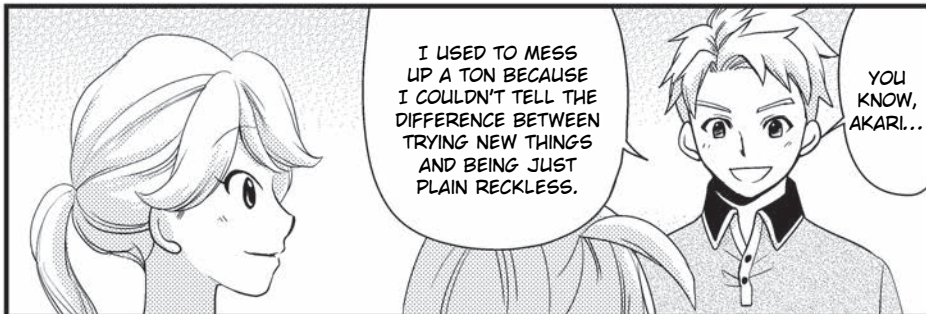
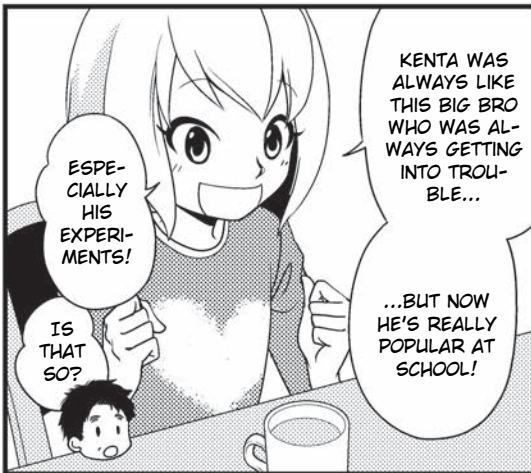
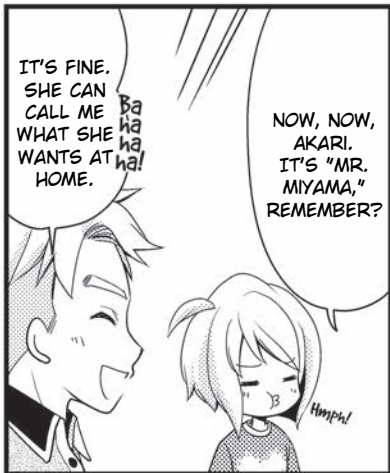
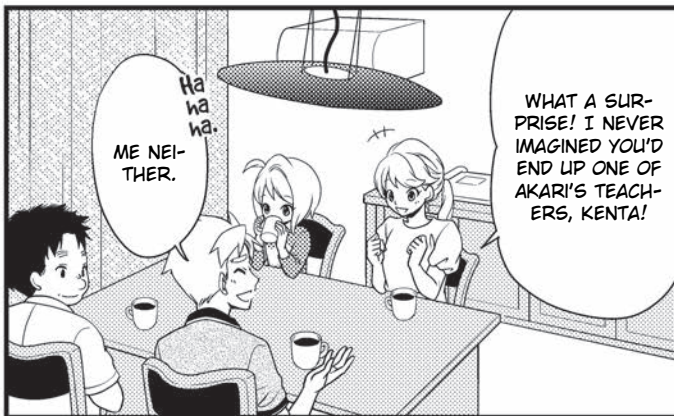


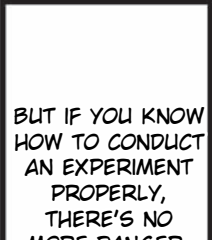
# HOW IS ELECTRICAL ENERGY CREATED?





NAH, I'VE STILL GOT A LONG WAY TO GO.

WELL, LOOK AT WHAT A FINE ADULT YOU'VE BECOME, KENTA.



BUT IF YOU KNOW HOW TO CONDUCT AN EXPERIMENT PROPERLY, THERE'S NO MORE DANGER. IT'S NOTHING BUT FUN!

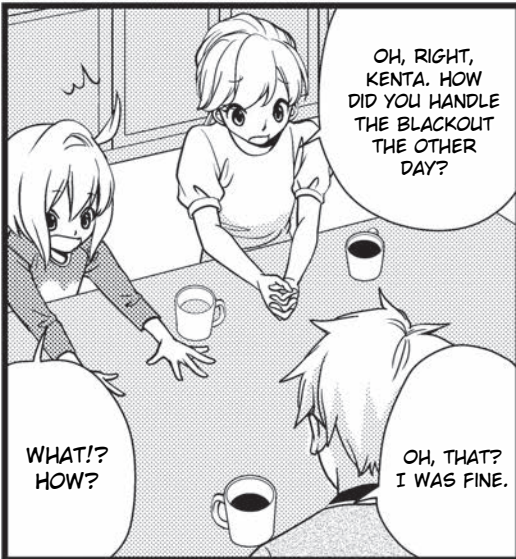


KENTA'S REALLY CHANGED NOW THAT HE'S ALL GROWN UP.

EXPERIMENTING WITHOUT BEING RECKLESS, HUH...



GRIP



OH, RIGHT, KENTA. HOW DID YOU HANDLE THE BLACKOUT THE OTHER DAY?

WHAT!? HOW?

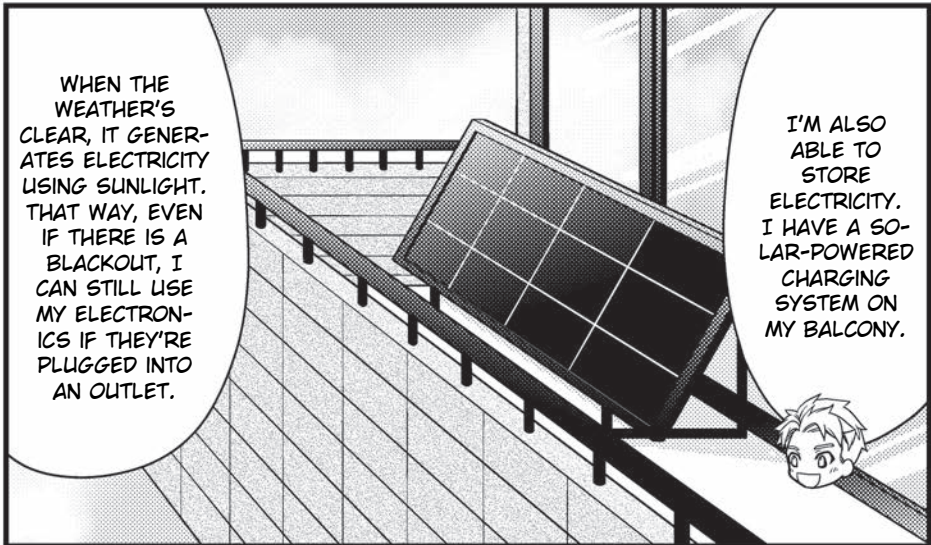
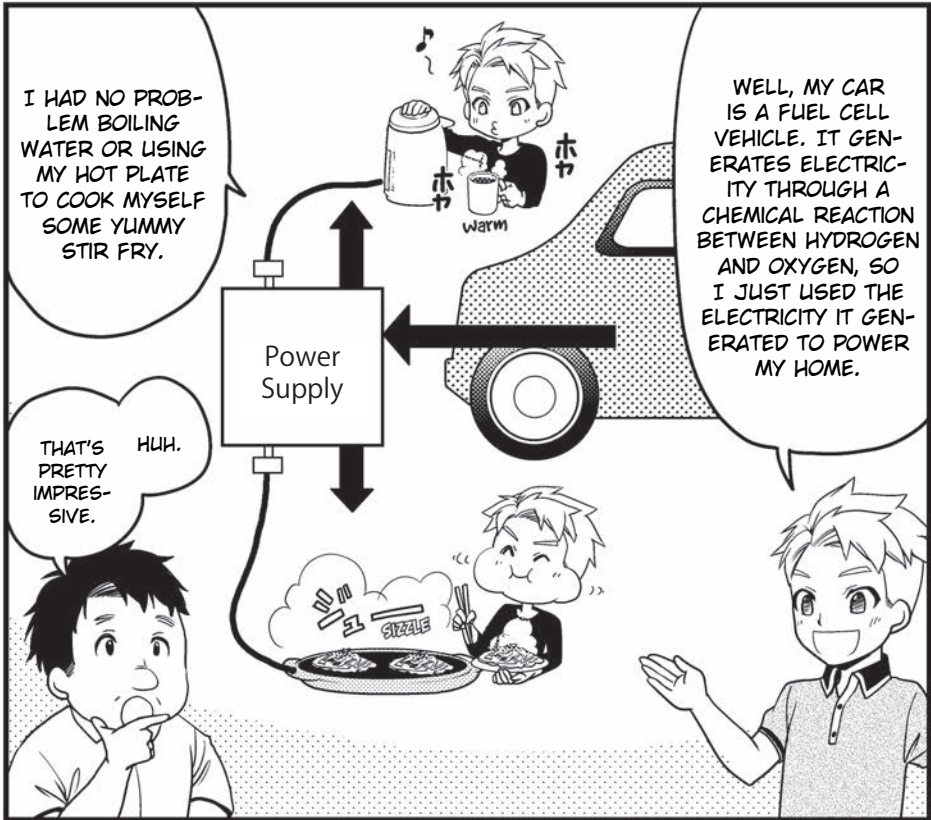
OH, THAT? I WAS FINE.



I WONDER WHAT SORT OF GROWN-UP I'LL BECOME?

Space not  
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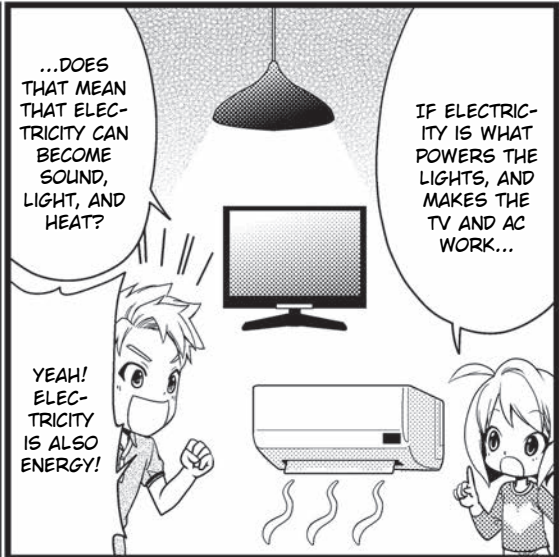
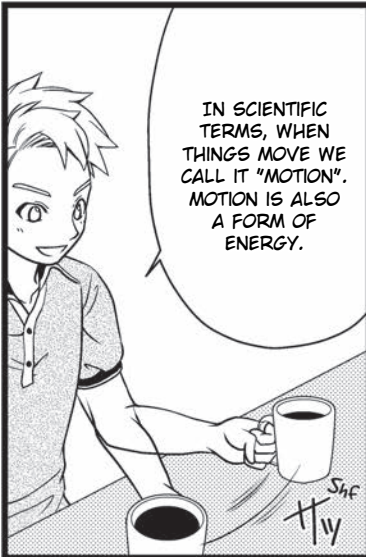
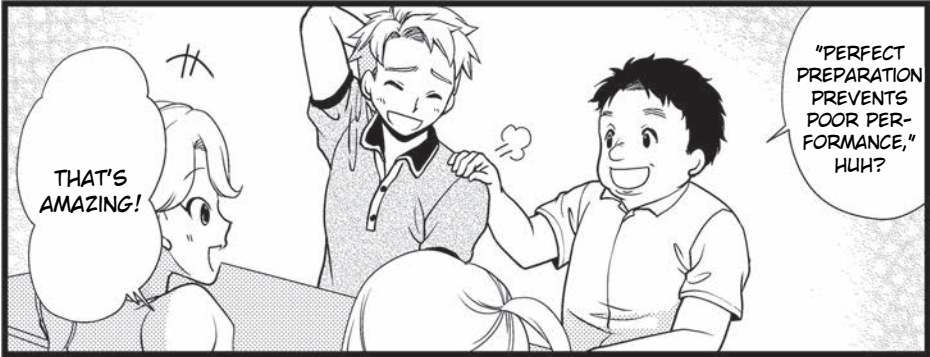




# CHAPTER 2: HOW IS ELECTRICAL ENERGY CREATED?

TRIVIA

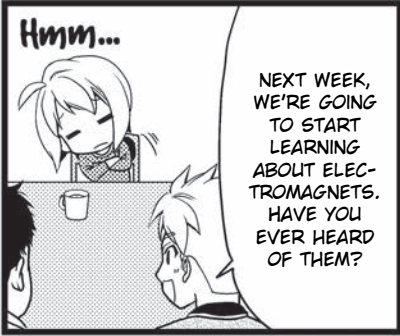
AN INCANDESCENT LIGHT BULB CHANGES ELECTRICITY INTO HEAT, THEN THAT HEAT CREATES LIGHT, BUT LED LIGHT BULBS DIRECTLY CONVERT ELECTRICITY INTO LIGHT, SO THEY SAVE ENERGY.



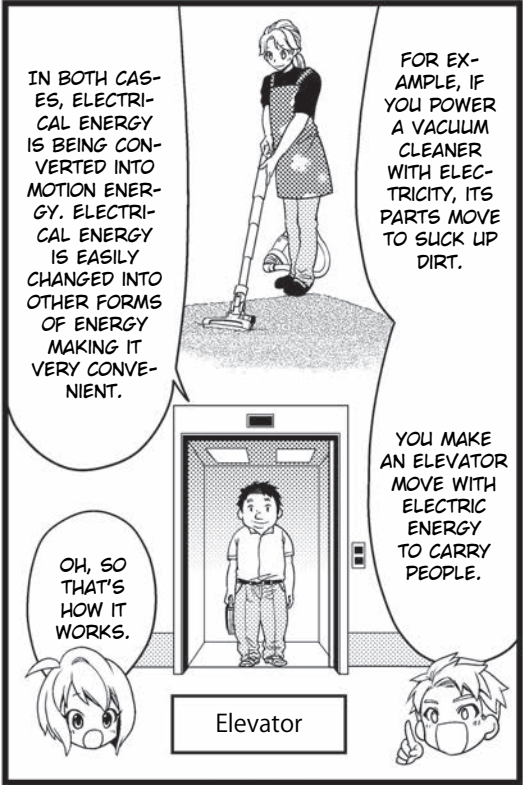


**TRIVIA**

THE EARTH IS A GIANT MAGNET. THE EARTH'S NORTH POLE IS A MAGNETIC SOUTH POLE, WHILE THE EARTH'S SOUTH POLE IS A MAGNETIC NORTH POLE. THAT IS WHY A COMPASS NEEDLE POINTS NORTH FOR N AND SOUTH FOR S.



Hmm...  
NEXT WEEK, WE'RE GOING TO START LEARNING ABOUT ELECTROMAGNETS. HAVE YOU EVER HEARD OF THEM?



IN BOTH CASES, ELECTRICAL ENERGY IS BEING CONVERTED INTO MOTION ENERGY. ELECTRICAL ENERGY IS EASILY CHANGED INTO OTHER FORMS OF ENERGY MAKING IT VERY CONVENIENT.

FOR EXAMPLE, IF YOU POWER A VACUUM CLEANER WITH ELECTRICITY, ITS PARTS MOVE TO SUCK UP DIRT.

YOU MAKE AN ELEVATOR MOVE WITH ELECTRIC ENERGY TO CARRY PEOPLE.

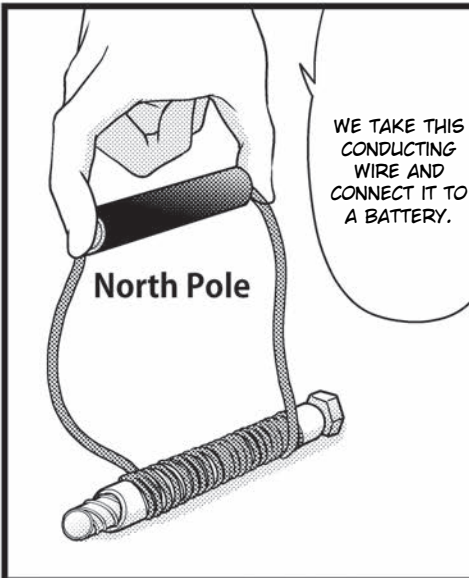
OH, SO THAT'S HOW IT WORKS.

Elevator



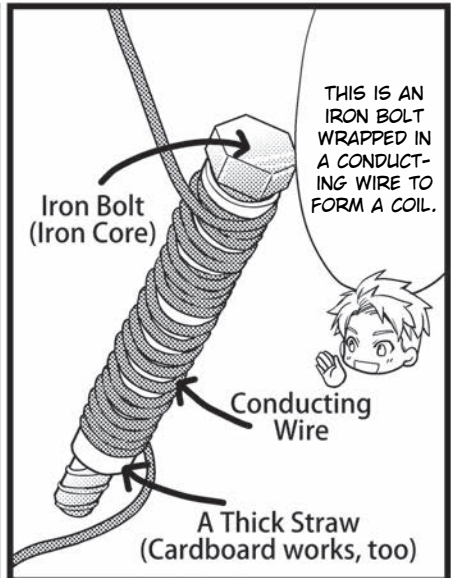
Rummage Rummage

YOU KNOW WHAT? I'VE GOT ONE ON ME.



WE TAKE THIS CONDUCTING WIRE AND CONNECT IT TO A BATTERY.

North Pole



THIS IS AN IRON BOLT WRAPPED IN A CONDUCTING WIRE TO FORM A COIL.

Iron Bolt (Iron Core)

Conducting Wire

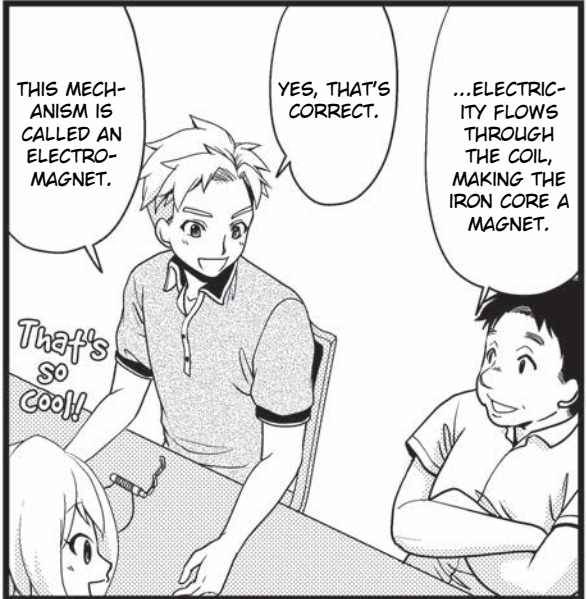
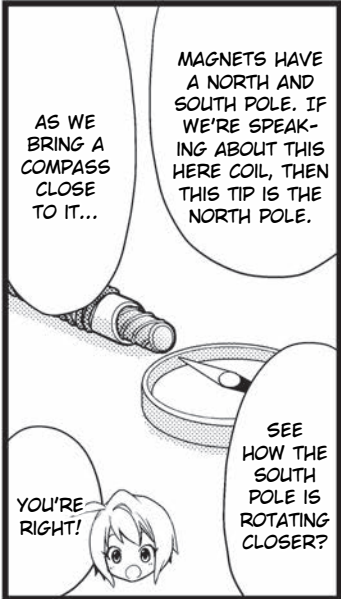
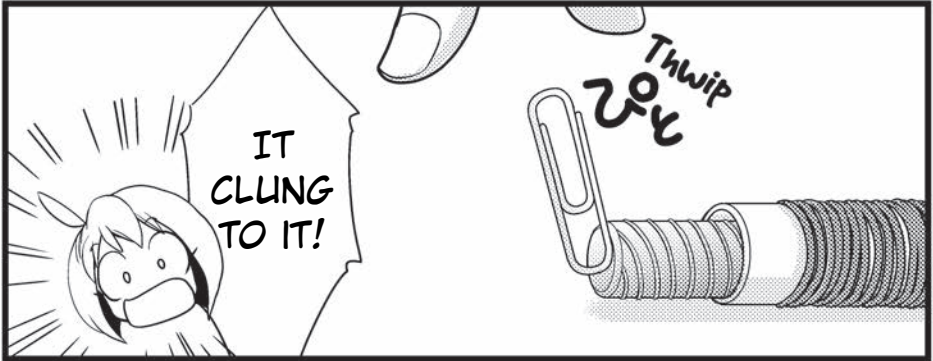
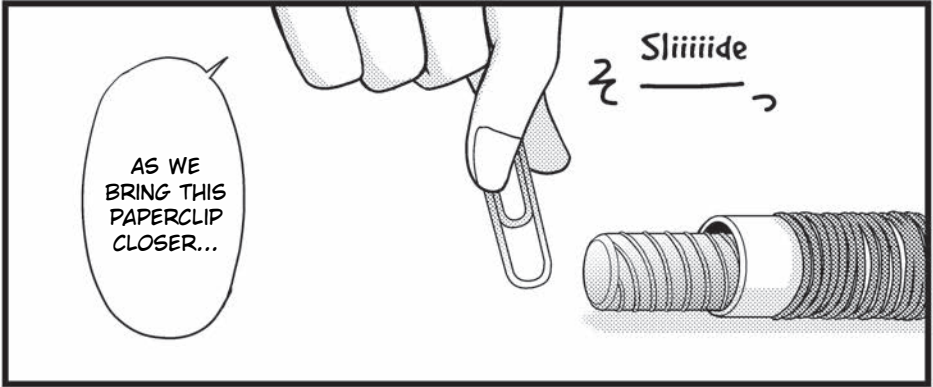
A Thick Straw (Cardboard works, too)

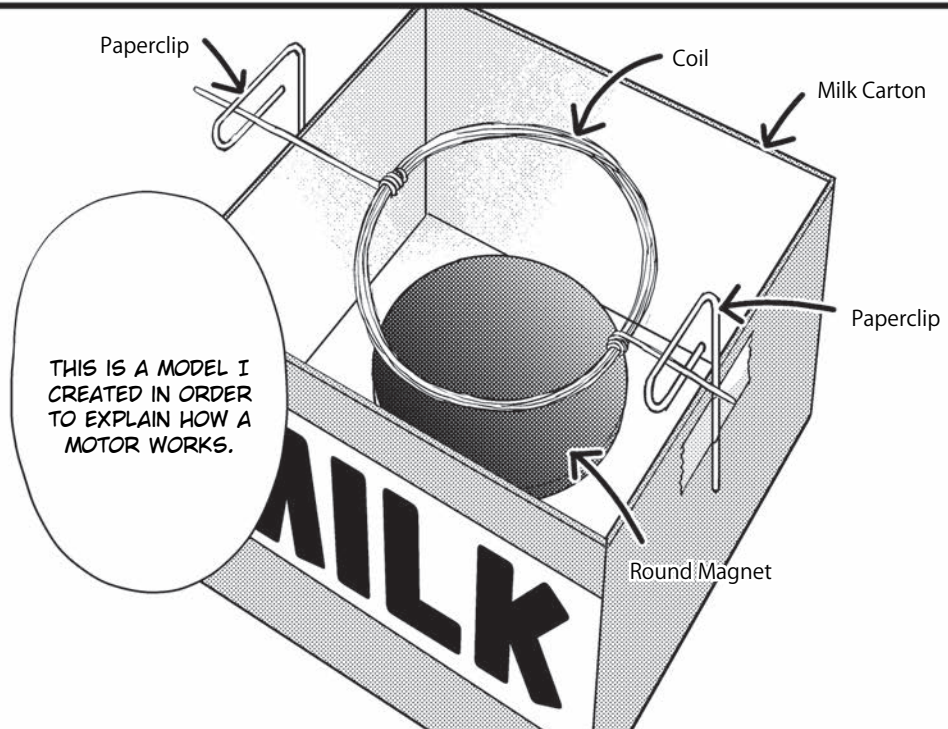
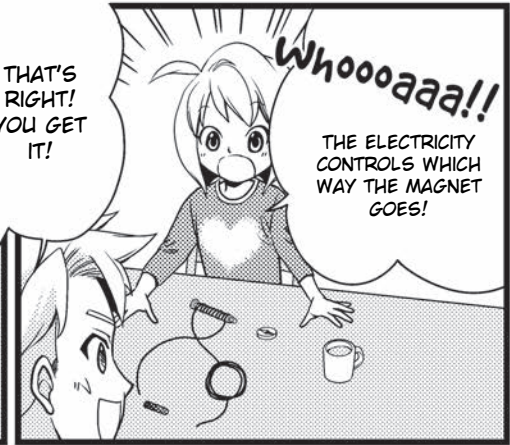
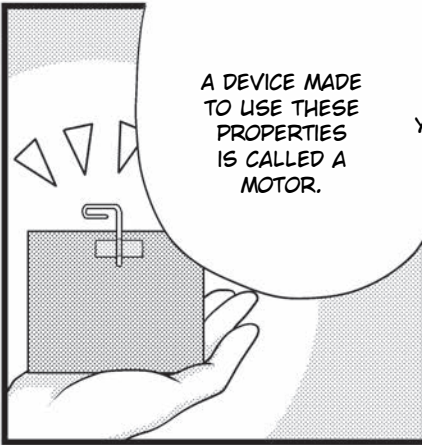
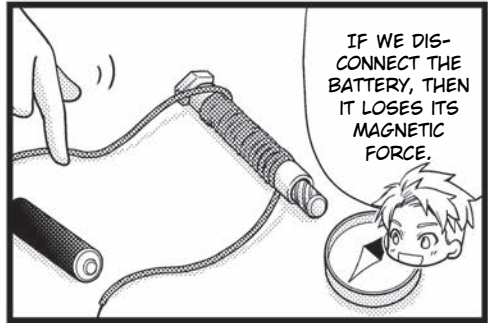
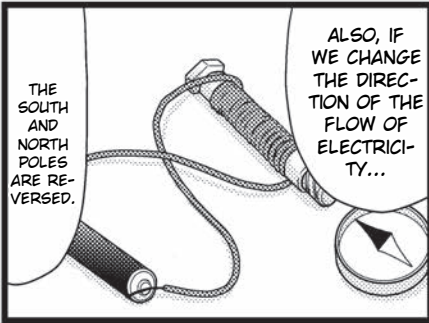


# CHAPTER 2: HOW IS ELECTRICAL ENERGY CREATED?

TRIVIA

EACH TINY GRAIN INSIDE OF IRON HAS ITS OWN NORTH AND SOUTH POLES, BUT SINCE THEY ALL POINT IN DIFFERENT DIRECTIONS, A PIECE OF IRON DOES NOT HAVE MAGNETIC FORCE.



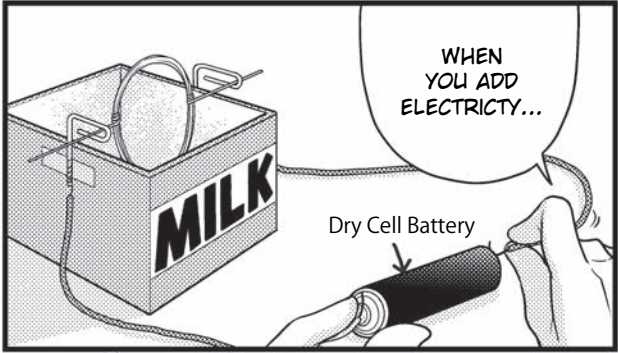




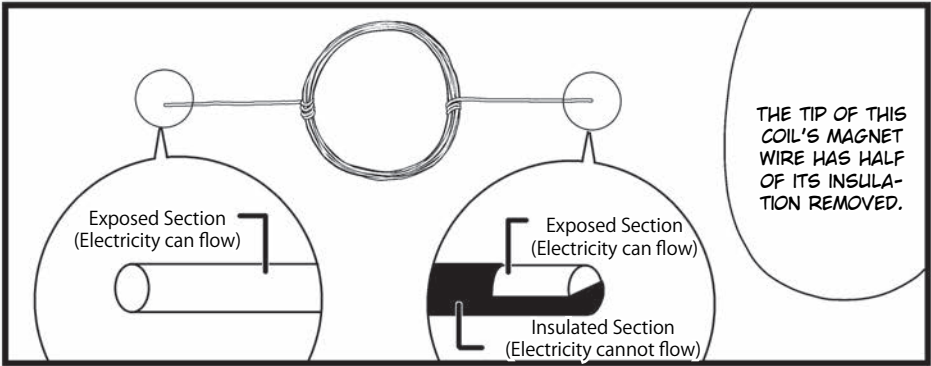
# CHAPTER 2: HOW IS ELECTRICAL ENERGY CREATED?

TRIVIA

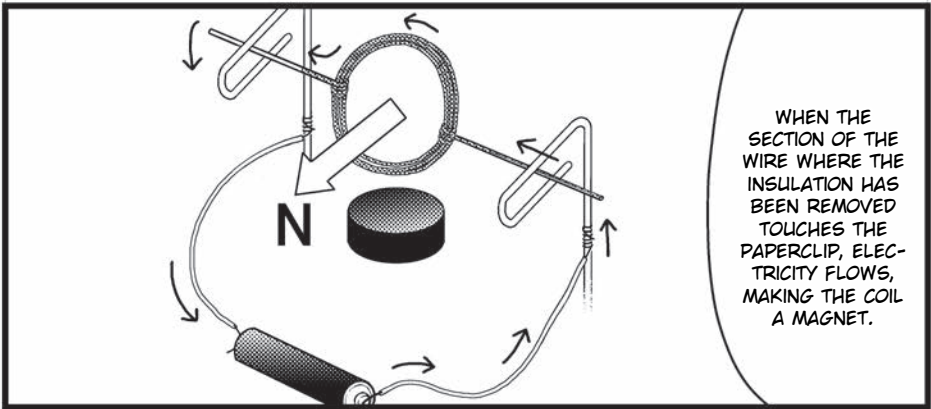
THE LINEAR MOTOR CAR USES ELECTROMAGNETS. THEY ARE CONVENIENT BECAUSE THE POLES CAN BE REVERSED EASILY.







THE TIP OF THIS COIL'S MAGNET WIRE HAS HALF OF ITS INSULATION REMOVED.



WHEN THE SECTION OF THE WIRE WHERE THE INSULATION HAS BEEN REMOVED TOUCHES THE PAPERCLIP, ELECTRICITY FLOWS, MAKING THE COIL A MAGNET.

THE ELECTRICITY STOPS FLOWING.

WHAT HAPPENS IF, RIGHT THEN, THE INSULATED PART TOUCHES THE PAPERCLIP?

**L-h**  
Silence

BUT THEN THE NORTH POLE WILL JUST CONTINUE TO BE DRAWN DOWN TOWARD THE MAGNET BELOW, SO THE SPINNING WILL STOP WHEN IT GETS TO THE BOTTOM, RIGHT?

THE PART UP HERE IS THE NORTH POLE, SO IT'S PULLED TOWARD THE SOUTH POLE OF THE MAGNET BELOW AND BEGINS TO SPIN.

HMM. YEAH, I SEE.



# CHAPTER 2: HOW IS ELECTRICAL ENERGY CREATED?

TRIVIA

WHEN AN ELECTRICAL CURRENT FLOWS THROUGH A CONDUCTING WIRE, A MAGNETIC FIELD IS FORMED AROUND THE WIRE.

**COOL!**

SO THE NORTH POLE MOVES BACK UP TO THE TOP, THE NON-INSULATED PART TOUCHES THE PAPERCLIP, AND THE WHOLE THING REPEATS. THE ROTATIONAL MOVEMENT CAUSED BY THE CHANGE IN THE MAGNET CREATES A KIND OF MOTOR.

SO IT JUST KEEPS MOVING WITH THE MOMENTUM IT'S SAVED UP.

OH, I GET IT! THEN IT WON'T BE PULLED TOWARD THE MAGNET ANYMORE.

CORRECT. IF WE DO THAT, IT LOSES ITS MAGNETIC FORCE.

HAVING THREE COILS ALLOWS THE MOTOR TO ROTATE MORE SMOOTHLY.

OOH!

Magnet

Shaft

Magnet

Coil

Pin

THIS IS A REAL MOTOR. SEE HOW THERE ARE THREE COILS?

THE PARTS ON EITHER SIDE ARE MAGNETS.

REALLY?

MOTORS ARE USED FOR ALL SORTS OF THINGS.



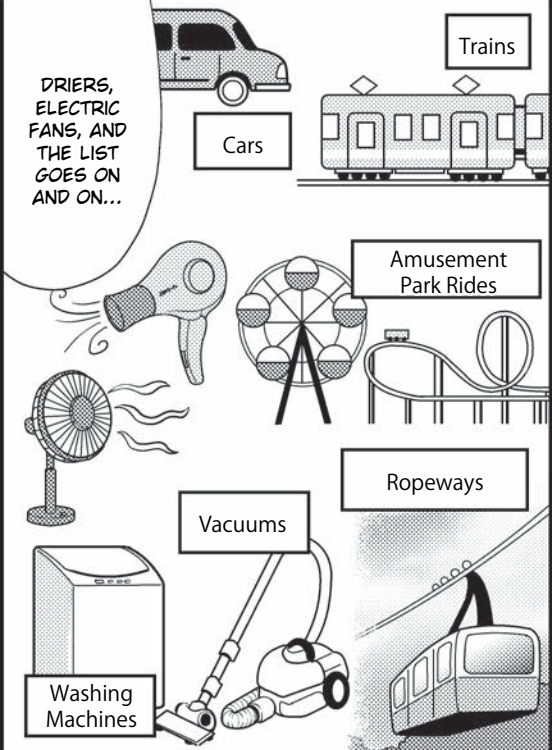
A 19TH CENTURY ENGLISH SCIENTIST.

WHO WAS SMART ENOUGH TO THINK UP THAT?



**MICHAEL FARADAY**  
(1791-1867)  
"THE FATHER OF ELECTROMAGNETISM"

DRIERS, ELECTRIC FANS, AND THE LIST GOES ON AND ON...



Cars

Trains

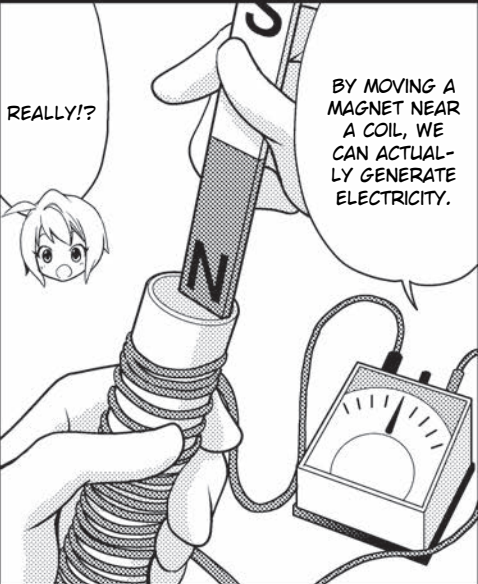
Amusement Park Rides

Ropeways

Vacuums

Washing Machines

REALLY!?

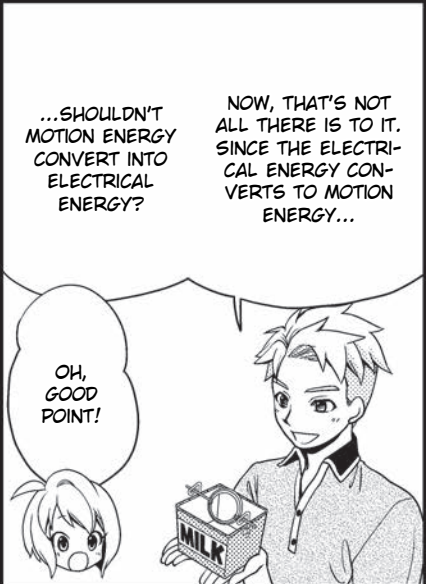


BY MOVING A MAGNET NEAR A COIL, WE CAN ACTUALLY GENERATE ELECTRICITY.

...SHOULDN'T MOTION ENERGY CONVERT INTO ELECTRICAL ENERGY?

NOW, THAT'S NOT ALL THERE IS TO IT. SINCE THE ELECTRICAL ENERGY CONVERTS TO MOTION ENERGY...

OH, GOOD POINT!

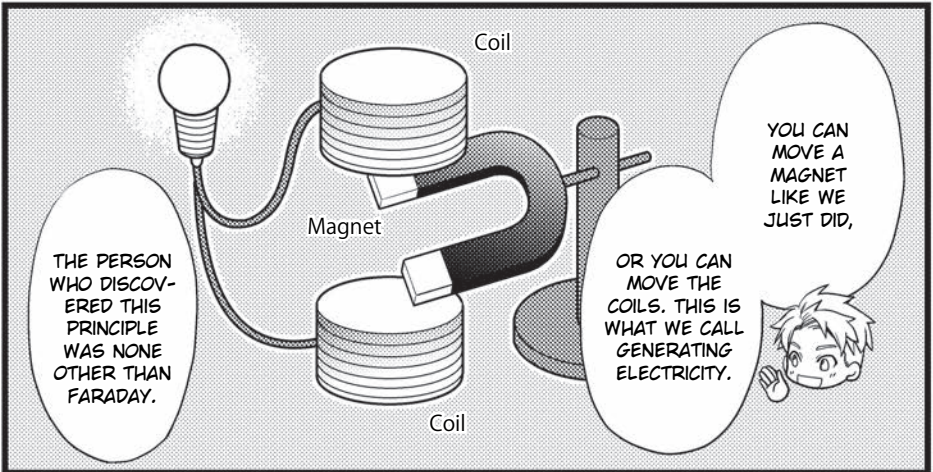
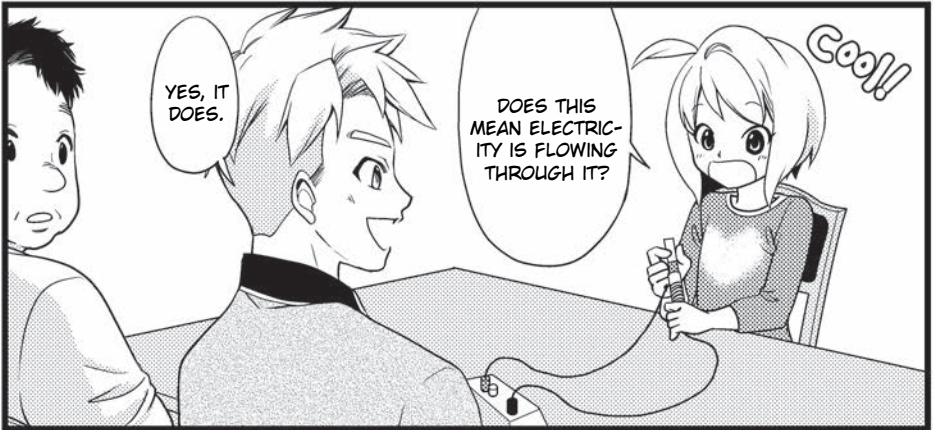
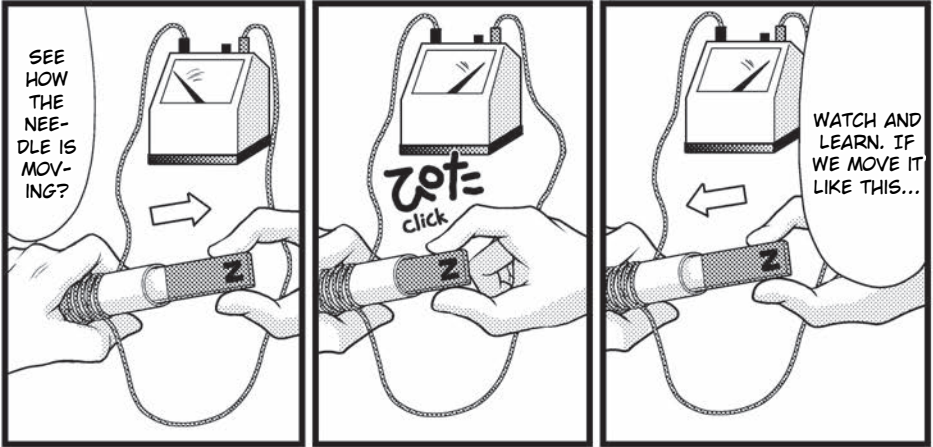




# CHAPTER 2: HOW IS ELECTRICAL ENERGY CREATED?

TRIVIA

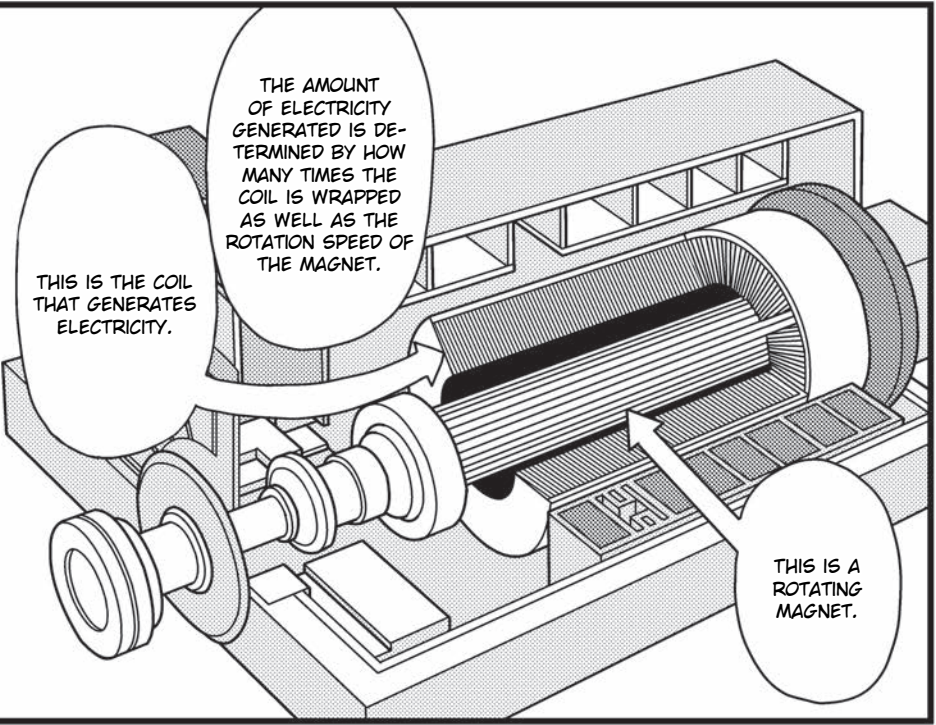
MOVING EITHER COILS OR MAGNETS INSIDE OF A MAGNETIC FIELD TO PRODUCE AN ELECTRIC CURRENT IS CALLED "ELECTROMAGNETIC INDUCTION."





TRIVIA

THE MAGNETS THAT ROTATE INSIDE OF GENERATORS IN POWER STATIONS ARE CALLED ELECTROMAGNETS.





# CHAPTER 2: HOW IS ELECTRICAL ENERGY CREATED?

## TRIVIA

WAVE POWER, WHICH GENERATES ELECTRICITY THROUGH THE RISING AND FALLING OF WAVES IN THE OCEAN, IS USED TO POWER LIGHTHOUSES AND OTHER THINGS. HOWEVER, IT IS NOT ALWAYS RELIABLE.

Energy

High place

Low place

THIS IS CALLED "POTENTIAL ENERGY."

THINGS IN HIGH PLACES POSSESS ENERGY. THIS IS BECAUSE THEY WANT TO FALL DOWNWARDS.

Hydroelectric Power

FOR EXAMPLE, THERE'S HYDROELECTRIC POWER. IT'S A FORM OF GENERATING ELECTRICITY THAT USES A DAM.

Dam

BOOM BOOM BOOM BOOM

WHOOOOOSH!

A DAM COLLECTS WATER AND THEN SYSTEMATICALLY MAKES IT FALL.

IT THEN USES THAT FALLING FORCE TO ROTATE THE IMPELLER.

Rotating Magnet

Coil

Generator

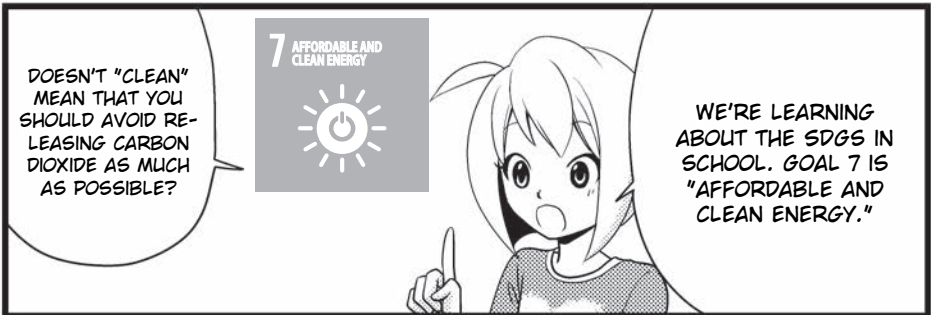
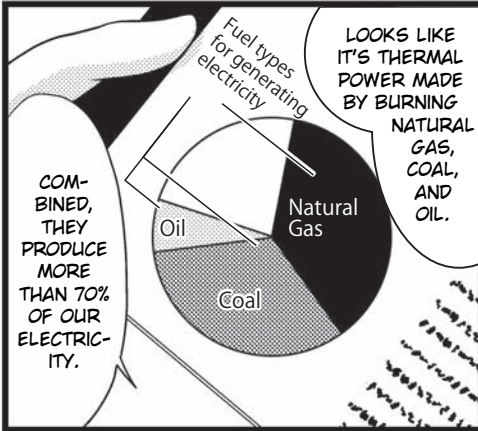
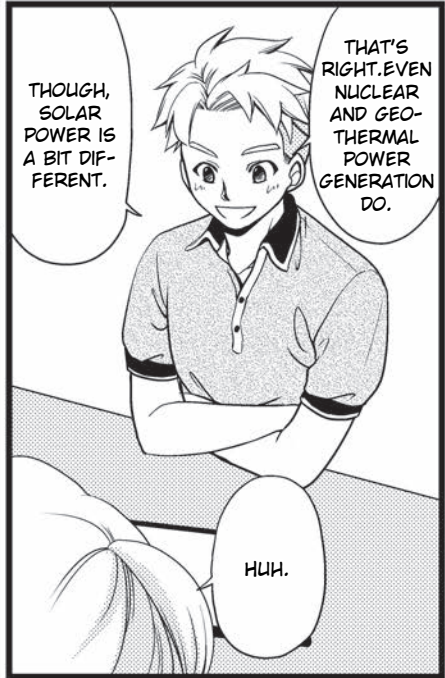
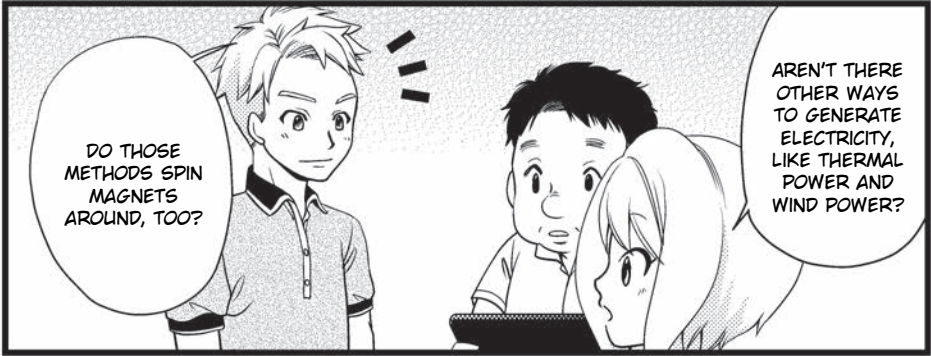
Water Turbine

THE IMPELLERS USED IN HYDROELECTRIC POWER ARE CALLED WATER TURBINES.



That's interesting.







# CHAPTER 2: HOW IS ELECTRICAL ENERGY CREATED?

TRIVIA

RENEWABLE ENERGIES SUCH AS SOLAR, WIND, AND GEOTHERMAL ARE IMPORTANT LOW-CARBON ENERGY SOURCES BECAUSE THEY PRODUCE ELECTRICITY WITHOUT RELEASING GREENHOUSE GASES.

THAT MEANS THAT WE NEED TO CONTINUE TO REDUCE CARBON DIOXIDE EMISSIONS.

AS CLIMATE CHANGE CONTINUES, WE'RE GOING TO FACE EVEN BIGGER PROBLEMS LIKE EXTREME WEATHER AND RISING SEA LEVELS.

Drought

Melting Ice

Islands Sinking

CARBON DIOXIDE IS CONNECTED TO RISING TEMPERATURES.

CORRECT. BURNING EARTH'S PRECIOUS FOSSIL FUELS, SUCH AS OIL, COAL, AND NATURAL GAS, IS CONNECTED TO GLOBAL WARMING.

IT'S ALSO CALLED "RENEWABLE ENERGY."

WHAT'S NATURAL ENERGY?

THIS SAYS THAT KENYA GENERATES 85% OF THEIR ELECTRICITY USING NATURAL ENERGY, PARTICULARLY GEOTHERMAL ENERGY. THAT'S PRETTY REMARKABLE.

OH, WOW!

ZSSSHHH

OH, I SEE...

BUT IT'S NOT ALWAYS RELIABLE. WE ARE TALKING ABOUT NATURE, AFTER ALL.

Whoosh

IT MEANS WAYS OF GENERATING ELECTRICITY THAT USE NATURE'S FORCES LIKE WIND, SUNLIGHT, AND WATER. IT DOESN'T USE UP NATURAL RESOURCES AND DOESN'T RELEASE CARBON DIOXIDE.

Dried up

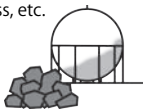



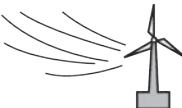
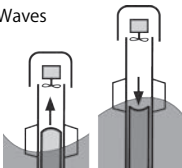
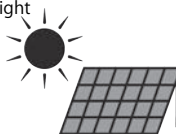
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## DIFFERENT WAYS TO GENERATE ELECTRICITY

THERE ARE MANY METHODS FOR GENERATING ELECTRICITY. NUMBERS ONE THROUGH SIX ROTATE MASSIVE COILS AND MAGNETS TO GENERATE ELECTRICITY. LET'S EXAMINE THE CHARACTERISTICS OF EACH.

Method	Fuel & Natural Resources	Benefits	Drawbacks
<p><b>1. Thermal Power</b> Uses the heat created from burning fossil fuels to rotate turbines, which turn the generators.</p>	<p>Natural gas, coal, biomass, etc.</p> 	<ul style="list-style-type: none"> <li>• Can reliably generate large amounts of electricity.</li> <li>• Amount of energy generated can be adjusted.</li> </ul>	<ul style="list-style-type: none"> <li>• Produces carbon dioxide.</li> <li>• Natural resources are finite.</li> </ul>
<p><b>2. Hydroelectric Power</b> Uses the force of water falling to rotate turbines, which turn the generators.</p>	<p>Water in a dam</p> 	<ul style="list-style-type: none"> <li>• Doesn't produce carbon dioxide.</li> <li>• If the dam has enough water, it can quickly generate electricity when needed.</li> </ul>	<ul style="list-style-type: none"> <li>• Constructing dams has a massive impact on the surrounding environment.</li> </ul>
<p><b>3. Geothermal Power</b> Uses the heat from underground magma to rotate turbines, which turn the generators.</p>	<p>Magma</p> 	<ul style="list-style-type: none"> <li>• Doesn't use up natural resources.</li> <li>• Doesn't produce carbon dioxide.</li> <li>• Can produce electricity around the clock and is unaffected by the weather.</li> </ul>	<ul style="list-style-type: none"> <li>• Only available in certain areas.</li> </ul>
<p><b>4. Nuclear Power</b> Nuclear Power Generation makes use of thermal energy generated by the nuclear fission to turn the generator by rotating a turbine.</p>	<p>Uranium</p> 	<ul style="list-style-type: none"> <li>• Stable generation of large amount of electricity with a small amount of fuel.</li> <li>• Zero CO<sub>2</sub> emissions during operation.</li> </ul>	<ul style="list-style-type: none"> <li>• Radioactive waste.</li> <li>• Need to take safety measures in case of an accident.</li> </ul>
<p><b>5. Wind Power</b> Uses the power of wind to rotate propellers, which turn the generators.</p>	<p>Wind</p> 	<ul style="list-style-type: none"> <li>• Doesn't use up natural resources.</li> <li>• Doesn't produce carbon dioxide.</li> </ul>	<ul style="list-style-type: none"> <li>• Amount of electricity generated depends on the direction and strength of the wind.</li> </ul>
<p><b>6. Wave Power</b> Uses the rising and falling of waves to cause the expansion and contraction of air inside containers to rotate turbines.</p>	<p>Waves</p> 	<ul style="list-style-type: none"> <li>• Doesn't use up natural resources.</li> <li>• Doesn't produce carbon dioxide.</li> </ul>	<ul style="list-style-type: none"> <li>• Very difficult to construct structures that can withstand the frequently changing ocean environment and severe weather such as typhoons and high tides.</li> </ul>
<p><b>7. Solar Power</b> Uses sunlight to make the electrons inside solar batteries move, generating electricity.</p>	<p>Light</p> 	<ul style="list-style-type: none"> <li>• Doesn't use up natural resources.</li> <li>• Doesn't produce carbon dioxide.</li> </ul>	<ul style="list-style-type: none"> <li>• Amount of electricity generated depends on the weather.</li> </ul>