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Analysis and Estimation of Technical Losses in Urban Distribution Feeders Bahawalpur

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Abstract: In this paper evaluation of power losses in the urban distribution feeders has been done. In Pakistan few methods had been implemented by Distribution Company to minimize technical power losses in urban distribution feeders. Observation in one year of three urban distribution feeders of Bahawalpur city region has been done, and conclusions are given. Feeders loads and distribution system arrangement has been assessed by conducting field survey method. Induction loads are supplied by the urban distribution feeders. Monthly power loss in percentage, line length (L), power factor (Pf) and capacity of line has been analyzed. Three feeders have been discussed by the sampled data. Critical observations were curtailed. Recommendations are there for up grading effectiveness of system and negotiating power losses by technical studies.

Keywords: energy loss, feasible zone, urban distribution feeders etc.

1. INTRODUCTION

Resistance to the power flow is offered by every electrical network element. This results in energy loss but it passes the current through electrical network elements. These electrical network losses are collectively called technical losses. Problems of low voltage and high energy loss are offered by the distribution system in Pakistan even in developing countries. Losses and potential drop problems of the distribution feeders depend on each other and load curves. It is noted that the overall distribution and transmission losses are 26-30% in Pakistan (Khalil *et al*, 2007).The major part of these losses is observed in the distribution zone (70-80%of overall "Transmission and Distribution" losses). According to national electric power regulatory authority & water and power development authority reports total loss is 1.5billion rupees per year due to technical losses and power theft (Barker *et al.,* 2000). Total eleven power distribution companies supplying power in Pakistan. In July, 2012 the total load on distribution transformer was 16500 MW (MEPCO, 2013) and total transmission line length of the eleven companies was 5130Km (NTDC, 2012). Total power available was 11200MW (WAPDA, 2012). So the distribution companies introduce some strategy to theft control, consumer interest and guidelines, commercialization, system up gradation and technical loss reduction. 3-5% power losses occur in primary distribution system. 10% variation in voltages at the consumer service mains is allowed in Pakistan. Three urban distribution feeders of Multan electric power company belong to one district of Bahawalpur zone have been analyzed by their statistical data for one years from 2012-2013 (Khan *et al.,* 2009).

2. METHODS TO REDUCE TECHNICAL LOSSES BY DISCO'S

Distribution companies are very much interested for introducing some techniques to reduce the technical power losses. The length of low tension line of three phases four wire line has been reduced and length of 11kV lines is expanded up to the consumer loads. High rating transformers like 200kVA & 100kVA etc. have been replaced by low ratings like 15kVA, 25kVA& 50kVA near to consumer loads.

DISCO'S is carrying out prime measures regarding proper repairing work, re-habitation of feeders and transformers to minimize extra power demand, changing conductors at required regions, the Repairing of distribution transformers framework and low voltage (LV) Lines, renovation of faulty circuit breakers and slack outcomes of sub-stations, lines and distribution transformers. Convenient operations of capacitors are checked in industrial services (Moradi *et al.,* 2014). Overloading of distribution transformer is avoided by high rating distribution transformer, elimination of inactive distribution transformer and shift 11kV feeders to adjacent sources. Interlink lines having more than 100 ampere current and 25 Km length to prevent overloading feeders. Tapping's of transformers and their parallel operation on transformer is very important work to be done. Three phase transformer should be used instead of single phase transformer. Single phase three wire transformer is replaced with

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three phase five wire transformer. It makes load balancing easy. Second low tension electrical circuit is run for low tension line carrying more than 75 ampere current and having length of more than 5 Km in order to improve the voltage regulation. Street light meter is used at the receiving terminal of the distribution transformer and conductor of size 100sq. mm. Also use one circuit breaker per feeder.

3. STATISTICS OF URBAN DISTRIBUTION FEEDERS

Inclusive age% power losses on three feeders of WAPDA are shown in **Table-1 and Table-2** in 2012-2013. Ratio of the monthly power losses and total input power supplied to the feeder during the financial year are defined as cumulative losses. Month received units, billed units their differences and losses in percentage are shown in the tables.

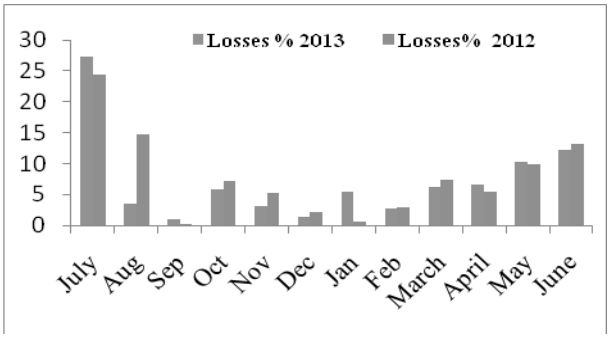
3.1 Shadrah Feeder

The table 01 shows the shadrah feeder month wise received unit, month wise billed unit & their differences and losses in percentage are calculated year 2012 & 2013.

Table 01. Shadrah feeder losses of Bahawalpur substation

Month	Received Unit	Billed Unit	Difference	Losses % 2013	Losses % 2012
July	2559040	1860748	698292	27.29	24.4
Aug	2534480	2444880	89600	3.54	14.7
Sep	2194380	2173477	20903	0.95	0.25
Oct	2087656	1965565	122091	5.8	7.2
Nov	1990784	1930045	60739	3.05	5.32
Dec	1915739	1887932	20807	1.45	2.17
Jan	1887456	1783901	10355	5.48	0.5
Feb	1852779	1800325	52454	2.8	2.96
March	1879920	1762834	117086	6.23	7.31
April	1934258	1805637	128621	6.6	5.51
May	1990087	1825421	164666	10.2	9.8
June	2078690	1986472	92218	12.2	13.1

The graph 01 shows the shadrah feeder month wise losses in percentage for the year 2012 & 2013.



Graph 01.Losses of Shadrah feeder of Bahawalpur substation

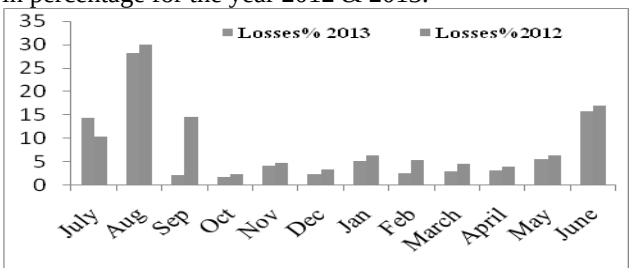
3.2 Sutlej Feeder

The table 02 shows the Sutlej feeder month wise received unit, month wise billed unit & their differences and losses in percentage are calculated year 2012-2013.

Table 02.Losses of Sutlej feeder of Bahawalpur substation

Month	Received Unit	Billed Unit	Difference	Losses % 2013	Losses %2012
July	2894460	2477478	417982	14.4	10.3
Aug	2709770	1945168	764602	28.2	30.10
Sep	2529750	2473833	55917	2.21	14.5
Oct	2478931	2435750	43181	1.74	2.32
Nov	2375643	2278453	97190	4.1	4.75
Dec	2298834	2243676	55158	2.34	3.321
Jan	2217365	2100341	117024	5.2	6.34
Feb	2154387	2098762	55625	2.5	5.3
March	2267549	2198970	68579	3.03	4.5
April	2304088	2232457	71631	3.1	3.9
May	2398726	2265895	132831	5.5	6.3
June	2495689	2300134	395555	15.8	16.99

The graph 01 shows the Sutlej feeder month wise losses in percentage for the year 2012 & 2013.



Graph 02. Losses of Sutlej feeder of Bahawalpur substation

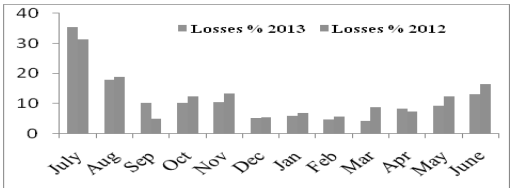
3.3 Model town B feeder

The table 03 shows the model town B feeder; month wise received units; month wise billed units their differences &losses in percentage are calculated for the year 2012-2013.

Table 03.Losses detail of MTB feeder

Month	Received Unit	Billed Unit	Difference	Losses % 2013	Losses % 2012
July	2163720	1399671	764049	35.31	31.3
Aug	2103950	1727491	376457	17.8	18.9
Sep	1725800	1550920	174880	10.13	5.0
Oct	1701235	1526752	174483	10.25	12.39
Nov	1697862	1519827	178035	10.48	13.23
Dec	1682318	1594527	87791	5.2	5.53
Jan	1673471	1574289	99182	5.9	6.87
Feb	1672318	1592317	8001	4.7	5.54
Mar	1772319	1697264	74955	4.2	8.65
Apr	1834916	1792341	42602	8.2	7.29
May	1934527	1843892	90635	9.2	12.42
June	2056731	1973625	83106	13.2	16.35

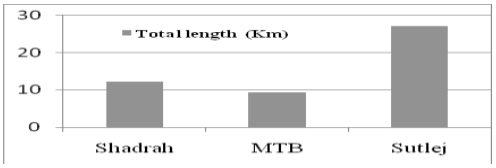
The graph 03 shows the MTB feeder month wise losses in percentage for the year 2012 & 2013. One subdivision data is given in table.4 which shows the total length of three feeders. graph04. Shows the length of the three different feeders



Graph 03.Losses of MTB feeder

Table-04 feeder wise length

Feeder Name	Total length (Km)
Shadrah	12.2
MTB	9.4
Sutlej	27.06

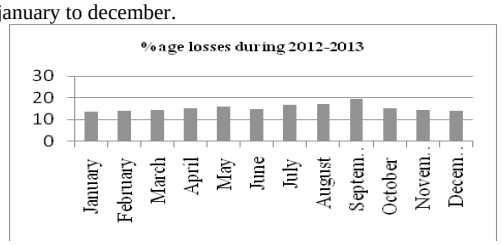


Graph 04.length of the three feeders

Table 05. Bahawalpur sub-division losses during 2012-13.

Number	Month	%age losses
01	January	13.77
02	February	13.89
03	March	14.45
04	April	15.21
05	May	15.98
06	June	14.99
07	July	16.56
08	August	17.11
09	September	19.40
10	October	15.21
11	November	14.21
12	December	14.02

The table 05 shows the Bahawalpur supdivision losses in percentage from january to december.



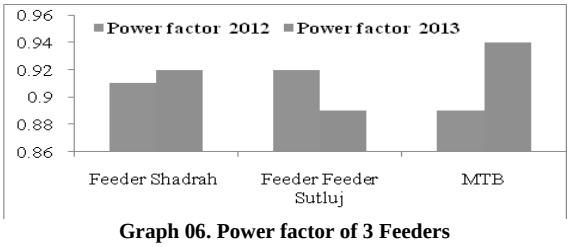
Graph 05. Bahawalpur subdivision Losses (%)

The graph 05 shows the Bahawalpur supdivision losses in percentage from January to December

Table 06. Power factor of 3 feeders

11kV Feeders	Pf 2012	Pf 2013
Shadrah	0.91	0.92
Sutluj	0.92	0.89
MTB	0.89	0.94

The table 06 shows the Power factors on various 11 kV urban feeders as on July, 2012 and July, 2013have been compared. The graph 06 shows the Power factor on various 11 kV urban feeders 2012 &2013have been compared.



Graph 06. Power factor of 3 Feeders

4. OBSERVED ANALYSIS

During 2012-13, 0.84 was the average power factor on urban feeders. The power factor is improved in 2012 to 0.89. Data for regulation was not available for 2012-13 but in 2012-13, 5.5% average regulation noticed. When 11kV feeder was studied, it was analyzed that kVA rating of distribution transformer was greater than maximum kVA demand; this leads to important issue of distribution transformer. One being larger iron loss due to higher rating and other being high initial cost. Power meters are not connected on distribution transformers (DTR).This leads to rough power consumption which results in errors in power loss analysis. Many distribution feeders have variable supply voltage of more than 10%. When voltage level is reduced, it causes increase in current as in case of induction motor (Khan el at, 2009), induction motor draws current increases from 10-15% in 10% voltage drop case, the starting torque decreases by 19% and the line losses in the distribution lines increases approximately 20%. If it is needed to solve this problem effectively, reduce the low tension length of transmission line and place high voltage distribution lines. Usually power factor is to be found above 0.8 to 0.89 in distribution feeders. When it is low (power factor) the distribution losses are high (Murthy el at, 2007).Actually when power factor is decreased the current passing through the conductor is increased. The losses are directly proportional to the square of current so, they increase to bend with each increase in current magnitude. It becomes deadly for the distribution system when capacitors are not fixed or working in that system. For the long scattered loads in urban areas long 11kV transmission line are used usually. High line resistance and power losses are the main concerns in these areas. During February, 2012 the %age losses were small.

5. PROPOSALS FOR UPGRADING SYSTEM (EFFICIENCY)

To limit losses with in permissible range transformer rating must be selected wisely. The rating of the transformer has to be taken within the very

nearby tolerable demands of loads on the existing systems. Energy meter should be fixed at distribution transformer so that exact voltage losses can be observed instead of rough ones. During low distribution voltage on feeders problems are observed, they can be handled by using switch changers at 11/33 kV at the proper and automatic controlled ways and using capacitors combination at the substations along with voltage regulator. By using shunt capacitors, we can reduce the line losses, at the receiving terminal of the consumers. These shunt capacitors have 2/3rd of the requirement of the consumers located at 2/3rd of the distance of distribution transformer. These shunt capacitors decrease 4-5% power losses at the peak load which can be fed to the new incoming consumer. It leads to 10% improvement in voltage regulation 20% reduction in current resulting overall 9% reduction in distribution losses depending on the degree of power factor improvement as shown by simulation. Further improvement in power system can be established by using express feeders (reducing 25% losses) and by HVDS which further diminishes losses 20-30%.These suggestions play a vital role in decreasing distribution losses up to 50%. For desired voltage regulation kVA*Km capacity of a given conductor should be considered. Below table 7, represent the 11kV and table 8, 415V line length with respect to different loads.

Table 07. 11kVlength of the line w.r.t loads

Size and code	max. Line length(km)	Loads connected(kw)
50 mm^{2}ACSR	25	350
30 mm^{2}ACSR	17	322
20 mm^{2}ACSR	14	302

Table 08. 415V line length w.r.t different loads.

Size and code	max. length of line (Km)	Connected load(kW)
30 mm^2 ACSR	1.6	6.34
20 mm^2 ACSR	1.0	4.43
13 mm^2 ACSR	1.0	5.31
30 mm^2 AAC ANT	1.6	7.42

6 CONCLUSIONS

From the result it is concluded that the remedies for power loss included proper selection of transformers with respect to peak load of the service area, feeders length should be decreased &proper re-organization of distribution electrical network, by proper meter placed on the receiving end transformer for losses checking, by using shunt capacitor in appropriate places either on the transmitting end at feeder terminal or at the receiving end of the consumers service mains. Distribution companies (DISCO'S) should take interest in initial investment for future savings. Current distribution system should be replaced by high voltage direct current (HVDC) system at emergency condition. For improvement in operating system workers should be properly and regular based skilled.

REFERENCE:

Barker, P., R. W. Philip and de Mello, (2000). Determining the impact of distributed generation on power systems. Radial distribution systems. In Power Engineering Society Summer Meeting, 2000. IEEE, Vol. 3, 1645-1656

Balda, J. C., (1997) "Measurements of neutral currents and voltages on a distribution feeder." Power Delivery, IEEE Transactions, Vol. 4, 1799-1804.

Chembe, D. K. (2009) "Reduction of Power Losses Using Phase Load Balancing Method in Power Networks," in Proceedings of the World Congress on Engineering and Computer Science, San Francisco, USA, 492-497.

Chung-Fu, C. (2008)"Reconfiguration and Capacitor Placement for Loss Reduction of Distribution Systems by Ant Colony Search Algorithm," Power Systems, IEEE Transactions on12, vol. 23, 1747-1755.

Dong, Z., F. Zhengcai, and Z. Liuchun, (2008) "Joint Optimization for Power Loss Reduction in Distribution Systems," Power Systems, IEEE Transactions on, vol. 23, 161-169.

Final Project Report, (2004) "Power System State Estimation and Optimal Measurement Placement for Distribution Multi-Utility Operation", Power Systems Engineering Research Centre, A National Science Foundation Industry.

Jong-Young, P., S. Jin-Man, and P. Jong-Keon, (2009) "Optimal Capacitor Allocation in a Distribution System Considering Operation Costs," Power Systems, IEEE Transactions on 24, vol. 24, 462-468.

Khalil, H. B. and S. J. H. Zaidi. (2014) "Energy crisis and potential of solar energy in Pakistan." Renewable and Sustainable Energy Reviews Vol. 31, 194-201.

Khan A.R and A. Qayyum. (2009) "The demand for electricity in Pakistan." Energy& Environment, Vol. 4, 701-710

Moradi, M.H. (2014) "An efficient hybrid method for solving the optimal sitting and sizing problem of DG and shunt capacitor banks simultaneously based on imperialist competitive algorithm and genetic algorithm." International Journal of Electrical Power & Energy Systems, Vol. 54, pp 101-111.

Murthy, K.V.S., R. Chandra, and M. R. Raju. (2007) "Electrical energy loss in rural distribution feeders-a case study." Vol. no 4, 33-37

Sivanagaraju, S., N. Sreenivasulu, M. Vijayakumar, and T. Ramana, (2002) "Optimal conductor selection for radial distribution, Systems," Electric Power Systems Research, vol. 63, 95-103.

Wan, J., K..N. Miu, (2003). Weighted least squares methods load estimation in distribution networks. Power Systems, IEEE Transactions, 1338-1345.