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Lesson plan : generating methane

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Generating Methane

High School



SUMMARY

In this lesson from **Clue into Climate**, produced by KQED (a California radio station), students will learn how methane digesters turn waste into usable gases and other fuels. Methane is a greenhouse gas known to trap heat more effectively than carbon dioxide. Find out how methane digesters can be used to turn pollution into an energy solution.



SAFETY NOTE

SENSITIVE: This resource contains material that may be sensitive for some students. Teachers should exercise discretion in evaluating whether this resource is suitable for their class.



SOURCE

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LESSON OBJECTIVES

Upon completing this lesson, the students will:

- Learn how methane digesters turn waste into usable gases and other fuels;
- Understand the energy-producing potential of some solid wastes; and
- Examine some systems of generating methane from waste.



ESSENTIAL QUESTIONS

1. How does methane gas affect the environment? (Increased methane in the atmosphere contributes to the greenhouse effect that leads to global warming.)
2. What kinds of waste can be converted into usable energy? (e.g., food scraps, manure, crops, wood)



DURATION

The activity requires one to two class periods.



COLLEGE & CAREER-READY SCIENCE STANDARDS 2021

STANDARD

HIGH SCHOOL EARTH AND SPACE SCIENCE

B-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.

DISCIPLINARY CORE IDEA (DCI)

LS1.C: Organization for Matter and Energy Flow in Organisms

As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.

As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken, and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.

Anaerobic cellular respiration follows a different and less efficient chemical pathway to provide energy in cells.

CROSS-CUTTING CONCEPTS (CCC)

Energy and Matter

Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

B-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

DISCIPLINARY CORE IDEA (DCI)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.

CROSS-CUTTING CONCEPTS (CCC)

Energy and Matter

Energy drives the cycling of matter within and between systems.



ENGAGE

The students will listen to this **Climate Watch** audio feature – “Methane: The Other Greenhouse Gas.” The audio is a little more than 4 minutes long. Visit <https://scetv.pbslearningmedia.org/resource/kqedcl11.sci.ess.methanetheothergreenhousegas/methane-the-other-greenhouse-gas/> to hear the audio. After listening, the students can reflect on these topics:

- Where methane comes from in our natural environment;
- How human activities are producing methane; and
- What is being done to reduce methane emissions.



EXPLORE

Discuss some of the things students might already know about methane, or creating fuel from plants, food scraps, and other waste. Tell students that corn can be used to create an alternative fuel called **ethanol** and that used cooking oil can be used to make biodiesel. Ask them if they think other plants could be used to create fuel. Also ask these questions:

- **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.

Create a KWLOQ chart like the one below. Have the students think about what we know about biogas and creating fuel from garbage. Write these ideas in the “K” section of the chart. 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.

K What I KNOW.	W What I WANT to know.	L What I LEARNED.	Q QUESTIONS I still have.



EXPLAIN

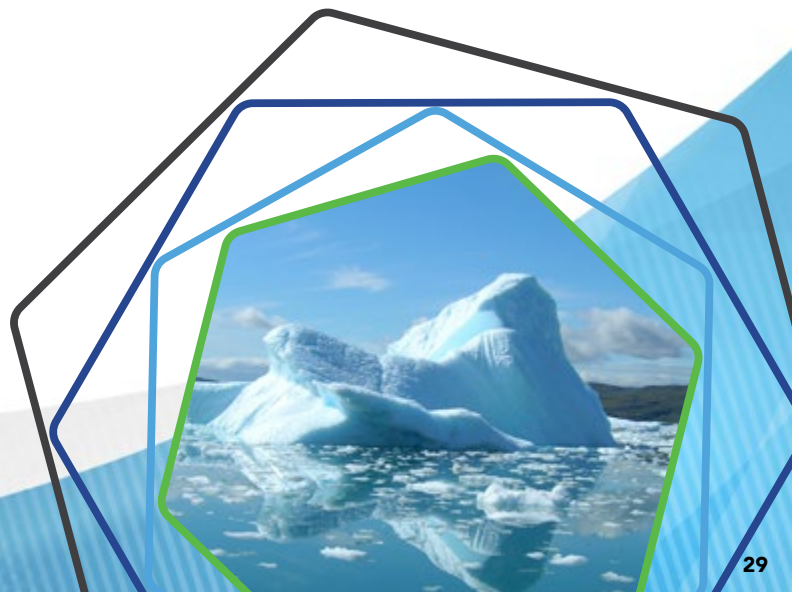
Watch the QUEST video **Turning Waste into Energy**. This video is about 7 minutes long. Visit <https://scetv.pbslearningmedia.org/resource/kqedcl11.sci.ess.turningwasteintoenergy/turning-waste-into-energy/> to view it.

While watching the video, students should take notes on any new information they find interesting about biogas and creating fuel from waste. After viewing the video, lead the students in a discussion to check for understanding and to share what they learned. Ask these questions:

- **How does methane gas affect the environment?** It affects the amount of greenhouse gas emissions.
- **What are the ecological advantages of converting animal waste into energy?** Allow reasonable student responses.
- **What is a methane digester?** It uses anaerobic bacteria to break down waste and produce usable biogas.
- **How might the use of methane digester technology affect the environment?** Converting trash into usable gases will reduce the amount of greenhouse gas emissions that could help the environment.

Write their ideas in the “L” section of the chart. 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.

NOTE: In South Carolina, there are many landfill gas-to-energy projects. BMW in the Upstate uses landfill gas to meet about 50 percent of its energy needs. For more information visit www.ameresco.com/wp-content/uploads/2020/07/bmw-manufacturing-palmetto-landfill-sc.pdf and <https://youtu.be/mntiGu3GRlc> and <https://youtu.be/H57WdjVBCU8>.





ELABORATE

Climate Careers' **Turning Waste into Energy** video features people who work in climate science. In groups of two, have students 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. Ruihong Zhang). Have the students consider these questions:

- **What do these jobs have to do with reducing the effect of methane on the environment?**
- **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?**

NOTE: Santee Cooper has many locations across the state that use landfill gas to generate energy that is put back on the electric grid. Learn more at www.santeecooper.com/news/2020/071420-Lets-Talk-Trash-Turning-Methane-Gas-into-Renewable-Energy.aspx or www.santeecooper.com/About/Newsroom/Archive.aspx and choose category "Green Power" and then the article "Let's Talk Trash: Turning Methane Gas into Renewable Energy." Also visit the S.C. Energy Office at energy.sc.gov/node/3080.

- **If biofuel technology becomes widely used, what jobs in this arena will be important in the future?**

Have partners work together to research two careers that may become important if biofuel technology becomes widely used. Students can decide how to present this research (e.g., formal paper, project-based presentation).



EVALUATE

Play the audio feature **Methane: The Other Greenhouse Gas**.

Explain to students that they will listen to the audio a second time to answer these questions. Stop and replay the audio as necessary for students to record their answers.

- **Why do some say it is better to release carbon dioxide into our atmosphere than to release methane?** Methane is a more potent warming gas.
- **What are two natural sources of methane in our world?** Termites and animal digestion
- **What are three human-produced sources of methane?** Landfills, oil and gas operations, and raising cattle
- **How do landfills produce methane?** Bacteria break down the garbage and produce methane.

NOTE: For more information, visit <https://doe.icfwebservices.com/> and see "RENEWABLE – Digester Gas" and "RENEWABLE – Landfill Gas."



E-LEARNING ACTIVITIES

- Have students visit the **U.S. Department of Energy (DOE) Biomass Program** website – www1.eere.energy.gov/biomass/abcs_biofuels.html. There they will find information about DOE's biofuels research. This activity can be used as supplemental information or for information to support the ELABORATE activity.
- Visit www.sciencebuddies.org/science-fair-projects/project_ideas/Energy_p027.shtml, **From Trash to Gas: Biomass Energy, Science Buddies (Making a Methane Digester)**. Experiment with different types of waste to find out how biomass produces gases that can be used as biofuel. This activity could be completed as a demonstration done by the teacher. NOTE: It uses materials that may be sensitive to some students.



DID YOU KNOW?

Every day, each of the world's **11 billion cattle** gives off one pound of methane – produced in their gut as they digest food. How much methane? It's about **274 billion pounds** or **137 million tons** annually.

