

*A Study of Electricity Utilization in Beach Resort Hotels, Chonburi Province for Energy Conservation*

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**Abstract**

This research investigates the standard electricity utilization in beach resort hotels based on a survey of four 4-star beach resort hotels in Chonburi, Thailand that was conducted in 2014. The main objective of the project was to know proportion of electricity in End-Use Category. Each hotel has total usable areas of 34,878.50, 24,706.56, 17,533.40 and 10,910.56 m<sup>2</sup> with total air-conditioned areas of 17,364.45, 8,327.48, 5368.35 and 8,212.56 m<sup>2</sup> respectively. The results shown that the hotel with most areas in usable, air-conditioned space and using central air conditioning system has the minimum index value of electrical consumption in air conditioning system to air-conditioned area equal to 72.36 kWh/m<sup>2</sup>/year. Unlike other three hotels with using split type air conditioning system that have this value equal to 89.92, 103.67 and 136.21 kWh/m<sup>2</sup>/year. Every hotel has the lowest proportion of electricity in lighting system compared with electrical consumption of air conditioning system and electric-mechanical system, which accounted for 5 – 10% of total electricity utilization and the maximum value of lighting density power is lower than 12 W/m<sup>2</sup>, which is considered the standard of Thailand Energy Conservation Promotion Act. Moreover, the study also found that the hotel with usable area most has annual electricity consumption for electric-mechanical equipment system that most in refrigerators, followed by pumps and other kitchen equipment, respectively which accounted for 53% of total electricity utilization. Finally, the results can also use as guidelines for designing beach resort hotels, Chonburi province for energy conservation, including the use of air conditioning systems appropriately.

Keywords: Beach Resort Hotel, Chonburi Province, Standard Electricity Utilization

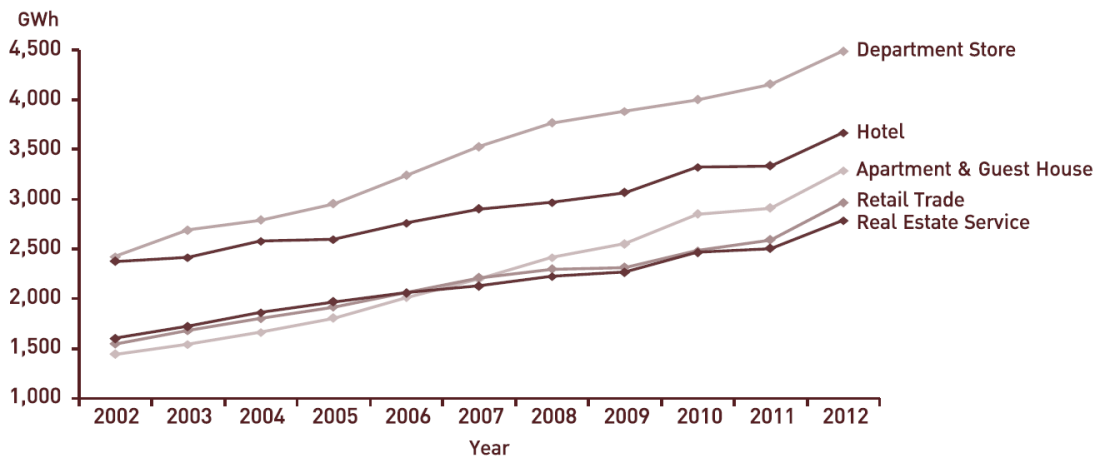
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## 1.Introduction

Nowadays, there are a lot of Beach Resort Hotels in Chonburi province, Thailand which provide 24-hour service (DEDE, 2005). The hotel business has highly using electricity ranked second from the department store which shown in figure 1.

Electricity Consumption by Commercial Cluster



**Figure 1:** Electricity demand in most commercial clusters continuously increased from 2002 to 2012. In 2012, the business & commerce that accounted for high electricity consumption were as follows: department stores, hotels, apartments & guest houses, retail trade and real estate services, respectively (EPPO, 2012).

Moreover, the Thai government also issued the energy conservation promotion launched by the ministry of energy. The resort including Beach Resort Hotel must do the survey and have to report the energy consumption, energy efficiency and potentials of energy conservation in order to determine the energy conservation targets and plans (Royal Thai Government Gazette B.E.2009, 2009, pp.7-12). This research aims to investigate and study the characteristics of electricity utilization and also to know the potentials of energy conservation in beach resort hotel, Chonburi province, Thailand. By explore the quantity of standard electricity utilization of four 4-star beach resort hotels, related to be the controlled building by The Energy Conservation Promotion Act B.E.2535 (1992). By choosing the samples of beach resort hotels in Chonburi province, the appropriate building orientation and the use of materials would be suitable to maximize the energy efficiency of the building envelope system, but still have the highly proper electricity consumption as well.

## 2.Thailand Energy Conservation Promotion Act B.E.2535 (1992)

Ministerial Regulation Prescribing Standard, Criteria, and Energy Management Procedures In Designated Factories and Buildings B.E. 2552 (1992) announced that hotels in Thailand including Beach Resort Hotels in Chonburi province must do the survey and have to report the energy consumption which can be achieved through the application of guidelines for building energy management (Royal Thai Government Gazette B.E.2009, 2009, pp.7-12). The status and potentials of energy conservation that is consistent with the energy conservation promotion act can be checked from the databases of the Department of Alternative Energy Development and Efficiency.

(DEDE, 2010) So the researcher has screened a benchmark for monitoring preliminary references of energy conservation potentials as shown in Table 1

**Table 1:** The reference index value from the Department of Alternative Energy Development and Efficiency (DEDE, 2010)

Lists	The reference index value from DEDE		
Electrical use for air-conditioned space per area (kWh/m <sup>2</sup> /year)	Average		
	172		
Electrical use for lighting system per area (kWh/m <sup>2</sup> /year)	Average		
	34.7		
Energy Use Intensity; EUI (Total electrical use per total area) (kWh/m <sup>2</sup> /year)	Reference		
	Average	Standard	High Efficient
	173.2	117.0	101.7
Lighting Power Density (LPD) (W/m <sup>2</sup> )	Average		
	7.8		
	Standard		
	12		
The proportion of air-conditioned space per total area (%)	67		
Electricity Utilization Proportion (%)	Air Conditioning System	Lighting System	Other System
	66	20	14

### 3. Methodology

This is a quantitative research to investigate and study the characteristics of electricity utilization and also to know the potentials of energy conservation in beach resort hotel, Chonburi province, Thailand. By explore the quantity of standard electricity utilization of four 4-star beach resort hotels, related to be the controlled building by The Energy Conservation Promotion Act B.E.2535 (1992). By choosing the samples of beach resort hotels in Chonburi province, the appropriate building orientation and the use of materials that would be suitable to maximize the energy efficiency of the building envelope system, but still have the highly proper electricity consumption as well. (Supornsahasransi, 2014) The 4 sample hotels were also selected by the beach resort hotels with area larger than 10,000 square meters, with 4-stars standard according to the Thailand Department of Tourism, classed under type-3 hotels by Thailand Hotel Act BE.2547 (2004) which are those hotels which provide accommodation, restaurant facilities and conference rooms to their guests, durations of business operation time are more than 10 years and the distances from Chonburi eastern coast are not more than 500 meters. All samples including 1) RAVINDRA BEACH RESORT & SPA, 2) THE GREENPARK RESORT, 3) SUNSHINE

GARDEN RESORT and 4) SUNSHINE HOTEL & RESIDENCES which contains physical characteristics of the buildings information as shown in Figure 2

Sampled Hotels	The Physical Characteristics of Hotel Building
<p><b>RAVINDRA BEACH RESORT &amp; SPA (277 rooms)</b></p> 	<p><b>The Central Facilities</b></p> <ul style="list-style-type: none"> <li>- Lobby Hall and Basement Parking : 2 Floors, 1 Building</li> <li>- The Convention Hall and BACK OF THE HOUSE : 2 Floors, 1 Building</li> <li>- ALL DAY DINING Restaurant and FACILITIES : 2 Floors, 1 Building</li> <li>- Beach Front Restaurant : 1 Floor, 1 Building</li> <li>- Spa and massage: 1 Floor, 1 Building</li> </ul> <p><b>Accommodation Building</b></p> <ul style="list-style-type: none"> <li>- Accommodation Room : 8 Floors, 2 Buildings</li> <li>- POOL VILLA : 1 Floor, 4 Buildings</li> <li>- POOL VILLA : 2 Floors, 1 Building</li> </ul>
<p><b>THE GREENPARK RESORT (194 rooms)</b></p> 	<p><b>The Central Facilities</b></p> <ul style="list-style-type: none"> <li>- Lobby Hall: 1 Floor, 1 Building</li> <li>- All day dining restaurant , Meeting room and BACK OF THE HOUSE : 3 Floors, 1 Building</li> <li>- Convention Room : 3 Floors, 1 Building</li> </ul> <p><b>Accommodation Building</b></p> <ul style="list-style-type: none"> <li>- Accommodation room : 3 Floors, 4 Buildings</li> <li>- Accommodation room : 4 Floors, 1 Building</li> <li>- The Bungalow : 1 Floor, 18 units</li> </ul>
<p><b>SUNSHINE GARDEN RESORT (141 rooms)</b></p> 	<p><b>The Central Facilities and Accommodation</b></p> <ul style="list-style-type: none"> <li>- Lobby Hall and Residential room : 2 Floors, 1 Building</li> <li>- All Day Dining Restaurant and BACK OF THE HOUSE : 1 Floor, 1 Building</li> <li>- Convention Room : 1 Floor, 1 Building</li> </ul> <p><b>Accommodation Building</b></p> <ul style="list-style-type: none"> <li>- Residential: 3 Floors, 1 Building</li> <li>- Bungalow: 1 Floor, 17 Buildings</li> </ul>
<p><b>SUNSHINE HOTEL &amp; RESIDENCE (275 rooms)</b></p> 	<p><b>The Central Facilities and Accommodation</b></p> <ul style="list-style-type: none"> <li>- Lobby, All Day Dining Restaurant , Residential Unit, Meeting Room and BACK OF THE HOUSE: 7 Floors, 1 Building</li> <li>- FACILITIES , CAFÉ and Residential Unit 12 Floors, 1 Building</li> <li>- Residential and Roof top swimming pool 7 Floors, 1 Building</li> <li>- Residential Building: 1 Building</li> </ul>

Figure 2: Physical characteristics of the buildings information.

The study consists of 4 major steps which are:

- 1) The basic statistical data collection
- 2) Survey of Standard Electricity Utilization; SEU
- 3) The actual electrical data collection
- 4) To analyze and interpret data that is detailed as follows:

*Step 1: The basic statistical data collection.*

The basic statistical data collection is divided into 4 sections: 1) Size of areas, 2) Number of guestrooms, 3) Average occupancy rate, and 4) Durations of business operation time. The data collected by the survey, and asked for information courtesy of sampled hotels entrepreneurs

*Step 2: Survey of Standard Electricity Utilization; SEU*

Quantity of Standard Electricity Utilization; SEU is derived from the characteristics of electricity utilization which owned by 12 months individual departments operation of sampled hotels. The Units of electrical consumption is “kilowatt-hours (kWh)” made from various factors that affect energy consumption such as size of usable area, number of working hours, number of workers, hotel’s operational characteristics, electrical device operational characteristics, etc. This information is derived from the basis physical collecting data and the survey by interviewing experts, entrepreneurs and employees of the hotel. Including the application of Standard Electricity Utilization Survey Forms from the Ministry of Energy (EPPO, 2015), as shown in Table 2

**Table 2:** Standard Electricity Utilization Survey Forms applied from the Ministry of Energy. (EPPO, 2015)

Name of Area	Device in each room	The Proportion of Work	Power (Watts)	Number of Device	Total Power (Watts)	Hours of use per day	Days of use per month	The Electrical units (kWh/Y)
Data part 1	Data part 2	Data part 3	Data part 4	Data part 5	Data part 6	Data part 7	Data part 8	Data part 9

*Step 3: The actual electrical data collection.*

The actual electrical data collection is the quantity of units actually used for total 12 months. The Units of electrical consumption is “kilowatt-hours (kWh)” derived from invoice/bill each month. This data is for analyze the potentials of Energy Conservation by comparison with the reference index from the Department of Alternative Energy Development and Efficiency (DEDE).

*Step 4: Analysis and interpretation of data.*

- 1) Preliminary Classification of standards electricity utilization survey is divided into three systems: a) air conditioning system, b) lighting system and c) electric-mechanical system by classifying each system based on the end-use electricity and types of electrical devices.
- 2) Calculated Energy Use Intensity (EUI) (kWh/m<sup>2</sup>) by comparing between Energy Use Quantity and size of area in order to realize the potentials of energy conservation according to reference index from DEDE.

3) Comparing electricity utilization information of the 4 sampled hotels to find the conclusion.

#### 4.Results & Conclusions

The basic statistical data of the sampled hotels for the study are shown in Table 3 with the results on issues as follows:

**Table 3:** The basic statistical data of all sampled hotels

<b>Lists</b>	<b>RAVINDRA BEACH RESORT &amp; SPA</b>	<b>THE GREENPARK RESORT</b>	<b>SUNSHINE GARDEN RESORT</b>	<b>SUNSHINE HOTEL &amp; RESIDENCES</b>
<b>Number of Rooms (Room)</b>	277	194	141	293
<b>Total Usable Area (Square Meter)</b>	34,878.00	24,706.56	17,533.40	10,910.56
<b>Total Conditioned Area (Square Meter)</b>	17,364.45	8,327.48	5,368.00	8,212.56
<b>The Proportion of Air- Conditioned space to Usable Area</b>	49.78%	33.71%	29.30%	75.27%
<b>The Average Occupancy Rate (for the year 2014)</b>	72.81%	80.87%	53.88%	81.05%
<b>Duration of Business Operations.</b>	2003-2014 (11 years)	2002-2014 (12 years)	1986-2014 (28 years)	1984-2014 (30 years)
<b>The Distance from the Sea</b>	By Sea (with private beach)	200 meters	266 meters	187 meters
<b>Type of Air- Conditioned system</b>	Central Air- Conditioning Type	Split Type	Split Type	Split Type

#### 4.1 The characteristics of electricity utilization

The survey results are shown in Table 4 which found that “RAVINDRA BEACH RESORT & SPA”, the hotel with most areas in usable and using central air conditioning system has the highest electrical consumption equal to 3,643,737.82 kWh/year .And the most annual electrical consumption is utilized for electric-mechanical equipment system which accounted for 53% of total electricity utilization. Unlike other three hotels (THE GREENPARK HOTEL RESORT, SUNSHINE GARDEN RESORT and SUNSHINE HOTEL & RESIDENCES) with using split

type air conditioning system that the most annual electrical consumption is utilized for air conditioning system, which accounted for 48-63% of total electricity utilization, followed by the electric-mechanical system which accounted for 31-46% of total electricity utilization. Furthermore, it was found that all sampled hotels have the minimum electricity utilization in lighting system which account for only 6-10%

**Table 4:** The characteristics of electricity utilization in all sampled hotels

Lists	RAVINDRA BEACH RESORT & SPA	THE GREENPARK RESORT	SUNSHINE GARDEN RESORT	SUNSHINE HOTEL & RESIDENCE
Air Condition System (kWh/year)	1,256,540.53 <b>34%</b>	748,836.24 <b>60%</b>	556,506.14 <b>63%</b>	1,118,596 <b>48%</b>
Lighting System (kWh/year)	350,234.42 <b>10%</b>	79,042.68 <b>6%</b>	54,925.72 <b>6%</b>	129,603.47 <b>6%</b>
Mechanical System- Electrical Equipment (kWh/year)	2,036,962.87 <b>56%</b>	418,447.13 <b>34%</b>	270,076.72 <b>31%</b>	1,087,273.30 <b>46%</b>
<b>Total</b> (kWh/year)	<b>3,643,737.82</b> <b>100%</b>	<b>1,246,326.05</b> <b>100%</b>	<b>881,508.58</b> <b>100%</b>	<b>2,335,472.77</b> <b>100%</b>
<b>Propor tion</b>  Air-Con Lighting Mechani cal- Electrical equipment				

#### 4.1.1 The characteristics of electricity utilization in air conditioning system

The results found that the hotel using central air conditioning system (RAVINDRA BEACH RESORT & SPA) has the most electrical consumption in Chiller Plants which accounted for 76.1% of total electricity utilization in air-conditioning system, which sent cooling to several local areas that most for guestrooms, followed by restaurants and other facilities.

Unlike other three hotels (THE GREENPARK HOTEL RESORT, SUNSHINE GARDEN RESORT and SUNSHINE HOTEL & RESIDENCES) with using split type air conditioning system that the most annual electricity consumption is utilized for guestrooms (rank#1) which accounted for 90.7-96.7% of total electricity utilization in air-conditioning system followed by restaurants and other facilities (rank#2) and meeting rooms (rank#3). Except SUNSHINE HOTEL & RESIDENCES that its rank#3 utilization is BACK OF THE HOUSE as shown in Table 5

**Table 5:** The characteristics of electricity utilization in air conditioning system

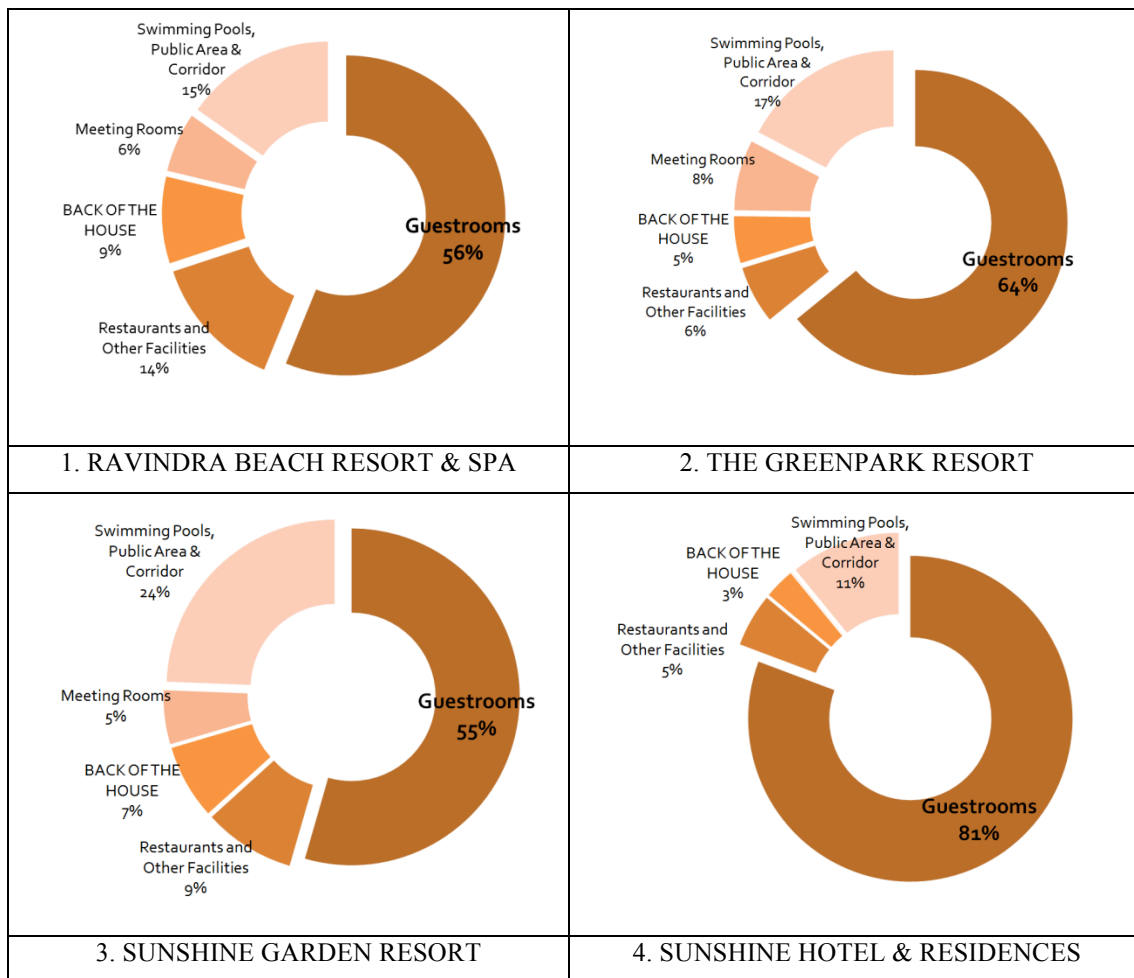
<p>Restaurants &amp; Other Facilities 5% BACK OF THE HOUSE 1% Meeting Rooms 1% Central AC Type Equipment (Chiller Plant) 76% Guestrooms 17%</p>	<p>BACK OF THE HOUSE 0.7% Meeting Rooms 0.8% Restaurants &amp; Other Facilities 3% Guestrooms 95.5%</p>
<p>1. RAVINDRA BEACH RESORT &amp; SPA (Central air conditioning system)</p>	<p>2. THE GREENPARK RESORT (Split type air conditioning system)</p>
<p>BACK OF THE HOUSE 0.4% Meeting Rooms 0.6% Restaurants &amp; Other Facilities 2% Guestrooms 97%</p>	<p>BACK OF THE HOUSE 0.8% Meeting Rooms 0.2% Restaurants &amp; Other Facilities 8% Guestrooms 91%</p>
<p>3. SUNSHINE GARDEN RESORT (Split type air conditioning system)</p>	<p>4. SUNSHINE HOTEL &amp; RESIDENCES (Split type air conditioning system)</p>



### 4.1.2 The characteristics of electricity utilization in lighting system

The results showed that all sampled hotels have the most electricity utilization in lighting system for illuminate the guestrooms which accounted for 56.2 - 80.7% of the total electricity utilization in lighting system. Following by ‘Swimming Pools, Public Area & Corridor’ (rank#2) which accounted for 11 - 15.3% of the total electricity utilization in lighting system, ‘Restaurant and Others Facilities’ (rank#3). Except THE GREENPARK RESORT that that its rank#3 utilization is ‘Meeting Rooms’ as shown in Table 6

**Table 6:** The characteristics of electricity utilization in lighting system

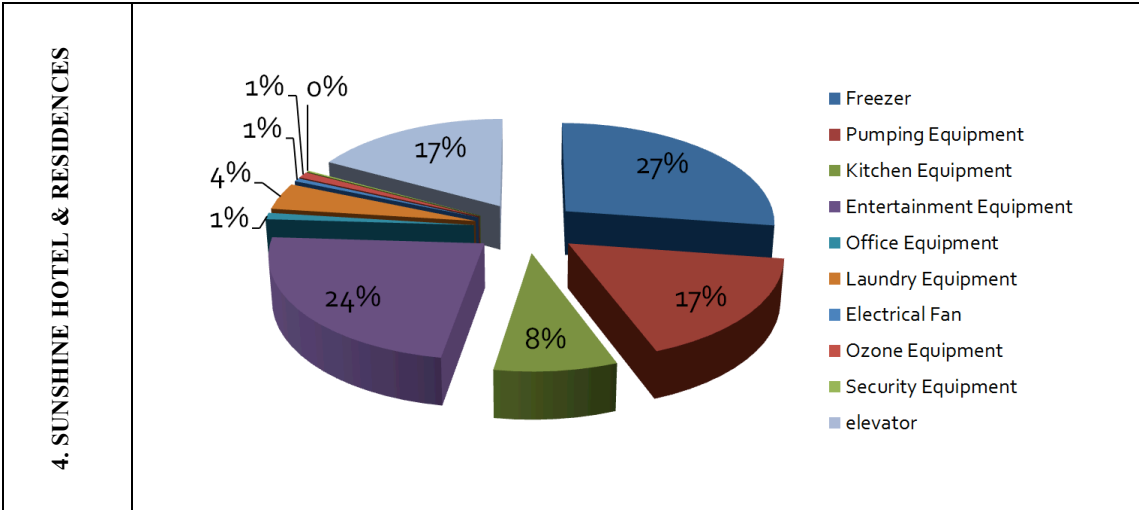


### 4.1.3 The characteristics of electricity utilization in electric-mechanical system

The results can be classified the types of electric-mechanical equipment in sampled hotel into 13 types including refrigeration equipment, pumping equipment, kitchen equipment, entertainment devices, office equipment, laundry equipment, electric fans, ozone equipment, security equipment, fitness equipment, spa equipment, heater backup equipment and elevators. All sampled hotels have the most electricity utilization in electric-mechanical system for refrigeration equipment especially in restaurants and guestrooms. And also notice that all sampled hotels have high electricity utilization in electric-mechanical system for pumping equipment, kitchen equipment, entertainment devices and elevators, etc. The details are shown in Table 7

**Table 7:** The characteristics of electricity utilization in electric-mechanical system

<p style="writing-mode: vertical-rl; transform: rotate(180deg);"><b>1. RAVINDRA BEACH RESORT &amp; SPA</b></p>	<p>Detailed description: This pie chart illustrates the distribution of electricity usage across various equipment at Ravindra Beach Resort &amp; Spa. The data is as follows:</p> <table border="1"> <thead> <tr> <th>Equipment Category</th> <th>Percentage</th> </tr> </thead> <tbody> <tr><td>Freezer</td><td>22%</td></tr> <tr><td>Pumping Equipment</td><td>19%</td></tr> <tr><td>Kitchen Equipment</td><td>18%</td></tr> <tr><td>Electrical Fan</td><td>11%</td></tr> <tr><td>Entertainment Equipment</td><td>10%</td></tr> <tr><td>Laundry Equipment</td><td>10%</td></tr> <tr><td>Office Equipment</td><td>5%</td></tr> <tr><td>Security Equipment</td><td>2%</td></tr> <tr><td>Exercise Equipment</td><td>1%</td></tr> <tr><td>SPA Equipment</td><td>1%</td></tr> <tr><td>Heater backup Equipment</td><td>1%</td></tr> <tr><td>elevator</td><td>0%</td></tr> <tr><td>Ozone Equipment</td><td>0%</td></tr> </tbody> </table>	Equipment Category	Percentage	Freezer	22%	Pumping Equipment	19%	Kitchen Equipment	18%	Electrical Fan	11%	Entertainment Equipment	10%	Laundry Equipment	10%	Office Equipment	5%	Security Equipment	2%	Exercise Equipment	1%	SPA Equipment	1%	Heater backup Equipment	1%	elevator	0%	Ozone Equipment	0%
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**4.2 Potentials of energy conservation**

By comparing the standard electricity utilizations of all sampled hotels. It was found that the hotel with most areas in usable, air-conditioned space and using central air conditioning system (RAVINDRA BEACH RESORT & SPA) has the minimum index value of electrical consumption in air conditioning system to air-conditioned area equal to 72.36 kWh/m<sup>2</sup>/year. Unlike other three hotels (THE GREENPARK RESORT, THE SUNSHINE GARDEN RESORT, SUNSHINE HOTEL & RESIDENCE) with using split type air conditioning system that have this value equal to 89.92, 103.67 and 136.21 kWh/m<sup>2</sup>/year, respectively and these are not exceed 172 kWh/m<sup>2</sup>/year which is the average of reference index value by Department of Alternative Energy Development and Efficiency (DEDE). The maximum value of lighting density power is lower than 12 W/m<sup>2</sup>. In addition, Energy Use Intensity (EUI) is not exceed 117 kWh/m<sup>2</sup>/year which is considered the standard of Thailand Energy Conservation Promotion Act as shown in Table 8

**Table 8:** Potentials of energy conservation

Lists	RAVINDRA BEACH RESORT & SPA	THE GREENPAR K RESORT	SUNSHINE GARDEN RESORT	SUNSHINE HOTEL & RESIDENCE	The reference value from the DEDE.
The proportion of air-conditioned space per area (%)	49.78%	33.71%	29.30%	75.27%	67%
Electrical Consumption for air conditioning system (kWh/m <sup>2</sup> /year)	72.36	89.92	103.67	136.21	Average
					172
Electrical Consumption for lighting system (kWh/m <sup>2</sup> /year)	10.04	3.19	3.13	11.88	Average
					34.7
Lighting Power Density (W/m <sup>2</sup> )	3.84	1.16	0.96	2.99	Average
					7.
					Standard
Energy Use Intensity (EUI) (kWh/m <sup>2</sup> /year) (Actual power consumption)	91.63	38.82	33.87	116.83	12
					Average
					173.2
					Standard
					117

### Recommendation

The results from this research study can also use as guidelines for designing 4-star beach resort hotels, Chonburi province, Thailand which controlled the operation of business and hotel facilities in related to the sampled hotels in this research. To achieve the potentials of energy conservation follow by the Energy Conservation Promotion Act B.E.2535 (1992), including the proposal of guidelines for selecting the appropriate use of air conditioning system, and futures studies on electrical budget plan for economics feasibility.

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