



Lesson 4c: Turning Waste into Energy

SUBJECTS

Earth Science

Physical Science

GRADE LEVELS

4–8

CA SCIENCE STANDARDS

Grade 6: Earth Sciences. 6. Sources of energy and materials differ in amounts, distribution, usefulness, and the time required for their formation. (a, b)

EARTH SCIENCE LITERACY PRINCIPLES

#7: Humans depend on Earth for resources. (7.10)

OVERVIEW

Methane is a greenhouse gas known to trap heat more effectively than carbon dioxide. Methane digesters, however, can be used to turn pollution into an energy solution. In this lesson, students will learn how methane digesters turn waste into usable gases and other fuels. Before engaging in this lesson, students should have a general understanding of how human activities impact climate change and our environment.

ESSENTIAL QUESTIONS

1. How does methane gas affect climate change? (*Increased methane in the atmosphere enhances the greenhouse effect, which leads to global warming.*)
2. What kinds of waste can be converted into usable energy? (*food scraps, manure, crops, wood, etc.*)

MEDIA RESOURCE

QUEST video: “Turning Waste into Energy”

Video Length: 7 minutes, 1 second

Link: <http://www.kqed.org/education/educators/clue-into-climate/renewable-energy.jsp>

Through watching this video, students will learn:

- How methane gas affects climate change
- About the ecological advantages of converting animal waste into energy
- What methane digesters are, how they work, and where such technologies are being used

VOCABULARY

biofuel

solid, liquid, or gaseous fuel produced from recently living, renewable biological resources such as crops, manure, and organic waste matter

biogas

a type of biofuel produced by the bacterial decomposition of organic waste matter

biomass

the total weight or mass of all living matter in a particular habitat or area

biomass energy

a renewable source of energy obtained from plants, food crops, agricultural waste, and other organic waste matter

compost

a mixture of decomposing food waste, paper and yard waste, and other organic wastes

ACTIVITY 1: WASTE TO WATTS

Time: 30 minutes

Materials:

- Computer with Internet access
- Projector and speakers
- Pencil
- Paper

Procedure:

1. Before watching the video, discuss some of the things students might already know about creating fuel from plants, food scraps, and other waste. Tell students that corn can be used to create an alternative fuel called ethanol. Ask them if they think other plants could be used to create fuel. What happens to food scraps when they are composted or thrown away? How does the food change? Have you ever heard of using manure for fuel? Why do you think animal waste can be converted into fuel? (*because it contains stored energy*). As a class, read the "Biomass Basics" section of the article found here: http://tonto.eia.doe.gov/kids/energy.cfm?page=biomass_home-basics-k.cfm.
2. Create a KWLQ chart on the board. Have students think about what you've been discussing and what they read in the above article. What do we know about biogas and creating fuel from garbage? Write these ideas in the "K" section of the chart.
3. Looking at the "W" section of the chart, ask students to think about anything they want to learn about biogas and creating fuel from waste. Write these ideas on the chart.
4. Watch "Turning Waste into Energy." While watching the video, students should take notes on any new information they find interesting about biogas and creating fuel from waste. Stop the video frequently to ensure student understanding.
5. After watching the video, ask students to share what they learned. Write their ideas in the "L" section of the chart.
6. Finally, have students share any questions they still have about biogas and creating fuel from garbage. Write these in the "Q" section of the chart. Then discuss the questions as a class.

ACTIVITY 2: MEASURING WASTE

Time: 60 minutes

Materials:

- Gloves
- Scale
- Trashcan
- Pencil
- Handout: Student Worksheet

Procedure:

1. After watching "Turning Waste into Energy," discuss what students learned about methane digesters.
 - a. What is a methane digester? (*It uses anaerobic bacteria to break down waste and produce usable biogas.*)
 - b. How might the use of methane digester technology affect climate change? (*Converting trash into usable gases will reduce the amount of greenhouse gas emissions, which could help slow global warming.*)

VOCABULARY

conservation

the protection or management of natural resources such as water and soil

methane digester

an anaerobic (low to no oxygen) chamber that facilitates the breakdown of manure and other wastes to produce usable energy sources

resource

a source of supply or support

sustainable

capable of being continued with minimal long-term effect on the environment

ACTIVITY 2 CONTINUED

2. Make copies of and hand out the Student Worksheet. Explain to students that they will be filling in the chart based on the results of this activity (steps 3, 4, and 5).
3. Have students put all their waste from one day's lunch in a trashcan and weigh it (know the weight of the trashcan so it can be subtracted from the total weight). Then, with gloves on, have students sort the trash into recyclables, trash, and food scraps. Weigh each type of waste. What percentage of the waste is recyclable? What percentage of the waste is trash? What percentage is food scraps?
4. Using the weight of the food scraps from one day's waste, ask students to calculate how much food scrap waste they would produce in a school year if they produced this same amount of waste every day. Example: 5 pounds per day x 180 school days = 900 pounds of waste per school year.
5. Discuss what students have learned by examining their lunch waste. How much waste do we produce? What percentage of this waste is recyclable? What percentage is food scraps? Brainstorm a list of ways students can reduce the waste they produce.



CLIMATE CAREERS

Discussion Questions/Activities

- “Turning Waste into Energy” featured people who work in climate science. In partners, talk about the two different jobs highlighted in the video: a conservation specialist working on converting manure to biogas (Allen Dusalt) and a professor who built a methane digester (Dr. RuihongZhang). What do these jobs have to do with climate change? What implications might Dusalt's and Zhang's work have for the future?
- Think about all the different levels of the biogas production process. What goes into making sure everything runs smoothly? If biofuel technology becomes widely used, what jobs in this arena will be important in the future?

ABOUT THE AUTHOR

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www.kqed.org/education

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ASSESSMENT IDEAS

- Generate a class list of the things students learned about biogas and methane digestion.
- In partners, students discuss and make a chart of the pros and cons of converting waste into usable energy.

WHAT CAN WE DO?

Compost your kitchen waste (except for bones, fish, and meat) and outdoor clippings (get a compost bin from <http://www.stopwaste.org/home/index.asp>). Use the compost on your lawn or garden and watch it grow! Composting can divert almost one-third of your household waste away from landfills. If making and using compost at home is not a possibility, see if local recycling and/or waste management programs accept food and yard scraps. Also, find out if your school would be interested in a composting program.

ADDITIONAL RESOURCES

“Biofuels: Beyond Ethanol,” *QUEST*

<http://www.kqed.org/quest/television/view/819>

QUEST meets with scientists who are investigating the latest methods being used to convert plants into fuel.

Biofuel Production, U.S. Department of Energy (grades 6–12)

http://www1.eere.energy.gov/biomass/pdfs/biofuel_production.pdf

In addition to a technological overview of using biomass to create biofuels, this lesson plan includes eight project ideas for researching biofuels in the classroom.

Biomass, U.S. Department of Energy

http://tonto.eia.doe.gov/kids/energy.cfm?page=biomass_home-basics

This Web resource provides a brief overview of biomass and a description of how energy can be made from garbage.

Biomass Program, U.S. Department of Energy

http://www1.eere.energy.gov/biomass/abcs_biofuels.html

On this website, students will find information about biofuels research being done by the U.S. Department of Energy’s Biomass Program.

From Trash to Gas: Biomass Energy, Science Buddies

http://www.sciencebuddies.org/science-fair-projects/project_ideas/Energy_p027.shtml

Experiment with different types of waste to find out how biomass produces gases that can be used as biofuel.

What Is Biomass? National Energy Education Development Project

http://www.need.org/needpdf/infobook_activities/IntInfo/BiomassI.pdf

This fact sheet explains what biomass is, how biomass energy is used, and how it is converted into gas and liquid fuels.



STUDENT WORKSHEET

Discussion Questions

1. What is a methane digester?
2. How might the use of methane digester technology affect climate change?
3. What are some ways you can reduce waste?

Measuring Waste

Type of Waste	Weight (pounds)	Percentage of Total	Total Weight (pounds) per School Year	Percentage of Total School Year
Recyclables				
Food Scraps				
Trash				
Total				