ISSN 0126-2807

Journal of Applied Sciences in Environmental Sanitation

Volume 7, Number 4: 257-262, December, 2012
© T2012 Department of Environmental Engineering
Sepuluh Nopember Institute of Technology, Surabaya
& Indonesian Society of Sanitary and Environmental Engineers, Jakarta
Open Access http://www.trisanita.org/jases

International peer-reviewed journal

Research Paper

SCHEME FOR ENERGY SAVING MEASURES IN GAZA STRIP AT NO COST

HATEM ELAYDI[1*], IMAD IBRIK[2] and EYAD A. KHOUDARY[3]

[1]Electrical Engineering Department, Islamic University of Gaza, Gaza, Palestine.
[2]Energy Research Centre An-Najah National University, Nablus, Palestine.
[3]Gaza Power Generating Company, Gaza, Palestine.
*Corresponding Author: Phone: +970-8-2860700; Fax: +970-8-2860800; E-mail: helaydi@iugaza.edu.ps

Received: 15th June 2012; Revised: 27th August 2012; Accepted: 31st August 2012

Abstract: The Palestinian electricity sector suffers from many electrical problems among them high electrical deficit rate, annual demand/growth studies, and absent energy management strategies and skills. The electrical deficit rate is estimated around 30%. One strategic solution to reduce the rate of electrical deficit is through energy saving measures for the commercial sector in Gaza Strip. The two approaches selected are lumen design method and optimal thermostat calibration in summer seasonal. Energy audits and analysis were particularly performed at Gaza Training Center, as commercial sector, and achieved saving of about 7% from the total electrical consumption with no additional cost. If we assume this percentage is the average saving of electrical energy that could be achieved in commercial sector of Gaza Strip by adopting the no cost electrical energy actions, then the rate of electrical deficit deceases to 23.3 %. This result highlights deficiencies in electrical power and huge wasted energy due to absent of electrical conservations programs. This study devises specific no cost electrical conservation approaches to commercial sector and being applicable for other sectors through energy management to overcome the electrical energy deficiency and reduce the electrical rate of deficit.

Keywords: Energy savings, energy conservation, energy management, Gaza electricity

INTRODUCTION

Electricity plays a major role in modern society; moreover, its consumption rate is a valuable index in determining the standards of livings. Palestinians in the West Bank and Gaza Strip have been living under Israeli occupation since 1967. They completely depended on Israel for their electricity supplies until 2002 when Gaza Power Generation Company was founded. This newly founded company was supposed to supply Gaza Strip with all of its power demands; however, it currently supplies 70MW out of 300MW in demands and the power generation company totally depends on fuel from Israel which leaves its operation under the mercy of the occupier. Currently, Israel supplies Gaza Strip with 120MW and Egypt adds another 19MW which leaves Gaza Strip with power shortage of about 90MW. Consumption numbers shows that average monthly electric energy consumption per capita in Gaza Strip is 57 KWh for 2011 compared to 594.425 KWh in Israel [1]. This leaves Gaza Strip to suffer from daily scheduled electric power outages. Many of the 1.4 million Palestinians residing in the Gaza Strip must cope with scheduled electricity cuts of 6-8 hours daily due to the increment in annual demand growth and the rate of electrical deficit reaching to 30 % in the year 2011[1]. Moreover, residents and companies in Gaza Strip went their own way to solve the power outage by buying small power generators that runs on either gas or diesel. These generators have disastrous effect on the local environment with enormous heath consequences. Since the ability to produce more electric power is limited due to the sage on Gaza Strip that was imposed by Israel since 2006, a power saving scheme is the only option left in order to save energy and allow the power for distribution.

The ultimate objective as first priority for this research is to reduce the electrical rate of deficit which is estimated at 30 % and generate energy savings. In this research, no cost programs are being investigated in educational institution as medium electric consumption customer in Gaza Strip and assess the outcomes of this research with the objective of implementing a no cost electrical conservation strategies. First, we introduce the research methodology used, then, we present observations on the outcomes obtained from measurement results and examination. The selected facility is an educational institution in Gaza Strip named Gaza Training Center (GTC) funded by UNRWA to educate and train Palestinian refugees. It consists of a number of buildings such as business administration, engineering, English and campus administration, electronic and communication, and other workshops and services.

Table 1 illustrates the electrical supply and demand pattern with the rate of deficit in Gaza Strip between the years 2008-2011. The covering of electrical deficit is difficult and the Palestinian can't cover the entire electrical deficit due to limited in the government budget.

Table 1: The growth of electrical deficit in Gaza Strip

Year	2008	2009	2010	2011
Supply	175	175	190	208
Demand	230	240	260	300
Deficit	23.9%	27.1%	26.9%	30.7%

This paper proposes a scheme for energy savings measures in order to reduce electrical power outage and to lower the impact of using alternative generating sources on environment. It is expected that this ultimate objective may be achieved by implementing the no cost electrical energy saving programs. This research represents the first program to evaluate the wasted energy in Gaza Strip. The proposed program scheme is designed to run at no cost. It mainly concentrates on lighting and air conditioning.

MATERIALS AND METHODS

Research methodology

The adopted approach in this study is the implementation of electrical conservation techniques through energy management for commercial sector in Gaza Strip. This approach includes gathering information or energy audits for selected organization or facility including their characteristic and investigates the potential to energy conservation opportunities. The data gathered below have been fed into worksheets to perform analysis on the results in GTC using excel office 2010 and Java script programs. The tools of collecting information for the research included review of relevant literature in international and Arab countries, and in Palestine. The data collected using interviews with the facilities managers, questionnaire survey for the electrical equipment rating and consumption, monthly bill invoice analysis, and review of measurement of electrical equipment.

A structured approach to energy saving scheme helps identifying and implementing the best ways to reduce energy costs. The scheme for commercial facility is based on: Establishing energy efficiency goals, identifying and benchmarking best practices in energy saving, determining success metrics and targets for improvements, developing an action plan for increasing energy efficiency and reducing emissions, and implementing energy savings systems and equipment such as upgrading or replacing inefficient equipment, installing high-efficiency lighting.

Engineering approaches

The research aims to use the results and conclusions obtained using Lux meter, in order to achieve electrical energy reduction. Electrical energy audits are the first step in this program scheme in order to investigate the potential for energy conservation opportunities. The auditing includes surveying the electrical data rate of light fittings and air condition in offices, labs, classrooms, administration, and other services buildings in GTC.

Data collected for auditing light fitting includes measurements of illumination level and dimensions; the illumination level was measured by lux meter instrument and the dimensions by tape meter. Measurement data of HVAC was recorded for indoor and outdoor temperature in the GTC buildings. The analysis of collected data is based on the outcomes of running Microsoft Java script and uploading the data of each into software database. In addition, determination the percentage of saving factor is achieved through comparing the energy saving with the annual electrical consumption of GTC.

Lumen Design Method

When fluorescent lamp is switched on, it emits a luminous flux in all directions. The intensity of light coming from a light source (i.e. a luminary fitting) is not that important, but rather the amount of light that is falling on a particular surface. It is referred to as illumination with the lux (lx) as its SI unit. Artificial lighting schemes are usually specified as being capable of supplying a specified number of lux on a horizontal working plane. The design method [2] can be arranged by measuring the illumination level at the specific area, and then compares it with the international standards for illumination. The optimum number of fixtures can be calculated using equation 3.1

$$N = (E \times A) / (n \times \phi \times K_u \times K_m) \qquad 3.1$$

Where N is number of units, E is illumination lm/m² (lux), A is area in m², n is number of lamps in the unit, Φ is luminous flux in lumen, Ku is reflectance factor (0.6-0.8), and Km is maintenance factor (it depends on the condition of the lamp, clean or not, 0.6- 0.8). The lumen design method was applied to 10 offices, labs, classes, and corridors buildings of GTC. The luminous flux Φ obtained from lamp manufacturer catalogues and other factors are known. Equation 3.1 is applied to a class at electronic and communication building with an area of 91 m ², and the number of used lamps is reduced to 20 pc instead of 40 pc currently in use.

$$N = (300 \times 91.5) / (2 \times 2500 \times .75 \times .75) = 10\,units$$
$$Total\ required\ lamps = N * n = 10 * 2 = 20\,Lamps$$

Therefore 20 lamps can be removed, and this procedure is followed for all areas in GTC. Table 2 illustrates the electrical energy saving through implementing this method.

Optimal thermostat adjustment method

People can reduce their electric bills by raising their thermostat setting during summer and reducing it during winter [3]. It is claimed that an increase of 1ºC in the thermostat setting can achieve as much as 6% reduction in the load [4]. The majority of people feel comfortable at a room temperature of 21-26 ºC depending on the relative humidity and other factors [4]. The optimal set point of thermostats to achieve saving cost in summer seasonal is 24 ⁰C for cooling distribution load. At T = 24°C and RH = 50%, almost all people feel comfortable at rest or doing light work. Adjust the air conditioner thermostat set point temperature percentage of saving in cooling system in summer can be calculated by equation 3.2[5]:

$$Energy\ saving\,\% = \frac{[(T_{exisit} - T_{out}) - (T_{suggested} - T_{out})]}{[(T_{existing} - T_{out})]} \qquad 3.2$$

Where T_{exist} is the current temperature inside the mom, T_{out} is temperature before cooling the space and $T_{suggeted}$ is the suggested room temperature. As an example, the energy saving at readjust the temperature from 22 ºC to 24 ºC at library building can be calculated by equation 3.2.

$$Energy\ saving\,\% = \frac{[(21-32)-(24-32)]}{[(21-32)]} = 27\%$$

This procedure is followed for all areas in GTC. This method is based upon the number of air conditions and their set point temperatures. The measure used is to controlling the set point temperature of the air condition to suit the indoor climate, depending upon the ambient temperature, and the seasonal operation hours.

OUTCOMES OF ELECTRICAL SAVING PROGRAMS

The light fittings distribution is approximated around 18% of total electrical consumption while HVAC system is 12%. Table 2 shows the saving of electrical energy after adopting excess removal lamps. The workshops achieved a saving factor of 17 %, 27% for commerce and 26% for English and administration. Table 2 shows the percentage achieved in different buildings after implementing the lumen method to remove the excess lamps.

Table 3 presents the electrical consumption of the HVAC system and annual energy saving after readjusting the thermostat to optimal temperature. The determinant factors that affect the calculation of the percentage saving energy are the indoor and outdoor temperature. Indoor temperature expresses the performance of HVAC system and the losses inside the required cooling area include the thermostat set point by human. Outdoor temperature is not controlled due to the variation in ambient temperature and humidity in the weather. The optimal thermostat set point is 24 C and this set point laying in comfortable temperature for human.

Table 2: Annual saving of energy & money for light fitting in GTC

	Existing of Fluorescent Lamps						Proposed of Fluorescent Lamps			
Nr	Building	Type	Q	Rate W	OH hr	Energy Used kWh/year	Required Lamps	Out Lamps	Energy Used kWh/year	Energy Saving kWh
1	Commerce	FL	146	36	1800	11353	114	32	8865	2488
2	Engineering	FL	490	36	1800	38102	389	101	30249	7854
3	English & Admin	FL	374	36	1800	29082	280	94	21773	7309
4	Electr& Com	FL	238	36	1800	18507	218	20	16952	1555
5	Workshops & Misc	FL	880	36	1800	68429	746	134	58009	10420
6	Total					165473				29627

Table 3: Economic analysis upon increase temperature set point (24˚C)

	Area	S.P	Tinlet	Toutlet	Tsugg	Rate	O.H	Using	Saving	Power saving	Energy saving
Nr	Name	⁰C	⁰C	⁰C	⁰C	Kw	Hour	kWh/year	%	KW	kWh/Year
1	Library	16	21	32	24	6.3	620	3906	27%	1.1	692.4
2	Commerce	15	21	34	24	2.6	620	1612	23%	0.4	241.8
3	Electronic Bldg	17	21	33	24	6.3	620	3906	25%	1.0	634.7
4	Admin.Bldg	16	21	34	24	14.7	620	9114	23%	2.2	1367.1
5	Engineerg.Bldg	18	21	32	24	12.6	620	7812	27%	2.2	1384.9
6	WorkShop	15	21	34	24	8.4	620	5208	23%	1.3	781.2
7	Communication	16	20	35	24	26.5	620	16430	27%	4.6	2847.9
8	Total							47988.0			7950.0

ANALYSIS OF RESULTS

Tables 2 and 3 show the outcomes of adopting no cost energy saving programs in GTC. The measured data reflect the waste energy from light fitting and HVAC system. The objective for this research is providing strategies to the top managements and employees to implement energy saving measures. The proposed scheme achieved energy saving of 9.6% of the total electrical consumption. The ultimate objective as first priority to this research is to reduce the electrical rate of deficit which is estimating to about 30%.

The total electrical energy purchases in the Gaza Strip in 2010 reached 1,544 GWh and the total consumption by commercial sector is 0.45 kWh/year. The energy saving in commercial sector will have an impact on reducing the electrical deficit. The saving factor achieved in this research is 9.6% and corresponds to 2.4 MW/year. If we assume this percentage is the average saving of electrical energy for commercial sector in Gaza Strip could be achieved by adopting the no cost electrical energy actions, the rate of electrical deficit deceases by 3.3%.

Most organizations are reluctant to invest in energy saving; however, no cost energy programs motivated us to adopt the electrical saving actions. Here, the removal of excess light fittings and adjusting thermostat set point doesn't incur any costs from GTC, and the implementation cost is zero so that the simple payback period also is immediate. Table 2 illustrates the annual saving money from no cost saving programs in USD and the no cost energy efficiency boosts the local economy and protects the environment through reducing throwing money and decrease the CO_2 emission.

CONCLUSION

The objective of this study was to reduce the electrical rate of deficit in Gaza Strip due to limited electrical power resources in order to meet the demand side and reduce the environmental impact. The proposed scheme requires zero investment to boost the electrical conservation programs. The scheme first component, lumen method was implemented to all classes, labs, offices, and other areas to reduce excess lamps and the second component consisted of evaluating thermostat set point of cooling system to optimal set point in summer seasonal in order to reduce the electrical consumption. The proposed no cost energy saving actions achieved annual average energy saving of 9% with 18603 kWh and equivalent to $ 2480.4. Assuming this percentage is the average saving of electrical energy that could be achieved by adopting the no cost electrical energy actions, then the rate of electrical deficit deceases by 3.3 %. The scheme success is based on its ability to be implemented right away with immediate returns.

References

1. 1. Frank Kreith & D. Yogi Goswami (Ed.), 2008. Energy Management and Conservation Handbook, CRC Press.
2. IEEE Std 739-1995, 1995. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities (IEEE Brounz Book) (ANSI).
3. Clive Beggs, 2009. Energy Management Supply and Conservation,2nd ed. Elsevier Ltd.
4. Palestinian Central Bureau of Statistics (PCBS). 2007-8. Energy Balance in Palestine. Available online: http://www.pcbs.gov.ps/Portals/ _PCBS/Downloads/book1621.pdf
5. Camilia Y. Mohammad, 1996. Lighting and Energy Saving. Alexandria, Egypt.
6. Obeid Hani, 1987. Artificial Lighting Systems: Planning and Design, 1st edition, Dar Al-Forqan for Publishing and Distribution.
7. Palestinian Energy & Natural Resources Authority(PENRA). Accessed time: 26/6/2011. [online] http://penra.gov.ps/index.php?option=com_content&view=article&id=590:2011-08-24-06-09-43&catid=1:2009-12-29-11-09-44&Itemid=29.
8. Gaza Electrical Distribution Company (GEDCO). [accessed date 25 June, 2010]. [online] http://www.gedco.ps/under.php.
9. Basel T. Q. Yaseen, 2008. Energy efficiency improvement and cost saving measures in some different industries in Palestine, MS Thesis, An-Najah National University.
10. John C. Van Gorp, 2004. Maximizing Energy savings with Enterprise Energy Management systems. IEEE Power & Energy. 2(1), 59-63.
11. Vine, E. L., 1986. Saving Energy the Easy Way: An Analysis of Thermostat Management. Energy, 11 (8), 811-820.