Summary: Students identify current energy use practices and incorporate the use of energy from methane into community design. NOTE: This activity is best used as a conclusion to additional renewable energy or biomass energy lessons.

Community Design: It's a Gas

Grade Level: 5–8 (9–12)

Subject Areas: Environmental Education, Language Arts, Science, Social Studies

Setting: Classroom, Computer lab, Library

Time:
Preparation: One–two hours
Activity: One week

Vocabulary: Anaerobic digestion, Biogas, Biomass, Methane

Academic Standards:
Common Core ELA: SL.6-8.4

NGSS: MS-ESS3-3
SEP: Constructing Explanations and Designing Solutions
DCI: ESS3.A: Natural Resources, ESS.C: Human Impacts on Earth Systems
CCC: Cause and Effect, Engineering and Technology on Society and the Natural World

WI Env Literacy & Sustainability: C1.B.e, C1.B.m, EX2.B.m, EX2.C.i, EX3, A.m, EX3.B.m, EX4.A.i, EX4.B.i, EX4.B.m, EX5.B.m, EN6.A.i, EN6.B.i, EN6.B.m, EN6.C.i, EN7.B.i

Materials

- Tag board or a map of the city
- Drawing utensils or 3-D models of trees, hills, roads, homes, etc.

Getting Ready:

In the days before you introduce this activity, make sure you are familiar with your community resources. Does your community have a landfill? Where is the wastewater treatment facility? How many large farms are in the area?

Objectives

Students will be able to

- identify possible sources of methane gas;
- discuss the benefits of using methane; and
- discuss the limitations of incorporating the use of methane into their community as it currently exists.

Background

Community Planning

In the not-so-distant past, humans developed buildings and communities with renewable energy in mind. The availability of sources of fuel was included in the decision-making process. In modern society, these considerations have often dropped. In a time of growth, community planners are faced with the task of balancing multiple objectives, including economic feasibility, governmental regulations, social and cultural conditions, professional ethics, and environmental and architectural principles. The added planning and up-front costs that are incurred when using renewable energy in the design can often hinder its use.

Some planners recognize the environmental and economic benefits of including renewable energy as a consideration. They address wind patterns, solar access, the availability of unobstructed, direct sunlight, and energy efficiency. By designing a community with renewable energy in mind, residents can save money while reducing energy costs and living in a naturally comfortable home environment.

This activity will focus on methane (CH_4), a form of biomass energy that is generated from multiple sources. Methane can be used in much the same way as natural gas, but makes use of resources that are renewable. Methane can be made from cow, pig, or poultry waste, wastewater treatment facilities, and/or closed landfills. Many Wisconsin communities have agriculture, treatment facilities, and landfills near them. The production of biogas happens in an anaerobic system, or a system without oxygen. This happens in natural areas such as swamps, large bodies of water, and even in the stomach of large animals.

Methane from Animal Waste

Farms that have large herds of cows (over 500 head), pigs, or poultry can economically convert the manure into methane gas. Currently farms with small herds are not able to take advantage of this technology unless they work together and combine their resources. Research is being conducted to make this process work on smaller farms as well as large farms.

The animal waste is collected and dumped into the digester, which can be above or below ground. There are two types of digesters—batch and continuous. A batch digester is loaded with the waste, left to digest, and is then emptied and the process starts over again. A continuous digester is continuously fed with waste.

Useful by-products of this process are biogas (methane) and a solid material that can be used as fertilizer or bedding for animals. One of the added benefits of using a digester is that the smell of the animal waste is greatly reduced, which improves air quality for homes near the farm.

Methane from Wastewater Treatment Facilities

Wastewater treatment facilities treat the water that "goes down the drain." This wastewater includes our showers, sinks, and toilets. The treatment facilities are responsible for removing organic matter from the water, removing odor, and restoring the water to a higher quality than when it came in. As our communities grow, the demands on these facilities grow. One way the treatment facility can take advantage of the growing amount of wastewater is to use that waste to generate energy. The energy that is generated is sometimes used to power the wastewater treatment facilities. This can lower their energy bill, and since the residents of the community pay for the energy bill with

tax money, it benefits not only the facility but the community as well. Some of the other benefits are the reduction of odors and the reduced production of solid waste. The solid waste that is produced can be used as a soil amendment after being processed.

Methane from Landfills

Most communities have a landfill nearby. When a landfill is filled up, it is then sealed off. Once the landfill is sealed, an anaerobic situation is created. The waste in the landfill breaks down in the absence of oxygen and gives off gases which are harmful to people and the environment. In order to prevent the release of the gases into the atmosphere the landfill gas is collected and flared. If you drive by a landfill at night, you can sometimes see the flares burning. One of the gases released is methane. Instead of burning the gas and not using it for the useful purpose, the gas can be burned to create electricity or used as fuel for heating.

See the activity "Roadside Renewables" for additional background information.

Procedure

Orientation

Talk about the principles and issues involved in community planning. Ask students what considerations they should address in designing the home plots and open spaces for a small community. Have them share ideas with the class. Encourage them to reflect on what comes into a community (electricity, water, fuel) and what leaves a community (waste, trash, heat). Consider other community needs such as transportation, recreation, privacy, etc.

Challenge students to identify which of the community activities are energy-related. Discuss which energy resources are currently used by most communities and how they enter and leave the community. Review costs and benefits of current energy use practices.

Introduce the topic of energy from alternative sources such as biomass. Can they name sources of biomass? Explain that there are many different ways biomass can be used to generate heat or electricity. Explain what methane is and how it can be made and used.

NOTE: This activity addresses one renewable resource—biomass from methane—which can be utilized in the development of a sustainable community. Refer to the activity "Sustainable Communities" in *Doable Renewables: A Renewable Energy Education Supplement* to the KEEP *Activity Guide* for an activity that includes all renewable energy resources.

Steps

1. Explain that the mayor of town X has requested information about biogas energy systems and is interested in developing more energy resources for his/her community. NOTE: Town X can be a fictional town or students can select an actual community such as their own. Other options include providing a map of a city for students or providing them tag board with pre-marked physical features such as rivers; wooded, plain, and wetland areas; topographical features; and existing structures (farms, homes, landfills, wastewater treatment facilities, power lines, etc.).

2. Inform the class that the goal is to assess a city for the potential of utilizing biogas energy technologies.

3. Establish teams of three or four students. If you are having students assess their own city, give them a few days to document the significant environmental and physical features, etc.

4. Explain that biogas energy technologies are often left out of the design of a city. Use the following questions to pose ideas for incorporating biogas into the students' site design:

   - What nonrenewable resources are currently heavily used?
   - Is there a renewable energy source being utilized for heat or electricity?
   - Are there options for incorporating biogas energy sources into active systems?
   - Which options seem the most cost effective?

5. Assign student groups the task of incorporating biogas energy technologies into their city. Give students a week to establish their design.

Closure

Have students present their findings to the entire class and lead a discussion on how they decided to lay out their city. The discussion should include benefits and drawbacks to developing methane systems in the community. Have other students critically analyze each subdivision, making recommendations for improvement. Have students redesign their subdivision after student presentations and critiques. How do the designs change over time?

Assessment

Formative

- Were students able to identify the many ways a community can utilize bioenergy in the form of methane?
- Were students able to show the benefits and drawbacks to developing a community utilizing renewable energy?

Summative
Take students on a tour of a landfill or wastewater treatment facility. Have each student prepare a question to ask their guide. Review the questions to assess understanding of methane production from solid waste.

Extension

Explain to students what biomass is and ask students to list some sources of biomass energy. Take them on a tour of a wastewater treatment facility or a farm. Explain to students what happens with animal and human waste and what could be done in the future.

Have students do the same activity and try to incorporate additional biomass energy technologies (alternative fuels, using wood as a source of fuel, industries that use wood products can burn their wood waste to generate heat and/or steam) into the design of the city. See the other activities and fact sheets to get more ideas.