APES Unit 6 Study Guide

Ultimate Review Packet (6.1 - 6.3)

6.1 - Renewable and Nonrenewable Energy

a. Define what a renewable energy source is and provide an example an energy source that is capable of being replenished or regenerated at or near the rate of consumption. Ex: solar, wind, hydroelectric, geothermal, biomass
b. Define what a nonrenewable energy source is and provide an example an energy source that exists in a fixed amount and cannot be replenished or regenerated near the rate of consumption. Ex: fossil fuels, nuclear
c. **Identify** and **describe** a potentially renewable energy source biomass is a potentially renewable energy source because it can be harvested far faster than its rate of regeneration, which could exhaust the resource.

6.2 - Global Energy Consumption

a. Define subsistence fuel and **describe** why these fuels are more utilized in less developed nations fuels that can easily be harvested from the surrounding env. such as wood, peat, dired animal waste. Less developed nations have less access to commercial fuels like fossil fuels/residents have less money to purchase comm. fuels
b. **Explain** why developed nations have higher per capita energy consumption than less developed nations greater industrialization leads to more energy consumption to power factories/offices/businesses, higher affluence of citizens leads to more energy consumption for travel, housing, devices
c. **Describe** how the global use of fossil fuels as an energy source compares to other sources FFs account for roughly 80% of global energy consumption
d. **Identify** a factor that influences use of an energy source and **describe** how a change in that factor would impact use price - as the price of an energy source increases there is less use of that energy source, availability - as the availability of an energy source increases price generally drops which leads to more use of that source, government regulation - subsidies can increase the use of an energy resource while increased taxes or regulations can decrease use of an energy source

6.3 - Fuel Types and Uses

a. **Describe** the difference between wood and charcoal and **identify** a use for either charcoal is wood that has been burned under low oxygen conditions for a long time, making it lighter and easier to transport. Either can be used for cooking or heating
b. **Describe** the formation of peat peat is partially decomposed organic matter formed in the acidic, low oxygen conditions beneath marshes/bogs/wetlands
c. **Explain** how peat can become anthracite coal, **identifying** intermediate coal forms in the process as peat is subjected to heat and pressure over millions of years, it is compressed into lignite, sub-bituminous, bituminous, and eventually anthracite coal. Each successive form of coal is more energy dense and contains fewer impurities
d. **Describe** the composition and extraction of petroleum fluid mixture of hydrocarbons, water, and sulfur that can be extracted from sedimentary rock formations by drilling a well through impermeable caprock above and pumping petroleum up to the surface
e. **Describe** the process of fractional distillation and identity TWO end uses for petroleum petroleum is heated which enables separation of different hydrocarbons based on their different boiling points. End uses include gasoline, plastic, bitumen/asphalt/tar, motor oil, diesel fuel, jet fuel

APES Unit 6 Ultimate Review Packet (6.3 - 6.5)

6.3 - Fuel Types and Uses (cont.)

f. **Describe** how the extraction of petroleum from oil sands/tar sands differs from traditional petroleum extraction extracting petroleum from tar sands requires using steam to heat bitumen into a liquid state that can be transported to refineries where more steam is used to separate petroleum from impurities like sand and clay

g. **Explain** TWO reasons that natural gas is considered a "cleaner" fossil fuel than coal (1) when burned it releases fewer impurities such as NO_x, SO_x, PM, CO, lead, mercury (2) when burned it releases less CO_2 than coal which contributes less to climate change

6.4 - Distribution of Natural Energy Resources

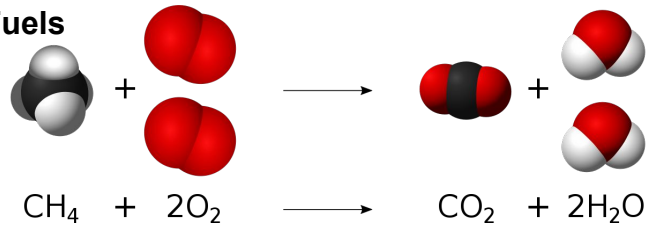
a. Rank the three fossil fuels in terms of their estimated remaining reserves from greatest to least coal, natural gas, petroleum/oil

b. **Identify** a region on earth that contains one of the largest known tar sands petroleum deposits Alberta Canada, Venezuela

c. **Describe** the geological characteristics associated with petroleum and natural gas deposits semi-permeable/porous, sedimentary rock formations such as shale or sandstone with impermeable rock layers above

6.5 - Fossil Fuels

a. Draw out the basic products and reactants in the combustion of methane (CH_4) and **Identify** the purpose of this reaction
The purpose is to produce heat



b. Draw out a diagram to represent the basic steps of producing electricity from fossil fuels

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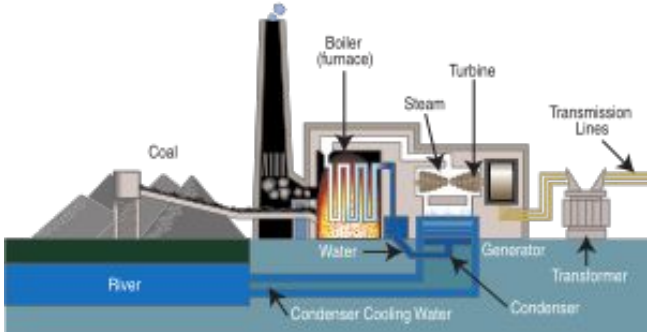


c. **Explain** the process of using fossil fuels to generate electricity combustion of fossil fuels releases heat that is used to convert water into steam so that the force/pressure of the steam can be used to turn a turbine, which is connected to an electrical generator that can convert the mechanical energy of the rotating turning into electrical energy

d. **Describe** the benefits and drawbacks of each of fossil fuel below

Coal: (+) cheapest and most abundant, requires less refining (-) combustion releases most air pollutants (PM, SO_x, NO_x) and CO_2 of any FF, ash contains mercury, lead arsenic, mining methods cause hab. loss	Petroleum/crude oil: (+) more energy-dense than coal, liquid state enables easy transport, ideal vehicle fuel source, emits less CO_2 than coal (-) oil spills leading to water contamination, pipelines on land fragment habitat, pipeline leaks can cont. ground water	Natural gas: (+) combustion releases fewest air pollutants and GHGs of any FF, can replace coal in electricity gen., ideal for heating buildings, extraction disrupts hab. less than coal (-) methane release, water use & cont. from fracking

APES Unit 6 Ultimate Review Packet (6.5 - 6.7)

6.5 - Fossil Fuels (cont.)

a. **Describe** the process of natural gas extraction via fracking a well is drilled vertically into the ground and then horizontally into a sedimentary rock formation containing natural gas. Water is then pumped into the well at high pressures in order to crack the rock and release the natural gas contained within it
b. **Describe** a water-related environmental consequence of fracking surface or groundwater depletion due to excessive amounts of water required for fracking fluid, groundwater contamination by fracking fluid/methane if pipe/well casing leaks, surface water contamination if flowback fluid/slick water/used fracking fluid overflows from storage ponds or is sprayed on land
c. **Describe** a non water-related environmental consequence of fracking increased seismic activity/earthquakes due to pressure from fracking fluid/wastewater injection, habitat loss/fragmentation due to roads/drilling equipment/storage ponds for flowback fluid, methane release contributing to climate change
d. **Identify** THREE components of fracking flowback fluid water, sand/clay, detergents/soaps or lubricants, disinfectants/antimicrobial compounds, salt, acids, radioactive chemicals/elements

6.6 - Nuclear Energy

a. **Explain** the process of a fission reaction a neutron is fired into the nucleus of a radioactive element such as uranium, splitting the nucleus and releasing energy and additional neutrons from the split nucleus which go on to split more nuclei and release more energy
b. **Explain** how nuclear energy can be used to generate electricity the heat from a fission reaction is used to convert water into steam which turns a turbine, which is connected to an electrical generator that can convert the mechanical energy of the turbine into electricity
c. **Describe** an environmental advantage and disadvantage of nuclear energy compared to fossil fuels (+) more energy dense fuel/more energy output per unit of fuel, no release of greenhouse gasses or air pollutants (-) risk of radiation release by meltdown or improper nuclear waste storage leading to mutations in organisms in surrounding ecosystems
d. Provide a brief **description** of each of the three largest nuclear meltdowns in history Three Mile Island - partial meltdown and radiation release due to testing error, Chernobyl - full meltdown and widespread radiation release due to cooling valve/pump failure causing numerous deaths, Fukushima - earthquake triggered by a tsunami shutdown cooling pumps leading to full meltdown and radiation release into atmosphere and ocean

6.7 - Biomass

a. **Identify** an environmental and human health consequence of using wood as a fuel source can lead to over harvesting and deforestation. Indoor combustion releases CO, PM, NO_x, VOCs
b. **Identify** the most common biofuel and **describe** its production and use ethanol is a gasoline alternative or additive in the case of E-85/flex fuel. It is produced from the fermentation of glucose/sucrose sources such as corn and sugarcane
c. **Explain** why ethanol combustion is considered carbon-neutral because the CO_2 released from ethanol combustion was recently taken out of the atmosphere via photosynthesis by corn or sugarcane, it is not adding additional carbon to the atmosphere that wasn't already there
d. **Describe** an environmental benefit of ethanol and an economic drawback of ethanol (+) does not require mining of fossil fuels and associated env. costs, does not release air pollutants when combusted, does not cause net carbon increase in the atmospheric (-) does not provide as much return on energy investment as fossil fuels, can compete with human or animal consumption of corn causing increase in prices/decrease in supply, requires drivers to purchase new vehicles to take advantage of or auto manufacturers to adjust to production methods

APES Unit 6 Ultimate Review Packet (6.8 - 6.9)

6.8 - Solar Energy

a. **Explain** the difference between active and passive solar energy active solar energy involves the use of mechanical or electrical equipment to convert sunlight into electricity or concentrated heat, while passive solar refers to the absorbing or blocking of heat from the sun without mechanical or electrical equipment

b. **Explain** the difference between the use of photovoltaic cells and concentrated solar thermal electricity generation photovoltaic cells generate an electrical current using semiconductors like silicon which emit voltage when photons of light from the sun strike them, while concentrated solar thermal systems use heliostats/mirrors to concentrate the sun's light on a central tower in order to heat water into steam to turn a turbine connected to an electrical generator

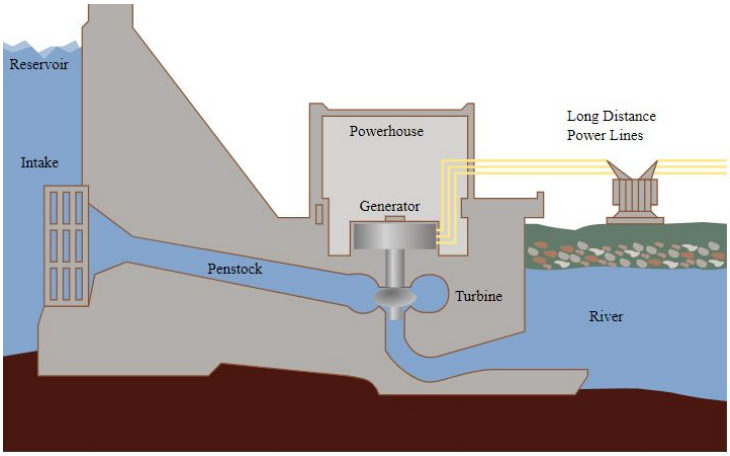
c. **Describe** TWO environmental benefits of solar energy compared to fossil fuels no release of air pollutants (PM, SO_x, NO_x, VOCs) or greenhouse gasses (CO_2, CH_4) during electricity generation, no continual fossil fuel mining required for electricity production after construction of solar farm/panels

d. **Identify** one environmental and one economic drawback of solar energy solar farms or concentrated solar plants can disrupt/fragment desert habitats, PV cells require mining of semiconductor metals, concentrated solar farms require fossil fuel inputs to construct. Solar energy is intermittent/cannot be used as baseload power

6.9 - Hydroelectric Power

a. Draw a diagram to show how water impoundment systems or hydroelectric dams are used to generate electricity and describe how water buildup behind the dam contributes increases electricity output

Water buildup behind the dam generates downward pressure due to the force of gravity which causes water to flow through the channel or past the turbine with greater force, leading to greater electricity production



b. **Explain** how hydroelectricity is generated using the terms kinetic, mechanical, and electrical energy kinetic energy of falling/flowing water is converted into mechanical energy by the spinning of a turbine, which is connected to an electrical generator that can convert this mechanical energy into electrical energy

c. **Describe** how run of river and tidal energy systems differ from water impoundment systems the kinetic energy of flowing/moving water comes from natural river current or tidal motion, rather than the force/pressure of water impoundment/the reservoir

d. **Describe** an environmental advantage and disadvantage of hydroelectric dams (+) produce electricity without releasing air pollutants or GHGs, mining of fossil fuels (-) flood habitat behind the dam to create reservoir, prevents nutrient-containing sediments from being deposited in floodplains/wetlands downstream, increase water temp. and evaporation rate in reservoir, release methane due to anaerobic decomposition of organic matter in reservoir, disrupt salmon/other migratory fish from swimming upstream to spawn/reproduce

e. Describe an economic advantage and disadvantage of hydroelectric dams (+) provide jobs to the local economy, reservoirs provide drinking/agricultural water source, reservoirs provide tourism/recreation income, provide base-load power generation (-) extremely high upfront cost to construct, requires residents in behind the dam communities to relocate for reservoir creation

APES Unit 6 Ultimate Review Packet (6.10 - 6.13)

6.10 - Geothermal Energy

a. **Describe** how geothermal energy can be used to produce electricity wells drilled deep into portions of the Earth's crust bring heat back up to the surface via heated water that can be used to generate steam to spin a turbine that drives an electrical generator
b. **Describe** an environmental and economic benefit of geothermal energy does not require the mining/combustion of fossil fuels and their associated env. consequences. It is a renewable and non-depletable energy source, it is not intermittent/can provide base-load power
c. **Identify** an economic and human health drawback of geothermal energy upfront construction cost is very high, depth to access geothermal heat is too far from surface in some regions of Earth. Can release hydrogen sulfide which is toxic to humans

6.11 - Hydrogen Fuel Cell

a. **Identify** the inputs and outputs of a Hydrogen Fuel Cell **Inputs**: Hydrogen gas + O_2 → **Outputs**: energy (electricity) + water
b. **Describe** how electricity is generated with a hydrogen fuel cell hydrogen atoms are separated into protons and electrons by a membrane that only allows protons through, forcing electrons to take an alternate path around the membrane, generating an electrical current
c. **Explain** how the use of a hydrogen fuel cell may still result in carbon emissions, even though the only waste product of the reaction in the cell is water currently most hydrogen gas is produced by combusting fossil fuels such as natural gas, which emits carbon
d. **Identify** a drawback and benefit of hydrogen fuel cell vehicles (-) lack of fuel distribution network, need for larger tanks in vehicles (+) no air pollutants (PM, VOcs, NO_x) released, doesn't require petroleum extraction

6.12 - Wind Energy

a. **Explain** the process of generating electricity using wind turbines kinetic energy of moving air turns turbine blades, which rotates a turbine, converting kinetic to mechanical energy. The turbine power an electric generator that converts mechanical energy into electrical energy.
b. **Describe** TWO environmental advantages of wind turbines no air pollutants/GHGs are released during electricity generation, no need to mine for fuel for electricity production (reducing associated FF mining env. effects), can share land with grassland or open water ecosystems (no habitat loss/fragmentation)
c. **Identify** one environmental and one economic drawback of wind turbines **env**: can kill bats or migratory birds, can only supplement base-load power sources (usually FFs) due to intermittency. **Econ**: intermittency means they can't serve as base load power, some property owners consider them an eyesore or source of noise pollution, often built far from cities utilizing power, requiring long distribution systems

6.13 - Energy Conservation

a. **Identify** TWO methods of reducing electricity use at home more energy efficient appliances, lower wattage light bulbs, increased natural lighting (paired with reduced artificial light usage)
b. **Identify** TWO methods of conserving energy used in heating/cooling a home programmable thermostats, increasing efficiency of insulation, passive solar design practices (double-paned windows, deciduous shade trees, heat absorbing flooring/wall materials, southern-facing windows with roof overhang in northern hemisphere)
c. **Identify** TWO methods of water conservation at home replacing grass with native plants/landscaping, rain barrels to catch runoff for use watering/washing cars, low flush toilets, low-flow showerheads, lower volume washers/dishwashers

6.13 - Energy Conservation (cont.)

d. **Describe** how a green roof can reduce the energy use of a building plants on the roof of a building prevent sun from heating the roof of the building, keeping it cooler in the summer and reducing electricity use for air conditioning, in the winter they insulate the roof and keep heat in

e. **Identify** TWO individual-scale methods and TWO government-scale methods to reduce energy used for transportation **Individual:** purchase a hybrid or BEV (battery electric vehicle), carpool to work/school, use public transportation more, walk or bike more. **Government**: raise CAFE vehicle standards, offer rebates to individuals purchasing BEVs, offer subsidies/tax credits to companies manufacturing BEVs, invest in more efficient/cheaper public transportation