

Bioenergy Sources

This bioenergy education curriculum was created through Ohio's 4-H Cloverbud program and the Ohio BioProducts Innovation Center (OBIC) to inform and educate future consumers and supporters of bio-based energy and its products. The curriculum was developed with support from the Northeast Regional Sun Grant Initiative, with a grant from the U.S. Department of Transportation: US DOT Assistance #DTOS59-07-G-00052.

The material consists of three bioenergy curriculum pieces in the content areas of 1) bioenergy sources, 2) bioenergy conversion, and 3) bioproducts. Each curriculum piece contains about nine educational activities.

Ohio State University Extension's 4-H Cloverbud program is designed to meet the developmentally appropriate needs of children ages 5 to 8, or in kindergarten through the second grade. However, this curriculum is **recommended for youth through fifth grade**. The Cloverbud youth development program emphasizes overall well-being by empowering young children with successful learning and positive social interaction through cooperative learning in non-competitive environments.

OBJECTIVES

- Begins to understand what the word *bioenergy* means
- Discovers the role of bioenergy sources (such as corn, grass, and soybeans) in creating bioproducts (such as fuel, electricity, plastics, and insulation)
- Recognizes the importance of bioenergy for environmental sustainability (renewable energy that is safe for the environment)
- Identifies various bioenergy sources for making bioproducts

GROUP SIZE

6 to 8 children per adult volunteer

LIFE SKILL AREAS

- Expands social skills
- Develops learning-to-learn skills
- Enhances eye-hand coordination and fine motor skills
- Improves self-confidence

VOLUNTEER TIPS

- Complete the first "Getting Started" activity for introductory purposes, and then choose one of the activities from each section.
- Create a fun, engaging atmosphere using pictures and video clips related to the activities.
- The length of time given to complete each activity is an estimate. Set a relaxed pace while completing each activity, allowing time for creativity and experimentation.
- For each section, choose a balance of activities, including movement, sitting down, and problem solving so that children are engaged in a variety of learning settings.
- Encourage children to make predictions or hypotheses (educated guesses) about what will happen as they complete the activities.

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TIME FRAME

This lesson is designed for a group meeting between 30 and 60 minutes. Each activity takes 5 to 15 minutes to complete.

BACKGROUND

Bioenergy is a renewable source of energy that is produced from plants and animals. Unlike bioenergy, fossil fuels, such as crude oil and coal, are not renewable. Because they are created over thousands to millions of years, fossil fuels are limited.

Some forms of bioenergy have been around for a long time. Examples include burning wood to create heat, using biodiesel and ethanol to fuel vehicles, and using methane gas and wood to generate electricity. More recently, developed forms of bioenergy use materials called “biomass,” such as sugar cane, grasses, straw, soybeans, and corn. Biomass is any plant or animal matter that uses sunlight to store energy. Plants do this through photosynthesis. Animal waste, which is comprised mainly of plant material, is also biomass.

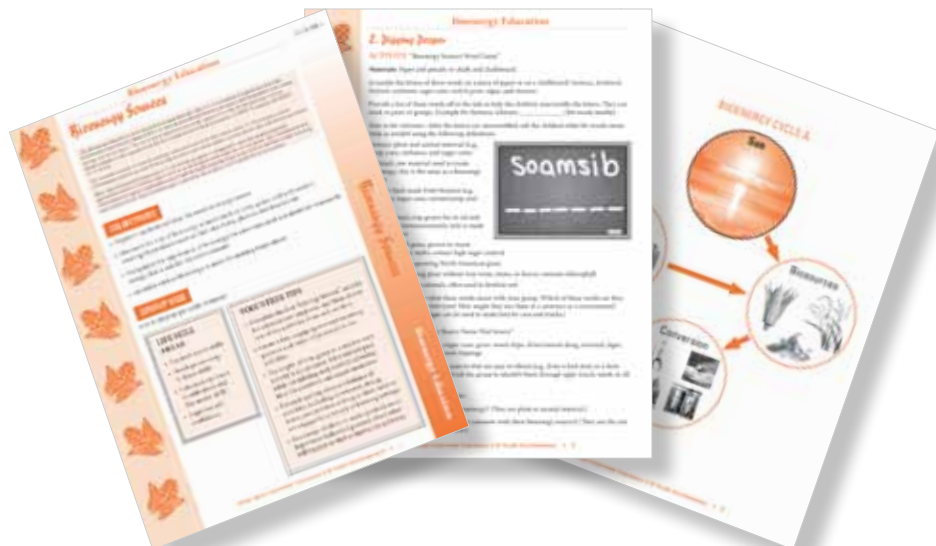
This curriculum helps children understand where bioenergy comes from (bioenergy sources), how bioenergy is changed (bioenergy conversion) into something more useable, and what the resulting products (bioproducts) are.

NATIONAL SCIENCE STANDARDS

- Characteristics of organisms and environments
- Understand scientific inquiry

SUCCESS INDICATORS

- Describes bioenergy
- Explains the relationship of biomass to bioenergy
- Appreciates environmental sustainability
- Recognizes existing and potential bioenergy sources



LEARNING ACTIVITIES

1. Getting Started

ACTIVITY “What Is Bioenergy?”

Materials: Paper and pencils or chalk and chalkboard.

Ask the children what words or phrases they see in the word *bioenergy*. Share with them that bioenergy is energy from plant and animal material. Explain that plants absorb energy from the sun, and that animals get their energy by eating plants or plant-eating animals. Share with the group that bioenergy is released from plant and animal material when the material is burned, and that biodiesel releases its energy when it is ignited (burned) to run automobile engines. Explain that wood releases its bioenergy when it is burned, and that it creates heat and light.

Review the following definitions with the group:

Bio means “life, living.” For example, plants and animals are *living* beings.

Energy means “power, work.” For example, energy *powers* cars and heats homes.

Ask the children to draw pictures of objects that would represent the words *bio* and *energy*. Then, share the pictures with the group.

Application: Questions to consider:

- Why do people need energy? [For driving cars and for using electricity for light, heat, air conditioning, computers, etc.]
- How would you define the word *bioenergy*? [Bioenergy is renewable energy from animals and plants to make electricity, heat, vehicle fuel, etc.]
- What do you know about bioenergy? [It can provide fuel for cars, using green energy.]
- What is important about bioenergy, especially in regards to meeting everyone’s energy needs in the future? [It needs to be renewable, environmentally friendly, affordable, and safe.]



ACTIVITY “Where Does Bioenergy Come From?”

Materials: The story titled *The Tale of Johnny Energy Seed* (available from the U.S. Department of Energy at <http://www.eia.gov/kids/resources/teachers/pdfs/TaleofJohnnyEnergySeed.pdf> or on page 9).

Read the story to the group. Ask the children if they know of any other similar short stories that they might like to share.

Application: The story highlights one example of how corn can be a source of bioenergy. What are other sources of bioenergy? [Some include soybeans, switchgrass, sugar cane, algae, and used vegetable oil.]

2. Digging Deeper

ACTIVITY “Bioenergy Sources Word Game”

Materials: Paper and pencils or chalk and chalkboard.

Scramble the letters of these words on a piece of paper or on a chalkboard: *biomass*, *feedstock*, *biofuels*, *soybeans*, *sugar cane*, *switch grass*, *algae*, and *manure*.

Provide a list of these words off to the side to help the children unscramble the letters. They can work in pairs or groups. Example for biomass: iobamss _____ (list words nearby).

Note to the volunteer: After the letters are unscrambled, ask the children what the words mean. Help as needed using the following definitions.

biomass: plant and animal material (e.g., poop, corn, soybeans, and sugar cane)

feedstock: raw material used to create bioenergy; this is the same as a bioenergy source

biofuels: fuels made from biomass (e.g., soybeans, sugar cane, animal poop, and grasses)

soybeans: bean crop grown for its oil and for food for humans/animals; tofu is made from soybeans

sugar cane: tall grass, grown in warm tropical regions; stalks contain high sugar content

switch grass: fast-growing North American grass

algae: water-growing plant without true roots, stems, or leaves; contains chlorophyll

manure: poop from animals, often used to fertilize soil



Application: Explore what these words mean with your group. Which of these words are they learning about for the first time? How might they use them in a sentence or a conversation? [Soybeans, corn, and algae can be used to make fuel for cars and trucks.]

ACTIVITY “Bioenergy Basics: Name That Source”

Materials: Corn, soybeans, sugar cane, grass, wood chips, dried animal dung, seaweed, algae, sunflower seeds, rice, bark, yard clippings.

Gather a variety of bioenergy sources that are easy to obtain (e.g., from a feed store or a farm co-op). Display the sources and ask the group to identify them through sight, touch, smell, or all three. Be aware of any allergies in your group.

Application: Questions to consider:

- Why are these items sources of bioenergy? [They are plant or animal material.]
- What characteristics do you find in common with these bioenergy sources? [They use the sun for its energy. They are renewable.]

3. Looking Within

ACTIVITY “Bioenergy and Biomass: Having Fun Together”

Materials: The book titled *Biomass: Fueling Change* by Niki Walker (check with your local library for availability).

Start with the first three sections: “Energy in Our Lives,” “Energy Problems,” and “Plant Power.” Then, follow up with other sections such as “Fueling Fires,” “Biogas,” and “Biofuels.”

Application: Questions to consider:

- How is the concept of biomass explained in the book? [Biomass is all organisms on earth and their wastes.]
- How do plants store energy from the sun? [Plants use and store energy from the sun by creating a type of sugar as their food during a process called photosynthesis.]
- Why is animal waste considered biomass? [When animals eat plants they do not digest all of the food, so bits of the material end up as waste or animal poop.]
- How can biomass produce electricity? [Electricity is usually made by burning coal to heat water to make steam. Biomass can replace part or all of the coal used to make steam in power plants.]
- What is biogas? [When biomass (plants) rots, it naturally produces a type of gas called biogas. Biogas burns cleaner than biomass and is used to heat, cook, and make electricity.]
- Is it true that engines running on some types of biodiesel smell like fried food? Why? [Biodiesel can be made from used cooking oil. Once the oil is filtered to remove food particles, a chemical process changes or converts it into biodiesel. The process does not remove the cooking oil smell completely, so the engine exhaust smells like fried food.]

ACTIVITY “Bioenergy and Saving the Planet: Environmental Sustainability”

Materials: Non-renewable energy sources: coal, oil, empty gasoline container, or other non-renewable sources; renewable energy sources: soybean, rice, vegetable oil, wood chips, or other renewable sources; paper; pencils.

Place all the energy sources in random order on a table. Make two signs: “Renewable Energy Sources” and “Non-renewable Energy Sources.” Place each sign at opposite ends of the table. Ask the children to sort the items into the two categories. Help them as needed.

Note to the volunteer: Share with the group that energy can be classified as renewable or non-renewable. Explain the difference between each energy type. Non-renewable energy sources such as fossil fuels (crude oil from the ground) eventually run out because they cannot be replaced easily. Renewable energy sources such as bioenergy (plants, trees, and vegetables) can be replaced or regrown repeatedly.

Share with the group that greenhouse gases (such as water vapor, carbon dioxide, methane, nitrous oxide, and ozone) occur naturally as the sun’s heat warms our planet and as gases trap some of this heat. Explain that greenhouse gases become harmful when too much heat is trapped, and that burning fossil fuels and using aerosol cans are just two ways that people add greenhouse gases to the atmosphere.

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Tell the group that bioenergy does not make greenhouse gases, because bioenergy sources such as plants and organisms consume carbon dioxide from the air at about the same rate that they release it when used as bioenergy products such as biodiesel and ethanol. Explain that renewable bioenergy brings about environmental sustainability and reduces our dependence on others to provide for our energy needs, which results in protecting our planet. Share that non-renewable energy releases greenhouse gases but does not consume any gases, so it adds harmful gases to the atmosphere.

Application: Discuss the importance of bioenergy sources for environmental sustainability as explained in the beginning of this activity. Discuss the issue of climate change, as well as the relationship between environmental sustainability and the preservation of our natural resources.

4. Bringing Closure

ACTIVITY “Making Sense of the Bioenergy Cycle”

Materials: Bioenergy Cycle A and Bioenergy Cycle B (included at the end of this activity).

Group or pair the children and ask them to role-play the bioenergy cycle by playing the role of the sun, biosources (such as plants, trees, and field crops), conversion (bioenergy change process), and bioproducts.

Note to the volunteer: Share Bioenergy Cycle A and Bioenergy Cycle B to help the children understand how the components relate to one another. Talk them through the various steps of this cycle. Consider using a video camera to record your group role-playing the bioenergy cycle. Share the video with family, friends, older 4-H youth, or at county fair with Cloverbud Show and Tell.

Application: Questions to consider:

- How can each step of the bioenergy cycle be role-played? [Answers will vary.]
- What are some other ways to explore the bioenergy cycle? [Plant biosources can be made into bioproducts. For example, corn can be made into packing peanuts. After the packing peanuts are used, they can be recycled into fresh ones or returned to the soil where new plants and crops can grow.]

ACTIVITY “Our Sun: The Ultimate Bioenergy Generator”

Materials: Permanent markers, plastic bags, paper towels, water, seeds, tape, sunshine. (Fast-growing seeds work best. Beans germinate quickly if they are soaked overnight.)

Ask each child to write his or her name on a plastic bag. Instruct the children to dampen some paper towels with water and place the seeds inside the folded towels. Then, have them put the paper towels with seeds in their plastic bags. Tape the bags onto a window that gets sunlight. Check on the seeds periodically to see that they have enough moisture.

Note to the volunteer: This activity works well over the course of two meetings (one to two weeks apart) to allow time for the seeds to sprout. Children should recognize a noticeable difference between the first meeting and the second.



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Explain to the children that bioenergy is actually a type of solar energy, and that plants and other biomass organisms grow and get energy from the sun through the process of photosynthesis. Share with the group that plants use energy from the sun, carbon dioxide from the air, and water to grow while oxygen and moisture are released. Explain that when the biomass is converted to energy through combustion or another process, this stored energy from the sun is released.

Application: Questions to consider:

- If a plant is being used for bioenergy, why does it matter how fast it grows? [Plants that grow fast can be turned into bioenergy sooner. This allows us to replace the bioenergy we have used sooner.]
- What are the seeds consuming to help them grow? [Sun, water, and nutrients.]
- What are they providing? [Oxygen, moisture, and—after the plants are converted—bioenergy.]

5. Going Beyond

ACTIVITY “Bioenergy Sources of Tomorrow”

Materials: Go on a nature hike to collect possible bioenergy sources such as leaves, twigs, straw, etc.

Bring all the items together and ask each child to talk about what they collected and why the items might be good bioenergy sources for the future [because they are fast-growing, dense, abundant, and not used for something else].

Safety Note: While on the hike, avoid hazards such as poison ivy, trees and shrubs with thorns, plants with burrs, etc.

Application: What are some other examples of bioenergy sources? [Methane gas from cows, seaweed for ethanol, used coffee grounds for biodiesel, etc.]



Bioenergy Sources

Reading Adventures

- Armentrout, D., and Armentrout, P. (2009). *Biofuels*. Vero Beach, FL: Rourke Publishing.
- Horn, G. (2010). *Biofuels (Energy Today)*. New York, NY: Chelsea House Publishers.
- Muschal, F. (2008). *Bio-fuels*. Ann Arbor, MI: Cherry Lake Publishing.
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- Raum, E. (2008). *Fossil fuels and biofuels*. Chicago, IL: Heinemann Library.
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- Richards, J. (2009). *Biofuels*. Tarrytown, NY: Marshall Cavendish Benchmark.
- Solway, A. (2008). *Biofuels*. Pleasantville, NY: Gareth Steven Publishing.
- Tabak, J. (2009). *Biofuels (Energy and the Environment)*. New York, NY: Facts on File, Inc.
- Walker, N. (2007). *Biomass: Fueling change*. New York, NY: Crabtree Publishing.

Web Links

www.eia.gov/kids/energy.cfm?page=biomass_home-basics

www.eia.gov/kids/energy.cfm?page=biofuel_home-basics

www.sciencenewsforkids.org/2006/04/microbes-at-the-gas-pump-3

www.alliantenergykids.com/EnergyandTheEnvironment/RenewableEnergy/022398

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PRIMARY ENERGY STORY: The Tale of Johnny Energy Seed



I'm Johnny Energy Seed. I plant energy seeds in a big field on my farm.

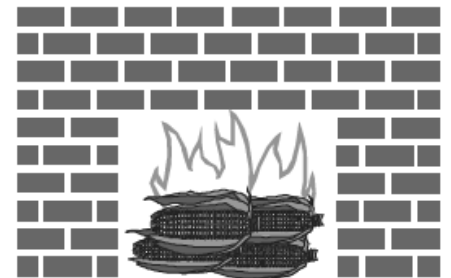
The sun shines. There is energy in the sun's rays. It helps my seeds grow into tall plants. My plants store the sun's energy in their roots, stalks, leaves and ears. Soon my energy plants look like this.



I can use the energy in my plants for many things. I can eat the seeds for energy for my body. This energy will help me grow and move and think.

I can feed my energy plants to my chickens, pigs, cows and horses. The energy will make my animals grow big and strong.

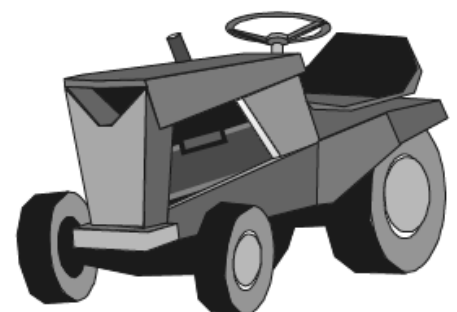
I can hang my energy plants in my barn to dry. Then I can burn them in my fireplace. The energy in my plants can keep me warm on cold winter nights.



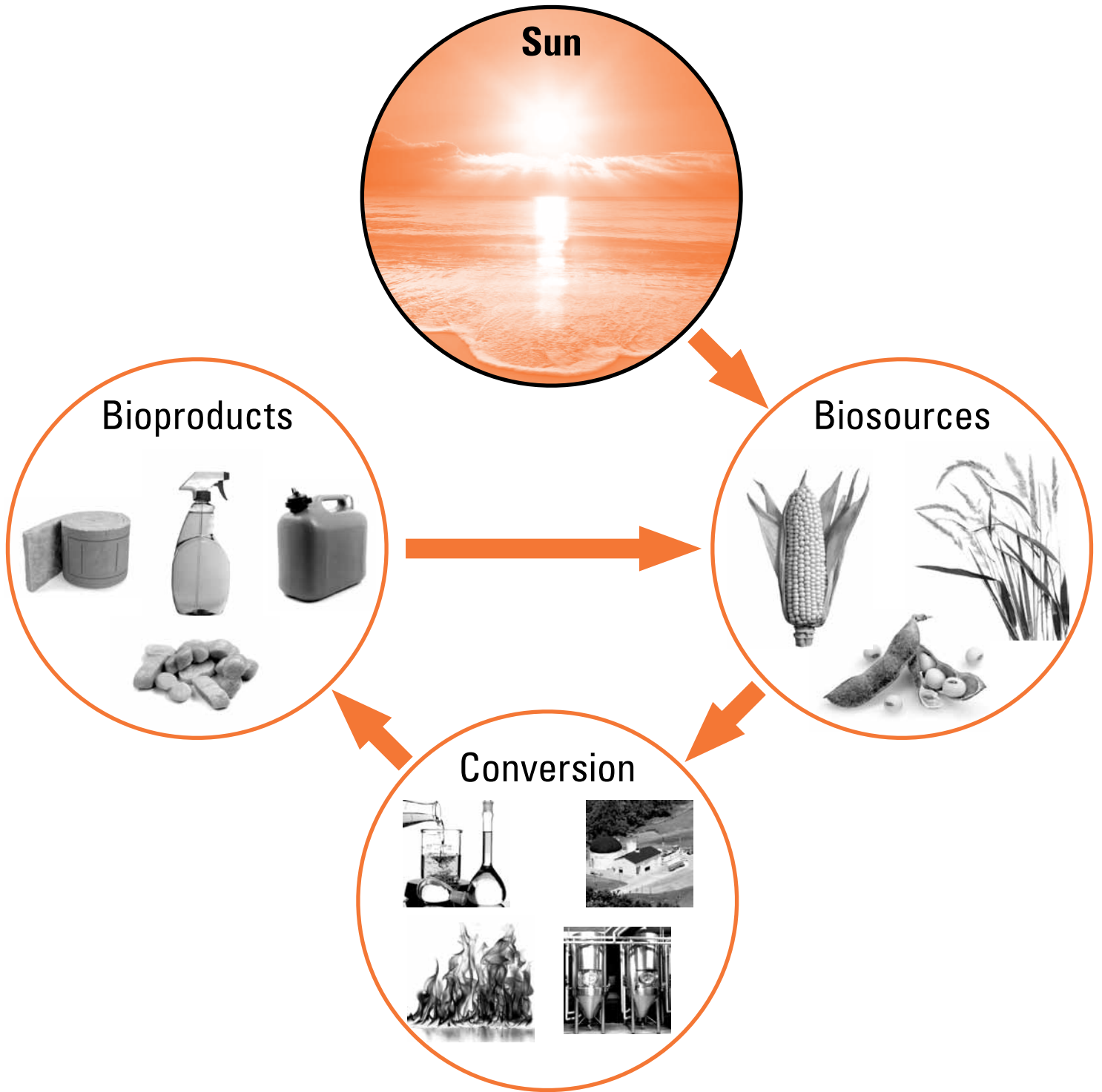
I can put my energy plants into a big container that keeps out the air. As my plants decay, they can make a gas that I can burn in my stove to cook my food.

I can also turn my energy plants into fuel for my tractor. I turn them into alcohol, like grapes are turned into wine. This alcohol fuel, called ethanol, can run my tractor.

As you can see, a seed of corn really is an energy seed. Why don't you plant some corn seeds and explore the ways you can use the energy in the plants you grow.



BIOENERGY CYCLE A



BIOENERGY CYCLE B

Nuclear Energy

Sun

Nuclear Fusion

Solar energy from the sun brings life to plants, seeds, and trees through photosynthesis.

Bioenergy products are consumed and waste byproducts are released as water, CO₂, etc. The byproducts biodegrade by sun and water into the earth/atmosphere for use by plants, animals, soil, etc.

Solar Energy—
Radiant Energy

Bioproducts

**Plastics, Fuel,
Lubricants**

Biosources

**Plants, Crops,
Trees, Animal Waste**

Conversion

Breakdown of matter
(biodigestion)

Fire

(combustion)

Chemical process

(esterification)

Fermentation

The energy stored in biomass and/or feedstock is converted to bio-based products such as plastics, fuel, and lubricants.

Plant life contains stored energy from the sun. It is harvested and collected as biomass and/or feedstock to change/convert energy to other useable forms.