ISETC2025

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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

MICRO-HYDRO TURBINE GENERATOR

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Abstract: This project investigates the performance comparison between two microturbine generators, one rated at 5V and the other at 12V, operating under the same water flow conditions. Micro-hydropower systems are increasingly recognized for their potential in small-scale renewable energy applications, especially in remote or off-grid areas. However, it remains unclear which microturbine performs more efficiently and generates better electrical output under identical flow conditions, posing a challenge for users in selecting the most suitable option for small-scale energy applications. Therefore, this project aim is to determine which turbine delivers higher efficiency and better output in terms of voltage, current, and overall power generation. By maintaining consistent flow rate and testing both turbines under identical conditions, this study provides useful insights for hobbyists, students, and small system designers in selecting suitable microturbine components. The project successfully achieved all outlined objectives, demonstrating the effectiveness of micro-hydropower systems in small-scale renewable energy generation. Through comparative testing under a constant water flow rate of 15 LPM, both 5V and 12V microturbine generators were evaluated for their output performance. The study revealed clear differences in efficiency, charging time, and power delivery, providing valuable insights into the selection of appropriate turbine voltage ratings for different energy requirements. This project confirms that, with proper configuration and component selection, micro-hydro systems can serve as a practical and eco-friendly power solution for off-grid or low-resource environments.

Keywords: *Micro-hydropower, microturbine generator, renewable energy, power output, battery charging*

INTRODUCTION

Access to electricity is essential for modern living, yet many rural and remote areas still struggle with limited or no grid connectivity. Micro hydro power systems provide an effective solution by harnessing the kinetic energy of flowing water to generate electricity using small turbines and generators (Anwar et al., 2021). These systems are especially valuable in off-grid communities due to their low environmental impact, affordability, and ability to operate on minimal water flow. A common choice in micro hydro setups includes 5V and 12V turbine models, often used in DIY and educational projects. However, users frequently select turbines without proper performance data, which may lead to poor efficiency or system mismatch (Chen et al., 2022). To address this issue, this project proposes an experimental performance comparison between 5V and 12V micro hydro turbines under identical water flow conditions. The main objectives of this project are to test both turbines using a fixed water flow rate of 15 liters per minute (LPM), evaluate their voltage output over time, and determine their effectiveness in charging a 12V battery. Using a controlled setup with a water source, multimeter, and battery, both turbines were connected individually and monitored for 30 minutes. Voltage readings were recorded at 2-minute intervals to assess performance consistency and charging capability. The results showed that while both turbines could generate power, the 12V turbine demonstrated higher and more stable voltage output, making it more suitable for practical applications such as battery charging. This finding supports the importance of evidence-based turbine selection for small-scale renewable energy systems (Kumar, 2020).

LITERATURE REVIEW

Micro hydro power systems have emerged as a promising solution for off-grid electricity generation, particularly in rural or remote areas where grid extension is economically unfeasible. These systems utilize the potential and kinetic energy of flowing water to drive micro turbines connected to generators, producing electricity in an environmentally friendly and cost-effective way (Anwar et al, 2021). Unlike large-scale hydroelectric dams, micro hydro systems can operate on minimal water flow, such as streams or irrigation canals, making them ideal for small-scale applications.

According to Kumar (2020), micro hydro systems are highly beneficial due to their low maintenance, renewable nature, and suitability for decentralized energy generation. The choice of turbine plays a critical role in system efficiency. Many micro hydro systems use small DC turbines, commonly available in 5V or 12V models, which are favored for educational purposes and do-it-yourself (DIY) energy kits. However, there is a lack of comparative performance data for these turbines under identical conditions. Chen et al. (2022) highlighted the performance gap in user knowledge, noting that most turbine selections are made without experimental validation, often leading to inefficiencies or system mismatch. Furthermore, the effectiveness of micro turbines depends heavily on consistent water flow, head pressure, and load matching, which can significantly impact power output.

This project builds on previous studies by directly comparing 5V and 12V micro turbines under the same 15 liters per minute (LPM) water flow to assess their voltage output and suitability for charging a 12V battery. The results are expected to contribute to the practical understanding of micro turbine performance in low-head, low-flow environments.

MATERIALS AND METHODS

Materials

5V and 12V Microturbine, 12V battery, Solar controller, Solar inverter, Multimeter, Stopwatch and Water source (tap)

Method

This study uses a quantitative experimental approach to compare the electrical output and efficiency of 5V and 12V microturbines under identical water flow conditions, aiming to identify the more suitable option for low-power applications such as charging small devices. The setup supports sustainable energy goals by exploring a low-cost, renewable solution for rural or off-grid areas, where stable electricity is often lacking (Mamat et al., 2025). The experiment was conducted using a high-flow tap to simulate stream-like conditions. The 12V turbine was connected to a water inlet, with its output linked to a solar charge controller, a 12V rechargeable battery, and a digital multimeter to monitor voltage. A 30-minute test was run with constant water flow, and voltage output was recorded throughout. After testing, the stored energy was used to charge a small hand fan, and the duration was measured to assess charging efficiency. The process was then repeated for the 5V turbine, keeping all other factors constant such as flow rate, battery type, wiring, and ambient conditions to ensure reliable comparison.

RESULTS AND ANALYSIS

Table 1 presents a comparative analysis of the performance of two microturbines rated at 5V and 12Vunder identical water flow conditions of 15 liters per minute (LPM). The table includes key metrics such as the initial battery voltage, final battery voltage after charging, the actual voltage output from the microturbine, and the total time taken to charge the battery.

Table 1. Battery Voltages and Charging Times for 5V and 12V Microturbine

Microturbine	Water flow rate	Initial Battery (V)	Final Battery (V)	Output Battery (V)	Charging Time
5V	15 LPM	0.997	2.897	1.99	2 hour 54 minutes
12V	15 LPM	8.254	11.975	3.722	1 hour 27 minutes

As shown in the table, the 12V microturbine demonstrates a more efficient charging process compared to the 5V variant. Although both systems operated at the same water flow rate, the 12V microturbine was able to charge a battery from 8.254V to 11.975V in only 1 hour and 27 minutes, with an output voltage of 3.722V. In contrast, the 5V microturbine charged a battery from 0.997V to 2.897V in 2 hours and 54 minutes, delivering a lower output voltage of 1.99V. This indicates that the 12V system provides a higher power output and charges the battery in a significantly shorter duration, making it more suitable for applications requiring rapid energy harvesting or greater energy demands. Figure 1 visually supports the data from Table 1 by illustrating the charging behavior of both microturbine systems over time. It provides a clear graphical representation of how quickly each battery reaches its final voltage under the same operating conditions.

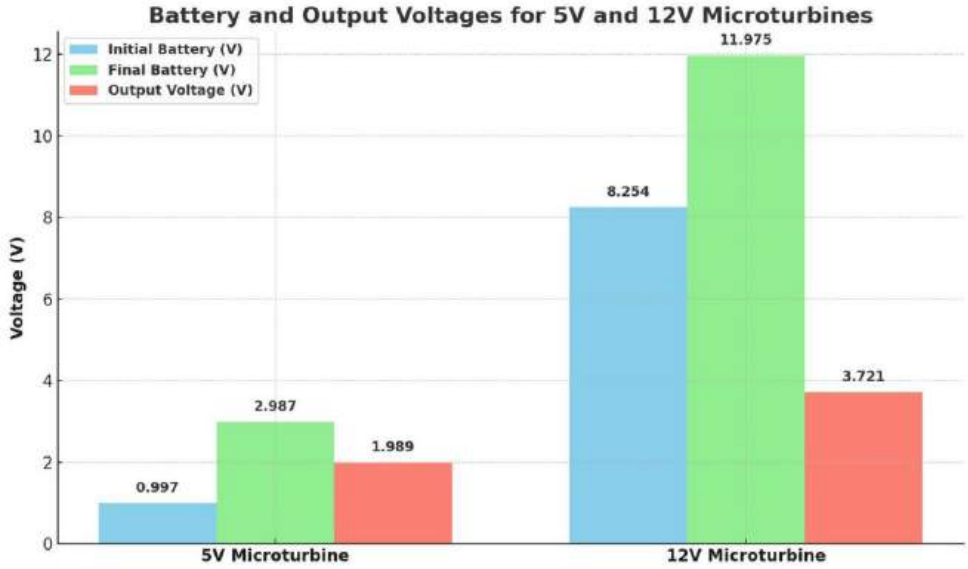


Figure 1. Comparison of Initial Battery, Final Battery, and Output Voltages for 5V and 12V Microturbines

From Figure 1, it is evident that the battery powered by the 12V microturbine reaches its final voltage at a significantly faster rate than the one powered by the 5V microturbine. This graphical evidence further reinforces the superior performance of the 12V microturbine in terms of both charging speed and voltage output.

DISCUSSION

The objective of this project was to evaluate and compare the performance of 5V and 12V micro hydro turbines under identical conditions using a constant water flow rate of 15 litres per minute (LPM). Each turbine was tested separately over a 30-minute period, with voltage measurements recorded every 2 minutes using a digital multimeter connected to a 12V rechargeable battery. The results revealed a clear distinction in performance between the two turbines. The 12V turbine consistently produced higher voltage levels, averaging close to its rated output and demonstrating a stable voltage trend. After a short initial rise, its output stabilized, indicating a steady operational state and the capability to effectively charge a 12V battery. In contrast, the 5V turbine delivered significantly lower voltage outputs throughout the test. While it did generate electricity, the voltage remained well below the level needed to charge a 12V battery efficiently. This confirms that the 5V turbine is unsuitable for direct charging of higher-voltage systems under the tested conditions. The comparison highlights that selecting a turbine with a voltage rating matched to the load is essential for maximizing energy transfer and charging efficiency.

These findings align with prior research. Kumar (2020) emphasized the need for voltage compatibility between turbines and batteries in micro hydro systems, while Chen et al. (2022) reinforced the importance of experimental data in guiding turbine selection for low-flow applications. Furthermore, SabahRE2 (2024) demonstrates that well-matched

micro-hydro systems can support community-based renewable energy solutions, especially when combined with solar hybrid systems. These recent developments reinforce the relevance of this study in promoting evidence-based turbine selection and optimizing micro-hydro performance for rural applications. Overall, this study confirms that the 12V microturbine offers superior performance and practical suitability for 12V battery charging, underscoring the value of system matching in renewable energy design.

CONCLUSIONS

In conclusion, the project successfully achieved all of its objectives, providing a clear comparison between 5V and 12V micro hydro turbines operating under identical water flow conditions. The results demonstrated that the 12V turbine outperforms the 5V turbine in terms of voltage output, charging efficiency, and overall stability. This confirms the importance of matching the turbine's output voltage to the battery's rated voltage to ensure effective energy transfer and optimal charging performance. While the 5V turbine was capable of generating power, its output was insufficient for directly charging a 12V battery, making it less suitable for such applications. The findings highlight the practical advantages of using 12V microturbines for small-scale or off-grid energy systems, particularly in rural or remote areas where reliable access to electricity is limited. Micro hydro systems configured with appropriate turbine-battery pairings offer a renewable, cost-effective, and sustainable energy solution. For future research or system enhancement, exploring the effects of varying flow rates, battery capacities, and different turbine models could yield valuable insights into maximizing performance across a broader range of real-world conditions. Such studies would further contribute to the development of efficient and adaptable micro hydroelectric power systems.

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