

**ENERGY  
REGULATION  
BOARD**

# **ENERGY**

## **SECTOR REPORT**

# **2018**





## Vision

“A proactive, firm and fair energy regulator”

## Mission Statement

To regulate the energy sector in order to ensure efficient provision of reliable and quality energy services and products

## Our Motto

“We safeguard your interests”

## Core Values

- |               |                    |
|---------------|--------------------|
| 1. Integrity  | 4. Transparency    |
| 2. Excellence | 5. Predictability  |
| 3. Team Work  | 6. Accountability. |

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# ABBREVIATIONS

|        |   |
|--------|---|
| BSA    | Bulk Supply Agreement                                 |
| CEC    | Copperbelt Energy Corporation Plc                     |
| CSO    | Central Statistical Office                            |
| ERB    | Energy Regulation Board                               |
| ESI    | Electricity Supply Industry                           |
| GRZ    | Government of the Republic of Zambia                  |
| HFO    | Heavy Fuel Oil  |
| IDC    | Industrial Development Corporation                    |
| INDENI | INDENI Petroleum Refinery Company Limited             |
| IPP    | Independent Power Producer                            |
| IPS    | Interconnected Power Systems                          |
| KNB    | Kariba North Bank                                     |
| KNBEPC | Kariba North Bank Extension Power Corporation Limited |
| KPI    | Key Performance Indicator                             |
| LHPC   | Lunsemfwa Hydropower Company Limited                  |
| LPG    | Liquefied Petroleum Gas                               |
| MD     | Maximum Demand  |
| MoE    | Ministry of Energy                                    |
| NECL   | Ndola Energy Company Limited                          |
| NFT    | Ndola Fuel Terminal                                   |
| NWEC   | North Western Energy Corporation Limited              |
| OMC    | Oil Marketing Company                                 |
| PPA    | Power Purchase Agreement                              |
| PQD    | Power Quality Directives                              |
| PQMS   | Power Quality Management System                       |
| PSA    | Power Supply Agreement                                |
| REA    | Rural Electrification Authority                       |
| SADC   | Southern Africa Development Community                 |
| SAPP   | Southern Africa Power Pool                            |
| UPP    | Uniform Pump Price                                    |
| TAZAMA | TAZAMA Pipelines Limited                              |
| TPPL   | TAZAMA Petroleum Products Limited                     |
| ZABS   | Zambia Bureau of Standards                            |
| ZEMA   | Zambia Environmental Management Agency                |
| ZPL    | Zengamina Power Company Limited                       |
| ZESCO  | ZESCO Limited   |

# UNITS OF MEASUREMENT

|                |   |
|----------------|---|
| bbl            | Barrels of oil  |
| GWh            | Giga-Watt hour (1,000 MWh)  |
| K              | Zambian Kwacha  |
| km             | Kilometre   |
| kV             | Kilo Volt   |
| kVA            | Kilo Volt Amperes (1,000 Volt Amps)                                 |
| kW             | Kilo Watt   |
| kWh            | Kilo Watt Hour  |
| MW             | Mega Watt   |
| MWh            | Mega Watt Hour (1,000 kWh)  |
| MT             | Metric Tonne (in this document means a mass equivalent to 1,000 kg) |
| m <sup>3</sup> | Cubic Meters  |
| US\$           | United States of America Dollar                                     |

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- ♦ Southern African Power Pool
- ♦ TAZAMA Pipelines Limited
- ♦ TAZAMA Petroleum Products Limited
- ♦ Zengamina Power Limited
- ♦ ZESCO Limited

# FOREWORD



The importance of energy to any economy cannot be overemphasised. In this regard, the Energy Regulation Board (ERB) has the critical responsibility of ensuring security of supply of energy services and products, providing a level playing field in the sector, setting cost reflective prices and safeguarding consumer interests. This 2018 edition of the Energy Sector Report therefore highlights the performance of the sector covering the operations of licensed entities; industry developments and innovations as well as challenges recorded in the energy sector. The report covers the sub-sectors that comprise the energy sector namely; petroleum, electricity and renewable energy.

In 2018, the petroleum sub-sector saw a number of innovations aimed at improving the provision of quality petroleum products in the supply chain. One such innovation was the Fuel Marking programme which began in February 2018 following the issuance of Statutory Instrument No. 69 of 2017 – The Energy Regulation (Petroleum Marking and Monitoring) Regulations. This complemented the existing sampling and testing framework for fuel quality control and monitoring already in place. It is envisaged that with the commencement and enforcement of fuel marking in the country, cases of dumping petroleum products destined for other countries will be curbed and guarantee Government revenue.

In 2018, the ERB continued to ensure that procurement of petroleum products was self-financing and petroleum prices remained cost reflective. Therefore, prices were reviewed every 60 days using the Cost-Plus Model each time petroleum products were imported into the country. The Cost-Plus Model provides for full cost recovery for all the players in the petroleum supply chain. In the period under review, the sub-sector further witnessed the commencement of the second phase of the construction of Government fuel depots in Mansa and Chipata to complement the existing storage facilities. Once commissioned, the depots will go a long way in achieving security of supply for Luapula and Eastern Provinces. To ensure that the enterprises in the petroleum value chain remained viable, the ERB continuously monitored their performance using Key Performance Indicators (KPIs) framework.

In the electricity sub-sector, the supply and demand situation remained stable. Investment in the sub-sector continued to be enhanced such as the construction of the Kafue Gorge Lower project with an estimated generation capacity of 750 MW which had reached an advanced stage with 60 percent of the works completed.

Following the approval of the Renewable Energy Feed-In Tariff (REFiT) Strategy by the Government, its operationalisation commenced through the Global Energy Transfer Feed-in Tariff Zambia (GET FiT Zambia) programme. When fully implemented, the nation will benefit from additional 200 MW renewable energy generating projects. Further, progress was made under the Industrial Development Corporation (IDC) scaling solar projects for the construction of Bangweulu (54 MW) and Ngonye (34 MW). To promote investment in the renewable energy sub-sector, the ERB finalised the development of a framework for regulating off-grid renewable energy projects.



The electricity sub-sector also recorded a rise in the number of quality of service complaints. This was evidenced by the increased number of delayed new power connection complaints recorded in the period under review. The ERB has engaged the utility with a view to implementing measures that will reduce this backlog.

It is envisaged that the information contained in the 2018 Energy Sector Report will be an invaluable reference document to industry stakeholders, academia, Government, the public and Non-Governmental Organisations as we strive to develop the energy sector and the economy together.



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**June 2019**

# 1.0 INTRODUCTION

## Macro-economic Outlook

In 2018, the global economy grew modestly by 3.9 percent compared to 3.7 percent growth recorded in 2017. The general improvement in the world economy was mainly attributed to continued strong economic performance in the emerging markets in Asia as growth in the other parts of the emerging world and the developing economies stabilised. The emerging markets and developing economies (EMDEs) generally achieved remarkable declines in inflation to an average of 3.5 percent in 2018<sup>1</sup>. Coincidentally, the advanced economies achieved an even sharper decline in inflation in 2018.

Meanwhile, in 2018, economic growth in Sub-Saharan African economies remained sluggish as most of them were still recovering from the economic slowdown of 2015/2016 which had been caused by a slump in commodity prices on the world market and weakening global demand. This was exacerbated by high oil prices during most part of the year. Consequently, economic growth was marginal and increased by 0.1 percentage points, from 2.6 percent in 2017 to 2.7 percent in 2018<sup>2</sup>. The drivers for the growth pattern were the region's largest economies namely: Angola, Nigeria, and South Africa that continued to experience external factors such as moderate global trade growth, tightened financing conditions and the strengthening of the US dollar.

In 2018, the Zambian economy was generally stable. In particular, economic growth remained resilient at about 4.0 percent, characterised by sustained price and financial stability with inflation maintained within the annual target range of 6.0 to 8.0 percent. The economic growth was mainly on account of improved performance in sectors such as mining, construction, manufacturing, wholesale and retail trade as well as stable and reliable energy supply. The year-on-year inflation rate increased marginally to 7.9 percent in 2018, compared to 6.1 percent in 2017<sup>3</sup>. The increase was mainly driven by non-food items.

In February 2018, the Bank of Zambia (BoZ) reduced the Monetary Policy Rate from 10.3 percent to 9.8 percent and the Statutory Reserve Ratio from 8.0 percent to 5.0 percent. The reduction was carried out in order to support financial sector stability and economic growth as well as to lower commercial bank's interest rates which had constrained access to credit to key sectors of the economy such as mining, agriculture, manufacturing and tourism, thereby stifling economic growth.

In the external sector, the registered growth in imports was 27.2 percent, while exports grew by 20.7 percent<sup>4</sup>. As such, the country's imports continued to exceed exports resulting in a Balance of Payments deficit of US\$142.5 million in 2018 compared to a surplus of US\$181.4 million in 2017.

In the first half of the year the exchange rate between Zambian Kwacha and United States Dollars was relatively stable and averaged K 9.88/US\$. Between July 2018 and December 2018, the exchange rate depreciated steeply to an average of 11.10/US\$.

Thus, for the period January to December 2018, the kwacha depreciated by 19.8 percent, that is from K9.97/US\$ to K11.94/US\$. This depreciation was mainly on account of the strengthening of the US dollar as a result of the hike in the Federal Reserve Fund rate (BOZ, 2019).

<sup>1</sup> World Bank, Global Economic prospects- January, 2019

<sup>2</sup> [pubdocs.worldbank.org/.../Global-Economic-Prospects-Jan-2019-Sub-Saharan-Africa](https://pubdocs.worldbank.org/.../Global-Economic-Prospects-Jan-2019-Sub-Saharan-Africa)

<sup>3</sup> Central Statistical Office, Monthly bulletin-December, 2018

<sup>4</sup> Ministry of Finance (MoF), March, 2019

## Performance of the Energy Sector

According to IRENA (2019), in 2018, the global energy landscape continued to witness major transformations with renewable energy options taking center stage. During the year investment costs in renewable energy continued to fall and played an increasingly vital role in helping countries develop modern and secure energy systems. Specifically, new large-scale approaches that combine grid and off-grid electrification helped many countries reduce the energy access gap. In addition mini-grids displayed significant signs of closing this gap in some countries. In the meantime, solar home systems became more efficient and less costly, thus becoming more affordable in South Asia and Sub-Saharan African economies, which account for the most significant gaps in energy access<sup>5</sup>.

Further, technological innovations including advanced photovoltaic modules continued to play an increasingly major role in accelerating the deployment of renewables in the electricity sector in 2018. Corporate investor actions are also shifting to renewables for instance multilateral development banks such as the World Bank are no longer financing coal investments. In addition Global insurance companies are also phasing out insurance coverage for coal projects. Some of the world's leading generation companies are moving to obtain all of their electricity from renewables and are encouraging their supply chains to do the same.

Many non-oil producing countries globally are shifting to renewables in order to reduce dependence on energy imports. Further, according to IRENA, a number of major oil producing countries are now setting targets for increasing renewables in their energy mix. For instance, the United Arab Emirates set a target to increase the proportion of renewables in its power supply to 44 percent and attain 70 percent reduction in carbon emission by 2050<sup>6</sup>.

## Performance of the Petroleum Sub-Sector

In 2018, crude oil prices fluctuated significantly, compared to 2017. Specifically, crude oil prices averaged US\$ 69.48/bbl in 2018, up from US\$ 52.50/bbl in 2017. The increase in the prices of crude oil was generally influenced by rising global demand forecast, limited crude oil stocks in the United States and heightened geopolitical tensions such as trade sanctions on Iran. The situation was further sustained by strong conformity from the Organisation of Petroleum Exporting Countries (OPEC) and participating non-OPEC countries to the supply quotas.

In sub-Saharan Africa, oil exporting countries benefitted from the rising international crude oil prices. Specifically, for large oil exporting countries in 2018 like Angola and Nigeria, rising oil prices led to improvement in the external balance and significant narrowing of the current account deficit, particularly, in the Central African Economic and Monetary Community (CEMAC)<sup>7</sup>.

Like in the year 2017, the high crude oil prices exerted inflationary pressures in most economies, especially in oil importing countries in 2018. In the case of Zambia, this resulted in two upward price adjustments in February and October. Meanwhile, the increase in oil prices was sustained until the fourth quarter of 2018 when there was a sharp decline caused by excess supply of oil from Russia, the United States of America and the world's leading oil exporter, Saudi Arabia, which increased its production to an all-time high. In addition, there was softening oil demand and uncertainty about global economic growth<sup>8</sup>. Specifically, according to International Energy Agency (IEA), the weak demand in India, Brazil and Argentina was caused by high prices, weak currencies and deteriorating economic activity.

<sup>5</sup> [www.worldbank.org](http://www.worldbank.org)

<sup>6</sup> International Renewable Energy Agency (IRENA), 2019

<sup>7</sup> World Bank, Global Economic Outlook, January, 2019

<sup>8</sup> OPEC Monthly Report, January 2019.

## Performance of the Renewable Energy Sub-Sector

In 2018, following the adoption of the renewable energy strategy, Zambia continued to make progress towards the implementation of strategies and programs that promote cleaner and affordable electricity. This is consistent with the transformations in the global energy sector, electricity investment shifted towards renewable energy, taking the market share away from coal and natural gases in 2018. In accordance with the Paris Agreement<sup>9</sup> and the 2030 Agenda for Sustainable Development<sup>10</sup>, most countries globally are shifting to cleaner and affordable electricity.

Some initiatives in Zambia included the scaling solar program, the Renewable Energy Feed-In-Tariff Strategy, banning of incandescent bulbs and import duty waiver on selected solar systems.

In May 2018, the ERB through Technical Assistance from co-operating partners determined the Feed in Tariffs (FiTs) for mini hydro power generation projects. The GETFiT Zambia Secretariat also launched the procurement process of round one of the 100 MW Solar PV projects.

In addition, construction works for the US\$ 60 million, 54 MW Bangweulu solar plant and US\$ 43.2million, 34 MW Ngonye solar power plant had reached advanced stages in 2018, with 80 and 60 percent of the works completed, respectively. Once commissioned, the solar plants are expected to supply ZESCO with solar electricity at USc 6.015/kWh and USc 7.84/kWh over the period of the power supply agreements. Together, these two plants are expected to inject a total of about 88 MW into the grid out of the 600 MW that was part of the directive by the President of the Republic of Zambia in his capacity as Chairperson of the Industrial Development Corporation (IDC), following the energy deficit crisis in 2015.

## Performance of the Electricity Sub-Sector

In 2018, the electricity sub-sector continued to undergo transformation with the increased inclusion of renewable energy in the mix. During 2018, electricity generation sent out increased marginally and there were no power deficits. Consequently, power imports reduced significantly and the country embarked on strategies towards increasing electricity generation. Some projects embarked on included the following: bid technical review of phase two of the 300 MW Maamba coal-fired thermal power plant, ZESCO's 750 MW Kafue Gorge Lower Hydro Power Station (KGL) and 15 MW Lusiwasi Upper Hydro Power Project. Meanwhile, the preparation process towards the construction of the 2,400 MW Batoka hydropower plant was expected to continue in 2019.

Further, in 2018 the Government commenced discussions towards energy sector-wide reforms including a review of the Electricity Act; and the Energy Regulation Act. On the commercial front there were no tariff adjustments in 2018 but nevertheless, the country remained committed towards attaining cost reflective tariffs.

The report is arranged in five sections as follows: section one is an introduction followed by section two which discusses the key developments and challenges in the petroleum sub-sector. Section three focuses on the key developments and challenges in the electricity sub-sector. Section four discusses licensing in the energy sector and section five discusses consumer affairs issues.

<sup>9</sup> Paris Agreement- agreement within the United Nations Framework Convention on Climate Change (UNFCCC), aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty. Signed on 22<sup>nd</sup> April, 2016, and entered into force on 4<sup>th</sup> November, 2016.

<sup>10</sup> 2030 Agenda for Sustainable Development positions access to affordable, reliable, sustainable and modern energy as a key pillar of Sustainable Development Goal no. 7(SDG 7).

## 2.0 PETROLEUM SUB-SECTOR

This section discusses Zambia's petroleum sub-sector value chain. In particular, the section discusses the supply of national fuel requirements, operations of state owned fuel enterprises, national consumption of fuel, market share of Oil Marketing Companies (OMCs), pricing of petroleum products, challenges and outlook for the petroleum sub-sector.



**Petroleum products bulk storage tanks**

### 2.1 Importation of fuel

Zambia's stock of petroleum products is met through imports. These comprise petroleum feedstock and finished products<sup>11</sup>. The imported feedstock is in the form of spiked<sup>12</sup> crude oil which is pumped through the 1,710 km long TAZAMA Pipeline and refined at the Government owned INDENI Petroleum Refinery Company Limited (INDENI) in Ndola on the Copperbelt Province of Zambia. The pipeline is jointly owned by the Governments of Zambia (67%) and Tanzania (33%). Refined petroleum products, on the other hand, are imported into the country mainly by road, and to a lesser extent by rail through Government contracted OMCs. The petroleum products are then distributed to various Government owned depots. In addition, when need arises the Government may allow other OMCs to import finished petroleum products to meet national consumption.

In 2018, INDENI contributed 35.4 percent to the national fuel requirement for petrol and diesel<sup>13</sup> (gas oil) compared to 30.4 percent in 2017. The rest of the national demand for petrol and diesel was met by the importation of finished products by Government and OMCs. OMCs uplift the finished products from Government fuel depots and distribute them to their own depots, service stations and commercial customers. Appendix 1 shows the petroleum value chain.

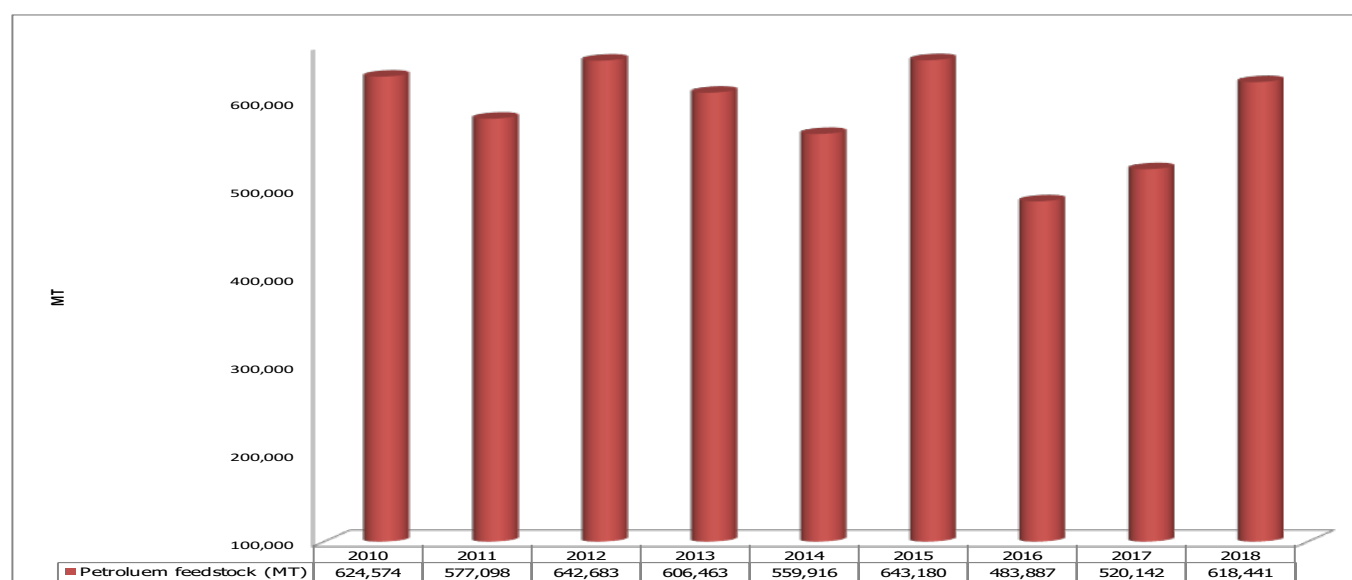
#### 2.1.1 Importation of petroleum feedstock

In 2018, the Government imported 6 cargoes of petroleum feedstock. Zambia predominantly consumes large quantities of diesel compared to other petroleum products; the petroleum feedstock therefore typically consists of 46 percent diesel, 41 percent crude oil (from Oman or Murban) and 13 percent condensate/naphtha. Therefore, the composition of the imported petroleum feedstock is tailored to meet the specific national fuel requirements. Figure 2-1 depicts the trends in the importation of petroleum feedstock from 2010 to 2018.

<sup>11</sup> This refers to refined petroleum products such as petrol, diesel and Jet A-1

<sup>12</sup> Spiked or Commingled feed stock is a combination of pure crude oil and other finished petroleum products

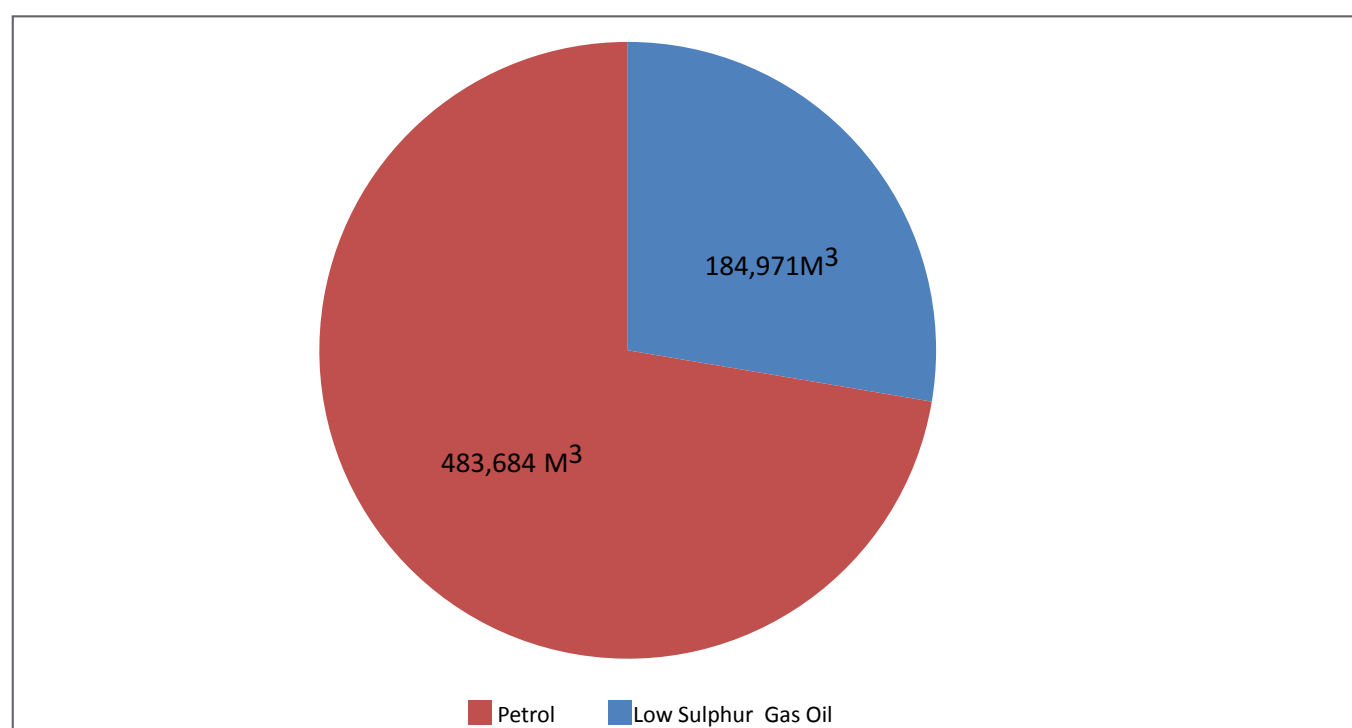
<sup>13</sup> Diesel includes low sulphur gas oil)

**Figure 2-1: Importation petroleum feedstock, 2010 - 2018**

During the period 2010 to 2018, petroleum feedstock imports averaged 586,265 MT. Peak importations were attained in 2010, 2012 and 2015. In 2016 and 2017 there was a steep drop in importation below the eight year average. Thereafter, there was a gradual increase. Specifically, between 2017 and 2018 imports increased by 18.9 percent from 520,142 MT to 618,441 MT.

### 2.1.2 Importation of finished petroleum products

The Government through TAZAMA imports finished petroleum products predominantly by road. Currently, only petrol and low sulphur gasoil (LSG) are imported by the Government, while OMCs import LPG, Jet A-1 and other petroleum products. The OMCs had ceased to import LSG for the mines and specialised users following the suspension of the import component of the licence to Distribute, Import and Export (Combined) effected on 1<sup>st</sup> July 2018. In 2018, Government and OMCs imported 483,684 M<sup>3</sup> of LSG. Meanwhile, Government imported 184,971 M<sup>3</sup> of petrol during the same period as depicted in Figure 2-2.

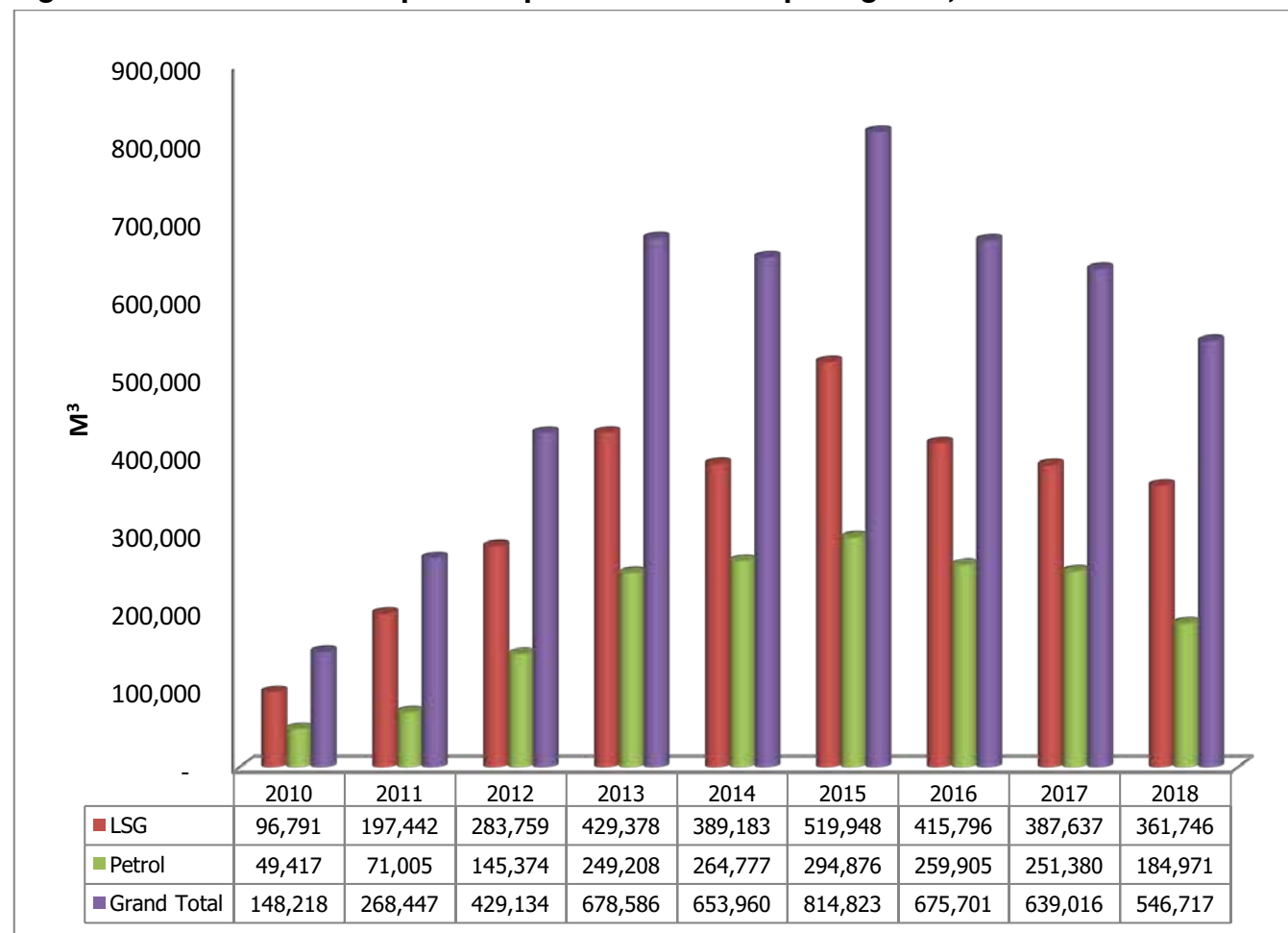
**Figure 2-2: Total imports of finished petroleum products (petrol and Low Sulphur Gas Oil) by Government and OMCs in 2018.**



### 2.1.2.1 Government Imports of petrol and low sulphur gasoil

Figure 2-3 shows that the importation of petrol and LSG reduced by 14.4 percent from 639,016 M<sup>3</sup> in 2017 to 546,717 M<sup>3</sup> in 2018. Specifically, LSG imports by Government declined from 387,637 M<sup>3</sup> in 2017 to 361,746 M<sup>3</sup> in 2018. The reduction was attributed to the reduction in uplifts of LSG from TAZAMA which resulted in the lack of ullage (storage space) for imports. This arose due to the overstocking of LSG by OMCs before the importation ban on 30<sup>th</sup> June 2018. Meanwhile, during the same period petrol imports declined from 251,380 M<sup>3</sup> to 184,971 M<sup>3</sup> mainly due to increased production from INDENI.

**Figure 2-3: Government imports of petrol and low sulphur gasoil, 2010 – 2018.**

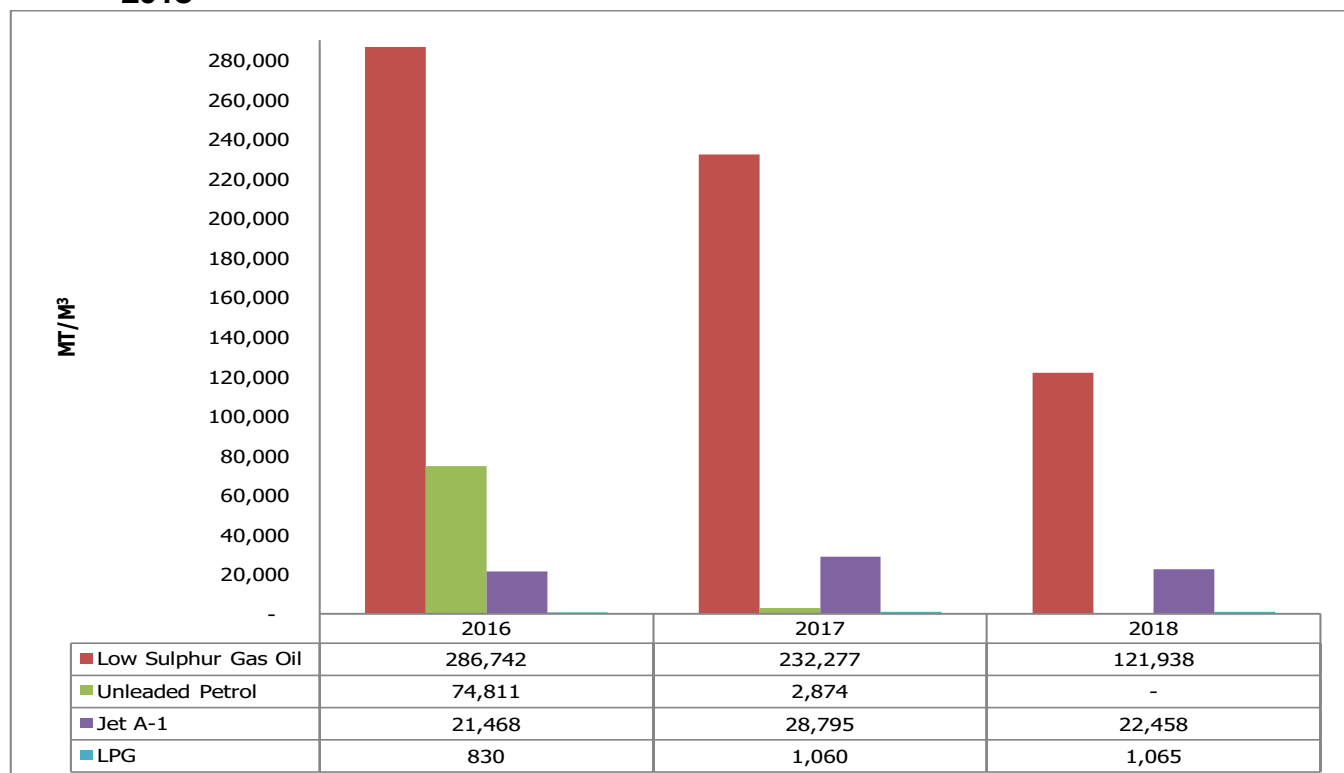


### 2.1.2.2 Oil Marketing Companies Imports

In 2018, there was a reduction in the importation of all petroleum products except for LPG. LSG imports reduced from 232,277 M<sup>3</sup> in 2017 to 121,938 M<sup>3</sup> in 2018 reflecting a 47.5 percent reduction. The reduction in imports was attributed to the suspension of the importation licence by the ERB for LSG for OMCs. However, some OMCs were granted waivers to import LSG for the mines and other specialised users. During the course of the year, the ERB revoked the waiver and no OMC was allowed to import LSG. Figure 2-4 shows the annual imported quantities of petroleum products by OMCs during the period 2016 - 2018.



**Figure 2-4: OMCs Annual imported quantities of petroleum products during periods 2016 - 2018<sup>14</sup>**



## 2.2 Operations at TAZAMA Pipelines Limited

TAZAMA pipeline has an installed capacity of 1.1 million MT per annum at an average flow rate of 160 M<sup>3</sup>/hour. TAZAMA pipelines now have a current annual throughput capacity of 800,000 MT per annum representing 72.7 percent utilisation.



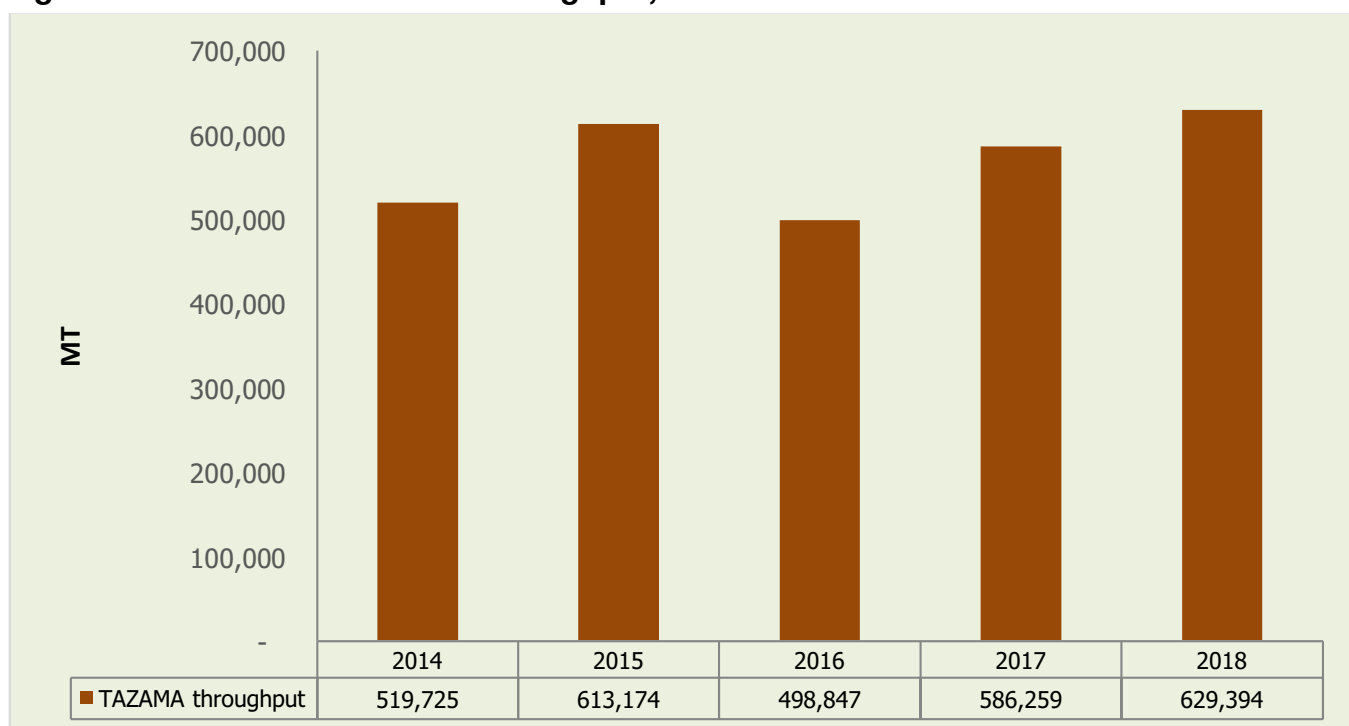
**A typical pumping station for TAZAMA Pipelines Limited**

<sup>14</sup> All products are in M<sup>3</sup> apart from LPG which is in MT

## 2.2.1 TAZAMA throughput

TAZAMA's throughput capacity has reduced to 800,000 MT per annum from a plated capacity of 1.1 million MT per year. The reduced throughput capacity is due to the degeneration of the pipeline over the years. As depicted in Figure 2-5 TAZAMA throughputs for petroleum feedstock averaged 569,480 MT in the period 2014 to 2018. Between 2016 and 2018 there was a gradual and consistent rise in the throughput. Specifically, between 2017 and 2018, the throughput increased by 7.4 percent from 586,259 MT to 629,394 MT. The increase in the throughput was mainly on account of improved flow rate attributed to the continued replacement of engines at the pumping stations. These replacements were done at Kigamboni and Elphons Pass pumping stations on the Tanzanian side as well as Chinsali pumping station in Zambia. Figure 2-5 depicts the throughput of the pipeline from 2014 to 2018.

**Figure 2-5: TAZAMA feedstock throughput, 2014 - 2018.**



## 2.2.2 Rehabilitation works at TAZAMA



**Rehabilitation works of ZT 1 tank at the Kigamboni Tank Farm in Dar es Salaam.**

In 2018, TAZAMA continued rehabilitation works on the pipeline and pumping stations. The rehabilitations included the replacement of the four old pumps at Kigamboni Pump Station in Dar-es-salaam in Tanzania and the replacement of identified corroded sections of the pipeline. This is depicted in Table 2-1.

**Table 2-1: TAZAMA pipeline rehabilitation works, 2018**

| No. | Rehabilitation Works   | Comment   |
|-----|--|---|
| 1.  | Replacement of 4 old pumps at Kigamboni Pump Station in Dar-es Salaam.   | This was carried out to improve the efficiency and reliability of the pump station.   |
| 2.  | Rehabilitation of ZT 1 tank at the Kigamboni Tank Farm in Dar es Salaam. | ZT 1 tank was under rehabilitation with the bottom plates being replaced. The works are scheduled to be completed in 2019.  |
| 3.  | Rehabilitation of corroded sections of the pipeline.                     | This was part of the on-going rehabilitation programme carried out to improve the reliability of the pipeline. The identification of corroded sections of the pipelines is done through regular pigging exercises which are carried out along the pipeline. |

### 2.3 Operations at INDENI Petroleum Refinery Company Limited

INDENI was commissioned in 1973 with a name plate (design) throughput capacity of 1.1 million MT per annum. Over the years, INDENI's throughput has reduced to around 850,000 MT per annum representing 77.3 percent capacity utilisation, mainly due to wear and tear of the plant. INDENI's achieved annual throughput per year is largely dependent on the volume of petroleum feedstock received from TAZAMA. In 2018 the average annual processing rate for INDENI was 110 M<sup>3</sup>/hr against the design rate of 160M<sup>3</sup>/hr.



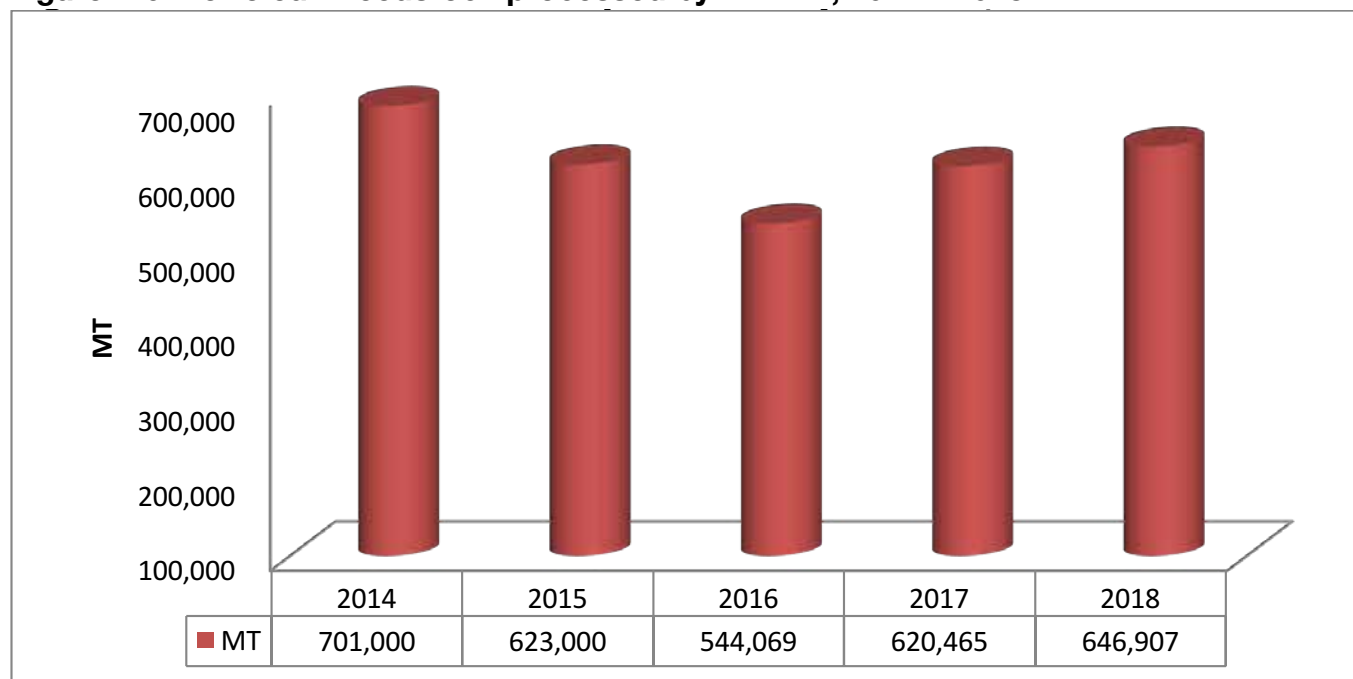
**INDENI Petroleum Refinery Plant**

### 2.3.1 INDENI throughput

INDENI throughput during the five year period, 2014 to 2018 averaged 627,088 MT. During this period, the highest throughput recorded was 701,000 MT in 2014, while the lowest was 544,069 MT in 2016. In 2018, INDENI achieved a throughput of 646,907 MT compared to 620,465 MT in 2017, representing an increase of 4.3 percent. In 2018, the refinery was operational for 293 days, having shut down for 72 days (45 days planned and 27 unplanned), against 300 days of operation and 65 days of shutdown in 2017.

Further, the 72 shutdown days reported in 2018 were higher than the set ERB Key Performance Indicator (KPI) shutdown target of 50 days. INDENI, therefore, did not meet its KPI target on operational days. The main reasons for the unplanned shutdowns included, ullage constraints on petrol, slop line leakages and other maintenance works at the refinery. Figure 2-6 depicts petroleum feedstock processed by INDENI for the period 2014 to 2018.

**Figure 2-6: Petroleum feedstock processed by INDENI, 2014 – 2018**



Source: INDENI

During the shutdown period in 2018, the Government imported finished petroleum products in order to guarantee security of supply.

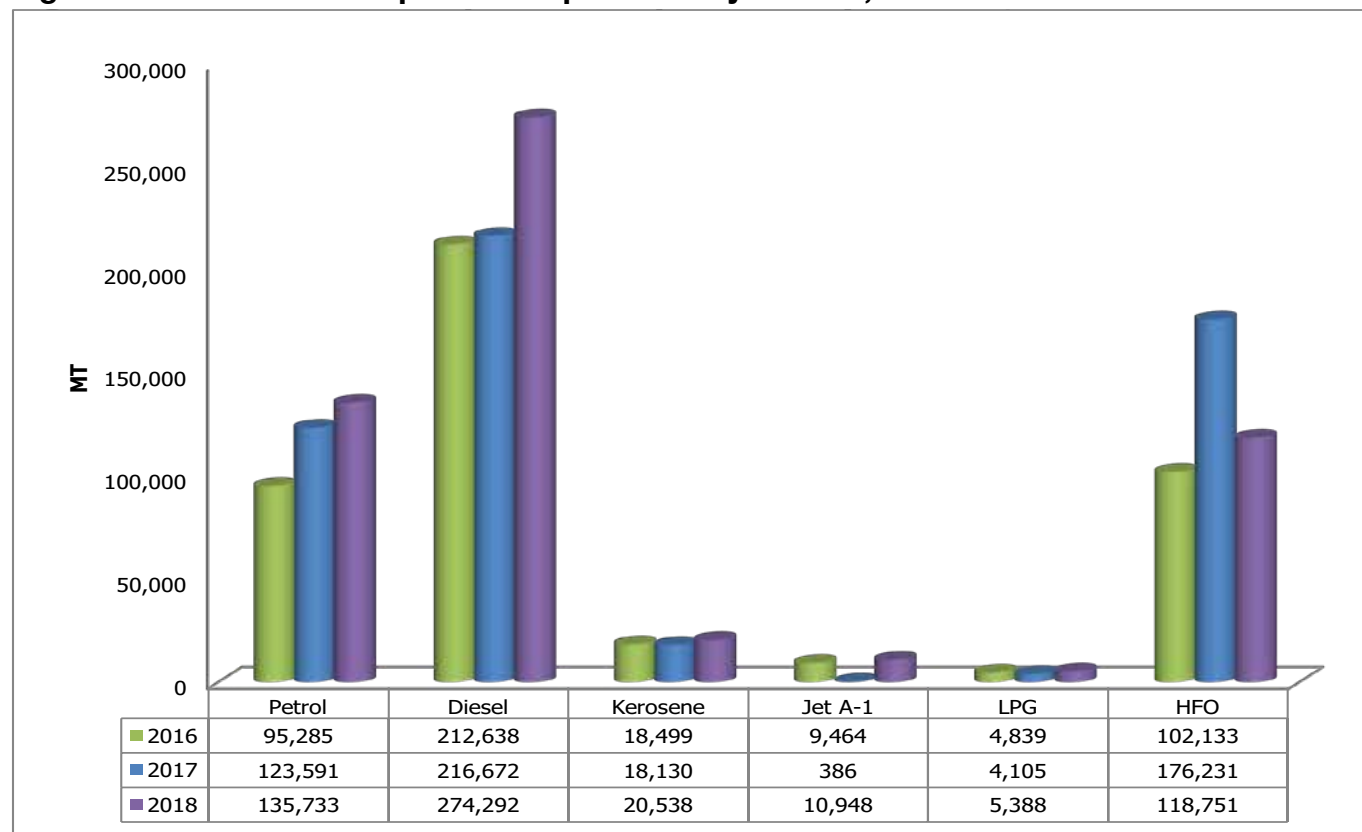
During the period under review, the bitumen plant remained operational with the Vacuum Distillation Unit having minor mechanical faults that were, however, resolved through routine scheduled repairs.

### 2.3.2 INDENI production

Generally, there was an increase in the production of all petroleum products in 2018 compared to 2017 except for Heavy Fuel Oil (HFO). Specifically, petrol production increased by 9.8 percent from 123,591 MT in 2017 to 135,733 MT in 2018. Similarly, diesel, kerosene, Jet A-1 and LPG increased by 26.6 percent; 13.3 percent; 2,736.3 percent; and 31.3 percent, respectively. The general increase in production was attributed to higher and consistent pumping rates by TAZAMA as well as the availability of petroleum feedstock.

Specifically for Jet A-1, the increase was attributed to a policy shift that encouraged OMCs to uplift Jet A-1 from TAZAMA instead of importing. Production of Kerosene and LPG remained fairly constant in 2016 and 2017, but however, increased by close to one third in 2018 reflecting the demand pattern for the two products. Meanwhile, there was a reduction in the production of HFO by 32.6 percent due to the use of lighter petroleum feedstock (Murban). Figure 2-7 shows the total production by INDENI for the period 2016 to 2018.

**Figure 2-7: Production of petroleum products by INDENI, 2016 - 2018**

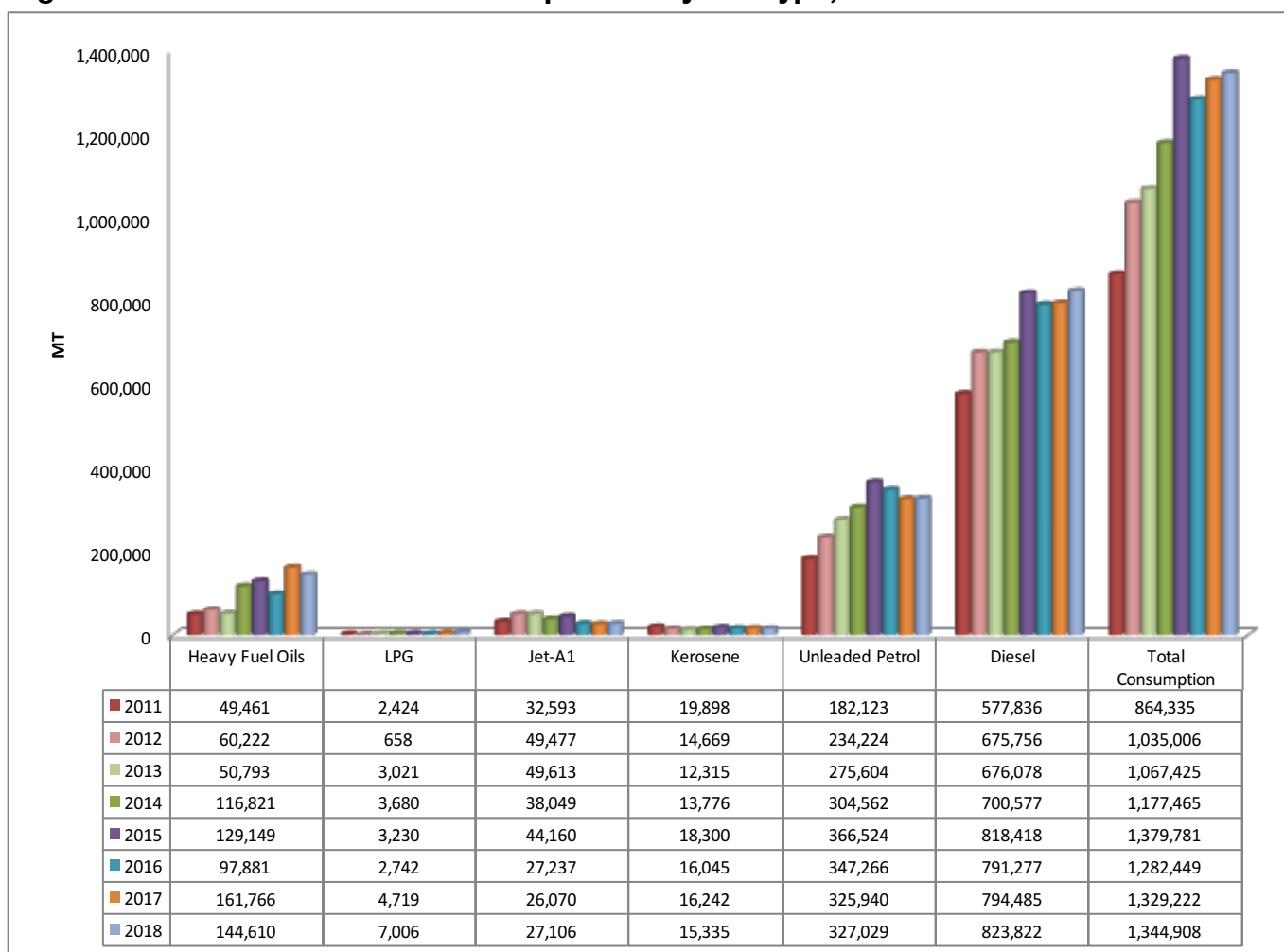


## 2.4 National consumption of petroleum products

In 2018 the total national demand for petroleum products increased marginally by 1.2 percent percent, from 1,329,222 MT in 2017 to 1,344,908 MT in 2018. The increase was mainly on account of increased demand for LPG, Jet A-1, diesel and petrol. Figure 2-8 shows the annual consumption trend for petroleum products in the country for the period 2011 to 2018.



**Figure 2-8 : Trend in national consumption of by fuel type, 2011 - 2018**



In 2018, the consumption of diesel increased by 3.7 percent from 794,485 MT (945,816 M) in 2017 to 823,822 MT (980,740 M). Diesel being a major input in the production of copper, this growth was in line with the recorded increase in mining output. According to the Zambia Chamber of Mines, copper production increased by 7.8 percent from 799,329 MT in 2017 to 861,946 MT in 2018.<sup>15</sup>

The second most consumed product in the hierarchy was petrol at 327,029 MT (436,039 M<sup>3</sup>) from 325,940 MT (434,587 M<sup>3</sup>)<sup>16</sup> in 2017. The consumption in 2018 reflected a marginal increase of 0.33 percentage points compared to 2017.

The consumption of LPG increased from 4,719 MT in 2017 to 7,006 MT in 2018 representing 48.5 percent. The increase in LPG was triggered by the increase in local demand due to most consumers using it as an alternative source of energy. Similarly, the consumption of Jet A-1 increased by 4.0 percent from 26,070 MT (32,792 M<sup>3</sup>) in 2017 to 27,106 MT (34,095 M<sup>3</sup>) in 2018.

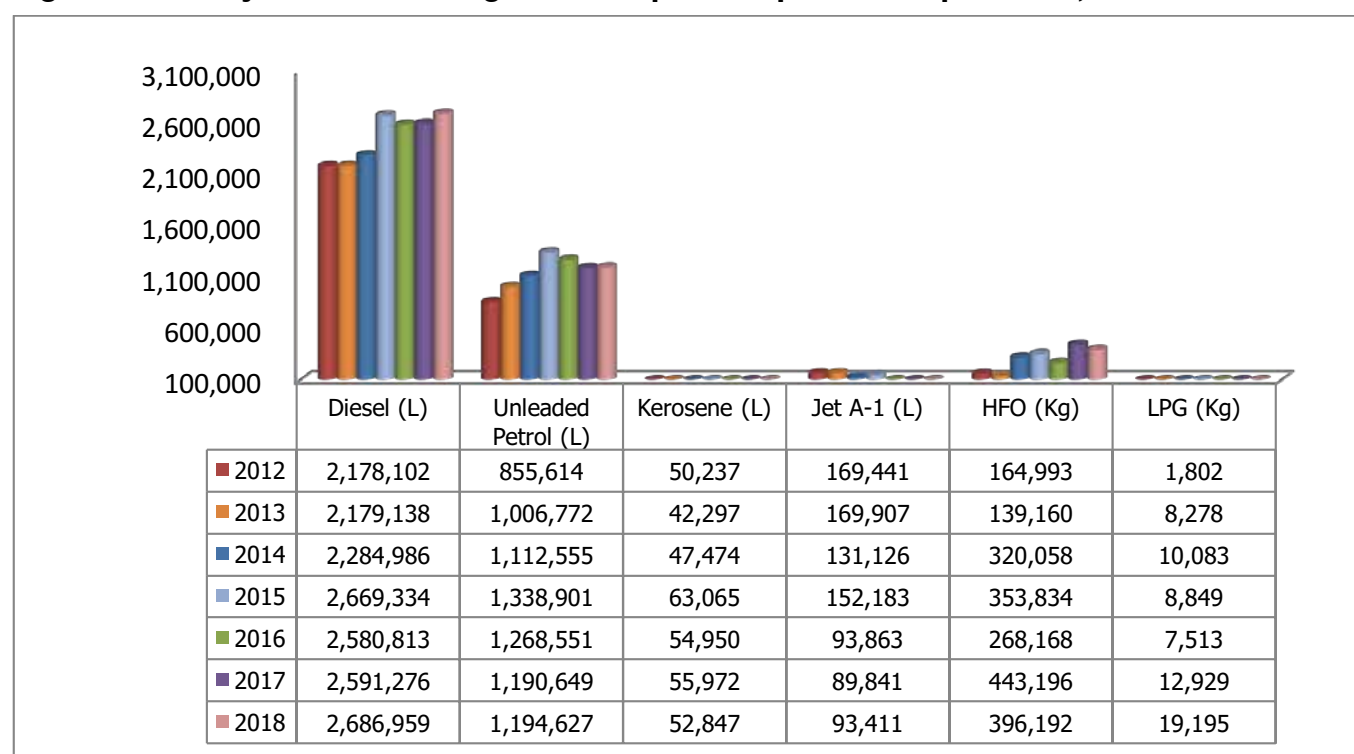
Meanwhile, the consumption of HFO decreased by 10.6 percent from 161,766 MT in 2017 to 144,610 MT in 2018. The reduction was mainly as a result of the supply constraint of HFO from INDENI. Similarly, there was a 5.6 percent reduction in the consumption of kerosene from 16,242 MT (20,430 M<sup>3</sup>) in 2017 to 15,355 MT (19,289 M<sup>3</sup>) in 2018.

## 2.5 Daily national average consumption of petroleum products

Figure 2-9 shows the trend in daily national average consumption of petroleum products for the period 2012 to 2018. The daily average consumption of all petroleum products increased compared to 2017, except for HFO and kerosene which declined. This was in line with the observed national annual consumption pattern.

<sup>15</sup> <http://mines.org.zm/the-2018-copper-production-hits-861946-tonnes/>

<sup>16</sup> In the case of petrol, 1 Metric Tonne is equivalent to 1.33m<sup>3</sup> using a density of 0.75 kilograms/litre

**Figure 2-9: Daily national average consumption of petroleum products, 2012 - 2018**

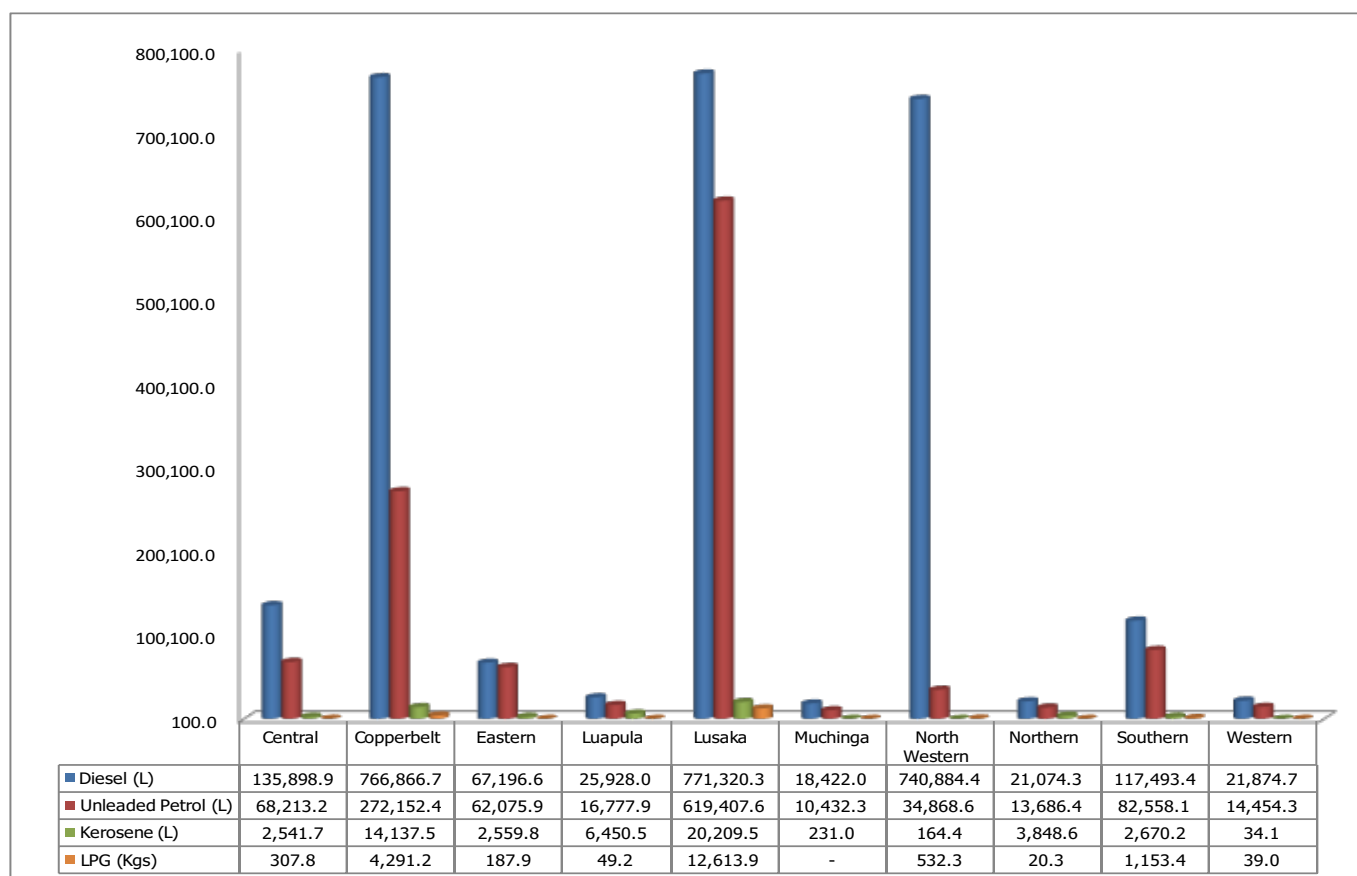
The daily national average consumption of diesel increased to 2,686,959 litres in 2018 from 2,591,276 litres in 2017 reflecting 3.7 percent. Similarly, the daily national average consumption of petrol increased marginally by 0.33 percentage points to 1,194,627 litres in 2018 from 1,190,649 litres in 2017. The daily national average consumption of Jet A-1 and LPG increased to 93,411 litres and 19,195 kgs per day from 89,841 litres and 12,929 kgs per day reflecting 4.0 percent and 48.5 percent increase, respectively. Meanwhile, there was a reduction in the average daily consumption of HFO and Kerosene to 396,192 kgs and 52,847 litres from 443,196 kgs and 55,972 litres per day translating to 10.6 percent and 5.6 percent decrease, respectively.

### 2.5.1 Daily national average consumption by Province

The daily average consumption of petroleum products per Province is shown in Figure 2-10. Due to the differences in economic and demographic factors; there are considerable differences in the consumption of petroleum products per province. In 2018, the total consumption of petroleum products continued to be higher in Lusaka, Copperbelt and North-Western Provinces. Meanwhile, Muchinga, Northern, Luapula and Western Provinces continued to consume the least total consumption of petroleum products.



**Figure 2-10: Provincial average daily consumption of diesel, petrol and kerosene, 2018**



### Diesel

The highest provincial daily average consumption of diesel was in Lusaka Province at 771,320 litres per day accounting for 28.7 percent of overall national daily consumption. This was followed by Copperbelt province at 766,867 litres per day reflecting 28.5 percent of consumption. North-Western province consumed 740,884 litres of diesel reflecting 27.6 percent of national daily average consumption. The Provinces with the least consumption for diesel on a daily basis were Muchinga, Northern and Western Provinces which accounted for 0.69 percent, 0.78 percent and 0.81 percent of national daily average consumption respectively.

### Petrol

With regards to the provincial average daily consumption of petrol, Lusaka Province had the highest consumption at 619,408 litres per day reflecting 51.8 percent of the daily national average consumption. This was followed by Copperbelt Province at 272,152 litres per day reflecting 22.8 percent of the total daily average national consumption of petrol. Meanwhile, the least consumers were Muchinga, Northern and Western Provinces. The three Provinces consumed a total of 38,573 litres daily representing 3.2 percent of the daily national average consumption of petrol.

### Kerosene

Lusaka Province accounted for the highest consumption of kerosene per day in 2018 at 20,209 litres reflecting 38.2 percent of the daily national average consumption. Copperbelt province accounted for second highest consumption of kerosene at 14,138 litres per day or 26.8 percent of the total daily national average consumption. Luapula province was third at 6,450 litres per day accounting for 12.2 percent of the daily national average consumption. The Provinces with the least consumption of kerosene on a daily basis were Western, North-Western and Muchinga which consumed 430 litres per day collectively.

## LPG

The daily national average consumption for LPG per Province was highest in Lusaka Province at 12,613 kgs per day or 65.7 percent of the overall daily average national consumption. This was followed by Copperbelt Province at 4,291 kgs per day accounting for 22.4 percent of the daily national average consumption. The Provinces with the least consumption of LPG on a daily basis were Northern, Luapula and Western Provinces which had a combined daily average consumption of 108 kgs per day.

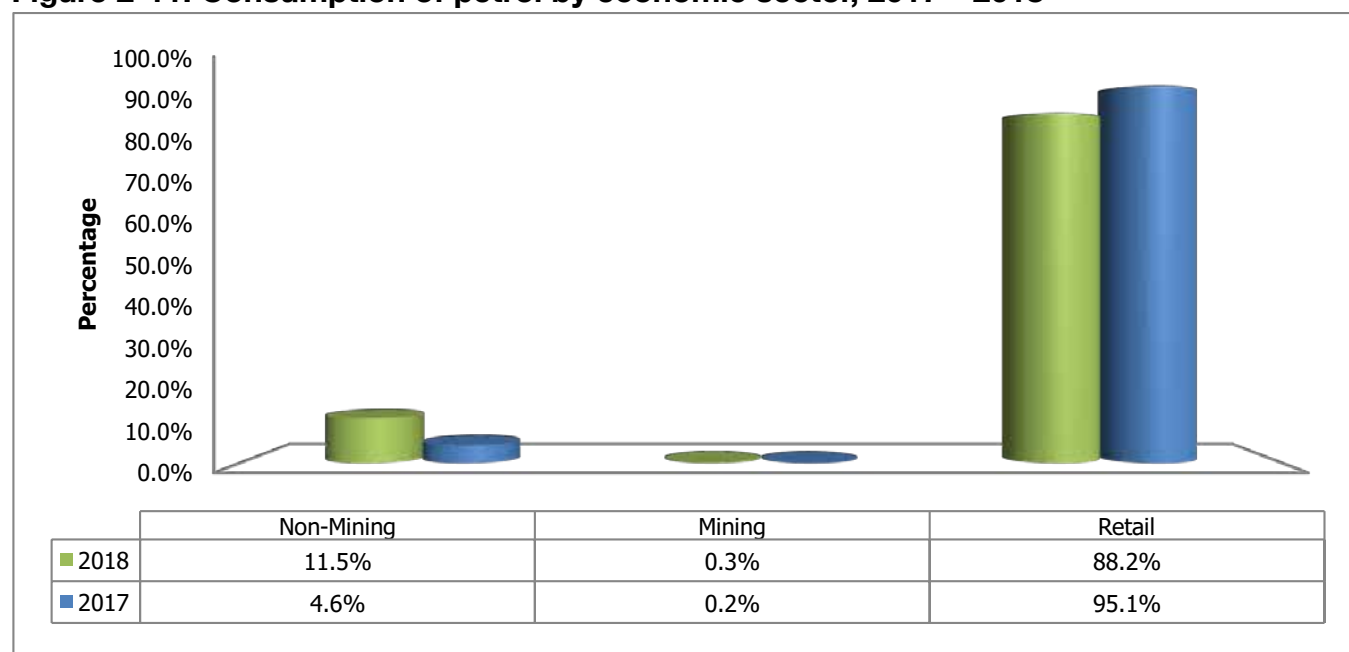
### 2.5.2 Consumption of petroleum products by economic sector

This section discusses the consumption of petrol and diesel by economic sector. The economic sectors are classified as follows: retail, mining and non-mining. Retail refers to petroleum products that are sold at the service stations, while mining refers to petroleum products delivered to and directly consumed by the mines. Non-mining refers to all the other sectors in the economy such as agriculture, transport, manufacturing and construction.

#### 2.5.2.1 Consumption of petrol by economic sector

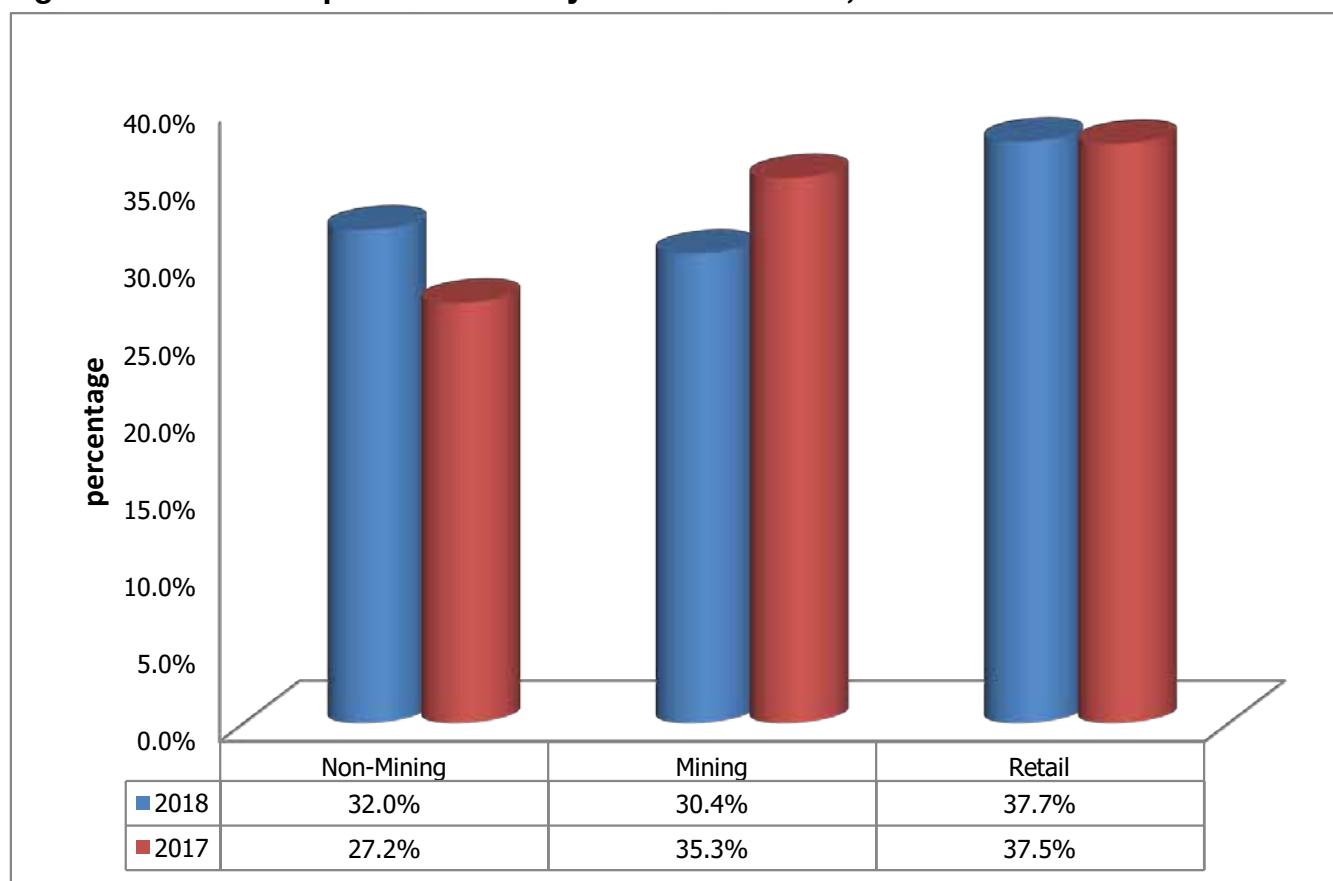
In 2018, the consumption of petrol was predominantly retail at 88.2 percent despite this, it declined compared to 95.1 percent recorded in 2017. This was followed by the non-mining sector at 11.5 percent reflecting a 6.9 percentage points increment from 4.6 percent in 2017. Meanwhile, the mining sector accounted for 0.3 percent from 0.2 percent in 2017. Figure 2-11 shows the consumption of petrol by economic sector in 2017 and 2018.

**Figure 2-11: Consumption of petrol by economic sector, 2017 – 2018**



#### 2.5.2.2 Consumption of diesel by economic sector

In 2018 the consumption of diesel was predominantly retail at 37.7 percent compared to 37.5 percent in 2017, reflecting a marginal increase of 0.2 percentage points. This was followed by the mining sector at 30.4 percent, while the non-mining sector accounted for 32 percent. Figure 2-12 shows the consumption of diesel by economic sector in 2017 and 2018.

**Figure 2-12: Consumption of diesel by economic sector, 2017 – 2018**

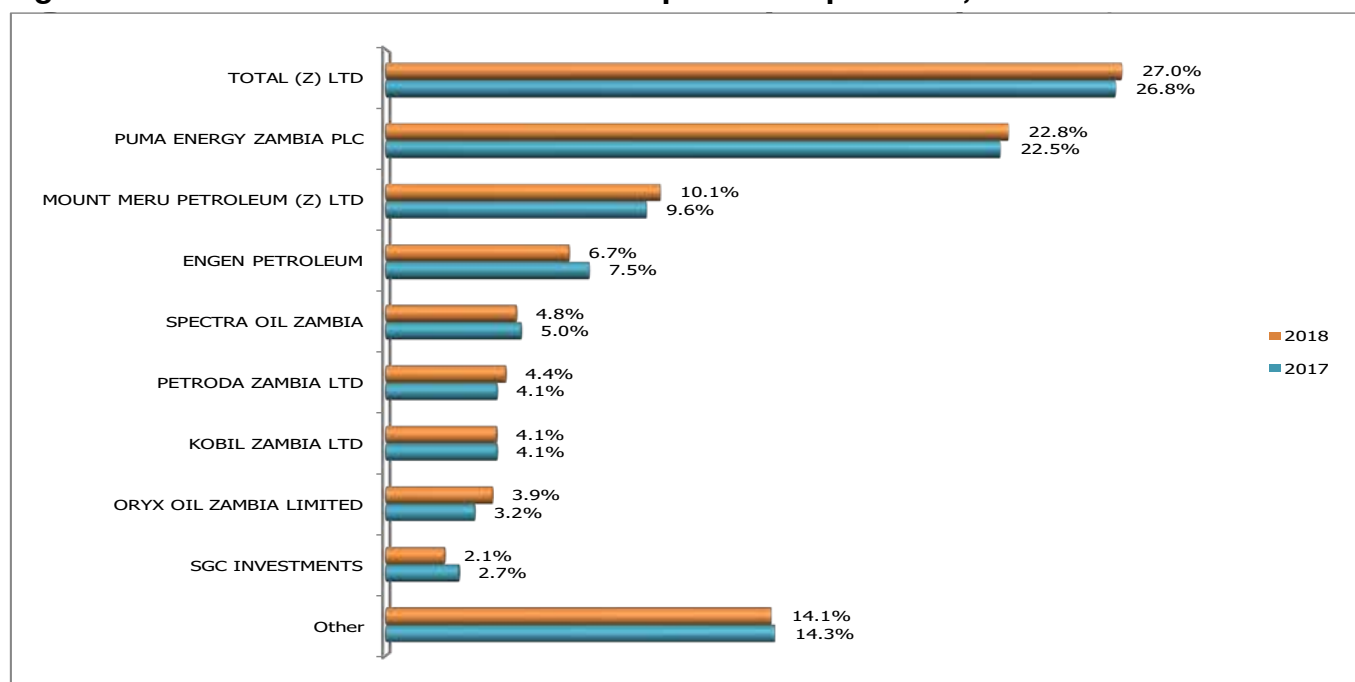
## 2.6 Market share of Oil Marketing Companies

This section discusses the combined market share of OMCs in 2018 for white products (*diesel, petrol, kerosene*), lubricants and Jet A-1. The size of an OMC is determined by its market share<sup>17</sup>. As at 31<sup>st</sup> December 2018, the number of licensed OMCs by the ERB stood at 87.

### 2.6.1 Market share of white products

The market share of OMCs for white products comprising diesel, petrol and kerosene is depicted in Figure 2-13. Puma Energy Zambia Plc (Puma Energy) and Total Zambia Limited (Total Limited) continued to lead the market for white products increasing the combined market share by 0.5 percentage points from 49.3 percent in 2017 to 49.8 percent in 2018. Total Limited maintained its lead with a market share of 27.0 percent increasing from 26.8 percent in 2017. This was followed by Puma Energy which recorded a marginal increase of 0.3 percentage points at 22.8 percent from 22.5 percent in 2017.

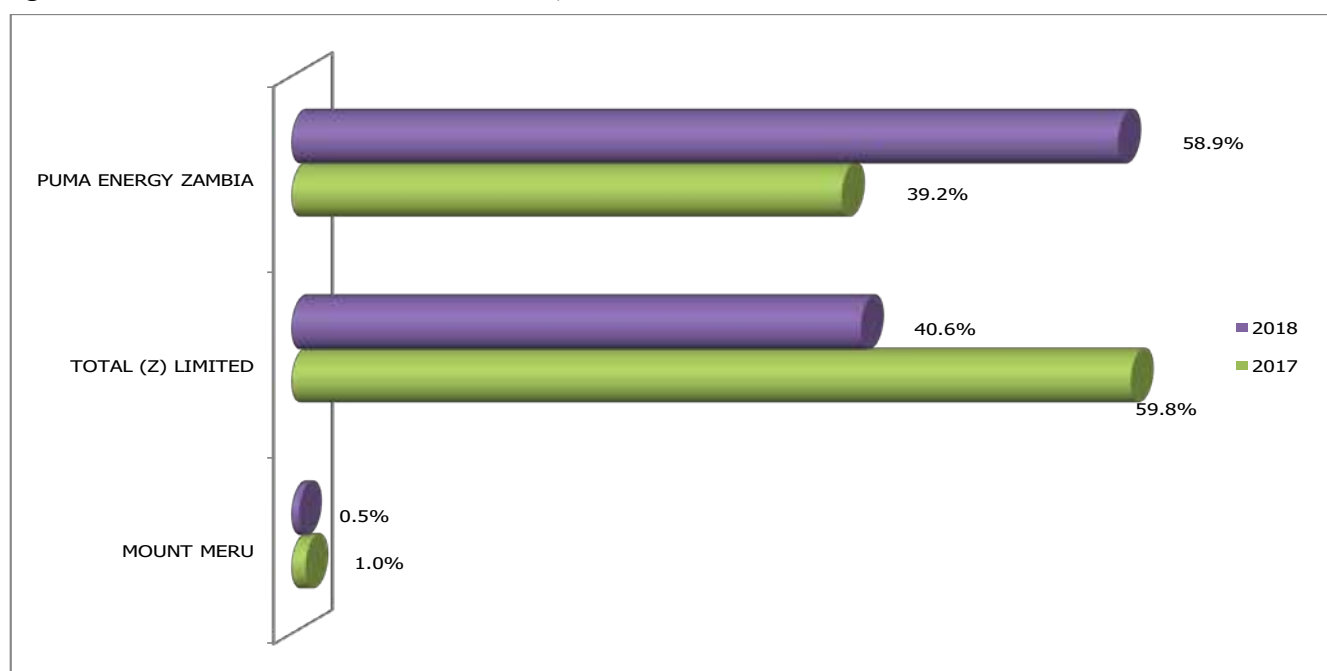
<sup>17</sup> Market share is defined as a percentage of an OMCs' total sales to the total industry market sales in a specified period of time

**Figure 2-13: OMCs' Market share for white petroleum products, 2017-2018**

In 2018, gains in market share were also recorded for Petroda, Mount Meru, and Oryx of 0.3, 0.5 and 0.7 percentage points, respectively. Meanwhile, Engen and SGC lost 0.8 and 0.6 percentage points, respectively.

### 2.6.2 Market share for Jet A-1

In 2018, there were three OMCs dealing in Jet A-1 namely; Puma Energy, Total Limited and Mount Meru. Puma Energy took the lead of the market accounting for 58.9 percent in 2018 compared to 39.2 percent in 2017. Total Limited's market share dropped to second position in 2018, accounting for 40.6 percent from 59.6 percent in 2017. The market share for Jet A-1 is shown in figure 2-14.

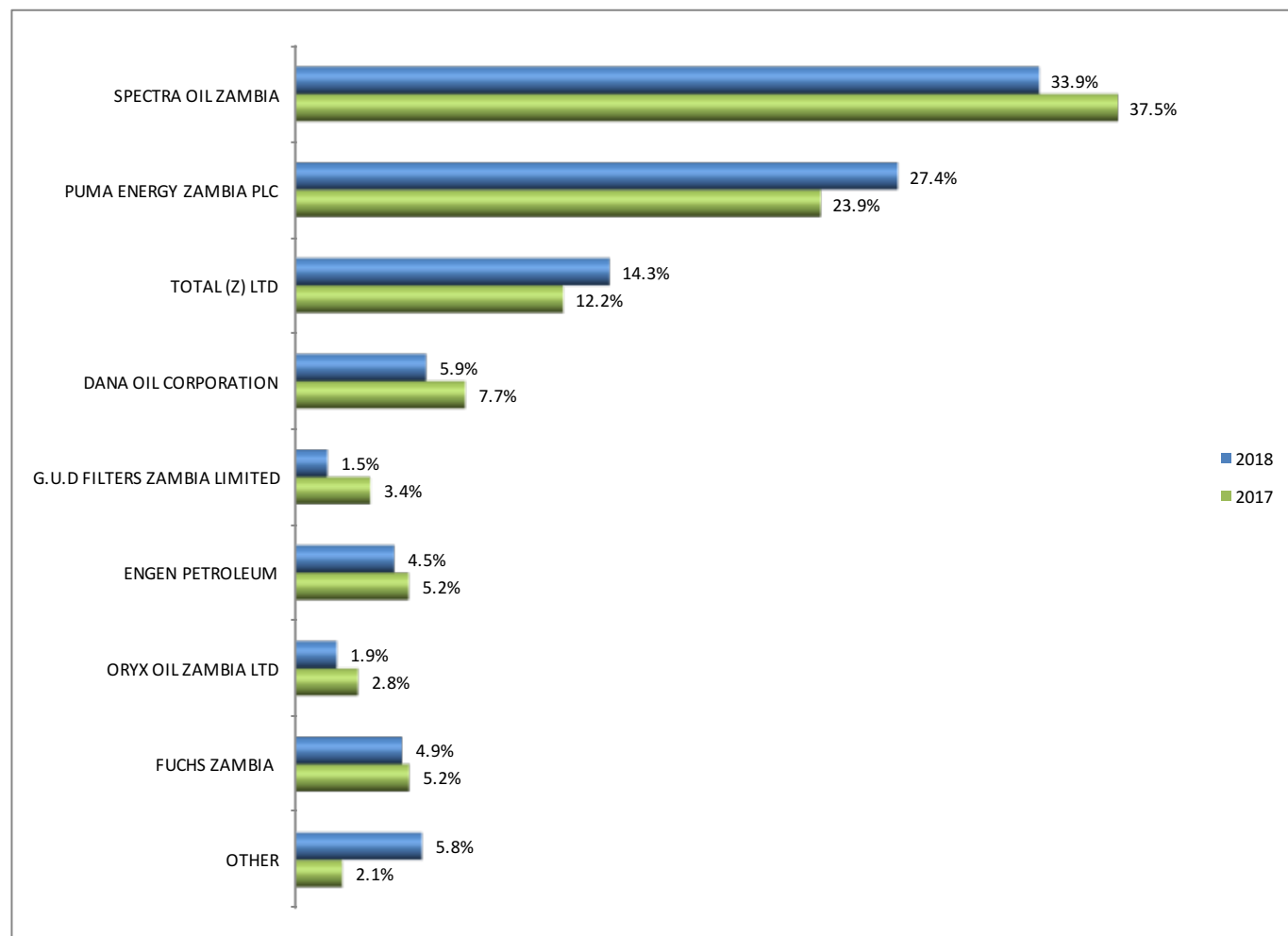
**Figure 2-14: Market share for Jet A-1, 2017 - 2018**

Meanwhile, Mount Meru recorded a reduction in the market share of 0.5 percentage points from 1 percent in 2017 to 0.5 percent in 2018.

### 2.6.3 Market share for lubricants

During 2018, the total number of companies dealing in lubricants and licenced by the ERB was 28. Spectra Oil Zambia maintained its lead in the market for lubricants at 33.8 percent. However, despite the lead, its market share declined by 3.7 percentage points from 37.5 percent in 2017. This was followed by Puma Energy Zambia which increased its market share by 3.5 percentage points to attain a market share of 27.4 percent. Total Zambia was next in the hierarchy with a market share of 14.3 percent, followed by Dana Oil at 5.95 percent. The market share for lubricants during the period under review compared to 2017 is shown in Figure 2-15.

**Figure 2-15: Market share for lubricants, 2017-2018**



G.U.D Filters, Oryx Oil, Engen, and Fuchs Zambia had market shares of 1.5, 1.9, 4.5 and 4.9 percent, respectively. Meanwhile, the other OMCs that deal in lubricants had a combined total market share of 5.8 percent in 2018.

### 2.7 Pricing of petroleum products

In Zambia, the prices of petroleum products are determined using the Cost-Plus Model (CPM). The CPM operates on the principle that the final price of petroleum products recovers all costs incurred in the fuel supply chain, that is, starting from the cost of product to the final price the consumer pays.



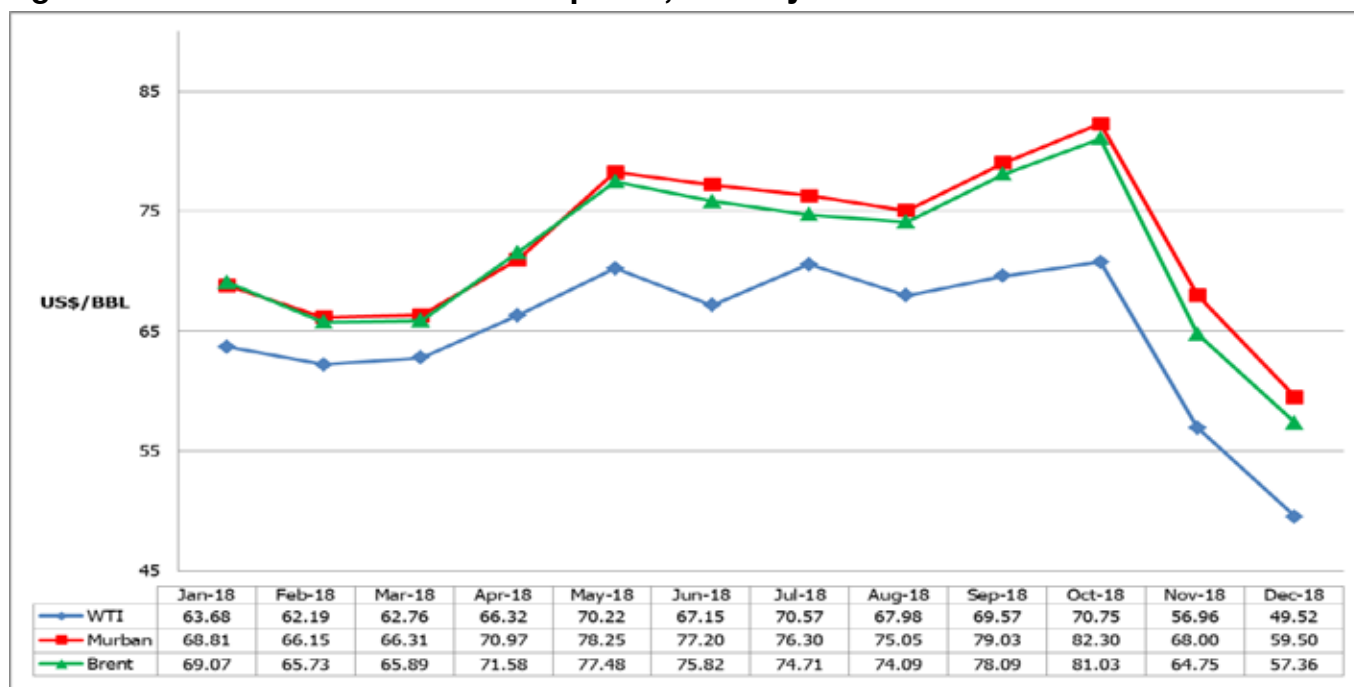
**A fuel attendant refueling a vehicle**

### **2.7.1 Determinants of petroleum prices**

Fuel prices globally, are influenced by the combined effects of the international petroleum product prices as well as macroeconomic factors (such as the exchange rate) in the respective domestic economies. In Zambia, in addition to trends in the international oil prices, fuel prices are largely influenced by fluctuations of the Zambian Kwacha against the United States Dollar exchange rate. This implies that any changes in these two factors could trigger a price adjustment. Other factors that can initiate a price adjustment are changes in cost-lines such as: levies, duties and fees; margins for transporters, OMCs or dealers; and pumping or processing fees.

### **2.7.2 Trend in International Oil Prices**

During 2018, international oil prices for WTI, Brent and Murban fluctuated between US\$ 56.96/bbl and US\$ 82.30/bbl. Generally, international oil prices increased by an average of 29.2 percent from an initial low of US\$ 63.68/bbl in January to a year high of US\$ 82.30/bbl in October 2018. Despite the general increase in the international oil prices during the ten month period, there were spots of temporary declines particularly for Murban crude in February, June, July and August, 2018. Figure 2-16 depicts the trend in International oil prices in 2018.

**Figure 2-16: Trend in International oil prices, January 2018 to December 2018**

From October onwards, crude oil prices declined to lowest levels in more than a year. The decline was on account of increased supply from the top three producers namely; United States of America (USA), Russia and Saudi Arabia who jointly produced more than one third of the global consumption. Furthermore, as a result of growing concerns over the US-China trade tension, the three countries sustained high oil production which caused international oil prices to plummet. Specifically, in the last quarter of 2018, prices for WTI, Murban and Brent declined on average as follows: from US\$ 70.75/bbl to US\$ 49.52/bbl; US\$ 82.30 to US\$59.50/bbl; and US\$ 81.03/bbl to US\$57.36/bbl respectively.

### 2.7.3 Trend in the exchange rate

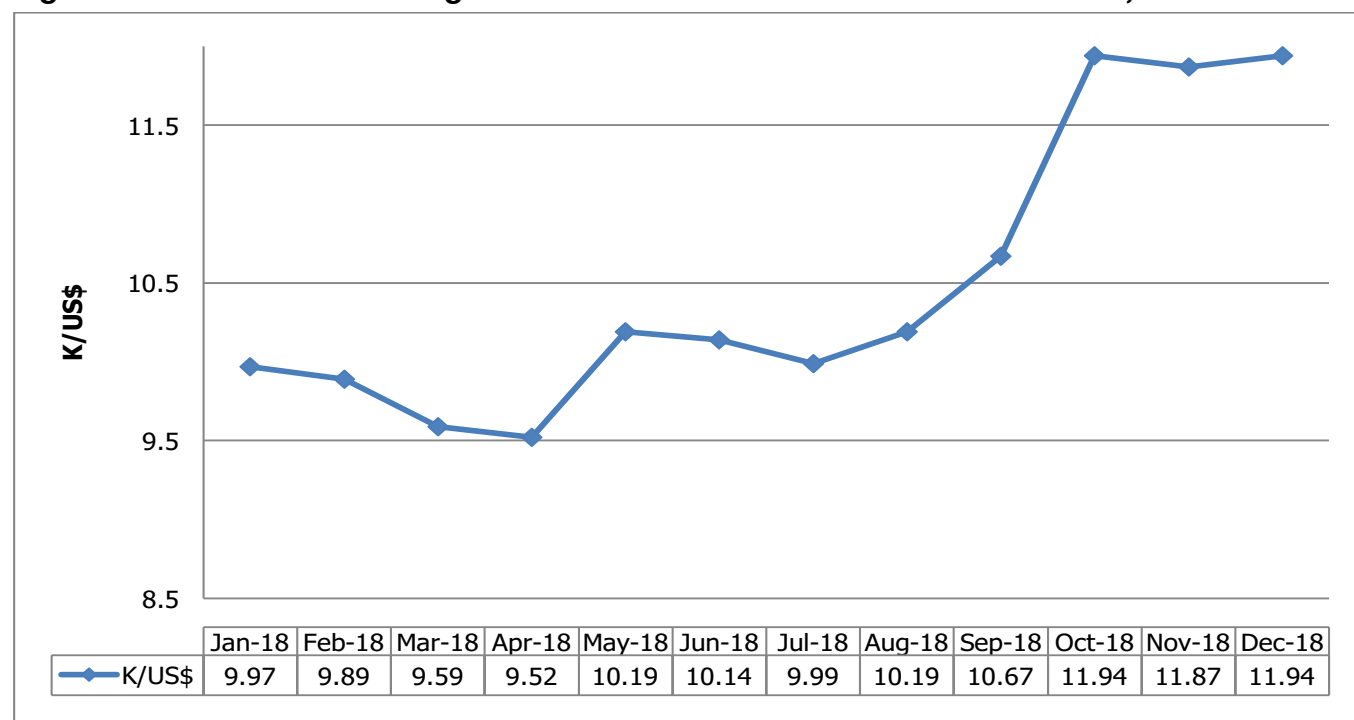
In the first half of the year, the exchange rate between Zambian Kwacha and United States Dollars was relatively stable and ranged between K9.52/US\$ in April 2018 and K10.19/US\$ in May 2018. During this period the exchange rate averaged K10.08/US\$.

Between July 2018 and December 2018, the exchange rate depreciated steeply from K9.99/US\$ to K11.94/US\$ in December 2018 representing a depreciation of 19.5 percent during this period.

Thus, for the period January to December 2018 the kwacha depreciated by 19.8 percent, that is from K9.97/US\$ to K11.94/US\$. This depreciation was initially triggered by sustained increase in the demand for fuel procurement which was compounded by the strengthening of the US dollar as a result of the hike in the Federal Reserve Fund rate and negative market sentiments arising from the downgrade of Zambia's credit rating (BOZ, 2019).

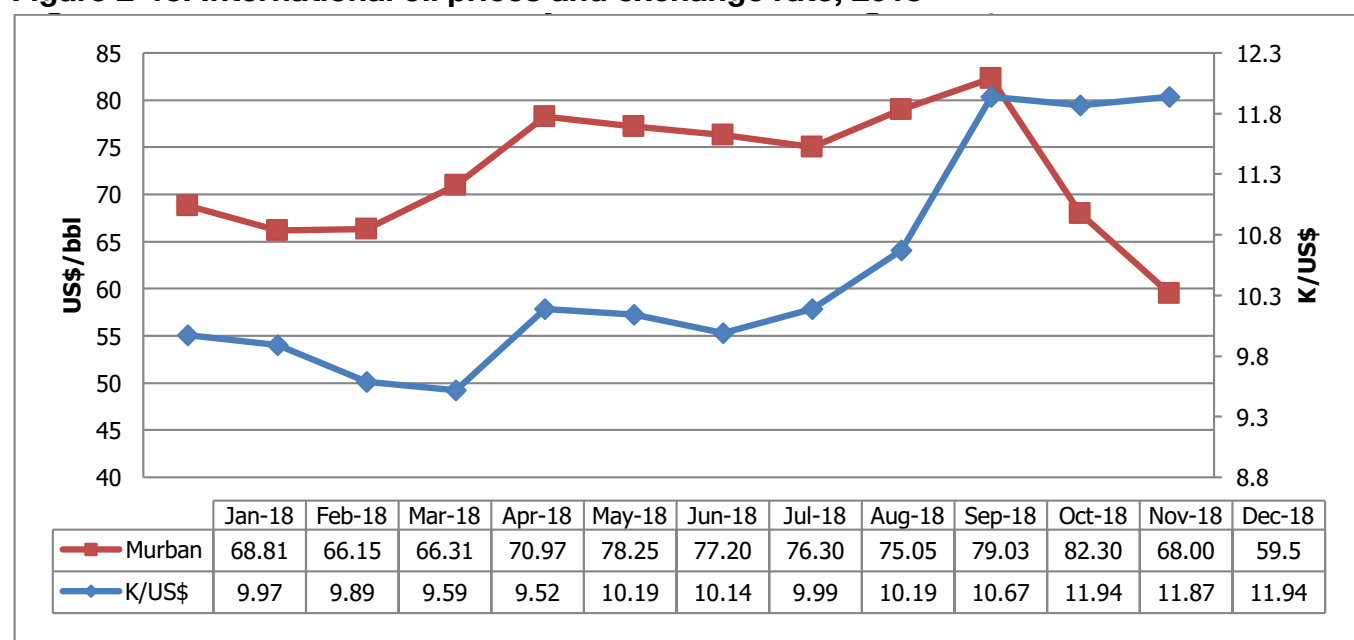
Figure 2-17 shows the trend in Exchange Rate of the US Dollar to Zambian Kwacha from January to December 2018.



**Figure 2-17: Trend in Exchange Rate of the US Dollar to Zambian Kwacha, 2018**

#### 2.7.4 Trend in international oil prices and exchange rate

The extent of change in fuel prices in Zambia is influenced by the combined movements in international oil prices and the exchange rate. In some cases, the two factors move in opposite directions therefore influencing the quantum of price adjustment. Figure 2-18 illustrates the characteristic trend pattern in the international oil price and exchange rate of the Kwacha to the United States Dollar during the year 2018. Between January and October 2018 the two factors moved in the same direction. However, beyond October 2018 these two factors moved in opposite directions, steeply downwards for Murban and marginally upwards for the exchange rate. This implied that the price benefits that could have arisen from a steep fall in international oil prices were slightly negated by the exchange rate which moved in a different direction. Figure 2-18 depicts the trend in international oil prices and exchange rate in 2018.

**Figure 2-18: International oil prices and exchange rate, 2018**

## 2.7.5 Pricing of petroleum products

In 2018, the ERB continued to review fuel prices using the CPM. The underlying assumption of the CPM is that the pump price of fuel covers all the costs incurred in the supply of fuel. Price reviews using CPM are done whenever petroleum feedstock and finished petroleum products are imported into the country approximately every 60 days.

ERB continued to implement the Uniform Pump Pricing (UPP) which entails that the price of fuel applied at all retail sites throughout the country are the same for particular products. Prior to the introduction of the UPP, the prices of petrol, diesel, kerosene and LSG at retail sites furthest from Government fuel depots were higher than the prices obtaining at sites closer to the Government fuel depots.

Appendix 1 shows the petroleum value chain in Zambia while the components of the CPM are depicted in Appendix 2. To account for both petroleum feedstock and finished petroleum products, the CPM computes a weighted wholesale price for both diesel and petrol as depicted below:

The weighted average wholesale price of diesel is calculated as follows:

- i. *Expected Revenue from imported Low Sulphur Gasoil (LSG) (A) = Total quantity of Imported LSG X The landed unit cost CIF Ndola*
- ii. *Revenue expected from INDENI Diesel (B) = Expected Diesel yields from processed Cargo X Computed Diesel Wholesale price as per CPM*
- iii. *Weighted Average Wholesale Price (C) = 
$$\frac{(A+B)}{\text{INDENI diesel yields} + \text{LSG Import Quantity}}$$*

The weighted average wholesale price of petrol is calculated as follows:

- i. *Expected Revenue from imported Petrol (D) = Total quantity of Imported Petrol X The landed unit cost CIF Ndola*
- ii. *Revenue expected from INDENI Petrol (E) = Expected Petrol yields from processed Cargo X Computed Petrol Wholesale price as per CPM*
- iii. *Weighted Average Wholesale Price (F) = 
$$\frac{(D+E)}{\text{INDENI Petrol yields} + \text{Petrol Import Quantity}}$$*

Table 2-2 shows the different cost elements that make up the wholesale price.

**Table 2-2: Cost Elements in the Wholesale Price as at 31<sup>st</sup> December 2018**

| COST ELEMENT   | UNIT COST      | BASIS                       |
|--|----------------|-----------------------------|
| Cost-Insurance-Freight (US\$/MT)   |                | Contract/Supplier Invoice   |
| Ocean Losses   | 0.30%          | Best Practice               |
| Wharfage   | 1.25%          | Tanzanian Harbour Authority |
| Finance Charges  | 0.00%          | Financier                   |
| Collateral Manager (US\$/MT)   | 0.00           | Stock Monitoring Agreement  |
| Insurance  | 0.11%          | Insurer                     |
| TAZAMA Storage Fee (US\$/MT)   | 2.00           | TAZAMA                      |
| TAZAMA Pumping Fee (US\$/MT)   | 54.00          | Approved ERB Pumping Tariff |
| TAZAMA Pipeline Losses ( <i>pipeline consumption of 0.83% &amp; allowable pumping losses of 0.65%</i> )  | 0.85%          | Guided by MoE               |
| Agency Fee (US\$/MT)   | 5.00           | Agency Agreement            |
| Refinery Fee (US\$/MT)   | 60.38          | Approved ERB Processing Fee |
| Refinery Processing Losses   | 6.50%          | Guided by MoE               |
| Terminal Losses ( <i>1% for LPG, 0.5% for Petrol Kerosene &amp; Jet A-1, 0.3% for diesel &amp; HFO</i> ) | 1%, 0.5%, 0.3% | Best Practice               |

The build-up to the pump price constitutes the terminal fee, respective statutory excise duty on the different products, the OMC, dealer and transporters margins which are all determined by the ERB, the ERB fees of 0.7% of turnover, the SRF (for infrastructure development in the sector and procurement of strategic reserves) and VAT on products. Table 2-3 gives an outline of these costs up to the pump.

**Table 2-3: Cost Elements in the Pump Price as at 31<sup>st</sup> December 2018**

| No | DETAILS                       | UNIT COSTS  | WORKINGS      |
|----|-------------------------------|---|---------------|
| 1  | Wholesale Price to OMC        | K9.70, K9.84, K9.36 & K11.94 per litre each for petrol, diesel, kerosene and LSG, respectively. | a             |
| 2  | Terminal Fee                  | K0.025/litre  | b             |
| 3  | Marking Fee                   | K0.10/litre   | c             |
| 4  | Excise Duty (incl.) road levy | K1.97/litre for Petrol, K0.62/litre for Diesel, K0 for Kerosene and K0.62/litre for LSG         | d             |
| 5  | Ex NFT Gate                   |   | $E=(a+b+c+d)$ |
| 6  | Transport Cost                | K0.26 for Petrol, K0.26 for Diesel, K0.09 for Kerosene and K0.26 for LSG                        | f             |
| 7  | OMC Margin                    | K0.89/litre   | g             |
| 8  | TOTAL (Excl VAT)              |   | $h=(e+f+g)$   |
| 9  | Dealer Margin                 | K0.65/litre   | i             |
| 10 | PRICE TO DEALER               |   | $j=(h+i)$     |
| 11 | ERB Fees                      | 0.7%  | k             |
| 12 | Strategic Reserves Fund       | K0.15/litre for Petrol, Diesel and Kerosene   | l             |
| 13 | Price before VAT              |   | $m=(j+k+l)$   |
| 14 | VAT                           | 16%   | n             |
| 15 | UNIFORM PUMP PRICE            | K/litre   | $o=(m+n)$     |

The ERB effects price changes to petroleum products if the proposed change to current wholesale prices is, on average, greater than the 2.5 percent trigger band. Therefore, petroleum products prices are not adjusted if the average change in the computed or proposed wholesale price is less than the 2.5 percent threshold.

### 2.7.6 Strategic Reserve Fund

The Strategic Reserve Fund (SRF) cost line is included in the petroleum price build-up and replaced the 15 days stock cost-line that OMCs were required to maintain in their depots to ensure security of supply. SRF was introduced in 2005 and is used for the following: to finance the development of petroleum infrastructure such as fuel depots; road works around fuel storage depots; rehabilitation of fuel tanks at storage depots and other infrastructure at the refinery. The fund is managed by the ERB on behalf of the Government.

During the period under review, SRF fee remained at K0.15/litre for petrol, diesel, kerosene and Jet A-1, and K0.15/kg for HFO and LPG. The ERB collects this fee through OMCs and has put in place a monitoring mechanism to ensure that OMCs remit the correct amount into the Fund.

### 2.7.7 Annual review of petroleum downstream margins

During the year 2018, the ERB reviewed and finalised margins for OMCs, dealers and transporters. The purpose of the review was to ensure that the margins were updated and reflective of cost dynamics; consistent with the changing economic variables such as inflation and exchange rate among others.

The new margins were implemented in October, 2018. In particular, OMC margins were increased from K0.56/litre to K0.89/litre. Similarly, dealer margins were increased from K0.38/litre to K0.65/litre. Further, the transporter margins were increased from K0.82/litre to K0.95/litre for distances above 20 kilometers and from K1.20/litre to K1.39/litre for distances below 20 kilometers.

Table 2-4 depicts the changes in the margins for OMCs, dealers and transporters in 2018.

**Table 2-4: Revised Margins for OMCs, Dealers and Transporters**

| Description                | Old Margin           | New Margin           |
|----------------------------|----------------------|----------------------|
|                            | K/litre              | K/litre              |
| OMCs                       | 0.56                 | 0.89                 |
| Dealers                    | 0.38                 | 0.65                 |
| Transporter Margin         | K/m <sup>3</sup> /km | K/m <sup>3</sup> /km |
| Transporters –Above 20 km  | 0.82                 | 0.95                 |
| Transporters – Below 20 km | 1.20                 | 1.39                 |

### 2.7.8 Pricing framework for Jet A-1

In 2018, the ERB approved the introduction of a market based formula pricing, Import Parity Pricing (IPP). The IPP is an alternative pricing model to the CPM that pegs prices to international benchmark prices for imported goods. The IPP mechanism is aimed at promoting maximum efficiency in the supply chain for Jet A-1, while at the same time ensuring that the domestic prices of Jet A-1 reflect the cost trends of petroleum products on the international market. The IPP mechanism will enable consumers to pay efficient market prices for fuel, while allowing INDENI to generate sufficient income to operate viably.

The new pricing framework for Jet A-1 will ensure that monthly automatic reviews are done and implementation of the framework was expected to be completed in 2019.

## 2.7.9 Regulatory Framework for Biofuels

The Government of the Republic of Zambia (GRZ) has since 2006 been promoting the use of biofuels. Biofuels are being promoted world-wide due to their potential to mitigate climate change and improve energy security. The National Energy Policy has since been revised to include biofuels. A Statutory Instrument (SI) No. 42 of 2008 was issued to include biofuels as part of fuels in Zambia in the Energy Regulation Act, thereby giving mandate to the ERB to regulate biofuels.

Biofuels standards ZS 706 and ZS 702 for ethanol and biodiesel respectively were promulgated by the Zambia Compulsory Standards Authority (ZCSA) allowing biofuels to be used as a fuel in Zambia.

In order to create a market for biofuels in Zambia, the Government has done the following:

- Pronounced that all biofuels of required standard for national blending will be purchased by the Government; and
- Pronounced the blending ratios for biodiesel (5%) and ethanol (10%).

It is envisaged that as a starting point and in order to assure quality control, blending of fuels meant for the Zambian market will be done at INDENI in Ndola and the Government depots. Furthermore, biofuels qualify for the agro-processing incentives under the Zambia Development Agency (ZDA) Act.

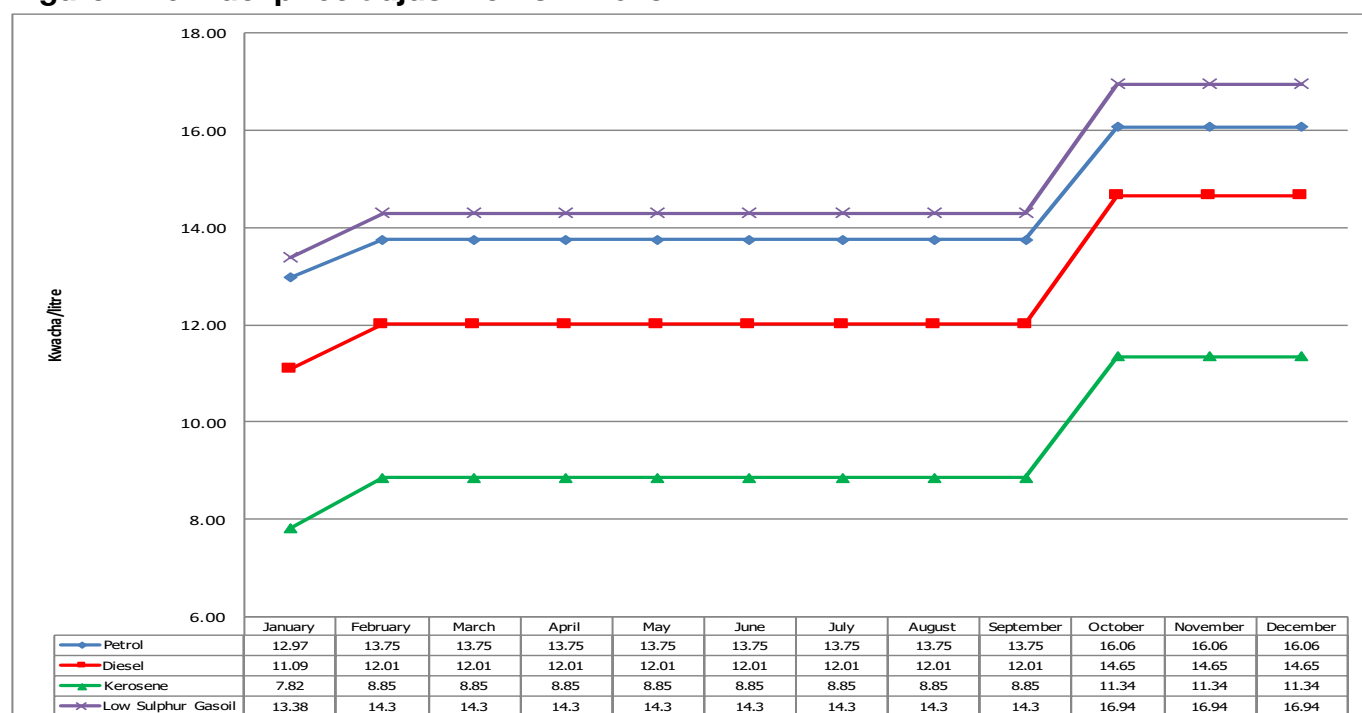
In 2018, following a stakeholder consultative meeting to discuss the proposed pricing framework for biofuel, it was resolved that a technical committee to deal with all issues requiring attention concerning the biofuels industry in Zambia be constituted. Thus, in 2018 a Committee was appointed by the Ministry of Energy (MoE).

## 2.8 Local and Regional Fuel Prices

### 2.8.1 National Fuel Pump Prices

In 2018, the ERB made two fuel price adjustments in February and October, respectively. Specifically, petrol, diesel and kerosene prices increased by 6.0, 8.3 and 13.2 percent, respectively in the February adjustment. In the October adjustment, the prices increased by 16.8, 22.0 and 28.1 percent, respectively. This is depicted in Figure 2-19.

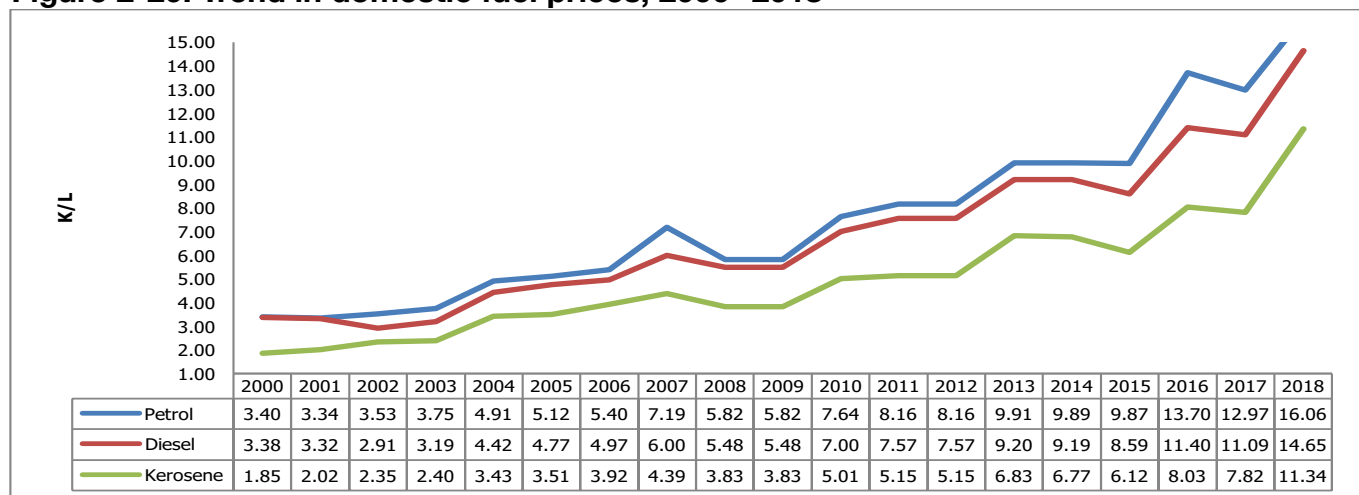
**Figure 2-19: Fuel price adjustments in 2018**



## 2.8.2 Trend in domestic fuel prices

Figure 2-20 shows the trend in the domestic pump prices of petrol, diesel and kerosene since 2000.

**Figure 2-20: Trend in domestic fuel prices, 2000 -2018**

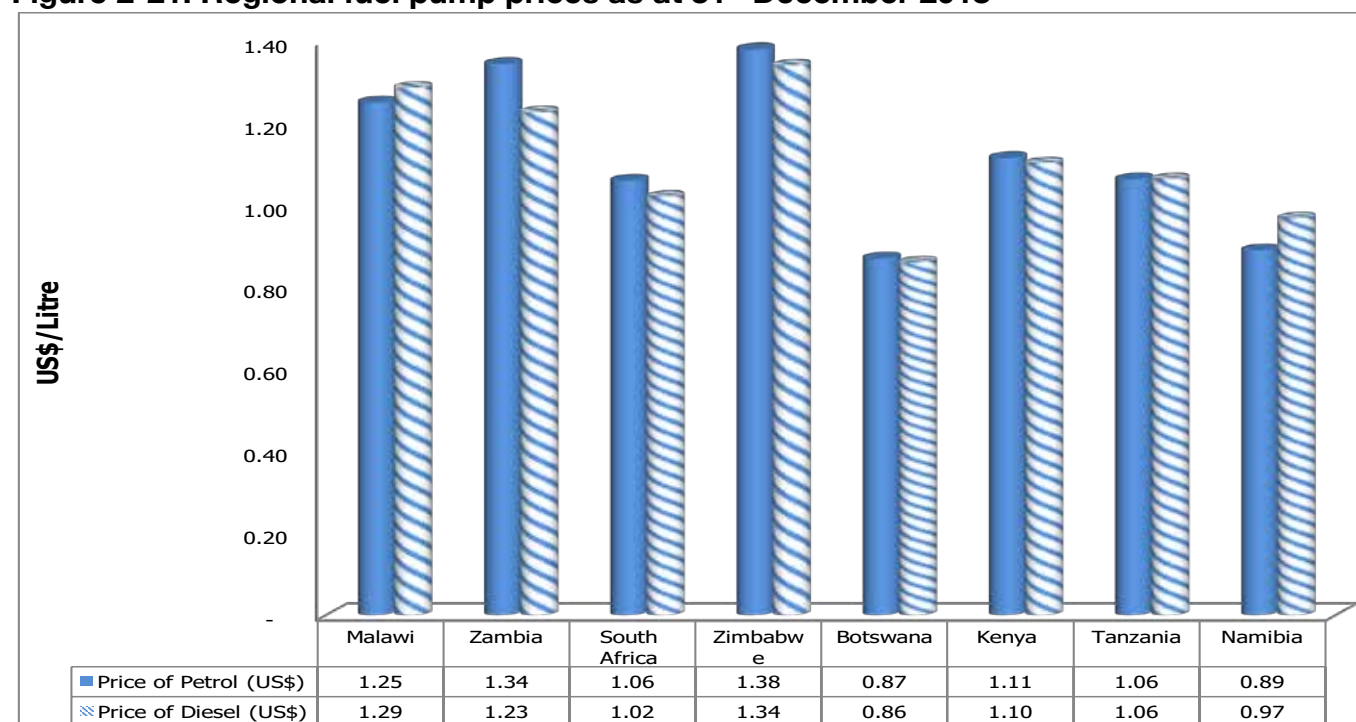


The nominal pump prices for the three products have generally been on the rise during the period 2000 to 2018. The price of petrol has been consistently higher than the price of the other two products. Between 2000 and 2018, the price of petrol had risen from K3.40 per litre in 2000 to K16.06 in 2018. Similarly, the price of diesel had risen from K3.38 per litre to K14.65 per litre, while that of kerosene had risen from K1.85 per litre to K11.34 per litre. The price adjustments have been inevitable because procurement of petroleum products is supposed to be self-financing and therefore fuel prices have to be cost reflective.

## 2.8.3 Regional Fuel Prices

Figure 2-21 shows the regional pump price comparison of petrol and diesel as at 31<sup>st</sup> December 2018 in selected African countries. Pump prices vary mainly on account of different factors including fiscal policy and different supply options among other factors.

**Figure 2-21: Regional fuel pump prices as at 31<sup>st</sup> December 2018**



Source: National Energy Regulators/Department of Energy websites

In terms of regional comparisons of fuel pump prices in selected African countries namely Malawi, Kenya, Namibia, South Africa, Tanzania, Zimbabwe and Zambia; Zimbabwe continued to exhibit the highest price of petrol, in the region, followed by Zambia, Malawi and Kenya. Similarly, diesel prices were highest in Zimbabwe followed by Malawi, Zambia, and Kenya. Meanwhile, Botswana recorded the lowest price for both petrol and diesel in the region at US\$ 0.87/litre and US\$0.86/litre respectively, as at 31<sup>st</sup> December 2018.

## **2.9 Audits of licensees in the petroleum sector**

In line with its mandate, the ERB monitors the performance and efficiency of the enterprises, having regard to the purposes for which they were established. In doing so, the ERB carries out technical and financial audits of petroleum infrastructure and performance of licensees in the sector. The scope includes compliance audits and grading of service stations; technical audits of TAZAMA and INDENI's KPIs; and compliance monitoring of petroleum products. This section discusses the various audit activities carried out under the petroleum sub-sector.

### **2.9.1 Technical audits of service station**

The technical audits are carried out on energy infrastructures to establish the level of compliance against relevant Zambian standards focusing on quality, safety and reliability of supply of energy products and services. The audit primarily focuses on compliance of the retail sites with the requirements stipulated in the following Zambian petroleum industry standards:

- ♦ **ZS 385 Part 2: Electrical installations in the distribution and marketing sector;**
- ♦ **ZS 385 Part 3: The installation of underground storage tanks, pumps dispensers and pipework at service stations and consumer installations; and**
- ♦ **ZS 703 – Rural Filling Stations: Code of Practice.**

During the period under review, the ERB undertook countrywide random initial and verification compliance inspections of operational service stations. Initial compliance inspections are conducted to ascertain the compliance level of service stations and identify the emerging issues in the first quarter of every year, while verification inspections are carried out to verify whether the emerging issues identified in the initial inspections had been addressed. The inspections were conducted to evaluate performance against the set Zambian Standards, licence conditions and Board Orders. During the period under review, the ERB conducted technical inspections of 258 service stations country wide. The overall technical compliance was found to be 88.8 percent against the target of 87 percent for the year 2018.

See Appendix 3 for Retail Sites Inspection Routine Checklist with scoring criteria.

### **2.9.2 Infrastructure Grading of service stations**

Infrastructure grading of service stations is a system that is used to inform all stakeholders (especially consumers) of the state of infrastructure (in terms of reliability and safety) at the service stations. It is also used as a tool to motivate the licensees to improve the state of infrastructure at their respective service stations. The grading of service stations involves administration of two checklists, that is, one focusing on technical compliance, while the other focuses on addressing service level to consumers. During the year 2018, no grading of service stations was carried out as the grading system was undergoing revision following stakeholder feedback.

### **2.9.3 Petroleum Product Quality Assessment**

Petroleum product quality assessments are conducted in order to ensure that the quality of fuel reaching the consumers is of acceptable quality as mandated in the Quality Control and Monitoring Guidelines for the Zambian Petroleum Fuel Industry.



In order to ensure the provision of quality, reliable and affordable services and products, the ERB set an overall compliance target of more than 95 percent to petroleum products quality standards by end of the 7<sup>th</sup> Strategic Business Plan (SBP) for the period 2018 – 2022. A baseline of 93 percent compliance for petroleum product quality was set for 2018 and increasing progressively to 94 percent in 2019, 95 percent in 2020 and greater than 95 percent in 2021.

During the period under review, 223 samples were collected from 14 various bulk fuel storage depots throughout the country for analysis. The laboratory analysis revealed an average overall product quality compliance of 95.2 percent which was above the set baseline of 93 percent compliance to petroleum quality standards for year one of the 2018-2021 ERB SBP.

#### 2.9.4 Technical KPIs for TAZAMA

TAZAMA is responsible for operating the oil pipeline from Dar-es-Salaam, Tanzania to Ndola, Zambia. In this regard, the technical KPIs performance for TAZAMA were benchmarked against the operation of the pipeline. Table 2-5 shows TAZAMA's performance on technical KPIs in 2018.

**Table 2-5: TAZAMA's performance on technical KPIs, 2018**

| Indicator                                | Performance | KPI Target | Comments     |
|--|-------------|------------|--------------|
| Throughput (MT)                          | 629,394     | 650,000    | Not achieved |
| Operational days                         | 295         | 315/365    | Not achieved |
| Pumping rate ( M <sup>3</sup> /Hr)       | 109         | 105        | Achieved     |
| Consumption and Loss (%)                 | 0.99        | 1.2        | Achieved     |
| No. of incidents: Safety and Environment | 14          | 0          | Not achieved |

#### 2.9.5. Financial KPI Audits - TAZAMA

In 2018, audits were conducted on two financial KPIs for TAZAMA. Table 2-6 shows TAZAMA's financial KPI performance for 2018.

**Table 2-6: TAZAMA's financial KPI performance, 2018**

| Indicator     | KPI Target | Score | Comment      |
|---------------|------------|-------|--------------|
| Current Ratio | 1.2        | 12.1  | Achieved     |
| Debtor Days   | 15         | 38    | Not achieved |

TAZAMA achieved the target for the current ratio but did not achieve the target for debtor days.

#### 2.9.6 INDENI Technical KPIs

INDENI processes petroleum feedstock which is pumped to the refinery by TAZAMA. In this regard, the technical KPIs performance for INDENI were benchmarked against the operation of the refinery. Table 2-7 shows a summary of technical findings for the KPIs.

**Table 2-7:INDENI's performance on technical KPIs, 2018**

| Indicator   | Cumulative Performance | KPI Target | Comment       |
|---|------------------------|------------|---------------|
| Throughput (MT)                                   | 646,901                | 700,000    | Not achieved  |
| Operational days                                  | 293                    | 315/365    | Not achieved  |
| Consumption and Loss (%)                          | 8.44                   | 8.5        | Achieved      |
| Quality compliance for Refined petroleum products | 100                    | 100        | Achieved      |
| Safety & Environment                              | 19                     | 0          | Not achieved: |

### 2.9.7 Financial KPI Audits INDENI

In 2018, audits were conducted on two financial KPIs for INDENI. Table 2-8 shows the financial KPI performance of INDENI.

**Table 2-8: INDENI's Performance on Financial KPI's**

| No. | Indicator     | KPI Target | Score | Comment      |
|-----|---------------|------------|-------|--------------|
| 1   | Current Ratio | 1          | 4     | Achieved     |
| 2   | Debtor Days   | 15         | 46    | Not achieved |

INDENI achieved the target for the current ratio but did not achieve the target for debtor days.

### 2.9.8 Tazama Petroleum Products Limited - Technical KPIs

TAZAMA Petroleum Products Limited (TPPL) a subsidiary of TAZAMA is responsible for storage, management of Government depots and distribution of petroleum products through OMCs. Table 2-9 shows a summary of technical findings for the KPIs.

**Table 2-9: TAZAMA Petroleum Products Limited Performance on technical KPIs, 2018**

| Indicator                                | Cumulative Performance |         | KPI Target            | Comments |
|--|------------------------|---------|-----------------------|----------|
| Throughput (MT)                          | Diesel                 | 803,570 | KPI under formulation |          |
|  | Petrol                 | 437,974 |                       |          |
|  | kerosene               | 23,874  |                       |          |
| Consumption and Loss (%)                 | Diesel                 | 0.21    | 0.3                   | Achieved |
|  | Petrol                 | 0.33    | 0.5                   | Achieved |
|  | kerosene               | 0.08    | 0.3                   | Achieved |
| No. of incidents: Safety and Environment | 0                      |         | 0                     | Achieved |

### 2.9.9 TAZAMA Petroleum Products Limited – Financial KPIs

In 2018, audits were conducted on four financial KPIs for TPPL. Table 2-10 shows the financial KPI performance of TPPL.

**Table 2-10: Financial KPI performance of TPPL, 2018**

| Indicator      | KPI Target | Score   | Comment      |
|----------------|------------|---------|--------------|
| Asset Turnover | 2          | 0.43    | Not Achieved |
| Current Ratio  | 1.2        | 0.77    | Not Achieved |
| Debtor Days    | 30 days    | 0 days  | Achieved     |
| Creditor days  | 90 days    | 50 days | Achieved     |

TPPL achieved the targets for debtor days and creditor days, while the company failed to achieve the targets for asset turnover and current ratio.

## 2.9.10 Government owned storage depots for white products



### TPPL Solwezi fuel depot

In 2018 Government commenced the second phase of the construction of fuel depots in Mansa, Chipata, Kabwe and Choma. Table 2-11 shows the summary and status of the fuel depots to be constructed.

**Table 2-11: Status of the construction of GRZ owned storage depots for white products as at 31<sup>st</sup> December, 2018**

| No. | Fuel Storage Depot | Estimated Cost US\$' million | Status  |
|-----|--------------------|------------------------------|---|
| 1.  | Mansa Fuel Depot   | 33.45                        | <ul style="list-style-type: none"> <li>Progress of the development of the Mansa Depot was at 55 percent by the close of December 2018. The depot will store 4 million litres of diesel, 2 million litres of petrol and 0.5 million litres of kerosene</li> <li>The depot is expected to be completed and commissioned in 2019.</li> </ul>   |
| 2.  | Chipata Fuel Depot | 7.5                          | <ul style="list-style-type: none"> <li>The capacity of the depot will be 7.0 million litres with the following breakdown: 4 million litres Diesel; 2 million litres Petrol; 0.5 million litres Kerosene; and 0.5 million litres Jet A-1.</li> <li>Construction works were underway during the period under review and are expected to be completed and commissioned in 2019.</li> </ul> |
| 3.  | Kabwe Fuel Depot   | Yet to be established        | <ul style="list-style-type: none"> <li>Land for the Kabwe Fuel Depot was identified works are expected to commence in 2019.</li> </ul>  |
| 4.  | Choma Fuel Depot   | Yet to be established        | <ul style="list-style-type: none"> <li>The fuel depot is expected to have a total capacity of 6.5 million litres.</li> </ul>  |

## 2.9.11 Development of Technical standards for petroleum tankers

During the period under review, the following standards were finalised and submitted to Zambia Bureau of Standards (ZABS) for publication:

- i) **DZS 371: ROAD TANK VEHICLES FOR PETROLEUM-BASED FLAMMABLE LIQUIDS – Specification; and**
- ii) **DZS 372: TRANSPORTATION OF PETROLEUM PRODUCTS: Operational Requirements for Road Tank Vehicles – Code of Practice**

Further, eight standards were revised to match the technological advancement in the petroleum sub-sector. The review of the standards was also triggered by the five year period which had elapsed from the date of promulgation based on ZABS procedures. The eight standards are tabulated in the Table 2-12.

**Table 2-12: Revised standards in the petroleum sub-sector, 2018**

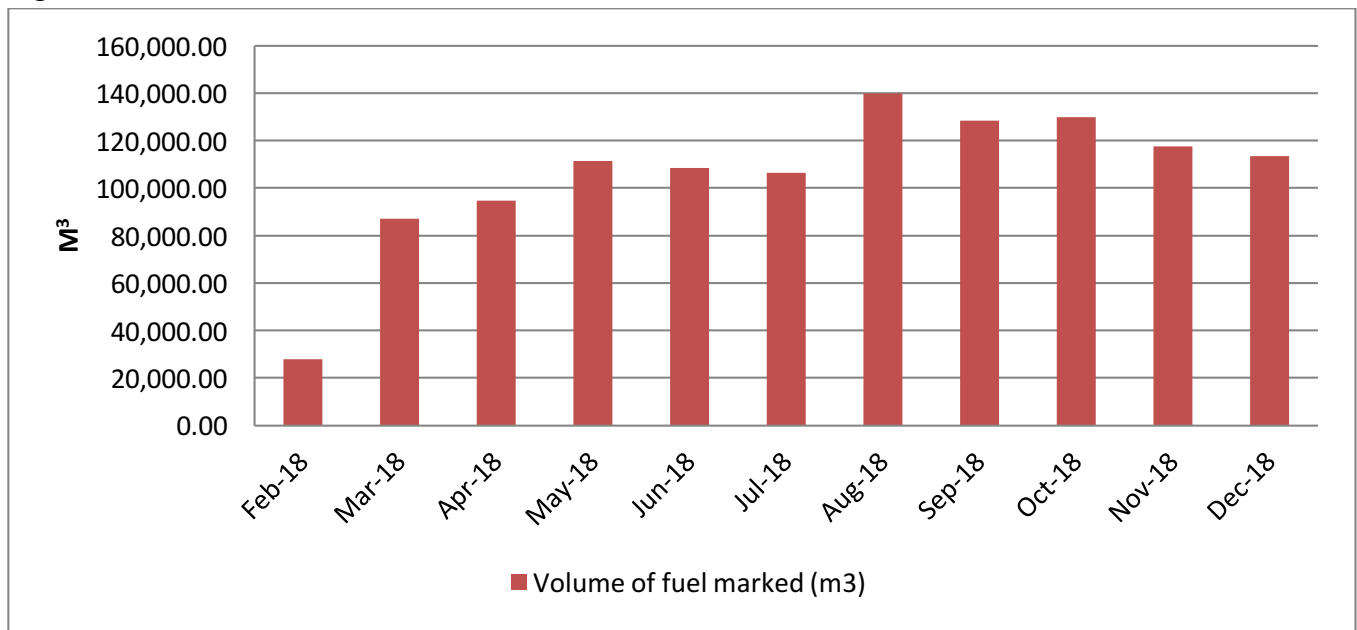
| No. | Code    | Name of Standard  | Standard Use  |
|-----|---------|---|---|
| 1   | DZS 395 | UNLEADED PETROL (GASOLINE) FOR MOTOR VEHICLES –Specification  | This Zambian Standard specifies requirements for Unleaded Petrol (gasoline) for Motor Vehicles  |
| 2   | DZS 369 | AUTOMOTIVE GAS OIL (DIESEL FUEL)-Specification  | This is also known as diesel and is used to efficiently power internal combustion diesel engines. This Standard addresses requirements and methods of sampling and testing for Automotive Gas Oil                   |
| 3   | DZS 426 | LIQUEFIED PETROLEUM GAS – Specification   | The petroleum gas mixture is intended primarily for use as fuel in domestic, commercial and industrial installations where a fuel volatility between that of commercial propane and commercial butane is acceptable |
| 4   | DZS 718 | Low Sulphur Gasoil (LSG) – Specification  | This a diesel fuel with substantially lowered sulphur content. The standard alleviates some of the pressure placed on the environment through lower sulphur dioxide emissions                                       |
| 5   | DZS 394 | AVIATION TURBINE FUEL – Specification for Jet A-1   | This Zambian Standard addresses requirements for Aviation Turbine Fuel, Jet A-1 in particular   |
| 6   | DZS 380 | ILLUMINATING KEROSENE – Specification   | The standard addresses requirements for Illuminating Kerosene for both domestic and industrial application.   |
| 7   | DZS 396 | SAMPLING PETROLEUM PRODUCTS :Part 1: Manual sampling of liquid hydrocarbons                           | This standard addresses the procedures to be used for obtaining, by manual methods, samples of liquid hydrocarbons  |
| 8   | DZS 422 | BITUMENS FOR BUILDING AND CIVIL ENGINEERING<br><br>PART 1: PENETRATION GRADE BITUMENS – Specification | This Zambian standard addresses the requirements for penetration grade bitumens which are suitable for use in road construction in Zambia   |

### 2.9.12 Fuel marking programme

Fuel marking is the process of adding a unique identifier (bio-chemical substance) in trace quantities into petroleum products before distribution to the market. The marker provides a secure, tamper-proof method of authentication. In Zambia, the marking programme commenced in February 2018 following promulgation of the Energy Regulation (Fuel Marking and Monitoring) Regulations, Statutory Instrument No. 69 of 2017. The main objectives of the programme are:

- To curb adulteration of petroleum products;
- To level the playing field for all industry players in the petroleum sub-sector by detecting and curbing smuggling of petroleum products;
- To guarantee maximum revenue for the Government; and
- To improve the quality of petroleum products.

With effect from February 2018, the ERB commenced marking of all product uplifted from all Government depots operated by TPPL. Marking of fuel was also undertaken at a number of OMC operated depots as and when the need arose. Beyond March 2018, all fuel supplied from TPPL was marked. Figure 2-22 shows the volume of fuel marked in 2018.

**Figure 2-22: Volume of Fuel Marked in 2018**

In June 2018, the ERB in collaboration with a contractor conducted baseline random sampling and testing of mainly retail sites. The exercise was aimed at ascertaining whether the marker had penetrated the entire supply chain in order for the ERB to commence field monitoring and enforcement activities. Analysis of the laboratory results following the discreet sampling and testing revealed the following:

- The marker concentration in the chain had reached optimal levels;
- A failure rate of 21 percent in the retail network, an indication of illicit activities; and
- 83 percent of the failed samples were along the North – South corridor i.e. Livingstone Chirundu to Chililabombwe where transit fuel is mainly moved.

With this background, the ERB commenced field monitoring activities in September 2018. A summary of the findings of the monitoring exercises conducted is contained in the Table 2-13:

**Table 2-13: Findings of fuel marking monitoring exercise**

| Month                              | Sep-18     | Oct-18     | Nov-18     | Dec-18     | Total      |
|------------------------------------|------------|------------|------------|------------|------------|
| Number of site visits              | 57         | 60         | 108        | 100        | 325        |
| Total number of samples tested     | 161        | 152        | 315        | 296        | 924        |
| Number of samples passed           | 144        | 143        | 293        | 280        | 860        |
| Number of suspect samples          | 6          | 7          | 9          | 4          | 26         |
| Number of failed field samples     | 11         | 2          | 13         | 12         | 38         |
| Number of confirmed Failed samples | 11         | 9          | 15         | 8          | 42         |
| Failure rate (%)                   | <b>6.8</b> | <b>5.9</b> | <b>4.8</b> | <b>2.4</b> | <b>4.5</b> |

The failed samples were recommended for technical hearings. In addition to the field monitoring and testing, the ERB also handled a number of cases referred to it by Law Enforcement Agencies involving illegal fuel vending.

## **2.10 Challenges in the petroleum sub-sector**

### **a. Illegal fuel vending**

Illegal fuel vending continued to pose a challenge for the petroleum sub-sector in 2018. Through the on-going fuel marking programme, it was established that there had been illegal fuel dumping and adulteration in Zambia. Specifically, as of September, 2018, the key results of the sampling and testing revealed the following:

- i. There was high level of fiscal tax avoidance through dilution of domestic products with unmarked products and kerosene; and
- ii. Fuel adulteration was rampant along the North-South transit corridor, particularly the Livingstone to the Copperbelt.

### **b. Concentration of service stations in urban areas**

The lack of adequate service stations in some rural areas led to illegal fuel vending and consequently safety concerns.

## **2.11 Outlook for the sub-sector**

### **Import Parity Pricing Framework for Jet A-1**

Following representations by stakeholders in the airline industry, the ERB in 2018 approved the use of a market based pricing formula, Import Parity Pricing (IPP) for Jet A-1 as an alternative to the CPM. The IPP will peg prices to international benchmark prices for imported goods and therefore promote price efficiency in the supply chain. Unlike the CPM, the IPP will be reviewed on monthly basis. The IPP framework will be operationalised in 2019.

## 3.0 ELECTRICITY SUB-SECTOR

This section discusses Zambia's electricity sub-sector. In particular, the section discusses the installed capacity, power generation by ZESCO, Independent Power Producers (IPPs), Operational performance of utilities, consumption by different economic sectors, power exports and imports, new developments, challenges and outlook for the sub-sector.

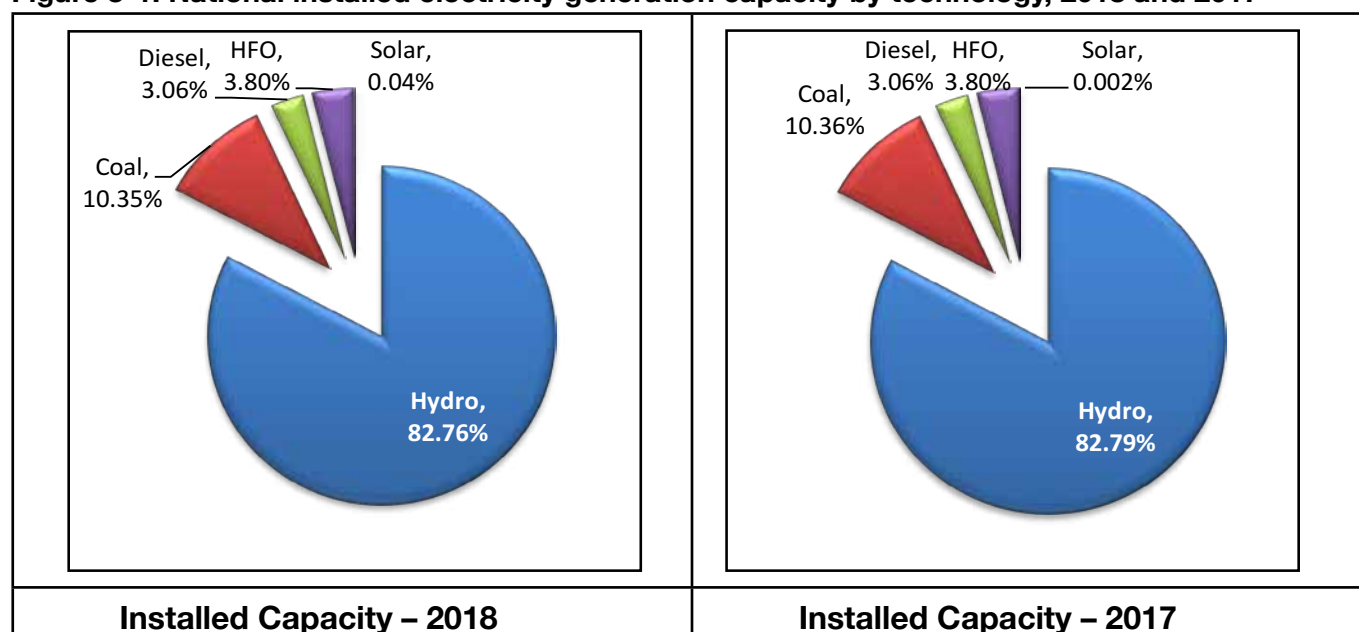
### 3.1 Zambia's installed electricity generation capacity

In 2018, Zambia's electricity generation mix continued to significantly rely on hydro power accounting for 82.76 percent of total installed generation capacity. The remainder of the generation mix was made up of coal (10.35%); HFO (3.80%); diesel (3.06%); and solar (0.04%). The hydro generation mix comprised of large, small and mini power generation stations<sup>18</sup>. ZESCO owned the bulk of the generation stations, while the rest were owned by IPPs. See Appendix 4 for the structure of the Electricity Supply Industry (ESI) in Zambia.

The national installed capacity increased by 0.05 percent to 2,898.23 MW in 2018, from 2,896.91 MW in 2017 (see Appendix 5). The increase was due to the new CEC's Kitwe-Riverside 1 MW grid connected Solar Plant, Muhanya Solar's Sinda Village 0.03 MW (Sinda District) and Standard Micro Grid's Mugurameno Village 0.01 MW (Chirundu District) Solar mini-grids.

Figure 3-1 compares the contribution of each generation technology in 2018 and 2017. Notably, there has not been much change in the proportions except for Solar which grew to 0.04 percent.

**Figure 3-1: National installed electricity generation capacity by technology, 2018 and 2017**



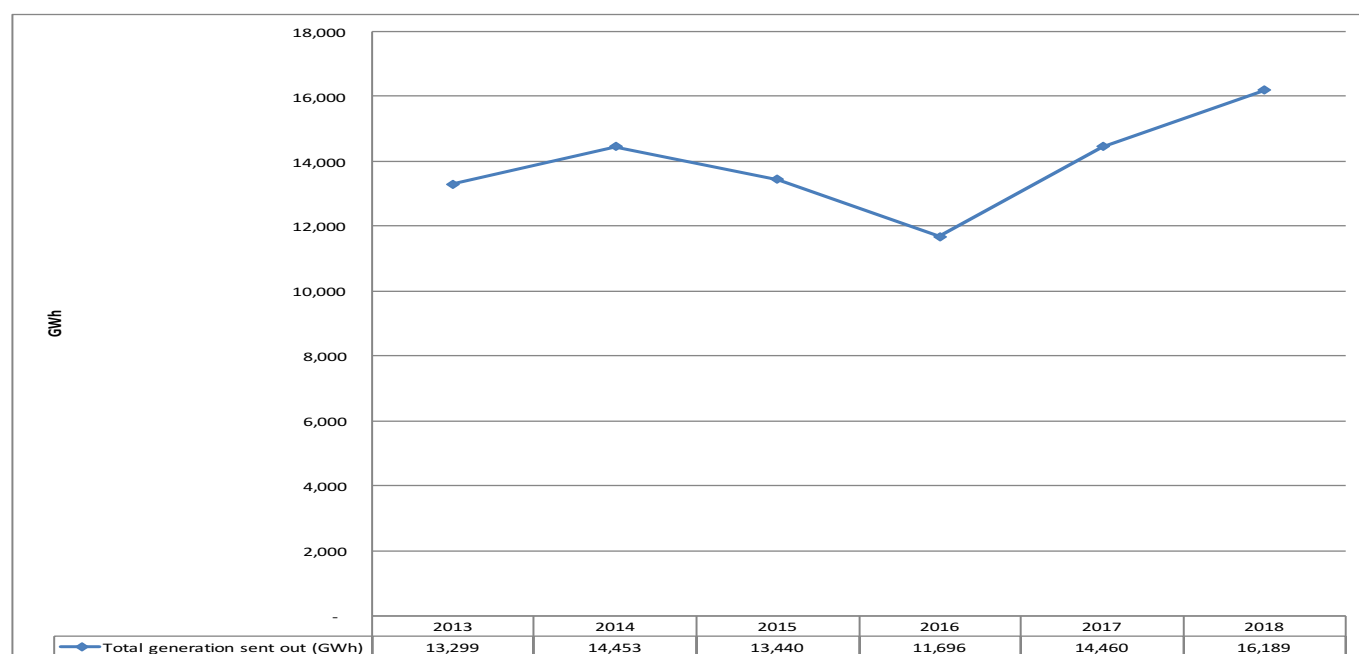
### 3.2 National electricity generation

In 2018, national electricity generation sent out increased by 12 percent to 16,189 GWh from 14,460<sup>19</sup> GWh recorded in 2017, this was mainly on account of uprating of Musonda falls power station. Figure 3-2 shows the trend in national electricity generation from 2013 to 2018.

<sup>18</sup> For this report, large power stations have a generating capacity of over 20 megawatts, while small power stations have a generation capacity of between 1 megawatt and 20 megawatts and mini hydro power stations have generation capacity of less than 1 megawatt.

<sup>19</sup> Revised after post reconciliation

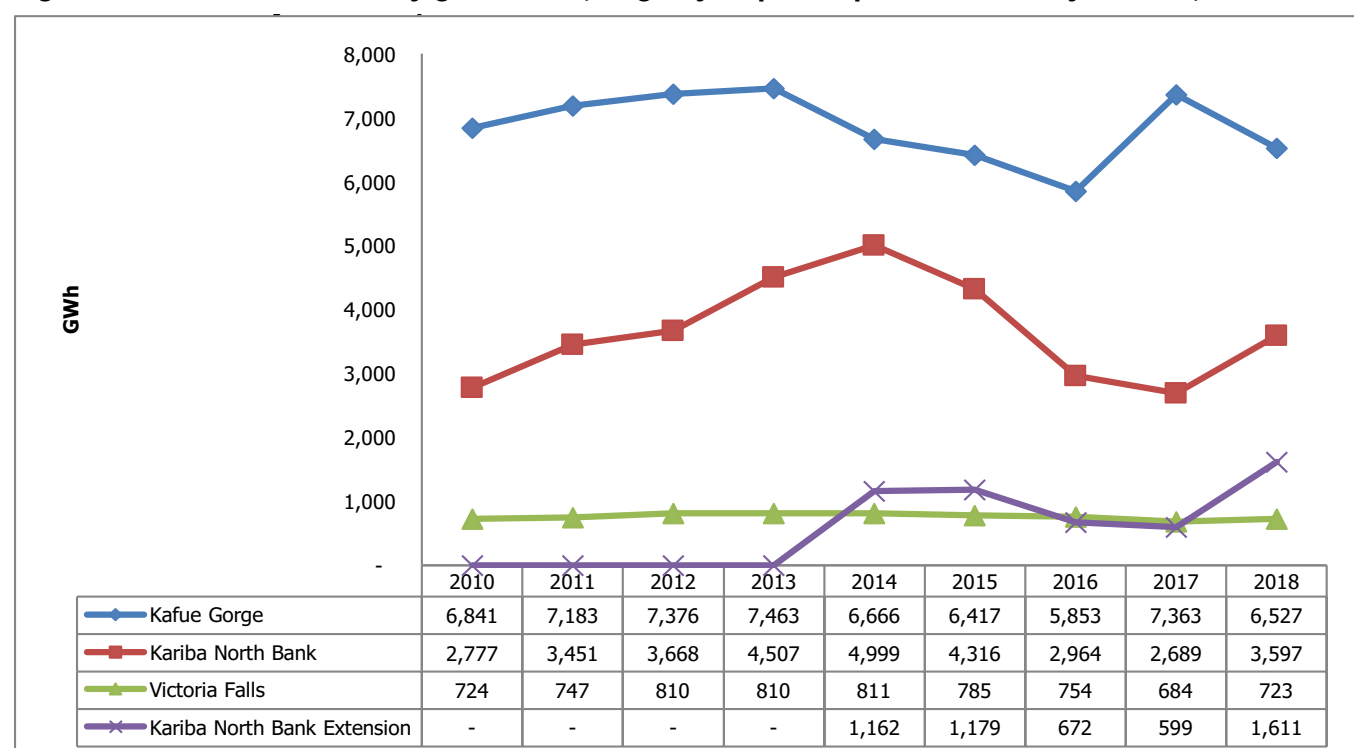


**Figure 3-2: Trend in national electricity generation, 2013 – 2018**

Generally, Zambia's power generation has increased on account of expansion in the installed power generation capacity. The increase in generation in 2018 is attributed to the uprating of Musonda Falls Power Station from 5 MW to 10 MW installed power generation capacity and increased generation at Kariba North Bank Extension (KNBE). Despite this overall growth in generation, the country, however, experienced a reduction in 2015 and 2016 on account of the low water levels.

### 3.3 Electricity generation from large hydro power plants owned by ZESCO

As at 31<sup>st</sup> December 2018, ZESCO owned four (4) large hydro power plants; Kafue Gorge (990 MW), Kariba North Bank (720 MW), KNBE (360 MW), and Victoria Falls (108 MW). Figure 3-3 shows the trend in electricity generation from ZESCO's large hydro power plants for the period 2010 to 2018.

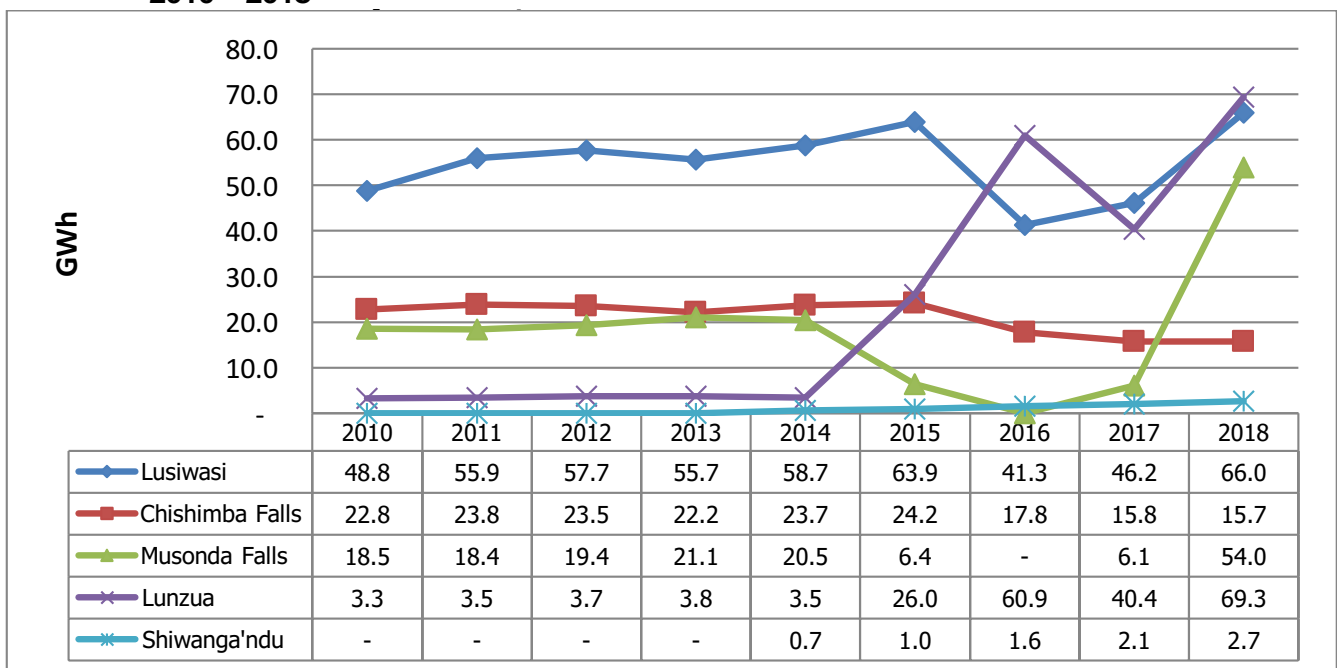
**Figure 3-3: Trend in electricity generation, large hydropower plants owned by ZESCO, 2010 - 2018**

During the year under review, electricity generation from ZESCO's large hydro power plants increased by 9.9 percent from 11,335 GWh in 2017 to 12,458 GWh in 2018. This was mainly attributed to the increase in generation from KNBE power station. KNBE power station was designed as a peaking plant to run when there is high demand for power. However, due to the shut-down of some generation units at Kafue Gorge power station to facilitate maintenance, the station was requested to ramp-up production resulting in the observed increase in electricity generation during the period under review.

### 3.4 Electricity generation from small and mini-hydropower plants owned by ZESCO

In 2018, total electricity generation from small and mini hydro plants owned by ZESCO increased significantly by 87.9 percent to 207.7 GWh in 2018 from 110.6 GWh in 2017. The observed increase in generation sent out was mainly from Musonda Falls which underwent an uprating and produced 54.0 GWh in 2018 compared to 6.1 GWh during the test runs in 2017. Figure 3-4 shows electricity generation sent out from small and mini hydro power plants owned by ZESCO for the period 2010 to 2018.

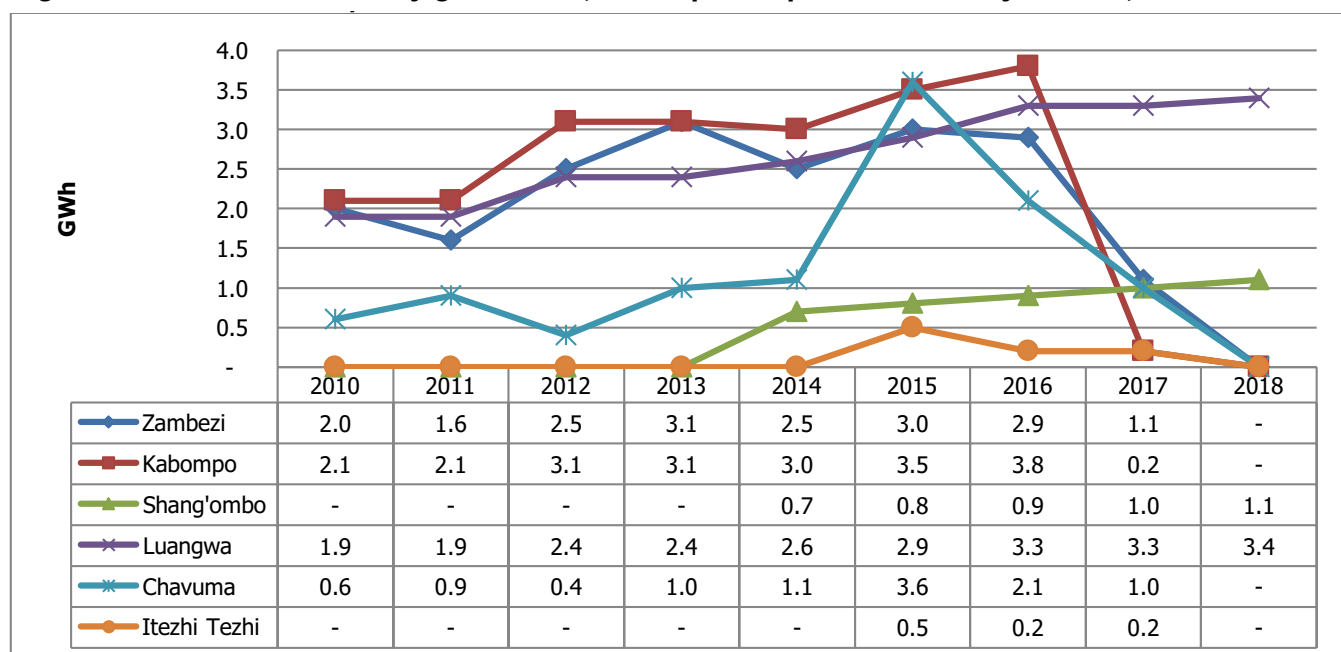
**Figure 3-4: Trend in electricity generation, small and mini-hydropower plants owned by ZESCO, 2010 – 2018**



### 3.5 Electricity generation from diesel power plants owned by ZESCO

In 2018, total generation from ZESCO's diesel power plants decreased by 48.8 percent from a total of 8.79 GWh in 2017 to 4.5 GWh in 2018, as depicted in Figure 3-5.

**Figure 3-5: Trend in electricity generation, diesel power plants owned by ZESCO, 2010 – 2018**

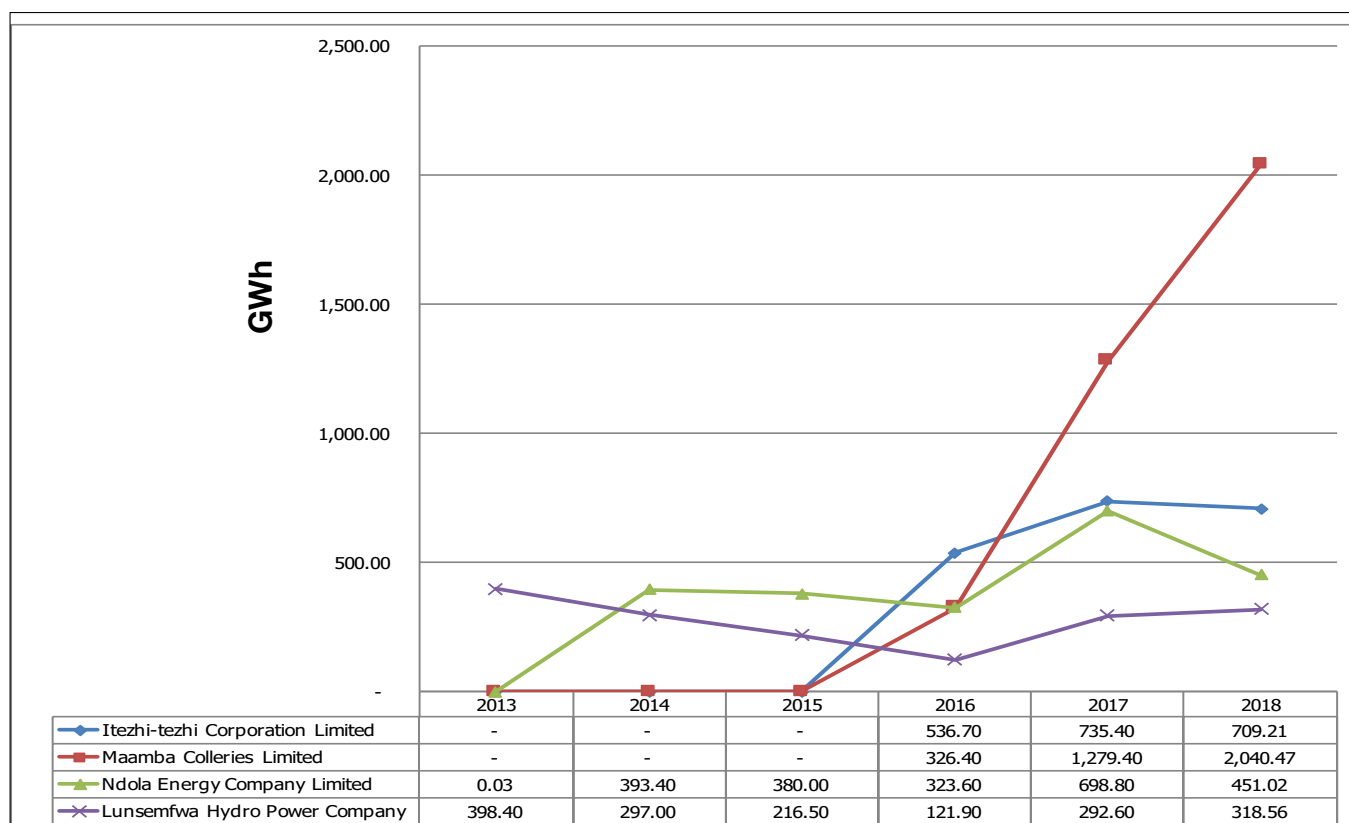


The decrease in generation from diesel power plants was on account of all Districts in North-Western province being connected to the national electricity grid. As shown in Figure 3-5, only two Districts that is Shang'ombo and Luangwa ran on diesel power in 2018.

### 3.6 Electricity generation from Independent Power Producers

In 2018, the ESI had five (5) IPP's namely: Lunsemfwa Hydro Power Company (LHPC), Ndola Energy Company Limited (NECL), Maamba Collieries Limited (MCL), Itezhi-Tezhi Power Corporation (ITPC) and Zengamina Power Limited (ZPL). Figure 3-6 shows the trend in electricity generation sent out by the IPP's for the period 2013 to 2018.

**Figure 3-6: Trend in electricity generation sent out by IPPs, 2013 – 2018**

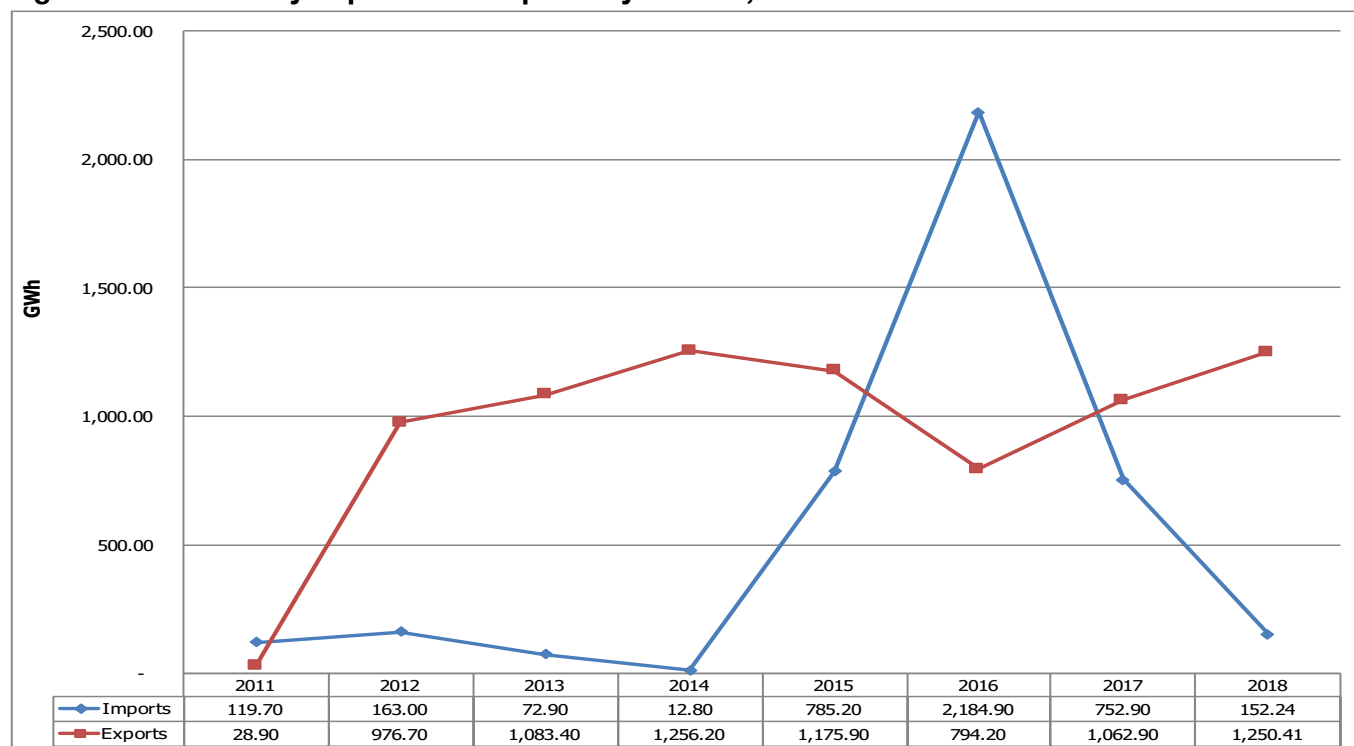


Electricity generation from IPP's increased by 17.1 percent to 3,519.26GWh in 2018 from 3,006.3 GWh in 2017. Specifically, MCL increased its generation by 59.5 percent to 2,040.5 in 2018 from 1,279.4 GWh in 2017. Notably, MCL operated at full capacity in 2018. Meanwhile, LHPC also recorded an increase in power generation of 8.9 percent to 318.6 GWh in 2018 from 292.6 GWh recorded in 2017, mainly on account of improved hydrological conditions. However, NECL and ITPC recorded reductions in the power generation during the year under review of 35.5 percent and 3.6 percent, respectively. The reduction in power generation from NECL was attributed to supply constraints of HFO from the source, INDENI.

### 3.7 Electricity exports and imports by ZESCO

ZESCO is a member of the Southern African Power Pool (SAPP) and engages in power trading in order to balance the supply and demand on its network. Further, it is also committed to various trade protocols, such as Power Purchase Agreements/Power Supply Agreements (PPA/PSA) that obligates the utility to export and import as the case may be. In 2018, ZESCO exported and imported electricity through the SAPP and bilateral markets. Figure 3-7 shows electricity exports and imports by ZESCO for the period 2011 to 2018.

**Figure 3-7: Electricity imports and exports by ZESCO, 2011 – 2018**



ZESCO recorded an increase in electricity exports in the SAPP Market by 15.3 percent from 1,062.9 GWh in 2017 to 1,225.5 GWh in 2018. The increase was mainly due to enhanced generation during the period under review. This also resulted into a significant decline in imports by 79.8 percent from 752.9 GWh in 2017 to 152.2 GWh in 2018 in the SAPP market..

### 3.8 National electricity consumption by economic sector

In 2018, the national electricity consumption increased from 12,192.0 GWh in 2017 to 13,080.1 GWh reflecting a 7.3 percent growth. The mining customers continued to consume the bulk of power followed by the domestic customers. Table 3-1 depicts the national electricity consumption by economic sector in 2018 and 2017.

**Table 3-1: National Electricity consumption by economic sector, 2018 – 2017**

| Ranking | Sector               | 2018     | 2017     | Movement in GWh | 2018              | 2017 |
|---------|----------------------|----------|----------|-----------------|-------------------|------|
|         |                      | in GWh   |          |                 | Proportion in (%) |      |
| 1       | Mining               | 6,681.9  | 6,202.0  | 479.9           | 51.1              | 50.9 |
| 2       | Domestic             | 4,336.9  | 4,146.9  | 190.0           | 33.2              | 34.0 |
| 3       | Finance and property | 713.9    | 640.0    | 73.90           | 5.5               | 5.2  |
| 4       | Manufacturing        | 593.1    | 503.4    | 89.70           | 4.5               | 4.1  |
| 5       | Agriculture          | 297.0    | 261.5    | 35.5            | 2.3               | 2.1  |
| 6       | Quarrying            | 147.6    | 118.2    | 29.4            | 1.1               | 1.0  |
| 7       | Trade                | 113.8    | 110.2    | 3.60            | 0.9               | 0.9  |
| 8       | Others               | 84.1     | 87.3     | (3.2)           | 0.6               | 0.7  |
| 9       | Energy and water     | 68.5     | 80.9     | (12.4)          | 0.5               | 0.7  |
| 10      | Transport            | 32.5     | 32.0     | 0.5             | 0.2               | 0.3  |
| 11      | Construction         | 10.8     | 9.6      | 1.2             | 0.1               | 0.1  |
|         | Total                | 13,080.1 | 12,192.0 | 888.1           | 100               | 100  |

The mining sector dominated the national consumption of electricity with a total consumption of 6,681.9 GWh representing 51.1 percent of the total national consumption. Domestic customers accounted for 33.2 percent of national consumption. The domestic customers share declined slightly from the prior year due to the increase in the consumption shares of other sectors.

### 3.9 Operational performance of utilities

#### 3.9.1 ZESCO Limited

As one of its core functions, the ERB monitors ZESCO's performance using the Key Performance Indicators (KPIs) framework. The objective of the framework is to evaluate ZESCO's performance with regard to efficiency in customer service, quality of service, financial management, commercial and technical operations. The framework is reviewed every three years. The current framework covers the period January 2017 to December 2019 and comprises nine (9) thematic areas. Table 3-2 shows specific KPIs and the assigned weighted scores.

**Table 3-2: ZESCO's KPI framework 2017 - 2019**

| No                                       | Key performance indicator | Assigned weight (%) |
|--|---------------------------|---------------------|
| 1.                                       | Metering Customers        | 10%                 |
| 2.                                       | Cash Management           | 20%                 |
| 3.                                       | Staff Productivity        | 15%                 |
| 4.                                       | Quality of Service Supply | 20%                 |
| 5.                                       | System Losses             | 10%                 |
| 6.                                       | Power Generation          | 10%                 |
| 7.                                       | Safety                    | 5%                  |
| 8.                                       | Customer Complaints       | 5%                  |
| 9.                                       | Equipment Failure         | 5%                  |
| <b>Total</b>                             |                           | <b>100%</b>         |
| <b>Minimum mandatory benchmark score</b> |                           | <b>75%</b>          |

The framework is an incentive based mechanism that links rewards to desired results or targets to be achieved within a given time. The Utility is awarded a tariff adjustment commensurate with its performance on the KPIs as indicated in Table 3-3.

**Table 3-3: Tariff award rules 2017 – 2019**

| No. | Attained KPI score       | Tariff awarded based on ERB computed adjustment |
|-----|--------------------------|---|
| 1   | 0 – 25%                  | 25%   |
| 2   | Above 25 – but up to 50% | 50%   |
| 3   | Above 50 – but up to 75% | 75%   |
| 4   | Above 75%                | 100%  |

This type of regulation gives utilities better incentives to reduce costs and/or improve the provision of services. In developing performance targets, the framework puts emphasis on those areas where cost savings may be realised and quality may be improved. Under the current framework the ERB has set a mandatory minimum score of 75 percent. Failure to meet the minimum benchmark score results in enforcement action being undertaken by the Board.

ZESCO is required to provide performance data to the ERB on a quarterly basis in a standardised excel spreadsheet to allow for consistency in data capturing and computation. The ERB reviews the reports by ZESCO for consistency, accuracy and completeness. The ERB also conducts periodic audits to validate the data.

During the review of the framework, the following are considered:

- The extent to which ZESCO has achieved the targets under the on-going framework;
- Relevance of the specific KPIs in addressing ZESCO's operational problems, consumer concerns as well as strategic challenges;
- Significance of the KPI in addressing consumer expectations;
- Significance and relevance in adhering to ERB Licence Conditions;
- Relevance of the KPI in achieving Government policy objectives;
- Significance of the KPI in achieving ERB strategic goals; and
- The KPIs should be SMART (Specific, Measurable, Achievable, Realistic and Time Bound).

During the period under review, the utility attained a consolidated annual average KPI score of 69 percent compared to 63 percent attained in 2017. ZESCO performed well in the customer metering, staff productivity, system losses, power generation and customer complaints resolution indicators. However, the utility did not perform well in the quality of service supply, safety and cash management. The detailed description of the current KPI framework is provided in Appendix 6.

Furthermore, table 3-4 compares ZESCO's annual performance on each indicator for the 2017 and 2018.

**Table 3-4: ZESCO's summary of KPI performance, 2017 - 2018**

| No.                | Indicator                 | Assigned Weight | Attained Annual Average Score |            |
|--------------------|---------------------------|-----------------|-------------------------------|------------|
|                    |                           |                 | 2017                          | 2018       |
| 1                  | Metering Customers        | 10%             | 10%                           | 5%         |
| 2                  | Cash Management           | 20%             | 6%                            | 7%         |
| 3                  | Staff Productivity        | 15%             | 14%                           | 15%        |
| 4                  | Quality of Service Supply | 20%             | 10%                           | 13%        |
| 5                  | System Losses             | 10%             | 5%                            | 9%         |
| 6                  | Power Generation          | 10%             | 10%                           | 10%        |
| 7                  | Safety                    | 5%              | 0%                            | 1%         |
| 8                  | Customer Complaints       | 5%              | 5%                            | 5%         |
| 9                  | Equipment Failure         | 5%              | 3%                            | 4%         |
| <b>Total Score</b> |                           | <b>100%</b>     | <b>63%</b>                    | <b>69%</b> |

## Technical Performance

Periodically, ERB undertakes technical inspections of ZESCO's electricity infrastructure in all the ten provinces of Zambia. These inspections cover generation, transmission and distribution facilities to determine compliance levels and ascertain adherence to standards, codes of practice, directives, licence conditions and any other applicable regulations. In undertaking this exercise, samples of these facilities are inspected.

The sample sizes for inspections have been growing over time that is from 115 in 2014 to 375 in 2018. In 2018 375 facilities were sampled for inspections and yielded a compliance level of 76.7 percent (weighted average) compared to 77.2 percent in 2017 for 313 facilities inspected.

As shown in the Table 3-5, except in 2016 ZESCO failed to meet the set target for compliance for energy infrastructure. Specifically in 2018 ZESCO scored 76.7 percent which was below the set standard for that year of 87 percent. ERB had set a target of more than 90 percent compliance by the end of 2021.

**Table 3-5: ZESCO's compliance rate of inspected facilities, 2014 -2018**

| S/N | Type of Facility                  | % Compliance |       |       |       |       |
|-----|-----------------------------------|--------------|-------|-------|-------|-------|
|     |                                   | 2014         | 2015  | 2016  | 2017  | 2018  |
| 1.  | Large Power Stations              | 90.60        | 96.40 | 94.90 | 95.26 | 95.0  |
| 2.  | Transmission Substations < 33kV   | 65.30        | 67.80 | 76.91 | 79.05 | 80.2  |
| 3.  | Distribution Substations ≥ 33kV   | 50.70        | 53.80 | 71.53 | 74.93 | 72.7  |
| 4.  | Mini Hydro Power Stations         | 80.10        | 82.80 | 86.17 | 82.62 | 68.5  |
| 5.  | Diesel Fuelled Power Stations     | 77.80        | 79.40 | 70.93 | 64.04 | 67.1  |
|     | ZESCO Average Compliance (Actual) | 63.95        | 76.00 | 80.1  | 77.2  | 76.7  |
|     | ERB Compliance Target ESI         | 80.00        | 80.00 | 80.00 | 85.00 | 87.00 |

The main areas of non-compliance related to safety, environment, maintenance, and security of supply such as; inadequate firefighting facilities which were overdue for periodic maintenance for a number of facilities; lack of firm capacity owing to lack of redundancy and difficult to access some facilities. Technical hearings are held followed by enforcement action as the case may be. In 2018, one technical hearing was held and no enforcement actions were taken.

### 3.9.2 Copperbelt Energy Corporation Plc

CEC is a private company that owns and operates high-voltage transmission and distribution systems that supply electricity to Zambia's mining companies based on the Copperbelt. Apart from supplying electricity to local mines, CEC has been exporting/wheeling electricity to the Democratic Republic of Congo (DRC). Further CEC also supplies power to residential customers in the CEC Village in Kitwe. During the year CEC invested in renewable energy power generation.

CEC purchases power from ZESCO through a Bulk Supply Agreement (BSA). Table 3-6 shows the performance of CEC from 2015 to 2018.



**Table 3-6: CEC's performance, 2015 - 2018**

| Business Element                      | 2015      | 2016      | 2017      | 2018      |
|---------------------------------------|-----------|-----------|-----------|-----------|
| Electricity Sales to the mines        | 4,092 GWh | 3,521 GWh | 3,512 GWh | 3,672 GWh |
| Power imports from SAPP               | 116.4 GWh | 302.8 GWh | 340.9 GWh | 82.4 GWh  |
| Transmission losses                   | 2.9%      | 3.6%      | 3.0%      | 2.27%     |
| Standby Generation Capacity           | 80 MW     | 80 MW     | 80 MW     | 80 MW     |
| Energy from Standby diesel generators | 7.17GWh   | 8.16 GWh  | 12.67 GWh | 13.84 GWh |
| Solar Plant Capacity                  | -         | -         | -         | 1 MW      |
| Generation from Solar Plant           | -         | -         | -         | 0.93 GWh  |

In 2018, CEC sold 3,672 GWh of electrical energy to its mining customers, representing a marginal increase of 4.6 percent from energy sales made in 2017 of 3,512 GWh. Meanwhile, transmission losses reduced from 3.0 percent recorded in 2017 to 2.7 percent in 2018. The company's standby installed generation capacity stood at 80 MW. Notably, in 2018, CEC commissioned a 1 MW capacity grid connected solar power plant located in Riverside, Kitwe which injected 0.93 GWh of energy into its grid.

#### Technical Performance

In 2018, as part of its compliance monitoring mandate the ERB conducted technical audits of CEC electricity infrastructure covering 42 facilities. As depicted in Table 3-7, the average compliance marginally declined by 1.8 percentage points to 97.1 percent from 98.9 percent in 2017.

**Table 3-7: CEC's average percentage compliance from 2015 to 2018**

| Type of Facility                                   | Compliance (%) |       |       |       |
|--|----------------|-------|-------|-------|
|  | 2015           | 2016  | 2017  | 2018  |
| CEC Substations (≥66kV) Overall Average Compliance | 92.87          | 96.00 | 98.90 | 97.07 |
| <b>ERB Compliance Target</b>                       | 80.00          | 85.00 | 85.00 | 87.00 |

The drop in compliance was not critical as the overall compliance was above the ERB set target of 87 percent for 2018.

### **3.9.3 Ndola Energy Company Limited**

Ndola Energy Company Limited (NECL) is an IPP that generates and supplies power to ZESCO under a long term PPA. The company operates a HFO power plant with a total installed capacity of 110 MW. The main source of HFO for NECL is from INDENI Refinery. In 2018 NECL supplied a total of 451.0 GWh to ZESCO.

#### Technical performance

In 2018, the ERB conducted the technical compliance audit of NECL HFO Phase I and II power generation plants in Ndola. The overall compliance level for the audited electricity infrastructure was at 100 percent compared to 96.7 percent compliance scored in 2017. NECL plants met the ERB performance target of 87 percent for 2018.

#### Challenges

NECL's major challenges faced in 2018 included grid voltage instability and frequency fluctuations outside the operating range of the power plant, lack of local laboratory services for quality testing and lack of HFO storage facilities.

To address the voltage instability and frequency fluctuations, the ERB is implementing the Power Quality Management System under ZS 387 – Power Quality and Reliability Standard.

The lack of local specialised laboratory facilities has resulted in the Company sending HFO samples for independent analysis outside Zambia and thereby incurring additional costs.

In order to address the challenge of inadequate HFO storage facilities, the company has plans to construct a 16,000MT HFO storage tank with auxiliary equipment.

### 3.9.4 Kariba North Bank Extension Power Corporation Limited

KNBE is wholly owned by ZESCO and was established as a Special Purpose Vehicle<sup>20</sup> (SPV) for developing the Kariba extension project. The SPV has an Operations and Maintenance Agreement with ZESCO. The Company owns the 360 MW Kariba North Bank Extension Power Station. The plant is operated as a peaking plant with an average operating time of 3.5 hours a day. ZESCO is the off-taker of power generated from the plant under a long term PPA.

In 2018, energy sent out by the plant increased by 169 percent, to 1,611 GWh from 599 GWh recorded in 2017. The increase in electricity generation was on account of the need to meet the deficit created by two machines at Kafue Gorge Power Station which were shut down for maintenance.

#### Technical performance

In 2018, the ERB conducted technical compliance audits of KNBE facilities and the average compliance was 92.6 percent compared to 93.3 percent overall score in 2017. Overall, performance was above the ERB set target of 87 percent for 2018.

### 3.9.5 Itezhi Tezhi Power Corporation Limited

Tata Africa Holdings (SA) Pty Limited and ZESCO jointly own and operate ITPC. The power plant has an installed generation capacity of 120 MW and became operational in 2017. During the year ITPC sold 709.21 GWh compared to 735.4 GWh in 2017 of energy to ZESCO, under a long term PPA.

#### Technical performance

In 2018, the ERB conducted technical compliance audits of ITPC electricity infrastructure. The compliance level was determined to be 96.5 percent compared to 85.2 percent in 2017 representing 11.3 percentage points increase. This was above the ERB performance target of 87 percent for 2018 as depicted in Table 3-8 below.

**Table 3-8: ITPC Compliance rate of inspected facilities, 2017 - 2018**

| Type of Facility                          | 2017 % Compliance | 2018 % Compliance |
|---|-------------------|-------------------|
| ITPC Overall Average Compliance Level (%) | 85.19             | 96.46             |
| ERB Compliance Target for ESI             | 85.00             | 87.00             |

<sup>20</sup> Special purpose vehicle (SPV), also known as special purpose entity (SPE), refers to a legal entity that is created to isolate a parent company from financial risk



**Part of Itezhi Tezhi Power Corporation**

### 3.9.6 Lunsemfwa Hydro Power Company Limited

LHPC owns and operates Mulungushi (32 MW) and Lunsemfwa (24 MW) power plants in Central Province. LHPC has a long term Power Supply Agreement with ZESCO for 15 years. During the year 2018, the Company generated 318.6 GWh as compared to 292.6 GWh generated in the prior year 2017, reflecting an 8.9 percentage increase.

The Company's main challenges were the reduced availability of water resources for generation, resulting from competing use of water resources such as farming which is inherent in this area.

#### Technical performance

As was the case with the other utilities, the ERB conducted technical audits of LHPC electricity infrastructure. The overall average compliance rate from the facilities inspected in 2018 was 94.3 percent compared to 83.6 percent in 2017. This was above the ERB target of 87 percent as depicted in Table 3-9.

**Table 3-9: LHPC's facilities inspected and compliance levels, 2014-2018**

| Type of Facility                | Compliance (%) |       |       |       |       |
|---------------------------------|----------------|-------|-------|-------|-------|
|                                 | 2014           | 2015  | 2016  | 2017  | 2018  |
| LHPC Overall Average Compliance | 81.20          | 75.60 | 88.31 | 83.61 | 94.25 |
| ERB Compliance Target           | 80.00          | 80.00 | 85.00 | 85.00 | 87.00 |

### 3.9.7 Zengamina Power Limited

ZPL is a private company that owns and operates an off-grid mini-hydro plant with an installed capacity of 0.75 MW. The power plant was officially commissioned in July 2007. ZPL is based in Kalene, North-Western Province and is owned by the North-West Zambia Development Trust (NWZDT). The Company generates and supplies power to Kalene Mission Hospital, Ikelengi central business district and surrounding areas.

The Company was established as a philanthropic project by the Trust, supported by International Charities, to supply power to the mission Hospital and not necessarily as a business venture. However, the company is being transformed to operate commercially to meet its operating costs as well as to expand the network.

Over the years ZPL has connected more than 315 customers of various categories including Residential, Social services, Off Peak Commercial, Standard Commercial and Small Business. However, the Company has positive growth prospects from emerging and expanding small business enterprises as well as residential customers in the area.

### Challenges

ZPL continued to operate with financial difficulties on account of non-cost reflective tariffs. According to ZPL, during the period under review, the Company had continued to run at a loss since 2007. However, the company had been working to find more sustainable ways of operating. Further, grid encroachment as a result of the connection of North-Western Province to the national grid posed challenges for ZPL's plans to expand its distribution network.

### Outlook

In view of the foregoing challenges, the utility intends to recapitalise using various funding options. Further, the company plans to change the business strategy and split into two separate companies for generation and distribution respectively. Once the restructuring is complete, the distribution company would negotiate and sign a Power Purchase Agreement (PPA) with the generation company.

## **3.9.8 North Western Energy Corporation Limited**

NWEC, is a private utility company that owns and operates power distribution and supply infrastructure that provide electricity to the mining townships (Lumwana, Kalumbila and Kabitaka) in North-Western Province of Zambia. NWEC has a 15-year distribution and supply licence, issued in 2008 to distribute up to 20 MW. In the case of supply of power to Lumwana township NWEC has in place a PPA with ZESCO. Meanwhile, for Kalumbila and Kabitaka NWEC purchases power from ZESCO at MD1 and MD2 for onward selling to these two townships.

In 2018, NWEC recorded an increase in the number of both domestic and commercial clients which has greatly contributed to company's financial performance. Table 3-10 shows the number of customers in 2018.

**Table 3-10: NWEC's customers in 2018**

| Sector      | Total | Percentage (%) |
|-------------|-------|----------------|
| Residential | 2,840 | 97.23%         |
| Commercial  | 81    | 2.77%          |
| Total       | 2,921 | 100%           |

Further, in 2018 NWEC signed a 10 year PSA with an industrial client within the Kalumbila industrial park project and is expected to supply energy loads of between 8 MVA and 12 MVA.

### Technical performance

In 2018, the ERB undertook a technical compliance audit of NWEC's Kabitaka, Lumwana and Kalumbila distribution facilities. The average compliance rate for all three facilities was 86.0 percent compared to 73.0 percent in 2017. Despite the notable increase of 13.0 percentage points, the performance was below the ERB set target of 87 percent for 2018 as depicted in Table 3-11.

**Table 3-11: NWEC's facilities inspected and compliance levels, 2015-2018**

| Type of Facility                | Compliance (%) |       |       |       |
|---------------------------------|----------------|-------|-------|-------|
|                                 | 2015           | 2016  | 2017  | 2018  |
| NWEC Overall Average Compliance | -              | 86.50 | 73.00 | 85.99 |
| ERB Compliance Target           | 85.00          | 85.00 | 85.00 | 87.00 |

### 3.9.9 Maamba Collieries Ltd

MCL is currently Zambia's largest IPP that generates and supplies power to ZESCO. MCL owns and operates a 300 MW coal fired thermal power plant situated in Maamba, Southern Province. In 2018, MCL supplied 2,040.7 GWh of power to ZESCO which was an increase of 59.5 percent from 1,279.4 GWh in 2017.

MCL also owns a 46 km double circuit transmission line from Maamba to Muzuma substation in Choma for power evacuation into the national grid.

#### Outlook

MCL intends to expand its capacity by another 300 MW beyond 2018. During the period under review, MCL was undertaking reviews of technical bids received from prospective constructors.

#### Technical Performance

In 2018, the ERB conducted a technical compliance audit of MCL's facilities. The overall average compliance rate was 94.7 percent against a target of 87 percent.

### 3.10 Operational performance of the electricity network

In 2018, the Interconnected Power Systems (IPS) in Zambia experienced a total of 27 major power system disturbances which affected most parts of the country compared to 30 interruptions recorded in 2017 as depicted in Appendix 7. Major supply interruptions, as defined in ZS 387 – 2 B.5.1 are any single events that:

- Lead to a loss of supply to a 1,000 consumers or large end-user consumers; and
- Forced interruption index greater than five system-minutes<sup>21</sup>.

### 3.11 Network performance

In 2018, the IPS experienced redundancy based constraints (N-1)<sup>22</sup> on some major lines such as the 330kV Kabwe - Pensulo line. Further, the IPS also experienced outages on some major lines such as the 330kV Leopards Hill - Kabwe line. Meanwhile, some generation plants, such as the Kafue Gorge Power Station and Maamba were on shutdown due to maintenance works.

### 3.12 Network expansion

In 2018, the Zambian IPS expansion included the following projects:

- Lusaka Transmission and Distribution Rehabilitation Project (LTDRP);
- Upgrade and commissioning of Leopards Hill switchgear;
- Construction and commissioning of Chipata West – Mchinji 33kV line;
- Construction of Chipata – Lundazi – Chama 132kV line;
- Mpika Step Down 330kV substation;
- Commissioning of Musonda Falls Power Station;
- Lusiwasi Upper Hydro Power Project; and
- Kafue Gorge Lower Power Station 750MW Project.

<sup>21</sup> System Minutes = (Energy not supplied MWh/Power at Peak)

<sup>22</sup> (N-1) technically referred to as a provision of backup infrastructure for redundancy.



### 3.13 Power quality management system

In 2018, the ERB undertook monitoring of the implementation of the PQMS and associated Directives.

As at 31<sup>st</sup> December 2018, the status on the implementation of the PQMS and PQDs is depicted in Table 3-12, against a target of 64 percent average compliance:

**Table 3-12: Implementation of the power quality management system and power quality directives, 2018**

| Licensee     | Total number of required recorders | Total number of recorders as at 31 <sup>st</sup> December 2018 | Percentage of total number of recorders as at 31 <sup>st</sup> December 2018 | Percentage Variance as at 31 <sup>st</sup> December 2018 |
|--------------|------------------------------------|--|--|--|
| ZESCO        | 161                                | 38   | 24%  | (76%)  |
| CEC          | 172                                | 115  | 67%  | (33%)  |
| LHPC         | 11                                 | 08   | 73%  | (27%)  |
| Ndola Energy | 03                                 | 03   | 100%   | -  |
| MCL          | 02                                 | 02   | 100%   | -  |
| <b>Total</b> | <b>349</b>                         | <b>166</b>   | <b>48%</b>   | <b>(52%)</b>   |

As at 2018 the ESI in Zambia required 349 recorders out of which 166 (48%) had been installed. MCL and NECL had fully installed the recorders while the rest had deficits starting with ZESCO, CEC and LHPC in that order.

#### 3.13.1 Power Quality Performance from 2015 to 2018

Over the years, the PQ performance has continued to improve from 64 percent in 2015 to 74.6 percent as of 31<sup>st</sup> December 2018. The 2018 performance was 3.5 percentage points above what was achieved in 2017. Table 3 - 13 shows the status of Power Quality Performance by IPS from 2015 to 2018..

**Table 3-13: Status of Power Quality Performance by IPS, 2015 - 2018.**

| Year            | Voltage Harmonics | Voltage unbalance | Voltage Dips | Interruptions | Voltage Regulation | Frequency | Average |
|-----------------|-------------------|-------------------|--------------|---------------|--------------------|-----------|---------|
| 2018 Compliance | 94.4%             | 96.3%             | 39.7%        | 78.3%         | 62.5%              | 45.3%     | 74.6%   |
| 2017 Compliance | 93.1%             | 96.9%             | 36.0%        | 70.5%         | 55.9%              | 50.5%     | 71.1%   |
| 2016 Compliance | 85.0%             | 91.0%             | 24.0%        | 50.0%         | 58.0%              | 56.0%     | 61.0%   |
| 2015 Compliance | 95.0%             | 97.0%             | 31.0%        | 54.0%         | 51.0%              | 53.0%     | 64.0%   |

### 3.14 Low power factor surcharge

The ERB approved the introduction of a low power factor surcharge for industrial, mining, commercial, agricultural and all customers on individual PPAs as a demand side management measure aimed at reducing reactive power on the system and in turn mitigating power deficit. This was consistent with the provisions of Clause 2.2.1 of the *Electricity (Grid Code) Regulations, Statutory Instrument No. 79 of 2013* which stipulates that the power factor at the point of supply or connection point shall be 0.92 lagging or better.

In 2018, implementation which was planned for 1<sup>st</sup> September 2018 had not taken place as modalities were still being refined. Consequently, the effective implementation date has been deferred.

### 3.15 **Zambian Distribution Grid Code**

Following the approval and establishment of the Distribution Grid Code Review Panel (DGCRP) by the ERB, in 2018, the Panel commenced the revision of the Code with the view to integrating renewable technologies in the national grid. The technical modalities of integration are expected to be concluded in 2019.

### 3.16 **Key Performance Indicators Framework for Non-State Owned Enterprises**

The ERB commenced performance monitoring of Non-State Owned Enterprises (NSOEs) on technical KPIs in 2017. In 2018, the ERB designed draft KPIs with a view of extending the monitoring of NSOEs to include financial and operational KPIs.

The rationale and specific objectives of the KPIs for NSOEs are as follows:

- a) To create a monitoring and evaluation framework for improved performance of the utilities thereby enhancing the provision of quality service;
- b) To provide motivation to management of utilities to achieve better outcomes; and
- c) The need for the ERB to collect data on the performance of NSOEs that would assist in carrying out its mandate.

The scope of the KPIs focuses on addressing major elements of the utilities' day to day operations with specific reference to technical, operational and financial challenges. The key performance areas that impact customers include the following:

- i. The need for metering to accurately measure consumption;
- ii. Reliable and sustainable provision of service;
- iii. Outage management; and
- iv. Need for adequate provision of information and resolution of customer complaints.

The proposed NSOEs KPIs will be extended to licensees that currently serve end-use customers who have no KPI framework in place. Appendix 8 shows the proposed KPIs, the weights and targets. The targets are benchmarked against the World Bank's utility benchmarking study and the Regional Electricity Regulators Association (RERA) KPI framework. Before full implementation in 2020, the framework will be subjected to stakeholder consultations and a pilot phase.

### 3.17 **Developments in the Electricity Sub-sector**

#### 3.17.1 **Rural Electrification**

In 2018, the Rural Electrification Authority (REA) successfully completed the implementation of ten (10) carry-over projects in Six Provinces across Zambia. These consisted of nine (9) Grid Extension Projects (GEPs) and one (1) mini hydro power project as depicted in Table 3-14.

**Table 3-14: Rural electrification projects implemented in 2018**

| No. | Name of Project   | Province      | District        | Type of Technology |
|-----|-------------------|---------------|-----------------|--------------------|
| 1   | Kala/Chembe       | Luapula       | Chembe/Kawambwa | Grid Extension     |
| 2   | Milenge III       | Luapula       | Samfya          | Grid Extension     |
| 3   | Chimpempe Mission | Luapula       | Kawambwa        | Grid Extension     |
| 4   | Milenge IV        | Luapula       | Samfya          | Grid Extension     |
| 5   | Kaso/Kayambi      | Northern      | Mungwi          | Grid Extension     |
| 6   | Mambwe Mission    | Northern      | Mbala           | Grid Extension     |
| 7   | Mpepo             | Muchinga      | Mpika           | Grid Extension     |
| 8   | Dimbwe            | Southern      | Kalomo          | Grid Extension     |
| 9   | Kataba Phase I    | Western       | Nalolo          | Grid Extension     |
| 10  | Kasanjiku         | North Western | Mwinilunga      | Mini Hydro         |



REA will in the ensuing years implement the Electricity Access and Supply Project (ESAP) in conjunction with the World Bank (WB). The objective of the Project is to increase electricity access in Zambia's targeted rural areas. There are three components to the project, the first component being on-grid electricity access expansion, the second component is the off-grid electricity access expansion and the third component is the capacity building and project implementation support.

Further, REA will implement the Increased Access to Electricity and Renewable Energy Programme (IAEREP) in conjunction with the European Union (EU). The objective of the Project is to establish and promotion of a conducive environment to actively encourage the enhanced participation of the private sector in delivering access to electricity and to promote clean energy based on renewable energies in Zambia.

### **3.17.2 Kafue Gorge Lower Hydro Power Project**

Kafue Gorge Lower Hydropower Project is located in the Kafue Gorge, about 65km upstream of the confluence of the Kafue River and the Zambezi River and 9km downstream of the existing 990MW Kafue Gorge Hydroelectric Power Station in Chikankanta District of Southern Province. The project will have an installed capacity of 750MW at an estimated cost of US\$2.2billion. Kafue Gorge Lower Power Development Corporation (KGLPDC) has been created as an SPV to develop the project. The SPV is wholly owned by ZESCO and has entered into a PSA with it. By the close of 2018, 60 percent of the works had been completed. The first generating unit is expected to be commissioned by the end of 2019 and the project is scheduled to be completed in 2020.

## **3.18 Developments under Renewable Energy**

A number of key developments took place under the renewable energy subsector during the period under review. This section highlights some of these developments.

### **3.18.1 Renewable Energy Feed In Tariffs**

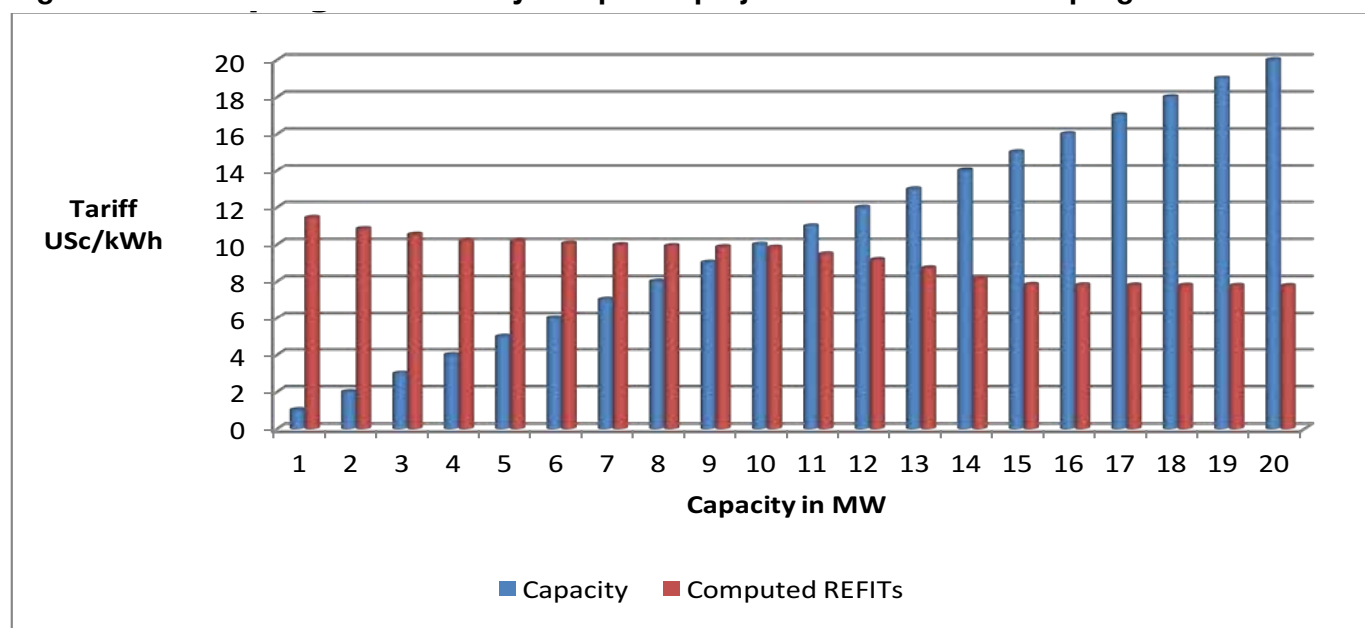
The Renewable Energy Feed In Tariffs (REFiT) Strategy was approved by the Government in October 2017. In Zambia, the Global Energy Transfer Feed In Tariff (GETFiT) will operationalize the REFiT programme. Since its official launch, the GETFiT programme has spearheaded the implementation of the REFiT strategy. REFiT provides an allocation of 200 MW of small- and medium-scale renewable energy projects up to a maximum size of 20 MW. Eligible renewables include solar PV, hydro, geothermal, biomass, and wind power. The GETFiT Programme has been allocated 200MW, which includes 100MW Solar PV and 100MW Small Hydropower Projects. The program aims to facilitate and increase investment in the Zambian private power sector. Zambia aims to develop up to 800 MW of on-grid solar generation in the next two to three years, including the 600 MW allocated to the IDC

Under the 100MW Solar PV energy implementation programme, the GETFiT Secretariat together with ERB developed standardised documents such as PPA, Grid Connection Agreements (GCA) and determined benchmark tariffs for the purpose of reverse auction.

During the period under review, GETFiT Zambia launched the Request for Proposal (RfP) stage of round 1 of the 100 MW Solar PV tender. Further, a total of ten shortlisted companies or consortia were selected following a competitive Request for Qualification which was concluded in June 2018. GETFiT Zambia partnered with ZESCO to assess the proposed sites to ensure that grid capacity is sufficient to connect the projects presented at a given location.

In December 2018, under the 100 MW Small Hydro implementation, the program launched the pre-registration phase for entities interesting in participating in the prequalification phase of the tender targeted to start in early 2019.

Furthermore, during the period under review, GETFiT Zambia and the ERB determined benchmark REFITs for projects ranging from 1 MW to 20 MW. Figure 3-8 shows the tabulation of tariffs.

**Figure 3-8: Feed-In-Tariffs for mini hydros power projects under the GETFiT programme**

### 3.18.2 Development of a regulatory framework for renewable energy – Off Grid and Mini Grid Regulatory Framework

The European Union (EU), under the Increased Access to Electricity and IAEREP provided assistance to the Zambian Government to improve electrification rates in the country, one pillar of this support includes providing grants to facilitate the development of mini-grids to supply customers in areas where the main electricity grid has not yet arrived. The EU in collaboration with the ERB, in 2018 proposed a regulatory framework for off-grids in order to attract investment and to enhance local technical capacities. The proposed framework will be piloted by REA before rolling out.

The proposed regulatory framework has suggested different licensing approaches for the following capacities: 0 – 100kW; 100 kW – 1 MW; and over 1 MW, that is, very light handed, light handed, and full licensing requirement respectively. The framework has also proposed different options on the treatment of security of tenure as well as the regulatory treatment of grid encroachment.

### 3.18.3 IDC scaling solar power projects

Following the approval of the PSA in 2016 between Bangweulu Power Company Limited and Ngonye Power Company Limited with ZESCO, the ERB in 2018 approved the commencement of the development of the two (2) commercial scale solar projects. The two will be situated in the Lusaka South Multi-facility Economic Zone.

#### 3.18.3.1 Bangweulu Power Company

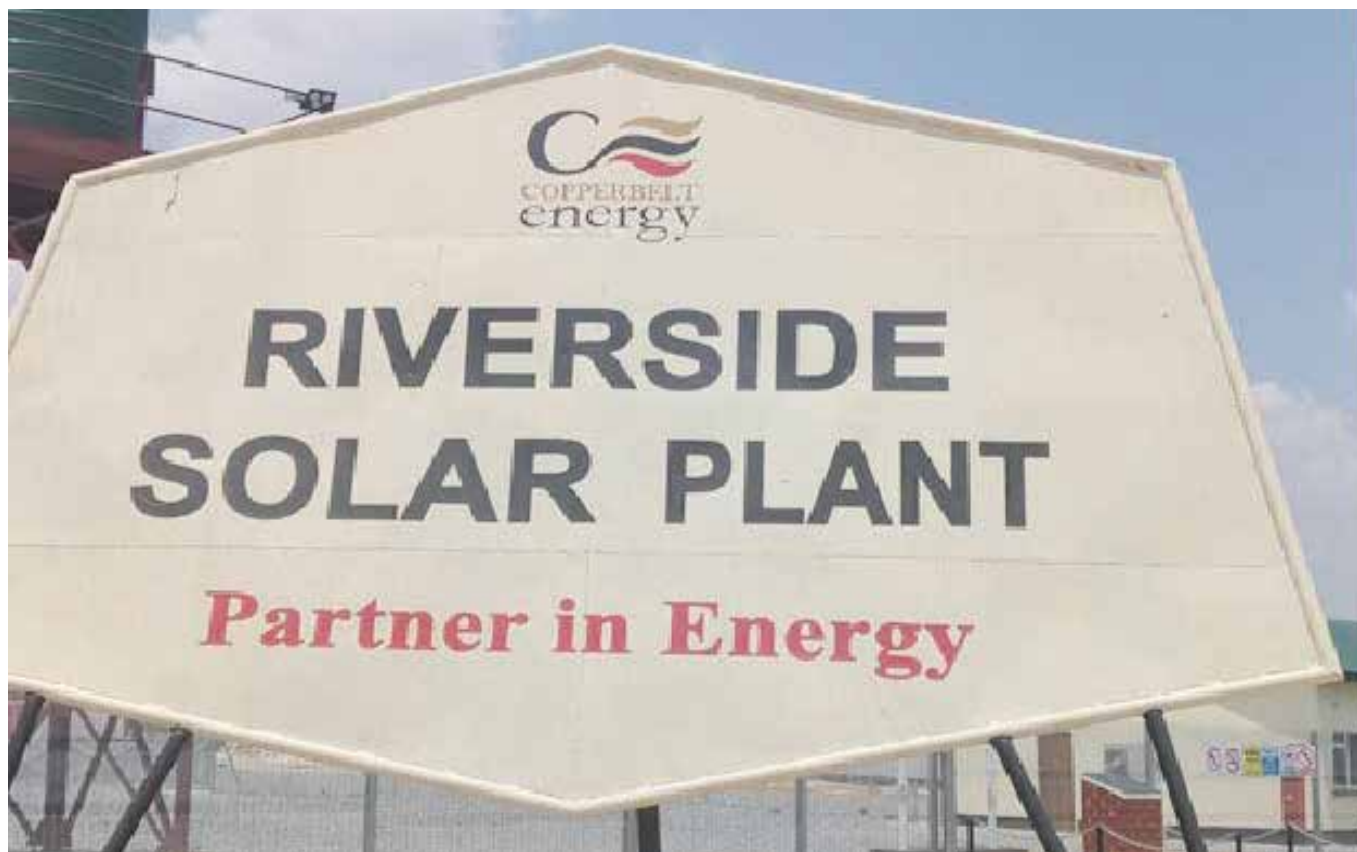
Bangweulu is an SPV jointly owned by IDC and Neoen S.A.S of France with shareholding interest of 20 and 80 percent respectively. Bangweulu will develop solar power plant that will feed into the ZESCO grid. The construction of the solar power plant commenced in 2018 and is expected to have an installed capacity of 54.3 MW at an estimated cost of US\$ 57.3 million. Total project construction progress was at 90 percent and test runs had commenced by the end of December 2018. The tariff applicable in the PPA, US cents 6.015/kWh, was determined through a competitive tendering process. The term for the PPA is 25 years, commencing from the Scheduled Commercial Operation Date (CoD) set for early 2019.

### 3.18.3.2 Ngonye Power Company

Like Bangweulu, Ngonye is an SPV jointly owned by IDC and Enel Green Power S.P.A of Italy with shareholding interest of 20 and 80 percent respectively. The construction of the solar power plant commenced in 2018 and is expected to have an installed capacity of 34 MW at an estimated cost of US\$ 43.2 million.

The tariff applicable, US cents 7.84/kWh, in the PPA was established through a competitive tender process. The term for the PPA is 25 years, commencing from the scheduled CoD set for the first quarter of 2019.

### 3.18.4 Kitwe Riverside Solar Power Plant



The Kitwe Riverside solar plant is a greenfield commercial scale grid-connected solar power plant owned by CEC. The plant is located on 40 hectares of land and can accommodate between 15 MW to 20 MW of solar farm. The Plant was constructed at a cost of US\$ 1.50 million and commissioned in the first quarter of 2018. Power will be evacuated through a 1.2 km long 11 kV line to a substation for onwards injection into the CEC grid.

The Company has also signed a Memorandum of Understanding (MoU) with the Copperbelt University to use the plant for training purposes.

### 3.18.5 Kasanjiku Mini Hydro Power Project

During the year under review, the REA applied to the ERB for an Investment Endorsement (I.E) in respect of the development of the 0.64 MW Kasanjiku Mini Hydro Power Project (KMHPP). The project is located about 130 km south-east of Mwinilunga town in Senior Chief Ntambu's area of North-Western province of Zambia. The project was estimated to cost over US\$ 8 million and financed by the Rural Electrification Fund.

During the period under review, the REA undertook a survey to estimate the community's ability and willingness to pay for power as well as customers' demand profile.

### 3.18.6 Muhanya Solar Mini-Grid



Sinda Solar micro-grid is owned by Muhanya Solar Limited. The micro-grid is located in Sinda District, in Eastern Province. The micro-grid was officially commissioned on 12<sup>th</sup> April, 2017 and has an installed capacity of 30 KWp that feeds into a distribution network stretching about 1.1 km.

#### Customers and Load

From an initial connection of only seven (7) households under the pilot phase operations, Muhanya micro-grid now has connected 60 households from 2012 when Muhanya took over the plant. Each household is installed with 5 amp circuit breaker. The main use of power is lighting and entertainment. Each household is installed with four (4) to eight (8) LED bulbs depending on the size of the house.

#### Challenges

Two major challenges had been reported by Muhanya. Firstly, the inability to connect more customers due to the lack of materials and equipment. Secondly, the arrival of the national electricity grid, which is barely a kilometer away, poses a challenge of grid encroachment.

### 3.18.7 Mugurameno standard micro-grid

During the period under review, the ERB approved an application for a license for Standard Micro-grid Initiatives Limited. The ERB issued a combined generation and supply licence to operate a solar micro-grid located in Mugurameno village of Chieftainess Chiawa of Chirundu District in Lusaka Province.

#### Tariffs and type of Services

At full operation, each standard micro-grid unit provides energy services to approximately 150 connections, and 900 users. With 150 small micro-grid units in operation the company could potentially supply clean solar power to approximately 135,000 users. The tariff structure is shown in the Table 3-15



**Table 3-15: Fixed Monthly Tariff based on Level of Consumption**

| Energy Service Plans                      | Description of services   | Price per month |
|---|---|-----------------|
|   |   | ZMW             |
| <b>Low Energy Service Plan Average</b>    | <ul style="list-style-type: none"> <li>♦ 2 Indoor Lights</li> <li>♦ USB</li> </ul>  | <b>67</b>       |
| <b>Medium Energy Service Plan Average</b> | <ul style="list-style-type: none"> <li>♦ TV</li> <li>♦ 3 indoor lights</li> <li>♦ USB</li> <li>♦ Security light</li> </ul>  | <b>210</b>      |
| <b>High Energy Service Plan Average</b>   | <ul style="list-style-type: none"> <li>♦ Refrigerator</li> <li>♦ Television + DVD/ Decoder</li> <li>♦ 5 indoor lights</li> <li>♦ USB</li> <li>♦ Security light</li> </ul> | <b>350</b>      |

### 3.19 Power Purchase agreements

In 2018, the ERB received and approved four (4) PPA/PSA from ZESCO as outlined in Table 3-16 below:

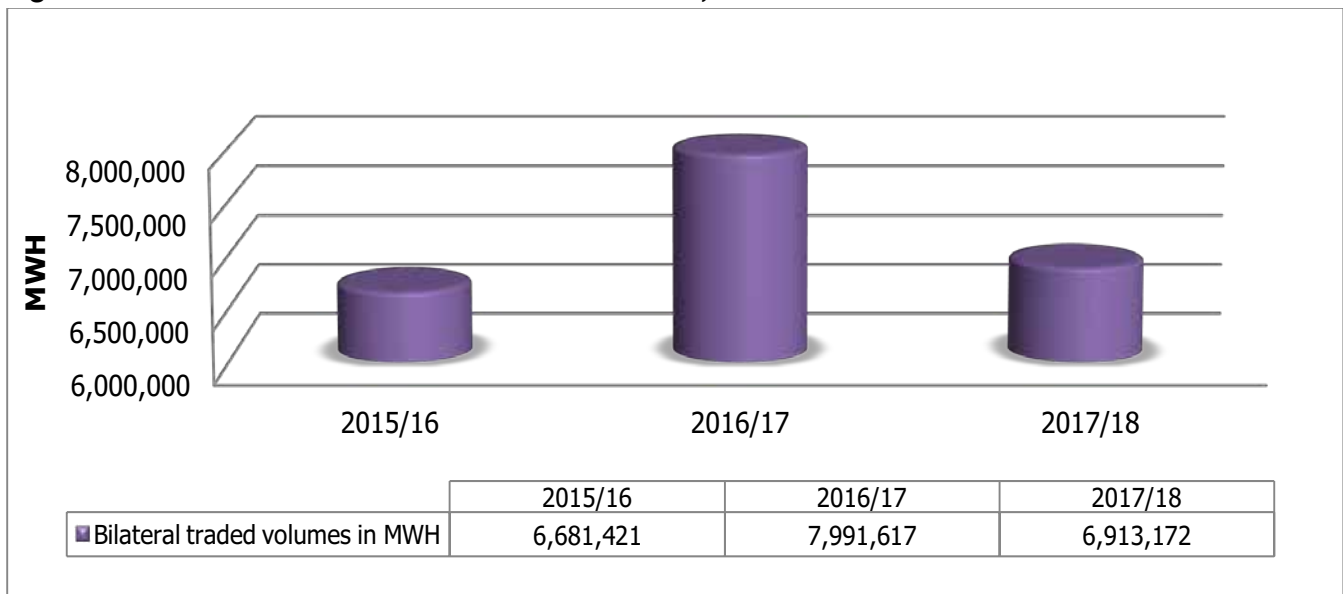
**Table 3-16: Summary of PPAs/ PSAs approved by the ERB in 2018**

| No | Name of PPA/PSA   | Contracted capacity | Duration of the agreement |
|----|---|---------------------|---------------------------|
| 1  | ZESCO and Sakunda Holdings Limited of Zimbabwe                              | 100 MW              | 15 months                 |
| 2  | Amendment of the ZESCO and Consolidated Farming Limited                     | 35 MW               | 20 years                  |
| 3  | ZESCO and Zimbabwe Electricity Transmission and Distribution Company (ZTDC) | Low Voltage 11 kV   | 5 Years                   |
| 4  | ZESCO and Societe Nationale D'Electricite S.A (SNEL)                        | 41 MW               | 9 months                  |

### 3.20 SAPP and Regional Developments

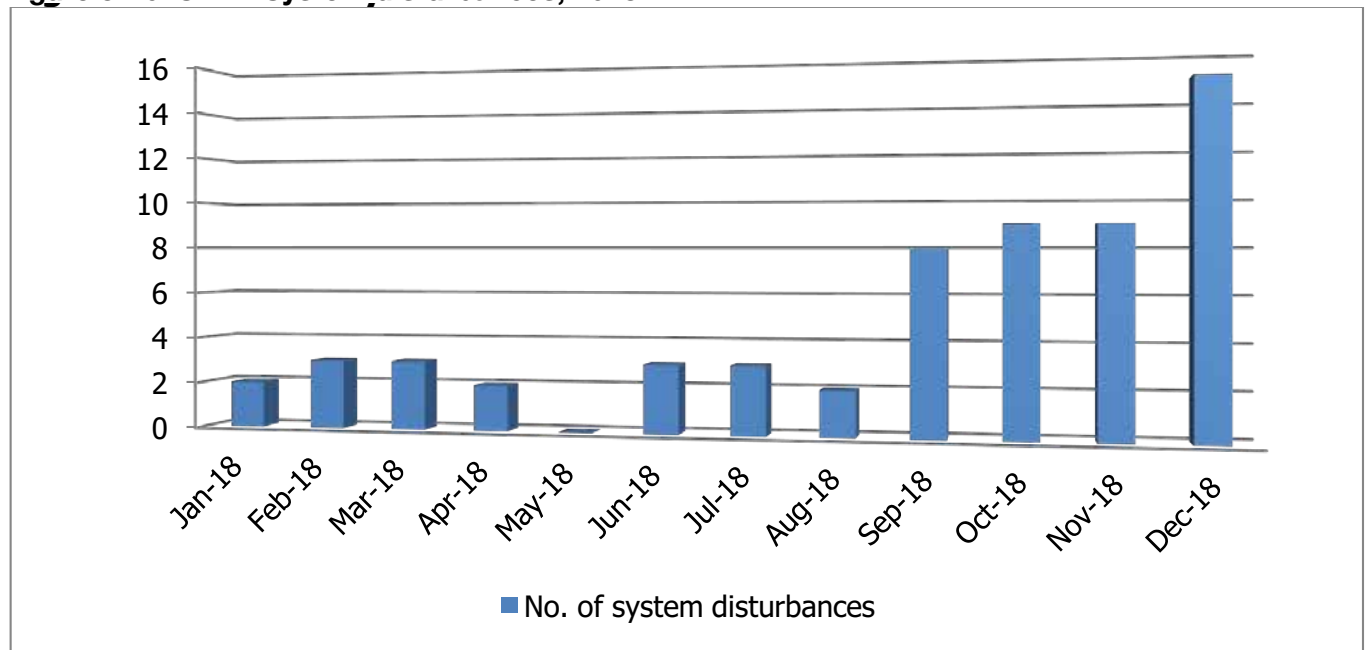
SAPP region recorded a new installed capacity amounting to 3,008 MW in 2017/18 of which 23 percent was from IPPs. The regional demand increased by 8.0 percent from 53,478 MW in 2016/17 to 57,762 MW 2017/18. According to SAPP, the installed generation capacity in the SAPP region stood at 67,190 MW with operating capacity of 60,719 MW against a demand of 57,762 MW resulting in an excess generation capacity of 2,957 MW.

The SAPP competitive market traded volumes have been going up from 2015 through to 2018. Below is a summary of the traded volumes on the bilateral market for 2015/16, 2016/17 and 2017/18. As depicted in Figure 3-9, bilateral traded volumes decreased significantly from 2016/17 through to 2017/18 due to transmission network constraints.

**Figure 3-9: SAPP Bilateral traded volumes in MWh, 2015/16 – 2017/18**

### SAPP System disturbances

During 2018, SAPP recorded some system disturbances with October, November and December recording the highest. The major disturbances that affected Zambia were characterised by frequency trips, power fluctuations and high system voltages. The extent of the disturbances is depicted in Figure 3-10.

**Figure 3-10: SAPP System disturbances, 2018**

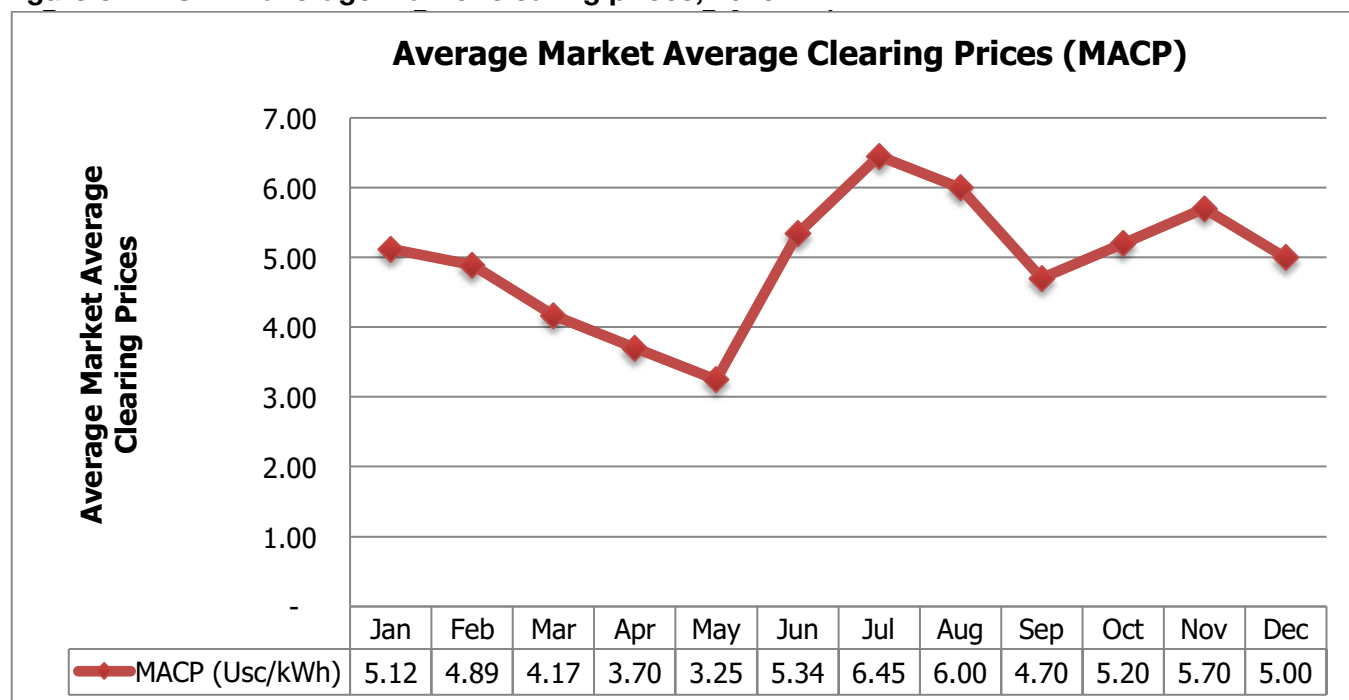
### SAPP Energy Trading

In the period under review, SAPP electrical energy traded on the SAPP competitive market increased to 2,124 GWh in 2018 from 1,023 GWh in 2017. Total turnover of USD 106.6 million was recorded in 2018 compared USD 75.6 million in 2017.

The SAPP power trading markets constitute the Day-Ahead Market (DAM), Intra-Day Market (IDM), Forward Physical Market Monthly (FPM-M) and Forward Physical Market Weekly (FPMW). The DAM continued to be the dominant market averaging 72.2 percent of total traded power. With the balance shared among the remaining three (03) markets.

The lowest prices were recorded in the months of April and May averaging USc3.7/kWh and USc3.25 respectively. The highest prices were recorded during the month of July 2018 when they peaked to USc 6.45/kWh. The rest of year saw slightly lower but stable market prices averaging USc 4.75/kWh as depicted in Figure 3-11.

**Figure 3-11: SAPP average market clearing prices, 2018**



### 3.21 Outlook in the Electricity Sub sector

Generally, the outlook of the electricity industry depicts a positive trajectory both in the short and long term particularly in the renewable energy sub-sector. The key issues will include the following:

#### 3.21.1 Cost of Service Study

Under the Cost of Service Study (CoSS), it is expected that the ERB will finalise the appointment of a Consultant to undertake the study and that the study will commence within 2019. The study will set new benchmark cost reflective tariffs for all customer categories that will be used for future tariff reviews and migration.

#### 3.21.2 Key Performance Indicators Framework for Non-State Owned Enterprises

Following the development of a regulatory framework for Non-State Owned Enterprises (NSOEs), the ERB will enhance its performance monitoring regime, commencing with a pilot phase that will cover licensees who currently serve end-use residential consumers. After stakeholder consultations the programme will then be rolled out to all licensees.

#### 3.21.3 New Investments in Generation

During the period under review, new investments specifically in generation, progressed well with one of the two IDC solar projects, Bangweulu, reaching technical commissioning stage as at December 2018 and the other, Ngonye, commencing construction. These projects are expected to enter commercial operations in the first quarter of 2019. Once operational, the projects are also expected to add diversity to Zambia's energy mix which is still predominantly hydro.

Meanwhile, the 750 MW Kafue Gorge Lower Power project recorded significant progress with over 60 percent works having been completed by the end of the year. It is expected that the project construction will steadily continue and reach commercial operation in 2020.





**Kafue George Lower Hydro Power Plant under construction.**

Furthermore, under the GETFIT renewable energy programme, it is expected that the milestones achieved during the period under review which included the receipt of 15 project proposals for the 100 MW solar tender and the determination of REFITs will gain momentum in 2019. It is envisaged that the small hydro procurement approach and tender will be finalised early in 2019. It is also expected that initiatives by the GETFIT Secretariat to mobilise more resources will gather momentum and that the Monitoring and Evaluation framework will be completed.

Meanwhile, the Governments of Zambia and Zimbabwe, have also made progress on preparations for the development of the Batoka Gorge Hydro Power project (2,400 MW) at an estimated cost of US\$5 Billion. It is expected that the preparatory studies which commenced in 2018 will be completed in 2019.

In the off-grid space, there are efforts towards increasing electrification rates in the country through developments of mini-grids that will supply customers in areas where the main electricity grid has not yet arrived. This will be supported by the development of a stable and predictable regulatory framework to support infrastructure development and open access.

Further regulatory developments expected in 2019 include the finalization as well as implementation of the Renewable Energy Regulatory Framework (RERF). It is also envisaged that net-metering rules will be finalized in 2019.

## 4.0 LICENSING IN THE ENERGY SECTOR

As one of its key functions, the ERB issues licences to undertakings engaged in entrepreneurial activities in the energy sector. The licensing process flow chart is outlined in Appendix 9.

### 4.1 Issuance of Standard Licences

During the period under review, a total of 103 standard licences were issued, of which 28 were in the electricity and renewable energy sub-sector, while 75 were in the petroleum sub-sector as shown in Figure 4-1 and Table 4-1. Of these, 81 were initial applications<sup>23</sup>, while 22 were for renewal of existing licences. Figure 4-1 shows the number of licences issued in 2018.

**Figure 4-1: Licences granted, 2018**

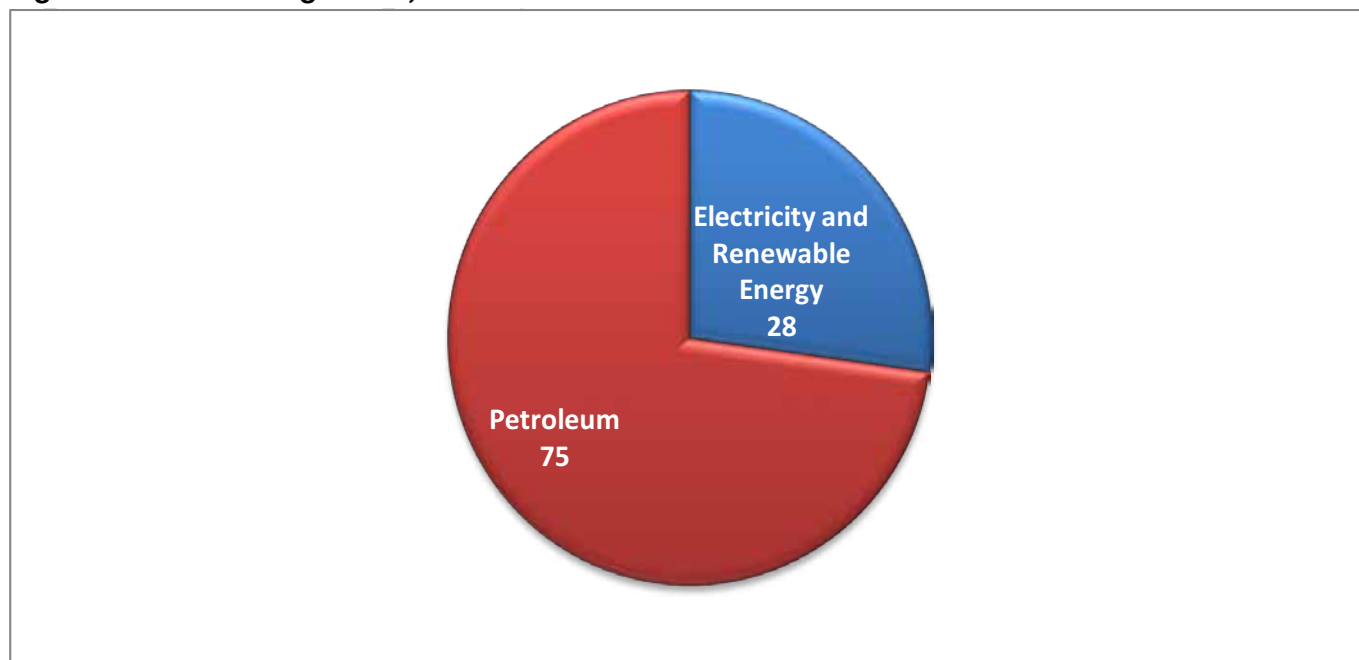


Table 4-1 shows the number of licences that were issued per quarter during the year 2018.

**Table 4-1: Licences granted per quarter, 2017 - 2018**

| Period       | Initial Applications |           | Renewals Applications |           |
|--------------|----------------------|-----------|-----------------------|-----------|
|              | 2018                 | 2017      | 2018                  | 2017      |
| Quarter 1    | 28                   | 9         | 6                     | 10        |
| Quarter 2    | 19                   | 34        | 4                     | 12        |
| Quarter 3    | 20                   | 23        | 3                     | 5         |
| Quarter 4    | 14                   | 19        | 9                     | 2         |
| <b>Total</b> | <b>81</b>            | <b>85</b> | <b>22</b>             | <b>29</b> |

Table 4-2 shows the breakdown of the licence types issued in 2018 compared to those issued in 2017.

<sup>23</sup> Initial applications refer to first time applications.

**Table 4-2: Licences type issued, 2017 - 2018**

| No                           | Type of Licence   | Number of Licences Issued |            |
|------------------------------|---|---------------------------|------------|
|                              |   | 2018                      | 2017       |
| 1.                           | Bio Ethanol Production  | 0                         | 1          |
| 2.                           | Blending and Packaging of Lubricants  | 1                         | 0          |
| 3.                           | Distribute, Import and Export of Liquefied Petroleum Gas                                  | 3                         | 2          |
| 4.                           | Distribute, Import and Export of Petroleum Products                                       | 27                        | 14         |
| 5.                           | Generation of Electricity   | 0                         | 1          |
| 6.                           | Generation of Electricity (Off-Grid)  | 1                         | 0          |
| 7.                           | Generation of Electricity for Own Use   | 1                         | 0          |
| 8.                           | Importation of Lubricants   | 9                         | 10         |
| 9.                           | Manufacture, Wholesale Importation and Installation of Solar Energy Systems <sup>24</sup> | 26                        | 51         |
| 10.                          | Retail of Liquefied Petroleum Gas   | 2                         | 1          |
| 11.                          | Retail of Petroleum Products  | 5                         | 6          |
| 12.                          | Road Transportation of Petroleum Products   | 28                        | 28         |
| <b>Total Licences issued</b> |   | <b>103</b>                | <b>114</b> |

Further, 22 retail sites were approved for inclusion onto existing Retail Licences. In addition, a total of 41 Construction Licences were also issued during the period under review, for the construction of retail sites and/or storage depots around the country.

## 4.2 Provisional Licences and Temporary Permits

The ERB issues provisional licences or temporary permits as an administrative arrangement which enable applicants to provisionally commence operations. The Provisional licence is valid for six months during which period a standard licence is expected to be issued after undergoing a gazetting process in the Government Gazette. Further, a temporary permit is issued to entities that already hold Retail of Petroleum Products Licences to enable them commence operations at new sites as they await gazetting. Table 4-3 shows the provisional/temporary authority granted to licensees in 2017 and 2018.

**Table 4-3: Provisional licences issued, 2017-2018**

| No                  | Provisional Licence/Temporary Permit  | 2018      | 2017       |
|---------------------|---|-----------|------------|
| 1.                  | Blending and Packaging of Lubricants  | 01        | -          |
| 2.                  | Distribute, Import and Export Liquefied Petroleum Gas (LPG)                               | 02        | 01         |
| 3.                  | Distribute, Import and Export Petroleum Products  | 19        | 20         |
| 4.                  | Electricity Supply  | 01        | -          |
| 5.                  | Generate, Distribute and Supply Electricity (Off-Grid Electricity Licence)                | 01        | -          |
| 6.                  | Generation of Electricity   | 01        | -          |
| 7.                  | Importation of Lubricants   | 14        | 08         |
| 8.                  | Manufacture, Wholesale Importation and Installation of Solar Energy Systems <sup>25</sup> | 18        | 58         |
| 9.                  | Retail of Liquefied Petroleum Gas (LPG)   | 01        | 02         |
| 10.                 | Retail of Petroleum Products  | 03        | 07         |
| 11.                 | Retail Site Inclusions  | 05        | 08         |
| 12.                 | Road transportation of petroleum products   | 27        | 23         |
| <b>Total issued</b> |   | <b>93</b> | <b>127</b> |

A total of 93 provisional licences were issued in 2018 compared to 127 issued in 2017.

<sup>24,25</sup> More licences for the Manufacture, Wholesale Importation and Installation of Solar Energy Systems were issued in the year 2017 due to the change statutory requirements.

## 5.0 CONSUMER AFFAIRS

Section 6 of the Energy Regulation Act gives the ERB the mandate to receive and investigate complaints from consumers on services and products provided by utilities operating in the energy sector.

### 5.1 Complaints Handling

In 2018, the ERB received 215 complaints. The number of resolved complaints stood at 117 representing a resolution rate of 54 percent<sup>26</sup>. Table 5-1 gives a breakdown of all the complaints received by sub-sector:

**Table 5-1: Complaints resolution rate per sub-sector, 2018**

| Sub-sector       | Received   | Resolved   | Resolution Rate % |
|------------------|------------|------------|-------------------|
| Electricity      | 153        | 70         | 45                |
| Petroleum        | 61         | 46         | 75                |
| Renewable Energy | 1          | 1          | 100               |
| <b>Total</b>     | <b>215</b> | <b>117</b> | <b>54</b>         |

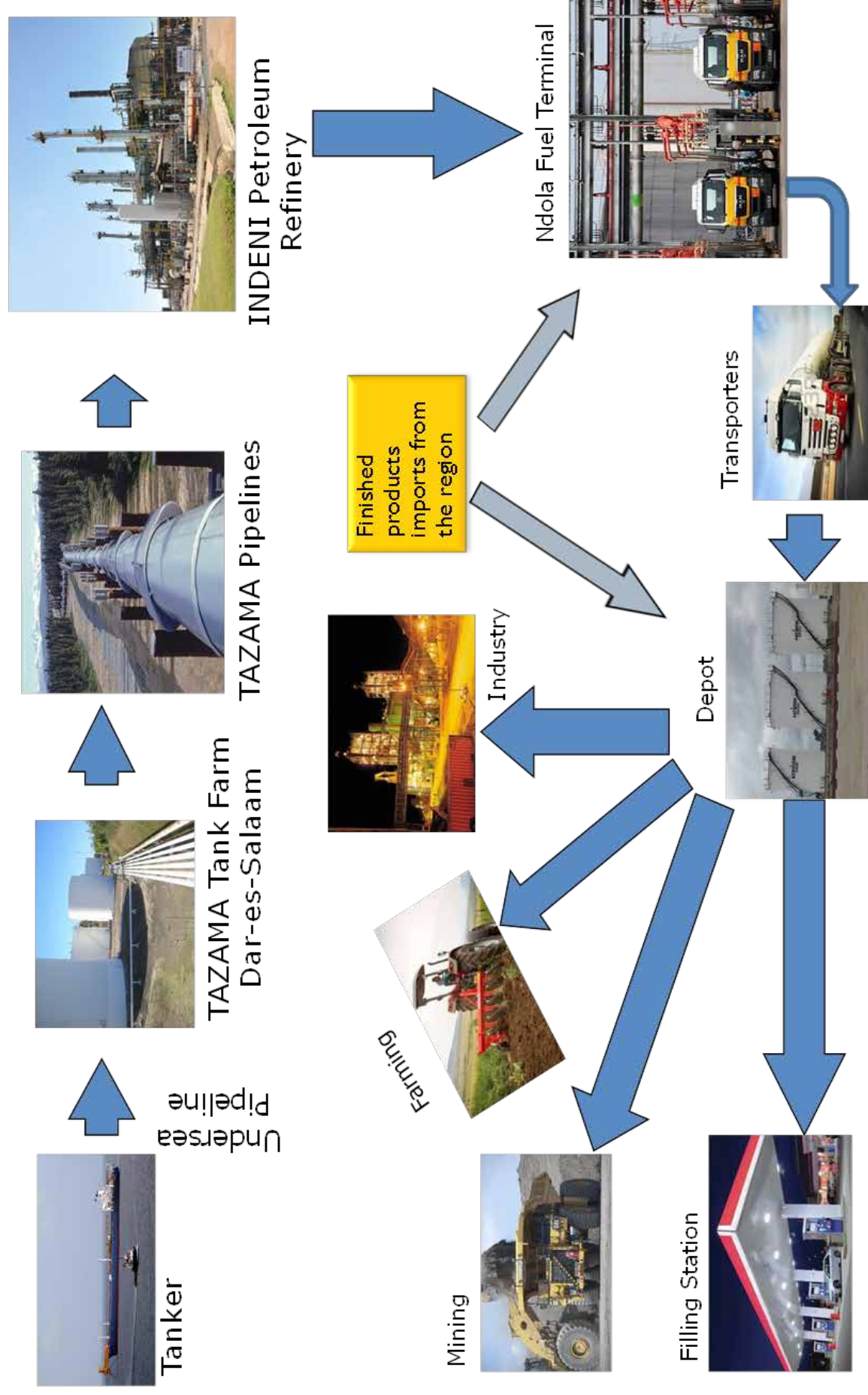
Depending on the complexity of a complaint under investigation, mediation meetings may be convened where the two parties (service provider and customer) are brought before the ERB (adjudicators) with a view of reaching an amicable conclusion.

In 2018, a total of 11 hearings were held. To keep the public informed on the complaints handling function, the ERB conducts awareness campaigns aimed at achieving this objective. The stakeholder engagement is also achieved through industry meetings facilitated by the ERB. Furthermore, the ERB has in place a Complaints Handling Procedure that guides the process of safeguarding consumer's rights.

<sup>26</sup> Resolution rate accounts for complaints referred to the ERB, while the KPI complaints resolution rate (appendix 6) refers to outages only by the Utility.



## Appendix 1: Petroleum value chain



## Appendix 2: Uniform Pump Price Build-Up

|                           |       | PETROL             | DIESEL             | KEROSENE           | LOW SULPHUR GASOIL (LSG) |
|---------------------------|-------|--------------------|--------------------|--------------------|--------------------------|
|                           |       | ZMW/M <sup>3</sup> | ZMW/M <sup>3</sup> | ZMW/M <sup>3</sup> | ZMW/M <sup>3</sup>       |
| WHOLESALE PRICE TO OMC    |       | 9,700.61           | 9,844.09           | 9,355.56           | 11,803.55                |
| Ndola Fuel Terminal Fee   |       | 25.00              | 25.00              | 25.00              | 25.00                    |
| Marking Fee               |       | 96.99              | 96.99              | 96.99              | 96.99                    |
| Excise Duty               |       | 1,970.00           | 620.00             |                    | 620.00                   |
| <b>Ex Refinery Gate</b>   |       | <b>11,792.60</b>   | <b>10,586.08</b>   | <b>9,477.55</b>    | <b>12,545.54</b>         |
| Transportation cost       |       | 260.00             | 260.00             | 90.00              | 260.00                   |
| <b>TOTAL (Excl VAT)</b>   |       | <b>12,052.60</b>   | <b>10,846.08</b>   | <b>9,567.55</b>    | <b>12,805.54</b>         |
| OMC Margin                |       | 890.00             | 890.00             | 890.00             | 890.00                   |
| 15 Days Holding Cost-Line |       | -                  | -                  | -                  | -                        |
| <b>TOTAL(Excl VAT)</b>    |       | <b>12,942.60</b>   | <b>11,736.08</b>   | <b>10,457.55</b>   | <b>13,695.54</b>         |
|                           |       |                    |                    |                    |                          |
| Dealer Margin             |       | 650.00             | 650.00             | 650.00             | 650.00                   |
| <b>PRICE TO DEALER</b>    |       | <b>13,592.60</b>   | <b>12,386.08</b>   | <b>11,107.55</b>   | <b>14,345.54</b>         |
| ERB Fees                  | 0.007 | 101.81             | 92.77              | 83.20              | 107.45                   |
| Strategic Reserves Fund   |       | 150.00             | 150.00             | 150.00             | 150.00                   |
| Price before VAT          |       | 13,844.41          | 12,628.85          | 11,340.75          | 14,602.99                |
| VAT                       | 0.16  | 2,215.11           | 2,020.62           |                    | 2,336.48                 |
| <b>Uniform Pump Price</b> |       | <b>16,059.51</b>   | <b>14,649.47</b>   | <b>11,340.75</b>   | <b>16,939.47</b>         |

## Appendix 3: Retail sites inspection routine checklist with scoring criteria.

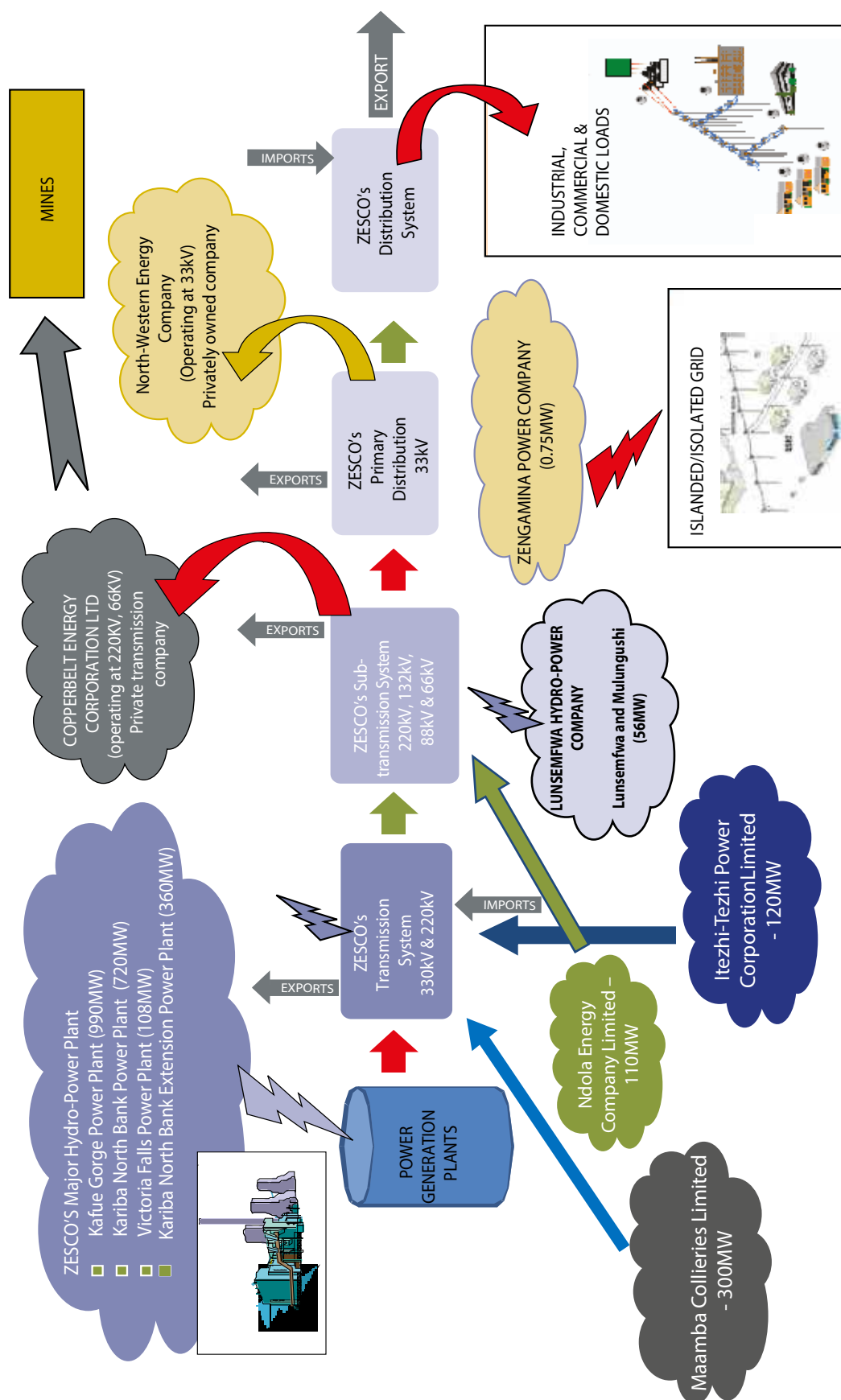
| No.      | ITEM  | CURRENT STATUS                        | SCORE | WORK INSTRUCTIONS/<br>COMMENT |  |
|----------|---|---------------------------------------|-------|-------------------------------|--|
| <b>A</b> | <b>Statutory Requirements(9points)</b>              |                                       |       |                               |  |
| 1        | ZW&MA certification(Dispensers)(02)                 | Displayed[ ] Valid[ ]                 |       |                               |  |
| 2        | Fire Certificate(02)                                | Displayed[ ] Valid[ ]                 |       |                               |  |
| 3        | Trading licence(02)                                 | Displayed[ ] Valid[ ]                 |       |                               |  |
| 4        | Storage of Petroleum Licence (02)                   | Displayed[ ] Valid[ ]                 |       |                               |  |
| 5        | ERB Valid Retail Licence (01)                       | First page Displayed & Valid[ ]       |       |                               |  |
| <b>B</b> | <b>Tanks Installed and Leak detection(14points)</b> |                                       |       |                               |  |
| 6        | Filler Box(02)                                      | Position[ ] Volume[ ]                 |       |                               |  |
| 7        | Product Colour Coding (Manhole covers)(02)          |                                       |       |                               |  |
| 8        | Leak Detection Tank farm(04)                        | Present[ ] Functioning[ ] Adequate[ ] |       |                               |  |
| 9        | Leak Detection Product delivery Line (04)           | Present[ ] Functioning[ ] Adequate[ ] |       |                               |  |
| 10       | Water Dip (02)                                      |                                       |       |                               |  |
| <b>C</b> | <b>Dispenser(5points)</b>                           |                                       |       |                               |  |
| 11       | Fuel Dispenser (03)                                 | Functioning[ ] Secure[ ] Presets[ ]   |       |                               |  |
| 12       | Product Colour Coding (Nozzles) (02)                |                                       |       |                               |  |
| <b>D</b> | <b>Safety, Fire &amp; Environment (58points)</b>    |                                       |       |                               |  |
| 13       | Symbolic Warning signage(04)                        |                                       |       |                               |  |
| 14       | Pump Island Crash Barriers (04)                     |                                       |       |                               |  |
| 15       | Price Display (02)                                  |                                       |       |                               |  |
| 16       | Fore court Surface(06)                              | Spill prone areas[ ] Driveways[ ]     |       |                               |  |
| 17       | Forecourt Drainage (06)                             | Present[ ] Adequate[ ]                |       |                               |  |
| 18       | Three Chamber Oil Inter captor (06)                 | Present[ ] Adequate[ ] Maintenance[ ] |       |                               |  |



## Appendix3: Retail sites inspection routine checklist with scoring criteria. *..continued*

| No.                  | ITEM                                       | CURRENTSTATUS                                  | SCORE | WORKINSTRUCTIONS/<br>COMMENT |  |
|----------------------|--|--|-------|------------------------------|--|
| 19                   | Functional Emergency Shut Off Switch(08)   | Present[ ] Visible[ ] Easily Accessible[ ]     |       |                              |  |
| 20                   | Electrical Wiring-MCB(02)                  | Properly installed[ ] Labelled[ ]              |       |                              |  |
| 21                   | Earth Connection Point for Tankers(02)     | Present[ ]                                     |       |                              |  |
| 22                   | Canopy clearance height of 4.5m (02)       | Hieght Labelled[ ]                             |       |                              |  |
| 23                   | Electrical Wiring-Canopy(02)               | Lighting[ ] Cables Secured[ ]                  |       |                              |  |
| 24                   | Vent Pipes(03)                             | Position[ ] Height[ ]                          |       |                              |  |
| 25                   | Fire Extinguisher(08)                      | Functional[ ] Valid[ ] Type[ ]                 |       |                              |  |
| 26                   | Sand Bucket/Box(03)                        | Loose & DrySand [ ] Red[ ] Labelled[]          |       |                              |  |
| <b>E</b>             | <b>Product Quality Monitoring(7Points)</b> |  |       |                              |  |
| 27                   | Hydrometers(02)and thermometer(01)         | Hydrometers for all products [ ]Thermometer[ ] |       |                              |  |
| 28                   | Recordsonsiteforthepast3months(02)         | Present[ ] Adequate[ ]                         |       |                              |  |
| 29                   | Format of records(02)                      | According to QCMG[ ]                           |       |                              |  |
| <b>E</b>             | <b>Ancillary services(7points)</b>         |  |       |                              |  |
| 30                   | Compressed air system(05)                  | Functional [ ] Tyre Inflator[ ] Gauge [ ]      |       |                              |  |
| 31                   | Customer Toilets(non-fee paying) (02)      | Functional [ ] Water [ ] Clean[ ]              |       |                              |  |
| <b>TOTALSCORE(%)</b> |  |  |       |                              |  |
|                      |  |  |       |                              |  |

## Appendix4: Structure of Electricity Supply Industry in Zambia



## Appendix 5: Installed generation capacity as at 31stDecember2018

| Undertaking                                | Station                | Machine      | Installed       |
|--|------------------------|--------------|-----------------|
|  |                        | Type         | Capacity (MW)   |
| <b>ZESCO Limited</b>                       | Kafue Gorge            | Hydro        | 990             |
|  | Kariba North           | Hydro        | 720             |
|  | Kariba North extension | Hydro        | 360             |
|  | Victoria Falls         | Hydro        | 108             |
|  | Lunzua River           | Hydro        | 14.5            |
|  | Lusiwasi               | Hydro        | 12              |
|  | Chishimba Falls        | Hydro        | 6               |
|  | Musonda Falls          | Hydro        | 10              |
|  | Shiwang'andu           | Hydro        | 1               |
| <b>Itezhi-tezhi Power Corporation</b>      | Itezhi-tezhi           | Hydro        | 120             |
| <b>Zengamina Limited</b>                   | Ikelengi               | Hydro        | 0.75            |
| <b>Lusemfwu Hydro Power Company</b>        | Mulunguish             | Hydro        | 32              |
|  | Lunsemfwu              | Hydro        | 24              |
|  | <b>Total Hydro</b>     |              | <b>2,398.25</b> |
| <b>Maamba Collieries Limited</b>           | MaambaPowerPlant       | Coal         | 300             |
|  | <b>Total Coal</b>      |              | <b>300</b>      |
| <b>Copperbelt Energy Generation Plants</b> | Bancroft               | Diesel       | 20              |
|  | Luano                  | Diesel       | 40              |
|  | Luanshya               | Diesel       | 10              |
|  | Mufulira               | Diesel       | 10              |
| <b>ZESCO Generation Plants</b>             | Kabompo                | Diesel       | 2               |
|  | Zambezi                | Diesel       | 1.36            |
|  | Mufumbwe               | Diesel       | 0.8             |
|  | Luangwa                | Diesel       | 2.6             |
|  | Lukulu                 | Diesel       | 0.32            |
|  | Chavuma                | Diesel       | 0.8             |
|  | Shango'mbo             | Diesel       | 1               |
|  | <b>Total Diesel</b>    |              | <b>88.88</b>    |
| <b>NdolaEnergyGenerationPlants</b>         | Ndola                  | HeavyFuelOil | 110             |
|  | <b>Total HFO</b>       |              | <b>110</b>      |
| <b>Rural Electrification Authority</b>     |                        |              |                 |
| <b>Generation Plants</b>                   | Samfya                 | Solar        | 0.06            |
| <b>Copperbelt Energy Corporation</b>       | Kitwe                  | Solar        | 1               |
| <b>Muhanya Solar Limited</b>               | Sinda Village          | Solar        | 0.03            |
| <b>Mugurameno</b>                          | Chirundu               | Solar        | 0.01            |
|  | <b>Total Solar</b>     |              | <b>1.1</b>      |
|  | <b>Grand Total</b>     |              | <b>2,898.23</b> |

*Note: The installed national capacity includes 80MW standby diesel generators from CEC generation plants.*

## Appendix 6: ZESCO's Annual Performance-2018.

| No. | KPI and Weight (%)      | Sub KPI   | Target  | Actual Performance  | Comment             |
|-----|-------------------------|---|---|---|---------------------|
| 1.  | Metering Customer (10%) | Quotation Time  | ZESCO is required to issue quotations for all types of connections within 30 days from the date of application;                   | Quotations were issued within 10 days on average.                                   | Target achieved     |
|     |                         | Connection Time   | ZESCO is required to make standard residential connection to supply within 30 days upon payment                                   | Standard connections were done within 49 days on average.                           | Target NOT achieved |
|     |                         | <b>Customer Metering Percentage Score 5%</b><br><b>Indicator was NOT fully achieved</b> |   |   |                     |
| 2.  | Cash Management (20%)   | Mining Customers debtor days  | ZESCO is required to reduce mining days to not more than 60 days.   | ZESCO's mining debtor days stood at 348 days as at 31 <sup>st</sup> December 2018.  | Target NOT achieved |
|     |                         | Export Customer debtor days   | ZESCO is required to reduce export debtor days to not more than 60  | ZESCO's export debtor days stood at 158 days as at 31 <sup>st</sup> December 2018.  | Target NOT achieved |
|     |                         | Domestic Customer Debtor Days   | ZESCO is required to reduce domestic (residential, commercial and maximum demands customers) debtor days to not more than 60 days | ZESCO's domestic debtor days stood at 69 days as at 31 <sup>st</sup> December 2018. | Target NOT achieved |
|     |                         | GRZ Customer Debtor Days  | ZESCO is required to reduce GRZ debtor days to not more than 90 days.   | ZESCO's GRZ debtor days stood at 732 days as at 31 <sup>st</sup> December 2018.     | Target NOT achieved |
|     |                         | <b>Cash Management Percentage Score 7%</b><br><b>Indicator was NOT achieved</b>         |   |   |                     |

| No. | KPI and Weight (%)              | Sub KPI   | Target   | Actual Performance  | Comment             |
|-----|---------------------------------|---|--|---|---------------------|
| 3.  | Staff Productivity (15%)        | Corporate Customer-Employee Ratio   | ZESCO is required to maintain a Corporate customer-employee ratio of 100:1 or better.  | ZESCO achieved a Corporate Customer-employee annual average ratio of 100:1.           | Target achieved     |
|     |                                 | Lusaka Division Customer-Employ ratio                                       | ZESCO is required to maintain a Lusaka Division customer-employee ratio of 100:1 or better.                                  | ZESCO achieved a Lusaka Division customer-employee annual average ratio of 178:1.     | Target achieved     |
|     |                                 | Copperbelt Division Customer-Employ ratio                                   | ZESCO is required to maintain a Copperbelt Division customer-employee ratio of 100:1 or better.                              | ZESCO achieved a Copperbelt Division customer employee annual average ratio of 164:1. | Target achieved     |
|     |                                 | Northern Division Customer-Employ ratio                                     | ZESCO is required to maintain a Northern Division customer-employee ratio of 75:1 or better.                                 | ZESCO achieved a Northern Division customer-employee annual average ratio of 111:1.   | Target achieved     |
|     |                                 | Southern Division Customer-Employ ratio                                     | ZESCO is required to maintain a Southern Division customer-employee ratio of 100:1 or better.                                | ZESCO achieved a Southern Division customer-employee annual average ratio of 123:1.   | Target achieved     |
|     |                                 | Staff Costs   | ZESCO is required to Reduce staff costs to 30% or less as a share of total operations and maintenance costs (O&M).           | ZESCO's annual staff costs stood at 24% of total annual O&M costs.                    | Target achieved     |
|     |                                 | Staff productivity Percentage Score 15%<br>Indicator was fully achieved.    |  |   |                     |
| 4.  | Quality of Service Supply (20%) | SAIDI <sup>1</sup>  | ZESCO is required to maintain the maintain an annual System Average Interruption Duration Index (SAIDI) of 32 hours or less. | ZESCO recorded annual average SAIDI of 37.5 hours per customer                        | Target NOT achieved |
|     |                                 | SAIFI <sup>2</sup>  | ZESCO is required to maintain the System Average Interruption Frequency Index (SAIFI) of 5.25 times or less.                 | ZESCO recorded annual average SAIFI of 3.5 times.                                     | Target achieved     |
|     |                                 | CAIDI <sup>3</sup>  | ZESCO is required to maintain the Customer Average Interruption Duration Index (CAIDI) at 6 hours or less                    | ZESCO recorded annual average CAIDI of 9.9 hours.                                     | Target NOT achieved |
|     |                                 | ASAI <sup>4</sup>   | ZESCO is required to maintain the Average System Availability Index (ASAI) at 90% or better.                                 | ZESCO recorded quarterly average ASAI of 95.6%.                                       | Target achieved     |
|     |                                 | Quality of Service Percentage Score 9%<br>Indicator was not fully achieved. |  |   |                     |

| No. | KPI and Weight (%)                 | Sub KPI  | Target   | Actual Performance   | Comment             |
|-----|------------------------------------|--|--|--|---------------------|
| 5.  | System Losses (10%)                | Transmission Losses  | ZESCO is required to maintain transmission losses at 6% or better.   | ZESCO recorded annual average transmission losses of 5.25%.                              | Target achieved     |
|     |                                    | Distribution Losses  | ZESCO is required to maintain distribution losses at 12% or better.  | ZESCO recorded annual average distribution losses of 10.45%.                             | Target achieved     |
|     |                                    | System Losses Percentage Score 9%<br>Indicator not fully achieved<br><br>Despite achieving the set target on all the two (2) indicators ZESCO did not fully achieve the KPI score because during June 2018, the Utility did not meet the required 12% distribution losses. |  |  |                     |
| 6.  | Power Generation (10%)             | Unit capability factor (UCF) <sup>5</sup> for large hydro plants   | ZESCO is required to maintain a generation UCF for large hydro power plants at 80% or better.                          | ZESCO recorded annual average UCF of 88% for large hydro power plants.                   | Target achieved     |
|     |                                    | UCF for small hydro plants   | ZESCO is required to maintain a generation UCF for mini hydro power plants at 60% or better.                           | ZESCO recorded annual average UCF of 93% for small hydro power plants.                   | Target achieved     |
|     |                                    | Power generation Score percentage Score 10%<br>Indicator fully achieved  |  |  |                     |
| 7.  | Safety (5%)                        | Fatality   | ZESCO is required to ensure that no fatalities are experienced on account of negligence.                               | ZESCO recorded nine (5) fatalities in 2018.  | Target NOT achieved |
|     |                                    | Lost time injury   | ZESCO is required to ensure that no Life-Threatening Injuries (LTIs) occur on account of negligence.                   | ZESCO recorded a total of 36 LTIs in 2018.   | Target NOT achieved |
|     |                                    | Safety Percentage Score 0 %<br>Indicator was not achieved.<br><br>The ERB noted a reduction in the fatalities and LTIs when compared to the prior year, where fatalities were 9 and LTIs were 63   |  |  |                     |
| 8.  | Customer Complaint Resolution (5%) | Complaint resolution rate  | ZESCO is required to maintain a total customer complaint resolution rate of 90% or better for all reported complaints. | ZESCO recorded annual average customer complaint resolution rate of 94.75%.              | Target achieved     |
|     |                                    | Replacement of faulty meters   | ZESCO is required to replace faulty meters within 5 days after a complaint is reported.                                | ZESCO recorded annual average duration of two (2) days for replacement of faulty meters. | Target achieved     |
|     |                                    | Customer complaints Percentage Score 5%<br>Indicator fully achieved.   |  |  |                     |

| No.                                   | KPI and Weight (%)     | Sub KPI  | Target  | Actual Performance   | Comment             |
|---------------------------------------|------------------------|--|---|--|---------------------|
| 9.                                    | Equipment Failure (5%) | Distribution transformer replacement rate                              | ZESCO is required to replace distribution transformers as a proportion of total number of distribution transformers in service/month at a rate of 0.1% or less. | ZESCO recorded annual average distribution transformer replacement rate of 0.175%. | Target NOT achieved |
|                                       |                        | Meters replacement rate  | ZESCO is required to replace meters as a proportion of total meters in service at a rate of 0.25% or less.  | ZESCO recorded annual average meters replacement rate of 0.05%.                    | Target achieved     |
|                                       |                        | Equipment Failure Percentage Score Indicator was not fully achieved 4% |   |  |                     |
| Total annual average percentage Score |                        |  | 69%   |  |                     |



## Appendix 7: Major System Disturbances recorded in 2018

| No. | Date                                   | Effect as defined in ZS 387 -2 B.5.1 | Description   |
|-----|--|--------------------------------------|---|
| 1.  | Monday 29 January 2018<br>09:13hrs     | End-use customer                     | At 09:13hrs, the IPS experienced a system disturbance due to the loss of 110.51MW of load at Kalumbila Mine. System frequency increased from 50.16Hz to 50.33Hz and then stabilised. The ZESA tie line experienced a power swing from 64.9MW import to 15.33MW import.  |
| 2.  | Wednesday 07 February 2018<br>19:30hrs | Over 1000 customers                  | At 19:30hrs when the 330kV Pensulo - Kasama line tripped due to the de-coupling of yellow phase insulator on tower 364 which resulted in the loss of power supply to Muchinga, Luapula and Northern provinces. Alternative supply was given through the 66kV network supported by Lunzua and Musonda Falls Power Stations.  |
| 3.  | Monday 12 February 2018<br>13:28hrs    | Over 1,000 customers                 | At 13:28hrs the Kafue West – 330kV Kafue Town line tripped on line differential protection which resulted in the loss of generation support of about 269MW from Maamba Collieries Limited. During the disturbance, the system frequency dropped from 49.99Hz to 49.85Hz while the 330kV voltage measured at Muzuma substation decreased from about 330kV to 281kV. About 120.3MW of load was lost on the IPS.                     |
| 4.  | Wednesday 21 February 2018<br>04:44hrs | System minutes                       | At 04:44hrs the Zambian IPS experienced a system disturbance when the 330kV Kariba South line 1 and Kariba South line 2 tripped on Directional over current and under frequency protection. ZESA confirmed that they had lost half of their grid.   |
| 5.  | Saturday 25 February 2018<br>14:34hrs  | System minutes                       | At 14:34Hrs the Zambian IPS experienced a system disturbance following the tripping of 400/330kV 450MVA Transformer 3 at Insukamini on DT neutral voltage displacement. This resulted in the ZESA control area separating from the Eskom control area hence resulting into a supply deficit on the northern SAPP region. Under frequency stage 1 protection operated.<br><br>All trading transactions were immediately suspended. |
| 6.  | Saturday 25 February 2018<br>19:09hrs  | End-use customer                     | At 19:09Hrs 330kV Lusaka West - Nambala 1 and 2 lines tripped out distance protection with immediate loss of load at Kalumbila Mine. ITPC, generator G1 tripped on over frequency protection and generator G2 offloaded on speed no load.   |
| 7.  | Saturday 03 March 2018<br>06:18hrs     | End-use customer                     | At 06:18hrs when Kalumbila Mine lost about 145 MW of load. Prior to the disturbance, the 330kV system voltage was at 347kV and 33kV voltage was at 34.7kV. After the disturbance, 330kV voltage rose to 405kV and 33kV voltage to 39kV. The disturbance was attributed to bad weather conditions (intensive lightning strikes).   |
| 8.  | Monday 12 March 2018<br>18:17hrs       | End-use customer                     | At 18:17hrs Kalumbila Mine lost about 81.6MW of load.<br><br>Kalumbila mine load dropped from 139.1MW to 57.5MW. During the disturbance 330kV system voltage rose from 347kV to 387.3kV and the 33kV voltage from 33.7kV to 38.7kV.   |
| 9.  | Wednesday 14 March 2018<br>10:34hrs    | System minutes                       | At 10:34hrs system disturbance observed following the tripping of generating machines in Eskom network. System frequency rose from 50.09Hz to 50.57Hz. The ZESCO - ZESA tie line experienced power swings from 134.2MW import to 356.2MW import. CEC-SNEL tie line experienced power swing from 100MW to 128MW export.  |

| No. | Date                              | Effect as defined in ZS 387 -2 B.5.1  | Description   |
|-----|-----------------------------------|---------------------------------------|---|
| 10. | Wednesday 14 March 2018 21:45hrs  | End-use customer                      | <p>At 21:45hrs Luano - 66kV Bancroft 2 line tripped in the CEC network.</p> <p>As a result, power swings on ZESA - ZESCO tie line were observed from 68.2MW import to 30.1MW export. System frequency rose to 49.93Hz from 49.84Hz. The IPS also experienced overvoltage conditions with voltage at Kitwe substation rising from 313kV to 331kV. CEC lost a load of 127.7MW.</p>  |
| 11. | Sunday 22 April 2018 19:03hrs     | System disturbance                    | <p>Circuit: 132kV Leopards Hill Roma line</p> <p>Description: Tripped on Distance protection Zone 1 Red phase, Fault Location of 17.3km.</p> <p>Finding: Cut conductor found at tower 66 on red phase, cross-arms on towers 64 and 65 pulled out of alignment.</p> <p>Impact: Lusaka Distribution network remained stable and no load restrictions were made.</p> <p>Restoration: Tuesday 24 April at 16:55hrs after replacing conductor and cross-arms on towers 63, 64 and 65.</p>  |
| 12. | Monday 07 May 2018 15:04hrs       | End-use customer                      | <p>Circuit: 220kV Michelo – Karavia Lines 1 and 2</p> <p>Description: Lines tripped out on Directional Over Power (DOP) Settings at 189MW</p> <p>Finding: Directional Over Power Trip</p> <p>Impact: Line was carrying 134MW before the event.</p> <p>Restoration:</p> <p>Michelo – 220kV Karavia 1 restored at 15:19hrs</p> <p>Michelo – 220kV Karavia 2 restored at 15:50hrs</p>  |
| 13. | Saturday 09 June 2018 11:13hrs    | End-use customer/ over 1000 customers | <p>Circuit: 220kV Michelo – Karavia line 1 and 2 (CEC – SNEL Tie line)</p> <p>Description: Tripped on Directional Over Power (DOP – 189MW)</p> <p>Finding: DOP triggered due to trip out of Inga Power Station in the SNEL network</p> <p>Impact: Line was carrying 130MW before event. Voltage at Kitwe rose up from 311kV to 326KV. Kalumbila mine lost 100MW on Over Voltage condition. A total of 20MW load was lost at Lumwana mine. Also another load was lost at the following stations: Zambezi, Lukulu, Mumbeshi Kabompo and Chavuma.</p> <p>Restoration:</p> <ul style="list-style-type: none"> <li>• Michelo – 220kV Karavia 1 restored at 11:28hrs</li> <li>• Michelo – 220kV Karavia 2 restored at 14:53hrs</li> </ul> |
| 14. | Saturday 09 June 2018 at 18:47hrs | Over 1000 customers                   | <p>Circuit: Transformers T1 and T2 at Roma Substation</p> <p>Description: T1 tripped on high winding temperature, and then T2 on Over Current.</p> <p>Finding: Winding Temperature trip on T2 which consequently tripped T2 on Over Current.</p> <p>Impact: Load demand of approximately 129.4 MW lost on Lusaka Distribution network.</p> <p>Restoration: Transformers restored at 19:10hrs</p>  |

| No. | Date                                  | Effect as defined in ZS 387 -2 B.5.1 | Description  |
|-----|---------------------------------------|--------------------------------------|--|
| 15. | Wednesday<br>27 June 2018<br>16:18hrs | Over 1000 customers                  | <p>Circuit: Leopards Hill 330kV Lines and Transformers</p> <p>Description: Loss of all 330kV lines and transformers at Leopards Hill substation.</p> <p>Finding: Caused by the operation of the 330kV Bus Bar protection due to a deficiency in the internal blocking logic on the protection device on the bus coupler. This was during pre-commissioning tests on the newly installed bus coupler current transformers</p> <p>Impact included the following:</p> <ul style="list-style-type: none"> <li>The system frequency, initially 49.87Hz at 16:16:01hours, increased to 54.3Hz at 16:18:47 and dropped to 50.2Hz at 16:18:51 as measured from KNBPS</li> <li>The system voltage monitored at Leopards Hill substation on the 330kV bus bar rose from 330.6kV at 16:17:08 to a maximum of 371.15kV at 16:21:23</li> <li>The ZESA - ZESCO tie line experienced a large surge in power flow from 71MW export to 533.3MW export at 16:18:48.</li> <li>Tripping of all the 330kV circuit breakers at Leopards Hill substation on breaker failure protection</li> <li>Loss of about 1626MW of load</li> </ul> <p>Restoration: completed by 19:00hrs</p> |
| 16. | Friday 29<br>June 2018 at<br>16:18hrs | Over 1000 customers                  | <p>Circuit: Leopards Hill - 88kV Waterworks line 2</p> <p>Description: Leopards Hill - 88kV Waterworks line 2 tripped and Auto-reclosed on distance protection zone. At Coventry -132kV Leopards Hill line tripped on backup protection.</p> <p>Lusaka West - 132kV Coventry tripped at 11:16hrs on Trip relay operated (100MW).</p> <p>At waterworks 88/33 kV transformers T1 and T5 CB 5TO and CB 5TRO also tripped.</p> <p>Finding: Disturbance caused by a Monkey shorting after climbing on Tower 6 from Leopards Hill substation.</p> <p>Description: Sub-transmission and distribution network system disturbance</p> <p>Impact: At Coventry Street substation 110MW Demand lost</p> <p>Restoration:</p> <ul style="list-style-type: none"> <li>Lusaka West - 132kV Coventry line restored at 11:34hrs.</li> <li>Coventry -132kV Leopards Hill line restored at 12:14hrs.</li> <li>At Coventry- 132/33kV T1A and T2A restored at 13:04hrs</li> <li>At Waterworks 88/33 kV T5 restored at 11:34hrs</li> <li>At Waterworks 88/33 kV T1 Restored at 11:34hrs</li> </ul>  |
| 17. | Tuesday 03<br>July 2018<br>15:25hrs   | Over 1000 customers                  | <p>At 15:25hrs at Leopards Hill substation 88kV Leopards Hill – Water Works lines 1 and 2 tripped on overcurrent and Earth fault.</p> <ul style="list-style-type: none"> <li>Loss of about 60.7MW of Load on the 88kV Network at Water Works substation due to a through fault on the Chalala feeder at Water Works Substation. The relay on the feeder was burnt.</li> <li>Substation restored at 16:12hrs</li> </ul>   |

| No. | Date                                       | Effect as defined in ZS 387 -2 B.5.1                  | Description   |
|-----|--|---|---|
| 18. | Wednesday<br>08 July 2018<br>09:28hrs      | End-use customers                                     | <p>At 09:28hrs at Lumwana substation 132kV circuits tripped out on overvoltage due to loss of Mining load at Kansanshi and Lumwana substation. Kansanshi Mine tripped due to an earth fault on 33kV mining feeder.</p> <ul style="list-style-type: none"> <li>Lumwana mine lost load of about 50MW and 150MW was lost at Kansanshi Mine. About 3MW load was lost on the 132kV Network at Lumwana on the North-western Grid.</li> <li>Loads restored by 09:55hrs</li> </ul>  |
| 19. | Thursday 12<br>July 2018<br>10:04hrs       | End-use customers                                     | <p>At 10:04hrs the 220kV Michelo - Karavia line 2 tripped.</p> <ul style="list-style-type: none"> <li>CEC network experienced a load loss of about 140MW</li> <li>The IPS was stabilised and loads restored by 13:00hrs</li> </ul>  |
| 20. | Thursday 12<br>July 2018<br>11:59hrs       | End-use customers                                     | <p>At 11:59hrs the 220kV Michelo - Karavia line 2 tripped.</p> <ul style="list-style-type: none"> <li>CEC network experienced a load loss of about 130MW</li> <li>The IPS was stabilised and loads restored by 10:22hrs the following day.</li> </ul>   |
| 21. | Tuesday 14<br>August 2018<br>23:14hrs      | Load loss on end-use customer and over 1000 customers | <p>At 23:14hrs system disturbance observed with tripping out of 330kV Kalumbila – Lumwana and Kansanshi- Lumwana lines on distance protection following the mechanical failure of the 33kV Reactor circuit breaker. Also the 330kV Msoro – Chipata West line tripped at both ends on overvoltage protection.</p> <ul style="list-style-type: none"> <li>Loss of about 45MW supply to Lumwana substation and 9.5MW supply to Chipata substation.</li> <li>330kV Msoro line was restored at 00:14hrs on 15<sup>th</sup> August. Lumwana substation was restored at 21:33hrs on 15<sup>th</sup> August, 2018.</li> </ul> |
| 22. | Tuesday 30<br>October,<br>2018<br>12:49hrs | 5.32  | <p>At 12:49hrs the Lusaka distribution network experienced a system disturbance. An increase in loading at Coventry Street Substation due to load transfers on distribution network resulted in trip out of the 132kV Coventry Street line circuit breaker CB 405 at Lusaka West Substation on directional overcurrent leaving Coventry street substation with only one source of supply at Leopards Hill remained as the only source of supply to Coventry Street Substation. At Coventry Street substation the Leopards Hill line circuit breaker CB 205 tripped at 12:50hrs on backup overcurrent protection.</p>  |

| No. | Date   | Effect as defined in ZS 387 -2 B.5.1 | Description   |
|-----|--|--------------------------------------|---|
| 23. | Wednesday<br>31 October,<br>2018<br>16:42hrs | 45.15                                | <p>At 16:42hrs the IPS experienced a system disturbance following the tripping of 330kV Kafue Town – Muzuma line on differential and distance Protection.</p> <ul style="list-style-type: none"> <li>▪ Tripping resulted in a loss of about 267MW generation after the trip out of generators G1 and G2 at Maamba Collieries Limited (MCL) Power Plant on over frequency.</li> <li>▪ Consequently, power swings were experienced on the ZESA tie line.</li> <li>▪ At the time of the system disturbance, NamPower were testing the HVDC after repair works and were importing about 110MW.</li> <li>▪ Lumwana mine lost load of about 50MW and 150MW was lost at Kansanshi Mine. About 3MW load was lost on the 132kV Network at Lumwana on the North-western Grid.</li> <li>▪ Loads were restored by 09:55hrs the following day.</li> </ul>  |
| 24. | Friday 2<br>November<br>2018,<br>10:53hrs    | 44.86                                | <p>At 10:53hrs the IPS experienced a system disturbance caused by the mechanical failure of support porcelain insulator of the line isolator marked 303 at Kitwe substation on the 330kV Kabwe line 3 resulting in the isolator to open on load.</p> <ul style="list-style-type: none"> <li>• This caused the operation of the 330kV bus zone protection tripping out Kabwe 3 line, 330kV bus coupler and Transformer T9 while Transformer T8AB tripped out on over current protection at Kitwe 330/220/11kV substation. Following the loss of 330/220kV Transformers at Kitwe substation, all the CEC load, ZESCO Copperbelt load and SNEL exports were supported from Luano resulting in Transformer T7AB, T8A and T9 to trip on over current protection.</li> <li>• ZESCO - ZESA tie line power flow swung from 37.78MW exports to 0MW. 330kV Kariba North - Kariba South 1 and 2 lines tripped out on over frequency protection.</li> <li>• System frequency rose from 50.13Hz to 55.4Hz (for 5 seconds) and stabilised at 50.25Hz.</li> <li>• System voltage at Kitwe rose from 316kV to 444.8kV. The resulting over voltage conditions on the power system resulted in loss of supply to North Western, Muchinga, Northern, Luapula, Eastern Provinces and parts of Lusaka and Central provinces as line tripped on Over Voltage protection</li> <li>• Approximately 1,210MW of load was lost.</li> <li>• Generation trip outs were as follows: <ul style="list-style-type: none"> <li>♦ Kafue Gorge: Units 2, 3 and 4 on Over Frequency protection.</li> <li>♦ Kariba North Bank: Units 5 and 6 on Over Frequency protection.</li> <li>♦ MCL: Units 1 and 2 Over Frequency protection.</li> <li>♦ ITPC: Unit 1 speed no Load.</li> <li>♦ NECL: All units (97MW) on under frequency</li> <li>♦ Victoria Falls : Unit B5</li> </ul> </li> <li>• Voltage Control was carried out by National Control Centre by switching out some 330kV lines on the IPS.</li> <li>• Supply was restored to the Copperbelt and parts of Lusaka by 12:15hrs, Northern, Central, Muchinga and Luapula provinces by 13:15hrs Eastern province by 13:24hrs, and North-Western by 13:29hrs.</li> </ul> |

| No. | Date                                    | Effect as defined in ZS 387 -2 B.5.1 | Description  |
|-----|---|--------------------------------------|--|
| 25. | Thursday 22 November 2018<br>15:48hrs   | 2.39                                 | <p>At 15:48hrs the Lusaka Distribution Network experienced a system disturbance following the tripping of 132kV Roma line, 132kV Coventry street line, and Transformers T2A and T1A 132kV circuit breakers from the 132kV bus bar on bus zone protection at Leopards Hill substation.</p> <ul style="list-style-type: none"> <li>Consequently, the 132kV Lusaka West - Coventry Street line tripped on over current protection resulting in the complete loss of supply to 132/33/11kV Coventry Street substation.</li> <li>Investigations revealed that the tripping was caused by a snapped blue phase jumper on 132kV Roma line bypass isolator which came in contact with the yellow phase jumper resulting into a phase to phase fault in the bus bar protected zone.</li> <li>Lusaka loads were restored by 16:11hrs.</li> </ul> |
| 26. | Tuesday, 25 December, 2018,<br>04:05hrs | 0.40                                 | <p>At 04:05hrs the IPS experienced a system disturbance due to the tripping of mine feeder CB 6LRO at Kansanshi substation, on earth fault protection.</p> <ul style="list-style-type: none"> <li>This was caused by a flashover on 33kV outdoor breaker due to water ingress.</li> <li>As a result, Kansanshi Mine lost load of approximately 100MW and consequently, 132kV Lumwana – Mufumbwe line tripped on overvoltage.</li> <li>CEC – SNEL tie line increased from 24.23MW exports to 46.53MW exports.</li> <li>ZESCO - ZESA tie line increased from 26MW exports to 176MW exports.</li> <li>Frequency rose from 49.88Hz to 50.06Hz and stabilised at 50.095Hz.</li> <li>System voltage at Kitwe rose from 315kV to 329.6kV.</li> <li>The IPS was normalised at 04:14hrs.</li> </ul>   |
| 27. | Tuesday, 25 December, 2018<br>10:17hrs  | 2.47                                 | <p>At 10:17hrs the IPS experienced a system disturbance due to the tripping of the 33kV smelter feeder at the Kansanshi Mine which resulted in mine losing about 140MW of load.</p> <ul style="list-style-type: none"> <li>CEC – SNEL tie line swung from 77MW exports to 85MW exports.</li> <li>ZESCO - ZESA tie line swung from 32MW exports to 193.4MW exports.</li> <li>System frequency rose from 49.87Hz to 50.16Hz and stabilised at 50.09Hz.</li> <li>The system voltage at Kitwe rose from 319.9kV to 328kV.</li> <li>Kansanshi Mine started loading the plant by 10:30hrs</li> <li>The IPS was normalised at 10:56hrs.</li> </ul>  |

## Appendix 8: Proposed KPIs for NSOEs

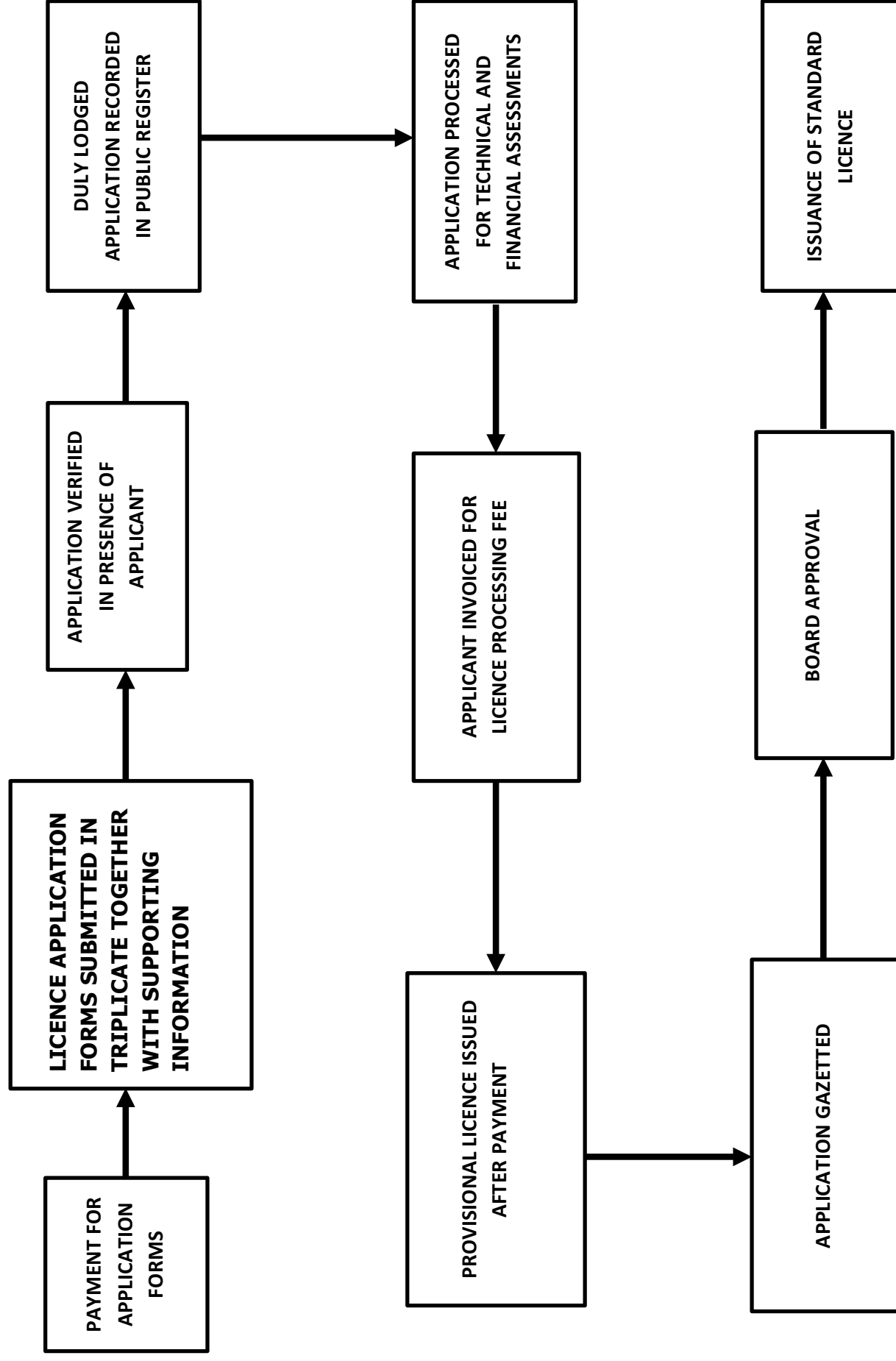
| No. | Key Performance Indicator   | Weight          | Target  |
|-----|---|-----------------|---|
| 1.  | <b>Financial performance indicators (ratios)</b><br>i. Liquidity ratios<br>ii. Profitability ratio<br>iii. Solvency ratios<br>iv. Efficiency/Cost management<br>v. Sustainability ratios  | Monitoring only | i. Liquidity ratios (current asset ratio, acid test ratio)<br>ii. Profitability ratios ( net profit, return on asset, return on equity, return on investment, gross profit margin, return on capital employed, asset turnover)<br>iii. Solvency ratios (debt-to-equity ratio, interest cover)<br>iv. Efficiency/Cost management (debtor days, creditor days, operating cost of electricity per MWh, operating cost per MWh installed, cost of electricity generation per MWh)<br>v. Sustainability ratios (average capital expenditure to net asset value, operational revenue to operational cost, total O&M to revenue)<br>The financial performance data will be collected for monitoring purposes only, in order to determine whether the utility is a going concern. |
| 2.  | <b>System Losses</b><br>i. Transmission losses<br>ii. Distributional losses   | 10%             | i. Transmission losses (6%)<br>ii. Distributional losses (10%)  |
| 3.  | <b>Customer Metering</b><br>i. Metered customers against the total number of customers;<br>ii. Percentage of customers on pre-paid meters;<br>iii. Replacement of faulty meters.<br>iv. Billing complaints received.<br>v. Standard Customer connection time<br>vi. Non-Standard Customer connection time | 15%             | i. All customers to be metered (100% metering);<br>ii. KPI to be monitored only;<br>iii. Within 48 hours.<br>iv. KPI to be monitored only<br>v. 30 days after payment is made.<br>vi. 90 days after payment is made.  |



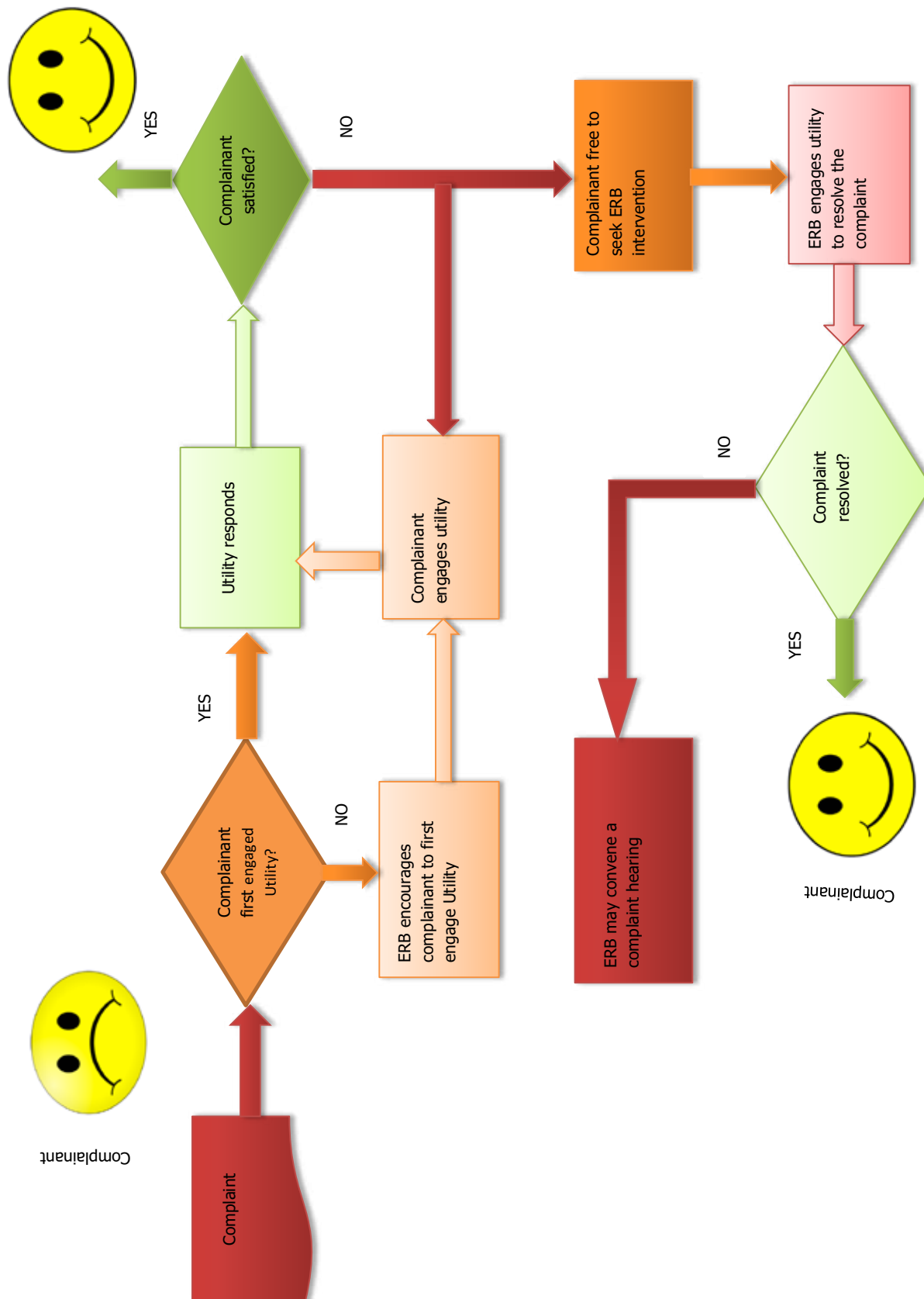
| No. | Key Performance Indicator  | Weight | Target   |
|-----|--|--------|--|
| 4.  | <b>Customer Service Office</b> <ul style="list-style-type: none"> <li>i. Existence of customer service office and officer(s), and a dedicated contact number;</li> <li>ii. Information/Tariff display</li> <li>iii. Complaint resolution Procedure</li> </ul>  | 10%    | <ul style="list-style-type: none"> <li>i. Utility has an office, officer and contact number (100%)</li> <li>ii. Display of customer information e.g. tariff schedule etc. (to be monitored only)</li> <li>iii. Display of Complaint resolution framework (to be monitored only)</li> </ul> |
| 5.  | <b>Customer Complaints Resolution Rate</b> <ul style="list-style-type: none"> <li>i. Complaint resolution rate; and</li> <li>ii. Complaints escalated to the regulator</li> </ul>  | 10%    | <ul style="list-style-type: none"> <li>i. Resolution of 95 percent of Complaints each month. (100%).</li> <li>ii. Number of complaints escalated to the ERB (to be monitored only).</li> </ul>   |
| 6.  | <b>Number and Frequency of outages</b> <ul style="list-style-type: none"> <li>i. Licencee is required to maintain an annual System Average Interruption Duration Index (SAIDI).</li> <li>ii. Licencee is required to maintain the System Average Interruption Frequency Index (SAIFI).</li> <li>iii. Licencee is required to maintain the Customer Average Interruption Duration Index (CAIDI).</li> </ul> | 25%    | <ul style="list-style-type: none"> <li>i. SAIDI dry season 27 hours or less, SAIDI wet season 36 hours</li> <li>ii. SAIFI wet season 5.5 times, dry season 5.0 times</li> <li>iii. CAIDI dry season 5 hours, wet season 7 hours</li> </ul>   |

| No.                | Key Performance Indicator   | Weight                           | Target   |                    |    |                                  |  |  |  |    |  |     |     |       |  |             |       |    |    |    |    |              |   |   |   |   |           |   |   |   |   |
|--------------------|---|----------------------------------|--|--------------------|----|----------------------------------|--|--|--|----|--|-----|-----|-------|--|-------------|-------|----|----|----|----|--------------|---|---|---|---|-----------|---|---|---|---|
| 7.                 | Service Restoration<br>( Average field staff response time)<br><br>Licencee required to restore service within stipulated time  | 10%                              | <table><tr><th colspan="2">Duration of outage</th><th colspan="4">Percentage of Customers affected</th></tr><tr><td colspan="2">5%</td><td>10%</td><td>20%</td><td>≥ 50%</td><td></td></tr><tr><td>0 ≤ 2 hours</td><td rowspan="3">Score</td><td>10</td><td>10</td><td>10</td><td>10</td></tr><tr><td>&gt;2 ≤ 6 hours</td><td>5</td><td>5</td><td>5</td><td>5</td></tr><tr><td>≥ 6 hours</td><td>0</td><td>0</td><td>0</td><td>0</td></tr></table> | Duration of outage |    | Percentage of Customers affected |  |  |  | 5% |  | 10% | 20% | ≥ 50% |  | 0 ≤ 2 hours | Score | 10 | 10 | 10 | 10 | >2 ≤ 6 hours | 5 | 5 | 5 | 5 | ≥ 6 hours | 0 | 0 | 0 | 0 |
| Duration of outage |   | Percentage of Customers affected |  |                    |    |                                  |  |  |  |    |  |     |     |       |  |             |       |    |    |    |    |              |   |   |   |   |           |   |   |   |   |
| 5%                 |   | 10%                              | 20%  | ≥ 50%              |    |                                  |  |  |  |    |  |     |     |       |  |             |       |    |    |    |    |              |   |   |   |   |           |   |   |   |   |
| 0 ≤ 2 hours        | Score   | 10                               | 10   | 10                 | 10 |                                  |  |  |  |    |  |     |     |       |  |             |       |    |    |    |    |              |   |   |   |   |           |   |   |   |   |
| >2 ≤ 6 hours       |   | 5                                | 5  | 5                  | 5  |                                  |  |  |  |    |  |     |     |       |  |             |       |    |    |    |    |              |   |   |   |   |           |   |   |   |   |
| ≥ 6 hours          |   | 0                                | 0  | 0                  | 0  |                                  |  |  |  |    |  |     |     |       |  |             |       |    |    |    |    |              |   |   |   |   |           |   |   |   |   |
| 8.                 | <b>Replacement of faulty equipment (Asset Reliability)</b><br><br>i. Replaced meters as a percentage of installed meters<br><br>ii. Replacement of distribution/supply transformers as a percentage of the total number of transformers | 10%                              | <br><br>i. No more than 0.25% of meters in service replaced.<br><br><br>ii. No more than 0.1% of the total distribution/ supply transformers replaced.   |                    |    |                                  |  |  |  |    |  |     |     |       |  |             |       |    |    |    |    |              |   |   |   |   |           |   |   |   |   |
| 9.                 | Safety  | 10%                              | <br><br>i. Maintain zero fatality on a quarterly basis<br><br>ii. Maintain zero Lost Time Injury (LTI) on a quarterly basis  |                    |    |                                  |  |  |  |    |  |     |     |       |  |             |       |    |    |    |    |              |   |   |   |   |           |   |   |   |   |

## Appendix 9: Licensing process flow chart



## Annex 1: ERB complaints procedure



## Annex 2 : ERB ZESCO approved electricity tariff structure in 2018.

| CUSTOMER CATEGORY  |                                   | TARIFFS  |
|--|-----------------------------------|----------|
| <b>1.METERED RESIDENTIAL(Prepaid) (capacity 15 kVA)</b>                  |                                   |          |
| R1 -Consumption up-to 200kWh in a month                                  | Energy charge/kWh)                | 0.15     |
| R2 - Consumption above 201 kWh in a month                                | Energy charge/kWh)                | 0.89     |
|  | Fixed Monthly Charge              | 18.23    |
| <b>2.COMMERCIAL TARIFFS (capacity 15kVA)</b>                             |                                   |          |
| Commercial   | Energy charge/kWh)                | 0.54     |
|  | Fixed Monthly Charge              | 96.41    |
| <b>3.SOCIAL SERVICES</b>   |                                   |          |
| Schools, Hospital, Orphanages, churches, water pumping & street lighting | Energy charge K/kWh               | 0.49     |
|  | Fixed Monthly Charge              | 83.84    |
| <b>4.MAXIMUM DEMAND TARIFFS</b>  |                                   |          |
| MD1- Capacity between 16 - 300 kVA                                       | MD Charge (K/kVA/Month)           | 24.45    |
|  | Energy Charge (K/kWh)             | 0.35     |
|  | Fixed Monthly Charge (K/ Month)   | 239.44   |
|  | Off Peak MD Charge (K/KVA/ Month) | 12.22    |
|  | Off Peak Energy Charge (K/ kWh)   | 0.26     |
|  | Peak MD Charge (K/KVA/ Month)     | 30.56    |
|  | Peak Energy Charge (K/kWh)        | 0.44     |
|  |                                   |          |
| MD2- Capacity 301 to 2,000 kVA   | MD Charge (K/kVA/Month)           | 45.73    |
|  | Energy Charge (K/kWh)             | 0.30     |
|  | Fixed Monthly Charge (K/ Month)   | 478.84   |
|  | Off Peak MD Charge (K/KVA/ Month) | 22.87    |
|  | Off Peak Energy Charge (K/ kWh)   | 0.23     |
|  | Peak MD Charge (K/KVA/ Month)     | 57.17    |
|  | Peak Energy Charge (K/kWh)        | 0.37     |
|  |                                   |          |
| MD3- Capacity 2,001 to 7,500kVA  | MD Charge (K/kVA/Month)           | 73.06    |
|  | Energy Charge (K/kWh)             | 0.25     |
|  | Fixed Monthly Charge (K/ Month)   | 1,014.55 |
|  | Off Peak MD Charge (K/KVA/ Month) | 36.52    |

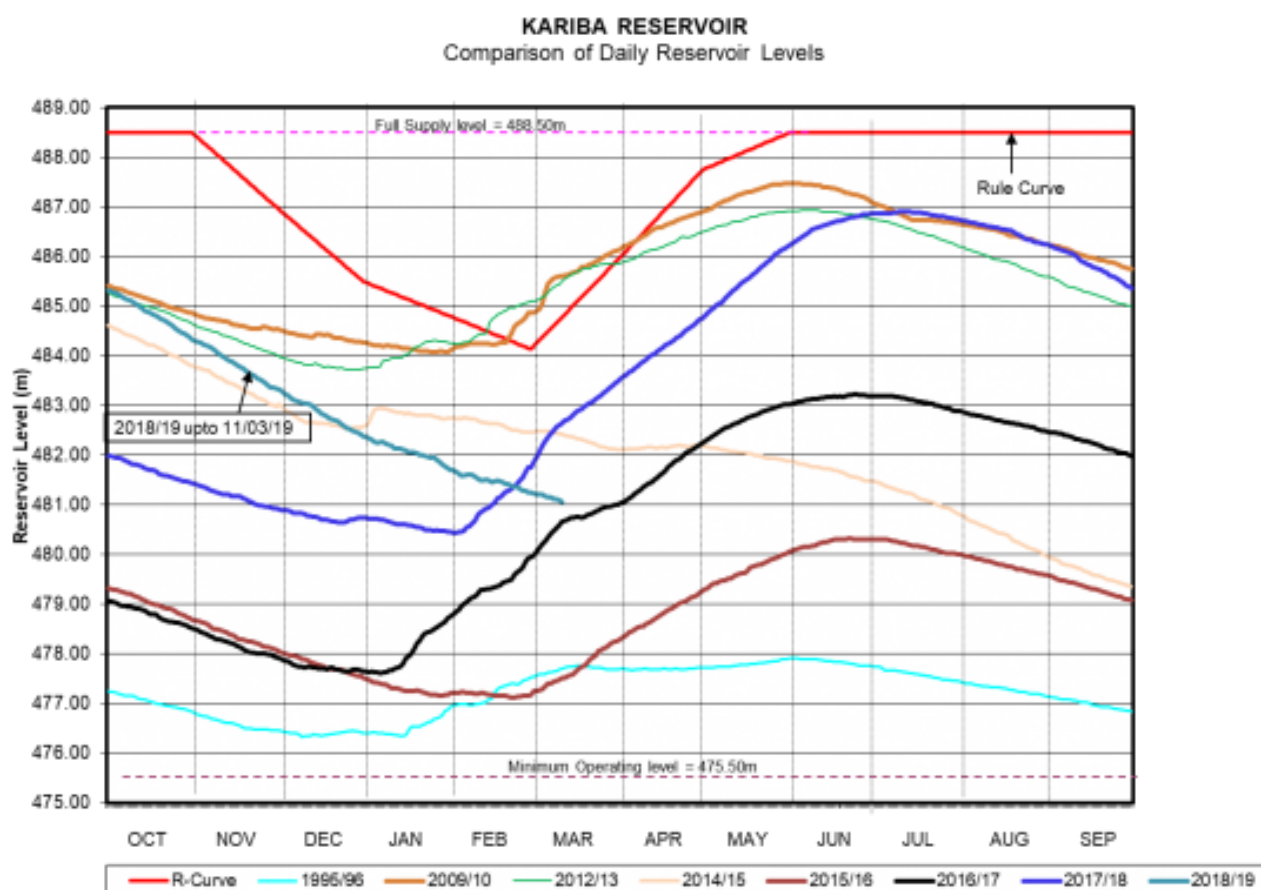
| CUSTOMER CATEGORY   |                                   | TARIFFS  |
|---|-----------------------------------|----------|
|   | Off Peak Energy Charge (K/kWh)    | 0.18     |
|   | Peak MD Charge (K/KVA/ Month)     | 91.33    |
|   | Peak Energy Charge (K/kWh)        | 0.30     |
|   |                                   |          |
| MD4 - Capacity above 7500 kVA up to 25,000 kVA  | MD Charge (K/kVA/Month)           | 73.47    |
|   | Energy Charge (K/kWh)             | 0.21     |
|   | Fixed Monthly Charge (K/ Month)   | 2,029.13 |
|   | Off Peak MD Charge (K/KVA/ Month) | 36.73    |
|   | Off Peak Energy Charge (K/kWh)    | 0.16     |
|   | Peak MD Charge (K/KVA/ Month)     | 91.84    |
|   | Peak Energy Charge (K/kWh)        | 0.25     |
| <b>NOTE; The above tariffs are:-</b><br><b>(a) Exclusive of 3% Government excise duty</b><br><b>(b) Exclusive of 16% Value Added Tax (VAT)</b><br><b>(c) All customers above 25 MVA are required to negotiate PPAs.</b> |                                   |          |

## Annex 3: ERB Approved Tariff Schedule for NWEK Customers in 2018

| CUSTOMER CATEGORY                         | 2018 TARIFF |
|---|-------------|
| <b>Residential Customers Tariffs</b>      |             |
| R1 - Consumption up-to 200 kWh in a month | 0.35        |
| R2 - Consumption above 200 kWh in a month | 0.89        |
| Fixed Monthly Charge                      | 18.23       |
| <b>Commercial Customers (15kVA)</b>       |             |
| Energy Charge                             | 0.71        |
| Capacity Charge                           | 45.72       |
| Fixed Monthly Charge                      | 131.25      |
| <b>Social Services</b>                    |             |
| Energy Charge                             | 0.71        |
| Capacity Charge                           | 131.25      |



## Annex 4: Water levels at Lake Kariba 1995/96 - 2018/19 rainy seasons



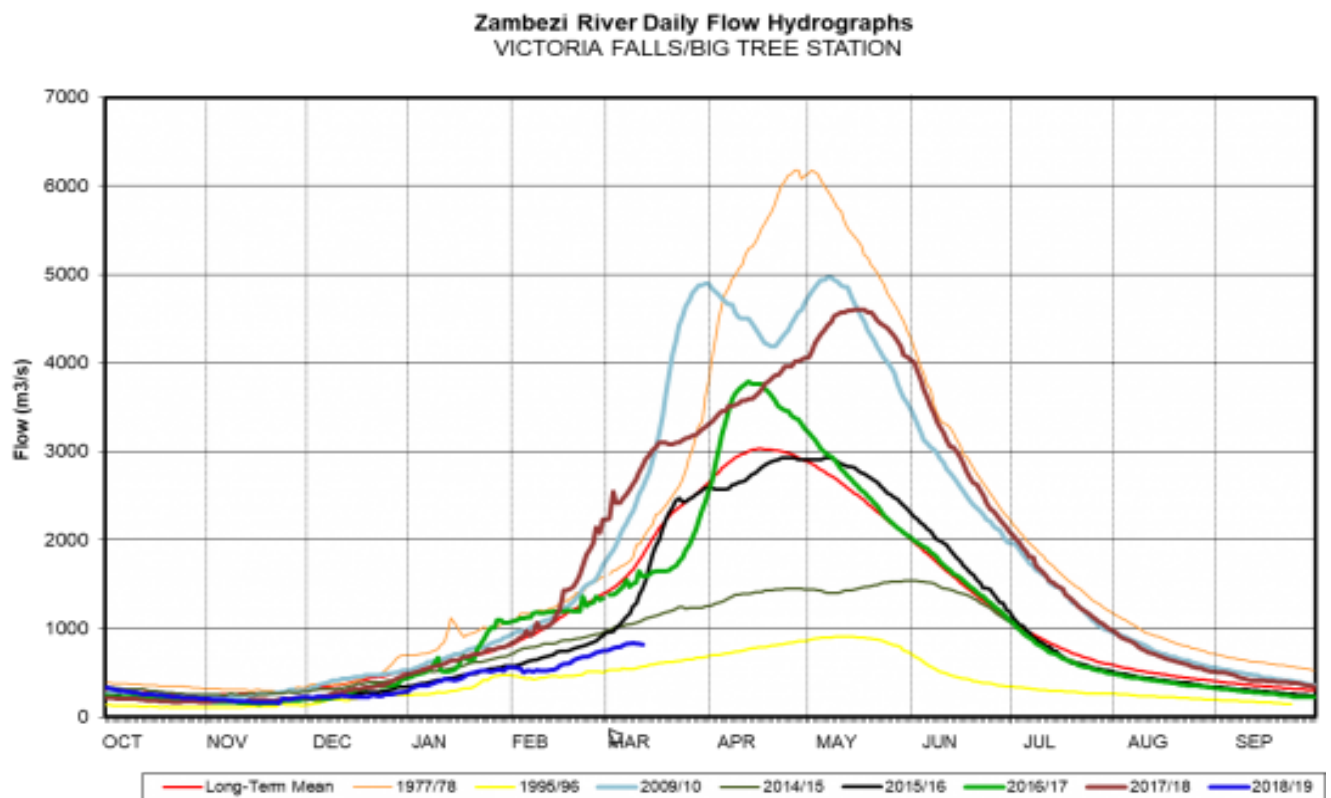
Source: Zambezi River Authority website

## Annex 5: Comparison of water levels March 2017 and March 2018

| Day | March 2017     |                 | March 2018     |                 |
|-----|----------------|-----------------|----------------|-----------------|
|     | Lake Level (m) | Percentage full | Lake Level (m) | Percentage full |
| 1   | 479.99         | 32%             | 481.87         | 46%             |
| 2   | 480.06         | 32%             | 481.97         | 47%             |
| 3   | 480.13         | 33%             | 482.08         | 48%             |
| 4   | 480.20         | 33%             | 482.18         | 48%             |
| 5   | 480.26         | 34%             | 482.29         | 49%             |
| 6   | 480.35         | 34%             | 482.36         | 50%             |
| 7   | 480.41         | 35%             | 482.43         | 50%             |
| 8   | 480.47         | 35%             | 482.49         | 51%             |
| 9   | 480.53         | 36%             | 482.56         | 51%             |
| 10  | 480.58         | 36%             | 482.60         | 52%             |
| 11  | 480.66         | 37%             | 482.64         | 52%             |

Source: Zambezi River Authority

## Annex 6: Zambezi River Daily Flow Hydrographs at Victoria Falls/ Big Tree Station



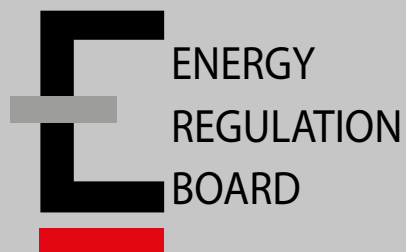
Source: Zambezi River Authority website

## Annex 7: SAPP transmission lines projects, 2018

| SAPP project name  | 2018 update/ progress   |
|--|---|
| Mozambique – Zambia interconnector                               | <p>The co-ordination activities of both the LIDAR survey and Geotechnical Investigations are ongoing. Financial Modelling and Economic Analysis is in progress.</p> <p>The Final Scoping Report and the Draft Terms of Reference for specialist studies were submitted to the Zambian and Mozambican authorities.</p> |
| Kolwezi – Solwezi transmission line                              | The Preliminary Design Report was approved on the 13 <sup>th</sup> December 2018.   |
| Zimbabwe – Zambia – Botswana – Namibia interconnector (ZIZABONA) | The Final Technical, Financial and Economic Feasibility Reports have been completed and approved by the sponsors.   |
| Luapula Hydro Electric Scheme                                    | The Inception Report was submitted, with all comments from the Stakeholders addressed.  |







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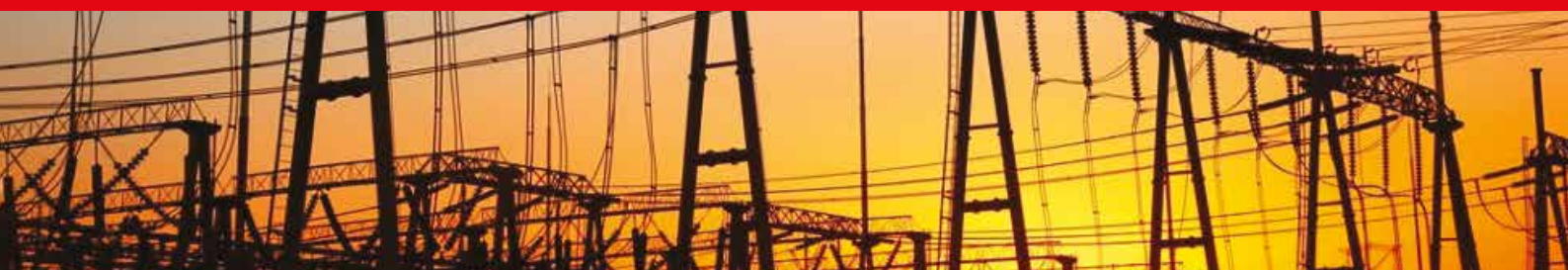
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