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Improvement of the Electric Power Utilization for Rumuogba Area in Port Harcourt, Rivers State using Power Capacitor

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ABSTRACT
This research study investigated how to improve electric power utilization for Rumuogba area in Port Harcourt, Rivers State using power capacitor. The outcome of the results were analysed and the following factors were determined such as; maximum demand, load factor, plant capacity factor and plant use factor with respect to the load point, existing and improved power factor, installed capacity, reserve capacity, hour plant is operating and hour plant is not operating, daily energy produced, maximum energy when running and maximum energy when fully loaded, penetration of capacitor/reactor bank, and the relationship between the power of the capacitor bank and loss reduction with power factor correction with respect to load point. The existing power factor was improved from 0.85 to 0.90; the maximum demand (kW or kVA) shows the specified time interval during the billing period. The load factor shows the amount of the electricity usage for the month when contrasted to his highest utilization for that similar month. Plant capacity factor measure how often a power plant runs for a specific period of time, from our results the maximum value is 70% (Woji Road) while the minimum values is 42% (Assemblies of God church). Plant use factor determine the ratio of actual energy produced (in kWh) in a given time period to the product of plant capacity and the number of hours the plant was in operation. Our results show that the 100% is the maximum values for (Ciona Suite, Emmanuel Jack S/S, Doma Estate, Evely Suite, Glory Refuge close and Eze Gbakagbaka Avenue) while the minimum value is 60% (Godfrey Ohuabunwa). The maximum reserve capacity value is 6.6 MW (Cumi Medical) and the frequent reserve capacity value is 6.3MW (Ciona Suite, Rumuorulu S/S I, Emmanuel Jack S/S, Apamini S/S II and Doma Estate). The applications of Electrical Transient Analyzer Program (ETAP version 12.6) software for simulation were adopted. The following recommendations were made: enabling power management systems for hardware; eliminating unutilized equipment; rearranging the center floor plan to maximize cooling potential; and modestly adopting more energy efficient components. It is said that these measures are able to reduce data center energy consumption by up to 30 percent. Furthermore, the following contributions to knowledge were ascertain; as the consumption rate moves toward the level of compute maximum demand, it will be important to pay increasing attention to the energy efficiency of the network regularly, in the future, consumers can generate power through their own distributed renewable energy, and more importantly, they can respond to the demand side by providing user-side load resources and power management techniques, such as provisioning, virtualization, and consolidation, should be provided as an effective solution for energy savings in data centres. In conclusion, it can be noted that the actual measures put in place often depend on the individual data centre, as different centers house specialized electrical power systems, components and are utilized for diverse purposes.
KEYWORDS: Load Factor, Installed Capacity (plant capacity), Plant Use Factor, Utilization Factor for Plant, Diversity Factor, Coefficient of Utilization or Utilization Factor Maintenance Factor, Depreciation Factor

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I. INTRODUCTION

The power distribution system is made up of transformers, poles and wire seen in neighborhoods circuits. Distribution substations monitor and adjust circuits within the system. The distribution substations in Rumuogba have the transmission line voltages of 33 kV and 11 kV respectively. The voltage is further reduced by distribution transformers to the utilization voltages of 415 volts three-phase or 240 volts single-phase supply required by most users.

Substations are made up of switches, transformers and other electrical equipment. Once the voltage has been lowered at the substation, the electricity flows to industrial, commercial, and residential centers through the distribution system. Conductors called feeders reach out from the substation to carry electricity to customers. At key locations along the distribution system, voltage is lowered by distribution transformers to the voltage needed by customers or end-users.

Electric distribution system power quality is a growing concern. Customers require higher quality service due to more sensitive electrical and electronic equipment. The effectiveness of power distribution system is measured in terms of efficiency, service continuity or reliability, service quality in terms of voltage profile and stability and power distribution system performance [1].

In the context of Rumuogba area distribution network, electric power interruption is becoming a day to day phenomenon. Even there are times that electric power interruption occurs several times a day, not only at the low voltage but also at the medium voltage distribution systems.

The drop of the voltage, especially at the residential loads, is causing early failure of equipment, blackening of light bulbs, and decreased efficiency and performance of high-power appliances. Damage of electronic devices and burning of light bulbs have also occurred due to over voltages.

With advancements in technologies both integrated in power systems and employed in relation to it, a risk of increase in failure frequencies in power distribution components is expected. Introduction and additions in system automation, wide expansion in power demand complications due to distributed generation etc., are contributing factors to this risk [2]..

The reliability and economic constraints might interfere with each other, and hence require an agreed balance. This balance should be achieved not only by the interest in making savings from the network and cost-effectiveness, but also by considering the societal requirements of high quality of uninterrupted energy requirements. The ethical aspects of research should cater to the social and environmental impact of optimal operation conditions in power systems, making the balance economically worth for both customers and grid owners [5].

1.2 Statement of the Problem

Rumuogba distribution network is currently making effort to change the state economic status from the current least developed level to a medium income level since it is industrialized area. Of the many aspects of this effort, expanding and strengthening of the electric power supply sector is one among the most emphasized economic dimensions.

Rumuogba distribution network is one of the selected areas as an industrial zone by the government and that makes the city a preferred location for most of the industries in the country, and hence considerable share of the electric power supply is supplied to the city. But, electric power interruption is becoming a day to day phenomenon which led to the following problems:

- Electric power interruption occurs several times due to over loading of distributed transformers by the customer usage.
- Low voltage experiences.
- Voltage drops due to the distance covered by the transmission line.
- Insufficient power supply from the National Grid.
- Poor maintenance on the transmission and distribution line.

1.3 Aim of the Study

The aim of this research work is to improving the Electric Power Utilization for Rumuogba area in Port Harcourt, Rivers State using power capacitor.

1.4 Objectives of the Study

The objectives of this research work are:

- To create the network using Electrical Transient Analyzer Program (ETAP version 12.6) software environment.
- To determine Power Flows and losses in lines.
- To simulate the network using shunt capacitor.

1.5 Scope of the Study

This study is limited to improving the electric power utilization for Rumuogba area in Port Harcourt, Rivers State.

II. LITERATURE REVIEWS

According to [8] present a comparative result of distribution reliability improvements that can be achieved by using various outdoor distribution devices. First, the work discusses the application of the most common types of devices, including line reclosers, automatic sectionalisers and manual switches. The paper concludes, all devices offer an improvement in reliability.

In view of [7], the authors developed a new reliability and security index that reflects both on direct and indirect characteristics. Direct characteristics deal with the risk to not fully supply load in various contingencies. Indirect characteristics address such undesirable conditions as circuit overloads, voltage problems, low stability margins, area interchange violations, in-sufficient generation reserves, unfeasible power flows, etc. Although indirect characteristics do not necessarily cause load losses, they nevertheless signal about a reduced security/reliability margin. This reduced margin may lead to sometimes hardly predictable and quantifiable load losses (via remedial actions, islanding, and instability), unforeseen events (cascading outages), severe system failures (voltage collapse), etc.

According to [3], the implementations of reliability improvement solutions on a test system have been evaluated from a socio-economical point of view. For each of the alternative solutions implemented on the test system, the average annual supply interruption cost to the customers supplied from the test system has been estimated. Furthermore, the maximum annual capital cost associated with the implementation of each solution has been estimated. Then, a reliability improvement solution is considered justified socio-economically if the capital cost associated with its implementation is less than the resulting reduction in the interruption cost to the customers.

According to [4], the author focuses on aging power systems. Aging of components is an important fact in power system reliability assessment. It results from a number of different reasons: deterioration, erosion, or damage of equipment. Regardless of reasons, most equipment may develop aging trend over time. As a result, aging may become the cause of load curtailments because of higher system failure probability. So it is necessary to examine aging characteristics in system reliability or in economic evaluation. Power systems with high reliability at low costs offer many benefits in competitive environment.

2.2 Electrical Substation

An electrical substation is a subsidiary station of an electricity generation, transmission and distribution system where voltage is transformed from high to low or the reverse using transformers. Electric power may flow through several substations between generating plant and consumer, and may be changed in voltage in several steps. A substation that has a step-up transformer increases the voltage while decreasing the current, while a step-down transformer decreases the voltage while increasing the current for domestic and commercial distribution [1].

Substations generally have:

- Switching equipment
- Protection equipment
- Control equipment
- One or more transformers

In a large substation circuit breakers are used to interrupt any short-circuits or over load currents that may occur on the network. In smaller distribution stations Recloser circuit breakers or fuses may be used for protection of distribution circuits. Other devices such as capacitors and voltage regulators may also be located at a substation. Substations may be on the surface in fenced enclosures, underground, or located in special-purpose buildings [1].

2.3 Distribution Substation

A distribution substation transfers power from the transmission system to the distribution system of an area. The input for a distribution substation is typically at least two transmission or sub transmission lines. Distribution voltages are typically medium voltage, between 2.4 kV and 33kV depending on the size of the area served and the practices of the local utility. Besides changing the voltage, the job of the distribution substation is to isolate faults in either the transmission or distribution systems. Distribution substations may also be the points of voltage regulation, although on long distribution circuits (several km/miles), voltage regulation equipment may also be installed along the line. Complicated distribution substations can be found in the downtown areas of large cities with high-voltage switching and backup systems on the low-voltage side [1].

2.4 Losses in Transmission

Transmitting electricity at high voltage reduces the fraction of energy lost to resistance, which varies depending on the specific conductors, the current flowing and the length of the transmission line. For example, a 100 mile (160 km) span at 765 kV carrying 1000 MW of power can have losses of 1.1% to 0.5%. A 345 kV line carrying the same load across the same distance has losses of 4.2%. For a given amount of power, a higher voltage reduces the current and thus the resistive losses in the conductor. For example, raising the voltage by a factor of 10 reduces the current by a corresponding factor of 10 and therefore the losses by a factor of 100, provided the same sized conductors are used in both cases. Even if the conductor size (cross-sectional area) is reduced ten-fold to match the lower current, the losses are still reduced ten-fold. Long-distance transmission is typically done with overhead lines at voltages of 115 to 1,200 kV. At extremely high voltages, more than 2,000 kV exists between conductor and ground corona discharge losses are so large that they can offset the lower resistive losses in the line conductors. Measures to reduce corona losses include conductors having larger diameters; often hollow to save weight or bundles of two or more conductors [6].

III. MATERIALS AND METHOD

3.1 Materials Used In the Analysis

- The distribution line data were collected from the Port Harcourt Electricity Distribution Company (PHEDC).
- Substation feeder data
- Conductor size, cross-sectional area with 160mm^2 (aluminum conductor)
- Transmission/distribution line data, bus-data including network diagram.
- Application of Electrical Transient Analyzer Program (ETAP version 12.6) software is exploited for the results.

3.2 Description of Electrical Power Utilization for Rumuogba area Distribution Network

The existing Rumuogba area distribution network consists of single line diagram, where the 132kV/33kV comes from Afam to Woji substation which is a distribution substation. The substation is fed by Afam 132kV power line from Afam generation station in Rivers State.

Starting from the generating station to the end users, voltage is needed to be stepped up and down several times in various substations; this ensures efficient transmission of power and minimizes the power losses. At the substation power factor is corrected and voltage is stepped down to 33kV which is then transferred to the distribution system (feeders) (TCN 2019). Figure 3.1 shows the single line diagram of Rumuogba.

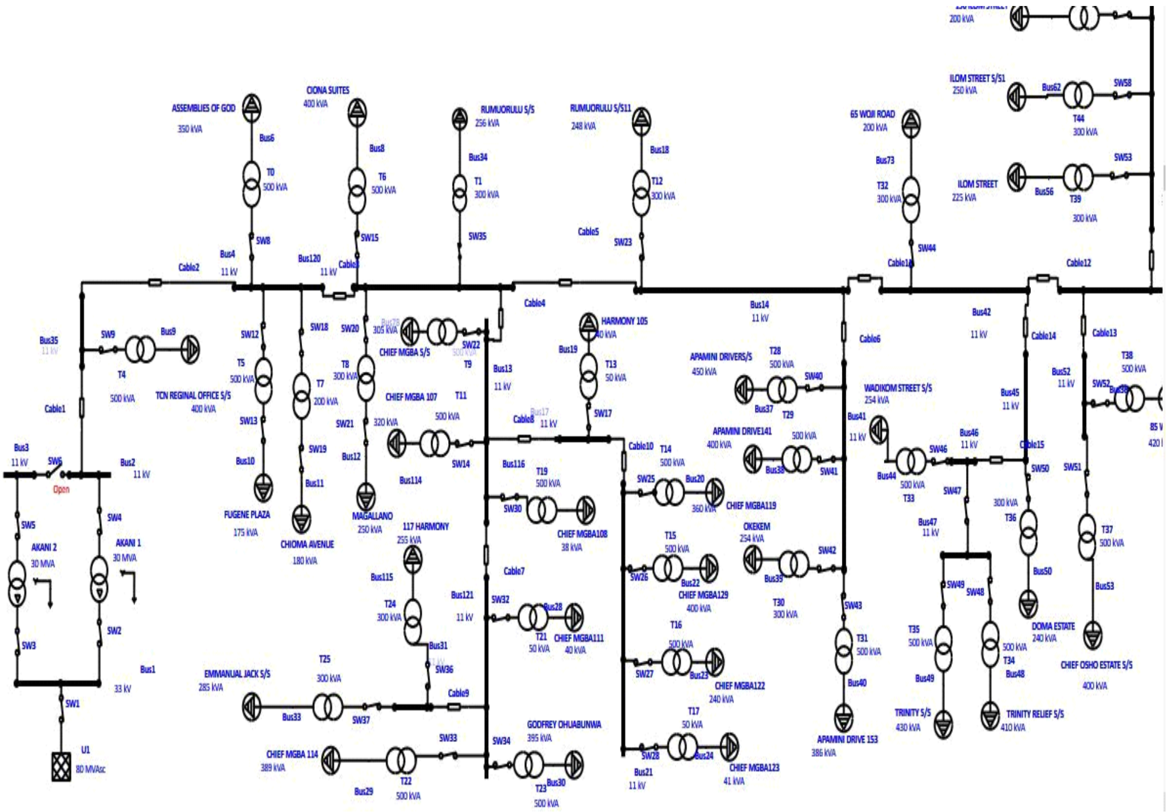

Figure 3.1: Single line diagram of Rumuogba Distribution Network

3.3 Coefficient of Utilization or Utilization Factor

It is defined as the ratio of total number of lumens reaching the working plane to the Total number of lumens emitting from source.

$$\text{Utilization Factor} = \frac{\text{Total Lumens reading the working plane}}{\text{Total lumens emitting from source}} \quad (3.1)$$

3.4 Maintenance Factor

It is defined as the ratio of illumination under normal working conditions to the illumination when everything is clean. Its value is always less than 1, and it will be around 0.8. This is due to the accumulation of dust, dirt, and smoke on the lamps that emit less light than that they emit when they are so clean. Frequent cleaning of lamp will improve the maintenance factor.

$$\text{Maintenance factor} = \frac{\text{Illumination under normal working condition}}{\text{Illumination under everything is clean}} \quad (3.2)$$

3.5 Depreciation Factor

It is defined as the ratio of initial illumination to the ultimate maintained illumination on the working plane. Its values are always more than 1.

$$\text{Depreciation factor} = \frac{1}{\text{Maintenance factor}} \quad (3.3)$$

3.6 Load Factor

It is the ratio of the average load to the maximum load for a certain period of time. The period of time a day, the load factor is a daily load factor and if the period of time is month the load factor is monthly load factor and similarly for the yearly load factor.

$$\text{Load factor} = \frac{\text{Average Load}}{\text{Max.Load}} \quad (3.4)$$

3.7 Installed Capacity (plant capacity)

It is the maximum generation in kW or MW and it is depend on the design of machine (generator)

Plant Capacity Factor

$$= \frac{\text{Actual energy produced in kW}}{\text{Maximum possible energy that could be produced (based on installed capacity)}} \quad (3.5)$$

$$\text{Plant Capacity Factor} = \frac{\text{Average load kW}}{\text{Installed capacity kW}} \quad (3.6)$$

3.8 Plant Use Factor

$$\text{Plant Use Factor} = \frac{\text{Actual energy produced (kWh)}}{\text{(plant capacity)x (no.of hours that the plant has been in operation)}} \quad (3.7)$$

$$\text{Plant Use Factor} = \frac{\text{Average load X time(24 hours if the time is a day)}}{\text{(Installed capacity)X (hours in operation in kW)}} \quad (3.8)$$

3.9 Utilization Factor for Plant

The utilization factors for a plant depend on the use to which the plant is put. A low utilization factor means that the plant is either a stand by plant or has been installed to take into account the future increase in the load.

$$\text{Utilization Factor for Plant} = \frac{\text{Maximum load utilization factor}}{\textit{Installed capacity}} \quad (3.9)$$

3.10 Diversity Factor

The effect of the diversity factor is to reduce the simultaneous maximum demand on the station (which means reduce the capital cost of the station) for the same individual demand and consequently a lower overall rate for a generation station electric.

$$\text{Diversity factor} = \frac{\text{Sum of consumer max.demand in kW}}{\textit{Max.load on the station (kW)}} \quad (3.10)$$

3.11 Mathematical Models for Power Losses

The main reason for losses in transmission and distribution lines is the resistance of conductors against the flow of current. The creation of heat in conductor as a result of the flow of current increases more temperature in it. This increase in the conductor's temperature further increases the resistance of the conductor and this will therefore raise the losses.

This indicates that ohmic power loss is the main component of losses in transmission and distribution lines. The value of the ohmic power loss is given as;

$$L_{ohmic} = I^2R \quad \text{kW}/Km/Phase \quad (3.11)$$

Where:

I = current along the conductor.

R = resistance of the conductor.

The formation of corona on transmission line is associated with a loss of power that will create some effect on the efficiency of the transmission line. The corona power loss, has the value

$$L_{corona} = \frac{242(f+25)}{\delta} . \sqrt{\frac{\text{r}}{\text{d}}}(v - v_o)^2 . 10^{-5} \quad KW/\ Km/Phase \quad (3.12)$$

Where:

f = frequency of transmission,

δ = air density factor,

r = radius of the conductor,

d = space between the transmission lines,

V = operating voltage and

Vo = disruptive voltage.

Taking the total power loss on transmission lines to be the summation of ohmic and corona losses, we have

$$T_{loss} = L_{ohmic} + L_{corona} \quad (3.13)$$

i.e.

$$T_{Loss} = I^2R + \frac{242\,(f+25)}{\delta} . \sqrt{\frac{\text{r}}{\text{d}}}(v - v_o)^2 . 10^{-5} \quad \text{kW}/Km/Phase \quad (3.14)$$

The general form of equation (3.4) is given by:

$$T_{Loss} = I^2 \frac{\rho l}{A} + \frac{242\,(f+25)}{\delta} . \sqrt{\left(\frac{A}{\pi d^2}\right)^2}(v - v_o)^2 . 10^{-5} \ \text{kW}/Km/Phase \quad (3.15)$$

Where:

ρ= resistivity of the conductor,

L = length of the conductor and

A = cross-sectional area of conductor.

IV. RESULTS AND DISCUSSION

4.1 Description of the Work

This session analyses the outcome of results and examine how Nigerian Agip Oil and Gas Company, Port Harcourt, 132/33kV injection transmission substation, network for improved performance using analytical.

4.2 The Outcome of Unimproved Case Study

Figure 4.1 demonstrates the simulation results of Rumuogba unimproved case study. It is observed that ETAP software was used and able to calculate and analyze the reliability in power system; therefore, to show the capability of the ETAP software, it can be considered that the simulation result show the existing case study.

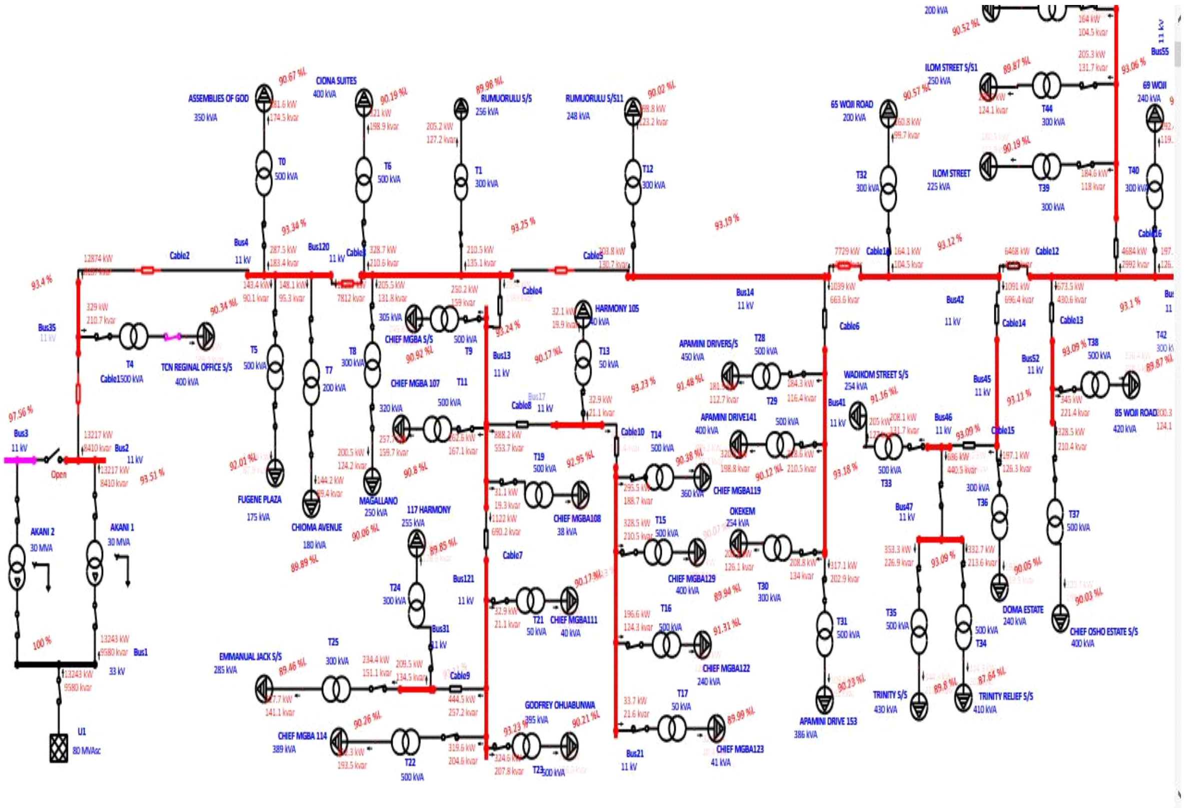

Figure 4.1 Rumuogba Unimproved Case Study

Table 4.2: Maximum demand, load factor, plant capacity factor and plant use factor with respect to the load point

Load Point	Maximum Demand (MW)	Load Factor (%)	Plant Capacity Factor (%)	Plant Use Factor (%)
TCN Regional Office S/S	20	60	48	80
Assemblies of God Church	15	55	42	60
Eugene Plaza	20	60	46	85
Chioma Avenue	15	58	44	60
Ciona Suite Limited	25	65	52	100
Rumuorulu S/S I	30	68	58	120
Rumuorulu S/S II	25	65	52	95
Chief Mgba S/S	20	60	48	85
Godfrey Ohuabunwa	15	55	40	60
Harmony	15	58	42	62

Emmanuel Jack S/S	25	65	55	100
Apamini S/S I	30	70	60	120
Apamini Drive	20	60	45	82
Apamini S/S II	25	65	50	85
Trinity Relief S/S	30	70	60	120
Okekem	15	58	45	60
Wadikom Street S/S	20	60	48	85
Doma Estate	25	65	50	100
Chief Osho Estate S/S	30	72	60	120
Ilom Street	35	74	68	125
Woji Road	45	80	70	135
Mini-Woji	30	70	60	120
Ilom S/S I	30	68	58	115
Evelyn Suit & Hotel	25	65	50	100
White Relief	20	60	45	85
White House	20	62	48	85
Glory Refuge Close	25	65	50	100
Ozulem Street	30	70	55	120
Eze Gbakagbaka Ave	25	65	52	100
Eze Gbakagbaka S/S	30	70	58	120
Amadi Odum	25	65	50	100
Destiny Refuge Close	25	65	52	100
Cumi Medical	25	65	54	100
Steve Integrated Suit	30	70	58	120

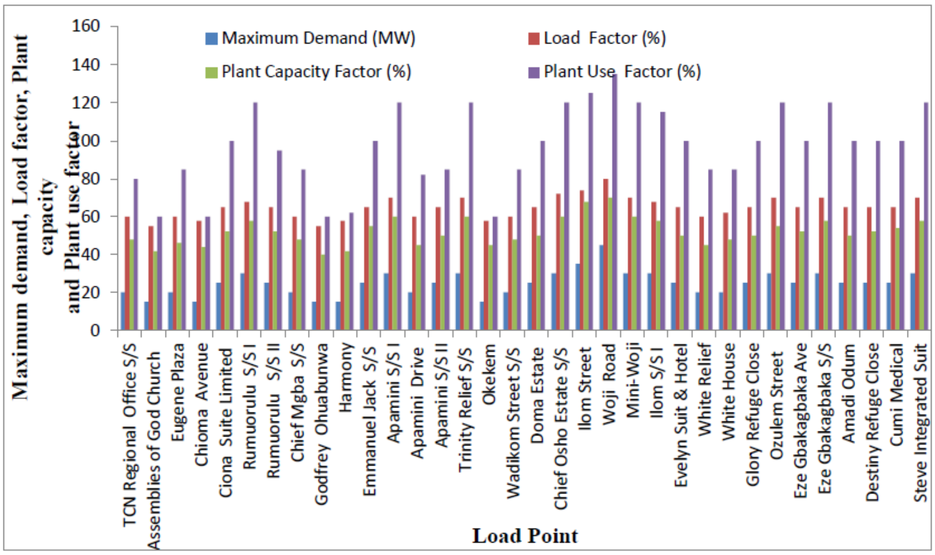

Figure 4.3: Maximum demand, load factor, plant capacity factor and plant use factor with respect to the load point

Table 4.2 and Figure 4.3 show the relationship between maximum demand, load factor, plant capacity factor and plant use factor with respect to the load point. From our results the maximum value is 45 kW (Woji Road) while the frequent maximum demand value is 30 kW (Rumuorulu S/S I, Apamini S/S I, Trinity Relief S/S, Chief Osho Estate S/S and Mini-Woji, Ilom S/S 1, Ozulem Street, Eze Gbakagbaka and Steve Integrated Suite) and the minimum value was given as 15 MW (Assemblies of God church, Chioma Avenue, Godfrey Ohuabunwa Harmony and Okekem). The maximum demand (kW or kVA) which is also known as the maximum power value shows the specified time interval, usually the average of 15 minutes (may vary) reached during the billing period.

The load factor is the amount of the electricity usage for the month when contrasted to his highest utilization for that similar month. Our results shows that maximum value was 80% which is located at Woji road, but frequency value were given as 65% (Ciona suite Ltd, Rumuorulu S/S I, Emmanuel Jack S/S, Apamini S/S II, Doma Estate, Evely Suite, Glory Refuge close, Amadi Odum and Cumi Medical) while the minimum value was 55% (Godfrey Ohuabunwa)

Plant capacity factor measure how often a power plant runs for a specific period of time. From our results the maximum value is 70% (Woji Road) while the frequency value is 60% (Apamini S/S I, Trinity Relief S/S, Chief Osho Estate S/S and Mini-Woji), but the minimum values is 42% (Assemblies of God church).

Plant use factor determine the ratio of actual energy produced (in kWh) in a given time period to the product of plant capacity and the number of hours the plant was in operation. Our results show that the 120% is the maximum values but the frequency value is 100% (Ciona Suite, Emmanuel Jack S/S, Doma Estate, Evely Suite, Glory Refuge close and Eze Gbakagbaka Avenue) while the minimum value is 60% (Godfrey Ohuabunwa).

Table 4.3: Installed Capacity, Reserve Capacity, Hour Plant is Operating and Hour Plant is not Operating with respect to Load Point

Load Point	Daily Energy Produced (MWh)	Installed Capacity (MW)	Reserve Capacity (MW)	Max. Energy when Running (MWh)	Max. Energy when fully Load (MWh)	Hour Plant is Operating (hrs)	Hour Plant is not Operating (hrs)
TCN Regional Office S/S	288.0	25.0	5.0	600.0	360.0	14.4	9.6
Assemblies of God Church	198.0	19.6	4.6	470.4	330.0	16.8	7.2
Eugene Plaza	288.0	26.0	6.0	624.0	339.0	13.0	11.0
Chioma Avenue	208.8	19.8	4.8	475.2	348.0	17.6	6.4
Ciona Suite Limited	390.0	31.3	6.3	750.0	390.0	12.5	11.5
Rumuorulu S/S I	452.5	28.8	5.8	764.3	456.0	10.6	13.4
Rumuorulu S/S II	390.0	31.3	6.3	750.0	390.0	12.5	11.5
Chief Mgba S/S	295.0	29.2	5.4	615.0	365.0	14.8	10.3
Godfrey Ohuabunwa	210.8	19.6	4.7	470.2	350.0	17.8	6.6
Harmony	212.2	20.2	5.0	478.0	352.2	18.0	6.8
Emmanuel Jack S/S	390.0	31.3	6.3	750.0	390.0	12.5	11.5
Apamini S/S I	453.5	28.6	5.6	763.8	455.0	10.8	13.5
Apamini Drive	290.0	28.0	5.2	592.0	358.0	14.2	9.8
Apamini S/S II	390.0	31.3	6.3	750.0	390.0	12.5	11.5
Trinity Relief S/S	451.9	28.6	5.7	765.8	458.0	10.8	13.2
Okekem	211.2	20.4	5.0	476.2	350.0	17.8	6.7
Wadikom Street S/S	305.0	30.0	6.0	620.0	368.0	15.4	10.2
Doma Estate	390.0	31.3	6.3	750.0	390.0	12.5	11.5
Chief Osho Estate S/S	453.0	29.0	6.1	764.8	460.2	10.9	13.6
Ilom Street	465.2	32.4	5.6	785.4	468.2	11.4	15.4
Woji Road	472.4	35.6	5.2	792.0	472.8	12.6	16.6
Mini-Woji	452.8	29.2	5.8	766.0	458.0	10.5	13.8
Ilom S/S I	453.0	28.9	6.0	766.5	456.2	10.8	13.6
Evelyn Suit & Hotel	392.0	31.6	6.5	750.0	392.2	12.5	11.7
White Relief	287.0	24.8	4.8	590.0	350.0	13.8	9.2
White House	290.0	25.5	5.2	610.0	365.0	14.6	9.8
Glory Refuge Close	391.0	31.3	6.4	750.2	391.8	12.6	11.7
Ozulem Street	451.8	28.9	5.9	765.0	460.0	10.6	13.7
Eze Gbakagbaka Ave	390.5	31.4	6.2	750.4	390.6	12.7	11.5
Eze Gbakagbaka S/S	452.6	30.0	5.8	764.4	458.0	11.0	13.6
Amadi Odum	390.8	31.1	6.4	750.2	391.2	12.5	11.6
Destiny Refuge Close	391.2	31.5	6.5	750.8	390.8	12.6	11.5
Cumi Medical	390.8	31.8	6.6	751.0	390.2	12.8	11.6
Steve Integrated Suit	452.8	28.6	6.0	765.2	462.0	10.8	13.8

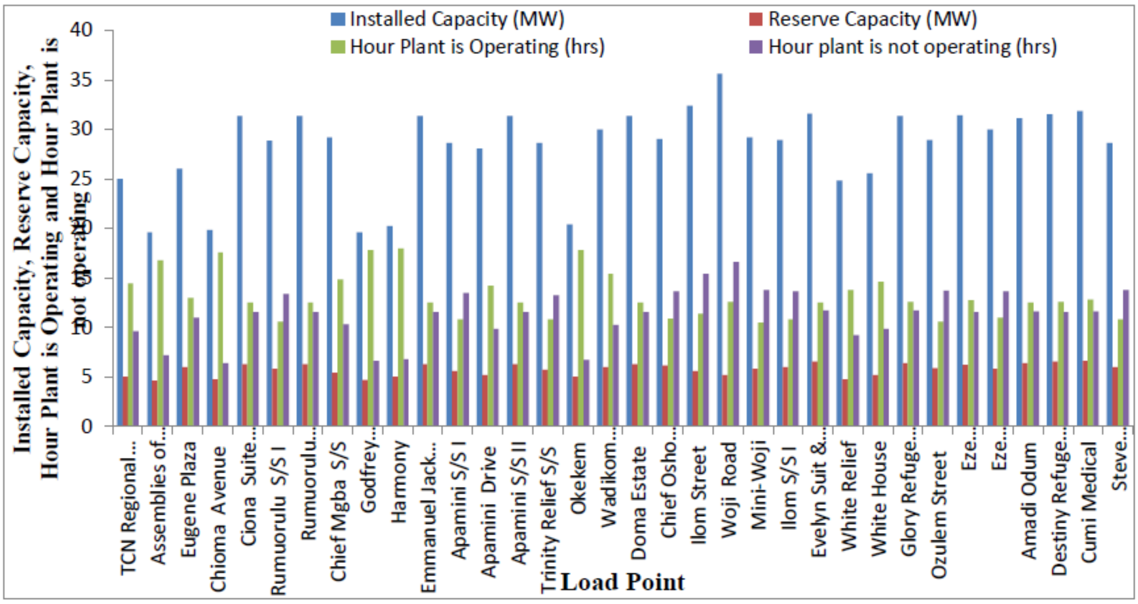

Figure 4.4: Installed Capacity, Reserve Capacity, Hour Plant is Operating and Hour Plant is not Operating with respect to Load Point

Table 4.3 and Figure 4.4 show the relationship between installed capacity, reserve capacity, hour plant is operating and hour plant is not operating with respect to load point with respect to the load point. From our results the installed capacity, or maximum effect, is the intended full-load sustained output of a power plant. The maximum value is 35.6 MW (Woji road) but the frequency value is 31MW (Ciona Suite, Rumuorulu S/S I, Emmanuel Jack S/S, Apamini S/S II, Doma Estate, Evelyn Suite & Hotel, Glory Refuge Close, Eze Gbakagbaka Avenue, Amadi Odum, Destiny Refuge Close and Cumi Medical) while the minimum value is 19MW (Assemblies of God Church and Godfrey Ohuabunwa).

The reserve capacity is the generating capacity available to the system operator within a short interval of time to meet demand in case a generator goes down or there is another disruption to the supply. The maximum reserve capacity value is 6.6 MW (Cumi Medical) and the frequent reserve capacity value is 6.3MW (Ciona Suite, Rumuorulu S/S I, Emmanuel Jack S/S, Apamini S/S II and Doma Estate).

Hour plant is operating is the time interval when the time is functioning, our results shows that the maximum hour is 18.0 hrs (Harmony Estate) while the minimum hour is 10.5 hrs (Mini-Woji).

Hour plant is not operating is the time interval when the time is not functioning, our results shows that the maximum hour is 16.6 hrs (Woji Road) while the minimum hour is 6.4 hrs (Chioma Avenue).

4.3: The Outcome of Improved Case Study

Figure 4.5 demonstrates the simulation results of Rumuogba improved case study. It is observed that ETAP software was used and able to calculate and analyze the reliability in power system which shows the capability of the ETAP software improved case study after simulation.

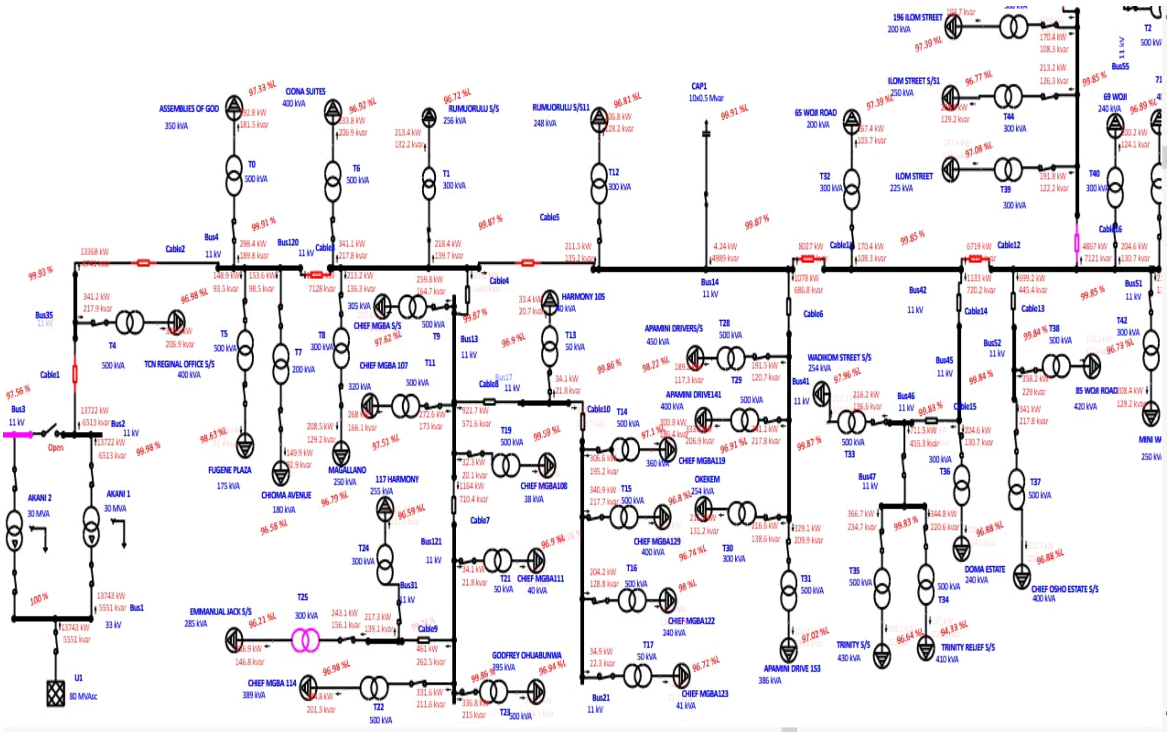

Figure 4.5: Installation of Shunt Capacitor to improve the Case Study 1

4.4: Discussion of Results

In essence, power-factor correction capacitors increase the current-carrying capacity of the system. By adding capacitive banks, you can add additional load to a system without altering the apparent power. Banks can also be used in a direct-current (DC) power supply to increase the ripple-current capacity of the power supply or to increase the overall amount of stored energy. These shunt capacitor banks inject reactive power into the network or line to compensate for line losses.

The existing power factor was improved from 0.85 to 0.90; the maximum demand (kW or kVA) shows the specified time interval during the billing period. The load factor shows the amount of the electricity usage for the month when contrasted to his highest utilization for that similar month. Plant capacity factor measure how often a power plant runs for a specific period of time, plant use factor determine the ratio of actual energy produced (in kWh) in a given time period to the product of plant capacity and the number of hours the plant was in operation. The reserve capacity is the generating capacity available to the system operator within a short interval of time to meet demand in case a generator goes down or there is another disruption to the supply. Hour plant show the operating time interval when the time is functioning and hour plant is not operating show the time interval when the time is not functioning.

V. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This research extensively examined how to improve electric power utilization for Rumuogba area in Port Harcourt using power capacitor, were simulated and analysed for the purpose of investigation.

The outcomes of the results were analysed and the following factors were determined such as; maximum demand, load factor, plant capacity factor and plant use factor with respect to the load point, existing and improved power factor, installed capacity, reserve capacity, hour plant is operating and hour plant is not operating, daily energy produced, maximum energy when running and maximum energy when fully loaded, penetration of capacitor/reactor bank, and the relationship between the power of the capacitor bank and loss reduction with pf correction with respect to load point.

In conclusion, it can be noted that the actual measures put in place often depend on the individual data center, as different centers house specialized electrical power systems, components and are utilized for diverse purposes.

The application of Electrical Transient Analyzer Program (ETAP version 12.6) software for simulation is adopted.

5.2 Recommendations

The following recommendations are made:

i. Enabling power management systems for hardware;

ii. Eliminating unutilized equipment;

iii. Rearranging the center floor plan to maximize cooling potential; and

- Modestly adopting more energy efficient components. It is said that these measures are able to reduce data center energy consumption by up to 30 percent.

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