Distribution System Energy Auditing with Recommendations

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Abstract

Electric utilities in India are facing the pressure of reducing costs and improving the quality and reliability of supply. Though the generation and transmission systems have been considerable technical development and capital investment, the distribution systems been neglected and suffered due to poor operating efficiencies leading to high losses. The work is aimed at Energy Auditing of 11kV Distribution Feeder and preparing perfect energy balance sheet of 11kV Distribution Feeder with recommendations to improve overall efficiency of the system.

1. Introduction

Today Indian Power Sector is facing major challenges, with the introduction of Reforms and Globalization. Despite the planners attaching utmost importance to energy sector since beginning, energy and peak power shortages are not only continuing, but also further increasing. The quality of the power supply in respect of reliability, stability and security is not ensured [1]. The reasons for energy crunch are due to: Population explosion and Elevation in living standards. Hence the only way is to use the available energy in a much planned and productive way than ever before. So the time has come when each and every power user has to think for efficient use of power. The need of hour is therefore 'Energy Auditing'. This really means to reduce the load demand by applying well established principles and techniques through efficient energy auditing [2][6].

The distribution systems have suffered mainly from the following reasons.

- High level of technical energy losses
- Very high commercial energy losses
- Unbalanced load
- Poor voltage regulation
- Poor metering
- Conductor heating / Equipment damages

1.1 Energy Auditing

Energy audit is an engineering technique used to establish the pattern of energy use and identification of how and where the losses are occurring. Electrical Energy is invisible; hence often it is wasted or made theft without being noticed except at the end of the month when energy is accounted or reviewed. The main objectives of energy audit are,

- Energy input to the system
- Energy utilized / sold (Energy sales).
- Energy losses in the system.
- To assess the efficiency of the system.
- To identify the area of high T&D losses
- To assess the extent of theft & pilferage
- To take appropriate steps for making the system technically more efficient and financially sustainable.

Energy audit distinctly addresses these problems of energy losses. Hence any savings in energy usage & losses directly leads to the profitability of the utility. Energy losses in the system are classified as Technical and Commercial losses [4][5].

Conducting the effective Energy Audit and preparing perfect energy balance sheet of distribution system the following facilities were made after initial walk over survey;

- All the consumer installations are metered.
- The energy meter readings both at sending end and at the sales points of all the consumers are taken simultaneously
- Electronic Tri-vector meters are provided on secondary side of all the Distribution transformers to facilitate recording of half hourly peak curve along with voltages, which facilitates correct assessment of L.T Line losses and
- The same accuracy class of energy meters were provided both for measuring Energy input to system and Energy sales.

The energy consumption of installations (energy sales) taken may not be accurate due to the following reasons:

- Arithmetical mistakes of billing.
- Human errors while noting energy meter readings.
- Meters not recording accurately
- Meters not recording in the light load conditions.
- Meters not recording and stopped.

- Meters recording more than actual consumption.
- Un-metered categories of installations were approximated rather than actual consumption.
- Theft of power, pilferage of power by bye-passing the energy meters and directly drawing power without energy meters [7].

1.2 Technical losses

The Technical losses in the system comprises

- 11 kV line losses
- Distribution transformer losses (Iron & Copper losses).
- L.T. Line losses
- Miscellaneous technical losses
  - Losses due to loose jump connections in the line
  - Losses due to short circuits & earth faults
  - Losses in service mains of installations.
  - Losses incurred in CT'S & current coils of energy meters.

1.3 Commercial Losses

The commercial losses comprises

- Mistakes in the billing.
- Meters not recording (MNR)
- Meters not recording correctly
- Meters bye passed due to defects/ intentionally.
- Meters not read & billed.
- Theft and pilferage.

1.4 Metered and Unmetered Installations

The assessed consumption of metered installations like Domestic, Commercial, L.T. Power, H.T. installations, Irrigation Pump sets, free installations, Water works, Public Street light installations and Temporary installations. The assessed consumption of each category of unmetered installations assessed as follows

- The I.P. set installations on the samples taken by Tongue Tester readings
- The free installations at assumed kWhr per installation per month and
- The Streetlight installations at assumed kWhr per month per kW of connected load.

1.5 Instruments and Software used

During survey several instruments used to collect the data from field,

- Global Positioning System (GPS) for 11kV drawing
- Electronic Trivector Meter (ETV Meter) and
- Meter Reading Instrument (MRI).

Softwares used

- MiPower (For load flow analysis, GPS Interface Single line diagram)
- Speed (To download data from ETV Meter to MRI)
- Lucid (To download data from MRI to PC)

2. System Details and Data Collection

The power supply to City considered and the surrounding areas is being catered from the 1X20 MVA, 1X15MVA, 66 /11 kV Master unit substation (MUSS), through 11 kV feeders. MUSS serves for about 12 feeders F-1 to F-12. The Geographical route and single line diagram of 11kV F4-Feeder is drawn by using Global positioning system (GPS) and *MiPower* software GPS Interface. Feeder-F4 considered caters 22 Distribution Transformer's (DTC's) shown in Table 1 . Figure 1. shows the Category wise installations on F4 feeder and Figure 2 shows Category wise percentage load on F4 Feeder

2.1 Data collection

- Consumer Name, Address, RR No, LD No and reading Date.
- Type of Meter, Make, Model, condition of meter, seal, revolution and its Monthly consumption
- Category of Installation, Type of Tariff and consumer's connected load
- Inventory of all the streetlights & water supply connections coming under LT network.

Table 1. Total capacity of F-4 feeder

Sl. No	Capacity of DTC's	Numbers	Total capacity in KVA
1	100 KVA	5	500
2	250 KVA	17	4250
Total		**22**	**4750**

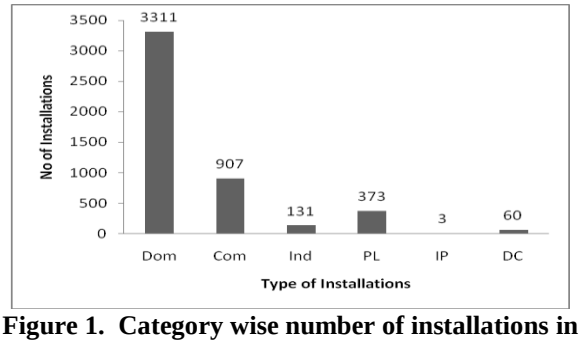

Figure 1. Category wise number of installations in F4 Feeder

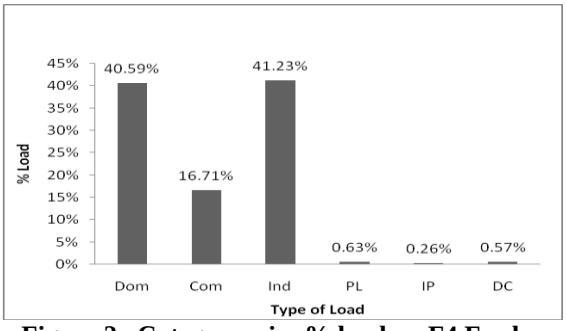

Figure 2. Category wise % load on F4 Feeder

3. Energy Auditing Results and Recommendations

Energy Audit results of 11kV Feeder & its DTC's with their Technical and Commercial losses is evaluated by monthly readings of ETV Meters at each DTC and at the respective consumer's Energy meters. The analysis of the system is been done with the help of power system analysis software package "MiPower" The following conclusions and recommendations are drawn during the survey:

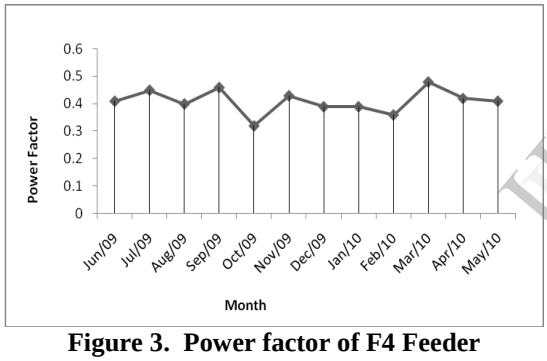

Figure 3. Power factor of F4 Feeder

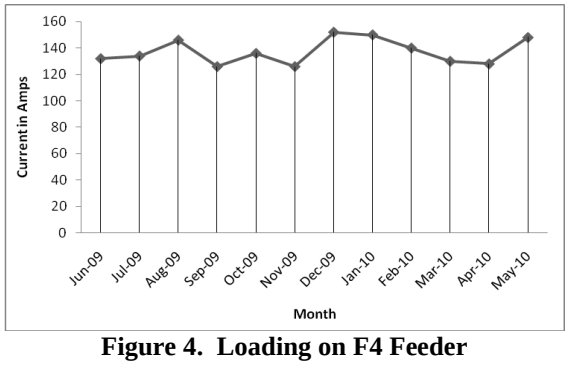

Figure 4. Loading on F4 Feeder

- Some of the DTC's were overloaded as per Figure 4 and 5, hence load on the overloaded DTC's is to be shifted to some other DTC's or capacity of these DTC's is to be increased.
- Percentage Unbalance loading between the phases is too high as per Figure 6 in some of the DTC's where domestic consumers are more. It is recommended to balance the load between the phases.

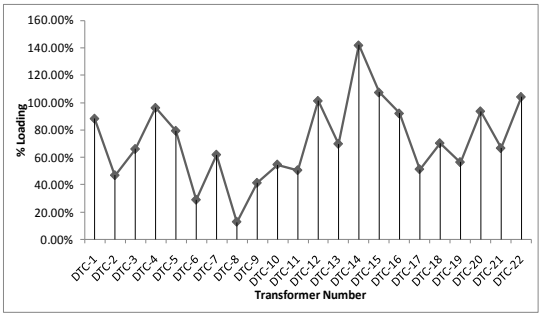

Figure 5. % Loading on Transformers

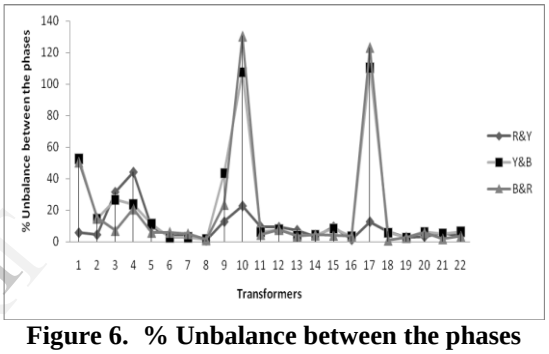

Figure 6. % Unbalance between the phases

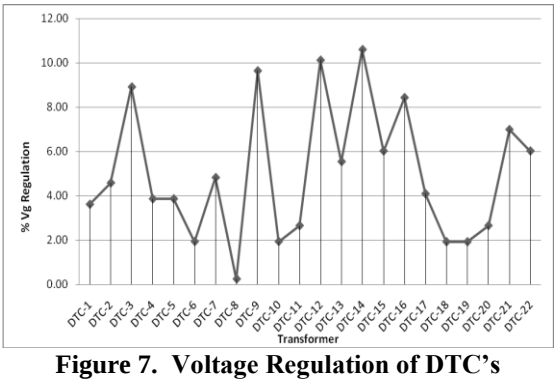

Figure 7. Voltage Regulation of DTC's

- Power factor recorded during maximum loading conditions is poor as per Figure 3. It is recommended to maintain the PF at 0.85 and above
- Figure 7 shows the Voltage Regulation of DTC's and recommended to maintain within 8%.
- The Technical loss on the Feeder is about 5.3%, which consists of 2.68% at 11 kV and 2.7% at LT Network as per Figure 10.
- The assessed Commercial loss in the feeder is to the tune of 21.40% which is very high.

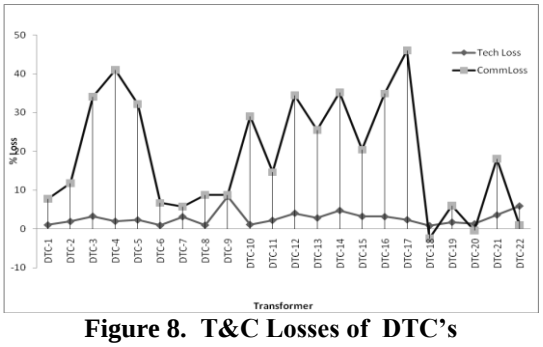

Figure 8. T&C Losses of DTC's

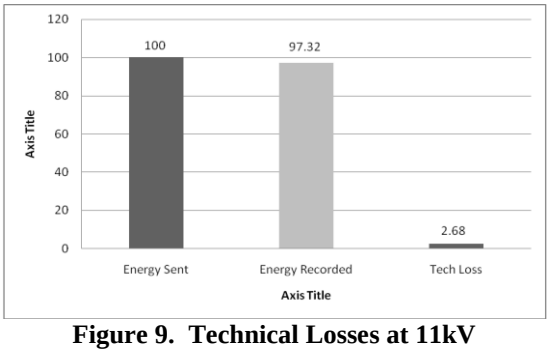

Figure 9. Technical Losses at 11kV

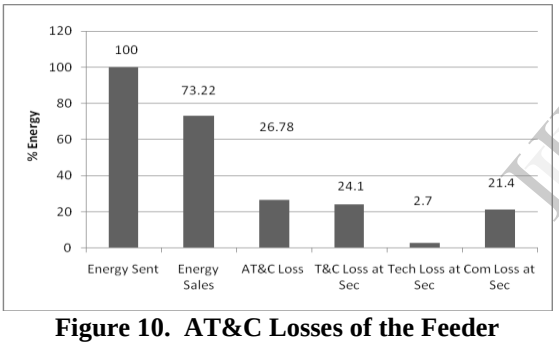

Figure 10. AT&C Losses of the Feeder

- Out of 22 DTC's, the Commercial loss recorded in 17 DTC's is more than 5% as per Figure 8 and
- Out of 22 DTC's, the Technical loss in 3 DTC's is more than 4% as per Figure 8.
- As per Figure 8 in most of the DTC's the Commercial loss recorded is more than 20% and above.
- As per Figure 10 Aggregate Technical & Commercial losses (AT&C) of the feeder is to an extent of 26.78%

Wherever the L.T distribution system losses are beyond the permissible limits of 4% for urban distribution system, following proposals were suggested for improvement of tail end voltage and reduction of line losses and bring down the losses below 4%. Wherever the Commercial losses are beyond the permissible limits the following proposals were suggested to bring down the losses.

- Existing Weasel ACSR and Squirrel ACSR conductors are to be replaced by Rabbit ACSR conductors. All the loose jumps are to be replaced with suitable size of PG Clamps and terminal points are to be replaced with suitable size of lugs and are to be crimped properly.
- All the Electromechanical Commercial Grade Energy Meters (EMCG) provided to Domestic and Commercial installations and are more than 10 years old, which does not record properly at the low load conditions. These meters have been recommended for calibration/ replacement. All the 3-Digit and Black meters are to be replaced with the new ones because of inconvenience faced while reading of meters during the survey. All the energy meters which are not recording (MNR) are to be replaced with the new ones.
- Energy meters are to be provided for all the Municipal water pumps and Streetlights.
- All the temporary connections and disconnections need proper observation.
- All the Direct Connections without energy meter and tampered meters are to be regularized by providing meters.
- All the power installations operated with ETV meters have been provided with CT's. Hence rate all the CT ratios for correctness and check meter condition.
- Change the existing Electro-Mechanical meters to Static Meters
- Installation of capacitors at all levels for power factor improvement
- Re-configuration of feeder lines & distribution transformers so as to reduce the length of LT lines and to share the load between overloaded and under loaded transformers
- Improving customer satisfaction

4. Conclusion

While T&D losses of anything below 20 per cent means the power utilities in the country would start making operational profits. Hence it is recommended to Energy Audit for distribution networks in order to improve distribution system efficiency and for better revenue realization through better control and monitoring and improved customer services through proper Auditing.

With the application of IT, highly advanced communication technologies and advance in Energy meters in collecting and processing of energy information at real time from the remote meters to account energy at the real time in order to reduce the losses is very essential.

5. References

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