GLOSSARY:

Biochemical conversion: The process of making biofuels by using enzymes of bacteria and other micro-organisms to break down biomass.

Biomass: Organic matter, especially plant matter, that can be converted to fuel and is therefore regarded as a potential energy source.

Bioreactor: A large fermentation chamber for growing bacteria or yeast under controlled conditions. Bioreactors are used in the biotechnological production of substances such as pharmaceuticals, antibodies, or vaccines, or for the bioconversion of organic waste.

Cellulose: Complex carbohydrate that is composed of glucose units, forms the main constituent of the cell wall in most plants, and is important in the manufacture of numerous products such as pharmaceuticals.

Enzymatic engineering: Process of modifying enzymes to produce new metabolites that are more efficient for fuel conversion.

Ethanol: A fuel made from organic matter (plant sugars) in a fermenting process.

Fuel Cell: A device that produces electricity by combining a fuel, usually hydrogen, with oxygen. In this reaction, electrons are freed from the hydrogen in the fuel cell by a catalyst, and gain energy from the chemical reaction binding hydrogen and oxygen; this provides a source for electric current. The exhaust of hydrogen fuel cells consists of only water. Fuel cells are currently used in spacecraft and increasingly in ground transportation.

Lignin: A complex polymer occurring in certain plant cell walls making the plant rigid.

Thermochemical conversion: Process in which heat is the dominant mechanism to convert biomass into another chemical form.

Triglycerides: A class of organic compounds that are esters consisting of three fatty acids joined to glycerol. The fatty acids may be the same or may be different. Triglycerides are the chief lipids constituting fats and oils and function to store chemical energy in plants and animals.

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Show Me Science Advanced

Energy - Biofuels Use on the Rise

K4579DVD

***Advanced* Teachers Guide**

SYNOPSIS:

Biofuels are renewable energy sources from organic materials such as plants or animals that are directly converted into liquid fuels. The two most common biofuels in use today are ethanol and biodiesel. Biofuels are often made from starches, sugars, cellulose and algae. Algae as a bio-fuel has become more common because it is easy to harvest and these single celled photosynthetic organisms are known for their rapid growth and high energy content.

CURRICULUM UNITS:

- Ecology
- Engineering
- Environmental science
- Physical science
- Physics

CAREER OPPORTUNITIES:

- Biologist
- Chemist
- Civil engineer
- Engineer
- Environmental engineer

PROGRAM OVERVIEW:

To keep up with our increasing demands for energy and fuel, scientists are constantly working to increase the reliability and performance of renewable energy technology. A small percentage of renewable energy is created with bio-fuels. Most common are ethanol and bio-diesel. Ethanol is made from fermenting biomass, such as grasses, wood chips, poplar trees and select agricultural waste. Fermentation is the breakdown of sugar resulting in alcohol and carbon dioxide. This is the same process that yeasts and bacteria perform in making bread, beer, wine, and some cultured foods.

A U.S. Department of Energy study predicted that these resources can produce enough ethanol to offset 30% of U.S. gasoline consumption by 2030. However, increased ethanol production comes with some complications. Some argue that food crop feed-stocks for bio-fuels may be problematic because when fuel prices rise, so do food prices as a result of the increased cost in production and transportation. If food and energy are in competition for land, food prices may have a similar effect on energy prices. Also, food surplus programs for countries with food short ages could see less donations as food surpluses might be used for biofuels instead. For these reasons, research has gained momentum regarding nonfood fuels such as poplar trees and algae.

Microscopic algae, or micro-algae, is emerging as a viable source in the production of liquid transportation bio-fuels. Micro-algae are single-cell, photosynthetic organisms known for their rapid growth and high energy content. Using the sun's energy, these microorganisms combine carbon dioxide with water, creating biomass more efficiently and rapidly than terrestrial plants. Oil-rich micro-algae strains are capable of producing the feedstock for a number of transportation fuels—biodiesel, "green" diesel, gasoline, and jet fuel, while mitigating the effects of carbon dioxide released from sources such as power plants.

This program investigates new technologies at facilities at Solazyme and Algenol and explains the processes behind their cutting edge micro-algae to fuel processes.

ISSUES & CRITICAL THINKING:

1. Nearly 100 years ago, Henry Ford proposed that ethanol become the primary fuel for automobile engines. However, it wasn't until the early 1970's that ethanol began to enter the U.S. fuel supply in quantity. Ask students why ethanol was not in the U.S. fuel supply until the 1970's.

Discuss with students what agricultural, political and technological changes need to happen for bio-fuels to become more prevalent today.

2. Have students research the process of cultivating algae for biofuels. Discuss difficulties such as lipid extraction and dewatering or other shocks that can kill an algal system.

3. Discuss pros and cons concerning the environment as a result of the manufacture and use of biofuels. Continue the discussion by researching the advantages and disadvantages of harvesting and burning fossil fuels, and in the production of nuclear fuel and the storage of its waste.

Compare and contrast with the environmental impact of producing an alternative energy technology.

4. Discuss non-food sources for ethanol, such as the use of switchgrass rather than corn.