SUSTAINABLE CAPSTONE PROJECTS (SCAP)
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WIND TURBINE

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INTRODUCTION

Wind turbines offer a sustainable solution for generating electricity, but their environmental impact can be reduced by using recycled materials. This project explores the design and construction of wind turbines with recycled materials, aiming to enhance sustainability and resource conservation.

The primary objectives of this project are to:

- Gain a comprehensive understanding of wind turbine design principles, focusing on the integration of recycled materials
- Identify and evaluate potential recycled materials for various wind turbine components
- Design a scalable wind turbine concept that incorporates recycled materials
- Analyze the financial and environmental implications of using recycled materials in wind turbine construction
- Construct a simplified scale model wind turbine utilizing recycled materials

MATERIALS USED IN CONSTRUCTION

Re-Used & Recycled Materials

- blades cut-up sections of recycled plastic pipe
- hub: Wood
- Yaw system, metal rods, and metal plates
- Wind Vane
- generator (Optional) re-used

Upgraded

- cables
- battery
- washing generator
- new shaft
- new bearing

FINAL PRODUCT

The upgrades that the turbine needed were to increase the efficiency of the system, the upgrades were at:

- **Washing machine motor:**
  the previous motor has a friction within the bearing, we replaced the motor with another one that bigger rotate smoothly.
- **Shaft and rotor:**
  We attached the shaft directly with the motor which is reduce the friction that caused by belt and rotor, and increased the stability of the motor and the blades
- **Wires and battery:**
  The wiring of the previous version of the wind turbine was connected without on/off switch which consumed the charge of the battery, the new version has switch and indicator if the battery on or off.
- **Wind vane and yaw mechanism :**
  Previous version of wind vane was smaller, with more surface area of wind vane move the wind turbine to wind direction that face the wind it rotate the wind blades.

Figure 1. The wind turbine in operation

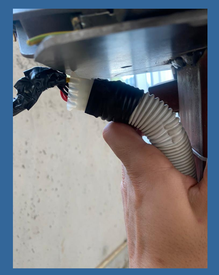

Figure 2. Wiring upgradesing to insure safety

Figure 3. System wiring

Figure 4. Motor test

RESULTS AND DISCUSSION

The vertical axis wind turbine (VAWT) Was tested in various wind conditions to measure its performance and efficiency. The turbine was able to generate electricity from wind speeds as low as 3m/s, indicating its suitable for operation in locations with moderate wind resources. The maximum power output of the turbine was achieved at a wind speed of around 7m/s. However, further optimization of the blade design and yaw system could potentially increase the turbine's power output and efficiency at higher wind speeds. Material Selection and Resource Conservation The integration of recycled materials throughout the turbine's design and construction significantly reduced the environmental impact of the project. By utilizing recycled Plastic for the blades, wooden scraps for the hub, and repurposed rubber for the belt drive, we minimized the reliance on virgin materials and contributed to resource conservation. The project's emphasis on recycled materials aligns with the principles of sustainable engineering and circular economy, where materials are continuously reused and recycled to minimize waste generation and environmental degradation. Challenges and Future Directions One of the primary challenges encountered during the project was the limited availability of specific recycled materials. This required careful consideration of alternative materials and a willingness to adapt the design to ensure the projects success. To further enhance the sustainability of the VAWT, future iterations could explore the use of bio-based or biodegradable materials for the blades and other components. Additionally, incorporating advanced aerodynamic designs and optimizing the yaw system could lead to improved efficiency and power output. In addition to these technical improvements, expanding the project scale to construct larger VAWTs could potentially generate more electricity and contribute to broader energy needs. Furthermore,

CONCLUSIONS

The project provided valuable problem diagnosing and solving skills. The project provided valuable hands-on experience in engineering design, construction, and material selection, fostering a deeper understanding of sustainable engineering principles. The limited availability of specific recycled materials presented a challenge, requiring careful consideration of alternative materials and design adaptations. The project reinforced the importance of considering the environmental impact of our designs from the outset, emphasizing the potential of innovation in sustainable energy solutions. The SCAP program provided a supportive and collaborative environment for learning and experimentation, aligned with the project's goals and furthering our understanding of sustainable engineering. Ultimately, the project was a valuable learning experience that deepened our understanding of sustainable engineering principles and demonstrated the feasibility of incorporating recycled materials into real-world applications.

REFERENCES

1. "Vertical Axis Wind Turbines for Sustainable Energy Generation" by Dr. Alireza Ahmadian
2. "Design and Construction of a Vertical Axis Wind Turbine Utilizing Recycled Materials" by a research team at the University of California, Davis
3. "Vertical Axis Wind Turbines: A Sustainable Approach to Wind Energy Generation" by Dr. Saeed Abbasi and Dr. Saeed Rahimi