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Improved Electric Power Supply to Daewoo Yard in Bayelsa State Nigeria.

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ABSTRACT*:Operating voltage in terms of transmission voltage (330KV,132KV) and distribution voltage (33KV, 11KV) are outside the allowable voltages affecting the quality of power supply, voltage profile and power factor respectively. Power transfer capability has always been confronted by synchronous or (rotor angle) stability or by thermal loading capability of transmission lines and equipment. Importantly, voltage stability (voltage magnitude and phase-angle) and power flow in the system network are taken seriously during the planning, expansion and operation of electrical power system in order to avoid voltage collapse, instability which may subsequently lead to partial or full system black-out. This research seriously considered the examination of the existing state of electrical power network from Ahoada to the (Gbarain NIPP Power generation station and National grid: 132KV) transmission station of 132/33KV Yenagoa, Bayelsa state in view to propose a power supply from the transmission sub-station of Yenagoa to the study case: Daewoo yard, Bayelsa State as a form of alternative power supply. Electrical transient analysing tool (Etap version 12.6) platform was used with the aim to reveal the system state with the application of the formulated voltage-drop/voltage-regulation equations and power flow analysis. The load consumption pattern of the facilities/equipment (machine) in the Daewoo yard for the purpose of determining the capacity of transformer needed to supply the given load: Accommodation A, B, C and Workshop A and B respectively. The overstressed/overloaded buses are beyond the acceptable regulatory limit and practice of voltage drop as declared by the IEE regulatory limits of (±10% or +0.95 – 1.05pu), while other respective buses are within the statutory marginal limits as required. It was necessary to improve the power quality and voltage profile of the system to fall within acceptable regulatory limits by using capacitor-bank compensator on bus 20 (300KVAR), Bus 23 (450KVAR), Bus 25 (600 KVAR) and bus 22 (350 KVAR) respectively, the determined size was accurately located at the affected buses by the penetration of the controller, this evidently improved the change in power quality, voltage profile and generally stabilizes the power system performance to about16.23% voltage-rise. In conclusion, the occurrence of black-out due to overload problems, low-power factor problem, and uncontrollable losses in the system were improved upon to ensure quality of electricity supply in Daewoo yard Bayelsa State, Nigeria.*

KEYWORDS:- *Capacitor-bank, Electrical transient analysing tool, Load Consumption, Power quality, Voltage profile and Overstressed/Overloaded buses.*

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I. INTRODUCTION

The electricity supply in Nigeria is facing mixed challenges ranging from slow growth in generation capacity, market deregulation process interference by Government, electrical transmission lines and distribution equipment vandalism, poor maintenance of existing electrical facilities and corruption [1]. In the perspective of [2], Nigerian government has spent over Twenty Billion US Dollar ($20 Billion) within the last twenty years solving the challenges of electricity power supply but it continues to harvest darkness in return. The Nigerian electricity power sector is noticeable by low generating capacity relative to installed capacity and much of the country's citizens do not have access to uninterrupted supplies of electricity [3]. To validate it only 25% of Nigeria’s 12,522MW of installed capacity reaches the end user, the widespread inefficiency means that only 3,879MW of this capacity is operational which mean that distribution companies suffer significant losses, with 46% of energy lost due through technical, commercial and collection issues [4]. In the perspective of [5],the involvement of the Independent Power Production will not only increase the availability of electricity, it still stimulates efficiency in the electricity industry. However, the existing evidence does not support this expectation, and this is because as at January 2013 the industry has just realized only about 4,500mw of the target [6]. According to [7], most of the industrial areas around the country suffered an average of 14.5 hours of power outage per day as against 19.5 hours of supply, and the cost of generating power supply by firms for production constitute about 36 per cent of total cost of production. Modern production will grand to halt without requisite energy infrastructure, as it is evident in most parts of the developing country. Hence, governments world over are committed to building energy infrastructure [8]. On the national cost, it was estimated that GDP growth could be boosted from 7-8% to 10-11% if power supplies were available [9].

Owing to the consistent decline in power distribution network in Daewoo yard which has become a major challenge due to non-alternative power supply via transmission line particularly to the Daewoo yard as a case study in Bayelsa State. This makes the study case to rely mainly on diesel power plant which strongly associated to operational fuel cost, making the power system and activities in Daewoo yard to experience: Outage (black-out), system collapse in terms of economic operations due to regular usage of power plant (diesel) without alternative power supply (from the grid), and owing to the huge operational fuel cost. This research work aimed at improving the electric power supply system to the Daewoo yard in Bayelsa States, Nigeria by looking at alternative power supply (from the grid).

This work seriously engaged an appropriate measure on the view to look at the prevailing condition of this study case, in order to: to analysis the activities in the Daewoo yard in term of power supply system via diesel power plant, in order to look at alternative power supply from the national grid, determine the efficiency of the power supply system, from the existing case, numerical data collected from Electricity Distribution Company, Bayelsa State on the view to implement it into voltage equations: voltage drop/voltage regulation equation, and Newton Raphson method was used in determining the reactive and active power of the network while electric transient analyser (ETAP) programme software for power flow simulation analysis.

1.3 Aim of Study

The aim of this work is to conduct an analysis to improve the electric power supply system to the Daewoo yard in Bayelsa States, Nigeria by looking at alternative power supply (from the grid).

1.4 Objectives of the Study

The Daewoo Company is strongly looking forward at an alternative power supply in order to reduce over dependence on their Independent Power Supply (IPS) by diesel plant, with the view to reduce cost. The objectives of this work will seriously engage an appropriate measure on the view to look at the prevailing condition of this study case, in order to:

i. Analysis the activities in the Daewoo yard in term of power supply system via diesel power plant, in order to look at alternative power supply from the national grid,
ii. Determine the efficiency of the power supply system, from the existing case
iii. Collect numerical data from Electricity Distribution Company, Bayelsa State on the view to implement it into voltage equations: voltage drop/voltage regulation equation.
iv. Using Newton Raphson method in determining the reactive and active power of the network while electric transient analyser (ETAP) programme software for power flow simulation analysis.

1.5 Scope of Study

This study will consider the analysis of voltage-drop and voltage-regulation equation techniques on the study case: Daewoo Yard Bayelsa State, Nigeria.

II. LITERATURE REVIEW

The distribution of bulk electricity from upstream to downstream and to the consumers is not an easy task; the daily needs of electrical energy (in MWh or KWh) by the power consuming equipment and devices from the industries, essential services, commercial services, residential homes, etc., and its configuration makes it more complex in nature. In the view of (Padiyar, 2015) the bulk of the power system is formed by the generating and transmission sub-systems. Electrical power is transported (transmitted) in smaller quantities from the transmission substation to the distribution substations. The vast majority of the industrial consumers are commonly supplied directly from the sub-transmission system [10].

The final stage of power transfer to the domestic consumers is the distribution substations. The distribution substations are divided into primary and secondary distribution [11]. [12] powers being generated do not match power demanded and at such the primary and secondary distribution sections are suffering due to inadequate power supply leading to low voltage margin, load shedding syndrome at the sub-transmission sections (132KV), poor energy management systems, power rationing at the secondary distribution sections (11KV), political interest, the incessant action of vandalism, etc., are factors that mitigate against constant power supply.

In the perspective of [13], there are two basic power generating stations such as Hydropower generating stations (located at Kainji, Shiroro, Jabba, etc.) and Thermal-power generating stations that uses fossil fuels such as natural gas, crude oil, coal, uranium, etc., (in their numbers in Nigeria). These bulk electricity generation stations utilize three basics " prime-mover-to generator techniques" (conventional techniques) of electricity generation namely hydropower systems, Steam turbine power systems and Gas turbine power systems. Steam and Gas turbines are a function of fossil fuels. Distributed generation units have several benefits such as stability, reliability, and economy; but it suffers some critical problems that may disturb these benefits as seen in [14]. Port-Harcourt Electricity Distribution Plc, or Port Harcourt Disco, Serves Bayelsa, Cross River Akwalbom and parts of Delta States in Nigeria's south-south zone. The Disco is in turn subdivided into six districts, namely, Calabar, Diobu, Ikom/Ogoja, Borikiri, Uyo and Yenegoa. Port-Harcourt Disco owns and maintains 22 Numbers of 33 kV and 64 Numbers of 11 kV circuits. It also operates 22 Numbers of 33/11kV injection Substations and 3,431 number of 11/0.415kV distribution substations. In addition, it possesses 1, 793 number of 11/0,415kV substations and 5,662 number of 0.415 kV circuits [15].

III. MATERIALS AND METHODS

The data used in this research work were obtained from the Nigeria Bureau of Statistics (NBS), Port Harcourt electricity distribution Company of Nigeria(PHED), Transmission Company of Nigeria (TCN) and the maintenance department of the various selected power plants to BayelsaYenagoa TCN Substation grid supply, for the purpose of this research work and analysis. Considering the prevailing condition of the power supply system particularly Daewoo yard in Bayelsa State, up to the neighbouring villages, need to be supplied by the national grid using the analysis of voltage drop, power flow equation, and voltage regulation equation techniques as adopted, while the analysis of the operational fuel cost of the diesel power supply before Yenagoa Transmission company of Nigeria (TCN) substation grid supply tie-in to Daewoo yard (the network diagram) are required for purpose of analysis and verification. Etap software was used for the power flow simulation on the application of Newton Raphson method.

The Description of Electricity Supply to Daewoo Yard

The analysis of power supply system from Ahoada through Gbarain NIPP to Bayelsa, Yenagoa Transmission Company of Nigeria (TCN) substation grid supply; as shown in figure 3.1 below, the line diagram supplying Daewoo yard was drawn using Etap Software simulation for purpose of alternative power supply from the grid.

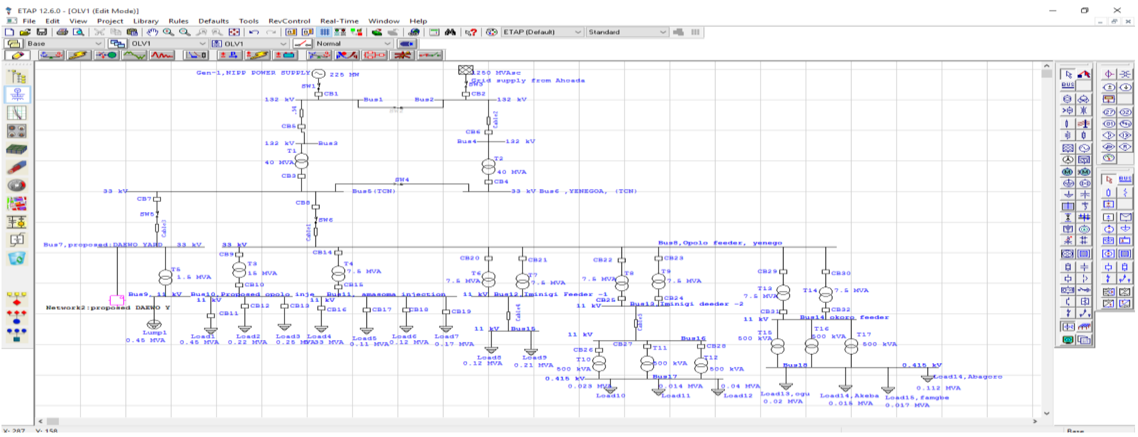

Figure 3.1: Single Line Diagram of Existing Power Supply to Yenagoa (Unsimulated)

Line parameters

Per-kilometre Active resistance (R_0)

$$R_0 = \frac{1000\,\ell}{A}(\Omega/km) \qquad 3.64$$

Where ℓ is the design resistivity of conductor (Ωm)

A is the cross-sectional area of conductor (m^2)

Per-Kilometer inductive reactance (Non-stranded conductor)

$X_0 = 0.445\left(\frac{D_{GMD}}{r}\right) + 0.0157(\Omega/km)$ 3.65

Where r is the conductor radius
D_{GMD} is the geometric mean distance between phase conductors.

Per-Kilometer Capacitive Susceptance b_0

$b_0 = \frac{7.58\ell}{Log\left(\frac{D_{GMD}}{r}\right)} \times 10^{-6}(\Omega/km)$ 3.66

Geometric Mean Distance

For a single Circuit
$D_{GMD} = \sqrt{D_{RB} D_{RY} D_{BY}}$ 3.67

Where D is the spacing between the conductors.
For overhead conductors arranged horizontally
$D_{GMD} = \sqrt[3]{2D^3} = D\sqrt[3]{2} = 1.26D$ *3.68*

Percentage Load on Feeder

% Loading of feeder $\frac{AverageCurrentonFeeder}{MaximumAllowableCurrent} \times 100$ 3.69

It can also be given as
% Loading of feeder $\frac{AverageCurrentonFeeder}{MaximumAllowableActive \quad LoadonFeeder} \times 100$ 3.70
Where Active power (P_D) on feeder = $\frac{AverageCurrentonFeeder}{60} \times 100$ 3.71

Complex Load on Distribution Transformers

Complex load demand transformer capacity × Percentage Loading on transformer
Where percentage loading on transformer = $\frac{I_R+I_Y+I_B}{3I_n} \times 100$ 3.72

Voltage Drop (V_D)

$V_D = V_S - V_r$ 3.73

Where: V_s = Sending end Voltage, V_r = Receiving end voltage
Hence, $V = IZ$;hence, $V_D = V_s - V_r = IZ$ *3.74*

Where I = Average Current on feeder and Z = Impedance of Feeder
Therefore, percentage voltage drop = $\frac{V_D}{V_S} \times 100's$ *3.75*

Transformer Tap Changing

The principle of regulating the secondary voltage is based on changing the number of turns on the primary or secondary in changing the transformation ratio.
$\frac{V_2}{V_1} = \frac{N_2}{N_1} = K$, hence, $V_2 = \frac{V_1 N_2}{N_1} = E_1 K$ 3.76

Where; K = Transformation ratio
V_1 = Primarily Voltage
V_2 = secondary Voltage

Decrease in primary turns causes increase in emf per turn, and so in secondary output voltage. Secondary output voltage can also be increased by increasing secondary turns and keeping primary turns fixed.

Shunt Capacitors

Shunt capacitors are switched in when capacity demand on the distribution system rises and voltage of the buses drop. Assume no load is supplied with a real power P, lagging reactive power, Q_1 and apparent power, S_1 at a lagging power factor.

Thus, $S_1 = (P_1^2 + Q_1^2)^{\frac{1}{2}}$ 3.77

When a shunt Capacitor of Q_cKVar is installed at the load, the apparent power can be reduced from S_1 to S_2.

$S_2 = (P^2 + Q_2^2)^{\frac{1}{2}}$ 3.78

$S_2 = (P^2 + (Q_1 - Q_C)^2)^{\frac{1}{2}}$ 3.79

Since current is directly proportional to power, (i.e I & S), automatically, reduction in the apparent power leads to reduced current flow. In turn line drop is reduced and voltage profile improved.

Power Factor Correction

If P is the real power supplied, Q is the lagging reactive power and S is the apparent power at a lagging power factor.

Then $cos\,\theta_1 = \frac{P}{S_1}$ 3.80

$cos\,\theta_1 = \frac{P}{(P^2+Q_1^2)^{\frac{1}{2}}}$ 3.81

When a shunt capacitor supplying reactive power of $Q_c$is applied, the new reactive power $Q_2$of the system will be $Q_2 - Q_1 - Q_c$

Hence, power factor becomes; $cos\,\theta_2 = \frac{P}{(P^2+Q_2^2)^{\frac{1}{2}}}$ 3.82

$cos\,\theta_2 = \frac{P}{(P^2+Q_1-Q_C)^{\frac{1}{2}}}$ 3.83

Determination of Optimal Capacitor Placement (OCP)

The minimization of the cost of the system was measured in four ways:

(i) Fixed capacitor installation cost
(ii) Capacitor purchase cost
(iii) Capacitor bank operating cost (maintenance and depreciation)
(iv) Cost of real power losses

Mathematically, cost can be represented as:

$Min\ objective\ function = \sum_{i=1}^{N_{bus}} (x_1 C_{oi} + Q_{ci} C_{1i} + B_i C_{2i} T) + C_2 \sum_{i=1}^{N_{load}} T_{IP}{}_L^I$ 3.84

Where; N_{bus} – Number of bus candidates, x_i – 0/1, 0 means no capacitor installed at bus i,C_{oi} – Installation cost, C_{Ii} – Per Kvar cost of capacitor banks, Q_{ci} – Capacitor bank size Kvar, B_i– Number of capacitor banks, C_{2i}– Operating cost of per bank, per year
T – Planning period (years), C_2 – Cost of each KWh loss, in $/KWh
l – Load levels, maximum average and minimum, T_1 - Time duration, in hours, of load level l

Determination of Compensation of Facts Devices

Improving the existing power factor using the desired power factor correction, we have.

$KW = KVA \times Pf$

Where; KW: Active power; KVA: Apparent power and Pf: Power factor

Similarly, the power triangle equation can be used in determining the size (rating) of capacitor in (K_{VAR} or M_{VAR}). This can be stated as:

$KW = KVA$ x pf – correction or $M_{VAR} = KW \times p\ factor - correction$

This means, that the apparent power (MVA) is the vector sum of the active power (MW) and reactive power (MVAR).

Evidently, the MVAR capacities of the capacitor required compensation, using the direct relationship as:

$Qc = \frac{P}{Pf_1} \times sin(cos^{-1}(Pf_1)) - Qc = \frac{P}{Pf_2} \times sin(cos^{-1}(Pf_2))$ 3.85

Where; Qc = Reactive power compensation of the capacitor, P = The total active power load in (MW), Pf_l = Existing power factor of the load, Pf_2 = Proposed/desired power factor to be used for correction, sin = Sinusoidal function, cos = Cosine function

Determination for Compensation of Power Electronic Controller

Power electrical device for control are used for the compensation of affected feeder/buses in the network; which are presented mathematically for purpose of sizing the capacity (rating) of the compensator;

$$Q_c = \frac{P}{Pf_1} sin(cos^{-1}(Pf_1)) - \frac{P}{Pf_2} \times sin(os^{-1}(Pf_2)) \qquad 3.86$$

(i) The existing power factor = 0.83

(ii) The proposed power factor = 0.84

(iii) Active power (MW) was given as: $MVA \times pf = MW$ 3.87

(iv) The existing capacity of substation transform feeding are study = case feeder = 1 × 15MVA. Hence; 15MVA× 0.83 = 12.45MW

substituting the data obtained into equation (23), shows that the capacity of static var required for compensation of the existing pf power factor of 0.83 to 0.84 proposed or defined evidently becomes 0.33MVAR (330KVAR).

Determinationof Voltage Rise

$$Voltage\ rise = \frac{static\ var \quad compensator \ \times transformerreaction}{Transformerrating \quad (KVAorMV\ A)}$$

Given the

Transformer reactance = 11%

Transformer rating = 15MVA

Static var compensation = $Q.3MV_{ar}$or 330 or KV_{ar} = 330 x $10^3{}_{Var}$

IV. RESULTS AND DISCUSSION

The power system network from Ahoada through Gbaran NIPP power station with capacity 225MW and grid power supply with capacity 250MVAR are modelled in electrical transient analyser tool (Etap 12.6) used to simulate the line diagram of the network as shown in figure 4.1below,

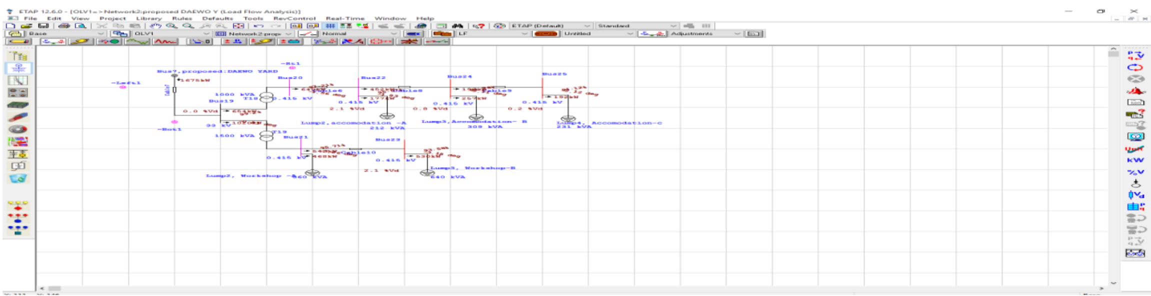

Figure 4.1: Proposed Power Supply Network to the Study case: Daewoo Yard (simulated)

The result in table 4.1 below shows the continuous, intermittent, and without Stand-By Load in accommodation 'A', 'B' and 'C' Area (Daewoo yard).

Table 4.1: Total Consumed Load for Accommodation 'A' Area (Daewoo Yard) without Stand-By Load.

S/No.	Accommodation	Continuous		Intermittent		Stand-By	
		KW	KVAR	KW	KVAR	KW	KVAR
1	'A' Area (Daewoo yard)	130.11	53.5	223.89	78.36	0	0
2	'B' Area (Daewoo yard)	227.81	74.88	216.8	75.67	0	0
3	'C' Area (Daewoo yard)	116.56	38.31	342.5	118.54	0	0

The result in figure 4.2 below shows that the accommodation 'B' Area (Daewoo yard), the highest continuous in KW and KVAR was (227.81 and 74.88), while the lowest in accommodation 'C' Area (Daewoo yard) continuous was KW and KVAR (116.56 and 38.31) respectively. In intermittent loading, accommodation 'C' Area (Daewoo yard) had highest KW and KVAR (342.5 and 118.54), while the lowest intermittent was on accommodation 'B' Area (Daewoo yard) KW and KVAR (216.8 and 75.67) respectively. The stand-by was zero (0) on accommodation 'A', 'B' and 'C' Area (Daewoo yard) KW and KVAR respectively.

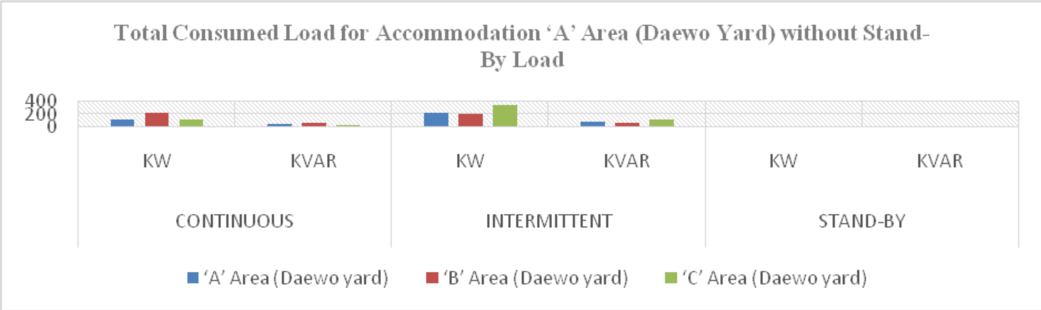

Figure 4.2 Consumed Load for Accommodation 'A' Area (Daewoo Yard) without Stand-By Load

During the Etap simulation, bus 9 of 11KV shows that it was overload, which indicates that system improvement on losses and voltage drop required compensation. The huge drop in voltage profile and power losses of about (10.23% and 11.05%) respectively in the network seriously retarded the power quality, voltage profile and power factor as shown in figure 4.3 below.

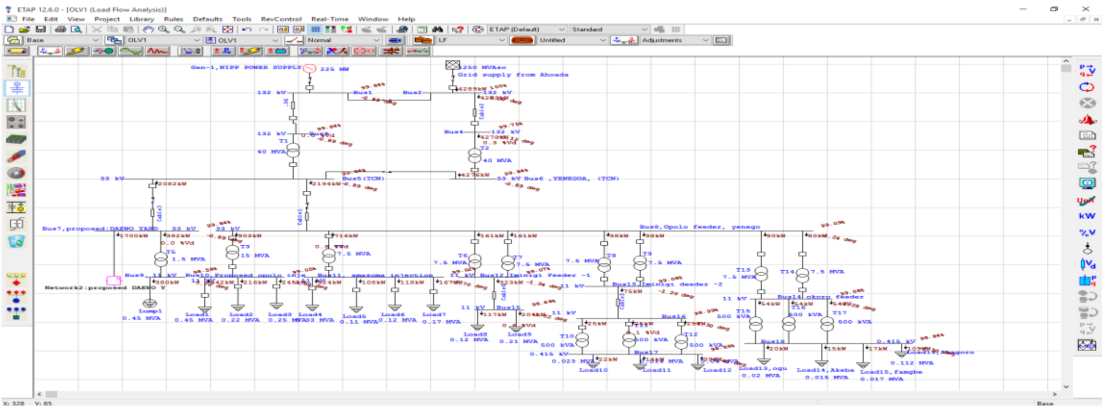

Figure 4.3: Improved Single Line Diagram of Existing Power Supply to Yenagoa (Simulated) with

Penetration of Capacitor Bank to Clear Affected Bus 9.

Evidently, electric power is proposed to take power supply from Bus 7 (Proposed: Daewoo yard) at Bus 33KV to Bus 19 of the proposed Daewoo Company with designed capacity of 1000KVA and 1500KVA transformer (from 33KV to 0.415KV) for company utilisation and consumption; the overload buses as indicated in the network, requested sizing the capacity of the compensation devices with 600KVAR at bus -20, 450KVAR at bus 25, 300KVAR at bus 21 and 450KVAR at bus 23 respectively. The compensation of power electronic controller strongly improves the power quality to enhance efficient power flow. Similarly, in figure 4.1 which shows progressive responses of a voltage magnitude and phase angle within (Buses 1 - 18), while buses 19-25 which shows irregular voltage phase angle required for improvement as shown in figure 4.4 below.

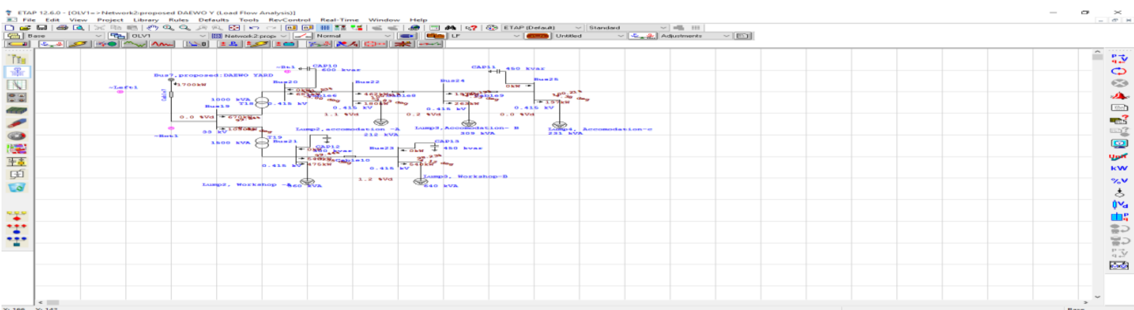

Figure 4.4: Improved Single Line Diagram to the Study case from the Supply System from Yenagoa withPenetration of 600KVAR, 450KVAR, 300KVAR and 450KVAR.

The result in table 4.2 below shows the continuous, intermittent, and with Peak Load in accommodation 'A', 'B' and 'C' Area (Daewoo yard).

Table 4.2.: Total Consumed Load for Accommodation (A, B and C Area of Daewoo Yard) on Peak Load

S/No.	Accommodation	Continuous		Intermittent		Peak Load
		KW	KVAR	KW	KVAR	KVA
1	'A' Area (Daewoo yard)	130.11	53.5	223.89	78.36	211.8
2	'B' Area (Daewoo yard)	227.81	74.88	216.8	75.67	308.7
3	'C' Area (Daewoo yard)	116.56	38.31	342.5	118.54	231.4

The result in figure 4.5 below shows that the accommodation 'B' Area (Daewoo yard) was the highest in continuous; KW and KVAR (227.81 and 74.88), while the lowest was accommodation 'C' Area (Daewoo yard) in continuous; KW and KVAR (116.56 and 38.31) respectively. The intermittent in 'C' Area (Daewoo yard); the highest in KW and KVAR was (342.5 and 118.54), while the lowest intermittent was on accommodation 'C' Area (Daewoo yard) KW and KVAR (38.31 and 116.56) respectively. The Peak Load for accommodation 'A, B, and C' was rated has 211.8, 308.7, and 231.4 respectively, which indicate that the peak load lies on accommodation 'B'.

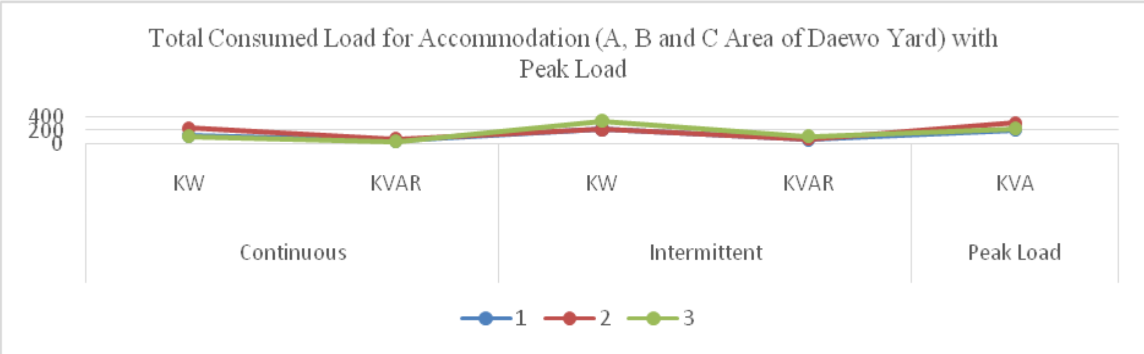

Figure 4.5: Consumed Load for Accommodation (A, B and C Area of Daewoo Yard) with Peak Load

The result table 4.3 below shows the company's existing voltage magnitude versus improved voltage magnitude with respect to their existing Buses. The voltage activity profile of the network was presented as results.

Table 4.3: Bus Number Versus Voltage Magnitude and Phase Angle.

Bus -Number	Voltage Magnitude	Voltage-Phase Angle
bus-1	99.2	-0.81
bus-2	100	0
bus-3	99.2	-0.81
bus-4	99.67	0.05
bus-5	99.2	-0.81
bus-6	99.2	-0.81
bus-7	97.94	-1.63
bus-8	97.84	-1.63
bus-9	98.42	-1.27
bus-10	98.44	-1.44
bus-11	98.05	-1.19
bus-12	98.45	-1.19
bus-13	98.36	-1.23
bus-14	98.24	-1.33
bus-15	98.44	-1.21
bus-16	98.21	-1.42
bus-17	99.2	-1.41
bus-18	97.21	-1.42
bus-19	95.71	-0.81
bus-20	95.07	-1.56
bus-21	93.58	-3.06
bus-22	94.28	-1.93
bus-23	93.58	-3.18
bus-24	94.28	-2.11
bus-25	94.12	-2.12

The result in figure 4.6 below shows that bus 2 and 4 has the highest voltage-phase angle of (0 and 0.05) respectively while bus 23 has the of lowest voltage-phase angle (-3.18). Bus 2 has the highest voltage while bus 23 has the lowest voltage magnitude of 93.58.

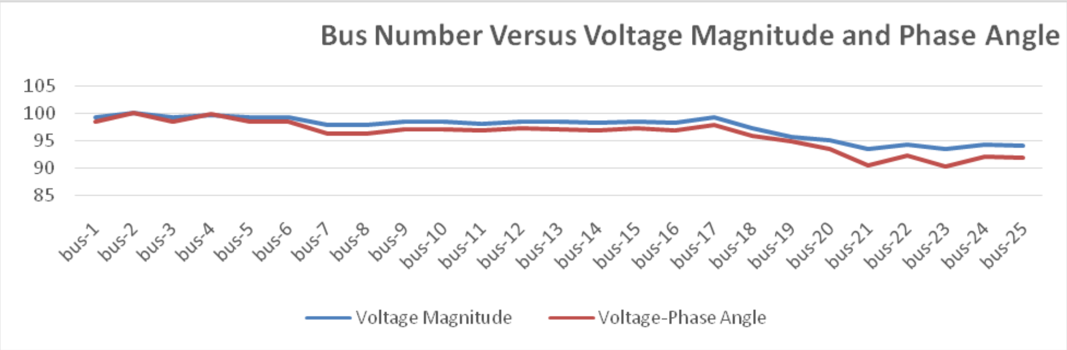

Figure 4.6: Line Diagram Showing the Bus Voltage Magnitude, Phase Angle Versus Bus Numbers.

The result table 4.4 below shows the bus-number, voltage magnitude existing, voltage magnitude improved versus existing and improved phase angles.

Table 4.4: Voltage Magnitude Existing, Voltage Magnitude Improved Versus Existing and Improved Phase Angles.

Bus number	Existing voltage magnitude	improved voltage magnitude	ext.ph.angle	imp.ph.angle
bus-1	99.2	99.84	-0.81	-0.81
bus-2	100	100	0	0
bus-3	99.2	99.84	-0.81	-0.81
bus-4	99.67	99.75	0.05	0.05
bus-5	99.2	99.84	-0.81	-0.81
bus-6	99.2	99.84	-0.81	-0.81
bus-7	99.2	99.84	-0.81	-0.81
bus-8	97.94	95.5	-1.63	-1.63
bus-9	97.94	98.58	-1.27	-1.63
bus-10	98.42	99.05	-1.44	-1.51
bus-11	98.39	99.02	-1.19	-1.63
bus-12	98.44	99.07	-1.23	-1.27
bus-13	98.05	98.68	-1.33	-1.44
bus-14	98.45	99.08	-1.21	-1.19
bus-15	98.36	98.99	-1.42	-1.23
bus-16	98.24	98.88	-0.81	-1.33
bus-17	98.44	99.08	-1.56	-1.21
bus-18	98.21	99.84	-3.06	-1.42
bus-19	99.22	99.84	-1.93	-0.81
bus-20	97.21	101.53	-3.18	-1.56
bus-21	95.71	99.44	-2.11	-3.06
bus-22	95.07	100.41	-2.12	-1.93
bus-23	93.58	98.23	-0.89	-3.18
bus-24	94.28	100.19	-3	-2.11
bus-25	94.12	100.21	-3.35	-2.12

The data in table 4.4 above was used in getting the chat result in figure 4.7 below, which shows that the existing voltage magnitude and improved voltage magnitude were all most equal respectively.

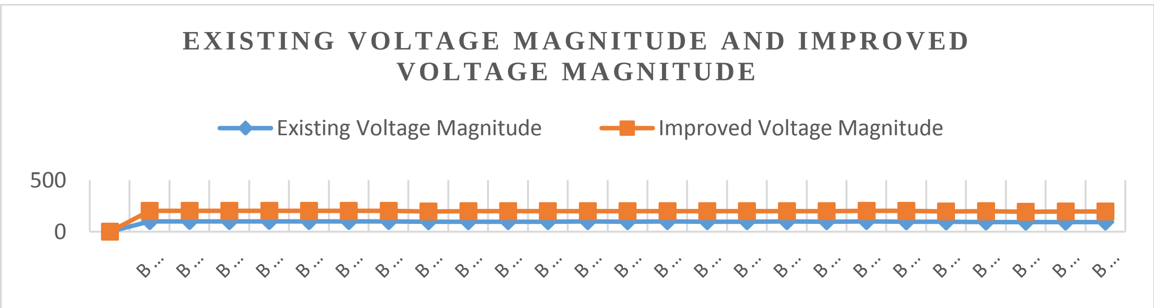

Figure 4.7 Existing Voltage Magnitude and Improved Voltage Magnitude

The data in table 4.4 above was used in getting the chat result in figure 4.8 below shows that the existing phase angle on Bus 19, has the lowest Value of -1.93 while bus 4 the has highest value of 0.05. The improved phase angle on bus 4 has the highest value of -0.8 and the lowest value of -1.93 on bus19. While the improved-phase angle which on compensation reduces the power losses and seriously improve power quality and phase angle by 10.6%.

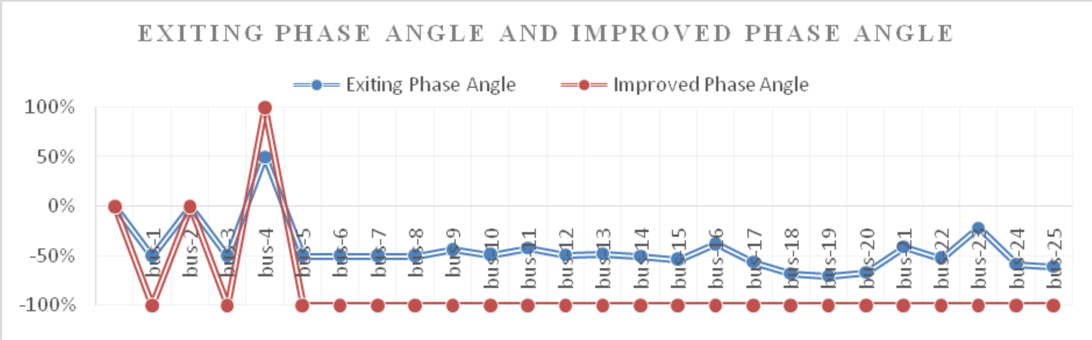

Figure 4. 8 Exiting Phase Angle and Improved Phase Angle

The result in table 4.5 below shows the bus-number, Bus-voltage Magnitude, and phase angles.

Table 4.5 Bus-Voltage Magnitude and Phase-Angle

Bus -Number	Bus-voltage Magnitude	phase-Angle
bus-1	99.2	-0.81
bus-2	100	0
bus-3	99.2	-0.81
bus-4	96.67	-0.05
bus-5	99.2	-0.81
bus-6	99.2	-0.81
bus-7	98.42	-1.51
bus-8	97.94	-1.63
bus-9	98.44	-1.27
bus-10	98.36	-1.19
bus-11	98.24	-1.23
bus-12	98.44	-1.33
bus-13	98.21	-1.21
bus-14	97.21	-1.42
bus-15	95.07	-1.56
bus-16	94.28	-1.93
bus-17	94.12	2.11
bus-18	95.71	2.12
bus-19	93.58	-3.06

The result in figure 4.8 below shows that the phase angle of Bus 2 was (0) while Bus-voltage Magnitude on Bus 2 was (100), indicating the highest respectively. While the phase angle of Bus 19 was (-3.06) while Bus-voltage Magnitude on Bus 19 was (93.58), indicating the lowest respectively.

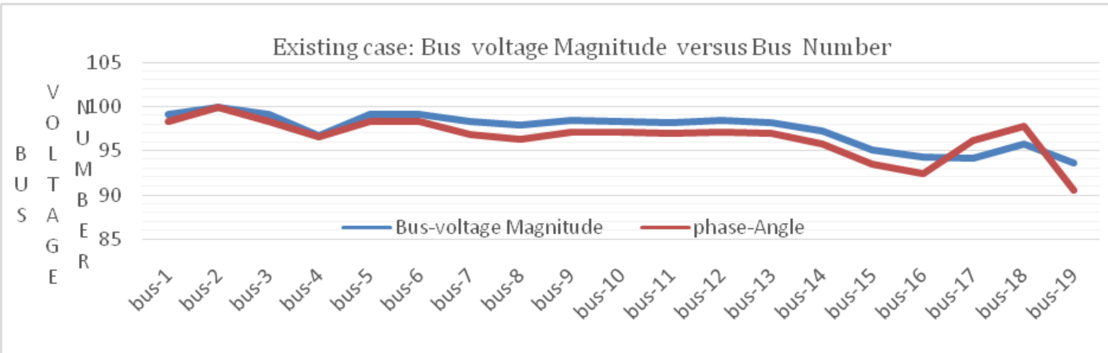

Figure 4.9: Existing case: Bus Voltage Magnitude Versus Bus Number

V. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Electric Transient Analyser programme (ETAP) software simulation was used to achieve the pre-upgrade and post-upgrade of transmission network of Daewoo yard Bayelsa state. In order to investigate and capture the activities of the study case, which strongly revealed violations in some specific buses: Bus 20,22, 23, 25 which were over loaded, the overstressed/overloaded buses were beyond the acceptable regulatory limits and practice of voltage drop as declared by the IEE regulatory limits of (±10% or +0.95 – 1.05pu), while other respective buses are within the statutory marginal limits as required. It was necessary to improve the power quality and voltage profile of the system to fall within acceptable regulatory limits on the existing power factor as desired or proposed power factor are evaluated and determined to size the capacity of the power electronic controller or facts device which are: bus – 20 (300KVAR), Bus 23 (450KVAR), Bus 25 (600 KVAR) and bus 22 (350 KVAR) capacitor-bank compensator. The determined size of the capacitor bank is accurately located at the affected buses by the penetration of the controller, this evidently improved the change in power quality, voltage profile and generally stabilizes the power system performance to about16.23% voltage-rise.

In conclusion, the occurrence of black-out due to overload problems, low power factor problem, and uncontrollable losses in the system were improved upon to ensure quality of electricity supply in Daewoo yard Bayelsa State, Nigeria.

5.3 Recommendation

There is strong need for power generation to march energy demand; this condition must be met in all standard because the continual increase in electric power demand, without corresponding increase in power generation, will seriously influence and bring the micro/macro-economic development of any nation to standstill.

Evidently, generation, transmission and distribution system must be designed to operate at specified power capability and voltage level, this mean that operating outside the available value affect quality of power reaching the consumers power supply. This has considered power losses, overload and poor maintenance. Therefore, optimizing performance and reliability of 33/11KV distribution system, this research recommends:

(i) Dedicating and upgrading the existing study cases of transformer loading, Busbar-panel (33KV)

(ii) Continually check load demand requirement to march energy generating capacity.

Proposed design of the distribution system to the study case at Daewoo yard, Yenegoa for purpose of alternative power supply system.

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