

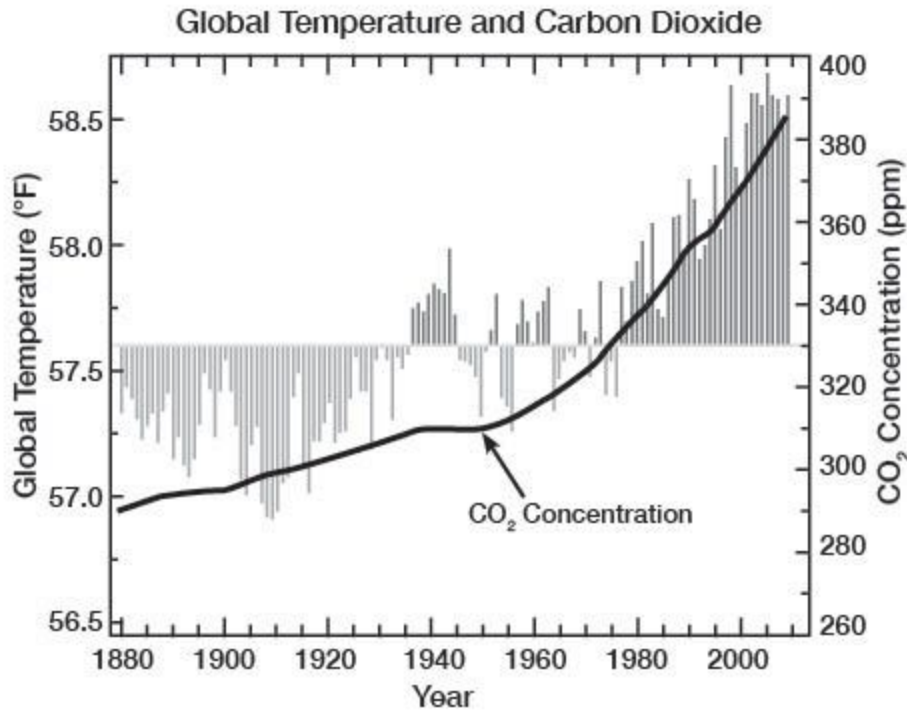
Energy Usage, Production, and Impact

Sample type:	Performance Task including stimulus and 4 items
Subject:	Earth Space Science
Learner:	High School
Standards:	NGSS: HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. SEP: Engaging in Argument from Evidence DCI: ESS3.A: Natural Resources DCI: ETS1.B: Developing Possible Solutions CCC: Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World CCC: Connections to Nature of Science: Science Addresses Questions About the Natural and Material World
DOK:	2-3

	Question 1	Question 2	Question 3	Question 4
Performance Expectation	HS-ESS3-2	HS-ESS3-2	HS-ESS3-2	HS-ESS3-2
DOK	2	3	2	2
SEP: Engaging in Argument from Evidence	x		x	x
DCI: ESS3.A: Natural Resources		x		x
DCI: ETS1.B: Developing Possible Solutions	x	x		x
CCC: Influence of Science, Engineering, and Technology on Society and the Natural World			x	x
CCC: Science Addresses Questions About the Natural and Material World	x			

Body of sample:

Stimulus:



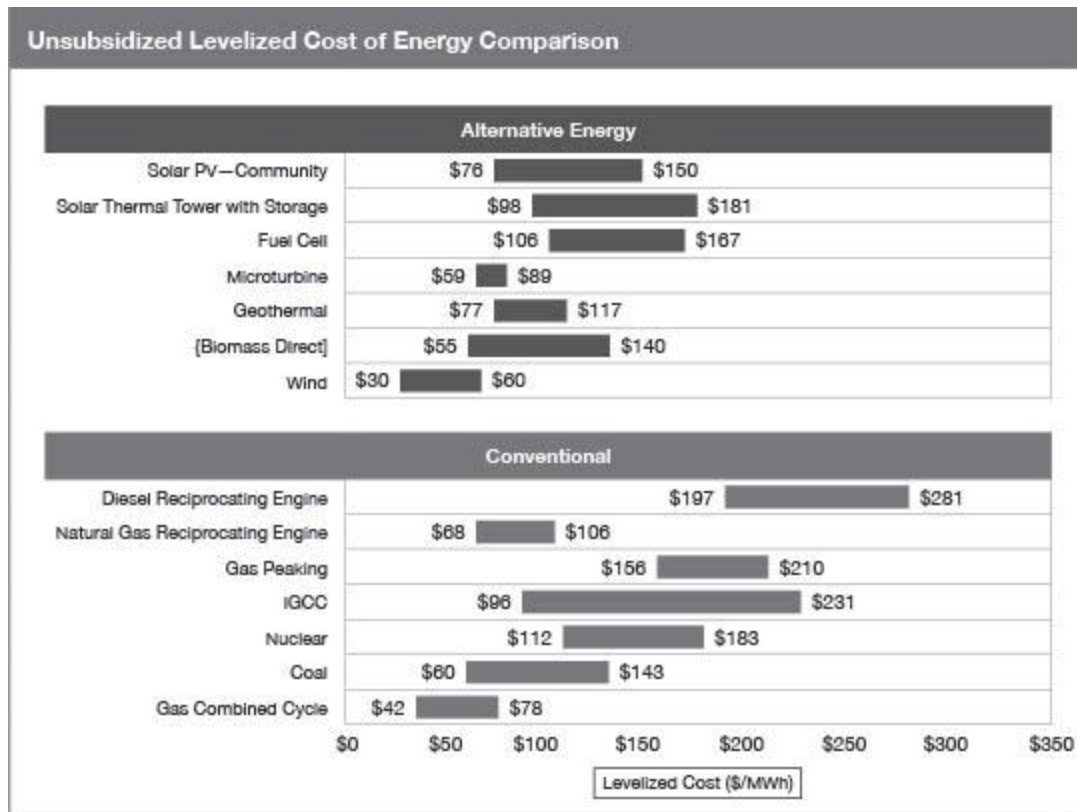
<https://www.isws.illinois.edu/statecli/climate-change/gtrends.htm>

The people of the United States use a large amount of energy in daily living — to run computers, cell phones, televisions, and other appliances; to drive cars; and to light, heat, and cool homes and businesses. And their need for energy continues to increase.

About 80% of the total energy consumed in 2017 was from fossil fuels, specifically the burning of coal, oil, natural gas, and petroleum. Emissions from burning these fossil fuels include carbon dioxide and numerous other gases. Production of these gases contributes to the greenhouse effect and causes acid rain. In addition, many health problems result from inhaling these gases, such as respiratory illnesses and heart diseases. The gases also contribute to ground-level ozone, which damages peoples' lungs, increasing the instances of asthma and chronic bronchitis.

Increasing global temperatures have also resulted in climate change, leading to changes in weather patterns and rising sea levels that affect the regions in which humans, animals, and plants live. Both droughts and excessive rain storms have caused food insecurity and displacement for humans and animals. As displacement occurs, other problems result as new organisms come in contact and compete for resources.

Despite the observable negative effects, the need for energy will not decline. Because fossil fuels are nonrenewable, societies are developing other forms of energy to meet this need.

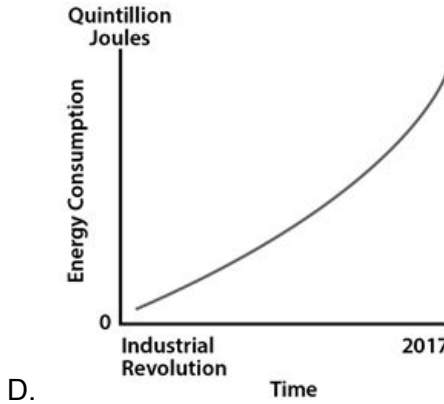
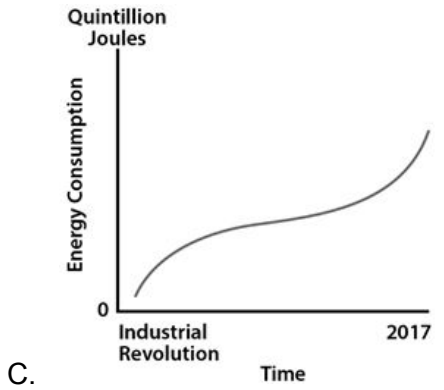
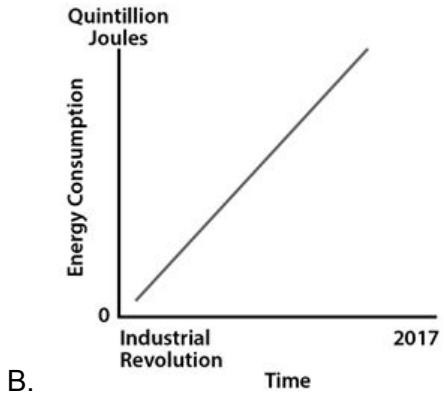
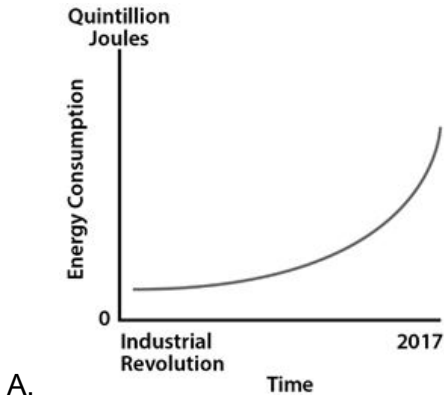


<https://www.lazard.com/perspective/levelized-cost-of-energy-2017/>

Item 1:

Evidence of Achievement: Students use their knowledge to analyze empirical evidence in the process of beginning to determine solutions to a problem.

Which graph correctly depicts energy consumption in the United States over time?



Distractor Rationales

- A. **Correct Answer.** Energy needs have grown since the Industrial Revolution due to technological advancements. Based upon the data, in 2017 energy needs reached 103 quintillion joules.
- B. This graph shows that in the year 2017, energy usage was about half of what it should be, which is in the quintillion joules.
- C. This graph shows an exponential growth in energy usage but not to the extent the data shows.
- D. This graph shows energy consumption reaching into the quintillion joules long before 2017 and increasing to a much greater amount than this by 2017.

Three-Dimensional Coach Data must match the graph. Evaluate the empirical evidence to determine the amount of energy consumption. Apply the evidence to the graphs.

Item 2:

Evidence of Achievement: Students use their knowledge to write about the associated environmental impacts of energy production and take into account the constraints and costs of other sources.

Since the Industrial Revolution, the United States has primarily been burning coal, oil, and natural gas for its energy use.

- a. What are two specific long-term environmental impacts of burning fossil fuels?
- b. What are some of the nonpolitical roadblocks that make renewable energy difficult to implement nationwide in the United States?

CR Rubric		Possible answers include:
Score	Description	
2	<p>The student demonstrates understanding of the Performance Expectation, including the ability to:</p> <ul style="list-style-type: none"> determine the associated environmental costs and risks; AND take into account a range of constraints, including cost and consider social, cultural, and environmental impacts. 	<p>a. Two specific long-term environmental impacts from burning fossil fuels are global warming and potentially raising acidic levels of water sources and soil, which can be harmful to an ecosystem and its inhabitants.</p> <p>b. The energy system in the United States is currently set up to burn fossil fuels. The transportation which carries coal, oil, and natural gas, the plants which burn fossil fuels, and the stations which distribute the electricity produced are already in place.</p> <p>Moving to a different type of energy resource would require tremendous amounts of money for gathering the resource, transporting the resource (if needed), developing and building facilities (solar farms, wind farms, geothermal plants, etc.), and distributing the electricity and/or energy source. Infrastructure must be built or changed to accommodate the new forms of energy.</p>
1	<p>The student demonstrates partial understanding of the Performance Expectation. Student is able to:</p> <ul style="list-style-type: none"> complete one of the tasks listed in the two-point score description; OR do both of the tasks listed in the two-point score description, but they contain errors. 	<p>a. The environmental impact from burning fossil fuels includes contributing to greenhouse gases and increasing acid rain.</p> <p>b. The United States cannot make the switch to renewable resources because it would cost too much.</p>
0	<p>The student demonstrates little or no understanding of the Performance Expectation.</p>	<p>a. The answer does not relate to or talk about environmental impacts.</p> <p>b. The answer does not give reasons for switching to renewable resources.</p>

Three-Dimensional Coach Look beyond the data. When developing possible solutions, be sure to pull in your scientific knowledge, based upon ideas and principles, and take into account a range of constraints in order to determine your answer. Apply what you already know to the data.

Item 3:

Evidence of Achievement: Students use their knowledge to evaluate energy plans, determining which one is the best based upon numerous factors.

California has set a goal of achieving economy-wide carbon neutrality by 2045. The state also wants to remain fiscally responsible. Order the following plans from best (1) to worst (3).

Plan A—Put 90% of investment into developing solar power resources, and divide the rest between geothermal and ocean wave and tidal resources, while maintaining the use of power plants that rely on fossil fuels.

Plan B—Immediately develop infrastructure for geothermal sources of energy, then follow up by adding wind energy while phasing out coal power plants in favor of natural gas.

Plan C—Focus on developing wind and geothermal power sources, although continuing to support solar, while gradually decommissioning coal and natural gas power plants.

Rubric	
1	C
2	B
3	A

Three-Dimensional Coach Don't forget, when determining possible design solutions, consider the social and cultural impacts of your solution. Many decisions are not made using science alone, but rely on social contexts to resolve issues.

Item 4:

Evidence of Achievement: Students determine all of the factors to consider when determining future energy sources.

The state of Illinois is considering proposals for a new power generation facility. The consulting company recommends a wind farm and lists all of the benefits of this option. Choose all the statements the consultants should include in their proposal.

- A. It is a reliable source of energy.
- B. It has no negative impacts on the environment.
- C. It is a renewable and sustainable source of energy.
- D. It is cost-efficient, even when compared to existing power plants.
- E. It is better suited to the area than other forms of energy generation.

Distractor Rationales

- A. Although there are prevailing winds, wind is not an everyday occurrence, and wind speed is highly variable.
- B. Wind farms need considerable amounts of land. People have objected to seeing turbines in their communities, and they can affect wildlife.
- C. **Correct Answer.** Wind can't be used up.
- D. **Correct Answer.** Wind energy is one of the least expensive sources of energy based on the provided graph.
- E. **Correct Answer.** According to the graph provided, wind has higher potential than solar, geothermal, or other forms of renewable energy in the region.

Three-Dimensional Coach Think big picture! When considering a possible solution, list all associated factors, whether scientific or not.

Sources: https://www.eia.gov/energyexplained/?page=us_energy_home