Lesson 3.10

Waste-to-Energy Incineration

Source: Adapted from Kraft General Foods Environmental Institute Solid Thinking about Solid Waste and -way with Waste: A Waste Management Curriculum for Schools 2nd ed., Dept of Ecology, State of Washington

Level: Secondary/Tertiary (ages 11+)

Key Terms: energy, incineration, waste

Subjects: Mathematics, Geography, and Science

OVERVIEW/BACKGROUND

We must look at all our options for safe and proper disposal. One of these options is the use of resource recovery facilities (also known as waste-to-energy plants). Resource recovery facilities are an expensive, highly technological method of dealing with large volumes of solid waste. The basic operating principle of resource recovery plants is to burn refuse. Recyclables may be separated out by mechanical means before burning ("front-end processing") or after burning, or they may not be separated out at all. In any case, 20 to 30 percent of the original refuse is non-combustible and non-recyclable and must be disposed of in a landfill.

Intense heat from burning is used to create steam, which in turn may be used to generate electricity. Solid waste managers hope that a continuing increase in the cost of electricity will help pay off the cost of energy recovery plant construction. Given the enormous volumes of solid waste produced in urban areas, some solid waste managers have come to see energy recovery facilities as necessary components of solid waste management systems, along with landfills and recycling.

Critics of energy recovery plants, however, raise objections. Some of these are the high cost of construction, the air pollution caused by refuse burning, and the ash, which contains heavy metals and must be disposed of in landfills. Critics also point out that energy recovery plants require a steady flow of garbage. Maintaining that flow, critics say, will discourage recycling and will allow people to avoid their individual responsibility to generate less waste. This objection can be answered by taking recycling into account when sizing the incinerator.

This lesson will explain waste-to-energy incineration and describe how it differs from simple burning of trash. The technical aspects of waste-to-energy incineration, air pollution controls, energy production benefits and reduction of solid waste volume will also be addressed.

TIME FRAME

45 minutes – 1 hour

OBJECTIVES

Upon completion of this lesson, your students will be expected to:

1. Describe waste-to-energy incineration.

2. Consider the positive and negative aspects of resource recovery as a solid waste management option.

3. Explain the differences between waste-to-energy incineration and open burning.

MATERIALS

This lesson requires the following resources:
- Student Handouts 3.10A - D
- Fact Sheet 3.3

PROCEDURE

1. Distribute and discuss Fact Sheet 3.3. Then have your students complete the worksheet on waste-to-energy values, Handout 3.10A.

2. Distribute and discuss Handout 3.10B. Then have your students complete the worksheet on waste-to-energy incineration, Handout 310C.

ASSESSMENT

Students will be evaluated based on:

1. Active participation in class discussion.

2. Successful completion of related activities.

3. Addition of completed items to portfolio (optional).

EXTENSIONS

1. Take your students on a field trip to a local incinerator if there is one nearby. Have your students complete Handout 3.10D during the visit.
2. Invite an incineration expert to talk about local waste-to-energy incineration. Additionally, many industrial plants operate waste-to-energy incinerators. Invite a representative of a local plant to give your class a presentation on the plant's incinerator.
3. Organize a debate around the following proposition: Our city/country should build a waste-to-energy plant to incinerate our garbage. Call solid waste managers, recyclers, leaders of environmental groups, and representatives of a burn plant construction company for various points of view on this subject.

Fact Sheet 3.3 – Waste-to-Energy Incineration

What is Waste-to-Energy Incineration?

Waste-to-energy incineration is the fourth aspect of the EPA's approach to solid waste management. It is the controlled burning of solid waste at extremely high temperatures - often as high as 2000° F. Incineration of all types currently accounts for 14% of solid waste disposal in the U.S. The EPA estimates that 23% of the municipal solid waste stream will be disposed of via incineration by 1995. Waste-to-energy incineration is widely used in Japan, some part of Europe, and elsewhere to reduce by as much 80 to 90% the volume of waste that must be landfilled.

Waste-to-energy incineration should not be confused with simple open burning of refuse. It is even different from mass-burn waste incineration common in the U.S. in the first half of the 20th century. In waste-to-energy incineration, the heat generated by the process is captured and turned into usable energy. The energy produced can be used either in the form of steam or in the form of electricity produced by steam turbine generators.

How much MSW can be incinerated?

Virtually all of the contents of the municipal solid waste stream are combustible at the high temperature of waste-to-energy incineration. Examples of combustible material include paper, food and yard waste, plastic, rubber, and wood. Non-combustible materials in the waste stream include glass, metals, ceramics, and clay.

The high-temperature of the burning refuse drastically reduces the volume of the solid waste. It also decreases gas and smoke emissions.

A Complex Issue

There are many points of view about using waste-to-energy incineration as a method of waste management. Some people have expressed concern over the air pollution that may result from the improper design or operation of waste-to-energy incinerators. In addition, there is some debate regarding the landfilling of the ash that is a by-product of incineration. This ash may contain high levels of heavy metals (cadmium, mercury, lead, etc.) and other toxins harmful to humans and the environment.

Modern waste-to-energy facilities address these concerns with sophisticated pollution-control devices. Scrubbers, electrostatic precipitators and fabric filters remove much of the acid, heavy metal and fly ash from an incinerator's air emissions. The ash from incineration poses virtually no groundwater contamination risk if landfilled in a properly designed and sealed sanitary landfill under normal operating conditions.

In addition to fears about possible pollution, a further obstacle to widespread waste-to-energy incineration is the cost of construction of facilities. Modern waste-to-energy facilities can cost as much as $200 million to build. However, due to the rising cost of disposing of waste in landfills, it is becoming increasingly cost-effective to consider waste-to-energy incineration.

Some people claim that the opportunities presented by waste-to-energy incineration are enormous, and not merely as a method of solid waste disposal. It is potentially part of the solution to our nation's energy needs as well. After all, any method of producing electricity will carry with it environmental consequences. Burning trash produces energy from materials that might otherwise go unused.

Plastic scrap and rubber tires have high-energy vales. For example, the energy content of a kilogram of plastic is more than twice that of a kilogram of some types of coal. And the rest of our trash that cannot be recycled is also a good fuel source. Waste-to-energy incineration allows us to use waste to generate electricity and reduces the amount of waste that must be landfilled.

Crucial to the efficient operation of a waste-to-energy incinerator is access to sufficient waste. Without adequate fuel supplies, MSW incinerators become expensive to operate on a per-ton basis and may need to supplement the waste with fossil fuels to maintain a high burn temperature.

The Energy Values of Different Materials When Incinerated*

Material	****BTU per pound**
Plastics	11,000 – 20,000
Rubber	10,900
Newspaper	8,000
Corrugated Boxes (paper)	7,000
Yard Wastes	3,000
Food Wastes	2,600
Average for MSW	4,500 – 4,800

*Source: Council on Plastics and Packaging in the Environment
**BTU stands for British Thermal Unit and is defined as the amount of heat required to raise the temperature of one pound of water one degree (Fahrenheit)

Handout 3.10A

Calculating Waste-to-Energy Values

1. Assuming that you have 91 tons (91,000 kg) of MSW, determine the relative weights of each kind of material: paper, yard waste, miscellaneous, metals, plastic, food waste, and glass. (For example, there will be 36 tons - or 36,000 kg - of paper.) Write your answers below.

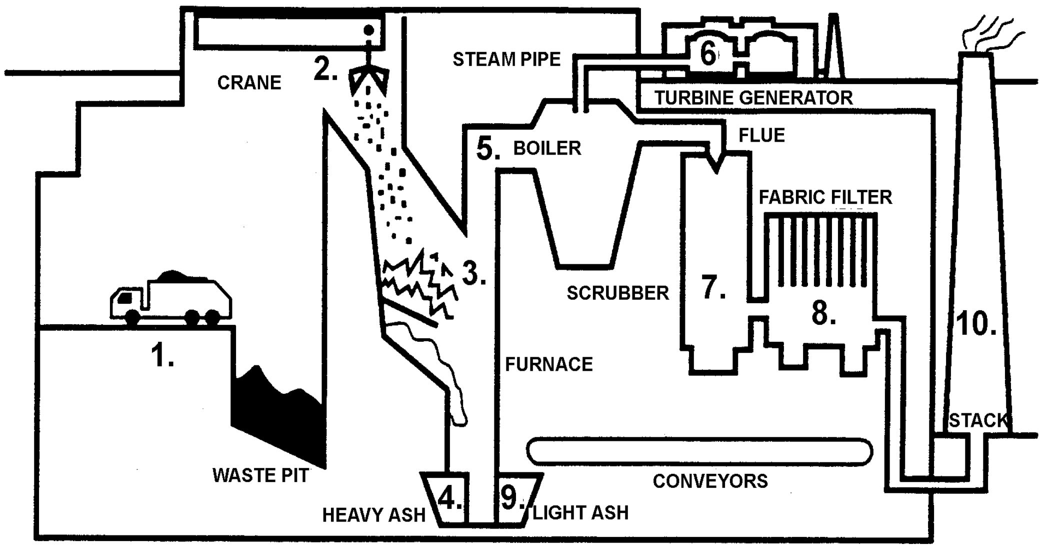
2. Using these weights and the chart in Handout 1, calculate the total energy that would be produced by the 100 tons of MSW in terms of BTUs (British Thermal Units). Show your calculations below.

3. A "kilowatt-hour" is a method of measuring amounts of electricity. Assuming that 3,142 BTUs will generate 1 kilowatt-hour, how many kilowatt-hours of electricity would be generated from 100 tons of MSW? Show your calculations below.

4. Ask your parents about your family's electrical usage. How many kilowatt-hours a month do you use? How many months would your house be able to run on the electricity generated by 100 tons of MSW?

Handout 3.10B

A Modern Waste-to-Energy Incinerator



1. Trucks dump trash ready for burning.
2. Crane lifts waste from pit up into furnace.
3. Trash is burned at high temperatures.
4. Heavy ash is collected and removed for disposal.
5. Heat from furnace makes steam in boiler.
6. Steam drives turbines and makes electricity.
7. Smoke and gases pass through scrubber to remove dangerous chemicals.
8. Fabric filter removes any leftover tiny ash particles.
9. Light ash is collected after scrubbing and filtering.
10. Remaining gases escape up smokestack.

Handout 3.10C

Waste-to-Energy Worksheet

1. Describe what makes modern waste-to-energy incineration different from other ways of burning trash.

2. Explain what percentage of MSW can be incinerated.

3. What are some of the reasons given in favour of building waste-to-energy incinerators?

4. What are some of the reasons given against building waste-to-energy incinerators?

Handout 3.10D

A Trip to a Waste-to-Energy Incinerator

Questions to be asked during a visit to an incinerator.

1. From where does the solid waste that the incinerator handles come?
2. Why is the incinerator located on this site? What tests or studies were done before it opened? When did it open?
3. Who owns and operates the incinerator?
4. What types of solid waste are burned at this incinerator?
5. How much solid waste does the incinerator process each day?
6. What is the fee for using the incinerator?
7. Does the incinerator handle any hazardous materials?
8. What air pollution controls does the incinerator have?
9. How much energy does the incinerator generate through the burning of trash? Who buys this energy?
10. What happens to the ash generated by this incinerator?