Coastal Wave Energy Generator

UCI Samueli School of Engineering | Department of Mechanical and Aerospace Engineering

ZOT WAVES

Team: Cuiyubo Ni
James Moran
Hein Aung

Sponsor:
Abdelrahman Elmaradny

Summary

Wave energy is a powerful, renewable resource that transforms the natural motion of ocean waves into electricity. Zot Waves aims to revolutionize this technology by developing a compact, affordable, and user-friendly wave energy converter (WEC) that can be easily deployed in coastal communities. Designed for everyday use, providing enough power to charge devices such as cellphones. Our design leverages a buoy system that harnesses the vertical (heave) motion of waves.

The primary objectives of Zot Waves are to:

- Develop a practical, small-scale WEC that is both affordable and easy to operate.
- Generate broader public interest in clean energy solutions.
- Demonstrate a working prototype capable of charging a cellphone from empty to full within five hours.

Initial tests indicate that Zot Waves meets these objectives, showing promising potential to make renewable energy more accessible and improve the quality of life for coastal residents and maritime workers.

References & Acknowledgments

[1] J. J. Uicker, G. R. Pennock, and J. E. Shigley, *Theory of Machines and Mechanisms*. New York, NY: Oxford University Press Inc, 2011.

[2] B. R. Munson, Fundamentals of Fluid Mechanics. New York, NY: Wiley, 2006.

[3] W. Lin, B. H. Shanab, C. Lenderink, and L. Zuo, "Multi-objective optimization of the buoy shape of an ocean wave energy converter using neural network and genetic algorithm," IFAC-PapersOnLine, vol. 55, no. 37, pp. 145–150, 2022. doi:10.1016/j.ifacol.2022.11.175

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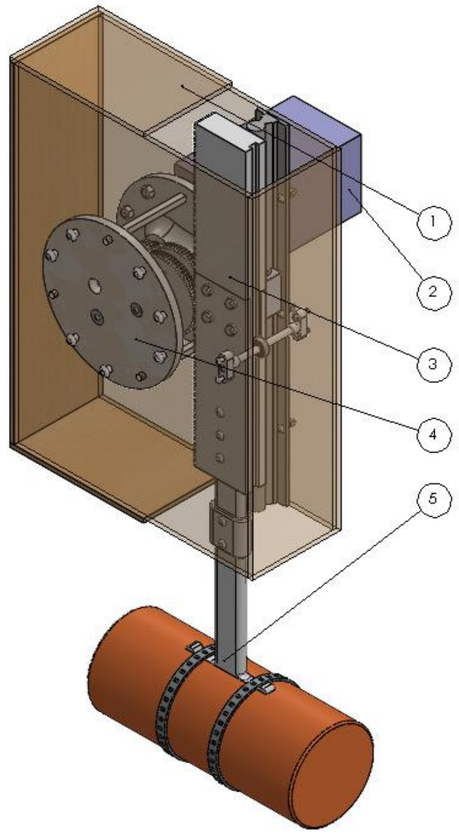
CAD Assembly



ITEM NUMBER	SUBSYSTEM
1	WEATHER-PROFFING WOODEN CHASSIS
2	5-20V CRANK GENERATOR
3	GUIDE RAIL & RACK GEAR LINEAR WAVE MOTION CAPTURE
4	GEAR TRAIN LINEAR TO ROTATIONAL MOTION TRANSLATION
5	STYROFOAM BUOY & BUOY MOUNTING

Considerations & Future Improvements

- MAE151A/B team contribution
  - Team Focus: design, simulation, and scaled-down prototype of the wave energy converter
  - Key Contributions: CAD modeling, material selection, 3D printing, gear ratio calculations, mechanical energy conversion analysis, and generator testing
  - Prior Research: wave energy, early concept validation
- Recommend future improvements:
  - Improve energy storage efficiency
  - Optimize the rack and pinion system or consider replacing it with a more direct-drive mechanisms to reduce energy loss
  - Perform (FEM) simulation test to analyze mechanical stress of each physical components
- Impact on society & Environmental considerations:
  - WEC device promotes renewable energy adoption
  - Affordable, small-scale energy solutions can benefit remote coastal communities
  - Buoy-based system minimizes environmental disruption compared to traditional offshore wind and wave energy systems

Analysis

Generator Testing:

- Equations:
  - Power = Voltage * Current
  - Voltage = Current * Resistance
  - Torque = Force * distance to application point
  - Buoyancy = density * submerged volume *gravity

USB Port: 110 rpms produced 5.36V at 3.89A for 20.85W

Alternate Ports: 115 rpms produced 5.09V at 1.03A for 5.24W

Cold Starting Generator:

Higher torque necessary to start than to run

Procedure:

- Rotate crank arm to horizontal position
- Wait 10 sec for capacitors to discharge
- Add hanging mass to arm until arm turns

Results: Average torque of 0.53Nm required to start generator

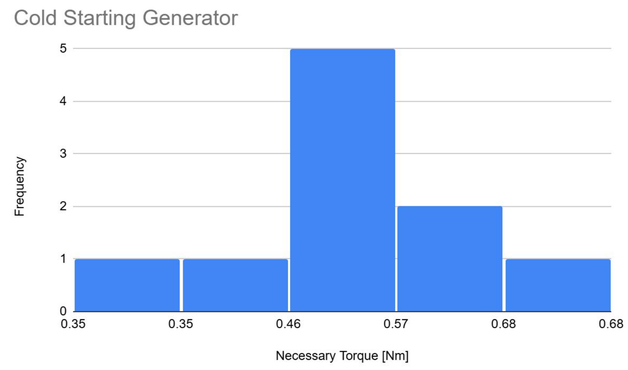


Figure 1: Frequency of torque values required to start crank generator

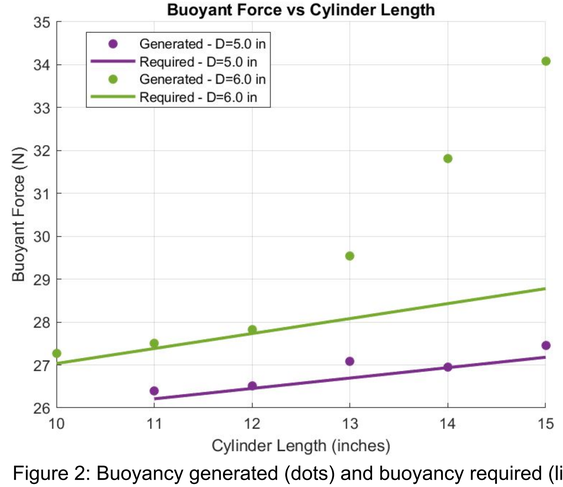


Figure 2: Buoyancy generated (dots) and buoyancy required (line) for different buoy sizes