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Fueling around with Energy: A Comparative Study of Conventional and Renewable Energy Use among Nations

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by Ralph E. Russo

Overview

For most of us living in the developed world, mastery of energy appears as simple as turning a key or flipping a switch. Such seemingly effortless tasks are the triumph of ingenuity. Yet their simplicity should not trivialize the progression of innovation that led us to this point in history, nor should it obscure understanding of the fundamental process by which our energy is extracted from the environment. *Fueling around with Energy* is an attempt to connect high school history students with realities of the environmental, economic, and political characteristics of the energy process in developed countries and the developing world. In completing this unit students will conduct a comparative study of conventional and renewable energy use in developed countries and in the developing world. The unit fits in the world history curriculum in the *Perspectives on the Present* unit offered by McDougal Littel in *Patterns of Interaction* textbook. It can also be used in any twentieth century history, current events class, and or international relations class. United States History classes can incorporate this in the study of U. S. society since World War II. Science teachers may also use parts of this unit to supplement a more scientific investigation of energy called for in an earth science or integrated science class. An interdisciplinary unit can easily be crafted in the simulation activity *World Energy Summit.* Students can be organized to investigate, explore, and present integrated analysis that incorporates scientific, historical data, narrative prose, and calculations. This might be ideal to use in high school freshmen cluster programs that encourage interdisciplinary activities among core subjects.

In general, this curriculum unit seeks to promote student achievement toward mastery of State and City Social Studies Program Goals. More specifically, activities of the unit are planned to address New Haven Social Studies Curriculum expectations, content strands, standards, performance, principles of teaching and learning, and social studies skills. (see Addendum 1) An attempt has been made to include activities that are integrative and value based. Moreover, lessons incorporate problem solving, organizing information, effective communication, and effective collaborative work. References to the New Haven Curriculum are noted throughout the unit.

Historical Relationships of Energy and Society

Throughout history, societies have prospered and failed based on their mastery of energy. Up until the Industrial Revolution, successful societies largely depended on the energy of the sun to fuel the needs of society. Most work was confined to the daylight hours. Humans depended on the product of the sun's energy-warmth, light, and photosynthesis. The latter is an essential element to all plant life on the planet. Agriculture would be impossible without it. In *Energy and World History* , Vaclav Smil refers to pre-industrial societies as solar societies. The harnessing of biomass fuel sources (plants and trees) was a tremendous technological development. One might say that the origin of civilization occurred with the spark that ignited the first prehistoric campfire. The premeditated harnessing of energy has been a mainstay of technologically advanced communities ever since.

Breakthroughs in technology and access to energy resources have given some societies a decisive technological edge in history. The benefits as well as the economic and environmental costs for acquiring and/or maintaining a particular energy standard is important for members of a society to understand. The implications for thrift or negligence in regard to energy use are crucial to the economic and environmental health of a society. Most recently China's headlong embracing of coal as a fuel raises the question of whether China's environment will deteriorate in the shadow of industrial development.

Other historical examples shed light on the importance of the relationship between energy, political decisions, and the welfare of a society. Imperial Japan suffered tragic economic and political costs as a consequence of the Japanese campaign to dominate Southeast Asia and the South Pacific in the 1930's and 40's. To secure energy resources for their empire, which were lacking in Japan, the imperial armed forces were willing to gamble that they could dispose of the United States' Pacific fleet at Pearl Harbor. In the words of Japanese Commander Yamato, the Japanese Imperial Navy ended up "waking the slumbering giant (United States)". Modern historians may argue that the post war Japanese economic and industrial boom was the result of United States' rebuilding in World War II's aftermath. However, it seems fair to presume that the leaders of Emperor Horohito's empire would have preferred a different outcome. Would they have chosen such an aggressive path to secure oil resources for an empire if they could have foreseen the loss of life suffered in the Pacific campaign, fire bombings, and atomic bombings that followed?

In Britain, the transition to coal burning was a fortuitous development for the English who had depleted their biomass forest reserves by the late 16th century. Turning to coal as a fuel source led to the discovery of the coking process, which produced coke, the fuel of the Industrial Revolution. With the impurities of raw coal removed, improved metallurgy allowed the invention of the engines which powered Britain, the United States and Europe into industrial pre-eminence previously unforeseen in world history. The subsequent innovation that has continued to follow these inventions, has allowed countries of the developed world to maintain a decisive technological, economic, political advantage over the developing countries. The result has been a much higher standard of living. The price for this standard of living is tremendous energy consumption.

The discoveries of fuels derived from crude oil have further enhanced the legacy of the developed world. These fossil fuels power 90% of transportation in the modern world. 1 They also act as a dominant home heating fuel. The use of fuel derived from crude oil has profoundly buttressed and intensified urbanization. Increased transportation systems and improved energy output advantages have allowed more people to live in urban areas without the reliance on large tracts of surrounding agricultural lands for food and biomass fuel. Smil presents this case in Energy in World History. Smil reports that traditional cities (not fueled by fossil

fuels) need surrounding agricultural land to produce food and fuel that is 40 to 100 times the land size of the urban area. The coal and oil fields that power fossil- fueled cities need only to be “no more than 10% of the urban area or as little as 1/10 of 1% of the urban area” 2. Consequently we possibly now have in the developed world more than ever before, larger urban areas located more closely together.

However, like the forests of England, fossil fuels, crude oil in particular, appear to be a very limited and exhaustible resource. While estimates of the limit of crude oil range from 50 to 100 years, it is plausible to consider how the world will be different without a plentiful supply of crude oil. Societies that can develop safe alternative fuels will be in the position to have a decisive technological, economic, and environmental edge as fossil fuels become scarcer and more expensive in the future. However as the current patterns of energy production and consumption suggest, reliance on renewable alternative fuel sources lags far behind conventional energy production and consumption. Regulation of nonrenewable energy sources with incentives and penalties is likely in the near future. An overview of conventional versus renewable energy consumption will show the disproportionate dependence on fossil fuels.

Renewable vs. Conventional Energy Sources

Scientists classify energy sources as conventional or renewable. Conventional energy sources include fossil fuels: oil, natural gas, and coal. Renewable energy sources include apparently cleaner and harder-to-deplete energy sources: wind, solar, tidal, and geothermal. Figure 1 differentiates between conventional and renewable energy sources. The World Energy Report includes percentages of how each energy source contributes toward meeting world energy demands. These percentages are included in the table.

Figure 1.

Conventional vs. Renewable energy sources with percentages of the world’s energy demand that they meet.

Conventional	*Renewable*
Oil 36%	hydropower 2.2%
Natural Gas 21%	biomass and combustible waste 2%
Coal 23%	geothermal *
Nuclear 7%	wind *

*combine for around 0.5%

Solar*

3 Global Energy Supply Swiss Federal Office of Energy 2002

According to the World Energy Outlook Report (), fossil fuels were the predominant fuel used to meet world energy demand in the year 2000. In a Swiss Federal Office of Energy summary of the report, 80% of the world’s energy demand was described as being met from fossil fuel energy. Oil provided 36% of the global energy need. Coal use (23%) was slightly more than natural gas use (21%). Nuclear energy fueled 7% of the world’s demand. By comparison, renewable energy sources comprised a much smaller fraction of the energy

needed to meet demand. Hydropower (2.2%) and non-commercial biomass (firewood, compost, and other combustible waste material) (2%) accounted for meeting less than 5% of the energy need. Geothermal, wind, and solar energy combined met only 0.5% of the energy demand. (World Energy Outlook Report) 4

Oil met 60% of the transportation demand. Coal met 55% of the demand for producing electricity. Non-commercial biomass is not sustainable in the developed world but is more widespread in developing countries. (Global Energy Supply published by the (3) Swiss Federal Office of Energy. *http://www.energie-schweiz.ch/internet/00480/?lang=en*) 5

Considering these examples may lead one to appreciate the importance of the relationship between energy and society: a relationship perhaps now taken for granted. Although, with the price of gasoline now consistently about $2.00 a gallon for regular gasoline, many will certainly be thinking about the economic costs of driving. The purpose of their inclusion in this unit and the primary aim of the unit are to challenge the notion that energy can be taken for granted. Through understanding of how energy works and how countries have historically used energy, hopefully students will embrace the challenge of responsible energy development and use. A summary and explanation of objectives follows.

Objectives

- Students will list the primary energy resources in different regions of the world and be able to differentiate between conventional and renewable energy sources.
- Students will describe orally and in writing the pattern of energy consumption and production in a specified area of the world.
- Students will identify the major international government organizations and nongovernmental organizations that address energy policy.
- Students will formulate an optimal energy policy better suited for their needs.

Knowing how different societies use energy and where abundant energy resources exist is a logical first step to understanding the relationship between energy and society. For example, the developed world relies heavily on conventional energy sources. Examining the geography of oil production and consumption helps one understand the problems of supply and demand. Crude oil is the primary fuel from which a variety of petroleum fuels, lubricants and additives are derived. The largest oil reserves can be found in the Middle East, parts of Russia, and Venezuela. Yet, the United States, Europe, Japan, and many developing countries rely on importing oil in order to maintain a standard of industry, production, and living. Without a continuous supply of crude and refined oil products, the economies and standards heretofore mentioned would be in serious jeopardy. Many countries try to lessen dependence on foreign energy sources by developing other forms of energy.

In 1973, France generated 80% of its power from fossil fuel. Now, France relies heavily on nuclear reactors for generating electricity. According to information published by *Green Nature* (*http://greennature.com/article744.html*) 58 nuclear reactors power 77% of France's electricity. 6 Dominant energy supplies in other areas of the world include large quantities of coal in the United States and China. However, large reserves of an energy source do not guarantee that a country will prosper from its use. Coal is a much dirtier source of fuel than oil or natural gas. Coal mining often leaves large tracts of land scarred and or porous with mine shafts. Burning coal creates environmental problems for the immediate area surrounding a coal fired plant. It also sends pollutants airborne where they may travel hundreds of miles and settle in bordering communities. Acid rain and acid lakes in the Northeastern United States have been linked to coal fired power plants in the Midwestern United States Ohio Valley. Damage to the environment raises questions of energy costs. In assessing the location of energy reserves and consumption, students should also examine the environmental and financial costs of particular types of energy.

Hopefully through the process of studying the benefits and drawbacks of conventional and renewable fuel sources, students will gain understanding of the differences and similarities respective societies have in regard to energy needs. Nations are utilizing a variety of energy resources in addition to fossil fuels. In the course of completing this unit students will explore the difference between conventional and renewable energy sources, examine the economic and environmental benefits and drawbacks to each type of energy, and plot where these energy sources are being used. Students will also compare patterns of energy consumption between the developing countries and the developed world. Through a simulation activity (*World Energy Summit*), students will be assigned a particular region of the world, construct analysis of energy use in that region, identify the implications of different types of energy use and formulate policy that will sustain their region through the foreseeable future. In the simulation, students will present position papers that describe energy policy for their region. In addition, students will present their work to the class in an oral presentation that utilizes audio and visual technology.

While fossil fuel use remains as the predominant fuel source for world energy consumption, renewable energy sources are employed in different areas and to varying degrees. Having students explore the actual and potential extent of renewable fuel use will help students better understand the link between energy and the environment. In the simulation, *World Energy Summit,* students will have the opportunity to discover and present the degree of renewable energy use and compare this with conventional energy use. Students who research nations that use wind power will see that the leaders in world production are Germany, Spain, the United States, Denmark, and India. (See figure 2)7 Another particular point of interest is Middelgrunden Wind Farm near Copenhagen. It has been operating as the first offshore cooperative wind farm since 2001.8

Figure 2

Global Wind Power Capacity Leaders

Germany 12,001 mw	
Spain	4,830 mw
USA	4685 mw
Denmark 2,880 mw	
India	1702 mw

Geothermal power producers of significance include the United States, Philippines, Mexico, Italy, Indonesia, Iceland and El Salvador. Students investigating energy use in these countries will see that the United States is

the leader in geothermal power production through generating 2,816.7 mw (megawatts) in 1995 and 2,228 mw in 2000. Projected output for 2005 is 2376 mw. Noticeably, while leading in world production, the United States decreased levels of production between 1995 and 2000. While production for 2005 is anticipated at higher levels than 2000, production will still be lower than 1995 levels. Geothermal power in the Philippines reflects positive growth. The amount of geothermal power output in the Philippines has increased from 1,227 mw in 1995 to 1909mw in 2000. The projected 2005 figure is 2673mw. Perhaps the most aggressive initiative to harness geothermal power is occurring in Indonesia where geothermal energy output has increased from 309mw in 1995 to 590mw in 2000. The anticipated figure for 2005 is 1988mw. Figures for Iceland show a tripling of energy output between 1995 and 2000. El Salvador plans on doubling 1995 geothermal energy by 2005. 9

In researching energy production in France, Canada, and the United States, students will discover that energy can be derived from the rise and fall of the tides. Unfortunately effective use of this renewable energy source is limited to areas that have a sufficient tidal range of about 23 feet (7m). While scientists have located about 255 sites around the world that would be suitable to harness tidal energy, only a couple are actually used to generate power. The La Rance River Estuary in France produces 5.4x 1010 watt-hours of power per year. In Canada, the Annapolis River tidal power plant is the first tidal power plant in North America. The United States and Canada are exploring ways to capture tidal energy in Nova Scotia and Maine.10

Hydroelectric power is a more common form of energy production than harnessing tidal power. In 1998, .3 TW of world energy consumption came from hydroelectric energy production. This is roughly 2% of world energy consumption. Nations that produce the most hydroelectric power are Canada, Brazil, USA, China, Russia, and Norway. Figure 3 lists the average output of each country in terawatts over a four year period (1999-2002).11

Figure 3

Hydroelectric output	
Country	output in TWhy-1
Canada	345
Brazil	288
USA	264
China	231
Russia	167
Norway	129

Students researching energy use in the USA and France will explore and present initiatives to capture energy from the sun. A point of interest for the United States is California. Having cancelled all projects to develop nuclear and coal fired power plants, California is home to Solar One and other solar power generation projects. Built in 1982 near Barstow California, Solar One consists of 1818 mirrors spread out in semi-circles around a 78 m high tower. The mirrors direct sunlight toward the tower which heats oil in a boiler to 3000 degrees Celsius. The hot oil is then used to produce 10kW of electricity via steam through a turbine.12

In France, a solar furnace at Odeilo focuses the energy of the sun on an area of less than one square meter via 11,000 flat mirrors. The focus point mirrors can reach 33,000 degrees Celsius.13

Energy reserves, like bodies of water transgress national boundaries. Because energy is a universal necessity and energy reserves are unevenly distributed, political concerns and disputes are commonplace. An array of international collaborative and cooperative mechanisms exists to facilitate market exchange of energy, promote responsible energy development, and limit environmental damage. These include economic consortiums such as OPEC, the Office of Petroleum Exporting Countries. Non-governmental organizations also exist. The United Nations sponsors the United Nations Development Program (UNDP) - *http://www.undp.org* - and the United Nations Department of Economic and Social Affairs Division for Sustainable Development . These agencies sponsor collaborative initiatives to promote responsible development such as the World Summit on Sustainable Development (WSSD). The United Nations Framework Convention on Climate Change adopted in 1992 and the Protocol added at the Kyoto Conference in 1997 address the environmental aspects of energy use. The United Nations Statistics Division also publishes yearly reports on energy -- *http://unstats.un.org/unsd/energy/yearbook/default.htm* Use of general search engines will provide ample materials for students to further explore the form and function of these organizations.

Essential Questions

How are conventional and renewable energy sources similar and different in terms of costs and effectiveness?

How is energy extracted from the environment?

What are the environmental and economic tradeoffs for conventional and renewable energy sources?

Where are the world’s nonrenewable and renewable energy supplies?

How do nations govern energy use? How does the international community govern energy use?

Strategies

Anticipatory guides, reading for information, simulation, and rubric assessment are the primary strategies proposed to complete this unit. Anticipatory guides may include a k-w-l chart and/or reading content prompts. Reading for information in response to an essential question also will help students focus their reading efforts.

Simulation will allow participants to gain valuable hands-on experience. Introducing a rubric for grading will also allow for targeted student work .

Activities

1. Given a map and a key with directions, plot the conventional and renewable energy reserves.

2. World Energy Summit: In this simulation students will present their research about energy use in an assigned region of the world. Students will examine conventional and renewable energy use.

3. Anticipation guides: Before reading students may complete an anticipation guide that is aimed at increasing anticipation about the main ideas of the reading.

ie. Agree or Disagree The Middle East has more coal reserves than oil.

Assessment: Student products will be assessed through a rubric. Products will include a map of world energy sources, a position paper describing energy policy for one world region, and a PowerPoint presentation of 14-20 slides that supplements the position paper. See Rubric

Lesson Plans

Lesson 1 Conventional vs. Renewable Energy

Objective

Students will be able to name and classify energy types as being conventional or renewable.

Students will be able to label a map showing areas rich in conventional energy production and consumption

Content Standards Addressed

Geography Strand

Content Standard 9: Places and Regions

Content Standard 12: Human and Environmental Interaction

History Strand

Content Standard 1: Historical Thinking

Procedure

Day One

1. Complete k-w-l activity anticipation guide:

a. Ask students to list all the forms of energy they can think of in thirty seconds.
b. Ask students to write c (for conventional) or r (for renewable) next to each energy source (30 seconds)
c. Ask students to write next to each energy type where they think that energy source is most produced and consumed (3-5 minutes)
d. Discuss responses with students. Write responses on the board.
e. Ask students what they would like to know about energy sources, conventional or renewable, where energy sources are produced/consumed

2. Assign a reading/show slides of different energy sources that show the different energy types, the definition of conventional versus renewable energy sources, and where they are produced and consumed

3. Have students take notes.

4. Distribute a blank world map. Ask students to label the map with the energy forms that were discussed in class. Students must create their own key that includes symbols for each conventional and renewable energy source discussed in class and symbols for where energy sources are located and where energy is most consumed.

Assessment

Excellent Average Below Average

For k-w-l activity

Thoroughness 1 2 3

Effort 1 2 3

Discussion 1 2 3

Notes

Accuracy 1 2 3

Map

Accuracy 1 2 3
Effort/creativity 1 2 3

Conclusion

Review differences between conventional and renewable energy sources

Lesson 2 The Great Debate! Conventional vs. Renewable Energy

Objective

After conducting research in teams, students will debate the veracity of the following statement:

Resolved: The limits of conventional fuel sources are exaggerated. There is enough conventional fuel to last a long, long time.

Content Standards Addressed

Geography Strand

Content Standard 9: Places and Regions

Content Standard 12: Human and Environmental Interaction

History Strand

Content Standard 1: Historical Thinking

Content Standard 2: Local, United States, and World History

Content Standard 3: Historical Themes

Procedure

Day One

1. Give the resolved statement to the class. Ask students to write a one to two paragraph response.

2. Read the responses and group like responses.

Day Two:

1. Assign students with like responses to teams of 3-5. Tell students that in one week the class will have a debate and come to resolution on the resolved topic.
2. Take students to the library for research.
3. Assign roles for each student on the team. Recorder, Taskmaster, Progress Reporter, Speaker(s)
4. Have the team hand in a team progress report each day leading up to the debate. (This can be as simple as a paragraph on lined paper or a specific list of items you want to know about (ie. The names of sources, reference materials, an outline)

Day Three: research day or group planning

Debate Day:

1. Organize the classroom so that groups can sit in their teams.
2. Organize the debate so that one spokesperson speaks for each group.
3. Give each group 1-3 minutes of floor time.

Assessment

Groups will be assessed on the following rubric:

Excellent Average Below Average Comment

Use of supporting evidence for each argument 1 2 3

Clarity of expression 1 2 3

Accuracy of information 1 2 3

Organization 1 2 3

Progress Reports 1 2 3

Response to the Debate 1 2 3

Conclusion

Note major arguments given for each group or side. Sum up the major arguments at the end of the class. Ask the class to write their response to the debate that night for homework.

Lesson 3 World Energy Summit

Objectives

Based upon the organized results of a prescribed research plan, students will present a summary of contemporary energy consumption for an assigned country or region. Faced with the economic and environmental cost and the energy needs of that country or region students will construct an energy policy for that region that is environmentally sound and promotes sustainable development.

Content Standards Addressed

Geography Strand

Content Standard 9: Places and Regions

Content Standard 12: Human and Environmental Interaction

History Strand

Content Standard 1: Historical Thinking

Content Standard 2: Local, United States, and World History

Content Standard 3: Historical Themes

Content Standard 4: Applying History

Procedures

Guidelines for each country or region:

1. Select a country or region.

2. Using reference materials, research the energy production and consumption patterns for that country or region.

3. Create a pie chart that outlines the current energy needs and consumption by type of energy of your country or region..

4. Research and report on the environmental impacts, financial costs, and any other effects of current energy use.

5. Present data on future energy needs for your country or region.

6. Draft a resolution with the larger body of countries/regions that outlines responsible energy use.

Assessment

Students gather at least two book sources 1 2 3

and five internet sources

Energy pie chart

Accuracy 1 2 3

Attention to detail 1 2 3

Analysis

Environmental impact 1 2 3
Financial costs 1 2 3
Special Factors 1 2 3

Future Energy Needs 1 2 3

Resolution

Contributed to the resolution 1 2 3

Addendum 1 Description of New Haven Public Schools Curriculum Expectations, Content Strands, Standards and Performance Addressed in Fueling Around With Energy

History Strand

Content Standard 1: Historical Thinking

Students will develop historical thinking skills, including chronological thinking and recognizing change over time; contextualizing, comprehending and analyzing historical literature; researching historical sources; understanding the concept of historical causation; understanding competing narratives and interpretations; and constructing narratives and interpretation.

Content Standard 2: Local, United States, and World History

Students will use historical thinking skills to develop an understanding of major historical periods, issues and trends in United States history, world history, and Connecticut and local history.

Content Standard 3: Historical Themes

Students will apply their understanding of historical periods, issues and trends to examine such historical themes as ideals, beliefs and institutions; conflict and conflict resolution; human movement and interaction; and science and technology in order to understand how the world came to be the way it is.

Content Standard 4: Applying History

Students will recognize the continuing importance of historical thinking and historical knowledge in their own lives and in the world in which they live.

Geography Strand

Content Standard 9: Places and Regions

Students will use spatial perspective to identify and analyze the significance of physical and cultural characteristics of places and world regions.

Content Standard 12: Human and Environmental Interaction

Students will use geographic tools and technology to explain the interactions of humans and the larger environment, and the evolving consequences of those interactions.

Notes

1. Smil p208

2. Smil p208.

3. Global Energy Supply Swiss Federal Office of Energy 2002

4. World Energy Outlook Report)

5. (Global Energy Supply published by the (3) Swiss Federal Office of Energy. *http://www.energie-schweiz.ch/internet/00480/?lang=en*)

6. Green Nature (*http://greennature.com/article744.html*) 58 nuclear reactors power 77% of France's electricity

7. Boyle, 2004 *Renewable Energy* from class notes on alternative energy- Professor Alessandro Gomez, *Energy Engines, and the Environment* Seminar YNHTI 2004

8. Boyle, 2004 *Renewable Energy* from class notes on alternative energy- Professor Alessandro Gomez, *Energy Engines, and the Environment* Seminar YNHTI 2004

9. Boyle, 2004 *Renewable Energy* from class notes on alternative energy- Professor Alessandro Gomez, *Energy Engines, and the Environment* Seminar YNHTI 2004

10. Duxbury, Duxbury, and Sverdrup, p. 298. *An Introduction to the World's Oceans* (sixth edition) 2000. McGraw Hill New York

11. Boyle, 2004 *Renewable Energy* from class notes on alternative energy- Professor Alessandro Gomez, *Energy Engines, and the Environment* Seminar YNHTI 2004

12. More Solar Energy E-Learning Zone. *http://www.cornwallis.kent.sch.uk/intranet/elearn/science/renew/1solar3.html*

The Cornwallis School, Maidstone, Kent, UK 2004

13. More Solar Energy E-Learning Zone. *http://www.cornwallis.kent.sch.uk/intranet/elearn/science/renew/1solar3.html*

The Cornwallis School, Maidstone, Kent, UK 2004

Reading List

Books

Engines, Energy, and Entropy. John Fenn. New York: W.H.Freeman and Company, 1982 Fenn presents thermodynamics in laymen's terms. Cartoon illustrations and drawings are helpful visual aids. The concepts are explained well in general terms but there is also plenty of scientific and mathematical notation.

Energy in World History. Vaclav Smil. San Francisco: Westview Press, 1994

Smil traces developments of energy usage from pre-industrial societies (solar societies) to the modern era. Straightforward and informative reading

An Introduction to the World's Oceans Alyn Duxbury, Alison Duxbury, and Keith Sverdrup,(sixth edition) New York: McGraw Hill, 2000. This college oceanography textbook is informative yet not a difficult read for most high school students. It covers topics such as The History of Oceanography, The Origins of the Ocean, Plate Tectonics, the Sea Floor, The Physical Properties of Water, The Chemistry of Seawater, The Structure of the Oceans, The Ocean and the Atmosphere, The Waves, The Tides, Coasts, Beaches, and Estuaries, Environmental Issues, The Ocean Environment, Production and Life in the Ocean, Plankton, Nekton, and Benthos. The chapter on tides contains information regarding energy from tides.

World Energy Assessment United Nations Development Program Bureau for Development Policy. New York 2000

This report was initiated by the UNDP, the United Nations Department of Economic and Social Affairs (UNDESA), and the World Energy Council (WEC) in 1998. It is a review of world energy production and consumption patterns. Great tables and graphs summarize an otherwise very lengthy yet comprehensive document.

On-Line Resources

Annual Energy Review 2002

http://scout.cs.wisc.edu/Archives/SPTFullRecord.php?ResourceId=111622

"The US Department of Energy's Energy Information Administration (EIA) describes itself as providing policy-independent data, forecasts, and analyses to promote sound policy making, efficient markets, and public understanding regarding energy and its interaction with the economy and the environment. The EIA Web site provides many informational pages and publications including the newly released 2001 Annual Energy Review. The report covers fossil fuels, nuclear electricity, renewable energy, and total energy by key activity all of which can be viewed online or downloaded. One handy feature of the site is the What's New link that contains all of the most important content changes that took place in this year's report. "

CIA-The World Fact Book

http://www.cia.gov/cia/publications/factbook/

This United States government website is an encyclopedia of information regarding every recognized country in the world. In addition to demographic information regarding the population and culture of each country, data on the economy, climate, and natural resources is listed. Reference maps and flags of the world are included.

Energy consumption and production is presented by source. Energy imported and exported is also listed.

Energy- Decisions of the General Assembly and the Commission on Sustainable Development: Decision made as part of the Plan of Implementation at the World Summit on Sustainable Development August 26- September 4, 2002

http://www.un.org/esa/sustdev/sdissues/energy/intergov/enr_ga.htm

This is an excellent primary source of commission work drawn up by the United Nations General Assembly. It is a resolution

regarding sustainable development.

Energy and Poverty: World Energy Outlook

http://www.worldenergyoutlook.org/weo/pubs/weo2002/EnergyPoverty.pdf

This chapter examines the relationship between the production and consumption of energy with poverty in the developing world.

Energy Sources

http://www.nrel.gov/education/pdfs/sources_energized.pdf

This resource contains 21 pages of information and lesson plans for teaching about renewable and nonrenewable energy sources.

Global Energy Supply

http://www.energie-schweiz.ch/internet/00480/?lang=en

Are you interested in a non-American interpretation of energy sources and consumption? The Swiss Federal Office of Energy Website contains information on energy matters on domestic and international areas. The site contains energy statistics and interpretation.

International Energy Agency Report

The IEA was founded in 1974 in response to OPEC oil crisis. The purpose is to ensure the energy security of industrialized nations. Its goal over the long term is to reduce vulnerability to oil supply disruptions for members through promoting energy efficiency, conservation, and the development of alternative fuel sources.

Lesson: Energy Sources: Renew, Renew

http://www.leeric.lsu.edu/bgbb/7/ecep/sources/c/c.htm

This one page classroom lesson teaches the difference between renewable and non-renewable energy sources. It is part of a website posted by the Louisiana government in 1992 to teach about home energy use and conservation.

Quiz: Renewable vs. Nonrenewable Energy Sources

http://www.quia.com/servlets/quia.activities.common.ActivityPlayer?AP_rand=1953188343&AP_activityType=3&AP_urlId=106563&AP_continuePlay=true&id=106563

Take an online quiz in Renewable vs. Nonrenewable energy sources. Hosted by Quia

-the Quintessential Instructional Archive-, it is part of a directory of thousands of on-line activities in more than 50 subject areas. All activities were created by educators.

Renewable Energy Sources Research Lesson

http://www.sciencenetlinks.com/lessons.cfm?DocID=26

This is a lesson on Renewable Energy Sources from Science NetLinks. Science NetLinks is part of the MarcoPolo Education Foundation, which provides free internet based classroom activities.

Renewable in the Global Energy Supply

http://www.iea.org/dbtw-wpd/textbase/papers/2002/leaflet.pdf

This is a fact sheet on renewable energy supply sponsored by the International Energy Agency.

United States Energy and World Energy Production and Consumption Statistics

http://energy.cr.usgs.gov/energy/stats_ctry/Stat1.html

Tables and statistics by the Central Energy Team, in the United States Geological Service that that show the United States and world energy production and consumption patterns.

What is Energy?

http://www.eia.doe.gov/kids/whatsenergy.html

Hosted by the Energy Information Agency, the official energy statistic bureau for the United States Government, this site explains the difference between renewable and nonrenewable energy sources. It is one page in length but has active links to every energy source and other related topics

World Energy Model 2002

http://www.worldenergyoutlook.org/weo/appendix1a.pdf

Energy projections are detailed in this report. It is detailed and explains the method by which projections are based on.

World Energy Outlook

http://www.worldenergyoutlook.org/weo/pubs/weo2002/weo2002.asp

Contains current and projected global energy needs by region. Published in 2002.

Outline: Fueling Around With Energy: A Comparative Study of Conventional and Renewable Energy Use around the World

By: Ralph Russo

Understanding the relationship between energy use and its impact on society is crucial to maintaining an effective energy policy

I The relationship between energy and society is important for leaders and citizens of society to understand.

a. The facility by which we access energy and labor saving engines obscures the process by which energy is produced, distributed, and consumed.
b. Historical examples show that energy needs often dictate state policy.

II. Objectives:

a. Students will map the primary energy resources used in different regions of the world.
b. They will compare patterns of energy consumption between the developing countries and the developed world.
c. Through simulation, students will construct analysis of energy use, identify the implications of different types of energy use and formulate policy.

III Content Strands

IV The relationship between energy and society has evolved with technological developments.

1. Energy resources in pre-industrial societies depended on large tracts of land for food and biomass fuel (Smil)
2. Energy resources in developing and developed countries rely on only a fraction of the space formerly needed to sustain a community. (Smil)

V Conventional vs. Renewable energy sources and their use

Conventional (nonrenewable) vs. Renewable energy sources
Fossil fuels wind
Oil solar
Natural Gas tidal
Coal geothermal
Nuclear

VI Benefits of conventional and renewable fuels

VII Limits of energy sources and environmental problems associated

VIII Who uses what fuels and where?