PowerWheel

Instruct. Inspire. Guide our Future.

R.B. Manufacturing

Inside...

- Getting Started
- All About Energy
- Activity Ideas
- Hydro Power & More

There has never been a more crucial time to teach our children about energy. As the Earth's population grows and our demand for resources increases, energy production and consumption have become perhaps the biggest issues on the global plate.

Our goal is to inspire tomorrow's leaders and consumers with an intuitive understanding of energy. We offer the PowerWheel as part of a growing global effort to steer our society toward a path of sustainability and responsibility.

PowerWheel *Patent Pending*
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Manual & Learning Guide
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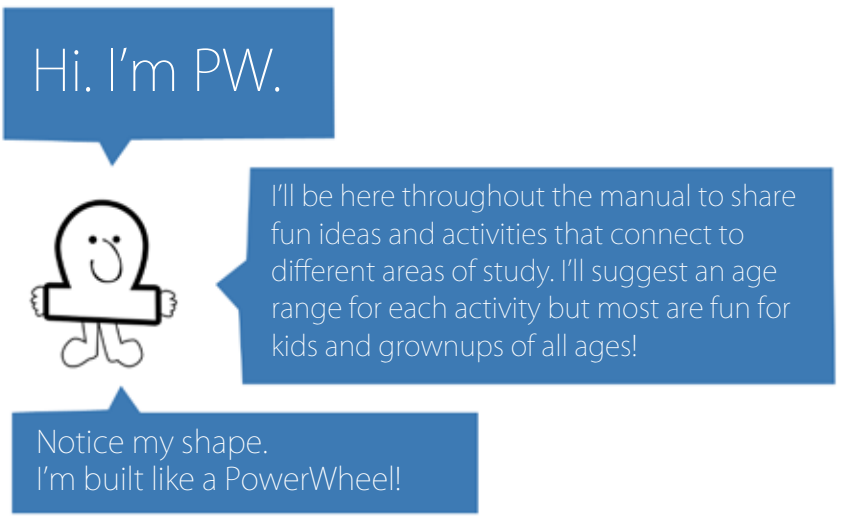

What is the PowerWheel?

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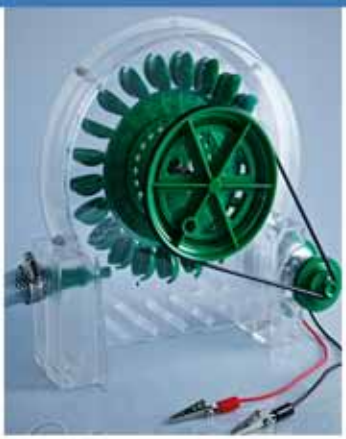
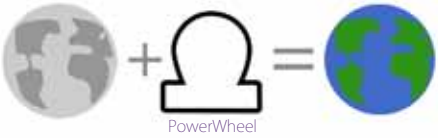
The PowerWheel is a micro hydro generator that hooks up to a faucet or hose



The PowerWheel takes energy from flowing water and converts it into mechanical energy and then into electricity.

The PowerWheel can open the floodgates of learning for all ages. Witnessing the PowerWheel in action inspires children to ask questions and make connections about power and energy.



The PowerWheel can be used in conjunction with energy lessons that reach beyond the classroom, connecting sources of electricity back to nature, and teaching towards a cleaner, more renewable future.

This manual is designed to enhance the knowledge and understanding of key concepts associated with energy and power production as well as to offer guidance, activities and suggestions for connecting the PowerWheel with these concepts.

Getting Started

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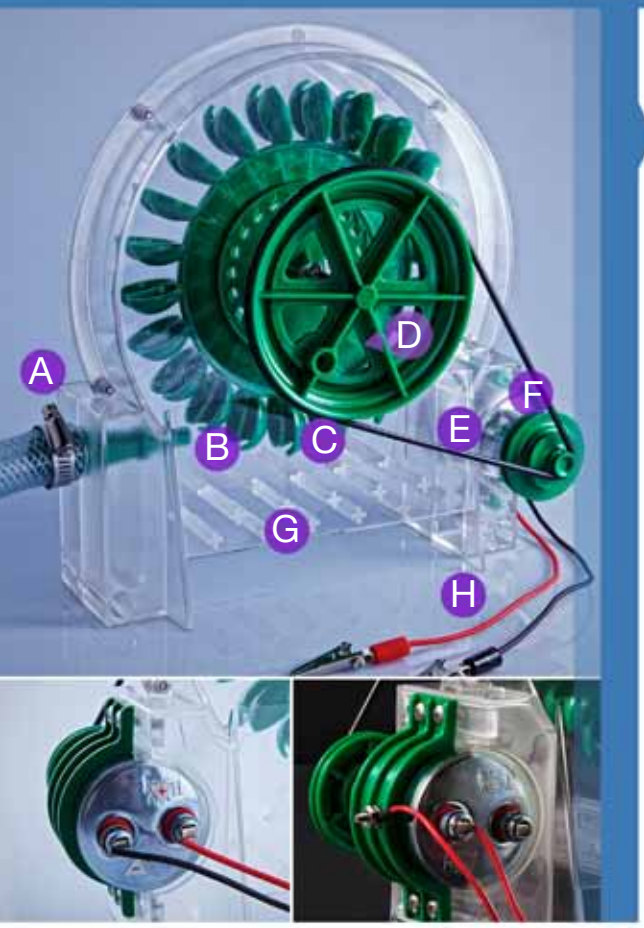

DC Generator

AC Generator

All the parts

- **A** Hose: *The hose connects to your tap or garden hose.*
- **B** Stationary Nozzle: *The nozzle shoots a strong stream a water at the buckets.*
- **C** Buckets: *The buckets receive the water flowing from the source and begin to turn the wheel.*
- **D** Manual Operation: *Place a pencil in this hole to crank the wheel by hand.*
- **E** Belt: *Connects the wheel to the generator.*
- **F** Generator: *Uses energy from wheel to produce power.*
- **G** Water discharge: *For drainage.*
- **H** Clips: *These connect to the generator (AC & DC differ).*

Directions For use with threaded faucet head or hose

1. Read safety instructions below
2. Place PowerWheel in a dry spot that will drain safely
3. With water off, attach PowerWheel's hose to threaded faucet or hose
4. With dry hands, attach wires to the + and - of the LED light strip
5. Turn water on!

Warning! Water and Electricity don't always mix!

Adult supervision necessary for children under 10
Do not submerge the PowerWheel in water
Keep fingers and other body parts out of the wheel.

Energy

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ENERGY is defined as the ability of matter to move, or to produce a chemical change in, other matter. ENERGY is also the ability to do work. POWER measures the rate of producing or using energy.

Conservation of Energy

(not to be confused with Energy Conservation...more on that later!)

THE CONSERVATION OF ENERGY is a law of physics which states that energy cannot be created or destroyed. Although the total amount of energy in a system remains constant, it is able to change from one form to another.

In the case of the PowerWheel, water is the source of energy. It changes forms multiple times as it falls through the hose, spins through the wheel, enters the generator and illuminates the LED light strip.

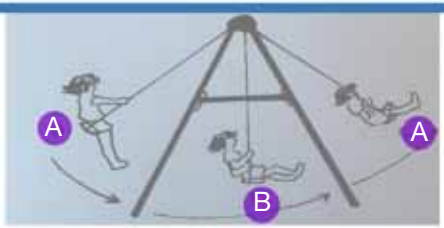
Potential vs. Kinetic

Energy's two main types

POTENTIAL ENERGY is stored energy. It is passive and doesn't do work until it is released. Energy is in its potential state when in chemical, gravitational, mechanical, and nuclear forms.

KINETIC ENERGY is energy in motion or active energy. Energy is in its kinetic state when in radiant, thermal, sound and electrical forms.

The water that is stored within the faucet waiting to fall through the hose and into the PowerWheel has POTENTIAL energy. As the water moves from the faucet through the hose and into the PowerWheel, that water is in motion and is in it's KINETIC form.



A At the swing's highest point on either side when it is no longer in motion, the swing has <u>all</u> potential energy.

B At the lowest point (assuming y=0) the potential energy has become <u>all</u> kinetic energy.

At all points between A and B, the swing has a mix of both potential and kinetic energy.

Types of Energy

As water flows through the PowerWheel we witness energy in many of its different states. Each state is a form of either potential or kinetic energy.

MECHANICAL ENERGY is unique because it can exist in both kinetic and potential forms. It is the energy an object holds due to its position or its motion. When the PowerWheel is running, the wheel itself possesses mechanical energy.

ELECTRICAL ENERGY is the energy produced by electrons moving through a substance, usually a wire. The PowerWheel's generator converts mechanical energy into electrical energy.

THERMAL ENERGY or heat energy is caused by the vibration and movement of the atoms and molecules within a substance. When electrical energy reaches the PowerWheel's LED light strip, some is converted into thermal energy.

RADIANT ENERGY is energy that travels in waves - visible light, x-rays, gamma rays and radio waves. The electrical energy produced by the PowerWheel's generator can be converted into radiant energy by attaching a light bulb or radio.

CHEMICAL ENERGY is a form of potential energy. It is energy that is stored in the bonds of atoms and molecules. When the PowerWheel is used to charge a battery, electrical energy becomes chemical energy.

Electricity

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ELECTRICITY is one of the most important types of energy. It is the collection of physical effects related to the force and motion of electrically charged particles.

Though electricity cannot be seen, heard or smelt, we know about it by what it does: it produces light, heat, magnetism and chemical effects. Electricity is not a source of power itself, it is a form of energy that has come from an original source (falling water, solar energy, the heating of gases or water). Most often, energy is transformed into electricity by means of an electric generator.

Electric Generators

An ELECTRIC GENERATOR is a machine that produces electricity by transforming mechanical energy into electrical energy. This transformation occurs because of the special relationship between electricity and magnetism. The branch of physics that studies this relationship is electromagnetism.

ELECTROMAGNETISM is based on the facts that: (1) an electric current produces a magnetic field and (2) a changing magnetic field produces an electric current. This process is called electro-magnetic induction.

Electric Current

ELECTRIC CURRENT is the flow of electric charge through a medium. There are two types of electric current abbreviated as AC and DC. A RECTIFIER is a used to switch between these two types of current.

DC DIRECT CURRENT flows in one direction only.

AC ALTERNATING CURRENT reverses the direction of its flow many times a second.

Electricity

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An ELECTRIC CIRCUIT is the path followed by an electric current. Electricity must flow in a circuit to do something useful. A circuit has three parts:

1. SOURCE of electric energy (eg. PW's generator)
2. OUTPUT DEVICE which uses the electrical energy to do something useful. (eg. LED light strip)
3. CONNECTION between the source and the output device. (eg. wires)

Measuring Electricity

VOLTAGE (V)	=	CURRENT (I)	X	RESISTANCE (R)
Voltage (V) measures the force of electrons pushing through a conductor, and overcoming the resistance. Unit: VOLTS		Current (I) is a measurement of the number of electrons flowing per second through a conductor. Unit: AMPS		Resistance (R) measures the resistance a conductor offers to the flow of electric current. Unit: OHMS

Electrical Power *(P)*

ELECTRICAL POWER is the rate of electric energy being used. It is measured in WATTS.

$$P = V \times I$$

Horsepower is also a measure of power. 1 hp = 746 Watts (0.746 kilowatts)
Power usage for your home is often measured in kilowatt/hours (kWh) - the number of kilowatts of power used over a one hour period.
How many kilowatt hours of electricity do you use in your home?

5-12 Find the figures for the voltage and current used by 5 common electrical devices. Using the power equation, have students solve for the watts used by each device. Next have them put the list in order from least power usage to greatest. Discuss with them what they find.

Turbines

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A TURBINE is a wheel turned by the force of moving fluids. TURBINES are among the simplest and most powerful machines.

A turbine does not create power but it is an integral part of the process of converting energy from its kinetic state to its mechanical state so that a generator can convert it into electricity.

Water Turbines

There are two main types of hydro turbines. Choosing which type is right for a specific location is done by considering the height of standing water - referred to as *head* - and the flow, or volume of water, at the site.

An IMPULSE TURBINE is driven by a high-speed stream of water directed against blades or buckets attached to a wheel. Impulse turbines work best with a tall head and a low volume. The PowerWheel uses a specific type of impulse turbine called a **Pelton Wheel**.

A REACTION TURBINE is mounted on a vertical shaft and is completely submerged under water. It is turned by the pressure and flow of the water upon it. Reaction wheels work best where there is a high volume and a short head.

Other Turbines

Steam

Steam turbines are some of the world's most powerful machines. They use high pressure steam to operate.

Gas

These work like steam turbines, but use hot gases directly, instead of using them to heat water into steam.

Wind

Wind turbines use blades attached to a shaft to harness the power of the wind.

K-8 Investigate the source of power for electricity in your town. Where is the nearest hydroelectric generator? Does it use impulse or reaction turbines? Why?

Large Scale Hydro

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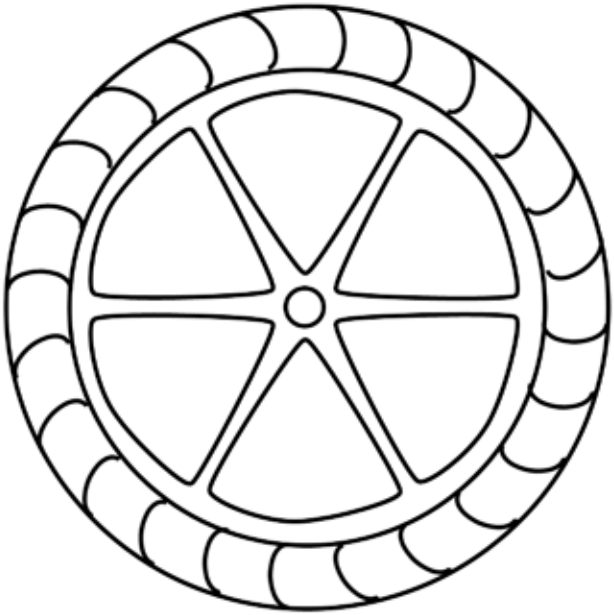
5.5 m
(550cm)

~160 MW
(160,000,000W)



18cm
30W

PowerWheel

New Colgate Powerhouse

New Colgate Powerhouse

New Bullards Bar Reservoir, California

The New Colgate Powerhouse is home to two of the largest Pelton Wheels ever built. To reach the powerhouse, water is carried nearly five miles downstream (which increases the head) from the New Bullards Bar Reservoir, then travels through a 26-foot-diameter tunnel, and plunges down a 15 foot diameter penstock to drive the two turbines which together can produce 315-325 megawatts of power.

Each of the two Pelton Wheels is about 18 feet in diameter (5.5 meters) which is about 30 times bigger than the Power Wheel!

wikipedia.org/wiki/New_Bullards_Bar_Dam
& ycwa.com/about/hydroelectric

Sources of Energy

In this day and age, the demand for energy is HUGE. Where does the energy we use come from? Looking closely at the sources of our energy consumption gives us insight into the impact this usage has on the environment.

Energy sources are generally broken into two categories

Renewable Energy

Describes those sources not easily replenished and can't be "used up." (e.g. solar, wind)

Non-Renewable Energy

Sources that are not easy to replenish. The more we use them, the less we have. (e.g. petroleum, coal)

See next page for list of types

K-2

Energy Detectives: " What energy source am I " game.
Art project: Paper mache the different types of renewables to decorate the classroom.

Energy: Renewable vs Non-renewable

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WATER!! Hydropower makes up 7% of the U.S.'s electricity generation. Large scale hydropower relies on dams or other water diversion structures as well as a place where water flows from a higher place to a lower one.

SOLAR energy can be used to heat spaces or water directly. It can also heat other fluids to very high temperatures which produces steam that then allows a turbine to operate a generator which produces electricity. Solar energy can be converted directly into electrical energy with the use of Photovoltaic devices, sometimes known as "solar cells." These cells are arranged into panels that are used on both small (in the case of a flashlight or calculator) and very large scales (arrays of panels that cover many acres and feed into power plants)

WIND: In addition to being used to move sailboats and to effect airplanes flying in the jetstream, wind can be used to create power with the use of a wind turbine. A wind turbine is similar to a water turbine in that it uses blades/buckets, attached to a wheel to harness the kinetic energy of a moving substance (in this case air) which powers a generator and thus creates electricity.

BIOMASS: Biomass refers to organic material that comes from living or recently living organisms. Biodiesel and ethanol are biomass by-products that are used as transportation fuel. Wood is used in much of the world for heat and for cooking.

GEOTHERMAL: Geothermal power uses the heat from the earth's core layers to produce steam or to bring water to a temperature that can regulate the interior temperature of a building.

PETROLEUM (OIL) is a fossil fuel* with a quickly dwindling reserve. The U.S. relies heavily on petroleum for transportation, heating, etc. but the risks are high with the overuse of this fossil fuel. Our demand for oil far outreaches the supply available, since what we do have took millions of years to form. When petroleum is burned as fuel it produces a number of byproducts that are harmful to our health and to the environment.

NUCLEAR energy is created by the splitting or combining of atoms. Splitting atoms to release the energy within that atom's nucleus is called NUCLEAR FISSION. When atoms are combined to create a larger atom, energy is also produced. This process is called NUCLEAR FUSION.

COAL is the most abundant fossil fuel* produced in the United States. When it is burned, it creates steam which then powers steam turbines. On top of being a non-renewable energy source, coal can be dangerous to mine, expensive to transport and produces numerous harmful greenhouse gases. It is currently used for almost HALF of all electricity generated in the U.S.

NATURAL GAS, in the form of tiny bubbles of odorless gas, is yet another fossil fuel*. It can be burned to produce heat and light. Natural gas makes up 25% or energy used in the U.S. and is a main source of heating for more than half of American homes. Burning natural gas produces far less harmful emmisions than both coal and oil but drilling, producing and storing the substance have negative environmental impacts.

* 3 out of 4 of the earth's main nonrenewable energy sources are considered FOSSIL FUELS. Fossil Fuels have developed from the remains of plants, animals and plankton that have been buried within the earth for millions and millions of years.

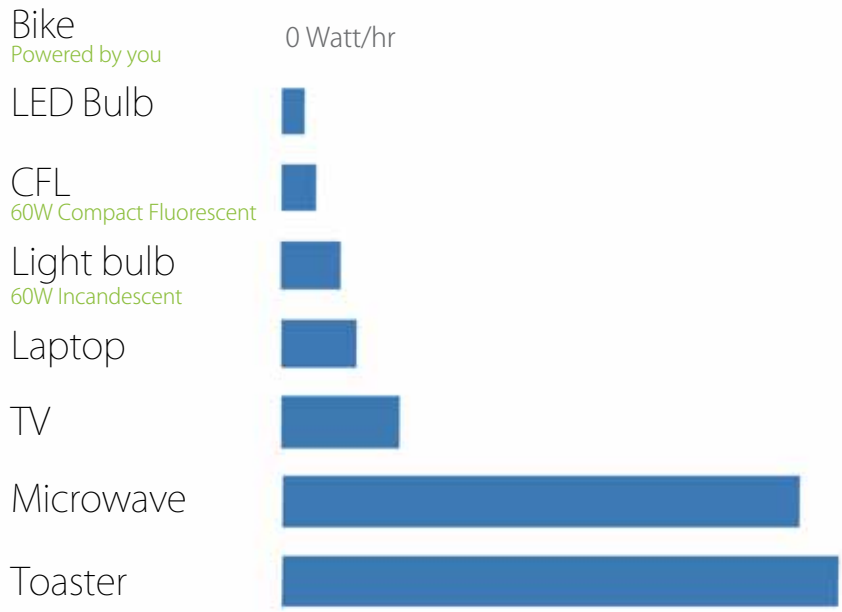
All Plan a city that is completely renewable or "clean." Where will power and electricity come from? How will you harness the earth's renewable resources. What is unique about the area that you can take advantage of? A river? Lots of wind? What are the biggest challenges? Benefits?

Energy in our lives

As populations and energy demands increase, our reliance on fossil fuels for many of our energy needs, has become increasingly risky. Now is the time to think, learn and teach about clean and renewable energy sources. It's also a great time to look more closely at how we use energy in our own lives. How could we use it more efficiently?

Energy generated in one hour

Energy used in one hour



These are estimates as all appliances are different

Conserving Energy

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Conserving Energy means making choices that result in using less energy.

Energy Efficiency refers to the use of technology that consumes less energy to do a particular function.

	Car	Lights etc.	Fridge	Food
Source of Energy	Gasoline, an oil product.	Approximately 90% of US electricity comes from non-renewables.	Electricity from mostly fossil fuels.	Gas used to transport to a grocery store
Ways to increase Efficiency	Electric cars and hybrids are generally considered cleaner and more efficient	CFLs = 4x more efficient than incandescent. LEDs =10x more efficient.	EnergyStar refridgerators	If you grow your own food, find ways of irrigating efficiently.
Ways to Conserve	Biking, walking and using public transport. Accelerating slowly in a vehicle.	Turn lights off, unplug appliances between uses.	Keep the door closed as much as possible. Let things cool before putting away	Buy local produce Buying in bulk.. Less plastic Less fossil fuels

Kids and Communities are POWERful!
Check out some of the incredible work people like you, both young and old, are doing to conserve energy, promote a clean environment and educate others! rb-mfg.com

Simple Demos

Run the PowerWheel by Hand

Run the PowerWheel by manually by sticking a pencil in the indicated hole. How fast do you need to turn it to light the LEDs?

Alter the Brightness

Can you alter the brightness of the bulb by regulating the water flow from the faucet?

Measure the Current

Use an ammeter to measure the electrical current generated at different flow rates.

Charging Batteries

Can you determine how long it would take to charge a rechargable AA battery?

Create Your Own Water Pressure

Place a 5 gallon water jug up high and run a hose from it to the PowerWheel. How much energy does it generate?

PowerWheel and Beyond

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Energy History

Human's relationship with energy production has a fascinating history. Follow the sequence of discoveries that have brought us from sheer muscle power as the primary source of energy, to the intricately mechanized and electrified society of today.

Water in our World

The PowerWheel is a great starting point for broader studies of water. Hydropower is an important example of one of the many varied roles water serves in our lives.

Hydro studies

Use the PowerWheel as an entry point for a deeper study of Hydropower. Explore the history, evolution, technologies and current uses of water's incredible POWER.

Renewable energy

There are endless opportunities to take a deeper look at renewable sources of energy. How are they integrated, if at all, into your city or town? Compare and contrast the different 'clean' energy sources.

Turbines

The world of turbines is vast! Along with the Pelton Wheel turbine used here in the PowerWheel, there are many forms and functions that turbines serve in today's world.

Installations

Check out our website for alternative installations of the PowerWheel. If you have documentation of your PowerWheel in use in your home or school, share it with us at rb-mfg.com!