Power Lines

Physical Science | Lesson Guide

5th Grade

Photo Description

This image shows a wooden utility pole with electrical equipment attached, including a transformer (the cylindrical container) and wires carrying electricity. The pole supports multiple cables and wires that stretch from one pole to another, delivering electrical power to homes and buildings in a community.

Scientific Phenomena

Anchoring Phenomenon: How does electricity travel from power plants to our homes through wires on poles?

Electricity flows through copper wires strung between utility poles, traveling at the speed of light from power generating stations to neighborhoods. The transformer visible on the pole converts high-voltage electricity (which travels long distances efficiently) into lower-voltage electricity that is safe for homes and schools to use. This system represents a technological solution to the challenge of distributing energy across distances.

Core Science Concepts

1. Electricity and Circuits: Electricity moves through closed pathways (circuits) made of conductive materials like copper. Power lines form a massive circuit connecting power plants to consumers.

2. Energy Transfer: Electrical energy is generated at power plants and transferred through wires to do work in homes (powering lights, appliances, computers).

3. Transformers and Voltage: Transformers change the strength of electrical current—high voltage for long-distance travel (reduces energy loss) and lower voltage for safe home use.

4. Conductive vs. Insulative Materials: Copper wires conduct electricity efficiently, while rubber and plastic insulation prevent dangerous electrical leaks.

Pedagogical Tip:

Help students understand transformers by using an analogy: "A transformer is like a water slide that changes the speed of water. High-speed electricity travels far on poles, then slows down to safe speeds for our homes—just like water slides that start steep and get gentler."

UDL Suggestions:

Provide multiple means of representation: Use diagrams showing electricity's path from power plant !' transmission lines !' transformer !' home. Offer tactile models where students can trace the journey with their fingers. For students with visual processing differences, use high-contrast images and provide a verbal description of the photo before analysis begins.

Zoom In / Zoom Out

Zoom In (Atomic Level):
At the microscopic level, electricity is the movement of tiny electrons (negatively charged particles) flowing through copper atoms in the wire. These electrons jump from atom to atom, creating the electrical current we use. The copper metal has electrons loosely bound to its atoms, making it an excellent conductor.

Zoom Out (Community/Infrastructure System):
The utility pole is one small part of a massive electrical grid spanning entire states and regions. This interconnected system includes power plants (generating electricity), transmission lines (long-distance transport), distribution lines (neighborhood delivery), and substations (voltage conversion points). Hundreds of poles work together to reliably deliver electricity to millions of people, involving careful coordination and maintenance.

Discussion Questions

1. "What do you think would happen if one of these power lines broke? How might it affect your neighborhood?" (Bloom's: Evaluate | DOK: 3)

2. "Why do you think the wires are made of metal instead of plastic or rubber?" (Bloom's: Analyze | DOK: 2)

3. "How is electricity different from water, and how are they similar in the way they travel through pipes and wires?" (Bloom's: Compare | DOK: 3)

4. "What would change if the transformer on this pole wasn't here?" (Bloom's: Synthesize | DOK: 3)

Potential Student Misconceptions

1. Misconception: "Electricity flows through the air between the wires."
   - Clarification: Electricity needs a conductive material (like copper wire) to flow through. It cannot travel through air under normal circumstances. The wires must touch or connect to complete a circuit.

2. Misconception: "All the wires do the same job."
   - Clarification: Different wires carry different types of electricity. Some carry high-voltage power for long distances, some carry lower-voltage power for homes, and some carry telephone or internet signals. Each has a specific purpose.

3. Misconception: "The transformer makes electricity stronger."
   - Clarification: The transformer changes voltage (electrical pressure), not the total amount of energy. It converts high-voltage electricity to lower, safer voltages—like reducing water pressure at a faucet, not creating more water.

Extension Activities

1. Build a Simple Circuit Model: Students construct a circuit using batteries, wires, light bulbs, and switches. They observe how breaking the circuit stops the flow of electricity, paralleling how a broken power line would affect delivery to homes.

2. Transformer Demonstration: Using two coils of wire, a battery, and iron nails, demonstrate electromagnetic induction. When students increase or decrease the current in one coil, they observe effects in the nearby coil, illustrating how transformers change electrical voltage.

3. Community Energy Audit: Students map all the utility poles and power lines in their neighborhood (with adult supervision), photograph them, and classify the types of equipment visible. They create a visual report showing how their neighborhood is connected to the electrical grid.

Cross-Curricular Ideas

1. Mathematics: Calculate the distance electricity travels from a power plant to a home using real-world data. Students solve word problems about energy loss over distance and compare percentages of efficiency in different types of power lines.

2. Social Studies: Research the history of electricity and how Thomas Edison, Nikola Tesla, and George Westinghouse contributed to the electrical grid system. Students create timelines or presentations explaining how rural areas gained access to electrical power.

3. Language Arts: Write persuasive letters to local utility companies explaining why power lines should be buried underground instead of on poles (considering safety, aesthetics, and storm damage). Research and cite evidence from multiple sources.

4. Art/Engineering: Design a more aesthetically pleasing utility pole or sketch alternative ways to deliver electrical power (underground cables, wireless transmission, etc.). Students present their innovations and explain the engineering trade-offs.

STEM Career Connection

1. Electrical Lineman/Linewoman: These workers install and repair power lines and equipment on utility poles. They climb poles, connect wires, and fix problems to keep electricity flowing to homes. They work for utility companies and must follow strict safety rules. Average Annual Salary: $65,000–$75,000

2. Electrical Engineer: Engineers design electrical systems, transformers, and power distribution networks. They use science and math to figure out how to send electricity safely and efficiently to millions of people. Many work in offices or laboratories. Average Annual Salary: $100,000–$110,000

3. Power Plant Operator: These workers control the machines and equipment that generate electricity at power plants. They monitor systems to ensure safe and reliable power production. They work shifts and are responsible for keeping the grid running smoothly. Average Annual Salary: $80,000–$95,000

NGSS Connections

Performance Expectation:
5-PS2-1: Support an argument that the gravitational force exerted by Earth on objects is directed down.

Related Performance Expectation:
5-LS2-1: Develop a model to describe that organisms are related and produce offspring of their own kind, but that the variety of offspring produced in any one reproductive event varies.

Disciplinary Core Ideas:
- 5-PS3.A - Energy can be transferred in various ways by electric currents. (Directly applicable)
- 5-ETS1.A - Defining and delimiting engineering problems involves specifying criteria and constraints for solutions.

Crosscutting Concepts:
- Energy and Matter - Energy can be transferred through various means.
- Systems and System Models - Electricity delivery is a complex system with multiple interconnected parts.

Science Vocabulary

* Transformer: A device that changes the strength of electrical current so electricity can travel safely and efficiently.

* Conductor: A material that allows electricity to flow through it easily, like copper or aluminum.

* Insulator: A material that prevents electricity from flowing, used to cover wires and keep them safe.

* Voltage: The electrical pressure that pushes electricity through wires (like water pressure in a hose).

* Circuit: A complete closed path that electricity flows through, from a power source back to that source.

* Utility Pole: A tall wooden or metal pole that holds electrical wires and equipment to deliver power to communities.

External Resources

Children's Books:
- How to Invent Everything: A Book That Reimagines All the Stuff We Use Every Day by Ryan North (includes sections on electricity)
- Electricity Shocks and Sparks by David Adler
- The Story of Electricity by Betsy Maestro