



# Biofuel

## Plants and Garbage Used as Renewable Sources of Fuel



China Lake, CA (Naval Air Warfare Center Weapons Division) -- Scientists are using chemistry to develop eco-friendly biofuels made from the cellulose found in plants and garbage. Plant materials are renewable sources of energy created through photosynthesis. The new fuel, butanol, can be used to replace gasoline, diesel fuel or a jet fuel. It can also function at high-altitude and Arctic temperatures.

*"We need fuels that are going to be here for the 21st, 22nd, and 23rd centuries, which is why we need biofuels."*

**Benjamin Harvey, research chemist**

### Framework

Middle School

### Standards

- NSES - B.i.1 ➤ A substance has characteristic properties (its freezing point, for example).
- NSES - C.iv.3 ➤ Sunlight is the major source of energy (photosynthesis).
- STL - 5.E ➤ Technologies can be used to break down waste.
- STL - 15.G ➤ Specialized equipment is used to improve the production of fuel.
- STL - 19.I ➤ Chemical technologies modify chemical substances.

### Content Illustrated

- Carbon cycle and photosynthesis.



# Content



## Life Science

- ▶ Plants store energy during photosynthesis. They use light, water, and carbon dioxide to make glucose and oxygen.
- ▶ Carbon can be described and followed as going through a cycle.

## Physical Science

- ▶ Energy in fuel is released as carbon bonds in long-chain hydrocarbons are broken down.
- ▶ Cellulose is composed of thousands of glucose molecules tied together. It is the most abundant substance on the planet.
- ▶ Cellulose is contained in waste products, such as old newspapers and banana peels, which can be sourced for fuel.
- ▶ Cellulose is used to make butanol. Butanol is a liquid at cold temperatures, even in Arctic conditions. It freezes at  $-100^{\circ}\text{C}$ .

## Earth & Space Science

- ▶ Energy from the sun comes in packages of photons.

## Engineering

- ▶ Engineers use specialized equipment to convert cellulose to butanol. Butanol can be converted to gasoline, diesel or jet fuel, and can be used for high flying (and very cold) conditions.

## Guiding Questions

*To think about as you watch:*

- ▶ What is the carbon cycle?

## Suggested Activities

- ▶ Watch this webisode as an additional resource for *Engineering Now: Sunflowers or Proteins*.
- ▶ Explore temperature scales (SI & English). What is the freezing point of alcohol? Of antifreeze? Of gasoline?
- ▶ Research the byproducts and environmental impact of burning fossil fuels. Compare to biofuels.

## Keywords

biofuel  
butanol  
carbon  
cellulose  
hydrocarbons  
fossil fuels  
photon  
photosynthesis

- ▶ *Biofuel* can be found online at [www.ndep.us/Biofuel](http://www.ndep.us/Biofuel). Visit [www.ndep.us/LabTV](http://www.ndep.us/LabTV) for a list of process skills modeled in webisodes.