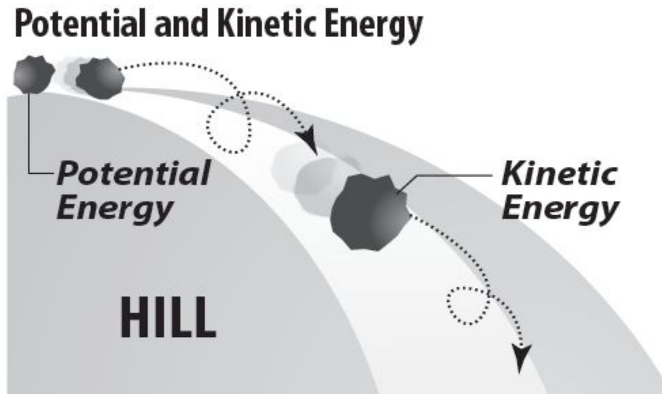
What is energy?



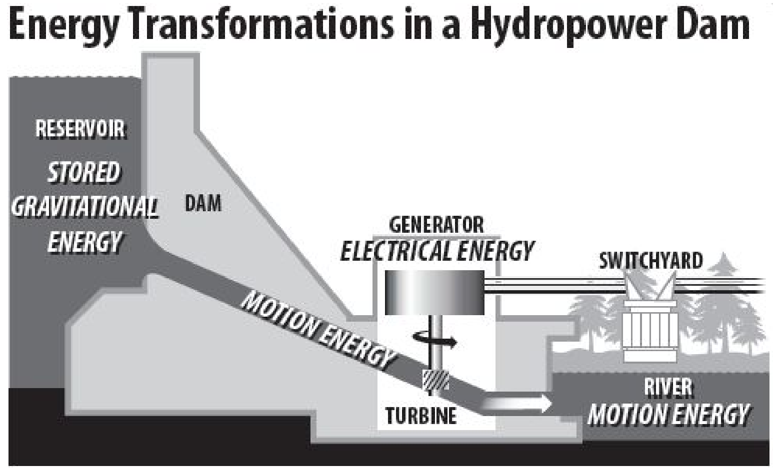
Energy makes change; it does things for us. It moves cars along the road and boats on the water. We use it to bake cakes in the oven and keep ice frozen in the freezer. It plays our favorite songs on the radio and lights our homes. Energy helps our bodies grow and allows our minds to think. Scientists define **energy** as the ability to do work or the ability to make a change. Energy is found in different forms, such as light, heat, sound, and motion. There are many forms of energy, but they can all be put into two categories: potential and kinetic.

Potential Energy

Potential energy is stored energy or the energy of position. Forms of potential energy include:

- **Chemical energy** is energy that is stored in the bonds of atoms and molecules that holds these particles together. Biomass, petroleum, natural gas, and propane are examples of stored chemical energy.
- **Nuclear energy** is energy stored in the nucleus of an atom. The energy can be released when nuclei are combined (fusion) or split apart (fission). In both fission and fusion, the mass is converted into energy.
- **Stored mechanical energy** is energy stored in objects by the application of a force. Compressed springs and stretched rubber bands are examples of stored mechanical energy.
- **Gravitational potential energy**. A rock on top of a hill contains potential energy because of its position. If a force pushes the rock, it rolls down the hill because of the force of gravity. The potential energy is converted into kinetic energy until it reaches the bottom of the hill and stops.

The water in a reservoir behind a hydropower dam is another example of potential energy. The stored energy in the reservoir is converted into kinetic energy (motion) as the water flows down a large pipe called a penstock and spins a turbine. The turbine spins a shaft inside the generator, where magnets and coils of wire convert the motion energy into electrical energy through a phenomenon called electromagnetism. This electricity is transmitted over power lines to consumers who use it to perform many tasks.

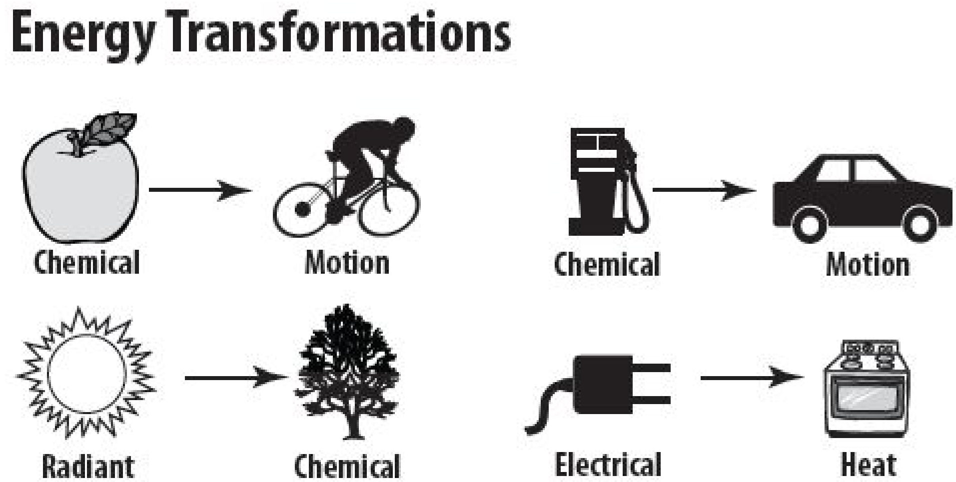


Kinetic Energy

Kinetic energy is energy in motion; it is the motion of electromagnetic and radio waves, electrons, atoms, molecules, substances, and objects. Forms of kinetic energy include:

- **Electrical energy** is the movement of electrons. The movement of electrons in a wire is called electricity. Lightning and static electricity are other examples of electrical energy.
- **Radiant energy** is electromagnetic energy that travels in waves. Radiant energy includes visible light, x-rays, gamma rays, and radio waves. Light is one type of radiant energy. Energy from the sun (solar energy) is an example of radiant energy.
- **Thermal energy** is the internal energy of substances; it is the vibration and movement of the atoms and molecules within substances. The faster the atoms and molecules move around, the more thermal energy in a substance, and the hotter it gets. Geothermal energy is an example of thermal energy. Thermal energy is sometimes called heat.
- **Sound** is the movement of energy through substances in longitudinal (compression/rarefaction) waves. Sound is produced when a force causes an object or substance to vibrate; the energy is transferred through the substance in a longitudinal wave.
- **Motion** is the movement of objects and substances from one place to another. Objects and substances move when an unbalanced force is acting on them according to Newton's Laws of Motion. A river flowing or breeze blowing are examples of motion energy.

Conservation of Energy



Your parents may tell you to conserve energy. "Turn out the lights," they might say. But to scientists, conservation of energy means something quite different. The Law of Conservation of Energy is not about saving energy. The law states that energy is neither created nor destroyed. When we consume energy, it doesn't disappear; we change it from one form into other forms. Energy can change form, but the total quantity of energy in the universe remains the same.

A car engine, for example, burns gasoline, converting the chemical energy in the gasoline into useful motion or mechanical energy. Some of the energy is also converted into light, sound, and heat. Solar cells convert radiant energy into electrical energy. Old fashioned windmills changed kinetic energy in the wind into motion energy to grind grain.

Energy Efficiency

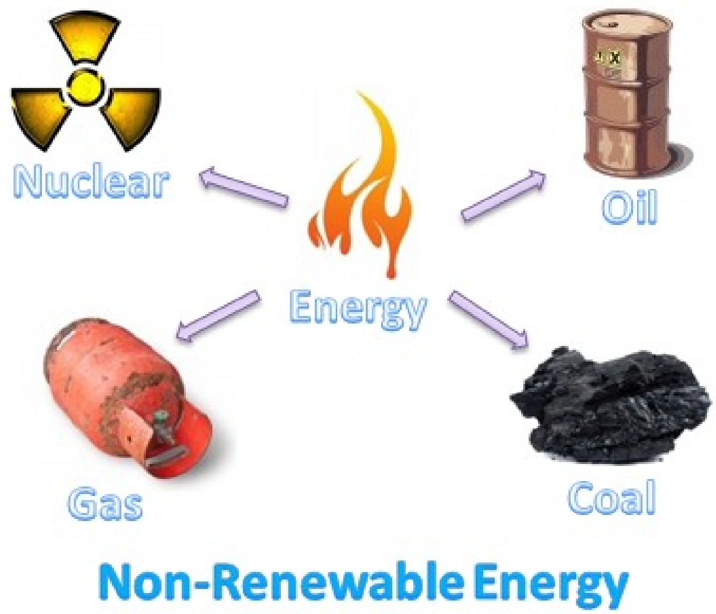
Energy **efficiency** is the amount of useful energy produced by a system compared to the amount of energy put in. A perfect energy efficient machine would convert all of the input energy into useful work. This is nearly impossible to do! Converting one form of energy into another form always involves a loss of usable energy. This is called a conversion loss. These losses are usually in the form of heat, or thermal energy. This 'waste heat' spreads out quickly into the surroundings and is very difficult to recapture.

A typical coal-fired power plant converts about 35 percent of the energy in the coal into electricity. The rest of the energy is lost as heat. A hydropower plant, on the other hand, converts about 90 percent of the energy in the water flowing through the system into electricity. Most transformations are not very efficient. The human body is a good example. Your body is like a machine, and the fuel for your machine is food. The typical body is about fifteen percent efficient when converting food into useful work such as moving, thinking, and controlling body processes. The rest is lost as heat. The efficiency of a typical gasoline powered car is about 15-25 percent.

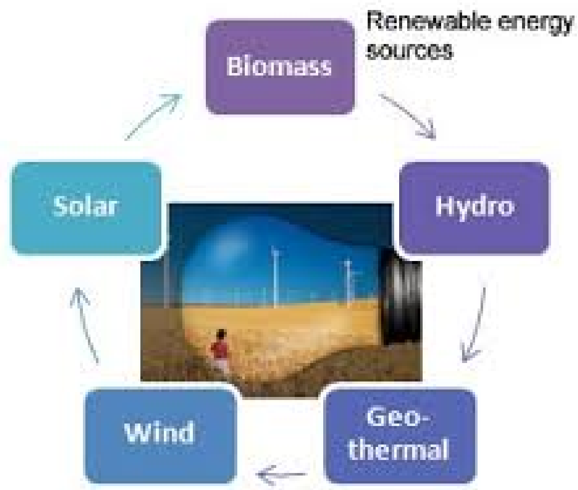
Sources of Energy

We use many different sources to meet our energy needs. All sources have advantages and disadvantages. Some are cheap; others are expensive. Some contribute to global warming; others are pollution-free. Some are limited in their supplies; others are abundant. Some are always available; others are only available some of the time.

Energy sources are classified into two groups—renewable and nonrenewable. In the United States, most of our energy comes from **nonrenewable energy sources**. Coal, petroleum, natural gas, propane, and uranium are nonrenewable energy sources. They are used to make electricity, heat homes, move cars, and manufacture all kinds of products from candy bars to MP3 players. They are called nonrenewable because the supplies of the fuels are limited. Petroleum, for example, was formed hundreds of millions of years ago, before dinosaurs lived, from the remains of ancient sea plants and animals. We cannot make more petroleum in a short time.



Renewable energy sources include biomass, geothermal energy, hydropower, solar energy, and wind energy. They are called renewable because they are replenished in a short time. Day after day, the sun shines, the wind blows, the rivers flow, and plants grow. Heat from inside the Earth—geothermal energy—is continuously made by the radioactive decay of elements in the Earth's core. We can harness this renewable energy to do work for us. We use renewable energy sources mainly to make electricity.



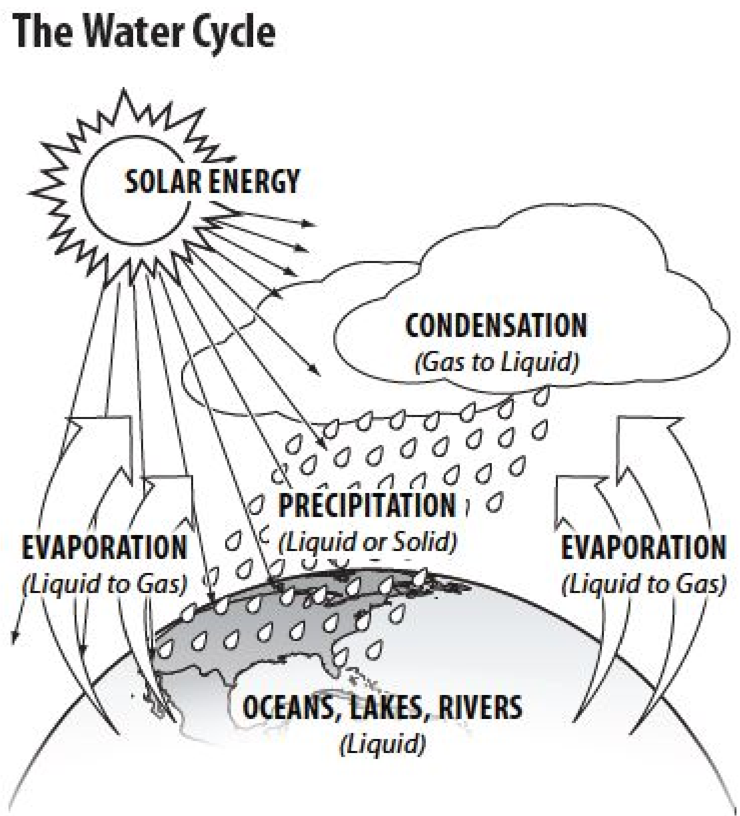
Characteristics of Water

Water is vital to life on Earth. All living things need water to survive. Water covers 75 percent of the Earth's surface. Our bodies are about two-thirds water. Water is made of two elements, hydrogen and oxygen. Both are gases. Two atoms of hydrogen combine with one atom of oxygen to create a molecule of water. The chemical formula for water is H2O. Water is found in three forms: liquid, solid, and gas. The liquid form is water. The solid form is ice. The gas form is invisible and is called water vapor. Water can change between these forms in six ways:

- **Freezing** changes liquid water into solid ice.
- **Melting** changes solid ice into liquid water.
- **Evaporation** changes liquid water into a gas, water vapor.
- **Condensation** changes water vapor (gas) into liquid water. For example, morning dew on the grass comes from water vapor.
- **Sublimation** changes ice or snow (solids) into water vapor (gas) without passing through the liquid state. The ice or snow seems to disappear without melting first.
- **Deposition** changes water vapor (gas) into ice (solid) without the vapor becoming a liquid first. Water vapor falls to the ground as snow.

The Water Cycle

In our Earth system, water is continually changing from a liquid state to a vapor state and back again. Energy from the sun evaporates liquid water from oceans, lakes, and rivers, changing it into water vapor. As warm air over the Earth rises, it carries the water vapor into the atmosphere where the temperatures are colder. The water vapor cools and condenses into a liquid state in the atmosphere where it forms clouds. Inside a cloud, water droplets join together to form bigger and bigger drops. As the drops become heavy, they start to fall. Clouds release precipitation as rain or snow. Liquid water is pulled by gravitational forces back to the oceans and rivers and the cycle starts again. This continuous cycle is called the water cycle or **hydrologic cycle**.



Water as an Energy Source—Hydropower

Humans have used the power of moving water for more than 2,000 years. The first references to watermills are found in Greek, Roman, and Chinese texts. They describe vertical water wheels in rivers and streams. These traditional water wheels turned as the river flowed, turning millstones that ground grain. By the fourth century, watermills were found in Asia and northern Europe. In the early 11th century, William the Conqueror noted thousands of watermills in England. Most used stream and river power, but some worked with the tides. Early water wheels were designed to allow water to flow beneath the wheel.

Later, millers diverted streams to flow over the tops of the wheels. More recently, wheels were placed on their sides — a more efficient method. In the late 1700s, an American named Oliver Evans designed a mill that combined gears, shafts, and conveyors.

After grain was ground, it could be transported around the mill. This invention led to water wheels being the main power source for sawmills, textile mills, and forges through the 19th century. In 1826, a French engineer, Jean-Victor Poncelet, designed an enclosed water wheel so that water flowed through the wheel instead of around it. This idea became the basis of the modern American water turbine. In the mid-1800s, James Francis, Chief Engineer of the Locks and Canal Company in Lowell, MA, improved the enclosed water turbine by reshaping the blades. Known as the Francis turbine, modern variations of this turbine are still in use today in hydropower plants. Generating electricity using moving water, or **hydropower**, began in the United States on July 24, 1880, when the Grand Rapids Electric Light and Power Company used flowing water to power a water turbine to generate electricity. It created enough power to light 16 lamps in the Wolverine Chair Factory. One year later, hydropower was used to light all the street lamps in the city of Niagara Falls, NY.

Next, we will present how to power of water can help you add spins to the Cold War Generator and generate insane amounts of electricity.

THE EXTRA WATER SPIN

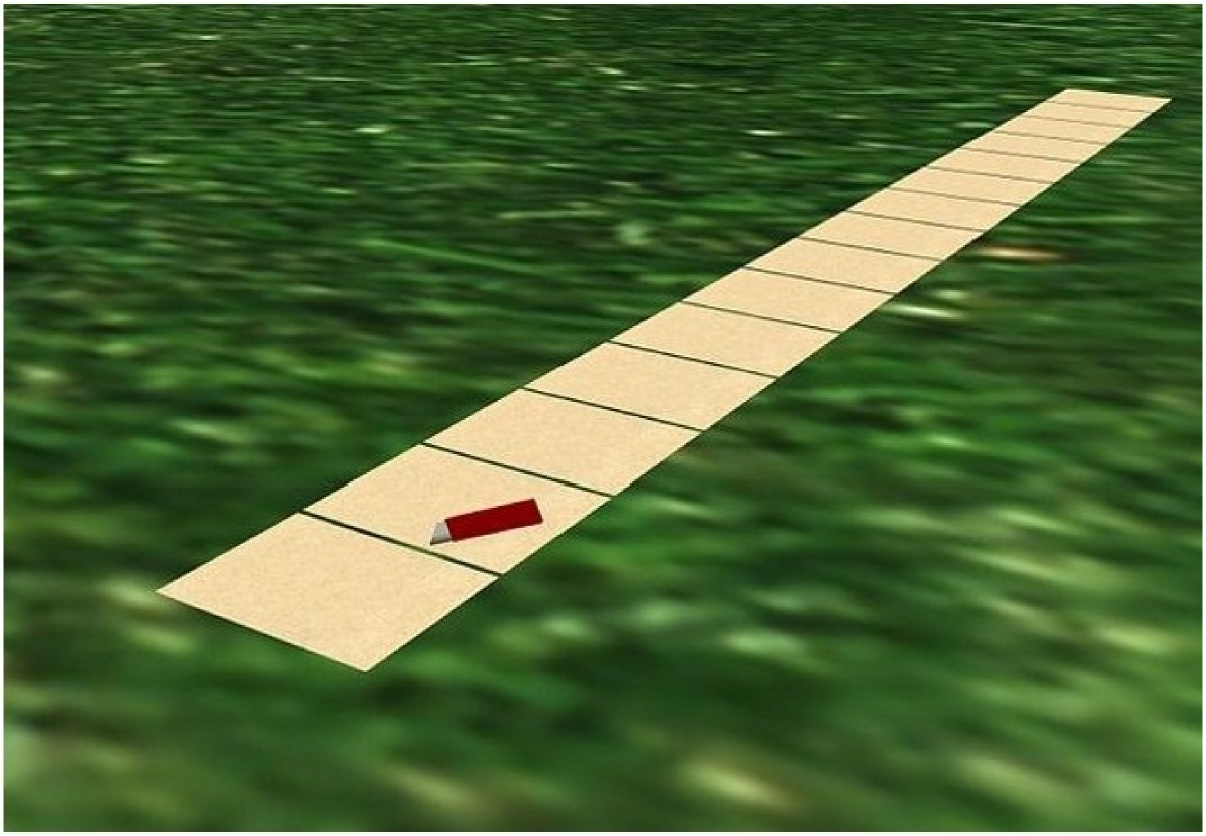
If you are fortunate enough to have a stream running through your land then you are blessed with a source of extra spins for the Cold War Generator. You can use this wheel even for a drain; it works on any running water. The principle will be explained at the end of the instructions.

Materials:

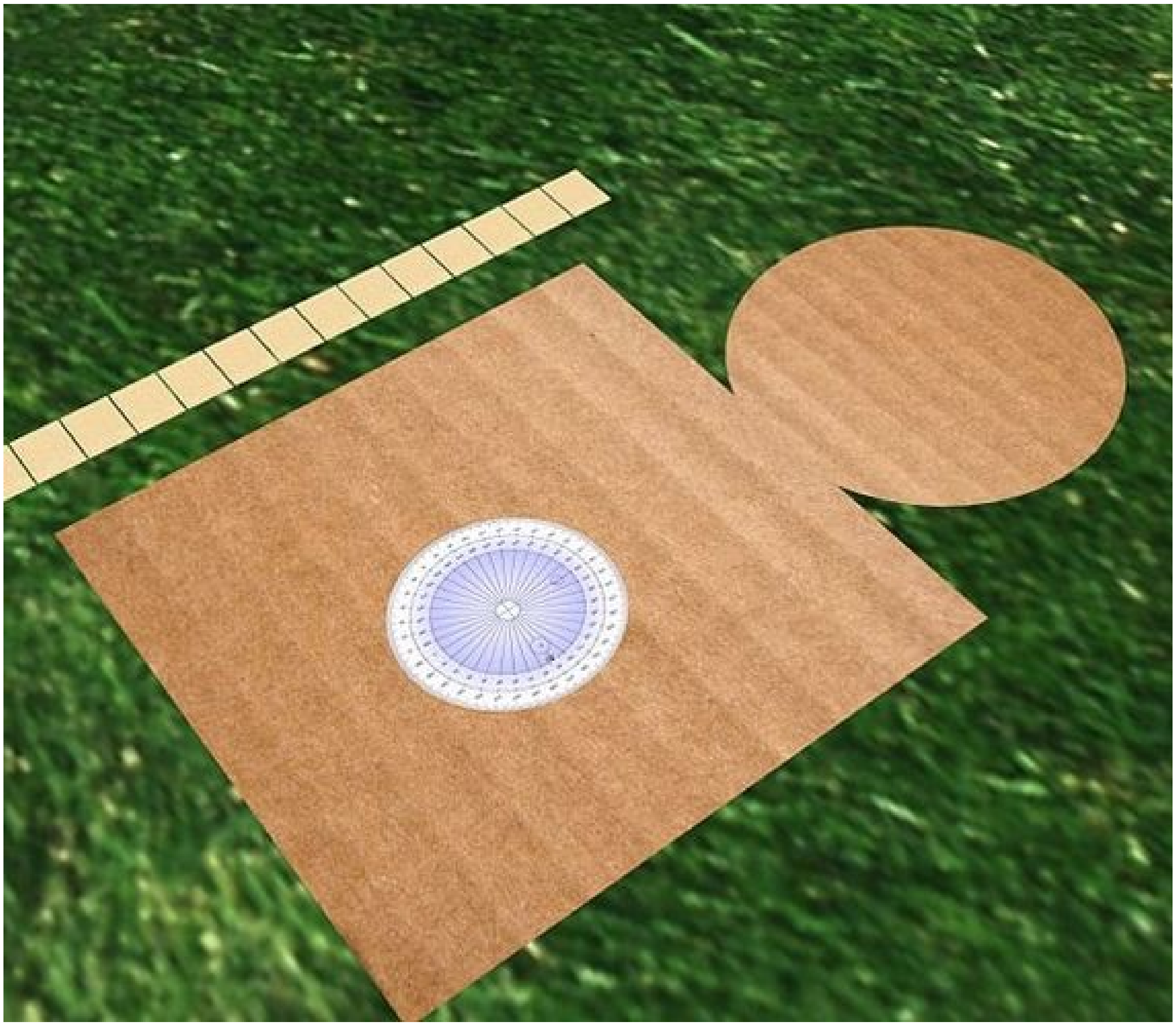
1. One long plywood sheet - 24" wide, 71" long, 0.5" width.
2. One large plywood square sheet - 50" x 50"
3. 40 screws
4. 8 - 10 pieces of rectangular wood - for the framework
5. One-Way Ratcheting Dog Clutch

1. Cut a long slice off of one side of the plywood that is 24 inches wide and 71 inches long.

2. Divide this slice into ten 7.1" sections. These sections will create your paddles once screwed into the side panels:



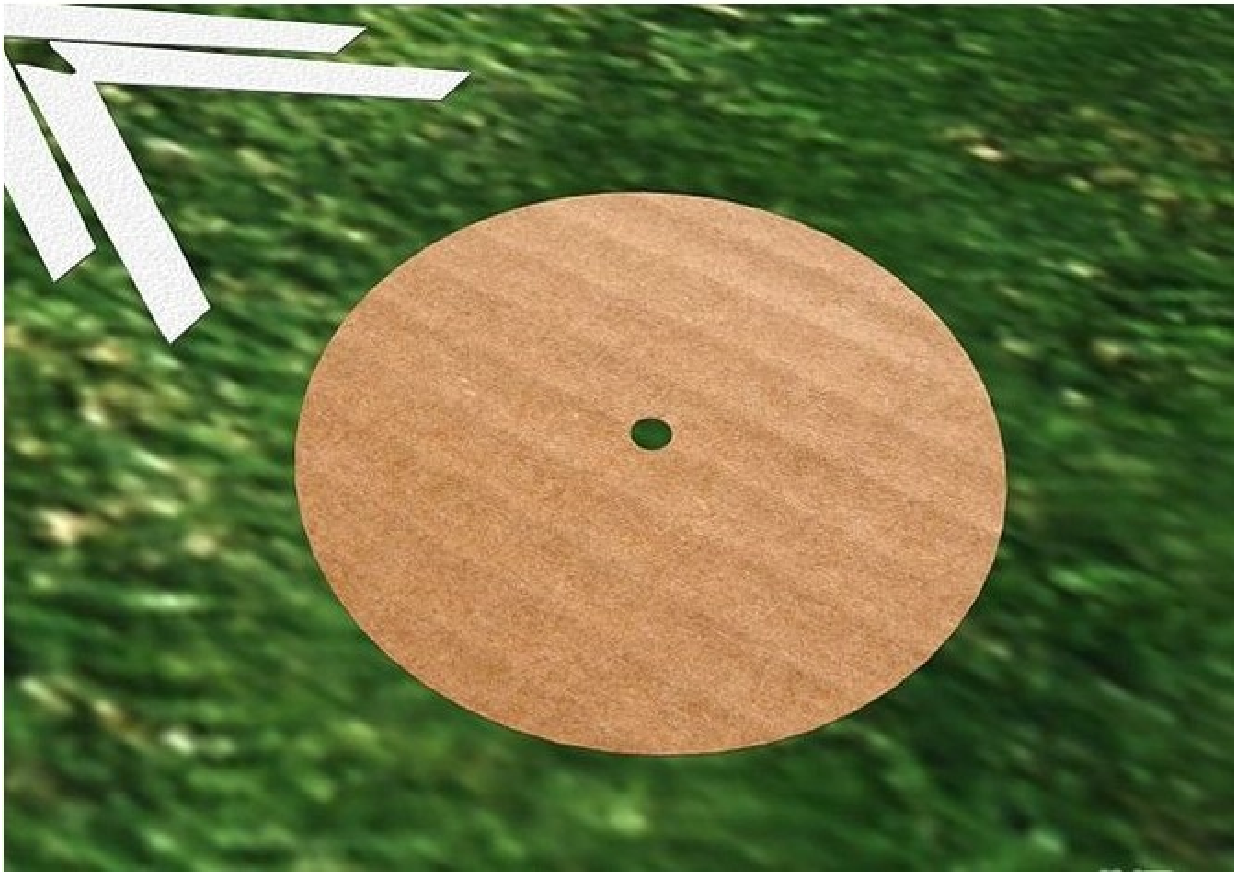
3. Mark a 47" diameter circle on the plywood sheet, or foam board and cut two round plywood sheets. The center is where the aluminum thread of the Cold War Generator will be placed:



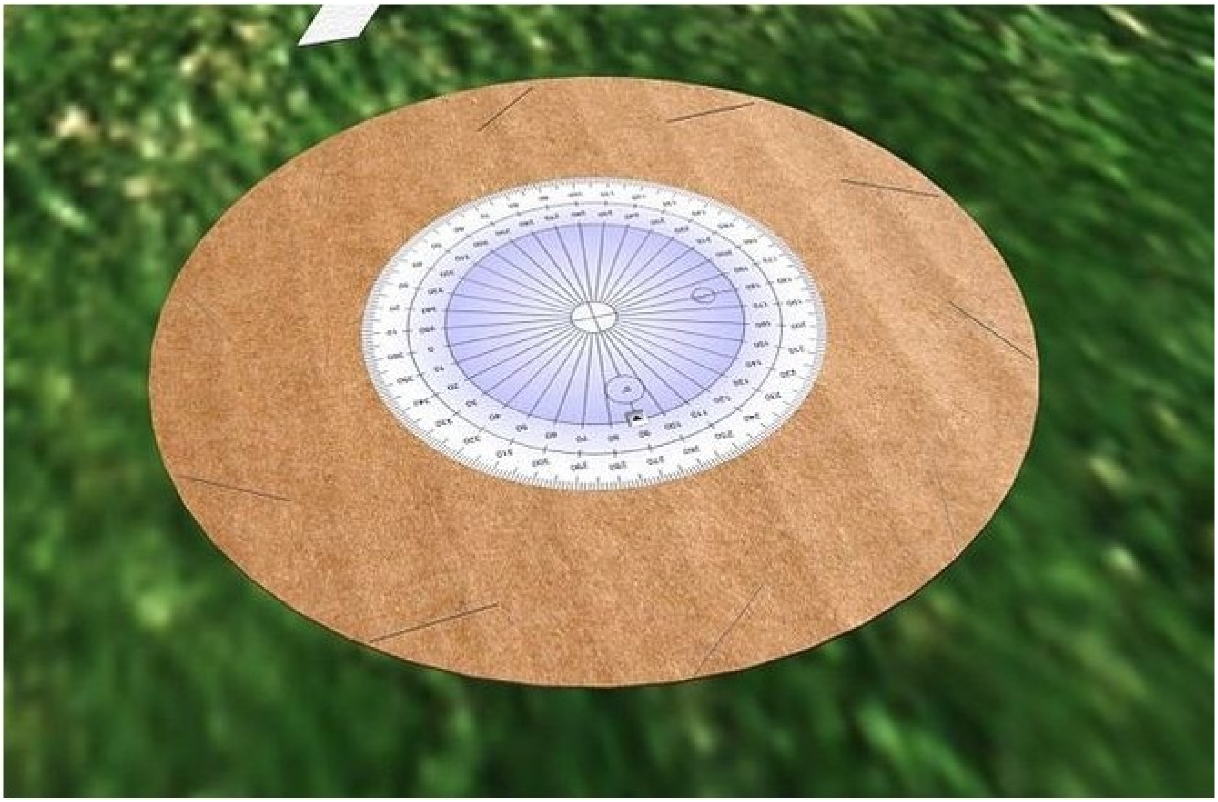
4. The Framework

Any waterwheel needs a framework supporting an axle on which it sits rotating freely as the flowing water pushes it around and spins the generator's aluminum thread. The height of the framework must be at least 53", depending of the depth of the water. Use screws to fix the framework and to tighten it together.

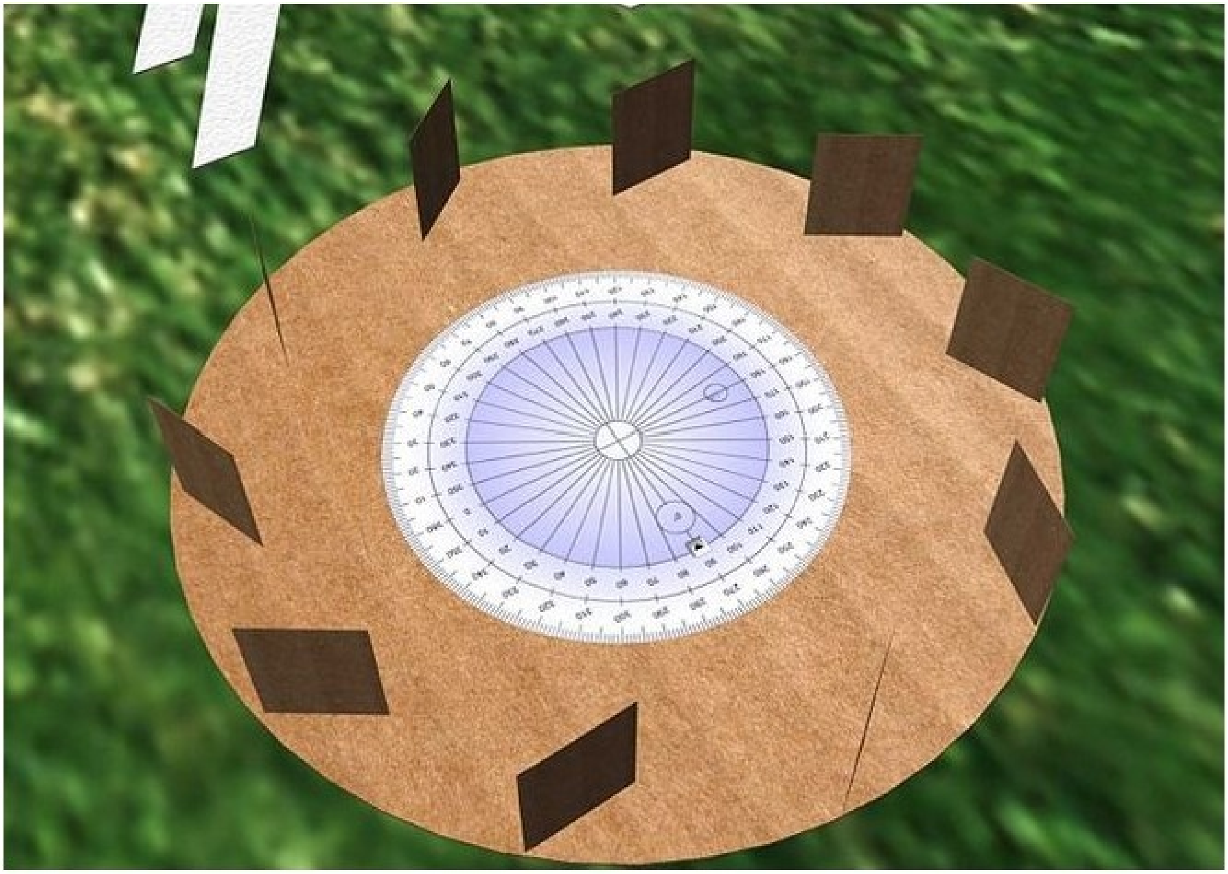
6. Lay one of the circular sides of the wheel on the ground:



7. Measure and mark where your paddles will go on the water wheel's side, setting each paddle at a 40 degree angle from the next paddle. Make sure each paddle is positioned at a diagonal towards the center of the water wheel. Use the image of spokes on a bike to help with this positioning:



8. Screw all paddles on the side along each marking you have just created:



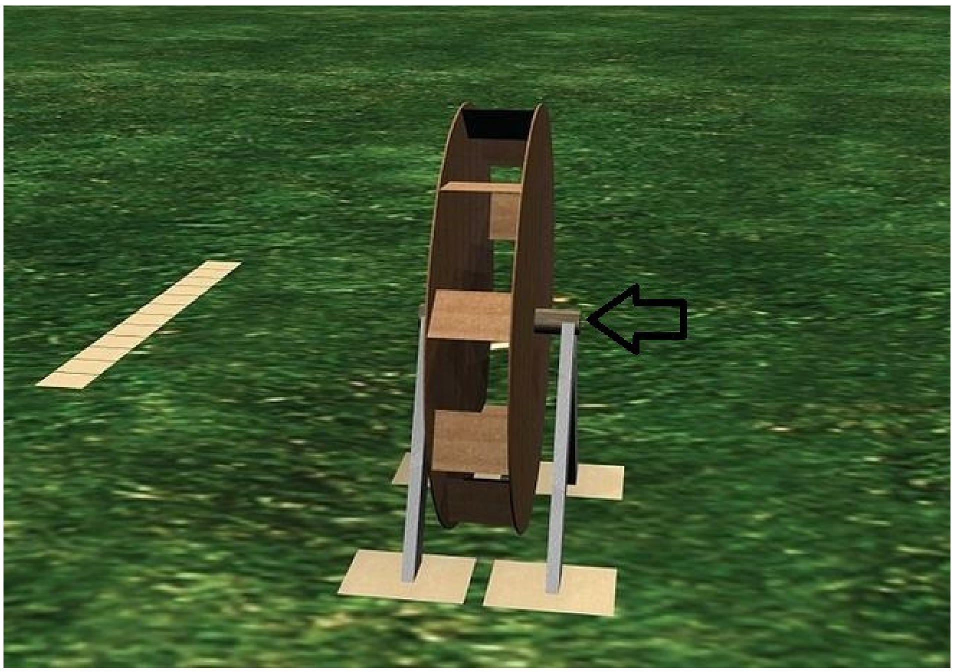
9. Attach the other side of the water wheel to the paddles that you have just attached to the first side of the wheel and screw the paddles on this side, as you did on the first one:

10. You need to waterproof the wheel to last any length of time without rotting in water, so you need two coats of Thompsons Waterseal to seal the plywood. This was not really enough since the ply remains porous - so much so that if the water level drops and the waterwheel stops spinning, the bottom of the wheel absorbs water where it dips in the stream. The wheel then turns unevenly for a week or so due to the uneven weight distribution which greatly increases the wear on the bearings and is less efficient. That said, after one year of operation the plywood still looks as good as new.

11. Fix the wheel onto the wooden frame.

12. On one side of the wheel (the side the generator will be) attach (using strong, water resistant adhesive) a One-Way Ratcheting Dog Clutch.

13. Attach the end of the aluminum thread (where the plate/handle goes) of the Cold War Generator to the clutch and let the water spin the wheel and add the extra spin to the already working generator.



The spin of the generator will be independent from the water wheel because of the clutch. Once the speed of the water wheel will reach 300 RPMs, the spins of the wheel will simply add to the spins of the Cold War Generator and provide an even bigger voltage that will result in more KW from your generator. The One-Way Ratcheting Dog Clutch will provide the extra spin for the generator as the driveshaft of the generator will maintain the minimum constant of 300 RPM.