Alternate Energy, Biofuels, and Biomass

Lesson created by: UTeach Outreach
Date of Lesson:
Description of the class: 5th-6th grade
Length of lesson: 35-45 minutes
Resources: UTeach Outreach

http://www.going-green-challenge.com/definition-of-renewable-energy.html

https://attra.ncat.org/attra-pub/viewhtml.php?id=312

http://www.eia.gov/cneaf/electricity/epm/table1_1.html

http://www.botany.utexas.edu/mbrown/

http://www.learnaboutenergy.org/renewable_energy/RenewableEnergy3.htm

http://science20.com/absentminded_professor/peak_uncertainty_when_will_we_run_out_fossil_fuels-70294

http://www.discoveringfossils.co.uk/fossilfuels.htm

http://fossil.energy.gov/education/energylessons/coal/gen)howformed.html

http://inventors.about.com/library/weekly/aacarsgasa.htm

http://library.thinkquest.org/17531/engdiag.jpg

I. TEKS Addressed:

(6.2) Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and field investigations. The student is expected to:

(B) design and implement experimental investigations by making observations, asking well-defined questions, formulating testable hypotheses, and using appropriate equipment and technology

(6.3) Scientific investigation and reasoning. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to:

(A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student

(6.9) Force, motion, and energy. The student knows that the Law of Conservation of Energy states that energy can neither be created nor destroyed, it just changes form. The student is expected to:

(C) demonstrate energy transformations such as energy in a flashlight battery changed from chemical energy to electrical energy to light energy

(6.7) Matter and energy. The student know that some of Earth's energy resources are available on a nearly perpetual basis, while other can be renewed over a relatively short period of time. Some energy resources, once depleted, are essentially nonrenewable. The student is expected to:

(A) research and debate the advantages and disadvantages of using coal, oil, natural gas, nuclear power, biomass, wind, hydropower, geothermal, and solar resources

(B) design a logical plan to manage energy resources in the home, school, or community

II. Overview:

The purpose of this lesson is to introduce students to the idea of energy transfer and the idea of biologically based fuel. Students will explore the different types of renewable energy, with an emphasis on energy from biomass. Students will discover what types of crops would be ideal candidates for biomass fuel. A discussion will explore the advantages and disadvantages of different types of renewable energy, as well as cover the energy transformations that occur.

III. Objectives:

1. Students will explore the different types of crops available for use as biofuel and identify what characteristics make them strong candidates for biofuel
2. Students will discuss the concept of energy transfer and how scientists are thinking of new and inventive ways of harvesting different forms of energy
3. Students will collect data, construct tables, and perform calculations to analyze and form conclusions

IV. Resources, Materials and Supplies:

Per group of 4 students:

- Large fragment of a coconut
- Corn cut off the cob
- soybean
- sturdy spoon (to scoop out coconut)
- triple beam balance
- a few sheets of paper towels
- calculator

Per class:

- clear container
- cup of dirt
- cup of oil

V. Advanced Preparation:

- Separating the corn from the cog can get messy, especially if the groups do it themselves. Before the lesson, have the corn already separated from the cob.
- Separate the coconut. First, drain the water from the coconut by drilling a hole in the husk. Then, wrap it in a plastic bag and either drop it on the ground or hit it with a sturdy object. Since the students are mainly looking for percentages, it is not necessary for each group to have the exact same sample size of coconut. If preparing coconuts a day or more in advance, be sure to refrigerate.

- Pour the oil and dirt into the container ahead of time, with the oil at the bottom. Do not move it rapidly, as the oil and dirt may mix.

VI. Supplemental Worksheets, Materials and Handouts:

Per student

- Biomass data worksheet
- Energy transformations worksheet
- Advantages/disadvantages worksheet

Per class (for doc cam)

- Biomass energy figure
- Efficiencies chart

VII. Background Information:

College Level

In 2006, about 80% of primary energy worldwide came from fossil fuels such as coal, oil, and natural gas. The burning of these fuels, especially coal, produces large amounts of carbon dioxide which, if released into the atmosphere, can lead to global warming via the greenhouse effect.

A growing concern about fossil fuels is the fact that they are nonrenewable resources. Fossil fuels are hydrocarbons such as coal, oil, and natural gas that formed from the organic remains of prehistoric plants and animals. The formation of oil and gas began approximately 300 million years ago. Prehistoric life form decomposed and accumulated on the seafloor. These organic remains were subject to unique conditions where there was no oxygen to break the remains down, nor were there any other life forms to feed on the remains. As sediment accumulated and the pile grew deeper, the organic material was subjected to heat and pressure, leading to the formation of oil and gas. This geological process occurs over millions of years, rendering it impossible to recreate to generate more fossil fuels. According to recent statistics, the earth's oil supply may be depleted within the next 100 years.

With the ongoing depletion of oil and concerns about harmful emission growing, research about alternate energies has grown considerably over the past decades. Though many processes have implemented alternate energy, little advancement has been made in widespread alternate energies for motor vehicles. In 2010, renewable energy accounted for approximately 11% of the energy produced in the U.S. while less than 5% of motor vehicles run on renewable energy.

Internal combustion engines have existed since before Henry Ford's Model T was invented. Dating back to 1680, most designs have run on fossil fuels, and continue to do so to this day. However, some of the original engines were intended to run on other fuels. The first internal combustion-powered automobile design, created by Swiss inventor Francois Isaac de Rivaz in 1807, used an engine that ran on hydrogen and oxygen, essentially an early fuel cell. In the late 1800s, Rudolf Diesel patented and showcased the first diesel engine. Unlike today's diesel engines, the original ran on peanut oil, showing Diesel's belief that biomass fuel was the real fuel of the future. Eventually, the engines were altered to accommodate the lower viscosity of fossil fuel. Today, research is turning back to Diesel's original intentions and finding ways to encourage the widespread use of biofuels.

Elementary Level

Energy comes in many different forms and is necessary for everyday life. One common energy source you may be familiar with is fossil fuels. Fossil fuel is a nonrenewable source of energy, which means it cannot be made again in a short period of time. Fossil fuels take many years to form so if we run out, we won't be able to produce more.

Since energy is so important, scientists have been hard at work researching alternative energy sources that are renewable such as sunlight, wind, water, and biofuels. These are readily available resources that won't run out and cause less pollution than burning fossil fuels.

Research of renewable resources is still underway to improve and minimize the limitation of each source. One major factor of renewable resources is cost. In the past, renewable resources weren't very cost-efficient and a lot of research was still needed. Since research has progressed, the cost of fossil fuels has increased and renewable resource apparatuses are more abundant.

VIII. Possible Misconceptions

- Alternate energy and renewable energy are the same thing—Renewable energy is a type of alternate energy. For example, nuclear energy is an alternate energy because it can serve as an alternative to fossil fuels. However, it is not a renewable energy because it is generated from uranium, a non-renewable resource.
- Any type of energy that is clean and environmentally friendly is a renewable energy—Though clean and environmentally friendly may be common attributes of renewable energy, they do not define it. The key word is *renewable*. Nuclear energy is clean and environmentally friendly, but cannot be considered renewable.
- Solar, wind, and biomass energy are the three most common forms of renewable energy—Hydropower is the largest source of renewable energy, producing 10% of electricity in the U.S. Hydropower is the process of converting flowing water into usable energy. One famous example of a hydropower power plant is Hoover Dam, providing electricity for many cities in California, Nevada, and Arizona.

IX. Vocabulary and Definitions

College Level

Biofuel—fuel whose energy is derived from biological carbon fixation. It is produced from renewable biological resources such as biomass.

Biomass—the total mass of living matter within a given environmental area

Chemical energy—is stored in the bonds of atoms and molecules

Electrical energy—energy made available by the flow of electric charge through a conductor

Mechanical energy—the energy that is possessed by an object due to its motion (kinetic energy) or due to its position (potential energy)

Renewable energy—an energy resource that is replaced rapidly by natural processes

Elementary Level

Biofuel—fuel made from organic matter, such as biomass

Biomass—organic matter that makes up plants and trees

Chemical energy—energy that is a result of chemicals reacting to each other

Edible—can be eaten

Electrical energy—energy made available by the flow of electricity

Finite—limited

Inedible—cannot be eaten; antonym for *edible*

Mechanical energy—the energy in an object due to its motion (kinetic energy) or due to its position (potential energy)

Renewable energy—energy generated from natural resources that is infinite or constantly renewed

X. Safety Considerations
Students may not taste or eat any of the biomass crops

XI. Question of the Lesson

Which crop has the most biomass that can be used for renewable energy?

Engagement		Time: 3-5 min
What the Teacher Will Do	Probing Questions	Expected Student Responses Potential Misconceptions
Today we are going to talk about the prospects of biofuels and how they'll be important in the future.		
Show the bottle of oil mixed with dirt. The oil should be near the bottom of the container and should not saturate the soil.	Do you recognize what is in this bottle?	Oil and dirt
	What might this bottle represent?	Oil underground
That's right! The bottle itself is a model of the earth. But there's only so much oil in the container.	Why are alternate energy sources so important?	You need to search for oil in harder to reach places. We need other sources of energy
We have a finite amount of crude oil in the earth's crust.	What do you think 'finite' means?	Limited or not a lot. (does it mean the same thing as 'infinite'?)
Great! Finite means limited On the board write Finite=limited		
Today we are going to explore resources that are not finite like fossil fuels but are abundant, clean, and affordable.		

Exploration		Time: 15-20 min
What the Teacher Will Do	Probing Questions	Expected Student Responses Potential Misconceptions
	What is renewable energy?	Energy that can be made

Renewable describes something that can be made again. That would make renewable energy something that can be made from resources that are always available or can be grown back very fast. Write on board: Renewable energy=energy made form natural resources that is infinite or constantly renewed	What type of resources can be considered ‘renewable’?	again Natural resources that grow fast like plants, or are always available like wind or sunlight
Those are some great examples of renewable resources! Today, we are going to focus on biomass. Biomass is plant materials that can be used as a source of energy. Write on board: Biomass= plant materials *When we say biomass, we must identify the edible and inedible parts of the plant. Edible parts of those that can be eaten.* Write on the board: Edible= can be eaten	If inedible is what you can eat, then what does ‘inedible’ mean?	Parts that can’t be eaten
Correct. The inedible parts are those that can’t be eaten. Write on board: Inedible= cannot be eaten *Though we usually only care for the edible parts, those aren’t the only important parts! Most of us throw away the inedible parts, but these are the best parts for biomass.* Write on board under inedible definition: Best for biomass	What are some examples of crops with both edible and inedible parts?	Corn, bananas, oranges, nuts, cherries, etc.
Those are great examples. The three		

crops that we are going to work with today are crops that are commonly used for biomass: corn, coconuts, and soybeans. *Now we are going to see how we are going to answer the question of the day: Which crop has the most biomass that can be used for renewable energy?* Post question on doc cam *Our job today is to figure out which of these three crops would be the best to use for renewable energy. The more biomass, the better.*	What parts of a coconut are edible? Inedible?	The white part/the husk
	How can we find which crop would have the most biomass?	Inedible parts are best for biomass, so we should measure the inedible parts of each crop to see which has the most
We need to measure the mass of the edible and inedible parts of each of the crops.	What units do we use to measure mass? What abbreviation to we use?	Grams (misconception: pounds). Abbreviated 'g' (misconception: 'G').
	What can we use to measure mass?	A triple beam balance or a scale
We will be using a triple beam balance today to measure mass. Remember: the abbreviation for grams is always a little 'g'. *Each pair will receive corn (it is already cut off the cob to prevent messes), part of a coconut, a soybean, a spoon, and a triple beam balance. With your group, measure the mass of the edible and inedible parts of each of your crops. Record these results on your worksheet and remember that you may not eat any of the supplies.*		

Allow groups to fill out top half of worksheet; circulate to answer questions and help.		

Explanation		Time: 10-15 min
What the Teacher Will Do	Probing Questions	Expected Student Responses Potential Misconceptions
If there are two teachers, one can start picking up extra supplies while the other teaches. *Now we can look at the percentage of what we can use for 'biomass' fuel. Follow along on your worksheet as we calculate the percentage of the corn on the cob that is edible.* Walk students through the first calculation; write it on the board as you talk them through it. *We first have to add the mass of the edible and inedible parts to get the total mass of the corn. Next, we divide the mass of the edible part by the total mass. We have to multiply this by 100 to get the percentage.* *Now complete the rest of the chart. Raise your hand if your group gets stuck.* *Right, plants get their energy from the sun.* *Through this process, the plants turn*	Did any of your crops have a higher percentage of inedible than edible parts? Which of the crops would be best for biomass and why? Where do crops like corn get their energy? What happens during photosynthesis?	Corn Corn— more inedible than edible parts The sun The plant turns energy from the sun into food

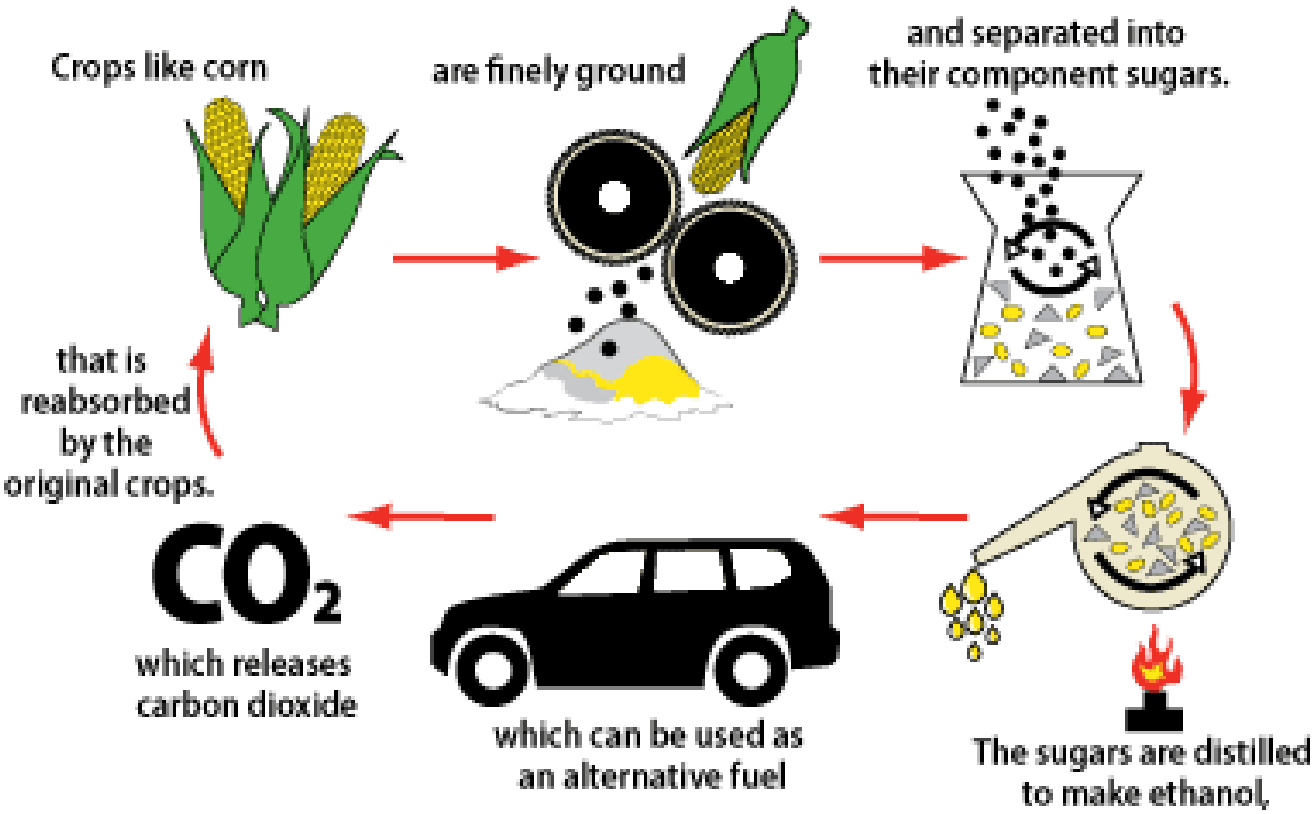
Explanation		Time: 10-15 min
What the Teacher Will Do	Probing Questions	Expected Student Responses Potential Misconceptions
this energy from the sun, called solar energy, into something called chemical energy. Turn to your energy diagrams and fill in the chart under 'biomass'. Post figure of corn/biofuel cycle on doc cam *That happens is crops like corn are finely ground and then separated in their component sugars. These sugars are then distilled to make ethanol. To distill the corn the component sugar parts can be further separated through boiling. These can then be used as alternate fuel.* Post efficiencies chart on doc cam *Now, let's take a look at this chart that shows how much it costs to run each car for 100 miles. Which ones are the most expensive? Which are the least expensive?*		Gas/ electric and solar

Elaboration		Time: 5 min
What the Teacher Will Do	Probing Questions	Potential Misconceptions

Those are great examples! Let's take a closer look at one we use very often: cars. *Look at your energy transformation worksheet.*	What are some other energy sources? What type of energy do you start out with in car engines?	Wind, solar, nuclear, hydrogen, etc. Chemical energy
The engines have gasoline in them, so they start out as having chemical energy. *The chemical energy inside the engine is transformed into mechanical energy to run the car.*	What does that energy turn into when you turn on the car and parts of the engine start moving?	It turns into mechanical energy
Another type of energy source we mentioned was solar energy. Let's take a closer look at that one. *Yes, that's definitely where the energy is coming from. The actual source in the circuit is called a solar cell. The light from the sun hits the panel, where it is stored in the cell.*	What would our source be with solar energy?	The sun
	What type of energy does a solar cell start out with? If we want the energy to transfer to a light bulb, what would the new type of energy be?	Light energy Heat and light energy
Not only will the light bulb light up, but it will also release some heat as well. Make sure everyone has filled in their Energy Transformation worksheet		

Evaluation	Time: 3-7 min

What the Teacher Will Do	Probing Questions	Expected Student Responses
Let's review what we've learned. (This section can be abridged if the class is running short on time)	What are some characteristics of biomass? What are some things in your house you can think of that convert electrical energy to another form of energy? What are some changes you can make in your home, school, or community to become more energy efficient?	It is made from plant materials, inedible parts work best, it is renewable Radio, microwave, television, etc. Recycle, turn off lights, unplug things that aren't in use, etc.



Cost per 100 miles

Gas (avg car)	$	21.43
Electric car	$	3.00
Hydrogen Fuel Cell	$	12.85
Solar	$	4.00

Name:________________________________ Date:_________________________

Biomass Data Worksheet

Question:

Of your three crops, which one would be the best to use for renewable energy?

Hypothesis (write a complete sentence):

____

____

Record:

Crop	Edible	Inedible (biomass)	Total (edible + inedible)
Corn			
Soybean			
Coconut			

$$\textit{Percentage} = \left(\frac{Mass\ of\ edible\ or\ inedible\ part}{Total\ mass\ of\ crop}\right) x\ 100$$

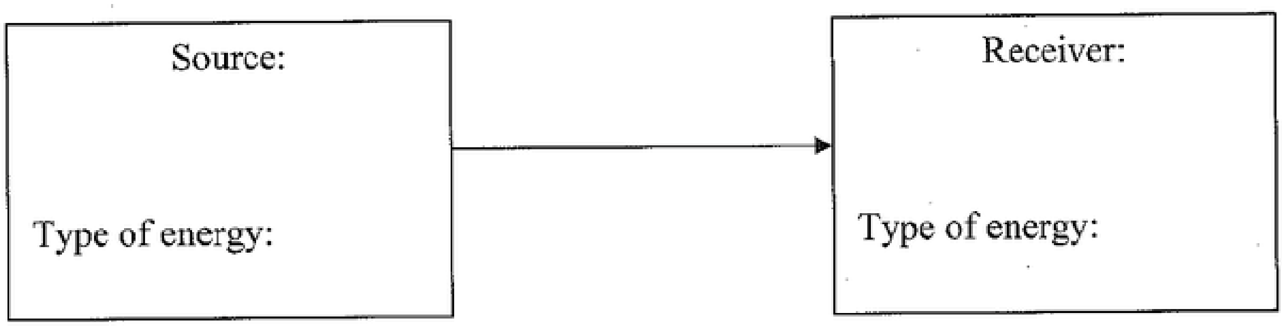
Crop	Edible %	Inedible (biomass) %
Corn		
Soybean		
Coconut		

Name:___________________________

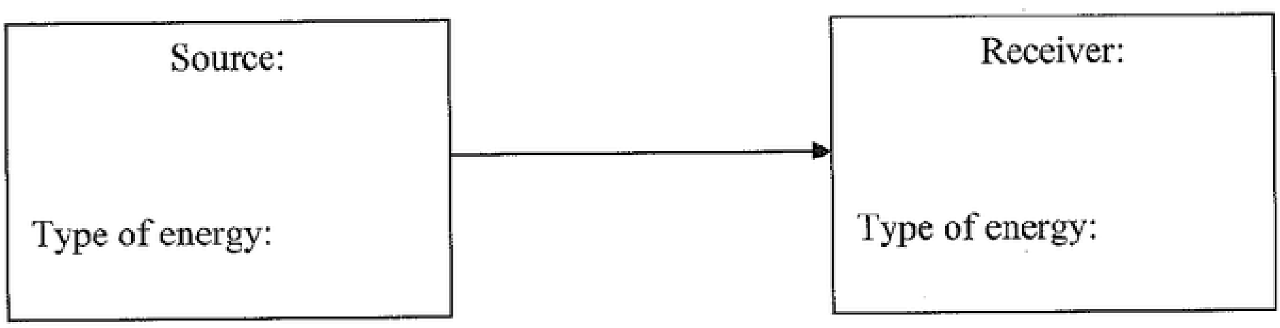
Energy Transformation

Instructions: Fill in the following energy diagrams. Be sure to label source, receiver, and type(s) of energy.

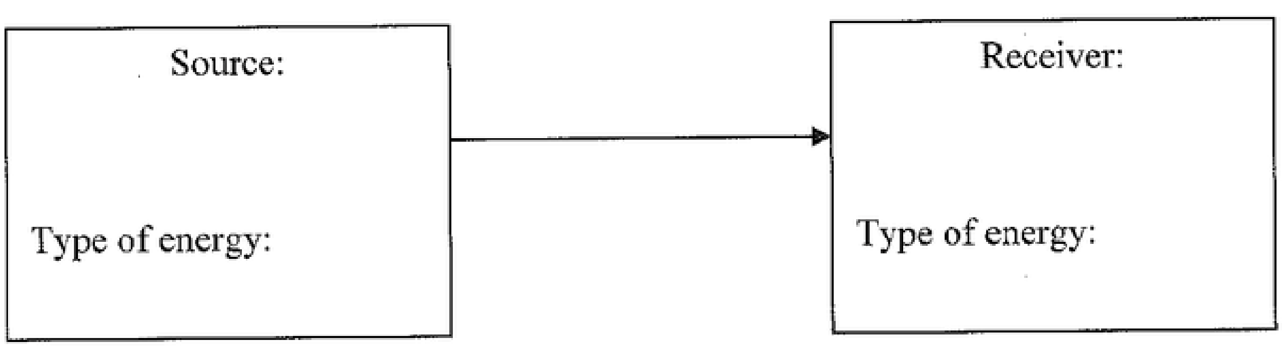
Biomass



Car Engine



Solar to Light Bulb



Question of the Day:

Which crop has the most biomass that can be used for renewable energy?