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Loadability Analysis of the Effect of Generation and Transmission Expansion in Southern Nigeria

F.O. Agbontaen* *email id: osazee.agbontaen@uniben.edu

S.A. Ike email id: sam.ike@uniben.edu

T. Aika email id: ayemhenre.aika@uniben.edu

*Corresponding author

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Abstract **– Electrical energy demand in Nigeria has increased due to economic activities as a result of increase in population. The Southern region, experience stranded power due to the proximity of most of the gas thermal power stations and inadequacy of the tie lines for load evacuation. The southern buses also experience over voltage as a result of the reactive power generation from the various power plants within the vicinity. The existing 330kV Nigeria transmission network was enhanced by the introduction of new lines and power stations and the effect was analyzed.**

Newton-Raphson algorithm in ETAP 12.6 was used to simulate and analyze the network. The parameters used for the study included bus data, transmission lines power rating, generators active power, transformers rating and base load.

The base case operating condition as obtained from the power flow on which the various transfer cases were implemented, gives a fair generation and loading pattern of the Nigerian grid. The total installed generating capacity of the base case considered was 11,948MW out of which 4,420.4MW was available for load level of 3,633.6MW. Result shows that the maximum load the existing network can accommodate when all single circuits in the network is changed to double circuit and ten (10) transmission lines and four (4) power stations is inserted into the network is 12,342.296MW and 6,429.228MVar at a loading capacity of 12,059.054MW and 7,411.694MVar. When the Newton – Raphson iteration method was applied, the enhanced network evacuated 97.71% of the energy, while 82.2% was evacuated by the existing network.

Keywords **– Transmission Line, Network, Loadability, Load Flow, Maximum Load, Power Station.**

I. Introduction

Increase in economic activities resulting from increase in population and social advancement has led to increase in electrical energy demand. This has increased the burden on the existing transmission assets and in some cases, has caused the loading of the transmission assets beyond their design limits with consequent reduction in power quality and power outages in extreme cases [1]. The current transmission system in Nigeria comprises 5523.8 km of 330 kV, 6801.49 km of 132 kV, 32No. 330/132 kV substations with total installed transformer capacity of 7688 MVA. 105No. 132/33/11 kV substations with total installed transformer capacity of 9130 MVA. The average available capacity on 330/132 kV is 7364 MVA and 8448 MVA on 132/33 kV [2]. Some of the major challenges associated with the South-South, South East and South West regions (Edo, Delta, Bayelsa, Rivers, Akwa Ibom, Cross River, Abia, Enugu, Anambra, Imo, Ebonyi, Oyo, Osun, Ekiti, Ondo and Ogun states) of the transmission network are over voltages due to reactive power generation from the various power plants within the vicinity and power is stranded due to the proximity of most of the gas thermal power stations and inadequacy of the tie lines to evacuate load. Lagos (Lagos State) south west region is prone to transmission congestion [2] – [3]. The grid bus is characterized by poor voltage profile in most parts of the network, frequent system collapse and exceedingly high transmission losses [4] – [5]. Thus, there is need to have a sustainable, reliable and stable supply to create an enabling balanced economy [6]. The unreliability of the System Network has impacted on the nation's socio-economic development and industrialization hence, the recent launch of the roadmap of the power sector reform by the Federal Government [7].

II. Related Work

In [8], the authors considered power flow analysis of the Nigeria 330kV electrical power system using Newton-Raphson algorithm in MATLAB/SIMULINK software. The results obtained showed that out of the 30 buses in the network examined, 7 bus voltages were outside the statutory limit of 0.95 – 1.05p.u that is 313.5 – 346.5KV which are buses 14 (Jos) with value 0.8171pu, bus 17 (Gombe) 0.8144p.u, bus 18 (Abuja) 0.9402pu, bus 19 (Maiduguri) 0.8268pu, bus 22 (Kano) 0.7609pu, bus 29 (Kaduna) 0.8738pu, and bus 30 (Makurdi) 0.8247p.u under normal uncompensated condition. Capacitive shunt compensation was carry out and appreciable values were recorded. Results obtained after compensation revealed acceptable voltage levels at the problem buses.

The analysis of power flow of Nigerian 330kV grid system (pre and post) using Matlab was examined by [9]. They assessed the reliability, stability and efficiency of the proposed (post reform) 10,000MW capacity 330kV grid and the volume to which it is going to offer option to the several issues that currently plague the prevailing (pre reform) grid. MATLAB was used; load flow studies was first conducted on both the 31 bus system pre reform grid and the 49 bus system post reform grid using both the Gauss-Seidel and Newton-Raphson iteration methods. The network was discovered to have significant deficiencies in voltage level and power flow along the transmission lines. The affected lines which were single circuits were replaced with double circuit transmission lines and the simulation results showed that this was able to lower the power evacuation burden on these lines well below their thermal ratings; it also showed reduction in line losses. Reactive power compensations were also applied at the buses that experienced high voltages and results revealed very high

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improvement in voltage levels at affected buses as no bus voltage exceeded the acceptable limits (-15% to +10% of nominal value) after compensation.

III. Methodology

Data was collected from Transmission Company of Nigeria (TCN) for load flow analysis. The analysis on the data was done using Newton – Raphson algorithm in Etap 12.6 load flow analyzer which is a power system modeling, design, analysis, optimization, control, and automation software.

Newton – Raphson method or techniques for load flow studies was used to simulate and investigate the generated power of the network. The load flow program calculates the magnitude and phase angle of the voltage at each bus, real and reactive power flowing in each line respectively.

A number of methods for power flow calculation use equations in different forms considering sending end i^{th}end or receiving end j^{th}end. In this work, we used the same method in section 2.26 of [10] where a detailed explanation of Newton-Raphson method as applicable to power flow problem was given.

The linear equation in compact form used is given as:

$$\begin{pmatrix} \Delta P \\ \Delta Q \end{pmatrix} = \begin{pmatrix} J_1 & J_2 \\ J_3 & J_4 \end{pmatrix} \begin{pmatrix} \Delta \delta \\ \Delta V \end{pmatrix} \quad (1)$$

IV. Presentation of System Data

The data used in this work is as presented in Tables 1 and 2. We considered 20 generating stations, 67 transmission lines and a total of 59 buses stations for the existing network. While the expanded network consist of sixty six (66) buses, seventy nine (79) transmission lines and twenty four (24) generating stations.

Table1: Existing 330kV Transmission Line Network circuit

S/N	From Station Location	To Station Location	No of circuits	Length (Km)	S/N	From Station Location	To Station Location	No of circuits	Length (Km)
1	Afam G.S	Alaoji T.S	2	25	35	Ikot - Ekpene T.S	Alaoji T.S	2	57.9
2	Afam G.S	PH main T.S	2	8	36	Ikot - Ekpene T.S	Odukpani T.S	2	88.5
3	Ahoda T.S	Gbarian G.S	2	87.4	37	Jebba G.S	Jebba T.S	2	8
4	Aiyede T.S	Olorunsogo G.S	1	125	38	Jebba T.S	Ganmo T.S	1	70
5	Ajah T.S	Lekki T.S	2	5.5	39	Jebba T.S	Osogbo T.S	2	157
6	Ajah T.S	Alagbon T.S	2	21	40	Jebba T.S	Shiroro G.S	2	244
7	Ajaokuta T.S	Geregu G.S	1	75	41	Jos T.S	Makurdi T.S	1	285
8	Aladja T.S	Sapele G.S	1	93	42	Kaduna T.S	Shiroro G.S	2	95
9	Alagbon T.S	Lekki T.S	2	24.5	43	Kaduna T.S	Kano T.S	1	230
10	Alaoji G.S	Alaoji T.S	2	50	44	Kaduna T.S	Jos T.S	1	197
11	Alaoji T.S	Owerri T.S	2	77.1	45	Kainji T.S	Kainji G.S	2	0.47
12	Asaba T.S	Onitsha T.S	2	65.8	46	Kainji T.S	Jebba T.S	2	81
13	Benin T.S	Ajaokuta T.S	2	195	47	Katampe T.S	Gwagwalada T.S	1	60
14	Benin T.S	Delta G.S	1	107	48	lokoja T.S	Ajaokuta T.S	1	215
15	Benin T.S	Sapela G.S	2	50	49	New Haven T.S	Ugwaji T.S	2	65
16	Benin T.S	Asaba T.S	2	153.9	50	New Haven T.S	Onitsha T.S	1	96
17	Birnin – Kebbi T.S	Kainji T.S	1	310	51	Odukpani T.S	Adiabor T.S	2	10
18	Damaturu T.S	Maiduguri T.S	1	260	52	Okearo T.S	Egbin T.S	2	30
19	Delta G.S	Aladja T.S	1	30	53	Omotosho G.S	Benin T.S	1	120
20	Egbin G.S	Benin T.S	1	218	54	Onitsha T.S	Okpai G.S	2	56
21	Egbin G.S	Aja T.S	2	14	55	Onitsha T.S	Alaoji T.S	1	138
22	Ganmo T.S	Osogbo T.S	1	87	56	Osogbo T.S	Aiyede T.S	1	119
23	Gbarian G.S	Yenegoa T.S	2	25	57	Osogbo T.S	Ikeja west T.S	1	235
24	Gombe T.S	Damaturu T.S	1	160	58	Osogbo T.S	Ihovbor G.S	1	251
25	Gombe T.S	Yola T.S	1	240	59	Owerri T.S	Ahoda T.S	2	73.6
26	Gwagwalada	Shiroro G.S	1	144	60	PH main T.S	Omoko T.S	2	83
27	Gwagwalada T.S	Lokoja T.S	1	135	61	Sapele G.S	Delta G.S	1	93
28	Ihovbor G.S	Benin T.S	1	20	62	Shiroro G.S	Katampe T.S	1	144
29	Ikeja west T.S	Akangba T.S	2	18	63	Paras energy T.S	Sagamu T.S	2	4
30	Ikeja west T.S	Omotosho T.S	1	160	64	Trans amadi T.S	PH main T.S	2	8
31	Ikeja west T.S	Okearo T.S	2	32	65	Egbin G.S	Ikorodu T.S	2	17
32	Ikeja west T.S	Egbin T.S	1	62	66	Ikorodu T.S	Sagamu T.S	2	34
33	Ikeja west T.S	Olorunsogo G.S	1	50	67	Asco G.S	Ajaokuta T.S		50
34	Ikot - Ekpene T.S	Ugwaji T.S	2	174		Total			6717.67

Table 2: Bus loading

S/N	Terminal Bus	Rating (MVA)	S/N	Terminal Bus	Rating (MVA)	S/N	Terminal Bus	Rating (MVA)
1	Afam	105.882	11	Delta	75.647	21	Kainji G.S	117.647
2	Aiyede T.S	117.647	12	Egbin G.S	1176.471	22	Kano T.S	217.529
3	Aja T.S	58.824	13	Ganmo T.S	75.882	23	Katampe T.S	235.294
4	Ajaokuta T.S	117.647	14	Geregu NIPP & G.S	164.706	24	Maiduguri T.S	58.824
5	Akangba T.S	131.765	15	Gombe T.S	235.294	25	New Haven T.S	294.118
6	Aladja T.S	96.588	16	Ikeja West T.S	352.941	26	Okaero T.S	117.647
7	Alaoji T.S	117.647	17	Jebba T.S	10.118	27	Okpia G.S	11.765
8	Alaoji G.S	52.588	18	Jebba G.S	117.647	28	Onitsha T.S	135.529
9	Benin T.S	184.471	19	Jos T.S	352.941	29	Oshogbo T.S	176.471
10	Birni-Kebbi T.S	117.647	20	Kaduna T.S	195.529	30	Shiroro G.S	72.353
						31	Yola T.S	117.647

V. Discussion of Result from the Analyzed Network

Analyzing the network to determine the performance effect when the Southern region was enhanced to allow more power to be evacuated within the network was done. To determine the load carrying capacity of the network, ETAP 12.6 Load flow Analyzer was used to simulate the 330kV expanded network consisting of sixty six (66) buses, seventy nine (79) transmission lines and twenty four (24) generating stations (13,290MW installed generating capacity). Meanwhile generating stations which has more than one stations in one place like Olorunsogo I and II were grouped together. The input data used in the simulation of the maximum load capacity are the various line loading and generation as obtained from Transmission Company of Nigeria (TCN) which represents the base case for the model. Electric power transfer was investigated by the insertion of the following power station; Calabar 561MW, Ibom 191MW, Aba 140 and Azura 450MW into the network which increased the total installed capacity to 13,290MW. The network was further expanded by transmission lines shown in table 3 to ascertain the maximum load capacity. Results shows that the network was able to evacuate 12,342.296MW and 6,429.228MVar at a loading capacity of 12,059.054MW and 7,411.694MVar. However, only Jos T.S (0.80p.u) was out of the statutory voltage limit of 0.85p.u – 1.05p.u. While Okearo T.S – Egbin G.S had the highest load as shown in the power flow and line flow result as presented in Table 4-5.

Table 3: Transmission lines added to the existing network.

S/N	Transmission line (From - To)	Length (Km)	No. of circuits)
1	Ikot Ekpene T.S - Ibom G.S	2.4	Double
2	Ikot Ekpene T.S - Afam G.S	107.8	Double
3	Aba G.S - Alaoji T.S	14	Double
4	Ibom G.S - Eket T.S	37.4	Double
5	Ikot Ekpene T.S - Calabar G.S	71	Double
6	Egbema T.S - Owerri T.S	5	Double
7	Eket T.S - Itu T.S	75	Double
8	Itu T.S - Aba T.S	74.7	Double
9	Adiabor T.S - Itu T.S	10	Double
10	Omotosho G.S - Ajah T.S	145	Double

Table 4. Power flow result of the enhanced network

S/N	Bus ID	V (p.u)	Pgen (MW)	Qgen (Mvar)	Pload (MW)	Qload (Mvar)	S/N	Bus ID	V (p.u)	Pgen (MW)	Qgen (Mvar)	Pload (MW)	Qload (Mvar)
1	Aba G.S	1.02	176.0	84.2	0.0	0.0	34	Ikot Epkene T.S	1.02	0.0	0.0	189.2	117.2
2	Adiabor T.S	1.00	0.0	0.0	0.0	0.0	35	Itu T.S	1.00	0.0	0.0	363.8	225.5
3	Aes G.S	1.00	256.8	195.7	181.6	112.5	36	Jebba G.S	1.03	498.8	203.7	96.6	59.9
4	Afam G.S	1.02	577.7	304.7	283.6	175.8	37	Jebba T.S	1.03	0.0	0.0	23.6	14.6
5	Ahoda T.S	1.04	0.0	0.0	0.0	0.0	38	Jos T.S	0.80	0.0	0.0	240.7	149.2
6	Aiyede T.S	0.97	0.0	0.0	169.0	104.7	39	Kaduna T.S	0.98	0.0	0.0	52.2	32.4
7	Aja T.S	1.00	0.0	0.0	91.0	56.4	40	Kainji G.S	1.03	700.6	312.8	482.8	299.2
8	Ajaokuta T.S	1.05	0.0	0.0	299.5	123.7	41	Kainji T.S	1.03	0.0	0.0	132.4	82.1
9	Akangba T.S	0.88	0.0	0.0	158.1	98.0	42	Kano T.S	0.85	0.0	0.0	334.9	207.6
10	Aladja T.S	0.99	0.0	0.0	266.0	164.8	43	Katampe T.S	0.96	0.0	0.0	0.0	0.0
11	Alagbon T.S	1.00	0.0	0.0	36.4	22.5	44	Lekki T.S	1.00	0.0	0.0	0.0	0.0
12	Alaoji G.S	1.04	745.2	304.4	197.4	122.3	45	Lokoja T.S	1.05	0.0	0.0	0.0	0.0
13	Alaoji T.S	1.02	0.0	0.0	655.9	406.5	46	Maiduguri T.S	1.00	0.0	0.0	36.4	22.5
14	Asaba T.S	1.02	0.0	0.0	0.0	0.0	47	Makurdi T.S	0.94	0.0	0.0	0.0	0.0
15	Asco G.S	1.05	88.2	18.9	40.0	24.8	48	New Haven T.S	0.99	0.0	0.0	190.1	117.8

S/N	Bus ID	V (p.u)	Pgen (MW)	Qgen (Mvar)	Pload (MW)	Qload (Mvar)	S/N	Bus ID	V (p.u)	Pgen (MW)	Qgen (Mvar)	Pload (MW)	Qload (Mvar)
16	Azura G.S	1.05	338.4	132.2	199.2	123.4	49	Odupkani G.S	1.01	228.5	114.9	274.7	170.2
17	Benin T.S	1.05	0.0	0.0	167.5	103.8	50	Okaero T.S	0.94	0.0	0.0	238.4	147.7
18	Birni-Kebbi T.S	0.99	0.0	0.0	88.0	54.5	51	Okpia G.S	1.03	322.8	111.5	19.3	11.9
19	Calabar G.S	1.05	668.5	547.8	496.5	307.7	52	Olorunsogo G.S	1.04	874.7	419.9	0.0	0.0
20	Damaturu T.S	0.99	0.0	0.0	0.0	0.0	53	Omoku G.S	1.04	654.9	311.9	390.6	242.1
21	Delta G.S	1.02	784.6	479.1	568.6	352.4	54	Omotosho G.S	1.01	680.8	487.9	0.0	0.0
22	Egbema G.S	1.04	300.4	116.2	197.4	122.3	55	Onitsha T.S	1.00	0.0	0.0	513.0	317.9
23	Egbin G.S	1.00	1169.9	905.5	216.5	134.2	56	Oshogbo T.S	0.98	0.0	0.0	334.0	207.0
24	Eket T.S	1.02	0.0	0.0	0.0	0.0	57	Owerri T.S	1.04	0.0	0.0	0.0	0.0
25	Ganmo T.S	0.98	0.0	0.0	206.8	128.2	58	Paras energy G.S	1.02	53.9	39.2	0.0	0.0
26	Gbarain G.S	1.04	230.9	90.5	0.0	0.0	59	PH main T.S	1.02	0.0	0.0	0.0	0.0
27	Geregu G.S	1.04	610.7	243.8	389.2	241.2	60	Sagamu T.S	1.01	0.0	0.0	0.0	0.0
28	Gombe T.S	0.93	0.0	0.0	155.4	96.3	61	Sapele G.S	1.06	1276.4	617.4	811.3	502.8
29	Gwagwalada T.S	1.02	0.0	0.0	0.0	0.0	62	Shiroro G.S	1.02	495.8	144.8	132.0	81.8
30	Ibom G.S	1.02	160.3	59.0	0.0	0.0	63	Trans amadi G.S	1.02	100.3	47.7	188.9	117.1
31	Ihovor G.S	1.05	347.3	135.7	198.9	123.3	64	Ugwuaji T.S	0.99	0.0	0.0	0.0	0.0
32	Ikeja West T.S	0.89	0.0	0.0	1503.7	931.9	65	Yenegoa T.S	1.03	0.0	0.0	192.1	119.0
33	Ikorodu T.S	1.01	0.0	0.0	0.0	0.0	66	Yola T.S	0.90	0.0	0.0	56.2	34.8
								Total		12342.3	6429.2	12059.1	7411.7

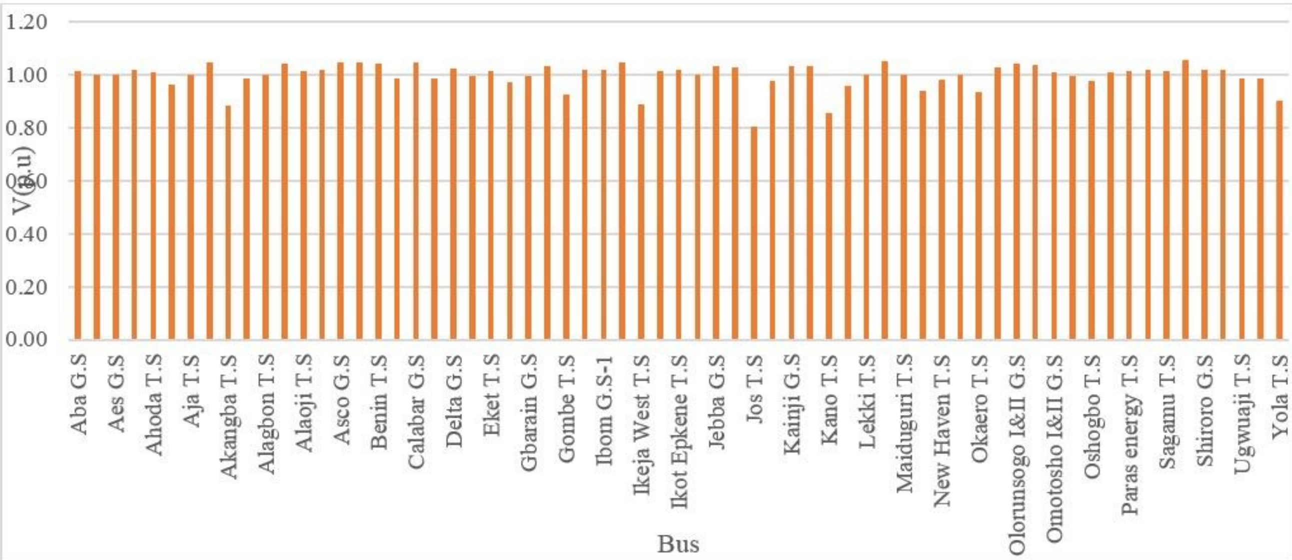

Fig. 1. Voltage profile of the enhanced network

Table 5. Line flow result of the enhanced network

S/N	From Bus	To Bus	P Flow (MW)	Q Flow (MW)	P Losses (MW)	Q Losses (Mvar)	S/N	From Bus	To Bus	P Flow (MW)	Q Flow (MW)	P Losses (MW)	Q Losses (Mvar)
1	Aiyede T.S	Olorunsogo G.S	181.9	65.7	6.5	-23.3	40	Jos T.S	Makurdi T.S	240.7	149.2	15.6	-81.8
2	Ajaokuta T.S	Benin T.S	229.9	-122.0	5.3	-123.4	41	Kaduna T.S	Shiroro G.S	476.1	61.9	11.7	-14.0
3	Ajaokuta T.S	Geregu G.S	148.0	-126.5	2.3	-120.6	42	Kainji T.S	Jebba T.S	155.1	-47.6	1.0	-54.7
4	Akangba T.S	Ikeja West T.S	158.1	98.0	0.4	-7.8	43	Kainji T.S	Kainji G.S	245.8	-84.6	0.0	-0.3
5	Aladja T.S	Delta G.S	269.2	169.6	3.2	4.8	44	Kano T.S	Kaduna T.S	132.4	82.1	7.0	-31.7
6	Alaoji G.S	Alaoji T.S	516.4	111.1	7.1	-5.5	45	Asaba T.S	Onitsha T.S	181.6	119.3	1.5	-39.4

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S/N	From Bus	To Bus	P Flow (MW)	Q Flow (MW)	P Losses (MW)	Q Losses (Mvar)	S/N	From Bus	To Bus	P Flow (MW)	Q Flow (MW)	P Losses (MW)	Q Losses (Mvar)
7	Alaoji T.S	Afam G.S	20.9	83.0	0.1	-17.5	46	Omotosho G.S	Aja T.S	244.8	146.2	0.9	-10.7
8	Alaoji T.S	Onitsha T.S	50.8	36.6	0.4	-44.1	47	Aba G.S	Alaoji T.S	36.6	29.2	0.0	-9.9
9	Asco G.S	Ajaokuta T.S	47.7	-23.1	0.1	-37.6	48	Ikot Epkene T.S	Afam G.S	3.7	-40.3	0.0	-77.2
10	Benin T.S	Egbin G.S	22.9	74.6	0.5	-72.5	49	Azura G.S	Benin T.S	138.6	-22.2	0.4	-32.0
11	Benin T.S	Delta G.S	3.7	-63.3	0.2	-36.5	50	Ibom G.S	Eket T.S	92.2	43.8	0.2	-25.9
12	Benin T.S	Omotosho G.S	14.4	74.2	0.4	-39.9	51	Owerri T.S	Egbema G.S	102.4	-38.6	0.6	-75.6
13	Benin T.S	Sapele G.S	453.6	-3.0	5.0	-16.1	52	Alaoji T.S	Owerri T.S	138.3	114.3	1.0	-51.1
14	Birni-Kebbi T.S	Kainji T.S	88.0	54.5	2.7	-91.3	53	Calabar G.S	Ikot Epkene T.S	167.9	160.9	1.7	-44.8
15	Damaturu T.S	Maiduguri T.S	36.9	-59.6	0.5	-82.2	54	Owerri T.S	Ahoda T.S	37.5	26.2	0.0	-3.7
16	Egbin G.S	Ikorodu T.S	142.5	116.3	0.9	-32.5	55	Ahoda T.S	Gbarain G.S	37.6	-41.8	0.1	-64.4
17	Egbin G.S	Aes G.S	74.4	55.7	0.1	-13.3	56	Gbarain G.S	Yenegoa T.S	192.1	119.0	0.6	-15.6
18	Egbin G.S	Aja T.S	117.2	111.1	0.2	-8.8	57	Itu T.S	Eket T.S	91.7	94.0	0.5	-50.1
19	Ganmo T.S	Oshogbo T.S	4.5	-17.7	0.0	-27.2	58	Aba G.S	Itu T.S	137.8	84.5	0.9	-48.3
20	Gombe T.S	Damaturu T.S	38.4	-100.7	1.5	-41.1	59	Odupkani G.S	Ikot Epkene T.S	81.9	90.9	0.5	-60.2
21	Gombe T.S	Kaduna T.S	272.8	-6.9	21.8	24.0	60	Adiabor T.S	Odupkani G.S	134.4	40.6	0.1	-6.5
22	Gombe T.S	Yola T.S	56.2	34.8	1.0	-61.3	61	Adiabor T.S	Itu T.S	134.3	47.0	0.1	-6.4
23	Gwagwalada T.S	Katampe T.S	190.6	144.5	3.8	-1.9	62	Aja T.S	Lekki T.S	15.0	-8.3	0.0	-3.8
24	Gwagwalada T.S	Lokoja T.S	115.4	135.4	1.5	-92.9	63	Aja T.S	Alagbon T.S	21.4	10.2	0.0	-14.4
25	Gwagwalada T.S	Shiroro G.S	76.1	-35.9	0.9	-45.0	64	Afam G.S	PH main T.S	237.8	-11.7	0.2	-4.7
26	Ibom G.S	Ikot Epkene T.S	149.1	53.6	0.0	-1.6	65	Trans amadi G.S	PH main T.S	22.3	65.8	0.0	-5.7
27	Ihovor G.S	Benin T.S	31.1	-16.1	0.1	-28.4	66	Omoku G.S	PH main T.S	260.1	48.4	2.8	-47.6
28	Ikeja West T.S	Egbin G.S	379.7	276.4	15.3	52.0	67	Alagbon T.S	Lekki T.S	15.0	12.4	0.0	-16.9
29	Ikeja West T.S	Okaero T.S	667.1	437.7	12.8	37.6	68	Lokoja T.S	Ajaokuta T.S	118.5	-113.7	1.6	-156.2
30	Ikeja West T.S	Omotosho G.S	447.6	332.3	20.2	74.8	69	Makurdi T.S	Ugwuaji T.S	266.8	-54.2	10.6	-121.6
31	Ikeja West T.S	Olorunsogo G.S	228.6	151.8	12.6	11.7	70	New Haven T.S	Onitsha T.S	174.8	-17.7	3.2	-16.4
32	Ikorodu T.S	Sagamu T.S	143.4	83.8	0.0	-1.0	71	Okaero T.S	Egbin G.S	926.9	659.9	21.4	74.4
33	Ikot Epkene T.S	Afam G.S	245.9	-114.7	0.1	-0.9	72	Okpia G.S	Onitsha T.S	462.2	134.4	6.8	-9.9
34	Ikot Epkene T.S	Alaoji T.S	2.0	55.8	0.0	-41.1	73	Asaba T.S	Benin T.S	183.2	79.9	2.5	-89.6
35	Ikot Epkene T.S	Ugwuaji T.S	292.9	-25.2	7.6	-86.0	74	Oshogbo T.S	Ihovor G.S	112.9	63.0	3.8	-67.1
36	Jebba G.S	Jebba T.S	440.6	61.3	0.8	-2.3	75	Oshogbo T.S	Aiyede T.S	13.0	-39.0	0.1	-36.5
37	Jebba T.S	Ganmo T.S	215.7	107.4	4.4	-3.1	76	Paras energy G.S	Sagamu T.S	143.4	82.8	0.1	-2.6
38	Jebba T.S	Oshogbo T.S	203.7	137.0	4.4	-89.4	77	Sapele G.S	Delta G.S	108.6	68.1	1.4	-26.6
39	Jebba T.S	Shiroro G.S	146.4	-99.0	2.7	-164.0	78	Shiroro G.S	Katampe T.S	148.1	61.2	4.0	-28.2
							79	Ugwuaji T.S	New Haven T.S	18.4	119.1	0.1	-4.1

VI. Conclusion

In this work, the system profile analysis revealed that the existing network evacuated more power when more power station and transmission lines were added for the purpose of system enhancement. The maximum power the network evacuated was 12,342MW and 6,429MVar at a loading of 12,059.054MW and 7,411.694MVar. Nigeria grid network can only evacuate between 1,000MW and 4,000MW due to inefficiency, unreliability, not properly ringed network, high losses and power station breakdown. From the analysis, more generating stations and transmission lines should be built and added to the network and the single circuit lines should be upgraded to double circuit lines in order to boost generation and transmission, while control devices should be used in high and low voltage areas.

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Authors' Profiles

Agbontaen Festus. O
Was born in Benin City, Edo State, Nigeria. He has Ordinary Diploma in Computer in Engineering, in 2003, B.Eng. and M.Eng. From University of Benin, Nigeria in Electrical/ Electronic Engineering and Electronics/ Telecoms in 2007 and 2012 respectively. He is a Lecturer in Electrical/Electronic Engineering Department, University of Benin, Nigeria, currently working on research in power system analysis and optimization using Flexible Alternating Current Transmission System (FACTS) devices. He is a Registered Engineer (Council for the Regulation of Engineering in Nigeria) and a member of the Nigerian Society of Engineers.

Prof. Ike Samuel
Is a lecturer in the Department of Electrical/Electronic Engineering, University of Benin, Benin City, Nigeria and currently Head of Electrical/Electronic Engineering Department with over eighty (18) years of teaching and research experience. He obtained B. Eng. Electrical/Electronic Engineering), M. Eng. and Ph.D. in Electric Power systems and Machines from University of Benin. He has published research papers in both national and international peer reviewed journals and a member of Nigerian Society of Engineers (NSE), and Council for the Regulation of Engineering in Nigeria (COREN).

Timothy A. Aika
He was born in Edo State, Nigeria. He has a B.Eng., and M.Eng. in Electrical/Electronic Engineering and Electrical power/Machine from University of Benin, Nigeria in 2009, and 2013 respectively. He is a Lecturer in Electrical /Electronic Engineering, University of Benin, Nigeria. His area of research is in Power Systems, Electrical Machines and Renewable Energy.