Drift-RMT: Powering Drifter Buoys with Wave Energy and Rotating Mass Technology

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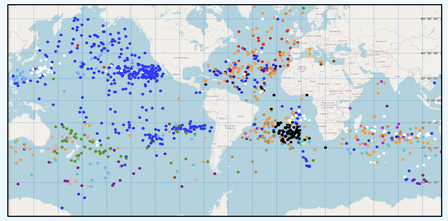
Motivation

Go-To-Market: NOAA Global Drifter Program
- Collect data to improve weather forecasting
- Over 1300 drifters deployed worldwide, goal: maintain a 5ºx5º grid
- Powered by 30 D-Cell Alkaline batteries

Problem
- Projected battery lifespan of 12-18 months
- Unreliable, 68% stop transmitting before expected lifetime is reached
- 400 replaced annually – Remainder become marine debris



Global Drifter Map

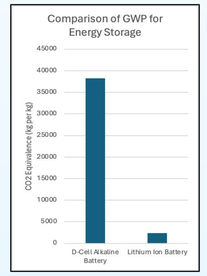
Solution

Design
- Wave energy converter (WEC)
- Eccentric rotating mass
- Gearbox & electromechanical generator
- 4 rechargeable 4.2 V lithium-ion batteries - lasts 23 days no charging
- H-Bridge or similar circuity

Characteristics
- Cannot inhibit drifter flow
- Attachable drogue
- Can survive different environments across globe
- Easily deployable
- Lightweight

Environmental Concerns:
- Noise disturbance
- Marine toxicity
- Marine debris of drifter

Environmental Solutions:
- Insulated electronics
- Encapsulated batteries
- Retrievable via GPS tracking

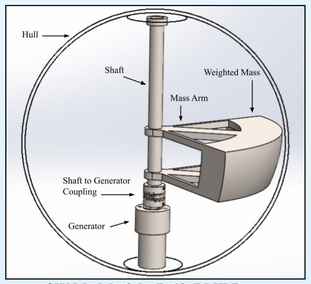


Global Warming Potential Comparison

Technical Design

Preliminary Design
- Approximate drifter hull size
- Center shaft with fixed mass
- Aligned generator

Specifications
- 0.38m Diameter Spherical hull
- 2kg Tungsten rotating mass
- ~170:1 Gear Ratio of Shaft to Motor
- 316 Stainless Steel Shaft



SW Model of the Drift-RMT Buoy

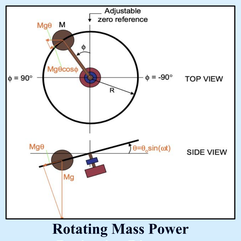
Power Estimate

Power Demanded
- Sensors ping every hour on the hour and that data is transmitted to satellite ~ 0.06 watt-hours every hour

Power Produced - Theoretical

$$P_{avg,resonance} = \frac{1}{2} Mgr\theta n$$

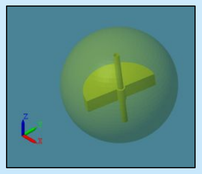
M – mass
g – gravity
r – hull radius
theta – buoy incline angle
n – generator efficiency



Rotating Mass Power Derivation Diagram

PTO Simulation

WEC-Sim
- Model used to generate data of heave/pitch/roll response and power output for given waves
- Simplified model used to reduce computation times

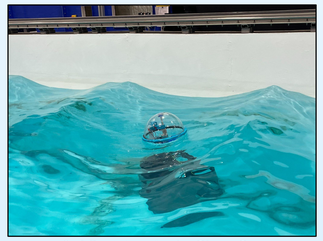


WEC-Sim Model

		Wave Period (s)					
		0.5	1	1.5	2	2.5	3
Wave Height (m)	0.05	0.01	0.02	0.18	0.01	0.01	0
	0.1	0.02	0.95	0.35	0.03	0.01	0
	0.15	0.05	1.81	1.26	0.09	0.03	0.01
	0.2	0.12	2.98	N/A	0.16	0.05	0.02
	0.25	0.24	N/A	N/A	0.28	0.12	0.04
	0.3	0.51	N/A	N/A	0.35	0.21	0.07

Power Matrix in Watts of Simplified WEC-Sim Model

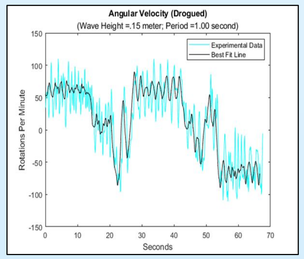
Build & Test



3rd Prototype in the Chase Ocean Engineering Wave Tank

Wave tank testing
- Goal: Develop a relationship between angular velocity of the rotating mass mechanism and different wave characteristics
- Conducted in Wave Tank in Chase Ocean Engineering Lab
- Tested under 12 wave settings, varying wave heights and periods

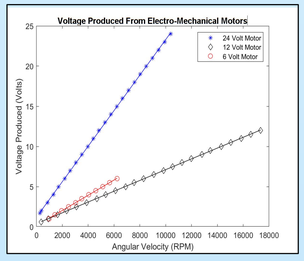
Drogue Considerations
- Investigated effect of drogue on buoy movement
- Used a 1:20 scaled drogue
- Observed reduction in horizontal translation with drogue attached
- Found that drogue regulated pitch and yaw motion rather than prohibiting it



Accelerometer Data of Rotating Mass With Drogue Attached

Materials
- Primary materials used were two plexiglass hemispheres, a hollow steel shaft, silicon gasket, 3D printed arm and configurable mass, M4 bolts and nuts, and silicon grease for additional waterproofing

Generator testing
- Goal: Develop the relationship between angular velocity and voltage produced for each motor
- Three different sized motors
- Given any combination of wave conditions and motor size, voltage production can be predicted
- Motor selection depends on factors including gear ratios, operating range, and battery specifications

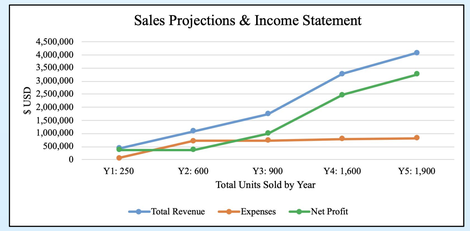


Voltage Produced vs. Motor Speed

Business Plan

Financials
- Sublicense design fee; multilevel drifter price based on instrumentation

Sales Price: $7,000, $9,000, $12,000 per unit; based on sensor package
License Fee: $1,500, $1,800, $2,400 respectively
Cost of Sales: $0 (Outsourced Manufacturing)
Gross Profit Margin: 27% (Averaged)



Sales Projection & Income Statement

UNH Holloway Competition
- Won 1st place and $15,000
- Validation of business plan

Riley, Kara, Cam, Will M. receiving the Holloway Competition 1st place award

Market Expansion
- Increase current concentration to global 3ºx3º grid over five years
- Expand current buoy networks for: weather prediction, climate mapping, disaster preparedness, shipping routes, fish population monitoring, oil concentration detection

Partners & End Users

Customer Discovery

Target Government and Private Organizations

Interviews conducted include,
- Dr. Shaun Dolk, *Manager of the Global Drifter Program, NOAA*
- Dr. Jake Kritzer, *Executive Director, NERACOOS, Portsmouth, NH*
- Dr. Tom Coolbaugh, *Operations Manager, Ohmsett Testing Facility, Leonardo, NJ*
- Peter Britz, *Director of Planning and Sustainability, Portsmouth, NH*
- Evan Alders, *MetOcean Telematics*