Oil and Coal & Gas – Black Gold!

http://upload.wikimedia.org/wiki/commons/c/ce/Oil_well.jpg
1. Powerpoint on Oil
2. Discussion
3. 8.75 Minute Break
4. DVD # 43 Non-renewables
5. Discussion.
World Population: 1950-2050

Population (billions):
- 3 Billion (1950)
- 4 Billion (1970)
- 5 Billion (1980)
- 6 Billion (2000)
- 7 Billion
- 8 Billion
- 9 Billion (2050)

Year:
- 1950
- 1960
- 1970
- 1980
- 1990
- 2000
- 2010
- 2020
- 2030
- 2040
- 2050
42 Gallons to the Barrel

- 7.6 Other Products
- 1.7 Liquefied Petroleum Gas (LP Gas)
- 4 Heavy Fuel Oil
- 10 Jet Fuel
- 19.6 Diesel Fuel & Heating Oil
- 10 Gasoline
World and U.S. Oil Consumption, 1960 - 2004
(million barrels per day)

Global Oil Consumption, 1980-2003

Million Barrels per Day

- North America
- Western Europe
- E. Europe & Former USSR
- Mideast & Africa
- Far East & Oceania
- Cent. & So. America

Years:
- 1980
- 1982
- 1984
- 1986
- 1988
- 1990
- 1992
- 1994
- 1996
- 1998
- 2000
- 2002
Origin (1): Chemistry

- Oil and gas are made of a mixture of different hydrocarbons.
- As the name suggests these are large molecules made up of hydrogen atoms attached to a backbone of carbon.
Methane
CH4

Propane
C3H8
• Most oil and gas starts life as microscopic plants and animals that live in the ocean.
Origin (3): Blooms

• Today, most plankton can be found where deep ocean currents rise to the surface.

• This upwelling water is rich in nutrients and causes the plankton to bloom.

• Blooms of certain plankton called dinoflagellates may give the water a red tinge.
Origin (4): On the sea bed

When the **plankton dies** it rains down on sea bed to form an organic mush.

If there are any animals on the sea bed these will feed on the organic particles.
Origin (5): Black Shale

- However, if there is little or no oxygen in the water then animals can’t survive and the organic mush accumulates.

- Where sediment contains more than 5% organic matter, it eventually forms a rock known as a Black Shale.
Kerogen
Origin (6): Cooking

As Black Shale is buried, it is heated.

Organic matter is first changed by the increase in temperature into kerogen, which is a **solid** form of hydrocarbon.

Around 90°C, it is changed into a **liquid** state, which we call oil.

Around 150°C, it is changed into a **gas**.

A rock that has produced oil and gas in this way is known as a **Source Rock**.
Origin (7): Migration

- Hot oil and gas is **less dense** than the source rock in which it occurs.

- Oil and gas **migrate upwards** up through the rock in much the same way that the air bubbles of an underwater diver rise to the surface.

- The rising oil and gas eventually gets trapped in pockets in the rock called **reservoirs**.
During mid-Mesozoic times around 150 million years ago, conditions were just right to build up huge thicknesses of Black Shale source rocks. The world’s main oil deposits all formed in warm shallow seas where plankton bloomed but bottom waters were deoxygenated.
The Kimmeridge Clay is a Black Shale with up to 50% organic matter. It is the main source rock for the North Sea Oil & Gas Province.
Exploration and Production (1): Oil Traps

- Some rocks are **permeable** and allow oil and gas to freely pass through them.
- Other rocks are **impermeable** and block the upward passage of oil and gas.
- Where oil and gas rises up into a dome (or anticline) capped by impermeable rocks it can’t escape. This is one type of an **Oil Trap**.
Exploration and Production (2): Reservoir Rocks

- The permeable strata in an oil trap is known as the Reservoir Rock.

- Reservoir rocks have lots of interconnected holes called pores. These absorb the oil and gas like a sponge.

As oil migrates it fills up the pores (oil-filled pores shown in black).
Seismic surveys are used to locate likely rock structures underground in which oil and gas might be found. Shock waves are fired into the ground. These bounce off layers of rock and reveal any structural domes that might contain oil.
Exploration and Production (4): Drilling the well

- Once an oil or gas prospect has been identified, a hole is drilled to assess the potential.

- The cost of drilling is very great. On an offshore rig, it may cost $10,000 for each metre drilled.

- A company incurs vast losses for every “dry hole” drilled.
Exploration and Production (5): Enhanced Recovery

• Although oil and gas are less dense than water and naturally rise up a well to the surface, in reality only 40-50% of the total will do so.

• To enhance recovery, a hole is drilled adjacent to the well and steam is pumped down. The hot water helps to push the oil out of the rock and up into the well.
A view of Signal Hill, just north of Long Beach, California, in 1930. The "forest" that you see are oil derricks, all drilled in the 1920's.
Monterey Formation with dark organic rich layers
Oro State Park, at the south flank of Morro Bay, is a superb locality to see the Monterey Formation.
Natural Gas
Methane
Methane

CH₄
Exploration and Production (6): Transport

- Once extracted oil and gas must be sent to a refinery for processing
- **Pipelines** transport most of the world’s oil from well to refinery
- **Massive Oil Tankers** also play an important role in distribution

Trans-Alaskan Pipeline
Before it can be used, crude oil must be refined. Hydrocarbons can be separated using distillation, which produces different fractions (or types) of oil and gas.

- Jet fuel
- Car fuel
- Road tar
Exploration and Production (8): Early History

Abraham Gesner (1797-1864)

- The modern era of oil usage began in 1846 when Gesner perfected the art of paraffin distillation.
- This triggered a massive worldwide boom in oil production.
- California was centre of activity in the early 1900s, famous for its gushers.
Global oil and gas occurrences are now well understood (provinces shown in green). Only Antarctica and the Arctic remain unexplored.
Practical Exercise 2

The Oil Prospector Game
Politics (1): Fuel source

- 84% of crude oil is refined into fuel, principally for cars and planes.

- Demand is ever increasing, especially due to growth of Chinese economy.


![Image: Quality Fuels](blogs.sun.com/richb/resource/NBC_at_the_Pump.jpg)
Politics (2): Other uses

- The remaining 16% of crude oil is used for a range of purposes shown above as well as synthetic fibres, dyes and detergents.
COAL
Coal Forms in Ancient Swamps away from silt and sand deposits.
COAL DEPOSITS-- USA

Average Heat Value

- Anthracite
- Bituminous
- Subbituminous
- Lignite
• Oil and Gas emit 15-30% less CO₂ than coal per watt of energy produced. Renewable energy is clean but not yet viable as fuel. Natural Gas 50% CO₂ of Petroleum
“Renewable” versus Non-Renewable Energy
A **wind farm** located in **Manjil**, Iran.

**Grand Coulee Dam** is a **hydroelectric gravity dam** on the **Columbia River** in the **U.S. state of Washington**.

**Nellis Solar Power Plant**, 14 MW power plant installed 2007 in Nevada, USA.
Geothermal in Iceland

Batteries that store energy
From the Sun or Lithium
Brazil has bioethanol made from sugarcane available throughout the country.

Total = 99.305 Quadrillion Btu

- Petroleum: 37%
- Natural Gas: 24%
- Coal: 23%
- Nuclear Electric Power: 9%
- Renewable Energy: 7%

Total = 7.301 Quadrillion Btu

- Biomass: 53%
- Hydropower: 34%
- Wind: 7%
- Geothermal: 5%
- Solar: 1%

Note: Sum of components may not equal 100% due to independent rounding.
A Penny for Your Thoughts!