ISSN: 2278 - 1323
International Journal of Advanced Research in Computer Engineering and Technology (IJARCET)
Volume 2, Issue 6, June 2013

Determination of Nontechnical Losses via Matlab Environment

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Abstract---Total energy supplied by the distribution utility does not reach to the consumer end. An extensive amount of energy is lost in the transmission and distribution system because of Technical and Non Technical losses. In power system the losses which cannot be predicted or calculated in advance known as non-technical losses. These losses are due to poor revenue cash flow, huge over-heads, unmanaged peak Load / Demand, large commercial losses due to poor billing.

The purpose of this paper is to investigate Nontechnical Losses and its economic consequences in power sector with the help of a case study and MATLAB Simulation in power system.

Keywords---Electricity Act-2007, Non Technical Losses (NTL), Prepaid Energy Meter.

I. INTRODUCTION

India faces endemic electrical energy and peak shortages. These shortages had a very injurious effect on the overall financial growth of the country. In 1966-67 the transmission and distribution losses in our country, were around 15% which after increasing gradually to 28.36 % by 2012-13.

In Indian scenario transmission and distribution losses percentage has been high to a certain extent. The term "distribution losses" refers to the difference between the amount of energy delivered to the distribution system and the amount of energy customer is to be paid. However, as per sample studies carried out by autonomous agencies including TERI, these losses have been estimated to be as high as 50% in some states. In a recent study carried by SBI capital markets, The Transmission and Distribution losses have been estimated as 58%[1].The Transmission and Distribution losses in the advanced Countries of the world ranging from 4-12%. Though, the Transmission and Distribution losses in India are not comparable with advanced countries because the system operating conditions are different in different countries. To study non-technical losses, which comprise a fraction of the total losses in electrical power systems, the first step is to understand the entire image of power system losses.

Power system losses can be divided into two categories: technical losses and non-technical losses. Technical losses are losses caused by actions internal to the power system and consist mainly of power dissipation in electrical system components such as transmission lines, power transformers, measurement systems, etc. Non-technical losses (NTL), on the other hand, are caused by actions external to the power system, or are caused by loads and conditions that the technical losses calculation failed to take into account. NTL are more difficult to measure because these losses are often unaccounted for by the system operators and thus have no recorded information.

The project region chosen for this study was the Kalpi Bridge, Morar, Gwalior district, Madhya Pradesh because it is not only rural but also an urban area.

II. ANALYSIS OF NON TECHNICAL LOSSES

As NTL (nontechnical losses) cannot be computed easily, while it can be estimated from preliminary results, i.e. the result of technical losses are first computed and subtracted from the total losses to obtain the balance as NTL. The technical losses are computed using suitable load-flow studies simulated under MATLAB environment. Even though some electrical power loss is unavoidable, steps can be taken to ensure that it is minimized. Some measures have been applied to this end, including those based on technology and those that rely on human effort and ingenuity. The technical losses would be computed with the help of case studies of Gwalior and then impact of non technical losses on them is shown.

Consider the transmission line length to be 3 km. The following are the specifications of a simple two bus system which is needed to complete a load-flow calculation for power loss in the transmission line are given below:

Base Values: 11000 Volts, 100 Ampere, 1.1 MVA, 110 Ohms

Transmission Line Resistance = 3 km × 0.266432 Ohms/conductor/km ×3 conductors
= 2.3978 ohms (Ω) = 0.021799 per unit (p.u.)

Transmission Line Reactance = 3 km × 0.348692 Ohms/cond./km × 3 conductors
= 3.1382 Ω = 0.028529 p.u.

Table I .Load Profiles for Industrial & Residential load

Time (Hrs)	Industrial Load(KVA)	Power Factor of Load 1	Residential Load(KVA)	Power Factor of Load 2
1	60	0.91	33	0.81
2	65	0.91	31	0.81
3	85	0.91	50	0.81
4	87	0.87	35	0.87
5	93	0.89	25	0.86
6	101	0.90	40	0.76
7	125	0.87	85	0.73
8	150	0.81	75	0.74
9	231	0.76	100	0.80
10	235	0.76	60	0.83
11	255	0.76	50	0.85
12	265	0.76	55	0.82
13	275	0.76	30	0.81
14	310	0.76	60	0.86
15	310	0.76	45	0.89
16	310	0.81	55	0.82
17	260	0.81	90	0.76
18	180	0.81	100	0.72
19	140	0.87	125	0.69
20	100	0.89	150	0.66
21	85	0.90	170	0.82
22	70	0.91	80	0.80
23	60	0.90	75	0.85
24	55	0.90	65	0.92

A load profile of 24 hours has been shown for ease and the further calculations have been done with the help of Newton-Raphson method. Figure2.1 shows the variation of industrial and residential loads during 24hours.

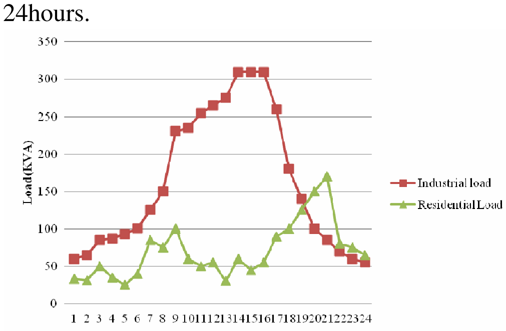

Fig.2.1 Load variations over 24 hours

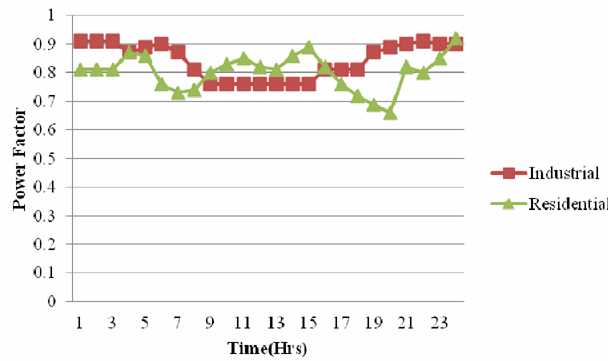

Fig.2.2 Variation of power factor over 24 hours

As shown in table I, the industrial load has its peak demand during day times and the residential load demand is more during morning and evening hours. The load peaks are at 310 KVA for load1 and 170 KVA for load 2. The average load demands (sum of peak values / no. of hours in a day) are 162.79 KVA and 70.16 KVA for load 1 and load 2, respectively. Load power factors are shown in Figure 2.2.
Resistance and reactance values of transmission line are taken from the datasheet of 11kv transmission line. To avoid overloading in the transmission line the conductor size and line length were chosen arbitrarily from the datasheet with the maximum conductor size of 120mm^2.
Figure2.3 and 2.4 shows the graph of active and reactive power losses respectively.

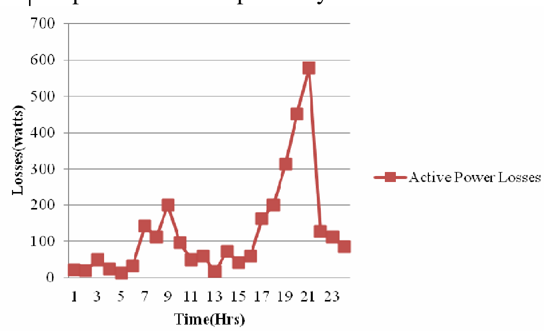

Fig.2.3 Active power losses

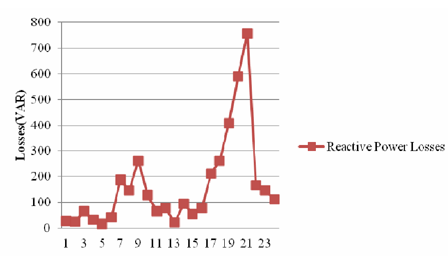

Fig.2.4 Reactive power losses

III. NONTECHNICAL LOSSES ADDITION

As shown in the case study, non technical losses are complex to calculate because it contains a major portion of transmission & distribution losses. Non technical losses can also be viewed as undetected load of customers that the utilities don't know. When an undetected load is attached to the system, the actual losses increase while the losses expected by the utilities will remain the same. The increased losses will show on the utilities' accounts, and the costs will be passed along to the customers as transmission and distribution charges. From the various studies, it has been concluded that NTL constitutes 2-3% of the total system losses. Thus calculations have been shown by adding 3% of the original KVA demand to one of the bus and the modified results have been shown using MATLAB simulation. Hence the total increase in losses has been calculated. The extra load profile with negative power factor addition is shown in the table II.

Table II. Extra Load Profile with Negative Power Factor Addition

Time(Hrs)	NTL Load(KVA) added at Bus 2	NTL Load Power Factor
1	2.92	-0.0247
2	3.01	-0.0247
3	4.15	-0.0247
4	3.80	-0.0265
5	3.55	-0.0259
6	4.40	-0.0235
7	6.12	-0.0218
8	6.90	-0.0231
9	10.00	-0.0241
10	9.01	-0.0251
11	9.25	-0.0259
12	9.75	-0.0245
13	9.20	-0.0242
14	11.01	-0.0259
15	10.45	-0.0267
16	10.80	-0.0239
17	10.25	-0.0226
18	8.26	-0.0215
19	7.96	-0.0222
20	7.25	-0.0218
21	7.90	-0.0235
22	4.65	-0.0240
23	4.41	-0.0250
24	3.80	-0.0275

Here the power factor contributions chosen are negative because the NTL load is assumed to be Inductive, i.e., motors or light fixtures. The extra load and negative power factor addition to second bus are shown in figure 3.1 and 3.2respectively.

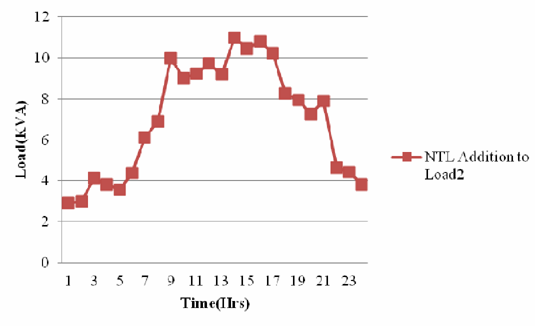

Fig.3.1 NTL addition

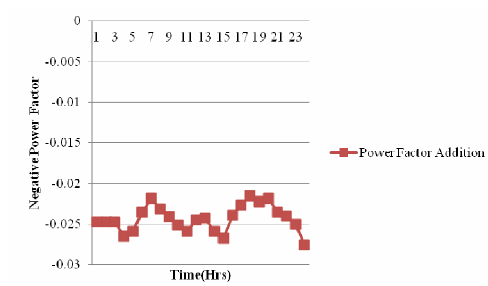

Fig.3.2 Power factor additions

The simulation is run with bus 1 as the slack bus. The NTL power factor is negative all times because of inductive NTL load assumption. After the simulation was done and evaluated, some remarkable results were evident. The active & reactive power losses along with NTL in transmission lines are shown in figure 3.3 and 3.4 respectively. The maximum active power losses occurred as shown in graph are 633.9512 watts maximum reactive power losses are while 829.6708 Watts.

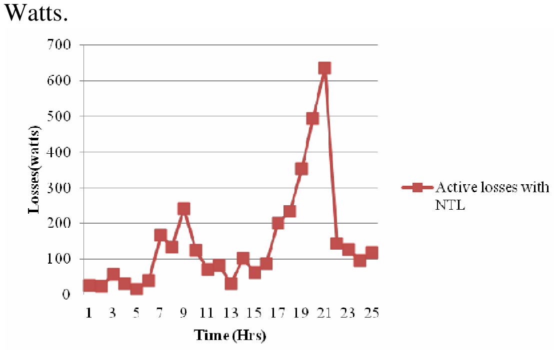

Fig.3.3 Active losses with NTL

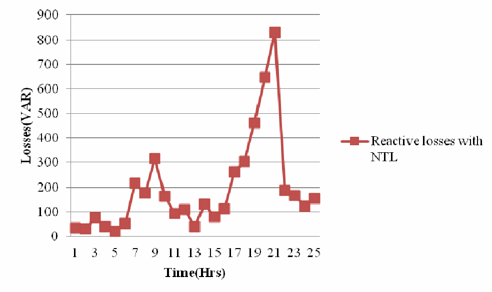

Fig.3.4 Reactive losses with NTL

IV. COMPARISON OF LOSSES

With the addition of NTL to one of the load, the overall system losses will increase. This large increase is due to only small addition i.e. only 3% load. Mainly reactive power losses have higher range than active power losses. The two losses are compared with the help of waveform shown in Figure 4.1 energy consumption divided by the length of the time period, in seconds. This information is always available for metered loads, because it is what the utilities' revenues is based on.

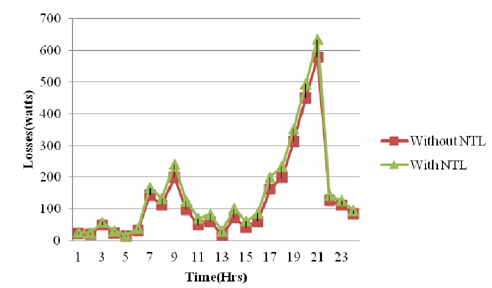

Fig.4

.1 Comparison of active power losses

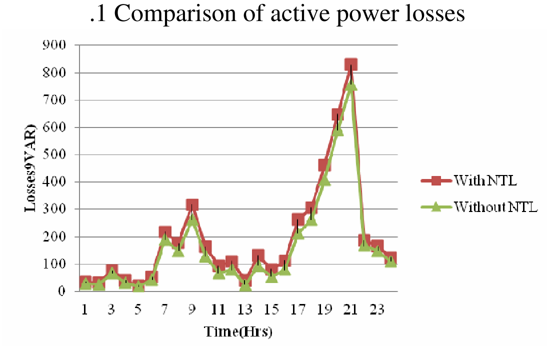

Fig.4.2 Comparison of reactive power losses

Due to power factor contribution of the NTL load the increase in load demand and the increase in transmission losses are not at the same levels. In fact, the losses increased at a larger rate than the loads. The average load here is computed by averaging the overall loss increase for each hour. The Figure 4.3 shows the net per unit increase in losses at bus 2 where as percentage increase of load and losses due to NTL are also shown in Figures 4.4 and 4.5 respectively.

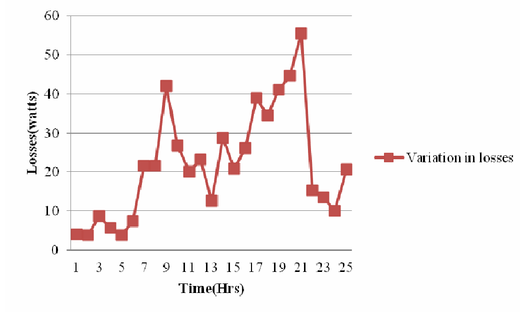

Fig.4.3 Per unit increase in losses

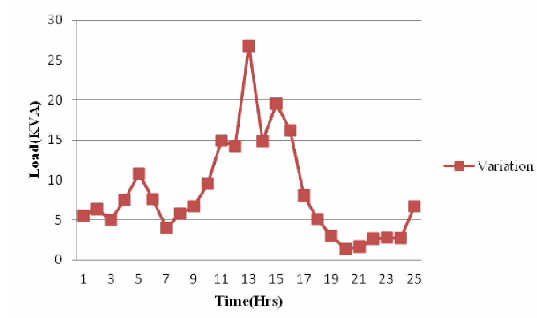

Fig.4.4 Percentage increase in load

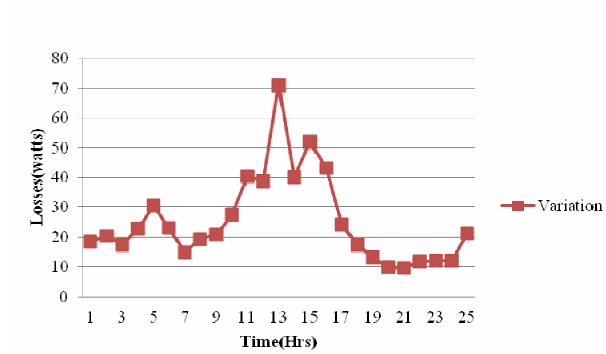

Fig.4.5 Percentage increase in losses

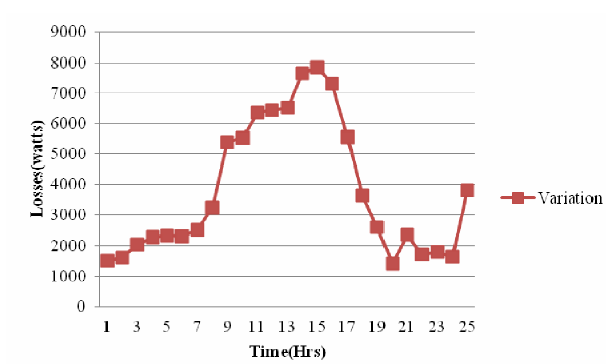

Fig.4.6 Total increase in losses

However the increase in transmission loss places a greater burden on the transmission equipment, the greater cause for concern would be the NTL load itself.

The total power losses in the transmission line are shown in the Figure 4.6 which is sum of NTL active power and losses increase due to NTL. When the lines get overheated, serious consequences can follow, from loss of material strength to the weakening of insulation possibly dangerous if the lines are in a crowded area. At this point, it is getting clear that making calculations for expected losses accurately is nearly impossible in practice. The way to obtain a fairly accurate value of average load demand is to utilize the information the utilities use to calculate the electric bills. The calculation requires energy consumption accumulated up to the beginning of the time period and the consumption accumulated at the end of the time period. The accumulated consumption at the end of the period is subtracted by the accumulated consumption at the beginning of the period. The result is the total consumption during the time period in kilowatt-hours, and the portion of the bill for energy consumption is based on this number. The net summary of the simulations result will be shown in table III.

Table III. Net Result Summary

SUMMARY OF LOSSES	CALCULATION ON AVERAGE BASIS (units)
Losses without NTL(watts)	97.9751
Losses with NTL(watts)	118.6527
Increase in losses(watts)	20.6776
%Increase in losses(watts)	21.1049
P.U. load power at Bus 2 without NTL(watts)	0.06378
P.U. load power at Bus 2 with NTL(watts)	0.006391
Increase in load(watts)	3774.8
%Increase in load(watts)	6.6941
Total increased losses(watts)[NTL Real power+ Increased transmission lines)	3795.4

From the above results it has been cleared that reducing non technical losses will make sure that the cost of electricity to the supplier will be reduced. The cost of the electricity to the customer will therefore also reduce, as the customers will not have to pay for the non technical losses in the electricity distribution network.

V. CONCLUSIONS

The measurement of technical and non technical losses and its effects on electrical power systems as a whole using existing analytical tools would be possible only if information about the technical and NTL loads themselves is available to the forecaster. Precisely estimating losses in distribution systems is becoming ever more important, as regulatory thinking shifts from input-based to output-based methods. Also private companies become more involved in the distribution segment of the electricity industry.

Replacement of the faulty energy meters would further reduce the non technical loss (i.e. the energy expenditure tendency is higher if the meter is faulty). The average energy expenditure of a consumer with a faulty energy meter is 23 per cent more than their tariff level. This fact indicates a serious loss of revenue to the board. In this work, it was decided to take a two bus system with one bus as slack bus and load is on another bus. The load profiles of simple industrial area and residential area has been taken. Then a small percentage (3 %) of NTL has been added to one of the load and the increased load and losses have been shown with the help of Newton-Raphson load flow method and MATLAB. Here negative power factor contributions are chosen because the NTL load is assumed to be inductive. All the simulation results have been shown in the form of line diagrams clearly. The readings of one full day have been taken. Then a case study of one small area has been carried out to determine the extent of non technical losses in that area. For one full month The total units supplied and total units billed have been thoroughly measured. Then their difference is used to determine the extent of non technical losses in that area. The loss calculation after addition of 3% load without NTL on average basis is 97.9751 watts and the losses with NTL become 118.6527 watts. There is 20.6776 watts increase in losses which is around 21.1049 % of total losses.

At the end, it has been concluded that utilities will have to concentrate on reducing technical and non technical loss.

Reducing these losses ensure that the cost of electricity to customers will be reduced and in turn the efficiency of the distribution network will be enhanced. Local bodies can play a main role in the effective utilization of electrical power. Hence, it is clear that it is tremendously important to bring the awareness of authorities to the up till now neglected area of rural power distribution system. It is also clear that such measures are essential for finding a least cost and time bound solution to the problem of energy shortage in MP.

REFERENCES

[1] Navani, J.P., Sharma, N.K., SapraS. (2004). "Technical and non-technical losses in power system and its economic consequence in Indian economy", International Journal of Electronics and Computer Science Engineering, 1(2), 757-761.

[2] Isha Awasthi, Ritu Agarwal, "Implementation of Simulink in Protection of Transmission Lines", International Journal of Advances in Electrical and Electronics Engineering, (IJAEEE), ISSN: 2319-1112), Vol. 01, No. 02, pp.195-202, (2012).

[3] Fourie, J.W. and Calmeyer, J.E., "A statistical method to minimize electrical energy losses in a local electricity distribution network," AFRICON, 2004, 7th AFRICON Conference in Africa, vol.2, no., pp. 667-673, 15-17 Sept. 2004.

[4] R. Alves, Member, IEEE, P. Casanova, E.Quirogas, 0. Ravelo, and W. Gimenez Reduction of Non-Technical Losses by Modernization and Updating of Measurement Systems 1-4244-0288-3/06/$20.00 ©2006 IEEE.

[5] Charles A. Gross, Power System Analysis (Second Edition). John Wiley & Sons, New York, 1986; pp. 255 – 298, and pp. 304 – 322.

[6] Annual report of power and energy division of planning commission, government of India, New Delhi, 2011-12.

[7] "All India Electricity Statistics", Central Electricity Authority, Ministry of Power, Government of India, New Delhi, 2011-12.

[8] Electricity Sector in India, "Key world energy statistics", 2012.

[9] A report on Madhya Pradesh Madhya Kshetra Vidyut Vitaran Company Limited (A wholly owned Govt. of MP Undertaking) RfP (Revised) for Appointment of Distribution Franchisee for Distribution and supply of electricity in Gwalior Town.

[10] Dan Suriyamongkol, "Non technical losses in electrical power systems", A Report presented to OhioUniversity ,November 2002.

[11] Tejinder Singh "Analysis of non technical losses and its economic consequences on power system – A case study of Punjab state", A report presented to Thapar University, June 2009.
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