

The End of Cheap Oil

Student Objective

The student:

- will be able to explain the biological, chemical and geological conditions necessary for oil to form
- will be able to explain how petrochemicals are part of most items used today
- will be able to explain what is meant by Peak Oil
- will be able to 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
peak oil
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 big 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.

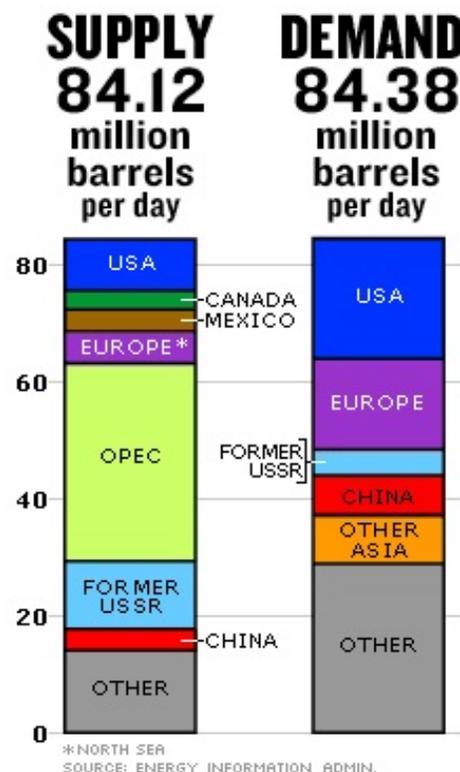
It is important to note that the point of maximum production tends to coincide with the

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 that ever existed 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 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. The Energy Information Administration (EIA) predicts that worldwide oil consumption *would* increase from 28.4 billion barrels a year in 2002 to 43 billion barrels per year by 2025—that is, *if it were possible*—if there in fact is that much oil that can be extracted. However, even at current supply and demand levels, we are not quite keeping up (see chart below).

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 off shore, 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.

However, because of differences in reserve reporting and the secrecy of many countries when it comes to money and resources, it is very difficult to tell when worldwide peak oil will occur--or even if it may have recently happened. World oil production has been essentially flat since the beginning of 2005. Of the 65 largest oil producing countries in the world, up to 54 have past their peak of production and are now in decline.

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 this energy 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 27min 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 (Peak Oil)

1. Begin the class with this scenario:

Imagine that you live in a world that has a finite food supply--when it is consumed, it cannot be grown or replaced. In the past, this world has had enough food, and you and your family have had as much food as you wanted to buy. The scientists tell you that your children will probably have enough food also--but sometime after that, it will become very scarce.. What should the people of this world do? Should everyone on Earth get the same amount of food every day, or should it change depending on what is needed by the individual? Or would it depend on who had the most money and could afford to buy the food--or who had the most power? And who should decide how the food would be rationed out?
2. Show Part 2 of the video. (Starting at 27min 54 seconds if using the full video link from You Tube, and ending at 59min 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:
 - do you think we've passed the point of Peak Oil? What evidence do you see for your answer?
 - are you addicted to oil? Could you do without it completely? How have you used oil so far today?
 - 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 (CO₂)** - 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
- **peak oil** - the moment when oil production reaches a maximum output before going into decline
- **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?

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

<https://www.youtube.com/watch?v=cPgnwi2m9M>

Additional mirror site of above video

Related 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

http://online.wvu.edu/Faculty/demo/Module_2/carbon_cycle_animation.html

Carbon Cycle animation

<https://sites.google.com/site/environmentforkids/how-oil-is-formed>

How Oil is Formed

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

Periodic Videos, Carbon

<http://www.nationmaster.com/country-info/stats/Energy/Oil>

NationMaster. Worldwide statistics of oil production and use

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

Department of Energy student pages on oil

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			.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.

The End of Cheap 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?

4. 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?