Issues in Energy Production

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v2.0

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Introduction

This unit book was carefully designed to provide students with the opportunity to think deeply and intelligently about the necessity of energy production and how its methods impact the environment. This unit-book does not preach environmental doctrine. The first chapter sets the tone by providing conflicting opinions on the extent of recent global warming and whether humans are responsible for it. Presented with the worst-case description of the harm that could be caused by global warming, in Chapter 2, students are encouraged to discuss whether America as a whole and they as individuals are obliged to do something to prevent it. In Chapter 3, students learn about the BP disaster and have a chance to discuss the advantages and dangers of relying on oil as a source of energy. After learning about attempts to replace the conventional gas-guzzling vehicle in Chapter 4, students discuss what kind of a car they, as environmentalists, should buy. In Chapter 5, students learn of the potential dangers of mountaintop mining and the practice of hydraulic fracturing ("fracking") used to release natural gas. They are asked to take on the roles of local farmers or natural-gas company CEOs and argue for and against fracking on a farmer's property in Pennsylvania. In Chapter 6, students decide whether they would allow a nuclear plant or disposal facility to be located within ten miles of their homes. Other chapters raise similar and often personal questions about using solar, wind-turbine, geothermal, biomass, and ocean-generated energy. Chapters 9 and 10 require students to examine their own carbon footprint and decide what they and the U.S. as a whole should do about their problems with greenhouse gases. Chapter 11 provides students with review questions and an essay question that teachers may use for a unit test on global warming.

To insure learning, each chapter provides students with multiple-choice questions on its important facts and concepts. To encourage higher-order thinking, students are assigned a short essay in which they express their opinions on the issues raised by the chapter. Teachers are presented with teacher pages that provide an overview of each chapter and their objectives and suggest teaching strategies.

CHAPTER 1

GLOBAL WARMING: CAUSED BY HUMAN ACTIVITY?

Overview

This chapter presents two sides of the issue of whether global warming exists and whether it is caused by human activity. The chapter begins with a description of three environmental disasters of the summer of 2010 (two heat waves and a flood) that many presume were caused by global warming. A chart shows the 0.8-degree Celsius increase in global warming since 1911. Most of the chapter consists of documents from various sources stating that global warming does or does not exist, and that it is or is not caused by human activity. Multiple-choice questions test students' understanding and their ability to analyze the articles. An essay question asks students to take a stand on the issues raised.

Objectives

Students will:

- read and analyze evidence that global warming does or does not exist and that it is or is not caused by human activities,
- discuss what they think the evidence presented in this chapter shows about global warming, and
- explain their own beliefs regarding global warming.

Strategies

Determine whether students have done their homework by reviewing their answers to the multiple-choice questions and discuss why each answer is correct. Emphasize that 0.8-degree Celsius increase in global temperature is equivalent to about 1.2-degrees Fahrenheit. Ask why less than 1.5-degrees warming could cause great changes in climate. Point out that climate change has been consistent in the past 25 years but its effects have not been uniform throughout the globe.

End class by having students volunteer to read their essays and explain what they originally believed about global warming and human activity and whether and how what they learned in this chapter has affected their thinking.

Assignment

Assign Chapter 2, and pass out the student reading and activities pages. Ask students to complete their assignment on their own paper if they run out of room on the handouts.

CHAPTER 1

GLOBAL WARMING: CAUSED BY HUMAN ACTIVITY?

One Hot Summer

August 9, 2010: Temperatures in the central U.S. were forecast to climb back to the 100-degree Fahrenheit (37.7 Celsius) mark that week, and in many areas it would feel much hotter than that… Excessive-heat warnings have been issued for nine states along the Mississippi River and a heat advisory covered parts of seven more states. It's the latest heat wave of a Northern Hemisphere summer that has shattered records around the world.

August 12, 2010: Russian President Dmitri Medvedev said that 25 percent of Russia's grain crops have been destroyed by weeks of drought and wildfires, leaving many Russian farmers close to bankruptcy.

August 14, 2010: Pakistan's Prime Minister Yousuf Raza Gilani said that 20 million people have been affected by the worst floods in his country's history.

There is some agreement that global warming *might have caused* unprecedented heat waves and the 2010 catastrophic fires in Russia, torrential rains in Pakistan, searing droughts in other parts of the world, and record-setting temperatures in the United States during the same year. These events have intensified the debate over climate change: whether it in fact exists, whether (if it exists) it is caused by human activities, and what if anything should be done about it. The following excerpts and one chart provide some evidence that could support either side in this debate. You will be asked to read these documents and decide what conclusions can and should be drawn from them.

March 2008: Dubious Professionals Deny Greenhouse Gases Are Causing or Will Cause Climate Change

We, the scientists and researchers in climate and related fields, economists, policymakers, and business leaders, [a total of 206] assembled at Times Square, New York City, participating in the 2008 International Conference on Climate Change … *Hereby declare:* That there is no convincing evidence that CO_2 emissions from modern industrial activity has in

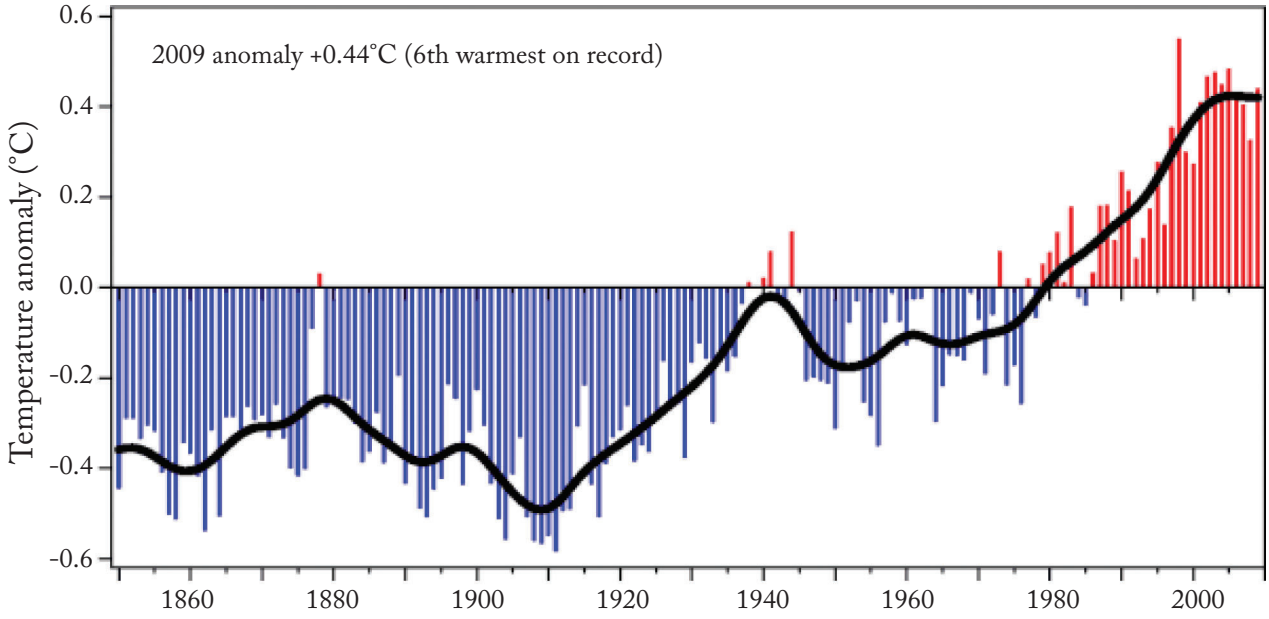
the past, is now, or will in the future cause catastrophic climate change… That attempts by governments to inflict taxes and costly regulations on industry and individual citizens with the aim of reducing emissions of CO_2 will pointlessly curtail the prosperity of the West and progress of developing nations without affecting climate… That human-caused climate change is not a global crisis… *Now, therefore, we recommend*—That world leaders reject the views expressed by the United Nations Intergovernmental Panel on Climate Change… That all taxes, regulations, and other interventions intended to reduce emissions of CO_2 be abandoned forthwith.[1]

February 2007: Report of Intergovernmental Panel on Climate Change

In its first major report [since 2001], the world's most authoritative group of climate scientists issued its strongest statement yet on the relationship between global warming and human activity. The Intergovernmental Panel on Climate Change said the likelihood was 90 percent to 99 percent that emissions of heat-trapping greenhouse gases like carbon dioxide, spewed from tailpipes and smokestacks, were the dominant cause of the observed warming of the last 50 years.[2]

Change in Global Air Temperature

Global Air Temperature[3]



1. Cornwall Alliance for the Stewardship of Creation Newsletter, October 4, 2010
2. http://www.nytimes.com/2007/02/06/science/earth/06clim.html
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April 2008: Dissent From a British Official

The following dissent was written by Nigel Lawson, a member of British Prime Minister Margaret Thatcher's Conservative Party's government:

> The readiness to embrace this fashionable belief has led the present Labor Government, enthusiastically supported by Democrats, to commit itself to a policy of drastically cutting back carbon dioxide emissions—at huge cost to the-British economy and to the living standards not merely of this generation, but of our children's generation, too.
>
> Now, I readily admit that I am not a scientist; but then neither are the vast majority of those who espouse the currently fashionable madness. Moreover, most of those scientists who speak with such certainty about global warming and climate change are not climate scientists, or Earth scientists of any kind, and thus have no special knowledge to contribute.
>
> Those who have to take the key decisions aren't scientists either. They are politicians.
>
> …Given that nowadays pretty well every adverse development in the natural world is automatically attributed to global warming, perhaps the most surprising fact about it is that it is not, in fact, happening at all. The truth is that there has so far been no recorded global warming at all this century.
>
> The world's temperature rose about half a degree Celsius during the last quarter of the 20th century but for the first seven years of the 21st century reveal there has been a standstill.
>
> Genuine climate scientists admit that Earth's climate is determined by hugely complex systems, and reliable prediction is impossible.
>
> That does not mean, of course, that we know nothing. We know that the planet is made habitable only thanks to the warmth we receive from the rays of the sun. Most of this heat bounces back into space; but some of it is trapped by the so-called greenhouse gases which exist in the Earth's atmosphere. If it were not for that, our planet would be far too cold for man to survive.
>
> The most important greenhouse gas is water vapor, including water suspended in clouds. Rather a long way behind, the second most important is carbon dioxide.
>
> The vast bulk of the carbon dioxide in the Earth's atmosphere is natural—that is, nothing to do with man. But there is no doubt that ever since the Industrial Revolution in the latter part of the 19th century, man has added greatly to atmospheric concentrations of carbon dioxide by burning carbon—first in the form of coal, and subsequently in the form of oil and gas, too.
>
> So it is reasonable to suppose that, other things being equal, this will have warmed the planet, and that further man-made carbon dioxide emissions will warm it still further.
>
> But in the first place, other things are very far from equal. And in the second place, even if they were, there is no agreement among reputable climate scientists over how much this

contributed to the modest late-20th century warming of the planet, and thus may be expected to do so in future.[4]

December 2007: Vice President Albert Gore's Nobel Prize Acceptance Speech on Climate Change

Albert Gore, vice president under President Bill Clinton, devoted years of his life researching and writing about global warming.

> [T]oday, we dumped another 70 million tons of global-warming pollution into the thin shell of atmosphere surrounding our planet, as if it were an open sewer. And tomorrow, we will dump a slightly larger amount, with the cumulative concentrations now trapping more and more heat from the sun…
>
> In the last few months, it has been harder and harder to misinterpret the signs that our world is spinning out of kilter. Major cities in North and South America, Asia and Australia, are nearly out of water due to massive droughts and melting glaciers. Desperate farmers are losing their livelihoods. Peoples in the frozen Arctic and on low-lying Pacific islands are planning evacuations of places they have long called home.. Stronger storms in the Atlantic and the Pacific have threatened whole cities… Millions have been displaced by massive flooding in South Asia, Mexico, and 18 countries in Africa… We are recklessly burning and clearing our forests and driving more and more species into extinction. The very web of life on which we depend is being ripped and frayed.[5]

4. Nigel Lawson, The real inconvenient truth: Zealotry over global warming could damage our Earth far more than climate change, Mailonline, October 4, 2010
5. Al Gore, "Nobel Peace Prize Acceptance Speech," Oslo, Norway, 10 Dec 2007

Name: _____ Date: _____

Student Activities

Global Warming: Caused by Human Activity?

A. Multiple-Choice

1. Which of the following is a definite sign that human activity is causing global warming:
   a. A drought in Russia
   b. Floods in Pakistan
   c. A very hot summer in the United States
   d. None of the above

2. On what fact about global warming, if any, do the authors of the various documents in this chapter agree?
   a. That average global temperatures have increased considerably
   b. That human activity is the cause of global warming
   c. That melting ice caps will raise ocean levels and flood major coastal cities
   d. None of the above

3. Which of the following is true:
   a. Global warming is the result of human activity
   b. There is no such thing as global warming
   c. Global temperatures were higher in the beginning of the 21st century than they were at the end of the 18th
   d. None of the above

4. The British official quoted in this chapter believes that:
   a. Human activity causes global warming
   b. There has been no global warming during the first decade of the 21st century
   c. Politicians are too quick to accept what most people believe to be true
   d. Both b and c

5. The chart in this chapter shows that:
   a. Global warming is caused by human activity
   b. There has been a decrease in global warming between 1940–1955
   c. There has been a great decrease in global warming
   d. There has been a steady increase in global warming since 1880

B. Essay

Write an essay of no fewer than 100 words explaining what you believe the relationship is between global warming and human activities. In your essay, indicate why you agree with at least one of the documents in the reading and why you disagree with at least one other document. Also note what your opinion was before you read this chapter.

CHAPTER 2
SCIENTIFIC EVIDENCE FOR GLOBAL WARMING

Overview

This chapter explains the method scientists use to verify their fact-backed hypotheses with reviews by their peers. The chapter explains that by applying this scientific method, experts in the field have agreed that the century-long trend of global warming was caused by increases in greenhouse gases, primarily carbon dioxide. The doomsday scenario predicted by one scientist is described in detail. A chart is included which shows that the U.S. is second to China in emitting carbon dioxide, and first in per-capita emissions. The activities section tests students' understanding of the facts and concepts presented in this chapter. An essay question asks them to present their thoughts about the threat posed to humans by global warming, its causes, and whether Americans should lead the world in reducing their country's carbon footprint.

Objectives

Students will:

- understand the method scientists apply in making and supporting their hypotheses,
- realize that experts in the field agree that global warming is caused by human activities and that its continued acceleration threatens to disrupt life on earth as we know it, and
- discuss what role Americans should play in curbing further global warming.

Strategies

After you have determined that students have completed their assigned homework, review their answers to the multiple-choice questions. Make sure that all students understand the facts, concepts, and reasons for the right answers to each question. Ask students to repeat what the aforementioned pessimistic climate expert predicted would occur if global warming continued to accelerate, and have students speculate what would happen to their community if the expert were right. Separate class into groups of no more than five students and ask them to discuss answers to their essay question among themselves and then ask each group to report the consensus it has reached to the rest of the class.

Assignment

Assign Chapter 3, and pass out the student reading and activities pages. Ask students to complete their assignment on their own paper if they run out of room on the handouts.

CHAPTER 2

SCIENTIFIC EVIDENCE FOR GLOBAL WARMING

Introduction

Scientists have developed a method for discovering the reasons for physical phenomena. They do their best to gather information and develop a theory based on the facts they obtain. Other scientists determine whether the explanation accounts for all the relevant information. If the theory fails to explain the known facts, other scientists reject it. These scientists continue to do more research and try to arrive at a more comprehensive theory which in turn is reviewed and modified as needed.

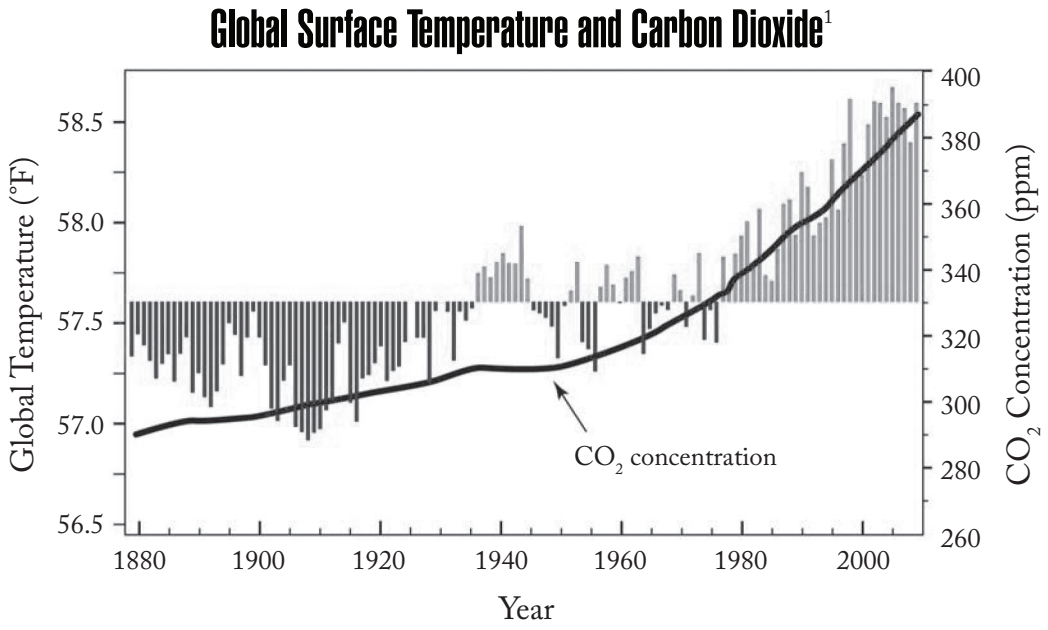
In this chapter you will learn what years of information gathering and theories and reviews by the scientific community have yielded about climate change and its causes. Most scientists agree with these conclusions, but admit that further research and better computer models are still needed to be more certain.

What Most Scientists Believe About Global Warming

The majority of scientists who have spent years studying climate and climate change have agreed on the following:

- Carbon dioxide (CO_2) is the most dangerous of the several greenhouse gases that prevent the earth's heat from being reflected back into space. Other greenhouse gases include methane, nitrous oxide, and ozone.
- The amount of carbon dioxide and other greenhouse gases in the earth's atmosphere has increased significantly over the past 130 years.
- Much of this increase is due to human activity, primarily the burning of fossil fuels and destroying forests that had once absorbed large quantities of carbon dioxide.
- The Earth's temperature has increased by over one degree Fahrenheit over the last 130 years.
- If present trends continue, however, the earth's average temperature will increase between 3 and 8 degrees by the end of this century.
- The ten hottest years have come since 1990 and the hottest year on record occurred in 2010
- Increased amounts of CO_2 in the earth's atmosphere have already and will, if this rate continues to grow, cause catastrophic changes in sea levels, precipitation, ocean currents, and global warming.

Global Temperature and Carbon Dioxide



Surface records show global average temperature continuing to rise during the last half century. Natural warming and cooling cycles (of several years to a decade) are also evident. Light gray (above average) and dark gray (below average) bars show global temperature compared to the average from 1901–2000. Source: NOAA/NCDC

The Worst-Case Scenario

As Yogi Berra, the famous New York Yankees catcher, once said, "It's hard to make predictions, especially about the future." There is little agreement among scientists about what will happen. However, even though scientists don't agree on the extent of the dangers of global warming, there are good reasons to prepare for the worst. Referring to the possibilities of extreme climate catastrophes, former assistant secretary of the U.S. Department of Energy Joseph Romm wrote:

> Imagine if the climate changed and extreme weather became so constant that it was no longer considered extreme. Mammoth heat waves like the one that killed 35,000 Europeans in 2003 would occur every other year. Mega-droughts and widespread wildfires, like those of the record-breaking 2005 wildfire season, which ravaged 8.5 million acres, would be the norm. This new climate would wipe out whole forests, including virtually every pine tree in British Columbia. The Arctic would have little or no summer ice, and the Greenland ice cap would melt, eventually raising sea levels by 20 feet.[2]

Romm predicted what could happen if carbon dioxide–based global warming persisted at an accelerated rate. By 2050, thousands would be wiped out by oppressive heat waves, water shortages, or torrential rains. Droughts would destroy crops in many areas and create desert-like

1. National Climate Data Center, U.S. Department of Commerce
2. Joseph Romm, Hell and High Water (Harper-Collins: New York, 2007), p. 53

conditions in what now are fertile fields. Forests not destroyed by fire would suffer from infestations of wood-devouring beetles. The disappearing rain forests would no longer absorb and store carbon dioxide. Frozen peat bogs in areas once subject to permafrost conditions would thaw out and release their carbon dioxide. The oceans would no longer be able to absorb millions of tons of CO_2. Acidification would lead to a mass extinction of the organisms in the food chain that nourish fish. Polar icecaps would continue to melt. Coastal cities in the U.S. and elsewhere would be under water. City folk would have to move further inland and fight for a place to live in the places that were still inhabitable. Untold millions could be dead or homeless and civilization as we know it would disappear.

None of these catastrophic events are necessarily going to happen. Romm and many other experts believe that humans could make so many major changes in their use of fossil fuels that the catastrophes just described would never occur. Other observers doubt that the globe is actually warming and regard Romm's predictions as misleading and greatly exaggerated.

Ten Top Countries in Carbon Emissions[3]

	Country	Total emissions (millions of metric tons of CO_2)	Per capita emissions (tons)
1.	China	6017.69	4.58
2.	United States	5902.75	19.78
3.	Russia	1704.36	12.00
4.	India	1293.17	1.16
5.	Japan	1246.76	9.78
6.	Germany	857.60	10.40
7.	Canada	614.33	18.81
8.	United Kingdom	585.71	9.66
9.	South Korea	514.53	10.53
10.	Iran	471.48	7.25

3. Information from Union of Concerned Scientists

Name: _____ Date: _____

Student Activities

Scientific Evidence for Global Warming

A. Multiple-Choice

1. According to this chapter, the scientific method:
   a. Is the best way of finding explanations for events
   b. Includes peer review and changing hypotheses when more evidence is presented
   c. Provides an excuse for irresponsible scientists to publish unfounded conclusions
   d. Both a and b

2. According to the best available scientific data:
   a. Global warming definitely accounts for many recent extreme weather occurrences
   b. There is a strong correlation of increases in carbon dioxide in the atmosphere and increasingly warm global temperatures
   c. Increased global warming is going to cause the polar icecaps to melt and oceans to rise by about 20 feet
   d. None of the above

3. Which of the following is not a greenhouse gas?
   a. Carbon dioxide
   b. Methane
   c. Nitrous oxide
   d. All of the above

4. A 20-foot rise in sea levels by 2100:
   a. Will definitely occur
   b. Is one of many possibilities if current trends continue to accelerate
   c. Will cause the polar ice caps to melt
   d. Can be prevented only if we stop burning fossil fuels

5. Which of the following are possible results of extreme global warming?
   a. Increases in rainfall in some parts of the world
   b. Rising level of oceans and flooding of major cities
   c. Severe droughts in some parts of the world
   d. All of the above

6. The evidence that global warming is caused by human activities is:
   a. Irrefutable
   b. A hypothesis accepted by most scientists
   c. Something we need not pay attention to
   d. Dangerous propaganda circulated by irresponsible scientists

7. Which of the top ten countries produce the most carbon dioxide emissions?
   a. The United States in total amount of emissions per capita
   b. China in total amounts of emissions
   c. Canada and the United States
   d. China in highest per-capita emissions

B. Essay

Write an essay of no fewer than 150 words responding to most of the major points covered in the following:

> The planet is warming up. Terrible things will continue to happen if present trends continue. The United States must lead the world in its fight against the global warming that is caused by human activities.

Be prepared to present your statement and either defend it against those who disagree, or explain why others might have changed your mind.

CHAPTER 3

MAJOR OIL SPILLS AND DEPLETION OF RESERVES

Overview

This chapter is concerned with oil spills, most notably the BP Deepwater Horizon disaster of 2010; the distinction between proven, probable, and possible oil reserves; and the cost of separating Canadian crude oil from the sands in which it is enmeshed. The underlying question is whether supplies of oil are sufficient for the foreseeable future. Multiple-choice questions test students' knowledge of the important facts and concepts covered in this chapter. The essay question asks them to explain their conclusions about the continued availability of the 20 million gallons of oil Americans use every day.

Objectives

Students will:

- realize that there is a limit to the amount of recoverable oil,
- know the three categories of oil reserves,
- understand that continued use of sand oil and deepwater drilling for oil requires risking serious damage to the environment, and
- discuss whether action should be taken during their lifetime to find alternatives to using petroleum as a source of energy.

Strategies

After determining whether students did their homework and understand major ideas and concepts in the chapter, ask them whether they believe that steps must be taken during their lifetime to reduce the use of oil as fuel. Ask them what they had learned from their reading that helped them form these beliefs and whether they think differently about this topic than they had before reading this chapter. During the discussion, make sure that students understand the differences

between proven, probable, and possible oil reserves and the damage that recovering them may do to the environment. Make sure they understand that the BP disaster was not an isolated incident and that the oil industry's willingness to manage risk is not keeping up with its ability to find and extract new sources of oil.

Assignment

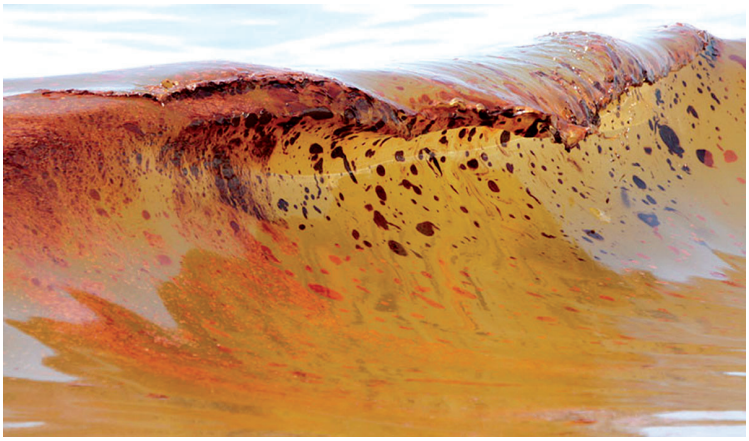
Assign Chapter 4, and pass out the student reading and activities pages. Ask students to complete their assignment on their own paper if they run out of room on the handouts.

CHAPTER 3

MAJOR OIL SPILLS AND DEPLETION OF RESERVES

Introduction

The warnings on the night of April 20, 2010, came in the form of ten light-signals. Each showed the presence of combustible gasoline coming from the pipe under the drilling rig operated by BP (British Petroleum). But the person assigned to set off an audible alarm to warn workers of a possible explosion did not know what to do when there were ten lights blinking at the same time. Two minutes later an explosion ripped through the rig.[1] One-hundred-fifteen of the 126 people on the rig were able to escape and find refuge in lifeboats. Eleven crewmembers died as the rig burst into flames. After a number of days it sank into the Gulf of Mexico, 90 miles from Venice, Louisiana.



Oil washes up on Orange Beach, Alabama, more than 90 miles from the BP oil spill.[2]

More was at stake than the immediate fate of the BP oil rig and its crew. Failure of the blowout preventer caused a free flow of oil from the well 5000 feet below the ocean surface. Before the well was finally sealed, five agonizing months later, an estimated 200 million gallons of oil had poured into the Gulf of Mexico. This was the largest accidental oil spill in history and caused an as yet unfathomable amount of damage to the sensitive wetlands along the Gulf coast, to the birds nesting in these areas, to the beaches enjoyed by vacationers, to the fish and shrimp beneath the Gulf waters, and to the entire sea food-chain beginning with the plankton floating in the oil-soaked waters of the Gulf.

1. David Martin, The Guardian, June 14, 2010
2. According to the official government report, released in January, 2011, the "blowout was the product of several individual missteps and oversights by BP," (and by the companies that leased the oil rig to BP and provided the casings for the drill operation) "were at fault," and that without "significant reform in both industry practices and government policies, might well recur."

Thousands of tourists, fishermen and shrimpers, and local businesspeople were deprived of their livelihoods and were left to depend on BP's promises to compensate them if they could document legitimate claims for their financial losses.

Major Oil Spills, 1967–2010			
Name	**Year**	**In or near**	**Gallons** (millions)
The Torrey Canyon	1967	U.K.	25–36
The Sea Star	1972	Oman	35
Amoco Cadiz	1978	France	69
Atlantic Empress	1979	Trinidad	90
Ixtoc	1980	Mexico	140
Castillo de Bellver	1983	S. Africa	79
Nowruz Oil Field	1983	Iran	84
Odyssey	1988	Canada	41
Exxon Valdez	1989	Alaska	11
ABT Summer	1991	Angola	51–81
M/T Haven	1991	Italy	45
Kolva River	1994	Russia	84
Deepwater Horizon	2010	U.S.	200

Oil Depletion, New Technologies, and Increased Risks

The BP oil spill was only one of many disasters and is unlikely to be the last (see chart). The problem, in part, is the search for new sources of crude oil as old fields are being depleting and the demand for energy is increasing. If new reserves of crude oil are not found, and demand for oil increases as China, India, and many other countries continue to industrialize, the world will eventually run out of oil.

The questions that must be answered are: When is the world likely to run out of oil?, and Is it in the foreseeable future or too far down the road to worry about it now? The answers to these questions depend partially on which of the three kinds of reserves is being considered:

1. Proven reserves, which have a 90% chance of being recovered with the existing technology at commercially and environmentally acceptable costs

2. Probable reserves, which have a 50% chance of being recovered with existing technologies at commercially and environmentally acceptable costs

3. Possible reserves, which have a 10% chance of recovery depending on technologies yet to be developed at commercially and environmentally acceptable costs.

In this chapter you will learn about the problems associated with recovering oil from its proven reserves. In the following chapter you will learn of the problems associated with other fossil fuels, namely coal and gas. [3,4,5]

	Country	Reserves (bbl)	Share
1	Saudi Arabia	264,100,000,000	19.78%
2	Canada[3]	178,100,000,000	13.21%
3	Iraq[4]	143,100,000,000	11.34%
4	Iran[5]	137,600,000,000	10.10%
5	Kuwait	101,500,000,000	8.71%
6	Venezuela	98,590,000,000	7.37%
7	United Arab Emirates	97,800,000,000	7.25%
8	Russia	79,000,000,000	4.45%
9	Libya	46,000,000,000	3.24%
10	Nigeria	36,220,000,000	2.69%
11	Kazakhstan	30,000,000,000	2.22%
12	Qatar	27,190,000,000	1.13%
13	United States	21,320,000,000	1.58%
14	China	15,700,000,000	1.19%
15	Algeria	15,150,000,000	0.90%
16	Angola	13,500,000,000	0.67%
17	Mexico	13,350,000,000	1.29%

Possible and Probable Sources of Oil

Under the heading of possible reserves, we may include other deepwater oil reserves like the one in the Gulf of Mexico. As shown by the BP disaster, the problem with these sources is what oil expert Edward C. Chou has explained is that "[o]ur ability to manage risks hasn't caught up with our ability to explore and produce in deep water." This has not stopped oil corporations from positioning rigs further and further from shore in waters up to a mile deep and then drilling down 35,000 feet through sand and rock to find the oil under the ocean floor. Individual rigs are designed to simultaneously drill for oil and pump it to the surface at these depths from as many as 35 wells at a time.

In examining the chart on the previous page, you might have noticed that Canada is right behind Saudi Arabia in proven oil reserves. Ten percent of the oil imported into the U.S. comes

3. See discussion of sand oil on the next page.
4. Political instability
5. Under sanctions

from sand-oil reservoirs in Canada. The oil is separated from the sands in which it is enmeshed by blasting large quantities of heated water through it at the rate of up to four barrels of water to every barrel of oil. The water is then stored in man-made lakes that contain the residue from the dirty oil. This process makes the lakes more toxic every time the water is recycled. Every day this process requires the same amount of natural gas that would be needed to heat 2.5 million American homes.

Referring to the danger of continuing the use of oil and other fossil fuels as a source of energy, one bard explained, "the faster you can drink it, the quicker it is gone."

Name: _____ Date: _____

Student Activities

Major Oil Spills and Depletion of Reserves

A. Multiple-Choice

1. The BP Deepwater Horizon oil spill:
   a. Was an isolated incident not likely to happen again
   b. Was the single worst accidental oil spill in history prior to 2010
   c. Caused little environmental damage
   d. Ended American's dependence on oil

2. The BP oil spill occurred in waters off the state of:
   a. Texas
   b. Florida
   c. Mississippi
   d. Louisiana

3. As of 2010, the second worst oil spill occurred in or near:
   a. Alaska
   b. Angola
   c. Mexico
   d. Russia

4. The phrase, "the faster you can drink it, the quicker it is gone," is in this chapter as an analogy to:
   a. The idea that the world may run out of oil
   b. The number of underage beer drinkers
   c. The need to curb drunk driving
   d. The fact that there are three kinds of oil reserves

5. What are the three types of oil reserves?
   a. Surface, sand, and deep water
   b. Commercially viable, dangerous, and ecologically unsound
   c. Proven, probable, and unproven
   d. None of the above

6. The countries whose combined proven reserves equal over 50% of the world's total oil reserves are:
   a. Saudi Arabia, Canada, Iraq, and Iran
   b. Iran, Iraq, Kuwait, and Saudi Arabia
   c. Kuwait, Libya, Saudi Arabia, and Venezuela
   d. Saudi Arabia, Kuwait, Iran, and Iraq

7. Deepwater oil rigs operate:
   a. A mile above the ocean floor
   b. 35,000 feet under the ocean floor
   c. With 35 wells at a time
   d. All of the above

8. One problem with using Canadian sand oil is that:
   a. It creates toxic water lakes
   b. It consumes large quantities of energy to heat the water
   c. It consumes large quantities of water
   d. All of the above

9. Reasons not to rely heavily on oil from the Middle East include:
   a. Several nations are either too politically chaotic or under sanctions
   b. Many are members of OPEC
   c. Canadian oil is cheaper to collect and does less damage to the environment
   d. All of the above

10. Based on the evidence in this chapter, the conclusion that is easiest to support is that:
    a. The United States can stop depending on oil
    b. There are many problems with continuing to depend on the world's oil supply
    c. The world will soon run out of oil
    d. None of the above

B. Essay

Write an essay of no fewer than 150 words explaining whether declining oil reserves are a problem that must be addressed during your lifetime. Base your opinion on what you learned by reading this chapter as well as what you already knew, and be prepared to share your opinion with your classmates.

CHAPTER 4
ALTERNATIVES TO GASOLINE-POWERED ENGINES

Overview

This chapter discusses the U.S. dependence on oil, the dangers of this dependence, and the attempt to produce cars that are more fuel-efficient than those using the conventional internal combustion engine. The chapter includes a chart showing the use of various sources of energy—oil, coal, natural gas, nuclear, electric, and renewable sources. The chapter discusses the partial OPEC oil embargo and the CAFE standards established by the federal government. Most of the narrative covers America's experiences with hybrid, electric plug-in, and hydrogen fuel-cell engines. Students are introduced to the Toyota Prius, the Nissan Leaf, the Chevrolet Volt, and the Tesla sports car as examples of attempts to replace conventional engines. Students are asked to explain which kind of car they would buy. An alternative assignment asks students to select one or two hybrids from a list provided in the chapter and search the Internet for reviews of these cars from ordinary people who drive them.

Objectives

Students will:

- become aware of the various sources of energy consumed by Americans; and
- understand the advantages and disadvantages of owning the hybrid, electric plug-in, and hydrogen fuel-cell automobiles.

Strategies

Determine whether students have completed their assignment by reviewing the answers to their assigned multiple-choice questions. Make sure they can list three sources of fossil fuel, and three other sources of energy. Discuss the cogeneration technique used to power the Prius's electric motor, why there are fewer electric cars on the road than hybrids, and whether there is a future for hydrogen fuel-cell cars. Ask students who obtained reviews of hybrid cars to share what they learned with the class. End class with a discussion of which car they would want to own

and why: conventional, hybrid, plug-in, or hydrogen, and whether the U.S. government should provide incentives or penalties (such as a higher gasoline tax) to encourage consumers to buy the most fuel-efficient and least-polluting automobiles.

Assignment

Assign Chapter 5, and pass out the student reading and activities pages. Ask students to complete their assignment on their own paper if they run out of room on the handouts.

CHAPTER 4

ALTERNATIVES TO GASOLINE-POWERED ENGINES

Introduction

In the previous chapter you learned that the proven oil reserves are gradually depleting and that the world is relying on dangerous deepwater sources and the extraction of oil from Canada's sands. Americans consume over 20 million barrels of petroleum in a single day in order to power their motor vehicles, heat their homes, run factories, and generate electricity.

Oil is but one of several forms of what are called "fossil fuels." Altogether, burning fossil fuels accounts for 78% of the energy produced every year. Unfortunately, there are two major disadvantages to our dependence on fossil fuels: (1) in addition to other heat-trapping waste products, they produce over 29 billion tons of carbon dioxide a year, and (2) at the current rate of increased usage, the world's supply of this energy source may run out or become too expensive by the end of this century.[1]

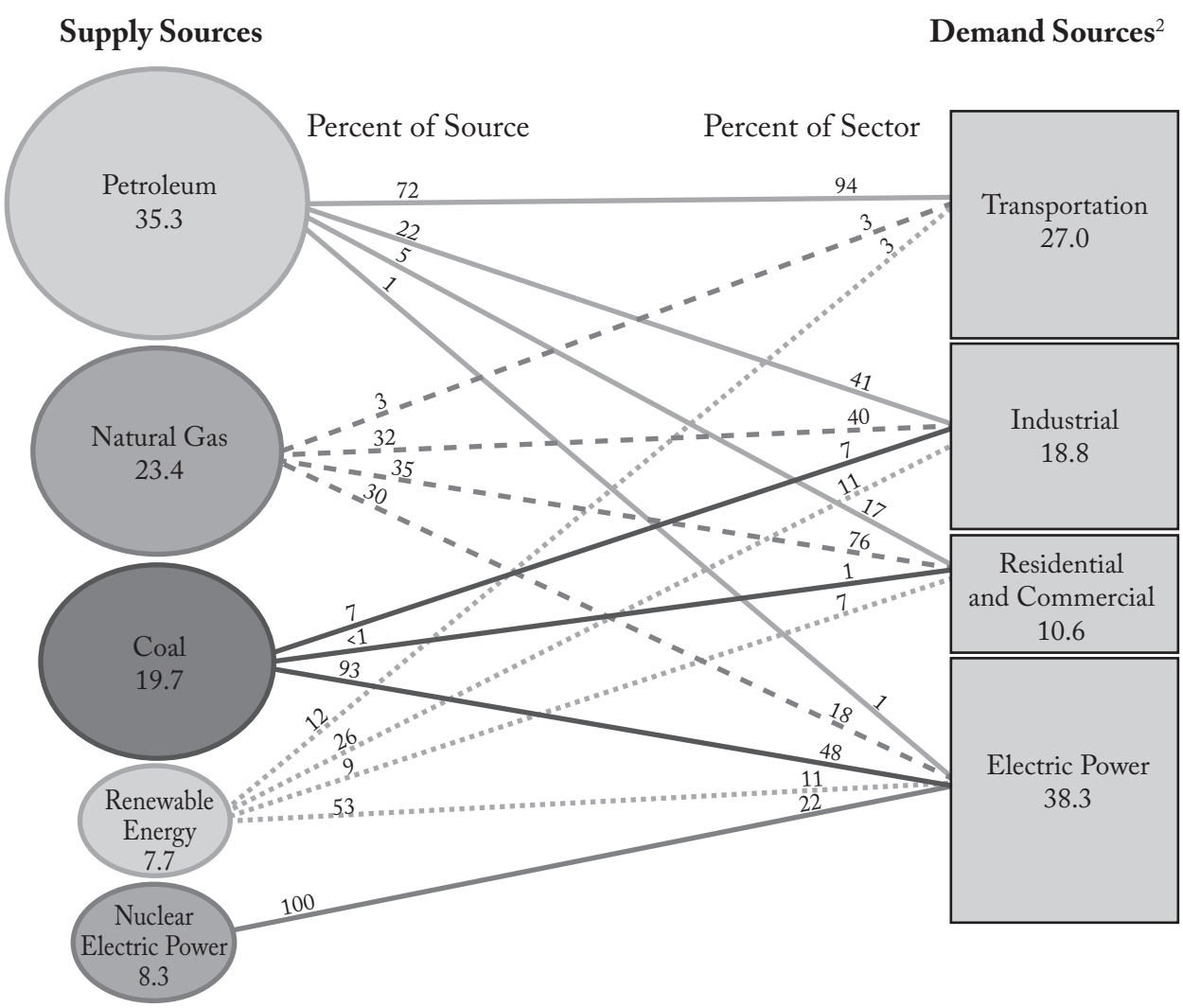
These two problems call for solutions. An alternative to burning fossil fuels must be found to meet the world's need for energy. One means of meeting future energy needs is to stop using so much. We can use less energy by lowering thermostats, driving more fuel-efficient cars, insulating our homes, increasing our use of public transportation, buying more-efficient appliances, and living more frugally.

Subsequent chapters examine alternatives to using fossil fuels such as solar, wind, and nuclear power. This chapter discusses steps that are being taken to reduce our use of oil to power our cars, SUVs, vans, trucks, trains, and airplanes that account for 27% of the energy consumed in our country.

U.S. Primary Energy Flow by Source and Sector, 2009

The following chart shows the major sources of the energy used in the United States and how that energy is used. In examining this chart, it may be useful to remember that that Americans have increased their use of energy by 50% since 1949. It should also be noted that only 7.7% of energy used in the U.S. is from renewable sources such as solar, wind, geothermal, and biomass. Eighty-four percent is produced by greenhouse gas–producing fossil fuels.

1. Almost one-fifth of that amount is produced in the United States.



Oil Embargo Leads to Establishing Corporate Average Fuel Economy Standards

The Corporate Average Fuel Economy Standards are usually referred to as "CAFE standards." They are the U.S. government's requirement that cars and trucks by each manufacturer of such vehicles get at least a certain number of miles per gallon on average. These standards were introduced as a response to the actions of Organization of Petroleum Exporting Countries (OPEC) in the 1970s. Then OPEC cut oil exports to the U.S. from 108 million gallons per month to 62 million gallons. This boycott resulted in a rapid increase in the price of a gallon of gas. Gas prices rose from an average of 36 cents per gallon to as high as 97 cents.[2] It also resulted in gas shortages, accompanied by huge lines around filling stations, people's cutting down on driving, an enforced 55-miles-per-hour speed limit on the nation's highways, and the importation of smaller and more fuel-efficient automobiles. When OPEC stopped its boycott, the supply of oil again

2. Adjusting for inflation, a gallon of gas in 1981 cost $3.47 (2010 dollars)

approached the demand for it. CAFE standards in the meantime rose from 18 miles per gallon in 1978 to 27.5 in 1985, and then were not increased for 25 years.

As awareness of the causes and effects of global warming increased, many people have worked at reducing fuel consumption. President Barack Obama used his authority as his nation's chief executive to increase CAFE standards to 35.5 mpg by 2016, a 30% increase over 2010 standards. Meanwhile, environmentally conscious drivers began to purchase cars that were even more fuel-efficient than dictated by national standards. As of this writing, the Prius (manufactured by Toyota) is the most popular of the fuel-efficient cars. It uses a combination of a small gasoline engine coupled with an electric motor in a configuration that is known as a hybrid. Prius drivers report getting an average of 50 mpg. The key to the success of this car is a process known as "cogeneration." When the driver brakes or coasts down hills, the electric motor applies resistance to the car's drivetrain, which causes the wheels to slow down.[3] This energy is transformed with a generator, converted into electricity, and stored in the car's battery. The battery, in turn, powers the electric motor.

Toyota and other car manufacturers are busy developing and improving fuel-efficient vehicles. The first fully electric car, the Nissan Leaf, hit the market in the U.S. in November 2010. It has an electric motor which can power the car for about 70 miles without recharging. The battery can be recharged overnight with a regular 110-volt house current using about $3 worth of electricity (about the price of one gallon of gas). Unfortunately, commercial charging-stations are few and far between, but plans are underway for more such installations. For people who drive 70 or fewer miles a day, the Leaf is a financially sound choice for local transportation and creates no polluting emissions. However, coal-fired generators, including many that emit tons of carbon dioxide and other polluting chemicals, produce almost 50% of all electric power used in the U.S.

Another plug-in electric car, the Chevrolet Volt, has a gasoline engine that vastly extends this car's range. The gasoline engine generates electricity that powers the car. When combined with the battery-powered electric engine it can achieve speeds up to 100 miles per hour. However, the car can only go about 45 miles on the electric engine. Running only on the gasoline engine the Volt gets about 35 miles per gallon. Running solely on electricity, the Volt, like the Leaf, can get the equivalent of about 100 miles per gallon.

Another Fuel-Efficient Vehicle That Produces No Harmful Emissions

If, in 2010, you had more than $100,000 to spend on a sports car that emitted no polluting chemicals, goes from 0–60 in less than four seconds, and hugs the road at high speeds, you might have looked at the electric-powered Tesla.[4] Unlike the Leaf, it will go over 200 miles before the battery has to be recharged, at a cost of somewhere between four and seven dollars.

3. How Hybrids Work, www.fueleconomy.gov
4. http://www.thecarconnection.com/image/100305953_bruce-richter-drives-the-2010-tesla-roadster-sport

Hydrogen as a Fuel for Your Car

In his State of the Union address in 2003, President George W. Bush proposed that Congress authorize spending $1.7 billion to speed the development of efficient hydrogen fuel-cell engines to power conventional automobiles. He promised that by 2020, most young Americans would learn to drive in a car fueled by hydrogen cells.

Hydrogen-fueled engines have many advantages. Hydrogen is contained in petroleum, natural gas, and even water. Hydrogen engines have been used in space exploration since the 1960s. Hydrogen engines emit water instead of harmful gases.

However, there are also serious problems with using hydrogen. First, it is expensive to separate it from petroleum, natural gas, and all other elements. Second, it is difficult and expensive to store and to transport. Third, it is highly combustible. Finally, there are hardly any fueling stations to fill hydrogen vehicles. Despite the federal government and private enterprise's spending billions of dollars, these problems remain. It is highly unlikely that any of those reading this book will learn to drive in a hydrogen-fueled automobile.

Name: _____ Date: _____

Student Activities

Alternatives to Gasoline-Powered Engines

A. Multiple-Choice

1. Why is it important that Americans decrease their dependence on oil?
   a. It is not important.
   b. Oil is a source of carbon dioxide pollution.
   c. Oil accounts for approximately 35% of all energy used in the United States.
   d. Both b and c.

2. How much oil is consumed in the United States every day?
   a. About 20 million barrels
   b. Enough to produce 35.3% of all energy it uses
   c. Both a and b

3. What is the single largest use of energy produced in the United States?
   a. Transportation
   b. Electric power
   c. Industry
   d. None of the above

4. Which of the following is not a fossil fuel?
   a. Coal
   b. Oil
   c. Nuclear materials
   d. Natural gas

5. What does OPEC stand for?
   a. Oil Producing Economically Challenged
   b. Organized Personal Economic Countries
   c. Organization of Petroleum Producing States
   d. None of the above

6. What caused the price of gasoline to rise rapidly in the United States during the 1970s?
   a. An increase in demand for gasoline
   b. OPEC's boycott
   c. Oil refinery explosions
   d. Wars in Middle Eastern countries

7. What creates electricity in hybrid cars?
   a. The gasoline engine
   b. Slowing the car down
   c. The generator
   d. All of the above

8. What is the main advantage of hybrid cars?
   a. They go faster than standard cars.
   b. They do not require fossil fuels.
   c. They use less gasoline.
   d. Their batteries can be recharged in any electric outlet.

9. In 2010, what was the best reason for not buying a Tesla?
   a. It was not very fast
   b. It did not go very far on one electric charge
   c. It was not a reliable car
   d. It was very expensive

10. What are the advantages of driving a hydrogen fuel-cell car?

    a. It uses a renewable source of energy.

    b. It has zero harmful emissions.

    c. It can find useable sources of fuel in any filling station.

    d. Both a and b.

B. Essay

Write an essay of no fewer than 150 words explaining why, given the opportunity, you might buy which of the following vehicles: a. hydrogen fuel-cell car, b. a hybrid, c. a plug-in electric car, or d. a conventional car. Explain not only why you would choose one of the vehicles mentioned, but also why you would not buy any of the others. In your essay, show that you understand the concepts and factual information in this chapter.

Or, use the Internet to research hybrid cars produced by other manufacturers. Select one or two and get several owners' testimonies of these vehicles' mileage and performance. Write up these reviews and be prepared to present them in class.

CHAPTER 5
COAL AND NATURAL GAS

Overview

This chapter covers a variety of issues associated with the use of coal and natural gas as a source of energy. The claim that there is such a thing as "clean coal" is explored and discredited. Carbon dioxide sequestering as a way of disposing of the harmful effects of burning coal is explained. Students are informed that most new coal generating plants are still not being built with the equipment needed to bury the by-products of combustion deep under the earth's surface. A description of removing entire mountaintops in order to uncover seams of coal is explained, and students are provided with arguments for and against this practice.

Natural gas is discussed as an abundant and cleaner alternative to using coal and oil to meet American's need for energy. A technique for reaching reserves of natural gas (known as "hydraulic fracturing," or "fracking") is described, and students read arguments for and against its use. After answering multiple-choice questions, students are assigned an essay in which they either assume the role of a farmer offered an opportunity to lease part of his land for hydraulic fracturing, or the natural-gas company CEO making the offer.

Objectives

Students will:

- become aware of the need for continuing the use of coal and natural gas to meet energy needs,
- become aware of the effects of coal and natural gas on the environment,
- learn about the extraction techniques known as mountaintop-removal mining and hydraulic fracturing, and
- evaluate the advantages and the disadvantages of both of these methods.

Strategies

After determining whether all students have completed their assigned homework, review their answers to the multiple-choice questions and make sure that they know and understand the basic facts and concepts presented in this chapter. Review the arguments for and against using mountaintop removal and hydraulic fracturing. Then ask for volunteers to role-play an imaginary dialogue between a farmer and a natural-gas company executive about using hydraulic fracturing on the owner's property. Make sure that the students engaged in this discussion consider the need for more energy, the advantages of using natural gas, and the possibilities of environmental damage. Conclude by asking students what important lesson they learned from this chapter on coal and natural gas.

Assignment

Assign Chapter 6, and pass out the student reading and activities pages. Ask students to complete their assignment on their own paper if they run out of room on the handouts. Ask for volunteers to prepare to participate in the simulation exercise, and make sure you have at least three students to be the CEO in the nuclear industry, and three to role-play the person living close to a nuclear disposal site or a person who lived close to the scene of a nuclear accident.

CHAPTER 5

COAL AND NATURAL GAS

Introduction

Of the 84% of America's energy that comes from burning fossil fuels, more than half comes from sources other than oil. Together, natural gas and coal account for almost 50% of our fossil-fuel consumption. This chapter explains why coal may not be an acceptable alternative to oil, and why some sources of natural gas, which is less polluting than oil, may also pose a threat to the environment.

Is There Such Thing as "Clean Coal"?

Long before oil wells were drilled anywhere in the world, coal was used to heat houses and power factories. The Industrial Revolution would never have happened without large quantities of coal harvested from dangerous underground tunnels by vulnerable miners. In the 21st century, coal has remained the major single source of fuel for generating electricity.[1]

Coal, however, has never been a clean form of energy. Coal-burning power plants account for two-thirds of sulfur dioxide and 40% of carbon dioxide emissions in the U.S. It also is a major source of mercury, a chemical associated with birth defects, in the ground and atmosphere. Burning coal produces more tons of garbage than is created by all the cities of the U.S. The American Lung Association has determined that 24,000 people die prematurely every year from the pollutants dispersed by burning coal.

During the early 21st century, the coal industry made a determined effort to convince the American public that coal was a source of clean energy.

1. Advertisement for "clean coal" cropped on 21-09, newsflash.worldpress.com

New Technology for Producing Cleaner Coal

A technology has been developed that would allow coal-powered factories to separate carbon emissions from burning coal and bury (some refer to this process as "carbon dioxide sequestering") 85%–95% of the carbon deep underground. Facilities that separate and sequester carbon dioxide can also burn off such by-products of combustion as hydrogen and provide a much cleaner burning coal. However, these technologies have not been fully proven and are more expensive than traditional methods of burning coal. New plants that generate electricity are being constructed that still use the older and more toxic technologies. These facilities will be in operation for the next 50 years and will cause 50% more pollution each year. One reason for continuing to build plants with the old technology is that it costs 10%–20% less than the new technology.

The Coal Equivalent to the 2010 BP Disaster

Before it is burned, coal is cleaned to wash out impurities. The water, along with the impurities, is stored in ponds close to the place where the coal is used. In addition, coal ash (what is left over once the coal is burned) is dumped into these ponds. There are approximately 600 coal-powered electric plants in the U.S. No one knows how much of the toxic waste has seeped into the groundwater surrounding these ponds. But a great number of people learned what happened in Roane County, Tennessee, on December 22, 2008, when the wall containing the storage pond collapsed and a billion gallons of its contents spilled onto hundreds of acres of farmland. The toxic tide ripped houses off of their foundations, turned farms into wasteland, seeped into the water supply, and poured into clean fishing streams. The total disaster cost over one billion dollars to clean up and destroyed the homes and livelihoods of thousands of Americans.

Mountaintop Mining

Another form of coal-related pollution is caused by a process called mountaintop mining (MTM), in which soil and rock are removed up to a depth of 800 feet to reach the coal that lies underneath.[2] After the coal is removed from the exposed surface, the mining company is supposed to restore the mountain to its original condition. To save both money and time, many coal companies leave the mountain's soil in the valleys below. In total, mountaintop mining has left a barren area equal in size to the state of Delaware.

Example of mountaintop mining

Although mountaintop mining accounts for only 8% of coal mined in the U.S., continuing this practice has become a very controversial issue. Two views of this issue are presented below:

2. nao.usace.army.mil/News/20090915_Permit21.asp

Criticism of Mountaintop Mining	In Defense of Mountaintop Mining
You've no doubt heard of "clean coal." Is mountaintop removal coal mining clean when coal companies clear-cut the trees and blow up our ancient Appalachian mountains, turning an area the size of Delaware into desolate moonscape? Is it clean when coal companies dump their debris into 2000 miles of sparkling, mountain streams that are the headwaters for much of the East Coast drinking water? Is it clean when mountaintop removal coal mining created far fewer jobs than would be created by building the infrastructure for clean, renewable, non-nuclear energy?[3]	Mountaintop mining is not the destructive process it is portrayed in the media. The industry must either leave the land as a redeveloped resource for the community, such as residential land, industrial parks, recreational or educational use, or retail development, or the land must be restored to its approximate its original appearance and status. More than 50,000 West Virginia families depend on mining for their livelihoods. In some counties, mountaintop mining is responsible for as much as 90 percent of the government budget.[4]

Focus on Natural Gas

Polluting Effects of Natural Gas, Oil, and Coal
(Per Billion BTU of Energy Input)

Air pollutant	Combusted source		
	Natural gas	Oil	Coal
Carbon dioxide	117,000	164,000	208,000
Carbon monoxide	40	33	208
Nitrogen oxides	92	448	457
Sulfur dioxide	0.6	1122	591
Particulates	7.0	84	2744
Mercury	0.000	0.007	0.016

Sources: EIA, 1998 Natural[5]

3. Karyn Strickler. *Appalachia is Rising Against Mountaintop Removal Coal Mining*, CommonDreams.org, September 27, 2010
4. Citizens for Coal, *Mountaintop Mining Facts*
5. Statistics supplied by U.S. Department of Energy, *Modern Shale Gas Development in the United States*

Among the three kinds of fossil fuels used to produce the world's energy, natural gas emits the least pollution. (See chart.) Natural gas is colorless, odorless, and shapeless. It is used primarily to cook our food, heat our homes, and generate our electricity, but also can be and is used to power our cars, buses, trucks, and airplanes.

Natural gas supplies almost one-quarter of the energy used by Americans. It is less polluting, more abundant, and no more expensive than oil refined into gasoline. It is often mentioned as a suitable substitute for oil, and an estimated 25% of its recoverable reserves can be found in North America.

There are several major problems associated with substituting natural gas for oil. First, the U.S. already has to import 13% of the natural gas it uses. Second, there are few filling stations that supply natural gas. Third, converting an engine from using gasoline to natural gas is an expensive proposition. Fourth, engines made to be used for regular gasoline as well as for natural gas are not fuel-efficient.

Hydraulic Fracturing

Major reserves of natural gas are encased in shale deposits 8000 to 10,000 feet below the surface. A complicated and only recently perfected method, hydraulic fracturing is needed to release the gas in these deposits and bring them to the surface. Hydraulic fracturing involves drilling down to the reserves of shale oil up to two miles under the ground and then sending a high-pressure mixture of many thousands of gallons of water and sand and chemicals to break up the shale and release the natural gas. After releasing the gas, water is siphoned out of the shale bed and stored in specially constructed ponds, pumped back underground, or sent to local treatment plants. The danger posed by this process is that the chemical-laden solutions spill into the environment or that the treatment plants cannot adequately process the thousands of gallons they are asked to handle.

In Dimock, Pennsylvania, methane released by hydraulic fracturing contaminated the water piped into the homes of local citizens for drinking and washing. In 14 different cases, homeowners were actually able to set fire to the water flowing out of their faucets. A report issued by the Pennsylvania Land Trust Association in 2010 documented over 1400 violations of regulations by drilling companies in less than two years. Two-thirds of these violations were believed to have impacted the environment.

Two Sides to the Story

"Hydraulic Fracturing Is Safe"	"Fracturing Causes Problems"
Shale producers point out that at no point do fracturing fluids come into contact with drinking water reservoirs. In fact, hydraulic fracturing takes place thousands of feet below the water table and thus are isolated from drinking water by thousands of feet and millions of tons of impermeable rock. The gas industry also notes that more than one million wells have been fractured without drinking water contamination. Should a surface spill or incident occur, state regulators have testified that they have sufficient authority to prosecute the offending parties so that incidents do not occur in the future.[7]	Earlier this decade, the Canadian drilling company EnCana began ramping up gas development in the Pavillion/Muddy Ridge field of Wyoming. In the summer of 2010, the majority of Pavillion residents who participated in a health survey reported respiratory problems, headaches, nausea, itchy skin, dizziness and other ailments. According to the Earthworks Oil and Gas Accountability Project, many residents also reported that their well water was tainted by fracking. Various ailments residents reported are associated with contaminants the U.S. Environmental Protection Agency has identified in Pavilion well water.[8]

6. United For Action.org
7. http://www.yourlawyer.com/topics/overview/hydraulic_fracturing_fracking

Name: _____ Date: _____

Student Activities

Coal and Natural Gas

A. Multiple-Choice

1. Of all the fossil fuels, which contains the fewest pollutants?
   a. Natural gas
   b. Oil
   c. Electricity
   d. Coal

2. Natural gas accounts for what percent of the energy used in the United States?
   a. 50%
   b. 20%
   c. 25%
   d. 75%

3. Hydraulic fracturing:
   a. Is used to mine for coal
   b. Is safe to use
   c. Endangers the water supply
   d. Does not help in obtaining natural gas

4. Mountaintop-removal mining is used to:
   a. Find sources of natural gas
   b. Unlock seams of coal
   c. Help deepwater drilling
   d. All of the above

5. If you were to find that the water from the faucet in your home caught on fire, you could probably blame:
   a. The local oil company
   b. The local coal company
   c. The local company engaged in hydraulic fracturing
   d. Bad luck

6. Hydraulic fracturing requires all but which one of the following techniques:
   a. Removing the tops of mountains
   b. Forcing water at extreme pressure underground
   c. Recycling water used to break the shale
   d. Mixing sand and chemicals with water

7. The least damage done in mountaintop-removal mining is to:
   a. The scenery
   b. The fish in lakes
   c. The men who dig up the coal
   d. The rivers and valleys in the region

8. What is the most important lesson you learned from reading this chapter?
   a. Coal is a fossil fuel.
   b. Accidents are caused by human carelessness.
   c. There is no such thing as completely clean oil or natural gas.
   d. Oil is the least polluting source of energy.

B. Essay

Write an essay of no fewer than 150 words either:

1. As an owner of a fairly prosperous 400-acre farm who will not give permission to anyone to drill for natural gas on his or her land. Base your arguments on the dangers of fracturing, the experiences of other people who allowed hydraulic fracturing, and alternatives to natural gas as sources of energy. Come to class prepared to defend your arguments.

2. Or, as the owner of a gas-exploration company who wants to secure permission from the farmer to drill for gas on his or her land using hydraulic fracturing. Base your arguments on the advantages of natural gas and the relatively few reports of environmental damage done by drilling for it. Come to class prepared to defend your arguments.

CHAPTER 6
THE NUCLEAR OPTION

Overview

This chapter begins with a famous prediction made during the 1950s, expressing the optimistic view of the time that nuclear-generated electricity would be produced at such a low cost it would be "too cheap to meter." The chapter continues by describing the nuclear accidents at Three Mile Island and Chernobyl and explains that these mishaps and other considerations account for the fact that no new nuclear plants were constructed in the United States between 1985–2010. The narrative points out that other countries (such as France) are far more dependent on nuclear energy than the U.S. and that the navy has commissioned nuclear-powered submarines and some surface vessels. Despite this proliferation, no major nuclear accidents have been reported. Students are informed that technological improvements, the need for more energy, and the absence of nuclear "incidents" have led to more calls for resuming construction of nuclear power plants.[1] This account is followed by a description of the attempt to find a safe place to deposit radioactive nuclear waste. The student-activity question departs from the usual multiple-choice format and instead asks students to identify facts on a long list as contributing to arguments for or against relying on nuclear reactors to meet America's energy needs.

Objectives

Students will:

- see the advantages of expanding America's capacity to generate electricity from nuclear powered plants,
- understand the difficulty of finding and developing a suitable site for disposing radioactive nuclear waste, and
- evaluate the arguments for and against building more nuclear-powered energy-producing plants.

1. This chapter was written before the tsunami caused serious damage to nuclear power plants in Japan in March 2011.

Strategies

After determining that students did their homework, ask them whether they would consent to having a nuclear-powered electricity-generating facility or a radioactive nuclear-waste disposal site built in their neighborhood. Ask students to give reasons why somebody should permit such facilities to be built in his or her locality. Encourage students who favor expanding America's production of nuclear power to participate in the discussion. After about ten minutes of examining the pros and cons of expanding nuclear-power production, review students' responses to the homework question and make sure that they know what happened at Three Mile Island, Chernobyl, and Yucca Mountain, and that they know the arguments for and against harnessing the power of the atom.

Assignment

Assign Chapter 7, and pass out the student reading and activities pages. Ask students to complete their assignment on their own paper if they run out of room on the handouts.

CHAPTER 6
THE NUCLEAR OPTION

Introduction

> *"It is not too much to expect that our children will enjoy in their homes electrical energy [created by nuclear energy] too cheap to meter."*
>
> —Lewis Strauss, the head of the Atomic Energy Commission, 1954

As you might have guessed, this widely optimistic remark about the future of electricity produced by nuclear-powered generators never came to pass. One event that caused this optimistic prediction to turn sour occurred on March 28, 1979. On that fateful day one of the two nuclear plants on Three Mile Island in Pennsylvania came dangerously close to overheating, which would have caused a complete meltdown of its nuclear core. As radiation escaped from the plant, Pennsylvania Governor Dick Thornburgh advised that pregnant women and preschool-age children within a five-mile radius of Three Mile Island be evacuated; 140,000 people left the area. After 14 years of cleaning up the nuclear mess created by the accident, further work was halted. One of the reactors on Three Mile Island was reactivated in 1986. The other was encased in concrete to contain all radioactive materials. Neither plant was recommissioned, and both were scheduled to go offline in 2014.

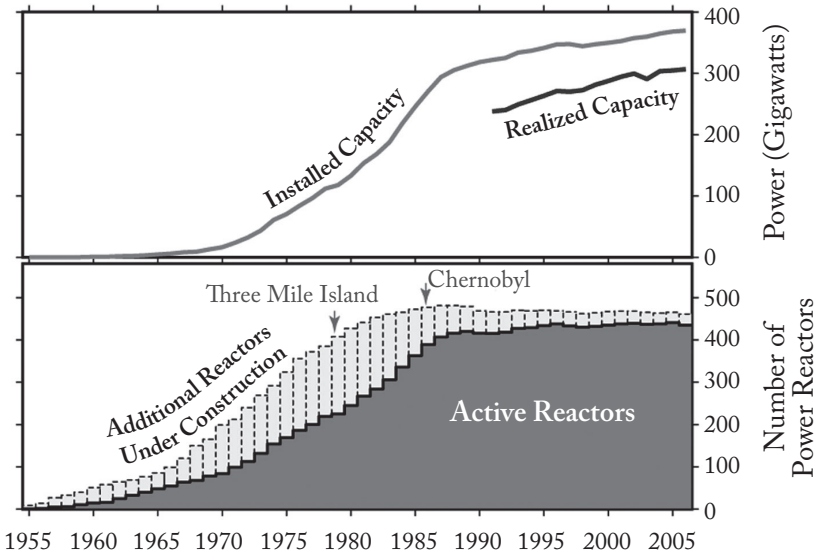
In reading this chapter, you will learn more about the dangers of relying on nuclear reactors to generate electric power. One reason is the possibility of a nuclear meltdown. Another is the difficulty of finding a safe place to store radioactive nuclear waste that could harm whatever it comes in contact with for thousands of years.

The Disaster at Chernobyl

Several investigating commissions concluded that the nuclear accident at Three Mile Island did not cause any permanent damage in the vicinity or elsewhere. In 1986, however, a much more serious nuclear accident occurred in the Soviet Union. The accident at the Chernobyl nuclear plant in the Ukraine led to the immediate death of 56 people, caused over 350,000 people to be evacuated, and contaminated an area where over five million people lived. According to some sources, various cancers and birth defects are still appearing that will or already have led to the premature deaths of over 200,000 people.

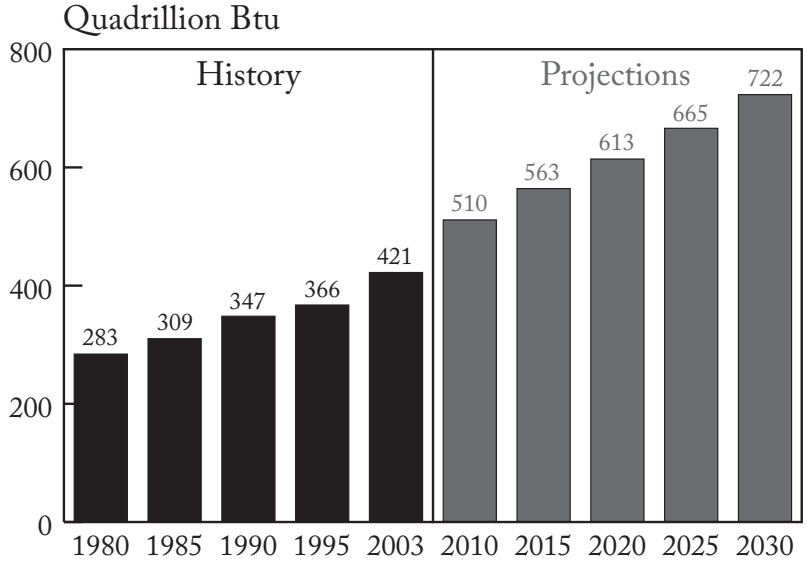
The accident at Three Mile Island and the disaster at Chernobyl caused many concerned citizens to rethink dependence on nuclear energy. It helped lead to ending construction of new commercial nuclear plants. As the accompanying chart shows, after 1985 practically no new nuclear plants came online. Fifty-nine completed proposals for building more plants were scrapped, rejected, or unable to secure financing. Uranium became more expensive and building costs increased. Problems arose on how to store the tons of radioactive nuclear waste that had potential for damaging the environment for thousands of years. Nobody wanted a nuclear reactor to be built anywhere close to their homes.[2] The latest reactor went online in 1996.

History of the Global Nuclear Power Industry



Revival of Interest in Building Nuclear Reactors

World Marketed Energy Consumption, 1980–2030[2]



Starting in the 1960s, France began building the nuclear reactors that by 2010 were producing almost 80% of their electricity. To date, the French have had no major nuclear incidents and export their low-cost reactor-generated electricity to five different countries.

With the launching of the submarine *Nautilus* in 1955, nuclear reactors have powered American ships. Nuclear power has also been used to propel aircraft carriers, destroyers, icebreakers and commercial ships. The U.S. Navy has accumulated over 6200 reactor-years of accident-free experience over the course of 230 million kilometers in operating 82 nuclear-powered ships. Great Britain, France, Russia, China, Japan, and India have also built ships powered by nuclear reactors.

2. http://wikimedia.org/wikipedia/commons/5/58/Nuclear_Power_History.png
3. Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May–July 2005), Web site http://www.eia.doe.gov/iea/; **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

Interest in building new nuclear power plants increased during the 1990s. People who believed that global warming was caused by burning fossil fuels argued that nuclear power plants create no carbon emissions. Furthermore, nuclear-fired power plants leak fewer radioactive pollutants into the air than coal-burning plants. Nuclear proponents also claim that the supply of fossil fuels is limited and much has to be imported from foreign countries that were often unfriendly. They also contend that virtually all methods of mining or drilling are likely to cause accidents and environmental damages. Furthermore, prices for these scarce commodities are continually rising, and demand for energy is doubling every 35 years. For these and other reasons the Energy Act of 2005 provided for government incentives to encourage building nuclear plants. Further incentives were contained in the American Recovery and Reinvestment Act of 2009.[4]

One byproduct of nuclear reactors is spent nuclear fuel. It is highly radioactive and can cause severe harm to human beings for over a thousand years, contaminate the water supply, the earth and the atmosphere. Every working nuclear-powered plant produces an average of 20 tons of radioactive spent fuel every year. One hundred and four operating nuclear plants are as of 2010 generating electricity and their share of nuclear waste. This spent fuel is currently being stored in containment facilities located close to every nuclear plant. Together these plants produce about 2000 tons of nuclear waste every year.

Storing Nuclear Waste

In 1982, Congress passed the Nuclear Waste Policy Act. This law made the U.S. Department of Energy (DOE) responsible for finding a place to store the nation's nuclear waste and prepare and manage underground storage facilities. After a 20-year search of many potential sites, the Department of Energy made its recommendation, announcing that Yucca Mountain, Nevada, was the safest place to store spent fuel. But local opposition to this site, technological issues, political pressure, and numerous lawsuits caused work on the Yucca Mountain site to be delayed, lose funding, and be subject to cost overruns. Originally scheduled to open in 1998, the date of operations was postponed to 2017. After previous administrations spent ten billion dollars on this project, however, President Obama ended it by failing to ask Congress to fund it in his 2011 budget request.

Several alternatives to storing nuclear waste at Yucca Mountain have been proposed. They include cooling spent nuclear rods for five years and then encasing them in steel containers surrounded by concrete covers; shooting them into space; and reusing spent fuel until 90% of its uranium has been eliminated.

There are strong objections to each of these methods and, to date, the only viable alternative to the Yucca Mountain option is to continue storing nuclear waste where it currently resides—in the 121 steel-encased pools scattered around the country under the protection and control of local nuclear plants. Optimists are confident that a suitable means of disposing nuclear waste will be found. Pessimists worry about terrorists, earthquakes, or accidents destroying nuclear disposal facilities.

4. Energy Information Administration, International Energy Annual

Name: _____ Date: _____

Student Activities

The Nuclear Option

A. Sorting Out Arguments

In one column of the chart below, place all the facts from the list and arguments that could be used to support the building of more nuclear power plants. Under the other column, place all the facts and arguments from the list that could be used to support the U.S. investing more money in oil, gas, and coal as a source of energy. Come to class prepared to defend your choices.

- It takes an estimated ten years and ten billion dollars to build a nuclear power plant.
- Few non-polluting coal plants have been or are being built.
- All but one nuclear power plant in the U.S. has had an accident-free record.
- Mountaintop mining
- The Yucca Mountain fiasco
- What happened at Chernobyl
- Problems transporting nuclear waste
- What happened at Three Mile Island
- Flammable liquids pouring out of water faucets
- The disposal and storage problem
- Need to double energy use in 35 years
- Natural gas burns much cleaner than oil or coal.
- Many nuclear power plants only need government approval and financing to begin construction.
- Coal fired power plants emit more radioactive ingredients than a nuclear fired power plant
- Pollution caused by burning fossil fuels is approaching dangerous levels.
- Most sources for cleaner-burning coal have been exhausted.
- New technological developments have made nuclear plants much safer.
- Two thousand tons of radioactive used nuclear fuel is produced every year
- What happened in Roane County, Tennessee
- The U.S. Navy has run nuclear-powered ships since 1955 without an accident.

Facts Supporting Building Nuclear Power Plants	Facts Supporting Investing Money in Oil, Natural Gas, or Coal as Sources of Energy
(example) What happened in Roane County, Tennessee	*(example) Natural gas burns much cleaner than oil or coal*

CHAPTER 7

SOLAR AND WIND: RENEWABLE AND NON-POLLUTING ENERGY SOURCES

Overview

This chapter introduces students to important information about using energy from the sun and the wind. It explains that the sun's energy is converted to electricity either directly by photovoltaic panels or by using its energy to create steam that drives an electrical generator. Examples of both types of devices are given: the former as used in individual projects to supply homes and commercial buildings, and the latter to produce electricity for entire regions. An explanation of how photovoltaic panels may be used to provide electricity for an individual students' home is an example of the former. An explanation of how visionary projects like DESERTEC may be used to supply energy to much of Europe, the Middle East, and North Africa provides an example of the latter.

Students learn that tapping the wind as an energy source goes back as far as the first sailboat, and that the wind's energy was first used to generate electricity in the beginning of the 20th century. Most of the remaining chapter explains the difficulties faced by the founders of the Cape Wind Project in Massachusetts. The chapter ends with a series of comments from various sources and perspectives on the Cape Wind Project.

Objectives

Students will:

- be aware of the potential to produce renewable and non-polluting energy by harnessing the powers of the sun and the winds,
- realize the strength of the arguments favoring and opposing the development of these sources of energy, and
- realize that solar and wind energy could play far larger roles in supplying the world's need for energy than it does presently.

Strategies

After you have determined that students have completed their assigned homework, review their answers to the multiple-choice questions. Make sure that all students understand the facts and concepts behind the right answers to each question. Encourage students to share their responses to the essay question via small-group discussions, staging a debate with rewards offered to winning presenters, or whole-class discussions. End by asking students to discuss whether they believe these three renewable energy sources may have a major impact on meeting the world's energy needs.

Assignment

Assign Chapter 8 and pass out the student reading and activities pages. Ask students to complete their assignment on their own paper if they run out of room on the handouts.

CHAPTER 7

SOLAR AND WIND: RENEWABLE AND NON-POLLUTING ENERGY SOURCES

Introduction

The best way of producing energy is to use renewable and non-polluting products of nature. A time-honored example was the windmill, which wind turbines and hydroelectric power have largely replaced. Other sources of renewable energy include converting the sun's heat into electricity, deriving heat from under the earth's surface, using energy from organic substances, and harnessing the power of ocean waves. This chapter explains how energy from the sun and the wind are harnessed and turned into electricity and discusses the pros and cons of using this energy.

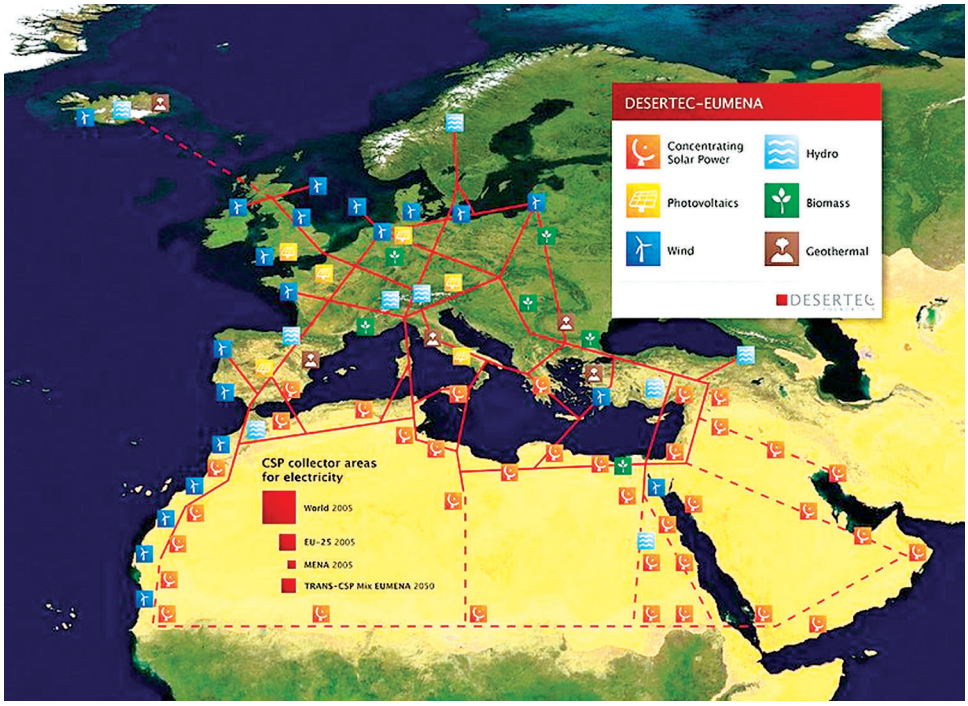
Solar Power

There are two forms of solar power: photovoltaic and solar-thermal. The former uses cells that transform energy from the sun directly into electricity. The problem with photovoltaic cells is that they can only produce energy during sunny days, but a major advantage is that the cells are thin and therefore easily installed on rooftops. Solar-thermal power uses mirrors that focus the sun's energy to produce steam. The steam is used to turn a turbine that generates electricity. The advantage of solar-thermal power is that the steam can be stored and used to generate electricity regardless of whether the sun is out.

Joshua Pearce, a professor of engineering in Ontario, Canada, claims that the potential for harnessing the sun's energy with photovoltaic cells in just one part of Ontario could generate enough power to replace all of the 104 nuclear power plants in the United States. The North African country of Morocco has already begun a $9 billion solar-thermal-power project scheduled to come online by 2015. When completed, the project will supply Morocco with 40% of its electricity needs.

The men and women who founded the energy-producing DESERTEC Foundation believe that "within six hours deserts receive more energy than mankind consumes within one year." Their goal is to harness the sun's power to heat water and generate electricity. The thermal power

produced in this manner could meet an estimated 15% of Europe's needs. DESERTEC's idealistic vision also includes providing clean drinking water from condensed steam. Given the fact that 90% of the world's population lives within 1700 miles of a desert, advocates claim that thermal power can supply 50% of the world's power needs by 2050.



DESERTEC's proposal for a clean supply of energy for the countries of Europe, the Middle East, and North Africa (EUMENA) includes wind turbines, hydroelectric, and geothermal forms of energy.[1]

Disadvantages to Solar-Thermal Power from the World's Deserts

Before enthusiastic readers write to their congresspersons or the president to advocate spending billions of dollars on generating solar-thermal-powered electricity, we should examine some of the problems associated with this form of energy:

1. Deserts are subject to sandstorms which would require heavy maintenance and the use of water to clean the reflecting mirrors needed to generate steam. Seawater may be used to generate steam, but that would limit the places that solar-thermal plants can be built.

2. The electricity produced by solar-thermal power plants must be sent hundreds of miles to where it will be consumed. Political disputes, terrorism, and lack of capital could delay, destroy, or discourage building these plants and the transmission lines.

1. Wikipedia, Creative Commons license (http://upload.wikimedia.org/wikipedia/commons/7/71/DESERTEC-Map_large.jpg)

There are answers to many of the criticisms of generating solar-thermal power, but not all of them are satisfactory:

1. Water heated into steam by the sun-directing mirrors can be used to clean them.

2. Transmission lines are no more likely to be intercepted than pipelines or ships carrying such fossil fuels as natural gas, coal, or oil.

3. Solar-thermal electric power may foster cooperation between its suppliers and consumers.

4. Finally, while the world will run out of polluting fossil fuels, solar energy will remain plentiful and inexpensive. Investment in this clean and plentiful source of energy should attract capital from all countries to meet their energy needs.

Solar Power to Pay for Your Family's Electricity?

Handy homeowners living in sunny climates can install enough solar panels on their houses to produce about 300 watts of electric power a month at an affordable cost. Unfortunately, 300 watts supplies only half the power needs of an average household of four people, and none of that power can be produced at night. However, in many areas, customers can arrange for their local electric power company to buy their electricity during the day and sell them electricity at night. In moderate climates, for a household paying between $200 to $250 for non-solar electricity every month, the payback period for photovoltaic power is usually over ten years and often as high as 15 to 20 years. But a smart shopper living in the right place and using government-provided tax credits can bring the payback time down considerably.

SOLAR POWER FOR YOUR HOME

Realizing the environmental and financial benefits of solar energy has never been easier or more affordable.

You can get solar panels installed on your home for as little as no money down, and reduce or eliminate your electric bill, and live the greener lifestyle you've always wanted.

Find out why solar is not only the right choice, but an easy decision by scheduling your free site evaluation today with an expert from our office!

A typical advertisement for home solar power

Harnessing the Wind

Though not as dependable as the sun, the wind is another attractive source of renewable and non-polluting energy. The wind has been used to propel sailing ships for some 7000 years. It has been used to pump water and grind grain for over 1300 years, and has been converted into electric energy beginning about a century ago. However, the wind-generated electricity industry did not begin until 1979. Thirty years later, wind accounted for less than 3% of America's electricity but 20% of Denmark's, 14% of Ireland's, and 8% of Germany's.

There have been and probably will be for long periods of time three major drawbacks to producing energy from the wind. First, winds have the unfortunate habit of not blowing all the time. Second, with blades reaching over 200 feet in length, wind turbines are expensive to build and maintain and often produce electricity more expensively than the electric energy derived from fossil fuels. Third, wind turbines are noisy and very visible. Many of these problems have become painfully obvious during the ten-plus-year fight to start the Cape Wind Project in the waters of Nantucket Sound, Massachusetts.

The Cape Wind Project

It seemed like an environmentalist's dream: Build a wind farm of 130 turbines in a 24-square-mile plot, nearly five miles from the closest shoreline. Create enough electricity to supply 440,000 homes. And do all this without polluting the environment, by using a renewable source of energy, and by building this project in one of the country's greenest states, Massachusetts.

There were, however, some concerns: Some people did not want anything so large (the tips of the blades to catch the wind would reach as high as 440 feet) to supposedly spoil the view for residents and tourists on the mainland. Migrating birds might need to alter their course or be caught up in the swirling blades (though even the Audubon Society did not think so). Native American tribes complained that the turbines would affect their sacred rituals that depended upon an unobstructed view of the rising sun. The electricity would be sold for twice the price that if produced from fossil fuels. An astonishing number of opponents, with a $20 million budget, opposed the project.

Permission to build this wind park for generating electric power had to be obtained from numerous state and federal agencies. And someone had to (and did) agree to buy the electricity that this enormous project would produce at twice the market price. Finally, $2.5 billion dollars needed to be raised to finance the Cape Wind Project. Ten years after the initial proposal for Cape Wind was filed, not one tower has been built, nor has the financing to complete this project been secured.

Arguments For and Against the Cape Wind Project

Even environmentally conscious people were split on the Cape Wind Project. Those who wanted to protect wildlife and keep the area open to fishing opposed the project. Those who were concerned about securing electricity from renewable and clean sources and wanted to make the U.S. less dependent on oil imports favored the project. Some people worried about the sheer cost of

2. U.S. Energy Information Administration

electricity produced by Cape Wind. Others were more concerned about the effect of burning polluting fuels. The following are a few statements from the many meetings and private conversations during the ten years of heated debate over Cape Wind:

A wind farm up close: five miles away, the turbines would appear to be about half an inch high.

- One-hundred-and-thirty turbines over 25 square miles will have little or no impact on oil consumption or the importation of foreign oil and it will not lower electric rates in any way.
- [These complaints] do not outweigh the powerful potential of offshore wind to help meet growing electricity demand, replace hydrocarbons, fight climate change, and ensure energy independence.[3]
- There are 18 fishing groups opposed to this project. And what happens if there is an impact on tourism? Even a two- or three-percent impact could cost millions.
- Six hundred to 1000 jobs would be created during construction of the wind farm, and 35 to 50 jobs would be created for ongoing operation and maintenance.
- The risks of this project outweigh its local public benefits. It has more benefit for the developer than it does for the public.
- In my mind Nantucket Sound is a special body of water. It has ultimately driven the Cape economy for decades and it's also nourished our souls.
- [The place] we found [for the wind turbines] is very similar to the conditions Europeans found for their first wind farms—low wave regime, reasonable proximity for taking up the power. And property values didn't decrease, tourism didn't drop off. The wind turbines became a tourist attraction, and I believe the same thing is going to happen on Cape Cod.[4]
- It's not going to make any difference, this one wind farm. You would have to build, I don't know, hundreds of wind farms of this size to have any slight impact on global warming.[5]
- Every time you flick a light switch, you should stop and think where that energy comes from. Does it cause a mountaintop in Kentucky to be blown up so fuel can be delivered to a Brighton power plant?[6]

3. Quoted in Courtney Craig, "Cape Wind: the Environmental Pros and Cons"
4. Quoted in Curt Nickisch, "As Battle Nears End, Cape Wind Still Divides"
5. Quoted in Rich Eldred, The Cape Codder, August 16, 2007
6. Quoted in Rich Eldred, The Cape Codder, August 16, 2007

Name: _____ Date: _____

Student Activities

Solar and Wind: Renewable and Non-polluting Energy Sources

A. Multiple-Choice

1. What difficulty is presented by using either solar power or wind power to generate electricity?
   a. Both pollute more than coal
   b. Both cost more to produce than energy derived from coal
   c. Neither can produce usable energy 24 hours a day
   d. Both are renewable forms of energy

2. The problems faced by the Cape Wind Project include:
   a. Local opposition
   b. High costs
   c. Opposition by some environmentalists
   d. All of the above

3. The founding idea behind DESERTEC is that:
   a. Solar energy is easily transported
   b. The sun provides more energy in six hours than the world needs in a year
   c. Solar panels are more efficient in producing energy than solar-thermal
   d. Energy produced from wind has no important part to play in producing inexpensive, renewable energy

4. A disadvantage to producing solar energy is:
   a. Start-up costs
   b. Wind-blown desert sands
   c. The sun does not shine 24 hours a day
   d. All of the above

5. Some form of wind-generated energy has been used:
   a. Since the discovery of fire
   b. To generate electricity since early in the 20th century
   c. To replace 30% of energy provided by fossil fuels
   d. As the main source of non-polluting energy in the world

6. Attempts to establish the Cape Wind Project have proven that:
   a. Wind farms are easy to establish
   b. There is little or no opposition to constructing offshore wind farms
   c. Wind farms produce electricity cheaper than conventional sources
   d. It is very difficult to overcome objections to building wind farms

7. It is highly likely that wind and solar energy will completely replace fossil fuels:
   a. By the year 2050
   b. When the world runs out of coal
   c. Never
   d. Before global temperatures increase by more than one degree

8. The main lesson to be learned from this chapter is that:
   a. Electricity derived from the wind and the sun will eventually replace energy generated from fossil fuels
   b. Energy derived from the wind and the sun is cheaper than energy derived from burning fossil fuels
   c. Deserts throughout the world are the most reliable, economic, and practical places to use in supplying the world with its energy needs
   d. Energy from the wind and the sun can play an important role in providing the energy needed in the future

B. Essay

Prepare to play the part of either:

a. A local resident of Cape Cod who opposes the Cape Wind Project

b. The CEO of the Cape Wind Project

c. A person concerned with the harm to birds and Native Americans' concern for their rituals

d. A person who will be paying at least two dollars more per month for electricity once the Cape Wind Project goes online

Write an essay of no more than 150 words presenting all your arguments for or against the Cape Wind Project.

CHAPTER 8

GEOTHERMAL, BIOMASS, AND OCEAN-GENERATED ENERGY

Overview

As the title implies, this chapter covers three major sources of renewable and environmentally friendly energy. It explores both the arguments for and those against using geothermal, biomass, and ocean-generated energy. Multiple-choice questions help you determine whether students mastered the important facts and concepts presented in the chapter. The essay/discussion exercise asks students to write an argument for using one form of these three carbon-neutral sources of energy and not one of the others.

Objectives

Students will:

- become familiar with the energy generating potential of geothermal, biomass, and ocean-generated sources,
- understand the arguments for and against using these energy sources, and
- decide which of the three hold the greatest promise for providing affordable, sustainable, and non-polluting energy for the greatest number of people.

Strategies

After you have determined that students have completed their assigned homework, review their answers to the multiple-choice questions. Make sure that all students understand the facts, concepts, and reasons that explain the right answers to each question. Encourage students to share their responses to the role they assumed in writing their essay question by one of the following strategies: small-group discussions, staging a debate with rewards offered to winning presenters, or whole-class discussions. End by asking students to discuss whether they believe that geothermal, biomass, or ocean-generated energy could have a major impact on reducing global warming.

Assignment

Assign Chapter 9, and pass out the student reading and activities pages. Ask students to complete their assignment on their own paper if they run out of room on the handouts.

CHAPTER 8

GEOTHERMAL, BIOMASS, AND OCEAN-GENERATED ENERGY

Introduction

This chapter covers three renewable and non-polluting sources of energy, geothermal, biomass, and ocean-generated, that might play an important role in meeting the world's needs. The word "geothermal" comes from the Greek words for "earth" and "heat." Biomass energy comes from organic material such as wood, plants, and manure, while ocean-generated energy harnesses the power of waves and tides.

Geothermal Energy

In centuries past, heat emanating from the earth was used for bathing (in hot springs and public baths) and to heat homes in ancient Rome. About 100 years ago, Italy became the site of the first commercial geothermal electric power plant; the second was built in New Zealand, 47years later.

Geothermal energy has been used directly in the form of heated water and indirectly by generating electricity from steam. With heat rising out of the earth, the world's best-known geyser ("Old Faithful") predictably erupts every 45 to 125 minutes. Since the 1940s, Iceland has used geothermal energy, which today provides 95% of its capital city of Reykjavik's needs. They have so much heated water that it is piped under roads and sidewalks to keep them clear of snow. Geothermal energy is also used directly to heat homes, commercial buildings, and even churches. Trained workers in this industry drill holes about 100 feet into the ground. Into these holes, they they install pipes filled with water or an antifreeze solution to transfer the heat from underground to buildings during cold weather. When the weather is warm, the building is cooled by pumping the heat out of the building and into the ground.[1] About 50 thousand of these systems are installed in the U.S. every year.

The most common form of geothermal energy, however, uses the steam it produces to generate electricity. The usual method of capturing this steam is to drill two holes one to two miles into the earth, pour water down one of them, and use the steam rising through the other hole to power electricity-producing generators.

1. To understand this idea, think of a refrigerator cooling food by pumping warm air into the kitchen.

Thirty percent of the world's geothermal power is produced in the U.S. Practically all of these plants are in western states because the earth's tectonic plates meet in that part of the country and release an easily accessible amount of geothermal energy. When all the facilities started in 2008 come online, they will produce enough electric power to heat four million homes, about 3% of all the residences in the U.S.

The Pros and Cons of Using Geothermal Energy

The major advantages of using geothermal power is that it is relatively inexpensive, far less polluting than fossil fuel or nuclear power, and sustainable. By one estimate, geothermal power costs one-third less to produce than power derived from fossil fuels. The greatest disadvantages are the high cost of drilling deep into the earth, the fact that 20% of the holes dug are unproductive (yield no energy), and that in rare cases drilling can cause minor earthquakes. Furthermore, the geological fault lines, where most cost-effective drilling can take place, are not accessible.

Biomass Energy

Biomass energy, or biofuel, is derived from plant and animal waste, including wood, garbage, and various grasses. The advantages of using energy created by burning plant and animal waste is that it is renewable and less-polluting. For untold centuries past, wood has been the chief source of biomass energy.

In recent years, the controversy surrounding biomass energy has focused on its use in producing ethanol—a fuel that is used in automobile engines. In the U.S, most ethanol is produced from corn. Use of corn-based ethanol has been hailed as a partial and non-polluting solution to America's dependence on imported foreign oil. Half of the gas sold in the U.S. is blended with ethanol. Environmentalists, corn farmers in 21 agricultural states, 22 senators hailing from these states, and several presidents have been convinced of the advantages of combining ethanol with conventional fuel. As a result, Congress passed a law in 2007 decreeing that 15 billion gallons of corn-based ethanol be produced in the U.S. by 2015 and 36 billion gallons by 2022.

Using Ethanol: Pro and Con

Since the ethanol law was passed, the public has become aware of the disadvantages of mandating production of corn-based ethanol:

1. In a world where billions go to bed hungry every night, valuable farmland should not be used to grow fuel for automobiles.

2. Ethanol is less efficient than gas derived from refined oil. It takes 1.4 gallons of ethanol to move a car as far as it could travel on a gallon of regular gas.

3. Energy used for growing corn, converting it into ethanol, and transporting the ethanol to oil refineries uses a large percentage of the conventionally generated energy that it saves.

4. Ethanol costs more to produce than it costs to produce an equal amount of gasoline. Therefore, the U.S. government spends billions of taxed dollars subsidizing corn used to produce ethanol, processing the corn into ethanol, and combining it with conventional gas. Presidential candidate John McCain summarized the objections to mandating production of ethanol by declaring: "*This subsidized program paid for by taxpayer dollars has contributed to pain at the cash register, at the dining room table, and a devastating food crisis throughout the world.*"

Advocates for ethanol have argued the following:

1. Ethanol cannot be blamed for causing a food crisis or for higher food prices.

2. Ethanol, many claim, can prevent engine knocking.

3. Combining ethanol with conventional fuel causes the regular fuel to burn more completely and thus releases fewer harmful greenhouse gases.

4. Producing corn-based ethanol supports rural economies in the U.S. and factories to produce ethanol from corn create jobs.

5. The cost of subsidies will decrease when production techniques improve and the price for fossil-based fuel increases.

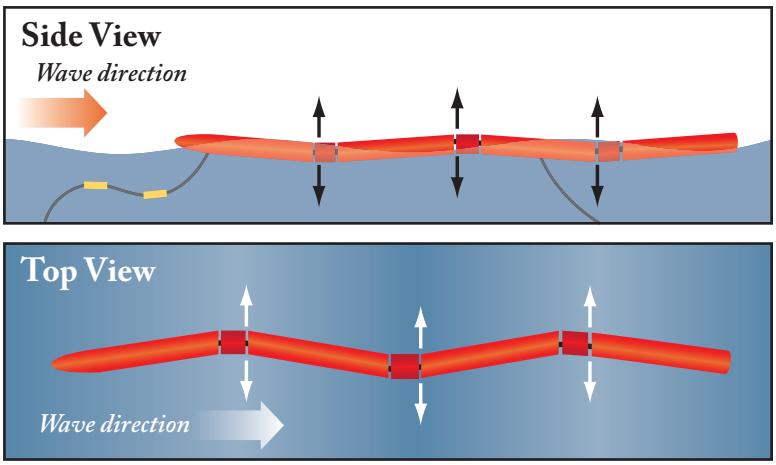
6. Ethanol can be produced efficiently from other biomass products. For instance, Brazil uses sugar cane, which cuts greenhouse-gas emissions by 86%, compared to corn-based ethanol that cuts emissions by only 20%. Other efficient biomass sources for producing ethanol may also be developed.

Energy Derived from the Oceans

Flowing river water has been used to create energy for many centuries. Huge dams such as the Boulder Dam in the U.S., the Aswan Dam in Egypt, and Three Gorges Dam in China are examples of dams that produce millions of kilowatts of electricity. However, dams failed to meet the increasing need for energy in the 21st century.

Innovative engineers have in more recent times thought of harnessing the energy of ocean waves and tides to do what electricity generating dams have been doing for generations. One form of ocean-based energy takes advantage of the movement of waves. An example of a device designed to take advantage of sea-wave motion is the Pelamis Wave Energy Converter, also known as the Sea Snake (see diagram). As waves

move sections of the long tube, pistons pump a fluid into hydraulic motors that generate electricity. The electricity is sent to shore by means of an under the sea bed cable. Champions of this snake-like device believe it can produce enough electricity to supply[2] 500 homes at an affordable price while using a renewable energy source.



The ebb and flow of ocean tides could be another source of a non-polluting energy. The most common way of producing this energy is to trap the water from incoming tides and use it to generate electricity as it rushes out while changing to low tide. This method has been applied in France since 1966 and has generated enough electricity to supply 240,000 homes, about one-quarter of the electricity produced by one nuclear power plant. Similar but smaller power plants have been installed or are in the planning stage at other ocean sites.

Unfortunately, there are numerous drawbacks to using the immense power created by the ebb and flow of ocean tides:

1. The limited number of potential sites for using tidal energy. Experts have concluded that, for sites to be cost-effective, the difference between high and low tide must be at least 16 feet.

2. Constructing catch basins can take up to ten years to build and are very expensive.

3. Because they are situated in the ocean, hydroelectric facilities are in great danger of being damaged by violent storms.

4. Although some of the aforementioned problems may be overcome, the fact remains that the tide only recedes for twelve hours per day. This limits the power-generating opportunities to one-half of each twenty-four hour period.

There are other ways of using the ocean's energy beside wave and tidal power and there are techniques constantly being invented and tested to overcome the difficulties mentioned in this section. As students of the problem of producing sustainable, non-polluting, and renewable energy, it is important that you keep up with current developments in this field.

2. Ocean Power and Delivery, Ltd., 2006, cited in U.S Department of Interior, Technological White Paper on Wave Energy Potential Use on the U.S. Outer Continental Shelf, May 2006.

Name: _____ Date: _____

Student Activities

Geothermal, Biomass, and Ocean-Generated Energy

A. Multiple-Choice

Choose the best alternative to each question and write your answers on your own paper or in your notebook.

1. Two important uses for thermal energy have been:
   a. For geysers and hot baths
   b. To keep streets and sidewalks free from snow
   c. A, b, and d
   d. Heat places directly and generate electricity

2. Which of the following is not a good reason for using geothermal energy?
   a. Geothermal energy stops earthquakes
   b. Geothermal energy does not cause pollution
   c. Geothermal energy is renewable
   d. Both b and c

3. Geothermal energy is:
   a. More polluting than coal
   b. More available than oil
   c. Less harmful to the environment than natural gas
   d. Available in most places

4. Which of the following cannot supply us with biomass energy?
   a. Wood
   b. Garbage
   c. Coal
   d. Sugar cane

5. Ethanol is:
   a. Seldom used in motor vehicles
   b. More efficient than regular gasoline
   c. Less harmful to the environment than most fossil fuels
   d. Produced in most states in the United States

6. Ethanol:
   a. Can be made from nuclear waste
   b. Creates no carbon footprint in processing
   c. Cannot reduce carbon emissions
   d. Is a way of reducing carbon emissions

7. Electricity can be produced from:
   a. All of the following
   b. Geothermal energy
   c. Nuclear energy
   d. Sugar cane

8. The Sea Snake is:
   a. A device that uses the power of tides to generate energy
   b. A long tube that uses energy produced by waves to make electricity
   c. A dragon-like creature from ancient myths
   d. Produced by a firm called Sea-Powered Energy

9. Which of the following will produce the least pollution:
   a. Wave and tidal energy
   b. Fossil fuels
   c. Nuclear energy
   d. Energy from corn

B. Essay Question

Pretend you are the CEO of a company that produces energy generated from geothermal sources, biomass materials, or the ocean. Write an essay of no fewer than 150 words in which you ask the government for a ten billion dollar grant to expand your company to help meet the world's need for efficient, inexpensive, and minimally polluting energy. Be sure you explain why supporting the energy your firm provides is a better use of government money than expanding at least one other means of producing energy. Come to class prepared to defend your position and criticize the arguments presented by other applicants.

CHAPTER 9
YOUR CARBON FOOTPRINT

Overview

This chapter requires students to estimate their carbon footprints. They are provided with a long list of daily activities that add to that average footprint or subtract from it. Some examples are thermostat settings in hot and cold weather, gas mileage, and use of public transportation. After answering all twenty questions, they tally their plus and minus points and multiply their final number by .2 and add the result to the average U.S. average per person's carbon footprint (24 tons).

Objectives

Students will:

- become aware of how much carbon pollution they and the average American creates,
- realize that the aggregate of their daily actions affect their carbon footprint, and
- discuss what they could do to decrease their carbon imprint with classmates and family

Strategies

After determining whether all your students completed their assignments, answer their questions as best you are able and ask them what they learned from this exercise. Write their answers on the chalkboard. Encourage students to question the reasons for the point values of different activities and ask them to explain what they learned from talking with their families about this assignment. Help students who require assistance in doing the math needed to determine their carbon footprint.

Assignment

Assign Chapter 10, and pass out the student reading and activities pages. Ask students to complete their assignment on their own paper if they run out of room on the handouts.

CHAPTER 9

YOUR CARBON FOOTPRINT

Introduction

The term 'carbon footprint' refers to the amount of carbon and other greenhouse gases individuals produce in their daily lives. We concern ourselves with an individual's carbon footprint because, as you have learned, there is no way of producing energy without causing some unintended damage to our earth. Since there are unintended consequences of using each of the sources of energy available to us, the only real solution to reducing greenhouse gases is for all of us, you and me included, to reduce our carbon footprints.

This chapter provides a tool to access your and your family's carbon footprint. Read the questionnaire appearing on the next three pages and score yourself and those with whom you live and discuss your answer with the people in your household. By following the directions at the end of this questionnaire you can get a rough idea of your household's carbon footprint and what you might do to reduce it.

*(**Teacher**: make one copy of the chart on the following three pages for each student)*

Your Carbon Footprint Survey

Topic	Question	Scoring	Your score
Air conditioning	Is air conditioner set to: • At 78 degrees or above • Between 70 and 77 • Below 70	Above 78 -2 70–77 +0 Below 70 +2 Not applicable -4	
Appliances	Does appliance have a high efficiency rating? • Refrigerator • Washer and drier, and dish washer	Yes on all -2 Yes on some 0 No on none +2	
Automobile	How many miles per gallon? • Under 20 • 21-25- • 26-35 • Over 35	Under 20 +5 21-25 +3 26-35 -3 Over 35 -6	
Clothes drier	Does family avoid using clothes drier? • Sometimes • Usually • Often	Sometimes 0 Usually -1 Often -2 Not applicable +1	
Cooking	Is microwave used as a substitute for the stove and oven? • Never • Seldom • Usually • Often	Never +1 Seldom 0 Usually -1 Often -2	
Dishwasher	Is it full before it is run and/or turned off before dry cycle: • Seldom? • Usually? • Often?	Seldom 0 Usually -1 Often -2 Not applicable -1	
Empty rooms	Is heat turned off and doors closed when room is generally not used?	Yes -1 No +1	
Fireplace	Is flue properly closed? Are doors to room with fireplace closed when fire is lit?	Yes on all -1 No on all + 1 Not applicable -3	
Flying	How many miles did you fly this year? • More than 3,000 miles • 1,000 to 2000 • 0–1,000	3,000 +3 1,000 to 2,000 +1 0 to 1,000 -2	
Food	Do parents buy locally grown foods or refrain from eating meat?	Both - 4 One of the two -2 Neither +1	

Furnace	Are air filters cleaned regularly? Does it use natural gas?	Yes on both -2 Yes on one -1 No on both +2 Not applicable 0	
Heat	Is thermostat set at under 72 degrees during days? Is it set at 55 degrees or lower at night or when house is empty?	Yes -2 No +2 Yes -2 No +2	
Insulation	Is the house properly insulated? • Walls • Attic	Yes on both -3 Yes on one +1 No on both +3 Not applicable 0	
Lights	Are bulbs energy efficient type? Do lights get shut off when room is empty?	Yes on both -2 Yes on 2 -1 No on 2 +1 No on all +2	
Recycling	Are paper products recycled at home? Are bottles recycled at home? Are tin cans recycled at home?	Yes on all -2 Yes on 1 -1 No on both +2	
Showers	Do family members' showers take less than five minutes?	Yes -1 No +1	
Solar or geothermal heating	Does the home use solar panels for electricity or hot water or use geothermal heat?	Yes -10 No +1	
Transportation	Do family members use public transportation? • Seldom • Whenever possible • Often • Use bike often	Seldom +2 Whenever possible? -1 Often? -2 Bike -3	
Washing machine	Is it generally run only when full?	Yes +1 No -1 Sometimes or not applicable 0	
Windows	Are windows properly sealed? Are shades used to keep heat out in summer and heat in during winter? Are storm windows used during cold weather?	Yes on all -3 Yes on most -1 Yes on one -1 No on all +3	
Discussed this survey with adult in home?	Extensively ---------- For at least one-half hour ------ Somewhat ---------- Not at all or just mentioned-----	-3 -2 -1 +2	
Signature of adult regarding discussion?		Yes -1 No +1	**Total Score**

Name: _____ Date: _____

Student Activities

Your Carbon Footprint

A. Compile Your Score

1. Make sure that you answer each question as accurately as possible on the copy of the chart that you get from your teacher or one you have reproduced. Invite the people you live with to help make your assessments. Then add and subtract where appropriate to arrive at your total score.

2. The average carbon footprint per person in this country is about 24 tons. If the number you came up with is a plus, add two-tenths (.2) of that to that number to 24 to determine your carbon footprint. If it is a minus, subtract two-tenths (.2) of that number from 24 to determine your carbon footprint.[1] **See example below:**

Score from Survey	Score from Survey X .2	Added to Personal Carbon Footprint Score	Your Carbon Footprint Score
Example 1 +20	+4	24 + 4	28
Example 2 -5	-1	24 - 1	23
Example 3 +7	+1.4	24 + 1.4	25.4

Chart for You to Complete Using Your Own Data (make and use your own copy)

Score from Survey	Score from Survey X .2	Added to Personal Carbon Footprint Score	Your Carbon Footprint Score

B. Essay Question

What have you learned about your family's carbon footprint, what could you do to reduce it, and why do you think it is or is not your responsibility to take action?

1. Note that the number you come up with is only a rough approximation of your effect on the estimated average person's carbon footprint.

CHAPTER 10
PROPOSED SOLUTIONS TO GLOBAL WARMING

Overview

This chapter explains the cap-and-trade strategy to reduce carbon emissions and provides a hypothetical example of how it works. Students learn that one alternative to using cap and trade is to impose a tax on carbon emissions. Arguments are presented for and against using a tax rather than the cap-and-trade approach. The chapter informs students that the defeated Clean Energy Act of 2010 relied primarily on implementing a complicated cap-and-trade strategy and was designed to reduce carbon emissions from 7,000 million metric tons recorded in 2005 to 2,000 million metric tons by 2050. The chapter explains several other strategies to reduce carbon such as doubling CAFÉ requirements and increasing taxes on gasoline.

The multiple-choice questions test whether students understand the basic ideas covered in this chapter and a required essay calls on them to decide between proposing the use of cap and trade, a carbon tax, or neither. An extra credit exercise provides students with information they need to have in order to decide, while playing the role of a CEO, whether they would install carbon-reducing technology to curb emissions or continue paying the fines that would allow their firm to pollute.

Objectives

Students will:

- understand how cap and trade works,
- choose between using cap and trade or a tax on carbon to reduce emissions, and
- explain why they think the government should do anything to reduce carbon emissions, and if so, what it should do.

Strategies

After determining whether students did their homework ask them to explain how the cap-and-trade strategy works. After you ascertain that students understand the concept, ask those who did the extra credit exercise to explain how they arrived at their answers. Spend the time needed to review all answers to multiple-choice questions and point out that some of them depend on students' opinion about the danger of global warming and the need to reduce carbon emissions. End class by asking students to report their views on what steps, if any, the U.S. government should take to curb global warming.[1]

Assignment

Assign Chapter 11, and ask students to outline their answers to at least five of the questions. Tell them they will have time in class to review the answers to the questions and that their test will consist of five randomly selected questions.

1. You may have trouble completing all of the suggested activities. If so, feel free to omit one or to spend another class on this chapter.

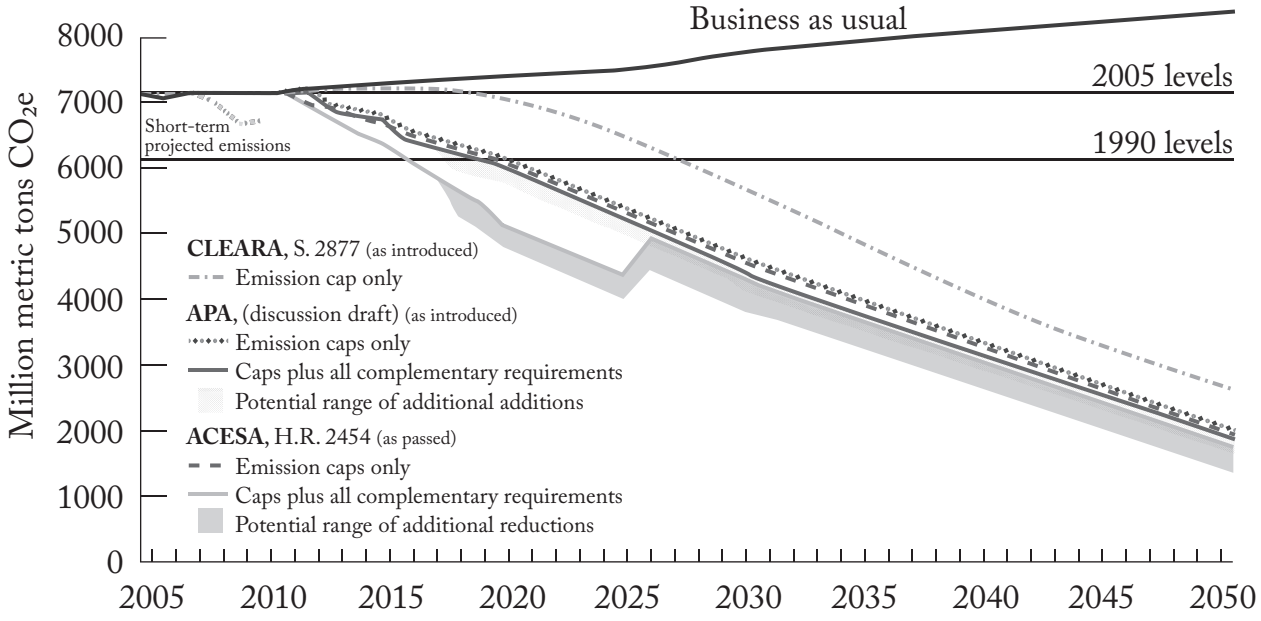
CHAPTER 10

PROPOSED SOLUTIONS TO GLOBAL WARMING

Introduction

The chart you are about to examine shows the goals that may have been achieved if a bill passed by the U.S. House of Representatives in 2009 had become law. For complicated political reasons, the American Clean Energy and Security Act (ACESA) was never brought up for a vote in the Senate before Congress adjourned in December, 2010. Although the bill will not be summarized in this chapter, some of its features and some other proposals will be presented, and you will have the opportunity to decide whether you would support any of them in an effort to limit greenhouse gas emissions.

Estimated Carbon Levels Under Three Different Proposals and Following Business as Usual[1]



1. World Resources Institute

Cap and Trade

The idea behind cap and trade is that we can reduce greenhouse gas emissions by establishing "caps" that limits the amount of pollutants that any company can produce. If a particular company produces more pollutants than it is allowed, it must pay a fine or buy the right to pollute more from a company that pollutes less than it is allowed. The purchase price would vary with the 'cap violation' fines that would be imposed by the government. Pollution caps could be reduced or increased by the agency that determines caps for each industry. Let's examine a hypothetical example of a 'cap and trade' situation:

> Acme Electrics produces 5,000 kilowatts of electricity and 1,000 tons of carbon a year more than it is allowed by the government's cap and trade policy. Zephyr Electronics produces 5,000 kilowatts of electricity and 1,000 tons of carbon a year less than is allowed. The fee for producing more than the cap is $100 a ton. Zephyr offers to sell its permission to pollute for $75 a ton. Acme decides it does not want to pay the permission to pollute to Zephyr or the government's $100 per ton fine and decides to invest by converting its plant to use more energy-efficient and cleaner fuels. Acme can become so much more efficient that two years down the line it can sell its surplus rights to pollute to other corporations.

Alternative to Cap and Trade

Another and more traditional way of changing the behavior of businesses that pollute is to simply put a tax of a fixed amount on each ton of polluting emissions. The tax would vary from firm to firm and its cost would be passed on to consumers. The money raised by the tax could be used to encourage companies to develop clean energy technology through outright grants or loans, to establish research laboratories, and or to compensate low-income people for increased cost of gasoline, electricity or heating oil. Higher prices for energy would also encourage conservation and therefore reduce carbon emissions.

Carbon Tax or Cap and Trade?

Opponents of cap and trade point to the fact that the government would need to cap, monitor, and inspect, thousands of different firms. Such a task would require a huge government bureaucracy and create opportunities for cheating.

Supporters of cap and trade believe their system is much simpler than slapping a tax on polluters:

> Cap and trade is a market, not a tax. It sets a hard limit on total emissions. Then a regulated exchange of tradable permits gives enterprise a choice: Invest in efficiency and better technology—or buy credits from more efficient players, underwriting their cleaner practices. [2]

2. Mark Lange, Cap and Trade is still the Right Call, The Christian Science Monitor, April 13, 2009

Other Proposals to Reduce Greenhouse Gas Emissions

- Double (Corporate Average Fuel Economy) CAFÉ standards by 2030
- Provide a voucher for up to $4,500 for anyone disposing of a car that gets less than eighteen miles per gallon and uses the money to buy an automobile that gets at least thirty miles per gallon
- Require all energy producing power plants to use renewable energy to produce at least 20% of its electricity
- Lend money without charging interest to all who spend it to reduce energy use in their homes
- Lend up to $50 billion to encourage vehicle manufacturers to build fuel-efficient automobiles including electric and hydrogen powered vehicles as well as hybrids
- Establish research facilities to concentrate on finding new ways to produce clean and efficient electric power
- Reimburse poor families who are negatively impacted by changes in energy production and use
- Finance a national network of stations to recharge electric cars

Name: _____ Date: _____

Student Activities

Proposed Solutions to Global Warming

A. Multiple-Choice

Choose the best alternative in each question and write your answers on your own paper or in your notebook. Answer each question in a complete sentence using the following as an example:

> CO_2 emissions can be reduced to 1990 levels in a decade or less and be reduced by 2,000 metric tons by 2050.

1. According to the chart on the first page of this chapter, at least one of the strategies for reducing CO_2 emissions would reduce carbon emissions:
   a. To 1990 levels by the late 2020s
   b. To 1990 levels in a decade
   c. From 7,000 metric tons to 2,000 metric tons by 2050
   d. All of the above

2. The idea behind cap and trade is:
   a. Clearly the best way to stop pollution
   b. Anything beats a tax on pollution
   c. You pay for the right to pollute and the government uses the money to encourage conservation
   d. The government can make money by fining firms that pollute

3. Which of the following ways of reducing the release of CO_2 involves the least government intrusion?
   a. Taxing companies for polluting
   b. Using a cap-and-trade strategy
   c. Prohibiting the use of fossil fuels to produce electricity
   d. Both a and c

4. Which of the following is the most sensible alternative to using cap and trade?
   a. Giving up entirely on reducing carbon levels
   b. Passing a law prohibiting plants that generate electricity to use fossil fuels
   c. Taxing firms for emitting greenhouse gases
   d. There is no good alternative to using cap and trade

5. What is/are the best argument(s) for not using cap and trade to reduce carbon emissions?
   a. The need for constant government oversight
   b. The opportunities for cheating and bribing
   c. The lack of a need to reduce carbon emissions
   d. Both a and b

6. Who would be least in favor of passing the American Clean Energy and Security Act?
   a. A CEO of a plant using nuclear energy to produce electricity
   b. The CEO of a company producing electric cars
   c. The CEO of a plant using coal to produce electricity
   d. A commuter who uses his gas guzzling car to drive an average of 75 miles a day

7. Who would be most in favor of passing the American Clean Energy and Security Act?
   a. A person who favored taxing carbon emissions
   b. An environmentalist
   c. A person who thinks the government has too much power already
   d. A person who believes each state should make its own carbon emission laws

8. What is the main reason for passing the voucher program mentioned in the "Other Proposals to Reduce Greenhouse Gas Emissions" section of the readings?
   a. Helping General Motors sell its cars
   b. Replacing gas guzzling vehicles with cars that pollute less
   c. Balancing the budget of the United States
   d. Stimulating economic growth

9. Which are the best reasons not to pass the American Clean Energy and Security Act? (Be prepared to support your answer in class.)

   a. It would cost the government money and raise the price of energy

   b. It would hurt people most who depend on nuclear energy

   c. It would cost money to solve a problem that does not exist

   d. Cap and trade is not the best solution to the problem of global warming

10. What is (are) the best reason (reasons) for supporting the cap-and-trade feature in the American Clean Energy and Security Act?

    a. B, c, and d

    b. Global warming is a potential threat to life on earth as we know it

    c. Only the federal government can deal with problems as big as global warming

    d. The problem of carbon pollution in the U.S. cannot be solved by individuals taking action to stop it

B. Essay

Write an essay of no fewer than 200 words favoring or opposing the cap-and-trade features in the American Clean Energy and Security Act and in favor or in opposition to two of the alternatives suggested under the heading of "Other Proposals to Reduce Greenhouse Gas Emissions." You may decide to cover some of the following topics:

- Does the cap-and-trade strategy make sense? Or is a simple carbon emission tax a better way to deal with the problem?
- Is global warming really a serious threat to our planet?
- Can the United States afford to support efforts to stop global warming or can it afford not to?

Possible leading sentences:

a. The United States should not use the cap-and-trade strategy to combat global warming because there is no firm evidence that it is the result of human activities, and even if it were, cap and trade is not the way to go about ending it

b. The United States might consider a better alternative to using cap-and-trade as a strategy to fight global warming, but whatever strategy it uses the federal government must be used to combat this challenge to life on earth as we know it

C. Extra Credit: How Cap and Trade Works

Write your answer to the following problem on your own paper or in your notebook and be prepared to explain your answer in class:

> Altman Electrics produces 5,000 kilowatts of electricity and 1,000 tons of carbon a year more than it is allowed by the government's cap-and-trade policy. The fee for producing more than the cap is $100 a ton. Altman could buy permission to pollute from Burg Inc., which can offer the right for $75 a ton.
>
> Altman Electrics is able to get a no-interest loan from the government and use it to build a new plant that will be so efficient that Altman will be able to avoid paying any fine ($100 a ton) or permission ($75 a ton) The new plant will cost $500,000 and will take five years to build.

How soon will Altman break even if they are paying:

a. For permission to pollute at $75 a ton?

b. The government's fine of $100 a ton?

CHAPTER 11
TEST PREPARATION QUESTIONS

Overview

The purpose of this chapter is to provide students with the most fair and appropriate assessment for this unit. The chapter contains ten broad questions and an optional essay question.

Objectives

Students will:

- study for a comprehensive assessment of what they learned in their study of global warming,
- help each other to prepare for the test, and
- receive help from their teacher in preparing for their unit assessment activity.

Strategies

One strategy is to divide students in groups of no more than five and then ask whether they need any help answering those questions that were posed in the text. After an appropriate amount of time, involve students in providing answers and go from group to group to help individual students who need more assistance. You might allow students to decide to answer the essay question instead of taking the test. Tell those who chose that alternative to work on their essay in class and hand it in the day after the test.

On the day of the test, I suggest that you give students five questions and ask them to pick three or four. You may wish to make a random selection or to choose questions that you consider were most appropriate.

CHAPTER 11

TEST PREPARATION QUESTIONS

Introduction

The following list of questions, geared to the chapters in your book, may be used to test you on this unit. The essay question that follows may serve as an alternative to a test.

Questions

1. Is global warming really due to human activity? Is it a real danger to the planet in your lifetime? Cite evidence to support your statement.

2. What is the relationship between greenhouse gases such as CO_2 and global warming? What is the worst-case scenario predicted by environmental alarmists? Give examples.

3. What are the three types of oil reserves? What are the dangers of relying on oil as our major source of energy?

4. If you were very concerned about global warming, explain what car you would buy? Why might you hesitate before buying an electric or a hydrogen-powered vehicle?

5. Why might it not be wise to count on "clean coal" or natural gas as our fuel needs despite the fact that both substances are plentiful?

6. Was nuclear energy ever "too cheap to meter" and what facts contribute to its not being "too cheap to meter" today? Why might you be willing to ignore these problems and support plans to build new electric-producing plants powered by nuclear fuel?

7. a. Distinguish between two types of solar power and explain why one of them could be used to realize DESERTEC's vision?

   b. How do the experiences of Cape Wind supporters show the difficulties of using off-shore wind turbines to generate electricity?

8. What are some of the advantages and some of the disadvantages of relying on (a) thermal energy, (b) energy produced by oceans, and (c) biomass energy?

9. What steps might homeowners take to reduce their carbon imprint?

10. Discuss the advantages and disadvantages of using cap and trade rather than a carbon tax as a means of reducing CO_2?

Optional Essay Questions

Respond to one of the following statements in an essay of no fewer than 700 words. Your grade will depend on how well you use ideas and facts covered in this unit to support your answers.

1. Even if it exists, global warming does not present a "clear and present danger" to our world and is not caused by human activity. Various attempts to phase out the use of fossil fuels would create more problems than they solve.

2. Global warming caused by human activity presents a "clear and present danger" to our planet. There are a number of non-polluting and renewable alternatives to the use of fossil fuels that can reduce our civilization's carbon footprint.

ANSWER KEY

Chapter 1

Global Warming: Caused by Human Activity?

A. Multiple-Choice Answers, pp. 7–8

1. None of these events is a definite sign that human activity is causing global warming, so **(d)**.

2. One fact authors of various documents in this chapter agree on is **(a)** that the average global temperatures have increased considerably.

3. Global temperatures were higher in the beginning of the twenty-first century than they were at the end of the eighteenth, so **(c)**. Scientific consensus agrees that human activity is responsible for a portion of global warming, but few if any climatologists claim that human activity is the sole cause of global warming, so **(a)** is not the best answer.

4. The British official quoted in this chapter believes **(d)** that there has been no global warming during the first decade of the twenty-first century and that politicians are too quick to accept what most people believe to be true.

5. The chart in this chapter shows **(b)** that there has been a decrease in global warming between 1940 and 1955.

Chapter 2

Scientific Evidence for Global Warming

A. Multiple-Choice Answers, pp. 14–15

1. According to this chapter, the scientific method **(b)** includes peer review and hanging hypotheses when more evidence is presented.

2. According to the best available scientific data, **(b)** there is a strong correlation between increases of carbon dioxide in the atmosphere and increasingly warm global temperatures.

3. All of the following are greenhouse gases: carbon dioxide, methane, and nitrous oxide, so **(d)**.

4. A twenty-foot rise in sea levels by 2100 **(b)** is one of many possibilities if current trends continue to accelerate.

5. All of the following are possible results of extreme global warming: increases in rainfall in some parts of the world, rising levels of oceans and flooding of major cities, and severe droughts in some parts of the world, so **(d)**.

6. The evidence that global warming is caused by human activities is **(b)** a hypothesis accepted by most scientists.

7. Correct answers are both that the United States leads the world in per capita carbon dioxide emissions **(a)**, and that China leads the world in total emissions **(b)**.

   Note: Canada is second in per capita omissions, only slightly behind the United States.

Chapter 3

Major Oil Spills and Depletion of Reserves

A. Multiple-Choice Answers, pp. 23–25

1. The BP Deepwater Horizon oil spill **(b)** was the single worst accidental oil spill prior to 2010.

2. The BP oil spill occurred in waters off the shore of **(d)** Louisiana.

3. As of 2010, the second worst spill occurred in or near **(c)** Mexico.

4. The phrase "the faster you drink it, the quicker it is gone" is used in this chapter as an analogy to **(a)** the idea that the world may run out of oil.

5. The three types (classifications) of oil reserves are **(d)** none of the above.

   Note: the three are proven, probable, and possible.

6. According to the chart, the countries whose combined proven reserves equal over 50% of the world's total oil deposits are **(a)** Saudi Arabia, Canada, Iraq, and Iran.

7. Deepwater oil rigs operate **(d)** a mile above the ocean floor, 35,000 feet under the ocean floor, and with 35 wells at a time.

8. The problems with using Canadian oil sands are that **(d)** it creates toxic water lakes, consumes large quantities of energy to heat the water, and consumes large quantities of water.

9. Reasons not to rely heavily on oil from the Middle East include **(a)** several nations are either too politically chaotic or under sanctions, and **(b)** many are members of OPEC.

   Note: Canadian oil does not do less damage to the environment.

10. There are many problems with continuing to depend on the world's oil supply, so **(b)**.

Chapter 4

Alternatives to Gasoline-Powered Engines

A. Multiple-Choice Answers, pp. 33–35

1. It is important that Americans decrease their dependence on oil because **(d)** oil is a source of carbon dioxide pollution, and it accounts for approximately 35% of all energy used in the United States.

2. The United States consumes **(c)** about 20 million barrels of oil every day, which is enough to produce 35.3% of all energy it uses.

3. The single largest use of energy in the United States is for **(a)** transportation.

4. Nuclear materials **(c)** are not fossil fuels.

5. The letters OPEC stand for Organization of the Petroleum Exporting Countries, so **(d)** none of the above.

6. The price of gasoline rose rapidly in the United States in the 1970s due to **(b)** OPEC's boycott.

7. Electricity is created in hybrid cars by **(d)** the gasoline engine, slowing the car down, the generator (and, yes, electric power outlets).

8. The main advantage of hybrid cars is **(c)** they use less gasoline.

9. In 2010, the best reason for not buying a Tesla was **(d)**, that it was very expensive.

   Note: The price of a Tesla has decreased dramatically.

10. The main advantage of driving a hydrogen-fueled car is **(d)**, it uses a renewable source of energy (hydrogen can be made from water), and it has zero harmful emissions (but the fuel is difficult and expensive to transport and is highly combustible).

Chapter 5
Coal and Natural Gas

A. Multiple-Choice Answers, pp. 44–45

1. Natural gas **(b)** is the fossil fuel that produces fewest pollutants.

2. Natural gas accounts for **(c)** 25% of the energy used in the United States.

3. Hydraulic fracturing **(c)** endangers the water supply.

4. Mountaintop removal is used to **(b)** unlock seams of coal.

5. If you were to find that water from a faucet in your home caught on fire, you could probably blame **(c)** the local company engaged in hydraulic fracturing.

6. Hydraulic fracturing requires all but **(a)** removing the tops of mountains.

7. In mountaintop-removal mining, the least damage done is to **(c)** the men who dig up the coal.

   Note: except that they may lose their jobs.

8. The most important lesson you learned from reading this chapter is **(c)** there is no such thing as completely clean oil or natural gas.

Chapter 6
The Nuclear Option

A. Sorting Out Arguments Answers, pp. 52–53

Facts Supporting Building Nuclear Power Plants	Facts Supporting Investing Money in Oil, Natural Gas, or Coal as Sources of Energy
(example) What happened in Roane County, Tennessee	*(example) Natural gas burns much cleaner than oil or coal*
Few non-polluting coal plants have been or are being built	It takes about 10 years and $10 billion to build a nuclear power plant
All but one nuclear power plant in the U.S. had an accident-free record (unless one argues one is enough)	The Yucca Mountain fiasco
Mountaintop mining	What happened at Chernobyl
Flammable liquids pouring out of water faucets	Problems transporting nuclear waste
Need to double energy use in 35 years	What happened at Three Mile Island
Many nuclear power plants only need government approval and financing to begin construction	The disposal and storage problem
Coal-fired plants emit more radioactive ingredients than a nuclear plant	Natural gas burns much cleaner than oil
Most sources for cleaner-burning fossil fuels have been exhausted	Pollution caused by burning fossil fuels is approaching dangerous levels

New technological developments have made nuclear plants much safer	Two thousand tons of radioactive used nuclear fuel is produced every year
The U.S. Navy has run nuclear-powered ships since 1955 without an accident	

Chapter 7

Solar and Wind: Renewable and Non-polluting Energy Sources

A. Multiple-Choice Answers, pp. 62–63

1. The difficulty presented by using either solar or wind power to generate electricity is that **(c)** neither can produce usable energy 24 hours a day.

   Note: (b) is wrong because, though they may cost more to build, they are cheaper to operate.

2. The problems faced by the Cape Wind Project include **(d)** local opposition, high costs, and opposition by some environmentalists.

3. The founding idea behind DESERTEC is that **(b)** the sun provides more energy in six hours than the world needs in a year.

4. A disadvantage to producing solar energy is **(d)** start-up costs, wind-blown desert sands, and the sun does not shine 24 hours a day.

5. Some form of wind-generated energy has been used **(b)** to generate electricity since early in the twentieth century.

   Note: that's the only one of these facts supported by the text.

6. Attempts to establish the Cape Winds Project have proven that **(d)** it is very difficult to overcome objections to building wind farms.

7. It is highly likely that wind and solar energy will **(c)** never completely replace fossil fuels.

8. The main lesson learned from this chapter is **(d)** energy from the wind and the sun can play an important role in providing the energy needed in the future.

Chapter 8

Geothermal, Biomass, and Ocean-Generated Energy

A. Multiple-Choice Answers, pp. 71–73

1. Two important uses for thermal energy have been for **(c)** geysers and hot baths, keeping streets and sidewalks free from snow, heating places directly, and generating electricity.

2. The following is not a good reason for using geothermal energy: **(a)** geothermal energy stops earthquakes.

3. Geothermal energy is **(c)** less harmful to the environment than natural gas.

4. Coal **(c)** cannot provide us with biomass energy.

5. Ethanol is **(c)** less harmful to the environment than most fossil fuels.

6. Ethanol is **(d)** a way of reducing carbon emissions.

7. Electricity can be produced from **(a)** geothermal energy, nuclear energy, and sugar cane.

8. The Sea Snake is **(b)** a long tube that uses energy produced by waves to generate electricity.

9. Wave and tidal energy **(a)** will produce the least pollution.

Chapter 9
Your Carbon Footprint

Answers to questions in this chapter cannot be specified.

Chapter 10
Proposed Solutions to Global Warming

A. Multiple-Choice Answers, pp. 86–88

1. According to the chart on the first page of this chapter, carbon emissions can be reduced to **(d)** 1990 levels by 2020, within a decade, and by 5,000 metric tons by 2050.

2. The idea behind cap and trade is **(c)** you pay for the right to pollute and the government uses the money to encourage conservation.

3. Using **(b)** a cap-and-trade strategy is the least intrusive strategy for government to reduce the release of CO_2.

   Note: Others may disagree—ask them to support their answers if they are different.

4. There is **(d)** no sensible alternative to using a cap-and-trade strategy listed in the text, so that is an acceptable answer. Some teachers may accept **(a)** giving up on reducing carbon levels or **(d)** taxing firms for emitting greenhouse gases if students support their answers with strong arguments.

5. The best arguments for not using the cap-and-trade strategy are **(d)** the need for constant government oversight, and the opportunities for cheating and bribing.

6. Since the provisions of the American Clean Energy and Security Act are not provided in the text, it's difficult for a student who does not do the research to answer the question. Research should show that the ACESA provides for cap-and-trade provisions and many of the other proposals listed in the last section of the readings. The CEO of a coal-burning electricity-generating plant **(c)** would have the most to lose from ACESA.

7. A **(a)** person favoring the taxing of carbon emissions and **(b)** an environmentalist would be most in favor of passing ACESA.

8. The main reason for passing the voucher program is **(b)** to replace gas-guzzling cars with vehicles that pollute less.

9. The best reason for not passing the ACESA is **(a)** it would cost the government money and raise the price of gas.

10. The best reasons for passing the ACESA are **(a)** global warming is a potential threat to life on the earth, only the Federal government can deal with problems as big as global warming, and the problem of carbon pollution in the U.S. cannot be solved by individuals acting alone.

C. Extra Credit: How Cap and Trade Works Answers, p. 89

Altman Electrics produces 5,000 kilowatts of electricity and 1,000 tons of carbon per year more than it is allowed by the government's cap-and-trade policy. The fee for producing more than the cap is $100 per ton, unless the company buys permission to pollute from Burg Inc. at a rate of $75 per ton.

Altman Electrics is able to get a no-interest loan from the government and use it to build a new plant that will be so efficient that Altman will be able to avoid paying any fines (at $100 a ton) or permission ($75 a ton). The new plant will cost $500,000 and take five years to build.

How soon will Altman break even if they are paying:

a. For permission to pollute at $75 per ton? **11 years and 8 months**

b. The government's fee of $100 per ton? **10 years**

Basis for the answers: Building the new plant will cost Altman $500,000 and take five years, so the total cost will be the $500,000 building cost plus 5,000 tons of excess carbon over that time. Depending which option Altman chooses, they will pay for the 5,000 tons of carbon at $75 per ton (or, $375,000) or at $100 per ton (or, $500,000).

Starting with the easier math problem, at $100/ton, Altman faces a $500,000 building cost and $500,000 of fines. Grand total costs: one million dollars. The new building saves them the $100,000/year of fines. So, the total cost divided by annual savings equals break even, which takes ten years ($1,000,000 $100,000 per year = 10 years).

At $75 per ton, Alton pays the $500,000 building cost plus $375,000 in permits for a grand total of $875,000. Breaking even at the rate of $75,000 per year will take eleven years and eight months ($875,000 $75,000 = 11.66 years).

Chapter 11

Test Preparation Questions

This chapter's discussion questions have no questions that have specific answers, except that the three types of oil reserves (question 3) are proven, probable, and possible.