RESEARCH ARTICLE OPEN ACCESS

Monetary Savings In Electricity Bill By Reviewing Transformer Design And Contract Demand For Prem Nagar (Railway) Colony In Jabalpur.

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ABSTRACT-In this paper existing electrical distribution network of Prem Nagar Railway colony in Jabalpur with specific reference to Transformer losses and Contract Demand has been studied.It includes proposal of revision in transformer capacity to minimize technical losses. This work undertakes techno-commercial study and proposes additions/ alterations/modifications for loss reduction/improvement in capacity of existing Distribution Transformers.The cost of proposed works has been compared with the cost of losses for establising commercial viability of alterations/additions for adoption.The work also includes optimization of Contract Demand which reduces the billing outlay for existing as well as restructured/suggested system installation.
Keywords – kVA rating, Contract Demand, Billing Demand, Maximum Demand, Discom tariff, Transformer losses.

Date Of Submission:03-09-2018 Date Of Acceptance: 18-09-2018

I. INTRODUCTION

The work includes study and analysis of existing Electrical Installation of Prem Nagar Railway Colony in Jabalpur [8] [11] to find out the losses [9] in transformers and converted them in monetary terms with reference to present electricity tariff of Discom MPEZ. Bureau of Energy Efficiency has set the benchmark for losses [4] in Distribution Transformers under Star Rating programme. Replacement of present transformer installation with BEE 5 star rated transformer as been suggested [11] with technical [10] and commercial viability of options with meeting Railway standard [6].

An effort also has been made to optimize the billing outlay by analyzing billing [7] pattern of the colony and suggesting the optimized Contract Demand with Discom in existing as well as modified system.

II. POWER DISTRIBUTION IN PREM NAGAR COLONY.

For this colony distribution system, the incoming supply is through 11 kV single circuit feeder from 33 kV Amanpur substation of MPEB, one transformer having 250 kVA capacity is installed in Prem Nagar Colony substation.

Prem Nagar colony substation is located close to load and power distribution network is of approximately 100 metre distance only. Power is distributed in colony by overhead 5 wire steel pole system and from pole to quarter service mains cables are used.

Fig - 1 Transformer in Prem Nagar Colony Substation.

Table – 1 Billing details of Prem Nagar Colony Substation for the period of Apr 2017 to Mar 2018.

Month	Billing demand in kVA	MD in kVA	Gross bill amount in □	Units kWH	Load Factor in %	PF
Apr 17	54	29	52458	5387	12	0.96
May 17	54	30	61496	6503	15	0.95
June 17	54	31	62204	6160	15	0.93
July 17	54	29	55920	5247	12	0.92
Aug 17	54	31	55012	5072	12	0.93
Sep 17	54	31	49658	4830	11	0.94
Oct 17	54	28	40005	3400	11	0.93
Nov 17	54	27	39607	3357	8	0.91
Dec 17	54	31	40343	3463	8	0.9
Jan 18	54	29	37183	3587	8	0.91
Feb 18	54	31	41895	3763	9	0.9
Mar 18	54	26	40130	3493	9	0.92

Based on the meter recording during the year 2017-18, the month wise co-relation of CD, MD and Billing Demand in graphical form is as under-

Fig - 2 Graph of Contract Demand, Maximum Demand and Billing Demand of Prem Nagar Colony Substation for the period April 2017 to Mar 2018

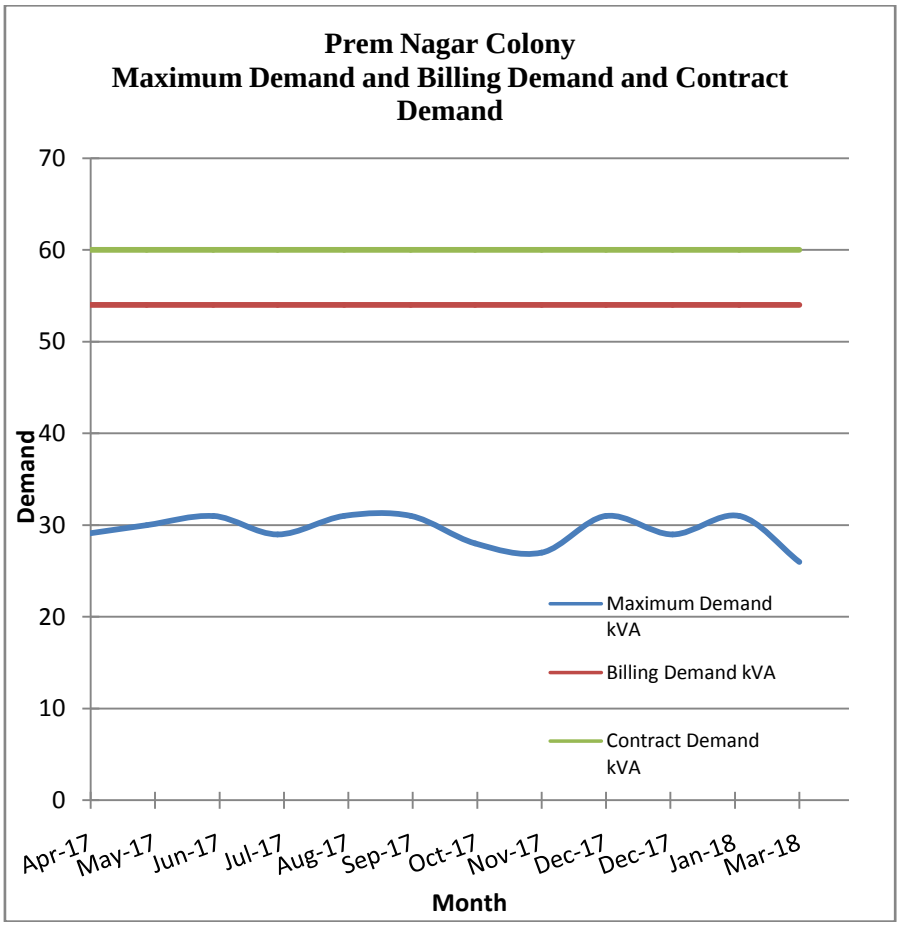

Table – 2 Summary of Prem Nagar Colony Substation for the period of Apr 2017 to Mar 2018.

Contract Demand in kVA	Transformer Installed Capacity In kVA	Highest Recorded Maximum Demand in a Year in kVA	Range of Load Factor in a year min-max %
60	250	31	9-15

On analysis of above data, certain areas wherein financial/energy savings are possible, have been investigated and are discussed hereunder

III. PROPOSEDRESTRUCTURING/RECOMMENDATIONS FOR PREMNAGAR COLONY.

Reduction of Transformer Capacity. Analysis of data reveals that the highest Maximum Demand recorded is 31 kVA. In view of above it is recommended to replace the existing 250 kVA transformer by 100 kVA transformer of standard rating.If Prem Nagar colony substation transformer is replaced with 5 star rated 100 kVA transformer then savings arise will be as under –

No Load Losses of existing 250 kVA transformer

= 620 watt [1]

No Load Losses of 5 star rated 100 kVA transformer = 46 watt*

(*as per Para- V)

Savings in No load losses = 574 watt

Hence energy saving in a year would be

574 watt x 8760/1000 = 5028.24 kWH

Considering the electrical energy unit charges as per tariff category HV 6.1 for 11 kV applicable for Railways [5], the savings would be

Unit cost 5028.24 x 5.85 = 29415.20

+Electricity Duty 5028.24 x 15% = 754.24

Total Saving in a year would be 30169.44

For evaluation of commercial feasibility, the price of 11 kV 100 kVA star rated transformer as indicated by Bangalore Electricity Supply Co. Published in their office memorandum no. "GM(Q, S&S)/BC-11/DGM-4/AGM-5/17-18/CYS-175 dt-26.10.2017" [2] have been taken as basis.

Cost of 5 star rated 100 kVA transformer is = □ 1,92,160/-

Simple Payback period is = 1,92,160 / 30,169.44 = 6.37 Year or say 6 year 5 months.

The above Simple Payback period over 6 years is in fact on higher side and is not realistic on account of following –

(1). The cost of 5 star rated Transformers has been considered whereas the cost of existing Transformers has not been discounted.

(2). Existing Transformer is of capacity 250 kVA and the present day cost of 250 kVA, 11 kV Transformer non star rated (conventional) as obtained from BESCOM (Bangalore Electricity Supply Company Limited) Common Schedule of Rate (w.e.f. 01.07.2017) [3] is □ 2,09,434/-. The difference in the cost of Transformer works out to (depreciated cost @50% of this cost can be considered) –

□ 1,92,160 - □ 1,04,717 (50% of □ 2,09,434/-) = □ 87,443/-.

With this consideration the payback period works out to 2 years and 11 months only.

Reduction of CD to 27 kVA.

As per applicable tariff of MPSEB [5] the MD charges are applicable for any recorded MD between 90% to 115% of CD. If the recorded MD is less than 90% of CD then the Billing Demand will be 90% of CD and if the recorded MD exceeds 115% of CD then penalty is levied by additional 30% of Demand Rate.

As such in case we so decide to reduce the CD to 27 kVA then normal demand charges @ Rs 290/kVA will be levied for any recorded demand between 24.3 kVA say 25 kVA (90% of CD) and between 31.05 kVA say 31 kVA(115% of CD). As per records of recorded MD, this reduction to 27 kVA suits the best.

Detailed calculations are indicated in the table below.From tariff - Billing Demand BD is 90% of Contract Demand CD or Maximum Demand Recorded whichever is higher.

Table – 3 Savings arisen after CD reduction for Prem Nagar Colony Substation for the period of Apr 2017 to Mar 2018.

Existing with CD 60 kVA, BD is minimum 54 kVA				After Modification (with CD 27 kVA, BD would be minimum 24 kVA)
Sl. No.	Month	MD in kVA	Monthly Fixed cost charges	Monthly Fixed cost charges
A	B	C	D = □ 290 x BD or MD whichever is higher	E = □ 290 x BD or MD whichever is higher
1	Apr 17	29	15660	8410
2	May 17	30	15660	8700
3	June 17	31	15660	8990
4	July 17	29	15660	8410
5	Aug 17	31	15660	8990
6	Sep 17	31	15660	8990
7	Oct 17	28	15660	8120
8	Nov 17	27	15660	7830
9	Dec 17	31	15660	8990
10	Jan 18	29	15660	8410
11	Feb 18	31	15660	8990
12	Mar 18	26	15660	7540
Total			□ 1,87,920	□ 1,0,2370

By reducing CD alone a net saving of - (From fixed charges) □ 1,87,920/-
(-) □ 1,02,370/-

Total □ 85,550/-
can be achieved per year.
If savings from transformer size reduction is also added total saving would be □ 85,550 + □ 30,169.44 = □ 1,15,719.44 per year and payback period becomes less than one year which is extremely attractive.

Replacement of overhead power distribution system with Aerial Bunched Cables.

Aerial bunched cables are now gaining popularity in distribution system and Railway is keen in replacing overheard 5 wire system with AB cables. However immediate replacement of present overhead distribution system with Aerial Bunched cables will not bring any major benefit due to the fact that, this being colony of government employees losses are not expected and due to very short length of supply wire the reduction in technical losses is not expected to be substantial.

IV. CALCULATION OF NO LOAD LOSSES OF 5 STAR RATED DISTRIBUTION TRANSFORMER

Bureau of Energy Efficiency, vide letter dt-19 December, 2016 with subject 'Important Instructions to all Distribution Transformer manufacturers and permittee' circulated the amendment notification, S.O. No. 4062 (E) for Distribution Transformer dated 16th December, 2016. Amendments in the star rating programs as follows [4]:Standard Losses in watts up to 11 KV Class for 5 star is as under –

Table- 4 - Scheduled Losses in 100 kVA BEE 5 star rated Transformers.

Sl. No.	Rating in kVA	Total losses on 50 % Loading	Total losses on 100% Loading
1	100	317	1130

From above table No Load Losses may be calculated as under-
Let No Load Losses be NLL and Full Load Losses be FLL
For 100 kVA Distribution Transformer –
Losses at 50% load =

$$NLL + (1/2)^2 FLL = 317$$
$$NLL + ¼ FLL = 317$$
$$4 NLL + FLL = 4 \times 317$$
$$4 NLL + FLL = 1268 \text{ -------- eq 1}$$

Losses at 100% load = 1130 ---------- eq 2

By subtracting eq 2 from eq 1
3 NLL = 138
Hence NLL = 138 / 3 = 46 watt

V. CONCLUSION :

In order to reduce the transformer losses BEE 5 star rated transformers should be used in lieu of present transformers not only because this will reduce the billing outlay but also as it saves environment by reducing Carbon emissions from fossil fuel consumption for electricity generation. The analysis reveals that this is also commercially viable looking to the present day electricity tariff.

Savings in Railway revenue in terms of billing outlay may also be achieved by optimizing Contract Demand both in present as well as restructured/suggested electrical distribution system which in turn reduce the fixed charges and lead to revenue savings by reduced tariff charges per unit of consumption. Such proposals do not involve any financial commitment but needs only a careful study of load pattern and just making correspondence with the utility for adjustment in contract demand. This is practically an effortless gain.

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Sandeep Kumar Yadav "Monetary Savings In Electricity Bill By Reviewing Transformer Design And Contract Demand For Prem Nagar (Railway) Colony In Jabalpur. 'International Journal of Engineering Research and Applications (IJERA) , vol. 8, no.9, 2018, pp 29-33