science generation

DELIVERING POWER TO THE PEOPLE

SCIENCE ACTIVITIES

SUPPLEMENTARY ACTIVITIES FOR OTHER CONTENT AREAS

FOCUS WORDS

Reader's Theater

Bike Power

Setting: Hamza and Cooper are sitting in the school cafeteria discussing some new equipment they saw in P.E. class the previous period. Olivia walks up and joins them.

Hamza: I hate them.

Cooper: I think they're great! Perfect for me to work out for my triathlon.

Olivia: What are you guys arguing about?

Hamza: Those stupid exercise bikes they just put in the gym.

Olivia: So Hamza, you're not into cardio fitness?

Hamza: P.E. is for sports! What does fitness have to do with it?

Cooper: Well, I think it has everything to do with it. The bikes are there to get more students into shape. Not everyone is into sports like you are.

Olivia: I haven't seen this equipment yet. Is it new?

Cooper: Yeah, Coach Thompson said they were supposed to come in at the beginning of the year, but since she wanted the kind that doesn't plug in, they took longer to get here from the factory, I guess.

Hamza: Wait, they have to plug in somehow. They need some way to get **current**. Didn't you see that they have a digital readout and a place to **charge** your phone? That's the only cool thing about them!

Cooper: That's just it! The **power** it takes to light the display comes from spinning the pedals around.

Olivia: You mean there's a **generator** inside the bike that turns motion into electricity?

Cooper: Right.

Hamza: That's ridiculous. You can't create electricity just by spinning something around.

Olivia: I have one word to say to you, Hamza...

Hamza: Yeah?

Olivia: Windmill.

Hamza: Oh, yeah.

Cooper: She so got you, dude.

Hamza: But a windmill is huge! Bike pedals can't do what windmills do.

Olivia: True. Bike pedals can **charge** your phone and light up the display, but wind turbines can put out a megawatt. That's enough to **power** 500 houses!

Hamza: Mega what?

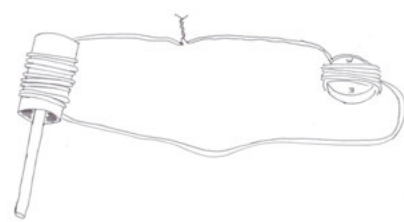
Cooper: Watt. Not what.

Hamza: What?

Olivia and Cooper: WATT!

Cooper: You know what a watt is. Ms. Q went over that last week.

Hamza: Oh, *watt*! Like with light bulbs. Why didn't you just say so? I remember that from when we made **generators** in science class. That was kind of fun.



Olivia: Right, and remember how Ms. Q wouldn't tell us why we needed that cardboard tube from the toilet paper rolls?

Cooper: Hamza didn't listen and brought a full roll to school! *(They laugh.)*

Hamza: I forgot about that part. I did get a lot of weird looks on the way to school that day.

Olivia: ANYWAY, so windmills have a bigger version of **generators** that **transform** kinetic wind energy to electrical energy.

Cooper: That's like the **transformation** from the kinetic energy of pedaling to electrical energy on those COOL bikes that Hamza hates.

Hamza: Okay, I guess I don't *hate* them... In fact, maybe if we sat on those bikes in all our classes instead of sitting at desks that we could supply **power** to the whole school.

Olivia: Hmmm.... Very cool idea, but do you really think we could sustain that long term? Seems like we'd get tired.

Cooper: We'd definitely have to **fuel** up with a good breakfast and the occasional energy bar. But I'm trying to picture myself learning algebra on a bike. I don't know if I could concentrate.

Reader's Theater

Bike Power

Hamza: *(more excited)* But think of all the energy we would **conserve**! Plus, if we got solar cells and windmills on the roof we'd be like *Rockin' Renewable Middle School* baby!

Olivia: Fun ideas, Ham, but I say we reduce our use of electricity instead of going crazy with all that stuff. We can start with light bulbs.

Hamza: Booooring!

Cooper: No, it's true. We already have the technology to make more light using less electricity. They're called energy-**efficient** lights. They cost more, but they last longer and use less **power**. Hamza, you might even be able to light one up with the watts you create pedaling one of those COOL new bikes in P.E.

Hamza: Not so cool.

Olivia and Cooper: Cool!

Hamza: Okay. Maybe a little cool.

In the Reader's Theater, Cooper says, "The **power** it takes to light the display comes from spinning the pedals around."

TURN AND TALK

In this situation, what does **power** mean? Come up with a tentative definition and write it below as Version 1.

Definition of **power**:

Version 1: ______________________________

____

Version 2: ______________________________

____

Version 3: ______________________________

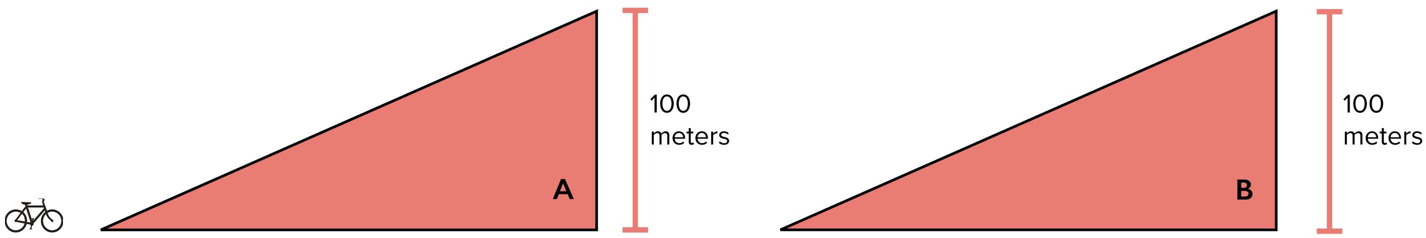
____

Version 4: ______________________________

____

More About Power

Biking Uphill



Look at the diagrams above of two identical hills and a bicycle.

If you pedaled the bike up Hill A and then later up Hill B, which time did you do more work?

Neither, of course! It's the exact same task each time.

Okay, here is where things get a little weird:

Let's say you rode up Hill A in 1 minute and Hill B in 2 minutes. Which time did you do more work?

- ☐ Hill A in 1 minute is more work.
- ☐ Hill B in 2 minutes is more work.
- ☐ Both situations are the same amount of work.

It's still the same amount of work. Really! Yes, it was probably much more difficult to pedal up Hill A in one minute than it was to pedal up Hill B in 2 minutes. But that doesn't matter when you're measuring work.

Huh?

You are probably thinking: "But why is it more exhausting to pedal up a hill fast?"

Hmmm… You're on to something here. The 1-minute climb up the hill and the 2-minute climb up the hill were indeed different situations. But how?

TURN AND TALK

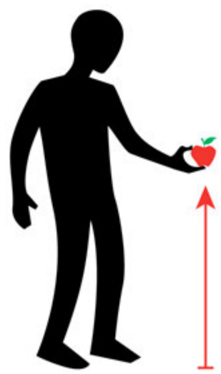
Which takes more **power** to pedal up?

- ☐ Hill A in 1 minute takes more **power**.
- ☐ Hill B in 2 minutes takes more **power**.
- ☐ Both situations use the same **power**.

It definitely took more **power** to pedal up Hill A in 1 minute. Go back to your tentative definition of **power** on the previous page and revise it. (Write your updated definition as Version 2.)

More About Power

Crunching the Numbers



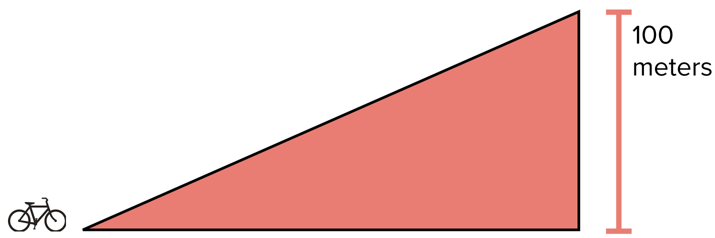
one joule, or

1 J

Let's recap.

It's the same amount of work to pedal up each hill, but it takes more **power** to pedal up the hill faster.

You might remember that work is measured by newton-meters, or joules. One joule is the amount of work it takes to raise something that weighs one newton a distance of one meter. What's something that weighs about a newton? Let's say an apple.



ten thousand joules, or

10,000 J

Based on the idea that it takes 1 joule to put an apple on a shelf, let's make a rough estimate that it takes 10,000 joules to pedal the bike up the hill.

Now, let's think again about your 1-minute climb up Hill A and your 2-minute climb up Hill B:

FAST climb up Hill A:

$$\frac{10{,}000 \text{ joules}}{60 \text{ seconds}}$$

SLOW climb up Hill B:

$$\frac{10{,}000 \text{ joules}}{120 \text{ seconds}}$$

WAIT!

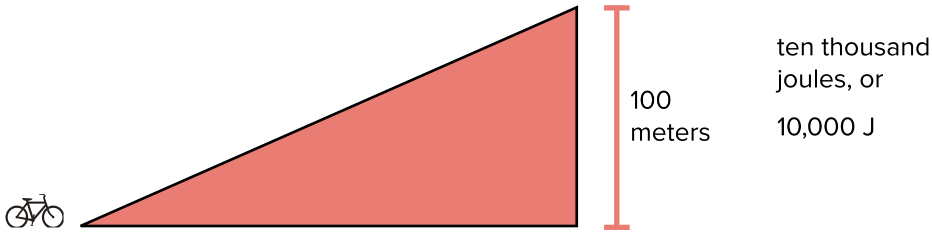
TURN AND TALK

Before you do the math, THINK! Which one is going to be the larger number? Will this number match the situation that you think takes more **power**?

Go back to your tentative definition of **power** on page 3 and revise it. (Write your updated definition as Version 3.)

More About Power

Conclusions



FAST climb: $\frac{\text{10,000 joules}}{\text{60 seconds}}$

SLOW climb: $\frac{\text{10,000 joules}}{\text{120 seconds}}$

$10000 \div 60 = 166.67$

$10000 \div 120 = 83.33$

These two numbers tell you a lot! They describe the **power** of the slow climb and the **power** of the fast climb. **Power** describes how quickly work is getting done.

So, when you pedaled up the hill slowly, you did 10,000 joules of work with a **power** rating of 83.33. When you pedaled up the hill quickly, you did 10,000 joules of work with a **power** rating of 166.67. But what is the unit for measuring **power**? *Watt!*

Reread this section of the Reader's Theater.

Olivia: Bike pedals can **charge** your phone and light up the display, but wind turbines can put out a megawatt. That's enough to **power** 500 houses!

Hamza: Mega what?

Cooper: *Watt*. Not what.

Hamza: What?

Olivia and Cooper: WATT!

Cooper: You know what a watt is. Ms. Q went over that last week.

Hamza: Oh, *watt*! Like with light bulbs. Why didn't you just say so?

Watts are used to describe the amount of **power**. If you pedal up a hill faster, it takes more watts. If a light bulb uses electricity faster, it takes more watts. The engine of a car might use 100 kilowatts (100,000 watts). And the wind turbine that Olivia mentioned is not using watts, but rather supplying watts to homes. A megawatt is one million watts.

Go back one more time to your definition of **power** that you wrote several pages back. Revise it one more time as Version 4, and make sure your definition works with this equation:

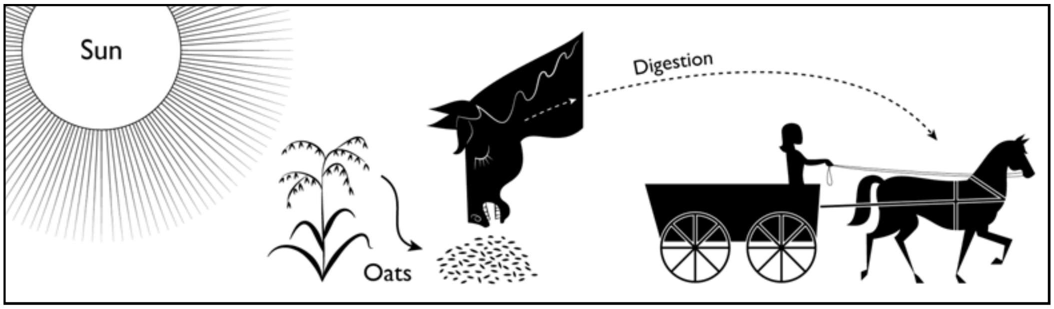
$$\textbf{Power} = \frac{\textbf{Work}}{\textbf{Time}}$$

Speaking Scientifically

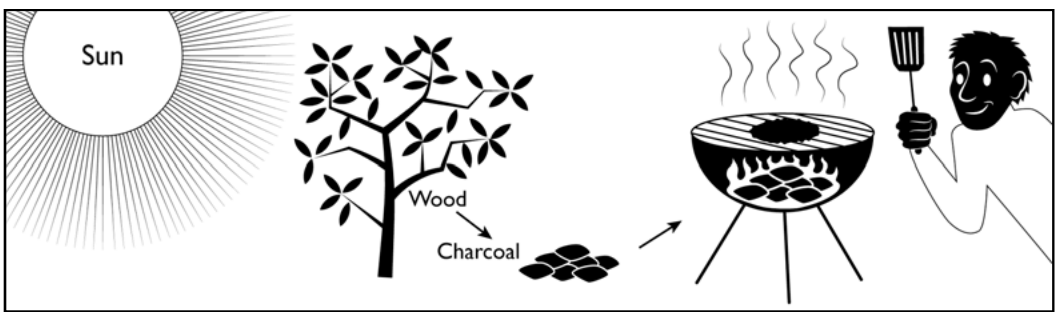
“Generating” electricity? Really? You decide...

Energy can be **transformed** from one type into another, but it can’t be made from nothing. And it can’t disappear. This idea is called “**conservation** of energy.” But **conservation** of energy is different from “**conserving** energy” – a phrase we use a lot to refer to using energy without wasting it.

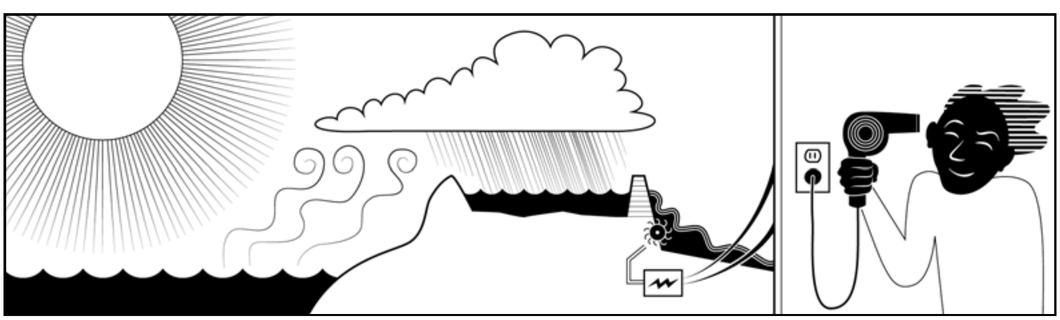
To get used to the idea of **conservation** of energy, try tracing energy as it moves through a system.



Write a caption to describe the flow of energy through this system:

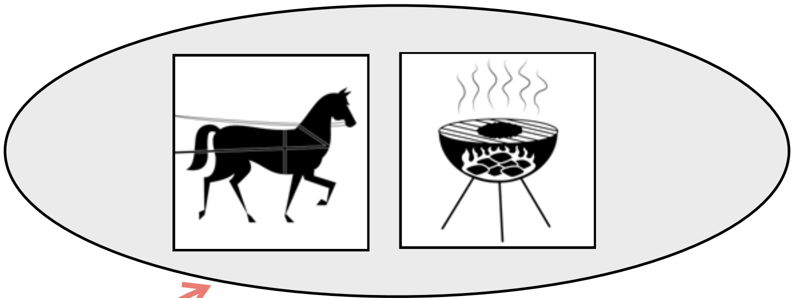


Write a caption to describe the flow of energy through this system:



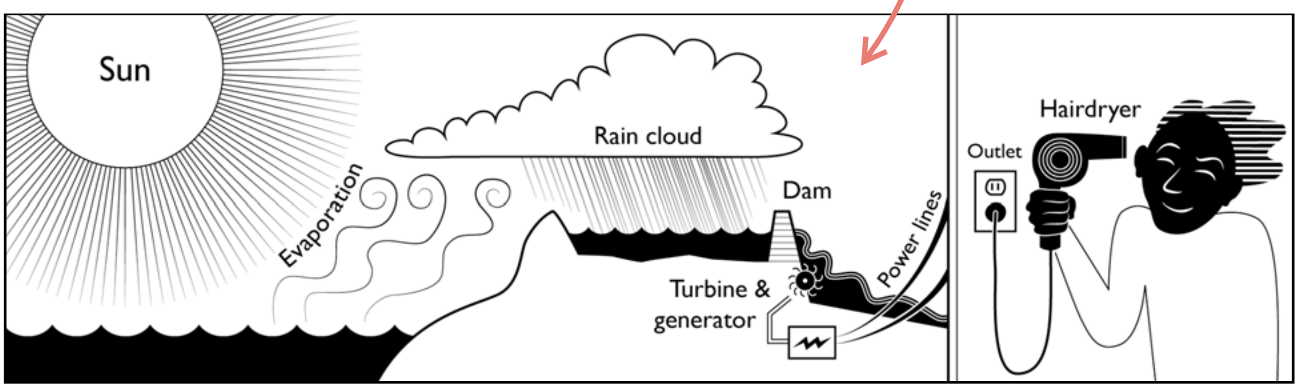
Write a caption to describe the flow of energy through this system:

Speaking Scientifically



A very important part of these two systems is that the charcoal and the oats both have stored energy in their chemistry (**fuel**). The horse **transforms** that chemical energy into kinetic energy by digesting the oats. In the second example, the cook **transforms** the chemical energy into thermal energy by setting the coal on fire.

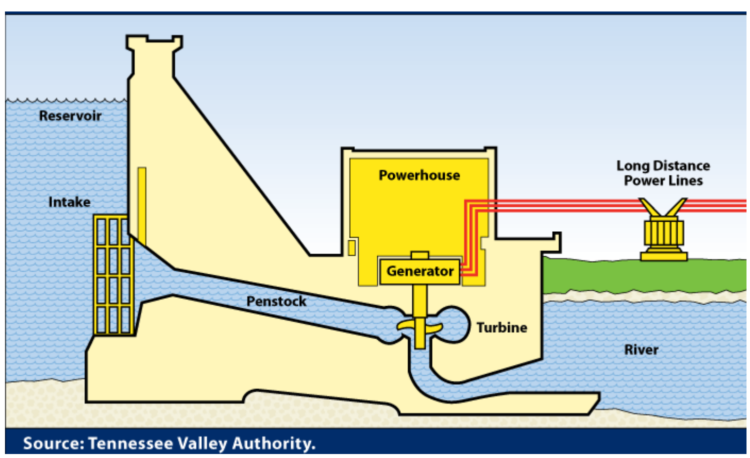
Let's take a closer look at the hair dryer system. How does this person's hair dryer get the energy to dry their hair?



TURN AND TALK

In the system to the right, the dam's powerhouse **transforms** the kinetic energy of the rushing water into electrical energy. How does this happen?

Locate the **generator** and the turbine in the diagram. Describe the flow of energy in this system.

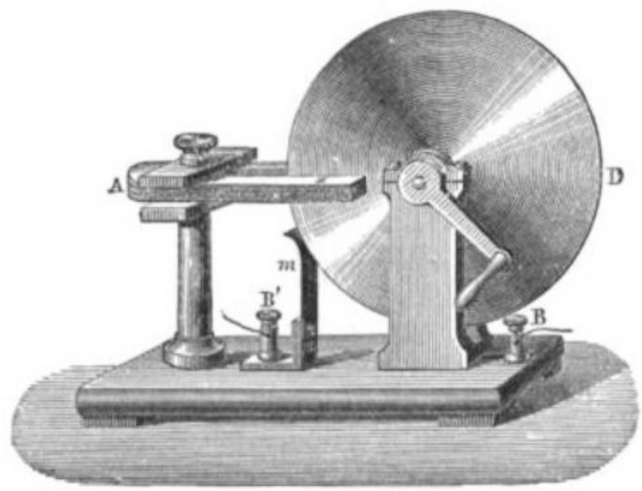


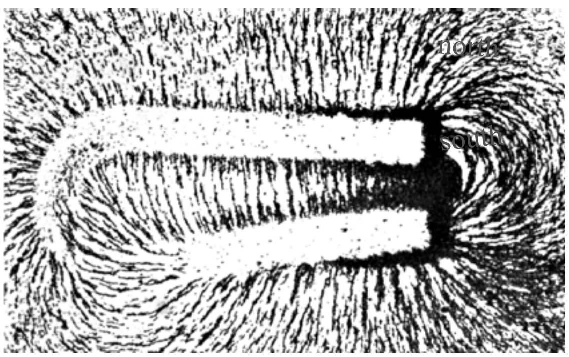
Speaking Scientifically

Michael Faraday (1791–1867)

What are the basics about generators?

Take a look at the **generator** below. It is called the Faraday Disk. It was one of the first examples of a machine using a magnetic field to **generate** electricity. Michael Faraday first constructed it by mounting a magnet on a stand. The magnets were shaped so the spinning disk could fit between the north and south poles of the magnet. While this contraption seems pretty simple, it can actually turn motion into electricity!





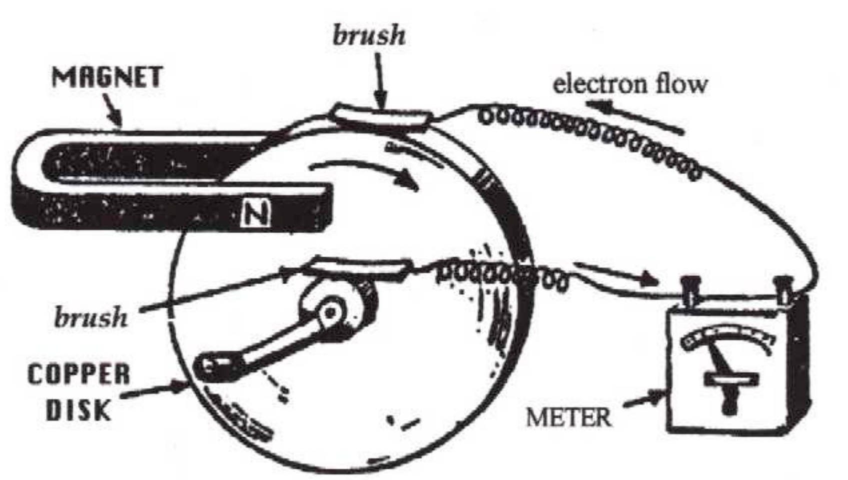
U-shaped magnets with the poles close together create stronger magnetic fields.

Here is another illustration of the same type of machine. The crank shown in this illustration is for spinning the disk to create the flow of electric **current** that can travel away from the **generator** to **power** other things, like the meter shown. **Generators** like this one use magnetic forces to make electrons move.

TURN AND TALK

Trace the energy flow in the illustration.

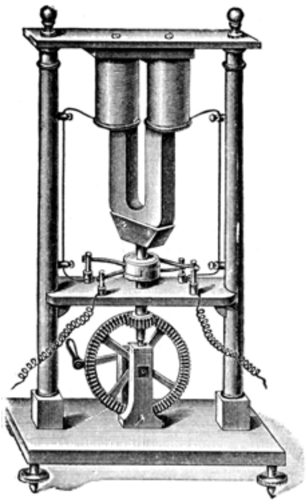
Discuss how a similar system might light up the display on a stationary bicycle.

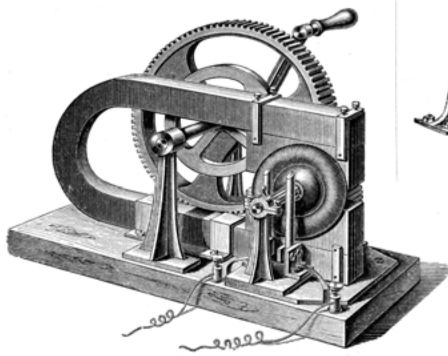


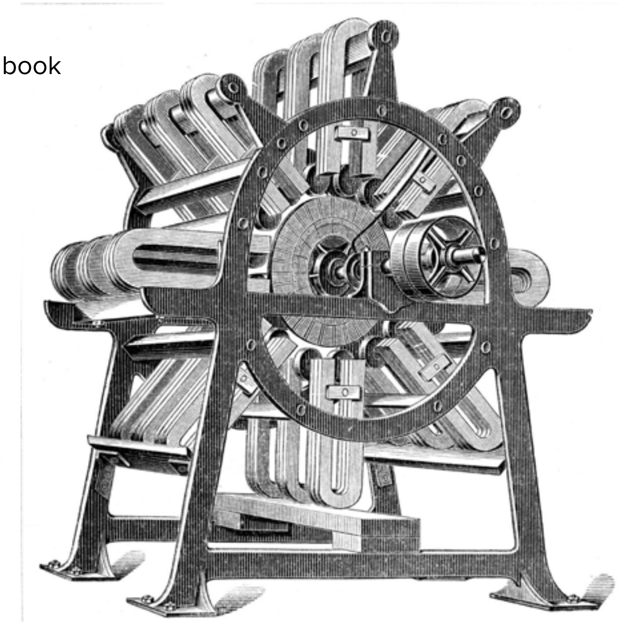
Speaking Scientifically

TURN AND TALK

These engravings of electrical **generators** were published in a book in 1884. They all spin, but how?



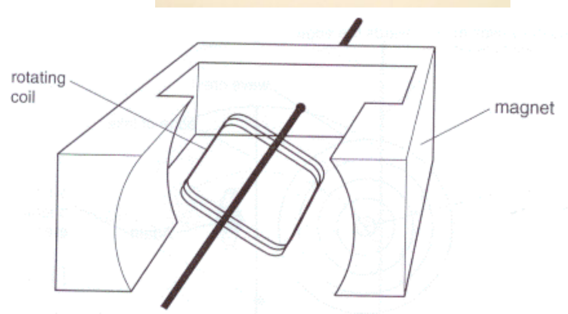




Avoiding the work of spinning by harnessing nature's kinetic energy…

Hamza's idea of providing energy to the school by pedaling the stationary bikes seems interesting, but is it practical? People have been thinking for many, many years about ways to spin magnets, disks, or copper wire coils in order to **generate** electrical energy. Some great ideas have emerged, and most of them involve turbines. Turbines are machines that make it possible for some other force (besides human energy!) to spin the parts of a **generator**. Usually turbines are fitted with something flat that's pushed by water or air and set up at an angle so that it spins. A pinwheel toy is a simple version of a turbine.

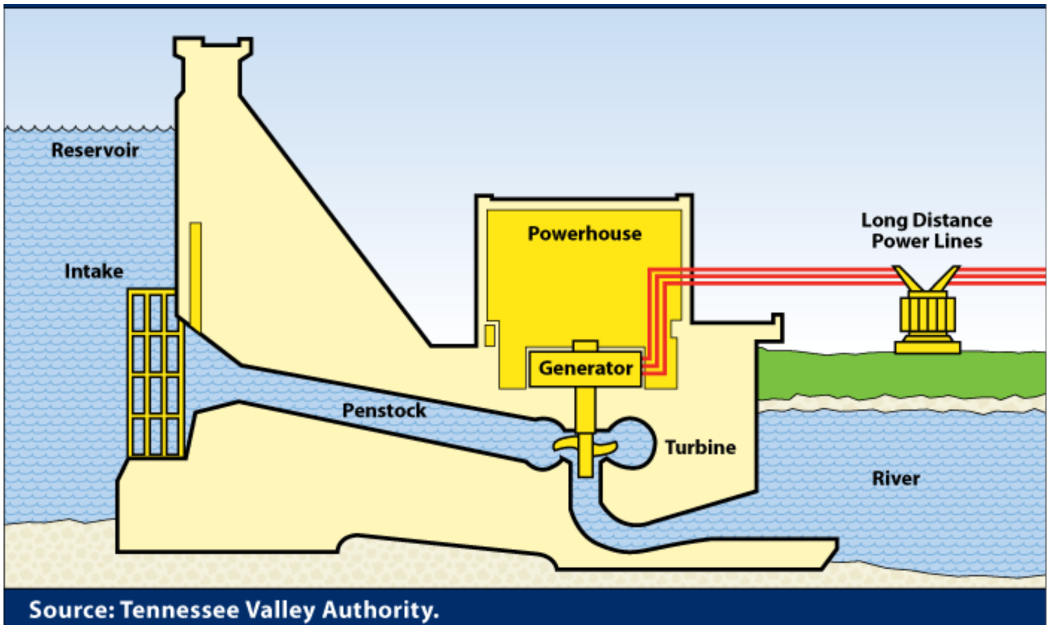
Now think about attaching the pinwheel toy to this simple **generator**. What would you need to make this work?



What you're imagining is actually a tiny windmill that **generates** electricity. Windmills are a great example of people figuring out a way to make something in nature do the work of spinning, instead of having to do it ourselves.

Spinning Turbines

Here are some ways people use nature to spin turbines:



Hydroelectric

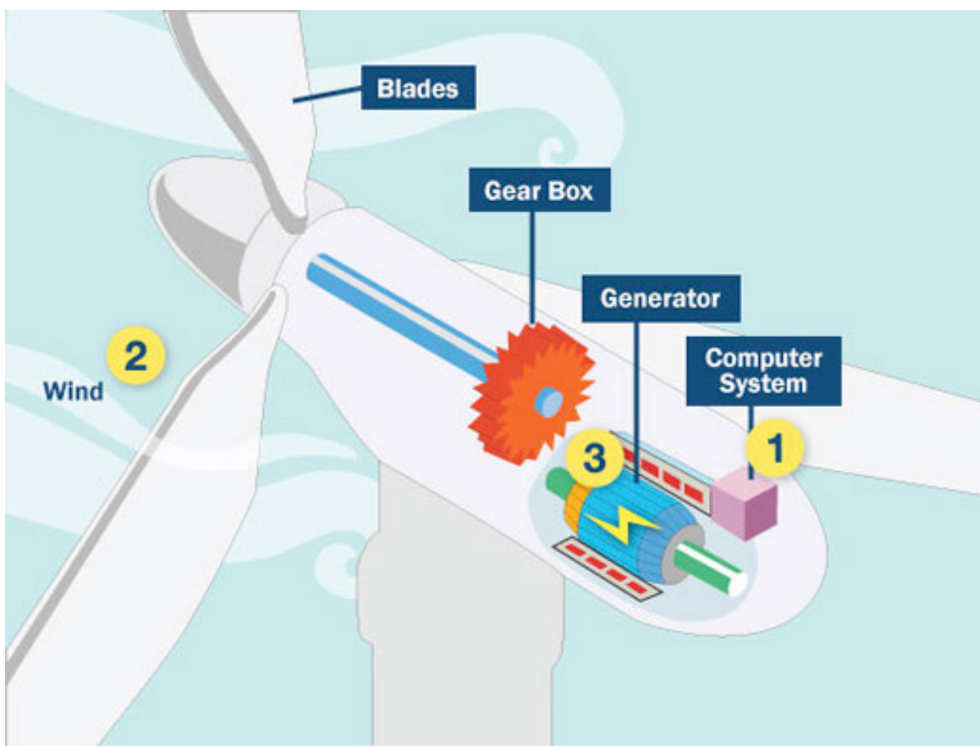
This is a diagram of a hydroelectric **power** plant. Can you see how it works? What kind of energy **transformations** are happening here?

Trace and describe the energy **transformations** with a partner.

Wind Turbine

Here is a diagram of a wind turbine. Can you see how it works? What kind of energy **transformations** are happening here?

Trace and describe the energy **transformations** with a partner.

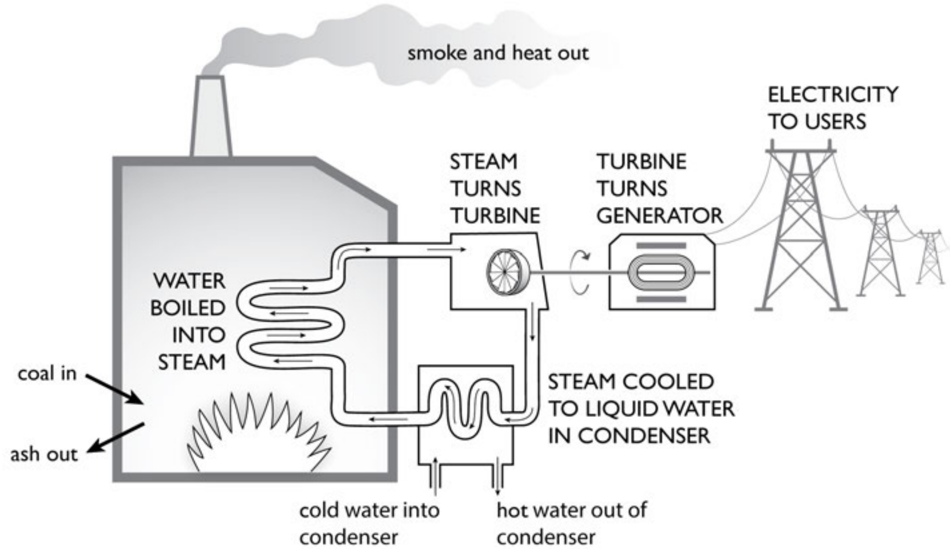


Thermal Power Plants

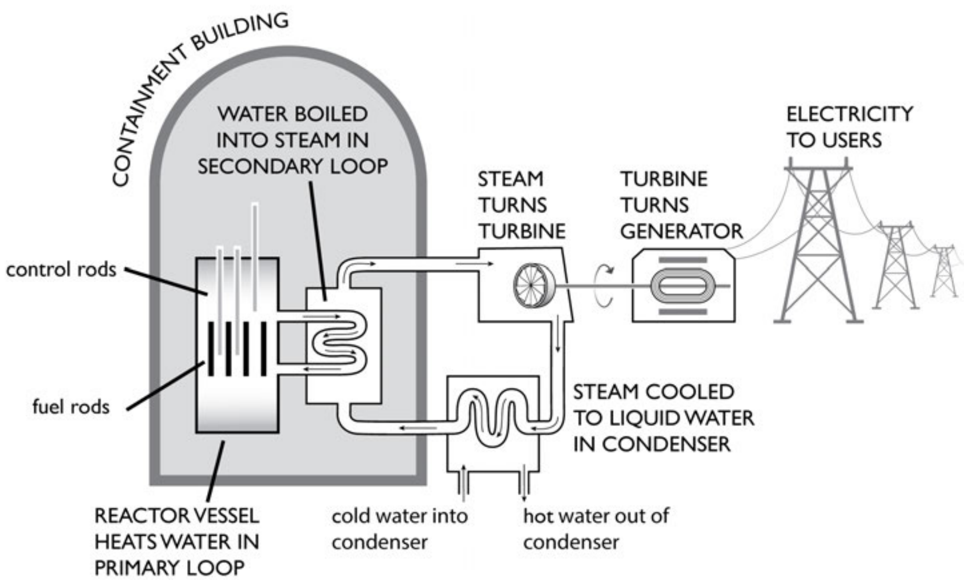
Below are diagrams of thermal **power** plants. Can you see how they work? What kind of energy **transformations** are happening? Can you explain how steam plays a role in these systems?

With a partner, trace and describe the energy **transformations** in the coal-fired **power** plant and the nuclear **power** plant. What is the same? What is different?

Coal-Fired **Power** Plant



Nuclear **Power** Plant



The system in the coal-fired thermal **power** plant burns coal to heat water. The boiling water creates steam that spins turbines. There are also thermal **power** plants that heat water using other methods than burning coal. A nuclear **power** plant uses uranium that has been made into nuclear **fuel**. Other common methods in the United States are burning natural gas, burning oil, burning trash, and sometimes even burning the gases given off at landfills.

Other Electricity Methods

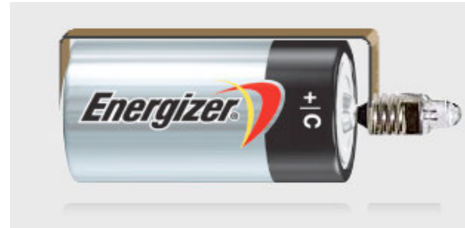
Most of the electricity we use comes from spinning turbines, but not all of it!

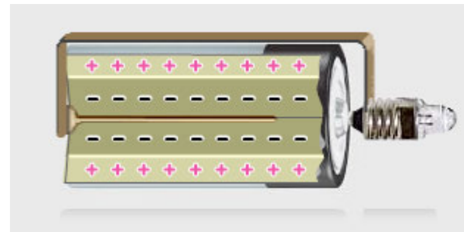
Consider Batteries:

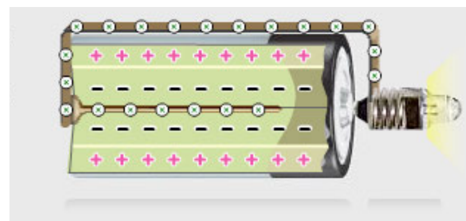
A chemical reaction inside of a battery starts when you complete the circuit with a wire or with a device like a flashlight or battery-**powered** toy.

In batteries we put certain chemicals close enough to each other to react, but also keep them separate from each other so the reaction is controlled.

The battery contains a collector that looks like a tiny rod that picks up the electric **current** and carries it out along an external circuit.





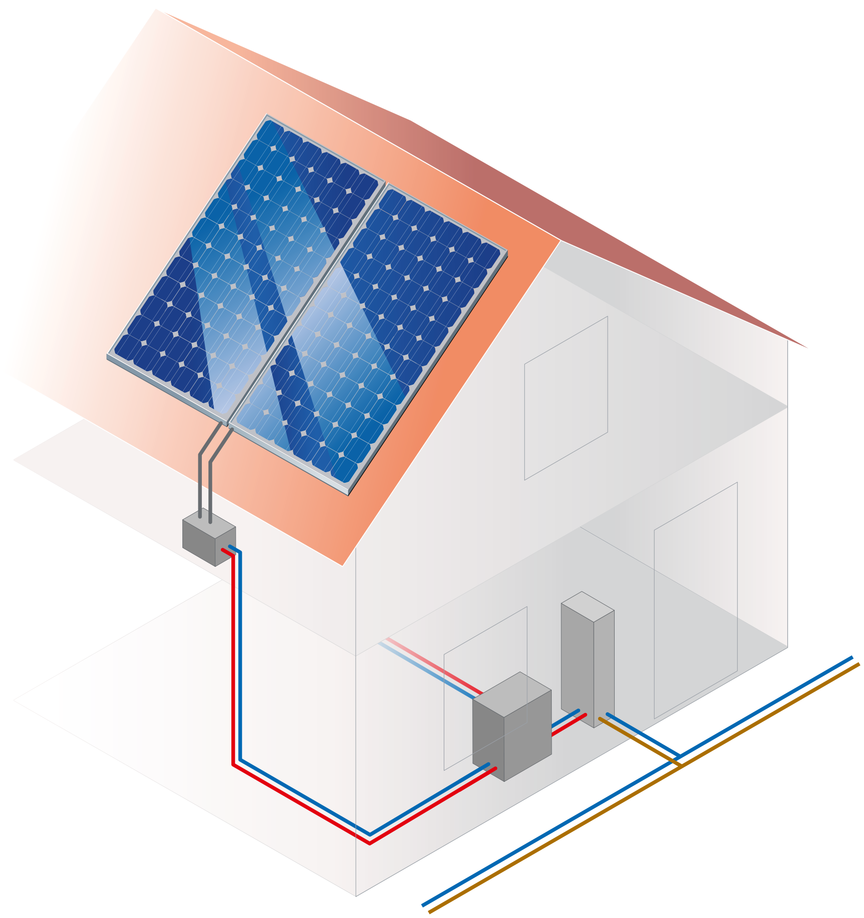


Consider Solar Cells:

Solar cells don't use spinning turbines, either.

In solar panels, light energy is transferred to some of the electrons, freeing them to move.

That electricity can quickly be made available for all of the electrical appliances within a home. In fact, if a house with solar cells **generates** more electricity than it uses, the electricity can move out to the national grid so other homes can use it.



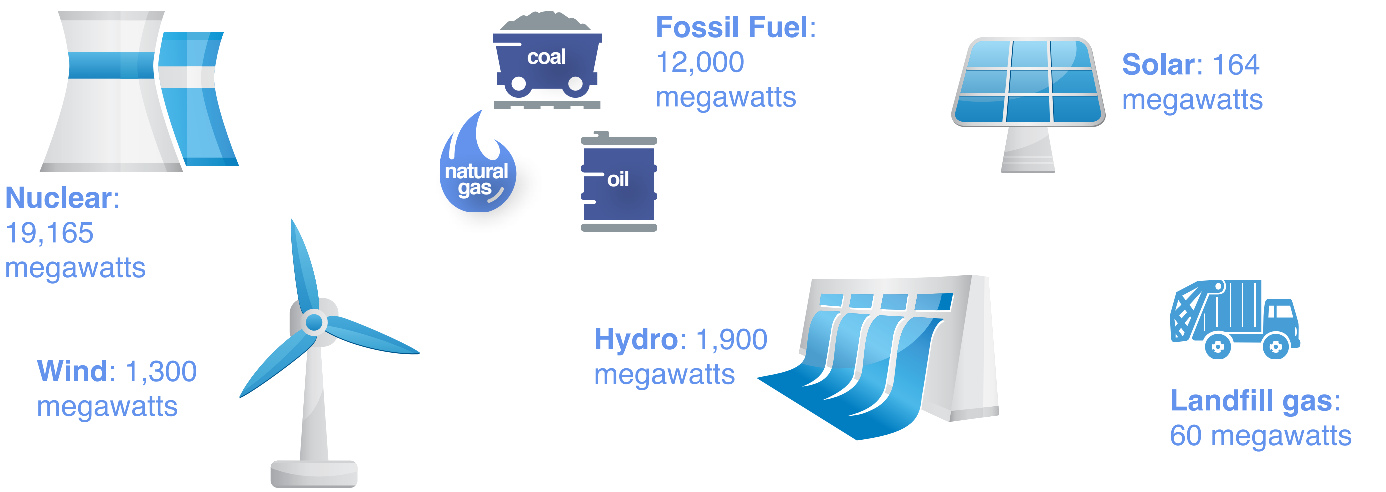
Energy Discussion Groups

Let's take a closer look at one American city's electricity supply.

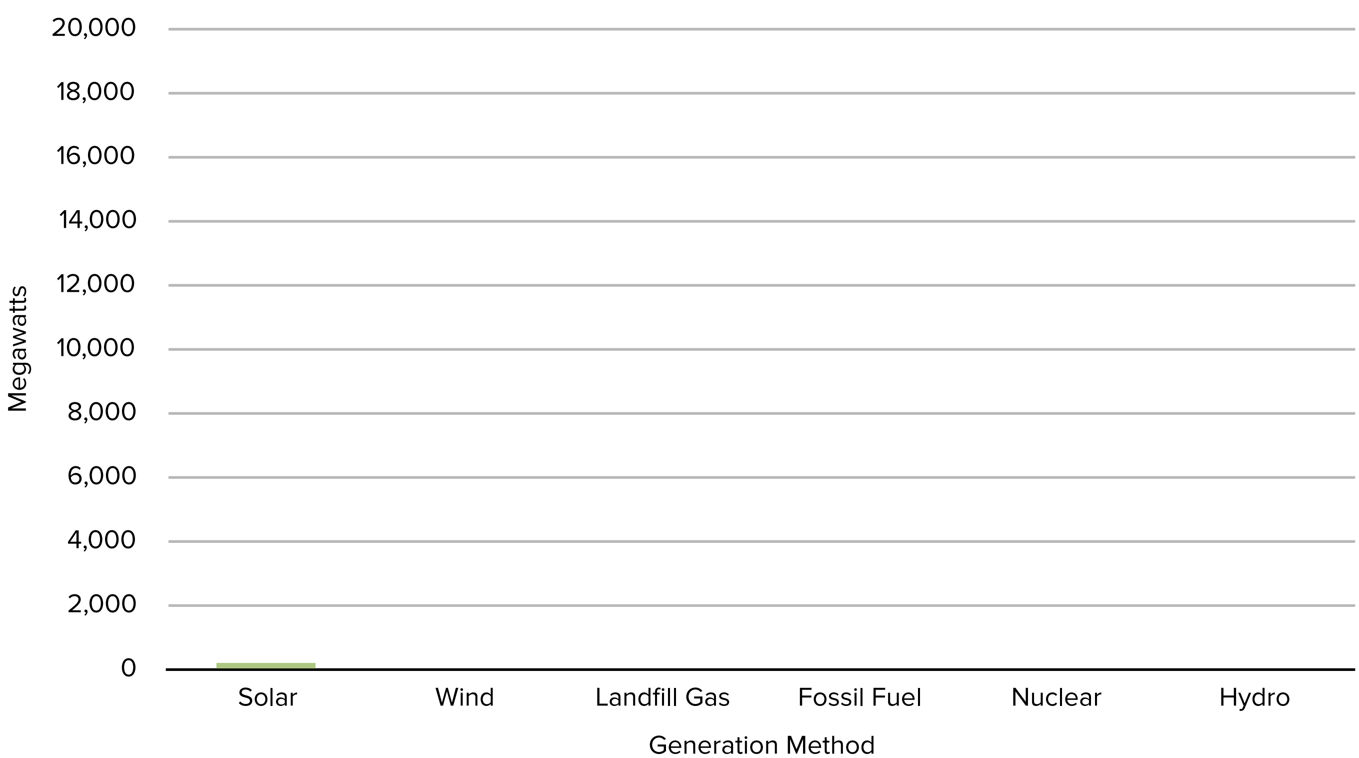
Baltimore, Maryland

A company called Baltimore Gas and Electric (BGE) is in charge of supplying electricity to the people of Baltimore. BGE is owned by a larger company called Exelon.

Exelon is a very important supplier of electricity all over the United States. In a report Exelon published in 2012, the company shared many important facts about how much electricity it **generates** and its methods of electricity generation.



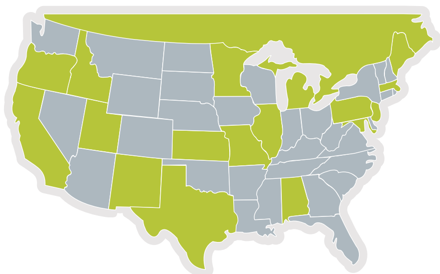
Note the amount of **power** supplied by Exelon's various methods of **generating** electricity above. To get a sense of how the quantities compare to each other, transfer the data above to the graph below. The first one has been done for you.



Energy Discussion Groups

Look over the list below that the Exelon company provided in its 2012 report. With a partner, look for patterns to determine which facilities **generate** more electricity and which facilities **generate** less. Do you see trends? Which types of facilities are the most powerful?

Generation Facilities



ALABAMA

- Gas: Hillabee (Combined Cycle), 740 MW

CALIFORNIA

- Hydro: Malacha *(Ownership Interest Only)*, 16 MW
- Solar: SEGS *(Ownership Interest Only)*, 8 MW

IDAHO

- Wind: Idaho Wind, 4 Projects, 128 MW

ILLINOIS

- Nuclear: Braidwood, Unit 1 - 1,190 MW; Unit 2 - 1,157 MW
- Nuclear: Byron, Unit 1 - 1,174 MW; Unit 2 - 1,150 MW
- Nuclear: Clinton, Unit 1 - 1,067 MW
- Nuclear: Dresden, Unit 2 - 880 MW; Unit 3 - 873 MW
- Nuclear: LaSalle, Unit 1 - 1,154 MW; Unit 2 - 1,162 MW
- Nuclear: Quad Cities, Unit 1 - 903 MW; Unit 2 - 937 MW
- Gas: SE Chicago, 296 MW
- Solar: Exelon City Solar, 10 MW
- Wind: Illinois Wind, 1 Project, 8 MW

KANSAS

- Wind: Kansas Wind, 2 Projects, 116.5 MW

MARYLAND

- Hydro: Conowingo, 572 MW
- Gas/Oil: Perryman,199 MW, Oil; 147.6 MW
- Gas: Gould Street, 97 MW
- Gas/Oil: Riverside, 74 MW, Gas; 115 MW, Gas/Oil; 39 MW, Oil
- Gas: Westport, 115.8 MW
- Gas: Notch Cliff, 100.7 MW
- Oil: Philadelphia Road, 60.9 MW
- Wind: Maryland Wind, 70 MW, 1 Project

MASSACHUSETTS

- Gas/Oil: Mystic, 1,406 MW, Gas (8-9 Combined Cycle); 8 MW, Oil (Jet); 560MW, Gas/Oil (7)
- Oil: Framingham, 31 MW
- Gas: Fore River (Combined Cycle), 688 MW
- Oil: New Boston, 16 MW
- Oil: West Medway, 119 MW

MAINE

- Oil: Wyman *(Ownership Interest Only)*, 36 MW

MICHIGAN

- Wind: Michigan Wind, 5 Projects, 352 MW

MINNESOTA

- Wind: Minnesota Wind, 9 Projects, 78 MW

MISSOURI

- Wind: Missouri Wind, 4 Projects, 163 MW

NEW JERSEY

- Nuclear: Oyster Creek, Unit 1 - 625 MW

NEW MEXICO

- Wind: New Mexico Wind, 1 Project, 27 MW

OREGON

- Wind: Oregon Wind, 4 Projects, 75 MW

PENNSYLVANIA

- Nuclear: Limerick, Unit 1 - 1,158 MW; Unit 2 - 1,153 MW
- Nuclear: Peach Bottom, Unit 2 - 1,148 MW; Unit 3 - 1,151 MW
- Nuclear: Three Mile Island, Unit 1 - 837 MW
- Oil: Falls, 51 MW
- LFG: Fairless Hills, 60 MW
- LFG: Pennsbury, 6 MW
- Oil: Croydon, 391 MW
- Oil: Delaware, 59 MW
- Oil: Richmond, 96 MW

PENNSYLVANIA

- Oil: Schuylkill, 33 MW
- Oil: Southwark, 52 MW
- Oil: Chester, 39 MW
- Oil: Eddystone, 760 MW, Oil/Gas; 60 MW
- Hydro: Muddy Run, 1,070 MW
- Hydro: Safe Harbor *(Ownership Interest Only)*, 277.7 MW
- Waste Coal: Colver, 25.5 MW
- Oil: Conemaugh *(Ownership Interest Only)*, 532.7 MW, Coal; 3.1 MW
- Oil: Keystone *(Ownership Interest Only)*, 716.2 MW, Coal; 4.3 MW
- Gas: Handsome Lake, 267.5 MW

TEXAS

- Gas: Mountain Creek, 805 MW
- Gas: Wolf Hollow (Combined Cycle), 705 MW
- Gas: LaPorte, 152 MW
- Gas: Colorado Bend (Combined Cycle), 50 MW
- Gas: Quail Run (Combined Cycle), 550 MW
- Gas: Handley, 1,265 MW
- Wind: Texas Wind, 282 MW, 13 Projects

UTAH

- Waste Coal: Sunnyside, 25.5 MW
- Gas: West Valley, 200 MW

CANADA

- Gas: Grande Prairie, 93 MW

Electricity Generation

The United States has had a difficult time developing a long-term energy policy because three different factors compete for top priority. Today you'll be considering which you think should be the top priority:

ENERGY SUPPLY SECURITY

An advocate of this priority might say, "We use electricity to run our businesses, to **charge** our phones, to do our banking, to run our medical equipment, and to run our law enforcement and military operations. Without a reliable way to **generate** electricity, life as we know it in our country would not exist. We must do whatever it takes to supply the U.S. with all the electricity we use."

ENVIRONMENT AND CLIMATE

An advocate of this priority might say, "We must minimize the environmental impacts of the supply, distribution, and use of energy. The evidence is clear that burning fossil **fuels** is affecting the climate. Many people suffer asthma and other medical conditions due to dirty methods of **generating** electricity. Solar and wind energy might be more expensive in the short term, but they are well worth our investment in the long term."

ECONOMICS AND JOB CREATION

An advocate of this priority might say, "If we spend a lot of money on expensive ways to **generate** electricity, taxes will have to go up even more and people won't be able to afford to buy goods and services. As a result, our country will not have a healthy economy and businesses won't be able to give people jobs."

Think about it. Which do you believe should be the top priority?

Once you've determined your priority, the next step is to decide on a form of electricity generation that you think we should increase in the U.S.

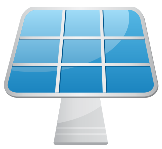
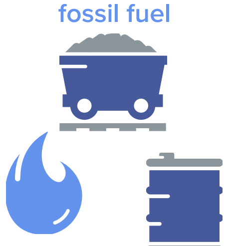
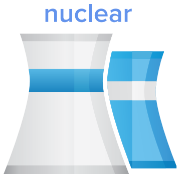
Also, think about a form of energy you think we should decrease. To develop a thoughtful position, you may use:

1. scientific information;
2. personal beliefs and values;
3. personal experience (what you know from the way you use electricity); and
4. information from the pro/con chart on the next page.

Electricity Generation

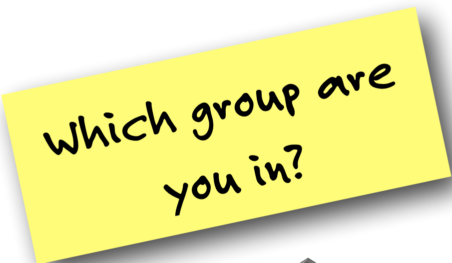
Pro/Con Chart

This chart lists some pros and cons about various methods of **generating** electricity.

	Pro	Con
solar 	• no greenhouse gases • unlimited supply • decentralization (can be produced locally instead of at one large plant)	• can't charge after the sun sets • expensive • panels take a lot of space
wind 	• no greenhouse gases • unlimited supply • decentralization	• wind not constant • noisy • turbines sometimes don't fit in with the natural landscape
landfill gas 	• reduces gas emissions from landfills (like methane) • uses waste for something helpful • using gas for **power** prevents it from going into soil	• increased recycling would reduce **fuel** supply • plant must relocate when gas is used • requires large volumes of landfill
fossil fuel 	• can **generate** a huge amount of electricity • cheap and abundant (especially coal) • **fuel** can be transported to the **power** plant easily	• pollution and greenhouse gases • extraction of **fuel** causes environmental damage • while abundant now, the supply won't last forever
nuclear 	• no greenhouse gases • the price of the **fuel** (like uranium) is more stable than fossil **fuels** • plant can run for long periods of time without interruption	• nuclear waste is dangerous and hard to store • accidents are extremely dangerous • nuclear plants use lots of water to cool the reactors, which can be an environmental problem
hydro 	• no greenhouse gases • dams last a long time • cheaper to maintain than thermal plants	• can flood large areas of land, displacing many people • dams change river ecosystems • if water supplies are low, hydro plants are affected

Electricity Generation

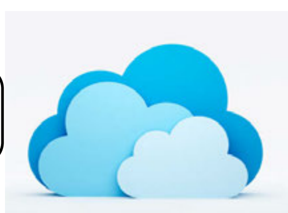
Make some notes to summarize your personal position about the top priority here:



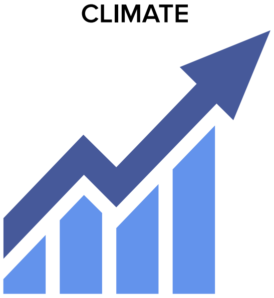
Now your teacher is going to place you in groups with people who agree with you regarding the priority for our national energy policy. But they may or may not agree with you regarding which forms of electricity generation to increase and which to decrease. Discuss your point of view with the group and together come up with a unified idea of how you think the U.S. should **generate** electricity.

Write bullet points listing the main ideas of what your group agreed on. Be ready to present your group's position to the class. Take notes in the other two boxes (next page) while other groups present. Think of ways to respectfully challenge their positions.

ENERGY SUPPLY SECURITY



ENVIRONMENT AND CLIMATE



ECONOMICS AND JOB CREATION

Our team agrees that...

Electricity Generation

Notes from another group's presentation:

☐  ☐  ☐ 

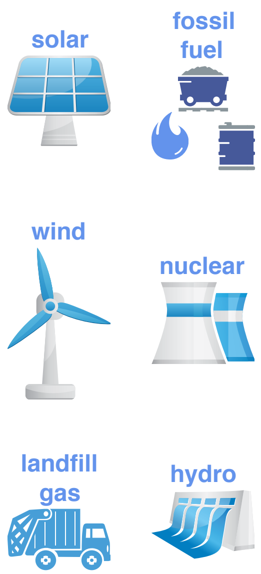
Notes from another group's presentation:

☐  ☐  ☐ 

Writing With and Without Bias

Using the pro/con chart on page 17, select one method of electricity generation to write about. The challenge of this activity is to write about the method in three different ways.

Select one:



Write a description of the technology you selected that conveys a bias *toward* using that technology.

Write a description of the technology you selected that conveys a bias *against* using that technology.

Write a description of the technology that is balanced and emphasizes facts and scientific thinking.

Energy Efficiency

Energy **efficiency** is the idea that a device can do more work using less energy. For example, cars today are far more **efficient** than they were 40 years ago. They use less gasoline to go the same distance.

Use the idea of **efficiency** to help you decide which light bulb you think would be the best for your home. Be ready to provide good arguments for your choice.

	Brand and Product Name	Technology	Wattage Used	Lumens (Light Output)	Life of Bulb	Estimated Energy Cost	Purchase Price
	GE: Reveal 40	incandescent bulb; filtered glass for color enhancement	40	360	1,000 hours	$5.75/ year	$4.99 (for a four-pack)
	GE: Energy-**efficient** Soft White	general-purpose halogen bulb	29	430	.9 year (based on 3 hours a day)	$3.49/ year	$4.99 (for a two-pack)
	Eco-stay: T2*	mini-spiral fluorescent bulb	9	500	up to 9 years (10,000 hours)	$1.18/ year	$3.99
	Eco-stay: LED	semi-directional, dimmable LED bulb	7	470	25,000 hours	$0.92/ year	$9.99

New Power Supply for Local Middle School

Carver Middle School is in for a big **transformation** – and a lot of controversy! The school board has decided that the school will **generate** its own electricity by installing solar panels on campus. This change will allow the school to save thousands of dollars a year by using this **renewable** source of energy to **power** lights, **charge** new computer tablets, and run air conditioning during the hot months! Great idea! It will even get a special award for being a "Green School."

However, the solar panels will be built on what is **currently** a little park where kids hang out during lunch. The park also contains a small garden where the school has started to grow some of its own vegetables. Many of the students, parents, and teachers are not happy about losing this little park. They like the idea of solar panels but think that they should be installed at other schools instead of theirs.

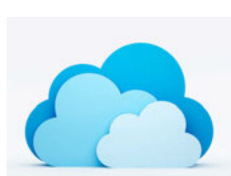
The school board arranged a meeting and invited three community members who support the solar panels to explain the benefits to the concerned crowd. Here are excerpts from their discussions:

Community Members

 Ms. Boswell	"Over the next few years, students and teachers are going to rely on laptops and computer tablets for nearly all of their texts. Even tests will be given on computers. We will rely on a consistent source of energy to **power** these devices in a way that we've not had to with books, paper, and pencils. With these new solar panels, we will know that **power** will always be on. Imagine if you were in the middle of a test and your computer ran out of **power** with no way to **charge** it!
 Mr. Barrett	"We realize that your garden is providing some vegetables for your school's cafeteria. Growing your own food is a terrific way to help the environment because it cuts down on oil consumption when transporting food from farms to grocery stores. We hate to see this garden go to make room for these new solar panels; however, **generating** your own source of **power** will have a far greater impact on protecting the environment. This **renewable** source of energy is clean and **efficient**. We will find space for a new garden."
 Mrs. Cartwright	"The company that is building these solar panels brought 150 new jobs to our local economy. This means that these families are now shopping at stores that some of you own, or getting their hair cut at salons where you work. They are paying taxes that go to our schools. A project like this is not only good for the environment, it is good for the economy. We need to do our part to keep these businesses going. This is a win-win for everyone!"

For discussion:
Each community member has shared his or her perspective on why the school should build the solar panels. Match the following priorities with each of their perspectives:


ENERGY SUPPLY SECURITY


ENVIRONMENT AND CLIMATE


ECONOMICS AND JOB CREATION

Which would be the most compelling perspective to you if you were in the audience? Why?

Examining the Focus Words Closely

SciGen Unit 8.3

→ Scientific or ✱ Everyday Use	Definition	Try using the word...
→ **transformation** *noun*	when studying energy, the change from one form of energy to another	*Hydroelectric dams are one place where an energy **transformation** occurs. Can you describe it?*
✱ **transform** *verb*	to make a thorough or dramatic change	*What are some organisms that **transform** during their lives? How do they change?*
→ **generate** *verb*	to produce	*Electricity can be **generated** from the energy of flowing water. What else **generates** electricity?*
✱ **generator** *noun*	a machine that converts one form of energy into another	*When might someone use a backup **generator** for electricity?*
→ **power** *noun*	work done in a certain amount of time (joules per second if the **power** is measured in watts)	*Does it take more **power** to pedal up a hill slowly or quickly? Why?*
✱ **power** *noun*	authority, control	*Who has more **power** at your school: the teachers or the principal?*
→ **fuel** *noun*	the material that is used up to produce power	***Fuels** store energy. How is food a **fuel**? How is gasoline a **fuel**?*
✱ **fuel** *verb*	to supply or provide what is needed for something to work	*How do you **fuel** up before exercising?*
→ **efficiency** *noun*	the ratio of the useful work performed by a device to the total amount of energy it uses	*How does technology improve your **efficiency** at completing schoolwork?*
✱ **efficient** *adjective*	working in a well-organized and competent way	*Are you **efficient** at getting ready for school? Explain.*
→ **conservation** *noun*	the idea that the total value of energy stays constant in a system	*Considering the **conservation** of energy, what happens to the energy that goes into a car crash?*
✱ **conserve** *verb*	to avoid wasteful use of something	*How can your family **conserve** resources to save money?*
→ **charge** *noun*	a property of matter responsible for electric and magnetic forces	*When is matter considered **charged**?*
✱ **charge** *verb*	to request an amount as a price	*Have you ever been **charged** too much for an item? What happened?*
→ **current** *noun*	the flow of electricity	*How do batteries create an electric **current**?*
✱ **currently** *adverb*	at the present time	*Name some challenges **currently** facing our government.*

