Overview of Unit on Alternative Energy Sources

Several of the 8th grade Earth Science objectives deal with renewable and nonrenewable sources of Energy. Students must understand the difference between these two main sources of Energy. The pros and cons of each source, and which source of energy works best for the local area where they live.

The focus of this unit is to improve students’ analytical skills. The activities are designed to enhance scientific thinking. Problem solving, observational, higher order thinking skills are targeted in the unit. Classroom activities are designed to be constructive so that students can come to an understanding of the objectives on their own, rather than gleaning all their information from a teacher lecture format, or a textbook. Teacher lecture and the textbook do have their place though, either as an introduction to the topic, background information, or as a way to tie things together at the end of the classroom activities or unit.

I also teach 7th and 8th grade Pre Algebra classes. Many times students do not see the “real world” applications of the math they are learning. My goal this year is to include at least one practical application with each math objective taught. I have included “The Carbon in Trees” activity as a science extension when teaching order of operations and exponents in my 7th grade honors and 8th grade Pre Algebra math classes.
A Daily Outline of the Energy Resources Unit

Day 1: Use the activity provided by Christine Webster to have students create the carbon cycle and discuss whether or not it is a balanced cycle.

Day 2: (Several weeks later when we are discussing energy resources.) Compare energy use today to energy use in the past. Discuss whether the energy was created by a renewable resource or a nonrenewable resource.

Day 3: Do activities “Observing Nonrenewable and Renewable Energy Resources”. Write down which you think is preferable and back up your opinion with facts. With your group, fill out the Non-Renewable Energy Resources Summary Chart. Determine which of these resources are doable in the state of Michigan.


Day 5: Focus on Biomass as an Energy Resource. Play power point presentation Bio fuels in the Gas Tank obtained from Karen Schmidt at Future Fuels from the Forest class.

Introduce students to forest resources being used for bio energy and bio fuel. Do Activity Putting on Pounds.

Day 7: Do activity: Monitoring Fermentation Using PH
Day 8: Culminating Activity: Debate about the pros and cons of each type of Bio Fuel. Students do a convincing presentation.

Day 1: The Carbon Cycle (Group Activity)

State Benchmarks Covered

E2.3A Explain how carbon exists in different forms such as limestone (rock), carbon dioxide (gas), carbonic acid (water), and animals (life) with Earth systems and how those forms can be beneficial or harmful to humans.

E2.3D Explain how carbon moves through the Earth system (including the geosphere) and how it may benefit (eg., improve soils for agriculture) or harm (eg. act as a pollutant) society.

Learning Objective:

1. Students will construct a diagram of the carbon cycle using concrete examples from each of Earth’s sphere. Then determine whether or not this is a balanced system.
2. Students will analyze the causes and effects of an unbalanced system.

Background Knowledge:

1. Students must know the definitions of Earth’s four spheres.
2. Students must know the difference between producers, consumers, and decomposers.

Pre-reading and discussion before activity

The day before beginning the activity assign as homework, reading Chapter 2, Section Cycles in the Earth System Pg. 36-38 in the text book titled Earth Science by Holt publishing, so students are familiar with the terms reservoir, and cycle.

The day of the activity: Initiate a discussion with students about the term reservoir and the various earth cycles. (5-10 Minutes)

The activity: Explain: “We will be doing a group activity today which involves the carbon cycle.” (Do not spend a lot of time explaining how the activity works. As a group, students should be reading the directions and doing the activity. The teacher circulates around the classroom monitoring the groups, helping and encouraging when necessary.)

Assessment: Rubric for grading group activity (Give to students before activity.)

1. Group diagram was made neatly. Ruler was used to draw any straight lines. 5 pts. _______
2. Within the Carbon Connections part of the activity each item was matched with the correct process description. 5 pts._______
3. Within the Questions and Conclusions part of the activity each question was answered with detail. 5 pts. ________
4. Each person in the group participated in the activity. 5pts._____ 

5. We really liked this activity because 
___________________________________________________________________________ 
___________________________________________________________________________ . 5 pts._______

6. We can make this activity better by -
___________________________________________________________________________ 
___________________________________________________________________________ .

5pts._______
The Carbon Cycle

Introduction: The Earth in some respects can be considered a closed system. Matter and Energy cycle through four different spheres in a constant effort to maintain balance. When products enter and leave the spheres, it is in response to an imbalance. In this lesson, we will use carbon to illustrate the movement of matter through the four different spheres.

Define the four spheres and give a few examples of what is included in them.

Geosphere -

Biosphere -

Hydrosphere -

Atmosphere -

Procedures

Create the Carbon Cycle

1. Obtain a packet of cards for each group and one chart per person from your teacher.
2. FIND the four large cards that say ATMOSPHERE, BIOSPHERE, GEOSPHERE, and HYDROSPHERE.
3. Lay them out on a table or desk in the same way as they are shown on the chart.
4. Now find the twelve process cards. Each descriptive process goes between two spheres. Use the clues to determine what two spheres are involved. For example:
Process 1: gaseous carbon dioxide dissolved into the ocean.
What two spheres are involved? ___________________________ and ___________________________

5. Place the process card between the two spheres on the table.
6. Decide which way the process is going. For example, process 1 is going from the atmosphere to the hydrosphere.
7. Draw an arrow on your chart between the two processes and LABEL THE PROCESS. It should look like this on your chart

   #1

   Atmosphere -------------> Hydrosphere

8. Repeat # 4 - 7 for the rest of the eleven processes. Continue to fill out your chart.

***ASK QUESTIONS IF NEEDED. WHEN YOU ARE DONE, ASK YOUR TEACHER CHECK YOUR CHART.
KEEP YOUR PROCESSES IN ORDER ON YOUR TABLE FOR THE NEXT SECTION.

**Carbon Connections**
1. Obtain samples of items related to the carbon cycle from your teacher.
2. List them in the table below.
3. Determine what items go with what process. You may NOT have all the processes represented. You may have MORE than ONE item for a process.

<table>
<thead>
<tr>
<th>Item Name</th>
<th>Process description / #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Item Name</td>
<td>Process description / #</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------------</td>
</tr>
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<td></td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Questions and Conclusions:** Use any information in this lab to help you answer the questions below.

1. How is carbon added to the atmosphere from other spheres? List three examples.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Process 4: Carbon Dioxide in the ocean is released into the air.</td>
<td>Process 5: Fossil Fuels are burned.</td>
<td>Process 6: Plants die and decompose. Fossilization may occur and fossil fuels made.</td>
</tr>
<tr>
<td>Process 7: Plants take up carbon nutrients from the soil through their roots.</td>
<td>Process 8: Calcite precipitates out of water and is deposited onto the bottom of the ocean.</td>
<td></td>
</tr>
<tr>
<td>Process 9: Water containing carbonic acid dissolves limestone in a cavern.</td>
<td>Process 10: Carbonate sediments (shells) are deposited on the bottom of the ocean floor.</td>
<td>Process 11: Plants absorb carbon dioxide from the air to make sugar and oxygen.</td>
</tr>
<tr>
<td>Hydrosphere</td>
<td>Biosphere</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>Geosphere</td>
<td>Atmosphere</td>
<td></td>
</tr>
</tbody>
</table>
Define the four spheres and give a few examples of what is included in them.

**Geosphere:** the solid Earth that lies beneath the oceans and atmosphere. It is composed of the core, mantle and crust.

**Biosphere:** all living things found on Earth.

**Hydrosphere:** all water on the Earth. Example: groundwater, oceans, surface, glaciers etc...

**Atmosphere:** the gaseous portion of the Earth. EX: air, oxygen, nitrogen, carbon dioxide.

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**Procedures**

**Create the Carbon Cycle**
Carbon Connections

There are several things you can do with them section to connect specific items to this cycle. Here is a list of items to get you started.

1. Candle (You could have it lit as a demo) or at the lab tables unlit
2. A Plant
3. Limestone - chemical and/or organic
4. Calcite (CaCO₃)
5. A picture of a volcano erupting.
6. Coal - any type
7. Petrified Wood
8. Petroleum
9. Sugar
10. Pop can of Sprite (2L works well because you can see the bubbles :)
11. Fossils
12. Shells
13. Sodium Bicarbonate and Vinegar - Fizzes releasing carbon dioxide.
14. Blown up balloon (Demo: Bromothymol Blue with Balloons and CO2 blown in using a straw
15. Combustion of a candle with BTB (rinse out beaker and add a little BTB and invert over the candle.
16. 0.5 M Hydrochloric Acid on Limestone fizzes releasing carbon dioxide.
17. Others....

Questions and Conclusions: Use any information in this lab to help you answer the questions below.

1. How carbon is added to the atmosphere from other spheres? List three examples. Added by volcanic eruptions, fossil fuel burning, respiration

2. What are the long term effects of adding carbon dioxide to the atmosphere? Carbon dioxide is one of the green house gasses that absorbs heat (infrared) energy given off by the Earth. This warms the Earth and makes it inhabitable. Humans are inflating this natural process by adding MORE carbon dioxide through the burning of fossils fuels. Long term effects will change the overall temperatures on Earth. Extension: Students can bring in newspaper articles and report on this.

3. How does deforestation affect the levels of atmospheric carbon dioxide? Deforestation will increase the levels of carbon dioxide because your removing trees so they can't photosynthesize.
4. How do the seasons in Michigan affect the amount of carbon dioxide in the air?
   Spring, Summer - decrease levels; Winter, Late Fall - increase levels due to the
   leaf fall of deciduous trees.

5. Look again at your chart and processes. List the carbon compounds found in the four
   spheres below.

   **Sphere / Carbon compound**
   Geosphere - Calcium carbonate (calcite); limestone
   Hydrosphere - Bicarbonate ion, calcium carbonate, carbon dioxide
   Biosphere - Carbon, Sugar (CH₂O)
   Atmosphere - Carbon Dioxide

6. What benefit does soil have when a plant dies and decomposes?
   **It recycles the carbon from the plant back into the soil. The process goes on...**

   It is really important for students to understand the decomposers must be part of cycle
   or nothing gets recycled. I always ask - who's most important? Producers, Consumers,
   or Decomposers.

7. Connect the carbon cycle to the stars. How is carbon created in stars?
   **Carbon is formed when 3 helium atoms fuse in older stars. During a supernova,
   carbon is sent into space only to be regathered again by gravity to form new star
   systems.**

   Resource: Prentice Hall Earth Science - Tarbuck and Lutgens

**Notes:**

**Closing:** Once all groups have finished the activity. Discuss answers to
questions with students to verbally check their understanding. Have the
students turn in the activity for credit.

Resources

Webster, Christine, *The Carbon Cycle*. Teacher at Hudsonville High School. cwebster@hpseagles.net.

Day 2 (Several weeks later when studying Energy Resources.)

**State Benchmarks covered:** Section- Human Impacts on Earth Systems, E2.4A Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their efforts on the environment, and include overall costs and benefits.

**Learning Objective:** Students will compare and contrast energy usage in the past and energy usage today and examine the negative impacts of human activities.

One week before beginning unit introduce the unit by having students complete “The Good Old Days Interview” adapted from Michigan Environmental Education Curriculum. (Energy Resources, Lesson 1)

Day 2- Students will discuss their findings from the survey. Focus on the Conclusions section of the Interview.

Rubric for grading survey: (Given along with interview so students know what is expected of them.)

1. Student completely filled out the first part of the survey. If they do not have any great grandparents that part of the survey is extra. 10pts.____

2. Answers to the conclusions were well thought out and explained in detail. 3pts for each question______
Name: ____________________________  "Good Old Days" Interview

**Directions:** Fill in the following table with information from your family, friends, and/or neighbors. Then answer the conclusions on the back of this sheet.

<table>
<thead>
<tr>
<th></th>
<th>Your family now</th>
<th>When your parents were your age</th>
<th>When your grandparents were your age</th>
<th>When your great-grandparents were your age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of people in home</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of rooms in home</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of cars and trucks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of drivers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most common method of transportation to school</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most common method of transportation to friends' house</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of container for milk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of food packaging</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy source for cooking</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Energy source for drying clothes</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Energy source for home heating</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric appliances - how many:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computers</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Radios</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>VCR and/or DVD players</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Televisions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Record players</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air conditioners</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microwaves</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toasters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refrigerators</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cell phones</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any other memories of differences?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

1. List at least 3 differences you observe from your data about the world in the past as compared to the world today.

2. Reflect on the differences between the world today and the world in the past. 
2a. What is the driving force of these changes?

2b. Do you think these changes are a positive or negative change for our world? Explain your answer.

Adapted from Michigan Environmental Education Curriculum (Energy Resources, Lesson 1) and Chemistry in the Community (American Chemical Society Publication, 1988).
Closing Activity: Fill in the following chart to make an educated guess as to whether the majority of the energy used in each generation is renewable or nonrenewable. As we proceed with the unit students will reflect back to this sheet to see if they were correct.

### Renewable Energy or NonRenewable?

Turn to the person next to you. Discuss, then predict what you think the terms renewable and non renewable mean.

Renewable Energy Sources
- ____________________________________________________
- ____________________________________________________
- ____________________________________________________

Nonrenewable Energy Sources
- ____________________________________________________
- ____________________________________________________
- ____________________________________________________

Fill in the following chart for each generation of your family. Check off whether the majority of the sources of energy renewable or nonrenewable? Use your survey to come up with examples of each.
<table>
<thead>
<tr>
<th></th>
<th>Renewable</th>
<th>Nonrenewable</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your family now</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When your parents were young</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When your grandparents were your age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When your great grandparents were your age</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Give students 10 minutes to complete this. Then have a class discussion about what they think. Refer to this later in the unit. Collect their work before they leave to give credit.
Day 3: Renewable and Nonrenewable Energy Resources

**State Standard:** E2.4A Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their efforts on the environment.

**Learning Objective:** Determine the environmental, economic, and social advantages and disadvantages of using different renewable and non-renewable resources.

Before beginning this lesson, reserve time in the library where resources and computers are available for students to work.

**Background Information:** (10 minute discussion) Write the following definitions in two columns on the board.

Renewable energy resources- replenish themselves through natural processes within a human lifespan.

Non-renewable energy resources- are finite or take millions of years to replace.

Write the various energy resources on large flashcards and have students classify them into renewable or non-renewable energy resources. Natural gas, Petroleum and its Derivatives, Uranium (Nuclear Fission), Coal, Biomass, Hydroelectric, Photovoltaic (PV), Passive Solar Heating, Active Solar Heating, Wind, Geothermal, Human Power (Can also use the Michigan Energy Resources Picture Cards that are included MEECS Energy Resources Lesson Plans provided by the Michigan Department of Environmental Quality.)
Group Activity: Renewable and Non-Renewable Energy Resources

Teacher Notes:

Objective: Make a poster of 1 type of energy resource and share your findings with the class.

Before beginning Activity: Divide the students into 9 groups. Each group will research one of the nine energy resources listed above.

Materials Needed For Each Group: A set of Chart Markers, 1 large piece of poster paper, 2 resources- Can be computer, text book, or any available materials in the library.

As each group presents their findings, hang posters up in classroom for everyone to see.

Grading Rubric: (See point value for each piece of information.)

Did you include all the information asked for on your poster written in your own words.

Did you include a picture?

Is your poster neat and colorful? (Must be in ink or marker- not pencil)

Did you use a straight edge to make all your lines?

While presenting: Did you speak in a loud clear voice?

Did you make eye contact with your audience?

Did you make sure you cited the sources that gave you the information for your poster? 3pts. ______
Group Activity: Renewable and Non-Renewable Energy Resources (Total Points: 25)

Objective: Make a poster of 1 type of energy resource and share your findings with the class.

Materials Needed For Each Group: A set of Chart Markers, 1 large piece of poster paper, 2 resources- Can be computer, text book, or any available materials in the library. A ruler or straight edge

Include the following information on your poster:

Type of Energy Resource 1 pt. _________
Is it renewable or non-renewable? 1 pt. _________
Definition of Resource 2 pts. _________
Picture 2 pts. _________

For the following advantages and disadvantages make sure you include how your energy resource effects the environment as one of your advantages or disadvantages.

3 Advantages of energy resource 3 pts. _________
3 Disadvantages of energy resource 3 pts. _________

Cost of using energy resource. Include transportation. 2 pts. _________

I obtained my information from these sources. 3pt. _________

Is your energy resource suitable for the state of Michigan? Why or why not? 3pts. _________

2 minute presentation of your findings to the class. 4 pts. _________

Day 4: Do the demonstrations “Observing Non-Renewable and Renewable Energy Resources” provided by the Michigan Environmental Education Curriculum Support, Lessons 4 and 5, Energy Resources Lesson Plans. Students complete charts included below as you do the demonstrations. (Instead of doing all parts of this lesson as a demonstration, students can do parts of the Renewable Energy Resources Lesson in small groups. The choice is yours.)

**State Standard:** E2.4A Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their efforts on the environment.

**Learning Objective:** Determine the environmental, economic, and social advantages and disadvantages of using different renewable and non-renewable resources.
Observing Non-renewable Energy Resources

Directions: Complete the following table as your teacher conducts each demonstration. Then answer the questions that follow.

Note: Bromothymol blue is a chemical indicator that turns yellow/green in the presence of carbon dioxide. Carbon dioxide is a greenhouse gas that contributes to global warming.

<table>
<thead>
<tr>
<th>Demonstration</th>
<th>Energy Resource</th>
<th>Particulates (soot, etc.)</th>
<th>Carbon Dioxide</th>
<th>Odor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bunsen Burner</td>
<td>Natural Gas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kerosene Lamp</td>
<td>Kerosene</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(petroleum derivative)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lump of Coal</td>
<td>Coal</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Which non-renewable energy resource(s) produced particulates when burned?

2. Which non-renewable energy resource(s) produced carbon dioxide when burned?

3. Which non-renewable energy resource(s) produced an odor when burned?
Observing Non-renewable Energy Resources

Directions: Complete the following table as your teacher conducts each demonstration. Then answer the questions that follow.

Note: Bromothymol blue is a chemical indicator that turns yellow/green in the presence of carbon dioxide. Carbon dioxide is a greenhouse gas that contributes to global warming.

<table>
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<td>Kerosene (petroleum derivative)</td>
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<td>YES</td>
<td>YES</td>
</tr>
<tr>
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<td>Coal</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

1. Which non-renewable energy resource(s) produced particulates when burned?
   All

2. Which non-renewable energy resource(s) produced carbon dioxide when burned?
   All

3. Which non-renewable energy resource(s) produced an odor when burned?
   All

4. Predict which non-renewable energy resource has the most negative environmental impact at the source? (Answers will vary.)
   In transit?
   At the point of end use?
Observing Renewable Energy Resources

**Directions:** Complete the following table as your teacher conducts each demonstration. Then answer the questions that follow.

**Note:** Bromothymol blue is a chemical indicator that turns yellow/green in the presence of carbon dioxide. Carbon dioxide is a greenhouse gas that contributes to global warming.

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<th>Carbon Dioxide Yes or no?</th>
<th>Odor Yes or no?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blow on the turbine</td>
<td>Wind</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pour water on the turbine</td>
<td>Water (hydro)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observe the sun warming a glass of water</td>
<td>Sun</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burn a wooden match</td>
<td>Wood (biomass)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Which renewable energy resource(s) produced particulates?

2. Which renewable energy resource(s) produced carbon dioxide?

3. Which renewable energy resource(s) produced an odor?

4. Predict which renewable energy resource has the most negative environmental impact at the source?
Observing Renewable Energy Resources

Directions: Complete the following table as your teacher conducts each demonstration. Then answer the questions that follow.

Note: Bromothymol blue is a chemical indicator that turns yellow/green in the presence of carbon dioxide. Carbon dioxide is a greenhouse gas that contributes to global warming.

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<td>No</td>
<td>No</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

1. Which renewable energy resource(s) produced particulates?
   **Wooden match, representing burning wood.**

2. Which renewable energy resource(s) produced carbon dioxide?
   **Wooden match, representing burning wood.**

3. Which renewable energy resource(s) produced an odor?
   **Wooden match, representing burning wood.**

4. Predict which renewable energy resource has the most negative environmental impact at the source? (Answers will vary.)
   In transit? __________
   At the point of end use? __________
Day 5: Present Power Point obtained from Karen Schmidt “Bio Fuels in the Gas Tank”

State Benchmarks: E5.4C - Analyze the empirical relationship between the emissions of carbon dioxide, atmospheric carbon dioxide levels, and the average global temperatures over the past 150 years.

E2.4 B - Explain how the impact of human activities on the environment (e.g., deforestation, air pollution, coral reef destruction) can be understood through the analysis of interactions between the four Earth systems.

Leaning Objective: Students will obtain information on the use of various forms of bio fuel used as energy resources from a power point presentation.

Provide students with a note taking form of the power point presentation, so they can take notes as the power point progresses.

Assessment: Glance at students’ notes before they leave class to make sure they were focusing on the power point and give class participation points.

Day 5

State Benchmark: E1.1A- Generate new questions that can be investigated in the laboratory or field.

Learning Objective: Students will estimate the tree biomass accumulated during their lifetime.

Teacher notes: Divide the students into groups of three.

Give students the grading rubric ahead of time so they understand what is expected of them.

Grading Rubric: (Total 20 pts.)

1. Our group has a reader that read the instructions for the activity. 5 pts.  
   _________

2. All students took turns doing parts of the activity. 5 pts. _______

3. Each person filled out their own activity sheet while collaborating with the others in the group. 5 pts. ________

4. All questions on the activity sheet were answered with detail. 5 pts. ___

Once all students are finished with the activity, have a whole class discussion of their finding. Emphasize the fact that not all trees contain the same amount of biomass as evidenced by the different equations used to calculate the biomass.

Collect the activity from the students to give them credit.
Activity: Putting on Pounds

By Amber Roth <amroth@mtu.edu>, Michigan Tech School of Forest Resources & Environmental Sciences

Description: As forest resources are increasingly being used for bioenergy and biofuel industries, foresters must be able to calculate the amount of mass, or biomass, for standing trees in a forest. To do this, foresters calculate the biomass of individual trees and project these estimates across a forest stand. For this activity you will estimate the tree biomass accumulated during the lifetime of a student in your class.

Objectives: Estimate tree biomass and average annual growth rate

Materials Needed:

Tree cookie (from tree older than your student)

Metric ruler and/or tape measure

Calculator

Pencil

Allometric equation for tree species of cookie used

Instructions:

Part 1: Calculate biomass for whole tree

Step 1: With pencil, draw two perpendicular lines that pass through the cookie’s pith as indicated in the diagram. Make all measurements in this activity along those lines (guides). Measure the two diameters in cm and calculate an average. This is the average diameter at breast height, D.

Diameter 1: _______ cm

Diameter 2: _______ cm

Average Diameter: _______ cm
Step 2: Calculate biomass for whole tree.

To calculate tree biomass, we use a standard allometric equation of the form $M=aD^b$ where $M$ is aboveground tree biomass (dry weight; kg), $D$ is the diameter at breast height (cm), and "a" and "b" are species specific coefficients.

For **aspen** cookies, use the equation $M=0.08 D^{2.35}$

For **balsam fir** cookies, use the equation $M=0.17 D^{2.16}$

Insert your total tree biomass ($M$) estimate in Part 3.

**Part 2:** Calculate biomass accumulated prior to the birth of your student (pre-birth tree biomass).

Step 1: From the bark inward, count the number of summer wood (dark) rings equal to the age of your student. Mark this ring with a pencil mark at the four places where it intersects your guides.

Step 2: Measure inner diameter of the wood between your pencil marks. Take a second measurement at a right angle to the first.

Inner diameter 1: _______ cm
Inner diameter 2: _______ cm
Step 3: Measure width of bark. Take a second measurement 90 degrees from the first.

Bark Width 1: _______ cm
Bark Width 2: _______ cm

Step 4: Add together all measurements from Steps 2 and 3 and divide by two. This is the average diameter at breast height estimate for this tree when your student was born.

Average diameter: _______ cm

Step 5: Calculate biomass for tree growth before your student was born (pre-birth tree biomass). Use the same allometric equation as in Part 1.

For aspen cookies, use the equation $M=0.08 \, D^{2.35}$

For balsam fir cookies, use the equation $M=0.17 \, D^{2.16}$

Insert your pre-birth tree biomass estimate ($M$) in Part 3.
**Part 3:** Calculate biomass accumulated during your student’s lifetime and the average annual growth rate during that time.

Step 1: To calculate the total biomass accumulated during a student’s life, subtract the pre-birth tree biomass from the total tree biomass.

Total tree biomass from Part 1: _______ kg \times 2.2 \text{ lbs/kg} = _______ \text{ lbs}

Pre-birth tree biomass from Part 2: _______ kg \times 2.2 \text{ lbs/kg} = _______ \text{ lbs}

Tree biomass accumulated during a student’s life: _______ kg \times 2.2 \text{ lbs/kg} = _______ \text{ lbs}

Step 2: To calculate the average annual growth rate during a student’s life, divide the tree biomass (lbs) accumulated during the student’s life by the age of your student (used in Part 2).

Average annual growth rate during a student’s life: _______ \text{ lbs/yr}
Day 6: Activity: Monitoring Fermentation Using PH of A “Trap”

State Benchmarks:

E1.1A Generate new questions that can be investigated in the laboratory or the field.

E2.2B Identify differences in the origin and use of renewable (e.g. solar, wind, water, biomass) and non-renewable (e.g. fossil fuels, nuclear sources of energy).

Teacher Notes: Before beginning activity: Show power point “Steps to Make Cellulosic Ethanol from Biomass presented by Dr. David R. Shonnard at Future Fuels from the Forest Summer Institute at Michigan Tech University. (Do not expect students to understand the minute scientific aspects of the process. Just give them an overview of each slide so they understand why they will be doing the activity.

Give students the grading rubric ahead of time so they understand what is expected of them.

Grading Rubric: (Total 20 pts.)

1. Our group has a reader that read the instructions for the activity. 5 pts.
   __________
2. All students took turns doing parts of the activity. 5 pts._______
3. Each person filled out their own activity sheet while collaborating with the others in the group. 5 pts. _________
4. All questions on the activity sheet were answered with detail. 5 pts. ____

Once all students are finished with the activity, have a whole class discussion of their finding. Emphasize the fact that not all trees contain the same amount of biomass as evidenced by the different equations used to calculate the biomass.

Collect the activity from the students to give them credit.
Fermentation Activity: One of the processes involved in making ethanol

Set-up 2: Using the lab equipment (adapted from Lab-Aids)

Materials:
- Baker's yeast 10 mL (2 tsp) in a jar or beaker
- Sugar 30 mL (2 T)
- Warm Water 200 mL (about 1 cup)
- Plastic spoon
- Erlenmeyer flask
- 2 hole stopper with thermometer and glass tube
- Plastic tubing
- Beaker
- 20 drops of 0.1% Bromothymol blue solution (BTB)

Procedure
1. Add yeast to warm water – let sit for 5 minutes
2. Add sugar to water/yeast suspension and stir.
3. Put mixture into Erlenmeyer flask
4. Cap with stopper (with thermometer and glass tube)
5. Connect tubing to glass tube
6. Fill beaker with 100 mL of water
7. Add 20 drops of BTB
8. Put loose end of tubing under water.
9. Observe and record temperature and color of water.
10. Continue to observe any changes occurring in either flask or the beaker.

Advantages of this set-up

Disadvantages of this set-up

Possible questions that could be investigated using this set-up

*Jaeger, Melissa., Teacher at Lakeshore Middle School, Grand Haven, Michigan.
Day 7 and 8  Discuss the pros and cons of various stocks of Bio Fuels by showing power point titled “Measuring Changes in Ecosystem Biodiversity Using Avian Population Monitoring” presented by Pamela Nankervis, Keweenaw Bay Indian Community Natural Resources Department, L’Anse, Michigan. Then spend 10 minutes outside observing the ecosystem on the school premises.

As the power point is being presented, initiate comments from students regarding the various slides being presented. Emphasize the pros and cons of the various bio fuel resources in terms of the diversity of wild life within that type of ecosystem.

**State Benchmark: E2.4 B-** Explain how the impact of human activities on the environment (e.g., deforestation, air pollution, coral reef destruction) can be understood through the analysis of interactions between the four Earth systems.

**Learning Objective:** Students will analyze the impact that each stock of Bio fuel has on diversity within the ecosystem.

Students will improve their science observation skills by conducting a field activity on school premises.

Teacher Notes: In this activity students will pick a “solo spot” outdoors in which to sit and observe for approximately 10 minutes. After finishing power point, take students outside as a group and practice the type of behavior you expect from them the next day as they sit in their solo spot. Pass out the following Activity Sheet ahead of time so they have an idea of what to look for the next day.
Field Activity: The Solo Spot Observation

Learning Objective: Observe and record the various wildlife you see or hear around the school premises for a 10 minute period.

Materials Needed: A clip board, writing utensil, Observation Form

Procedure:

1. Choose a solo spot from one of the following places around the school. The pond, or the edge of the wet lands. It is your special spot; treat the life there with respect, and be careful not to harm any living thing. You are only to observe and record what you see, hear or smell.
   Rules for choosing spot:
   a. Walk to your solo spot.
   b. Use your senses.
   c. Record what you see, smell, hear.
   d. Share at class meeting.
   e. Your teacher must be able to see you.

2. Fill out the following observation sheet.
Solo Spot Observation Sheet

1. The solo spot I have chosen is located

__________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

2. Date____________________

3. Today’s Temperature ________,
Weather Conditions ____________________________________________________________.

4. Stay at your solo spot for 10 minutes. List any observations below.

<table>
<thead>
<tr>
<th>Sounds Heard</th>
<th>Smells</th>
<th>Type of Wildlife</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Day 9: Culminating Unit Activity- The company that you work for Bio Fuel Technologies wants to convert land or forest stock into bio fuels. It has chosen the community of Arbor Springs to locate their plant. Your job is to present a convincing case for the bio fuel type you want to promote. Present your case to the local governing board. Then they will determine which type of plant is built.

State Benchmark: E2.4B Explain how the impact of human activities on the environment (e.g., deforestation, air pollution, coral reef destruction) can be understood through the analysis of interactions between the four Earth systems.

Learning Objective: Develop a presentation which analyzes the pros and cons of the various types of bio fuel resources.

Teacher notes: Write on board the different types of bio fuel stock: Corn, Soybean, Rye, Sunflower, Palm, Sugar Cane, Switch grass, Wood, Prairie Biomass. Divide the students into 9 different groups. Grade students using the following rubric. Students can do a power point presentation, or a series of posters.
Bio Fuel Technologies Presentation (Total Pts- 25)

Bio Fuel Technologies, the company you work for, wants to convert land or forest stock into bio fuels. It has chosen the community of Arbor Springs to locate their plant. Arbor Springs is located in an area that has a diverse ecosystem. There are woods and forests within a 30 mile radius as well as farms and prairie.

Your job is to present a convincing case for the bio fuel type you want to promote. Present your case to the local governing board. You must assume that your audience, the local governing board, has no background knowledge of bio fuels. So your presentation must be designed to inform and instruct. Then they will determine which type of plant is built.

Your presentation, which can be a power point or a poster presentation, will be given to another class which will act as the local governing board for Arbor Springs. They will determine which type of plant to locate in Arbor Springs.

To make your presentation as convincing as possible, include the following.

The names of the people in your group. 1 pt.

Type of Bio fuel Resource 1 pt. ________

Definition of Resource 2 pts._______

Picture 2 pts._______
For the following advantages and disadvantages make sure you include how your energy resource effects the environment and the local wild life, as one of your advantages or disadvantages.

3 Advantages of energy resource 3 pts._______

3 Disadvantages of energy resource 3 pts.________

Cost of using energy resource. Include transportion. 2 pts.________

I obtained my information from these sources. 3pt.______

During your presentation: Did you speak in a clear, loud voice? 3pts. ______

Did you make eye contact with your audience? 3pts._

Did you allow time within your 4 minute budget for a Question and answer period? 2 pts. ____

Extra Credit of 10 points- if your bio fuel type is chosen.

Math Focal Point: A2.4- Models of Real-World Situations Using Families of Functions.

A2.4.2 Adapt the general symbolic form of a function to one that fits the specifications of a given situation by using the information to replace arbitrary constants with numbers.

Teacher Information

Student Background Information: Students must know how to follow order of operations with equations that include exponents.

Use the following rubric to assess the students.

Grading Rubric: (Total 20 pts.)

1. Our group has a reader that read the instructions for the activity. 5 pts.
   __________

2. All students took turns doing parts of the activity. 5 pts._______
3. Each person filled out their own activity sheet while collaborating with the others in the group. 5 pts. _________
4. All questions on the activity sheet were answered with detail. 5 pts. ____

Once all students are finished with the activity, have a whole class discussion of their finding. Emphasize the fact that not all trees contain the same amount of biomass as evidenced by the different equations used to calculate the biomass.

Collect the activity from the students to give them credit.
Activity: The Carbon in Trees

Description: Recent interest in the use of forests for carbon sequestration and bioenergy require knowledge about the amount of carbon stored in a tree or forest. For this activity, you will estimate the amount of carbon stored in a nearby or favorite tree.

Objectives: Measure tree diameter; calculate biomass and carbon mass

Materials Needed:
Tree(s); Diameter tape and/or tape measure; Calculator and/or spreadsheet software; Pencil; Allometric equation for tree species

Instructions:

Step 1: Measure Diameter
If using a tape measure, measure the circumference of the tree at breast height (4.5 feet off the ground; see figure). If necessary, convert this value to cm. Then, using the tree circumference, calculate the diameter.

Circumference: _______ cm  Diameter: _______ cm

OR: If using a diameter tape, the tree is measured the same way but it is not necessary to calculate diameter since the tape already does that for you. If necessary, convert this value to cm.

Diameter: _______ cm

Step 2: Calculate biomass for whole tree.
To calculate tree biomass, we use a standard allometric equation of the form \( M = aD^b \) where \( M \) is aboveground tree biomass (dry weight; kg), \( D \) is the diameter at breast height (cm), and “a” and “b” are species specific coefficients. Locate

<table>
<thead>
<tr>
<th>Species</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash</td>
<td>0.16</td>
<td>2.35</td>
</tr>
<tr>
<td>Aspen</td>
<td>0.05</td>
<td>2.51</td>
</tr>
<tr>
<td>Balsam fir</td>
<td>0.07</td>
<td>2.50</td>
</tr>
<tr>
<td>Basswood</td>
<td>0.09</td>
<td>2.35</td>
</tr>
<tr>
<td>Beech</td>
<td>0.20</td>
<td>2.39</td>
</tr>
<tr>
<td>Eastern hemlock</td>
<td>0.10</td>
<td>2.36</td>
</tr>
<tr>
<td>Northern white cedar</td>
<td>0.09</td>
<td>2.23</td>
</tr>
<tr>
<td>Red maple</td>
<td>0.16</td>
<td>2.31</td>
</tr>
<tr>
<td>Red oak</td>
<td>0.13</td>
<td>2.42</td>
</tr>
<tr>
<td>Red pine</td>
<td>0.78</td>
<td>2.42</td>
</tr>
<tr>
<td>Sugar maple</td>
<td>0.17</td>
<td>2.36</td>
</tr>
<tr>
<td>White birch</td>
<td>0.12</td>
<td>2.43</td>
</tr>
<tr>
<td>White oak</td>
<td>0.20</td>
<td>2.16</td>
</tr>
<tr>
<td>White pine</td>
<td>0.75</td>
<td>2.38</td>
</tr>
<tr>
<td>Yellow birch</td>
<td>0.09</td>
<td>2.59</td>
</tr>
</tbody>
</table>
the coefficients for the species of tree that you have in the table and calculate tree biomass (M).

Tree Species: ____________________

Biomass (M): _______ kg

**Step 3: Determine carbon content**

Since carbon is the major building block for life, a tree contains a large portion of carbon (about half of its biomass). To determine how much carbon is in your tree:

Multiply biomass (M) by 0.521 for **hardwood** trees.
Multiply biomass (M) by 0.498 for **softwood** trees.

Carbon content: _______ kg C

Multiply by 2.2 to convert to lbs.

Carbon content: _______ lb C

**Bonus Question:** One lb of C is equal to 3.67 lbs of CO₂. Also, a car emits 19.6 lbs of CO₂ for each gallon of gas. If a person uses 400 gallons of gas a year, then their CO₂ emissions from driving would equal the amount of carbon sequestered in _______ of these trees.

**Michigan Benchmarks Covered In This Unit**

**Subject: Earth Science**

**E1.1A** – Generate new questions that can be investigated in the laboratory or field.

**E2.2B**- Identify differences in the origin and use of renewable and non renewable resources of energy.

**E2.3A**- Explain how carbon exists in different forms such as limestone, carbon dioxide, carbonic acid, and animals within Earth systems and how those forms can be beneficial or harmful to humans.

**E2.3D**- Explain how carbon moves through the Earth system and how it may benefit or harm society.

**E2.4B**- Explain how the impact of human activities on the environment through the analysis of interactions between the four Earth systems.

**E5.4C**- Analyze the empirical relationship between the emissions of carbon dioxide, atmospheric carbon dioxide levels, and the average global temperature over the past 150 years.

**Math Benchmarks**

**A2.4 Models of Real-World Situations Using Families of Functions.**

**A2.4.2** Adapt the general symbolic form of a function to one that fits the specifications of a given situation by using the information to replace arbitrary constants with numbers.
Bibliography
