



Investigation and analysis on the energy consumption of starred hotel buildings in Hainan Province, the tropical region of China



Shilei Lu ^{a,*}, Shasha Wei ^a, Ke Zhang ^b, Xiangfei Kong ^a, Wei Wu ^c

^aSchool of Environmental Science and Technology, Tianjin University, Tianjin 300072, China

^bCCCC First Harbor Consultants Co., Ltd., Tianjin 300222, China

^cDepartment of Housing and Urban-Rural Development of Hainan, Haikou 570100, China

ARTICLE INFO

Article history:

Received 11 January 2013

Accepted 7 July 2013

Keywords:

Building energy consumption
Energy utilization indicator
Multiple regression analysis
Multi-factor analysis of variance
Starred hotel buildings
Tropics

ABSTRACT

This paper reported a study of energy consumption of 27 starred hotels in Hainan Province. Total and subentry energy consumption indicators were defined to indicate the building energy efficiency after collecting the building basic information and energy consumption of these hotels. Eighteen potential independent significant factors were selected to analyze energy utilization indicators (EUIs) and the climate adjusted energy utilization indicators (EUI_{clt}) were calculated by using the degree-day method. Then, multiple regression analysis between EUI_{clt} and continuous scale factors was applied to establish the normalization EUI data model and results indicated that the electricity percentage, number of guestrooms and equivalent guestrooms are the key points influencing total energy efficiency of hotels. Lastly, on the basis of multi-factor analysis of variance (ANOVA) between the EUI_{norm} and categorical factors of the sampled hotel buildings, double glazing window is the significant factor that influences the total unit energy consumption greatly.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

The rapid growth of world energy consumption, exhaustion of conventional energy sources, and lopsidedness of resources distribution create a severe energy situation. With the over-growing energy use, building energy consumption (BEC) accounts for a significant proportion in the total energy consumption in developed and developing countries [1]. The worldwide contribution from buildings towards energy consumption has steadily grown to 20–40% in developed countries and exceeded the other major sectors such as industry and transportation in EU and USA. Growth in population, new requirement for building services and comfort levels, together with the rise in time spent inside buildings cause the upward trend of energy demand to continue in the future [2]. And a growing concern about energy consumption is its likely adverse effects on the environment, so it is a particular priority to improve energy efficiency of buildings [3,4].

1.1. Worldwide energy consumption and efficiency in hotel buildings

The energy performance of hotel buildings in various parts of the world has been reported in large volumes. And a growing concern has been addressed regarding the high amount of energy

consume in hotels [5]. Reviews of a number of hotels' energy consumption indicators around the world are presented in Table 1 [6–16]. Overall, the values of annual average energy consumption indicators vary greatly not only in different regions during the same period, but also within the same region in different periods. And the annual average energy consumption per gross floor area is related to climate and the country's development level. Hotels located in extremely cold [17] and hot areas [6,8,9], with long cold winter or hot and humid summer, consume mainly more energy than those in relatively temperate regions [12]. And hotels in the developing world dissipated more energy than those in developed country in similar climate conditions [1,8,9]. As indicated in Table 1, most of them focused on determining the total energy consumption details which include all energy sources such as electricity, gas, liquefied petroleum gas (LPG), coal, steam, and diesel oil, and two studies focused on only electricity consumption [13,18]. As presented in Table 1, the percentage range of electricity consumption in the total energy consumption is between 45% and 86%.

1.2. The status of hotel building energy efficiency in China

The rapid economic growth in China has a positive relation with the rapid development of tourist industry, leading to the construction of more hotel buildings in the major cities. Meanwhile, the building energy consumption was doubled from 1998 to 2009 in China [19]. As one type of the buildings with high energy

* Corresponding author. Tel./fax: +86 22 27402177.

E-mail address: lvshilei@tju.edu.cn (S. Lu).

Nomenclature

BEC	building energy consumption	$EUI_{1,2,3}$	energy consumption for unit hotel GFA, guest rooms, guestroom-nights sold
GFA	the area of all enclosed space of the unit measured	$EUI_{AC,LR,MS,SA}$	the equivalent electricity consumption of AC, LR, MS, SA systems respectively
PACA	the percentage that the air condition area accounts for the GFA	EUI_{clt}	the climate adjustment value of building energy use indicators
PSPA	the percentage that special-service area accounts for the GFA	EUI_{obs}	the observation energy use indicators in the observation year
AC	air conditioning equipment	EUI_{norm}	the normalized energy utilization indicator
LR	lighting and room facility	$EUI_{clt1,2,3}$	the climate normalized $EUI_{1,2,3}$ of the observation year
MS	miscellaneous service equipment	EUI_{ACclt} , EUI_{LRclt} , EUI_{MSclt} , EUI_{SAclt}	the climate normalized EUI_{AC} , EUI_{LR} , EUI_{MS} , EUI_{SA} of the observation year
SA	special-service area devices	$EUI_{norm1,2,3}$	the normalized $EUI_{1,2,3}$
LPG	liquefied petroleum gas	EUI_{ACnorm} , EUI_{LRnorm} , EUI_{MSnorm} , EUI_{SANorm}	the normalized EUI_{AC} , EUI_{LR} , EUI_{MS} , EUI_{SA}
FCU	fan coil units system		
CAV	constant air volume system		
VAV	variable air volume system		
DHW	domestic hot water		
EUI	energy utilization indicator		

consumption [20], hotel buildings should further improve energy efficiency and consumption reduction. The energy performance of different kinds of public buildings in various climate zones of

China has been reported [21]. In 2008, the total annually averaged electricity intensity of hotel buildings besides heating energy consumption in major cities like Beijing, Shanghai, and Shenzhen was

Table 1

The average consumption indicators for hotel buildings worldwide (kW h/m²/year, unless specified otherwise).

Country or region (data for the year)	Energy utilize indicator (EUI), kW h/m ² /year, unless specified otherwise	Electricity/total (%)	Additional remarks	Source
Singapore (2008)	264.71–592.33, average 426.96	77	29 Hotels (guest rooms cover on average 64% of the hotel's gross floor area): 5*(11), 4*(13), 3*(5)	[6]
Greece (2002)	134.67	68.34	Rethimno hotel located in Crete in southern Greece, total surface area is 3821 m ² , 3*	[7]
Turkey Antalya (2005)	194.28–733.77, average 425.36	85.95	32 Hotels, 5*	[8]
Italy (2001)	249–436, average 364.4	–	–	[9]
Portugal (2001)	99–444.6, average 296.4	–	–	[9]
Cyprus (2001)	24.2 kW h/guest night	70	–	[10]
Majorca (2001)	14.2 kW h/guest night	57	–	[10]
Zanzibar (1999)	61.4–254.4, average 71.1 kW h/guest night	–	30 Hotels with 173 members including hotel managers, technical engineers and cooks	[11]
New Zealand (1998–2000)	159 (hotel) 83 (bed and breakfast) 69 (motel) 171 (backpacker)	75	107 hotels: hotel (30), bed and breakfast (22), motel (20), backpacker (35)	[12]
Vietnam (2000)	80–237, average 141 (4*) 41–426, 143 (3*) 26–271, 101 (2*) 9–165, 78 (resort)	–	50 Hotels: 4*(9), 3*(25), 2*(12), resort (4), gives only electricity consumption	[13]
Spain (2003)	88.4 (seasonal hotels, 3*) 122.0 (seasonal hotels, 4*) 179.6 (annual hotels, 3*) 199.8 (annual hotels, 4*)	45.4 61.9 57.3 55.9	31 Hotels in the Balearic islands: seasonal hotels 4*(3), 3*(11); annual hotels 4*(8), 3*(9)	[14]
Europe (2004)	129.3–859.2, average 364.3 (Hilton)	49.3	73 hotels (attach to Hilton), 111 hotels (attach to Scandic)	[15]
Taiwan (2010)	123.7–567.7, average 285 (Scandic) 191–712.1, average 280.1; 52.5–171.1, average 104.2 kW h/guestroom-night (a) 159.3–375.8, average 237.7; 50.3–205.4, average 106 kW h/guestroom-night (b) 89.7–382.9, average 186.3; 42.4–194.7, average 82.9 kW h/guestroom-night (c) 94.64–317.3, average 143.6; 21.5–116.6, average 59.1 kW h/guestroom-night (d)	48.3 83 86 86 82	200 Hotels distributed well around the island: a-international tourist hotel (45), b-standard tourist hotel (19), c-hotel enterprise (116), d-bed and breakfast (20), guestroom-night = number of room*occupancy*365	[16]

Download English Version:

<https://daneshyari.com/en/article/7166442>

Download Persian Version:

<https://daneshyari.com/article/7166442>

[Daneshyari.com](https://daneshyari.com)