**UNITED REPUBLIC OF TANZANIA**

# MINISTRY OF ENERGY

# POWER SYSTEM MASTER PLAN 2020 UPDATE

2,115MW JNHPP

400 kV Transmission line

Renewables

Gas Fired Power Plant

**FINAL REPORT**

**September ,2020**
**DODOMA**

# FOREWORD

The PSMP 2020 Update is the result of review of PSMP 2016. The overall objective of the review was to re-assess the short term (2020 – 2024), medium term (2025 – 2034) and long term (2035 – 2044) in terms of power generation and transmission plans requirement with primary goal of increasing access to modern energy, enhance power supply availability, reliability and affordability in the country. To achieve this goal the Government will continue to involve other stakeholders in the sector to implement least cost generation and transmission projects.

The PSMP 2020 Update reflects and accommodates Government policy guidelines and recent economic development experienced during the fifth Government phase, including development in electricity sub-sector. The Plan also reflects various regionals vision on energy. The PSMP 2020 Update is a joint effort by inter-governmental institutions which spent eight (8) months working hard and tirelessly to come up with this Plan. The entire work was carried out from February to September, 2020 by a team of experts from Ministry of Energy , Ministry of Finance and Planning, Tanzania Electric Supply Company, National Bureau of Statistics, Rural Energy Agency, Tanzania Petroleum Development Corporation and Energy and Water Utilities Regulatory Authority.

On behalf of the Ministry of Energy, I acknowledge the Task Force Team for their hard work and tireless efforts to ensure completion of PSMP 2020 Update. I also acknowledge Deputy Permanent Secretary, Eng. Leonard R. Masanja, Director for Policy and Planning, Mr. Haji Y. Janabi, Acting Commissioner for Electricity and Renewable Energy, Mr. Edward L. Ishengoma, Assistant Commissioner for Electricity, Eng. Innocent G. Luoga, Assistant Commissioner for Electricity Development, Eng. Styden Rwebangila for their close guidance during preparation of Plan. Moreover, I thank the Managing Director of TANESCO, Dr. Tito E. Mwinuka, Deputy Managing Director for Investment of TANESCO, Eng. Khalid James for their assistance and guidance provided to the Task Force Team.

Nevertheless, I extend my sincere appreciations to the MoFP, PO-RALG, TANESCO, ZECO, Regional Admistrative Secretaries and District Administrative Secretaries for enabling collection of necessary and essential data of electricty demand of the entire country. The data provided were used as the critical input for PSMP 2020 Update. Furthermore, I thank all the public and private sector stakeholders and development pertners for their valuable comments and contributions. Nevertheless, I thank all professionals from various institutions who were invited to contribute their inputs during PSMP 2020 Update preparation, their invaluable contribution is highly appreciated. I hereby once again thank Task Force Team members who participated in the preparation of PSMP 2020 Update and their names appended in appendex 1.

Eng. Zena A. Said

**Permanent Secretary**

# Executive Summary

**Introduction**

The Power System Master Plan 2020 has been prepared using data on electricity demand gathered during industrial survey  in the entire country. The PSMP also infers on methodology and procedures used in the previous PSMP of 2008 and its subsequent updates in 2009, 2012 and 2016. These reviews were necessary given the changes that were taking place or that were being anticipated in the Tanzanian economy and in the resulting electricity demand.

The Ministry of Energy (MoE) therefore decided to review the Power System Master Plan  2016 Update and prepare 2020 Update that will guide the next 25 years of its power development. The PSMP 2020 Update builds on previous update studies.

**Load Forecast**

The methodologies used in the load forecast were trend line analysis and econometric method. Trend line analysis considered the time series data of the past 25 years from 1995 to 2019, whereby 2019 was a base year for this Plan. An econometric forecast was reviewed to ensure the forecast is consistent with the growth pattern of other economic variables such as sectoral GDP in the Tanzania's economy. The key drivers for the forecast are: Electrification Program; Industrial load growth; Power losses; and Interconnection of Isolated Grid.

The Plan provides a forecast of the anticipated needs of the population and economy of Tanzania for the period to 2044 under base case assumptions. The projected average peak demand growth in MW for the total system, Grid and isolated System/Grids is projected to reach 17,611 MW (2044) from 1,120 MW in (2019) and in the year 2025 and 2030 the peak demand will be 2,677 MW and 4,878 MW respectively which is equivalent to an average growth of 11.7 percent per year. Similarly, the current system losses is 16.19 percent and the target is to reach 12 percent by 2026 to the end of planning horizon. Furthermore, the rate of electrification (connection) grows from 30.1 percent in 2020 to 96.1 percent in 2044.

**Generation Planning**

Total installed capacity in the country is 1,602.32 MW which comprises of interconnected Grid System (1,565.72 MW) and isolated Grid System (36.60 MW). The National Grid System comprises of hydro and thermal generation units owned by TANESCO and IPP's with total capacity of 1,565.72 MW (base year 2019) out of which hydro 573.70 MW (36.64%), natural gas 892.72 MW (57.02%), liquid fuel, 88.80 MW (5.67%) and biomass 10.50 MW (0.67%). The highest system Maximum Demand (MD) recorded was 1,120 MW reached on 30$^{th}$ November 2019.

The generation plan criteria consider reserve margin, generation mix, loss of load expectation, outage rates, plant life span, operation & maintenance costs and lead time. It retained the base case scenario as a recommended power generation expansion plan for the country.

In order to meet the forecasted demand, the country requires a total installed generation capacity of 3,971.4 MW in the short term, 12,255.7 MW in the medium and 20,200.6 MW in the long term.The Plan indicates power generation mix which varies over the planning period and by 2044 the generation mix consist of 5,690.4 MW (28.15%) of hydro; 6,700 MW (33.18%) of natural gas; 5,300 MW (26.24%) of coal; 800 MW (3.96%) of wind; 715 MW (3.54%) of solar; and 995 MW (4.93%) of geothermal of power generation.

The National Grid system connected diesel/HFO plants have been phased out from 2021 and retained as reserve capacity for emergency through out the planning period. This Plan observes a reserve margin on firm capacity in the range of 15 - 20 percent.

The plan indicates that Julius Nyerere Hydropower Plant (2,115 MW) will be in operation by 2022 bringing a total installed capacity to 3,810.9 MW from which 2,001.9

MW is a surplus capacity. The surplus capacity may be traded with the neighbouring countries, enabling Tanzania to be a power hub.

**Transmission Planning**

An assessment of major power flows was conducted across the country over the planning horizon in order to plan for reinforcement and expansion of grid network to isolated and partially connected regions. The assessment was done by calculating the ranges of major interface flows for critical system conditions in short, medium and long term throughout the planning horizon.

In order to evacuate the generated power to the load centres, the transmission expansion plan determines new lines and required system upgrades. The planned lengths of power transmission projects includes 3,150.20 km of 400 kV, 1,833.70 km of 220 kV and 920.80 km of 132 kV in the short term;  2,444.45 km of 400 kV, 650.70 km of 220 kV and 192.00 km of 132 kV in the medium term; and 610.00 km of 400 kV, 1,180.30 km of 220 kV and 155.20 km of 132 kV in the long term.

**Economic and Financial Analysis**

The economic and financial analyses were done by taking into account ten (10) relevant basic economic and financial assumptions which are discounted rate, interest rate, debt to equity ratio, loan conditions, Interest During Construction (IDC), inflation rate on Capital costs, foreign exchange rate, depreciation rate, income rate and Return On Equity (ROE).

The proposed power expansion plan requires a total of USD 38,340.4 Million throughout the planning horizon, of which USD 9,526.4 Million will be required in the period of 2020-2025. When inflation and interest during construction are added, total investment required rises to USD 50,589.2 Million in the long run, about two third of this amount is earmarked for power generation projects over the planning horizon.

The financing of capital expenditure for new projects is based on 70 percent debt and 30 percent equity financing (except for Government fully funded projects) of the draw-downs capital expenditure. Therefore, when considering new projects only, the additional unit cost of power supply is 13.7 UScents/kWh in 2021 and decreases sharply to a low value of 9.6 UScents/kWh in 2022 and reaching an average of 5.5 UScents/kWh from 2023 towards end of the planning period. The sharp decline is due to introduction of JNHPP.

The Long Run Marginal Cost of power projects was calculated on a year-by-year basis by examining the incremental cost over the base year. Nevertheless, the marginal costs of generation, transmission and distribution can be added to result in the overall cost of power supply after considering transmission and distribution losses. The planning horizon Marginal Costs for generation, transmission, distribution and supply in US cents/kWh are 6.7, 1.0, 2.2 and 9.6 respectively.

**Conclusion and Recommendation**

Tanzania has set the target to reach electricity consumption per capita of 490 kWh per annum by 2025 which is an indicator for middle income countries. Therefore, in order to meet this target, more investment is needed in power generation, transmission and distribution network.

The PSMP 2020 Update among other things considered the Government Industrialization Agenda which requires substantial power supply to meet demand growth. In this regard, power demand forecast was conducted as a base for generation, transmission and investment planning.

The key recommendations are:

a) The Government to continue with conserted efforts to mobilize the huge financial resources required to implement the Plan including attracting private investment in the electricity sub-sector;
b) The Government should fast track the short term plan which requires immediate decision and action;

c) The Government to ensure that strategic power projects are studied to full feasibility so as to reduce project implementation lead time and cost during implementation;
d) The Government to continue investing in the exploration and development of hydrocarbons to increase more discoveries;
e) The Government to fast-track the implementation of interconnection transmission lines and negotiations to commence for possible power trading up to 1,500 MW within the SAPP and EAPP starting from 2023;
f) There is need to prepare Implementation Strategies including capacity building on nuclear power generation; and
g) The Government to prepare a comprehensive Power System Master Plan in 2025 as the last was conducted in 2008 and updated several times (2009, 2012, 2016 and 2020).

# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# LIST OF ABBREVIATIONS

| | |
|---|---|
| AfDB | African Development Bank |
| AMR | Automatic Meter Reading |
| AU | African Union |
| BoT | Bank of Tanzania |
| CCGT | Combined Cycle Gas Turbine |
| DSM | Demand Side Management |
| EAC | East African Community |
| EAPP | Eastern African Power Pool |
| EPC | Engineering, Procurement and Construction |
| ESCOM | Electricity Supply Company of Malawi |
| EWURA | Energy and Water Utilities Regulatory Authority |
| FYDP | Five Years Development Plan |
| GIIP | Gas Initially In Place |
| GoT | Government of Tanzania |
| GWh | Gigawatt-hours = 1,000,000,000 watt-hours |
| IDC | Interest During Construction |
| IAEA | International Atomic Energy Agency |
| IEA | International Energy Agency |
| IGCC | Intergrated Gassification Combined Cycle |
| IPP | Independent Power Producer |
| JNHPP | Julius Nyerere Hydropower Project |
| kWh | Kilowatt-hours = 1,000 watt-hours |
| LTPP | Long Term Plan Perspective |
| MoE | Ministry of Energy |
| MoFP | Ministry of Finance and Planning |
| MVA | Mega Volt Ampere |
| MVAr | Mega Volt Ampere Reactive |
| MW | Megawatt = 1,000,000 watts |
| MWh | Megawatt-hours = 1,000,000 watt-hours |
| NBS | National Bureau of Statistics |
| NDC | National Development Corporation |

| | |
|---|---|
| NGO | Non-Governmental Organisations |
| OCGT | Open Cycle Gas Turbine |
| PBPA | Petroleum Bulk Procurement Agency |
| PPA | Power Purchase Agreement |
| PPP | Public Private Partnership |
| PS | Permanent Secretary |
| PSMP | Power System Master Plan |
| PURA | Petroleum Upstream Regulatory Authority |
| R&D | Research and Development |
| REA | Rural Energy Agency |
| SADC | Southern African Development Community |
| SDG | Sustainable Development Goals |
| SAPP | Southern African Power Pool |
| SME | Small and Medium Enterprises |
| SNC | SNC-Lavalin International Inc. |
| SPP | Small Power Producer |
| STG | Steam Turbine Generator |
| SVC | Static Var Compensator |
| TANESCO | Tanzania Electric Supply Company Limited |
| TANWAT | Tanzania Wattle Company |
| TCF | Tonnes Cubic Feet |
| TFT | Task Force Team |
| TGDC | Tanzania Geothermal Development Company |
| TPC | Tanzania Plantation Company |
| TPDC | Tanzania Petroleum Development Corporation |
| TZS | Tanzanian Shillings |
| URT | United Republic of Tanzania |
| USD | United States Dollar |
| ZECO | Zanzibar Electricity Corporation |
| ZTK | Zambia – Tanzania – Kenya Interconector |

# CHAPTER 1

## 1. INTRODUCTION

### 1.1. Background

The Power System Master Plan 2020 uses historical electricity data and new anticipated loads gathered during industrial surveys in the entire country. The PSMP also infers on the methodology and procedures used in the previous PSMP of 2008 and its subsequent updates in 2009, 2012 and 2016.

A consulting firm, ACRES International (Canada) prepared the first PSMP for Tanzania in 1985, which was followed by several updates until 2007. In 2008, SNC - Lavalin Consultant of Canada developed another new PSMP for the Government of Tanzania through TANESCO. The new plan provided a fundamentally new outlook to guide the development of the power sector in Tanzania. The study provided a detailed assessment of load demand projections, available options for meeting the demand and requirements for a new higher voltage backbone transmission system for the country.

Since then, the PSMP 2008 was firstly updated in 2009 by the then Ministry of Energy and Minerals and TANESCO with the technical support from the consultant SNC-Lavalin. The revision considered progress and challenges encountered during the implementation of the previous PSMP studies. PSMP 2012 was updated by a technical team which comprised of experts from the Ministry of Energy and Minerals, TANESCO, President's Office - Planning Commission, Ministry of Finance, TPDC, EWURA, REA and NBS. In order to cope with rapidly changing power requirements and the Government desire to restructure and drive the electricity sub-sector, the Team updated the power investment plan under the PSMP 2016 Update with technical and financial assistance from Japan International Cooperation Agency (JICA).

The PSMP 2020 Update builds on previous update studies and spearheaded by the Government Technical Team, again drawn from the Ministry of Energy, Ministry of Finance and Planning, TANESCO, EWURA, REA, TPDC, and NBS. The Plan incorporates comments from various stakeholders, including Private Sector and Energy Development Partner Group.

### 1.2. Purpose of PSMP 2020 Update

The Power System Master Plan 2020 Update reflects and accommodates Government policy guidelines and recent economic development experienced during the Fifth Government Phase, including development in the electricity sub-sector . The Plan reflects also the visions of the Southern African Development Commmunity , East African Community and African Union . The policy guidelines include, among others, the Government's desire to accelerate industrial and economic growth to attain the Vision 2025; the Government target to ensure 100 percent universal access to modern energy by 2030 ; construction of Standard Gauge Railway that demands reliable power supply; advancing the commissioning date of the Julius Nyerere hydropower project from 2035 as recommended by PSMP 2016 Update to 2022; the National Energy Policy 2015 that emphasise deliberate efforts to develop coal and renewable energy resources in the country for power generation; electrification aimed at achieving 50 percent connection rate by 2025; the Five Year Development Plan 2016 - 2021; and Electricity Supply Industry Strategy and Roadmap 2014 - 2025. Therefore, the PSMP 2020 underline the least-cost plan for additions of new power generation capacity, with the corresponding transmission requirements.

The overall objective is to re-assess the short term (2020 – 2024), medium term (2025 - 2034) and long term (2035 - 2044) in terms of power generation and transmission plans requirement for Tanzania. The goal of the Plan is to increase access to modern energy, enhance power supply availability, reliability and affordability in the country.

In order to achieve this goal, the Government will continue to involve other stakeholders in the power sector to implement the least-cost generation and transmission projects. Specifically, the implementation of the power investment plan will:

a) facilitate early attainment of the Tanzanian Development Plan Vision 2025;
b) accelerate rural electrification level and connection of new customers;

c) facilitate power trading in the region such as Eastern African Power Pool and Southern Africa Power Pool ; and
d) improve voltage levels and power supply reliability in the regional and National Grid.

For a sustainable power development, the short term investment plan in the PSMP 2020 requires immediate decisions and actions by the Government. The medium and long term plans require coordinated planning and project development studies. This approach ensures future power supply utilizes the least-cost projects that safeguard national interest in the planning horizon.

### 1.3. Scope of Work

The following five (5) primary components underlie the PSMP 2020 Update:

a) Confirmation of planning criterion;
b) Load forecast update including the collection of past and future power demand in all regions;
c) Generation plan update, including updating and confirming data on all generation sources, existing, current under construction and future options;
d) Transmission plan update, including ongoing additions and reinforcement to the existing system, plans for interconnecting presently isolated areas and options for export to neighbouring countries; and
e) Investment plan update, economic and financial analysis on planned power projects.

### 1.4. Information Collected in the Plan

The following information were used for the PSMP 2020 Update:

#### 1.4.1. Load Forecast Data

The historical records of 25 years (1995 – 2019) for the following information were used in load forecast:

a) Peak demand at substation, region and national level;
b) Energy sales by customer category and region;

c) Level of losses, energy production, energy purchases and energy exports;
d) Population number per region and household size;
e) The information on the accelerated electrification programme and its implementation status;
f) Current and recent electricity forecasts;
g) Performance of the national economy up to the year 2019; and
h) Information on expectations for the growth of the national economy and the individual sectors.

#### 1.4.2.Generation Data

a) Data on the existing generating plants maintained by TANESCO, SPPs and IPPs project developers;
b) Data on the available and potential power generation resources, including gas, hydropower, coal and renewable power resources (wind, solar, biomass);
c) Existing hydrological data adopted from previous PSMPs; and
d) Data on hydrological characteristics of reservoirs, records of inflows, discharges, spills for the reservoirs maintained by TANESCO.

#### 1.4.3.System Planning Data

a) Existing system operating and maintenance data;
b) Fuel types, prices, volume and characteristics;
c) Generation and transmission expansion planning criteria;
d) Inventory and characteristics of existing and committed units including hydro units, simple cycle gas turbine units, combined cycle units and others (solar, wind and geothermal);
e) Inventory and characteristics of transmission facilities including transmission lines and substations;
f) Transmission system current configuration and short term plans; and
g) Previous study reports on identified new generation options and transmission.

### 1.5. Factors Considered in the Update Plan

The updated Plan has taken into account a broad spectrum of new information and planning criteria. The primary factors affecting the results, as compared with the PSMP 2016 Update, include:

#### 1.5.1. Load Forecast

a) The ongoing accelerated electrification program to connect 290,000[1] new customers annually for the first five years from 2020 to 2024, and to repeat or double the efforts in regions exhibiting low connectivity at the end of the first five years;
b) The impact of the current level of electricity losses on the forecast;
c) Program for interconnection of remaining isolated load systems by 2023;
d) Emerging of high demands of power for industries and mining activities such as the construction of smelters;
e) Construction of Standard Gauge Railway that demands reliable power supply; and
f) Average household size of 8 persons.

#### 1.5.2. Generation Options

a) Availability of resources to meet projected demand (hydro, gas, coal, wind, solar and geothermal);
b) The lead time of projects (fast-track hydro projects, which usually have very long lead time);
c) End of Contracts or Retirement of projects; and
d) The capital cost of the proposed projects.

#### 1.5.3. Transmission Plan

a) Concentrating on 400 kV and 220 kV backbone voltage;
b) Developing transmission plans in the short, medium and long term while focusing on the introduction of 400 kV where necessary, instead of defining requirements for the whole horizon up to the year 2044; and
c) The capital cost of the proposed projects.

[1] TANESCO Corporate Business Plan (2020/21)

# CHAPTER 2

## 2. POWER DEMAND FORECAST

### 2.1. Background

This Chapter provides an estimate of the power demand in Tanzania over the study period from 2019 to 2044. The load forecast study provides a set of energy and power forecasts for Tanzania Interconnected Power System and the isolated systems in the short, medium and long term. The electricity forecast informs the planning of generation and transmission infrastructure. This forecast study explicitly accounts for changed economic background, Government development objectives in the power sector in addition to addressing specific issues concerning the power demand.

### 2.2. Factors Considered in the Load forecast

The load forecast study considered the following factors:

**(i)** **System losses:** the level of losses in 2019 was 16.19 percent, split as 5.88 percent and 10.31 percent for transmission and distribution losses (technical and non-technical) respectively. The plans to reduce power losses and their treatment in the forecast will affect the overall generation requirements over the forecast period. Compared to power losses in 2015, there is a significant drop in losses due to an increase in the rate of inspecting customers and efforts to replace conventional electricity meters to smart meters (LUKU) and construction of high voltage transmission lines (400 kV) to connect significant power loads.

The system losses decreased from 17.47 percent in 2015 to 16.19 percent in 2019 due to the reinforcement of distribution and transmission systems. The Government target is to reduce the total power system losses to as low as 12 percent by 2026 onward. The PSMP 2020 adopted the Government target of attaining 12 percent of system losses from 2026 through the projection period. **Table 2-1** shows the actual and projected system losses.

**Table 2-1:** The Actual and Projected Power System Losses in Percentage

| **Years** | **2015** | **2019** | **2020** | **2021** | **2022** | **2025** | **2026** | **2044** |
|---|---|---|---|---|---|---|---|---|
| Transmission | 6.20 | 5.88 | 5.88 | 5.50 | 4.70 | 4.10 | 4.00 | 4.00 |
| Distribution | 11.27 | 10.31 | 10.31 | 9.90 | 8.90 | 8.20 | 8.00 | 8.00 |
| **Total** | **17.47** | **16.19** | **16.19** | **15.40** | **13.60** | **12.30** | **12.00** | **12.00** |

**(ii)** **New significant power loads in Tanzania:** Currently, the demand forecast study shows that the industrial load growth continues to play a strong drive in the load growth in Tanzania. The Government policy for industrialization drives impacts on the industrial properties with consequent implications to the sudden addition of significant industrial loads. A significant issue in planning is the combination of the size, timing and uncertainty of these new loads. The load forecast will identify industrial loads and assess the likely impact on each regional load forecast.

**(iii)** **Rate of electrification:** The Government committed to accelerating the level of its population with electricity supply in the country by connecting 50 percent of the households to electricity network by 2025. The National Energy Policy and the Tanzania Rural Electrification Expansion Program (TREEP) will serve to guide the levels of rural electrification. In this respect, the Government has a five-year electrification program whereby the target is to connect 290,000 new customers per annum from 2020 to 2025. The REA is actively involved in rolling out rural electrification mainly by grid extension to villages and load centers lacking electricity connection. Other initiatives include the densification program in all regions in Tanzania Mainland; the electrification of Ngorogoro from Loliondo Isolated Diesel power plant; and the electrification of villages that are in proximity to the Bulyanhulu-Geita, Geita-Nyakanazi, Makambako-Songea transmission lines and Tanzania – Kenya 400 kV transmission line corridor from Singida – Arusha – Namanga.

**(iv)** **Interconnection of isolated systems:** The load forecast assessed the possibility and timing for the interconnection of the isolated regions into the National Grid System. These efforts are well in line with the forecast to accelerate electrification in Tanzania by connecting the remaining two (2) regions (Kigoma and Katavi) by 2023. However, it is recognized that some districts in Kagera and Lindi regions receive power supply through the medium voltage lines. Other districts in the regions like Liwale and Mafia have isolated (off-grid) power generation and distribution systems. The prime drivers to interconnecting the isolated regions are mainly to provide adequate and reliable power and relieve the country from costly diesel-powered generation and importation of power.

(v) **The number of persons per household:** Household size is critical in load forecast as it determines specific consumption and degree of electrification. The Plan has adopted the number of 8 persons per household as used in PSMP 2012 Update. In most urban Tanzania, it is common to observe one house with more than five households. Also, it is common to see small houses (huts) in one compound. In turn, a different household occupies each hut; however, households share one electricity connection (meter).

(vi) **Tariffs:** Economic theory suggests that the consumption of goods or services will decrease as the selling price of the good or service increases. Therefore, this study assumes that electricity tariffs will decrease significantly after the completion of Julius Nyerere Hydropower Plant. Hence, the decrease in the tariff will lead to an increase in electricity consumption and stimulate investment in various sectors.

(vii) **System load factor: Figure 2-1** presents the records of load factors from 2000 to 2019. The graph indicates that the load factor has been quite steady from 2000 to about 2004. During that period, the load factor averaged about 64.6 percent, with variation between 65.1 percent and 65.5 percent. For the past ten years, the average load factor rose to about 67.4 percent, while the highest load attained was 76.0 percent in 2012. However, based on the best practices, this Plan has used a 70 percent load factor as the benchmark throughout the planning horizon.

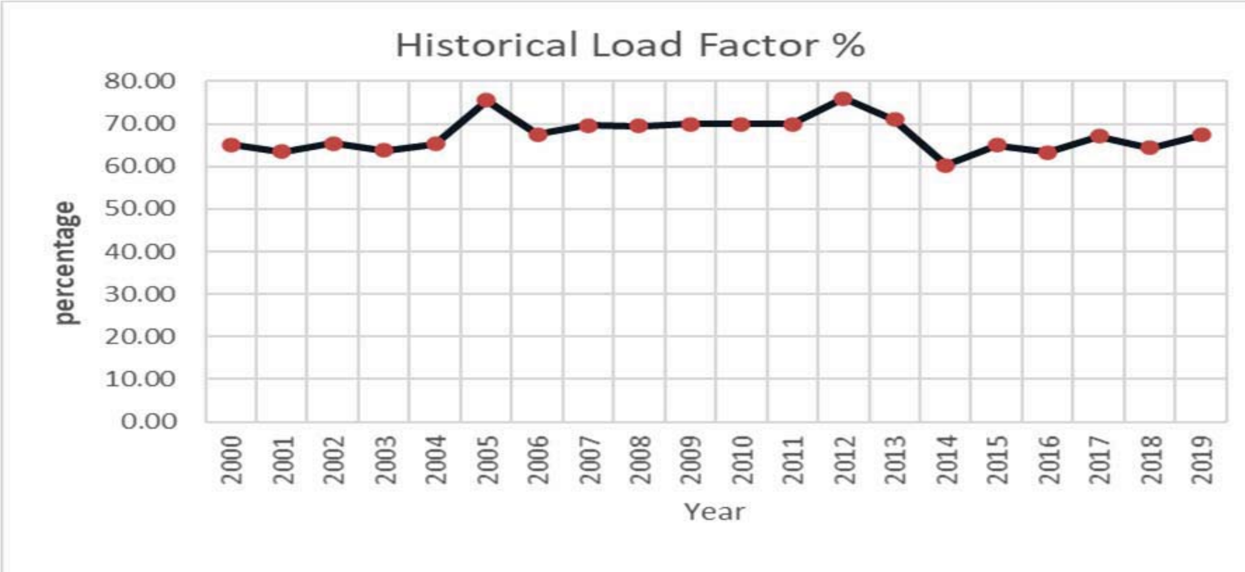



**Figure 2-1:** Historical Load Factor

## 2.3. National Economy

### 2.3.1. Highlights of the Economy

The real GDP has recorded an average growth rate of 6.4 percent over the period from 2008 to 2019. Growth slowed down in 2012 to 4.5 percent, lower than 7.7 percent recorded in 2011, on account of the negative impacts of the weather condition. However, the growth in real GDP bounced back to 6.8 percent in 2013, and it slowed down again in 2015 to 6.2 percent. According to Economic Survey Report 2019, the economy continues to grow consistently due to the rapid increase in Government spending in infrastructure development in the country. The economic activities which recorded higher growth in 2019 were Mining and quarrying (17.7 percent), construction (14.8 percent) and transport (8.7 percent). The economy is, however, expected to pick up in the medium term following Government initiative to stabilize power supply and implement development projects as outlined under FYDP II. **Figure 2-2** summarises the GDP growth over the period 2008 – 2019.

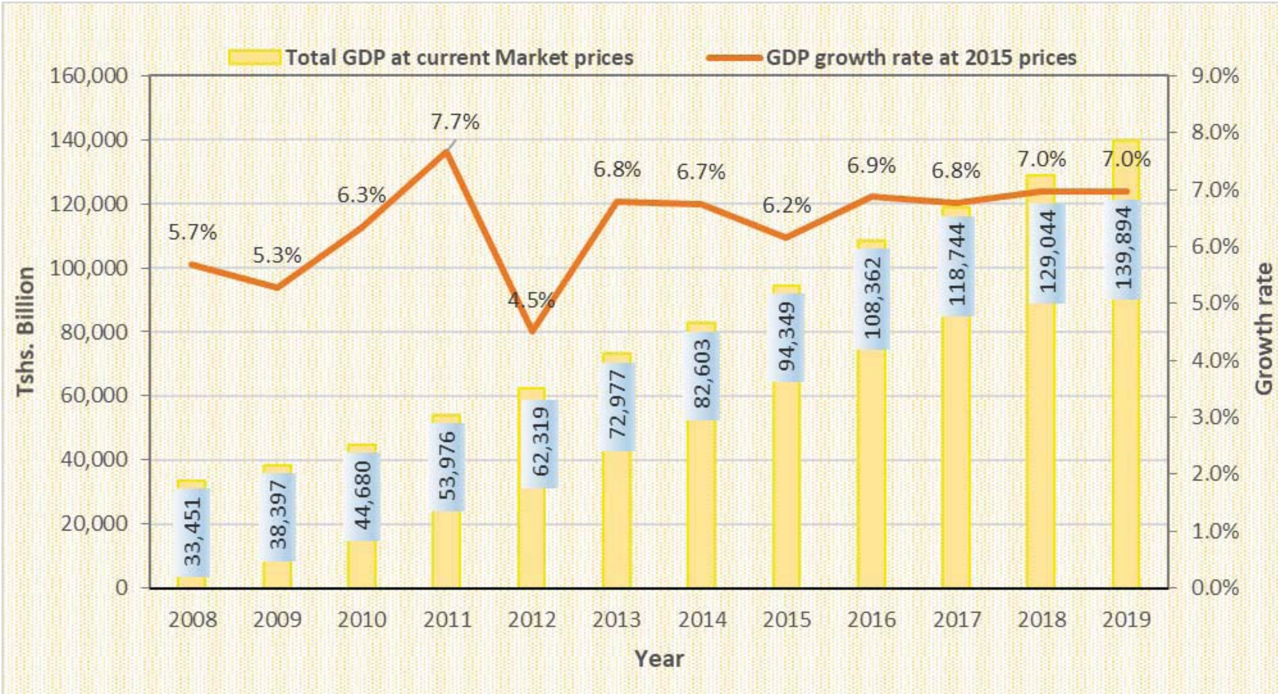



**Figure 2-2:** Historical Gross Domestic Product (GDP)

#### 2.3.2.Inflation

The annual inflation rate in Tanzania has been at a single-digit averaging 7.8 percent over the period from 2008 to 2019. However, in 2011 and 2012, inflation reached double digits of 16.0 percent and 12.7 percent, respectively. These spikes of high inflation were due to global food and energy crises and drought in countries. The overall annual average inflation rate decreased to 3.4 percent in 2019 compared to 3.5 percent in 2018 on account of the high food supply in the country, low fuel price and a good supply of electricity for industrial production.

Food is the main contributor to Consumer Price Index (CPI), accounting for 37.1 percent of the total CPI basket, followed by transport (12.5 percent) and energy (8.7 percent). The high proportions of CPI show that food prices, fuel prices and energy are very significant in the determination of the inflation trend in the country. The variation of weather and energy supply has an impact on inflation.

### 2.3.3. Economic Outlook

The review of leading indicators for economic growth such as electricity generation, cement production and consumption-based tax revenues, credit to the private sector, and exports of manufactured, mineral and agricultural commodities have shown positive performance during 2019. The performance of those leading indicators, coupled with continued efforts to stabilize power supply and the implementation of on-going Government policy under FYDP II, the overall performance of the economy in 2020 and beyond is expected to increase to an average of 7.1 percent in the medium term. In the medium-term, growth is expected to pick up supported by continued implementation of infrastructure projects including roads, airports, ports, construction of central railways line into the standard gauge and construction of Julius Nyerere Hydropower Project for stable power supply in manufacturing industries, favourable weather conditions for agriculture production and other Government initiatives under place.

### 2.3.4. Long Term Perspective

Tanzania's long term growth potential is high, as the country begins to make full use of its resources and expands from a comparatively small market base. The availability of supporting infrastructure is a crucial factor in accelerating the pace of growth of new sectors of the economy. It is worth noting that Tanzania's infrastructure, such as railways, roads, water supply, power systems and telecommunication facilities, requires considerable capital investment for their rehabilitation and expansion to meet emerging demands. Tanzania has made a lot of progress in power development to meet demand growth.

The "Tanzania Development Vision 2025" articulates the long term development plan for Tanzania. The Vision 2025 projects a growth of 8 percent of the economy annually by 2025, but in 2019 the economy grew at 7 percent. The PSMP 2020 update has taken into consideration the "Vision 2025," which aims at increasing power capacity at a rate of 15 percent per annum in order to support the economic development envisaged in "Vision 2025". Likewise, the forecast of power demand considered the Tanzania Five Year Development Plan 2016/17 to 2020/21.

The Government aims to increase the value chain in agriculture products as agriculture employs the majority of Tanzanians, estimated at 67 percent of the employed population. In this regard, the Government plans to add value in agricultural products by forming agro-industries and agro-processing industries by revamping the textile, garment, clothing and leather industries.

The FYDP recognizes the challenges on resource mobilization and it has zeroed in on a few areas of prioritization, of which their implementation will unleash the country's growth potentials. These are in areas of industrial, agriculture, transport, energy, ICT and human resources. According to the FYDP, concerted and strategic measures will aim to accelerate annual economic growth of between 8 percent and 10 percent. Likewise, an overall investment will be raised to more than 30 percent of GDP per year in current prices.

The FYDP document recognizes that there are several challenges, which require the Government to address them to move Tanzania to a higher level of production. One of the critical challenges is the development of low-cost energy to make Tanzania a destination for producing efficient and competitive goods and services as well as a source for competitive energy supplies within the region. As such, Tanzania[2] is ranked medium in terms of its competitiveness in attracting investment in the country. The main objectives of the Plan are to improve infrastructure networks as well as to attain low-cost energy service that allows more inflow of investments into the country.

#### 2.3.5. Population

**Table 2-2** presents the human population estimates by region for the last four censuses as well as projections of the population from 2019 to the end of the forecast period. The growth rates assumed for each region correspond to the growth between the census of 2002 and the census of 2012. The population projections do not account for adjustments for the in and out-migration between census periods; the adjustments are assumed part of the census exercise.

[2] World Economic Forum: The Global Competitiveness Report, 2018-2019

## Table 2-2: **Regional Population Projection (in Thousand)**

| S/N | Mainland | 1978[1] | 1988[1] | 2002[1] | 2012[1] | 2019 | 2025 | 2030 | 2035 | 2040 | 2044 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Arusha | 926 | 744 | 1,293 | 1,694 | 2,052 | 2,362 | 2,612 | 2,854 | 3,091 | 3,277 |
| 2 | Dar es Salaam | 843 | 1,361 | 2,498 | 4,365 | 5,275 | 5,995 | 6,529 | 7,062 | 7,647 | 8,146 |
| 3 | Dodoma | 972 | 1,235 | 1,699 | 2,084 | 2,569 | 3,082 | 3,578 | 4,117 | 4,693 | 5,183 |
| 4 | Iringa | 925 | 1,193 | 1,495 | 941 | 1,122 | 1,290 | 1,429 | 1,564 | 1,695 | 1,798 |
| 5 | Kagera | 1,010 | 1,314 | 2,034 | 2,458 | 3,128 | 3,848 | 4,552 | 5,341 | 6,214 | 6,975 |
| 6 | Kigoma | 649 | 857 | 1,679 | 2,128 | 2,707 | 3,312 | 3,892 | 4,531 | 5,220 | 5,800 |
| 7 | Kilimanjaro | 902 | 1,105 | 1,381 | 1,640 | 1,907 | 2,187 | 2,431 | 2,671 | 2,914 | 3,119 |
| 8 | Lindi | 528 | 646 | 791 | 865 | 1,004 | 1,138 | 1,258 | 1,381 | 1,505 | 1,604 |
| 9 | Manyara | na | 604 | 1,040 | 1,425 | 1,811 | 2,212 | 2,593 | 3,008 | 3,448 | 3,817 |
| 10 | Mara | 724 | 946 | 1,369 | 1,744 | 2,298 | 2,925 | 3,575 | 4,359 | 5,304 | 6,200 |
| 11 | Mbeya | 1,080 | 1,476 | 2,070 | 1,709 | 2,137 | 2,562 | 2,946 | 3,361 | 3,823 | 4,231 |
| 12 | Morogoro | 939 | 1,221 | 1,760 | 2,218 | 2,662 | 3,081 | 3,449 | 3,827 | 4,215 | 4,530 |
| 13 | Mtwara | 772 | 889 | 1,128 | 1,271 | 1,451 | 1,626 | 1,784 | 1,948 | 2,114 | 2,246 |
| 14 | Mwanza | 1,443 | 1,877 | 2,942 | 2,773 | 3,676 | 4,666 | 5,672 | 6,900 | 8,433 | 9,931 |
| 15 | Pwani | 517 | 636 | 889 | 1,099 | 1,295 | 1,486 | 1,654 | 1,829 | 2,010 | 2,158 |
| 16 | Rukwa | 452 | 699 | 1,142 | 1,005 | 1,232 | 1,484 | 1,741 | 2,030 | 2,340 | 2,604 |
| 17 | Ruvuma | 562 | 780 | 1,117 | 1,377 | 1,617 | 1,863 | 2,091 | 2,326 | 2,560 | 2,746 |
| 18 | Shinyanga | 1,324 | 1,764 | 2,805 | 1,535 | 1,934 | 2,297 | 2,600 | 2,900 | 3,194 | 3,425 |
| 19 | Singida | 614 | 792 | 1,091 | 1,371 | 1,658 | 1,967 | 2,271 | 2,600 | 2,940 | 3,215 |
| 20 | Tabora | 818 | 1,036 | 1,718 | 2,292 | 2,974 | 3,647 | 4,264 | 4,924 | 5,615 | 6,172 |
| 21 | Tanga | 1,038 | 1,280 | 1,642 | 2,045 | 2,392 | 2,766 | 3,127 | 3,513 | 3,910 | 4,239 |
| 22 | Njombe | na | na | na | 702 | 820 | 923 | 1,007 | 1,086 | 1,160 | 1,218 |
| 23 | Katavi | na | na | na | 565 | 771 | 1,001 | 1,242 | 1,544 | 1,926 | 2,304 |
| 24 | Simiyu | na | na | na | 1,584 | 2,196 | 2,934 | 3,736 | 4,761 | 6,103 | 7,489 |
| 25 | Geita | na | na | na | 1,740 | 2,335 | 2,993 | 3,658 | 4,441 | 5,368 | 6,224 |
| 26 | Songwe | na | na | na | 999 | 1,240 | 1,490 | 1,730 | 1,994 | 2,280 | 2,525 |
| | **MAINLAND TOTAL** | 17,038 | 22,455 | 33,583 | 43,625 | 54,265 | 65,140 | 75,422 | 86,872 | 99,723 | 111,177 |
| | **Zanzibar** | | | | | | | | | | |
| 22 | North Unguja | 77 | 97 | 137 | 187 | 227 | 256 | 277 | 297 | 318 | 334 |
| 23 | South Unguja | 52 | 70 | 95 | 116 | 136 | 149 | 158 | 167 | 177 | 184 |
| 24 | Urban West | 142 | 209 | 391 | 594 | 717 | 810 | 879 | 944 | 1,008 | 1,058 |
| 25 | North Pemba | 106 | 137 | 186 | 212 | 283 | 355 | 420 | 488 | 559 | 618 |
| 26 | South Pemba | 99 | 128 | 176 | 195 | 262 | 326 | 381 | 437 | 495 | 543 |
| | **ZNZ TOTAL** | 476 | 641 | 985 | 1,304 | 1,626 | 1,897 | 2,115 | 2,333 | 2,556 | 2,737 |
| | **Country Total** | 17,514 | 23,096 | 34,568 | 44,929 | 55,891 | 67,036 | 77,537 | 89,205 | 102,279 | 113,914 |

**NOTE:**

1. Actual Population Census Results were 1978, 1988, 2002 and 2012.
2. **"na"** means that Manyara, Njombe, Katavi, Simiyu, Geita, and Songwe regions were not yet established.

### 2.4. The Energy Sector

#### 2.4.1. Institution Framework

Tanzanian energy sector involves several stakeholders, which are Government and Non-Government institutions within and outside the country. The types of stakeholders in the energy sector of Tanzania vary significantly. They range from pro users of energy, production of energy equipment, financiers of energy projects, researchers, Non-Governmental organizations, policymakers and regulators of the energy sector. Key players, in the energy sector, include the Ministry of Energy, Tanzania Electric Supply Company, Tanzania Petroleum Development Corporation, the Rural Energy Agency, the Energy and Water Utilities Regulatory Authority Petroleum Upstream Regulatory Authority, Petroleum Bulk Procurement Agency, Tanzania Geothermal Development Company, National Environment Management Council (NEMC), Occupation Safety and Health Authority, Development Partners and Private Sector (Independent Power Producers.

#### 2.4.2. Legal Framework

These are the Electricity Act of 2008, the Petroleum Act of 2015, Energy and Water Utilities Regulatory Authority Act of 2001 and the Rural Energy Act of 2005 and their amendments. The National Energy Policy, 2015, which is the overall guide in the energy sector development sustainably and supports the development of energy through Public and Private Partnership , utilization of natural resources and application of energy efficiency technologies.

#### 2.4.3. Electricity Subsector

The Tanzanian power system (National Grid) comprises of hydro and thermal generation units owned by TANESCO and IPP's with a total nameplate (installed) capacity of 1,565.72 MW (as of December 2019) out of which 573.7 MW hydro and 892.72 MW natural gas, liquid fuel 88.8 MW and Biomass 10.5 MW. IPPs capacity constitutes 189 MW, equivalent to 12.07 percent of the total installed capacity. Thermal generators serve the isolated system with a total nominal capacity of 36.6 MW.

TANESCO has so far been the sole vertically integrated electricity supplier on Tanzania mainland, and supplies bulk electricity to Zanzibar. However, the National Energy Policy of 1992 introduced the participation of the private sector in the electricity sub-sector. The independent power producers (IPP), include Songas 189 MW, which supplies power to TANESCO. Other Small Power Producers (SPP) include TPC 9 MW, TANWAT 1.5 MW, Tulila 5 MW, Mwenga 4 MW, Andoya 1 MW, Yovi 0.95 MW, Matembwe 0.59 MW and Darakuta 0.32 MW. These SPPs either sell power to TANESCO or/and distribute through their mini-grid networks. Tanzania also imports electricity through cross-border interconnections of 17 MW from Uganda, 8 MW Zambia and 1 MW from Kenya[3]. The distribution of electricity in Zanzibar is the sole responsibility of the Zanzibar Electricity Corporation (ZECO).

### 2.5. Performance of the Current Power System

The administrative regions of TANESCO, generally follow the political-administrative regions in Tanzania. However, Dar es Salaam region is composed of four TANESCO regions. The National Grid does not include two regions of Kigoma and Katavi, these regions are being served by isolated system. Four regions of Kagera, Rukwa, Lindi and Mtwara have a partial connection to the National Grid through medium voltage connection.

**Table 2-3** shows that the system peak demand of Tanzania grew by 31.57 percent over the period 2012 to 2019. On the other hand, the units generated in the primary grid system grew by 35.82 percent. In comparison, electricity imports both locally and foreign declined by 35.63 percent in the same period.

**Table 2-3:** Units of Electricity Generated and Imports

| Years | 2012 | 2014 | 2016 | 2018 | 2019 |
|---|---|---|---|---|---|
| Peak Demand – MW | 851.35 | 934.62 | 1041.63 | 1116.58 | 1120.12 |
| Units Generated – GWh | 5537.8 | 6028.9 | 6788.9 | 7048.4 | 7521.2 |
| Units Imported (Local) - GWh | 2,564.10 | 2,149.40 | 1,819.50 | 1,512.40 | 1,576.50 |
| Units Imported (foreign) - GWh | 60.9 | 61 | 101.5 | 117.5 | 113.2 |

**Source:** TANESCO

**Table 2-4** shows the coverage of the power transmission networks in Tanzania. A total of 670 km of new 400 kV lines were constructed and currently operated at 220 kV. By

[3] There is PPA between Tanzania and Kenya but currently Tanzania is not importing electricity from Kenya.

the end of 2019, approximately 1300.1 km of 220 kV lines or 15.7 percent of new lines were constructed annually from 2012 to 2019. Another 135 km of 132 kV lines were constructed over the same period, while the 66 kV lines remained at the current length of 543 km.

**Table 2-4:** Transmission Line Expansion Coverage

| **Years** | **2012** | **2014** | **2016** | **2018** | **2019** |
|---|---|---|---|---|---|
| Lengths of 400 kV in km | 0 | 0 | 670 | 670 | 670 |
| Lengths of 220 kV in km | 1710.69 | 2,227.85 | 2,745 | 2922.14 | 3,010.7 |
| Lengths of 132 kV in km | 1,538 | 1538.75 | 1626 | 1657.06 | 1672.57 |
| Lengths of 66 kV in km | 543 | 543 | 543 | 543 | 543 |

**Source:** TANESCO

**Table 2-5** presents the units of electricity sales and the number of customers by regional loads of Tanzania in 2019. The table also shows the degree of electrification in each of the load centers considering that customers in tariff category T1 represent the households with electricity connections in the country. The table shows that the degree of electrification varies from one region to the other. The overall rate of population with access to electricity is 78.4 percent[4] in Tanzania Mainland as a result of the on-going rural electrification programs in the country.

[4] Energy Acess and Use Situation Survey II in Tanzania Mainland 2019/20

**Table 2-5:** Electricity Sales and Number of Customers

| Region Name | | Arusha | Dar es Salaam | Dodoma | Iringa | Kagera | Kigoma | K'Manjaro | Lindi | Manyara | Mara | Mbeya | Morogoro | Mtwara | Mwanza | Pwani | Rukwa | Ruvuma | Shinyanga | Singida | Tabora | Tanga | Simiyu | Geita | Katavi | Songwe | Njombe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Region Connected to Grid System?** | Yes/No | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Regions Connected to Main Grid | 23 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Regions in Isolated Systems | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Number of Regions | 27 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Energy Consumption per Tariff in thousand (000)** | kWh | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Domestic Customers | D1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Residential, Commercial, Light Industry and Street Lighting | T1 | 192,484 | 1,246,111 | 121,918 | 60,101 | 46,238 | 33,859 | 122,116 | 26,992 | 28,114 | 53,398 | 113,616 | 139,113 | 44,450 | 143,167 | 136,630 | 23,567 | 41,942 | 55,283 | 38,316 | 58,900 | 108,119 | 18,628 | 39,294 | 13,607 | 32,136 | 31,166 |
| Low Voltage Supply | T2 | 59,079 | 318,157 | 25,804 | 11,452 | 5,332 | 2,904 | 21,916 | 2,083 | 3,982 | 5,340 | 18,014 | 14,775 | 7,794 | 29,681 | 48,679 | 575 | 1,779 | 5,572 | 6,339 | 4,486 | 21,645 | 2,311 | 8,100 | 37 | 892 | 2,557 |
| High Voltage Supply | T3 | 154,766 | 1,036,282 | 32,314 | 37,347 | 28,826 | 3,565 | 43,031 | 692 | 2,879 | 105,298 | 70,031 | 114,317 | 3,727 | 122,463 | 265,516 | 3,224 | 6,666 | 236,102 | 4,823 | 5,160 | 222,190 | 3,320 | 5,624 | 0 | 133 | 5,444 |
| Bulk Supply - Zanzibar | T5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Auxilliary and own Use | T6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Golden Pride Tanzania (T3) | T7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bulyanhulu Gold Mine (T3) | T8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Prepaid LUKU Meters (D1, or T1) | LUKU | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Regional** | | 406,329 | 2,600,551 | 180,036 | 108,900 | 80,396 | 40,328 | 187,063 | 29,767 | 34,851 | 164,036 | 201,661 | 268,204 | 55,970 | 295,311 | 450,825 | 27,366 | 50,386 | 296,956 | 49,478 | 68,546 | 351,954 | 24,259 | 53,017 | 13,644 | 33,161 | 39,166 |
| Residential, Commercial, Light Industry and Street Lighting | T1 | 192,484 | 1,246,111 | 121,918 | 60,101 | 46,238 | 33,859 | 122,116 | 26,992 | 28,114 | 53,398 | 113,616 | 139,113 | 44,450 | 143,167 | 136,630 | 23,567 | 41,942 | 55,283 | 38,316 | 58,900 | 108,119 | 18,628 | 39,294 | 13,607 | 32,136 | 31,166 |
| Low Voltage Supply | T2 | 59,079 | 318,157 | 25,804 | 11,452 | 5,332 | 2,904 | 21,916 | 2,083 | 3,982 | 5,340 | 18,014 | 14,775 | 7,794 | 29,681 | 48,679 | 575 | 1,779 | 5,572 | 6,339 | 4,486 | 21,645 | 2,311 | 8,100 | 37 | 892 | 2,557 |
| High voltage supply | T3 | 154,766 | 1,036,282 | 32,314 | 37,347 | 28,826 | 3,565 | 43,031 | 692 | 2,879 | 105,298 | 70,031 | 114,317 | 3,727 | 122,463 | 265,516 | 3,224 | 6,666 | 236,102 | 4,823 | 5,160 | 222,190 | 3,320 | 5,624 | 0 | 133 | 5,444 |
| **Total Regional** | | 406,329 | 2,600,551 | 180,036 | 108,900 | 80,396 | 40,328 | 187,063 | 29,767 | 34,851 | 164,036 | 201,661 | 268,204 | 55,970 | 295,311 | 450,825 | 27,366 | 50,386 | 296,956 | 49,478 | 68,546 | 351,954 | 24,259 | 53,017 | 13,644 | 33,161 | 39,166 |
| **Tariff Share of Consumption** | % | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Domestic Customers | D1 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Residential, Commercial, Light Industry and Street Lighting | T1 | 47.4% | 47.9% | 67.7% | 55.2% | 60.0% | 84.0% | 65.3% | 90.7% | 0.0% | 32.6% | 56.3% | 51.9% | 79.4% | 48.5% | 30.3% | 86.1% | 83.2% | 18.6% | 77.4% | 85.9% | 30.7% | 76.8% | 74.1% | 99.7% | 96.9% | 79.6% |
| Low Voltage Supply | T2 | 14.5% | 12.2% | 14.3% | 10.5% | 6.7% | 7.2% | 11.7% | 7.0% | 0.0% | 3.3% | 8.9% | 5.5% | 13.9% | 10.0% | 10.8% | 2.1% | 3.5% | 2.2% | 12.8% | 6.5% | 6.2% | 9.5% | 15.3% | 0.3% | 2.7% | 6.5% |
| High Voltage Supply | T3 | 38.1% | 39.9% | 17.9% | 34.3% | 33.3% | 8.8% | 23.0% | 2.3% | 0.0% | 64.2% | 34.7% | 42.6% | 6.7% | 41.5% | 58.9% | 11.8% | 13.2% | 79.2% | 9.7% | 7.5% | 63.1% | 13.7% | 10.6% | 0.0% | 0.4% | 13.9% |
| Bulk Supply - Zanzibar | T5 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Auxilliary and own Use | T6 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Golden Pride Tanzania (T3) | T7 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Bulyanhulu Gold Mine (T3) | T8 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Prepaid LUKU Meters (D1, or T1) | LUKU | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **Regional Share of Total Consumption** | % | 6.6% | 42.5% | 2.9% | 1.8% | 1.3% | 0.7% | 3.1% | 0.5% | 0.0% | 2.7% | 3.3% | 4.4% | 0.9% | 4.8% | 7.4% | 0.4% | 0.8% | 4.9% | 0.8% | 1.1% | 5.8% | 0.4% | 0.9% | 0.2% | 0.5% | 0.6% |
| **Number of Consumers** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Domestic Customers | D1 | 37,621 | 39,211 | 39,211 | 17,709 | 68,342 | 26,256 | 53,957 | 20,037 | 19,982 | 52,729 | 91,736 | 57,423 | 26,349 | 42,757 | 27,948 | 20,825 | 31,933 | 3,615 | 25,962 | 27,286 | 45,098 | 13,538 | 17,744 | 4,151 | 28,950 | 16,323 |
| Residential, Commercial, Light Industry and Street Lighting | T1 | 135,331 | 631,638 | 631,638 | 61,906 | 28,648 | 20,078 | 144,638 | 18,663 | 13,469 | 20,688 | 65,089 | 79,321 | 26,704 | 93,946 | 121,873 | 12,800 | 26,204 | 33,479 | 18,000 | 29,650 | 75,966 | 13,819 | 24,682 | 8,877 | 25,287 | 34,498 |
| Low Voltage Supply | T2 | 282 | 1,390 | 1,390 | 101 | 37 | 16 | 92 | 17 | 30 | 36 | 90 | 90 | 52 | 127 | 216 | 6 | 20 | 40 | 24 | 35 | 103 | 13 | 44 | 2 | 7 | 23 |
| High Voltage Supply | T3 | 61 | 372 | 372 | 28 | 6 | 2 | 9 | 2 | 2 | 11 | 19 | 38 | 8 | 44 | 75 | 6 | 8 | 20 | 2 | 5 | 28 | 5 | 6 | 0 | 2 | 11 |
| Bulk Supply - Zanzibar | T5 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 |
| Auxilliary and own Use | T6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Golden Pride Tanzania (T3) | T7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bulyanhulu Gold Mine (T3) | T8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Prepaid LUKU Meters (D1, or T1) | LUKU | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | | 173,285 | 672,513 | 672,511 | 79,740 | 97,032 | 46,360 | 198,704 | 38,709 | 33,451 | 73,462 | 156,934 | 136,869 | 53,110 | 136,474 | 150,112 | 33,638 | 57,165 | 37,162 | 44,988 | 56,976 | 121,185 | 27,375 | 42,436 | 13,030 | 54,246 | 50,856 |
| Residential, Commercial, Light Industry and Street Lighting | T1 | 172,952.0 | 670,749.0 | 670,749.0 | 79,614.0 | 96,990.0 | 46,342.0 | 198,603.0 | 38,690.0 | 33,421.0 | 73,415.0 | 156,825.0 | 136,744.0 | 53,053.0 | 136,303.0 | 149,821.0 | 33,626.0 | 57,137.0 | 37,094.0 | 44,962.0 | 56,936.0 | 121,054.0 | 27,357.0 | 42,406.0 | 13,028.0 | 54,237.0 | 50,822.0 |
| Low Voltage Supply | T2 | 282.0 | 1,390.0 | 1,390.0 | 101.0 | 37.0 | 16.0 | 92.0 | 17.0 | 30.0 | 36.0 | 90.0 | 90.0 | 52.0 | 127.0 | 216.0 | 6.0 | 20.0 | 40.0 | 24.0 | 35.0 | 103.0 | 13.0 | 44.0 | 2.0 | 7.0 | 23.0 |
| High voltage supply | T3 | 61.0 | 372.0 | 372.0 | 26.0 | 6.0 | 2.0 | 9.0 | 2.0 | 2.0 | 11.0 | 19.0 | 38.0 | 5.0 | 44.0 | 75.0 | 6.0 | 8.0 | 20.0 | 2.0 | 5.0 | 28.0 | 5.0 | 6.00 | 0 | 2.0 | 11.0 |
| **Total Regional** | | 173,285 | 672,511 | 672,511 | 79,740 | 97,032 | 46,360 | 198,704 | 38,709 | 33,451 | 73,462 | 156,934 | 136,869 | 53,110 | 136,474 | 150,112 | 33,638 | 57,165 | 37,162 | 44,988 | 56,976 | 121,185 | 27,375 | 42,436 | 13,030 | 54,246 | 50,856 |
| **Customer Percentage of Total** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Domestic Customers | D1 | 21.71% | 5.83% | 5.83% | 22.21% | 70.43% | 56.66% | 27.15% | 51.76% | 0.00% | 71.78% | 58.46% | 41.95% | 49.61% | 31.33% | 18.62% | 61.91% | 55.86% | 9.73% | 59.59% | 47.89% | 37.21% | 49.45% | 41.79% | 31.86% | 53.37% | 32.10% |
| Residential, Commercial, Light Industry and Street Lighting | T1 | 78.10% | 93.91% | 93.91% | 77.69% | 29.52% | 43.30% | 72.79% | 48.19% | 0.00% | 28.16% | 41.48% | 57.95% | 50.28% | 68.54% | 81.19% | 38.05% | 44.09% | 90.09% | 40.01% | 52.04% | 62.68% | 50.48% | 58.09% | 68.13% | 46.62% | 67.84% |
| Low Voltage Supply | T2 | 0.16% | 0.21% | 0.21% | 0.13% | 0.04% | 0.03% | 0.05% | 0.04% | 0.00% | 0.05% | 0.06% | 0.07% | 0.10% | 0.09% | 0.14% | 0.02% | 0.03% | 0.13% | 0.05% | 0.06% | 0.08% | 0.05% | 0.10% | 0.02% | 0.01% | 0.05% |
| High Voltage Supply | T3 | 0.03% | 0.06% | 0.06% | 0.03% | 0.01% | 0.00% | 0.00% | 0.01% | 0.00% | 0.01% | 0.01% | 0.03% | 0.01% | 0.03% | 0.05% | 0.02% | 0.01% | 0.05% | 0.00% | 0.01% | 0.02% | 0.02% | 0.01% | 0.00% | 0.00% | 0.02% |
| Prepaid LUKU Meters (D1, or T1) | LUKU | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| **Regional Share of Total Customers** | % | 5.64% | 21.90% | 21.90% | 2.60% | 3.16% | 1.51% | 6.47% | 1.26% | 1.09% | 2.39% | 5.11% | 4.46% | 1.73% | 4.44% | 4.89% | 1.10% | 1.86% | 1.21% | 1.47% | 1.86% | 3.95% | 0.89% | 1.38% | 0.42% | 1.77% | 1.66% |
| **Specific Consumption in thousands (000)** | kWh/ Cust | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Regional Average Consumption** | | 2 | 4 | 8 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 3 | 1 | 1 | 8 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 |
| Residential, Commercial, Light Industry and Street Lighting | T1 | 1 | 2 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Low Voltage Supply | T2 | 209 | 229 | 19 | 113 | 146 | 182 | 238 | 123 | 129 | 148 | 200 | 164 | 150 | 234 | 225 | 96 | 89 | 137 | 264 | 128 | 210 | 178 | 184 | 18 | 127 | 111 |
| High voltage supply | T3 | 2,538 | 2,786 | 87 | 1,494 | 3,361 | 1,777 | 4,781 | 346 | 1,440 | 9,573 | 3,686 | 3,289 | 745 | 2,784 | 3,542 | 537 | 833 | 11,785 | 2,411 | 1,032 | 7,935 | 664 | 937 | 0 | 67 | 495 |
| **Total Regional** | | 2 | 4 | 8 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 3 | 1 | 1 | 8 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 |
| **Population ('000) - 2019** | | 2,052 | 5,275 | 2,569 | 1,132 | 3,128 | 2,707 | 1,907 | 1,004 | 1,811 | 2,298 | 2,437 | 2,662 | 1,451 | 3,676 | 1,293 | 1,333 | 1,617 | 1,924 | 1,638 | 2,974 | 2,392 | 2,196 | 2,333 | 771 | 1,240 | 1,278 |
| **Average Size of House Hold** | | 4.7 | 4.0 | 4.2 | 3.9 | 4.7 | 4.8 | 3.9 | 3.8 | 5.1 | 5.9 | 3.7 | 4.2 | 3.8 | 5.8 | 3.8 | 5.3 | 4.2 | 5.9 | 5.2 | 5.9 | 4.2 | 6.7 | 6.3 | 6.4 | 5.1 | 4.0 |
| **Number of House Holds** | | 437.0 | 1,319.0 | 612.0 | 288.0 | 666.0 | 564.0 | 489.0 | 264.0 | 355.0 | 390.0 | 677.0 | 634.0 | 382.0 | 634.0 | 341.0 | 252.0 | 385.0 | 329.0 | 319.0 | 504.0 | 569.0 | 328.0 | 371.0 | 121.0 | 243.0 | 320.0 |
| **Degree of electrification - 2019** | | 40% | 51% | 110% | 28% | 15% | 8% | 41% | 15% | 9% | 19% | 27% | 22% | 14% | 22% | 44% | 14% | 15% | 11% | 14% | 11% | 21% | 8% | 11% | 11% | 22% | 16% |

Source: TANESCO

### 2.6. Recent Development in Electricity Sub-sector

The following are the major projects that have been implemented or under construction in electricity sub-sector since 2016:

a) Construction of the Julius Nyerere Hydropower Plant (2,115 MW) at Rufiji River expected to be completed by 2022;
b) Construction of Kinyerezi I extension (185 MW) expected to be completed by July 2021;
c) Commissioning of Backbone Transmission Investment Project (BTIP – 400 kV) from Iringa to Shinyanga via Dodoma and Singida in 2016;
d) Construction of 400 kV transmission line from Singida – Arusha – Namanga expected to be completed by 2021;
e) Commissioning of 220 kV transmission line from Makambako – Songea in 2018;
f) The on-going rural electrification program – REA phase III, Densification project, Peri-urban Project, and Result based electrification projects. The rural electrification program runs from 2020 over the next five years up to 2025. The electrification efforts will be rolled out for another five years, depending on the level of electrification in a given region;
g) Extension of grid system (132 kV) from Tabora to Katavi via Inyonga and Kaliua as a parallel project under the Tabora – Kigoma via Urambo, Kaliua and Nguruka project by 2021;
h) Construction of 400 kV transmission line from Nyakanazi to Kigoma and 220 kV transmission line from Bulyanhulu to Geita and Geita to Nyakanazi by 2022;
i) Replacement of conventional meters with its subsequent smart metering system under the AMR system to large power users and medium customers and legalizing illegal customers;
j) Development of Rusumo (80 MW), which is equally shared by Burundi, Rwanda and Tanzania and Murongo – Kikagati Hydropower (14 MW), which is equally shared by Tanzania and Uganda. All these projects will be commissioned by 2021; and

k) Commissioning of 132 kV transmission line from Mtwara to Lindi (Mahumbika) with a total route length of 80 km in 2018.

## 2.7. Forecast Methodology

### 2.7.1. General

The current load forecast uses a similar approach and methodology as was developed and used for the 2008 forecast (PSMP 2008) and subsequent forecasts of 2009 and 2011. Initially, the forecast projects electricity sales – at the customer level, adding up for the implied distribution and transmission losses to arrive at the energy requirements and peak demand for each region; and then at each level aggregates to get total system energy and peak demand for the country.

The Forecast applied two methodologies, namely:-

a) Trend line analysis – applied for regional forecasts and aggregated to arrive at total country forecasts; and
b) Econometric analysis – this approach provided an overall check on the reasonableness of the forecast results obtained using the trend-line approach.

## 2.8. Approach Used for Forecasts

In achieving national load forecasts, regional load forecasts were performed individually based on the following steps:

a) First, derived a forecast of sales for the regional loads using a trend-line approach in which the trends in the number of customers and the unit consumption in each category of load were studied. The objective was to establish the underlying trend and projection growth rates;
b) Assessed the impact of specific factors for load forecast in the country;
c) Estimated the load factors that would apply in the regional systems;
d) Estimated the losses, both transmission, distribution-categorized as technical as well as non-technical losses and derive the energy required; and
e) Derived a forecast of the energy and peak demand for the sector.

The forecasting approach also took into account Tanzania Development Vision 2025, Long Term Plan Perspective (LTPP: 2010-2025) and Five Year Development Plan II as a basis of judgment in applying future growth rates to the unit consumption of electricity.

Furthermore, the approach accounts explicitly for the expected new industries as obtained from the recent industrial surveys and a special program to accelerate electricity connection.

#### 2.8.1.Data Validation

Data validation was carried out by tracing historical changes in a given data set. Graphs of the necessary input data (e.g customers and unit consumption) were assembled for each region for visual analysis and establishing historical trends. This examination permitted the selection of a historical period and appropriate growth rates for future load projections.

#### 2.8.2.Assumptions

The assumptions employed are categorized into two groups, general and specific assumptions. General assumptions are summarised in **Table 2-6** while the specific ones were applied to specific regions.

**Table 2-6:** General Assumptions used in the forecast

| High Case | Base Case | Low Case |
|---|---|---|
| Base Year Data 2019 | Base Year Data 2019. | Base Year Data 2019 |
| Target – Achieve 100% of the 290,000 new customers per annum for 5 years. | Target – Achieve 75% of the High Case target (217500). | Target – Achieve 50% of the High Case target (145,000) |
| Household size – 8 people | Household size – 8 people. | Household size – 8 people |
| Emerging of high demands of electricity (industrial survey Government industrialization policy and intention to reduce the price per unit due to low-cost power from Julius Nyerere hydropower plant in 2025) | Emerging of high demands of electricity (industrial survey): Assuming structural breaks – delays and shifts of projects. Further Government industrialization policy and intention to reduce the price per unit due to low-cost power from Julius Nyerere hydropower plant in 2025. | Historical growth rates and low unit price |

| High Case | Base Case | Low Case |
| --- | --- | --- |
| By 2025 Tanzania is assumed to be a middle-income country according to the TDV 2025:<br><br>Regions connected to the National Grid from 19 to 23 in 2020/21 and 26 by 2025/26.<br><br>Power losses from 19% in 2014/15 to 14% in 2020/21 and attain 12% by 2025/26<br>Per capita consumption (kWh) from 108 observed during 2014/15 to 377 in 2020/21 and 490 for 2025/26 | By 2025 Tanzania is assumed to be a middle-income country according to the TDV 2025<br><br>Regions connected to the National Grid from 19 to 23 in 2020/21 and 26 by 2025/26.<br><br>Power losses from 19% in 2014/15 to 14% in 2020/21 and attain 12% by 2025/26.<br>Per capita consumption (kWh) from 108 observed during 2014/15 to 377 in 2020/21 and 490 for 2025/26. | Business as usual, following historical trends |

**Source:** PSMP 2020 Update Team Compilation.

The specific assumptions used in the forecast for each region have considered the following factors:

i. Population growth;
ii. Number of people per household;
iii. Rate of increase in customers under the electrification program (applied to T1 customers);
iv. Rate of increase in customers in T2 and T3 as well as in T1 beyond the electrification program;
v. Unit consumption for all three customer categories;
vi. Amount and timing of new industrial loads; and
vii. Amount and timing of significant expansions of existing T3 customers.

#### 2.8.3.Projection of the Economic and Demographic Parameters

The load forecast study considers three periods of analysis. The short term from 2020 to 2024 – this period has a relatively high growth, during which 1.45 million customers will be connected. The medium term period covering 2025 to 2034 with moderate growth rate responding to LTPP. The long term that is 2035 to 2044, responding to characteristics of middle-income countries.

An assessment of historical GDP growth over the past 14 years reveals that the economic growth rate has been stable in all periods. The 25-year forecast study uses GDP growth rates availed by the Ministry of Finance and Planning. **Table 2-7** summarises the applicable GDP growth rates.

**Table 2-7:** GDP Growth Analysis

| Analysis Period | High Case | Base Case | Low Case |
|---|---|---|---|
| 2020 - 2025 | 7.20% | 6.10% | 5.30% |
| | | | |
| 2026 - 2030 | 7.50% | 6.60% | 5.50% |
| | | | |
| 2031 – 2035 | 7.30% | 6.40% | 5.20% |
| | | | |
| 2036 - 2044 | 7.20% | 6.10% | 5.00% |

**Sources:**

1. PSMP 2020 Update Team Compilation.
2. Ministry of Finance and Planning.

### 2.8.4. Loads from Potential Major Customers

The Government has been heavily promoting investment in extractive and other industries. Following these efforts, new potential significant customers have been identified, including mining and manufacturing industries, with their expected power needs and respective locations, as shown in **Table 2-8**. The identified load includes, 76.2 MW of power requirement in mining activities, 51 MW in sugar factories and 28 MW in cement factories and the rest of power required are for other industries. The new identified customers are explicitly considered in the forecast of the respective region.

**Table 2-8:** Identified Potential Loads

| Major Loads | Capacity (MW) | Location | Expected Online |
|---|---|---|---|
| M/S Iron & Steel Ltd | 6 | Dar es Salaam | 2020 |
| M/S Tanzania Railways Corporation | 20 | Dar es Salaam | 2020 |
| Expansion of Mloganzila Referral Hospital | 5 | Dar es Salaam | 2022 |
| DUWASA | 6 | Dodoma | 2025 |
| Kagera Sugar | 11 | Kagera | 2020 |
| Mbeya Cement | 5 | Mbeya | 2023 |
| Mkulazi (Mbigiri) sugar Factory | 10 | Morogoro | 2022 |
| Mahenge Resources(Black Rock) | 23.2 | Morogoro | 2025 |
| Kilombero Sugar Company Limited | 30 | Morogoro | 2022 |
| Tanza Graphite Company Ltd | 18 | Morogoro | 2020 |
| MWAUWASA | 6.8 | Mwanza | 2022 |
| Tanzania Breweries Limited | 9.9 | Mwanza | 2022 |
| BUSOLWA Mining Co. Ltd | 5 | Mwanza | 2020 |
| Geita Gold Mining Limited | 5 | Geita | 2020 |
| Jielong Holding (T) Ltd | 6 | Shinyanga | 2020 |
| Kom Food Product | 8 | Shinyanga | 2022 |
| Jambo Food Product | 5.9 | Shinyanga | 2020 |
| M/S Kahama Mining Corp. Ltd | 5 | Shinyanga | 2026 |
| Williamson Diamond Ltd | 7 | Shinyanga | 2023 |
| Rhino Cement | 18 | Tanga | 2021 |
| Sparcoci International Ltd | 8 | Pwani | 2021 |
| Lodhia Steel 3 | 8 | Pwani | 2020 |
| Rhino Cement Comp | 5 | Pwani | 2020 |
| Goodwill | 5 | Pwani | 2020 |
| Shungubwen Mining | 8 | Pwani | 2020 |
| Salt Industry (Processing, Grading, Packaging, an | 5 | Mtwara | 2021 |
| New Fertilizers Industry | 10 | Mtwara | 2021 |
| Makonde Plateau Water and Sanitation | 5 | Mtwara | 2020 |
| Fumba Uptown Living | 18 | Zanzibar | 2020 |
| Fumba Town Development | 12 | Zanzibar | 2020 |
| Maruhubi Port | 5 | Zanzibar | 2021 |
| Chumini Estate House | 20 | Zanzibar | 2020 |
| ZECO Reinforcement Line | 7 | Zanzibar | 2020 |
| **Total** | **326.8** | | **2020-2026** |

**Source:** PSMP 2020 Update Team Compilation.

### 2.8.5. Load Forecast Results

**Table 2-9** provides a summary of load forecast results for each region from 2019 (base) to 2044. There is a noticeable increase of annual demand growth starting from 2022 to 2026. The growth is mainly due to identified additional power demands from existing customers, new customers (information obtained from power demand survey 2019) and a special electrification program which tallies with Government's policy statement of connecting 50 percent of the population by 2025.

The table also shows rate of electrification (connection) grows from 30.1 percent in 2020 to 96.1 percent in 2044. The derived rate of electrification does not include the population using private power sources such as a renewable solar systems, therefore the rate of electrification derived in the current forecast study is lower than 37.7 percent electrification rate reported by NBS (Energy Access and Use Situation Survey II, 2019/20).

**Table 2-10** provides the corresponding peaks forecast for each region, and an evolution of the interconnected grid system, including all the isolated regions. **Table 2-11** presents projected total annual peak demand (MW) and energy generation (GWh) requirements. **Figures 2-3** to **2-5** visualize the sales, peak demand and generation forecasts for the three load forecast scenarios considered. The forecast is based on actual data of 2019 and data for the proceeding years from 2020 up to the year 2044 were estimated. Furthermore, the estimates were based on unconstrained demand consumption.

**Table 2-9:** Detailed Forecast Results - GWh

| Sales, Generation and peak demand-Total country | | BASE CASE | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Region** | **Unit** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2030** | **2035** | **2040** | **2044** |
| Arusha | GWh | 406.4 | 439.8 | 495.1 | 557.1 | 625.1 | 700.6 | 811.5 | 1,519.3 | 2,615.5 | 4,458.2 | 6,808.9 |
| Dar es Salaam | GWh | 2,600.6 | 2,732.9 | 3,038.3 | 3,460.8 | 3,964.2 | 4,542.0 | 5,272.3 | 10,279.6 | 16,249.4 | 23,376.4 | 29,140.3 |
| Dodoma | GWh | 180.0 | 223.5 | 240.2 | 216.7 | 240.2 | 270.3 | 303.7 | 438.3 | 736.3 | 1,154.3 | 1,462.5 |
| Geita | GWh | 53.0 | 56.3 | 61.9 | 72.7 | 89.8 | 111.6 | 150.0 | 336.8 | 720.7 | 1,631.3 | 3,048.0 |
| Iringa | GWh | 108.9 | 118.6 | 131.5 | 146.0 | 162.4 | 183.8 | 217.4 | 435.5 | 697.4 | 1,020.4 | 1,318.6 |
| Kagera | GWh | 80.4 | 80.9 | 87.8 | 105.3 | 126.3 | 150.2 | 172.1 | 355.6 | 741.7 | 1,478.6 | 2,673.7 |
| Katavi | GWh | 13.6 | 14.2 | 15.2 | 17.7 | 18.8 | 19.9 | 21.7 | 36.2 | 82.5 | 239.4 | 561.2 |
| Kigoma | GWh | 40.3 | 44.5 | 49.5 | 55.8 | 60.4 | 68.7 | 77.9 | 210.9 | 819.5 | 1,195.3 | 1,610.0 |
| K'Manjaro | GWh | 187.0 | 203.4 | 224.5 | 244.3 | 268.0 | 295.0 | 329.1 | 516.5 | 794.1 | 1,196.8 | 1,634.4 |
| Lindi | GWh | 29.8 | 31.5 | 36.1 | 43.4 | 54.4 | 67.9 | 84.7 | 159.2 | 318.2 | 638.6 | 786.7 |
| Manyara | GWh | 34.8 | 38.5 | 42.8 | 48.5 | 56.5 | 65.1 | 78.3 | 161.5 | 407.0 | 651.1 | 946.3 |
| Mara | GWh | 164.0 | 175.8 | 191.8 | 217.4 | 247.0 | 290.3 | 318.1 | 619.4 | 1,136.1 | 2,254.0 | 4,142.1 |
| Morogoro | GWh | 268.2 | 290.3 | 321.1 | 360.8 | 404.6 | 500.8 | 600.2 | 1,020.4 | 2,107.8 | 3,260.7 | 4,457.7 |
| Mbeya | GWh | 201.7 | 216.9 | 243.0 | 277.8 | 318.5 | 368.5 | 433.7 | 946.5 | 2,009.0 | 3,169.1 | 4,534.9 |
| Mtwara | GWh | 56.0 | 59.3 | 64.4 | 84.8 | 125.6 | 185.5 | 243.4 | 416.4 | 665.7 | 981.5 | 1,356.8 |
| Mwanza | GWh | 295.3 | 318.1 | 350.4 | 392.7 | 444.0 | 518.1 | 615.3 | 1,182.6 | 2,509.7 | 3,768.0 | 5,202.4 |
| Pwani | GWh | 450.9 | 474.5 | 509.8 | 625.6 | 758.7 | 979.1 | 1,087.1 | 1,644.0 | 2,484.9 | 3,624.5 | 4,910.5 |
| Njombe | GWh | 39.2 | 40.8 | 44.9 | 55.4 | 70.3 | 91.6 | 113.8 | 181.3 | 289.5 | 398.8 | 514.8 |
| Rukwa | GWh | 27.4 | 30.5 | 43.7 | 54.5 | 68.8 | 87.4 | 105.6 | 176.5 | 344.6 | 476.6 | 619.8 |
| Ruvuma | GWh | 50.4 | 53.8 | 61.9 | 73.8 | 90.9 | 113.6 | 143.3 | 286.6 | 674.3 | 1,027.8 | 1,442.7 |
| Singida | GWh | 49.5 | 55.0 | 62.4 | 72.7 | 84.6 | 100.6 | 121.3 | 244.8 | 558.4 | 839.5 | 1,118.6 |
| Shinyanga | GWh | 297.0 | 328.0 | 362.5 | 400.3 | 440.7 | 485.7 | 573.3 | 1,136.2 | 2,188.0 | 3,098.8 | 4,015.6 |
| Simiyu | GWh | 24.3 | 26.7 | 29.7 | 35.7 | 44.1 | 57.7 | 73.4 | 164.9 | 673.8 | 1,018.1 | 1,392.3 |
| Songwe | GWh | 33.2 | 34.4 | 37.8 | 46.5 | 58.1 | 73.7 | 88.5 | 145.5 | 290.5 | 406.6 | 529.0 |
| Tabora | GWh | 68.6 | 76.3 | 89.3 | 104.0 | 121.7 | 141.2 | 179.4 | 538.2 | 1,606.5 | 2,765.8 | 4,224.7 |
| Tanga | GWh | 351.9 | 378.7 | 408.4 | 440.4 | 487.3 | 537.7 | 640.2 | 1,250.9 | 2,560.2 | 3,875.2 | 5,169.1 |
| Zanzibar _Pemba | GWh | 43.3 | 49.2 | 55.5 | 62.2 | 69.6 | 77.9 | 87.2 | 151.8 | 231.3 | 290.2 | 345.4 |
| Zanzibar _Unguja | GWh | 458.6 | 488.2 | 453.8 | 485.0 | 519.8 | 560.9 | 595.5 | 738.3 | 898.0 | 1,092.1 | 1,258.0 |
| | | | | | | | | | | | | |
| Total (Grid + Isolated) - GWh | | 6,614 | 7,081 | 7,753 | 8,758 | 10,020 | 11,645 | 13,538 | 25,294 | 45,410 | 69,388 | 95,225 |
| Growth rate | | | 7.1% | 9.5% | 13.0% | 14.4% | 16.2% | 16.3% | 13.3% | 9.5% | 8.3% | 8.3% |
| **T1** | GWh | 3,368 | 3,688 | 4,181 | 4,795 | 5,473 | 6,226 | 7,180 | 14,742 | 28,676 | 43,934 | 60,431 |
| **T2** | GWh | 652 | 673 | 695 | 752 | 809 | 867 | 993 | 1,875 | 3,494 | 6,161 | 9,301 |
| **T3** | GWh | 2,594 | 2,719 | 2,851 | 2,996 | 3,139 | 3,284 | 3,619 | 6,126 | 10,198 | 15,569 | 21,135 |
| Les Newload | GWh | 0 | 0 | 26 | 215 | 599 | 1,267 | 1,746 | 2,551 | 3,042 | 3,723 | 4,358 |
| Total Sales | GWh | 6614 | 7081 | 7753 | 8758 | 10020 | 11645 | 13538 | 25294 | 45410 | 69388 | 95225 |
| Distribution losses | GWh | 783 | 822 | 857 | 919 | 997 | 1110 | 1226 | 2294 | 4092 | 6206 | 8481 |
| Distribution loss rate | GWh | 10.6% | 10.4% | 10.0% | 9.5% | 9.0% | 8.7% | 8.3% | 8.3% | 8.3% | 8.2% | 8.2% |
| **Generation required at S/S** | GWh | 7397 | 7903 | 8610 | 9677 | 11017 | 12755 | 14764 | 27588 | 49502 | 75594 | 103706 |
| Recovered loadshedding | GWh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Transmission Losses | GWh | 435 | 435 | 439 | 455 | 474 | 510 | 591 | 1,104 | 1,980 | 3,024 | 4,148 |
| Transmission Loss rate | GWh | 5.9% | 5.5% | 5.1% | 4.7% | 4.3% | 4.0% | 4.0% | 4.0% | 4.0% | 4.0% | 4.0% |
| **Net Generation** | GWh | 7,832 | 8,338 | 9,049 | 10,132 | 11,491 | 13,265 | 15,355 | 28,692 | 51,482 | 78,618 | 107,854 |
| Station use | GWh | 39 | 42 | 45 | 51 | 57 | 66 | 77 | 143 | 257 | 393 | 539 |
| Fraction of Station use | GWh | 0.5% | 0.5% | 0.5% | 0.5% | 0.5% | 0.5% | 0.5% | 0.5% | 0.5% | 0.5% | 0.5% |
| **Gross Generation** | GWh | 7861 | 8028 | 9098 | 10176 | 11470 | 13240 | 15271 | 28663 | 51496 | 78657 | 107937 |
| Annual Growth rate | | | 2.1% | 13.3% | 11.8% | 12.7% | 15.4% | 15.3% | 13.4% | 9.5% | 8.3% | 8.3% |
| **Sum of Peak Demands (M** | MW | 1,120 | 1,435 | 1,629 | 1,809 | 2,036 | 2,329 | 2,677 | 4,878 | 8,554 | 12,854 | 17,611 |
| **Coincident Peak(MW)** | MW | 1,120 | 1,425 | 1,533 | 1,702 | 1,914 | 2,189 | 2,514 | 4,573 | 7,958 | 11,867 | 16,111 |
| Annual Growth rate | | | 27.2% | 7.5% | 11.0% | 12.5% | 14.3% | 14.8% | 12.7% | 8.9% | 8.0% | 7.9% |
| Overall electrification level | % | 28.4 | 30.1 | 31.3 | 32.2 | 33.3 | 34.4 | 36.2 | 48.5 | 75.7 | 86.3 | 96.1 |

**Source:** PSMP 2020 Update Team Compilation

**Table 2-10:** Regional Peak Demand Forecast - MW

| Non-coincidence Peak Demand Forecast | | | | | | | | | | | | | | BASE CASE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 |
| Arusha | 58 | 71 | 84 | 94 | 105 | 118 | 134 | 156 | 182 | 205 | 230 | 259 | 292 | 327 | 366 | 409 | 458 | 513 | 574 | 642 | 718 | 802 | 897 | 1,003 | 1,121 | 1,257 |
| Dar es Salaan | 581 | 644 | 734 | 818 | 916 | 1,030 | 1,181 | 1,353 | 1,532 | 1,733 | 1,970 | 2,171 | 2,369 | 2,577 | 2,793 | 3,019 | 3,246 | 3,483 | 3,722 | 3,960 | 4,197 | 4,430 | 4,655 | 4,872 | 5,078 | 5,380 |
| Dodoma | 33 | 45 | 50 | 44 | 48 | 54 | 59 | 65 | 70 | 75 | 79 | 84 | 94 | 103 | 115 | 127 | 140 | 153 | 168 | 185 | 204 | 216 | 228 | 242 | 255 | 270 |
| Geita | 13 | 14 | 16 | 19 | 22 | 27 | 35 | 42 | 48 | 54 | 61 | 74 | 88 | 101 | 116 | 130 | 147 | 176 | 207 | 240 | 274 | 310 | 348 | 411 | 479 | 563 |
| Iringa | 19 | 22 | 25 | 29 | 32 | 35 | 41 | 48 | 55 | 63 | 71 | 81 | 89 | 98 | 106 | 118 | 129 | 142 | 155 | 167 | 177 | 188 | 198 | 210 | 225 | 244 |
| Kagera | 8 | 9 | 11 | 13 | 15 | 18 | 21 | 24 | 29 | 34 | 41 | 48 | 57 | 68 | 80 | 95 | 111 | 130 | 153 | 180 | 213 | 251 | 296 | 350 | 416 | 494 |
| Katavi | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 13 | 14 | 15 | 17 | 20 | 24 | 28 | 34 | 41 | 49 | 58 | 71 | 84 | 103 |
| Kigoma | 8 | 10 | 12 | 13 | 14 | 15 | 17 | 19 | 23 | 27 | 32 | 43 | 58 | 79 | 108 | 150 | 161 | 173 | 184 | 198 | 211 | 226 | 242 | 258 | 276 | 297 |
| K'Manjaro | 42 | 49 | 55 | 59 | 64 | 69 | 75 | 80 | 88 | 95 | 102 | 110 | 120 | 129 | 139 | 150 | 160 | 173 | 185 | 199 | 214 | 229 | 246 | 263 | 281 | 302 |
| Lindi | 3 | 4 | 4 | 5 | 7 | 8 | 11 | 13 | 15 | 17 | 20 | 23 | 26 | 30 | 35 | 42 | 50 | 59 | 71 | 85 | 102 | 111 | 120 | 129 | 140 | 145 |
| Manyara | 7 | 8 | 10 | 11 | 12 | 14 | 16 | 18 | 21 | 24 | 26 | 32 | 39 | 48 | 58 | 72 | 79 | 86 | 95 | 103 | 114 | 124 | 135 | 148 | 161 | 175 |
| Mara | 11 | 12 | 14 | 16 | 19 | 23 | 25 | 28 | 35 | 42 | 49 | 58 | 69 | 81 | 95 | 110 | 132 | 158 | 191 | 230 | 279 | 342 | 421 | 523 | 656 | 765 |
| Morogoro | 45 | 52 | 59 | 67 | 74 | 90 | 107 | 125 | 136 | 148 | 160 | 183 | 215 | 250 | 289 | 332 | 381 | 419 | 459 | 501 | 547 | 595 | 653 | 705 | 759 | 823 |
| Mbeya | 58 | 66 | 75 | 82 | 92 | 103 | 116 | 131 | 150 | 171 | 196 | 225 | 259 | 299 | 346 | 401 | 430 | 463 | 498 | 534 | 575 | 618 | 664 | 714 | 767 | 838 |
| Mtwara | 11 | 12 | 14 | 17 | 25 | 37 | 48 | 58 | 63 | 68 | 74 | 81 | 89 | 97 | 107 | 119 | 127 | 138 | 148 | 159 | 171 | 185 | 200 | 216 | 233 | 251 |
| Mwanza | 58 | 66 | 75 | 83 | 94 | 107 | 125 | 145 | 163 | 181 | 202 | 235 | 275 | 323 | 380 | 451 | 488 | 527 | 570 | 616 | 664 | 717 | 773 | 834 | 900 | 960 |
| Pwani | 47 | 53 | 60 | 75 | 92 | 121 | 134 | 151 | 167 | 183 | 202 | 224 | 249 | 276 | 307 | 342 | 377 | 417 | 460 | 508 | 563 | 623 | 690 | 766 | 849 | 908 |
| Njombe | 11 | 12 | 14 | 16 | 20 | 25 | 30 | 33 | 35 | 38 | 40 | 43 | 46 | 50 | 54 | 59 | 61 | 65 | 68 | 71 | 75 | 78 | 82 | 86 | 91 | 95 |
| Rukwa | 8 | 9 | 14 | 17 | 20 | 25 | 29 | 31 | 33 | 35 | 39 | 46 | 51 | 58 | 67 | 76 | 80 | 83 | 88 | 92 | 96 | 100 | 105 | 110 | 116 | 123 |
| Ruvuma | 11 | 12 | 14 | 17 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 58 | 70 | 84 | 101 | 123 | 133 | 144 | 155 | 168 | 180 | 195 | 210 | 228 | 246 | 267 |
| Singida | 12 | 14 | 16 | 18 | 21 | 24 | 28 | 33 | 37 | 40 | 44 | 57 | 68 | 82 | 97 | 113 | 122 | 131 | 142 | 151 | 162 | 173 | 184 | 195 | 208 | 222 |
| Shinyanga | 24 | 28 | 34 | 38 | 42 | 47 | 57 | 68 | 80 | 94 | 109 | 129 | 154 | 183 | 219 | 264 | 294 | 327 | 364 | 406 | 452 | 504 | 563 | 629 | 704 | 742 |
| Simiyu | 11 | 11 | 12 | 14 | 16 | 20 | 24 | 27 | 30 | 32 | 34 | 44 | 57 | 76 | 104 | 146 | 155 | 164 | 173 | 183 | 194 | 204 | 217 | 228 | 241 | 257 |
| Songwe | 3 | 4 | 4 | 5 | 6 | 8 | 10 | 11 | 14 | 15 | 16 | 19 | 23 | 27 | 32 | 40 | 43 | 47 | 52 | 57 | 63 | 69 | 76 | 83 | 92 | 98 |
| Tabora | 11 | 12 | 15 | 18 | 21 | 24 | 30 | 38 | 47 | 57 | 72 | 93 | 120 | 154 | 197 | 253 | 284 | 320 | 358 | 402 | 450 | 503 | 564 | 630 | 704 | 780 |
| Tanga | 77 | 88 | 97 | 103 | 113 | 122 | 142 | 164 | 180 | 200 | 221 | 264 | 309 | 359 | 414 | 473 | 514 | 556 | 600 | 646 | 694 | 743 | 794 | 847 | 901 | 954 |
| Znz_Pemba | 10 | 11 | 13 | 15 | 16 | 18 | 20 | 23 | 25 | 28 | 31 | 34 | 38 | 42 | 46 | 48 | 50 | 52 | 54 | 57 | 59 | 61 | 64 | 66 | 69 | 72 |
| Znz_Unguja | 86 | 87 | 90 | 96 | 102 | 114 | 121 | 127 | 133 | 138 | 143 | 149 | 154 | 160 | 167 | 173 | 180 | 187 | 194 | 193 | 200 | 208 | 216 | 223 | 231 | 227 |
| System Peak | 1,120 | 1,435 | 1,629 | 1,809 | 2,036 | 2,329 | 2,677 | 3,053 | 3,439 | 3,850 | 4,323 | 4,878 | 5,488 | 6,177 | 6,951 | 7,851 | 8,554 | 9,309 | 10,116 | 10,968 | 11,885 | 12,854 | 13,897 | 15,042 | 16,283 | 17,611 |
| Growth | | 28.1% | 13.5% | 11.0% | 12.5% | 14.4% | 14.9% | 14.0% | 12.6% | 12.0% | 12.3% | 12.8% | 12.5% | 12.6% | 12.5% | 12.9% | 9.0% | 8.8% | 8.7% | 8.4% | 8.4% | 8.2% | 8.1% | 8.2% | 8.3% | 8.2% |

**Source:** PSMP 2020 Update Team Compilation.

**Table 2-11:** Peak Demand and Energy Generation Forecasts

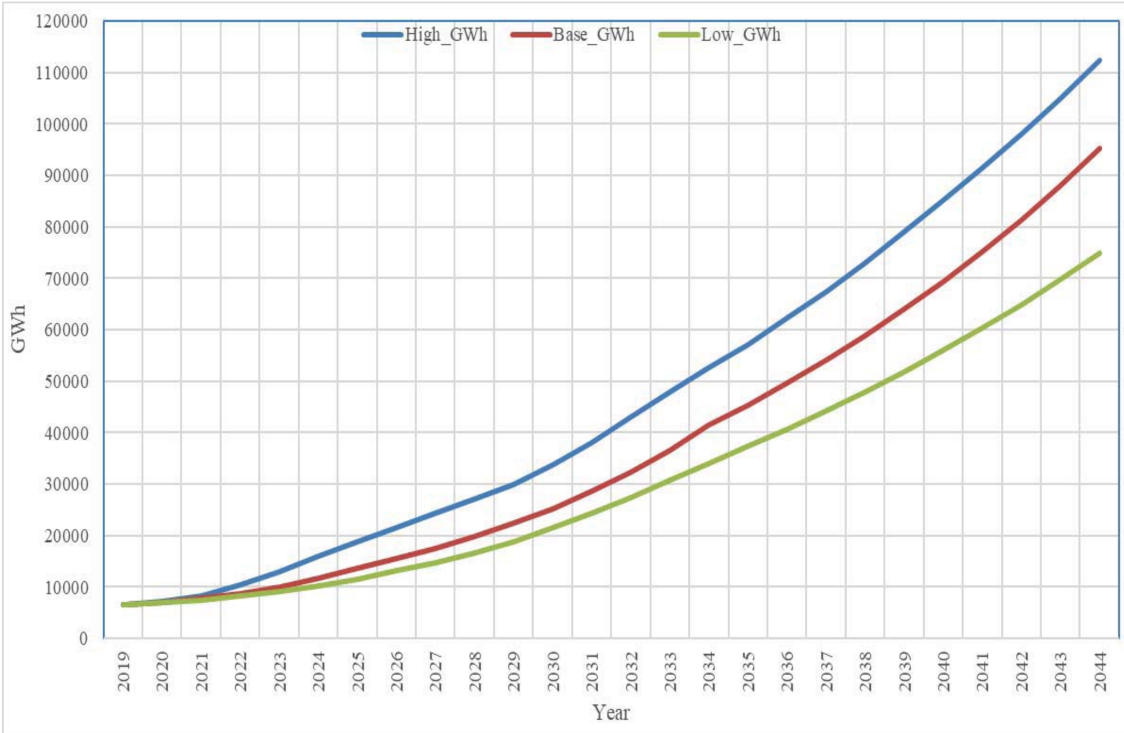
| Year | Sum of Peak - MW | Coincidental Peak - MW | Gross Generation - GWh |
|---|---|---|---|
| **2019-Unconstrained** | 1,120.12 | 1,120 | 7,861 |
| **2020** | 1,435.00 | 1,425 | 8,028 |
| **2021** | 1,629.00 | 1,533 | 9,098 |
| **2022** | 1,809.00 | 1,702 | 10,176 |
| **2023** | 2,036.00 | 1,914 | 11,470 |
| **2024** | 2,329.00 | 2,189 | 13,240 |
| **2025** | 2,677.00 | 2,514 | 15,271 |
| **2026** | 3,053.00 | 2,868 | 17,575 |
| **2027** | 3,439.00 | 3,229 | 19,880 |
| **2028** | 3,850.00 | 3,615 | 22,403 |
| **2029** | 4,323.00 | 4,059 | 25,271 |
| **2030** | 4,878.00 | 4,573 | 28,663 |
| **2031** | 5,488.00 | 5,137 | 32,413 |
| **2032** | 6,177.00 | 5,772 | 36,654 |
| **2033** | 6,951.00 | 6,485 | 41,475 |
| **2034** | 7,851.00 | 7,311 | 47,022 |
| **2035** | 8,554.00 | 7,958 | 51,496 |
| **2036** | 9,309.00 | 8,649 | 56,277 |
| **2037** | 10,116.00 | 9,386 | 61,376 |
| **2038** | 10,968.00 | 10,160 | 66,818 |
| **2039** | 11,885.00 | 10,992 | 72,601 |
| **2040** | 12,854.00 | 11,867 | 78,657 |
| **2041** | 13,897.00 | 12,806 | 85,136 |
| **2042** | 15,042.00 | 13,827 | 92,130 |
| **2043** | 16,283.00 | 14,927 | 99,627 |
| **2044** | 17,611.00 | 16,111 | 107,937 |

**Source:** PSMP 2020 Update Team Compilation.

Table 2-12: **Comparison of Sum of Peak Demand in MW for Low, Base and High case**

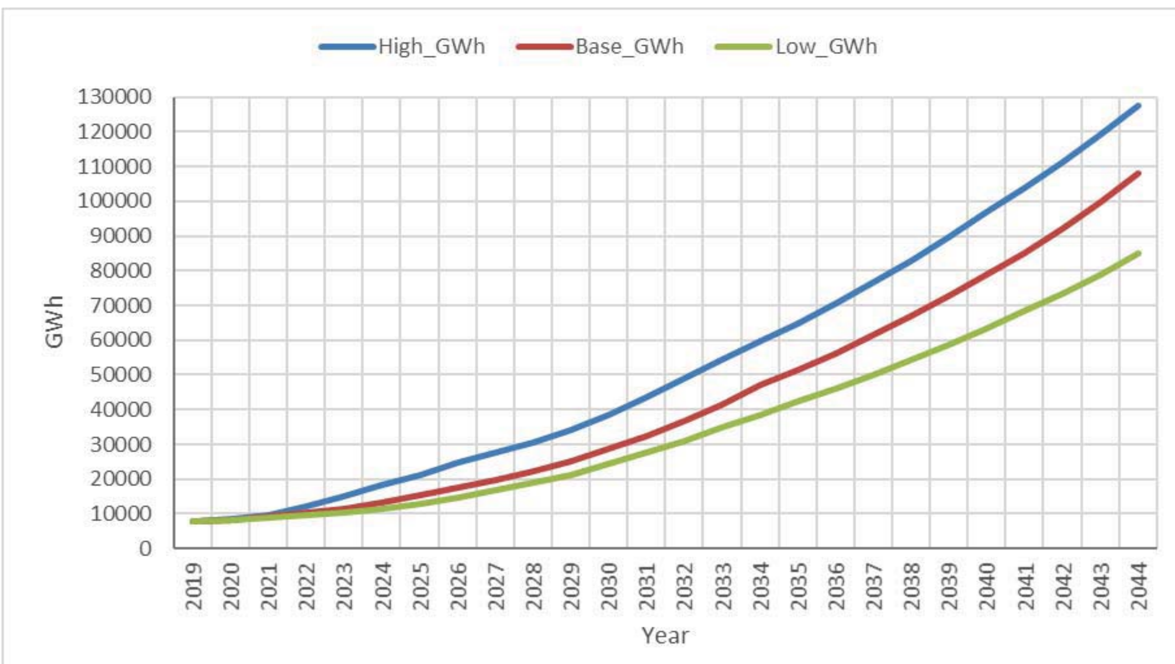
| Year | Low Case | Base Case | High Case |
|---|---|---|---|
| 2019 | 1,120 | 1,120 | 1,120 |
| 2020 | 1,405 | 1,435 | 1,549 |
| 2021 | 1,565 | 1,629 | 1,731 |
| 2022 | 1,702 | 1,809 | 2,129 |
| 2023 | 1,852 | 2,036 | 2,602 |
| 2024 | 2,043 | 2,329 | 3,134 |
| 2025 | 2,289 | 2,677 | 3,662 |
| 2026 | 2,581 | 3,053 | 4,212 |
| 2027 | 2,897 | 3,439 | 4,700 |
| 2028 | 3,246 | 3,850 | 5,212 |
| 2029 | 3,637 | 4,323 | 5,736 |
| 2030 | 4,147 | 4,878 | 6,469 |
| 2031 | 4,702 | 5,488 | 7,267 |
| 2032 | 5,246 | 6,177 | 8,146 |
| 2033 | 5,850 | 6,951 | 9,058 |
| 2034 | 6,456 | 7,851 | 9,890 |
| 2035 | 7,040 | 8,554 | 10,703 |
| 2036 | 7,642 | 9,309 | 11,608 |
| 2037 | 8,276 | 10,116 | 12,553 |
| 2038 | 8,939 | 10,968 | 13,546 |
| 2039 | 9,640 | 11,885 | 14,627 |
| 2040 | 10,379 | 12,854 | 15,762 |
| 2041 | 11,164 | 13,897 | 16,894 |
| 2042 | 12,008 | 15,042 | 18,139 |
| 2043 | 12,910 | 16,283 | 19,463 |
| 2044 | 13,862 | 17,611 | 20,804 |

**Source:**PSMP 2020 Update Team  Compilation.



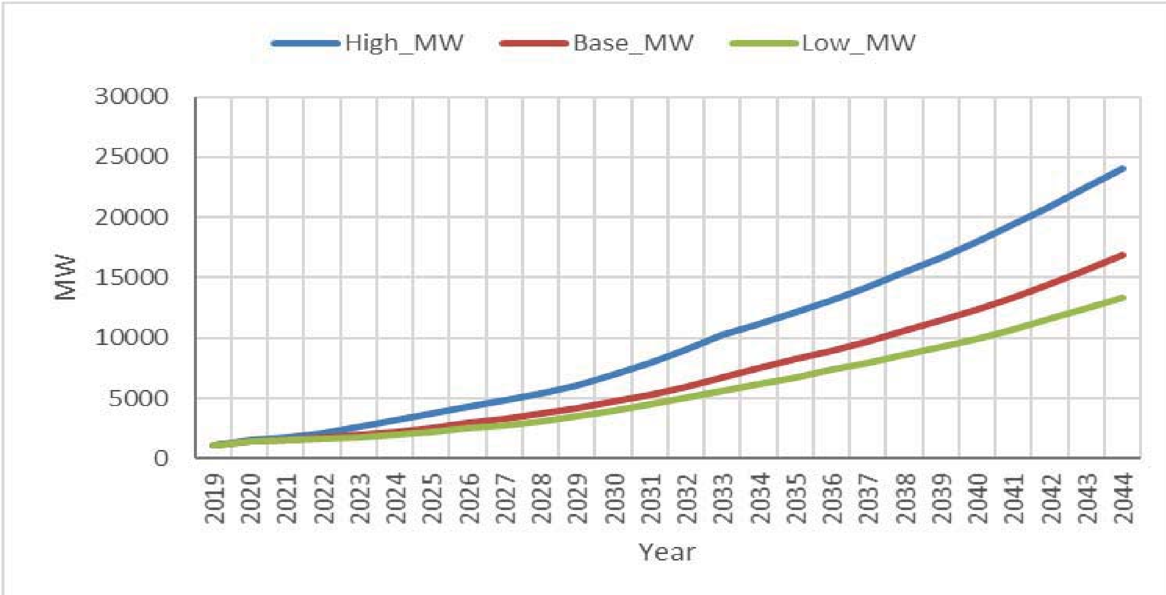

**Source:** PSMP 2020 Update Team Compilation

**Figure 2-3:** Electricity Sales Forecasts: 2019 – 2044




**Source:** PSMP 2020 Update Team Compilation

**Figure 2-4:** Gross Generation Forecast: 2019 – 2044




**Source:** PSMP 2020 Update Team Compilation

**Figure 2-5:** Peak Demand Forecast: 2019 – 2044

## 2.9. Derivation of Energy Sales Forecast – Econometric Analysis

### 2.9.1. Background

This sub-section derives forecasts of electricity at the national level using econometric principles and the results are compared with the forecast results obtained using the trend analysis approach described in the previous section.

The econometric method involves the estimation of causal relationships between energy sales or consumption (the dependent variable) and factors influencing consumption (the independent variables). From a conceptual point of view, there are three issues in a load electricity forecasting that need particular attention as described below:

(i). Both sides of the equation need to be compatible: It is inappropriate to consider variables reflecting conditions in an entire nation with a variable reflecting only a part of the nation (e.g., sales for a region compared to GDP of the country as a whole);

(ii). The use of an econometric analysis is only appropriate on large "populations". It should not be used on consumer categories where there are a relatively small number of customers, each with very high consumption. In such a case, decisions by a small number of consumers can have a significant impact on the utility load. Econometric analysis is not equipped to handle such situations; and

(iii). The past trend will continue in the future: It should be noted that this approach implicitly assumes that conditions in the past will prevail in the future. Significant changes such as accelerated electrification and rapid expansion of the mining activities, industries, and other identified loads must, therefore, be considered as additions to this method.

#### 2.9.2.Econometric Method

The econometric method consists of two steps.

**Step 1:** Plot the Sales vs. economic and demographic indicators, i.e., fit – via a regression analysis – an equation of the form:

Sales (t) = α + β • (demographic indicators, t) + γ • (economic indicators, t)

Where at time t:

Sale = Sales in GWh (Sales could be T1 Sales, T2 Sales, T3 Sales or Country Sales),

Demographic indicators = Population, housing, etc.

Economic indicators = GDP, or a subset thereof, and α = constant, β, and γ are the (estimated) coefficients.

**Step 2:**

Assuming that in time, the relationship established in Step 1 between Sales and the other variables --demographic, economic-- will hold; and

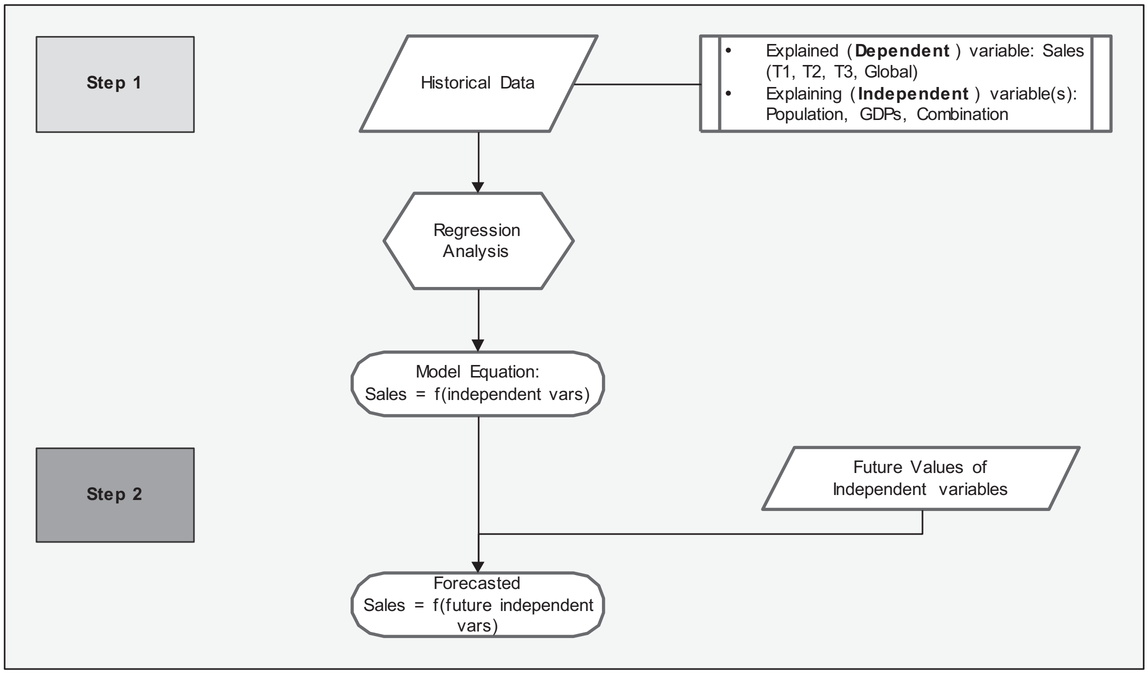
Based on reasonable assumptions as to the evolution in the future of these (independent[5]) variables, which evolution is usually measured in terms of growth rates[6] (in percent), obtaining the forecast values of the Sales, at a future time t, by substituting the forecast values of the independent variables into the equation obtained in step 1.

The available historical data considered in the econometric forecast include, the GDP values by components (Agriculture, Industry, and Services sectors), and Demography (Population). These variables or a combination of them are the explaining variables or independent variables of the energy model. The explained or dependent variable is the

[5]The term “independent” variable is used to designate an explanatory factor as opposed to “explained” or forecasted variable —in this case, Sales or Consumption— which is also termed as the “dependent” variable.

[6]By way of Population and Economic forecasts

electricity Sales (global sales or sales by customer category). **Figure 2-6** illustrate the process of the econometric forecast modeling.




**Source:** PSMP 2008

**Figure 2-6:** Econometric Forecast Modelling

A vital element of the econometric process is the selection of the independent variables or combination of independent variables to be used in the equation "to explain" the dependent variables. A certain number of criteria are generally used to select the combination of independent variables.

In line with this method, T1, T2, T3, and the Total electricity Sales were each plotted against a series of combinations of independent variables or predictors. The ensuing results obtained after applying the above criteria are as follows:

### (i) Forecast for Category T1

Category T1 is composed of residential, commercial, light industry, and street lighting customers. A series of relationships between sales to T1 customers and several combinations of various economic and demographic parameters were examined. The regression equation is given by:

T1 Sales as a function of Total GDP

That is:

T1 = 268.1763071 + 0.022419789 x GDP

Where T1 is expressed in GWh, and the Total GDP is in TZS Billion (constant 2015) prices.

The details of this relationship are as follows:

**Table 2-13:** Relation between T1 and GDP

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.966929331 |
| R Square | 0.93495233 |
| Adjusted R Squai | 0.931699947 |
| Standard Error | 165.7448071 |
| Observations | 22 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 7897099.01 | 7897099.01 | 287.4668181 | 2.46353E-13 |
| Residual | 20 | 549426.8216 | 27471.34108 | | |
| Total | 21 | 8446525.832 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 268.1763071 | 97.17523986 | 2.759718499 | 0.012085024 | 65.47230873 | 470.8803054 | 65.47230873 | 470.8803054 |
| GDP | 0.022419789 | 0.001322323 | 16.95484645 | 2.46353E-13 | 0.019661471 | 0.025178107 | 0.019661471 | 0.025178107 |

### (ii) Forecast for Category T2

Category T2 includes low voltage commercial, service, and industrial supply. A series of relationships between sales to T2 customers and several combinations of various economic and demographic parameters were examined. The equation is given by:

T2 Sales as a function of the sum of industry and services GDPs

That is:

T2 Sales = 237.291439 + 0.005862273 x (Industry +Services GDPs)

Where T2 is expressed in GWh, and the Industry Plus Services GDP is in TZS Billion (constant 2015 prices).

The details of this relationship are as follows:

**Table 2-14:** Relation between T2 and GDP

| *Regression Statistics* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Multiple R | 0.904151157 | | | | | | | |
| R Square | 0.817489314 | | | | | | | |
| Adjusted R Square | 0.80836378 | | | | | | | |
| Standard Error | 55.76278307 | | | | | | | |
| Observations | 22 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | | | |
| Regression | 1 | 278556.0943 | 278556.0943 | 89.58262471 | 7.9128E-09 | | | |
| Residual | 20 | 62189.75951 | 3109.487975 | | | | | |
| Total | 21 | 340745.8538 | | | | | | |
| | | | | | | | | |
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 237.291439 | 28.98007586 | 8.188088954 | 8.12532E-08 | 176.8400601 | 297.742818 | 176.8400601 | 297.742818 |
| Industry & Services | 0.005862273 | 0.000619376 | 9.464809808 | 7.9128E-09 | 0.004570278 | 0.007154268 | 0.004570278 | 0.007154268 |

### (iii)Forecast for Category T3

Category T3 includes high voltage supply, agricultural, significant commercial buildings and Industries. A series of relationships between sales to T3 customers and several combinations of various economic and demographic parameters were examined.

The best relationship found was:

Sales to T3 customers as a function of a sum of Agriculture and Industry GDPs alone That is:

T3 Sales = -331. 0222336 + 0.048372663 x (Agric + Industry GDPs)

Where T3 is expressed in GWh and the Agriculture plus Industry GDP is in TZS Billion (constant 2015 prices).

The details of this relationship are as follows:

**Table 2-15:** Relation between T3 and GDP

| *Regression Statistics* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Multiple R | 0.969030267 | | | | | | | |
| R Square | 0.939019659 | | | | | | | |
| Adjusted R Square | 0.935970642 | | | | | | | |
| Standard Error | 177.7009468 | | | | | | | |
| Observations | 22 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | | | |
| Regression | 1 | 9725105.336 | 9725105.34 | 307.9745509 | 1.2891E-13 | | | |
| Residual | 20 | 631552.5297 | 31577.6265 | | | | | |
| Total | 21 | 10356657.87 | | | | | | |
| | | | | | | | | |
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | -331.0222336 | 105.7943945 | -3.12892035 | 0.005286219 | -551.7054734 | -110.33899 | -551.705473 | -110.33899 |
| Agriculture+Industry | 0.048372663 | 0.002756402 | 17.5492037 | 1.2891E-13 | 0.042622909 | 0.05412242 | 0.04262291 | 0.05412242 |

### (iv)Forecast of Total Sales Using the General Equation

The total sales can be derived by taking the sum of the sales to the individual categories or by directly regressing it by the socioeconomic variables. As in the preceding section, the (direct) fitting of the Total (or Global) Sales is carried out by examining a series of relationships between total sales and various economic and demographic variables.

Hence, the best relationship found was:

Total sales as a function of total GDP

That is:

Global Sales = -49.95291326 + 0.056231384 x GDP

Where Total Sales is expressed in GWh and the Total GDP is in TZS Billion (constant 2015 prices).

The details of this relationship are as follows:

**Table 2-16:** Relation between Total Sales and GDP

| *Regression Statistics* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Multiple R | 0.985946009 | | | | | | | |
| R Square | 0.972089533 | | | | | | | |
| Adjusted R Square | 0.97069401 | | | | | | | |
| Standard Error | 267.0523874 | | | | | | | |
| Observations | 22 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | | | |
| Regression | 1 | 49677769.65 | 49677770 | 696.5770465 | 5.11978E-17 | | | |
| Residual | 20 | 1426339.553 | 71316.978 | | | | | |
| Total | 21 | 51104109.2 | | | | | | |
| | | | | | | | | |
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *.ower 95.0%* | *Upper 95.0%* |
| Intercept | -49.95291326 | 156.5712993 | -0.319043 | 0.753002407 | -376.5549206 | 276.6491 | -376.5549 | 276.649094 |
| GDP | 0.056231384 | 0.002130562 | 26.392746 | 5.11978E-17 | 0.051787109 | 0.060676 | 0.0517871 | 0.060675658 |

### 2.10. Result of Electricity Forecast using Econometric

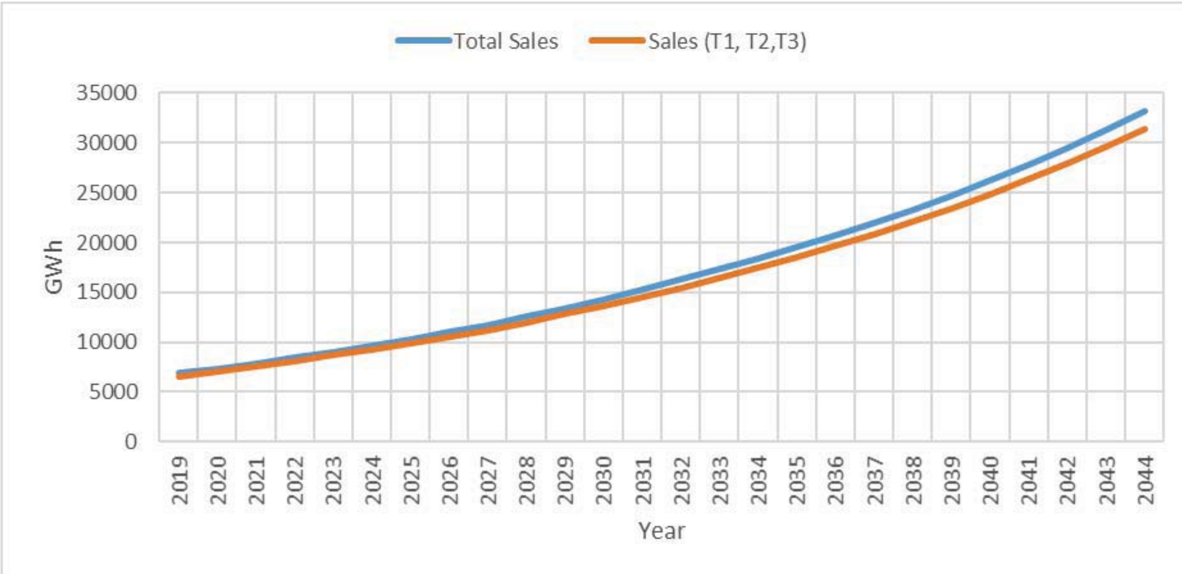
The best relationship found for each tariff category was used to forecast electricity sales for T1, T2, T3, and total electricity sales. **Table 2-17** presents the forecast for electricity sales for each tariff category.

**Figure 2-7** visualizes the sum of the forecast results for the three load categories and the total country forecast, as detailed in **Table 2-17**. The figure indicates that a sum of forecast (T1+T2+T3) compares well with the total forecast (total sales vs. total DGP values).

**Table 2-17:** Sales Forecast (GWh) by Econometric Method

| YEAR | T1 | T2 | T3 | T1+T2+T3 | Total |
|---|---|---|---|---|---|
| 2019 | 3,029 | 721 | 2,831 | 6,581 | 6,875 |
| 2020 | 3,222 | 760 | 3,074 | 7,055 | 7,358 |
| 2021 | 3,427 | 801 | 3,332 | 7,560 | 7,872 |
| 2022 | 3,649 | 846 | 3,608 | 8,103 | 8,430 |
| 2023 | 3,891 | 895 | 3,907 | 8,692 | 9,035 |
| 2024 | 4,140 | 940 | 4,199 | 9,279 | 9,661 |
| 2025 | 4,399 | 987 | 4,501 | 9,887 | 10,310 |
| 2026 | 4,675 | 1,037 | 4,824 | 10,536 | 11,002 |
| 2027 | 4,973 | 1,091 | 5,173 | 11,237 | 11,749 |
| 2028 | 5,291 | 1,149 | 5,545 | 11,984 | 12,547 |
| 2029 | 5,635 | 1,212 | 5,948 | 12,795 | 13,411 |
| 2030 | 5,998 | 1,277 | 6,373 | 13,648 | 14,321 |
| 2031 | 6,380 | 1,347 | 6,819 | 14,546 | 15,279 |
| 2032 | 6,781 | 1,419 | 7,288 | 15,488 | 16,284 |
| 2033 | 7,202 | 1,496 | 7,781 | 16,478 | 17,340 |
| 2034 | 7,636 | 1,575 | 8,288 | 17,499 | 18,428 |
| 2035 | 8,081 | 1,656 | 8,810 | 18,547 | 19,547 |
| 2036 | 8,554 | 1,741 | 9,363 | 19,659 | 20,732 |
| 2037 | 9,056 | 1,832 | 9,950 | 20,838 | 21,990 |
| 2038 | 9,587 | 1,929 | 10,572 | 22,088 | 23,324 |
| 2039 | 10,151 | 2,031 | 11,232 | 23,414 | 24,738 |
| 2040 | 10,749 | 2,140 | 11,931 | 24,820 | 26,238 |
| 2041 | 11,383 | 2,255 | 12,673 | 26,312 | 27,829 |
| 2042 | 12,056 | 2,377 | 13,460 | 27,893 | 29,515 |
| 2043 | 12,769 | 2,506 | 14,295 | 29,570 | 31,305 |
| 2044 | 13,526 | 2,644 | 15,180 | 31,349 | 33,202 |

**Source:** PSMP 2020 Update Team Compilation.




**Source:** PSMP 2020 Update Team Compilation

**Figure 2-7:** Econometric Sales Forecast – Sum of Three Categories versus Total

**Table 2-18** shows further results of the econometric approach as a trend of electricity share per customer tariff category. It is expected that the projections of electricity tariff decrease will stimulate the increase in electricity consumption of T2 and T3 customer categories and facilitate Tanzania to become a middle-income country. Notwithstanding, a significant contribution of the T1 category in overall sales, its share is gradually declining, reaching 43.15 percent in 2044 from the highest share observed in 2019. Similarly, T2 share shows a declining trend reflecting graduation of the T2 category into the T3 category (agriculture and Industry). Conversely, T3 categories, shows an increasing trend from 43.01 percent in 2019 to 48.42 percent, surpassing the T1 category. The increase in T3 sales is despite their lower share in the early years of projections. T3 Sales increased mainly on account of the expected increase and expansion of industrial and mining activities.

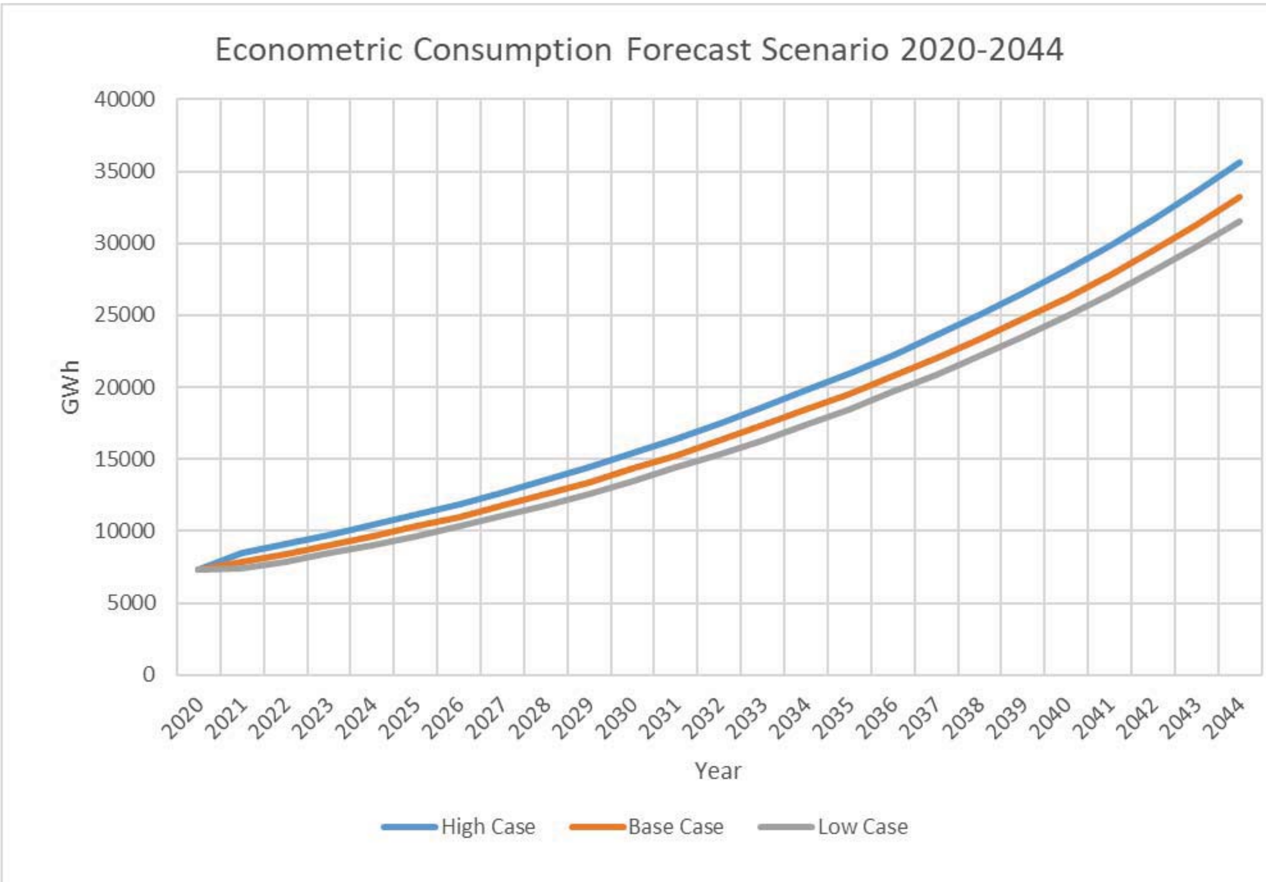
Table 2-18: Trend of Electricity Share per Customer Tariff Category in Percentage

| Year | T1 (%) | T2 (%) | T3 (%) |
|---|---|---|---|
| 2019 | 46.03 | 10.96 | 43.01 |
| 2020 | 45.66 | 10.77 | 43.57 |
| 2021 | 45.33 | 10.60 | 44.07 |
| 2022 | 45.03 | 10.44 | 44.52 |
| 2023 | 44.76 | 10.29 | 44.95 |
| 2024 | 44.62 | 10.13 | 45.25 |
| 2025 | 44.49 | 9.98 | 45.53 |
| 2026 | 44.37 | 9.84 | 45.79 |
| 2027 | 44.25 | 9.71 | 46.04 |
| 2028 | 44.15 | 9.59 | 46.27 |
| 2029 | 44.04 | 9.47 | 46.49 |
| 2030 | 43.95 | 9.36 | 46.69 |
| 2031 | 43.86 | 9.26 | 46.88 |
| 2032 | 43.78 | 9.16 | 47.06 |
| 2033 | 43.70 | 9.08 | 47.22 |
| 2034 | 43.64 | 9.00 | 47.37 |
| 2035 | 43.57 | 8.93 | 47.50 |
| 2036 | 43.51 | 8.86 | 47.63 |
| 2037 | 43.46 | 8.79 | 47.75 |
| 2038 | 43.41 | 8.73 | 47.86 |
| 2039 | 43.36 | 8.68 | 47.97 |
| 2040 | 43.31 | 8.62 | 48.07 |
| 2041 | 43.26 | 8.57 | 48.17 |
| 2042 | 43.22 | 8.52 | 48.26 |
| 2043 | 43.18 | 8.48 | 48.34 |
| 2044 | 43.15 | 8.43 | 48.42 |

**Source:** PSMP 2020 Update Team Compilation.

### 2.11. Sensitivity Analysis

The uncertainties are commonly inherent in the forecast. Therefore, it is prudent to consider the load forecast results as a band of probable loads above and below a base forecast as opposed to a single value for each year. A range of values for various components of GDP have been used to derive the forecast band using econometric principles. **Figure 2-8** illustrates the load forecasts for each set of assumptions. The graphs suggest that the low scenario grows about 1 percentage point less on average than the base case. Conversely, the high scenario grows at a 1.1 percentage point faster than the base case.




**Source:** PSMP 2020 Update Team Compilation

**Figure 2-8:** Econometrics Forecast Scenarios

### 2.12. Comparison of Load Forecast - Trend Line vs. Econometric Analyses

**Table 2-19** provides a comparison of the forecast results obtained using an econometric and trend line analyses, respectively. The two forecasting methods gave comparable forecast results that exhibit a similar trend.

The table also shows that from 2022 the trend analysis approach projects relatively higher sales (GWh) forecasts than the counterpart econometric approach. As shown in **Figure 2-9**, the annual sales growth rates under the trend approach grows at a sustainable rate necessary to achieve the overall objective of connecting 96.1 percent of the population by 2044. As such, the growth in electricity using the trend line approach averages 11.3 percent per annum while the growth using the econometric approach lag behind and averages 6.5 percent per annum.

The differences in the forecast results are primarily because of inclusion of the new industrial loads and the rural electrification initiative under the trend analysis. Furthermore, the trend line considers the government efforts to reduce electricity losses from 16.19 percent in 2019 to 12 percent by 2026. The interventions echo the Government industrialization drive and its desire to attain the status of a middle-income country.

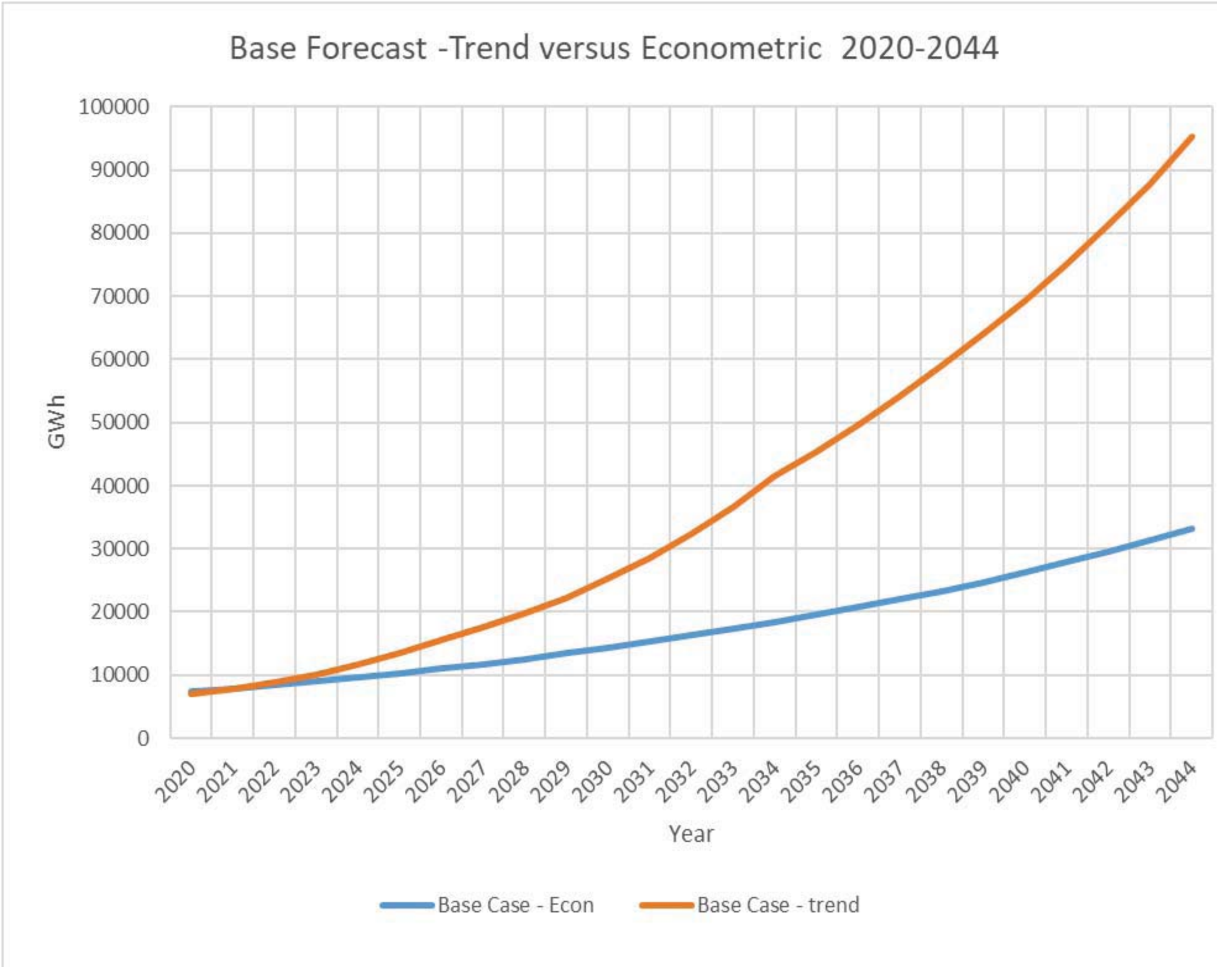
In contrast, the econometric analysis excluded the two exogenous variables. Furthermore, the trend analysis assumes that the past trend will repeat, implying that economic variables such as real GDP and electricity sales will behave the same way in the future.

Without such interventions under the trend line approach, the two approaches used in forecasting electricity would primarily suggest comparable forecast results.

**Table 2-19:** Energy Sales Forecast Comparison: Econometric Vs. Trend (in GWh)

| Year | Econometric | Trend | Difference (Econometric Vs Trend) | Difference (Percent) |
|---|---|---|---|---|
| 2020 | 7,358.04 | 7,081.00 | -277.04 | -3.77 |
| 2025 | 10,309.81 | 13,538.00 | 3,228.19 | 31.31 |
| 2030 | 14,321.30 | 25,294.00 | 10,972.70 | 76.62 |
| 2035 | 19,546.57 | 45,410.00 | 25,863.43 | 132.32 |
| 2040 | 26,237.85 | 69,388.00 | 43,150.15 | 164.46 |
| 2044 | 33,201.79 | 95,225.00 | 62,023.21 | 186.81 |

**Source:** PSMP 2020 Update Team Compilation.




**Source:** PSMP 2020 Update Team Compilation

**Figure 2-9:** Base Forecast – Trend versus Econometric Analysis 2020-2024

# CHAPTER 3

## 3. POWER GENERATION PLANNING

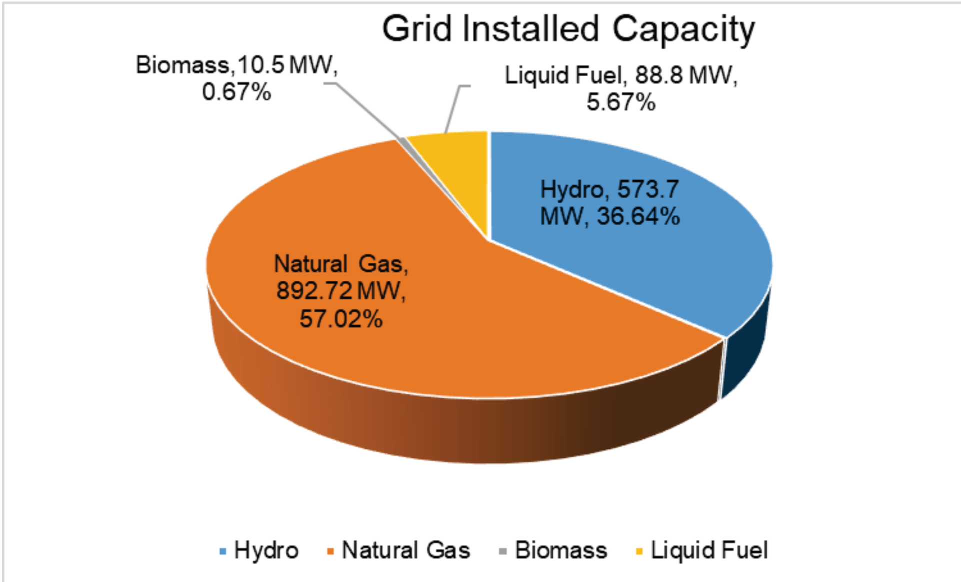
### 3.1. Introduction

This Chapter provides a comprehensive idea about generation systems and various planning strategies in general and the specific factors considered during power generation planning. Generation plan uses results from load forecast as criteria to determine the new capacity of generation required to meet the load demand. The power generation planning study first considers expanding the existing system, where feasible before planning for the future addition in the power generation system.

A comprehensive generation plan will enhance the security of power supply through the effective use of available energy resources in the country. The Plan considers various indigenous resources, including natural gas, coal, hydro and renewables (Geothermal, Wind and Solar). However, nuclear resources will be considered in future Plans.

### 3.2. Existing Generation system

Total installed capacity in the country is 1,602.32 MW which comprises of interconnected Grid System (1,565.72 MW) and isolated Grid System (36.60 MW). The National Grid System comprises of hydro and thermal generation units owned by TANESCO and IPP's with total capacity of 1,565.72 MW (base year 2019) out of which hydro 573.70 MW (36.64%), natural gas 892.72 MW (57.02%), liquid fuel, 88.80 MW (5.67%) and biomass 10.50 MW (0.67%) as provided in **Figure 3-1**. The highest system Maximum Demand (MD) recorded was 1,120.12 MW reached on 30$^{th}$ November 2019, which is a base year for this study. However, during the preparation of the Plan, the highest system Maximum Demand recorded was 1,151.66 MW on 27$^{th}$ February 2020.




**Source:** PSMP 2020 Update Team Compilation

**Figure 3-1:** Current Generation Mix

### 3.3. Existing Generation Plants

#### 3.3.1. Hydropower Generation Plants

##### 3.3.1.1. Hydroelectric Plants

Tanzania National Grid has 13 existing hydroelectric power plants with total installed capacity 573.7 MW **Table 3-1** shows the corresponding firm and average energy of the hydropower plants.

**Table 3-1:** Existing Hydropower Plants

| S/N | Plant Name | Capacity (MW) | Average Energy (GWh) | Firm Energy (GWh) | Year Installed | Age in 2020 (Years) |
|---|---|---|---|---|---|---|
| 1 . | Mtera | 80.00 | 429.0 | 195 | 1988 | 33 |
| 2 . | Kidatu | 204.00 | 1,111.0 | 601 | 1975 | 46 |
| 3 . | Hale | 21.00 | 93.0 | 55 | 1967 | 54 |
| 4 . | Kihansi | 180.00 | 694.0 | 492 | 2000 | 21 |
| 5 . | New Pangani Falls | 68.00 | 341.0 | 201 | 1995 | 26 |
| 6 . | Nyumba ya Mungu | 8.00 | 36.0 | 20 | 1968 | 53 |
| 7 . | Uwemba | 0.84 | 7.3 | 2.3 | 1991 | 30 |
| 8 . | Mwenga | 4.00 | 24.0 | 6 | 2012 | 9 |
| 9 . | Yovi | 0.95 | 8.3 | 8.3 | 2012 | 9 |
| 10 . | Matembwe | 0.59 | 0.4 | 0.565 | 2015 | 6 |
| 11 . | Darakuta | 0.32 | 0.2 | 0.315 | 2013 | 8 |
| 12 . | Andoya | 1.00 | 5.2 | 5.913 | 2015 | 6 |
| 13 . | Tulila | 5.00 | 30.0 | 6.176 | 2015 | 6 |
| | **TOTAL** | **573.70** | **2,779.6** | **1,593.6** | | |

**Source:** PSMP 2020 Update Team Compilation.

#### 3.3.1.2. Characteristics of Hydropower Plants

Tanzania hydropower generation plants are in two groups namely: large Scale (above 10 MW) and small scale (below 10 MW). These categories consist of a reservoir and run-off river type, as shown in **Table 3-2** and **Table 3-3**. The Government owns the major hydropower plants through TANESCO, while the private sector (IPPs) owns the small power plants.

**Table 3-2:** Characteristics of the Existing Large Hydropower Plants

| CHARACTERISTICS \ PROJECT NAME | Mtera | Kidatu | Nyumba ya Mungu | Hale | New Pangani Falls | Lower Kihansi |
|---|---|---|---|---|---|---|
| Owner | TANESCO | TANESCO | TANESCO | TANESCO | TANESCO | TANESCO |
| Location | Iringa | Morogoro | Kilimanjaro | Tanga | Tanga | Morogoro |
| Type | Reservoir | Reservoir | Reservoir | Run-off river | Run-off river | Run-off river |
| Max. supply level (m.a.s.l.) | 698.50 | 450.00 | 688.91 | 342.44 | 177.50 | 1,146.00 |
| Min. supply level (m.a.s.l.) | 690.00 | 433.00 | 679.15 | 342.44 | 176.00 | 1,141.00 |
| Recommended min. operational level (m.a.s.l.) | 690.00 | 437.00 | 683.76 | N/A | 176.50 | 1,143.00 |
| Storage vol. at max. level (mill. $m^3$) | 3,750.00 | 167.00 | 1,118.11 | 0.00 | 1.31 | 1.62 |
| Storage vol. at min. level (mill. $m^3$) | 563.00 | 40.00 | 246.71 | 0.00 | 0.50 | 0.62 |
| Active storage volume (mill. $m^3$) | 3,200.00 | 125.00 | 600.00 | 0.00 | 0.80 | 1.00 |
| Surface area at max. vol. ($km^2$) | 604.96 | 9.62 | 148.52 | 0.00 | 0.75 | 0.27 |
| Gross head at max. level (m) | 101.0 (Francis) | 175.0 (Francis) | 25.2 (Francis) | 70.0 (Francis) | 169.7 (Francis) | 852.75 (Pelton) |
| Gross head at min. level (m) | 92.00 | 160.00 | 20.60 | 70.00 | 168.00 | 847.75 |
| Energy equivalent ($kWH/m^3$) | 0.23 | 0.42 | 0.05 | 0.13 | 0.42 | 2.06 |
| Firm energy generation (GWh) | 195.00 | 601.00 | 20.00 | 55.00 | 201.00 | 492.00 |
| Average energy (GWh) | 429.00 | 1,111.00 | 35.00 | 93.00 | 341.00 | 694.00 |
| Avg. generation for each $m^3/s$ ($MW/(m^3/s)$ | 0.85 | 1.50 | 0.20 | 0.50 | 1.50 | 7.40 |
| Rated turbine discharge (total plant) ($m^3/s$) | 96.00 | 140.00 | 42.50 | 45.00 | 45.00 | 23.76 |

**Table 3-3:** Characteristics of the Existing Small Hydropower Plants

| CHARACTERISTICS \ PROJECT NAME | Mwenga | Tulila | Andoya | Darakuta | Madope | Yovi | Ikondo | Matembwe | Diwale | Kikuletwa | Uwemba | Tosamaganga |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Owner | IPP | IPP | IPP | IPP | IPP | IPP | IPP | IPP | IPP | IPP | TANESCO | TANESCO |
| Location | Iringa | Ruvuma | Ruvuma | Manyara | Njombe | Morogoro | Njombe | Njombe | Morogoro | Kilimanjaro | Njombe | Iringa |
| Type | Run-off river | Run-off river | Run-off river | Run-off river | | Run-off river | Run-off River | | Run-off River | Run-off River | Run-off River | Run-off River |
| Max. supply level (m.a.s.l.) | 1,127.00 | 747.50 | N/A | N/A | N/A | 1,225.01 | N/A | 1,489.50 | 1,462.00 | N/A | N/A | N/A |
| Min. supply level (m.a.s.l.) | 1,127.00 | 746.50 | N/A | N/A | N/A | 1,224.30 | N/A | 1,480.00 | 1,460.00 | N/A | N/A | N/A |
| Recommended min. operational level (m.a.s.l.) | 1,127.00 | 746.50 | N/A | N/A | N/A | N/A | N/A | N/A | | N/A | N/A | N/A |
| Storage vol. at max. level (mill. $m^3$) | 0.00 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Storage vol. at min. level (mill. $m^3$) | 0.00 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Active storage volume (mill. $m^3$) | N/A - Run of River | 0.60 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Surface area at max. vol. ($km^2$) | 0.00 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Gross head at max. level (m) | 62.00 | 7.5 (Kaplan) | 36 (Fransis) | N/A | N/A | 357.30 | N/A | N/A | N/A | N/A | N/A | 41.00 |
| Gross head at min. level (m) | 58.50 | 22.50 | 36.00 | N/A | N/A | 357.30 | N/A | 10.00 | 40.00 | 14.50 | N/A | 40.00 |
| Energy equivalent ($kWH/m^3$) | N/A - Run of River | N/A | N/A | N/A | N/A | 2,763.00 | N/A | N/A | N/A | N/A | N/A | 1.18 |
| Firm energy generation (GWh) | 6.00 | 6.18 | 5.91 | 0.32 | N/A | 8.30 | N/A | 0.57 | 16.60 | N/A | N/A | 0.10 |
| Average energy (GWh) | 24.00 | 30.00 | 5.25 | 0.20 | N/A | 8.30 | N/A | 0.40 | N/A | N/A | 7.30 | 0.12 |
| Avg. generation for each $m^3/s$ ($MW/(m^3/s)$ | 0.50 | 0.19 | 0.28 | N/A | N/A | 2.76 | N/A | N/A | N/A | N/A | N/A | 0.22 |
| Rated turbine discharge (total plant) ($m^3/s$) | 8.00 | 26.60 | 3.60 | N/A | N/A | 0.36 | 4.30 | N/A | 10.00 | 12.00 | N/A | 22.74 |

**Sources:**

1. Small Hydro Mapping Report, “Renewable Energy Resource Mapping: Small Hydro – Tanzania” (2018) – REA/ the World Bank.
2. World Small Hydropower Development Report, UNIDO (2016).
3. Review of studies conducted for the potential sites.
4. Team survey to the potential sites, data collection and compilation, (2019).
5. PSMP 2020 Update Team Compilation.

### 3.3.2. Thermal Power Plants and their Characteristics

**Table 3-4** shows that there are 19 thermal power plants in the National Grid System. These plants and their types of fossil fuel consists of eight (8) gas-fired plants, two (2) are biomass plants, seven (7) diesel-fired plants, one (1) industrial diesel oil (IDO) plant and one (1) Heavy Fuel Oil (HFO) plant. TANESCO's Diesel, IDO and HFO plants which are connected to the National Grid, currently operate as a reserve capacity.

The average economic life of thermal power plants is twenty-five (25) years. Through proper maintenance and interim replacement of major parts, the plant's economic life may reach about 30 years.

**Table 3-4:** Existing Thermal Power Plants

| Plant | Technology | Fuel | Units | Installed Capacity (MW) | Available Capacity (MW) | Station Service (%) | Net Available Capacity (MW) | FOR (%) | Combined Outage Rate (%) | Maximum Plant Factor (%) | Available Energy (GWh) | Year Installed | Nominal Service Life Years | Retirement Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **IPP UNITS** | | | | | | | | | | | | | | |
| TANWAT | STG | Bagasse | 1 | 1.5 | 1.0 | 2.0 | 1.5 | 5.0 | 13.0 | 50.0 | 6.1 | 2010 | 20 | 2030 |
| TPC | STG | Bagasse | 1 | 9.0 | 7.0 | 2.0 | 8.8 | 5.0 | 13.0 | 50.0 | 36.7 | 2011 | 20 | 2031 |
| **Subtotal** | | | | **10.5** | **8.0** | | **10.3** | | | | **42.8** | | | |
| **TANESCO UNITS** | | | | | | | | | | | | | | |
| Ubungo I | GE | Gas | 10 | 102.0 | 80.0 | 2.0 | 100.0 | 5.0 | 13.0 | 80.0 | 665.5 | 2007 | 20 | 2027 |
| Songas | GT | Gas | 6 | 189.0 | 189.0 | 2.0 | 185.2 | 5.0 | 13.0 | 80.0 | 1,233.1 | 2006 | 20 | 2026 |
| Ubungo II | GT | Gas | 3 | 129.0 | 86.0 | 2.0 | 126.4 | 5.0 | 13.0 | 80.0 | 841.7 | 2011 | 25 | 2036 |
| Kinyerezi I | GT | Gas | 4 | 150.0 | 105.0 | 2.0 | 147.0 | 5.0 | 13.0 | 80.0 | 978.7 | 2015 | 25 | 2040 |
| Kinyerezi II | GT | Gas | 8 | 248.2 | 203.0 | 2.0 | 243.3 | 5.0 | 13.0 | 80.0 | 1,619.5 | 2018 | 25 | 2043 |
| Tegeta | GE | Gas | 5 | 45.0 | 30.0 | 2.0 | 44.1 | 5.0 | 13.0 | 80.0 | 293.6 | 2009 | 20 | 2029 |
| Mtwara I | GE | Gas | 9 | 18.0 | 8.0 | 2.0 | 17.6 | 5.0 | 13.0 | 80.0 | 117.4 | 2007 | 20 | 2027 |
| Mtwara II | GE | Gas | 2 | 4.0 | 8.0 | 2.0 | 3.9 | 5.0 | 13.0 | 80.0 | 26.1 | 2017 | 20 | 2037 |
| Somanga | GE | Gas | 3 | 7.5 | 7.5 | 2.0 | 7.4 | 5.0 | 13.0 | 80.0 | 48.9 | 2010 | 20 | 2030 |
| **Subtotal** | | | | **892.7** | **716.5** | | **874.9** | | | | **5,824.5** | | | |
| **TANESCO Reserve Capacity - Grid Connected** | | | | | | | | | | | | | | |
| Biharamulo | DG | Diesel | 5 | 4.1 | n/a | 2.0 | 4.1 | 8.0 | 18.0 | 75.0 | 24.5 | 2015 | 20 | 2035 |
| Zuzu | DG | Diesel | 3 | 7.4 | 6.4 | 2.0 | 7.3 | 8.0 | 18.0 | 75.0 | 43.8 | 1980 | 20 | 2000 |
| Nyakato | DG | HFO | 10 | 63.0 | 36.0 | 2.0 | 61.7 | 8.0 | 18.0 | 75.0 | 373.2 | 2013 | 20 | 2033 |
| Songea | DG | Diesel | 3 | 7.7 | n/a | 2.0 | 7.5 | 8.0 | 18.0 | 75.0 | 45.4 | 2005 | 20 | 2025 |
| Ludewa | DG | Diesel | 3 | 1.3 | n/a | 2.0 | 1.2 | 8.0 | 18.0 | 75.0 | 7.5 | 2010 | 20 | 2030 |
| Mbinga | DG | Diesel | 2 | 2.0 | n/a | 2.0 | 2.0 | 8.0 | 18.0 | 75.0 | 11.8 | 2007 | 20 | 2027 |
| Madaba | DG | Diesel | 1 | 0.5 | n/a | 2.0 | 0.5 | 8.0 | 18.0 | 75.0 | 2.8 | 2010 | 20 | 2030 |
| Namtumbo | DG | Diesel | 1 | 0.3 | n/a | 2.0 | 0.3 | 8.0 | 18.0 | 75.0 | 2.0 | 2012 | 20 | 2032 |
| Ngara | DG | Diesel | 2 | 2.5 | n/a | 2.0 | 2.5 | 8.0 | 18.0 | 75.0 | 14.8 | 2015 | 20 | 2035 |
| **Subtotal** | | | | **88.8** | | | **87.0** | | | | **526.0** | | | |
| **TOTAL ON GRID** | | | | **992.0** | | | **972.2** | | | | **6,393.3** | | | |
| **Off-Grid** | | | | | | | | | | | | | | |
| Mafia | DG | Diesel | 4 | 3.0 | 2.4 | 2.0 | 2.9 | 8.0 | 18.0 | 75.0 | 17.8 | 1970 | 20 | 1990 |
| Mpanda | DG | Diesel | 5 | 5.4 | 3.8 | 2.0 | 5.3 | 8.0 | 18.0 | 75.0 | 32.0 | 1992 | 20 | 2012 |
| Kigoma | DG | Diesel | 7 | 8.3 | 6.3 | 2.0 | 8.1 | 8.0 | 18.0 | 75.0 | 48.9 | 2010 | 20 | 2030 |
| Inyonga | DG | Diesel | 3 | 1.6 | n/a | 2.0 | 1.6 | 8.0 | 18.0 | 75.0 | 9.7 | N/A | N/A | N/A* |
| Kasulu | DG | Diesel | 2 | 2.5 | 2.5 | 2.0 | 2.5 | 8.0 | 18.0 | 75.0 | 14.8 | 2011 | 20 | 2031 |
| Bukoba | DG | Diesel | 4 | 2.6 | 2.2 | 2.0 | 2.5 | 8.0 | 18.0 | 75.0 | 15.2 | 1991 | 20 | 2011 |
| Sumbawanga | DG | Diesel | 4 | 5.0 | 5.0 | 2.0 | 4.9 | 8.0 | 18.0 | 75.0 | 29.6 | 2011 | 20 | 2031 |
| Loliondo | DG | Diesel | 4 | 3.8 | 2.5 | 2.0 | 3.7 | 8.0 | 18.0 | 75.0 | 22.2 | 2012 | 20 | 2032 |
| Tunduru | DG | Diesel | 4 | 2.1 | n/a | 2.0 | 2.0 | 8.0 | 18.0 | 75.0 | 12.2 | 1991 | 20 | 2011 |
| Liwale | DG | Diesel | 2 | 0.8 | n/a | 2.0 | 0.8 | 8.0 | 18.0 | 75.0 | 5.0 | 2013 | 20 | 2033 |
| Kibondo | DG | Diesel | 2 | 2.5 | 2.5 | 2.0 | 2.5 | 8.0 | 18.0 | 75.0 | 14.8 | 2010 | 20 | 2030 |
| **Subtotal (off grid)** | | | | **37.5** | | | **36.8** | | | | **222.2** | | | |
| **Grand Total** | | | | **1,029.5** | | | **1,008.9** | | | | **6,615.5** | | | |

**Source:** PSMP 2020 Update Team Compilation.

### 3.4. Existing Plants Retirement

In the scheduling of new generation plants, existing generating units were assumed to be retired at the end of their usual "economic" service life or end of plant contract. The hydroelectric plants, however, were assumed to remain in service throughout the planning period. The plants include Hale and Nyumba ya Mungu power plants which will undergo rehabilitation before 2022. Upon completion of rehabilitation, the plant life span will be extended, depending on the manufacturer's guidelines of each new component installed. Thus, these plants will not be retired after their normal economic service life. The economic life of power plants in **Table 3-5** will be re-estimated after major maintenance made based on the manufacturers' guidelines.

**Table 3-5:** Existing Plants Retirement Dates

| Plant Name | Nominal Capacity (MW) | Normal Service Life (years) | Year Installed | Retirement Year |
|---|---|---|---|---|
| **HYDRO** | | | | |
| Mtera | 80 | 50 | 1988 | 2038 |
| Kidatu | 204 | 50 | 1975 | 2025 |
| Hale | 21 | 50 | 1967 | 2017 |
| Kihansi | 180 | 50 | 2000 | 2050 |
| New Pangani Falls | 68 | 50 | 1995 | 2045 |
| Nyumba ya Mungu | 8 | 50 | 1968 | 2018 |
| Mwenga | 4 | 15 | 2012 | 2027 |
| Uwemba | 0.843 | 50 | 1991 | 2041 |
| Yovi | 0.95 | 15 | 2016 | 2031 |
| Tulila | 5 | 20 | 2015 | 2035 |
| Matembwe | 0.59 | 10 | 2016 | 2026 |
| Darakuta | 0.32 | 20 | 2013 | 2033 |
| Andoya | 1 | 10 | 2015 | 2025 |
| **THERMAL** | | | | |
| Songas | 189 | 20 | 2006 | 2026 |
| Tegeta Gas Engine | 45 | 20 | 2009 | 2029 |
| Ubungo I | 102 | 20 | 2008 | 2028 |
| Ubungo II | 105 | 20 | 2012 | 2032 |
| Kinyerezi I | 150 | 25 | 2015 | 2040 |
| Kinyerezi II | 248.22 | 25 | 2018 | 2043 |
| Mtwara I | 18.00 | 20 | 2007 | 2027 |
| Mtwara II | 4.00 | 20 | 2010 | 2030 |
| Somanga | 7.50 | 20 | 2010 | 2030 |
| Zuzu Diesel | 7.44 | 20 | 1980 | 2000 |
| Nyakato | 63 | 20 | 2013 | 2033 |
| Biharamulo | 4.14 | 20 | 2015 | 2035 |
| Songea | 7.67 | 20 | 2005 | 2025 |
| Inyonga | 1.636 | N/A | N/A | N/A |
| Ludewa | 1.27 | 20 | 2010 | 2030 |
| Mbinga | 2 | 20 | 2007 | 2027 |
| Ngara | 2.5 | 20 | 2015 | 2035 |
| TANWAT | 2.7 | 20 | 2010 | 2030 |
| TPC | 17 | 20 | 2011 | 2031 |

**Note:**

1. Rehabilitation of power plants (Thermal & Hydro) extends the life span by 50% to 80%.
2. Inyonga capacity (1.636 MW) comprises of original Inyonga Units (0.816 MW) and transferred units from Namtumbo (0.34 MW) and Madaba (0.48 MW).
3. N/A – Not Accessible.

**Source:** PSMP 2020 Update Team Compilation.

### 3.5. Power Generation Resources

#### 3.5.1. Hydropower

Tanzania has abundant potentials of hydropower because its inland area is above sea level with precipitous rivers. Various studies, including feasibility studies, project proposals and consultation with project developers on hydropower potential in Tanzania, have been carried out over a long period. The reviewed studies revealed an increase of the potential hydropower capacity from 4,700 MW in 2012 to 7,491.2 MW in 2020 equivalent to an energy of 41,172 GWh and 65,622.91 GWh respectively. **Table 3-6** shows the capacity of hydroelectric power potential available in Tanzania. The Map showing river basins available in Tanzania is shown in **Appendix II**.

**Table 3-6:** Hydropower Potential in Tanzania

| Range of Capacity (MW) | Total Range Capacity (MW) | Percentage (%) | Number of Potential Sites |
|---|---|---|---|
| 0 – 9 | 602.31 | 8.0 | 450 |
| 10 – 49 | 396.6 | 5.3 | 22 |
| 50 – 199 | 2,453.3 | 32.7 | 21 |
| 200 – 500 | 1,924.0 | 25.7 | 7 |
| 500 and above | 2,115.0 | 28.2 | 1 |
| **Total** | **7,491.2** | **100** | **501** |

**Source:**

1. Small Hydro Mapping Report, "Renewable Energy Resource Mapping: Small Hydro – Tanzania" (2018) – REA/ the World Bank.
2. World Small Hydropower Development Report, UNIDO (2016).
3. Review of studies conducted for the potential sites.
4. Team survey to the potential sites, data collection, and compilation, (2019).

##### 3.5.1.1. Tanzania Hydrological System

In order to consider one or more hydroelectric power development options, it is imperative to have a clear assessment of the hydrology and hydroelectric power system capabilities. Historical river flow records spanning at least 30 years enables the determination of the capability of power generation of a hydroelectric system.

This study infers the studies of the ongoing hydroelectric power projects, datasets developed during the previous Power System Master Plans, following an intensive review and analysis of datasets.

Hydrological characteristics of the rivers flowing into resevoirs of existing and potential large hydropower plants is shown in **Table 3-7** and **Table 3-8** respectively with details of the gauging stations used for hydrological data collection.

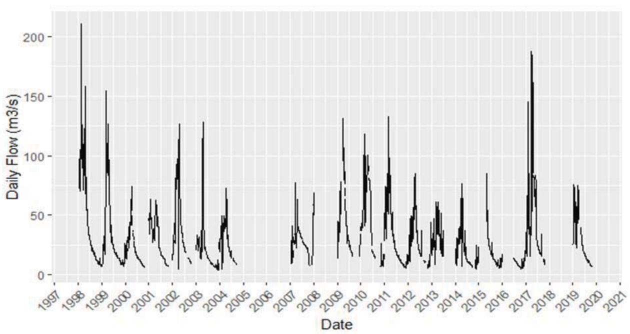
**Table 3-7:** Details of the Gauging Stations for Hydrological Data Monitoring for Existing Hydropower Plants

| PLANT | GAUGING STATION(s) | START | FLOW ($m^3/s$) | | | REMARKS |
|---|---|---|---|---|---|---|
| | | (Year) | Max | Min | Mean | |
| Nyumba ya Mungu | Kikuletwa River at TPC (1DD1) | 1959 | 247.2 | 3.86 | 10.32 | Very high flow variability |
| | Ruvu River at Kifaru (1DC2A) | 1959 | 58.55 | 1.2 | 5.09 | High flow variability |
| Hale/Pangani | Pangani River at Korogwe(1D14) | | | | | No current data available |
| | Pangani River at Mnyuzi (1D17A) | 1967 | 157.7 | 0.78 | 20.63 | Very high flow variability, with very low flows during dry seasons |
| | Luengera River at Korogwe(1DA1) | | | | | No current data available |
| Mtera | Kizigo River at Chinugulu | 1957 | 1805 | 0 | 34.33 | High flows Dec -April,low flows Jul -Oct, experiences dry spells of zero flow |
| | Little Ruaha River at Mawande(1KA31) | 1957 | 190.7 | 1.84 | 20.65 | High flows Dec -April, low flows Jul -Oct with No zeros |
| | Great Ruaha River at Msembe (1KA59) | 1963 | 1397 | 0 | 42.6 | High flows Mar-May, low Aug-Nov , with some years of zero flows |
| Kidatu | Great Ruaha River at Msosa (1KA5) | | | | | No current data available |
| | Yovi River at Confluence (1KA38A) | | | | | No current data available |
| | Lukose River at Mtandika (1KA37) | 1957 | 375.6 | 0 | 61.2 | High variations of flow with dry spells |
| Kihansi | Kihansi River at Lutaki (1KB32) | 1984 | 90.52 | 1.15 | 15.66 | High flow variability |

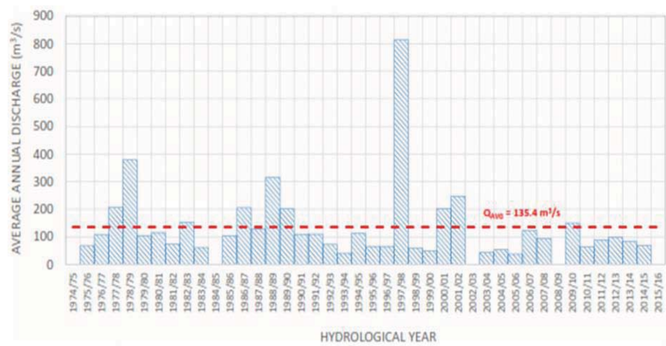
**Table 3-8:** Details of the Gauging Stations for Hydrological Data Monitoring for Planned Hydropower Plants

| PROJECT | GAUGING STATION(s) | START (Year) | Flow ($m^3/s$) | | | REMARKS |
|---|---|---|---|---|---|---|
| | | | Max | Min | Mean | |
| Julius Nyerere | Rufiji River at Stieglers Gorge(1K3B) | 1960-80, 2018 | 2211 | 500 | 902 | High variations of flow, data was extended using model to cover the missing period from 1980 - 2016 |
| Malagarasi | Malagarasi River at Mbelagure(4A9) | 1956 | 800 | 17.2 | 135.4 | High flows Feb-Jun, low flows Sep-Nov, no record of zero flows |
| Kakono | Kagera River at Pumping Station | 2013 | 500.2 | 100 | 213 | Minor variations of flow |
| Ruhudji | Ruhudji River at Itipula (NC2) | 1998 | 210.5 | 3.78 | 30.82 | High variations of flow between wet and dry sasons |
| Rumakali | Rumakali River at Mwakauta(1RC11A) | 1994 | 67.4 | 1 | 8.22 | High variations of flow between wet and dry sasons |
| Masigira | Ruhuhu River at Masigira(1RB2) | 1971 | 228.1 | 5.28 | 31.9 | High variations of flow between wet and dry sasons |
| Kikonge | Kikonge (1RB3) | 1971-73,1991 | 1332 | 22.6 | 178.1 | Good Hydrology, minor flow vaiations |
| Mpanga | Mpanga River at Mpanga Mission(1KB8) | 1955 | 92.45 | 9.56 | 30.6 | Moderate variations of flow |
| Mnyera | Mnyera River at Taveta | | | | | No current data available |
| Songwe | Songwe River at Kasumulu(1RD1) | | | | | No current data available |

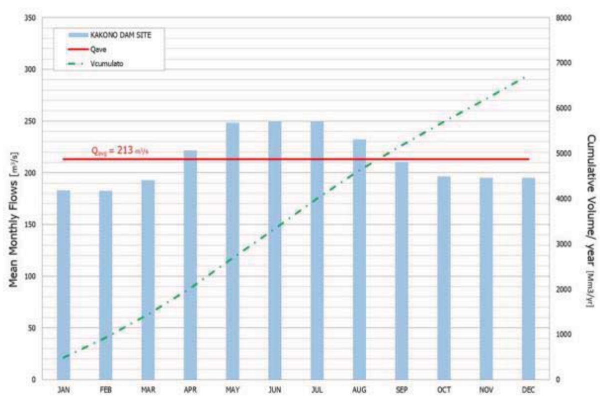
**Source:** PSMP 2020 Update Team Compilation.




a) Ruhudji

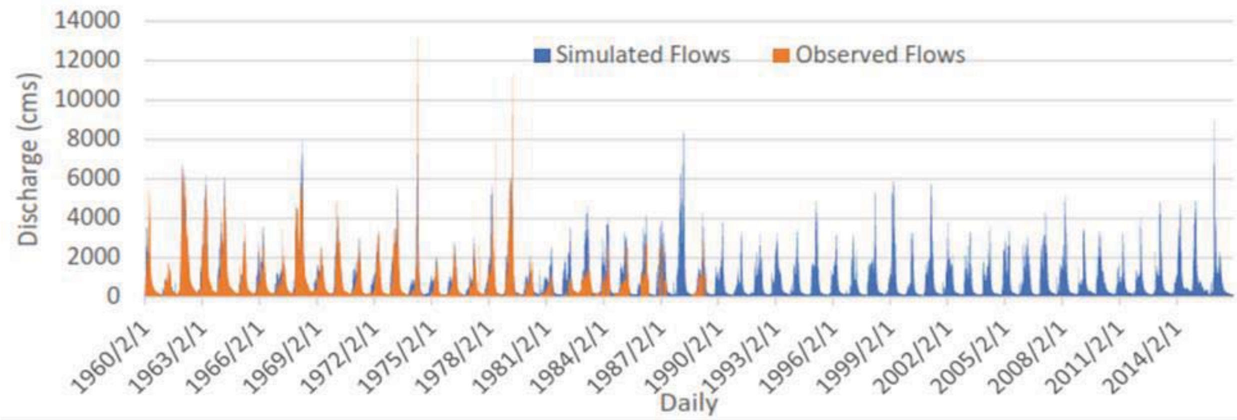



b) Malagarasi




c) Kakono


d) Kikonge




e) Julius Nyerere

**Figure 3-2 (a) – (e):** Discharge Variations of Selected Hydropower Potential Sites

#### 3.5.2.Thermal Resources

Tanzania is endowed with huge potential thermal resources, including natural gas, coal and biomass. The Plan considers these resources as a fuel for power generation during planning period. However, this plan considers power generating plants operated by imported fuel such as Industrial Diesel Oil (IDO), Diesel Oil and Heavy Fuel Oil (HFO) as reserve capacity due to high operation and maintenance costs.

**(i) Natural Gas**

Tanzania has a significant amount of natural gas reserves of 57.54 TCF. According to the Natural Gas Utilization Master Plan (NGUMP) 8.3 TCF out of 57.54 TCF is allocated for electricity generation. The allocated natural gas can generate approximately 7,094.02 MW (177.35 GWyr) using Combined Cycle Gas Turbine (CCGT) technology. **Table 3-9** shows the natural gas discoveries.

**Table 3-9:** Natural Gas Discoveries

| DISCOVERY BLOCK / LOCATION | YEAR DISCOVERED | CURRENT STATUS | GAS RESERVE PROVEN BY DECEMBER, 2018 - P50 (TCF) | RESOURCE - GIIP (TCF) |
|---|---|---|---|---|
| **Songosongo** | 1974 | Stated | 0.729 | 2.500 |
| **Mnazi Bay** | 1982 | Stated | 0.482 | 5.000 |
| **Kiliwani North** | 2008 | Stated - Gas production has been halted due to low reservoir pressure | | 0.070 |
| **Mkuranga** | 2007 | Not yet developed | | 0.200 |
| **Ntorya** | 2012 | Not yet developed | | 0.466 |
| **Mambakofi** | 2015 | Not yet developed | | 2.170 |
| **Total Gas Onshore** | | | | **10.406** |
| **Block 1** | 2011 | Not yet developed | | 0.470 |
| | 2012 | Not yet developed | | 3.530 |
| | 2012 | Not yet developed | | 8.500 |
| | 2013 | Not yet developed | | 0.600 |
| | 2014 | Not yet developed | | 1.100 |
| **Block 2** | 2013 | Not yet developed | | 6.000 |
| | 2012 | Not yet developed | | 5.000 |
| | 2013 | Not yet developed | | 5.400 |
| | 2013 | Not yet developed | | 2.500 |
| | 2014 | Not yet developed | | 3.000 |
| | 2014 | Not yet developed | | 1.700 |
| | 2015 | Not yet developed | | 1.800 |
| **Block 3** | 2012 | Not yet developed | | 2.000 |
| **Block 4** | 2010 | Not yet developed | | 1.800 |
| | 2010 | Not yet developed | | 1.900 |
| | 2013 | Not yet developed | | 0.800 |
| | 2014 | Not yet developed | | 1.030 |
| **Total Gas Deep Sea** | | | | **47.130** |
| **Total Gas in Deep Sea and Onshore** | | | | **57.536** |

**Source:** TPDC

### (ii) Coal

The coal demand in Tanzania has been growing mainly for industrial use, which drives the development of coal mining activities. According to reviewed studies, the coal reserves capacity has increased from 954.65 Mton in 2016 to 1,208 Mton in 2020, which is equivalent to 808.40 GWyr. The Songea Karoo belt in Southern Tanzania has the majority of discoveries of coal reserves in Tanzania. Coal fields exist in three regions of the country in Rukwa, Mbeya and the largest in Njombe as shown in **Table 3-10**. Intergrated Gasification Combined Cycle (IGCC) have been considered in the implementation of coal fired plants. IGCC plants use synthesis (syngas) to turn gas turbine to generate electricity. Syngas is obtained by converting coal through a process called gasification. Technically, IGCC are more efficient than Open Cycle Gas Turbine (OCGT) and environmentally friendly.

**Table 3-10:** Areas with Potential Coal Resource in Tanzania

| S/N | Coal Mine Name | Reserve (mil.t) |
|---|---|---|
| 1 . | Mchuchuma | 428 |
| 2 . | Katewaka | 100 |
| 3 . | Ngaka | 423 |
| 4 . | Kiwira (Ivogo Ridge) | 90 |
| 5 . | Mbeya | 109 |
| 6 . | Rukwa | 58 |
| **Total** | | **1,208** |

**Source:** STAMICO, NDC, PSMP 2016

### 3.5.3.Renewable Resources

The renewable resource available in Tanzania includes solar, wind, geothermal, biomass and tidal waves. Even though these resources have not yet been fully tapped for power generation, recently, the Government has been promoting investment in renewable energy projects in order to increase renewable energy share in power generation mix.

#### (i) Solar

During the development of this Plan, various studies on solar resources have been reviewed and indicated that the solar potential is estimated to be more than 670 MWp. The potential regions which are suitable for solar power generation have solar insolation ranging from 4.5 to 6.0 kWh per square meter per day about 10 hours from 0800hours to 1700hours. Some of these regions are Dodoma, Singida, Shinyanga, Iringa, Katavi, Rukwa, Tabora and Mara. The spatial distribution of annual solar radiation in Tanzania Map is shown in **Appendix III.**

#### (ii) Wind

Through various studies conducted in Tanzania revealed that the country has a potential of wind, which can generate more than 1,000 MW of power. The average wind speed in a day which can generate power ranges from 3 to 10 m/s as indicated in **Table 3 – 11.** Tanzania Wind Map is shown in **Appendix IV**.

**Table 3-11:** Wind Potential Sites in Tanzania

| S/N | Region | District | Average Wind Speed at 10m (m/s) | Average Wind Speed at 30m (m/s) |
|---|---|---|---|---|
| 1. | Singida | Singida (Kititimo) | 8.2 | 9.4 |
| 2. | Njombe | Njombe (Makambako) | 7.6 | 8.7 |
| 3. | Iringa | Mufindi (Usokami) | 7.5 | >7.5 |
| 4. | Kilimanjaro | Mwanga (Mgagao) | 3.75 | 4.85 |
| 5. | Tanga | Korogwe (Mkumbara) | 4.14 | 4.9 |
| 6. | Arusha | Karatu | 4.9 | 5.5 |
| 7. | Dar es Salaam | Kigamboni (Gomvu) | 3.56 | 4.28 |
| 8. | Mtwara | Mtwara (Litembe) | 3.21 | 4.47 |
| 9. | Pwani | Mafia | No Measurements | 4.01 |
| 10. | Mwanza | Ukerewe | 3.55 | 4.9 |

**Source:** TANESCO

### (iii)Biomass

Primary energy consumption in Tanzania includes 85 percent biomass out of which, 75 percent is consumed in rural areas, heavily contributing to deforestation. Studies indicate that there are 10 biomass power plants with a total installed capacity of 105 MW as shown in **Table 3-12**. Most of these plants are operating in the isolated grid and are owned by IPP for their use.

**Table 3-12:** Existing Biomass Power Plants (IPP)

| Power Plant Name | Fuel | Capacity (MW) | Grid Connection Status |
|---|---|---|---|
| Mufindi (Cogen) | Wood by products | 27 | Off-grid |
| Sao Hill (Cogen) | Wood by products | 6 | Off-grid |
| Kibena | Wood by products | 3 | Off-grid |
| Misenyi (Kagera) | Bagasse | 4 | Off-grid |
| Tanzania Plantation Company (TPC) | Bagasse | 15 | On-grid |
| Mkonge Energy System (I,II & III) | Sisal by products | 2.8 | Off-grid |
| Mkonge Energy System IV (Usambara) | Sisal by products | 1.6 | Off-grid |
| TANWAT | Wood by products | 3 | On-grid |
| Mgololo | Wood by products | 40 | Off-grid |
| Ngombeni (Mafia) | By products from coconut trees. | 2.5 | Off-grid |
| **Total** | | **105** | |

**Source:** Regulatory Performance Report on Electricity Sub-Sector for The Year Ended (2018), Tanzanian energy sector under the universal principles of the Energy Charter (2015).

### (iv) Geothermal

Tanzania is endowed with substantial geothermal potential, which has not yet been utilized. Several reconnaissance surveys and few detailed studies on the potential of geothermal resources have provided essential information for the estimation of power generation from geothermal resources. As of 2020, the total potential of the geothermal resource is 5,000 MW as shown in **Table 3-13** and the Government plan is to generate 995 MW during the next 25 years from 2020, as shown in **Section 3.6.3**.

**Table 3-13:** Geothermal Potential Sites in Tanzania

| S/N | GEOTHERMAL SETTINGS / SYSTEMS | SITE | ESTIMATED CAPACITY (MW) | TOTAL CAPACITY (MW) |
|---|---|---|---|---|
| 1 . | South-Western and Northern Volcanic Provinces (Mbeya, Songwe, Arusha, Manyara and Kilimanjaro). | Ngozi | 1,000 | |
| | | Kiejo-Mbaka | 300 | |
| | | Songwe | 100 | |
| | | Natron | 250 | 2,300 |
| | | Meru | 250 | |
| | | Manyara | 200 | |
| | | Eyasi | 200 | |
| 2 . | Coastal basin geothermal systems (Coast Region, Morogoro, Tanga). | Kisaki | 300 | |
| | | Luhoi | 300 | |
| | | Tagalala | 200 | 1,200 |
| | | Mtende | 200 | |
| | | Utete | 200 | |
| 3 . | Intra-cratonic geothermal systems (Mara, Shinyanga, Singida, Dodoma). | Takwa/Gonga | 200 | |
| | | Ibadakuli | 100 | |
| | | Maji Moto-Mara | 300 | 800 |
| | | Kondoa | 100 | |
| | | Msule/Mpondi | 100 | |
| 4 . | Western rift geothermal systems (Kagera, Rukwa, Katavi). | Mtagata | 200 | |
| | | Maji moto-Rukwa | 200 | |
| | | Mapyo | 150 | 700 |
| | | Kanazi | 150 | |
| **TOTAL** | | | **5,000** | **5,000** |

**Source:** Tanzania Geothermal Development Company (TGDC)

In developing geothermal resource potential for power generation various challenges are encountered, these challenges are such as:

(i). High upfront investment costs;
(ii). Long lead time from conception to production of electricity;
(iii). Capital intensive and high exploration cost and risk;
(iv). Inadequate capital resource to undertake necessary studies; and
(v). Remote location of the resources and limited infrastructures for accessing it.

Therefore, geothermal power projects included in the generation expansion plan are limited to the projects which have a high possibility of development potential.

### (v) Uranium

The National Energy Policy of 2015 and the Mineral Policy of Tanzania of 2009 acknowlegde the availability of uranium resource in the country. Tanzania confirmed to have Uranium resources of 58,500 ton discovered along Mkuju River at Namtumbo district, this potential resource is equivalent to 927.5 GWyr of energy. Studies have revealed that there are uranium prospects in different areas, including Singida, Tabora, and Dodoma, as indicated in **Table 3-14**. Therefore, further comprehensive studies should be carried out to explore and assess uranium resources in the country.

The plan has not considered the uranium resource for power generation due to the following reasons:

(i) The Government is creating enabling environment for nuclear electricity generation including the policies, legal and regulatory framework on uranium resource and nuclear electricity generation; and

(ii) Human Capacity building on nuclear power technologies and other related matters.

**Table 3-14:** Uranium Resources in Tanzania

| Name | Region | Size (ton)/Status |
|---|---|---|
| Mkuju | Ruvuma | 58,500 |
| Kianju Mbuga | Singida | Study is ongoing |
| Ndala Mbuga | Tabora | Study is ongoing |
| Bahi Swamp | Dodoma | Study is ongoing |

**Source:** Geological Survey of Tanzania (GST).

## 3.6. Power Projects Development

### 3.6.1. Hydropower Projects

#### 3.6.1.1. Candidate Projects

**Table 3-15** shows potential hydropower projects identified from various sites across the available water basins. The hydropower projects with more than 10 MW have a total generation capacity of 5,197.4 MW. The current update infers firm energy from previous PSMP 2008 and its Updates (2009, 2012, 2016) and review of various studies.

**Table 3-15:** Hydropower Project Candidates

| S/N | Project Name | Capacity (MW) | Average energy (GWh) | Firm energy (GWh) | River |
|---|---|---|---|---|---|
| 1 | Julius Nyerere | 2,115.0 | 9,264.0 | 6,307.0 | Rufiji |
| 2 | Ruhudji | 358.0 | 2,000.0 | 1,333.0 | Ruhudji |
| 3 | Ikondo Mnyera | 340.0 | 1,832.0 | 1,316.0 | Mnyera |
| 4 | Kikonge | 300.0 | 1,268.0 | 883.8 | Ruhuhu |
| 5 | Rumakali | 222.0 | 1,322.0 | 1,075.9 | Rumakali |
| 6 | Mpanga | 160.0 | 1,061.1 | 717.8 | Mpanga |
| 7 | Songwe Sofre (163.2 MW)* | 81.6 | 382.5 | 237.0 | Songwe |
| 8 | Iringa Kilolo | 150.0 | 994.8 | 672.9 | Lukosi |
| 9 | Songwe Manolo (180.2 MW)* | 90.1 | 471.7 | 295.1 | Songwe |
| 10 | Mnyera Taveta | 145.0 | 850.0 | 622.0 | Mnyera |
| 11 | Mnyera Kwanini | 143.9 | 693.8 | 617.3 | Rufiji |
| 12 | Mnyera Mnyera | 137.4 | 662.3 | 589.4 | Rufiji |
| 13 | Mnyera Pumbwe | 122.9 | 592.2 | 527.2 | Rufiji |
| 14 | Upper Kihansi | 120.0 | 69.0 | 99.0 | Rufiji |
| 15 | Mnyera Kisingo | 119.8 | 577.3 | 513.9 | Rufiji |
| 16 | Masigira | 118.0 | 664.0 | 492.0 | Ruhuhu |
| 17 | Kakono | 87.0 | 573.0 | 335.0 | Kagera |
| 18 | Mnyera Ruaha | 60.3 | 290.8 | 258.7 | Rufiji |
| 19 | Iringa (Nginayo) | 52.0 | 262.8 | 223.1 | Rufiji |
| 20 | Malagarasi | 49.5 | 181.0 | 21.4 | Malagarasi |
| 21 | Mbarali | 38.5 | 199.0 | 107.9 | Kimani Falls |
| 22 | Iringa (Ibosa) | 36.0 | 186.1 | 106.9 | Little Ruaha |
| 23 | Songwe Bupigu (34 MW)* | 17.0 | 76.5 | 50.5 | Songwe |
| 24 | Njombe | 32.0 | 165.4 | 123.9 | Ruhuhu -1 |
| 25 | Rusumo (80 MW)* | 26.7 | 253.5 | 129.0 | Rusumo |
| 26 | Mhanga | 26.6 | 252.9 | 74.6 | Lukosi |
| 27 | Songea | 15.0 | 142.4 | 82.4 | Ruhudji |
| 28 | Nakatuta (Liparamba) | 15.0 | 140.8 | 29.7 | Ruvuma |
| 29 | Kikuletwa | 11.0 | 103.3 | 30.8 | Kikuletwa |
| 30 | Kikagati (14 MW)* | 7.0 | 43.8 | 33.0 | Kagera |
| | **Total** | **5,197.4** | **25,576** | **17,906** | |

**Note:** *These are a shared project with neighbouring countries.

**Sources:**

1. Small Hydro Mapping Report, "Renewable Energy Resource Mapping: Small Hydro – Tanzania" (2018) – REA/ the World Bank.
2. World Small Hydropower Development Report, UNIDO (2016).
3. Review of studies conducted for the potential sites.
4. Team survey to the potential sites, data collection, and compilation, (2019).

#### 3.6.1.2. Hydropower Plant Characteristics

**Table 3-16** shows the characteristics of the hydroelectric plants, which can generate more than 10 MW. The characteristics provide an overview of the plant in general, plant firm energy, and the capacity to be used during the development of the generation plan model.

**Table 3-16:** Characteristics of Hydropower Project Candidates

| CHARACTERISTICS \ PROJECT NAME | Julius Nyerere | Rumakali | Ruhudji | Ikondo Mnyera | Kikonge | Mpanga | Songwe Sofre (163.2 MW)* | Iringa Kilolo | Songwe Manolo (180.2 MW)* | Mnyera Taveta | Mnyera Kwanini | Mnyera Mnyera | Mnyera Pumbwe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Generation** | | | | | | | | | | | | | |
| Installed capacity (MW) | 2,115 | 222 | 358 | 340 | 300 | 160 | 81.6 | 150 | 90.1 | 145 | 144 | 137 | 123 |
| Average energy (GWh) | 9,264 | 1,322 | 2,000 | 1,832 | 1,268 | 1,061 | 383 | 995 | 472 | 850 | 694 | 662 | 592 |
| Firm energy (GWh) | 6,307 | 1,076 | 1,333 | 1,316 | 884 | 718 | 237 | 673 | 295 | 622 | 617 | 589 | 527 |
| **Power house** | | | | | | | | | | | | | |
| Number of units | 4 | 3 | 4 | 4 | N.A | 2 | 3 | N.A | 3 | 2 | 2 | 2 | 2 |
| Gross head at max. level (m) | 100 | 1,295 | 765 | 405 | N.A | 374 | 315 | N.A | 253 | 155 | N.A | N.A | N.A |
| Gross head at min. level (m) | 99 | 1,265 | 765 | 400 | N.A | 350 | 285 | N.A | 173 | 150 | 160 | 155 | 130 |
| Tailwater level (m.a.s.l) | 59 | N.A | N.A | N.A | N.A | N.A | 825 | N.A | 527 | N.A | N.A | N.A | N.A |
| Rated turbine discharge (total) (m3/s) | 353 | 19 | 54 | 100 | N.A | 52 | 59 | N.A | 69 | 125 | 105 | 103 | 111 |
| MW/($m^3$/s) based on calc Qmax | 1 | 12 | 7 | 3 | N.A | 3 | 3 | N.A | 2 | 1 | N.A | N.A | N.A |
| **Reservoir** | | | | | | | | | | | | | |
| Max. supply level (m.a.s.l.) | 159 | 2,055 | 1,478 | 1,070 | N.A | 734 | 1,140 | N.A | 780 | 490 | 805 | 960 | 645 |
| Min. supply level (m.a.s.l.) | 158 | 2,025 | 1,440 | 1,030 | N.A | 710 | 1,110 | N.A | 700 | 490 | 805 | 960 | 645 |
| Full supply level (m.a.s.l) | 174 | 2,055 | 1,478 | 1,070 | N.A | 734 | 1,140 | N.A | 780 | 490 | 805 | 960 | 645 |
| Recommended min. operational level (m.a.s.l.) | 158 | 2,025 | 1,367 | 1,030 | N.A | 710 | 1,110 | N.A | 700 | N.A | N.A | N.A | N.A |
| Storage vol. at max. level (mill. $m^3$) | 13,000 | 280 | 300 | 800 | N/A | 75 | 440 | N/A | 260 | N/A | N/A | N/A | N/A |
| Storage vol. at min. level (mill. $m^3$) | 12,000 | 24 | 31 | 20 | N/A | 7 | 80 | N/A | 0 | N/A | N/A | N/A | N/A |
| Active storage volume (mill. $m^3$) | 1,000 | 256 | 269 | 780 | N/A | 68 | 360 | N/A | 260 | N/A | N/A | N/A | N/A |
| Surface area at max. vol. ($km^2$) | 1,250 | 13 | 14 | 38 | N.A | 3 | 15 | N.A | 11 | N.A | N.A | N.A | N.A |

| PROJECT NAME / CHARACTERISTICS | Upper Kihansi | Mnyera Kisingo | Masigira | Rusumo (80 MW)* | Mnyera Ruaha | Kakono | Iringa (Nginayo) | Malagarasi | Mbarali | Iringa (Ibosa) | Songwe Bipugu (34 MW)* | Njombe | Mhanga | Nakatuta (Liparamba) | Songea | Kikuletwa | Kikagati (14 MW)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Generation** | | | | | | | | | | | | | | | | | |
| Installed capacity MW | 120 | 120 | 118 | 27 | 60 | 87 | 52 | 49.5 | 39 | 36 | 17 | 32 | 27 | 15 | 15 | 11 | 7 |
| Average energy GWH | 69 | 577 | 664 | 254 | 290 | 573 | 263 | 181 | 199 | 186 | 76.5 | 165 | 250.1 | 141 | 141 | 103 | 44 |
| Firm energy GWH | 99 | 514 | 492 | 129 | 259 | 335 | 223 | 21 | 108 | 107 | 51 | 124 | 74.6 | 30 | 82 | 31 | 33 |
| **Powerhouse** | | | | | | | | | | | | | | | | | |
| Number of units | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 3 | N.A | 2 | 3 | N.A | N.A | N.A | N.A | N.A | N.A |
| Gross head at max. level (m) | 854 | N.A | 238 | 35 | N.A | 26 | N.A | 847 | N.A | N.A | 80 | N.A | N.A | N.A | N.A | N.A | N.A |
| Gross head at min. level (m) | N.A | 105 | 237 | 30 | 110 | 24 | 196 | 833 | N.A | 151 | 55 | N.A | N.A | N.A | N.A | N.A | N.A |
| Tailwater level (m.a.s.l) | N.A | N.A | N.A | 1,290 | N.A | 1,156 | N.A | N.A | N.A | N.A | 1,165 | N.A | N.A | N.A | N.A | N.A | N.A |
| Rated turbine discharge(total) (m3/s) | 17 | 134 | 57 | 207 | 67 | 240 | 30 | | N.A | 28 | 50 | N.A | N.A | N.A | N.A | N.A | N.A |
| MW/($m^3$/s) based on calc Qmax | N.A | N.A | 2 | 0 | N.A | 0 | N.A | 7 | N.A | N.A | 1 | N.A | N.A | N.A | N.A | N.A | N.A |
| **Reservoir** | | | | | | | | | | | | | | | | | |
| Max. supply level (m.a.s.l.) | 1,146 | 415 | 938 | 1,325 | 1,070 | 1,182 | 977 | N.A | N.A | 1,212 | 1,245 | N.A | N.A | N.A | N.A | N.A | N.A |
| Min. supply level (m.a.s.l.) | 1,441 | 415 | 937 | 1,320 | 1,060 | 1,180 | 977 | N.A | N.A | 1,212 | 1,230 | N.A | N.A | N.A | N.A | N.A | N.A |
| Full supply level (m.a.s.l) | 1,146 | 415 | 938 | 1,325 | 1,070 | 1,182 | 977 | N.A | N.A | 1,212 | 1,245 | N.A | N.A | N.A | N.A | N.A | N.A |
| Recommended min. operational level (m.a.s.l.) | N.A | N.A | 937 | 1,320 | N.A | 1,180 | N.A | 843 | N.A | N.A | 1,230 | N.A | N.A | N.A | N.A | N.A | N.A |
| Storage vol. at max. level (mill. $m^3$) | N.A | N/A | 24 | 1,250 | N/A | 27 | N/A | 457,000 | N/A | N/A | 350 | N.A | N/A | N/A | N/A | N.A | N/A |
| Storage vol. at min. level (mill. $m^3$) | N.A | N/A | 23 | 0 | N/A | 0 | N/A | 427,000 | N/A | N/A | 100 | N.A | N/A | N/A | N/A | N.A | N/A |
| Active storage volume (mill. $m^3$) | 1 | N/A | 2 | 1,250 | 288 | 27 | N/A | 457,000 | N/A | N/A | 250 | N.A | N/A | N/A | N/A | N.A | N/A |
| Surface area at max. vol. ($km^2$) | N.A | N.A | 3 | 390 | N.A | 14 | N.A | 169,000 | N.A | N.A | 30 | N.A | N.A | N.A | N.A | N.A | N.A |

**Note:**

1. * These are a shared project with neighbouring countries.
2. N.A – Not Accessible
3. N/A – Not Applicable.

**Source:** PSMP 2020 Update Team Compilation.

### 3.6.2. Thermal Power Projects Characteristics

This section discusses the characteristics of thermal power projects (natural gas and coal), as detailed in **Table 3-17**.

**Table 3-17:** Characteristics of Thermal Power Project Candidates

| Plant | Fuel | Technology | Installed Capacity (MW) | Station Service (%) | Net Available Capacity (MW) | Forced Outage Rate (%) | Combined Outage Rate (%) | Maximum Plant Factor (%) | Available Energy (GWh) | Nominal Service Life (Years) |
|---|---|---|---|---|---|---|---|---|---|---|
| **GAS FIRED PLANTS** | | | | | | | | | | |
| Kinyerezi I ext | Natural Gas | OCGT | 185 | 1.6 | 182 | 5 | 13 | 80 | 1,212 | 25 |
| Mtwara I | Natural Gas | CCGT | 300 | 2.0 | 294 | 5 | 11 | 80 | 1,957 | 25 |
| Kinyerezi III | Natural Gas | CCGT | 600 | 2.0 | 588 | 5 | 11 | 80 | 3,915 | 25 |
| Somanga Fungu TANESCO | Natural Gas | CCGT | 600 | 2.0 | 588 | 5 | 11 | 80 | 3,915 | 25 |
| Tegeta New | Natural Gas | CCGT | 320 | 2.0 | 314 | 5 | 11 | 80 | 2,088 | 25 |
| Kinyerezi IV | Natural Gas | CCGT | 330 | 2.0 | 323 | 5 | 11 | 80 | 2,153 | 25 |
| Ubungo I New | Natural Gas | CCGT | 320 | 2.0 | 314 | 5 | 11 | 80 | 2,088 | 25 |
| Ubungo II New | Natural Gas | CCGT | 470 | 2.0 | 461 | 5 | 11 | 80 | 3,066 | 25 |
| Somanga Fungu PPP | Natural Gas | CCGT | 320 | 2.0 | 314 | 5 | 11 | 80 | 2,088 | 25 |
| Dodoma | Natural Gas | CCGT | 600 | 2.0 | 588 | 5 | 11 | 80 | 3,915 | 25 |
| Somanga Mtama | Natural Gas | CCGT | 345 | 2.0 | 338 | 5 | 11 | 80 | 2,251 | 25 |
| Mtwara II | Natural Gas | CCGT | 300 | 2.0 | 294 | 5 | 11 | 80 | 1,957 | 25 |
| Kinyerezi I New | Natural Gas | CCGT | 320 | 2.0 | 314 | 5 | 11 | 80 | 2,088 | 25 |
| Ubungo New | Natural Gas | CCGT | 320 | 2.0 | 314 | 5 | 11 | 80 | 2,088 | 25 |
| Mtwara III | Natural Gas | CCGT | 600 | 2.0 | 588 | 5 | 11 | 80 | 3,915 | 25 |
| Kinyerezi II New | Natural Gas | CCGT | 470 | 2.0 | 461 | 5 | 11 | 80 | 3,066 | 25 |
| Bagamoyo | Natural Gas | CCGT | 300 | 2.0 | 294 | 5 | 11 | 80 | 1,957 | 25 |
| **Subtotal** | | | **6,700** | | | | | | **43,719** | |
| **Coal Projects** | | | | | | | | | | |
| Kiwira I | Coal | STG | 200 | 8.0 | 184 | 8 | 20 | 80 | 1,186 | 25 |
| Kiwira II | Coal | STG | 200 | 8.0 | 184 | 8 | 20 | 80 | 1,186 | 25 |
| Mchuchuma I | Coal | STG | 300 | 8.0 | 276 | 8 | 20 | 80 | 1,779 | 25 |
| Mchuchuma II | Coal | STG | 400 | 8.0 | 368 | 8 | 20 | 80 | 2,373 | 25 |
| Mchuchuma III | Coal | STG | 300 | 8.0 | 276 | 8 | 20 | 80 | 1,779 | 25 |
| Ngaka I | Coal | STG | 200 | 8.0 | 184 | 8 | 20 | 80 | 1,186 | 25 |
| Ngaka II | Coal | STG | 400 | 8.0 | 368 | 8 | 20 | 80 | 2,373 | 25 |
| Rukwa I | Coal | STG | 300 | 8.0 | 276 | 8 | 20 | 80 | 1,779 | 25 |
| Mbeya I | Coal | STG | 300 | 8.0 | 276 | 8 | 20 | 80 | 1,779 | 25 |
| Rungwe | Coal | STG | 600 | 8.0 | 552 | 8 | 20 | 80 | 3,559 | 25 |
| Mbeya II | Coal | STG | 600 | 8.0 | 552 | 8 | 20 | 80 | 3,559 | 25 |
| Mbeya III | Coal | STG | 600 | 8.0 | 552 | 8 | 20 | 80 | 3,559 | 25 |
| Kiwira III | Coal | STG | 300 | 8.0 | 276 | 8 | 20 | 80 | 1,779 | 25 |
| Rukwa II | Coal | STG | 600 | 8.0 | 552 | 8 | 20 | 80 | 3,559 | 25 |
| **Subtotal** | | | **5,300** | | | | | | **31,437** | |
| **Total** | | | **12,000** | | | | | | **75,156** | |

**Source:** PSMP 2020 Update Team Compilation.

### 3.6.3. Renewable Projects

**Table 3-18** and **3-19** shows the potential candidates for renewable energy (solar, wind, geothermal, and hybrid) development in Tanzania.

**Table 3-18:** Renewable Energy Project Candidates

| S/N | Plant Name | Location | Fuel Type | Capacity (MW/MWp) |
|---|---|---|---|---|
| | | **SOLAR PROJECTS** | | |
| 1 . | Shinyanga I (Kishapu) | Kishapu | Solar | 150 |
| 2 . | Dodoma I | UDOM | Solar | 55 |
| 3 . | Dodoma II | Michese | Solar | 60 |
| 4 . | Manyoni | Monyoni | Solar | 100 |
| 5 . | Same Kilimanjaro | Same | Solar | 50 |
| 6 . | Kigoma | Kigoma | Solar | 5 |
| 7 . | Singida | Singida | Solar | 150 |
| 8 . | Shinyanga II | Sinyanga | Solar | 150 |
| | **Total Solar Projects** | | | **720** |
| | | **WIND PROJECTS** | | |
| 1 . | Singida I | Singida | Wind | 100 |
| 2 . | Makambako | Makambako | Wind | 300 |
| 3 . | Njombe I | Njombe | Wind | 100 |
| 4 . | Singida II | Singida | Wind | 100 |
| 5 . | Singida III | Singida | Wind | 200 |
| 6 . | Njombe II | Njombe | Wind | 200 |
| | **Total Wind Projects** | | | **1,000** |
| | | **HYBRID PROJECTS** | | |
| 1 . | Loliondo Power Plant - TANESCO | Loliondo | Diesel-Solar | 1 |
| 2 . | Mafia | Mafia | Diesel-Solar-wind | 7 |
| | **Total Hybrid Projects** | | | **8** |
| | **Total Renewable Projects** | | | **1,728** |

**Source:** TANESCO.

**Table 3-19:** Geothermal Project Candidates

| Forecasts Generation from 2025 - 2045 | | | | | | |
|---|---|---|---|---|---|---|
| S/N | Geothermal Projects | Capacity (MW) by 2025 | Capacity (MW) by 2030 | Capacity (MW) by 2035 | Capacity (MW) by 2040 | Capacity (MW) by 2045 |
| 1 | (i) Ngozi phase I | 30 | | | | |
| | (ii)Ngozi phase II | 40 | | | | |
| | (iii) Ngozi phase III | | 30 | | | |
| | (iv)Ngozi phase IV | | | 30 | | |
| | (v) Ngozi phase V | | | | 30 | |
| | (vi) Ngozi phase VI | | | | | 30 |
| 2 | Songwe | 5 | | 5 | 15 | 20 |
| 3 | Kiejo- Mbaka | 60 | | 40 | 30 | 25 |
| 4 | Luhoi | 5 | | 10 | 20 | 10 |
| 5 | Natron | 60 | 50 | 40 | 30 | 30 |
| 6 | Kisaki | | 60 | 25 | 30 | 30 |
| 7 | Meru | | 50 | 40 | 20 | 35 |
| 8 | Ibadakuli | | 5 | 10 | 10 | 35 |
| | **Total** | **200** | **195** | **200** | **185** | **215** |

**Source:** Tanzania Geothermal Development Company (TGDC)

### 3.6.4. Project Development Costs

Capital costs for all candidate power projects are based on benchmarking of feasibility studies, Budget Speech 2020/21 from the Ministry of Energy, previous PSMPs Updates, International Atomic Energy Agency, U.S. Energy Information Administration and project developers. Construction costs for hydro, thermal and renewable projects are summarized in **Table 3-20** and **Table 3-21**.

## **Table 3-20:** Hydropower Project Construction Costs

| PLANT | Units | Capacity (MW) | Unit Capital Cost ($/kW) 2019 | Capital cost $M no IDC / 2019[1, 2 &3] | Construction Period (months) | Pre-construction costs (%ge of total capital cost ) | Annual expenditure as % of total capital cost | | | | | | TOTAL (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1 | 2 | 3 | 4 | 5 | 6 | |
| Rusumo (80 MW)* | 3 | 26.7 | 4,232.2 | 113 | 36** | 4.5 | 55.5 | 35.0 | 5.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Murongo/Kikagati (14 MW)* | 2 | 7 | 2,071.4 | 29 | 24 | 4.5 | 75.5 | 20.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Julius Nyerere | 9 | 2115 | 1,348.3 | 2,852 | 36** | 4.5 | 11.5 | 19.0 | 41.0 | 24.0 | 0.0 | 0.0 | 100.0 |
| Malagarasi | 3 | 49.5 | 2,911.9 | 144 | 48 | 4.5 | 5.5 | 40.0 | 30.0 | 20.0 | 0.0 | 0.0 | 100.0 |
| Ruhudji | 4 | 358 | 1,138.0 | 407 | 48 | 4.5 | 25.5 | 30.0 | 20.0 | 20.0 | 0.0 | 0.0 | 100.0 |
| Songwe Manolo (180 MW)* | 6 | 90 | 3,055.6 | 275 | 48 | 4.5 | 5.5 | 40.0 | 30.0 | 20.0 | 0.0 | 0.0 | 100.0 |
| Kakono | 2 | 87 | 3,223.0 | 280 | 51 | 4.5 | 5.5 | 40.0 | 30.0 | 15.0 | 5.0 | 0.0 | 100.0 |
| Rumakali | 3 | 222 | 1,690.2 | 375 | 48 | 4.5 | 35.5 | 30.0 | 20.0 | 10.0 | 0.0 | 0.0 | 100.0 |
| Upper Kihansi | 2 | 120 | 1,840.0 | 221 | 45 | 4.5 | 35.5 | 30.0 | 20.0 | 10.0 | 0.0 | 0.0 | 100.0 |
| Masigira | 2 | 118 | 2,214.0 | 261 | 54 | 4.5 | 35.5 | 30.0 | 20.0 | 10.0 | 0.0 | 0.0 | 100.0 |
| Kikonge | 3 | 300 | 2,469.7 | 741 | 66 | 4.5 | 5.5 | 40.0 | 30.0 | 20.0 | 0.0 | 0.0 | 100.0 |
| Mnyera Kwanini | 2 | 144 | 1,141.0 | 164 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Mpanga | 2 | 160 | 1,865.6 | 298.50 | 48 | 4.5 | 35.5 | 30.0 | 20.0 | 10.0 | 0.0 | 0.0 | 100.0 |
| Mnyera Taveta | 2 | 145 | 1,419.0 | 206 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Songwe Sofre (163.2 MW)* | 5 | 81.6 | 2,982.7 | 152 | 48 | 4.5 | 35.5 | 30.0 | 20.0 | 10.0 | 0.0 | 0.0 | 100.0 |
| Iringa (Nginayo) | 2 | 52 | 2,413.0 | 125 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Iringa (Ibosa) | 2 | 36 | 3,418.0 | 123 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Mnyera Mnyera | 2 | 137 | 2,000.5 | 274 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Ikondo Mnyera | 4 | 340 | 1,958.2 | 666 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Mnyera Kisingo | 2 | 119.8 | 2,621.4 | 314 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Mnyera Ruaha | 2 | 60 | 4,251.3 | 255 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Mnyera Pumbwe | 2 | 123 | 1,783.0 | 219 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Iringa Kilolo | 3 | 150 | 2,000.0 | 300 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Songwe Bupigu (34 MW)* | 5 | 17 | 5,897.1 | 58 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Mbarali | TBD | 38.5 | 4,311.7 | 166 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Njombe | TBD | 32 | 4,250.0 | 136 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Mhanga | TBD | 27 | 3,518.0 | 95 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Songea | TBD | 15 | 3,518.0 | 53 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Nakatuta (Liparamba) | TBD | 15 | 3,518.0 | 53 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Kikuletwa | TBD | 11 | 3,518.0 | 39 | 36 | 4.5 | 35.5 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 | 100.0 |

**Note:**

1. * These are a shared project with neighbouring countries.
2. ** These are candidate projects under construction.
3. TBD – To Be Determined.

**Sources:**

1 . Budget Speech 2020/21– Ministry of Energy.

2 . PSMPs (2008, 2012 and 2016).

3 . Capital Cost and Performance Characteristic Estimates for Utility Scale Electric Power Generating Technologies (February, 2020).

(https://www.eia.gov/analysis/studies/powerplants/capitalcost/pdf/capital_cost_AEO2020.pdf).

4 . Tanzania Geothermal Development Company.

5 . Feasibity Studies.

## **Table 3-21:** Thermal and Renewable Project Construction Costs

| Plant | Fuel | Technology | Nominal Capacity MW | Unit Capital Cost ($/kW)[3] | Capital cost $M no IDC / 2019[1, 2, 3 & 4] | Annual expenditure as % of total capital cost | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1 | 2 | 3 | 4 | 5 | |
| **GAS FIRED PLANTS** | | | | | | | | | | | |
| Kinyerezi I ext ** | Natural Gas | OCGT | 185 | 1,016.2 | 188 | 68 | 10 | 22 | 0 | 0 | 100 |
| Mtwara I | Natural Gas | CCGT | 300 | 1,213.0 | 363.9 | 2 | 58 | 40 | 0 | 0 | 100 |
| Kinyerezi III | Natural Gas | CCGT | 600 | 1,124.0 | 674 | 55 | 45 | 0 | 0 | 0 | 100 |
| Somanga Fungu TANESCO | Natural Gas | CCGT | 600 | 1,124.0 | 674 | 60 | 40 | 0 | 0 | 0 | 100 |
| Tegeta New | Natural Gas | CCGT | 320 | 1,124.0 | 360 | 70 | 30 | 0 | 0 | 0 | 100 |
| Kinyerezi IV | Natural Gas | CCGT | 330 | 1,213.0 | 400 | 50 | 50 | 0 | 0 | 0 | 100 |
| Ubungo I New | Natural Gas | CCGT | 320 | 1,124.0 | 360 | 55 | 45 | 0 | 0 | 0 | 100 |
| Ubungo II New | Natural Gas | CCGT | 470 | 1,124.0 | 528 | 70 | 30 | 0 | 0 | 0 | 100 |
| Somanga Fungu PPP | Natural Gas | CCGT | 320 | 1,062.5 | 340 | 20 | 50 | 30 | 0 | 0 | 100 |
| Dodoma | Natural Gas | CCGT | 600 | 1,124.0 | 674 | 20 | 50 | 30 | 0 | 0 | 100 |
| Somanga Mtama | Natural Gas | CCGT | 345 | 1,262.0 | 435 | 20 | 50 | 30 | 0 | 0 | 100 |
| Mtwara II | Natural Gas | CCGT | 300 | 1,113.0 | 334 | 60 | 40 | 0 | 0 | 0 | 100 |
| Kinyerezi I New | Natural Gas | CCGT | 320 | 1,062.5 | 340 | 20 | 50 | 30 | 0 | 0 | 100 |
| Ubungo New | Natural Gas | CCGT | 320 | 1,062.5 | 340 | 20 | 50 | 30 | 0 | 0 | 100 |
| Mtwara III | Natural Gas | CCGT | 600 | 1,124.0 | 674 | 20 | 50 | 30 | 0 | 0 | 100 |
| Kinyerezi II New | Natural Gas | CCGT | 470 | 1,262.0 | 593 | 20 | 50 | 30 | 0 | 0 | 100 |
| Bagamoyo | Natural Gas | CCGT | 300 | 1,200.0 | 360 | 20 | 50 | 30 | 0 | 0 | 100 |
| **COAL FIRED PLANTS** | | | | | | | | | | | |
| Kiwira I | Coal | IGCC | 200 | 2,186.0 | 437 | 40 | 40 | 20 | 0 | 0 | 100 |
| Kiwira II | Coal | IGCC | 200 | 2,186.0 | 437 | 40 | 40 | 20 | 0 | 0 | 100 |
| Mchuchuma I | Coal | IGCC | 300 | 2,185.7 | 656 | 40 | 40 | 20 | 0 | 0 | 100 |
| Mchuchuma II | Coal | IGCC | 400 | 2,185.7 | 874 | 40 | 40 | 20 | 0 | 0 | 100 |
| Mchuchuma III | Coal | IGCC | 300 | 2,185.7 | 656 | 40 | 40 | 20 | 0 | 0 | 100 |
| Ngaka I | Coal | IGCC | 200 | 2,186.0 | 437 | 40 | 40 | 20 | 0 | 0 | 100 |
| Ngaka II | Coal | IGCC | 400 | 2,344.4 | 938 | 40 | 40 | 20 | 0 | 0 | 100 |
| Rukwa I | Coal | IGCC | 300 | 2,344.4 | 703 | 40 | 40 | 20 | 0 | 0 | 100 |
| Mbeya I | Coal | IGCC | 300 | 2,185.7 | 656 | 40 | 40 | 20 | 0 | 0 | 100 |
| Rungwe | Coal | IGCC | 600 | 2,185.7 | 1311 | 40 | 40 | 20 | 0 | 0 | 100 |
| Mbeya II | Coal | IGCC | 600 | 2,319.3 | 1392 | 40 | 40 | 20 | 0 | 0 | 100 |
| Mbeya III | Coal | IGCC | 600 | 2,347.1 | 1408 | 40 | 40 | 20 | 0 | 0 | 100 |
| Kiwira III | Coal | IGCC | 300 | 2,319.3 | 696 | 40 | 30 | 30 | 0 | 0 | 100 |
| Rukwa II | Coal | IGCC | 600 | 2,185.7 | 1522 | 40 | 40 | 20 | 0 | 0 | 100 |
| **RENEWABLE PROJECTS** | | | | | | | | | | | |
| **A. SOLAR** | | | | | | | | | | | |
| Shinyanga I (Kishapu) | Solar | PV | 150 | 780.7 | 117 | 60 | 40 | 0 | 0 | 0 | 100 |
| Dodoma I | Solar | PV | 55 | 1,706.9 | 93.9 | 60 | 40 | 0 | 0 | 0 | 100 |
| Dodoma II | Solar | PV | 60 | 1,706.9 | 102.4 | 60 | 40 | 0 | 0 | 0 | 100 |
| Manyoni | Solar | PV | 100 | 1,785.0 | 178.5 | 60 | 40 | 0 | 0 | 0 | 100 |
| Same | Solar | PV | 50 | 1,785.0 | 89.3 | 60 | 40 | 0 | 0 | 0 | 100 |
| Singida | Solar | PV | 150 | 780.7 | 117 | 10 | 90 | 0 | 0 | 0 | 100 |
| Shinyanga II | Solar | PV | 150 | 780.7 | 117 | 10 | 90 | 0 | 0 | 0 | 100 |
| **B. WIND** | | | | | | | | | | | |
| Singida I | Wind | Wind | 100 | 1,265.0 | 126.5 | 100 | 0 | 0 | 0 | 0 | 100 |
| Makamako | Wind | Wind | 300 | 1,265.0 | 379.5 | 100 | 0 | 0 | 0 | 0 | 100 |
| Njombe I | Wind | Wind | 100 | 1,265.0 | 126.5 | 100 | 0 | 0 | 0 | 0 | 100 |
| Singida II | Wind | Wind | 100 | 1,265.0 | 126.5 | 100 | 0 | 0 | 0 | 0 | 100 |
| Singida III | Wind | Wind | 200 | 1,265.0 | 253.0 | 100 | 0 | 0 | 0 | 0 | 100 |
| Njombe II | Wind | Wind | 200 | 1,265.0 | 253.0 | 100 | 0 | 0 | 0 | 0 | 100 |
| **C. GEOTHERMAL** | | | | | | | | | | | |
| Songwe | Geothermal | Geothermal | 5 | 2,521.0 | 12.6 | 30 | 60 | 10 | 0 | 0 | 100 |
| Ngozi (wellhead) & Ngozi I | Geothermal | Geothermal | 30 | 2,521.0 | 75.6 | 30 | 60 | 10 | 0 | 0 | 100 |
| Kiejo – Mbaka | Geothermal | Geothermal | 60 | 2,521.0 | 151.3 | 30 | 60 | 10 | 0 | 0 | 100 |
| Natron | Geothermal | Geothermal | 60 | 2,521.0 | 151.3 | 30 | 60 | 10 | 0 | 0 | 100 |
| Luhoi | Geothermal | Geothermal | 5 | 2,521.0 | 12.6 | 30 | 60 | 10 | 0 | 0 | 100 |
| Ngozi II | Geothermal | Geothermal | 40 | 2,521.0 | 100.8 | 30 | 60 | 10 | 0 | 0 | 100 |
| Geothermal Phase I | Geothermal | Geothermal | 195 | 2,521.0 | 491.6 | 30 | 60 | 10 | 0 | 0 | 100 |
| Geothermal Phase II | Geothermal | Geothermal | 200 | 2,521.0 | 504.2 | 30 | 60 | 10 | 0 | 0 | 100 |
| Geothermal Phase III | Geothermal | Geothermal | 185 | 2,521.0 | 466.4 | 30 | 60 | 10 | 0 | 0 | 100 |
| Geothermal Phase IV | Geothermal | Geothermal | 215 | 2,521.0 | 542.0 | 30 | 60 | 10 | 0 | 0 | 100 |

**Note:**

1. ** These are Candidate Projects under Construction.

**Sources:**

1. Budget Speech 2020/21– Ministry of Energy.
2. PSMPs (2008, 2012 and 2016).
3. Capital Cost and Performance Characteristic Estimates for Utility Scale Electric Power Generating Technologies (February, 2020) – (https://www.eia.gov/analysis/studies/powerplants/capitalcost/pdf/capital_cost_AEO2020.pdf).
4. Tanzania Geothermal Development Company (TGDC).
5. Feasibity Studies.

### 3.6.5.Fuel Costs

The fuel prices for generation planning were obtained from regulatory authorities (EWURA & PURA), Feasibility Studies, previous PSMPs, International benchmarcking including U.S. Energy Information Administration and potential developers/suppliers. **Table 3-22** shows natural gas and coal prices in 2020.

**Table 3-22:** Natural Gas and Coal Price

| Plant | Fuel | Installed Capacity MW | Fuel price $/mmBTU | Plant heat rate BTU/kWh | Fuel cost $/kWh | Fixed operating cost /kW-year | Variable operating cost $/kWh |
|---|---|---|---|---|---|---|---|
| **GAS FIRED PLANTS** | | | | | | | |
| Kinyerezi I ext | Natural Gas | 185 | 5.559 | 8,281 | 0.0460 | 16.3 | 0.0507 |
| Mtwara I | Natural Gas | 300 | 5.129 | 6,666 | 0.0342 | 12.2 | 0.0361 |
| Kinyerezi III | Natural Gas | 600 | 5.559 | 6,090 | 0.0339 | 12.2 | 0.0357 |
| Somanga Fungu TANESCO | Natural Gas | 600 | 5.206 | 6,666 | 0.0347 | 12.2 | 0.0366 |
| Tegeta New | Natural Gas | 320 | 5.559 | 6,090 | 0.0339 | 12.2 | 0.0357 |
| Kinyerezi IV | Natural Gas | 330 | 5.559 | 6,090 | 0.0339 | 12.2 | 0.0357 |
| Ubungo I New | Natural Gas | 320 | 5.559 | 6,090 | 0.0339 | 12.2 | 0.0357 |
| Ubungo II New | Natural Gas | 470 | 5.559 | 6,090 | 0.0339 | 12.2 | 0.0357 |
| Somanga Fungu PPP | Natural Gas | 320 | 5.206 | 6,666 | 0.0347 | 12.2 | 0.0366 |
| Dodoma | Natural Gas | 600 | 5.559 | 6,090 | 0.0339 | 12.2 | 0.0357 |
| Somanga Mtama | Natural Gas | 345 | 5.206 | 6,666 | 0.0347 | 12.2 | 0.0366 |
| Mtwara II | Natural Gas | 300 | 5.129 | 6,090 | 0.0312 | 12.2 | 0.0331 |
| Kinyerezi I New | Natural Gas | 320 | 5.559 | 6,090 | 0.0339 | 12.2 | 0.0357 |
| Ubungo New | Natural Gas | 320 | 5.559 | 6,090 | 0.0339 | 12.2 | 0.0357 |
| Mtwara III | Natural Gas | 600 | 5.129 | 6,090 | 0.0312 | 12.2 | 0.0331 |
| Kinyerezi II New | Natural Gas | 470 | 5.559 | 6,090 | 0.0339 | 12.2 | 0.0357 |
| Bagamoyo | Natural Gas | 300 | 5.559 | 6,090 | 0.0339 | 12.2 | 0.0357 |
| **COAL FIRED PLANTS** | | | | | | | |
| Kiwira I | Coal | 200 | 2.360 | 8,700 | 0.0212 | 40.58 | 0.0257 |
| Kiwira II | Coal | 200 | 2.360 | 8,700 | 0.0212 | 40.58 | 0.0257 |
| Mchuchuma I | Coal | 300 | 2.573 | 8,700 | 0.0231 | 40.58 | 0.0276 |
| Mchuchuma II | Coal | 400 | 2.573 | 8,700 | 0.0231 | 40.58 | 0.0276 |
| Mchuchuma III | Coal | 300 | 2.573 | 8,700 | 0.0231 | 40.58 | 0.0276 |
| Ngaka I | Coal | 200 | 2.100 | 8,700 | 0.0189 | 40.58 | 0.0234 |
| Ngaka II | Coal | 400 | 2.100 | 8,700 | 0.0189 | 40.58 | 0.0234 |
| Rukwa I | Coal | 300 | 2.360 | 8,700 | 0.0212 | 40.58 | 0.0257 |
| Mbeya I | Coal | 300 | 2.360 | 8,700 | 0.0212 | 40.58 | 0.0257 |
| Rungwe | Coal | 600 | 2.360 | 8,700 | 0.0212 | 40.58 | 0.0257 |
| Mbeya II | Coal | 600 | 2.360 | 8,700 | 0.0212 | 40.58 | 0.0257 |
| Mbeya III | Coal | 600 | 2.360 | 8,700 | 0.0212 | 40.58 | 0.0257 |
| Kiwira III | Coal | 300 | 2.360 | 8,700 | 0.0212 | 40.58 | 0.0257 |
| Rukwa II | Coal | 600 | 2.360 | 8,700 | 0.0212 | 40.58 | 0.0257 |

**Sources:**

1. The petroleum (Natural Gas Indicative Price) (Special Strategic Investment) Order 2017;
2. Feasibility Studies;
3. Project Developers; and
4. Indicative for large power plants (Above 10 MW) in Tanzania.

### 3.6.1.Project Screening

The development of alternative plans and their comparisons use comperative unit costs for alternative technology. The Screeining tables for candidate power projets are shown from **Table 3-23** to **3-25**.

## **Table 3-23:** Screening of Thermal Generation Projects

| PROJECT / NAME | Unit | Kinyerezi I ext | Mtwara I | Kinyerezi III | Somanga Fungu TANESCO | Tegeta New | Kinyerezi IV | Ubungo I New | Ubungo II New | Somanga Fungu PPP | Dodoma | Somanga Mtama | Mtwara II | Kinyerezi I New | Ubungo New | Mtwara III | Kinyerezi II New | Bagamoyo | Kiwira I | Kiwira II | Mchuchuma I | Mchuchuma II | Mchuchuma III | Ngaka I | Ngaka II | Rukwa I | Mbeya I | Rungwe | Mbeya II | Mbeya III | Kiwira III | Rukwa II |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Cost | | 188.0 | 363.9 | 674.4 | 674.4 | 359.7 | 400.3 | 359.7 | 528.3 | 340.0 | 674.4 | 435.4 | 333.9 | 340.0 | 340.0 | 674.4 | 593.2 | 360.0 | 437.2 | 437.2 | 655.7 | 874.3 | 655.7 | 437.2 | 937.8 | 703.3 | 655.7 | 1311.4 | 1391.6 | 1408.3 | 695.8 | 1522.0 |
| Installed capacity | MW | 185 | 300 | 600 | 600 | 320 | 330 | 320 | 470 | 320 | 600 | 345 | 300 | 320 | 320 | 600 | 470 | 300 | 200 | 200 | 300 | 400 | 300 | 200 | 400 | 300 | 300 | 600 | 600 | 600 | 300 | 600 |
| Station service | % | 1.6% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% |
| Net capacity | MW | 182.04 | 294 | 588 | 588 | 313.6 | 323.4 | 313.6 | 460.6 | 313.6 | 588 | 338.1 | 294 | 313.6 | 313.6 | 588 | 460.6 | 294 | 184 | 184 | 276 | 368 | 276 | 184 | 368 | 276 | 276 | 552 | 552 | 552 | 276 | 552 |
| Unit availability | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Scheduled maintenance | wks per unit | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Forced outage rate | % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Combined outage rate | % | 13 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | | 20 | | 20 | | 20 | 20 |
| Net capacity available (after derating for outage) | MW | 160 | 263 | 526 | 526 | 281 | 290 | 281 | 412 | 281 | 526 | 303 | 263 | 281 | 281 | 526 | 412 | 263 | 150 | 150 | 225 | 299 | 225 | 150 | 299 | 225 | 225 | 449 | 449 | 449 | 225 | 449 |
| Earliest on-power date | Yr | 2021 | 2025 | 2028 | 2029 | 2029 | 2031 | 2032 | 2032 | 2034 | 2033 | 2037 | 2039 | 2041 | 2042 | 2043 | 2044 | 2040 | 2032 | 2034 | 203l | 2038 | 2043 | 2032 | 2036 | 2036 | 2029 | 2034 | 2033 | 2039 | 2038 | 2044 |
| Service life | Yrs | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| O & M | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fixed O & M | $/kW | 16.3 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 40.58 | 40.58 | 40.58 | 40.58 | 40.58 | 40.58 | 40.58 | 40.58 | 40.58 | 40.58 | 40.58 | 40.58 | 40.58 | 40.58 |
| Variable O & M | $/kWh | 0.0507 | 0.0361 | 0.0357 | 0.0366 | 0.0357 | 0.0357 | 0.0357 | 0.0357 | 0.0366 | 0.0357 | 0.0366 | 0.0331 | 0.0357 | 0.0357 | 0.0331 | 0.0357 | 0.0357 | 0.0257 | 0.0257 | 0.0276 | 0.0276 | 0.0276 | 0.0234 | 0.0234 | 0.0257 | 0.0257 | 0.0257 | 0.0257 | 0.0257 | 0.0257 | 0.0257 |
| Total capital cost with IDC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Unit capital cost | US $/kW | 1016.2 | 1213.0 | 1124.0 | 1124.0 | 1124.0 | 1213.0 | 1124.0 | 1124.0 | 1062.5 | 1124.0 | 1262.0 | 1113.0 | 1062.5 | 1062.5 | 1124.0 | 1262.0 | 1200.0 | 2186.0 | 2186.0 | 2185.7 | 2185.7 | 2185.7 | 2186.0 | 2344.4 | 2344.4 | 2185.7 | 2185.7 | 2319.3 | 2347.1 | 2319.3 | 2536.7 |
| Capital cost | USD Mil. | 185.0 | 356.6 | 660.9 | 660.9 | 352.5 | 392.3 | 352.5 | 517.7 | 333.2 | 660.9 | 426.7 | 327.2 | 333.2 | 333.2 | 660.9 | 581.3 | 352.8 | 402.2 | 402.2 | 603.2 | 804.3 | 603.2 | 402.2 | 862.7 | 647.1 | 603.2 | 1206.5 | 1280.2 | 1295.6 | 640.1 | 1400.3 |
| Avg capital cost per available capacity | $/kW avail | 1158.8 | 1355.0 | 1255.6 | 1255.6 | 1255.6 | 1355.0 | 1255.6 | 1255.6 | 1186.9 | 1255.6 | 1409.8 | 1243.3 | 1186.9 | 1186.9 | 1255.6 | 1409.8 | 1340.5 | 2686.0 | 2686.0 | 2685.6 | 2685.6 | 2685.6 | 2686.0 | 2880.6 | 2880.6 | 2685.6 | 2685.6 | 2849.8 | 2884.0 | 2849.8 | 3116.9 |
| Annual fixed cost | $/kW avail | 30.2 | 27.2 | 26.2 | 26.2 | 26.2 | 27.2 | 26.2 | 26.2 | 25.5 | 26.2 | 27.7 | 26.1 | 25.5 | 25.5 | 26.2 | 27.7 | 27.0 | 76.7 | 76.7 | 76.7 | 76.7 | 76.7 | 76.7 | 78.7 | 78.7 | 76.7 | 76.7 | 78.4 | 78.7 | 78.4 | 81.0 |
| **Cashflow in year prior to on-power** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| -7 | % of capital | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| -6 | % of capital | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| -5 | % of capital | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -4 | % of capital | | 0 | | 0 | 0 | 0 | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -3 | % of capital | 22 | 40 | | 0 | 0 | 0 | 0 | 0 | 30 | 30 | 30 | 0 | 30 | 30 | 30 | 30 | 30 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| -2 | % of capital | 10 | 58 | 45 | 40 | 30 | 50 | 45 | 30 | 50 | 50 | 50 | 40 | 50 | 50 | 50 | 50 | 50 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| -1 | % of capital | 68 | 2 | 55 | 60 | 70 | 50 | 55 | 70 | 20 | 20 | 20 | 60 | 20 | 20 | 20 | 20 | 20 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| 0 | % of capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Avg total cost at on-power | $/kW avail | 1203.9 | 1488.6 | 1295.1 | 1290.8 | 1282.0 | 1402.4 | 1295.1 | 1282.0 | 1280.0 | 1354.1 | 1520.4 | 1278.1 | 1280.0 | 1280.0 | 1354.1 | 1520.4 | 1445.7 | 2839.1 | 2839.1 | 2838.6 | 2838.6 | 2838.6 | 2839.1 | 3044.8 | 3044.8 | 2838.6 | 2838.6 | 3012.2 | 3048.3 | 3012.2 | 3294.6 |
| Annuity over economic life (year-end) | $/kW avail | 103.3 | 127.7 | 111.1 | 110.8 | 110.0 | 120.3 | 111.1 | 110.0 | 109.8 | 116.2 | 130.5 | 109.7 | 109.8 | 109.8 | 116.2 | 130.5 | 124.1 | 219.3 | 219.3 | 219.2 | 219.2 | 219.2 | 219.3 | 235.2 | 235.2 | 219.2 | 219.2 | 232.6 | 235.4 | 232.6 | 254.5 |
| Total annual fixed cost | $/kW avail | 133.5 | 154.9 | 137.3 | 136.9 | 136.2 | 147.5 | 137.3 | 136.2 | 135.3 | 142.4 | 158.2 | 135.7 | 135.3 | 135.3 | 142.4 | 158.2 | 151.1 | 296.0 | 296.0 | 296.0 | 296.0 | 296.0 | 296.0 | 313.8 | 313.8 | 296.0 | 296.0 | 311.0 | 314.1 | 311.0 | 335.5 |
| **Fuel cost calculation** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fuel type | | NG | NG | NG | NG | NG | NG | NG | NG | NG | NG | NG | NG | NG | NG | NG | NG | NG | Coal | Coal | Coal | Coal | Coal | Coal | Coal | Coal | Coal | Coal | Coal | Coal | Coal | Coal |
| Heat rate | kJ/kWh | 8,281 | 6,666 | 6,090 | 6,666 | 6,090 | 6,090 | 6,090 | 6,090 | 6,666 | 6,090 | 6,666 | 6,090 | 6,090 | 6,090 | 6,090 | 6,090 | 6,090 | 8,216 | 8977 | 8,977 | 8977 | 8,977 | 8977 | 8,977 | 8977 | 8,977 | 8977 | 8,977 | 8977 | 8,977 | 8977 |
| Fuel cost | $/kWh | 0.0460 | 0.0342 | 0.0339 | 0.0347 | 0.0339 | 0.0339 | 0.0339 | 0.0339 | 0.0347 | 0.0339 | 0.0347 | 0.0312 | 0.0339 | 0.0339 | 0.0312 | 0.0339 | 0.0339 | 0.0212 | 0.0212 | 0.0231 | 0.0231 | 0.0231 | 0.0189 | 0.0189 | 0.0212 | 0.0212 | 0.0212 | 0.0212 | 0.0212 | 0.0212 | 0.0212 |
| Total fixed cost | $/kW avail. | 133.5 | 154.9 | 137.3 | 136.9 | 136.2 | 147.5 | 137.3 | 136.2 | 135.3 | 142.4 | 158.2 | 135.7 | 135.3 | 135.3 | 142.4 | 158.2 | 151.1 | 296.0 | 296.0 | 296.0 | 296.0 | 296.0 | 296.0 | 313.8 | 313.8 | 296.0 | 296.0 | 311.0 | 314.1 | 311.0 | 335.5 |
| Total variable cost | $/kWh avail. | 0.09677 | 0.07025 | 0.06958 | 0.07128 | 0.06958 | 0.06958 | 0.06958 | 0.06958 | 0.07128 | 0.06958 | 0.07128 | 0.06434 | 0.06958 | 0.06958 | 0.06434 | 0.06958 | 0.06958 | 0.04688 | 0.04688 | 0.05070 | 0.05070 | 0.05070 | 0.04220 | 0.04220 | 0.04688 | 0.04688 | 0.04688 | 0.04688 | 0.04688 | 0.04688 | 0.04688 |

**No**

**te:**

1.NG = Natural Gas

**Table 3-24:** Screening of New Hydropower Projects

| PROJECT NAME / CHARACTERISTICS | | | Rusumo (80 MW)* | Murongo/Kikagati (14 MW)* | Julius Nyerere | Malagarasi | Ruhudji | Songwe Manolo (180.2 MW)* | Kakono | Rumakali | Upper Kihansi | Masigira | Kikonge | Mnyera Kwanini | Mpanga | Mnyera Taveta | Songwe Sofre (163.2 mw)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Installed capacity MW | | | 27.0 | 7.0 | 2,115.0 | 49.5 | 358.0 | 90.1 | 87.0 | 222.0 | 120.0 | 118.0 | 300.0 | 143.9 | 160.0 | 145.0 | 81.6 |
| Average Energy GWH | | | 253.5 | 43.8 | 9,263.7 | 181.0 | 2,000.0 | 471.7 | 573.0 | 1,322.0 | 69.0 | 664.0 | 1,268.0 | 693.8 | 1,061.1 | 850.0 | 382.5 |
| | | | | | | | | | | | | | | | | | |
| **Capital costs** | | | | | | | | | | | | | | | | | |
| Capital cost $ Million | | | 113.0 | 29.0 | 2,851.6 | 144.1 | 407.4 | 275.0 | 280.4 | 375.2 | 220.8 | 261.3 | 740.9 | 164.3 | 298.5 | 205.8 | 152.2 |
| Year of estimate | | | 2021 | 2021 | 2022 | 2024 | 2025 | 2028 | 2026 | 2026 | 2026 | 2028 | 2028 | 2036 | 2033 | 2034 | 2035 |
| **IDC calculation** | | | | | | | | | | | | | | | | | |
| % cost year -6 | 6 | 0.666 | | | | | | | | | | | | | | | |
| % cost year -5 | 5 | 0.713 | | | | | | | 0.05 | | | | | | | | |
| % cost year -4 | 4 | 0.763 | | | 0.24 | 0.20 | 0.20 | 0.20 | 0.15 | 0.10 | 0.10 | 0.10 | 0.20 | | 0.10 | | 0.10 |
| % cost year -3 | 3 | 0.816 | 0.050 | | 0.41 | 0.30 | 0.20 | 0.30 | 0.30 | 0.20 | 0.20 | 0.20 | 0.30 | 0.20 | 0.20 | 0.20 | 0.20 |
| % cost year -2 | 2 | 0.873 | 0.350 | 0.20 | 0.19 | 0.40 | 0.30 | 0.40 | 0.40 | 0.30 | 0.30 | 0.30 | 0.40 | 0.40 | 0.30 | 0.40 | 0.30 |
| % cost year -1 | 1 | 0.935 | 0.555 | 0.76 | 0.12 | 0.06 | 0.26 | 0.06 | 0.06 | 0.36 | 0.36 | 0.36 | 0.06 | 0.36 | 0.36 | 0.36 | 0.36 |
| % cost of pre-Construction | 0 | 1.000 | 0.045 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Total | | | 1.000 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Cost with IDC, USD Mil. | | | 178.2 | 46.2 | 4,284.7 | 217.6 | 622.3 | 415.1 | 422.6 | 579.6 | 341.1 | 403.6 | 1,118.5 | 255.6 | 461.1 | 320.1 | 235.1 |
| Unit Capital Cost, USD/kW | | | 6,598.2 | 6,593.9 | 2,025.8 | 4,395.8 | 1,738.3 | 4,607.5 | 4,857.3 | 2,610.8 | 2,842.2 | 3,420.0 | 3,728.2 | 1,776.3 | 2,881.8 | 2,207.6 | 2,881.2 |
| **Fixed annual cost** | | | | | | | | | | | | | | | | | |
| Fixed annual cost (capital + interest UAP) | | | 12.91 | 3.34 | 310.47 | 15.77 | 45.09 | 30.08 | 30.62 | 42.00 | 24.71 | 29.24 | 81.04 | 18.52 | 33.41 | 23.19 | 17.04 |
| Fixed O & M, USD Mil. | 10 | | 0.27 | 0.07 | 21.15 | 0.50 | 3.58 | 0.90 | 0.87 | 2.22 | 1.20 | 1.18 | 3.00 | 1.44 | 1.60 | 1.45 | 0.82 |
| Total fixed annual cost | | | 26.09 | 6.76 | 642.08 | 32.03 | 93.77 | 61.06 | 62.11 | 86.22 | 50.63 | 59.66 | 165.09 | 38.48 | 68.42 | 47.84 | 34.89 |
| **Unit cost of energy** | | | | | | | | | | | | | | | | | |
| Average energy $/kWh | | | 0.10 | 0.15 | 0.07 | 0.18 | 0.05 | 0.13 | 0.11 | 0.07 | 0.73 | 0.09 | 0.13 | 0.06 | 0.06 | 0.06 | 0.09 |

| PROJECT NAME / CHARACTERISTICS | Iringa (Nginayo) | Iringa (Ibosa) | Mnyera Mnyera | Ikondo Mnyera | Mnyera Kisingo | Mnyera Ruaha | Mnyera Pumbwe | Iringa Kilolo | Songwe Bupigu (34 MW)* | Mbarali | Njombe | Mhanga | Songea | Nakatuta (Liparamba) | Kikuletwa |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Installed capacity MW | 52.0 | 36.0 | 137.4 | 340.0 | 119.8 | 60.3 | 122.9 | 150.0 | 17.0 | 38.5 | 32.0 | 26.6 | 15.0 | 15.0 | 11.0 |
| Average Energy GWH | 262.8 | 186.1 | 662.3 | 1,832.0 | 577.3 | 290.8 | 592.2 | 994.8 | 76.5 | 199.0 | 165.4 | 250.1 | 140.8 | 140.8 | 103.3 |
| | | | | | | | | | | | | | | | |
| **Capital costs** | | | | | | | | | | | | | | | |
| Capital cost $ Million | 125.5 | 123.0 | 274.1 | 665.8 | 314.0 | 255.1 | 219.3 | 300.0 | 58.5 | 162.9 | 135.4 | 95.0 | 52.8 | 52.8 | 38.7 |
| Year of estimate | 2035 | 2035 | 2029 | 2038 | 2039 | 2039 | 2039 | 2039 | 2040 | 2040 | 2040 | TBD | TBD | TBD | TBD |
| **IDC calculation** | | | | | | | | | | | | | | | |
| % cost year -6 | | | | | | | | | | | | | | | |
| % cost year -5 | | | | | | | | | | | | | | | |
| % cost year -4 | | | | | | | | | | | | | | | |
| % cost year -3 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| % cost year -2 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 |
| % cost year -1 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 |
| % cost of pre-Construction | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Total | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Cost with IDC, USD Mil. | 195.2 | 191.4 | 426.4 | 1,035.8 | 488.6 | 396.8 | 341.2 | 466.7 | 91.0 | 253.4 | 210.6 | 147.8 | 82.1 | 82.1 | 60.2 |
| Unit Capital Cost, USD/kW | 3,754.0 | 5,317.6 | 3,103.2 | 3,046.5 | 4,078.2 | 6,581.1 | 2,776.2 | 3,111.5 | 5,352.7 | 6,581.1 | 6,581.1 | 5,555.4 | 5,473.1 | 5,473.1 | 5,473.1 |
| **Fixed annual cost** | | | | | | | | | | | | | | | |
| Fixed annual cost (capital + interest UAP) | 14.14 | 13.87 | 30.90 | 75.06 | 35.40 | 28.76 | 24.72 | 33.82 | 6.59 | 18.36 | 15.26 | 10.71 | 5.95 | 5.95 | 4.36 |
| Fixed O & M, USD Mil. | 0.52 | 0.36 | 1.37 | 3.40 | 1.20 | 0.60 | 1.23 | 1.50 | 0.17 | 0.39 | 0.32 | 0.27 | 0.15 | 0.15 | 0.11 |
| Total fixed annual cost | 28.81 | 28.10 | 63.17 | 153.51 | 72.00 | 58.11 | 50.67 | 69.14 | 13.36 | 37.10 | 30.84 | 21.68 | 12.05 | 12.05 | 8.83 |
| **Unit cost of energy** | | | | | | | | | | | | | | | |
| Average energy $/kWh | 0.11 | 0.15 | 0.10 | 0.08 | 0.12 | 0.20 | 0.09 | 0.07 | 0.17 | 0.19 | 0.19 | 0.09 | 0.09 | 0.09 | 0.09 |

**Note:** *These are a shared project with neighbouring countries.
**Source:** PSMP 2020 Update Team Compilation.

## **Table 3-25:** Screening of New Renewable Projects

| PROJECT NAME / CHARACTERISTICS | Unit | Shinyanga I (Kishapu) | Dodoma I | Dodoma II | Manyoni | Same | Singida | Shinyanga II | Singida I | Makambako | Njombe I | Singida II | Njombe II | Singida III | Songwe | Ngozi (wellhead) & Ngozi I | Kiejo – Mbaka | Natron | Luhoi | Ngozi II | Geothermal Phase I | Geothermal Phase II | Geothermal Phase III | Geothermal Phase IV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Source** | | Solar | Solar | Solar | Solar | Solar | Solar | solar | Wind | Wind | Wind | Wind | Wind | Wind | Geothermal | Geothermal | Geothermal | Geothermal | Geothermal | Geothermal | Geothermal | Geothermal | Geothermal | Geothermal |
| Capital Cost | | 117.098 | 93.8795 | 102.414 | 178.5 | 89.25 | 117.098 | 117.098 | 126.5 | 379.5 | 126.5 | 126.5 | 253 | 253 | 12.605 | 75.63 | 151.26 | 151.26 | 12.605 | 100.84 | 491.595 | 504.2 | 466.385 | 542.02 |
| Installed capacity | MW | 150 | 55 | 60 | 100 | 50 | 150 | 150 | 100 | 300 | 100 | 100 | 200 | 200 | 5 | 30 | 60 | 60 | 5 | 40 | 195 | 200 | 185 | 215 |
| Station service | % | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% |
| Net capacity | MW | 148.5 | 54.45 | 59.4 | 99 | 49.5 | 148.5 | 148.5 | 99 | 297 | 99 | 99 | 198 | 198 | 4.9 | 29.4 | 58.8 | 58.8 | 4.9 | 39.2 | 191.1 | 196 | 181.3 | 210.7 |
| **Unit availability** | | | | | | | | | | | | | | | | | | | | | | | | |
| Scheduled maintenance | wks per unit | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Forced outage rate | % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Combined outage rate | % | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| **Net capacity available** | MW | 132.9 | 48.7 | 53.2 | 88.6 | 11 | 132.9 | 132.9 | 88.6 | 265.9 | 88.6 | 88.6 | 177.2 | 177.2 | 4.2 | 25.2 | 50.5 | 50.5 | 4.2 | 33.7 | 164.1 | 168.3 | 155.6 | 180.9 |
| (after derating for outage) | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| **Earliest on-power date** | Yr | 2027 | 2024 | 2031 | 2040 | 2042 | 2023 | 2041 | 2025 | 2037 | 2041 | 2036 | TBD | 2039 | 2023 | 2023 | 2024 | 2027 | 2027 | 2026 | 2030 | 2035 | 2040 | 2044 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| **Service life** | Yrs | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| **O & M** | | | | | | | | | | | | | | | | | | | | | | | | |
| Fixed O & M | $/kW | 15.25 | 15.25 | 15.25 | 15.25 | 15.25 | 15.25 | 15.25 | 26.34 | 26.34 | 26.34 | 26.34 | 26.34 | 26.34 | 128.544 | 128.544 | 128.544 | 128.544 | 128.544 | 128.544 | 128.544 | 128.544 | 128.544 | 128.544 |
| Variable O & M | $/kWh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00116 | 0.00116 | 0.00116 | 0.00116 | 0.00116 | 0.00116 | 0.00116 | 0.00116 | 0.00116 | 0.00116 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| **Total capital cost with IDC** | | | | | | | | | | | | | | | | | | | | | | | | |
| Unit capital cost | US $/kW | 1,280.98 | 585.86 | 585.86 | 560.22 | 560.22 | 1,280.98 | 1,280.98 | 790.51 | 790.51 | 790.51 | 790.51 | 790.51 | 790.51 | 2,521.00 | 2,521.00 | 2,521.00 | 2,521.00 | 2,521.00 | 2,521.00 | 2,521.00 | 2,521.00 | 2,521.00 | 2,521.02 |
| Capital cost | US $ x $10^6$ | 192.15 | 32.22 | 35.15 | 56.02 | 28.01 | 192.15 | 192.15 | 79.05 | 237.15 | 79.05 | 79.05 | 158.10 | 158.10 | 12.61 | 75.63 | 151.26 | 151.26 | 12.61 | 100.84 | 491.60 | 504.20 | 466.39 | 542.02 |
| Avg capital cost per available capacity | $/kW avail | 1,445.41 | 661.06 | 661.06 | 632.14 | 2,546.47 | 1,445.41 | 1,445.41 | 891.99 | 891.99 | 891.99 | 891.99 | 891.99 | 891.99 | 2,996.58 | 2,996.58 | 2,996.58 | 2,996.58 | 2,996.58 | 2,996.58 | 2,996.58 | 2,996.58 | 2,996.58 | 2,996.61 |
| Annual fixed cost | $/kW avail | 31.49 | 23.65 | 23.65 | 23.36 | 94.09 | 31.49 | 31.49 | 38.34 | 38.34 | 38.34 | 38.34 | 38.34 | 38.34 | 179.70 | 179.70 | 179.70 | 179.70 | 179.70 | 179.70 | 179.70 | 179.70 | 179.70 | 179.70 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| Cashflow in year prior to on-power | | | | | | | | | | | | | | | | | | | | | | | | |
| -7 | % of capital | | | | | | | | | | | | | | | | | | | | | | | |
| -6 | % of capital | | | | | | | | | | | | | | | | | | | | | | | |
| -5 | % of capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | |
| -4 | % of capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -3 | % of capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| -2 | % of capital | 40 | 40 | 40 | 40 | 40 | 90 | 90 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| -1 | % of capital | 60 | 60 | 60 | 60 | 60 | 10 | 10 | 100 | 100 | 100 | 100 | 100 | 100 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 0 | % of capital | | | | | | | | | | | | | | | | | | | | | | | |
| Avg total cost at on-power | $/kW avail | 1,503.224 | 687.502 | 687.502 | 657.421 | 2,648.332 | 1,575.494 | 1,575.494 | 891.986 | 891.986 | 891.986 | 891.986 | 891.986 | 891.986 | 3,239.303 | 3,239.303 | 3,239.303 | 3,239.303 | 3,239.303 | 3,239.303 | 3,239.303 | 3,239.303 | 3,239.303 | 3,239.333 |
| Annuity over economic life (year-end) | $/kW avail | 165.607 | 75.741 | 75.741 | 72.427 | 291.762 | 173.569 | 173.569 | 98.268 | 98.268 | 98.268 | 98.268 | 98.268 | 98.268 | 356.868 | 356.868 | 356.868 | 356.868 | 356.868 | 356.868 | 356.868 | 356.868 | 356.868 | 356.871 |
| Total annual fixed cost | $/kW avail | 197.097 | 99.387 | 99.387 | 95.784 | 385.851 | 205.059 | 205.059 | 136.612 | 136.612 | 136.612 | 136.612 | 136.612 | 136.612 | 536.571 | 536.571 | 536.571 | 536.571 | 536.571 | 536.571 | 536.571 | 536.571 | 536.571 | 536.575 |
| **Fuel cost calculation** | | | | | | | | | | | | | | | | | | | | | | | | |
| Fuel type | | | | | | | | | | | | | | | | | | | | | | | | |
| Fuel price | $/GJ | | | | | | | | | | | | | | | | | | | | | | | |
| Heat rate | kJ/kWh | | | | | | | | | | | | | | | | | | | | | | | |
| Fuel cost | $/kWh | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| **Total fixed cost** | $/kW avail. | 197.10 | 99.39 | 99.39 | 95.78 | 385.85 | 205.06 | 205.06 | 136.61 | 136.61 | 136.61 | 136.61 | 136.61 | 136.61 | 536.57 | 536.57 | 536.57 | 536.57 | 536.57 | 536.57 | 536.57 | 536.57 | 536.57 | 536.57 |
| **Total variable cost** | $/kWh avail. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00116 | 0.00116 | 0.00116 | 0.00116 | 0.00116 | 0.00116 | 0.00116 | 0.00116 | 0.00116 | 0.00116 |

**Note:** Geothermal Phase I,II,II and IV sites are clarified in Table 3-31.
**Source:** PSMP 2020 Update Team Compilation

### 3.7. Generation Plan

#### 3.7.1. Generation Plan Strategies and Criteria

##### 3.7.1.1. Generation Plan Strategies

This update adopted and reviewed some strategies applied in the preparation of PSMP 2008 and its Updates (2009, 2012 and 2016). **Table 3-26** shows the overall power development strategies.

**Table 3-26:** Overall Power Development Strategies

| Element | Reason |
| --- | --- |
| Base-Case load forecast | To take account of all identified new industrial loads, including background load growth, and to target a 96.1 percent electrification rate by 2044. |
| Interconnect isolated regions | To the extent that it is economic and feasible to do so, in order to promote social and economic development. |
| Install all new generation options that are feasible in the short term | To accommodate committed projects to meet the projected short term demand. |
| Use a judicious mix of hydro and non-hydro generation options | To avoid over-reliance on hydro with the attendant risk of power shortages during dry periods. |
| Accept limited amounts of firm exports | To balance demand and energy supply with an acceptable reserve margin. |
| Schedule new generation so that sufficient reserve margin is provided to allow for future pool power trading | To improve the economics of system expansion by developing revenue potential, while also providing improved security of energy supply |

##### 3.7.1.2. Generation Plan Criteria

a. **Reserve Margin:** This Plan assumes a reserve margin of 15 to 20 percent of the system installed capacity.

b. **Generation Mix:** This Plan considers an increase in the share of renewable energy and coal resources.

c. **Loss of Load Expectation**: The Plan maintains the use of a maximum loss of load expectation (LOLE) of 5 days per year as established in 2008 and its Updates (2009, 2012 and 2016). The LOLE values are based on a hydropower during a low flow period with a return period of 1:30 years, or 97 percent probability of exceedance.

d. **Outage rates:** The plan assumes that there will be planned and forced outages at the generating plants. The Combined Outage Rates per year is a result of scheduled maintenance and forced outages. **Table 3-27** outlines the selected outage rates based on different power generation technologies.

**Table 3-27:** Outage Rates for Power Generation

| Generation Type | Schedule maintenance in weeks per year | Forced outage in percentage of time per year | Combined outage rate percent |
|---|---|---|---|
| Coal (IGCC) | 6 | 8 | 20 |
| Gas Turbine (GT) | 4 | 5 | 13 |
| Combined Cycle Gas Turbine (CCGT) | 3 | 5 | 11 |
| Hydroelectric | 4 | 5 | 8 |
| Geothermal | 4 | 7 | 15 |

e. **Plant Life Span: Table 3-28** shows the plant life spans. The life span values inform the determination of average unit generation costs for preliminary comparisons, and for determining retirement dates for existing and future plants in the development of generation plan.

**Table 3-28:** Power Plants Life Span

| Technology Type | Normal Sevice life (years) |
|---|---|
| Gas Turbines | 25 |
| Combined Cycle Gas Turbine | 25 |
| Medium Speed Diesel | 20 |
| Low Speed Diesel | 25 |
| Coal | 35 |
| Hydroelectric Plant | 50 |
| Renewable (Wind, Solar, Geothermal) | 25 |

**Note:** The indicated generic economic life time is normally extended through proper maintenance and replacement of major equipment.
**Source:** PSMP 2020 Team compilation

f. **Operation, Maintenance (O&M), and other costs:** Unit generation costs include allowances for operation and maintenance. For thermal plants, the operation and maintenance costs are part of fixed and variable costs. In contrast, for hydroelectric plants, O&M cost is considered as a fixed cost. **Table 3-29** shows the Operation and Maintenance costs for various generation technologies.

**Table 3-29:** Selected Operation and Maintenance Costs for Generation Technologies

| Plant Type | Unit size (MW) | Fixed O&M (US$/kW-yr) | Variable O&M (US$/kWh) |
|---|---|---|---|
| Coal | 300 | 40.58 | 0.0258 |
| Gas Turbine (GT) | 60 | 16.30 | 0.0507 |
| Combined Cycle Gas Turbine | 300 | 12.2 | 0.0356 |
| Hydroelectric | 100 | 29.86 | 0 |
| Geothermal | 50 | 128.544 | 0.00116 |
| Solar PV w/ Single Axis Tracking + Battery Storage | 150 MWAC Solar 50 MW \| 200 MWh Storage | 31.27 | 0 |
| Solar PV w/ Single Axis Tracking | 150 MWAC | 15.25 | 0 |
| Fixed-bottom Offshore Wind: Monopile Foundations | 400 MW \| 10 MW WTG | 110 | 0 |

**Source:** U.S. Energy Information Administration, Capital Cost, and Performance Characteristics Estimates for Utility-Scale Electric Power Generating Technologies (2020).

g. **Lead times:** A critical issue in determining the possible scheduling of new projects is the minimum lead-time that would be required to complete the project implementation process up to commercial operation date. Factors considered during the estimate of minimum lead-time are the level of preparation of the project (Pre-feasibility, feasibility, bankable document etc.).

This Plan considered that the earliest lead times will be January 2021. **Table 3-30** shows the time for each of the individual activities leading up to the implementation of the project and on-power, of which can be used to assess an appropriate minimum lead time of a project.

**Table 3-30:** Lead times for Power Generating Projects

| Activity | Time (months) |
|---|---|
| Prefeasibility study, following a reconnaissance level project identification. | 6-12 |
| Feasibility study (including consultant selection). | 12-24 |
| Feasibility study update (where required). | 6-12 |
| Environmental study. | 12 |
| ESIA Approval/Certification. | 3 |
| Preparation of tender documents, access permit acquisition, resettlement and compensation. | 12 |

| Activity | Time (months) |
|---|---|
| Project financing. | 12 |
| Tendering. | 6-12 |
| Final design (including consultant selection) – depending on size/complexity. | 12-18 |
| Construction (depending on size/complexity). | 24-72 |

**Source:** PSMP 2020 Update Team Compilation.

Several factors determine the overall lead time required for the construction of a given power plant. The factors are Government commitment, environmental approval process, private or public ownership, availability of funds, size and complexity of the project and the extent to which activities may be fast-tracked for instance carrying out activities in parallel, such as final design and preparation of the Enviromental Impact Assessment (EIA).

#### 3.7.2. Power Trading

Tanzania is a member of SAPP and EAPP, from which there is a posibility of power exchange with neighbouring countries and the regions as a whole. In respect to this, Tanzania is implementing regional interconnector projects which will enable power exchange, hence enhancing security of supply between Member States of the power pools.

Currently, the ongoing construction of strategic interconnector projects are from Tanzania to Kenya, Zambia, Burundi, and Rwanda. Other planned strategic interconnectors are from Tanzania to Uganda, Mozambique, Democratic Repubic of Congo and Malawi. The ongoing interconnector projects have a total transfer capability of about 1,500 MW while planned strategic interconnectors shall have transfer capability of 1,200 MW. The detailed parameters for ongoing and planned interconnectors can be referenced from Chapter Four.

Moreover, the generation plan results will provide annual respective capacities available which Tanzania may exchange with other countries in the regions through out the planning horizon.

### 3.8. Generation Plan Results

The PSMP 2020 Update generation plan consider the load forecasted demand under Base Case Scenario to propose generation projects for future country's power requirement. **Table 3-31** presents the details of the proposed projects over tha planning horizon. In the period 2020 – 2044, Tanzania requires the total installed capacity of 20,200.6 MW. The Plan indicates power generation mix consisting of hydro (5,684 MW or 28.15%), natural gas (6,700 MW or 33.18%), coal (5,300 MW or 26.24%), wind (800 MW or 3.96%), solar (715 MW or 3.54%), geothermal (995 MW or 4.93%) and (0 MW or 0%) diesel/HFO by 2044.

Furthermore, **Table 3-31** shows that total installed generation capacity in the short term is 3,971.4 MW, medium term is 12,255.7 MW and long term is 20,200.6 MW. The installed power supply capacity satisfies the forecasted load demand of the respective terms, leaving adequate surplus capacity for reserve and trading needs.

The plan indicates that Julius Nyerere Hydropower Plant will come into full operation by 2022, bringing the total installed capacity to **3,810.9 MW** rendering a surplus power capacity of **2,001.9 MW**. However, due to limitation in transmission capacity, the power generation plan indicates that the maximum power to be traded is **1,000 MW** in 2023 and additional of **500 MW** by 2025 onwards.

**Figures 3-3** and **3-4** illustrate the evolution of the installed power capacity and generation resource mix over the planning horizon to 2044. The figures show that the share of coal and renewable resources is increasing in the generation mix while oil (Diesel and HFO) connected to the National Grid will be phased out by 2021.

The utilization of the least cost generation sources like JNHPP will lead to economic dispatch of power generation plants and that suggest to non-utilization of some of thermal powered plants. However, under climatic consideration development of thermal power plants is inevitable. Furthermore, in order for the country to fully utilize thermal power plants and export the aforementioned surplus capacity, investment in short term for power interconnector projects to SAPP and EAPP is recommended. In this regard, it is further recommended that, arrangements to initiate bilateral and multilateral power exchange agreements have to start immediately.

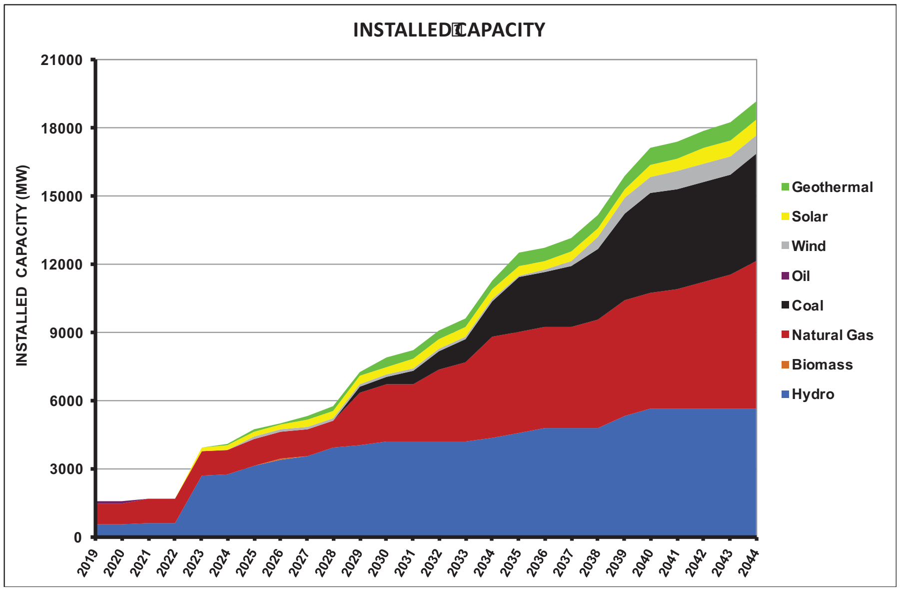



**Figure 3-3:** Installed Generation Capacity

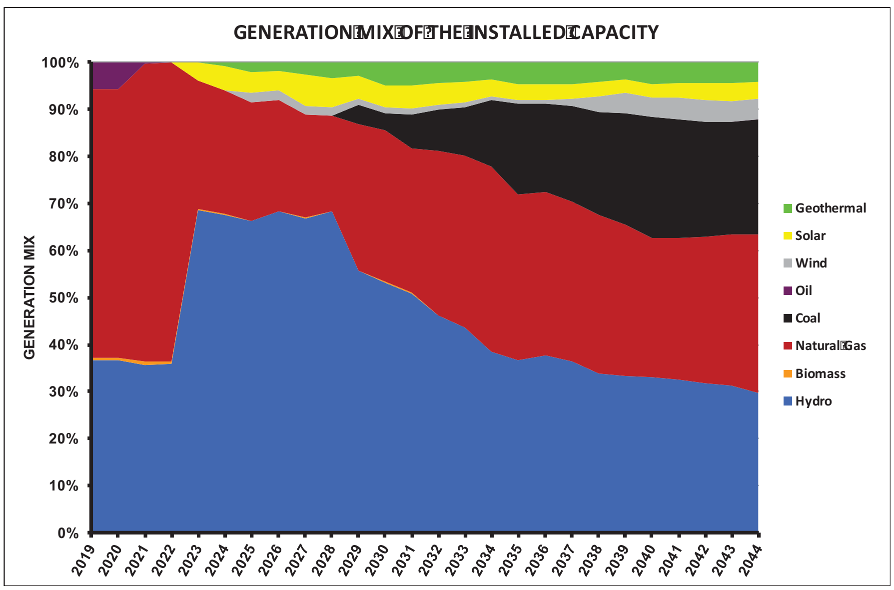



**Figure 3-4:** Generation Mix of the Installed Capacity

**Table 3-31:** Generation Plan

| YEAR | PLANT | FUEL | TYPE | ADDITION | | TOTAL SUPPLY | | DEMAND | | SURPLUS / DEFICIT | | RESERVE MARGIN | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | CAPACITY (MW) | AVERAGE ENERGY (GWH) | CAPACITY (MW) | AVERAGE ENERGY (GWH) | CAPACITY (MW) | AVERAGE ENERGY (GWH) | CAPACITY (MW) | AVERAGE ENERGY (GWH) | CAPACITY (%) | ENERGY (%) |
| 2019 | All existing plants | | | | | 1,565.7 | 9,172.9 | | | | | | |
| | | | | | | 1,565.7 | 9,172.9 | 1,120.1 | 7,861.0 | 445.6 | 1,311.9 | 39.8 | 16.7 |
| 2020 | | | | | | 1,565.7 | 9,172.9 | 1,435.0 | 8,028.0 | 130.7 | 1,144.9 | 9.1 | 14.3 |
| 2021 | Kinyerezi I ext | Gas | SC | 185.0 | 1,232.0 | 1,750.7 | 10,404.9 | | | | | | |
| | Rusumo (80 MW)* | Hydro | Hydro | 27.0 | 253.5 | 1,777.7 | 10,658.4 | | | | | | |
| | Murongo/Kikagati - (14 MW)* | Hydro | Hydro | 7.0 | 43.8 | 1,784.7 | 10,702.2 | | | | | | |
| | Biharamulo (Retire)** | Diesel | Diesel | (4.14) | (24.52) | 1,780.6 | 10,677.7 | | | | | | |
| | Namtumbo (Retire)** | Diesel | Diesel | (0.34) | (2.01) | 1,780.2 | 10,675.6 | | | | | | |
| | Madaba (Retire)** | Diesel | Diesel | (0.48) | (2.84) | 1,779.8 | 10,672.8 | | | | | | |
| | Songea (Retire)** | Diesel | Diesel | (7.67) | (45.43) | 1,772.1 | 10,627.4 | | | | | | |
| | Ludewa (Retire)** | Diesel | Diesel | (1.27) | (7.52) | 1,770.8 | 10,619.8 | | | | | | |
| | Zuzu (Retire)** | Diesel | Diesel | (7.40) | (43.83) | 1,763.4 | 10,576.0 | | | | | | |
| | Mbinga (Retire)** | Diesel | Diesel | (2.00) | (11.85) | 1,761.4 | 10,564.2 | | | | | | |
| | Nyakato (Standby)** | Diesel | Diesel | (63.00) | (373.18) | 1,698.4 | 10,191.0 | | | | | | |
| | Ngara (Retire)** | Diesel | Diesel | (2.50) | (14.81) | 1,695.9 | 10,176.2 | 1,629.0 | 9,098.0 | 66.9 | 1,078.2 | 4.1 | 11.9 |
| 2022 | Julius Nyerere | Hydro | Hydro | 2,115.0 | 9,263.7 | 3,810.9 | 19,439.9 | 1,809.0 | 10,176.0 | 2,001.9 | 9,263.9 | 110.7 | 91.0 |
| 2023 | Singida | Solar | Solar | 150.0 | 274.8 | 3,960.9 | 19,714.7 | | | | | | |
| | Songwe | Geothermal | Geothermal | 5.0 | 39.4 | 3,965.9 | 19,754.1 | | | | | | |
| | Ngozi (wellhead) & Ngozi I | Geothermal | Geothermal | 30.0 | 236.5 | 3,995.9 | 19,990.6 | | | | | | |
| | Export | Export | Export | (1,000.00) | (4,380.00) | 2,995.9 | 15,610.6 | 2,036.0 | 11,470.0 | 959.9 | 4,140.6 | 47.1 | 36.1 |
| 2024 | Malagarasi | Hydro | Hydro | 49.5 | 181.0 | 3,045.4 | 15,791.6 | | | | | | |
| | Dodoma I | Solar | Solar | 55.0 | 100.8 | 3,100.4 | 15,892.4 | | | | | | |
| | Kiejo – Mbaka | Geothermal | Geothermal | 60.0 | 473.0 | 3,160.4 | 16,365.4 | | | | | | |
| | Songas (Retire) | Gas | SC | (189.00) | (1,233.12) | 2,971.4 | 15,132.2 | 2,329.0 | 13,240.0 | 642.4 | 1,892.2 | 27.6 | 14.3 |
| 2025 | Ruhudji | Hydro | Hydro | 358.0 | 2,000.0 | 3,329.4 | 17,132.2 | | | | | | |
| | Singida I | Wind | Wind | 100.0 | 644.0 | 3,429.4 | 17,776.2 | | | | | | |
| | Mtwara I | Gas | CCGT | 300.0 | 1,957.0 | 3,729.4 | 19,733.2 | | | | | | |
| | Export | Export | Export | (500.00) | (2,190.00) | 3,229.4 | 17,543.2 | | | | | | |
| | Andoya (Retire) | Hydro | Hydro | (1.00) | (5.91) | 3,228.4 | 17,537.3 | | | | | | |
| | Matembwe (Retire) | Hydro | Hydro | (0.95) | (0.60) | 3,227.5 | 17,536.7 | 2,677.0 | 15,271.0 | 550.5 | 2,265.7 | 20.6 | 14.8 |
| 2026 | Kakono | Hydro | Hydro | 87.0 | 573.0 | 3,314.5 | 18,109.7 | | | | | | |
| | Rumakali | Hydro | Hydro | 222.0 | 1,322.0 | 3,536.5 | 19,431.7 | | | | | | |
| | Upper Kihansi | Hydro | Hydro | 120.0 | 69.0 | 3,656.5 | 19,500.7 | | | | | | |
| | Ngozi II | Geothermal | Geothermal | 40.0 | 315.3 | 3,696.5 | 19,816.1 | | | | | | |
| | Darakuta (Retire) | Hydro | Hydro | (0.32) | (0.32) | 3,696.2 | 19,815.7 | 3,053.0 | 17,575.0 | 643.2 | 2,240.7 | 21.1 | 12.7 |
| 2027 | Mtwara (Retire) | Gas | GE | (18.00) | (117.00) | 3,678.2 | 19,698.7 | | | | | | |
| | Shinyanga I (Kishapu) | Solar | Solar | 150.0 | 327.0 | 3,828.2 | 20,025.7 | | | | | | |
| | Natron | Geothermal | Geothermal | 60.0 | 473.0 | 3,888.2 | 20,498.7 | | | | | | |
| | Luhoi | Geothermal | Geothermal | 5.0 | 39.4 | 3,893.2 | 20,538.2 | | | | | | |
| | Mwenga (Retire) | Hydro | Hydro | (4.00) | (24.00) | 3,889.2 | 20,514.2 | 3,439.0 | 19,880.0 | 450.2 | 634.2 | 13.1 | 3.2 |
| 2028 | Kikonge | Hydro | Hydro | 300.0 | 1,268.0 | 4,189.2 | 21,782.2 | | | | | | |
| | Songwe Manolo (180.2 MW)* | Hydro | Hydro | 90.1 | 471.7 | 4,279.3 | 22,253.9 | | | | | | |
| | Masigira | Hydro | Hydro | 118.0 | 664.0 | 4,397.3 | 22,917.9 | | | | | | |
| | Kinyerezi III | Gas | CCGT | 600.0 | 3,914.0 | 4,997.3 | 26,831.9 | | | | | | |
| | Ubungo I (Retire) | Gas | GE | (102.00) | (685.00) | 4,895.3 | 26,146.9 | 3,850.0 | 22,403.0 | 1,045.3 | 3,743.9 | 27.1 | 16.7 |
| 2029 | Somanga Fungu TANESCO | Gas | CCGT | 600.0 | 4,228.0 | 5,495.3 | 30,374.9 | | | | | | |
| | Mbeya I | Coal | Steam | 300.0 | 2,103.0 | 5,795.3 | 32,477.9 | | | | | | |
| | Mnyera Mnyera | Hydro | Hydro | 137.4 | 662.3 | 5,932.7 | 33,140.2 | | | | | | |
| | Tegeta (Retire) | Gas | GE | (45.00) | (290.10) | 5,887.7 | 32,850.1 | | | | | | |
| | Tegeta New | Gas | CCGT | 320.0 | 2,087.5 | 6,207.7 | 34,937.5 | 4,323.0 | 25,271.0 | 1,884.7 | 9,666.5 | 43.6 | 38.3 |
| 2030 | Geothermal Phase I (Mbeya, Manyara, Morogoro, Arusha, Shinyanga) | Geothermal | Geothermal | 195.0 | 1,537.3 | 6,402.7 | 36,474.8 | | | | | | |
| | Mtwara Additional (Retire) | Gas | GE | (4.00) | (26.00) | 6,398.7 | 36,448.8 | | | | | | |
| | TANWAT (Retire) | Biomass | Biomass | (1.50) | (10.00) | 6,397.2 | 36,438.8 | | | | | | |
| | Somanga (Retire) | Gas | GE | (7.50) | (48.93) | 6,389.7 | 36,389.9 | 4,878.0 | 28,663.0 | 1,511.7 | 7,726.9 | 31.0 | 27.0 |
| 2031 | Dodoma II | Solar | Solar | 60.0 | 210.0 | 6,449.7 | 36,599.9 | | | | | | |
| | Mchuchuma I | Coal | Steam | 300.0 | 2,103.0 | 6,749.7 | 38,702.9 | | | | | | |
| | Kinyerezi IV | Gas | CCGT | 330.0 | 2,153.1 | 7,079.7 | 40,855.9 | | | | | | |
| | Yovi (Retire) | Hydro | Hydro | (0.95) | (8.30) | 7,078.7 | 40,847.6 | | | | | | |
| | TPC (Retire) | Biomass | Biomass | (9.00) | (70.00) | 7,069.7 | 40,777.6 | 5,488.0 | 32,413.0 | 1,581.7 | 8,364.6 | 28.8 | 25.8 |
| 2032 | Kiwira I | Coal | Steam | 200.0 | 1,186.3 | 7,269.7 | 41,963.9 | | | | | | |
| | Ubungo I New | Gas | CCGT | 320.0 | 2,087.5 | 7,589.7 | 44,051.4 | | | | | | |
| | Ngaka I | Coal | Steam | 200.0 | 1,314.0 | 7,789.7 | 45,365.4 | | | | | | |
| | Ubungo II (Retire) | Gas | SC | (129.00) | (842.00) | 7,660.7 | 44,523.4 | | | | | | |
| | Ubungo II New | Gas | CCGT | 470.0 | 3,066.0 | 8,130.7 | 47,589.4 | 6,177.0 | 36,654.0 | 1,953.7 | 10,935.4 | 31.6 | 29.8 |
| 2033 | Mpanga | Hydro | Hydro | 160.0 | 1,061.1 | 8,290.7 | 48,650.5 | | | | | | |
| | Dodoma | Gas | CCGT | 600.0 | 3,914.0 | 8,890.7 | 52,564.5 | | | | | | |
| | Mbeya II | Coal | Steam | 600.0 | 3,558.9 | 9,490.7 | 56,123.4 | 6,951.0 | 41,475.0 | 2,539.7 | 14,648.4 | 36.5 | 35.3 |
| 2034 | Somanga Fungu PPP | Gas | CCGT | 320.0 | 2,087.8 | 9,810.7 | 58,211.2 | | | | | | |
| | Kiwira II | Coal | Steam | 200.0 | 1,289.0 | 10,010.7 | 59,500.2 | | | | | | |
| | Rungwe | Coal | Steam | 600.0 | 3,558.9 | 10,610.7 | 63,059.2 | | | | | | |
| | Mnyera Taveta | Hydro | Hydro | 145.0 | 850.0 | 10,755.7 | 63,909.2 | 7,851.0 | 47,022.0 | 2,904.7 | 16,887.2 | 37.0 | 35.9 |
| 2035 | Songwe Sofre (163.3 MW)* | Hydro | Hydro | 81.6 | 382.5 | 10,837.3 | 64,291.7 | | | | | | |
| | Geothermal Phase II (Mbeya, Manyara, Morogoro, Arusha, Shinyanga) | Geothermal | Geothermal | 200.0 | 1,575.0 | 11,037.3 | 65,866.7 | | | | | | |
| | Iringa (Nginayo) | Hydro | Hydro | 52.0 | 262.8 | 11,089.3 | 66,129.4 | | | | | | |
| | Iringa (Ibosa) | Hydro | Hydro | 36.0 | 186.1 | 11,125.3 | 66,315.5 | | | | | | |
| | Tulila (Retire) | Hydro | Hydro | (5.00) | (6.18) | 11,120.3 | 66,309.3 | 8,554.0 | 51,496.0 | 2,566.3 | 14,813.3 | 30.0 | 28.8 |
| 2036 | Mnyera Kwanini | Hydro | Hydro | 143.9 | 693.8 | 11,264.2 | 67,003.1 | | | | | | |
| | Rukwa I | Coal | Steam | 300.0 | 276.0 | 11,564.2 | 67,279.1 | | | | | | |
| | Singida II | Wind | Wind | 100.0 | 644.0 | 11,664.2 | 67,923.1 | | | | | | |
| | Ngaka II | Coal | Steam | 400.0 | 2,804.0 | 12,064.2 | 70,727.1 | 9,309.0 | 56,277.0 | 2,755.2 | 14,450.1 | 29.6 | 25.7 |
| 2037 | Makambako | Wind | Wind | 300.0 | 1,932.0 | 12,364.2 | 72,659.1 | | | | | | |
| | Somanga Mtama | Gas | CCGT | 345.0 | 2,250.9 | 12,709.2 | 74,910.1 | 10,116.0 | 61,376.0 | 2,593.2 | 13,534.1 | 25.6 | 22.1 |
| 2038 | Mchuchuma II | Coal | Steam | 400.0 | 2,804.0 | 13,109.2 | 77,714.1 | | | | | | |
| | Ikondo Mnyera | Hydro | Hydro | 340.0 | 1,832.0 | 13,449.2 | 79,546.1 | | | | | | |
| | Kiwira III | Coal | Steam | 300.0 | 1,779.5 | 13,749.2 | 81,325.5 | 10,968.0 | 66,818.0 | 2,781.2 | 14,507.5 | 25.4 | 21.7 |
| 2039 | Mtwara II | Gas | CCGT | 300.0 | 1,957.0 | 14,049.2 | 83,282.5 | | | | | | |
| | Singida III | Wind | Wind | 200.0 | 1,288.0 | 14,249.2 | 84,570.5 | | | | | | |
| | Mnyera Kisingo | Hydro | Hydro | 119.8 | 577.3 | 14,369.0 | 85,147.8 | | | | | | |
| | Mnyera Ruaha | Hydro | Hydro | 60.3 | 290.8 | 14,429.3 | 85,438.6 | | | | | | |
| | Mnyera Pumbwe | Hydro | Hydro | 122.9 | 592.2 | 14,552.2 | 86,030.8 | | | | | | |
| | Mbeya III | Coal | Steam | 600.0 | 3,558.9 | 15,152.2 | 89,589.8 | | | | | | |
| | Iringa Kilolo | Hydro | Hydro | 150.0 | 994.8 | 15,302.2 | 90,584.6 | 11,885.0 | 72,601.0 | 3,417.2 | 17,983.6 | 28.8 | 24.8 |
| 2040 | Manyoni | Solar | Solar | 100.0 | 175.0 | 15,402.2 | 90,759.6 | | | | | | |
| | Geothermal Phase III (Mbeya, Songwe, Manyara, Morogoro, Arusha, Shinyanga) | Geothermal | Geothermal | 185.0 | 1,456.9 | 15,587.2 | 92,216.4 | | | | | | |
| | Songwe Bupigu (34 MW)* | Hydro | Hydro | 17.0 | 76.5 | 15,604.2 | 92,292.9 | | | | | | |
| | Mbarali | Hydro | Hydro | 38.5 | 199.0 | 15,642.7 | 92,491.9 | | | | | | |
| | Njombe | Hydro | Hydro | 32.0 | 165.4 | 15,674.7 | 92,657.3 | | | | | | |
| | Bagamoyo | Gas | CCGT | 300.0 | 1,957.0 | 15,974.7 | 94,614.3 | | | | | | |
| | Kinyerezi I (Retire) | Gas | SC | (150.00) | (1,034.00) | 15,824.7 | 93,580.3 | 12,854.0 | 78,657.0 | 2,970.7 | 14,923.3 | 23.1 | 19.0 |
| 2041 | Njombe I | Wind | Wind | 100.0 | 644.0 | 15,924.7 | 94,224.3 | | | | | | |
| | Shinyanga II | Solar | Solar | 150.0 | 274.8 | 16,074.7 | 94,499.1 | | | | | | |
| | Kinyerezi I New | Gas | CCGT | 320.0 | 2,087.8 | 16,394.7 | 96,587.0 | | | | | | |
| | Uwemba (Retire) | Hydro | Hydro | (0.84) | (2.30) | 16,393.9 | 96,584.7 | 13,897.0 | 85,136.0 | 2,496.9 | 11,448.7 | 18.0 | 13.4 |
| 2042 | Ubungo New | Gas | SC | 320.0 | 2,087.8 | 16,713.9 | 98,672.5 | | | | | | |
| | Same Kilimanjaro | Solar | Solar | 50.0 | 175.0 | 16,763.9 | 98,847.5 | | | | | | |
| | Export (Retire) | Export | Export | 1,500.0 | 6,570.0 | 18,263.9 | 105,417.5 | 15,042.0 | 92,130.0 | 3,221.9 | 13,287.5 | 21.4 | 14.4 |
| 2043 | Mtwara III | Gas | CCGT | 600.0 | 3,914.7 | 18,863.9 | 109,332.2 | | | | | | |
| | Mchuchuma III | Coal | Steam | 300.0 | 2,103.0 | 19,163.9 | 111,435.2 | | | | | | |
| | Kinyerezi II (Retire) | Gas | CCGT | (248.22) | (1,619.50) | 18,915.6 | 109,815.7 | 16,283.0 | 99,627.0 | 2,632.6 | 10,188.7 | 16.2 | 10.2 |
| 2044 | Rukwa II | Coal | Steam | 600.0 | 2,103.0 | 19,515.6 | 111,918.7 | | | | | | |
| | Geothermal Phase IV (Mbeya, Manyara, Morogoro, Arusha, Shinyanga) | Geothermal | Geothermal | 215.0 | 1,693.1 | 19,730.6 | 113,611.8 | | | | | | |
| | Kinyerezi II New | Gas | CCGT | 470.0 | 3,066.0 | 20,200.6 | 116,677.7 | 17,611.0 | 107,937.0 | 2,589.6 | 8,740.7 | 14.7 | 8.1 |

**Note:**

1. ** Diesel Power plants connected to the National Grid will Retire/be standby in 2021.
2. *These are a shared project with neighbouring countries.
3. Geothermal projects from 2026 to 2044 are shown in lump sum, for more clarification on the specific project sites refer Table 3-13.

**Source:** PSMP 2020 Update Team Compilation.

# CHAPTER 4

## 4. TRANSMISSION EXPANSION PLAN

### 4.1. Introduction

This Chapter provides an update of transmission plan based on the load forecast and generation plan presented in previous chapters. Practically, the overall current logical planning process used for the conceptual primary transmission system is more or less similar to the PSMP 2008 and its Updates (2009, 2012 and 2016).

Significant power flows assessment was conducted across the country throughout the planning horizon in order to plan for reinforcement and new transmission lines. The assessment was done by calculating ranges of major interface flows for critical system conditions at intervals for short, medium and long term throughout the planning horizon. These ranges of major interface power flow between geographic subsystems follow a generation planning sequence, grid station load forecast, ranges of load levels and known operating constraints. This information led to a conceptual update design of the transmission additions or changes where necessary. Likewise, the information will provide early feedback of transmission costs associated with the least cost generation plan.

Load flow simulations were carried out in short, medium and long term using generation data as an input to transmission plan. The result provides detailed information for transmission system expansion, reinforcement and addition.

#### 4.1.1. Objective

The main objective is to identify definitive near to medium term and an indicative long term plan for the transmission system expansion, reinforcement and addition. More specifically, transmission expansion plan objectives are:

a) To ensure security of supply in the short term by coordinating electricity supply and demand;
b) To ensure security of supply in the medium and long term by developing the National Grid;
c) To ensure accessible transmission routes using good maintenance practices;

d) To determine the location, capacity and type of the required power transmission development and upgrades over the planning horizon by 2044;

e) To establish the timing of the transmission upgrades across years 2024, 2034 and 2044; and

f) To estimate the capital cost in investment plan associated with the transmission system development and upgrades.

In the context of this Plan, the transmission expansion plan determines the system upgrades that will allow the planned generation to serve the forecasted load. Additionally, a corresponding investment plan is developed to estimate the cost of the transmission expansion plan associated to the generation and sub-transmission plans which provide the basic input to financial and economic analysis.

The transmission plan identifies the most economical system additions while satisfying a pre-defined set of technical criteria. Such criteria composes a set of rules that measure the system performance and compare several scenarios on a common technical basis, ensure the adequate operation of the power system under both normal and emergency conditions, once the infrastructure has been built.

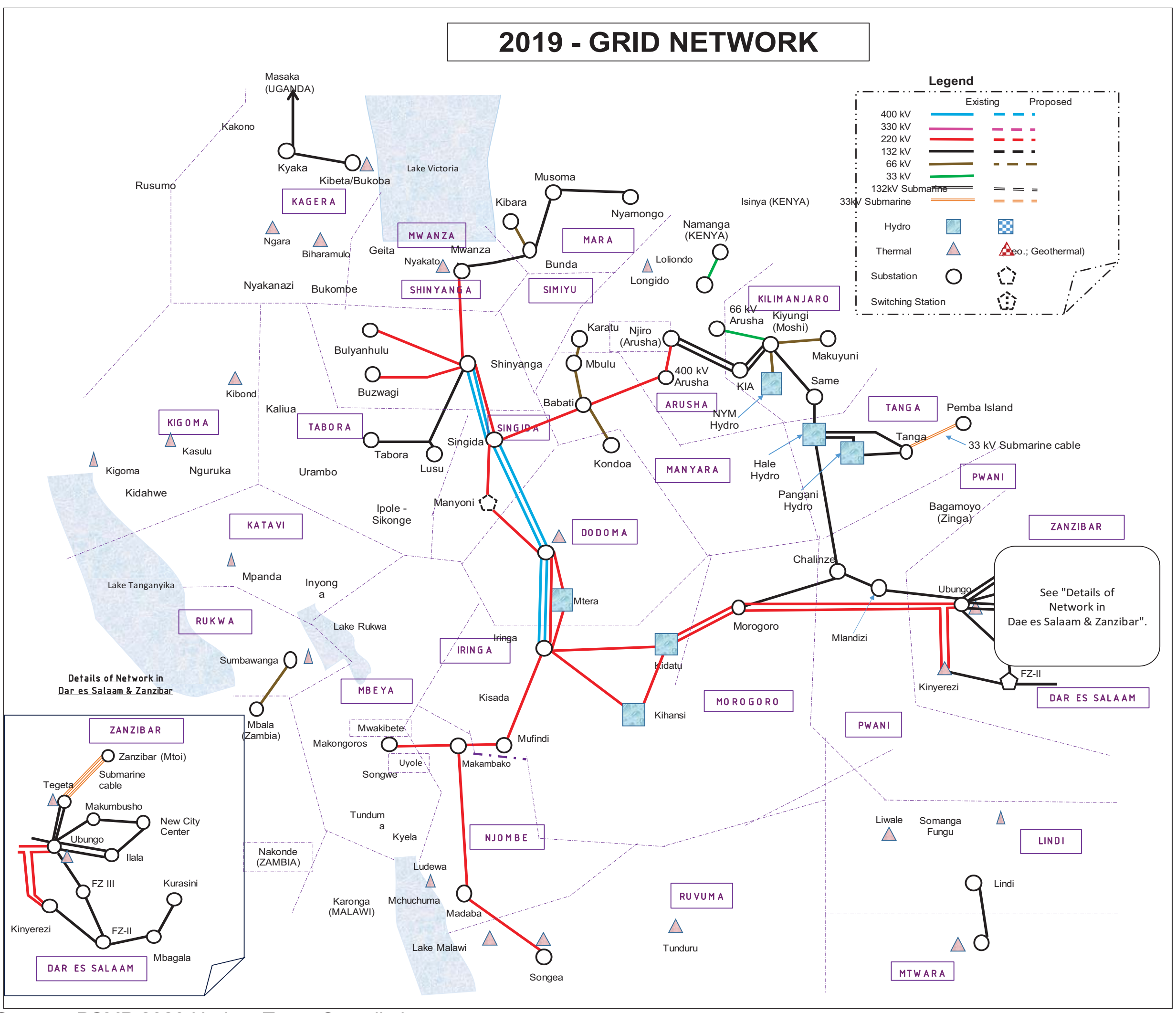
#### 4.1.2.Existing Grid System

There are transmission lines of different voltage capacities all over the country. The transmission system comprises of 670 km of 400 kV, 3,010.7 km of 220 kV, 1,672.57 km of 132 kV, and 543 km of 66 kV. The isolated centers away from the grid have generating units with an aggregate nominal capacity of 36.598 MW. TANESCO imports power from Uganda through 132 kV, Zambia through 66 kV lines and Kenya through 33 kV line. **Figure 4-1** shows the existing grid network, and **Table 4-1** shows the existing transmission line system with line parameters.

Simulation of the existing power system under peak load conditions revealed that there is a constrain in the Dar es Salaam and Pwani Grid Network including the following portions of lines: Kinyerezi – Ubungo 220 kV; Kinyerezi – Gongo la Mboto – Mbagala – Kurasini 132 kV; Chalinze – Hale – Arusha 132 kV; and Ubungo – Makumbusho 132 kV which had exceeded their thermal limits. Therefore, these lines could not transmit all demanded power. This lead to introduction of new lines such as: 414 km of 400 kV Singida –

Arusha project; 253 km of 400 kV JNHPP – Chalinze – Kinyerezi; 345 km of 400 kV Chalinze Dodoma; and 60 km of 220 kV Chalinze - Bagamoyo; 541 km of 400 kV of Chalinze – Segera – Arusha; 64 km of 220 kV Segera – Tanga; and 220 kV Kinyerezi – Ubungo – Mburahati.

The proposed increase of power generation in Mbeya, Iringa, Pwani and Dar es Salaam regions has necessitated the reinforcement of the 220 kV lines in these areas so that power can be evacuated to the load centres. Following this, 400 kV transmission lines of 253 km JNHPP – Chalinze – Kinyerezi; 345 km of 400 kV Chalinze – Dodoma; and 616 km Iringa – Kisada – Mbeya – Tunduma – Sumbawanga, to mention the few, are planned for construction as per **Tables 4-8, 4-9** and **4-10.**




**Source:** PSMP 2020 Update Team Compilation

**Figure 4-1:** Existing Grid System

**Table 4-1:** Parameters of the Existing Transmission Line System

| NO. | FROM - TO SUBSTATION | VOLTAGE (KV) | ROUTE LENGTH (KM) | NO. OF TOWERS | No. OF CIRCUITS | TYPE OF SUPPORT | TOWER CONFIG | TYPE & NO. OF INSULATORS/PHASE | CONDUCTOR TYPE AND SIZE (Nominal Al ) | YEAR COMMISSIONED | CURRENT RATING*[1] (AMPS) | FULL RATING (MVA) | NORMAL RATING (MVA) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MOROGORO-UBUNGO 1st | 220 | 172 | 456 | 1 | GUYED | HORIZONTAL | 15/16 STANDARD TYPE | BLUEJAY 565.5 sq mm ACSR | 1975 | 1092 | 416 | 333 |
| 2 | **KINYEREZI - MOROGORO** | 220 | 180 | 499 | 1 | SELF SUPPORT LATTICE | | 15/16 GLASS | BLUEJAY 565.5 sq mm ACSR | 1975 | 1092 | 416 | 365.7984 |
| | Section I (Kinyerezi - Kimara) | 220 | 8 | 37 | 1 | SELF SUPPORT LATTICE | VERTICAL | 15/16 GLASS | 2 x BLUEJAY 565.5 sq mm ACSR | 1975 | 2*1092 | 2*416 | 2*365.7984 |
| | Section II (Kimara - Morogoro) | 220 | 172 | 462 | 1 | SELF SUPPORT LATTICE | TRIANGULAR | 15/16 GLASS | BLUEJAY 565.5 sq mm ACSR | 1995 | 1092 | 416 | 333 |
| 3 | **KINYEREZI - UBUNGO** | 220 | 15 | 36 | 1 | SELF SUPPORT LATTICE | | 15/16 GLASS | BLUEJAY 565.5 sq mm ACSR | 1995 | 1092 | 416 | 365.7984 |
| | Section I (Kinyerezi - Kimara) | 220 | 8 | 23 | 1 | SELF SUPPORT LATTICE | VERTICAL | 15/16 GLASS | 2 x BLUEJAY 565.5 sq mm ACSR | 1995 | 2*1092 | 2*416 | 2*365.7984 |
| | Section II (Kimara - Ubungo) | 220 | 7 | 13 | 1 | SELF SUPPORT LATTICE | TRIANGULAR | 15/16 GLASS | BLUEJAY 565.5 sq mm ACSR | 1993 | 1092 | 416 | 333 |
| 4 | KIDATU-MOROGORO 1ST | 220 | 128 | 320 | 1 | GUYED | HORIZONTAL | 15/16 STANDARD TYPE | BLUEJAY 565.5 sq mm ACSR | 1975 | 1092 | 416 | 333 |
| 5 | MOROGORO- KIDATU 2nd | 220 | 130 | 328 | 1 | SELF SUPPORT | TRIANGULAR | 15/16 STANDARD TYPE | BLUEJAY 565.5 sq mm ACSR | 1993 | 1092 | 416 | 333 |
| 6 | KIDATU- IRINGA | 220 | 163 | 441 | 1 | SELF SUPPORT | HORIZONTAL | 15/16 STANDARD TYPE | BISON 350 sq. mm ACSR | 1985 | 679 | 259 | 207 |
| 7 | IRINGA- MUFINDI | 220 | 130 | 336 | 1 | SELF SUPPORT | HORIZONTAL | 15/16 STANDARD TYPE | BISON 350 sq. mm ACSR | 1985 | 679 | 259 | 207 |
| 8 | IRINGA- MTERA | 220 | 107 | 297 | 1 | SELF SUPPORT | HORIZONTAL | 15/16 STANDARD TYPE | BISON 350 sq. mm ACSR | 1985 | 679 | 259 | 207 |
| 9 | MTERA- DODOMA | 220 | 130 | 303 | 1 | SELF SUPPORT | HORIZONTAL | 15/16 STANDARD TYPE | BISON 350 sq. mm ACSR | 1985 | 679 | 259 | 207 |
| 10 | DODOMA- SINGIDA | 220 | 214.3 | 528 | 1 | SELF SUPPORT | HORIZONTAL | 15/16 STANDARD TYPE | BISON 350 sq. mm ACSR | 1988 | 679 | 259 | 207 |
| 11 | SINGIDA- SHINYANGA | 220 | 205 | 532 | 1 | SELF SUPPORT | HORIZONTAL | 15/16 STANDARD TYPE | BISON 350 sq. mm ACSR | 1988 | 679 | 259 | 207 |
| 12 | **SHINYANGA - MWANZA (NYAKATO)** | 220 | 140 | 336 | 1 | SELF SUPPORT | HORIZONTAL | 15/16 STANDARD TYPE | BISON 350 sq. mm ACSR | 1988 | 679 | 259 | 207 |
| | Shinyanga - T-Point | 220 | 84.4 | 202 | 1 | SELF SUPPORT | HORIZONTAL | 15/16 STANDARD TYPE | BISON 350 sq. mm ACSR | 1988 | 679 | 259 | 207 |
| | T-Point - MWANZA (NYAKATO) | 220 | 55.8 | 134 | 1 | SELF SUPPORT | HORIZONTAL | 15/16 STANDARD TYPE | BISON 350 sq. mm ACSR | 1988 | 679 | 259 | 207 |
| | T-Point - MABUKI | 220 | 416m | 2 Gantry towers | 1 | SELF SUPPORT | HORIZONTAL | 15/16 STANDARD TYPE | BISON 350 sq. mm ACSR | 1988 | 679 | 259 | 207 |
| 13 | **MUFINDI- MBEYA** | 220 | 220 | 544 | 1 | SELF SUPPORT | HORIZONTAL | 15/16 STANDARD TYPE | BISON 350 sq. mm ACSR | 1985 | 679 | 259 | 207 |
| | MUFINDI - T-Point | 220 | 60.3 | 149 | 1 | SELF SUPPORT | HORIZONTAL | 15/16 STANDARD TYPE | BISON 350 sq. mm ACSR | 1985 | 679 | 259 | 207 |
| | T-Point - MBEYA | 220 | 159.7 | 395 | 1 | SELF SUPPORT | HORIZONTAL | 15/16 STANDARD TYPE | BISON 350 sq. mm ACSR | 1985 | 679 | 259 | 207 |
| | T-Point - MAKAMBAKO | 220 | 404m | n/a | 1 | n/a | n/a | n/a | 33kV CU/XPLE/SWA/PVC 1X240 sq.mm single | 1985 | 679 | 259 | 207 |
| 14 | UBUNGO - MLANDIZI | 132 | 48.8 | 168 | 1 | GUYED | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1963 | 406 | 93 | 74 |
| 15 | MLANDIZI-CHALINZE | 132 | 48.2 | 166 | 1 | GUYED | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1963 | 406 | 93 | 74 |
| 16 | CHALINZE- MOROGORO | 132 | 82 | 288 | 1 | GUYED | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1967 | 406 | 93 | 74 |
| 17 | CHALINZE- HALE | 132 | 175 | 534 | 1 | GUYED | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1963 | 406 | 93 | 74 |
| 18 | **HALE-TANGA** | 132 | 60 | 389 | 1 | WOODEN H-POLE | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1971 | 406 | 93 | 74 |
| | HALE-MAWENI | 132 | 53 | 344 | 1 | WOODEN H-POLE | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1971 | 406 | 93 | 74 |
| | MAWENI -TANGA | 132 | 7 | 45 | 1 | WOODEN H-POLE | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1971 | 406 | 93 | 74 |
| 19 | **HALE- SAME** | 132 | 173 | 561 | 1 | GUYED | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1975 | 406 | 93 | 74 |
| | SAME-T-point | 132 | 99.3 | 322 | 1 | GUYED | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1975 | 406 | 93 | 74 |
| | T-Point - HALE | 132 | 73.7 | 239 | 1 | GUYED | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1975 | 406 | 93 | 74 |
| | T-Point - Kasiga | 132 | 308m | 2 Gantry towers | 1 | SELF SUPPORT | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1975 | 406 | 93 | 74 |

| NO. | FROM - TO SUBSTATION | VOLTAGE (KV) | ROUTE LENGTH (KM) | NO. OF TOWERS | No. OF CIRCUITS | TYPE OF SUPPORT | TOWER CONFIG | TYPE & NO. OF INSULATORS/PHASE | CONDUCTOR TYPE AND SIZE (Nominal Al ) | YEAR COMMISSIONED | CURRENT RATING*[1] (AMPS) | FULL RATING (MVA) | NORMAL RATING (MVA) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | SAME- KIYUNGI | 132 | 102 | 291 | 1 | GUYED | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1975 | 406 | 93 | 74 |
| 21 | UBUNGO- ILALA 1st | 132 | 9.5 | 25 | 2 | SELF SUPPORT | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1963 | 962 | 440 | 352 |
| 22 | **NYAKATO (MWANZA)-MUSOMA** | 132 | 210 | 628 | 1 | SELF SUPPORT | HORIZONTAL | 9/ 10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1989 | 406 | 93 | 74 |
| | NYAKATO (MWANZA)-T-Point | 132 | 133.4 | 399 | 1 | SELF SUPPORT | HORIZONTAL | 9/ 10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1989 | 406 | 93 | 74 |
| | T-Point - MUSOMA | 132 | 76.2 | 228 | 1 | SELF SUPPORT | HORIZONTAL | 9/ 10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1989 | 406 | 93 | 74 |
| | T-Point - BUNDA | 132 | 326m | 2 Gantry towers | 1 | SELF SUPPORT | HORIZONTAL | 9/ 10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1989 | 406 | 93 | 74 |
| 23 | **SHINYANGA - TABORA** | 132 | 203 | 587 | 1 | SELF SUPPORT | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1989 | 406 | 93 | 74 |
| | SHINYANGA - Lusu | 132 | 60 | 174 | 1 | SELF SUPPORT | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1989 | 406 | 93 | 74 |
| | Lusu-Tabora | 132 | 143 | 413 | 1 | SELF SUPPORT | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1989 | 406 | 93 | 74 |
| | T-Point - LUSU | 132 | 345m | 2 Gantry towers | 1 | SELF SUPPORT | HORIZONTAL | 9/10 STANDARD TYPE | 1 x WOLF 150 sq. mm ACSR | 1989 | 406 | 93 | 74 |
| 24 | NYM - KIYUNGI | 66 | 53 | 463 | 1 | WOODEN POLES | TRIANGULAR | 5/ 6 STANDARDTYPE | RABBIT 50 sq. mm ACSR | 1968 | 197 | 23 | 18 |
| 25 | KIYUNGI - ARUSHA | 66 | 78 | 625 | 1 | WOODEN POLES | TRIANGULAR | 5/ 6 STANDARDTYPE | RABBIT 50 sq. mm ACSR | 1967 | 197 | 23 | 18 |
| 26 | BABATI- KONDOA | 66 | 85 | 251 | 1 | SELF SUPPORT | TRIANGULAR | 7/ 7 STANDARD TYPE | WOLF 150 sq. mm ACSR | 1999 | 406 | 46 | 37 |
| 27 | BABATI- MBULU | 66 | 85 | 192 | 1 | SELF SUPPORT | TRIANGULAR | 7/ 7 STANDARD TYPE | WOLF 150 sq. mm ACSR | 1999 | 406 | 46 | 37 |
| 28 | MBULU- KARATU | 66 | 65 | 172 | 1 | SELF SUPPORT | TRIANGULAR | 7/ 7 STANDARD TYPE | WOLF 150 sq. mm ACSR | 1999 | 406 | 46 | 37 |
| 29 | **KIHANSI- IRINGA** | 220 | 96.9 | 279 | 1 | | | | | 1998 | 1,092 | 416 | 333 |
| | Section I: Kihansi - Escapment | 220 | 1.67 | 2 | 1 | SELF SUPPORT | TRIANGULAR | 15/ 16 STANDARD TYPE | PHEASANT 645.1 sq. mm ACSR | 1998 | 1,187 | 452 | 362 |
| | Section II: Escapement - Iringa | 220 | 95.23 | 277 | 1 | SELF SUPPORT | TRIANGULAR | 15/ 16 STANDARD TYPE | BLUEJAY 565.5 sq mm ACSR | 1998 | 1,092 | 416 | 333 |
| 30 | KIHANSI - KIDATU | 220 | 180 | 529 | 1 | SELF SUPPORT | TRIANGULAR | 15/ 16 STANDARD TYPE | BLUEJAY 565.5 sq mm ACSR | 1999 | 1,092 | 416 | 333 |
| 31 | UBUNGO- ILALA 2nd | 132 | 9.5 | 25 | 1 | SELF SUPPORT | VERTICAL DOUBLE CKT | 11/ 12 STANDARD TYPE | WOLF 150 sq. mm ACSR | 1999 | 962 | 440 | 352 |
| 32 | UBUNGO- KIPAWA (FZIII) | 132 | 11 | 35 | 1 | SELF SUPPORT | VERTICAL DOUBLE CKT | 11/ 12 STANDARD TYPE | WOLF 150 sq. mm ACSR | 2000 | 406 | 93 | 74 |
| 33 | **PANGANI FALLS-TANGA** | 132 | 63.5 | 223 | 1 | SELF SUPPORT | | 10/12 STANDARD TYPE | HAWK 241.6 sq. mm ACSR | 1995 | 659 | 301 | 241 |
| | Section I - (Pangani-Songa) | 132 | 8.5 | 33 | 1 | SELF SUPPORT | VERTICAL DOUBLE CKT | 10/12 STANDARD TYPE | HAWK 241.6 sq. mm ACSR | 1995 | 659 | 301 | 241 |
| | Section II - (Songa - T-point) | 132 | 45 | 155 | 1 | SELF SUPPORT | TRIANGULAR | 10/12 STANDARD TYPE | HAWK 241.6 sq. mm ACSR | 1995 | 659 | 301 | 241 |
| | Section III - (T-point - Tanga) | 132 | 10 | 35 | 1 | SELF SUPPORT | TRIANGULAR | 10/12 STANDARD TYPE | HAWK 241.6 sq. mm ACSR | 1995 | 659 | 301 | 241 |
| | KANGE -T-point | 132 | 285m | 2 Gantry towers | 1 | SELF SUPPORT | HORIZONTAL | 10/12 STANDARD TYPE | HAWK 241.6 sq. mm ACSR | 1995 | 659 | 301 | 241 |
| 34 | **PANGANI FALLS - HALE** | 132 | 13.5 | 33 | 2 | | | | | 1995 | 659 | 301 | 241 |
| | - Section I | 132 | 8.5 | 33 | 1 | SELF SUPPORT | VERTICAL | 10/12 STANDARD TYPE | HAWK 241.6 sq. mm ACSR | | 659 | 301 | 241 |
| | - Section II | 132 | 5 | 10 | 1 | SELF SUPPORT | TRIANGULAR | 10/12 STANDARD TYPE | HAWK 241.6 sq. mm ACSR | | 659 | 301 | 241 |
| 35 | SINGIDA-BABATI | 220 | 150 | 424 | 1 | SELF SUPPORT | TRIANGULAR | 15/16 STANDARD TYPE | RAIL 483.8 sq. mm ACSR | 1996 | 993 | 378 | 303 |
| 36 | BABATI- NJIRO (ARUSHA) | 220 | 162 | 433 | 1 | SELF SUPPORT | TRIANGULAR | 15/16 STANDARD TYPE | RAIL 483.8 sq. mm ACSR | 1996 | 993 | 378 | 303 |
| 37 | KYAKA - MTUKULA (Line to the border with UGANDA) Off Grid | 132 | 30 | 85 | 1 | SELF SUPPORT | HORIZONTAL | 10/12 STANDARD TYPE | TIGER 125 sq. mm ACSR | 1992 | 361 | 83 | 66 |
| 38 | KYAKA - KIBETA (BUKOBA) Off Grid | 132 | 54.5 | 157 | 1 | SELF SUPPORT | HORIZONTAL | 10/12 STANDARD TYPE | TIGER 125 sq. mm ACSR | 1992 | 361 | 83 | 66 |
| 39 | SHINYANGA - BULYANHULU | 220 | 129.5 | 277 | 1 | SELF SUPPORT | HORIZONTAL | POLYMERIC TYPE | BISON 350 sq. mm ACSR | 2000 | 679 | 259 | 207 |
| 40 | SUMBAWANGA - KASESYA | 66 | 93 | 569 | 1 | MONOPOLE STEEL | TRIANGULAR | COMPOSITE TYPE | WOLF 150 sq. mm ACSR | 2002 | 406 | 46 | 37 |

| NO. | FROM - TO SUBSTATION | VOLTAGE (KV) | ROUTE LENGTH (KM) | NO. OF TOWERS | No. OF CIRCUITS | TYPE OF SUPPORT | TOWER CONFIG | TYPE & NO. OF INSULATORS/PHASE | CONDUCTOR TYPE AND SIZE (Nominal Al ) | YEAR COMMISSIONED | CURRENT RATING*[1] (AMPS) | FULL RATING (MVA) | NORMAL RATING (MVA) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | BUNDA-KIBARA | 66 | 50 | 300 | 1 | WOODEN POLES | HORIZONTAL | 5/6 STANDARD TYPE | WOLF 150 sq. mm ACSR | 2007 | 197 | 23 | 18 |
| 42 | MUSOMA-NYAMONGO | 132 | 90 | 238 | 1 | SELF SUPPORT | TRIANGULAR | POLYMERIC TYPE | WOLF 150 sq. mm ACSR | 2011 | 406 | 93 | 74 |
| 43 | SHINYANGA-BUZWAGI | 220 | 108 | 237 | 1 | SELF SUPPORT | TRIANGULAR | POLYMERIC TYPE | BISON 350 sq. mm ACSR | 2000 | 679 | 259 | 207 |
| 44 | UBUNGO - MAKUMBUSHO | 132 | 7 | 37 | 1 | SELF SUPPORT - MONOPOLE | VERTICAL | PORCELAIN | HAWK 241.6 sq. mm ACSR | 2010 | 659 | 151 | 121 |
| 45 | KIYUNGI - MAKUYUNI | 66 | 34 | 172 | 1 | SELF SUPORT LATTICE | VERTICAL | PORCELAIN | WOLF 150 sq. mm ACSR | 2012 | 406 | 46 | 37 |
| 46 | UBUNGO - KUNDUCHI (I) | 132 | 12 | 50 | 1 | SELF SUPORT LATTICE | HORIZONTAL | 9/10 GLASS | HAWK 241.6 sq. mm ACSR | 1980 | 406 | 93 | 74 |
| 47 | KIYUNGI - NJIRO (ARUSHA) - 1 | 132 | 71.6 | 208 | 1 | SELF SUPORT LATTICE | TRIANGULAR | 9/10 PORCELAIN | HAWK 241.6 sq. mm ACSR | 1983 | 406 | 93 | 74 |
| | i. KIYUNGI - KIA | 132 | 35 | | 1 | SELF SUPORT LATTICE | TRIANGULAR | 9/10 PORCELAIN | HAWK 241.6 sq. mm ACSR | 1983 | 406 | 93 | 74 |
| | ii. KIA - NJIRO (ARUSHA) | 132 | 36.6 | | 1 | SELF SUPORT LATTICE | TRIANGULAR | 9/10 PORCELAIN | HAWK 241.6 sq. mm ACSR | 1983 | 406 | 93 | 74 |
| 48 | KIYUNGI -NJIRO (ARUSHA) - 2 | 132 | 70 | 207 | 1 | SELF SUPORT LATTICE | TRIANGULAR | 9/10 PORCELAIN | HAWK 241.6 sq. mm ACSR | 2015 | 406 | 93 | 74 |
| | i. KIYUNGI - KIA | 132 | 35 | 85 | 1 | SELF SUPORT LATTICE | TRIANGULAR | 9/10 PORCELAIN | HAWK 241.6 sq. mm ACSR | 2015 | 406 | 93 | 74 |
| | ii. KIA - NJIRO (ARUSHA) | 132 | 35 | 122 | 1 | SELF SUPORT LATTICE | HORIZONTAL | 9/10 PORCELAIN | HAWK 241.6 sq. mm ACSR | 2015 | 406 | 93 | 74 |
| 49 | KINYEREZI - FZII | 132 | 3 | 16 | 1 | SELF SUPORT LATTICE | VERTICAL | 9/10 GLASS | HAWK 241.6 sq. mm ACSR | 2016 | 406 | 93 | 74 |
| 50 | UBUNGO - KUNDUCHI (II) | 132 | 12 | 65 | 1 | MONOPOLE STEEL | VERTICAL | POLYMERIC TYPE | HAWK 241.6 sq. mm ACSR | 2012 | 406 | 93 | 74 |
| 51 | **KUNDUCHI - ZANZIBAR (I)** | 132 | 64 | 96 | 1 | | | | | 1980 | 286 | 65 | 52 |
| | Section I : Overhead (Kunduchi - Ras Kilomoni) | 132 | 4 | 16 | 1 | SELF SUPORT LATTICE | HORIZONTAL | 9/10 GLASS | HAWK 241.6 sq. mm ACSR | 1980 | 286 | 65 | 52 |
| | Section II : Submarine cable (Raskilomoni - Ras Fumba) | 132 | 38 | n/a | 1 | n/a | n/a | n/a | XLPE Type (X –Linked Polyethylene) Submarine | 1980 | 286 | 65 | 52 |
| | Section III: overhead (Ras Fumba - Zanzibar(mtoni)) | 132 | 22 | 80 | 1 | SELF SUPORT LATTICE | HORIZONTAL | 9/10 GLASS | HAWK 241.6 sq. mm ACSR | 1980 | 286 | 65 | 52 |
| 52 | **KUNDUCHI - ZANZIBAR (II)** | 132 | 63.6 | 132 | 1 | | | | | 2013 | 640 | 146 | 117 |
| | Section I : Overhead (Kunduchi - Ras Kilomoni) | 132 | 4.6 | 23 | 1 | MONOPOLE STEEL | VERTICAL | POLYMERIC TYPE | HAWK 241.6 sq. mm ACSR | 2013 | 640 | 146 | 117 |
| | Section II : Submarine cable (Raskilomoni - Ras Fumba) | 132 | 37 | n/a | 1 | n/a | n/a | n/a | XLPE Type (X –Linked Polyethylene) Submarine cable, 94 sq.mm CU | 2013 | 640 | 146 | 117 |
| | Section III: overhead (Ras Fumba - Zanzibar(mtoni)) | 132 | 22 | 109 | 1 | MONOPOLE STEEL | VERTICAL | POLYMERIC TYPE | HAWK 241.6 sq. mm ACSR | 2013 | 640 | 146 | 117 |
| 53 | IRINGA-DODOMA 1 | 220 (400) | 224.6 | 590 | 1 | SELF SUPORT LATTICE | VERTICAL | POLYMERIC TYPE | 2 X BLUEJAY 565.5 sq mm ACSR | 2016 | 2*1092 | 416 | 2*365.79 |
| 54 | IRINGA-DODOMA 2 | 220 (400) | 224.6 | 590 | 1 | SELF SUPORT LATTICE | VERTICAL | POLYMERIC TYPE | 2 X BLUEJAY 565.5 sq mm ACSR | 2016 | 2*1092 | 416 | 2*365.79 |
| 55 | DODOMA SINGIDA 1 | 220 (400) | 216.5 | 563 | 1 | SELF SUPORT LATTICE | VERTICAL | POLYMERIC TYPE | 2 X BLUEJAY 565.5 sq mm ACSR | 2016 | 2*1092 | 416 | 2*365.79 |
| 56 | DODOMA SINGIDA 2 | 220 (400) | 216.5 | 563 | 1 | SELF SUPORT LATTICE | VERTICAL | POLYMERIC TYPE | 2 X BLUEJAY 565.5 sq mm ACSR | 2016 | 2*1092 | 416 | 2*365.79 |
| 57 | SINGIDA SHINYANGA 1 | 220 (400) | 228.9 | 594 | 1 | SELF SUPORT LATTICE | VERTICAL/HORIZONTAL | POLYMERIC TYPE | 2 X BLUEJAY 565.5 sq mm ACSR | 2016 | 2*1092 | 416 | 2*365.79 |
| 58 | SINGIDA SHINYANGA 2 | 220 (400) | 228.9 | 594 | 1 | SELF SUPORT LATTICE | VERTICAL/HORIZONTAL | POLYMERIC TYPE | 2 X BLUEJAY 565.5 sq mm ACSR | 2016 | 2*1092 | 416 | 2*365.79 |
| 59 | MTWARA - MAUMBIKA (LINDI) | 132 | 80 | 487 | 1 | WOODEN POLE | HORIZONTAL | 9/10 GLASS | HAWK 241.6 sq. mm ACSR | 2017 | 286 | 65.38 | 54.8 |
| 60 | KURASINI - MBAGALA | 132 | 15.1 | 44 | 1 | Lattice tower (38), Steel | vertical | Toughned glass 9/11 | HAWK 241.6 sq. mm ACSR | 2017 | 659 | 151 | 120.8 |
| 61 | MBAGALA - FZII | 132 | 16.2 | 65 | 1 | Lattice tower (48), Steel | vertical | Toughned glass 9/12 | HAWK 241.6 sq. mm ACSR | 2017 | 659 | 151 | 120.8 |
| 62 | FZII - KIPAWA(FZIII) | 132 | 7.4 | 57 | 1 | Steel Poles | vertical | Toughned glass 9/13 | HAWK 241.6 sq. mm ACSR | 2017 | 659 | 151 | 120.8 |
| 63 | **ILALA - New City Center** | 132 | 3.1 | | 1 | | | | | | | | |
| | Section I: Overhead Line | 132 | 1.3 | 5 | 1 | Lattice Tower | TRIANGULAR | Toughned glass 9/13 | HAWK 241.6 sq. mm ACSR | 2016 | 659 | 151 | 120.8 |
| | Section II:Underground cable | 132 | 1.8 | n/a | 1 | n/a | n/a | n/a | XLPE/CWS/HDPE (IEC60840) core:1x 1000sq.mm: Overall dia:83mm; 766A single conductor/phase | 2016 | 659 | 151 | 120.8 |

| NO. | FROM - TO SUBSTATION | VOLTAGE (KV) | ROUTE LENGTH (KM) | NO. OF TOWERS | No. OF CIRCUITS | TYPE OF SUPPORT | TOWER CONFIG | TYPE & NO. OF INSULATORS/PHASE | CONDUCTOR TYPE AND SIZE (Nominal Al ) | YEAR COMMISSIONED | CURRENT RATING*[1] (AMPS) | FULL RATING (MVA) | NORMAL RATING (MVA) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | New City Center - MAKUMBUSHO | 132 | 6.67 | n/a | 1 | n/a | n/a | n/a | XLPE/CWS/HDPE (IEC60840) core:1x 1000sq.mm: Overall dia:83mm; 766A single conductor/phase | 2016 | 659 | 151 | 120.8 |
| 65 | MAKAMBAKO - MADABA | 220 | 110 | 317 | 1 | SELF SUPORT LATTICE | HORIZONTAL | Toughened glass insulators are proposed. | The recommended conductor is an aluminium steel reinforced conductor (ACSR) Bluejay 565.5 mm² single conductor | 2018 | 1092 | 416 | 332.8 |
| 66 | MADABA-SONGEA | 220 | 140 | 403 | 1 | SELF SUPORT LATTICE | HORIZONTAL | Toughened glass insulators are proposed. | The recommended conductor is an aluminium steel reinforced conductor (ACSR) Bluejay 565.5 mm² single conductor | 2018 | 1092 | 416 | 332.8 |
| 67 | UBUNGO-UGP1 | 220 | 1.5 | n/a | 1 | n/a | n/a | n/a | XLPE/CWS/HDPE (IEC60840) core:3 x Single core 500sq.mm Aluminium cable | 2008 | 1092 | 416 | 332.8 |
| 68 | UBUNGO 220 - UBUNGO 132 (I) (T4) | 132 | 0.1 | 2 Gantry towers | 1 | SELF SUPPORT | HORIZONTAL | 15/16 GLASS | BLUEJAY 565.5 sq mm ACSR | 2008 | 1092 | 416 | 332.8 |
| 69 | UBUNGO 220 - UBUNGO 132 (II) (T5) | 133 | 0.1 | 2 Gantry towers | 1 | SELF SUPPORT | HORIZONTAL | 15/16 GLASS | BLUEJAY 565.5 sq mm ACSR | 2008 | 1092 | 416 | 332.8 |
| 70 | UBUNGO 220 - SONGAS | 132 | 0.05 | 2 Gantry towers | 1 | SELF SUPPORT | HORIZONTAL | 15/16 GLASS | BLUEJAY 565.5 sq mm ACSR | 2004 | 1092 | 416 | 332.8 |
| 71 | UBUNGO 220 - UGP2 | 132 | 0.05 | n/a | 1 | n/a | n/a | n/a | 145kV XLPE/CWS/HDPE (IEC60840) core:1x 630sq.mm Aluminium conductor | 2012 | 1092 | 416 | 332.8 |
| 72 | KUNDUCHI - WAZO | 132 | 5 | 15 | 1 | Concrete poles | Triangular | 10&9 | HAWK 241.6 sq. mm ACSR | | 659 | 151 | 120.8 |
| 73 | KUNDUCHI - TEGETA GAS PLANT | 132 | 0.3 | n/a | 1 | n/a | n/a | n/a | XLPE/CWS/HDPE (IEC60840) core:1x 300sq.mm Aluminium cable | 2009 | 659 | 151 | 120.8 |
| 74 | NYAKATO 220 KV - NYAKATO HFO PLANT | 220 | 0.2 | n/a | 1 | n/a | n/a | n/a | A2XS(FL)2YsR(AL)2Y-GC 1x300RM/50 127/220(245)kV acc.to IEC 62067 note:300 sq.mm | 2013 | 659 | 151 | 120.8 |

**Note:** Normal Rating = Full Rating * 80%

| Voltage | Total Length (above Table) | No. of Lines (Above Table) | Comments |
|---|---|---|---|
| 400kV | 670 | 3 | |
| 220kV | 3010.7 | **21** | |
| 132kV | 1672.57 | **32** | 2x Submarine Cables Included |
| 66kV | 543 | **8** | |
| Total | 5896.27 | 64 | |

| VOLTAGE (KV) | ROUTE LENGTH (KM) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2020 | 2019 | 2018 | 2017 | 2016 | 2015 | 2014 | 2013 |
| 400kV | 670 | 670 | 670 | 670 | 670 | 0 | 0 | 0 |
| 220kV | 3010.7 | **3010.7** | 2,922.14 | 2,833.57 | 2,745 | 2,745 | 2,227.85 | 1,710.69 |
| 132kV | 1672.57 | **1672.6** | 1657.06 | 1641.53 | 1,626 | 1,626 | 1,583.75 | 1,541.50 |
| 66kV | 543 | 543 | 543 | 543 | 543 | 543 | 543 | 543 |
| Total | 5896.27 | 5896.3 | 5792.2 | 5688.1 | 4,914 | 4914 | 4354.6 | 3795.19 |

**Source:** TANESCO (December 2019)

#### 4.1.3.Development of New Interconnectors

Power interconnection between countries is essential to increase the exchange capacity within the regions, to ensure reliability and security of power supply through power trading. The operational experienced in recent years lead to necessary adjustments of the plans for establishing new interconnectors. These interconnectors are:

i. **Tanzania (Singida – Arusha – Namanga) – Kenya (Isinya) 400 kV interconnection project**: The project is under construction and is expected to be commissioned in 2021;

ii. **Tanzania – Zambia 400 kV interconnection project:** The construction of the project is expected to commence in April 2021 and commissioned by 2023;

iii. **Tanzania (Nyakanazi – Kyaka) – Uganda (Masaka) 400 kV interconnection project**: The project is planned to be commissioned by 2025;

iv. **Tanzania – Mozambique 400 kV interconnection project:** Inter-Utility Memorandum of Understanding (IUMOU) for Construction of Tanzania-Mozambique Interconnector between Electricidade de Mozambique (EDM) and TANESCO was extended in June 2018;

v. **Tanzania, Rwanda, and Burundi Interconnection Project:** The project has been driven by the construction of 80 MW hydropower project at Rusumo border. The project will enable the National Grids of the three countries to interconnect through the 220 kV transmission line, which is expected to be commissioned in 2021;

vi. **Tanzania – Malawi 400 kV interconnection project:** Tanzania completed a pre-feasibility study up to the border of Malawi, while Malawi has completed a feasibility study to the border of Tanzania. TANESCO and ESCOM (Malawi) are on discussion of developing the project;

vii. **Tanzania (Shinyanga – Mwanza – Musoma) – Kenya (Kilgories) 400 kV interconnection project:** The project is under the planning stage, with initial proposals for its commissioning in 2025; and

viii. **Tanzania (Kigoma) – Burundi (Itaba) 220 kV Interconnection Project:** The project is under planning stage.

ix. **Tanzania (Rukwa) – DRC (Katanga Province) 400 kV Interconnection Project:** The project is under planning stage.

**Figures 4-2**, **4-3** and **4-4** show the grid network of 400 kV, 220 kV and 132 kV lines in short, medium and long term plan.

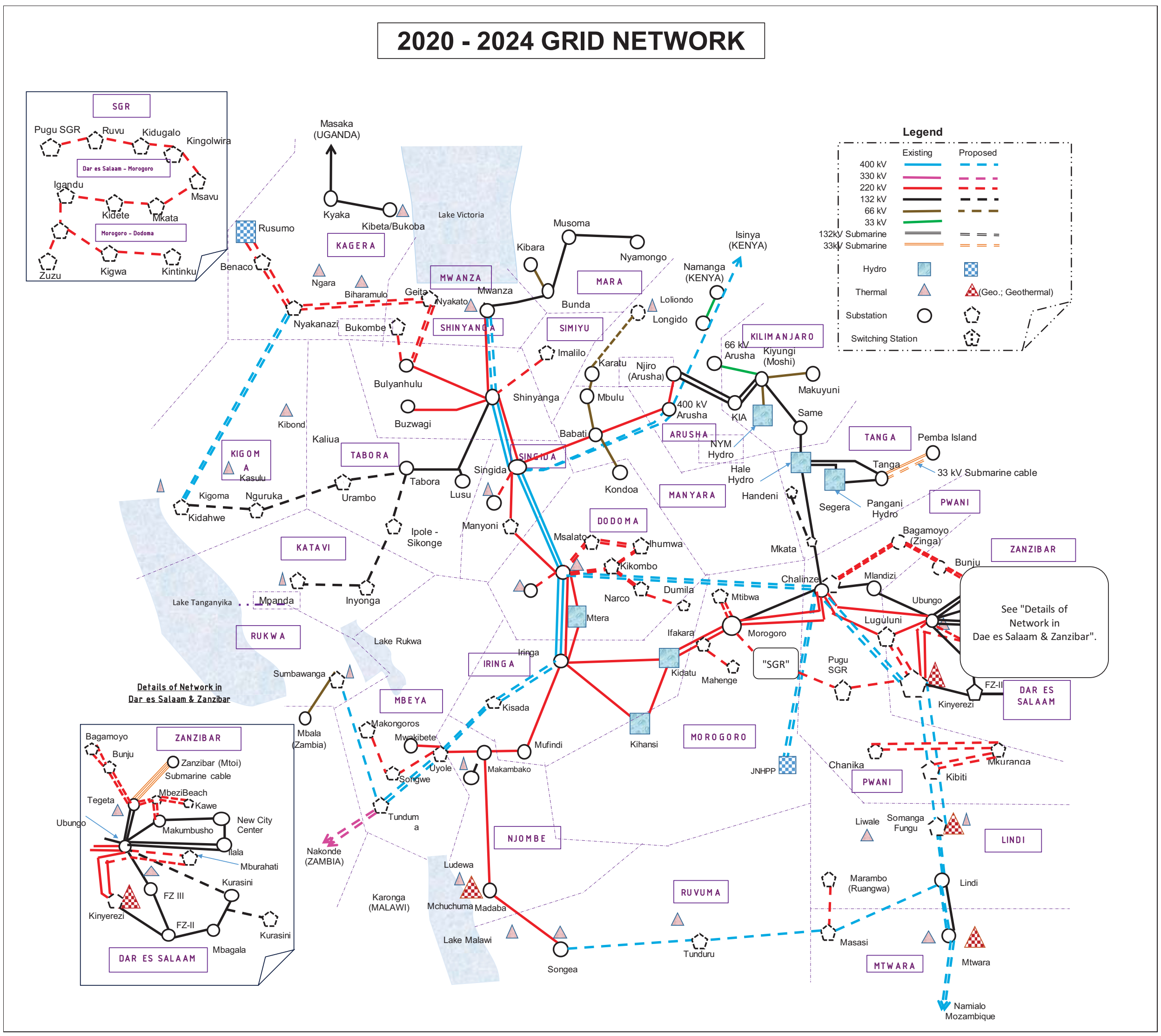



**Figure 4-2:** Generation and Transmission Plan – Year 2020 – 2024

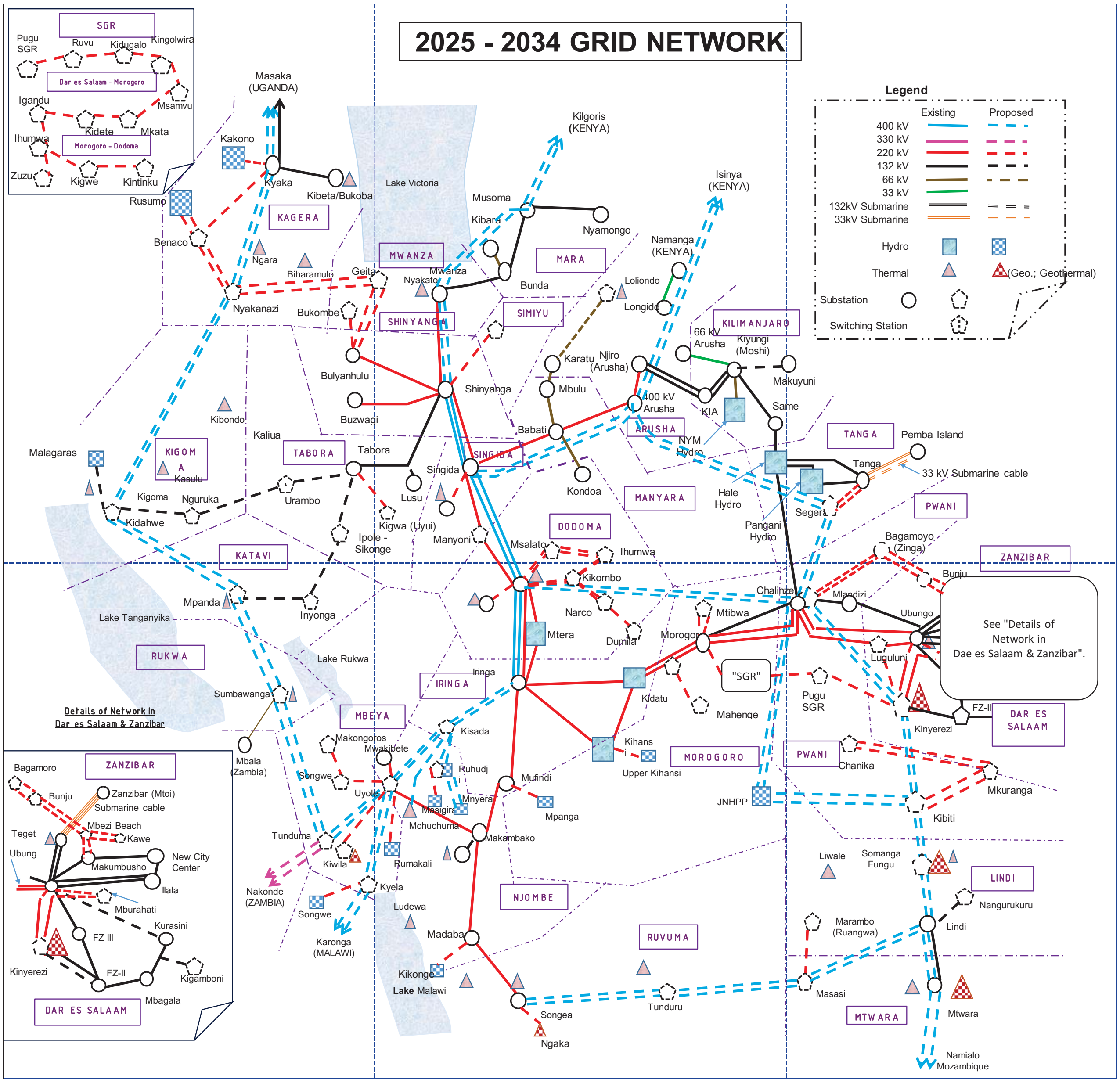



**Figure 4-3:** Generation and Transmission Plan – Year 2034

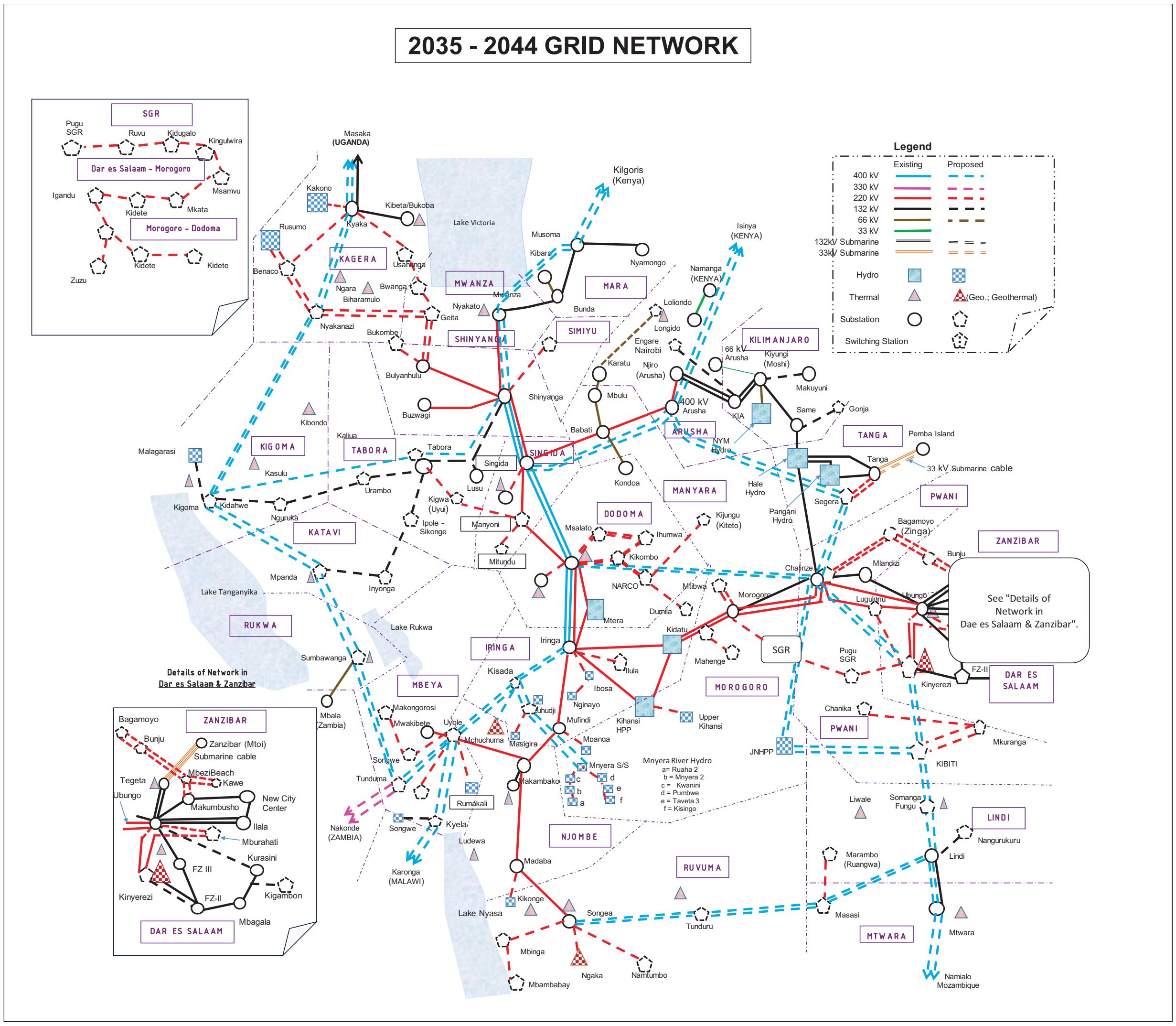


**Figure 4-4:** Generation and Transmission Plan – Year 2044

### 4.1.4. Drivers for Grid Development

#### 4.1.4.1. Reinforcement of Grid Security

The Government intend to connect all isolated grid and reinforce the National Grid in order to ensure grid reliability and security of power supply in the country. In this regard, the Western, Northern and Lake Zones need new transmission capacity addition. Similarly, the South-West and Coast Zone areas need transmission reinforcement to supply power to the load centers.

The Government has initiated several projects to reinforce Grid security and reliability, particularly in the short term. These projects include: 400 kV Singida – Arusha – Namanga; 400 kV transmission lines for evacuation of power in JNHPP (JNHPP –

Chalinze, Chalinze – Dodoma and Chalinze – Kinyerezi, 220 kV Chalinze – Bagamoyo); 400kV Iringa – Mbeya – Tunduma – Sumbawanga; 220 kV Kinyerezi – Ubungo – Mburahati; 220 kV Kibiti – Mkuranga – Chanika; 400 kV Mtwara – Somanga; Somanga – Kibiti – Kinyerezi and JNHPP – Kibiti; and 400 kV Nyakanazi – Kigoma – Mpanda – Sumbawanga.

#### 4.1.4.2. Grid Expansion to Explore Renewable Energy Resources

Development of renewable energy requires a stable grid to the point where renewable energy sources are available. An increase in the generation from renewable energy will further increase variations in the grid power system between years with low precipitation and years with high precipitation. Therefore, to accommodate renewable energy sources to the grid it requires stability of the National Grid. Initiatives are in place to motivate renewable power generation through the procurement of wind and solar project developers to a maximum of 200 MW and 150 MW, respectively, as a first round.

#### 4.1.4.3. Reliable Grid Creates Value

The load forecast shows that there will be high growth of power demand mainly due to the increase of industrial, agricultural, construction and extractive activities. The growth in these activities will lead to higher levels of energy consumption. It is anticipated that the grid system needs to be reinforced for a more reliable connection between regions and contribute to uniform electricity prices across the country.

#### 4.1.4.4. The Future of Tanzania is Electric

The Government‘s policy is to attain access rate to electricity of more than 75 percent by 2025 and 100 percent by 2030. In addition to that, the electricity demand in transport and industrial sectors is expected to grow hence there is need to strengthen grid capacity.

### 4.2. Transmission Planning Criteria

Planning methodologies and criteria used in PSMP 2016 Update were reviewed and used in this Update. Transmission planning considers the operation of the power system under two possible criteria, which are: Normal operating conditions (N-0) and Contingency operating conditions (N-1).

### 4.2.1.Operating Conditions

#### (i) Normal operating conditions (N-0)

Under normal operating conditions, the transmission infrastructure is assumed to be entirely available (no equipment has been forced out of service).

#### (ii) Contingency Operating Conditions (N-1)

The principle is that the National Grid will be operated and scheduled based on the so called N-1 criterion. This means that under normal system conditions a fault in one single component (line or transformer) will have no influence on the general power supply. This criterion establishes security of supply as a stronger driving force in grid development.

In this Chapter, the Plan has set a target to rectify all known breaches of the planning criteria by 2044. The deadline has been predetermined to ensure that there is a capacity to carry out investment projects related to additional priorities. Therefore, only outages of equipment rated at 220 kV or above will be considered under the N-1 criteria.

It should be noted that in most cases for voltage class of 220 kV and above, the line thermal capability is not the main limiting factor for the amount of power transferred. Transfer limits are usually dictated by steady state stability, dynamic stability and voltage stability.

### 4.2.2.System Voltage Criteria

The acceptable voltage range for operating the system is based on factors such as equipment limitations and motor operation under normal and contingency conditions as shown in **Table 4-2**

**Table 4-2:** Acceptable Operating Voltage Range

| **Condition** | **Acceptable Voltage Range** |
|---|---|
| Normal System Conditions | 95% – 105% |
| Contingency Conditions | 90% – 110% |

**Note:** Healthy systems usually target a minimum voltage close to 1.0 per unit (p.u) in the bulk system.

#### 4.2.3. Equipment Thermal Loading Criteria

The transmission system must be planned/designed to allow all transmission lines and equipment to operate within the following limits as indicated in **Table 4-3**.

**Table 4-3:** Thermal Loading Criteria

| Condition | Thermal Loading Limit |
|---|---|
| Normal System Conditions | Defined Normal Load Capacity |
| System Design Contingencies of Long Duration (i.e. an outage involving the failure of a transformer) | Defined Normal Load Capacity |
| System Design Contingencies of Short Duration (i.e. not involving a transformer) | Defined Emergency Load Capacity (120% of normal rating for 10 hours per year) |

#### 4.2.4. Grid Substation Load Forecast

The grid substation load forecast updates are shown in **Tables 4-4**, **4-5** and **4-6** in short, medium and long term respectively. Individual existing and future grid substations were modelled in the load flow simulations in short, medium and long term so that the corresponding total updated load forecasts in all regions were used as one of the inputs.

**Table 4-4:** 2024 Grid Substation Load forecast

| LOAD DISTRIBUTION FOR 2024 | | | | |
|---|---|---|---|---|
| **AREA** | **BusBar No.** | **Busbar Name** | **MW** | **MVAR** |
| **Arusha** | 505001 | Tarusha_3B1 33.000 | 43.68 | 14.36 |
| | 505281 | Tnjiro _3B1 33.000 | 34.16 | 11.23 |
| | 505282 | Tnjiro _3B2 33.000 | 34.16 | 11.23 |
| | **Total** | | **112.00** | **36.81** |
| **Manyara** | 505091 | Tbabati_3B1 33.000 | 2.34 | **0.77** |
| | 505092 | Tbabati_3B2 33.000 | 2.34 | **0.77** |
| | 505681 | Tkaratu_3B1 33.000 | 3.21 | **1.05** |
| | 505721 | Tmbulu _3B1 33.000 | 0.70 | **0.23** |
| | 505701 | Tkondoa_3B1 33.000 | 1.60 | **0.53** |
| | 505701 | Tkondoa_3B1 33.000 | 0.37 | **0.12** |
| | 506093 | Tbabati_7B3 11.000 | 0.90 | **0.30** |
| | 506094 | Tbabati_7B4 11.000 | 0.90 | **0.30** |
| | 506701 | Tkondoa_7B1 11.000 | 0.64 | **0.21** |
| | **Total** | | **13.00** | **4.27** |
| **Dar es Salaam** | 502182 | Tkinye1_2B2 220.00 | 112.76 | 37.06 |
| | 503024 | Pug 220.00 | 13.27 | 4.36 |
| | 503181 | Tkinye1_1B1 132.00 | 132.66 | 43.60 |
| | 503311 | Tubu220_1B1 132.00 | 66.33 | 21.80 |
| | 503461 | Tkipawa_1B1 132.00 | 66.33 | 21.80 |
| | 503651 | Twazo _1B1 132.00 | 6.63 | 2.18 |
| | 505321 | Tubu110_3B1 33.000 | 26.53 | 8.72 |
| | 505322 | Tubu110_3B2 33.000 | 26.53 | 8.72 |
| | 505391 | Tilala _3B1 33.000 | 9.12 | 3.00 |
| | 505391 | Tilala _3B1 33.000 | 9.12 | 3.00 |
| | 505392 | Tilala _3B2 33.000 | 9.12 | 3.00 |
| | 505392 | Tilala _3B2 33.000 | 9.12 | 3.00 |
| | 505461 | Tkipawa_3B1 33.000 | 66.33 | 21.80 |
| | 505462 | Tkipawa_3B2 33.000 | 66.33 | 21.80 |
| | 505481 | Tkunduc_3B1 33.000 | 10.28 | 3.38 |
| | 505482 | Tkunduc_3B2 33.000 | 10.28 | 3.38 |
| | 505511 | Tmkumbu_3B1 33.000 | 26.53 | 8.72 |
| | 505512 | Tmkumbu_3B2 33.000 | 26.53 | 8.72 |
| | 505571 | Tncc _3B1 33.000 | 8.29 | 2.73 |
| | 505572 | Tncc _3B2 33.000 | 8.29 | 2.73 |
| | 505732 | Tfzii_33B1 33.000 | 26.53 | 8.72 |
| | 505733 | Tmbgl_33B1 33.000 | 26.53 | 8.72 |
| | 505734 | Tkurs_33B1 33.000 | 6.63 | 2.18 |
| | 505735 | Tlemugur_3B133.000 | 19.90 | 6.54 |
| | 505799 | Tubungo_3B1 33.000 | 106.13 | 34.88 |
| | 505801 | Mbhat_1 33.000 | 26.53 | 8.72 |
| | 505803 | Lugulun 33.000 | 39.80 | 13.08 |
| | 505811 | Kunduch 33.000 | 6.63 | 2.18 |
| | 505815 | Chanik 33.000 | 19.90 | 6.54 |
| | **Total** | | **989.00** | **325.07** |
| **Coast** | 503025 | Ruvu 220.00 | 1.82 | **0.60** |
| | 503026 | Kidugal 220.00 | 1.82 | **0.60** |
| | 505551 | Tmlandi_3B1 33.000 | 2.73 | **0.90** |
| | 505552 | Tmlandi_3B2 33.000 | 2.73 | **0.90** |
| | 505761 | Tchali_3B1 33.000 | 4.55 | **1.50** |
| | 505762 | Tchali_3B2 33.000 | 4.55 | **1.50** |
| | 505812 | Kawe 33.000 | 0.91 | **0.30** |
| | 505813 | Bunju 33.000 | 0.91 | **0.30** |
| | 505814 | Zinga 33.000 | 0.91 | **0.30** |
| | 505816 | Mkurang 33.000 | 7.28 | **2.39** |
| | 505817 | Kibit 33.000 | 7.28 | **2.39** |
| | 507666 | Tchali_3B3 33.000 | 9.10 | **2.99** |
| | **Total** | | **44.60** | **14.66** |
| **Dodoma** | 502022 | Tdodoma_2B2 | 15.76 | 5.18 |
| | 505021 | Tdodoma_3B1 33.000 | 3.50 | 1.15 |
| | 505022 | Tdodoma_3B2 33.000 | 5.25 | 1.73 |
| | 505781 | Tdodoma_3B1 33.000 | 7.00 | 2.30 |
| | **Total** | | **31.51** | **10.36** |
| **Iringa** | 505031 | Tiringa_3B1 33.000 | 6.41 | 2.11 |
| | 505032 | Tiringa_3B2 33.000 | 6.54 | 2.15 |
| | 505171 | Tkihanh_3B1 33.000 | 3.25 | 1.07 |
| | 505251 | Tmufind_3B1 33.000 | 10.66 | 3.51 |
| | 505738 | Tkisada_3B1 33.000 | 1.06 | 0.35 |
| | 506251 | Tmufind_7B1 11.000 | 5.08 | 1.67 |
| | **Total** | | **33.00** | **10.85** |
| **Njombe** | 505221 | Tmkamba_3B1 33.000 | 24.00 | 7.89 |
| | **Total** | | **24.00** | **7.89** |

| LOAD DISTRIBUTION FOR 2024 (Continues) | | | | |
|---|---|---|---|---|
| **AREA** | **BusBar No.** | **Busbar Name** | **MW** | **MVAR** |
| Kagera | 501070 | Tkaronga_4B | 4.78 | 1.57 |
| | 501081 | Tz-Ug 400.00 | 9.55 | 3.14 |
| | 504005 | Tkyaka_1B 132.00 | 0.96 | 0.31 |
| | 505754 | Tnyaka_3B 33.000 | 0.14 | 0.05 |
| | 505758 | Tnickel_3B 33.000 | 1.43 | 0.47 |
| | 505800 | Ngara 33.000 | 0.14 | 0.05 |
| | | **Total** | **17.00** | **5.59** |
| Kigoma | 505809 | Kigoma 33.000 | 14.00 | 4.60 |
| | **Total** | | **14.00** | **4.60** |
| K'Manjaro | 505441 | Tkia _3B1 33.000 | 9.43 | 3.10 |
| | 505442 | Tkia _3B2 33.000 | 9.43 | 3.10 |
| | 505471 | Tkiyung_3B1 33.000 | 28.29 | 9.30 |
| | 505601 | Tsame _3B1 33.000 | 3.51 | 1.15 |
| | 505711 | Tmakuyu_3B1 33.000 | 7.67 | 2.52 |
| | 505712 | Tmakuyu_3B2 33.000 | 7.67 | 2.52 |
| | | **Total** | **66.00** | **21.69** |
| Lindi | 504002 | Tlindi_1B1 132.00 | 0.44 | 0.14 |
| | 505746 | Tsomanga_3B133.000 | 2.67 | 0.88 |
| | 505747 | Tsomanga_3B233.000 | 2.67 | 0.88 |
| | 505748 | Tlindi_3B1 33.000 | 2.67 | 0.88 |
| | **Total** | | **8.00** | **2.63** |
| Mara | 505361 | Tbunda _3B1 33.000 | 0.26 | 0.08 |
| | 505362 | Tbunda _3B2 33.000 | 2.33 | 0.77 |
| | 505561 | Tmusoma_3B1 33.000 | 2.60 | 0.85 |
| | 505562 | Tmusoma_3B2 33.000 | 2.60 | 0.85 |
| | 505581 | Tnyamon_3B1 33.000 | 10.77 | 3.54 |
| | 505581 | Tnyamon_3B1 33.000 | 1.86 | 0.61 |
| | 505691 | Tkibara_3B1 33.000 | 1.59 | 0.52 |
| | | **Total** | **22.00** | **7.23** |
| Mbeya | 505051 | Tmbeya _3B1 33.000 | 10.14 | 3.33 |
| | 505052 | Tmbeya _3B2 33.000 | 10.14 | 3.33 |
| | 505739 | Tmbeya_3B1 33.000 | 5.07 | 1.67 |
| | 505740 | Tmbeya_3B2 33.000 | 5.07 | 1.67 |
| | 505759 | Tkyela_3B 33.000 | 13.52 | 4.44 |
| | 505760 | Tkyela_3B2 33.000 | 13.52 | 4.44 |
| | 507002 | Ttundu_33B2 330.00 | 40.55 | 13.33 |
| | | **Total** | **20.28** | **6.66** |
| Songwe | 505741 | Ttundu_3B1 33.000 | 4.00 | **1.31** |
| | 505742 | Ttundu_3B2 33.000 | 4.00 | **1.31** |
| | | **Total** | **8.00** | **2.63** |
| Morogoro | 502231 | Tmorogo_2B1 220.00 | 21.45 | 7.05 |
| | 503027 | Kinglwir 220.00 | 7.15 | 2.35 |
| | 503231 | Tmorogo_1B1 132.00 | 7.15 | 2.35 |
| | 505151 | Tkidath_3B1 33.000 | 0.84 | 0.28 |
| | 505152 | Tkidath_3B2 33.000 | 0.81 | 0.27 |
| | 505231 | Tmorogo_3B1 33.000 | 7.15 | 2.35 |
| | 505232 | Tmorogo_3B2 33.000 | 21.45 | 7.05 |
| | 505820 | Mtibw 33.000 | 20.02 | 6.58 |
| | **Total** | | **86.00** | **28.27** |
| Mtwara | 504003 | Tmtwara_3B1 132.00 | 11.67 | 3.83 |
| | 505751 | Tmtwara_1B2 33.000 | 23.33 | 7.67 |
| | | **Total** | **35.00** | **11.50** |
| Mwanza | 505261 | Tmwanza_3B1 33.000 | 8.73 | 2.87 |
| | 505261 | Tmwanza_3B1 33.000 | 9.85 | 3.24 |
| | 505262 | Tmwanza_3B2 33.000 | 9.85 | 3.24 |
| | 505201 | Tmabuki_3B1 33.000 | 6.57 | 2.16 |
| | | **Total** | **35.00** | **11.50** |
| Geita | 505753 | Tgeita_3B 33.000 | 26.00 | **8.55** |
| | | **Total** | **26.00** | **8.55** |
| Rukwa | 504732 | Tsumb_6B1 66.000 | **10.91** | **3.59** |
| | 505806 | Mpanda 33.000 | **13.09** | **4.30** |
| | | **Total** | **24.00** | **7.89** |
| Ruvuma | 505736 | Tmadaba_3B1 33.000 | 14.77 | 4.85 |
| | 505737 | Tsongea_3B1 33.000 | 9.23 | 3.03 |
| | | **Total** | **24.00** | **7.89** |
| Shinyanga | 505071 | Tshinya_3B1 33.000 | 3.65 | 1.20 |
| | 505071 | Tshinya_3B1 33.000 | 3.65 | 1.20 |
| | 505071 | Tshinya_3B1 33.000 | 3.65 | 1.20 |
| | 505111 | Tbulyan_3B1 33.000 | 4.45 | 1.46 |
| | 505112 | Tbulyan_3B2 33.000 | 3.82 | 1.25 |
| | 505121 | Tbuzwag_3B1 33.000 | 18.83 | 6.19 |
| | 505501 | Tlusu _3B1 33.000 | 6.94 | 2.28 |
| | | **Total** | **45.00** | **14.79** |
| Simiyu | 505810 | Simiyu | **19.00** | **6.24** |
| | | **Total** | **19.00** | **6.24** |
| Singida | 505081 | Tsingid_3B1 33.000 | 11.50 | 3.78 |
| | 505082 | Tsingid_3B2 33.000 | 11.50 | 3.78 |
| | | **Total** | **23.00** | **7.56** |
| Tabora | 505621 | Ttabora_3B1 33.000 | 0.95 | 0.31 |
| | 505622 | Ttabora_3B2 33.000 | 0.16 | 0.05 |
| | 505804 | Ipole 33.000 | 4.23 | 1.39 |
| | 505805 | Inyonga 33.000 | 2.85 | 0.94 |
| | 505807 | Urambo 33.000 | 3.17 | 1.04 |
| | 505808 | Nguruka 33.000 | 11.63 | 3.82 |
| | | **Total** | **23.00** | **7.56** |
| Tanga | 503421 | Tkange _1B1 132.00 | 27.29 | 8.97 |
| | 504008 | Tsegera_1B1 132.00 | 39.93 | 13.12 |
| | 505381 | Thalehy_3B1 33.000 | 2.33 | 0.77 |
| | 505381 | Thalehy_3B1 33.000 | 2.33 | 0.77 |
| | 505421 | Tkange _3B1 33.000 | 3.33 | 1.09 |
| | 505432 | Tkasiga_3B2 33.000 | 7.19 | 2.36 |
| | 505531 | Tmaweni_3B1 33.000 | 2.00 | 0.66 |
| | 505631 | Ttanga _3B1 33.000 | 3.33 | 1.09 |
| | 505632 | Ttanga _3B2 33.000 | 3.33 | 1.09 |
| | 505633 | Ttanga _3B3 33.000 | 4.99 | 1.64 |
| | 505818 | Handen 33.000 | 9.98 | 3.28 |
| | 505819 | Mkat 33.000 | 9.98 | 3.28 |
| | | **Total** | **116.00** | **38.13** |
| Zanzibar - Pemba | 503661 | Tzanzi1_1B1 132.00 | 18.35 | 6.03 |
| Zanzibar - Unguja | 503671 | Tzanzi2_1B1 132.00 | 113.89 | 37.43 |

**Source**: PSMP 2020 Update Team Compilation

**Table 4-5:** 2034 Grid Substation Load forecast

| LOAD DISTRIBUTION FOR 2034 | | | | |
|---|---|---|---|---|
| **AREA** | **Bus No.** | **Bus Name** | **MW** | **MVAR** |
| **Arusha** | 51211 | Nji132Mb 132.00 | 393.00 | 129.17 |
| | 51501 | Isi400Mb 400.00 | 200.00 | 65.74 |
| | **Total** | | **593.00** | **194.91** |
| **Manyara** | 50116 | Bab066Mb 66.000 | 22.35 | 7.35 |
| | 50716 | Kar066Mb 66.000 | 43.60 | 14.33 |
| | 50916 | Mbu066Mb 66.000 | 3.05 | 1.00 |
| | **Total** | | **69.00** | **22.68** |
| **Dar es Salaam** | 10311 | Ubu132Mb 132.00 | 917.44 | 301.55 |
| | 11507 | Chanik 220.00 | 170.40 | 56.01 |
| | 11508 | Pug 220.00 | 59.64 | 19.60 |
| | 11510 | Kidugal 220.00 | 55.38 | 18.20 |
| | 11519 | Mburah 220.00 | 299.70 | 98.51 |
| | 11601 | Kawe 132.00 | 149.10 | 49.01 |
| | 11803 | Kin132Mb 132.00 | 649.94 | 213.63 |
| | 12002 | Bunj 33.000 | 51.12 | 16.80 |
| | 12202 | Sds1132Mb 33.000 | 438.78 | 144.22 |
| | 12302 | Kunduchi 33.000 | 106.50 | 35.00 |
| | **Total** | | **2,898.00** | **952.53** |
| **Pwani** | 10411 | Cha132Mb 132.00 | 71.22 | 23.41 |
| | 10611 | Mla132Mb 132.00 | 51.88 | 17.05 |
| | 11402 | Bag220Mb 220.00 | 94.73 | 31.14 |
| | 11509 | Ruv 220.00 | 11.24 | 3.69 |
| | 12102 | Mkurang 132.00 | 30.33 | 9.97 |
| | 20402 | Kibit 220.00 | 28.15 | 9.25 |
| | 91201 | Kib132Mb 132.00 | 40.45 | 13.29 |
| | **Total** | | **328.00** | **107.81** |
| **Dodoma** | 50816 | Kon066Mb 66.000 | 13.42 | 4.41 |
| | 80212 | Dod220Mb 220.00 | 108.58 | 35.69 |
| | **Total** | | **122.00** | **40.10** |
| **Iringa** | 40112 | Muf220Mb 220.00 | 48.78 | 16.03 |
| | 60412 | Iri220Mb 220.00 | 64.22 | 21.11 |
| | **Total** | | **113.00** | **37.14** |
| **Njombe** | 40115 | Makmbko 220.00 | 56.91 | 18.71 |
| | **Total** | | **56.91** | **18.71** |
| **Kagera** | 11513 | Benac 220.00 | 2.23 | 0.73 |
| | 11514 | Kabang 220.00 | 10.05 | 3.30 |
| | 20501 | Mas400Mb 220.00 | 30.19 | 9.92 |
| | 90701 | Rus220Mb 220.00 | 24.26 | 7.97 |
| | 91002 | Kya132Mb 132.00 | 24.26 | 7.97 |
| | 91301 | Mas220Mb 220.00 | 200.00 | 65.74 |
| | **Total** | | **291.00** | **95.65** |
| **Katavi** | 90301 | Mpa400Mb 400.00 | 16.00 | 5.26 |
| | **Total** | | **16.00** | **5.26** |
| **Kigoma** | 11617 | Tz -Bur 220.00 | 28.04 | 9.22 |
| | 90402 | Kig220Mb 220.00 | 79.41 | 26.10 |
| | 90602 | Nya220Mb 220.00 | 36.54 | 12.01 |
| | **Total** | | **144.00** | **47.33** |
| **K'Manjaro** | 50311 | Kiy132Mb 132.00 | 100.36 | 32.99 |
| | 50313 | Kia132Mb 132.00 | 36.36 | 11.95 |
| | 51011 | Sam132Mb 132.00 | 7.27 | 2.39 |
| | **Total** | | **144.00** | **47.33** |
| **Lindi** | 501 | Kilw 220.00 | 10.43 | 3.43 |
| | 20201 | Som400Mb 400.00 | 14.79 | 4.86 |
| | 20301 | Lin400Mb 400.00 | 14.79 | 4.86 |
| | **Total** | | **40.00** | **13.15** |
| **Mara** | 11516 | Tk-Kilgoris 400.00 | 200.00 | 65.74 |
| | 30201 | Bun220Mb 220.00 | 17.91 | 5.89 |
| | 30301 | Mus220Mb 220.00 | 32.04 | 10.53 |
| | 30316 | Nyamo220Mb 220.00 | 56.05 | 18.42 |
| | **Total** | | **306.00** | **100.58** |

| LOAD DISTRIBUTION FOR 2034 ( Continues) | | | | |
|---|---|---|---|---|
| **AREA** | **Bus No.** | **Bus Name** | **MW** | **MVAR** |
| **Mbeya** | 40212 | Mbe220Mb 220.00 | 310.17 | 101.95 |
| | 49101 | Karonga 220.00 | 74.83 | 24.59 |
| | **Total** | | **385.00** | **126.54** |
| **Songwe** | 42001 | Nak400Mb 400.00 | 200.00 | 65.74 |
| | 90102 | Tundum 400.00 | 38.00 | 12.49 |
| | **Total** | | **238.00** | **78.23** |
| **Morogoro** | 11511 | Kingolwir 220.00 | 12.40 | 4.07 |
| | 60112 | Kid220Mb 220.00 | 56.16 | 18.46 |
| | 60212 | Kih220Mb 220.00 | 7.97 | 2.62 |
| | 80111 | Mor132Mb 132.00 | 185.20 | 60.87 |
| | 80401 | Mti132Mb 220.00 | 57.27 | 18.83 |
| | **Total** | | **319.00** | **104.85** |
| **Mtwara** | 20401 | Mtw400Mb 400.00 | 19.74 | 6.49 |
| | 21001 | Moz400Mb 400.00 | 94.26 | 30.98 |
| | **Total** | | **114.00** | **37.47** |
| **Mwanza** | 30112 | Mwa220Mb 220.00 | 324.52 | 106.66 |
| | 51302 | Seg220Mb 220.00 | 108.48 | 35.66 |
| | **Total** | | **433.00** | **142.32** |
| **Geita** | 11519 | Bukomb 220.01 | **12.13** | 3.99 |
| | 30401 | Gei220Mb 220.00 | **112.87** | 37.10 |
| | **Total** | | **125.00** | **41.09** |
| **Rukwa** | 90101 | Sum400Mb 400.00 | 73.00 | 23.99 |
| | **Total** | | **73.00** | **23.99** |
| **Ruvuma** | 20701 | Tun400Mb 220.00 | 39.50 | 12.98 |
| | 20902 | Son220Mb 220.00 | 39.50 | 12.98 |
| | 40601 | Mad220Mb 220.00 | 39.00 | 12.82 |
| | **Total** | | **118.00** | **38.78** |
| **Shinyanga** | 70112 | Bul220Mb 220.00 | 126.50 | 41.58 |
| | 70312 | Shi220Mb 220.00 | 75.90 | 24.95 |
| | 71010 | Buzw220 220.00 | 50.60 | 16.63 |
| | **Total** | | **253.00** | **83.16** |
| **Simiyu** | 11520 | Simiy 220 | 140.00 | 46.02 |
| | **Total** | | **140.00** | **46.02** |
| **Singida** | 80312 | Sin220Mb 220.00 | 108.00 | 35.50 |
| | **Total** | | **108.00** | **35.50** |
| **Tabora** | 70201 | Lus220Mb 220.00 | 85.05 | 27.95 |
| | 70401 | Tab220Mb 220.00 | 157.95 | 51.92 |
| | **Total** | | **243.00** | **79.87** |
| **Tanga** | 51111 | Tan132Mb 132.00 | 454.00 | 149.22 |
| | **Total** | | **454.00** | **149.22** |
| **Zanzibar _Pemba** | | | **47.95** | 15.76 |
| **Zanzibar _Unguja** | | | **173.16** | 56.91 |
| **Grid System Peak** | | | **7,545.00** | 2,479.92 |

**Source**: PSMP 2020 Update Team Compilation

**Table 4-6:** 2044 Grid Substation Load forecast

| LOAD DISTRIBUTION FOR 2044 | | | | |
|---|---|---|---|---|
| **AREA** | **Bus No.** | **Bus Name** | **MW** | **MVAR** |
| Arusha | 51211 | Nji132Mb 132.00 | 1,207.00 | 396.72 |
| | 51501 | Isi400Mb 400.00 | 200.00 | 65.74 |
| | **Total** | | **1,407.00** | **462.46** |
| Manyara | 50116 | Bab066Mb 66.000 | 54.42 | 17.89 |
| | 50716 | Kar066Mb 66.000 | 106.15 | 34.89 |
| | 50916 | Mbu066Mb 66.000 | 7.42 | 2.44 |
| | **Total** | | **168.00** | **55.22** |
| Dar es Salaam | 10311 | Ubu132Mb 132.00 | 1,635.12 | 537.44 |
| | 11507 | Chanik 220.00 | 303.70 | 99.82 |
| | 11508 | Pug 220.00 | 106.29 | 34.94 |
| | 11510 | Kidugal 220.00 | 98.70 | 32.44 |
| | 11519 | Mburah 220.00 | 534.14 | 175.56 |
| | 11601 | Kawe 132.00 | 265.74 | 87.34 |
| | 11803 | Kin132Mb 132.00 | 1,158.37 | 380.74 |
| | 12002 | Bunj 33.000 | 91.11 | 29.95 |
| | 12202 | Sds1132Mb 33.000 | 782.02 | 257.04 |
| | 12302 | Kunduchi 33.000 | 189.81 | 62.39 |
| | **Total** | | **5,165.00** | **1,697.65** |
| Pwani | 10411 | Cha132Mb 132.00 | 189.33 | 62.23 |
| | 10611 | Mla132Mb 132.00 | 137.93 | 45.34 |
| | 11402 | Bag220Mb 220.00 | 251.85 | 82.78 |
| | 11509 | Ruv 220.00 | 29.89 | 9.82 |
| | 12102 | Mkurang 132.00 | 80.63 | 26.50 |
| | 20402 | Kibit 220.00 | 74.84 | 24.60 |
| | 91201 | Kib132Mb 132.00 | 107.52 | 35.34 |
| | **Total** | | **872.00** | **286.61** |
| Dodoma | 50816 | Kon066Mb 66.000 | 28.49 | 9.36 |
| | 80212 | Dod220Mb 220.00 | 230.51 | 75.76 |
| | **Total** | | **259.00** | **85.13** |
| Iringa | 40112 | Muf220Mb 220.00 | 101.02 | 33.20 |
| | 60412 | Iri220Mb 220.00 | 132.98 | 43.71 |
| | **Total** | | **234.00** | **76.91** |
| Njombe | 40115 | Makmbko 220.00 | 56.91 | 18.71 |
| | **Total** | | **56.91** | **18.71** |
| Kagera | 11513 | Benac 220.00 | 11.64 | 3.83 |
| | 11514 | Kabang 220.00 | 52.37 | 17.21 |
| | 20501 | Mas400Mb 220.00 | 157.25 | 51.69 |
| | 90701 | Rus220Mb 220.00 | 126.37 | 41.54 |
| | 91002 | Kya132Mb 132.00 | 126.37 | 41.54 |
| | 91301 | Mas220Mb 220.00 | 200.00 | 65.74 |
| | **Total** | | **674.00** | **221.53** |
| Katavi | 90301 | Mpa400Mb 400.00 | 99.00 | 32.54 |
| | **Total** | | **99.00** | **32.54** |
| Kigoma | 11617 | Tz -Bur 220.00 | 55.50 | 18.24 |
| | 90402 | Kig220Mb 220.00 | 157.18 | 51.66 |
| | 90602 | Nya220Mb 220.00 | 72.32 | 23.77 |
| | **Total** | | **285.00** | **93.67** |
| K'Manjaro | 50311 | Kiy132Mb 132.00 | 202.12 | 66.43 |
| | 50313 | Kia132Mb 132.00 | 73.23 | 24.07 |
| | 51011 | Sam132Mb 132.00 | 14.65 | 4.81 |
| | **Total** | | **290.00** | **95.32** |
| Lindi | 501 | Kilw 220.00 | 36.24 | 11.91 |
| | 20201 | Som400Mb 400.00 | 51.38 | 16.89 |
| | 20301 | Lin400Mb 400.00 | 51.38 | 16.89 |
| | **Total** | | **139.00** | **45.69** |
| Mara | 11516 | Tk-Kilgoris 400.00 | 200.00 | 65.74 |
| | 30201 | Bun220Mb 220.00 | 123.98 | 40.75 |
| | 30301 | Mus220Mb 220.00 | 221.87 | 72.92 |
| | 30316 | Nyamo220Mb 220.00 | 388.15 | 127.58 |
| | **Total** | | **934.00** | **306.99** |
| Mbeya | 40212 | Mbe220Mb 220.00 | 647.74 | 212.90 |
| | 49101 | Karonga 220.00 | 156.26 | 51.36 |
| | **Total** | | **804.00** | **264.26** |

| LOAD DISTRIBUTION FOR 2044 (Contnues) | | | | |
|---|---|---|---|---|
| **Area** | **Bus No.** | **Bus Name** | **MW** | **MVAR** |
| **Songwe** | 42001 | Nak400Mb 400.00 | 200.00 | 65.74 |
| | 90102 | Tundum 400.00 | 94.00 | 30.90 |
| | **Total** | | **294.00** | **96.63** |
| **Morogoro** | 11511 | Kingolwir 220.00 | 30.70 | 10.09 |
| | 60112 | Kid220Mb 220.00 | 139.08 | 45.71 |
| | 60212 | Kih220Mb 220.00 | 19.74 | 6.49 |
| | 80111 | Mor132Mb 132.00 | 458.64 | 150.75 |
| | 80401 | Mti132Mb 220.00 | 141.84 | 46.62 |
| | | **Total** | **790.00** | **259.66** |
| **Mtwara** | 20401 | Mtw400Mb 400.00 | 41.73 | 13.71 |
| | 21001 | Moz400Mb 400.00 | 199.27 | 65.50 |
| | **Total** | | **241.00** | **79.21** |
| **Mwanza** | 30112 | Mwa220Mb 220.00 | 691.01 | 227.12 |
| | 51302 | Seg220Mb 220.00 | 230.99 | 75.92 |
| | | **Total** | **922.00** | **303.05** |
| **Geita** | 11519 | Bukomb 220.01 | 52.39 | 17.22 |
| | 30401 | Gei220Mb 220.00 | 487.61 | 160.27 |
| | **Total** | | **540.00** | **177.49** |
| **Rukwa** | 90101 | Sum400Mb 400.00 | 118.00 | 38.78 |
| | **Total** | | **118.00** | **38.78** |
| **Ruvuma** | 20701 | Tun400Mb 220.00 | 85.70 | 28.17 |
| | 20902 | Son220Mb 220.00 | 85.70 | 28.17 |
| | 40601 | Mad220Mb 220.00 | 84.60 | 27.81 |
| | | **Total** | **256.00** | **84.14** |
| **Shinyanga** | 70112 | Bul220Mb 220.00 | 356.00 | 117.01 |
| | 70312 | Shi220Mb 220.00 | 213.60 | 70.21 |
| | 71010 | Buzw220 220.00 | 142.40 | 46.80 |
| | | **Total** | **712.00** | **234.02** |
| **Simiyu** | 11520 | Simiy 220 | 247.00 | 81.18 |
| | **Total** | | **247.00** | **81.18** |
| **Singida** | 80312 | Sin220Mb 220.00 | 212.00 | 69.68 |
| | | **Total** | **212.00** | **69.68** |
| **Tabora** | 70201 | Lus220Mb 220.00 | 262.15 | 86.16 |
| | 70401 | Tab220Mb 220.00 | 486.85 | 160.02 |
| | | **Total** | **749.00** | **246.18** |
| **Tanga** | 51111 | Tan132Mb 132.00 | 916.00 | 301.07 |
| | | **Total** | **916.00** | **301.07** |
| **Zanzibar _Pemba** | | | 71.90 | 23.63 |
| **Zanzibar _Unguja** | | | 227.16 | 74.66 |
| **Grid System Peak** | | | 16,917.00 | 5,560.35 |

**Source**: PSMP 2020 Update Team Compilation

### 4.3. Projects under Implementation

The Plan also considers the transmission projects under implementation. These projects are:-

i. 400 kV Singida – Arusha – Namanga transmission line and associated Substations at Singida and Arusha and Interconnection at Namanga;

ii. 220 kV Transmission Line Project for Electrification of Dar es Salaam – Morogoro Standard Gauge Railway Line Phase I and associated traction Substations at Pugu, Ruvu, Kidugalo and Kingolwira;

iii. 220 kV Morogoro – Dodoma Transmission Line Project for Electrification of Morogoro – Makutupora Standard Gauge Railway Line Phase II and associated traction Substations at Mkata, Kidete, Godegode, Igandu, Ihumwa, Kigwe and Kintiku;

iv. 220 kV Bulyanhulu – Geita Transmission Line Project and associated Substations at Geita and Bulyanhulu;
v. 220 kV Geita – Nyakanazi Transmission Line Project and associated Substations at Nyakanazi;
vi. 220 kV Rusumo – Nyakanazi Transmission Line Project and associated Substations at Benako;
vii. 220kV Shinyanga - Simiyu Transmission Line Project and associated Substations at Imalilo;
viii. 220kV Kinyerezi - Luguluni transmission Line and associated substation at Luguruni.
ix. 400 kV Nyakanazi – Kigoma Tansmission Line Project and associated Substation at Kigoma (Kidahwe);
x. 132 kV Tabora – Kigoma Transmission Line Project and Associated Substations at Urambo, Nguruka and Kidahwe;
xi. 132 kV Tabora – Katavi Transmission Line Project and Associated Substations at Ipole, Inyonga and Mpanda; and
xii. 132 kV Kurasini – Kigamboni Transmission Line Project and Associated Substations at Kigamboni.

#### 4.4. Planned Transmission Line Projects

The following are some of the planned 400 kV and 220 kV transmission line projects that are under different implementation stages:

The 400 kV Transmission Line Projects are:-

i. Iringa – Kisada – Mbeya – Tunduma – Sumbawanga and interconnection with Zambia at Tunduma and associated Substations at Kisada, Mbeya, Tunduma and Sumbawanga,
ii. JNHPP – Chalinze, Chalinze - Dodoma, Chalinze – Kinyerezi, JNHPP Kibiti, Chalinze – Segera – Arusha,
iii. Mtwara – Songea and associated substation at Masasi, Tunduru and Songea;

iv. Mtwara – Lindi – Somanga. Somanga – Kinyerezi,
v. Northwest Grid: Sumbawanga – Mpanda and Kigoma – Nyakanazi and
vi. Shinyanga – Tabora – Kigoma.

The 220 kV Transmission Line Projects are:

i. Segera – Tanga, Chalinze – Bagamoyo,
ii. Morogoro – Mtibwa,
iii. Mbeya – Songwe – Chunya,
iv. Dodoma City Ring Circuit (Zuzu – Msalato – Ihumwa – Kikombo, Ihumwa – NARCO),
v. NARCO – Dumila, Ifakara – Mahenge,
vi. Shinyanga – Simiyu,
vii. Kibiti – Mkuranga – Chanika,
viii. Kinyerezi – Ubungo – Mburahati,
ix. Bulyanhulu – Bukombe,
x. Songea – Mbambabay,
xi. NARCO – Kijungu (Kiteto),
xii. Manyoni – Kigwa (Uyui),
xiii. Manyoni – Mitundu (Manyoni) and
xiv. Songea – Namtumbo.

### 4.5. Transmission System Additions - Least Cost Expansion Plan

Following the result of transmission planning analysis PSMP 2020 Update recommends an addition transmission system that includes transmission lines, substations and compensators in short, medium and long term plan which fulfill transmission planning criteria.

#### 4.5.1. Transmission System Parameters

In designing and recommending transmission line addition various parameters were used as indicated in **Table 4-7**.

**Table 4-7:** Transmission line assumed parameters

| Voltage (kV) | Conductor | Name | Size ($mm^2$) | *Normal Rating (MVA) |
|---|---|---|---|---|
| 400 | ACSR | Sorbus | 659.4 | 626.31 |
| | | Blue jay | 564 | 605.25 |
| 220 | ACSR | Sorbus | 659.4 | 344.47 |
| | | Blue jay | 564 | 332.89 |
| 132 | ACSR | Wolf | 150. | 74 |
| | | Hawk | 241 | 121 |
| | XLPE | — | 300/400 | 143 |
| | | — | 95 | 52 |
| 66 | ACSR | Wolf | 150 | 37 |
| | | Rabbit | 50 | 18 |

**Note:** * 80% of current rating.

#### 4.5.2.Transmission Lines Additions

The recommended transmission line addition results are shown in **Tables 4-8**, **4-9** and **4-10**.

## **Table 4-8:** Transmission System Additions from 2020 to 2024

| RATED VOLTAGE (kV) | FROM | TO | REMARKS | ROUTE LENGTH (KM) | NO. OF CIRCUITS | CONDUCTOR | | | YEARS TO BE COMMISSIONED | CURRENT RATING (Amps) | FULL RATING (MVA) | NORMAL RATING (MVA) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | CODE NAME | No .OF CONDUCTOR'S PER PHASE | ALLUMINIUM SECTIONAL AREA (mm²) | | | | |
| 400 | Singida | Kisongo (Arusha) | | 300 | 2 | Bluejay | 2 | 564 | 2020 | 1092 | 3,026.24 | 2,420.99 |
| 400 | Arusha | Isinya (Kenya) | Up To Kenya border | 114 | 2 | Bluejay | 2 | 375 | 2020 | 1092 | 3,026.24 | 2,420.99 |
| 220 | Morogoro | Mtibwa | | 88 | 1 | Bluejay | 1 | 564 | 2023 | 1092 | 416.11 | 332.89 |
| 220 | Wind project | Singida | Evacuation of Singida Wind farm | 10 | 1 | Bluejay | 2 | 564 | 2023 | 1092 | 832.22 | 665.77 |
| 400 | Iringa | Kisada | | 106 | 2 | Bluejay | 2 | 564 | 2023 | 1092 | 3,026.24 | 2,420.99 |
| 400 | Kisada | Mbeya | | 285 | 2 | Bluejay | 2 | 564 | 2023 | 1092 | 3,026.24 | 2,420.99 |
| 400 | Mbeya | Tunduma | | 122 | 2 | Bluejay | 2 | 564 | 2023 | 1092 | 3,026.24 | 2,420.99 |
| 400 | Tunduma | Sumbawanga | | 203 | 2 | Bluejay | 2 | 564 | 2023 | 1092 | 3,026.24 | 2,420.99 |
| 220 | Solar 1 | Dodoma | Evacuation of Dodoma Wind farm | 10 | 1 | Bluejay | 1 | 242 | 2023 | 1092 | 416.11 | 332.89 |
| 132 | Wind project | Makambako | Evacuation of Makambako Wind farm | 10 | 1 | Hawk | 1 | 242 | 2023 | 659 | 150.67 | 120.53 |
| 400 | JNHPP | Chalinze | 2 X 1,048 MW | 160 | 2 | Sorbus | 3 | 659.4 | 2022 | 1274 | 5,295.92 | 4,236.73 |
| 400 | Chalinze | Kinyerezi | | 93 | 2 | Sorbus | 3 | 659.4 | 2022 | 1274 | 5,295.92 | 4,236.73 |
| 400 | Chalinze | Dodoma | | 345 | 2 | Sorbus | 3 | 659.4 | 2022 | 1274 | 5,295.92 | 4,236.73 |
| 220 | Chalinze | Bagamoyo (Zinga) | | 60 | 1 | Sorbus | 2 | 659.4 | 2022 | 1274 | 970.92 | 776.73 |
| 220 | Bagamoyo (Zinga) | Chalinze | | 60 | 1 | Sorbus | 2 | 659.4 | 2022 | 1274 | 970.92 | 776.73 |
| 400 | Mtwara | Lindi (Mahumbika) | | 60 | 2 | Sorbus | 2 | 564 | 2024 | 1130 | 3,131.55 | 2,505.24 |
| 400 | Lindi ( Mahumbika) | Somanga | | 210 | 2 | Sorbus | 2 | 564 | 2024 | 1130 | 3,131.55 | 2,505.24 |
| 400 | Somanga | Kibiti | | 79.56 | 2 | Sorbus | 2 | 659.4 | 2024 | 1130 | 3,131.55 | 2,505.24 |
| 400 | Kibiti | Kinyerezi | | 110.56 | 2 | Sorbus | 2 | 659.4 | 2024 | 1130 | 3,131.55 | 2,505.24 |
| 220 | Narco | Dumila | | 117 | 1 | Sorbus | 1 | 659.4 | 2024 | 1130 | 430.59 | 344.47 |
| 400 | Mtwara | Mozambique | MOTA Interconnector | 100 | 2 | Sorbus | 2 | 659.4 | 2025 | 1130 | 3,131.55 | 2,505.24 |
| 132 | Tabora | Ipole | | 127 | 1 | Hawk | 1 | 242 | 2024 | 659 | 150.67 | 120.53 |
| 132 | Ipole | Inyonga | | 138 | 1 | Hawk | 1 | 242 | 2024 | 659 | 150.67 | 120.53 |
| 132 | Inyonga | Mpanda (Katavi) | | 140 | 1 | Hawk | 1 | 242 | 2024 | 659 | 150.67 | 120.53 |
| 132 | Tabora | Urambo | | 131 | 1 | Hawk | 1 | 242 | 2024 | 659 | 150.67 | 120.53 |
| 132 | Urambo | Nguruka (Uvinza) | | 185 | 1 | Hawk | 1 | 242 | 2024 | 659 | 150.67 | 120.53 |
| 132 | Nguruka | Kigoma ( Kidahwe) | | 79 | 1 | Hawk | 1 | 242 | 2024 | 659 | 150.67 | 120.53 |
| 220 | Bulyanhulu | Geita | | 55 | 2 | Bluejay | 1 | 564 | 2020 | 1092 | 832.22 | 665.77 |
| 220 | Geita | Nyakanazi | | 144 | 2 | Bluejay | 1 | 564 | 2021 | 1092 | 832.22 | 665.77 |
| 220 | Rusumo | Nyakanazi | Evacuation of Rusumo HPP | 94 | 2 | Bluejay | 1 | 564 | 2021 | 1092 | 832.22 | 665.77 |
| 400 | Nyakanazi | Kigoma | | 280 | 2 | Sorbus | 2 | 659.4 | 2022 | 1130 | 3,131.55 | 2,505.24 |
| 400 | Uyole (Mbeya) | Kyela | | 80.66 | 2 | Sorbus | 2 | 659.4 | 2025 | 1130 | 3,131.55 | 2,505.24 |
| 400 | Kyela | Karonga (Malawi) | | 39.79 | 2 | Sorbus | 2 | 659.4 | 2023 | 1130 | 3,131.55 | 2,505.24 |
| 220 | Mbeya | Songwe | | 41 | 2 | Sorbus | 1 | 659.4 | 2024 | 1130 | 861.18 | 688.94 |
| 220 | Songwe | Chunya (Makongoros) | | 73 | 2 | Sorbus | 1 | 659.4 | 2024 | 1130 | 861.18 | 688.94 |
| 132 | Mkata | Handeni | | 46.8 | 1 | Hawk | 1 | 242 | 2024 | 659 | 150.67 | 120.53 |
| 220 | Zuzu | Msalato | | 32 | 2 | Sorbus | 2 | 659.4 | 2023 | 1130 | 1,722.35 | 1,377.88 |
| 220 | Msalato | Ihumwa | | 12 | 2 | Sorbus | 2 | 659.4 | 2023 | 1130 | 1,722.35 | 1,377.88 |
| 220 | Ihumwa | Kikombo | | 52 | 2 | Sorbus | 2 | 659.4 | 2023 | 1130 | 1,722.35 | 1,377.88 |
| 220 | Kikombo | Zuzu | | 47 | 2 | Sorbus | 2 | 659.4 | 2023 | 1130 | 1,722.35 | 1,377.88 |
| 220 | Kikombo | Narco | | 50 | 2 | Sorbus | 2 | 659.4 | 2023 | 1130 | 1,722.35 | 1,377.88 |
| 400 | Songea | Tunduru | | 230 | 2 | Sorbus | 2 | 659.4 | 2024 | 1130 | 3,131.55 | 2,505.24 |
| 400 | Tunduru | Masasi | | 194 | 2 | Sorbus | 2 | 659.4 | 2024 | 1130 | 3,131.55 | 2,505.24 |
| 400 | Masasi | Lindi | | 141 | 2 | Sorbus | 2 | 659.4 | 2024 | 1130 | 3,131.55 | 2,505.24 |
| 220 | Masasi | Marambo (Ruangwa) | | 65 | 1 | Sorbus | 1 | 659.4 | 2024 | 1130 | 430.59 | 344.47 |
| 220 | Ifakara | Mahenge | | 68 | 1 | Sorbus | 1 | 659.4 | 2024 | 1130 | 430.59 | 344.47 |
| 220 | Shinyanga (Iibadakuli) | Simiyu (Imalilo) | | 113 | 2 | Sorbus | 2 | 659.4 | 2023 | 1130 | 1,722.35 | 1,377.88 |
| 220 | Pugu (SGR SS) | Chanika (Buyuni) | | 16 | 2 | Sorbus | 2 | 659.4 | 2024 | 1130 | 1,722.35 | 1,377.88 |
| 220 | Chanika (Buyuni) | Mkuranga | | 60 | 2 | Sorbus | 2 | 659.4 | 2024 | 1130 | 1,722.35 | 1,377.88 |
| 220 | Kinyerezi | Ubungo | | 17 | 1 | Bluejay | 2 | 564 | 2023 | 1130 | 861.18 | 688.94 |
| 220 | Kinyerezi | Mburahati (Mabibo) | | 2 | 1 | Bluejay | 2 | 659.4 | 2023 | 1130 | 861.18 | 688.94 |
| 220 | Zinga | Bunju | | 18 | 2 | Sorbus | 2 | 659.4 | 2024 | 1130 | 1,722.35 | 1,377.88 |
| 220 | Bunju | Kunduchi | | 14 | 2 | Sorbus | 2 | 659.4 | 2024 | 1130 | 1,722.35 | 1,377.88 |
| 220 | Kunduchi | Mbezi Beach | | 6 | 2 | Sorbus | 2 | 659.4 | 2024 | 1130 | 1,722.35 | 1,377.88 |
| 220 | Mbezi Beach | Makumbusho | | 11 | 2 | Sorbus | 2 | 659.4 | 2024 | 1130 | 1,722.35 | 1,377.88 |
| 220 | Mbezi Beach | Kawe | | 8.7 | 2 | Sorbus | 2 | 659.4 | 2024 | 1130 | 1,722.35 | 1,377.88 |
| 132 | Malagalasi | Kigoma (Kidahwe) | Evacuation of Malagalasi | 74 | 1 | Hawk | 1 | 242 | 2024 | 659 | 150.67 | 120.53 |
| 220 | Kishapu Solar P | Shinyanga | Evacuation of Power from Kishapu Solar Farm | 10 | 1 | Bluejay | 1 | 659.4 | 2024 | 1092 | 416.11 | 332.89 |

**Source**: PSMP 2020 Update Team Compilation

## **Table 4-9:** Transmission System Additions from 2025 to 2034

| RATED VOLTAGE (kV) | FROM | TO | REMARKS | ROUTE LENGTH (KM) | NO. OF CIRCUITS | CONDUCTOR | | | YEARS TO BE COMMISSIONED | CURRENT RATING (Amps) | FULL RATING (MVA) | NORMAL RATING (MVA) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | CODE NAME | No .OF CONDUCTOR'S PER PHASE | ALLUMINIUM SECTIONAL AREA ($mm^2$) | | | | |
| 400 | JNHPP | Kibiti | Evacuation of JNHPP | 172 | 2 | Sorbus | 3 | 659.4 | 2025 | 1274 | 5,295.92 | 4,236.73 |
| 220 | Kibiti | Mkuranga | | 60 | 2 | Sorbus | 2 | 659.4 | 2025 | 1274 | 1,941.84 | 1,553.47 |
| 400 | Chalinze | Segera | | 175 | 2 | Sorbus | 2 | 659.4 | 2025 | 1274 | 3,530.61 | 2,824.49 |
| 400 | Segera | Arusha | | 366 | 2 | Sorbus | 2 | 659.4 | 2025 | 1274 | 3,530.61 | 2,824.49 |
| 220 | Segera | Tanga | | 64 | 2 | Sorbus | 2 | 659.4 | 2025 | 1274 | 1,941.84 | 1,553.47 |
| 400 | Kigoma | Mpanda | | 290 | 2 | Sorbus | 2 | 659.4 | 2026 | 1130 | 3,131.55 | 2,505.24 |
| 400 | Mpanda | Sumbawanga | | 119 | 2 | Sorbus | 2 | 659.4 | 2026 | 1130 | 3,131.55 | 2,505.24 |
| 400 | Shinyanga | Mwanza | | 140 | 2 | Sorbus | 2 | 659.4 | 2025 | 1130 | 3,131.55 | 2,505.24 |
| 400 | Mwanza | Musoma | | 210 | 2 | Sorbus | 2 | 659.4 | 2025 | 1130 | 3,131.55 | 2,505.24 |
| 400 | Musoma | Kilgoris (Kenya) | | 179 | 2 | Sorbus | 2 | 659.4 | 2025 | 1130 | 3,131.55 | 2,505.24 |
| 220 | Kakono P/S (Hydro) | Kyaka | 87MW | 39 | 1 | Bluejay | 1 | 564 | 2025 | 1092 | 416.11 | 332.89 |
| 400 | Nyakanazi | Kyaka | Interconnectioon project to Uganda | 30 | 2 | Sorbus | 2 | 564 | 2025 | 1130 | 3,131.55 | 2,505.24 |
| 400 | Kyaka | Masaka (Uganda) | | 30 | 2 | Sorbus | 2 | 564 | 2025 | 1130 | 3,131.55 | 2,505.24 |
| 220 | Bulyanhulu | Bukombe | | 66.5 | 1 | Sorbus | 1 | 659.4 | 2030 | 1130 | 430.59 | 344.47 |
| 132 | Kiyungi | Makuyuni | | 34 | 1 | Hawk | 1 | 242 | 2025 | 659 | 150.67 | 120.53 |
| 220 | Tabora | Kigwa - Uyui | Initially the line to be charged in 132kV | 42 | 1 | Sorbus | 1 | 659.4 | 2026 | 1130 | 430.59 | 344.47 |
| 132 | Lindi | Nangurukuru (Kilwa ) | | 158 | 1 | Hawk | 1 | 242 | 2026 | 659 | 150.67 | 120.53 |
| 132 | Kiyungi | Makuyuni | | 34 | 1 | Hawk | 1 | 242 | 2026 | 659 | 150.67 | 120.53 |
| 400 | Ruhudji | Kisada | Evacuation of Hydro Proje | 140 | 2 | Sorbus | 2 | 659.4 | 2025 | 1130 | 3,131.55 | 2,505.24 |
| 220 | Rumakali PP | Mbeya (Uyole) | Evacuation of HPP | 70 | 1 | Sorbus | 1 | 659.4 | 2026 | 1130 | 430.59 | 344.47 |
| 220 | Dodoma Solar | Dodoma | Evacuation of Dodoma So | 12 | 1 | Bluejay | 1 | 564 | 2025 | 1092 | 416.11 | 332.89 |
| 220 | Ngozi (wellhead) & Ngozi I | Mbeya | Evacuation of Geothermal | 35 | 1 | Bluejay | 1 | 564 | 2025 | 1092 | 416.11 | 332.89 |
| 220 | Masigira | Ruhudji | Evacuation of Masigira Po | 100 | 1 | Bluejay | 1 | 564 | 2027 | 1092 | 416.11 | 332.89 |
| 220 | Kikonge | Madaba | Evacuation of Kikonge HPP | 49 | 1 | Bluejay | 1 | 564 | 2027 | 1092 | 416.11 | 332.89 |
| 220 | Mnyera | Ruhudji | Evacuation of Mnyera HPP | 50 | 1 | Bluejay | 1 | 564 | 2027 | 1092 | 416.11 | 332.89 |
| 220 | Kwanini P/S | Mnyera S/S - Ruaha 2 T | T- branch | 10 | 2 | Bluejay | 2 | 564 | 2028 | 1092 | 1,664.43 | 1,331.55 |
| 220 | Mnyera S/S (new) | Taveta 3 P/S | (119.8+83.9+122.9)MW | 26 | 1 | Bluejay | 2 | 564 | 2034 | 1092 | 832.22 | 665.77 |
| 220 | Ruaha 2 P/S (Hydro) | Mnyera S/S (new) | (60.3+137.4+143.9)MW | 33 | 2 | Bluejay | 2 | 564 | 2028 | 1,092 | 1,664.43 | 1,331.55 |
| 220 | Ngaka | Songea | Evacuation of Power | 37 | 1 | Bluejay | 1 | 564 | 2032 | 1092 | 416.11 | 332.89 |
| 400 | Mchuchuma P/s | Kisada | Evacuation of Mchuchuma | 200 | 1 | Sorbus | 2 | 659.4 | 2025 | 1130 | 1,565.77 | 1,252.62 |
| 220 | Mpanga P/S (Hydro) | Mufindi | 160MW | 65 | 1 | Bluejay | 1 | 564 | 2031 | 1092 | 416.11 | 332.89 |
| 220 | Uyole | Kiwira | | 35.6 | 1 | Sorbus | 1 | 659.4 | 2032 | 1130 | 430.59 | 344.47 |
| 220 | Kihansi P/S (Hydro) | Upper Kihansi P/S (Hyd | 47 MW | 10 | 1 | Bluejay | 1 | 564 | 2034 | 1092 | 416.11 | 332.89 |
| 400 | Somanga Fungu S/S | Future CGT3 -1 | 648 MW | 20 | 1 | Bluejay | 1 | 564 | 2028 | 1092 | 756.56 | 605.25 |

**Source**: PSMP 2020 Update Team Compilation

## **Table 4-10:** Transmission Additions from 2035 to 2044

| RATED VOLTAGE (kV) | FROM | TO | REMARKS | ROUTE LENGTH (KM) | NO. OF CIRCUITS | CONDUCTOR | | | YEARS TO BE COMMISSI | CURRENT RATING (Amps) | FULL RATING(MVA) | NORMAL RATING (MVA) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | CODE NAME | No .OF CONDUCT | ALLUMINIUM | | | | |
| 220 | Songea | Mbinga | | 92.5 | 1 | Sobber | 1 | 659.4 | 2037 | 1130 | 430.59 | 344.47 |
| 220 | Mbinga | Mbambabay | | 53.8 | 1 | Sobber | 1 | 659.4 | 2037 | 1130 | 430.59 | 344.47 |
| 132 | KIA | Engare Nairobi | | 40.1 | 1 | Hawk | 1 | 242 | 2036 | 659 | 150.67 | 120.53 |
| 132 | Same | Gonja | | 49.1 | 1 | Hawk | 1 | 242 | 2038 | 659 | 150.67 | 120.53 |
| 220 | NARCO | Kijungu (Kiteto) | | 157 | 1 | Sobber | 1 | 659.4 | 2037 | 1130 | 430.59 | 344.47 |
| 220 | Manyoni | Kigwa (Uyui) | | 200 | 1 | Sobber | 1 | 659.4 | 2037 | 1130 | 430.59 | 344.47 |
| 220 | Manyoni | Mitundu (Manyoni) | | 106 | 1 | Sobber | 1 | 659.4 | 2037 | 1130 | 430.59 | 344.47 |
| 220 | Geita | Bwanga | | 61 | 1 | Sorbus | 1 | 659.4 | 2041 | 1130 | 430.59 | 344.47 |
| 220 | Bwanga | Usahunga | | 62 | 1 | Sorbus | 1 | 659.4 | 2041 | 1130 | 430.59 | 344.47 |
| 220 | Usahunga | Kyaka | | 228 | 1 | Sorbus | 1 | 659.4 | 2041 | 1130 | 430.59 | 344.47 |
| 2202 | Songea | Namtumbo | | 70 | 2 | Sorbus | 1 | 659.4 | 2036 | 1130 | 8,619.59 | 6,895.67 |
| 400 | Shinyanga | Tabora | | 195 | 2 | Sorbus | 2 | 659.4 | 2040 | 1130 | 3,131.55 | 2,505.24 |
| 400 | Tabora | Kigoma | | 415 | 2 | Sorbus | 2 | 659.4 | 2040 | 1130 | 3,131.55 | 2,505.24 |
| 132 | Songwe B S/S | Kyela | (79.5+88.1)MW | 7 | 1 | Hawk | 2 | 242 | 2035 | 659 | 301.34 | 241.07 |
| 132 | Songwe A S/S | Songwe B S/S | | 40 | 1 | Hawk | 2 | 242 | 2035 | 659 | 301.34 | 241.07 |
| 132 | Songwe Sofwe P/S (Hydro) | Songwe A S/S | 79.5MW | 16 | 1 | Hawk | 1 | 242 | 2035 | 659 | 150.67 | 120.53 |
| 220 | Iringa (Ibosa) | Iringa ( Tagamenda) | Evacuation of Ibosa and Nginayo HPP | 81 | 1 | Bluejay | 1 | 564 | 2035 | 1092 | 416.11 | 332.89 |
| 220 | Ibosa P/s (Hydro) | Nginayo P/S (Hydro) | 52 MW | 10 | 1 | Bluejay | 1 | 564 | 2035 | 1092 | 416.11 | 332.89 |
| 220 | Iringa ( Kilolo-Ilula) | Iringa ( Tagamenda) | evacuation of Kilolo HPP | 39 | 1 | Bluejay | 1 | 564 | 2039 | 1092 | 416.11 | 332.89 |
| 220 | Pumbwe P/S (Hydro) | Mnyera S/S - Taveta 3 T/L | | 10 | 1 | Bluejay | 2 | 564 | 2039 | 1092 | 832.22 | 665.77 |
| 220 | Mnyera 2 P/S | Mnyera S/S - Ruaha 2 T/L | T- branch | 10 | 2 | Bluejay | 2 | 564 | 2035 | 1092 | 1,664.43 | 1,331.55 |
| 220 | Pumbwe P/S (Hydro) | Mnyera S/S - Taveta 3 T/L | | 10 | 1 | Bluejay | 2 | 564 | 2030 | 1092 | 832.22 | 665.77 |

**Source**: PSMP 2020 Update Team Compilation.

### 4.5.3. Reactive Compensation

It was assumed that each 400 kV line would be compensated by two line-connected reactors located at the two line ends. The magnitude of each reactor was taken as 35 percent of the full line charging value, which is equivalent to a total of 70 percent compensation. These line-connected reactors would be switched on and off based on the system operation requirements. However, for line switching (or energization), these reactors must be switched on to avoid high voltages at the open line ends (Ferranti Effect). These factors are subject of a detailed dynamic study performed at design stage.

Variable reactors were sized to ensure the adequacy of the system operating conditions as given in the planning criteria.

### 4.5.4. Substation Additions

The numbers of circuit breakers for the 400 kV and 220 kV systems are based on the breaker and a half scheme, as shown in **Figure 4-5**. Each bay is composed of three (3) breakers and provides two positions for transmission line, transformer or compensation equipment. Sub-transmission switchgear has not been considered as it depends greatly on how many positions will be needed, which in turn, depends on the local area planning.

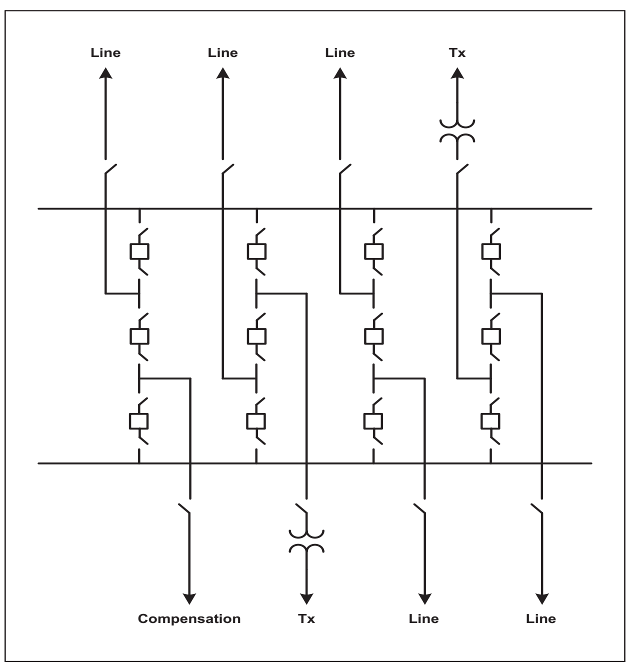



**Figure 4-5:** Breaker and Half Scheme

### 4.6. Load Flow Analysis

The proposed transmission system is based on the load forecast and the new power plants as presented in the Chapter Two and Three. The short, medium and long term study was considered as follows:

a) Year 2019 existing peak load case;
b) Year 2024 peak load case;
c) Year 2034 peak load case; and
d) Year 2044 peak load case.

Each case has been analyzed under both normal (N-0) and contingency (N-1) conditions. System reinforcement including transmission lines, transformers/ substations and reactive power compensations were defined as appropriate.

#### 4.6.1. Year-2019 case

In year 2019, simulation of existing peak load revealed that the Kinyerezi – Ubungo 220 kV line, the Chalinze – Hale 132 kV line, Kinyerezi – Gongolamboto – Mbagala – Kurasini 132 kV line, Ubungo – Makumbusho 132 kV line had exceeded their thermal limit. Therefore, they could not transfer all the demanded power. This has resulted in the introduction of Kurasini – Kigamboni (Dege) project 132 kV, Kinyerezi – Ubungo – Mburahati 220 kV line, stringing of Chalinze Hale 132 kV line and Kinyerezi - Gongolamboto – Mbagala – Kurasini 132 kV line and the reinforcement of power network in Dar es Salaam and Pwani.

#### 4.6.2. Year-2024 case

The major short term plan lines addition will consist of 400 kV double Circuit Lines: JNHPP – Chalinze – Kinyerezi and Chalinze – Dodoma; Singida – Arusha – Namanga; Iringa – Mbeya – Tunduma – Sumbawanga; Mtwara – Somanga – Kibiti – Kinyerezi; and Lindi – Masasi – Tunduru Songea.

220 kV transmission line addition includes: Shinyanga – Simiyu; Morogoro – Mtibwa; Bulyanhulu – Geita; Geita – Nyakanazi; Rusumo – Nyakanazi; Mbeya – Songwe – Chunya; Dodoma City (Zuzu – Msalato – Ihumwa – Kikombo – Zuzu, Ihumwa – NARCO)

Ring Circuit; Ifakara – Mahenge; Shinyanga – Simiyu; Kibiti– Mkuranga– Chanika; Kinyerezi – Ubungo –Mburahati; and Zinga – Kunduchi – Makumbusho.

These lines will carry amount of power generated at each plant to maintain the load/generation balance. Contingency analysis (N-1) for this case was performed and no voltage or overloading problems were encountered in the bulk system. Under contingency conditions the voltage check was based on the (0.9-1.1 p.u) limits and the loading was based of the transmission line/transformer emergency capacity (rating B).

#### 4.6.3.Year 2034 case

The major lines addition by the year 2034 are divided into two categories. The first is the expansion of the 400 kV network composed of: Chalinze – Segera – Arusha; Northern West Grid (Kigoma – Mpanda – Sumbawanga); Shinyanga – Mwanza Musoma; and the JNHPP – Kibiti. The second is the expansion of 220 kV network in Dar es Salaam area composed of: Chalinze Bagamoyo; Bagamoyo – Bunju – Kunduchi – Makumbusho; and Kinyerezi – Luguluni. Other 220 kV additions are Segera – Tanga; Bulyanhulu – Bukombe; Kibiti – Mkuranga; Kakono – Kyaka; and NARCO (Dodoma) – Dumila.

Under normal conditions (N-0), all bus voltages are within the limits (0.95 -1.05 pu), as defined in the planning criteria. No voltage violations are recorded in the bulk system (220 kV and above.). Transmission line power flows are also below the line normal capacity (rating A).

Contingency analysis (N-1) for this case was performed and no voltage or overloading problems were encountered in the bulk system. Under contingency conditions the voltage check was based on the (0.9-1.1 pu) limits and the loading was based of the transmission line/transformer emergency capacity (rating B).

#### 4.6.4.Year 2044 case

This case represents the ultimate load flow case for the power system. Generally, the importance of such a case is to plan the system in the early years ie 2024 and 2034 with an eye on the foreseen ultimate configuration. Both the 400 kV and 220 kV networks were expanded as many power plants were considered. Since the generation is mostly concentrated in the South and coastal areas and there are substantial load centers at North, reactive power compensation played an important role in reaching satisfactory operating conditions for the system developed.

Under normal conditions (N-0), all bus voltages are within the limits (0.95 -1.05 pu), as defined in the planning criteria. No voltage violation is recorded in the bulk system (220 kV and above). Transmission line power flows are also below the line normal capacity (rating A).

Contingency analysis (N-1) for this case was performed and no voltage or overloading problems were encountered in the bulk system. Under contingency conditions the voltage check was based on the (0.9-1.1 pu) limits and the loading was based of the transmission line/transformer emergency capacity (rating B).

### 4.7. Short Circuit Study

A Short circuit study was performed only on the bulk system (220 kV and above) and results are given in **Table 4-11.**

A typical equivalent machine reactance of 15 percent and step-up transformer reactance of 10 percent were assumed for short circuit current calculations. Classical assumptions (flat conditions) were assumed and all bus voltages were set to 1.05 pu.

All fault currents for 400 kV and 220 kV substations are within the practical switchgear ratings for these levels. The minimum switchgear short circuit rating is in the range of 63 kA for 400 kV level and 40 kA for 220 kV level. Therefore, the year 2044 case with the overall 400/220 kV transmission system does not experience any switchgear short circuit rating problems.

Table 4-11: Year 2044 Short Circuit Results

| BUS | | | 3 - ph Short Circuit Currents | | |
|---|---|---|---|---|---|
| **No.** | **Name** | **kV** | **kA** | **MVA** | **X/R Ratio** |
| **400 kV Buses** | | | | | |
| 10401 | Chalinze | 400 | 41.26 | 11,106 | 14.8 |
| 11504 | Rumakali | 400 | 30.32 | 7,643 | 50.3 |
| 11506 | JNHPG | 400 | 30.17 | 8,181 | 13.7 |
| 11515 | Mara | 400 | 8.26 | 2,313 | 10.1 |
| 11516 | TK Kilgoris | 400 | 5.03 | 148 | 7.2 |
| 11517 | Kyaka | 400 | 8.33 | 2,295 | 11.7 |
| 11801 | Kiny | 400 | 57.86 | 15,118 | 22.0 |
| 20201 | Somanga | 400 | 47.78 | 12,878 | 14.6 |
| 20227 | Dom CCGT | 400 | 16.38 | 5,973 | 1.6 |
| 20232 | Kisada Wind | 400 | 19.83 | 7,756 | 1.1 |
| 20234 | CCGT II | 400 | 20.75 | 7,086 | 2.1 |
| 20235 | CCGT I | 400 | 20.39 | 7,016 | 2.0 |
| 20301 | Lindi | 400 | 29.28 | 8,586 | 7.3 |
| 20401 | Mtwara | 400 | 30.43 | 8,874 | 7.6 |
| 20601 | ST I | 400 | 30.25 | 8,200 | 13.7 |
| 20611 | JNHPP PGI | 400 | 30.13 | 8,172 | 13.6 |
| 21001 | Mozambique | 400 | 15.65 | 4,361 | 10.6 |
| 21002 | Kibiti | 400 | 48.80 | 12,989 | 16.9 |
| 30101 | Mwa | 400 | 11.86 | 3,181 | 15.3 |
| 40210 | Mbeya | 400 | 39.04 | 10,314 | 24.9 |
| 40605 | Taveta | 400 | 21.03 | 5,549 | 19.0 |
| 40701 | Masa | 400 | 9.09 | 2,362 | 24.3 |
| 41301 | Ruh | 400 | 14.29 | 3,618 | 43.5 |
| 41401 | Mnyera | 400 | 20.43 | 5,308 | 24.2 |
| 41501 | Kwanini | 400 | 22.68 | 5,895 | 23.9 |
| 41601 | Ruhudji | 400 | 34.88 | 8,984 | 28.4 |
| 41701 | Ikonda | 400 | 25.76 | 6,661 | 26.4 |
| 42001 | Nak | 400 | 18.71 | 5,127 | 12.3 |
| 42101 | Kis | 400 | 45.90 | 11,839 | 27.7 |
| 42501 | Mnyera | 400 | 34.65 | 8,903 | 30.0 |
| 51301 | Segera | 400 | 18.91 | 4,956 | 20.9 |
| 51401 | Arusha | 400 | 13.92 | 3,677 | 18.6 |
| 51501 | Isinya | 400 | 9.38 | 2,485 | 18.0 |
| 60401 | Iringa | 400 | 32.68 | 8,537 | 22.1 |
| 70301 | Shinyanga | 400 | 15.42 | 4,176 | 13.8 |
| 70402 | Tabora | 400 | 15.38 | 4,113 | 15.9 |
| 80201 | Dodoma | 400 | 27.94 | 7,701 | 11.7 |
| 80301 | Singida | 400 | 20.53 | 5,437 | 18.0 |
| 90101 | Sumbawanga | 400 | 24.64 | 6,540 | 17.5 |
| 90102 | Tunduma | 400 | 27.95 | 7,631 | 12.7 |
| 90301 | Mpanda | 400 | 20.31 | 5,369 | 18.6 |
| 90401 | Kigoma | 400 | 16.74 | 4,450 | 17.1 |
| 90601 | Nya | 400 | 11.28 | 2,973 | 19.2 |
| 91301 | Masaka | 400 | 6.78 | 1,860 | 12.2 |
| 91501 | Ruk | 400 | 22.87 | 6,021 | 19.6 |

| BUS | | 3 - ph Short Circuit Currents | | | |
|---|---|---|---|---|---|
| **No.** | **Name** | **kV** | **kA** | **MVA** | **X/R Ratio** |
| **220 kV Buses** | | | | | |
| 501 | Kilwa | 220 | 5.53 | 839 | 11.5 |
| 10312 | Ubungo | 220 | 32.13 | 9,537 | 18.2 |
| 10411 | Chalinze | 220 | 5.66 | 37,888 | 13.4 |
| 11402 | Bagamoyo | 220 | 4.52 | 30,384 | 14.2 |
| 11503 | Lindi | 220 | 39.56 | 6,466 | 8.2 |
| 11507 | Chanika | 220 | 31.57 | 4,669 | 15.0 |
| 11508 | Pugu | 220 | 28.64 | 7,124 | 16.8 |
| 11509 | Ruvu | 220 | 19.60 | 2,933 | 13.1 |
| 11510 | Kidugalo | 220 | 14.82 | 2,241 | 11.9 |
| 11511 | Kingoluwira | 220 | 15.11 | 2,311 | 10.7 |
| 11513 | Benaco | 220 | 13.48 | 1,962 | 18.1 |
| 11514 | Kabanga | 220 | 7.43 | 1,098 | 15.0 |
| 11518 | Bukombe | 220 | 6.70 | 1,002 | 12.2 |
| 11519 | Mburahati | 220 | 16.79 | 7,811 | 16.2 |
| 11601 | Kawe | 220 | 14.13 | 2,408 | 5.4 |
| 11617 | TZ - Bur | 220 | 11.43 | 1,591 | 44.1 |
| 11802 | Kiny | 220 | 25.54 | 10,887 | 26.0 |
| 12001 | Bunju | 220 | 28.49 | 3,993 | 7.4 |
| 12101 | Mkuranga | 220 | 19.59 | 2,887 | 15.6 |
| 12301 | Kunduchi | 220 | 28.96 | 4,444 | 10.5 |
| 20219 | Ubu 1 New | 220 | 35.07 | 5,926 | 16.0 |
| 20220 | Ubu New | 220 | 17.38 | 6,622 | 16.0 |
| 20221 | Mbeya Coal | 220 | 34.18 | 5,403 | 19.3 |
| 20228 | Makambako wind | 220 | 3.87 | 560 | 19.5 |
| 20229 | CCGT IPP | 220 | 20.89 | 3,272 | 4.2 |
| 20230 | Kilol | 220 | 24.19 | 4,511 | 2.1 |
| 20231 | Sing solar | 220 | 18.36 | 3,129 | 3.0 |
| 20233 | Simiyu | 220 | 6.47 | 976 | 12.2 |
| 20402 | Kibiti | 220 | 28.38 | 3,990 | 33.9 |
| 20511 | Masaka | 220 | 21.08 | 3,087 | 16.9 |
| 20701 | Tund | 220 | 17.73 | 2,528 | 25.3 |
| 20801 | Nga | 220 | 35.36 | 4,853 | 78.3 |
| 20802 | Songwe | 220 | 21.28 | 3,090 | 18.9 |
| 20803 | Sing Wind | 220 | 20.00 | 2,977 | 13.9 |
| 20804 | Kishap | 220 | 17.03 | 2,573 | 12.0 |
| 20805 | Solar Dom | 220 | 21.00 | 3,076 | 16.8 |
| 20902 | Son | 220 | 30.27 | 4,208 | 46.4 |
| 30112 | Mwa | 220 | 17.19 | 2,519 | 16.6 |
| 30201 | Bund | 220 | 12.77 | 1,909 | 13.3 |
| 30301 | Muso | 220 | 14.15 | 2,168 | 10.6 |
| 30316 | Nyamongo | 220 | 9.33 | 1,397 | 13.1 |
| 30401 | Geita | 220 | 10.68 | 1,567 | 16.3 |
| 40112 | Mufindi | 220 | 13.20 | 2,087 | 8.3 |
| 40115 | Makambako | 220 | 13.90 | 2,203 | 8.2 |
| 40212 | Mbeya | 220 | 30.06 | 8,566 | 26.3 |
| 40214 | Uyole | 220 | 20.20 | 6,647 | 12.6 |
| 40215 | Kiwira | 220 | 28.82 | 7,241 | 36.8 |
| 40601 | Madaba | 220 | 16.51 | 2,393 | 19.2 |
| 40801 | Kik | 220 | 19.12 | 2,678 | 37.1 |
| 41001 | Rum | 220 | 14.43 | 2,051 | 26.9 |

| BUS | | 3 - ph Short Circuit Currents | | | |
|---|---|---|---|---|---|
| No. | Name | kV | kA | MVA | X/R Ratio |
| 220 kV Buses ( Continues) | | | | | |
| | | | | | |
| 41101 | Geo | 220 | 29.06 | 4,284 | 15.5 |
| 41201 | Mpa | 220 | 10.66 | 1,583 | 14.3 |
| 42801 | Kyak | 220 | 12.82 | 1,843 | 22.0 |
| 49101 | Karonga | 220 | 10.20 | 1,474 | 20.2 |
| 50112 | Babati | 220 | 7.39 | 1,173 | 8.1 |
| 51101 | Tanga | 220 | 9.81 | 1,485 | 11.8 |
| 51212 | Njiro | 220 | 18.66 | 2,705 | 19.3 |
| 51302 | Segera | 220 | 19.97 | 2,838 | 26.7 |
| 51402 | Arusha | 220 | 18.76 | 2,718 | 19.4 |
| 60112 | Kid | 220 | 19.62 | 3,001 | 10.8 |
| 60212 | Kih | 220 | 16.78 | 2,481 | 15.0 |
| 60312 | Mtera | 220 | 12.10 | 1,924 | 8.0 |
| 60412 | Iringa | 220 | 35.98 | 5,252 | 17.6 |
| 60501 | Ibosa | 220 | 11.85 | 1,712 | 20.2 |
| 70112 | Bulyanhulu | 220 | 11.28 | 1,701 | 12.2 |
| 70201 | Lusu | 220 | 10.89 | 1,665 | 10.8 |
| 70312 | Shinyanga | 220 | 22.71 | 3,059 | 11.9 |
| 70401 | Tabora | 220 | 17.28 | 2,489 | 21.2 |
| 71010 | Buzwagi | 220 | 10.89 | 1,582 | 15.6 |
| 80112 | Morogoro | 220 | 21.27 | 3,358 | 8.4 |
| 80212 | Dodoma | 220 | 24.82 | 3,629 | 17.2 |
| 80312 | Singida | 220 | 25.31 | 3,209 | 13.3 |
| 90402 | Kigoma | 220 | 11.43 | 1,591 | 44.1 |
| 90602 | Nya | 220 | 16.16 | 2,323 | 21.8 |
| 90701 | Rusumo | 220 | 11.88 | 1,733 | 17.8 |
| 91001 | Kyaka | 220 | 14.30 | 2,189 | 10.7 |

| BUS | | | 3 - ph Short Circuit Currents | | |
|---|---|---|---|---|---|
| No. | Name | kV | kA | MVA | X/R Ratio |
| 330 kV Bus | | | | | |
| 401402 | Taza | 330 | 16.55 | 4,785 | 3.1 |

**Source:** PSMP 2020 Update Team Compilation.

## 4.8. Transmission and Substation Costs

### 4.8.1. Transmission Voltage Options

It is expected that 132 kV, 220 kV and 400 kV system voltage levels will be the main transmission technology choice for the transmission expansion. Variable Shunt Reactor and Line Shunt Reactor are used to improve the receiving end voltages on long and heavily loaded lines. These devices are still considered to delay or replace the need for new transmission lines where they appeared to be economical and practical.

#### 4.8.2. Cost Estimates

Cost estimate was investigated for transmission lines, transformers, substations and compensation. The cost estimate of the bulk system was based on unit costs for transmission lines, substation switchgears, transformers and reactive power compensation (SVR and LSR), as given in **Tables 4-12**, **4-13** and **4-14**.

#### 4.8.3. Transmission Unit Costs

Transmission line and substation costs have been benchmarked from recent TANESCO studies and transmission line projects under implementation in Tanzania based on international competitive bidding. **Table 4-12** shows transmission line unit costs that were used in this plan. Unit costs for various substation components are summarized in **Table 4-13**. Costs for new switching substations include circuit breakers, disconnectors, switches, current and voltage transformers, relay buildings, structures and site preparation.

**Table 4-12:** Unit Cost of Transmission Lines[7]

| Rated Voltage (kV) | Unit Cost (1,000 USD/km) | |
|---|---|---|
| | Single Circuit | Double Circuit |
| 400 | 300 – 400 | 380 - 450 |
| 220 | 185 – 270 | 230 - 320 |
| 132 | 155 – 195 | 165 - 210 |

**Source:** PSMP 2020 Update Team Compilation.

**Table 4-13:** Unit Cost of Substation per Bay

| Substation Cost MUSD/bay | | |
|---|---|---|
| 132 kV | 220 kV | 400 kV |
| 3.49 | 5.89 | 9.68 |

**Source:** PSMP 2020 Update Team Compilation

**Table 4-14:** Unit cost of transformers and reactive compensation

| | kUSD/MVA | MUSD /100 MVAr |
|---|---|---|
| Transformer | 11.56 | |
| Variable Shunt Reactor (SVR) | | 3.56 |
| Line Shunt Reactor (LSR) | | 2.74 |

**Source:** PSMP 2020 Update Team Compilation.

[7] One bay means the designated compartment where switchgear and buses are configured to interconnect a transmission line or a transformer. The costs include the switchgear, the buses, the structures, Control/Protection devices and site preparation. (Building is not included)

### 4.9. Transmission System Project Costs

The major 400 kV and 220 kV, transmission additions required for the above Least Cost Expansion Plan are illustrated in **Figures 4-2**, **4-3** and **4-4**, the costs of the transmission additions are listed in **Tables 4-15, 4-16** and **4-17**, those for transformers are listed in **Tables 4-18**, **4-19** and **4-20,** substation additions are listed in **Tables 4-21, 4-22** and **4-23** and reactive compensation are listed in **Table 4-24.**

The total transmission system costs in the Least Cost Expansion Plan from 2020 up to 2024 are approximately **USD 3,187.46 million** and from 2025 up to 2034 is **USD 1,936.06 million** while from 2035 up to 2044 are **USD 813.38 million**. Accounting to the total amount from 2020 up to 2044 will be **USD 5,936.90 million**.

**Table 4-15:** Phased Transmission Lines Cost Estimates 2020-2024

| From | To | Rated Voltage (kV) | No. of Circuits | No. of Conductor per phase | Route Length (km) | Unit Cost k$/km | Total Cost M$ | Year of Commissioning |
|---|---|---|---|---|---|---|---|---|
| Bulyanhulu | Geita | 220 | 2 | 1 | 55 | 230 | 12.65 | 2020 |
| Singida | Kisongo (Arusha) | 400 | 2 | 2 | 317 | 415 | 131.555 | 2021 |
| Arusha | Isinya (Kenya) | 400 | 2 | 2 | 114 | 415 | 47.31 | 2021 |
| Rusumo | Nyakanazi | 220 | 2 | 1 | 94 | 230 | 21.62 | 2021 |
| Geita | Nyakanazi | 220 | 2 | 1 | 144 | 230 | 33.12 | 2021 |
| Nyakanazi | Kigoma | 400 | 2 | 2 | 280 | 415 | 116.2 | 2021 |
| Dar es salaam | Msamvu | 220 | 1 | 1 | 160 | 185 | 29.6 | 2021 |
| Msamvu | Ihumwa | 220 | 1 | 1 | 236 | 185 | 43.66 | 2020 |
| Ihumwa | Kitinku | 220 | 1 | 1 | 174 | 185 | 32.19 | 2020 |
| Kinyerezi | Ubungo | 220 | 2 | 1 | 17 | 230 | 3.91 | 2022 |
| Kinyerezi | Mburahati (Mabibo) | 220 | 1 | 2 | 2 | 230 | 0.46 | 2022 |
| JNHPP | Chalinze | 400 | 2 | 3 | 160 | 450 | 72 | 2022 |
| Chalinze | Kinyerezi | 400 | 2 | 3 | 93 | 450 | 41.85 | 2022 |
| Chalinze | Dodoma | 400 | 2 | 3 | 345 | 450 | 155.25 | 2022 |
| Chalinze | Bagamoyo (Zinga) | 220 | 1 | 2 | 60 | 230 | 13.8 | 2022 |
| Zuzu | Msalato | 220 | 1 | 1 | 32 | 185 | 5.92 | 2023 |
| Msalato | Ihumwa | 220 | 1 | 1 | 12 | 185 | 2.22 | 2023 |
| Ihumwa | Kikombo | 220 | 1 | 1 | 52 | 185 | 9.62 | 2023 |
| Kikombo | Zuzu | 220 | 1 | 1 | 47 | 185 | 8.695 | 2023 |
| Kikombo | Narco | 220 | 1 | 1 | 50 | 185 | 9.25 | 2023 |
| Morogoro | Mtibwa | 220 | 1 | 2 | 88 | 228 | 20.02 | 2023 |
| Shinyanga (libadakuli) | Simiyu (Imalilo) | 220 | 1 | 2 | 113 | 228 | 25.7075 | 2023 |
| Iringa | Kisada | 400 | 2 | 2 | 106 | 415 | 43.99 | 2023 |
| Kisada | Mbeya | 400 | 2 | 2 | 285 | 415 | 118.275 | 2023 |
| Mbeya | Tunduma | 400 | 2 | 2 | 122 | 415 | 50.63 | 2023 |
| Tunduma | Sumbawanga | 400 | 2 | 2 | 203 | 415 | 84.245 | 2023 |
| Somanga | Kibiti | 400 | 2 | 2 | 79.6 | 415 | 33.034 | 2024 |
| Kibiti | Kinyerezi | 400 | 2 | 2 | 110.6 | 415 | 45.899 | 2024 |
| Tabora | Ipole | 132 | 1 | 1 | 127 | 155 | 19.685 | 2024 |
| Ipole | Inyonga | 132 | 1 | 1 | 138 | 155 | 21.39 | 2024 |
| Inyonga | Mpanda (Katavi) | 132 | 1 | 1 | 140 | 155 | 21.7 | 2024 |
| Tabora | Urambo | 132 | 1 | 1 | 131 | 155 | 20.305 | 2024 |
| Urambo | Nguruka (Uvinza) | 132 | 1 | 1 | 185 | 155 | 28.675 | 2024 |
| Nguruka | Kigoma ( Kidahwe) | 132 | 1 | 1 | 79 | 155 | 12.245 | 2024 |
| Chanika (Buyuni) | Mkuranga | 220 | 2 | 2 | 60 | 275 | 16.5 | 2024 |
| Kibiti | Mkuranga | 220 | 2 | 2 | 60 | 275 | 16.50 | 2025 |
| Mkata | Handeni | 132 | 1 | 1 | 46.8 | 155 | 7.254 | 2024 |
| Mbeya | Songwe | 220 | 1 | 2 | 41 | 228 | 9.3275 | 2024 |
| Songwe | Chunya (Makongorosi) | 220 | 1 | 2 | 73 | 228 | 16.6075 | 2024 |
| Mtwara | Lindi (Mahumbika) | 400 | 2 | 2 | 60 | 415 | 24.9 | 2024 |
| Lindi ( Mahumbika) | Somanga | 400 | 2 | 2 | 210 | 415 | 87.15 | 2024 |
| Mtwara | Mozambique | 400 | 2 | 2 | 100 | 415 | 41.5 | 2024 |
| Songea | Tunduru | 400 | 2 | 2 | 230 | 415 | 95.45 | 2024 |
| Tunduru | Masasi | 400 | 2 | 2 | 194 | 415 | 80.51 | 2024 |
| Masasi | Lindi | 400 | 2 | 2 | 141 | 415 | 58.515 | 2024 |
| Masasi | Marambo (Ruangwa) | 220 | 1 | 1 | 65 | 185 | 12.025 | 2024 |
| Ifakara | Mahenge | 220 | 1 | 1 | 68 | 185 | 12.58 | 2024 |
| Narco | Dumila | 220 | 1 | 1 | 117 | 185 | 21.645 | 2024 |
| Zinga | Bunju | 220 | 2 | 2 | 18 | 275 | 4.95 | 2024 |
| Bunju | Kunduchi | 220 | 2 | 2 | 14 | 275 | 3.85 | 2024 |
| Kunduchi | Mbezi Beach | 220 | 2 | 2 | 6 | 275 | 1.65 | 2024 |
| Mbezi Beach | Makumbusho | 220 | 2 | 2 | 11 | 275 | 3.025 | 2024 |
| Mbezi Beach | Kawe | 220 | 2 | 2 | 8.7 | 275 | 2.3925 | 2024 |
| Malagalasi | Kigoma (Kidahwe) | 132 | 1 | 1 | 74 | 155 | 11.47 | 2024 |
| Karatu | Loliondo | 66 | 1 | 1 | 200 | 120 | 24 | 2024 |
| | **Total** | | | | | | **1,888.48** | |

**Table 4-16:** Phased Transmission Lines Cost Estimates 2025 - 2034

| From | To | Rated Voltage (kV) | No. of Circuits | No. of Conductor per phase | Route Length (km) | Unit Cost k$/km | Total Cost M$ | Year of Commissioning |
|---|---|---|---|---|---|---|---|---|
| Chalinze | Segera | 400 | 2 | 2 | 175 | 415 | 72.63 | 2025 |
| Segera | Arusha | 400 | 2 | 2 | 366 | 415 | 151.89 | 2025 |
| Segera | Tanga | 220 | 2 | 2 | 64 | 275 | 17.60 | 2025 |
| Uyole (Mbeya) | Kyela | 400 | 2 | 2 | 80.7 | 415 | 33.47 | 2025 |
| Kyela | Karonga (Malawi) | 400 | 2 | 2 | 39.8 | 415 | 16.51 | 2025 |
| Nyakanazi | Kyaka | 400 | 2 | 2 | 253 | 415 | 105.00 | 2025 |
| Kyaka | Masaka (Uganda) | 400 | 2 | 2 | 30 | 415 | 12.45 | 2025 |
| JNHPP | Kibiti | 400 | 2 | 3 | 172 | 450 | 77.40 | 2025 |
| Shinyanga | Mwanza | 400 | 2 | 2 | 140 | 415 | 58.10 | 2025 |
| Mwanza | Musoma | 400 | 2 | 2 | 210 | 415 | 87.15 | 2025 |
| Musoma | Kilgoris (Kenya) | 400 | 2 | 2 | 179 | 415 | 74.29 | 2025 |
| Kakono P/S (Hydro) | Kyaka | 220 | 1 | 1 | 39 | 185 | 7.22 | 2026 |
| Ruhudji | Kisada | 400 | 2 | 2 | 140 | 415 | 58.10 | 2025 |
| Kinyerezi | Luguruni | 220 | 2 | 2 | 22.6 | 275 | 6.22 | 2025 |
| Kigoma | Mpanda | 400 | 2 | 2 | 290 | 415 | 120.35 | 2026 |
| Mpanda | Sumbawanga | 400 | 2 | 2 | 119 | 415 | 49.39 | 2026 |
| Lindi | Nangurukuru (Kilwa ) | 132 | 1 | 1 | 158 | 155 | 24.49 | 2026 |
| Kiyungi | Makuyuni | 132 | 1 | 1 | 34 | 155 | 5.27 | 2026 |
| Rumakali PP | Mbeya (Uyole) | 220 | 1 | 1 | 70 | 185 | 12.95 | 2026 |
| Masigira | Ruhudji | 220 | 1 | 1 | 100 | 185 | 18.50 | 2028 |
| Tabora | Kigwa - Uyui | 220 | 1 | 1 | 42 | 185 | 7.77 | 2028 |
| Kikonge | Madaba | 220 | 1 | 1 | 49 | 185 | 9.07 | 2028 |
| Songwe B S/S | Kyela | 132 | 1 | 2 | 10 | 175 | 1.75 | 2028 |
| Songwe A S/S | Songwe B S/S | 132 | 1 | 2 | 40 | 175 | 7.00 | 2028 |
| Songwe Sofwe P/S (Hydro | Songwe A S/S | 132 | 1 | 1 | 16 | 155 | 2.48 | 2028 |
| Mnyera | Ruhudji | 400 | 1 | 1 | 50 | 185 | 9.25 | 2029 |
| Bulyanhulu | Bukombe | 220 | 1 | 1 | 66.5 | 185 | 12.30 | 2030 |
| Uyole | Kiwira | 220 | 1 | 1 | 35.6 | 185 | 6.59 | 2032 |
| Ngaka | Songea | 220 | 1 | 1 | 37 | 185 | 6.85 | 2032 |
| Mchuchuma P/s | Kisada | 400 | 1 | 2 | 200 | 350 | 70.00 | 2031 |
| Mpanga P/S (Hydro) | Mufindi | 220 | 1 | 1 | 65 | 185 | 12.03 | 2033 |
| | **Total** | | | | | | **1,154.03** | |

**Table 4-17:** Phased Transmission Lines Cost Estimates 2035 - 2044

| From | To | Rated Voltage (kV) | No. of Circuits | No. of Conductor per phase | Route Length (km) | Unit Cost k$/km | Total Cost M$ | Year of Commissioning |
|---|---|---|---|---|---|---|---|---|
| Iringa (Ibosa) | Iringa ( Tagamenda) | 220 | 1 | 1 | 81 | 185 | 14.99 | 2035 |
| Ibosa P/s (Hydro) | Nginayo P/S (Hydro) | 220 | 1 | 1 | 10 | 185 | 1.85 | 2035 |
| KIA | Engare Nairobi | 132 | 1 | 1 | 40.1 | 155 | 6.22 | 2036 |
| Songea | Namtumbo | 220 | 1 | 1 | 70 | 185 | 12.95 | 2036 |
| Same | Gonja | 132 | 1 | 1 | 49.1 | 155 | 7.61 | 2037 |
| NARCO | Kijungu (Kiteto) | 220 | 1 | 1 | 157 | 185 | 29.05 | 2037 |
| Manyoni | Mitundu (Manyoni) | 220 | 1 | 1 | 106 | 185 | 19.61 | 2037 |
| Songea | Mbinga | 220 | 1 | 1 | 92.5 | 185 | 17.11 | 2037 |
| Mbinga | Mbambabay | 220 | 1 | 1 | 53.8 | 185 | 9.95 | 2037 |
| Ilula ( Kilolo) | Iringa ( Tagamenda) | 220 | 1 | 1 | 39 | 185 | 7.22 | 2039 |
| Mnyera 2 P/S | Ruaha 2 | 220 | 1 | 2 | 10 | 228 | 2.28 | 2039 |
| Pumbwe P/S (Hydro) | Mnyera Taveta | 220 | 1 | 2 | 10 | 228 | 2.28 | 2039 |
| Manyoni | Kigwa (Uyui) | 220 | 1 | 1 | 200 | 185 | 37.00 | 2040 |
| Shinyanga | Tabora | 400 | 2 | 2 | 195 | 415 | 80.93 | 2040 |
| Tabora | Kigoma | 400 | 2 | 2 | 415 | 415 | 172.23 | 2040 |
| Geita | Bwanga | 220 | 1 | 1 | 61 | 185 | 11.29 | 2041 |
| Bwanga | Usahunga | 220 | 1 | 1 | 62 | 185 | 11.47 | 2041 |
| Usahunga | Kyaka | 220 | 1 | 1 | 228 | 185 | 42.18 | 2041 |
| | **Total** | | | | | | **486.18** | |

**Table 4-18:** Phased Transformer Cost Estimates 2020 – 2024

| Substation | Region | HV/LV (kV) | Rating (MVA) | No. of T.x | Total Cost (M$) | Commissioning Year |
|---|---|---|---|---|---|---|
| Bulyanhulu | Shinyanga | 220/33 | 30 | 1 | 0.35 | 2020 |
| Geita | Geita | 220/33 | 50 | 2 | 1.16 | 2020 |
| Lemugul (Kisongo) | Arusha | 400/220 | 250 | 2 | 5.78 | 2020 |
| Lemugul (Kisongo) | Arusha | 220/33 | 125 | 2 | 2.89 | 2020 |
| Iringa | Iringa | 400/220/33 | 250/250/85 | 2 | 8.67 | 2021 |
| Iringa | Iringa | 220/33 | 125/125/37.5 | 2 | 4.34 | 2021 |
| Dodoma | Dodoma | 400/220/33 | 250/250/85 | 2 | 8.67 | 2020 |
| Dodoma | Dodoma | 220/33 | 125/125/37.5 | 2 | 4.34 | 2020 |
| Singida | Singida | 400/220/33 | 250/250/85 | 2 | 8.67 | 2020 |
| Singida | Singida | 220/33 | 125/125/37.5 | 2 | 4.34 | 2020 |
| Shinyanga | Shinyanga | 400/220/33 | 315/315/105 | 2 | 10.92 | 2021 |
| Shinyanga | Shinyanga | 220/33 | 125/125/37.5 | 2 | 4.34 | 2021 |
| Rusumo (BENACO) | Kagera | 220 | 30 | 2 | 0.69 | 2021 |
| Nyakanazi | Kagera | 400/220/33 | 120/120/45 | 2 | 4.16 | 2021 |
| Kigoma | Kigoma | 400/132/33 | 120/70/50 | 2 | 3.58 | 2021 |
| Mburahati (Mabibo) | Dar es Salaam | 220/132/33 | 200/200/45 | 2 | 6.94 | 2022 |
| Buzwagi | Shinyanga | 220/33 | 30 | 1 | 0.35 | 2022 |
| Zegereni | Dar es Salaam | 220/33 | 60 | 2 | 1.39 | 2022 |
| Chalinze | Pwani | 400/220/33 | 250/250/85 | 4 | 14.45 | 2022 |
| Kinyerezi | Dar es Salaam | 400/220/33 | 250/250/85 | 4 | 14.45 | 2022 |
| Bagamoyo | Pwani | 220/33 | 125 | 2 | 2.89 | 2022 |
| Msalato | Dodoma | 220/33 | 50 | 2 | 1.16 | 2023 |
| Kikombo | Dodoma | 220/33 | 100 | 2 | 2.31 | 2023 |
| Ihumwa | Dodoma | 220/33 | 30 | 2 | 0.69 | 2023 |
| NARCO | Dodoma | 220/33 | 45 | 2 | 1.04 | 2023 |
| Simiyu | Simiyu | 220/33 | 45 | 2 | 1.04 | 2023 |
| Luguluni | Dar es Salaam | 220/33 | 45 | 2 | 1.04 | 2023 |
| Chanika | Dar es Salaam | 220/33 | 45 | 2 | 1.04 | 2024 |
| Mkuranga | Coast | 220/33 | 120 | 2 | 2.77 | 2024 |
| Mtibwa | Morogoro | 220/33 | 45 | 2 | 1.04 | 2023 |
| Mbeya | Mbeya | 400/220/33 | 200/200/70 | 2 | 6.94 | 2023 |
| Tunduma | Mbeya | 400/330/33 | 250/250/85 | 2 | 8.67 | 2023 |
| Kisada | Iringa | 400/220/33 | 150/150/45 | 2 | 5.20 | 2023 |
| Sumbawanga | Rukwa | 400/66/33 | 100/100/35 | 2 | 3.47 | 2023 |
| Somanga | Lindi | 400/220 | 125 | 2 | 2.89 | 2024 |
| Somanga | Lindi | 220/33 | 85 | 2 | 1.97 | 2024 |
| Kibiti | Lindi | 400/220 | 125 | 2 | 2.89 | 2024 |
| Kibiti | Lindi | 220/33 | 85 | 2 | 1.97 | 2024 |
| Ipole | Tabora | 132/33 | 15 | 1 | 0.17 | 2024 |
| Inyonga | Tabora | 132/33 | 15 | 1 | 0.17 | 2024 |
| Mpanda | Katavi | 132/33 | 35 | 1 | 0.40 | 2024 |
| Urambo | Tabora | 132/33 | 35 | 1 | 0.40 | 2024 |
| Nguruka | Tabora | 132/33 | 15 | 1 | 0.17 | 2024 |
| Dumila | Dodoma | 220/33 | 30 | 2 | 0.69 | 2024 |
| Mtwara | Mtwara | 400/132 | 100 | 3 | 3.47 | 2024 |
| Mtwara | Mtwara | 400/220 | 125 | 2 | 2.89 | 2024 |
| Mtwara | Mtwara | 220/33 | 85 | 2 | 1.97 | 2024 |
| Lindi | Lindi | 400/132 | 100 | 2 | 2.31 | 2024 |
| Mkata | Tanga | 132/33 | 30 | 2 | 0.69 | 2024 |
| Handeni | Tanga | 132/33 | 30 | 2 | 0.69 | 2024 |
| Songwe | Songwe | 220/33 | 45 | 2 | 1.04 | 2024 |
| Makongolos (Chunya) | Mbeya | 220/33 | 45 | 2 | 1.04 | 2024 |
| Masasi | Mtwara | 400/33 | 45 | 2 | 1.04 | 2024 |
| Tunduru | Ruvuma | 400/33 | 45 | 2 | 1.04 | 2024 |
| Ruangwa | Lindi | 400/33 | 30 | 2 | 0.69 | 2024 |
| Songea | Ruvuma | 400/33 | 125 | 2 | 2.89 | 2024 |
| Ifakara | Morogoro | 220/33 | 20 | 2 | 0.46 | 2024 |
| Mahenge | Morogoro | 220/33 | 60 | 2 | 1.39 | 2024 |
| Makumbusho | Pwani | 220/132 | 150 | 2 | 3.47 | 2024 |
| Mbezi Beach (Bunju) | Dar es Salaam | 220/33 | 50 | 2 | 1.16 | 2024 |
| Kunduchi | Dar es Salaam | 220/33 | 60 | 1 | 0.69 | 2024 |
| Kawe | Dar es Salaam | 220/33 | 50 | 2 | 1.16 | 2024 |
| Malagalasi | Kigoma (Kidahwe) | 11/132 | 60 | 2 | 1.39 | 2024 |
| Loliondo | Arusha | 66/33 | 25 | 1 | 0.29 | 2024 |
| | **Total** | | | | **191.26** | |

**Table 4-19:** Phased Transformer Cost Estimates 2025 - 2034

| Substation | Region | HV/LV (kV) | Rating (MVA) | No. of T.x | Total Cost (M$) | Commissioning Year |
|---|---|---|---|---|---|---|
| Segera | Tanga | 400/220/33 | 150/150/45 | 2 | 5.20 | 2025 |
| Tanga | Tanga | 220/132/33 | 150/150/45 | 2 | 5.20 | 2025 |
| Kyela | Mbeya | 400/220/33 | 180/180/45 | 2 | 6.24 | 2025 |
| Kyaka | Kagera | 400/220 | 125 | 2 | 2.89 | 2025 |
| Kyaka | Kagera | 220/33 | 85 | 2 | 1.97 | 2025 |
| Makutuni | Knjaro | 132/33 | 30 | 2 | 0.69 | 2026 |
| Nangulukulu | Lindi | 132/33 | 30 | 2 | 0.69 | 2025 |
| Mwanza | Mwanza | 400/220/33 | 250/125/85 | 2 | 7.23 | 2026 |
| Musoma | Mara | 400/132/33 | 250/125/85 | 2 | 7.23 | 2026 |
| Kigoma | Kigoma | 400/132/33 | 120/70/50 | 2 | 3.58 | 2026 |
| Mpanda | Katavi | 400/132/33 | 120/70/50 | 2 | 3.58 | 2026 |
| Rujewa (Mbalali) | Mbeya | 220/33 | 30 | 2 | 0.69 | 2028 |
| Same | Knjaro | 132/33 | 30 | 1 | 0.35 | 2028 |
| Manyoni | Singida | 220/33 | 30 | 2 | 0.69 | 2029 |
| Kigwa | Iyui | 132/33 | 30 | 2 | 0.69 | 2030 |
| Bukombe | Geita | 220/33 | 30 | 2 | 0.69 | 2030 |
| | **Total** | | | | **47.63** | |

**Table 4-20:** Phased Transformer Cost Estimates 2035-2044

| Substation | Region | HV/LV (kV) | Rating (MVA) | No. of T.x | Total Cost (M$) | Commissioning Year |
|---|---|---|---|---|---|---|
| Mbinga | Ruvuma | 220/33 | 30 | 2 | 0.69 | 2035 |
| Mbambabay | Ruvuma | 220/33 | 30 | 2 | 0.69 | 2036 |
| Engare Nairobi | Knjaro | 132/33 | 30 | 2 | 0.69 | 2036 |
| Namtumbo | Ruvuma | 220/33 | 45 | 2 | 1.04 | 2036 |
| Gonja | Knjaro | 132/33 | 30 | 2 | 0.69 | 2037 |
| Kijungu | Kiteto Manyara | 220/33 | 30 | 2 | 0.69 | 2037 |
| Mitundu | Singida | 220/33 | 30 | 2 | 0.69 | 2040 |
| Tabora | Tabora | 400/132 | 250 | 2 | 5.78 | 2040 |
| Tabora | Tabora | 132/33 | 125 | 2 | 2.89 | 2040 |
| Bwanga | Geita | 220/33 | 45 | 2 | 1.04 | 2041 |
| Usahunga | Kagera | 220/33 | 45 | 2 | 1.04 | 2041 |
| | **Total** | | | | **15.95** | |

**Table 4-21:** Phased Substation Cost Estimates 2020 – 2024

| Substation | Region | Switchgear (kV) | No. of Bays | Unit Cost M$/bay | Total Cost M$ |
|---|---|---|---|---|---|
| Bulyanhulu | Shinyanga | 220 | 2 | 5.25 | 10.51 |
| Geita | Geita | 220 | 3 | 5.25 | 15.76 |
| Rusumo | Kagera | 220 | 3 | 5.25 | 15.76 |
| Nyakanazi | Kagera | 400 | 3 | 6.83 | 20.48 |
| Kigoma | Kigoma | 400 | 4 | 6.83 | 27.31 |
| Singida | Singida | 400 | 2 | 6.83 | 13.65 |
| Arusha | Arusha | 400 | 6 | 6.83 | 40.96 |
| Arusha | Arusha | 220 | 4 | 5.25 | 21.01 |
| Morogoro | Morogoro | 220 | 2 | 5.25 | 10.51 |
| Mtibwa | Morogoro | 220 | 4 | 5.25 | 21.01 |
| Iringa | Iringa | 400 | 2 | 6.83 | 13.65 |
| Kisada | Iringa | 400 | 6 | 6.83 | 40.96 |
| Mbeya | Mbeya | 400 | 6 | 6.83 | 40.96 |
| Tunduma | Mbeya | 400 | 5 | 6.83 | 34.13 |
| Tunduma | Mbeya | 330 | 4 | 6.83 | 27.31 |
| JNHPP | Pwani | 400 | 11 | 6.83 | 75.09 |
| Chalinze | Pwani | 400 | 9 | 6.83 | 61.44 |
| Chalinze | Pwani | 220 | 7 | 5.25 | 36.77 |
| Bagamoyo (Zinga) | Pwani | 220 | 6 | 5.25 | 31.52 |
| Somanga | Lindi | 400 | 6 | 6.83 | 40.96 |
| Kibiti | Pwani | 400 | 8 | 6.83 | 54.61 |
| Kibiti | Pwani | 220 | 4 | 5.25 | 21.01 |
| Tabora | Tabora | 132 | 3 | 4.04 | 12.12 |
| Ipole | Tabora | 132 | 3 | 4.04 | 12.12 |
| Inyonga | Katavi | 132 | 2 | 4.04 | 8.08 |
| Urambo | Tabora | 132 | 2 | 4.04 | 8.08 |
| Nguruka | Tabora | 132 | 3 | 4.04 | 12.12 |
| Mkata | Pwani | 132 | 4 | 4.04 | 16.16 |
| Handeni | Tanga | 132 | 2 | 4.04 | 8.08 |
| Mtwara | Mtwara | 400 | 6 | 6.83 | 40.96 |
| Mtwara | Mtwara | 400 | 6 | 6.83 | 40.96 |
| Mtwara | Mtwara | 400 | 6 | 6.83 | 40.96 |
| Lindi | Lindi | 400 | 7 | 6.83 | 47.79 |
| Msalato | Dodoma | 220 | 5 | 5.25 | 26.27 |
| Ihumwa | Dodoma | 220 | 6 | 5.25 | 31.52 |
| Kikombo | Dodoma | 220 | 3 | 5.25 | 15.76 |
| Songea | Ruvuma | 400 | 3 | 6.83 | 20.48 |
| Tunduru | Ruvuma | 400 | 4 | 6.83 | 27.31 |
| Masasi | Mtwara | 400 | 4 | 6.83 | 27.31 |
| Masasi | Mtwara | 220 | 2 | 5.25 | 10.51 |
| Ifakara | Morogoro | 220 | 3 | 5.25 | 15.76 |
| Simiyu | Simiyu | 220 | 3 | 5.25 | 15.76 |
| Kibiti | Lindi | 220 | 1 | 5.25 | 5.25 |
| Mkuranga | Pwani | 220 | 4 | 5.25 | 21.01 |
| Chanika (Buyuni) | Pwani | 220 | 4 | 5.25 | 21.01 |
| Ubungo | Dar es Salaam | 220 | 2 | 5.25 | 10.51 |
| Mburahati | Dar es Salaam | 220 | 4 | 5.25 | 21.01 |
| Zinga | Pwani | 220 | 4 | 5.25 | 21.01 |
| Bunju | Pwani | 220 | 4 | 5.25 | 21.01 |
| Kunduchi | Dar es Salaam | 220 | 4 | 5.25 | 21.01 |
| Mbezi Beach | Dar es Salaam | 220 | 5 | 5.25 | 26.27 |
| Kawe | Dar es Salaam | 220 | 3 | 5.25 | 15.76 |
| Makumbusho | Dar es Salaam | 220 | 4 | 5.25 | 21.01 |
| **Total ( 2020 - 2024)** | | | | | **1,318.32** |

**Table 4-22:** Phased Substation Cost Estimates 2025 -2034

| Substation | Region | Switchgear (kV) | No. of Bays | Unit Cost M$/bay | Total Cost M$ |
|---|---|---|---|---|---|
| Segera | Tanga | 400 | 4 | 6.83 | 27.31 |
| Tanga | Tanga | 220 | 2 | 5.25 | 10.51 |
| Uyole | Mbeya | 400 | 2 | 6.83 | 13.65 |
| Kyela | Mbeya | 400 | 4 | 6.83 | 27.31 |
| Kyela | Mbeya | 220 | 2 | 5.25 | 10.51 |
| Nyakanazi | Kagera | 400 | 2 | 6.83 | 13.65 |
| Kyaka | Kagera | 400 | 4 | 6.83 | 27.31 |
| Kyaka | Kagera | 220 | 2 | 5.25 | 10.51 |
| Lindi | Lindi | 220 | 3 | 5.25 | 15.76 |
| Nangulukulu | Lindi | 132 | 2 | 4.04 | 8.08 |
| Songwe | Songwe | 220 | 4 | 5.25 | 21.01 |
| Uyole | Mbeya | 220 | 2 | 5.25 | 10.51 |
| Mwanza | Mwanza | 400 | 4 | 6.83 | 27.31 |
| Musoma | Mara | 400 | 2 | 6.83 | 13.65 |
| Kigoma | Kigoma | 400 | 1 | 6.83 | 6.83 |
| Kigoma | kigoma | 220 | 2 | 5.25 | 10.51 |
| Mpanda | Katavi | 400 | 6 | 6.83 | 40.96 |
| Rujewa (Mbalali) | Mbeya | 220 | 4 | 5.25 | 21.01 |
| Kiyungi | Kilimanjaro | 220 | 2 | 5.25 | 10.51 |
| Makuyuni | Kilimanjaro | 132 | 3 | 4.04 | 12.12 |
| Same | Kilimanjaro | 220 | 3 | 5.25 | 15.76 |
| Manyoni | Singida | 220 | 4 | 5.25 | 21.01 |
| Tabora | Tabora | 220 | 3 | 5.25 | 15.76 |
| Kigwa | Iyui | 220 | 3 | 5.25 | 15.76 |
| Kigwa | Iyui | 132 | 2 | 4.04 | 8.08 |
| Bukombe | Geita | 220 | 3 | 5.25 | 15.76 |
| **Total** | | | | | **431.12** |

**Table 4-23:** Phased Substation Cost Estimates 2035 - 2044

| Substation | Region | Switchgear (kV) | No. of Bays | Unit Cost M$/bay | Total Cost M$ |
|---|---|---|---|---|---|
| Songea | Ruvuma | 220 | 1 | 5.25 | 5.25 |
| Mbinga | Ruvuma | 220 | 4 | 5.25 | 21.01 |
| Mbambabay | Ruvuma | 220 | 3 | 5.25 | 15.76 |
| KIA | Kilimanjaro | 132 | 1 | 4.04 | 4.04 |
| Engare Nairobi | Kilimanjaro | 132 | 3 | 4.04 | 12.12 |
| Same | Kilimanjaro | 132 | 1 | 4.04 | 4.04 |
| Gonja | Kilimanjaro | 132 | 3 | 4.04 | 12.12 |
| NARCO | Dodoma | 220 | 1 | 5.25 | 5.25 |
| Kijungu (Kiteto) | Dodoma | 220 | 3 | 5.25 | 15.76 |
| Kigwa ( Uyui) | Tabora | 220 | 3 | 5.25 | 15.76 |
| Manyoni | Singida | 220 | 6 | 5.25 | 31.52 |
| Mitundu (Manyoni) | Singida | 220 | 3 | 5.25 | 15.76 |
| Geita | Geita | 220 | 1 | 5.25 | 5.25 |
| Bwanga | Geita | 220 | 4 | 5.25 | 21.01 |
| Usahunga | Geita | 220 | 4 | 5.25 | 21.01 |
| Kyaka | Kagera | 220 | 1 | 5.25 | 5.25 |
| Songea | Ruvuma | 220 | 1 | 5.25 | 5.25 |
| Namtumbo | Ruvuma | 220 | 3 | 5.25 | 15.76 |
| Shinyanga | Shinyanga | 400 | 1 | 6.83 | 6.83 |
| Tabora | Tabora | 400 | 4 | 6.83 | 27.31 |
| Kigoma | Kigoma | 400 | 1 | 6.83 | 6.83 |
| **Total** | | | | | **272.90** |

(1) Cost estimate is based on “a breaker and a half” scheme.

(2) Switchgear associated with the power plants is not included.

(3) Subs transmission or distribution switchgear is not included.

(4) Expansion of existing substation is not included.

**Table 4-24:** Phased Reactive Compensation Cost Estimate

| Substation | SVR | | | LVR | | |
|---|---|---|---|---|---|---|
| | MVAr | Total No | Cost | MVAr | Total No | Cost |
| Iringa | 40/60 | 2 | 4.27 | 60 | 2 | 3.29 |
| Singida | | | | 60 | 6 | 9.86 |
| Shinyanga | | | | 60 | 4 | 6.58 |
| Mwanza | | | | 60 | 4 | 6.58 |
| Musoma | | | | 40 | 4 | 4.38 |
| Chalinze | | | | 90 | 6 | 14.80 |
| Dodoma | | | | 90 | 2 | 4.93 |
| Kinyerezi | | | | 40 | 2 | 2.19 |
| Kibiti | | | | 60 | 6 | 9.86 |
| Mtwara | | | | 40 | 4 | 4.38 |
| Tunduru | | | | 30 | 4 | 3.29 |
| Chalinze | | | | 90 | 2 | 4.93 |
| Segera | | | | 90 | 2 | 4.93 |
| Tanga | | | | 30 | 2 | 1.64 |
| Segera | | | | 90 | 2 | 4.93 |
| Arusha | | | | 90 | 2 | 4.93 |
| Mbeya | 50/90 | 2 | 6.41 | 30 | 4 | 3.29 |
| Tunduma | 30/50 | 1 | 1.78 | 30 | 5 | 4.11 |
| Sumbawanga | 30/50 | 2 | 3.56 | | | |
| Nyakanazi | 30/-30 | 2 | 2.14 | | | |
| Kigoma | 70/-70 | 3 | 7.48 | | | |
| Sumbawanga | | | | 60 | 2 | 3.29 |
| Mpanda | | | | 60 | 2 | 3.29 |
| Kigoma | | | | 60 | 2 | 3.29 |
| Geita | | | | 30 | 1 | 0.82 |
| Benaco ( Ngara) | 10/-10 | 1 | 0.36 | | | |
| | | **Total - SVR** | **25.99** | | **Total - LVR** | **109.60** |
| | | **Total** | **135.59** | **MUSD** | | |

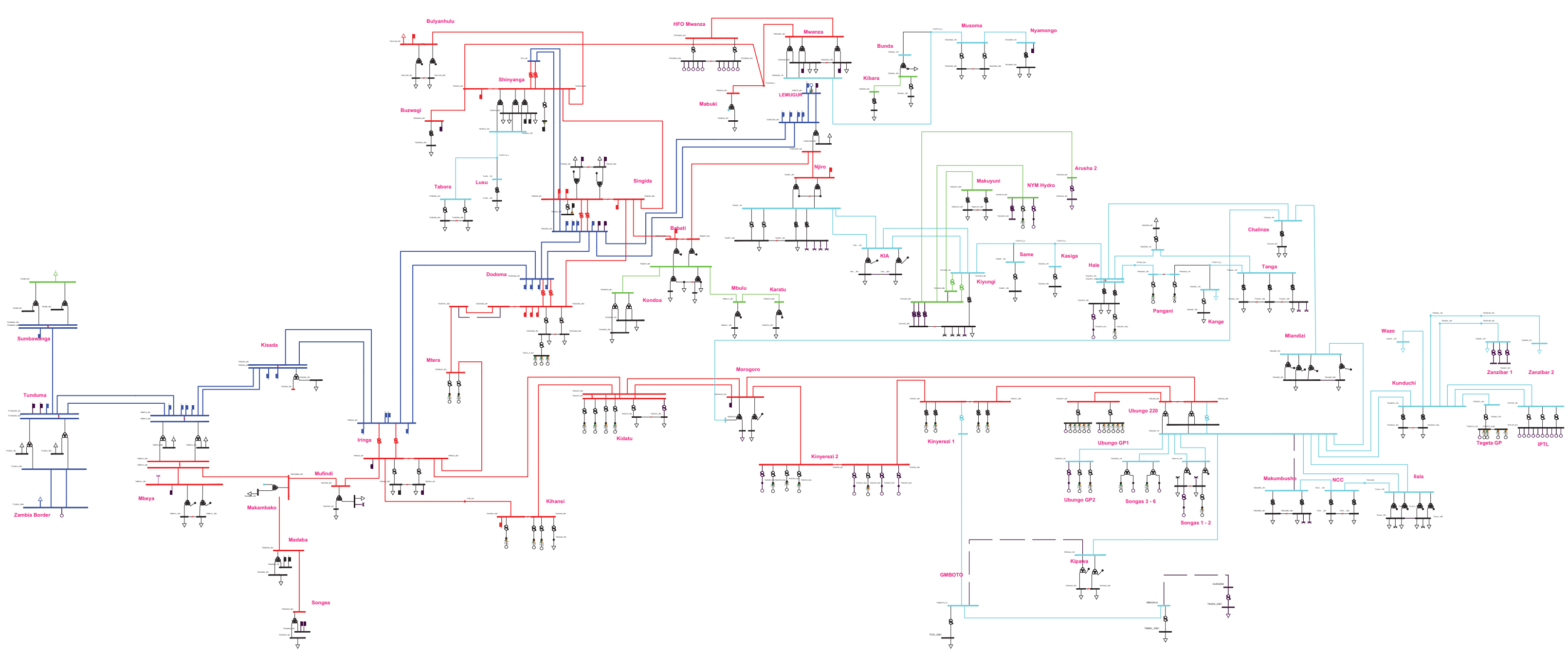
#### 4.9.1.Summary of Cost Estimates

The overall phased costs for the transmission lines, transformers, substations and reactive power compensation over the planning horizon (2020-2044) are summarized in **Table 4-25**.

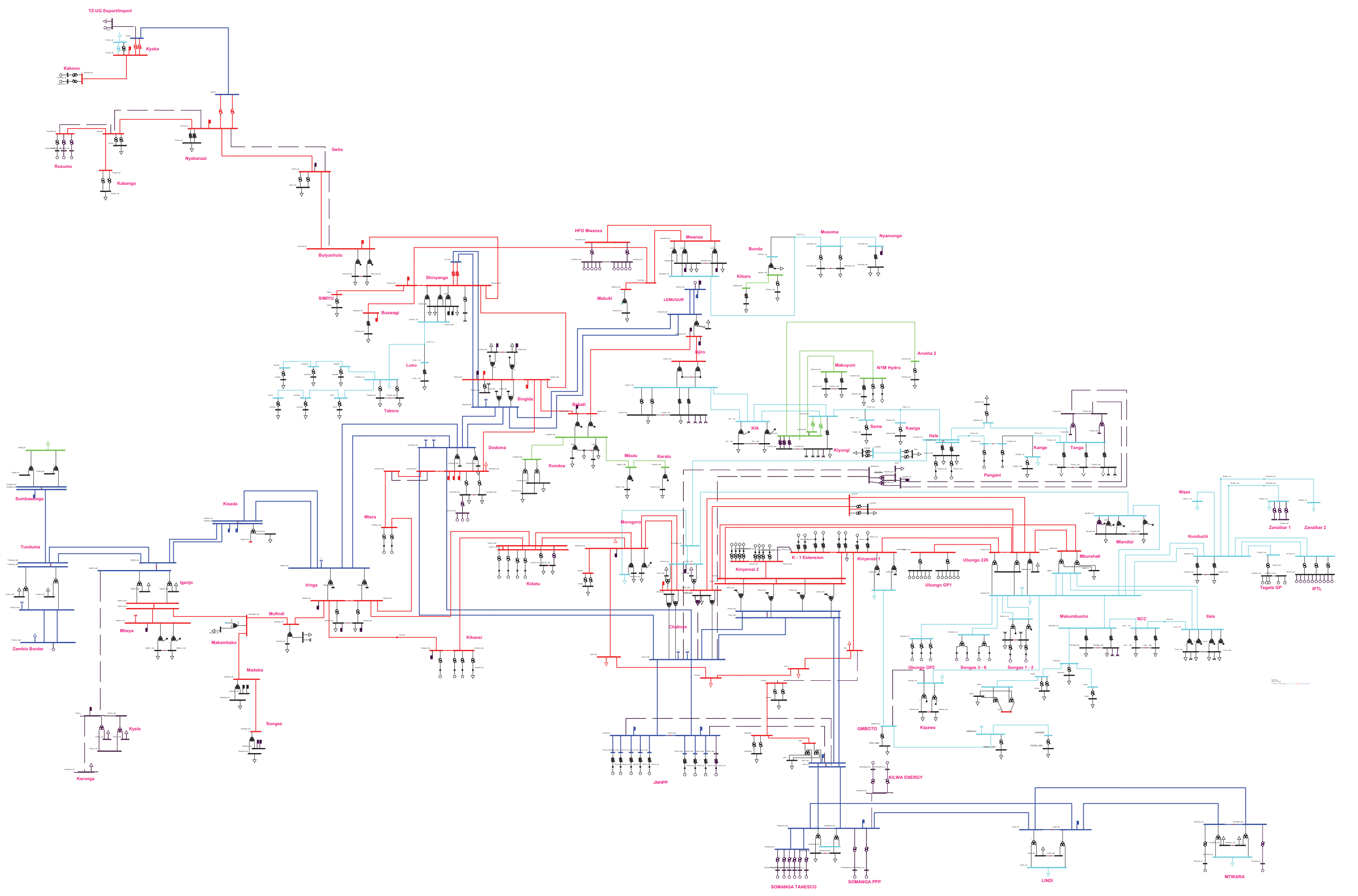
**Table 4-25:** Cost Estimates Summary

| Cost of | Option, MUSD | | | Total |
|---|---|---|---|---|
| | 2020-2024 | 2025-2034 | 2035-2044 | |
| Transmission Lines | 1,888.48 | 1,154.03 | 486.18 | 3,528.69 |
| Transformers | 191.26 | 47.63 | 15.95 | 254.84 |
| Substation | 1,318.32 | 431.12 | 272.90 | 2,022.33 |
| Compensation | 61.01 | 47.46 | 27.12 | 135.59 |
| **Total** | **3,459.08** | **1,680.23** | **802.15** | **5,941.46** |
| **% of Each Phase** | **58.22%** | **28.28%** | **13.50%** | **100%** |

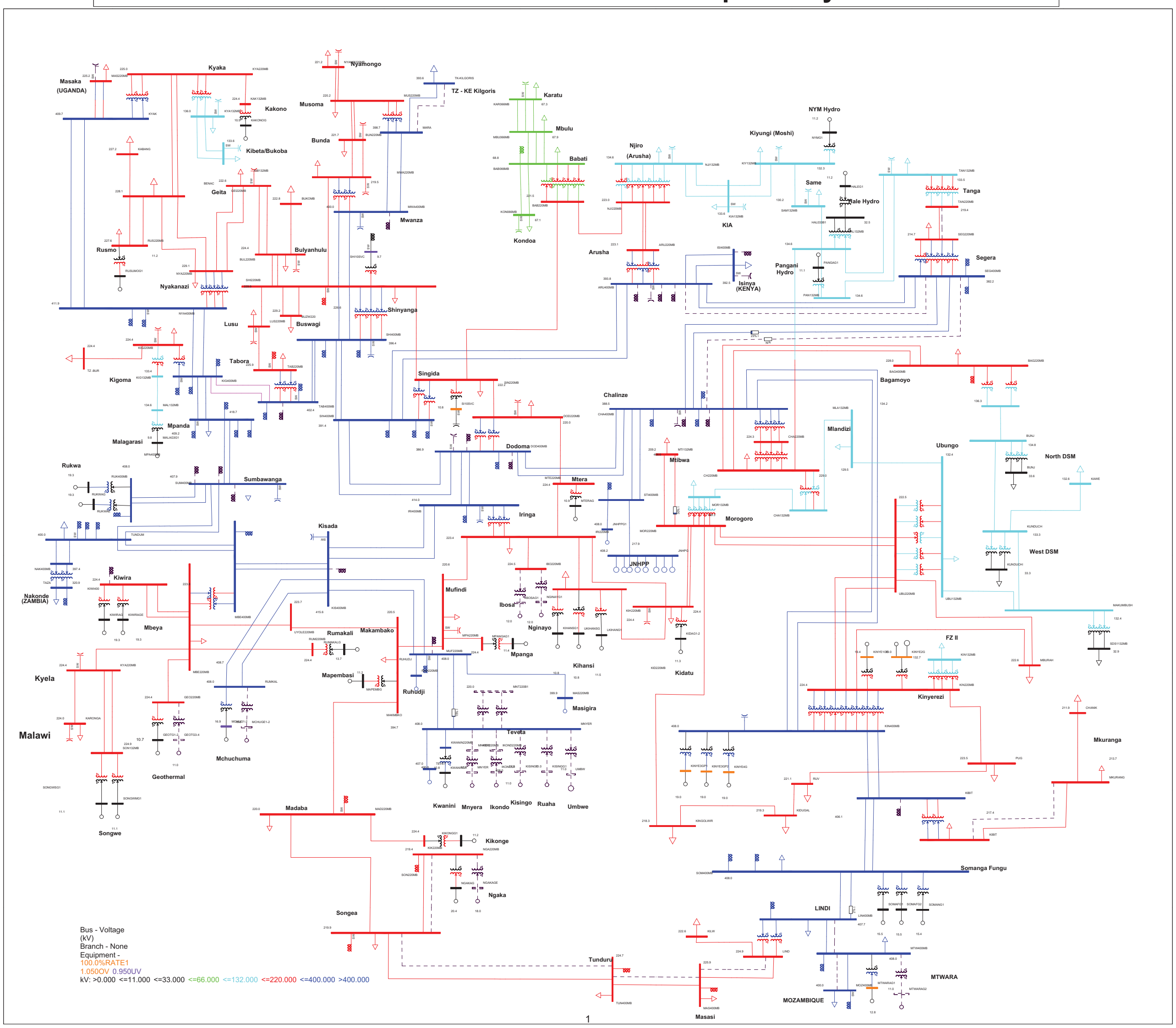
# Tanzania Existing Grid Network - 2019



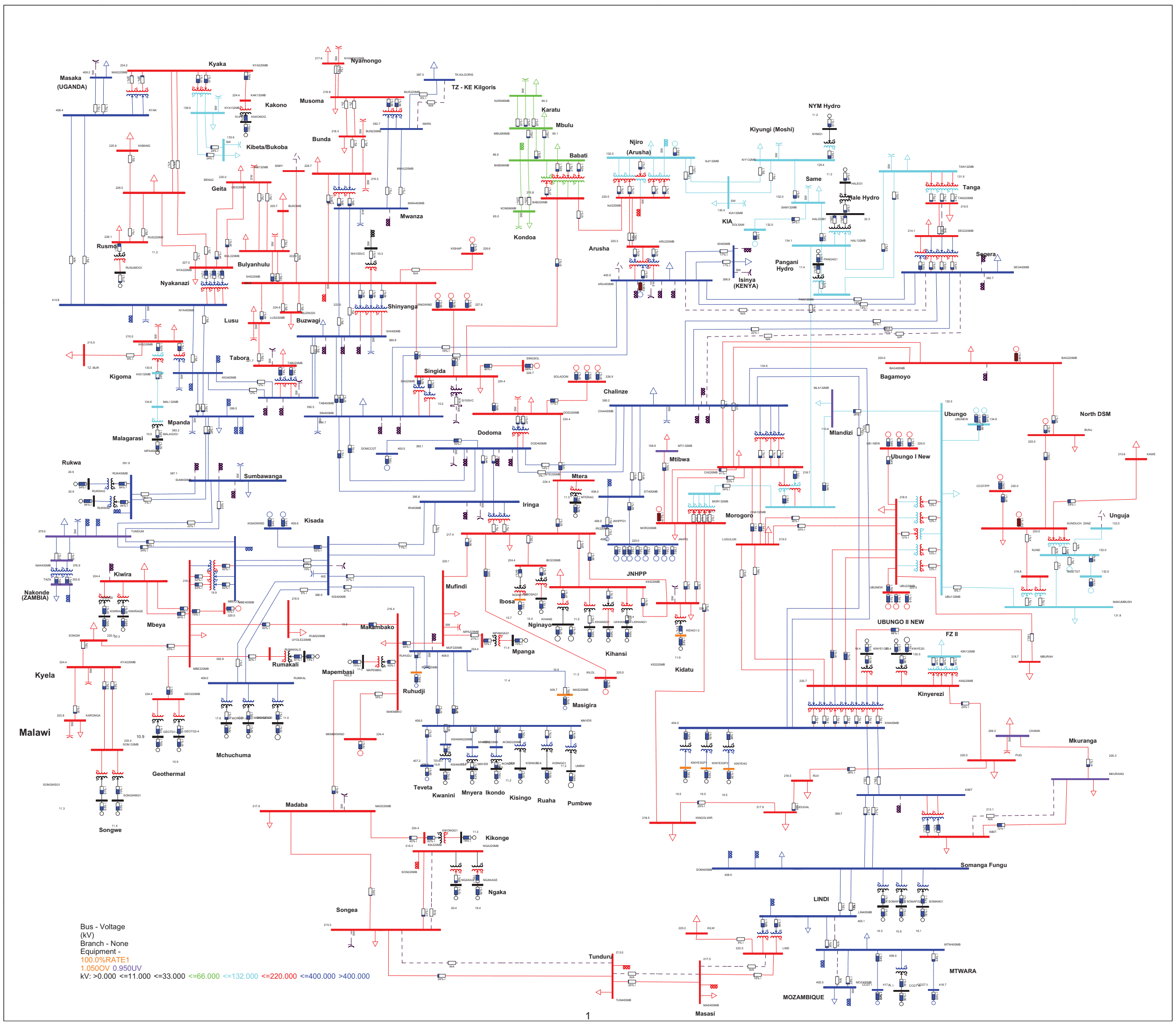
# Tanzania Grid Network in 2024



# Load Flow for the Tanzanian interconnected power system - Year 2034



# Load Flow for the Tanzanian Grid Network - Year 2044



# CHAPTER 5

## 5. ECONOMIC AND FINANCIAL ANALYSIS

### 5.1. Introduction

Economic and Financial concepts are essentially used to determine the costs to be incurred and the resulting benefits from investing in the proposed power projects. They both involve ascertaining the net present value of a project based on its estimated present and future cash flows, appropriately discounted.

The economic and financial analysis on the proposed power investment plan identifies planning criteria used in the analysis that covers two major sub-chapters, namely:

(a) A financial analysis of the proposed generation and transmission expansion plans; and

(b) An estimate of the long-run marginal cost of generation, transmission and distribution.

It also spells out the required cost to implement the proposed power expansion plan so that players can identify projects to be implemented either independently or in partnership. The modality of implementing these projects can be either purely Government or Private or in partnership between the Public and Private Sector (PPP).

In this respect, the Government will have two roles to play as follows:

(i) To mobilize financial resources in order to implement some of the earmarked projects; and

(ii) To continue creating a conducive environment for attracting private investors in the electricity sub-sector.

Generally, all strategic power generation, transmission lines and substations upgrades projects will be implemented by Government while the remaining generation and related power evacuations projects may be implemented by Private Sector.

However, it is important to note that the analysis done under this Chapter does not cover the economics of interconnecting the isolated load centres. This is due to the fact that the Government is implementing two transmission projects with a capacity of 132 kV to connect the remaining two regions of Kigoma and Katavi to the National Grid by 2023.

## 5.2. Basic Assumptions

The economic and financial analyses were done by taking into account some relevant basic economic and financial assumptions, which are described hereunder:

### 5.2.1. Discount Rate

The Plan considers discount rate as the time value of money which is used to calculate present values of a series of future costs. An appropriate discount value has to be selected by taking into account the reflection of opportunity cost of capital; and normally tends to be higher in regions where capital is relatively scarcer. Thus, the choice of discount rate is discretionary. Nevertheless, some studies might use the Weighted Average Cost of Capital as the method for calculating the discount rate but this does not provide the perfect value in every situation.

Typically, the use of a higher discount rate tends to favour thermal power projects in cost comparisons with hydropower projects due to their lower initial costs, but higher yearly operating costs. In contrast, lower discount rates would favour hydro plants, where most of the expenditures are at the beginning of the project cycle. By considering the previous PSMPs, a discount rate of 10 percent (which excludes inflation) was used in converting capital costs into equivalent annual costs over the life of a project and for comparisons of unit generation costs for initial screening of options.

### 5.2.2. Interest Rate

Interest rate is also considered as the cost of the loan, and it usually varies from one Financier to the other. This implies that different sources of finance have a different cost of loans to be offered. Basing on experience, the interest rate for commercial loans in the long term borrowing varies from 4.4 percent for Government lending and 7 percent for private investor. However, for the purpose of this Plan, a weighted average interest rate of 5.8 percent has been considered to represent the required return for the Financiers. This rate represents an average cost of debt in Tanzania.

### 5.2.3. Debt Equity Ratio

Most Financiers and Banks prefer to use the standard debt equity ratio of 70:30 to finance infrastructural projects including power generation and transmission. Therefore, this ratio has been adopted in this Plan.

#### 5.2.4. Loan Condition

For the purpose of this Plan, loan tenure for financing power projects is set at fifteen (15) years of which two (2) years being grace period for all power projects except hydropower projects which is assumed to be four (4) years.

#### 5.2.5. Interest During Construction (IDC)

This is interest incurred directly as the result of investment cost obtained as loan during construction. This has impact on the overall project cost as it is added on the project cost by capitalizing them. In this Plan, 5.8 percent per annum which is equal to the interest rate has been assumed in calculating IDC of projects based on the Investment Plan.

#### 5.2.6. Inflation Rate on Capital Cost

The analysis made in this Plan is based on constant prices of the year 2019. The Constant Price Method avoids the assumption of the price escalation, as forecasting inflation rate in long term is not reliable. Also, price escalation of benefit and cost will be balanced out if the escalation rate is the same for both of them in the Investment Plan. Therefore, price escalation is not priced in the Investment Plan but it will only be shown to highlight figures which could have been involved.

#### 5.2.7. Foreign Exchange Rate

An exchange rate of **TZS 2,316.4** against **1 USD** has been used for this Plan as provided in the Government guidelines for the Preparation of Plans and Budgets for the Financial Year 2019/20 – 2021/22.

#### 5.2.8. Depreciation Rate

The depreciation rates applied in this Plan are calculated basing on the economic life of various power projects to be implemented. Thus, the following depreciation rates have been applied:

(i). Hydropower projects – 2% per annum;
(ii). Gas fired and Renewable energy power projects – 4% per annum;
(iii). Coal fired power projects – 3% per annum; and
(iv). Transmission projects – 3% per annum.

#### 5.2.9. Income Tax

Tanzanian Corporate Income Tax (CIT) rate is 30 percent. This implies that benefit exceeding cost is subject to deduction of 30 percent tax value in Investment Plan.

#### 5.2.10. Return On Equity

Return On Equity (ROE) is a measure of financial performance calculated by dividing net income by shareholders' equity. Usually, utilities have many assets and debt on the balance sheet compared to a relatively small amount of net income. A normal ROE in the utility sectors is about 10 to 12.5 percent. For the purposes of this Plan, the ROE is assumed to be 12 percent.

### 5.3. Financial Analysis

The financial analysis of projects under this Plan follows from the analysis done on its economic perspective and long run marginal costs. Likewise, this section presents the approach and results of the financial analysis. The financial analysis takes into consideration the previous PSMPs from the financial point of view and focuses on the financing of the power projects and the total amount of required debt and equity. During financial forecasting period the annual interest costs, repayment of debt and income taxes were presented.

#### 5.3.1. Summary of Financial Analysis

For the purposes of aligning with the Tanzania Development Vision 2025, the financing requirement to implement the PSMP in the short run (2020 – 2025) is about **USD 9,526.4 Million**, of which debt financing will be USD 4,516.1 Million and equity will be USD 5,010.3 Million. **Table 5-1** shows the breakdown of projections of the annual financing requirement in the short run.

**Table 5-1:** Short Run Financing Requirement

US$ Million

| Investments | Capacity MW | Online Year | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | Project Total |
|---|---|---|---|---|---|---|---|---|---|
| **Generation** | | | | | | | | | |
| Julius Nyerere HPP 2,115 MW | 2,115.0 | 2022 | 550.0 | 1,169.2 | 684.4 | - | - | - | 2,403.5 |
| Rusumo HPP 80 MW | 26.7 | 2021 | 39.6 | 5.7 | - | - | - | - | 45.2 |
| Ruhudji HPP 358 MW | 358.0 | 2025 | - | - | 122.2 | 122.2 | 81.5 | 81.5 | 407.4 |
| Kakono HPP 87 MW | 87.0 | 2026 | - | - | 28.0 | 112.2 | 84.1 | 42.1 | 266.4 |
| Rumakali HPP 222 MW | 222.0 | 2026 | - | - | - | 150.1 | 112.6 | 75.1 | 337.7 |
| Kikonge HPP 300 MW | 300.0 | 2028 | - | - | - | - | - | 74.1 | 74.1 |
| Malagarasi HPP 49.5 MW | 49.5 | 2024 | - | 14.4 | 57.7 | 43.2 | 28.8 | - | 144.1 |
| Murongo-Kikagati HPP 14 MW | 7.0 | 2021 | 23.2 | 5.8 | - | - | - | - | 29.0 |
| Lower Songwe HPP (Manolo) 180.2 MW | 90.1 | 2028 | - | - | - | - | - | 27.5 | 27.5 |
| Kihansi II - Upper Kihansi HPP 120 MW | 120.0 | 2026 | - | - | - | 88.3 | 66.2 | 44.2 | 198.7 |
| Masigira HPP 118 MW | 118.0 | 2028 | - | - | - | - | - | 104.5 | 104.5 |
| Kinyerezi - I Extension 185 MW | 185.0 | 2021 | 18.8 | 41.4 | - | - | - | - | 60.2 |
| Mtwara I 300 MW | 300.0 | 2025 | - | - | - | 7.3 | 211.1 | 145.6 | 363.9 |
| Singida - I (wind) 100 MW | 100.0 | 2025 | - | - | - | - | - | 126.5 | 126.5 |
| Singida (solar) 150 MW | 150.0 | 2023 | - | - | 11.7 | 105.4 | - | - | 117.1 |
| Dodoma Solar - I 55 MW | 55.0 | 2024 | - | - | - | 56.3 | 37.6 | - | 93.9 |
| Ngozi (wellhead) & Ngozi - I 30 MW | 30.0 | 2023 | - | 22.7 | 45.4 | 7.6 | - | - | 75.6 |
| Kiejo – Mbaka 60 MW | 60.0 | 2024 | - | - | 45.4 | 90.8 | 15.1 | - | 151.3 |
| Natron 60 MW | 60.0 | 2027 | - | - | - | - | - | 45.4 | 45.4 |
| Ngozi - II 40 MW | 40.0 | 2026 | - | - | - | - | 30.3 | 60.5 | 90.8 |
| Songwe 5 MW | 5.0 | 2023 | - | 3.8 | 7.6 | 1.3 | - | - | 12.6 |
| Luhoi 5 MW | 5.0 | 2027 | - | - | - | - | - | 3.8 | 3.8 |
| **Total Generation Investments** | **19,639.7** | | **631.6** | **1,262.9** | **1,002.3** | **784.6** | **667.2** | **830.6** | **5,179.2** |

| Transmission | Voltage Level (kV) | Online Year | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | Project Total |
|---|---|---|---|---|---|---|---|---|---|
| Rufiji-Chalinze-Dodoma (400kV) | 400 | 2022 | 67.3 | 235.6 | 33.7 | - | - | - | 336.5 |
| Kinyerezi-Chalinze (400kV) | 400 | 2022 | 24.0 | 84.0 | 12.0 | - | - | - | 119.9 |
| Ruhudji-Kisada (400kV) | 400 | 2025 | - | - | - | 34.9 | 20.3 | 2.9 | 58.1 |
| Rusumo-Nyakanazi (220kV) | 220 | 2021 | - | 38.4 | - | - | - | - | 38.4 |
| Malagarasi-Kidahwe (Kigoma) (132kV) | 132 | 2024 | - | - | 3.9 | 7.7 | 1.3 | - | 12.9 |
| Kakono-Kyaka (220kV) | 220 | 2026 | - | - | - | - | - | 6.5 | 6.5 |
| Rumakali-Mbeya (Uyole) (220kV) | 220 | 2026 | - | - | - | - | - | 11.7 | 11.7 |
| JNHPP-Kibiti (400kV) | 400 | 2025 | - | - | - | - | 52.4 | 34.9 | 87.3 |
| Singida-Arusha-Namanga (400kV) | 400 | 2021 | 92.1 | 13.2 | - | - | - | - | 105.3 |
| Bulyankhulu-Geita (220kV) | 220 | 2020 | 7.1 | - | - | - | - | - | 7.1 |
| Geita-Nyakanazi (220kV) | 220 | 2021 | 29.3 | 19.6 | - | - | - | - | 48.9 |
| "North West Grid" Iringa-Mbeya-Tunduma-Sumbawanga-Mpanda-Kigoma-Nyakanazi (400kV) | 400 | 2026 | 55.4 | 129.4 | 129.4 | 129.4 | 138.6 | 92.4 | 674.5 |
| Tabora-Urambo-Nguruka-Kidahwe (Kigoma) (132kV) | 132 | 2024 | 8.2 | 8.2 | 24.6 | 32.8 | 8.2 | - | 82.0 |
| Tabora-Ipole-Inyonga-Nsimbo (Katavi) (132kV) | 132 | 2024 | 4.8 | 9.6 | 28.8 | 43.1 | 9.6 | - | 95.9 |
| Ibadakuli (Shinganya)-Imalilo (Simiyu) (220kV) | 220 | 2023 | - | - | 8.5 | 34.0 | - | - | 42.5 |
| Tanzania (Nyakanazi)-Kyaka-Uganda (Masaka) (400kV) | 400 | 2025 | - | - | 34.8 | 69.5 | 52.1 | 17.4 | 173.8 |
| Chalinze-Segera (400kV); Segera-Tanga (220kV) | 400; 220 | 2025 | - | - | 15.0 | 60.0 | 45.0 | 30.0 | 150.0 |
| Chalinze-Bagamoyo (220kV) | 220 | 2022 | - | 51.0 | 34.0 | - | - | - | 85.0 |
| Segera-Arusha (400kV) | 400 | 2025 | - | - | 16.2 | 64.7 | 48.5 | 32.4 | 161.8 |
| Morogoro-Mtibwa (220kV) | 220 | 2023 | - | - | 31.5 | 21.0 | - | - | 52.6 |
| Tanzania-Mozambique (MOTA) Interconnection (400kV) | 400 | 2024 | - | - | - | 24.9 | 16.6 | - | 41.5 |
| Tanzania-Malawi (TAMA) Interconnection (400kV) | 400 | 2025 | - | - | - | 21.5 | 53.9 | 32.3 | 107.7 |
| Mbeya-Songwe-Chunya (Makongoros) (220kV) | 220 | 2024 | - | - | 5.6 | 14.0 | 8.4 | - | 28.0 |
| Mkata-Handeni (132kV) | 132 | 2024 | - | - | - | - | 32.9 | - | 32.9 |
| Dodoma City Ring Circuit (220kV) | 220 | 2023 | - | 22.9 | 57.2 | 34.3 | - | - | 114.5 |
| NARCO (Dodoma)-Dumila (220kV) | 220 | 2024 | - | - | - | 13.4 | 8.9 | - | 22.3 |
| Songea-Tunduru-Masasi-Lindi (400kV); Masasi-Ruangwa (220kV) | 400; 220 | 2024 | - | - | 69.1 | 172.7 | 103.6 | - | 345.4 |
| Ifakara-Mahenge (220kV) | 220 | 2024 | - | - | - | - | 30.2 | - | 30.2 |
| Tanzania (Mwanza)-Kenya (Kilgoris) Interconnection (400kV) | 400 | 2025 | - | - | - | 57.2 | 143.0 | 85.8 | 285.9 |

| Transmission | Voltage Level (kV) | Online Year | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | Project Total |
|---|---|---|---|---|---|---|---|---|---|
| Lindi-Nangurukuru (Kilwa) (132kV) | 132 | 2026 | - | - | - | - | 9.8 | 24.5 | 34.3 |
| Zinga-Kunduchi-Makumbusho (220kV) | 220 | 2024 | - | - | - | 89.1 | 59.4 | - | 148.4 |
| Karatu-Loliondo (66kV) | 220 | 2024 | - | - | 4.9 | 12.1 | 7.3 | - | 24.3 |
| Chanika-Mkuranga-Kibiti (220kV) | 220 | 2024 | - | - | - | - | 84.1 | - | 84.1 |
| Kinyerezi-Ubungo-Mburahati (220kV) | 220 | 2022 | - | - | 42.8 | - | - | - | 42.8 |
| Dar-Moro-Dodoma SGR-TL (220kV) | 220 | 2020 | 48.5 | 20.0 | - | - | - | - | 68.5 |
| Kinyerezi-Luguruni (220kV) | 220 | 2025 | - | - | - | 1.0 | - | 6.2 | 7.3 |
| Mtwara-Somanga Fungu (400kV) | 400 | 2024 | - | - | 29.3 | 146.7 | 117.3 | - | 293.4 |
| Somanga-Kibiti-Kinyerezi (400kV) | 400 | 2024 | - | - | - | 123.1 | 82.1 | - | 205.2 |
| Iringa-Dodoma-Singida-Shinyanga (Existing TL - 400kV) - Transformers & Compesators (TL Upgrade) | 400 | 2021 | 37.6 | 40.7 | - | - | - | - | 78.3 |
| Shinyanga-Buzwagi (Existing TL-220kV) - Buzwagi Substation (TL Upgrade) | 220 | 2022 | - | - | 0.4 | - | - | - | 0.4 |
| Morogoro-Ubungo (Existing TL - 220kV) - Zegereni Substation (TL Upgrade) | 220 | 2022 | - | - | 1.4 | - | - | - | 1.4 |
| **Total Transmission Investments** | | | **374.4** | **672.4** | **582.9** | **1,207.2** | **1,133.4** | **376.9** | **4,347.2** |
| | | | | | | | | | |
| **Total Investments** | | | **1,005.9** | **1,935.3** | **1,585.2** | **1,991.8** | **1,800.7** | **1,207.5** | **9,526.4** |
| **Cumm. Investments** | | | **1,005.9** | **2,941.2** | **4,526.4** | **6,518.2** | **8,318.9** | **9,526.4** | |
| **Investments subjected to Debt:Equity** | | | **375.6** | **686.9** | **804.2** | **1,723.3** | **1,671.4** | **1,190.1** | |
| ***Financing*** | ***Contribution Ratio*** | | | | | | | | |
| *Govt Fully Financed Investments* | *100% Equity* | | 630.3 | 1,248.3 | 781.0 | 268.5 | 129.3 | 17.4 | |
| *Debt* | *70%* | | 262.9 | 480.8 | 562.9 | 1,206.3 | 1,170.0 | 833.1 | |
| *Equity* | *30%* | | 112.7 | 206.1 | 241.3 | 517.0 | 501.4 | 357.0 | |
| *Total Debt/Year* | | | **262.9** | **480.8** | **562.9** | **1,206.3** | **1,170.0** | **833.1** | **4,516.1** |
| *Total Equity/Year* | | | **743.0** | **1,454.4** | **1,022.3** | **785.5** | **630.7** | **374.4** | **5,010.3** |

| **CAPITAL NEEDED** | **$ Million** |
|---|---|
| Short Term (2020 - 2025) | **9,526.4** |

**Note:** Project costs marked with red colour are partial cost since construction of these projects goes beyond 2025.

Similarly, in order to implement this Plan for the entire planning horizon (2020 – 2044) approximately **USD 38,340.4 Million** is required as capital cost for generation and transmission projects, as detailed in **Appendix V.**

However, after including the distribution projects, drawdown of capital financing and IDC, the total required capital expenditures for financing the power projects increases to USD 58,377 Million as shown in **Table 5-2**.

**Impact of Financing Capital Expenditure:** The financing of capital expenditure given in **Table 5-2** is based on the 70 percent debt and 30 percent equity financing (except for the Government fully funded projects) the inclusion of IDC amounting to USD 9,173 Million changes the debt to equity ratio to be 71 percent and 29 percent respectively of the drawdowns for capital expenditure.

**Table 5-2:** Breakdown of Capital Costs Requirement over the Plan Horizon (2020-2044)

| Capital Costs and Financing Items | | (Mill. USD) | % |
|---|---|---|---|
| **1) Capital Costs without Inflation and IDC** | | | |
| Generation | | 32,612 | |
| Transmission | | 5,728 | |
| Distribution | | 10,864 | |
| **Total Capital Cost (excl. Inflation & IDC)** | | **49,204** | |
| **2) Drawdowns for Financing Capital Expenditures** | | | |
| Debt financed | | 32,290 | 66% |
| Equity financed | | 16,914 | 34% |
| Total Financing without IDC | | **49,204** | **100%** |
| **3) Overall Financing including IDC** | | | |
| IDC | 9,173 | | |
| Debt | 32,290 | | |
| Total Debt (Drawdown + IDC) | | 41,463 | 71% |
| Equity | | 16,914 | 29% |
| Total Financing including IDC | | **58,377** | **100%** |

#### 5.3.2. Financed by Debt

Optimal capital structure is the mix of debt and equity financing. Debt financing often requires the borrower to adhere to rules regarding financial performance. Usually, there is a short and long term debt financing. However, power investment requires long term financing that is fifteen (15) to twenty (20) years.

#### 5.3.3. Interest During Construction

The Interest During Construction (IDC) for the generation and transmission over the period of 2020 to 2044 amounts to **USD 9,173 Million**, which increases the overall cost of capital expenditure by 18.6 percent. The IDC is added to the debt principal resulting to increase in total debt obligation, which is recovered together with the principal debt over the planning horizon.

#### 5.3.4. Inflation

The projects will be implemented one after another during the planning horizon, hence the inflation will have impact on the total cost of implementing this Plan. In this case, inflation rate of 1.8 percent per year has been assumed, which is a combination of USA and TZ CPI indexes. Based on annual inflation of 1.8 percent, the overall capital costs will increase by **USD 3,076 Million** (accumulation) an increase of 5 percent.

The breakdown of total capital expenditure, inflation and Interest During Construction for power projects over the planning horizon is shown in the **Table 5-3**.

**Table 5-3:** Breakdown of Overall Financing Requirements for Capital Costs[8]

| Cost Item | (Mill. USD) | (Mill. USD) | (%) |
|---|---|---|---|
| **1) Capital Costs without Inflation and IDC** | | | |
| Generation | 32,612 | | 66.3 |
| Transmission | 5,728 | | 11.6 |
| Distribution | 10,864 | | 22.1 |
| **Total Capital Cost (excl. Inflation & IDC)** | **49,204** | | **100.0** |
| | | ***Inflation*** | |
| **2 Capital Costs with Inflation** | | *(Mill. USD)* | |
| Generation | 35,386 | 2,774 | 90.2 |
| Transmission | 6,031 | 302 | 9.8 |
| Distribution | 10,864 | - | - |
| **Total Capital Cost (incl. Inflation)** | **52,280** | **3,076** | **100.0** |
| **3) Capital Costs with Inflation and IDC** | | | |
| Interest During Construction | 9,173 | | |
| Capital Cost incl. Inflation | 52,280 | | |
| **Total Capital Costs (incl Infl & IDC)** | **61,453** | | |

#### 5.3.5. Unit Cost of Power Supply for Proposed Projects

The unit cost of power supply derived on a financial basis for the new power projects was calculated for each year of the planning horizon by dividing the Annual Revenue Requirements (ARR) by the energy supplied. The financial cost of power supply is derived on an accounting basis and includes the depreciation expense, financing costs and net income for the Utility. Likewise, the financial unit cost of supply is obtained by

[8] Transmission cost of USD 5,728 Million excludes costs incurred before 2019 for the projects under construction.

dividing the ARR by the energy supplied for that particular year. **Table 5-4** presents the ARR, energy supplied and the computed unit cost of annual power supply.

According to the information on the **Table 5-4**, the unit cost of power supply decreases sharply from 13.7 UScents/kWh in 2021 to a low value of 9.6 UScents/kWh in 2022 and reaching an average of 5.5 UScents/kWh from 2023 towards end of the planning period. The sharp decline of the unit cost of power supply is due to introduction of JNHPP. Nevertheless, the ARR considered in this analysis caters for the new investments only and not for the overall ARR of the power utility.

**Table 5-4:** Annual Revenue Requirements, Energy Supplied and Unit Cost of Supply

| Year | Annual Rev. Requirement (Mill. USD) | Energy Supply (GWh) | Unit Cost of Supply (USc/kWh) |
|---|---|---|---|
| 2020 | - | - | - |
| 2021 | 106 | 778 | 13.7 |
| 2022 | 346 | 3,623 | 9.6 |
| 2023 | 478 | 10,848 | 4.4 |
| 2024 | 642 | 11,588 | 5.5 |
| 2025 | 906 | 15,658 | 5.8 |
| 2026 | 1,015 | 18,173 | 5.6 |
| 2027 | 995 | 18,956 | 5.3 |
| 2028 | 1,348 | 24,956 | 5.4 |
| 2029 | 1,792 | 33,925 | 5.3 |
| 2030 | 1,842 | 35,401 | 5.2 |
| 2031 | 2,152 | 39,882 | 5.4 |
| 2032 | 2,646 | 48,056 | 5.5 |
| 2033 | 3,162 | 57,148 | 5.5 |
| 2034 | 3,646 | 65,690 | 5.6 |
| 2035 | 3,766 | 68,717 | 5.5 |
| 2036 | 4,196 | 74,785 | 5.6 |
| 2037 | 4,522 | 78,150 | 5.8 |
| 2038 | 5,018 | 84,795 | 5.9 |
| 2039 | 5,597 | 93,955 | 6.0 |
| 2040 | 5,985 | 98,008 | 6.1 |
| 2041 | 6,340 | 100,816 | 6.3 |
| 2042 | 6,704 | 103,089 | 6.5 |
| 2043 | 7,360 | 109,335 | 6.7 |
| 2044 | 8,188 | 118,508 | 6.9 |

### 5.4. Long Run Marginal Costs

Generally, the Long Run Marginal Cost (LRMC) is the incremental cost incurred by a firm in producing one (1) additional unit of electricity when all inputs are variable. In particular, it is an extra cost incurred by the firm as it increases the scale of its operations by not only adding more workers to a given factory but also by building a larger factory/plant.

The LRMC under this Plan is considered as the cost of supplying an incremental unit of electricity (kWh) to the system at a future date. It is used as a base for electricity pricing due to the rationale that it directs customer through the price charged for electricity towards the most efficient use of resources available. Theoretically, if price is equal to marginal cost of supply, an optimal allocation of resources takes place and economic efficiency will result.

Usually, the Marginal Cost is one among factors considered during the development of electricity tariffs. The LRMC of electricity supply are computed to satisfy the criterion of economic efficiency. Similarly, Marginal Costs are usually adjusted to arrive at an appropriate tariff structure that meets various other goals and constraints, including, the financial viability of the power projects, social objectives, metering and billing constraints. Nevertheless, this Plan focuses exclusively on the estimate of Long Run Marginal Costs and does not address the financial viability or tariff structure issues.

#### 5.4.1.Approach Used to Estimate Marginal Costs

The computation of Marginal Costs focuses into two broad cost categories namely: demand or capacity-related costs and energy-related costs. Marginal capacity costs (also referred to as marginal demand costs) are taken as the costs of investment in generation, transmission and distribution to supply additional units plus the fixed costs of operation and maintenance.

The projected capital investment cost of power generation, transmission and distribution projects forms the demand costs. Marginal energy costs are the costs of fuel, energy purchases and the variable operating and maintenance costs needed to provide additional kilowatt-hours.

It is important to note that, the mandate for this Plan considered only the expansion of the generation and transmission system. It does not include the estimate of capital costs for the expansion of distribution system to meet the system needs at the end of this Plan (2044). Thus, an estimate of the distribution investments is required, even though it is not part of the mandate for the Plan.

Investment in distribution networks are capital intensive systems. Timely investments are crucial for long term reliability of their service. In coming years, many networks will need extensive investments idue to their aging. Also, energy efficiency, Demand Side

Management (DSM), network energy loss reduction, quality of service standards, and security of power supply require active, flexible, and smart networks thus intensive investments.

Unreliable and inadequate power supply infrastructure have significant adverse effects on the public and the economy as a whole. An appropriate planning process is essential to ensure ongoing efficient and reliable power supply. To determine this, a tool to identify and assess the investment requirements of distribution networks has to be available.

However, based on various study including PSMP 2008, it is assumed that the distribution costs will amount to about twice (200 percent) of the investment costs in transmission. According to Tanzania Development Vision 2025, it’s expected that villages electrification will reach 100 percent by 2025, hence the distribution investment cost during the short run (2020-2025) is expected to be above 200 percent of transmission investment cost and slightly below 200 percent of the transmission cost in the medium and long term (2026-2044).

On the other hand, Operation and Maintenance costs are expected to be minimum during the short term, higher during the medium and long term due to planned and unplanned maintenance carried out on the aged distribution infrastructure. Therefore, total distribution costs during the short term will be lower compared to medium and long term.

#### 5.4.2.Summary of Results

The Long Run Marginal Cost of power projects was calculated on a year-by-year basis by examining the incremental cost over the base year. This approach is closer to the robust definition of Long Run Marginal Cost.

From the analyses, the unit cost of generation, transmission and distribution were calculated for each year as presented in **Table 5-5**.

**Table 5-5:** Long Run Marginal cost (US cents per kWh) for the period 2020-2044

| Period | Marginal cost of Generation | Marginal cost of Transmission | Marginal cost of Distribution | Marginal cost of Supply |
|---|---|---|---|---|
| 2020-2025 | 14.9 | 3.9 | 7.2 | 24.9 |
| 2026-2034 | 6.5 | 0.6 | 1.4 | 8.3 |
| 2035-2044 | 5.2 | 0.6 | 1.4 | 7.0 |
| **2020-2044** | **6.7** | **1.0** | **2.2** | **9.6** |

The marginal costs of generation, transmission and distribution cannot simply be added to result in the overall marginal cost of power supply since there are transmission losses ranging from 5 to 4 percent as well as distribution losses in the order of 15 to 12 percent short, medium and long term periods.

# CHAPTER 6

## 6. CONCLUSION AND RECOMMENDATIONS

### 6.1. Conclusion

Tanzania has consistently identified that inadequate, expensive, unreliable and limited access to power are critical constraints to economic growth of the country. To address these challenges, there is a need of robust power infrastructure that supports the economic and social development agenda of the country. The Government has set the target to reach electricity consumption per capita of 490 kWh per annum by 2025 equally the Government intend to build an industrial led economy to support its desire to attain a status of a higher middle income country by 2025. Therefore, in order to meet these targets, more investment is required in power generation, transmission and distribution network.

The PSMP 2020 Update details a least cost power generation plan for the country in immediate to long term up to 2044 that satisfies the forecasted demand over the planning horizon. The Plan also include an associated transmission expansion plan to evacuate power from generation sources to the respective load centres across the country.

The Generation Plan considered the available energy resources in the country which includes hydro, natural gas, coal, solar, wind and geothermal for power generation. Generated power will be used domestically as well as export while ensuring that the country has adequate, affordable, reliable and security of power supply over the planning horizon.

In order to meet the forecasted demand, the country requires a total installed generation capacity of 3,966 MW in the short term, 12,257  MW in the medium and 20,200.6 MW in the long term.The Plan indicates power generation mix which varies over the planning period and by 2044 the generation mix consist of 5,690.4 MW (28.15%) of hydro; 6,700 MW (33.18%) of natural gas; 5,300 MW (26.24%) of coal; 800 MW (3.96%) of wind; 715 MW (3.54%) of solar; and 995 MW (4.93%) of geothermal of power generation.

Power generation from diesel/HFO has been phased out from 2021 and retained as reserve capacity for emergency through out the planning period. This Plan observes a reserve margin on firm capacity in the range of 15 - 20 percent.

In order to evacuate the generated power to the load centres, the transmission expansion plan determines new lines and required system upgrades. The planned lengths of power transmission projects includes 3,150.20 km of 400 kV, 1,833.70 km of 220 kV and 920.80 km of 132 kV in the short term; 2,444.45 km of 400 kV, 650.70 km of 220 kV and 192.00 km of 132 kV in the medium term; and 610.00 km of 400 kV, 1,180.30 km of 220 kV and 155.20 km of 132 kV in the long term.

By the end of the planning period the generation and transimsion plans provides sufficient energy to meet the country needs in the National Grid system as well as connecting all isolated loads.

Moreover, the Plan provides export capacity of 1,500 MW, however due to limitation of transmission capacity in the short term only 1,000 MW may be traded within EAC and SADC regions from 2023 and the remaining 500 MW may be traded from 2025. The country's available surplus power capacity and its cross border infrastructure enables power trading within EAC and SADC regions and thus will enable Tanzania to be the power hub in the SAPP and EAPP.

The proposed power expansion plan requires a total of USD 38,340.4 Million throughout the planning horizon, of which USD 9,526.4 Million will be required in the period of 2020-2025. When inflation and interest during construction are added, total investment required rises to USD 50,589.2 Million in the long run, about two third of this amount is earmarked for power generation projects over the planning horizon.

### 6.2. Recommendations

The Task Force Team recommends the following:

a) Most of the planned power projects have no full feasibility study reports. Therefore, the Government to ensure that strategic power projects are studied to full feasibility level before implementation of the respective projects so as to reduce project implementation lead time and cost. Particularly, to speed up feasibility studies for geothermal resources in order to enhance the implementation of identified geothermal projects;

b) The Government to continue investing in the exploration and development of hydrocarbons to increase more discoveries. Further, invertsment in processing and transportation infrastructure is required to satisfy projected high demand of natural gas for power generation. Extension of the natural gas pipeline network from Dar es Salaam to other regions including Dodoma and Pwani (Bagamoyo) to be fast-tracked to allow its use for the proposed gas-fired power plants;

c) Implementation of this Plan requires huge financial resources thereby needs concerted efforts in mobilizing financing for both power generation and transmission projects. The Government to continue with efforts of attracting private investment in the electricity sub-sector;

d) The Government to fast-track the implementation of interconnection transmission lines and negotiations to commence for possible power trading up to 1,500 MW within the SAPP and EAPP starting from 2023;

e) Uranium resources has not been considered for power generation in this Plan. The National Energy Policy of 2015 and the Mineral Policy of Tanzania 2009 acknowledge the availability of uranium resource in Tanzania. There is need to prepare Implementation Strategies including human capacity building on the use of nuclear for power generation. Such strategies will ensure future utilization of nuclear resource for power generation by 2045;

f) The Government through the Ministry of Energy to consider establishing a monitoring and evaluation Task Force responsible for preparation of the Implementation Strategy for effective implementation of PSMP 2020 Update; and

g) The Government to conduct a comprehensive Power System Master Plan in 2025 as the last was conducted in 2008 and updated several times (2009, 2012, 2016 and 2020). Preparation to start on January, 2023.

# APPENDICES

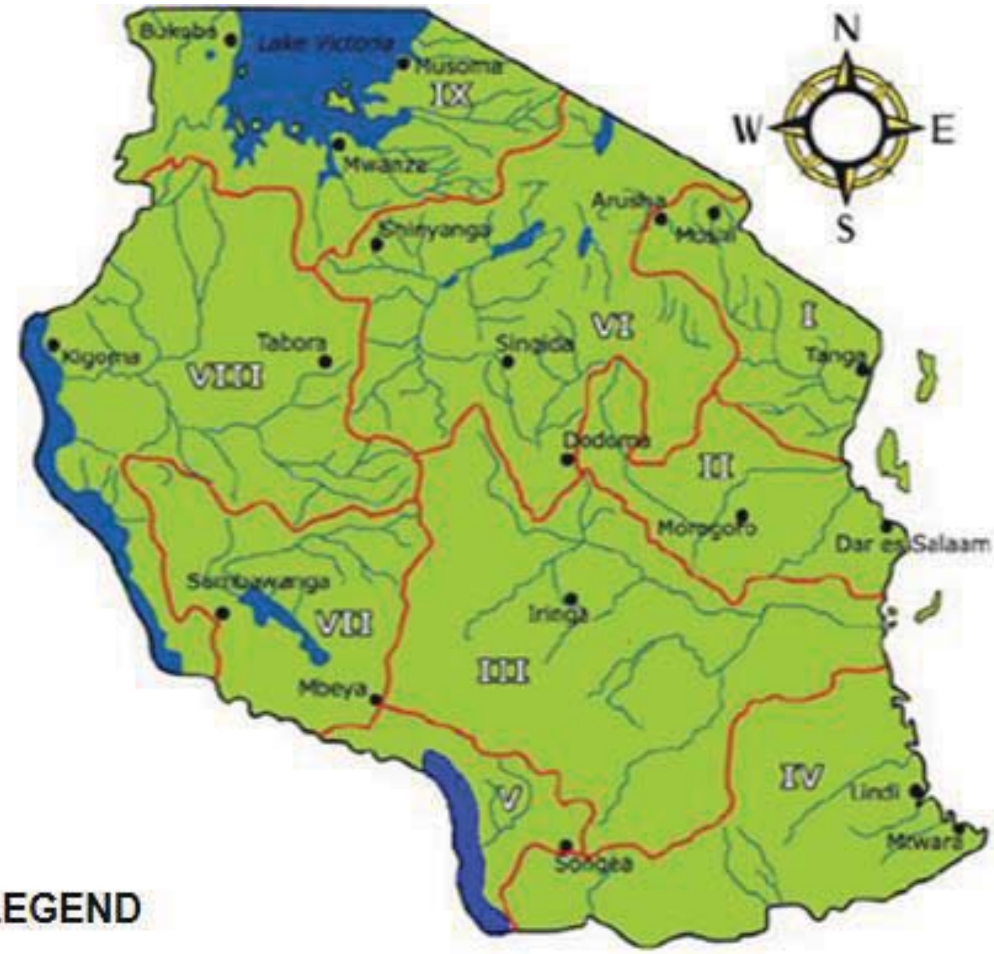
**APPENDIX I:** Task Force Team Involved In Preparation of PSMP 2020 Update

| S/N | NAME | ORGANIZATION | RESPONSIBILITIES |
|---|---|---|---|
| 1. | Juma F. Mkobya | MoE | Team Leader + Generation Planning |
| 2. | Ephata J. Ole-Lolubo | EWURA | Load Forecast |
| 3. | Rustis S. Bernad | NBS | Load Forecast |
| 4. | John F. Kitonga | EWURA | Load Forecast |
| 5. | Marianus I. Mgendera | TANESCO | Load Forecast |
| 6. | Abdallah M. Chikoyo | TANESCO | Generation Planning |
| 7. | Elias R. Kajiru | TANESCO | Generation Planning |
| 8. | Ahmed M. Chinemba | MoE | Generation Planning |
| 9. | Godson C. Bisansaba | MoE | Generation Planning |
| 10. | Fokas Daniel | TANESCO | Transmission Planning |
| 11. | Jensen G. Mahavile | REA | Transmission Planning |
| 12. | Zuwena B. Nkwanya | MoE | Transmission Planning |
| 13. | Lusajo K. Mwakaliku | MoE | Economic + Financial Analysis |
| 14. | Oliver F. Mtatifikolo | TPDC | Economic + Financial Analysis |
| 15. | Jesca E. Mugyabuso | MoFP | Economic + Financial Analysis |
| 16. | Mathew D. Maduhu | TANESCO | Economic + Financial Analysis |

**INVITEES**

| S/N | NAME | ORGANIZATION | RESPONSIBILITIES |
|---|---|---|---|
| 1. | Elineema Mkumbo | REA | Hydrology Expert |
| 2. | James Kirahuka | TANESCO | Hydrology Expert |
| 3. | Rasmus Hyera | TGDC | Geothermal Expert |
| 4. | Patricia Nguliule | TANESCO | Documentation |

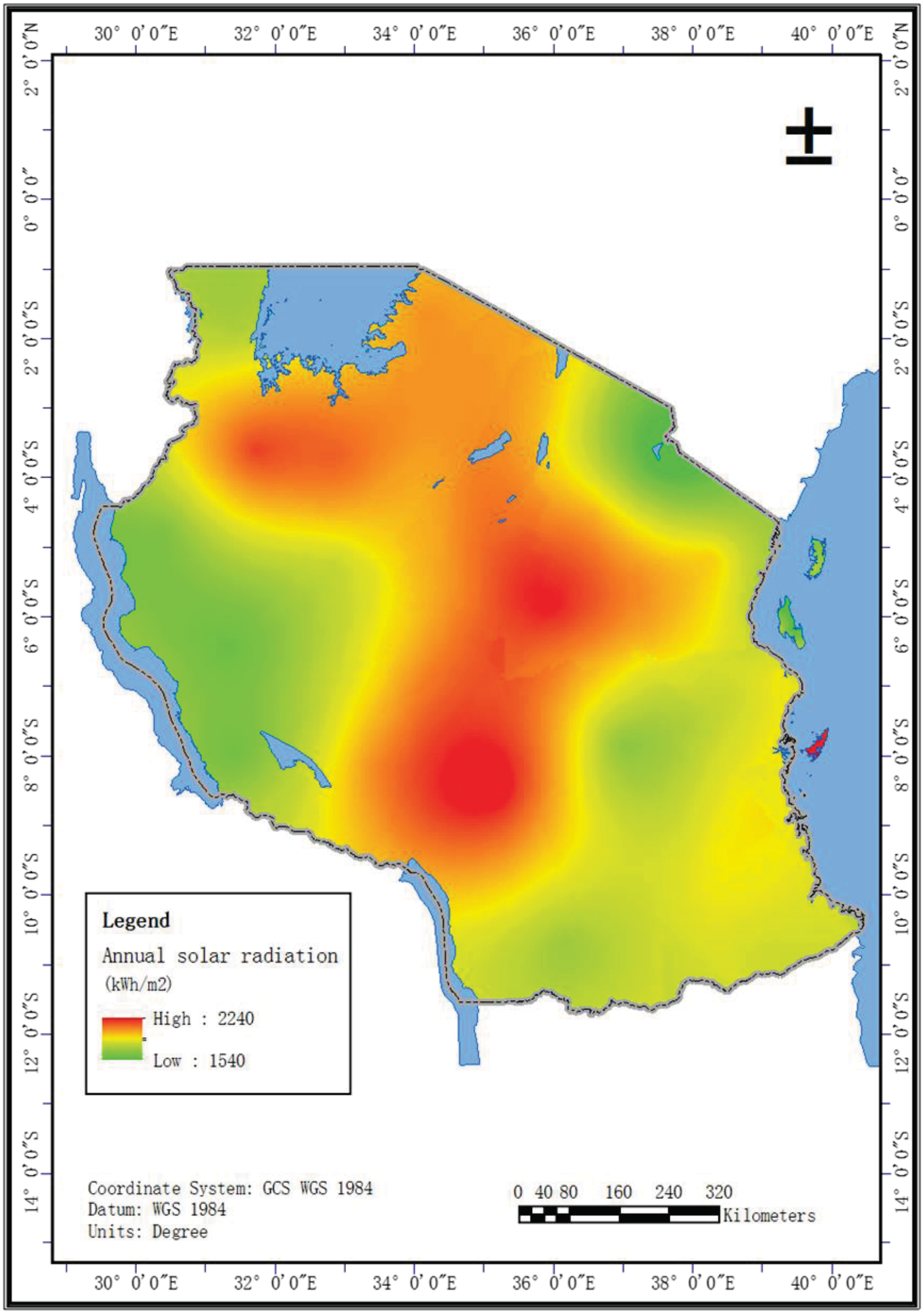
**APPENDIX II:** River Basins in Tanzania




LEGEND

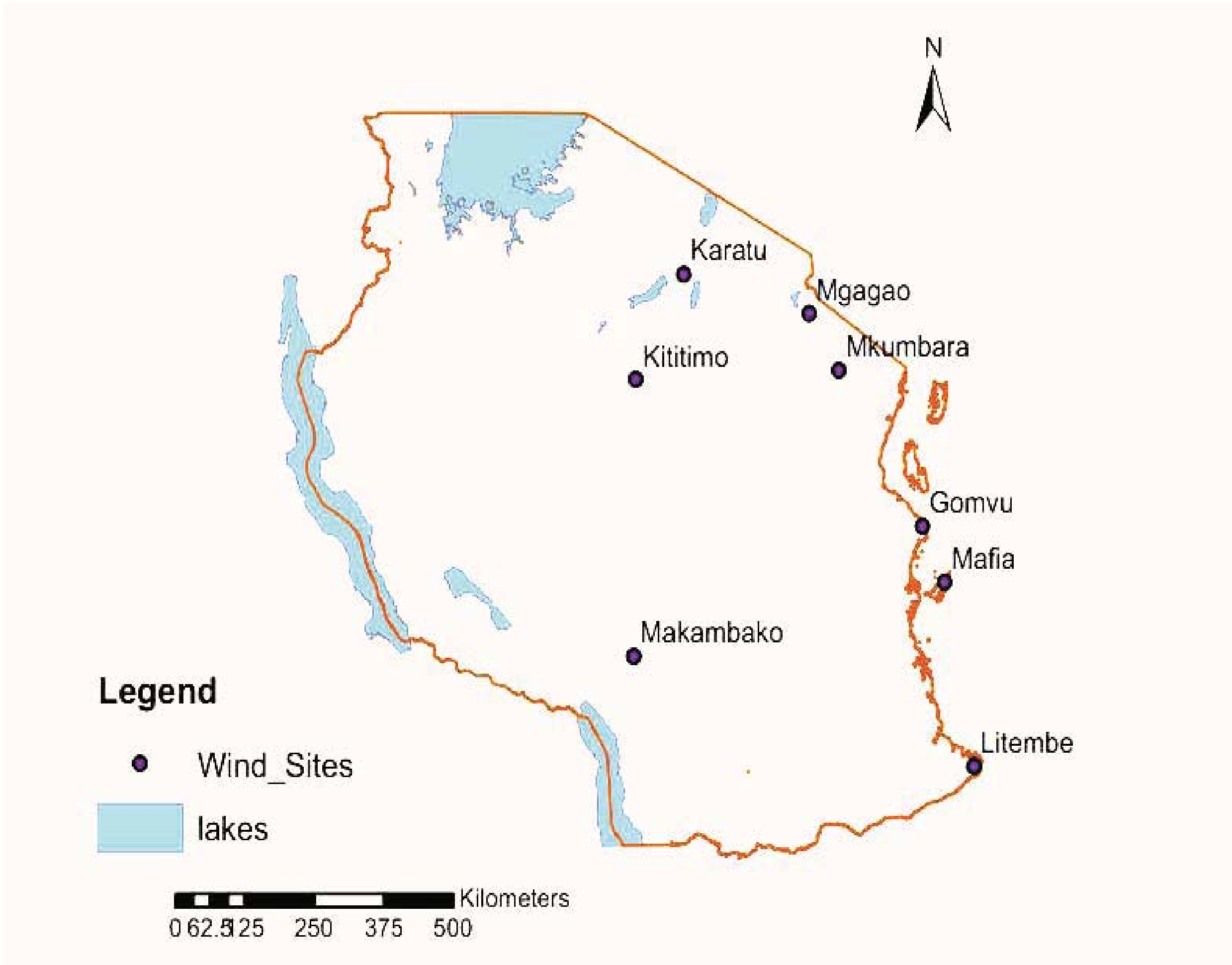
| | | |
|---|---|---|
| I – Pangani Basin | IV – Ruvuma and Southern Coast Basin | VII – Lake Rukwa Basin |
| II – Wami Ruvu Basin | V – the Lake Nyasa | VIII – Lake Tanganyika Basin |
| III – Rufiji Basin | VI – The internal drainage basin | IX – Lake Victoria Basin |

**APPENDIX III:** Spatial distribution of Annual Solar Radiation in Tanzania




**Source:** Report on the Assessment of Solar Energy Potential Resources and Development of Solar Map of Tanzania, (2014).

**APPENDIX IV:** Tanzania Wind Map




**Source:** TANESCO

**APPENDIX V:** Financing Requirements of the Entire Plan

US$ Million

| Investments | Capacity MW | Online Year | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | Project Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Generation** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Julius Nyerere HPP 2,115 MW | 2,115.0 | 2022 | 550.0 | 1,169.2 | 684.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2,403.5 |
| Rusumo HPP 80 MW | 26.7 | 2021 | 39.6 | 5.7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 45.2 |
| Ruhudji HPP 358 MW | 358.0 | 2025 | - | - | 122.2 | 122.2 | 81.5 | 81.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 407.4 |
| Kakono HPP 87 MW | 87.0 | 2026 | - | - | 28.0 | 112.2 | 84.1 | 42.1 | 14.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 280.4 |
| Rumakali HPP 222 MW | 222.0 | 2026 | - | - | - | 150.1 | 112.6 | 75.1 | 37.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 375.3 |
| Kikonge HPP 300 MW | 300.0 | 2028 | - | - | - | - | - | 74.1 | 296.4 | 222.3 | 148.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 740.9 |
| Malagarasi HPP 49.5 MW | 49.5 | 2024 | - | 14.4 | 57.7 | 43.2 | 28.8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 144.1 |
| Murongo-Kikagati HPP 14 MW | 7.0 | 2021 | 23.2 | 5.8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 29.0 |
| Lower Songwe HPP (Manolo) 180.2 MW | 90.1 | 2028 | - | - | - | - | - | 27.5 | 110.0 | 82.5 | 55.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 275.0 |
| Kihansi II - Upper Kihansi HPP 120 MW | 120.0 | 2026 | - | - | - | 88.3 | 66.2 | 44.2 | 22.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 220.8 |
| Masigira HPP 118 MW | 118.0 | 2028 | - | - | - | - | - | 104.5 | 78.4 | 52.3 | 26.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 261.3 |
| Mpanga HPP 160 MW | 160.0 | 2033 | - | - | - | - | - | - | - | - | - | - | 119.4 | 89.5 | 59.7 | 29.8 | - | - | - | - | - | - | - | - | - | - | - | 298.5 |
| Songwe Sofre HPP 163.2 MW | 81.6 | 2035 | - | - | - | - | - | - | - | - | - | - | - | - | 60.9 | 45.7 | 30.4 | 15.2 | - | - | - | - | - | - | - | - | - | 152.2 |
| Songwe Bupigu HPP 34 MW | 17.0 | 2040 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 23.4 | 23.4 | 11.7 | - | - | - | - | 58.5 |
| Mnyera Kwanini HPP 143.9 MW | 143.9 | 2036 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 65.7 | 65.7 | 32.9 | - | - | - | - | - | - | - | - | 164.3 |
| Mnyera Taveta HPP 145 MW | 145.0 | 2034 | - | - | - | - | - | - | - | - | - | - | - | - | 82.3 | 82.3 | 41.2 | - | - | - | - | - | - | - | - | - | - | 205.8 |
| Iringa (Nginayo) HPP 52 MW | 52.0 | 2035 | - | - | - | - | - | - | - | - | - | - | - | - | - | 50.2 | 50.2 | 25.1 | - | - | - | - | - | - | - | - | - | 125.5 |
| Iringa (Ibosa) HPP 36 MW | 36.0 | 2035 | - | - | - | - | - | - | - | - | - | - | - | - | - | 49.2 | 49.2 | 24.6 | - | - | - | - | - | - | - | - | - | 123.0 |
| Mnyera Mnyera HPP 137.4 MW | 137.4 | 2029 | - | - | - | - | - | - | - | 109.6 | 109.6 | 54.8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 274.1 |
| Ikondo Mnyera HPP 340 MW | 340.0 | 2038 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 266.3 | 266.3 | 133.2 | - | - | - | - | - | - | 665.8 |
| Mnyera Kisingo HPP 119.8 MW | 119.8 | 2039 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 125.6 | 125.6 | 62.8 | - | - | - | - | - | 314.0 |
| Mnyera Ruaha HPP 60.3 MW | 60.3 | 2039 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 102.0 | 102.0 | 51.0 | - | - | - | - | - | 255.1 |
| Mnyera Pumbwe HPP 122.9 MW | 122.9 | 2039 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 87.7 | 87.7 | 43.9 | - | - | - | - | - | 219.3 |
| Iringa Kilolo HPP 150 MW | 150.0 | 2039 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 120.0 | 120.0 | 60.0 | - | - | - | - | - | 300.0 |
| Mbarali HPP 38.5 MW | 38.5 | 2040 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 66.4 | 66.4 | 33.2 | - | - | - | - | 166.0 |
| Njombe HPP 32 MW | 32.0 | 2040 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 54.4 | 54.4 | 27.2 | - | - | - | - | 136.0 |
| Kinyerezi - I Extension 185 MW | 185.0 | 2021 | 18.8 | 41.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 60.2 |
| Mtwara I 300 MW | 300.0 | 2025 | - | - | - | 7.3 | 211.1 | 145.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 363.9 |
| Kinyerezi - III 600 MW | 600.0 | 2028 | - | - | - | - | - | - | - | 370.9 | 303.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 674.4 |
| Somanga Fungu TANESCO 600 MW | 600.0 | 2029 | - | - | - | - | - | - | - | - | 404.6 | 269.8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 674.4 |
| Ubungo New 320 MW | 320.0 | 2042 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 68.0 | 170.0 | 102.0 | - | - | 340.0 |
| Somanga Fungu PPP 320 MW | 320.0 | 2034 | - | - | - | - | - | - | - | - | - | - | - | - | 68.0 | 170.0 | 102.0 | - | - | - | - | - | - | - | - | - | - | 340.0 |
| Somanga Mtama 345 MW | 345.0 | 2037 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 87.1 | 217.7 | 130.6 | - | - | - | - | - | - | - | 435.4 |
| Ubungo - I New 320 MW | 320.0 | 2032 | - | - | - | - | - | - | - | - | - | - | - | 197.8 | 161.9 | - | - | - | - | - | - | - | - | - | - | - | - | 359.7 |
| Tegeta New 320 MW | 320.0 | 2029 | - | - | - | - | - | - | - | - | 251.8 | 107.9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 359.7 |
| Dodoma (Gas) 600 MW | 600.0 | 2033 | - | - | - | - | - | - | - | - | - | - | - | 134.9 | 337.2 | 202.3 | - | - | - | - | - | - | - | - | - | - | - | 674.4 |
| Ubungo - II New 470 MW | 470.0 | 2032 | - | - | - | - | - | - | - | - | - | - | - | 369.8 | 158.5 | - | - | - | - | - | - | - | - | - | - | - | - | 528.3 |
| Kinyerezi - IV 330 MW | 330.0 | 2031 | - | - | - | - | - | - | - | - | - | - | 200.1 | 200.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 400.3 |
| Mtwara II 300 MW | 300.0 | 2039 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 200.3 | 133.6 | - | - | - | - | - | 333.9 |
| Kinyerezi - I New 320 MW | 320.0 | 2041 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 68.0 | 170.0 | 102.0 | - | - | - | 340.0 |
| Kinyerezi - II New 470 MW | 470.0 | 2044 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 118.6 | 296.6 | 177.9 | 593.2 |

| Investments | Capacity MW | Online Year | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | Project Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mtwara III 600 MW | 600.0 | 2043 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 134.9 | 337.2 | 202.3 | - | 674.4 |
| Bagamoyo 300 MW | 300.0 | 2040 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 72.0 | 180.0 | 108.0 | - | - | - | - | 360.0 |
| Singida - I (wind) 100 MW | 100.0 | 2025 | - | - | - | - | - | 126.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 126.5 |
| Singida - II (wind) 100 MW | 100.0 | 2036 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 126.5 | - | - | - | - | - | - | - | - | 126.5 |
| Singida - III (wind) 200 MW | 200.0 | 2039 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 253.0 | - | - | - | - | - | 253.0 |
| Makambako 300 MW | 300.0 | 2037 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 379.5 | - | - | - | - | - | - | - | 379.5 |
| Njombe I 100 MW | 100.0 | 2041 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 126.5 | - | - | - | 126.5 |
| Singida (solar) 150 MW | 150.0 | 2023 | - | - | 11.7 | 105.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 117.1 |
| Shinyanga - II (solar) 150 MW | 150.0 | 2041 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 11.7 | 105.4 | - | - | - | 117.1 |
| Dodoma Solar - I 55 MW | 55.0 | 2024 | - | - | - | 56.3 | 37.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 93.9 |
| Shinyanga - I (Kishapu) 150 MW | 150.0 | 2027 | - | - | - | - | - | - | 70.3 | 46.8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 117.1 |
| Dodoma Solar - II 60 MW | 60.0 | 2031 | - | - | - | - | - | - | - | - | - | - | 61.4 | 41.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | 102.4 |
| Manyoni Solar 100 MW | 100.0 | 2040 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 107.1 | 71.4 | - | - | - | - | 178.5 |
| Same Kilimanjaro Solar 50 MW | 50.0 | 2042 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 53.6 | 35.7 | - | - | 89.3 |
| Ngozi (wellhead) & Ngozi - I 30 MW | 30.0 | 2023 | - | 22.7 | 45.4 | 7.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 75.6 |
| Kiejo – Mbaka 60 MW | 60.0 | 2024 | - | - | 45.4 | 90.8 | 15.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 151.3 |
| Natron 60 MW | 60.0 | 2027 | - | - | - | - | - | 45.4 | 90.8 | 15.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 151.3 |
| Ngozi - II 40 MW | 40.0 | 2026 | - | - | - | - | 30.3 | 60.5 | 10.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 100.8 |
| Songwe 5 MW | 5.0 | 2023 | - | 3.8 | 7.6 | 1.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 12.6 |
| Luhoi 5 MW | 5.0 | 2027 | - | - | - | - | - | 3.8 | 7.6 | 1.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 12.6 |
| Geothermal - I (Mbeya, Manyara, Morogoro, Arusha, Shinyanga) 195 MW | 195.0 | 2030 | - | - | - | - | - | - | - | - | 147.5 | 295.0 | 49.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 491.6 |
| Geothermal - II (Mbeya, Manyara, Morogoro, Arusha, Shinyanga) 200 MW | 200.0 | 2035 | - | - | - | - | - | - | - | - | - | - | - | - | - | 151.3 | 302.5 | 50.4 | - | - | - | - | - | - | - | - | - | 504.2 |
| Geothermal - III (Mbeya, Songwe, Manyara, Morogoro, Arusha, Shinyanga) 185 MW | 185.0 | 2040 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 139.9 | 279.8 | 46.6 | - | - | - | - | 466.4 |
| Geothermal - IV (Mbeya, Manyara, Morogoro, Arusha, Shinyanga) 215 MW | 215.0 | 2044 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 162.6 | 325.2 | 54.2 | 542.0 |
| Mbeya I 300 MW | 300.0 | 2029 | - | - | - | - | - | - | - | 262.3 | 262.3 | 131.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 655.7 |
| Kiwira III 300 MW | 300.0 | 2038 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 278.3 | 208.7 | 208.7 | - | - | - | - | - | - | 695.8 |
| Kiwira - I 200 MW | 200.0 | 2032 | - | - | - | - | - | - | - | - | - | - | 174.9 | 174.9 | 87.4 | - | - | - | - | - | - | - | - | - | - | - | - | 437.2 |
| Ngaka - I 200 MW | 200.0 | 2032 | - | - | - | - | - | - | - | - | - | - | 174.9 | 174.9 | 87.4 | - | - | - | - | - | - | - | - | - | - | - | - | 437.2 |
| Ngaka - II 400 MW | 400.0 | 2036 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 375.1 | 375.1 | 187.6 | - | - | - | - | - | - | - | - | 937.8 |
| Mchuchuma - I 300 MW | 300.0 | 2031 | - | - | - | - | - | - | - | - | - | 262.3 | 262.3 | 131.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 655.7 |
| Mchuchuma - II 400 MW | 400.0 | 2038 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 349.7 | 349.7 | 174.9 | - | - | - | - | - | - | 874.3 |
| Mbeya II 600 MW | 600.0 | 2033 | - | - | - | - | - | - | - | - | - | - | - | 556.6 | 556.6 | 278.3 | - | - | - | - | - | - | - | - | - | - | - | 1,391.6 |
| Kiwira - II 200 MW | 200.0 | 2034 | - | - | - | - | - | - | - | - | - | - | - | - | 174.9 | 174.9 | 87.4 | - | - | - | - | - | - | - | - | - | - | 437.2 |
| Mchuchuma - III 300 MW | 300.0 | 2043 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 262.3 | 262.3 | 131.1 | - | 655.7 |
| Rukwa I 300 MW | 300.0 | 2036 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 281.3 | 281.3 | 140.7 | - | - | - | - | - | - | - | - | 703.3 |
| Rungwe 600 MW | 600.0 | 2034 | - | - | - | - | - | - | - | - | - | - | - | - | 524.6 | 524.6 | 262.3 | - | - | - | - | - | - | - | - | - | - | 1,311.4 |
| Mbeya III 600 MW | 600.0 | 2039 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 563.3 | 563.3 | 281.7 | - | - | - | - | - | 1,408.3 |
| Rukwa II 600 MW | 600.0 | 2044 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 608.8 | 608.8 | 304.4 | 1,522.0 |
| **Total Generation Investments** | **19,639.7** | | **631.6** | **1,262.9** | **1,002.3** | **784.6** | **667.2** | **830.6** | **737.0** | **1,163.1** | **1,708.6** | **1,120.9** | **1,042.2** | **2,070.7** | **2,359.4** | **1,758.6** | **1,647.4** | **924.6** | **1,599.6** | **2,333.6** | **2,071.9** | **1,665.0** | **547.8** | **954.6** | **1,627.2** | **1,564.1** | **536.6** | **32,612.0** |

| Transmission | Voltage Level (kV) | Online Year | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | Project Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rufiji-Chalinze-Dodoma (400kV) | 400 | 2022 | 67.3 | 235.6 | 33.7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 336.5 |
| Kinyerezi-Chalinze (400kV) | 400 | 2022 | 24.0 | 84.0 | 12.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 119.9 |
| Ruhudji-Kisada (400kV) | 400 | 2025 | - | - | - | 34.9 | 20.3 | 2.9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 58.1 |
| Rusumo-Nyakanazi (220kV) | 220 | 2021 | - | 38.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 38.4 |
| Kikonge-Madaba (220kV) | 220 | 2028 | - | - | - | - | - | - | - | - | 9.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 9.1 |
| Malagarasi-Kidahwe (Kigoma) (132kV) | 132 | 2024 | - | - | 3.9 | 7.7 | 1.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 12.9 |
| Kiwira-Uyole (220kV) | 220 | 2032 | - | - | - | - | - | - | - | - | - | - | - | - | 38.1 | - | - | - | - | - | - | - | - | - | - | - | - | 38.1 |
| Kakono-Kyaka (220kV) | 220 | 2026 | - | - | - | - | - | 6.5 | 0.7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 7.2 |
| Mchuchuma-Kisada (400kV) | 400 | 2031 | - | - | - | - | - | - | - | - | - | - | 42.0 | 28.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | 70.0 |
| Ngaka-Songea (220kV) | 220 | 2032 | - | - | - | - | - | - | - | - | - | - | - | - | 6.9 | - | - | - | - | - | - | - | - | - | - | - | - | 6.9 |
| Rumakali-Mbeya (Uyole) (220kV) | 220 | 2026 | - | - | - | - | - | 11.7 | 1.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 13.0 |
| Masigira-Ruhudji (220kV) | 220 | 2028 | - | - | - | - | - | - | - | 16.7 | 1.9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 18.5 |
| Mnyera Mnyera-Ruhudji (220kV) | 220 | 2029 | - | - | - | - | - | - | - | - | - | 9.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 9.3 |
| Mnyera Ruaha-Mnyera Mnyera (220kV) | 220 | 2039 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2.3 | - | - | - | - | - | 2.3 |
| Mnyera Pumbwe-Mnyera Mnyera (220kV) | 220 | 2039 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2.3 | - | - | - | - | - | 2.3 |
| Mpanga-Mufindi (220kV) | 220 | 2033 | - | - | - | - | - | - | - | - | - | - | - | - | - | 12.0 | - | - | - | - | - | - | - | - | - | - | - | 12.0 |
| Iringa (Nginayo-Ibosa)-Iringa (Tagamenda) (220kV) | 220 | 2035 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 15.2 | 1.7 | - | - | - | - | - | - | - | - | - | 16.8 |
| Iringa (Kilolo)-Iringa (Tagamenda) (220kV) | 220 | 2039 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 7.2 | - | - | - | - | - | 7.2 |
| Lower Songwe (Manolo)-Kyela (132kV) | 132 | 2028 | - | - | - | - | - | - | - | - | 11.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 11.2 |
| JNHPP-Kibiti (400kV) | 400 | 2025 | - | - | - | - | 52.4 | 34.9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 87.3 |
| Singida-Arusha-Namanga (400kV) | 400 | 2021 | 92.1 | 13.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 105.3 |
| Bulyankhulu-Geita (220kV) | 220 | 2020 | 7.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 7.1 |
| Geita-Nyakanazi (220kV) | 220 | 2021 | 29.3 | 19.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 48.9 |
| "North West Grid" Iringa-Mbeya-Tunduma-Sumbawanga-Mpanda-Kigoma-Nyakanazi (400kV) | 400 | 2026 | 55.4 | 129.4 | 129.4 | 129.4 | 138.6 | 92.4 | 249.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 924.0 |
| Tabora-Urambo-Nguruka-Kidahwe (Kigoma) (132kV) | 132 | 2024 | 8.2 | 8.2 | 24.6 | 32.8 | 8.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 82.0 |
| Tabora-Ipole-Inyonga-Nsimbo (Katavi) (132kV) | 132 | 2024 | 4.8 | 9.6 | 28.8 | 43.1 | 9.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 95.9 |
| Ibadakuli (Shinganya)-Imalilo (Simiyu) (220kV) | 220 | 2023 | - | - | 8.5 | 34.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 42.5 |
| Tanzania (Nyakanazi)-Kyaka-Uganda (Masaka) (400kV) | 400 | 2025 | - | - | 34.8 | 69.5 | 52.1 | 17.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 173.8 |
| Chalinze-Segera (400kV); Segera-Tanga (220kV) | 400; 220 | 2025 | - | - | 15.0 | 60.0 | 45.0 | 30.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 150.0 |
| Chalinze-Bagamoyo (220kV) | 220 | 2022 | - | 51.0 | 34.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 85.0 |
| Segera-Arusha (400kV) | 400 | 2025 | - | - | 16.2 | 64.7 | 48.5 | 32.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 161.8 |
| Morogoro-Mtibwa (220kV) | 220 | 2023 | - | - | 31.5 | 21.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 52.6 |
| Tanzania-Mozambique (MOTA) Interconnection (400kV) | 400 | 2024 | - | - | - | 24.9 | 16.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 41.5 |
| Tanzania-Malawi (TAMA) Interconnection (400kV) | 400 | 2025 | - | - | - | 21.5 | 53.9 | 32.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 107.7 |
| Mbeya-Songwe-Chunya (Makongoros) (220kV) | 220 | 2024 | - | - | 5.6 | 14.0 | 8.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 28.0 |
| Mkata-Handeni (132kV) | 132 | 2024 | - | - | - | - | 32.9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 32.9 |
| Dodoma City Ring Circuit (220kV) | 220 | 2023 | - | 22.9 | 57.2 | 34.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 114.5 |
| NARCO (Dodoma)-Dumila (220kV) | 220 | 2024 | - | - | - | 13.4 | 8.9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 22.3 |
| Songea-Tunduru-Masasi-Lindi (400kV); Masasi-Ruangwa (220kV) | 400; 220 | 2024 | - | - | 69.1 | 172.7 | 103.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 345.4 |
| Ifakara-Mahenge (220kV) | 220 | 2024 | - | - | - | - | 30.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 30.2 |
| Tanzania (Mwanza)-Kenya (Kilgoris) Interconnection (400kV) | 400 | 2025 | - | - | - | 57.2 | 143.0 | 85.8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 285.9 |
| Bulyankhulu-Bukombe (220kV) | 220 | 2030 | - | - | - | - | - | - | - | - | - | - | 28.8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 28.8 |
| Tabora-Kigwa (Uyui) (220kV) | 220 | 2028 | - | - | - | - | - | - | - | - | 48.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 48.1 |

| Transmission | Voltage Level (kV) | Online Year | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | Project Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lindi-Nangurukuru (Kilwa) (132kV) | 132 | 2026 | - | - | - | - | 9.8 | 24.5 | 14.7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 49.0 |
| Kiyungi-Makuyuni (132kV) | 132 | 2026 | - | - | - | - | - | - | 28.6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 28.6 |
| Songea-Mbinga-Mbambabay (220kV) | 220 | 2037 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 42.3 | 28.2 | - | - | - | - | - | - | - | 70.5 |
| KIA-Engare Nairobi (132kV) | 132 | 2036 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 23.1 | - | - | - | - | - | - | - | - | 23.1 |
| Same-Gonja Gonja (132kV) | 132 | 2037 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 24.5 | - | - | - | - | - | - | - | 24.5 |
| NARCO (Dodoma)-Kijungu (Kiteto) (220kV) | 220 | 2037 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 30.5 | 20.3 | - | - | - | - | - | - | - | 50.8 |
| Manyoni-Kigwa (Uyui) (220kV) | 220 | 2040 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 10.6 | 26.4 | 15.8 | - | - | - | - | 52.8 |
| Manyoni-Mitundu (Manyoni) (220kV) | 220 | 2037 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 60.8 | 6.8 | - | - | - | - | - | - | - | 67.6 |
| Shinyanga-Tabora-Kigoma (400kV) | 400 | 2040 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 15.1 | 30.3 | 60.6 | 90.8 | 90.8 | 15.1 | - | - | - | - | 302.8 |
| Zinga-Kunduchi-Makumbusho (220kV) | 220 | 2024 | - | - | - | 89.1 | 59.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 148.4 |
| Geita-Bwanga-Usahunga-Kyaka (220kV) | 220 | 2041 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 12.0 | 47.8 | 35.9 | 23.9 | - | - | - | 119.6 |
| Songea-Namtumbo (132kV) | 132 | 2036 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 35.0 | - | - | - | - | - | - | - | - | 35.0 |
| Karatu-Loliondo (66kV) | 220 | 2024 | - | - | 4.9 | 12.1 | 7.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 24.3 |
| Chanika-Mkuranga-Kibiti (220kV) | 220 | 2024 | - | - | - | - | 84.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 84.1 |
| Kinyerezi-Ubungo-Mburahati (220kV) | 220 | 2022 | - | - | 42.8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 42.8 |
| Dar-Moro-Dodoma SGR-TL (220kV) | 220 | 2020 | 48.5 | 20.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 68.5 |
| Kinyerezi-Luguruni (220kV) | 220 | 2025 | - | - | - | 1.0 | - | 6.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 7.3 |
| Mtwara-Somanga Fungu (400kV) | 400 | 2024 | - | - | 29.3 | 146.7 | 117.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 293.4 |
| Somanga-Kibiti-Kinyerezi (400kV) | 400 | 2024 | - | - | - | 123.1 | 82.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 205.2 |
| Iringa-Dodoma-Singida-Shinyanga (Existing TL - 400kV) - Transformers & Compesators (TL Upgrade) | 400 | 2021 | 37.6 | 40.7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 78.3 |
| Shinyanga-Buzwagi (Existing TL-220kV) - Buzwagi Substation (TL Upgrade) | 220 | 2022 | - | - | 0.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.4 |
| Morogoro-Ubungo (Existing TL - 220kV) - Zegereni Substation (TL Upgrade) | 220 | 2022 | - | - | 1.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1.4 |
| Mufindi-Mbeya (Existing TL - 220kV) - Rujewa Substation (TL Upgrade) | 220 | 2028 | - | - | - | - | - | - | - | - | 21.7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 21.7 |
| Dodoma-Singida (Existing TL - 220kV) - Manyoni Substation (TL Upgrade) | 220 | 2029 | - | - | - | - | - | - | - | - | - | 21.7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 21.7 |
| Hale-Same-Kiyungi (Existing TL - 132kV) - Same Substation (TL Upgrade) | 132 | 2028 | - | - | - | - | - | - | - | - | 16.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 16.1 |
| **Total Transmission Investments** | | | **374.4** | **672.4** | **582.9** | **1,207.2** | **1,133.4** | **376.9** | **294.8** | **16.7** | **108.0** | **31.0** | **70.8** | **28.0** | **45.0** | **12.0** | **15.2** | **16.8** | **221.9** | **140.3** | **113.3** | **176.8** | **66.8** | **23.9** | **-** | **-** | **-** | **5,728.4** |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Total Investments** | | | **1,005.9** | **1,935.3** | **1,585.2** | **1,991.8** | **1,800.7** | **1,207.5** | **1,031.8** | **1,179.7** | **1,816.6** | **1,151.8** | **1,112.9** | **2,098.7** | **2,404.4** | **1,770.6** | **1,662.6** | **941.4** | **1,821.5** | **2,473.8** | **2,185.2** | **1,841.8** | **614.7** | **978.5** | **1,627.2** | **1,564.1** | **536.6** | **38,340.4** |
| **Cumm. Investments** | | | **1,005.9** | **2,941.2** | **4,526.4** | **6,518.2** | **8,318.9** | **9,526.4** | **10,558.2** | **11,737.9** | **13,554.6** | **14,706.4** | **15,819.3** | **17,918.0** | **20,322.4** | **22,093.0** | **23,755.5** | **24,696.9** | **26,518.5** | **28,992.3** | **31,177.5** | **33,019.3** | **33,634.0** | **34,612.5** | **36,239.8** | **37,803.8** | **38,340.4** | |
| **Investments subjected to Debt:Equity** | | | **375.6** | **686.9** | **804.2** | **1,723.3** | **1,671.4** | **1,190.1** | **1,031.8** | **1,179.7** | **1,816.6** | **1,151.8** | **1,112.9** | **2,098.7** | **2,404.4** | **1,770.6** | **1,662.6** | **941.4** | **1,821.5** | **2,473.8** | **2,185.2** | **1,841.8** | **614.7** | **978.5** | **1,627.2** | **1,564.1** | **536.6** | |
| ***Financing*** | ***Contribution Ratio*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Govt Fully Financed Investments* | *100% Equity* | | 630.3 | 1,248.3 | 781.0 | 268.5 | 129.3 | 17.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| *Debt* | *70%* | | 262.9 | 480.8 | 562.9 | 1,206.3 | 1,170.0 | 833.1 | 722.3 | 825.8 | 1,271.6 | 806.3 | 779.1 | 1,469.1 | 1,683.0 | 1,239.4 | 1,163.8 | 659.0 | 1,275.1 | 1,731.7 | 1,529.7 | 1,289.3 | 430.3 | 685.0 | 1,139.1 | 1,094.8 | 375.6 | |
| *Equity* | *30%* | | 112.7 | 206.1 | 241.3 | 517.0 | 501.4 | 357.0 | 309.6 | 353.9 | 545.0 | 345.5 | 333.9 | 629.6 | 721.3 | 531.2 | 498.8 | 282.4 | 546.5 | 742.1 | 655.6 | 552.6 | 184.4 | 293.6 | 488.2 | 469.2 | 161.0 | |
| *Total Debt/Year* | | | **262.9** | **480.8** | **562.9** | **1,206.3** | **1,170.0** | **833.1** | **722.3** | **825.8** | **1,271.6** | **806.3** | **779.1** | **1,469.1** | **1,683.0** | **1,239.4** | **1,163.8** | **659.0** | **1,275.1** | **1,731.7** | **1,529.7** | **1,289.3** | **430.3** | **685.0** | **1,139.1** | **1,094.8** | **375.6** | **24,685.9** |
| *Total Equity/Year* | | | **743.0** | **1,454.4** | **1,022.3** | **785.5** | **630.7** | **374.4** | **309.6** | **353.9** | **545.0** | **345.5** | **333.9** | **629.6** | **721.3** | **531.2** | **498.8** | **282.4** | **546.5** | **742.1** | **655.6** | **552.6** | **184.4** | **293.6** | **488.2** | **469.2** | **161.0** | **13,654.5** |

| | USD Million | | |
|---|---|---|---|
| **CAPITAL NEEDED** | **Total** | **Debt** | **Equity** |
| Short Term (2020 - 2025) | **9,526.4** | 4,516.1 | 5,010.3 |
| Medium Term (2026 - 2034) | **14,229.2** | 9,960.4 | 4,268.7 |
| Long Term (2035 - 2044) | **14,584.9** | 10,209.4 | 4,375.5 |
| **Total Plan (2020 - 2044)** | **38,340.4** | **24,685.9** | **13,654.5** |