

PROJECT IDEA SUBMISSION – RESEARCH

LABORATORY INFORMATION

Name: Warsinger Water Labs Date: 9/5/2024

LABORATORY'S LIAISON CONTACT INFORMATION

Name: Sultan Alnajdi

Title: Ph.D. Student E-Mail: salnajdi@purdue.edu

Phone: (814)-470-1365 Cell: () Fax: ()

Address: _____

Street Address / P.O. Box

Room/Suite #

City

State

ZIP Code

PROJECT NAME

Marine Energy Collegiate Competition 2025

GENERAL PROJECT DESCRIPTION

Every year, the U.S. Department of Energy challenges collegiate students to bring novel and exciting developments in the marine energy industry. The competition challenges an interdisciplinary team of students to research, build, and test a device that harnesses marine and renewable energy. The marine industry is a growing field that will play a vital role in powering the "blue economy." This blue economy includes the sustainable use of ocean resources to promote economic growth, community livelihoods and the ecosystem as whole. This team will create an efficient device that can process complex wave energy to power desalinization in non-uniform conditions.

WHAT IS THE MECHANICAL ENGINEERING PROBLEM (APPARATUS) YOU ARE WANTING SOLVED (BUILT)?

While reverse osmosis has proven to be a highly effective desalination process, it has high pressure and energy requirements. To meet these requirements, the existing technology must be placed in areas with high wave activity and simple wave motion. This process is highly essential in areas with little to no access to freshwater, but it severely impacts the shoreline of such areas which worsens the existing issue.

With the rise of climate change, and the increasing need for freshwater sources in drought and other crisis affected areas, the team will engineer a solution that can harness complex waveforms to accumulate a pressure gradient of at least 40-45 bars utilizing an energy accumulator. The primary goal is to create a solution that not only minimizes external

energy and fossil fuel consumption, but also to harness complex and non-uniform wave activity by improving the wave energy converter itself.

WHY IS THIS PROBLEM (APPARATUS) WORTH SOLVING (BUILDING)? (Value Proposition)

80% of the Earth's surface is water, and is our largest untapped energy source; meanwhile, 1 in 10 people across the world don't have access to clean water, and the existing technology does not meet the increasing demands without significantly damaging the environment. This environmental damage contributes back into the water scarcity issue and creates a tough to break feedback loop. The existing technology is exceedingly hard to transport, and the product doesn't have a lifecycle past 4 years without frequent maintenance due to corrosive effects.

Creating a desalination system that can harness clean energy to fuel the desalination process, in areas with variable (low and high) wave activity, can increase the production of clean water sustainably. Furthermore, if these devices can reside in the ocean with little human maintenance and external power consumption, these can be used as long-term solutions for desert and areas with water scarcity.

WHAT ARE THE MOST IMPORTANT FUNCTIONAL REQUIREMENTS AND SPECIFICATIONS FOR THIS PROJECT?

Req 1: Applicable in a wide range of geographical areas and not damage existing coastal wildlife.

Req 2: Process complex and less ideal waves and convert them into energy.

Req 3: Be cost effective and have an ROI of less than 10 years.

Req 4: Able to self-produce energy to power itself for longer than 2-year periods.

Req 5: Not contain any damaging parts to external environment and wildlife and protect against any wildlife interference.

Spec 1: The device must require as little assembly and parts as possible.

Spec 2: Must be able to process complex wave behavior and convert less than ideal wave conditions into at least 40-45 bar of pressure to power desalination.

Spec 3: Require little to no external non-renewable energy to sustain itself for extended periods of time between maintenance

WHAT DO YOU ANTICIPATE THE STUDENTS DESIGNING, ANALYZING, BUILDING/PROTOTYPING AND TESTING? BE AS SPECIFIC AS POSSIBLE.

Design:

A large-scale system that will convert wave energy into pressure for the reverse osmosis desalinization process to occur, utilizing complex wave forms and improving stabilization for the device to sustain itself in oceanic environment for extended periods of time. Preferably this design will also be utilizing 100% external renewable energy to power auxiliary functions of the device.

Analyze:

The team must analyze wave behavior and reverse osmosis experimental and simulated data to create a better design for a wave energy converter that can process complex waves and produce high amounts of pressure. They must create simulations and theoretical models on the behavior of the device in low to medium wave behaviors and environmental conditions.

Build:

A large scale, testable device that can process motion inputs, generates pressure-gradient and convert wave energy into power for the system to run. The system must have a way to protect from environmental conditions such as salt accumulation, and still be able to produce consistent clean water if working at less ideal conditions.

Test:

Utilizing a complex wave simulation that we will develop through this project, the device will be tested using the facilities in Herrick labs, which can produce theoretical data. The Civil Engineering hydraulics lab towing tank will be used for physical testing and compare the experimental data to the theoretical data produced through simulation. We must also have instrumentation and calibration data for this device, as well as the effects of water corrosion on the device.

WHAT IS YOUR BEST ESTIMATE OF THE COST OF THE HARDWARE, COMPONENTS, MATERIALS, ... OF THE PROPOSED PROTOTYPE?

Total \$ 15000 - 20000

Hardware Costs: 15000

Component Costs: 2000

Material Costs: 1000

HOW MUCH TIME AND EFFORT WOULD YOU EXPECT TO SPEND ON THIS PROJECT IF YOU WERE DOING IT INTERNALLY?

Calendar Months: 6-8

Total Hours (Engineering, Shop, ...): 6000-7000

DO YOU BELIEVE THE PROJECT CAN BE COMPLETED WITH EXISTING TECHNOLOGY, IF NOT, ELABORATE ON NEEDED DEVELOPMENTS?

Wave energy technology and simulation software exists both theoretically and practically, however in niche markets and applications. The general ideas behind this device such as reverse osmosis, desalinization, and energy converters are pre-existing. However, there is further research needed in the different methods of RO (pulse flow, batch etc.) and experimentation in how to utilize these technologies to be cost-effective, have a broader application which can be accomplished within the timeframe for the class. Furthermore, the parts and materials are utilized in already existing technologies (pumps, buoys, valves etc.) and are simple devices we have covered in our prior classes that can be utilized to create a much more complex device that can perform in non-uniform conditions.

CONCERNS OR OTHER RELATED INFORMATION ASSOCIATED TO THE PROPOSED PROJECT?

Concerns:

Other Info:

There are other potential seniors that are willing to be onboard this project, but as I have not received confirmation from them, I have not listed them below.

ATTACH ANY APPROPRIATE SKETCHES, DRAWINGS, STANDARDS, DATA, PHOTOS, ... USEFUL IN JUDGING APPROPRIATENESS AND SCOPE OF PROPOSED PROJECT.

(list of attachments)

ARE YOU WORKING WITH ME SENIORS WHO YOU WOULD LIKE ON THIS PROPOSED PROJECT? YES/NO (If YES, provided what information you can.)

| NAME | PUID | PHONE | EMAIL |
|-------------|------------|----------------|-----------------|
| Nikitha Sam | 0033568000 | (901)-612-4077 | nsam@purdue.edu |
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Save this filled out .docx with the following naming nomenclature: “RESEARCH_*project name* – *student point of contact full name*.docx” where the *italic strings* get replaced with appropriate actual text strings.

If you have any questions concerning a proposed project or completing this form please contact Professor Greg Jensen.

To submit this document for consideration, please complete the survey using either the QR code or the link below.



https://purdue.ca1.qualtrics.com/jfe/form/SV_bkCjo7jyE5Wb7ro

C. Greg Jensen, PhD

Director of Senior Design
Professor of Engineering Practice
School of Mechanical Engineering, Room 2195
Purdue University
585 Purdue Mall
West Lafayette, IN 47907-2088

Office: 765-496-0214

Cell: 801-367-6145

Fax: 765-496-1114

E-mail: jensen23@purdue.edu