



2021

ENERGY

SECTOR REPORT



OUR VISION, OUR MISSION, CORE VALUES

OUR VISION

A proactive, firm and fair energy regulator

OUR MISSION

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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TABLE OF CONTENTS

EDITORIAL TEAM	I
LIST OF FIGURES	VIII
LIST OF TABLES	X
LIST OF APPENDICES.....	XII
LIST OF ANNEXES.....	XII
ABBREVIATIONS.....	XIII
UNITS OF MEASUREMENT	XV
ACKNOWLEDGEMENTS.....	XVI
FOREWORD	XVII
1.0 INTRODUCTION.....	1
1.1 Performance of the Global Energy Sector	2
1.2 Performance of the local petroleum subsector	2
1.3 Performance of the local electricity subsector	3
1.4 Performance of the local renewable energy subsector.....	3
1.5 Overview of the energy sector in Zambia.....	4
1.6 Contribution of the Electricity Subsector to GDP	5
1.7 Structure of the Report	6
2.0 PETROLEUM SUB-SECTOR.....	7
2.1 Importation of fuel.....	7
2.1.1 Importation of petroleum feedstock.....	7
2.1.2 Importation of finished petroleum products.....	8
2.1.2.1 Importation of Petrol and Diesel by Government.....	8
2.1.1.2 Imports of finished petroleum products by OMCs	9
2.2 Operations at TAZAMA Pipelines Limited	9
2.2.1 TAZAMA throughput	10
2.2.2 Rehabilitation and Maintenance works at TAZAMA.....	10
2.3 Operations at INDENI Petroleum Refinery Company Limited	10
2.3.1 INDENI throughput.....	11
2.3.2 INDENI production of petroleum products.....	12
2.4 National consumption of petroleum products.....	12

2.4.1	Daily national average consumption of petroleum products.....	13
2.4.2	Daily national average consumption by Province.....	14
2.4.3	Consumption by economic sector	14
2.4.4	Consumption of diesel by economic sector	15
2.4.5	Consumption of petrol by economic sector.....	15
2.5	Market Share of Oil Marketing Companies	15
2.5.1	Market share for white products	16
2.5.2	Market share for Jet A-1	16
2.5.3	Market share for lubricants	17
2.5.4	Number of Retail Service Stations Operated by OMCs	18
2.5.5	Market share for LPG	18
2.5.6	LPG Bulk storage facilities	19
2.6	Pricing of Petroleum Products	19
2.6.1	Determinants of petroleum prices	20
2.6.2	Trends in the international oil prices in 2021.....	21
2.6.3	Trend in the exchange rate in 2021	22
2.6.4	Trends in the international oil prices and the exchange rate	23
2.6.5	Petroleum Pricing Mechanism in Zambia	23
2.6.5.1	Wholesale Price Build-up	24
2.6.5.2	Pump Price Build-up	24
2.7	The Energy fund.....	25
2.8	Annual Review of Petroleum Downstream Margins.....	25
2.9	Pricing Framework for Jet A-1.....	25
2.10	Domestic and Regional Fuel Prices	26
2.10.1	Domestic Fuel Pump Prices.....	26
2.10.2	Trends in domestic fuel prices.....	26
2.10.3	Regional Fuel Prices	26
2.11	Compliance of Licensees in the Petroleum Subsector.....	27
2.11.1	Petroleum Product Quality Monitoring	27
2.11.2	Petroleum Infrastructure Compliance.....	28
2.11.3	Environmental Impact Assessments	29
2.11.4	Key Performance Indicators for Petroleum Subsector.....	29

2.11.5 TAZAMA Pipelines Limited	29
2.11.6 INDENI Petroleum Refinery Limited	30
2.11.7 TAZAMA Petroleum Products Limited	31
2.11.8 Government owned storage depots for white products	31
2.11.9 Development of Guidelines in the Petroleum Subsector	33
2.11.10 Infrastructure grading of service stations	33
2.12 Fuel Marking Programme.....	34
2.13 Challenges in the Petroleum Subsector	35
2.13.1 Low Supply of petroleum feedstock	35
2.13.2 Distribution of Retail Site Networks.....	36
2.13.3 Illegal Fuel Vending	36
2.14 Outlook in the Petroleum Subsector.....	36
2.14.1 Government Reforms	36
2.14.2 Revised Pricing Cycle	36
2.14.3 Private Sector Led Petroleum Products Procurement	36
2.14.4 Enhanced National Petroleum Storage Capacity	36
2.14.5 Implementation of the Import Parity Pricing Model for Jet A-1.....	36
3.0 ELECTRICITY SUBSECTOR.....	37
3.1 Zambia's installed electricity generation capacity	37
3.2 Hydrological Situation in Zambia	38
3.3 National Electricity Generation Sent Out	40
3.3.1 Electricity Generation from Large Hydro Power Plants Owned by ZESCO.....	41
3.3.2 Electricity Generation from Mini-Hydro Power Plants Owned by ZESCO	41
3.3.3 Electricity generation from diesel power plants owned by ZESCO.....	42
3.3.4 Electricity generation from Independent Power Producers	43
3.4 Domestic and Regional Power Trading.....	43
3.4.1 Power Purchase and Supply Agreement	44
3.4.2 Trade on the Southern Africa Power Pool	44
3.4.3 ZESCO Electricity Imports and Exports	44
3.4.4 Electricity Generation and Consumption	45
3.4.5 Analysis of national electricity consumption by economic sector	46
3.5 Operational Performance of Electricity Entities.....	47

3.5.1 ZESCO Limited	47
3.5.1.1 ZESCO's performance on the KPI framework	48
3.5.1.2 Technical Performance - ZESCO	48
3.5.2 Rural Electrification Authority	49
3.5.2.1 Electricity Services Access Projects (ESAP)	50
3.5.2.2 Kasanjiku hydro Power Mini-Grid	50
3.5.2.3 Challenges Faced by the Authority in 2021	50
3.5.3 Copperbelt Energy Corporation Plc	50
3.5.3.1 Technical performance - CEC	51
3.5.3.2 Challenges Faced by CEC	52
3.5.4 Ndola Energy Company Limited	52
3.5.4.1 Technical Performance	53
3.5.4.2 Challenges faced by NECL	53
3.5.5 Lunsemfwa Hydro Power Company Limited	54
3.5.5.1 Technical performance	54
3.5.6 Maamba Collieries Limited	55
3.5.6.1 Technical performance	55
3.5.6.2 Challenges faced by MCL	55
3.5.7 North-Western Energy Corporation Limited	56
3.5.7.1 Challenges Faced by NWECC	56
3.5.8 Itzhi Tezhi Power Corporation	56
3.5.8.1 Technical performance	56
3.5.9 Zengamina Power Limited	57
3.5.9.1 Technical Performance	57
3.5.9.2 Challenges faced by Zengamina	57
3.5.9.3 Prospects for Zengamina	57
3.5.10 Dangote Industries Zambia Limited	57
3.5.10.1 Technical Performance	58
3.5.10.2 Challenges faced by Dangote	58
3.6 Operational Performance of the Interconnected Power System	59
3.7 National Network Expansion	59
3.8 National Network Constraints	59

3.9 Power Deficit and Load Management	59
3.10 Power Quality Management System	60
3.11 Power Quality Performance	60
3.12 Low Power Factor Surcharge Mechanism	61
3.13 Revision of the Electricity (Grid Code) Regulations, SI 79 of 2013 and Zambian Distribution Grid Code	61
3.14 Implementation of Wiring of Premises Standard – ZS 791	61
3.15 Key Performance Indicators for Non-State Owned Enterprises	62
3.16 Cost of Service Study	63
3.17 Outlook in the Electricity Subsector	64
3.17.1 New Power Generation Projects	64
3.17.1.1 Kafue Gorge Lower Hydro Power Station	64
3.17.1.2 Batoka Gorge Hydro Electric Scheme	64
3.17.1.3 Tariff Reforms (Multi-Year Tariff Framework)	65
3.17.1.4 Open Access	65
4.0 RENEWABLE ENERGY SUB-SECTOR	66
4.1 Renewable Energy in Zambia	66
4.2 Performance of entities in renewable energy	67
4.3 Bangweulu Power Company Limited	67
4.4 Ngonye PV Power Plant	67
4.5 CEC Solar Power Plant	67
4.6 Engie Power Corner Limited	68
4.7 Global Energy Transfer Feed - in Tariff (GETFIT) Programme	68
4.8 Challenges in the Renewable Energy Subsector	68
4.9 Outlook of the Renewable Energy Subsector	69
5.0 LICENSING IN THE ENERGY SECTOR	70
5.1 Types of Licences and Permits Issued by ERB	70
5.2 Performance of Licensing	71
5.2.1 Provisional Licences and Construction Permits Issued	71
5.2.2 Standard Licences	71
5.2.3 Update on Regulations Drafted and Enacted in the Energy Sector	72
5.2.4 Outlook on Licensing	72
5.2.5 Summary of the Energy Regulation (General) Regulations, 2021	

(Statutory Instrument No. 42 Of 2021)	72
5.2.5.1 Application to establish or operate an enterprise or carryout a licensed activity	72
5.2.5.2 Licensing Requirements	73
5.2.5.3 Additional criteria for grant of licence	73
5.2.5.4 Request for additional information for the licence	73
5.2.5.5 Technical Inspections for licence	73
5.2.5.6 Regulation 8: Fit and proper person	73
5.2.5.7 Objection to grant of Licence	74
5.2.5.8 Notice of rejection of application for Licence	74
5.2.5.9 Transfer, Pledge, Assign or Encumber of Licence	74
5.2.5.10 Application for permit to construct energy facility, installation or common carrier	74
5.2.5.11 Transfer, Pledge, Encumber or Assignment of permit	74
5.2.5.12 Excluded Activities	75
6.0 CONSUMER AND PUBLIC AFFAIRS	76
6.1 Stakeholder Engagements	76
6.2 Complaints Handling	76
6.3 Consumer Platforms for Lodging Complaints	78
6.4 Media Engagements	78
6.5 Social Media	79
6.6 OUTLOOK ON CONSUMER AFFAIRS	79
APPENDICES	80
ANNEXES	119

LIST OF FIGURES

Figure 2-1: Importation of petroleum feedstock, 2010 - 2021	8
Figure 2-2: Government imports of diesel and petrol, 2010-2021	8
Figure 2-3: Throughput for feedstock for TAZAMA pipelines, 2017-2021	10
Figure 2-4: Petroleum feedstock processed by INDENI, 2017 – 2021	11
Figure 2-5: Trend in INDENI production from 2016 to 2021	12
Figure 2-6: Proportion of national consumption by product, 2021	13
Figure 2-7: Diesel consumption by economic sector, 2020 - 2021	15
Figure 2-8: Petrol consumption by economic sector, 2020-2021	15
Figure 2-9: Market share for white petroleum products, 2020-2021	16
Figure 2-10: Market Share for Jet A-1, 2020 - 2021	17
Figure 2-11 Market share for Lubricants, 2020-2021	17
Figure 2-12: Number of Retail Service Stations Operated by OMCs as at 31st December, 2021	18
Figure 2-13: Retail LPG market share, 2020-2021	18
Figure 2-14: Global determinants of oil prices	21
Figure 2-15: Trend in international crude oil prices, January to December, 2021	22
Figure 2-16: Trend in the K/US\$ Exchange Rate during 2021	22
Figure 2-17: Trend in international oil prices and the exchange rate, 2021	23
Figure 2-18 Pump Price build-up of petroleum products	24
Figure 2-19: Trend in nominal pump prices 2000 to 2021	26
Figure 2-20: Regional petrol pump prices as at 31st December, 2021	27
Figure 2-21: Regional diesel pump prices as at 31st December, 2021	27
Figure 2 -22: Field Sampling	34
Figure 2 -23: Total number of samples collected and tested by province	35
Figure 3-1: Installed electricity generation by technology, 2021	38
Figure 3-2: Trend Analysis of Dam Levels at Kafue Gorge, 2021	39
Figure 3-3: Trend Analysis of Dam Levels at Kariba Complex, 2021	39
Figure 3-4: Trend Analysis of Dam Levels at Victoria Falls, 2021	40
Figure 3-5: Trend Analysis of Dam Levels at Itzhi-Tezhi, 2021	40

Figure 3-6: Trend in SAPP total traded volumes, Jan-Dec 2021	44
Figure 3-7: Imports and exports of electricity 2011 – 2021	45
Figure 3-8: Trend in electricity generation and consumption, 2016-2021	45
Figure 3-9: Proportion of electricity consumption per economic sector	47
Figure 3-10: ZESCO annual average KPI performance, 2021.....	48
Figure 3-11: CEC's electricity infrastructure compliance rate, 2020 - 2021	52
Figure 3-12: NECL's electricity infrastructure compliance rate, 2020 - 2021	53
Figure 3-13: NWECC percentage compliance rate, 2020 - 2021	56
Figure 3-14: Dangote electricity infrastructure compliance rate, 2016 - 2021	58
Figure 3-15: Weekly Average Load Management, 2021	60
Figure 3-17 Proposed Dam Site for Batoka Gorge Hydro Electric Scheme	65

LIST OF TABLES

Table 1-1: Gross Value Added by Industry at Constant 2010 Prices, Q1 2020- Q4** 2021	6
Table 2-1: OMCs importation of finished petroleum products, 2016-2021	9
Table 2-2: National petroleum consumption, 2020 - 2021	12
Table 2-3: Daily average consumption, 2020 - 2021	13
Table 2-4: Provincial average daily consumption of diesel, kerosene and petrol, 2021.....	14
Table: 2-5 OMCs LPG Bulk Storage facilities, 2021	19
Table 2-6: Roles of the players in the petroleum supply chain	20
Table 2-7: Wholesale price build-up	24
Table 2-8: Pump price build-up statutory fees	25
Table 2-9: December 2021 fuel pump price adjustment	26
Table 2-10: Petroleum Products Sample Test Results	28
Table 2 -11: Results of Petroleum Infrastructure Compliance Monitoring	28
Table 2-12: Reviewed EIAs for proposed energy projects by subsector	29
Table 2-13: TAZAMA's Performance against KPIs	30
Table 2-14: INDENI's Performance against KPIs	30
Table 2-15: TPPLs Performance against KPIs	31
Table 2-16: Status of the construction of GRZ fuel depots as at 31st December, 2021	32
Table 2-17: Grading Key for fuel Service Stations	33
Table 2-18: Results of the Fuel Marking exercise by Province	35
Table 3-1: National installed generation capacity in MW, 2020 – 2021	37
Table 3-2: Main Reservoir Water Dam Levels – (January to December, 2021)	38
Table 3-3: Electricity Generation from Large Hydro Power Plants Owned by ZESCO in GWh, 2010 - 2021	41
Table 3-4: Electricity Generation from Mini-Hydro Power Plants Owned by ZESCO in GWh, 2010-2021	42
Table 3-5: Electricity generation from diesel power plants owned by ZESCO in GWh, 2010-2021	42
Table 3-6: Electricity Generation from Independent Power Producers in GWh, 2013-2021	43
Table 3-7: Electricity consumption by economic sector, 2020 – 2021	46
Table 3-8: ZESCO's KPI framework January 2020 - December 2022.....	47
Table 3-9: ZESCO's Infrastructure Percentage Compliance 2017-2021	49

Table 3-10: Projects implemented by REA in 2021	49
Table 3-11: CEC Installed capacity, 2021	51
Table 3-12: Purchases and Sales of Electricity by CEC, 2021	51
Table 3-13: CEC's Infrastructure Compliance rates, 2017-2021	51
Table 3-14: NECL Percentage Compliance, 2017-2021	53
Table 3-15: LHPC's Percentage Compliance, 2017-2021	54
Table 3-16: MCL's Percentage Compliance, 2018-2021	55
Table 3-17: ITPC's Percentage Compliance, 2017-2021	57
Table 3-18: Network Constraints and Contingencies, 2021.....	59
Table 3-19: Progress on installation of PQR as at 31st December 2021.....	60
Table 3-20: Summary of Power Quality Performance, 2020 - 2021	61
Table 3-21: Technical KPIs Assessments of Non-SOE, 2020 - 2021	63
Table 5-1: Types of licences issued by the ERB and their durations	70
Table 5-2: Provisional licences issued 2020 - 2021	71
Table 5-3: Standard licences per type 2020 - 2021	71
Table 6-1: Stakeholder Engagements in 2021	76
Table 6-2 Type of complaints received in 2021.....	77
Table 6-3: 2021 Complaints Resolution Rate by Sub-sector	77
Table 6-4: Number of Complaints Heard during Complaints Meetings - 2021	78
Table 6-5: Media Activities in 2021	78

LIST OF APPENDICES

Appendix 1 Retail sites as at December 2021.....	80
Appendix 2: Petroleum value chain.....	82
Appendix 3: Licence application Form	83
Appendix 4: Declaration of availability of funds Form.....	85
Appendix 5: Components of the Cost Plus Model	87
Appendix 6 Installed electricity generation mix in Zambia in 2021	90
Appendix 7 Structure of Electricity Supply Industry in Zambia	91
Appendix 8 ZESCO KPIs for the year 2020- 2022	92
APPENDIX 9 - Major System Disturbances Recorded in 2021	96
Appendix 10 Approved KPIs for NSOEs	113
Appendix 11 ERB Licensing Process flow chart	114
Appendix 12 ERB complaints handling procedure	115
Appendix 13: Applicable Tariffs Schedule for ZESCO in 2021	116
Appendix 14: Applicable Tariffs Schedule for NWECA in 2021	118

LIST OF ANNEXES

Annex 1 ERB Electricity Tariff Determination Methodology	119
Annex 2: Consumer rights and Obligations	120

ABBREVIATIONS

AfDB	African Development Bank
BOZ	Bank of Zambia
CEC	Copperbelt Energy Corporation Plc
CoSS	Cost of Service Study
COVID-19	Corona Virus Disease - 2019
EF	Energy Fund
EIA	Environmental Impact Assessment
ERB	Energy Regulation Board
ESR	Energy Sector Report
ESI	Electricity Supply Industry
EU	European Union
GETFIT	Global Energy Transfer Feed in Tariff
GRZ	Government of the Republic of Zambia
HFO	Heavy Fuel Oil
IAEREP	Increased Access to Electricity and Renewable Energy Production
IDC	Industrial Development Corporation
IEA	International Energy Agency
IMF	International Monetary Fund
INDENI	INDENI Petroleum Refinery Company Limited
IPP	Independent Power Producer
IPS	Interconnected Power System
IFC	International Finance Corporation
KFGPS	Kafue Gorge Power Station
KNB	Kariba North Bank
KNBEPC	Kariba North Bank Extension Power Corporation Limited
KNBPS	Kariba North Bank Power Station
KPI	Key Performance Indicator
LHPC	Lunsemfwa Hydropower Company Limited
LPG	Liquefied Petroleum Gas
LSGO	Low Sulphur Gasoil
MCL	Maamba Collieries Limited
MD	Maximum Demand
MoE	Ministry of Energy
NECL	Ndola Energy Company Limited

NEP	National Energy Policy
NFT	Ndola Fuel Terminal
NWEC	North Western Energy Corporation Limited
OMC	Oil Marketing Company
OPEC	Organisation of the Petroleum Exporting Countries
PPA	Power Purchase Agreement
PQ	Power Quality
PQD	Power Quality Directives
PQMS	Power Quality Management System
PSA	Power Supply Agreement
SADC	Southern African Development Community
SAPP	Southern African Power Pool
UPP	Uniform Pump Price
VFPS	Victoria Falls Power Station
TAZAMA	TAZAMA Pipelines Limited
TPPL	TAZAMA Petroleum Products Limited
ZABS	Zambia Bureau of Standards
ZEMA	Zambia Environmental Management Agency
ZSA	Zambia Statistics Agency
ZPL	Zengamina Power Company Limited
ZESCO	ZESCO Limited

UNITS OF MEASUREMENT

Bbl	Barrels of oil
GWh	Giga Watt-hour
K	Zambian Kwacha
Km	Kilometre
kV	Kilo Volt
kVA	Kilo Volt Amperes
kW	Kilo Watt
kWh	Kilo Watt-hour
m/bd	million barrels per day
MW	Mega Watt
MWh	Mega Watt-hour
MT	Metric Tonne
m ³	Cubic Meters
US\$	United States of America dollar

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Ndola Energy Company Limited
North Western Energy Corporation Limited
Office for Promotion of Private Power Investment
Oil Marketing Companies
Road Transport and Safety Agency
Rural Electrification Authority
Southern African Power Pool
TAZAMA Pipelines Limited
TAZAMA Petroleum Products Limited
Zambia Atomic Energy Agency
Zambia Statistics Agency
Zengamina Power Limited
ZESCO Limited

FOREWORD



The energy sector is one of the main drivers of the economy without which much of the development the country has experienced would not have been possible. The past year has seen numerous developments in the energy sector with many lessons learnt. It is my pleasure to present the 2021 Energy Sector Report (ESR), the flagship publication of the Energy Regulation Board (ERB) that captures key highlights of all the notable achievements that have taken place in the petroleum, electricity and renewable energy subsectors.

At policy level, Statutory Instrument No. 42 of 2021, 'the Energy Regulation (General) Regulations' was issued in 2021 to complement the implementation of the Energy Regulation Act No. 12 of 2019 and the Electricity Act No. 11 of 2019. These Regulations are aimed at enhancing the regulatory mandate of the ERB and making it more responsive to the licensing needs of various stakeholders in the sector.

In the electricity subsector, the much anticipated Electricity Cost of Service Study (CoSS) which commenced in December 2019 was successfully completed in December 2021. The study was undertaken by Energy Market and Regulatory Consultants (EMRC) of the United Kingdom with financial support from the African Development Bank (AfDB). The findings of the study were submitted to the Government of the Republic of Zambia for policy direction on the recommendations.

During the year, the ERB received four electricity tariff applications, of which, three (3) were duly lodged. The ERB will finalise the review of the tariff applications and render its decision in 2022.

The past year highlighted a 16.3 percent increase in electricity generation from 15,159 GWh in 2020 to 17,636 GWh in 2021. This increase was attributed to the improved hydrology and increased generation capacity. Looking forward, there are positive prospects for increased electricity generation as the ERB issued at least 33 construction permits to mini grid operators in 2021. These operators included Engie Power Corner with 29 construction permits and Renewable Energy and Water Solutions Limited (RENWASOL) Zambia, under Solar 23, with four construction permits, both of which are operating under the Increased Access to Electricity and Renewable Energy Production (IAEREP) Programme with the support from the European Union (EU). Additionally, renewable energy prospects remain optimistic in 2022 with numerous projects earmarked for development under Beyond the Grid Fund Africa (BGFA) and more power plants to be constructed by Engie Power Corner.

In the petroleum subsector, there were two petroleum price reviews implemented. The first was in January 2021 when the wholesale price of petrol, diesel and Low Sulphur Gasoil (LSGO) were adjusted upwards, while maintaining the pump prices constant. This was achieved through the suspension of the Value Added Tax (VAT) through Statutory Instrument No. 125 of 2020. Further, Excise Duty on petrol was reduced by K1.43/litre and removed on diesel through Statutory Instrument

No. 5 of 2021. It is worth noting that, the constant fuel prices on the domestic market were sustained by Government subsidies in the form of price support that was issued on contract basis to some Oil Marketing Companies (OMCs). However, the price support to OMCs was discontinued when the contracts elapsed in December 2021. As a result, the second petroleum price review in December 2021 led to an upward adjustment of both the wholesale and national pump prices.

On the other hand, international oil prices generally increased throughout the course of the year while the Kwacha gradually appreciated against the United States Dollar from K22.61/US\$ recorded in June 2021 to close the year at K16.81/US\$. For this reason, the possible reduction in the pump prices which could have resulted from the appreciation of the Kwacha against the United States Dollar in the month of December 2021 was averted by the continuous increase in the international oil prices.

Towards the end of the year, reforms were pronounced in which INDENI would be put on care and maintenance and refining of petroleum feed stock would cease in the upstream. In addition, a policy directive was made that TAZAMA pipeline would only facilitate the transportation of Low Sulphur Gasoil (LSGO). These changes are expected to result in the reduction in the cycle of petroleum price reviews from sixty (60) days (i.e. petroleum feedstock cargo consumption period) to thirty (30) days in order to be cost reflective and responsive to the movement in the international oil prices and the exchange rate. Thus, looking to 2022, the ERB will be carrying out monthly petroleum price reviews.

I trust that this publication will provide useful information and statistics on the developments, opportunities and challenges experienced in the energy sector this past year. As the ERB, we hope that this information will serve as a useful input into the development process and we shall endeavor to work collaboratively with all our stakeholders for the betterment of the energy sector and the economy as a whole.

Eng. Yohane Mukabe
Director General

July 2022

1.0 INTRODUCTION

The global economic growth was estimated to have increased to 5.9 percent in 2021 from a recession of 4.3 percent experienced in 2020¹. The growth in the global economy was the fastest post-recession pace in 80 years, largely because of strong rebounds from a few major economies. Further, increased spending by governments and provision of liquidity by central banks aided the recovery¹. However, many emerging markets and developing economies continued to struggle with the COVID-19 pandemic and its aftermath². As at October 2021, advanced economies had achieved a COVID-19 vaccination rate of 58.0 percent compared to about 36.0 percent in emerging market economies and less than 5 percent in developing countries. The primary constraints in vaccination in developing countries were supply and distribution¹. Among low-income economies, where vaccination has lagged, the effects of the pandemic reversed poverty reduction gains and aggravated food insecurity among other long-standing challenges.

In Sub-Saharan Africa, economic growth was projected to increase to 2.8 percent compared to 2.4 percent contraction in 2020. This growth was underpinned by stronger external demand, mainly from China and the United States, higher commodity prices, and containment of COVID-19. Many industrial and agricultural commodity exporting countries experienced deep contractions in 2020. Activity in the three largest economies in Africa—Angola, Nigeria, and South Africa partially recovered. Foreign direct investments in the region have been resilient, recouping about the pre-pandemic levels and workers' remittances to the region had held up better than expected³.

The Zambian economy was projected to grow by 3.3 percent in 2021 against a contraction of 2.8 percent recorded in 2020. The rebound of the economy in 2021 was attributed to the relaxation of COVID-19 restrictions that allowed for the resumption of economic and other activities. Preliminary data indicates that the Gross Domestic Product (GDP) for the fourth quarter of 2021 grew by 2.1 percent against a contraction of 3.1 percent recorded in the same period in 2020 (ZSA, 2022). This growth was on account of positive growth in five sectors namely: Information and Communication (1.4%); Construction (1.1%); Public Administration (0.5%); Transport and Storage (0.5%); and Manufacturing (0.3%).

Overall, the annual inflation rate closed at 16.4 percent in December 2021 compared to 19.2 percent in the same period in 2020. In the fourth quarter of 2021, annual overall inflation rate declined sharply to an average of 18.9 percent from 23.7 percent in the third quarter. This was largely driven by the appreciation of the Kwacha against the US dollar and the dissipation of base effects, particularly for meat and poultry products⁴. The monthly interbank kwacha to dollar mid-rate exchange rate averaged K16.78/ US\$ in December 2021 compared to K21.30/US\$ in January, 2021. The Bank of Zambia (BOZ) attributed the appreciation to positive sentiments after a Staff-Level Agreement was reached with the International Monetary Fund (IMF).

Meanwhile, according to the BOZ the average prices of copper increased by 50.2 percent from US\$ 6,189.87/MT in 2020 to US\$ 9,297.98/MT in 2021. The increased demand in China due to the anticipated economic recovery, in view of COVID-19 vaccine rollouts, largely contributed to the price increase.

¹ <https://www.worldbank.org/en/news/press-release/2021/06/08/world-bank-global-economic-prospects-2021>

² 2022 Budget Speech by the Minister of Finance available at https://www.parliament.gov.zm/sites/default/files/images/publication_docs/BUDGET%20SPEECH%20_%202022.pdf

³ <https://thedocs.worldbank.org/en/doc/600223300a3685fe68016a484ee867fb-0350012021/related/Global-Economic-Prospect-Regional-Overview-SSA.pdf>

⁴ Bank of Zambia Monetary Policy Statement February, 2022.

1.1 Performance of the Global Energy Sector

In 2021, the International Energy Agency (IEA) estimated that the global energy demand increased by 4.6 percent, marginally offsetting the 4.0 percent contraction recorded in 2020⁵. The emerging markets and developing economies accounted for the largest proportion in growth at 70.0 percent. This followed lifting of restrictions and the recovery of the global economy that pushed energy use in 2021 above the pre- COVID-19 levels. In terms of energy demand by fuel type, oil was expected to increase by 6.2 percent in 2021.

Further preliminary report from IEA (2021) indicated that the demand for electricity was projected to increase by 4.5 percent in 2021. This growth was almost five times greater than the decline in 2020, cementing electricity's share in final energy demand above 20.0 percent. The share of renewables in electricity generation was projected to account for 30.0 percent in 2021 of the generation mix, the highest share since the beginning of the Industrial Revolution. Specifically, Solar PV and wind were expected to contribute two-thirds of renewables' growth. The renewable energy subsector was projected to steadily grow due to expected additional energy generation capacities. Comparably to electricity demand, coal was estimated to have increased by a 4.5 percent in 2021. China accounted for the largest share of this growth at 50.0 percent. Further, natural gas demand was set to grow by 3.2 percent in 2021, propelled by increasing demand in Asia, the Middle East and Russia⁴.

1.2 Performance of the local petroleum subsector

During the period under review the national consumption of petroleum products increased by 10.2 percent from 1,329,290.66 MT in 2020 to 1,464,822.66 MT in 2021. This growth was in line with the economic recovery in 2021. The consumption of diesel increased by 11.8 percent from 912,813.96 MT in 2020 to 1,020,201 MT in 2021. Equally, unleaded petrol increased by 16.9 percent to 396,661.37 MT in 2021 from 339,431.09 MT in 2020. Further Jet A-1 recorded an increase of 33.1 percent from 16,573.4 MT in 2020 to 22,056.9 MT in 2021. Furthermore, LPG recorded a marginal increase of 0.5 percent from 7,945 MT in 2020 to 7,981 MT in 2021. Meanwhile, Kerosene and Heavy Fuel Oil (HFO) recorded a decline in consumption of 66.2 percent and 65.8 percent in 2021 from 2020 respectively. The decline in consumption for HFO and kerosene was attributed to supply constraint from the INDENI Refinery. In addition, the availability of close substitutes for the two products negatively impacted consumption as consumers opted to switch to substitutes such as diesel, solar electric lamps and efficient cook stoves when the products were unavailable.

Crude oil prices increased in 2021 owing to the growing global petroleum demand that outstripped supply. The demand was driven by the easing of pandemic-related restrictions and a growing economy. The spot price of Brent crude oil, a global benchmark, averaged US\$ 70.68/bbl in 2021 compared to an average of US\$41.76/bbl in 2020, reflecting a price increase of 69.3 percent. Additionally, the average spot price of West Texas Intermediate (WTI) nearly doubled to US\$ 67.99/bbl in 2021 from US\$ 39.23/bbl in 2020. The price of Murban crude oil which is mainly used as a benchmark in Zambia, opened the year with an average of US\$54.93/bbl in January 2021 and closed at \$82.73/bbl in December 2021, reflecting an increase of 50.6 percent. The movement in international oil prices necessitated the ERB to adjust pump prices in December, 2021 for petrol by 20.1 percent from K17.62 to K21.16. Meanwhile, diesel increased by 29.2 percent from K15.59 to K20.15.

In the fourth quarter of 2021, Government pronounced reforms to restructure the petroleum subsector. These reforms included the conversion of TAZAMA Pipelines Limited (TAZAMA) from a petroleum feedstock pipeline carrier to transporting finished petroleum products (Low Sulphur Gasoil/ Diesel). Further, INDENI Petroleum Refinery was placed on care and maintenance. As a result, the national

⁵ <https://www.iea.org/reports/global-energy-review-2021?mode=overview>

petroleum products would now be met by the importation of finished petroleum products only. In line with this development, the pricing framework for petroleum products was revised downwards from 60 days to 30 days.

1.3 Performance of the local electricity subsector

In 2021 the national installed electricity capacity increased to 3,318.43 from 3,011.23 MW in 2020. This was attributed to the commissioning of 300 MW out of the total 750 MW installed capacity at Kafue Gorge Lower hydro power plant and the commissioning of 6 MW out of the 15 MW installed capacity at Lusiwasi Upper hydro power plant⁶. The national installed capacity is still dominated by hydro generation accounting for 81.5 percent from 79.6 percent in 2020. The national electricity generation sent out increased from 15,159 GWh in 2020 to 17,636 GWh in 2021 representing growth of 16.3 percent. Overall, hydro generation accounted for 16,072.9 GWh of the electricity produced in 2021 compared to 14,210.71 GWh in 2020 reflecting a 13.1 percent growth. This was attributed to improved rainfall patterns experienced in the 2020/2021 season and the increased installed capacity.

During the review period the CoSS was finalised. One of the key objectives of the study was the determination of economic costs of electricity supply in the country. Although, the study was delayed due to the outbreak of the COVID - 19 pandemic, it was successfully completed on 31st December, 2021. The dissemination of the findings and implementation of the recommendations of the study would be undertaken in 2022.

The Minister of Energy signed into law Statutory Instrument No. 42 of 2021, “The Energy Regulation (General) Regulations, 2021”. This paved way for the operationalisation of the Electricity Act No. 11 of 2019 and the Energy Regulation Act No. 12 of 2019.

1.4 Performance of the local renewable energy subsector

Under the support of the EU through the IAEREP programme which commenced in 2018, the ERB in April 2019 finalised the mini-grid regulatory framework. The package of the approved regulations includes licensing, grid encroachment, tariff and technical requirements for three categories of mini-grids: below 100kW, up to 1MW, and larger than 1MW.

The rationale of the mini-grid regulatory framework is to enhance the ease of doing business in the electricity sub-sector for private companies intending to invest in rural areas, by applying light-handed regulations to mini-grid operators. Following the enactment of the Energy Regulation Act No.12 of 2019 and the Electricity Act No. 11 of 2019, there was need to align the Board approved mini-grid regulatory framework with the new laws. In this regard, Terms of Reference were submitted to the Ministry of Energy, for review.

In addition to the mini-grid regulatory framework, ERB and IAEREP collaborated in the drafting of net-metering rules and the possible integration of the rules into the revised Zambian Distribution Grid Code. A sensitization workshop was held and techno-economic feasibility analysis was reviewed in 2021.

ERB also collaborated with the Zambia Bureau of Standards to develop draft regulation for stand-alone solar home systems, in order to ensure mandatory compliance by licensees and those importing stand-alone solar home systems for own use. Following the enactment of SI No.42 of 2021, the process remained a preserve of the Zambia Compulsory Standards Agency (ZCSA).

⁶ During the year, KGL and Lusiwasi Upper Hydro Power plants underwent commissioning tests.

Regarding biofuels, only one enterprise held the licence for the production of biofuels in 2021. Keen interest was however shown by potential biofuel producers.

1.5 Overview of the energy sector in Zambia

The energy sector in Zambia is overseen by the Ministry of Energy (MoE) which is responsible for policy formulation while the ERB is responsible for regulating the sector. The Energy Regulation Act No.12 of 2019 and the Electricity Act No.11 of 2019 mandates the ERB to develop regulatory procedures and systems to facilitate the regulation of the energy sector. The effective implementation of policy is achieved through collaborative effort by private and public players. The energy sector comprises three sub-sectors namely: Electricity, Petroleum and Renewable Energy.

The electricity sub-sectors in Zambia is dominated by ZESCO Limited (ZESCO) which is a vertically integrated utility that generates, transmits, and distributes electricity. Following the liberalization of the electricity subsector in 1995, the industry has seen an increase in the number of private investors. This includes Independent Power Producers (IPPs), Transmission Network Service Providers (TNSPs) and Distribution Network Service Providers (DNSPs) as well as mini - grid operators.

In 2021, the following private companies were operational: Copperbelt Energy Corporation Plc (CEC), Lunsemfwa Hydro Power Company (LHPC), North Western Energy Corporation Limited (NWECL), Ndola Energy Company Limited (NECL), Zengamina Power Limited (ZPL), Itezhi Tezhi Power Company Limited (ITPC), Maamba Collieries Limited (MCL), Dangote Industries Zambia Limited, Bangweulu Power Company Limited, and Ngonye Power Company Limited. ZESCO is the off taker of the majority of the power produced by IPPs and owns most of the generation, transmission and distribution Infrastructure in the country.

As at 31st December 2021, the total national installed electricity generation capacity stood at 3,318.4 MW of which 81.5 percent was hydro generation based. Meanwhile, the national population with access to electricity stood at 32.8 percent of which 70.8 percent was in urban and 8.1 percent in rural areas⁷.

The petroleum industry in Zambia is classified into upstream and downstream sub-sectors. The upstream sector refers to Government institutions responsible for the transportation, refining, storage and distribution of petroleum products in the country. These include TAZAMA Pipelines Limited (TAZAMA), INDENI Petroleum Refinery Company Limited (INDENI) and TAZAMA Petroleum Products Limited (TPPL). TAZAMA has the mandate to operate and maintain the 1,710 Km pipeline that was used in the transportation of petroleum feedstock from Dar es Salaam to Ndola. However, following the pronouncements to restructure the petroleum subsector, this will be converted to transporting finished petroleum products while INDENI was placed under care and maintenance. TPPL is in charge of operating and managing the country's petroleum storage facilities that distributes petroleum products to downstream players. During the year, there were six petroleum storage facilities located in Ndola, Lusaka, Mansa, Mpika, Mongu and Solwezi. Meanwhile, additional facilities in Lusaka and Chipata were under construction.

The downstream sector is composed of OMCs, dealers and transporters who are involved in the distribution of petroleum products to the end consumers. There were 460 filling stations as at 31st December 2021. Additionally, 138 OMCs and 143 transporters were registered under the same period. Diesel⁸ remains the most consumed petroleum product in the country accounting for 69.6 percent of the total demand in 2021. This was followed by petrol at 27.1 percent under the same

⁷ Zambia Demographic Health Survey (2018)

⁸ Includes LSGO

period. The other products namely Jet A-1, LPG, HFO and Kerosene account for the remaining 3.3 percent of the national consumption.

The renewable sector has undergone significant development and is dominated by hydro and solar technologies. Zambia has eight mini hydro power stations: Musonda falls power station (10MW) located in Luapula Province, Chishimba Falls power station (6MW) and Lunzua power station (14.8MW) located in Northern Province, Shiwang'andu power station (1MW) located in Muchinga, Lusiwasi Lower power station (12MW) and Lusiwasi Upper Power Station (15MW) located in Central Province, Zengamina power station (0.70MW) and Kasanjiku (0.64MW) power station located in North-western Province.

The solar industry is dominated by grid connected Bangweulu (54.3 MWp), Ngonye (34 MWp) located in Lusaka South Multi-Facility Economic Zone (LSMFEZ) and CEC's Kitwe Riverside (1MWp) solar power stations. Additionally, the existing solar off-grids include eight under Solera Power (0.01MWp, 0.015MWp, 0.024MWp, 0.025MWp, 0.024MWp, 0.024MWp, 0.015MWp, 0.024MWp), Standard Micro-Grid (0.01MWp), Chibwika Royal Establishment (0.032MWp) and Engie Power Corner (0.028MWp).

The Government of the Republic of Zambia has continued to support the uptake of renewable energy by ensuring an enabling environment, resulting in a swell in investment within the Renewable Energy sub-sector, with over 200 companies holding the licence to Manufacture, Supply, Installation and Maintenance of Renewable Energy generating Equipment.

1.6 Contribution of the Electricity Subsector to GDP

Overall, based on the ZSA Quarterly report for quarter four of 2021, the gross GDP was estimated at 142,676.80 million kwacha. The Electricity sector accounted for 1.85 percent share towards the GDP under the same period.

Table 1-1: Gross Value Added by Industry at Constant 2010 Prices, Q1 2020- Q4 2021**

Industry	(K' millions) 2020				(K' millions) 2021				Q4 Growth Rate (%)	% Contribution to growth
	Q1	Q2	Q3	Q4	Q1*	Q2*	Q3*	Q4**		
Agriculture, forestry and fishing	3,312.5	2,539.2	1,592.9	2,922.5	3,551.7	2,724.4	1,707.4	2,315.1	-20.8	-1.7
Mining and quarrying	3,597.6	3,874.6	3,927.5	3,904.0	3,518.4	3,580.1	3,561.7	3,682.5	-5.7	-0.6
Manufacturing	2,795.0	3,239.7	2,850.0	2,780.6	2,709.7	3,537.1	3,010.8	2,893.7	4.1	0.3
Electricity, gas, steam and air conditioning supply	531.6	579.9	614.2	602.8	606.8	650.4	675.1	691.3	14.7	0.3
Water supply; sewerage, waste management and remediation activities	83.2	86.0	88.6	89.6	87.0	88.4	90.0	90.8	1.4	0.0
Construction	3,147.7	3,159.6	3,809.7	3,524.8	3,156.3	3,874.9	4,176.2	3,922.1	11.3	1.1
Wholesale and retail trade; repair of motor vehicles and motorcycles	6,211.6	5,803.2	7,491.7	6,616.7	6,455.8	6,336.9	7,268.6	6,651.8	0.5	0.1
Transportation and storage	1,311.4	1,389.9	1,512.1	1,294.7	1,357.4	1,403.7	1,678.5	1,459.0	12.7	0.5
Accommodation and food service activities	478.0	543.9	489.5	536.2	461.9	600.6	555.1	577.6	7.7	0.1
Information and communication	1,126.5	2,162.1	2,343.0	2,741.8	1,392.0	2,629.7	2,753.4	3,243.7	18.3	1.4
Financial and insurance activities	1,606.2	1,740.4	1,780.5	1,613.5	1,931.2	1,827.5	1,903.4	1,521.5	-5.7	-0.3
Real estate activities	1,244.0	1,255.0	1,266.1	1,277.3	1,288.8	1,300.5	1,312.3	1,324.1	3.7	0.1
Professional, scientific and technical activities	701.3	680.5	637.4	672.4	707.7	723.1	631.7	674.3	0.3	0.0
Administrative and support service activities	337.6	352.3	352.3	342.6	337.8	392.3	358.2	347.4	1.4	0.0
Public administration and defense; compulsory social security	1,918.1	1,545.8	1,488.9	1,501.8	1,517.9	1,547.4	1,661.6	1,683.7	12.1	0.5
Education	2,776.0	1,849.1	2,133.4	2,162.8	2,178.1	2,227.6	2,223.0	2,241.7	3.6	0.2
Human health and social work activities	625.2	637.2	650.0	655.0	656.4	656.7	660.1	658.4	0.5	0.0
Arts, entertainment and recreation	50.4	36.9	35.1	42.6	28.1	53.8	65.0	59.7	40.1	0.0
Other service activities	280.7	283.2	285.7	288.2	290.8	293.4	296.1	298.8	2.7	0.0
Total Gross Value Added for the economy	32,134.7	31,758.6	33,348.6	33,569.6	32,233.9	34,448.6	34,588.1	34,305.8	2.2	2.1
Taxes less subsidies	1,651.0	1,542.5	1,991.3	1,758.7	1,716.0	1,684.3	1,932.0	1,768.1	0.5	0.0
Total for the economy, at market prices	33,785.7	33,301.1	35,339.9	35,328.3	33,949.9	36,132.9	36,520.1	36,073.9	2.1	2.1

*Revised **First release Source: ZamStats, National Accounts

1.7 Structure of the Report

This report is arranged in six sections as follows: section one outlines the introduction, while section two highlights the performance and outlook of the petroleum subsector. Section three discusses the performance and the outlook in the electricity subsector and section four discusses the performance of the renewable energy subsector. Section five discusses licensing in the energy sector and section six discusses consumer affairs issues.

2.0 PETROLEUM SUB-SECTOR

This section provides details of the petroleum value chain, supply of national fuel requirements, operations of state owned enterprises, national consumption of fuel, market share of OMCs and pricing of petroleum products. Further, the section also highlights the challenges and outlook of the petroleum subsector.



Fuel tankers off-loading at a fuel depot

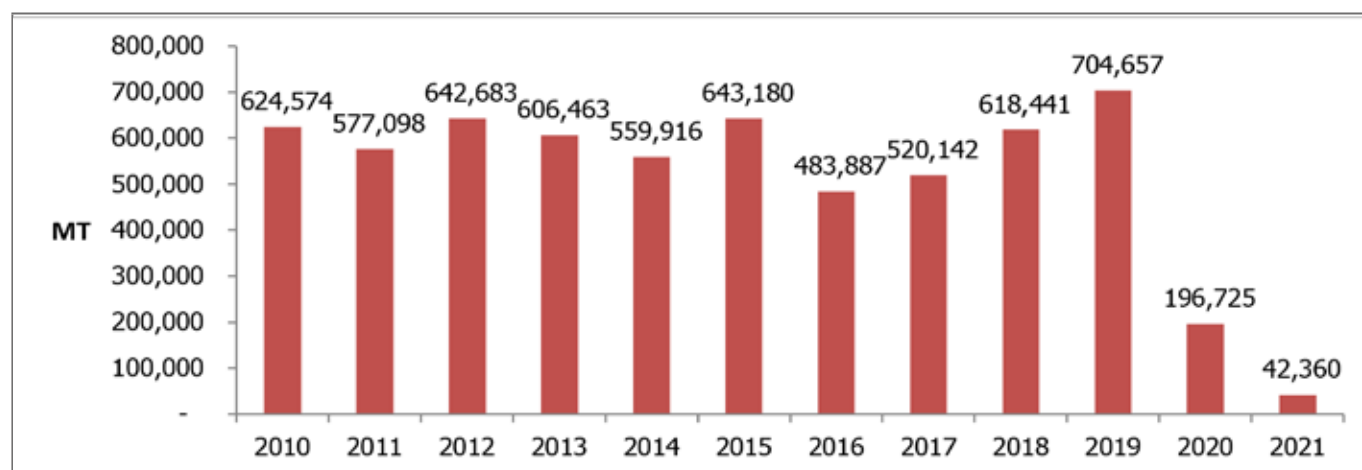
2.1 Importation of fuel

Generally Zambia has been importing fuel to meet its national consumption. Traditionally, the importation comprised two modes; namely petroleum feedstock and finished petroleum products until November 2021 when Government announced reforms to restructure the petroleum sub-sector. One of the measures was to switch to importing only finished petroleum products. The imported petroleum feedstock was processed into refined petroleum products at INDENI. In 2021, the refinery was operational for 26.9 days and on shutdown for 338.1 days of which 36 days were due to maintenance works while the rest was attributed to lack of petroleum feedstock. However, in the period under review, fuel was mostly supplied by Government contracted suppliers and OMCs.

2.1.1 Importation of petroleum feedstock

In 2021, the importation of petroleum feedstock declined from 196,725 MT in 2020 to 42,360 MT reflecting a 78.5 percentage reduction. Government announced petroleum reforms in the petroleum subsector which included the shift to 100.0 percent importation of finished petroleum products in the country. Consequently, the refinery was placed under care and maintenance and the country imported one petroleum feedstock cargo compared to the ideal average of seven cargoes in previous years. Figure 2-1 shows the Importation of petroleum feedstock in 2021.

Figure 2-1: Importation of petroleum feedstock, 2010 - 2021

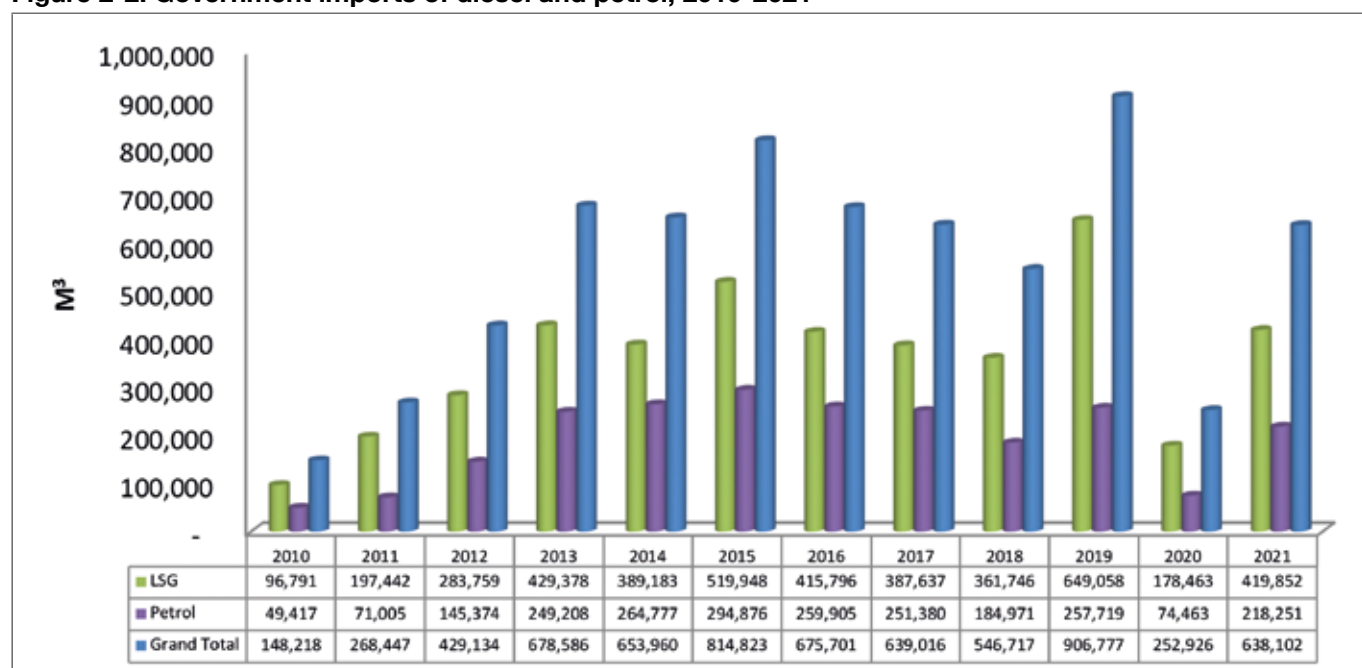


2.1.2 Importation of finished petroleum products

2.1.2.1 Importation of Petrol and Diesel by Government

Overall, 1,272,064 M³ and 499,863 M³ of diesel⁹ and petrol respectively, were imported into the country in 2021. Government contracted supplies accounted for close to 218,251 M³ of petrol and 419,852 M³ of diesel of imports in 2021. This reflected an increase of 135.3 percent for diesel compared to 178,463 M³ in 2020. Equally, petrol increased by 191.5 percent compared to 74,866 M³ in 2020. The increase in imports by Government suppliers was partly attributed to meeting the market demand as there was limited production at INDENI. INDENI was only operational for 26.9 days as earlier indicated. Figure 2-2 shows the trend in Government importation for diesel and petrol for the period 2010 to 2021.

Figure 2-2: Government imports of diesel and petrol, 2010-2021



⁹ Include low Sulphur gasoil

2.1.1.2 Imports of finished petroleum products by OMCs

The importation of finished petroleum products by OMCs is depicted in Table 2-1. Overall, the importation of most petroleum products increased in 2021 compared to 2020. This was mainly on account of the Government policy to issue importation waivers to OMCs in order to compliment the supply of fuel in the country. Notably, the importation of Jet A-1 and LPG recorded significant increase of 402.3 percent and 189.3 percent, respectively. Additionally, HFO imports increased by 18.4 percent and low Sulphur Gasoil (LSGO) increased by 10.0 percent. Meanwhile, petrol imports marginally declined by 0.3 percent.

Table 2-1: OMCs importation of finished petroleum products, 2016-2021¹⁰

Year	Low Sulphur Gas Oil (M ³)	Unleaded Petrol (M ³)	Jet A-1 (M ³)	Liquefied Petroleum Gas (MT)	Heavy Fuel Oil (MT)	Kerosene (M ³)	Butane (MT)
2016	286,742	74,811	21,468	830			
2017	232,277	2,874	28,795	1,060			
2018	121,938	-	22,458	1,065			
2019	11,086	900	31,594	1,111			
2020	774,533	282,355	5,351	2,609	12,199		
2021	852,212	281,613	26,880	7,548	14,440	3,348	132

2.2 Operations at TAZAMA Pipelines Limited

TAZAMA is a petroleum feedstock pipeline that is jointly owned by Governments of Zambia and Tanzania. The pipeline stretches across the two countries at a distance of 1,710 kilometers from the port of Dar-es-Salaam, Tanzania, to Ndola, Zambia. Along the pipeline there are seven pumping stations, with five being located in Tanzania and two located on the Zambian side.



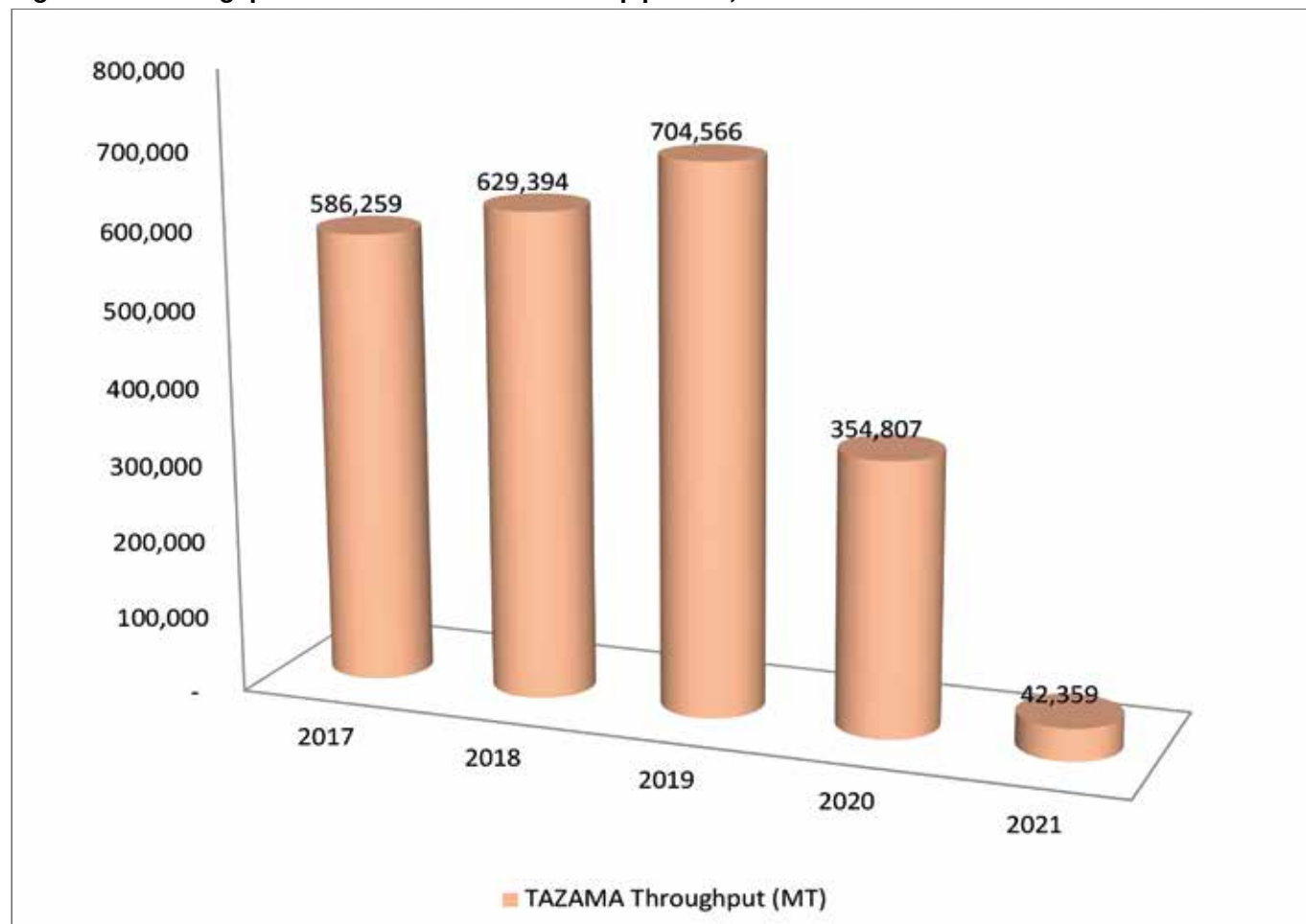
TAZAMA Pipelines Limited

¹⁰ Data was not available for HFO, Kerosene and Butane for the period 2016 - 2020

2.2.1 TAZAMA throughput

During 2021, TAZAMA experienced an increased number of unplanned shutdown days of 336 resulting in a significant decline in the annual throughput of 42,359 MT compared to 354,808 MT in 2020, representing a reduction of 88.1 percent. The significant reduction was largely due to lack of petroleum feedstock which led to the pipeline to be operational for only 29 days. Figure 2-3 depicts the throughput of the pipeline from 2017 to 2021.

Figure 2-3: Throughput for feedstock for TAZAMA pipelines, 2017-2021



2.2.2 Rehabilitation and Maintenance works at TAZAMA

During the year ended 31st December 2021, there were no rehabilitation works undertaken on the pipeline and pumping stations. This was due to constrained operations mainly attributed to low supply of Petroleum feedstock.

2.3 Operations at INDENI Petroleum Refinery Company Limited

INDENI was configured as a hydro-skimming¹¹ refinery plant located in Ndola. The refinery is designed to process comingled (spiked) crude that contains Gasoil, Condensate, Naphtha and Crude oil. The main products refined from comingled crude oil include LPG, Butane, Light Gasoline, Heavy Gasoline, Reformate, Special Cut Kerosene, Jet A1, Industrial Kerosene, Illuminating Kerosene, Automotive Gasoil, Fuel Oil and Bitumen.

¹¹ Hydro-skimming refinery is defined as a refinery equipped with atmospheric distillation, naphtha reforming and hydro treating processes. A hydro-skimming refinery comes with an addition of catalytic reformer which produces higher octane reformates and also generates other products such as hydrogen for hydro treating units.

INDENI's annual throughput per year is largely reliant on the volume of comingled crude received from TAZAMA. INDENI's throughput capacity reduced to around 850,000 MT per annum due to abrasion of the plant over the years.

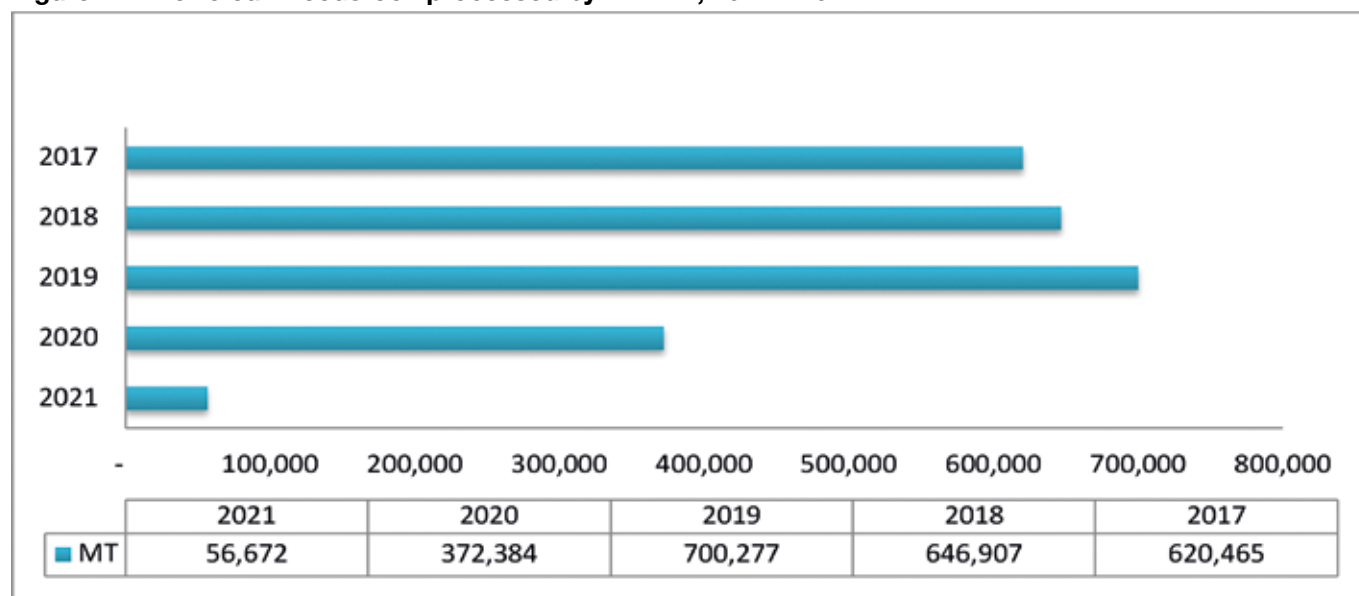


INDENI Refinery plant

2.3.1 INDENI throughput

INDENI throughput during the five year period, 2017 to 2021 averaged 479,341 MT. During this period, the highest throughput recorded was 700,277 MT in 2019, while the lowest was 56,672 MT in 2021. In 2021, INDENI's throughput significantly reduced to 56,672 MT from 372,384 MT in 2020, representing a reduction of 84.8 percent. In 2021, the refinery was operational for 26.9 days, having shut down for 338.1 days due to lack of petroleum feedstock to process. Figure 2-4 shows petroleum feedstock processed by INDENI, for the period 2017 to 2021.

Figure 2-4: Petroleum feedstock processed by INDENI, 2017 – 2021

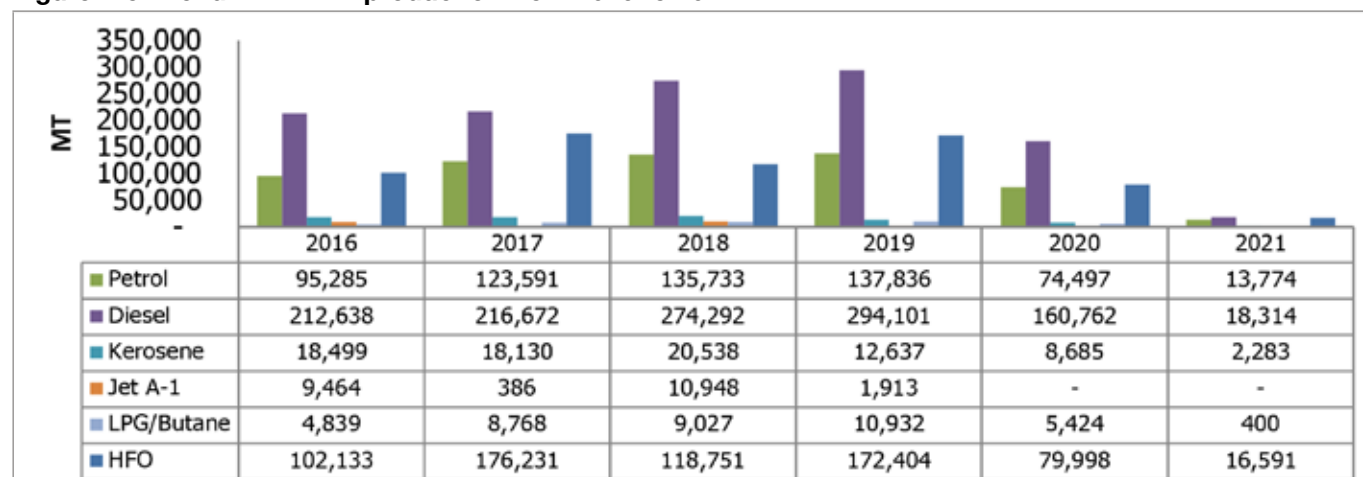


Source: INDENI

2.3.2 INDENI production of petroleum products

Overall, INDENI aggregate production reduced by 84.4 percent from 329,366 MT in 2020 to 51,361.8 MT in 2021 mainly on account of fewer operational days being only 26.9 days due to lack of petroleum feedstock. During the non-operational days, the Government issued import waivers to OMCs in order to supplement Government contracted suppliers in meeting national demand. The trend in INDENI Production from 2016 to 2021 is shown in Figure 2-5.

Figure 2-5: Trend in INDENI production from 2016 to 2021



2.4 National consumption of petroleum products

Table 2-2 compares the national consumption of petroleum products in 2020 and 2021. Overall, the consumption of petroleum products in the country grew by 10.2 percent from 1,329,290.66 MT in 2020 to 1,464,822.16 MT in 2021. The increase in petroleum consumption was in line with the estimated national economic growth of 3.3 percent in 2021 by the Ministry of Finance.

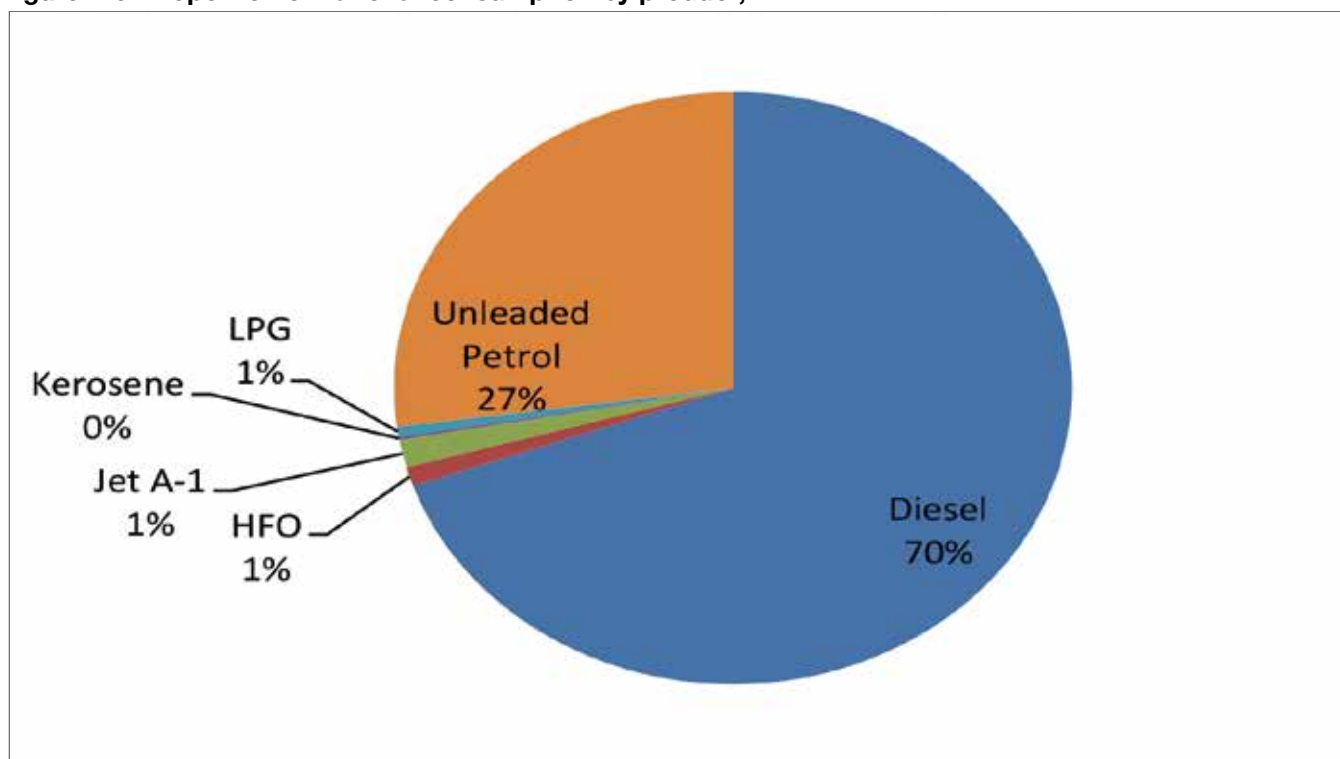
Table 2-2: National petroleum consumption, 2020 - 2021

Product	2020	2021	% Change
Diesel (MT)	912,813.96	1,020,200.98	11.8
Heavy Fuel Oil (MT)	45,023.05	15,384.94	-65.8
Jet A-1 (MT)	16,573.35	22,056.93	33.1
Kerosene (MT)	7,504.17	2,536.84	-66.2
LPG (MT)	7,945.04	7,981.10	0.5
Unleaded Petrol (MT)	339,431.09	396,661.37	16.9
Grand Total	1,329,290.66	1,464,822.16	10.2

Jet A-1 accounted for the largest percentage increase at 33.1 percent mainly on account of the re-opening of the aviation sector following the easing of COVID-19 restrictions in nearly all parts of the globe. This was followed by petrol that increased by 16.9 percent in 2021. Diesel consumption increased by 11.8 percent from 912,814 MT in 2020 to 1,020,201 MT in 2021. Further, in 2021 the consumption of LPG marginally increased by 0.5 percent from 7,945 MT to 7,981 MT in 2020. Meanwhile, there was a decline in the consumption of HFO and Kerosene by 65.8 percent and 66.2 percent, respectively. One of the factors attributed to the decrease in consumption of Kerosene is the availability of close substitutes such as solar lamps, increased household connections to the ZESCO grid, Mini-Grids and the switch to efficient sources of energy for cooking. Additionally, supply constraints due to the shutdown of INDENI led to suppressed demand for both HFO and Kerosene.

In terms of proportion of national consumption by product, diesel is the most consumed product in Zambia accounting for 70.0 percent of total consumption in 2021, followed by 27 percent for petrol, while the rest of the products account for 3 percent of the national consumption. This is shown in Figure 2-6.

Figure 2-6: Proportion of national consumption by product,



2.4.1 Daily national average consumption of petroleum products

The national average daily consumption for petroleum products increased for all products except for HFO and Kerosene. The average daily national consumption of diesel increased to 3.33 million litres in 2021 from 2.98 million litres in 2020. Equally, the average daily national consumption of petrol increased from 1.24 million litres to 1.45 million litres in 2021. Further, Jet A-1 and LPG average national consumption increased to 76,012.50 litres and 21,866.03 kgs from 57,115.02 litres and 21,767.23 kgs, respectively. Meanwhile, HFO and Kerosene national average daily consumption decreased to 42,150.53 kgs and 8,687.82 litres from 123,350.82kgs and 25,767.23 litres, respectively. Table 2-3 depicts the average daily consumption of petroleum products.

Table 2-3: Daily average consumption, 2020 - 2021

OMC	2020	2021	% Change
Diesel (L)	2,977,214.48	3,327,465.70	11.8
Heavy Fuel Oil (Kgs)	123,350.82	42,150.53	-65.8
Jet A-1 (L)	57,115.02	76,012.50	33.1
Kerosene (L)	25,699.21	8,687.82	-66.2
LPG (Kgs)	21,767.23	21,866.03	0.5
Unleaded Petrol (L)	1,239,930.92	1,448,991.30	16.9

2.4.2 Daily national average consumption by Province

The provincial average daily consumption of petroleum products correlates with the level and type of economic activities in a particular region. According to the ZSA latest provincial GDP shares for 2020, Lusaka accounted for the highest proportion at 30.4 percent followed by Copperbelt at 22.5 percent and North-Western provinces at 14.9 percent. Meanwhile, the provinces with the least shares were Northern, Luapula, and Western with an average of 2.8 percent, 2.5 percent and 2.1 percent, respectively. Overall, the consumption of petroleum products varied in 2021 in line with the share of provincial GDP. Despite this, Lusaka, and Copperbelt provinces accounted for the highest consumption for all the three products as depicted in Table 2-4.

Table 2-4: Provincial average daily consumption of diesel, kerosene and petrol, 2021

Province	Diesel (L)	Proportion	Unleaded Petrol (L)	Proportion	Kerosene (L)	Proportion
Central	221,711.74	7%	107,213.39	7%	463.57	5%
Copperbelt	1,010,795.70	30%	278,187.36	19%	2,085.60	24%
Eastern	79,987.68	2%	85,951.06	6%	418.54	5%
Luapula	46,128.97	1%	29,967.96	2%	1,909.29	22%
Lusaka	1,017,883.55	31%	721,729.68	50%	2,868.83	33%
Muchinga	40,791.09	1%	21,615.31	1%	72.35	1%
Northern	46,797.41	1%	38,011.53	3%	441.82	5%
Northwestern	630,949.01	19%	55,842.04	4%	135.62	2%
Southern	195,388.13	6%	83,736.62	6%	292.21	3%
Western	37,032.41	1%	26,736.34	2%	0	0%
Average Daily Consumption	3,327,465.70	100%	1,448,991.30	100%	8,687.82	100%

The average daily consumption of diesel was 3,327,466 litres in 2021. Lusaka Province accounted for the highest consumption at 31.0 percent. This was followed by Copperbelt and North-Western Provinces at 30.0 percent and 19.0 percent, respectively. The provinces with the least proportion of consumption at 1.0 percent each were Luapula, Muchinga, Northern and Western Provinces.

Lusaka and Copperbelt Provinces accounted for the highest proportions of petrol daily average consumption at 1,448,991 litres reflecting 50.0 percent and 19.0 percent, respectively. This was followed by Central Province at 7.0 percent. Meanwhile, the provinces with the least share of average daily national consumption were Muchinga (1%), Luapula (2%) and Western (2%).

Kerosene average national consumption stood at 8,688 litres per day. Lusaka, Copperbelt and Luapula accounted for the highest share of the daily consumption at 33 percent, 24.0 percent and 22.0 percent, respectively. The provinces with the least consumption were Muchinga (1%) and North-Western (2%), while there was no reported consumption for Western Province.

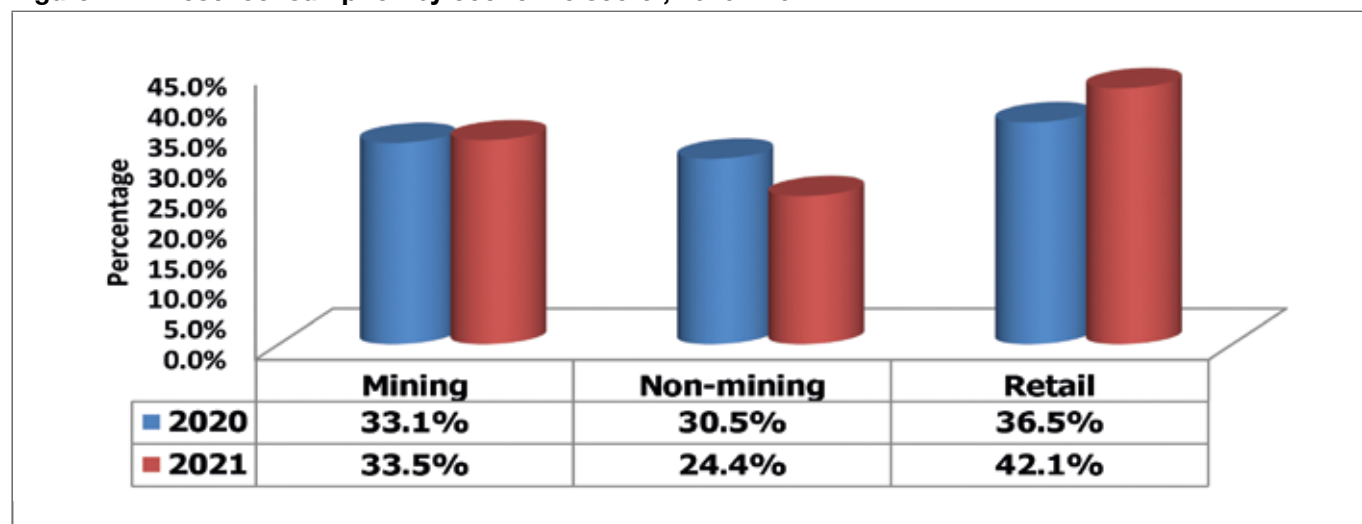
2.4.3 Consumption by economic sector

The ERB classifies the consumption of petrol and diesel into three main economic sectors namely: retail, mining and non - mining. This classification is mainly on account of the way data is captured. The retail sector is used to denote petroleum products that are consumed from filling 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 mainly commercial in nature.

2.4.4 Consumption of diesel by economic sector

Overall, the mining (33.5%) and non-mining (24.4%) collectively accounted for the largest consumption at 57.9 percent in the review period. Meanwhile, the retail sector accounted for 42.1 percent of diesel consumption in 2021. Figure 2-7 shows the diesel consumption by economic sector for 2021 and 2020.

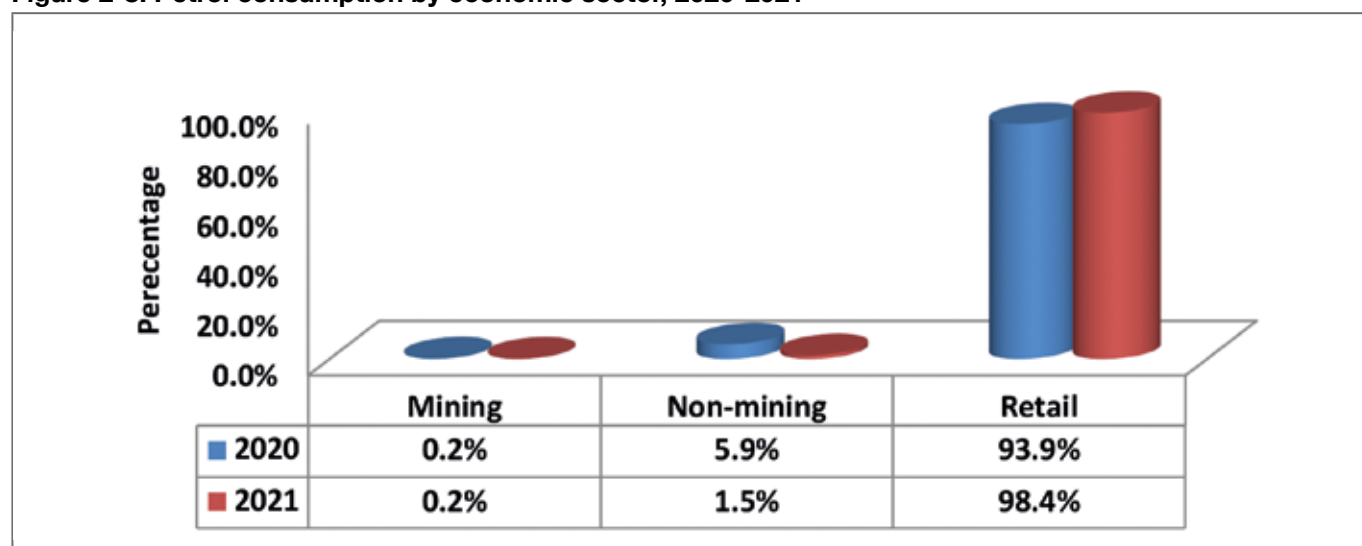
Figure 2-7: Diesel consumption by economic sector, 2020 - 2021



2.4.5 Consumption of petrol by economic sector

The retail sector accounted for the highest proportion of the petrol consumed at 98.4 percent, an increase of 4.5 percentage points from 93.9 percent in 2020. The mining sector maintained its share of 0.2 percent in 2021. However, the non-mining sector recorded a decline in the consumption of petrol from 5.9 percent in 2020 to 1.59 percent in 2021. Petrol consumption by economic sector is depicted in Figure 2-8.

Figure 2-8: Petrol consumption by economic sector, 2020-2021



2.5 Market Share of Oil Marketing Companies

This section discusses the combined market share for OMCs in 2021 for white products¹², lubricants and Jet A-1. The size of the volumes sold by an OMC depicts its market share¹³.

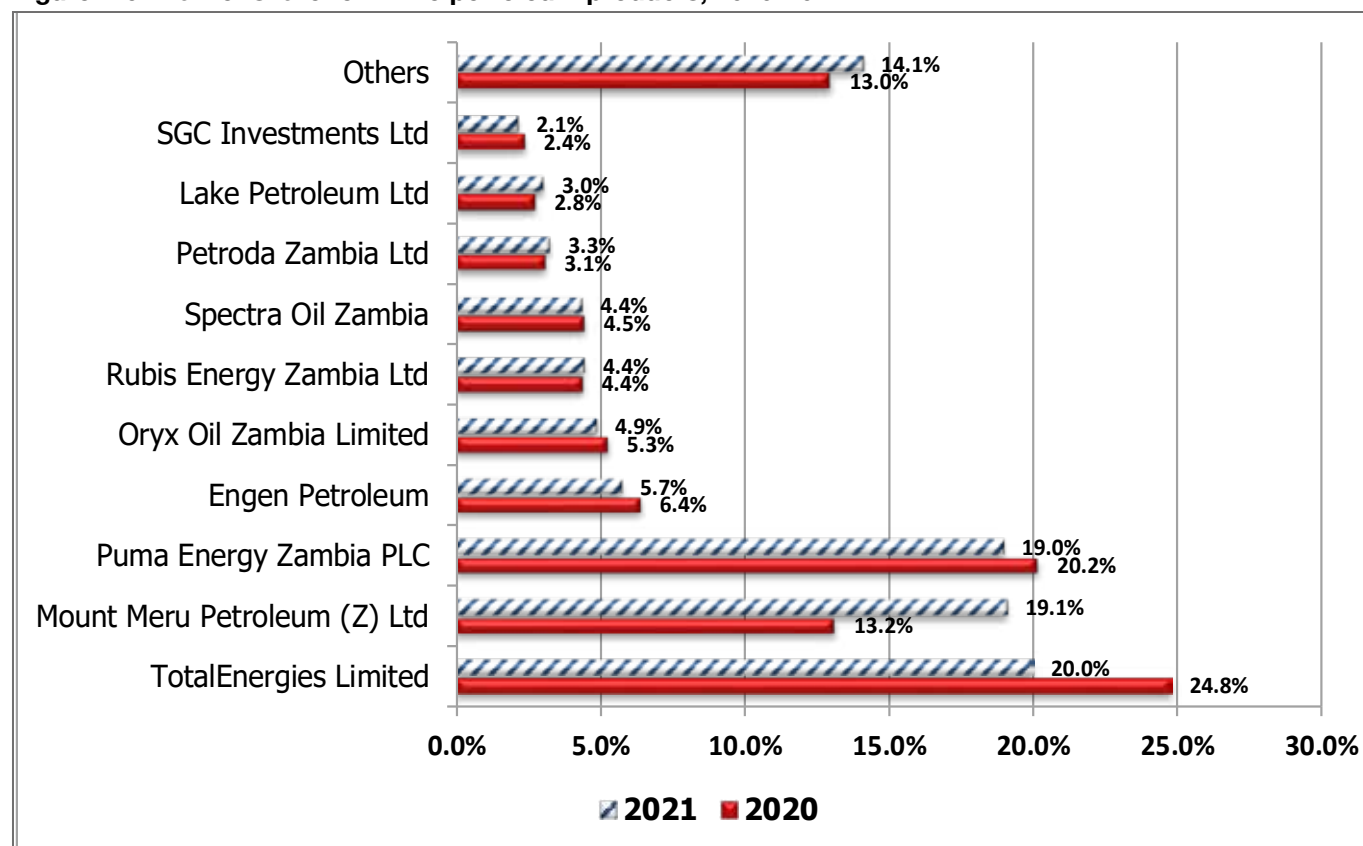
¹² Refers to diesel, petrol, kerosene

¹³ Percentage of an OMCs' total sales to the total industry market sales in a specified period of time

2.5.1 Market share for white products

Although TotalEnergies continued to dominate the market for white products at 20 percent in 2021, its share declined by 4.8 percentage points. Mount Meru recorded the highest gain in market share of 5.9 percentage points to stand at 19.1 percent leaving Puma Energy Zambia Plc in third position with 19.0 percent. Mount Meru increased its retail service network and became the OMC with the highest number of service stations at 67 in the country. Figure 2-9 depicts the market share of white product in Zambia in 2021 compared to 2020.

Figure 2-9: Market share for white petroleum products, 2020-2021

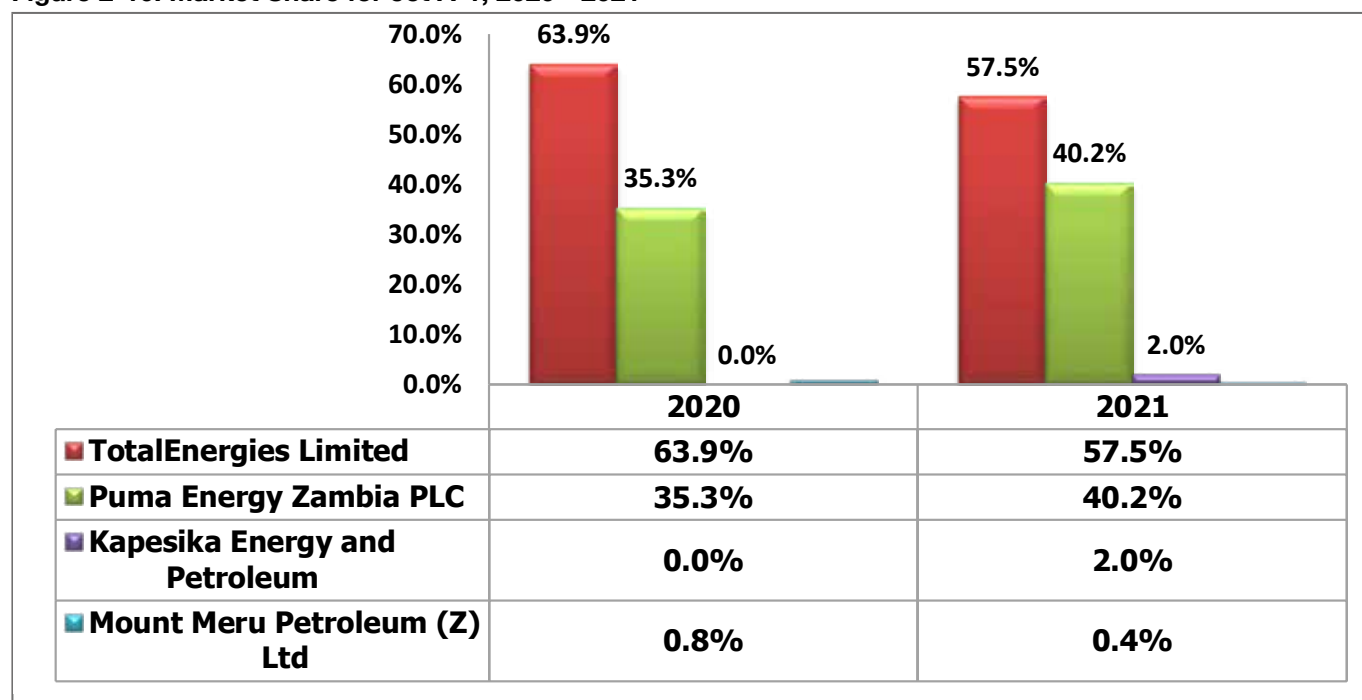


As depicted, marginal growth was recorded for Lake Petroleum and Petroda Zambia Limited of 0.2 percentage points each in market share. The rest of the OMCs recorded marginal decrease except for Rubis Zambia which maintained its market share at 4.4 percent. Meanwhile, other OMCs collectively accounted for 14.1 percent market share.

2.5.2 Market share for Jet A-1

In 2021 the market share for Jet A-1 was dominated by four OMCs namely TotalEnergies, Puma Energy, Kapesika Energy and Petroleum Limited and Mount Meru. TotalEnergies had the highest market share at 57.5 percent. However, this was a reduction compared to 63.9 percent in 2020. Puma Energy Zambia Plc was in the second position at 40.2 percent and recorded a gain of 4.9 percentage points in comparison to 2020. Kapesika Energy and Petroleum Limited entered the market in 2021 ranked third at 2.0 percent, while Mount Meru was in the fourth position at 0.4 percent. Figure 2-10 shows the market share for Jet A-1 in 2020 and 2021.

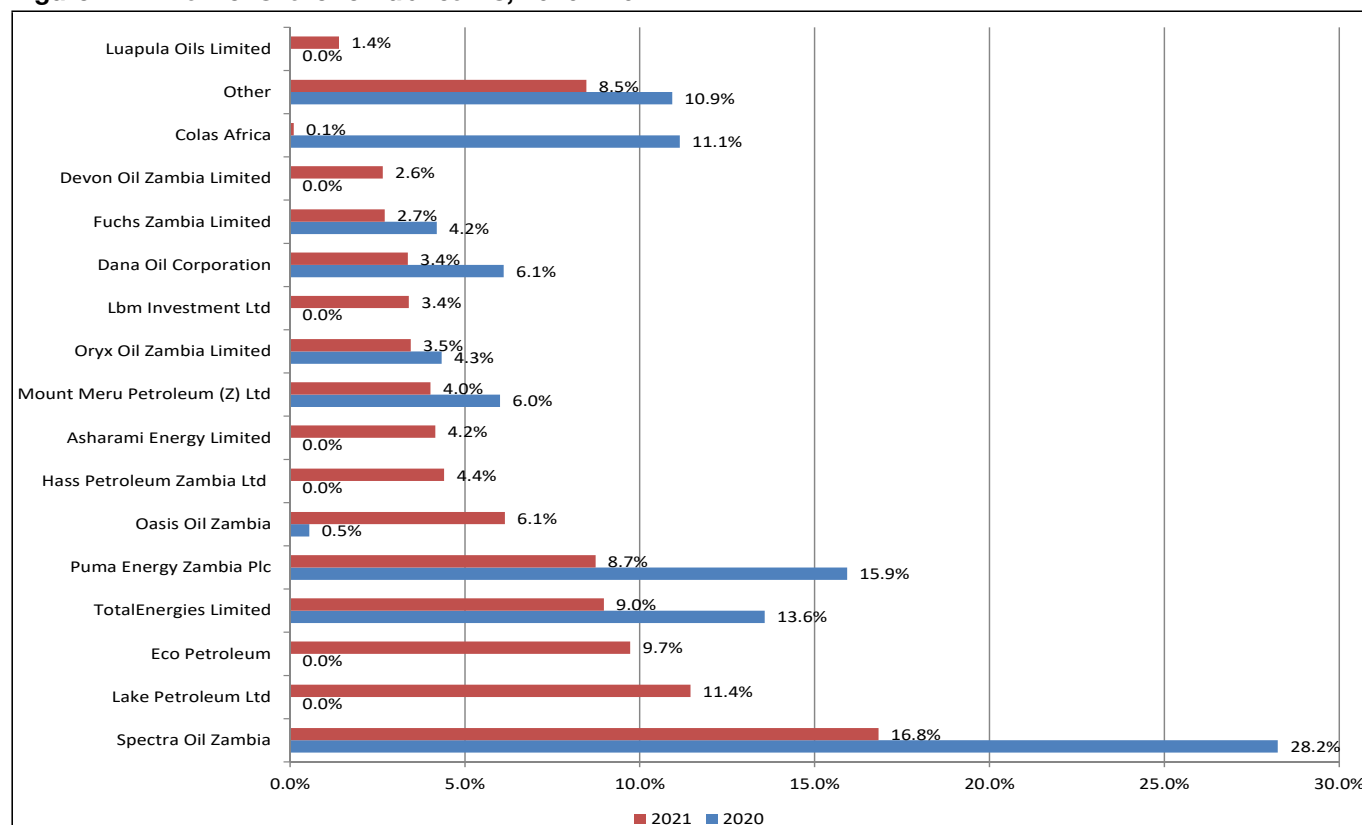
Figure 2-10: Market Share for Jet A-1, 2020 - 2021



2.5.3 Market share for lubricants

The market share for lubricants for licensed companies in 2021 is shown in figure 2-11. The number of licensed lubricant dealers in 2021 was 86 compared to 31 in 2020. Spectra oil continued to dominate the market in 2021 at 16.8 percent though this reflected an 11.4 percentage points decline compared to 28.2 percent in 2020. Puma Energy was next at 15.9 percent and TotalEnergies at 13.6 percent, with the rest of the market share summarised in Figure 2-11.

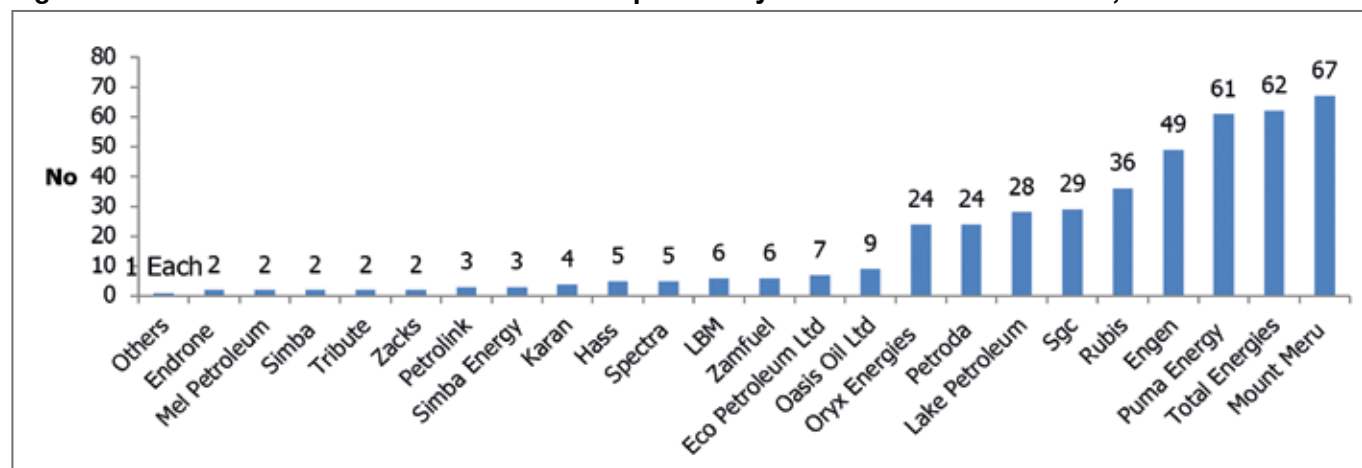
Figure 2-11 Market share for lubricants, 2020 - 2021



2.5.4 Number of Retail Service Stations Operated by OMCs

The filling stations are part of the petroleum value chain that distribute finished petroleum products to the end users in the economy. Filling stations serve the purpose of refueling by motorists, for minor to major motor vehicle maintenances, shopping and resting places before resuming journeys among others. In 2021, there were 460 retail sites across the country. Mount Meru accounted for the largest share at 67 followed by Total Energies Zambia at 62. Puma Energy Plc was next at with 61, while Engen Petroleum had 49 sites. Refer to Appendix 1 for a detailed summary of retail sites by location.

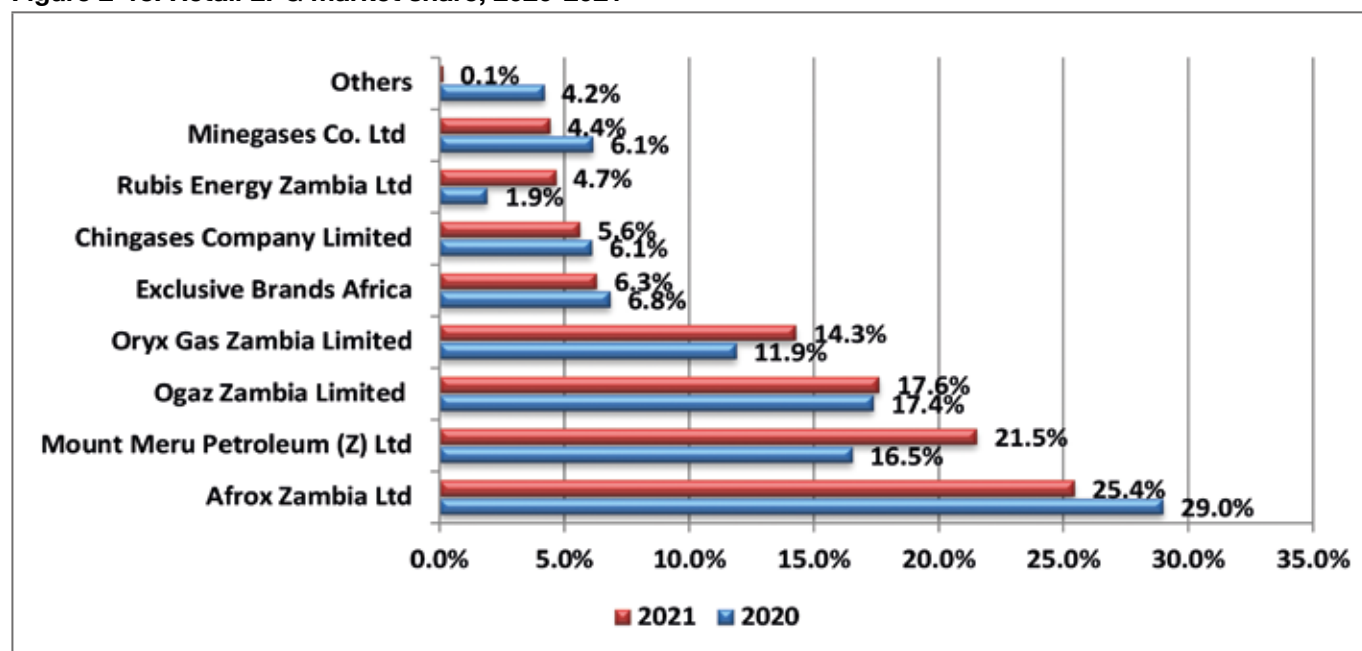
Figure 2-12: Number of Retail Service Stations Operated by OMCs as at 31st December, 2021



2.5.5 Market share for LPG

The retail LPG market in Zambia is characterized by a few players. In 2021, 12 OMCs were actively trading in LPG. Based on the ERB study, most OMCs cited capital requirements for infrastructure and distribution facilities as one of the barriers in the market. Afrox Zambia Limited was the leader for the domestic LPG market at 25.4 percent in 2021. This was followed by Mount Meru, Ogaz Zambia Limited, and Oryx Gas at 21.5 percent; 17.6 percent and 14.3 percent, respectively. The rest of the information is summarized in Figure 2-13.

Figure 2-13: Retail LPG market share, 2020-2021



2.5.6 LPG Bulk storage facilities

In 2021, LPG Bulk storage facilities increased to 2,611 MT from 2,498 MT in 2020. This comprised 1,800 MT at INDENI, while the rest was under OMCs ownership. Table 2-5 shows the distribution of LPG bulk storage facilities by OMC in 2021.

Table: 2-5 OMCs LPG Bulk Storage facilities, 2021

No.	Name	Capacity (MT)	Location
1	Afrox Zambia	143	Ndola, Kitwe and Lusaka
2	Oryx Gas	134	Ndola
3	Meru Gas	120	Chibombo
4	Kobil	40	Lusaka
5	Exclusive Brands	90	Lusaka
6	Ogaz	50	Lusaka
7	Minegases	45	Ndola, Chingola and Kitwe
8	Chingases	55	Lusaka
9	Oxyzam	41	Lusaka
10	Ziko Gas	58	Lusaka
11	INDENI	1,800	Ndola
12	Lake Gas	35	Ndola
	Grand Total	2,611	

2.6 Pricing of Petroleum Products

According to Section 4, of the Energy Regulation Act no. 12 of 2019, one of the key functions of the ERB is to determine, regulate and review charges¹⁴ and tariffs in the energy sector. The ERB uses the Cost Plus Model (CPM) to determine the price of petroleum products. The CPM operates in such a way that the final price of petroleum products should cover all the costs that are incurred in the fuel supply chain, from the port of discharge in Dar-es-Salaam to the final consumer.

The key players that are involved in the procurement, transportation, distribution and retailing of petroleum products with their specific roles are explained in Table 2-6.

¹⁴ Where charges include prices, fees, rates, surcharges, levies, penalties, deposits, connection charges or fees, use of system charges or any other charge made for the provision of any service, commodity or product that a licensee renders in the course of carrying out its licensed activity.

Table 2-6: Roles of the players in the petroleum supply chain

No.	Petroleum Supply Chain Player	Role
1.0	Ministry of Energy	<ul style="list-style-type: none"> i) Float import tenders based on requirements of Petroleum products. ii) Opening of tender, evaluation and awarding of supply Contract. iii) Coordinate the determination of quantity requirements/projection for a specified period. iv) Ensure that the quantities from the supplier are delivered. v) Give policy guidance to the petroleum sub sector. vi) Monitor and manage strategic reserves. vii) To procure petroleum products to meet market demand.
2.0	Energy Regulation Board	<ul style="list-style-type: none"> i) Regulate the petroleum sub sector. ii) Ensure compliance by Suppliers and OMCs to operational requirements as per licence conditions. iii) Facilitate fuel marking process and product quality monitoring. iv) Project and the national demand of petroleum products in collaboration with MOE and OMCs.
Petroleum Upstream Sector		
3.0	TAZAMA Pipelines Limited	<ul style="list-style-type: none"> i) Operate and maintain the 1,710 Km pipeline that was used in transportation of petroleum feedstock from Dar es saalm to Ndola ii) Ensure receipt of imported products of Suppliers in designated GRZ Depots. iii) Participate in procurement of petroleum feedstock in collaboration with INDENI.
4.0	INDENI Petroleum Refinery Limited	<ul style="list-style-type: none"> i) Process petroleum feedstock to finished petroleum products. ii) Participate in the procurement of petroleum feedstock in collaboration with TAZAMA.
5.0	TAZAMA Petroleum Products Limited	Operate and manage the country's petroleum storage facilities that distributes petroleum products to downstream players, specifically; <ul style="list-style-type: none"> i) Offer handling and storage facilities for petroleum products received in the country. ii) Offer storage services to OMCs. iii) Wholesale of petroleum products produced by INDENI from the Ndola Fuel Terminal (NFT) and Government Depots to OMCs.
Petroleum Downstream Sector		
6.0	Oil Marketing Companies	<ul style="list-style-type: none"> i) Distribute petroleum products to Consumers, Retailers (Dealers) and Government.
7.0	Petroleum Transporters	<ul style="list-style-type: none"> i) Transport petroleum products to OMCs, Retailers (Dealers) and Government.
8.0	Retailers (Dealers)	<ul style="list-style-type: none"> i) Selling of petroleum products at filling stations to consumers.
9.0	Consumers	<ul style="list-style-type: none"> i) Buy petroleum products at prices regulated by the ERB.

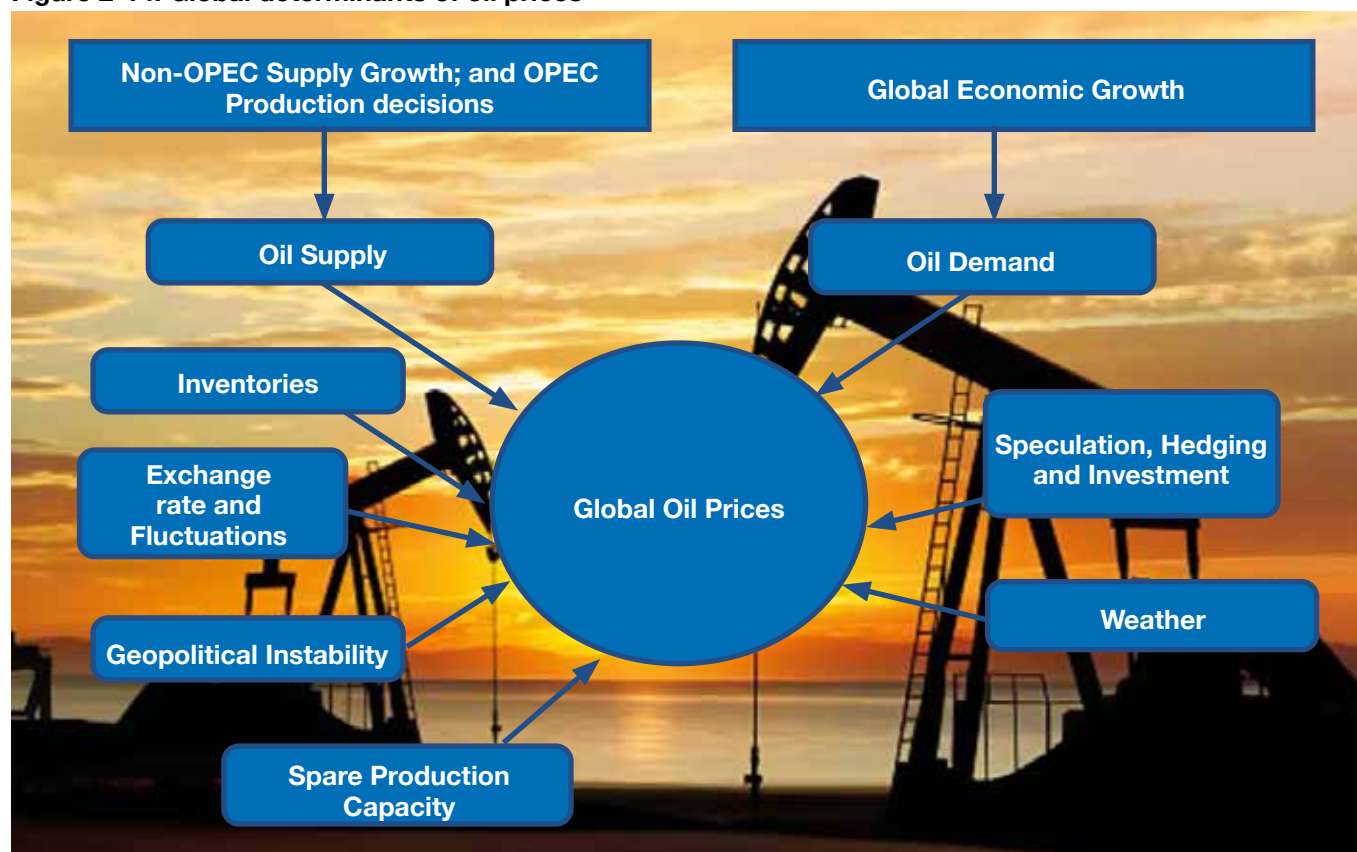
Meanwhile, following the pronouncements by government to institute reforms in the petroleum sub sector in the fourth quarter of 2021, TAZAMA Pipeline will be converted to transporting finished products. Additionally, INDENI will be placed under care and maintenance.

2.6.1 Determinants of petroleum prices

Broadly, the price of petroleum products on the international market is determined by supply and demand for both petroleum feedstock and finished petroleum products. In terms of supply, around 40 percent of the world's production of crude oil is controlled by the Organisation for the Petroleum

Exporting Countries (OPEC). OPEC sets oil prices, imposes production ceilings and allocates production quotas. Geo-political tensions in major oil producing countries such as threats of war and instability or trade tensions also influence the price of petroleum products. Meanwhile, with regards to demand, the major economies and consumers of oil such as the United States of America (USA), China and India influence the price of petroleum products to a large extent. Figure 2-14 depicts the other factors that influence oil prices on the global market.

Figure 2-14: Global determinants of oil prices

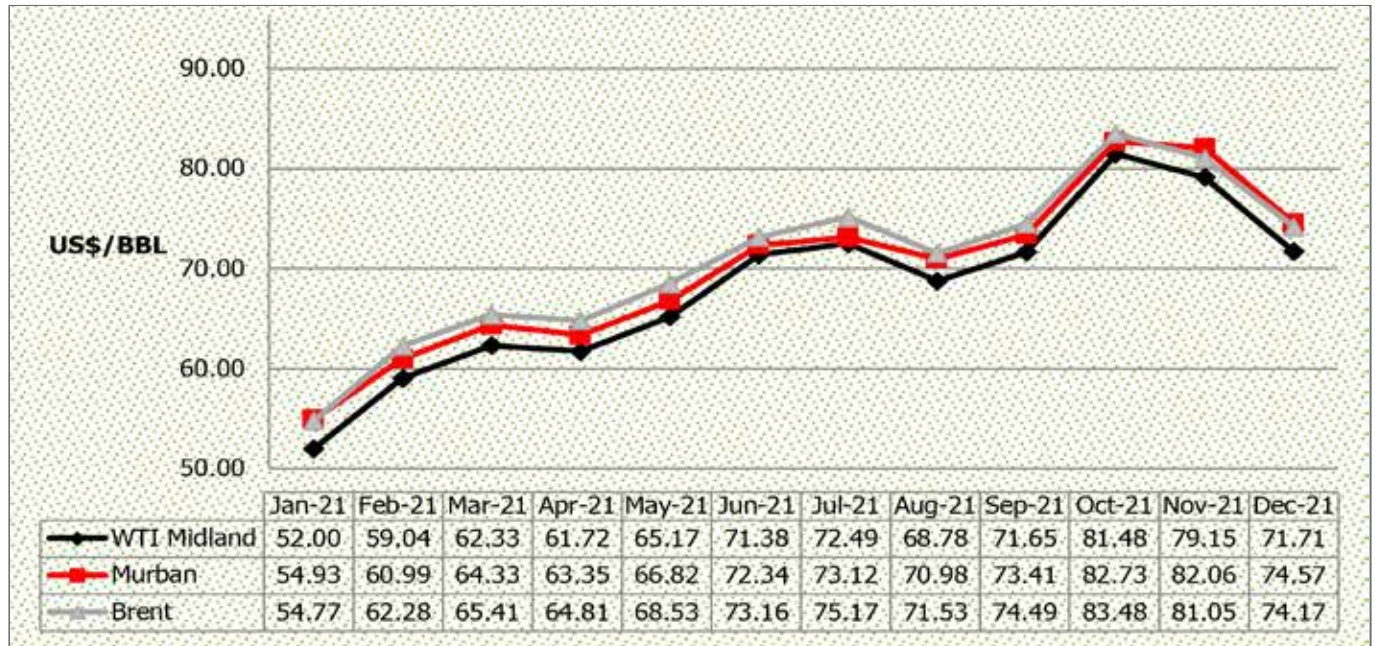


Zambia imports all its petroleum products therefore, petroleum prices are mainly determined by the international oil prices and the exchange rate between the Zambian Kwacha and the United States Dollar. In addition to these factors, petroleum prices are also influenced by changes in the cost-lines such as levies, duties and margins for transporters, OMCs and dealers, as well as pumping or processing fees.

2.6.2 Trends in the international oil prices in 2021

Figure 2-15 shows the trend in the international crude oil prices, namely West Texas Intermediate (WTI), Brent and Murban Crude during the period January to December, 2021.

Figure 2-15: Trend in international crude oil prices, January to December, 2021

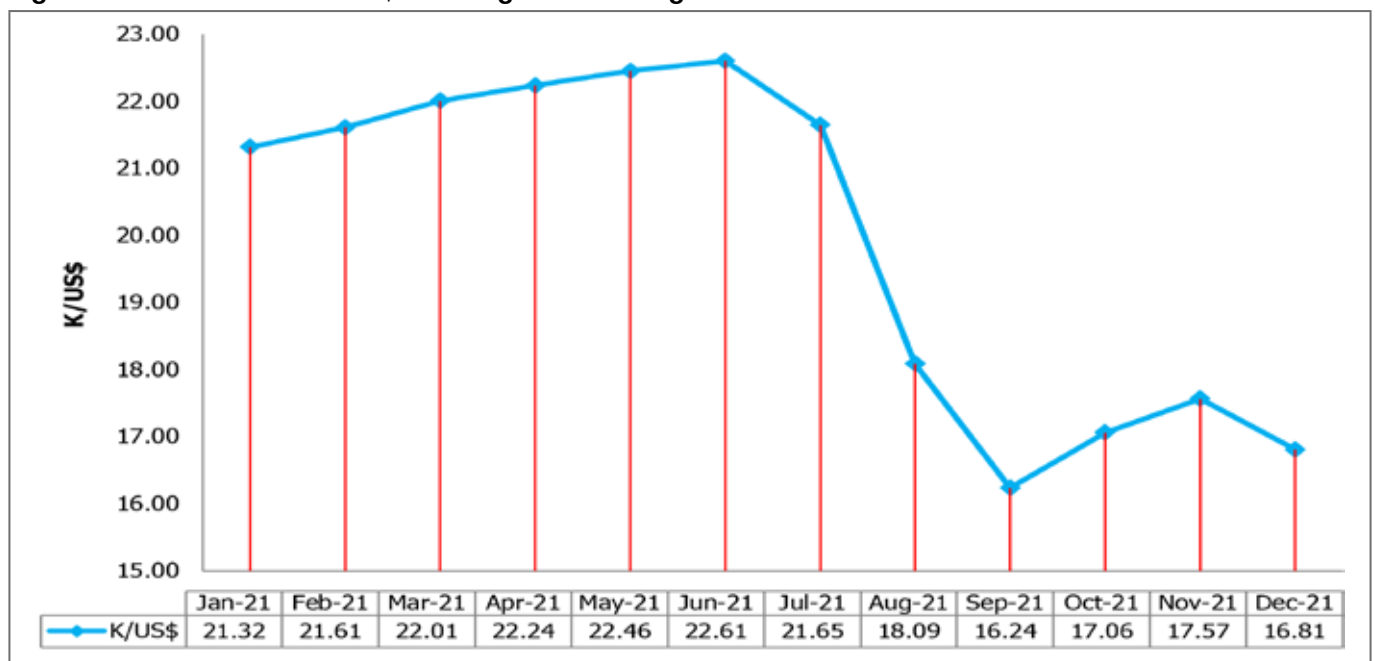


Generally, crude oil prices were on an upward trajectory throughout 2021. Crude oil prices increased to peak levels in October, 2021 before they declined marginally in December. The general increase in the crude oil prices on the international market during 2021 was mainly attributed to recovering demand, following the increased COVID-19 vaccination rates coupled with the relaxation of the pandemic-related restrictions and supply cuts by the Organization of the Petroleum Exporting Countries and its allies, collectively known as OPEC+ resulting in a quick rise in petroleum demand than supply. The OPEC+ commenced the crude oil production cuts in late 2020.

The price of crude oil on the international market averaged US\$53.90/bbl in January, 2021 and increased to a peak level of US\$82.56/bbl by late October, 2021 before declining to \$74.57/bbl in December, 2021.

2.6.3 Trend in the exchange rate in 2021

Figure 2-16: Trend in the K/US\$ Exchange Rate during 2021



The Kwacha was relatively stable during the first half of 2021, on account of improved foreign exchange supply mostly from foreign portfolio investors and mining companies, but appreciated steeply between June and September, 2021. The appreciation was attributed to improved market sentiments and sustained supply of foreign exchange from non-resident investors in Government securities. Beyond September, 2021, the Kwacha depreciated marginally until November, 2021, after which it appreciated slightly, to close the year at K16.81/US\$ in December, 2021. The marginal appreciation experienced in December, 2021 was due to positive sentiments after a Staff-Level Agreement was reached between Government and the International Monetary Fund (IMF).

2.6.4 Trends in the international oil prices and the exchange rate

In the first half of 2021, the kwacha was relatively stable as the international oil prices were rising. Beyond June, 2021, the kwacha appreciated against the United States Dollar up until September, 2021, when it depreciated marginally against the United States Dollar. Meanwhile, the prices of oil on the international market generally increased through out 2021.

Figure 2-17: Trend in international oil prices and the exchange rate, 2021



Figure 2-17 above shows that the two fundamentals that influence the price of oil on the international market moved in opposite directions during 2021. In the first half of the year, when the kwacha was relatively stable, the international oil prices were increasing. Similarly, when the exchange rate appreciated against the United States Dollar, beyond June, 2021, the international oil prices continued to increase hence, negating any possible benefits that could have been realized from the appreciation of the kwacha against the United States Dollar.

2.6.5 Petroleum Pricing Mechanism in Zambia

As a sector regulator, charged with the responsibility of reviewing and determining the prices of petroleum products, the ERB uses the Cost Plus Model (CPM), which took effect in January 2008, to determine the price of all petroleum products namely, petrol, diesel, LSGO, Kerosene, Jet A-1, LPG and Heavy Fuel Oil (HFO). The CPM determines the domestic prices of petroleum products as a sum of all the costs that are incurred in the fuel supply chain, from the port of discharge in Dar-es-salaam

to the Government fuel depots in Ndola. Under the CPM, the ERB regulates both the wholesale and retail prices of petrol, diesel including LSGO and Kerosene. However, for Jet A-1, Bitumen, LPG and HFO, the ERB regulates the prices only up to the wholesale level. In the case of the retail price of LPG, the ERB takes a Light Handed Regulation approach, where the LPG traders are allowed to set their own retail price, subject to approval of any adjustments by the ERB. The retail prices are determined by the traders themselves.

The cost elements in the CPM are divided into two groups:

- i. Wholesale price build-up for crude oil; and
- ii. Retail/Pump price build-up.

2.6.5.1 Wholesale Price Build-up

The cost elements that constitute the wholesale price build-up are presented in Table 2-7.

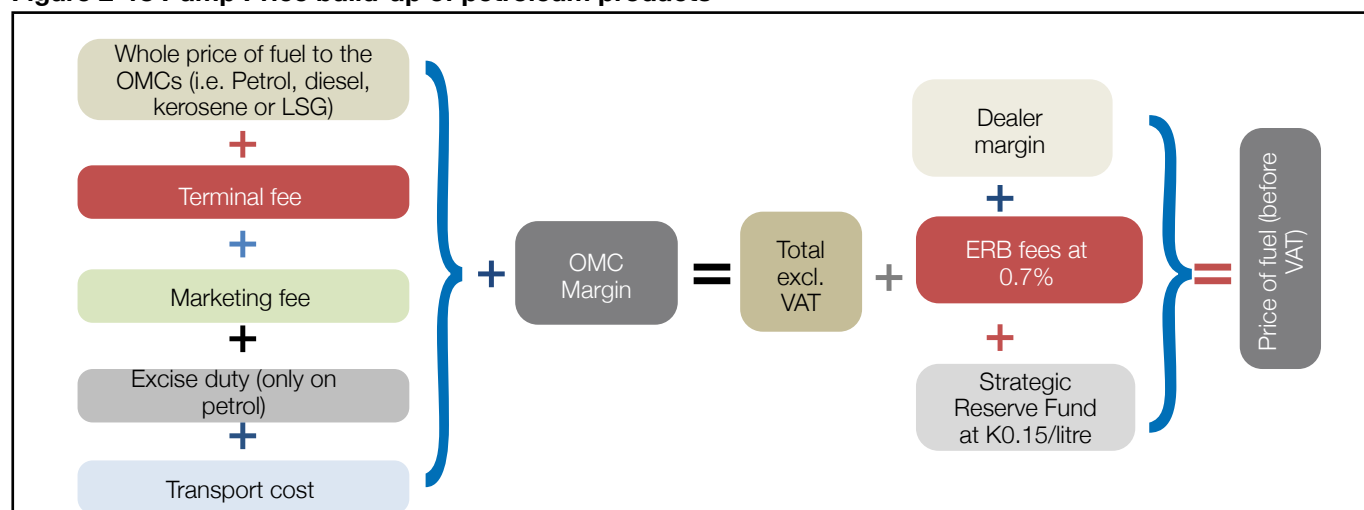
Table 2-7: Wholesale price build-up

Cost element	Unit cost	Basis
Cost-Insurance-Freight (US\$/MT)		Contract/Supplier Invoice
Ocean Losses	0.00%	Contract
Wharfage	1.25%	Tanzanian Harbour Authority
Insurance	0.11%	Insurer
TAZAMA Storage Fee (US\$/MT)	2.00	TAZAMA
TAZAMA Pumping Fee (US\$/MT)	49.00	Approved ERB Pumping Tariff
TAZAMA Pipeline Losses (<i>pipeline consumption of 0.50% & allowable pumping losses of 0.50%</i>)	1.00%	Determined by ERB
Agency Fee (US\$/MT)	5.00	Agency Agreement
Refinery Fee (US\$/MT)	55.38	Approved ERB Processing Fee
Refinery Processing Losses	7.5%	Determined by ERB
Terminal Losses (<i>1% for LPG, 0.5% for Petrol Kerosene & Jet A-1, 0.3% for diesel & HFO</i>)	1%, 0.5%, 0.3%	Best Practice

2.6.5.2 Pump Price Build-up

The cost lines that constitute the pump price build-up are depicted in Figure 2-18

Figure 2-18 Pump Price build-up of petroleum products



During 2021, the following were the statutory fees/ taxes that were applicable to the pump price build-up¹⁵.

Table 2-8: Pump price build-up statutory fees

No.	Pump Price Build-up Cost Line	Product	Previous (before 2021)	Current (during 2021)
1.	Excise Duty	Petrol	K2.07/litre	K0.64/litre
		Diesel	K0.66/litre	K0.00/litre
		Kerosene	K0.00/litre	K0.00/litre
		LSG	K0.66/litre	K0.00/litre
2.	VAT	Petrol	16%	0%
		Diesel	16%	0%
		Kerosene	0%	0%
		LSG	16%	0%

2.7 The Energy fund

The Energy Regulation Act No. 12 of 2019 has provided for the creation of the Energy Fund. The Energy Fund was established for the purposes of:

- (a) Ensuring stability of supply in the energy sector;
- (b) The development of the energy sector;
- (c) Ensuring the availability of strategic reserves; or
- (d) Any other purposes as may be prescribed by ERB

The existing Strategic Fuels Reserve and the Electricity Strategic Funds will be administered under the Energy Fund. In 2021, the ERB commenced the process of developing regulations for administering the Energy Fund. These regulations are expected to be ready in 2022.

2.8 Annual Review of Petroleum Downstream Margins

According to section 4 of the Energy Regulation Act No. 12 of 2019, the Energy Regulation Board is mandated to determine, regulate and review charges and tariffs in the energy sector. For the petroleum sub-sector, the ERB also regulates the margins of petroleum downstream players, namely, OMCs, Dealers and Transporters. In January 2021, the ERB implemented the margins of OMCs, Dealers and Transporters, that were reviewed and determined in 2020.

Further, in December, 2021, the ERB, with the Margins Committee reviewed the margins which were implemented in January 2021. The review was in line with the changes in the key fundamentals that influence them, that is, the exchange rate and the inflation rate. It is envisaged that the reviewed margins will be effected in 2022.

2.9 Pricing Framework for Jet A-1

As an advance step towards the implementation of the Import Parity Pricing (IPP) Model for Jet A-1, the ERB successfully carried out the test run of the IPP model for Jet A-1, from June to October, 2021. It is envisaged that the model will be fully implemented in 2022.

¹⁵ Removal of VAT through Statutory Instruments No. 125 of 2020; and amendment to Excise Duty through Statutory Instrument No. 5 of 2021.

2.10 Domestic and Regional Fuel Prices

2.10.1 Domestic Fuel Pump Prices

During 2021, the energy sector had its challenges with supply or imports of petroleum feedstock. Consequently, there was only one fuel price adjustment which was done on 16th December, 2021. The price of petrol, diesel and Low Sulphur Gas Oil (LSGO) were adjusted upwards as shown in Table 2-9 while the price of kerosene remained constant:

Table 2-9: December 2021 fuel pump price adjustment

National Uniform Pump Prices K/Litre				
Product	Old	New	Absolute Variance	% Change
Petrol	17.62	21.16	3.54	20.09
Diesel	15.59	20.15	4.56	29.25
Kerosene	15.39	15.36	0	0
Low Sulphur Gasoil	17.82	22.29	4.47	25.08

2.10.2 Trends in domestic fuel prices

Figure 2-19 shows the trend in the nominal pump prices of petrol, diesel and kerosene from 2000 to 2021.

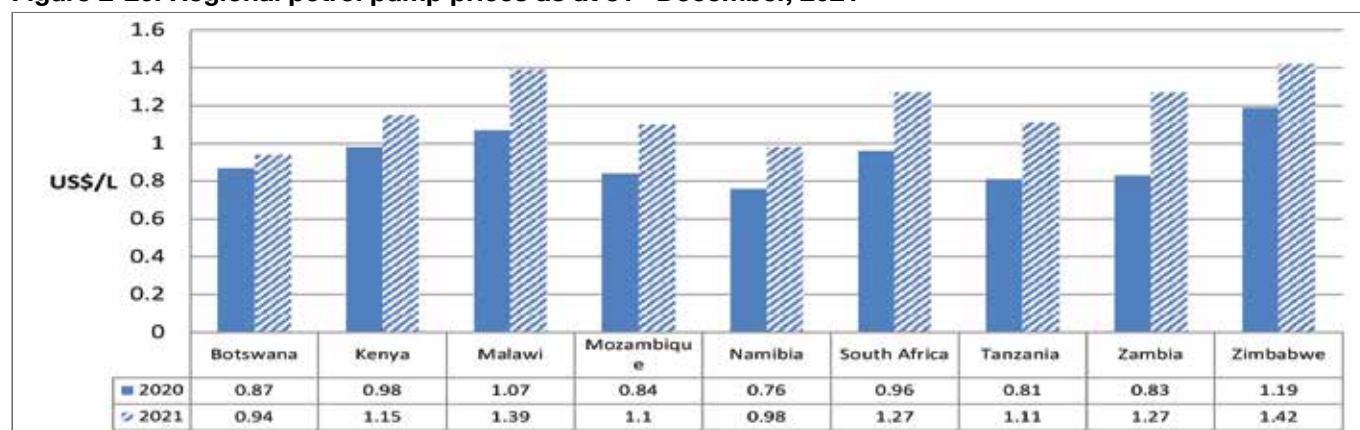
Figure 2-19: Trend in nominal pump prices 2000 to 2021



Generally, the price of petrol, diesel and kerosene were on an upward trajectory throughout the period 2000 to 2021. The retail price of petrol and diesel continued to increase above the price of kerosene in the period under review. In 2021, only the price of petrol and diesel were adjusted while the price of kerosene remained constant.

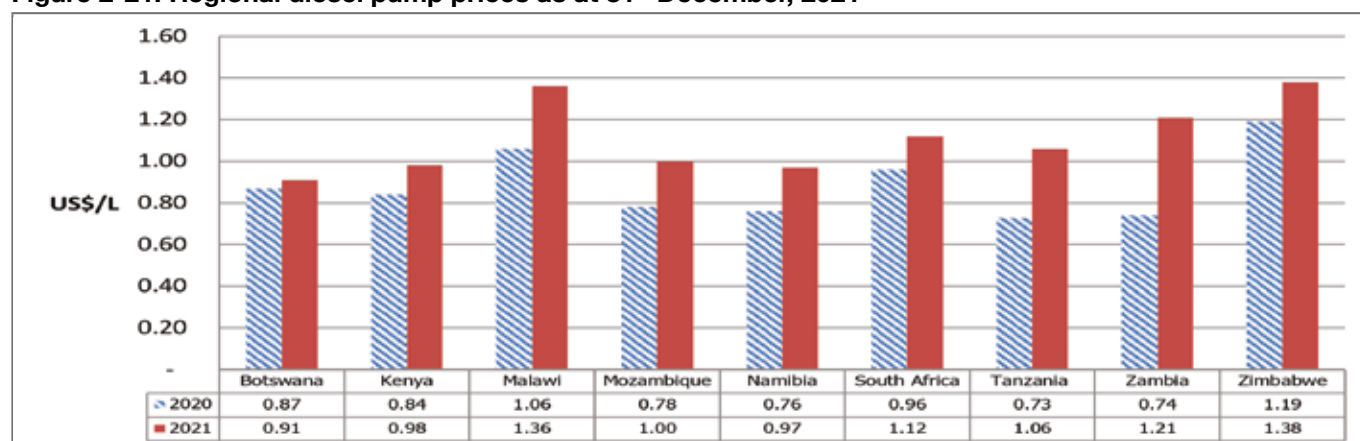
2.10.3 Regional Fuel Prices

The prices for petrol and diesel in selected African countries differ due to differences in fiscal regimes as well as distance to the sea. Despite this, prices for both petrol and diesel increased in 2021 compared to the same period in 2020 in all countries during the period under review. Figure 2-20 shows the the price of petrol as at 31st December in 2020 and 2021.

Figure 2-20: Regional petrol pump prices as at 31st December, 2021

As depicted in Figure 2-20, Zimbabwe had the highest price for petrol in 2021 at US\$1.42/litre, while Botswana had the lowest at US\$0.94/litre. Meanwhile, the petrol price closed the year at US\$1.27/litre under the same period in Zambia.

Diesel prices ranged from highest at US\$1.38/litre in Zimbabwe to lowest in Botswana at US\$ 0.91/litre. The price for diesel in Zambia as at 31st December, 2021 was US\$1.21/litre. This information is highlighted in Figure 2-21

Figure 2-21: Regional diesel pump prices as at 31st December, 2021

2.11 Compliance of Licensees in the Petroleum Subsector

2.11.1 Petroleum Product Quality Monitoring

Section 4(h) of the Energy Regulation Act No. 12 of 2019, mandates the ERB to collaborate with the Zambia Bureau of Standards, to design standards with regard to the quality, safety and reliability of the supply of energy. Clause 31 (a) of the aforementioned Act, further compels all licensees in the energy sector to meet the minimum standards relating to quality of goods and services as may be specified or published by the ERB.

In line with the above, the ERB conducts routine petroleum product sampling of fuel depots countrywide and randomly at service stations. The said sampling is conducted twice every quarter to ascertain the quality of petroleum products at depots. The samples are collected in triplicates, one sample is retained at the depot, one is stored at the ERB laboratory and one is taken to the contracted Laboratory for analysis. In the case where the sample fails to meet the set minimum standard, the retained sample is submitted to a different Laboratory for analysis. The results from the two laboratories are compared prior to the ERB undertaking appropriate action against the erring licensee. Further, the Licensee has an option to take the sample retained on site to a laboratory of their choice for analysis.

In 2021, a total of 287 petroleum product samples were collected from the Government and Non State OMCs depots countrywide for testing against respective Zambian Petroleum Product Quality Standards in 2021. The overall results for the tests are shown in Table 2 -10:

Table 2-10: Petroleum Products Sample Test Results

Product	No. of Samples Collected		Quality Compliance (%)	
	2020	2021	2020	2021
Unleaded Petrol	76	105	97.4	96.2
Diesel (Automotive Gas Oil)	117	120	97.4	100.0
Low Sulphur Gas Oil	34	37	97.1	100.0
Kerosene	07	8	100.0	100.0
Jet A -1	18	17	100.0	100.0
Total	252	287	97.6	98.6

The overall petroleum quality compliance for the year 2021 was 98.6% compared to 97.6% in December 2020. This represents a marginal increase in Petroleum Product Quality compliance and exceeds the ERB SBP compliance target of 95.0%. The Increased petroleum Product quality compliance is attributed to the Fuel Marking programme, which requires all petroleum products on the Zambia market to be marked with a chemical bio marker, in an effort to combat adulteration.

2.11.2 Petroleum Infrastructure Compliance

Energy Regulation Act No. 12 of 2019 mandates the ERB to ensure safe and sound operations of energy infrastructure. Specifically, Section 4(v) of the Act empowers the ERB to close energy facilities whose operations contravene with the Energy Regulation Act, with regards to the safety and health of persons or consumers. In this regard, the ERB undertakes compliance audits of petroleum infrastructure. The said audits are aimed at assessing compliance to the Zambian petroleum standards and regulations that guarantees sustainable operations.

Compliance monitoring assessments were carried out for petroleum infrastructure during the period under review. The overall average compliance for petroleum infrastructure recorded for 2021 was 89.1 percent compared to 95.1 percent in 2020. This decrease in compliance was attributed to lack of technical hearings and consequent enforcement actions which were not undertaken due to COVID-19 restrictions. Notably, infrastructure compliance monitoring for INDENI and TAZAMA were not undertaken as both facilities were largely non-operational. The results of the petroleum infrastructure compliance monitoring are shown in Table 2-11.

Table 2 -11: Results of Petroleum Infrastructure Compliance Monitoring

No.	Facility	Compliance (%)	
		2020	2021
1.	Filling Station	89.9	86.3
2.	Fuel Depot	94.7	87.8
3.	LPG Depot/ Filling Plant	96.7	93.3
4.	Refinery	97.7	N/A
5.	Pipeline	96.2	N/A
	Average Overall compliance	95.1	89.1
	ERB Annual Targets	91.0	93.0

2.11.3 Environmental Impact Assessments

The ERB collaborates with the Zambia Environmental Management Agency (ZEMA) to formulate measures that minimize the environmental impact of activities carried out in the energy sector. In line with the above, the establishment of an energy infrastructure requires undertaking an Environmental Impact Assessment (EIA). Once the developer meets the requirements of an EIA, a copy of the report is submitted to the ERB for review. The ERB undertakes independent inspections to validate the EIA reports from ZEMA.

During the year, the ERB reviewed a total of 167 EIA for proposed energy projects mainly in the petroleum subsector compared to 104 in 2020 as indicated in Table 2-12 below.

Table 2-12: Reviewed EIAs for proposed energy projects by subsector

No.	Subsector	2020	2021
1.	Electricity	5	1
2.	Petroleum	92	165
3.	Renewable Energy	7	1
	Total	104	167

2.11.4 Key Performance Indicators for Petroleum Subsector

One of the regulatory tools that the ERB uses to monitor the efficiency and performance of enterprises is the Key Performance Indicators (KPI) framework. Consequently, the ERB approved a set of Financial and Technical KPIs for TAZAMA, INDENI and TPPL. It was further agreed that the KPIs will be monitored on a quarterly basis and reviewed annually. The reports are meant to assess the performance of enterprises as well as inform the determination of tariffs, fees, rates and other regulatory decisions.

In line with the aforementioned, the result of the assessment KPIs for TAZAMA, INDENI, and TPPL were monitored in 2021, are discussed in this section.

2.11.5 TAZAMA Pipelines Limited

The performance of TAZAMA was assessed against five technical KPI targets and two financial KPIs namely: Throughput, Operational days, Pumping rate and Consumption and Loss, and Safety and environmental incidents, trade debtor days and current ratio respectively.

Throughput, Operational Days and Pumping Rate KPIs were not achieved due to non-availability of feedstock in Quarter 1, 2 and 4 and in the third Quarter the pipeline was only operational for 29 days against the 92 available days the KPI on Safety and Environment was not achieved as the Pipeline recorded four incidents mainly leakages namely: three leaks caused by external corrosion which recorded a cumulative crude oil spill of 41m³, and a fourth leakage was caused by a third party in a case of attempted drill vandalism which resulted in 2m³ of crude oil spill. All the 43m³ of crude oil spilt was not recovered but instead sunk to the ground within the TAZAMA Right of Way (ROW) causing soil contamination. The results of the KPI assessment are shown in Table 2-13.

Table 2-13: TAZAMA's Performance against KPIs

No.	Indicator	KPI Target	Actual Performance		Comment
			2020	2021	
1.0 Technical KPIs					
1.1	Throughput (Metric Tons)	650,000	354,647.1	54,953.3	Not Achieved
1.2	Operational days	315	170	29	Not Achieved
1.3	Pumping Rate (m³/hr)	105	105.6	65.1	Not Achieved
1.4	Consumption and Loss (%)	1.2	0.8	0.8	Achieved
1.5	Safety & Environment	0	2	4	Not Achieved
2.0 Financial KPIs					
2.1	Current ratio	1.2	6.8	1.1	Not Achieved
2.2	Debtor days	15	92.0	71.3	Not Achieved

As shown in Table 2-13, TAZAMA did not achieve the financial KPI targets for current ratio and trade debtor days. This was mainly attributed to slow settlement of payments for invoices issued for services rendered in the period under review. This was further coupled with the huge decline in stock level position on account of the low supply of petroleum feedstock.

2.11.6 INDENI Petroleum Refinery Limited

In 2021, INDENI's technical and financial performance was assessed against five Technical and two Financial KPIs namely: Throughput, Operational days, Consumption and Loss, Quality Compliance for refined petroleum products, Safety, Health, Environment and Quality (SHEQ) incidents, trade debtor days and current ratio respectively.

INDENI achieved two KPI targets on Product Quality Compliance and Safety and Environment. However, the Throughput and Operational Days KPIs were not achieved due to non-availability of feedstock in Quarter one, two and four. In Quarter three the refinery was only operational for 26.9 days against the 92 available days. The refinery was also on unplanned shutdown for 2.2 days due to power and equipment failure. In addition, the Consumption and Loss KPI target was also not achieved.

During 2021, INDENI did not achieve the financial KPI target for current ratio and trade debtor days. This was mainly due to delayed settlement of payments for invoices issued and a significant reduction in stock level position on account of the low supply of petroleum feedstock leading to low generation of income through processing fees. The results of the KPI assessment are shown in Table 2-14.

Table 2-14: INDENI's Performance against KPIs

No.	Indicator	KPI Target	Actual Performance		Comment
			2020	2021	
1.0 Technical KPIs					
1.1	Throughput/MT	700,000	372,066.33	56,672.21	Not achieved
1.2	Operational days	315	175.43	26.91	Not achieved
1.3	Consumption and Loss (%)	8.50	122.51	13.66	Not achieved
1.4	Quality compliance for Refined petroleum products	100	100	100	Achieved
1.5	SHE No of incidents	0	8	0	Achieved
2.0 Financial KPIs					
2.1	Current Ratio	1	2.03	0.79	Not Achieved
2.2	Debtor days	15	92	19.79	Not Achieved

2.11.7 TAZAMA Petroleum Products Limited

TPPL continued to be monitored against four technical and four financial KPIs, namely: throughput, unaccountable losses, No. of product quality incidents, No of safety and environment incidents, asset turnover, current ratio, debtor days ratio and creditor days.

TPPL achieved the technical KPI targets for Unaccountable Losses, Petroleum Product Quality Incidents and Safety and Environment Incidents. Throughput volumes at all six Government depots continued to be monitored for trend analysis. A trend of the throughput volumes over the last three years indicated a general decline in volumes from 1,503,830 M³ in 2019, to 711,063 M³ in 2020 and 901,544.19 M³ in 2021. The decrease was due to reduced refinery output. TPPL also achieved the targets for product quality and SHEQ KPIs.

With regard to the financial KPI targets, the current ratio, trade debtor and creditor days were achieved in the period under review. On the other hand, the target for Asset Turnover was not attained by TPPL during the period under review. This was mainly due to a reduction in petroleum products in government storage facilities. The results of the KPI assessment are shown in Table 2-15.

Table 2-15: TPPLs Performance against KPIs

No.	Indicator	Product	Set KPI target (%)	Actual Performance		Comment	
				2020	2021		
1.0 Technical KPIs							
1.1	Throughput (m³)	All	-	711,063	901,554.19	Not assessed	
1.2	Unaccountable Losses (%)	Diesel	0.30	0.22	0.28	Achieved	
		Petrol	0.50	1.80	1.77	Not Achieved	
		Kerosene	0.30	0.15	0.13	Achieved	
1.3	No. of Petroleum Product Quality Incidents	-	0	0	0	Achieved	
1.4	No. of Safety Health and Environmental incidents	-	0	0	0	Achieved	
2.0 Financial KPIs							
2.1	Asset turnover ratio	-	2		1.61	0.46	Not Achieved
2.2	Current ratio	-	1.2		2.09	4.72	Achieved
2.3	Debtor days	-	30 days		0	0	Achieved
2.4	Creditor days	-	90 days		74.52	15.25	Achieved

2.11.8 Government owned storage depots for white products

In 2021, the Government continued to embark on the construction of petroleum storage depots across the country. During the year, two storage depots in Lusaka and Chipata were at near completion levels which will assist with the goal of ensuring the security of supply of petroleum products.



Fuel depot

As at 31st December 2021, the country had six operational depots in Lusaka, Ndola, Mpika, Mongu, Solwezi and Mansa. Meanwhile, works had advanced at the two upcoming fuel depots. It is expected that the number of operational depots will increase to eight by the close of December 2022. Table 2-16 shows the status of New Lusaka and Chipata fuel depots as at 31st December, 2021.

Table 2-16: Status of the construction of GRZ fuel depots as at 31st December, 2021

No.	Fuel Storage Depot	Status	Estimated Cost US\$' million
	New Lusaka Fuel Depot	<ul style="list-style-type: none"> Construction works had reached advanced completion stages during the period under review. Progress on the development of the depot was at about 90% by close of December 2021. The depot will have a capacity of 102 million litres with the following breakdown: <ul style="list-style-type: none"> 60 million litres Diesel; 40 million litres Petrol; and 2 million litres Kerosene. 	124
	Chipata Fuel Depot	<ul style="list-style-type: none"> Construction works had reached advanced completion stages during the period under review. Progress on the development of the depot was at about 90% by close of December 2021. The depot will have a capacity of 7.0 million litres with the following breakdown: <ul style="list-style-type: none"> 4 million litres Diesel; 2 million litres Petrol; 0.5 million litres Kerosene; and 0.5 million litres Jet A-1. 	37

2.11.9 Development of Guidelines in the Petroleum Subsector

In order to effectively regulate the petroleum subsector, the ERB finalized the development of Guidelines for use of mobile phones and other portable electronic equipment at petroleum infrastructure. These Guidelines will be approved in 2022.

2.11.10 Infrastructure grading of service stations

The ERB has developed rating criteria for grading service stations (Technical and Consumer criteria).

- i) The technical criteria, which focuses on the state of the infrastructure is based on ZS 385: THE PETROLEUM INDUSTRY whose components are as follows:
 - Code of Practice Part 2: Electrical installations in the Distribution and Marketing Sector;
 - Code of Practice Part 3: The installation of underground storage tanks, pumps/dispensers pipework at service stations and consumer installations; and
 - Code of Practice Part 5: Operational Requirements at the service station.
- ii) The consumer criterion is based on customer perceptions and the relevant Zambian standards. Furthermore, the Mystery Customer Model is used in administering the consumer criterion.

The two criteria were administered simultaneously and the compliance rates calculated as follows:

The Overall Compliance Rate (OCR) used is based on a weighted average approach where technical compliance constitutes 70.0 percent while 30.0 percent for consumer compliance as depicted in equation below.

$$\text{Overall Compliance Rate (OCR)} = 0.7T + 0.3C$$

Where, T = Technical Compliance Rate; and

C = Consumer Compliance Rate

OCR is subsequently used to grade sites in accordance with the criteria set out above. The grades range from A up to C and are guided by the grading key as indicated in Table 2-17

Table 2-17: Grading Key for fuel Service Stations

Grade	Score (%)	Interpretation
A	95 -100	Very good service station
B	80 -94	Good service station
C	79 and below	Fair service station

After the assessment is conducted, the grade is displayed in a conspicuous place at a filling station.

During the period under review, 243 of the targeted 323 service stations were graded, representing a 75.2 percent completion rate. The grading exercise was affected by a surge in the COVID-19 cases and subsequent travel restriction measures. The highest percentage at 65.4 percent of the 243 service stations were graded B, 20.6 percent were graded A and 14.0 percent were graded C.

Further, it is worth noting that lower graded service stations do not in any way imply lower quality or off specification of fuel.

2.12 Fuel Marking Programme

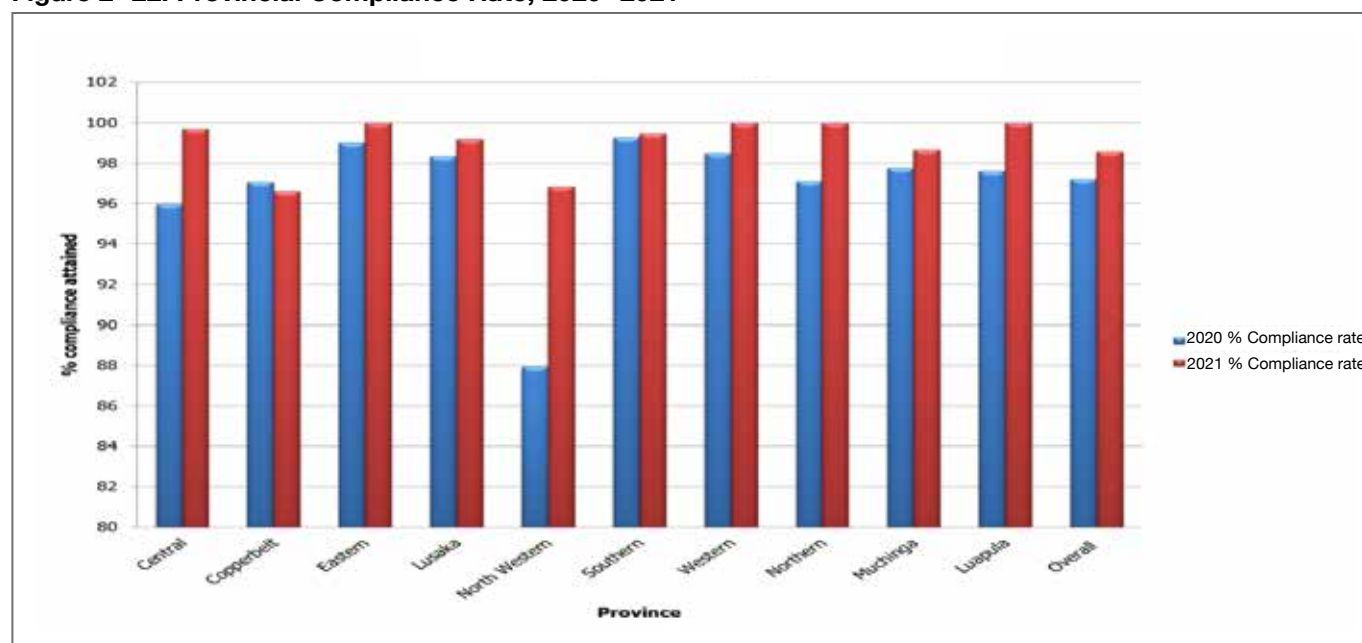
In line with Statutory Instrument (SI) No. 69 of 2017, the ERB continued to implement the fuel marking programme in accordance with the provisions of the Petroleum Marking and Monitoring Regulations. Fuel marking entails the addition of a unique biochemical substance – in small predetermined quantities to all Unleaded Petrol, Diesel, LSGO and Kerosene uplifts meant for domestic consumption thereby giving the fuel a distinctive identification or “fingerprint”.

As such, Fuel Marking enables the ERB to curb adulteration of petroleum products. Further it also enables the ERB to distinguish legitimately procured fuel from illegitimately sourced fuel through the use of proprietary fuel marker detection equipment. In this regard, all domestic fuel uplifts from all Government depots countrywide, as well as at designated OMC depots were appropriately marked prior to distribution on the Zambian market. The total volume of fuel marked during the period under review was 1,868,667.8m³ compared to 1,582,319.4m³ marked in 2020. This represented an increase of 18.1 percent in the quantity of fuel marked countrywide.

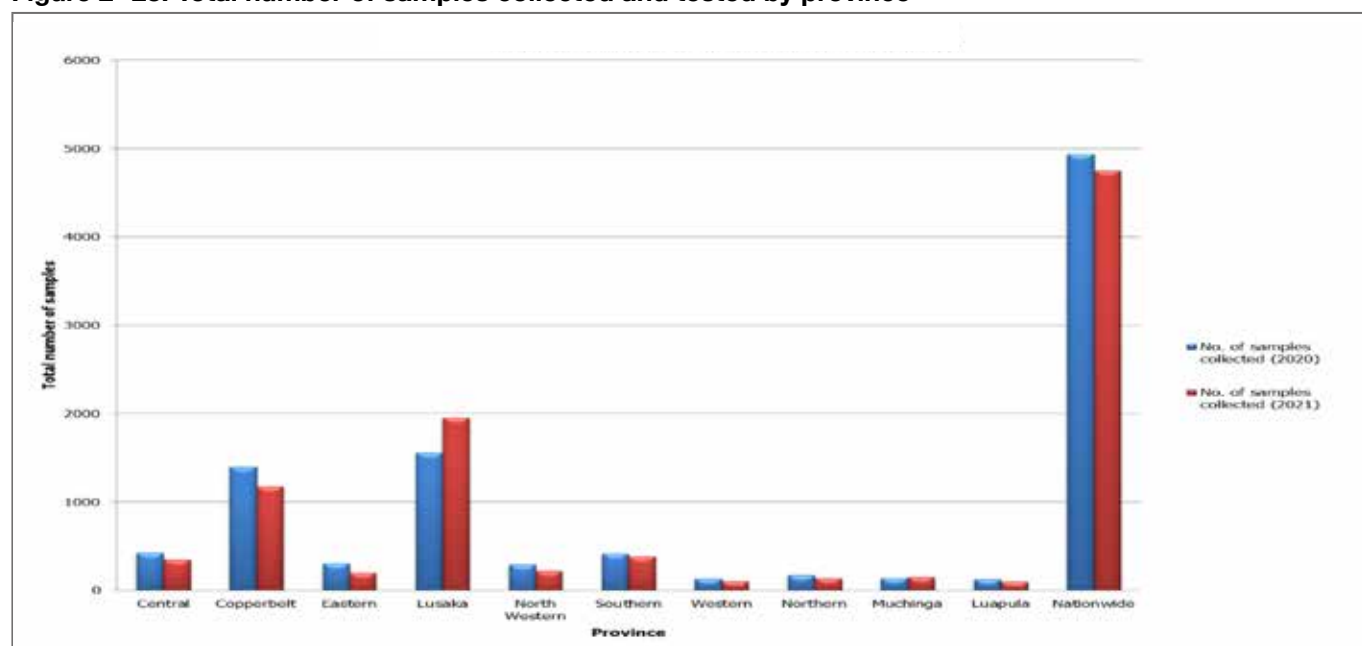
Quarterly field compliance monitoring inspections were undertaken at operational service stations and identified consumer sites (including those at the mines) countrywide as prescribed in the Fuel Marking KPI Framework. The inspections involved the sampling and testing of fuel to ascertain compliance of marker levels in line with the provisions of SI No. 69 of 2017.

During the period under review, an overall compliance rate of 98.6 percent was attained, thus exceeding the set KPI target of 95 percent. Further, all the 10 provinces each recorded overall compliance rates above the set 95 percent target respectively, with the North-Western Province recording the most significant improvement in compliance from 87.9 percent recorded in 2020 to 96.8 percent in 2021. In addition, the results showed an increase of 1.4 percent from the overall compliance achieved in 2020. The increase in overall compliance was attributable to the sustained frequency of compliance inspections (in line with the Fuel Marking KPI framework) and the enhanced awareness by OMCs regarding their obligations as outlined in the Regulations.

Figure 2 -22: Provincial Compliance Rate, 2020 -2021



There was however, a reduction in the total number of samples collected in 2021 of 4,748 as compared to the 4,941 collected in 2020 due to travel restrictions caused by the COVID-19 pandemic mainly during the first quarter of the year.

Figure 2 -23: Total number of samples collected and tested by province

The overall results of the fuel marking sampling and testing exercise by province for the period under review were as tabulated in Table 2-18.

Table 2-18: Results of the Fuel Marking exercise by Province

Province	2020 sampling and testing results		2021 sampling and testing results	
	No. of samples collected	% Pass rate	No. of samples collected	% Pass rate
Central	421	96.0	343	99.7
Copperbelt	1,395	97.1	1,177	96.6
Eastern	301	99.0	197	100.0
Lusaka	1,553	98.3	1,950	99.2
Northwestern	290	87.9	221	96.8
Southern	415	99.3	380	99.5
Western	132	98.5	100	100.0
Northern	173	97.1	135	100.0
Muchinga	135	97.8	149	98.7
Luapula	126	97.6	96	100.0
Total	4,941	97.2	4,748	98.6

2.13 Challenges in the Petroleum Subsector

2.13.1 Low Supply of petroleum feedstock

During the year 2021, low supply of petroleum feedstock continued to be a challenge for the petroleum subsector. Only one cargo of petroleum feedstock was imported into the country in the third quarter of 2021. For the rest of the year, the country relied on imports of finished petroleum products by Government contracted suppliers and the private sector. Subsequently, Government pronounced reforms to restructure the petroleum subsector in order to improve its performance.

2.13.2 Distribution of Retail Site Networks

In 2021, the uneven distribution of retail sites between rural and urban areas continued to pose a challenge for the petroleum sub-sector. This exacerbated illegal fuel vending in un-serviced rural areas and consequent safety and quality concerns to the consumers.

In order to increase the number of filling stations in rural areas, Government has embarked on establishing rural filling stations that are leased out to private operators.

2.13.3 Illegal Fuel Vending

In 2021, illegal fuel vending continued to pose a challenge in the petroleum sub sector. The ERB conducted a study to determine the prevalence and impact of illegal fuel vending in Zambia. The study results showed that illegal fuel vending was rampant in areas without retail sites, along the line of rail, in Border towns and in areas with low numbers of retail sites.

2.14 Outlook in the Petroleum Subsector

In 2022, the announced reforms by the Government of the Republic of Zambia to restructure the petroleum subsector, are expected to be implemented.

2.14.1 Government Reforms

In the fourth quarter of 2021, the Government through the MOE announced reforms in the petroleum subsector. Under the new reforms, INDENI will be put under care and maintenance while TAZAMA will be converted into a finished products pipeline that will be pumping diesel only. Under the new petroleum subsector reforms, INDENI will have a revised role as storage facility for the diesel that will be transported through TAZAMA as well as being a blending facility for biofuels. Further, INDENI is also expected to undertake marking of fuel at the various marking points. The Government reforms are expected to be implemented within 2022 and all players with new roles are expected to take up positions within this time frame.

2.14.2 Revised Pricing Cycle

In line with the new Government reforms and reconfiguration of the upstream players in the petroleum supply chain, the pricing cycle will be revised from the 60 days cycle to 30 days cycle. The revised 30 days pricing cycle is expected to commence in January 2022, where the ERB will be announcing new petroleum products prices every month in support of the new reconfiguration of the upstream players in the petroleum subsector.

2.14.3 Private Sector Led Petroleum Products Procurement

A second petroleum subsector reform was announced in which Government will no longer be involved in the procurement of petroleum products into the country. Under this reform, OMCs will be involved in the procurement of petroleum products while Government will only be involved in the price regulation. This reform is expected to start in the second half of 2022.

2.14.4 Enhanced National Petroleum Storage Capacity

The constructions of the Chipata and New Lusaka Fuel Depots by end of 2021 were at advanced stages. The two fuel depots are expected to be commissioned in 2022 and will increase the total national petroleum storage capacity. The total number of operational fuel depots across the country will increase from six to eight.

2.14.5 Implementation of the Import Parity Pricing Model for Jet A-1

The test run of the Import Parity Pricing (IPP) model for Jet A-1 was successfully completed in the fourth quarter of 2021. The model is expected to be implemented fully during 2022.

3.0 ELECTRICITY SUBSECTOR

This chapter provides information on the electricity sub-sector in Zambia which is dominated by the public utility company, ZESCO Limited, and supported by several IPPs. ZESCO buys power from Independent Power Producers in Zambia and is involved in generation, transmission and distribution of power. Other key players are responsible for transmission and supply of electricity to major end use customers, mainly mining customers.

Subsequent sections discuss the performance of the electricity subsector in 2021, new developments, constraints and challenges and conclude with the outlook of the sector.



KGL Roller Compacted Concrete (RCC) Dam wall

3.1 Zambia's installed electricity generation capacity

Power generation in Zambia is still predominantly hydro based. In 2021, the installed capacity had increased significantly owing to the construction and commissioning of two (02) machines at Kafue Gorge Lower power project. The national installed electricity capacity increased to 3,318.4 from 3,011.2 MW in 2020 as depicted in Table 3-1. This was attributed to the commissioning of 300 MW out of the total 750 MW installed capacity at Kafue Gorge Lower hydro power plant and commissioning of 6 MW out of the 15 MW installed capacity at Lusiwasi Upper hydro power plant. The national installed capacity is still dominated by hydro generation accounting for 81.5 percent from 79.6 percent in 2020.

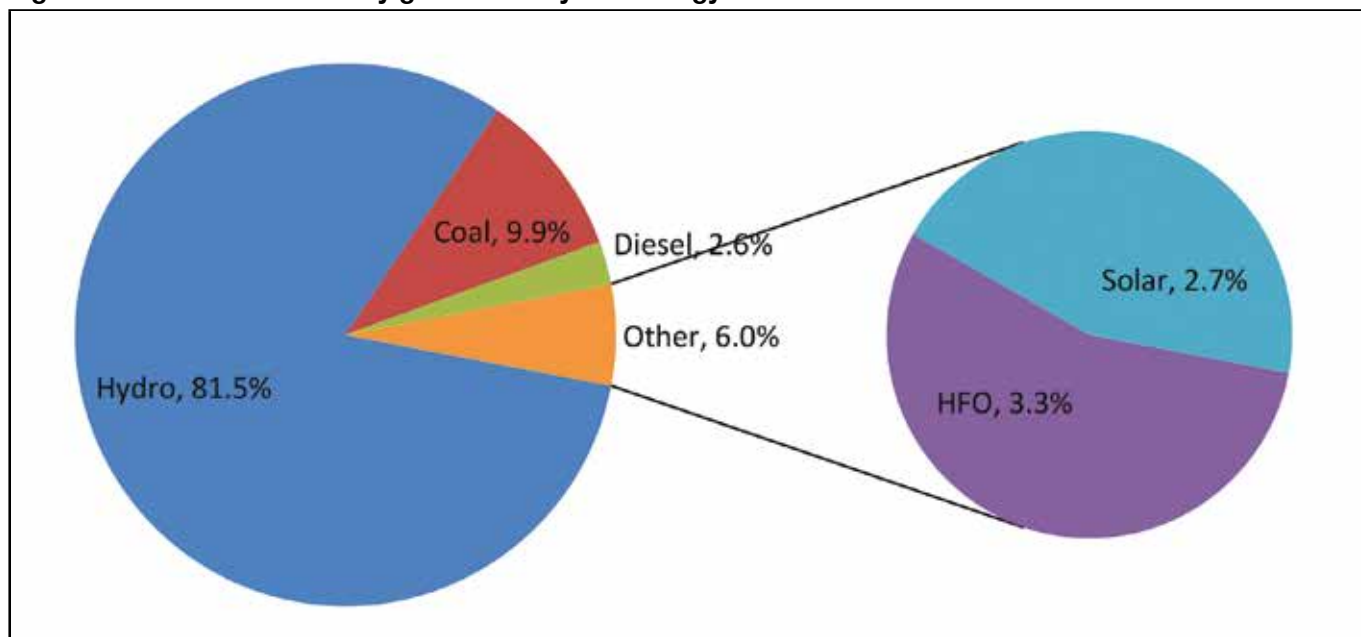
Table 3-1: National installed generation capacity in MW, 2020 – 2021¹⁶

No	Technology	2021	2020		MW
1	Hydro	2,704.50	2,398.50	↑	306.00
2	Coal	330	330	→	0.00
3	Diesel	84.8	83.6	↑	1.20
4	Heavy Fuel Oil	110	110	→	0.00
5	Solar	89.13	89.13	→	0.00
	Grand Total	3,318.43	3,011.23	↑	307.20

¹⁶ Diesel installed generation capacity includes CEC's 80MW GTAs

Figure 3-1 shows the proportion of electricity installed by technology in 2021. Hydro generation accounted for 81.5 percent followed by coal at 9.9 percent. Additionally, HFO accounted for 3.3 percent, while Solar was at 2.7 percent and Diesel at 2.6 percent.

Figure 3-1: Installed electricity generation by technology – 2021



3.2 Hydrological Situation in Zambia

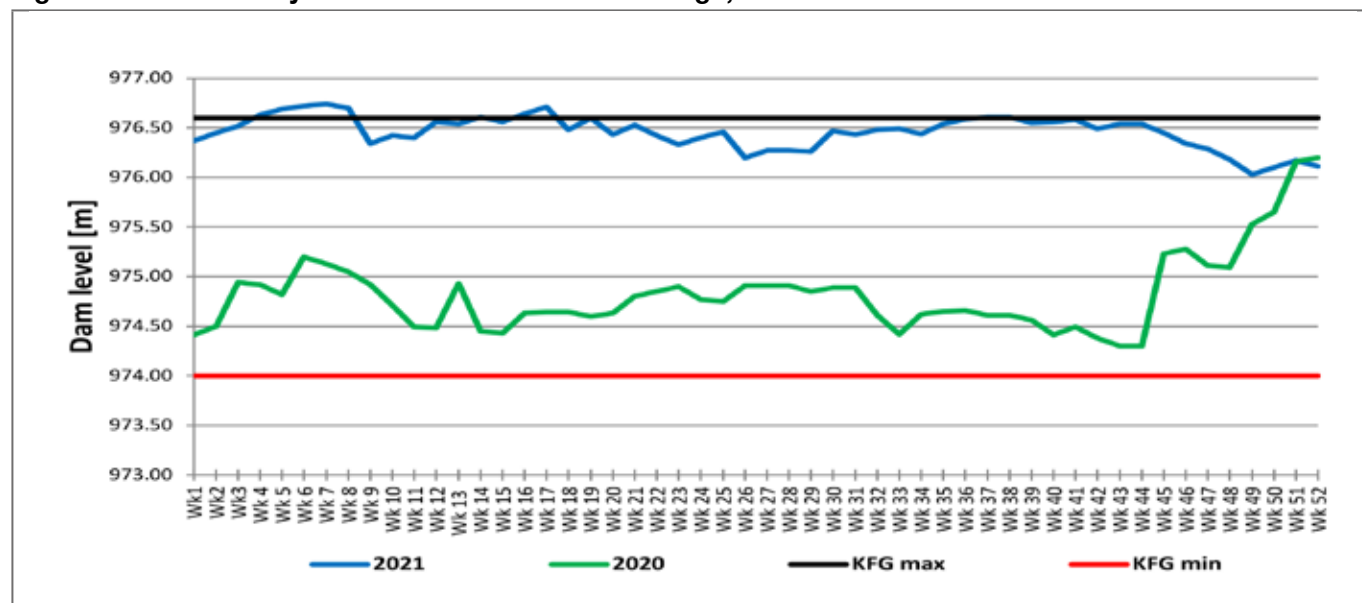
Table 3-2 depicts the actual dam water levels for 2021 and provides the respective design operational levels as monitored by Zambezi River Authority (ZRA) and other key stakeholders, for power generation compared to 2020.

Table 3-2: Main Reservoir Water Dam Levels – (January to December, 2021)

Main Water Reservoir	Dam Design Operational Levels [m]		Year 2021 Actual Dam Levels [m]		Year 2020 Actual Dam Levels [m]	
	Min. Dam Level	Max. Dam Level	Start Level [Jan]	End Level [Dec]	Start Level [Jan]	End Level [Dec]
KFGPS	974.0	976.6	976.37	976.11	974.45	976.27
KNBPS	475.5	487.71	478.44	478.22	476.69	478.39
VFPS	881.5	883.2	882.20	881.80	881.85	882.10
ITPC	1,006.0	1,030.5	1019.13	1023.36	1014.66	1,018.53

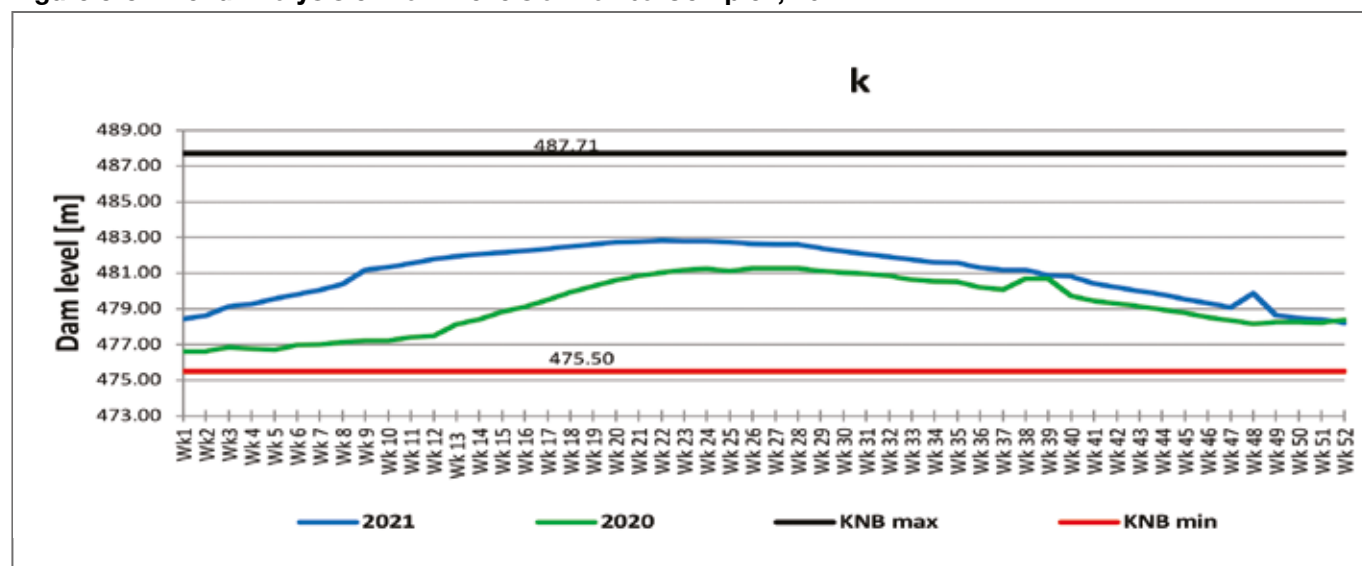
Figures 3 -2 to 3-5 depicts the graphical representation of the dam levels on a weekly basis for the year 2021 compared to 2020 trends.

Figure 3-2: Trend Analysis of Dam Levels at Kafue Gorge, 2021



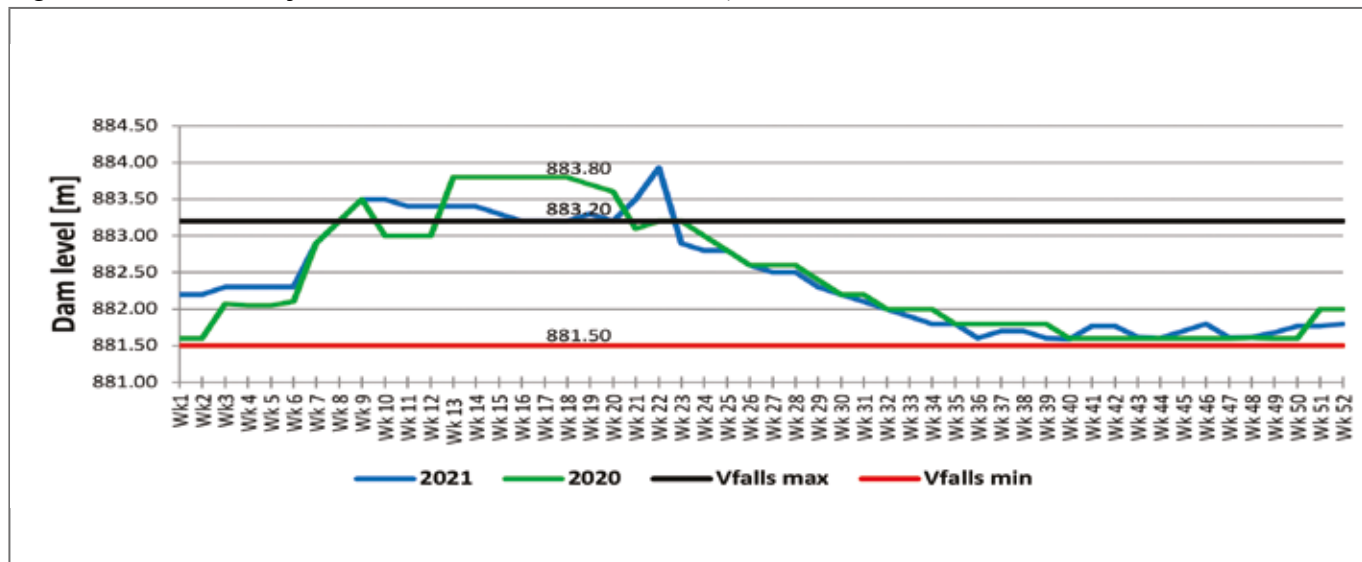
The main water reservoir at Kafue Gorge is designed to operate between levels of 974.00m minimum and 976.60m maximum for hydropower generation. The dam level closed the period under review at 976.11m equivalent to 87.15 percent of usable storage on 31st December, 2021. In 2020 on the same date, the dam level was at 976.27m equivalent to 87.31 percent of usable storage.

Figure 3-3: Trend Analysis of Dam Levels at Kariba Complex, 2021



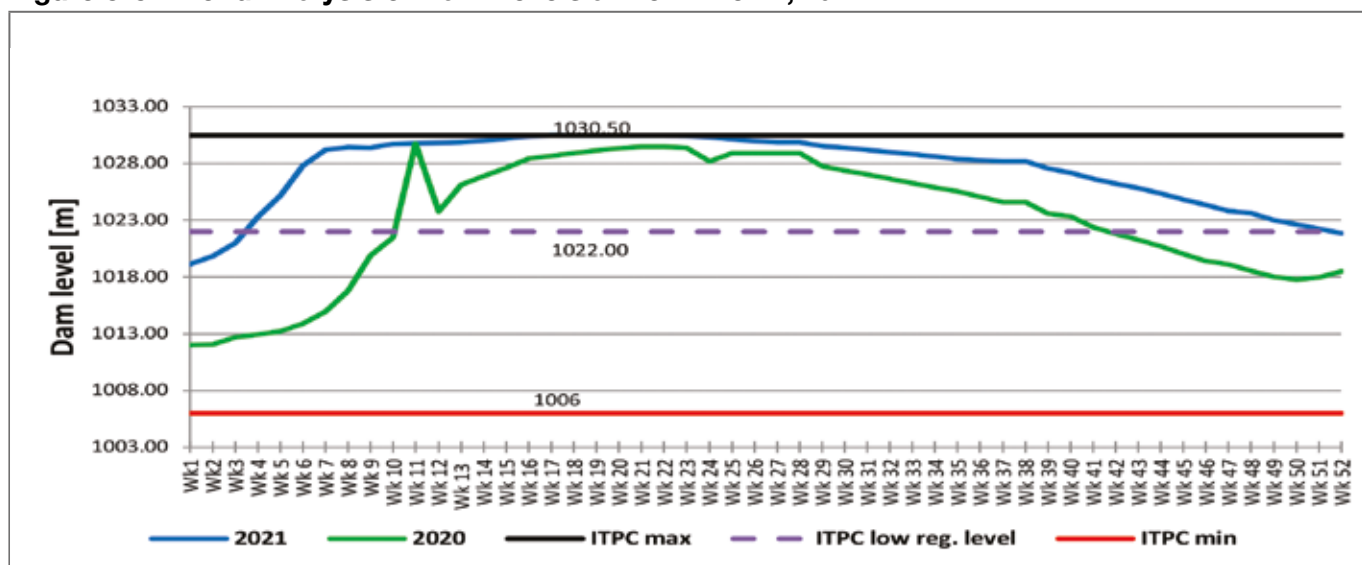
For optimum power generation, the Kariba dam is designed to operate between maximum and minimum levels of 475.50m and 487.71m respectively. In 2021, the dam level closed at 476.22m equivalent to about 20.65 percent of usable storage, while in 2020, the dam level closed at 478.38m equivalent to 20.8 percent of usable storage.

Figure 3-4: Trend Analysis of Dam Levels at Victoria Falls, 2021



For optimum hydro power generation, the main water reservoir at Victoria Falls is designed to operate between minimum and maximum levels of 881.50m and 883.2m respectively. In 2021, the dam level closed at 881.80m equivalent to 17.65 percent of usable storage while, in 2020, the dam level closed at 882.10m equivalent to 35.29 percent usable storage.

Figure 3-5: Trend Analysis of Dam Levels at Itzhi-Tezhi, 2021



For optimum hydro power generation, the main water reservoir at Itzhi-Tezhi is designed to operate between minimum and maximum levels of 1,006m and 1,030.50m respectively. In 2021, the dam level closed at 1,023.36m equivalent to 70.86 percent of usable storage, while, in 2020, the dam level closed at 1,018.53m equivalent to 51.14 percent of usable storage. Itzhi- Tezhi was designed to serve as a primary water storage facility for Kafue Gorge power station to hold equivalent of 6 billion cubic meter of water.

3.3 National Electricity Generation Sent out

The national electricity generation sent out increased by 16.3 percent to 17,636 GWh in 2021 from 15,159 GWh recorded in 2020. Overall, hydro generation accounted for 16,072.9 GWh of the electricity produced in 2021 compared to 14,210.71 GWh in 2020, reflecting a 13.1 percent growth. This was attributed to improved rainfall patterns experienced in the 2020/2021 season.

3.3.1 Electricity Generation from Large Hydro Power Plants¹⁷ Owned by ZESCO

ZESCO owned four large hydro power plants in 2021 namely: Kafue Gorge (990 MW), Kariba North Bank (720 MW), Kariba North Bank Extension (KNBE) (360MW) and Victoria Falls (108 MW). During the year under review, there was an increase of 17.6 percent in generation sent out from the large hydro power plants from 11,716 GWh in 2020 to 13,775 GWh. As earlier indicated, this was mainly on account of the improved hydrological cycle in the Zambezi and Kafue River Basins. Table 3-3 shows the trend in ZESCO's large hydro power stations' generation sent out from 2010 to 2021.

Table 3-3: Electricity Generation from Large Hydro Power Plants Owned by ZESCO in GWh, 2010 - 2021¹⁸

Station/Year	Kafue Gorge	Kariba North Bank	Victoria Falls	Kariba North Bank Extension	Grand Total
2010	6,841	2,777	724		10,342
2011	7,183	3,451	747		11,381
2012	7,376	3,668	810		11,854
2013	7,463	4,507	810		12,780
2014	6,666	4,999	811	1,162	13,638
2015	6,417	4,316	785	1,179	12,697
2016	5,853	2,964	754	672	10,243
2017	7,363	2,689	684	599	11,335
2018	6,527	3,597	723	1,611	12,458
2019	6,165	3,021	725	1,363	11,274
2020	6,027	3,431	764	1,494	11,716
2021	7,185	4,288	1,571	731	13,775

Overall, there was an increase in generation sent out in all the hydro power plants except for KNBE which recorded a decline of 51.1 percent. KNBE by design is a peaking plant and as such, it is usually the last power plant to be dispatched.

3.3.2 Electricity Generation from Mini-Hydro Power Plants Owned by ZESCO

The electricity generation sent out from ZESCO's Small and Mini-Hydro Power Plants increased by 15.2 percent in 2021 compared to the same period in 2020. This was mainly attributed to the generation sent out from Lusiwasi Upper Hydro Power Station. All the mini-hydro power stations recorded a decline due to reduced river inflows. Unlike some large hydro power stations, all of the mini-hydro power stations owned by ZESCO are powered by run-off river water with no storage. Table 3-4 shows the trend in ZESCO's mini-hydro power stations' generation sent out from 2010 to 2021.

¹⁷ Hydropower plants are traditionally broken down into categories depending upon their size based on the World Bank. The smallest plants, with capacities of between 1 and 100 kW are called micro hydropower plants. Between 100 kW and 1 MW a plant is described as a mini hydropower plant. Small hydropower plants are generally those with capacities of between 1 and 10 MW, but this upper limit can vary from country to country and in some cases may be as high as 30 MW. Plants with capacities larger than 10 MW (or up to 30 MW depending on jurisdiction) are classed as large hydropower plants.

¹⁸ KNBE commissioned in 2014

Table 3-4: Electricity Generation from Mini-Hydro Power Plants Owned by ZESCO in GWh, 2010-2021

Station/ Year	Luiwasi Lower	Chishimba Falls	Musonda Falls	Lunzua Lower	Shiwang'andu ¹⁹	Lusiwasi Upper ²⁰	Grand Total
2010	48.80	22.80	18.50	3.30			93.40
2011	55.90	23.80	18.40	3.50			101.60
2012	57.70	23.50	19.40	3.70			104.30
2013	55.70	22.20	21.10	3.80			102.80
2014	58.70	23.70	20.50	3.50	0.70		107.10
2015	63.90	24.20	6.40	26.00	1.00		121.50
2016	41.30	17.80	-	60.90	1.60		121.60
2017	46.20	15.80	6.10	40.40	2.10		110.60
2018	66.00	15.70	54.00	69.30	2.70		207.70
2019	26.20	18.40	51.00	69.70	3.30		168.60
2020	34.50	12.80	57.00	84.00	3.20		191.50
2021	29.57	11.36	53.92	72.01	2.44	51.27	220.57

As depicted in Table 3-4, Shiwang'andu recorded the largest decline of 23.7 percent from 3.20 GWh in 2020 to 2.4 GWh in 2021. Equally, there was a reduction of 14.3 percent; 11.2 percent; 5.4 percent; and 14.3 percent for Lusiwasi Lower, Chishimba Falls, Musonda Falls and Lunzua, respectively.

3.3.3 Electricity generation from diesel power plants owned by ZESCO

In 2021, the generation sent out from diesel power plants owned by ZESCO declined by 60 percent from 3.7 GWh in 2020 to 1.5 GWh in 2021. ZESCO has over the years been extending its coverage of the national grid to areas which were serviced by diesel power plants. Consequently, the generation from diesel power plants has been declining since 2015 as depicted in Table 3-5.

Table 3-5: Electricity generation from diesel power plants owned by ZESCO in GWh, 2010-2021²¹

Station/ Year	Zambezi	Kabompo	Shangombo	Luangwa	Chavuma	Itezhi Tezhi	Chama	Lundazi	Grand Total
2010	2.0	2.1	-	1.9	0.6	-	-	-	6.6
2011	1.6	2.1	-	1.9	0.9	-	-	-	6.5
2012	2.5	3.1	-	2.4	0.4	-	-	-	8.4
2013	3.1	3.1	-	2.4	1.0	-	-	-	9.6
2014	2.5	3.0	0.7	2.6	1.1	-	-	-	9.9
2015	3.0	3.5	0.8	2.9	3.6	0.5	-	-	14.3
2016	2.9	3.8	0.9	3.3	2.1	0.2	-	-	13.2
2017	1.1	0.2	1.0	3.3	1.0		-	-	6.8
2018	-	-	1.1	3.4	-	-	-	-	4.5
2019	-	-	1.1	4.0	-	-	-	-	5.1
2020	-	-	1.0	1.7	-	-	0.1	0.9	3.7
2021	-	-	1.1	-	-	-	0.1	0.3	1.5

¹⁹ Shiwangandu was commissioned in 2014

²⁰ Lusiwasi Upper was commissioned in 2021

²¹ ZESCO diesel power plants were decommissioned owing to grid extension

3.3.4 Electricity generation from Independent Power Producers

The overall electricity generation sent from IPPs in 2021 increased marginally by 1.4 percent compared to 2020. Electricity generation sent out increased to 3,637.98 GWh in 2021 from 3,586.58 GWh. The generation sent out by IPPs was mixed with increases recorded for Itezhi-Tezhi Power Company (ITPC), Lunsemfwa Hydro Power Company (LHPC) as well as Ngonye, while a decline for Maamba Collieries Limited (MCL), Ndola Energy Company (NECL) and Bangweulu. Meanwhile, Kafue Gorge Lower generated the first 893.33 GWh in 2021. The Electricity generation from Independent Power Producers is depicted in Table 3-6.

Table 3-6: Electricity Generation from Independent Power Producers in GWh, 2013-2021

Station/ Year	Itezhi-tezhi Corporation Limited ²²	Maamba Collieries Limited ²³	Ndola Energy Corporation Limited	Lunsemfwa Hydro Power Limited	Bangweulu Power Limited ²⁴	Ngonye Power Limited	Kafue Gorge Lower ²⁵	Grand Total
2013	-	-	0.03	398.40	-	-	-	398.43
2014	-	-	393.40	297.00	-	-	-	690.40
2015	-	-	380.00	216.50	-	-	-	596.50
2016	536.70	326.40	323.60	121.90	-	-	-	1,308.60
2017	735.40	1,279.40	698.80	292.60	-	-	-	3,006.20
2018	709.21	2,041.47	451.02	318.56	-	-	-	3,520.26
2019	715.80	1,886.93	698.74	174.01	77.06	40.50	-	3,593.04
2020	772.18	1,895.61	596.23	172.41	92.15	58.00	-	3,586.58
2021	829.11	1,296.62	117.17	354.09	89.24	58.42	893.33	3,637.98

Table 3-6 illustrates that generation sent out from MCL declined by 31.6 percent from 1,895.61 GWh in 2020 to 1,296.62 GWh in 2021. This was mainly attributed to the major overhaul maintenance that was undertaken and meant that the machines were unavailable for most time of the year. It should be noted that unlike the regular routine annual maintenance, this was unique as it was the first time since the machines were commissioned that such maintenance was undertaken.

The reduction in energy generation recorded by Bangweulu from 92.15 GWh in 2020 to 89.24 GWh in 2021 was attributed to outages on the national electricity grid. Equally, NECL annual electricity generation sent out declined to 117.17 GWh from 596.23 GWh reflecting 80.3 percent reduction. This was attributed to lack of HFO supply as the main source INDENI refinery, was on shut down for most part of the year. LHPC and ITPC stations recorded an increase of 105.4 percent and 7.4 percent, respectively. This was mainly on account of improved hydrological cycle.

3.4 Domestic and Regional Power Trading

Players in the electricity subsector engage in power trading through Power Purchase and Supply Agreements (PPAs and PSAs) at local and regional level. The ERB approves PPAs and PSAs relating to domestic power trading, import or export of electricity.

²² Itezhi-Tezhi commenced operations in 2016

²³ Maamba commenced operations in 2016

²⁴ Bangweulu and Ngonye commenced operations in 2019

²⁵ Kafue Gorge Lower is not fully completed but commissioned the first two units (300 MW) in 2021

3.4.1 Power Purchase and Supply Agreement

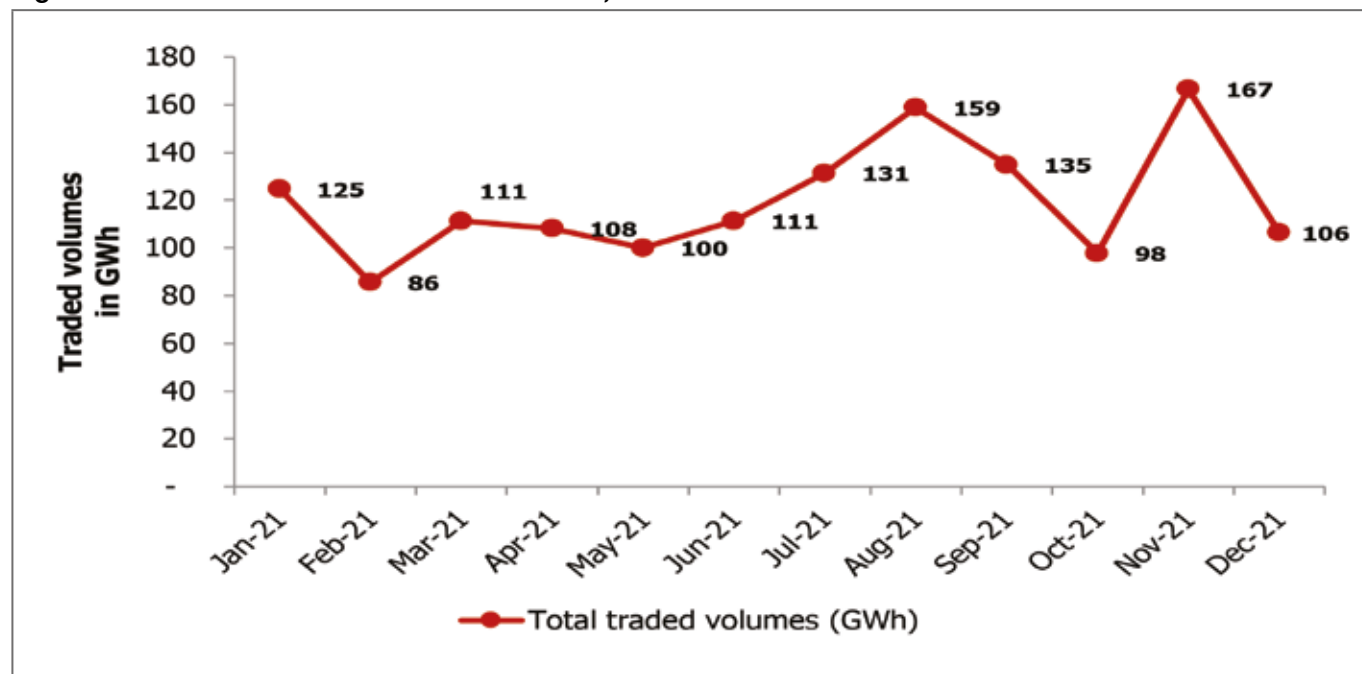
During the period under review, GreenCo Power Services Limited submitted a PPA with LHPC, for the ERB's regulatory approval. The PPA related to the supply and purchase of 5 MW of excess capacity from LHPC. The ERB granted regulatory approval to the PPA on 18th August, 2021.

3.4.2 Trade on the Southern African Power Pool

Southern African Power Pool (SAPP) is a regional power trading block in Southern Africa. SAPP was established in August 1995 and comprises²⁶ 17 state power utilities in the Southern African Development Community (SADC) region. SAPP aims at providing a platform where Utilities are able to trade excess electricity on a competitive market thereby providing sustainable energy source.

There was a decline in total traded volumes on the SAPP market from 1,527 GWh in 2020 to 1,439 GWh in 2021, representing a 6.0 percent decrease. Figure 3-6 shows the trend in the total traded volumes during the year:

Figure 3-6: Trend in SAPP total traded volumes, Jan-Dec 2021

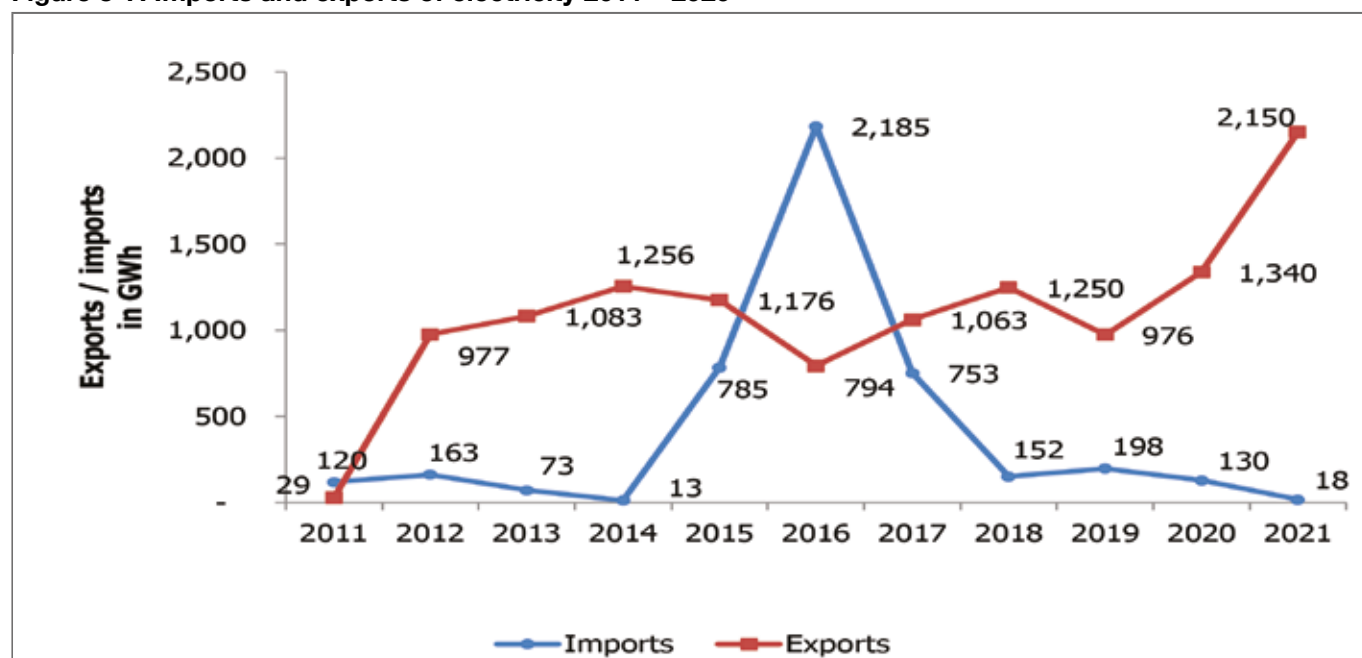


3.4.3 ZESCO Electricity Imports and Exports

In 2021, ZESCO imported and exported electricity through the SAPP market and bilateral agreements. Figure 3-7 shows ZESCO's imports and exports from 2011 to 2021:

²⁶ About SAPP | Southern African Power Pool

Figure 3-7: Imports and exports of electricity 2011 – 2020

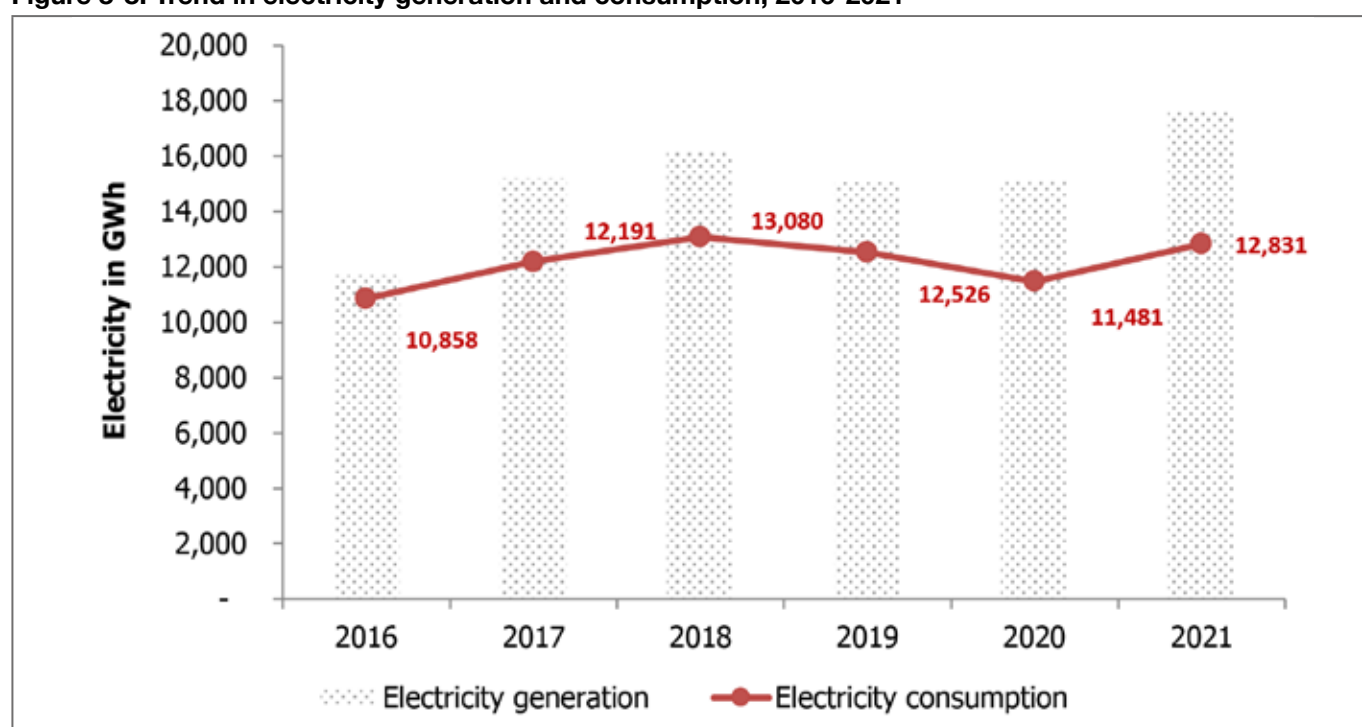


Arising from the increase in electricity generation, exports grew by 60 percent from 1,340 GWh in 2020 to 2,150 GWh in 2021. The growth was driven by increased demand in Congo, Namibia and Botswana. Despite increased electricity generation, the country continued to import low voltage electricity for the border towns namely, Lundazi and Chama from ESCOM of Malawi as the two districts are not connected to Zesco grid.

3.4.4 Electricity Generation and Consumption

During the year 2021, electricity generation increased by 16.3 percent from 15,159GWh in 2020 to 17,636 GWh in 2021. The total electricity consumption also recorded an increase by 12 percent from 11,481 GWh in 2020 to 12,832GWh in 2021. Figure 3-8 shows the trend in electricity generation and consumption from 2016 to 2021:

Figure 3-8: Trend in electricity generation and consumption, 2016-2021



The increase in electricity consumption in 2021 was mainly attributed to increased domestic consumption while the dip recorded in 2020, was attributed to the slowdown in the economic activities due to the effects of the COVID-19 pandemic. Electricity generation shown in Figure 3-8 includes system losses which range between 15 to 20 percent from transmission and distribution systems. The excess generation after losses is exported to neighboring countries through bilateral agreements or traded on the SAPP market.

3.4.5 Analysis of national electricity consumption by economic sector

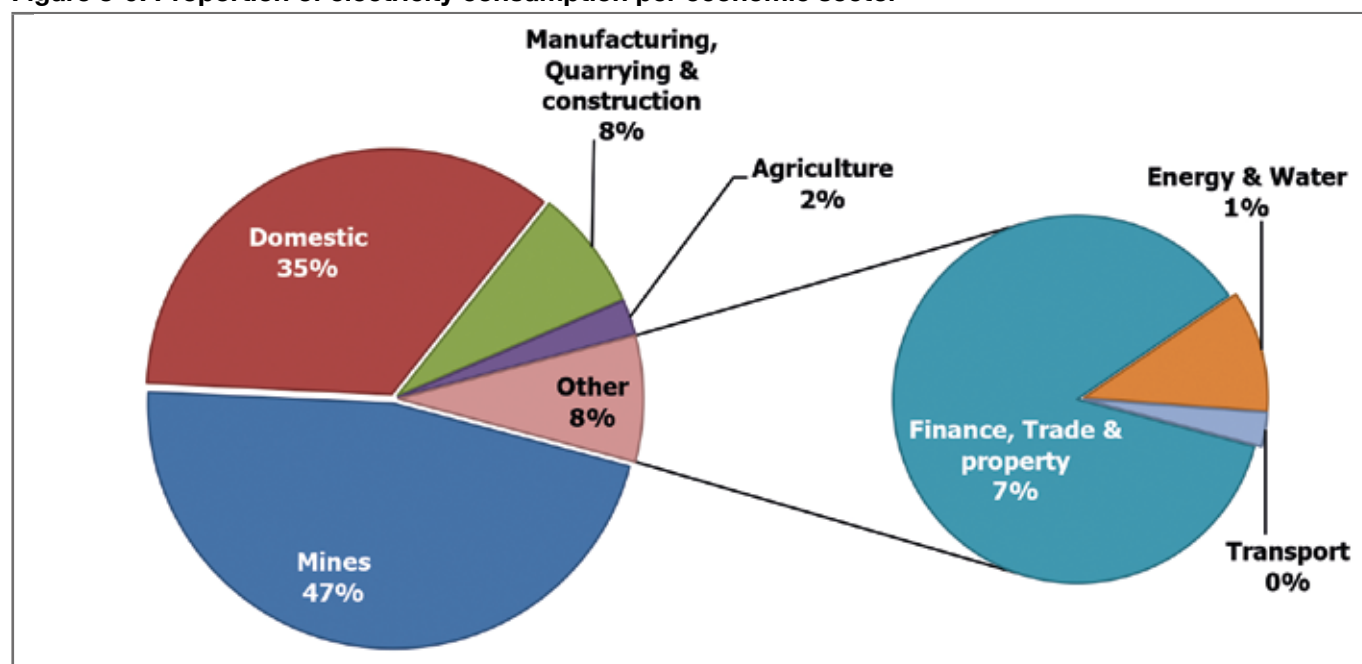
Table 3-7 provides a summary of the electricity consumption per economic sector for 2020 and 2021:

Table 3-7: Electricity consumption by economic sector, 2020 – 2021

Economic sub-sector	2020 (MWh)	2021 (MWh)	Movement (MWh)	Percentage %
Mines	5,806	5,980	174	↑ 3
Domestic	3,867	4,477	610	↑ 16
Manufacturing	450	436	-14	↓ -3
Quarrying	257	572	315	↑ 123
Construction	8	9	1	↑ 13
Agriculture	261	294	32	↑ 12
Finance, Trade & Property	710	918	209	↑ 29
Energy & Water	93	114	21	↑ 22
Transport	29	32	3	↑ 11
	11,481	12,831	1,351	↑ 12

As presented in Table 3-7, all the economic sectors reported an increase in the electricity consumption except for the manufacturing sector which recorded a decline by 3 percent. The quarrying sector recorded the highest increase in consumption of 123 percent, followed by the finance, trade & property sector which increased by 29 percent. The other sectors recorded increases between 3 to 22 percent as depicted in Table 3-7.

With regards to electricity consumption ratios, the mining sector accounted for 47 percent whereas domestic customers accounted for 35 percent. Manufacturing and Agriculture sectors accounted for 8 percent and 2 percent respectively. The rest of the economic sectors accounted for 8 percent of overall electricity consumption. Figure 3-9 shows the electricity consumption ratios per economic sectors in 2021:

Figure 3-9: Proportion of electricity consumption per economic sector

3.5 Operational Performance of Electricity Entities

The ERB monitors the efficiency and performance of the licensees with regards to the purposes for which they were established. This section highlights the performance of licensed enterprises in the electricity subsector.

3.5.1 ZESCO Limited

The ERB has agreed on a KPI framework with ZESCO which runs for three (3) years. The KPI framework focuses on the operational performance of ZESCO with specific emphasis on quality of service supply, financial management, commercial and technical operations.

The current KPI framework covers the period January 2020 to December 2022 and comprises 11 thematic areas. Table 3-8 shows specific KPI's and the assigned weighted scores.

Table 3-8: ZESCO's current KPI framework

No	Key Performance Indicator (KPI)	Assigned score (%)
i.	New Customer Connections	10
ii.	Customer Metering	5
iii.	Financial performance	10
iv.	Efficiency	15
v.	System Losses	7.5
vi.	Staff Productivity	10
vii.	Quality of service	20
viii.	Power generation	5
ix.	Safety	10
x.	Customer Service	5
xi	Power Quality	2.5
	Total	100
	Minimum required score	75

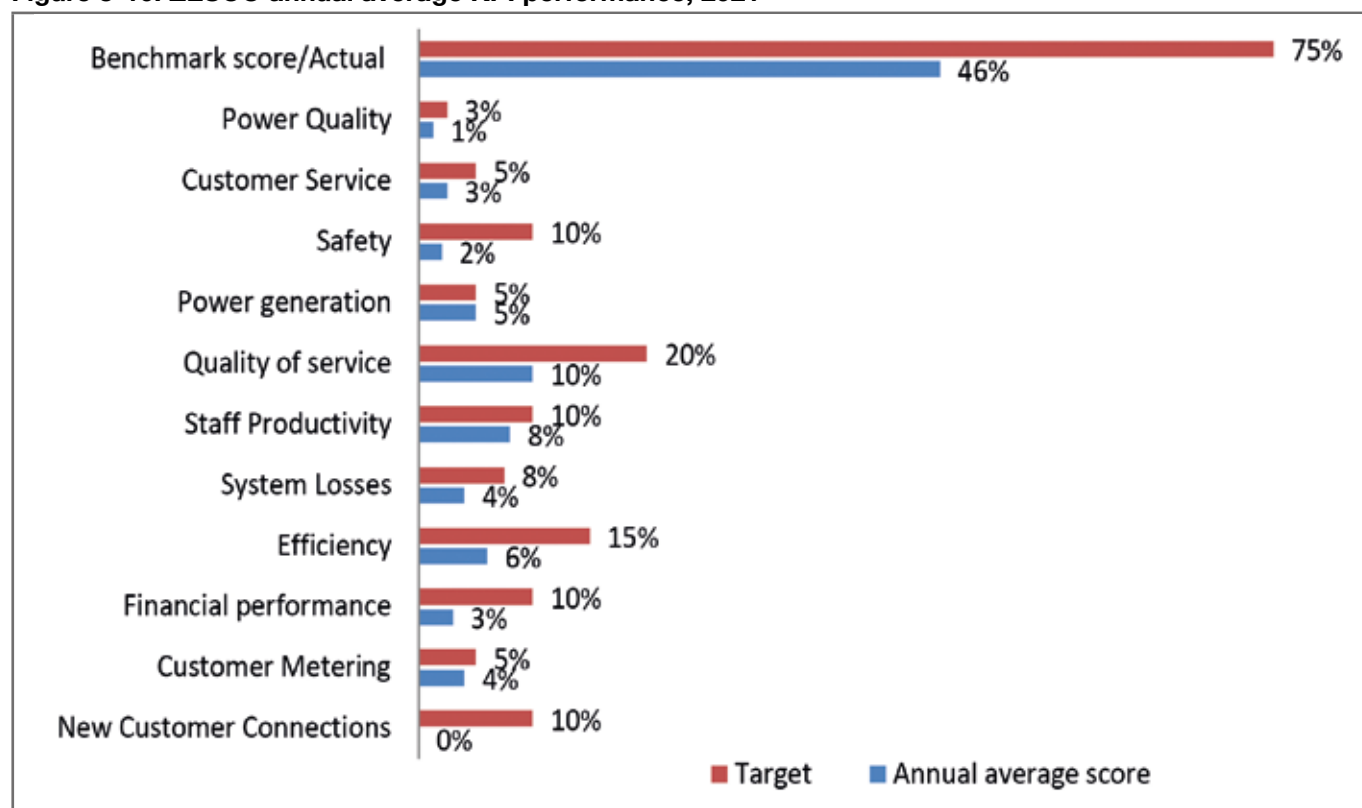
The choice of the KPI's was based on the International best practices in Utility Performance monitoring studies such as the World Bank's Utility bench-marking indicators for Sub-Saharan Africa²⁷.

The framework is designed to enable ZESCO to undertake self-performance appraisal and is used by the ERB for tariff determination. This is intended to balance the interests of customers against those of the utility by ensuring that its operational performance meets consumers' needs and expectations.

3.5.1.1 ZESCO's performance on the KPI framework

In 2021, ZESCO achieved an average annual score of 46 percent which was below the minimum required or mandatory benchmark score of 75 percent. Figure 3-10 shows a summary of ZESCO performance on the KPIs during 2021:

Figure 3-10: ZESCO annual average KPI performance, 2021



As depicted in Figure 3-10 overall, ZESCO did not meet all the KPI targets except for power generation. The Utility cited inadequate financial resources due to non-cost reflective tariffs and connection fees as a main reason for failure to meet KPI targets. The Utility further stated that the non-settlement of invoices by some of its customers impacted on its performance.

3.5.1.2 Technical Performance - ZESCO

The ERB is mandated to monitor the efficiency and performance of enterprises in undertaking licensed activities in order to ensure efficient provision of energy services and products to the consumers.

In 2021, the ERB conducted the technical compliance audits of ZESCO's electricity infrastructure covering generation, transmission and distribution. The overall average compliance was found to be 87.0% compared to 80.0% in 2020 inspections and did not meet the ERB set target of 93.0% by December 2021. Most safety and maintenance related non-compliances remained unresolved. Table 3-9 depicts ZESCO's performance over the years from 2017 to 2021.

²⁷ Monitoring Performance of Electric Utilities : Indicators and Benchmarking in Sub-Saharan Africa (<https://openknowledge.worldbank.org/handle/10986/13030>)

Table 3-9: ZESCO's Infrastructure Percentage Compliance 2017-2021

Type of Facility/Substation	2017 % Compliance	2018 % Compliance	2019 % Compliance	2020 % Compliance	2021 % Compliance
Large Hydro Power Stations	95.3	95.0	93.0	95.0	96.0
Transmission Substations>33kV	79.1	79.3	82.0	86.0	90.0
Distribution Substations≤33kV	74.9	73.3	74.0	78.0	73.0
Mini Hydro Power Stations	82.6	68.5	94.0	98.0	95.0
Diesel generation stations	64.0	67.1	64.0	81.0	81.0
ZESCO Overall Average Compliance	79.2	76.7	81.0	80.0	87.0
ERB SBP Compliance Target for ESI	85.0	87.0	89.0	91.0	93.0

3.5.2 Rural Electrification Authority

The Rural Electrification Authority (REA) is a statutory body created through the Rural Electrification Act No. 20 of 2003 with the mandate to facilitate increased access to electricity in rural areas in Zambia.

REA promotes the implementation of energy projects using various methods and technologies such as the extension of the national grids, solar home systems, solar mini-grids, mini-hydro and other renewable energy sources. According to REA, the Authority has an ambitious target of achieving a rural electrification access rate of 51.0 percent by the year 2030.

During the year 2021, 18 projects were completed consisting of 11 Grid extension projects and seven solar power plants. Table 3-10 shows projects implemented in 2021.

Table 3-10: Projects implemented by REA in 2021

No.	Name of Project	Province	District	Type of Technology	Status as of 31 st December 2021
1.	Shakeemba	Central	Shibuyunji	Grid Extension	Completed
2.	Jembo	Southern	Pemba	Grid Extension	Completed
3.	Luembe	Eastern	Nyimba	Grid Extension	Completed
4.	Kalungu-Sansamwenge	Muchinga	Isoka	Grid Extension	Completed
5.	Luano	Central	Luano	Grid Extension	Completed
6.	Luswishi Farm Block	Copperbelt	Lufwanyama	Grid Extension	Completed
7.	Kipushi	North-Western	Mushindamo	Grid Extension	Completed
8.	Kasanjiku Phase - Lot 1	North-Western	Mwinilunga	Grid Extension	Completed
9.	Mununshi	Luapula	Mwense	Grid Extension	Completed
10.	Nangweshi	Western	Sioma	Grid Extension	Completed
11.	Shamilimo- Munyati	Central	Shibuyunji	Grid Extension	Completed
12.	Chunga Solar Mini-Grid Phase I & II	Central	Mumbwa	Solar Mini-Grid	Completed
13.	Moyo Mini Hospital Mini-Grid	Southern	Pemba	Solar Mini-Grid	Completed
14.	Kampekete Solar Mini Grid	Lusaka	Chongwe	Solar Mini Grid	Completed
15.	Ngabwe Mini Grid (Mumeno)	Central	Ngabwe	Solar Mini Grid	Completed
16.	Ngabwe Mini Grid (Mukatamwene)	Central	Ngabwe	Solar Mini Grid	Completed
17.	Ngabwe District Council	Central	Ngabwe	Solar Mini Grid	Completed
18.	Chaba Chilubi Mainland Solar Mini Grid Project	Northern	Chilubi	Solar Mini Grid	Completed

3.5.2.1 Electricity Services Access Projects (ESAP)

REA is implementing the Electricity Services Access Projects (ESAP). ESAP is the World Bank funded project aimed at increasing household connection to electricity through subsidising connection charges. As at 31st December 2021, the last-mile subsidy connections under the Output-Based Aid (OBA) stood at 40,311 connections against a target of 45,000 representing a 90 percentage achievement. This is broken down as follows:

- 10,719 were women headed households;
- 23,719 were male headed; and
- 5,873 were Small to Medium Enterprises (SMEs). Of the total SMEs connected, 1,208 were female owned while the remaining 4,665 were male owned.

3.5.2.2 Kasanjiku hydro Power Mini-Grid

The Government of the Republic of Zambia provided funding to the REA for the development of the Kasanjiku Mini Hydro Power Plant (KMHPP) in Mwinilunga District of North-Western Province at the cost of US\$ 10.2 million. The Power Plant is situated on the Kasanjiku River about 15km North-West of Ntambu Village and 18km upstream of the confluence of the Kasanjiku River with the Kabompo River. The rated capacity of the plant is 640kW.

The plant was commissioned in 2021 and is currently supplying electricity to Luwi Mission Hospital on pro bono. REA has also constructed the distribution network to supply Ntambu and Sailunga chiefdoms which include schools, churches, households and businesses.

The investment costs were estimated at US\$10,225,011.96 (K209,612,745.18) broken down as follows:

- US\$8,698,932.85 was for power station and 20km of 33kV overhead line;
- US\$ 1,445,884.10 was for distribution network; and
- US\$80,195.01 for billing system and communication network.

3.5.2.3 Challenges Faced by the Authority in 2021

The challenges faced by the Authority in 2021 included the following:

- Lack of Private Sector Participation;
- Low-income levels in rural areas;
- Delay in supply goods and services;
- Lack of Internal Wiring of beneficiary facilities;
- Delayed procurement approvals by Zambia Public Procurement Authority (ZPPA); and
- Depreciation of the Zambian Kwacha

3.5.3 Copperbelt Energy Corporation Plc

CEC is an independent power company with investments in electricity transmission and distribution networks. CEC is a member of the SAPP and is listed on Lusaka Stock Exchange (LuSE).

CEC has standby generators of 80 MW installed capacity and a 1 MWp solar power plant as broken down in Table 3-11.

Table 3-11: CEC Installed Capacity, 2021

Station	Installed Capacity (MW)	Available Capacity (MW)
Luano	40	20
Bancroft	20	20
Kankoyo	10	10
Maclaren	10	10
Solar	1	1
Total	81	61

In 2021, CEC generated 5,963 MWh from its standby generators. Further, in 2021 CEC purchased 1,921,195 MWh and sold 1,874,613 MWh to its customers on the Copperbelt as shown in Table 3-12.

Table 3-12: Purchases and Sales of Electricity by CEC, 2021

Energy Purchases and Sales (MWh)		
Purchases	ZESCO	1,510,018
	LHPC	315,744
	Dangote	95,433
	Total	1,921,195
Sales		1,874,613
Computed Loses		2.42%

3.5.3.1 Technical performance

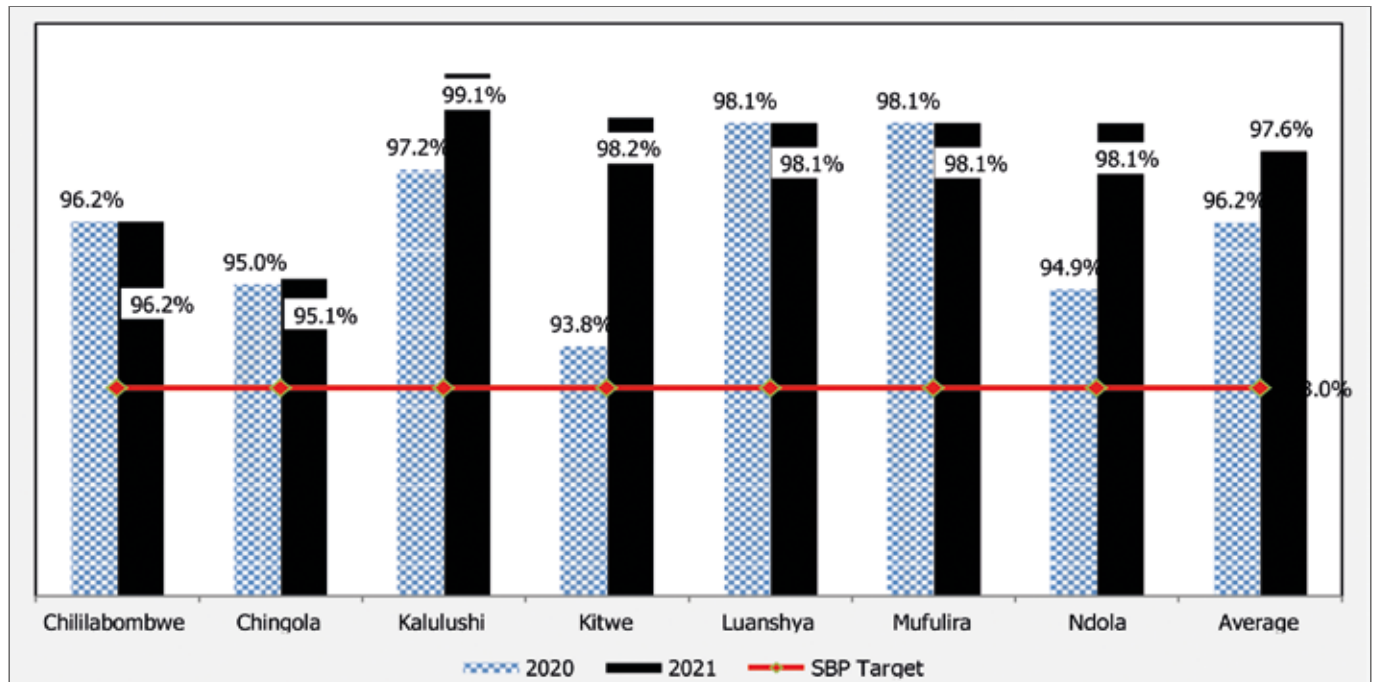
The ERB conducted the technical compliance audits of CEC electricity infrastructure covering the transmission and Gas Turbine Alternators (GTA). The average compliance for the transmission facilities was found to be 97.6 percent in 2021 compared to 96.0 percent in 2020 while for the GTAs the percentage compliance in 2021 dropped from 100 percent to 98.3 percent. Despite the decline of 1.7 percentage points, this was above the ERB set target of 93.0 percent by December 2021. Table 3-13 depicts CEC's performance over the years from 2017 to 2021.

Table 3-13: CEC's Infrastructure Percentage Compliance rates, 2017-2021

Type of Facility/Substation	2017 % Compliance	2018 % Compliance	2019 % Compliance	2020 % Compliance	2021 % Compliance
CEC Transmission - Chililabombwe	100.0	99.0	96.2	96.6	96.2
CEC Transmission - Chingola	98.7	97.1	93.0	95.6	95.1
CEC Transmission - Kalulushi	96.3	97.0	94.9	96.2	99.1
CEC Transmission - Kitwe	98.9	94.9	89.6	93.6	98.2
CEC Transmission - Luanshya	99.6	98.0	96.1	97.0	98.1
CEC Transmission - Mufulira	100.0	97.9	98.1	96.0	98.1
CEC Transmission - Ndola	99.4	96.0	94.5	96.8	98.1
CEC Gas Turbine Alternators (GTAs) 80MW	100.0	100.0	98.0	100.0	98.3
ERB SBP Compliance Target for ESI	85.0	87.0	89.0	91.0	93.0

Figure 3-11 shows the graphical representation of the compliance levels of CEC electricity infrastructure for 2021 compared to 2020.

Figure 3-11: CEC's electricity infrastructure compliance rates, 2020 - 2021



3.5.3.2 Challenges Faced by CEC

The challenges faced by CEC in 2021 include the following:

- Thefts of overhead conductors. However the utility continued collaborating with the state security and several arrests were made in the 4th quarter; and
- COVID-19 pandemic impacted travel and maintenance schedules.

3.5.4 Ndola Energy Company Limited

NECL is an IPP which generates power and sells to ZESCO through a PPA. NECL operates the HFO power plant located in Ndola. The total installed capacity of the power plant stands at 110 MW. In 2021 NECL supplied 117,168.13 MWh to its sole customer, ZESCO.



Ndola Energy Power Plant

3.5.4.1 Technical Performance

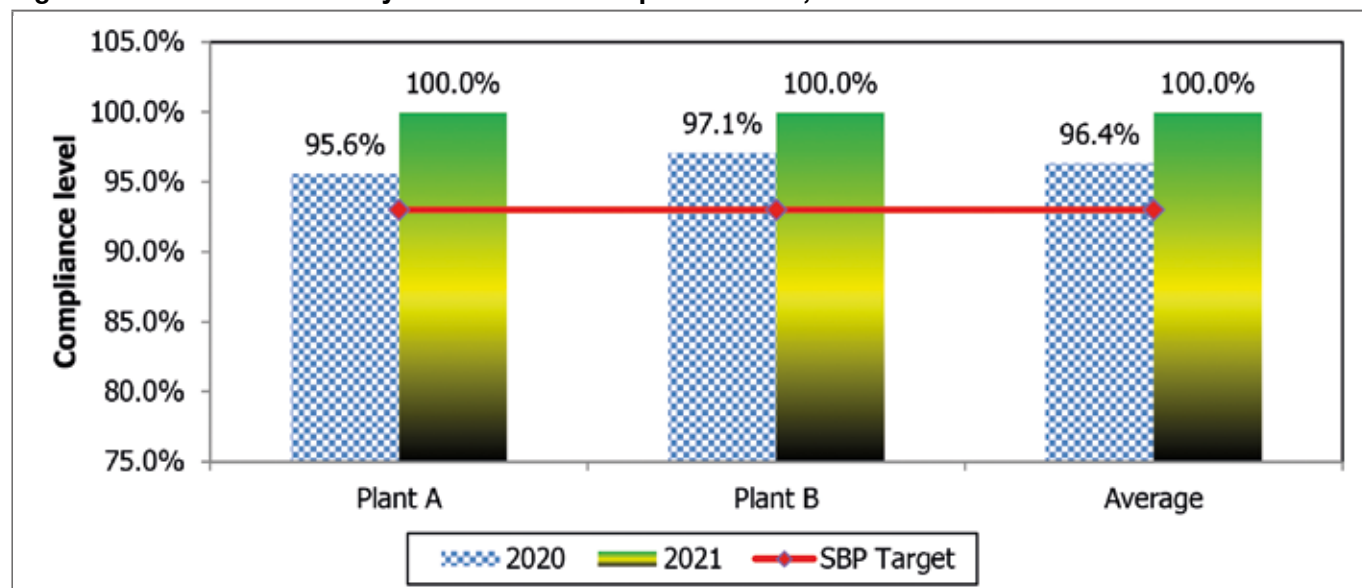
In 2021, the ERB conducted the technical compliance audits of NECL electricity generation infrastructure. The average compliance levels for both NECL's Phase I and Phase II generating plants was 100.0 percent for 2021 compared to 96.4 percent in 2020. The overall performance of NECL infrastructure was above the ERB compliance target of 93 percent for 2021 as depicted in the Table 3-14 below.

Table 3-14: NECL Percentage Compliance, 2017-2021

Type of Facility/Substation	2017 % Compliance	2018 % Compliance	2019 % Compliance	2020 % Compliance	2021 % Compliance
Phase I Plant	96.7	100.0	100.0	95.6	100.0
Phase II Plant	-	100.0	100.0	97.1	100.0
NECL Overall Average Compliance Level	96.7	100.0	100.0	96.4	100.0
ERB SBP Compliance Target for ESI	85.0	87.0	89.0	91.0	93.0

Figure 3-12 shows the graphical representation of the compliance levels of NECL electricity infrastructure for 2021 compared to 2020.

Figure 3-12: NECL's electricity infrastructure compliance rates, 2020 - 2021



3.5.4.2 Challenges faced by NECL

During the period under review, NECL faced the following challenges:

- Cash flow challenges that emanated from delayed payments of outstanding bills by ZESCO;
- Non-availability and shortages of HFO resulting in reduced generation and frequent unscheduled plant shutdown; and
- Lack of independent fuel test laboratories in the region that can perform quality and reliable tests of fuel compelling NECL to send samples for testing outside Zambia. This results in delays in fuel certification which consequently results in unscheduled plant shutdown.

3.5.5 Lunsemfwa Hydro Power Company Limited

LHPC is an IPP based in Kabwe, Central Province and has two hydro power stations with a combined installed capacity of 56 MW namely; Mulungushi Power Station (MPS) 32 MW and Lunsemfwa Power Station (LPS) 24 MW. LHPC has off-take agreements with ZESCO and CEC. In 2021 LHPC and Africa GreenCo Power Services Limited entered into a PPA for the sale of 5 MW of power.



Intake/Dam facility for LHPC Hydro Power Station

3.5.5.1 Technical performance

The ERB conducted technical compliance audits of LHPC electricity infrastructure in 2021. The audit covered the two generation power stations, namely Lunsemfwa and Mulungushi, part of LHPC 66 kV Line A and B infrastructure at Converter 66/33/11 kV Substation, Transformer T5 and its accessories at 88 kV Kabwe Step Down Substation. Table 3-15 depicts the percentage compliance of audited infrastructure from 2017 to 2021.

In 2021, LHPC compliance level declined to 91.8 percent compared to 92.8 percent recorded in 2020. This was below the ERB compliance target of 93 percent by December 2021.

Table 3-15: LHPC's Percentage Compliance rates, 2017-2021

Type of Facility/Substation	2017 % Compliance	2018 % Compliance	2019 % Compliance	2020 % Compliance	2021 % Compliance
Converter 66/33/11KV	80.9	94.0	93.0	86.0	92.7
Kabwe Step Down 66/88kV	83.0	100.0	88.0	93.0	94.8
Mulungushi Power Station	80.8	93.0	93.0	96.0	89.3
Lunsemfwa Power Station	89.7	90.0	93.0	96.0	89.1
LHPC Overall Average Compliance	83.6	94.3	91.8	92.8	90.5
ERB SBP Compliance Target for ESI	85.0	87.0	89.0	91.0	93.0

3.5.6 Maamba Collieries Limited



Maamba Collieries plant

MCL is located in Sinazongwe District of Southern Province. The Company owns and operates a 300MW coal-fired power plant, comprising two-150 MW units as well as the coal mine. MCL has signed a long term PSA with ZESCO and during the year under review, MCL generated 1,494.09 GWh and sent out 1,296.62 GWh. The difference is attributed to auxiliary consumption.

The power plant uses the self-burning low grade coal at the MCL mine to mitigate the environmental effects that would occur if the coal was left unused. Using the coal to produce electricity with a suitable technology reduces greenhouse gases (GHGs) emissions associated with self-burning coal.

3.5.6.1 Technical performance

The ERB conducted the 2021 technical compliance audit of MCL electricity generation infrastructure. The overall average compliance was 98.3 percent, compared to 97.5 percent in 2020. This compliance was above the ERB target of 93.0 percent compliance rate for 2021 as depicted in the Table 3-16 below.

Table 3-16: MCL's Percentage Compliance rates, 2018-2021

Type of Facility/Substation	2018 % Compliance	2019 % Compliance	2020 % Compliance	2021 % Compliance
Maamba thermal power station	94.7	95.4	97.0	96.4
330kV switchyard	94.7	95.4	98.0	100.0
MCL Overall Average Compliance Level	94.7	95.4	97.5	98.3
ERB SBP Compliance Target for ESI	87.0	89.0	91.0	93.0

3.5.6.2 Challenges faced by MCL

In 2021 MCL carried out major maintenance works on one of its generating unit. During this process it was established that some of the turbine's internal components, namely HIP diaphragms and diaphragms carriers, were deformed.

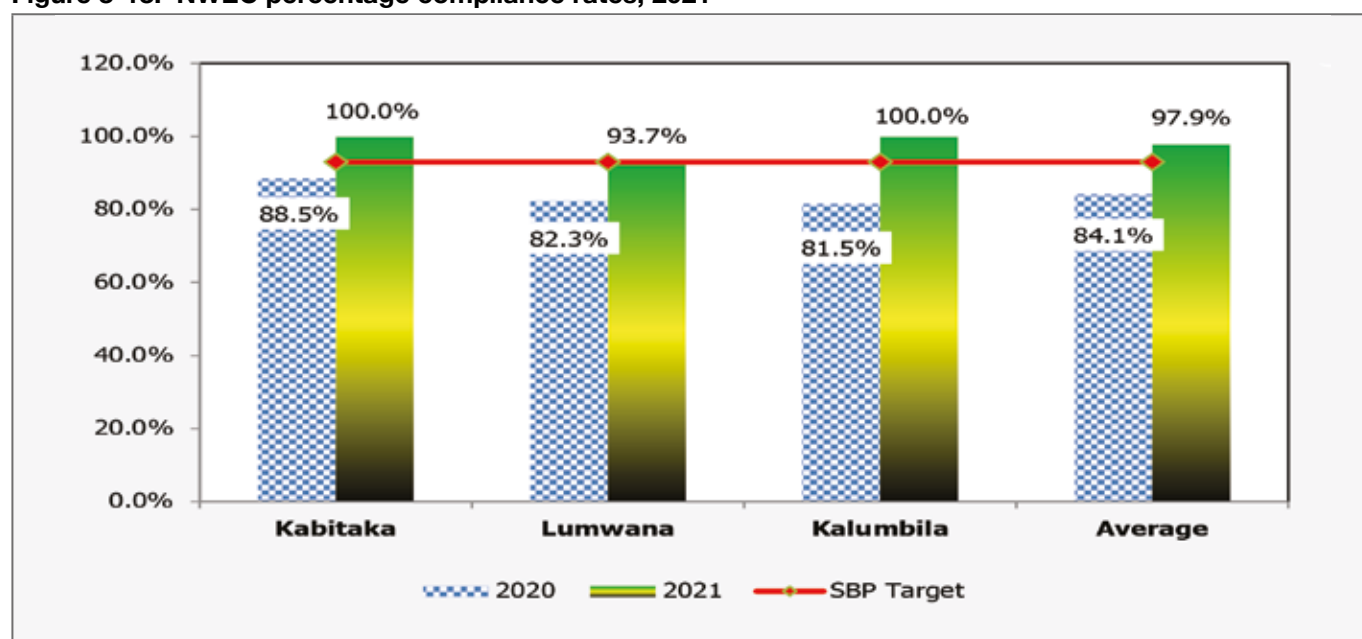
3.5.7 North-Western Energy Corporation Limited

NWEC is a Distribution Network Service Provider (DNSP) which owns and operates a distribution system and purchases power in bulk from ZESCO for onward distribution to the non-mining load of Lumwana, Kalumbila and Kabitaka mining townships in North-Western Province. NWEC has a PPA with ZESCO with a contracted capacity of 20 MVA for a period of 15 years. Figure 3-13 shows the compliance rate for NWEC in 2021.

In 2021, NWEC had 3,255 customers broken down as follows:

- 3,171 residential customers;
- 73 commercial customers;
- 10 social services customers; and
- 1 industrial customer.

Figure 3-13: NWEC percentage compliance rates, 2021



3.5.7.1 Challenges Faced by NWEC

During the period under review, NWEC faced the following challenges:

- Difficulties in accessing project funding and high interest rates; and
- Increased operational costs due to high maintenance costs.

3.5.8 Itezhi Tezhi Power Corporation

ITPC is a Joint Venture IPP Company owned by ZESCO and TATA Power Company Limited which owns a 120 MW Hydro Power Station comprising two units rated 60 MW each. The Company has a long term PPA with ZESCO to supply power from its hydro power plant located in Itezhi Tezhi District in Central Province, Zambia.

3.5.8.1 Technical performance

In 2021, the ERB conducted the technical compliance audits on the electricity infrastructure for ITPC. The compliance level was determined to be 93.2 percent for period under review compared to 95.0 percent in 2020 indicating a 1.85 percentage point decrease. Despite this decrease, the overall

performance of ITPC infrastructure was above the ERB compliance target of 93 percent for 2021 as depicted in the Table 3-17 below.

Table 3-17: ITPC's Percentage Compliance rates, 2017-2021

Type of Facility/Substation	2017 % Compliance	2018 % Compliance	2019 % Compliance	2020 % Compliance	2021 % Compliance
ITPC Hydro Electric Power Stations	85.2	94.9	93.0	95.0	92.0
220kV Switch Yard		98.0	94.0		94.3
ITPC Overall Average Compliance Level	85.2	96.5	93.5	95.0	93.2
ERB SBP Compliance Target for ESI	85.0	87.0	89.0	91.0	93.0

3.5.9 Zengamina Power Limited

Zengamina Power Limited (ZPL) is an off-grid mini-hydro power plant located in Ikelenge District of North-Western Province with an installed capacity of 0.75 MW. The plant was commissioned in 2007 and supplies electricity to over 800 customers that includes households, hospitals, schools, and small businesses.

3.5.9.1 Technical Performance

In 2021, a technical inspection on the electricity infrastructure for ZPL was undertaken by the ERB. There was a marginal increase in the compliance level of 1.0 percentage points from 91.0 percent in 2020 to 92.0 percent in 2021. However, the achieved results were below the ERB compliance target of 93.0 percent for the period under review.

3.5.9.2 Challenges faced by Zengamina

During the period under review, ZPL faced resistance to fully migrate to ERB approved electricity tariffs by consumers.

3.5.9.3 Prospects for Zengamina

- ZPL has plans to expand its capacity by setting up an additional 200 KWp solar power and 400 KWh of Battery Energy Storage System;
- Connect an additional 3,000 households and businesses; and
- Catalyze significant productive use amongst customers.

3.5.10 Dangote Industries Zambia Limited

Dangote owns and operates a 30 MW thermal power plant that supplies electricity to its cement production plant located in Masaiti District. Dangote has entered into a PSA with CEC for the excess power amounting to 8 MW. During the period under review, CEC purchased 95,433 MWh from Dangote.

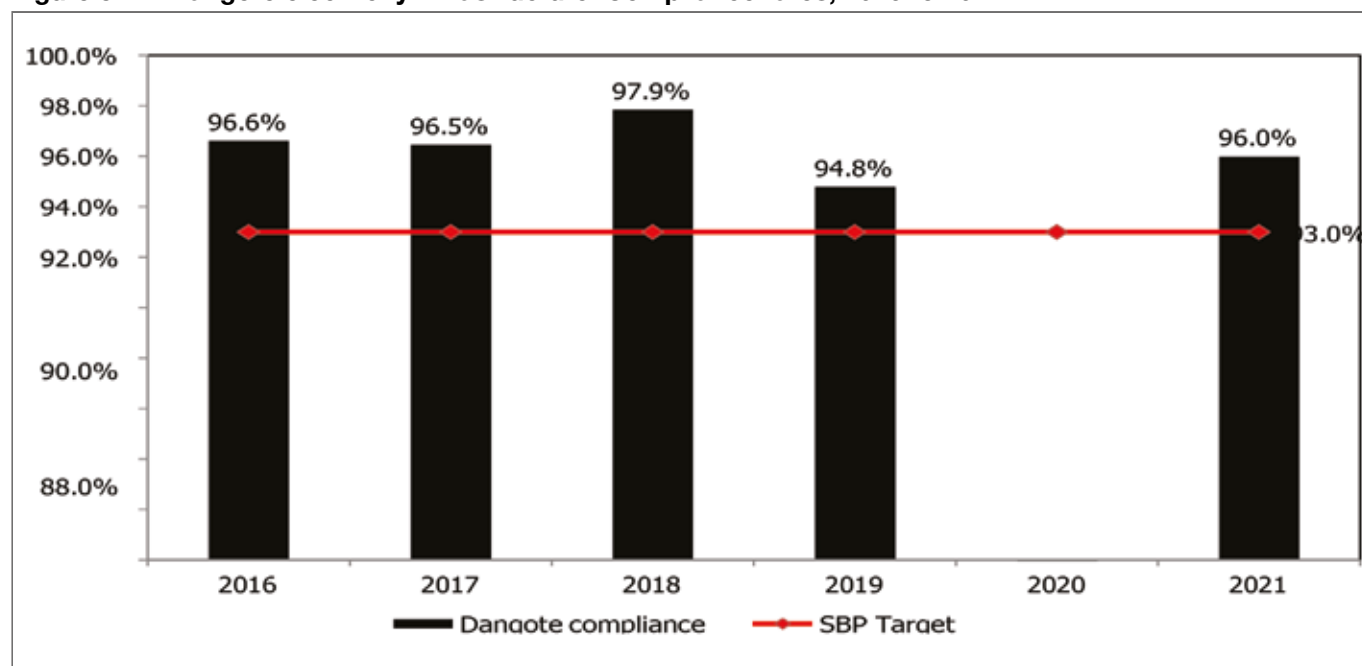


Dangote Cement Thermal Boilers Plant

3.5.10.1 Technical Performance

In 2021, the ERB conducted the technical compliance audits on the electricity infrastructure for Dangote and the overall compliance level was 96.0 percent. This was above the ERB compliance target of 93.0 percent for 2021. In 2020, Dangote infrastructure was not audited but figure 3-14 depicts Dangote's compliance levels from 2016 to 2021.

Figure 3-14: Dangote electricity infrastructure Compliance rates, 2016 to 2021



3.5.10.2 Challenges faced by Dangote

Dangote faced the following challenges during the year:

- Unexpected heavy rains experienced had negative impact on the power plant and led to power trips due to voltage fluctuations;
- The COVID 19 pandemic affected the completion of the grid connection project due to delays in receiving support services; and
- The rise in the coal and diesel prices had negative impact on the operations of the plant.

3.6 Operational Performance of the Interconnected Power System

The function of System Operation is anchored by ZESCO who holds a System Operator license issued by ERB. In 2021, the IPS experienced a total of 115 major system disturbances and faults compared to 27 disturbances recorded in 2020. The details of the major interruptions are depicted in **Appendix 9**. The Power Quality and Reliability Standard ZS 387 Part 2 under Clause B.5.1 define major supply interruptions as:

- i. Any single event that lead to loss of supply to a 1,000 consumers or large end-user consumer; and
- ii. Forced interruption index greater than five system- minutes²⁸

3.7 National Network Expansion

In 2021, ZESCO undertook major network expansion projects that included the following:

- i. Implementation of Lusaka Transmission and Distribution Reinforcement Project (LTDRP);
- ii. Construction of 330kV Kabwe Step Down to Pensulo line 2;
- iii. Construction of 330kV KGL line to Lusaka West Substation via LSMFZ for power evacuation from the newly constructed KGL power plant;
- iv. Installation of reactors at Nambala substation and commissioning of the second line on Nambala to Kalumbila 330kV twin tower corridor.

3.8 National Network Constraints

In 2021, the Zambian IPS experienced the following network constraints in normal operation as a result of contingencies as depicted in Table 3-18:

Table 3-18: Network Constraints and Contingencies, 2021

No.	Network Constraint Location	Impact on the Network
1.	330kV Kafue Gorge - Leopards Hill line	In case of contingency limits, power evacuation at Kafue Gorge Lower is affected.
2.	330kV Kafue Town - Muzuma line	In case of contingency limits, Victoria Falls Power Station (VFPS), MCL and Nampower dispatch is affected.
3.	330kV Kabwe - Pensulo line	In case of contingency limits, supply to Northern, Luapula, Muchinga and Eastern provinces is affected.
4.	330kV Muzuma - Mukuni line	In case of contingency limits, VFPS, MCL and Nampower dispatch is affected.

Note that under normal operation without considering any line outage, the transmission network is able to transmit all power as demanded.

3.9 Power Deficit and Load Management

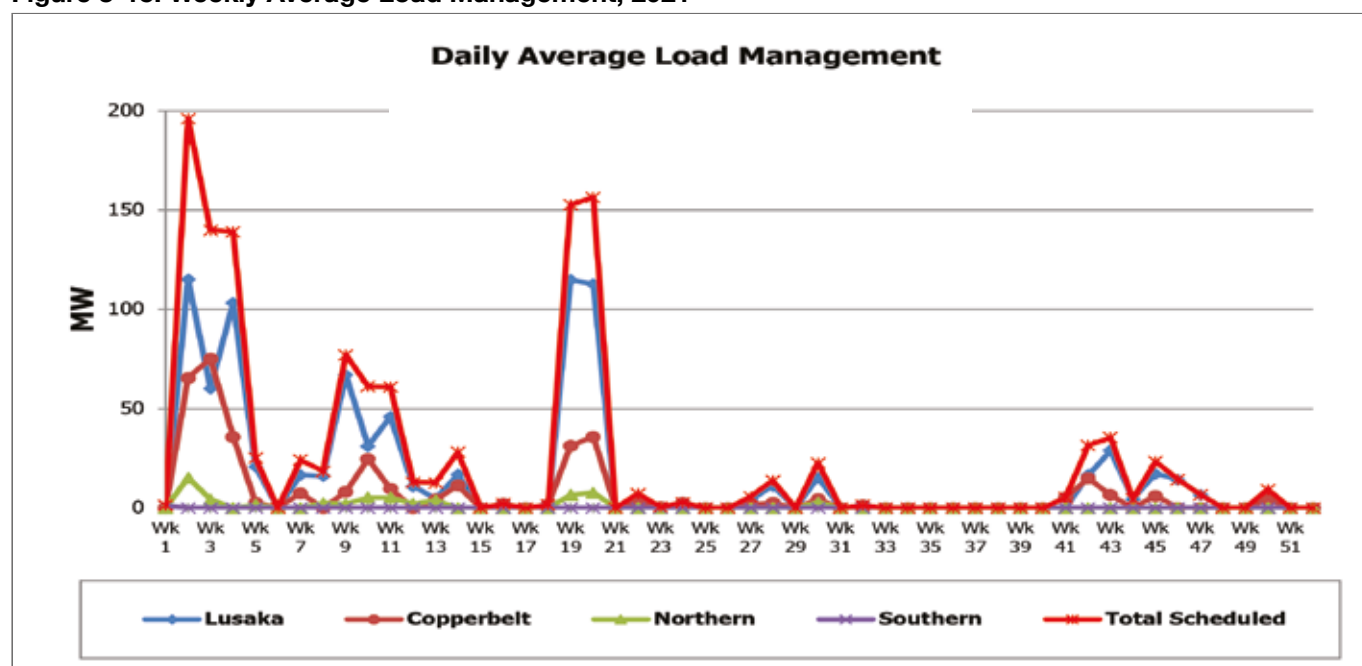
In 2021, the maximum demand recorded in Zambia was about 2,238 MW in the month of November on 17th at about 19:50 hours against peak generation of about 2,358.8 MW during the same period. In 2021, the highest power deficit recorded in week 2 was about 200 MW and was attributed to the reduced generation mainly due to low water levels in the main water reservoirs. The declared power deficits affected all the ZESCO's four Divisions namely Lusaka, Copperbelt, Northern and Southern. It was however noted that, for the most part of second half of the year there was reduced to no load management undertaken as a result of appreciation in dam levels.

Figure 3-15 shows a comparison of the weekly average load management carried out during the

²⁸ System Minutes = Energy not supplied in MWh/ Power at Peak

period under review.

Figure 3-15: Weekly Average Load Management, 2021



3.10 Power Quality Management System

In 2021, the ERB continued to implement the Power Quality Management System (PQMS) and enforce Power Quality (PQ) Directives in order to facilitate for a technically and economically efficient Zambian Interconnected Power System (IPS). Additionally, the 7th ERB Strategic Business Plan for the period 2018 to 2021 set a minimum target of 73 percent compliance to power quality standards by all licensed entities by December 2021.

Licensees in the electricity sub-sector are required to install power quality recorders (PQR) at sufficient locations on their respective networks to adequately monitor and report system performance as prescribed in the Zambian Standards, **ZS 387: Parts 1 to 4 - Power Quality and Reliability Standards**. Table 3-19 shows the progress achieved on installation of PQR by licensees on the IPS as at 31st December 2021.

Table 3-19: Progress on installation of PQR as at 31st December 2021

Licensee	ZESCO	CEC	NECL	MCL	LHPC	ITPC	BPC	Total
No. of sites targeted for installation	161	172	3	2	11	2	1	352
No. of sites with installed recorders	94	164	3	2	None-reporting	2	1	266
No. of sites without recorders/ None reporting sites	67	8	0	0	11	0	0	86
% of sites without recorders	42%	5%	0%	0%	None-reporting	0%	0%	24%

3.11 Power Quality Performance

A total of 266 sites installed with power quality recorders were monitored out of 352 representing 75.6 percent sample size compared to 62.5 percent in 2020. The aggregated overall power quality performance of the IPS in 2021 was 71 percent compared to 75.3 percent in 2020 indicating a drop of 4.3 percent in compliance. The 2021 performance was below the ERB SBP target of 73 percent

by December 2021. Table 3-20 presents a summary of the power quality performance of the IPS in Zambia for 2021 compared to 2020.

Table 3-20: Summary of Power Quality Performance, 2020 - 2021

Year	Voltage Harmonics	Voltage unbalance	Voltage Dips	Interruptions	Voltage Regulation	Frequency	Average
2021 Q4	97%	97%	39%	65%	67%	67%	73%
2021 Q3	96%	96%	37%	73%	49%	41%	70%
2021 Q2	94%	93%	35%	77%	53%	87%	71%
2021 Q1	91%	94%	42%	68%	59%	45%	70%
2021 % Compliances	95%	95%	38%	71%	57%	60%	71%
2020 % Compliances	95%	96 %	44 %	88%	57%	57%	75%

3.12 Low Power Factor Surcharge Mechanism

Clause 2.2.1 of the **Electricity (Grid Code) Regulations SI 79, 2013** provides that distributors and end-use customers shall take all reasonable steps to ensure that the power factor at the point of supply is at all times 0.92 lagging or better, unless otherwise agreed to in an existing contract between the participants. In fulfilling this requirement, ZESCO applied to the ERB to introduce power factor surcharge for Maximum Demand (MD) customers operating with low power factor as a demand side management measure aimed at reducing reactive power.

In 2021, the Grid Code Technical Committee (GCTC) recommended to the Board to commence surcharge scheme implementation on 1st April 2022.

3.13 Revision of the Electricity (Grid Code) Regulations, SI 79 of 2013 and Zambian Distribution Grid Code

The ERB established the GCTC and Distribution Grid Code Review Panel (DGCRP) to maintain the Electricity (Grid Code) Regulations, SI 79 of 2013 and the Zambian Distribution Grid Code, respectively.

In 2021, the GCTC and the DGCRP finalized the review process of the Transmission and Distribution Grid Codes. The revised draft Codes incorporates the connection requirements for Renewable Energy Power plants in the Zambian IPS. The two Codes are envisaged to be presented for approval in 2022.

Further, in 2021 the GCTC and DGCRP and its related Expert Working Groups continued to meet on a quarterly basis as mandated by Law, mostly virtually in owing to COVID-19 Government Guidelines, for smooth implementation of the Codes. The joint Committees reviewed and recommended for approval exemption applications from specific clauses of the Codes from GreenCo Power Services Limited, among other tasks.

3.14 Implementation of Wiring of Premises Standard – ZS 791

In 2021, the Expert Working Group established by the ERB comprising ESI stakeholders for the implementation of **ZS 791 Standard: Wiring of Premises – Code of Practice** continued to work on the development of Practical Guides for easy application of the Standard.

In spearheading the implementation of the ZS 791 Standard, the Expert Working Group is expected to carry out the following among others;

- i. Devise and propose best approach for successful implementation of the Wiring of Premises Code of Practice for the ESI in Zambia;
- ii. Recommend the mode of certifying the electricians involved in the wiring of premises;
- iii. Devise and recommend means of monitoring compliance by all stakeholders to Wiring of Premises Standard; and
- iv. Monitor the impact and effectiveness of the training program on the Wiring of Premises Standard offered to students as incorporated in the curriculum by TEVETA.

It is envisaged that the successful implementation of the ZS 791 would address and reduce the safety incidents and accidents that have been on the increase in recent past.

During the period under, the Expert Working Group had finalized drafting Domestic Practical Guide and was submitted for the Board's approval. In the first quarter of 2022, the Working Group shall continue to develop the Industrial Practical Guide.

3.15 Key Performance Indicators for Non-State Owned Enterprises

The ERB developed, in consultation with, and agreed on a Key Performance Indicators (KPI) framework for the period 2021 to 2023 with Non-State Owned Enterprise (Non-SOE). The key objective of the framework is to monitor and measure the technical and operational performance of Non-SOE Licensees in the ESI in Zambia, so as to ensure efficient, reliable and quality service delivery to the energy consumers.

In 2021, the framework was implemented under the five (5) thematic areas listed below:

- i). Quality of Service Supply;
- ii). System Losses;
- iii). Power Generation;
- iv). Infrastructure Compliance; and
- v). Safety.

The ERB received and reviewed self-assessed performance reports from four Non-SOEs namely; CEC, LHPC, MCL and NECL. As at June 2021, the quality of service indicator recorded an aggregated compliance percentage of 99.47 percent compared to 99.5 percent in 2020, while system losses of 2.17 percent were recorded compared to 1.97 percent in 2020. The results for individual performance against the average targets for power generation are as follows;

- a. LHPC scored 99.12 percent and met the target of 80 percent for large hydro;
- b. NECL scored 0.2 percent and did not meet the target of 50 percent for thermal power; and
- c. MCL scored 39.94 percent and did not meet the target of 50 percent thermal power plant.

The Non-SOEs did not meet the safety indicator recording with LHPC posting a fatality in quarter 1 of 2021. Therefore, the average score on safety failed to meet the target of 0 fatalities and lost time. While electricity infrastructure compliance scored 96.51 percent in 2021 compared to 96.71 percent in 2020.

Table 3-21 presents a Summary of the Technical KPIs assessments for non-SOE in 2021 compared to 2020.

Table 3-21: Technical KPIs Assessments of Non-SOE, 2020 - 2021

No.	Indicator	Average Target	2020 Average Score (%)	2021 Average Score (%)	Compliance Status
1.	Quality of Service – Transmission and Distribution (%)	90 ²⁹	99.50	99.40	Achieved
2.	System Losses (%)	5	1.97	2.17	Achieved
3.	Power Generation (%)	60 ³⁰	45.36	43.74	Not achieved
4.	Safety	0 ³¹	4	1	Not achieved
5.	Electricity Infrastructure Compliance Level (%)	91	96.71	96.51	Achieved

3.16 Cost of Service Study

The Cost of Service Study (CoSS) commenced in the fourth quarter of 2019. It was undertaken by Energy Markets and Regulatory Consultants (EMRC) of United Kingdom with the financial support of African Development Bank (AfDB).

The objectives of the study were twofold: firstly, to determine electricity tariffs that would promote economic efficiency of production and consumption and ensure financial viability of the electricity sector, while taking into account social and equity considerations; and, secondly, to provide a basis for strategy formulation regarding the gradual transition from existing financial-cost based tariffs to economic cost-based tariffs, setting of targeted life-line tariffs and associated subsidy mechanism while at the same time maintaining the household consumer category level economic-cost based tariff. To achieve the objectives, the study undertook the following:

- Determined the long-term least cost generation, transmission, distribution and supply³² programs to meet the forecasted electricity demand in Zambia over the medium to long-term;
- Estimated the long-run marginal cost (LRMC) of generation, the average incremental cost (AIC) of transmission, and AIC of distribution and supply;
- Determined the economic cost of supply by voltage level, from generation through to the supply level;
- Designed the economic cost-based tariffs for structure and levels that reflect economic cost of service by consumer category;
- Determined the appropriate tariff structures, and the level of the social life-line tariff,
- Proposed a comprehensive strategy for transition from financial to economic based tariffs; and
- Prepared a roll out plan for communicating the results of the study, and the proposed strategy of implementation to all stakeholders.

The scope of the study included 10 major deliverables as follows:

- First field visit for data collection and preparation of the Inception Report;
- Review of structure and conduct of the power sector including the legal and regulatory framework;
- Electricity demand forecasts for a period of 20 years;
- Determination of medium to long-term development programs (Least cost expansion plans for generation, transmission and distribution);
- Determination of economic cost of supply and structure and levels of tariffs;
- Life-line tariff mechanism, analysis of existing tariffs, and adjustment to economic based tariffs;
- Review of financial performance of ZESCO and preparation of projections;

²⁹ Average Target includes: [Transmission Target of 95% and Distribution Target of 85%].

³⁰ Average Target includes: [Large Hydro Target 80% and Two Thermal Plants Targets of 50%].

³¹ Average Target includes Zero Fatality and Zero Lost Time Injury (LTI).

³² Distribution and Supply means down to 220 Volts

- viii. Transmission wheeling charges;
- ix. Assessment of ERB approach to review of tariff applications; and
- x. Tariff adjustment roll-out strategies.

The study was successfully completed in December, 2021 and the reports have been submitted to the Government of the republic of Zambia for policy direction on the implementation of the recommendations.

3.17 Outlook in the Electricity Subsector

Generally, the outlook of the electricity industry in Zambia is poised for growth both in the short and long-term. The key growth areas include the following:

3.17.1 New Power Generation Projects

3.17.1.1 Kafue Gorge Lower Hydro Power Station

In 2013, ZESCO set up a Special Purpose Vehicle (SPV), the Kafue Gorge Lower Power Development Corporation (KGLDC) to spearhead the construction of a 750 MW hydro power plant at an estimated cost of US\$2.2billion.

The Kafue River Basin has the potential to generate over 1,500 MW of electricity at full utilization of the 600 meter head. The feasibility studies to harness this potential begun in the early 1960s.

Once fully completed, the hydro power station will consist of five turbines with an installed capacity of 150 MW each. The estimated water usage will be 95.89m³/s for each unit. The Power Plant will have a 138meters high dam with a water storage capacity of 82.96million cubic metres (mcm) at full supply and 21.78mcm at low levels.

As of 2021, ZESCO stated that two turbines have been commissioned with the third turbine in the process of being commissioned. The Utility aims to commission the fourth and fifth turbines within 2022. It is expected that with the commissioning of all five turbines in 2022, the operations of the plant will contribute to mitigating the current electricity deficit within the nation.



Kafue Gorge Lower Hydro Power Station

3.17.1.2 Batoka Gorge Hydro Electric Scheme

Batoka Gorge Hydro Electric Scheme (BGHES) is one of the imminent committed projects which will be constructed on the Zambezi River Basin at the border of Zambia and Zimbabwe. The dam site is located about 47 km downstream of the Victoria Falls Power Station and about 118 km of the planned Devils Gorge Power Station as shown in Figure 3-17.

Figure 3-17 Proposed Dam Site for Batoka Gorge Hydro Electric Scheme

In September 2019, a consortium of Power China and General Electric was awarded the tender to develop the project by the Zambwzi River Authority. The consortium has been conducting studies to optimise the plant and mobilise financial resources to commence the construction of the project with an estimated total installed capacity of 2400MW shared equally on both sides of the river.

3.17.1.3 Tariff Reforms (Multi-Year Tariff Framework)

The Electricity Act No. 11 of 2019 has provided for a Multi-Year Tariff Framework and Automatic Cost-Pass-Through. This will allow tariff predictability and maintain cost reflectivity. The ERB with support from the IEAREP Project commenced the development of Multi-Year Tariff Framework Regulatory Tools. This is expected to be finalised by end of 2022.

3.17.1.4 Open Access

The Electricity Act No. 11 of 2019 has also provided for open access to the electricity network in order to enhance trade by removing the barriers posed by limited access to the network. The ERB with support from GETFIT Secretariat was developing the open access regulatory regime. The open access framework will propose an appropriate market structure for open access. Further, the framework will also design the appropriate transmission pricing methodology. Both the market structure and pricing framework will be supported by appropriate rules and regulations. This will guarantee non-discriminatory access to the network.

Open access to the network will spur trade and attract private capital into the electricity sub-sector especially in the power generation segment. The market is envisaged to have eligible sellers and contestable buyers. This will provide consumer sovereignty and the competitive phenomenon is expected to enhance efficiency and service provision.

4.0 RENEWABLE ENERGY SUB-SECTOR

Combating climate change and reducing greenhouse gas emissions through the utilization of cleaner technologies has become top priority for many countries. This is eminent from the global landscape that is shifting from fossil fuels and leaning towards renewable energy sources.

Zambia is endowed with abundant renewable energy resources which include hydropower, biomass, sunlight, wind and geothermal heat.

4.1 Renewable Energy in Zambia

The Government of the Republic of Zambia has in line with Vision 2030 established goals for the energy sector, aimed at achieving universal access to clean, reliable and affordable energy at the lowest total economic, and financial, social and environmental costs by 2030. Additionally, the Rural Electrification Master Plan (REMP) 2008–2030 targets to reach national electricity access rate of 66 percent³³ of the total population and 51.0 percent of the rural population by 2030. Through these policies, Government's objective is to diversify the country's energy mix, increase access to electricity (especially in rural areas) and reduce the use of wood fuel.

The renewable energy subsector has undergone significant development in line with the National Energy Policy (NEP) 2019 which aims at facilitating the development and deployment of renewable as well as alternative energy. Additionally, these developments are in line with the Energy Regulation Act No. 12 of 2019, the Electricity Act No. 11 of 2019 and SI No.42 of 2021 that seek to provide a clear legislative framework for enhancing growth of the sector.

Zambia has seven mini-hydro power stations, located within Central, Luapula, Muchinga, Northern and North western Provinces of Zambia. The aggregate generation capacity is 45.2MW, contributing to approximately 1.52 percent of the national installed capacity.

As regards Zambia's bioenergy potential, it's significance can be seen from the abundant agricultural and forestry biomass resources. In Zambia, approximately 58.0 percent of the land is suitable for sustainably growing energy crops, which include soya beans, sugarcane, cassava and sunflower. Biomass residues and waste, for use as energy sources are also available in significant amounts. A recent study supported by the Food and Agriculture Organization³⁴ (FAO), quantified the biomass resource potential in the country and further stated that Biomass based energy contributes significantly to the country's total energy consumption, supplying over 70.0 percent of the country's energy needs. The ERB is determined to support the utilization of cleaner biomass technologies from viable feedstock options.

Zambia enjoys long and intense hours of annual sunlight to support solar energy generation, with sunshine hours, averaging around 8hrs per day (with an optimum of approximately 6.40 hours) or approximately 3000 sunshine hours per annum. The photovoltaic market remains dominated by Government projects.

³³ Zambia's rural electrification in top gear (africanreview.com)

³⁴ Sustainable Bioenergy Potential in Zambia (2020)

Though wind resource is available within the entire country, there are specific areas where wind regimes are said to be appropriate for electricity generation. Generally, range wind speeds in Zambia average between 7m/s to 8m/s. MoE developed a wind atlas to identify areas where electricity could be generated.

Though no utility-scale wind power plant exists in Zambia, keen investor interest has been shown by feasibility studies being undertaken. Mphepo Power plans to develop the first plant at Unika I, in Katete, Eastern Province, with capacity of 150MW. Upepo Energy intends to construct an electricity power plant in Masaiti, Copperbelt Province. The power plant will utilize wind and solar energy.

Currently, 80 hot springs exist in Zambia, but only about 35 are rated high in terms of surface temperature, flow rate, proximity to power lines, as well as ease of access and relative energy potential. The mid 1980s saw the commissioning of a geothermal energy generation plant at the Kapisya hot springs. Efforts to revive the power plant are underway. Further, following exploration works in the Bweengwa River Geothermal Resource Area in the southern part of Lochnivar National Park, Kalahari Geo Energy Limited plans to pilot a geothermal plant within 2022. Exploration works undertaken thus far, have included the drilling of slim wells and the results obtained confirm a geologic setting conducive for the support of power generation.

The aggregated generation capacity from renewable energy is currently standing at 133.83 MW, contributing to approximately 4.49 percent of the national installed capacity.

The general exceptional renewable potential continues to improve Zambia's energy divergence resulting in more keen interest from potential investors.

4.2 Performance of entities in renewable energy

The performance of the grid connected solar photovoltaic (PV) plants was reviewed in 2021. The said review focused on the enterprises' adherence to contractual energy dispatch to the grid, its performance guarantee, as well as the health of the PV systems. Through this process, the performance models generated can be applied to new systems, enable correct investment decisions and better regulatory framework and government policies.

4.3 Bangweulu Power Company Limited

Bangweulu Power Company (BPC) owns and operates a 54.3 MWp solar power plant situated in the Lusaka South Multi Facility Economic Zone (LSMFEZ). In the year under review, Bangweulu solar PV plant delivered a total of 89.19 GWh in 2021 which was a decrease of 3.37 percent from the 92.20GWh of the energy delivered in 2020.

4.4 Ngonye PV Power Plant

Ngonye PV solar power plant is connected to the grid with an installed capacity of 34 MWp situated in the LSMFEZ. In 2021, Ngonye PV power plant delivered to the grid, a total of 58,424.2 MWh, compared to 2020, where a total of 58, 002.8 MWh was delivered. This represents a percentage increase of 0.73.

4.5 CEC Solar Power Plant

CEC's owned and operated a 1 MWp solar PV plant on the Copperbelt that generates clean and reliable energy. The level of plant compliance to licence conditions, standards, codes and guidelines by CEC was satisfactory and CEC continued to implore the best practices to improve the performance of the solar power plant in 2021.

4.6 Engie Power Corner Limited

Engie Power Corner Limited owns and operates a 28.35 kWp mini-grid in Chitandika Village of Chipata District in Eastern Province. In June 2021, Chitandika Smart Solar Minigrid was hybridized to include a diesel genset of 40 kVA as backup system. In 2021, Chitandika sold 21,331 KWh of energy and had 190 customers.

4.7 Global Energy Transfer Feed - in Tariff (GETFiT) Programme

Officially launched in February 2018, the Global Energy Transfer Feed - in Tariff (GETFiT) programme was designed to facilitate private sector investment in small and medium-scale renewable energy Independent Power Projects. It aims at diversifying Zambia's generation mix through promoting development of solar and min hydro power plants. Initially, GETFiT Zambia aimed to produce 200 MW of renewable energy, that is, 100 MW solar PV and 100 MW hydropower projects respectively. However, due to the positive results obtained from the competitive bidding of solar projects, 120 MW of solar projects was procured at an average tariff of US\$4.41/kWh. Meanwhile, feasibility study rights were granted to developers for the first phase of 50 MW of mini-hydro projects.

While the GET FiT Zambia Solar PV tender achieved some of the lowest tariffs in the region and presented a good opportunity to diversify the country's energy mix, the implementation stalled due to structural challenges in the sector. The diversification to be met through the said programme also delayed due to the impacts of COVID-19.

Notwithstanding the setbacks that have been experienced, the Government of the Republic of Zambia remains committed to addressing the challenges to unlock delays in the GETFiT Zambia projects and to ensure that the Zambian people benefit from the favorable electricity tariffs. It is a clear expectation that by addressing the inherent sectoral challenges, private sector participation will be stimulated, ultimately increasing generation and access to electricity.

4.8 Challenges in the Renewable Energy Subsector

The following are the challenges the subsector continues to face;

- The ever changing renewable energy technologies require continuous development and revision of standards, codes and guidelines;
- The absence of a clear electronic management waste policy continued to pose risk to the environment. This is due to the fact that renewable energy technologies are potential electronic waste;
- Growing markets face challenges with quality of renewable energy products entering the country;
- The multi-institutional involvement in the issuance of an energy license renders the process tedious and lengthy for investors;
- Resistance by the public to use renewable energy as they consider that grid power is better than mini-grid power;
- Weather conditions and time of day affect the generation of energy (energy storage needed);
- High tariffs pose a risk on the affordability of the consumers who have seasonal income;
- Fragmented supply of renewable energy products in the country. Most are profit oriented and focused along the line of rail;
- Information on development of renewable energy business is difficult to gather as it is scattered amongst so many institutions;
- Challenges in communities socially accepting new technologies because of lower cost of traditional methods when compared with new technologies;

- Social concerns regarding the safety of liquid and gaseous biofuels;
- Lack of tailor made financial products for small players in the market (financial institutions are biased towards big entities, resulting in less favorable platforms for SMEs to invest); and
- Lack or limited knowledge on taxes and applicable incentives by small scale traders.

4.9 Outlook of the Renewable Energy Subsector

In 2022, the ERB intends to revise the 2016 renewable energy regulatory framework to guide the transition of renewable energy technologies in Zambia, in light of the emerging issues in the sub-sector.

The CEC solar power plant located in Riverside, Kitwe is set for expansion in 2022. The Company's solar energy generation capacity will increase to 34 MWp from the current 1 MWp. This expansion will not only contribute to the global energy transition, but will also enhance Zambia's efforts to diversify its energy mix.

Engie Power Corner intends to expand its generation capacity by including more power plants to the already existing one. On the other hand, RENWASOL Zambia also intends to construct solar power plants within Zambia. These projects will be made possible through the European Union's IAEREP Project.

Beyond the Grid Fund for Zambia (BGFZ) is an ambitious Multi-Year programme that aims to increase energy access, improve livelihoods and catalyze economic activities in rural and peri-urban areas. BGFZ aims to incentivize the emergence of new private sector business models, offering affordable and clean energy access with funding from the Nordic Environment Finance Cooperation (NEFCO). The projects are set to begin in 2022 with RDG Collective Limited, ZPL and Vitalite Zambia Limited.

The ERB in collaboration with the Zambia Bureau of Standards (ZABS), planned to develop standards for bioethanol for cooking. This is in line with ERB's mandate as enshrined under Section 4(h) of the Energy Regulation Act No 12, of 2019 among other functions. This activity will be undertaken in 2022, with support from the United States Agency for International Development (USAID) Alternatives to Charcoal (A2C) Project.

In line with Government pronounced reforms on the petroleum subsector upstream, where the role of INDENI will be changed to bulk storage and biofuel blending facility, there will be enhancement in the infrastructure setup for the development required for the biofuel industry to successfully take off in the market.

5.0 LICENSING IN THE ENERGY SECTOR

The ERB is mandated to issue licences to all energy enterprises in Zambia. Licences are issued to ensure an optimal and conducive regulatory environment in the energy sector. This section aims to highlight the types of licences that are issued by the ERB.

5.1 Types of Licences and Permits Issued by ERB

Currently, the ERB has 24 types of licences that are issued under electricity, petroleum, and renewable energy subsectors. The electricity sub-sector has seven while the petroleum sub sector has 12 licence types each having a tenure ranging from 5 - 30 years and 1.5 - 15 years respectively. There are four types of licences in the renewable energy subsector, which have a tenure ranging from 5 – 20 years. Entities that intend to construct an energy facility, its installation or become a common carrier shall apply for a construction permit which is valid for two years. The types of licenses and permits issued by the ERB are indicated in Table 5.1.

Table 5-1: Types of licences issued by the ERB and their durations

No.	Licence Type	Duration (Years)
ELECTRICITY		
1.	Generation of Electricity	30
2.	Transmission of Electricity	30
3.	Distribution of Electricity	15
4.	Supply of Electricity	05
5.	Trading of Electricity	20
6.	System Operator of transmission and distribution system	05
7.	Embedded Generation of Electricity for Own Use	05
RENEWABLE ENERGY		
8.	Manufacture, Supply, Installation and Maintenance of Renewable Energy Generating Equipment	05
9.	Production, Storage, Marketing and Transportation of Renewable Energy	05
10.	Production and Blending of Biofuels	05
11.	Generation, Transmission, Distribution and Supply of Electricity (off – grid)	20
PETROLEUM		
12.	Importation of Petroleum Feedstock	05
13.	Pipeline Transportation of Petroleum Feedstock	05
14.	Refining of Petroleum Feedstock	15
15.	Terminal Storage of Petroleum Products	10
16.	Combined Licence to Distribute, Import and Export Petroleum Products	05
17.	Retail of Petroleum Products	05
18.	Road Transportation of Petroleum Products (including LPG)	03
19.	Importation, Blending and Packaging, Distribution and Export of Lubricants	05
20.	Wholesale Marketing of Petroleum Products	1.5
21.	Retail of Liquefied Petroleum Gas (LPG)	05
22.	Combined Licence to Distribute, Import and Export of Liquefied Petroleum Gas	05
23.	Transportation and marketing of Coal	05
PERMITS		
	Construction Permit	02

5.2 Performance of Licensing

5.2.1 Provisional Licences and Construction Permits Issued

Provisional licences may be issued by the ERB to applicants who have met all the licensing requirements and whose applications are ready for gazetting. This is to cushion the 14 days period it takes for a Gazette Notice to mature with respect to licence applications. The duration for a Provisional Licence should not exceed a period of six months.

The ERB issued 279 provisional licences during the year 2021 representing an increase of 17.2 percent from the 238 provisional licences issued in 2020. Table 5-2 presents a summary of provisional licences issued in 2021:

Table 5-2: Provisional licences issued 2020 - 2021

S/N	Provisional Licence/Temporary Permit	2020	2021
1	Importation, Blending and Packaging, Distribution and Export of Lubricants	26	21
2	Combined Licence to Distribute, Import and Export Petroleum Products	45	97
3	Supply of Electricity	0	3
4	Generate, Distribute and supply Electricity(Off-Grid Electricity Licence)	1	1
5	Distribute, Import and Export Liquefied Petroleum Products	33	4
6	Generation of Electricity	0	1
7	Trading of Electricity	0	1
8	Manufacture, Supply, Installation and Maintenance of Energy Generating Equipment	38	22
9	Retail of Liquefied Petroleum Gas (LPG)	0	1
10	Retail of Petroleum Products	8	7
11	Retail site inclusions	0	19
12	Road Transportation of Petroleum Products	44	45
13	Construction permits	43	57
	Total Issued	238	279

5.2.2 Standard Licences

A total of 117 Standard Licences were issued in the year 2021 compared to 227 in 2020 broken down as follows; electricity one, renewable energy 23 and 93 in the petroleum subsector. Table 5-3 gives a breakdown of standard licences issued by type.

Table 5-3: Standard licences per type 2020 - 2021

S/N	Type of Licences	2020	2021
1	Combined Licence to Distribute, Import and Export Petroleum Products	41	38
2	Combined Licence to Distribute, Import and Export of Liquefied Petroleum Gas	01	03
3	Export of Liquefied Petroleum Gas (Butane)	43	01
4	Inclusions of Retail sites to Existing Retail Licences	21	05
5	Generation, Distribution and Supply of Electricity for an Off-Grid Electricity System	01	01
6	Distribution, Importation, Blending and Packaging of Lubricants	31	17
7	Manufacture, Supply, Installation and Maintenance of Energy Generating Equipment	37	23
8	Retail of Petroleum Products	8	05
9	Road Transportation of Petroleum Products	44	24
	Total Issued	227	117

5.2.3 Update on Regulations Drafted and Enacted in the Energy Sector

During the period under review, the Energy Regulation (General) Regulations, statutory Instrument No. 42 of 2021 was developed and enacted, while the following Regulations/ Rules were still under the enactment process:

- i. Under the Energy Regulation Act No.12 of 2019
 - ERB Tribunal Rules; and
 - Administration of the Energy Fund Regulations
- ii. Under the Electricity Act No.11 of 2019
 - Sale and Purchase of Electricity outside Zambia Regulations;
 - Declaration of Emergency Regulations;
 - Open Access Regulations; and
 - Supply of Electricity Regulations

5.2.4 Outlook on Licensing

The Energy Regulation (General) Regulations Statutory Instrument No. 42 was signed into law in 2021. The new regulations kick start the implementation of the Energy Policy of 2019 as well as the Energy Regulation Act No. 12 of 2019. With the new regulations, the ERB is now well placed to expand its licensing mandate and be more responsive to the licencing needs for stakeholders.

Some of the notable developments in the new regulations include;

- Provision of the force of law to requirements to the extent that applicants are required to submit information that is true and correct failure to which an application may be revoked or suspended;
- Prescription of criteria to determine a fit and proper person;
- Prescription of an application form for a construction permit and the standardisation and strengthening of requirements for the grant of a permit; and
- Provision of a list of activities that qualify for exclusion from the requirement to obtain a licence. Regulation 27 clearly stipulates activities that qualify for exemption.

The new regulations have further introduced a new requirement for licence and permit holders to take out liability insurance to cover the cost of any damage incurred by the licensee or permit holder. The section below provides a summary of the Energy Regulation (General) Regulations, of 2021.

5.2.5 Summary of the Energy Regulation (General) Regulations, 2021 (Statutory Instrument No. 42 Of 2021)

5.2.5.1 Application to establish or operate an enterprise or carryout a licensed activity

The Regulations have replaced the old Application Form with a new Application Form I in the First Schedule. The new Form among others has introduced a declaration clause. This will place an obligation on the applicant to ensure that the information submitted is true and correct (Refer to Appendix 3). The rational was that the declaration would bind the applicant and in the event that the declaration is false, the ERB could either suspend or revoke the Licence as this is one of the grounds for revocation. Therefore, it will be the applicant's obligation to ensure that the Form is obtained and filled in correctly. The Form under section B has also provided that an applicant attaches a declaration of availability of funds Form which has been prescribed in the Regulations as Form II, thereby replacing the requirement for an applicant to submit a six months bank statement (Refer to Appendix 4).

5.2.5.2 Licensing Requirements

The licensing requirements have been enhanced through the issuance of SI 42 of 2021 which has included amendments and revision to the checklist, responding to new developments in the energy sector. Further, the new regulations provide that the applicants that do not meet the requirements will have their licence application suspended until they meet the requirements.

The Regulations have also drawn a distinction between the General Licensing requirements under Regulation 4 and the specific requirements of each activity as listed under the Third Schedule. Therefore, an applicant for a Licence would need to comply with the requirements under Regulation 4 and the specific requirements depending on the activity being applied for.

5.2.5.3 Additional criteria for grant of licence

In considering whether to grant or reject a licence, Regulation 4 has provided additional criteria to supplement the licensing requirements and are listed as follows:

- a. The economic and financial benefits of the activity to the country, or area where the activity shall be undertaken;
- b. The current national economic and energy policies;
- c. The ability of the applicant to operate in a manner that is not harmful to the health and safety of consumers and other members of the public; and
- d. Any other matter that the ERB may consider likely to have a bearing on the activity or works.

5.2.5.4 Request for additional information for the licence

Despite Regulation 4 and 5 providing a list of licensing requirements, the ERB may request additional information from an applicant specifying the period within which the information should be made available.

5.2.5.5 Technical Inspections for licence

As part of the licensing process, ERB may conduct technical inspections of the site before making any recommendation on whether a licence should be granted or rejected. This entails that the inspections are now a statutory procedure and anyone who prevents the ERB officers from entering and undertaking the said inspection may be cited for contravention of the law.

5.2.5.6 Regulation 8: Fit and proper person

Section 14(1) (e) has provided that a licence will not be granted to a person who is not a Fit and Proper person as prescribed. The prescribed criteria for determination of a Fit and Proper person to be granted a licence include the following:

- a. Whether the applicant can guarantee a security of supply at the minimum barest cost;
- b. Whether the applicant is legally disqualified;
- c. Whether the applicant engages in bribery or other corrupt practices; and
- d. Whether the applicant is compliant with the submissions or returns and payment of fees, charges, levies, penalties and fines under the Act etc.

5.2.5.7 Objection to grant of Licence

The Licensing Regulations has prescribed a Form III in the First Schedule to be used by objectors to grant of licences. This will ensure uniformity in the manner the objections are made to the ERB.

5.2.5.8 Notice of rejection of application for Licence

In order to notify the applicant of the rejection of an application, the regulations have prescribed the notice of rejection of application in Form VI in the First Schedule. Previously, the ERB would only issue a letter notifying the applicant that their application has been rejected.

5.2.5.9 Transfer, Pledge, Assign or Encumber of Licence

The Repealed Energy Act had a provision for the transfer of Licenses but did not provide for the manner and form of transferring. The new Energy Regulation Act under section 18 now provides for transfer, pledge, assignment or encumbering of Licences to be done in a prescribed manner and Form. The Regulations have prescribed Form IX in the First Schedule to be filled in by a Licensee who intends to transfer, pledge, assign or encumber a licence.

The Regulations have also prescribed the criteria that the ERB will consider before effecting a transfer, pledge, assignment or encumbrance which are as follows:

- (a) Whether the licensee has discharged outstanding obligations with the ERB or any other appropriate authority;
- (b) The ERB has not initiated proceedings to suspend or revoke the Licence;
- (c) The Licensee has not, in the last 12 months immediately before the application, contravened the Act or these regulations; and
- (d) On any other terms and conditions that the ERB may determine.

Further, the prescribed Form has listed the requirements that a licensee ought to submit to the ERB.

5.2.5.10 Application for permit to construct energy facility, installation or common carrier

With the introduction of section 22 in the Energy Regulation Act, a person who intends to construct an energy facility, installation or common carrier should do so in a prescribed manner and form. To this end, the Regulations have prescribed an application Form XII in the First Schedule to be filled by an applicant. Further, Regulation 19 has prescribed the requirements for granting a permit which have been standardized and strengthened.

5.2.5.11 Transfer, Pledge, Encumber or Assignment of permit

With the introduction of issuance of a permit under section 22 of the Energy Regulation Act, the Regulations have prescribed Form IX in the First Schedule for transfer, pledge, encumber or assignment of Permit.

5.2.5.12 Excluded Activities

The ERB used to issue waivers for a one - off importation of specified products. However, regulation 27 has provided for excluded activities from licencing requirements as listed below;

- (a) Importation of lubricants for domestic or non-commercial use;
- (b) Importation of lubricants for use in equipment for sale, where the:
 - (i) Lubricant is in the imported equipment; and
 - (ii) Equipment is imported together with the lubricant on one consignment but as two separate units.
- (c) Importation of solar for domestic or non-commercial use;
- (d) Importation of solar for use in Government projects and not for commercial purpose, and
- (e) Importation of Lubricants for use in equipment meant for Government projects and not for commercial purposes

Regulation 27 has further defined the meaning of “domestic or non-commercial use” to mean the following:

- a. Household use that does not exceed fifty litres or its equivalent; and
- b. A dwelling house with maximum generating capacity of five Kilowatts including accompanying accessories and a small holding with maximum generating capacity of 10 Kilowatts, including accompanying accessories.

6.0 CONSUMER AND PUBLIC AFFAIRS

Consumers are considered one of the key stakeholders in the Energy Sector as they access energy products and services offered by licensees. Therefore, the ERB constantly takes deliberate steps to engage consumers in different ways.

6.1 Stakeholder Engagements

In order to ensure that consumers are aware of their rights and obligations as they access products and services offered by licensees, the ERB conducts various sensitisation programmes through various platforms. Among the avenues used are community awareness meetings, Mobile Office engagements, radio and TV programs, social media presence, the ERB website, media tours/briefings, participation at traditional ceremonies, exhibitions and trade expositions.

In 2021, the Government announced several COVID-19 measures to mitigate the spread of the pandemic. Consequently, most planned activities of a physical nature meant to engage the consumers could not be executed. However, following the relaxation of the COVID-19 protocols in the second half of 2021, the ERB undertook public engagements in Kabwe, Mumbwa, Chinsali, Mazabuka, Choma, Gwembe, Mongu, Kitwe, Livingstone and Senanga as depicted in tables 6-1.

Table 6-1: Stakeholder Engagements in 2021

Activities	2021
Community Awareness Meetings	12
Mobile Office Engagements	28
Total	40

6.2 Complaints Handling

The Energy Regulation Act as read together with the Electricity Act mandates the ERB to receive, investigate and resolve complaints from consumers arising from the provision of products and services by licensees operating in the Energy Sector. In that regard, the ERB has a Complaints Procedure that guides the handling of complaints.

In line with the ERB Complaints Procedure, consumers are first required to report complaints to the respective service provider before engaging the ERB for intervention. However, for product quality complaints and electrical incidents, consumers are encouraged to report such matters to the ERB immediately. This is to enable the ERB conduct its own independent investigations while evidence is still available or traceable. The investigations may include collection of fuel samples from the affected service station and motor vehicle/equipment.

In the year under review, the ERB received and determined 634 complaints compared to 447 in 2020. This represents a 42.0 percent increase in the number of complaints received in 2021. This increase could be attributable to increased radio programme initiatives undertaken in 2021 amidst COVID-19. The consumer complaints handled comprised pricing of energy products and services, product quality, location of energy infrastructure and customer care. The complaints emanated from the electricity, petroleum and renewable energy subsectors. Table 6-2 shows the number of complaints received in 2021 by type.

Table 6-2 Type of complaints received in 2021.

Sub-sector	Type of Complaint	Received
Electricity	Delayed Service Connections	459
	Faulty Meters	20
	Power Outage	52
	Low Voltage	11
	Delayed Meter Separation	4
	Disputed Bill	2
	Replacement of Service Cables	9
	Electrical Faulty/Danger Call	2
	Erratic Power Supply	1
	Compensation Claim	9
	Other Electricity ³⁵	31
	Sub Total	600
Petroleum	Fuel Contamination	12
	Lack of Air Pressure	3
	Underthrowing	1
	Illegal Fuel Vending	1
	Fuel Pricing	5
	Other Fuel ³⁶	10
	Sub Total	32
Renewable Energy - Solar	Renewable Energy - Solar	2
	Sub Total	2
	Total Complaints Received	634

As depicted in table 6-2, the highest proportion of complaints received at about 94 percent were related to the provision of products and services in the electricity sub-sector. This was mainly on account of delayed electricity connections. On the other hand, the petroleum sub-sector accounted for 5.0 percent, while less than 1.0 percent of the total complaints related to renewable energy.

With regard to the complaints resolution rate by subsector, the petroleum subsector had the highest resolution rate at 81.0 percent, followed by renewable subsector at 50.0 percent. Meanwhile, the electricity sub-sector had the lowest resolution rate at 40.0 percent. As earlier mentioned, the low resolution rate was mainly on account of the high number of unresolved delayed service connections by the ZESCO.

Table 6-3: 2021 Complaints Resolution Rate by Sub-sector

Sub-Sector	Received	Resolved	Pending	Resolution Rate (%)
Electricity	600	241	359	40%
Petroleum	32	26	6	81%
Renewable Energy	2	1	1	50%
TOTAL	634	268	366	42%

Notably, as depicted in the Table 6-3 above, the overall resolution rate of 42.0 percent achieved was below an institutional performance target of 90.0 percent.

As part of complaints resolution process, the ERB held quarterly meetings with service providers and complainants to resolve outstanding matters. Specifically, 311 complaints under electricity and one

³⁵ **Other Electricity:** - falling poles, re-routing of overhead cables, shortage of meters, abnormal depletion of electricity pre-paid units, encroachment, etc.

³⁶ **Other Fuel:** - uncompetitive practices, rationing of fuel, unsafe trading practices, poor customer service, etc.

complaint from the petroleum subsector were considered. Arising from the meeting interventions, 107 complaints were resolved thereby reducing the number of unresolved complaints for the year as indicated in table 6-4.

Table 6-4: Number of Complaints Heard during Complaints Meetings - 2021

Sub-sector	Complaints Heard	Complaints Resolved after Mediation Hearing
Electricity	311	106
Petroleum	1	1
Total	312	107

6.3 Consumer Platforms for Lodging Complaints

There are a number of platforms through which consumers may lodge complaints with the ERB which include the following:

- ERB Offices in Lusaka, Kitwe, Chinsali and Livingstone
- ERB Toll Free Line – **8484**
- Consumer Councils (Chipata and Solwezi)
- Letters and Emails – erb@erb.org.zm
- Mobile Office – Community awareness programs

6.4 Media Engagements

The Energy Regulation Act mandates the ERB to disseminate information and promote the participation of the public in the provision of energy products and services. To that end, the ERB partnered with the media in order to raise awareness levels among industry stakeholders. The communication platforms employed by the ERB to engage with the media in information dissemination included television, radio, social media, newspapers and the ERB website. Stakeholders, through the media, were sensitised on key regulatory developments taking place in the energy sector. Table 6-5 provides details of the media engagements undertaken in 2020 and 2021 on selected media platforms.

Table 6-5: Media Activities in 2021

Table 3 - CP Media Activities FY 2021				
No	Period	Media Activity	Number of Activities	
			2020	2021
1.	Quarter 1	Media Engagements	10	22
		TV/Radio Program	41	00*
2.	Quarter 2	Media Engagements	45	51
		TV/Radio Program	03	00*
3.	Quarter 3	Media Engagements	42	24
		TV/Radio Program	13	46
4.	Quarter 4	Media Engagements	21	07
		TV/Radio Program	04	13
Total			179	163

**Note: No activities undertaken due to Covid-19 guidelines by Ministry of Health*

From the table above, 163 media engagements were undertaken in 2021 compared to 179 in 2020.

The reduction in media engagements was attributed to COVID-19 restrictions and the slowed down operations in Quarter 2 during the General Elections campaign period.

In the period under review, the ERB conducted its fourth Annual Energy Media Awards ceremony on 23rd December, 2021, whose objective was to recognise journalists for covering energy related stories in both the electronic and print media categories. In addition, the awards were used as a platform to share with the media key regulatory highlights for the year 2021.

6.5 Social Media

In order to enhance communication with its stakeholders, the ERB continued its presence on social media platforms such as FaceBook. In 2021, **70** posts were uploaded on the ERB Facebook page and **299,105** views were recorded as compared to **36** posts with 116,446 views in 2020.

6.6 OUTLOOK ON CONSUMER AFFAIRS

In 2022, the ERB in line with the Energy Regulation Act, intends to operationalise the Consumer Councils (CCs) starting with Chipata and Solwezi districts. The CCs will be rolled out to other parts of the country in the near future. This development will ensure timely, effective and efficient consumer complaints handling on account of enhanced physical presence. Further, the CCs will enhance the institution's visibility and community engagement on various energy matters.

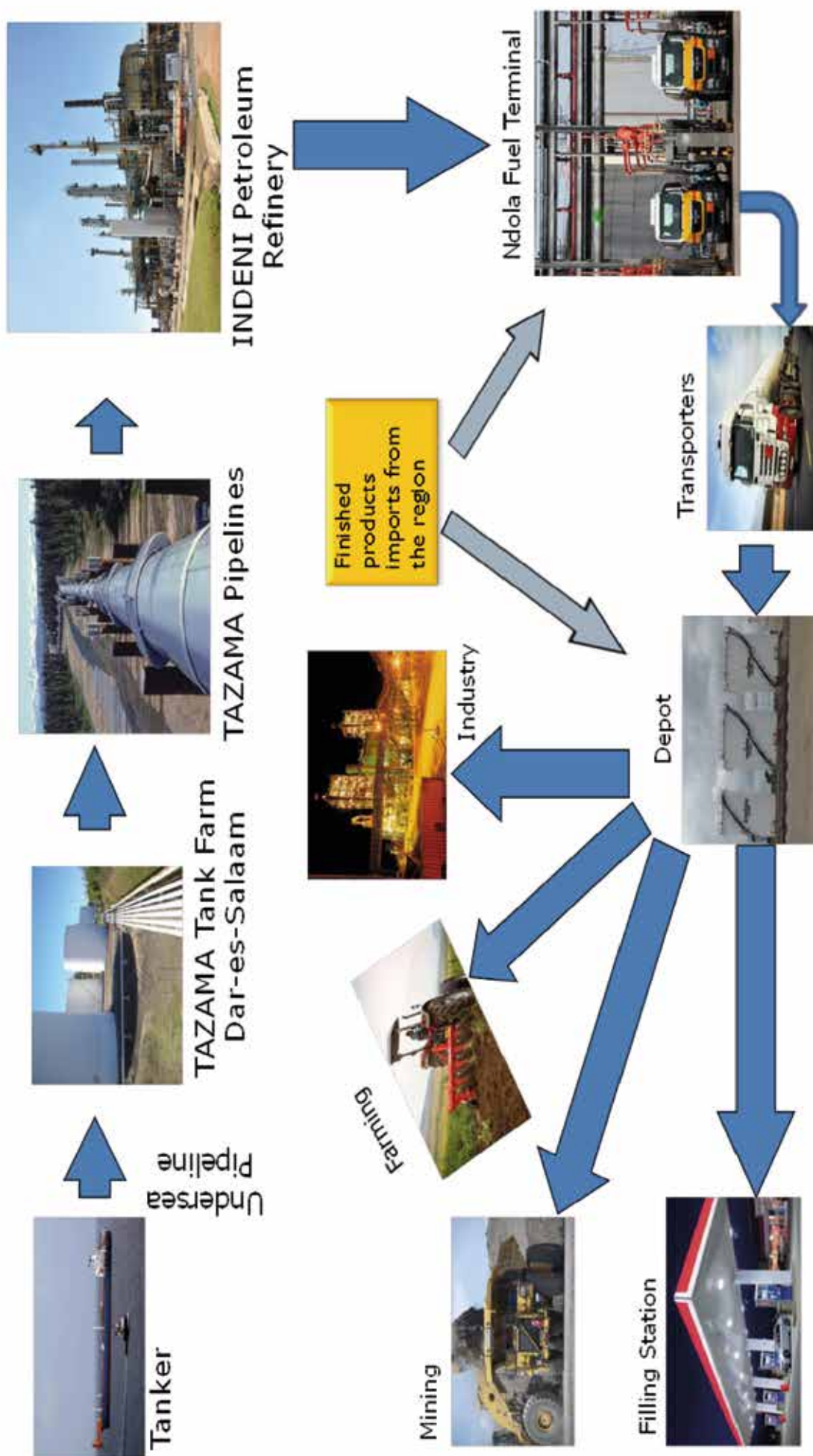
Appendix 1 Retail sites as at December 2021

OMC	Central	Copperbelt	Eastern	Luapula	Lusaka	Muchinga	Northern	Northwestern	Southern	Western	Total
Admire Energy Ltd					1						1
Asharami Energy Resources Zambia					1						1
Collum Lunm Tian Petroleum					1						1
Eco Petroleum Ltd		3		1		1	1	1			7
Endrone Petroleum							2				2
Enigma	1										1
Engen	1	11	1	1	27		2	2	3	1	49
Fa Fuel Ltd		1									1
Hass		2			2					1	5
Japawa						1					1
Karan Investments Z Ltd	1	1			1				1		4
Kasgon Energy Limited				1							1
Lake Petroleum Ltd	3	10			12	1		1	1		28
Lbm Investments Limited		1		1		1	3				6
Luapula Oils Ltd				1							1
Lushomo	1										1
Mel Petroleum						1		1			2
Mon Fuel And Oil Investments Limited								1			1
Mount Meru Petroleum Zambia Ltd	10	10	2	1	28	1	1	6	6	2	67
Ngucha					1						1
Oasis Oil Ltd			6		3						9
Oilbay (Z) Ltd	1										1
Oryx Energies Zambia Limited		7	2	1	11				2	1	24
Petroda Zambia Ltd		6			17			1			24
Petrolink	1	1						2			4
Puma Energy Zambia	3	15	5	1	23	1	1	3	6	3	61
Ravasia					1						1
Refuel										1	1
Rubis Zambia Ltd	4	13	2		11				5	1	36
Sgc		16	2		7		3		1		29
Simba Energy		1				2					3

Appendix 1 Retail sites as at December 2021 Count.

OMC	Central	Copperbelt	Eastern	Luapula	Lusaka	Muchinga	Northern	Northwestern	Southern	Western	Total
Simba Oil Company	1				1						2
Sino Petroleum					1						1
Spectra Oil Corporation	1				4						5
Star Oil Company Ltd		1									1
Surya					2						2
Total Energies	7	18	1	1	26	2	1	2	3	1	62
Tribute								2			2
Ufuel	1										1
Www Investment Ltd	1										1
Zacks	1					1					2
Zamfuel	1		2		3						6
Zhongkuang Zambia Services Co. Ltd		1									1
Grand Total	39	118	23	9	184	12	14	22	28	11	460

Appendix 2: Petroleum value chain



Appendix 3: Licence application Form



Form I

(Regulation 3 (1) and 12(2))

ENERGY REGULATION BOARD
The Energy Regulation Act, 2019

(Act No. 12 of 2019)

The Energy Regulation (General) Regulations, 2021**APPLICATION FOR A LICENCE**

INSTRUCTIONS	FOR OFFICIAL USE
1. Complete the form fully (incomplete forms will not be accepted) 2. Use capital letters	File Number: Date Initial Application Received: Date of Due Lodgement:

SECTION A: DETAILS OF THE APPLICANT

Registered Company name in full e.g. XYZ INVESTMENTS (PVT) LTD

Trade name in full e.g. ABC PETROLEUM

Company Details

Physical address: _____

Telephone number(s): _____

Email address: _____

Contract Person:

Full Name: _____

Title: _____

Physical address: _____

Cell phone number(s): _____

Email address: _____

This application is for a licence to*: _____

☐

Initial Application

☐

Renewal Application

Details of any other Energy Regulation Board Licences held, applied or being applied for by the applicant:

SECTION B:

Attachments (to be completed by applicant)

Please tick to show that the required document is attached. After finalising, please date and sign the attached checklist and send together with the application.

- | | | |
|--------|---|----------------|
| (i) | Proof of payment for Application fee | YES () NO () |
| (ii) | Certificate of Incorporation | YES () NO () |
| (iii) | Declaration of availability of funds form | YES () NO () |
| (iv) | Business plan | YES () NO () |
| (v) | Latest stamped PACRA printout | YES () NO () |
| (vi) | ZRA Tax clearance certificate | YES () NO () |
| (vii) | PACRA latest annual return | YES () NO () |
| (viii) | Relevant checklist | YES () NO () |

SECTION C: DECLARATION BY THE APPLICANT

I (full names) _____ hereby declare

that all information provided herein is within my personal knowledge and that -

- I am duly authorized to make this declaration;
- I am the designated person responsible for this Licence and any conditions attached thereto;
- I have read and understood this form and all accompanying regulations related hereto;
- All information provide herein is to the best of my knowledge true and correct;
- I undertake to provide additional information in whatever form the ERB may require in order evaluating this application.

Signed at _____ (place) on this _____ day of _____ (month) (year)

Signature

NOTE:

*Indicate whether the application is an initial application or renewal

Appendix 4: Declaration of availability of funds Form



Form II

(Regulation 4(1) and 19)

ENERGY REGULATION BOARD

The Energy Regulation Act, 2019

(Act No. 12 of 2019)

The Energy Regulation (General) Regulations, 2021

DECLARATION OF AVAILABILITY OF FUNDS

INSTRUCTIONS	FOR OFFICIAL USE
1. Complete the form fully (incomplete forms will not be accepted)	File Number: _____
2. Use capital letters	

I, _____¹, in my capacity as **Director/Partner/Principal**² of _____
 _____³ (hereinafter called the “**Applicant**”).

I hereby declare and confirm as follows:

- that I am duly authorised to make this declaration;
- that, prior to making this declaration, I have made all appropriate enquiries into the business affairs and financial obligations of the Applicant; and
- accompanying this declaration is one of the following options, selected below:
 - a bank account statement issued by a financial institution within of the date of this declaration showing that a sum of the Total business Cost is contained in the bank account ;

OR

- a letter from a financial institution dated in the last confirming that the Total business Costs, in the amount of⁴, are available or will be made available to the Applicant for use on the business .

I understand that any false, fictitious or fraudulent statements knowingly made by me to the Energy Regulation Board may result in the Licence being revoked.

Signature of Declarant: _____

Date of Signature: _____

Name of Declarant (block capitals): _____

Job Title of Declarant (block capitals): _____

NOTES:

- In circumstances where the Applicant is a body corporate, a director of the Applicant who is duly authorised to make the declaration must complete this declaration. If the Applicant is a sole trader or an individual, the sole trader or an individual must complete this declaration.
- 1 Please insert the name of the person who is making the declaration.
 - 2 Please put a line through the options that are not applicable to you.
 - 3 Please insert the name of the entity on behalf of whom the declaration is being made. If the Applicant is a sole trade or an individual please insert sole trader or individual in this field.
 - 4 Please insert appropriate amount in applicable currency.

Appendix 5: Components of the Cost Plus Model

a. The Wholesale Price Build up

Since 2008, the ERB uses the CPM to determine wholesale and pump prices for petrol, diesel, low sulphur gasoil and kerosene. The model operates in such a way that all the attendant costs incurred along the petroleum supply chain from the port of discharge in Dar-es-salaam to INDENI refinery where the feedstock is processed up to the NFT where the product is stored and sold are taken into account. The different cost elements up to the wholesale price include:

i. Cost-Insurance-Freight

The Cost-Insurance-Freight (CIF) of the petroleum feedstock cargo is the landed cost of the cargo at the port of Dar-es-Salaam. The quantities of the constituent components of the petroleum feedstock, which include crude oil, condensate, naphtha and diesel, are multiplied by the unit costs to derive the total monetary cost of the feedstock.

The information is obtained from the supplier invoices which is based on the contract between Government and the oil supplier and ultimately used to develop a profitability statement.

ii. Ocean Losses

The normally acceptable loss incurred in the loading and offloading of petroleum feedstock and petroleum products from a vessel are set to 0.00%.

iii. Wharfage

The Tanzania Harbour Authority levies a statutory charge on the importation of petroleum products. At present, this is 1.25% of the CIF Dar-es-Salaam cost.

iv. Insurance

The insurance costs are set at 0.11% of CIF. The insurance covers the cost of insuring the feedstock from the Dar-es-Salaam to Ndola.

v. Storage Fee

TAZAMA charges US\$2/MT to the importer for any petroleum feedstock quantities that are stored at the Dar-es-Salaam tank farm on the last day of the month. The amount was agreed upon between TAZAMA and Government.

vi .TAZAMA Pumping Fee

TAZAMA charges US\$49.00/MT to the importer for transporting petroleum feedstock through the pipeline from the Dar-es-Salaam tank farm to the Refinery in Ndola.

vii. TAZAMA Pipeline Losses

Consumption and losses for TAZAMA are currently set at 1.00%.

viii. Agency Fee

The Government appointed TAZAMA as agent to discharge specific duties in the procurement of

petroleum feedstock. The Agency fee is currently US\$5/MT, the fee is agreed between the Government and agent. The key function of the agent, amongst others, is to ensure compliance by the supplier to the terms and conditions of the supply contract.

ix. Processing Fee

INDENI charges a processing fee of US\$55.38/MT to the importer for refining (processing) petroleum feedstock.

x. Refinery Losses

Some petroleum feedstock quantities are lost during the refining process due to:

- a. Normal processing losses;
- b. Consumption, as some quantities are consumed as fuel in the process; and
- c. The consumption and losses figure are set at 5.0%.

xi. Terminal Losses

These are terminal losses as prescribed by international norms. A loss level of 0.5% is allowed for petrol whilst a loss level of 0.5% has been allowed for kerosene and jet A-1, 0.3% for diesel and Heavy Fuel Oil (HFO) covering handling and storage losses. A loss of 1% is provided for liquefied petroleum gas (LPG).

b. The Retail Pump Price Build-up

The specific cost elements of the pump price as at 31st December, 2021 are discussed below:

i. Terminal Fee

The NFT charges a fee of K0.063/litre on petrol, diesel and kerosene uplifts at the terminal.

ii. Marking Fee

The price of petrol, diesel, kerosene and LSGO incorporates a cost line referred to as the Marking Fee of K96.99/M³ or 9.70 ngwee/litre. The Marking Fee covers the cost of the chemicals used to mark petroleum products, the taxes on the chemicals and the staff costs of implementing the fuel marking programme.

iii. Excise Duty

During the year under review, Statutory Instrument No. 5 of 2021 was issued to revise the excise duties inclusive of road levy as follows; K0.64/litre on Petrol, K0.00/litre on Diesel, K0.00/litre on LSGO and 0% on Kerosene.

iv. Transport Cost

The transport cost is the transport charge that is applied in all towns to equalize the pump prices to the national uniform pump price.

v. OMC Margin

The ERB determines the OMC margin. This refers to the amount of money an OMC can make on each unit of petrol, diesel, kerosene and LSGO they distribute. The OMC margin covers the costs of

the OMC and allows the OMC to earn a reasonable return on its assets. The current ERB determined OMC margin is K1.58/litre. The OMC margin is reviewed on a regular basis by the ERB using the revenue requirement methodology i.e. a regulatory best practice for regulation of utilities.

vi. Dealer Margin

The ERB determines the dealer margin. This refers to the amount of money a service station owner can make on each unit of petrol, diesel, kerosene and LSGO they retail. The dealer margin covers the costs of the dealer and allows the dealer to earn a reasonable return on its assets. Currently, the ERB determined dealer margin is K1.07/litre. The dealer margin is reviewed on a regular basis by the ERB using the revenue requirement methodology i.e. a regulatory best practice for regulation of utilities.

vii. Strategic Reserves Fund

The Strategic Reserves Fund (SRF) cost-line of K0.15/litre is currently applicable to petrol, diesel and kerosene. The SRF cost-line is collected from consumers through OMCs.

viii. ERB License Fees

The ERB licence fees are set at 0.7% of the OMC's turnover. The fee forms part of the Non tax revenue that is remitted to Ministry of Finance Treasury account.

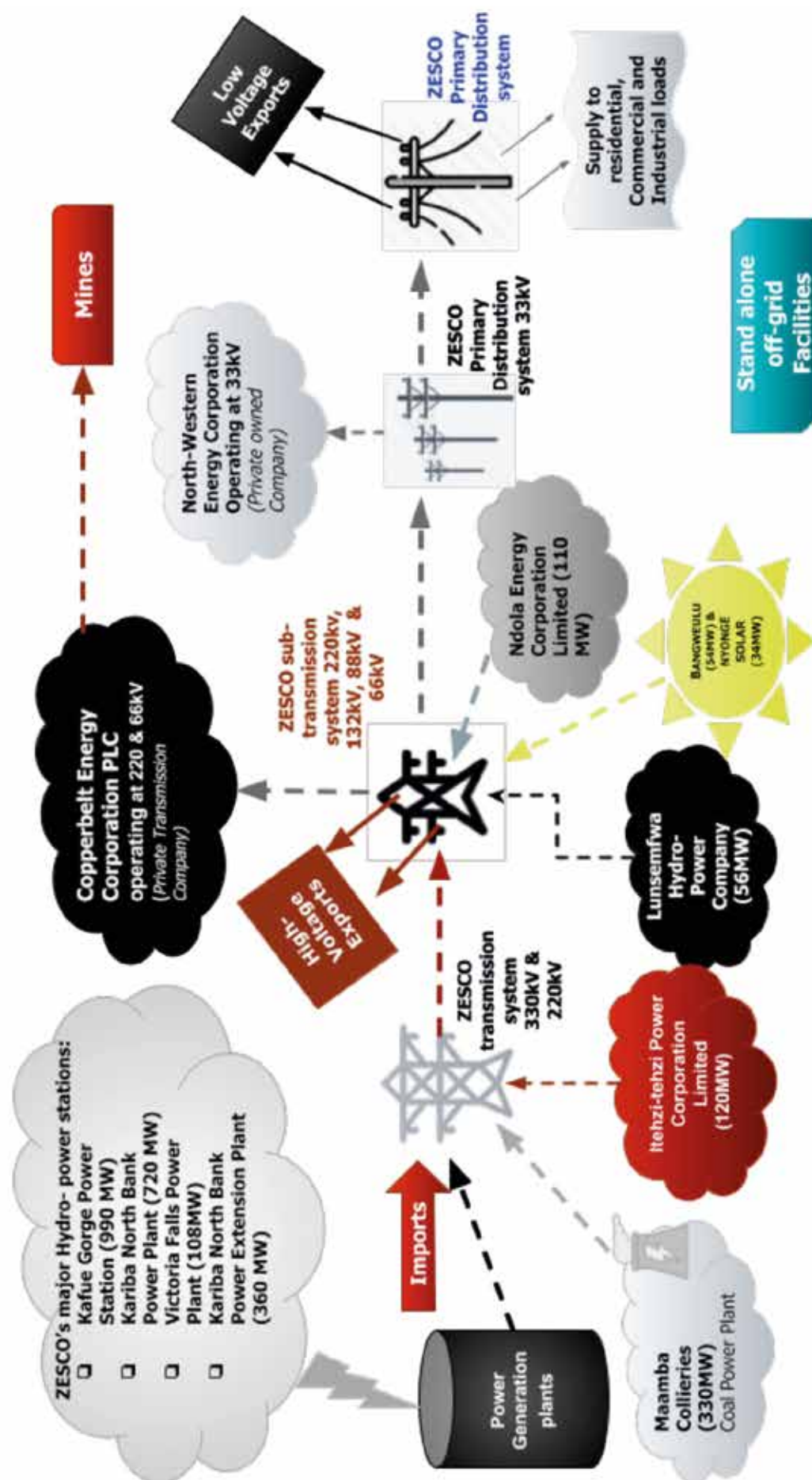
ix. Value Added Tax

The current applicable Value Added Tax (VAT) on petrol and diesel is 16%. There is no VAT applied on domestic kerosene. During the year under review, Statutory Instrument No. 125 of 2020 temporally suspended VAT.

Appendix 6 Installed electricity generation mix in Zambia in 2021

Licensee's Name	Station	Technology	Installed Capacity (MW)
ZESCO Limited	Kafue Gorge	Hydro	990
	Kariba North bank	Hydro	720
	Kariba North Extension	Hydro	360
	Victoria Falls	Hydro	108
	Lunzua River	Hydro	14.8
	Lusiwasi	Hydro	12
	Chishimba Falls	Hydro	6
	Musonda Falls	Hydro	10
	Shiwang'andu	Hydro	1
	Lusiwasi upper	hydro	6
	Kafue Gorge Lower	Hydro	300
Itezhi-tezhi Power Corporation	Itezhi-tezhi	Hydro	120
Zengamina Limited	Ikelengi	Hydro	0.7
Lunsemfwa Hydro Power Company	Mulungushi	Hydro	32
	Lunsemfwa	Hydro	24
Total Hydro			2,704.50
Maamba Collieries Limited	Maamba Power Plant	Coal	300
Dangote Cement Zambia Limited	Dangote Thermal Power Plant	Coal	30
Total Coal			330
Copperbelt Energy Corporation Generation Plants	Luano	Diesel	40
	Bancroft	Diesel	20
	Kankoyo	Diesel	10
	Maclaren	Diesel	10
ZESCO Limited Generation Plants	Shang'ombo	Diesel	1.6
	Lundazi	Diesel	1.75
	Chama	Diesel	1.45
	Total Diesel		84.8
Ndola Energy Generation Plants	Ndola	Heavy Fuel Oil	110
Total Heavy Fuel Oil			110
Rural Electrification Authority Generation Plants	Samfya	Solar	0.06
Copperbelt Energy Corporation	Kitwe	Solar	1
Muhanya Solar Limited	Sinda Village	Solar	0.03
Ngonye Power Limited	LSMFEZ	Solar	34
Bangweulu Power Company Ltd	LSMFEZ	Solar	54
Solera Power	Luangwa bridge	Solar	0.01
Standard Microgrid	Kafue	Solar	0.02
Mugurameno	Chirundu	Solar	0.01
Total Solar			89.13
Grand Total			3,318.43

Appendix 7 Structure of Electricity Supply Industry in Zambia



Appendix 8 ZESCO KPIs for the year 2020- 2022

No.	Thematic areas	Sub indicators	Rationale	Proposed Weight
1)	New Customer connections	<ul style="list-style-type: none"> i. Maintain Ratio of paid up quotations to new connections at 1:2 ii. Connect all new standard applications within 20 days from the date of payment of the quotation iii. Connect all new non-standard application within 60 days from the date of payment iv. Issue quotations for new applications of all connection types within 10 days from date of application 	The KPI has been selected due to the increasing delays in customer connections, this will also assist ZESCO comply with the Electricity Supply and Quality of Consumer Service as per ZS 397	10%
2)	Efficiency	<ul style="list-style-type: none"> i. Cost Management (monitoring only) <ul style="list-style-type: none"> ▪ Operating Cost of electricity per MWh (excluding Depreciation) ▪ Capacity costs - Indicator of costs of peak - consumption Cost per kW of installed capacity ▪ Operating cost per megawatt installed ii. Asset Reliability <ul style="list-style-type: none"> ▪ Maintain Replacement of Distribution transformers as % of Installed Transformers at 0.1% of total number of transformers in operation Capacity ▪ Maintain Replacement of meters as % of installed meters at 0.25% of the total number of meters. iii. Debtor Days <ul style="list-style-type: none"> ▪ Reduce mining debtor days to not more than 60 days ▪ Reduce export debtor days to not more than 60 days ▪ Reduce domestic debtor days to not more than 60; and ▪ Reduce GRZ debtor days to not more than 90. iv. System losses <ul style="list-style-type: none"> ▪ Maintain Transmission losses at 6% or less; and ▪ Maintain distribution Losses at 12% or better per quarter. 	To assist ZESCO in becoming efficient with regards to system losses, cost management, customer debt collections and payments to suppliers, through this KPI the ERB will also monitor ZESCO's asset reliability.	25%

Appendix 8 ZESCO's KPI for the year 2020- 2022 Cont.

No.	Thematic areas	Sub indicators	Rationale	Proposed Weight
3)	Staff productivity	<ul style="list-style-type: none"> i. Number Generation staff to total energy generated per generation station ii. Maintain one (1) Technical Transmission staff per seven (7) kilometer of transmission line iii. Maintain one (1) Technical Distribution Staff per 10 kilometres of distribution line iv. Maintain one (1) Distribution Staff per 120 customers v. Maintain 30 percent Staff Costs as proportion of total O&M Costs (<i>Excluding. Dep and Purchases from IPPs</i>) vi. Ratio of technical to non-technical staff 	To encourage staff productivity at generation, transmission and distribution level. The KPI will also assist benchmark ZESCO's staff productivity to best international practice and monitor the deployment of its staff especially those that are directly involved in the operations and maintenance of the infrastructure used in the generation, transmission and distribution.	7.5%
4)	Quality of Service	<ul style="list-style-type: none"> i. Maintain the Dry Season (DS) System Average Interruption Duration Index (SAIDI) at 27 hours or less and Wet Season (WS)-SAIDI at 36 hours or less; ii. Maintain the DS System Average Interruption Frequency Index (SAIFI) of 5 times or less and WS-SAIFI 5.5 times or less; iii. Maintain the DS-Customer Average Interruption Duration Index (CAIDI) at 5 hours or less and WS-CAIDI at 7 hours or less; and iv. Maintain the Average System Availability Index (ASAI) at 90% or better. 	To encourage ZESCO improve its quality of service through the reduction of outage duration and its frequency	20%
5)	Power Quality	<ul style="list-style-type: none"> i. Install 123 power quality meters by 2021 ii. Maintain the power quality at a minimum of 70% in 2020 and 75% and above beyond 2021 for monitored sites 	To ensure ZESCO improves power quality in accordance with the ZS 387 (Electricity Supply – Power Quality & Reliability)	2.5%

Appendix 8 ZESCO's KPI for the year 2020- 2022 Cont.

No.	Thematic areas	Sub indicators	Rationale	Proposed Weight
6)	Power Generation	<ul style="list-style-type: none"> i. Plant Capacity Factor for each generation plant (monitoring) ii. Maintain the Unit Capability Factor (UCF) for large hydro plants at 80% or better. iii. Maintain the UCF for Mini hydro plants at 60% or better per quarter. iv. Planned Loss factor v. Unplanned Loss factor 	To monitor the efficiency of ZESCO's power generation plants and encourage utilization at full capacity subject to availability of water.	5%
7)	Safety	<ul style="list-style-type: none"> i. Maintain Zero fatality per quarter ii. Maintain Zero Life Threatening Injuries (LTI) per quarter. iii. Number of high potential Misses per employee (monitoring) iv. Recordable Case Incident Severity Index (monitoring) 	To ensure that ZESCO maintains higher safety standards for its employees and the general public	10%
8)	Customer Service	<ul style="list-style-type: none"> i. Maintain outage complaints resolution rate at 90% ii. Maintain Non-Outage complaints resolution rate at 87% iii. Resolve outage complaints within 24 hours from the date the complaint is logged iv. Resolve Non-outage complaints within 30 days from the date the complaint is logged v. Call centre answer speed (Percentage of calls answered within 30 seconds) – monitoring 	To improve service delivery by ensuring that customer complaints are attended to and resolved in good time in accordance with ZS 397	5%
9)	Meter maintenance and reading	<ul style="list-style-type: none"> i. Replacement of faulty Meters must be done within 3 days after a complaint is lodged ii. Maintain time lag between meter reading and bill dispatch of not exceeding 14 days 	To ensure faulty meters are replaced as soon as possible to lessen inconvenience to the affected customers. Also to ensure bills are dispatched in good time to reduce debt age	5%

Appendix 8 ZESCO's KPI for the year 2020- 2022 Cont.

No.	Thematic areas	Sub indicators	Rationale	Proposed Weight
10)	Financial KPIs	<ul style="list-style-type: none"> i. Liquidity <ul style="list-style-type: none"> ▪ Maintain Current Ratio of one (1) and above ▪ Maintain Quick ratio of 0.5 or above ii. Profitability (monitoring) <ul style="list-style-type: none"> ▪ Calculation of a ROCE ▪ Calculation of Gross profit margin ▪ Calculation of Net profit margin ▪ Calculation of the Asset turnover ratio iii. Solvency <ul style="list-style-type: none"> ▪ Maintain Debt to Equity ratio of 2 or above ▪ Maintain Debt ratio of 1 or above ▪ Maintain interest coverage ratio of 1 or more iv. Sustainability <ul style="list-style-type: none"> ▪ Average capital expenditure to net asset value (monitoring) ▪ Maintain Total O&M Cost to Revenue ratio of 60% 	To encourage ZESCO to maintain a health Liquidity, solvent and financial viability and sustainability.	10%
	Total			100%

APPENDIX 9 - Major System Disturbances Recorded in 2021

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
1	01 Jan 2021	00:34 hrs	Kansanshi Mine	System disturbance experience on 01/01/2021 at 00:34hrs following loss of 155.6MW load by Kansanshi Mine due to a fault on 33kV mining feeder which tripped on overcurrent. 33kV mining feeder restored at 12:03hrs after replacing shuttered insulators and contacts on line and CB isolators	01 Jan 2021	00:50 hrs
2	24 Jan 2021	18:29 hrs	CEC	ZESCO experienced a system disturbance on 24/01/2021 at 18:29hrs characterized by Tie - line power swings and loss of system load on over-voltage due to the tripping of 220kV CSS - Maposa 1/Frontier T-off line on differential protection in the CEC network.	24 Jan 2021	18:36 hrs
3	24 Jan 2021	23:48 hrs	BPC/ ES-KOM	System Disturbance experienced at 23:48hrs on 24/01/2021, ZESCO experienced a dip in frequency from 50.154Hz to 49.01Hz and went off parallel with ESKOM following the tripping of the 400kV Matimba – Phokoje interconnector. IPS normalised at 23:56hrs and back in parallel with Eskom at 00:24hrs on 25/01/2021.	24 Jan 2021	23:56 hrs
4	28 Jan 2021	13:34 hrs	SNEL	System Disturbance experienced on 28/01/2021 at 13:34hrs characterised by Tie - line power swings, due to the tripping of 220kV Karavia - Lubumbashi line in the SNEL network. IPS Normalised at 13:40hrs.	28 Jan 2021	13:40 hrs
5	06 Feb 2021	13:09 hrs	Kafue GIS	330KV Muzuma line tripped at Kafue end, at 13:09hrs. At Kafue GIS - DI, Zone 1, Red phase and FL=138.2Km. At Muzuma - DI, Zone 3 and FL=43Km was registered. Line was restored at 13:40hrs. Victoria Falls synchronized back to the grid at 13:46hrs after successfully islanding during the tripping and Nampower was normalized at 13:45hrs.	06 Feb 2021	13:45 hrs

APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
6	07 Feb 2021	16:24 hrs	Kalumbila Mine	System Disturbance experienced on 07/02/2021 at 16:24hrs characterised by Tie - line power swings, due to loss of 100MW at Kalumbila Mine due to a lightning strike. IPS Normalised at 16:30hrs.	07 Feb 2021	16:30 hrs
7	14 Feb 2021	23:52 hrs	Kansanshi Mine	System Disturbance experienced at 23:52hrs due to the loss of load at Kansanshi mine resulting in system over voltages after an animal short circuited one of the transformers in Kansanshi mine. IPS Normalised at 00:05hrs on 15/02/21.	15 Feb 2021	00:05 hrs
8	25 Feb 2021	13:05 hrs	SNEL	At 13:05hrs on 25/01/2021, ZESCO experienced a system disturbance due to a tripping of one Generator Unit internal to the SNEL network that resulted in loss of 201.5MW. IPS normalised at 13:11hrs.	25 Feb 2021	13:11 hrs
9	25 Feb 2021	03:21 hrs	V/Falls	V/Falls – 220kV Sesheke line tripped at 03:21hrs at both ends. About 189.6MW of load lost. At V/falls- DI, Zone 1, all phases, 114.83km. At Sesheke - DI, Zone 1, all phases, no FL given. Restored at 03:48hrs & Syn-chronised with Nampower at 03:53hrs.	25 Feb 2021	03:53 hrs
10	01 Apr 2021	03:12 hrs	EDM	System disturbance experienced on 01/04/21 at 03:12hrs due to tripping of Bus Coupler at Songo (HCB) in the EDM network (Mozambique). System frequency dropped from 49.715Hz to 49.405Hz and rose 50.24Hz, remained on high side for about 15minutes. IPS Normalized at 03:29hrs.	01 Apr 2021	03:29 hrs
11	06 Apr 2021	00:06 hrs	SNEL	System disturbance experienced on 06/04/2021 at 00:06hrs due to tripping of 220kV Luano – Karavia and Michelo – Karavia 1 & 2 lines on directional over power caused by the blocking and deblocking of converter 1 & 2 at Kolwezi in SNEL network. IPS Normalised at 00:20hrs.	06 Apr 2021	00:21 hrs

APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
12	08 Apr 2021	00:14 hrs	BPC/ ZESA	System disturbance experienced at 00:14hrs on 08/04/2021 following the tripping of 400kV Insukamini - Phokoje line in the ZESA network. Consequently ZESCO and ZESA went off parallel Eskom. System frequency excursions from 50.02Hz to 48.64Hz then rose to 50.47Hz and Settled at 50.1Hz. IPS Normalized by 00:21hrs. 400kV Insukamini- Phokoje line Restored at 04:54hrs	08 Apr 2021	00:21 hrs
13	08 Apr 2021	23:33 hrs	SNEL	System disturbance experienced at 23:33hrs on 08/04/2021 following the tripping of 220kV Karavia – Lubumbashi line 1 in SNEL network. System frequency excursions from 49.84Hz to 50.16Hz then Settled at 49.81Hz. IPS Normalized by 23:39hrs.	08 Apr 2021	23:39 hrs
14	12 Apr 2021	02:35 hrs	BPC/ ZESA	System disturbance experienced at 02:35hrs on 12/04/2021 following the tripping of 400kV Insukamini - Phokoje line in the ZESA network. Consequently ZESCO & ZESA went off parallel Eskom. Back in parallel at 04:54hrs. System frequency excursions from 50.09Hz to 48.65Hz then rose to 50.48Hz and Settled at 50.1Hz. IPS Normalized by 02:40hrs.	12 Apr 2021	02:40 hrs
15	14 Apr 2021	23:15 hrs	BPC/ ZESA	System disturbance experienced at 23:15hrs on 14/04/2021 due to tripping of 400kV Insukamini-Phokoje interconnector, hence off parallel with Eskom. System frequency dropped from 49.983Hz to 49.31Hz then settled at 49.692Hz. IPS Normalized by 23:25hrs.	14 Apr 2021	23:25 hrs
16	15 Apr 2021	17:11 hrs	SNEL	System disturbance experienced on 15/04/2021 at 17:11hrs due to tripping of 220kV Luano – Karavia and Michelo – Karavia 1 & 2 lines on under over Voltage caused by the blocking and deblocking of converter 1 & 2 at Kolwezi in SNEL network. System frequency reduced from 50.0Hz to 49.55Hz then settled at 50.14Hz. IPS Normalized at 17:14hrs.	15 Apr 2021	17:14 hrs

APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
17	18 Apr 2021	04:54 hrs	SNEL	System disturbance experienced on 18/04/2021 at 04:54hrs due to loss of load in the SNEL network. System frequency went from 50.08Hz to 50.61Hz then settled at 50.02Hz. IPS Normalized at 04:59hrs.	18 Apr 2021	04:59 hrs
18	19 Apr 2021	15:06 hrs	ESKOM	System disturbance experienced on 19/04/2021 at 15:06hrs due to loss of load in the Eskom network (230MW). System frequency went from 49.8Hz to 50.27Hz. IPS Normalised at 15:20hrs.	19 Apr 2021	15:20 hrs
19	20 Apr 2021	22:45 hrs	BPC/ ES-KOM	Experienced system disturbance on 20/04/2021 at 22:45hrs following tripping of 400kV Insukamini – Phokoje and 400kV Phokoje – Matimba lines in BPC network. Consequently ZESCO and Eskom went off parallel and frequency dropped from 50.18Hz to 49.28Hz and stabilized at 49.80Hz. IPS stabilized at 23:00hrs and ZESCO- Eskom back in parallel at 01:32hrs.	20 Apr 2021	23:00 hrs
20	28 Apr 2021	17:24 hrs	ESKOM	Experienced a system disturbance on 28/04/21 at 17:24hrs due to the tripping of the 533kV DC Apollo CS Pole line 1 & 2 in the Eskom network. Pole 2 restored at 20:37hrs. A loss of 1054MW in generation was recorded in the Eskom network. IPS stabilized at about 19:08hrs.	28 Apr 2021	19:08 hrs
21	24 May 2021	10:58 hrs	SNEL	A system disturbance was experienced at 10:58hrs on 24/05/2021 due to tripping of 220kV Michelo-Karavia lines 1&2 and Luano- Karavia line caused by the tripping of 2 converters at Kolwezi in the SNEL network. ZESA Tie line swung from 64.9MW imports to 56.2MW exports Frequency rose from 50.04Hz to 50.19Hz. IPS normalized by 11:03hrs.	24 May 2021	11:03 hrs
22	29 May 2021	00:50 hrs	SNEL	Experienced a system disturbance on 29/05/2021 at 00:50hrs due to loss of load in the SNEL network. SNEL Interconnector swung from 73.5MW export to 75.3MW import. ZESA tie-line swung from 145.8MW export to 235.6MW export. IPS normalized at 00:55hrs.	29 May 2021	00:55 hrs

APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
23	29 May 2021	14:30 hrs	SNEL	Experienced a system disturbance on 29/05/2021 at 14:30hrs due to loss of 100MW load in the SNEL network as a result of bush fires. SNEL Inter-connector swung from 108.5MW export to 68.45MW import. ZESA tie-line swung from 115.4MW export to 270.4MW export. IPS normalized at 14:45hrs.	29 May 2021	14:45 hrs
24	02 Jun 2021	12:00 hrs	BPC/ ZESA	System disturbance experienced on 02/06/2021 at 12:00hrs due to tripping of 400kV Insukamini-Phokoje line. Frequency dipped from 50.05Hz to 48.38Hz then rose and settled at 50.14Hz. 220kV Michelo-Karavia lines 1 and 2 and 220kV Luano-Karavia line tripped on U/F. 128MW lost. All circuits normalised by 12:43hrs.	02 Jun 2021	12:43 hrs
25	02 Jun 2021	13:54 hrs	SNEL	System disturbance experienced on 02/06/2021 at 13:54hrs due to tripping of 220kV Michelo-Karavia lines 1 and 2 and 220kV Luano-Karavia line tripped on main protection. 134MW lost. Voltage at Kitwe rose from 316kV to 327kV then settled at 318kV. Frequency rose from 50Hz to 50.3Hz then settled at 49.9Hz. All circuits normalised by 14:16hrs.	02 Jun 2021	14:16 hrs
26	19 Jun 2021	13:39 hrs	SNEL	System disturbance experience on 19/06/21 at 13:39hrs due to tripping of 120kV Kasapa – Luputo line in SNEL network characterized by power swing, frequency execution and Voltage dips. SNEL the load reduced from 154MW export to 39MW export. ZESA tie lines reduced from 189.5MW import to 68MW import. IPS normalized at by 14:00hrs.	19 Jun 2021	14:00 hrs
27	25 Jun 2021	12:36 hrs	SNEL	Zesco experienced a system disturbance at 12:36hrs on 25/06/2021 due to the tripping of 120kV Kasapa – Lubumbashi line in SNEL network due to bush fires. System frequency rose from 49.9Hz to 50.09Hz and settled at 49.9Hz. ZESA tie line swung from 16.28MW import to 119.99MW export. IPS normalized at 14:00hrs.	25 Jun 2021	14:00 hrs

APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
28	28 Jun 2021	01:16 hrs	BPC/ ZESA	Zesco experienced a system disturbance at 01:16hrs due to the tripping of 400kV Insukamini Phokoje and 330kV Songo Bindura interconnectors on DTT & power swing block respectively. Effects: System frequency dropped from 50.418HZ to 47.978HZ then rose and settled at 50.241HZ. ZESA tie line swung from 239.4MW import to 141.5MW export then dropped to 0MW. SNEL interconnectors swung from 108.8 MW export to 25.6MW then dropped to 0MW. 330kV KNB – KNS 1 & 2 interconnectors tripped on U/F on both ends. Restored at 01:55hrs & 01:57hrs respectively.	28 Jun 2021	01:55 hrs
29	28 Jun 2021	18:55 hrs	SNEL	ZESCO experienced a system disturbance at 18:55hrs due to the tripping of 220kV Michelo – Karavia line 1 & 2 in SNEL network on D.O.P the tripping was reported to be caused by the tripping of 2 converters at Kolwezi. System frequency rose from 50.02HZ to 50.2HZ and settled at 49.9HZ. ZESA tie line swung from 148MW import to 59MW export. IPS normalised at 19:01hrs.	28 Jun 2021	19:01 hrs
30	30 Jun 2021	08:04 hrs	KNBPS	ZESCO experienced a system disturbance at 08:04hrs due to the tripping of G1 & G2 m/c's at Kariba North Bank PS due to loss of DC supply to the Unit Controllers. Personnel were working on battery charger at the time and caused a short circuit which in turn caused momentary loss of DC supply to the Controllers. IPS normalised at 08:21hrs.	30 Jun 2021	08:21 hrs
31	02 Jul 2021	12:28 hrs	KFG	330kV KWest line tripped at 12:28hrs as investigations on the SF6 gas low alarm were being carried out.	02 Jul 2021	12:31 hrs
32	03 Jul 2021	09:33 hrs	KFGL	330/33kV Tx DT tripped at 09:33hrs on Diff.	03 Jul 2021	11:47 hrs
33	07 Jul 2021	17:07 hrs	System Disturbance	System Disturbance experienced at 17:07hrs on 07/07/2021 following loss of 143.08MW at Kalumbila mine. Subsequently ZESA tie-line swung from 1.58MW import to 143.108MW export. Cause of tripping external to ZESCO. SNEL interconnector was stable. IPS normalized by 12:12hrs	07 Jul 2021	17:12 hrs
34	08 Jul 2021	14:43 hrs	SNEL	System Disturbance experienced at 14:43hrs due to the tripping of 220kV Luano Karavia & Michelo Karavia 1 & 2 lines on DOP. Report of bush fire in SNEL network. IPS normalized by 14:46hrs	08 Jul 2021	14:46 hrs

APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
35	10 Jul 2021	18:17 hrs	KNBE	Gen 5 taken out on emergency at 18:17hrs due to heavy water leakage following snapped generator air cooler pipe.	10 Jul 2021	19:38 hrs
36	13 Jul 2021	11:49 hrs	KFG	G5 tripped at 11:49hrs on "Spherical valve closing". Restored on 13/07/2021 at 02:59hrs after repair works on control valve 375.	14 Jul 2021	02:59 hrs
37	15 Jul 2021	09:24 hrs	KSD	88/66kV Tx T3 and T4 and 66kV Mulungushi line B taken out on 15/07/2021 at 09:24hrs to cut down overgrown trees.	15 Jul 2021	17:04 hrs
38	19 Jul 2021	01:06 hrs	SNEL	System Disturbance experienced on 19/07/2021 @ 01:06hrs due to the loss of load in SNEL network.	19 Jul 2021	01:15 hrs
39	19 Jul 2021	15:35 hrs	SNEL	System Disturbance Experienced on 19/07/2021 at 15:35hrs due to the loss of load in SNEL network. Report of partial black out at Kolwezi	19 Jul 2021	15:40 hrs
40	20 Jul 2021	06:02 hrs	SNEL	System Disturbance Experienced on 20/07/2021 at 06:02hrs due to the loss of 168MW load in SNEL network.	20 Jul 2021	06:04 hrs
41	25 Jul 2021	14:45 hrs	Lumwana	330/132kV Tx T4, 330/33/11kV Tx T2 and 330kV bus coupler tripped at 14:45hrs on Bus Bar protection after closing 330kV ring. Tx T4 restored at 15:52hrs, Tx T2 restored at 15:52hrs, bus coupler restored at 15:51hrs.	25 Jul 2021	15:51 hrs
42	25 Jul 2021	15:08 hrs	SNEL	System disturbance experienced on 25/07/2021 at 15:08hrs due to loss of load in the SNEL network.	25 Jul 2021	15:11 hrs
43	25 Jul 2021	21:21 hrs	SNEL	System disturbance experienced on 25/07/2021 at 21:21hrs following tripping of a 65MW generator at Nseke PS in the SNEL network.	25 Jul 2021	21:34 hrs
44	27 Jul 2021	14:15 hrs	ITPC	G1 was taken out at 14:15hrs to seal heavy oil leakage on OPU runner blade supply line. 60MW lost.	27 Jul 2021	16:54 hrs
45	27 Jul 2021	19:46 hrs	KNBPS	G4 tripped at 19:46hrs on hot air temperature. Restored at 20:12hrs after disconnecting two temperature probes.	27 Jul 2021	20:12 hrs
46	27 Jul 2021	12:39 hrs	Lumwana	330/33/11kV T2 tripped at 12:39hrs on Buchholz OLTC. This was during bleeding to clear the alarm that had registered. Restored at 17:45hrs after investigations.	27 Jul 2021	17:45 hrs

APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
47	28 Jul 2021	22:09 hrs	KFGL	G2 taken out at 22:09hrs to seal water leakage on the generator stator air coolers. Restored at 02:02hrs on 29/07/2021 after sealing the water leaks.	29 Jul 2021	00:02 hrs
48	30 Jul 2021	00:34 hrs	SNEL	System disturbance experienced on 30/07/2021 at 00:34hrs due to loss of about 200MW load in the SNEL network. IPS normalized at 00:44hrs.	30 Jul 2021	00:44 hrs
49	31 Jul 2021	03:32 hrs	SNEL	System disturbance experienced on 31/07/2021 at 03:32hrs due to loss of about 156MW load in the SNEL network. IPS normalized at 03:35hrs.	31 Jul 2021	03:35 hrs
50	04 Aug 2021	01:27 hrs	SNEL	System disturbance experienced on 04/08/2021 at 01:27hrs due to loss of load in the SNEL network. IPS normalised at 01:39hrs.	04 Aug 2021	01:39 hrs
51	05 Aug 2021	17:14 hrs	Kitwe	330/220/11kV Tx T9B tripped at 17:14hrs on both HV and LV CBs. NCC bus zone alarm registered. At Switching Station O/C and bus zone were registered. Tripping occurred immediately after CEC enabled 66kV bus protection which was disabled when working on 220/66kV Tx T6. Restored at 17:40hrs. Further investigations being done.	05 Aug 2021	17:40 hrs
52	08 Aug 2021	09:00 hrs	KNBE	G5 tripped at 09:00hrs on mechanical over speed due to malfunctioned speed sensors.	08 Aug 2021	10:50 hrs
53	08 Aug 2021	16:03 hrs	SNEL	System disturbance experienced on 07/08/21 at 16:03hrs following the tripping of Michelo - 220kV Karavia line. About 296MW load was lost on the IPS. Kansanshi lost 56MW, Lumwana lost 43MW and CEC lost 18.7MW, No load was lost on ZESCO distribution network.	08 Aug 2021	16:09 hrs
54	08 Aug 2021	14:21 hrs	System Disturbance	IPS experienced a total system collapse (Black Start) on 08/08/21 at 14:21hrs, following loss of 1,184MW of generation on the ZESCO power system. Kafue Gorge lost 800MW, Kariba North lost 620MW, Maamba Collieries lost 266MW, Itzhi Tezhi lost 100MW and Victoria Falls lost 98MW. By 22:44hr IPS was stable & end of black start was declared.	08 Aug 2021	22:44 hrs

APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
55	10 Aug 2021	11:14 hrs	VFPS	A Station and B station tripped at 11:14hrs on O/Frequency and loss of 400V auxiliary respectively due to through fault from 33kV Linda line 1 caused by a bird. 33kV Linda line 1 also tripped on DEF whereas 33kV Linda line 2 was just opened. Report of cut jumpers on 33kV Linda line 1.	10 Aug 2021	13:43 hrs
56	10 Aug 2021	10:17 hrs	Leopards Hill	330kV Kabwe line 1 take out on emergency at 10:17hrs to replace vandalized bolts and nuts on towers 180 and 197.	10 Aug 2021	13:33 hrs
57	12 Aug 2021	15:33 hrs	SNEL	System disturbance experienced on 12/08/2021 at 15:33hrs due to tripping of converters 1 and 2 at Kolwezi in the SNEL network. 220kV Michelo-Karavia lines 1 and 2 and 220kV Luano-Karavia line tripped on main protection. 161.177MW lost. 220kV Michelo-Karavia lines 1 and 2 restored at 15:47hrs.	12 Aug 2021	15:38 hrs
58	13 Aug 2021	11:38 hrs	SNEL	System disturbance experienced on 13/08/2021 at 11:38hrs due to loss of load in the SNEL network.	13 Aug 2021	15:24 hrs
59	14 Aug 2021	05:38 hrs	SNEL	System disturbance experienced on 14/08/2021 at 05:38hrs due to loss of load in the SNEL network.	14 Aug 2021	15:42
60	16 Aug 2021	19:05 hrs	SNEL	System disturbance experienced on 16/08/2021 at 19:05hrs due to tripping of 220kV Kolwezi - Fungulume line in the SNEL network.	16 Aug 2021	19:09 hrs
61	17 Aug 2021	14:45 hrs	SNEL	System disturbance experienced on 17/08/2021 at 14:45hrs following loss of load in SNEL network, characterised by tie-line power swings and voltage fluctuations.	17 Aug 2021	14:59 hrs
62	18 Aug 2021	07:49 hrs	Victoria Falls	220/33kV Tx T1A tripped at 07:49hrs on Diff and O/C on both HV & LV CB's. This was due to the tripping of 33kV Linda line 1 on O/C due to a cut jumper caused by a bird. Nampower lost 180MW load following tripping of their Converter. A-Station and B station machines tripped on gen over current.	18 Aug 2021	08:40 hrs
63	20 Aug 2021	20:00 hrs	New W/ Works	132/33 TxT2 tripped at 20:00hrs both on LV and HV side on Diff and LV REF due to termination failure on Y- phase btw TxT2 and 33kV isolator 2TR3.	21 Aug 2021	20:06 hrs

APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
64	27 Aug 2021	23:08 hrs	Kabwe Step Down	66kV line B tripped at 23:08hrs at both ends. At KSD on DI, Zone1, phase A, FL=19Km. At Converter on E/F. Attempt on 28/08/2021 at 07:29hrs after clearance by LHPC but tripped instantly on SOTF, DI & Zone 1. Report of a vandalized 8 spans in all phases at Converter end. Vandalized portion isolated. Line restored at 17:45hrs & Mulungushi PS sync'd at 18:00hrs on 28/08/21.	28 Aug 2021	17:45 hrs
65	31 Aug 2021	18:35 hrs	Coventry	132/33/11kV TxT1AB bank tripped at 18:35hrs on T1B Diff protection. Investigation revealed termination failure between 11kV B/B and 11kV CB 1TXO. Report of fire in 11kV cubicle, causing substantive damage to CTs. Isolated T1B. Restored T1A at 20:57hrs. Alternative supply to arrange for 11kV loads.	31 Aug 2021	20:57 hrs
66	03 Sep 2021	20:26 hrs	Coventry	132/11kV T2B tripped at 20:26hrs on O/C on LV side due to a flash over from 11kV Chifinga feeder where the CB got burnt. Restored at 17:31hrs on 04/09/21 after replacing the burnt CB.	04 Sep 2021	17:13 hrs
67	06 Sep 2021	18:23 hrs	Nampower	System Disturbance experienced a system disturbance at 18:23hrs following the loss of load in Nampower network due to tripping of the Converter.	06 Sep 2021	20:20 hrs
68	07 Sep 2021	14:19 hrs	Nambala	330kV Kalumbila line 2 tripped at 14:19hrs from both ends due to flashover on CT secondary cable. Nambala-Diff, DI zone1 Y phase, FL=116km. Kalumbila-DI zone1, FL-nil	07 Sep 2021	17:07 hrs
69	13 Sep 2021	09:58 hrs	KNBPS	G2 tripped at 09:58hrs on turbine water level too high. Synchronised at 15:40hrs after changing float switch for second pump start.	13 Sep 2021	15:40 hrs
70	18 Sep 2021	10:52 hrs	KFGL	G1 tripped at 10:52hrs on reverse power. Investigations found that the turbine inlet valve was partially closed.	18 Sep 2021	14:18 hrs
71	19 Sep 2021	09:08 hrs	Ndola Energy	66kV Ndola Refinery line tripped at 09:08hrs on diff protection due to a snapped red phase conductor on 3rd span & 4th tension pole from S/S.	19 Sep 2021	19:35 hrs

APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
72	20 Sep 2021	12:38 hrs	SNEL	System Disturbance experienced on 20/09/21 at 12:38hrs due the tripping of 220kV Michelo - Karavia line 1&2 and 220kV Luano - Karavia line on main protection following the tripping of Converter # 1&2 at Kolwezi & Inga. All lines restored by 14:10hrs. IPS normalised at 12:45hrs.	20 Sep 2021	12:45 hrs
73	24 Sep 2021	01:26 hrs	KSD	88/66KV TXs T5 and T3&T4 Bank tripped at 01:26hrs on the LV sides on; T5 on O/C, TXs T3&T4 on main protection.	24 Sep 2021	01:56 hrs
74	24 Sep 2021	01:26 hrs	Converter S/S	66/33KV 20MVA TXs T1 and T2 tripped at 01:26hrs on; TX T1 on LV E/F, TX T2 on E/F HV & LV. Restored TXs at 02:25hrs.	24 Sep 2021	02:25 hrs
75	24 Sep 2021	01:26 hrs	Mulungushi and Lunsemfwa PSs	All units except for one unit at Lunsemfwa PS tripped on over frequency.	24 Sep 2021	02:21 hrs
76	28 Sep 2021	06:27 hrs	SNEL	System Disturbance at 06:27hrs following loss of 174MW as a result of tripping of the Michelo - 220kV Karavia line 1 &2 and Luano - 220kV Karavia on DOP due to tripping of Converter 1&2 at Kolwezi in the SNEL network. 220kV lines Restored by 06:53hrs. IPS Normalized at 06:32hrs.	28 Sep 2021	06:32 hrs
77	01 Oct 2021	16:38 hrs	Luano	330kV Kansanshi line tripped and A/R (high speed) at 16:38hrs on both ends. At Luano end on Diff, DI, Blue Phase, FL=26.96km, no zone. At Kansanshi end on DI, Zone 1, Blue Phase, FL=117.9km. Kansanshi Mine lost load of 127.212MW. 33kV Solwezi line tripped on U/V. 12.49MW lost.	01 Oct 2021	16:57 hrs
78	01 Oct 2021	16:38 hrs	Lumwana	330kV Kansanshi line tripped on over-voltage. 50.8MW lost. At Kansanshi end, line opened at 16:41hrs for voltage control.	01 Oct 2021	17:03 hrs
79	05 Oct 2021	15:05 hrs	SNEL	System disturbance experienced on 05/10/2021 at 15:05hrs following the tripping of Michelo 220kV Karavia line 1 and 2, Luano 220kV Karavia line on DOP. IPS stabilized at 15:10hrs. Michelo 220kV Karavia line 1 restored at 15:36hrs. Luano 220kV Karavia line restored at 15:36hrs. Michelo 220kV Karavia line 2 restored at 16:40hrs.	05 Oct 2021	15:10 hrs

APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
80	05 Oct 2021	15:48 hrs	System Disturbance	System disturbance experienced on 05/10/2021 at 15:48hrs following the loss of 148.48MW at Kalumbila mine due to tripping of Kalumbila 33kV mine feeder ring B on Non-directional O/C. IPS stabilized at 15:50hrs. Feeder restored at 16:44hrs.	05 Oct 2021	15:50 hrs
81	05 Oct 2021	17:53 hrs	SNEL	System disturbance experienced on 05/10/2021 at 17:53hrs following the tripping of Michelo 220kV Karavia line 1 and 2, Luano 220kV Karavia line on DOP. IPS stabilized at 17:55hrs. Michelo 220kV Karavia line 2 restored at 18:44hrs. Luano 220kV Karavia line restored at 18:15hrs. Michelo 220kV Karavia line 1 restored at 18:15hrs.	05 Oct 2021	17:55 hrs
82	06 Oct 2021	07:24 hrs	Ndola Refinery	66kV NECL line & NECL phase 2 tripped at 07:24hrs on Diff. Investigations found cut jumper.	06 Oct 2021	19:20 hrs
83	07 Oct 2021	20:10 hrs	SNEL	System disturbance experienced on 07/10/2021 at 20:10hrs following the tripping of Michelo 220kV Karavia line 1 and 2, Luano 220kV Karavia line on DOP. IPS stabilized at 20:16hrs. Michelo 220kV Karavia line 1. Restored at 20:33hrs. Luano 220kV Karavia line. Restored at 20:33hrs. Michelo 220kV Karavia line 2. Restored at 22:02hrs.	07 Oct 2021	20:16 hrs
84	08 Oct 2021	18:00 hrs	System Disturbance	Zambian IPS experienced a total system collapse (Black Start) on 08/10/21 at 18:00hrs following loss of 2,267.0MW system generation. Disturbance emanated from Kariba North Bank Power Station where all units tripped following CB failure on G5. 657MW generation lost. IPS was stable by 23:30hrs & black start un-declared at 00:10hrs on 09/10/2021	08 Oct 2021	23:30 hrs
85	11 Oct 2021	11:20 hrs	Kafue Town	88kV Nampundwe line tripped at 11:20hrs on E/F after jumper on B-phase on tower # 167 came off the clamp due to hotspot. Restored at 17:05hrs after replacing the jumper.	11 Oct 2021	17:05 hrs
86	13 Oct 2021	6:17 hrs	Kapiri Mposhi	88kV Mpongwe line tripped at 06:17hrs on O/C. Line patrol instituted after failed attempt but nothing found.	13 Oct 2021	12:47 hrs
87	16 Oct 2021	18:09 hrs	KNBPS	G6 tripped at 18:09hrs on thrust Pad Bearing temperature high. Restored at 18:52hrs after disconnecting a temperature controller on the thrust bearing.	16 Oct 2021	18:52 hrs

APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
88	18 Oct 2021	21:18 hrs	KNBPS	G2 tripped at 21:18hrs on thrust bearing temperature high 72°C. Restored at 21:43hrs after forcing the probe #18 which caused a spike.	18 Oct 2021	21:43 hrs
89	27 Oct 2021	19:52 hrs	Kafue Town	88kV Mazabuka line tripped and locked out at 19:52hrs on main protection. On attempt to restore at 21:21hrs, line tripped instantly on E/F. Line isolated at 21:34hrs to mend a cut jumper on tower #1. Restored at 23:41hrs.	27 Oct 2021	23:41 hrs
90	29 Oct 2021	02:25 hrs	KNBPS	G4 tripped at 02:25hrs on shear pin mechanical protection. Preliminary investigation show 2 shear pins bent on guide vane #12 & 13 respectively. On bars for inspection at 23:14hrs. Off bars at 00:17hrs on 30/10/2021 for inspection. Synchronised at 11:48hrs on 30/10/2021 after cleaning the actuator.	30 Oct 2021	11:48 hrs
91	30 Oct 2021	15:44 hrs	KNBPS	Unit 3 tripped at 15:44hrs on loss of supply to IO Cards. Restored at 17:27hrs after securing supply to IO cards that had loosened in the slot.	30 Oct 2021	17:27 hrs
92	01 Nov 2021	15:25 hrs	Lusaka West	132/33kV Tx T2B tripped at 15:25hrs on LV REF due to termination failure on 33kV cable take off. Tx T2B tripped instantly on HV REF on attempt to restore at 21:24hrs after re-terminated the failed cable.	03 Nov 2021	04:27 hrs
93	02 Nov 2021	17:17 hrs	Leopards Hill	330kV Kariba line 2 tripped at 17:17hrs at both ends on diff, FL=61.5km at Kariba end and Diff at L/Hill end.	02 Nov 2021	17:20 hrs
94	02 Nov 2021	22:46 hrs	KNBPS	G3 tripped at 22:46hrs on loss of field excitation stage 1. Restored at 00:40hrs on 03/10/2021 after resetting the alarms.	03 Nov 2021	00:40 hrs
95	03 Nov 2021	08:14 hrs	KNBPS	G3 tripped at 08:14hrs due to loss of field excitation caused by a faulty U10 thyristor. Synchronised at 17:41hrs and excitation switched to manual mode due to suspected malfunctioning auto mode.	03 Nov 2021	17:41 hrs

APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
96	06 Nov 2021	07:26 hrs	ZESA	IPS experienced a total system collapse (Black Start) on 06/11/21 at 07:26hrs, following loss of 2,185.71MW of generation on the ZESCO power system caused by system disturbance in the SAPP network. Unscheduled power flows of up to 600MW from ZESA to ZESCO before tie-line tripped. Frequency spiked to 54.15Hz and dropped to 41.0Hz. By 13:40hrs IPS was stable, & end of black start was declared.	06 Nov 2021	14:40 hrs
97	08 Nov 2021	21:21 hrs	LSMFEZ	330/33kV Tx T3 tripped both sides and L/Out at 21:27hrs on Bulcholz. Tx isolated at 23:40hrs for Tests. Line isolated at 23:40hrs. Restored TX at 02:44hrs on 09/11/2021 after satisfactory IR tests.	09 Nov 2021	02:44 hrs
98	08 Nov 2021	21:21 hrs	Bangweulu	33kV Bangweulu line tripped on 08/11/2021 at 21:27hrs on E/F and L/Out. Investigations revealed failed 33kV cable termination at the cable take-off at LSMFEZ end. Line isolated at 23:40hrs. Restored at 18:00hrs on 09/11/2021 after cable re-termination.	09 Nov 2021	18:00 hrs
99	09 Nov 2021	18:37 hrs	Vic Falls	220kV Sesheke line tripped at both ends at 18:37hrs on DI zone 2 FL=150.9km. At Sesheke on DI zone 1 ABC FL=23km. Restored at 20:30hrs. Nampower synchronized at 20:38hrs. Delay due to Sesheke S/S going invalid after tripping and report of thunderstorms.	09 Nov 2021	20:30 hrs
100	11 Nov 2021	16:15 hrs	Kalumbila	Kalumbila-330/33kV TX T1, T2 & T3 tripped at 16:15:35hrs on over voltage the HV side only. Restored at 16:36hrs due to loss of load at Kalumbila Mine. 330kV Nambala line 1 tripped at 16:15:41hrs on O/V. Restored at 16:47hrs. ITPC- Gen 1 & 2 tripped at 16:15hrs on O/V. Restored at 16:53hrs & 16:55hrs respectively.	11 Nov 2021	16:36 hrs
101	13 Nov 2021	17:51 hrs	Chambishi	330kV Luano line tripped at 17:51hrs on both ends. @ Luano, DI, zone 1, A & B, FL=7.35km & Diff. @ Chambishi, DI, zone 1, & Diff. Restored at 19:20hrs.	13 Nov 2021	19:20 hrs

APPENDIX 9- Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
102	14 Nov 2021	20:01 hrs	System Disturbance	System disturbance experienced at 20:01hrs on 14/11/2021 due to loss of load by Kansanshi and Lumwana mine. 330kV Lumwana – Kansanshi line tripped on O/V at Lumwana end only. Restored at 20:04hrs. 132kV Circuits in N/Western province tripped on O/V. Restored by 20:20hrs. Total load lost: Kansanshi mine 127MW, Lumwana mine 55MW, Zesco 6MW. IPS normalized at 20:10hrs.	14 Nov 2021	20:20 hrs
103	16 Nov 2021	23:00 hrs	SNEL	Experienced system disturbance on 16/03/2021 at 23:00hrs due to loss of load on the SNEL Interconnectors (148.8MW). Frequency rose from 50.138Hz to 50.53Hz and stabilized at 50.178Hz. Voltage at Kitwe Switching Station rose from 316kV to 335kV and stabilized at 319kV ZESA tie-line swung from 73.55MW Imports to 75.55MW Exports. SNEL tie-line dropped from 199.08MW Exports to 43.86MW Exports. No loss of load in ZESCO. IPS normalised at 23:05hrs	16 Nov 2021	23:05 hrs
104	18 Nov 2021	00:17 hrs	V/Falls	A1, A2, A3 & A4 Machines tripped at 00:17hrs on over frequency due to tripping of 3.3/33kV Transformer on LV side. (7.8MW lost). Restored at 01:30hrs. Units sync'd by 01:37hrs.	18 Nov 2021	01:37 hrs
105	22 Nov 2021	12:53 hrs	SNEL	System disturbance experienced on 22/11/2021 at 12:53hrs due to loss of load in the SNEL network. ZESA tie-line swung from 20.55MW import to 84.79MW export. SNEL interconnector dropped from 198.76MW export to 80.28MW export Voltage at Kitwe rose from 321.23kV to 332.36kV. Frequency swung from 50.069Hz to 50.203Hz. IPS normalised at 12:59hrs.	22 Nov 2021	12:59 hrs
106	23 Nov 2021	19:16 hrs	SNEL	System disturbance experienced on 23/11/2021 at 19:16hrs due to tripping of Converter # 1 at Kolwezi S/S in the SNEL network. Consequently, 220kV Luano-Karavia line and 220kV Michelo-Karavia lines 1 and 2 tripped on U/V. - ZESA tie-line swung from 45MW export to 290.4MW export. Voltage at Kitwe rose from 269.18kV to 312.42kV. Frequency swung from 49.87Hz to 50.186Hz. IPS normalised at 19:30hrs.	23 Nov 2021	19:30 hrs

APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
107	24 Nov 2021	12:50 hrs	Kansanshi	330kV Lumwana line tripped at 12:50hrs on both ends after loss of mining load. At Lumwana on over voltage and Kansanshi on direct intertrip. (Load lost: Kansanshi 135.2MW and Lumwana 51.2MW). Restored at 13:06hrs.	24 Nov 2021	13:06 hrs
108	24 Nov 2021	18:09 hrs	System Disturbance	System Disturbance experienced at 18:09hrs due to loss of load at Kansanshi 64MW and at Lumwana Mines 47MW on over voltage. Report of heavy rainfall and lightening at the mine. (Total load lost 111MW). ZESA tie-line swung from 101MW import to 68MW export and settled at 11MW import. Voltage at Kitwe rose from 323kV to 334kV and settled at 317kV. Frequency swung from 50.119Hz to 50.210Hz and settled at 50.099Hz. Further loss of 110MW load at Kalumbila mine experienced at 18:23hrs. IPS normalised at 19:58hrs.	24 Nov 2021	19:58 hrs
109	27 Nov 2021	21:27 hrs	MCL	G1 taken out on emergency at 21:27hrs due to boiler leakage. Synchronised on 02/12/2021 at 15:15hrs.	02 Dec 2021	15:15 hrs
110	30 Nov 2021	16:02 hrs	KGL	G2 tripped at 16:02hrs on cooling water flow low. Synchronised at 17:31hrs after tightening the loose connection in flow meter.	30 Nov 2021	17:31 hrs
111	03 Dec 2021	10:01 hrs	Luano	330/33kV Tx T7A taken out at 10:01hrs to facilitate emergence works on HV winding temperature gauge were there was a report of high temperature readings. Gauge tested and found to be defective. Trip circuit for temperature gauge disabled and restored at 15:13hrs.	03 Dec 2021	15:13 hrs
112	03 Dec 2021	12:08 hrs	Roma	132/33kV Tx T1 taken out at 12:08hrs on emergency to facilitate for Distribution to replace defective 33kV CB on Katuba feeder. Restored at 22:50hrs after replacing the CB on Katuba feeder.	03 Dec 2021	22:50 hrs

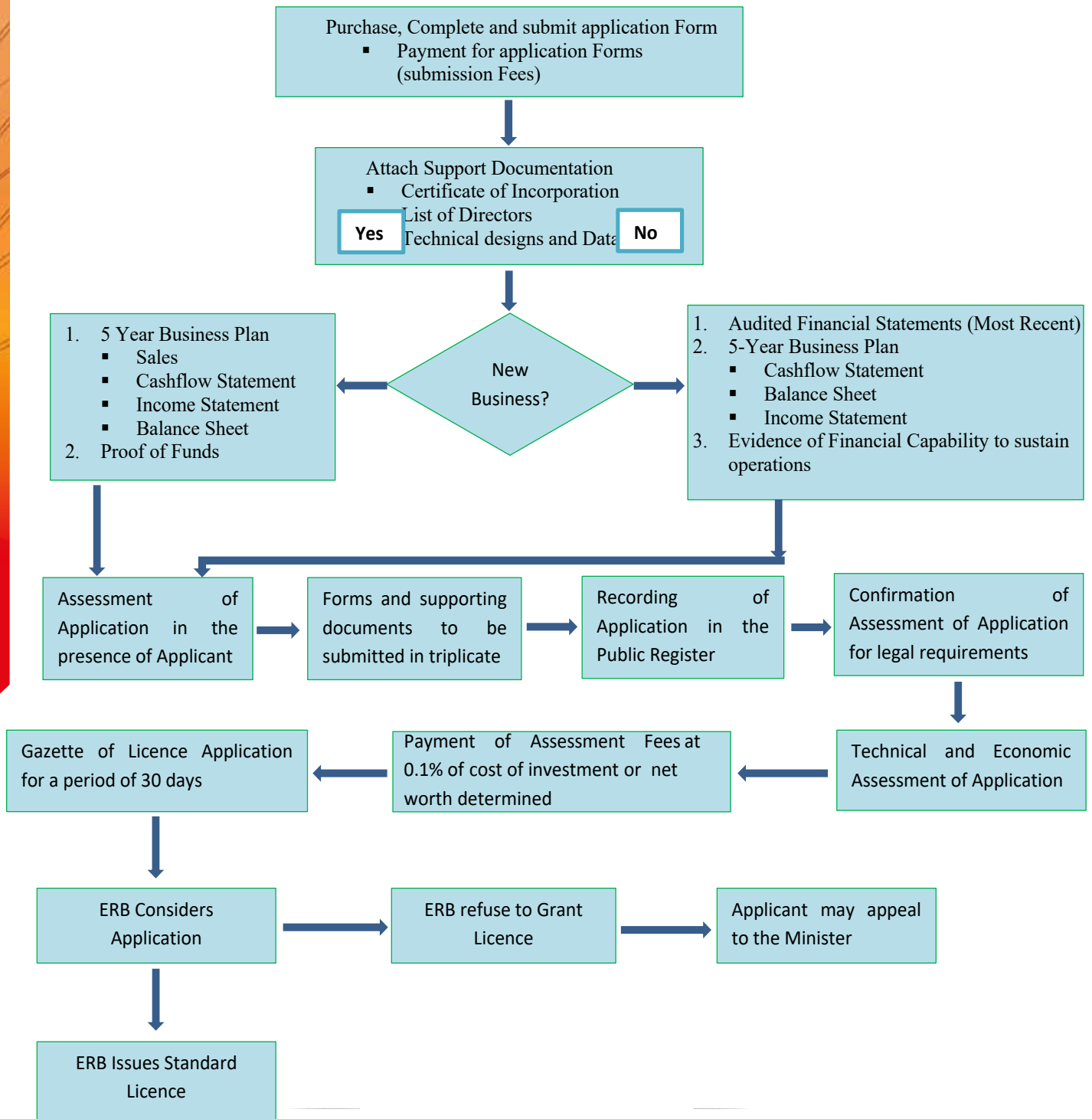
APPENDIX 9 - Major System Disturbances Recorded in 2021 Cont.

No.	Date	Outage Time	Station/ Area	Description of System Disturbance/Event	Restoration Date	Restoration Time
113	07 Dec 2021	13:26 hrs	SNEL	System disturbance experienced on 07/12/2021 at 13:26hrs characterised by power swings, frequency excursions and voltage swings caused by the tripping of 220kV Michelo – Karavia lines 1 and 2 and 220kV Luano – Karavia line on DOP due to a fault on the DC link in the SNEL network. Lines restored by 13:40hrs. IPS normalised at 13:45hrs.	07 Dec 2021	13:45 hrs
114	11 Dec 2021	05:00 hrs	BPC	System disturbance experienced on 11/12/2021 at 05:00hrs due to tripping and auto reclosing of 400kV Matimba-Phokoje line. ZESA tie-line swung from 115MW import to 350MW export. SNEL interconnectors (All three) tripped on U/F and lost load of 165MW. System normalised at 05:10hrs.	11 Dec 2021	05:10 hrs
115	11 Dec 2021	17:46 hrs	SNEL	System disturbance experienced on 11/12/2021 at 17:46hrs due to tripping of Converter 1 at Inga and Converters 1 and 2 at Kolwezi in the SNEL network. ZESA tie-line swung from 218MW import to 64MW export. SNEL interconnectors (All three) tripped on DOP and lost load of 176MW. System normalised at 17:54hrs.	11 Dec 2021	17:54 hrs

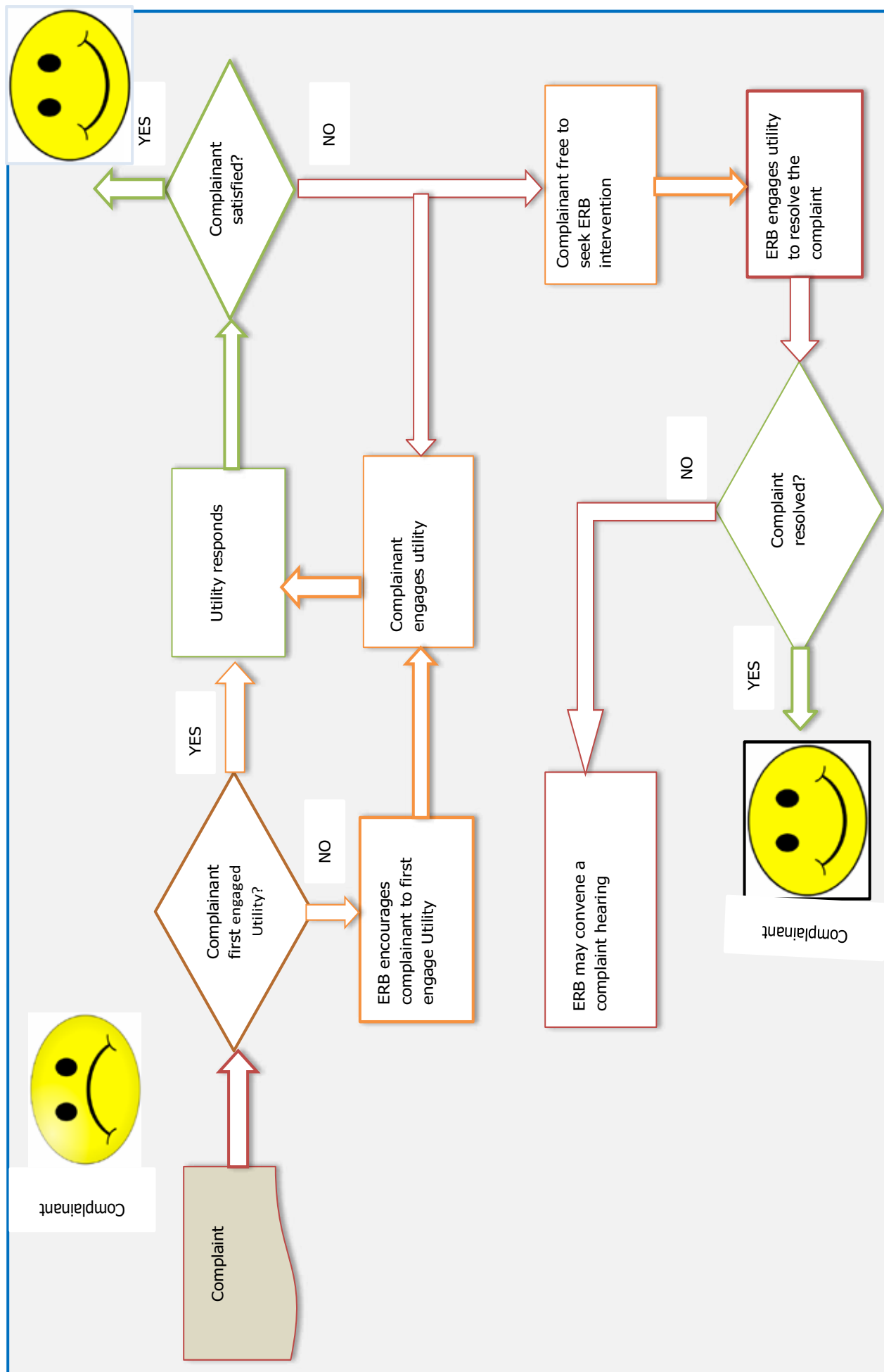
Appendix 10 Approved KPIs for NSOEs

No.	Scope/Thematic area	Weight	Specific KPIs
1.	Financial performance indicators (ratios)	N/A	Monitoring the following financial ratios: <ul style="list-style-type: none"> i. Liquidity ratios ii. Profitability ratios iii. Solvency ratios iv. Efficiency/Cost management v. Sustainability ratios
2.	System Losses	5%	Maintain distributional losses (10%)
3.	Customer Metering	15%	<ul style="list-style-type: none"> i. All customers to be metered; i. Percentage of customers on pre-paid meters; ii. Replacement of faulty meters; iii. Billing complaints received;
4.	Customer Service Office	5%	<ul style="list-style-type: none"> i. Existence of customer service office and officer(s), and a dedicated contact number; ii. Information/Tariff display; iii. Complaint resolution Procedure.
5.	Customer Complaints Resolution Rate	20%	<ul style="list-style-type: none"> i. Complaint resolution rate; and ii. Complaints escalated to the regulator.
6.	Number and Frequency of out-ages	25%	Maintain the following power indices: <ul style="list-style-type: none"> i. SAIDI at 27 hrs and 36 hrs for Dry & wet seasons respectively. ii. SAIFI at 5 times and 5.5 times for Dry & wet seasons respectively. iii. CAIDI 5 hrs and 7 hrs for Dry & wet seasons respectively. iv. ASAI at 90% or better.
7.	Service Restoration Time	10%	<ul style="list-style-type: none"> i. Licencee required to restore service within 6 hours.
8.	Replacement of faulty equipment (Asset Reliability)	10%	<ul style="list-style-type: none"> i. Replaced meters as a percentage of installed meters; ii. Replacement of distribution/supply transformers as a percentage of the total number of transformers.
9.	Safety	10%	<ul style="list-style-type: none"> i. Maintain zero fatality on a quarterly basis; ii. Maintain zero Lost Time Injury (LTI) on a quarterly basis.

Appendix 11 ERB Licensing Process flow chart



Appendix 12 ERB complaints handling procedure



Appendix 13: Applicable Tariffs Schedule for ZESCO in 2021

Customer category	Tariff components	Current tariff	Approved Tariffs Effective 1st January 2020
1. METERED RESIDENTIAL (Prepaid) (capacity 15 kVA)			
R1 – Consumption from 1 - 100 kWh in a month	Energy charge/kWh	0.15	0.47
R2 – Consumption between 101kWh - 300 kWh in a month	Energy charge/kWh	0.89	0.85
R3 – Consumption above 300kWh	Energy charge/kWh	Nil	1.94
	Fixed Monthly Charge	18.23	Abolished
2. Commercial Tariffs (capacity 15kVA)			
C1 – Consumption up to 200kWh	Energy charge/kWh	0.54	1.07
C2 – Consumption above 200kWh	Energy charge/kWh	Nil	1.85
	Fixed Monthly Charge	96.41	Abolished
3. Social Services			
Schools, Hospital, Orphanages, churches, water pumping & street lighting	Energy charge K/kWh	0.49	1.19
	Fixed Monthly Charge	83.84	203.73
4. Maximum Demand Tariffs			
MD1- Capacity between 16 - 300 kVA	MD Charge (K/kVA/Month)	24.45	42.79
	Energy Charge (K/kWh)	0.35	0.61
	Fixed Monthly Charge (K/ Month)	239.44	419.02
	Off Peak MD Charge (K/ KVA/Month)	12.22	21.39
	Off Peak Energy Charge (K/ kWh)	0.26	0.46
	Peak MD Charge (K/KVA/ Month)	30.56	53.48
	Peak Energy Charge (K/ kWh)	0.44	0.77
MD2- Capacity 301 to 2,000 kVA	MD Charge (K/kVA/Month)	45.73	80.03
	Energy Charge (K/kWh)	0.3	0.53
	Fixed Monthly Charge (K/ Month)	478.84	837.97
	Off Peak MD Charge (K/ KVA/Month)	22.87	40.01
	Off Peak Energy Charge (K/ kWh)	0.23	0.39
	Peak MD Charge (K/KVA/ Month)	57.17	100.03
	Peak Energy Charge (K/ kWh)	0.37	0.66

Appendix 13: Applicable Tariffs Schedule for ZESCO in 2021

Customer category	Tariff components	Current tariff	Approved Tariffs Effective 1st January 2020
MD3- Capacity 2,001 to 7,500kVA	MD Charge (K/KVA/Month)	73.06	126.39
	Energy Charge (K/kWh)	0.25	0.43
	Fixed Monthly Charge (K/Month)	1,014.55	1,755.17
	Off Peak MD Charge (K/KVA/Month)	36.52	63.2
	Off Peak Energy Charge (K/kWh)	0.18	0.32
	Peak MD Charge (K/KVA/Month)	91.33	157.99
	Peak Energy Charge (K/kWh)	0.3	0.54
MD4-Capacity 7500kVA to 25,000 kVA	MD Charge (K/KVA/Month)	73.47	127.39
	Energy Charge (K/kWh)	0.21	0.36
	Fixed Monthly Charge (K/Month)	2,029.13	3,510.39
	Off Peak MD Charge (K/KVA/Month)	36.73	63.55
	Off Peak Energy Charge (K/kWh)	0.16	0.27
	Peak MD Charge (K/KVA/Month)	91.84	158.88
	Peak Energy Charge (K/kWh)	0.25	0.45
Bulk Distributors tariff (Purchasers of Power for distribution)	Maximum Demand customers - MD Charge/KVA/month	Nil	58.6
	Retail customers – Energy charge / kWh	Nil	0.49
NOTE; The above tariffs are:-			
(a) Exclusive of 3% Government excise duty			
(b) Exclusive of 16% Value Added Tax (VAT)			

Appendix 14: ERB Applicable Tariffs Schedule for NWECA in 2021

Description	Approved tariffs K/kWh
Residential Customers	
R1 (1-100kWh)	0.47
R2 (101-300 kWh)	0.85
R3 (Above 300 kWh)	1.94
Commercial Customer (Consumption Capacity up to 15KVA)	
C1 (1-200 kWh)	1.07
C2 (Above 200 kWh)	1.85
Social Services Customers	
Energy Charge	1.19
Monthly Fixed Charge	203.73
Maximum Demand Customers (Above Consumption Capacity of 15KVA) (newly introduced)	
MD Charge (K/kVA/Month)	42.79
Energy Charge (K/kWh)	0.61
Fixed Monthly Charge (K/Month)	419.02
Off Peak MD Charge (K/KVA/Month)	21.39
Off Peak Energy Charge (K/kWh)	0.46
Peak MD Charge (K/KVA/Month)	53.48
Peak Energy Charge (K/kWh)	0.77
Note that the above tariffs are;	
<ul style="list-style-type: none"> - Exclusive of excise duty at 3% - Value Added Tax at 16% 	

Annex 1 ERB Electricity Tariff Determination Methodology

The ERB uses the Revenue Requirement Methodology otherwise known as the Cost of Service methodology in its tariff determination process. Revenue Requirement means the revenue that a regulated utility needs to earn in a test year in order to provide adequate service to its customers and earn a fair return for its shareholders. Typical formula of RR is as presented as follows:

$$RR = O + D + T + r \cdot RB$$

Where;

RR = Revenue Requirement;

OMA = Operating Expenses, maintenance and administration expense;

D = Depreciation and amortization expense;

T = Income Tax Expenses;

r = allowed rate of return on Rate Base (Fixed Asset plus working Capital);

RB = rate base (or regulatory asset base – RAB = (OC - AD);

OC = original cost of assets when placed in service;

AD = accumulated depreciation on assets since placed in service; and

R*RB = return on rate base or cost of capital;

- i. In reviewing tariff applications, the ERB's use of the RR methodology is also premised on the following key regulatory principles:
- ii. Recovery of prudently incurred costs by the Utility – only just and reasonable costs incurred wholly and exclusively for the provision of electricity are allowed in the tariff determination process ;
- iii. Recognition of used and useful Utility assets – only assets currently used by the utility to provide electricity to its customers are included in the Rate Base;
- iv. Financial sustainability of the Utility – the applicable tariffs should enable the utility cover both capital and operational costs as well as earn a reasonable return;
- v. The need to attain cost reflective tariffs – the Government's National Energy Policy (NEP) advocates for cost reflective pricing of all energy services;
- vi. Delivery of quality service – tariff increases must be accompanied by noticeable improvements in the quality of services provided; and

Social considerations for the indigent customers – accessibility and affordability for the poor (R1 as proxy for lifeline tariff).

The above are internationally accepted tariff determination principles.

Annex 2: Consumer rights and Obligations

1. All consumers have the right to:

2. Access to reliable and safe electric power consistent with industry standards is your right as a consumer;
3. Receiving advance notification about interruption of power supply from service provider (power company) is your right as a consumer;
4. Access fair, courteous and expeditious complaint resolution mechanisms to have their grievances addressed; and Access information about service connection, quality of service, service problems, service charges, price structure, complaints procedures, disconnection and termination of service, and pay points.
5. Consumer Responsibilities
6. Consumers have a responsibility to pay electricity bills in full, promptly and honestly
7. It is the consumer's responsibility not to use electricity unlawfully *via* illegal connections, meter tampering or any other device that interferes with normal connections
8. Consumers have a responsibility to use only qualified electricians registered with Engineering Institute of Zambia
9. Energy Regulation Board has a Toll Free Line (TFL) 8484 that operates from Monday to Friday, from 08:00 to 13:00 hours and from 14:00 hours to 17:00 hours
10. Any person or consumer may seek the Energy Regulation Board's intervention if they are not satisfied with the way their complaint has been handled by an energy utility or they consider the outcome inconclusive

Complaints to the Energy Regulation Board may be channeled through letters, e-mail, telephone, Mobile Office and/or in person at any ERB Office.

Notes

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Notes

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We safeguard your interests