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# REVIEW OF ZAMBIA'S POTENTIAL FOR MORE VALUE ADDITION TO THE DOWNSTREAM COPPER CHAIN

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## ABSTRACT

*Zambia copper industry has been in existence for over a century. The country contains most known reserves in Africa and holding about 6 percent known copper reserves in the world. Copper production plays a big role in the performance of the economy. Copper exports account for more than 70 per cent of total exports and 12 per cent of the country GDP.*

*However, with the rich history of mining and copper reserves, studies have shown that Zambia still exports more than 70 per cent of her raw copper blister or copper anodes. Only 5 percent of copper cathodes produced consumed locally to further produce finished products such as copper rods and cables. The study will, therefore, focus on the potential that Zambia has to add value in the copper chain downstream. Specifically, the research focused on the downstream copper production and processing potential in respect of copper blister or anodes, copper cathodes, copper rod and cables. In addition the study reviewed whether the current mineral development policies and taxation are adequate to encourage value addition downstream and also investigate local and regional market for the final copper product.*

*The research utilised statistical data available from Central Statistical Office, Bank of Zambia, Chambers of Mines, ZCCM-IH and international Copper Study groups to establish production, export copper and import of copper rods or cables. In addition to the above, research included visits to the only two copper fabricators ZAMEFA based in Luanshya and Neelkanth Cables Limited in Ndola.*

*Using the statistical data collected and field visits to the fabrication industry, it was established that Zambia has a potential to add more value to its downstream copper chain by producing more than 1million copper blister or cathodes from the available smelter facilities and though enhancement of policies and taxation incentives.*

**Keywords:** *Value addition, copper production, mining, fabrication.*

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## **INTRODUCTION**

Copper has been the major mineral explored and mined in Zambia for nearly a century. At the time of Zambia's Independence in 1964, there were a number of commercial mining operations and hence her future lay in the hands of mining especially copper mining. The period 1969 to about 2000 was a period of decline in mining activity in Zambia. Copper production fell from about 740,000 tonnes to just above 200,000 tonnes per annum respectively. After privatisation of mines, from 1997, more mines have been opened in the North-western province of Zambia. This province is colloquially referred to as the 'New Copperbelt' of Zambia.

For nearly a century raw copper has been exported from Zambia as either copper anodes or copper cathodes to Europe, Asia and America. Copper cathodes can be further processed into electrical cables, motor vehicle components such as radiators, air conditioning units, alternators, starter motors and wiring accessories.

The fact that Zambia has immense experience in the copper mining industry compared to its neighboring countries, means the level of maturity in the industry should have evolved a century down the line. We should have been exporting more copper and copper related products than all the countries in Southern African and Africa as a whole. As per report by Woodmac (2018), DRC has bypassed Zambia in copper production. Zambia has invested in the smelters on the Copperbelt and north-western province of Zambia. Combined copper production potential from the smelters alone is over one million tonnes yet total copper production for 2017 alone was 791,000 tonnes. Zambia has potential to produce another 500,000 tonnes from her leaching plant. Meaning the total copper production can be potentially be more than 1.5 million tonnes.

Despite Zambia's level of mining maturity being higher than her neighbouring countries, over 95 per cent of copper cathodes are exported out of Zambia and only about 5 per cent is further processed into finished goods like cables. In 2013, the Government of the Republic of Zambia introduced a 15 per cent export levy on the export of copper concentrates in order to discourage export of raw copper and in return add value to the copper mining industry. Copper cathodes and anodes are exported and shipped mainly into China, Middle East, Asia and Far East Asia.

This study was undertaken in order to determine the potential for more value addition to the downstream copper mining industry in Zambia and what it will take to achieve the potential.

## **PRE-INDEPENDENCE MINING AND PRODUCTION**

It was the presence of copper in Zambia which led to the region being put under British indirect rule in 1889 (Sikamo, 2015) after the partition of Africa. The years following 1889 saw extensive exploration activities in the region by western companies and individuals. Exploration activities led to the first commercial copper being produced

at Kansanshi, Solwezi, in 1908 (Roan Consolidated Mines, 1978). Table 1 shows the establishment of Mines in Zambia before independence in 1964.

**Table 1: Mines established in Northern Rhodesia (Sikomo, 2016: Copper mining in Zambia – History and Future)**

Owner	Mine	Year Started	Infrastructure					
Rhodesia Selection Trust(RST)	Luanshya	1928	Underground	Concentrator	Smelter			
	Mufulira	1933	Underground	Concentrator	Smelter	Refinery		
	Chibuluma	1955	Underground	Concentrator	Leach Plant			
	Chambeshi	1965	Underground	Open Pit	Concentrator	Leach Plant	Refinery	
	Kalengwa	1969	Open Pit	Concentrator	Concentrator			
Anglo American Corporation (AAC)	Nchanga	1937	Underground	Open Pit	Concentrator	Roatser Leach	Leach Plant	Refinery
	Rhokana	1931	Underground	Open Pit	Concentrator	Roatser Leach	Smelter	Refinery
	Bancroft	1957	Underground	Concentrator				

### Independence and the Golden Age

Copper production in Zambia became a central point to the development plan of the country of the newly independent country of Zambia. Green (2009) notes at independence in 1964, Zambia’s status as a middle income country with prospects to develop into an even more prosperous nation was because of its rich copper deposits. Economic growth in Zambia is inextricably linked to the copper industry. Hence, decline and increase in copper production alternate with decline and increase in overall economic performance and this is demonstrated by Zambia’s economic history. Table 2 shows the production trend for the period 1973 to 1994.

**Table 2: Trends in copper production, 1973 – 1994 in tonnes (Simutanyi, 2008)**

Year	Tons
1973	750,000
1980	550,000
1991	400,000
1992	441,000
1993	402,950
1994	360,347

## RE- PRIVATISATION OF MINES

The legal framework for the privatisation process was set by the 1995 Mines and Minerals Act (GRZ, 1995). The Act liberalised the investment regime and provided for fiscal incentives to be negotiated with each mining company and enshrined in Development Agreements (DAs). The DAs provided very favourable financial terms for the mining companies, because they were negotiated at a time of very low prices and the mines required significant re-capitalisation.

### Mines Investment since Privatisation

Since the early 2000s, mining investment has boomed (Zambia Chamber of Mines, April 2014) with over US\$ 10 billion FDI since privatisation (Table 3). These have been dominated by the mining industry.

**Table 3: Mines investment since privatisation (ICMM, 2014)**

Mine	Mopani	KCM	Lubambe	FQM	Lumwana	Kansanshi
Investment (US\$ Billion )	2.24	2.9	0.49	2.23	2	2.54

Table 4 shows how Zambia's Mines were ranked in 2014 compared to other Mines in the world.

**Table 4: Zambia's 2014 Mines' ranking among the top 20 mines globally by production capacity(ISCG,2014a)**

Rank	Mine	Country	Onwer(s)	Source	Capacity
1	Escondida	Chile	BHP Billiton(57.5%), Rio Tinto Corp.(30%), Japan Escondida(12.5%)	Concs &SX-EW	1050
2	Grasberg	Indonesia	P. T. Freeport Indonesia Co. (PT-FI), Rio Tinto	Concentrates	790
3	Collahuasi	Chile	Anglo American (44%), Glencore plc (44%), Mitsui +Nippon (12%)	Concs &SX-EW	520
4	Los Bronces	Chile	Anglo American (75.5%), Mitsubishi Corp.(24.5%)	Concs &SX-EW	490
5	Codelco Norte	Chile	Codelco	Concs &SX-EW	450
6	Antamina	Peru	BHP Billiton (33.75%), Tech(22.5%), Glencore plc (33.75%), Mitsubishi Corp.(10%)	Concentrates	450
7	Morenci	United States	Freeport-McMoRan Inc 85%, 15% affiliates of Sumitomo Corporation	Concs &SX-EW	450
8	El Teniente	Chile	Codelco	Concs &SX-EW	443
9	Taimyr Peninsula (Nriisk/Talnakh Mills)	Russia	Norilsk Nickel	Concentrates	430
10	Los Pelambres	Chile	Antofagasta Plc(60%), Nippon Mining(25%), Mitsubishi Materials (15%)	Concentrates	400
11	Radomiro Tomic	Chile	Codelco	SX-EW	400
12	Andina	Chile	Codelco	Concentrates	300
13	Kansanshi	Zambia	First Quantum Minerals Ltd(80%), ZCCM(20%)	Concs &SX-EW	285
14	Bingham Canyon	United States	Kennecott	Concentrates	280
15	Batu Hijau	Indonesia	Pt Newmont Nusa Tenggara (PT Pukuafu 20%, Newmont 41.5%, Sumitom	Concentrates	250
16	Sarcheshmeh	Iran	National Iranian Copper Industry Co.	Concs &SX-EW	249
17	Cerro Verde II (Sulphid	Peru	Freeport-McMoRan Copper and Gold Inc 53.5%, Compania de Minas Buenaventura 18.5%, Sumitomo 21%	Concentrates	240
18	Olympic Dam	Australia	BHP Billiton	Concs &SX-EW	225
19	Cuajone	Peru	Grupo Mexico (54.1%), Marmo Corp. (15%), Freeport- McMoRan Copper and Gold	Concs &SX-EW	212
20	Konkola	Zambia	Konkola Copper Mines (Vedanta 79.4%, ZCCM 20.6%)	Concentrates	200

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## CURRENT COPPER PRODUCTION AND VALUE ADDITION POLICIES

### Major Copper Smelters in the Zambia

Zambia has four major copper smelters on the Copperbelt and North Western Province of Zambia, namely, Nchanga Copper Smelter, Chambishi Copper Smelter, Kansanshi Copper Smelter and Mopani Mufulira Copper. Table 5 below shows the copper production potential for each smelter compared to the actual production for the year 2016.

**Table 5: Major Copper mines production 2016 - Major Copper Mines Production 2016 ('000' tonnes)**

<b>Mining Company</b>	<b>KCM</b>	<b>Mopani</b>	<b>Kansanshi</b>	<b>Chambishi</b>	<b>Total</b>
Potential Smelter Production	300	275	300	250	1125
Mine Production	186	41	273	50	550

According to the International Copper Study group (ISCG, 2018), Zambia share of the copper production in 2017 was approximately 5 per cent of that of the whole world. This is a slight improvement from 4 to 5 per cent. As can be seen from table 6, Zambia copper smelters accounts for more than three quarters of the total Southern Africa copper smelters. Wood Mackenzie (August, 2018) reported copper refined in Africa for the year 2017 as 1,281 tonnes and 325 tonnes were refined in Zambia as copper cathodes out of the production of 791 tonnes (Table 6).

**Table 6: Southern Africa Copper Smelter (Mintek 2016)**

<b>Smelter</b>	<b>Location</b>	<b>Copper Capacity(tonnes/ year)</b>
Kansanshi	Solwezi, Zambia	300,000
KCM(Konkola Copper Mines plc)	Nchanga, Chingola, Zambia	300,000
Chambishi Copper Smelter	Chambishi, Zambia	250,000
Mopani Copper Mines	Mufulira, Zambia	250,000
Palabora	Phalaborwa, South Africa	160,000
Dundee Precious Metals	Tsumeb, Namibia	45,000
BCL Ni - Cu Smelter	Selebi Phikwe,Botswana	30,000
Rubamin	Likasi, DRC	20,000
Copalcor	Germiston, South Africa	5,000
<b>Totals</b>		<b>1,360,000</b>

### **Copper anodes and cathodes production potential**

KCM has a potential to produce more than 400,000 tonnes of copper per annum at full running capacity. 300,000 tonnes copper production potential from its smelter alone in Chingola town and 100,000 tonnes per year from tailings leach plants in Chingola as well. The product from the Nchanga Smelter are copper anodes which are transported to Nkana refinery in Kitwe for further processing into copper cathodes.

Copper production in Africa has since doubled in the past decade. DR Congo is a neighbouring country that has since surpassed Zambia in its copper production. Wood Mackenzie (2018) shows progress of African countries in Copper refined Production (Table 7).

**Table 7: Global copper mine production outlook - (tonnes copper in concentrate and leach output) (Wood Mackenzie May 2018 Report)**

Country	2013	2014	2015	2016	2017	2018	2019	2020
Botswana	43	52	32	10	4	9	15	22
Congo DR	951	1,086	1,099	1,082	1,152	1,376	1,638	1,800
Eritrea	22	89	65	25	8	12	17	17
Mauritania	38	33	45	33	29	30	30	30
Morocco	9	17	20	21	20	19	18	14
South Africa	81	92	94	83	79	81	79	89
Zambia	750	710	717	766	791	902	1,010	1,083
Others	15	16	26	32	36	36	37	37
Total Africa	1,908	2,095	2,097	2,051	2,120	2,465	2,844	3,092

2017 total world refined consumption was approximately twenty-three million (Table 8) of which China consumes eleven million and India 0.5 million (Table 8).

**Table 8: World Copper refined consumption (kt) (Woodmac August 2018 publication)**

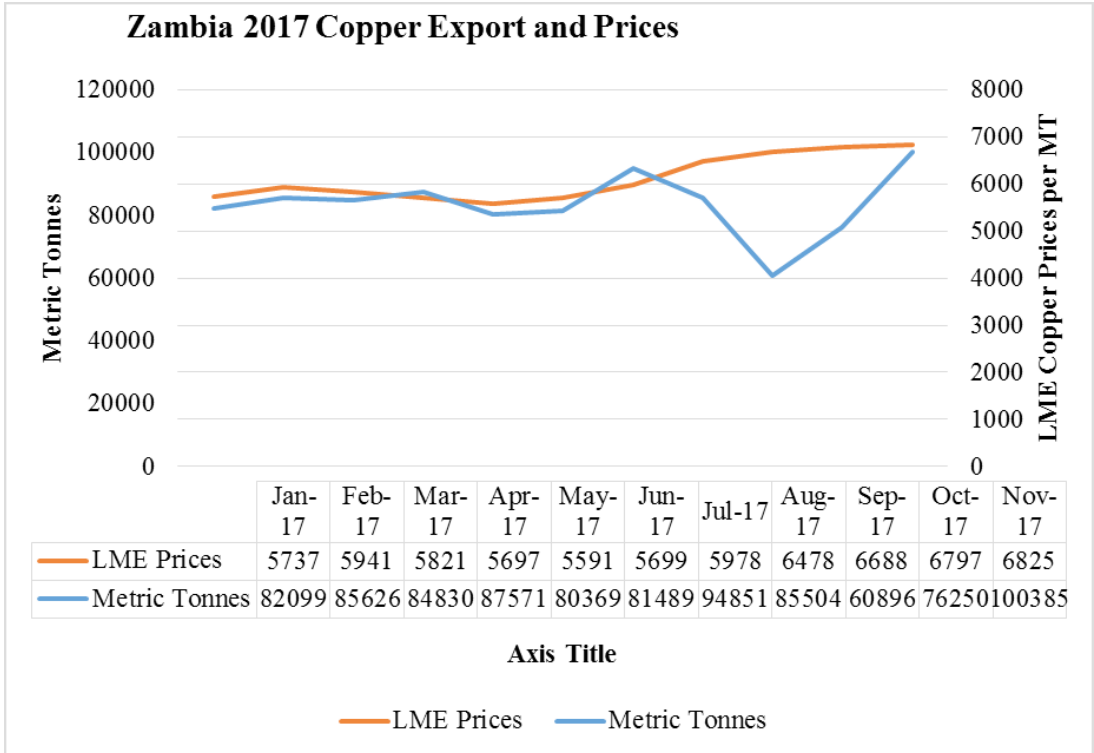
Country	2013	2014	2015	2016	2017
Africa					
Egypt	89	105	110	105	98
South Africa	75	65	63	58	59
Other Africa	44	49	52	53	55
<b>Total</b>	<b>208</b>	<b>219</b>	<b>225</b>	<b>216</b>	<b>212</b>
<b>Percent Change</b>	<b>-10.8</b>	<b>5.1</b>	<b>2.3</b>	<b>-3.6</b>	<b>-2.1</b>
<b>Asia</b>					
China	9165	9836	10185	10678	11054
India	422	431	486	498	500
Indonesia	251	254	255	246	248
Japan	990	1050	1008	985	1025
Malaysia	202	221	238	247	256
South Africa	698	680	675	682	701
Taiwan	436	464	470	491	498
Thailand	248	253	273	341	359
Vietnam	100	127	162	202	200
Other ASEAN	52	53	53	53	53
Other Indian Sub	41	41	41	42	43
Other Eastern Asia	44	44	44	44	44
<b>Totals</b>	<b>12649</b>	<b>13454</b>	<b>13890</b>	<b>14509</b>	<b>14981</b>
<b>Percent Change</b>	<b>8.4</b>	<b>6.4</b>	<b>3.3</b>	<b>4.5</b>	<b>3.2</b>
Middle East					
Iran	126	137	145	143	140
Saudi Arabia	217	224	224	216	211
United Arab Emirates	275	346	379	399	401
Other Middle East	32	33	35	35	35
<b>Totals</b>	<b>650</b>	<b>740</b>	<b>783</b>	<b>793</b>	<b>787</b>
<b>Percent Change</b>	<b>92</b>	<b>13.7</b>	<b>5.9</b>	<b>1.2</b>	<b>-0.9</b>



## Zambia Copper Exports

According to the Central Statistics Office (December 2017 report) Copper exports for the year 2017 was 920,000 tonnes with November 2017 recording the highest for the year at 100,000 tonnes as illustrated in figure 1 below.

**Figure 1: 2017 copper exports (Zambia Central Statistics)**



## Capital and Finance in the Rod or Cable Production industry

Though the investment in the industry is not as heavy as compared to the mining industry, most Zambian owned companies cannot afford investment to the tune of US\$16 million. This is the initial cost of putting up Neelkanth cable plant in Ndola. The investment in mining operations are indicated in Table 3 above. The cost of borrowing on the market to set up such a plant within Zambia is costly to as high as 35 per cent interest rates.

## Zambia Copper Markets

The market for copper and copper alloy manufactured within Zambia is limited for wire products (World Bank, 2011) and can be characterised in Table 9 as follows:

**Table 9: Zambia Copper Markets (World Bank, 2011)**

<b>Public Sector</b>	<b>Private Sector</b>
ZESCO- busbars (imported); switchgear (imported); bare and insulated wire and cables (LV domestic; MV/HV imported); lightning conductors	Wire and Cable Producers – wire rod (domestic)
Zamtel – telephone cable (domestic)	Building and Construction – building wire (domestic); data cable (imported); coaxial cable (imported), telephone cable (domestic)
Railway Systems of Zambia – signaling cable	Transformer manufacture and repair – copper strip (imported), connectors (imported)
Mining	Mining and mining equipment companies – jobbing castings and engineering materials (domestic and imported)

### **Skilled Labour and Man power**

The industry for processing copper cathodes into rod and cable is not a labour intensive one. Sophisticated machines ranging from Furnaces to wire cables stripping may require only a small crew to operate as evidenced from the visits to Zambia Metals Fabrication (ZAMEFA) and Neelkanth Cables. A continuous rod mill with a 30,000 tonnes per year may require staff less than 200 to undertake operations, maintenance, sales and administration.

### **Zambia Mineral Development Resource Policy (MRDP)**

The Government of the Republic of Zambia has had two main policies for mineral resources. The July 2013 policy was a revision of the 1995 policy and draws attention to the vision of 2030 for Zambia which provides a blue print for achieving accelerated growth aiming at raising standards of living for the people of Zambia (MRDP, July 2013).

Clause 7.10 of the mineral policy (MRDP, July 2013) explains value addition to the raw materials by identifying market potential for the national and regional consumption of raw material of value added products.

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## Review of taxation in the mining industry

Taxation plays vital role in the attraction of both local and foreign direct investment (FDI) in the mining industry. Zambia like any rich copper mining country has had a number of taxation changes in the past twenty years to attract investment in the sector while collecting revenue.

### General Taxation Instruments in the Mining industry

The main tax categories in mineral extraction are shown in Table 10:

**Table 10: Taxation Instrumentations**

Direct Taxes				Indirect Taxes	
Profit Based		Revenue Based			
Company Tax	Excess or variable profit tax	Mineral Royalties	Windfall Tax	VAT	customs and import duty

### Taxation and tax incentives in Zambia's mining industry

Zambia has had changes to its tax regime since privatisation. Five distinct tax regimes have been applied in the period 1997 to 2016:

1. The Development Agreements (DA) negotiated with individual mines at privatisation
2. The "2008 regime" (the tax regime used between April 2008 and March 2009)
3. The "2009 regime" (the tax regime used between April 2009 to March 2012)
4. The "2012 regime" (the tax regime that has been in effect since April 2012)
5. The "2016 regime" (the tax regime that has been in effect since April 2016)

**Table 11: Major mining tax regimes changes (Manley (2015), IMF (2017) and ZRA(2018)**

	1964	1966	1970	1983	1986	2000	2008	2009	2012	2015	2016
Royalty	13.5	13.5				0.6	3	3	6	6-9	4-6
Export Tax		40		4-8	13						
Corporate income tax	37.5-40		45	45	45	25	30	30	30	30	30
Variable income tax							15	15	15	15	
Windfall tax							25-75				
Capital allowance	5	5	100	100	100	100	25	100	100	25	25
Reference price	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Ring fencing	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Loss carry - forward	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tax haven owner	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
state ownership	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fiscal stability	No	No	Yes	No	No	Yes	No	No	No	No	No

### The 2016 mineral royalty tax regime

Mineral royalty is a payment received as consideration for the extraction of minerals (table 12). Holders of the following mining rights are liable to mineral royalty on minerals produced under their respective licenses:

1. Large scale mining license
2. Large scale gemstone licenses
3. Small scale mining license
4. Small scale gemstone license and
5. Artisan's mining right

**Table 12: Mineral royalty effective June 2016**

Description	Mineral Royalty
Base Metals(other than copper)	5% on norm value
Energy and industrial minerals	5% on gross value
Gemstones	6% on gross value
Precious metals	6% on norm value

Where the base metal produced or recoverable under the licence is copper, the mineral royalty rate payable is:

- (a) 4 per cent of the norm value when the norm price of copper is less than US\$4,500 per tonne
- (b) 5 per cent of the norm value, when the norm price of copper is US\$4,500 and less than US\$6,000 per tonne

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(c) 6 per cent of the norm value, when the norm+ value price of copper is US\$6,000 per tonne or greater

### **Current mining tax incentives**

Guaranteed input tax claim for seven years on pre-production expenditure for exploration companies in the mining sector

1. 10 year period carry forward on tax losses(5 years for prospecting and exploration companies).
2. Any mining company holding a large –scale mining license carrying on the mining of base metals is taxed at 30 per cent.
3. Other mining companies are taxed at 35 per cent.
4. Dividends paid by a company holding a large –scale mining license and carrying on the mining of base metals is taxed at 0 per cent.
5. 25 per cent capital allowances on mining equipment and related expenditure when assets brought into use.
6. Property transfer tax on transfer of mining rights is 10 per cent.
7. Mineral royalty is 6 per cent on all minerals( Base, precious and gemstones).

### **Zambia Mineral Resource Development Policy**

The Republic of Zambia has put in place measures to add value to the upstream production of copper by discouraging export of raw material. There are a number of taxes on raw material from ore to copper concentrate. There is a 10 percentage tax slapped on any mining company wishing to export this raw material. However, the importation of raw material processing equipment attracts a duty free charge.

The 2013 MRDP (page 10, clause 7.10) states that Government will promote and facilitate the development of downstream processing capacities for minerals by:

- (a) Providing an appropriate legal and fiscal regime;
- (b) Exploring opportunities to expand the local metallurgical plant capacity in the country; and
- (c) Identifying market potential for national and regional consumption of value added products.

The Government of the Republic of Zambia announced the 7<sup>th</sup> National Development Plan (7NDP) for the period 2017 to 2021. This is the successor to the 6<sup>th</sup> National Development Plan, 2013 to 2016. The goal of the 7NDP is to create a diversified and resilient economy for sustained growth and socio-economic transformation driven, among others, by agriculture, tourism, manufacturing and mining. This document outlines Zambia’s direction for all social economic driven sectors including the mining and manufacturing industry. Zambia has had so far three development plans since the

introduction of the medium term development planning process in the early 2000s, namely the Fifth Development Plan, 2006-2010(FNDP), Sixth National Development Plan, 2011-2015(SNDP) and the revised Sixth National Development Plan, 2013-2016 (R-SNDP).

**Table 13: GDP performance by Sector (Central Statistics 2016 and 7NDP):**

<b>Sector</b>	<b>2000(%)</b>	<b>2014(%)</b>
Agricultural, Forestry and Fishing	23.8	6.8
Mining and Quarrying	4.2	14.6
Manufacturing	9.8	6.8
Electricity, Gas and Water	3.2	2.6
Construction	7.4	8.9
Restaurant, Bars and Hotels	1.8	1.6
Wholesale and Retail Trade	18.8	21.8
Transport, storage and Communications	3.3	5.9
Financial Intermediaries and Insurances	8.5	3.1
Real Estate and Business Services	7.7	6.6
Community Social and Personal Development	10.5	14.4

## **DISCUSSION**

Though Democratic Republic of Congo is producing more copper than Zambia, Zambia still enjoys maturity and experience in the copper industry. Zambia has smelters which are yet to be developed in DRC. In Addition, Zambia has developed a good road and railway system compared to her neighbour DRC.

Zambia is well placed to capture the raw copper production coming from DRC and add more value to the copper. Already some mines are processing concentrates from DRC. There is a huge potential to increase production by treating more and more concentrates from DRC. In case DRC moves a step further into processing their own concentrates, Zambia can equally move a step further to purchase most of the anodes and generate copper cathodes, slimes and copper rod production.

### **Value addition: Mining and Refinery Process**

Copper anode or copper blisters is not a final product. Copper anodes are further processed to copper cathodes, a product used in copper rod production. This means that selling of copper anodes comes at cost as the final receiving smelter and refinery need to melt or refine respectively. The cost of refinery or melting of copper anodes is

deducted at the source of material and factored in the copper anodes as per international standard copper or blister contract.

However, processing copper anodes within Zambia at reduced cost of electricity, the charges of refining are eliminated and only controlled in the refinery. Current copper anodes refinery charges on spot contracts are around US\$210 per tonne (Woodmac, August 2018).

For example, every 450 tonnes of copper anodes treated at Nkana Refinery in Kitwe, 1 tonne of anode slimes is produced. Copper anode slimes comprises of valuable elements such as gold, silver, copper, selenium, palladium, platinum (KCM website [www.kcm.co.zm/our-products](http://www.kcm.co.zm/our-products)). Depending on the elements composition, the cost per tonne averages US\$33,000 (Metal Bulletin, August 2018). This helps reduce the cost of running both the smelter and the refinery. Zambia can produce 2,500 tonnes copper anodes per year if all the smelter reach their potential of 1.125 million tonnes production and if the anodes are refined into copper cathodes.

The current copper cathode premiums for Shanghai CIF grade A is around US\$75/tonne (Metal Bulletin, June 2018). Assuming all our Copper anodes are refined into finished copper cathodes at the above premium, the premium earnings alone will be US\$80 million. Table 14 below illustrates the earnings from copper cathodes compared to copper anodes/blister.

**Table 14: Value addition analysis (Wood Mackenzie, August 2018)**

Product	Tonnes	LME Price	Premium(US\$)	Final Price	Value(US\$)
Cathodes	300,000	6,618.00	75	6,693.00	2,007,900,000.00
Silmes	667	33,000.00	0	33,000.00	22,000,000.00
<b>Total</b>					<b>2,029,900,000.00</b>

Product	Tonnage	Element	Unit of Measure	LME Price(US\$)	Anode Composition	Quantity	Value(US\$)
Blister/Anode	300,000	Copper	US\$/tonne	6,000.00	99.60%	298,800	1,792,800,000.00
		Gold	US\$/g/tonne	15.00	30	289,357	4,340,347.55
		Silver	US\$/g/tonne	1,200.00	1	9,645	11,574,260.13
		TC	US\$/tonne	185.00		300,000	55,500,000.00
<b>Total</b>							<b>1,753,214,607.68</b>

Where: TC means treatment charge (deduction to value)

### Value addition

Value addition is said to be a process of enhancing the product or services so that they are worth more because they have been improved or something has been added to create more value(IJSR, 2015) and below is the summary for copper:

**Stage 1: Mining and refinery process.** In this stage, copper ore is extracted from underground or open pit and goes through crushing process together with removal of impurities to create a product with high level of copper purity.

**Stage 2: Metal fabrications.** In this stage the copper is transformed into shapes such as stranded copper wires, insulated copper wires, copper bars and inductor coils.

**Stage 3:** This is the final stage. It includes the assembly of the components that may have been made in stage 2 into final finished products such as electrical Gadgets and appliances, instruments, machines, equipment such as cars, electrical generators.

Table 15 below explains the value added from first stage to final stage. It is clear that the final product has more value added to it as evidenced by the price which is 30 times the first stage. The value addition trend across the stages is estimated by the curve with the coefficient of determination (R-squared) of 0.9974. Only 0.26 percent of estimation is not determinable, modeled as per below:

$$p = 6.0117x^{2.3717} \text{ Equation 1}$$

Where

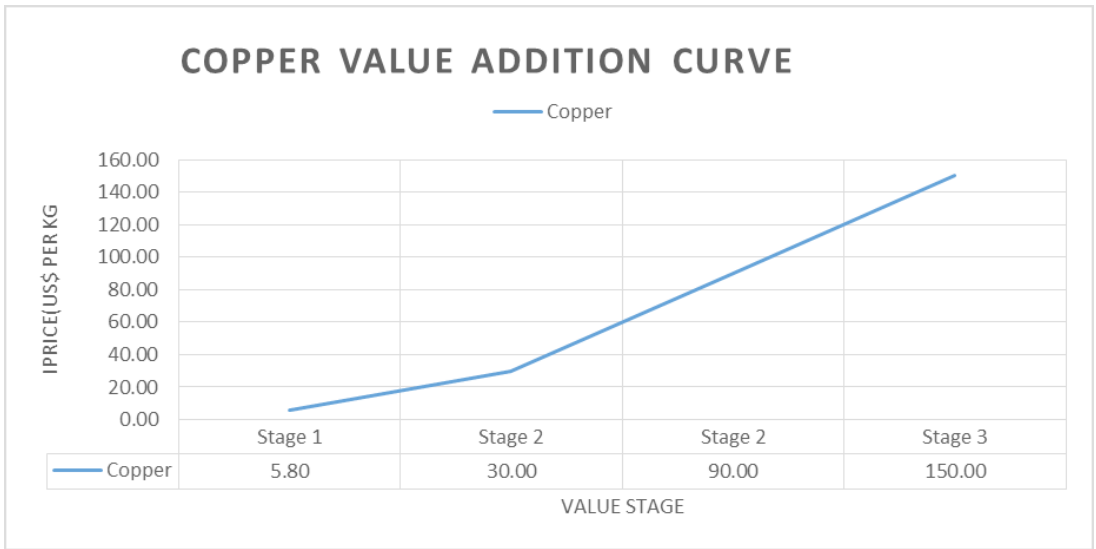
$p$  – is the price per kilogram of copper at each value addition and  $x$  stages from 1 to 3.

**Table 15: Copper value stages (Mulunda et. al, 2015)**

Mineral	Stage Value			
	Stage 1	Stage 2	Stage 2	Stage 3
	Refined Copper(US\$/kg)	Rod wire(US\$/kg)	Inductor Coil(US\$/kg)	Inductor Coil in Music speaker(US\$/kg)
Copper	5.80	30.00	90.00	150.00

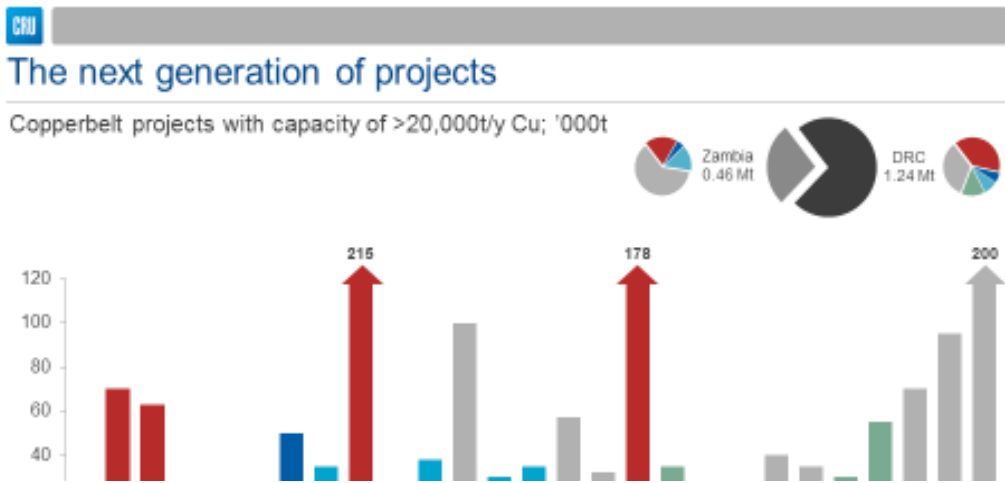


**Figure 2: Copper value addition curve (Mulunda et al., 2015)**



**Copper mining projects by 2030**

Figure 3 shows projects with more than 20,000 tonnes per year production potential for Zambia and the Democratic Republic of Congo (DRC). Combined projects for Zambia is approximately 460,000 tonnes and while that of DRC is 1,240,000 tonnes per year.



**Figure 3: The next generation of projects (CRU, 2018)**

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## Energy Costs in Zambia

Energy costs, in particular electricity tariffs, have attracted much attention and controversy in recent years (ICMM, 2014). The cost of energy for mines on the Copperbelt – which are supplied by Copperbelt Electricity Corporation – has more than double since 2004, from around 3.3 US cents/kWh (ICMM, 2014) to about 7.3 US cents/kWh. Mines in North-western Province are supplied by Zambia Electricity Supply Corporation.

## Transportation and Shipping cost

Although Zambia may have developed a better road and railway system compared to the DRC, a lot is still required to improve the supply chain infrastructure. There has been an increased fleet occurrence in the country compared to twenty years ago. Few transporters used to own fleets of trucks. The current scenario however is that a number of small companies and individuals now own trucks which they attach to well established and international recognised fleet companies like Access world, Tanzania Road Haulage(TRH) and Reload Logistics to mention but a few. The clubbing of small companies helps to make the fleet huge. This has helped reduce the cost of production from Zambia by road to port from around \$150 per tonne to \$95 per tonne in the last five years (ZDA, 2016). The effect of copper price fluctuation and fleet availability helped reduce and stabilise the supply chain.

**Table 16: 2016 Transportation cost to port by road (Source: ZDA)**

<b>Exports to Beira(Mozambique)</b>	
From	Rate
Lusaka	US\$145
Ndola	US\$156
Kitwe	US\$156
Chingola	US\$156

<b>Exports to Durban(South Africa)</b>	
From	Rate
Lusaka	US\$150
Ndola	US\$183
Kitwe	US\$183
Chingola	US\$183

<b>Exports to Dar -es Salaam(Tanzania)</b>	
From	Rate
Lusaka	US\$150
Ndola	US\$133
Kitwe	US\$133
Chingola	US\$133

Zambia has evolved over a century as far as mining of copper is concerned. Compared to others, DR Congo for example, Zambia has better infrastructure such as smelters, refineries, and railway and road networks.

With this infrastructure, she is well positioned to import more copper from neighbouring countries that are starting to produce copper and process into copper anodes, cathodes and final products such as copper cables and related product.

## **CONCLUSION**

The objective of this research was to determine Zambia's potential to add value on the copper chain downstream production. It has been established that Zambia has a huge potential to produce more copper anodes given the capacity of her current four major smelter on the Copperbelt and North Western province. All together Zambia, can cast to capacity of 1,125,000 tonnes of copper anodes/blister. All that is required is investment in production of copper ore as Zambia holds more than 5 per cent of the world copper reserves. In order to operate these smelters, mine owners need to source for customs concentrates from neighboring Congo to boost up feed rate and increase production.

However the refining of all the anodes into cathodes will remain a challenge for Zambia in the near future as refining cost are high compared to China and India which are the destination of the anodes. Besides this, China and India alone account for more than 30 per cent (Wood Mackenzie, August 2018) of the copper refining in the world and has numerous smelters and refineries that demand raw materials from Africa. China, India and East Asia demand for the red metal will be hard to replace.

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