

# Study of Electrical Energy Consumption and Potential Saving in Malaysia Commercial Kitchen

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## Abstract

The commercial kitchen sector in Malaysia, a cornerstone of the nation's vibrant culinary landscape, is experiencing significant growth driven by economic development and urbanisation. This expansion is accompanied by a substantial increase in electrical energy consumption, posing challenges related to rising operational costs and environmental sustainability. This study investigates the patterns of electrical energy usage in Malaysian commercial kitchens, identifies potential energy-saving, and analyses the associated cost-saving benefits. The research highlights the importance of optimising energy consumption in commercial kitchens. By analysing the current consumption patterns, assessing the efficiency of major appliances, and exploring behavioural and procedural changes, the study provides actionable insights for enhancing energy efficiency.

## 1. Introduction

The commercial kitchen sector is vital to Malaysia's culinary landscape, serving as a hub for gastronomic experiences in restaurants, hotels, and catering establishments. With economic growth and urbanisation, the demand for culinary services and electrical energy in these kitchens is increasing. Efficient energy management is crucial for both economic and environmental sustainability.

In industrialised nations, energy consumption in residential and commercial buildings has increased by 20% to 40% over the past decade, with residential energy usage being a significant part of the demand [1]. Many consumers use energy inefficiently due to outdated appliances, highlighting the need for energy conservation [2]. Malaysia's economic development has led to a rise in commercial kitchens using energy-intensive appliances. The country's energy landscape includes conventional and renewable sources, with electricity essential for kitchen operations.

As the demand for culinary services grows, the need to address environmental impacts and operational costs becomes more pressing. The commercial kitchen industry faces the challenge of optimising energy consumption without compromising service quality. This is particularly important in Malaysia, where sustainable development and resource efficiency are gaining prominence.

Studying electrical energy consumption and potential savings in Malaysia's commercial kitchens is driven by rising energy costs, the need to reduce carbon footprints, and the goal of enhancing energy infrastructure resilience by reducing peak demand.

## 1.1 Energy consumption analysis

The features of a building, such as construction materials and insulation, are clear contributors to energy inefficiency across various building types. A study by van den Brom et al. (2018) on energy consumption performance gaps found that newly constructed buildings using modern materials tend to have lower energy consumption compared to recently renovated older buildings. Additionally, the research identified disparities between actual and theoretical (simulated) energy consumption. The behaviour of occupants significantly influences the overall energy usage, particularly in residential buildings, as noted by Bourgeois in 2005. Even in buildings sharing the same energy labelling, variations in consumption may arise based on factors like the set temperature for heating or cooling [3].

## 1.2 Electrical consumption in commercial kitchens

Individuals who once managed energy consumption in commercial kitchens have transitioned to different roles or assumed new responsibilities. Electricity use is a big part of how we consume energy globally and plays a crucial role in economic growth. In Malaysia, the amount of electricity each person uses went up from 3900 kilowatt-hours (kWh) in 2010 to 4750 kWh in 2019, according to the Department of Statistics Malaysia. Understanding how we use electricity is essential for economic development [4].

## 1.3 Efficiency Standard in Malaysia

Currently, there are no standards, labels, or energy testing protocols for appliances in Malaysia. The only exception dates back to 1989 when the Ministry of Energy, Telecommunications, and Posts introduced efficiency standards for motors. However, there are pending energy efficiency regulations, currently in draft form and yet to be publicly disclosed. These regulations are rumoured to encompass directives for establishing minimum energy performance standards for appliances like fans, room air conditioners, and refrigerators. A voluntary labelling program is also anticipated for various appliances such as televisions, computers, monitors, washing machines, and dishwashers. The Department of Electricity and Gas Supply has enlisted the assistance of SIRIM to formulate these standards [5].

## 1.4 Commercial Kitchen

Household kitchens play a crucial role in maintaining a decent quality of life, serving as a fundamental component within a residence for storing items and carrying out activities such as food preparation, cooking, and laundry. Assessing the impact of kitchens on energy consumption is vital for effectively reducing overall demand, enabling consumers to manage their energy expenses at an affordable level and contributing to the goal of achieving net-zero energy usage [6].

## 2. Methodology

### 2.1 The Selected Building

The buildings selected are located on the main campus of UTHM, Parit Raja, Batu Pahat, Johor. There are commercial kitchens for culinary students, so the building chose to do this project in a lab commercial kitchen.

### 2.2 Electric Energy Usage Pattern

The aim of the research is to understand how electricity is utilised in the kitchen laboratory. Since the lab's electricity bill is not provided, the actual electric usage must be measured manually. To improve accuracy, we suggest using a current flow detector. The objective is to gain insights into the lab's true patterns of electricity consumption, even without billing information.

### 2.3 Calculated the energy consumption

Applying the power calculation formula:

$$\text{Energy consumption} = \text{power rated} \times \text{hour} \times \text{quantity} \quad (1)$$

The formula allows us to determine the power consumption for each piece of equipment, and aggregating these values provides the total energy consumption. Analysis of the data enables the identification of peak usage times and the assessment of equipment, lighting efficiency, and other equipment used in the kitchen.

### 2.4 Electric user for the kitchen analysis

Energy usage patterns in a commercial kitchen exhibit distinct profiles during various operational phases. During the preparation phase, energy consumption peaks with the operation of food processors, blenders, and

refrigeration for ingredient storage. Lighting contributes moderately to this phase. Kitchens can invest in energy-efficient appliances and implement zoning for targeted lighting to enhance efficiency. The cooking phase sees the highest energy usage, primarily from stovetops and ovens, with additional energy spent on ventilation systems and microwaves.

## 2.5 Equipment operation hour

The equipment's operating hours differ from the kitchen operating hours due to the equipment's nature and usage frequency. For instance, lights, fans, and air-conditioning systems run continuously during operational and maintenance tasks to provide necessary illumination and ventilation for the crew. Core equipment like freezers, chillers, multiplexers, ice machines, heat treatment machines, and water heaters operate as needed during operational and non-operational hours. This ensures that specific conditions are maintained, such as the temperature of raw products, hot water in the storage tank, ice stock, and product quality. Consequently, the compressor operation for a walk-in cold room leads to fluctuating energy consumption as the thermostat cycles on and off to maintain the desired temperature.

## 2.6 Equipment power-rated

The kitchen's energy consumption is significantly influenced by various equipment's power ratings and operating patterns, each with its own power rating. Lights, fans, and air-conditioning systems, which operate continuously during operational and maintenance tasks, consume steady energy to ensure proper illumination and ventilation. Core equipment, such as freezers, chillers, multiplexers, ice machines, heat treatment machines, and water heaters, also operate at all times to maintain critical conditions like the temperature of raw products and hot water, resulting in high, constant energy consumption.

## 3. Result

### 3.1 The selected building

The primary location for this study is on the campus of UTHM Parit Raja, Batu Pahat, Johor. The research takes place in the lab commercial kitchen, designed like a restaurant and fully equipped for kitchen operations. The equipment is utilised three days a week, corresponding to when Food Services classes are held. The office hours start at 8.00 am and end at 5.00 pm, with 9 working hours, and sometimes it operates more than office hours for the extra class.

### 3.2 The trend of electric energy

The trend of energy is not consistent because the equipment is operating for a long time, and it is because the bill value is so high. The energy consumption for Monday is necessary to use a big appliance for cooking, it is necessary to use the appliances for cooking in large quantities compared to the class times on Sunday and Thursday. It is because the use of big appliances for cooking in large quantities at events or workshops on Monday compared to class times on Sunday and Thursday is driven by the need to accommodate larger crowds, time constraints, diverse menu offerings, professional catering requirements, presentation standards, and logistical considerations inherent to such occasions.

### 3.3 The list of appliances that has in the commercial kitchen taken for analysis of energy consumption

Table 1 details the energy consumption of various appliances in a commercial kitchen, highlighting their quantity, power, operating hours, and total energy consumption in both watt-hours (Wh) and kilowatt-hours (kWh). The highest energy consumers are the Ceiling Exposed Split Unit and the Combi Bake Oven, which consume 68.64 kWh and 58.50 kWh per month. The Combi Oven (66.00 kWh) and Coffee Machine (20.40 kWh) also significantly contribute to the overall energy usage. Conversely, LED Downlights (2.16 kWh) and Halogen Lamps (5.18 kWh) have relatively lower consumption. Continuous operation appliances, such as the Island Chiller, Upright 4 Door Chiller, and Upright 4 Door Freezer, which run 24 hours a day, also account for substantial energy usage. The total monthly energy consumption across all appliances is 276.06 kWh. This analysis indicates that a few high-power appliances significantly impact overall energy consumption, underscoring the need for energy-saving measures such as upgrading to more efficient appliances, optimising usage times, and improving operational practices to reduce energy costs and enhance sustainability.

**Table 1** List appliance

No	Appliances	Qty	Power (W)	Operating Hours (Hrs)	Energy Consumption (Wh)	Energy Consumption (kWh)
1	LED downlight	15	12	12	2160	2.16
2	Ceiling exposed split unit	2	2860	12	68640	68.64
3	Coffee machine	2	3400	3	20400	20.40
4	Combi oven	2	11000	3	66000	66.00
5	LED tube light	22	40	12	10560	10.56
6	Halogen lamp	12	36	12	5184	5.18
7	Combi bake oven	1	19500	3	58500	58.50
8	Island chiller	1	500	24	12000	12.00
9	Bulkhead lamp	7	60	12	5040	5.04
10	Upright 4 door chiller	1	408	24	9792	9.79
11	Upright 4 door freezer	1	741	24	17784	17.78
Total					276060	276.06

### 3.4 Energy Consumption for Kitchen Equipment

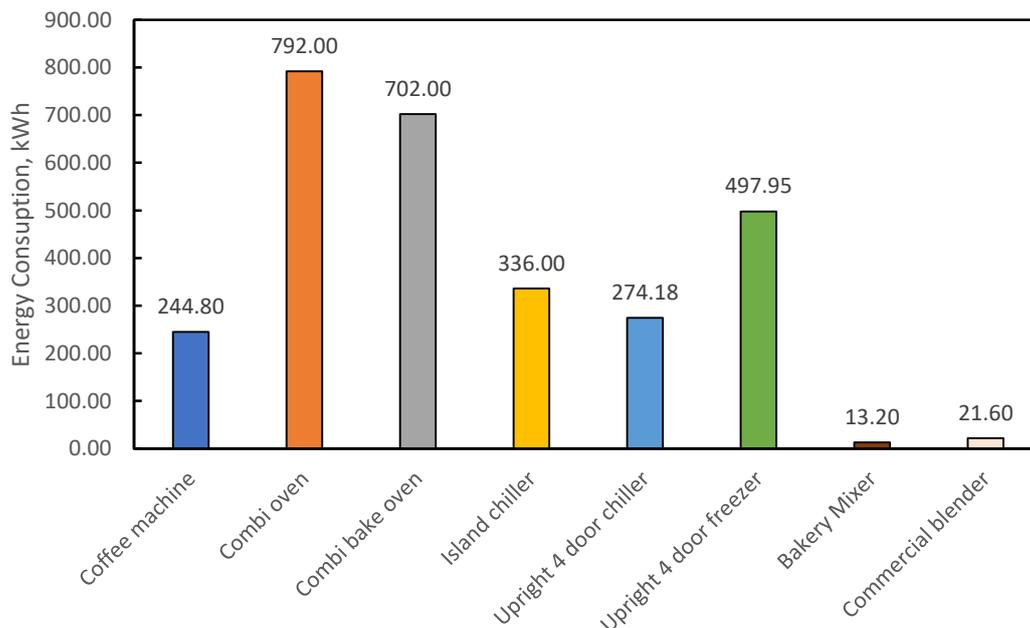
**Fig. 1** The graph of energy consumption for kitchen equipment in a month

Fig. 1 shows Kitchen Equipment Energy Consumption (kWh/month), which illustrates the monthly energy usage in kilowatt-hours (kWh) for various kitchen appliances and equipment. The coffee machine consumes 244.80 kWh per month. The combi oven, with a consumption of 792.00 kWh per month, is the highest energy user among the listed equipment. Following closely, the combi bakes oven uses 702.00 kWh per month, making it the second

highest in energy consumption. The island chiller consumes 336.00 kWh per month, while the upright 4-door chiller and the upright 4-door freezer use 274.18 kWh and 497.95 kWh per month, respectively. On the lower end, the bakery mixer shows a minimal energy consumption of 13.20 kWh per month, and the commercial blender consumes slightly more at 21.60 kWh per month.

The graph highlights that the combi oven and combi bake oven are the most energy-intensive appliances, indicating either higher power requirements, more frequent use, or larger operational scale. In contrast, the bakery mixer and commercial blender are the least energy-consuming, suggesting less frequent use, lower power requirements, or more efficient energy use. This visual comparison of energy usage is valuable for cost analysis and energy management in a kitchen setting, helping businesses in the food industry identify which equipment contributes most to energy expenses and optimize their energy consumption to reduce operational costs.

### 3.5 Total energy consumption

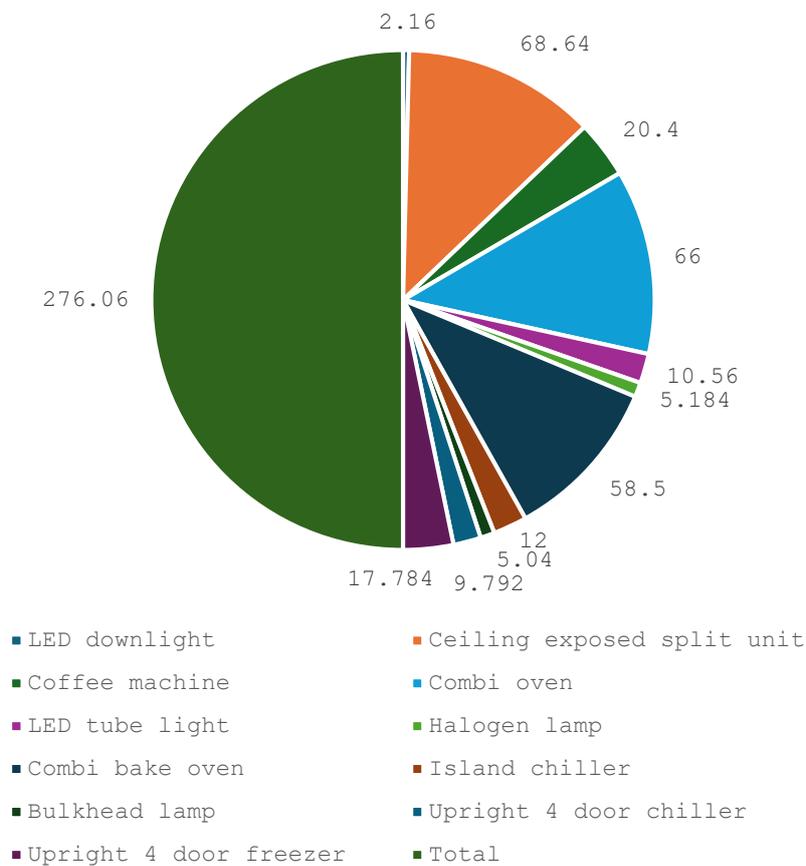


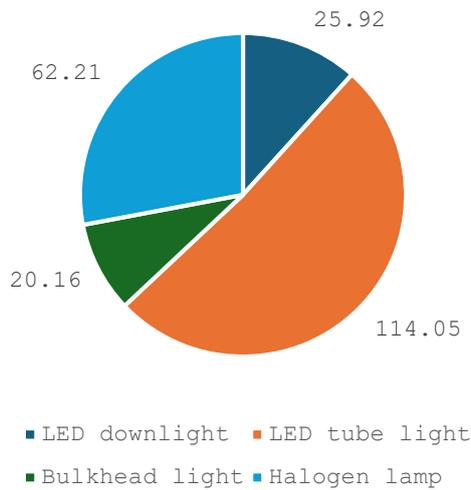
Fig. 2 Total energy consumption in one day

Fig. 2 illustrates the energy consumption for the commercial kitchen at FPTV in UTHM. To analyse the kitchen's energy usage, we need to collect data on the power rating of each piece of equipment present. The total daily energy consumption is approximately 276.06 kWh. The kitchen is equipped with LED downlights, LED tube lights, halogen lamps, and bulkhead lights. Halogen lamps provide crucial lighting for kitchen users, aiding in tasks such as cooking and locating equipment like knives. Proper lighting, including temperature and illumination, is essential for the correct appearance of food, the right eating ambiance, and a cozy environment. Halogen lamp use 5.184 kwh which have 12 of the halogen lamp in the kitchen. We can see from the graph the ceiling exposed split unit use 68.64kwh in one month and total of quantity that provide is 2. The power rating for 1 ceiling exposed split unit is about 2860 and it operates around 12 hour and 1 week it only operates for 3 days.

### 3.6 The lighting energy consumption

The total lighting energy consumption in the commercial kitchen is approximately 246.53 kWh (Fig. 3). The types of lighting used include LED downlights, LED tube lights, bulkhead lights, and halogen lamps. According to the data, LED tube lights consume the most energy, with a total of 114.05 kWh. This high consumption is attributed to the large number of LED tube lights installed, which is about 22 units. The second highest energy consumption is from halogen lamps, which use 86.40 kWh, with around 12 units in use. LED downlights consume 62.21 kWh,

indicating significant energy usage, likely due to their operational requirements and the number of units. Bulkhead lights have the lowest energy consumption at 20.16 kWh, possibly due to fewer units or higher energy efficiency.

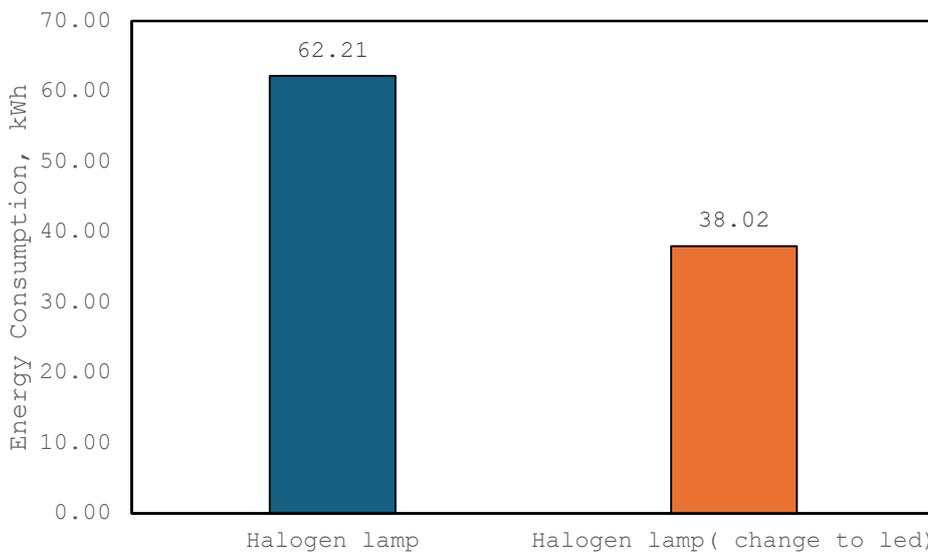


**Fig. 3** The lighting energy consumption in one day

Other miscellaneous lighting fixtures also contribute 25.92 kWh to the total energy consumption. This analysis suggests that while LED lighting options are generally more energy-efficient, the overall energy consumption can still be high if many fixtures are used. The significant energy usage by halogen lamps also highlights a potential area for energy efficiency improvements, such as replacing them with LED alternatives.

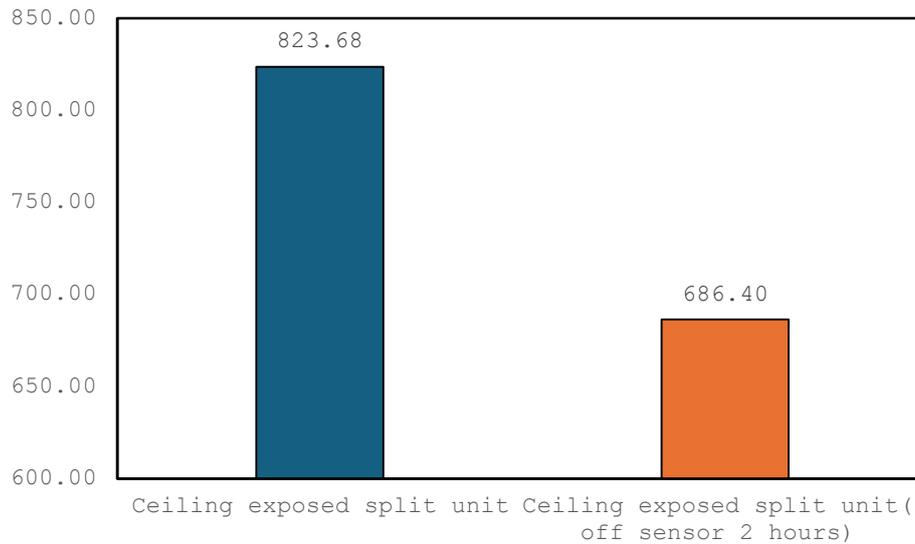
### 3.7 The difference when halogen lamp changes to LED lamp

The bar graph (Fig. 4) illustrates the monthly energy consumption differences between a halogen lamp and an LED lamp. The halogen lamp consumes 62.21 kWh of energy per month, whereas replacing it with an LED lamp reduces the consumption to 38.02 kWh monthly. This change results in a significant energy savings of 24.19 kWh monthly. The graph highlights the greater energy efficiency of LED lamps than halogen lamps, showcasing substantial cost savings on electricity bills and contributing to reduced carbon emissions. This evidence supports the adoption of LED lighting as a viable strategy for enhancing energy efficiency and promoting sustainability.



**Fig. 4** Energy Consumption difference when halogen lamp change to LED lamp in month

### 3.8 Decrease the operation of ceiling exposed split unit for 2 hours



**Fig. 5** Comparison graph after reducing 2-hour operation for ceiling exposed split unit in a month

Fig. 5 illustrates the monthly energy consumption of a Ceiling Exposed Split Unit under two different operating conditions. When the unit operates continuously without any sensor adjustments, it consumes 823.68 kWh per month. However, when the unit's sensor is turned off for 2 hours daily, the monthly energy consumption decreases to 686.40 kWh. This adjustment results in a significant energy savings of 137.28 kWh per month, representing approximately a 16.67% reduction. Such a reduction lowers electricity bills and contributes to environmental sustainability by reducing the carbon footprint associated with electricity generation. The chart highlights that simple operational adjustments, like turning off sensors for a short period each day, can substantially enhance energy efficiency and promote sustainable practices in energy-intensive environments like commercial kitchens.

## 4. Recommendations

Improving user attitudes towards energy efficiency in commercial kitchens is crucial for reducing energy consumption and operational costs. To achieve this, several strategies can be implemented. Education and training are essential; conducting regular workshops and providing information about saving energy can raise kitchen users' awareness of the importance of energy efficiency and its benefits for both the environment and the business.

Another effective strategy is to shorten the operating hours of energy-intensive appliances. Significant energy savings can be achieved by optimising the usage schedule and ensuring that appliances are turned off when not in use. This can be particularly effective in reducing peak energy consumption and minimising unnecessary energy usage during off-peak hours.

Additionally, when using chillers, consider storing items in smaller portions. This practice can improve cooling efficiency as smaller portions cool faster and require less energy to maintain the desired temperature. It also minimises the frequency and duration of chiller door openings, thereby reducing the loss of cool air and the energy needed to restore the temperature.

## 5. Conclusion

In the way to improve energy efficiency in commercial kitchens, users should be educated about pre-heating times and discouraged from turning on all appliances at once. Upgrading to energy-efficient appliances, conducting regular maintenance, and implementing energy audits are crucial. Installing smart energy management systems, using programmable thermostats and lighting controls, and training staff on energy-saving practices can optimise energy consumption. Shortening operating hours, enhancing insulation and ventilation, integrating renewable energy sources, and implementing LED lighting also help reduce energy usage. Adopting these strategies can significantly lower energy consumption and operational costs and contribute to environmental sustainability. Education, incentives, engagement, technological support, policy implementation, and continuous improvement are key elements in promoting a positive energy efficiency attitude.

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## Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

## Author Contribution

This research and analysis was designed by (Muhammad Adam bin Abu Hasan) who performed for the research. (Mr Zamri bin Noranai) guide me to perform the result and provide idea for the research.

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