Electrical Energy – Investigation 1

What is the Flow of Energy when the Propeller Spins?

Plan Investigation 1

Note: This sequence assumes that students have completed the Motion Energy sequence.

This first investigation starts with an elicitation of student ideas about electrical energy in the context of an electric fan. What evidence of energy do they see, and where does that energy come from? Some students’ explanations will end at the outlet on the wall. Other students may have some general ideas about electricity originating at a power plant and coming through wires to their homes and school. Next, students meet the motor and propeller assembly that they will work with for three sessions. They connect a hand crank generator to a motor that turns a propeller. They work with Energy Cubes to reason about energy transfer and transformation in the hand crank generator/propeller system. The Energy Tracking Lens is the framework for “telling the energy story.” They apply their ideas of motion energy and electrical energy to windmills.

Learning Targets Introduced in this Investigation

- The presence of electrical energy can be inferred by its transformation into another form.
- Electrical energy can be transferred between objects through wires.
- Motion energy can be transformed into electrical energy by a generator.
- Electrical energy can be transformed into motion energy by a motor.

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Materials

For the class:
- Desk top electric fan
- Student notebooks
- 6 Classroom energy cubes
- 1 large sheet of paper or white board
- 2 extra propellers (replacement parts)

For each pair of students:
- Hand crank generator
- Motor and propeller assembly
Preparation

- Set up the desk top electric fan near an outlet in a place where all can see it.
- Review the resource *Motors and Generators* on the last page of this Investigation and page 3 of the student notebook. Many students will be unfamiliar with those objects, which they will use in this investigation, and will have questions.
- Place the Model of Energy poster where all can see it.
- Add a new sticker and an “E” to all of the energy cubes.
1. Elicit Ideas about Electrical Energy

Introduce electrical energy
Distribute the Electrical Energy student notebooks.

*Today we start investigating another kind of energy we call electrical energy. Our lives are surrounded by things that use electricity, so you already have some ideas about electricity and electrical energy. Name some things that use electrical energy.*

- Students respond

*Let’s start by thinking about an object that will look very familiar and that uses electrical energy.*

Provide an object to think with
Turn on the fan.

- What changes do you observe?
  - The fan blades move, air is moving, etc.

- What can you say about energy?
  - The fan gained motion energy.

*Nothing collided with the fan, there isn’t any twisted elastic band or bent paint paddle that is giving the fan blade motion energy.*

Where did the energy come from?
Don’t answer this now, but use the next 3 minutes to gather some of your ideas (notebook, page 2 – Where do you think the energy comes from?).

*Where do you think the energy of the fan comes from? And where did that energy come from? And where did that energy come from? Track the energy back as far as you can. Make sketches and jot down your ideas.*

- Share your ideas about where the energy of the fan came from with your table group.

Listen to student ideas
Have students share their ideas with the class. How far back were they able to go? What resources are students bringing to the study of electrical energy?

2. Investigate/Explore

Introduce the Question

*We’ve explored energy flow in collisions and springboards and pompons and in elastic–band–run propellers and we keep asking, “Where does the energy come from? Where does the energy go?”*

Ask students to turn to the notebook cover that shows a photo of windmills or wind–powered generators in a field.

*In the case of these windmills or wind–powered generators, where does the energy come from and where does the energy go?*

Listen for ideas.
**Introduce the hand crank generator.** This is kind of like a windmill that uses wind to make electrical energy that can be transferred to homes and schools. Instead of the wind turning the blades to make the generator spin to make electrical energy, someone’s hand makes the crank turn to make the generator spin to make electrical energy. The generator in this hand crank generator is tiny compared to the generators that windmills use, but it does the same thing: it transforms motion energy into electrical energy.

Students will need an introduction to both generators and motors. Direct them to page 3 of the student notebook, *Motors and Generators*, where there is a brief explanation of what each does and the difference between them.

Next, show students a motor–propeller assembly and introduce the investigation question.

*What is the flow of energy when the propeller spins?*

Direct attention to notebook page 4, *What is the flow of energy when the propeller spins?* and ask students to complete the writing as they explore the materials.

*The star of today’s lesson is electrical energy. There is no direct indicator of this kind of energy so your challenge is to find evidence that electrical energy is part of the energy story.*

**Warning:** advise students to crank at a moderate speed (demonstrate), not as fast as they can – we’ve found the generator gears can break if you crank them vigorously. They are expensive!

**Hand out materials**

When students first get the generator, they should just turn the handle and observe what happens inside.

Let students figure out how to connect the hand crank generator to the motor. They should look for indicators (motion of the crank and the propeller) of energy and address the Energy Tracking Lens questions as they develop as detailed a response as they can to the Investigation Question, “What is the flow of energy when the propeller spins?”

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### 3. Make Meaning

**All class – 20 Mins.**

The purpose of this discussion is to map the flow of energy through the generator–propeller system (tell the energy story) and to add to the model of energy.

Students form a circle so everyone can see the chart paper or white board on the floor and can see and listen to each other.

**Our Investigation Question today is:**

*What is the Flow of Energy when the propeller spins?*

Ask for a volunteer to draw the components and use the energy cubes to track the flow of energy through the system.

Remind the class of their responsibilities during the presentation.

*As you listen*

- What questions would I like to ask?
- How would your cube story be the same or different?
- Have we answered all of the Energy Tracking Lens questions?
Notes: As students map the energy flow, ask them to show where the transformations occur: the generator (motion energy → electrical energy) and the motor (electrical → motion).

Students may have noticed the air moving near the propeller, or the motor warming up. Someone may want to add a circle to represent another component, “air,” as a focus for an energy cube with an “M” for motion energy or “Th” for thermal energy.

After the cube story, invite the rest of the class to begin the discussion.

- **What questions do you have?** Encourage students to address their questions to one another and to use the materials or cubes to clarify their questions or responses.
- **How would your cube story be the same or different?** You can ask another student to move the cubes.
- **Have we answered all of the Energy Tracking Lens Questions?**

Here’s a possible follow-up question:

> There’s no indicator of electrical energy. What evidence convinces you that this form of energy is part of the energy story?

### What’s an example of an energy story of a hand crank generator and a motor/propeller?

This is the first scenario that involves continuous flow of energy.

#### Here’s a consensus story from one group of 4th graders.

- **The components of the system**: hand crank generator, motor, propeller. Some groups included wires, air and/or a hand! Some groups argued that the wires were part of the generator and didn’t merit their own circle.
- **Forms of energy**: motion energy (M), electrical (Elec)
- **Gains and losses**: based on observable evidence, the hand loses energy and the propeller gains energy. We can infer many gains and losses in between.
- **Transfers and transformations**: motion energy transferred from the hand to the hand – crank generator where it is transformed into electrical energy which is carried by wires to the motor where the electrical energy is transformed to motion energy; motion energy is transferred to the propeller. Students may also observe that the air moves and infer the motion energy of the propeller is transferred to the air.
- **Where did the energy come from and where did the energy go?** Energy came from the hand and went to the air.

#### Wrap Up

*We began with the question, What is the flow of energy when the propeller spins?*

*We have used the energy cubes to represent the flow of energy—the transfer of energy from one component to the next to the next—and to highlight the transformation of energy from motion energy to electrical energy, and later from electrical energy back to motion energy.*

#### Add to the Model of Energy

What new ideas about energy can students add to the Model of Energy?

#### If Time Permits

Ask:

> What if the hand crank generator is next door and there are very long wires – what would happen then?
Motors and Generators

Generators transform motion energy into electrical energy. Motors transform electrical energy into motion energy.

Both are the same inside: wires spinning past magnets.

A generator can function as a motor, and vice versa. Test this by connecting two hand crank generators and turning first one and then the other.

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Motion In (Spinning) → Electricity Out → Called a Generator

Electricity In → Motion Out (Spinning) → Called a Motor