Regional Harmonization of Regulatory Frameworks and Tools for Improved Electricity Regulation in COMESA

Maiden Report

Utility Key Performance Indicators (UKPI) for COMESA

Submitted to: Regional Association of Energy Regulators for Eastern and Southern Africa (RAERESA)

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Abbreviations

Acronym	Full form
ADFI	Average duration of forced interruptions
AfDB	African Development Bank
ANOFT	Average number of forced outages for all transmission lines
COMESA	Common Market for Eastern and Southern Africa
CAIDI	Customer Average Interruption Duration Index
EAC	East African Community
EAPP	East African Power Pool
EBIT	Earnings Before Interest and Tax
EEHC	Egyptian Electricity Holding Company
EgyptERA	Egyptian Electric Utility and Consumer Protection Regulatory Agency
EHV	Extra High Voltage
ERB	Energy Regulatory Board *(Zambia)*
EREA	Energy Regulators Association of East Africa
FY	Financial Year
GWh	Giga Watt hour
GDP	Gross Domestic Product
HHI	Herfindahl-Hirschman Index for Generation function
HV	High Voltage
Hz	Hertz
IMS	Information Management System
KENGEN	Kenya Electricity Generating Company
kg	Kilogram
kms	kilometers
KPI	Key Performance Indicators
kWh	Kilo Watt Hours
LV	Low Voltage
MIS	Management Information Systems
MV	Medium Voltage
MVA	Mega Volt Ampere
MW	Mega Watt

Acronym	Full form
MWh	Mega Watt Hours
O&M	Operation & Maintenance
PTWG	Project Technical Working Group
RAERESA	Regional Association of Energy Regulators for Eastern and Southern Africa
RE	Renewable Energy
REG	Rwanda Energy Group
REGIDESO	Régie de Production et de Distribution de l'Eau et de l'Électricité *(Burundi)*
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
STEG	Société Tunisienne de l'électricité et du gaz *(Tunisia)*
T & D	Transmission and Distribution
USc	US Cents
USD	US Dollar
UKPI	Utility Key Performance Indicators
VRPPS	Variable renewable energy-based power plants

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Executive Summary

This being the Maiden Report on Utility KPIs - the KPIs and data assets have been populated for the Member States based on data collected and other publicly available information. Data was also collected during the **field missions** to the five countries - Egypt, Ethiopia, Rwanda, Tunisia and Uganda. Based on the data as received from the countries and other publicly available data, the KPIs under various heads have been compiled in this report.

Egypt, Kenya, Rwanda and Uganda report a number of indicators, next in line are Ethiopia, Tunisia followed by Burundi, Djibouti, Eritrea, Libya, Somalia, South Sudan and Sudan.

Following indicators are being proposed for **incentive-based regulation** to begin with:

- Generation availability (%)
- System load factor (%)
- Transmission availability (%)
- Distribution system losses (%)

Indicators such as SAIFI and SAIDI can be deployed once the electricity market is further developed in the region as metrics for performance-based incentive regulation.

Phased reporting of utility KPIs

The KPIs proposed have been divided into 2 phases based on criticality of monitoring and feasibility of reporting. The reporting of performance is proposed to begin with Phase 1 KPIs. Reporting of Phase 2 KPIs is proposed to begin 1 year after commencement of Phase 1 reporting – this is to provide adequate time to member countries to prepare their data systems for reporting these indicators.

For the "Auto-computed" indicators, data will not be inputted; these will be automatically computed by the IMS. The auto-computed value will be displayed in input forms as read-only.

The phase-wise segregation of the utility KPIs is shown below.

Phase 1	Phase 2	Auto-computed
1. Generation		
Installed capacity (MW)	Annual energy generation capability (GWh)	Self-consumption rate (%)
Net energy generated (GWh)		Operating reserve capacity (%)
Generation availability (%)	Forced outage duration (hours)	
Dependable capacity (MW)	Planned outage duration (hours)	
Gross energy generated (GWh)	Generation substation capacity (MVA)	
Operating reserve capacity (MW)		
2. System operations		

Phase 1	Phase 2	Auto-computed
Peak demand (MW), date and time	Minimum demand (MW), date and time	
System load factor (%)	Number of frequency excursions: > 50.5 Hz or < 49.5 Hz	
	System minutes lost (minutes)	
3. Transmission - In country		
Transmission availability (%)	Average duration of forced interruptions (ADFI) (hours)	
Transmission system losses (%)	Average number of forced outages for all transmission lines (ANOFT)	
Transmission network length - Country level (circuit-kms)	Network utilization factor - Transmission	
Transmission substation capacity - Country level (MVA)		
4. Transmission - Tie lines		
Electricity import (GWh)	Transmission substation capacity - Tie lines (MVA)	
Electricity export (GWh)		
Transmission network length - Tie lines (circuit-kms)		
Transmission network capacity - Tie lines (MVA)		
5. Distribution		
Distribution system losses (%)	Distribution stepdown transformer (XX/4_ _ or XX/2_ _ volts) capacity (MVA)	
System Average Interruption Frequency Index (SAIFI)	Network utilization factor - Distribution	
System Average Interruption Duration Index (SAIDI) (hours)		
Distribution network length (circuit-kms)		
Distribution substation capacity (MVA)		
6. Retail supply		

Phase 1	Phase 2	Auto-computed
Number of customers		Customer Average Interruption Duration Index (CAIDI) (hours)
Prepaid customers (%)		
Electricity access rate (%)		
Total energy billed to customers (GWh)		
Electricity consumption per capita (kWh)		
Staff productivity		
Electricity consumption per unit GDP (GWh per USD million)		
7. Financial performance		
Return on asset (%)	O&M expenses index	
Current ratio	Return on equity (%)	
Profit after tax (USD million)	Fixed asset turnover ratio	
	Total asset turnover ratio	
	Profit before tax (USD million)	
8. Power market		
Market share based on energy purchase (%)		Competition index/ Herfindahl-Hirschman Index for Generation function (HHI)
9. Integration of renewable energy		
CO2 Emissions from Electricity Generation ('000 Tonnes)		Grid emission factor (Tonnes CO2/ MWh)

The utility KPIs have been proposed to have a **uniform set of regional utility performance indicators across the COMESA Member States**. This will help to track **utility performance across the region** and work as a **standard set of indicators** for all utilities to track and report their country's performance against those of their peers and enable them to identify areas which they may wish to consider improvement upon.

Further, the KPIs have been selected which broadly monitor the licensee and the utility's performance by tracking end-outcomes rather than micro-monitoring multiple intermediate outputs.

Going forward, each country should maintain a MIS (Management Information System) of these indicators which should help improve data quality, storage, management and retrieval of these indicators and data assets.

1 Introduction

1.1 Background

The excel based framework tool developed for utility KPIs is discussed in the framework report; this report presents the results of the data collection exercise on the developed evaluation tool for utility KPIs. This includes data collected during the various rounds of interactions held during the workshops and also the field mission to the five select countries - Egypt, Ethiopia, Rwanda, Tunisia and Uganda.

1.2 Structure of the Maiden Report - Utility Key Performance Indicators (UKPI) for COMESA

This report is structured as follows:

Chapter 1: Introduction

This chapter gives a general introduction to the maiden report on utility KPIs for COMESA Member States.

Chapter 2: Reporting of Utility KPIs across COMESA Member States

In this chapter, utility KPIs as finalized in the framework report have been discussed in detail along with the performance of the COMESA Member States on the same subject to data availability.

Chapter 3: Conclusion

This chapter presents the conclusion for the maiden report on utility KPIs.

2 Reporting of Utility KPIs across COMESA Member States

2.1 Utility KPIs

Based on discussions held with the stakeholders during the Consultative Workshop in Cairo during 13-14th May 2024 and further discussions held during the Information Management System (IMS) Workshop in Zambia during 5-6th June 2024 and finalised subsequently during the Validation Workshop at Kigali during 30-31st July 2024, a set of utility KPIs for efficient tracking and monitoring of utility performance have been submitted as part of the Final Framework Report. This being the Maiden Report on Utility KPIs - the KPIs and data assets have been populated for the Member States based on data collected and other publicly available information.

In this chapter, a list of key performance indicators (KPIs) and data assets under the following heads have been assessed for comprehensive tracking of utility performance of Member States:

1 Generation

2 System operations

3 Transmission - In country

4 Transmission - Tie-lines

5 Distribution

6 Retail supply

7 Financial performance

8 Power market

9 Integration of renewable energy

The utility KPIs have been proposed to have a **uniform set of regional utility performance indicators across the COMESA Member States**. This will help to track **utility performance across the region** and work as a **standard set of indicators** for all utilities to track and report their country's performance against those of their peers and enable them to identify areas which they may wish to consider improvement upon.

Further, the KPIs have been selected which broadly monitor the licensee and the utility's performance by tracking end-outcomes rather than micro-monitoring multiple intermediate outputs. While defining the KPIs, we have endeavoured that the KPIs are in line with international nomenclature and definitions in order to make performance benchmarkable with other utilities.

A summary list of KPIs and data assets is described in the table below:

Table 1: Summary list of utility KPIs and data assets recommended for reporting

1. Generation	1.1 Installed capacity (MW) 1.2 Dependable capacity (MW) 1.3 Annual Energy generation capability (GWh) 1.4 Operating reserve capacity (MW, %) 1.5 Gross energy generated (GWh) 1.6 Net energy generated (GWh)	1.7 Self-consumption rate (%) 1.8 Forced outage duration (hours) 1.9 Planned outage duration (hours) 1.10 Generation availability (%) 1.11 Generation substation capacity (MVA)
2. System operations	2.1 Peak demand (MW), date and time 2.2 Minimum demand (MW), date and time 2.3 System load factor (%)	2.4 Number of frequency excursions: > 50.5 Hz or < 49.5 Hz 2.5 System minutes lost (minutes)
3. Transmission – In country	3.1 Average duration of forced interruptions (ADFI) (hours) 3.2 Average number of forced outages for all transmission lines (ANOFT) 3.3 Transmission availability (%) 3.4 Transmission system losses (%)	3.5 Transmission network length - country level (circuit-kms) 3.6 Transmission substation capacity - country level (MVA) 3.7 Network utilization factor - Transmission
4. Transmission – Tie-Lines	4.1 Electricity import (GWh) 4.2 Electricity export (GWh) 4.3 Transmission network length - Tie lines (circuit-kms)	4.4 Transmission network capacity - Tie lines (MVA) 4.5 Transmission substation capacity - Tie lines (MVA)
5. Distribution	5.1 Distribution system losses (%) 5.2 System Average Interruption Frequency Index (SAIFI) 5.3 System Average Interruption Duration Index (SAIDI) (hours) 5.4 Distribution network length (circuit-kms)	5.5 Distribution substation capacity (MVA) 5.6 Distribution stepdown transformer (XX/4_ _ or XX/2_ _ volts) capacity (MVA) 5.7 Network utilization factor - Distribution
6. Retail supply	6.1 Customer base 6.2 Prepaid customers (%) 6.3 Electricity access rate (%) 6.4 Total energy billed to customers (GWh) 6.5 Electricity consumption per capita (kWh)	6.6 Electricity consumption per unit GDP (GWh per USD million) 6.7 Customer Average Interruption Duration Index (CAIDI) (hours) 6.8 Staff productivity

7. Financial performance	7.1 O&M expenses index 7.2 Return on asset (%) 7.3 Return on equity (%) 7.4 Current ratio	7.5 Fixed asset turnover ratio 7.6 Total asset turnover ratio 7.7 Profit before tax (USD million) 7.8 Profit after tax (USD million)
8. Power market	8.1 Market share based on energy purchase (%)	8.2 Competition index/ Herfindahl-Hirschman Index for Generation function (HHI)
9. Integration of renewable energy	9.1 CO2 Emissions from Electricity Generation ('000 Tonnes)	9.2 Grid emission factor (Tonnes CO2/ MWh)

The above KPIs in the form of an excel spreadsheet were floated to the Member States and data sought on them. Data was also collected during the **field missions** to the five countries - Egypt, Ethiopia, Rwanda, Tunisia and Uganda. Based on the data as received from the countries and other publicly available data, the KPIs under various heads have been compiled.

Egypt, Kenya, Rwanda and Uganda report a number of indicators, next in line are Ethiopia, Tunisia followed by Burundi, Djibouti, Eritrea, Libya, Somalia, South Sudan and Sudan. Accordingly, based on available data from the COMESA Member States, the comparative analysis of utility performance has been carried out in the subsequent sections.

2.2 Generation

In this section, KPIs and data sets concerning generation have been assessed. The KPIs and data assets covered are - installed capacity, dependable capacity, annual energy generation capability, operating reserve capacity, gross energy generated, net energy generated, self-consumption rate, forced outage duration, planned outage duration, generation availability and generation substation capacity.

2.2.1 Installed capacity (MW)

Installed capacity is the nameplate or rated or design capacity of the generating plant/ unit under the condition of maximum reactive power flows or minimum power factor requirement. As per available data, Egypt has the highest installed generation capacity of ~60 GW, followed by Libya (12 GW) and Tunisia (6 GW) across COMESA Member States. Next, is Ethiopia with an installed capacity of 5 GW followed by Kenya and Sudan at 3.7 GW. The installed capacity (in MW) is provided in the table below:

Table 2: Installed Capacity (in MW)

Country	Installed Capacity (MW)
Burundi	116
Djibouti	123
Egypt	60,094
Eritrea	240

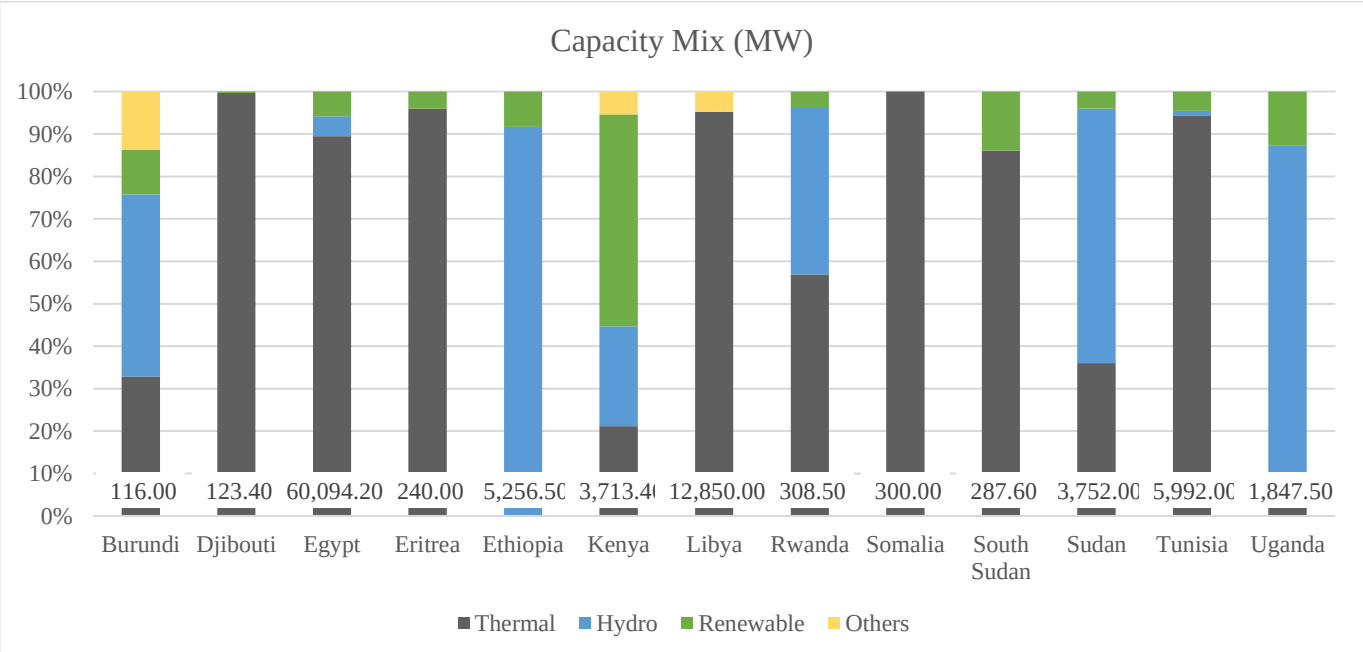
Country	Installed Capacity (MW)
Ethiopia	5,257
Kenya	3,713
Libya	12,850
Rwanda	308
Somalia	300
South Sudan	287
Sudan	3,752
Tunisia	5,992
Uganda	1,848

Note: For Burundi, data was available for 2021; Eritrea, Egypt, and Ethiopia, data was available for 2022; rest of the countries data is for 2023

Additionally, for Burundi, Kenya and Rwanda 16 MW, 200 MW and 46 MW import capacity has been considered

The technology-wise installed capacity mix across the COMESA Member States is shown below:

Figure 1: Technology-wise installed capacity across COMESA Member States (in %age)



Note: Diesel/oil based capacity is considered under thermal

It is observed that Djibouti, Egypt, Eritrea, Ethiopia, Somalia, South Sudan, and Tunisa majorly rely on a single generating source, unlike, Burundi, Kenya, Libya, Sudan and Uganda which have balanced generation mix. Dependence on single generating sources raises concern about energy security and climate

risk. Burundi, Ethiopia, Rwanda, Sudan and Uganda have substantial share of hydropower in the energy mix. Egypt and Tunisia majorly rely on gas-based generation.

Further, Eritrea, Somalia and South Sudan majorly rely on diesel/oil-based generation which increases the cost of energy generation and raises concerns about energy security.

2.2.2 Dependable capacity (MW)

Dependable capacity is the current maximum available capacity after de-rating of the installed capacity for the power generation due to equipment aging, maintenance requirements, environmental restrictions, fuel quality issues, or other operational constraints. Based on available data – In Egypt, Kenya, Tunisia and Uganda, the installed capacity has de-rated by 2%, 6%, 25% and 15% respectively.

2.2.3 Annual energy generation capability (GWh)

Annual energy generation capability indicates the energy generation capability per annum for the overall system, which is the sum of the energy generation capability of each power plant in a country. For computation of annual energy generation capability, the plant availability factor and the plant factor are considered which signifies the maximum energy that can be generated from the power plant. Plant factor depends on the design of the power plant. Most countries do not report this indicator. Since the value of the indicator depends upon the technical design of the plant, this metric should be tracked and reported by the generators. In 2022, Egypt reported annual generation capability of 204,637 GWh.

2.2.4 Operating reserve capacity (MW, %)

The operating reserve is the generating capacity available to the system operator within a short interval of time to meet demand in case of a generator fault or disruption in the supply. It is the sum of Spinning reserve and Quick reserve and considered as the size of single largest generation unit in the system. The size is to be taken as average over the reporting period.

Spinning reserve is defined as the extra power generating capacity of the generator that is already synchronized to the system. This extra power is achieved by increasing the torque of the turbine rotor. Quick reserve is a fast-acting reserve designed to restore system frequency within one minute of a fault.

The operating reserve capacity will be expressed both in MW and % terms. For %, the total installed capacity shall be used as the base for calculating the percentage. This indicator is presently not being reported.

2.2.5 Gross energy generated (GWh)

Gross energy generated is the total energy generated from a power plant at the output side of the main transformers, i.e. including the amount of electricity used in the plant auxiliaries and in the transformers. The gross energy generation (in GWh) based on available data is provided in the table below:

Table 3: Gross energy generation (GWh)

Country	Gross Energy Generation (GWh)
Djibouti	655

Country	Gross Energy Generation (GWh)
Egypt	214,197
Tunisia	21,286

Note: For Djibouti data was available for 2021, Egypt, data was available for 2022; Tunisia for 2023

Rest of the countries need to streamline the reporting of this indicator on public websites and annual reports. This will also help to compute the indicator on self-consumption rate (%) as this is an input parameter.

2.2.6 Net energy generated (GWh)

Net energy generated is the total energy generated from a power plant at the output of the main transformers excluding the amount of electricity used in the plant auxiliaries and in the transformers. The net energy generated (GWh) is shown below.

Table 4: Net energy generation (GWh)

Country	Net Energy Generation (GWh)
Burundi	519
Djibouti	541
Egypt	207,349
Kenya	13,289
Rwanda	1,199
Libya	47,384
South Sudan	549
Tunisia	20,848
Uganda	6,032

Further, segregation of the above indicator based on the fuel-type is shown in the country-wise excel spreadsheets being submitted separately.

2.2.7 Self-Consumption Rate (%)

Self-consumption rate is the extent of auxiliary energy consumption within the plant premises. Generally, the auxiliary consumption for hydro plants and fossil fuel power plants is in the range of 0.5% - 2% and 7% - 15% of the total power generated. For the fossil fuel plants, the auxiliary consumption is on the higher side due to consumption in equipment such as feed pumps, cooling water pumps, air fan, etc. Egypt and Kenya report this indicator. In 2022, Egypt has generator wise self-consumption rate as: Thermal (3.38%), Hydro (1.83%), Solar (2.76%) and Wind (0.83%). KENGEN (Kenya) has generator wise self-consumption rate as: Thermal (1.71%), Hydro (3.27%), Wind (0.71%) and Geo-thermal (4.03%) for 2023.

2.2.8 Forced outage duration (hours)

Forced outage duration is the period for which the generating unit is unavailable to produce power due to unexpected breakdown. It leads to loss of revenue and productivity of the generator during the outage period and sometimes may lead to a high repair and maintenance costs because of unplanned maintenance work. This indicator is presently not being reported.

2.2.9 Planned outage duration (hours)

Planned outages duration is the period for which the planned maintenance of the system is performed to reduce the future unexpected breakdown of the system. Maintenance of damaged or aging equipment, system upgradation to increase electric reliability and future consumer growth are the main reasons for scheduling the planned power outage.

Generally, the outage for hydro plants is planned during the lean water season. Likewise, outage of wind generator may be planned during lean wind season. Outage of solar generator, if required, may be planned during the rainy season.

2.2.10 Generation availability (%)

Generation availability is the fraction of the period in which the generation assets are available without any outages, expressed as a percentage. It is calculated as:

[1 - (forced outages hours + planned outage hours)/ Total hours in the period]

This indicator determines the extent to which the plant is available to meet the system demand. Non-availability of a plant can be due to variety of reasons such as unavailability of fuel/ water, unavailability of machines due to planned or unplanned outage and unavailability of transmission capacity to evacuate power from the plant.

Generally, for the thermal and hydro plant the availability of 85% and above is desirable. In Egypt (92.80%), Kenya (KENGEN) (94.03%) and Rwanda (98%), the availability of hydro generators is above the benchmark availability.

In Egypt (90.15%) and Kenya (KENGEN) (82.93%) the availability of thermal generators is above and comparable to the benchmark availability respectively. However, in Rwanda (60.58%), the availability of thermal generators is far below the benchmark availability due to extended maintenance time and multiple incidents that happened at the plants (REG Annual Report 2023).

This indicator serves as an important parameter for setting up incentive-based regulation and monitoring generator performance. Many countries across the world such as USA, India, UK use this as a parameter for setting up gain/loss sharing mechanism between the seller and buyer.

2.2.11 Generation substation capacity (MVA)

This indicator measures the sum of installed capacity of generator transformers.

Generation substation capacity is an important data set for generation which signifies that the country has enough substation capacity to transform the power generated at the generator terminal to transmit the power towards load centers. The generation substation capacity should be optimum in line with the installed capacity of the country.

Countries need to report on this indicator – with the exception of Kenya. KENGEN reports the same in its annual report.

2.3 System Operations

In this section, KPIs and data sets concerning system operation have been assessed. The KPIs and data assets covered are - peak demand, minimum demand, system load factor, number of frequency excursions and system minutes lost.

2.3.1 Peak demand (MW)

Peak demand is the demand when consumer's demand for electricity is highest. Typically, peak demand occurs during the summer season due to higher usage of electricity. Peak demand season results in higher generation costs as expensive generators are required to run in order to meet the peak demand for electricity. The system peak demand (in MW) is shown in the table below:

Table 5: Peak demand (in MW)

Country	Peak Demand (MW)
Burundi	72
Djibouti	132
Egypt	34,200
Kenya	2,149
Rwanda	185
South Sudan	26
Sudan	3,454
Tunisia	4,825
Uganda	919

Note: For Tunisia data is for 2022; Egypt data is for FY 2022-23; Rest of the countries data is for 2023

2.3.2 Minimum demand (MW)

Minimum demand is the demand when the consumer's demand for electricity is at its lowest. Based on available data, Djibouti, Egypt, Rwanda, South Sudan and Tunisia reported minimum demand of 31.25 MW, 27000 MW, 80.39 MW, 24.5 MW and 1,337 MW respectively.

2.3.3 System load factor (%)

System load factor characterizes the system load curve in terms of the extent of its "Peakiness" or "Flatness".

It is expressed as a percentage and computed as:

[Energy transmitted through the system (GWh) X 1000] / (Peak demand (MW) X Number of hours in the reporting period)

A value close to 100% denotes a flatter load curve which is desirable because this makes demand more predictable and easier for generation planning. System load factor depends on the type of load connected to the system, i.e. if all the loads are running all the time, then the system load factor would be on the higher side which may be in the case of data centers, refrigerated warehouse, supermarket etc. which runs throughout day and night.

Generally, at country level the system load factor of 40%-60% is desirable, given a mixed load of residential, industrial and commercial consumers whose demand varies throughout the day and across the seasons. In 2022, Egypt, Kenya and Tunisia have a system load factor of 63.10%, 70.6% and 55,23% respectively.

This is also a commonly used indicator for incentive-based regulation, particularly in advanced economies such as USA which has a well-developed energy market.

2.3.4 Number of frequency excursion (> 50.5 Hz or < 49.5 Hz)

Number of frequency excursions measures the number of times of which system frequency crosses outside the specified band of > 50.5 Hz or < 49.5 Hz. The frequency excursion occurs due to a power system demand-supply mismatch. If the electricity demand is lower than the electricity supply, the power system frequency increases and vice versa. This indicator is presently not being reported.

2.3.5 System minutes lost (minutes)

System minutes lost is determined by calculating the ratio of unsupplied energy during an outage to the energy that would be supplied for one minute if the supplied energy was at its peak value. It measures the severity of each system disturbance relative to the size of the system, in terms of duration of total system wide blackout. One system minute indicates an equivalent of total system interruption, with the magnitude of annual system peak, for one minute.

The formula used for calculating the system minutes lost is:

System Minutes Lost = (Sum of unsupplied energy (MW mins))/ (System peak demand (MW))

When this index for a specific incident is greater than one minute, that incident can be normally classified as a major interruption. Tunisia reported system minutes lost as 14.23 minutes.

2.4 Transmission-In country

In this section, KPIs and data sets concerning in-country transmission have been assessed. The KPIs and data assets covered are - average duration of forced interruptions, average number of forced outages for all transmission lines, transmission availability, transmission system losses, transmission network length, transmission substation capacity and network utilization factor are assessed to track the performance of transmission utilities. This section would not be applicable to Somalia and South Sudan as presently there is no integrated national transmission grid.

2.4.1 Average duration of forced interruptions (ADFI) - hours

Average duration of forced interruptions is the total duration of forced interruptions affecting the transmission line circuits divided by the total number of interruptions, excluding force majeure and third-party interferences. A lower duration of forced interruption is desirable, otherwise it impacts the transmission availability which further leads to a lower recovery of annual revenue requirement for the transmission utility. This indicator is a direct indication of the quality of supply of electricity. Djibouti (2021) and Rwanda (2022) reported ADFI as 26.43 hours and 8.50 hours respectively.

2.4.2 Average number of forced outages for all transmission lines (ANOFT) - hours

Total number of forced outages multiplied by 100 km and divided by the total kms. length of transmission lines owned by licensee, per voltage level. This is an index to compare the per circuit km. number of forced outages across countries. A lower level of ANOFT is desirable. In 2022, Rwanda reported ANOFT as 37.

2.4.3 Transmission availability (%)

Transmission system availability is the fraction of the period in which the transmission assets are available without any outages.

$$\text{Transmission System Availability (\%)} = 1 - \frac{\text{Forced outages hours} + \text{Planned outage hours}}{\text{Total hours in the period}}$$

This is the most important KPI for a transmission licensee as it determines the extent to which the various components of transmission network (lines, substations, transformers, relays, couplers, etc.) are available to meet the requirements of various transmission system users (generation plants, transmission customers and distribution utilities). Non-availability of a transmission component can be due to variety of reasons such as planned maintenance, equipment failure, natural event like lighting, etc.

Utility should target transmission availability greater than 98%.

For Kenya, Rwanda and Uganda transmission availability is 99.95% (2021), 99.72% (2023) and 98.22% (2023) respectively which is more than the transmission availability benchmark. Egypt reports transmission availability of 64%. This is an important indicator to monitor transmission utility performance and setting up **incentive-based regulation for transmission utilities**.

2.4.4 Transmission system losses (%)

Transmission system losses are the difference between the electrical energy entering into the transmission network from generation and/or another transmission network and exiting the transmission network to another transmission network, distribution network or end-user. Losses in transmission network are largely technical losses arising due to long length of conductors and the associated resistance involved.

It is expressed as a percentage of electrical energy entering the transmission network. Typical losses of best performing transmission utilities are in the range of 2% to 3%.

The transmission system loss (in %) is shown in the table below:

Table 6: Transmission system loss (%)

Country	Transmission loss (%)
Djibouti	2.33%
Egypt	3.68%
Ethiopia	5.00%
Kenya	4.50%
Rwanda	3.06%
Somalia	4.00%
South Sudan	1.90%
Sudan	4.00%
Tunisia	2.16%
Uganda	4.78%

Note: For Djibouti data is for 2021, Tunisia and Egypt data is for 2022; For the rest of the countries data is for 2023

Most countries report this indicator in their respective utility annual accounts.

2.4.5 Transmission network length-country level (circuit-kms.)

Transmission network length is the total circuit length of transmission lines with start and end points within the country. Generally, the transmission line length (in ckt. km) is categorized based on voltage levels as shown below:

Table 7: Transmission network length (in ckt. km)

Country	HV (ckt. km.)	EHV (ckt. km.)
Djibouti	419	-
Egypt	22,503	22,575
Ethiopia	1,908	-
Kenya	2,672	6,917
Libya	17,365	1,204
Rwanda	1,158	-
Somalia	1,100	-

Country	HV (ckt. km.)	EHV (ckt. km.)
Sudan	6,635	
Tunisia	6,646	210
Uganda	3,913	606

Note: For Djibouti data was for 2018, Egypt, Ethiopia and Rwanda data was available for 2022; Rest of the countries data is for 2023.

It is generally observed that countries with separate transmission utilities maintain and report this indicator. Egypt, Kenya, Rwanda, Tunisia and Uganda report this data asset in their annual reports.

2.4.6 Transmission substation capacity-country level (MVA)

Transmission substation capacity is an important data asset which signifies that the country has enough substation capacity to transform and transmit the power generated at the generator terminal to the load centers.

Table 8: Transmission substation capacity (in MVA)

Country	HV (MVA)	EHV (MVA)
Djibouti	36	-
Egypt	70,741	118,290
Kenya	5,455	-
Rwanda	998.55	-
Sudan	5952.6	619.5
Tunisia	13,525	1,600
Uganda	4,513	1,932

Note: For Djibouti data is for 2018, Egypt for 2022; Rest of the countries data is for 2023.

2.4.7 Network utilisation factor-Transmission

Network utilization factor-transmission indicates extent of utilization or loading of transformation capacity of the network or transmission network adequacy for the country. It is computed as the ratio of peak demand in transmission network (in MVA) to the total transformation capacity (in MVA) installed in transmission substations at country and interconnect levels. This indicator is presently not being reported.

2.5 Transmission-Tie Lines

In this section, KPIs and data sets concerning transmission tie-lines have been assessed. The KPIs and data assets covered are - electricity import, electricity export, tie-line transmission network length, tie-line transmission network capacity and tie-line transmission substation capacity.

2.5.1 Electricity import (GWh)

Electricity import data asset captures the total units of electricity imported via tie lines. The electricity import (in GWh) is shown in the table below:

Table 9: Electricity import (in GWh)

Country	Electricity Import	Electricity import/ (production + electricity imports) (%)
Egypt	1589	1%
Kenya	644	5%
Rwanda	97	8%
Sudan	1,361	7%
Tunisia	2,576	11%
Uganda	41	1%

Note: For Egypt data is for 2022; Rest of the countries data is for 2023

2.5.2 Electricity export (GWh)

Electricity export data asset captures the total units of electricity exported via tie lines. The electricity export (in GWh) is shown in the table below:

Table 10: Electricity export (in GWh)

Country	Electricity Export (GWh)
Egypt	95
Kenya	27
Rwanda	9
Sudan	72
Tunisia	80
Uganda	485

2.5.3 Transmission network length - Tie lines (circuit-kms)

Transmission network length-tie lines captures the transmission network length between the two countries. A higher transmission network length tie-lines is desirable, which indicates that the country is well-connected with the neighboring countries for regional power transmission. The transmission network length tie-lines (in ckt. km.) is shown in the table below:

Table 11: Transmission Network Length -Tie lines (ckt. km.)

Country	HV (ckt. km.)	EHV (ckt. km.)
Burundi	184	-
Djibouti	164	283
Egypt	500	32
Ethiopia	499	866
Kenya	27	1246
Libya	500	-
Rwanda	228	-
Sudan	466	-
Tunisia	6,646	210
Uganda	141	-

Note: For Egypt data is for 2022; Rest of the countries data is for 2023

2.5.4 Transmission network capacity-tie lines (MVA)

Transmission network capacity- tie lines captures the transmission network capacity of tie-lines. A higher transmission network capacity is desirable, which indicates that the country is well-placed for import/export of bulk power from/to neighboring countries. The transmission network capacity tie-lines (in MVA) is shown in the table below:

Table 12: Transmission Network Capacity -Tie lines (MVA)

Country	HV (MVA)	EHV (MVA)
Burundi	48	-
Djibouti	200	-
Egypt	433	500
Ethiopia	422	1222
Kenya	78	1222
Libya	433	-
Rwanda	112	-

Country	HV (MVA)	EHV (MVA)
Sudan	311	-
Uganda	133	-

Note: For Egypt data is for 2022; Rest of the countries data is for 2023

2.5.5 Transmission substation capacity - Tie lines (MVA)

Transmission substation capacity-tie lines is the sum of the installed capacity of transformers at transmission substations located in tie-lines. A higher transmission substation capacity of tie-lines is desirable. The transmission substation capacity tie-lines (in MVA) is shown in the table below:

Table 13: Transmission Substation Capacity -Tie lines (MVA)

Country	HV (MVA)	EHV (MVA)
Burundi	211	-
Djibouti	126	-
Egypt	376	1250
Ethiopia	120	750
Kenya	46	1050
Libya	376	-
Rwanda	180	-
Sudan	300	-
Uganda	80	-

Note: For Egypt data is for 2022; Rest of the countries data is for 2023

2.6 Distribution

In this section, KPIs and data sets concerning distribution have been assessed. The KPIs and data assets covered are - distribution system losses, system average interruption frequency index (SAIFI), system average interruption duration index (SAIDI), distribution network length (circuit-kms), distribution substation capacity, distribution stepdown transformer and network utilization factor - distribution.

2.6.1 Distribution system losses (%)

Distribution system losses are the difference between the electrical energy entering the distribution network from the transmission network, another distribution network and/or embedded generation, and the electrical energy exiting the distribution network for consumption purposes. It is **expressed as a percentage** of the electrical energy entering the distribution network.

This KPI is used to measure the total losses in the distribution network which **includes technical and non-technical (or commercial) losses**. Technical losses arise from the distribution network elements due to reasons such as design losses, overloading of equipment, etc. Non-technical losses arise due to commercial reasons such as theft of electricity, illegal connections, billing inefficiency, slow reading meters, unmetered consumers who are billed on flat rate basis, etc. Increased level of losses burdens utility with increased power purchase costs and a consequent increase in consumer tariffs. Thus, losses are an important indicator of operational efficiency. Since power purchase cost is a significant proportion of the total revenue requirement of the utility, consumer tariffs can be highly sensitive to any increase in power purchase cost.

Distribution losses can significantly vary between utilities depending upon factors such as proportion between high voltage and low voltage assets, network loading conditions, age of assets, consumer mix, geographical characteristic of the utility's service area, etc. Hence it is difficult to compare performance of any two utilities. The distribution loss (in %) is shown in the table below:

Table 14: Distribution system losses (in %)

Country	Distribution loss (%)
Burundi	19.00%
Djibouti	17.34%
Egypt	21.39%
Eritrea	23.00%
Ethiopia	17.00%
Kenya	18.00%
Libya	16.90%
Rwanda	17.07%
Somalia	17.50%
South Sudan	20.00%
Sudan	20.50%
Tunisia	16.54%
Uganda	17.35%

Note: For Burundi and Djibouti data was available for 2021; For Ethiopia and Tunisia data is for 2022; Rest of the country data is for 2023. For Uganda - distribution system losses are for UMEME Ltd.

Distribution system losses are widely used to monitor distribution utility performance. This is one of the most commonly used indicators for setting up **incentive-based regulation** in countries such as USA, UK and India.[1]

2.6.2 System Average Interruption Frequency Index (SAIFI)

System Average Interruption Frequency Index (SAIFI) is the total number of times that a typical consumer experiences forced interruptions during the period under review. It may vary significantly from utility to utility depending on the network configuration and capital invested in the networks. It is an important indicator of the **reliability of the supply** delivered by the utility and thus determines the level of customer satisfaction with the quality of supply.

There is no published international benchmark value for SAIFI since it depends on the characteristics of the utility that might be significantly different. Ideally, a utility should target to minimize the frequency of unplanned interruptions to the extent possible. A lower SAIFI numbers represent less interruptions and better electricity reliability in the distribution system. SAIFI index in Djibouti, Egypt, Kenya, Rwanda and Sudan are 28.7, 1.28, 44.91, 29.32 and 14.00 respectively as per available data. Some advanced countries such as USA use this indicator for setting up incentive-based regulation.

2.6.3 System Average Interruption Duration Index (SAIDI) hours

System Average Interruption Duration Index (SAIDI) is the total duration of forced interruption faced by a typical consumer during the period under review. SAIDI is a key component for measuring the non-availability of supply to customers. Non-availability of supply indicates the time, in hours per annum, that customers on average did not have access to electricity from the grid. The measurement of SAIDI is an important aspect to track utility's performance of providing uninterrupted power supply to its consumers. A lower SAIDI number represents continuous access to electricity from the grid to the consumers. SAIDI index in Djibouti, Egypt, Kenya, Rwanda and Sudan are 17.11, 107.40, 8.37, 14.69 and 58.60 respectively.[2]

Besides reliability, it also shows that the time for restoring the supply is within acceptable limits or it is taking too long. Some advanced countries such as USA use this indicator for setting up incentive-based regulation.

2.6.4 Distribution network length (circuit-kms.)

Distribution network length denotes the total circuit length of distribution lines with start and end points within the area of supply. The distribution network length (in ckt. km.) is shown in the table below:

Table 15: Distribution network length (in ckt. km.)

Country	LV	MV
Djibouti	640	399
Egypt	232,516	330,290
Ethiopia	60,704	54,300

[1] *Source: The Expansion of Incentive (Performance Based) Regulation of Electricity Distribution and Transmission in the United States Working Paper*
[2] *Data for Sudan is from the UPBEAT portal*

Country	LV	MV
Kenya	83,245	217,784
Rwanda	18,726	10,777
South Sudan	695	252
Tunisia	125,042	64,614
Uganda	31,090	34,038

Note: For Djibouti data is for 2019, for Ethiopia and Tunisia data is for 2022; Rest of the countries data is for 2023. For Uganda data shown is for UMEME Ltd.

2.6.5 Distribution substation capacity (MVA)

This indicator measures the sum of installed capacity of transformers at distribution substations. Distribution substation capacity is an important data set which signifies that the country has enough substation capacity to transform the power transmitted to the distribution level. The distribution substation capacity should be sufficient to handle the power to be distributed to the end consumer. Egypt and Kenya have a distribution substation capacity of 93357 MVA and 4847 MVA respectively.

2.6.6 Distribution stepdown transformer (XX/4_ _ or XX/2_ _ volts) capacity (MVA)

This indicator measures the sum of installed capacity of distribution transformers. Distribution stepdown transformer signifies that the country has enough distribution transformer capacity to cater to the consumers in the distribution utilities area of supply. Egypt and Kenya have a distribution transformer capacity of 93357 MVA and 9444 MVA respectively. Very few countries are reporting this indicator.

2.6.7 Network utilization factor - Distribution

Network utilization factor indicates the extent of utilization or loading of transformation capacity of the distribution network. This is computed as the ratio of peak demand in distribution network (in MVA) to the total transformation capacity (in MVA) in distribution substations and distribution transformers. Egypt and Kenya have a network utilization of 37% and 15% respectively.

2.7 Retail Supply

In this section, KPIs and data sets concerning retail supply have been assessed. The KPIs and data assets covered are – number of customers, prepaid customers, electricity access rate, total energy billed to customers, electricity consumption per capita, electricity consumption per unit GDP, customer average interruption duration index and staff productivity.

2.7.1 Number of customers

Customer base describes the **number of customers with a legal connection to the network**. Only those customers who consume electricity for their own use (and not for resale) are considered under this data asset. This data asset would track the year-on-year growth in the number of electricity connections. This is indeed important in the present context since most of the countries have low access and tracking the absolute

number of connections makes it easy for the governments to design appropriate policy measures to encourage increase in the number of connections. As per available data, the consumer base (in numbers) is shown in the table below:

Table 16: Number of customers

Country	Number of Customers
Burundi	228,922
Djibouti	71,928
Egypt	39,110,000
Ethiopia	4,324,859
Kenya	9,212,754
Rwanda	1,504,128
South Sudan	56,766
Tunisia	4,472,737
Uganda	2,107,906

Note: For Burundi, Djibouti and Ethiopia data is for 2022; Rest of the countries is for 2023.

2.7.2 Prepaid customers (%age)

This indicator is measured as the ratio of the number of domestic customers with a legal prepaid meter connection to the total number of domestic customers with a legal connection. For a high performing utility, the ratio should be close to 100%. A higher prepaid consumers eliminates manual errors, improves billing efficiency, and also helps consumers optimize their consumption through real time consumption data. As per latest data available, the prepaid customer (%age) is shown in the table below:

Table 17: Prepaid customers (%age)

Country	Prepaid Customers (%)
Egypt	41.00%
Ethiopia	22.76%
Kenya	16.74%
Rwanda	88.73%
South Sudan	100.00%
Tunisia	99.80%

Country	Prepaid Customers (%)
Uganda	98.54%

Note: For Egypt data is for 2022; Ethiopia data is for 2022; Rest of the countries data is for 2023. Uganda data is for UMEME Ltd.

2.7.3 Electricity access rate (%age)

It is the proportion of population with access to electricity. It is computed as below:

(Number of domestic connections X Average household size) / Total population

Where,

- Connections are to be considered across all connection types - Network connected, Off-network, Stand alone

- Average household size is to be considered as per latest census data

- Population is to be considered as per latest census data extrapolated to reporting year using decadal growth rate

- All data to be considered combined for Urban and Rural

This KPI signifies the level of electricity access within population of the country. It is an important KPI which denotes a progressive economy as electricity is one of the basic necessities of modern society. A higher electricity access rate is an indicator of poverty alleviation, economic growth, and improved living standards. Based on the World Bank data, in 2022, the electricity access rate for the COMESA Member States is shown in the table below:

Table 18: Electricity access rate (in %)

Country	Electricity Access (%)
Burundi	10%
Djibouti	65%
Egypt	100%
Eritrea	55%
Ethiopia	55%
Kenya	76%
Libya	70%
Rwanda	51%
Somalia	49%
South Sudan	8%

Country	Electricity Access (%)
Sudan	63%
Tunisia	100%
Uganda	47%

2.7.4 Total energy billed to customers (GWh)

Total energy billed to customers is measured as the total units of energy invoiced to customers during the reporting period. Sometimes, the total energy sold by the utility is not equal to the total energy billed to the consumers due to inefficiency of the meter reader or faulty meters which is reflected in the billing efficiency. In an ideal case, the billing efficiency should be 100%. As per available data, the energy billed (in GWh) is shown in the table below:

Table 19: Total energy billed to customers (in GWh)

Country	Energy Billed (GWh)
Burundi	275
Egypt	133,532
Kenya	10,232
Libya	29,049
Rwanda	925
South Sudan	142
Tunisia	17,304
Uganda	4,329

Note: For Burundi and Egypt data was available for 2022; Rest of the countries data is for 2023

2.7.5 Electricity consumption per capita (kWh)

Electricity consumption per capita indicates the electricity consumption on a per-person basis in a country. It is computed as the ratio of total electricity consumed by residential customer category across the country (kWh) during the reporting period to the average population of the country during the reporting period. It is also an indicator of economic growth and improved living standards in a country. The electricity consumption per capita (in kWh) is shown in the table below:

Table 20: Electricity consumption per capita (in kWh)

Country	Electricity consumption per capita
Burundi	32.89

Country	Electricity consumption per capita
Djibouti	464.11
Egypt	1578.39
Eritrea	-
Ethiopia	90.49
Kenya	179.25
Libya	3793.01
Rwanda	64.55
Somalia	21.12
South Sudan	-
Sudan	323.29
Tunisia	1495.40
Uganda	82.38

Source: US Energy Information Administration; World Bank database

2.7.6 Electricity consumption per unit GDP (GWh per USD million)

Electricity consumption per unit GDP indicates electricity consumption on a per-unit GDP basis. It is computed as the ratio of total electricity consumed by all customer categories across the country (GWh) during the reporting period to the total GDP of the country (USD million) during the reporting period. It is also an indicator of economic growth and improved living standards in a country.

This KPI indicates the contribution of electricity sector towards the overall economy of the country. Electricity is one of the key drivers of the economy and usually has a high correction with GDP growth of the country. The electricity consumption per unit GDP (in GWh per USD million) is shown in the table below:

Table 21: Electricity consumption per unit GDP (GWh per USD million)

Country	Electricity consumption per unit GDP
Burundi	0.12
Djibouti	0.15
Egypt	0.41
Eritrea	-
Ethiopia	0.11
Kenya	0.09
Libya	0.73
Rwanda	0.08

Somalia	0.04
South Sudan	-
Sudan	0.42
Tunisia	0.39
Uganda	0.09

Source: US Energy Information Administration; World Bank database for 2021

2.7.7 Customer Average Interruption Duration Index (CAIDI)

The customer average interruption duration index (CAIDI) is the average electrical power outage duration that any given consumer would experience. It is an important aspect of measuring the quality of service to customers and is computed as a ratio of SAIDI to SAIFI.

CAIDI may vary significantly from utility to utility depending on the network configuration and capital invested in the networks. CAIDI index in Egypt, Kenya, Rwanda and Sudan is 96.08, 2.24, 0.50 and 4.19 respectively.

2.7.8 Staff productivity

Staff productivity indicates the average number of customers served by each employee. It is calculated as the ratio of total customers to total employees in the distribution and retail supply functions. Employees include permanent and contractual staff, which excludes vendors. In case of bundled utility, corporate/ common employees are to be allocated using the employee count of individual functions as basis.

This KPI is an important measure of productivity of the utility staff. A higher value denotes better productivity, which means an average employee is able to serve a greater number of customers. Employee cost is a significant part of the total operating cost of any distribution utility and monitoring this KPI helps the utility to keep a control over its operational costs.

Variances among utilities may be attributable to technologies used, capital intensity and role within the value chain. Hence, its trend should be monitored over time within each utility. In Burundi, Egypt, Kenya, Tunisia and Uganda staff productivity parameter is reported as 160, 272, 919, 326 and 724.

2.8 Financial Performance

In this section following KPIs and data assets are discussed - O&M expense index, return on asset, return on equity, current ratio, fixed asset turnover ratio, total asset turnover ratio, profit before tax and profit after tax to track the financial performance of the utilities.

2.8.1 O&M expenses index

The O&M expense index indicates O&M expenses incurred for every unit of electricity sold. This is a measure of operational efficiency of the utility. The KPI includes employee expenses, administration & general expenses and repairs & maintenance expenses while specifically excluding any power generation or purchase related costs. The exclusion of power-related costs allows this KPI to be benchmark-able against other utilities.

Generally, a low O&M cost may result in a need for a very high investment and O&M cost in the future, as it shows inadequate preventive operations and maintenance practices followed by the utility. Further, excessively high O&M costs may be the result of old infrastructure of the utilities or higher renumerations and other general expenses done by the utility.

A reducing trend is recommended. However no published benchmark data is available.

The O&M expenses index (in USc/kWh) is shown in the table below:

Table 22: O&M expense index (in USc/kWh)

Country	G	T	D	Integrated GTD
Kenya	2.63	0.16	1.04	-
Tunisia	-	-	-	3.09
Uganda	1.07	0.37	1.64	-

Note: For Tunisia data was available for 2022; Rest of the countries data is for 2023

2.8.2 Return on assets (%)

Return on assets (RoA) indicates the ability of the company to deploy its assets to generate profitability. It is computed as Earnings Before Interest and Tax (EBIT)/ (Net Fixed Assets + Current Assets). A higher value is desirable, which means the company is more efficient and productive at managing its balance sheet to generate profits. Generally, RoA for power companies is low due to large capital asset base. The return on assets (in %) is shown in the table below:

Table 23: Return on assets (in %)

Country	G	T	D	Integrated GTD
Ethiopia*	-0.12%	-	4.22%	-
Kenya	1.09%	0.21%	5.43%	6.73%
Rwanda	-	-	-	-3.43%
Tunisia	-	-	-	0.95%
Uganda	1.01%	2.00%	-	-

*Note: *Ethiopia has bundled generation and transmission; analysis for Tunisia is for 2022; Rest of the countries data is for 2023; respective annual reports*

In Ethiopia generating and transmission companies have an impairment loss which has resulted into negative return of assets. Further, in Rwanda, utilities are in loss due to high cost of sales and a lower tariff recovery.

2.8.3 Return on equity (%)

Return on equity (RoE) indicates the ability of the company to generate profitability on equity infused. It is computed as Net Income/ Equity. A higher value of RoE is desirable. The return on equity (in %) is shown in the table below:

Table 24: Return on equity (in %)

Country	G	T	D	Integrated GTD
Ethiopia*	-8.16%	-	3.61%	-
Kenya	1.83%	17.16%	-5.62%	-
Rwanda	-	-	-	Nil
Tunisia	-	-	-	Nil
Uganda	3.80%	5.01%	1.64%	-

*Note: *Ethiopia has bundled generation and transmission; analysis for Tunisia is for 2022; rest of the countries data is for 2023; respective annual reports*

In Rwanda and Tunisia, the equity is negative. Thus, RoE in this case is zero, as there is no return on equity.

2.8.4 Current ratio

Current ratio indicates the availability of short-term assets to service short-term obligations. It is computed as current assets/current liabilities. A value greater than 1 is desirable and denotes higher liquidity. Current ratio is shown in the table below:

Table 25: Current ratio

Country	G	T	D	Integrated
Ethiopia*	0.10	-	7.48	-
Kenya	2.07	0.79	0.61	-
Rwanda	-	-	-	0.55
Tunisia	-	-	-	0.83
Uganda	0.24	2.02	0.68	-

*Note: *Ethiopia has bundled generation and transmission; analysis for Tunisia is for 2022; rest of the countries data is for 2023; respective annual reports*

2.8.5 Fixed asset turnover ratio

Fixed asset turnover ratio measures the ability of the utility to generate revenues from utilization of fixed assets. It is computed as total operating revenue/average net fixed assets. The fixed asset turnover ratio is shown in the table below:

Table 26: Fixed assets turnover ratio

Country	G	T	D	Integrated
Ethiopia*	0.04	-	0.63	-
Kenya	0.10	0.01	0.73	-
Rwanda	-	-	-	0.23
Tunisia	-	-	-	0.61
Uganda	0.05	0.37	-	-

*Note: *Ethiopia has bundled generation and transmission; analysis for Tunisia is for 2022; rest of the countries data is for 2023; respective annual reports*

2.8.6 Total asset turnover ratio

Total asset turnover ratio measures the ability of utility to generate revenues from utilization of fixed and non-fixed assets. It is computed as total operating revenue/average total net assets. Total asset turnover ratio is shown in the table below:

Table 27: Total asset turnover ratio

Country	G	T	D	Integrated
Ethiopia*	0.03		0.33	
Kenya	0.09	0.01	0.59	-
Rwanda	-	-	-	0.23
Tunisia	-	-	-	0.32
Uganda	0.05	0.26	-	-

*Note: *Ethiopia has bundled generation and transmission; analysis for Tunisia is for 2022; rest of the countries data is for 2023; respective annual reports*

2.8.7 Profit before tax (USD million)

Profit before tax is the profit after considering operating and financing costs, and before tax, which provides a clear picture of a company generating profits. Profit before tax is shown in the table below:

Table 28: Profit before tax (in USD Million)

Country	G	T	D	Integrated
Ethiopia*	-453.80		45.26	
Kenya	61.22	5.91	-31.84	-
Rwanda	-	-	-	-30.55

Country	G	T	D	Integrated
Tunisia	-	-	-	-121.60
Uganda	12.89	33.06	5.12	-

*Note: *Ethiopia has bundled generation and transmission; analysis is based on 2023 dataset; respective annual reports*

2.8.8 Profit after tax (USD million)

Profit after tax is the net profit which is available to shareholders, after considering operating, financing, and tax costs, which provides a clear picture of the profitability of a company. Profit after tax is shown in the table below:

Table 29: Profit after tax (in USD Million)

Country	G	T	D	Integrated
Ethiopia*	-454.44		45.26	
Kenya	36.02	3.85	-22.93	-
Rwanda	-	-	-	-51.25
Tunisia	-	-	-	-123.84
Uganda	8.98	25.07	4.07	-

*Note: *Ethiopia has bundled Generation and Transmission; above analysis is based on 2023 dataset; respective annual reports*

2.9 Power Market

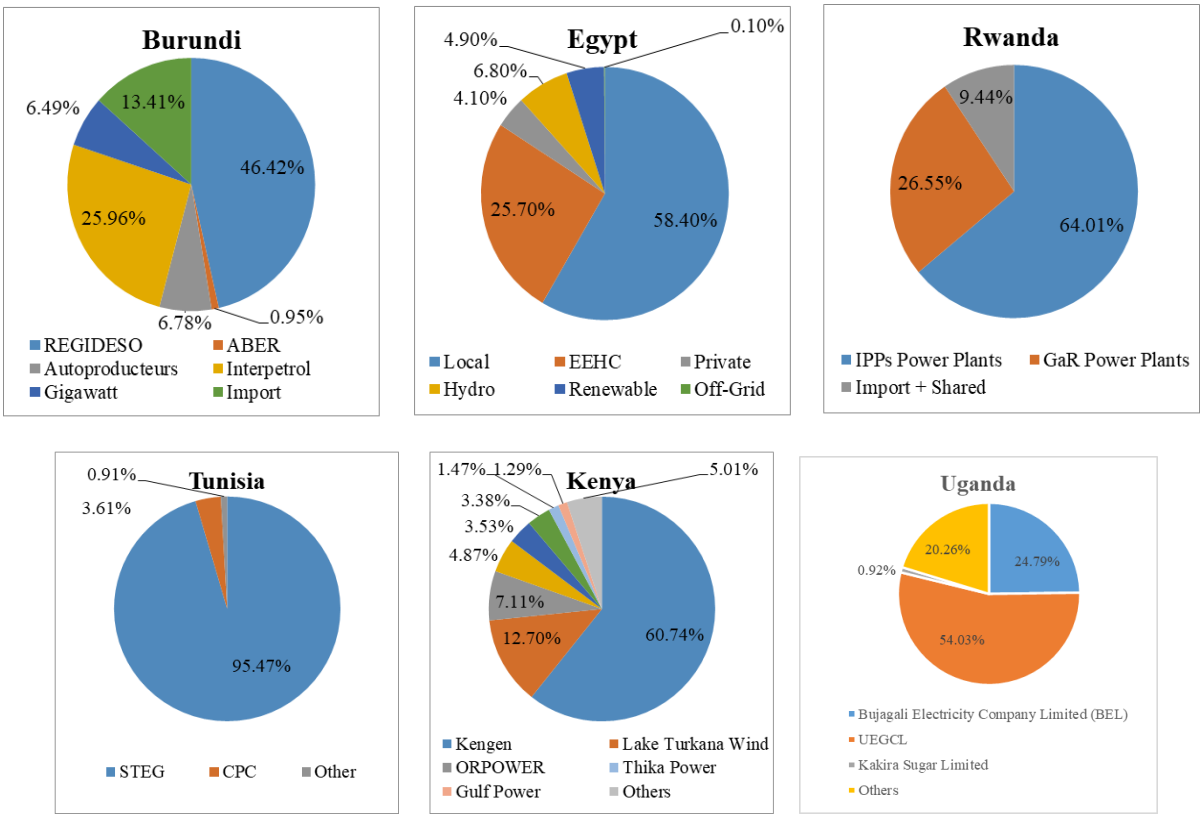
In this section, KPIs and data sets concerning the overall power market have been assessed. The KPIs covered are - market share based on energy purchase (%) and Competition index/Herfindahl-Hirschman Index for Generation function (HHI).

2.9.1 Market share based on energy purchase

The ratio of energy generated by a particular power producer to the total energy on the interconnected system. Power producer here relates to an owner rather than individual generating unit or plant. If an owner owns several units or plants, the indicator would be computed on an aggregated basis for the owner.

This ratio indicates the diversification of market players in the power market.

Figure 2: Power market share (%)



Key observations from the above are as:

- In Burundi, largest players are REGIDESO - market share of 46% and Interpetrol with share of 26%
- In the case of Egypt, local power plants and EEHC plants have a share of 58% and 26% respectively
- In Rwanda, IPPs have the largest share at 64% followed by Government of Rwanda at 27%
- STEG owns the major share of the market in Tunisia at 96%
- In Kenya, KENGEN, Lake Turkana Wind and ORPOWER have the major share of the market

2.9.2 Competition index/ Herfindahl-Hirschman Index for Generation function (HHI)

The Herfindahl Hirschman Index (HHI) analyses competition in the electricity sector by measuring the concentration of firms in a market thereby giving insight on the state of competition. It is calculated by squaring the market shares of all firms in the market and summing the squares as follows. Market share is at an owner level rather than individual generating unit or plant.

HHI = summation (Market share) ^ 2

A market with an HHI of less than 0.1 is considered a competitive marketplace, an HHI of 0.15 to 0.25 is moderately concentrated, and an HHI of 0.25 or greater is highly concentrated.

Kenya and Uganda reported average HHI index for electricity power generation at 0.50 and 0.36 in the 2022/2023 financial year. This is above the benchmark of 0.10, signifying low competition.

2.10 Integration of renewable energy

In this section, KPIs and data assets concerning integration of renewable energy have been assessed. The KPIs and data assets covered are - CO_2 emissions from electricity generation ('000 Tonnes) and grid emission factor (Tonnes CO2/ MWh).

2.10.1 CO_2 emissions from electricity generation ('000 Tonnes)

CO_2 emissions from electricity generation means the CO_2 emissions generated from fossil fuel based generating plants. Countries having a higher share of thermal power plants would emit large amounts of CO_2 into the atmosphere. Kenya generated 6,654 (‘000 tonnes) of CO2 emissions from their fossil fuel plants during the period July 2022 to June 2023. Kenya is the only country amongst the countries of our study to report this value in their annual statistics report.

2.10.2 Grid emission factor (Tonnes CO2/ MWh)

Grid emission factor is an index to measure CO_2 emissions generated by fossil fuel based generating plants connected to the grid for every MWh of energy transmitted through the grid. Kenya has grid emission factor as 0.50.[3] Kenya reports this value in their annual statistics report.

2.11 Phased reporting of utility KPIs

The KPIs proposed have been divided into 2 phases based on criticality of monitoring and feasibility of reporting. The reporting of performance is proposed to begin with Phase 1 KPIs. Reporting of Phase 2 KPIs is proposed to begin 1 year after commencement of Phase 1 reporting – this is to provide adequate time to member countries to prepare their data systems for reporting these indicators.

For the “Auto-computed” indicators, data will not be inputted; these will be automatically computed by the IMS. The auto-computed value will be displayed in input forms as read-only.

The phase-wise segregation of these KPIs is shown below.

Phase 1	Phase 2	Auto-computed
1. Generation		
Installed capacity (MW)	Annual energy generation capability (GWh)	Self-consumption rate (%)
Net energy generated (GWh)		Operating reserve capacity (%)
Generation availability (%)	Forced outage duration (hours)	
Dependable capacity (MW)	Planned outage duration (hours)	
Gross energy generated (GWh)	Generation substation capacity (MVA)	
Operating reserve capacity (MW)		
2. System operations		

[3] *Source: EPRA Statistics Report 2023*

Phase 1	Phase 2	Auto-computed
Peak demand (MW), date and time	Minimum demand (MW), date and time	
System load factor (%)	Number of frequency excursions: > 50.5 Hz or < 49.5 Hz	
	System minutes lost (minutes)	
3. Transmission - In country		
Transmission availability (%)	Average duration of forced interruptions (ADFI) (hours)	
Transmission system losses (%)	Average number of forced outages for all transmission lines (ANOFT)	
Transmission network length - Country level (circuit-kms)	Network utilization factor - Transmission	
Transmission substation capacity - Country level (MVA)		
4. Transmission - Tie lines		
Electricity import (GWh)	Transmission substation capacity - Tie lines (MVA)	
Electricity export (GWh)		
Transmission network length - Tie lines (circuit-kms)		
Transmission network capacity - Tie lines (MVA)		
5. Distribution		
Distribution system losses (%)	Distribution stepdown transformer (XX/4_ _ or XX/2_ _ volts) capacity (MVA)	
System Average Interruption Frequency Index (SAIFI)	Network utilization factor - Distribution	
System Average Interruption Duration Index (SAIDI) (hours)		
Distribution network length (circuit-kms)		
Distribution substation capacity (MVA)		
6. Retail supply		

Phase 1	Phase 2	Auto-computed
No. of customers		Customer Average Interruption Duration Index (CAIDI) (hours)
Prepaid customers (%)		
Electricity access rate (%)		
Total energy billed to customers (GWh)		
Electricity consumption per capita (kWh)		
Staff productivity		
Electricity consumption per unit GDP (GWh per USD million)		
7. Financial performance		
Return on asset (%)	O&M expenses index	
Current ratio	Return on equity (%)	
Profit after tax (USD million)	Fixed asset turnover ratio	
	Total asset turnover ratio	
	Profit before tax (USD million)	
8. Power market		
Market share based on energy purchase (%)		Competition index/ Herfindahl-Hirschman Index for Generation function (HHI)
9. Integration of renewable energy		
CO2 Emissions from Electricity Generation ('000 Tonnes)		Grid emission factor (Tonnes CO2/ MWh)

3 Conclusion

The utility KPIs have been proposed to have a **uniform set of regional utility performance indicators across the COMESA Member States**. This will help to track **utility performance across the region** and work as a **standard set of indicators** for all utilities to track and report their country's performance against those of their peers and enable them to identify areas which they may wish to consider improvement upon.

Further, the KPIs have been selected which broadly monitor the licensee and the utility's performance by tracking end-outcomes rather than micro-monitoring multiple intermediate outputs. While defining the KPIs, we have endeavoured that the KPIs are in line with international nomenclature and definitions in order to make performance benchmarkable with other utilities.

Going forward, each country should maintain a MIS (Management Information System) of these indicators which should help improve data quality, storage, management and retrieval of these indicators and data assets.