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FEASIBILITY STUDY TO USE SOLAR SYSTEM AS AN ALTERNATIVE SOURCES OF ELECTRICITY FOR EDUCATIONAL INSTITUTIONS: A CASE STUDY IN UNIKL MITEC

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ABSTRACT

This feasibility study presents a case study conducted at UniKL MITEC, exploring the feasibility of implementing a solar system as an alternative source of electricity for the institution. With a growing emphasis on sustainability and renewable energy, educational institutions are seeking ways to reduce their environmental impact and contribute to a greener future. The study aims to assess the practicality and benefits of adopting solar energy at UniKL MITEC, considering financial, technical, and environmental factors specific to the institution. The quantitative analysis evaluates the financial viability of implementing a solar system at UniKL MITEC, including the initial investment costs, potential savings, and return on investment. It also considers factors such as available rooftop space and solar irradiation levels. The qualitative assessment involves interviews and surveys with key stakeholders, including administrators, faculty members, students, and energy experts, to gather insights on their perceptions, expectations, and potential challenges. The expected outcomes of this study include a comprehensive assessment of the financial feasibility of implementing a solar system at UniKL MITEC, along with specific recommendations tailored to the institution's requirements. The findings of this feasibility study will assist UniKL MITEC in making informed decisions regarding the implementation of a solar system. The study highlights the potential cost savings, energy independence, and positive environmental impact associated with adopting solar energy. It aims to provide a roadmap for the institution to transition to renewable energy sources, promote sustainability, and serve as an example for other educational institutions in embracing clean energy solutions.

1.0 Introduction

Universities are frequently compared to towns or cities due to their size, their ability to accommodate and serve the needs of large student populations, the numerous activities that take place on campus, and the large number of diverse buildings, including laboratories, classrooms, offices, residential accommodation, cafeteria, sports, and recreation centres. Accordingly, it is one of the industries that uses the most energy daily.

The potential for energy efficiency and renewable energy deployment at universities is substantial, and they represent promising ways to meet an institution's energy needs without imposing a significant climate burden. To achieve successful investment and results, it is essential to comprehend the current level of commitment to energy actions [1].

The primary objective of this paper is to assess the current level of engagement in energy efficiency measures within higher education institutions, with a specific focus on UniKL MITEC. Additionally, the study aims to identify suitable locations for the installation of solar photovoltaic panels within the institution and evaluate the associated installation costs, potential electricity savings, and return on investment. By examining these factors, the study seeks to provide valuable insights and recommendations to facilitate the adoption of sustainable energy practices at UniKL MITEC and enable informed decision-making regarding the implementation of solar photovoltaic systems.

1.1 Objectives

The objectives of the feasibility study on using a solar system as an alternative source of electricity for educational institutions, specifically the case study in UniKL MITEC, can be outlined as follows:

i. To understand the positive environmental impact of implementing solar energy and the institution's role in sustainability
ii. To analyze the electricity consumption trends at UniKL MITEC
iii. To analyze the initial investment costs, potential savings in electricity expenses, and estimating the return on investment

1.2 Problem Statement

The problem statement of the feasibility study on using a solar system as an alternative source of electricity for educational institutions, specifically the case study in UniKL MITEC, can be framed as follows:

i. Rising electricity costs pose financial challenges for UniKL MITEC, impacting its operational expenses and budgetary constraints.
ii. UniKL MITEC's reliance on grid electricity poses a risk to energy security and reliability, potentially disrupting educational activities and compromising the institution's functionality.
iii. Implementing a solar power system at UniKL MITEC offers educational opportunities for students to learn about renewable energy, aligning with the institution's objective of promoting quality education and innovation.

2.0 Methodology

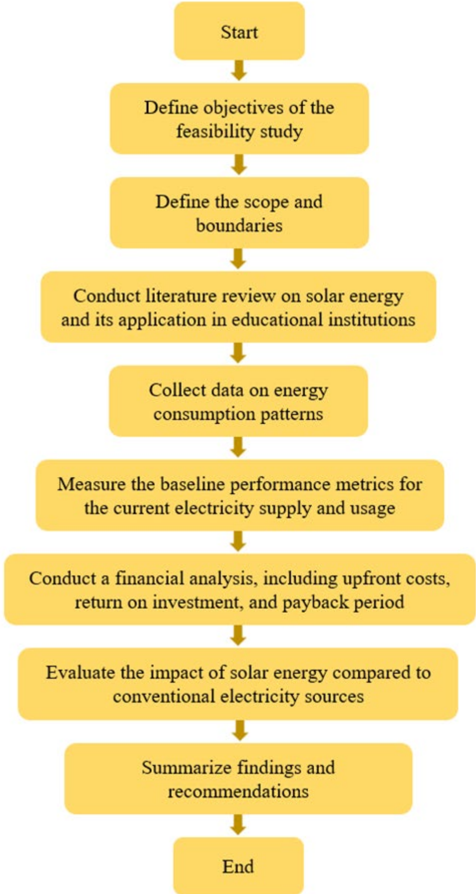


Figure 1: *Flowchart (FYP 1 & FYP2)*

2.1 Data Collection

Collecting specific data on energy consumption in UniKL MITEC by reaching out to UniKL MITEC directly or consulting the institution's energy management department or relevant authorities to obtain accurate and up-to-date data on energy consumption at UniKL MITEC. The electricity consumption at UniKL MITEC over a 12-month period from March 2022 to February 2023 was collected in this study.

2.2 Financial Analysis

This summary outlines the key steps involved in conducting a financial analysis for a feasibility study on the use of solar systems in educational institutions:

- **Upfront Costs:** Determine the initial investment required for installing solar systems, including equipment and labor.

- **Incentives and Grants:** Identify available incentives or grants to offset upfront costs.

- **Financing Options:** Evaluate different financing options such as self-financing, lease agreements, or power purchase agreements.

- **Financial Projections:** Develop a financial model to project the performance of solar systems over time, considering energy savings, revenue generation, and maintenance costs.

- **Return on Investment (ROI):** Calculate ROI by dividing net savings by upfront investment costs.

- **Payback Period:** Determine the time it takes for cumulative savings to equal initial investment costs.

- **Sensitivity Analysis:** Assess the impact of variables like energy prices or maintenance costs on financial outcomes.

- **Risk Assessment:** Evaluate potential financial risks and develop mitigation strategies.

- **Financial Reporting:** Prepare a comprehensive report summarizing upfront costs, ROI, payback period, sensitivity analysis, and risk assessment.

3.0 Result and Discussion

3.1 Comparison Table

University energy use affects sustainability, cost savings, and education. Solar PV (photovoltaic) systems offer renewable energy and advantages over traditional power sources. This comparison compares universities with and without solar PV systems on energy source, cost savings, environmental impact, resilience, educational possibilities, and community engagement [2].

Universities can comply with sustainability goals and improve their environmental footprint by understanding solar PV system pros and cons. ***Table 1*** compares a university with a solar PV system to one without, showing its benefits and drawbacks:

Table 1: *The Differences Between a University with A Solar PV System and A University Without a Solar PV System*

Features	University with Solar PV System	University without Solar PV System
Renewable Energy Source	Relies on solar energy	Depends on traditional power sources
Environmental Impact	Clean energy generation with minimal greenhouse gas emissions	Reliance on fossil fuels or other non-renewable energy sources with associated emissions
Energy Independence	Partially or fully self-sufficient in electricity generation	Fully dependent on the grid for electricity
Cost Savings	Potential for reduced electricity costs through solar energy generation	Reliant on grid electricity pricing
Energy Efficiency	Efficient conversion of sunlight into electricity	Less efficient energy utilization
Sustainability	Promotes a green campus image	Less focus on sustainability
Educational Opportunity	Enables hands-on learning about renewable energy	Missed opportunity for practical education
Long-Term Investment	Potential for long-term cost savings and return on investment	No financial benefits or potential for revenue generation through solar energy
Maintenance and Lifespan	Requires regular maintenance but has a long lifespan	No maintenance requirements specific to solar PV systems

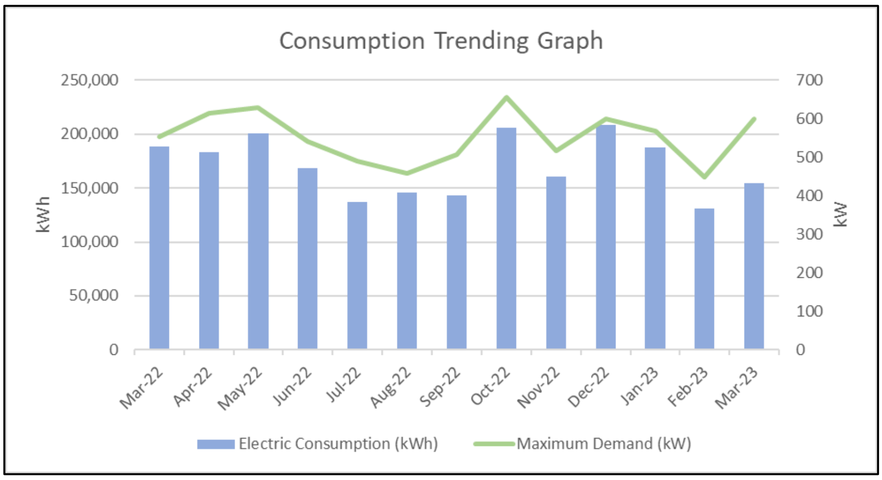
Peak Power Generation	Maximum power output during peak sunlight hours	No peak power generation associated with solar PV systems
Scalability	Can be expanded or upgraded as needed	Limited scalability potential

3.2 Data Collection – Electric Bill

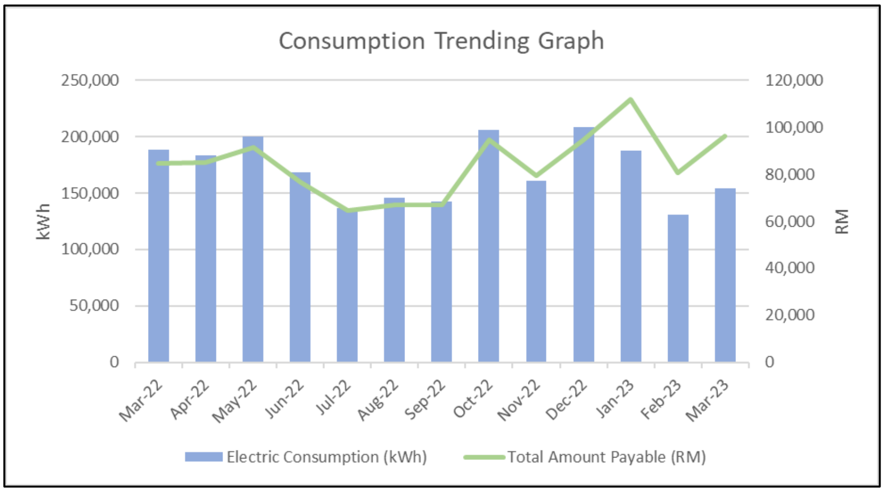
The table and graph depict the trend in electricity consumption at UniKL MITEC over a 12-month period from March 2022 to February 2023:

Table 2: *UniKL MITEC Electric Consumption*

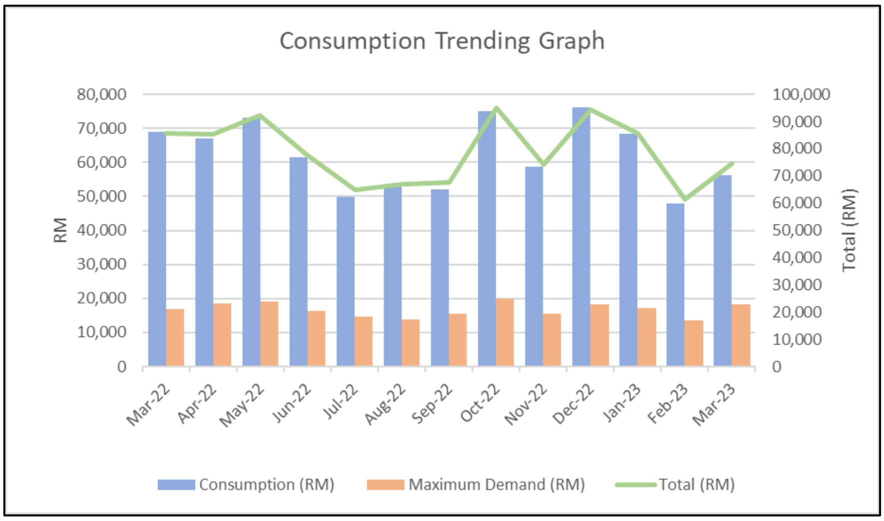
Month	Consumption (Rate RM0.365)		Maximum Demand (Rate RM 30.300)	
	kWh	RM	kW	RM
Mar-22	188622	68,847.03	554	16,786.20
Apr-22	183,292	66,901.58	614	18,604.20
May-22	200,289	73,105.49	629	19,058.70
Jun-22	168,091	61,353.22	542	16,422.60
Jul-22	136,894	49,966.31	489	14,816.70
Aug-22	145,503	53,108.60	459	13,907.70
Sep-22	142,870	52,147.55	508	15,392.40
Oct-22	205,694	75,078.31	655	19,846.50
Nov-22	160,567	58,606.96	517	15,665.10
Dec-22	208,696	76,174.04	599	18,149.70
Jan-23	187,199	68,327.64	568	17,210.40
Feb-23	131,190	47,884.35	449	13,604.70
Average / month	**171,576**	**62,625.09**	**549**	**16,622.08**



Graph 1: *Consumption Trending Graph Electric – Consumption and Maximum Demand*



Graph 2: *Consumption Trending Graph Electric – Consumption and Amount Payable*



Graph 3: *Consumption Trending Graph Electric – Consumption, Maximum Demand & Total*

Below is a table with approximate sunrise, sunset, dawn, and dusk times for Pasir Gudang, Malaysia. Please note that these times can vary slightly throughout the year due to factors such as daylight-saving time and atmospheric conditions [3].

Table 3: *Pasir Gudang - Sunrise, Sunset, Dawn, and Dusk Times Past 6 months [3]*

Date	Sunrise	Sunset	Length	Change	Dawn	Dusk	Length	Change
Today	06:55	19:07	12:12		06:33	19:29	12:56	
-1 day	06:55	19:07	12:12	00:00 equal length	06:33	19:29	12:56	00:00 equal length
-1 week	06:55	19:06	12:11	00:01 shorter	06:33	19:28	12:55	00:01 shorter
-2 weeks	06:56	19:06	12:10	00:02 shorter	06:34	19:28	12:54	00:02 shorter
-1 month	06:58	19:07	12:09	00:03 shorter	06:37	19:29	12:52	00:04 shorter
-2 months	07:07	19:14	12:07	00:05 shorter	06:46	19:35	12:49	00:07 shorter
-3 months	07:16	19:20	12:04	00:08 shorter	06:55	19:41	12:46	00:10 shorter
-6 months	06:49	18:52	12:03	00:09 shorter	06:27	19:14	12:47	00:09 shorter

Table 4: *Pasir Gudang - Sunrise, Sunset, Dawn, and Dusk Times Next 6 months [3]*

Date	Sunrise	Sunset	Length	Change	Dawn	Dusk	Length	Change
Today	06:55	19:07	12:12		06:33	19:29	12:56	
-1 day	06:56	19:07	12:11	00:01 shorter	06:33	19:29	12:56	00:00 equal length
-1 week	06:56	19:07	12:12	00:00 equal length	06:34	19:30	12:56	00:00 equal length
-2 weeks	06:57	19:09	12:12	00:00 equal length	06:35	19:32	12:57	00:01 longer
-1 month	07:00	19:13	12:13	00:01 longer	06:38	19:35	12:57	00:01 longer
-2 months	07:05	19:17	12:12	00:00 equal length	06:43	19:39	12:56	00:00 equal length
-3 months	07:03	19:12	12:09	00:03 shorter	06:42	19:33	12:51	00:05 shorter
-6 months	06:49	18:52	12:03	00:09 shorter	06:27	19:14	12:47	00:09 shorter

3.3 Design and Area Consideration

3.3.1 Rooftop Solar Photovoltaic (PV)

Installing a rooftop solar PV system on the UniKL MITEC warehouse offers benefits such as generating clean electricity on-site and reducing reliance on traditional power sources. Specific requirements depend on factors like roof area, orientation, shading, and desired capacity. Engineering and design considerations ensure optimal positioning and efficiency of the solar panels. This installation aligns with UniKL MITEC's sustainability commitment, serving as an educational demonstration of clean energy technologies and raising awareness about the benefits of solar power.

Figure 2: *Rooftop Area – Warehouse*

Figure 3: *Rooftop Solar Photovoltaic (PV) Design*

3.3.2 Parking Lot Solar Photovoltaic Awnings

Solar parking lots are an innovative solution to meet the demand for renewable energy and sustainable infrastructure. These lots integrate solar panels to generate clean electricity, aligning with the goal of combating climate change and transitioning to renewables. UniKL MITEC, with its focus on technology and engineering education, can demonstrate its commitment to sustainability by implementing solar parking lots. This integration maximizes land use efficiency and offers practical learning opportunities for students in solar energy technology.

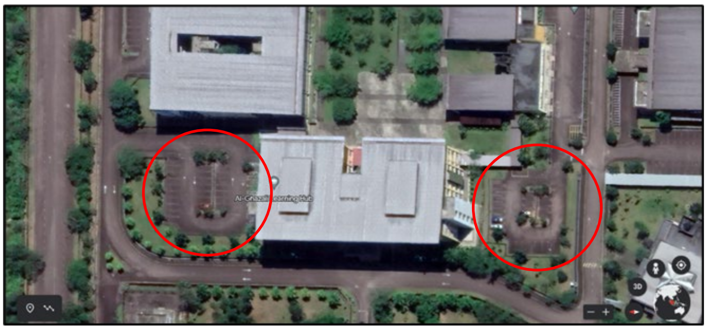


Figure 4: *Parking Lot Area*

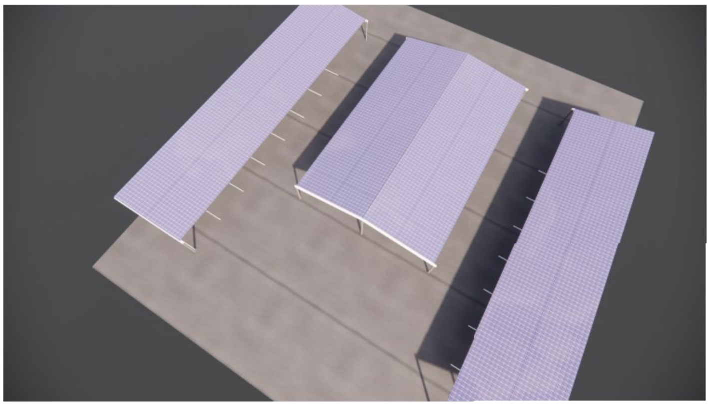


Figure 5: *Parking Lot Solar Photovoltaic Awnings Design*

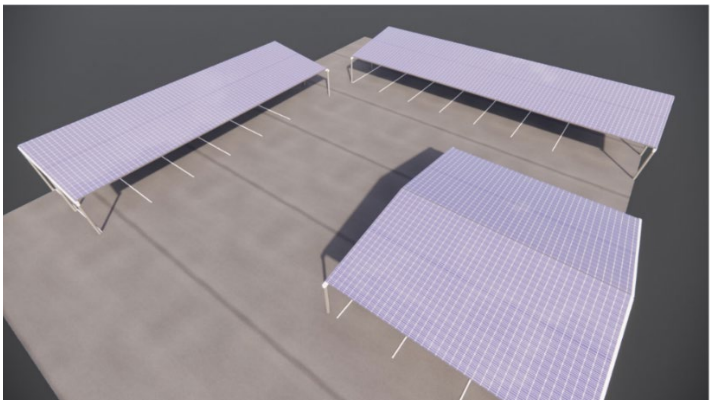


Figure 6: *Parking Lot Solar Photovoltaic Awnings Design*

3.4 Return on Investment (ROI)

Return on Investment (ROI) measures the profitability of an investment compared to its cost. In solar panel installations, ROI focuses on saving costs by reducing demand charges on electric bills. Electric bills consist of energy consumption (kWh) and demand charges (kW). By installing rooftop solar panels, campuses generate their own electricity, reducing energy drawn from the grid and lowering the energy component of the bill [4].

Solar panels also impact demand charges. During peak periods, solar power offsets the need for grid electricity, reducing maximum demand and demand charges. Savings on demand charges depend on factors like solar panel system size, capacity, rate structure, and utility tariff. Energy management strategies, such as load shifting or storage, optimize the solar system's ability to cut maximum demand and reduce demand charges.

Table 3: *UniKL MITEC Electric Consumption*

Month	Consumption (Rate RM0.365)		Maximum Demand (Rate RM 30.300)	
	kWh	RM	kW	RM
Mar-22	188622	68,847.03	554	16,786.20
Apr-22	183,292	66,901.58	614	18,604.20
May-22	200,289	73,105.49	629	19,058.70
Jun-22	168,091	61,353.22	542	16,422.60
Jul-22	136,894	49,966.31	489	14,816.70
Aug-22	145,503	53,108.60	459	13,907.70
Sep-22	142,870	52,147.55	508	15,392.40
Oct-22	205,694	75,078.31	655	19,846.50
Nov-22	160,567	58,606.96	517	15,665.10
Dec-22	208,696	76,174.04	599	18,149.70
Jan-23	187,199	68,327.64	568	17,210.40
Feb-23	131,190	47,884.35	449	13,604.70
Average / month	**171,576**	**62,625.09**	**549**	**16,622.08**
Monthly Total (RM)	**79,247.17**			
Average / year (RM)	**= 62,625.09 × 12 months = 751, 501.10**		**= 16,622.08 × 12 months = 199,464.96**	
Annually Total (RM)	**950,966.10**			

Table 4: *Calculation Different Rate of Electric Consumption*

Month	Maximum Demand (kW)	RM30.30 (Maximum Demand Rate)	RM0.365/kWh (Normal Rate)	Rate Differences (RM)
Mar-22	554	16,786.2	202.21	16,583.99
Apr-22	614	18,604.2	224.11	18,380.09
May-22	629	19,058.7	229.585	18,829.12
Jun-22	542	16,422.6	197.83	16,224.77
Jul-22	489	14,816.7	178.485	14,638.22
Aug-22	459	13,907.7	167.535	13,729.22
Sep-22	508	15,392.4	185.42	15,206.98
Oct-22	655	19,846.5	239.075	19,607.43
Nov-22	517	15,665.1	188.705	15,476.40
Dec-22	599	18,149.7	218.635	17,931.10
Jan-23	568	17,210.4	207.32	17,003.08
Feb-23	449	13,604.7	163.885	13,440.82
Average Rate Differences / Month (RM)				**16,420.94**
Rate Differences / Year (RM)				**= 16,420.94 × 12 months = 197,051.28**

Table 5: *Electricity Cost Without Maximum Demand*

Month	Consumption (Rate RM0.365)		Maximum Demand (Rate RM 30.300)		Saving Cost (Without Maximum Demand)
	kWh	**RM**	**kW**	**RM**	**RM**
Mar-22	188,622	68,847.03	554	16,786.20	52,060.83
Apr-22	183,292	66,901.58	614	18,604.20	48,297.38
May-22	200,289	73,105.49	629	19,058.70	54046.79
Jun-22	168,091	61,353.22	542	16,422.60	44,930.62
Jul-22	136,894	49,966.31	489	14,816.70	35,149.61
Aug-22	145,503	53,108.60	459	13,907.70	39,200.90
Sep-22	142,870	52,147.55	508	15,392.40	36,755.15
Oct-22	205,694	75,078.31	655	19,846.50	55,231.81
Nov-22	160,567	58,606.96	517	15,665.10	42,294.86
Dec-22	208,696	76,174.04	599	18,149.70	58,024.34
Jan-23	187,199	68,327.64	568	17,210.40	51,117.24
Feb-23	131,190	47,884.35	449	13,604.70	34,279.65
Average / Month	**171,576**	**62,625.09**	**549**	**16,622.08**	**45,949.10**
Average Total / Month (RM)	**79,247.17**				
Average / Year (RM)	**= 62,625.09 × 12 months = 751, 501.10**		**= 16,622.08 × 12 months = 199,464.96**		**= 45,949.10 × 12 months = 551,389.20**
Annually Total (RM)	**950,966.10**				

Table 6: *Potential Saving After Solar Energy System (Percentage %)*

Month	Total Consumption (RM)	Potential Saving (RM)	After Cut MD (RM)	Potential Saving (%)
Mar-22	85,633.23	16,786.20	52,060.83	19%
Apr-22	85,505.78	18,604.20	48,297.38	21.8%
May-22	92,164.19	19,058.70	54,046.79	20.2%
Jun-22	77,775.82	16,422.60	44,930.62	21.1%
Jul-22	64,783.01	14,816.70	35,149.61	22.9%
Aug-22	67,016.30	13,907.70	39,200.90	20.8%
Sep-22	67,539.95	15,392.40	36,755.15	22.8%
Oct-22	94,924.81	19,846.50	55,231.81	20.9%
Nov-22	74,272.06	15,665.10	42,294.86	21.1%
Dec-22	94,323.74	18,149.70	58,024.34	19.2%
Jan-23	85,538.04	17,210.40	51,117.24	20.1%
Feb-23	61,489.05	13,604.70	34,279.65	22.1%
Average / Month	**62,625.09**	**16,622.08**	**45,949.10**	**21%**
Average / Year (RM)	**= 62,625.09 × 12 = 751, 501.10**	**= 16,622.08 × 12 = 199,464.96**	**= 45,949.10 × 12 = 551,389.20**	**26.5%**

Calculating the ROI of a solar panel installation involves considering the upfront investment, ongoing maintenance costs, expected energy production, and projected savings on energy and demand charges over the system's lifespan. By comparing these savings with the initial investment, the financial viability of the solar project can be assessed. The ROI calculation provides an estimate of the profitability and payback period of the solar investment:

Annual Savings = RM 16,622.08 / month × 12
= RM 199,464.96 / year

Average maximum demand = 549
Average maximum demand / day = 549 ÷ 20days
= 27.45 kW

According to information obtained from the Sustainable Energy Development Authority (SEDA) website, a solar PV installation with a capacity of 500 kWp at UniKL MITEC requires approximately 2,505.0m² of space. The estimated upfront cost for this installation is RM1,402,800.

Space Required = 2,505.0 m²
1 kWp = 5 m²

Proposed Installed Capacity = 500 kWp
Estimated Minimum Upfront Cost = RM 1,402,800

Return on Investment = RM 1,402,800 ÷ RM 199,464.96
= 7 years payback period

4.0 Conclusion

The feasibility study confirms that implementing a solar system at UniKL MITEC is financially viable in the long run, despite the initial high investment. The savings from reduced electricity bills and potential government incentives outweigh the upfront costs. This adoption of solar power significantly reduces UniKL MITEC's carbon footprint and promotes sustainability.

Utilizing solar energy allows UniKL MITEC to reduce reliance on the national grid, ensuring energy security and mitigating risks associated with electricity price fluctuations and power outages. The solar system also serves as an educational tool, offering research opportunities, practical training, and raising awareness about renewable energy technologies. This aligns with the institution's commitment to holistic education and sustainable practices.

The feasibility study should assess technical aspects such as available roof space, building orientation, shading, and required energy capacity. Based on these findings, it is recommended that UniKL MITEC proceed with solar system implementation as an alternative electricity source. However, detailed analysis, engineering design, financial modeling, and stakeholder consultation are crucial for successful installation. Regular monitoring and maintenance will optimize system performance and longevity.

5.0 Acknowledgement

I sincerely thank everyone who contributed to the completion of this thesis on harnessing solar energy. Special thanks to my supervisor, Ts. Dr. Adnan Hj. Bakri and my co-supervisor Dr. Muhammad Bin Azmi for their invaluable expertise and unwavering support throughout this research journey.

I extend my heartfelt appreciation to the faculty members of UniKL MITEC for providing a conducive academic environment and fostering intellectual curiosity. I am grateful to the participants who contributed through interviews, surveys, and data sharing, enriching the research.

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I am thankful to my family for their unconditional love and belief in my abilities. Their support has been instrumental in my academic pursuits. Lastly, I dedicate this thesis to individuals and organizations striving for a sustainable future through renewable energy, including solar power.

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