A Practical Approach for Distribution Loss Reduction in Assam using Network Re-conductoring Method

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***Abstract*— Distribution losses contribute tremendously to deteriorating power scenario of Assam. It is desirable to adopt various loss reduction methods to promote the economic growth of a state and country as a whole. This paper focuses on the causes of distribution losses in Assam and its reduction by adopting network Re-conductoring method so as to contribute to the conservation of electrical energy which would be otherwise wasted as power loss during distribution. For this purpose, information from few substations in Guwahati has been collected in order to analyze the loss scenario in these study areas. In addition to that, this paper also reflects the amount of savings if the existing lines are replaced by the optimized technique. Here, the conservation of electricity refers to minimisation of loss resulting in the improvement of the existing system.**

***Keywords*— network re-conductoring, power loss, substation**

I. INTRODUCTION

The per capita energy consumption is a vital parameter for economic development of a country. The energy demand has been approximately increasing at a rate of 8.46% per annum and this energy demand can be expected to be met by increased generation giving priority to the quality of supply. The quality of supply will depend upon the transmission and distribution losses and its reduction will lead to efficient fulfillment of energy demand without wastage.

Energy conservation is the fastest, cost-effective and practical method of overcoming energy shortage. It is found that there is major scope of energy conservation in electrical distribution system and in consumer's installation [1]. While using energy, a considerable amount of energy is wasted. It is estimated that there exists a potential of saving of about 30% energy used by us in daily life. In Assam, daily requirement of energy in peak hours is about 1200 MW. A 30% saving would yield a saving of more than 200MW, which is a considerable amount. This much saving would result in lowering power shortage significantly. The Conservation and efficient utilization of energy resources play a vital role in narrowing the gap between demand and supply of energy.

Normally, the Generation, transmission and distribution of electrical energy involve many operational losses. The technical losses occur naturally and are caused because of power dissipation in transmission lines, transformers, and other power system components [2]. Considering all the points, this paper aims to analyze the ways to reduce losses in the practical field of Assam considering data of two substations.

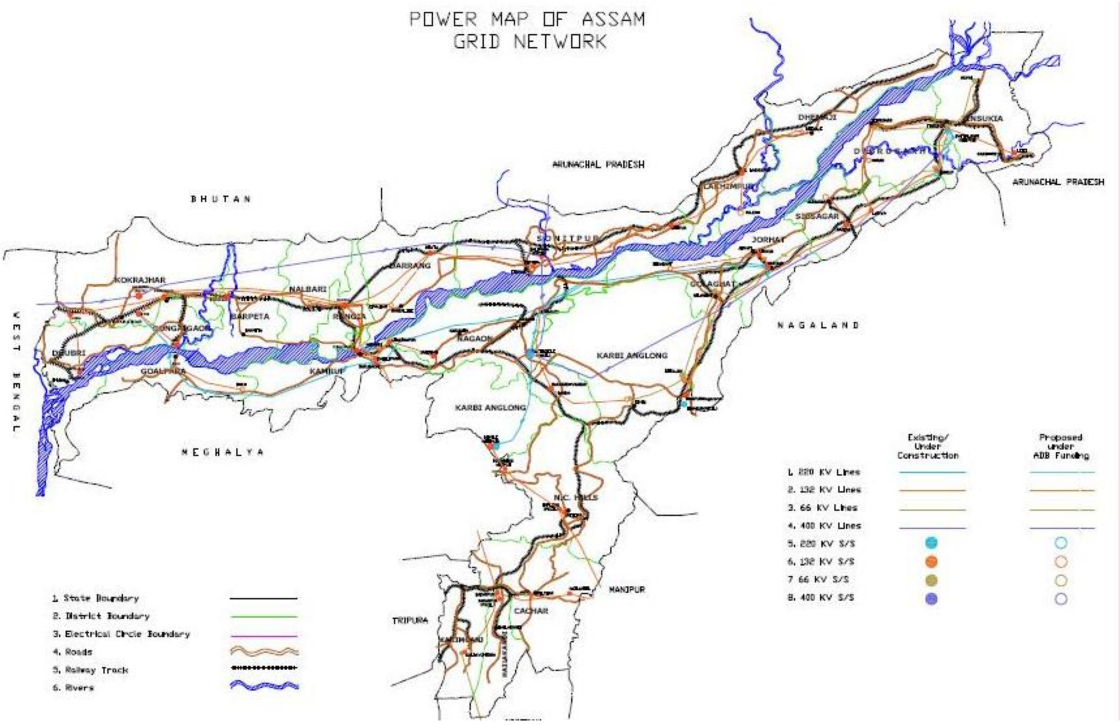

Fig 1. Existing Power Scenario Of Assam

In this paper two local substations are considered as a field of analysis. The foremost objective of the distribution reform is to achieve efficient and quality power supply to the consumers at reasonable cost. The distribution system has about 30 to 40 % of total investments in the electrical sector, but nevertheless, they have not received the technological impact in the same manner as the generation and transmission systems. Ideally, losses in an electric system should be around 3% to 6% [3]. In the advanced countries, it is less than 12%. However, in developing countries, around 20% of active power losses occur and so utilities in the power sector are now interested in reducing this distribution loss in order to be more competitive with the dependence of electricity prices on the system losses in deregulated markets. The transmission and distribution losses of India are among the highest in the world. Although, the transmission and distribution (T&D) losses in India is reported to be around (30-33) % but in real field it is much higher than this value. With the inclusion of the non-technical losses, the total losses go as high as 60-65% in many states with an average of about 35- 40% accounting for an estimate of financial loss of around 1.5% of the national Gross Domestic Product [4].The major amount of losses in a power system occurs in primary and secondary distribution lines. There are certain factors contributing to the increase in the lines losses in the primary and secondary systems. Today over 21% (excluding power theft) of the total electrical energy generated in India is lost in transmission (4-6%) and distribution (15-18%). The electrical power deficit in the country is currently about 18%. Obviously, the reduction in distribution losses can reduce this deficit considerably. So, the primary and secondary distribution systems must be properly planned so as to ensure it to be within acceptable limits [4].

There is possibility that the T&D losses can be brought down from existing approximately 50% to nearly 15% through various technical and commercial measures. One of the main reasons for having high losses in developing countries such as India is due to stretching of the distribution lines beyond the limits of the load centers, so also the increase of load abnormally without considering the current carrying capacity of the conductors and mismatch of generation and load causing imbalance in reactive power generation .Therefore, it is of utmost importance to select appropriate conductors in the distribution system because it determines the current density and the resistance of the line. The most preferred solution for problems like high losses and voltage drops is network reconductoring.

In this paper, Network reconductoring has been used as a measure to reduce the distribution losses for two particular area of Assam viz. Jalukbari and Zoo Road area. Network Re-conductoring is the replacement of the existing conductor on the feeder along with an optimal conductor size for optimal length of the feeder. There are certain factors contributing to the increase in the lines losses in the primary and secondary systems [5]. Some of them are-

A. Lengthy Distribution lines

In practice, 11 KV and 415 volts lines, remote rural areas are hurriedly extended over long distances to feed loads scattered over large areas. Thus the primary and secondary distribution lines in remote areas lay radially more frequently and usually extend over long distances. This results in high line resistance and therefore high I^2R losses in the line which will affect the performance of the power system.

Table I

Conductor specifications

Size of Conductor (with code no)	KW-KM for 8% volt. drop at 0.8 pf	Maximum of length of line (KM)	Load that can be connected (KW)
30 MM^2 ACSR Rabbit	11.76	1.6	7.35
20 MM^2 ACSR Weasel	7.86	1	4.86
13 MM^2 ACSR	5.58	1	5.58
30 MM^2 AAC ANT	12.06	1.6	7.54
16 MM^2 Gnat	6.96	1	6.96
50MM^2 ACSR Rabbit	10,640	30	355
30MM^2 ACSR Weasel	7,200	20	360
20MM^2 ACSR Squirrel	5,120	15	341

B. Inadequate Size of Conductors

Rural loads are usually scattered and generally fed by radial feeders. The conductor size of these feeders should be adequate. The size of the conductors should be selected on the basis of (KVA x KM) capacity of standard conductor for a required voltage regulation.

II. CAUSES OF DISTRIBUTION LOSSES AND REDUCTION MEASURES

The cause for technical losses in power systems is due to energy dissipated in the conductors and equipments used for transmission, transformation, sub-transmission and distribution of power. The technical losses in our power systems are high especially in the distribution systems. The main issue in Distribution systems or rather more appropriately the issue confronting the power sector as a whole, is the reduction of Transmission & Distribution (T & D) losses to acceptable minimum levels. During the last few years some of utilities variously estimated the losses in the range over 30% to 50% much higher than the preceding years. Taking into consideration the Indian conditions such as far-flung rural areas, nature of loads, system configuration etc. the reasonable permissible (technical) energy losses should be 10%-15% in different states. While the losses in Extra High Voltage (EHV) network are about 4%-5%, bulk of the losses occurs in distribution system. It is well known that these losses in Distribution systems include non-technical or commercial losses and that of power by various users with or without connivance of utility staff. These constitute a large component of overall losses. More than half of the T&D losses are commercial losses due to rampant theft & pilferage of electricity, meter tampering, unauthorized connections and un-metered supply.

It is, therefore, necessary to bring about improvements in planning implementation and operation of distribution systems in a scientific and efficient manner. Technical losses [5] can be reduced and brought down to acceptable levels but cannot be made zero. The causes of high technical losses are varied and require different remedial measures to be implemented to bring them down to acceptable levels. Reduction of I^2R loss in distribution systems is very essential to improve the overall efficiency of power system. Addition to that improving energy efficiency is probably the most profitable thing that can be done in the short term. This paper includes network re-conductoring method as a short term measure for distribution loss reduction.

A. Network Re-conductoring

Network reconductoring [5] is the technique where a scheme of replacement of existing conductor on the feeder by conductor of optimal size for optimal length of the feeder is done. This technique is used when the prevailing conductor is found to be no more optimal because of quick load growth. It is done when percentage loading of the conductor exceeds economic loading or to replace the deteriorated/off size conductor. The conductor's size is a very important parameter in curtailing the loss occurring in a distribution system as it determines the current density and the resistance of the line. From the studies of different conductor sizes it has been found out that it is more economical to use conductors of higher cross sectional area. The replacement of existing line conductors by bigger sized conductors will result in reduction of technical losses in direct proportion to the ratio between the resistance of the new and existing conductor as a reduced conductor size can enhance I^2R losses and an increase in the voltage drop which causes a loss of revenue as consumer's consumption is decreased and thus the revenue is also lowered[6].

The advantages of this method like increase in the feeder's capacity to handle expansion of load demand along with improvement of voltage profile undoubtedly leads to the reduction of the losses.The increase in the size of the conductors will require additional investment, which may not compensate for the reduction in losses.

The most used practice is to find out whether the conductor is able to deliver the peak demand of the consumers at the prescribed voltages i.e. voltage drop must remain within the prescribed allowable limits as specified in the Indian Electricity Act, 2003. This scheme is much useful for the developing countries [6], where the annual growth rates are high and the conductor sizes are chosen to minimize the initial capital investment. Alternate conductors/cables may also be considered wherever suitable. The only defect with this scheme is that it leads to additional investment which increases the initial investment of the feeders.

III. RESULTS AND DISCUSSION

Two substations under Guwahati circle is selected for analysis consideration. Here effort has been made to figure out the distribution losses of different areas and its causes were also discussed. Different methods are available for reducing the transmission and distribution losses [6] but we select network Re-conductoring method for our analysis. This paper includes investigation of line losses for six different conductor material namely Squirrel, Weasel, Rabbit, Racoon, Wolf and Dog [7].

The following sections thus include various data regarding different substations of Guwahati. Guwahati Electrical Circle-1 has been demarcated into thirteen sub-divisions namely Ulubari, PaltanBazar, Machkhowa, Fancy Bazar, Narengi, Chandmari, Uzan Bazar, Zoo Road, Capital, Kalapahar, Garbhanga, Basistha and Sonapur to look after the needs of its consumers. It has total 128777 nos. of consumers dominated by domestic consumer (84%).

Table II

Key parameters of the Circle

Peak Demand	122 MW
33/11 kV Substations	18 No.s (142.5 MVA Capacity)
33 kV Feeders	24 No.s (194 Ckt.km)
11 kV Feeders	78 No.s (672.9 Ckt.km)
Distribution Transformers	2163 No.s (441657 kVA Capacity)
Annual Input Energy	618.80 MU
Annual Billed Energy	507.24 MU

Above substations receives power mainly from Kapili (NEEPCO, A Central Sector Agency), Karbi-Langpi, Lower Assam Grid (Eastern Grid) and Upper Assam Grid (Kathalguri,Namrup and Lakwa)[8].

A. *Field data Analysis*

Substation data have been collected from practical survey of the localities. The collected data are used for calculation of losses in this paper. The collected data for the substations are given below-

1. *Jalukbari Substation:*

The needed parameter for line loss investigation is collected from Jalukbari Substation and are summarized below

Table III

Parameters of Jalukbari substation

Latitude:	26.1441365 degree North
Longitude:	91.6614947 degree East
Conductor used:	Squirrel
Peak Demand:	18 MW
Distribution Loss:	30%
Distribution Length:	7 km
Area covered:	Maligaon, Adabari, Sadilapur, Kamakhya, Pandu, Jalukbari (AEC), Lankeshwar, Khanamukh, Satmile, Dharapur, Tetelia, Boragaon, Gorchuk, Pamohi, Kalyan nagar (hilly area).

In Jalukbari substation Squirrel conductor is used for distribution of power in practical.

Table IV

Distribution losses w.r.t different conductors

Name of the conductors	Squirrel	weasel	rabbit	racoon	dog	wolf
Diameter (in mm)	6.33	7.77	10.05	12.27	14.15	18.13
Resistivity (ohm-metre)	1.394	0.929	0.552	0.371	0.279	0.187
(i^2 R) Loss (KW)	1000	540	157	73.3	40.4	16.42

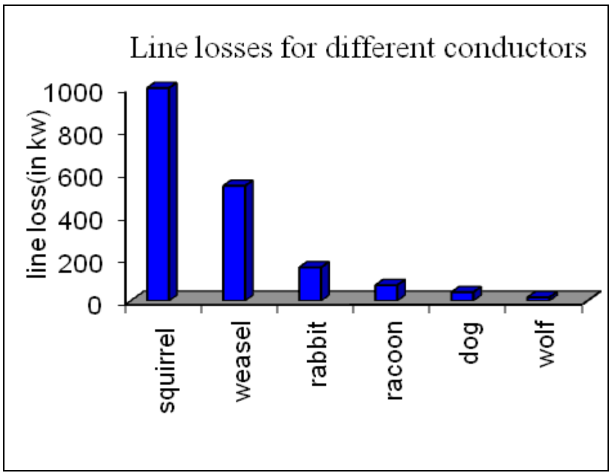

Fig.2. Line losses for different conductor of Jalukbari Substation

But from the analysis it comes to light that Wolf conductor is the most efficient as compared to other considered conductors and it will reduce the losses to a great extent if used instead of the existing squirrel conductor. So this paper recommends replacing existing conductor by wolf or Dog conductor. Economic analysis is necessary for further analysis. Along with this, this paper also shows the amount of power saving in case of replacement of existing conductor by different conductor material as mentioned above.

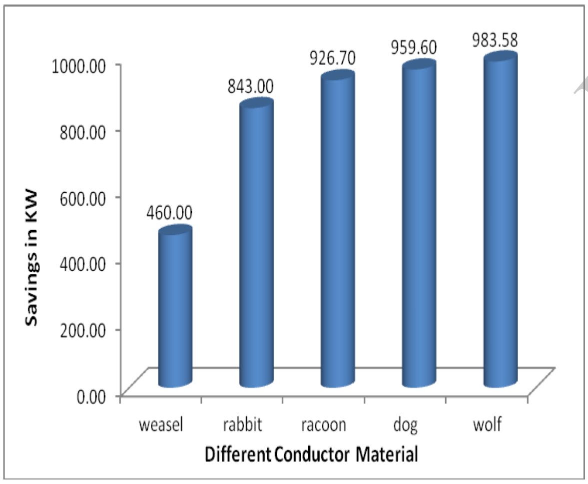

Fig 3. Comparision of savings after replacement of existing conductor

2. *Zoo Road Substation:*

Table V

Parameters of Zoo Road substation

Latitude:	25.562265 degree North
Longitude:	93.076172 degree East
Conductor used	Squirrel
Peak Demand:	14MW
Distribution Loss:	10%
Distribution Length:	10 KM
Area covered:	Japorigog, G.S. road, Gitanagar, Bamunimaidan, Tarun nagar, Doordarshan

In Zoo Road substation the existing conductor used is squirrel conductor.

Table VI
Distribution losses w.r.t different conductor

Name of the conductors	squirrel	weasel	rabbit	racoon	dog	wolf
Diameter (in mm)	6.33	7.77	10.05	12.27	14.5	18.13
Resistivity (ohm-metre)	1.394	0.99	0.552	0.371	0.29	0.187
(i^2 R) Loss (KW)	93.8	37.9	13.3	6.03	3	1.4

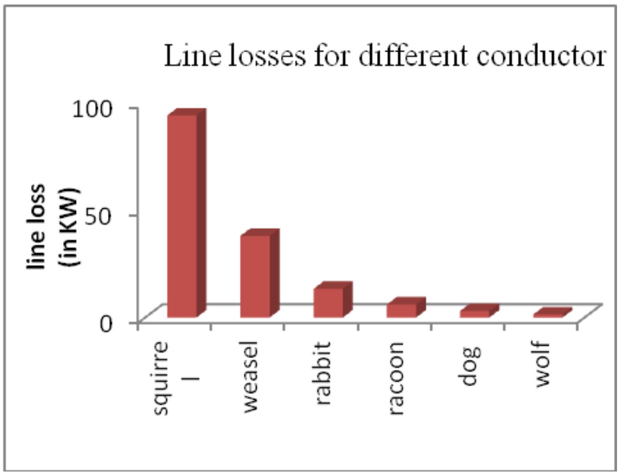

Fig 4. Line losses for different conductor of Zoo Road Substation

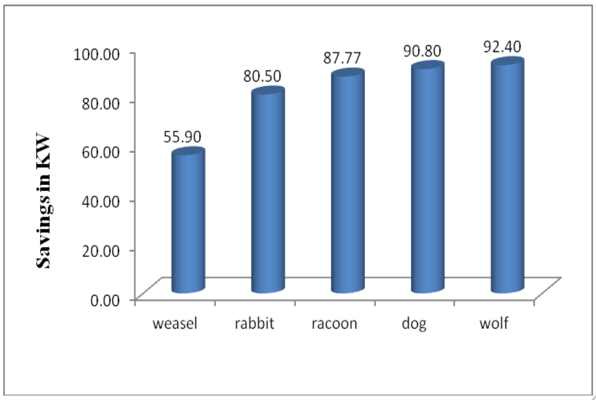

Fig 5. Comparision of savings after **replacement of existing conductor**

From the above Fig.5 we can conclude that the distribution loss is minimum in case of wolf conductor which has already been used in Zoo Road substation and it is giving the best possible result. In future it is expected to use heat spring cables to reduce the losses. In the above analysis we have plotted the diameters of six different conductors against their respective power losses.

Hence we can conclude that by Re-conductoring method we can reduce a good amount of loss which results in conservation of energy. Though the cost factor comes into consideration it is very much necessary to reduce the losses to some extent if not to the desired value. So far, wolf shows the best result yet it has not been used due to its cost and various other reasons.

IV. CONCLUSION

Energy conservation is the quickest, cheapest and most practical method of overcoming energy shortage. It is found that there is major scope of energy conservation in electrical distribution system and in consumer's installation. For efficient and reliable operation of a distribution system, a reliable and well knit communication network is required to facilitate project coordination of the maintenance and fault activities of the distribution system.

At present transmission and distribution losses are very high in North Eastern region especially in Assam. This paper investigates the opportunities to reduce these losses. At present, the existing system refers to maximum losses. So from this investigation it is concluded that if the existing system is replaced by Re-conductoring method, an optimum solution can be obtained. It is observed that in Jalukbari substation area if the existing conductor is replaced by Wolf conductor, maximum 983.58 KW can be saved by this method. Similarly in case of Zoo road substation also 92.40 KW can be saved by replacing Wolf conductor. Existing conductor reflects the highest losses in comparison with the other conductors. For future scope, economic analysis is required for further optimization.

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BIOGRAPHY

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