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“Woody Biomass-Nebraska”
Science Lesson Plan

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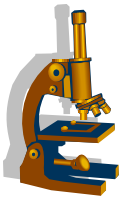
the.News

A daily news broadcast for High School and Middle School students now under development by MacNeil/Lehrer Productions



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“Woody Biomass-Nebraska” Science Lesson Plan

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Spring, 2010

Dear Educator,
This *the.News* online video report for *the.Sci* & *the.*Gov provide middle and high school students with a valuable exercise in science, social studies, and language arts with this **6:08** minute video report on "Woody Biomass-Nebraska" at www.pbs.org/newshour/thenews/thesci and www.pbs.org/newshour/thenews/thegov Correspondent, Robyn Wisch takes an in-depth look at alternative energy sources and Nebraska's contribution to conservation.. Lessons for science, social studies and language arts are available to support this video in the "For Educators" section of the website. All videos and curricula have been informed by *the.News* instructional design that can be found on the website www.pbs.org/newshour/thenews. The curriculum includes content-based standards, discussion questions, student activities, vocabulary and primary reference sources. A complete transcript of each video report includes time codes to assist in isolating specific segments of the video and to augment the instruction of media literacy and multimedia production. All of this material is presented as options to fit teachers' instructional needs.

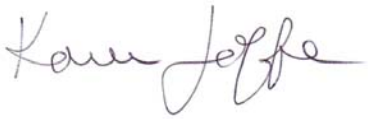
References to Larry Bell's "The 12 Powerful Words" are highlighted in **bold** in the lesson plans, in the "thought starter" questions on the home page and educator's page, and in the transcript (to denote where they are used in the video segment).

We have also added general topics to correlate to the lessons and video as well as concept based curriculum examples.

We welcome our partners at the Omaha Public Schools who have joined *the.News* in a special pilot project during the 09-10 school year. We are also developing a new authoring tool for students called *YOU.edit*, to launch in spring 2010. It will give students an online tool to remix the content of *the.News* reports, so they can create their own multimedia presentations. This editing tool will reside on our website so that it will be available to all students with an internet connection. It will be password protected so that it can serve as a viable educational asset that allows classroom teachers to assign multimedia projects within the security and content safety of *the.News* website.

Answers to **student "thought starter"** questions listed below the video**.**
#1. wood, wind power, solar power, ethanol
#2. Arbor Day
#3. woody biomass

Sincerely,



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Woody Biomass-Nebraska

This lesson was designed to support *the.News* video "Woody Biomass- Nebraska" The video can be found online at www.pbs.org/newshour/thenews/thesci and www.pbs.org/newshour/thenews/thegov

Omaha Public Schools Science Standards
http://www.ops.org/District/LinkClick.aspx?fileticket=Hbqyrrg2ydM%3d&tabid=912&mid=2006

Grade 8
Standard 03: Explore elements, compounds and chemical reactions.

Grade Level:
Grades 7–12

Content Areas:
Science

Key Concept(s)
Students will be able to define woody biomass and **explain** its use as a fuel. They will learn what the carbon cycle is and calculate their carbon footprints. They will be able to **explain** how burning wood for fuel is a carbon neutral process.

Objectives:
Students will

- Be able to define woody biomass.
- **Analyze** the carbon cycle and trace the path of carbon in it.
- **Explain** how burning wood is a carbon neutral process.
- Calculate their carbon footprints.
- **Formulate** a plan to reduce household carbon emissions.

Omaha Public Schools Science Standards Grades 9–12
http://www.ops.org/District/LinkClick.aspx?fileticket=Hbqyrrg2ydM%3d&tabid=912&mid=2006
Biology 1–2, AP Biology
Standard 06: Investigate ecological interactions including human impacts on the environment.

Conceptual Lens: Energy/Matter

Enduring Understanding: In order to create a clean energy economy it is necessary to develop alternative energy sources.

Key Vocabulary:

- **Alternative fuel**: Fuel not traditionally used in producing energy. Whereas coal, oil, and natural gas are conventional fuels, biodiesel, woody biomass, and hydrogen are alternative fuels.
- **Biomass**: Material made from plants and animals and used as fuel. Wood and manure are examples of biomass.
- **Carbonate**: a chemical compound that contains carbon
- **Carbon dioxide**: a gas found in the air that is produced in exhalation and by burning carbon-containing compounds
- **Carbon footprint**: the amount of greenhouse gas emissions from an individual, household, business, or organization
- **Carbon neutral**: describes the process of removing the same amount of carbon dioxide from the air that is put in
- **Fossil fuel**: oil, coal, and natural gas
- **Particulates**: very tiny particles that pollute air and water
- **Woody biomass**: wood and plant material used as a fuel

Sources: All my own definitions derived from New Oxford American Dictionary and various Web sources.

McRel
http://www.mcrel.org/
Science
Level III (Grades 6–8)

Standard 6: Understands relationships among organisms and their physical environment

Benchmark 4: Knows how energy is transferred through food webs in an ecosystem (e.g., energy enters ecosystems as sunlight, and green plants transfer this energy into chemical energy through photosynthesis; this chemical energy is passed from organism to organism; animals get energy from oxidizing their food, releasing some of this energy as heat)

Materials:

- "Woody Biomass-Nebraska" from *the.Gov* and *the.Sci*
  www.pbs.org/newshour/thenews/thesci
  www.pbs.org/newshour/thenews/thegov
- Internet access
- Information from home to calculate carbon footprints, such as utility usage—see step 3 of the lesson plan for details
- Paper and markers to make a carbon cycle map (optional)

Lesson Topics:

- Alternative fuel
- Biomass
- Carbon cycle
- Fossil fuels and the carbon cycle
- Carbon footprint

Time Frame:
Three to four class periods, two to three for learning about the carbon cycle and another for calculating carbon footprints and devising a plan to lower emissions

McRel
http://www.mcrel.org/

Level IV (Grades 9–12)
Standard 6: Understands relationships among organisms and their physical environment

Benchmark 1: Knows how the interrelationships and interdependencies among organisms generate stable ecosystems that fluctuate around a state of rough equilibrium for hundreds or thousands of years (e.g., growth of a population is held in check by environmental factors such as depletion of food or nesting sites, increased loss due to larger numbers of predators or parasites)

Benchmark 3: Knows that as matter and energy flow through different levels of organization in living systems and between living systems and the physical environment, chemical elements (e.g., carbon, nitrogen) are recombined in different ways

Background:
You may be wondering: What is woody biomass? Well, it's just wood, the stuff people have been burning for millennia. It may come in the form of logs, sawdust, wood chips, wood pellets, or other woody plant material. So why is wood considered an alternative fuel when it's been around forever? It's an alternative to fossil fuels, first off. And although burning wood in traditional ways such as fires and ordinary furnaces produces pollution in the form of ash, smoke, gases, and particulates, more modern methods of burning cut way down on these by-products, making it a cleaner alternative to burning fossil fuels.

Woody biomass is considered carbon neutral. What this means is that even though carbon (in the form of carbon dioxide) gets released when wood is burned, it doesn't add any carbon to Earth's carbon cycle because it already captured the same amount of carbon from the air when the plant was growing and taking in carbon dioxide during photosynthesis. This is important because

carbon dioxide is a greenhouse gas, and human activities are adding more carbon to the atmosphere all the time.

The Carbon Cycle
You can better understand why wood is carbon neutral by knowing the carbon cycle. A good diagram and explanation of the cycle is at this NASA Earth Observatory page: The Carbon Cycle (http://earthobservatory.nasa.gov/Features/CarbonCycle/carbon_cycle.php).

Carbon is the fourth most common element in the universe. It is found in all living things as well as in minerals and compounds. There are two aspects to the carbon cycle. The geologic carbon cycle takes place over hundreds of millions of years and involves carbon found in minerals and chemical compounds. When carbon dioxide in the air combines with water, it forms carbonic acid. The acid combines with elements in soil in the process of weathering and forms chemical compounds called carbonates. The carbonates are washed into streams and carried to the ocean, where they form sediment at the bottom. Shells of marine animals add more carbon to the sediment. The carbonates are drawn even deeper into the Earth when one tectonic plate subducts, or slips beneath another. The carbon returns to the atmosphere during volcanic eruptions, which spew out great quantities of carbon dioxide.

The biological carbon cycle is the second aspect of the process and involves carbon stored and removed by living processes. Carbon circulating in this process can make its journey anywhere from days to thousands of years. Plants remove carbon from the air during photosynthesis. Animals take in carbon from eating plants. Animals that eat other animals ingest carbon from their prey. When plants and animals die, some of the carbon in their cells goes into the ground and some is released into the air during decomposition. Very large concentrations of dead plants and animals transform over millions of years into reserves of fossil fuels. Of course, every time an animal exhales, carbon dioxide goes into the air. Plant respiration also gives off carbon dioxide. As on land, ocean plants and animals consume and release carbon. Ocean water also takes on carbon dioxide from the air and releases it back, depending on water temperature. Warm surface temperatures release carbon dioxide, while cold water removes carbon from the air.

Living processes, volcanic eruptions, and fires are natural ways carbon enters the atmosphere. But these processes are carbon neutral. They are only releasing carbon that had been stored in the bodies of plants and animals, or in the soil. If people weren't adding additional carbon to the atmosphere, the cycle would remain balanced with equal amounts being stored and removed through the cycle. But burning fossil fuels rapidly adds much more carbon than the cycle can remove naturally, resulting in a carbon imbalance. Deforestation makes the problem worse, as fewer trees are available to remove atmospheric carbon during photosynthesis.

Today there is more carbon dioxide in the air than at any time in the past 500,000 years. That's why finding alternatives to burning fossil fuels is so important.

Partnership for 21st Century Skills
http://www.p21.org/

Communication and Collaboration
- Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts

Core Subjects and 21st Century Themes
- Global awareness
- Environmental literacy

Critical Thinking and Problem Solving
- Effectively analyze and evaluate evidence, arguments, claims and beliefs
- Synthesize and make connections between information and arguments
- Interpret information and draw conclusions based on the best analysis
- Identify and ask significant questions that clarify various points of view and lead to better solutions

- **Information Literacy**
- Access information efficiently (time) and effectively (sources)
- Evaluate information critically and competently
- Use information accurately and creatively for the issue or problem at hand
- Manage the flow of information from a wide variety of sources

- **ICT (Information, Communications and Technology) Literacy**
- Use technology as a tool to research, organize, evaluate and communicate information
- Use digital technologies (computers, PDAs, media players, GPS, etc.), communication/networking tools and social networks appropriately to access, manage, integrate, evaluate and create information to successfully function in a knowledge economy

Your Carbon Footprint
The way we live impacts the carbon cycle. If we use utilities powered by fossil fuels and drive gasoline-powered vehicles, we are adding carbon faster than the Earth can naturally balance it. There are online calculators that help you figure your carbon footprint, or how much carbon dioxide your activities and lifestyle add to the atmosphere. The higher the number, the more

carbon you are adding. Knowing your carbon footprint can help you determine ways to cut back on emissions.

How Woody Biomass Can Help

As shown in the *the.News* segment, burning wood can be clean and efficient, and it won't add to atmospheric carbon the way burning fossil fuels does. Additional perks include reducing the risk of forest fires by removing dead wood and recycling material that might otherwise end up in landfills, where it eventually decomposes and gives off methane, a greenhouse gas much worse than carbon dioxide. Only a small percentage of wood waste is being used for fuel, so there is an ample supply. And, of course, wood is a renewable resource, the growing of which removes carbon from the air.

Wood isn't a perfect fuel. When burned in the traditional way it produces toxic gases as well as ash and particulates. Special furnaces burn the wood more efficiently, generating more heat and releasing fewer pollutants in the process. As examples in the *the.News* segment show, burning wood can be less expensive and less polluting than burning fossil fuels. Turns out that being neutral—carbon neutral—is a pretty good strategy. The fuel people have used for thousands of years may return to favor as a "new" alternative fuel.

Lesson Plan:

1. Students view "Woody Biomass-Nebraska" on *the.Gov and the.Sci* www.pbs.org/newshour/thenews/thesci and www.pbs.org/newshour/thenews/thegov.
2. In the segment, Scott Josiah describes woody biomass as recycled carbon. To explore what this means, students will learn about the carbon cycle. The NASA Earth Observatory article The Carbon Cycle (http://earthobservatory.nasa.gov/Features/CarbonCycle/carbon_cycle.php) is an excellent discussion of the process. Give students a chance to read through the information and then go over the carbon cycle diagram at http://earthobservatory.nasa.gov/Features/CarbonCycle/carbon_cycle4.php with the group, discussing the paths carbon takes as it circulates from land and water to air and back. Ask students to **describe** both the geologic and biological aspects of the cycle. What conclusions can they draw about the amount of time it takes for carbon to move through the cycle? What is the effect of adding carbon to the system by burning fossil fuels?
3. Upon wrapping up the first day of this lesson, explain to students that they will be calculating their carbon footprints and that they will need certain information to do that. They will need their average monthly use of electricity, natural gas, heating oil, and propane. They can use either average monthly cost or average monthly units used (kilowatt-hours, therms, or gallons), which can be found on utility bills and possibly online from the utility company. They will need to know how many miles each car in the

family is driven per day or week. They also need to know about energy-saving measures such as recycling and using energy efficient appliances. Have students ask their parents to help them gather this information to bring in the next day. Students can preview the Household Emissions Calculator at http://www.epa.gov/climatechange/emissions/ind_calculator.html to see what information they will need.

4. Allow students to explore the carbon cycle further by playing the interactive game Element on the Move (http://www.open2.net/science/element/html/element.html), in which they choose the correct processes to move a carbon atom through the cycle. Adobe Shockwave is required to play the game. After the main screen opens, students can click on "help" in the menu to bring up the instructions for playing the game. Note: If students don't all have access to the interactive, they can also work in small groups to draw a "map" of the carbon cycle (similar to the diagram in step 2) in which they illustrate where carbon travels and how. Students will need one to two class periods to complete the game or map.
5. Review what students learned about the carbon cycle by having them take the Element on the Move quiz (in the menu on the main page of the game). Even if students didn't complete the interactive, you can pose the quiz questions as a review.
6. Ask students to **explain** why burning woody biomass is carbon neutral and burning fossil fuels is not. They may not realize that everyday activities such as riding in a car or heating a home add carbon to the atmosphere. To better understand their impact on the carbon cycle, have them calculate their carbon footprints. The Environmental Protection Agency's Household Emissions Calculator, at http://www.epa.gov/climatechange/emissions/ind_calculator.html, walks them through the process. How do students' yearly household emissions compare with the average?
7. Suggestions for reducing carbon emissions are included as part of the calculator, and there are many more. Ask students to do some research to **formulate** a plan to reduce their household emissions and estimate how much they can shrink their footprints. Students will share their plans with the class. Encourage them to put their plans into use and check with them in a few weeks to see how it's going.

Assessment:

Use the Element on the Move quiz to assess students' understanding of the carbon cycle. Also evaluate students on whether they gathered the necessary information to calculate their carbon footprints and on the accuracy of their research and creativity and in planning ways to reduce emissions.

Extensions:

- In small groups, students can conduct research into a facility that burns woody biomass for fuel. They can get a good look at the system used at Lied Lodge in Nebraska City, Neb. by clicking on this link: http://www.liedlodge.org/about/fuelwood.cfm. How does the system work? What are its advantages and disadvantages? Ask students to make a

presentation for the class that profiles this or another system. Other examples include schools in Darby, Mont. and the city of St. Paul, Minn. This Forests and Rangelands page from the U.S. Department of the Interior has a state-by-state listing of facilities and communities that are using wood fuel: http://www.forestsandrangelands.gov/Woody_Biomass/success/index.shtml.

- Students conduct research into using wood for fuel and fill in a misconception/fact chart. In the left-hand column of a two-column chart are the following misconceptions: burning wood is polluting, burning wood depletes forests, and burning wood increases atmospheric carbon. In the right-hand column, students write statements of fact that address the misconceptions after conducting some research.

Resources:
Carbon Cycle Diagram from Teachers' Domain:
http://www.teachersdomain.org/resource/tdc02.sci.phys.matter.ccycle/

Marian Koshland Science Museum of the National Academy of Sciences Carbon Cycle pages:
http://www.koshland-science-museum.org/exhibitgcc/carbon01.jsp

NASA's Earth Observatory's The Carbon Cycle:
http://earthobservatory.nasa.gov/Features/CarbonCycle/carbon_cycle.php

U.S. Forest Service's Woody Biomass Utilization: http://www.fs.fed.us/woodybiomass/

U.S. Energy Information Administration's Energy Kids page on Biomass:
http://tonto.eia.doe.gov/kids/energy.cfm?page=biomass_home-basics-k.cfm

Windows to the Universe's The Carbon Cycle:
http://www.windows.ucar.edu/tour/link=/earth/Water/co2_cycle.html

Activity Designer:
*Rhonda Lucas Donald is a freelance writer and educational consultant***.**