Youth Education & Interpretation It's in Our Nature

Your Source of Energy

MISSOURI DEPARTMENT OF NATURAL RESOURCES

GRADE LEVEL:

Upper Middle School to High School

SUBJECT AREAS:

Sciences, Math

DURATION:

Preparation Time: 15 minutes
Activity Time:
Part 1: one 50-minute class session
Part 2: one 50-minute class session

SETTING:

Classroom

SKILLS:

Application, Analysis, Synthesis

KEY WORDS:

Infrastructure, Photosynthesis, Respiration, Consumers, and Combustion

SUMMARY

In the first part of this activity students will explore the role the Sun plays in providing much of the Earth's energy. The second part of the activity asks the students to locate the commercial energy production facilities nearest their school and to explore the energy transmission and transportation systems surrounding them.

OBJECTIVES

Part 1: Photosynthesis

THE STUDENT WILL:

- Explore the role the Sun plays in providing energy to all life forms on Earth
- Make connections between the energy from the Sun and the energy in the food they eat
- Make connections between the energy from the Sun and other forms of energy they use in their daily lives

Part 2: Energy Infrastructure

THE STUDENT WILL:

- Locate the various energy production facilities near their school
- Explore how their energy is produced and determine the proximity of this infrastructure to their location
- Explore the energy transmission systems that deliver the energy used by their school
- Consider the impacts on daily life if easy access to energy is interrupted

MATERIALS

- Diagram of the carbon cycle
- Copy of the maps of energy production facilities found in Missouri

BACKGROUND

PART 1: PHOTOSYNTHESIS

The Sun provides the vast majority of the energy that exists on our planet. Without the Sun's energy most forms of life on Earth could not exist. Plants depend on a chemical process called photosynthesis (see below).

$CO_2 + H_2O \longrightarrow$ Plant Tissue + O_2

This reaction is driven by the energy found in sunlight and allows plants to build complex chemical structures, construct tissue and carry out their life processes.

The plants in turn serve as food for other organisms (consumers). These consumers gain energy and the raw materials for building body tissue, by feeding on plants directly, or by consuming other animals that eat plants. Consumers gain energy by essentially reversing the photosynthetic process (see handout attached to this lesson for a suggested way to demonstrate this principle to students).

More information can be found in the Forms of Energy section in the general background section of the energy curriculum.

The other forms of energy we use on a daily basis are also derived from the energy in sunlight.

Wood, coal, gasoline and natural gas are all products of recent or ancient decayed plant matter and therefore are the result of photosynthesis. When these substances are "burned" the chemical bonds are broken in a process called combustion, yielding energy in the form of both heat and light.

The hydrologic cycle is also driven by the Sun's energy, resulting in evaporation and precipitation. This process constantly renews the flow of river systems and can be used to generate hydroelectric power.

Similarly, wind is a result of the uneven heating of the Earth's surface by sunlight. The wind holds great potential to be harnessed for energy production.

Part II: ENERGY INFRASTRUCTURE

With the advent of the modern industrial age we now have access to complex forms of energy on a daily basis. Easily obtained energy is used to heat and cool our homes, provide light indoors and at night, and power most of our technology-based tools. In most cases electricity is generated by converting other forms of energy to heat, and the heat is then used to convert water into steam. The rapidly expanding steam is used to force large turbine systems to rotate. These turbines contain large magnetic fields and an electrical current is generated.

Electrical power is typically produced by a large power plant and then distributed to individual homes and buildings through a transmission system. Typically the electricity is "stepped up" to a higher voltage using transformers prior to distribution to regional communities using large high-tension wires. Before entering a home or business this high voltage electricity is reduced to a lower voltage using a "stepdown" station. These can often be seen in your community and consist of a series of transformers enclosed in a high-fenced compound. The resulting lower voltage is distributed to your neighborhood using overhead wires or underground cable systems.

In addition to electrical power, another common source of on-demand energy is natural gas or propane. Many homes use gas-fired furnaces for heating and cooking needs. A national distribution network is used to transport natural gas, and many of these pipes run right though Missouri.

PROCEDURE

WARM UP

Set the stage by asking the students:

- *Where does the Earth's energy come from?*
- *What form of energy do you use most in your home?*
- *Where is the source of the energy used in your home?*

Part I:

Review the carbon cycle diagram included with this lesson. Discuss the reversible nature of chemical reactions (see demonstration activity attached).

Ask the students to create an energy flow chart or poster that indicates all the steps involving energy required to produce a bowl of milk and cereal.

The students should be able to trace most of the energy used to generate a bowl of milk and cereal back to energy from the Sun.

Part II:

Review with the students the sources of energy, and how such energy is delivered to our homes, schools and businesses. Show the students the maps depicting the major energy systems present in Missouri.

Have the students locate several of the nearest power plants.

Ask the student to consider how the materials used to generate power (coal, natural gas and petroleum) are brought into the state.

Have the students locate parts of the national energy infrastructure that are used to import energy related fuels into the state of Missouri.

Does the school use natural gas? Where does this line come into the school? (Look for a meter and above ground pressure regulator hooked-up to the building)

Discuss with the students the source of fuels Missouri imports.

Ask the students to think of the location of the nearest step-down transformer station. Are the low voltage transmission lines in their neighborhood above ground or buried?

Challenge the students to consider what it would be like if the power was turned off for a week.

- *What problems would result? (Waste treatment plants shutdown, patients at hospitals, deaths due to heat or cold, etc.*
- *Would anyone be in trouble without this energy source (elderly, medically dependent, etc.)?*

EXTENSIONS

Investigate a map of Missouri on the US Energy Information Administration to learn more about where pipelines cross the state and where the nearest power plant is located. https://www.eia.gov/state/index.php?sid=MO#tabs-4

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MISSOURI DEPARTMENT OF NATURAL RESOURCES

MISSOURI LEARNING STANDARDS:

SCIENCE GRADE LEVEL STANDARDS:

Physical Sciences

PS1 — Matter and Its Interactions

Concept A: Structure and Properties of Matter

- **6-8.PS1.A.4:** Develop a model that describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. [Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]

PS3 — Energy

Concept A: Definitions of Energy

- **6-8.PS3.A.3:** Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.]

Concept B: Conservation of Energy and Energy Transfer

- **6-8.PS3.B.1:** Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.]

Life Sciences

LS1 — From Molecules to Organisms: Structure and Processes

Concept C: Organization for Matter and Energy Flow in Organisms

- **6-8.LS1.C.1:** Construct a scientific explanation based on evidence for the role of photosynthesis and cellular respiration in the cycling of matter and flow of energy into and out of organisms.

LS2 — Ecosystems: Interactions, Energy, and Dynamics

Concept B: Cycles of Matter and Energy Transfer in Ecosystems

- **6-8.LS2.B.1:** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, including food chains and food webs.]

NGSS:

Physical Science

MS-PS3 Energy

MS-PS3-3: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [*Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]*

MS-PS3-5: Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [*Assessment Boundary: Assessment does not include calculations of energy*.]

Life Science

MS-LS1 From Molecules to Organisms: Structures and Processes

MS-LS1-6: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [*Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]*

MS-LS2 Ecosystems: Interactions, Energy and Dynamics

MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [*Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]*

Science and Engineering Practices

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6-8 builds on K-5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3)

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-5), (MS-LS1-6)

Engaging in Argument from Evidence

Engaging in Argument from evidence in 6-8 builds on K-5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed worlds.

- Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. (MS-PS3-5)

Developing and Using Models

Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop a model to describe phenomena. (MS-LS2-3)

Disciplinary Core Ideas

PS3.A: Definitions of Energy

- Temperature is a measure of the average kinetic energy of particles o f matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3), (MS-PS3-4)

PS3.B: Conservation of Energy and Energy Transfer

- When the motion of energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5)
- Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)

LS1.C: Organization for Matter and Energy Flow in Organisms

- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)

LS2.B: Cycle of Matter and Energy Transfer in Ecosystems

- Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)

Crosscutting Concepts

Energy and Matter

- Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (MS-PS3-5)
- The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-3)
- Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (MS-LS1-6)
- The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3)

DEMONSTRATION ACTIVITY: GAINING ENERGY BY REVERSING CHEMICAL REACTIONS

This short activity demonstrates the reversible nature of chemical reactions and the law of energy conservation (energy cannot be created or destroyed).

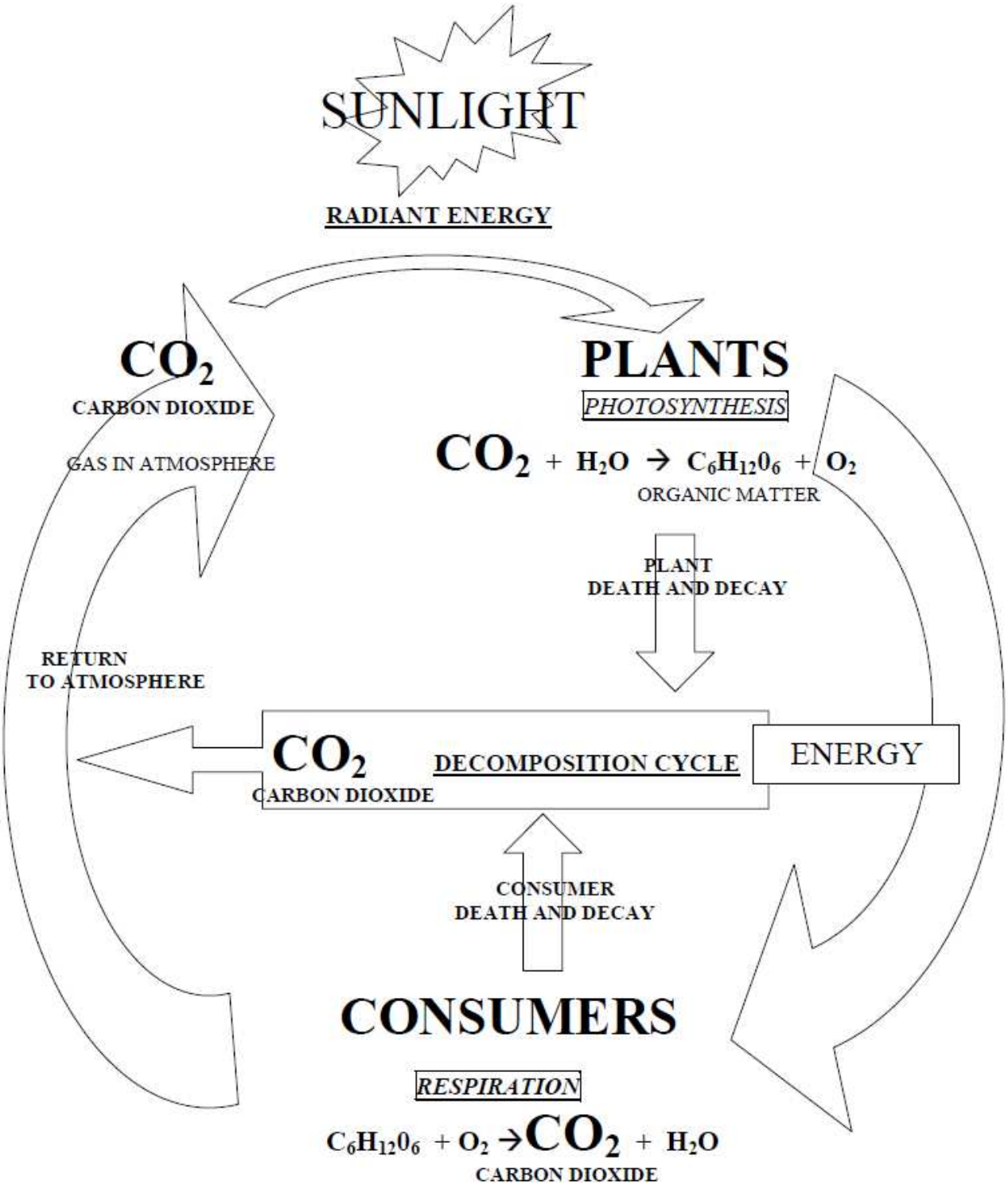
Mark two spots (A and B) on the floor about 10 feet apart. Have two students begin to slowly walk from point A towards B (these two students represent two atoms that are participating in a chemical reaction). As they walk instruct another student, who represents *energy*, to link elbows with each of the two "atoms" thus joining them with a chemical bond. When they reach spot B…discuss how the two atoms have joined (formed a chemical bond) with the help of the *energy* student **(an energy input)**.

Now ask these students to slowly reverse the whole reaction…as they walk backwards…the *energy* student should let go of the two atoms (students) and takes a step away from the reaction letting the "atoms" separate. Discuss with student, that in order to reverse the reaction *energy* had to leave the reaction **(energy was released).**

Summary: Energy that was required to conduct the reaction in one direction was given off when the reaction was reversed. Plants use the sun's energy to build molecules in a process called photosynthesis. When we eat a plant and break the plant molecules back apart (respiration) then energy is produced. All life depends on the plants and gains energy by reversing the reactions of photosynthesis (see diagram to right).

But, what if you eat meat…such as from a cow?

Remember that the cow built itself from eating plants so you are still gaining energy that originally came from the sun.


SUNLIGHT
RADIANT ENERGY
CO_2
CARBON DIOXIDE
GAS IN ATMOSPHERE
PLANTS
PHOTOSYNTHESIS
$CO_2 + H_2O \rightarrow C_6H_{12}0_6 + O_2$
ORGANIC MATTER
PLANT
DEATH AND DECAY
RETURN
TO ATMOSPHERE
CO_2
CARBON DIOXIDE
DECOMPOSITION CYCLE
ENERGY
CONSUMER
DEATH AND DECAY
CONSUMERS
RESPIRATION
$C_6H_{12}0_6 + O_2 \rightarrow CO_2 + H_2O$
CARBON DIOXIDE