# The Water Cycle


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## PROBLEM STATEMENT

Our client, Danny Love from PGE (Portland General Electric), seeks to make the power grid more sustainable because clean and renewable energy is inaccessible to many.

## UNITED NATIONS SUSTAINABLE DEVELOPMENT GOAL #7

*Guarantee access to affordable, reliable, sustainable, and modern energy for all!*

- There is not a lot of rain in some areas
- Financial stress, or money problems
  - Solar panels are expensive
- Power outages cause problems for people
  - No access to electricity
  - Can't charge a phone or keep food cool

## OBJECTIVE

- **Primary:** Make a device that is affordable, reliable and sustainable for users who live in rainy areas like Portland and are in need of an alternative energy source.
- **Secondary:**
  - Create a cheap, durable waterwheel.
  - Educate others about renewable energy like hydropower.

## USER REQUIREMENTS

### Implicit

**Affordable**
- Affordable for low income households

**Reliable**
- Works well in gutters
- Waterproof

**Easy to install**
- No professional installation needed
- One-time downloadable code

**Easy to maintain**
- Only check monthly
- Minor adjustments as needed

### Explicit

**Affordable**
- Mass producible
- Materials are low-cost

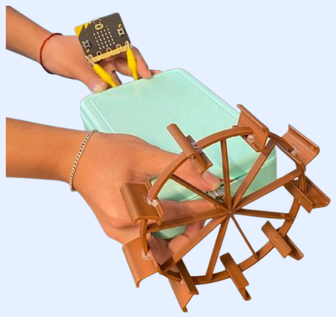
**Reliable**
- Works immediately after one assembly
- It works well in wet climates/areas

**Easy to install**
- Few parts for assembly
- Less assembly time

**Easy to maintain**
- Check only when water is available
- Clean gutters as needed

## CITATIONS


- D. Love, Interview, February 5th, 2025.
- Clean Energy Choices. (n.d) http://portlandgeneral.com/energy-choices
- Goal 7 | Department of Economic and Social Affairs. (n.d). http://sdgs.un.org/goals/goal7

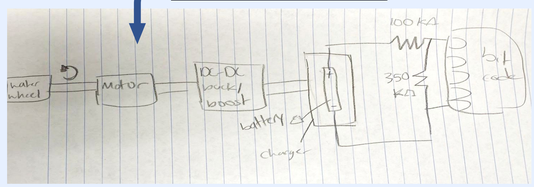



## DESCRIPTION

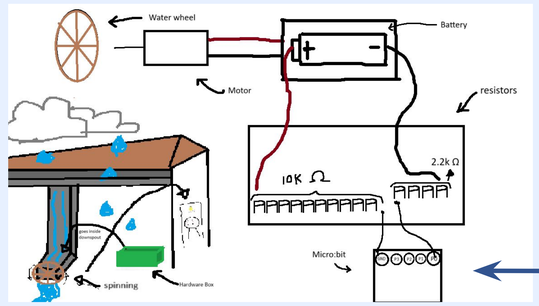
A water wheel that is attached to a motor which is connected to a battery. The battery is attached to resistors and a Micro-bit.

This device will be housed within a downspout of a home.

**INITIAL SKETCH**

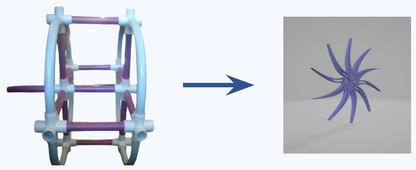



**CURRENT SKETCH**



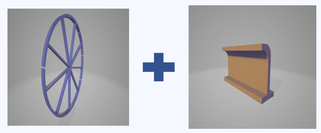

## BEFORE

1. Rapid prototyping with PVC pipes
2. Using **Fusion360** to make water wheel



## AFTER

1. Make it look like an actual wheel
2. Add paddles so it could collect water to push the wheel



## ENGINEERING DESIGN PROCESS

### 1 INTERVIEW

- Find a issue that we were connected to
- Talk to Danny Love for more insight

### 2 NAMING THE ISSUE

- How can we make clean and affordable energy accessible for low-income households?

### 3 VISION

- We want people to be educated about access to cleaner and more affordable energy sources.

### 4 EXPERIMENTING

- The creation of our water wheel was inspired by Portland's rainy climate and history of power outages.

### 5 ENGAGING FEEDBACK

- After our first prototype we added a Battery Management System (BMS) to monitor the state of the battery.

### 6 TELL THE WORLD

- Waterwheels should be used to their full potential!

## TESTING PROCESS

### Testing the Code

1. Use voltmeter to read battery's voltage
2. Use Micro-bit & code to read battery's voltage
3. Compare numbers for accuracy

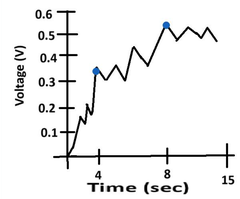
### Testing our Motor

1. Connect motor to water wheel
2. Connect motor wires to voltmeter
3. Run water onto water wheel and start timer
4. See if output of voltmeter is increasing and consistent as wheel spins

## DATA 1

| TRIAL | Battery's Voltage | Resistance (Independent Variable) | Micro:bit Output (Dependent Variable) |
|---|---|---|---|
| 1 | 4.02V | 450kΩ | 0.012V |
| 2 | 4.02V | 12.5kΩ | 4V |

## DATA 2




**Running under sink**

## RESULTS

### WHAT WORKED

- Our new model was able to spin more consistently, because of the paddles on it.
- Our calculations for resistors were more accurate after experimenting

### WHAT DIDN'T WORK

- The original prototype didn't catch enough water to make it spin.
- Our data was inconsistent at first because of wiring and code.

### HOW IT HELPS OUR USERS:

- Our users know how much energy they have to use
- Our users can rely on the wheel to not get jammed
  - Less to worry about, more to benefit from

## CONCLUSION

### NEXT STEPS

- **Generate more energy for use**
  - Improve the model for greater efficiency
  - Place multiple Water-Cycles around the house
- **Upgrade materials (i.e., stainless steel, plastic, iron)**
  - Utilize materials that make it more compact, waterproof, rustproof.
    - This makes it more sustainable and easier to maintain
- **Make readings more accurate on Micro:bit with code**
  - Allows users to have a better understanding of how much energy they can use

These steps are going to help our users by making more energy for them to work with when the power goes out, as our current design doesn't produce as much as it could.