SUSTAINABLE CAPSTONE PROJECTS (SCAP)
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Development Micro Solar Power System Based On Steam Rankin Cycle

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INTRODUCTION

Concept of the project:

- ✓ *A micro solar power system that uses the **Steam Rankine Cycle** to convert solar energy into electricity. The system generates steam to drive a turbine connected to an electric generator.*

Motivation:

- ✓ *Renewable Energy Need: Rising energy demand and climate concerns make solar power essential.*
- ✓ *Access for Remote Areas: Provides off-grid, reliable power for underserved regions.*
- ✓ *Climate Action: Reduces reliance on fossil fuels and cuts carbon emissions.*
- ✓ *Educational Innovation: Advances research and knowledge in sustainable technologies.*

Benefits:

- ✓ ***Eco-Friendly:** Reduces emissions and promotes clean energy.*
- ✓ ***Localized Energy:** Provides independent, off-grid power.*
- ✓ ***Cost-Effective:** Low long-term operational costs.*
- ✓ ***Scalable:** Adaptable for small communities or industries.*

Objectives:

- ✓ *Build a working micro solar power system.*
- ✓ *Improve energy efficiency.*
- ✓ *Test feasibility for remote applications.*
- ✓ *Assess environmental impact.*
- ✓ *Conduct a cost-benefit analysis.*

MATERIALS USED IN CONSTRUCTION

- ✓ *Heat exchanger taken from air conditioning unit in the workshop*
- ✓ *Stainless steel flexible pipes to make water connection*
- ✓ *Nuts to connect between pipes*
- ✓ *A past to fill any holes to ensure no leaks*
- ✓ *Car radiator water pump to circulate the water*
- ✓ *A 12 v battery to power the pump*
- ✓ *The turbine housing*
- ✓ *Transparent fiber glass to make front and back to cover the turbine*

FINAL PRODUCT

- ➢ *Our open-cycle micro solar power system was designed with key modifications to optimize performance. The turbine was enhanced by adding a metal blade, rebalancing it for stability, and reinforcing it with fiberglass material for durability. A metal pipe connects the turbine to the condenser, ensuring efficient steam flow, while additional pipes link the condenser to the pump and the pump back to the turbine, forming a continuous cycle. The turbine is integrated with the main solar-heated system, where solar energy generates steam to drive the cycle.*
- ➢ *During testing, we evaluated turbine performance after the modifications and ensured that all pipe connections were leak-proof under operational conditions. Steam flow rate and pressure were carefully monitored throughout the system, and tests were conducted to measure heat transfer efficiency and power output. We also assessed the system's reliability under varying solar intensities and during different operational phases, including startup and steady-state operation. These efforts confirmed the functionality and efficiency of the system, demonstrating its potential for sustainable energy production.*

RESULTS AND DISCUSSION

- ➢ *The open-cycle micro solar power system demonstrated successful performance, with turbine modifications improving stability and efficiency. The adjusted piping system ensured efficient steam flow, minimizing heat loss and confirming the system's reliability under varying solar intensities. The results showed consistent power output during steady-state operation, validating the feasibility of the system for small-scale energy generation. Moving forward, the project could benefit from further optimization of the turbine design to enhance energy conversion efficiency, the use of advanced materials for better durability, and integration of sensors for real-time performance adjustments. Additionally, exploring scalability for larger applications, incorporating thermal energy storage for continuous operation, and conducting long-term testing in diverse environments will be essential for improving system performance and broadening its applicability.*

CONCLUSIONS

The most significant finding in our project was the successful modification of the turbine, which improved stability and performance, ensuring efficient steam conversion. Adjustments to the piping system optimized steam flow, reducing energy loss. Testing showed consistent power output, validating the viability of the Steam Rankine Cycle for small-scale energy generation. These results are significant because they demonstrate the potential of micro solar power for sustainable energy in remote areas. Challenges included time-consuming turbine rebalancing and maintaining consistent heat input under variable solar conditions. Through the Sustainable Capstone Project, I gained valuable hands-on experience in renewable energy, system design, and teamwork. This project reinforced the importance of precision, testing, and interdisciplinary collaboration in developing sustainable solutions.

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