Wave-Energy Converter | + Coastal Currents -

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Objective: To develop an innovative renewable energy solution utilizing energy from ocean waves.

Executive Summary

A major part of the design methodology was to incorporate various technologies into one coherent design. Tasked with a budget of $500, Coastal Currents' set out to fulfill a set of target goals:

- PR-001: Minimum 30% Efficiency
- DC-001: 24 "x 24" Size Constraint
- QA-007: Targets Coastal Residential Use

To satisfy these needs, Coastal Currents have analyzed existing solutions and have developed both an ideal CAD model and a physical proof of the rotating mass concept.

Impacts

- Environmental Considerations:
  - Positives
    - Zero emission
  - Concerns
    - Wildlife interactions
    - Possible plastic pollution
- Societal Considerations:
  - Positives
    - Lower dependence on grid
  - Concerns
    - Interaction with boats

Proof of Concept

Solution

- Rotating mass design
- Buoy floats and pitches alongside waves
- Eccentric counterweight spins a generator producing electricity

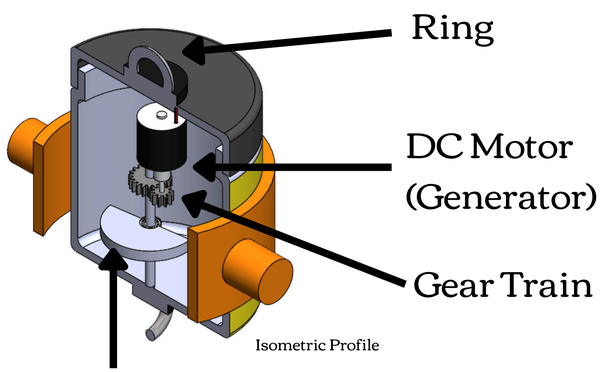
Key Features

- Pivoting Design
  - Pitch induces rotation
- Eccentric Counterweight
  - Rotates generator shaft
- Generator
  - Produces measurable voltage

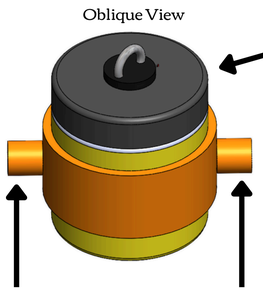
Design Specifications

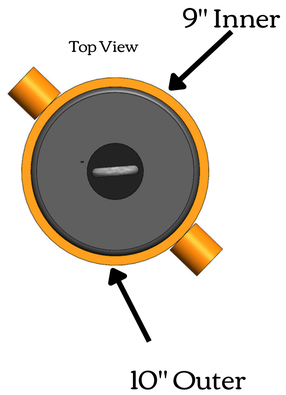
- Overall Size
  - 10" Diameter x 10" Height
- Weight
  - 15 lb Total Weight
  - 5 lb Rotating Mass

CAD Models



Rotating Mass with One Way Bearing





Data & Analysis

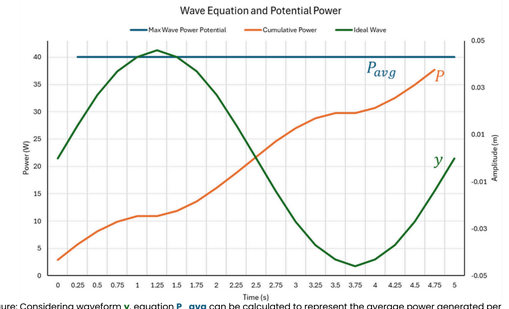


Figure: Considering waveform y, equation P_avg can be calculated to represent the average power generated per wave. The team's designed buoy could hypothetically harness a power (P), which could result in a 95% efficiency. [1]

$$P_{avg} = \frac{\rho_w g^2 \zeta^2 D(k_w d_w)}{4\omega}$$

$$P = \sum mgD\omega\sin(\theta)$$

$$y = 0.0457\sin(\frac{2\pi}{5}t)$$

$D(k_w d_w)$ = Depth Factor
d_w = Water Depth (m)
g = Gravitational Acceleration (m/s^2)
k_w = Wave Number
m = Mass of the Rotating Mass (kg)
P = Instantaneous Power (W)
P_{avg} = Potential Power Per Wave (W)
y = Desired Sinusoidal Water Wave
θ = Rotational Angle of the Buoy
λ = Wavelength (m)
ζ = Undisturbed Wave Amplitude (m)
ρ_w = Water Density (kg/m^3)
ω = Angular Frequency (rad/s)

Improvements / Possible Shortcomings

- Determination of deployment conditions
- Optimized design dimensions
- Analyzed efficiencies

Quarter 2 Objectives

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References

[1] Chen, F., Duan, D., Han, Q., Yang, X., and Zhao, F., 2019, "Study on Force and Wave Energy Conversion Efficiency of Buoys in Low Wave Energy Density Seas," Energy Conversion and Management, 182, pp. 191-200.