

Lesson 2: Recovering Energy from Waste

Duration: 3-4 class periods

Lesson Overview:

Students learn about new options for solving solid waste problems and the advantages of capturing and using methane as an energy source. Methane bubbles are created and burnt in a lab demonstration to learn about the physical characteristics of methane.

Objectives:

- Students will learn about new technologies for minimizing the impact of solid waste.
- Students will discuss alternatives for reducing, reusing, recycling, and recovering solid waste.
- Students will observe the physical characteristics of methane.

Essential Questions:

How do the physical characteristics of methane allow for new and existing options for reducing solid wastes?

Materials:

- Computer connected to the Internet
- TV or other projection device
- Option: if enough computers are available, have students access the www.thinkgreen.com site
- Student worksheet: Trash Reduction and Recycling at Home
- Burning Methane Bubbles Lab and necessary material and equipment listed on it (alternative – methane bubbles demonstration videos available on the internet.
- Landfill Gas to Energy (PDF) available at www.thinkgreen.com/classroom under "ThinkGreen Resources."

Lesson (Session 1):

1. Review with students what they have found out so far about how organic and other solid waste is handled in the school and in their community.
2. Explain that today, they will get some new ideas about how to handle solid waste in a way that can help everyone. By the end of the class, they should know about three different ways to handle solid waste.
3. Take a small piece of paper in a safe clear container and burn it. Ask students to list what came out of that reaction. Ask them to describe products from burning that would be wanted and things that would not be wanted. Keep this list visible as you work through the next part.

4. Write the word, methane, on the board. Invite students to review what they know about methane. Many may have heard about it being produced by cows and other livestock. Explain that they will be focusing on how methane is generated as a natural part of the decomposition of solid organic waste.
5. Discuss the generation of methane in a controlled environment, such as a landfill, and how it can be captured and converted to energy. Ask students if they know there is no harmful or negative impact on the environment in this case. Have them visit www.thinkgreen.com/landfill-gas-to-energy to learn more.
6. Ask the class to predict some of the physical characteristics of methane. Predictions could include - it's produced by decomposition or organic matter in landfills, it burns, it contributes to climate change. Tell the class that to learn more about methane's physical characteristics you will now conduct a lab demonstration on with methane gas. Note: If you are uncomfortable conducting the demo you can substitute any of a number of online teacher demos of this lab.
7. Conduct the Burning Methane Bubbles lab. Students will want you to repeat the demonstration. Do the student observations confirm any predictions of the physical characteristics of methane?
8. Write the chemical formula for the methane combustion:
$$\text{CH}_4 + \text{O}_2 \text{ -----} > \text{CO}_2 + 2\text{H}_2\text{O}$$

See if they can identify something else that came out of the reaction.

(thermal energy that we often call heat)

9. Ask students to brainstorm possible ways that we could use this thermal energy produced by methane gas.
10. In the next steps, if you have computers available for all students, assign one of the next three resources. Have them take notes and be ready to share their findings.
 - a. Connect online to Waste Management's website www.thinkgreen.com. Play the online demonstration of "Landfill Gas to Energy" found under the main navigation of www.thinkgreen.com. They can also view Discovery Channel's Talkin' Trash episode: Fuel for Thought. <http://www.thinkgreen.com/fuel-for-thought>
 - b. Connect online to <http://www.thinkgreen.com/burning-questions>. This is an episode of Discovery Channel's Talkin' Trash that focuses on how to get energy for electricity from burning solid waste. Students should also view the Waste to Energy section of the Think Green site.
 - c. Next play the online demonstration "Beneficial Land Reuse." You can also have them view the episode, The Secret Life of Landfills, <http://www.thinkgreen.com/secret-life-of-landfills>.
 - d. Based on information gathered earlier by the student teams discuss whether these approaches could be or are being used locally in their communities' landfills.
11. Move on to an expanded discussion with the class of possible ways to implement the 4 R's at your school, community or at homes, based on what the students have learned. Questions for discussion could include: What could we do to reduce waste in our school? Examples could come from the cafeteria or in waste generated in classrooms or on the school grounds. What at our school can be reused instead of recycled? How can we increase the kinds of

items that are recycled or increase the number or amount of thing already recycled? Are there ways to reuse natural resources such as water (e.g. rain? gardens) and garden "waste", (e.g. composting)?

12. Finally ask the class to discuss their responsibility to do anything with the information they have learned in the last few days.

Home Extension:

Assign the worksheet: Trash Reduction and Recycling at Home. Students should use it to find out what kinds of changes they may wish to make at home in order to increase their participation in the 4 R's.

Standards Correlation:

National Science Education Standard 12EST2.2 Science often advances with the introduction of new technologies. Solving technological problems often results in new scientific knowledge. New technologies often extend the current levels of scientific understanding and introduce new areas of research.

National Science Education Standard 12BPS3.2 Chemical reactions may release or consume energy. Some reactions such as the burning fossil fuels release large amounts of energy by losing heat and by emitting light.

Guidelines for Excellence in Environmental Education 3.2B Evaluate whether personal action is warranted.

Guidelines for Excellence in Environmental Education 3.1B Evaluate the consequences of an environmental issue.