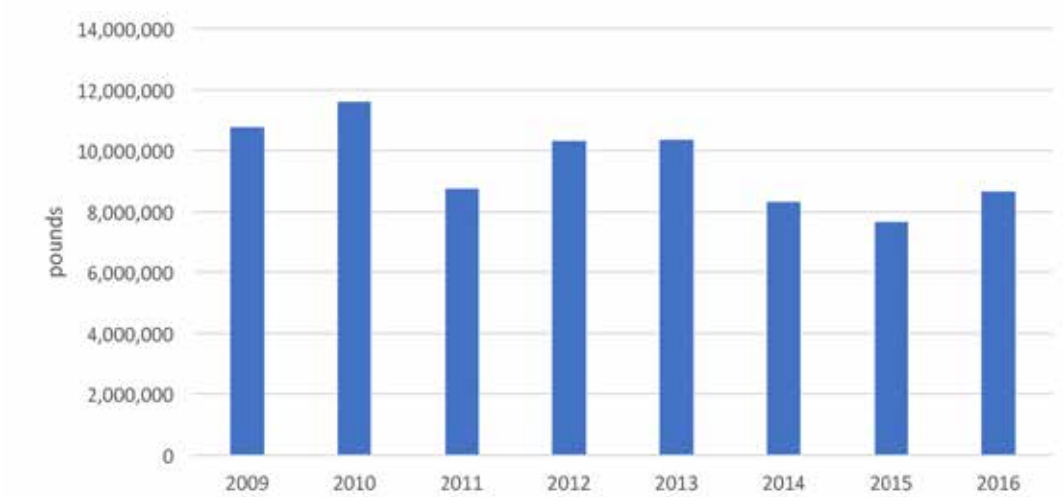
In response to persistent low uranium price, the Langer Heinrich uranium mine decided to reduce production by 20% for two years from 2016. As part of restructuring and cost reduction plans, some operations were suspended and low-grade ore that had been stockpiled will feed the plant. This ensured the company's sustainability during the difficult times posed by the double whammy of a weakening uranium spot price and appreciating South African rand. Production increased in 2016, to 2,236 tonnes from 2,228 tonnes in 2015.

Rössing Uranium has been in operation for 40 years. The mine significantly increased output from 1,245 tonnes in 2015 to 1,850 tonnes in 2016. This is in part due to ramping up to continuous operation after two years of curtailed production but also as a result of improvements in their mining activities, which increased mill throughput and as a result increased total production.

In part due to weak uranium prices in both rand and dollar terms, AREVA's Trekkopje continued with care and maintenance in 2016, meaning it did not produce any uranium oxide in 2016. The Erongo Desalination Plant saw the mine reduce reliance on NamWater during the drought, providing the mine (and other local mines and municipalities) with an alternate water source.

A 10 year moratorium on applications for exclusive prospecting licences (EPLs) for nuclear fuel minerals was terminated effective 15 December 2016, providing an opportunity for further exploration within the country. There are a number of exploration companies conducting activities in Namibia, such as Valencia with its Norasa uranium project. Bannerman is pushing ahead with its Etango project. In March 2015 Bannerman commissioned its Heap Leach Demonstration Plant, and reported positive results in the first and second phases of the plant's operations. A feasibility study puts production at 3,000-4,000 tonnes of uranium per oxide in the first five years of production, and thereafter at 2,700-3,600 tonnes per year for the remainder, with a minimum life of 16 years and targeted life of over 20. During 2016, the 6-phase metallurgical program at the Heap Leach Demonstration Test surpassed assumptions, positioning the operation favourably once the uranium price recovers as anticipated (in the medium term).

URANIUM PRODUCTION



Source: Ministry of Mines and Energy

Beneficiation:

Enrichment of uranium is limited to handful of facilities in thirteen countries: France, Germany, Netherlands, the UK, Japan, the USA, Russia, China, Argentina, Brazil, India, Pakistan, and Iran. As it stands there is currently an excess of global enrichment capacity. Beyond this, South Africa is home to unused enrichment facilities and rather imports fuel for its sole nuclear reactor.

Uranium leaves the mine as uranium oxide. In this form it still contains some impurities and so is refined before it is converted to uranium hexafluoride. Once converted into gaseous uranium hexafluoride, it can then be enriched either through the diffusion process or the centrifugal process. The cost of enrichment is mainly related to the energy requirements, with gaseous diffusion requiring significantly more energy than the centrifugal process. Centrifuge technology has become the preferred method of enrichment, with diffusion seeing less of a share and slowly becoming obsolete.[21]

Further downstream beneficiation of uranium requires a high degree of specialised labour, of which there is a severe shortage within Namibia. In order to add value to uranium oxide, it would need to be converted into uranium hexafluoride (as discussed above). Commercial conversion plants only operate in Canada, China, France, Russia and the USA. Two of the world's largest uranium oxide exporters, Australia and Kazakhstan, do not convert uranium oxide. Construction of a conversion or enrichment facility is often said to be prohibitive due to the cost alone, estimated to cost anywhere between US$250 million and US$500 million. As a result, more than 75% of uranium oxide produced is not converted or enriched in the country of production. Being well beyond government's ability to finance, significant private capital investment would need to be sourced. Given the current investment climate, as discussed earlier, this is unlikely to be the case. Beyond this, Namibia is unlikely to attract private capital as these types of facilities are generally located within relative proximity to nuclear power plants and nations that are perceived to have very stable governments.

The conversion and enrichment of uranium is heavily regulated by international bodies and agreements, and has far-reaching geopolitical implications as the processes could lead to the development of nuclear weapons. Namibia's ties to North Korea (the Democratic People's Republic of Korea) have been under scrutiny, especially in recent times as the hermit nation has been actively pursuing its nuclear weapons programmes, allegedly completed a successful test of its most powerful nuclear weapon to date, and has repeatedly launched missiles over Japan in a show of force and in retaliation to sanctions. It is thus unlikely that nations such as Japan, South Korea and the USA would be eager to allow Namibia to develop conversion and enrichment facilities. This, in conjunction with the aforementioned infrastructure, skills and other challenges posed, suggests that any attempts at downstream uranium beneficiation are highly unlikely to meet any level of success.

Finally, uranium hexafluoride production in Namibia poses a further challenge. Uranium hexafluoride is a

[21] http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/conversion-enrichment-and-fabrication/uranium-enrichment.aspx

highly toxic substance/material that can take the form of a solid, liquid or gas at different temperatures, manipulated depending on the situation and immediate use (such as storage or enriching). However, it reacts violently with water (or even water vapour) and becomes highly corrosive. As such, it is safer to transport uranium oxide which is significantly less reactive, and is as radioactive in this form as it was in nature underground.

In short, uranium enrichment is expensive, requires an extremely high degree of skills from a very small number of people, and the initial conversion generates very little additional value. Once converted into fuel rods, however, uranium can be used to power nuclear power stations. For Namibia, however, it appears unlikely that Nuclear power-stations will be of use. The reasons for this are that Nuclear power tends to be of a significantly larger scale than Namibia's power demands require, as well as significantly more expensive than conventional thermal (and increasingly, renewable) power. Given that Namibia needs access to cheap power to industrialise, and would need to sell the excess (expensive) power into the region (where cheaper thermal power is available), it is highly unlikely that a nuclear power-plant will be viable in Namibia for a number of decades. However, on the off-chance that such a plant becomes viable, it is still likely to be more efficient to purchase enriched uranium from one of the global enrichers, than to carry out that phase of the value-chain in Namibia.

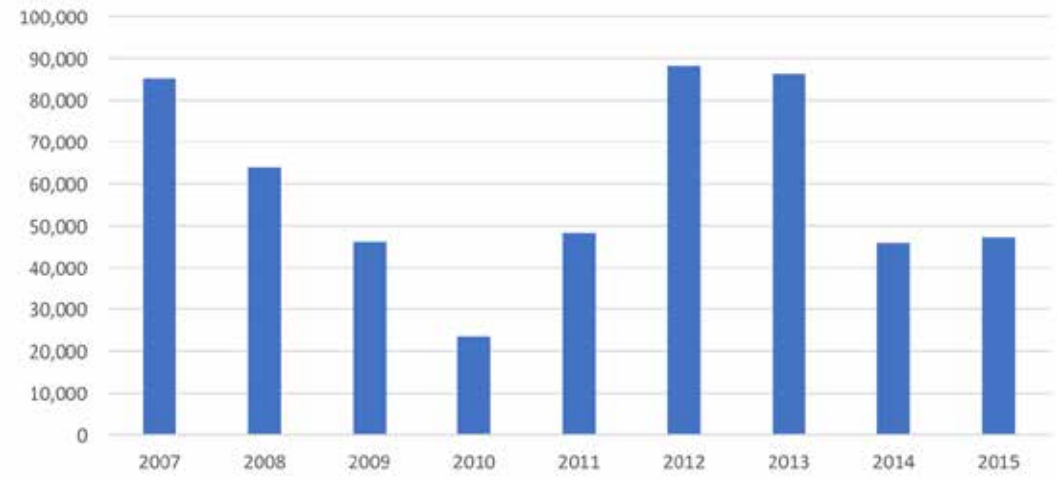
Dimension Stone

Dimension stone refers to natural stone or rock that is quarried and then finished – cut, trimmed, or drilled to specific dimensions and shapes - to be used for construction or monuments. These are chosen for their colour, grain, texture and pattern. The main types found in Namibia are marble, granite, dolerite, conglomerate and sodalite.

More than half of demand is attributed to the construction industry, with the remainder being the funeral/monument industry and some minor specialty applications. As a result of the 2008 Global Financial Crisis and subsequent slowdown in construction, global demand declined markedly and has been recovering slowly. The market is driven by low prices, increasing availability and choice of products, and a steady demand for use in houses. Global dimension stone production is estimated at over 150 million tonnes in 2014. There are approximately thirty countries that contributed to this total, led by China, Turkey, India, Indonesia and Italy. Major exporters of granite are Brazil, Canada, China, India, Italy, and Spain, whilst major marble exporters are Italy, Spain, China, Turkey, Greece.

This industry is heavily reliant on electrically-driven equipment that cuts and shapes the stones. Thanks to automation, these can run non-stop meaning there are minimal labour requirements. The skills that are needed in the cutting process can be taught on the job. Key to keeping this commodity competitive is access to cheap, uninterrupted power supply. This poses a problem not only in Namibia, but in the region as well, where generation capacity has been an issue and energy costs continue to rise.

DIMENSION STONE PRODUCTION (TONNES)



Source: Ministry of Mines and Energy

Operations:

Namibia currently has a number of producers operating within the country, with most quarries found in the Erongo region. R.E.D Graniti Ltd is part of an Italian group that owns operations in various countries, such as Finland, Brazil and South Africa. Marmorwerke Karibib quarries a range of dimension stone, such as granite, marble and basalt slabs and tiles. They export to nations such as Germany, China and Japan. Damara Granite also operates in the Erongo region.

A high premium is paid for first-grade blocks, and so most of Namibia's production is exported in the form of blocks.

Beneficiation:

Dimension stone can be quarried and then finished by a producer, or quarried and then sent off to a manufacturer (who is closer to the end market) to be finished. Generally, stone blocks are quarried and then shipped to international processing plants which convert these into slabs, tiles, or requested products and sell them to architects/homeowners. It has become an increasing trend for large companies to own operations around the world in order to ensure regular supply for their beneficiation plants, as is the case with R.E.D Graniti. Further value addition normally takes place at the final market, in order to meet the final specific demand requirements, reduce damage or breakage, and minimise transport costs.

Graphite

Graphite is a naturally-occurring form of carbon that has a range of extreme properties, such as being extremely soft, yet extremely inert and resistant to heat. Its properties make it suitable for a host of industrial applications. Natural graphite mined for commercial purposes can usually be classified into either flake, high-crystalline, or amorphous graphite. These are often further sub-divided into grades based on carbon content, impurities and particle size. Synthetic graphite has a high carbon content, but is expensive to produce and so is generally reserved for highly specialised industries. As a result, natural graphite and synthetic graphite rarely compete.

There are fewer than 20 countries that produce over 1 million tonnes of graphite per year, with China producing about 66% of global supply. Brazil, Canada, India and Turkey account for most of the remainder, with small contributions from countries such as Mexico, Russia, Norway, Sri Lanka and Madagascar.

The properties of graphite make it suitable for many metallurgical uses, such as in refractories, crucibles and the steelmaking process. Graphite also has non-metallurgical uses, such as in batteries, brake linings, lubricants and pencils. Refractories are predominantly used in cement, lime, and steel manufacturing, meaning that demand for graphite is fairly dependent on these industries. Demand for high-purity graphite (either synthetic or highly-refined natural graphite) is increasing for new technological applications, such as lithium-ion batteries.

Operations:

Gecko Namibia has entered into a joint venture with Imerys Graphite to develop the Okanjande graphite mine near Otjiwarongo. The mine is expected to process just short of 400,000 tonnes of relatively low-grade ore per year. This will be transported to the now repurposed Okorusu plant, where it will be refined through flotation and gravimetric separation, to produce an estimated 20,000 tonnes of graphite per annum. The life of mine is estimated at 20 years. This is then to be transported, by road, to Walvis Bay for export via the harbour.

Argosy Minerals Lt is a mineral exploration company operating out of Australia, with interest in the Erongo (Area 51) Graphite Project. As yet, no final decision has been officially communicated. Rather, the company claims to be reviewing and considering funding opportunities before announcing a final strategy.

Next Graphite is an exploration development company that owns a majority stake in the Aukum graphite project, some 170km from Lüderitz. This is the site of Namibia's only historic graphite mine that operated occasionally between 1940 and 1974. Aukam is home to a high-value form of natural graphite called vein graphite, with medium to large flake distribution. Vein graphite is a fairly pure form with a low sulphur content that is sought after, especially since its occurrence is restricted to a few locations worldwide. Next Graphite intends to bring this mine back into production and develop a new graphite processing facility. The company has entered into an agreement to supply 5,000 tonnes of this high-grade ore per year, sub-

ject to receiving a full mining licence which it applied for in early 2017.[22]

Beneficiation:

Africa contributed less than 1% of global graphite supply. As a result, any graphite production in Namibia would be insignificant in terms of global supply and would be only for export. However, graphite can be a specialised market based on the type and quality of the graphite, meaning that operations can compete without economies of scale. Graphite ore beneficiation is done by using flotation processes which increase the carbon content of the graphite, as is the prospect with the Okurusu and Aukum facilities. Further value addition involves detailed processing to make a range of different grades, incorporating various blends of refined graphite. This sort of beneficiation is generally done by specialised processors, who source a variety of graphite. An operation of this sort in Namibia would be faced with many challenges such as the significant capital investment, a lack of variety in domestic graphite, and its distance from end-users. Most importantly, a Namibian producer would have to break into an established market where the product needs to be tested, characterised, and certified by consumers. This continues to be a major barrier to entry.

Manganese

Manganese is a metallic element that does not occur as a free element in nature, but rather in around 300 other minerals.[23] However, only about a dozen are of mining significance and are rarely found in deposits with a high enough concentration to make it commercially viable. The majority of high grade ore reserves are located in the southern hemisphere, with South Africa, Brazil, Australia and Gabon supplying around 90% of the global ore market.

The most important application of manganese is in the steel manufacturing process, accounting for well over 80% of demand. Although only a small amount of manganese is used in relation to the iron content, manganese plays a vital role and no substitute exists for it. As such, steelmaking is heavily reliant on manganese as an input. Manganese is also used for its corrosive resistance and alloying properties in aluminium manufacturing, for products ranging from kitchenware and roofing, to beverage cans. Manganese is also used as an alloying addition to other metals, such as with copper or titanium. Non-metallurgical applications only account for around 5% of manganese demand. These applications include use in dry-cell batteries, micronutrients in fertiliser and animal feed, colourant in some paints, and in chemicals (such as for purifying water).

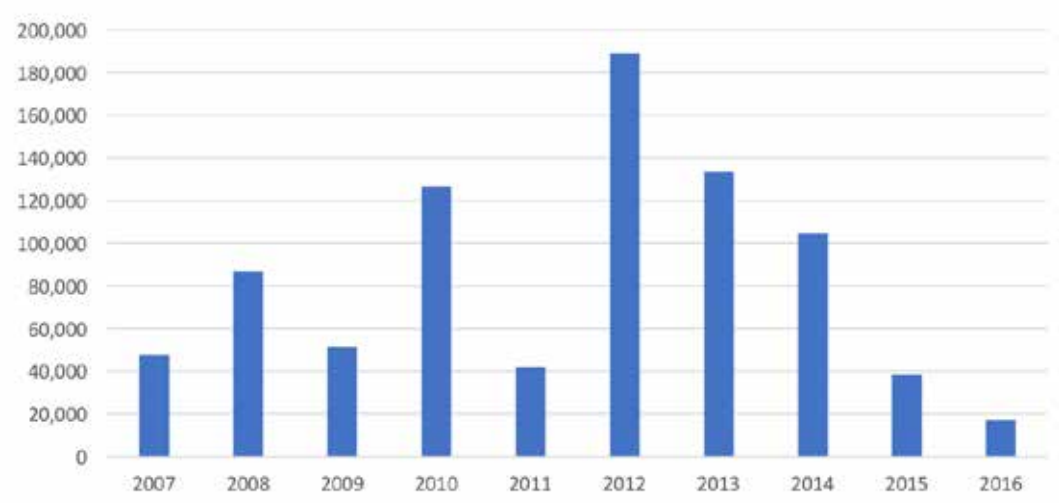
As a result of its dependence on the steel industry, the market for manganese has struggled over the past few years. With the slowdown in steel manufacturing, as well as the excess steel smelting capacity worldwide, the manganese price has fallen significantly from 2011 to 2015. As a result, many operations worldwide collapsed. This includes the Australian-based Shaw River Manganese, which owns the Otjozondu operation in Namibia. These collapses have led to some recovery in the price, which has continued slowly into 2017. It is hoped that the prices continue to recover, to the point that manganese operations can be resumed.

Operations:

There were two notable companies operating in Namibia, Purity Manganese and Shaw River Manganese (Otjozondu Mining). Purity Mining was placed under provisional liquidation in September 2015, after it was claimed to be hopelessly insolvent. It was reported that various operators were considering purchasing the defunct operation, but no details were provided. Shaw River Manganese owned and operated the Otjozondu mine near Okahandja. As mentioned above, it is hoped that these operations can be continued once the outlook for the manganese market is more positive, and is worthwhile for long-term investment.

[22] http://www.nextgraphite.com/news/press-releases/detail/220/correction-next-graphite-announces-jv-partners-closing-of
[23] http://www.manganese.org/about-mn/reserves/

MANGANESE PRODUCTION (TONNES)



Source: Ministry of Mines and Energy

Beneficiation:

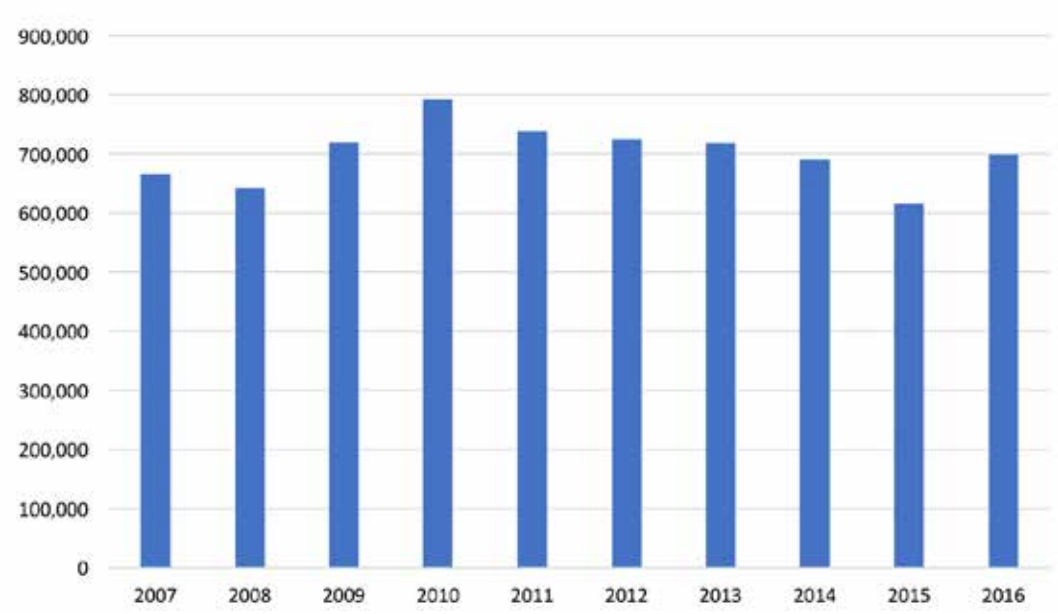
Beneficiation of manganese ore is often very specific to the type of ore (or mineral) it is derived from, as well as its intended end use (such as for metallurgical or chemical purposes). As a result, refining is generally done closer to the place of consumption. Domestic steel production, fed by domestic iron ore, would provide an attractive incentive to develop local manganese concentrate production and vice versa, as these go hand-in-hand. The issue of steel manufacturing is dealt with separately under the iron ore section. However, downstream manganese beneficiation would require low electricity costs and significant capital investment in modern technology in order to achieve efficient production costs. Beneficiation for non-metallurgical uses is not commercially viable. For chemical applications this is normally done closer to the point of consumption, and the amount of manganese as an input is insignificant in comparison to other inputs.

Salt

Salt, harvested for commercial or household use, is either found as a mineral in bedded deposits or in brine. An example of brine is seawater, which generally contains between 1%-5% salt. This marine salt is recovered through evaporation of seawater in artificial ponds or coastal basins, as is the case in Namibia. This sort of production requires a rate of evaporation much higher than that of precipitation (i.e. rain) and either quick transport to the end-market or shipping facilities. Major salt producing nations include Australia, Canada, China, France, Germany, India, Mexico and the United States. Global salt production is gauged at around 300 million tonnes per year, with the fifteen largest producers responsible for about 85% of this. In comparison, Africa produces a mere 7 million tonnes per year and only about 1 million of this is produced in Southern Africa. Namibia, a marine salt producer, leads production in Southern Africa and is followed by Botswana.

The majority of salt demanded worldwide is for use by the chemical sector. Other applications are in road maintenance, food processing and agriculture, and water treatment. Without a developed chemical sector in Africa, demand on the continent is mostly restricted to food processing and agriculture. With its use in a variety of industries, especially industries expected to grow, salt demand worldwide is projected to increase steadily.

WALVIS BAY SALT COMPANY PRODUCTION (TONNES)



Source: Chamber of Mines

Operations:

Namibia is the largest producer of salt in Southern Africa, and the largest producer of marine salt on the continent. The largest and most well-known producer is Salt & Chemicals, which operates the salt field operation at Walvis Bay. Seawater is pumped from the natural lagoon into a series of ponds. The company has produced more than 700,000 tonnes of salt from 4,500 hectares. In 2016 the company completed a large expansion project, raising its output to 1 million tonnes per year from 5,500 hectares as from 2020. The coarse salt is refined and beneficiated to industrial grade or table salt by sister companies, Walvis Bay Salt Refiners and Ekango Salt Refiners, prior to export. The operation currently exports to neighbouring countries, West Africa and Europe. It received certification from a US body in late 2016, meaning that the company can expand its exports to include the USA.

The Salt Company also operates in the central coastal region, with the capacity to produce about 120,000 tonnes of salt a year. Unlike Salt & Chemicals, which falls under a South African parent company, the Salt Company is a wholly Namibian-owned operation.

Gecko Namibia has a local affiliate, Gecko Salt, which has plans for salt operations at the Otjivalunda salt pans close to Etosha National Park and the Cape Cross Salt operation at Henties Bay. Gecko holds mining claims for the salt at the Otjivalunda salt pans, where it plans to harvest the salt and refine it at its plant. The plant, situated close to Oshakati, is envisaged to produce sodium sulphate for export and washing powder for the domestic market. Cape Cross Salt was initially established in 2000 and closed in 2009. In recent years Gecko took over operations and started producing salt under three mining claims it professes to possess. However, this is at the centre of a dispute. Early in 2017 the Cape Cross Salt company opened a case of theft against Gecko, alleging that Gecko was carrying out its operations illegally. Gecko maintains that it has not operated illegally, apparently having been given the rights to operate there by another company, Cape Cross Namibia Investment. The matter is still under investigation and the outcome will determine if Gecko will be able to continue its operation at Cape Cross.

Beneficiation:

Salt can be refined to industrial/chemical grade, at 98.75% sodium chloride, through to food grade, at 99% sodium chloride. Marine salt production minimises the inclusion of contaminants and is washed with brine to remove impurities before being dried in a centrifuge. The price of salt varies according to its form and level of refinement. Processed and iodised salt are relatively pure and fetch relatively higher prices, and so can be shipped greater distances. However, these are sold in limited quantities. Namibia's marine salt is produced at a large scale and is delivered at competitive prices through ocean freight. The focus for further value addition here should lie in its upstream integration – using industrial salts or brine as inputs

for chemical production to service domestic needs. Generally these are only produced close to the final market, and so is unlikely to be pursued at a large, export scale in Namibia. Walvis Bay Salt Refiners has indicated its intention to expand production to include caustic soda for the domestic market. Caustic soda is a fundamental input in many mining processes, with Namibian mines relying entirely on imports.[24]

Silica Sand

Silica sand is one of the most common varieties of sand, made up of silicon dioxide. Producing silica sand commercially requires certain chemical and physical specifications, depending on the intended use. Global production is greater than 220 million tonnes per year, with most countries producing silica sand. This is because quartz-rich sand and sandstone, which are the main sources, are found throughout the world. The USA and China are the largest producers, followed by several European countries such as Belgium, the Netherlands, and Italy. South Africa is the largest producer is Africa, with output insignificant compared to the US or China. Silica sand is generally produced for domestic use with only rare large-scale operations for export. This is because silica sand is cheap and abundant.

Demand is forecast to grow steadily, due to its use in a wide range of applications. These include glass-making, metal casting and production, chemical production, construction, ceramics, water filtration, and oil and gas recovery (or 'fracking'). With its diverse uses, silica sand is produced with different chemical and physical specifications depending on the end use.

Operations:

Very little data is available on silica sand in Namibia, with intermittent output data being submitted to the Ministry of Mines and Energy. Namibia exports very little silica sand, producing mainly for domestic consumption and supplementing this with imports from the Netherlands and South Africa.

2013 saw Hakahana Industries being awarded a 15-year contract to supply the Tess Glass manufacturing plants with silica sand. The Tses Glass manufacturing project was launched in 2013 and proposed to build four independent glass factories in the village of Tses. This would make it one of the largest dynamic glass manufacturing plants in the world. However, the project has been mired in controversy since its inception.[25] Initially the Village Council had donated land for the plant, but in 2016 it was disputed that the correct procedures for this were circumvented and thus invalidated the donation.[26] Workers were to be trained to assist with construction and then be employed in the factory, but this was cancelled by the regional authority after it had come to light that an environmental impact assessment had not yet been submitted. The final scoping report for the environmental impact assessment and environmental management plan, as required by law, was only completed in August 2016.

Beneficiation:

Silica sand is not commonly pursued commercially on a large scale for export, barring a few exceptions, due to its low selling price, high transport costs and natural abundance. Naturally pure silica sand is refined by being washed and screened, with further process to extract any impurities either unnecessary or rarely used. Further value addition can be done to make specialty grades or develop silica-based chemicals. Plants for this are generally situated close to the end user, with access to a large market and cheap electricity making them competitive. For this reason it is not viable for Namibia to pursue further silica sand beneficiation on an export scale, as domestic producers would not be able to compete. However, Namibia could focus on upstream linkages, developing domestic manufacturing plants that use silica sand as a primary input. This would not only fuel the creation of jobs through the associated manufacturing processes, but also stimulate development of domestic silica sand producers. In turn, this would boost domestic employment and value addition, whilst reducing the country's reliance on imports from neighbouring countries.

[24] http://namibtimes.net/walvis-bay-to-become-major-producer-of-caustic-soda/
[25] https://www.namibian.com.na/index.php?id=138311&page=archive-read
[26] https://www.newera.com.na/2016/05/13/village-leaders-halt-kapendas-land-transaction/

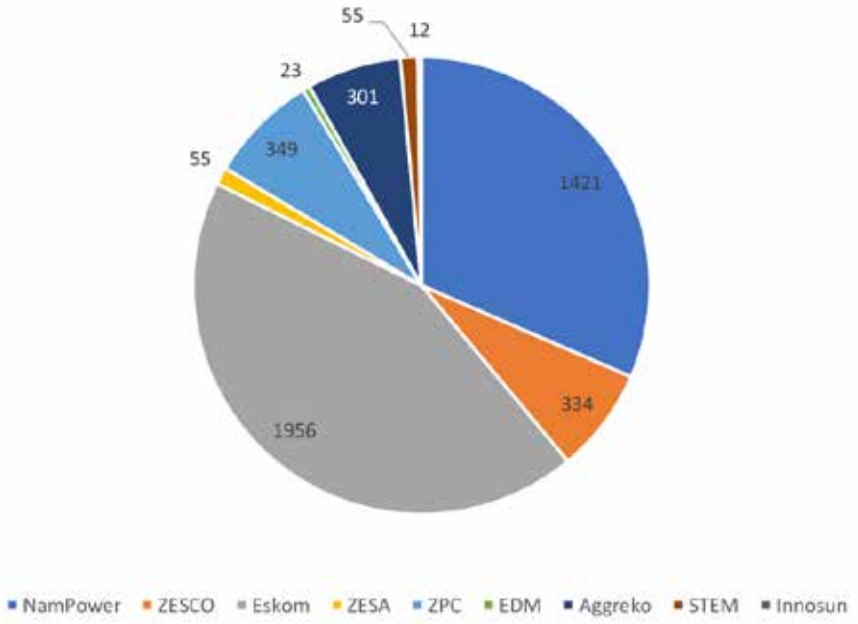
Infrastructure and Upstream

There is more to beneficiation than just the simple downstream processing of the mined ores. As explained previously, beneficiation also includes upstream and sidestream processes. In the case of the mining industry and mineral beneficiation, this encompasses the infrastructure and inputs required for extraction, processing, refining and manufacturing. The obvious inclusions would be infrastructure, water and electricity, but as hinted earlier, there are opportunities for some current operations to produce import-substituting inputs. By substituting imports with domestically-produced inputs, not only is the local economy stimulated through the transactions and employment, but a positive impact is also seen in the reduction of the country's import bill. These are explored in more detail below.

Energy

Current energy consumption by mining, smelting and refining operations within Namibia already exceeds 1,200 GWh. With growth in mining and downstream beneficiation, this could surpass 2,000 GWh by 2030. To put this into perspective, Namibia's total electricity demand for 2016 was 4,008 GWh with NamPower only supplying 1,421 GWh.[27]

UNITS INTO SYSTEM (GWH) 2016

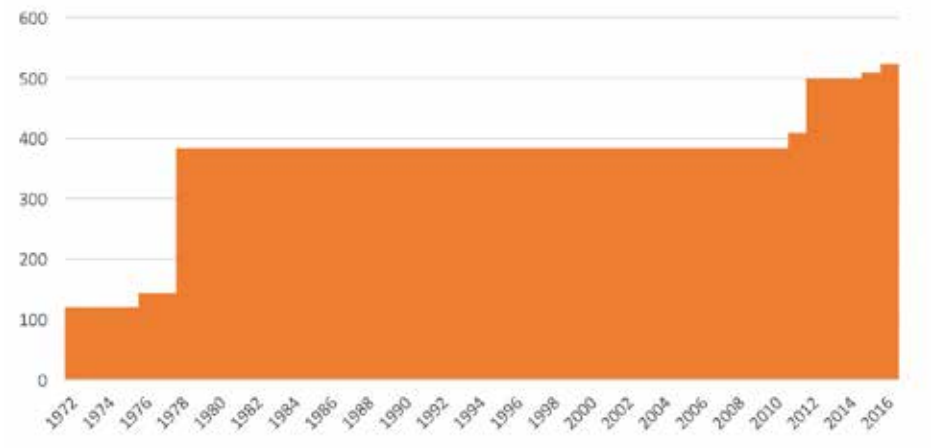


Source: NamPower

This shows the massive shortfall in domestic generation capacity present in Namibia, meaning that the nation is heavily reliant on importing energy from power utilities in neighbouring countries. This raises some concern, as NamPower imports from abroad have been subject to price and supply issues in the past, such as Eskom's 'load-shedding', and low-hydro dam levels in Zambia and Zimbabwe, and a volatile currency. In addition, a potential of regional energy deficits remains over the medium term. Should this deficit materialise, NamPower will be unable to meet demand as it stands, let alone increased demand brought about by downstream beneficiation and the consequent industrialisation. A nationwide power outage in 2016 was identified as the reason why Dundee Precious Metals Tsumeb had reduced production in 2016 compared to 2015.[28]

[27] NamPower AR pg 25
[28] CoM AR 2016 pg33

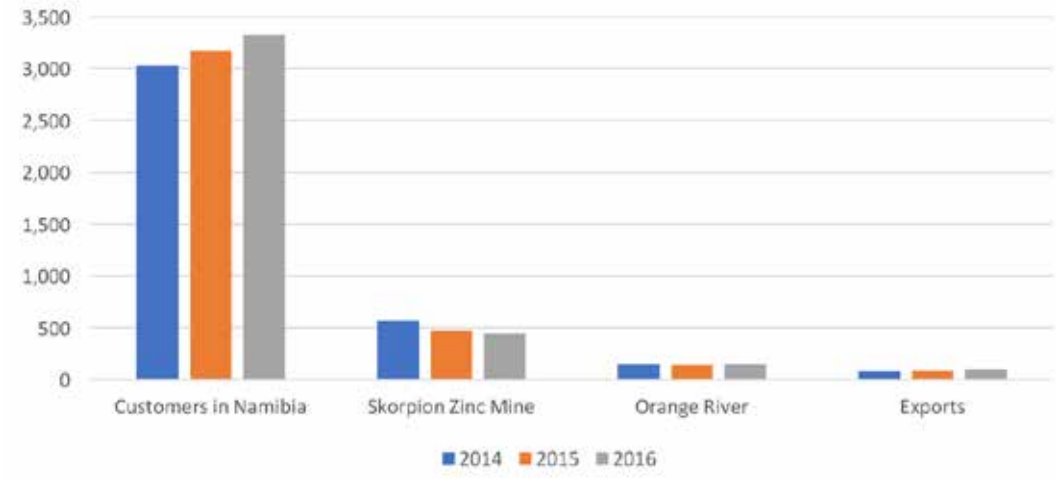
NAMIBIAN GENERATION CAPACITY (MW)



Source: Nampower

In order to relieve some pressure on NamPower, minimise rising electricity costs and ensure uninterrupted supply, many mining operations have taken to securing their own small-scale generation capacity. Some operations, such as in diamond mining and gold mining, are producing some power onsite using diesel or heavy fuel oil generators. Diesel or heavy fuel oil generation is only capable of meeting the needs for small activities (as opposed to the entire operation), and so is restricted for use in these or to ensure uninterrupted supply to identified crucial processes. More and more, mining operations are shifting to small independent solar plants – thereby guaranteeing some supply and contributing to their sustainability efforts. As of 2015, members of the Chamber of Mines had an embedded generation capacity of 67 MW solar photovoltaic power, with a further 38 MW planned.

UNITS SOLD (GWH)



Source: NamPower

It comes as no surprise that most mining operations are fairly energy intensive, although this varies according to factors such as the commodity, the extraction method and the chosen processing techniques, amongst others.

Activities in the dimension stone industry are not energy intensive, but rely on uninterrupted power supply to keep automated machinery running 24/7. Any further downstream beneficiation projects would be low in energy intensity, especially compared to mineral extraction and beneficiation, with the only concern being uninterrupted supply.

Mining for manganese and iron ore have similar energy requirements, which are not very intensive when compared to other commodities. However, downstream value addition to produce a concentrate or pellets are moderately energy intensive. Further beneficiation, i.e. smelting, is extremely energy intensive and

dependent on output and production methods. However, this process needs low energy costs to compete with global producers and so is an unlikely addition to current energy demand. With iron ore being a fairly new venture in Namibia, energy requirements for mining and steelmaking are difficult to determine. This is made even more complex by the variety of production process that are available, as well as the scale and purity of the inputs. The increase in energy intensity from mining to downstream manufacturing is extremely large, and so is often reserved for countries with low energy prices in order to compete globally.

By far the most energy intense downstream activities are copper and zinc refining and smelting, which require massive amounts of energy for the facilities. Again, developing this industry relies on cheap electricity in order to reduce production costs and compete with production elsewhere, while realising acceptable profit margins.

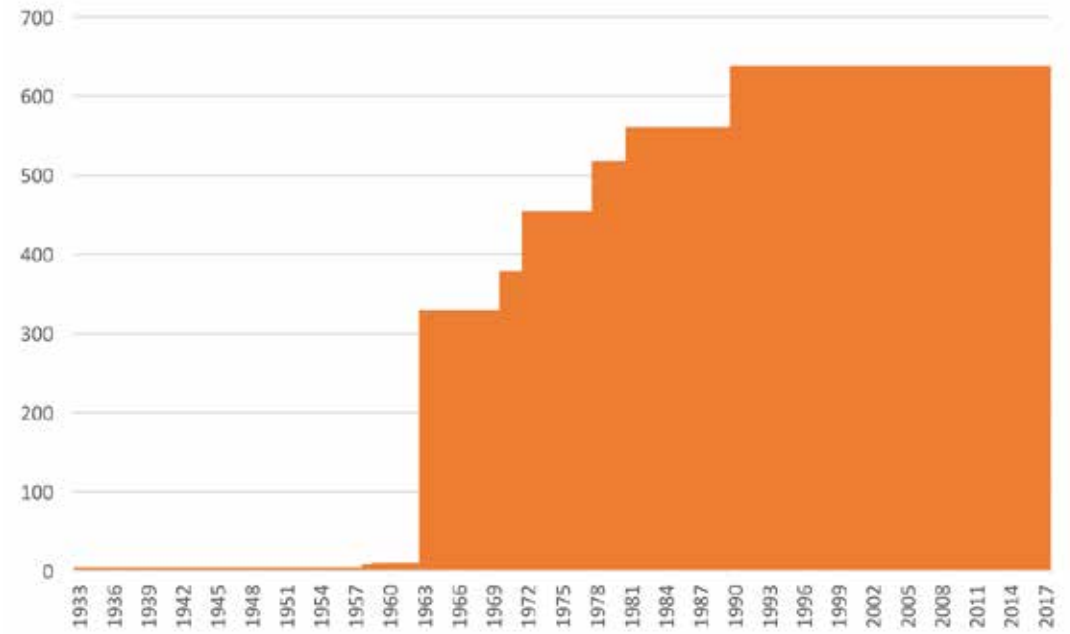
Uranium mining and oxide production is a fairly energy intensive procedure. According to the VTT Technological Research Centre of Finland the total energy consumption for uranium mining in Namibia was 306 GWh in 2008 and 318 GWh in 2010. This is prior to the completion of the Husab uranium mine. With Husab's total potential output being twice that of the other two Namibian mines, energy requirements for this sector alone will more could more than double to over 700 GWh annually once Husab reaches peak production. With current life of mine predictions for the three major uranium mines, this high level of energy demand will be sustained at least until the mid-2020s. Any downstream value addition, such as conversion or enrichment, would result in significantly more pressure on domestic energy requirements.

The common thread that runs through this discussion is the need for increased, reliable domestic generation capacity and cheaper electricity prices. Not only will this prevent any downtime losses due to issues like load-shedding, but cheaper electricity will make domestic beneficiation processes more feasible and more likely to compete with international production. NamPower has already committed to increasing some generating capacity with renewable energy initiatives, as outlined in policies such as the Fifth National Development Plan (NDP5). However, these do not add the generation capacity to significantly reduce the reliance on imports from neighbouring countries. The Baynes Hydro Power Project, on the Kunene River, could aid with this. The construction of the dam is estimated to take six years and will provide employment both in its construction and once completed, through its operation and agricultural projects. Unfortunately, this project has been on the cards for more than a decade and has still not commenced. With mining operations taking it upon themselves to guarantee some of their own energy requirements, an opportunity arises for the private sector. The increase in mines that are looking to build small independent solar plants, which require skills, inputs and maintenance that the mines cannot provide themselves, allows private firms to capitalise and extends benefits to secondary industries.

Water

Namibia, being a semi-arid country, faces severe water supply constraints. This came to the fore with the recent drought seen in the mid-2010s, driving both households and industries not only to curb their water usage, but actively reduce consumption. The mining industry is the second largest consumer of water, after municipalities, and accounts for approximately 25% of annual consumption. In an attempt to reduce pressure on the national water utility and prolong the availability of water reserves, mines invested in a host of measures, often at significant costs to themselves. These measures included efforts such as finding alternative water sources (such as boreholes), recycling water, and investing in new technologies and techniques that are much more water efficient. Although decent rains in early 2017 brought some relief, water security remains a concern not only for the mines, but the country as a whole. New mining operations would add strain to an already low reserve, while the potential downstream beneficiation process would only compound this.

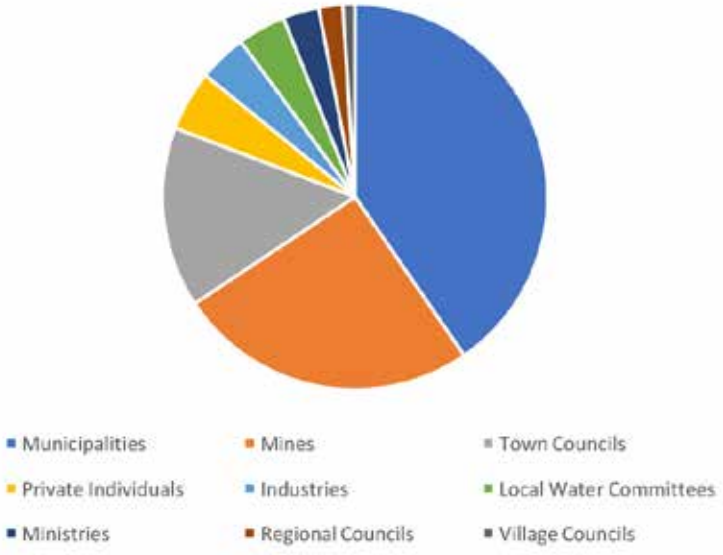
DAM CAPACITY (MILLIONS OF CUBIC METRES)



Source: NamPower

Dimension stone production needs water at every stage, from quarrying through to end-product beneficiation. Most dimension stone projects are not extremely large, and so do not use excessive amounts of water. Furthermore, this water can be recycled relatively cheaply and effectively. Similarly, water in silica sand processing is used for washing and sizing, and thereafter can be recycled for use in the same processes again. Namibia's salt industry is based on marine salt, mostly making use of brine (i.e. clean salt water) with some fresh water used for purification. Compared to the base and ferrous metals, the diamond industry's water needs are low where it is mostly used for onshore processing and washing. With the country's diamond mining situated along both the Atlantic Ocean and Orange River, a significant proportion of the water used is drawn from the sea.

CONSUMPTION BY CUSTOMER TYPE (2015)

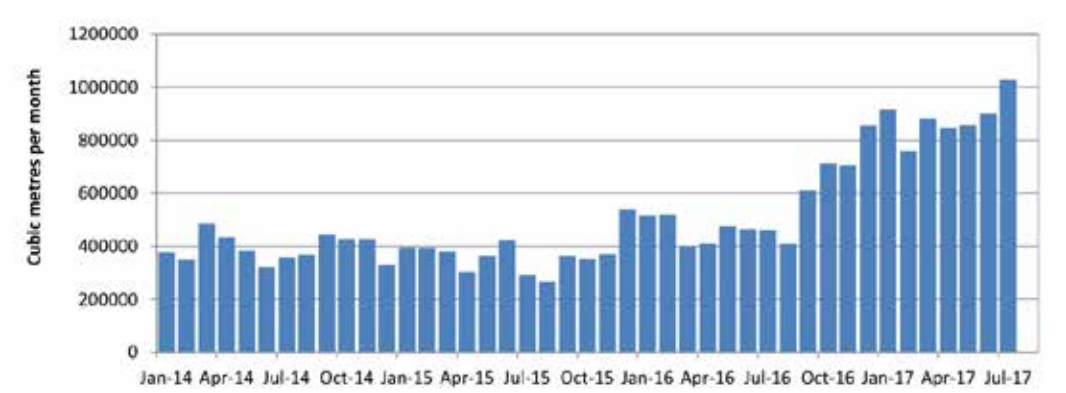


Source: NamWater

Zinc and lead processing are not only energy intensive, but water intensive as well. The zinc and lead operations based in Rosh Pinah draw water from the Orange River. In an attempt to reduce some of their consumption and relieve pressure on the river, Skorpion Zinc obtained permission from the Ministry of Water Affairs and Forestry in 2016 to begin treating water from the pit and reusing it in ore treatment. Any zinc value addition facilities, such as smelting, are also highly water intensive and would outstrip water supply from the Orange River. It has already been established that a gold refinery in Namibia is not viable, its excessive water requirements only serve to confirm this. Furthermore, current gold operations draw their water from the central areas of Namibia, which already struggle to meet water demand and would not be able to support the additional demand from a gold refinery. Navachab gold mine battled significantly with the water cuts implemented as a result of the drought. In attempt to overcome this, the pit dewatering system was upgraded to supplement their supply, and a sewerage treatment plant was built to recover waste water to be used in the mining operations. Although this did aid in water supply during the drought, the high costs of this process brought the mine's profitability into jeopardy.

Uranium mines are by far one of the largest consumers of water in the country, with the three large uranium mines (Rössing Uranium, Langer Heinrich, and Swakop Uranium (Husab)) being the second, third and fourth largest contributors to NamWater's revenue. The uranium mines competed with the coastal communities for scarce water resources, leading AREVA to resort to desalination. The Erongo Desalination Plant, owned by AREVA and operated by Aveng Water, was completed in 2010 with a capacity to supply 20 million cubic meters of water per year and can be expanded to 45 million cubic meters per year.[29] The desalination plant assists NamWater in meeting water demand from uranium mines, and supplied water to coastal municipalities during the drought. Rössing Uranium has proposed a second, smaller desalination plant capable of producing about 3 million cubic meters per year for the coast. Water supplied by the Erongo Desalination Plant is reported to cost as much as N$90 per unit, seeing expenditure on water skyrocket by over 130% from 2013 to 2014.[30] [31] This is what has led Rössing to seek to secure its own desalination plant, in order to significantly reduce costs, and has seen support from other mines in the area. The environmental clearance certificate for this was granted in 2016. However, the required water permits have not yet been granted.

ERONGO DESALINATION PLANT PRODUCTION

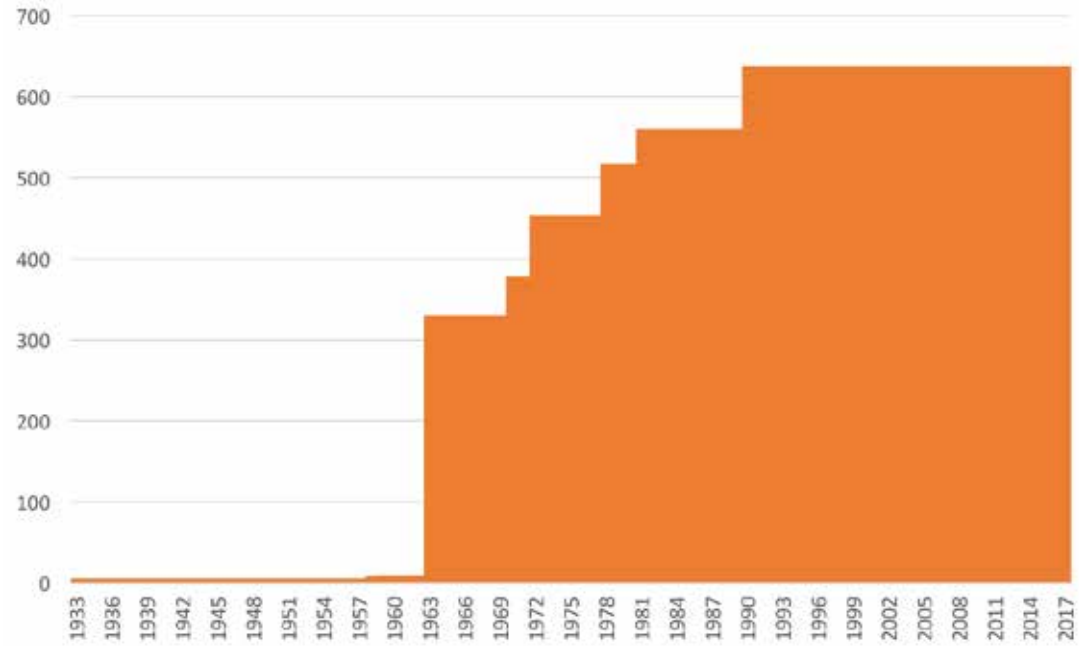


Source: Chamber of Mines

The water issues in Namibia pose a significant problem not only for current mining operations, but are prohibitive for many downstream beneficiation opportunities. The provision of bulk infrastructure services has taken a backseat since independence, and this is evident when one takes a closer look at dam capacity. With the completion of the Hardap dam in 1963, almost half of Namibia's current 637,866 million cubic metres of dam capacity was installed. Between 1963 and 1990 an odd 230,000 million cubic metres of dam capacity was added, meaning that 88% of dam capacity was installed before 1990. This is set to change with the Neckartal dam which is expected to be completed in 2018 and add another 880,000 million cubic metres. Neckartal is, however, situated in the //Karas region, approximately 40 kilometers northwest of Keetmanshoop. The intended use is to supply water for an irrigation scheme in the area. The combination of its purpose and location mean that this is not a solution for the additional water needed by many of the identified value-addition activities.

[29] Com AR 2016 pg 25.
[30] Rossing stakeholder report 2016 pg 61
[31] https://www.namibian.com.na/154797/archive-read/R%C3%B6ssing-gets-desalination-lifeline

DAM CAPACITY (MILLIONS OF CUBIC METRES)



Source: NamPower

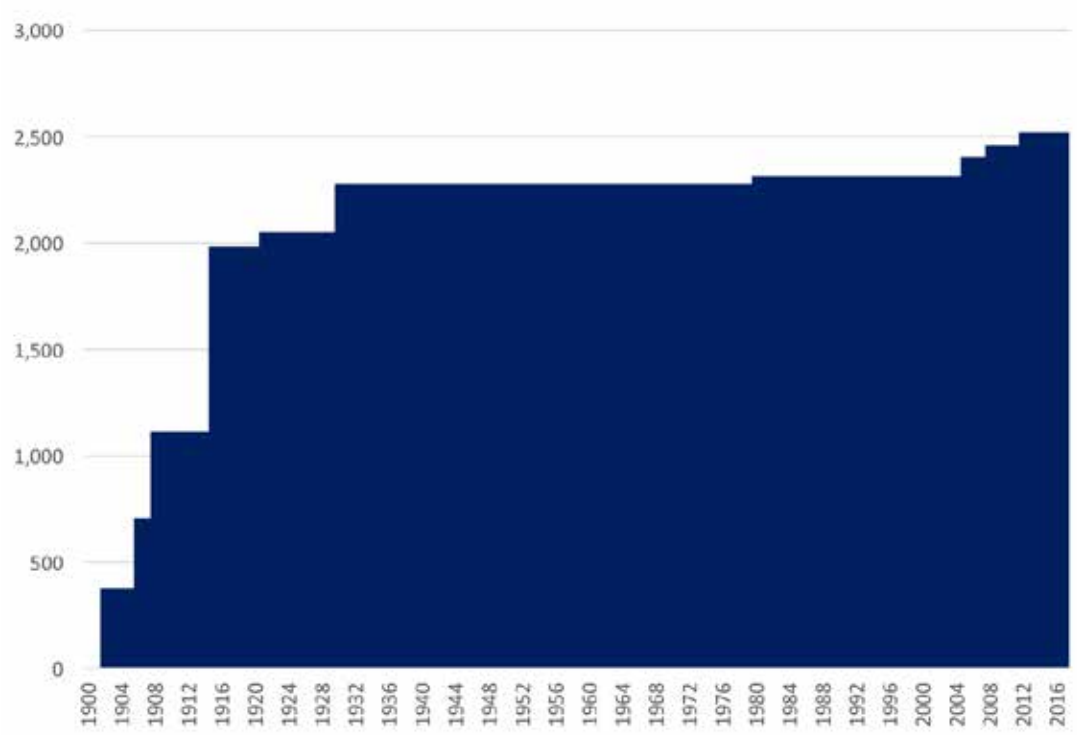
Rail

Namibia's rail network stretches from Lüderitz to Ariamsvlei in the south, up to Windhoek and Gobabis in the central and eastern regions and through to Swakopmund and Walvis Bay on the coast. The network also runs from Tsumeb and Grootfontein in the central northern region, through Otjiwarongo to Usakos, ending in Walvis Bay via Arandis. This network forms part of Namibia's aspirations to become a transport and logistics hub for the SADC region. However, the state of the rail infrastructure and its operator are grave. The Fifth National Development Plan acknowledges the sorry state of the rail sector, going so far as to classify it as being characterised by "dilapidated infrastructure" and "aged and obsolete locomotives".[32] This comes as no surprise, as the majority of the rail infrastructure was installed pre-1932.

Rail transport operations are run by state-owned TransNamib. In 1990, TransNamib operated 88 locomotives to transport just below 2 million tonnes of freight that year, with many locomotives dating back to 1967. Not much had changed by 2016, when TransNamib owned 97 locomotives. Only 52 were operational and some more than 50 years old, shifting little over 2 million tonnes. Government came to the rescue in January 2017, purchasing six new General Electric locomotives for the transport of sulphuric acid from the Dundee Precious Metal Tsumeb Smelter to Arandis, where it is offloaded and transported by road to uranium mines.[33] Over and above this, in mid-2017 the parastatal requested N$3.1 billion over the next five years in order to prevent insolvency, as part of a long-term business plan that requires a total of N$19 billion to "turn around" the ailing company.[34] Around N$15 billion of this is supposed to be used to upgrade the rail infrastructure between Walvis Bay and Tsumeb, as the rail network itself is owned by government. The gradual shift of bulk transport away from rail and towards private road freight has adverse effects, such as added pressure to the structural integrity of the road infrastructure. This necessitates further expenditure to maintain and upgrade road infrastructure, amplifying government's expenditure on transport infrastructure.

[32] National Planning Commission, "Namibia's 5th National Development Plan", 39.
[33] New Era, "Govt buys locomotives worth N$300 million for TransNamib".
[34] Shinovene Immanuel, "TransNamib's N$19 billion wish list".

INSTALLED RAIL NETWORK (KILOMETRES)



Many Namibian mining operations produce ores and beneficiated materials in bulk and are situated far from main export terminals such as the port of Walvis Bay. Transport by rail generally offers an efficient and effective remedy, allowing for the transportation of significant volumes. Despite the rail network running past many mining areas and leading to the main export terminal at Walvis Bay, TransNamib does not capture as large a share of the transport segment as it could. This is in part due to relatively competitive pricing by private road transport firms, as well as operational issues with TransNamib such as poor service delivery, leadership issues and underinvestment. Ageing infrastructure and maintenance challenges have added to TransNamib's operational issues, with train derailments becoming an all too regular occurrence.

Over a number of years, TransNamib has absorbed large amounts of public funds without any turnaround strategies succeeding in changing the company's poor financial and operational performance. The entity has significant potential to capture a large share of mining transport requirements from bulk-producing operations, such as zinc, copper and uranium. In 2014, less than 7% of Rosh Pinah Zinc Corp's transportation expenditure went towards TransNamib, with the overwhelming majority being captured by private road transport. Dundee Precious Metals in Tsumeb is relatively more reliant on TransNamib, spending approximately a third of its operational transport costs on rail transport in 2014.

Copper smelting and refining, zinc manufacturing and iron ore production would all benefit significantly from upgraded rail infrastructure and improved performance, allowing for greater volumes to be transported efficiently and eventually exported. Iron ore mining requires access to the rail network for transportation, and any steel manufacturing operations would necessitate a new railway in order to supply iron ore (including imports), as well as to transport the finished materials for export. As recognised by government, the rail sector requires significant investment in order for rail to capture 30% of the market share at the end of the NDP5 period. This requires significant investment in infrastructure and rolling stock, as well as ensuring that rail provides an efficient and competitively-priced alternative to road transport. A shift towards more rail transport would not only see a reduction in the need to maintain the road infrastructure, but also less road traffic in a country notorious for its high road accident and death rates.

Targets over NDP5	2016 (Baseline)	2017/18	2018/19	2019/20	2020/21	2021/22
Rail as % total transport market share	24%	25%	26%	28%	30%	30%

Upstream

Opportunities for upstream linkages, i.e. producing inputs for mining and beneficiation, also exist. Some have already been exploited, such as the agreement for Lodestone to supply ore as an input for Ohorongo's cement manufacturing process. Ohorongo is Namibia's only cement-producing company, commencing production in December 2010. The company is a posterchild of upstream linkages and beneficiation not only with the mining sector, but also wider industries in Namibia. Raw materials for production are sourced from within Namibia, with the entire value chain for production being in the country. Raw materials, such as gypsum and iron ore, are sourced from local mines. Alternative fuels, such as charcoal and wood chips, are similarly procured from Namibian entities. As a result, 67% of Ohorongo's procurement expenditure benefits Namibian entities.

More upstream opportunities are available and could be successfully exploited. In 2016, mines in Namibia procured goods and services to the value of almost N$12 billion from Namibian-registered firms, compared to just over N$6.5 billion on external or international procurement. At first glance, these figures seem to indicate that nearly two thirds of mining procurement spend benefits the domestic economy. To some extent this is the case. However, it is not the full picture. While much of the spend does go towards Namibian-registered firms, it does not mean that the goods are produced within our borders. Instead of these inputs being produced locally, they are imported through locally registered extensions of established international operations. As a result, these have no contribution to Namibian value addition and add to the large import bill.

Should Namibia choose to go ahead and establish a steel manufacturing industry, despite the challenges and problems such an action would face, it is necessary to nurture the manganese industry. As discussed earlier, the main application of manganese is in steel manufacturing and so the price of manganese is directly related to the market for steel. Should prices recover, it is possible that Namibian manganese operations would restart and ensure a local supply for domestic steel production. However, Namibia's domestic manganese ores alone do not justify the establishment of a steel industry. However, as established earlier, manganese is used in many manufacturing processes and so Namibian manufacturing stands to benefit from manganese production as an input, regardless of a domestic steel industry.

The expansion of the Tsumeb smelter by Dundee Precious Metals saw the installation of a gas clearing and acid plant, officially inaugurated on 06 April 2016. This plant captures the sulphur dioxide emitted during the smelting process and converts it into sulphuric acid. Sulphuric acid is used during the leaching process in mining, which extracts the precious metal, copper or uranium from the ore as a result of a series of chemical reactions. Prior to the commissioning of the Tsumeb acid plant, mines relied solely on imports of sulphuric acid. Although the plant only produced 191,630 tonnes of sulphuric acid in 2016, well below what is required by the mines in Namibia, the output was subsequently sold to local uranium mines. This demonstrates a successful upstream beneficiation link where a by-product in one industrial mining operation is exploited to create a value-added input for other mining operations, in the process creating a substitute for imported goods. Transport of sulphuric acid has been made easier thanks to government, which in 2016 announced the purchase of 90 sulphuric acid tanker wagons allowing Tsumeb's production to be transported to the purchasing mines via rail.

Another potential upstream beneficiation link exists in Namibia, and has not yet been exploited. This is the production of chlorine gas and caustic soda by the salt operations situated on the coast. By making use of an electrochemical unit, an electric current is passed through brine. The compounds dissociate and then recombine to form chlorine gas, dissolved caustic soda, and hydrogen. Chlorine compounds can be used as disinfectants in water treatment, and a market exists for selling these to municipalities and the national water utility. Caustic soda (sodium hydroxide) is used by the local uranium mines in the uranium leaching process. Some caustic soda is also used by other operations, such as Debmarine Namibia, B2Gold and Skorpion Zinc. Caustic soda is not only used for leaching, but can also be used to neutralise acids produced by mines in their operations. In 2014, demand for caustic soda by local mines stood at just over 32,000 tonnes. Total domestic demand for caustic soda is estimated to be almost double this, as it is also used in a host of applications in industries ranging from paper manufacturing, to textiles, through to soaps and detergents. This is a viable market to expand into for the local salt operations, with steady demand which can be supported by local secondary industries even beyond the closing of local mines in the long term. No domestic production of chlorine and caustic soda has yet begun, although in mid-2016 Walvis Bay Salt

Refiners announced that they were looking to expand their capacity to exploit this market.[35] Since then, there has been no official update on their progress. It remains to be seen if this upstream value addition opportunity is exploited.

Textile Manufacturing

Opportunity for an upstream into the mining industry can be found in a different form of manufacturing – that of textiles. Safety equipment, such as personal protective equipment and clothing, is a necessity for all mining operations as mandated by employment legislation. Many of these products currently procured by mines are imported and sold on by domestic suppliers, indicating an opportunity for local production to take up some of this market share.

Although textile manufacturing has a poor track record in the region and Namibia in particular (for example, the failed Ramatex project in the 2000s), there are prospects for a domestic industry. A steady level of demand exists, not just through mines, but a wider range of industries who also require personal protective equipment and the like, such as the construction industry. Mining procurement already favours domestic suppliers, who already capture around two thirds of overall mining procurement expenditure. This does not, however, guarantee that procurement goes towards locally-produced goods and services, as this figure includes imported goods supplied by Namibian firms. However, that local procurement is favoured by mines provides an edge for local manufacturing. Depending on the success of such initial ventures, these could, in time, be developed for regional and eventually overseas exports.

Initial manufacturers would find it difficult to break into and compete in an established market, although some domestic suppliers are present and as mentioned above, appear to be favoured by mines in Namibia. Cymot, a Namibian company, has seen success with its local Namsafe and Tooltech brands, and in late 2010 expanded its operations to cater directly for mining and industrial operators as well. In 2014, Cymot captured just under N$3 million from Rosh Pinah Zinc Corp for personal protective equipment alone. This shows that there is potential for local suppliers to provide the mines with certain safety and similar equipment. Other Namibian suppliers are also active in the mining industry, such as Safe Wear Namibia and Xtreme Safety Wear. Support by the mining industry, and other industries requiring similar products, will not guarantee success, however.

[35] http://namibtimes.net/walvis-bay-to-become-major-producer-of-caustic-soda/

Conclusion

Mining has formed a crucial sector of the Namibian economy since Independence. Government has placed focus on value addition for many years, although not much success in these efforts has been witnessed. The industry is subject to a variety of taxes, with many of these exclusive to the industry and at relatively high rates. Over and above this, recent policy developments have bred negative investment sentiment, rather than enticing investment in new developments. As the Chamber of Mines is quick to point out, the perception that Namibia only exports raw or unprocessed mineral products is off target. There are a host of active mining and exploration activities, with many of them carrying out significant value addition to extracted materials. Examples of these are the cutting and polishing of diamonds, production of uranium oxide from uranium ore, zinc refining at Rosh Pinah, and copper cathode production at the Tschudi copper mine. This beneficiation is sensible as it is feasible and efficient to do this as close to the mine as possible, prior to transportation.

A number of further beneficiation opportunities have also been identified, such as steelmaking and gold refining. However, even though there is potential for these operations, the commercial viability and sustainability of each prospective beneficiation activity needs to be examined within its context to determine whether it should be pursued. Some opportunities, such as chlor-alkali production, can be implemented successfully to meet some local demand, but are unlikely to succeed at export level. Other activities, such as uranium conversion and enrichment, face inhibitory capital investment, global overcapacity and fluctuating commodity prices. Upstream beneficiation and linkages are likely to provide more successful opportunities, as is the case with Ohorongo cement and potential domestic textile manufacturing for personal protective equipment and clothing.

Many positive effects are attributed to beneficiation, such as employment creation, domestic industry growth, and a lower import bill. However, pursuing beneficiation at all costs in order to realise these targets should be avoided, as any possible gains could be eroded due to the fact that the commodity industry and the industry for basic manufactured commodity products are characterised by price-taking entities. Thus, in many instances, beneficiation should not be pursued at all costs in order to achieve these positive effects, as the consequences could prove worse than any possible gains. Downstream value addition industries generally develop in areas that have a comparative advantage in the beneficiation process rather than where there is a higher endowment of natural resources. Domestic water and energy security pose a threat not only to any potential beneficiation activities, but also to already present mining and beneficiation operations within Namibia. Namibia is heavily reliant on energy imports from neighbouring countries, which face long-term supply constraints themselves. Beneficiation activities, whether downstream or upstream, would require cheap, reliable energy supply. At present, Namibia imports energy while focusing on attempting to force miners to reduce "un-processed" exports. A simpler solution to the balance of payments problem, however, would simply be to reduce energy imports, driving a similar improvement in the balance of payments.

The implication is that if government wants to develop successful downstream mineral beneficiation industries in Namibia, it is not sufficient that those resources are extracted in Namibia. What is needed instead is sufficient infrastructure to meet demand requirements, an investment climate and a regulatory framework that incentivise investment in smelting, refining and/or manufacturing activities in Namibia. A similar policy approach to diamond beneficiation should be adopted – beneficiation should not be thrust on mining activities as their enforced responsibility, but rather specialised manufacturing companies need to be attracted. In essence, miners should be able to remain miners, while manufacturers should be positively incentivised to set-up shop in country to develop the value-chain of certain strategic minerals. The focus should not remain just on downstream beneficiation, as significant upstream integration opportunities exist.

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