



Grade Four Instructional Segment 2: Renewable Energy

It takes energy to turn on the lights or move a car, but where does that energy come from? Our modern energy infrastructure involves complex chains of energy transfer between many objects and across vast distances. During IS2, students investigate several forms of energy and create devices that convert one form to another. They relate these abstract ideas about energy forms to the specific energy resources they rely on in everyday life.

GRADE FOUR INSTRUCTIONAL SEGMENT 2: RENEWABLE ENERGY

Guiding Questions

- How do we get electricity and fuel to run cars and power electronic devices?
- How does human use of natural resources affect the environment?

Performance Expectations

Students who demonstrate understanding can do the following:

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. *[Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]*

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. *[Assessment Boundary: Assessment does not include quantitative measurements of energy.]*

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* *[Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]*

**The performance expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea.*

GRADE FOUR INSTRUCTIONAL SEGMENT 2: RENEWABLE ENERGY

The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education*:

Highlighted Science and Engineering Practices	Highlighted Disciplinary Core Ideas	Highlighted Crosscutting Concepts
<p>[SEP-2] Developing and Using Models</p> <p>[SEP-3] Planning and Carrying Out Investigations</p> <p>[SEP-6] Constructing Explanations (for science) and Designing Solutions (for engineering)</p> <p>[SEP-8] Obtaining, Evaluating, and Communicating Information</p>	<p>PS3.A: Definitions of Energy</p> <p>PS3.B: Conservation of Energy and Energy Transfer</p> <p>PS3.D: Energy in Chemical Processes and Everyday Life</p> <p>ESS3.A: Natural Resources</p> <p>ETS1.A: Defining Engineering Problems</p>	<p>[CCC-4] Systems and System Models</p>

Highlighted California Environmental Principles and Concepts:

Principle I The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.

Principle II The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies.

Principle IV The exchange of matter between natural systems and human societies affects the long-term functioning of both.

Principle V Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes.

CA CCSS for ELA/Literacy Connections: RI.4.3, 5; W.4.1, 7

CA ELD Standards Connections: ELD.PI.4.2, 10a, 11

While everyday conversations might discuss a person “running out of energy” or energy “being consumed,” science refers to energy being transferred to other objects or being transformed into a different form. If an object has energy of motion (or any other form of energy), students should always ask, “Where did that energy come from?” If it appears to be losing energy (e.g., slowing down, cooling down, or getting dimmer), they should ask, “Where did the energy go?” Teachers open this segment by posing these questions about different everyday objects such as a toaster that heats up when plugged into an electrical outlet, a tablet computer whose bright screen shines using a battery, and a car that moves using gasoline.

Before understanding complex devices such as these, students conduct a series of **investigations [SEP-3]** where they observe, **model [SEP-2]**, and discuss situations where energy is transferred from one object to another, transferred from place to place, or transformed from one form of energy to another. The goal of these activities is for students to develop and refine their language for describing energy, their concept of what scientists mean when they use the term energy, and to begin to collect evidence that energy can be transferred from place to place by sound, light, heat, and electric currents (4-PS3-2). Teams of students can visit stations where each team examines different **systems [CCC-4]**, such as the following:

- Energy of motion to sound: one block collides into another block or a moving ball collides into another ball
- Elastic energy to motion: a rubber-band catapult or a trampoline
- Light energy to heat: sunlight or a heat lamp on a surface
- Chemical energy to heat and/or light: a hand warmer, a candle flame, a light stick
- Light energy to electrical energy to sound: solar panel connected to a circuit that rings an electrically-operated doorbell
- Wind energy to motion: blowing on a pin wheel or leaves moving on a tree
- Motion into heat energy via friction: rubbing hands together or sliding objects across surfaces such as sand paper and carpet
- Mechanical energy to motion: wind-up devices such as wind-up toy chicks, chattering teeth, cars, or hand crank generators spinning a fan motor
- Motion to sound: vibrating tuning forks

After exploring a few of the stations freely, the class convenes to try to come up with a list of all the different forms of energy they have observed. While they investigated the energy of motion in IS1, this is the first time they explicitly consider all the different forms of energy. They then return to the stations with their science notebooks and for each station they fill in a table with (1) the forms of energy observed, (2) changes they observed in the interactions, (3) the transfers of energy from one object to another or from one place to another, and (4) the transformations of energy (e.g., light to electrical energy). This table comprises a **conceptual model [SEP-2]** of interactions between objects. Like all models of a **system [CCC-4]**, this table describes the components of the system, how they relate or interact with one another, and can be used to **explain [SEP-6]** the behavior of the system. Their explanations should emphasize how different processes can move energy from one place to another. After experiences with systems in the real world, students can investigate computer simulations of

simple systems that depict interactions that are usually invisible in the real world (PhET n.d.a).

To tie these small systems back to the broader world, students **obtain, evaluate, and communicate information [SEP-8]** about fuels and other energy sources. The energy we use to power devices like cars, computers, and homes does not disappear but instead is converted into other forms such as motion, light, or heat. This energy must come from somewhere, and students trace these chains of energy transfer back to several different sources in the natural environment. In some cases, the natural resources directly consumed to make the energy are abundant and constantly replenished so they are called *renewable* energy resources (like energy from the Sun, wind, and water). Some renewable energy sources, such as trees cut for firewood, can take several decades to grow before they can be used for fuel. Because they are not formed or accumulated over a human lifetime, some energy resources are called *nonrenewable* (like coal, oil, natural gas, and the uranium used in nuclear power plants). Obtaining energy from all these resources changes and damages the natural environment, but extracting some energy sources is much more harmful than others (California's Environmental Principles and Concepts [EP&Cs I, II, IV]). Teachers assign students to **obtain information [SEP-8]** about a specific renewable resource (e.g., wind, solar, water stored behind dams used to drive hydroelectric generation, biofuels) and nonrenewable resource (e.g., fossil fuels such as gasoline, natural gas, or coal). Students review information they find in print and digital media to discover which objects and forms of energy play a role in each energy resource; how the energy resource is used (running cars, generating heat, producing electricity); and how the use of the energy source affects the environment (EP&C II).

Engineering Connection: Renewable Energy with Low Environmental Impact



Student teams complete a design project that demonstrates some form of renewable energy with low environmental impact. Teachers can either dictate a class-wide energy challenge or allow teams to pursue their own energy projects. The emphasis is on **designing a solution [SEP-6]** that meets certain criteria, including potential environmental impacts (EP&Cs II, V) and converts energy from one form to another (4-PS3-4). Students should then test and improve their design, striving to make it a more efficient energy conversion device.

Student teams communicate their findings about different energy sources and demonstrate their energy conversion devices at a class Energy Day. They have interactive demonstrations and exhibits where students teach their families about the various forms of energy, science,

technology, efficiency, conservation, environmental impacts, and careers in the energy industry.

Opportunities for ELA/ELD Connections



As part of the project about fuels and other sources that provide energy, and using the information gathered, students write an opinion piece about supporting (or not supporting) the use of renewable or nonrenewable energy resources. Their opinion pieces should consider the environmental impacts of using either renewable or nonrenewable resources (EP&C II).

CA CCSS for ELA/Literacy Standards: RI.4.3, 5; W.4.1, 7

CA ELD Standards: ELD.PI.4.10a, 11

Sample Integration of Science and ELD Standards in the Classroom



Students have been engaged in investigating the phenomena of energy transformation (4-ESS3-1). Students worked in small groups to conduct a short research project on different aspects of humans' impact on Earth's resources.

They **obtained and combined information [SEP-8]** to explain how energy and fuels are derived from natural resources and how their uses affect the environment. The students used books, Internet sources, and other reliable media to work together in small groups to construct a coherent explanation of how human uses of energy derived from natural resources affect the environment in multiple ways, how some resources are renewable and others are not, and possible actions that humans could take in the future. Each small group co-developed a written explanation and prepared a digital presentation with relevant graphics to present their research.

CA ELD Standards: ELD.PI.4.2

Source: Lagunoff et al. 2015, 246–247

EP&C Connection: Students work in small groups to conduct a short research project on different aspects of humans' impact on Earth's resources and natural systems (EP&C II).