

## APES Chapter 14-16 Supplemental Notes

### Geology & Energy Resources

- *ERT-4.A. Describe the geological changes and events that occur at convergent, divergent, and transform plate boundaries.*
  - Convergent boundaries can result in the creation of mountains, island arcs, earthquakes, and volcanoes.
  - Divergent boundaries can result in seafloor spreading, rift valleys, volcanoes, and earthquakes.
  - Transform boundaries can result in earthquakes.
  - Maps that show the global distribution of plate boundaries can be used to determine the location of volcanoes, island arcs, earthquakes, hot spots, and faults.
  - An earthquake occurs when stress overcomes a locked fault, releasing stored energy.
- *EIN-2.K. Describe natural resource extraction through mining.*
  - As the more accessible ores are mined to depletion, mining operations are forced to access lower grade ores. Accessing these ores requires increased use of resources that can cause increased waste and pollution.
  - Surface mining is the removal of large portions of soil and rock, called overburden, in order to access the ore underneath. An example is strip mining, which removes the vegetation from an area, making the area more susceptible to erosion.
- *EIN-2.L. Describe ecological and economic impacts of natural resource extraction through mining.*
  - Mining wastes include the soil and rocks that are moved to gain access to the ore and the waste, called slag and tailings that remain when the minerals have been removed from the ore. Mining helps to provide low cost energy and material necessary to make products. The mining of coal can destroy habitats, contaminate ground water, and release dust particles and methane.
  - As coal reserves get smaller, due to a lack of easily accessible reserves, it becomes necessary to access coal through subsurface mining, which is very expensive.
- *EIN-2.N. Explain the variables measured in an ecological footprint.*
  - Ecological footprints compare resource demands and waste production required for an individual or a society.
- *STB-1.A. Explain the concept of sustainability.*
  - Sustainability refers to humans living on Earth and their use of resources without depletion of the resources for future generations. Environmental indicators that can guide humans to sustainability include biological diversity, food production, average global surface temperatures and CO<sub>2</sub> concentrations, human population, and resource depletion.
  - Sustainable yield is the amount of a renewable resource that can be taken without reducing the available supply.
- *ENG-3.A. Identify differences between nonrenewable and renewable energy sources.*
  - Nonrenewable energy sources are those that exist in a fixed amount and involve energy transformation that cannot be easily replaced.
  - Renewable energy sources are those that can be replenished naturally, at or near the rate of consumption, and reused.
- *ENG-3.B. Describe trends in energy consumption.*
  - 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.
- *ENG-3.C. Identify types of fuels and their uses.*
  - 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.

- *ENG-3.D. Identify where natural energy resources occur.*
  - The global distribution of natural energy resources, such as ores, coal, crude oil, and gas, is not uniform and depends on regions' geologic history.
- *ENG-3.E. Describe the use and methods of fossil fuels in power generation.*
  - 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.
- *ENG-3.F. Describe the effects of fossil fuels on the environment.*
  - Hydrologic fracturing (fracking) can cause groundwater contamination and the release of volatile organic compounds.
- *ENG-3.G. Describe the use of nuclear energy in power generation.*
  - 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.
- *ENG-3.H. Describe the effects of the use of nuclear energy on the environment.*
  - 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.
- *ENG-3.I. Describe the effects of the use of biomass in power generation on the environment.*
  - 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.
- *ENG-3.J. Describe the use of solar energy in power generation.*
  - 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.
- *ENG-3.K. Describe the effects of the use of solar energy in power generation on the environment.*
  - 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.
- *ENG-3.L. Describe the use of hydroelectricity in power generation.*
  - 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.
- *ENG-3.M. Describe the effects of the use of hydroelectricity in power generation on the environment.*
  - 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.

- *ENG-3.N. Describe the use of geothermal energy in power generation.*
  - 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.
- *ENG-3.O. Describe the effects of the use of geothermal energy in power generation on the environment.*
  - 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.
- *ENG-3.P. Describe the use of hydrogen fuel cells in power generation.*
  - Hydrogen fuel cells are an alternate to non-renewable 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.
- *ENG-3.Q. Describe the effects of the use of hydrogen fuel cells in power generation on the environment.*
  - 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.
- *ENG-3.R. Describe the use of wind energy in power generation.*
  - 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.
- *ENG-3.S. Describe the effects of the use of wind energy in power generation on the environment.*
  - Wind energy is a renewable, clean source of energy. However, birds and bats may be killed if they fly into the spinning turbine blades.
- *ENG-3.T. Describe methods for conserving energy.*
  - 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.
- *STB-3.B. Describe the impacts of human activities on aquatic ecosystems.*
  - Organisms have a range of tolerance for various pollutants. Organisms have an optimum range for each factor where they can maintain homeostasis. Outside of this range, organisms may experience physiological stress, limited growth, reduced reproduction, and in extreme cases, death.

*College Board Acronyms (ENG=Energy Transfer, ERT=Interactions Between Earth Systems, EIN=Interactions Between Species and the Environment, STB=Sustainability)*