REPORT ON THE ANALYSIS OF KEY PERFORMANCE INDICATORS (KPIs) OF GENERATION AND DISTRIBUTION COMPANIES

JANUARY-DECEMBER, 2010

1.0 EXECUTIVE SUMMARY

The Nigerian Electricity Regulatory Commission was established by the Electric Power Sector Reform (EPSR) Act, 2005 **"to create, promote, and preserve efficient industry and market structures and to ensure the optimal utilization of resources for the provision of electric services"** as one its mandate.

Various Key Performance Indicators were developed for the generation, transmission and distribution companies. After several meetings with the Performance Managers of these companies, the final reporting template was adopted for monthly submission to the Commission. The objective of the indicators was to have a clear picture of the industry's performance and then set a benchmark for the electricity industry.

This report shows the result on the analyses of key performance indicators (KPIs) of the generation and distribution companies. The result, however, does not really reflect the true state of the industry because of the inaccuracy of the data submitted by the industry operators.

PART I: ANALYSIS OF GENERATION COMPANIES

2.0 INTRODUCTION

With ongoing Government efforts to boost power generation in the country it is very important to monitor the performance of operating Generation Companies in the Country and assess whether they are making use of their resources efficiently and effectively in generating electricity. The parameters used by the Commission for this assessment and comparative analysis of generation companies, the Key Performance Indicators (KPIs), include Heat Rate, Capacity Factor, Load Factor, Percentage Internal Utilization, Sent Out Efficiency, Station Availability Factor, Station Reliability Factor, amongst others.
The KPIs provide a useful measure of how well a power plant is operated and managed.

This report shows the result of the analyses of the performance of each of the generation company using Key Performance Indicators (KPIs) unique to their operations. The result, however, does not really reflect the true state of the industry because of the inaccuracy of the data submitted by the industry operators.

The major constraint in the analysis is that there is lack of commitment/poor response by Operators in submitting their monthly reports and there are a lot of discrepancies/inaccuracies in the KPIs submitted by them.

The following is a report on the performance of Generation Companies in the country covering January – December, 2010.

3.0 ANALYSIS AND RESULTS

3.1 Load Factor:

The Load Factor (%) is mathematically defined as Actual Energy Generation (MWh)/ Available Capacity (MW) x Hours the Station was available within the period (Hrs). Data from eighteen (18) Power Stations were used and the results shown in Figure 1. As can be seen from the figure, the values for the Load Factor ranged from 14.30% at Afam I-V to 79.27% at Okpai Power Station. A higher load factor means more output from the generator.

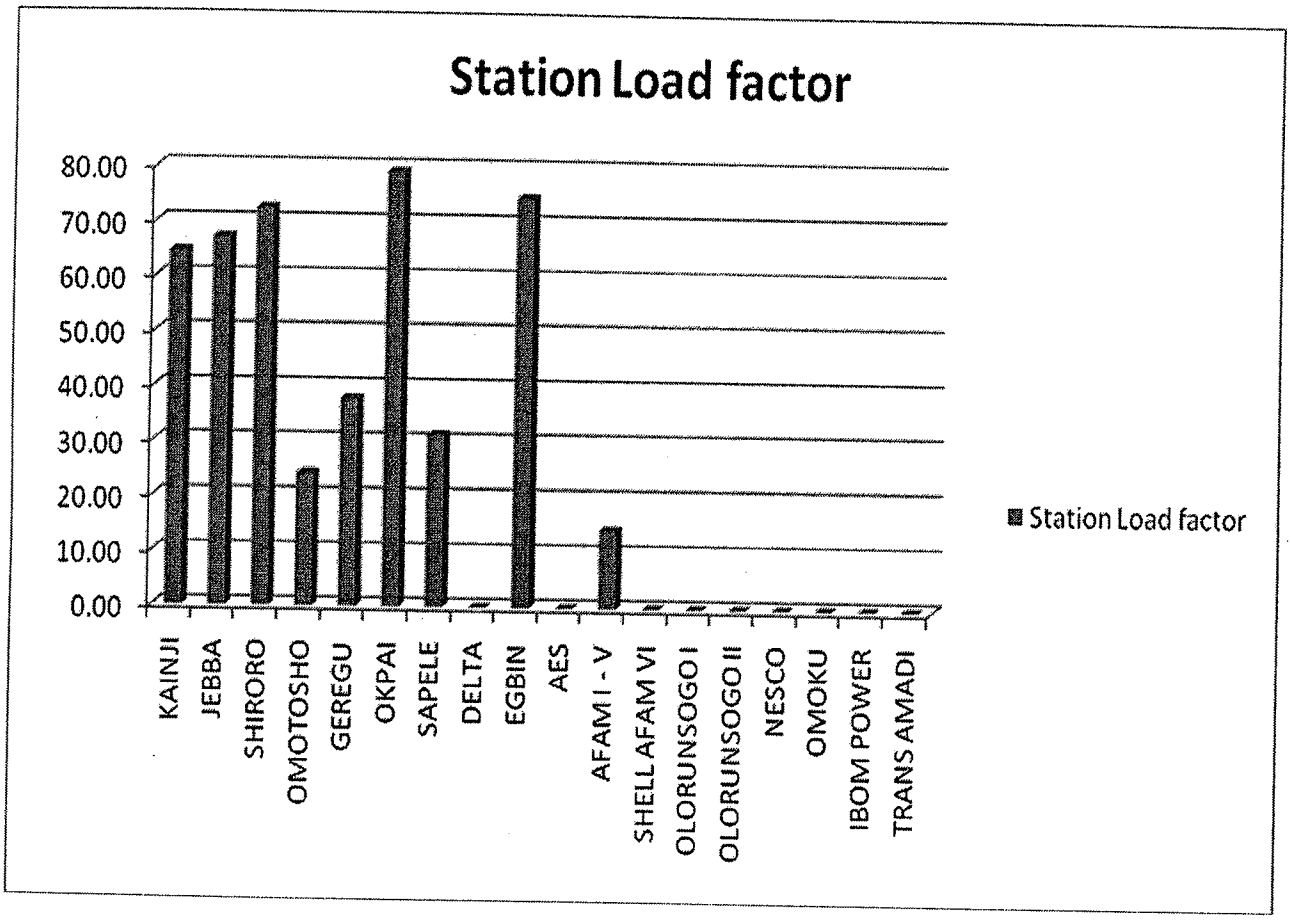


Figure 1: Load Factor of Generation Plants

3.2 Capacity Utilization Index:

Capacity Utilization Index is mathematically defined as Available Capacity (MW)/ Installed Capacity (MW) for the Power Plant. Figure 2 shows a graphical representation of the data obtained. Values for the Capacity Utilization Index ranged between 1.66% at Afam I-V and 76.90% at Okpai Power Station. The MYTO allows for a minimum of 70% Capacity Utilization Index. It can be seen from the graph, that it is only Jebba and Okpai Power Stations that have met MYTO's target.

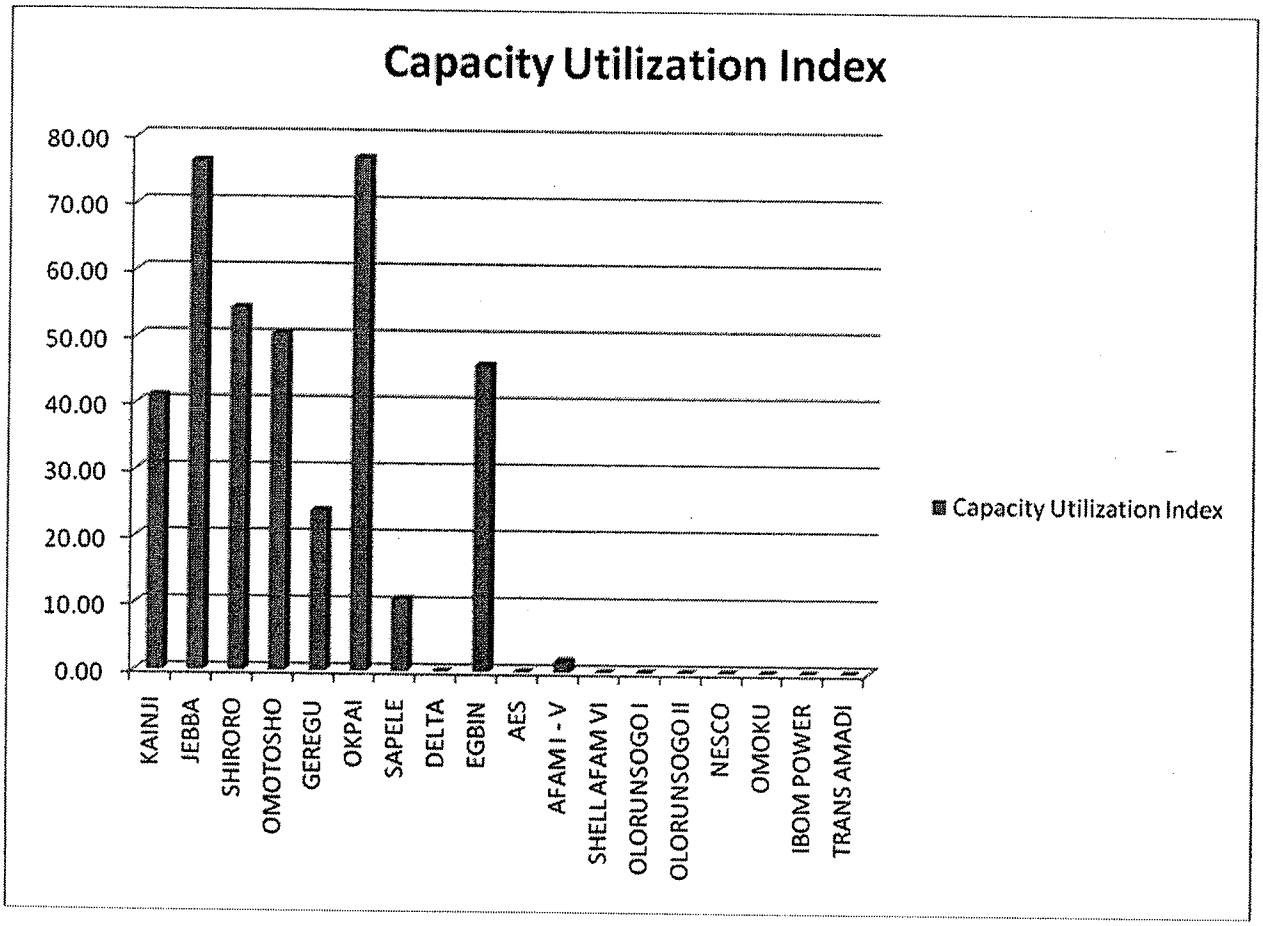


Figure 2: Capacity Utilization Index of Power Plants

3.3 Generation Utilization Index:

The Generation Utilization Index is the ratio of the Average Actual Generation (MW) to the Available Capacity (MW) of the Power Plant. Figure 3 shows a graphical representation of the data obtained. Values for the Generation Utilization Index ranged between 22.79% at Afam I-V and 82.60% at Shiroro. As can be seen from the graphs, Kainji, Jebba, Shiroro, Okpai, and Egbin Power Stations have a Generation Utilization Index above 70%.

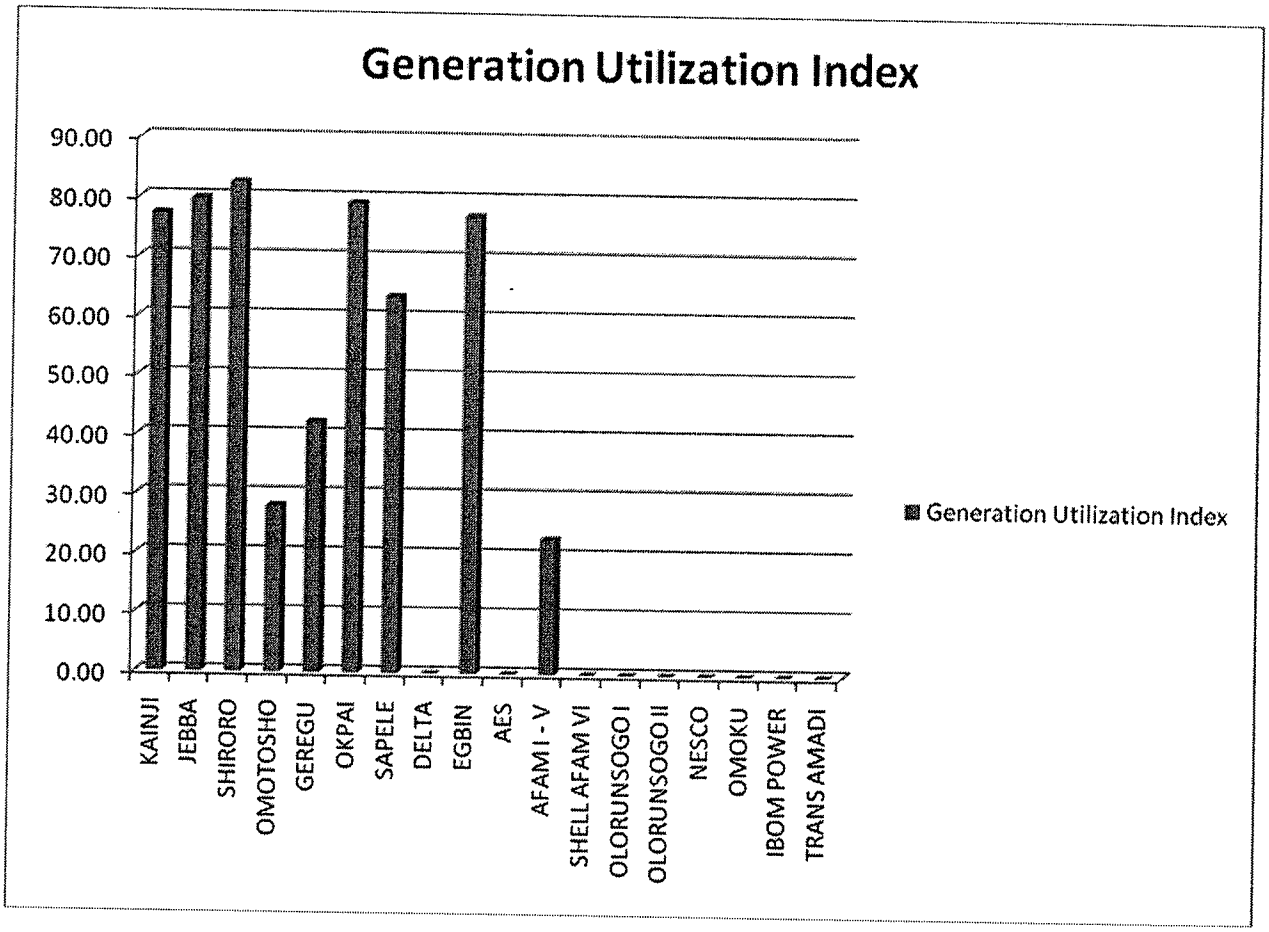


Figure 3: Generation Utilization Index

3.4 Station Reliability Factor

Station Reliability Index describes the reliability of the station with respect to availability of plants. The Station Reliability Factor ranged between 11.11% at Omotosho Power Station to 100% at Okpai Power Station. Figure 4 shows the values obtained for Station Reliability Factor as a percentage for each plant. Sapele Power Station recorded a negative value because the number of unavailable units were more than the number of available units in the Station.

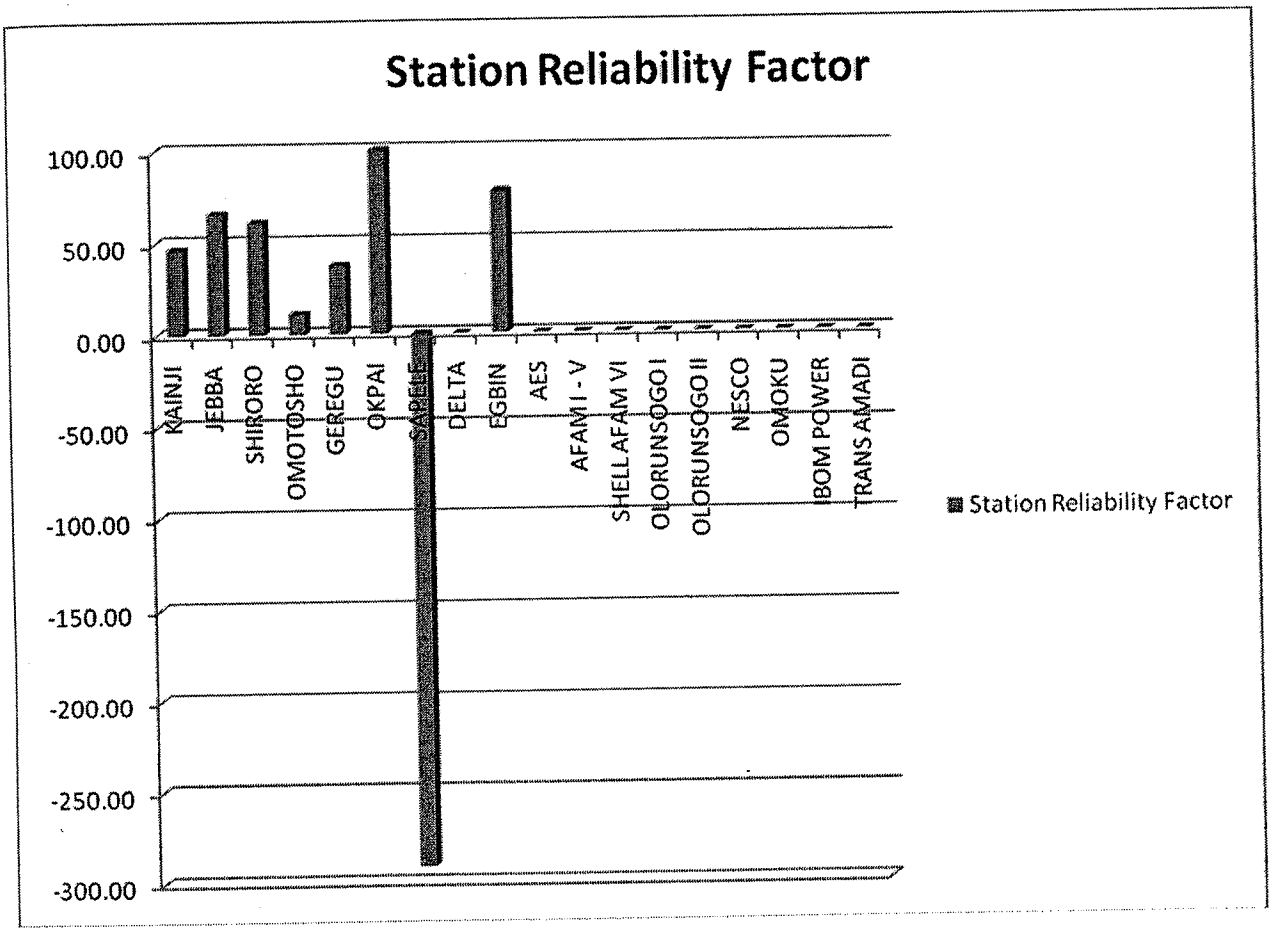


Figure 4: Station Reliabilty Factor

3.5 Heat Rate:

The Heat Rate (MJ/MWh) is mathematically defined as the Volume of Fuel Consumed x Calorific Value of the Fuel / Energy Generation from the Power Plant. Figure 5 below shows the Heat Rate which varies between 8,251.50 MJ/MWh at Okpai Power Station to 111,619.11 MJ/MWh at Afam I-V. The MYTO allows for a Heat Rate of 10, 000MJ/MWh. The Power Stations that have their Heat Rate above the MYTO allowed value need to improve on their efficiency.

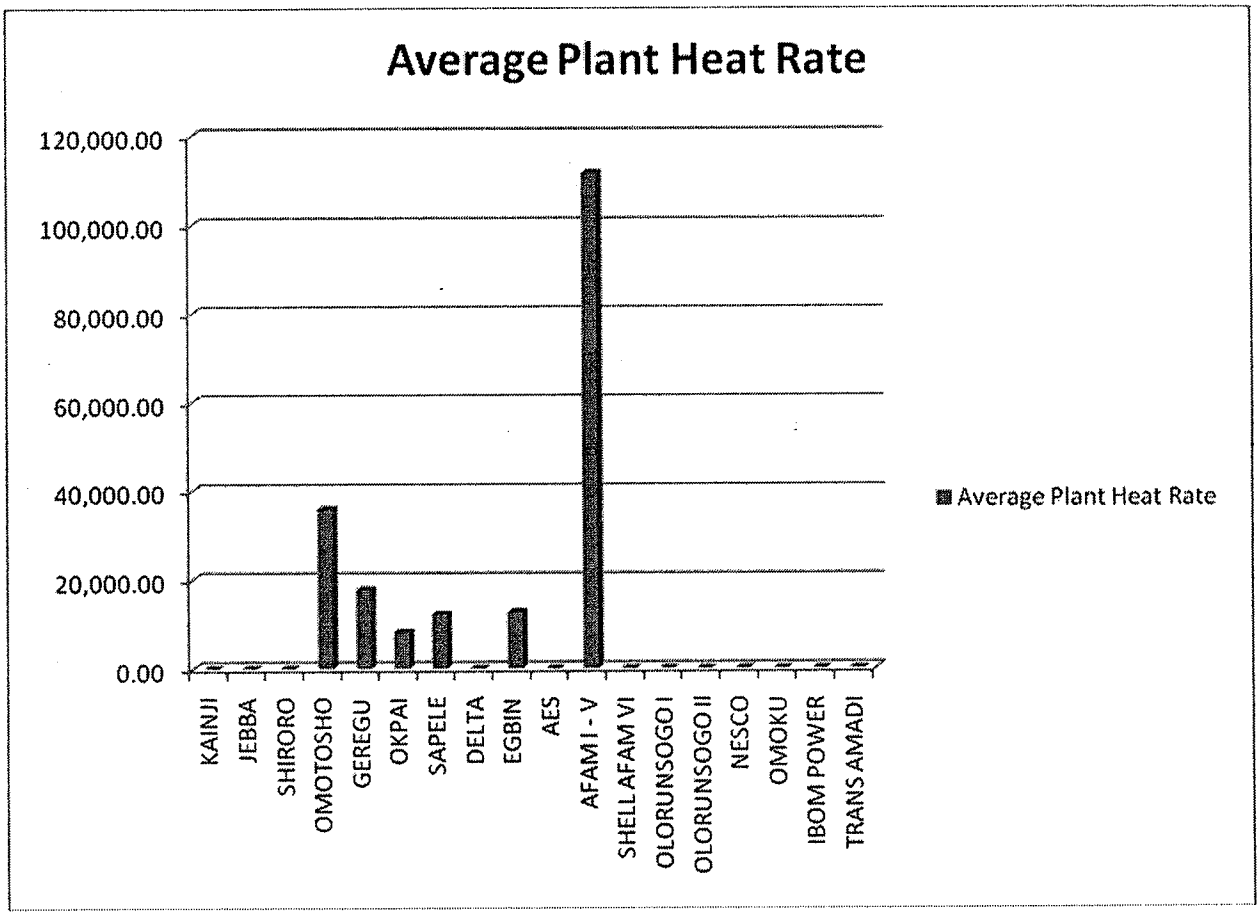


Figure 5: Average Plant Heat Rate

3.6. Internal Utilization:

Internal Utilization is mathematically defined as [Energy Generated by the Station (MWh) – Energy sent out to the grid from the station (MWh)] / Energy Generated by the Station (MWh) in %. Figure 6 is a graphical representation of the Internal Utilization obtained for each power plant. The Steam Stations e.g. Egbin Power Station and Sapele Power Station have a higher Internal Utilization than the Gas and Hydro Power Stations because of the various auxiliaries like the boilers and condensers in the station.

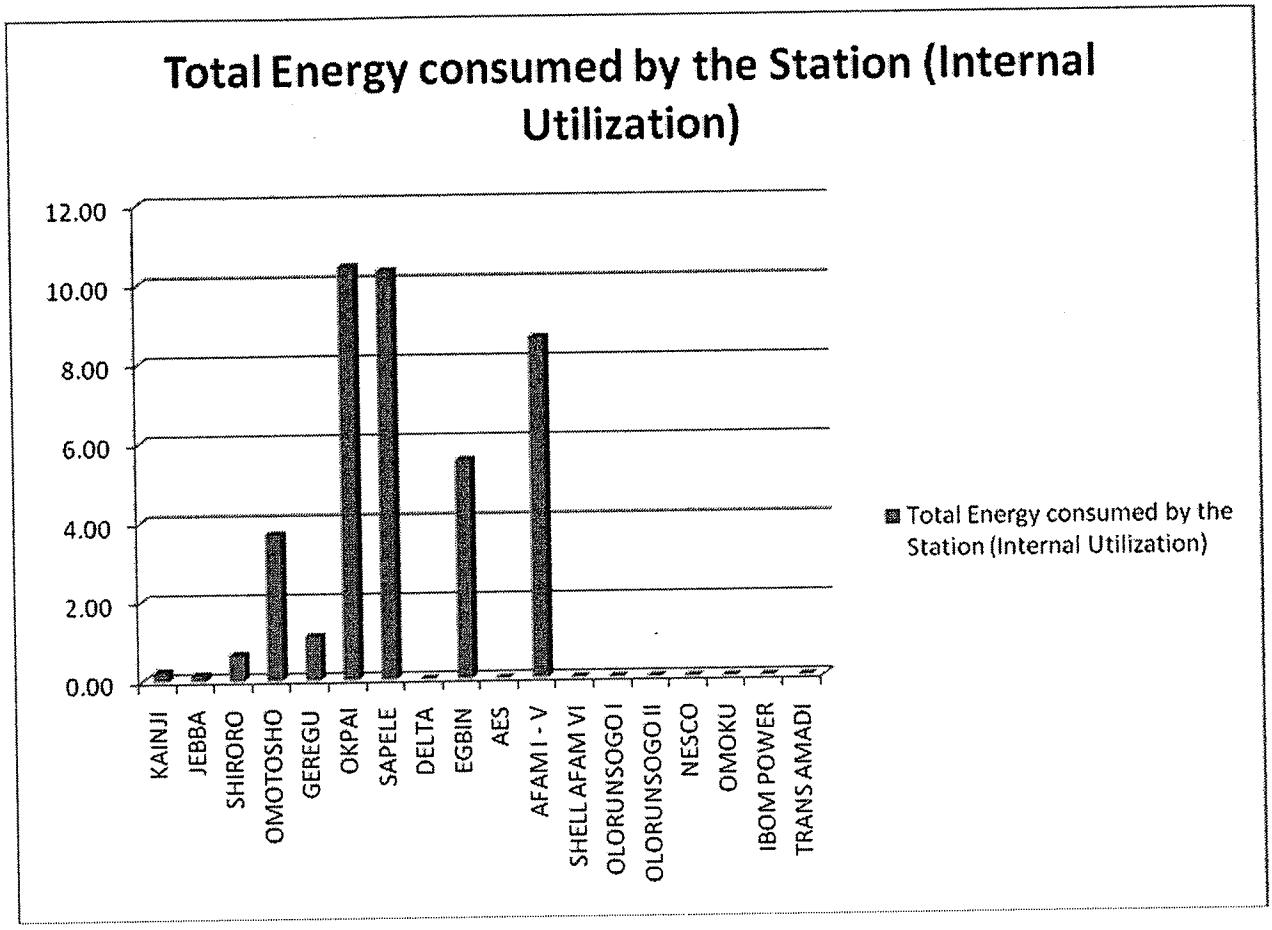


Figure 6: Internal Utilization

3.7 Sent Out Efficiency:

Sent Out Efficiency is mathematically defined as [Energy Sent Out to the grid from the Power Plant (MWh) / Potential Energy Output from the Power Plant operated at 100% within the period (MWh)] x 100. Values for the Sent Out Efficiency ranged from 11.70% at Afam I-V to 72.31% at Okpai as seen in figure 7. The MYTO allows for a sent Out Efficiency of 34%. Stations with Sent Out Efficiency above the MYTO allowed value need to improve their performance.

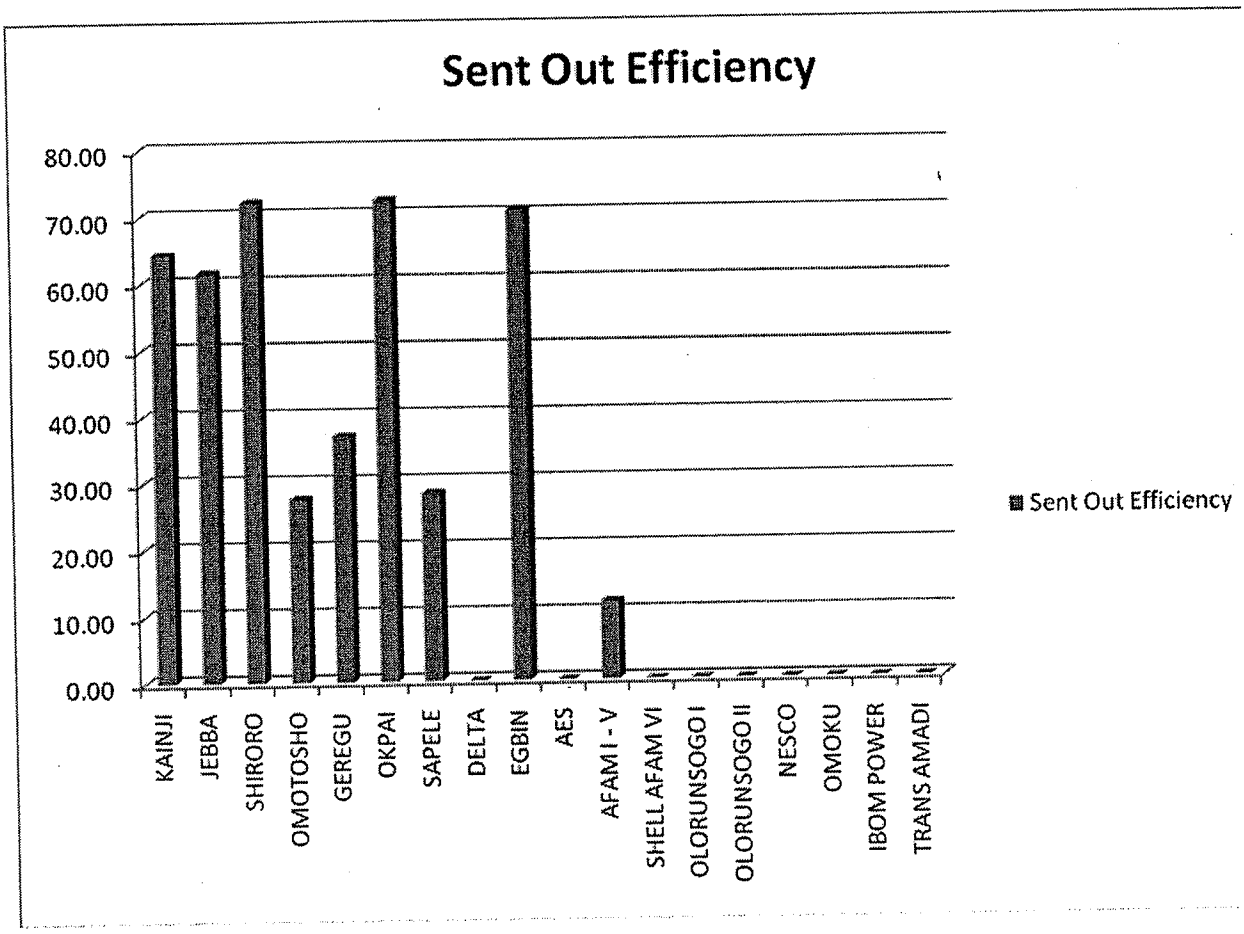


Figure 7: Sent Out Efficiency

4.0 DISCUSSION AND CHALLENGES:

The validity of the results for the KPIs can only be true where the data used for determining a particular KPI is accurate. Particular values that are questionable are:

1. The Station Reliability Factors should normally range between 0% and 100%. The presence of negative values for this indicator implies these stations have more redundant generating plants than operational ones.
2. From the analyses, it shows that the Generation Stations operating below the MYTO benchmarks on some of the indicators are not operating efficiently and effectively.
3. Inaccurate data from just a few generation plants created difficulties in assessing the true performance of the industry as the Commission can only work with the information provided. Thus the importance of accurate KPI data cannot be more emphasized.
4. As can be seen in the analyses of the KPIs, some Power Plants do not send any KPIs to the Commission, even after several letters have been written and calls have been made to them. The time delay in receiving some data from some of the Power Stations is also a cause for concern.
5. A major challenge to the performance of gas powered generation plants is the unavailability and inadequate supply of gas fuel to the respective stations due to factors beyond their control.

PART II: ANALYSIS OF DISTRIBUTION COMPANIES

5.0 INTRODUCTION

With ongoing Government efforts to privatize the Distribution Companies in the country it is very important to monitor the performance of operating Distribution Companies in the Country and assess whether they are making use of their resources efficiently and effectively in distributing electricity. The parameters used by the Commission for this assessment and comparative analysis of distribution Companies, the KPIs, include System Average Interruption Duration Indicator (SAIDI), System Average Interruption Frequency Indicator (SAIFI), Customer Average Interruption Duration Indicator (CAIDI), Customer Average Interruption Frequency Indicator (CAIFI), HV Faults Clearance Index, LV Faults Clearance Index, Technical Losses amongst others.

The KPI provide a useful measure of how well a Distribution Company is operated and managed.

This report shows the result of the analyses of the performance of each of the distribution company using Key Performance Indicators (KPIs) unique to their operations. The result, however, does not really reflect the true state of the industry because of the inaccuracy of the data submitted by the industry operators.

The major constraint in the analysis is that there is lack of commitment/poor response by Operators in submitting their monthly reports and there are a lot of discrepancies/inaccuracies in the KPIs submitted by them.

The following is a report on the performance of Distribution Companies in the country covering January – December, 2010.

6.0 ANALYSES AND RESULTS

6.1 SAIDI:

The **System Average Interruption Duration Index (SAIDI)** is commonly used as a reliability indicator by electric power utilities. SAIDI is the average outage duration for each customer served, and is calculated as: *[sum of all customer interruption durations/total number of customers served]*. SAIDI is measured in units of time, often minutes or hours.

The value presented by Enugu EDC is 849.46Hrs, as against values like 18.87Hrs from Kaduna EDC and 20.13Hrs from Abuja EDC which are not realistic.

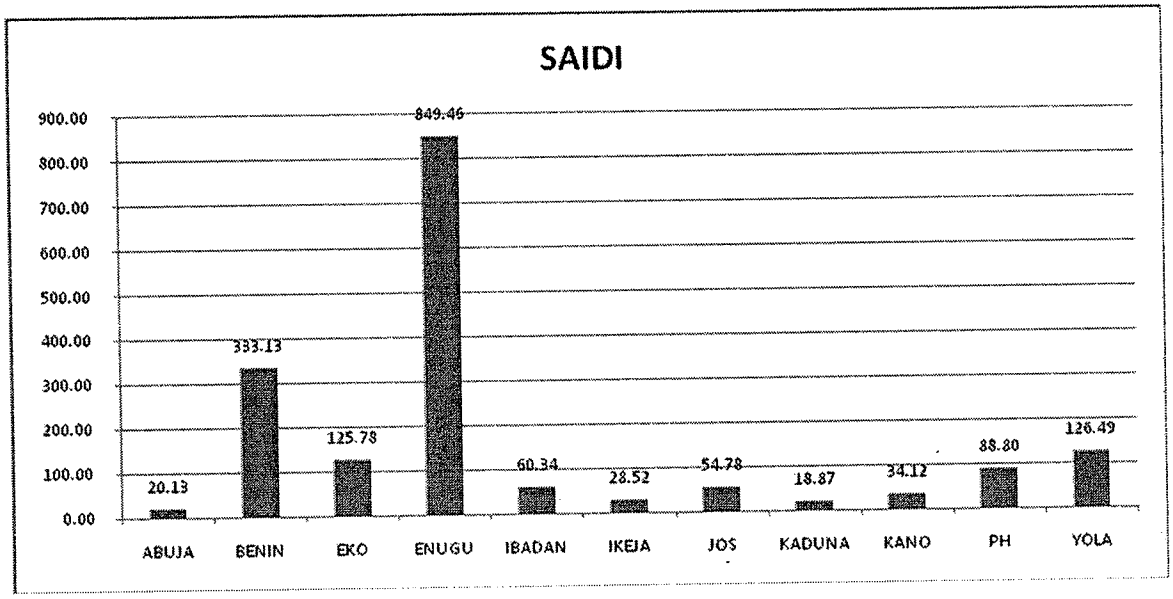
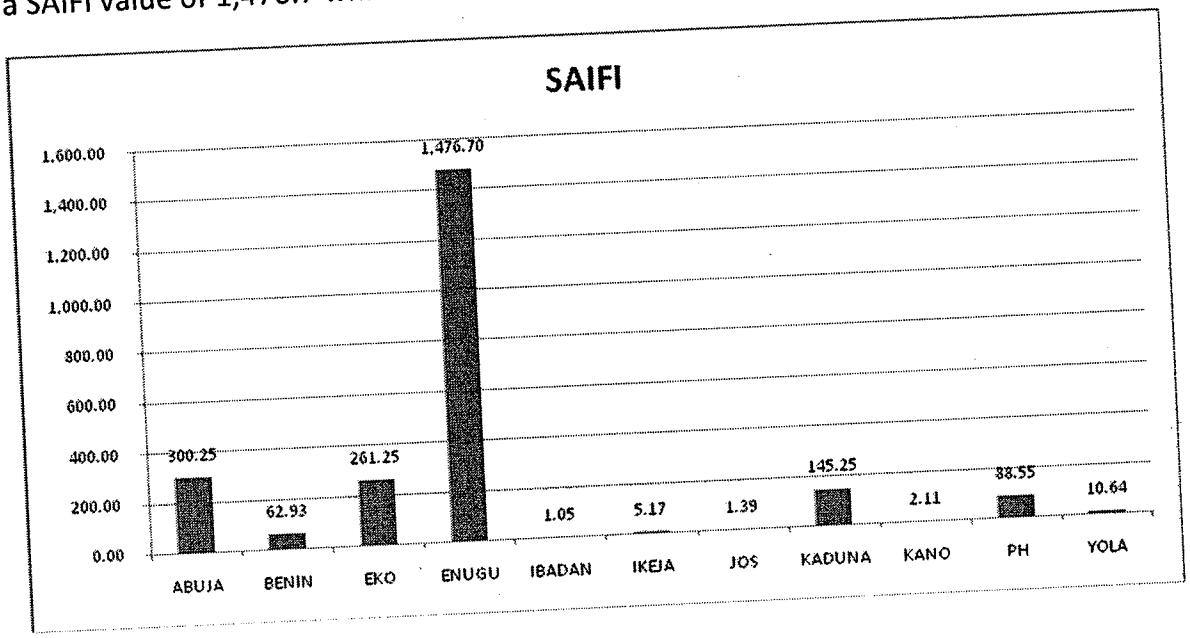


Figure 1: SAIDI of Distribution Companies

6.2 SAIFI:

The **System Average Interruption Frequency Index (SAIFI)** is commonly used as a reliability indicator by electric power utilities. SAIFI is the average number of interruptions that a customer would experience, and is calculated as *[total number of customers' interruptions / total number of customers served]*

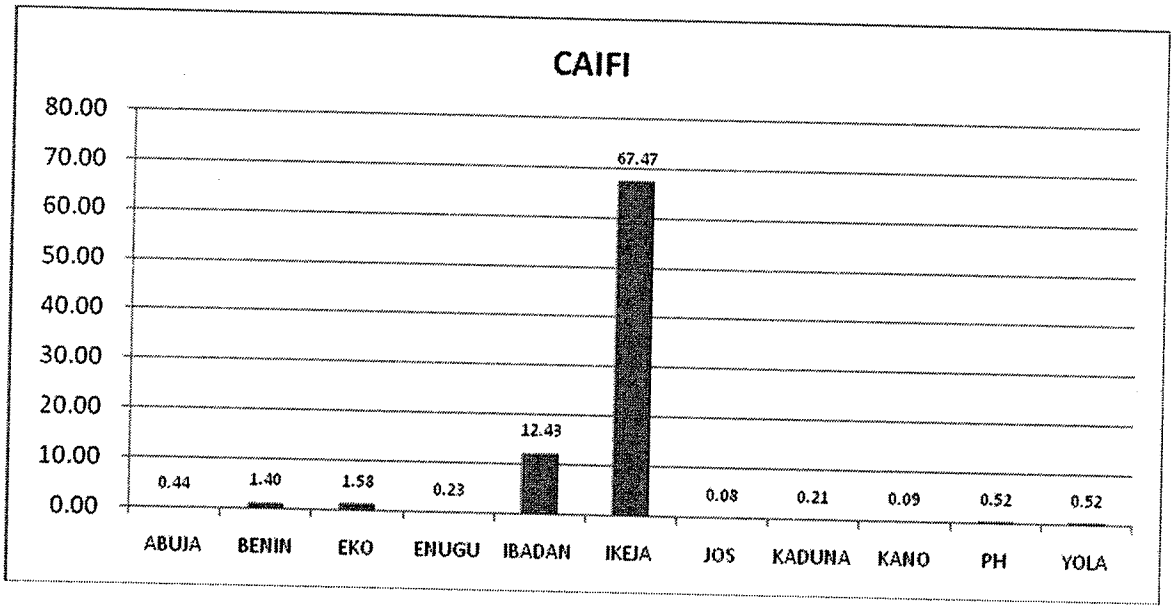
SAIFI is measured in units of interruptions per customer. Summarily, Enugu EDC has a SAIFI value of 1,476.7 while Ibadan EDC has a value of 1.05 which is not realistic.



CAIFI:

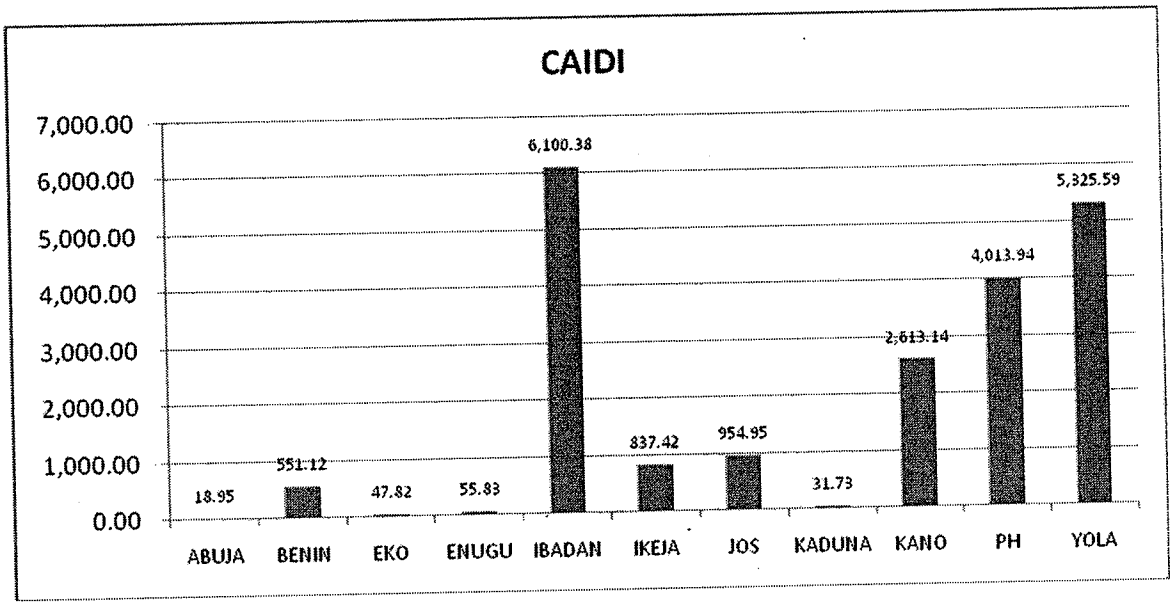
The **Customer Average Interruption Frequency Index (CAIFI)** is a popular index used in electrical reliability analysis. It is designed to show trends in customers interrupted and helps to show the number of customers affected out of the whole customer base.

From the analysis done, Ikeja EDC has the highest CAIFI value of 67.47 while Jos EDC having a value of 0.08 is not realistic.

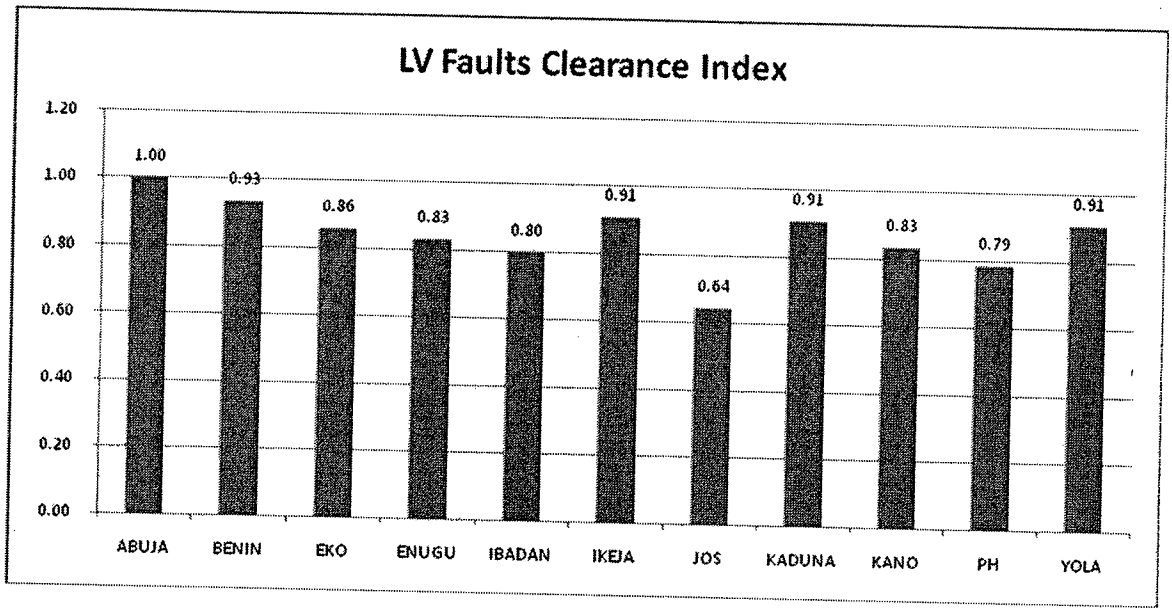


CAIDI:

The Customer Average Interruption Duration Index (CAIDI) is a reliability index commonly used by electricity utilities. Directly related to SAIDI and SAIFI, it is calculated as [*sum of all customer interruption durations/ total number of customer interruptions*] or $\frac{SAIDI}{SAIFI}$ gives the average outage duration that any given customer would experience. It can also be viewed as the average restoration time. CAIDI is measured in units of time, often minutes or hours. Values for the CAIDI ranged between 6,100.38Hrs at Ibadan EDC and 18.95Hrs at Abuja EDC (which is not realistic).



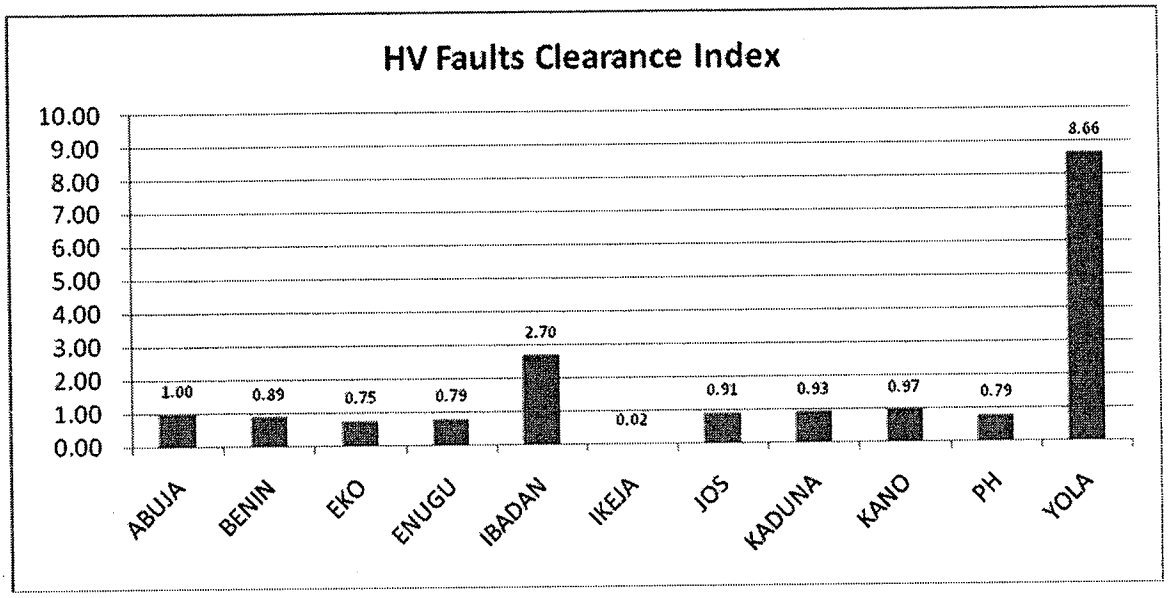
This is the ratio of Ratio of Number of LV faults cleared within 8 hours to the Total LV faults reported within a pre-specified period i.e. with in a month.



Values for the LV Faults Clearance Index ranged between 1.00 in Abuja EDC and 0.64 at Jos EDC. It shows Abuja EDC LV Faults Clearance Index is 1.00 which is not realistic.

6 **HV Faults Clearance Index:**

This is the ratio of Ratio of Number of HV faults cleared within 8hours to the Total HV faults reported within a pre-specified period i.e. with in a month.



From the analysis, it can be seen that Ibadan and Yola EDC have awkward values. Values for the HV Faults Clearance Index ranged between 1.00 in Abuja EDC and 0.02 at Ikeja EDC. It shows Abuja EDC LV Faults Clearance Index is 1.00 which is not realistic.

7.0 DISCUSSION AND CHALLENGES:

The validity of the results for the KPIs can only be true where the data used for determining a particular KPI is accurate. Particular values that are questionable are:

1. Inaccurate data from most of the Distribution Companies created difficulties in assessing the true performance of the industry as the Commission can only work with the information provided. Thus the importance of accurate KPI data cannot be more emphasized.
2. Some Distribution Companies do not send any KPIs to the Commission or are slow in sending their KPIs, even after several letters have been written and calls have been made to them.

8.0 WAY FORWARD

1. Generation and Distribution Companies should be reminded of their responsibility to provide NERC with KPI reports for their respective companies on a monthly basis and in a timely manner.
2. Feedback from the Commission to Generation and Distribution Companies on how they fared comparatively in terms of their performance and suggestions on areas that need improvement is recommended.
3. Generating Stations whose values are outside the MYTO benchmarks need to improve their performance in these areas.
4. Performance Software Packages (such as PerformanceSoft, Oracle, SAP and other softwares) are required to enable the Commission process large volumes of data/information to meaningful, readable and understandable form.

9.0 CONCLUSION

Penalty measures should be put in place to counter and discourage giving of wrong and inaccurate data. This will, in future, help in improving the efficiency and management of our resources in the power sector.