Library Progress International *Print version ISSN 0970 1052*
Vol.44, No.4, Jul-Dec 2024: P. 1534-1541 *Online version ISSN 2320 317X*

Original Article *Available online at www.bpasjournals.com*

Measurement of Hotel Electrical Energy Consumption: Case Study of Hotels in Bandung

Elsha Juliani[1], Burhanuddin Halimi[2]

[1] student, school of electrical engineering and informatics, Bandung Institute of Technology, Bandung, Indonesia.
[2]doctor, school of electrical engineering and informatics, Bandung Institute of Technology, Bandung, Indonesia.

How to cite this article: Elsha Juliani, Burhanuddin Halimi (2024). Measurement of Hotel Electrical Energy Consumption: Case Study of Hotels in Bandung. Library Progress International, 44(4), 1534-1541

Abstract:

As an archipelagic country, Indonesia has enormous Indonesian tourism potential which is being developed. This tourism potential needs to be supported by the availability of sufficient and comfortable hotels or accommodations which is in line with the availability of electrical equipment facilities. For lodging owners or lodging management, it is necessary to know the condition of electrical energy consumption in hotels, where the results obtained can be used as a consideration for determining room prices, as well as data on making improvements in the form of building energy optimization measures in hotels for good use of electrical energy. and efficient. Based on real-time measurement results, it is known that the average electrical energy consumption required for weekdays and weekend days is 111.21 kWh and 159.55 kWh. The total electrical energy for one week of observation at the hotel is 923.49 kWh with a total tariff of IDR 1,334,166,- which needs to be spent for one week, and with this value, it is known that the tariff for 1 month is IDR 5,336,664,- and IDR 64,039,968,- for one year. Based on the calculation results for scenario 2, the total electrical energy obtained for one week is 949.43 kWh with a total tariff of IDR 1,371,640,- which needs to be spent for one week, and with this value, it is known that the tariff for 1 month is IDR 5,486,560,- and IDR 65,838,723, - for one year, where there is a difference of 2.8%. Meanwhile, based on the results of assumptions in scenario 1 which is the maximum point of electrical energy use, and scenario 2 is the result of predictive assumptions which adjust the duration based on user habits, the average use of electrical energy at the Bumi-Sawunggaling Hotel is currently 28%.

Keywords: electrical energy consumption, energy measurement, calculation, building energy, hotel.

Introduction

As an archipelagic country, Indonesia is blessed with the beauty of its natural and cultural resources. So, it is not surprising that many domestic and even foreign tourists visit various tourist areas in Indonesia, making this tourism sector one of the sectors that makes a big contribution to economic growth in Indonesia. In 2022, the number of foreign tourist visits will reach 5.89 million people with tourism foreign exchange value reaching US$ 6.72 billion, while the number of domestic tourist visits will reach 734.86 million people [1]. In fact, until November 2023 alone, the number of foreign tourist visits was recorded to have reached 10.4 million people, while the number of domestic tourist visits reached 749.11 million people [2].

With millions of tourists traveling in various regions of Indonesia, Java Island is the largest tourist destination chosen by domestic tourists based on survey results by the Central Statistics Agency (BPS), namely 74.25% of the total tourist destinations in Indonesia [2]. By realizing the magnitude of Indonesia's tourism potential, it is important to develop and improve tourist attractions in various regions in Indonesia.

A tourist destination area referred to as a tourist spot must have 3As, namely Attractiveness, Amenities or facilities, and Accessibility [3]. In this research, the focus is on the problems of the Amenities or facilities section. One of the mandatory

and important facilities that tourist destinations have is accommodation in the form of a hotel or guest house. Having comfortable lodgings can increase the attraction of tourists to visit and stay at these tourist attractions for a certain period. This can be seen from the increase in star hotel occupancy rates in Indonesia. Based on a report from the Central Statistics Agency in November 2023, the cumulative Room Occupancy Rate (TPK) of star hotels from January to November 2023 reached 50.46 percent, an increase of 3.57 points compared to the TPK in the same period in 2022, which was 46.89 percent [2].

To support visitor comfort while at the accommodation, it needs to be supported by complete electrical equipment facilities. Starting from the condition of room lighting, bathroom, water, and television to air conditioning in the form of AC, are factors that tourists pay attention to when choosing a place to stay. The level of completeness of electrical equipment facilities also influences the number of visitors and the length of stay of visitors at the accommodation. However, often these electrical equipment are used excessively or not as they should be. This can cause increasing use of electrical power. Of course, this will increase the cost of electrical energy for the accommodation.

Electrical energy consumed today is dominated by the building sector, especially commercial buildings such as hotels which contribute quite high CO2 emissions, which is likely related to the fact that hotels generally prioritize guest comfort and the guest mindset is centered on a luxury experience without additional pressure to energy saving behavior. Apart from that, hotels also operate 24/7, 365 days a year [4]. The need to estimate electrical energy consumption in existing buildings is becoming increasingly important, as greater attention is now being paid to controlling utility costs, total energy consumption, and CO2 emissions. Energy usage estimates can be utilized for various purposes such as justifying proposed repair work, developing a budget for utility costs, and so on [4].

This is also supported by the results of an audit conducted in [5], electrical energy consumption dominates energy use by 70% in hotels in big cities. In terms of energy users, air conditioning systems consume approximately 65% of the total energy used by hotels. This can be a consideration for focusing on savings that can be made. The important impact of implementing savings measures as carried out in [6] by modifying the shape of the hotel's daily electricity load profile causes the maximum peak power and hotel energy consumption during peak price hours to decrease. To achieve high energy efficiency, several factors are expected to be verified regarding building performance [7]. One of the most significant obstacles to achieving internal building energy efficiency is a lack of knowledge about the factors that determine energy use [8].

For lodging owners or lodging management, it is important to know the factors that influence the amount of electricity energy used. This can also later be a consideration for electricity rates for room rental at accommodation. Therefore, it is important to carry out research related to measuring electrical energy consumption in existing hotel buildings as a first step that needs to be taken to optimize building energy. The hotel chosen in this research is the Bumi Sawunggaling Hotel, which is a hotel in the 1 Star hotel category. By measuring the use of electrical energy in this hotel, you can later see how daily electrical energy usage is at the Bumi Sawunggaling Hotel. These results can later be processed and analyzed so that further action can be taken to improve and progress hotel management.

II. Methodology

A. Research Stages

This research was carried out using steps as described in Fig.1 below.

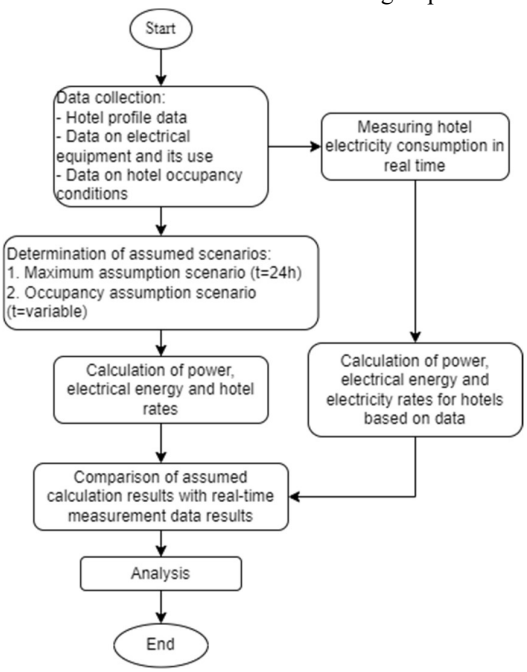

Fig. 1. Research Stages

B. Data

Four basic types of data need to be collected to be able to determine energy use and performance, namely energy consumption data, energy cost data, hotel characteristics data, and equipment data with high energy consumption [5]. To obtain these data, this research was carried out in three ways, namely:

a. Direct observation, some data related to the hotel building profile was carried out by direct observation of the hotel to determine the condition of the hotel rooms and areas along with the electrical equipment used.
b. Power Quality Analyzer (PQA), this tool is used to measure electrical energy consumption in hotels in real time which is done with the data collection time interval set to every 30 minutes for one week.

III. Result

A. Hotel Description

The object of research carried out in this research is the Bumi Sawunggaling Hotel which is located on Jl. Sawunggaling, no. 13, Tamansari, district. Bandung Wetan, Bandung City, West Java Province, postal code 40116. This hotel consists of 22 rooms, 2 meeting rooms on three floors with details of room type and area of each area as follows.

TABLE I. NUMBER OF ROOMS AND AREAS AT THE BUMI SAWUNGGALING HOTEL

No	Room Type	Lt 1	Lt 2	Lt 3	Lt 2+	Total
1	Superior Room	4	4	6		14
2	Deluxe Room				3	3
3	Deluxe Hot Water		4			4
4	Suite Room				1	1
5	Meeting Room	2				2
Room area (m^2)		777.5	146.7	118.7	135.3	1178.1

Based on the data collected, it is known that the largest electrical equipment power is AC, amounting to 50% of the total electrical equipment power as seen in Fig 2. In addition, based on the total power for each hotel room, it can be seen in Fig. 3 that the room with the largest percentage of power consumption is Meeting Room 2, followed by the Suite Room and pump. However, if the total power for all room types is added up because each room has a different amount, there

will be a change in the percentage of power consumption based on room type as seen in Fig. 4 where the room with the largest percentage of total power is taken over by the Superior room type which has the largest number of rooms.

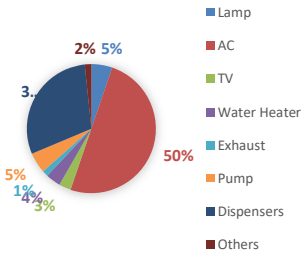

Fig. 5. Percentage of electrical power consumption based on type of electrical equipment

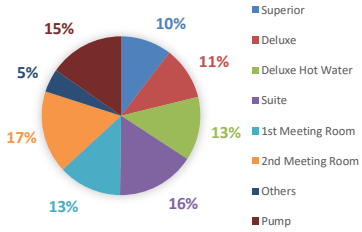

Fig. 6. Percentage of electrical power consumption based on area type

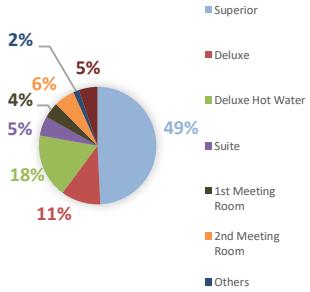

Fig. 7. Percentage of electrical power consumption based on the total number of each type of area

B. Measurement of Power Consumption and Electrical Energy in Realtime

Retrieving hotel data to measure overall power usage for one week (starting from Saturday to Friday) uses a measurement tool, namely the Hioki 3196 Power Quality Analyzer which can store power data within a certain period. Data for hotel electricity consumption is measured every 30 minutes. In Fig. 5, you can see a graph of changes in electrical power consumption each time during one week of observation. Changes in electrical power consumption are influenced by the number of hotel room occupancies each day during the observation period as shown in Table II.

With hotel electricity consumption data as in Fig. 5, the average value of power consumption used at each time of the day can be taken. In this research, researchers carried out three average scenarios, namely: a) average overall power consumption over time; b) average power consumption over time for weekday types, namely Monday, Tuesday, Wednesday, and Thursday; c) average power consumption each time for weekend day types, namely Friday, Saturday and Sunday.

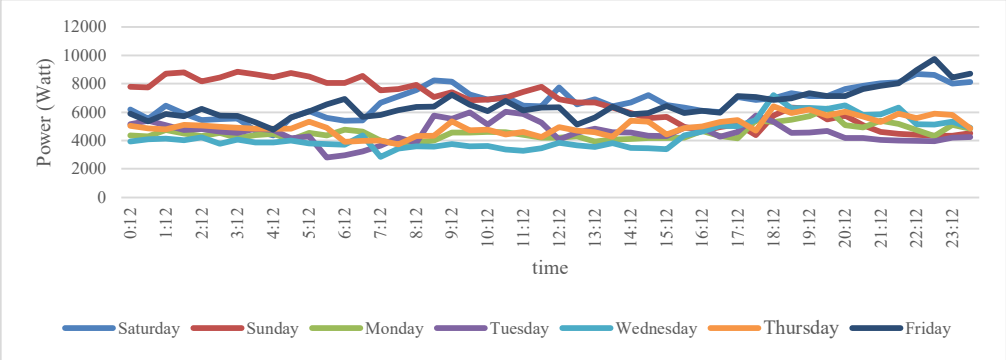

Fig. 8. Graph of hotel electricity consumption per day

TABLE II. TOTAL HOTEL ROOM OCCUPANCY

No	Day	Superior	Deluxe	Deluxe Hot Water	Suite	Total
1	Saturday	12	3	3	1	19
2	Sunday	2	0	1	0	3
3	Monday	1	0	3	1	5
4	Tuesday	1	0	0	0	1
5	Wednesday	3	0	2	0	5
6	Thursday	7	0	2	0	9
7	Friday	7	2	3	1	13

In Fig.6 it can be seen that power consumption during weekends is higher than power consumption during weekdays. This is also supported by hotel room occupancy data where more rooms are occupied during weekends compared to weekdays.

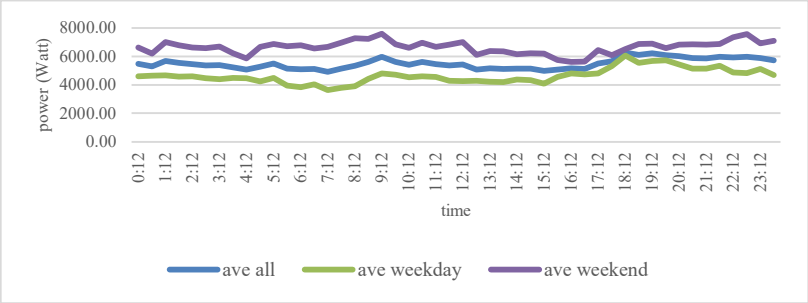

Fig. 9. Graph of the average value of hotel power per time

Based on hotel electrical power consumption data as in Fig.5, the total value of the hotel's daily electrical energy consumption can be seen, as described in Table. III. Based on PLN's basic electricity tariff, for the Bumi Sawunggaling Hotel which uses an electric power limit in the range of 6600 VA to 200 kVA, it is included in the B2/TR tariff group. Therefore, the basic electricity tariff is IDR 1,444.70 [9]. Therefore, the total electrical power for one week is explained in Table III. below below. By knowing the tariff for one week, you can also get an estimate of the electricity tariff for one month and one year.

TABLE III. DAILY HOTEL ELECTRICITY RATES

No	Day	Energy (kWh)	BaseTariff	Total tariff
1	Saturday	161.68	Rp1,444.70	Rp233,579.10
2	Sunday	160.09	Rp1,444.70	Rp231,282.02
3	Monday	109.33	Rp1,444.70	Rp157,949.05
4	Tuesday	110.16	Rp1,444.70	Rp159,148.15
5	Wednesday	105.32	Rp1,444.70	Rp152,155.80
6	Thursday	120.03	Rp1,444.70	Rp173,407.34
7	Friday	156.88	Rp1,444.70	Rp226,644.54
Total tariff 1 week				Rp1,334,166.00
Total tariff 1 month*				Rp5,336,664.01
Total tariff 1 year**				Rp64,039,166.14

*1 month estimate = 4 weeks, **1 year estimate = 12 months

C. Calculation of Power and Electrical Energy Consumption Based on Assumed Scenarios

1) 1st Scenario: Assuming Maximum Electricity Consumption (duration of use for 24 hours)

For the maximum assumption scenario, it is assumed that all electrical equipment in the hotel is used to the maximum, namely the assumption that all rooms are fully occupied and the equipment is used for 24 hours. Although this is unlikely to happen, the results of this assumption can be used as an upper limit for power and electrical energy consumption in hotels.

In Table IV. it can be seen that the maximum power and energy required by the hotel to meet its electricity needs for various types of rooms/areas. Based on this table, it is known that the maximum energy that a hotel can achieve in one day for maximum usage conditions for 24 hours is 1114,176 kWh. Table VI describes the maximum electricity prices issued by the hotel.

TABLE IV. POWER CONSUMPTION AND ELECTRIC ENERGY BASED ON AREA TYPE

No	Room Type	Power (kW)	Number	Duration (h)	Energy @area (kWh)	Total Energy (kWh)
1	Superior	1.633	14	24	39.19	548.688
2	Deluxe	1.6914	3	24	40.594	121.7808
3	Deluxe Hot Water	2.0414	4	24	48.994	195.9744
4	Suite	2.511	1	24	60.264	60.264
5	1st Meeting Room	2.032	1	24	48.768	48.768
6	2nd Meeting Room	2.63	1	24	63.12	63.12

7	Others	0.7492	1	24	17.981	17.9808
8	Pump	2.4	1	24	57.6	57.6
Total Energy Max		15.688				1114.176

TABLE V. ELECTRICITY PRICE RATES BASED ON ROOM TYPE

No	Type Room	Power (kW)	Number	Tariff @room	Total Tariff
		1	2	3 = 1 x 24h x Rp 1,440.70	2 x 3
1	Superior	1.633	14	Rp56,463.91	Rp790,494.80
2	Deluxe	1.6914	3	Rp58,483.20	Rp175,449.60
3	Deluxe Hot Water	2.0414	4	Rp70,585.08	Rp282,340.32
4	Suite	2.511	1	Rp86,822.34	Rp86,822.34
5	1st Meeting Room	2.032	1	Rp70,260.06	Rp70,260.06
6	2nd Meeting Room	2.63	1	Rp90,936.98	Rp90,936.98
7	Others	0.7492	1	Rp25,904.94	Rp25,904.94
8	Pump	2.4	1	Rp82,984.32	Rp82,984.32
Total Maximal Tariff				Rp1,605,193.36	

2) 2nd Scenario: Assumed User Electricity Consumption Scenario (duration of usage adjusted to possible hotel occupants)

In this assumed scenario, the assumed duration of use for each type of electrical equipment is different for one day of use, which can be seen in Table VI below. With this duration of use, the predicted electrical energy consumption is calculated for each type of room/area as shown in Table VII, along with the electricity rates in Table VIII.

TABLE VI. ASSUMED DURATION OF USE OF ELECTRICAL EQUIPMENT BY HOTEL RESIDENTS

No	Equipment	Power (kW)	Duration (h)	Energy (kWh)
1	Lamp	2.411	12	28.932
2	AC	23.24	12	278.88
3	TV	1.38	8	11.04
4	Water Heater	1.75	1	1.75
5	Exhaust	0.682	24	16.368
6	Pump	2.4	6	14.4
7	Dispensers	13.8	1	13.8
8	Others	0.761	4	3.044
Total		46.424		368.21

TABLE VII. PREDICTED ELECTRIC ENERGY CONSUMPTION BASED ON ROOM TYPE

No	Room Type	Number	Esc2 (kWh)	Total Esc2 (kWh)
1	Superior	14	12.713	177.982
2	Deluxe	3	14.034	42.103
3	Deluxe Hot Water	4	14.384	57.538
4	Suite	1	24.01	24.1
5	1st, 2nd Meeting Room	1	34.096	34.096
6	Others	1	26.617	26.617

TABLE VIII. PREDICTED ELECTRICITY RATES BASED ON ROOM TYPE

No	Room Type	Number	Tariff @room	Total Tariff
1	Superior	14	Rp 18,366.47	Rp 257,130.60
2	Deluxe	3	Rp 20,275.50	Rp 60,826.49
3	Deluxe Hot Water	4	Rp 20,781.14	Rp 83,124.57
4	Suite	1	Rp 34,686.67	Rp 34,686.67
5	1st , 2nd Meeting Room	1	Rp 49,258.49	Rp 49,258.49
6	Others	1	Rp 38,453.29	Rp 38,453.29
Total				Rp5 23,480.11

3)Comparison of measurement and calculation result

Based on the prediction results based on the scenario explained in the previous subchapter, with the results of measuring hotel electricity consumption in real-time, the predicted results of total electrical energy can be compared along with a comparison of electricity rates with real-time measurement results. You can see in Figure 7 the comparison results of electrical energy in scenario 1 with the results in scenario 2, both the energy value for each room and the total energy value for both scenarios. In total, the energy in scenario 2 uses an average of 31% of the maximum total energy in scenario 1.

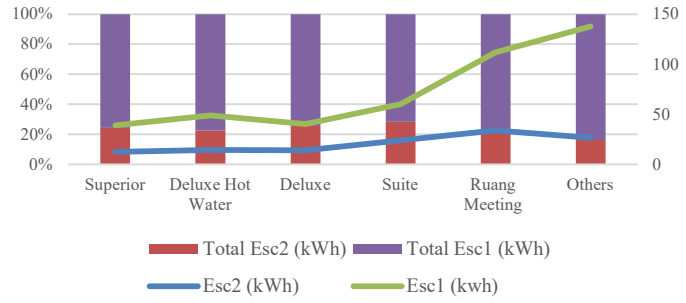

Fig. 10. Comparison of predicted electrical energy and maximum electrical energy for hotels

In Table IX. You can see the results of the required electricity tariff based on the results of 2nd scenario which are compared with the electricity tariff results according to the real-time measurement results.

TABLE IX. COMPARISON OF TOTAL ELECTRICITY RATES FOR 2ND SCENARIO RESULTS WITH REAL-TIME MEASUREMENT RESULTS

No	Day	Esc2 (kWh)	Total Tariff of Esc2	Ereal (kWh)	Total Tariff of Realtime
1	Saturday	288.44	Rp 416,707.53	161.68	Rp 233,579.10
2	Sunday	66.43	Rp 95,967.38	160.09	Rp 231,282.02
3	Monday	106.49	Rp 153,849.86	109.33	Rp 157,949.05
4	Tuesday	39.33	Rp 56,819.76	110.16	Rp 159,148.15
5	Wednesday	93.52	Rp 135,114.99	105.32	Rp 152,155.80
6	Thursday	144.38	Rp 208,580.87	120.03	Rp 173,407.34
7	Friday	210.84	Rp 304,599.68	156.88	Rp 226,644.54
Total tariff 1 week		949.43	Rp 1,371,640	923.49	Rp 1,334,166
Total tariff 1 month*			Rp 5,486,560		Rp 5,336,664
Total tariff 1 year**			Rp 65,838,724		Rp 64,039,968

III. Conclusion

This research shows the results of measurements and calculations based on the assumed scenario of electrical energy consumption at a hotel, namely the Bumi Sawunggaling Hotel, which is a type of 1-star hotel in the city of Bandung. Based on real-time measurement results, it is known that the average electrical energy consumption required for weekdays and weekend days is 111.21 kWh and 159.55 kWh. The total electrical energy for one week of observation at the hotel is 923.49 kWh with a total tariff of IDR 1,334,166,- which needs to be spent for one week, and with this value, it is known that the tariff for 1 month is IDR 5,336,664,- and IDR 64,039,166,- for one year. Meanwhile, based on the results of assumptions in scenario 1 which is the maximum point of electrical energy use, and scenario 2 is the result of predictive assumptions which adjust the duration based on user habits, the average use of electrical energy at the Bumi-Sawunggaling Hotel is currently 28%. Based on these values, the Bumi-Sawunggaling Hotel is already in good condition for electricity usage. It can be seen that compared to the scenario assumption results, some measurement results are lower than the assumed calculations. Furthermore, based on these results, the management of Hotel Bumi Sawunggaling can carry out further analysis by using the results of this research as a consideration for carrying out further optimization steps for building energy at Hotel Bumi-Sawunggaling.

Acknowledgment

This research would not have been possible without the support and collaboration of my supervisor and the Bumi Sawunggaling Hotel staff. Their contributions have been invaluable, and I greatly appreciate their time and assistance.

References

[1] Tim Komunikasi dan Media KTT AIS FORUM 2023, "Indonesia Terima Dokumen Acuan Pariwisata Ramah Lingkungan," Kominfo, 10 October 2023. [Online]. Available: https://www.kominfo.go.id/content/detail/52180/indonesia-terima-dokumen-acuan-pariwisata-ramah-lingkungan/0/rilis_media_gpr. [Accessed December 2023].

[2] Badan Pusat Statistik, "Berita Resmi Statistik - Perkembangan Pariwisata November 2023," Januari 2024. [Online]. Available: https://www.bps.go.id/id/pressrelease/2024/01/02/2346/kunjungan-wisatawan-mancanegara-pada-november-2023-mencapai-917-41-ribu-kunjungan--naik-30-17-persen--year-on-year--.html. [Accessed Januari 2024].

[3] Tim Infografis Kominfo, "Saatnya Kembangkan Potensi Pariwisata Indonesia," Kominfo, 18 August 2015. [Online]. Available: https://www.kominfo.go.id/content/detail/5640/saatnya-kembangkan-potensi-pariwisata-indonesia/0/infografis. [Accessed Desember 2023].

[4] A. Rotimi, A. Bahadori-Jahromi, A. Mylona and P. Godfrey, "Estimation and Validation of Energy Consumption in UK Existing Hotel Building Using Dynamic Simulation Software," *Sustainability,* vol. 9, no. 8, 2017.

[5] Humas EBTKE, "Panduan Praktis Penghematan Energi di Hotel," 2 October 2020. [Online]. Available: https://ebtke.esdm.go.id/post/2020/10/08/2653/panduan.praktis.penghematan.energi.di.hotel. [Accessed January 2024].

[6] M. Beccali, P. Finocchiaro, M. Ippolito, G. Leone, D. Panno and G. Zizzo, "Analysis of some renewable energy uses and demand side measures for hotels on small Mediterranean islands: A case study," *Energy,* no. 157, pp. 106-114, 2018.

[7] N. Giang, M. Ichinose, R. Sasaki and E. Tokuda, "ASSESSMENT OF ENERGY CONSUMPTION AS A PERFORMANCE INDEX IN HIGH-RISE BUILDINGS IN HANOI, VIETNAM," *Journal of Building Performance,* vol. 8, no. 1, pp. 25-38, 2017.

[8] H. Yoshino, T. Hong and N. Nord, "IEA EBC annex 53: Total energy use in buildings—Analysis and evaluation methods," *Energy and Buildings,* vol. 152, pp. 124-136, 2013.

[9] PT.PLN, "Tarif Adjustment," October 2023. [Online]. Available: https://web.pln.co.id/pelanggan/tarif-tenaga-listrik/tariff-adjustment. [Accessed December 2023].