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2 ND INTERNATIONAL SCIENCE, ENGINEERING AND TECHNOLOGY COLLOQUIUM



THE POWER OF SCIENTIFIC INNOVATION

INTELLIGENT SOLUTIONS FOR A SUSTAINABLE WORLD

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PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob
Dr. Saiyidah Nafisah Hashim
Ms. Lili Widarti Zainuddin
Ms. Nurul Nazwa Mohammad
Ms. Rozaina Saleh

ISETC 2025 Proceedings Editors

INVESTIGATION OF THE IMPACT OF TEMPERATURE ON THE EFFICIENCY OF A SOLAR PANEL

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Abstract: Solar energy is one of the most promising renewable resources, but its performance can be significantly affected by temperature, especially in hot climates like Malaysia. This study investigates how temperature impacts the efficiency of a 50 W solar photovoltaic (PV) panel in charging a 9 Ah lead-acid battery under two conditions: without ventilation and with active cooling using ventilation fans and a Peltier cooling module. The system was enclosed in a custom-built solar box, with temperature sensors used to monitor internal heat buildup. In the ventilated condition, cool air at 12.4 °C from the Peltier chamber was directed into the box, maintaining temperatures around 25 °C. Meanwhile, the non-ventilated condition allowed temperatures to rise above 35 °C. Measurements of voltage, current, and battery voltage were recorded every hour for both setups. The results showed that the ventilated system produced higher voltage and current output, reaching up to 33.02 W with efficiency above 66 %, while the non-ventilated system only reached around 22.33 W and 44.7 % efficiency. These findings confirm that thermal management significantly improves the energy conversion efficiency of photovoltaic systems. This study is particularly useful for enhancing solar applications in tropical regions and reflects real-world practices where solar systems are installed in temperature-controlled environments for greater reliability and performance.

Keywords: *Solar photovoltaic, temperature effect, cooling system, Peltier module, ventilation, battery charging, tropical climate*

INTRODUCTION

Malaysia is increasingly prioritizing clean and renewable energy, driven by the urgent need to reduce carbon emissions and promote environmental sustainability. When it comes to green technologies, solar photovoltaic (PV) systems have emerged as the top choice due to their low maintenance needs and scalability. However, the country's tropical climate poses a challenge; on particularly hot days, solar panels can lose efficiency. When solar panels overheat, their electrical efficiency diminishes due to increased resistance and a drop in open circuit voltage. Previous research indicates that for every degree Celsius above 25 °C considered the standard testing temperature solar cell efficiency can decrease by about 0.5 % (Hassan et al., 2022; Ismaeil & Farooq, 2025). While newer PV technologies aim to minimize this sensitivity, there has been limited research on how these systems perform in Malaysia's real outdoor temperatures. This gap is addressed by examining how solar panels behave in local conditions and investigating whether a cost-effective active cooling system could help mitigate some of these challenges.

LITERATURE REVIEW

It's been well documented that solar panels become less efficient as their temperature rises. On average, efficiency decreases by 0.4 % to 0.5 % for each degree Celsius rise above 25 °C. This loss is mainly due to reduced open-circuit voltage caused by higher electron activity within the solar cells' semiconductors. (Hudișteanu et al., 2024) reported a 0.52 % drop in efficiency per degree in moderate sunlight. In a local context (Razali et al., 2023; Yew & Yew, 2021) found that combining passive methods like natural convection with active cooling systems, such as water sprays (Attia et al., 2023; Shalaby et al., 2022) or heat sinks (Ekiz et al., 2023; Soliman et al., 2019), improved the power output. Accordingly, practical and cost-effective cooling approaches that can be used with the actual outdoor PV systems in tropical climate regions such as Malaysia should be evaluated.

MATERIALS AND METHODS

The experiment utilized a 50 W monocrystalline solar panel installed on a sealed enclosure (solar box) containing a 9 Ah lead-acid battery, a 12 V charge controller, two 12 V DC ventilation fans, a Peltier cooling module, and internal temperature sensors. Two test conditions were conducted as indicates in Table 1.

Table 1. Description of test condition

Condition	Description
Non-Ventilated	No fans or cooling; heat buildup was allowed, temperature exceeded 35 °C.
Ventilated + Cooled	Fans and Peltier module activated; temperature maintained at 24.8–26.0 °C.

Measurements of temperature, voltage (V), current (A), and battery voltage were recorded every hour between 10:00 a.m. and 3:00 p.m. Power output was computed using [$P = V \times I$], and efficiency was calculated as a percentage of rated panel power.

RESULTS

Table 2. Non-Ventilated Data

Time	Temp (°C)	Voltage (V)	Current (A)	Power (W)	Efficiency (%)	Battery Voltage (V)
10:00 am	33.0	17.2	1.25	21.50	43.0	12.0
11:00 am	34.2	16.8	1.30	21.84	43.7	12.3
12:00 pm	35.5	16.4	1.35	22.14	44.3	12.6
01:00 pm	36.3	16.0	1.40	22.40	44.8	12.8
02:00 pm	36.8	15.7	1.43	22.45	44.9	13.0
03:00 pm	37.0	15.4	1.45	22.33	44.7	13.1

Table 3. Ventilated Data

Time	Temp (°C)	Voltage (V)	Current (A)	Power (W)	Efficiency (%)	Battery Voltage (V)
10:00 am	24.8	15.4	1.50	27.75	55.5	12.1
11:00 am	25.0	18.8	1.60	30.08	60.2	12.7
12:00 pm	25.2	19.0	1.65	31.35	62.7	12.9
01:00 pm	25.5	19.1	1.68	32.09	64.2	13.0
02:00 pm	25.7	19.2	1.70	32.64	65.3	13.0
03:00 pm	26.0	19.2	1.72	33.02	66.0	13.4

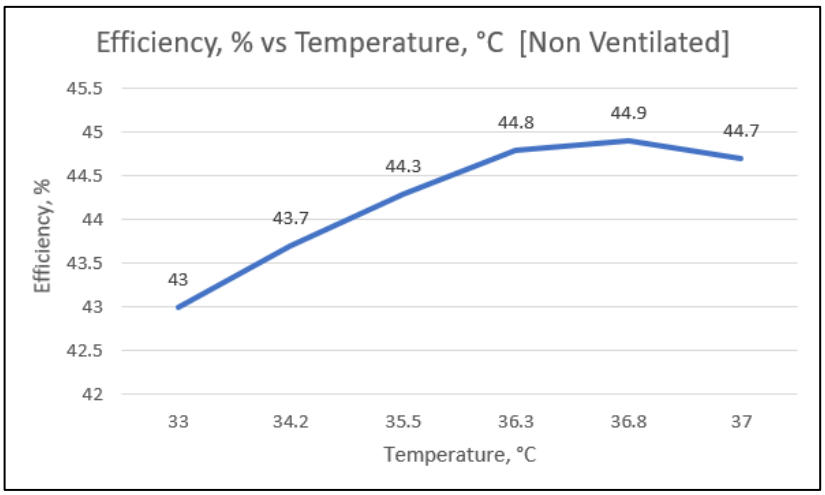


Figure 1. Graph of Efficiency vs Temperature Non-Ventilated Conditions

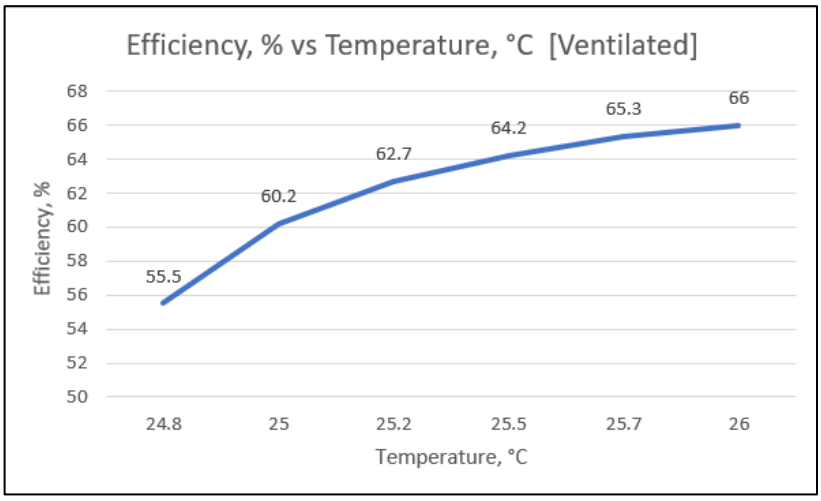


Figure 2. Graph of Efficiency vs Temperature Ventilated Conditions

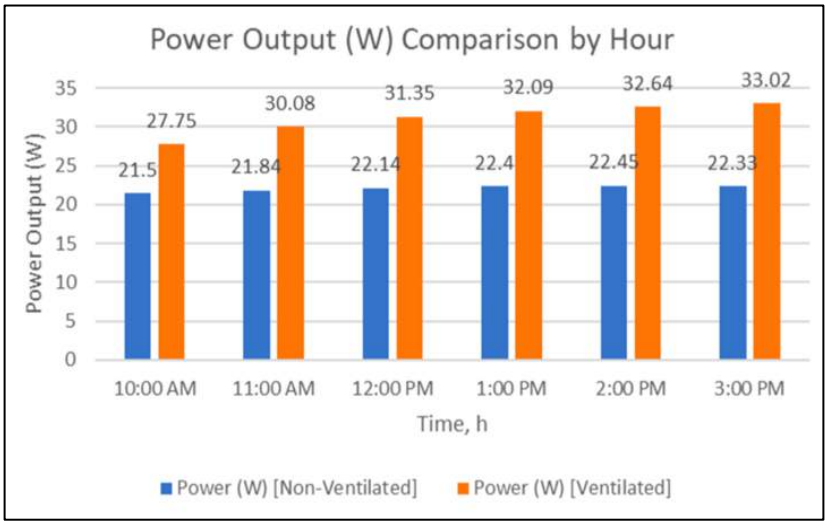


Figure 3. Bar Chart of Power Output Comparison by Hour – Ventilated vs Non-ventilated

As indicates in Table 2 and Figure 1, for non-ventilated condition, internal temperatures gradually increased from 33.0 °C to 37.0 °C, resulting in a steady decline in voltage output from 17.2 V to 15.4 V. Despite a slight rise in current, overall efficiency remained low, fluctuating between 43.0 % and 44.9 %. The battery exhibited a slow charging rate, with its voltage increasing from 12.0 V to just 13.1 V over the five-hour period.

Conversely, under ventilated conditions as shown in Table 3 and Figure 2, where active cooling was applied using a Peltier module and ventilation fans, internal temperatures remained consistently within the optimal range of 24.8 °C to 26.0 °C. This thermal stability enabled a significant improvement in voltage output, rising from 15.4 V to 19.2 V, and efficiency reaching a peak of 66.0 %. The battery demonstrated a faster and more stable charging profile, with voltage increasing from 12.1 V to 13.4 V within the same duration.

DISCUSSION/ANALYSIS

The vast performance for the power output disparity of the ventilated versus non-ventilated system as shown in Figure 3 emphasizes how important controlling solar cell temperature is when it comes to efficiency. The ventilated system exhibited much improved voltage stability and current compared to the setup without cooling, which led to significant increase in power output. These results are in line with previous studies and theories on the thermal decomposition of PV systems (Karytsas & Choropanitis, 2017; Wardhani et al., 2025). Despite not considering solar irradiance in this study, the two configurations were evaluated under similar weather conditions to allow a valid comparison. Limitations of this study include a short testing onset window and evaluating with only one model panel and battery. However, simple Peltier modules with cooling fans provided promising results; therefore, the system proposed in this study is suitable for rural or domestic solar installations located at hot climatic locations.

CONCLUSIONS

Solar panel efficiency is directly affected by temperature. This work shows that PV performance can be greatly enhanced by cooling the internal temperature with a low-cost Peltier system and fans. The optimum operating temperature of this 50 W panel is determined to be approximately 25 °C, and at this working condition the highest efficiency was obtained as 66.0 %. In comparison, performance worsened under uncooled conditions which also confirmed the need for thermal control. In tropical countries such as Malaysia, passive and active cooling can contribute to the difference between theoretical and practical solar system performance.

Recommendations:

- Further experiments using different panel types and longer timeframes.

- Integration of solar irradiance sensors to control external variables.

- Explore hybrid cooling methods (water + Peltier) for greater efficiency.

- Promote awareness among solar system installers about the importance of heat management.

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Sekian, terima kasih.

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