# Roadside Renewables

**Summary:** **Students build a model landfill, observe the decomposition process, and collect the gas that is emitted from the model.**

## Objectives

Students will be able to

- explain why we use landfills;
- identify materials that go into a landfill and what is recycled; and
- explain how methane is collected from a closed landfill.

## Background

### What is a Landfill?

A landfill is not simply a hole in the ground where we dispose of trash, but a thought out system of disposing of waste. Landfills are designed to protect the soil, groundwater, and air from being polluted by the items we throw away. Landfills have a liner of clay and a synthetic material that keeps the liquids in a landfill inside so they will not leach into the soil or groundwater. Landfills also get a layer of soil put on top of them at the end of the day, called a daily cover, to reduce problems with animals and smells and to keep debris from blowing away.

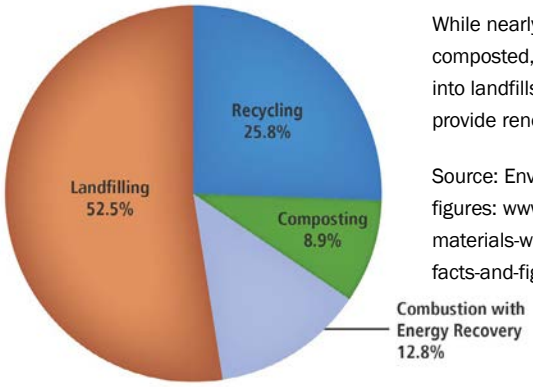
### Why Do We Use Landfills?

Throughout the world, humans dispose of things they do not need anymore. In the United States, we also use landfills to hold the things we no longer want. Most households have a trash can and a recycling bin somewhere, and once a week the trash and recycling are picked up by a truck and taken away. What happens after it leaves the curb? It goes to two separate places. Approximately 26% of the waste is recyclable materials that go to a recycling plant where they are sorted and shipped to other places to be reused. Approximately 53% of our trash goes to a landfill where it is dumped, piled, and plowed, to be continued forever. Nearly 9% of waste is composted. The remaining 12.8% of trash is burned by incineration.

### Life cycle of a Landfill

A landfill location must be approved before the building begins. This can be a long and complicated process because many people do not want to live next to a landfill. There is often a lot of public opinion on the location. Then an environmental impact study must be conducted in order to determine what effect, if any, the landfill will have on the environment. The impact study is reviewed by the Wisconsin Department of Natural Resources, and, if the environmental impact study is completed without raising concern then the local government or private company must submit forms to obtain permits and raise the money to build a landfill. A vote from the public is often needed to raise the money to build a landfill. After these first steps have been completed, the landfill is built.

Once the landfill is operating, our waste begins to be brought by truck and local citizens to be disposed of. A landfill has small




While nearly 30% of our trash is recycled or composted, there is still more than 50% that goes into landfills. This never-ending pile of waste can provide renewable energy for years to come.

Source: Environmental Protection Agency (2015) figures: www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

**Grade Level:** 5–8 (9–12)

**Subject Areas:** Environmental Education, Family and Consumer Education, Science

**Setting:** Classroom

**Time:**
**Preparation:** 90 minutes
**Activity:** One 50-minute class period to construct models, plus several weeks to watch the process unfold

**Vocabulary:** Anaerobic digestion, Decomposition, Landfill, Leachate, Methane

**Academic Standards:**
NGSS: MS-ESS3-3
SEP: Constructing Explanations and Designing Solutions
DCI: ESS3.C: Human Impacts on Earth Systems
CCC: Influence of Science, Engineering, and Technology on Society and the Natural World

WI Env Literacy & Sustainability: C1.A.m, C1.B.e, EX2.A.i, EX2.A.m, EX2.B.i, EX2.B.m, EX2.C.e, EX3.A.m, EX3.B.m, EX4.A.i, EX4.A.m, EX5.C.i, EN6.A.i, EN6.A.m, EN6.B.m, EN6.C.m

**Materials:** Samples of commonly discarded waste materials, including recyclable materials (kitchen scraps, leaves, newspaper, plastic bottles etc.) NOTE: Natural materials and food waste will work best for this activity. Think about what items decompose quickly.

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**Each group of students will need the following:**

- Copies of ***Pre- and Post-Activity Worksheets, How to Build a Model Landfill–Student Activity Sheet,*** and ***Roadside Renewables–Data Sheet***
- Glass or plastic jars with tight covers
- Drill for drilling holes in jar covers.
- One foot of plastic or glass tubing
- Ceramic clay in slip (liquid) form
- Scissors
- Rubber bands
- Plastic bag or other lightweight bag/balloon
- Clear plastic wrap

## Resources:

*How Stuff Works*
https://science.howstuffworks.com/environmental/green-science/landfill.htm

## Related KEEP Activities:

"Community Design–It's a Gas"–*BioFutures.* "Biomass Gazette"–*BioFutures.*

## Credits:



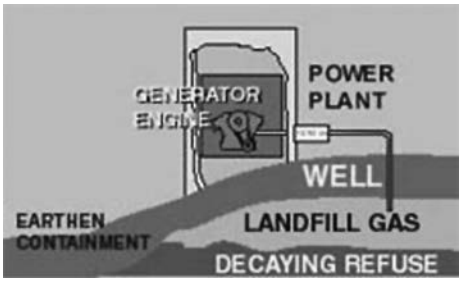
areas called cells where dumping takes place in during the day. This is done so it is easier to manage and easier to cover the smaller area with dirt at the end of the day (daily cover). Once a cell is closed, it is covered with a six-inch layer of soil and another section is used the next day. Once a cell is closed and permanently capped the methane generated from decomposition can be collected (see section on Energy from Landfills).

Once the landfill is closed and capped, it must be monitored. The landfill is monitored to look for leaks in the liner and several groundwater wells are also tested regularly in order to determine if any liquid/leachate from the landfill has leached into the groundwater.

**Energy from Landfills**

The material in a landfill decomposes because there are anaerobic bacteria that thrive in the oxygen-free (anaerobic) environment. As decomposition takes place, gases are given off. This process is called anaerobic digestion. Methane, carbon dioxide, and other landfill gases are pulled out of the landfill through well and vacuum systems that are piped into the landfill. 50–60% of the gas given off by a landfill is methane. Methane is a gas that can be used to generate electricity and can be used like natural gas for heating spaces, heating water, and cooking. Natural gas is a non-renewable fuel that is usually burned to produce heat and to generate electricity. Methane is a very harmful greenhouse gas and must therefore be burned, or flared, as it is released from the landfill.

While the United States has reduced the waste going into our landfills by recycling, there will always be landfills. Because landfills will remain the main place to dispose of our waste, this source of energy is considered renewable. Not only are we generating energy from the methane, but we are reducing the amount of climate changing gases that are released into the atmosphere. This reduces smog, pollution, and global climate change and generates energy.




*This graphic shows a simple cross section of a landfill and how energy can be harnessed from it.*

Source: Primary Power International. Ithica, Mich.

## Procedure

### Orientation

Ask students what happens to their trash after it is taken to the curb. They should reply that it is picked up by the garbage truck and then it is taken to the landfill. Make sure students know the difference between what happens to their recycling and their garbage.

Show students the collection of sample waste materials. Hold up each of the materials and ask students where each item should go (landfill or recycling). Separate them into two piles and have the landfill materials ready for the activity. NOTE: You can identify biomass materials as any organic matter, such as any plant material.

Ask students to share what they know about landfills and how they operate. Correct or supplement their answers with information found in the Background and other sources. Make sure students understand the following key points:

- Nearly 53% of our trash goes to a landfill
- It takes many years for the trash to decompose and the landfill will eventually be full and a new landfill will need to be built.
- Landfills need to be covered and monitored to protect the environment.
- The trash in the landfill decomposes even when the landfill is covered.
- The process of decomposition gives off gases that are harmful to the environment. Because the gas is considered a source of pollution, it must be burnt or collected. The gas being collected is composed of carbon dioxide, methane, and many other gases.
- One thing that can be done with the gas is to burn it to create electricity and/or heat.

### Steps

1. Divide the class into groups of four and explain that each group will be building a model landfill.

2. Provide each group with a copy of the ***How to Build a Model Landfill*** handout. Review the steps and, after students understand the activity, provide each group with a bag of landfill materials (the bulk of the materials should be organic matter such as food waste and yard waste). Hand out or have one student from each group collect the other materials needed for the activity.

3. After students have completed building their model, tell them that their landfill has been closed by the city and that it is time to seal it up. Explain that when the material in the landfill breaks down, it generates gases and those gases need to be vented out of the landfill.

4. After students have completed sealing their landfill, ask why the landfill needs to be sealed tightly. NOTE: If students are not able to seal their landfills with the rubber bands, they might use extra clay. The landfill needs to be sealed so the gas will not escape.

5. Hand out the ***Pre-Activity Worksheet.*** Students should complete the form as a group.

6. If possible, place the models outside in the sun, in a sunny interior window, or another warm place. Hand out copies of ***Roadside Renewables–Data Sheet*** and have students monitor their landfills and complete the questions at the end. This activity may take an extended amount of time to produce enough gas to be viewed by the students. The more easily broken down the materials are and the more tightly the jar is sealed, the better off you will be.

7. Ask students what they think cities and municipalities do with the collected gas. Explain that in closed landfills which do not collect the methane for energy, the methane must be burned off. You can sometimes see this as you drive by a landfill at night. Inform them that because the city has decided to use the gas from the landfill for energy, they must burn the methane so it is not released into the atmosphere (see **Background**). Methane is burned and used much like natural gas. **Caution: Students should release the gas from their landfills outdoors in a well ventilated area; it is too risky to try to burn the gas their landfills might generate.**

### Closure

Review the discussion in the **Orientation** about which materials are recycled and which items are not. Hold up a few items and ask students where they should go. Have students review the purpose of a landfill and how it works for communities. See if they list landfills as a potential energy source within their descriptions.

Have students complete the **Post-Activity Worksheet** and discuss the results.

Ask students why landfills need to be closed when they are full. Ask them to explain what happens inside the landfill. Why does the gas need to be collected and flared off? What is another option besides flaring or burning off?

## Assessment

**Formative**

- Can students describe the purpose of a landfill and how it works for the community?
- Have students list materials that should go into a landfill and what should be recycled.
- Ask students to explain how landfills can be an energy source for the community.
- Can they identify the gas that is collected from landfills?
- How thoroughly did students complete their *Roadside Renewables–Data Sheet*?

**Summative**

Have students conduct additional research on landfills as an energy source, listing pros and cons of this resource. Do they think capturing and using gas from landfills is a good option? Why or why not?

## Extension

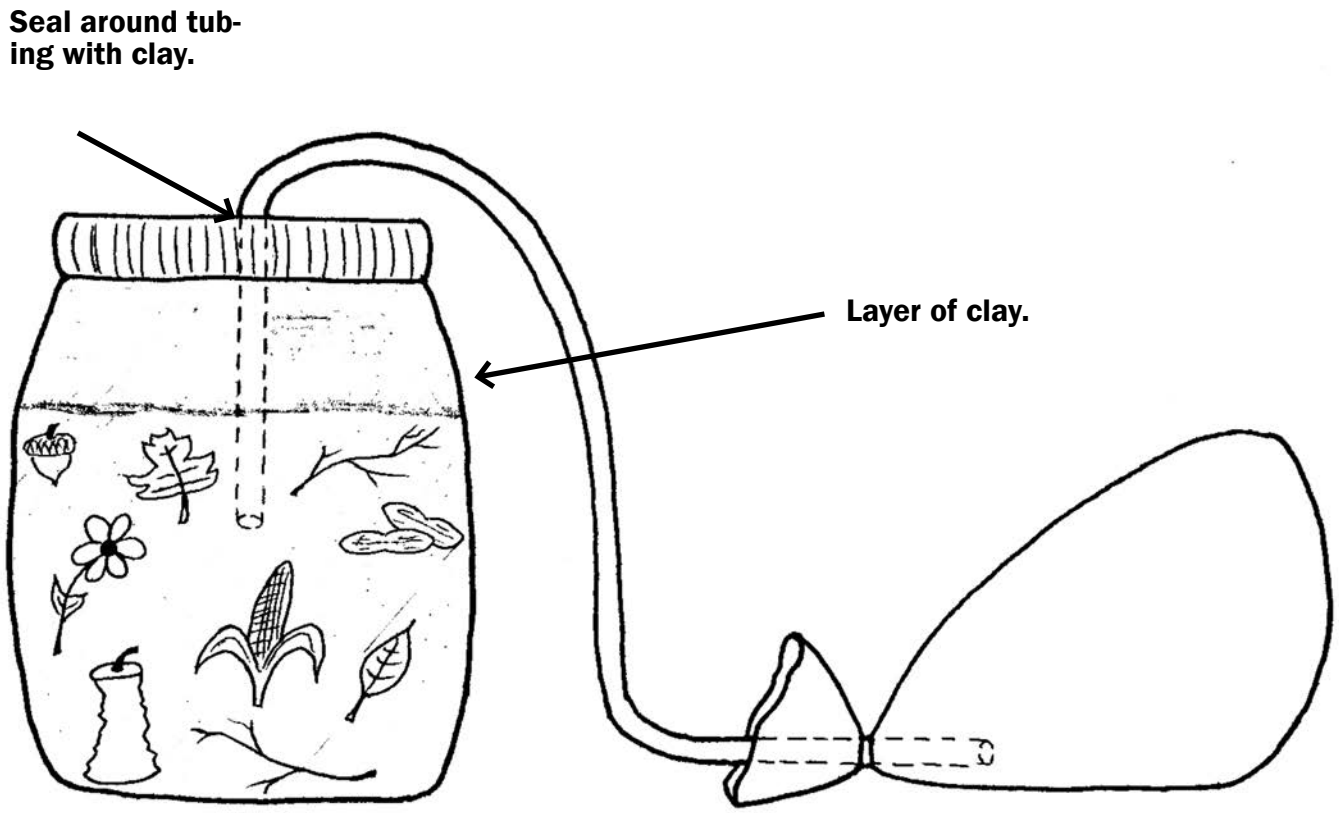
Have students work in groups to find out if there are any landfills in Wisconsin that use anaerobic digestion to generate energy. Put a state map on the board and have students mark them as they locate them. Have one student call the local landfill to find out the history of the landfill. How long will it last? Where was the last landfill and what is it being used for now? Are there any closed landfills nearby? What are those used for?

Take students on a field trip to a landfill so students can see how much waste is generated.

NOTE: This activity uses materials that can also be composted or put into a yard waste facility. These materials were used in the activity because they decompose much faster than the other materials we put into a landfill. Consider building a compost bin with your students to discuss this process as well.

# How to build a model landfill

1. Drill a hole in the lid of your container the size of the plastic tubing.
2. Fill your landfill with materials from the landfill pile. Write down the materials you put in your landfill on the ***Roadside Renewables–Data Sheet.***
3. Add a couple drops of water.
4. Insert the plastic tubing into the landfill pile and then cover the top of the waste with a layer of clay.
5. Push the other end of the plastic tube through the lid of the container and carefully seal the container with clay.
6. Put a light-weight plastic bag (or balloon) on the end of the tubing and seal it tightly with a rubber band.
7. Make sure that the landfill is sealed against any leaks and pay special attention to the area surrounding the plastic tube.



# Roadside Renewables Pre-activity Worksheet

1. What did you put in your landfill?

2. How long do you think it will take the plastic bag to fill with gas?

3. Fill out the data sheet.

# Post-activity Worksheet

1. How many days did it take for your landfill to produce gas?

2. Did your landfill produce gas before other students', at the same time as others', or not at all? Why?

3. What would you do differently next time you build a landfill in order to produce gas more quickly?

# Roadside Renewables Data Sheet

| Date | Observations |
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