Examination of the Reliability of Electricity Service in Nigeria and the Contemporary Reliability Challenges Encountered by Service Providers and Customers

Presented by

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Outline

- Introduction
- Reliability Measures
- Typical KPI Data Relating to Reliability
- Reliability Indices
- Challenges on Reliability Issues
- Conclusion

Introduction

- Most people and businesses which purchase electricity are interested to know how reliable the supply will be.
- Power disruptions come in form of Planned outage, Unplanned outage and Momentary interruptions.
- Power disruptions drain money which affects the economy of a state with loss in productivity of every business.
- Ensuring service reliability is important in utility regulation due to its effect on investors (service provider), customers and the state.
- The current trend of electric utility restructuring and deregulation also pose a unique challenge for enforcing service reliability.
- Regulators enforce quality regulation to improve service reliability.

Introduction ….

- In brief, reliability has to do with total electric interruptions - complete loss of voltage, not just deformations of the electric sine wave.
- Reliability does not cover sags, swells, impulses or harmonics which are issues of power quality.
- Reliability indices typically consider such aspects as:
  - the number of customers;
  - the connected load;
  - the duration of the interruption measured in seconds, minutes, hours, or days;
  - the amount of power (KVA) interrupted; and
  - the frequency of interruptions.
- Power reliability can be defined as the degree to which the performance of the elements in a bulk system results in electricity being delivered to customers within accepted standards and in the amount desired.

Reliability Measures

- There are many indices for measuring reliability.
- The three most common are: (As defined in IEEE Standard 1366)
  - **SAIFI** - system average interruption frequency index, is the average frequency of sustained interruptions per customer over a predefined area. It is the total number of customer interruptions divided by the total number of customers served**.**
  - **SAIDI**- system average interruption duration index, is commonly referred to as customer minutes of interruption or customer hours, and is designed to provide information as to the average time the customers are interrupted. It is the sum of the restoration time for each interruption event times the number of interrupted customers for each interruption event divided by the total number of customers**.**
  - **CAIDI** - customer average interruption duration index, is the average time needed to restore service to the average customer per sustained interruption. It is the sum of customer interruption durations divided by the total number of customer interruptions.

Reliability Measures

- Other indices for measuring reliability are:
  - **MAIFI** - the total number of customer momentary interruptions divided by the total number of customers served. Momentary interruptions are defined in IEEE Std. 1366 as those that result from each single operation of an interrupting device such as a recloser.
  - **LOLP (Loss of Load Probability)** - used to characterize the adequacy of generation to serve the load on the bulk power system; it does not model the reliability of the power delivery system—transmission and distribution—where the majority of outages actually occur.
  - **High Voltage fault Clearing Index** – Percent of high voltage fault cleared within eight hours.
  - **Metering index** – Ratio of number of customers metered to the total number of customer served by the service provider. Introduced in Nigeria due to our peculiar situation on issues of metering. More of service issue than reliability of supply.

Typical KPI Data Relating to Reliability

January 2015

Item	Description	Units	Abuja	Benin	Eko	Enugu	Ibadan	Ikeja	Jos	Kaduna	Kano	PH	Yola
HV faults	Total number of HV (33kV and 11kV) faults reported in the month	number	555	1,879	612	3,042	2,680	663	1,312	235	94	272	122
HV faults cleared within 8 hours	Total number of HV (33kV and 11kV) faults cleared within 8 hours	number	362	1,435	248	2,786	2,193	370	1,312	220	64	220	81
Interruption duration	Total duration of 33kV system outages	hours	840	524			18,239	7,376	443	386		261	357
Customer interruptions - number	Total number of all recorded customer interruptions in the month	number		2,361	4,520	9,538	3,729	640	1,736	235	1,013	557	200
Customer interruptions - customers affected	Total of the numbers of customers affected by each recorded interruption	number		818,855	383,701	135	788,909	321	1,736			243,899	729
Total customers	Total number of customers of all classes at the end of the month	number	742,602	818,855	383,701	704,288	1,428,361	689,302	309,290	373,753	297,673	331,683	171,984
Metered customers	Total number of customers of all classes with functioning meters at the end of the month	number	357,045	561,174	205,638	383,022	463,131	235,353	110,774	142,939	109,672	149,426	35,674
HV faults clearance index	Percentage of HV faults cleared within 8 hours	%	65%	76%	41%	92%	82%	56%	100%	94%	68%	81%	66%

Reliability Indices

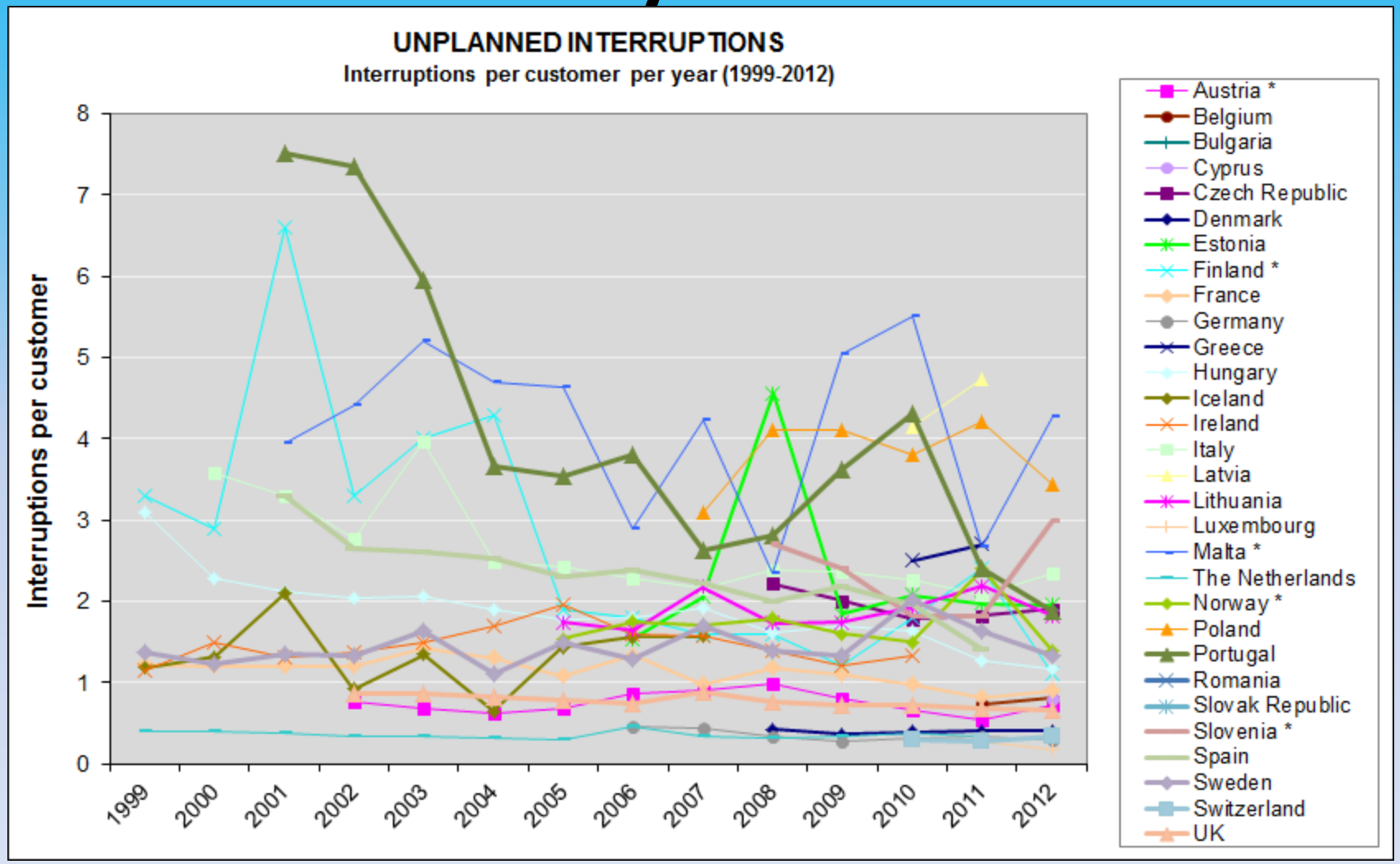
January 2015

Index	Description	Abr.	Abuja	Benin	Eko	Enugu	Ibadan	Ikeja	Jos	Kaduna	Kano	PH	Yola
Customer Average Interuption Duration Index	Sum of customer Interruptions duration /Total number of Customer Interruptions	**CAIDI**	NA	0.22	0.00	0.00	4.89	11.53	0.26	1.64	0.00	0.47	1.79
System Avarage Intruption Frequency Index	Total Number of Customers Interruptions/Total number of customers served	**SAIFI**	0	6,282	0	0	120,885	41	30	NA	0	2,303	18
System Avarage Intruption Duration Index (Customer minites of interuptions)	Sum of restorations time for interruptin event times number of interupted customers/Total Number of Customers	**SAIDI**	0	1,256	0	0	24,177	8	6	NA	0	461	4
Metered customers Index	Percentage of Metered Customers	**MCI**	48	69	54	54	32	34	36	38	37	45	21
HV faults clearance index	Percentage of HV faults cleared within 8 hours	%	65%	76%	41%	92%	82%	56%	100%	94%	68%	81%	66%

Reliability Indices ….

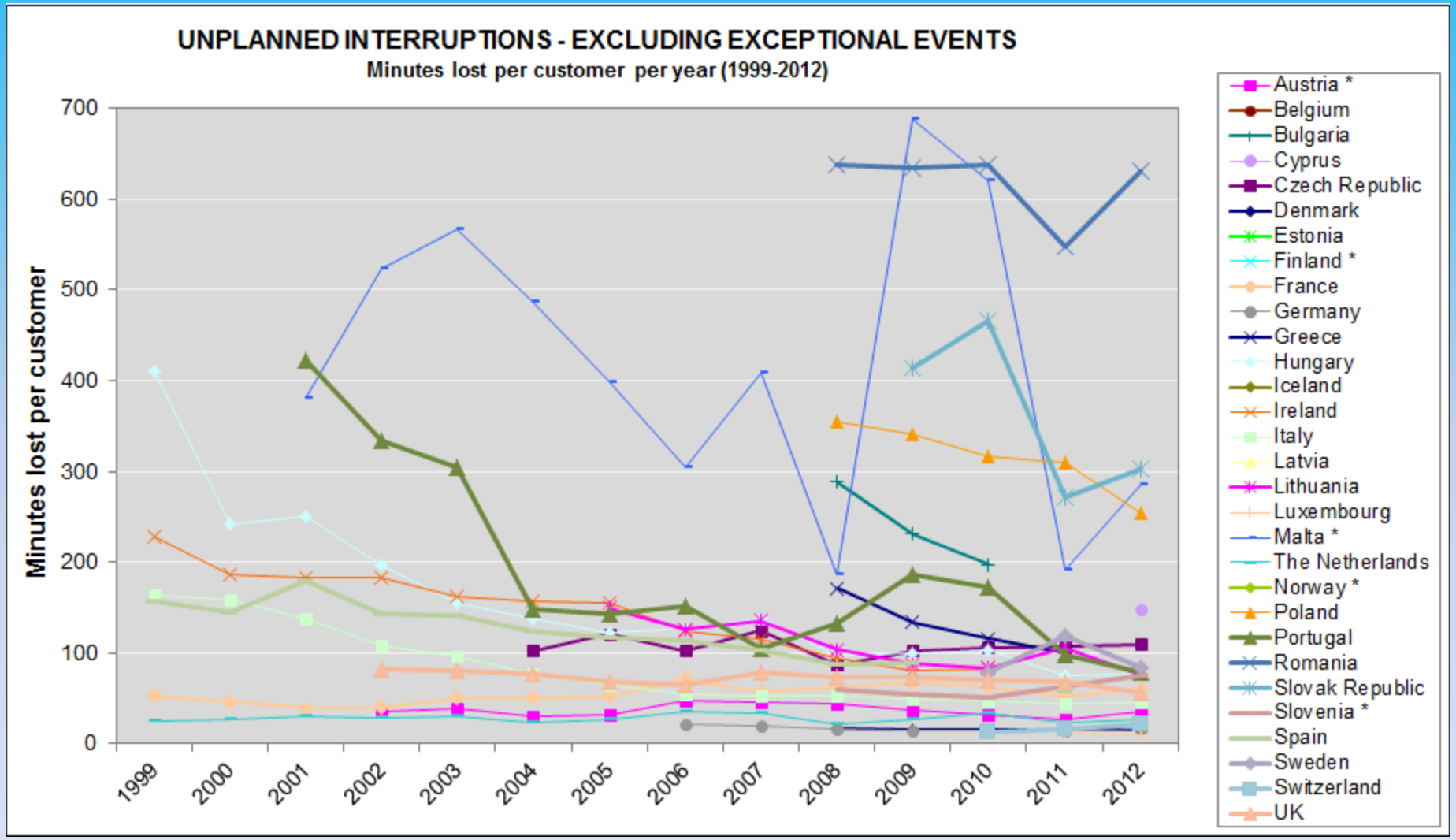
- Comments on the Indices computation
  - Number of interruptions at the 33KV and 11KV were used for the computation as given
  - Outage duration used is that of 33KV which will affect larger number of customers but does not consider outages at low voltage distribution levels
  - Momentary Interruptions were not captured

Reliability Indices



Sample of SAIFI from other countries copied from Council of European Energy Regulators Benchmarking Report 5.1 on continuity of electricity supply Feb. 2014

Reliability Indices



Sample of SAIDI from other countries copied from Council of European Energy Regulators Benchmarking Report 5.1 on continuity of electricity supply Feb. 2014

Challenges on Reliability Issues

- Incorrect and reliable data from the service providers :
  - evidenced from the KPI submissions
  - Technology challenges (SCADA and information system)
  - Gaming of the system (Human factors)
- Supply from the Grid:
  - Poor supply and generation availability
  - System Collapses
  - Load allocation and Transmission Constraints

Supply from the Grid

- Poor supply and generation availability factor

DETAILS	MW	HRS	DATE
PEAK DEMAND FORECAST (CONNECTED + SUPPRESSED LOAD)	14,630	20:00	30/04/2015
GENERATION CAPABILITY AT PEAK	6649.5	-do-	-do-
UNITS ON BAR CAPABILITY AT PEAK	3491.2	-do-	-do-
PEAK GENERATION	3157.2	-do-	-do-
LOWEST GENERATION	2616.8	13:00	30/04/2015
8-HOURLY DURATION PEAK	3030.8	0000-0800	-do-
	2821.9	0900-1600	-do-
	3157.2	1700-2400	-do-
PEAK GENERATION TO DATE	4517.6	22:00	23/12/2012
MAXIMUM AVAILABLE CAPACITY TO DATE	7492.6	06:00	14/04/2014
MAXIMUM PEAK GENERATION CAPABILITY TO DATE	7099	07:00	13/04/2014
MAXIMUM ENERGY GENERATED (MWH) TO DATE	99,450.60	0000-2400	31/10/2014

Extract from the NCC Daily operational Report of Friday 1st May, 2015

Supply from the Grid

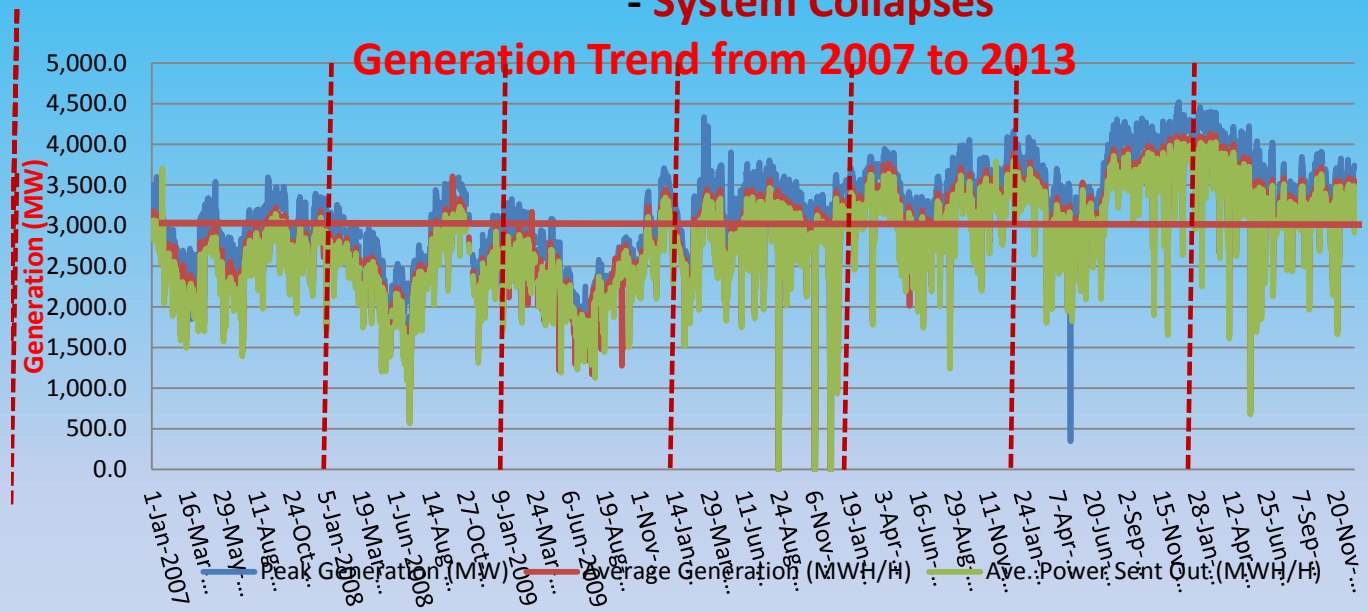
- Poor supply and generation availability

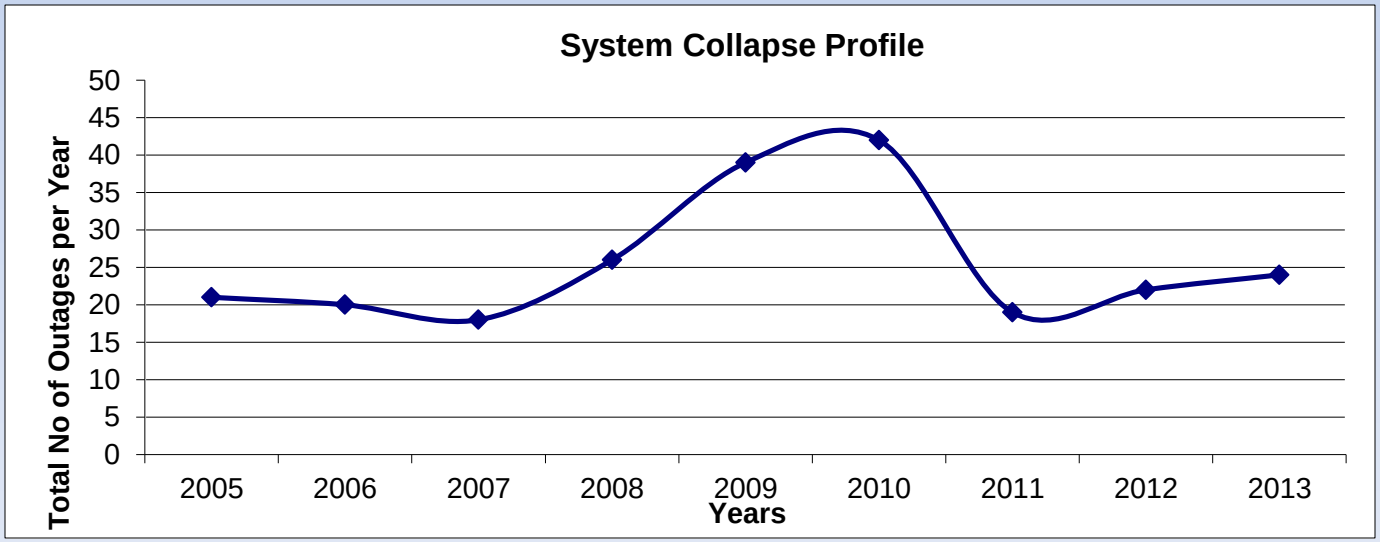
S/N	Power Station	Installed Capacity (MW)	Average Daily Peak (MW)	Year's Max. Peak (MW)	Capacity Factor (%)
1	Kainji	760	120.57	205	16%
2	Jebba	578.4	328.96	451	57%
3	Shiroro	600	317.91	700	53%
4	Egbin	1320	681.12	1014	52%
5	AES	300	166.93	257.8	56%
6	Sapele	1020	57.4	156	6%
7	Sapele NIPP	250	150.11	359.3	60%
8	Ibom	190	0	0	0%
9	Okpai	480	353.26	473	74%
10	Afam I-IV	931.6	43.48	65	5%
11	Afam VI	655	411.51	660	63%
12	Delta	822	199.6	431	24%
13	Geregu	414	133.91	424	32%
14	Omoku	100	0	0	0%
15	Olorunshogo	335	62	213.8	19%
16	Olorunshogo II	500	116.65	328.7	23%
17	Omotosho	335	63.68	111.2	19%
18	Omotosho NIPP	451	219.97	455	49%
19	Trans-Amadi	136	0	0	0%
20	Geregu NIPP	434	121.19	452	28%
21	Rivers IPP	180	94.35	155	52%
22	Alaoji		0	0	0
23	Ihovbor NIPP	508	96.26	311	19%

Obtained from 2013 Generation Report developed from NCC Operational Report

Supply from the Grid

- System Collapses





Obtained from 2013 Generation Report developed from NCC Operational Report

Supply from the Grid

- Load allocation and Transmission Constraints

2013 Energy Delivered						
DISCOs	2013	2012	2011	% Load Delivered	MYTO Allocation	Deviations
Abuja	3,101,891,010	2,806,259,770	2,446,685,420	13.13	11.50	1.63
Benin	2,983,917,185	2,833,737,587	2,891,278,193	12.63	9.00	3.63
Eko	2,349,262,020	2,266,838,911	2,074,286,556	9.95	11.00	-1.05
Enugu	2,681,102,538	2,611,673,770	2,407,175,990	11.35	9.00	2.35
Ibadan	3,258,771,110	3,154,298,979	3,118,558,102	13.80	13.00	0.80
Ikeja	3,524,958,210	3,416,941,650	2,680,057,850	14.93	15.00	-0.07
Jos	1,084,490,654	1,072,805,486	1,006,288,850	4.59	5.50	-0.91
Kaduna	1,634,539,859	1,718,692,515	1,660,261,762	6.92	8.00	-1.08
Kano	910,019,967	1,028,942,309	1,189,522,425	3.85	8.00	-4.15
PH	1,680,167,938	1,849,618,028	1,453,512,706	7.11	6.50	0.61
Yola	407,200,460	343,174,759	363,921,230	1.72	3.50	-1.78
Total	23,616,320,952	23,102,983,764	21,291,549,084			

Table obtained from Report on the 2013 Commercial KPI

Conclusion

- Electricity Service in Nigeria is still evolving hence the reason for the challenges identified in the course of the presentation.

- Therefore, it is my hope that we will take some moments to discuss the way forward together.

THANK YOU