Research Article Impact Factor: 4.226 ISSN: 2319-507X
Suraj Ambulkar, IJPRET, 2016; Volume 4 (9): 365-377 IJPRET

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

A PATH FOR HORIZING YOUR INNOVATIVE WORK

PERFORMANCE ANALYSIS OF ENERGY AUDIT TERMS OF LIGHTNING AND PUMP SYSTEM IN HOSPITAL

SURAJ AMBULKAR, RITVIK RANADE, HEMANT VILAYATKAR, NANDKISHOR HADKE

BE Final year Electrical (DMIETR), Wardha, India

Accepted Date: 15/03/2016; Published Date: 01/05/2016

Abstract: In this paper, we have included the brief study of present assessment of lighting & pump in AVBR hospital, Wardha, By carrying out a detailed energy audit for lighting and pump load in AVBRH premises with its systematic methodology specified as per Bureau of Energy efficiency (BEE) and it is being suggested that efficient lighting and Pump should be installed in hospital campus and within the premises to reduce overall extreme energy consumption. On the other hand proper mounting of lights & uniform luminous flux distribution in each room of hospital has also suggested. Along with these efficient pump characteristics studied and proper recommendation given so as to improve the performance of the pump in the hospital. Thereby our objective is to achieve energy conservation through replacing & arranging earlier lighting system & pump system by new efficient one.

Keywords— Extreme Energy Consumption, Bureau of Energy Efficiency (BEE), Energy Audit, Efficient Lighting, Efficient pump characteristics, Energy Conservation

PAPER-QR CODE

Corresponding Author: MR. SURAJ AMBULKAR

Access Online On:

www.ijpret.com

How to Cite This Article:

Suraj Ambulkar, IJPRET, 2016; Volume 4 (9): 365-377

INTRODUCTION

In India, Electrical energy consumption is more in private hospitals as compared to government hospital .So it is essential to find out those reasons which are responsible for high energy consumption. So here we have carried out study of energy consumption & conservation in hospital lighting & pump load on the basis of practical implementation of energy audit in **"Acharya Vinoba Bhave Rural Hospital Sawangi (Meghe)"**, wardha district of Maharashtra state (India).Pumping & Lighting is an important loading on power system, but mostly we have seen in lighting that energy consumption is not used efficiently as lumen / watt consumption is more. & luminous efficacy is less in terms of wattage. Even though fixture of CFL lighting was good solution earlier but nowadays LED lighting is being adopted by most of commercial institutions and therefore we have suggested replacement of earlier lighting with an energy efficient lighting, to achieve energy conservation by using lighting system efficiently. Whereas in case of pump energy audit, pump efficiency was calculated by collecting data, in this efficiency found very low with respect to head along with the flow capacity in liter/minute and thus concluded that due to selection of improper rating i.e. either overrating or underrating of pump, the pump efficiency get lowered and pump should always operate at its full rated capacity so that the maximum output can be obtained and ultimately the efficiency of the pump will increase. Whole procedure used for carrying out energy audit of hospital lighting loads & pumping loads, with its calculation, data observations, solution & suggestions has been given below .whole analysis & case study of this paper is carried out as per rules framed by BEE.

ENERGY CONSUMPTION PROFILE OF AVBRH

In AVBRH Lighting and pump contributes about 32% (20% lighting + 12% Pump Load) of the total energy consumed in the hospitals. Lighting load includes tube lights, lamps, bulbs, TV, computer, fans, and UPS inverter charging of dc batteries for mobiles &Laptops and pumping loads .on the other hand loads like HVACs, Cooking, Office equipments, Special equipments, Refrigeration contributes the rest 68% of the total energy consumed. Energy saving opportunities are identified based on the share of each sector contributes.

INSTRUMENTS USED FOR LIGHTING ENERGY AUDIT AND PUMP PERFORMANCE ANALYSIS

Digital Distance Meter:-It is the meter used for measuring the various dimensions of the room is to be audited. Then user can take reading of various parameters like height, length, width for the calculation and analysis of lighting energy audit.

Lux Meter: - Light source emits the lights and it gives total illumination over given surface & it is measured in (luminous flux) Lux or meter –candle (1 Lux =1 lumen per square-meter).Lux meter measures the total Light energy emitted by light source in Lux with the help of light sensor instrument fitted inside the Lux meter. Reading of 3 to 5 places are taken to find out what is the average room Lux level.

Digital flow meter:-For the measurement of the flow of the water through the pipe, we use Digital Flow Meter.

Clamp meter: - For the total electric power consumption, we need to measure the voltage and current which we have measured with the help of the clamp meter.

PERFORMANCE ANALYSIS OF LIGHTING ENERGY AUDIT

Methodology

Our target is to find out the net electrical energy consumption from different lighting loads (tube lights, lamps, bulbs, TV, computer, fans, and UPS inverter) connected in each & every room of hospital, this is done by carrying out an energy audit, this energy audit is for finding out average Lux, ILER (Installed load efficacy ratio) &Lighting efficiency of overall room.

For example, suppose auditor has to do energy audit of a single room, then his aim should be as per information given below;

To calculate average Lux: - To know Room Lux Level (readings of 3 or 5 places) (Lux level readings can be taken by Lux meter). And then he will calculate average Lux by taking average of no of readings taken.

To calculate Room Index:-To know overall size of room by taking length, width & height (length, width & height can be taken by digital distance meter)\

To calculate ILER (Installed load efficacy ratio):- therefore to find out actual Lux/W/m2 & to find out Target Lux /W/m2depends upon Light Power per square meter and Light Power per square meter is depends upon Average wattage reading of room.

To decide lighting efficiency of the room

Points To Remember Before Calculations:-

Volume of room means L×W×H (cubic feet)=>L×W×H×〖0.308〗^3 cubicmtr

Area of room means L×W (square feet) =>L×W× 〖0.308〗^2 Squremtr

Average Lux level=((averageof 3 to 5 readingofLux))/noofredings

Average wattage reading of room: its average of wattage ratings of all individual loads connected in room

Room Index (Room index is the ratio of room plan area to half the wall area between working and luminaire planes)

$$RI=\frac{L\times W}{H_m\times(L+W)}$$

*Where L=Length of room, W=width of room

*Hm= mounting height i.e. the vertical distance between the working plane and the luminaire.

- **Light Power per square meter**= $\frac{\text{averagewattagereadingofroom}}{\text{areaofroommetre}^2}$
- **Lux per wattage per square meter**=$\frac{\text{AverageLuxlevel}\times\text{averagewattagereadingofroom}}{\text{areaofroommetre}^2}$
- **Target Lux per wattage per square meter or CRI =** CRI (color rendering index) has to select from table as per value of RI (Room Index)
- **ILER(Installed load efficacy ratio)**$\text{ILER}=\frac{\text{actualLuxperWattpermetre}^2}{\text{targetLuxperWattpermetre}^2}$

A. Calculations

Step 1: measure floor area of the interior: $\text{Area} = \text{L}\times\text{W}\times .308^2\ \text{sq. mtr}$

Step 2: calculate the room index: $RI=\frac{L\times W}{H_m\times(L+W)}$

Step 3: determine the total circuit watts of the installation by a power meter if a separate feeder for lighting is available. If the actual value is not known a reasonable approximation can be obtained by totaling up the lamp wattages including the ballasts

Total circuit watts = ----------

Step 4:

Calculate watts per square meter $\text{Wattspermetre}^2 = \frac{\text{value of step 3}}{\text{value of step 1}}$

Step 5:

Ascertain the average maintained luminance by using Lux meter or Eav .maintained =------

Step6:

To calculate

$$\text{Luxperwattpermetresqure} = \frac{\text{step 5}}{\text{step 4}}$$

Step7:

ObtainedTargetLuxperwattpermetresqureor color rendering index for type of interior/ application and RI

Step 8:

$\text{CalculateILER} = \frac{\text{step 6}}{\text{step 7}}$

D. Avbrh Lighting Energy Analysis

Lux (Average)	XX	Very Low Lux levels. Need more lights
	XX	Lux levels are border line.
	XX	Good Lux levels. Adequate for working.

ILER (Installed load efficacy ratio)	XX	Very In-efficient lighting. Redeployment of Lights required
	XX	Lighting efficiency on borderline
	XX	Efficient Lighting deployment

Room	XX	Very Poor lighting efficiency
	XX	Poor lighting efficiency
	XX	Lighting efficiency can be improved by re-deployment
	XX	Good lighting efficiency

Demo of Room Lighting Parameter Calculation Table 1.1

	Size L (Feet)	Size W (Feet)	Size H (Feet)	Lux Avg	AREA SQM	VOL CUM	light load (W)
Main Building Ground floor Dental-OPD	13	9	9	47	11	32	500
Ortho Building 1nd Floor 2)TMT room	16	10	12	81	15	52	500
Main Building Ground floor MRI HOD Cabin	10	13	10	125	12	37	630
Ortho Building Ground Floor Ortho X-ray Room-I	29	14	12	64	38	143	441

	Room Index	Light Power / SQM	Lux / W / SQM	Target Lux / W / SQM	ILER*
Main Building Ground floor Dental-OPD	0.59	43.94	1.07	36.00	0.03
Ortho Building 1nd Floor 2)TMT room	0.53	33.80	2.40	36.00	0.07
Main Building Ground floor MRI HOD Cabin	0.58	50.84	2.46	36.00	0.07
Ortho Building Ground Floor Ortho X-ray Room-I	0.76	11.67	5.48	36.00	0.15

Purpose of Calculating ILER TABLE 1.2

B. Purpose Of Calculating ILER TABLE 1.2

Installed load efficacy ratio is the indicator of lighting load performance. Following table gives ILER assessment for various limits of ILER value.

table 1.2 Indicator of performance

ILER	Assessment
0.75 or over	Satisfactory to good
0.51-0.74	Review suggested
0.5 or less	Urgent action required

C. Purpose Of Selecting Target Lux/W/M2 (W/M2/100 Lux) Or CRI Table 1.3

CRI is a measure of the effect on the perceived color of objects. To determine CRI of the lamp, the color appearances of a set of standard color chips are measured with special equipment under a reference light source with the same correlated color temperature as the lamp being evaluated.

Table 1.3 Target Lux/W/m2 (W/m2/100 Lux) values for maintained luminance on horizontal plane for all room indices and applications.

Room index	Commercial lighting Ra=40-85	Industrial lighting Ra=40-85	Industrial lighting (CR is not expected) Ra= 20-40
5	53(1.89)	49(2.04)	67(1.49)
4	52(1.92)	48(2.08)	66(1.52)
3	50(2.00)	46(2.17)	65(1.54)
2.5	48(2.08)	44(2.27)	64(1.56)
2	46(2.17)	42(2.38)	61(1.64)

1.5	43(2.33)	39(2.56)	58(1.72)
1.25	40(2.50)	36(2.78)	55(1.82)
1	36(2.78)	33(3.03)	52(1.92)

D. Remarks

- Lighting load is not very high. Only around 80 KW
- However, the Lux levels are very poor at most places, which need immediate attention.
- Lux levels are to be improved immediately, and average LUX of 100 needs to be maintained for a comfortable work place ambience.
- Where ILER is below 0.5, lights have to be re-positioned, so that the Lux levels are maintained with less power consumption. All the locations where ILER is below 0.5 signify in-efficient lighting. At least 77% of the rooms fall under this category.
- Day lighting is also not effectively used in the wards. This should be looked into.

E. Problems Which Causes High Consumption Of Electricity

One of the factors that effect on high consumption of electricity is 'lumen'. If the luminous intensity of the CFL light is low then the room has less lumen. But if the luminous intensity of the light is proper then the room is properly visible. The problem causes when there is large number of light for the small room. This will lead to wastage of electricity.

F. Solution Suggested

1. **LEED Requirement for Lighting**

The LEED 2009 day lighting standards were intended to connect building occupants with the outdoors through use of optimal day lighting techniques and technologies. According to these standards, the maximum value of 1 point can be achieved through four different approaches. The first approach is a computer simulation to demonstrate, in clear sky conditions, the daylight luminance levels 108-5,400 Lux on, September 21 between 9:00 a.m. and 3:00 p.m. Another prescriptive approach is a method that uses two types of side-lighting, and three types of top-lighting to determine if a minimum of **75% day lighting is achieved in the occupied spaces**. A third approach uses indoor light measurements showing that between 108-5,400 Lux have been achieved in the space. The last approach is a combination of the other three calculation methods to prove that the daylight illumination requirements are achieved.

G. Option

A type of device used is the light tube, also called a **tubular day lighting device (TDD),** which is placed into a roof and admits light to a focused area of the interior. These somewhat resemble recessed ceiling light fixtures. They do not allow as much heat transfer as skylights because they have less surface area.

H. Energy saving in lighting system

- Make maximum use of natural light
- Switch off the lights, fan when not required
- Select light colors for interiors
- Provide timer switches PV controls
- Providing lighting transformers to operate at reduced voltage
- Install energy efficient lamp, luminaries and controls

1. Performance Analysis of Pump Energy Audit

A. Methodology

During audit, we have collected all the electrical as well as mechanical data with the help of measuring instruments and then we have analyzed the obtained data to calculate the efficiency of the pump. For the measurement of the flow of the water through the pipe, we use Digital Flow Meter. While measuring the flow of water, we have to select a straight pipe having maximum length by which accurate readings can be obtained. Then we have to set the ultrasonic transducer in such a manner that maximum ultrasonic wave transmitted by the transmitter can be received by the receiving transducer. The position and distance between the transducers is also important, hence transducer should always set at maximum signal strength. For the Flow we have to insert an internal diameter of the pipe in the Flow Meter which can be calculated from the outer diameter and the thickness of the particular pipe by simple way i.e. (Inner diameter=Outer diameter-thickness).

A. Head Measurement

It is very inconvenient to measure the head of the pump by a conventional manner with help of the tape meter hence we used Digital distance meter in which measurement of distance is based on the reflection of LASER beam. Due to the LASER, it has wide range of applications. Sometimes the Head may be located underground in the case of submersible pump which can be easily measured with these Digital Distance Meter.

1	Pump Name	velocity (ft/s)	flow (l/s)	outer diameter (inch)	inner diameter(inch)	Wall thickness(inch)	Head
2	Dept. of Gynaecology	2.54 ft/s	1.134 l/s	2	1.7	0.15	70ft
3	Behind cots submersible	8.18	6.89	2.5	2.3	0.1	51 ft
4	Behind cots	4.4	4.93	3	2.7	0.15	51 ft
5	ortho	5.2	7.07	3	2.8	0.1	47.7ft
6	Guest House Borewell	2.88	2.36	2.5	2.3	0.1	45ft
7	MIDC	9.87	6.72	2.5	2.1	0.2	1.1m

Electric Parameter Measurement

For the total electric power consumption, we need to measure the voltage and current which we have measured with the help of the clamp meter. In these way all the observation i.e. head, flow, voltage and current.

Analysis and Result Prediction

From the data collected, Input and Output Energy can be found out for the calculation of the efficiency. The Input energy is calculated as and

Where,

ρ = flow of liquid

q=density of liquid

g=gravity

h=Head of the Pump

In the same manner, the efficiency of all pumps is calculated which is as per under. From the table it is observed that most of the pumps are operated at very less efficiency i.e.28%. So as to know the reason behind these low efficiencies, we took reference of the standard manufacturing manual of the same pump model from which we observed that as per the manual the high rating pump i.e. 7.5 HP should be used for the head of 25 meter and more, so as to get the maximum flow (Liter/minute) but in hospital these high rated pump are used for the head of 15 meter due to which pump get over rated than the actual rating requirement for the motor. Even the difference between the outputspowers of pump also vary in wide range.

PUMP	GYNEC	Behind CVTS submersible	Behind CVTS submersible	ORTHO	MIDC
VELOCITY FPS	2.54	8.18	4.40	5.20	9.87
FLOW LPS	1.13	6.69	4.93	7.07	6.72
Flow LPM	68	401	296	424	403
FLOW CuM / Hr	4.08	24.08	17.75	25.45	24.19
Pipe Outer Dia	2.00	2.50	3.00	3.00	2.50
Pipe Inner Dia	1.70	2.30	2.70	2.80	2.10
Pipe Thickness	0.15	0.10	0.15	0.10	0.20
Head Ft	70.00	51.00	51.00	47.70	3.50
Head M	21.34	15.54	15.54	14.54	1.07
HYD Power KW	0.24	1.02	0.75	1.01	0.07
Shaft Power KW	0.40	1.70	1.25	1.68	0.12
Spacing In	0.50	0.98	1.45	1.48	0.98
Signal Strength	800.00	750.00	700.00	780.00	745.00
Time	0.51	0.68	0.69	0.61	0.57
1 Phase Motor Reading	7.4A/387V	10.5A/394V	3.7A/397V	8A/400V	13A/390V
Current 1 Phase	7.40	10.50	3.70	8.00	13.00
Voltage 1 Phase	387.00	394.00	397.00	400.00	390.00
Motor Power KW	3.97	5.73	2.04	4.43	7.03
Efficiency %	9.97	29.66	61.56	37.90	1.67

Fig: Observation of the entire Pump

From the manufacturer's website, Discharge LPM

Product Code	HP/KW	Stage	Size	10	15	18	21	24	26	30	34	37	40	45	50	55	60	66
LNH 16 A(132 Ft)	7.50/5.50	0	75x50	-	-	-	-	-	-	-	700	660	630	600	500	-	-	-
LNH 18 A(132 Ft)	7.50/5.50	0	75x65	-	-	-	-	1040	980	920	880	780	-	-	-	-	-	-
LNH 19 A(132 Ft)	7.50/5.50	0	100x75	-	-	1400	1200	1100	1000	900	-	-	-	-	-	-	-	-

B. Remark And Suggesions

- As per the website of the pump manufacturer's, these pumps are manufactured for high head, i.e. head above 25 meters. However, we were using it on low heads.
- Only one pump (behind CVTS) has acceptable efficiency.
- MIDC Pump is the least efficient since the head is very low, and the pump used is not designed for this head. We need low head high flow pump.
- The pump in GYNEC department needs to be checked. The output flow is very low.
- Pumps are also running dry, or overflowing. Need to install dry run protection, and tank overflow protection. This will cost less than Rs. 7500/- per pump.

CONCLUSION

We have carried out case study by practically applied energy audit procedure for hospital lighting load and also various solutions have been suggested to authority of avbrh for using energy in efficient way stead of wasting energy into excessive consumption and therefore our objectives of energy conservations is fulfilled.

REFERENCES

1. Bureau of energy efficiency ,"performance assessment of lighting system '' government of India 2010

2. Energy audit: a case study to reduce lighting cost by Malkiat Singh, Gurpreet Singh, Harman deep Singh AJCST,2012

3. Conservation of Energy: a Case Study on Energy Conservation in Campus Lighting in an Institution Biswajit Biswas1, Sujoy Mukherjee2 , Aritra Ghosh3 Department of AEIE, Murshidabad College of Engineering & Technology, India , IJMER, 2012.