Nature's Power

booklet

By SOLARE

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SOLAR ENERGY

1. What is Solar Energy?

a. Solar energy is like a gift from the sun that we've used for a very long time, even before knowing how to make fire! It is the energy we receive from the light and heat of the sun. Thanks to this energy, we also have other "friends" like wind, ocean waves, flowing water, and trees, all contributing to renewable energy. Solar energy is incredibly clean, doesn't harm the environment, and is available everywhere – just open the door, and you can feel the sunlight! This is why more countries around the world are using solar energy to generate electricity and help protect the Earth.

b. History of Solar Energy Use in Production

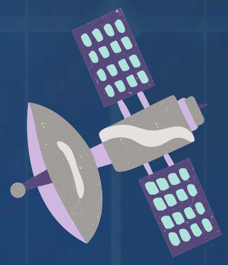
Solar energy has been utilized by humans for a very long time, dating back to ancient times around the 7th century BC. Back then, people used sunlight to start fires by directing the sun's rays onto shiny objects! Later, the Greeks and Romans even employed mirrors to concentrate sunlight and light torches for religious ceremonies.

In 1839, a young French scientist named Edmond Becquerel, at just 19 years old, discovered something remarkable: the photovoltaic effect! He found that sunlight could generate electricity when experimenting with metals in a special solution.

By 1954, three talented scientists—Daryl Chapin, Calvin Fuller, and Gerald Pearson—developed silicon solar cells, the first type of solar cell capable of absorbing and converting sunlight into electrical energy for everyday use.

Today, satellites and spacecraft orbiting the Earth are also "powered" by solar energy! Isn't that amazing?

2. How Does Solar Energy Work?



There are two main ways to use solar energy:

a. Passive Solar Energy:

Simply put, passive solar energy involves using sunlight and heat directly without any special equipment. This approach is cost-effective and easy to implement. Here are some fun examples of how we can utilize solar energy in everyday life:

1. South-facing house design: This helps your home receive more sunlight during the winter, reducing the need for heating.
2. Use of good insulation materials: Keeps your house warm in the winter and cool in the summer.
3. Planting shade trees: These trees help reduce the amount of heat absorbed into the house, keeping it from getting too hot.
4. Using skylights: Provides natural lighting for your home, helping you save on electricity for lighting.
5. Drying clothes outdoors: Use sunlight to dry clothes instead of an electric dryer, saving energy while leaving clothes with a pleasant fresh scent!

These methods are not only good for the environment but also help you save on costs and keep your home comfortable year-round.

b. Active Solar Energy:

When we want to convert sunlight into electricity or hot water, we can use some specialized equipment. This is a highly efficient approach, although the initial investment cost may be higher compared to other methods.

There are two main types of systems:

1. Solar Power System: Think of this as a trio of superheroes. First, the solar panel acts like a "light absorber," capturing sunlight and converting it into electricity. Then, the inverter works like magic, transforming the electricity from one form to another so it can be used by household appliances. Finally, the controller ensures that everything runs smoothly and safely.
2. Solar Water Heating System: This system functions like a "super-fast water heater." The thermal collector absorbs sunlight and transfers the heat to the water storage tank, providing hot water for bathing, washing, or cooking without the need for gas or electric heating.

These systems allow us to use solar energy in a smart and efficient way!

3. What is a Solar Panel System?

a. Definition

A solar panel (Solar Panel) consists of multiple photovoltaic cells (Solar Cells), which convert light energy into electrical energy. When in operation, the current intensity, voltage, or resistance of the solar panel changes depending on the amount of sunlight it receives.

When you want to use solar energy to generate electricity for your home, there are some important "friends" you need to know about:

- Solar Panels: These are the "sunlight absorbers" that help convert sunlight into electricity. There are two common types of solar panels:
    - Monocrystalline Panels: These are like shiny gems, highly efficient but can be more expensive.
    - Polycrystalline Panels: Similar to a cookie made of many small pieces, they are more affordable but slightly less efficient.

The number of panels you need and their arrangement depends on various factors like roof space, climate, and the amount of sunlight in your area.

- Inverter: This acts as the "magic" that converts the electricity from the solar panels into a form that can be used in your home. There are three types of inverters:
    - String Inverter: The most affordable, but efficiency can drop if a panel is shaded.
    - Micro Inverter: More expensive but allows each panel to perform well, even in shaded conditions.
    - Power Optimizer Inverter: A balanced option between cost and efficiency, ensuring the panels work at their best.

b. Other Components:

- Mounting System: These are the "supports" that hold the panels in place without being attached directly to the roof. They help position the panels at the right angle to maximize sunlight absorption.
- Monitoring System: Like a "digital assistant," it tracks the amount of electricity generated and alerts you if any issues arise.
- Storage System: This acts like a "battery warehouse," storing energy for later use or overnight. In some areas, you can sell excess electricity back to the power company.

With these "friends," solar energy will help you have clean and cost-effective electricity!

c. How It Operates

A solar panel functions like an "electricity generator" from sunlight, and it accomplishes this in three steps:

- Light Absorption: When sunlight hits the panel, it's like "super-energy rays" that cause "electrons" and "holes" (positively charged spaces) to appear inside the panel.
- Voltage Creation: These electrons and holes are separated by a special "barrier" within the panel, creating a type of "push energy" known as voltage.
- Electricity Generation: Finally, the solar panel connects to an external "circuit," allowing the current to flow out and be stored or used for your devices.

And that's how solar panels convert sunlight into electricity through these three fascinating steps!

4.Benefits and Limitations of Solar Panels and Solutions

Benefits

- Renewable and Sustainable Energy: Solar energy is a renewable source that does not cause environmental pollution, helping to reduce greenhouse gas emissions and protect the environment.
- Reduced Electricity Costs: By installing a solar panel system, users can save on monthly electricity expenses. Additionally, some areas have policies that allow users to sell excess electricity, providing an extra source of income.
- Energy Independence: Solar panel systems reduce reliance on the national power grid, which is especially useful in remote areas or places with frequent power outages.
- Low Maintenance: Solar panels have a long lifespan and require minimal maintenance. Periodic cleaning is sufficient to ensure optimal performance.

Limitations

- High Initial Investment Cost: The installation cost of a solar panel system is still high, even though prices have decreased in recent years.
- Dependence on Weather Conditions: The efficiency of solar panels depends on the amount of sunlight, which can be reduced on cloudy or rainy days.
- Installation Space Requirement: Installing a solar panel system with sufficient capacity requires a large installation area, which can be challenging for homes with limited roof space.
- Environmental Impact from Production: The production process of solar panels consumes significant energy and can cause pollution if not managed properly.

Solutions

- Government Support Policies: Incentive policies such as subsidies, tax reductions, and government grant programs can help lower the initial investment costs.
- Energy Storage Technology: Use energy storage systems like batteries to store excess power generated during the day for use at night or on cloudy days.
- Performance Optimization: Use high-efficiency solar panels and solar tracking systems to enhance energy capture.
- Recycling and Waste Management: Develop technologies for recycling solar panels and managing waste to minimize the environmental impact of production and disposal.
- Education and Awareness: Increase education and community awareness about the benefits of solar energy and how to optimize the use of these systems.

5. DIY Experiment

5.1. Solar Oven

Functioning

A solar oven directs sunlight into the cooking space, where the heat is concentrated and retained. The process may vary depending on the design, but all solar ovens require materials with high reflectivity (such as mirrors, polished metal, or aluminum foil) placed at specific angles to collect light. Solar ovens need to retain heat well for stable cooking, often achieved by separating the external air from the air inside the oven or cooking pot. This can be done through a process similar to the greenhouse effect, trapping heat under a transparent lid. However, this may cause heat loss, and solar ovens tend to be less efficient on cloudy days. Therefore, using a hybrid oven (combining solar and electric power) is the best choice.

Materials

- Cardboard box (pizza box)
- Aluminum foil
- Black construction paper (for heat absorption)
- Plastic wrap
- Glue or tape
- Insulation material (e.g., newspaper or cotton)
- Ruler
- Scissors
- Thermometer (optional)

Step by step

Use scissors to cut the top of the pizza box. Cut along three sides, leaving about 2.5 cm (1 inch) between the edges of the lid and the box. Fold the lid up so that it stands when the box is closed.

- Cover the inside of the lid with aluminum foil so that it reflects sunlight. To do this, wrap the foil tightly around the lid, then tape it to the back or outer surface of the lid.

This will help direct more sunlight into the oven and increase its heat efficiency.

- Use transparent plastic wrap to create an airtight "window" that allows sunlight to enter the box. To do this, open the box and tape a layer of plastic wrap over the opening you created when cutting the top of the lid. Leave about 2.5 cm (1 inch) of plastic overlap around the edges, and securely tape down each side to seal in the air.

- This step ensures that heat is trapped inside the box, improving the oven's efficiency.

- Line the bottom of the box with black construction paper (as black absorbs all known wavelengths of light and converts them into heat). The black surface will be where you place the food for cooking. The amount of paper needed will depend on the size of the pizza box you are using for the solar oven.

- This step helps maximize heat absorption to cook the food more efficiently.

- To insulate the oven and retain more heat, roll up sheets of newspaper and place them at the bottom of the box. Tape them down to form a border around the cooking area.
- Make sure to roll the newspaper in a way that allows the lid to close while maintaining the seal inside the box so that air cannot escape.
- This step helps to keep the heat inside, enhancing the efficiency of the solar oven.

- Take the solar oven outside to a sunny spot (ideally between 11 a.m. and 3 p.m.) and adjust the lid until the sunlight is reflected as much as possible from the aluminum foil onto the plastic-covered window.
- This step maximizes the amount of sunlight entering the oven, helping to heat up the cooking area more effectively.

5.2. Mini Solar Panel

Preparation

- Solar cells to capture sunlight.
- Frame to secure the solar panel, including the back cover, base frame, and frame border strips.
- Soldering wires.
- Covering sheet for the frame, usually made of tempered glass.
- Tools such as pliers.
- Multimeter (electrical meter).
- Frame.
- Backing material (mica or aluminum)

Step by step

Step 1: Assemble the Frame for the Solar Panel

- First, set up the back cover and base frame for the solar panel. The frame size will be determined by the number of cells in each panel. Based on the number of solar cells you plan to use, create a frame border with suitable dimensions.
- Use scissors to cut the materials to the desired size, then use screws to attach the frame cover to the back cover. At this point, coat the back cover and base frame with three layers of UV-resistant paint. Allow the paint to dry completely and ensure that the base frame fits snugly with the back cover.

Step 2: Attach the Solar Cells

- Cut the soldering wire to an appropriate length and proceed to attach each solar cell one by one. First, use a soldering pen to wet the lines on the front of the cell with Flux solution. Then, take a piece of soldering wire and gently press the soldering iron along the wire to bond it to the cell using the solder.
- Next, press the soldering wire down along the entire line on the center of the cell, ensuring that the solder melts evenly across the line so that the wire adheres securely to the solar cell.

Step 3: Connect the Soldered Cells into a Series

At this step, arrange and connect the solar cells into a series. If the panel is set up in a structure of 4 rows vertically and 9 rows horizontally, you will only need to connect 9 cells in one series.
Solder the excess wire from the front of cell 1 to the back of cell 2. Continue in this manner to create the next series of cells.

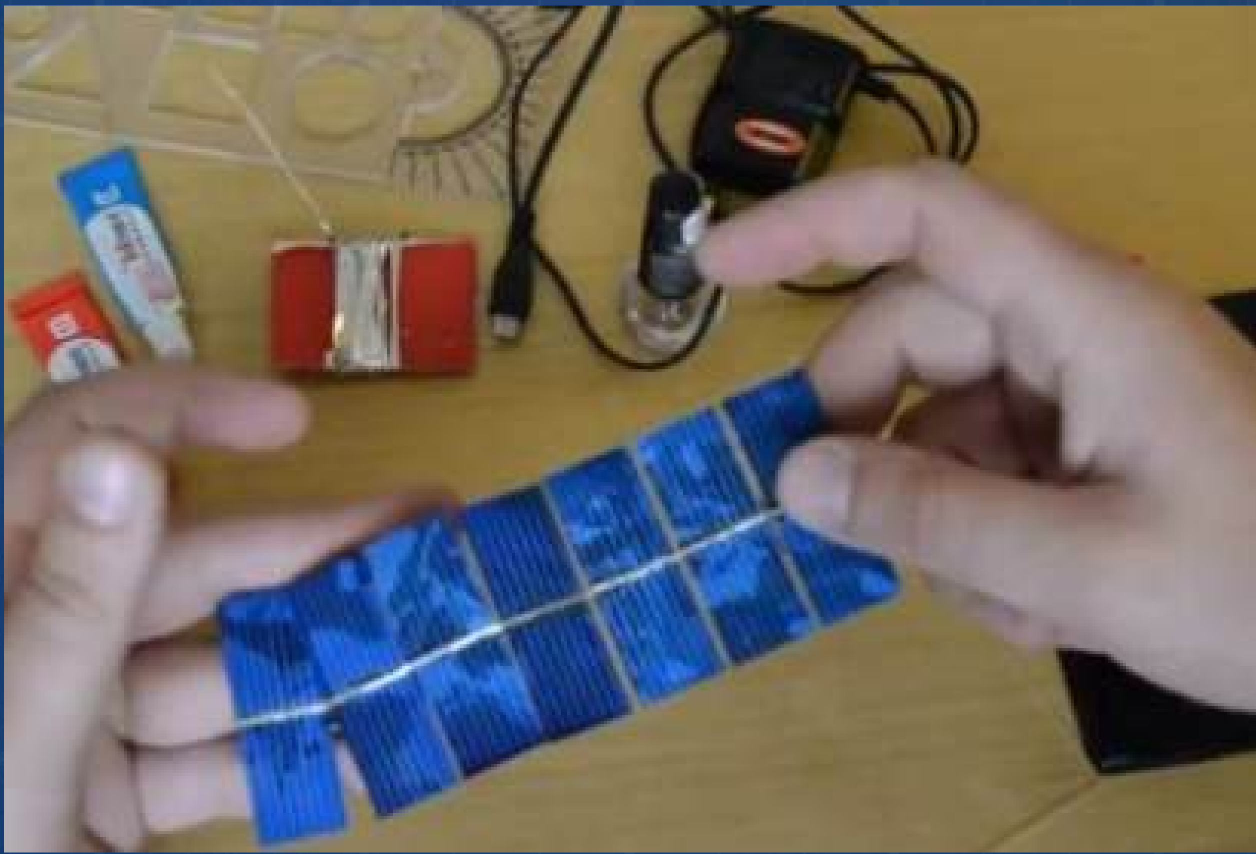
Step 4: Place the Series of Cells onto the Solar Panel Base Frame

After securing the series of cells, attach them to the base frame using silicon adhesive. Depending on the layout structure of the panel, position the solar cells appropriately.
However, the negative wires from the front of series 1 must be connected to the positive wires from the end of series 2 using thicker soldering wire.

Step 5: Attach the Base Frame to the Back Cover and Install the Protective Cover for the Solar Panel

Fit the base frame onto the back cover and fasten it securely with screws. For the negative and positive cells, connect the two separate wires on each cell with copper wire, ensuring that the wires are long enough to reach the external energy collection devices.
You should also install a blocking diode on the positive lead to prevent energy from discharging at night. Test the solar panel again to ensure it is functioning properly, and then install the tempered glass cover on top of the panel, securing it with screws.

Step 6: Test the Functionality of the Solar Panel



Move the newly assembled solar panel to an area with direct sunlight. Connect the positive terminal of the multimeter to the positive terminal of the solar panel and the negative terminal of the multimeter to the negative terminal of the solar panel.

First, measure the voltage output. If your solar panel consists of 4 rows vertically and 9 rows horizontally (36 cells), the voltage should be approximately 18V. Next, check the current, which for this panel setup should be around 3.5A.

5.3. Solar Panel Toy Car

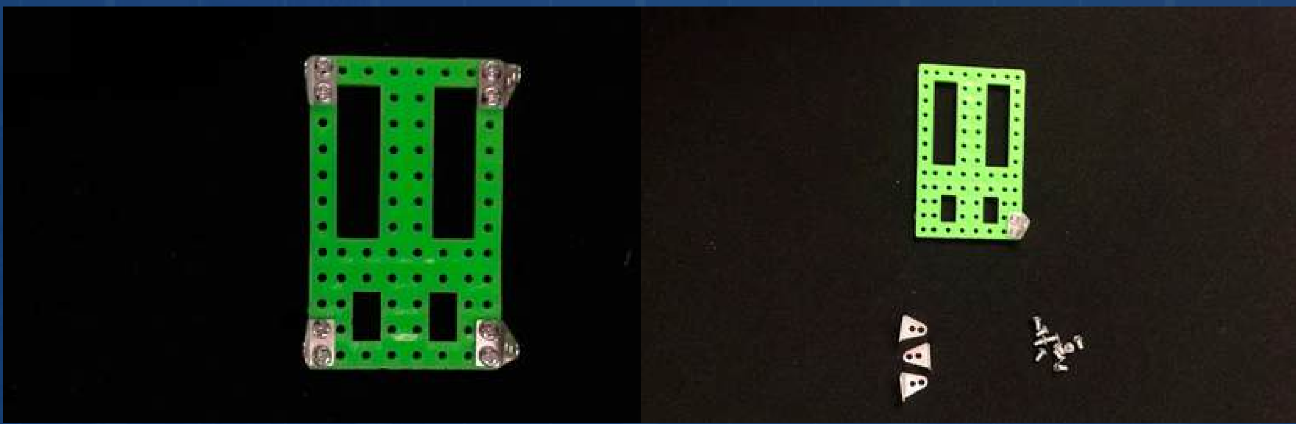
Preparation

- 3.5 mm Phillips-Head screwdriver
- Green board base
- 4 iron stands
- 10 3.5 mm screws
- 2,6 cm iron shafts
- plastic gear
- 8-1 small gear
- 3 yellow shaft sleeves
- 4 glue wheels
- K30 motor
- Glue foam
- Iron motor holder

Step by step

Step 1: Begin Assembling

- Use the 3.5 cm screws to attach the 4 iron stands to the green board. Each iron stand will be attached to the corners of the green board with two screws.

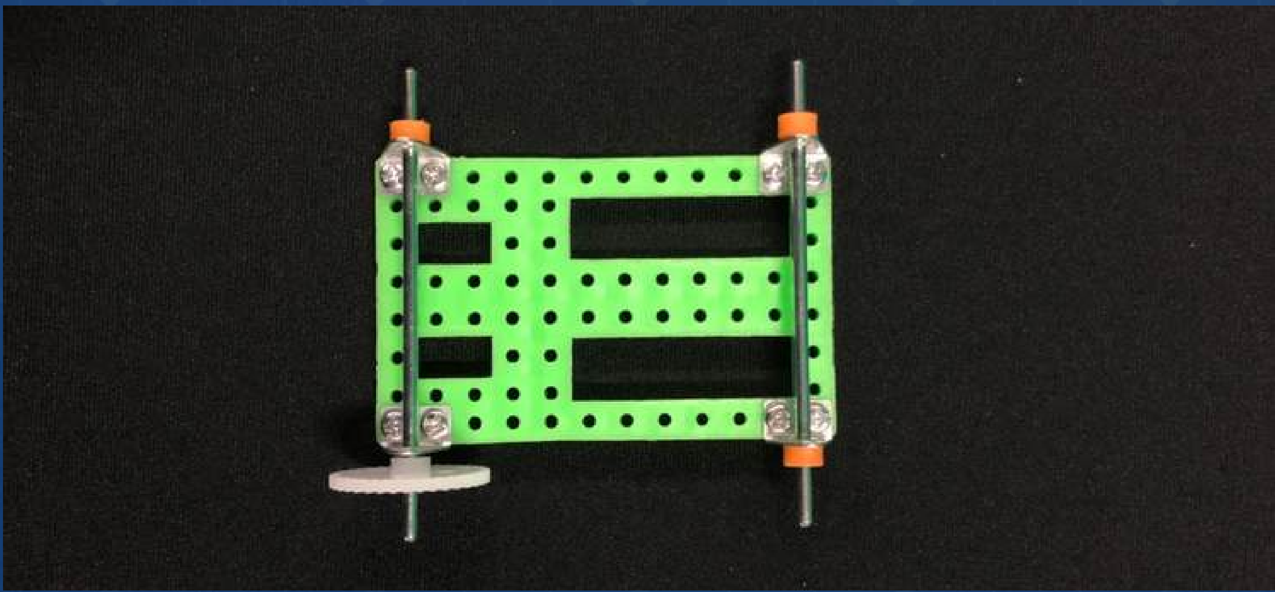


Step 2: Iron Shafts

- Slide the plastic gear a half inch down the iron shaft. Make sure to put the convex part towards the inside. Take a yellow shaft sleeve and do the same on the other iron shaft.

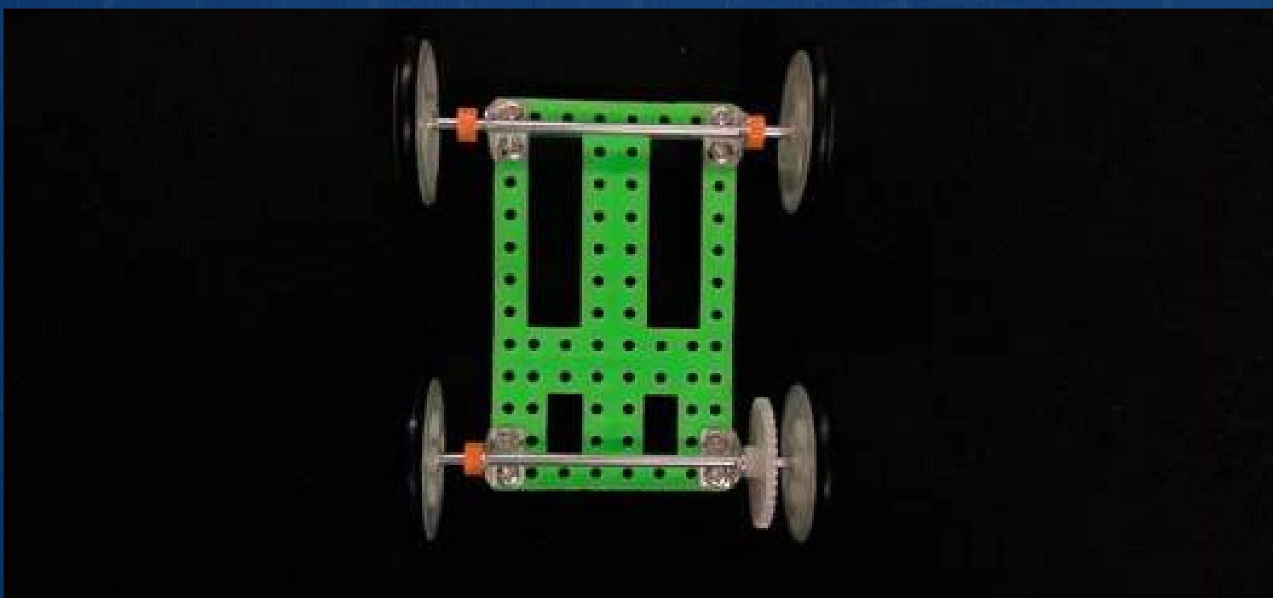
Step 3: Installing the Iron Shafts

- Put the iron shafts through the bottom holes of the iron stands. Attach the shaft sleeves to the remaining ends of the iron shafts. Make sure the shaft sleeve isn't too tight. This ensures that the car will be able to move.



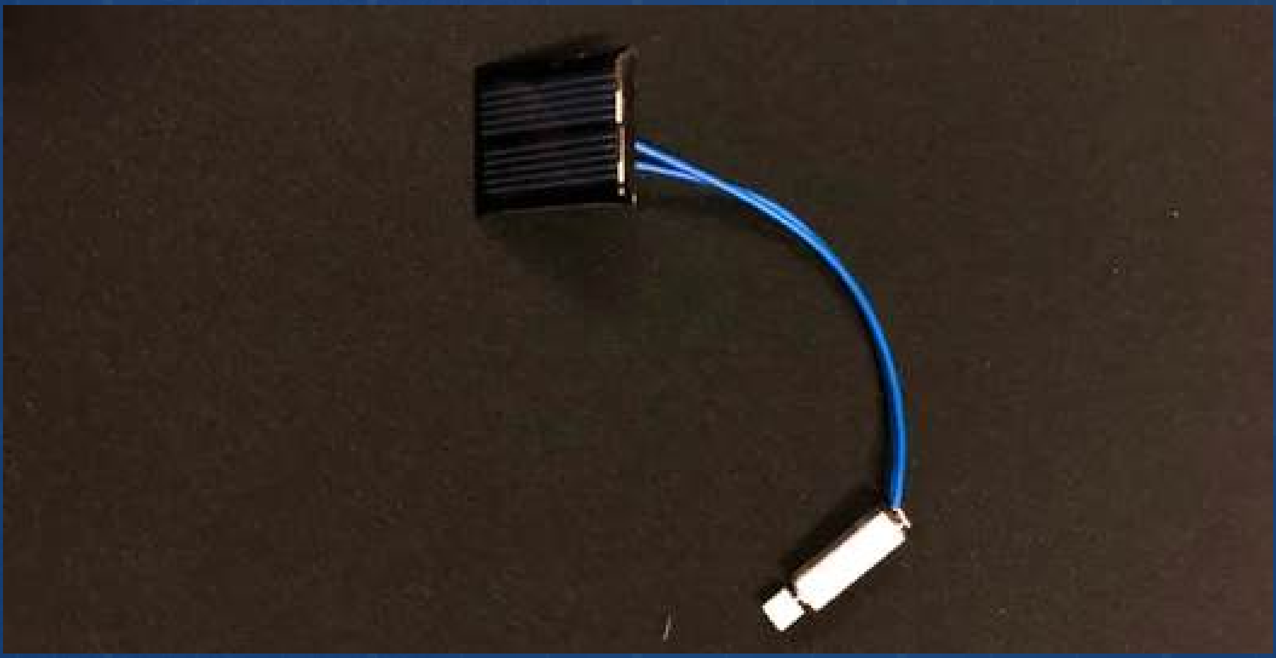
Step 4: Attach the Wheels

- Attach the four wheels to each end of the iron shafts.



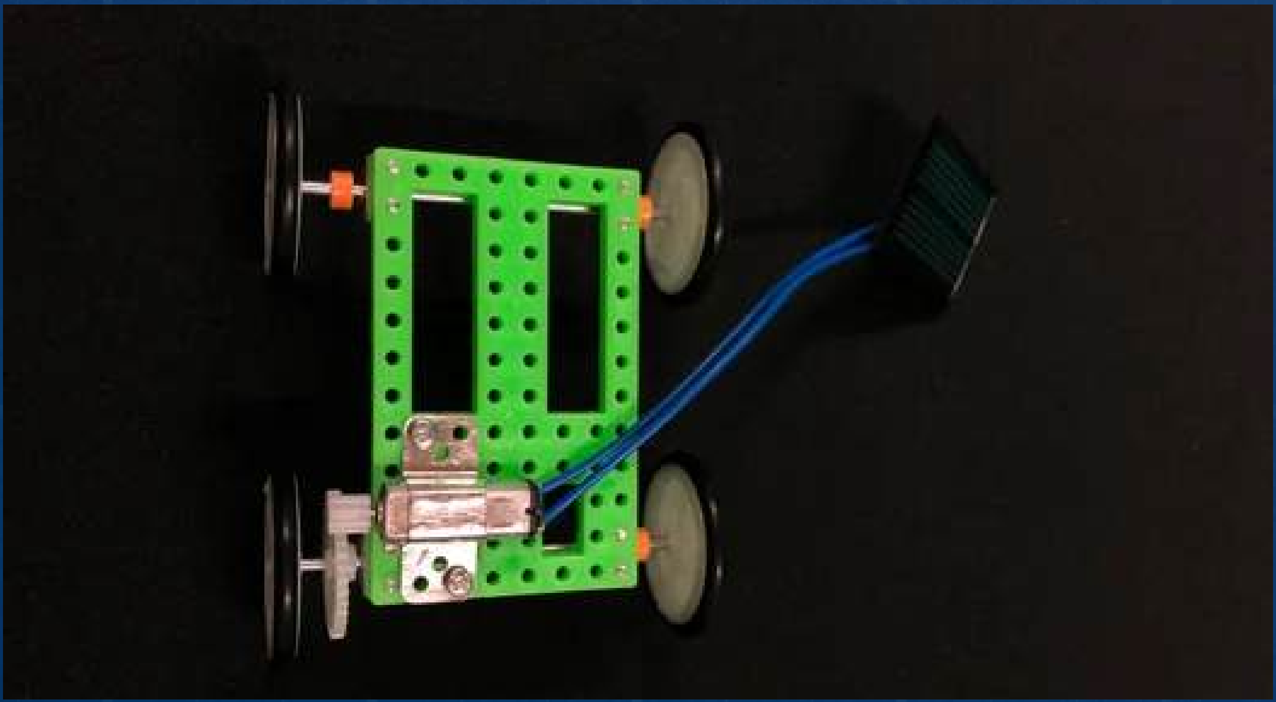
Step 5: Begin Assembling the Motor

- Install the 8-1 small gear on to the end of the K30 motor.



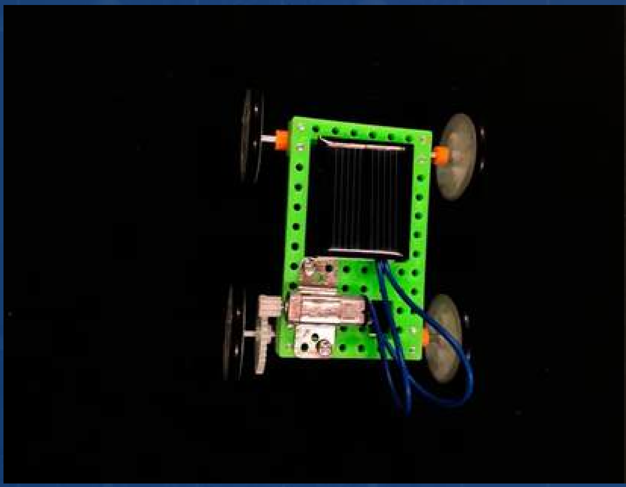
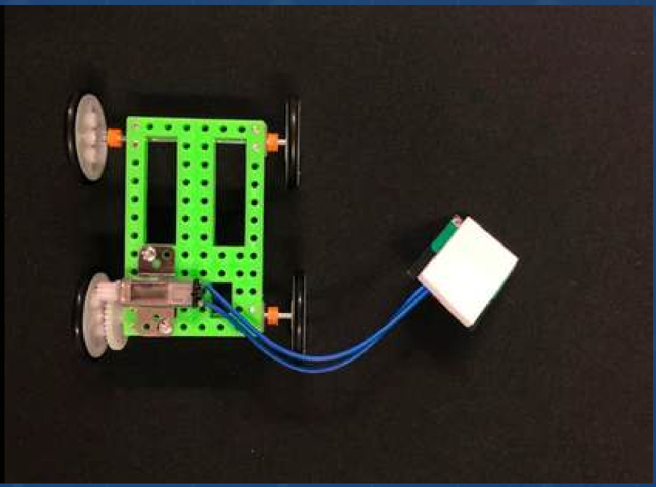
Step 6: Attaching the Motor

- Take your iron motor holder and attach the motor to the board with two 3.5 mm screws, according to the image. Make sure it is easy to rotate the gear.



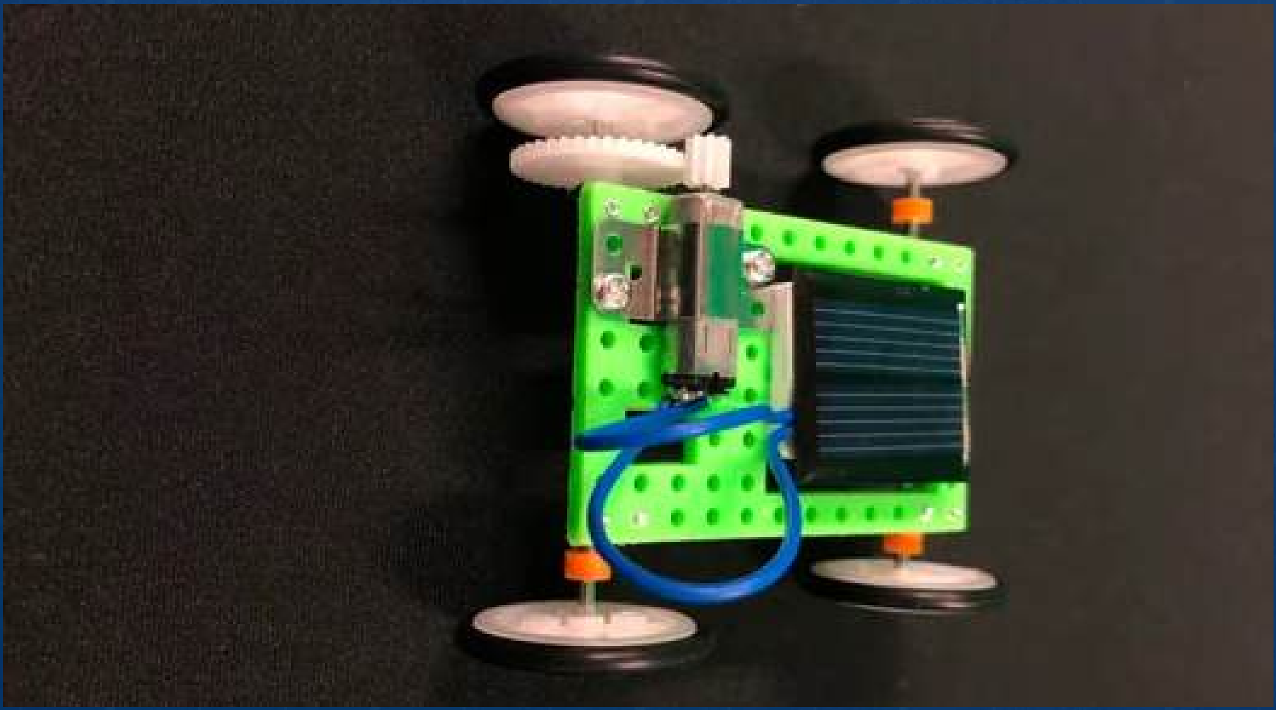
Step 7: Attaching the Solar Panel

- Paste one side of the glue foam to the back side of the solar panel. Stick the panel to the green board.

Step 8: Finished Product

- Take your car to a place with direct sunlight and test it out. If there is enough sunlight, the car should move fast. It will stop once it is no longer in sunlight



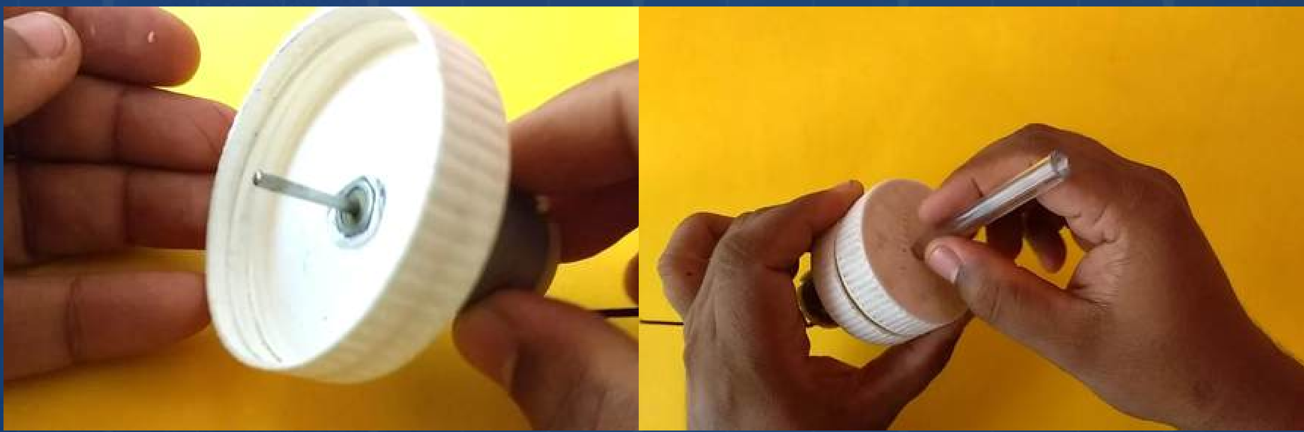
5.4. Solar Powered Motor Water Pump

Preparation

- Bottle cap
- Tubes or pen
- Mini motor (12v or 9v)
- Glue gun
- Solar panel
- 7809 voltage regulator IC if needed
- Soldering iron
- Cutting knife

Step by step

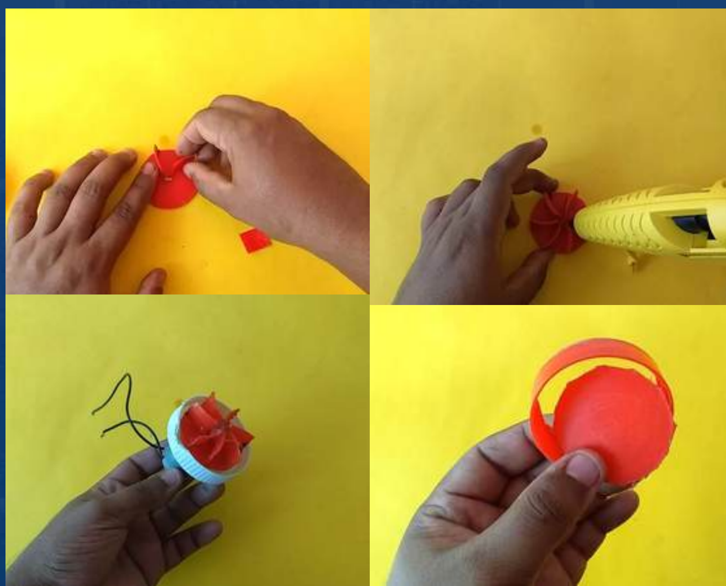
Step 1:



- we need 3 bottle caps with medium size. 2 caps of same size is necessary. Cut the bottle caps at the center so that we can insert motor shaft through it.
- put another hole in the second cap to insert suction tube.

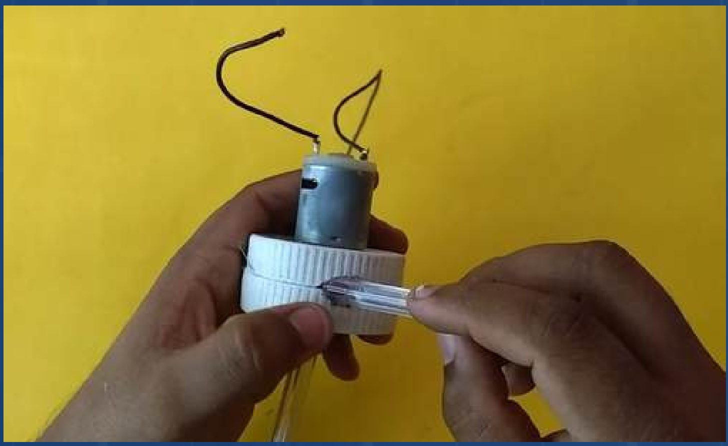
Step 2: Impeller Design

- The most important part of centrifugal pump is impeller design. Cut a round part from one of the caps and create an impeller as shown in the figure using glue gun or any type of adhesive. watch the video to understand it.



- After creating impeller, place it inside other bottle cap in which motor is connected. place the impeller in the motor shaft and check if it is properly rotating.

Step 3: Finalizing the Motor

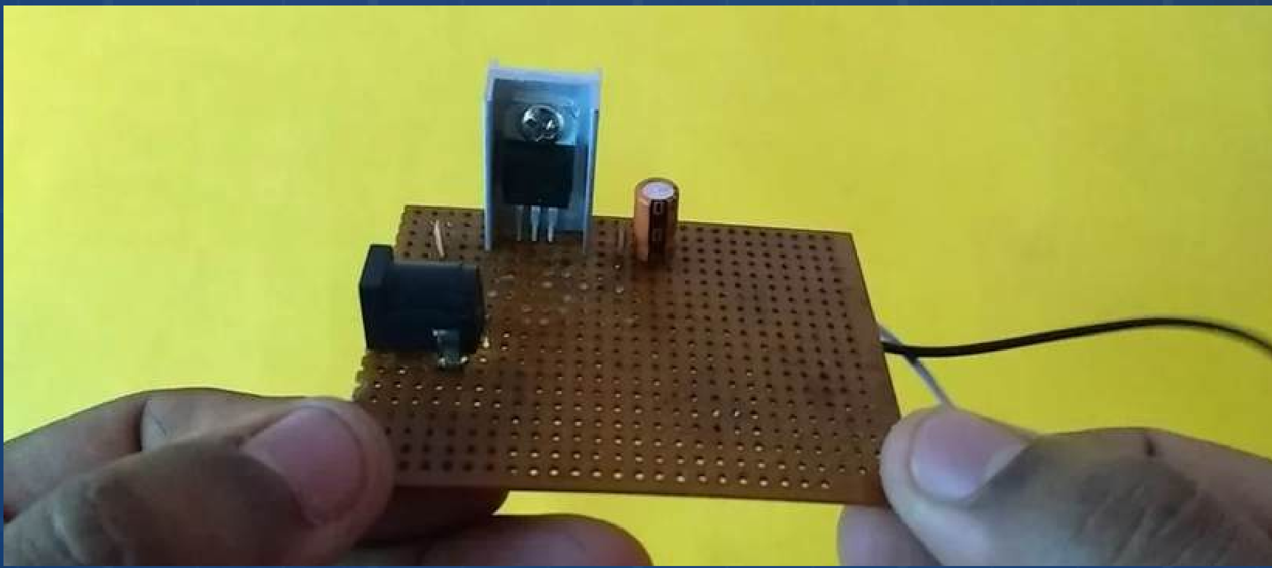


- Now close the motor pump's housing using the third bottle cap. Make sure that you have put a hole in the third cap and connected a tube at its center.

- Put a hole in the side of the impeller box(see the figure or video) and place an outlet tube on that hole.

- Connect the suction tube (you can cut it from a pen- i used a pen) to a large bottle as shown in the figure. Make sure to properly connect suction tube to the bottle without any leakage so that no air get into the system
- Now fill the bottle with water and it will fill the impeller box in the motor also.
- Initially I tried to pump water without filling pump housing with water but it was not worked as it will not produce enough suction or low pressure at the center of impeller. so i connect the motor like in the last image, that is suction tube is connected to the bottle and fill it with water. when water level in the bottle increases it will fill the pump housing too (impeller box), so a column of water connected from the bottle to pumps housing.

Step 4: Attaching the Solar Panel



- I have used a 7809 voltage regulator (easy to make-circuit available in internet). I have used a 12v solar panel, even though it is a 12v panel, it will produce a range of voltage from 12v to 24v depending upon the intensity of sunlight so i used a voltage regulator(you can connect the motor to battery too)

Step 5: Test

- Use a switch to control the motor. Now it is time to test the motor. If you have properly set the things above, it should work. Hope everyone makes it. Have fun. Watch the video so that you can properly understand it.

II. Wind Energy

1. What is Wind Energy?

a. Concept

Wind energy is the process of converting the kinetic energy generated by wind into mechanical power or electricity. This is accomplished through the use of wind turbines, which capture the wind's motion to drive a generator that produces electrical energy. Wind energy is a renewable and clean source of energy, as it relies on natural atmospheric movements and does not emit greenhouse gases during generation.

b. History of its Exploitation in Production

Humans have utilized wind energy for thousands of years. The earliest known windmills were used in Persia around 500-900 AD for grinding grain and pumping water. By the Middle Ages, windmills had spread to Europe, where they were used primarily for milling grain. In the 19th century, windmills became popular in the United States for water pumping on farms. Modern wind energy technology began to develop in the 1970s with the oil crisis, which spurred interest in alternative energy sources. Today, wind farms are widespread, contributing significantly to the world's electricity supply.

2. How Does Wind Energy Work?

a. Onshore Wind Energy

This refers to wind turbines located on land. Onshore wind energy is easier to install and more accessible for maintenance. However, it can be affected by landscape and turbulence, which may reduce efficiency in some regions.

b. Offshore Wind Energy

Offshore wind energy involves turbines installed in bodies of water, typically in oceans. These locations tend to have more consistent and stronger winds, allowing for higher electricity generation. The challenges include higher installation and maintenance costs due to harsh maritime conditions.

3. What is a Wind Turbine System?

a. Definition

A wind turbine system consists of a rotor, nacelle (housing for the generator and gearbox), tower, and various electrical components. The rotor blades capture the wind's energy and cause the rotor to spin, converting kinetic energy into mechanical energy, which the generator then transforms into electrical energy.

b. Main Components

- Rotor Blades: Capture the wind and cause the rotor to spin.
- Nacelle: Houses key components like the gearbox and generator.
- Tower: Elevates the turbine to take advantage of higher wind speeds at greater heights.

Generator: Converts mechanical energy from the rotor into electrical energy.

c. How it Works

The rotor blades rotate when exposed to wind, turning the rotor shaft connected to a generator. The generator converts the mechanical rotation into electrical power, which is then transmitted through cables to the power grid or directly used in nearby facilities.

4. Benefits and Limitations of Wind Turbines and Solutions

- Benefits:
  - Clean and renewable energy source.
  - Low operational costs once installed.
  - Can be used on agricultural land without significantly disrupting farming.

- Limitations:
  - Intermittency of wind can affect consistency of power generation.
  - Can be considered unsightly and generate noise.
  - Installation and maintenance can be expensive, especially offshore

- Solutions:
  - Use of energy storage systems to store excess power for use during low-wind periods.
  - Improved turbine designs to minimize noise and visual impact.
  - Government incentives and subsidies to lower installation costs.

5. DIY Experiments

5.1. Wind Turbine

- Materials
  - One-liter plastic bottle: This will form the base (tower) of your wind turbine.
  - Smaller plastic bottle: This will serve as the nacelle (housing for the turbine's axle).
  - Marbles, rocks, or heavy objects: These will weigh down the base and keep it stable.
  - Scissors: For cutting the bottles.
  - Drill and quarter-inch drill bit: To create holes for the axle.
  - Drinking straws: To construct the turbine's rotor and blades.
  - Paper: To form the blades.
  - Tape: To secure components.
  - Paper clips: For making the axle and other parts.
  - Glue: To attach components securely.
  - String: To test the turbine's lifting power.
  - Small weights: Like washers or additional paper clips, to hang on the turbine for testing.

Step by step

Step 1: Building the Tower

The first step is constructing a stable base for your wind turbine, which we will create using a one-liter plastic bottle.

- Cut the top off the bottle: Begin by cutting off the neck of the bottle using scissors. This will serve as the base of the wind turbine, providing a sturdy foundation.
- Add weight to the base: Fill the bottom of the bottle with marbles, rocks, or other heavy objects. This step is crucial because it will prevent your turbine from toppling over when exposed to wind. You need a strong, stable base to ensure smooth turbine operation.
- Prepare the nacelle connection: Use scissors to cut two pieces from the top of the bottle. These cuts will allow you to attach a smaller plastic bottle horizontally on top, which will act as the nacelle that holds the axle and blades.

Step 2: Preparing the Nacelle and Axle

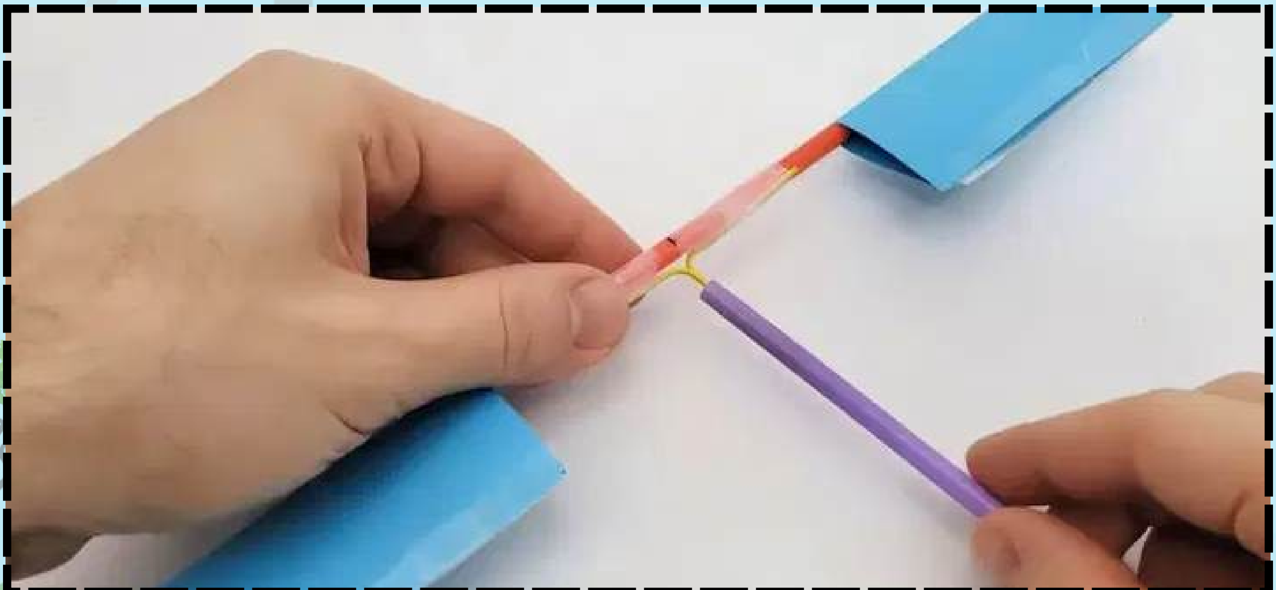
The nacelle houses the axle and rotor blades, allowing them to spin freely.

- Drill holes for the axle: Using a quarter-inch drill bit, carefully drill a hole in the cap and bottom of the smaller bottle (the nacelle). Make sure these holes are slightly larger than the diameter of the drinking straws that will serve as the axle, ensuring smooth rotation.
- Ensure a free-spinning axle: After drilling the holes, insert a straw through them to check that it can spin freely. If the straw doesn't rotate smoothly, widen the holes slightly using the drill bit.

Step 3: Crafting the Turbine Blades

The blades are one of the most critical components of your wind turbine. They capture the wind's energy, which powers the rotor and axle.

- Make the blade templates: Cut two rectangles from a sheet of paper, each measuring approximately 8 by 10 centimeters. This basic design is easy to make, but you can experiment with different shapes and sizes for better performance.
- Shape the blades: Without creasing them, fold each piece of paper in half lengthwise and tape the edges together to form a teardrop shape when viewed from the side. The teardrop design helps the blades catch more wind, increasing efficiency.
- Attach the blades to the rotor: Pinch the end of one straw and press it into another to create a longer straw. Mark the straw at 10 cm from each end. Apply glue from the end of the straw up to this line, and attach one blade to the straw with the rounded side facing up. Hold it in place until the glue dries. Repeat for the second blade on the opposite side.



Step 4: Assembling the Rotor and Axle

Now, you'll complete the assembly of the rotor and axle system, which is crucial for the turbine's ability to spin and generate mechanical movement

- Prepare the axle: Straighten a paper clip and bend it into a T-shape using needle-nose pliers. Attach this T-shaped paper clip to the center of your rotor (the two connected straws) with tape. This setup will help balance the blades and keep the axle aligned.
- Secure the axle: Take another straw and slide it over the T-shaped paper clip to form the axle. Make sure it fits tightly and spins without friction. Tape the straw to the rotor securely.
- Curve the blades: For optimal performance, the blades need to be curved. Wrap each blade tightly around the straw and hold it for about one minute. This will give them a natural curve that helps them capture wind more effectively. Once you've curved both blades, let them uncurl.

Step 5: Final Assembly

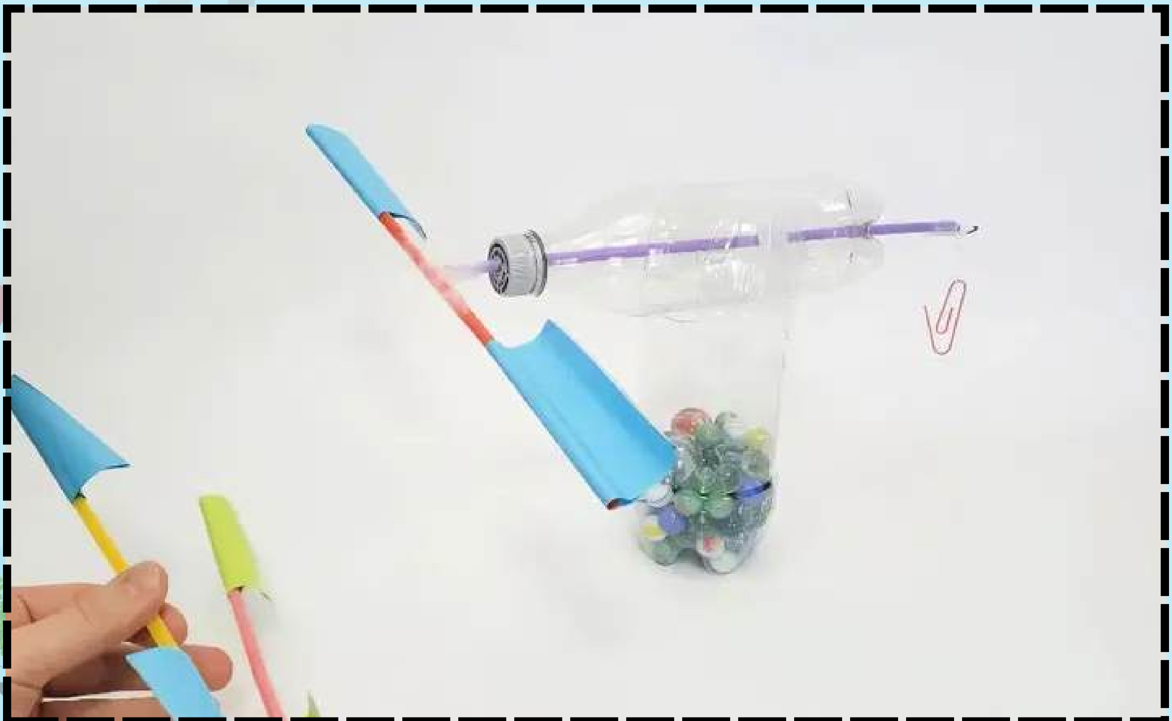
Now that you have all the components ready, it's time to put everything together and prepare for testing.

- Assemble the turbine: Take the smaller bottle (nacelle) and place it horizontally on top of the larger bottle (tower). Thread the axle (with the blades attached) through the holes in the smaller bottle.
- Connect the axle halves: Pinch the end of one straw and insert it into the other straw to join the two halves of the axle. Ensure the straws fit snugly but don't press too hard, as this could bend or damage them. Spin the rotor by hand to check that the entire assembly can rotate smoothly.
- Secure the nacelle: If necessary, use tape to attach the nacelle securely to the tower. You want to ensure the smaller bottle doesn't wobble when the rotor spins.

Step 6: Testing Your Wind Turbine

Your wind turbine is now fully assembled and ready for testing. Follow these steps to evaluate its performance:

- Use a fan: Place a small tabletop fan a short distance from your wind turbine. Turn the fan on to its lowest speed and observe whether the blades start spinning. If the turbine doesn't rotate, move the fan closer or increase the speed.
- Experiment with weights: Tie a piece of string slightly longer than the tower height to the paper clip attached to the axle. Attach small weights, such as washers or additional paper clips, to the string. As the turbine spins, observe how much weight the turbine can lift. This experiment simulates the mechanical work that a real wind turbine performs when generating electricity.
- Reset and test different conditions: To reset the string, simply turn off the fan and unwind the axle by hand. You can also experiment with different variables, such as changing the blade size, shape, or fan speed, and measure how each factor affects the turbine's performance.



5.2. Wind-Powered Car

- Preparation
    - Large wood craft sticks with 5 holes (4.8mm holes)
    - 5V DC motor (2mm shaft)
    - Motor mount
    - Thumbscrew and hardware or Medium 1-1/4" Bolts
    - Plastic propeller *Choose from 2, 3, or 4 Vane
    - L-shaped Just Clip It connectors or here
    - 1-inch axles (2mm diameter)
    - Wheels (2mm diameter)
    - AA batteries
    - AA 2 cell holder with switch & wires
    - Double-sided tape
    - Balloon
    - Paper clip

Step by step

Step 1: Prepare the Base

- Choose 3 large wood craft sticks. (Color is optional. One for the base, and two for the left & right)
- Attach the motor mount to the base by inserting the large threaded screw through the hole of the plastic mount.
- Check that the motor mount is sitting on the top side. The bottom side of the base wood stick will have the large screw ready for the thumbscrew to be attached.
- Twist the plastic thumb nut onto the screw.
- Assemble the large wood craft sticks in a "U" shape using four (4) L-shaped Just Clip It plastic connectors.

*You might need an adult's help to attach the sticks securely.

Step 2: Attach the Wheels and Axles

- Using the 4.8mm holes of the left & right structure of the car, insert the 1 inch axle through the second hole from the top.
- Using your index and thumb finger, gently press fit both wheels by aligning the 3mm center with the axle.

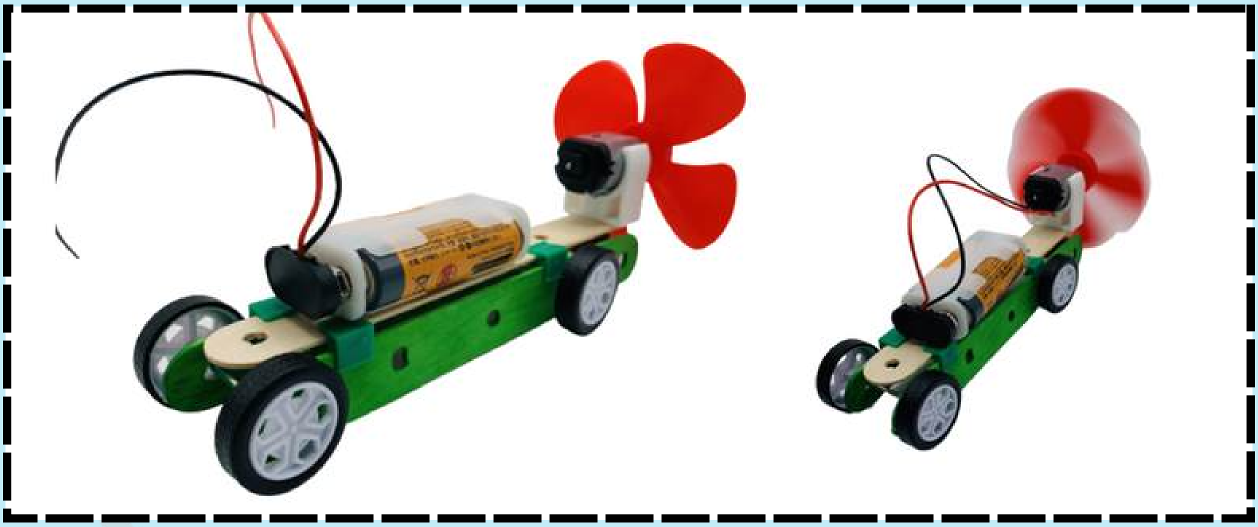
Step 3: Create the Propeller and Wind Propulsion

- Slide the motor into the motor mount with the shaft facing outward.
- Gently press the propeller onto the motor.
- Using double-sided tape, adhere the AA battery holder to the opposite end of the motor.
- Carefully attach the red and black wires to the motor as pictured. (Pay attention to polarization + & -)

The propeller with start to spin! The breeze should flow from the propeller facing you. If it does not you may need to reverse the red and black wires.

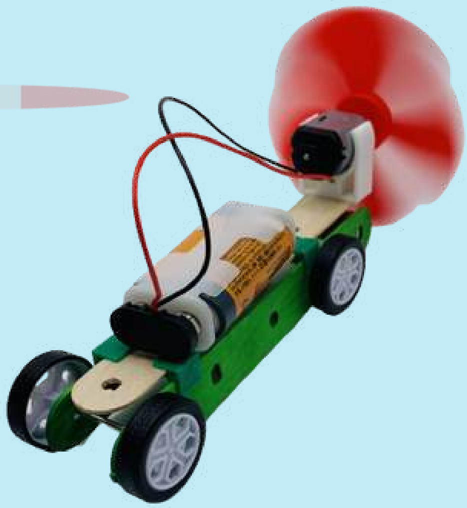
Step 4: Let's Test It!

Find an open space with a clear path for the car to travel. Hard wood or tiled floors will work best.



- Turn on the DC motor. The spinning propeller will create a wind force that pushes the car forward.
- Experiment with the angle of the propeller to see how it affects the car's movement.

Step 5: Race and Decorate



- Gather your friends, classmates, or family members for a wind-powered car race!
- Decorate your car with additional stickers, paint, numbers, drawings, or other fun materials :)

*Consider using 3D software like Tinkercad to design an aerodynamic hood for the front 4.8mm hole near the front wheels.

III. Hydropower (Water Energy)

1. What is Hydropower?

- a. Concept

Hydropower is the energy derived from the movement of water, usually from rivers or dams, to generate electricity. This form of energy harnesses the gravitational force of falling or flowing water to spin turbines, which then drive generators to produce electricity. Hydropower is considered a reliable and consistent renewable energy source, as water flow is relatively predictable.

- b. History of its Exploitation in Production

Humans have used hydropower for thousands of years, beginning with water wheels used for grinding grain in ancient Greece around 100 BC. The first industrial use of hydropower for electricity generation occurred in the late 19th century. In 1882, the world's first hydropower plant was built in Appleton, Wisconsin, USA. Since then, large-scale hydropower dams have become widespread, contributing significantly to global electricity production.

2. How Does Hydropower Work?

a. Conventional Hydropower

This involves the use of dams to create a reservoir of water. The controlled release of water through turbines generates electricity. It is the most common form of hydropower.

b. Run-of-River Hydropower

This type does not require a large reservoir; instead, it uses the natural flow of rivers to generate electricity. It has a smaller environmental footprint but may be less reliable due to seasonal water flow variations.

3. What is a Hydropower System?

a. Definition

A hydropower system typically includes a dam (if applicable), turbines, generators, and transmission lines. The dam controls the flow of water, which passes through turbines to spin them and produce mechanical energy. This energy is then converted into electrical energy by the generator.

b. Main Components

- Dam (if applicable): Controls water flow and creates a reservoir for power generation.
- Turbine: Converts the kinetic energy of flowing water into mechanical energy.
- Generator: Converts mechanical energy into electricity.
- Penstock: A pipe that directs water flow from the reservoir to the turbine.

Spillway: Allows excess water to bypass the turbine for flood control.

c. How it Works

Water is directed from the reservoir (or river) through the penstock to the turbine, causing it to spin. The turbine's rotation drives a generator, which converts the mechanical energy into electrical energy. This electricity is then transmitted to the power grid.

4. Benefits and Limitations of Hydropower Systems and Solutions

- Benefits:
  - Reliable and consistent power generation.
  - Provides energy storage and grid stability.
  - Can be used for flood control and irrigation.

- Limitations:
  - High initial construction cost.
  - Can disrupt local ecosystems and displace communities.
  - Susceptible to drought, which affects water availability.

- Solutions:
  - Implement fish ladders and other technologies to mitigate the impact on aquatic life.
  - Develop small-scale hydropower projects to reduce environmental disruption.
  - Use advanced materials and construction techniques to lower costs and improve efficiency.

5. DIY Experiments

a. Materials

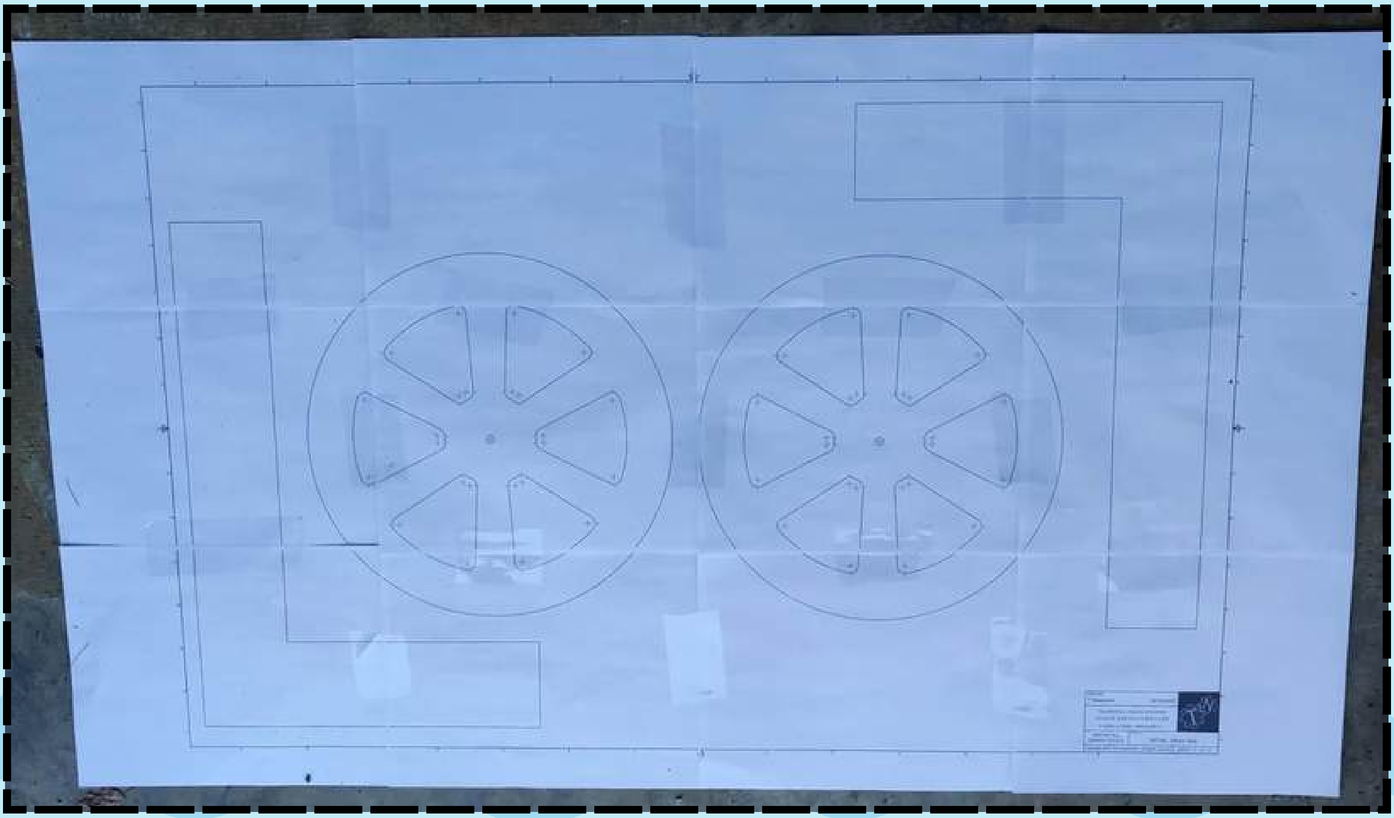
- Coping saw
- Tape measure
- Printer
- Paper
- Materials:
- 1/2" Plywood
- 3/4" PVC pipe
- Dowel rod
- Polyurethane coating
- Water
- Glue
- Sandpaper
- Electronics:
- Arduino MEGA 2560
- Water pump
- Motor
- Power supply
- Sensor
- LCD
- Wires

Step by step

Step 1: Building Frame

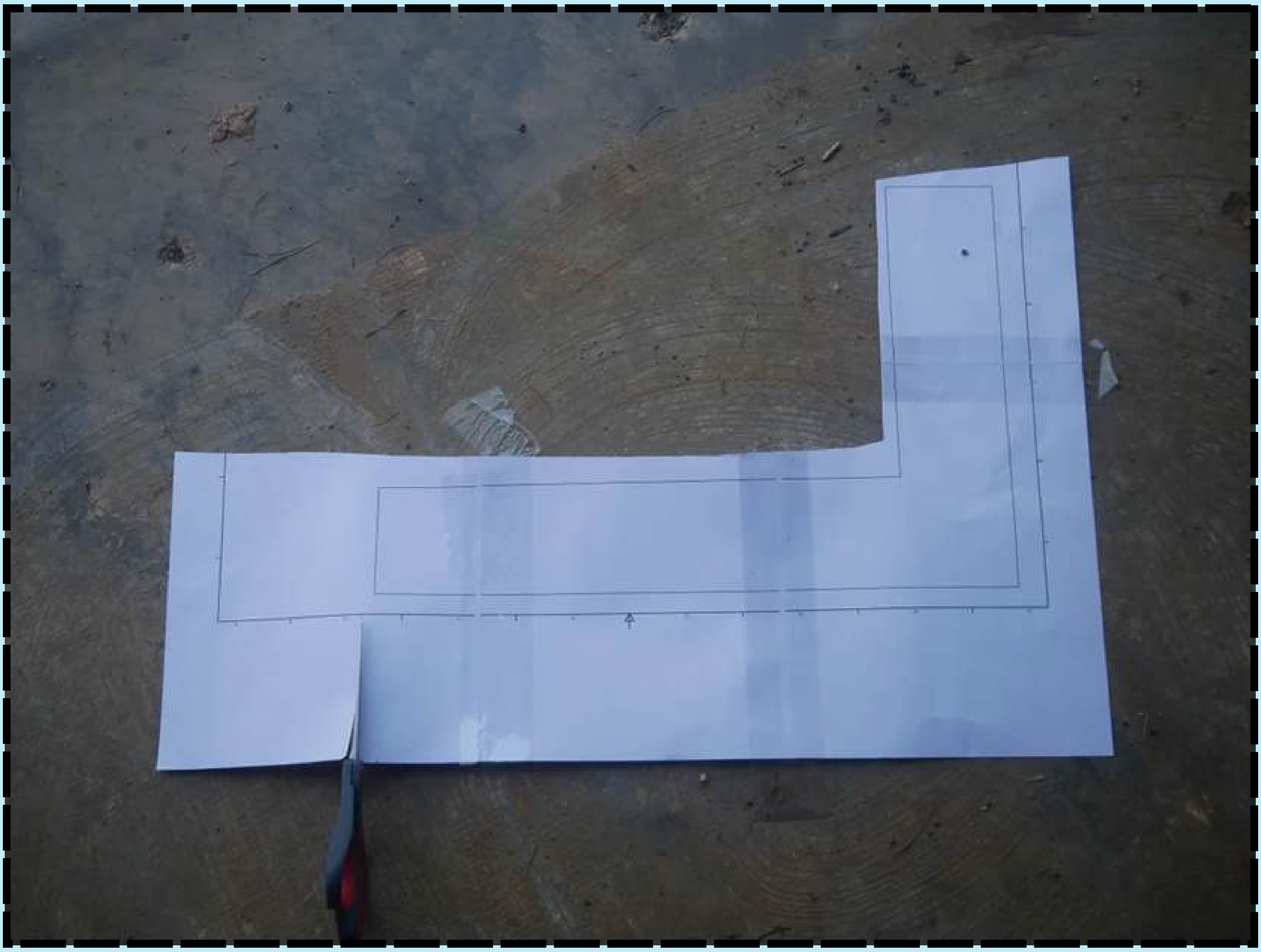
Building the frame of the whole project is a great place to start. Take your plywood and if it's larger than 1',6" x 1', cut it into that square. This will be the base of the frame.

Step 2: Assembly of Waterwheel PT.1



- To make the templates for the plywood pieces, you will need to print them on six sheets of 8.5x11 paper and then tape them together to form a single 24x36 sheet.
- Use clear tape to join the sheets together and make sure there are no gaps or overlaps. You should end up with a large sheet that looks like this.

Step 3: Assembly of Waterwheel PT.2

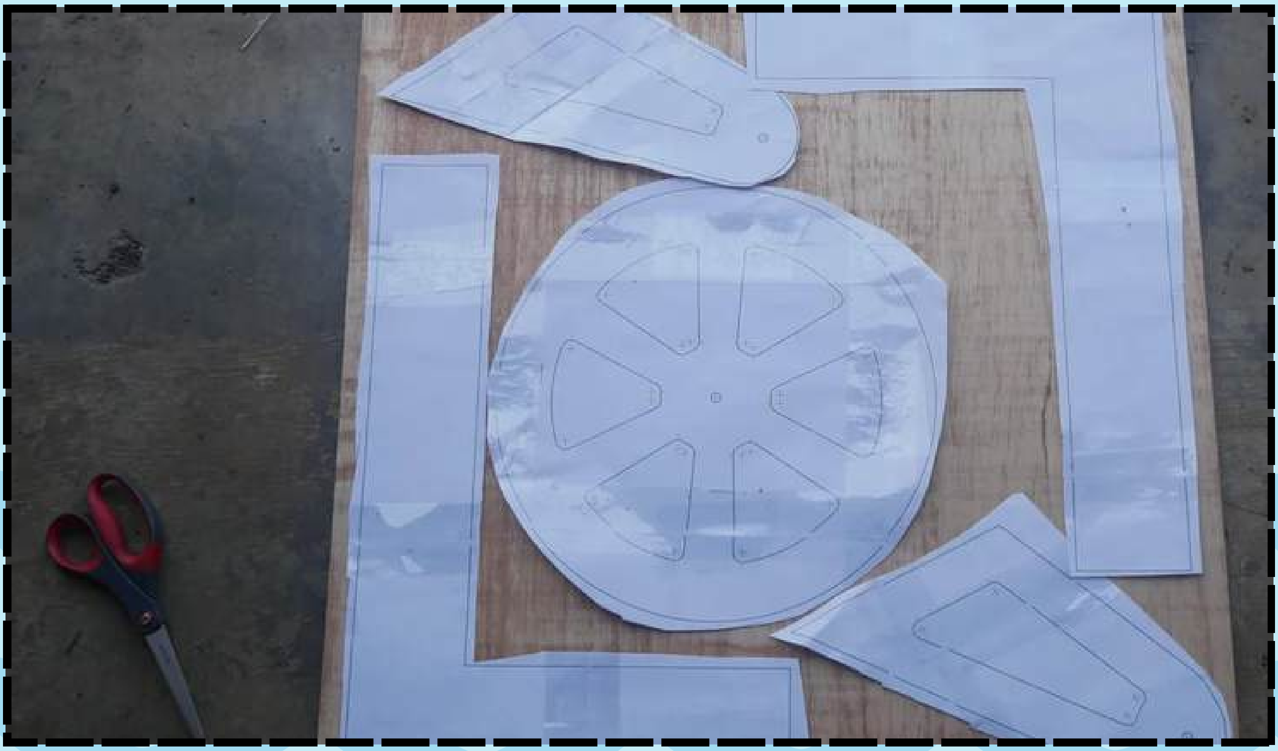


- Before you begin adhering the template to the plywood, you may want to cut them out from the large sheet to make it easier to tile them.
- Use scissors or a utility knife to cut along the solid lines of each template leaving about ¼" of gap with the cut lines to promote adhesion. Be careful not to cut into the solid lines, as they indicate where the pieces be cut. You should end up with several paper pieces that look like this.

Step 4: Assembly of Waterwheel PT.3

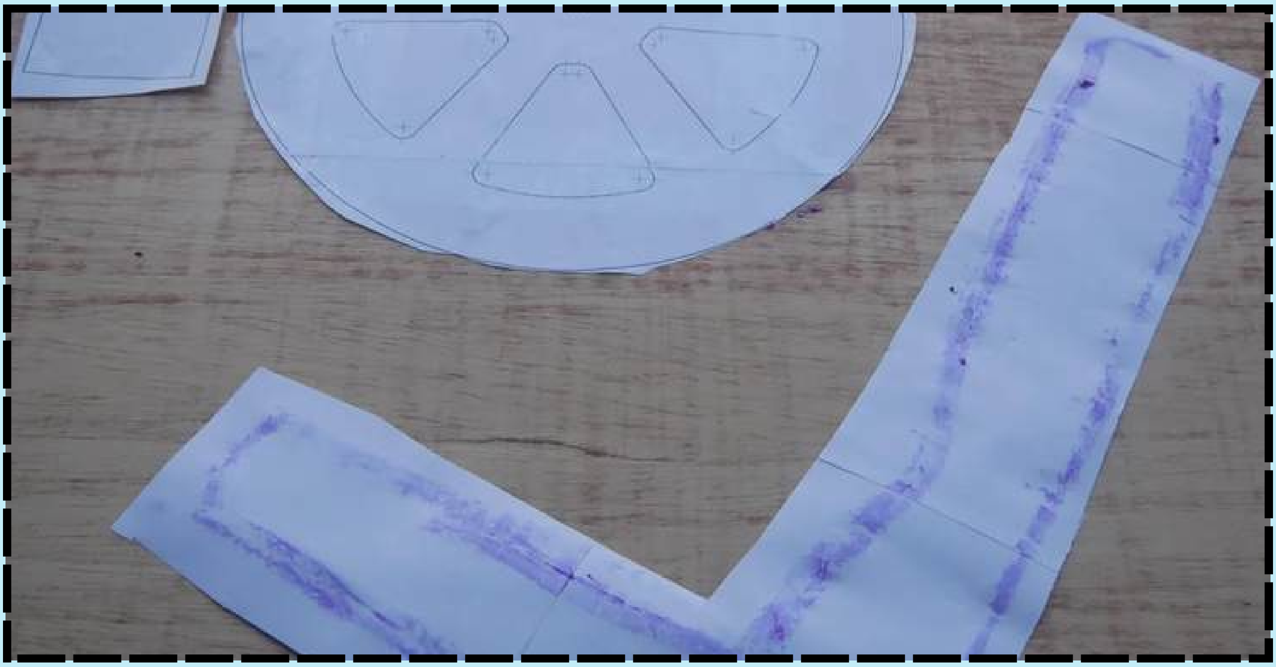
- At this point all the templates should be cut out and ready to adhere to the wood material.

Step 5: Assembly of Waterwheel PT.4



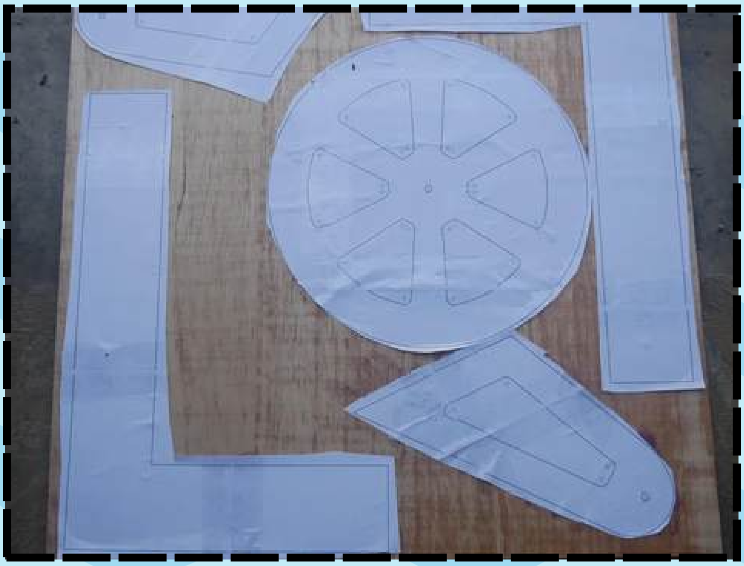
- Arrange the cutout templates on your stock material in a way that maximizes the use of the available space.
- You can try different orientations and positions of the templates until you find the most efficient layout.

Step 6: Assembly of Waterwheel PT.5



- The next step is to attach the templates to the boards using some kind of adhesive.
- There are many options for this, such as M3 super 77 spray adhesive, which is a popular choice but very expensive. A cheaper alternative is a regular glue stick from a craft store.
- This works well as long as you apply the glue evenly and thoroughly, especially along the edges.

Step 7: Assembly of Waterwheel PT.6



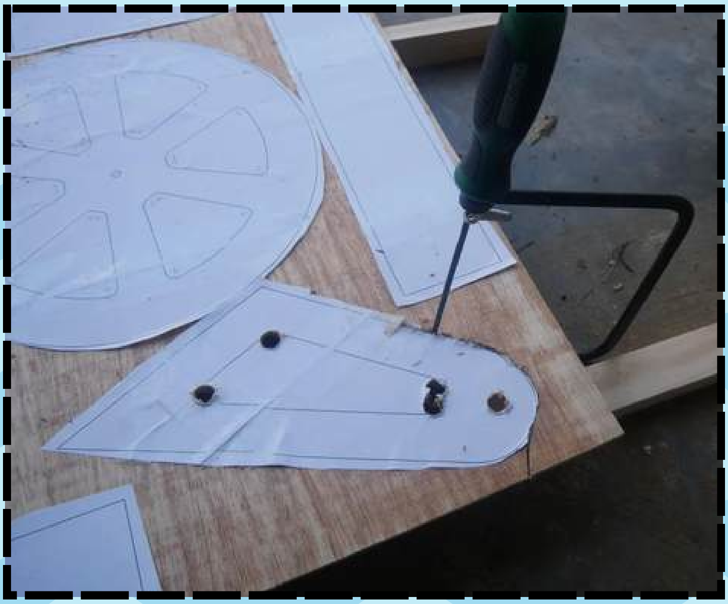
- After cutting out and gluing the templates onto the board, make sure that almost no stock material is wasted and that the glue is completely dry before moving on to the next step.

Step 8: Assembly of Waterwheel PT.7

- To begin processing the parts, you need to use a saw to create curved edges on each template. This will ensure that the templates match the design specifications and have smooth corners. It will also make it easier to maneuver the saw without getting stuck or causing damage.

Step 9: Assembly of Waterwheel PT.8

- You can now start to cut out the pieces of the project. A good tip is to cut along the outer lines first and begin from a point that is close to the edge of the material. This way, you can avoid wasting time and material by cutting off the excess parts.



Step 10: Assembly of Waterwheel PT.9

Once you have the exterior of the part cut out, take your saw and remove the blade on one end. Then insert it into the piece and replace the blade .
When complete it should look like the second picture. This configuration will allow you to cut out the interior of the parts.

Step 11: Assembly of Waterwheel PT.10

Once the parts are cutout. Remove the templates. This will leave a paper residue on some of the parts in the areas that the templates were glued particularly well.

Step 12: Assembly of Waterwheel PT.11

To remedy the fuzzy edges and the leftover paper residue, take a piece of sand paper and go over the part completely. When complete your part should look like this. Now repeat these steps for each part.

Step 13: Assembly of Waterwheel PT.12

The next step is to take the wall cutouts and cut 3 screws along the bottom of each panel. These holes will be used to attach the wall to the base plate.
Simply line the walls up with the precut baseplate and screw each piece together resulting in a strong bond that isn't watertight yet, shown in the second picture.

Step 14: Assembly of Waterwheel PT.13

To make the structure watertight simply lay
a bead of hot glue in each internal joint.

Step 15: Assembly of Waterwheel PT.14

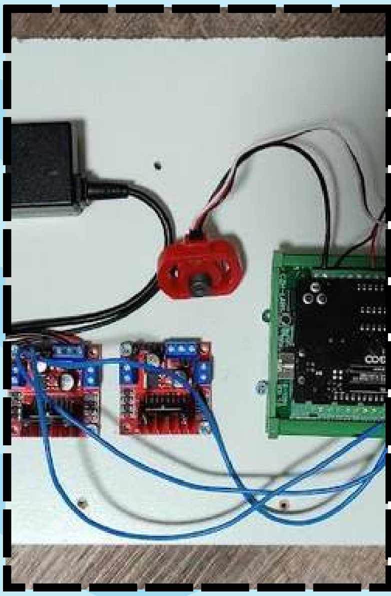
Moving on to the waterwheel, Take the dimensions for the pvc pipe and cut them down to the appropriate length and cross section. Now take the wheel and begin filling it. Use the fixture that you cutout from the plans before. It will align and hold the pieces in place while you lay a bead of hot glue.

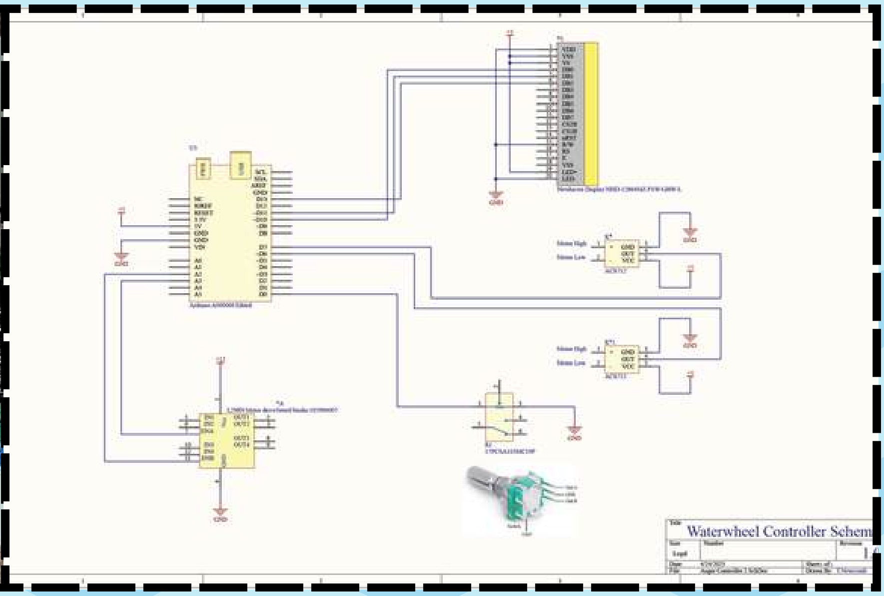
Step 16: Completed Waterwheel

Once final assembly of each component is complete, the design should look like this.

Step 17: Electronic Connections

Once the parts are cutout. Remove the templates. This will leave a paper residue on some of the parts in the areas that the templates were glued particularly well.





Step 18: Software

```
#include <avr/io.h>
#include <util/delay.h>


// Pin definitions
#define ACS712_PIN A0      // Pin connected to ACS712 analog output
#define POT_PIN A1         // Pin connected to potentiometer analog output
#define PWM_PIN 3          // Pin connected to L298N PWM input
#define SERIAL_BAUDRATE 9600


void setup() {
// Initialize Serial monitor
Serial.begin(SERIAL_BAUDRATE);
 // Set PWM pin as output
pinMode(PWM_PIN, OUTPUT);
 // Set up Timer1 for PWM generation
TCCR1A = (1 << COM1A1) | (1 << WGM11) | (1 << WGM10); // Set non-inverted mode,
fast PWM mode https://learn.sparkfun.com/tutorials/pulse-width-modulation/all
TCCR1B = (1 << CS11) | (1 << WGM12) | (1 << WGM13);   // Set prescaler to 8
OCR1A = 0;                                             // Initialize PWM duty cycle
to 0
}


void loop() {
// Read ACS712 sensor value
int acsValue = analogRead(ACS712_PIN);
 // Read potentiometer value
int potValue = analogRead(POT_PIN);
 // Map potentiometer value to PWM duty cycle (0-255)
int dutyCycle = map(potValue, 0, 1023, 0, 255);
 // Update PWM duty cycle
OCR1A = dutyCycle;
 // Print sensor and potentiometer values on Serial monitor
Serial.print("power generated in Amps: ");
Serial.print(acsValue);
Serial.print("\t Potentiometer Value: "
Serial.print(potValue);
Serial.print("\t PWM Duty Cycle: ");
Serial.println(dutyCycle);
 // Add delay for stability
_delay_ms(100);
}
```

Use the provided code to read from the electronics, which is written for Arduino IDE. Make sure to open a new project, define your board, and upload to your microcontroller. After this, open up the serial monitor to read the data from the electronics.

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THE END

Nature's Power

by SOLARE