Unit 6: Energy Resources
UNIT PLAN

AP Environmental Science
Unit 6
Suggested Duration: 14-15 Days

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UNIT NARRATIVE

The goal for this unit is that students can explain of the current state of (mostly nonrenewable) energy resource use in the United States and Globally, describe the advantages and disadvantages of alternatives to the status quo and make claims supported by evidence and reasoning about these alternatives, and have enough background to make sense of future developments around energy resource use.

this unit is that The Energy Resources unit starts with an analysis of global and regional energy consumption to explore the patterns and trends in quantity by type of energy resource, focusing on trends in renewable vs non-renewable resources (Day 01). After exploring how the majority of the world's energy comes from fossil fuels, students are ready to explore the use and impact of fossil fuel energy resources in detail by researching one of the three types of fossil fuel energy resource and creating a mini-poster to share with a gallery walk (Days 02-03). This section of the unit concludes with students exploring two unconventional fossil fuels, fossil fuels that must be extracted using more difficult and expensive techniques, over two instructional days (Days 04-05). The first lesson in this arc starts with a Do Now where students will describe diagram of a coal burning power plant, a key diagram for the AP Exam (Day 04). Students will attempt to describe each step in the process of converting coal into electricity and the environmental impacts of this process using only the diagram before a Teacher Think Aloud to explain the correct answers. The remainder of this lesson focuses on hydraulic fracturing (AKA Hydrofracking or Fracking) with students watching a TED Talk with discussion questions to compare the environmental impact with conventional fossil fuels extraction(Day 04). The second lesson in this arc focuses on the unconventional fossil fuel called Tar Sands (AKA oil sands, crude bitumen, bituminous sands) where students will watch a series of short videos and complete discussion questions (Days 05). This completes the fossil fuel section of this unit.

Now students are ready to explore Nuclear Energy as it is also a nonrenewable energy resource but is widely considered a transition energy resource that can help society transition off fossil fuels and to renewable energy resources. This lesson spans two instructional days (Days 06-07) and starts with a webquest (Day 06) where students will explore how nuclear reactor creates electricity using an online tour, (another key diagram for the AP Exam and part of the exit ticket) how nuclear fission works using a PhET simulation, nuclear power plants in their state/region, the nuclear fuel cycle, and

radioactive decay and half-life using another PhET simulation. In the second day of this lesson arc students will watch a TED Talk debate (Day 07) about the need for nuclear energy as a transition energy resource and engage in discussion as a class using guided discussion questions.

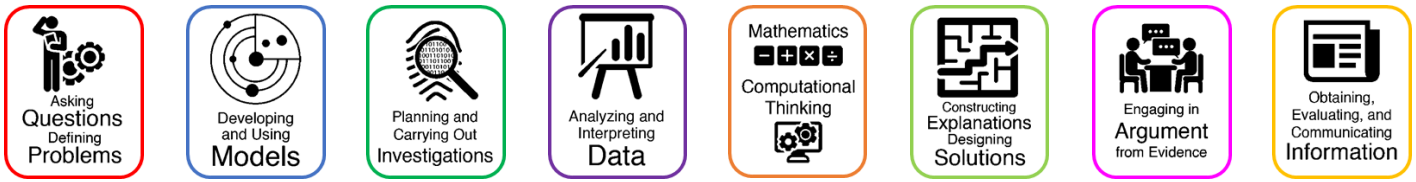
The next section of this unit explores all the different types of renewable energy resources (Days 08-10). Students will work in groups of 2-3 to research a specific renewable energy resource using guiding questions and then share their research in a gallery walk format. Students will take notes about all the other energy resources using the Renewable Energy Chart, followed by some time to share and compare notes with a partner, followed by a teacher debrief to answer stamp key points about each renewable energy resource, answer questions, and address misconceptions.

The last section of this unit addresses some miscellaneous topics that are related to energy resources. First students will work with a partner to complete a webquest about using hydrogen as an energy resource (particularly in vehicles) and describe the potential benefits and drawbacks of using hydrogen fuel cells (Day 11). Next students will explore energy conservation strategies (residential and large scale) by completing a webquest with a partner and a focus on describing the advantages and disadvantages of each technique (Day 12). To conclude this section and the unit students will spend the last instructional day practicing with mathematical routines related to energy resources because this is one of the units that is very likely to be tested with calculations on the AP Exam (Day 13).

FOR EXTRA PRACTICE OR REVIEW THE TEACHER CAN ASSIGN ALL OF PART OF THE UNIT 6 PROGRESS CHECK QUIZ ON AP CLASSROOM.

Focus on Disciplinary Literacy

In science, disciplinary literacy is synonymous with the science and engineering practices. The SEPs are the context through which all science concepts should be taught. In the lessons, you will find the Science and Engineering practices icons when the SEPs are being explicitly used by students.



APES Teams Join Link: This Teams is essential for teachers and contains both district resources and Physics Course Leader and Team contributions. All professional development meetings and trainings will be hosted in Professional Development Channel of this Team, and teachers will need to join to appreciate the full support and hard work the Course Leaders put in to help support the Physics teacher family.

UNPACKED CONTENT STANDARDS

Below are the standards **taught** and **assessed** in this unit.

Topic		Learning Objective		Essential Knowledge	
6.1	Renewable and Nonrenewable Resources	ENG-3.A	Identify differences between nonrenewable and renewable energy sources.	ENG-3.A.1	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.
6.2	Global Energy Consumption	ENG-3.B	Describe trends in energy consumption.	ENG-3.B.1	The use of energy resources is not evenly distributed between developed and developing countries.
				ENG-3.B.2	The most widely used sources of energy globally are fossil fuels.
				ENG-3.B.3	As developing countries become more developed, their reliance on fossil fuels for energy increases.
				ENG-3.B.4	As the world becomes more industrialized, the demand for energy increases.
				ENG-3.B.5	Availability, price, and governmental regulations influence which energy sources people use and how they use them.
6.3	Fuel Types and Uses	ENG-3.C	Identify types of fuels and their uses.	ENG-3.C.1	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.
				ENG-3.C.2	Peat is partially decomposed organic material that can be burned for fuel.
				ENG-3.C.3	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.
				ENG-3.C.4	Natural gas, the cleanest of the fossil fuels, is mostly methane.
				ENG-3.C.5	Crude oil can be recovered from tar sands, which are a combination of clay, sand, water, and bitumen.
				ENG-3.C.6	Fossil fuels can be made into specific fuel types for specialized uses (e.g., in motor vehicles).
				ENG-3.C.7	Cogeneration occurs when a fuel source is used to generate both useful heat and electricity
6.4	Distribution of Natural Energy Resources	ENG-3.D	Identify where natural energy resources occur.	ENG-3.D.1	The global distribution of natural energy resources, such as ores, coal, crude oil, and gas, is not uniform and depends on regions' geologic history
6.5	Fossil Fuels	ENG-3.E		ENG-3.E.1	The combustion of fossil fuels is a chemical reaction between the fuel and oxygen that yields carbon dioxide and water and releases energy.

			Describe the use and methods of fossil fuels in power generation.	ENG-3.E.2	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 spins a generator, producing electricity.
				ENG-3.E.3	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.	ENG-3.F.1	Hydrologic fracturing (fracking) can cause groundwater contamination and the release of volatile organic compounds.
6.6	Nuclear Power	ENG-3.G	Describe the use of nuclear energy in power generation.	ENG-3.G.1	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
				ENG-3.G.2	Radioactivity occurs when the nucleus of a radioactive isotope loses energy by emitting radiation.
				ENG-3.G.3	Uranium-235 remains radioactive for a long time, which leads to the problems associated with the disposal of nuclear waste.
				ENG-3.G.4	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.	ENG-3.H.1	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.H.2	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.
6.7	Energy from Biomass	ENG-3.I	Describe the effects of the use of biomass in power generation on the environment.	ENG-3.I.1	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.
				ENG-3.I.2	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.
6.8	Solar Energy	ENG-3.J	Describe the use of solar energy in power generation.	ENG-3.J.1	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.
				ENG-3.J.2	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.
				ENG-3.J.3	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.	ENG-3.K.1	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.

6.9	Hydroelectric Power	ENG-3.L	Describe the use of hydroelectricity in power generation.	ENG-3.L.1	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. The turbine spins a generator, producing electricity. Turbines can also be placed in small rivers, where the flowing water spins the turbine, which spins a generator and forms electricity.
				ENG-3.L.2	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.	ENG-3.M.1	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.
6.10	Geothermal Energy	ENG-3.N	Describe the use of geothermal energy in power generation.	ENG-3.N.1	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 spins a turbine, which spins a generator, producing electricity.
		ENG-3.O	Describe the effects of the use of geothermal energy in power generation on the environment.	ENG-3.O.1	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.
6.11	Hydrogen Fuel Cell	ENG-3.P	Describe the use of hydrogen fuel cells in power generation.	ENG-3.P.1	Hydrogen fuel cells are an alternate to nonrenewable fuel sources. They use hydrogen as fuel, combining the hydrogen fuel 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.	ENG-3.Q.1	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.
6.12	Wind Energy	ENG-3.R	Describe the use of wind energy in power generation.	ENG-3.R.1	Wind turbines use the kinetic energy of moving air to spin a turbine, which spins a generator, producing electricity.
		ENG-3.S	Describe the effects of the use of wind energy in power generation on the environment.	ENG-3.S.1	Wind energy is a renewable, clean source of energy. However, birds and bats may be killed if they fly into the spinning turbine blades.
6.13	Energy Conservation	ENG-3.T	Describe methods for conserving energy.	ENG-3.T.1	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.
				ENG-3.T.2	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.

KEY UNDERSTANDINGS AND QUESTIONS

Important big ideas and processes for the unit.

Key Understandings
❑ EIN-2: When humans use natural resources, they alter natural systems. ❑ STB-1: Humans can mitigate their impact on land and water resources through sustainable use. – not in CED ❑ ENG-3: Humans use energy from a variety of sources, resulting in positive and negative consequences. ❑ 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. ❑ 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 the world becomes more developed, their reliance on fossil fuels for energy increases. ❑ As developing countries become more developed, their reliance on fossil fuels for energy increases. ❑ Availability, price and government regulations influence which energy resources people use and how they use them. ❑ Wood is commonly used as fuel in the forms of firewood and charcoal. ❑ The global distribution of natural energy resources, such as ores, coal, crude oil, and gas, is not uniform and depends on regions' geologic history. ❑ 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 are lignite, bituminous and anthracite. ❑ Natural gas, the cleanest fossil fuels, is mostly methane. ❑ Fossil fuels can be made into specific fuel types for specialized uses (e.g., in motor vehicles). ❑ Cogeneration occurs when fuel source is used to generate both useful heat and electricity**.** ❑ The combustion of fossil fuels is a chemical reaction between the fuel and oxygen that yields caron 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. The steam turns into a turbine which generates electricity. ❑ Humans use a variety of methods to extract fossil fuels from the earth for energy generation. ❑ Hydrologic fracking can cause ground water contamination and the release of volatile organic compounds. ❑ Crude oil can be recovered from tar sands, which are a combination of clay, sand, water, and bitumen. They are a thicker, heavier for of petroleum. ❑ Large Tar sands deposits are located in Canada (Alberta) and parts of Venezuela and the U.S. ❑ Tar sands must be surface mined and are some of the largest strip min projects in history. ❑ Tar sands must be processed by steam injection to separate bitumen from sand, followed by chemical and thermal processing to make synthetic crude oil. ❑ Processing of tar sands bitumen requires larges amount of fresh water. ❑ Pipelines carrying tar sands derived synthetic oil travel hundreds of miles across the US to move it to refineries. This creates habitat fragmentation and significant risk of oil spills.

- ❑ Nuclear power is generated through fission where atoms of U-235 which are stored in fuel rods and split into smaller parts after being struck by neutron. Nuclear fission releases large amounts 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.
- ❑ U-235 remains radioactive for a long time which leads to problems associated with the disposal of nuclear waste.
- ❑ Nuclear power generation is a non-renewable energy source. It is considered a cleaner energy source because it does not produce air pollutants.
- ❑ 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
- ❑ Hydrogen fuel cells are an alternate to nonrenewable fuel sources. They use hydrogen as fuel, combining the hydrogen fuel 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.
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- ❑ 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.
- ❑ Students must **SHOW ALL WORK** for all APES calculation questions.
- ❑ Dimensional Analysis calculations should be done using railroad tracks to cross out canceling units (in the numerator and denominator) until the only units left are what is required to answer the question.
- ❑ Percentages are equivalent to a fraction over 100
- ❑

Key Questions

BIG IDEA 1 – *Energy Transfer*

- Why are fossil fuels the most widely used energy resources in the world if they are nonrenewable?

BIG IDEA 4 – *Sustainability*

- What would a sustainable energy plan for the United States look like?
- What is the most sustainable energy resource?
- Do renewable energy resources have negative environmental impacts?
- How can people use less energy at home? How can society

ROADMAP

AT A Glance: Unit #:				
Day	**Date**	**Lesson**	**Lesson Title**	**Lesson & Pacing Notes**
1		01	Global Energy Consumption	
2		02	Fossil Fuels – Day 1	
3		03	Fossil Fuels – Day 2	
4		04	Electricity & Fracking	
5		05	Tar Sands	
6		06	Nuclear Energy	
7		07	Nuclear Energy Debate	
8		08	Renewable Energy Project - 1	
9		09	Renewable Energy Project - 2	
10		10	Renewable Energy Project - 3	
11		11	Hydrogen Fuel Cells (HFC)	
12		12	Energy Conservation	
13		13	Energy Math	
14	**TX_SCI_APEnvironmentalScience_S26_UE6**			
15	**Succes Day (time permitting)**			

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 1 **Global Energy Consumption**	**STANDARD(s):** **Topic 6.1: Renewable & Nonrenewable Resources** **ENG-3.A - Identify** differences between nonrenewable and renewable energy sources. **Topic 6.2: Global Energy Consumption** **ENG-3.B - Describe** trends in energy consumption. **Topic 6.4: Distribution of Natural Resources** **ENG-3.D - Identify** where natural energy resources occur **SWBAT: Describe** the distribution of natural resources throughout the United States **SWBAT: Describe** the major trends in global and United States energy consumption by analyzing data **DISCIPLINARY LITERACY FOCUS:**  	**KEY UNDERSTANDINGS CHECKLIST:** ❑ 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. ❑ 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 the world becomes more developed, their reliance on fossil fuels for energy increases. ❑ As developing countries become more developed, their reliance on fossil fuels for energy increases. ❑ Availability, price and government regulations influence which energy resources people use and how they use them. ❑ Wood is commonly used as fuel in the forms of firewood and charcoal. ❑ The global distribution of natural energy resources, such as ores, coal, crude oil, and gas, is not uniform and depends on regions' geologic history. **LESSON CONTEXT FOR LESSON MASTERY:** Students will examine maps and data about US Natural Resource distribution and energy consumption in the US and World to build understanding about how the US compares to other countries/regions in the amount and types of energy resources. **LOOK-FORS 🔍 (What to observe students doing or producing)** • Students describing historical trends in global and U.S. energy use. • Students comparing total energy use and per capita energy use. • Students comparing the percentage nonrenewable vs renewable energy resources amount off fossil fuels use. • Students describing that natural resources are unevenly distributed due to geography and geology • Students comparing energy use (amount and types) between developed and developing nations.	Day01-U6-Energy-Distribution-Consum **TEACHER BACKGROUND CONTENT RESOURCES.** Our World in Data-Energy Smedes APES 6.2 AP Classroom 6.2 video#1 AP Classroom 6.2 video#2

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		COMMON MISCONCEPTIONS ⚑ (Historical/widespread misunderstandings) • Students think energy is used equally everywhere. Natural resources are evenly distributed. They fail to make the connection that geological and climatic factors cause uneven resource availability. • Students confusing total and per capita energy use for a population. **MAKING CONNECTIONS** • Sustainable energy use is one of the key pillars of creating sustainable societies • Reducing the use of fossil fuels (by conservation or efficiency) is one of the most effective ways to reduce air pollution and climate change (Unit 09).	
Day 2 Fossil Fuels Day 1	**STANDARD(s):** **Topic 6.3 – Fuel Types and Uses** **ENG-3.C - Identify** types of fuels and their uses. **Topic 6.5 – Fossil Fuels** **ENG-3.E - Describe** the use and methods of fossil fuels in power generation. **ENG-3.F - Describe** the effects of fossil fuels on the environment. **SWBAT: Compare and contrast** the different types of fossil fuels by describing the characteristics	**KEY UNDERSTANDINGS CHECKLIST:** ❑ 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 are lignite, bituminous and anthracite. ❑ Natural gas, the cleanest fossil fuels, is mostly methane. ❑ Fossil fuels can be made into specific fuel types for specialized uses (e.g., in motor vehicles). ❑ The global distribution of natural energy resources, such as ores, coal, crude oil, and gas, is not uniform and depends on regions' geologic history **LESSON CONTEXT FOR LESSON MASTERY:** Students will work as partners to research one of the three conventional fossil fuel resources and make a **mini poster** about their energy resources to share with classmates. Groups will huddle with same-topic partners to compare	Day02-03-U6-Energy-NonrenewableEne **TEACHER BACKGROUND CONTENT RESOURCES**. **Khan Academy – Nonrenewable energy resources** **Guide to the Creation and Production of Petroleum** – formation of oil and natural gas

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 3 **Fossil Fuels Day 2**	and environmental impacts of each. **DISCIPLINARY LITERACY FOCUS:** Constructing Explanations Designing Solutions	notes and identify the main points that need to be shared with classmates. Students will then be partnered with different-topic groups to share their findings about their fossil fuel. Students will record their information and data on the Fossil Fuels Chart (Day 3) **LOOK-FORS (What to observe students doing or producing)** • Students comparing the three types of coal. • Students describing how crude oil is refined into other products. • Students comparing advantages and disadvantages of coal, oil, and natural gas in writing and discussion. • Students describing how oil and natural gas are commonly found together. **COMMON MISCONCEPTIONS (Historical/widespread misunderstandings)** • Students think energy is used equally everywhere. Natural resources are evenly distributed. They fail to make the connection that geological and climatic factors cause uneven resource availability. **MAKING CONNECTIONS** • The biggest connection for fossil fuel energy resources is the fact that their use is a huge impact on the carbon cycle (Unit 1) because carbon trapped in sedimentary rock is rapidly being extracted and burned which releases that carbon to the atmosphere which is a major cause of climate change (Unit 9) • Coal is commonly mined through surface mining (Unit 5). • The extraction of oil and natural gas is a much different process than the surface mining (Unit 5) because it has a much smaller footprint on the ground and has different environmental impacts such as oil spill (Unit 08) and methane release (Unit 09).	National Geographic - Coal – formation and 3 types of coal
Day 4 **Electricity & Fracking**	**STANDARD(s):** **Topic 6.5 – Fossil Fuels** **ENG-3.E - Describe** the use and methods of fossil fuels in power generation.	**KEY UNDERSTANDINGS CHECKLIST:** ❑ The combustion of fossil fuels is a chemical reaction between the fuel and oxygen that yields caron dioxide and water and releases energy.	Day04-U6-Energy-Electricity-Fracking.dc

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
	ENG-3.F - Describe the effects of fossil fuels on the environment. **Explain** the process used to create electricity in a coal burning power plant **Explain** the process of hydraulic fracking and **describe** the environmental impacts of using this process. **DISCIPLINARY LITERACY FOCUS:**  	❑ Energy from fossil fuels is produced by burning those fuels to generate heat which then turns water into steam. The steam turns into a turbine which generates electricity. ❑ Humans use a variety of methods to extract fossil fuels from the earth for energy generation. ❑ Hydrologic fracking can cause ground water contamination and the release of volatile organic compounds. **LESSON CONTEXT FOR LESSON MASTERY:** This lesson includes two topics that are not directly related but have been combined into one less in the interest of time. Students will watch videos about coal burning power plants and hydraulic fracturing (fracking), record observations and answer CFUs on the student document, then engage in small group and class discussions. **LOOK-FORS 🔍 (What to observe students doing or producing)** ❑ Students describing the steps of a coal burning power plant using a diagram. ❑ Students correctly label or interpret diagrams of coal power plants and fracking wells. ❑ Students analyze data showing emissions and environmental impacts by fuel type. Students use correct vocabulary (e.g., combustion, turbine, generator, emissions, fracking, nonrenewable). **COMMON MISCONCEPTIONS ⚑ (Historical/widespread misunderstandings)** Students think that natural gas is completely clean. They cannot make the connection that It burns cleaner than coal but still emits CO_2 and can leak methane. Fracking not only uses water, but fluids contain chemical additives that can contaminate groundwater. **Making Connections** Fracking is another example of the low hanging fruit principle. Much/most of the conventional fossil fuel resources have already been accessed (low hanging fruit) so we are turning to unconventional fossil fuels like natural gas from fracking (high hanging fruit) which is typically harder and more costly to access and/or use and has more significant environmental impacts	**TEACHER BACKGROUND CONTENT RESOURCES**. Just Energy Blog post Nat Geo Video NRDC - Fracking Seeker - video Smedes APES 6.5

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 5 **Tar Sands**	**STANDARD(s):** **Topic 6.3 – Fuel Types and Uses** **ENG-3.C - Identify** types of fuels and their uses. **Topic 6.5 – Fossil Fuels** ~~**ENG-3.E - Describe** the use and methods of fossil fuels in power generation.~~ **ENG-3.F - Describe** the effects of fossil fuels on the environment. **SWBAT: Explain** the process of extracting and using the energy from tar/oil sands **SWBAT: Describe** the environmental impacts of using oil sands as an energy resource **DISCIPLINARY LITERACY FOCUS:** Constructing Explanations Designing Solutions	**KEY UNDERSTANDINGS CHECKLIST:** ❑ Humans use a variety of methods to extract fossil fuels from the earth for energy generation. ❑ Crude oil can be recovered from tar sands, which are a combination of clay, sand, water, and bitumen. They are a thicker, heavier for of petroleum. ❑ Large Tar sands deposits are located in Canada (Alberta) and parts of Venezuela and the U.S. ❑ Tar sands must be surface mined and are some of the largest strip min projects in history. ❑ Tar sands must be processed by steam injection to separate bitumen from sand, followed by chemical and thermal processing to make synthetic crude oil. ❑ Processing of tar sands bitumen requires larges amount of fresh water. ❑ Pipelines carrying tar sands derived synthetic oil travel hundreds of miles across the US to move it to refineries. This creates habitat fragmentation and significant risk of oil spills. **LESSON CONTEXT FOR LESSON MASTERY:** Tar/oil sands are an unconventional fossil fuel because the extraction process is much more complicated, expensive, and environmentally degrading. Tar/oil sands were identified as an energy resource over 100 years ago but because of all the difficulty and expense involved in extracting and processing them have not been used at any significant scale until the past few decades when they became profitable due to rising oil prices. Students will explore Oil/Tar Sands by watching videos with opposing perspectives on the use of this unconventional fossil fuel and a guided whole class discussion led by the teacher. **LOOK-FORS 🔍 (What to observe students doing or producing)** • Students describing tar sands (oil sands) as a mixture of sand, clay, water, and bitumen. • Students identifying where tar sands are found, such as Alberta, Canada.	Day05-U6-Energy-TarSands.docx **TEACHER BACKGROUND CONTENT RESOURCES.** Canadian Tar Sands – The Largest Industrial Project in Human History TED – The True Cost of Oil Suncor Oil Sands Tour Video – Oil Sands 101

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		• Students describing the major environmental impacts of using tar sands as an energy resources including: habitat destruction, large amounts freshwater used that is not able to be released back into surface waters. **COMMON MISCONCEPTIONS ⚑ (Historical/widespread misunderstandings)** • Students think that tar sands oil is the same as conventional crude oil deposits. • Students think that tar sands pollution is only local (Alberta, Canada) They do not connect that emissions and deforestation contribute to global climate change and oil spills from pipelines can affect areas hundreds of miles away from the mines. **MAKING CONNECTIONS** • Tailings ponds for tar sands processing have a lot in common with the manure lagoons created by CAFOs. The waste that is stored in them is entirely different chemically but contain hold water that cannot be safely released into surface waters. Both are highly toxic wastewater stored in open ponds that over time can leak into ground water or rupture that can result in massive environmental destruction. • Tar sands require so much extraction and processing that the net amount of energy available from them is much less than conventional crude oil resources, similar to comparing the net amount of energy availble from anthracite to lignite.	

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 6 **Nuclear Energy** **Day 7** **Nuclear Energy Debate**	**STANDARD(s):** **Topic 6.6 – Nuclear Power** **ENG-3.G - Describe** the use of nuclear energy in power generation**.** **ENG-3.H - Describe** the effects of the use of nuclear energy on the environment. **SWBAT: Explain** the process used in a U-235 nuclear power plant to create electricity using a diagram of a nuclear power plant. **SWBAT: Describe** the advantages and disadvantages of using nuclear energy resources. **DISCIPLINARY LITERACY FOCUS:**  	**KEY UNDERSTANDINGS CHECKLIST:** ❑ Nuclear power is generated through fission where atoms of U-235 which are stored in fuel rods and split into smaller parts after being struck by neutron. Nuclear fission releases large amounts 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. ❑ U-235 remains radioactive for a long time which leads to problems associated with the disposal of nuclear waste. ❑ Nuclear power generation is a non-renewable energy source. It is considered a cleaner energy source because it does not produce air pollutants. ❑ 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 **LESSON CONTEXT FOR LESSON MASTERY:** Day 06 - Students will work individually and with table partners to complete a Nuclear Energy WebQuest to explore how energy stored in atoms can be used as an energy resource through nuclear fission. They will also take a virtual tour of a nuclear power plant, explore the life cycle on radioactive nuclear fuel, and explore the radioactive half-life of nuclear fuel. Day 07 – Students will have some time to work on the webquest activity from Day 06. Students will then watch a TED Talk that is a debate between two experts arguing about the need for nuclear energy as a transition energy resources as society moves toward a sustainable energy future. Students will record notes and observations and engage in disunion with classmates about the debate points made during the video. **LOOK-FORS 🔍 (What to observe students doing or producing)**	 Day06-07-U6-Energy-Nuclear.docx **TEACHER BACKGROUND CONTENT RESOURCES.** **Khan Academy – Nuclear Power** Smedes APES 6.6 **IAEA – What is Clean Energy Transition and How Does Nuclear Power Fit In?** **TED: Does the World Need Nuclear Energy? (23 min)**

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		• Students describing the process of nuclear fission. • Students labeling and describing each component of step of how a nuclear power plant generates electricity . • Students labeling a diagram of a nuclear power plant. • Student discussing how long it will take before spent nuclear fuel rods will become nontoxic/safe using radioactive half life. **COMMON MISCONCEPTIONS ⚑ (Historical/widespread misunderstandings)** • Thinking that nuclear power produces air pollution and/or CO_2 (greenhouse gases) because they have smokestack with what appears be smoke coming out of them (but is actually steam from water used to cool the nuclear reactors) • Confusing nuclear fission with fusion (both release large amounts of energy – remember that fusion "fuse" is two things/atoms being put together, but fission is a split, or two things/atoms being split into pieces. **MAKING CONNECTIONS** • Nuclear Energy primarily uses Uranium as an energy source and it must be mined and refined, like other mined minerals, before being using in a Nuclear Power Plant to generate electricity, so it has many of the same environmental impacts as surface mining or underground mining. • Nuclear Power Plants function primarily the same as fossil fuel power plants only the high-pressure steam is created using nuclear fission instead of burning fossil fuels. • Nuclear power is difficult to accurately compare with other energy resources because its major environmental/health impact is creating radioactive waste that is dangerous for hundreds of thousands of years and must be stored for longer than people can accurately account for.	
Day 8 **Renewable Energy 1**	**STANDARD(s):** **Topic 6.7: Energy from Biomass**	**KEY UNDERSTANDINGS CHECKLIST:** ❑ Renewable energy sources are those that can be replenished naturally, at or near the rate of consumption, and reused.	

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 9 **Renewable Energy 2** **Day 10** **Renewable Energy 3**	**ENG-3.I - Describe** the effects of the use of biomass in power generation on the environment. **Topic 6.8: Solar Energy** **ENG-3.J - Describe** the use of solar energy in power generation. **ENG-3.K - Describe** the effects of the use of solar energy in power generation on the environment. **Topic 6.9: Hydroelectric Power** **ENG-3.L - Describe** the use of hydroelectricity in power generation. **ENG-3.M - Describe** the effects of the use of hydroelectricity in power generation on the environment. **Topic 6.10: Geothermal Energy** **ENG-3.N - Describe** the use of geothermal energy in power generation. **ENG-3.O - Describe** the effects of the use of geothermal energy in power generation on the environment. **Topic 6.12: Wind Energy** **ENG-3.R - Describe** the use of wind energy in power generation. **ENG-3.S - Describe** the effects of the use of wind energy 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. ❑ 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. ❑ 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 spins a turbine, which spins a generator, producing electricity. ❑ 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. ❑ Wind turbines use the kinetic energy of moving air to spin a turbine, which spins a generator, producing 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. **LESSON CONTEXT FOR LESSON MASTERY:** Students will work in small groups to research particular aspects of a renewable energy resource and create a mini-poster about this energy resource to share with classmates. **Days 08-10**	 Day08-10-U6-Energy-RenewableEnergy. **TEACHER BACKGROUND CONTENT RESOURCES**. **Khan Academy – Solar Energy** **Student-Energy-renewable energy videos** - see videos on left panel for each renewable energy

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
	SWBAT: Describe the advantages and disadvantages of different renewable energy resources relative to each other and to nonrenewable energy resources. **DISCIPLINARY LITERACY FOCUS:**  	Students will research and create a mini poster for one of the following renewable energy resources: • Biomass – focus on corn ethanol • Solar – Photovoltaic Cells • Solar - Concentrated Solar Power (Solar Power Plant) • Hydroelectric – Rivers • Hydroelectric - Tidal • Geothermal • Wind – both onshore and offshore **Day 11** Students will share their information with classmates in a galley walk or speed dating format. **LOOK-FORS (What to observe students doing or producing)** • Students describing how the energy resource is harnessed and usually converted into electricity. • Discussion about the advantages and disadvantages of energy resources. • Choosing images to convey the most important points about an energy resource. **COMMON MISCONCEPTIONS (Historical/widespread misunderstandings)** • Thinking that renewable energy resources do not have negative environmental impacts. They all do. • Confusing passive and active solar energy. If a solar energy system requires any machinery, it is an active system. Passive systems can only be used to heat buildings or water. **MAKING CONNECTIONS** • Solar Energy is similar to the process of photosynthesis by producers in that they both store sunlight in a form that can be used later. • All renewable energy resources other than Geothermal directly or indirectly come from the sun.	

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 11 **Hydrogen Fuel Cells (HFC)**	**Topic 6.11: Hydrogen Fuel Cell** **ENG-3.P - Describe** the use of hydrogen fuel cells in power generation. **ENG-3.Q - Describe** the effects of the use of hydrogen fuel cells in power generation on the environment. **SWBAT: Explain** the processes of creating hydrogen fuel through electrolysis and using hydrogen fuel to create electricity **SWBAT: Describe** the advantages and disadvantages of using hydrogen fuel cells for vehicles as part of a renewable energy plan. **DISCIPLINARY LITERACY FOCUS:**  	**KEY UNDERSTANDINGS CHECKLIST:** ❑ Hydrogen fuel cells are an alternate to nonrenewable fuel sources. They use hydrogen as fuel, combining the hydrogen fuel 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. **LESSON CONTEXT FOR LESSON MASTERY:** Students will explore how hydrogen fuel cells **ARE NOT A RENEWABLE ERNERGY RESOURCE** but can be part of a more sustainable energy future if used along with renewable energy resources using a teacher demonstration and watching videos with guided questions and small group and whole class discussion. **LOOK-FORS 🔍 (What to observe students doing or producing)** • Students comparing the process of a hydrogen fuel cell can creating hydrogen fuel through electrolysis versus a hydrogen fuel cell being used to power a vehicle. • Students describing the environmental benefits and challenges of hydrogen fuel. **COMMON MISCONCEPTIONS 🚩 (Historical/widespread misunderstandings)** • Thinking that hydrogen fuels cells are ALWAYS renewable/sustainable because they do produce and pollution or emit CO_2. Hydrogen fuels are only as renewable/sustainable as the process that was used to create the hydrogen fuel. Hydrogen fuels cells are essentially only an energy storage technology. • Thinking that Hydrogen Fuel cell (HFEV) cars are the same as battery powered electric vehicles (BEV). Hydrogen fuel cells produce electricity onboard using hydrogen fuel, while BEVs **s**tore energy in batteries to use to power the vehicle. **MAKING CONNECTIONS**	Day11-U6-Energy-HFC.docx **TEACHER BACKGROUND CONTENT RESOURCES.** **Fuel Cells Explained** **Smedes APES 6.11**

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		Hydrogen is not a energy resource like fossil fuels, sunlight, or wind because hydrogen fuel must be created which requires energy, but it still can be an important tool for a renewable energy future when renewable energy is used to create the hydrogen fuel.	
Day 12 **Energy Conservation**	**Topic 6.13: Energy Conservation** **ENG-3.T - Describe** methods for conserving energy. **SWBAT: Explain** how energy conservation is related to sustainability**.** **SWBAT: Describe** the pros and cons of different energy conservation techniques for households and on a larger scale (cities, regions, countries). **DISCIPLINARY LITERACY FOCUS:**  	**KEY UNDERSTANDINGS CHECKLIST:** ❑ 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. **LESSON CONTEXT FOR LESSON MASTERY:** Students will compare different techniques to conserve energy on a large scale (society and communities) and small scale (at home) using videos and guided discussion. **LOOK-FORS 🔍 (What to observe students doing or producing)** • Students use correct terminology: energy efficiency, conservation, sustainability, smart grid, green building design. • Students proposing **realistic solutions** for saving energy in their homes or communities. • Students discussion the advantages and disadvantages of different energy conservation techniques. **COMMON MISCONCEPTIONS 🚩 (Historical/widespread misunderstandings)** • Students think that conservation means using less energy only at home but do not consider how decisions made about large scale structures have significant impacts on energy use (communities, industries, states, and nations) for systems like transportation, building codes, etc.	Day12-U6-Energy-Conservation.docx **TEACHER BACKGROUND CONTENT RESOURCES.** **Khan Academy – Energy Conservation**

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		MAKING CONNECTIONS • Every bit of energy that is conserved (or not wasted) is less of an energy resource that needs to be extracted or collected, refined and transported to the consumer for use. This means decreased impacts of mining, decreased amounts of air pollution (for fossil fuels) • There is no sustainable use of energy resources without energy conservation as part of the design	
Day 13 **Practice - Energy Math**	**Science Practice 6.A**: **Determine** an approach or method aligned with the problem to be solved. **Science Practice 6.B**: Apply appropriate mathematical relationships to solve a problem, with work shown (e.g., dimensional analysis). **Science Practice 6.C: Calculate** an accurate numerical answer with appropriate units. **SWBAT:** Perform accurate calculations for energy topics by showing all their work. **Disciplinary Literacy Focus** 	**KEY UNDERSTANDINGS CHECKLIST:** ❑ Students must **SHOW ALL WORK** for all APES calculation questions. ❑ Dimensional Analysis calculations should be done using railroad tracks to cross out canceling units (in the numerator and denominator) until the only units left are what is required to answer the question. ❑ Percentages are equivalent to a fraction over 100 **LESSON CONTEXT FOR LESSON MASTERY:** Students will practice energy calculations individually and in small groups. Teacher should determine the amount of guided practice vs partner practice vs independent practice based on class needs for scaffolding. Teacher guided practice should be done as a Think Aloud with Explicit Explanations. Students should work in partners or small groups to jot-pair-share answers and processes used to set up calculations. **LOOK-FORS 🔍 (What to observe students doing or producing)** • Students use correct terminology: energy efficiency, conservation, sustainability, smart grid, renewable integration. • Students propose realistic solutions for saving energy in their homes or communities. **COMMON MISCONCEPTIONS 🚩 (Historical/widespread misunderstandings)** • Students using percentages in calculations directly rather than using the fraction/decimal that the percentage represents (x/100) • Students not using railroad tracks to perform calculations with dimensional analysis	Day13-APES-Energy MathPractice-studer Day13-APES-Energy MathPractice-AK.doc Exit_Ticket-Day13-Energy.docx Exit_Ticket-Day13-Energy-AK.docx **TEACHER BACKGROUND CONTENT RESOURCES** AP Classroom 6.13 Video#2

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		• Confusing Kilowatts and Kilowatt-hours (kWh) – Watts are measurements of Power (energy use/ time or Joules/sec) but Kilowatt-hours are a measurement of energy (power times time). **MAKING CONNECTIONS** • The power bill that students' parents receive at their home tells them the number of kilowatt-hours (kWh) that they used each month and the amount they owe is calculated as: $$\#\ \boldsymbol{kWh}\ \boldsymbol{x}\ \frac{\$}{\boldsymbol{kWh}} = \boldsymbol{total\ cost}$$ • Students must be able to make accurate calculations using dimensional analysis on the AP Exam and Energy questions are one of the common types.	
Day 14 **Unit 6 Exam**	**Unit Exam 6: Energy Resources** **TX_SCI_APEnvironmentalScience_S26_UE6**	**Scanning Deadline: Jan 28, 2026**	
Day 15	**Success Day (time permitting)**		

VERTICAL STANDARDS

This section details the **progression** of key student expectations/standards** in the courses **before** and **after** this course. This will help you understand what **prior knowledge skills to build upon** and guide you in knowing what **skills you are preparing your students** for in the subsequent course.

BEFORE AP Environmental Science

Grade 5

3-5(7) Force, motion, and energy. The student knows the nature of forces and the patterns of their interactions. The student is expected to:

- 5(8)(A) - investigate and describe the transformation of energy in systems such as energy in a flashlight battery that changes from chemical energy to electrical energy to light energy;
- 5(8)(B) - demonstrate that electrical energy in complete circuits can be transformed into motion, light, sound, or thermal energy and identify the requirements for a functioning electrical circuit; and

Grade 6/7

6(8) Force, motion, and energy. The student knows that the total energy in systems is conserved through energy transfers and transformations. The student is expected to:

- 6(8)(A) - compare and contrast gravitational, elastic, and chemical potential energies with kinetic energy;
- 6(8)(B) - describe how energy is conserved through transfers and transformations in systems such as electrical circuits, food webs, amusement park rides, or photosynthesis; and

6(11) Earth and space. The student understands how resources are managed. The student is expected to:

- 6(11)(A) research and describe why resource management is important in reducing global energy, poverty, malnutrition, and air and water pollution, and
- 6(11)(B) explain how conservation, increased efficiency, and technology can help manage air, water, soil, and energy resources.

7(8) Force, motion, and energy. The student understands the behavior of thermal energy as it flows into and out of systems. The student is expected to:

- 7(8)(A) - investigate methods of thermal energy transfer into and out of systems, including conduction, convection, and radiation;
- 7(8)(B) - investigate how thermal energy moves in a predictable pattern from warmer to cooler until all substances within the system reach thermal equilibrium; and
- 7(8)(C) - explain the relationship between temperature and the kinetic energy of the particles within a substance.

7(11) Earth and space. The student understands how human activity can impact the hydrosphere. The student is expected to:

- 7(11)(A) analyze the beneficial and harmful influences of human activity on groundwater and surface water in a watershed; and
- 7(11)(B) describe human dependence and influence on ocean systems and explain how human activities impact these systems.

8th Grade Science

8(11) Earth and space. The student knows that natural events and human activity can impact global climate. The student is expected to:

- 8(11)(A) use scientific evidence to describe how natural events, including volcanic eruptions, meteor impacts, abrupt changes in ocean currents, and the release and absorption of greenhouse gases influence climate;
- 8(11)(B) use scientific evidence to describe how human activities, including the release of greenhouse gases, deforestation, and urbanization, can influence climate; and
- 8(11)(C) describe the carbon cycle.

Pre-AP Biology (Grade 8 or 9)

Pre-AP Chemistry (Grade 9 or 10)

After AP Environmental Science

AP Biology (Grade 10, 11 or 12)

AP Chemistry

VOCABULARY GLOSSARY

Domain-specific words and definitions for this unit.

Key Content Vocabulary
Renewable energy – *energy that is collected from renewable resources that are naturally replenished on a human timescale. It includes sources such as sunlight, wind, rain, tides, waves, and geothermal heat.[3]* ***Nonrenewable resource (AKA finite resource) -*** *is a natural resource that cannot be readily replaced by natural means at a pace quick enough to keep up with consumption.[1] An example is carbon-based fossil fuels.* ***Hydraulic Fracturing (Fracking) -*** *a well stimulation technique involving the fracturing of bedrock formations by a pressurized liquid. The process involves the high-pressure injection of "fracking fluid" (primarily water, containing sand or other proppants suspended with the aid of thickening agents) into a wellbore to create cracks in the deep-rock formations through which natural gas, petroleum, and brine will flow more freely.* ***Oil/Tar Sands -*** *a type of unconventional petroleum deposit. Oil sands are either loose sands or partially consolidated sandstone containing a naturally occurring mixture of sand, clay, and water, soaked with bitumen, a dense and extremely viscous form of petroleum.* ***Nuclear Fission*** *– a reaction in which the nucleus of an atom splits into two or more smaller nuclei. The fission process often produces gamma photons, and releases a very large amount of energy even by the energetic standards of radioactive decay.* *Ethanol –* ***Photovoltaic solar cells (PV cells) –*** *an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon.[1]* ***Hydroelectricity –*** *Electricity produced using kinetic energy of moving water spin turbines.* ***Geothermal Power –*** *electrical power generated from geothermal energy, the thermal energy in the Earth's crust which originates from the formation of the planet and from radioactive decay of materials in currently uncertain[1] but possibly roughly equal[2] proportions.* ***Hydrogen Fuel Cell –*** *an electrochemical cell that converts the chemical energy of a fuel (often hydrogen) and an oxidizing agent (often oxygen[1]) into electricity through a pair of redox reactions.[2] Fuel cells are different from most batteries in requiring a continuous source of fuel and oxygen (usually from air) to sustain the chemical reaction, whereas in a battery the chemical energy usually comes from metals and their ions or oxides[3] that are commonly already present in the battery, except in flow batteries. Fuel cells can produce electricity continuously for as long as fuel and oxygen are supplied.* ***Wind Power –*** the use of wind turbines to generate electricity. ***Efficiency –*** $\text{Efficiency} = \frac{\text{Useful power output}}{\text{Total power input}}$

Related Vocabulary			
turbine	*Active solar energy*	*Concentrated Solar Power*	
Methane	*Passive solar energy*	*Electrolysis*	
Peat	Tidal energy	*Green Building Design*	
Uranium-235	Hydroelectric Dam		

Radioactive half-life Three Mile Island Chernobyl Fukushima	Hydrogen sulfide Battery Electric vehicles (BEV) FCEV (Fuel Cell Electric Vehicle) Hybrid vehicles Intermittency FCEV (Fuel Cell Electric Vehicle)		