The Age of Oil

Student Objectives
The student:
- will explain the biological, chemical and geological conditions necessary for oil to form
- will explain how petrochemicals are part of most items used today
- will explain how a decrease in oil production could affect our society.

Materials
- *Crude: The Incredible Journey of Oil* internet download (see Internet Sites below)
- Science Journal

Key Words:
anoxic
carbon dioxide
energy density
finite
petrochemical
photosynthesis
phytoplankton
sequestered

Time:
(2) class times of 45 minutes to 1 hour

Background Information

Oil is a finite resource. It was formed millions of years ago under certain geological conditions from the remains of vast numbers of microscopic sea creatures. Geologists have become adept at spotting rock formations that might contain oil, with the result that most (if not all) of the large fields have already been found. In fact, the majority of the world's oil supply flows from a relatively small number of regional oil fields, and over 20% of the world's petroleum comes from just 14 large oil regions. These large fields are on an average 45+ years old, and according to some geologists, many are past their "peak".

The Hubbert Peak Theory, also known as Peak Oil, looks at the long-term rate of extraction and depletion in conventional petroleum and other fossil fuels. Peak Oil is the moment when oil production reaches a maximum output and then goes into decline. It is named after American geophysicist Marion King Hubbert, who created a model of known oil reserves. He proposed, in 1956, that production of oil from conventional sources would peak in the continental United States between 1965 and 1970, and worldwide within "about half a century", and that after the "peak", production would decline, graphically following a bell shaped curve. His prediction of U.S. oil peak turned out to be so accurate that his methods are being used to try to predict the time of peak oil worldwide.

It is important to note that the point of maximum production tends to coincide with the midpoint of depletion of the resource. This means that when we reach the Hubbert Peak, **we will have used half of all the recoverable oil on our planet.** The majority of geologists estimate the original total of petroleum resources at two trillion barrels of conventional oil (not including oil contained in tar sands). Consuming the first trillion barrels of crude oil took approximately 150

years. If we were to continue to deplete our oil supply at today's rate, the other half of our reserves would be consumed in roughly thirty-two years. However, this doesn't take into account the annual increase in world oil consumption, and the increased energy demand from countries such as China and India, who are experiencing rapid growth in transportation and industry.

Oil companies have understandably extracted the easier-to-reach, cheap oil first. The oil pumped first was on land, near the surface, under pressure, light and "sweet" (meaning low sulfur content) and therefore easy to refine into gasoline. This oil had an **energy density** of 100:1 meaning it contained 100 times more energy than it took to extract it. The remaining oil, sometimes offshore, far from markets, in smaller fields, or of lesser quality, takes more money and energy to extract and refine. Some of the deep-sea, far offshore wells have an energy density of only 4:1. Under these more difficult and costly conditions, the rate of extraction declines. Furthermore, individual oil fields eventually reach a point where they become economically, and energetically, no longer viable.

Although world crude oil production from traditional methods, remained relatively flat in the first part of this century, new sources of unconventional oil were starting to be exploited–most notably fracking of "tight oil" from deep rock formations, and extracting a useable product (shale oil) from oil shale rock by pyrolysis (heating the rock to a very high temperature). These processes are even more costly than deep sea drilling, and are also associated with the risk of high environmental costs. However, by 2015, five million barrels a day of "light tight oil" was being produced by fracking. This additional production technique had many proclaiming an end to the concern that Peak Oil was imminent. However, the costs associated with these new oil recovery technologies are so high they are only cost effective when the barrel cost of oil is high.

Many economists speculate that when the cost of oil increases, it affects the worldwide economy so that it dampens the demand for oil–thereby forcing the price down and making the more expensive oil production techniques cost prohibitive. So, this sets up a "yo-yo" effect. When the cost of oil is high, unconventional oil production makes sense, but the increased energy price slows the economy, people conserve and change habits, decreasing demand. With a lowered demand, the oil price drops, expensive oil extraction procedures decrease, the economy picks up, people "forget" their conservation and revert back to using more oil, increasing demand, and the price of oil goes up again.

It is important to understand that abundant inexpensive oil has not been just about cheap gasoline and diesel fuel for transportation. Oil is a particularly efficient source of large amounts of energy, and as such has enabled our population to increase and thrive. Additionally, our industrial societies and our financial systems were built on the assumption of continual growth – growth based on ever more readily available cheap fossil fuels. Oil is so important that its peak will have vast implications across the realms of geopolitics, lifestyles, agriculture and economic stability. Significantly, for every one joule of food consumed in the United States, around 10 joules of fossil fuel energy have been used to produce it.

Procedure - Day 1 (Oil's Origin)

1. Ask the class where the energy in oil and gasoline came from. The answers will vary–in the ground, from dinosaurs, etc. Keep asking related questions (like where did the energy for the green plants come from) until the students arrive at the Sun as an answer. Tell

them they are correct, that the energy in oil, gas, and other fossil fuels came from the Sun, and today they will find out how sunlight was turned into oil.

2. Show part 1 of the video. If you use the direct link, the video is already broken into three parts, if you are using the mirror sites (YouTube), end the video at 27 min 54 seconds (the last words are... "And there it stayed, trapped until humans came along; the sludgy remains of tiny brainless plants waiting to hold dramatic sway over the future of the most intelligent life form the planet has ever seen".)
3. Allow 5 - 10 minutes for the students to complete the Science Journal.
4. Lead a class discussion about the video. Some topics to discuss might include:
    - How slow the formation of oil was, and how long ago the process began.
    - How specific the condition had to be for oil to be formed–not all of the Earth produced oil.
    - How precious oil is–we shouldn't be wasting it and using it up so fast!
    - What do you think is meant in the last statement by oil "holding a dramatic sway" over our future?
    - What has oil given us (both good and bad)?

Procedure - Day 2 (Our Addiction to Oil)

1. Ask the students if they have used oil today. Lead a discussion about their energy usage. (You may wish to write their answers on the board.) Make sure the students include: the oil needed to grow, transport, and cook their food; their clothing; their electrical usage at home and school; plastics, etc.
2. Show Part 2 of the video. (Starting at 27 min 54 seconds if using the full video link from YouTube, and ending at 59 min 04 sec. The last words are, "Hidden in the black magic of an oil reservoir, is a climate demon from the distant past, and we unleash it at our peril".)
3. Allow 5 - 10 minutes for the students to complete the Science Journal.
4. Lead a class discussion about the issues in the video. Some topics to discuss might include:
    - Are you addicted to oil? Could you do without it completely?
    - Why haven't we seen the "shock" of a declining oil supply as predicted by some of the experts in the video? *(rise in fracking and oil shale production, leveling off of demand due to conservation and a rise in alternative fuels, it could be still too soon or the effect too slow to notice)*
    - How would your day-to-day life change if oil became too expensive for most people to buy more than a couple gallons a week?
    - How will your diet change if long distance transportation is cost prohibitive? What foods will be available in your area to eat?
    - What alternative sources of energy can we currently implement easily into our existing society and infrastructure? What new technologies should we be pursuing?
    - What changes can we make now as individuals to help offset upcoming problems? as a community? as a country?
    - What plans can you personally make to prepare?

Key Words & Definitions

- **anoxic –** lacking oxygen
- **carbon dioxide (CO_2)** – a colorless, odorless, incombustible gas composed of one carbon and two oxygen atoms
- **energy density –** the amount of energy stored per unit volume
- **finite** – limited, having an end
- **petrochemical** – a chemical obtained from petroleum or natural gas
- **photosynthesis** – the synthesis of organic compounds from carbon dioxide and water (with the release of oxygen) using light energy absorbed by chlorophyll
- **phytoplankton** – small, free floating organisms that use carbon dioxide, release oxygen and convert minerals to a form animals can use
- **sequestered** – locked up, bound up or set apart. Carbon is sequestered below ground in the rocks, oil and natural gas.

Related Research

1. Use the class' concept map from the *World Population* activity. With another color, or a tissue overlay, add the concept "less cheap energy". Discuss the overlaps and the differences.
2. Research the history of electric cars and new transportation research and inventions. How can these new inventions help transition to a world with less fossil fuels?
3. Research how many "food-miles" your school lunch items traveled. What is the average distance traveled of your lunch?
4. Show one or two videos about fracking, and lead a class debate on whether the increase in oil production is worth the risks that fracking entails.

Related Reading

- ***Luz Sees the Light (Future According to Luz)*** by Claudia Davila (Kids Can Press, 2011) A topical graphic novel about a spunky girl who organizes her community to transform a run-down lot into a self-sustaining park and garden, ideal for progressive kids and their parents.

Internet Sites

Video for this lesson**:**

http://www.abc.net.au/science/crude/

Crude: The Incredible Journey of Oil, ABC Television (Australia), Science Series.

https://www.youtube.com/watch?v=IC40mZHu2ZQ

Mirror site–same video as above

Other Sites:

https://www.youtube.com/watch?v=cJ-J91SwP8w&feature=kp

300 years of fossil fuels in 300 seconds by the Post Carbon Institute.

https://www.youtube.com/watch?v=4uKgU7krWzE

Don't Worry, Drive On: Fossil Fools & Fracking Lies by the Post Carbon Institute

https://www.youtube.com/watch?v=Tudal_4x4F0

How Does Fracking Work?, a teacher created Ted Ed lesson describing how fracking works, the chemicals used, and the environmental hazards.

https://www.youtube.com/watch?v=x7wfx9IHtjE

Tar Sands and Oil Shale, Taylor Russell's video discusses how tar sands and oil shale is mined, the economic benefits, and the ecological problems associated with each. (Note: there is a mathematical error in the video. It states that 800 billion barrels of oil would last the U.S. 400 years at our current rate, but it actually is just over 100 years.)

http://periodicvideos.com/videos/006.htm

Periodic Videos, Carbon

http://www.eia.gov/kids/energy.cfm?page=oil_home-basics

Department of Energy student pages on oil.

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Florida NGSS Standards & Related Subject Common Core

			.1	.2	.3	.4	.5	.6	.7	.8	.9	.10	.11	.12
Grade 6														
Characteristics of Scientific Knowledge	**# 2**	**SC.6.N.2**	**X**	**X**	**X**									
Earth Structures	**# 6**	**SC.6.E.6**	**X**											
Grade 7														
Practice of Science	**# 1**	**SC.7.N.1**							**X**					
Characteristics of Science Knowledge	**# 2**	**SC.7.N.2**	**X**											
Earth Structures	**# 6**	**SC.7.E.6**		**X**				**X**						
Energy Transfer & Transformations	**# 11**	**SC.7.P.11**		**X**										
Interdependence	**# 17**	**SC.4.L.17**			**X**									
Grade 8														
Science & Society	**# 4**	**SC.8.N.4**	**X**											
Matter & Energy Transformations	**# 18**	**SC.8.L.18**	**X**											
Social Studies Standards	**Sixth Grade:** SS.6.G.3.2 **Seventh Grade:** SS.7.E.1.5, SS.7.C.2.13 **Eighth Grade:** SS.8.A.1.3, SS.8.E.1.1, SS.8.G.5.1, SS.8.G.5.2													
Language Arts Standards	**Sixth Grade:** LAFS.6.SL.1.1 **Seventh Grade:** LAFS.7.SL.1.1 **Eighth Grade:** LAFS.8.SL.1.1													

Sixth Grade Benchmarks

Science–Big Idea 2: The Characteristics of Scientific Knowledge

- SC.6.N.2.1 - Distinguish science from other activities involving thought.
- SC.6.N.2.2 - Explain that scientific knowledge is durable because it is open to change as new evidence or interpretations are encountered.
- SC.6.N.2.3 - Recognize that scientists who make contributions to scientific knowledge

come from all kinds of backgrounds and possess varied talents, interests, and goals.

Science–Big Idea 6: Earth Structures

- SC.6.E.6.1 - Describe and give examples of ways in which Earth's surface is built up and torn down by physical and chemical weathering, erosion, and deposition.

Social Studies–Geography

- SS.6.G.3.2 - Analyze the impact of human populations on the ancient world's ecosystems.

Language Arts–Standards for Speaking & Listening

- LAFS.6.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.

Seventh Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- SC.7.N.1.7 - Explain that scientific knowledge is the result of a great deal of debate and confirmation within the science community.

Science–Big Idea 2: The Characteristics of Scientific Knowledge

- SC.7.N.2.1 - Identify an instance from the history of science in which scientific knowledge has changed when new evidence or new interpretations are encountered.

Science–Big Idea 6: Earth Structures

- SC.7.E.6.2 - Identify the patterns within the rock cycle and relate them to surface events (weathering and erosion) and sub-surface events (plate tectonics and mountain building).
- SC.7.E.6.6 - Identify the impact that humans have had on Earth, such as deforestation, urbanization, desertification, erosion, air and water quality, changing the flow of water.

Science–Big Idea 11: Energy Transfer and Transformations

- SC.7.P.11.2 - Investigate and describe the transformation of energy from one form to another.

Science–Big Idea 17: Interdependence

- SC.7.L.17.3 - Describe and investigate various limiting factors in the local ecosystem and their impact on native populations, including food, shelter, water, space, disease, parasitism, predation, and nesting sites.

Social Studies–Economics

- SS.7.E.1.5 - Assess how profits, incentives, and competition motivate individuals, households, and businesses in a free market economy.

Social Studies–Civics and Government

- SS.7.C.2.13 - Examine multiple perspectives on public and current issues.

Language Arts–Standards for Speaking & Listening

- LAFS.7.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.

Eighth Grade Benchmarks

Science–Big Idea 4: Science and Society

- SC.8.N.4.1 - Explain that science is one of the processes that can be used to inform decision making at the community, state, national, and international levels.

Science–Big Idea 18: Matter and Energy Transformations

- SC.8.L.18.1 - Describe and investigate the process of photosynthesis, such as the roles of

light, carbon dioxide, water and chlorophyll; production of food; release of oxygen.

Social Studies–American History

- SS.8.A.1.3 - Analyze current events relevant to American History topics through a variety of electronic and print media resources.

Social Studies–Economics

- SS.8.E.1.1 - Examine motivating economic factors that influenced the development of the United States economy over time including scarcity, supply and demand, opportunity costs, incentives, profits, and entrepreneurial aspects.

Social Studies–Geography

- SC.8.G.5.1 - Describe human dependence on the physical environment and natural resources to satisfy basic needs in local environments in the United States.
- SC.8.G.5.2 - Describe the impact of human modifications on the physical environment and ecosystems of the United States throughout history.

Language Arts–Standards for Speaking & Listening

- LAFS.8.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.

National Next Generation Science Standards - Sixth to Eighth Grade Standards

Science – Earth's Place in the Universe

- MS-ESS1-4 - Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6 billion year old history.

Science – Earth and Human Activity

- MS-ESS3-1 - Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy and groundwater resources are the result of past and current geoscience processes.
- MS-ESS3-4 - Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
- MS-ESS3-5 - Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Note: Related Common Core Language Arts Standards are listed in the Florida section above.

The Age of Oil

Day 1 - Oil's Origin

1. Describe how oil is formed. Be sure to use these words in your description: anoxic (ocean), carbon, phytoplankton, photosynthesis, pressure, sunlight, temperature.

2. What did the video mean when it said we are living in the Age of Oil?

The End of Cheap Oil

Day 2 - Our Addiction to Oil

1. With the real possibility of a reduction in petroleum products occurring simultaneously with a growing population, I think we should.....

2. List as many ways as you can think of to limit our use of natural resources and save our fossil fuels.

3. If you knew for sure that gasoline prices would increase tenfold in ten years (ten times what it is today), what do you think should be done to prepare...

...by your family?

...in your neighborhood?

...by our country?