

Future Fuels Teaching Unit

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State Level Grade level Content Expectation (Michigan)

E2.4A Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their effects on the environment, and include overall costs and benefits.

Key Concepts: Sustainability, renewable and nonrenewable resources, ethanol

Objectives

At the end of this unit students will be able to:

1. Define sustainability as it relates to nature resources.
2. Classify renewable and nonrenewable fuel resources.
3. Identify common fuels used in the US and their sources.
4. Identify who primarily uses a particular fuel.
5. Explain why that particular fuel is used instead of an alternative.
6. Explain how the various fuels are processed.
7. Explain the environmental impacts of the processing and use of an identified fuel.
8. Compare ethanol use to gasoline.
9. Determine the feasibility of growing ethanol feedstocks Montcalm County.

Skills: Create, Compare and Contrast, Classify, Justify

Additional Subjects: Language arts, geography, history, current affairs, mathematics

Time: 5 days (70 minute class periods)

Background:

The Earth provides resources that are used to sustain human affairs. The supply of nonrenewable natural resources is limited and their extraction and use can release elements and compounds into Earth systems. They affect air and water quality, ecosystems, landscapes, and may have effects on long-term climate. Plans for land use and long-term development must include an understanding of the interactions between Earth systems and human activities.

Procedures:

Day 1: Students discuss prior reading assignment on ethanol use in Michigan. Listen to a short lecture on sustainability, and renewable resources. They will then conduct research into a given energy resource and present a power point presentation on that particular energy resource.

Day 2: Student will conduct research on their assigned energy resources.

Day 3: Student will prepare their power point presentation.

Day 4: Students will present their power point to the class. They will then be assigned their assessment project, which is rank order and justify each energy source as to whether it would be a viable source in our community.

Day 5: Students will read 3 articles on ethanol fuel and its production and impacts (Food vs. Fuel: Diversion of Crops Could Cause More Hunger) (Ethanol: Myths and Realities) (Panel Sees Problems in

Ethanol Production). They will then hold a class discussion on the topic. As a final assignment students will write a one page opinion on the choice of ethanol as a fuel.

Day 1 - Renewable Energy Sources

Key Concepts: Sustainability, renewable and nonrenewable resources

Objectives: At the end of this lesson students will:

1. Define sustainability as it relates to nature resources.
2. Classify renewable and nonrenewable fuel resources.
3. Identify common fuels used in the US and their sources.
4. Identify who primarily uses a particular fuel.
5. Explain why that particular fuel is used instead of an alternative.

1. Students discuss prior reading “Ethanol could save state's economy”.

(http://www.stateneews.com/index.php/article/2007/02/ethanol_could_save_state039s)

2. Lecture:

- Define Sustainability and resource.
 - A resource is an aspect of the physical environment that people value and use.
 - A renewable resource can be regenerated if used carefully.
 - Wood, water, wind, sun light etc.
 - A nonrenewable resource cannot be replaced once it is used up.
 - Petroleum, coal,
 - Discuss Sustainability vs. renewable.
 - Rate used vs. amount available or amount of time needed to regenerate.
- Classify energy "resources" both renewable vs. nonrenewable.
 - **What is renewable energy?**
 - Renewable energy can offer inexhaustible power generated by the natural processes of wind, sun, water, plant growth, and heat from the earth being converted into power, steam and heat.
 - Collectively, the energy captured by these technologies is referred to as renewable.
- Examples of important energy resources.
 - Wind; Solar; Hydropower; Biomass; Geothermal; Petroleum; Nuclear.
- Alternative energy sources
 - Discuss what alternative energy resources mean.
 - Give examples of alternative energy resources.
 - **Wind - Wind power** captures the energy of air currents using turbine blades; as the blades rotate, electricity is generated.
 - **Solar - Solar power** offers multiple applications, from powering traffic lights to heating water.
 - **Hydro - Hydro power** captures the energy generated by water's movement and converts it into electricity.
 - **Biopower - Biopower** releases the energy trapped in organic material, or biomass. Biopower uses biomass energy to generate electricity..
 - **Geothermal - Geothermal power** uses heat from below the earth's surface to produce electricity or heat buildings and water systems
 - **Nuclear Energy - Uses** the energy held in atoms to heat water and produce electricity. Very controversial because of waste generated.

3. Research

Divide students into teams of two. Assign each team an energy resource, they will be responsible for researching one of the following: Solar; Wind; Geothermal; Biomass; Petroleum; Nuclear power; or Hydropower

Distribute the Renewable Energy Resources student sheet.

In their research, students could use any of the following online resources, as well as any others you find appropriate. They also could use print resources available in the classroom or library.

- Clean Energy Basics <http://www.nrel.gov/learning/> provides more in-depth information.
- Energy Story <http://www.energyquest.ca.gov/story/index.html> has a chapter devoted to each type of renewable energy.
- The U.S. Department of Energy's <http://www.eere.energy.gov/> has some information as well.

As outlined on the student sheet, after students have finished their research and one-page summaries, they should present their findings to the class. They could use PowerPoint, Excel, or other creative presentation formats. At appropriate times during the presentations, lead discussions to help the rest of the class process the information and compare the benefits and the drawbacks of each type of resource. Ask questions such as:

What are the potential impacts of the different types of energy?

What are the benefits of each?

What are the drawbacks of each?

Are there any environmental impacts from the different types of energy?

Are there economic impacts from the different types of energy?

What sort of social issues impact the use of alternative sources of energy?

What is the greatest factor that has kept alternative energy sources from being universally accepted/adopted?

Students take notes on each energy source which they will later use in an assessment.

Assessment:

Students keep notes of each presentation. They must rank in numerical order the type of energy that would be most beneficial to our local area. They must justify the ranking of each.

Exploring Alternative Energy Sources: Research Guide

Name: _____

Research Partner: _____

In this lesson, you will investigate various alternative energy sources.

You will be placed into a group of two to research one of the following energy sources, as assigned: Solar; Wind; Geothermal; Biomass; or Hydropower. As a team:

- You will write a one-page summary of the energy source
- Prepare a short presentation for the class.
- The first part of your project involves researching as much factual information as you can about your assigned topic. Be sure to collect facts along with charts and graphs that contain relevant data, photographs, diagrams, flowcharts, and any other interesting information you can gather about your topic.

- As part of your project and presentation, you will need to create a type of multimedia display that you will use to teach your classmates about the alternate energy form/renewable resource you have studied.
- Projects need to be high quality with attention to detail, accurate spelling, grammar, punctuation, etc.
- Accuracy counts, so be sure to thoroughly research the facts and practice what you will say in your presentation ahead of time.

Exploring Alternative Energy Sources: Research Guide

Name: _____

During the presentation you must take notes on the details of each energy source. You will later use these notes to help write an energy use ranking paper.

1. Name of product or energy source.
2. Name of a natural resource used in the product.
3. Is this a renewable or nonrenewable resource?
4. Where does this resource come from (location or country?)
5. How is the energy gathered and/or created?
6. How is the energy stored for later use?
7. What are the waste by-products of this form of resource/energy?
8. Currently, what is keeping this form of energy from widespread use?
9. Who primarily uses this type of energy?
10. What is the cost of using this type of energy?
11. What are the potential impacts of the use of this type of energy?
12. What are the benefits of this type of energy?
13. What are the drawbacks of this type of energy?
14. Are there any environmental impacts from this type of energy?
15. Are there economic impacts from this type of energy?
16. What sort of social issues impact from the use of from this type of energy?
17. What is the greatest factor that has kept this type of alternative energy sources from being universally accepted/adopted?

Assessment:

Exploring Alternative Energy Sources: Assessment

Name: _____

Using the notes from each of the presentations. You must rank in numerical order the type of energy that would be most beneficial to our local area. You must justify the ranking of each energy source. This paper will be approx.2-3 pages long. You will also

Day 2: Student will conduct research on their assigned energy resources.

Day 3: Student will prepare their power point presentation.

Day 4: Students will present their power point to the class. They will then be assigned their assessment project, which is to rank order and justify each energy source as to whether it would be a viable source

in our community. Assignment/Assessment will be collected and graded. Correct information and justification will be the grade emphasis.

Day 5: Students will read 3 articles on ethanol fuel and its production and impacts (Food vs. Fuel: Diversion of Crops Could Cause More Hunger) (Ethanol: Myths and Realities) (Panel Sees Problems in Ethanol Production).

They will then hold a class discussion on the topic.

As a final assignment students will write a one page opinion on the choice of ethanol as a fuel.

Reading Handouts for Unit

Ethanol could save state's economy

http://www.statenews.com/index.php/article/2007/02/ethanol_could_save_state039s

America's gluttonous appetite for oil is not new. For the seventh time, President Bush mentioned the importance of energy independence in his State of the Union address last month. Bush also expressed the need for the United States to invest in the production of ethanol. Now, Michigan finds itself at an important crossroad. With a forlorn manufacturing-based economy, Michigan clearly needs to start restructuring its economy for the future. The question begs itself to be asked: Is this corn-based fuel the yellow brick road Michigan so desperately needs? We think it is. Michigan's unique resources make it the ideal state to lead the way in ethanol production and innovation. We have two quite necessary ingredients — lots of corn and lots of water. If we want to be pioneers in the field of alternative fuels, there's no time to waste sitting around hoping for the perfect emissions-free, super efficient fuel to fall into our laps. At this point, ethanol is one of the most promising alternative fuels, and the state needs to embrace it. Ethanol is produced less expensively and more efficiently than standard gasoline. Opponents to ethanol production worry about the excessive use of water required. A plant that was proposed in Ithaca would need about 1,200 gallons of water each minute. That would add up to 630 million gallons a year. However, ethanol production uses 10 times less water than gasoline on a gallon-to-gallon basis, according to MSU chemical engineering Professor Bruce Dale. And Alex Sagady, an East Lansing environmental consultant, said most of the water would be treated and reused. Dale also notes that the energy gained from one barrel of oil can create 20 barrels of ethanol. The need to relinquish our addiction to Middle Eastern oil is far too great. As the threat of terrorism becomes more and more real, we continue to funnel money to an area that is becoming more hostile toward American interests and a breeding ground for many terrorist sects. Shopping for fuel in America's heartland rather than the war-torn Middle East would do a lot to strengthen and stabilize our economy. With ethanol, the natural gas needed for its production comes from our friendly neighbors Mexico and Canada. As China and India expand at their current lightning pace, the demand for fuel skyrockets as we attempt to keep up. Those who triumph in tomorrow's economy will be the ones who develop cheaper, more efficient forms of energy today. If Michigan takes an active role in ethanol production and research, it will claim a lucrative spot in the new economy.

Published on Tuesday, February 13, 2007

Ethanol: Myths and Realities

Ten questions -- and answers -- about the fuel that's supposed to save the economy

With high gas prices making alternative fuels increasingly attractive, no alternative fuel has received as much attention as ethanol. Some hail the fuel, which can be derived from plants including corn, wheat, barley and sugarcane, as a savior of American energy policy, while others see it as a fad popularized by its heavily subsidized corporate backers.

The reality is complex. Though still a tiny industry compared to gas, ethanol could become a more prominent part of the U.S. and world fuel supply in coming years.

Still, as ethanol's public profile rises, there's plenty of misinformation swirling around and a host of questions. What exactly is ethanol? How is it made and used? And is it really a viable alternative to gas? Here's what you need to know now.

What exactly is ethanol?

The fuel is derived from plants through a fairly straightforward process. In one common method Corn, is first ground into a fine powder, mixed with water, and then heated. An enzyme is then added to convert the mixture into sugars before yeast is added to ferment it. The resulting liquid, called "beer," is about 10% alcohol. A distillation process then separates the alcohol from the rest of the mixture before the remaining water is removed. The result is essentially pure alcohol. A small amount of gas is added to render the liquid undrinkable. Then the fuel can be used by itself or as a supplement to gasoline to power cars.

Ethanol has three advantages, at least in theory: It's renewable, it can be domestically produced, and it burns cleaner than gas. The world's largest producers of ethanol are the U.S., which makes it primarily from corn, and Brazil, which mashes the stuff out of sugarcane.

Beyond high gas prices, why is everyone talking about ethanol?

It's becoming an increasingly important part of the fuel supply, and has the potential to become still more crucial. President George W. Bush and members of Congress have expressed support for ethanol use. And this spring, refiners in parts of Texas and the Northeast have been replacing a gasoline additive called MTBE (for methyl tertiary-butyl ether) with ethanol. MTBE, a chemical used to oxygenate fuel, can contaminate drinking water. And Ethanol which does not present the same danger, can serve the same purpose in fuel.

That's not all. The 2005 energy bill requires that the U.S. boost its ethanol production to 7.5 billion gallons by 2012, up from about 4 billion in 2005. This sounds like a whole lot of ethanol, but bear in mind, last year the U.S. slurped up almost 140 billion gallons of gas.

Are there any problems with ethanol?

Oh, yes. Ethanol can't travel in pipelines along with gasoline, because it picks up excess water and impurities. As a result, ethanol needs to be transported by trucks, trains, or barges, which is more expensive and complicated than sending it down a pipeline. As refiners switched to ethanol this spring, the change in transport needs has likely contributed to the rise in gas prices. Some experts argue that the U. S. doesn't have adequate infrastructure for wide ethanol use.

Also, ethanol contains less energy than gas. That means drivers have to make more frequent trips to the pump.

Doesn't producing ethanol on a large scale use a great deal of energy?

Yes. Some ethanol skeptics have even argued that the process involved in growing grain and then transforming it into ethanol requires more energy from fossil fuels than ethanol generates. In other words, they say the whole

movement is a farce.

There's no absolute consensus in the scientific community, but that argument is losing strength. Michael Wang, a scientist at the Energy Dept.-funded Argonne National Laboratory for Transportation Research, says "The energy used for each unit of ethanol produced has been reduced by about half [since 1980]." Now, Wang says, the delivery of 1 million British thermal units (BTUs) of ethanol uses 0.74 million BTUs of fossil fuels. (That does not include the solar energy -- the sun shining -- used in growing corn.) By contrast, he finds that the delivery of 1 million BTUs of gasoline requires 1.23 million BTU of fossil fuels.

Producing ethanol could get more efficient soon as new technologies help farmers get more corn per acre of land and allow ethanol producers to get more of the fuel from the same amount of corn. The companies developing new corn technologies include chemical giant Dupont ([DD](#)) and Monsanto ([MON](#)), which sells genetically modified seeds as well as chemicals for protecting crops.

So where can I find ethanol?

There's a good chance you're using it already. It's mixed into gas in many regions of the country including the corn-belt Midwest, and states like California and New York which had already banned MTBE. The regions making the transition this spring are the Northeast and parts of Texas.

Cars in the U.S. can normally drive on E10, a mixture of 10% ethanol and 90% gasoline, that is sometimes called gasohol. It's how Americans usually take their ethanol. Relatively few cars available here are "flex-fuel," meaning that they can run on much higher concentrations of ethanol. The fuel E85, which is 85% ethanol, is sold at some gas stations concentrated in the Midwest.

Is ethanol cheaper than gas?

Surprise, surprise, it isn't. The move this spring by more regions to use ethanol means that demand has spiked, driving up prices. On Monday, the New York harbor price was around \$3 per gallon compared with about \$2.28 for gasoline (before being mixed with ethanol). In other words, for now ethanol is helping to increase prices at the pump, not to push them down.

So ethanol production and distribution are also controlled by market forces, right?

Only to a certain degree. In addition to heavily subsidizing the ethanol produced domestically, the U.S. government levies a 54 cent per gallon tariff on imports from other countries, such as Brazil, a lower-cost producer. This, of course, discourages the U.S. from importing cheaper ethanol.

Why not eliminate the tariffs?

Well, the idea behind the tariffs is to foster domestic production of ethanol. But amid the ongoing furor over high gas prices the idea of repealing the levy has gained momentum in Washington. Though it would probably annoy ethanol producers like agricultural giant Archer Daniels Midland ([ADM](#)), removing the tariffs could have some benefits. It would help ease price pressures and would likely encourage Brazil to boost its ethanol production. However, it's probably not a short-term solution.

Brazil is undergoing an ethanol revolution far more drastic than that in the U.S. Flex-fuel cars which can run solely on ethanol are widely available and the ethanol supply is short enough that the government recently reduced the mandatory ethanol content in gasoline from 25% to 20%.

"Brazil is the model" for how ethanol can be brought into use, wrote Citigroup ([C](#)) analyst P. J. Juvekar in a recent report. But while buying ethanol from Brazil could be useful in the future, it's not going to reduce the pain of a road trip this summer.

What companies stand to benefit from increased ethanol use?

There is a crop of American ethanol producers. ADM is by far the largest, pumping out about one-quarter of the U.S. total. MGP Ingredients ([MGPI](#)) is one of the many smaller companies involved. Verasun Energy and Aventine Renewable Energy, two other producers of note, have recently filed to go public.

What can we expect to change in the future?

At present commercial corn-based ethanol comes from corn kernels. One of the more exciting ethanol prospects on the horizon is cellulosic ethanol, which can be made from a number of plant by-products, including cornstalks. Although it's unlikely to be commercially available for at least a few years, cellulosic ethanol eventually could help substantially reduce costs. In other words, your car in the future could run on the refuse of farms across the U.S.

Panel Sees Problems in Ethanol Production

<http://www.nytimes.com/2007/10/11/science/11water.html>

By CORNELIA DEAN

Published: October 11, 2007

Greater cultivation of crops to produce ethanol could harm water quality and leave some regions of the country with water shortages, a panel of experts is reporting. And corn, the most widely grown fuel crop in the United States, might cause more damage per unit of energy than other plants, especially switchgrass and native grasses, the panel said.

The panel, convened by the [National Research Council](#), said improved agricultural practices, water recycling and other steps might reduce possible problems. But it added that “fundamental knowledge gaps” made it difficult to predict what would happen as the nation’s embrace of biofuel crops expanded. Meanwhile, it said, it would be “prudent” to encourage the use of ethanol sources other than corn.

Production of ethanol from corn kernels is on the rise, the panel said, adding that President Bush has called for the annual production of 35 billion gallons of ethanol by 2017, an amount that would account for about 15 percent of liquid transportation fuels in the United States.

But increased production could greatly increase pressure on water supplies for drinking, industry, hydropower, fish habitat and recreation, the report said. Facilities that turn plants like corn into liquid fuel would add to the pressure on water supplies, though these bio-refineries are relatively modest water consumers compared with agriculture, the panel said.

The research council, an arm of the [National Academy of Sciences](#), issued the report yesterday. It is available at the academy’s Web site, nas.edu. It was financed by the [National Science Foundation](#), the [Environmental Protection Agency](#) and other agencies and foundations.

The report noted that additional use of fertilizers and pesticides could pollute water supplies and contribute to the overgrowth of aquatic plant life that produces “dead zones” like those in the Chesapeake Bay, the Gulf of Mexico and elsewhere.

Online Resources

“High Gas Prices Could Mean Cold Classrooms and Cancelled Trips”

http://www.pbs.org/newshour/extra/features/july-dec05/gascosts_11-21.html

“Can a New Light Bulb Save the Environment?”

http://www.pbs.org/newshour/extra/features/jan-june05/led_6-13.html

Power and Deregulation

<http://www.pbs.org/newshour/bb/infrastructure/power/#>

Blowin’ in the Wind: Wind Power

<http://www.pbs.org/newshour/bb/environment/jan-june01/blowing.html>

Light Bulb Technology

http://www.pbs.org/newshour/bb/science/july-dec05/bulb_11-10.html

The Future of Fuel

<http://www.pbs.org/newshour/science/hydrogen/index.html>

Eco-Friendly Buildings

http://www.pbs.org/newshour/bb/environment/jan-june05/building_4-15.html

The Earth Debate: Energy

<http://www.pbs.org/now/science/unenergy.html>

American Energy Sources

<http://www.pbs.org/newshour/bb/infrastructure/power/#>

U.S. Department of Energy

http://www.energy.gov/engine/content.do?BT_CODE=DOEHOME