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Energy Use and Consumption of Thailand's Commercial Buildings in 2010

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Abstract. This study is a part of a project that aims at making an energy consumption database for buildings on a national scale in Asia countries. This paper describes the outline of surveyed buildings and the energy consumption in Thailand of 2010. Survey items are the building scale, the proportion of main application, the business hours, the ownership form, the combination of energy usage, the completion year, and so on.1287 building were surveyed and the energy consumption in 1101 buildings were analyzed. In this paper, the statistical method is applied to process the survey data and the current situation of energy consumption of commercial buildings in Thailand is discussed according to the different survey items.

Keywords: Commercial Buildings, energy consumption, Thailand

1. Introduction

In 2010, final energy consumption by economic sector showed the expanded consumption in all sectors comprising energy consumed in agricultural sector amounted to 3,701 ktoe, an increase of 6.4% from the previous year, industrial sector 25,871 ktoe, increased 7.5%, residential sector 11,013 ktoe, increased 9.2%, commercial sector 5,520 ktoe, increased 11.7% and transportation sector 25,061 ktoe, increased 3.8%. Of this total, the greatest share of 36.4% was from energy consumed in industrial sector, followed by transportation sector, residential sector, commercial sector and agricultural sector shared 35.2%, 15.5%, 7.7% and 5.2% respectively [1], [2]. Although the commercial and residential sectors are not the largest energy consumption sectors in Thailand, however, these two sectors hold the potential for improvements in energy efficiency, as the occupants in both residential and commercial buildings continue to add plug loads.

The objective of this research is to analyze the characteristic of energy utilization of several building types in Thailand's commercial sector in order to observe the potential for implementation of the energy efficiency concept in future study.

2. Outline of the Survey

2.1. Survey objects

In this study, building information were surveyed for professional use in each field building type of Thailand in 2010, which including department store, education, hospital, hotel and office facilities of Thailand in all region of the country [3].

2.2. Survey items

Building's data is mainly for energy consumption which including [4]:

1. Building outline: building type, business type, floor space, building system, opening time, etc.

2. Energy consumption by system and fuel type for energy utilization.

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From the cooperation with Government Sector for data collection [5], [6], 1287 designated buildings were investigated. Among them, the effective numbers are chosen through the statistical method is done as shown in the Fig. 1 [7]. Firstly, except the buildings whose completion year, total floor area and annual electric power are not be listed. Secondly, except the buildings whose energy consumptions per unit area are over 10 times of average or below one-tenth of average are removed. Finally, the data of 1101 commercial buildings as the effective numbers are obtained to analyze, as shown in the Table 1.

Fig. 2 shows the map of Thailand, there are 74 provinces and capital Bangkok. And the country is been divided into four regions. The capital Bangkok belongs to the central. Fig. 3 shows the effective numbers of the difference usage buildings and regions in Thailand. It is found that central part of the country has the max no. of building compared to other region. However among those building in central region, these buildings were beated in Bangkok area almost 63%, which contain 48%, 63%, 52%, 74%, 71%, of department store, education, hospital, hotel and office.

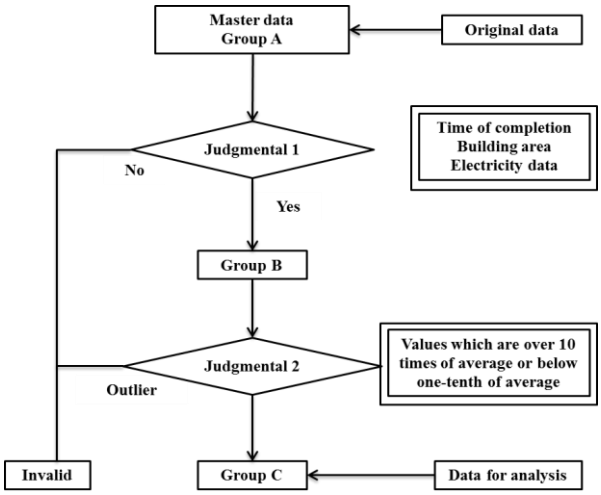

Fig. 1: Judgment of effective number

Table 1: Effective number of the building system with different function

Usage	Survey Number	Effictive Number	Effective Rate
department	334	324	97%
education	121	91	75%
hospital	168	137	82%
hotel	173	148	86%
office	491	401	82%
Total	1287	1101	86%

Fig. 2: Map of Thailand

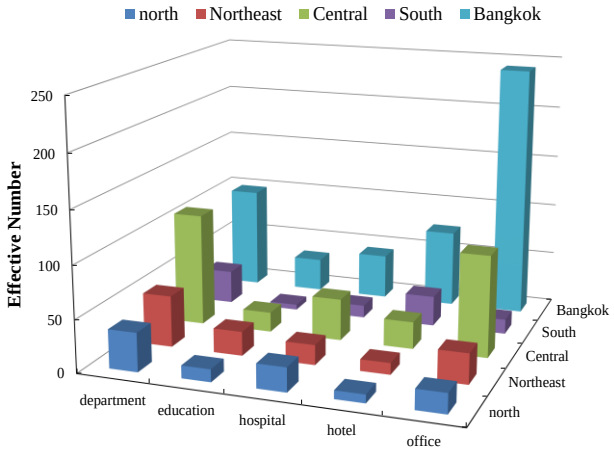

Fig.3: effective number by the building usage and region

3. Outline of the Buildings Surveyed

3.1. Building scale

The analysis of building scale by usages has been done [8] which illustrated in Fig. 4. Large-scale construction building with the total floor area is more than 10000 ㎡ accounted for 86% of the entire buildings surveyed. From the perspective of the building by usage, the large-scale construction number is more than 90% of the entire buildings in the education, hospital and hotel facilities. Building scale of office facilities and department facilities are focus on 30000 ㎡ or less, accounted for about 70% of their own.

3.2. Time of completion

Percentages of the time of completion by usages were analyzed [9] which shown in Fig. 5. In Thailand the percentage of the buildings which were completed before the 1990s is 31% of the total, the percentage of the buildings which were completed in the 1990s is the largest, accounting for 42 percent of the total. The percentage of the buildings which were completed in 2000 after is 27% of the total. In education facility, the percentage of the buildings which were completed before the 1990s accounted for 57%, compared to other facilities, the building age is long.

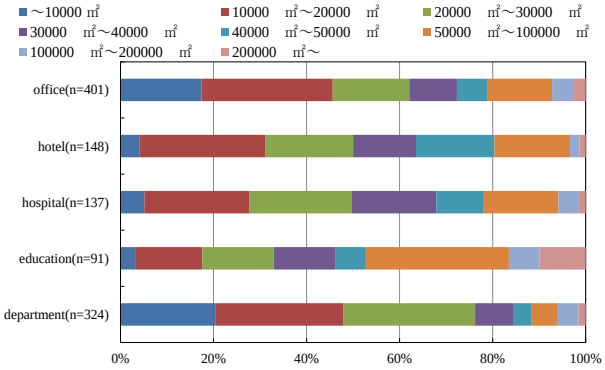

Fig. 4: Percentages of the building scale by usages

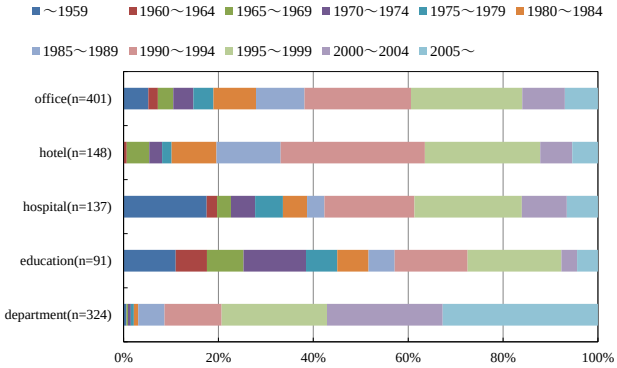

Fig. 5: Percentages of the time of completion by usages

3.3. HVAC area

Generally, most buildings have the A/C system in order to provide thermal comfort. In this study, the HVAC introduced area, accounting for 62% of the whole building area. The rate of introduction of HVAC of department facility is the largest, reached to 84%.The following is made in order, hotel, hospital, office and educational, which accounted for 69%, 55%, 54%, 46% as shown in Fig. 6.

3.4. The different combination

Fig. 7 shows the percentage of energy sources in order to utilize building systems. Electricity is the largest proportion which accounting for 49% of total energy source in 2010. The combination of the electricity and LPG has the least proportion, accounting for 2% of the whole. On department and office facility, the proportion of the combination of the only electricity are more the 50% of their whole. On education facility, there are two kinds of combinations, only electricity, electricity and petroleum, the proportion of only electricity accounted for 91%.

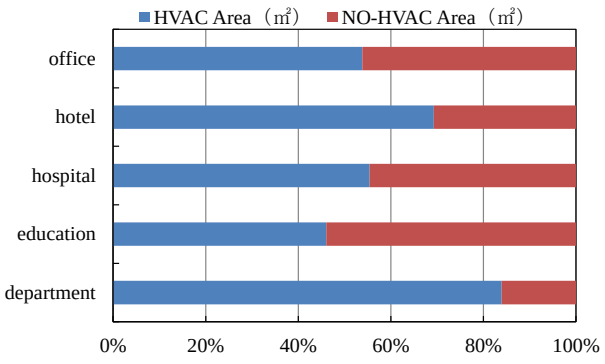

Fig. 6: Percentages of the HVAC area by usages

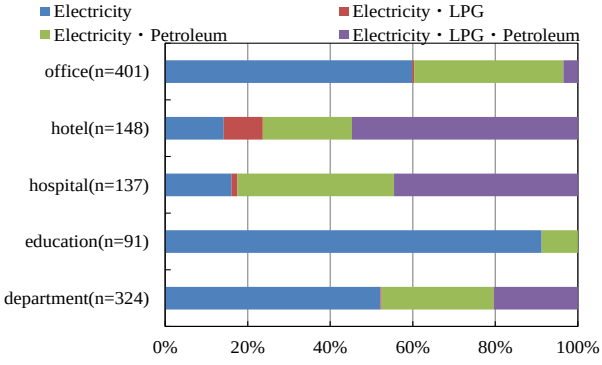

Fig. 7: Percentage of the different combination by usages

4. Situation of Energy Consumption

4.1. Primary energy consumption by region

Fig. 8 shows the primary energy consumption by regions. Compared to other areas, Bangkok has the largest annual primary energy consumption by 40377 TJ/year due to the concentration of commercial building is more than 50% in Bangkok area. Bangkok belongs to Thailand's central region, and its annual primary energy consumption accounted for 69% of total energy consumption of central region. North area and south area have relatively few buildings, so the annual primary energy consumptions are relatively low.

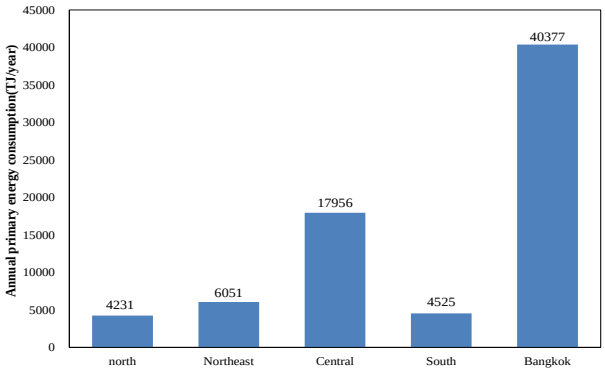

Fig. 8: Primary energy consumption by regions in 2010

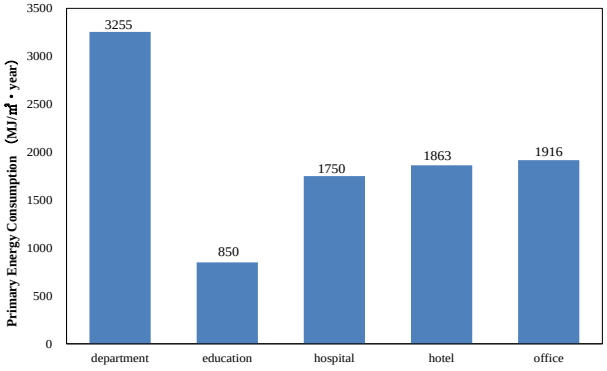

Fig. 9: Primary energy consumption by usages in 2010

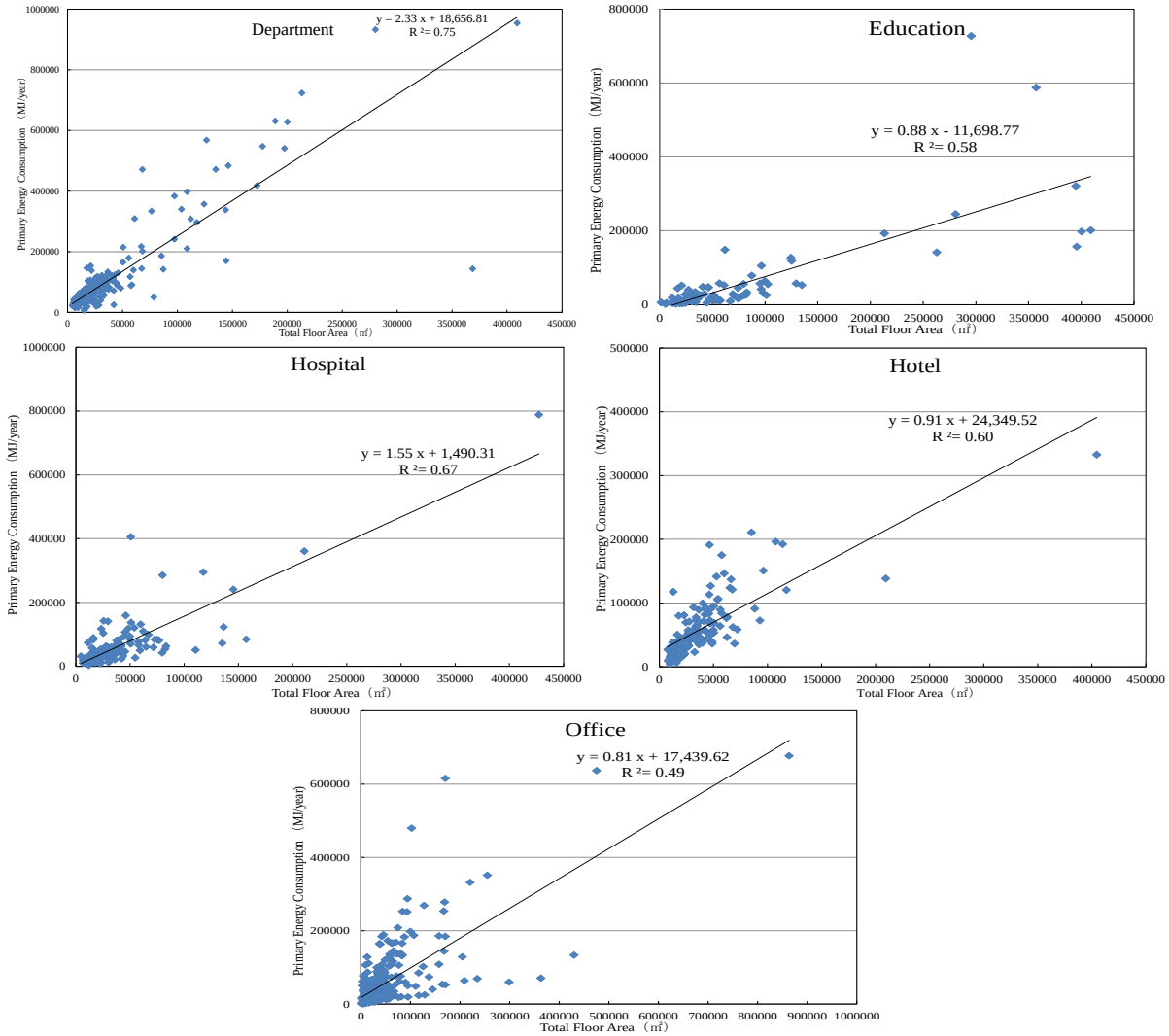

Fig. 10: Analysis of dispersion map of floor area and the primary energy consumption by usages

4.2. Primary energy consumption by usage

Fig. 9 shows the Primary energy consumption by usages. Educational facility has the smallest primary energy consumption per unit by 850MJ / m ²year, considered that opening hours of day is short and closed

long time. Department facility has the largest primary energy consumption per unit by 3255MJ / m ²year, considered that opening hours of day is long and annual has many operating days.

4.3. Floor area and energy consumption relationship

Fig. 10 shows the analysis of dispersion map of floor area and the primary energy consumption by usages [10]. From the Fig. constant correlation can be seen of the total floor area and primary energy consumption of the building in each use. The coefficient of determination of total floor area and primary energy consumption of department is 0.75, compared to other uses, has the highest correlation. The coefficient of determination of office is 0.49, compared with other uses has the lowest correlation.

5. Conclusions

This study analyses the characteristic of energy consumption and affect parameters of Thailand's designated building in 2010 with different building function and scale, relationship between primary energy consumption and several parameters are discussed. Conclusions are as follow:

- The central part of the country has the max number of building compared to other region. And almost 63% of those buildings in central region were beated in Bangkok area which consequence to consume highest primary energy consumption .
- The percentage of the buildings which were completed in the 1990s is the largest, accounting for 42 percent of the total.
- Educational facility has the smallest primary energy consumption per unit by 850MJ / m ²year, considered that opening hours of day is short and closed long time.

In future, add the energy consumption in 2011 of Thailand commercial building, and compared with 2010 which is necessary to add the survey items for the multiple regression analysis including the more variables. In addition, the accurate data survey should be done to prove the precision of analysis. Future energy situation data of Thailand commercial building will take into account in order to predict the future energy utilization and conservation measure.

6. References

[1] Department of Alternative Energy Development and Efficiency, Thailand Energy situation 2010, from http://www. dede.go.th

[2] Department of Alternative Energy Development and Efficiency, Electric power in Thailand 2010, from http://www. dede.go.th

[3] Matsusako Keisuke, Study on the Energy Consumption Data Base Construction of the Non-house Buildings in Kyushu : Part4 Outline of Surveyed Buildings and Measures to Energy Conservation, Architectural Institute of Japan, Kyusyu Branch.2, Environmental Systems(48), pp.209-212, March 2009

[4] Aoki Nobuaki, Study on the Energy Consumption Data Base Construction of the Non-house Buildings in Kyushu : Part 2 Outline of the Objective Buildings, Architectural Institute of Japan, Kyusyu Branch.2, Environmental Systems(47), pp.149-152, March 2008

[5] Energy Policy and Planning Office, from http://www. Eppo.go.th

[6] Department of Alternative Energy Development and Efficiency, from http://www. dede.go.th

[7] Xingzhi Shi, Weijun Gao, Analysis of Energy Consumption of Public Buildings in Kitakyushu (2011)

[8] Hosaka keichi, Kametani shigeki, Takaguchi Hirota, Study on the Environmental Load Database for Buildings Energy and water consumption and CO2 emission in Kanto Area (2007)

[9] Arai Tsuneyasu, Study on the Energy Consumption Data Base Construction of the Non-house Buildings in Kyushu : Part 3 the Actual Condition of Energy Consumption , Architectural Institute of Japan, Kyusyu Branch.2, Environmental Systems(47), pp.153-156, March 2008

[10] Yoda Hirotoshi, Study on the Energy Consumption Data Base Construction of the Non-house Buildings in Kyushu : Part 1 Outline of the Investigation and its Method, Architectural Institute of Japan, Kyusyu Branch.2, Environmental Systems(47), pp.145-148, March 2008