Ranah Research:
Journal of Multidisciplinary Research and Development
082170743613 ranahresearch@gmail.com https://jurnal.ranahresearch.com
E-ISSN: 2655-0865
DOI: https://doi.org/10.38035/rrj.v7i1

Energy Consumption Analysis and Efficiency Improvements in the Hospitality Sector: A Case Study of Hotel A in Jakarta Tanah Abang

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Abstract: The hospitality industry is known for its high energy use. The operation of many 24-hour facilities raises energy demand. The Minister of Culture and Tourism's Decree Number KM.03/HK.001/MKP.02 requires that the quality of services and facilities be examined. Air conditioners, water heaters, exercise facilities, and conference rooms all require reliable electrical systems. Energy efficiency is essential, especially for facilities that use a lot of power, including heat pump water heaters in restrooms and fitness center equipment. Hotel A in Jakarta Tanah Abang, which has not yet implemented energy conservation measures, requires energy management systems and audits to improve efficiency. The Energy Consumption Intensity (IKE) is the amount of energy used by a building to increase a conditioned area over a month or a year. The study's goal is to determine IKE values for the period February 2024 to June 2024, as well as energy consumption patterns in accordance with the standards. This study included data collecting, interviews, observations, and direct measurements to determine the energy usage of each month and the entire facility. The IKE calculation approach yielded the following findings for each month: February 5,069701417 kWh/m2/month, March 5,235947214 kWh/m2, April 5,009387155 kWh (m2), May 6,335605837 kWh(m2), and June 6,127963403 kWh/m2. With scores ranging from 5 to 6,3 performance energy consumption, electricity falls into the "Very Efficient" category, eliminating the need for energy savings that could disrupt hotel operations.

Keyword: Energy Efficiency, Energy Consumption Intensity (IKE), Energy Management Systems

INTRODUCTION

There have been several studies in the literature reporting that hotels are recognized as industries with high energy consumption. Various facilities offered, operating 24 hours non-stop, increase energy consumption. A considerable amount of literature has been published on the need to consider the quality of services and hotel facilities, as supporting tools,

according to the Decree of the Minister of Culture and Tourism Number KM.03/HK.001/MKP.02 regarding hotel classification. Various hotel facilities offered to guests, such as air conditioning, water heaters, fitness centers, meeting rooms, restaurants, etc., require an adequate electrical system with efficient usage. Hotel facilities that require significant electrical power include bathrooms and fitness centers. Bathrooms require large amounts of electricity to power heat pump water heaters to maintain a constant temperature of 50º C. Fitness centers have various exercise equipment, such as treadmills and other devices that need electricity to operate.

Electricity is used not only for operating hotel facilities but also for hotel operations, such as hotel lighting, air conditioning, hotel security systems, etc. Hotel owners or managers sometimes use electricity excessively or beyond efficient usage levels. One such example is Hotel A, located in Jakarta Tanah Abang, which has been operating for about five years without implementing energy conservation measures. This needs to be done to reduce unnecessary energy consumption. Therefore, efficiency in electricity usage for hotel operations is required through the implementation of energy management systems via audits.

An audit, in a broad sense, means evaluating an organization, system, process, or product. Electrical energy audits are systematic processes to evaluate the usage of electrical energy in a building, facility, or location to determine the level of electricity consumption and reduce inefficient energy consumption. Energy audits consist of two stages: Initial Energy Audit and Detailed Energy Audit. The first step in auditing is to conduct an initial audit, which involves collecting data on electricity usage and its utilization. The next step is to analyze the Energy Consumption Intensity (IKE) value. If the IKE value exceeds the standard, indicating inefficiency, a detailed energy audit will be conducted. A detailed energy audit is carried out if the IKE value exceeds the predetermined standard, by reviewing historical data, building documentation, complete IKE observation and measurement, and potential energy savings in the preparation of the electrical energy audit report.

Energy-saving efforts in a building, such as a hotel, can only be undertaken if the usage and amount of energy consumed in each hotel building are known. The aim of this research is to assess the performance of electricity usage and determine the IKE value at Hotel A in Jakarta Tanah Abang through an energy audit, by understanding the historical consumption of electricity.

METHOD

Data Collection

A three-star hotel located in the central region of a major Indonesian city was selected for this study. The hotel features 203 modern and comfortable rooms and offers various amenities such as a restaurant, bar, swimming pool, and gym. Easy access to several local tourist attractions, including a national monument, a prominent mosque, and a national museum, is provided by the hotel. It is considered an ideal accommodation for business and leisure travelers seeking a comfortable, affordable, and strategically located stay.

Table 1. List Of Room Area For Each Floor

No	Room	Length (m)	width (m)	Area (m^2)
1	B2	49,85	36,5	1819,525
2	B1	49,85	36,5	1819,525
3	1st Floor	35,6	34,7	1235,32
4	2nd Floor	14,45	34,7	501,415
5	Hall	20,1	17,35	348,735
6	3rd Floor	35,6	14,45	514,42
7	3A Floor	35,6	14,45	514,42
8	5th Floor	35,6	14,45	514,42
9	6th Floor	35,6	14,45	514,42
10	7th Floor	35,6	14,45	514,42
11	8th Floor	35,6	14,45	514,42

No	Room	Length (m)	width (m)	Area (m^2)
12	9th Floor	35,6	14,45	514,42
13	10th Floor	35,6	14,45	514,42
14	11th Floor	35,6	14,45	514,42
15	12th Floor	35,6	14,45	514,42
16	15th Floor	35,6	14,45	514,42
17	16th Floor	35,6	14,45	514,42
18	17th Floor	35,6	14,45	514,42
19	18th Floor	35,6	14,45	514,42
20	19th Floor	35,6	14,45	514,42
21	20th Floor	35,6	14,45	514,42
Total				13955,24

The hotel comprises 20 floors, including 2 basements designated for vehicle parking, and 1 lobby. It features 203 rooms and 8 meeting rooms. The hotel also offers various amenities such as a comfortable lounge area, a gym, a beauty salon, a kids' playground, a restaurant, and several other facilities. The details of the room area for each floor can be found in Table 1.

Initial Energy Audit.

The Initial Energy Audit collects and compiles historical energy data to determine annual energy usage. The Energy Consumption Intensity (IKE) is then calculated and compared to IKE standards to determine if energy consumption meets criteria. IKE evaluates a building's energy efficiency. In industry or factories, the word "specific energy consumption" refers to the quantity of energy consumed per unit of output produced. Energy Consumption Intensity is an intermediate quotient of total energy consumption over a period (one year) with building space, expressed in kWh/m2 per year(7). Countries such as ASEAN and APEC have used IKE in a variety of ways. Calculations are shown in the following equation:

$$IKE = \frac{kWh}{m^2} = \frac{Total\ kWh}{Luas\ Area} \qquad (1)$$

IKE Electric categorizes electrical energy use in a region based on wastefulness or compliance with norms. The Indonesian National Standards (SNI) provides IKE values for buildings. Electrical energy consumption over time divided by building unit area (9). Sectors that can be determined include:

1. Building details and total area (m2).
2. Annual building energy use (kilowatt hours).
3. Annual IKE of structures (kWh per square meter).
4. Building energy expenses.

ASEAN-USAID performed research in 1987 and presented findings in 1992, revealing IKE's main goal. Electricity for Indonesia is as follows:

Table 2. Ike Electricity Results Of Asean-Usaid Research In 1992

No	Location Name	kWh/m^2/year
1	Office	240
2	Shopping Centre	330
3	Hotel/Apartment	300
4	Hospital	380

According to the ASEAN-USAID study conducted in 1987, different standards were established for each category of place. The smallest standard was set for offices at 240 kWh/m²/year, while the largest standard was for shopping centers at 330 kWh/m²/year. The actual IKE values in the field can be compared to the reference standard values from the 1987 ASEAN-USAID study using data from TABLE 2. Based on these results, the Ministry of Energy and Mineral Resources established standard values through Ministerial Regulation

No. 13/2012 regarding energy consumption in air-conditioned and non-air-conditioned buildings. The standard Energy Consumption Intensity values were determined in accordance with the regulation as follows:

Table 3. IKE Standard Minister Of Energy And Mineral Resources Regulation No.13 Year 2012

No	Criteria	Air-conditioned room (kWh/m^2/month)	Non Air-conditioned room (kWh/m^2/month)
1	Highly Efficient	4,17 - 7,92	0,84 - 1,67
2	Efficient	7.92-12.08	1.67-2.5
3	Moderately Efficient	12.08-14.58	-
4	Somewhat Wasteful	14.58-19.17	-
5	Wasteful	19.17-23.75	2.5-3.34
6	Very Wasteful	23.75-37.75	3.34-4.17

In accordance with the standard values set by the Ministry of Energy and Mineral Resources (ESDM), energy consumption is divided into 6 criteria for rooms with air conditioning and divided into 4 for rooms without air conditioning. The specific standards can be referenced in Table 3.

Detailed Energy Audit

A detailed energy audit needs to be carried out if the initial energy audit gives an overview of the IKE value of electricity more than the specified standard value. A detailed energy audit needs to be carried out to find out the profile of energy use in buildings, so that it can be seen what energy-using equipment has a large energy consumption. Detailed Energy Audit is done by directly measuring every equipment that uses electrical energy. The results are used as an Energy Saving Opportunity Analysis. Things that need to be considered in the Detailed Energy Audit are:

A detailed energy audit needs to be carried out to find out the energy usage profile of the building, so that it can be seen what energy-using equipment has a large energy usage. All energy analysis relies on measurement results. The results of Measurement results must be reliable and have an acceptable error. For this reason, it is important to ensure that the measuring instruments used have been calibrated by an authorized agency. The measuring instruments used can be either permanently installed in the installation or temporarily installed.

Energy Saving Opportunity (PHE) Analysis

Energy Saving Opportunities is the potential to save electricity usage. Energy can be likened to money because its status is very vital for the needs of a company for operations to keep running. Its use must be done economically because of its limited availability and not necessarily renewable. Every industry or company must make efforts that focus on saving energy usage.

The hospitality business is part of the commercial sector, which accounts for 3% of total national energy consumption and grows at an annual rate of 8.6%. The hotel business in Indonesia is expanding rapidly, with a growth rate of 12.5% from 2007 to 2011, owing to a 9-13% increase in the number of travelers during that time. The efficient use of energy in hotel buildings must still be able to meet the hotel's operating needs without wasting or excessive energy while prioritizing the 4K concept, which is:

1. Convenience

   Comfort encompasses all facets of making guests feel at ease during their stay at the hotel. This includes properly maintained hotel rooms, furnishings, and amenities such as air conditioning and water heaters.
2. Safety

   The hotel must make customers feel safe while they are there by providing security equipment such as fire alarms, regulated access to rooms, and enough security surveillance
3. Aesthetics and elegance

Aesthetics and elegance of the hotel environment contribute to a memorable guest experience. This includes appealing interior design, stunning grounds or landscape, and the cleanliness and upkeep of all hotel facilities.

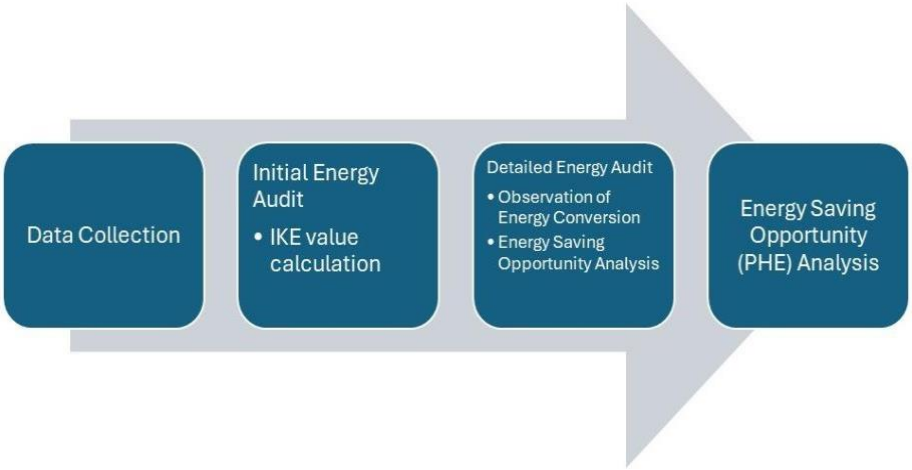

Figure 1. Energy Audit Stage Flow

Figure 1 illustrates the comprehensive process of conducting an energy audit. The audit begins with Data Collection, where a three-star hotel with 203 rooms and various amenities in a major Indonesian city is analyzed. Detailed room areas are provided in Table 1, showcasing the hotel's extensive space across multiple floors. The next step is the Initial Energy Audit, which involves compiling historical energy data to compute the Energy Consumption Intensity (IKE). This metric is compared against established standards from ASEAN-USAID and Indonesian regulations (Tables 2 and 3) to evaluate the building's energy efficiency.

RESULT AND DISCUSSION

Electrical Energy Distribution System

The electricity distribution system at a three-star hotel in Central Jakarta, Indonesia, is supplied by the national power company (PLN) for use in hotel operations. Electrical power is obtained at 20 kV, a high voltage from PLN, which is then stepped down using a transformer to a voltage category of three phases. This lower voltage is subsequently distributed to the Low Volt Main Distribution Panel (LVMDP), making it ready for use in the hotel's operations

FIGURE 2. Low Volt Main Distribution Panel (LVMDP)

Figure 2 depicts the Low Voltage Main Distribution Panel (LVMDP), which operates at low voltage levels and serves as the primary power distribution unit for all feeder installations it supports. The LVMDP is categorized as low voltage because it operates at 220 volts for single-phase circuits, derived from one phase relative to neutral. For three-phase

systems, the operational voltage is 380 volts, obtained from the line-to-line voltage between phases R, S, and T. This configuration ensures efficient distribution of electrical power within the building's infrastructur .

Electric Energy Consumption

The WBP (Peak Load Time) kWh value is taken between 18.00 to 22:00, while the value of kWh LWBP (Outside Peak Load Time) is taken outside the peak load time. Below is the data on the results of electrical energy consumption during the period February 2024 to June 2024.

Table 4. Electricity Consumption

Month	Febuary	March	April	May	June
kWh LWBP	58202,9	59874,0	57730,0	73533,8	70589,6
kWh WBP	12546,0	13194,9	12177,2	14881,1	14927,6
Total	70748,9	73068,9	69907,2	88414,9	85517,2

Based on the data provided, the smallest energy consumption occurred in April, amounting to 69,907.2 kWh. The largest energy consumption occurred in May, with a value of 88,414.9 kWh. The monthly electricity energy consumption in Table 4 varies. The differing values of electricity energy consumption each month could be attributed to the occupancy rate of the rooms.

Energy Audit

The Energy Consumption Intensity (IKE) represents the amount of electrical energy usage per square meter of building area over a specific period. The total area of Hotel A in Jakarta Tanah Abang is 13,955.24 square meters. Using the provided energy consumption data, the IKE value for the month of February can be calculated as follows.

$$\text{IKE} = \frac{\text{kWh}}{\text{Area}} = \frac{70748,9}{13955,24} = 5,069701417 \text{ kWh/m2/month} \quad (1)$$

The calculation for the IKE value in February yielded a result of 5.069701417 kWh/m²/month. Below are the calculated IKE values for each subsequent month:

Table 5. IKE Value Calculation Results For Each Month

No	Month	Consumption kWh	IKE kWh/m2/month	Description
1	Febuary	70748,9	5,069701417	Highly Efficient
2	March	73068,9	5,235947214	Highly Efficient
3	April	69907,2	5,009387155	Highly Efficient
4	May	88414,9	6,335605837	Highly Efficient
5	June	85517,2	6,127963403	Highly Efficient

Based on the data presented in TABLE 5 regarding the calculation of the Energy Efficiency Index (IKE), it is observed that the values recorded from February 2024 to June 2024 range between 5 and 6.3. These IKE values indicate that electricity consumption remains within the category of highly efficient according to the standards set forth in the Regulation of the Minister of Energy and Mineral Resources No. 13 of 2012.

Energy Savings Opportunity Analysis

The calculation results of the Energy Efficiency Index (IKE) fall within the "Highly Efficient" category according to the standards set by the Regulation of the Minister of Energy and Mineral Resources No. 13 of 2012. The low intensity of electricity consumption is likely attributable to the widespread use of energy-efficient equipment, such as LED lighting, LED televisions, and low-energy hair dryers. Given these findings, there is no immediate need for

additional energy-saving measures that could disrupt hotel operations. However, it is important to remain vigilant against energy wastage in order to maintain the IKE value

CONCLUSION

The electrical energy distribution system at the three-star hotel in Central Jakarta is supplied by the national power company (PLN), which delivers a high voltage of 20 kV. This power is then transformed into a lower three- phase voltage for safe distribution through the Low Volt Main Distribution Panel (LVMDP), effectively supporting the hotel's operational needs. Analysis of energy consumption data from February to June 2024 shows significant fluctuations, mainly influenced by occupancy rates and operational demands. April recorded the lowest consumption at 69,907.2 kWh, while May saw the highest at 88,414.9 kWh. This variation underscores the correlation between energy use and hotel occupancy, with peak periods driving increased demand. The Energy Consumption Intensity (IKE) metric, which assesses electrical energy use per square meter of the hotel over time, provides further insights. The hotel covers a total area of 13,955.24 square meters, and in February, the IKE was calculated to be approximately 5.07 kWh/m²/month. Subsequent months reported IKE values ranging from 5.01 to 6.33 kWh/m²/month, maintaining "Highly Efficient" status according to the Minister of Energy and Mineral Resources Regulation No. 13 of 2012. These findings indicate effective energy management, attributed to energy- saving technologies like LED lighting and efficient appliances. While there is no immediate need for additional energy-saving measures, continued monitoring and awareness regarding energy conservation are vital to sustain these favorable IKE values and prevent wastage. Ongoing oversight will optimize energy performance as hotel operations evolve, supporting both cost-effective management and a commitment to sustainability within the hospitality sector.

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