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# LOAD FLOW ANALYSIS OF 132KV CALABAR TRANSMISSION SYSTEM FOR IMPROVED PERFORMANCE USING GLOBAL BEST ARTIFICIAL BEE COLONY (GABC) ALGORITHM

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# ABSTRACT

Load flow analysis plays an important role in the planning, operation, optimization and control of a power system network. Over the years, the Calabar 132Kv transmission system has witnessed voltage losses and load shedding due to insufficient power generation, inadequate or nonexistent reserves and the inability of the transmission companies to adequately manage the reactive power flow on the transmission line. This research titled "Load flow analysis of the 132kv Calabar transmission system for improved performance using Global-best Artificial Bee, Colony Algorithm (GABC)". Electrical Transient Analyzer Program (ETAP) was used to evaluate the real time load profile of the transmission network under consideration, and its optimization was simulated in a MATLAB environment. The aim of the research is to evaluate the condition of the transmission network load flow performance for improved stability and overall efficiency. Thus, determining the quantity of voltage loss during transmission, thereby providing the network with a viable recommendation which will form a medium-term policy framework for operation that will enhance and deliver quality as well as efficient electricity supply to the people connected to the transmission line. The outcome of our evaluation reveals that, bus 30 has a generated voltage of 403megawatts and the load supply of 252megawatts and the losses alone accounted for 151megawatts. The power lost on the 132Ky Calabar network was largely due to over loading, long distance, transmission/distribution lines ageing as well as inadequate control infrastructure. Also, it is observed that the result of the reactive power optimization for 100 maximum trial runs of the 179-bus network is 74megawatts which shows a reduction in power loss after optimization. Having evaluated the performance of the 132Kv Calabar sub-transmission network Cross River State, as a case study, to increase power capacity, outdated 132KV sub-transmission networks should be modernized and continued investment is needed in the power sector, particularly with the expansion of 132Kv sub-transmission networks and the introduction of distributed generation. Finally, for future growth, very old power transformers should be replaced with ones that have a higher MVA capacity, particularly Amika feeder lines linking Ekpo-Abasi, Calabar-South, Mary-Slessor road, by the main entrance of the University of Calabar. This analysis provides a tangible and detailed information of the Calabar 132kv transmission system operation capacity as well as the data for timely improvement of the network by the power sector

#### policy makers.

*Keywords*: Load flow analysis, Global Best Artificial bee colony, load flow evaluation and transmission line network.

#### 1. Introduction

An important role for load flow analysis is played in the design, management, and control of power system networks. In the recent few decades, a number of optimisation algorithms have been introduced, including the evolutionary algorithm, particle swarm optimisation, harmony search, artificial bee colony, and ant colony optimisation. Its performance was evaluated using the benchmark optimisation function, and its development was inspired by modelling the intelligent foraging behaviours of honey bees in their colony. The following are only a few of GABC's key advantages over other optimisation algorithms:

- Simplicity, flexibility and robustness of modelling
- Use of fewer control parameters when compared to another search algorithm.
- Ease of hybridization with other optimization algorithms.
- Ability to handle the objective cost with stochastic nature.
- Ease of implementation with basic mathematical and logical operations.
- Accuracy, strong convergence and reliability.

This work has examined a sufficient amount of the literature, and other scholars have written about and reported their findings, therefore it is reasonable to assume that the matter has been resolved. However, the amount of study in this field is limitless due to technological advancements, the usage of effective calculation tools, greater sensitivity, and simplicity of convergence. The innovative Global Best Artificial Bee Colony (GABC) Algorithm will therefore be the approach and methodology for this effort.

In the past, load flow issues were examined using the Newton-Rahpson (NR) approach. However, NR has certain intrinsic flaws such the inability to handle heavily loaded networks, the need for starting value assumptions, and anomalous operating situations. The load flow problem for the Calabar 132KV 179 bus real transmission network, is solved using the Global Best Artificial Bee Colony algorithm (GABC), a recently invented swarm intelligence-based technique, to eliminate the limitations of the existing NR method.

The Calabar 132KV sub-transmission infrastructure is carefully examined, and it becomes clear that the transmission companies

are unable to adequately control the reactive electrical power flow of the network, which results in voltage losses and load shedding [1]. These networks are linked to insufficient and electricity distribution insufficient generation capacity. Inadequate or non-existent reserves and insufficient control infrastructure are other significant factors impacting stability. Therefore, to ensure effective performance, a thorough network analysis, planning, optimisation, operation, and control must be made as soon as possible to prevent a complete system failure. Similar to how the most recent collapse of the national power grid was witnessed.

This study aims to evaluate the existing 132KV Calabar transmission system's load flow performance for the stability of the network and overall efficiency. Thus, providing the network with a framework for medium-term operation.

The following goals are the focus of this study on the load flow evaluation of the 132KV, 179buses making up the actual Calabar subtransmission network:

- 1. To create a standard swarm intelligence model based on GABC to calculate the voltage magnitudes, phase angle of load buses, actual and reactive power flows, and other parameters of the transmission line.
- 2. To assess the transmission lines' present condition using the data at hand.
- 3. Using the algorithm known as the Global Best Artificial Bee Colony (GABC) Algorithm, model, modify, and simulate the network.
- 4. To make better use of the base-case simulation's findings in order to reduce loss of power across the 132KV Sub-transmission system and to improve the overall actual and reactive power flow.
- 5. To confirm that the Global Best Artificial Bee Colony (GABC) optimisation technique used in this research has significant benefits over other traditional algorithms.

The significance of this research study lies in the solutions it will provide for efficiently reducing real and reactive power losses and appropriately injecting reactive and active electrical power into the networks in an effort to boost performance and provide better service. Once more, the evaluation's findings will offer helpful data for future growth.

Modelling and simulating unique Gbest ABC algorithms for the 132KV Calabar zonal transmission system is the goal of this research project. This is necessary in order to increase the quality of the power being transmitted and distributed throughout the metropolis of Calabar and its surroundings. The model being proposed is an accurate technological approach that is extremely effective, efficient, and high convergence for studying a transmission network that is under a lot of stress, such as the Calabar network. To analyse this system using GABC, for the network under consideration real time data was sourced and simulated in a MATLAB environment.

# 2.0 Literature Review

Due to its strength and simplicity of use, the ABCA has gained a lot of popularity since it was first introduced. It has been effectively used by numerous researchers to solve issues in a variety of application areas. The ABCA was initially used to solve issues with numerical optimization (Karaboga, 2005). In (Karaboga, & Basturk, 2007a), the ABCA was expanded to include constrained optimization problems. It was also used to train neural networks, classify medical patterns, and solve clustering issues (Akay, et al., 2008). In order to suggest relevant supplementary materials for a learner based on their style of learning, interests, and difficulties, most recently (Hsu et al., 2012) employed ABC and suggested a customized auxiliary material system for recommendations on Facebook. The goal of the suggested strategy was to find appropriate learning materials quickly. In order to enhance the ABCA's capacity for global search and use it to address TSP issues, (Xing, et al., 2007) further investigated the mechanism that controls the selection of local optimal solutions.

Singh, (2009) compared the ABCA strategy to GA, ACO, and tabu search (TS) while solving the leaf-constrained minimum spanning tree (LCMST) problem. In order to reduce real power loss, enhance voltage profile, and balance feeder load subject to the radial network topology in which all loads must be powered on, (Rao, et al., 2008) used the ABCA to network reconfiguration problem in a radial distribution system. In terms of the quality of the answer and computation as a whole, the ABCA's outcomes outperformed the other methods tested in the study. Direct linear transformation (DLT), one of the camera calibration methods, was solved by (Bende, & Ozkan, 2008) using the ABCA by creating a relationship between 3D object coordinates plane linearly. Results produced by the ABCA were compared against those of the DE algorithm.

The ABCA was utilised by (Karaboga, 2009) to construct digital IIR filters in the field of signal processing. The ABCA was used by (Pawar, et al., 2008) to solve a variety of mechanical engineering issues, such as multi-objective improvement of electro-chemical machining procedure parameters, improvement of process parameters for abrasive flow machining, and milling. Recently, the most well-liked fields in which ABCA has gained popularity include machine intelligence and cybernetics.

Summarily, In the past, load flow issues were examined using the Newton-Rahpson (NR) approach. However, NR has certain intrinsic flaws such the inability to handle heavily loaded networks, the need for starting value assumptions, and anomalous operating situations. The load flow problem for the Calabar 132KV 179 bus real transmission network, is solved using the Global Best Artificial Bee Colony algorithm (GABC), a recently invented swarm intelligence-based technique, to eliminate the limitations of the existing NR method.

The work of several scholars on transmission system network analysis was examined in the previous sections. In order to effectively evaluate transmission network, the challenge of effective computation of huge networks, fast convergence, and overall efficient system sensitivity becomes paramount. The Global Best Guided Artificial Bee Colony (GABC) is taken into consideration for addressing these issues.

Thus, GABC is used in this study to evaluate the current state of operation of the 132KV Calabar transmission system in order to enhance its stability and design an efficient control method to mitigate these challenges associated with the conventional Newton Rahpson, Gaus-siedel, Fast-Decoupled method, and other known nature-inspired search optimization algorithm mentioned above. Therefore, decreasing the load shedding and transmission line losses that are frequently observed in the city of Calabar and its environs.

# 3. Methodology

Mathematical model and fundamental equations of load flow analysis on an n-bus system. Consider an n-bus system comprising of voltages, angles, admittances and line (MW and MVAR) flows between pairs of buses indexed at WS say i, k; then the real and reactive power may be represented as

Where;

$$P_{i} = V_{i} * V_{k} * Y_{i,k} * \cos(\delta_{k} - \delta_{i})$$
$$Q_{i} = V_{i} * V_{k} * Y_{i,k} * \sin(\delta_{k} - \delta_{i})$$

 $V_{i} \qquad (3.4) \qquad (3.1)$   $V_{k} = \text{voltage at the } i^{\text{th}} \text{ bus}$   $Y_{i,k} = \text{voltage at the } k^{\text{th}} \text{ bus}$   $\delta_{k} \qquad \delta_{i}^{\text{=}} \text{ the admittance between bus } i \text{ and bus}$ 

#### bus i, k angles

k.

It should be noted that a bus is referred to be a generator bus when it produces electricity; otherwise, it is referred to as a load-bus. A slack bus is frequently required to accommodate (suck-up) the extra power flows.

The line flows may further be expressed as changes in the computed real bus/or generator powers with respect to pre-specified real bus/or generator values and is expressed as:

$$\Delta P_i = \left| P_i^{sp} - P_i^{cal} \right| \tag{3.2}$$

Where;

 $P_i^{sp}$  = the specified real bus powers at power exchange sequence i, and

 $P_i^{cal} =$  = the computed real bus powers at power exchange sequence i, using eqn. 3.3

Similarly, the reactive power changes may be expressed as:

$$\Delta Q_i = \left| Q_i^{sp} - Q_i^{cal} \right|,$$

Where;

 $Q_i^{sp}$  = = the specified reactive bus powers at power exchange sequence i, and

 $Q_i^{cal}$  = the computed reactive bus powers at power exchange sequence i, using eqn. 3.4

The admittances, line power demand, and generations are typically predetermined, whereas the bus voltages and angles are determined through initial guesswork and load-flow programme solution. The total of all bus power sequence exchanges is then used to calculate the net power balance as follows:

$$\Delta P_{net} = \sum_{i}^{n} \Delta P_{i}$$

And,

$$\Delta Q_{net} = \sum_{i}^{n} \Delta Q_{i}$$

The ABC algorithm's objective function (F), which was created to identify the load flow issue, is as follows:

$$F = \sqrt{\sum \Delta P i^2 + \sum \Delta} Q i^2$$

Where i = 1, 2, 3... number of bus bars

# **3.1** Cross-Section of Nigerian 132KV Power Transmission Network (Calabar Zone)

In this research paper, the Calabar 132kv transmission network was investigated and a special attention was paid to the Calabar 132kv transmission station is considered strategic and unique to the Nigerian national grid. The station has seven (7) incoming 330kV lines, two (2) 330kV outgoing lines and fourteen (14) 132kV outgoing lines to step down transmission stations in the network. The transmission station consists of four (4) 150MVA step-down transformer (resulting in a total station capacity of 600MVA or 480MW) for stepping the incoming 330kV to 132kV. The transformer has nomenclatures given as; T1A, T1B, T2A and T2B. Two (2) 75MX reactors R1 and R2 are connected to the 330kV bus-bar for voltage stability. Two earthing transformers (GT1A and GT2A) are attached to the transformers, and GT1A is connected to the tertiary of T1A while GT2A is connected to the tertiary of T2A. The generators are assumed to be operating at 80% of their maximum installed capacity with the highest being the EGBIN thermal station which will be assumed as the power swing bus for the Load flow Analysis. The information for the accurate representation of this test system was obtained through an authorized data gathering from the Transmission Company of Nigeria Substation.

Typical values of machine parameters such as steady state and dynamic data that could not be obtained from TCN (Transmission Company of Nigeria) was implemented for simulation in this research work. Lagos has one of the Largest 132kv Transmission Network in Nigeria. The Lagos metropolitan Transmission network has the following line voltage levels:

# 3.2 Analysis of ABC Variants and Its Application for Load Flow Computation

ABC Variants are ABC\_Normal, ABC\_Gbest and ABC\_mfe\_controlled. In this work, the performance of ABC\_Gbest was compared with ABC\_normal and ABC\_mfe controlled optimization algorithms. Although there are several improved versions of GA, DE and PSO in the literature. In the Analysis, we used the same population number and the maximum evaluation number for all problems although it is a known fact that these control parameters affect the performance of algorithms significantly.

However, in most comparative studies these parameter values of (1.5, 0.4\*10, and 0) are varied with respect to the dimension of the problems or to their other characteristics. The reason is that we assumed the users of an algorithm do not know much about the recommended values of these parameters for their problems to be optimized.

While ABC\_normal and ABC\_mfe controlled employ crossover operators to produce new or candidate solutions from the present ones, ABC\_Gbest does not. ABC\_Gbest produces the candidate solution from its parent by a simple operation based on taking the difference of randomly determined parts of the parent and a randomly chosen solution from the population. However, in ABC the best solution discovered so far is not always held in the population since it might be replaced with a randomly produced solution by a scout. Therefore, it might not contribute to the production of trial solutions.

The ABC optimization is applied to obtain the bus voltage magnitude () and voltage phase angle ( $\delta$ ) by minimize the value of objective function, which gives as:

$$min(x), x = (x1,2,\ldots,xi,\ldots,xn-1,xn)$$
 (3.8)

This objective function constrained by the inequalities lower bound (Lb) and upper bound (Ub).  $Lb \le xi \le Ub$ 

The voltage magnitude and voltage phase angle are limited in range  $0.5 \le Vi \le 1.05$  and  $-5 \le \delta i \le 5$ .

The objective function (F) that designed to determine the load flow problem by using ABC algorithm is:  $F=\sqrt{\sum} \Delta Pi2 + \Delta Qi2$  (3.9) Where; *i* =1, 2, 3... number of bus bars. The optimization process will continue until the best fitness value is reached. This mismatch power is close to zero the whole application of ABC algorithm approach in load flow computation is as shown in Figure



Figure 3.1(a): Single line diagram of Nigerian 330Kv/132Kv power system.



Figure 3.1(b): A Single line diagram of a 132 Kv Calabar sub-region transmission network

# 4.0 Result Analysis, Simulations and Plots With the following simulation para

meter settings, the GABC method is being applied to the 179-bus Calabar 132KV transmission networks: Intel i3-4010U 1.70 GHz processor and 4 GB of RAM are used to perform the proposed GABC algorithm in MATLAB. Population number NP = 250, maximum iteration number Tmax = 50, mutation factor F = 0.8, crossover factor CR = 0.8, penalty factor w1, w2, and w3 are all set to 6.0, w4, w5, and w8 are set to 1.00.001, and w6 and w7 are set to 7.00.001 are all used in the construction of the ABC method.

#### Alert Summary Report

	% Alert S	Settings			
	Critical	<b>Marginal</b>			
Loading					
Bus	100.0	95.0			
Cable / Busway	100.0	95.0			
Reactor	100.0	95.0			
Line	100.0	95.0			
Transformer	100.0	95.0			
Panel	100.0	95.0			
Protective Device	100.0	95.0			
Generator	100.0	95.0			
Inverter/Charger	100.0	95.0			
Bus Voltage					
OverVoltage	105.0	102.0			
UnderVoltage	95.0	98.0			
Generator Excitation					
OverExcited (Q Max.)	100.0	95.0			
UnderExcited (Q Min.)	100.0				

From table 4.2 above, the real time crittical report/result of the network under consideration (330/132kv) is analysed or evaluated indicating the numbers of buses and types, the line rating limits, the operating percentage as well as phase angle type. This critical report shows the various buses that are operating under sever/bad network conditions.

#### Table 4.3: Marginal report of the 132Kv transmission network real time result

# Marginal Report



Table 4.3: above shows the marginal report of the evaluation of the network under consideration. It is revealed that only bus 13 is operating at significant normal condition.

Table 4.4: Load flow Report of the 132KV transmission network real time result

	Bus		Voltage	Gen	eration	I	Load		L	oad Flo	W			XFMR
	₽	₩V %	Mag. Ang.	₩W	Mva	F MŸ	W Mvar	_	Ð	₩W	Mvar	Amp	%₽F	%Тар
讣	us184	330.000	73.957	-1.7	000.0	000.0	0.000 0	.000	OWERRIBus37	-30	9.903	-109.573	777.6	94.3
									Bus23	30	9.903	109.573	777.6	94:3
*	CALABAR Bus30	330.0	000 100.000	0.0	403.571	252.48	8 235.280	14	5.813 Bus174		168.291	106.	675 3	48.6 84.5
*	EGBEMA 38	330.0	000 100.000	0.0	730.703	168.88	4 0.012		0.000 OWERRIBus37		730.691	168.	884 13	12.1 97.4
\$	GARMO Bus39	330.0	000 100.000	0.0	84.587	0.430	9 10.000		0.000 ÆBBA Busši		74.587	0.	430 1	30.5 100.0
*	GEREGU Busi2	330.6	000 100.000	0:0	498.686	*****	10.000		0.000 AJAOKUTA Bus10		488.686	-2081.	811 37	41.2 =22.9
斑	BBA Busši	330.000	98.488	-0.3	000.0	0.000 22	0.383 0	.000	GARMO Bus39	=7	3.461	0.000	130.5	100.0
									ÆBBA GS Bus47	=7	3:461	0.000	130.5	100.0
									KAINЛ Bus24	=7	3.461	0.000	130.5	100.0
*	JEBBA GS Bus47	330.6	000 100.000	0:0	84.587	0.430	10.000		0.000 ÆBBA Busši		74:587	0.	430 1	30.5 100.0
*	KAINJI Bus24	330.0	000 100.000	0.0	744.709	7.01	4 378.400		0.000 KEBBI Bus23		291.722	6.	584 S	10.5 100.0
									ÆBBA Bussi	7	4.587	0.430	130.5	100.0
¥	EBBI Bus23	330.000	94.067	-1.3	666.6	0.000 27	4.484 0	.000	KAINЛ Bus24	-27	4.484	0.000	\$10.\$	100.0
Ł	okoja bus 13	330.000	102.811	-0.5	666.6	0.000 1	0.570 0	666	BENIN Bushi	11	3.942	159.539	333.6	58:1
									AJAOKUTA Bus10	-12	4.512	-159.539	344.4	61.5
*	OMOTOSHO Bus28	330.6	000 100.000	6.6	333.723	69.17	329.700		0.000 BENIN Bust1		4.023	69.	172 1	21.2 <u>5</u> .8
0	WERRIBus37	330.000	83.931	-1.5	000.0	0.000 26	\$.\$02 0	.000	Bus184	35	1.323	128.394	777.6	94.2
									EGBEMA 35	-61	6.824	-125.394	1312.1	98.0
*	PAPALANTO Bus7	330.0	000 100.000	0.0	*****	*****	9.000		0.000 PAPALANTO Bus183	i	163.184	395.	623 7	48.7 38.1
									Bus38 Ikeje west 2	1356	7.850 -9	0454.260	160024.3	=14:8
₽	APALANTO Busi83	330.000	93.880	4.1	666.6	666.6	0.000 0	666.	PAPALANTO Bus7	-12	6.105	-381.461	748.7	31:4
									Bus88	12	6.105	381.461	748.7	31.4
₽	h Bus 4	330.000	12.196	-32.8	000.0	0.000	7.389 0	.000	AFAMBus2	-1	6.360	-3.444	239.8	97.9
									Bus89		8.971	3:444	137.8	93:4
*	Indicates a voltage regu	hated bus ( v	oltage controlla	el of swin	ig type ma	shine sonn	iested to it)							
# #	adicates a bus with a load	mismatch of	more man 0.1 N	IVA										

Table 4.4 shows the Load Flow Report of the 132 KV Transmission Network Result in Real Time including the 179 buses that makes up the Calabar Transmission System.

Note that from the table above, the total voltage generation and consumption is shown on the table reflecting the Calabar Zone on Bus 30 Including the bus codes, voltage, magnitude, bus types, bus power injection ( $S_{mva}$ ), real and reactive power respectively. In the table above star (\*) indicates a voltage regulated bus (voltage controlled or swing type machine connected to it). And the (#) indicates a bus with a load mismatch of more than 0.1 MVA.



# Figure 4.1: Critical % Operating Load Profile For 330kv Components And Operating Condition

The graph above shows the critical % operating load profile for 330kv components and operating condition of each affected components within the Grid. The key indicators in the graph show the interpretation of the condition of each component respectively. Hence, from the result obtained, the Papalanto Gen3 suffers 3 major setbacks such as; overload, under excitation and under voltage conditions.



# Figure 4.2: Critical %Operating Load Profile for 132Kv Components and Operating Condition

The graph above shows the percentage average daily load profile and working condition critical buses within the Grid and from all indications it is obvious that Bus 149 is under a serious Over Voltage condition and that has created a wider margin in the outputs of other buses within the network, also bus 178 has a marginal Under voltage condition while bus 68 has the lowest voltage range. Hence, there is a need for power balancing and matching in the grid to ensure adequate transmission of power with regard to

Nigerian Journal of Engineering Research Unicross (NJERU) ISSN No. 2971-785X 69 | P a g e

the load demand to the different load centers within the network.

SUMMARY OF TOTAL GENERATION, LOADING & DEMAND						
	MW	Mvar MVA	% PF			
Source (Swing Buses):						
	19275.840	-91564.840	93571.780 20.60 Leading			
Source (Non-Swing Buses):						
Barris Barris A	329.412	0.000	529.412 100.00 Lagging			
4 6181 420118886	19805.250	-91564.840	93682.270 21.14 Leading			
Total Motor Load:	10000.200	01001010	Society Little Little			
	188.224	116.651	221.440 85.00 Lagging			
Total Static Load:						
	5499.683	29.163	5499.760 100.00 Lagging			
Total Constant I Load						
	0.000	0.000	0.000			
Total Generic Load:		0.000	0.000			
	0.000	0.000	0.000			
Apparent Losses	14113 250	01310 660				
	14117.350	-91710.660				
System Mismatch:	0.000	0.000				
	0.000	0.000				

# TABLE 4.5: SUMMARY OF TOTAL GENERATION, LOADING AND DEMAND

From table 4.5 above, it is observed that the total electric power demand is over 19 megawatts and the apparent losses during transmission is over 14 megawatts indicating the high risk on the transmission network due to long distances and obsolete transmission and distribution facilities which also goes a long way to hinder the delivery of power to the consumers.



Figure 4.3: Nigerian 330/132Kv Transmission line load flow pattern (Upstream)



Figure 4.4: Nigerian 330/132Kv Transmission line load flow pattern (Downstream)



Figure 4.5: GABC Calabar Daily Load Flow Profile

The GABC graph above show the daily load flow profile of energy consumption in the Calabar transmission and distribution power network. From the result it is obvious here that the Amika feeder takes a progressively low output and has the highest frequency of high load condition.



Figure 4.6.: Summary of GABC Load Flow Analysis for Calabar 132/ 33/11kv Down Stream Zone



Figure 4.7: Results of reactive power optimization for hundred trial runs 179 bus networks

### 4.2 Summary

In this study, the use of the Gbest guided artificial bee colony method to address reactive power optimization is described. The actual Calabar 132KV 179-bus network, is used for this study. The outcomes of these case studies show that the GABC algorithm is effective more than other existing optimization techniques at tracking the best solution for the optimization of the reactive power problem. The guided gbest ABC algorithm can be a useful tool for nonlinear complicated engineering optimization problems in addition to reactive power optimization problems.

The real Calabar 132kV 179-bus was used to assess the efficiency and robustness of the gbest-guided ABC algorithm. The results were 73.4556 MW power loss and critical ratio of 0.986315668 (i.e., this test was conducted at a significance level of 0.05). If the statistical value is greater than the significance threshold (i.e.,) in the instance of the Wilcoxon rank sum test, the hypothesis will be kept by (or vice versa).

The reactive power load is 126.2 MVAR, while the total active power load is 283.4 MW. There are six generators attached to buses 1, 2, 5, 8, 11, and 13. Bus 1 is regarded as the standard bus. Buses 10, 12, 15, 17, 20, 21, 23, 24, and 29 are where the compensators are attached, accordingly. The branches of the transformer are, in order, (6-9), (6-10), (4-12), and (28-27).

#### 5.0 Conclusion

Load flow analysis using GABC data and graph is an effective tool for maintaining power system stability while reducing outages. The GABC data provides a comprehensive solution for analysing the load distribution within the system. This data can then be depicted graphically, which makes it easier to understand the system's behaviour and make informed decisions accordingly, the benefits significantly outweigh them. In the network system data analysis as shown in this research clearly indicates the overall performance of the Nigeria national power grid in a simpler format (GABC) which give power investors, operators and a common man a clear interpretation to the condition of the system.

Sequel to the nature of epileptic power condition in Nigeria as shown in the result in this work, it is noticeable that the power crisis lies mostly on the Distribution network. Hence, it is importance for the distribution companies to put more resources and energy into the distribution network areas as we can see in the case of the Calabar 132/33/11kv load centre or zone. Load flow analysis using GABC data and graph offers various advantages. GABC analysis facilitates a better understanding of the load distribution in the system, while the graphical representation makes it easier to spot issues and identify their causes, which helps in troubleshooting and decision making.

# 6.0 Contribution to Knowledge

In order to determine the status of the power flow in the 179-bus network, the base-case networks were simulated. It was discovered that the transmission line connecting buses which are operating in a critical condition suffered losses because of overloading, distance, and line ageing. Since lines with the highest real and reactive loss are connected to buses with the lowest voltage angle magnitude, respectively, both the real and reactive power flow can be impacted by changes in bus voltage angles and voltage magnitude. 84.3% was the crucial threshold at which 2 buses were functioning, while 96.9% was the marginal point at which 5 buses were working. Although the marginal bus voltage areas were within acceptable bounds, any change in load demand will push these buses to a breaking point, so efforts should be made to enhance the networks' ability to supply electricity.

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#### Author Contributions:

Simeon Ebahe Okachi carried out the research writing and Akpama carried out the simulation and the optimization.