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A Study of Electrical Energy Saving in Office

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Abstract

The purpose of this paper is to study the ways of electrical energy saving in office by 1) studying the payback period of replacing certain electric lamp with the new ones with higher technology (e.g. LED lamp) and also comparing their effects, 2) studying the benefit of using individual manual lighting controls, the individual manual switch for controls individual lights, 3) collecting the data of how much electrical energy using for any electrical appliances (e.g. lamp, air condition, computer, printer, television, refrigerator, etc.), then calculating approximate electricity costs from electrical energy using for any electrical appliances, the data provided for awareness of the people who use electrical appliances in office for reducing their electrical energy using.

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Keywords: electricity saving, office, lighting

1. Introduction

Office Buildings are one of the highest levels of energy consumption buildings compared with energy consumption in other building sectors. The total annual energy consumption in office buildings varies in the range 100 - 1,000 kWh per square metre per year, depending on the geographic location, operational schedules, use of HVAC systems, use and type of office equipment, type of lighting equipment, energy policy in each office, etc. Most energy consumption in office buildings is for heating and cooling system, lighting system, ventilation system and office equipment.

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Nomenclature

HVAC	Heating, Ventilation, and Air Conditioning
LED	Light-Emitting Diode
CFL	Compact Fluorescent Lights
kWh	Kilowatt Hour (commonly used as a billing unit for energy delivered to consumers by electric utilities)
BTU	British Thermal Unit

The database of electricity consumption in Thailand provided by Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, Thailand, shown in Table 1. Over 30% of total energy consumption is used in Bangkok, the capital and the most populous city of Thailand.

Table 1. Electricity consumption in Thailand

Year	Electricity Consumption (GWh)
2005	121,229
2006	127,811
2007	133,178
2008	135,449
2009	135,209
2010	149,320
2011	148,700
2012	162,343
2013	176,973

The portions of electricity consumption in the major energy consuming sectors are shown in Fig. 1. and electricity consumption in office buildings is classified in business sector.

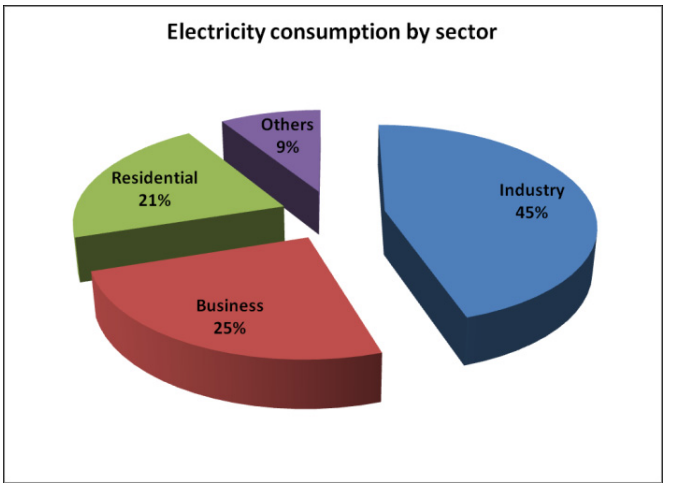

Fig. 1. Electricity consumption by sector

Bangkok has a "tropical savanna climate" (tropical wet and dry climate) under the Koppen climate classification with hot, rainy and cool seasons. Temperatures are fairly hot year-round, varies from an average low of 22.0 °C (71.6 °F) in December to an average high of 35.4 °C (95.7 °F) in April with a daily mean temperature of 29.13 °C (84.43 °F). From the high temperatures of Bangkok, the most energy consumption in office buildings in Thailand, especially Bangkok, is for cooling system (air conditioner) and the second is for lighting system. There are many ways to saving energy consumption from cooling system, such as choose the ENERGY STAR (TM) air conditioner, often clean the air filter, set the temperature at 25 °C (78 °F) to balance comfort with energy and cost savings, etc. And this research will focus on the electricity consumption saving in lighting system.

2. Research Methodology

This research is focus on the electricity consumption saving in lighting system in office by 1) studying the payback period of replacing certain electric lamp with the new ones with higher technology (e.g. LED lamp) and also comparing their effects, 2) studying the benefit of using individual manual lighting controls, the individual manual switch for controls individual lights. Furthermore, the data of how much electricity consumption for any office appliances is collected, then calculating approximate electricity costs, the data provided for awareness of the people in office who use office appliances for reducing their electricity using.

3. LED Lamp

Nowadays, the most electricity-saving and energy efficient lighting products is LED lamp. LED lamp is a light-emitting diode product that is assembled into a lamp for use in lighting system. LED lamps have electrical efficiency and life span several times better than incandescent lamps, and significantly better than most fluorescent lamps. But the prices of LED lamps are relatively high compared with CFL lamps and incandescent lamps. Then, cost comparisons of each type of lamps (for 50,000 hours of use) are shown in Table 2.

Table 2. Cost comparison between LED, CFL and incandescent lamps

	LED	**CFL**	**Incandescent**
Life span (average)	50,000 hours	10,000 hours	1,000 hours
Watts of electricity used (equivalent to 60 W incandescent bulb)	7 W	14 W	60 W
Cost per bulb (price in Thailand) *** exchange rate / 32 THB : 1 USD**	$12.50 (400 THB)	$3.75 (120 THB)	$0.56 (18 THB)
kWh of electricity used over 50,000 hours	350 kWh	700 kWh	3,000 kWh
Cost of electricity ($0.10 per kWh)	$35	$70	$300
Bulbs needed for 50,000 hours of use	1	5	50
Equivalent 50,000 hours bulb expense	$12.50	$18.75	$28.00
Total cost for 50,000 hours (cost of electricity + bulbs)	$47.50	$88.75	$328.00
Cost savings by switching from incandescent	$280.50	$239.25	-
Cost savings by switching from CFL	$41.25	-	-

Remarked that cost of electricity, bulb price and bulb life span in Table 2. will vary. The figures used in Table 2. are for comparison only, and are not exact.

From the data in Table 2. show that, at 10,000 hours of use, total cost of LED and CFL lamp using are $19.50 and $17.75 respectively. But 10,000 hours are the average life span of CFL lamp then, cost of a new CFL lamp will be accounted to the total cost of CFL lamp using, that made it cost $17.75 + $3.75 = $21.50 at 10,000 hours of use. The payback period of replacing old CFL lamp with LED lamp is around 10,000 hours of use.

Furthermore, there are many advantages of LED lamp over CFL and incandescent lamp as shown in the comparison table of the features of LED, CFL and incandescent lamps (Fig. 2.)

	LED	CFL	Incandescent
Frequent on/off cycling	no effect	shortens lifespan	some effect
Turns on instantly	yes	no, takes time to warm up	yes
Durability	durability	fragile	fragile
Heat Emitted	3.4 BTU / hour	30 BTU / hour	85 BTU / hour
Sensitivity to temperature and humidity	no	yes	some
Hazardous Materials	none	1-5 mg of mercury / bulb	none

Fig. 2. Comparison table of the features of LED, CFL and incandescent lamps

4. Individual Manual Lighting Controls Lamp

The research site of this part is at Dean's office of Faculty of Science and Technology, Suan Sunandha Rajabhat University, Bangkok, Thailand. An office hour is 8am to 5pm, Monday to Friday, but office opens in early morning (5am to 8am), and in evening (5pm to 8pm) with lower electricity using. And office also opens in Saturday and Sunday (office hour 7am to 5pm) with lower electricity using too. The study of this part is to study how electricity saving, when using individual manual lighting controls, the individual manual switch for controls individual lights.

Assume that electricity consumed by lighting system in this office in ordinary office hour (8am to 5pm, Monday to Friday) is 1 arbitrary energy unit per hour (in short, 1 U). Electricity using is lower than 1 U in Saturday, Sunday and also in early morning and evening in Monday to Friday. Then, after using individual manual lighting controls, electricity consumed by lighting system in office is reduced as shown in Table 3.

Table 3. Electricity consumption in office before and after using individual manual lighting controls

Day	Time	Electricity consumption in arbitrary energy unit per hour, U	
		Before using individual manual lighting controls (Total electricity consumed)	After using individual manual lighting controls (Total electricity consumed)
Mon - Fri	5am - 8am	0.2 U (3 hours = 0.6 U)	0.2 U (3 hours = 0.6 U)
	8am - 5pm	1.0 U (9 hours = 9.0 U)	0.5 U (9 hours = 4.5 U)
	5pm - 8pm	0.5 U (3 hours = 1.5 U)	0.3 U (3 hours = 0.9 U)
Sat - Sun	7am - 5pm	0.5 U (10 hours = 5.0 U)	0.3 U (10 hours = 3.0 U)
Total electricity consumption		16.1 U	9.0 U

per week

Data from Table 3. show that, when using individual manual lighting controls, total electricity consumption per week reduced from 16.1 U to 9.0 U (44.1% reduced).

5. Power Meter

The last part of this research is to use power meter for collecting the data of electricity consumption of any office appliances, computing the average value, and then, calculating electricity costs with rate $0.10 per kWh (or 10c per kWh), as shown in Table 4.

Table 4. Electrical energy and electricity costs of office appliances

Office appliances	Electrical energy (kWh)	Electricity costs per hour
LCD Monitor	0.022	0.22c
CRT Monitor	0.085	0.85c
Desktop Computer	0.097	0.97c
Notebook	0.056	0.56c
Laser Printer (Working)	0.340	3.40c
Laser Printer (Standby)	0.045	0.45c
Ink Jet Printer (Working)	0.040	0.40c
Ink Jet Printer (Standby)	0.011	0.11c
Fax Machine (Standby)	0.012	0.12c
Copier (Working)	0.544	5.44c
Copier (Standby)	0.087	0.87c
Wi-Fi Router	0.009	0.09c
Cell Phone Charger	0.004	0.04c
LCD Television	0.112	1.12c

6. Result and Conclusion

The payback period of replacing CFL lamp with LED lamp is around 10,000 hours of use. When using electric lamp for 50,000 hours (average life span of LED lamp), total cost (cost of lamps and electricity) savings by switching from incandescent and CFL lamp to LED lamp is $280.50 and $41.25 respectively. And there are other advantages of LED lamp over CFL and incandescent lamp as shown Fig. 2.

Using individual manual lighting controls, the individual manual switch for controls individual lights, made weekly electricity consumption for lighting system in Dean's office of Faculty of Science and Technology, Suan Sunandha Rajabhat University, Bangkok, Thailand, reduced from 16.1 U to 9.0 U (44.1% reduced).

The data of electricity consumption and electricity costs for any office appliances is collected by Power Meter, and then, this data will be provided for awareness of the people in office who use office appliances for reducing their electricity using.

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