Name(s)

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Project Number

J1005

Project Title

Making Hydropower More Environmentally Friendly

Abstract

Objectives

The purpose of this project is to make hydroelectric generators more environmentally friendly and contribute to energy production. The U.S. gets 81% of its energy from fossil fuels, which contribute to air pollution and climate change. Hydropower is one way to become less reliant on burning fossil fuels for energy. However, dams currently harm downstream ecosystems, emit 403 metric tons of methane every year, and prevent 97% of fish from reaching upstream breeding grounds due to sedimentation, still water, stratification, and pond scum. Our hydropower design should be able to convert 75% of the potential energy into electricity, not harm the environment, and work the same or better when scaled up and under the force of water.

Methods

We constructed our prototype using wood for the fish ladder. Our turbine is made of 3D printed materials, Legos, a coil of copper wire, magnets, cardboard, and a plastic tube. Our generator works by converting rotary to linear motion. When the water wheel spins, another wheel (Wheel 2) that is connected to it by a shaft and located on land also spins. When Wheel 2 spins, a coil of wire moves back and forth over a tube with magnets inside. Since we couldn't test our design in water (cardboard and wood parts), we first tested the speed of just the water wheel under a faucet at various rates (15, 25, 47, 69, 200 mL/s). We then mimicked the revolutions per second (rps) generated by these rates (0.6, 1.4, 1.7, 2.1, 3.4 rps) by turning the water wheel with a drill. We recorded the voltage (V) and current in amps (I) produced from our generator using a voltmeter. Finally, we used the formula: P=I*V to find out the Energy (P in mJ/s) produced. We calculated Gravitational Potential Energy using the formula GPE = m*g*h, where m is the mass of water, g is gravity, and h is the height of the water above the wheel.

Results

The generator converted 17% of the potential energy at 15 mL/s of water, 33% at 25 mL/sec, 22% at 47 mL/s, 19% at 69 mL/sec, and 11% at 200 mL/s (average of 3 trials each). This means our device was on average 20.4% effective, far off from the modern day dams which are 90% effective.

Conclusions

Our project met most of our criteria, but fell short in generating electricity. On average, our generator was able to convert 20.4% of the available energy into electricity. This is not as efficient as modern day generators (90%). However, we can add gears to increase the number of times that the coil moves back and forth for one rotation of Wheel 2. If improved, our design can revolutionize the green energy industry and

Summary Statement

We created an environmentally friendly hydroelectric generator that will be able to match those that are used today.

Help Received

We designed, created, and tested our prototype ourselves, but obtained help form internet research on creating an electric generator.