Title: Waste to Energy
Grades: 4
Subjects: Science, Math, Social Studies, Language Arts
Time: 50 minutes

Objectives:

- Identify and describe forms of waste management and how they can affect the environment.
- Add, subtract, and divide whole numbers.
- Find the mean (e.g., average) of a given set of whole numbers.
- Organize, interpret and analyze data using graphic representations (e.g., bar graphs).
- Locate geographic information on a US map.

Standards:

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

- Benchmark # 1: Know that technologies often have costs as well as benefits (e.g., as new technologies are developed, man's need for energy increases, resources are used and more pollution/waste is created) and this can have an enormous effect on people and other living things.
- Benchmark # 5: Understand that technology may affect the environment both negatively and positively (e.g., waste to energy facilities reduce the amount of waste and produce energy, but may also add air pollutants to the environment).

Science Standard 9: Understand the sources and properties of energy.

- Benchmark #1: Know that heat is often produced when one form of energy is converted to another form.

Mathematics Standard 3: Use basic and advanced procedures while performing the process of computation.

- Benchmark # 6: Determine the effects of addition, subtraction, multiplication and division on the size and order of numbers.
- Benchmark # 8: Solve real world problems involving number operations.

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

- Benchmark # 1: Understand that data represents specific pieces of information about real-world objects or activities.
- Benchmark # 4: Organize and display data in simple bar graphs, pie charts and line graphs.
- Benchmark # 5: Read and interpret simple bar graphs, pie charts and line graphs.
- Benchmark # 6: Understand that data comes in many different forms and that collecting, organizing and displaying data can be done in many ways.

Geography Standard 3: Understand the concept of regions.

- Benchmark # 2: Understand how regions change over time and the consequences of these changes (e.g., construction of facilities- WtE plants).

Language Arts Standard 8: Use listening and speaking strategies for different purposes.

- Benchmark # 3: Respond to questions and comments (e.g., gives reasons in support of opinions).
  Benchmark # 5: Use strategies to convey a clear main point when speaking (e.g., express ideas in a logical manner, use specific vocabulary to present information).

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Materials:

- Copy of “From Waste to Energy” by Robert Green
- US map
- Poster markers in a variety of colors
- Art materials: paper, markers, rulers, pencils, erasers
- Waste-to-Energy Facility sketch provided below
- Major Users of WtE in the US data table provided below (Waste to Energy Chart)

Overview: Demand for energy has increased considerably in the past hundred years. Energy is used to power our electrical devices, to heat our homes and businesses and to fuel most forms of transportation. In using energy we consume valuable natural resources and create waste products that have an affect on the environment. Since it is highly unlikely the need for energy will decrease in the future, it is vitally important that we learn to use energy wisely, reducing not only the amount we consume, but also the amount of solid waste we create from its consumption.
There is a type of solid waste management that uses household waste to create energy. This process not only provides the benefit of eliminating waste, but also uses the heat generated in the process to produce steam, which in turn generates electrical power. This process is known as Waste-to-Energy (WtE). The WtE facilities produce electricity through combustion, incinerating the trash. Modern incinerators can reduce the amount of the waste by as much as 95%, varying somewhat depending upon the composition of the trash and how much material, such as metal, is recovered from the ash for recycling purposes. Currently, there are more than fifty WtE facilities operating in the New England and Middle Atlantic states, processing approximately 70 US tons of trash per day.

There is however controversy surrounding this issue. Many people are still concerned about burning trash to generate energy. Burning certain types of materials can cause toxins, such as dioxin, to escape into the atmosphere. Therefore, strict guidelines and standards have been put into place to monitor the types of trash that are incinerated in the US, and researchers continue to study the issue of converting waste to energy.

Kid’s Speak: We use more and more energy each and every day. We use it to make electricity, heat and fuel. It powers our laptops and TVs, gives us hot water and warm, comfy spaces, and helps transport us from place to place. It is very important that we learn not to waste the energy we use in our everyday lives, and to use it in an efficient manner.

Eco-Fact: There are modern Waste to Energy facilities today that can reduce the amount of waste going to landfills by 80- 95%, depending on the composition of the waste.

Procedures:
Before Conducting the Lesson:

- Read the book “From Waste to Energy” by Robert Green and discuss with students different ways waste can be used to create energy.
- Introduce the Waste-to-Energy (WtE) process using incinerators to reduce waste and generate electricity. Discuss the pros and cons of WtE.
- Display the sketch of the WtE facility provided, below and use this sketch to explain the process of how trash is converted into energy: Garbage trucks bring trash to the WtE facility. No liquids, tires, or waste from hospitals are allowed. The trash is dropped into the receiving area. A crane picks it up and drops the trash into a hopper and the trash is pushed into the fire. A metal grate moves the trash back and forth slowly so that it burns completely. All that is left after the trash has been burned is ash and metal. The metal is removed using a magnet. It is sent to a recycling center to be reused. The ash is treated and sent to landfills to be used as cover material. At the same time the trash is burning, heat is being produced. This heat is used warm the water in the boilers. This heat changes the water from a liquid to steam. The steam is used to turn a turbine that produces electricity, which is later transferred to homes and businesses in the area.

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Conducting the Lesson:

- Explain to students that states, which have large communities built on sandy type soils, often choose to use WtE management, because using landfills potentially risks the waters around them. These states have found that WtE is a better option for protecting the environment. Ask students to find the states listed on the data table provided and identify in which regions of the country these states are located.

- Show students the data table provided. This table indicates which US states are major users of WtE technology for solid waste management. Ask students to:

    - Find the total number of WtE facilities for the states listed on the data table.
    - Find the average number of WtE facilities per state.
    - Find the total number of tons of trash processed in these states using WtE technology.
    - Find the average amount of tonnage processed in these states using WtE technology.

- Show students how to convert the data in the table into a bar graph. Create a class graph showing the number of WtE facilities by state.

- Provide students with the appropriate materials, and have them create individual bar graphs using the data table to show the amount of trash each state processes by tonnage.

After Conducting the Lesson:

- Have students use the bar graphs, both their own and the class graph, to answer questions similar to the following:

    - Which state processes the greatest amount of trash using WtE technology? Why might this be?
    - Which state processes the second most amount of trash?
    - Which states are very close to each other in the amount of trash they process using WtE technology?
    - Which of the six states process the least amount of trash using the WtE technology?
    - Which state has the most WtE facilities?
    - Which state has the least number of facilities?
    - Which states have the same number of facilities?

Adaptations:

- Math activities in this lesson can be done individually, in small groups or in whole group session.

Extensions:

- Students can research to find out which other states have WtE facilities and the number of facilities in each state.
- Students can locate all the WtE facilities in the US and identify their location on a US map. Have students determine the number of facilities in each region of the US.
- Students can create a simple flow chart to show how trash moves through a WtE facility to reduce the trash and produce electricity.

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