Journal of Advances in Science and Technology
Vol. 12, Issue No. 25, (Special Issue) December-2016, ISSN 2230-9659

Design and Implementation of Street Lighting in Technical Institution campus for Optimum Energy Saving: Case Study

Prof. Shivanand. D. Hirekodi[1]*, Prof. B. R. Umarane[2]

[1]Assistant Professor& Maintenance Engineer, Department of Electrical & Electronics Engineering, Hirasugar Institute of Technology, Nidasoshi, Karnataka, India

[2]Department of Electrical & Electronics Engg, Hirasugar Institute of Technology, Nidasoshi, Karnataka, India

Abstract – This paper presents the design of energy efficient street lighting scheme and its implementation to technical institution for optimum energy saving. Even though the more initial cost to implement the plan, considerable amount of energy saving can be obtained by choosing the efficient street lighting plan and energy efficient long life lamps. The design of street lighting scheme includes campus survey, selection of street lighting poles, cross arms and fittings as per manufacturer guidelines for proper illumination and energy efficiency. The optimum energy saving can be achieved by installing high power LED fittings. The designed energy efficient street lighting plan is suggested for technical institution and is implemented. This will help to increase the reliability of the electric supply & considerable amount of savings in electricity charges.

Key words: Street Lighting, High Power LED and Optimum Energy Saving.

----------♦----------

I. INTRODUCTION

The use of electrical energy is exponentially increasing both in domestic and industrial sectors. The per capita consumption of Electrical Energy is taken now a day as an index of country's growth. Because of improper planning of power generation and depletion of conventional energy sources, the gap between the supply and the demand is continuously increasing. To manage this gap the usual method adopted by the state electricity boards is random load shedding which doesn't take the consumer's interest. This has created a renewed awareness about the economic advantage of energy conservation. Recently, the concept of energy audit and load management has emerged and is being applied throughout the world [1]. The fundamental concept of Energy audit and Load management is to bring both supplier and consumer together across the table and discuss the use of available electrical energy for maximum benefit and minimum inconvenience and loss for both. Thus a time has come to utilize the available energy efficiently, optimally for the mutual benefits of consumer and supplier [2]. This paper deals with design of street lighting plan and its implementation to professional institution for optimum energy saving. The design of street lighting scheme includes campus survey, selection of street lighting poles, cross arms and fittings as per manufacturer guidelines for proper illumination and energy efficiency. The optimum energy saving can be achieved by installing high power LED fittings. Optimum energy saving will help to increase the reliability of the electric supply and reduce the electricity charges per month.

II. HISTORY OF HIRASUGAR INSTITUTE OF TECHNOLOGY, NIDASOSHI

The Hirasugar Institute of Technology has been started by Shri Jagadguru Panchama Nijalingeshwar (SJPN) Trust, Nidasoshi in the year 1996 with the sole motto of imparting technical education to the rural masses of this region. Shri Jagadguru Panchama Nijalingeshwar Mahaswamiji was the 9th seer of Shri Siddha Sounsthan Math, Nidasoshi that is famous for its religious bearing in the northern parts of Karnataka and southern parts of Maharashtra. It has Glorious history of about 300 years. The Institution is situated in a quiet, calm and pollution free rural setting, which enjoys a salubrious climate throughout the year. The Institution has its campus spread over 48 acres of land with spacious infrastructure. The existence and functioning style of the institution emulates a gurukul system. The institution is affiliated to Visvesaraya Technological University (VTU), Belgaum, Karnataka and recognized by All India Council for Technical Education (AICTE), New Delhi.

III. DESIGN OF STREET LIGHTING SCHEME

Effective energy-efficient street lighting design integrates efficient lamp technologies, optimum pole height and placement, efficient light distribution, and aesthetics while using the least energy and meeting requirements for visibility and appropriate light levels The conceptual flow diagram to design street lighting plan and its implementation is shown in Fig.1

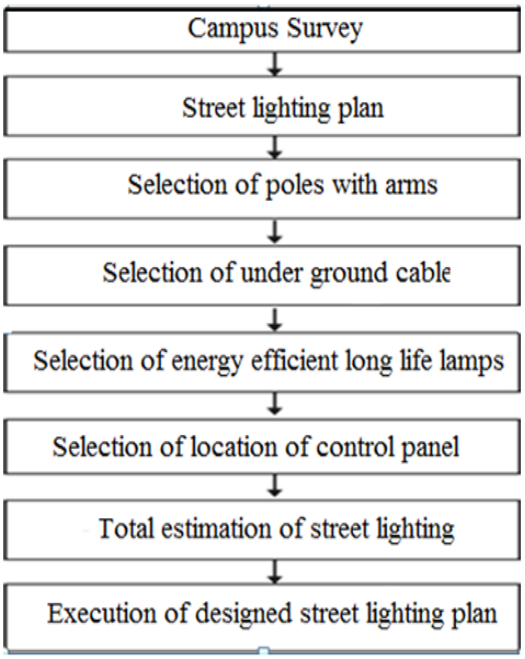

Fig. 1 Conceptual Flow Diagram to Design Street Lighting Plan and its Implementation

The design of street lighting scheme include the following steps

A. Campus Survey

B. Street Lighting Plan

C. Selection of Poles with Arms

D. Selection of Under Ground Cable

E. Selection of Energy Efficient Long Life Lamps

F. Selection of Control Panel Location

G. Total Estimation of Street Lighting Scheme

H. Execution of designed street lighting plan

A. Campus Survey

In design of efficient street lighting scheme and its implementation, the first step is to do campus survey of the institution. This has helped to select the location of poles and number of poles required for the whole campus street lighting, location of control panel, and further estimation of cost of poles and to prepare street lighting plan.

B. Street Lighting Plan

The second step in design of efficient street lighting scheme and its implementation is to prepare the street lighting plan. The detail street lighting plan is prepared after campus survey of the institution. The layout of street lighting plan of Hirasugar Institute of Technology is shown in Fig.2.

C. Selection of Poles with Arms

The various types of poles are generally used for street lighting such as M.S. swaged tubular, RCC, PSC and GI poles. The highly durable GI hexagonal poles and cross arms are selected. This has helped to estimate the cost of poles and arms. The table I shows the cost comparison of different types of poles and arms.

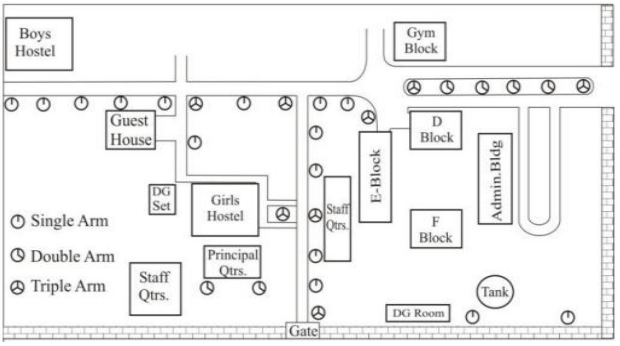

Fig. 2 Layout of Street Lighting Plan of College campus.

TABLE I. COST COMPARISON OF DIFFERENT TYPES OF POLES AND CROSS ARMS

Description	*7mt. GI poles with accessories in Rs.*	*7mt. M. S. swaged tubular poles with accessories in Rs*	*7mt.RCC poles with accessories in Rs.*	*7mt. PSC with accessories in Rs.*
Pole	16500.00	10500.00	5200.00	3500.00
Single arm bracket	3500.00	2500.00	500.00	500.00
Double arm bracket	4900.00	3500.00	1200.00	1000.00
Tripple arm bracket	5985.00	4500.00	2200.00	2000.00

D. Selection of Under Ground Cable

The total length of cable required for street lighting of campus is 850 mtrs.The Suitable size of underground cable for cabling the street lighting is used to keep voltage drop within 6% of normal supply voltage .The polycab make, 4 core , 16mm2,1.1 KV class aluminum armored cable is used.

E. Selection of Energy Efficient Long Life Lamps

The most important element of the illumination system is the light source. It is the principal determinant of the visual quality, cost, and energy efficiency aspects of the illumination system [3].

Street lighting installations normally use one of three types of high intensity discharge (HID) lamps: high pressure sodium vapor (HPSV), metal halide (MH), or mercury vapor (MV). HPSVs produce a yellowish light, have a long life, are very energy-efficient, and have good lumen maintenance (maintain light output for a long period of time), but have poor color rendering properties. MH lamps are the most frequently used alternative to HPSV in new installations. They are also quite efficient and provide much better color rendering. However, these lamps tend to have a shorter lamp life (some models below 10,000 hours) and poor lumen maintenance over the life of the lamp. Recent developments have shown improvements in these areas, but the improved lamps are presently limited in supply and higher in cost. MV lamps are the least efficient of the HID types and have poor lumen maintenance.

Light-emitting diode (LED) technology is a fast-evolving technology with significant energy-saving potential. Operating for an average of 10 hours per day, LEDs have a life span of up to 13 years, and provide a pleasant spectrum of light .The lifetime and performance depends on quality of the LED, system design, operating environment, and other factors such as the lumen depreciation factor over a period of time.

Although the upfront cost of the LED is more than the cost of most HID lamps, the energy consumed by the LED is half of the lamp's energy (or less) and LEDs last longer than conventional lamps, resulting in significant savings. The LED fixture does not require ballast or a capacitor; instead it converts the supply voltage to low voltage direct current, using a small electronic power supply. The types of lamps commonly used for street lighting are listed in Table II with brief descriptions[4].

TABLE II. LAMPS COMMONLY USED FOR STREET LIGHTING

Type of Lamp	*Luminous Efficacy (lm/W)*	*Color Rendering Properties*	*Lamp life in hrs*
High Pressure Mercury Vapor (MV)	35-65 lm/W	Fair	10,000-15,000
Metal Halide (MH)	70-130 lm/W	Excellent	8,000-12,000
High Pressure Sodium Vapor (HPSV)	50-150 lm/W	Fair	15,000-24,000
Low Pressure Sodium Vapor	100-190 lm/W	Very Poor	18,000-24,000
Low Pressure Mercury Fluorescent Tubular Lamp (T12 &T8)	30-90 lm/W	Good	5,000-10,000
Energy-efficient Fluorescent Tubular Lamp (T5)	100-120 lm/W	Very Good	15,000-20,000
Light Emitting Diode (LED)	70-160 lm/W	Good	40,000-90,000

The Selection of Energy Efficient Long Life Lamps is carried out by comparing the illumination levels of generally used light fittings for street lighting, their cost and durability. The energy efficient, Alpha Lite make high-power LED light fittings have been selected for the street lighting of college campus. Table II indicates the details of different types of light fittings generally used for street lighting. Table III indicates the cost analysis of standard make commonly used street light fittings.

TABLE. III. COST COMPARISON OF DIFFERENT TYPES OF LIGHT FITTINGS

Sl. no.	*Description*	*Cost per unit in Rs.*	*Qty*	*Amount in Rs.*
1	Sodium Vapour lamp 250W	7200.00	70	504000.00
2	High power LED 48W	14999.00	70	1049930.00
3	T5fittings(5x24W)	7500.00	70	525000.00
4	Metal hellaide 250W	10000.00	70	700000.00
5	GSL Type fittings	9000.00	70	630000.00

F. Selection of Location of Control Panel and its operation

The selection of suitable location of control panel is very important for proper operation and ease maintenance of street lighting. From survey report, proper location of control panel is fixed. The M.S. fabricated and powder coated street light control panel houses two numbers of automatic ON/OFF Timers, 63Amps MCBs, 63 Amps fuse cut-outs, 100 Amps NO/NC contractors and two energy meters for energy auditing. The entire street lighting scheme of campus is monitored controlled in two schedules. The

circuit of first schedule is operated from 7pm to 10pm and second circuit schedule is from 7pm to 6am

G. Total Cost of Estimation of Street Lighting

After proper selection of pole with arms, underground cable, energy efficient long life lamps and location of control panel, total cost of street lighting of campus is estimated. The table IV shows the details of GI poles, cross arms, light fittings, cables and control panels used for installation and commissioning of street lighting scheme for college campus.

TABLE IV.DETAILS OF FITTINGS AND ACCESSORIES USED FOR COMMISSIONING OF STREET LIGHT SCHEME FOR CAMPUS.

S. N	*Description of work/item*	*Unit*	*Qty*	*G.I.Hexagonal poles with LED fittings*	
				Rate in Rs.	*Amount in Rs.*
1	Fabricating, supplying & erection of 7mt Street light type poles with accessories.	Nos	32	23800	761600.00
2	Fabricating, supplying & fixing of cross arm brackets				
	i)Single arm	Set	18	4900	88200.00
	ii)Double arm		05	6999	34995.00
	iii)Tripple arm		09	8550	76950.00
3	Supplying, installing, testing of street light fittings with necessary accessories.	Nos	70	14999	1049930.00
4	Supplying of LT UG cable,1.1kV,4 Core, 10sq.mm.	Km	.85	165	140250.00
5	Digging of trench for laying cable & refilling of the same after laying cable	Km	.85	80/mt	68000.00
6	Fabricating ,Supplying & Mounting MS control box with 100A fuse cutout,63A MCB,100NO/NC contactors, timers for automatic ON/OFF etc	Set	01	41000	41000.00
				TOTAL COST OF THE PROJECT	**2260925.00**

H. Execution of designed street lighting plan

After total estimation of street lighting, with the approval of management authorities, execution of the designed efficient street lighting plan is carried out for optimum energy saving. Table V. shows energy cost comparison of 250W, 70 nos. sodium vapour lamp and 36/48w led fittings for 10hrs. consumption per day. Table VI. gives the summary of net saving in energy cost due to installation of high power LED fittings for street lighting in the campus. Fig.3-6 shows the actual implementation of street lighting project in college campus.

TABLE V.ENERGY COST COMPARISON OF 250W, 70 NOS. SODIUM VAPOUR LAMP AND 36/48W LED FITTINGS FOR 10HRS. CONSUMPTION PER DAY

S.N	*Description*	*Qty.*	*Unit price in Rs.*	*Unit consumption/ day*	*Amount/ Day (Rs.)*	*Amount/ Year (Rs.)*
1	Energy cost with 250W, SV Lamp	70	5.8	175	1015	370,475.00
2	a)Energy cost with 48W LED	40	5.8	19.2	111.36	40,646.40
	b)Energy cost with 36W LED	30	5.8	10.8	62.64	22,863.60

TABLE VI. SUMMARY OF NET SAVING IN ENERGY COST DUE TO INSTALLATION OF LED FITTINGS.

Total no. of LED fittings installed at campus	70
Date of Installation of LED fittings in the Campus	26/01/2011
Energy Consumption from the date of Installation up to	30/07/2016
Energy Cost comparison for	4 .5 Years.
Total Energy cost of 250W SV Lamp for 4 .5Years	Rs.1667137.00
Total Energy cost @ Rs.5.8/unit with 36/48W LED Lamps for 4.5 Years	Rs.285795.00
Net Saving on Electricity bill for 4.5 Years	Rs.13,81,342.00
No. of units consumed for 4.5 years as per energy meters reading since installation upto 30/07/2016	49274 units

Fig.3.Street lighting near office building of campus

Fig.4.Street lighting near boys hostel of campus

Fig.5.Street lighting near staff quarters of campus

Fig.6.Street lighting along approach road of campus

IV. CONCLUSION

This paper deals with design of street lighting plan and its implementation to professional technical institution for optimum energy saving. By proper survey, planning, selection of street lighting plan by comparison of different plans as per manufacturer guidelines for proper illumination and energy efficient long life lamps by comparing different energy efficient long life lamps from different manufacturers, efficient street lighting plan has designed and hence optimum energy saving is achieved. Optimum energy saving which will help to increase the reliability of the electric supply & considerable amount of savings in electricity charges. The designed efficient street lighting plan suggested for professional technical institution and is implemented.

ACKNOWLEDGEMENT

Authors wish to thank the authorities of S.J.P.N. Trust's Hirasugar Institute of Technology, Nidasoshi-591236, Karnataka, India for taking up green campus initiative and providing the necessary financial assistance to carry out this work.

REFERENCES

Prof. Shekhappa G. Ankaliki, (2010). *"Energy Conservative Measures by Energy Audit and Load Management"* International eJournal of Mathematics and Engineering 96, 895 - 902. ISSN 0976 – 1411

Prof. Gopinath S. (2001). *"Energy Audit Principles, Scope and Methodologies"* Workshop on Renewable Energy Sources and Energy Audit at PSTI, Bangalore from pp. 1-4.

World Bank (2009). Energy Sector Management Assistance Program (ESMAP). Energy Efficient Cities Initiative. *Good Practices in City Energy Efficiency: Akola Municipal Corporation, India - Performance Contracting for Street Lighting Energy Efficiency.* Washington DC, USA.

USAID ECO-III. (2010). Guidelines Energy Efficient Street Lighting. BEE.

Corresponding Author

Prof. Shivanand. D. Hirekodi*

Assistant Professor& Maintenance Engineer, Department of Electrical & Electronics Engineering, Hirasugar Institute of Technology, Nidasoshi, Karnataka, India

E-Mail – sdhirekodi.eee@hsit.ac.in