

## **Study of Building Energy Index and Energy Efficiency Measures for Residential Colleges at UTHM Main Campus**

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**Abstract:** Energy is one of the most important elements in the world. A case study was conducted to determine the energy and Building Energy Index (BEI) and energy efficiency measures in the building. The project is continued with the focus on the residential college at UTHM main campus which are Kolej Kediaman Tun Fatimah (KKTF) and Kolej Kediaman Tun Dr Ismail (KKTDI) where the project is performed by collecting energy usage and gross floor area for the residential colleges in the year 2019-2021. The calculation for building energy index (BEI) is calculated by using the formula energy usage per gross floor area. The comparison between the BEI calculation for residential colleges in UTHM main campus with the Malaysia Standard and the energy efficiency measures is proposed. It is expected to get a building energy index for years 2019 to 2021 and the results was compared where the pattern was decreasing. It is estimated that the result was lower and satisfied the MS1525 Malaysia Standard, but the energy efficiency measures had been made for the residential colleges in UTHM main campus to improve the energy and electric usage.

**Keywords:** BEI, Residential College, Electric Usage, Energy Efficiency Measures.

### **1. Introduction**

Energy especially electricity sources are used widely and intensively in commercial, R&D development, industrial and human daily life. The industrial sector such as the building sector used almost 50% of the total end user energy consumption by sector. Kolej Kediaman Tun Fatimah (KKTF) and Kolej Kediaman Tun Dr Ismail (KKTDI) are chosen as the location at UTHM main campus and are always occupied with the students and staff. In Malaysia, the building sector contributes almost half of the electrical energy consumption due to building and construction activities. In 2018, the Ministry of Energy, Science, Technology, Environment and Climate Change stated that Malaysia will be able to save up to RM 46.9 billion in energy spending between 2016 and 2030[1]. Based on the MS1525 [2], the building energy index (BEI) standard for the building is 135 kWh/m<sup>2</sup>/yr.

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In an effort in ensuring that institutions and buildings meet the required BEI directives, one of the institutions that require to meet these standards is the University Tun Hussein Onn Malaysia [3]. The varsity, as an institution of higher learning, must meet the BEI requirements and as such, there is a need to conduct a study on the school so that all the measures are taken, data collected, and analyzed to determine if the institution complies with the directives.

The study aims to identify annual energy usage for all residential colleges at UTHM main campus, to determine the building energy index (BEI) for residential colleges at UTHM main campus and to propose the energy efficiency measures to be practised by students at UTHM residential colleges. Two residential colleges are select which are Kolej Kediaman Tun Fatimah (KKTF) and Kolej Kediaman Tun Dr Ismail (KKTDI). Collect the data from annual monthly electric bill for the whole year from 2019 until 2021, measure the gross floor area of residential college buildings at UTHM main campus, analysis and calculate the building energy index (BEI) and propose the energy efficiency measures at UTHM residential college the main campus.

## **2. BEI standard for School Institutions**

A school institution or a university also posed in a study to optimize BEI, a preliminary audit that includes a quick analysis of the operation of services and facilities, observation and a walkthrough energy use in the facilities of Chancellery building in University Utara Malaysia (UUM) [4]. The study proves significant compliance of MS1525:2007 in the building implementing energy-efficient measures as it achieves valuable BEI of 136 kWh/m<sup>2</sup>/year. The government's target as stated in early explanation of a reference towards an energy efficiency utilization of power thereby achievable [5]. The study of Kamalluden in 2012 also argued that the standard MS1525 recommends the optimum energy index of 135kWh/m<sup>2</sup>/year in building energy consumption in Malaysia [6]. However, it is not met by numerous buildings and facilities as the construction users are not aware of whether their building fulfilled the said standard. BEI's objective is achieved by several method sequences, such as the collection of the gross floor area of the building, building's index induces by excellence software, collating data regarding the building's energy consumption records, and analyzing the energy index trend of the said building BEI can also track if the energy consumption increases or decreases by pitting two correlated and different set of data [6].

Energy Efficiency Index (BEI), or also known as Building Energy Index (BEI) is the indicator used to monitor the performance of energy consumption in buildings. This index is also used as the point of reference, which provides the baseline for energy performance comparison. At the same time, it offers the owners, tenants and operators with best understanding of their building energy utilization to organize an effective energy efficiency scheme for the future [7]. Building Energy Index (BEI) Labelling is one of the government initiatives toward sustainable building and development especially in the construction sector. BEI Labelling is established to encourage government staff to improve the energy performance of a building. As BEI implemented several grounds in energy consumption to optimize maximization of energy efficiency, it is defined that energy efficiency is the usage of less minimized energy optimization to deliver the same energy level inducing a decrease in human greenhouse emissions and carbon footprint[8].

## **2. Methods**

Methods for the study are to collect the data from the annual monthly electric bill for the whole year from 2019 until 2021, investigate and measure the gross floor area of residential college buildings at UTHM main campus from 2019 until 2021, calculate and analyse building energy index and propose energy efficiency measures at UTHM residential college at main campus.

The first step method is selecting the residential college buildings which are Kolej Kediaman Tun Fatimah (KKTF) and Kolej Kediaman Tun Dr Ismail (KKTDI). Next, collection of data for the Building Energy Index (BEI) calculation which is the monthly electric bill in UTHM residential college and gross floor area of each residential college. After that, calculate the data from the total gross floor area of residential college buildings, total monthly electric usage in the year 2019 to 2021 and calculate the

building energy index for each of residential colleges. Lastly, the analysis of data is by comparing the BEI result with the standard BEI result, make the discussion about the pattern of the graph figure and proposing the energy efficiency measures for students at UTHM residential colleges.

### 2.3 Equations

To calculate and make analysis for the BEI of the residential college in UTHM, it is expressed by kWh/m<sup>2</sup>/year where the total gross floor area of residential college buildings and the total monthly electric usage in-year must be identified. Then, it can be calculated by using the formula of Building Energy Index (BEI) also can be calculated using Microsoft excel software. The calculation for Building Energy Index (BEI) is as follows:

$$BEI = \frac{\text{Total Energy Usage (kWh)}}{\text{Gross Floor Area (m}^2\text{)}} \text{ Eq. 1}$$

## 3. Results and Discussion

The analysis of electric consumption was based on the monthly summary report of the year 2019,2020,2021 for residential colleges in UTHM which are Kolej Kediaman Tun Fatimah (KKTF) and Kolej Kediaman Tun Dr Ismail (KKTDI). Figure 1 and Figure 2 below shows the UTHM electrical bills detail for the year of the residential colleges.

### 3.1 Electric usage

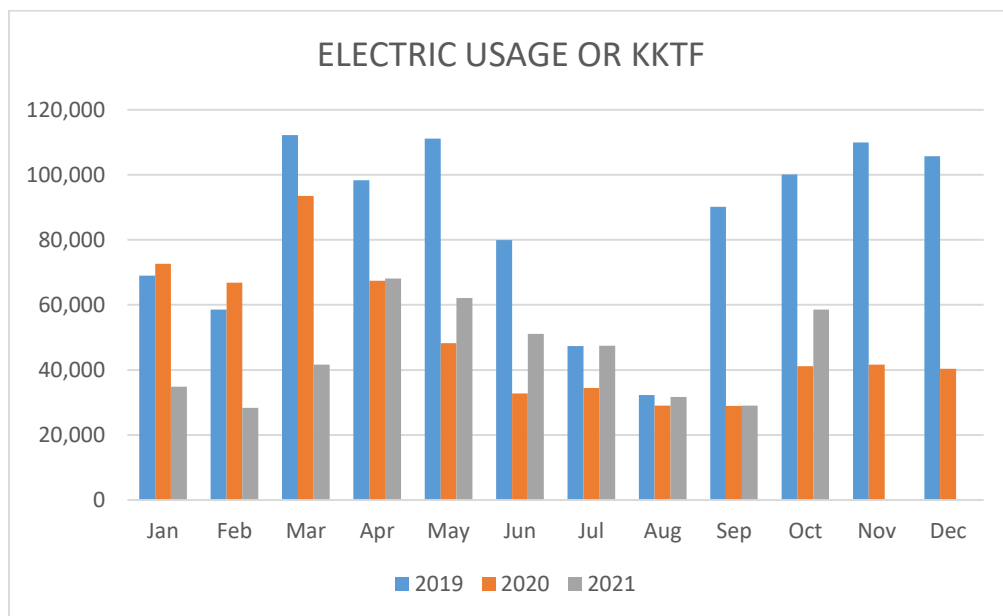


Figure 1: Electrical usage for Kolej Kediaman Tun Fatimah (KKTF)

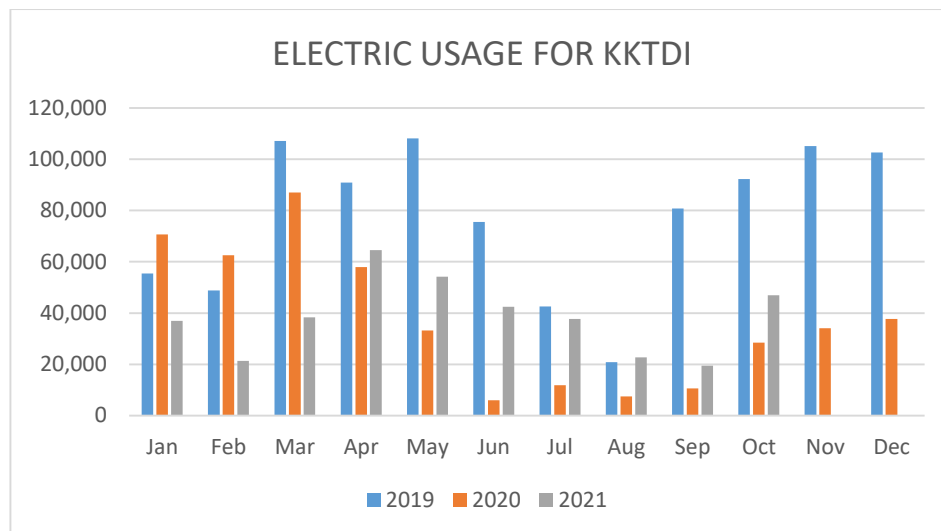


Figure 2: Electrical usage for Kolej Kediaman Tun Dr Ismail (KKTDI)

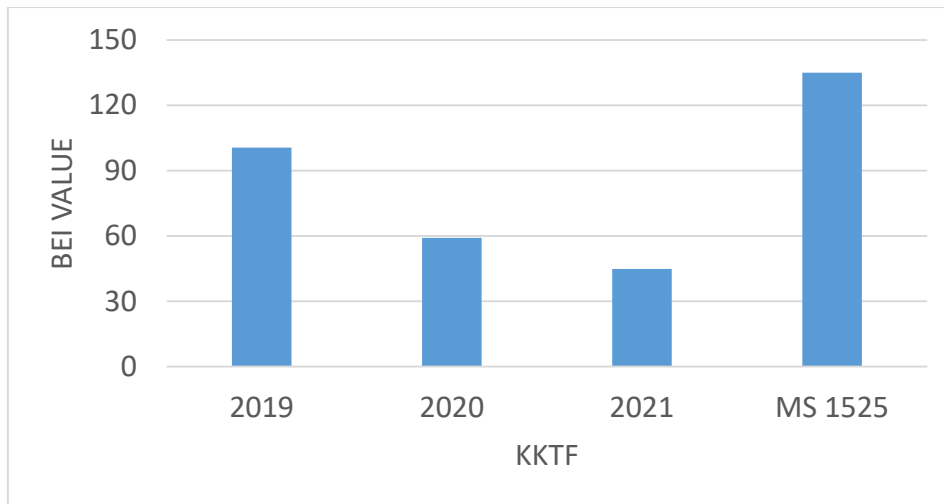
Table 1: Gross floor area for residential college in UTHM

RESIDENTIAL COLLEGE	KKTF	KKTDI
GROSS FLOOR AREA,m <sup>2</sup>	10,094.12	10,371.28

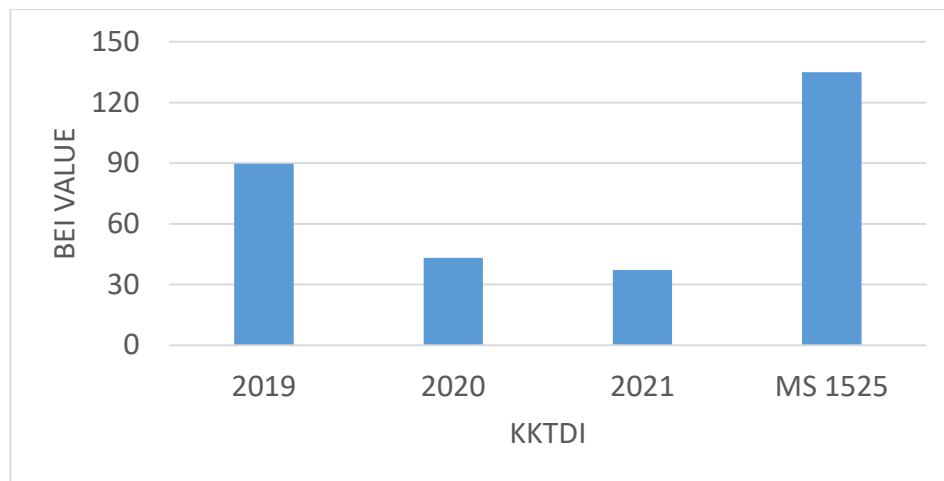
Table 2: The Building Energy Index (BEI) for residential colleges in UTHM

Residential Colleges	Year	BEI (kWH/m <sup>2</sup> /year)
KKTF	2019	100.50
	2020	59.13
	2021	44.86
KKTDI	2019	89.69
	2020	43.17
	2021	37.08

Table 2 shows the Building Energy Index (BEI) for residential colleges in UTHM. Despite Covid-19 and Movement Control Order (MCO) by the government, the residential colleges still are operating and received students and staff that had some technical problems for their work and studies such as the internet problem in their hometown, the disturbance from their family and surrounding hometown, lab project and research and facilitate the students to having study group and discussion among their friends. So, based on these factors, the UTHM campus allowed the students to occupy the residential college in UTHM main campus.



**Figure 3: Building Energy Index for Kolej Kediaman Tun Fatimah (KKTF)**



**Figure 4: Building Energy Index for Kolej Kediaman Tun Dr Ismail (KKTDI)**

### 3.2 Discussions

From the calculation, Building Energy Index (BEI) for Kolej Kediaman Tun Fatimah (KKTF) obtained from 2019 is 100.50 kWh/m<sup>2</sup>/year, for 2020 is 59.13 kWh/m<sup>2</sup>/year and for 2021 is 44.86 kWh/m<sup>2</sup>/year. Therefore, it can be concluded that Kolej Kediaman Tun Fatimah (KKTF) is lower than the best BEI practice and recommended by Malaysia Standard which is 135 kWh/m<sup>2</sup>/year. From the calculation for Kolej Kediaman Tun Dr Ismail (KKTDI), the calculation obtained from 2019 is 89.69 kWh/m<sup>2</sup>/year, for 2020 is 43.17 kWh/m<sup>2</sup>/year and for 2021 is 37.08 kWh/m<sup>2</sup>/year. Therefore, it can be concluded that Kolej Kediaman Tun Dr Ismail (KKTDI) is lower than the best BEI practice and recommended by Malaysia Standard which is 135 kWh/m<sup>2</sup>/year. It also showed that Kolej Kediaman Tun Fatimah (KKTF) and Kolej Kediaman Tun Dr Ismail (KKTDI) was using lower energy and electric usage.

According to Pusat Pembangunan dan Penyelenggaraan (PPH) UTHM staff, the factor that affected the lower energy and electric usage for residential colleges in UTHM is due to Covid-19 and Movement Control Order (MCO) by the government to lower and decreasing the risk for Covid-19 from students, especially in residential colleges. During the MCO order in March 2020 until August 2021 as in the graph, it showed the declined pattern before Covid-19 occurred which from 2019 until Covid-19 occurred in Malaysia in 2020 until 2021.

Although the Building Energy Index (BEI) for residential colleges in UTHM for Kolej Kediaman Tun Fatimah (KKTF) and Kolej Kediaman Tun Dr Ismail (KKTDI) is lower than the Malaysia Standard which is 135 kWh/m<sup>2</sup>/year, suitable efficiency measures can be taken to make sure students can be practised to minimized the energy and electric usage in residential colleges in UTHM.

The energy efficiency measures that can be taken by students in residential colleges include:

- i. Make sure to switch off energy and electric usage when not in use.
- ii. Create an awareness campaign in residential colleges for students to appreciate and gain more knowledge about the importance of saving energy and electric usage.
- iii. Minimize the gross floor area for energy and electric usage in residential colleges.
- iv. Apply rules and regulations for students especially in residential colleges to limit the use of electrical appliances to minimize energy and electric usage.
- v. Give a fine or penalty for students if they ignore or disobey the rules and regulations for residential colleges.

#### 4. Conclusion

Based on the building energy index (BEI) calculation, residential colleges in the UTHM energy index is lower compared to the recommended value. The result is not really showed the actual performance of energy index due to electric usage for 2021 is not fully updated and also due to student reduction in residential colleges because of Covid-19 and MCO restriction from the government. Several factors also take place which are the university and residential colleges were fully utilizes first semester and second semester because for the third semester usually for sem break and industrial training.

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