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A study of electricity use performance of Hong Kong office tenants

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ABSTRACT

In 2010, a consultation document, Hong Kong's Climate Change Strategy and Action Agenda, was published proposing a voluntary carbon intensity reduction target of 50–60% by 2020 (from the 2005 level). In terms of sectoral contribution to Hong Kong's GHG emissions, electricity generation is the largest source of local GHG emissions. It accounted for about 67% of total emissions in 2008, and close to 90% of electricity consumption is related to buildings, within which Commercial buildings consumed around 65% electricity in 2010. Electricity consumed by buildings contributes to about 60% of Hong Kong's GHG emissions. Hence, electricity conservation of commercial buildings becomes one of the tools for GHG emissions. We present the results of a survey study on the energy consumption performance of the office tenants.

1. INTRODUCTION

Electricity consumed by buildings contributes to about 60% of Hong Kong's GHG emissions. Hence, electricity conservation of commercial buildings becomes one of the tools for GHG emissions. Before proposing any conservation and efficiency measures, an extensive survey should be conducted and in-depth field data about electricity consumption levels and extent of use of energy efficient equipment for some commercial buildings should be collected.

In this paper, we present the results of a survey study on the existing office building operational electricity performance. In particular, we focused on the behavior and characteristics of the office tenants.

According to Rating and Valuation Department (R&VD), Hong Kong Property Review, private office buildings in Hong Kong are classified by a grading scheme Grade A, B, C Office with respect to the nature and air-conditioning system of building shown as follows:

Grade A - modern with high quality finishes; flexible layout; large floor plates; spacious, well-decorated lobbies and circulation areas; effective central air-conditioning; good lift services zoned for passengers and goods deliveries; professional management; parking facilities normally available.

Grade B - ordinary design with good quality finishes; flexible layout; average-sized floor plates; adequate lobbies; central or free-standing air-conditioning; adequate lift services, good management; parking facilities not essential.

Grade C - plain with basic finishes; less flexible layout; small floor plates; basic lobbies; generally without central air-conditioning; barely adequate or inadequate lift services; minimal to average management; no parking facilities.

Hence, the building samples were drawn from the building list of Hong Kong Property Review (2013) in accordance with the distribution of Grade A, B, C buildings in Hong Kong. The randomly drawn samples were used to fill up the above-mentioned energy consumption groups in accordance with the types of air-conditioning system used in their building

2. SAMPLING FRAME

The sampling frame follows stratified sampling method. From Hong Kong Property Review (2013), we can have the distribution of floor are by office grade shown in Table 1.

Table 1: Distribution of office by Grade

Office Type	Grade A	Grade B	Grade C
Total Area (m^2)	6,744,000	2,424,700	1,520,300
Percentage	60%	25%	15%
Number of Sample required	60	30	30

In order to enhance the representativeness of the sample, the samples were randomly selected from seven districts with the corresponding office grades. The % sample allocation for each District followed the district distribution in Hong Kong Property Review (2013) shown in Table 2.

Table 2: Distribution of office grade by district

District no.	Name	Grade A	Grade B	Grade C
1	Sheung Wan	3.42%	14.10%	27.19%
2	Central	23.84%	14.48%	11.45%
3	WanChai/CausewayBay	13.48%	23.51%	20.67%
4	North Point/ QuarryBay	11.00%	6.24%	3.99%
5	Tsimshatsui	12.03%	13.05%	13.33%
6	Yau Ma Tei/ Mong Kok	4.96%	12.68%	13.85%
7	Others	31.28%	15.94%	9.51%

The office tenants of the selected building are randomly selected for survey. In the survey, about 120 observations are the expected sample size.

3. DATA DESCRIPTION

The energy end-use information and other energy consumption factors were collected, from which we can analysis some properties of energy consumption due to the difference in physical, operational and types of equipment used in the office.

3.1 Energy Consumption Indicator: The energy consumption indicator can be represented by Energy Use Intensity (EUI), the annual energy consumption (kWh) per unit floor area (m2) shown in Table 3.

Table 3: Summary of energy consumption indicator (EUI)

EUI (kWh/m2)	Grade A	Grade B	Grade C
Average	145.76	130.95	168.35
Minimum	24.51	55.49	24.65
Maximum	497.43	284.61	869.35
Standard deviation	89.75	63.11	135.73
No. of building samples	63	33	36

3.2 Energy consumption factors: Survey was carried out to obtain sufficient data to represent the energy consumption characteristics (factors), e.g., weekly operation hours, lighting intensity, etc., shown in Table 4.

Table 4. Average of energy consumption factors by office grade

Subject No.	Unit	Grade A	Grade B	Grade C
Floor Area	m2	1071.98	139.22	115.52
Weekly Operation Hours	hour	52.54	50.86	50.68
Staff Number	Number	115.50	8.97	8.54
Lighting Intensity	W/m2	19.97	19.92	19.29
Central A/C	0=No, 1=Yes	0.97	0.76	0.25
Air Side Distribution Provided by Landlord	0=No, 1=Yes	0.35	0.06	0.00
% of server room area	percentage	0.83	0.00	0.00
Desktop	number	114.21	10.03	9.92
Printer and Photocopier	number	18.37	2.00	2.42
Server	number	4.05	0.52	0.36

*% of server room area having dedicated A/C system to the total IFA area

4. OBSERVATIONS AND DISCUSSIONS

4.1 Properties of EUIs by office grade

From Table 3 and Table 4 above, we can find that Grade C has the largest variance of EUI and smallest average floor area respectively. However, Grade C's average EUI is the largest as well. It is expected since majority of Grade C's tenants need to pay their utility bills including their own air conditioning services (no central air conditioning service). Comparing with Grade A and B office tenants, Grade A's use more electricity per floor area in general, 145.76 kWh/m2 of Grade A larger than 130.95 kWh/m2 of Grade B.

4.2 EUI of different office grade's tenants

We would like to test if the EUIs of different office grades are statistically equal. We performed F-test for determining equality of variances, and found that no variances are equal. Then, we performed t-test with unequal variances, and found that the averages are equal. Table 5 is the summary of test statistics.

Table 5: Test results for determine equality of sample EUI

	F-test	t-test
EUI pair	P(F<=f) one-tail	P(T<=t) one-tail
Grade A & B	0.0161	0.1750
Grade A & C	0.0022	0.1879
Grade B & C	0.0000	0.0716

In short, we can conclude that, statistically, there is not difference between average EUIs of different office grade tenants.

4.3 Results from Grade A and B

Since there are only 15% of total office areas belonging to Grade C, we would skip the discussions about Grade C's EUI. Fig. 1 shown below presents the distribution of EUI against floor area for Grade A and B office tenants. We can observe that the EUI is positively in proportion to the office floor area.

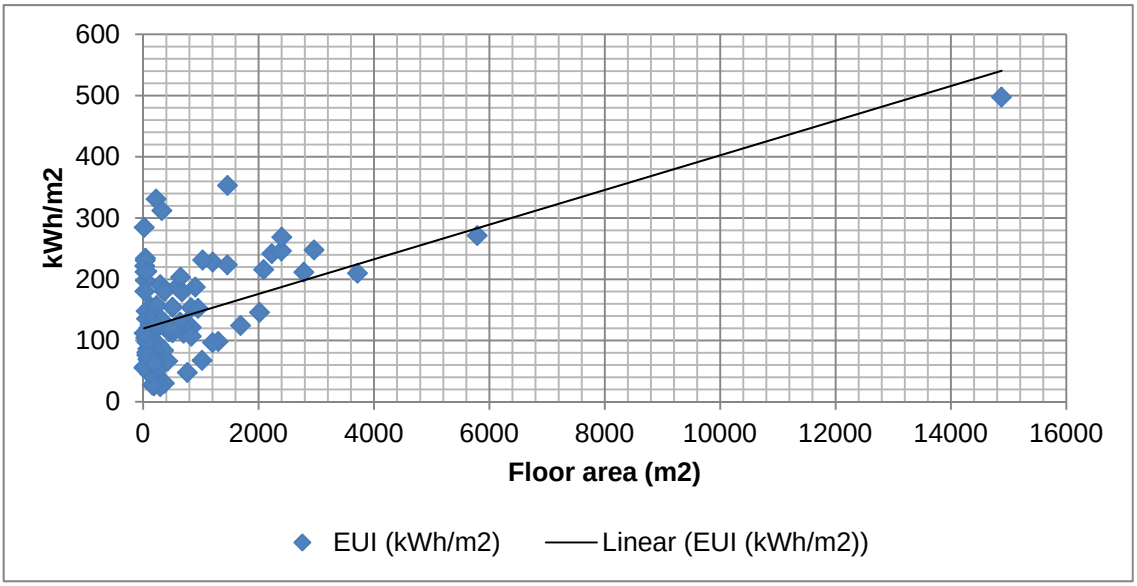

Fig. 1 Distribution of energy use intensity against floor area for Grade A and B tenants

However, it should be noted that if the offices with the floor area smaller than 100 m^2, their EUIs are greater the one with the floor area between 100-300 m^2, on average. Table 6 shows the corresponding results.

Table 6 Distribution of EUI by floor area of Grade A and B.

				No. of offices belongs to	
Floor area (m2)	Average	Min	Max	A	B
< 100	141.30	55.49	284.61	5	18
100 - 200	86.44	25.99	155.23	13	7
200 - 300	117.18	24.51	331.10	9	3
300 - 700	141.98	30.25	312.08	10	5
> 700	191.92	47.52	497.43	26	0

4.5 EUI from different cities

From Xu et al. (2013) and Chung (2011), we can find some office EUI's survey results in different cities. Table 7 provides the summary and shows that Hong Kong's offices consume more energy per floor area than other cities in China.

Table 7 EUI of office buildings in other cities

	EUI (kWh/m2)	No. of sample
Hong Kong	148	132
Shanghai*	108	42
Wuhan*	98.7	3
Shenzhen*	83.1	14
Fuzhou*	86.8	47
Hong Kong**	130	60

** Xu et al. (2013); **Source: Chung (2011);

5. CONCLUSIONS

In this study, properties of the office electricity consumption are reported according to the office grades and by floor area. We found that in general the EUI is positively in proportion to the office floor area. Statistically, we cannot find any significant difference between Grade A, B, and C's EUI. We also find that Hong Kong's offices consume more energy per floor area than other cities in China, like Shanghai and Shenzhen.

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