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Pre And Post Privatisation Assessment Of Transcorp Power Gas Turbine Plants Using Standard Key Performance Indicators

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***Abstract*— This research work aims at assessing, using Key Performance Indicators as recommended by The Nigerian Electricity Regulatory Commission, (NERC), the performance of Transcorp Power Limited Power Plants, Ughelli, Delta State, for the period 2008-2015, to determine if the Privatisation of the PHCN has been effective.**

Parameters for assessing the gas turbine units and the overall station performance were collected from the power station. These data which includes installed and available capacity of plants, Number of hours run, Peak load values, Average generation in (MW), Number of trip records, Heat Supplied and Energy generated by each gas turbine and the overall station, pre and post privatisation of the facility, were collated and analysed with the aid of Microsoft Excel Spreadsheet to obtain the needed results.

Result shows that pre-privatisation (2008 -2012), Total Energy generated by the station were valued at 1,510,988.0 MWh and 1,582,696.90MWh in 2008 and 2009 respectively as against 2014 and 2015 that were estimated at 2,804,067.20MWh and 2,894,031.80MWh respectively. Energy exported to the grid, pre-privatisation was estimated at 1,486,338.02MWh and 1,539,157.35MWh for 2008 and 2009 respectively, and post-privatisation values were 2,671,872.20MWh and 2804575.94MWh in 2014 and 2015 respectively. The capacity factor peak values were 73.53% in 2008 and 71.60% in 2009 while 2014 and 2015 recorded all-time peak values of 89.24% and 81.23% by GTs 16 and 17 respectively. Generation Utilization Index in 2008, 2009 and 2010 averaged at 77.77%, 76.73% and 66.14% respectively whereas, it averaged at 85.34 % and 76.74% for 2014 and 2015 respectively. There were also better performances in peak load values, Number of hours run, etc, post-privatisation than it was pre-privatisation of Transcorp Power Limited, Ughelli. From these results, it can be inferred that the generating units were underutilized pre-privatisation period.

Keywords—Transcorp Power Limited; Nigeria Power Sector; Gas turbine; Privatisation; Thermal efficiency; Power Generation; Gas consumption; Power Privatisation

I. INTRODUCTION

Substantial expansion in quantity, quality, and access to infrastructure services, especially electricity, is fundamental to rapid and sustained economic growth and poverty reduction. Yet, for the past four decades, inadequate quantity, quality and access to electricity services have been a regular feature in Nigeria [1].

In Nigeria, access to reliable and stable supply of electricity is a major challenge for both the urban and rural dwellers. The challenge, however, is more significant in the rural areas where only about 10% of the population has access to electricity [2]. Nigeria's electricity demand far outstrips the supply, which is epileptic in nature. The acute electricity supply hinders the country's development and not only restricts socio-economic activities to basic human needs; it adversely affects quality of life [4].

The objective of the electric energy system is to provide the needed energy services [3]. Energy services are the desired and useful products, processes or indeed services that result from the use of electricity, such as for lighting, powering of electrical appliances etc. [5].

The electricity consumption in Nigeria is extremely low due to inadequate supply. As of 2011, electricity consumption stood at just 149kwh per capita [6] and dropped to 144kWh by 2014 [7]. At 149kWh per capita, Nigeria's electricity consumption is one of the lowest in the world, about 4times less than the African average (563kWh per capita) and 17 times less than the world's average of 2596kWh per capita [8].

Most of Nigeria's Power Facilities were being managed by the defunct Power Holding Company of Nigeria (PHCN), a public sector charged by law for the generation, transmission, distribution, or marketing and sales of electricity to the public in Nigeria [9]. until the Electric Power Sector Reform (EPSR) Act of 2005 and the consequent unbundling and privatisation of the sector that has permitted Independent Power Producers (IPPs) to obtain licenses to generate electricity.
Prior to privatisation and unbundling process, Nigeria's electricity generation has always hovered between 2000 to 4000MW of available capacity, not much has changed after the privatisation process. This forms the background of study for this research work: to overview the power sector and assess with some performance indicators associated with the gas turbine power plants, the Performance Of Transcorp Power Limited, Ughelli, pre and post privatisation, ascertaining if the unbundling process was a step in the right direction. Fig 1 is a schematic of the unbundled power sector.

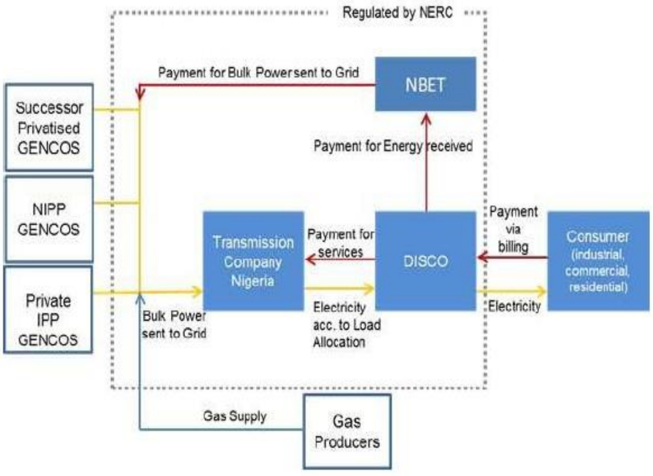

Fig 1: Structure of the Nig. Power Sector Post-Privatisation

II. GAS TURBINES IN TRANSCORP POWER LIMITED, UGHELLI, DELTA STATE

The station was built in 1964 with an installed capacity of 2X36MW (72MW), from two Stal-Laval gas turbines. Then, the station was called Delta I under Electricity Corporation of Nigeria (ECN).

In 1975, six units of General Electric (GE) Frame 5 gas turbines (20MW each) were installed in the station known as Delta II, after the merger of Niger Dam Authority (NDA), Kainji and the ECN to form the National Electric Power Authority (NEPA).

In 1978, additional six units of GE Frame 5 gas turbines, like the ones installed in 1975, were added, (Known as Delta III) to boost the installed capacity to a total of 312MW, as follows:

Delta	I,	2X36	72MW
Delta	II,	6X20	120MW
Delta	III,	6X20	120MW
Total			**312MW**

The station was upgraded in 1991 with the addition of 6 X 100MW (600MW) GE Frame 9 gas turbines. From 2000 to 2008, Delta II and Delta III GE units were upgraded to 150MW station each: built by Hitachi of Japan. The control systems were upgraded to Mark V, a fully computerized control system for Delta II and III. While Delta I was scrapped. Delta IV control system was also upgraded to Mark V by GE of USA which built the station. Today, the installed generation capacity of Transcorp Power stands at 900MW. Most of the electricity produced by Transcorp Power is transported through a network of conductors, to the national grid.

A. Generators in Transcorp Power Limited, Ughelli

Delta II and Delta III are Horizontal Shaft types and have ratings of 11/11.5kv from original manufacturers. (Siemens and Maidensha) with an operating speed of 3000rpm. Delta IV generator is a horizonatal shaft with torque adjuster and coupling.

B. Raw Materials for production

Transcorp Power Ughelli gets supply of natural gas from Shell Petroleum Development Company (SPDC) for Delta II & III at a gas pressure of 21 – 22bars and Nigeria Gas Company (NGC) for Delta IV at a gas pressure of 19 – 21bars, but both SPDC and NGC can complement each other in times of emergency through a tripartite gas line valve.

The other major raw material is the atmospheric air that is filtered and compressed. Part of the air is used for cooling and atomization of the diesel fuel (where need be) for combustion during operation. Most part of the compressed air is used for the combustion in the combustion chambers, with the natural gas.

Hydrogen is used in cooling the heavy generators at Delta IV because of the enormous heat that the generator windings emit. Hydrogen cools ten times better than air, hence its preference for air despite its high inflammability. The hydrogen is generated locally, from the electrolysis of water. Lube oil or lubricant oil is used in the gas turbine station for lubrication of the bearings, for hydraulic pressure and heat extraction.

C. Components and Auxiliaries of the Gas Tubine Plants at Transcorp Power Limited, Ughelli

i. The starting device – a 3.3kV starting motor or prime mover in a black start system.
ii. The air-filter arrangement
iii. The compressor
iv. The combustion chambers
v. The turbines
vi. The expansion below or exhaust
vii. The generator
viii. The exciter

D. The Piping Arrangement at Transcorp Power Limited, Ughelli, Delta State

Piping arrangement is as follows:

i. The gas supply piping
ii. The lube oil piping

iii. The hydraulic oil piping

iv. The cooling water piping

v. The air piping

vi. The hydrogen piping

vii. The CO_2 piping

Fig 2: Piping Arrangement in Transcorp Power, Ughelli

E. Method of Electricity Production

The gas turbine use natural gas and compressed air as fuel to burn and rotate the shaft that turns the generator thereby generating electricity. Excitation is necessary to produce the required magnetic flux. Most of the electricity is transported through step up transformers and network of conductors to various location around the country in the form of grid. Some parts of the electricity are utilized locally within and outside the plant.

F. Hydrogen Gas Production Plant

Hydrogen gas (H_2) is produced in the station for cooling the heaven General Electronics (GE) turbine generators of Delta IV.

Plant Details:

Model: 00700

Capacity: 2 x 15Nm^3/h

Frequency: 50Hz

Date of Commissioning: 1998/1999

G. Antifire System

The plant is equipped with sprinkler and hydrant fire fighting systems with automatic CO_2 high sensitive flame detector and combating mechanics for fire emergency.

H. The Station's Switchyard

The Delta IV 330kV Highyard is configured to 1 1/2 breaker system to evacuate generated electricity from six (6) units of 6 x 100 Megawatts (600MW) of the plant into the national grid for onward distribution to power consumers [10].

III. MATERIALS AND METHODS

Ughelli Power, now Transcorp Power Limited, Ughelli, Delta State is among the 18 electricity successor companies unbundled from Power Holding Company of Nigeria (PHCN). Owing to various changes in the Federal Government policies in the electricity industry from 1973 to 2009, Transcorp Power has on various occasions changed its name and outlook.

3.1. OVERVIEW OF TRANSCORP POWER LIMITED

i. Over 52 years of Service.

ii. Transcorp Power has four (4) power plants, Delta I, Delta II, Delta III & Delta IV with the "Delta I retired".

iii. Transcorp power has an installed capacity of 900MW.

iv. Custom fitted Engine starters in Delta II and Delta III turbines enables the station to black start the National Grid in case of emergency or cases of total or partial system collapses.

v. Transcorp Power provides auxiliary facilities for staff, such as: Staff Housing, Medicare, School and Recreational Club.

vi. Transcorp Power Limited has five major departments: The Operations Department, The Efficiency Department, Performance Management and Planning Department, Health, Safety and Environment Departs, Plant Maintenance Department which includes Mechanical Maintenance Department, Electrical and Control Department, Protection, Communication and Metering Department, Workshop Services Department, Civil and Estate Department.

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3.2 DESCRIPTION OF EACH STATION

DELTA I

This station used to house the two numbers stal-laval units of 36MW each. These units have since been scrapped. Plans existed for fresh packaged gas turbines installation in the spaces provided.

The main blocks of Delta 1 serve as offices of the two Assistant General Managers (Plant Services and production), some other principal managers and mechanical/vehicle workshops.

The operational switchings in Delta 1 and 2 (132/33kV) Hi-yard are performed by the TCN operators, while the local lightings for the offices in Delta 1 and around are powered from the switchyard through the 33/0.415kV transformer. The radiating feeders in Delta 1 switch yard include:

i. Benin 132kV Line 1 and 2
ii. Effurun 132kV Line
iii. Ughelli Old Road 33kV feeder
iv. Isoko/Ughelli 33kV feeder
v. Agbarho/Eku 33kV feeder
vi. Aladja 33kV feeder
vii. Shell 33kV feeders 1 and 2.

These 33 kV feeders are served through 2Nos 132/33kV (45/30 MVA) transformers.

DELTA II

This station comprises of 6x25MW (H25 Hitachi) units, on a total installed capacity of 150MW; (GTs 3, 4, 5, 6, 7, 8) The station is served gas mainly from SPDC-Ughelli East Gas Plant at pressure ranging from 20-22 bars. Some of these GTs often trip on faults involving compressor, bleed valve position problem, exciter problem, starting (diesel) problems etc.

GTs 3 and 5 has been out of service since 2007 due to generator fault caused by wrong phase termination between the 132kV main bus, transformer and units generators.

GT 4 was out of service due to starting device problems and confirmation of 81MVA transformer (T3) status from TCN since 2007 but came into operation in 2011.

DELTA III

This station also comprises of 6x25MW (H125 Hitachi) units on a total installed capacity of 150MW. The units operate on natural gas pressure range of 20-22bars from mainly SPDC-Ughelli East Gas Plant.

The main problems that occur on the Delta 3 units are similar to that of Delta 2. Such problems include inadequate gas supplies from SPDC, Major excitation problems, Mark V, Uninterrupted Power Supply (UPS) and monitor failures, vibration; oil leaks etc. the source of supply to the units on cranking motor on 3.3kV is still on temporary facility from Delta IV (132/3.3kV) starting transformer. Efforts should be made to install a separate and permanent source from Delta 3 switchyard as originally designed.

Lack of statutory inspections on the units based on exceeded Expected Operating Hours (EOH) is likely to cause unpredicted outages on these units with time.

DELTA IV

This is a station of 6x100MW (GE) units on a total installed capacity of 600MW. Common problems in Delta 4 pre-privatisation include:

i. Cooling water pump failures
ii. Cranking motor failures
iii. Accessory gear box failures
iv. Hot exciter/PCC rooms
v. Torque converter failure
vi. Flame detector/ignition failures
vii. Hydrogen leaks problems
viii. Oil ingress to the generator due to oil seal damages
ix. Seal oil differential failure
x. Air inlet filter problems
xi. Exhaust system failure [10]

3.2 OPERATION DATA USED FOR ANALYSIS

With the ongoing government effort 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 towards electricity generation.

The parameters used for this assessment and comparative analysis of Transcorp Power Limited are the recommended Key Performance Indicators (KPI) from National Electricity Regulatory Commission [11].

The monthly/annual generation performances are dependent on these factors:

i. Energy Generated (MWh): This gives account of the daily, monthly and annual energy production from the available plants for the periods under consideration. It is a measure of the energy generated in MW and the number of hours, run (h).

ii. Energy Consumed (MWh): Energy consumed in MWh is an account of energy that is used in-house at Transcorp Power Limited for powering major equipments, facilities and offices.

iii. Energy Exported (MWh): This gives account of the value of energy sent out in MWh to the national grid for onward transmission and distribution. Most of the electricity is evacuated through step-up transformers and network of conductors through various locations around the country. Energy exported to the grid is simply Energy Generated (MWh) less Energy consumed in the stations.

iv. Running Hours: This denotes the recorded time in hours run by each plant for the periods under consideration.

v. Unit Trip Records: Trip records show how much frequency each unit was not under operation due to several reasons ranging, from maintenance to damage. Higher trip records for a unit plant would contribute to poor performance and low percentage contribution of the plant to the station's generation.

vi. Gas Supplied and Consumed By the Station: Transcorp Power Limited, Ughelli gets supply of natural gas from Shell Petroleum Development

Company (SPDC) for Delta II and III at a gas pressure of 21-22bars, and from Nigeria Gas Company (NGC) for Delta IV at a gas pressure of 19-21bars. Both SPDC and NGC can complement each other in times of emergency through a tripartite gas line valve.

3.3 METHODOLOGY

The following parameters were used in assessing individual units and overall station performance within the periods under review; 2008-2015. These Key Performance Indicators (KPIs) provide a useful measure of how well a power plant is operated and managed.

Data for this study were obtained from Transcorp Power gas turbine power station's data bank via the assistance of the company's Efficiency Department. These are inventory records of monthly energy generation between 2008 and 2015 and operational statistics showing the period when each of the plant units had major outages. Data collected includes:

i) Energy Generated in MWh
ii) Energy Consumed in MWh
iii) Energy Exported to the Grid MWh
iv) Gas consumed in Standard Cubic Foot (SCF)
v) Unit Trip Records
vi) Load Factor
vii) Installed Capacity & Available Capacity in MW

Equations employed for this work are as contained in [12].

3.3.1 Capacity Factor (CF): The extent of use of the generating plant is measured by the Capacity Factor (CF) which is the ratio of the average energy output of a unit plant for a given period of time to the plant capacity.

$$CF = \frac{\text{Capacity of available units in a given time interval}}{\text{Total installed Capacity}} \quad (3.1)$$

Thus, the characteristic behavior of generating plant depends substantially on the capacity factor and utilization factor. High capacity factor is desired for economic operation of the plant. Values of capacity factors are normally expressed in percentages

3.3.2 Availability Factor (AF): This is the ratio of the actual time the unit was in service to the total interval under consideration. The more the availability factor, the better the total output and performance. Values are best expressed in percentages.

$$AF = \frac{\text{Actual time (running hours) the unit (plant) was in service}}{\text{The Total time under consideration}} \quad (3.2)$$

3.3.3 Load Factor (LF): This is the ratio of the average load to the maximum demand for a particular period. Since the average load is always less than the maximum demand, load factor is always less than unity. Load factor values are expressed in percentages.

$$LF = \frac{\text{Average Station generation capacity}}{\text{The Peak Load during same period}} \quad (3.3)$$

Since facilities likely never operate at full capacity for the duration of an entire 24-hour day. A high load factor means power usage is relatively constant.

3.3.4 Generation Utilization Index (GUI): Otherwise known as the utilization factor is the ratio of the maximum demand to the rated capacity of the power plant. The utilization factor measures the use of the total installed capacity of the plant. Values of GUI are best expressed in percentages. Higher values indicate a better performance and effective utilization of plants.

$$GUI = \frac{\text{Average Actual Generation (MW)}}{\text{Available Capacity (MW)}} \quad (3.4)$$

3.3.5 Units Contribution to Station's Total Output (UCT): This is the ratio of the total energy generated by a unit (plant) in a given time to the total energy generated by the station in the same period. A higher percentage contribution to the total output by a plant means a desirable performance of that plant. These values are normally expressed in percentages.

$$UCT = \frac{\text{Total Energy Generated by a plant in a given time}}{\text{The Total Energy generated by the station in the same period}} \quad (3.5)$$

3.3.6 Thermal Efficiency: This simply represents the fraction of heat in terms of gas supplied that is converted to work (Energy generated). It is a dimensionless performance measure of a heat engine that uses thermal energy. In general, efficiency of even the best heat engines is quite low. Best Thermal efficiency usually is less than 40% due to several reasons ranging from power required to drive the compressor, friction and heat losses, design inefficiency etc.

$$\text{Thermal Eff.} = \frac{\text{Energy Generated}}{\text{Heat Supplied}} \quad (3.6)$$

ASSUMPTIONS

I Each unit is allowed 10days for combustion inspection, therefore the total running hours in a year is: 24hours x (365-10) = 8520hours

2. Each unit is expected to operate at its installed capacity [12].

RESULTS AND DISCUSSION

The summary of the data obtained is shown in the figures below:

RESULTS AND DISCUSSION:

Table 1: UNIT CONTRIBUTION TO THE STATION, HOURS ROUN IN, CAPACITY FACTOR, AVAILABILITY FACTOR (%) FOR 2008 AND 2009

	INST. Capacity	Available Capacity	Energy Generated (MWh)		Unit Contribution to Station (%)		Hours Run		Capacity Factor (%)		Availability Factor (%)	
UNITS	**MW**	**MW**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**
GT 3	25	20	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GT 4	25	20	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GT 5	25	20	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GT 6	25	20	49856	144091	3.15	9.54	3243.60	8294.30	25.44	73.53	38.07	97.35
GT 7	25	20	18799	0	1.19	0.00	1227.20	0.00	9.59	0.00	14.40	0.00
GT 8	25	20	54038	121772	3.41	8.06	3088.80	6737.20	27.58	62.14	36.25	79.08
GT 9	25	23	70692	142372	4.47	9.42	4286.30	7421.90	33.19	66.84	50.31	87.11
GT 10	25	23	66766	95950	4.22	6.35	3815.00	5039.90	31.35	45.05	44.78	59.15
GT 11	25	23	85515	90054	5.40	5.96	4665.50	7373.10	40.15	42.28	54.76	86.54
GT 12	25	23	75505	60640	4.77	4.01	5594.40	6187.10	35.45	28.47	65.66	72.62
GT 13	25	23	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GT 14	25	23	85714	148607	5.42	9.84	5183.20	7803.60	40.24	69.77	60.84	91.59
GT 15	100	100	0	239889	0.00	15.88	0.00	2844.20	0.00	28.16	0.00	33.38
GT 16	100	95	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GT 17	100	100	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GT 18	100	100	465797	49667	29.43	3.29	5675.50	552.90	54.67	5.83	66.61	6.49
GT19	100	100	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GT 20	100	100	610015	417946	38.54	27.66	7073.10	5124.30	71.60	49.05	83.02	60.14
Total			**1582697**	**1510988**			43853	57377				
Ave.									**20.51**	**26.17**		

Table 2: UNIT CONTRIBUTION TO THE STATION, HOURS ROUN IN, CAPACITY FACTOR, AVAILABILITY FACTOR (%) FROM 2010 TO 2015

	Insta. Cap.	Ava.Cap	Energy Generated (MWh)			Unit Contribution to Station (%)			Hours Run			Capacity Factor (%)			Availability Factor (%)		
UNITS	**MW**	**MW**	**2012**	**2011**	**2010**	**2012**	**2011**	**2010**	**2012**	**2011**	**2010**	**2012**	**2011**	**2010**	**2012**	**2011**	**2010**
GT 3	25	20	0	0	0	0.00	0.00	0.00	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
GT 4	25	20	62423	4017	0	3.69	0.27	0.00	8205	300	0	31.85	2.05	0.00	96.30	3.52	0.00
GT 5	25	20	0	0	0	0.00	0.00	0.00	0	0	0	0	0.00	0.00	0.00	0.00	0.00
GT 6	25	20	0	597	67032	0.00	0.04	3.43	0	100	5095	0	0.30	34.21	0.00	1.17	59.80
GT 7	25	20	0	0	106537	0.00	0.00	5.45	0	0	7042	0	0.00	54.37	0.00	0.00	82.65
GT 8	25	20	101901	9814	23432	6.02	0.66	1.20	7120	755	1624	52	5.01	11.96	83.57	8.86	19.06
GT 9	25	23	0	71685	116857	0.00	4.82	5.98	0	4863	8211	0	33.65	54.86	0.00	57.08	96.38
GT 10	25	23	0	0	35901	0.00	0.00	1.84	0	0	2325	0	0.00	16.85	0.00	0.00	27.29
GT 11	25	23	0	97225	106519	0.00	6.53	5.45	7306	6940	7983	0	45.65	50.01	85.76	81.45	93.70
GT 12	25	23	72,419	80895	110181	4.28	5.44	5.64	7028	5554	8263	34	37.98	51.73	82.49	65.19	96.99
GT 13	25	23	0	0	0	0.00	0.00	0.00	0	0	0	0	0.00	0.00	0.00	0.00	0.00
GT 14	25	23	0	28,193	75883	0.00	1.89	3.88	0	2811	6434	0	13.24	35.63	0.00	32.99	75.52
GT 15	100	100	0	0	0	0.00	0.00	0.00	0	0	0	0	0.00	0.00	0.00	0.00	0.00
GT 16	100	95	414827	479355	409981	24.50	32.21	20.97	0	6575	5626	48.69	56.26	48.12	0.00	77.17	86.03
GT 17	100	100	242198	0	0	14.31	0.00	0.00	0	0	0	28.43	0.00	0.00	0.00	0.00	0.00
GT 18	100	100	5,874	9186	485468	0.35	0.62	24.83	1656	132	6803	0.69	1.08	56.98	19.43	1.55	79.84
GT19	100	100	107474	291003	269097	6.35	19.56	13.77	6016	4775	4088	12.61	34.16	31.58	70.61	56.04	47.98
GT 20	100	100	685717	416146	147907	40.51	27.96	7.57	6831	6214	2115	80.48	48.84	17.36	80.18	72.94	24.82
Total			**1328220**	**1488116**	**1954795**												
Ave												**17.44**	**15.46**	**25.76**			

	INST. Cap.	Ava Cap.	Energy Generated (MWh)			Unit Contribution to Station (%)			Hours Run			Capacity Factor (%)			Availability Factor (%)		
UNITS	**MW**	**MW**	**2015**	**2014**	**2013**	**2015**	**2014**	**2013**	**2015**	**2014**	**2013**	**2015**	**2014**	**2013**	**2015**	**2014**	**2013**
GT 3	25	20	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0	0	0	0
GT 4	25	20	115043	151512	62423	3.98	5.40	3.69	7072	8430	8205	58.71	77.32	31.85	83.01	98.94	96.30
GT 5	25	20	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0	0	0	0
GT 6	25	20	109206	13804	0	3.77	0.49	0.00	6616	720	0	55.73	7.04	0	77.65	8.45	0
GT 7	25	20	111125	81764	0	3.84	2.92	0.00	6797	4525	0	56.71	41.73	0	79.78	53.11	0
GT 8	25	20	107176	135173	101901	3.70	4.82	6.02	6937	7842	7120	54.69	68.98	52.00	81.42	92.04	83.57
GT 9	25	23	78343	0	0	2.71	0.00	0.00	4557	0	0	36.78	0	0	53.49	0	0
GT 10	25	23	130203	131219	0	4.50	4.68	0.00	7525	7332	0	61.13	61.61	0	88.32	86.06	0
GT 11	25	23	124260	108181	0	4.29	3.86	0.00	7525	6153	7306	58.34	50.79	0	88.32	72.71	85.76
GT 12	25	23	114876	148494	72419	3.97	5.30	4.28	7070	8390	7028	53.93	69.72	34.00	82.98	98.48	82.49
GT 13	25	23	121811	44009	0	4.21	1.57	0.00	6968	2289	0	57.19	20.66	0	81.78	26.86	0
GT 14	25	23	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0	0.00	0.00	0.00
GT 15	100	100	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0	0.00	0.00	0.00
GT 16	100	95	579260	616262	414827	20.02	21.98	24.50	7200	7603	0	67.99	72.33	48.69	84.51	89.23	0.00
GT 17	100	100	570250	692038	242198	19.70	24.68	14.31	7128	8244	0	66.93	81.23	28.43	83.66	96.76	0.00
GT 18	100	100	13608	0	5874	0.47	0.00	0.35	212	0	1656	1.6	0	0.69	2.49	0.00	19.43
GT19	100	100	488108	5466	107474	16.87	0.19	6.35	6134	60	6016	57.29	0.64	12.61	71.99	0.70	70.61
GT 20	100	100	230763	676145	685717	7.97	24.11	40.51	3092	7803	6831	27.08	79.36	80.48	36.29	91.58	80.18
Total			**2894032**	**2804067**	**1692833**												
Ave												**39.67**	**35.08**	**16.04**			

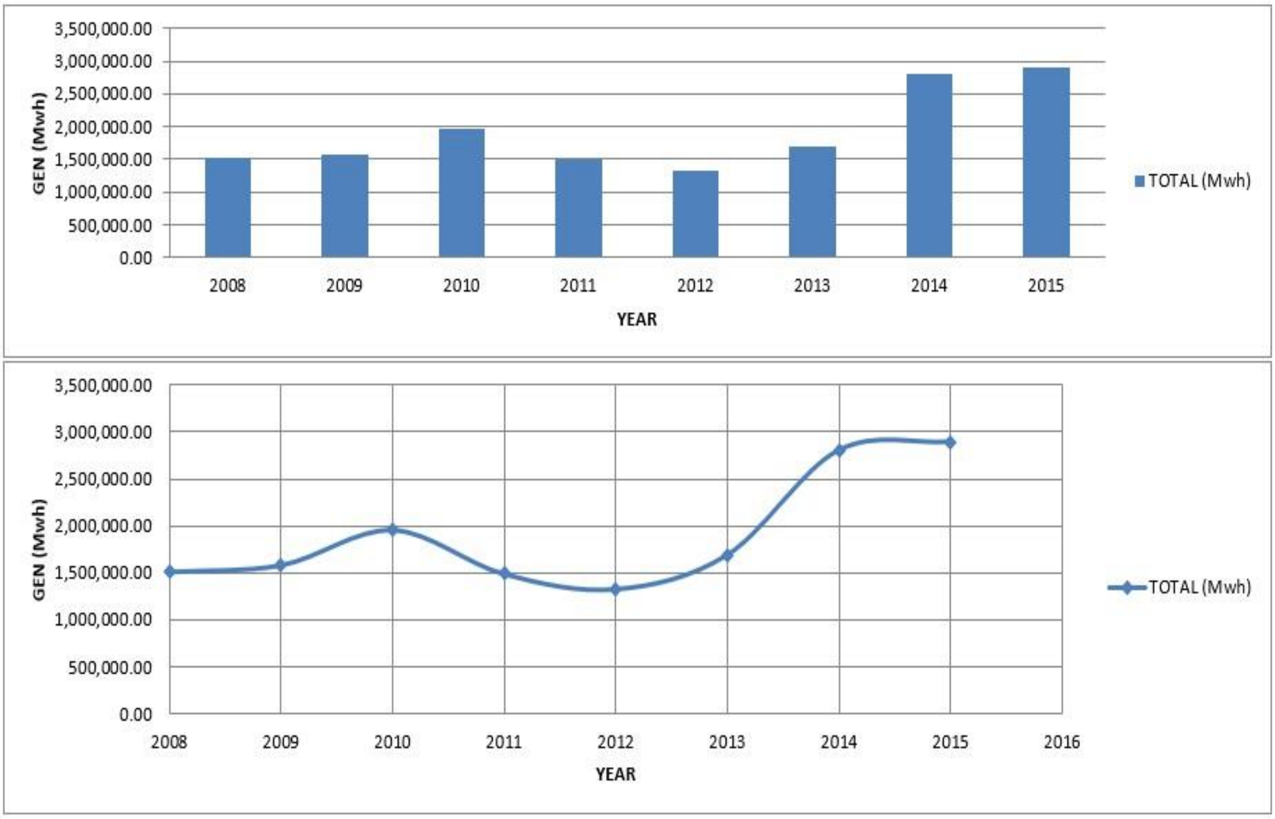

Fig 3: COMPARISON OF TOTAL ENERGY GENERATED: PRE & POST PRIVATISATION

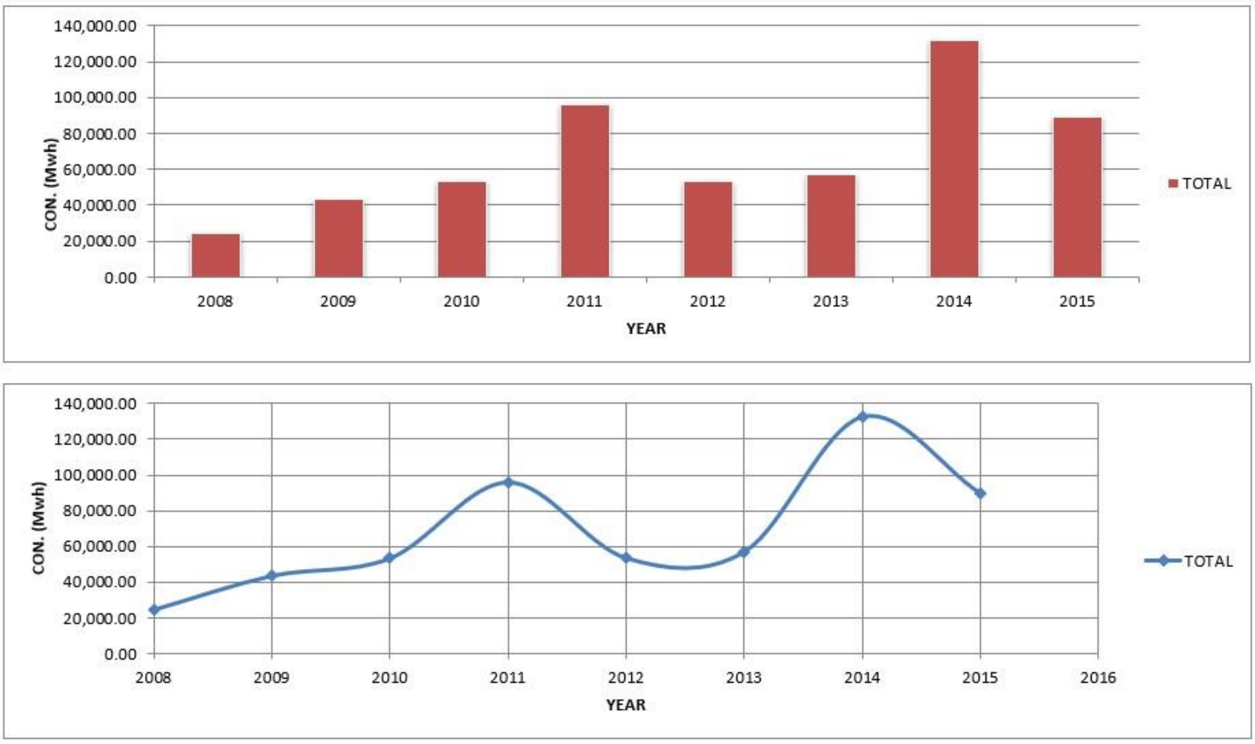

Fig 4: COMPARISON OF TOTAL ENERGY CONSUMED: PRE & POST PRIVATISATION

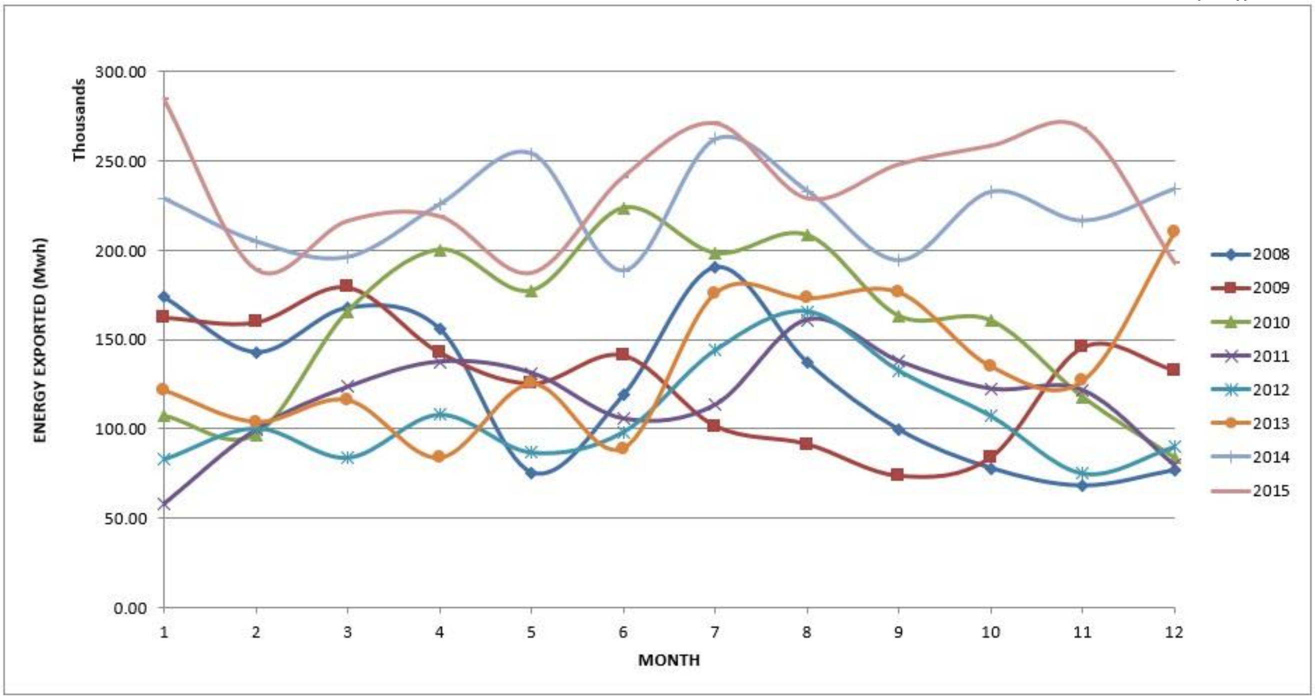

Fig 5: COMPARISON OF MONTHLY ENERGY EXPORTED: PRE & POST PRIVATISATION

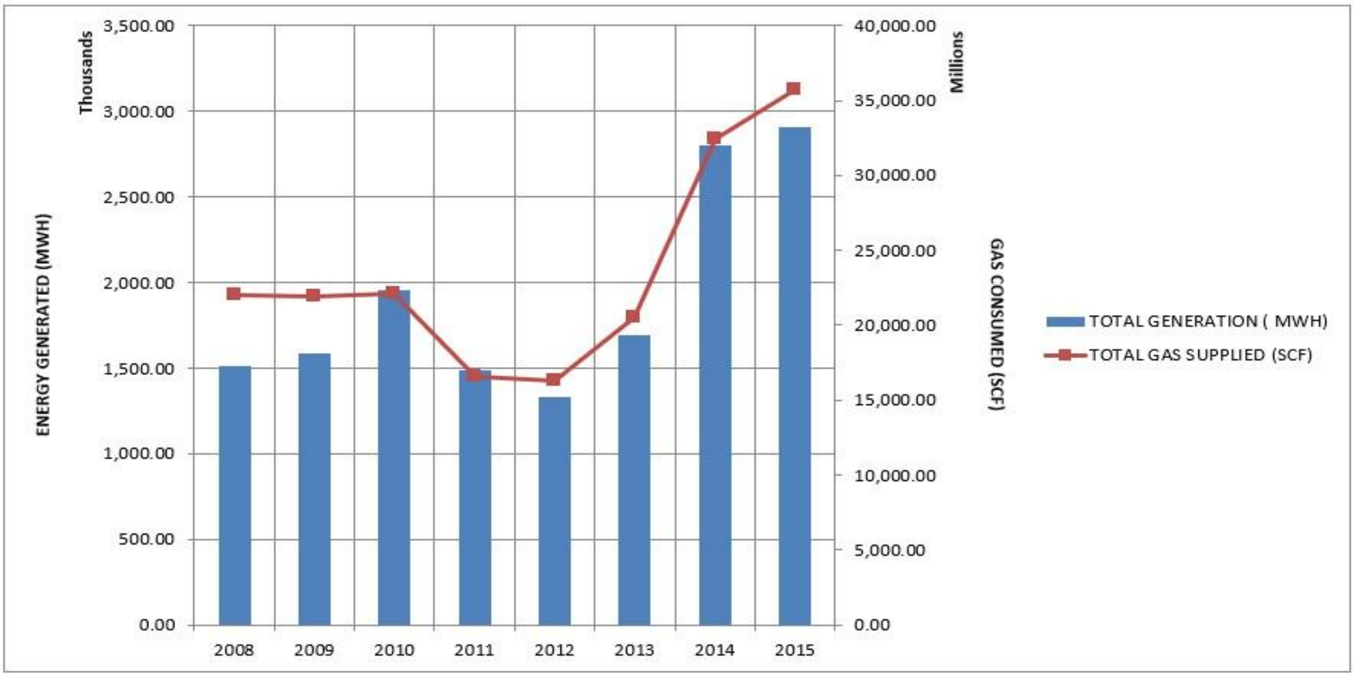

Fig 6: COMPARISON OF TOTAL GAS CONSUMED & ENERGY GENERATED: PRE & POST PRIVATISATION

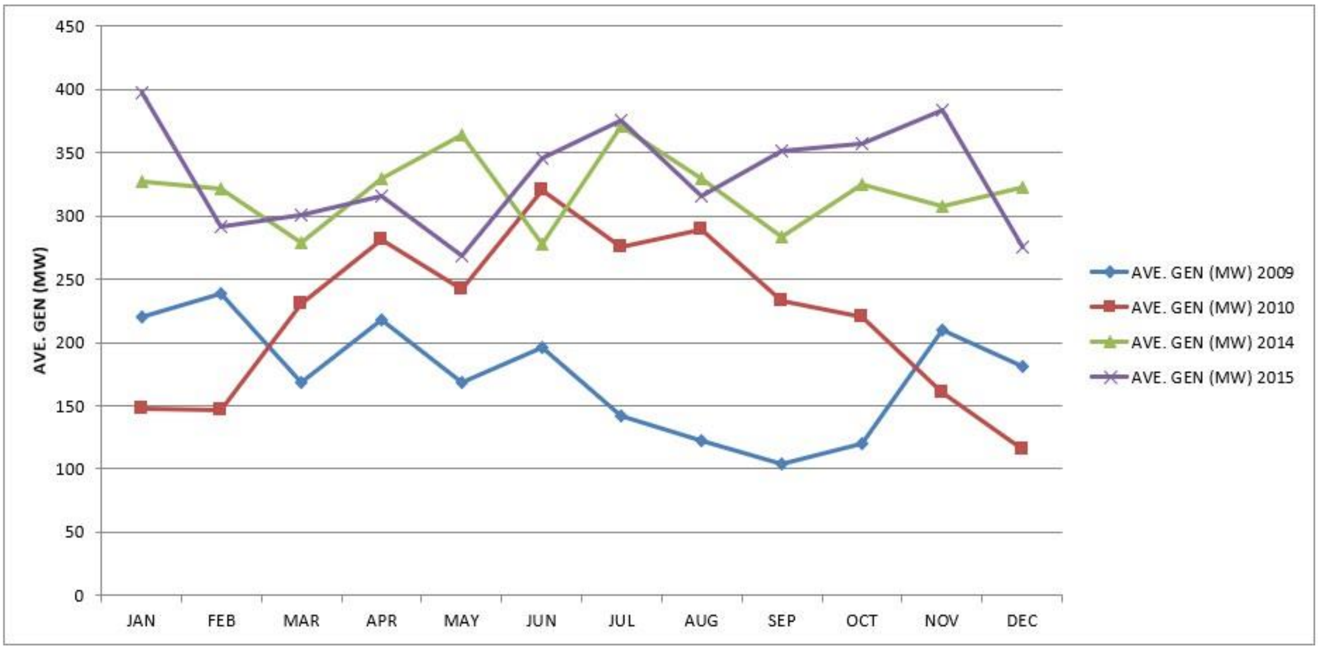

Fig. 7: COMPARISON OF AVERAGE GEN (MW) PRE (2009 & 2010) AND POST PRIVATISATION (2014 & 2015)

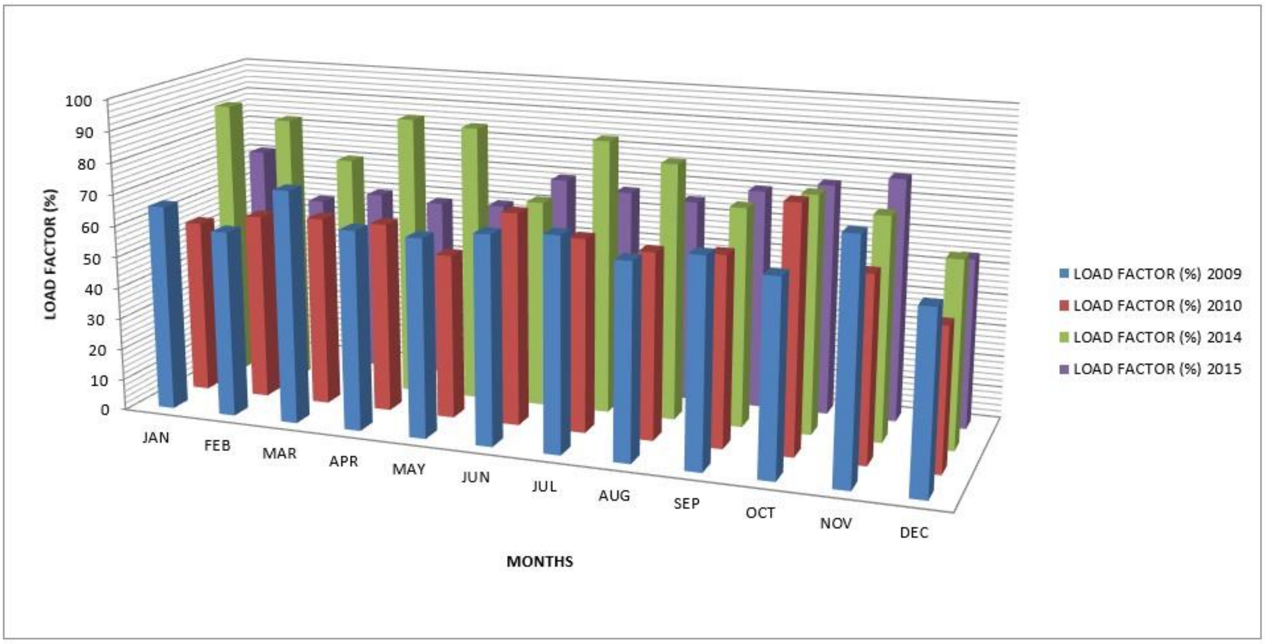

Fig 8: COMPARISON OF LOAD FACTOR (%) PRE (2009 & 2010) AND POST PRIVATISATION (2014 & 2015)

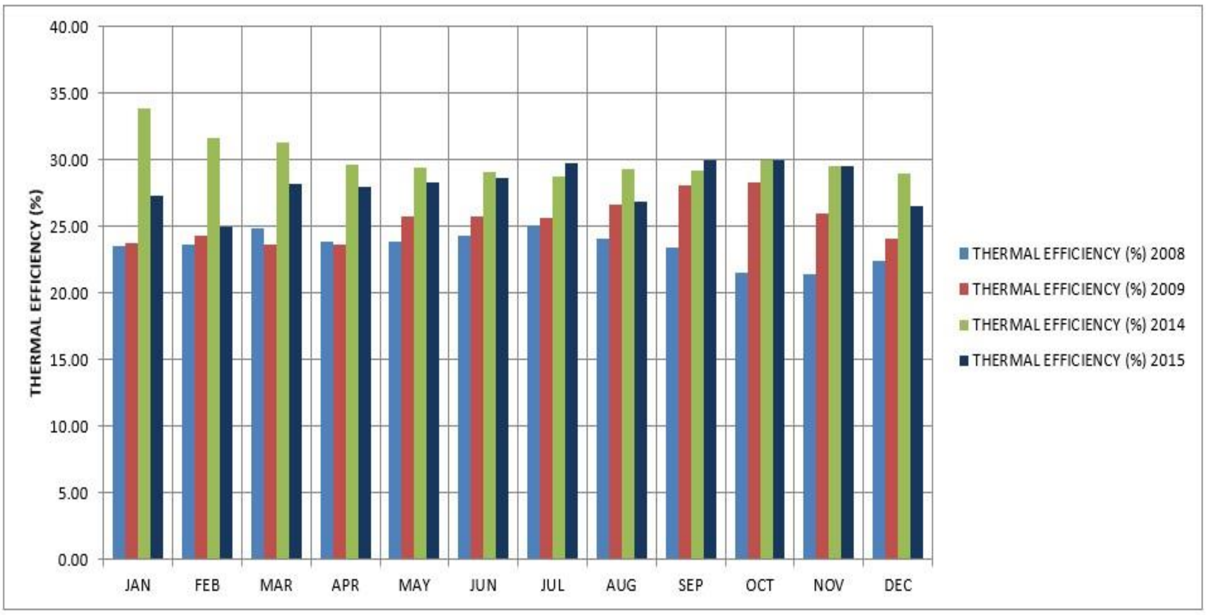

Fig. 9: COMPARISON OF ANNUAL THERMAL EFFICIENCY PRE & POST PRIVATISATION

4.0 DISCUSSIONS

4.1 ENERGY GENERATED

As clearly tabulated and shown in Table 1&2 and Fig 3 in 2008, the total energy generated was 1,510988.00MWh out of 10 functional gas turbine units. In 2009, total energy generated was 1,582,696.90MWh from 10 functional units also. 2010 had a total energy generated at 1,954,793.40 out of 12 functional units. 2011 had a total of 1488116MWh less than what was generated in 2010. A total of eleven gas turbine units were functional. Best performance was from Delta 4 and a peak generation was got from GT 20

In 2013 there was an increase in generation better than the previous year in 2012 which recorded 1,328,219.50MWh . 1,692,883MWh was recorded in 2013.

Post-Privatisation, Generation skyrocketed to 2,804,067MWh in 2014 with an increase in GT availability to 12. GTs 5, 6, 10, 11 which were not performing in 2013 were revived to their maximum performances.

In 2015 an all-time generation of 289,403MWh was witnessed, highest value recorded so far in Transcorp Power Limited within the years under review. Other non-operational GTs such as GT9 and GT 18 which did not perform in 2014 were also revived.

Maximum monthly generation was recorded in January 2015 valued at 295716.50MWh and 271001.6MWh in May 2014 as against 179863.90 in January 2008 and 230,189.10MWh in June 2010.

4.2 ENERGY CONSUMED

As shown in Fig4, total energy consumed in 2008, 2009, 2010 (before privatisation) were 24,649.98MWh, 43,539.55MWh and 53,353.99MWh respectively as against 132,194.40MWh and 89,455.86MWh recorded in 2014 and 2015 respectively. The increased consumption values could be likened to the corresponding increases in generation values. Higher generation would result in a higher energy consumption values over same period. Energy consumed refers to the energy used up in the facilities for administrative works and also for powering other auxiliary equipment in the plants like the hydrogen plants, Filtration machines etc.

4.3 ENERGY EXPORTED TO GRID

Fig 5 shows a representation on energy exported to the grid. Energy exported to the grid is a huge function of what is generated by the station. Pre-privatisation shows a record of 1,486,338.02MWh, 1,539,157.35MWh and 1,901,440.40MWh for the year 2008, 2009 and 2010 respectively.
Post-privatisation of Transcorp Power Ltd, higher records of 2,671, 872.20MWh and 2,804,575.94 in 2014 and 2015 respectively. Maximum values were obtained in July 2014 and Jan. 2015 valued at 262,343.00MWh and 284,660.20MWh respectively.

4.4 NUMBER OF HOURS RUN

Tables 1 &2 shows the total number of hours run in 2008 by the units was 57, 377hours, it dropped to 43,853hours in 2009 and rose again to 65,609hrs in 2010. Compared to post-privatisation values, 2014 recorded 69,291hrs while 2015 has a record-high of 84,833hours.

Peak value was recorded by GT10 valued at 7,515hrs in 2015 as against 7422 and 7033 recorded by GT9 and GT20 in 2008 and 2009 respectively.

4.5 CAPACITY FACTOR:

Tables 1 & 2 shows detailed information on the comparison of capacity factors pre and post privatisation of Transcorp power Limited**.** The maximum capacity factor for 2008 was recorded by GT6 and valued at 73.53%. It was valued at 71.60% by GT 20 in 2009. Compared to post-privatisation value in 2014 at 81.23% by GT 17 and 89.24% by GT16 in 2015

4.6 AVAILABILITY FACTOR

Tables 1 &2 shows that availability factors were better post-privatisation as seen in 2014 and 2015 when compared with previous years. Value as high as 98.94% and 98.47% were recorded for GT4 and GT12 respectively. 2015 has values as high as 88.32% and 84.51% for GT8 and GT13 respectively. 2014 value for GT12 met the industry standard of 95% compared with previous work on other gas turbines as cited, availability factor (%) is relatively fair.

4.7 LOAD FACTOR:

Fig.8 shows detailed information on the comparison on peak load and load factor values pre and post-privatisation of Transcorp Power Limited, Ughelli. Delta State. It can be seen that the load factor records were more impressive post-privatisation on the average. Jan 2014 had an all-time value of 90.06%, also 89.79% in April 2014. 77.29% was recorded in Nov. 2015. These are against peak record of 75.1% in November 2015, pre-privatisation. International best practice as cited for load factor is 80%, post privatisation values of 2014 exceeded this standard unlike in the other years.

4.8 UNIT CONTRIBUTION TO STATION'S TOTAL OUTPUT

Tables 1 & 2 shows detailed information on the percentage unit contributions pre and post privatisation of Transcorp power Limited.

2008 and 2009 for GT 12 were valued at 4.01% and 4.77% respectively. Individual unit's generation in MWh were valued at 60640MWh and 75505MWh for 2008 and 2009 respectively. Almost double the energy generated in MWh were obtained post-privatisation by the GT12 in 2014 and 2015 respectively but the percentage contribution in 2015 is only 3.97% in relation with the Total energy generated in Mwh in same year. 2014 value was much higher than in 2015. It was valued at 5.3%

A look at the performance of each gas turbine unit to the station's generation as shown in Tables 4.14-4.16 reveals that GT2 which has been unavailable pre-privatisation was resuscitated to maximum performance post-privatisation. Same also were the cases of GT 13 and GT19.

On the other way round, GT14 which was at its best performance pre-privatisation has not been functional post-privatisation of Transcorp Power Limited for the periods under review due to persistent blade failure which has lingered since 2011 due to parts unavailability for the original manufacturers.

In general, a total of 10 gas turbines were operational pre-privatisation as against 12 and 14 fully operational turbines post-privatisation in 2014 and 2015 respectively.

4.10 GAS SUPPLIED & ENERGY GENERATED

Fig.6 shows clearly that much volume of gas was supplied post privatisation (2014 and 2015) which equally resulted in the improved Total Generation (MWh) than in the previous years.

4.11 THERMAL EFFICIENCY

Fig.9 shows that thermal efficiency of plants post-privatisation outweighs their performance prior privatisation. January 2014 has a recorded all-time value of 33.85% and 31.66%, 31.33% in February and March, respectively. 2015 equally recorded high thermal efficiencies of 29.78%, 29.93%, and 29.48% in July, September, October, and November, respectively. This is as against peak values of 25.06% in July 2008 and 28.32% in October 2009.

5.0 CONCLUSION

Privatisation of the power industry has been argued and adopted as a step in the right direction towards achieving stable electricity. In this study, from the data analysis carried out and findings in Transcorp Power Limited, Ughelli; one the privatized power generating companies in Nigeria, some interesting results turned out.

Energy generated in megawatts-hour after the company has been completely privatized (2013-2015) far outweighs what used to be obtainable. Total Energy exported to the national grid for onward distribution equally improved tremendously post privatisation of Transcorp Power Limited as against what has always been obtainable over the past decade.

There were great improvements also with regards to unit contribution to station generation post privatisation of the station. Most of the abandoned units came back to their maximum performances. Percentage generation to installed station capacity also saw an increase. Also recorded was an improved generation and thermal efficiency of the plants post privatisation.

The number of hours the plants were in operation post privatisation far outweighs their values pre-privatisation as seen from the availability factors recorded. Post

privatisation values of the Generation Utilization Index, Capacity Factors and Thermal Efficiencies of plants were equally more desirable than it were pre-privatisation.
From the aforementioned findings, it suffices to say that privatisation has really paid off in Transcorp Power. It could be inferred that management under the private sector is way better than it was with the government.

5.1 ACKNOWLEDMENTS

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