

Lesson 4: Don't Waste: Recover!

Students will investigate the process of energy conversion and relate that process to waste-to-energy technology.

Length of Lesson: 1-2 class sessions

Subject Area(s): Science

Objectives

Students will:

- Define and identify different types of energy.
- Identify how energy converts from one form to another in a series of everyday activities and during the waste-to-energy process.
- Complete an investigation that demonstrates energy conversion.
- Identify the correct order of the waste-to-energy process.
- Summarize how the energy conversion process they've demonstrated relates to the waste-to-energy process.

Materials

For lesson

- Post-it notes (one per student)
- Access to Internet
- Student Activity Sheet- Out of Order!
- Highlighters
- Middle school video clip: Renewable Resources
 - www.thinkgreen.com/classroom

For investigation

- Student Activity Sheet- Burn, Turn and Learn
- Metal coffee can with lid (one per group)
- Hot plate (one per group)
- Safety Goggles (one per student)
- Water
- Scissors (one per group)
- Pinwheel (one per group) (<http://www.wikihow.com/Make-a-Pinwheel>)
- Tape
- Pot Holder (one per group)

Background Information

- Everything that occurs in the world comes about as an exchange of energy. There are many forms of energy including light, sound, electrical, chemical, magnetic, mechanical, heat and elastic. For more information, go to <http://www.eia.doe.gov/kids/energyfacts/science/formsofenergy.html>
- Energy cannot be seen, heard, felt, touched, created or destroyed. It can only change from one form to another. This is called an energy conversion. Energy conversions are the reason that we can turn on the television, skate on roller blades or ring a doorbell.

- The type of energy that heats the house and turns on the computer frequently comes from the burning of fossil fuels--oil, coal, and natural gas. These energy sources are the remains of plants and animals that lived on this planet millions of years ago. They are called non-renewable energy because they can only be used once. They are inexpensive and easy to use, but they create pollution when we remove the fuels from the earth and when we burn them.
- Solar, wind and hydro power are also energy sources. They are called renewable sources, because they can be used over and over again.
- Another renewable energy source can come from our waste. Through waste-to-energy technology, solid waste can be converted into clean, renewable electric power. This is called "recovery."
- Waste-to-energy plants generate enough electricity to power almost three million households. But providing electricity is only one advantage of burning waste. The other major advantage is that it reduces the amount of garbage in landfills.
- Waste-to-energy technology uses garbage to fire an industrial boiler. The process relies on the basic steps below. (A more detailed series of steps can be found on the Out of Order student activity sheet)
 - The fuel is burned, releasing heat.
 - The heat turns water into steam.
 - The high-pressure steam turns the blades of a turbine generator to produce electricity.
 - A utility company sends the electricity along power lines to homes, schools and businesses.
- According to the US Department of Energy, in 100 pounds of garbage, more than 80 pounds can be burned as fuel to generate electricity at a power plant. These fuels include paper, plastics and yard waste. A ton of garbage generates enough electricity to heat a typical office building for one day.
- You and students can view an animated video of the waste-to-energy process at <http://www.thinkgreen.com/waste-to-energy>
- View the Renewable Resources video at www.thinkgreen.com/classroom

Procedure

1. Ask students the following question: "How can trash help you watch your favorite television show?" Have students share answers. (While answers may vary, students should refer back to the process of recovery they learned about in Lesson 3. Generally speaking, when trash is burned as a part of the waste-to-energy process, it is converted to electricity which powers the television.)
2. Introduce students to the process of recovery by watching Talkin Trash: Burning Questions at <http://www.thinkgreen.com/burning-questions>.
3. Put the word, "energy" on the board and ask students to define it. (See background information). Energy is defined as "the ability to do work" but students may see energy as much more.
4. Distribute the Post-it notes and ask students to write an example of "energy" on the note. Post these examples on the board or a wall, and have students read them aloud. Challenge students to organize their examples using the energy categories in the background information.
5. Review the concept of energy conversion with students. You may want to share a few examples of energy conversions right in your classroom such as sharpening a pencil, growing plants or turning on a light.

6. Then ask students to select one example from their Post-it notes and share how it represents an energy conversion, or how it could be changed into another type of energy. Here are a couple:
 - a. When their cell phone rings rings, sound energy is converted to magnetic energy and then electrical energy and then back to sound energy on the other side.
 - b. When they play soccer, chemical energy from food is converted to kinetic energy to let their legs kick the ball.
7. Tell students that they are going to conduct an investigation that shows how energy converts from one form to another.
8. Divide students into groups and distribute the materials. Challenge each group to look at the materials and discuss how they might be used to convert heat energy into motion. (If your students aren't used to this type of problem solving, they may be challenged with this approach. Encourage them to be patient and confident with their own ideas as they think through their options. You may want to guide them to think about how heat can make a pinwheel turn and encourage them to think about positioning with both the pinwheel and an opening/hole to let out hot air.) Discuss student responses.
9. Then distribute the Burn, Turn and Learn student activity sheet and have students refer to the diagram to see one way that the energy conversion can be accomplished.
10. Have students follow the directions on the sheet to complete the investigation. Or, if you are comfortable having them use their own idea for creating an energy conversion, ensure that you approve it first for safety reasons.
11. Once they complete #5, challenge them to predict what will happen once their can is heated.
12. Have them finish the investigation and complete the "observe" and "analyze" sections of the sheet.
13. Discuss answers, ensuring that they understand that the heat energy from the steam converts to mechanical energy in order to turn the pinwheel. Ask students if they know how this demonstration relates to waste-to-energy technology. The next step in the lesson will show them. (In waste to energy technology, heat from trash that is burned turns into steam which powers a turbine to generate electricity. In its simplest form, heat energy converts to motion energy (which this process demonstrates) and then motion energy in the generator converts to electric energy). More about this process is below.
14. Distribute the Out of Order student activity sheet. The sheet shows the specific steps in the waste-to-energy process; however, the steps are out of chronological order.
15. Have student groups review the out-of-order steps. Then have them use the first column to predict the correct order used in the process.
16. Direct students to the video at www.thinkgreen.com/waste-to-energy. Have them use the information from the video to put the steps in the correct order in column two. Share the correct answers.
17. Then ask students which steps in this process relate to the investigation they just completed. (Step 4 is the heat source. Step 6 is the steam. Step 7 is the steam powering the turbine to create electricity.) Have students highlight each step where energy converts from one form to another. They should note that nearly every step represents some type of energy conversion.
18. Finally, have students summarize what they've learned by answering the following questions:
 - a. What is energy?
 - b. How does energy convert from one form to another?

- c. How does energy conversion apply to the waste-to-energy process?

Extension

- For one day, have students record every energy conversion that they observe or take part in.
- Have students create a diagram that illustrates the waste-to-energy process.

Home Extension

Do students know if a waste-to-energy facility exists in their town? Have students and their families investigate whether there is a local facility and, if so, whether any of that power is used for their home. If they do not have a local facility, challenge students and their families to call their local waste management company and find out whether this technology is planned.

Evaluation

You can evaluate your students using the following three-point rubric:

- **Three points:** Students correctly identify examples of energy and energy conversions; work effectively in groups to conduct the investigation; are able to analyze how the investigation shows energy conversions; create a logical order for the waste-to-energy process; and make appropriate connections between energy conversions and waste-to-energy technology.
- **Two points:** Students correctly identify examples of energy and energy conversions; work somewhat effectively in groups to conduct the investigation; have difficulty analyzing how the investigation shows energy conversions; create a somewhat logical order for the waste-to-energy process; and make somewhat appropriate connections between energy conversions and waste-to-energy technology.
- **One point:** Students are unable to identify examples of energy and energy conversions; unable to work effectively in groups to conduct the investigation; unable to analyze how the investigation shows energy conversions; unable to create a logical order for the waste-to-energy process; and unable to make appropriate connections between energy conversions and waste-to-energy technology.

Standards Correlation

This lesson plan may be used to address the National Science Education Standards listed below.

Subject: Science as Inquiry

Standard: Abilities necessary to do scientific inquiry

Benchmarks:

- Identify questions that can be answered through scientific investigations.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.

- Think critically and logically to make the relationships between evidence and explanations.
- Communicate scientific procedures and explanations.

Subject: Science as Inquiry

Standard: Understandings about scientific inquiry

Benchmark: Different kinds of questions suggest different kinds of scientific investigations.

Subject: Physical Science

Standard: Transfer of energy

Benchmarks:

- Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei and the nature of a chemical.
- Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature.
- In most chemical and nuclear reactions, energy is transferred into or out of a system.

This lesson plan may be used to address the National Environmental Education Standards listed below.

Strand 1: Questioning, Analysis, and Interpretation Skills

Guideline: Questioning

Benchmarks:

- Pose clear questions and ideas to test, reformulating them when necessary.
- Clarify their own beliefs about the environment and discuss how those beliefs are reflected in the questions they ask.

Strand 1: Questioning, Analysis, and Interpretation Skills

Guideline: Designing Investigation

Benchmarks:

- Select types of inquiry appropriate to their questions.
- Select tools that are appropriate for their environmental investigations based on the questions asked and the type of information sought.

Strand 1: Questioning, Analysis and Interpretation Skills

Guideline: Organizing Information

Benchmarks:

- Explain why they chose specific ways of ordering and displaying information.
- Present environmental data in ways that demonstrate possible relationships between sets of information.

Strand 1: Questioning, Analysis and Interpretation Skills

Guideline: Working with models and simulations

Benchmark: Use models to represent and investigate aspects of the physical world such as weather and specific phenomena such as hurricanes.

Strand 1: Questioning, Analysis and Interpretation Skills

Guideline: Drawing conclusions and developing explanations

Benchmarks:

- Consider the possible relationships among two or more variables.
- Use their proposed explanations to form new questions and suggest new avenues of inquiry.

Strand 2: Knowledge of Environmental Process and Systems

Guideline: Changes in matter

Benchmark: Describe a variety of chemical reactions and offer examples from daily life and the local environment.

Strand 2: Knowledge of Environmental Process and Systems

Guideline: Energy

Benchmarks:

- Trace the flow of energy in examples that encompass several different transfers and transformation of energy.
- Explain how the process of life is based on the conversion, utilization, storage and transfer of energy.