RECOVER

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Recover

Of all the stages in the waste management hierarchy, recover is the one most forgotten. Few people in Canada ever realize a fourth "R" exists. This is due, partly because some recovery methods are either named or classified differently in this country, or certain recovery methods are deemed unsuitable.

Recover
is the extraction of organic and inorganic material or energy from mixed waste.

The extraction is facilitated through composting, Energy-From-Waste operations, *gasification*, microwave technology, landfill reclamation, and biogas recovery. Composting is such an important topic that it has been given its own chapter.

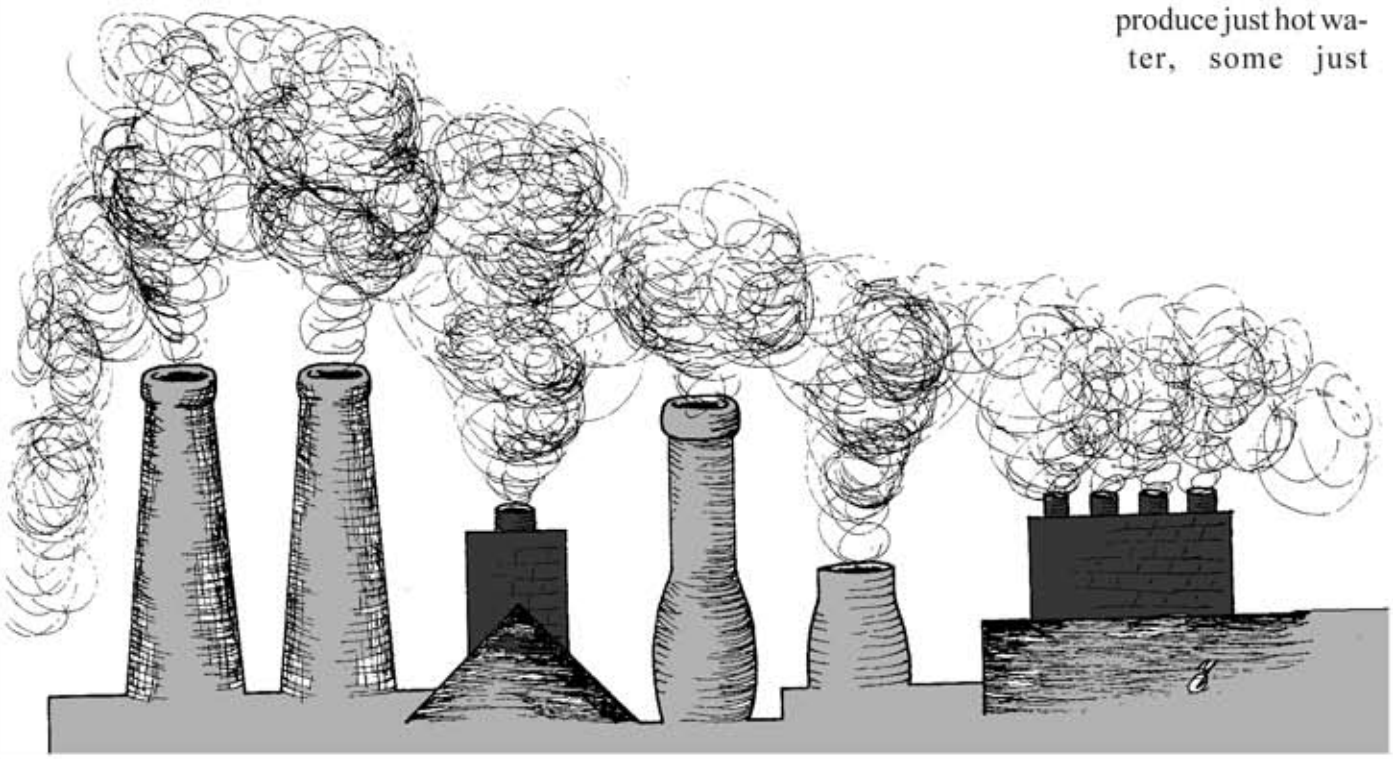
This chapter will focus on the other recovery techniques. Some are fully operational on a large scale while others are still relatively experimental. Regardless, when used correctly, recovery can squeeze the last bit of use out of the waste we produce.

Energy From Waste

The use of waste as a fuel or fuel supplement in the production of energy, evokes two very different points of view. One side of the argument sees Energy-From-Waste (E.F.W.) facilities as a useful and sound method of handling garbage. The other side feels this is not an environmentally conscious procedure and diverts attention away from the other "R's" (reduce, reuse, recycle). Before discussing the benefits and disadvantages, let us first examine how waste is converted into energy.

Waste is used in one of three forms in an Energy-From-Waste facility. Garbage can be used "as received" which means there is no sorting or further processing; once the trash arrives at the facility it is incinerated "as is". Refuse Derived Fuel (R.D.F.), the second form, is produced by removing glass, metals, and other recyclable or undesirable materials from the mixed waste. The remaining material is shredded. Generally, this process is done at the E.F.W. plant itself. Densified Refuse Derived Fuel is the third form. After being handled like regular R.D.F., the waste is further processed before becoming pelletized. These pellets can be burned by themselves or serve as a solid fuel supplement.

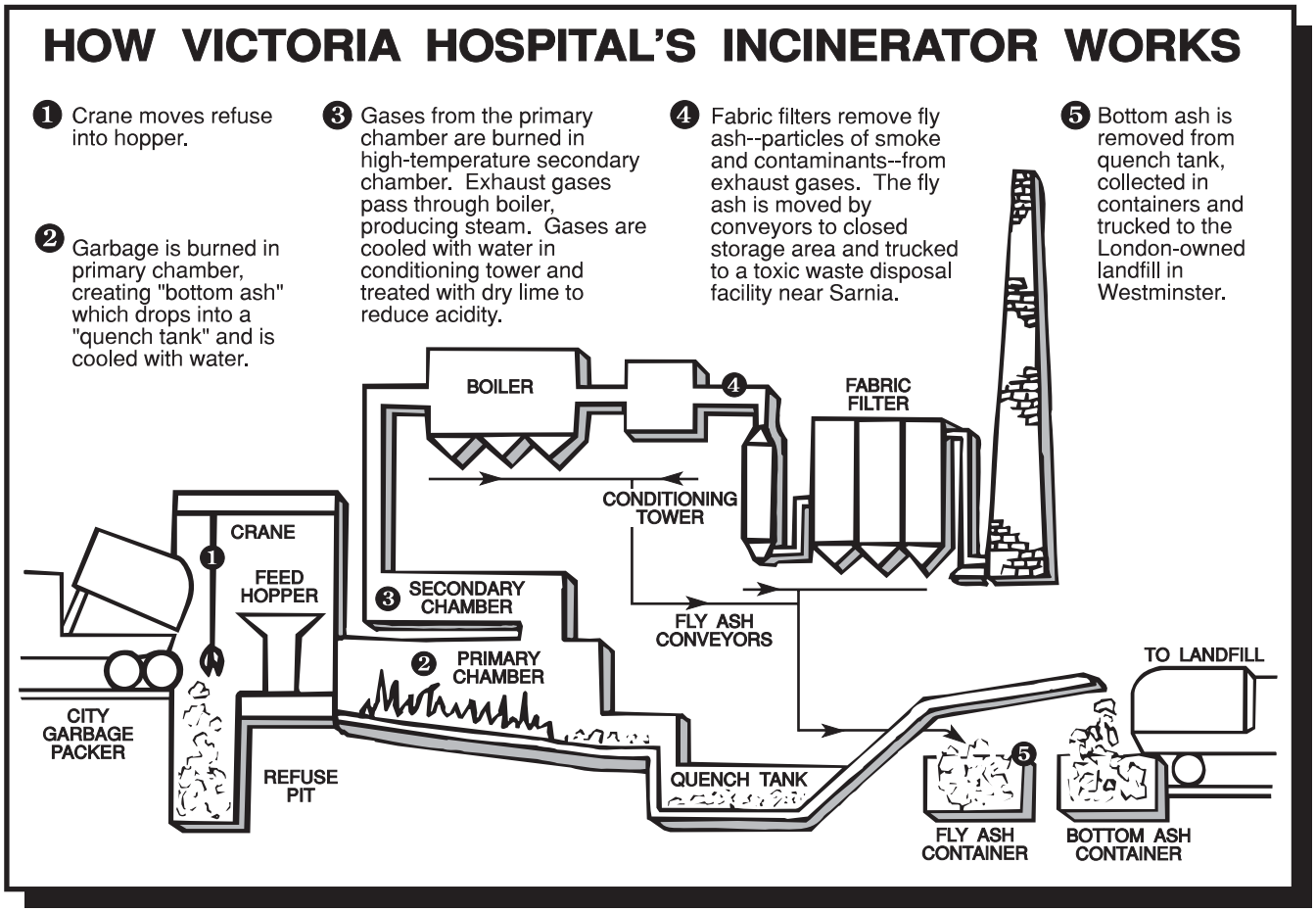
One of these three fuels is then sent to a furnace, where the conversion of waste into energy begins. A by-product of any type of combustion is heat. In Energy-From-Waste operations, the heat is used to either increase the temperature of water or to produce steam. Hot water is piped out of the plant. Pipes and radiators in buildings distribute the heat from the water to warm the air. In some cases the water is used for heating purposes in the Energy-From-Waste facility itself. If the burning of waste results in the production of steam, then electricity can be generated. High pressure, superheated steam is sent to power turbines; the turbines power generators which in turn produce electricity. The plant may use the electricity or sell it to other power companies. Some plants produce just hot water, some just



Energy From Waste (cont.)

steam, and others, called combined heat and power plants, make both.

Victoria Hospital Corporation's Commissioners Road complex in London Ontario, has a combined heat and power Energy-From-Waste plant on site. Municipal solid waste is brought in and burned "as received"; no biomedical waste from the hospital is used by the plant. When operating at full capacity, close to 100% of the hospital's hot water and steam needs can be fulfilled. Approximately half of the electricity required by the hospital can also be generated.
The benefit of this type of recovery facility is not just the production of energy. The garbage remaining after



combustion (ashes) has a reduction in volume of 70% to 90% when compared to the volume of the original waste. What this means is instead of taking 100 m^3 of garbage to the landfill, Energy-From-Waste techniques reduce this figure to 10 m^3. As a result landfill space is also saved.

Locating new landfills is difficult in most areas but in some regions it is near impossible. The island of Hawaii is home to 850,000 people. Each year 5,000,000 tourists visit this Pacific paradise. Space on the island is limited, naturally. To deal with its waste, the island built an Energy-From-Waste facility called H-Power. By processing the waste into Refuse Derived Fuel, H-Power has reduced by 90%, the volume of waste going to the landfill. Many European countries, where population densities are high, use Energy-From-Waste technology to conserve space.

Energy From Waste (cont.)

Using waste to produce energy has also been considered as a substitute for coal fueled or nuclear powered generating stations. When combusted, coal produces sulphur dioxide and nitrogen oxides that contribute to acid rain. The used fuel from nuclear power plants is classified as radioactive waste; it can be hazardous for millions of years. Energy-From-Waste operations are said to avoid both of these problems (emissions and hazardous waste). However, burning waste is not trouble free.

It is nearly impossible to collect 100% clean and combustible refuse in large quantities. Even in areas where recycling and similar waste diversion methods are in place, batteries, household cleaners, and other hazardous waste will be found in the waste stream. While some facilities separate the material before it is burned, a degree of contamination is still present .

Once inside the combustion chamber (furnace) the contaminants are either sent up the smokestack or collected near the bottom of the furnace. Hazardous materials carried into the atmosphere are called air emissions. They include gases and *fly ash*. Most of the gas released is carbon dioxide. The release of this gas into the air contributes to the *Greenhouse Effect*. Carbon dioxide is produced in such vast quantities that its capture and proper disposal is impractical.

Heat from the combustion process turns the heavy metal mercury into mercury gas. This too is carried up the stack. Upon descending, mercury gas can lead to forest declination or accumulate in the fish that we humans eat. Acid gases resulting from E.F.W. operations, include sulphur dioxide and nitrogen oxides; the same gases produced by coal-fired plants. Hydrogen chloride also can be released by burning waste. When dissolved in water this poisonous gas forms hydrochloric acid. Many of these gases are the same ones that E.F.W. techniques were said to avoid.

Fly ash, by itself, is not really a major problem. It may be a pollutant but the real hazard is generated by what attaches to the ash. Heavy metals such as cadmium are transported by fly ash into the atmosphere. After landing on the ground and in bodies of water, the ash and heavy metals can be consumed by plants, animals, or humans. As the metals move up the food chain, they become more concentrated through a process called *biological magnification*. A more detailed study of this process is found in the Hazardous Waste chapter.

Toxic organic chemicals, dioxins for example, can be released as gases or in fly ash. Other chemicals include polyaromatic hydrocarbons and hydrobenzenes can be carried by food peelings, yard waste and household cleaners into the garbage Energy-From-Waste facilities use.

Though combustion reduces the volume of waste significantly (up to 90%) some material is still left over. This collects in the bottom of the furnace and is called *bottom ash*. Because toxins do not burn, those that do not escape out of the stacks remain in this ash. Even though energy was generated and the volume of waste reduced, the garbage is no less toxic than before it was processed. In fact, the toxicity increases as the volume decreases.

Captured fly and bottom ash must go somewhere. If government standards are followed, toxic ash is deposited in either a monofill or a secured landfill. While ashes take up less landfill space than normal waste, they concentrate the hazardous material in a smaller area. Ironically, the better the filters and *scrubbers* in an Energy-From-Waste facility, the more total ash that facility must dispose.

Energy From Waste (cont.)

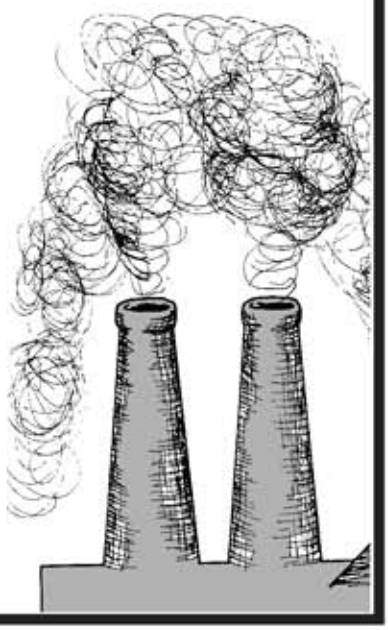
Perhaps the biggest problem with the use of waste to produce energy is it distracts from the other stages of the waste management hierarchy. Rather than teach people to reduce, reuse, recycle, or compost, it perpetuates the "use and throw it away" mentality. People do not adjust their lifestyles when they can leave their waste for someone else to look after.

In April 1991, the Ontario Ministry of the Environment and Energy imposed a ban on the construction of future Municipal Solid Waste (M.S.W.) incinerators. This includes Energy-From-Waste facilities and the use of municipal waste for refuse derived fuel. The ban affects any proposed incinerator, regardless of whether it is operated by municipal or private enterprises. Hazardous waste and biomedical incinerators are not covered under the same regulation (Regulation 555/92).[1]

The main reason for the aforementioned ban is to clarify which waste management techniques should be or should not be included in a municipality's waste planning. By excluding M.S.W. incinerators, the 3 R's receive the emphasis the provincial government feel they deserve.

Existing M.S.W. incinerators must renew their license to operate, periodically. Under the new regulations, these facilities must upgrade their methods and emissions control equipment to new standards or risk being denied a new license.

Energy-From-Waste facilities can be an important part of a comprehensive waste management system, but these plants should only be utilized on materials that cannot be handled by the other "R's". If enough people practice the first three "R's" and composting, then Energy-From-Waste operations would not be an issue; there would not be enough waste reaching this type of recovery to make its widespread use economically feasible.



Other Methods

Recovery is not limited to the use of combustion to produce energy. Landfill mining, *gasification*, microwave technology, and biogas extraction are alternatives to the burning of waste. Some of these technologies recoup energy while others allow valuable elements to be removed from waste.

Landfill Mining

With new landfills becoming increasingly difficult to locate and existing landfills quickly reaching their capacity, people have been looking at new ways to alleviate these problems. Landfill mining or reclamation is one proposed solution. What this involves is the recovery of useful materials already located in poorly operating or non-operative (closed) landfills. Benefits from this procedure include a decrease in the need for more landfill space, the lessening of environmental problems, and a better return on investment when compared to traditional landfill closure.

Basically, the reclamation process is as follows. Material is excavated from the landfill then processed by a series of screens. The first screen allows material 7.5 cm or less in size to fall through. Plastics, textiles, wood, and metals generally do not pass through the first screening. These items can be further separated to be used as fuel for incineration or marketed for recycling. A second screen prevents items over 2.5 cm from falling any further. Cans and bottles are typically the items captured by the second screen; they account for approximately 25% of the material recovered. Most of the matter that passes through both screens is soil. Half of all the material excavated is recovered as soil. Uses for the soil include construction fill, road sub-base deposits, landscaping in areas of limited public access and top cover for landfills. Materials that cannot be reused or recycled are shredded or baled then placed back into the landfill.

Presently, the classification of the recovered soil and its hazards along with the marketability of the recyclable and combustible materials has not been established. The cost savings when compared to landfill closure is still under evaluation. Landfill reclamation however, may prove to be a sound method of repairing yesterday's waste management mistakes.

Gasification

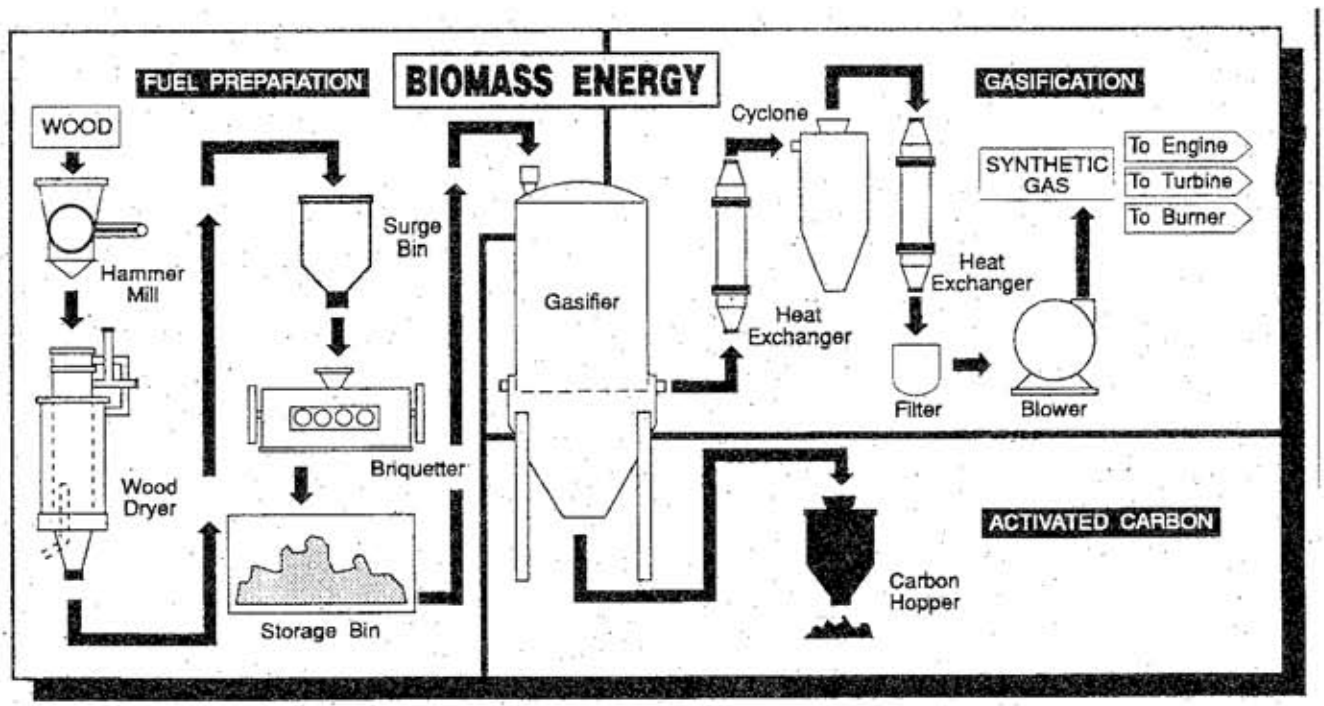
Gasification is the conversion of a solid or liquid into a gas. In the context of waste management, it is really biomass gasification; the conversion of organic waste into a synthetic gas. This process is said to be capable

Other Methods (cont.)

of using agricultural waste, sewage sludge, separated municipal solid waste, food processing waste, or wood waste as the source for the fuel. Wood waste will serve as our example.

Forestry, saw mills, and manufacturing operations produce left over wood. Respiration by the trees and the transportation of cut lumber by water, allow chemicals and other toxins to collect in the wood waste. Burning the material can cause atmospheric pollution while burying the scrap may lead to toxins seeping into soils and groundwater. Through gasification, the waste can be converted into fuel and useful by-products.

Wood waste is dried, shredded then compacted into pellets. A *gasifier* heats the pellets to 538°C. The oxygen free environment inside the gasifier means the pellets do not burn. Instead, a chemical reaction called *pyrolysis gasification* occurs resulting in the production of synthetic gas that can be used for dry kilns, boilers or as a fuel in the making of electricity. The gas can also be piped to industrial applications just like natural gas. After the gasification is complete there is no ash to dispose of. Instead, all that remains is carbon dust and activated carbon. Both are useful by-products capable of being utilized in the purification of air or water.



Microwave Technology

Microwave technology is an experimental recovery technique. By using microwaves, the molecular bond of a material or object can be broken, reducing either back into their elemental state. In the case of used tires, microwaves can recover four different materials. An average 10 kg tire can produce 4 kg of carbon, 1 kg of steel, .01 kg of sulphur, and 4.5 ℓ of oil. There is no burning or oxidation, so microwave technology is said to produce no emissions. A small amount of electricity is required, just slightly more than one tenth of a kilowatt hour per kilogram of tires. The final benefit is 100% of the materials recovered are marketable.

Other Methods (cont.)

Biogas Extraction

The conditions in a landfill are such that the decomposition of organic matter takes place anaerobically. A by-product of the work carried out by the decomposer micro-organisms is the generation of biogas; this is approximately 50% carbon dioxide (CO_2) and 50% methane (CH_4). Methane is an odourless, colourless, inflammable hydrocarbon that forms explosive mixtures with air. Traditionally, most of the biogas escaped into the atmosphere. Some made its way into pipes and homes where explosions and other accidents occurred. Modern landfills have biogas control systems designed mainly to control methane. Originally, the gas was simply flared, however, it was soon realized that landfill gas could be recovered to produce energy.

Removing methane, the useful particle of biogas, starts with a series of perforated pipes securely inserted into the landfill. The recovered vapour travels up and out of the ground then passes through a filter. The gas is then compressed, chilled, monitored, and piped to the user. Boilers and kilns can use the methane as fuel. Some landfills have facilities where the gas is used in the production of electricity. Another option is selling the methane for upgrading to a higher quality fuel. It is believed that a tonne of waste can produce 100 times its volume in biogas over ten years. In the United States of America, as of 1989, 87 landfill gas recovery operations were saving the equivalent of 1.6 million tonnes of coal per year. All of these facts seem to deem this form of recovery useful.

Unfortunately, there are negative aspects. The most disturbing is the by-products of combusting methane. Carbon dioxide, by volume, is the most plentiful of all Greenhouse gases, however, methane is believed to be over twenty times more damaging. During combustion a chemical reaction turns methane and oxygen into carbon dioxide, water vapor and heat. So, what happens is one greenhouse gas (CH_4) is converted into another (CO_2). Landfills are only the world's third largest sources of methane; agriculture and coal mining are number one and two, respectively. The debate over whether methane should be used as fuel, hinges on establishing whether the volume of methane produced by landfills is more damaging than the volume and impacts of the by-products of its burning.

Another problem is not all methane can be recovered, some still escapes. In order to be economically feasible, methane fueled facilities will need to ensure there is a steady supply of the gas, and that the return gathered by producing energy, outweighs recovery costs.

Recovery can be a viable method of handling waste. As mentioned in the previous chapter, composting is a wonderful way to extract valuable resources from our garbage. However, by no means should recovery be the hub of any waste management program. Reduction, reuse, and recycling are more energy efficient. Only when the first three stages of the waste management hierarchy have been employed or are not feasible, should recovery, especially the combustion of waste, take place. When waste is burned there is more than just garbage going up in smoke.

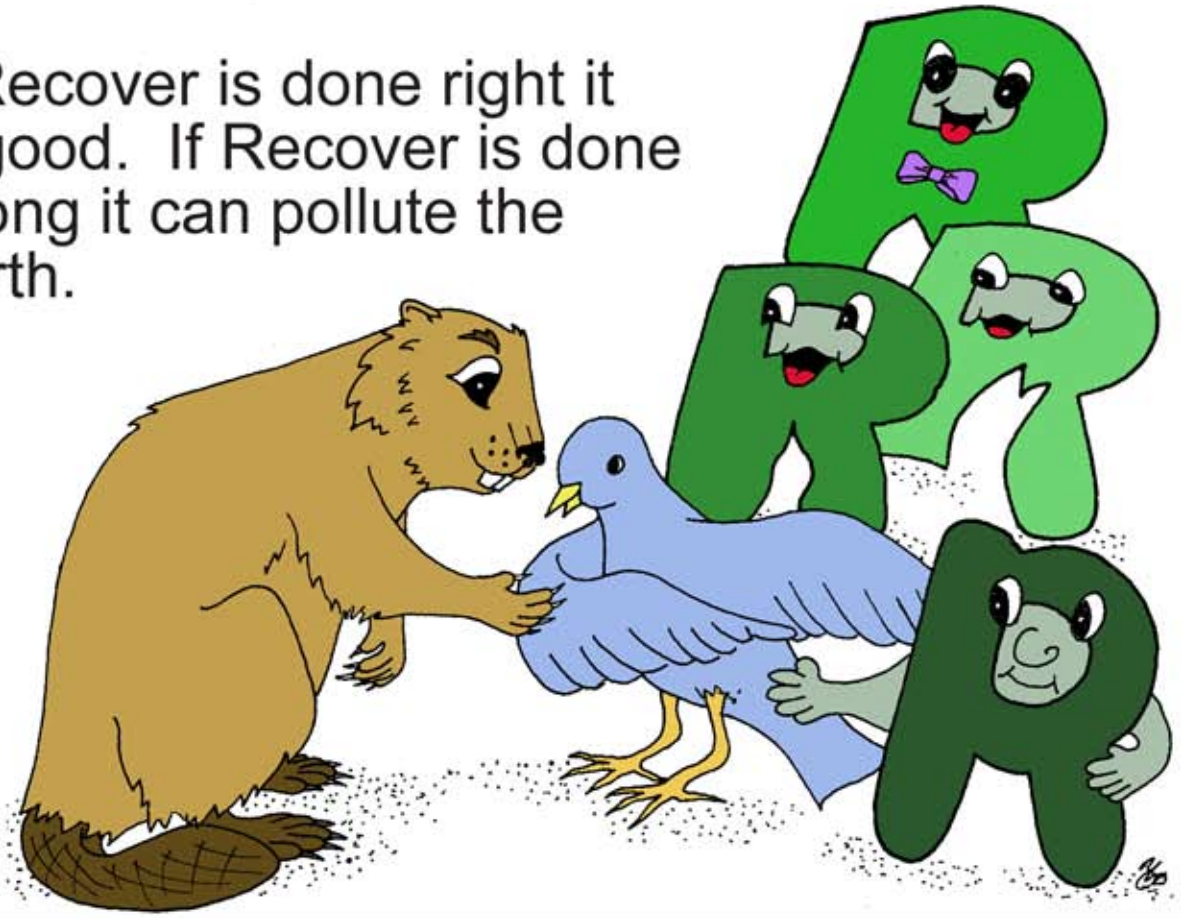
Brewster Facts

1. Recover is the fourth "R".

2. Some waste cannot be Reduced, Reused, Recycled or Composted. This waste can be Recovered.

3. Recover takes energy and other good things from waste.

4. If Recover is done right it is good. If Recover is done wrong it can pollute the Earth.



Mine Sweep

OBJECTIVE: To demonstrate how old landfills can be a source of valuables.

MATERIALS: crayons or pencil crayons, pencil or pen, HANDOUT: **Mine Find** (F13)

VOCABULARY: landfill mining, magnet, recovered, recycled, reduce, reuse, separate, waste

BACKGROUND:

In the past there were no widespread recycling programs. Most of the waste people produced was buried. Even today some areas still send all of their waste to the landfills. What these two situations have created is "buried treasure".

Hidden in some landfills are steel, glass, aluminium, paper, organic waste and other materials. These items can take hundreds of years to biodegrade. Removing these items is much more practical. Instead of leaving the metals and other items to rot they can be recovered. Taking materials out of landfills is called landfill reclamation or landfill mining.

This activity will teach the children to recognize that old landfills can be somewhat valuable and to strengthen the idea that waste must be diverted before it is buried.

PROCEDURE:

1. Ask the children if they know what a landfill is. Explain that landfills are places where waste is buried. Mention that sometimes old caves and mines are used to hold waste.

2. Now tell the class that in the days of post WWII people did not Reduce, Reuse or Recycle; everything went to the landfills. Some people still bury all their waste. Explain that this means steel, glass and other useful things are buried with the garbage.

3. In some places people are digging up old landfills to remove the useful things. Tell the students they are going to "dig" useful things out of an old landfill.

4. Distribute copies of the HANDOUT: **Mine Find** (F13) to the class. The children are to colour and circle the items they think should be recycled, composted or reused. You may wish to have the children use different colours to differentiate between recyclable, compostable and reusable items.

Mine Sweep (cont.)

EXTENSION:

1. Explain to the class why things should be Reduced, Reused or Recycled before they are put in a landfill.

2. Have the students bury steel cans in a sandbox. Use a magnet to remove the steel. Tell the class that magnets are sometimes used to separate steel from other landfill materials.

3. Have the children discuss where the items they pulled out of their landfill should go.

EVALUATION:

1. Ask the children which is better; to recycle things before they are put in a landfill or to put things in a landfill, dig them up, then recycle them.

2. Have the children draw a picture of one recyclable item on the HANDOUT: **Mine Find** (F13).

3. Ask the class if they are going to be careful about what they put in their garbage. Will they make sure recyclable items are not thrown away?

Brewster Facts

1. There are really four "R"s. The fourth R is called recover. Recover removes energy and other useful things from waste.

2. Taking energy and things from waste is a good idea. The natural resources used to make the waste are used again.

3. Burning waste to make energy, digging recyclable things out of old landfills and collecting landfill gas are some ways to recover.

4. Recover is good if it does not cause pollution or other problems. The waste left over after Recover is garbage.

Boiling For Dollars

OBJECTIVE: To demonstrate how energy can be derived from waste.

MATERIALS: ADULT SUPERVISION, barbecue or fire pit, burnable garbage (clothes, cardboard, boxboard, old newspapers), matches, a pot, ice cubes, thermometer, HANDOUT: **Powered Pinwheel** (F19)

VOCABULARY: electricity, Energy-From-Waste, experiment, fossil fuels, pollution, recovery, steam

BACKGROUND:

Energy-From-Waste (E.F.W.) operations are a controversial method of recovery. Waste is used as a fuel to produce steam. The steam in turn is used directly for heating purposes or to generate electricity. Positive features of E.F.W. processes include not only the extraction of energy but a reduction in waste volume; the ashes left after waste is burned are small compared to the waste's pre-burned volume. E.F.W. also creates energy without the use of fossil fuels.

Negative impacts are the possibility of air pollution created by burning waste, the potential for highly toxic ash and the feeling that E.F.W. techniques do not teach people to be responsible for their waste.

By completing the experiment in this activity the children will be able to see how waste can be used as a source of energy.

PROCEDURE:

1. Ask the class if anyone has seen leaves being burned. Follow this question by asking the students to describe what they saw (i.e. smoke, odour, etc.).

2. Ask the students if they have stood beside a fire. Did they feel heat? Explain heat is a form of energy. When something is burned energy "appears" as flames and heat.

3. Reiterate the background information section of this activity to the class. Tell them they are going to do an outdoor experiment to "get" energy from waste.

4. Prepare a firepit or use a portable barbecue. Place old construction paper, clothes, cardboard and boxboard in the pit/barbecue. **Do not** put plastics, metals, wet organic waste or hazardous waste in the pit/barbecue.

5. Light the waste then place a pot of ice cubes above the flames. Tell the class to watch carefully to see what happens to the cubes. Mention they should also pay attention to the colour of the flames, whether an odour forms, etc. Keep adding waste until the ice cubes melt.

Boiling For Dollars (cont.)

PROCEDURE (cont.)

6. Have the students write about what they observed. They should mention what garbage was burned, what happened to the ice cubes and any problems they observed (smoke, odour, etc.).

EXTENSION:

1. Continue the experiment until the water boils. Explain to the children that the boiling water (steam) is used in real Energy-From-Waste plants.

2. Have the children think of problems caused by burning waste.

3. Have the children make or use a pin wheel with a very long handle and hold it over the steam of a kettle to see how it turns. See HANDOUT: **Powered Pinwheel** (F19)

EVALUATION:

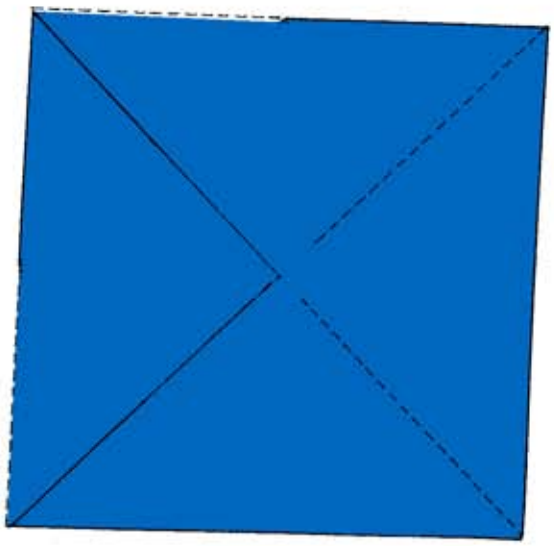
1. Ask the children to explain what happened to the heat from the fire (heat was used to melt ice).

2. Do the children think burning garbage is a good idea? Why?

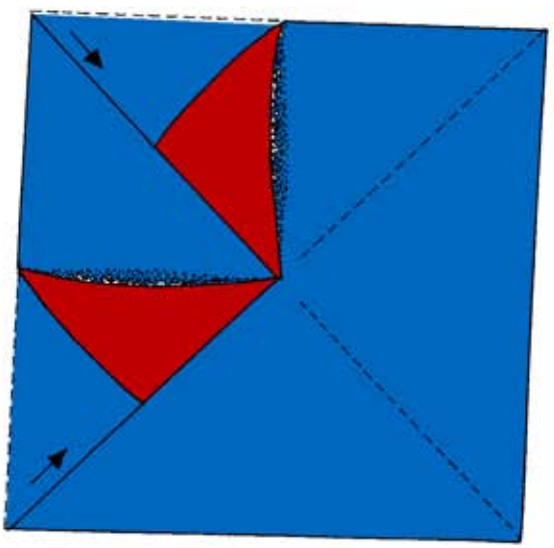
3. Ask the children what the boiling point for water is.

Powered Pinwheel

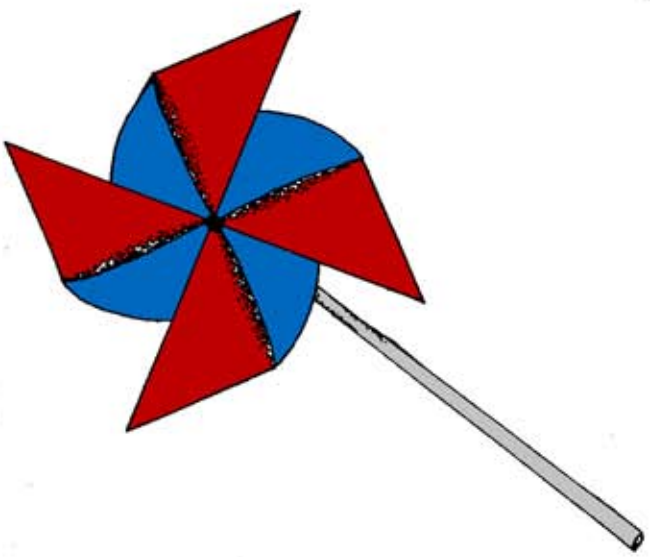
As an extension for this activity the children can make this simple project at home or as a group in the classroom.



Start with a perfect square and cut into each corner until you are almost at the centre. (leave an area in the middle of the square uncut)



When the cutting is done take the four corners and gather them so that they meet in the centre and fasten them there using tape, glue or other type of fastener. You can then fasten a long stick or rod to the back and you have a homemade pin-wheel.



When the pinwheel is done it should be held over the steam of a kettle so the students can see that even a small amount of steam has the power to move the pinwheel.

Brewster Facts

1. In Canada few people know a fourth "R" exists. Recover is the forgotten "R".

2. Recover allows us to remove energy and resources from waste. Waste that is not reduced, reused, recycled or composted is not always garbage. It can contain energy and natural resources.

3. Energy-From-Waste plants use waste as a fuel to produce energy. Landfill mining involves digging up old landfills so useful materials can be removed. Biogas extraction takes the gas produced by landfills and uses it to produce energy. Microwaves can turn old tires back into their original materials. All of these things are recovery methods.

4. Recover is not used very much because it can cause problems. Unless proper pollution control equipment is used, recover can harm the environment.

5. When used properly recover is a good way to handle waste. Recovering energy and natural resources uses waste to its fullest. Waste that is no longer useful is garbage. Recover makes sure that only useless materials are thrown away.

The Final Frontier

OBJECTIVE: Students will theorize possible uses for Energy-From-Waste power.

MATERIALS: pen, paper and model materials (i.e. cardboard, paints, ruler etc.)

VOCABULARY: electrical, energy, Energy-From-Waste, fossil fuels, power, recover, reduce, resource, reuse, thermal, waste

BACKGROUND:

Energy-From-Waste operations have traditionally produced thermal and electrical energy. Most of this energy is used for heating and lighting buildings.

We all know fossil fuels provide us with most of the energy we use today but we should also remember these fuels are limited. When people reduce, reuse, recycle and compost there is still a small amount of waste left over. This makes waste a never ending resource. If fossil fuels became non-existent tomorrow, Energy-From-Waste power could assume an important role. This activity will have the children think of future uses for Energy-From-Waste power.

PROCEDURE:

1. Relay the BACKGROUND SECTION of this activity to the class.

2. Tell the children to think about all of the things they use each day that require energy.

3. Explain to the students they are going to design a way to use Energy-From-Waste power. Give them an example such as a lawn mower that uses electricity generated by burning waste or a car with a converter system that turns trash into usable fuel.

4. Each student should use small essays, pictures, diagrams, models etc. to demonstrate their idea. Tell the children to be as creative as their imagination will let them.

EXTENSION:

1. Have the children locate the Energy-From-Waste plant closest to their school or city.

2. Arrange a class trip to visit an Energy-From-Waste facility.

3. Find out how much waste the facility burns each day and how much energy this produces. Find the average total energy your school uses each day then calculate how many days it would take the facility to produce enough energy for one day at your school.

The Final Frontier (cont.)

EVALUATION:

1. Do the students understand the importance of energy in their lives?

2. Ask the students to name some negative impacts of Energy-From-Waste operations.

3. What garbage would be left for recover if the student's school reduce, reuse, recycle, and compost?

Ecotalk

COMPOSTED - things that have been placed in a composter and turned into finished compost are said to be composted.

ELECTRICAL - is a word used to describe something that works by, contains or produces electricity.

ELECTRICITY - is a type of energy.

ENERGY - is the power used to move vehicles, light lights, and heat homes. Gasoline, propane and the sun all provide energy. The food we eat gives us energy to breath, walk, talk, etc.

ENERGY-FROM-WASTE - a way to recover energy from waste. Normally waste is burned to create steam which is used to make electricity.

EXPERIMENT - is a test people do to learn about something new.

FOSSIL FUELS - are fuels like gasoline, oil, coal and propane. Old plants and animals that have died and been pressed beneath layers and rocks make fossil fuels.

LANDFILL MINING - waste from old landfills is dug up then the useful portion of the waste is recovered.

MAGNET - something that attracts or attaches to iron.

POLLUTION - is caused by people being careless with waste. Pollution makes the air, land and water dirty. This hurts people, animals, natural resources and the environment.

POWER - is a term used in physics. Power is the rate at which work is done or energy is transmitted. In everyday words, power is electrical energy or the energy produced by a machine.

RECOVER - is the fourth "R". Recover allows us to remove energy and resources from waste.

RECYCLED - is a word used to describe something that has gone through the recycling process.

REDUCE - is the first "R". Reduce is easy, all you have to do is not make any waste or as little waste as possible.

REUSE - is the second "R". Reuse means to use an item more than once instead of throwing it away. For example, plastic ice cream containers can be reused to hold plants.

SEPARATE - to divide from another thing or other things. Recycling companies sometimes separate clear glass from coloured glass.

Ecotalk (cont.)

STEAM - is the thing water changes to when it is boiled. Ice is water in solid form, water is water in liquid form and steam is water in a gas or vapour form.

THERMAL - something caused by heat. Furnaces use thermal energy caused by burning coal, oil, or gas to heat homes.

WASTE - is the things left over from people's activity. Food scraps, old newspapers, grass clippings and many other things are waste. Most waste can be reduced, reused or recycled. Only a very small portion is truly useless; this is called garbage.

Glossary

BIOLOGICAL MAGNIFICATION: the biological concentration of a substance, increased through links in a food chain.

BOTTOM ASH: the material left on the grates or in the combustion chamber of an incinerator or Energy-From-Waste facility.

EMISSIONS: the light, heat, gas, smoke, or particulate that is released into the atmosphere when matter is combusted or incinerated.

FLY ASH: residue particles from the combustion process, carried into the atmosphere by smoke, air, and flue gas if not captured by filters and scrubbers.

GASIFICATION: cellulose, in organic matter, is converted by chemical reaction, to a gas called synthesis gas.

GASIFIER: a pyrolyser that maximizes gas production, to produce char and a combustible gas.

GLOBAL WARMING: an increase in temperature around the world believed to be caused by the Greenhouse Effect.

GREENHOUSE EFFECT: describes the build-up in the atmosphere of pollutant gases which do not allow heat coming from the earth to escape into space.

INCINERATION: as it relates to solid waste, the use of an enclosed device, utilizing controlled flame combustion, to reduce the volume of waste.

N.I.M.B.Y.: an acronym for the Not In My Backyard syndrome. The term is used to describe individual, neighbourhood or community reaction and opposition to a perceived threat.

PARTICULATE: very small pieces of solid matter or droplets of liquid suspended or carried in the air; some are air pollutants.

PYROLYSIS: the process of heating matter to a very high temperature in a nearly oxygen-free environment to produce gas as an end product.

RESOURCE RECOVERY: to take what is viewed as waste and recover usable material or energy.

SCRUBBERS: an air-pollution-control device that uses a spray of water to trap pollutants and to cool emissions.

Resources

1. Bluewater Recycling Association
   P.O. Box 1330
   Grand Bend, Ontario
   N0M 1T0
   Phone: (519) 238-8661
   Fax: (519) 238-2330

2. Ministry of Environment and Energy
   135 St. Clair Avenue West
   Toronto, Ontario
   M4V 1P5
   Phone: (416) 323-4321
   Fax: (416) 323-4643

3. Recycling Council of Ontario
   489 College Street, Suite 504
   Toronto, Ontario
   M6G 1A5
   Phone: (416) 960-1025
   (800) 263-2849
   Fax: (416) 238-8053

4. Victoria Hospital Corporation
   800 Commissioners Road, East
   London, Ontario
   N6A 4G5
   Phone: (519) 685-8500
   Fax: (519) 685-8147

5. Laidlaw Environmental Services Limited
   3221 North Service Road
   Burlington, Ontario
   L7R 3Y8
   Phone: (416) 336-1800
   Fax: (416) 336-0670

6. Greenpeace
   185 Spadina Avenue, 6th Floor
   Toronto, Ontario
   M5T 2C5
   Phone: (416) 345-8408
   Fax: (416) 345-8422

7. Pollution Probe
   12 Madison Avenue
   Toronto, Ontario
   M5R 2S1
   Phone: (416) 926-1907
   Fax: (416) 926-1601

8. Citizen Clearinghouse on Waste Management
   RR#2
   Cameron, Ontario
   K0M 1G0
   Phone: (705) 887-1553
   Fax: (705) 887-4401

Resources (cont.)

9. Greater Detroit Resource Recovery Authority
   Adminstrative Building
   5700 Russell Street
   Detroit, Michigan
   48211
   Phone: (313)-876-0449
   Fax: (313)-876-0457

Videos

Unless specified all videos listed are available for use through the Bluewater Recycling Association.

Refuse Industry Productions, Garbage in America (Vol. III), Landfills, Options, and Solutions.

Speakers

1. The Bluewater Recycling Association
   P.O. Box 1330
   Grand Bend, Ontario
   N0M 1T0
   Phone: (519) 238-8661
   (800) 265-9799
   Fax: (519) 238-2330

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   489 College Street, Suite 504
   Toronto, Ontario
   M6G 1A5
   Phone: (416) 960-1025
   (800) 263-2849
   Fax: (416) 960-8053

3. Ministry of Environment and Energy
   135 St. Clair Ave West
   Toronto, Ontario
   M4V 1P5
   Phone: (416) 323-4321
   Fax: (416) 323-4643

4. Global Action Plan (G.A.P.)
   R.R.#4, 6080 Durham Road 23
   Uxbridge, Ontario
   L4P 1K4
   Phone: (416) 852-4786
   Fax: (416) 852-4786

5. Ontario Hydro
   Speakers Bureau
   700 University Avenue
   Toronto, Ontario
   M5G 1X6
   Phone: (416) 592-2322
   (800) 668-8500

Resources (cont.)

Speakers (cont.)

6. Federation of Ontario Naturalists
   355 Lesmill Rd.
   Don Mills, Ontario
   M3B 2W8
   Phone: (416) 444-8419
   Fax: (416) 444-9866

7. Pollution Probe
   12 Madison Avenue
   Toronto, Ontario
   M5R 2S1
   Phone: (416) 926-1907
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8. Greenpeace
   185 Spadina Avenue, 6th Floor
   Toronto, Ontario
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   Phone: (416) 345-8408
   Fax: (416) 345-8422

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Personal Notes