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Estimation of Potential Load Demand of Local Government Areas of Ekiti State, Nigeria

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Abstract: - The estimation of the potential load demand of local government areas in Ekiti State, Nigeria, was carried out using per capita demand estimate of a fully electrified urban area and population data. The pessimistic load demands of the local government areas were calculated through the use of per capita of a rural community in Ekiti state. This was achieved through the injected powers and the State's zonal population. The study demonstrated that there is wide difference between the projected load demands and the actual supply; thus impairing rural electrification of the State.

Keywords: - *injected power, load centers, load demand, power balance.*

I. INTRODUCTION

Efficient power management is prerequisite in maintaining consumer confidence. One form of maintaining or at least controlling power is by injecting sizeable power into the zone substation. Often this form of power augmentation is needed for relatively short period where substations supply large load components. A small quantity of about 3 to 4 MW was released by the Akure injection substation at night periods, when the entire state depended on 132/33kV injection substation at Akure.[1] The zone substation has been supplied from a long transmission from Oshogho axis. Power injection variations that occur in power systems are generally nonlinear [2].It was noted that low load allocation on most of the 33kV feeders varied and particularly more pronounced on the Akure—Ado-Ekiti feeder.[3] Variations occur in other injection substations within the state and that connecting to adjoining states with maximum injected power ranging from 4MW to 12.7MW. The load on power station varies from time to time due to uncertain demands of the consumers and is known as variable load on the station [4]. The maximum injected power is the highest power supply for a distribution network over a period of time [5]. The maximum injected power is the highest power supply for a distribution network over a period of time. This study examines the load power balances of sixteen Local governments of the Ekiti State Senatorial district depicted in Figure 1.

Figure 1: Local Government Areas in Ekiti State

Electrical power balance is the mathematical difference between the injected powers and the (power demand) load on the busses. For example, the power balance for Ado-Ekiti depends on the difference between the summation of the injected powers from Osogbo and Akure and the summation of loads on busses in that region. The power flow could be calculated using successive approximations method, which this study adopts. Whilst power utility companies envisage making a healthy profit for their operations, the bottom-line would still be healthy as long as substantial power needed to meet the load demands is injected into the distribution network. Inadequate power injection creates power failure to the consumers as well as incurring loss of revenue to the power authority. Ekiti has a tropical climatic condition of rainy and dry seasons of April-October and November-March respectively [6], temperature ranging from 21^0C to 28^0C with high humidity, with varying power demands.[7]

II. MATERIALS AND METHODS

The following sets of data were obtained from the Power Holding Company of Nigeria (PHCN)Ado-Ekiti, namely:(i) the injected power into the state; (ii) the load demand at the various 33 kV load centers and (iii) the distribution network diagram. The consumers' population dataset of the local government areas(LGAs) of interest was obtained from the Ministry of lands and National Population Commission, Ado-Ekiti.
The per capita demand for each LGA was estimated using:

$$per\ capita\ demand = \frac{power\ \ supply\ \ to\ selected\ \ area}{population\ \ \ of\ selected\ \ area} \quad (1)$$

To make relative comparison with that obtained by [8] for a fully electrified urban community with known supply from PHCN and population, per capita demand estimated for Ado-Ekiti was 0.064 kW, which is lower than that obtained for Oluyole load center (Oyo State) of 0.094 kW as estimated by [9]. Figure 5 shows a one-line diagram of Ekiti State 33kV network with associated nodal power distribution, i.e. $S_{ii} = P_{ii} + jQ_{ii}$, where P_{ii} and Q_{ii} are active and reactive powers respectively[10]. From Figure 5, expression for the power balance per LGA can be deduced. As an example, the power balance for Ado-Ekiti LGA is S_{21},noting that in real operations, the Iyamoye – Ido (2) line (from Fig. 5) is opened, which is estimated as follows:
(a)By power balance, the per capita demand for Ekiti State, Nigeria is expressed as:
$S_{21} = (S_0+S_{18}) - (S_1+S_4+S_5+S_{20}+S_{24}+S_{26}+S_{32}+S_{35}+S_{37}) = 19.662 + j15.741$ [8]
(b) Per capita demand =0.064 kW per capita.

(c) The power demand for each LGA is computed using:

$$demand = per\ capita\ demand \times population\ of\ LGA \quad (2)$$

3.0 Results and Analysis

3.1 Results

Estimations of potential load demand for Ekiti local government areas are presented in Table 1.

Table1 Expected Maximum Demand at the 33kV load centers

	Ekiti State LGA	Headquarters	2006 Population Census (LGA)	Pmin, MW	Pmax, MW
1.	Ado-Ekiti	Ado –Ekiti	308,621	19.752	29.010
2.	Efon Alaaye	Efon-Alaaye	86,941	5.564	8.172
3.	Ekiti West	Omuo-Ekiti	137,955	8.829	12.968
4.	Ekiti South West	Ilawe-Ekiti	165,277	10.577	15.536
5.	Ekiti West	Aramoko Ekiti	179,872	11.512	16.908
6.	Emure	Emure Ekti	93,844	6.006	8.825
7.	Gbonyin	Ode Ekiti	148,193	9.484	13.930
8.	Ido/Osi	Ido Ekiti	159,114	10.183	14.957
9.	Ijero	Ijero Ekiti	221,405	14.170	20.812
10.	Ikere	Ikere Ekiti	147,335	9.429	13.851
11.	Ikole	Ikole Ekiti	168,436	10.780	15.833
12.	Ilejemeje	Iye Ekiti	43,550	2.787	4.094
13.	Irepodun/Ifelodun	Igede Ekiti	129,149	8.266	12.140
14.	Ise Orun	Ise Ekiti	113,754	7.280	10.693
15.	Moba	Otun Ekiti	146,496	9.376	13.771
16.	Oye	Oye Ekiti	134,210	8.589	12.616
Total				152.586	224.116

3.2Analysis of Expected Maximum Demand at the 33 kV Load Centers

An expected total power demand for Ekiti State that will accommodate rural electrification, based on results tabulated in Table 1, is estimated as 224.12 MW (optimistic) as drawn in Fig. 3 and 152.6 MW (pessimistic) as drawn in Fig. 2. The interception of maximum demand of both optimistic and pessimistic estimation is presented in Fig.4, which shows a clear difference in the values of power demands at individual points of the chart. These demands are significantly in excess of the present connected demand. The progressive pessimistic and optimistic power demands for all the local government areas are clearly stated in Table 1. The connected demand of Ekiti local government areas presently is 37.5MW.

A random look at two local government areas: Ado-Ekiti and Ilejemeje LGAs. Ado-Ekiti LGA, for instance, has a population of 308,621[11] with a pessimistic power demand of 19.752 MW while the optimistic power demand is 29.01 MW. This is grossly in variance with the estimated maximum demand. This implies that the present demand is even insufficient to adequately supply Ado-Ekiti load center. The maximum demand (pessimistic) for this load center is 19.8MW signifying that the present demand can sufficiently supply Ado-Ekiti only at base loads.

For Ilejemeje, the optimistic maximum demand and the pessimistic maximum demand are 4.1MW and 2.83 MW respectively. This load center at both peak and base values can be sufficiently supplied by the present demand connected.

In essence, for the Ekiti State, the presently connected demand of 37.5MWis far below the total power demand of 224.12MW that will accommodate rural electrification of the state.

III. CONCLUSION

The study has shown that the presently connected demand of 37.5MW is far below the total power demand of 224.12MWrequired to accommodate rural electrification of the Ekiti State. For the anticipated economic growth of the State, it is pertinent that efforts to supply the required power demand by the three tiers of government and the concerned power authorities should be intensified.

IV. RECOMMENDATION

1. The reconfiguration of the present Ekiti network will improve the power distribution to the consumers.
2. The required 224.12MW for adequate power supply to the consumers should be provided by the the three tiers of government, individuals and corporate organizations.

V. ACKNOWLEDGMENT

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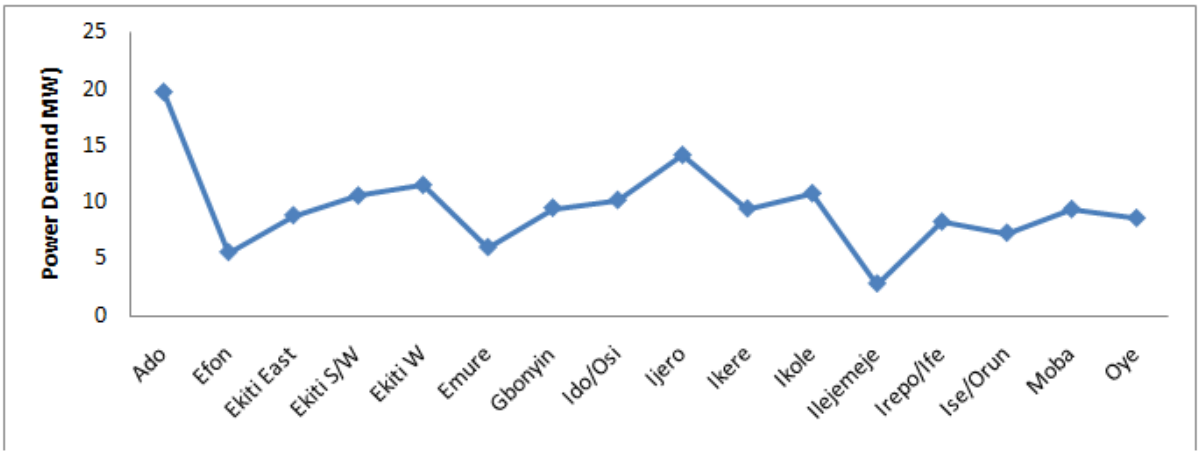

Figure 2: Estimated Maximum Demand (pessimistic) at 33kV Load center

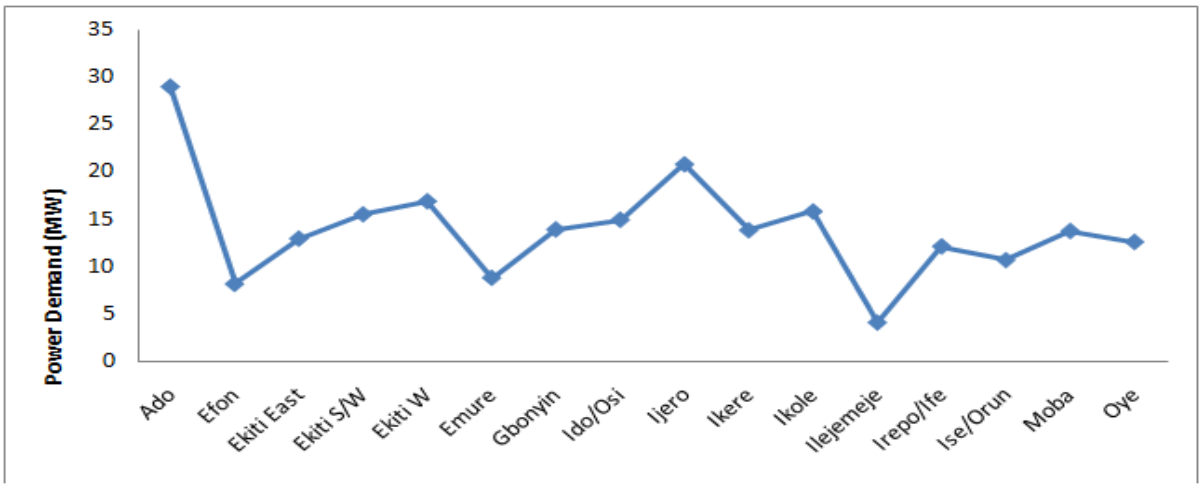

Figure 3: Estimated Maximum Demand (optimistic) at Ekiti 33kV Load centers

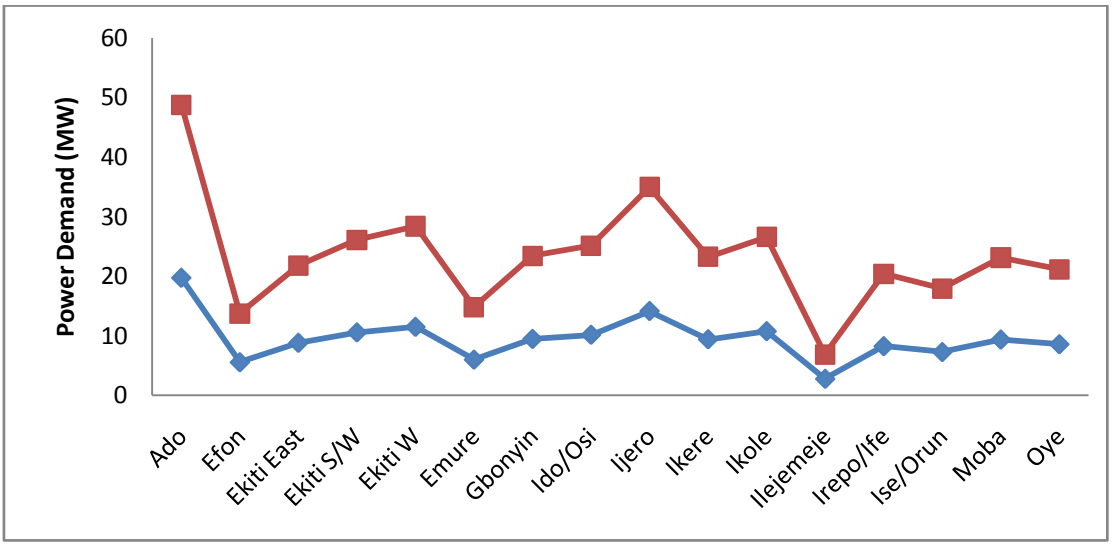

Figure 4: Interception of optimistic and pessimistic Maximum Demand of Ekiti 33kV Load centers

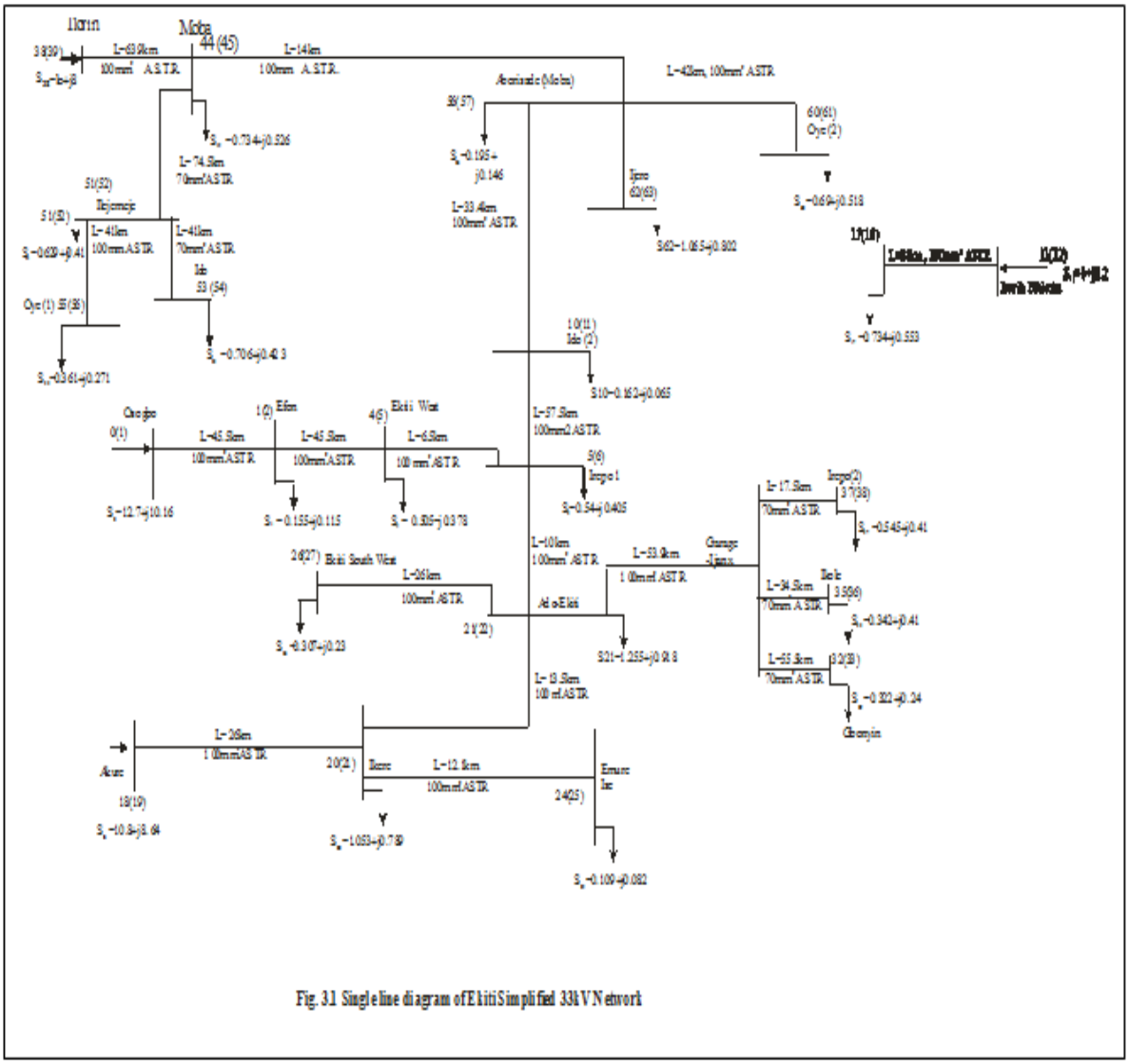

Figure 5: One line diagram of Ekiti 33kV network

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