ONE STEP™

CLASS TALK

#stompoutcarbon for a better tomorrow!

FROM LEFTOVERS TO LIFESAVERS

HomeBiogas

Approximately 72 billion pounds of food ends up in landfills and incinerators each year. When food decomposes, a colorless, odorless gas called methane is produced. This isn't the only way that methane gets into the atmosphere. Methane is produced as the result of natural processes and human activities alike, including oil and natural gas systems, agricultural activities, coal mining, combustion, wastewater treatment, and enteric fermentation, to name a few. Unfortunately, methane is a powerful greenhouse gas, trapping 28 times more heat than carbon dioxide.

S1E4 (24 mins)

From Leftovers to Lifesavers

Leftovers become life-saving fuel with this backyard supercomposting system that is revolutionizing lives across the world.

But what if you could divert some of the methane being produced into something more useful? In this video, students will learn how one organization has developed a backyard system that captures the methane released as food waste decomposes and turns it into cooking biogas and plant fertilizer. This "super composter" uses all organic matter, prevents additional methane from entering the atmosphere, and provides free renewable energy to empower people in remote and rural areas across the world.

Concepts Covered

- Food waste, landfills
- Human impact on the environment
- Greenhouse effect and gases
- Methane emissions and effects
- Enteric fermentation
- Anaerobic and aerobic digestion
- Biogas as a form of renewable energy
- Composting
- Ways to reduce food waste

VOCABULARY

Use the Teaching Slides to review these words and concepts as needed.

emission (noun)

The root word for emissions is emit. When you emit something, it means you give out something like a gas. For example, cows emit methane during digestion. Emission refers to the thing or gas being emitted.

For example, waste that enters our landfills accounts for about 19% of all methane emissions in the U.S.

- So what do you think carbon emissions refer to? That's right, gases that relate to carbon, mainly carbon dioxide.
- How does the HomeBiogas system reduce emissions?

renewable energy (noun)

Biogas is a type of renewable energy. Renewable energy is clean energy, which means it comes from natural sources or processes that are not likely to run out.

For example, wind and solar energy are other examples of renewable energy—we are not likely to run out of sunlight and wind. Wind is another form of renewable energy.

- How do we harness the power of the wind?
- What are other forms of renewable energy?
- Why is renewable energy important?

organic (adjective)

Organic refers to things that are living organisms. Organic waste is waste from plant and animal sources.

- What kinds of organic matter can be turned into biogas?
- What kinds of organic matter can be composted?

BEFORE THE VIDEO

** questions for grades 6–12*

1. Why do you think people throw away so much food every day?

2. What kind of negative impacts might rotting food have on our planet? Brainstorm ideas with a partner.

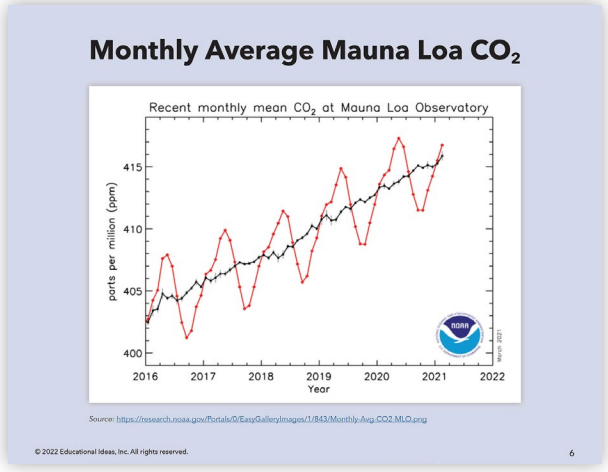
3. What is a landfill? What happens at a landfill? What are some of the problems with landfills?

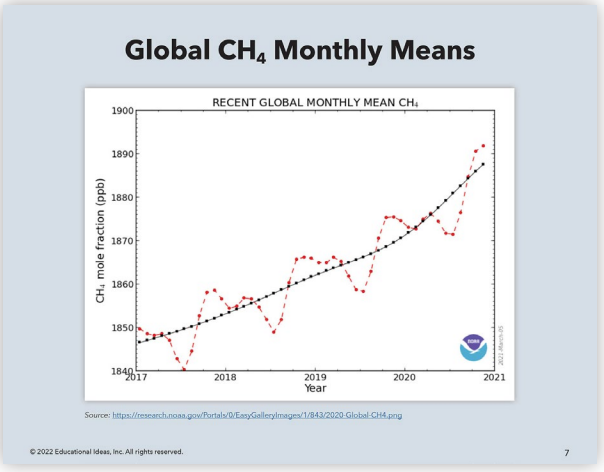
4. What is composting? How does this help the environment and people?

5. Have you ever heard of methane? What do you know about it?

6. *Display a graph of global annual CO_2 emissions and graph of methane emissions. Highlight the different units of parts per million (ppm) and parts per billion (ppb), ensuring that students understand 1 ppm is a thousand times greater than 1 ppb. Students discuss the following prompts in small groups, then share with the class:

   - What trends do you notice?
   - Carbon dioxide and methane are both greenhouse gases that trap heat in the atmosphere. Which greenhouse gas are you most concerned about, and why? *(Do not confirm or deny any student ideas.)*





AFTER THE VIDEO

** questions for grades 6–12*

1. Discuss what you learned about methane and its impact on the environment.

2. Ask students to share their reactions to the HomeBiogas system.

3. How does the HomeBiogas system impact people living in rural areas?

4. If you had an outdoor space to put a HomeBiogas system, would you want to use one? Why or why not?

5. *Revisit the graphs of global annual CO_2 emissions and methane emissions. Students discuss the following prompts in small groups, then share with the class:

   - Methane reacts to oxygen in the atmosphere, meaning it lasts approximately 8 years. When methane is oxidized, it forms water and carbon dioxide. Carbon dioxide lasts 300–1,000 years in the atmosphere, according to NASA. Discuss which greenhouse gas is now more concerning, and why. *(The purpose of this question is to reflect on changes to thinking when new information is presented. There is no "right" answer as to which greenhouse gas is more concerning; instead, focus on ensuring students are using relevant evidence to support their claims.)*

   - How has your thinking about carbon dioxide and methane emissions changed?

6. What are the advantages and disadvantages of using biogas?

7. *Discuss the process of enteric fermentation. Is this an aerobic or anaerobic process, and how do you know?

8. Agriculture is the largest source of humane methane emissions. Do you think all farms should be required to have a system like the HomeBiogas system? Why do you think that?

9. *Vermont runs a program called "Cow Power," in which electricity customers can elect to pay a small increase to directly support farms producing biogas. Brainstorm other ways that the government or organizations can encourage biogas use and production.

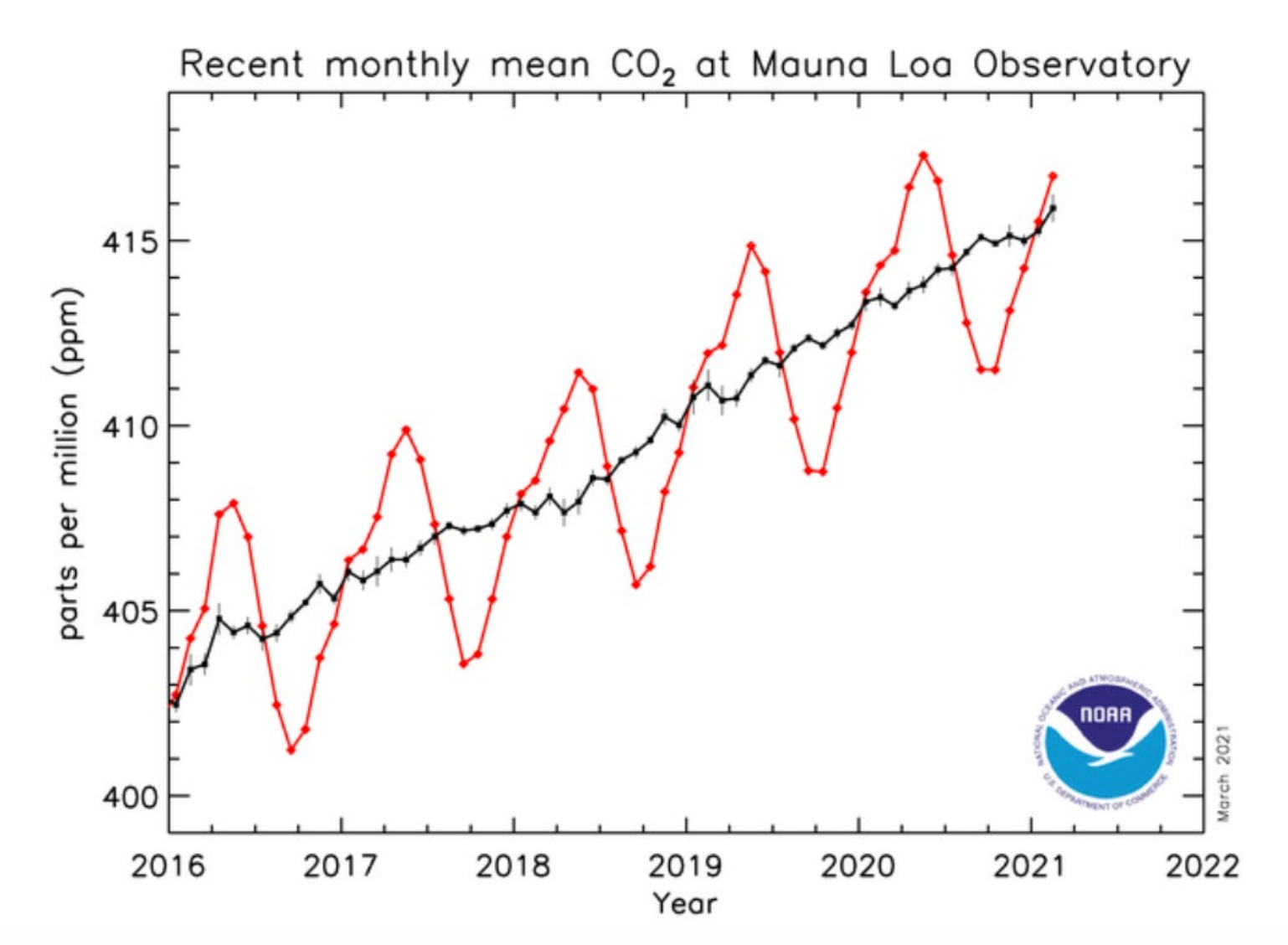
10. Which actions to reduce food waste are most feasible for you to achieve?

NOTE-TAKING

As students watch the video, in class or at home, have them take notes as an accountability assessment.

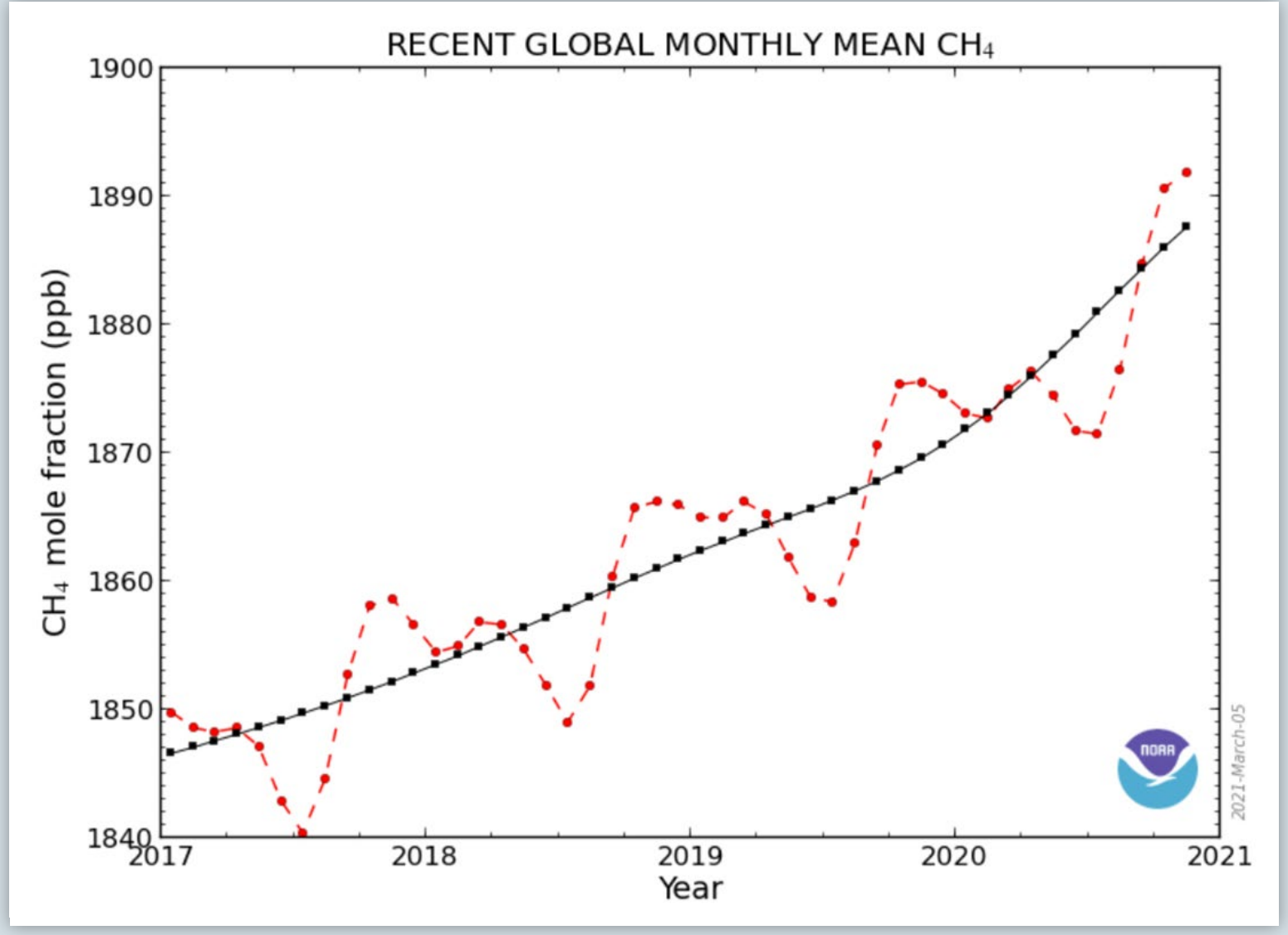
1. How many pounds of food is wasted every year?
2. What does food waste release as it decomposes?
3. Does carbon dioxide or methane trap more heat in the atmosphere? How much more?
4. List three things that produce methane emissions.
5. Explain how biogas is created.
6. Does composting use oxygen? What kind of materials can be composted?
7. Does biogas creation use oxygen? What kinds of materials can be used to create biogas?
8. Name three ways you can reduce food waste.
9. Write down two important things you learned in this episode.
10. Write down two questions you may have about this episode.

Monthly Average Mauna Loa CO_2



Source: https://research.noaa.gov/Portals/0/EasyGalleryImages/1/843/Monthly-Avg-CO2-MLO.png

Global CH_4 Monthly Means



Source: https://research.noaa.gov/Portals/0/EasyGalleryImages/1/843/2020-Global-CH4.png

TEACHING SLIDES

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(adjective)

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Grades 4–5

4-ESS3-1: Obtain and combine information to describe that energy and fuels are derived from natural resources and that their uses affect the environment.

5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information	**ESS3.A:** Natural Resources **ESS3.C:** Human Impacts on Earth Systems	Cause and Effect Systems and System Models **Connections to Engineering, Technology, and Applications of Science** Interdependence of Science, Engineering, and Technology Influence of Engineering, Technology, and Science on Society and the Natural World **Connections to Nature of Science** Science Addresses Questions About the Natural and Material World.

Grades 6–8

MS-ESS3–3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MS-ESS3–4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Constructing Explanations and Designing Solutions	**ESS3.C:** Human Impacts on Earth Systems	Cause and Effect **Connections to Engineering, Technology, and Applications of Science** Influence of Science, Engineering, and Technology on Society and the Natural World **Connections to Nature of Science** Science Addresses Questions About the Natural and Material World

Grades 9–12

HS-ESS3–4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

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

HS-ETS1–3: Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions **Connections to Nature of Science** Scientific Knowledge is Open to Revision in Light of New Evidence	**ESS3.C:** Human Impacts on Earth Systems **ETS1.B:** Developing Possible Solutions **LS2.B:** Cycles of Matter and Energy Transfer in Ecosystems	Stability and Change Energy and Matter **Connections to Engineering, Technology, and Applications of Science** Influence of Science, Engineering, and Technology on Society and the Natural World