Power Lines

Physical Science | Lesson Guide

3rd Grade

Photo Description

This photo shows a wooden utility pole with a large gray transformer and several wires attached to it. The transformer is a metal box that hangs on the pole, and thick black wires connect to it from above and below. The pole holds equipment that helps bring electricity to homes and buildings in neighborhoods.

Scientific Phenomena

Anchoring Phenomenon: How does electricity travel from power plants to our homes?

This image represents the infrastructure of electrical energy distribution. Electricity is generated at power plants and travels through wires (conductors) to transformers—like the one shown—which change the voltage of the electricity so it is safe to use in homes. The transformer reduces high-voltage electricity coming from distant power plants into lower-voltage electricity suitable for residential use. This process happens through electromagnetic induction, where changing electric currents in one coil of wire induce currents in another coil, allowing energy to be transferred and modified without direct physical contact.

Core Science Concepts

1. Energy Transfer: Electricity is a form of energy that flows through conductive materials (like copper wires) from one place to another. The transformer moves this energy to where people need it.

2. Conductors and Insulators: Metal wires are conductors—they allow electricity to flow easily through them. The rubber and plastic coverings on wires are insulators that prevent electricity from escaping and keep people safe.

3. Systems and Components: A utility pole is part of a larger electrical distribution system that includes power plants, transmission lines, transformers, and household wiring all working together.

4. Safety and Technology: Transformers and other equipment on utility poles are examples of human-designed technology that helps us use electricity safely and efficiently.

Pedagogical Tip:

When teaching about electricity, avoid using the "current flowing like water" metaphor exclusively with third graders, as it can create misconceptions about electricity being a fluid substance. Instead, emphasize that electricity is energy that travels through wires, and use tangible examples like how a light bulb lights up when plugged in.

UDL Suggestions:

To support diverse learners, provide multiple means of representation: (1) Use visual diagrams showing how electricity travels from the power plant !’ wires !’ transformer !’ homes; (2) Allow students to trace the path with their fingers on the diagram; (3) Use a pre-recorded audio description of the transformer's function for students who need auditory support; (4) Provide tactile models of transformers and wires that students can touch and manipulate.

Zoom In / Zoom Out

Zoom In (Invisible/Microscopic Level):
At the atomic level, electricity is the movement of tiny particles called electrons through the metal wires. These electrons are so small we cannot see them, but billions of them flow together through the copper wire to carry energy. Inside the transformer, changing magnetic fields—also invisible—cause electrons in one wire to start moving, transferring energy to another wire.

Zoom Out (Large System Level):
This single transformer is one piece of an enormous electrical grid that covers entire regions, states, or countries. Power plants generate electricity, transmission lines carry it across long distances, substations with transformers like this one step down the voltage, and finally distribution lines deliver safe electricity to thousands of homes, schools, and businesses. All of this connects to form an interconnected system of energy delivery that society depends on every day.

Discussion Questions

1. Why do you think the transformer is mounted high up on the pole instead of on the ground? (Bloom's: Analyze | DOK: 2)
   - This encourages students to think about safety and accessibility.

2. What would happen to homes if the transformer on this pole broke and stopped working? (Bloom's: Evaluate | DOK: 3)
   - This helps students understand the importance of this technology to daily life.

3. How do you think electricity gets to the transformer in the first place? (Bloom's: Create | DOK: 3)
   - This prompts students to trace energy pathways and think about the larger system.

4. The wires coming into the transformer are thicker than the wires leaving it. Why might that be? (Bloom's: Analyze | DOK: 2)
   - This connects to voltage differences and power transmission concepts.

Potential Student Misconceptions

1. Misconception: "Electricity is used up as it travels through the wires, so homes far away don't get enough electricity."
   - Clarification: Electricity travels very quickly through wires at nearly the speed of light. While some energy is lost as heat in very long distances, transformers and the electrical system are designed so that homes far and near receive the electricity they need.

2. Misconception: "The transformer makes electricity, just like a factory."
   - Clarification: Transformers do NOT make electricity—they change it from one form to another (high voltage to low voltage, or vice versa). Power plants make electricity; transformers just modify it safely.

3. Misconception: "All the wires carry the same type of electricity."
   - Clarification: Different wires carry electricity at different voltages (strengths). The thick wires at the top carry very strong electricity that would be dangerous in homes. The transformer reduces it to a safe level for household use.

Extension Activities

1. Design a Neighborhood Electrical System
   - Provide students with yarn, tape, and drawings of houses. Ask them to design how electricity would travel from a pretend power plant (one side of the classroom) through a transformer (a box they decorate) to homes (arranged around the room). Have them label conductors and insulators and discuss why placement matters.

2. Electrical Safety Scavenger Hunt
- Create a classroom or school scavenger hunt where students find images or actual examples of transformers, power lines, utility poles, and electrical outlets. At each stop, ask: "Is this safe to touch? Why or why not?" This reinforces the connection between the utility pole infrastructure and household safety.

3. Build a Simple Electromagnet Model
- Using a battery, wire, and a nail, guide students in building a simple electromagnet to understand how changing electricity creates invisible magnetic forces (the principle inside a transformer). Have them experiment with how many coils of wire make the magnet stronger, connecting to the idea that transformers use coils to transfer energy.

Cross-Curricular Ideas

1. Mathematics: Have students measure and estimate the height of utility poles in your neighborhood, then create a bar graph comparing different poles' heights or counting how many transformers are visible on one street.

2. English Language Arts: Have students write a narrative story from the perspective of an electron traveling from a power plant through the transformer to power a light bulb in a home. This builds vocabulary and helps them understand the energy journey.

3. Social Studies: Research and discuss which jobs are needed to build, maintain, and repair utility poles and transformers in your community. Create a class presentation on "Community Helpers: Electricians and Utility Workers."

4. Art: Have students create a colorful diagram or mural showing the journey of electricity from the power plant to homes, using different colors for different voltages or using symbolic imagery for energy movement.

STEM Career Connection

1. Electrician: An electrician installs, repairs, and maintains electrical systems in homes and buildings. They work with wires, outlets, and equipment similar to transformers. Some electricians specialize in working on utility poles and power lines. Average Salary: $56,900/year.

2. Power Plant Operator: A power plant operator controls machines that generate electricity from coal, water, wind, or solar energy. They monitor the system to make sure electricity is safely produced and sent out through transformers to homes. Average Salary: $87,180/year.

3. Electrical Engineer: An electrical engineer designs and improves electrical equipment, including transformers and power distribution systems. They use math and science to make sure electricity travels safely and efficiently from power plants to homes. Average Salary: $104,970/year.

NGSS Connections

Performance Expectation: 3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

Disciplinary Core Ideas:
- 3-PS2.B Electric and magnetic forces can be used to make things move without touching them.

Crosscutting Concepts:
- Cause and Effect Changes in one part of a system affect other parts (e.g., a transformer changes voltage, which affects what appliances can safely use the electricity).
- Systems and System Models The electrical grid is a system with multiple parts working together.

Science Vocabulary

* Electricity: A form of energy that flows through wires and powers lights, appliances, and devices in our homes.

* Transformer: A metal box on utility poles that changes the strength of electricity so it is safe to use in homes and buildings.

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

* Insulator: A material (like rubber or plastic) that stops electricity from flowing through it, keeping us safe.

* Utility Pole: A tall wooden or metal pole that holds wires and equipment for delivering electricity, phone service, and internet to neighborhoods.

* Voltage: The strength or pressure of electricity moving through a wire.

External Resources

Children's Books:

Electrons and Electricity* by Rebecca L. Johnson (illustrated by Steve Jenkins) – A visually rich exploration of electricity, electrons, and how power gets to our homes.

Let's Learn About Electricity* by Bobbi Katz – An easy-to-understand picture book that explains what electricity is and how we use it every day.

How We Use Energy* by Rebecca Olien – A book exploring different energy sources and how electricity powers our communities.