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Identification of Weak Elements for Assessment of Transmission Network Expansion Planning: A Case Study of Nigerian 28-Bus 330 kV System.

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ABSTRACT

Nigeria power system was privatized in 2005 to cope with ever increasing power demand. This consequently, attracted private investors and the Nigeria power system witnessed more generation. Notwithstanding, transmission network was not given equal attention by Transmission Company of Nigeria (TCN). This has led to stranded generation and overloading of the transmission network (TN). Therefore, this article proposed transmission network expansion for Nigerian 28-bus 330 kV grid system using Neplan application software. Towards this end, power flow analysis was carried out using Newton-Ralphson iterative power flow technique to determine Voltage magnitude at the buses, current flowing on each transmission line. Ten buses had their voltage magnitude falling outside the statutory limit of 1± 0.05 per unit and seven transmission lines had their values exceeded the line flow limit. Static Var Compensator (SVC) was incorporated to each of those ten buses. The SVC supply negative var into the violated buses to supplement the positive reactive power of the lagging loads. This action made all the buses to have their values normalized and both active and reactive power flow improved but the seven overloaded lines still remained slightly overloaded. Parallel transmission lines were added to the seven overloaded lines with the SVC still in the circuit. The network then remained stable with no line overloaded and no violation of voltage magnitude in any bus.

Keyword: Electricity reform act, Overstressed, SVC, TEP, Steady State Stability.

1. INTRODUCTION

The Nigeria government instituted Electricity Reform Act in 2005 due to the continuous rapid increase in electrical power demand from over 200 million Nigerians Ogundare, et al (2022). This reform encouraged private sector participation in the business of electricity generation.

This reform led to formation of three (3) companies to handle the business of electricity. The companies are the generation company, transmission company and distribution company. The power generated has to be distributed to the consumers by the transmission company via the transmission lines. Therefore, reliable transmission expansion planning becomes highly important for effective and smooth operation of Nigeria power systems Ogundare et al (2022). But the transmission company is not privatized and left in the hand of the federal government. Now that the transmission network is solely handled by the government, it is unable to carry all the power generated to the consumers without being overstressed. So due to this overloading problem, the transmission line is long overdue for expansion.

To carry out transmission network expansion, there is the need to perform power flow analysis. In power flow analysis, some power system parameters are important to determine the system performance. These parameters include voltage angle and magnitude at every bus of the system, reactive and active power flow at all the buses and power flows through interconnecting power channels, reactive power flows along the transmission lines, real and reactive power losses along the transmission lines and total power losses Ogundare (2013). Power is conveyed to the consumer's loads from generation to consumers by the product of current and voltage.

Most loads are inductive in nature. In this wise, the loads consume reactive power and therefore, the voltage and current waveforms are out of phase by some angles. Reactive power refers to the power in the power system which does no useful work but needed to maintain the voltage to deliver the real power. As the load is increasing, this angle is also increasing. As the load is increasing the reactive power of the load will also increase and this will cause voltage reduction in the buses connected to such loads. When the load is increasing, the current flowing would also increase and this will leads to increase in voltage drop. The buses that experience low voltage has to be compensated and likewise the transmission lines which have line rating exceeded must be expanded.

In this paper, the Static Var Compensator (SVC) is used for voltage compensation and parallel transmission line is used for line rating compensation. This method concerns the analysis of the power system network to identify a topologically weak transmission lines. A topologically weak line, as defined by Alayande et. al. (2018), is one which cannot be loaded up to its full capability limit without yielding a lower power transfer capability. (Alayande et al. 2019) also emphasizes the need to reinforce the existing topologically weak power networks, especially during critical outages in order to maximize the delivery desired of the network.

This could be seen as the expansion of the network through the addition of new transmission lines without actually introducing any additional new substations into the existing network. Consequently, the capital cost associated with the reinforced network is substantially minimized. The overall aim of this procedure is to improve the integrity of the existing network and it could be referred to as Transmission Expansion Planning (TEP) (Alayande, Jimoh, and Yusuff, 2018). The buses with voltage magnitudes outside the statutory limit are the critical buses.

Many researchers had done lots of work on the use of SVC and have been documented in the open literature. SVC is a power electronic based device (Alok and Amar, 2012) that can generate negative var to compensate the positive var of the lagging load and thereby improve the voltage magnitude of the bus as well as minimize power losses. Guneet *et al.* (2012) carried out work on SVC placement by genetic algorithm. The author used Electrical Transient Analyzer Program (ETAP) software to carry out simulation.

The use of SVC in this work increases the voltage magnitude of the buses and power flows on the line improved. Benzergua *et al.,* (2012) presented an approach to improve voltage magnitude using optimal placement of static var compensator in the Algerian distribution system. The results showed the impact the SVC has in transmission losses which help to improve the voltage profile of the system and reduce the system's active power losses.

Furthermore, Reddy (2013) worked on voltage collapse prediction and voltage stability enhancement using static var compensator in which the methods were applied on WSCC-9 bus and IEEE-14 bus systems. The results obtained were used to evaluate the reactive power compensation and better operation and planning. It was concluded that the voltage stability of the weak bus was enhanced after the placement of SVC.

2. MODELING POWER FLOW WITH SVC

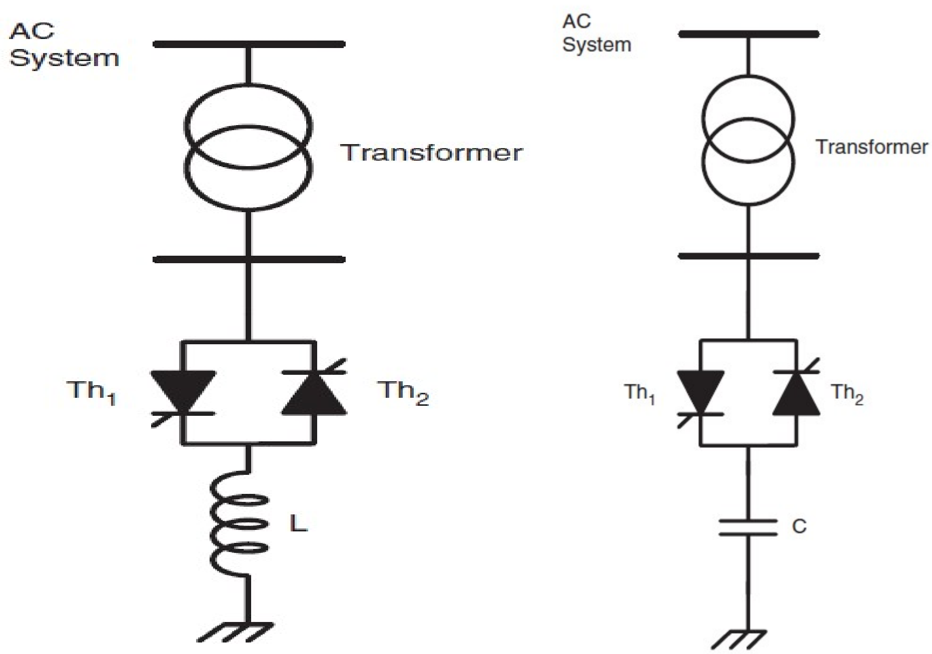

Figure 1: Schematic diagram of SVC (Saravana, 2015)

The equivalent susceptance, which neglects harmonic current, can be expressed as

$$B_{eq} = B_L(\alpha) + B_C \quad (1)$$

Where;

$$B_L(\alpha) = -\frac{1}{\omega L}\left(1 - \frac{2\alpha}{\pi}\right) \quad (2)$$

$$B_C = \omega \times C \quad (3)$$

The reactive power provided by SVC in power flow framework can be expressed as

$$Q_{SVC} = -V_K^2 . B_{SVC} \quad (4)$$

The constraint on the reactive power at bus k is

$$B_{SVC}^{min} \leq B_{SVC} \leq B_{SVC}^{max} \quad (5)$$

3. THE SAMPLE NETWORK

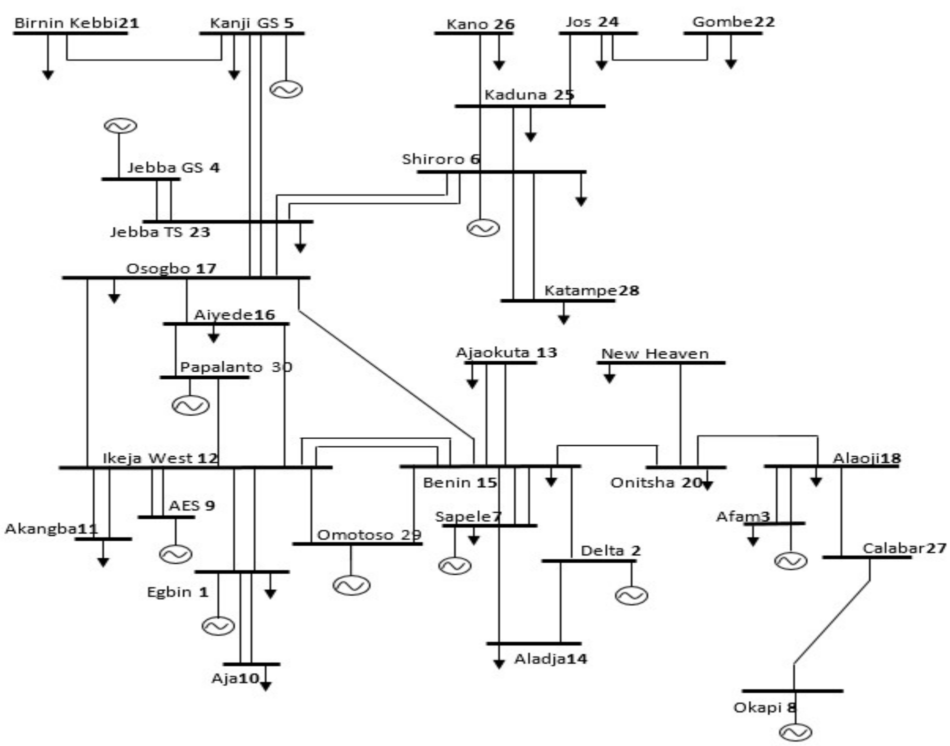

Figure 1: Nigerian 28-bus 330 kV Network System

4. RESULTS AND DISCUSSION

Table 1 shows the results of Newton-Ralphson power flow analysis. It shows that ten (10) out of twenty-eight (28) buses experienced low voltage. Those buses are indicated in Table 2. Table 3 indicates the power flow and losses on each transmission line. The summary of active and reactive power losses are 536.55 MW and 781.68 MVAR respectively as indicated in Table 4.

From the result of Table 3, seven transmission lines have high losses. The lines with high losses are collated as shown in Table 5. Low voltage magnitude and high line losses are not acceptable as quality power supply. SVC was used as compensator for the low voltage buses. With the compensator, power flow was carried out. The power flow result is shown in Table 6. All the violated buses are no longer experience low voltage as shown in Table 7. The summary of line losses after compensation is contained in Table 8. The losses drop from 536.55 MW and 781.68 MVAR to 534.847 MW and 117.76 MVAR respectively. The power flow result using SVC and addition of parallel transmission lines to each of the seven overloaded lines is shown in Table 9. From the result of Table 9, no bus is constrained and no transmission line is overloaded. The power loss was reduced significantly to 287.64 MW and -588.417 MVAR. Therefore, the transmission network becomes more efficient.

Table 1: Initial Power Flow Result

BUS NO	Voltage %	Angle Degree	P Load MW	Q Load MVAR	P Gen MW	Q Gen MVAR
1	100	0	68.9	51.7	455.045	817.973
2	100	4.4	89	20	670	204.477
3	100	36.6	52.5	39.4	431	535.302
4	100	2.1	0	0	495	161.888
5	100	3.7	7	5.2	624.7	9.891
6	100	-9.4	70.3	36.1	388.9	755.4
7	100	-0.2	20.6	15.4	190.3	983.996
8	100	88.2	0	0	750	282.47
9	100	2.4	0	0	750	50.577
10	99.12	-0.7	274.4	205.8	0	0
11	92.24	-3.2	633.2	474.9	0	0
12	97.45	-0.1	13.8	10.3	0	0
13	96.05	-0.5	96.5	72.4	0	0
14	96.74	0.1	383.3	287.5	0	0
15	97.58	1.1	275.8	206.8	0	0
16	90.96	-4.6	201.2	150.9	0	0
17	96.05	-1.1	427	320.2	0	0
18	98.28	36.9	177.9	133.4	0	0
19	61.29	2.2	184.6	138.4	0	0
20	69.15	8.9	114.5	85.9	0	0
21	91.07	-3.7	130.6	97.9	0	0
22	80.33	-25.9	11.3	8.2	0	0
23	99.89	1.9	70.3	52	0	0
24	79.39	-25	193	144.7	0	0
25	89.84	-15.7	220.6	142.9	0	0
26	68.7	-33.8	290.1	145	0	0
27	87	59.4	102	86.3	0	0
28	99.13	-9.9	110	89	0	0

Table 2: Violated Buses Without Compensation

Bus No	Voltage %	P Load MW	Q Load MVAR	P Gen MW	Q Gen MVAR
11	92.24	633.2	474.9	0	0
16	90.96	201.2	150.9	0	0
19	61.29	184.6	138.4	0	0
20	69.15	114.5	85.9	0	0
21	91.07	130.6	97.9	0	0
22	80.33	11.3	8.2	0	0
24	79.39	193	144.7	0	0
25	89.84	220.6	142.9	0	0
26	68.7	290.1	145	0	0
27	87	102	86.3	0	0

Table 3: Line Flow and Losses Without Compensation

S/N	Bus No	Element No	P MW	Q MVAR	P Loss MW	Q Loss MVAR	% Ploss
1	Bus 18	LINE 18-20	752.897	-25.454	287.615	218.938	38.2%
2	Bus 20	LINE 18-20	-465.281	244.392	287.615	218.938	61.8%
3	Bus 27	LINE 8-27	-698.359	69.597	51.6412	352.067	7.39%
4	Bus 8	LINE 8-27	750	282.47	51.6412	352.067	6.8%
5	Bus 18	LINE 18-27	-561.123	387.186	35.2359	231.288	6.27%
6	Bus 27	LINE 18-27	596.359	-155.897	35.2359	231.288	5.9%
7	Bus 15	LINE 15-20	-131.258	705.385	30.2265	207.452	23%
8	Bus 20	LINE 15-20	161.484	-497.933	30.2265	207.452	18.7%
9	Bus 25	LINE 25-26	407.653	253.576	17.5533	108.576	5.7%
10	Bus 26	LINE 25-26	-290.1	-145	17.5533	108.576	6.05%
11	Bus 12	LINE 9-12	-366.367	-17.674	8.6328	7.6141	2.35%
12	Bus 12	LINE 9-12 (2)	-366.367	-17.674	8.6328	7.6141	2.3%
13	Bus 9	LINE 9-12	375	25.289	8.6328	7.6141	2.35%
14	Bus 9	LINE 9-12 (2)	375	25.289	8.6328	7.6141	2.3%
15	Bus 25	LINE 6-25	-369.156	-261.371	8.3927	48.5868	2.27%
16	Bus 25	LINE 6-25 (2)	-369.156	-261.371	8.3927	48.5868	2.22%
17	Bus 6	LINE 6-25	377.548	309.957	8.3927	48.5868	2.27%
18	Bus 6	LINE 6-25 (2)	377.548	309.957	8.3927	48.5868	2.22%
19	Bus 15	LINE 7-15	-51.784	-268.933	7.401	-0.7814	14.29%
20	Bus 15	LINE 7-15 (2)	-51.784	-268.933	7.401	-0.7814	12.5%
21	Bus 15	LINE 7-15 (3)	-51.784	-268.933	7.401	-0.7814	14.29%
22	Bus 7	LINE 7-15	59.185	268.152	7.401	-0.7814	12.5%
23	Bus 7	LINE 7-15 (2)	59.185	268.152	7.401	-0.7814	14.29%
24	Bus 7	LINE 7-15 (3)	59.185	268.152	7.401	-0.7814	12.5%
25	Bus 24	LINE 24-25	-204.336	-115.676	5.7222	10.5886	2.8%
26	Bus 25	LINE 24-25	210.058	126.265	5.7222	10.5886	2.7%

S/N	Bus No	Element No	P MW	Q MVAR	P Loss MW	Q Loss MVAR	% Ploss
27	Bus 23	LINE 6-23	278.573	-33.685	5.2113	-11.522	1.8%
28	Bus 23	LINE 6-23 (2)	278.573	-33.685	5.2113	-11.522	1.9%
29	Bus 6	LINE 6-23	-273.362	22.163	5.2113	-11.522	1.8%
30	Bus 6	LINE 6-23 (2)	-273.362	22.163	5.2113	-11.522	1.9%
31	Bus 19	LINE 19-20	-184.6	-138.4	4.6973	29.2411	2.5%
32	Bus 20	LINE 19-20	189.297	167.641	4.6973	29.2411	2.48%
33	Bus 18	LINE 3-18	-184.837	-247.566	4.413	0.3853	2.39%
34	Bus 18	LINE 3-18 (2)	-184.837	-247.566	4.413	0.3853	2.39%
35	Bus 3	LINE 3-18	189.25	247.951	4.413	0.3853	2.33%
36	Bus 3	LINE 3-18 (2)	189.25	247.951	4.413	0.3853	2.33%
37	Bus 14	LINE 2-14	-391.843	-112.487	4.0419	16.8381	1.03%
38	Bus 2	LINE 2-14	420.885	129.325	4.0419	16.8381	1.02%
39	Bus 11	LINE 11-12	-316.6	-237.45	3.97	17.1741	1.25%
40	Bus 11	LINE 11-12(2)	-316.6	-237.45	3.97	17.1741	1.25%
41	Bus 12	LINE 11-12	320.57	254.624	3.97	17.1741	1.24%
42	Bus 12	LINE 11-12(2)	320.57	254.624	3.97	17.1741	1.24%
43	Bus 12	LINE 12-16	189.219	124.989	3.1134	-0.3639	1.65%
44	Bus 16	LINE 12-16	-186.105	-125.353	3.1134	-0.3639	1.67%
45	Bus 21	LINE 5-21	-130.6	-97.9	2.8151	-52.943	2.16%
46	Bus 5	LINE 5-21	133.415	44.956	2.8151	-52.943	2.11%
47	Bus 15	LINE 2-15	-183.506	-45.338	1.6093	9.8143	0.88%
48	Bus 2	LINE 2-15	185.115	55.153	1.6093	9.8143	0.87%
49	Bus 17	LINE 17-23	-115.649	-80.409	1.036	-32.077	0.90%
50	Bus 17	LINE17-23 (2)	-115.649	-80.409	1.036	-32.077	0.90%
51	Bus 17	LINE17-23 (3)	-115.649	-80.409	1.036	-32.077	0.90%
52	Bus 23	LINE 17-23	116.685	48.332	1.036	-32.077	0.89%
53	Bus 23	LINE17-23 (2)	116.685	48.332	1.036	-32.077	0.89%
54	Bus 23	LINE17-23 (3)	116.685	48.332	1.036	-32.077	0.89%
55	Bus 1	LINE 1-12	55.843	285.361	0.9544	-0.0448	1.71%
56	Bus 1	LINE 1-12 (2)	55.843	285.361	0.9544	-0.0448	1.71%
57	Bus 12	LINE 1-12	-54.889	-285.406	0.9544	-0.0448	1.74%
58	Bus 12	LINE 1-12 (2)	-54.889	-285.406	0.9544	-0.0448	1.74%
59	Bus 23	LINE 5-23	-241.319	16.384	0.8239	-3.7493	0.34%
60	Bus 23	LINE 5-23 (2)	-241.319	16.384	0.8239	-3.7493	0.34%
61	Bus 5	LINE 5-23	242.142	-20.133	0.8239	-3.7493	0.34%
62	Bus 5	LINE 5-23 (2)	242.142	-20.133	0.8239	-3.7493	0.34%
63	Bus 14	LINE 7-14	8.543	-175.013	0.6873	-10.873	8.05%
64	Bus 7	LINE 7-14	-7.855	164.14	0.6873	-10.873	8.75%
65	Bus 15	LINE 15-17	50.892	-9.046	0.288	-44.033	0.57%
66	Bus 17	LINE 15-17	-50.604	-34.988	0.288	-44.033	0.57%
67	Bus 13	LINE13-15 (2)	-48.25	-36.2	0.223	-34.234	0.48%

S/N	Bus No	Element No	P MW	Q MVAR	P Loss MW	Q Loss MVAR	% Ploss
68	Bus 13	LINE 13-15	-48.25	-36.2	0.223	-34.234	0.48%
69	Bus 15	LINE13-15 (2)	48.473	1.966	0.223	-34.234	0.48%
70	Bus 15	LINE 13-15	48.473	1.966	0.223	-34.234	0.48%
71	Bus 12	LINE 12-17	44.707	10.357	0.1435	-33.511	0.32%
72	Bus 17	LINE 12-17	-44.563	-43.869	0.1435	-33.511	0.32%
73	Bus 28	LINE 6-28	-55	-44.5	0.1137	-16.969	0.21%
74	Bus 28	LINE 6-28 (2)	-55	-44.5	0.1137	-16.969	0.21%
75	Bus 6	LINE 6-28	55.114	27.53	0.1137	-16.969	0.21%
76	Bus 6	LINE 6-28 (2)	55.114	27.53	0.1137	-16.969	0.21%
77	Bus 23	LINE 4-23	-247.432	-81.196	0.0679	-0.2521	0.03%
78	Bus 23	LINE 4-23 (2)	-247.432	-81.196	0.0679	-0.2521	0.03%
79	Bus 4	LINE 4-23	247.5	80.944	0.0679	-0.2521	0.03%
73	Bus 28	LINE 6-28	-55	-44.5	0.1137	-16.969	0.21%
74	Bus 28	LINE 6-28 (2)	-55	-44.5	0.1137	-16.969	0.21%
75	Bus 6	LINE 6-28	55.114	27.53	0.1137	-16.969	0.21%
76	Bus 6	LINE 6-28 (2)	55.114	27.53	0.1137	-16.969	0.21%
77	Bus 23	LINE 4-23	-247.432	-81.196	0.0679	-0.2521	0.03%
78	Bus 23	LINE 4-23 (2)	-247.432	-81.196	0.0679	-0.2521	0.03%
79	Bus 4	LINE 4-23	247.5	80.944	0.0679	-0.2521	0.03%
73	Bus 28	LINE 6-28	-55	-44.5	0.1137	-16.969	0.21%
74	Bus 28	LINE 6-28 (2)	-55	-44.5	0.1137	-16.969	0.21%
75	Bus 6	LINE 6-28	55.114	27.53	0.1137	-16.969	0.21%
76	Bus 6	LINE 6-28 (2)	55.114	27.53	0.1137	-16.969	0.21%
91	Bus 16	LINE 16-17	-15.095	-25.547	0.0192	-25.663	0.13%
92	Bus 17	LINE 16-17	15.114	-0.116	0.0192	-25.663	0.13%

Table 4: Summary of Line Losses Without Compensation

	From Area/Zone	PLoss MW	Q Loss MVAR	P Gen MW	Q Gen MVAR	P Load MW	Q Load MVAR
1	Network	536.545	781.675	4754.945	3801.975	4218.4	3020.3
2	Area 1	536.545	781.675	4754.945	3801.975	4218.4	3020.3

Table 5: Overstressed Transmission Lines

S/N	Element No	P MW	Q MVAR	P Loss MW	QLoss MVAR
1	LINE 8-27	750	282.47	51.6412	352.067
2	LINE 18-27	596.359	-155.897	35.2359	231.288
3	LINE 18-20	752.897	-25.454	287.615	218.938
4	LINE 25-26	407.653	253.576	17.5533	108.576
5	LINE 6 - 25	377.548	309.957	8.3927	48.5868
6	LINE 15-20	161.484	-497.933	30.2265	207.452
7	LINE 2-14	420.885	129.325	10.457	87.3

Table 6: Power Flow With SVC

Bus No	U %	P Load MW	Q Load MVAR	P Gen MW	Q Gen MVAR	Q Shunt MVAR
1	100	68.9	51.7	453.347	422.319	0
2	100	89	20	670	158.744	0
3	100	52.5	165.989	431	0	0
4	100	0	0	495	110.424	0
5	100	7	94.131	624.7	0	0
6	100	70.3	36.1	388.9	57.079	0
7	100	20.6	15.4	190.3	390.875	0
8	100	0	0	750	50.927	0
9	100	0	231.427	750	0	0
10	99.12	274.4	205.8	0	0	0
11	98.51	633.2	474.9	0	0	-185.232
12	99.15	13.8	10.3	0	0	0
13	97.51	96.5	72.4	0	0	0
14	96.76	383.3	287.5	0	0	0
15	98.99	275.8	206.8	0	0	0
16	100	201.2	150.9	0	0	-184.293
17	96.93	427	320.2	0	0	0
18	99.44	177.9	133.4	0	0	0
19	100	184.6	138.4	0	0	-105.403
20	95.56	114.5	85.9	0	0	-147.905
21	100	130.6	97.9	0	0	-79.705
22	100	11.3	8.2	0	0	-19.841
23	99.91	70.3	52	0	0	0
24	100	193	144.7	0	0	-124.27
25	100	220.6	142.9	0	0	-167.927
26	100	290.1	145	0	0	-178.264
27	100	102	86.3	0	0	-141.486
28	99.13	110	89	0	0	0

Table 7: Improved Voltage Magnitude of Violated Buses with SVC Compensation.

Bus No	Voltage %	P Load MW	Q Load NVAR	P Gen MW	Q Gen MVAR	Q Shunt MVAR
11	98.51	633.2	474.9	0	0	-185.232
16	100	201.2	150.9	0	0	-184.293
19	100	184.6	138.4	0	0	-105.403
20	95.56	114.5	85.9	0	0	-147.905
21	100	130.6	97.9	0	0	-79.705
22	100	11.3	8.2	0	0	19.841
24	100	193	144.7	0	0	-124.27
25	100	220.6	142.9	0	0	-167.927
26	100	290.1	145	0	0	-178.264
27	100	102	86.3	0	0	-141.486

Table 8: Summary of Losses With Compensation Using SVC

S/N	From Area/Zone	P Loss MW	Q Loss MVar	P Gen MW	Q Gen MVar	P Load MW	Q Load MVar	Q Shunt MVar
1	Network	534.847	117.766	4753.247	743.422	4218.4	3020.3	19.841
2	Area 1	534.847	117.766	4753.247	743.422	4218.4	3020.3	19.841
3	Zone 1	534.847	117.766	4753.247	743.422	4218.4	3020.3	19.841

Table 9: Power Flow With Incorporation of SVC and Additional Transmission Lines

Bus No	U %	U angle	P Load MW	Q Load MVAR	P Gen MW	Q Gen MVAR	Q Shunt MVAR
1	100	0	68.9	51.7	206.14	456.808	0
2	100	9.5	89	20	670	90.375	0
3	100	23.4	52.5	450.241	431	0	0
4	100	4.7	0	0	495	111.578	0
5	100	6.3	7	94.028	624.7	0	0
6	100	-6.2	70.3	36.1	388.9	56.021	0
7	100	5.5	20.6	15.4	190.3	434.977	0
8	100	44.9	0	54.623	750	0	0
9	100	3.4	0	229.691	750	0	0
10	99.12	-0.7	274.4	205.8	0	0	0
11	98.5	-2.8	633.2	474.9	0	0	485.118
12	99.14	0.4	13.8	10.3	0	0	0

Bus No	U %	U angle	P Load MW	Q Load MVAR	P Gen MW	Q Gen MVAR	Q Shunt MVAR
13	97.76	4.1	96.5	72.4	0	0	0
14	97.92	5.5	383.3	287.5	0	0	0
15	99.24	5.6	275.8	206.8	0	0	0
16	100	-3.9	201.2	150.9	0	0	-183.82
17	96.9	1.2	427	320.2	0	0	0
18	99.94	22.4	177.9	133.4	0	0	0
19	100	6.5	184.6	138.4	0	0	225.956
20	97.86	9.8	114.5	85.9	0	0	574.588
21	100	-0.9	130.6	97.9	0	0	-79.705
22	100	-20.1	11.3	8.2	0	0	19.841
23	99.91	4.5	70.3	52	0	0	0
24	100	-19.6	193	144.7	0	0	-124.27
25	100	-12.4	220.6	142.9	0	0	119.428
26	100	-18.3	290.1	145	0	0	130.173
27	100	32.1	102	86.3	0	0	162.891
28	99.13	-6.8	110	89	0	0	0

Table 10: Summary of Losses With SVC and Parallel Transmission Lines

From Area/Zone	P Loss MW	Q Loss MVAR	P Gen MW	Q Gen MVAR	P Load MW	Q Load MVAR	Qc Shunt MVAR
	MW	**MVar**	**MW**	**MVar**	**MW**	**MVar**	**MVar**
Network	287.64	-588.42	4506.04	365.776	4218.4	3020.3	2085.949
Area 1	287.64	-588.42	4506.04	365.776	4218.4	3020.3	2085.949
Zone 1	287.64	-588.42	4506.04	365.776	4218.4	3020.3	2085.949

5. CONCLUSION

Nigeria power transmission network cannot accommodate all the power generated simultaneously. Due to this inadequacy, method of load shedding is used to distribute power to the consumers. This results into stranded generation and eventual loss of economy. Incorporation of SVC and additional parallel transmission line to the transmission network is able to reduce power loss on the transmission line and can wheel more power thereby solve the problem of stranded generation.

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