WATTER Jacks Finalized Testing (MECC25)

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Project Description

The Marine Energy Collegiate Competition (MECC)

- An annual competition organized by the U.S. Department of Energy
- Design solutions for harnessing marine energy (tidal, current, waves)
- Project goal: rigorous data testing & data collection of final prototype (in closed water)
- Able to relate our design to the *Blue Economy* (economic growth through the ocean) through a business plan challenge

Sponsors

- U.S. Department of Energy
- Northern Arizona University
- NAU Energy Club
- Kenautics inc.

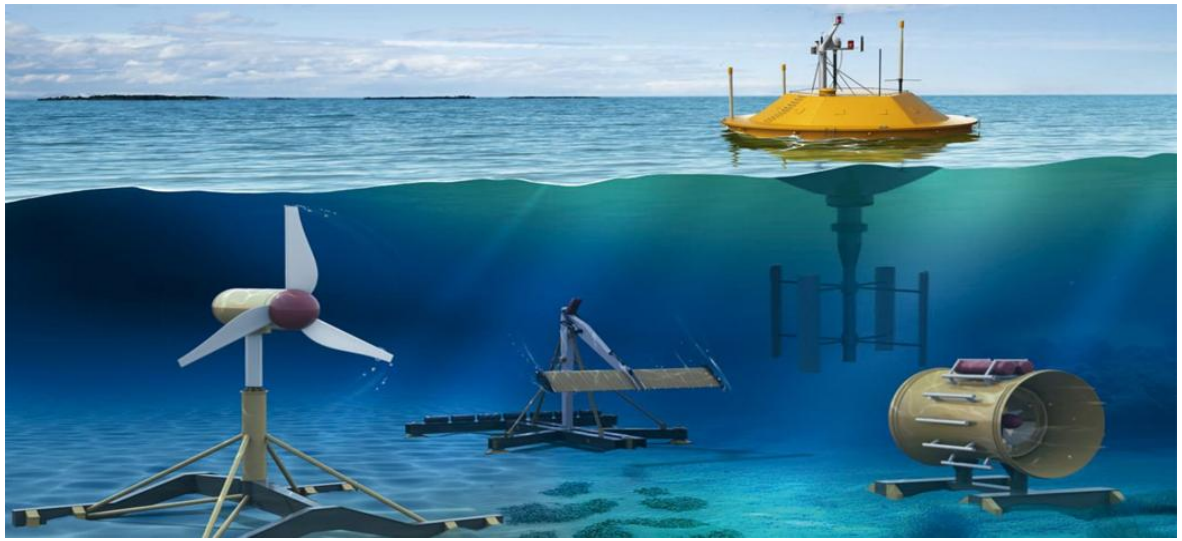


Figure [1]: Examples of marine energy generators

Design Requirements Summary

Table [1]: Design Requirement Summary Table

Customer Requirements:	**CR#**	**Engineering Requirements:**	**ER#**
User Safety	CR1	Resistance to Marine Environment: Water resistant	ER1
Design: Balanced, efficient, reliable	CR2	Average Energy Output: 200W/hr	ER2
Cost: Budget-friendly, high output	CR3	Continuous Operation: 4800 W/day	ER3
Environment: Marine life safe	CR4	Marine Compatibility: 6 +	ER4
Aesthetics: Coastal visual harmony	CR5	Majority Use of Marine Energy: + 51%	ER5
Adaptability: Multi-climate tested	CR6	Auto Shutdown: 2-second response	ER6
Manufacturing: Quick, easy build	CR7		
Energy Harvesting Method	CR8		

Top Level Testing Summary

Table [2]: Table of Testing Plans (MECC compliant)

Test Name	Range	Risks	Mitigations	CR#/ER#
Internak Air Pressure	1.5 atm, 2 hrs	Leaks	Sealant	ER1, CR1, CR4, CR6
Hydrophobic	No Leaks	Leaks	Same as Pressure Test	ER1, CR1, CR4, CR6
Electronics	Within limits	Corrosion, Overload	Grease, Thick Wiring	ER2, ER8
Environmental Monitoring	Stable Readings	None	N/A	CR4
Neutral Buoyancy	Positive/near-neutral	Sinking	Increase Volume	ER1, ER6,
Counterweight Adjustment	Optimized Rotation	Imbalance	Adjust Weight	ER6
Charge Time	Varied Charge Times	Inefficiency	Analyze Data	ER2, ER3, ER4
Drop/Stress	No Damage	Failure	Reinforce Structure	ER1, ER7

Detailed Testing Plans
(Hydrophobic & Internal Pressure)

- Test/experiment summary:
  - DR's being tested.
  Is the device air/water resistant? CR1, CR2, CR7, ER1, ER3, ER4
  - Equipment
  Closed body of water, air compressor/air pump, meter stick, timer
  - Isolated Variables
  Internal pressure
  -Calculated Variables.
  Internal pressure & time
- Procedure
  Originally, seal each half of the buoy and pressurize them to 1.5 atm
  1.Submerge the buoy into the water and hold it in the water until visually we see bubbles
  2.Open the buoy and see if the internal area is dry/wet
- Results
  The device did leak around the top of the device and was not sealed properly during the first test.
  Second test resulted in minor leaking which is reparable.
  Update: it is now airtight & watertight

Video [1]: Hydrophobic Test at WEC Center

Detailed Testing Plans
(Electronics & Environmental Monitoring)

- Test/experiment summary:
  - DR's being tested.

  Are the electronics in working order and can we get a reading on on-board the circuit boards? CR1, CR2, CR6, CR7, CR8, ER2, ER3, ER5, ER6
  - Equipment

  Electronic assembly, mobile device, hand/drill
  - Isolated Variables

  RPM & connectivity
  - Calculated Variables

  Power Visualization & connectivity
- Procedure
  1. **Connect the wires to the circuit boards and ensure that all the boards are powered.**
  2. **Connect mobile device to Electronic assembly**
  3. **Rotate axle to confirm power is being generated via app**
  4. **Check app to see any delay in readings**
- Results

  Entire electronic system gets power when turned on. The Electronic subassembly connects to the mobile device and gives near real time readings.

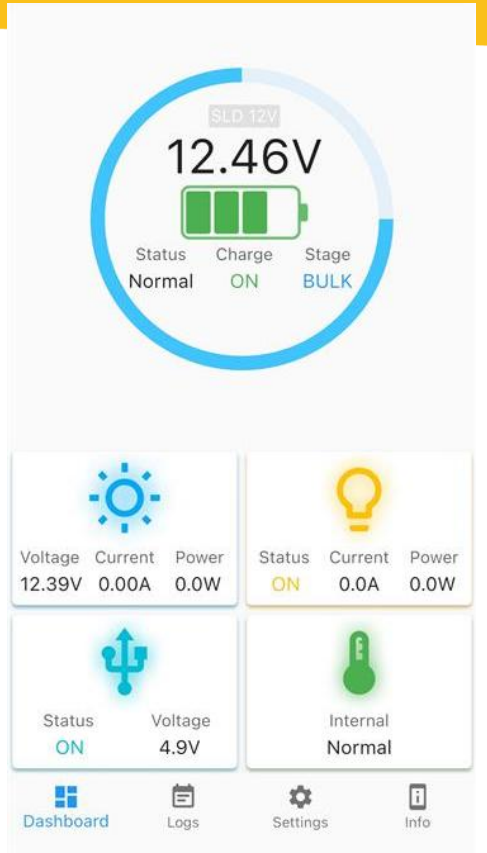
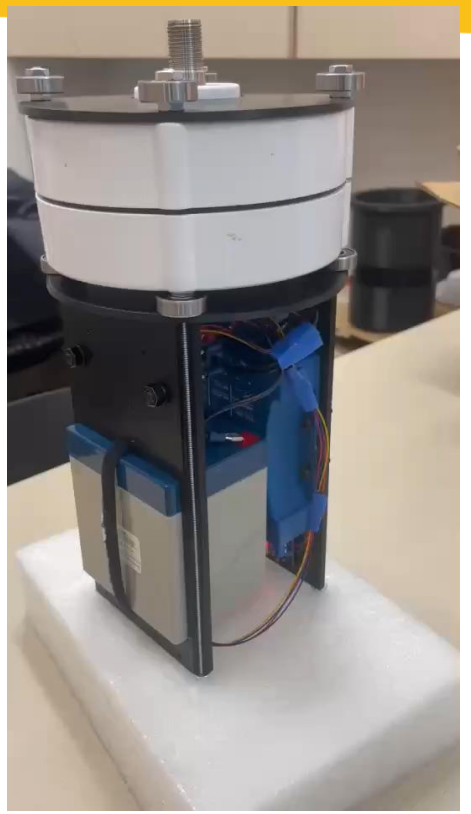


Figure [2]:Connected App with Power Readings



Video [2]: Electronic Subassembly Powered On

Detailed Testing Plans
(Neutral Buoyancy & Counterweight Adjustment)

- Test/experiment summary:
  - DR's being tested.

    Is the buoy positively/neutrally buoyant? What is the needed counterweight? CR4, CR5, CR6, CR8, ER3, ER4, ER5,

    - Equipment

    Closed body of water and equivalent mass of Internals to simulate

    - Isolated Variables.

    Weight/density of buoy

    - Calculated Variables.

    Displacement of water relative to buoy and Buoyancy

- Procedure
  1. **Open the device and add objects of equivalent mass to the internals into it.**
  2. **Place the device in water and let it idle and see if the buoy will float or sink.**
  3. **Remove the device from the water**

- Results

  The device was positively buoyant, even with the internal mass being slightly higher than the mass of the actual internals. Need to do calculations for counterweight.

  Update: sum of needed weight is ~45N for scale model (counterweight + anchor/mooring line)

Video [3]: Buoyancy testing in CWC Tank

Detailed Testing Plans (Charge Time)

- Test/experiment summary:
  - DR's being tested.

  What is the charge rate of the buoy? ER2, ER3, ER4

  - Equipment

  Drill/dynamometer, Torque adapter, tachometer, mobile device, stopwatch, electronic assembly

  - Isolated Variables.

  RPM(short time), Torque

  - Calculated Variables.

  RPM (longer time)
- Procedure
  1. **Connect drill to buoy & buoy to app**
  2. **Spin the drill until app shows charging**
  3. **Run spindle for 60 secs, measure RPM with tachometer and change in charge**
  4. **Do calculations for 24-hour period**
- Results

  The minimal RPM needed to charge the buoy is 400 RPM it will take 20 min to charge

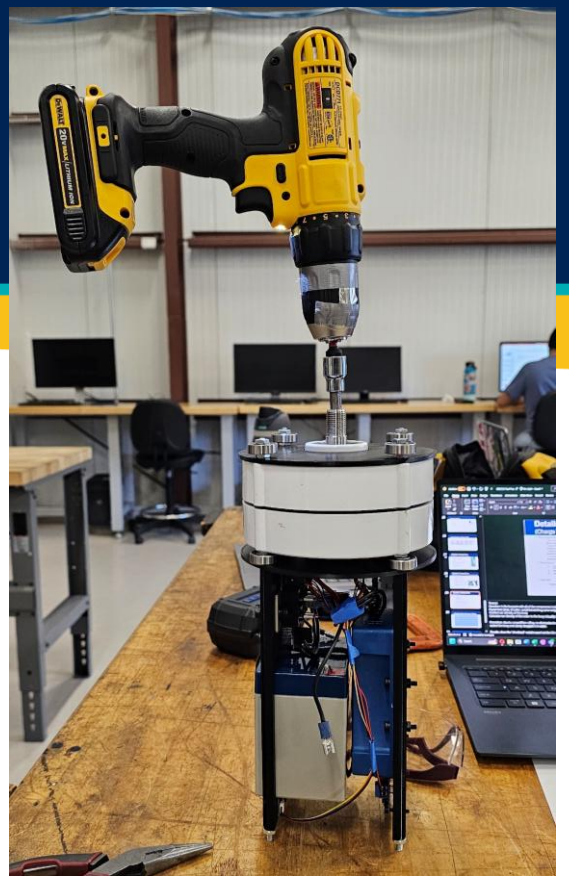


Figure [3]: ***DO NOT TRY THIS AT HOME***

Specification Sheet Preparation

Table [3]: Customer Requirements

Customer Requirements	CR Met?	Client Acceptable
User Safety	Yes	Yes
Design Presentation	Yes	Yes
Cost Efficiency	Yes	TBD
Environmentally Safe	Yes	Yes
Aesthetically Appealing	Yes	Yes
Ease of Manufacturing	Yes	Yes
Energy Harvesting	Yes	Yes

Specification Sheet Preparation

Table [4]:Engineering Requirements

Engineering Requirements	Target Values	ER Met?	Measured/Calculated	Client Acceptable
Resistant to marine environment	IPX7	Yes	IPX7	Yes
Energy Output	60 W/hr	Yes	500 W/hr	Yes
Continuous Operation	1440 W/day	Yes	11,000 W/day	Yes
Efficiency	>50%	Yes	~85%	Yes
Controlled Testing	Testable Size ~ .7m (length)	Yes	0.7 m	Yes
Compatible with diverse marine environments	>= 6	Yes	Yes	Yes
Majority Marine Energy	>=51%	Yes	100%	Yes
Remote Shutdown	10 second	Yes	~5 sec	Yes

QFD

1	Resistance to Marine Environment														
2	Energy Output														
3	Continuous Operation	+													
4	Efficiency	+		+											
5	Laboratory/Controlled Testing Compatability	+	-												
6	Compatibility with Diverse Marine Conditions		+	+		-									
7	Majority Use of Marine Energy	+	-												
8	Remote Shutdown Capability	+	+	+											
					Technical Requirements								Bench Marking		
	Customer Needs	Customer Weights	Weight %	Resistance to Marine Environment	Energy Output	Continuous Operation	Efficiency	Laboratory/Controlled Testing Compatability	Compatibility with Diverse Marine Conditions	Majority Use of Marine Energy	Remote Shutdown Capability	CorPower	Sea Wave Energy Limited SWEL	Eco Wave Power
1	User Safety	5	6.60	4							9	7	7	6
2	Design Presentation	2	16.50	6	6			5	5	5	5	8	6	6
3	Cost Efficiency	4	8.25				7	6				4	8	7
4	Environmental Safety	4	8.25	5					6	6	8	5	7	8
5	Aesthetically Appeal	3	11.00	6	6	6				6	6	6	6	4
6	Adaptability Across Climates	5	6.60	7	7	8	9	7	8	8	8	7	7	5
7	Ease of Manufacturing	5	6.60	8	8	8	8	8	8	8	8	4	3	7
8	Energy Harvest	5	6.60	7	7	7	7	6	6	7	7	7	4	8
	Technical Requirement Units			IPXX	W/hr	W/ day	%	CM	Varity	%	t,d			
	Technical Requirement Targets			IPX7	60	1440	> 50%	0.7	>= 6	>= 51%	10s, 5m			
	Absolute Technical Importance			180	140	133	148	139	144	167	220			
	Relative Technical Importance			4	7	8	3	2	6	5	1			

Figure [3]: House of Quality

Thank You!
Questions?