Electrical Power Distribution Upgrade: Case of Towns in Akwa Ibom State, Nigeria.

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ABSTRACT

The primary function of an electric power system is to provide electrical energy to its customers as economically as possible and with an acceptable degree of continuity and quality. This paper is tailored to address the solutions to some of the problems or defects in the electrical distribution system in Akwa Ibom State like bent or broken poles, tie straps, cross arms, insulators and over loaded or leaking transformers. Load forest, analysis of the existing injection and distribution substation based on engineering design to provide room for expansion and estimation of cost to carry out rehabilitation and replacement of defective equipment were some of the measures use to solve these problems.

(Keywords: electrical energy, electrical distribution, distribution capacity)

INTRODUCTION

Society has become more dependent on reliable distribution of electricity and simultaneously the demand of cost efficiency has increased since new incentives have appeared. The distribution of electricity is a natural monopoly in the sense that, it is not economically realistic with parallel infrastructures (Wallnestrom, 2008). Modern society has come to expect that the supply of electrical energy will be continuously available on demand. This is not possible due to random failure of equipment and the system which are generally outside the control of power system personnel.

Electricity supply generally involves a very complex and highly integrated system (Moute, 2007). Failures in any part of it can cause interruption which range from inconveniences in a small number of local residents to major and widespread catastrophic disruption of supply. The economic impact of these outages is not restricted to loss of revenue by the utility or loss of energy utilization by the customer, but includes indirect costs imposed on society and the environment due to outage. The principal objective of electrical power upgrade in a power distribution utility enterprise is to provide the acquisition, use and disposal of distribution system assets to provide level of service required by customers in the cost-effective manner encompassing the strategic planning maintenance and operations of a physical resource throughout its life.

LOAD FORECAST IN UYO, IKOT EKPENE AND EKET

Generally, the load growth rate for major towns in Nigeria could be as high as 10% but for a state capital it could be more because of the rapid expansion occasioned by the state government policies (Ibom Power Company, 2007). This is true of new state capitals but stabilizes to about this value (10% growth rate) after a period of about 5 years after state creation. Thus, this figure can be used for Uyo. The existing load for Uyo is estimated to be 77.6MVA (Ibom Power Company, 2007) and using this growth rate of 10%, the yearly loads for the next 5years are shown in Table 1.

Ikot Ekpene is one of the major towns in Akwa Ibom State and local governments headquarter. Its closeness to Aba one of the major commercial cities in Nigeria is responsible for the fast increase in load demand. Eket another town in Akwa Ibom is about 45% of the state capital load demand; this is due to the presence of oil and gas

activities such as Exxon Mobile. The yearly load increase is shown in Table 1.

All the same, the load growth rate should be in the neighborhood 5%. Thus, the yearly loads for the next 5years are shown in Table 1. Eket is a major town in the state and also the base of one of the oil major companies, Exxon Mobil. There would be continuous influx of artisans of different skills seeking for employment with oil and gas servicing companies. The load growth rate for this town could be as high as 7.5%. The yearly loads for the next 5years are shown also in table 1.

PRESENT FACILITIES/UPGRADE IN THE VARIOUS TOWNS UNDER STUDY

- ✓ **UYO:** there are three injection substations within the town rated as follows:

i) 2 x 15MVA
ii) 2 x 7.5 MVA, and
iii) 1 x 2.5 MVA

There is need to either upgrade the present three or construct two additional injection substation to take care of the load centres at the secretariat and industrial estate. For the secretariat and industrial estate a 2 x15 MVA and 1 x 15MVA will be adequate.

- ✓ **IKOT EKPENE:** Presently Ikot Ekpene has a feeder from Uyo and with a 1 x 7.5 MVA injection substation which inadequate for such a growing town. There a need for additional 2 x 15MVA substation to take care of the rapid increasing load as a result of its closeness to Aba in Abia. To implement this, a new 33kV line has to be constructed or a 132/33kV substation needs to be constructed at Ikot Ekpene.

- ✓ **EKET:** Presently Eket has a 2 x 15MVA injection substation which is grossly inadequate for a town with oil and gas activities. To meet the required load demand of the town an additional 2 x15MVA injection substation will be required to take care of the rapid increase in the load demand. To adequately meet the Power requirement, the NIPP is presently constructing a 132/33kV line from Uyo to Eket so as to help evacuate the power from Ikot Abasi power plant .

DISTRIBUTION SUBSTATION IN UYO, IKOT EKPENE AND EKET

- ✓ **UYO:** the existing capacity or number of 500kVA distribution transformer in Uyo town is about 72% which is presently overloaded. To overcome this situation of overloading, the town requires extra 26 distribution transformers. If this action of upgrade is delayed up to the fifth year as shown in table 2, 66 distribution transformers will be required.

- ✓ **IKOT EKPENE:** for this town, there are 36 500kVA distribution transformers, which grossly is inadequate. To improve the situation and extra 28 distribution transformers will be required. If intervention is delayed to fourth year as shown in Table 2, additional 12 distribution transformers will be required to improve the situation which leads to increase in cost of implementation.

Table 1: Load Forecast for Uyo, Ikot Ekpene, and Eket.

Name of town	Estimated existing load MW	Growth Rate	Estimated Loads MW				
			After 1yr	After 2yrs	After 3yrs	After 4yrs	After 5 yrs
Uyo	62.08	10%	68.32	75.12	82.64	90.88	100
Ikot Ekpene	15.04	5%	15.76	16.56	17.44	18.32	19.2
Eket	30.4	7½ %	32.72	35.12	37.76	39.68	42.64

Source: Ibom Power Company, 2007

- ✓ **IKOT EKPENE:** for this town, there are 36 500kVA distribution transformers, which grossly is inadequate. To improve the situation and extra 28 distribution transformers will be required. If intervention is delayed to fourth year as shown in Table 2, additional 12 distribution transformers will be required to improve the situation which leads to increase in cost of implementation.

- ✓ **EKET:** the existing 500kVA distribution transformer in Eket is 71 and to maintain loading of 70% in each transformer, an extra 58 relief distribution transformers will be required. If action is delayed till fourth year, 38 relief transformers will be required as shown in Table 2.

DISTRIBUTION NETWORK REHABILITATIONS

33kV Line: There are two types of conductor sizes on the 33kV network and these are:

- Wolf conductor ($150mm^2$) Aluminum conductor steel reinforce (ACSR) of rated current 400A, equivalent to 23MVA at 33kV
- Hyena conductor $100mm^2$ ACSR of current rating equal 310A equivalent to 18MVA.

11kV Line: Similarly, the same types of conductors are used on the 11kV network with the corresponding ratings:

- 150mm2, rating 7.7.MVA
- 100mm2, rating 6MVA

Table 2: Distribution Transformer Requirement for Uyo, Ikot Ekpene and Eket.

s/n	Name of town	Existing installed distribution transformer capacity (MVA)	0 year		After 1 yrs		After 2yrs		After 3yrs		After 4yrs		After 5yrs	
			Est. existing load in MW	Additional capacity	Est. load in MW	Additional capacity	Est. load in MW	Additional capacity	Est. load in MW	Additional capacity	Est. load in MW	Additional capacity	Est. load in MW	Additional capacity
1	Uyo	143.8	77.6	13MVA (26x500) kVA	85.4	0	93.9	0	103.3	0	113.6	33MVA (66x500kVA)	125	0
2	Ikot Ekpene	18	18.8	14MVA (28x500) kVA	19.7	0	20.7	0	21.8	0	22.9	6MVA (12x500kVA)	24	0
3	Eket	35.2	38	29MVA (58x500) kVA	40.9	0	43.9	0	47.2	0	49.6	19MVA (38x500kVA)	53.3	0

Source: Ibom Power Company, 2007

Table 3: Cross–arm Defect.

s/n	Location	Description of Materials	Qty of Defects	Required Action
1	Uyo	Wooden cross-arm (11kV)	55	To be replaced
		Wooden cross-arm (33kV)	5	
2	Ikot Ekpene	Wooden cross-arm (11kV)	17	To be replaced
		Wooden cross-arm (33kV)	0	
3	Eket	Wooden cross-arm (11kV)	19	To be replaced
		Wooden cross-arm (33kV)	0	

Table 4: Undersized Conductors and Poles.

s/n	Location	Description of Materials	Qty of Defects	Required Action
1	Uyo	Undersized conductor LT	47,600m	To re-conduct the line with correct sizing
		Undersized conductor (11)	7500	
		Undersized conductor (33)	3300	
		LT poles	95	Defective poles to be replaced
		HT concrete poles	6	
2	Ikot Ekpene	Undersized conductor LT	113,800	To re-conduct the line with correct sizing
		Undersized conductor (11)	0	
		Undersized conductor (33)	0	
		LT poles	65	Defective poles to be replaced
		HT concrete poles	1	
3	Eket	Undersized conductor LT	74,400	To re-conduct the line with correct sizing
		Undersized conductor (11)	0	
		Undersized conductor (33)	0	
		LT poles	45	Defective poles to be replaced
		HT concrete poles	1	

Table 5: Tie Straps Insulators and D-Irons.

s/n	Location	Description of Materials	Qty of Defects	Required Action
1	Uyo	Tie straps (pair) 11kV	31	Defective tie straps, insulators, and D-Iron should be replaced
		Tie straps (pair) 33kV	10	
		11kV insulators	26	
		D-iron	120	
2	Ikot Ekpene	Tie straps (pair) 11kV	7	Defective tie straps, insulators, and D-Iron should be replaced
		Tie straps (pair) 33kV	0	
		11kV insulators	15	
		D-iron	300	
3	Eket	Tie straps (pair) 11kV	11	Defective tie straps, insulators, and D-Iron should be replaced
		Tie straps (pair) 33kV	0	
		11kV insulators	13	
		D-iron	200	

Table 6: Distribution Substation Defects.

s/n	Location	Description of Materials	Qty of Defects	Required Action
1	Uyo	J & P fuses	534	J & P fuses & holders, feeder pillar & holders, burnt cable and fences should be replaced
		J & P fuses holder	360	
		Feeder pillar	41	
		Feeder pillar fuses	36	
		Cable from TX to F/P (300mm)	60	
		Cable from TX to F/P (500mm)	240	
		Fence to be replaced	6	
		Upriser cable (150mm 4 core)	4,845	
2	Ikot Ekpene	J & P fuses	120	J & P fuses & holders, feeder pillar & holders, burnt cable and fences should be replaced
		J & P fuses holder	120	
		Feeder pillar	21	
		Feeder pillar fuses	-	
		Cable from TX to F/P (300mm)	80	
		Cable from TX to F/P (500mm)	60	
		Fence to be replaced	70	
		Upriser cable (150mm 4 core)	1,260	
3	Eket	J & P fuses	133	J & P fuses & holders, feeder pillar & holders, burnt cable and fences should be replaced
		J & P fuses holder	133	
		Feeder pillar	27	
		Feeder pillar fuses	-	
		Cable from TX to F/P (300mm)	-	
		Cable from TX to F/P (500mm)	240	
		Fence to be replaced	9	
		Upriser cable (150mm 4 core)	735	

Low Tension (LT) 415V: More different sizes of conductors are used on the LT system varying from 70mm^2 to 150mm^2. The preferred size is 150mm^2 corresponding to a rating =289kVA. Tables 3-6 shows the various defects observed within the network.

CONCLUSION

The following recommendations are some of the way forward to solve some of the problems in the electrical distribution industry case of Akwa Ibom State. The 2 x 30/40MVA 132/33kV transformers in Uyo should be changed to 2 x 60MVA 132/33kV transformers as soon as possible. The 33kV bus-section circuit breaker which is damaged should be replaced soonest in addition to the 33kV circuit breaker on feeder 2 which also needs replacement.

The two new injection substation of 2 x 15 and 2 x 7.5 MVA should be constructed with Uyo town to take of load around the secretariat and industrial estate.

Looking at table 2, 9 x 500 kVA 11/0.415kV transformers should be installed to take care of the extra load in Uyo.

To avoid the operational restrictions that would be associated with upgrading the existing injection substation of 132/33kV at Ikot Ekpene to 2 x 15MVA 33/11kV but still attached to Aba-Uyo

33kV feeder, a 132/33kV substation with 2 x 30MVA transformer should be installed. The existing Aba-Itu 132kV line can be turned in and out or feed off.

The existing 7.5MVA 33/11kV injection substation at Ikot Ekpene should be upgraded to 2 x 15 MVA substations. It is recommended that the 132kV single circuit line should be upgraded to double circuit.

Finally, the 45MVA 132/33kV transformers in Eket should be upgraded to a 60MVA, while additional 33kV feeder should be created for Eket Township. Additional two injection substations of 1 x 15 MVA and 2 x 15MVA 33/11kV should be constructed within Eket town to take care of increasing load as a result of the presence of oil and gas activities. Similarly, this will also lead to an increase in the numbers of distribution transformers estimated at about 29 x 500kVA 11/0.415 substation. Additional 29 x 500KVA 11/0.415 substations should be established after 3 years. All defects identified in Tables 3 to 6 should be rehabilitated and replaced as soon as possible.

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