

# Use of Conserved Rainwater to Propel a Vehicle

ENGR 101 – Fall 2018

Green energy is being used more each day. Wind turbines, wave turbines, hydroelectric dams, geothermal heating/cooling, biofuels, and solar panels are all being constantly improved to be more efficient and environmentally friendly. Roughly 7% of the world's energy is currently generated from these sources. However, there is another source of energy that has not been tapped – rain. The potential energy of 1 inch of rain fall on the average single-story house, if captured at the roof height provides approximately 120 kJ of energy, and even more if the rain can be captured in motion. Devices to convert and store this energy could be created, utilizing an untapped and readily available energy source. In addition, the water itself could be stored for a variety of everyday uses.

Your challenge is to design a scaled, proof-of-concept prototype for rain energy conversion. Your prototype device will propel a model vehicle as far as possible in a straight line by converting the potential energy of one-half liter of water at a height of 60 cm. All water must be contained within the device and a penalty will be assessed for any water spilled. At the competition,  $\frac{1}{2}$  liter of water will be provided by FEP Staff for final testing. The competition will be held during class time, but at a location to be determined. Note: the location may have a tile floor, carpeted floor, or even be outside.

## Device Requirements

- The only power source to be used is the  $\frac{1}{2}$  liter of water. If any stored energy is used in the device besides elevated water, disqualification of the design will be assessed.
- The device must be capable of storing at least 0.7 liters of water.
- The device must include at least one compound machine consisting of two or more simple machines that function simultaneously.
- The cost of the device, including the vehicle, must be under \$20. Receipts for all purchases should be included as an appendix of your technical report. Recyclable materials do not count towards the budget.
- Each team must provide their own vehicle which must be no larger than 12 inches long, 12 inches wide, and 6 inches tall. The car may not be used as a projectile.
- The vehicle must hold a PASCO Wireless force accelerometer parallel to the floor.
  - 7cm wide x 9.5cm long x 3cm tall (excluding hook), 3.3 oz (95 g)



Figure 1. Photograph of the PASCO Force/Acceleration Sensor used during testing.

## Contest Operation

The ½ liter of water will be poured into the car's water storage device, then the signal for the car to go will be given. Once the car is started, it may not be touched by any team member.

At the end of the run, the water will be measured to ensure no loss.

During the first run, the straight line distance traveled from the initial location of the front of the car to the final position will be recorded. The goal of the first run is to travel as far as possible in a straight line without losing any water. You will also record the time the car takes to travel 1 meter from the starting position.

During the second run, you will be given a target distance ranging from 5 to 8 meters from the starting line. The object of the second run is to add sufficient water so that the car lands on the specified target. The second run will begin immediately after all groups have completed the first run. The team may manually reset their device between runs.

## Research Topics

For the individual background research, each team member should select 1-2 of the following topics such that collectively all topics are researched within the group. Teams may decide they need to explore additional topics, but should research these at a minimum. Team members should cite at least 2 reliable sources per topic. The collection of individual research will be compiled to create the background section of the technical report.

- Green energy: What is it and why it's important
- Potential and kinetic energy
- Energy harvesting
- Examples of water as a power source
- Simple and compound machines
- Position, velocity, and acceleration equations and their relationship to one another

**Failure to submit the individual background research will result in expulsion from your team and a zero on Project 1.**

## Honors Requirements

Students enrolled in the honors section of this courses have additional project requirements.

For project 1, honors groups will dive deeper into the future work of their design. When working on a prototype it is important to consider the future uses of the larger model and scalability of the concept. While all students will consider the improvements and future uses of their design in the technical report, honors groups will elaborate on this topic following the prompts below.

- How would your device be scaled to collect rainwater from an average single-story house? Consider the scaling ratio for the water collected, the height the water is collected at, and the size of the device/vehicle.
- When scaling this device, are there any elements to your design that may need changed or could pose potential problems?
- What could an average homeowner do with your scaled device? What benefit does it provide to them? Why should someone purchase this device?
- What other applications are there for harvesting rainwater?

## Scoring and Penalties

The devices will be scored using the following formula:

$$S = (D_1 - 100W_1 - O_1) - (\Delta_2 + 100W_2)$$

where:

D = Distance car traveled (mm)

W = Water spilled over 25 mL (mL)

O = Distance off the centerline (mm)

$\Delta$  = Distance from the target (mm)

<sub>1</sub> = Data from first test

<sub>2</sub> = Data from second test

Devices from teams in your section of the course will be compared for the Model performance score using the relationship below. Which compares your team score,  $S_{team}$ , with the maximum score from the class,  $S_{class\ max}$ , and is multiplied by the scalar 25 to get the 25% of the project grade for Model Performance.

$$P = 25 \frac{S_{team}}{S_{class\ max}}$$

## Deliverables and Deadlines

All assignments should be submitted to eCampus by 11:59 on the due date unless otherwise specified.

\* Assignments with an asterisk are individual – each team member must submit those assignments. All others are to be submitted 1-per-team.

| DELIVERABLE                     | GRADING              | DUE DATE       |
|---------------------------------|----------------------|----------------|
| Team charter and Gantt chart    | Assignment grade     | 9/3, 11:59 PM  |
| *Individual background research | 10% of project grade | 9/4, 11:59 PM  |
| Model performance               | 25% of project grade | 9/12 in class  |
| Technical Report                | 35% of project grade | 9/23, 11:59 PM |
| PowerPoint Presentation         | 20% of project grade | 9/23, 11:59 PM |
| *Engineering Logbook            | Assignment grade     | 9/26 in class  |
| Peer Evaluations                | 10% of project grade | 9/30, 11:59 PM |

**Failure to submit the individual background research will result in expulsion from your team and a zero on Project 1.**