Grades 3 & 4

Biogas As A Source Of Energy

LESSON 3

Objectives

The students will:

- Analyze the importance of energy and how they use energy in their lives.
- Describe the difference between renewable and non–renewable sources of energy.
- Experiment with creating and capturing biogas.

Materials

- Student Handout: "Diagram of Biogas Digester" (one copy per student)
- Teacher Reference Sheet: "Experiment: Creating Biogas" (additional materials list included)
- "Winter in Songming" book

Procedure

1. **Discuss energy.** Ask students, "How do you use energy? What types of energy can you identify?" When you move, you are using energy. When you talk or think, you are using energy. When you drive, use a light or watch TV, you are using energy. Ask the students to name five activities they do each day that use energy. Next, inquire if they can think of anything they do that does not use energy. (No – everything you do requires energy!)

   Ask the students, "Where does energy come from?" Listen to their responses. Summarize their statements. Guide students to the conclusion that all energy starts with the sun.

   Explain the concept of perpetual, renewable and non–renewable energy.

   - **Perpetual Energy** – Comes from sources that do not run out. Sources of perpetual energy include:
     Wind
     Sun
     Geothermal *(heat from deep within the Earth)*
   - **Renewable Energy** – Comes from sources that do not run out or that can be replenished within a short period of time. Sources of renewable energy include:
     Water
     Biomass *(energy obtained from plants, animals or their products such as wood, corn, grasses or manure)*

National Standards Addressed

NEXT GENERATION SCIENCE STANDARDS

ESS3.A Natural resources
Energy and fuels humans use are derived from natural sources and their use affects the environment. Some resources are renewable over time, others are not.

ESS3.C Human impacts on Earth systems
Societal activities have had major effects on the land, ocean, atmosphere, and even outer space. Students describe things society does to protect Earth's resources and Environments.

LS1.C Organization for matter and energy flow in organisms
Food provides animals with the materials and energy they need for body repair, growth, warmth, and motion. Plants acquire material for growth chiefly from air, water, and process matter and obtain

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Procedure (continued)

- **Non–Renewable Energy** – Comes from sources that cannot be replenished within a short period of time. Sources of non–renewable energy include:

  Oil Coal
  Natural Gas Nuclear Energy

2. **Discuss biogas as a form of energy.** In the story, "Winter in Songming," Zadou uses a gas burner to cook breakfast. Ask students where they might have burners in their own homes (on their stovetop, for example). Clarify that in Songming County, people have recently started to use a source of energy called biogas to fuel their gas burners.

   What is biogas? What is methane gas?
   Biogas is a form of energy that comes from living things. Biogas is generally made from animal manure. In Songming County, the biogas comes from pig and cattle manure. The people use biogas digesters to convert the manure into methane gas, which is a type of biogas. (Refer to the video, "Journey to China," to see how a biogas digester works. The video can be found at **www.readtofeed.org** in the resources section.)

   Distribute the copies of the handout: "Diagram of Biogas Digester". Discuss how the biogas digester works.

3. **Conduct the experiment creating biogas.** This experiment simulates the biogas oven that Zadou's family uses in "Winter in Songming." This experiment lets students observe biogas being produced from organic matter.

   Distribute copies of the "Methane Production Chart" for the students to record the measurements during the experiment. Have different students take the measurements for the class over the time period of the experiment. (If you want each student or pair of students to have their own methane bottle, multiply the materials accordingly.)

4. **Discuss biogas as a renewable form of energy.** At the end of the experiment, discuss with students how Zadou's family was able to create energy by using manure from their pigs and water buffalo. They used this energy to cook their meals on their gas burner. Explain to students that their stove at home probably uses either electricity or natural gas. Zadou's family has a similar type of burner, but it uses biogas instead.

   Ask, "Is biogas a renewable source of energy or not?" You must first consider what the source of the energy is. The source is the manure from the pigs and water buffalo. Is this source of energy renewable? Yes, because you can continue to get manure from the animals as long as they are alive. Thus, this is a renewable source

Standards (continued)

energy from sunlight, which is used to maintain conditions necessary for survival.

LS2.A Interdependent relationships in ecosystems
The food of almost any animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants, while decomposers restore some materials back to the soil.

LS2.B Cycles of matter and energy transfer in ecosystems
Matter cycles between the air and soil and among organisms as they live and die.

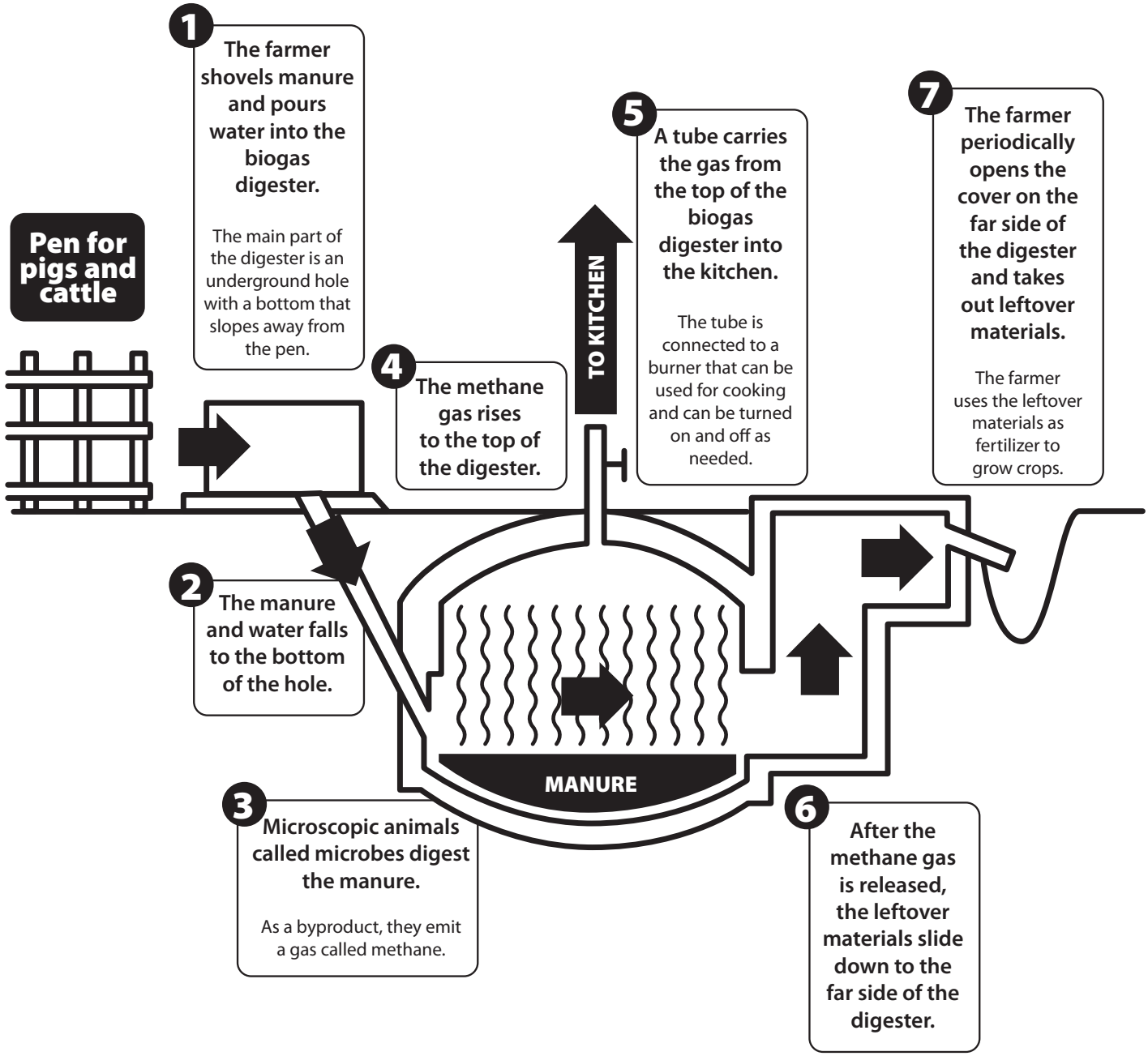
PS3.D Energy in chemical processes and everyday life
Energy can be "produced," "used," or "released" by converting stored energy. Plants capture energy from sunlight, which can later be used as fuel or food.

Student Handout:

Diagram of Biogas Digester

Name _____

There are different types of biogas digesters. This diagram is based on actual biogas digesters that Heifer International provides to people in Songming County, China.



of energy. It is also a source of energy that is easy for the farmers in Songming County to obtain, as they can get it directly from their animals. Discuss how this source of energy is a cheap and easy way for people in Songming County and in many parts of the world to get energy.

Links To Heifer International

Cooking with Gas – Biogas!

In China and in many other areas of the world, Heifer International has introduced biogas digesters to rural communities. The project participants learn how to build and maintain the biogas digesters. The digesters provide a cheap and simple way for people to get energy from a renewable source that they have easy access to – animal manure. By using biogas digesters people no longer need to cut down trees for firewood. This in turn helps to stabilize and protect the environment. In addition, by not having to collect firewood, each household saves up to three hours a day of work that they can now direct towards other productive activities.

Teacher Reference Sheet:
Experiment: Creating Biogas

Materials:

(Amounts below are used to make 3 model digesters. For more digesters, multiply ingredients accordingly.)

- 3 bottles
  (1 liter clear plastic; wide mouth preferred such as a sports drink bottle)
- 3 balloons
  (good quality balloons, so they don't tear)
- Duct tape
- Scraps of raw vegetables and grass – 1 cup
- Soil from the outdoors
  (not bagged potting soil) – 1 cup
- Permanent marker
- Student Handout: "Methane Production Chart" (one copy per student)
- Scoop or large spoon
- Funnel
- Ruler
- String

Directions:

1. Explain to the class that the objective of the experiment is to create methane gas (a type of biogas). They will be doing this by using microbes and feeding them food scraps.
2. Explain that microbes are living organisms that are so small that you cannot see them without a microscope. Microbes can be found in soil. As a byproduct of digestion, microbes emit methane gas.
3. Introduce or review the term "hypothesis." A hypothesis is what scientists think the answer will be to their question. After conducting the experiment scientists (the students) determine whether their hypotheses were true or false. Tell students that the question for this experiment is: What will happen if we combine microbes with food?

   Ask the students for ideas on what the hypothesis for this experiment could be. Example hypothesis: If we combine microbes with food, the microbes will create methane gas.(Student hypotheses may vary.)

   Have students record their hypotheses on the "Methane Production Chart."
4. Thoroughly mix the vegetable scraps, grass, and soil. Ask the students why soil is being added into the mix (because microbes will be living in the soil).
5. Divide the mixture evenly and place into the bottles.
6. Stretch the balloons so that the opening fits tightly over the opening of the bottles. Use duct tape to seal the balloons to the bottle and to make sure no outside air can get in.
7. With a permanent marker make a line on the bottle to mark the top of the mixture and write the date next to it. Measure the distance from the bottom of the bottle to the top of the mixture. On the "Methane Production Chart", write down the measurement of distance from the bottom of the bottle to the top of the mixture.
8. Record the balloon circumference as zero on the "Methane Production Chart."
9. Leave the bottles in a place where they will get sunlight. Over the next few days, the microbes in the soil should digest the mixture and create methane gas. The methane will inflate the balloon. At the same time, the amount of mixture at the bottom of the bottle should decrease because the microbes are digesting it.
10. Every other day, make a line on the bottle to mark the amount of mixture in the bottle. Measure the distance from the bottom of the bottle to the top of the mixture and record this information on the chart. Also measure the circumference of the balloon. Have students record the results on the chart.
11. At the same time measure the circumference of the balloon by wrapping the string around the widest part. Have students record the results on the chart.

It will take about two weeks for the microbes to digest all the food. After that time period, review the "Methane Production Chart" with the students and discuss the questions that follow. Dispose of the gas by popping the balloons away from any source of fire. You may want to dispose of the gas outdoors because of its odor, but have the students nearby so they can smell the gas as it escapes.

Student Handout:

Methane Production Chart

_____

Name

Question: What will happen if we combine microbes with food?

Hypothesis: _____

_____

People can use methane gas to create energy to power their stoves and cook food. Let's see if we can make methane gas. Follow your teacher's directions for the experiment, and keep track of your data using this chart.

Day	Level of Mixture in Bottle	Circumference of Balloon

Questions:

1. As the days went by, what happened to the level of the mixture in the bottle?

   _____

2. As the days went by, what happened to the circumference of the balloon?

   _____

3. What caused the level of the mixture to change?

   _____

4. What caused the circumference of the balloon to change?

   _____

5. How did microbes get into the bottle?

   _____

6. Was your hypothesis correct? How do you know?

   _____

Teacher Reference Sheet:

Methane Production Chart

Question: What will happen if we combine microbes with food?

Hypothesis: If we combine microbes with food, the microbes will create methane gas. (Student hypotheses may vary.)

People can use methane gas to create energy to power their stoves and cook food. Let's see if we can make methane gas. Follow your teacher's directions for the experiment, and keep track of your data using this chart.

Day	Level of Mixture in Bottle	Circumference of Balloon

Questions:

1. As the days went by, what happened to the level of mixture in the bottle?
   The mixture level decreased.

2. As the days went by, what happened to the circumference of the balloon?
   The circumference increased.

3. What caused the level of mixture change?
   The microbes were eating the grass and vegetables, which caused the level of mixture to decrease.

4. What caused the circumference of the balloon to change?
   As the microbes ate the grass and vegetables, they emitted methane. Because methane is a gas, it rose to the top of the bottle and inflated the balloon.

5. How did microbes get into the bottle?
   The microbes live in soil. When we added soil to the mixture, the microbes were added to the mixture and put into the bottle.

6. Was your hypothesis correct? How do you know?