# ENERGY EFFICIENCY AND GREEN BUILDING: A CASE OF PRINCE OF SONGKLA UNIVERSITY, THAILAND

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**Abstract**- Energy security is one of the global concerns. With energy management in buildings, it is essential to understand both patterns of energy consumption and status of energy conservation measurements. Prince of Songkla University (PSU), Hatyai Campus, located in the southern part of Thailand, has initiated the energy audit procedures applying to existing buildings with the aim of reducing energy consumption in the campus. This study investigated the electricity consumption focusing at lighting system in President'soffice (PO) building as the administrative functionsfor the university as a whole.Generally, electricity cost of research case study depends on 2 parts; 1) Capacity (Watt), and 2) Operating time (hrs). Therefore, energy consumption of a building can be reduced by reducing capacity of appliances and outlet and also decreasing the operating time. In practical, lamps in the building have been changed. Mostly, the T8 fluorescent lamps (∅ 8/8 inch) were replaced to T5 (∅ 5/8 inch).As the reduction of operating time 25%, switch to turning on 6 hrs instead of 8 hrs work time could save energy from 16570.32 to 12427.74 Watt equaled to 4,142 Watt saving. This could reduce cost of about 16984.58 Bht/month or 485 USD/month (At paying rate 4.07 Bht/Watt). The energy conservation measurement was also recommended in 4 time zones. The working time(8.30 – 16.30 hr) presented the highest energy consumption in a day. The peak demand was recorded in summer (March to April). The working and operating procedures from human result in peak of electricity consumption. Thus, users' activities for energy conservation greatly affect the amount of consumption.Significantly, the most effective approach to save energy is to increase the awareness of the users and staff to switch off the room lights and equipment before leaving. Alternatively, this could also be achieved by assigning a person to switch off all lights and equipment after work hours. The energy saving is not only one's task responsibility but public participation is also required to provide sustainable academic community.

**Keywords**- Energy Audit, Energy Conservation,Energy Consumption, Energy Security, Public Awareness.

## I. INTRODUCTION

### Importance of energy conservation

Governments have a responsibility to provide effective energy security across the country. In many developing countries there is normally very little margin between existing power supply and electricity demand. With increasing electricity use from existing consumers and new connections, new generation needs to be brought on line to meet increasing demand. In addition, due to changing climate patterns and the increasing risk of drought, countries that are highly dependent on electricity from hydro as their main source of electricity are losing much of their generation capacity resulting in intensive power rationing (UNIDO, 2010). In Thailand, the Ministry of Energy has also implemented projects to encourage energy conservation and efficient energy consumption, and has worked with local administrative organizations to enhance communities' energy capacity. The campaign to reduce 10% energy consumption in government administration offices was applied since March 2012 to promote energy conservation and cost saving.

### Energy consumption in office buildings

With energy management in buildings, it is essential to understand the status of energy consumption; where and how much energy is being used. Fig 1 shows the energy consumption ratio of a tenant building with a rentable ratio of more than 60% (with heat source).

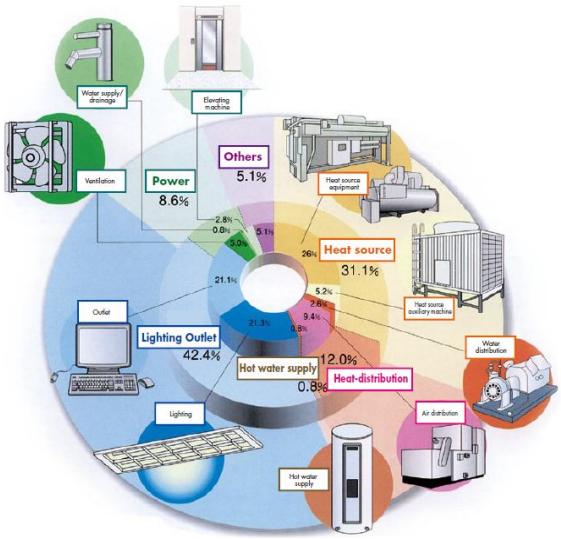



**Fig 1 The classification of energy consumption in office buildings**

### Energy audit program

An energy audit (EA) is a process to monitor working problems, improve occupants comfort, and optimize energy use of existing buildings (Sterlinget al., 1994, and Rahman, 2009). Energy audits and monitoring

energy use is indicated as the first step towards increasing energy efficiency within an organization. In addition, it identifies the opportunities for energy conservation. It was also described as a key element for decision making in energy management. The process is periodic in nature, and it assesses changes in building use, the condition of existing equipment, and the applicability of new energy-efficient technologies. In this regard, Prince of Songkla University (PSU), Hatyai Campus, Thailand, has introduced the energy audit procedures that applies to existing buildings aiming to reduce energy consumption.

## II. DETAILS EXPERIMENTAL

### 2.1. Materials and Procedures

**Study site and energy audit process**

President's office, PSU, comprises of three buildings:Building 1, Building 2, and Building 3. Both Building 1 and 3 have three floors, Building 2 has four floors. Totally all of three buildings divided into 124 small parts and consists of the following divisions by 7 functions: General affairs, financial, personnel, building and ground, student affairs, planning, and education services. This study was conducted to audit the electricity consumption focusing at lighting system in President's office building which is the administrative function of university. For this purpose, an energy audit team was set under the supervision of division management.

## III. RESULTS AND DISCUSSION

### 3.1. General building characteristic

The buildings of President's office comprised of 4 floors as show in Fig. 2 – 5.

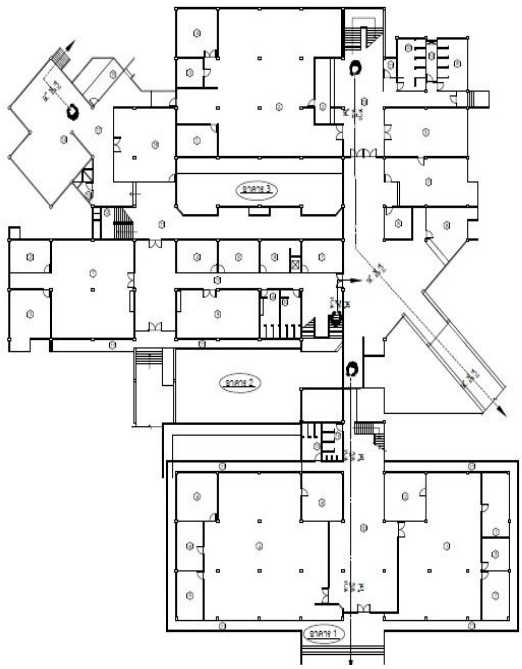


**Fig 2 First floor of President's office building**



**Fig 3 Second floor of President's office building**

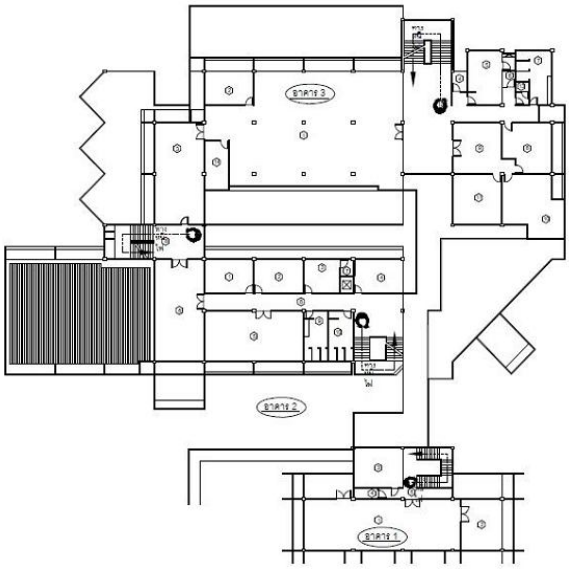


**Fig 4 Third floor of President's office building**

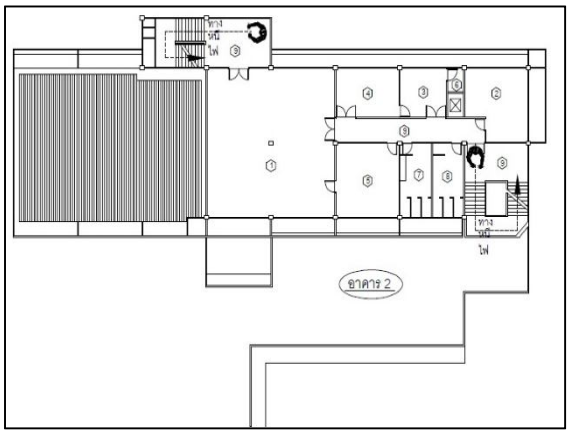


**Fig 5 Fourth floor of President's office building**

### 3.2 Electricity consumption in campus

Electricity consumption in PSU, Hatyai campus was classified into faculty and organization, institutes, and buildings as presented in Fig 6.Electricity consumption of the president's office has increased to

485,092, 574,020, and 574,560 unit (Watt) from 2013-2015, respectively. This costs 2,394,000 Bht (68,400 USD) in recent year (2015).

Table 1 describes the classifications of energy usage, and function of appliances. The operation period of electricity equipment (i.e. air conditioning, indoor temperature, lights-out, and etc) in government offices are strictly controlled rather thanthe general office buildings, and these efforts for energy conservation are demonstrated as intensity.

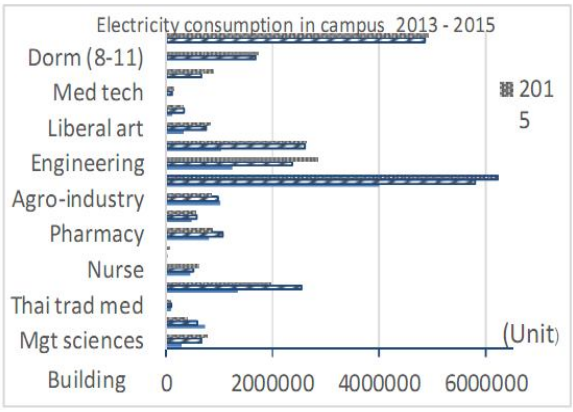



**Fig 6 The electricity consumption in PSU 2013-2015**

**Table 1Energy consumption structure**

| Energy usage classification | | Major energy consuming equipment |
|---|---|---|
| **Item** | **Detail** | |
| Heat source | Heat source main body | Chiller, boiler |
| Heat distribution | Air distribution | Air conditioning unit, fan coil unit, etc |
| Lighting systen and outlet | Lighting | Lighting appliances |
| | Outlet | Office equipment, etc. |
| Power | Ventilation | Fans in office, parking |
| | Elevating machine | Elevator, escalator, etc |
| Others | Others | Transformer loss, etc |

### 3.3. Lighting audit and energy saving

Florescent lamps could provide more light intensity than the spot light without producing waste heat. Therefore, most of lamps used in the President's office building are Recessed Luminas with Electronic Florescent Lamps.The lighting system was surveyed in terms of tubular fluorescent lamp. Mostly, the T8 fluorescent lamps (∅8/8 inch) were replaced to T5 (∅5/8 inch). The lighting system in President's office was verified and exhibited in Table 2. This could means energy saving from 88,471 Watt to 69,043 Watt.

As the reduction of operating time 25%, switch to turning on 6 hrs instead of 8 hrs work time could save energy from 16570.32 to 12427.74 Watt equaled to 4,142 Watt saving. This could reduce cost of about 16984.58 Bht/month or 485 USD/month (At paying rate 4.07 Bht/Watt).

**Table 2 Lighting system in President's office building**

| Type of fluorescent lamp | Unit | Set | Amount |
|---|---|---|---|
| T5 1198 mm Ft 1*28 W | 1 | 1 | 100 |
| | | 45 | 1 |
| T5 1198 mm Ft 3 * 28 W | 3 | 3 | |
| T5 588.7 mm Ft 1 * 14 W | 1 | 1 | 43 |
| Compact-Fluorescent bulb 9 W | 1 | 1 | 111 |
| | | 22 | 1 |
| T5 1198 mm Ft 2 * 28 W | 2 | 1 | |
| T5 588.7 mm Ft 3 * 14 W | 3 | 21 | 1 |
| | | 22 | 1 |
| T5 1198 mm Ft 2 * 28 W | 2 | 1 | |
| T5 588.7 mm Ft 2 * 14 W | 2 | 4 | 1 |
| T8 Ft 2 * 18 W Surrounding | 2 | 8 | 1 |
| LED bulb 12 W | 1 | 1 | 29 |
| T8 588.7 mm Ft 2 * 18 W | 2 | 4 | 1 |
| Ceiling bulb 32 W | 1 | 2 | 1 |

### 3.4 Energy conservationand recommendation

From basic principle in electricity calculation, it was found that the cost of electricity consumption depends on 2 parts; 1) Capacity (Watt), and 2) Operating time (hrs). Therefore, energy consumption of a building can be reduced while maintaining or improving the level of comfort in the building by reduce capacity of appliances and outlet and/or decrease operating time. They can typically be categorized into

- Reducing cooling demand;
- Reducing the energy requirements for ventilation;
- Reducing energy use for lighting;
- Reducing electricity consumption of office equipment and appliances;
- Good housekeeping and people solutions.

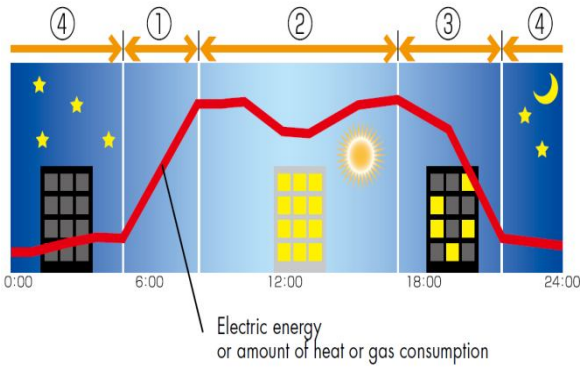
This study was emphasized on reducing energy use for lighting. Generally, this can be accomplished through:

- Making maximum use of daylight while avoiding excessive solar heat gain;
- Using task lighting to avoid excessive background luminance levels;
- Installing energy-efficient luminaires with a high light output to energy ratio;
- Selecting lamps with a high luminous efficacy;
- Providing effective controls that prevent lights being left on unnecessarily.

**Classification of energy conservation by time zone**

The energy conservation center, Japan (2010) recommended the energy conservation in office buildings that several points for energy conservation can be extracted from the trends in energy consumption according to time zone. Though keeping track of energy by electricity, fuel, or the combination of these two, or by consumption structure classification is the best way, information analysis can also be realized only with the total amount of

electricity. The following describes the major points for energy conservation based on the energy consumption characteristics of the four time zones.




① Time before the start of working (6.00-8.30 hr)
② Working time (8.30 – 16.30 hr)
③ Overtime (Optional 16.30-18.30 hr)
④ Non-used time (Night time/ holidays)

**Fig 7 Energy consumption characteristics of four time zones (The energy conservation center, Japan, 2010)**

**1) Time before the start of working (6.00-8.30 hr)**

Energy consumption of this time zone raising with regards to staff and employers arrive at the office in time for the start of working result in lighting/outlet load increasing during this period (Fig 8). The energy conservation measures was suggested as follow. The blind on the east side of the building should be closed at the end of the working hours to reduce solar load in the next morning. At operation starting time of the air conditioning for cooling, outside air intake should be stopped to reduce loads.

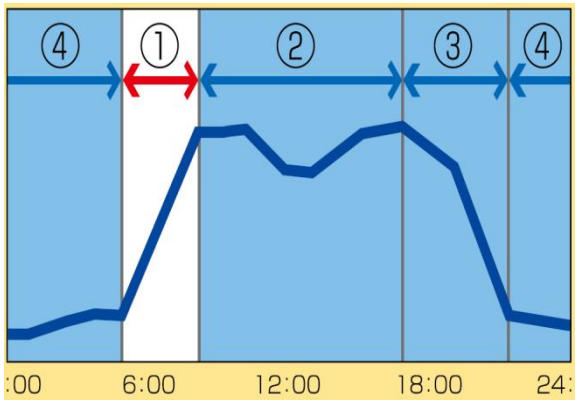



**Fig 8 Time before the start of working (6.00-8.30 hr)**

**2) Working time**

This is the highest energy consumption in a day. The peak demand was recorded in summer (March to April). The working and operating procedures from human result in peak of electricity consumption. Thus, users' activities for energy conservation greatly affect the amount of consumption. Also, due to the difference in the air conditioning load according to seasons, management of the facility's operation efficiency is the essential point for energy conservation.

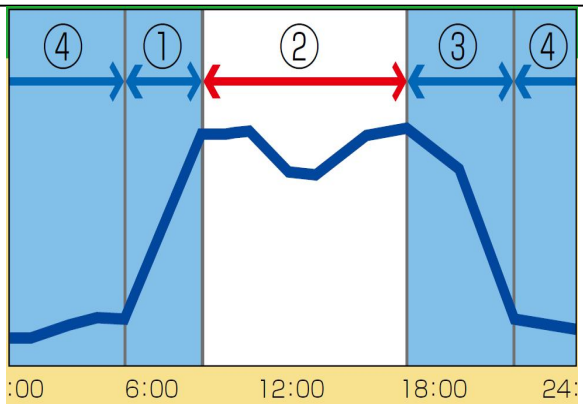



**Fig 9 Working time (8.30-16.30 hr)**

The energy conservation measures were proposed as

✓ Turning off light at lunch time 1.30-2.00 hrs

✓ Turning on the fan in air conditioned room could save energy for 20%

✓ Reducting operating time of air conditioner, lighting

✓ Open curtain receiving sunlight in the afternoon instead of turning on lamps

✓ Standby mode for electrical appliances i.e. computer, copy machine, fax machine, printer

✓ Setting timer to operate only in working hour for electrical devices i.e. coffee machine, drinking water dispenser, kettle

**3) Overtime**

Energy consumption decreases gradually compared to the time zone before the start of business.Limited partitions and management of the facility's operation efficiency is the essential points for energy conservation during this time zone, since air conditioning/lighting/outlet load is partial during the overtime.

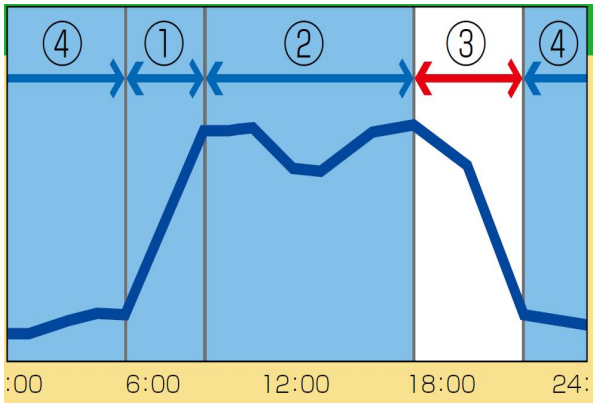



**Fig 10 Overtime (16.30-18.30 hr)**

Energy conservation measures for overtime zone could be suggested, as follows:

✓ Lightings in the office should only be turned on in a zone where employees stay working, and the partitions should be limited

✓ Lightings in the common area should be turned on partially

✓ Switch the power of the hot water supplier and warm-water cleaning toilets in floors without any employer left to night mode

**4) Non-used time (Night time/Holiday)**

Since this time zone does not include working hours, general air conditioning and most of the lightings are turned off, resulting in an extremely low energy consumption compared to daytime. However, as it is referred to as a "base load", amount of energy consumption of this time zone is consumed 24hours /7days. Thus, energy conservation will be very effective during this time zone.

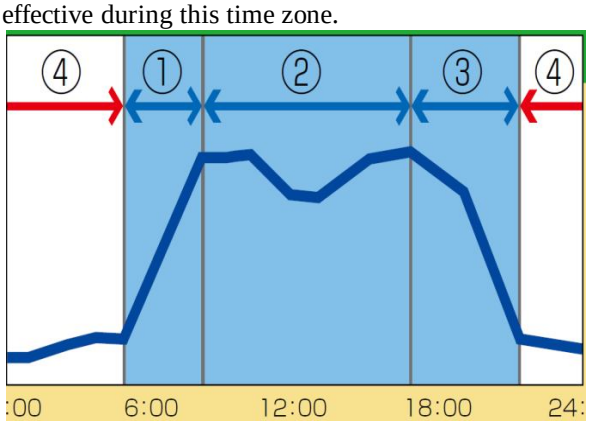



**Fig 11 Non-used time (Night time / Holiday)**

The energy conservation recommendation of this time period was suggested as follow.

✓ Confirm whether lightings and ventilation are necessary by making a tour of inspection at midnight to eliminate waste

✓ Consolidate the load of electrical transformers, and reduce the number of operating transformers to cut down iron loss (no-load loss)

✓ Reduce the number of elevators in operation.

✓ Turn off the vending machines at night time by timer control

✓ Renew transformers to high-efficiency top runner transformers to minimize loss

## CONCLUSIONS

President's office, PSU, comprises of three buildings; building 1, building 2, and building 3. Both building 1 and 3 have three floors, building 2 has four floors.The president's office has increasing electricity consumption equaled to 485,092, 574,020, and 574,560 unit (Watt) from 2013-2015. This costs 2,394,000 Bht (68,400 USD) in recent year (2015).The energy consumption is peak during working time (8.30 – 16.30 hr). Thus, users' activities for energy conservation greatly affect the amount of consumption.Reasonably, the energy saving is not only one's task responsibility but public participation is also required to provide sustainable academic community. Significantly, the most effective approach to save energy is to increase the awareness of the users and staff to switch off the room lights and equipment before leaving. Alternatively, this could also be achieved by assigning a person to switch off all lights and equipment after work hours.

## ACKNOWLEDGMENTS

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