WAVE AHEAD OF THE ENERGY CRISIS

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Energy is a scarce, often destructive, and highly demanded resource in society. It that has traditionally been provided from non-renewable and destructive fossil fuel sources. Renewable energy sources are a clean and safe method of harnessing energy, but they are not always efficient. Our goal is to harness wave energy using a prototype of our design to create a renewable energy source that is safe and reliable with application all over the world.

OUR PROJECT

Our grand challenge solution is a linear generator that harnesses wave power as a renewable energy source. We created a prototype generator that is submerged under water and protected by a waterproof housing. The housing is attached to a buoy at the surface of the water, allowing it to oscillate. The internal generator is composed of a tightly-wound copper coil, which oscillates around a neodymium magnet in the center. The motion created by the waves causes the box to rise and fall in a periodic motion. The magnet contained inside induces a current in the moving coil and provides us with sustainable, clean, electricity.

CURRENT RENEWABLE ENERGY STATUS

The topic of renewable energy is frequently discussed in today's environmental situation. Humans have discovered many ways to create energy through earth's natural resources. However, this has proven environmentally damaging and unsustainable due to finite resources. These non-renewable resources called fossil fuels are biological materials containing hydrocarbon, which is burned and used as a source of energy. These finite forms of energy make up roughly 87% of our global energy needs (McFadden, 2019). As fossil fuels are finite and their use is associated with dramatic increases in global air pollution, scientists and engineers have been working to find alternative sustainable sources of energy. In order to solve this grand challenge, a renewable energy source is needed.

PROJECTED IMPACT

Using renewable energy sources is essential for our society; issues like pollution and global warming threaten the longevity of our existence. Having tested and proven the efficacy of our prototype, we believe our design could be scaled up to a much larger generator that can be adapted and used in many different parts of our oceans. Our vision is that wave energy should account for a considerable percentage of clean, renewable, energy worldwide. This unlimited source of energy would change our world drastically.

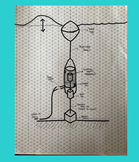
HOW WAVE CONVERTERS FUNCTION:

Wave energy generators utilize the power of the ocean's waves to create a source of reliable energy. We are working with a point absorber generator concept, which is any type of generator that uses the oscillating motion of the ocean's surface to generate electricity. Wave energy generators are used around the world, however, they are not a significant contributor to the total energy that we use on a global scale. Innovation in this field is important because wave energy is clean, ubiquitous, and renewable.

METHODS

PROJECT DESIGN AND PROTOTYPING

1) Floating buoy moves up and down with waves, in doing so pulls a strong cable.
2) This cable is affixed to a box which contains a coil and all electronic systems inside
3) A magnet fixed to the seabed by a rod extends up and through a stuff box and into the main pressurised electronics and coil room.
4) The movement of the box containing the coil oscillates over the magnet to induce a current - giving us useable electricity.



COPPER WIRE AND METAL INDUCTION

1. In order to create energy and electricity underwater, we will use coiled copper wire and a neodymium magnet to manipulate the magnetic field and induce a current into the coil.
2. Magnet will remain anchored
3. Copper wire will be fixed to the box, which will oscillate with the waves and around the fixed magnet.

ARDUINO SETUP

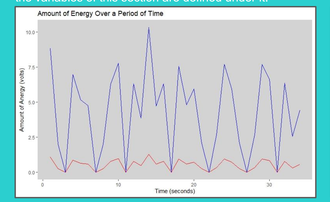
RESULTS

DATA

We took these design improvements and estimated the difference in amplitude, periodicity, and frequency, and plugged in these new numbers to our equation on the right in order to find the improved energy output. The equation on the right shows how the Pave (power output) is found. We used the rightmost equation to find Pave, the variables of this section are defined under it.

$$P_{ave} = \frac{E_0}{T} = \frac{1}{2}\mu A^2\omega^2\frac{\lambda}{T} = \frac{1}{2}\mu A^2\omega^2 v.$$

A= amplitude
μ= linear mass density
w= angular frequency
v= speed of wave
Pave= power output (watts)



Legend
Experimental output
Optimized output

Over the Fall 2019 semester, we constructed and tested an early, experimental design. This was a prototype that was functional, but much less efficient compared to our redesign from this semester. Last semester, we tested our prototype in a large fish tank and recorded the generated output from this design using Arduino board readers. In the Fall, we worked hard to bring our basic prototype to life; however, we were not satisfied with the amount of energy we generated. Our purpose this semester was to redesign the prototype by applying all that we had learned the previous semester through testing. Improvements included adding more space for oscillation, a longer coil, a stronger magnet, and an overall redesign to reduce drag. Although lab time was compromised during the 2020 Spring semester, we continued making these hypothetical improvements remotely. Instead of implementing them physically and testing the new prototype, we estimated the numerical improvements each value would add to the equation. From there, we plugged these values in and were able to calculate a theoretical output. The above graph shows how the optimized output is much more significant than the experimental output from last semester.

CONCLUSION

Based on the optimized results, one can see the critical thinking that went into this semester's improvements. We are all extremely proud of the efficiency we created this semester, especially considering the switch to remote learning. It was beneficial working with a large group from various different intellectual backgrounds as we all contributed different ideas for improvements on the prototype. Our graph is the clearest example of the impact of our work. The energy output skyrocketed from last semester as a result of the countless hours we all spent problem solving in Zoom conferences and on our own. This energy output is that of a small prototype as well, so if implemented in the ocean at full-size, the energy output would be quite useful. When the semester went online, we thought we were hopeless because of the physical nature of our project. However, as we started working from home, we overcame this obstacle and created something great amongst all the chaos by putting our heads together.

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