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ENERGY AUDIT: A POTENTIAL TO REDUCE LIGHTING COST IN AN INDUSTRY

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***Abstract* — ENERGY-The most vital element of any industry, has greatest importance as the operating expense. Energy is the only element which has the highest potential cost savings then the Labor and Material. Lighting is an essential service in all the industries which provides a major scope to achieve energy efficiency by incorporation of modern efficient lamps for the best operational practices. Identification of areas of energy wastage is done and cost effective recommended actions are given. Thus the translation of conservational ideas into realities by evolving technically feasible solution with economical considerations has been conducted. Thus the paper represents the industrial lighting load management.**

Keywords- Energy Audit, Lighting Audit, Lighting-Energy Management, Financial Analysis, Energy Conservation

I. INTRODUCTION

"Energy can neither be created nor be destroyed it can be just transformed from one form to another. The total energy in the universe is constant." This law of energy conservation is very important in the terms of economic savings of an industry. This is because the material and the labour cost of any industry remains to a very nearly constant value, but the cost effective measures can only be taken in the field of energy. In this era of 21st century, it has become very important to conserve the energy due to the drastic increase in the energy demands. Not only the demand increases but also it directly affects the operating cost. Thus it becomes necessary to perform energy audit by implementing the energy management techniques which results in the energy conservation.

Implementing energy audit determines the use of energy or consumption and identification methods for energy savings. The emerging technologies in the field of energy audit provide such technically improved instruments which are used for monitoring and measurement of energy in various fields. This gives the detailed analysis and makes the inspection of the performance of the operation or the machine**.**

II. ENERGY AUDIT

Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Industrial energy audit is an effective tool in defining and pursuing comprehensive energy management programme. [1]

To conduct an energy audit it generally includes:

- Material Balance
- Energy Balance
- Energy monitoring and targeting
- Financial Analysis & management

The energy audit focuses upon the objectives such as:

- Relating energy inputs & product outputs
- Highlighting wastages in major areas
- Implementation of energy conservation
- Realisation of savings
- Waste minimisation & recovery
- Resource conservation

Thus it is very necessary for any organisation or industry to follow up the energy audit in order to suppress the increase cost in the demand of energy.

Types of Energy Audits

The energy audit orientation would provide positive results in reduction energy billing for which suitable preventive and cost effective maintenance and quality control programmes are essential leading to enhanced production and economic utility activities. The type of energy audit to be performed depends upon the function or type of industry. There can be two types of energy audit.

- Preliminary audit (walk-through audit)

- Detailed audit (diagnostic audit). [2]

(a) Preliminary audit (Walk-through audit)

In a preliminary energy audit, readily-available data are mostly used for a simple analysis of energy use and performance of the plant. This type of audit does not require a lot of measurement and data collection. These audits take a relatively short time and the results are more general, providing common opportunities for energy efficiency. The economic analysis is typically limited to calculation of the simple payback period, or the time required paying back the initial capital investment through realized energy savings. [2]

(b) Detailed audit (Diagnostic audit)

For detailed (or diagnostic) energy audits, more detailed data and information are required. Measurements and a data inventory are usually conducted and different energy systems (pump, fan, compressed air, steam, process heating, etc.) are assessed in detail. Hence, the time required for this type of audit is longer than that of preliminary audits. The results of these audits are more comprehensive and useful since they give a more accurate picture of the energy performance of the plant and more specific recommendation for improvements. The economic analysis conducted for the efficiency measures recommended typically go beyond 3 the simple payback period and usually include the calculation of an internal rate of return (IRR), net present value (NPV), and often also life cycle cost (LCC).[2]

III. LIGHTING

Lighting is the most visible form of energy consumption. It accounts for 17 % of total energy consumed in India. In commercial and industrial buildings as much as 30 % of the electricity bill is due to lighting. Because of advances in lighting technologies, a number of energy efficient lighting products are now available along with better understanding of the lighting needs. Since the country's energy generation is not able to match the demand, conservation of energy appears to be the only solution to reduce this gap. [3]

Lighting doesn't account to great percentage of total industrial usage in audits, yet lighting comprises a huge energy usage and cost. Lighting inventory should be prepared during audit. Make, specifications, duration of usage are important in preparing audit report. Lights generally left switched on results in energy loss. Now with the use of energy management systems, timers, occupancy sensors are useful in turning off lights when not required. A facilities lighting arrangement are the areas to look out for. Energy saving techniques and to adhere to a better luminance re-orientation can also be proposed.[4]

It becomes very important for any industry to save energy and highlight the major areas of wastage of energy and implement the proper action plan thus by relating input to the output. Lighting provides a very simple and quite easy way to save energy by performing the audit. Moreover this visual audit provides the energy save to the extent of 15-20% of power consumption in a lighting part or the system.

IV. CASE STUDY : LIGHTING AUDIT PERFORMANCE IN AN INDUSTRY

All lighting critical parameters including input voltage, power factor, illumination etc. were included during the energy audit.

- It is suggested to replace the conventional magnetic ballast by more energy efficient ballast, with due consideration of life and power factor apart from watt loss.
- High Pressure Mercury Vapour (HPMV) lamps can be replaced with efficient High Pressure Sodium Vapour (HPSV) lamps.
- It is recommended to use maximum natural light wherever possible in various areas. All the fixtures should be cleaned periodically to get sufficient illumination. The height of all fixtures can be adjusted wherever possible at adequate levels.

SR NO.	TYPES OF LIGHT
1	MLL-160 WATT
2	CFL- 23/20 WATT
3	PL- 9 WATT
4	STREET LIGHT METAL HALIDE LAMP- 250 WATT
5	HELOZEN LAMP
6	SODIUM VAPOUR LAMP (HPSV)
7	HPMV
8	MERCURY HELIDE LAMP
9	T/L- 26 WATT

Table 1: The lighting fixtures details

PLANT NAME	GROUND FLOOR	FIRST FLOOR	SECOND FLOOR	THIRD FLOOR	FOURTH FLOOR	FIFTH FLOOR	TOTAL	PL FITTINGS
MCP	58	47	35	35	7	0	150	18
TMP	19	7	7	6	7	0	46	3
MECL	9	3	5	3	4	0	24	
PCL3	35	6	0	0	0	0	41	
AMMONIA	19	18	16	0	0	19	72	16
MNZ LIQUID	34	22	22	16	0	0	94	
MNZ SOLID	38	20	20	14	19	12	113	
ANTRACOL	24	17	14	19	0	0	84	
SF10	13	7	3	0	0	0	23	
MONO AQUOUS	5	6	6	0	0	0	17	
TOTAL	**120**	**200**					**664**	**38**

Table 2: Details of lighting installation in plant

1. STEET LIGHT- MLL-160 WATT
   CFL-23/20WATT
   PL-9WATT
2. PLANT LIGHT- 2*23 WATT CFL & 160 MLL FITTINGS

SR NO	LOCATION	FITTINGS	INSTALLED LOAD(WATT)	WORKING LOAD(WATT)	LUX MEASUREMENTS L1	L2	L3
1	SUBSTATION	HPMV	250	250	35	45	37
2	ANTRACOL COMPRESSOR ROOM	6 CFL	138	115	80	90	70
3	SECOND FLOOR ANTRACOL	1 HPSV 13 CFL	618	348	25	22	13
4	MNZ SOLID GROUND FLOOR	1 HPMV 32 PL/CFL	890	600	40	32	35
5	MNZ LIQUID UTILITY	5 TL 2 PL 1 HPSV	383	320	40	60	69
6	TMP UTILITY	1 HPSV 9 PL	331	313	35	3645	
7	MCP UTILITY	16 TL	416	338	80	90	88
8	MONO AQUOUS GROUND FLOOR	1 HPSV 8 PL	322	268	20	24	30
9	AMMONIA	2 HPSV 2 HPMV	1324	734	35	30	35
10	SF10	8PL 6CFL	152	114	25	29	30
11	MECL GROUND FLOOR	1 HPSV 10PL/6CFL	460	344	22	30	27

Table 3: Details of lux level measurements

Details of light load:
Approximately 150 metal halide lamps are installed in overall plant.

V. RESULTS AND DISCUSSION

LOCATION	VOLT	AMP	KW	P.F.	KVA
STREET LIGHT MAIN DISTRIBUTION PANEL	419	28.8	17.1	0.92	18.5
TMP PLANT PANEL	422	25.7	17.2	0.93	18.5

Table 4: The overall measured lighting load at distribution panel at night time

Suggestion:

- It is suggested to install servo stabilizer/voltage transformer for the above lighting location feeders. This will provide stabilised voltage for the lighting equipment. By reducing voltage from 420V to 390V, illumination level shall not be affected. Lux level shall also remain same.
- The performance of gears such as chokes, ballasts will also improve due to the stabilised voltage.

Savings Anticipated:

- **For TMP Plant Panel:**

Here, $KW = \sqrt{3}VI\cos\emptyset = 17$

I=25.7 Amp

$V = IR$

$R = \frac{V}{I}$

= 422/25.7

= 16.42Ω

If voltage is reduced to 390V by servo stabilizer, then

KW= 1.72*0.390*23.75*0.93

=14.81kw

(Here, R= 16.42 and I= 390/16.42 =23.75)

Hence savings will be = 17.2kw-14.81kw

=2.39kw

Annual savings will be (in KWh) = 2.39kw*11hrs*365days

= 9595 KWh

- **For Street Light Panel:**

Here, $KW = \sqrt{3}VI\cos\emptyset = 17.1$

I=27.8 A

$V = IR$

$R = \frac{V}{I}$

= 419/27.8

= 15.07Ω

If voltage is reduced to 390V by servo stabilizer, then

KW= 1.72*0.390*25.87*0.92

=15.96kw

(Here, R= 15.07 and I= 390/15.07=25.87)

Hence savings will be = 17.1kw-15.96kw

=1.14kw

Annual savings will be (in KWh) = 1.14kw*11hrs*365days

= 4577 KWh

TOTAL ANNUAL SAVINGS WILL BE:

(In KWh) = 9595+4577 = 19066 KWh

(In Rs) = 14172KWh* Rs 7.2/unit

= Rs. 1.020 Lacs/- per year

INVESTMENT:

Cost of 2*25 KVA servo stabilizers Rs. 50000*2= Rs. 1Lacs/-

PAYBACK PERIOD:

It shall be 12 months.

Install servo stabilizer/voltage transformer at identified main lighting panels to save energy			
Savings		**Investment**	**Payback period**
KWh	In Rs.	Rs.	Months
19066	1.02 Lacs	100000	12

Table 5: Energy conservation proposal

ENERGY CONSERVATION TIPS:

- Reduction of excessive illumination levels to standard levels using switching decamping**.**
- Select ballasts and lamps carefully with high power factor and long term efficiency in mind.
- Consider delighting, skylights, etc
- Consider painting the walls with a lighter colour and using lighting fixtures.
- Usage of LEDs from the incandescent lights.

ENERGY SAVING TIPS TO REDUCE BUISNESS ENERGY COSTS: [5]

- Establish energy efficient technologies.
- Get energy audit done.
- Replace existing bulbs with LEDs.
- Switch off equipment's when not in use

- Minimize use of artificial lighting
- Usage of energy saving feature

CONCLUSION

A great thought says that the net energy saved is the energy generated. It is such that if some amount of energy is saved it will be directly is used in other purpose so that it is termed as the energy generated. The lighting does not accounts a major part in the usage of energy but then also a huge amount of energy can be saved through by performing the audit. The paper described about reduction of lighting cost of an industry after the survey done. Moreover the payback period and recommendation is provided for ensuring the conservation of energy and the action plan. This will surely make power saving about approximately 15-17% of the energy consumption in lighting. The data provided in the paper also shows how we can save the electrical energy by just incorporating some installations and making the operation/machine energy efficient. Some conservation tips are also provided which are in general to be incorporated to save the energy.

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