Electricity Basics
High School

Table of Contents

Electricity Basics - High School

Objectives:

- Through questioning and observing, students will be able to identify the use of electricity in their home, school and community.
- Students will be able to discuss the basic units of electricity (Volts, Amps, Ohms, Watts)
- Through visualizations and discussions students will be able to understand the sources of electricity.
- After completing a hands-on project students will be able to demonstrate how electricity is generated, transmitted and stored.

Materials:

Activity 1 - George Washington Bridge

In Kit:

- NYC Skyline handout
- Maker Tape (2 long, 1 short)
- 4 LED lights
- Coin cell battery

In Addition:

- Student Instruction Guide

Activity 2 - State Transmission Map

In Kit:

- 3 LED Lights
- Maker tape (13 pieces)
- Map of NYS electricity transmission
- Energy storage facility
- Coin cell battery
- Hand crank and handle
- Solar panel

In Addition:

- Wooden cubes
- Home Sticker Sheet
- Student Instruction Guide

Teacher Tips:

- Be mindful of student airtime during whole group discussions. It is always important that we are diversifying the voices in the room and allowing those who would be otherwise quiet an opportunity to be heard, especially when a conversation could be moving quickly. Offer a time for everyone who wants to share, one comment or connection, before calling on the same student for a second share. Once everyone has been given ample opportunity to contribute at their comfort level with the discussion, then open the floor up for more discussion as time permits!

- Explicitly teaching and then using content vocabulary will support knowledge development for students - especially those where english is their second language and those who potentially struggle with “language

heavy" activities. Front loading content specific vocabulary will allow all students to participate in the conversation. Be intentional and consistent with your use of vocabulary too.

- As students complete each activity, have them put it to the side - keeping their work area clear. By clearing the space it allows the students to focus on the finished product and celebrate their work.

Key Vocabulary:

Electricity - Electricity is the flow of electrical energy. Electricity energy is when tiny particles called electrons are moving through a circuit.
Electrons - negatively charged subatomic particles that jump from atom to atom when electrically charged.
Circuit - A closed loop of conductive materials where electricity can flow from the power source through the path to the load back to the power source.
Load - The component using electrical power. Light bulb, motor, appliance
Power source - The source of the electrical energy. Battery, solar panel, power plant, wind turbine
Path - conductive material that allows electrons to flow through.
Power Plant - Place where physical energy is converted into electrical energy.
Transmission - The bulk movement of electrical energy from a generating site to electrical substations and community grids for consumer use.
Generation - The process of transforming a primary energy source (heat or kinetic energy) into electrical energy.
Renewable electricity - Electricity that is generated from a renewable energy source that will never run out, such as wind, solar, water, biomass
Non-renewable electricity - Electricity that is generated from a nonrenewable energy source that will run out, such as coal, oil, natural gas, nuclear.
Components of Ohm's Law:
Voltage: A volt is a unit of electric potential, also known as electromotive force. Voltage is the potential for electrical energy to move and is analogous to water pressure.
Current: An amp, short for ampere, is a unit of electrical current. Amperage is the strength of a current of electricity or the amount of electrons at any one point in time in the circuit.
Resistance: is the measure of the opposition to electrical current flow in a circuit. It is measured in Ohms.

Lesson Steps:

Introduction & Electricity Discussion - 10 minutes

1. Introduce NYPA team and get to know students ***(slide 2)***

2. Have students **Think of 3 things that you could not live without that use electricity?** Give students time to share their responses out loud. Encourage them to think of all sorts of different things. ***(slide 3)***

3. **Define electricity.** Electricity is the flow of electrical energy. Electricity energy is when tiny particles called electrons are moving through a circuit. ***(slide 4)***

4. **Define circuit.** ***(slide 5)***
    a. A simple series circuit is made up of four parts: a load - the lightbulb, the power source - battery, the switch and the path or wires in which the path of electricity can flow from the power source

through the path to the load back to the power source. If there are multiple load points along the path, and disruption occurs, power will be lost to all load points along the circuit.

b. In a parallel circuit, the electricity has multiple paths for travel to the various load points within the circuit. If a disruption occurs within one path, it will not disrupt the flow of electricity to the others.

5. **Controlling a circuit.** We do things to control electrons in a circuit all day long, we turn on a light switch and make a closed circuit so the electrons can flow to the lights. We plug in our phones to charge and we make a closed circuit for electrons to flow to the battery of the phone.

6. **Ohm's Law:** explain the concept of Ohm's Law. Electric circuits have pressure & flow ***(slide 6)***
   a. Voltage is the pressure, the higher the voltage the more electrons are pushed to move.
   b. The current is the number of electrons flowing through the circuit are called amps. It is the amount of electrons in the circuit. The more amps the more electrons.
   c. The opposition to the flow of electricity is resistance measured in ohms.
   d. When you multiply voltage and current you get watts or the measure of power.
      i. 100 watt light bulb takes 100 watts of power.
   e. When you multiply current and resistance you get voltage.
   f. There is a mathematical relationship between current, resistance, and voltage. This is called Ohm's Law. Greater voltage results in more current and greater resistance results in less current. By doubling the voltage across a circuit the current will also double. However, if the resistance is doubled the current will fall by half. In other words by doubling the voltage across a circuit the current will also double. However if the resistance is doubled the current will fall by half.
   g. Ohm's law may be easier to understand with an analogy. Current flowing through a wire is like water flowing through a hose. Increasing voltage with a higher-volt battery increases the current. This is like opening the tap wider so more water flows through the hose. Increasing resistance reduces the current. This is like stepping on the hose so less water can flow through it.
   h. In a series circuit the **amps** are constant and **volts** get changed based on the individual components in the circuit. In a parallel circuit the opposite is true, **voltage** is constant and **amps** are changed based on the individual components

Activity 1 Build - New York Skyline - 20 minutes **(slide 7)**

7. Introduce EB Activity 1: Let's make our own circuits! We have a dilemma and NYPA needs your help. The New York City Skyline seems to have lost all power and we need your help to build the circuitry that makes it light up the night sky. Before we can fix the NYC Skyline, let's go over some basics to make sure we have what we need to resolve this issue and do it safely. We are going to use the materials in our kit to build a circuit to turn the lights back on along the skyline.

8. Review the safety notes with students ***(slide 8)***
   a. Do not put electrical components in your mouth.
   b. Always have a load in the circuit.
   c. Never run a path directly from the battery, back to the battery.
   d. If anything gets hot, call over the teacher.

9. Have students clear their workspace. Hand out Activity 1 Kit and instruction guide. ***(slide 9)***

10. Review the materials in the kit with students. ***(slide 10)***

a. Maker Tape is the path for the circuit, it conducts electricity and is sticky once you peel off the white paper. Teach students how to peel sticky back from Maker Tape. ***(slide 11)***
b. LED is the light. Demonstrate that the LED has a shorter leg and longer leg. The shorter leg is negative and the longer leg is positive. Electrons only flow in one direction in these light emitting diodes. The shorter leg always needs to be on the same side of the circuit as the negative(-) side of the battery. And the longer or positive(+) side needs to be connected to the positive(+) side of the battery.
c. Battery is the power source - the battery has a + on the positive side
d. Have the students follow along with the student guide for creating the circuit with you.

Sharing & Closing - 10 minutes **(slide 13)**

11. As you see students begin to finish up, call everyone back together to discuss the following questions of wonder.
    a. **What is the difference between series circuit and parallel circuit?** ***(slide 14)***
        i. Series circuit - all of the lightbulbs are on one path
        ii. Parallel circuit - all the lightbulbs are on separate paths.
    b. **Which type of circuit did you create today?** Parallel
    c. **What are the basic components of a circuit?**
        i. Power source - battery, outlet, solar panel, generator
        ii. Load - light bulb, motor
        iii. Path - maker tape, wires, metal, water, humans
    d. **What does Ohm's Law help us do?** ***(slide 15)***
        i. Ohm’s law helps us to understand the components of our circuitry. Helps keep us safe by telling us what load we can use and what resistance we need. We can use Ohm’s law to control the amount of current in a circuit, adding resistors to reduce the current flow and taking them away to increase the amount of current.

12. Have students clean up workspaces to get ready for a new project. Congratulate them and let them know they have successfully worked to light up the night sky. They are going to be great electrical engineers that NYPA needs.

Generation & Transmission Discussion - 10 minutes **(slide 16 Transition)**

13. Ask students **Where does electricity come from? How does it get to us?** ***(slide 17)***
    a. Allow students to respond with what they think, (they may be off-base responses and that's okay, you will help them understand after this conversation). Explain why electricity is important to our community, and how it is generated is important to NYPA. In activity 1 you used a battery, which generates a little bit of power where they need it. Think about all of the things in our community that use electricity, where does the electricity to power all of those buildings and trains and microwaves and cell phones and lights come from?
    b. **It is generated or made in a Power Plant.** There are many different types of Power Plants around New York State. We have small clean energy plants and hydroelectric plants and solar panel farms and wind turbine farms. ***(slide 18)***
    c. **If electricity is generated in a power plant, how does it get to us in our home?** If electricity is generated in a power plant, how does it get to us in our home? It travels along big

transmission lines and smaller power lines. Sometimes stopping at energy storage facilities and substations to hold the electricity. ***(slide 19)***

14. **What are renewable and Non Renewable sources of energy?** ***(slide 20)***
    a. There are two different sources that we get electrical energy from. Renewable and Nonrenewable. Explain that non-renewable energy means there is a limited supply of that resource that makes the generator spin, like coal or natural gas, similar to the limited amount of resources in the battery. Explain that renewable energy means we will never run out of that resource that makes the generator spin, like falling water at a hydroelectric plant.

Activity 2 Build - Community Map - 20 minutes **(slide 21)**

15. Review the safety notes with kids before handing out materials ***(slide 22)***

16. Hand out kits and additional components for activity 2.

17. Have students take out maps. Students will model generation and transmission of electricity across New York State. There is a very simplified map of the state. What electricity generation plants do you see? ***(slide 23)***

18. Review the materials they will receive in their kit.
    i. There is a block that will represent a home.
    ii. There is Maker Tape and LEDs and a battery like last time, the battery represents the non-renewable energy source.
    iii. The yellow motor is going to represent the hydropower plant. You are going to attach the handle to the side and when you crank it, it will generate electricity. This represents a renewable energy source
    iv. The little solar panel goes to the north of your circuit and that will generate electricity too. This represents a renewable energy source

19. Have students follow along with the student guide for creating the circuit on the map with you.

Sharing & Closing - 15 minutes **(slide 24 Transition)**

20. Students will reflect and share all they accomplished.
    a. How is electrical power created? ***(slide 25)***
    Have students explain and cite evidence from the map. Electrical power is created by a generator in a power, hydro or solar plant. A physical force, steam, wind, water pushed a turbine with blades around in a circuit. This spins a shaft inside a generator that excites the electrons and makes them jump. The electrons push each other through transmission lines to substations to your home.
    b. How is electricity transmitted? ***(slide 26)***
    Have students explain and cite evidence on their map of how electricity is transmitted through Maker Tape pathways.

21. Have students clean up, and be prepared to take home any supplies left in their activity bags. End with a closing thought:

a. Today you were NYPA engineers, using both renewable and non-renewable energy to solve a problem and transmit electricity to a home. NYPA has thousands of electricians, engineers and specialists that keep all of our lights on day and night. Everyday the citizens of New York State use more and more electricity in different ways, we need your great minds to keep the lights on and design solutions for our communities now and in the future. **What careers do you think you could have with NYPA in the future? What problems do you want to solve?** ***(slide 27)***
b. We really enjoyed being with you today, if you have questions, we can answer them as we wrap up our time together today.

LIGHT THE PATH

NYC SKYLINE

RESIDENTIAL HOUSING

FREEDOM TOWER

ONE FINANCIAL

EMPIRE STATE

CHRYSLER BUILDING

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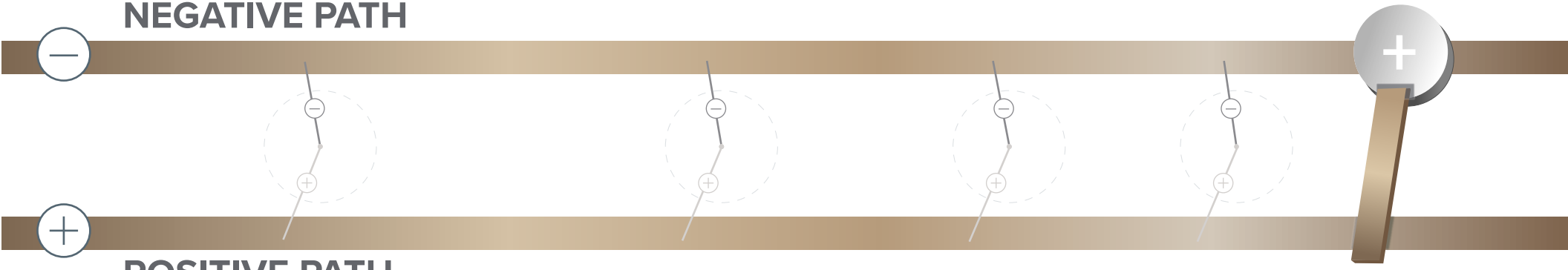
BATTERY

Place BATTERY positive side up, along the NEGATIVE path



NEGATIVE PATH

POSITIVE PATH

LED LEGS

Shorter leg is negative (-)
Longer leg is positive (+)

SWITCH

Use small strip of MAKER TAPE to create the switch for your battery

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Electricity Basics 1 High School

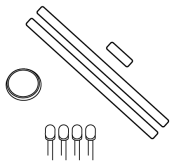
How does a circuit work? Activity 1

Project Overview:

Through an investigation, you will be able to identify the different components used to create electrical circuits within your home, school, and community.

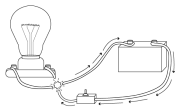
Materials (included in Activity One bag)

- NYC Skyline handout
- Maker Tape (2 long, 1 short)
- 4 LED lights
- Coin cell battery



Safety

Coin Cell batteries should not be piled or stored in a way that they could accidentally pile onto each other. Piled coin cell batteries could cause a short circuit.



Short Circuits are very dangerous. They happen when electricity flows without passing through a load such as an LED or fan.

Coin Cell batteries are amazing, but if eaten by humans or animals can become lethal. Never put any type of electrical part in your mouth.

Circuit Schematics:

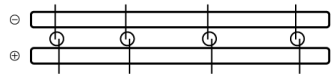
LEDs

Take out the handout and the LED lights. Notice the longer leg is positive (+), the shorter leg is negative (-).

- Poke both LEDs through handout at designated areas.
    - Tip: use pencil to poke holes in handout
- Separate the legs of the LEDs flat along the backside of the paper so that one leg crosses each path..
- Make sure the shorter legs of the LEDs are resting on the negative path and the longer leg on the positive path.

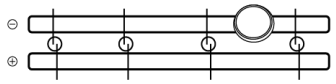
Maker Tape

- Secure LED legs with the 2 longer strips of Maker Tape along each of the paths. Make sure the paths do not cross or touch.

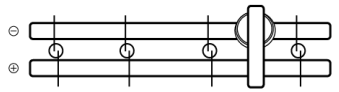


Battery

- Place the battery in the designated area with positive (+) side up.



- Adhere the short Maker Tape strip to the center of the positive transmission line, then connect to the center of the battery. This will complete your circuit. Notice the battery is also the switch that can be opened/closed in this schematic.

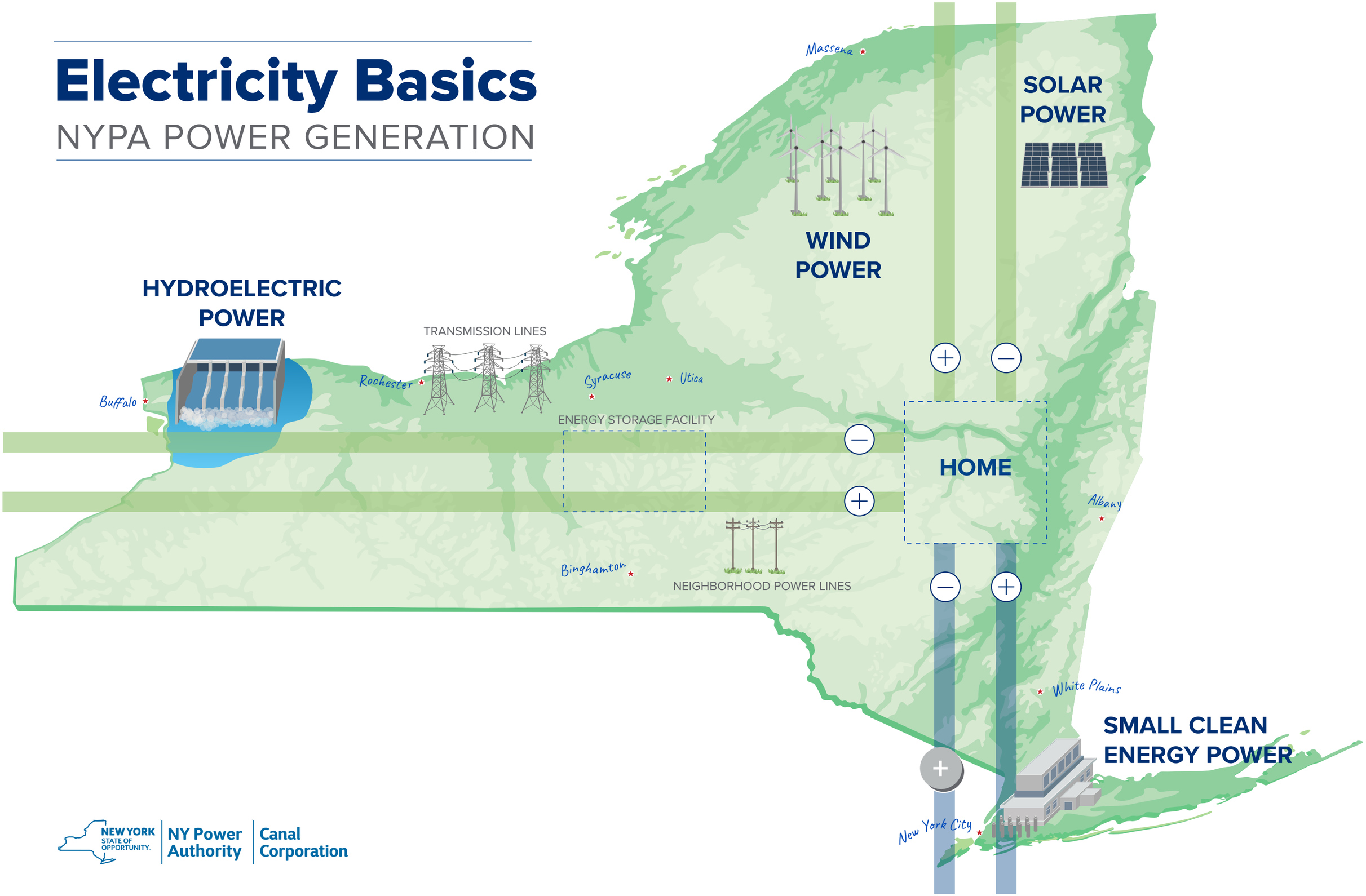


The NYC skyline lights up when your circuit is closed!

WHYMAKER EDUCATION THROUGH MAKING

Electricity Basics

NYPA POWER GENERATION



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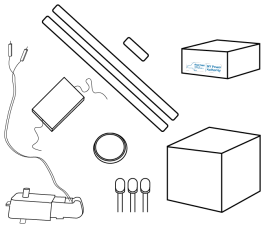
Electricity Basics Activity 2 Middle & High School

New York State Electricity Transmission

Project Overview:

Electricity is important to our community. Let's learn how it is generated and transmitted to power everything in our lives. In this project you will build a model of renewable and non-renewable energy sources, transmission lines and energy storage facilities that generate and transmit electricity for a home in NYS.

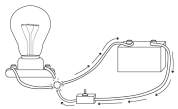
Materials:



- 3 LED lights
- 1 wooden cube (home)
- Maker Tape (13 pieces)
- Map of NYS electricity transmission
- Energy Storage Facility
- Coin cell battery (*non-renewable*)
- Hand Crank motor (*renewable*) & handle
- Solar panel (*renewable*)

Safety

Coin Cell batteries should not be piled or stored in a way that they could accidentally pile onto each other. Piled coin cell batteries could cause a short circuit.

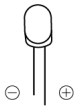


Short Circuits are very dangerous. They happen when electricity flows without passing through a load such as an LED or fan.

Coin Cell batteries are amazing, but if eaten by humans or animals can become lethal. Never put any type of battery in your mouth.

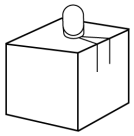
Project Steps:

Home: Cube & LEDs

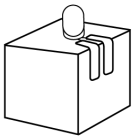


Remember the longer leg of the LED is positive (+), the shorter leg is negative (-). The cube symbolizes your home.

1. Separate the legs of all 3 LEDs. Bend the LED legs to create "knees" so the LED can "sit" on top of the cube with the legs hanging off the side of the cube. Sit 1 LED on each colored side of the cube. The negative side of the LED always is on the right.
    a. Use 2 small strips of Maker Tape to secure the legs of the LED by sticking the tape vertically along the side of the cube - one strip per leg, do not let tape overlap.



2. Repeat with the other 2 LEDs on the other two green sides.

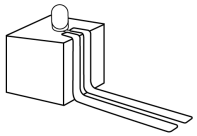


3. Place the cube on the map where it says "*home*." Be sure to match the green sides of the cube with the green pathways and the blue side of the cube with the blue pathway.
4. You can use the stickers to decorate your home later.

Transmission Lines: Maker Tape

5. Place Energy Storage facility on designated map location, secure the box by following the next step.

Create the transmission lines by following the pathways on the map for the non-renewable and renewable power sources.

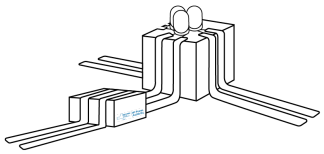


Make sure none of the transmission lines cross or overlap!

Non-Renewable Energy Source (blue pathway)

6. The 2 medium size strips of Maker Tape will be used to connect the LED to the non renewable transmission lines. Start by sticking the Maker Tape to cover some of the smaller tape on the cube, making a connection. Then continue down the cube and along the blue transmission line. This will secure the cube to the paper and build the path for the circuit. Do this for both blue paths. Make sure the parallel paths do not touch each other.

Renewable Energy Source (green pathways)

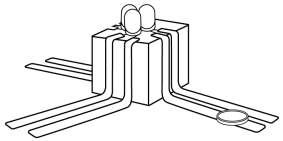


7. Using the other 4 strips of Maker Tape, one for each path. Repeat the step above to create the pathways for the green transmission lines. Make sure the parallel paths do not touch each other. **Do not secure the ends of the Maker Tape completely to paper on the green transmission lines - the loose ends of tape are needed to attach the hand crank.**

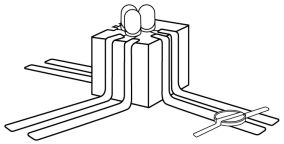
Power Sources: Battery, Hand Crank, Solar Panels

Non-Renewable Power Source (Battery)

Use the last small strip of Maker Tape to create the switch for the battery.



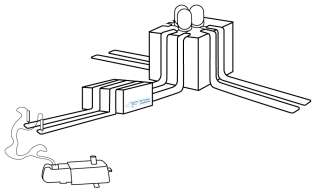
8. Place battery negative (-) side down, on top of the pathway extending from the negative (-) or shorter leg of the LED.
9. Complete this circuit by sticking Maker Tape across the top of the positive side (+) of the battery and running it across to the positive pathway.



10. The battery will not be fully attached to the paper and that's okay.

Renewable Power Source (Hand Crank Generator)

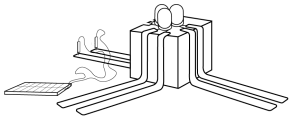
11. On the end of the western transmission lines, by the hydroelectric plant, secure the metal tip of the red wire from the hand crank to the positive (+) pathway of your green transmission line using the free end of the Maker Tape.



12. Repeat the step above for the black wire, on the negative (-) path.
13. Attach the handle to the white shaft coming out of the side of the yellow motor.

This is just like how a hydroelectric plant uses flowing water to spin the blades of the generator and a wind turbine needs blowing wind to turn the blades and generate electricity. The motor is acting like a generator using the energy of movement into electrical energy.

Renewable Power Source (Solar Panel)



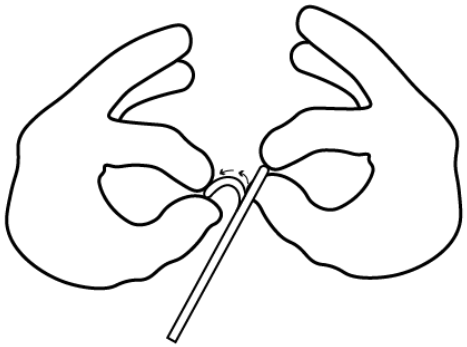
14. On the end of the northern transmission lines, the solar panels secure the metal tip of the red wire from the solar panel to the positive (+) pathway of the green transmission line using the end of tape left free along the pathway.
15. Repeat the step above for the black wire, on the negative (-) path.

Unlike the battery and hand crank, the solar panel relies on light from the sun. Put your solar panel close to the window or use a flashlight to make your LED shine. It will be very dim and hard to see because it takes a lot of the sun's energy to make electricity.

Expert tips and tricks

- When peeling paper off of the Maker Tape, use your thumb to roll the Maker Tape back towards the paper and catch the sticky side on your finger.

- Remove the paper slowly and leave some of the paper in place while you are securing it to the project - If not, it could stick to itself!
- Make sure none of the transmission lines are touching each other. There has to be separate circuits for each power source and each LED.



Questions of Wonder:

- What do you use electricity for?
- How does an electric circuit work?
- What is required to make an electric circuit function?
- How do we convert the earth's natural resources into electrical energy?
- Where does electrical energy come from?
- How does electrical energy get generated?
- How is electricity transmitted to your house?
- How is electricity measured?
- How does electricity play a role in your future?
- What jobs do you think people have that work with electricity?

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