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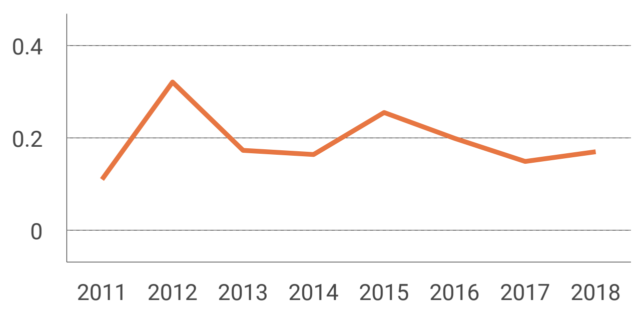

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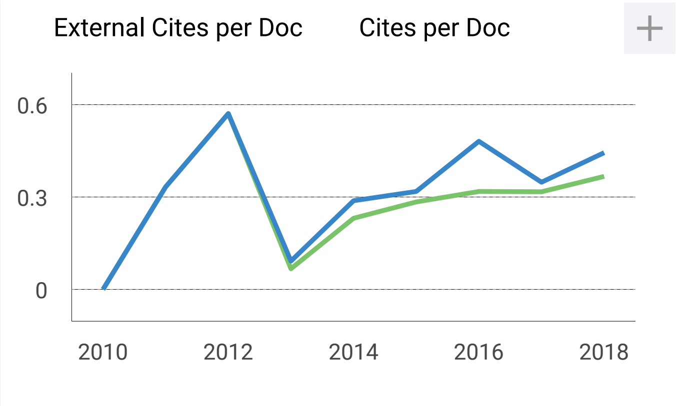

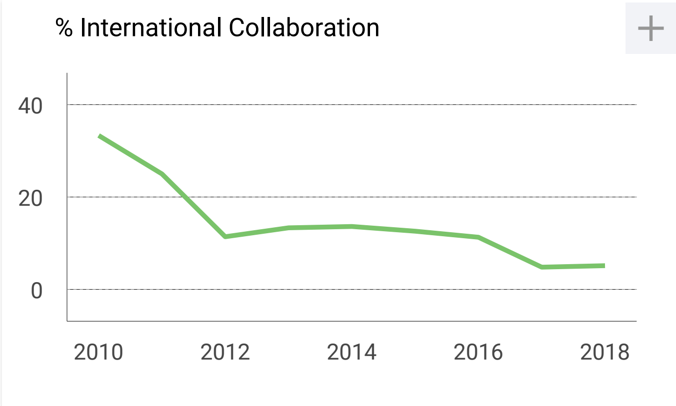

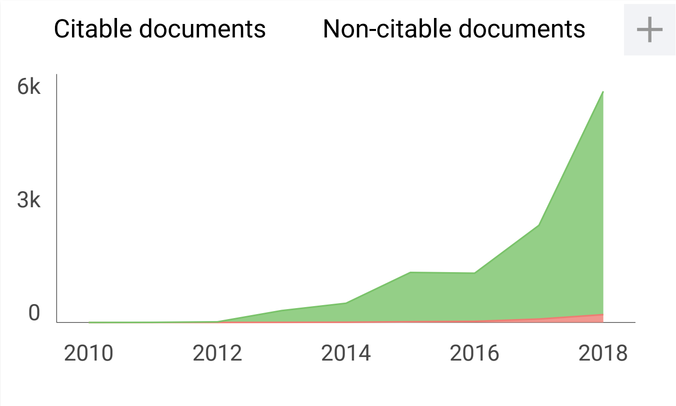

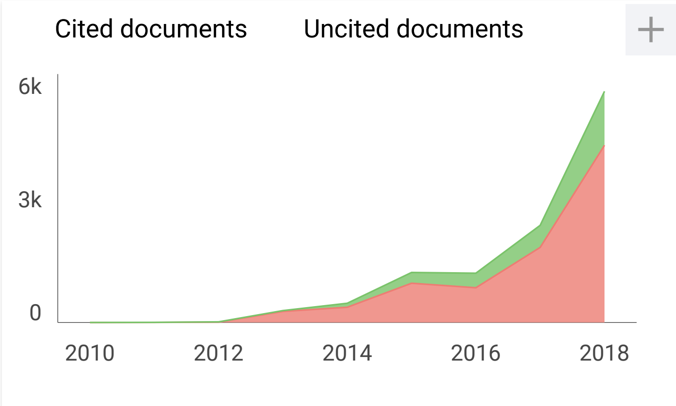

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PREFACE: The 4th International Conference in The Era of Uncertainty (ICPEU)

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Abstract

The honourable Vice Dean of General Affairs at Faculty of Engineering: Dr. Muhammad Ruslin Anwar, Department Head of Regional and Urban Planning, Dr. Abdul Wahid Hasyim, the honourable keynote speakers – Dr. Kakuya Matsushima from Kyoto University – Japan, Dr. ONG Ghim Ping Raymond from the National University of Singapore – Singapore, Dr. Hadid Subki from the International Atomic Energy Agency (IAEA). Vienna – Austria, Dr. Surjono from Universitas Brawijaya – Indonesia and Dr. Emil Elestianto Dardak, M. Sc. – Vice Governor of East Java Province – Indonesia, and ladies and gentlemen.

Assalamualaikum Wr Wb

I would like to thank everyone in this room today for your enthusiasm and participation in the 4th International Conference on Planning in the Era of Uncertainty at Universitas Brawijaya.

ICPEU is a biennial event that we have organized since 2013. We have focused on the discussion of sustainable development since the very beginning, as we truly believe that this topic is very relevant to what we, in the field of planning, face at the moment and in the future.

In 2013 we started off the discussion with the big question, does planning theory can be applied thoroughly in practice? It was a very memorable discussion as we explored many interdisciplinary problems and solutions in planning. We then developed our topic to sustainable development in 2015 as we considered this as an underlying topic for all relevant problems and solutions. Again, the discussion was remarkable. Papers from different countries participated at the event. In 2017, we started publishing our papers on IOP Proceedings, which is a Scopus-indexed form of publication. We published 67 papers from different universities in different countries. And we believe that this event at this moment, will be more successful than our predecessors. The topic Strengthening Rural Urban Sustainability Goals is yet another situation that we all can relate to. A problem that requires collective attention to achieve equality and sustainability in the future development.

Looking back at the events that we have organized so far, we learned that the pursuit of achieving sustainability has attracted ever-growing global interest. We have received papers from Australia, Thailand, Malaysia, Singapore, Japan, Sweden, France, and also Indonesia, discussing and showcasing multi-level efforts in achieving sustainable development from different perspectives. In short, the response that we received has been overwhelmingly positive.

I would like to thank our dearly sponsors, Universitas Brawijaya, the Faculty of Engineering, ESRI, Institut Atsiri, Persada Printing, UB Press, RRI, UB TV for their support that have allowed us to organize this event. We received a number of 163 extended abstracts for this event, and unfortunately, we could only accept a number of 76 selected ones to be published on our upcoming IOP Proceeding and Jurnal Tata Loka. Therefore, I would like to congratulate all authors that have made it this far.

To close this speech, I would like to once again welcome you to Malang, I wish you a wonderful two-day seminar, and I look forward to learning new insights. Thank you very much.

Wassalamualaikum Wr Wb.

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Preface

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Regional Development and Public Policy

Fairness Of Intensity of Energy Consumption for Cooling Targets

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Abstract. In Indonesia, the auditing of building energy follows the procedure of SNI 6196-2011, while the whole building's performance evaluation uses the criteria of the GBCI. Both institutions' target is based on the intensity of energy consumption (IEC), of which 65% is the intensity of energy consumption for cooling (IECC). This research studied the IECCs of hotels in Indonesia, using a computer-simulation method with the Design Builder software. A virtual hotel was constructed based on two design scenarios, using (1) ordinary design and (2) green design as suggested by the GBCI. The two variables used were the hotel's geographical coordinates and altitude. The research found a significant potential for cooling energy savings if, in particular, the building's altitude was considered in the standards. Green buildings in lower altitudes have their IECC higher than those in higher altitudes. The highest IECC is 191.79 kWh/m².year for a green hotel in Medan, which is 35.71 kWh/m².year lower than GBCI standard. The lowest IECC is 85.39 kWh/m².year for a green hotel in Bandung, which is 142.11 kWh/m².year lower than GBCI standard. The average deviations of the IECCs from the standards of the GBCI and the ASEAN USAID were 76.25 kW/m2.year and 43.75 kW/m2.year, respectively.
*Keywords**:** Intensity of energy consumption; energy savings; green building standard; geographical coordinate.*

1. Introduction

Driven by global warming, climate change is a real problem worldwide, which threatens the sustainability of the Earth as a habitable planet for all human beings. At the Conference of the Parties 21, held in Paris in December 2015, the 195 countries that attended agreed to reduce carbon dioxide (CO_2) emissions from fossil-based fuels to maintain the CO_2 concentration in the atmosphere below 380 ppm and to limit the global environment temperature increase to 1.5°C [1]. Previously, the Intergovernmental Panel on Climate Change [2] assumed the global temperature increase to be between 1°C and 3.7°C in the twenty-first century, which would depend on future greenhouse gas emissions. Scientists agree that the continuing increase of global temperature promotes longer heat waves, more frequent droughts and torrential rains, as well as stronger typhoons. Reducing fossil-based fuel consumption is thus urgent.

Buildings consume a large percentage of energy. For example, in Indonesia, buildings use around 50% of the country's total energy and 70% of its electrical energy, which are higher than the energy used by its industries and means of transportation [3]. For buildings, air conditioning can consume more than 50% of their total energy consumption [4]. The increase in outdoor air temperature caused by global warming and urban heat islands might contribute to the increase in air conditioning installations to keep buildings thermally comfortable, as shown in the estimated 700 million air conditioners installed worldwide [5].

It is crucial to control buildings' energy consumption through better building designs, building energy management and audit, supported by realistic building standards. Countries have established their own institutions to assist architects and builders in constructing more energy-efficient buildings, such as the USA with its Leadership in Energy and Environmental Design (LEED) and Singapore with its Building and Construction Authority Greenmark [6]. In Indonesia, the Standar Nasional Indonesia regulates the procedure of the building energy audit through SNI 6196:2001, which is based on a research report by the Association of Southeast Asian Nations–United States Agency for International Development's (ASEAN–USAID) Building Energy Conservation Project. Another institution called the Green Building Council of Indonesia (GBCI) provides a Greenship (a rating tool that contains energy efficiency and conservation guidelines). The ASEAN–USAID and the GBCI target their energy audit according to the intensity of energy consumption (IEC), which is based on total building energy value [7]. The intensity of energy consumption for cooling (IECC) is 65% of the IEC the ratio of electrical energy consumption to air-conditioned floor area per year, kWh/m^2.year (**Error! Reference source not found.**).

Table 1. IEC and IECC of ASEAN–USAID and GBCI

No.	Classification	ASEAN–USAID	GBCI
		IEC/IECC (kWh/m².year)	
1	Offices	240/156	250/162.5
2	Hotels (apartments)	300/**195**	350/**227.5**
3	Shopping centres (commercial)	330/214.5	450/292.5

The IEC targets of the ASEAN–USAID and the GBCI are grouped according to the building classifications. Hotels fall under the commercial sector, contributing 3% of Indonesia's national energy consumption, with a growth rate of 8.6% a year. Indonesia hotels grew rapidly at 12.5% from 2007 to 2011, in response to the 9–13% tourism increase in the corresponding years (Indonesia–USAID *et al.*, 2015). The Indonesian government vigorously promotes its tourism industry and invites foreign investors [8], speeding up the development of hotels.

The cities' geographical positions and altitudes give them different climates and weather conditions, which affect the buildings' air-conditioning performances. A city's geographical position determines its climatic parameters, that is, air temperature, relative humidity and solar radiation. Its altitude affects its outdoor air temperature.

This paper reports the results of computer simulation-based experiments to answer two questions: (1) What is the energy performance of Indonesia's hotels according to their geographical positions and altitudes? (2) Are there any significant deviations between the hotels' IECCs and the targets of the ASEAN–USAID and the GBCI? The computer simulation also tested the effect of each building's orientation on its IECC, which could give architects a reasonable argument when choosing a certain orientation.

1.1 Theoretical review

A building's energy consumption is influenced by its characteristics, occupants' behaviour and other factors, including subjective comfort preferences [9][10], socio-demographic characteristics [11], cognitive factors [12] and cultural dimensions [9] [13]. The heating, ventilating and air conditioning (HVAC) system determines the rate of heat transfer in the building and contributes a significant percentage (up to 65%) of the building's energy consumption [14].

A warm-humid climate is usually characterised by warm outdoor air (25–32ºC), high relative humidity (60–90%) and high prevalence of no wind. HVAC is commonly associated with cooling because heating is not needed in most areas. However, there are highlands in Indonesia with cooler outdoor air, below 25ºC, where cooling is not really needed if indoor heat gain is insignificant. The hotels' indoor air temperature is commonly set far below 24°C to provide a stronger cooling sensation to their customers upon entry. However, since the building energy efficiency movement has become more popular, hotels have responded by setting their thermostats to 24°C, which is believed to be an acceptable common thermal comfort standard. Hotels located in areas with 24°C outdoor air temperature have an advantage to use this outdoor air; thus saving energy for cooling by letting in outdoor air. Using Equation (1), places with altitudes higher than 466 m above sea level are likely to have outdoor air temperatures lower than 24°C. The relationship between air temperature and altitude is expressed through Equation (1):

$$T = Tsl - 0.6h^{0} \quad (1)$$

Where:

T = the air temperature of a location at °C; *Tsl* = the average air temperature at sea level at °C of the same or similar latitude to the corresponding location; 0.6 = a constant; and *h* = the location's altitude (in 100 m). For Indonesia, the *Tsl* is 26.8°C.

2. Methods

This research used a computer-simulation method to analyse the energy performances of two digital models of a hotel, namely, ordinary and green. The ordinary hotel was constructed based on common materials, while the green hotel was constructed based on the green building principles. The software used for this research is called Design Builder 4.1.0.042. The energy performances of those two virtual hotels were simulated as if they had different geographical locations and altitudes. The two dependent variables were the hotels' world coordinates and altitudes. The independent variable was the IECC. Nine cities were sampled as representatives of Indonesia's cities and were simulated based on nine scenarios (**Table 2**).

Table 2. Nine representative cities

Coordinate group	Altitude group	City	Coordinates	Altitude above sea level (m)
North latitude (+23.5° to +0.5°)	Low land	Medan	03° 38' N 098° 38' E	20
	Medium land	Manado	01° 33' N 124° 53' E	475
	High land	Toba Samosir	02° 35' N 099° 27' E	1,550
Equator (+0.5° to -0.5°)	Low land	Pontianak	00° 05' N 109° 22' E	1
	Medium land	Gorontalo	00° 34' N 123° 05' E	250
	High land	Bukittinggi	00° 18' N 100° 22' E	925
South latitude (-0.5° to -23.5°)	Low land	Jakarta	06° 10' S 106° 49' E	46
	Medium land	Yogyakarta	07° 48' S 110° 21' E	210
	High land	Bandung	06° 57' S 107° 37' E	865

Source: google earth
Lowland: 0–200 m; medium land: 201–700 m; high land: above 700 m.

Latitude is distance from the north or south of the equator (an imaginary circle around the Earth halfway between the North Pole and the South Pole). It determines the angle of sunlight striking the building's envelope. Altitude, like elevation, is the distance above sea level.

The IEC targets of the ASEAN–USAID and the GBCI are for the whole electrical energy consumption. Since this research focused on the electrical energy consumption for air conditioning, the IEC targets were modified. Air conditioning contributes 65% of a building's whole energy consumption. Thus, the IEC targets of the ASEAN–USAID and the GBCI were modified to IECC, from 300 kWh/m^2.year and 350 kWh/m^2.year to 195 kWh/m^2.year and 227.50 kWh/m^2.year, respectively. The design differences between the two hotels and the parameters used in the calculation are respectively presented in **Table 3** and **Table 4**.

Table 3. Differences between ordinary and green hotels

Design	Ordinary hotel	Green hotel
Building coverage ratio	40.00%	40.00%
Floor area ratio	2.4	2.4
Layout	double loaded	double loaded
Window-to-wall ratio	6.67%	6.67%
Number of floors	6	6
Area of building	65 x 18 (m^2)	65 x 18 (m^2)
Height of building	22.0 m	22.0 m
Ground to floor height	4.0 m	4.0 m
Floor to floor height	3.6 m	3.6 m
Number of rooms	100	100
Material of roof	metal deck	metal deck – super insulated
Material of floors	concrete floor tiles	concrete floor tiles
Secondary skin	No	glass fibre reinforced concrete board 50%
Shading	No	concrete-plastered insulation
Window	single glazed	double glazed low-E
Window frame	Aluminium	aluminium
Wall	plastered brick	brick with insulation
Coefficient of performance, Air Conditioner	3.0	3.5

A healthy and comfortable hotel follows certain standards which consist of air temperature, humidity, and air exchange. Those standards can be used as a reference. The scenario for the healthy and comfortable hotel standards are presented in **Table 4.**

Table 4. Parameters and criteria for thermal calculation

Parameters	Criteria	
	Ground floor	1st–5th floors
Thermostat range	12–24°C	12–24°C
Humidity	50%	50%
Air speed	0.25 m/s	0.25 m/s
Air change rate	0.73 ach	0.50 ach
Wind sensitivity	0.25 ach	0.25 ach
Clothing	1.00 clo	1.00 clo
Number of people	126 persons	84 persons
People's activity	100 W	70 W
Sensible heat gain	13.99 W/m^2	11,84 W/m^2
Latent heat gain	2.00 W/m^2	2.00 W/m^2
Type of system	mixed mode	mixed mode
Efficiency	95%	95%
Lighting level	300 lux	300 lux
Hours of operation		
Weekdays	1 x 24 h	1 x 24 h
Weekend	1 x 24 h	1 x 24 h

3. Results and Discussions

Table 5 presents the results of the computer-based experiments. For all cities, the IECCs of ordinary hotels are higher than those of green hotels. Their deviations range from 21.4 kWh/m^2.year to 108.75 kWh/m^2.year, regardless of orientation. These findings show that the GBCI's design recommendation worked well in reducing energy consumption. However, ordinary hotels on high lands could have their IECCs lower than the ASEAN–USAID's and the GBCI's standards. Converting ordinary hotels to green hotels further drops their IECCs and therefore offer significant energy-saving potential. As expected, the IECCs of north–south-facing hotels are lower than those of east–west-facing ones.

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Table 5. IECC from computer-based simulation

Coordinates	City	Altitude	Orientation	IECC from simulation		IECC target from standard	
				Ordinary hotels	Green hotels	ASEAN–USAID	GBCI
				kWh/m².year			
North latitude (NL)	Medan	Low land (L)	N–S	289.45	191.79	195.00	227.50
			E–W	301.65	192.90		
	Manado	Medium land (M)	N–S	278.62	185.13		
			E–W	293.33	186.67		
	Toba Samosir	High land (H)	N–S	188.22	98.09		
			E–W	200.38	99.85		
Equator (EQ)	Pontianak	Low land	N–S	264.53	180.13		
			E–W	284.79	183.18		
	Gorontalo	Medium land	N–S	215.76	169.83		
			E–W	249.41	174.68		
	Bukittinggi	High land	N–S	110.63	90.14		
			E–W	126.51	92.31		
South latitude (SL)	Jakarta	Low land	N–S	275.96	190.93		
			E–W	292.84	191.90		
	Yogyakarta	Medium land	N–S	212.98	159.98		
			E–W	238.55	161.66		
	Bandung	High land	N–S	106.79	85.39		
			E–W	123.84	88.01		

Figure 1 summarises north–south-oriented hotels in the nine representative cities. It shows the consistent phenomenon that hotels on high lands have lower IECCs than those on low lands. This phenomenon is expected because high lands have higher air temperature than low lands, which affects the energy consumption of the air conditioning system. Ordinary hotels on high lands (Samosir, Bukittinggi and Bandung) have IECCs slightly lower than the ASEAN–USAID standard. Even without adopting any green building guidelines, the hotels in those cities comply with the ASEAN–USAID's IECC standard. However, adopting those guidelines in the hotels significantly lowers their IECCs. This shows that there is still a high potential for energy savings if green building guidelines are applied in locations where the outdoor air temperature is comfortable.

Medan, Pontianak and Jakarta are on low lands. In those cities, green hotels can only reach IECCs slightly lower than the ASEAN–USAID's standard. For example, a green hotel in Medan has an IECC of 191.79 kWh/m^2.year, which is 1.79 kWh/m^2.year lower than the ASEAN–USAID's standard. This shows that adopting green building guidelines is important for buildings on low lands.

The cities' geographical positions do not seem to affect their IECCs (Figure 1). Even though all of the nine selected cities are within the tropical lines (23.5 NL 23.5 SL), they are not far from the equator. The northernmost city in the sample, Medan, lies at 03^o 38' NL, and the southernmost city, Yogyakarta, lies at 07^o 48' SL. Pontianak lies at 00^o 05' NL and it is known as a hot city. However, the experiments found that ordinary and green hotels located on the equator have lower IECCs than those in other latitudes with corresponding altitudes. Hotels in Pontianak have IECCs lower than those in Jakarta.

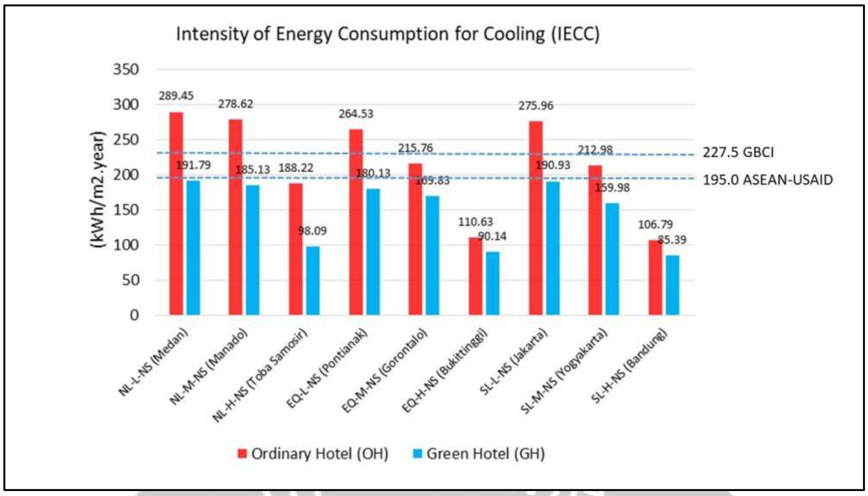

Figure 1. IECCs of hotels in the nine selected cities.

The experiments confirmed that the higher the altitude of a hotel's location is, the lower the hotel's IECC is, as higher lands have lower air temperature. Therefore, altitude has a larger effect on hotels' IECCs than geographical position (latitude). However, this finding should be interpreted carefully. It might be caused by the relatively narrow spread of the samples. The farthest sample from the equator is Yogyakarta, which is located at 07° 48' SL. Simulations with hotels located far from the equator line but still within 23° 30' NL (tropic of Cancer) and 23° 30' SL (tropic of Capricorn) should be conducted to verify whether geographical position does not affect IECC. Between the tropic of Cancer and the tropic of Capricorn, the sun passes the zenith of any location twice a year during its path, back and forth, to the north and to the south.

The simulation results show a wide range of deviations between the ordinary hotels' and the green hotels' IECCs and the ASEAN–USAID's and the GBCI's targets. The average deviation, maximum IECC and minimum IECC are calculated by using Equation (2) and presented in Table 6 (ordinary hotels) and Table 7 (green hotels).

$$d_{\bar{x}} = \frac{\sum \left| x_i - \bar{x} \right|}{n} \quad (2)$$

Where:

$d_{\bar{x}}$ = average deviation in kWh/m².year; x_i = IECC from simulation in kWh/m².year; $\bar{x}$ = IECC target in kWh/m².year; and n = sample population.

Maximum IECC = $\bar{x} + d_{\bar{x}}$, and minimum IECC = $\bar{x} - d_{\bar{x}}$.

Table 6. Ordinary hotels' IECC deviations from ASEAN–USAID's and GBCI's standards

ASEAN–USAID's IECC target	195.00 kWh/m².year
minimum IECC deviation from ASEAN–USAID's target	164.76 kWh/m².year
maximum IECC deviation from ASEAN–USAID's target	225.24 kWh/m².year
average deviation from ASEAN–USAID's target	30.24 kWh/m².year
GBCI's IECC target	227.50 kWh/m².year
minimum IECC deviation from GBCI's target	225.24 kWh/m².year
maximum IECC deviation from GBCI's target	229.76 kWh/m².year
average deviation from GBCI's target	2.26 kWh/m².year

Table 6 shows that for ordinary hotels using the ASEAN–USAID's IECC standard, the minimum and the maximum IECCs are 164.76 kWh/m².year and 225.24 kWh/m².year, respectively. With a

deviation of 30.24 kWh/m².year, the IECC for a thermally comfortable and energy-saving hotel ranges from 164.76 kWh/m².year to 195 kWh/m².year. For a thermally comfortable but not energy-saving hotel, the IECC ranges from 195.01 kWh/m².year to 225.24 kWh/m².year. The same procedure has been performed by using the GBCI's IECC standard. It is found that for a thermally comfortable and energy-saving hotel, the IECC ranges from 225.24 kWh/m².year to 227.50 kWh/m².year. For a thermally comfortable but not energy-saving hotel, the IECC ranges from 227.51 kWh/m².year to 229.76 kWh/m².year.

Table 7 shows green hotels' IECCs. Using the same procedure applied in Table 6, the green hotels' average deviation from the ASEAN–USAID's target is 43.75 kWh/m².year. Thermally comfortable and energy-saving hotels are possible with the IECC ranging from 151.25 kWh/m².year to 195 kWh/m².year. Thermally comfortable yet not energy-saving hotels are possible with the IECC ranging from 195.01 kWh/m².year to 238.75 kWh/m².year.

Table 7. Green hotels' IECC deviations from ASEAN–USAID's and GBCI's standards

ASEAN–USAID's IECC target	195.00 kWh/m².year
minimum IECC deviation from ASEAN–USAID's target	151.25 kWh/m².year
maximum IECC deviation from ASEAN–USAID's target	238.75 kWh/m².year
average deviation from ASEAN–USAID's target	43.75 kWh/m².year
GBCI's IECC target	227.50 kWh/m².year
minimum IECC deviation from GBCI's target	151.35 kWh/m².year
maximum IECC deviation from GBCI's target	303.75 kWh/m².year
average deviation from GBCI's target	76.25 kWh/m².year

Whether to adopt the ASEAN–USAID's or the GBCI's IECC standards is the hotel owner's choice. Currently, the Indonesian government does not enforce the IECC target yet even though it is urgently required. The ASEAN–USAID's IECC target is 32.5 kWh/m².year; it is lower than the GBCI's. An ordinary hotel in Gorontalo (medium land) can have its IECC comply with the GBCI's target but not with ASEAN-USAID's (see Figure 1). In other words, there is no need for hotels in Gorontalo to adopt green building guidelines if their owners refer to the GBCI. However, those hotels have significant potential for energy savings if green building guidelines are applied.

4. Conclusion

Computer simulation results found energy saving potential of green hotels.

1. Based on the results of the computer-based experiments, it can be concluded that applying a single IECC target for all hotels, which are located at different altitudes and geographical coordinates, is arguable; significant energy-saving potentials can be overlooked. Flexible IECC targets are then needed and achievable. With the current online advanced geographic information system, it is possible to easily obtain the weather data of a certain location to calculate the lowest possible IECC for green buildings. Thus, the fairness of the IECC can be achieved. The highest IECC is 191.79 kWh/m².year for a green hotel in Medan. This is 3.21 kWh/m².year and 35.71 kWh/m².year lower than, respectively, ASEAN-USAID and GBCI standard. The lowest IECC is 85.39 kWh/m².year for a green hotel in Bandung. This is 109.61 kWh/m².year and 142.11 kWh/m².year lower than, respectively, ASEAN-USAID and GBCI standard.
2. The average deviation in green building is 43.75 kWh/m².year based on ASEAN-USAID standard and 76.25 kWh/m².year based on the GBCI standard.

Further studies are needed to elaborate on the research conclusion that provides practical suggestions for more flexible and applicable IECC targets. Those studies should consider the following:

1. This research cannot firmly conclude the effect of buildings' latitude to the IECC yet. This is because the latitude of the samples only ranges from 03° 38' N (Medan) to 07° 48' S

(Yogyakarta). This is the range of hotels' latitude found in Indonesia. Further research should expand the latitude to 23°30' N and 23°30' S.

2. This research did not take each hotel's rank into account. The hotels might have a wide range of internal load that reflects their rank from one to five stars.

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