Small Scale Wind Turbine

Sean St. Pierre, Wezam Wilfred Paully-Umeh, Bryant Ly, Henry Xing Zhou, Randy Nguyen
MAE 189 Capstone Design: Team 17, SCWT Design
Sponsored by Mahmoud Abdelgalil

Overview

Mission Statement: Single household family requires portable device that uses renewable wind energy to generate power for camping applications.

Project Guidelines: Design a small-scale portable wind turbine capable of providing electricity overnight for the appliances of camping family (2x cell phones, 1x camera battery charger, 1x flashlight, 1x backup battery bank).

Design Criteria

O - objective, C - constraint, F - function, M - mean

Attributes	O	C	F	M
Must be Safe				
Should be lightweight and sizeable (less than 10 lbs)				
Should be portable so that it could be 'added to a hiking backpack'				
Should be easily deployed and assembled				
Might be mounted to a surface, such as backpack or tent				
Must be durable enough to withstand wind conditions				
Should collect wind power automatedly				
Should charge to specific capacity within a time span (8 hours)				
Should charge 5 appliances at once				
Must be cost-effective (budget of $750)				
Should be easily manufactured				

References and Acknowledgements

Our team would like to thank our team sponsor: **Mahmoud Abdelgalil** for their expertise and guidance.

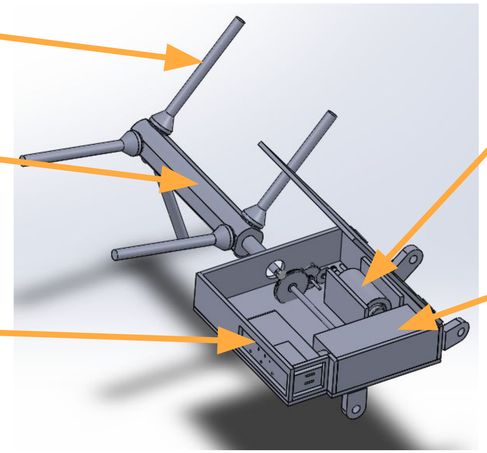
References:
[1] "California Average Wind Speed City Rank." USA.com
[2] "Wind Turbine Calculator" Omni Calculator
[3] "Battery Bank Size Calculations." Leading Edge
[4] "How do you choose a power bank with the right capacity?" Cool Blue
[5] "How to Choose the Right Size Generator." Consumer Reports
[6] "The Complete Guide to Camera Batteries (Part One)." Wolfcrow

Solution: Small-Scale Portable Wind Turbine

Turbine Blade Shafts: Drag-based, holds fabric (3x)

Generator Shaft: Turns the generator (1x)

Power Distributor: Charges appliances (1x)



Generator: Produces power (1x)

Power Bank: Holds charge (1x)

PICTURE OF ASSEMBLED SMALL SCALE WIND TURBINE PROTOTYPE

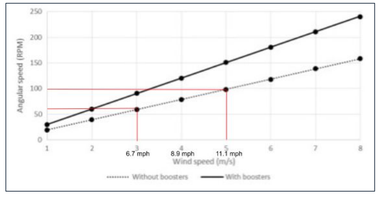
PICTURE OF DISASSEMBLED TURBINE BLADES

Engineering Analysis

Existing design: Supports the generation of ~1000RPM @ 10mph winds. 17" DIA x 8" H The RPM, accompanied by the 1:42 gear ratio, translates to the necessary voltage needed to power the camping appliances.

Oversight: This requires massive torque. Necessity for a 10ft x 5ft turbine blade. Needs to be addressed.

1:42 GEAR RATIO



RPM VS WIND SPEED

Hardware Performance

Turbine Assembly Goal:
1000 RPM in 10 MPH winds

In these conditions:
Produce 13.2W and 16V

SHOWCASING GENERATOR WILL PRODUCE 18.2W @ 2500 RPM

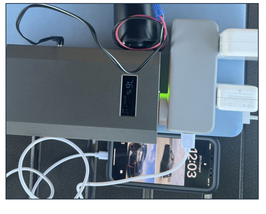
Components:

Generator: 13V input at max 2500 rpm

Power Distributor: Distributes 110V AC and 5V DC outputs.

Power Bank: 24000mAh/88.8Wh. 15V input.

POWER DISTRIBUTING TO VARIOUS DEVICES



Team Contribution

Project Manager: Sean St. Pierre - Overseeing project solution brainstorm and contributed heavily to prototype formation, manufacturing, and assembly.

Project Specialist: Randy Nguyen - Completion of thorough website design and focus on document formatting.

Software Lead: Wezam Paully-Umeh - Data analyst for quantitative data. Ensured design functions met required power and current generation values.

Hardware Lead: Bryant Ly - Design brainstorm and confirmation of compliance in requirements.

Production Lead: Shuo Xing Henry Zhou - Formation of expected project guidelines and designing the CAD Models.

Future Recommendations

Appropriate Materials
- Body - Thermoplastics, Lightweight Metal
- Blade - Nylon Fabric

Horizontal Axis Wind Turbine (HAWT)
- Despite design complexity, HAWT can be portable and compact.
- Performs better (efficiency, minimizing losses)

Collapsible Properties
- Complementary to HAWT, easy assembly, portability, stability.

Engineering Analysis Oversight
- Necessity for massive torque pushes us to:
  - Search for more effective blade shape, generator with less starting minimum torque, or lose the gears.