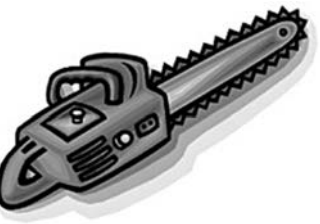

Don't Waste Waste

Summary: Students "harvest" celery to demonstrate waste accumulation from timber practices and brainstorm uses for the waste products.

Objectives

Students will be able to

- describe the parts of a tree;
- define biomass;
- identify alternative uses of the wood that is left behind after harvesting; and
- explain how biomass can be used to create energy.

Background

Biomass is defined as any plant-derived organic matter available on a renewable basis, including dedicated energy crops and trees, agricultural food and feed crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, animal wastes, municipal wastes, and other waste materials. Biomass can provide energy in the form of electricity, heat, steam, and fuels. Bioenergy is the energy which can be generated from the use of biomass. Because biomass uses crops that are available on a renewable basis, it is considered a renewable energy source like sun, wind, water, and the heat from the earth (geothermal energy). According to the United States Department of Energy, biomass has been the largest source of renewable energy every year since 2000. Agricultural crops can be grown solely for bioenergy production, or the agricultural by-products can be used to create bioenergy.

According to the Department of Tourism, Wisconsin's history is tied closely with the history of its forests. Before Wisconsin was admitted into the Union in 1848, approximately 63-86 percent of Wisconsin was covered with forests. Between 1859 and 1930, more than half of Wisconsin's forests were cut down. It is during this time that Wisconsin became a world leader in logging. Since then, many of our forests have been restored, but Wisconsin still generates income from logging and the use of its forests. Forests are used by industry and individuals for various purposes including profit and recreation.

Wisconsin's industrial sector is already using bioenergy from wood wastes and residues. Companies are able to use wood to produce heat (thermal energy) and electricity. According to the United States Department of Energy, the forest products industry uses 85% of the wood waste available to generate heat energy and electricity. Due to technological improvements, the amount of wood wasted when converting a log into a product has greatly improved. Some companies generated over half of their energy from biomass. Industrial wood residue or wood waste is any part of the tree that is not used for the primary product such as paper or timber. This can include leaves, branches, stumps, or any other part of the tree that is determined unusable by the company. Sawdust and wood chips can also be utilized to generate bioenergy. The wood residue can be used to heat a substance such as water or air. This heated water or air can then be used, for example, to maintain the temperature of an on-site kiln used for drying the wood products. Wood residue can also be burned to create steam, which then turns a turbine and creates energy.

NOTE: This activity calls the wood left after logging "waste." That "waste" is actually a very important part of the ecosystem. The organic materials such as leaves, branches, and twigs that remain after a harvest act as shelter for some animals. This material also decomposes as it lies on the forest floor and nutrients are released into the soil, making it better suited for the current trees and the trees to come in future years.

Procedure

Orientation

Ask students to think of things that they throw away, but that could be used/reused. Paper that has been printed on one side can be used for scratch paper. An aluminum can may be used to store things on a desk. A plastic bottle can be used as a water bottle. Tell students that there are other things that are considered waste that can be used for a second purpose.

Grade Level: 5–8 (K–4)

Subject Areas: Environmental Education, Language Arts, Mathematics, Science

Setting: Classroom

Time:
Preparation: 30–60 minutes
Activity: One week

Vocabulary: Bioenergy, Biomass, Industrial wood residue

Materials

- Scale (see Getting Ready)
- Each group of students will need the following:
- A bunch of celery
- Two or three plastic knives
- A ruler
- Two large trays
- Calculators
- Copies of ***Don't Waste Waste – Recording Page*** (optional)

Getting Ready:

Before the lesson, clean and weigh each bunch of celery and calculate the total. Determine the weight of each tray or zero out the scale.

Academic Standards:

Common Core ELA: RST.6-8.7

Common Core Math: MP1, MP5, MP6, MP7, 2.MD, 3.MD2, 3.NBT2, 3.0A7, 6.RP3c

NGSS: 5-LS2-1, MS-LS1-6, MS-LS2-3
SEP: Constructing Explanations and Designing Solutions, Developing and using models
DCI: ESS3.A: Natural Resources, ESS.C: LS1.C: Organization for Matter and Energy Flow in

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Organisms, LS2.B: Cycle of Matter and Energy Transfer in Ecosystems
CCC: Energy and Matter

WI Env Literacy & Sustainability: C1.A.m, C1.B.e, EX2.A.e, EX2.A.m, EX2.B.e, EX2.B.i, EX4.A.i, EX4.A.m, Ex4.B.i, EX4.B.m, EX5.C.e, EX5.C.i, EN6.B.e, EN6.B.i, EN6.C.i, EN6.C.m

Related KEEP Activities:

"Roasted Peanuts"– *KEEP Energy Education Activity Guide.* "So You Want to Heat Your Home"—*KEEP Energy Education Activity Guide.* "Photosynthesis Promenade"– *BioFutures.* "Corn in Your Car"– *BioFutures*

Divide the class into groups of two to four students each. Ask students to list the parts of a tree and use a stalk of celery to show those parts. Draw the tree on the board as the students name the parts of the tree. Tell the groups that their assignment is to harvest trees. Celery will represent the trees. Hand out bunches of celery to each group of students along with a ruler, plastic knives, trays, and calculators.

Provide each group with a copy of the ***Don't Waste Waste–Recording Page***. Have each group weigh their celery bunch and record date before they begin cutting. Students should predict the weight of celery they will be able to harvest before cutting and record their estimates. Students should then cut straight pieces of celery that are three inches (7.6 cm) long. Walk around the room making sure the pieces are straight and accurately measured. Instruct the groups to put their cut pieces on one tray and the leftovers on another. Stop working on the data sheet and go to Step 1 below.

Steps

1. Inform the class that the celery-cutting exercise simulated a forestry project where trees were harvested and cut for lumber.

2. Point out that the groups successfully produced lumber, but what about the leftovers?

3. Use the ***Don't Waste Waste–Recording Page*** to record their findings and comments for Step 2. Ask groups to weigh their accumulated waste (subtracting the weight of the tray from the total if you did not zero out the scale). Provide the class with the weight of the celery before it was "harvested." Instruct the class to calculate what percentage of their harvest was "waste" (divide the weight of the leftover celery by the weight of the pre-cut celery). Discuss the results.

4. Explain that when trees are harvested, there is waste material as well. Have the class list the parts of a tree that might be leftover as a result of timber production (leaves, branches, bark).

5. Explain that the waste from industrial use of timber is called industrial wood residue and is a form of biomass. Ask the class what they think biomass is and help them develop a definition (see *Background*).

6. Ask the class to list what they think happens or should happen to this waste material. List student ideas on the board, noting if they mention using the biomass as an energy source. Introduce the term bioenergy and explain its role in industrial energy production (see *Glossary*).

7. Have students explore the Internet and other sources to learn more about the use of industrial timber waste for bioenergy. Ask students to list benefits and drawbacks of using timber waste for energy.

Closure

Draw a picture of a tree on the board and have students list the many ways humans use it as a resource. Make sure they include energy.

Clean the celery and use it as a healthy snack for the class.

Assessment

Formative

- Were students able to do the math to figure out how much of the celery was actually wasted?
- Were students able to draw a connection between using the waste and creating energy as a biomass source?

Summative

Throughout the activity, we have been referring to the wood not used by the timber company as "waste." This wood is not really wasted, even if it is left on the forest floor. As it decomposes, it adds valuable nutrients that are important to the ecosystem. Ask students if they can think of a new term for this wood.

Examples include: secondary materials, wood residue, co-products.

Take students on a field trip to a local company who utilizes wood products (paper company, timber company) and uses biomass energy or invite a representative from that company to come to the classroom to discuss how they use biomass as an energy source.

Extensions

Have the class participate in a role play about the fate of a clear cut forest, debating the pros and cons of using the industrial waste for bioenergy.

Research the idea of a zero-waste product—a product that has no waste from the production aspect. Are there companies that do this? If so, how do they do it? (Example: some utilities use cogeneration – combined heat and power.)

For younger students, you can simplify the lesson by just looking at the piles of waste and seeing how much there is instead of calculating actual percentages.

Don't Waste Waste Recording Page

1. What is the total weight of the timber (celery) harvested? _____ grams (the whole class).

2. Estimate how much of the "forest" is usable and how much is waste.

   Usable _____ **%** (Usable weight / total weight)

   Waste_____ **%** (Leftover weight / total weight)

3. Cut the celery into straight "logs" that are three inches (7.6 cm) long. Then, weigh the logs and the leftover (waste) material. Record your data in the first row of the table below.

Group	Usable	Waste	Total
Your Group's Harvest	**(g)**	**(g)**	**(g)**
Harvest total from other groups:			
1.	(g)	(g)	(g)
2.	(g)	(g)	(g)
3.	(g)	(g)	(g)
4.	(g)	(g)	(g)
5.	(g)	(g)	(g)
6.	(g)	(g)	(g)
7.	(g)	(g)	(g)
8.	(g)	(g)	(g)
Total	**(g)**	**(g)**	**(g)**

4. Gather the findings of the other groups' harvest and fill in the table.

5. In the table above, add the class total of usable and waste timber.

   Usable _____ **grams**

   Waste_____ **grams**

6. Find the average usable timber percentage (total usable divided by the weight in Question 1. *(Remember to move the decimal point to get the percentage.)*

   _____ **%**

7. Find the average waste timber (total waste divided by the weight in Question 1. *(Remember to move the decimal point to get the percentage.)*

   _____ **%**