06 Energy Resources and Consumption

Content Area: **Science**
Course(s): **AP Environment**
Time Period: **Semester 2**
Length: **2 weeks**
Status: **Published**

Standards

CCC.3	Scale, proportion, and quantity.
CCC.5	Energy and matter: Flows, cycles, and conservation.
SEP.5	Using Mathematics and Computational Thinking
SEP.6	Constructing Explanations and Designing Solutions
SCI.HS-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
SCI.HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
SCI.HS-ESS3-2	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
SCI.HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
SCI.HS-ESS3-3	Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
SCI.HS-ESS2-4	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
SCI.HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

Enduring Understandings

Humans use energy from a variety of sources, resulting in positive and negative consequences.

Energy conversions underlie all ecological processes.

Energy cannot be created; it must come from somewhere.

As energy flows through systems, at each step more of it becomes unusable.

Humans depend on all of the planet's systems for a variety of resources, some of which are renewable or replaceable and some which are not.

Essential Questions

How does human use of renewable and nonrenewable energy resources impact the environment?

Knowledge and Skills

Unit 6

6.1 Renewable and Nonrenewable Resources

Knowledge

- Nonrenewable energy sources are those that exist in a fixed amount and involve energy transformation that cannot be easily replaced. ENG-3.A.2 Renewable energy sources are those that can be replenished naturally, at or near the rate of consumption, and reused.

Skills

- Explain environmental concepts, processes, or models in applied contexts.

6.2 Global Energy Consumption

Knowledge

- The use of energy resources is not evenly distributed between developed and developing countries.
- The most widely used sources of energy globally are fossil fuels.
- As developing countries become more developed, their reliance on fossil fuels for energy increases.
- As the world becomes more industrialized, the demand for energy increases.
- Availability, price, and governmental regulations influence which energy sources people use and how they use them.

Skills

- Calculate an accurate numeric answer with appropriate units.

6.3 Fuel Types and Uses

Knowledge

- Wood is commonly used as fuel in the forms of firewood and charcoal. It is often used in developing countries because it is easily accessible.
- Peat is partially decomposed organic material that can be burned for fuel.
- Three types of coal used for fuel are lignite, bituminous, and anthracite. Heat, pressure, and depth of burial contribute to the development of various coal types and their qualities.
- Natural gas, the cleanest of the fossil fuels, is mostly methane.
- Crude oil can be recovered from tar sands, which are a combination of clay, sand, water, and bitumen.
- Fossil fuels can be made into specific fuel types for specialized uses (e.g., in motor vehicles).

- Cogeneration occurs when a fuel source is used to generate both useful heat and electricity.

Skills

- Describe environmental concepts and processes.

6.4 Distribution of Natural Energy Resources

Knowledge

- The global distribution of natural energy resources, such as ores, coal, crude oil, and gas, is not uniform and depends on regions' geologic history.

Skills

- Explain relationships between different characteristics of environmental concepts, processes, or models represented visually.

6.5 Fossil Fuels

Knowledge

- The combustion of fossil fuels is a chemical reaction between the fuel and oxygen that yields carbon dioxide and water and releases energy.
- Energy from fossil fuels is produced by burning those fuels to generate heat, which then turns water into steam. That steam turns a turbine, which generates electricity.
- Humans use a variety of methods to extract fossil fuels from the earth for energy generation.
- Describe the effects of fossil fuels on the environment.
- Hydrologic fracturing (fracking) can cause groundwater contamination and the release of volatile organic compounds.

Skills

- Describe environmental problems.

6.6 Nuclear Power

Knowledge

- Nuclear power is generated through fission, where atoms of Uranium-235, which are stored in fuel rods, are split into smaller parts after being struck by a neutron. Nuclear fission releases a large amount of heat, which is used to generate steam, which powers a turbine and generates electricity.
- Radioactivity occurs when the nucleus of a radioactive isotope loses energy by emitting radiation.
- Uranium-235 remains radioactive for a long time, which leads to the problems associated with the disposal of nuclear waste.
- Nuclear power generation is a nonrenewable energy source. Nuclear power is considered a cleaner energy source because it does not produce air pollutants, but it does release thermal pollution and

hazardous solid waste
- Three Mile Island, Chernobyl, and Fukushima are three cases where accidents or natural disasters led to the release of radiation. These releases have had short- and long-term impacts on the environment.
- A radioactive element's half-life can be used to calculate a variety of things, including the rate of decay and the radioactivity level at specific points in time.

Skills

- Explain relationships between different characteristics of environmental concepts, processes, or models represented visually.

6.7 Energy from Biomass

Knowledge

- Burning of biomass produces heat for energy at a relatively low cost, but it also produces carbon dioxide, carbon monoxide, nitrogen oxides, particulates, and volatile organic compounds. The overharvesting of trees for fuel also causes deforestation.
- Ethanol can be used as a substitute for gasoline. Burning ethanol does not introduce additional carbon into the atmosphere via combustion, but the energy return on energy investment for ethanol is low.

Skills

- Describe potential responses or approaches to environmental problems.

6.8 Solar Energy

Knowledge

- Photovoltaic solar cells capture light energy from the sun and transform it directly into electrical energy. Their use is limited by the availability of sunlight.
- Active solar energy systems use solar energy to heat a liquid through mechanical and electric equipment to collect and store the energy captured from the sun.
- Passive solar energy systems absorb heat directly from the sun without the use of mechanical and electric equipment, and energy cannot be collected or stored.
- Solar energy systems have low environmental impact and produce clean energy, but they can be expensive. Large solar energy farms may negatively impact desert ecosystems.

Skills

- Explain patterns and trends in data to draw conclusions.

6.9 Hydroelectric Power

Knowledge

- Hydroelectric power can be generated in several ways. Dams built across rivers collect water in reservoirs. The moving water can be used to spin a turbine. Turbines can also be placed in small rivers, where the flowing water spins the turbine.
- Tidal energy uses the energy produced by tidal flows to turn a turbine.
- Hydroelectric power does not generate air pollution or waste, but construction of the power plants can be expensive, and there may be a loss of or change in habitats following the construction of dams.

Skills

- Justify a proposed solution, by explaining potential advantages

6.10 Geothermal Energy

Knowledge

- Geothermal energy is obtained by using the heat stored in the Earth's interior to heat up water, which is brought back to the surface as steam. The steam is used to drive an electric generator.
- The cost of accessing geothermal energy can be prohibitively expensive, as is not easily accessible in many parts of the world. In addition, it can cause the release of hydrogen sulfide.

Skills

- Explain environmental concepts and processes.

6.11 Hydrogen Fuel Cell

Knowledge

- Hydrogen fuel cells are an alternate to nonrenewable fuel sources. They use hydrogen as fuel, combining the hydrogen and oxygen in the air to form water and release energy (electricity) in the process. Water is the product (emission) of a fuel cell.
- Hydrogen fuel cells have low environmental impact and produce no carbon dioxide when the hydrogen is produced from water. However, the technology is expensive and energy is still needed to create the hydrogen gas used in the fuel cell.

Skills

- Explain environmental concepts, processes, or models in applied contexts.

6.12 Wind Energy

Knowledge

- Wind turbines use the kinetic energy of moving air to spin a turbine, which in turn converts the mechanical energy of the turbine into electricity.

- Wind energy is a renewable, clean source of energy. However, birds and bats may be killed if they fly into the spinning turbine blades.

Skills

- Describe potential responses or approaches to environmental problems.

6.13 Energy Conservation

Knowledge

- Some of the methods for conserving energy around a home include adjusting the thermostat to reduce the use of heat and air conditioning, conserving water, use of energy-efficient appliances, and conservation landscaping.
- Methods for conserving energy on a large scale include improving fuel economy for vehicles, using BEVs (battery electric vehicles) and hybrid vehicles, using public transportation, and implementing green building design features.

Skills

- Calculate an accurate numeric answer with appropriate units.

Make connections to other units by considering:

Humans use energy from a variety of sources, resulting in positive and negative consequences.

Key vocabulary you need to know		
nonrenewable resource	active solar energy	Conservation
renewable resource	passive solar energy	hybrid vehicle
fossil fue	Hydroelectricity	Potential energy
Cogeneration	Turbine	Battery Electric Vehicle (BEV) green building
Combustion	Generator	greenhouse gases
Fracking	tidal energy	Ore

nuclear power	Geothermal energy	Overburden
radioactive half life	Hydrogen fuel cell	tailings/slag
Biomass	Kinetic energy	subsurface mining
PV solar cell	surface mining	

Figures/ Equations to know

Half life: amount remaining=(original amount) x (0.5x), where x = number of half lives

Rate of change: (final value-initial value)/(final year-initial year)

Percent change: [(final value-initial value)/initial value]

Total energy used: kWx hours = kWh

Energy Efficiency: efficiency of step 1 x efficiency of step 2, etc., x 100

Transfer Goals

Relate human population growth to shifts in energy uses

Connect environmental issues to extraction and use of various forms of energy

Assessments

https://docs.google.com/document/d/1wR7bQF-8AQoRrt0g4C3hKja0yjwDjC9_BiAmONWbTcI/edit?usp=sharing

Modifications

https://docs.google.com/document/d/1ODqaPP69YkcFiyG72fIT8XsUIe3K1VSG7nxuc4CpCec/edit?usp=sharing