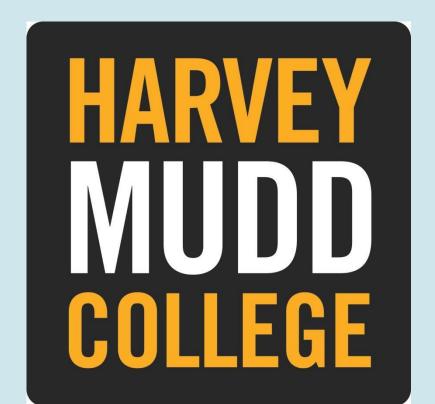


Vertical-Axis Wind Turbine

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Problem Statement

Vertical-axis wind turbines (VAWTs) are **promising renewable energy sources** in areas experiencing multi-directional wind flow, though extensive aeroelastic validation of VAWTs has not occurred. The DTU/HWU Clinic Team is working to **increase the power generation capabilities** of a previously developed VAWT prototype for **Malaysia deployment**. This prototype will be used to **validate VAWT models** on the **simulation software HAWC2**. By contributing to the literature and research of VAWTs, we set the stage for advancements in their design and implementation.

Future Work

- Adjust gear ratio to maximize power output and improve shaft to gear connection
- Improve high-speed rotation by stabilizing center shaft and balancing blades to reduce instability
- Decrease bearing wear by supporting turbine shaft from the bottom
- Reduce drag of the struts by adding small airfoils
- Replace 3-phase generator with DC generator to enable **dual motor-generator** functionality, allowing for self-starting and raising the power coefficient, C_p , to reach optimal tip speed ratio, TSR

Impact

- Accelerate innovation in VAWT technology
- Enable wind energy adoption in urban areas
- Reduce environmental degradation with renewable and sustainable energy technologies
- Support global collaboration and exchange

VAWT Structural and Functional Components

Last Year's Progress

- Fabricated VAWT prototype and developed an equivalent model on HAWC2
- Unreliable electronics prevented data collection to validate HAWC2 model
- Provided mechanical and electrical recommendations to improve power generation capabilities of subsequent VAWT prototype iteration

HAWC2 Validation

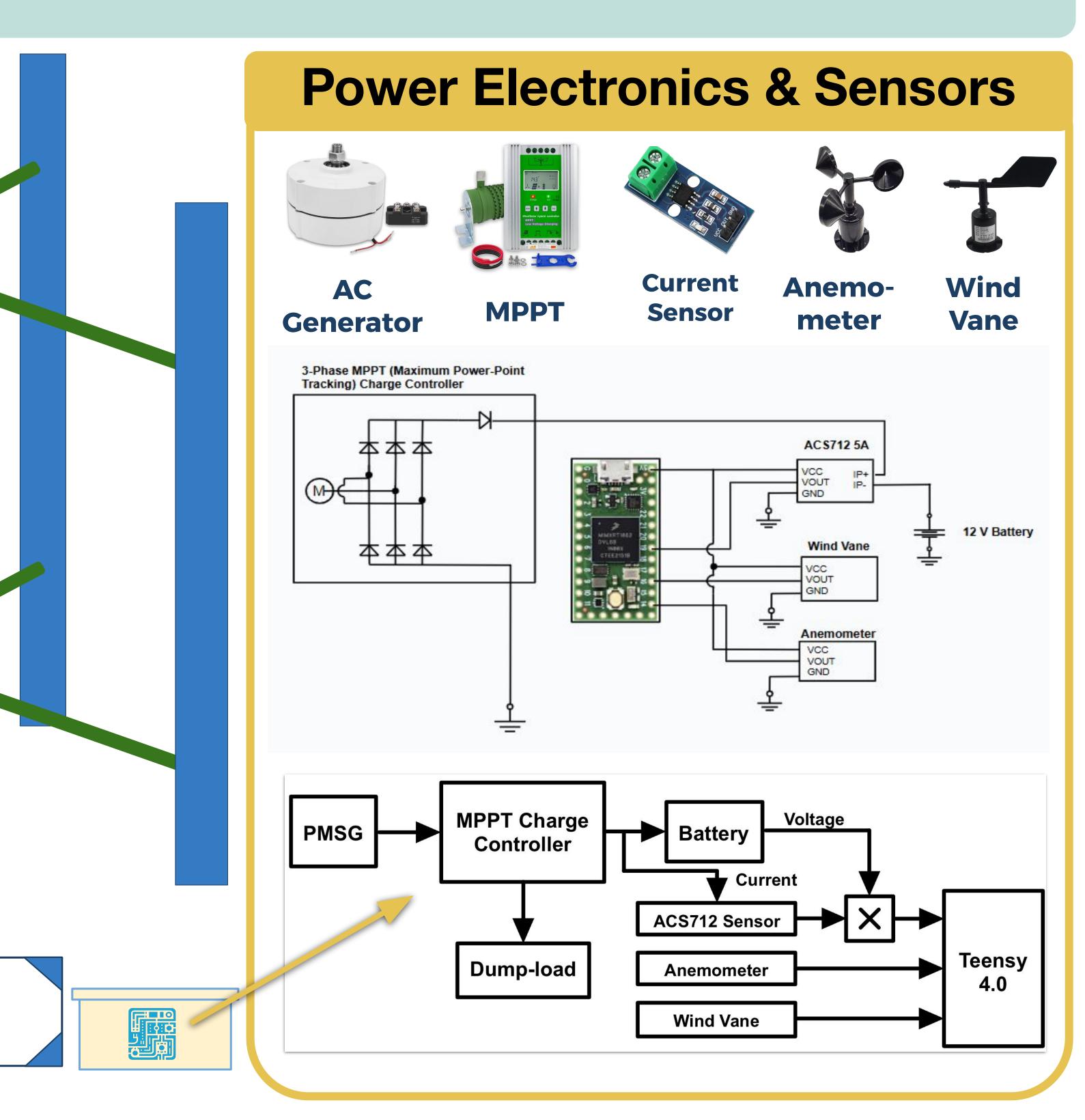
- Performed simulations in the fall semester and identified issues with HAWC2, worked with DTU to resolve issues
- Validation from most recent testing in progress

Cost-Benefit Analysis From the data obtained during the pickup truck testing the team estimated a power delivery of approximately 15W. The cost of the turbine is estimated around \$2200. The payback period is around 66 years which is not ideal. Mechanical Improvements Shortened Aluminum Struts to be lighter and fit in pickup truck Taller Shaft Tower to minimize deflection Corrosion Resistant,

Stainless Steel Bearings

2.5 : 1 Gear Ratio between

shaft and generator



Conclusion

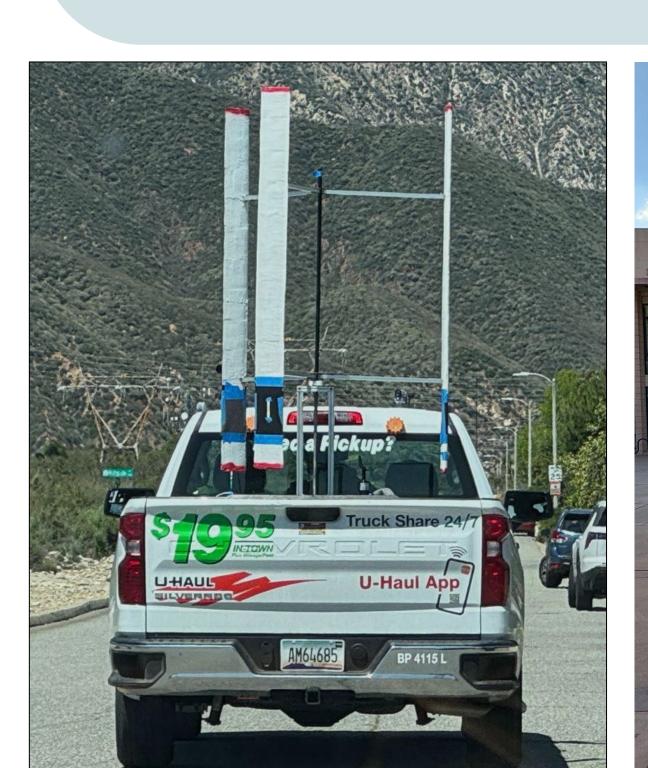
Results

DTU/HWU Clinic: Weather Characteristics vs Time Current vs Time Output Outp

- Generated current at wind speeds ~10-15 m/s, aligning with system's expected performance range.
- Trials 11 & 19 shows a clear, positive correlation between current and wind speed, demonstrating expected rotor inertia
- The VAWT achieved self-starting and current generation at higher wind speeds
- Testing validates MPPT, current sensing system, and generator's capability to convert rotational energy to electrical energy
- Testing reveals critical improvements:
 - Strengthen shaft-to-gear connection to prevent mechanical slippage
 - Recalibrate wind vane to improve data reliability.

Pickup Truck Testing

Location: Rancho Cucamonga, California, USA **Testing Protocol:** The VAWT was mounted on a pickup truck and driven at speeds ranging from **15 to 45 mph**. This setup provided **consistent wind exposure**, enabling the VAWT to reach the necessary tip speed ratios (TSRs) and power coefficients (C_P) to generate up to **2 A of current for charging a 12V battery**.





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