

**Gifted and Talented  
Trimester 1 2022  
Grades 2 & 3 Home Project  
Engineering Design Process**

**Renewable Energy: Engineering Sail Cars**

# Question: What Is Energy?

**Answer: Energy is the ability to do work.**



**Energy comes in many forms: chemical energy, electrical energy, heat energy, light energy, mechanical energy and nuclear energy.**

# Conservation of Energy

**“Energy is neither created  
nor destroyed.”**

**The amount of energy in a system is conserved over time.**

# Renewable vs. Nonrenewable



Examples of renewable energy:  
solar, biofuel, wind,  
geothermal, hydropower

***LIMITLESS***



Examples of nonrenewable energy:  
fossil fuels (coal, oil, natural gas)

***LIMITED***

# Wind Energy

A type of renewable energy provided by the wind.

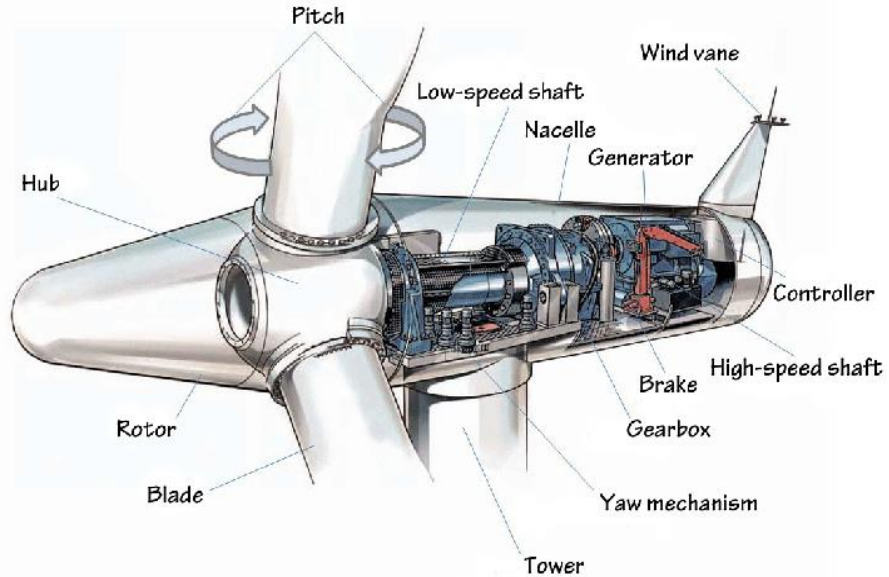
Wind turbines



# Wind Turbines



## The major components of a wind turbine



SOURCE: Center on Globalization, Governance, and Competitiveness, Duke University

# Solar Energy

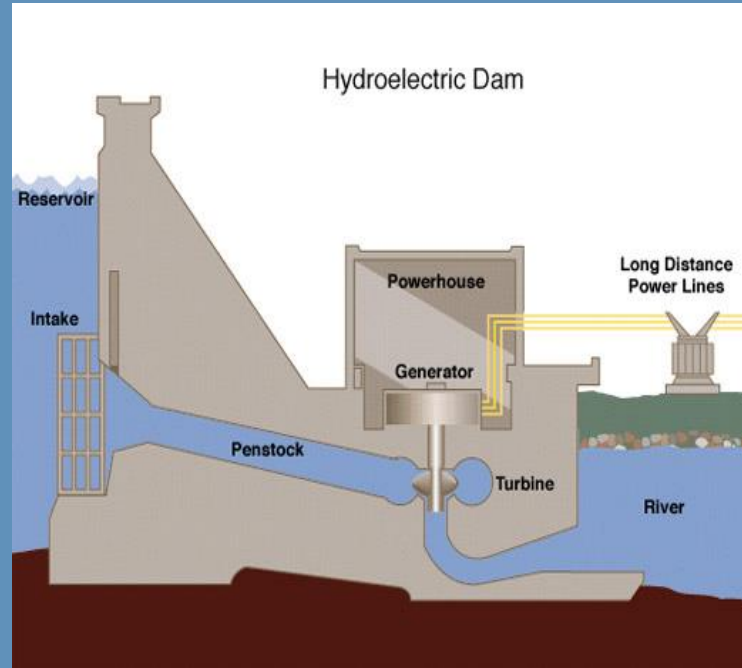
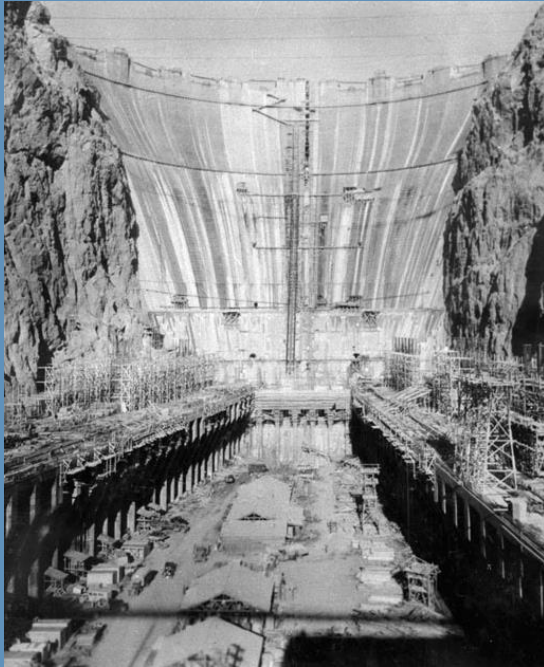


**Photo Voltiac Cells**



**Concentrated Solar**

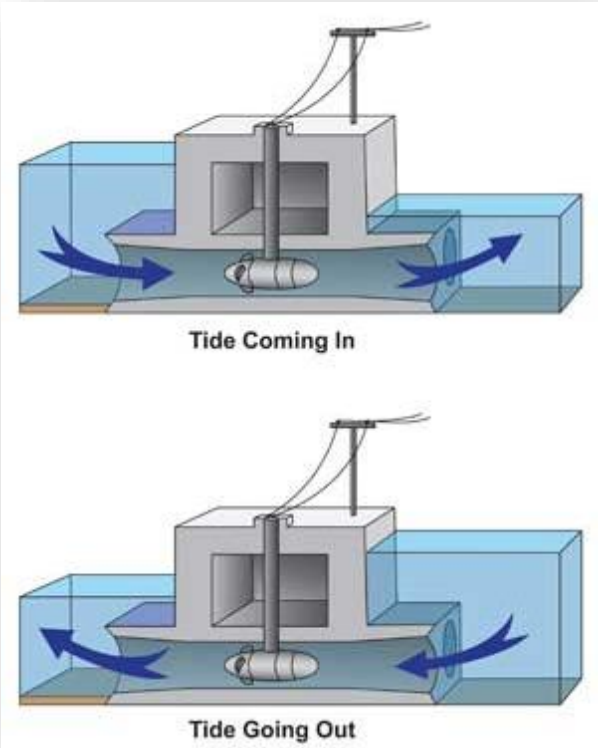
# Hydropower





# Other Types of Renewable Energy

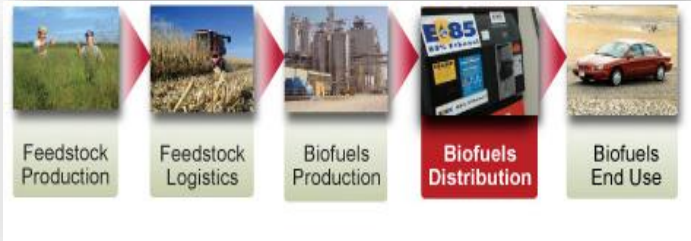
hydro / tidal



geothermal



biofuels



# Background

The burning of fossil fuels is considered a polluting, non-renewable form of power production. It is the job of future engineers to develop clean and sustainable means of producing energy—mostly for generating electricity, but also to power our vehicles.

Can you think of any interesting natural sources of power? Maybe lightning, volcanoes or large storms? In fact, the last of these examples (storms) are currently being used today—in a sense! Wind power offers one of the simplest, least expensive, and safest sources of renewable power production.

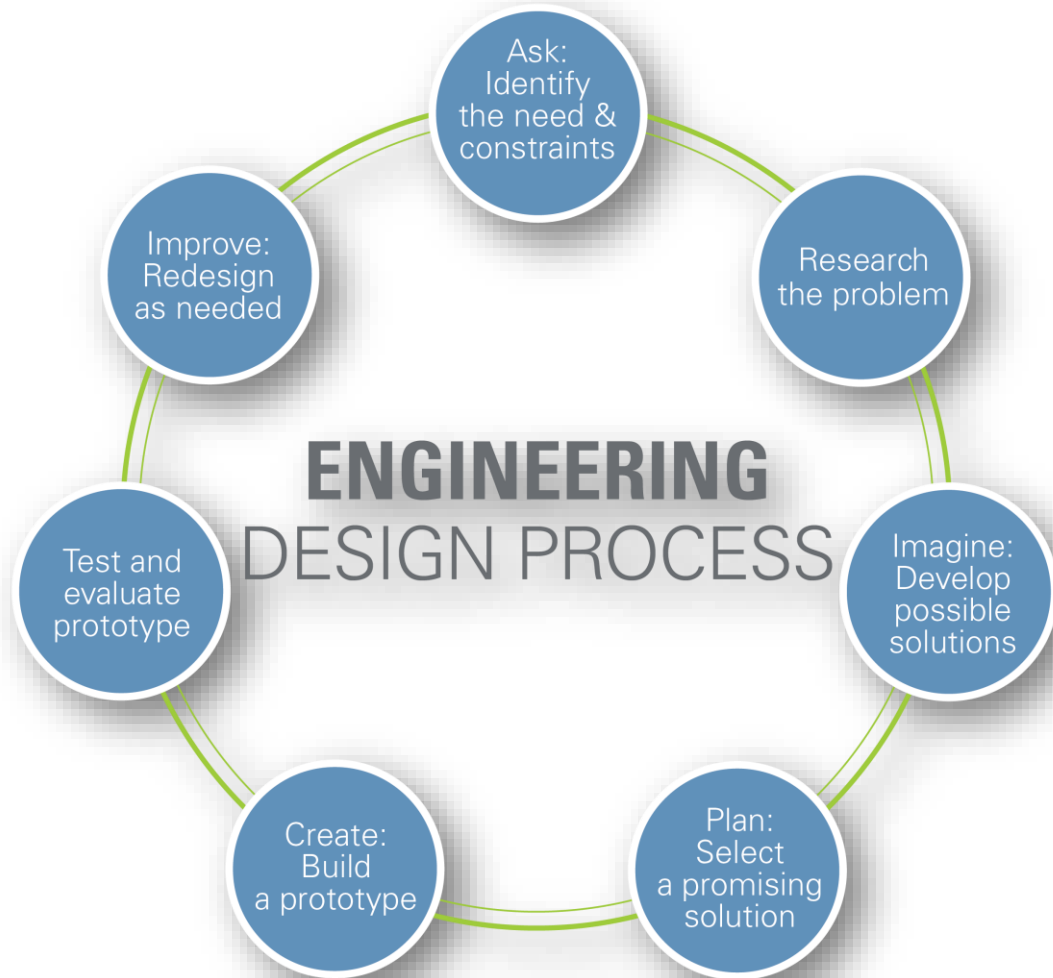
This project will have you explore the use of wind power in the design, construction and testing of "sail cars," which, in this case, are little wheeled carts with masts and sails that are powered by the moving air generated from a box fan.

# Sail Car Challenge

You will now become a design engineer. The [engineering design process](#) will be explored. The focus of the activity is on renewable energy, as well as the engineering design, testing and redesign of small cars made from household materials.

## [Engineering Connection](#)

The use of renewable forms of energy is a major focus for today's engineers. Wind power is one of the simplest and least expensive sources of renewable energy. By designing wind-powered model cars, you will experience the steps of the [engineering design process](#) while exploring and gaining a better understanding of how wind power may be utilized. Automotive Engineers are a big part of car construction and they work with Aerodynamic Engineers for design. Aerodynamics are considered when designing sports cars for speed. The car is made in a way that allows it to glide through air resistance.



# Sail Car Challenge

Are you ready to apply your design skills to move a car using wind power? This is your engineering design challenge: You will transform into an engineer challenged to design masts and sails. Design a sail (including a mast) to propel your car forward, catching the "wind" from a box fan. You will create a car base with axles and wheels. You will then design a mast and sail that uses your choice of materials from the list. This is your chance to be creative! Like engineers everywhere, you'll be following the steps of the engineering design process. You'll be brainstorming ideas (imagine, develop possible solutions), planning and sketching your best idea, building and testing your ideas as prototype cars, then redesigning by making improvements and testing again—until you are satisfied with your design and ready to test it against other classmates. (Materials on the next slide.)

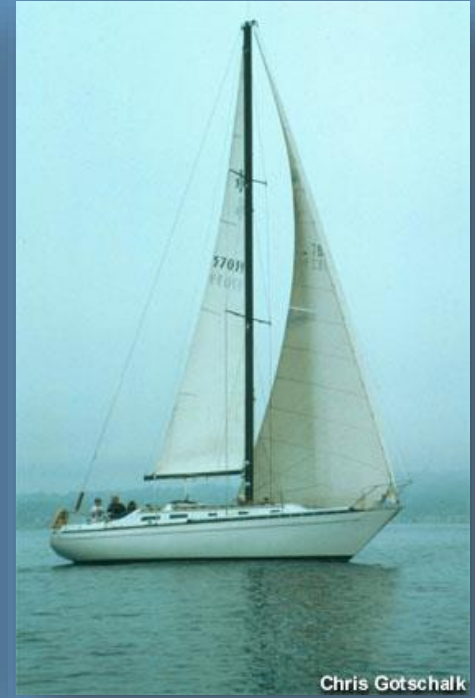
# Sail Car Challenge

You will need:

- 2 coffee stirrers, to serve as axles
- 4 Life Savers® mints (ring-shaped hard candies), to serve as wheels
- 8 plastic beads, such as pony beads
- corrugated cardboard rectangle, 3 x 5 inches (7.5 x 12.5 cm); when cutting the pieces, make sure to orient the cardboard so the inner channels in the two-ply cardboard run parallel to the short side of the rectangle, so as to line up to hold the stirrers as axles for the car base
- choice of mast material: 2-3 Popsicle sticks OR 1-2 wooden skewers
- choice of sail materials: 12 x 12-inch (30.5 x 30.5-cm) piece of aluminum foil OR 12 x 12-inch (30.5 x 30.5-cm) piece of tissue paper OR 5 index cards
- paper and pencils, for design drawings
- hot glue gun, glue sticks, scotch and duct tape, wooden skewers and scissors, for sail car construction
- smooth floor or flat cardboard test track, 36 inches (~90 cm) long
- colored tape, for setting up the track
- box fan
- stopwatch
- (optional) stickers to decorate cars

# Sail Types

How will you make your sail? How will it best catch the wind? Think of the different masts and sails you have seen. Here are pictures of two different sail types; one is rigid like a surfboard, the other is flexible like fabric. Notice how they are shaped and positioned. Think of your experiences with the wind. Brainstorm! Use your imagination to come up with the best mast and sail shapes using the materials on the list.



# Engineers test, test and retest...

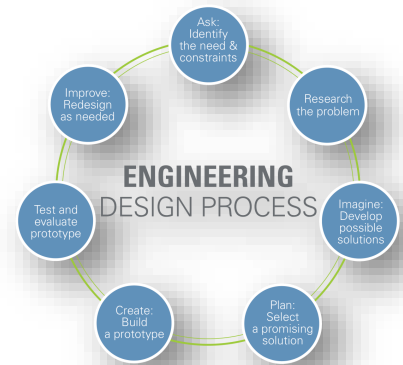
You will be doing some testing as part of the project.

That's how you will test your designs to see if they work and think of improvements. After your improvements are made, you will test again. That is what engineers do!



## Procedure... Brainstorming Planning...Ask, Research & Imagine...

Brainstorm, decide on materials and draw sketches of your mast and sail designs (see picture below). Take a piece of paper and a pencil to sketch and plan out your ideas for your sails. Look at the list of materials again while you are planning to help you. Engineers always have a plan before they begin.

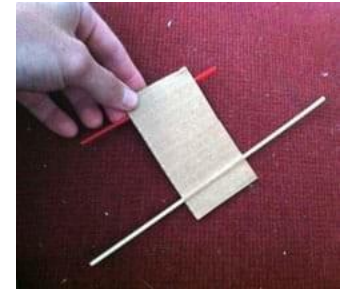
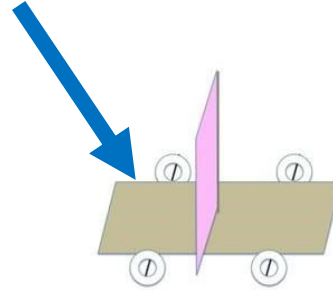


## Procedure... Create & Build

After you have your plan....begin building your sail car according to your plan.

**\*Do not use building materials or hot glue gun without your parent's supervision.**

Prepare a car base composed of a piece of cardboard with axles, beads and wheels installed (see picture to the right). To do this, slip a wooden skewer between the cardboard layers (going "with the grain") where you want to place the axles, in order to widen the cardboard channels a bit, making for easier insertion of the stirrers as axles. Then insert the two stirrer axles. For each wheel, slip onto the stirrer end a bead, the ring-shaped candy, and a second bead. Next, trim the stirrer axle (if way too long) and tape the stirrer end (hub) to keep the items from slipping off. The beads help keep the wheels from wobbling. **Note: By following this procedure, you are able to focus on mast and sail design alone. This will allow everyone to have the same car base then we can reliably compare the performance of each sail independently. It is impossible to make experiment runs perfectly independent.**



To make the car base, use a wooden skewer to widen two cardboard channels a bit so the stirrers/axles slide in easier.



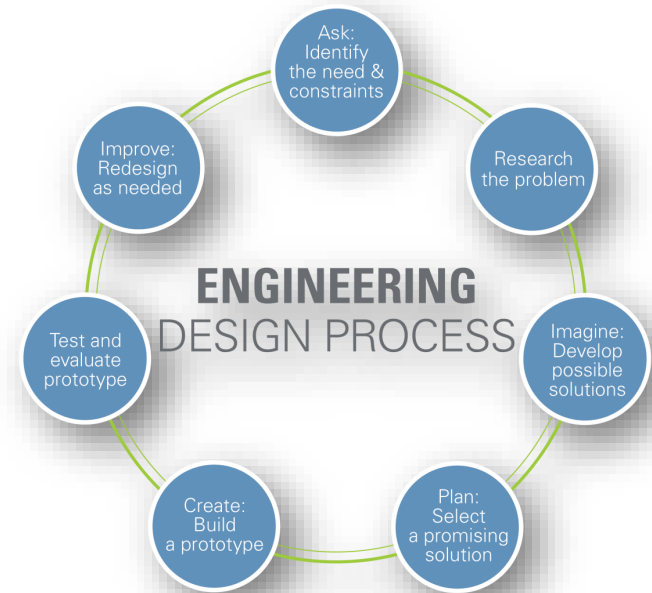
After you complete the base, you can move on to constructing your sails. Use materials from the material list.

### Procedure.... Test, Evaluate, then Improve

After you finish your building process it is time to test! Set up a flat area with a start and finish line 36 inches apart. Then turn on the fan, placing the car in front of the fan at the start line, and letting go. Take advantage of these tests to observe your car's performances and make adjustments in design and materials. For example, fixing wobbly wheels, strengthening the mast and making sure it does not drag on the ground, altering the sail materials, design or orientation, etc.

### Procedure.... Data on Test Results

Fill in the [Sail Car Test Table Sheet](#) with the results from your tests.



Make sure you have fun with the creation of your sail car.

Here is a list of what you need to bring on your Group's due date.

- Your sketches or plans
- Your Sail Car Prototype
- Completed Sail Car Test Table

## **Project Due Dates:**

Group 1 – November 4, 2022

Group 2 – November 7, 2022

Group 3 – November 9, 2022

Group 4 – November 14, 2022

