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Industrial Energy Consumption Cost Analysis

Prakash NB[1], Hemalakshmi GR[2]

[1]*Associate Professor, EEE Department, National Engineering College, Kovilpatti, Tamilnadu, India*
[2]*Assistant Professor, CSE Department, National Engineering College, Kovilpatti, Tamilnadu, India*

***Abstract*— The main objective of this paper is to examine the industrial energy consumption and analyzing the power cost, which is the significant and prime factor for running an industry. This work has been done taking into consideration of the renewable energy generation from windmills and the energy consumption from a spinning mills. The experimental results produced an overall outcome of the present scenario of the power cost and shows that the per unit energy cost optimization is very much essential in near future for industrial people to make a note in mind.**

***Keywords*— Energy consumption, windmills, spinning mill, per unit energy cost, optimization.**

I. INTRODUCTION

In today's world, the electricity we procure from the government is mandatory and there is no other connectivity to draw electricity from any other source rather than running our own diesel generators for power generation. Therefore, the TANGEDCO (Tamilnadu Generation and Distribution Company) based on the TNERC (Tamilnadu Electricity Regulatory Commission) rules and regulations fixes the tariff rates for the industrial and commercial consumers considering the factors like transmission charges, wheeling charges, etc. The TANGEDCO will revise the tariff rates once in a year or once in two years with the approval of TNERC as the generation cost increases due to the increase in the raw materials and operation and maintenance of the substations. Presently the industrial consumers are mainly considered as the HT consumers and there may be different types of tariff available for consumers based on their factory unit. Let us not deeply discuss about the other tariff rates rather than only the HT industrial current consumption tariff – IA. The tariff rates for IA are given below.

- Industrial Consumption @ Rs.6.35 per unit
- Peak Hour Consumption @ Rs.1.27 per unit
- Night Hour Consumption Rebate @ 5% of Rs.63.5 per unit.
- Demand Charges @ Rs.350 per KVA
- E.Tax @ 5% on REC & RDC
  - REC- Realized Energy Charges
  - RDC- Recorded Demand Charges

The TANGEDCO also allows the industrial consumers to have their own power generators like windmills, solar plants, diesel generators, etc. for their consumption. However the consumer should enter into an agreement with TANGEDCO with respect to power purchase agreement (PPA) or energy wheeling agreement (EWA). The energy generated by the above generators may be directly adjusted with the consumption corresponding to the concern distribution circles. This kind of practice attract the industrial people to invest in the renewable energy and green energy power generators for own consumption which comes under the category of group captive power (GCP) scheme. Majority of the spinning mill owners and other industry owners enter into the renewable power energy generation and captive consumption scheme and get benefited as it reduces the per unit power cost and also becomes an assert for their industrial development. Keeping all this into consideration, the paper has been experimented in two different aspects.

- Energy consumption per unit cost analysis without any renewable energy generation (Windmill, Solar etc.)
- Energy consumption per unit cost analysis with renewable energy generation & adjustment under GCP.

The paper is organized as follows. Section.II reviews the literature survey towards energy cost analysis. Section.III describes the proposed methodology implemented. Section.IV illustrates the experimental results obtained. Section.V concludes with the inference and results.

II. LITERATURE SURVEY

Energy Management can be characterized as "the sensible and compelling utilization of vitality to amplify benefits and to improve aggressive positions through authoritative measures and streamlining of vitality productivity in the process" (Cape, 1997).

Benefits boost can be additionally accomplished with a cost decrease focusing on the vitality costs amid each gainful stage (by and large the three most vital operational expenses are those for materials, work and electrical and warm vitality) (Demirbas, 2001).

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In addition, the change of aggressiveness is not restricted to the lessening of sensible expenses, but rather can be accomplished additionally with a perfect administration of vitality costs which can build the adaptability and consistence to the progressions of market and global ecological controls (Barbiroli, 1996).

Energy Management is an all around organized process that is both specialized and administrative in nature. Utilizing procedures and standards from both fields, Energy Management screens, records, explores, breaks down, changes, and controls vitality utilizing frameworks inside the association. It ought to ensure that these frameworks are provided with all the vitality that they require as productively as could be allowed, at the time and in the shape they require and at the least conceivable cost (Petrecca, 1992).

Resource consumption is one of the largest factors affecting your profitability and competitiveness. Reducing energy cost and improving energy efficiency is easier rather than controlling the labor, maintenance cost. Intelligent metering, reduction in peak demand and maximizing power system use and assessing power system capacity will be helpful in energy management system. (courtesy. http://www.powerlogic.com/literature/3000BR1108% 20EE%20for%20Industry.pdf).

Simona Capobianchi et al. (2011) developed a flow model which helps the organization to establish efficient energy management system which can develop, understand, implement, identify and review the progress of consumption, monitoring and control system. The proposed model yields 10% of the energy savings and improves the efficacy of the system.

Harsh Harit et al. (2013) analyzed energy and cost analysis in pulp and paper industry and arrived that the 50% energy and cost can be saved when high efficiency 30HP pumps are used instead of 60HP pumps. They also analyzed the energy and cost analysis of pumps, washers and suggested that proper insulation will reduce heat loss in turn reduce energy consumption and power cost and the investment in insulation can be paid back within 5-6 months. The literature reviews that; still there is a room to work towards energy management system which reduces the power cost and maximize the profitless and efficiency.

III. Proposed Methodology

The industrial energy consumption and the windmill generation have been taken from a private spinning mill company associated with the Tuticorin Electricity Distribution Circle, Tuticorin.

The proposed methodology flow diagram is shown in Figure.1. The first step is the collection of data and then modifying the data according to the process of CC bills. Then consider the wind energy generator energy units and tabulate it. Then with the help of the consumption and generator units CC bill calculation will be made for both with and without consideration of the captive power generation.

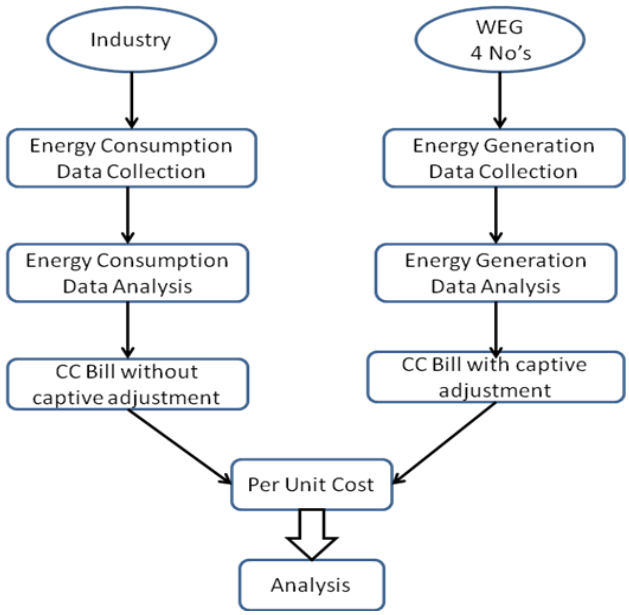

Figure.1 Proposed flow model of audit work

The month wise wind energy generation and industrial energy consumption are shown in Table 1 and 2 given below.

TABLE I
WIND ENERGY GENERATION UNITS FOR THE YEAR 2016-2017

SL.NO	Month	WEG-1	WEG-2	WEG-3	WEG-4	Total
1	April'2016	18839	16275	21222	84540	140876
2	May	40158	29114	20808	187180	277260
3	June	35574	53399	131256	448100	668329
4	July	73868	108863	235764	765860	1184355
5	August	61999	105046	98226	669040	934311
6	September	73038	102932	306504	897680	1380154
7	October	63557	96167	281268	676360	1117352
8	November	59069	57002	30312	235460	381843
9	December	46199	50785	17928	13820	128732
10	January'2017	67680	60954	61614	50020	240268
11	February	106444	103912	44172	82680	337208
12	March	103117	95268	63288	118580	380253
	Total	749542	879717	1312362	4229320	7170941

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TABLE II
ENERGY CONSUMPTION AND WIND ENERGY UNIT ADJUSTED DETAILS

S.No	Month	Consumption	LT Units	Demand	WEG Units
1	April'2016	1835500	6220	2835	133416
2	May	1697005	5915	2835	256442
3	June	1762622	5978	2835	286622
4	July	1737654	5946	2835	297654
5	August	1831342	5698	2835	343342
6	September	1834119	5641	2835	374119
7	October	1702897	5463	2835	284397
8	November	1412066	4094	2835	116066
9	December	1720272	4768	2835	1720272
10	January'2017	1473076	4004	2835	849076
11	February	1861244	4996	2835	1329353
12	March	1625429	5091	2835	354487

IV. EXPERIMENTAL RESULTS

The industrial current consumption charges have been calculated based on the tariff fixed by the TNERC and the TANGEDCO rules and regulations. Presently the per unit cost has been arrived based on the tariff rates mentioned in the introduction section. The Table.3 depicts the per unit cost arrived for the financial year 2016-2017. The table clearly indicates that the per unit cost varied from minimum range of Rs. 7.45 to a maximum range of Rs.7.62. From the table we can conclude that the per unit cost for energy will get reduced with respect to the industrial energy consumption. Higher the consumption lower the per unit cost and vice versa.

TABLE III
PER UNIT COST FOR ENERGY WITHOUT INCLUDING WIND ENERGY UNITS

Month	Ind.Cons	Pk Unit	Night Unit	Dmd	LT Unit	E.Tax	Total	Per Unit
	6.35	1.27	0.319	350	8.05	5%	Amount	Cost
April'2016	11655425	580949	-173217	992250	50071	662902	13770380.04	7.45
May	10776236	554025	-163021.8	992250	47615.8	617474	12826578.36	7.51
June	11192650	562559	-169452.8	992250	48122.9	637487	13265615.59	7.48
July	11034103	547827	-165025.1	992250	47865.3	628670	13087690.09	7.48
August	11629022	583997	-175896.6	992250	45868.9	660964	13738205.17	7.46
September	11646662	582981	-175539.3	992250	45402	662052	13755807.72	7.45
October	10813396	539090	-163060	992250	43977.2	617703	12845355.80	7.50
November	8963393	429717	-123376.4	992250	37046.1	520228	10821257.99	7.62
December	10923727	544474	-225175.7	992250	38382.4	624189	12899847.48	7.46
January'2017	9354033	439369	-127970	992250	32232.2	539862	11231775.66	7.58
February	11818899	595884	-177963.7	992250	40217.8	671190	13942477.54	7.45
March	10321481	514147	-154421.5	992250	40652.5	591414	12307522.27	7.53

The graph in Figure.2 shows the pictorial representation of the study made for the industrial energy consumption per unit cost analysis. It also indicates that cost increased to Rs. 7.62 during the month of November 2016 with consumption of 8963393 units. Similarly, considering the wind energy generation units the CC bill calculation without including any charges like system operating charges, wheeling charges, transmission charges and operating charges in the calculation, the per unit has been arrived as shown in the Table.4. The graph in Figure.2 represents the pictorial representation of the study made for the industrial energy consumption including the WEG units and per unit cost has been analyzed.

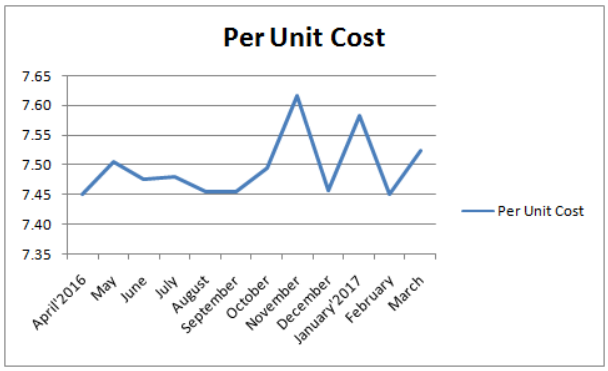

Figure.2 Per unit cost analysis without WEG units

TABLE IV
PER UNIT COST FOR ENERGY INCLUDING WIND ENERGY UNITS

Month	Ind.Cons	Pk Unit	Night Unit	Dmd	LT Unit	E.Tax	Total	Per Unit
	6.35	1.27	0.319	350	8.05	5%	Amount	Cost
April'2016	10834642	526006	159805.5	992250	50071	679386	13244160.37	7.17
May	9121130	452565	133922.4	992250	47615.8	584578	11334061.27	6.63
June	7180902	358802	120612.2	992250	48122.9	484006	9186695.76	5.18
July	3886142	182306	77450.76	992250	47865.3	309871	5497884.09	3.14
August	5992371	294328	111291	992250	45868.9	416343	7854451.81	4.26
September	3323241	187452	73786.6	992250	45402	276505	4900636.19	2.66
October	4068605	218832	75232.48	992250	43977.2	312173	5713069.33	3.33
November	6651763	317194	88217.24	992250	37046.1	430835	8519305.14	6.00
December	10141729	497731	216068.4	992250	38382.4	617332	12505493.26	7.23
January'2017	7904490	356532	112198.1	992250	32232.2	484733	9884435.03	6.67
February	9747877	493018	153837	992250	40217.8	601486	12030685.62	6.43
March	8033415	391102	130558.2	992250	40652.5	511633	10101610.97	6.18

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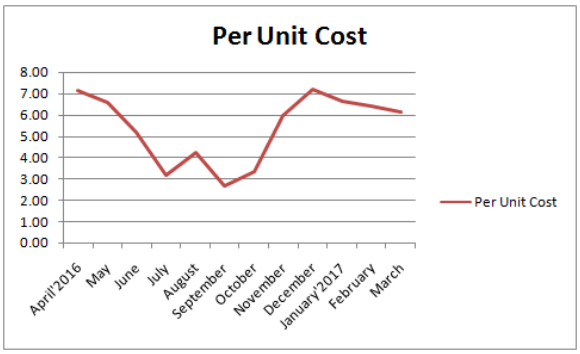

Figure.3 Per unit cost analysis with WEG units

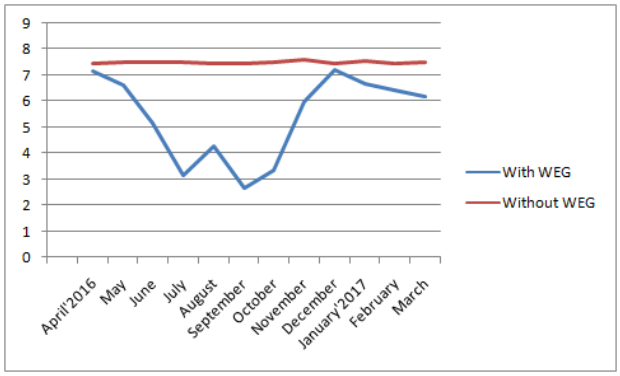

Figure.4 Per unit cost comparison with and without WEG units

V. CONCLUSION

In this section, the industrial current consumption energy charges has been analyzed based on two different category; one considering the wind energy units into account and other category is non-consideration of wind energy units. From the experimental results comparison shown in Figure.4, it has been clearly visualized that the per unit cost has been drastically reduced comparing with the pure consumption without WEG units cost.

Therefore, it is appreciated that the industrial owners having wind mills will be highly benefited compared to the non-windmill owners. This will also encourage the HT consumers to promote renewable energy generation further which in turn reduces the cost and gives good return on interest within a period of twenty years.

Conflict Of Interest

The authors declare that they have no conflict of interest.

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