



Title: Trash to Gas

Grade: Middle School

Subjects: Science, Math, Social Studies

Time: 50- 60 minutes and daily observation

Standards: Students will ...

Technology Standard 3: Understand the relationship among science, technology, society and the individual.

- Benchmark # 6: Know ways technology is used to protect the environment (e.g., developing alternative forms of energy to replace the use of fossil fuels).

Geography Standard 14: Understand how human actions modify the physical environment.

- Benchmark # 4: Understand the environmental consequences of both the unintended and intended outcomes of major technological changes in human history (e.g., the effects of automobiles using fossil fuels, the expansion of the amount of land brought into agriculture).

Geography Standard 16: Understand the changes that occur in the meaning, use, distribution and importance of resources.

- Benchmark # 7: Understand how the development and widespread use of alternative energy sources (e.g., biomass) might have an impact on societies (in terms of, e.g., air and water quality, existing energy industries, and current manufacturing practices).

Mathematics Standard 4: Understand and apply the basic and advanced properties of the concepts of measurement.

- Benchmark # 2: Solve problems involving perimeter (circumference) and area of various shapes.
- Benchmark # 6: Select and use real units and tools, depending on the degree of accuracy required, to find measurements for real-world problems.

Mathematics Standard 6: Understand and apply the basic and advanced concepts of statistics and data analysis.

- Benchmark # 1: Understand basic characteristics of measures of central tendency (i.e., mean, median, mode).
- Benchmark # 4: Read and interpret data in charts, tables and plots.
- Benchmark # 5: Use data and statistical measures for a variety of purposes (e.g., formulating and testing hypothesis).
- Benchmark # 6: Organize and display data using tables, graphs (e.g., line, circle, bar), frequency distributions, and plots.
- Benchmark # 8: Understand the same set of data can be represented using a variety of tables, graphs, and symbols and that different modes of representation often convey different messages (e.g., variations in scale can alter a visual message).

Objectives: Students will be able to...

- Identify types of materials that fall under the category of biomass, and describe how biomass can be used as a fuel source.
- Explain the benefits of biomass as alternative energy source.
- Collect, record, and organize data using a variety of graphic representations.

Materials:

- Nine two liter soda bottles
- Duct tape - Disposable gloves
- One cup of cow manure
- Scale
- Uncooked vegetable peels



- Mashed banana
- Nine latex balloons
- 20 liters of distilled water
- Funnel
- Tape measure
- Colored pencils
- Bleach
- Chart paper
- Poster markers
- Data worksheet provided below

Overview: Today, in the 21st Century, people are dependent upon a constant, artificial power source to help sustain them in their everyday lives. Rapid growth in the areas of technology, industry, and medical science has led to exponential growth in population. Unfortunately, this has caused a growing demand for energy, and therefore an increase in the amounts of pollutants released into the atmosphere, water, and soil. In this technological era, the four main areas of energy consumption (e.g., transportation, agriculture, manufacturing, and electrical power) are under constant demand and strain, and the most common source to meet these energy needs is the burning of fossil fuels. Whether it is coal power plants creating electricity or hundreds of millions of people driving vehicles, the burning of such a large amount of fossil fuel is undoubtedly having a negative effect on our planet, resulting in pollution, depletion of natural resources, and global warming. At the same time fossil fuel consumption is damaging the planet, it is simultaneously affecting the health of human beings.

To affect positive change, not only must we change the way in which we use energy (e.g., through conserving, recycling, reusing), we must also change the sources for the energy that we consume for power. Today, science and technology are helping to combat energy problems by creating effective ways in which to efficiently harness renewable energy sources, such as wind, water, and solar power. Natural energy is bountiful, it does not deplete natural resources, and it is considerably less harmful to the environment than burning of fossil fuels.

Another alternative to fossil fuels and natural energy sources is biomass. Biomass produces natural gas called biogas. Biogas is created from the fermentation of organic materials, such as manure, commercial waste, and energy crops. When these materials decompose in a minimal oxygen environment, they release methane and carbon dioxide. Once released into the air, the chemical gases mix with oxygen and become combustible. Biogas is a natural and renewable source of energy that allows us to use the waste material that humans create everyday. Organic products, such as rotting food and garbage, and other decomposing natural materials that typically end up in landfills can be used to produce a natural, renewable energy source. Biogas can be used to heat buildings, produce electricity and fuel vehicles.

Kid's Speak: Fossil fuels are still the primary energy source used today to power transportation, agriculture, manufacturing systems, and to produce electricity. As a result Earth's natural resources are being depleted, the air, water and soil are polluted, and there is a major concern that global warming is effecting climate change worldwide.

Alternative sources of energy provide a solution to this problem. Biomass is one form of alternative energy that can reduce our dependence on fossil fuels. Cow manure, dead plants, and rotting food are all forms of biomass. When decomposed in a nearly oxygen free environment they produce a natural gas called biogas. Biogas can be used to heat homes, generate electricity, and fuel automobiles.

Eco-Fact: Every year we fill enough garbage trucks to form a line that would stretch from Earth, halfway to the moon.

Procedures:
Before Experiment:



1. Display a list of vocabulary terms, such as those below that relate to the various forms of energy. Ask students to sort and classify the terms into categories and record them. What categories did they identify? Which terms did they assign to each category? Were there any terms that did not fit a category? Compile and display a class version of the categories and terms suggested by the students and discuss how the terms were categorized. List of terms may include the following: bio-diesel, biomass, carbon dioxide, coal, crops, decomposing matter, electricity, ethanol, fuel, gas, geothermal, heat, hydroelectric, hydrogen, landfill, light, manure, methane, nuclear, oil, power, solar, sunlight, thermal, trash, waste, water, wind, wood
2. Discuss the environmental issues that have resulted from the use fossil fuels as the primary energy source. Review the types of renewable energy sources available for use today. Provide students with background information on biomass and its by-product, biogas. Ask students to suggest an explanation as to why biogas is considered a safer, more environmentally friendly fuel source in comparison to fossil fuels.
3. Return to the categorized list of terms and ask students if there are any changes, additions, or deletions they would like to make to the class list. Discuss their recommendations.
4. Explain to students that they are going to conduct an experiment to test the amount of gas released from three different mixtures of biomass: cow manure, cow manure and vegetable peels, and cow manure and mashed bananas. Ask student to develop a hypothesis to answer the following question: Which combination of biomass ingredients will release the most biogas?

Begin Experiment Preparation:

1. Wash and clean nine two litter soda bottles. Discard the bottle caps appropriately.
2. Label three bottles with each of the three types of biomass mixtures described above.
3. Wear disposable gloves. Measure ten grams of manure on a scale and place the manure in one of the bottles labeled cow manure. Do the same for the two other bottles labeled cow manure. For the other six bottles, weigh five grams of manure for each and place manure in bottles.
4. Place five grams of vegetable peels in each of the appropriately labeled bottles.
5. Place five grams of mashed banana in each of the appropriately labeled bottles. Dispose of the gloves in an appropriate manner, wash hands well and put on a new pair of gloves.
6. Fill each bottle with distilled water. Use the funnel to help with this process.
7. Place a balloon over the mouth of each bottle and secure the balloon with a piece of duct tape.
8. Place the bottles in an open area, outside of the building.
9. Clean the scale and lab area with a bleach solution, and wash hands thoroughly.

Experiment:

1. Display a chart in the classroom similar to the one provided.
2. On each day of the following week, assign a student to collect data for one of the three different types of biomass. Assign a different student to collect the data daily. Have the students observe any changes to the balloons placed over the three bottles and measure the circumference of each balloon at its widest point. Have students record the data collected on the class chart. Students should record the date, time, and balloon circumference for each bottle over a five day period on the included data worksheet. 3. At the end of the week, have students find the average measurement for each type of biomass fuel and use their data to create a bar graph. Have students use different colors to represent the three different types of biomass.

After the Experiment:

- Students will analyze the bar graph to identify which biomass mixture had the greatest amount of gas released and which had the least amount. Is there a steady increase of gas emissions per day? Have any of the mixtures reached a point where the emissions have peaked? What conclusion can be drawn from this experiment? Did students prove or disprove their hypotheses? Discuss the implications for using biomass as an alternative energy source and generate a class conclusion to be recorded on the chart.
- Display student bar graphs around the class chart for future reference.



Adaptations:

- Students can write out the vocabulary terms on individual 3x5 index cards and use these to sort and classify the terms into the various categories they identify. This allows students a hands-on activity for organizing information.
- Teacher can conduct the experiment as demonstration for younger children.

Extensions:

- Use the bar graph to generate a line graph. Discuss the value of using a variety of graphic organizers to represent data.
- Visit a waste treatment facility.