


Lesson No. 12



Energy

May 11, 2006

April Huff
North Seattle Community College
Mathematics & Sciences

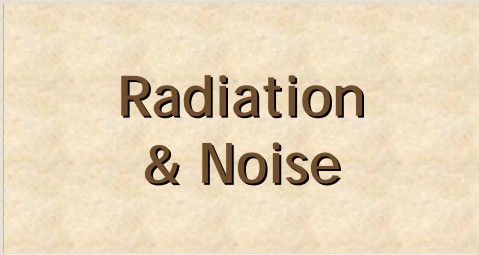
ENV H 311: Lesson 12 1

Announcements

❖ There have been a couple of changes to the course schedule -- check on-line for the most current version.

ENV H 311: Lesson 12 2

Next Lesson



**Radiation
& Noise**

ENV H 311: Lesson 12 3

ENERGY

Non-Renewable Sources

All Energy Sources

- Coal
- Natural Gas
- Oil
- Nuclear Power
- Hydropower
- Geothermal
- Solar
- Wind
- Biomass (Fuelwood)
- Biofuels (corn ethanol)

Petroleum / Crude Oil

Petroleum / Crude Oil

- Oil as it comes out of the ground.
- Produced by the decomposition of buried dead organic matter from plants & animals that were subjected to high temperatures & pressures over millions of years.

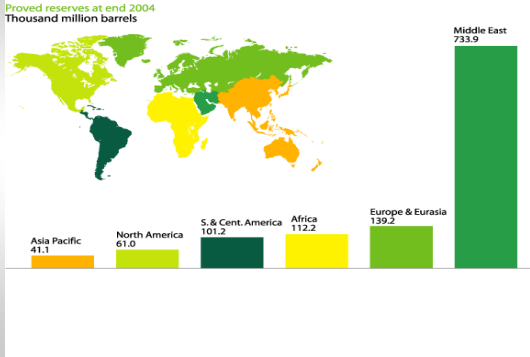
Oil Reserve Numbers...

- Saudi Arabia has 22.1% of worlds oil reserves.
- Iran = 11.1%
- Iraq = 9.7%
- Kuwait = 8.3%
- UAE = 8.2%
- Venezuela = 6.5%
- Russia = 6.1%
- Kazakhstan = 3.3%
- Libya = 3.3%
- Nigeria = 3.0%

USA & Oil

- USA imports 55% of oil used
- ~25% comes from coasts of TX and LA
- ~17% comes from Alaska

Proved Oil Reserves 2004



ANWR – 1002 Area

- USGS 1998 Estimates = 11.6 million to 31.5 billion barrels
- Those technically recoverable = 4.3 billion to 11.8 billion barrels
- Remaining deposits too expensive to extract.

How much oil remains globally?

- Identified global reserves should last about 53 years at current usage.
- Only 42 years if usage increases 2% a year.
- Potentially more – need to search for more reserves.

How much oil remains in the USA?

- Reserves will last 15-24 years at current rate.
- Only 10-15 years if rate increases 2% each year.
- ANWR would only provide the worlds oil demand for 1-5 months or the US's oil demand for 7-24 months.

Random oil tidbits

- First commercial oil well drilled in Titusville, PA in 1859.
- Alaska pipeline is 800 miles long (stretches from Prudhoe Bay to Valdez).
- US consumes 19.7 million barrels / day of oil.
- 1 barrel = 42 gallons
- In 1988, average fuel efficiency of new vehicles was 22.1 mpg. In 2003 = 20.8 mpg

Top Oil Consumers % world consumption

- USA = 24.9%
- China = 8.6%
- Japan = 6.4%
- Russian Federation = 3.4%
- Germany = 3.3%
- India = 3.2%
- South Korea = 2.8%
- Canada = 2.6%
- France = 2.5%
- Italy = 2.4%
- Data from British Petroleum World Energy Review (2005).

Products made from petroleum

- Shower head and curtain
- Asphalt
- Tires
- Pesticides and fertilizers
- CDs / DVDs
- Small household appliances
- Vinyl and plastic furniture
- Bicycle components
- Light switch
- Components of large household appliances
- Linoleum flooring
- Plastic cups & dishware
- Non-stick coating on cookware
- Paraffin waxes
- Toothbrush
- Detergents & cleaning supplies

Natural Gas

Natural Gas

- Found underground in gaseous state.
- Mixture of:
 - 50 – 90% Methane (CH_4)
 - Remaining = ethane (C_2H_6), propane (C_3H_8), butane (C_4H_{10}), hydrogen sulfide (H_2S)

Natural Gas

- Conventional natural gas lies above most reservoirs of crude oil.
- Unconventional natural gas is found elsewhere – too costly to extract.
- Gas is tapped – unwanted gases removed
- Methane cleansed of impurities – ready for use.

Proven Natural Gas Reserves

- Russia = 26.7% of reserves
- Iran = 15.3%
- Qatar = 14.4%
- Saudi Arabia = 3.8%
- UAE = 3.4%
- USA = 2.9%
- Nigeria = 2.8%
- Algeria = 2.5%
- Venezuela = 2.4%
- Iraq = 1.8%

Proven Natural Gas Reserves, 2004



Gas facts

- First commercial extraction of natural gas was in 1821. Technology poor to transport it safely.
- Usage increased after WWII. 1950's – 1960's thousands of miles of pipelines were constructed underground.
- If laid end to end, network today would extend to the moon and back twice.

Natural Gas Consumption (% worlds consumption)

- USA = 24.0%
- Russian Federation = 15.0%
- United Kingdom = 3.6%
- Canada = 3.3%
- Iran = 3.2%
- Germany = 3.2%
- Italy = 2.7%
- Japan = 2.7%
- Ukraine = 2.6%
- Saudi Arabia = 2.4%

Coal

Coal

- Solid fossil fuel formed in several stages as buried plant remains are subjected to intense heat & pressure over millions of years.

Coal Facts

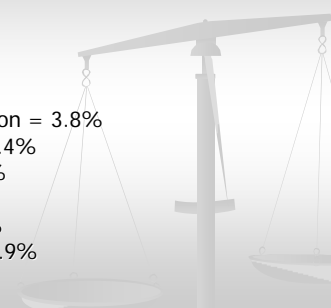
- Used to generate 62% of world's electricity.
- Coal generates 51% of USA's electricity.
- USA = 27.1% of global reserves.
- Russia = 17.3%
- China = 12.6%
- India = 10.2%
- Australia = 8.6%

Coal

- Most abundant fossil fuel.
- Identified reserves – at the current world usage rate, will last us 225 years.
- Unidentified reserves + identified = 900 yrs

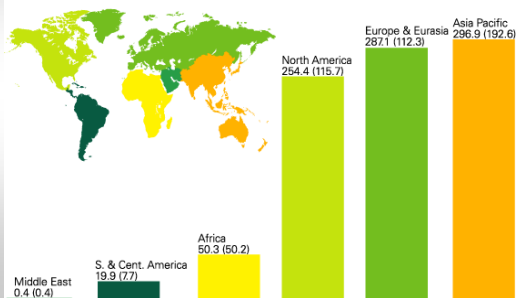
Coal consumption (% worlds consumption)

- China = 34.4%
- US = 20.3%
- India = 7.4%
- Japan = 4.3%
- Russian Federation = 3.8%
- South Africa = 3.4%
- Germany = 3.1%
- Poland = 2.1%
- Australia = 2.0%
- South Korea = 1.9%



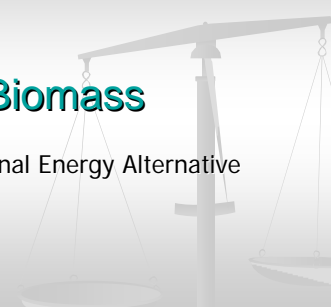
Proven Coal Reserves 2004

Proved reserves at end 2004
Thousand million tonnes (share of anthracite and bituminous coal is shown in brackets)



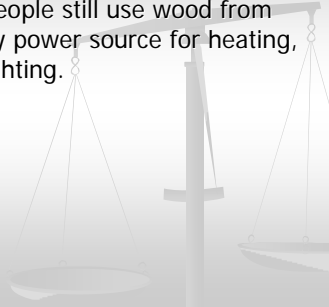
Biomass

Conventional Energy Alternative



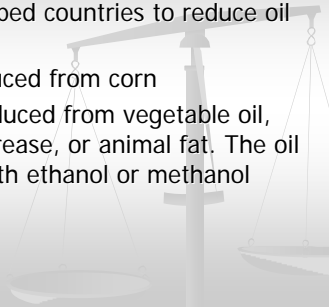
Biomass

- Over 1 billion people still use wood from trees as primary power source for heating, cooking, and lighting.



Biofuels

- Used by developed countries to reduce oil consumption.
- Ethanol – produced from corn
- Biodiesel – produced from vegetable oil, used cooking grease, or animal fat. The oil /fat is mixed with ethanol or methanol (wood alcohol)



Alternative Energy Sources and Fuels

Geothermal Energy

A way to produce electricity

Geothermal Stats

- Provides less than 0.5% of total primary energy worldwide.
- US = provides electricity to 1.4 million homes.
- Iceland is leader in using this natural resource. 86% of nations residences are heated by geothermal energy.

Thermal Conversion Process or Thermal Depolymerization Process

Fuel Source
Turning anything into oil

Who is running the show?

- Changing World Technologies
- <http://www.changingworldtech.com/>

The Process

- Basically a series of steps to recreate what mother nature takes to do in millions of years in a much shorter time frame.

TCP / TDP

- For the past 4 years a pilot plant in PA has been experimenting with a variety of organic waste sources to turn into oil.
- What they've tried: sludge from WWTP, PVC piping, medical waste (non-radioactive, that is), ground up electronics, kitchen garbage, tires, all types of plastic.

The Future...

- Full scale plant to open in Missouri near Butterball turkey plant.
- ConAgra in Colorado in the works to build plant near feedlots.

TCP / TDP

Estimations for the Missouri plant based on 200 tons of turkey waste/day the plant will be able to produce:

- 10 tons of gas
- 600 barrels of oil
- 11 tons of pure minerals
- 21,000 gallons of water
- all of which will be free of toxins and nearly all impurities.

Costs

- \$20 million to build plant
- only requires 15 BTUs of energy to produce 100 BTUs of oil, and further, that the oil can be made for ~\$15 a barrel. This is about \$3 to \$7 more than regular oil drilled in Alaska (\$8 - \$12).
- Estimated that prices will drop within the next ten years to be comparable.

If a human fell into the process

- 175 pound human would produce:
- 38 pounds of oil
- 7 pounds of gas
- 7 pounds of minerals
- 123 pounds of water.

Environmental Concerns?

- Recycling carbon already at the surface – so no need for drilling.
- However, since we are producing a gasoline to burn – still emitting CO₂ in the atmosphere.
- Process will continue to raise concerns about global warming.

Tidal Energy

A look at another way to create electricity

Tidal Energy Stats

- Largest facility is La Rance France, which has operated over 30 years.
- Small facilities are operating in China, Russia, and Canada.
- Release no pollutants, but have impacts on the ecology of estuaries and tidal basins.

Wind Power

Using wind to produce electricity

Wind Stats

- Fastest growing energy resource
- 30% per year globally between 2000 - 2004
- USA – 3.9% of electricity generated from wind, most of it in Texas and California
- Denmark is the world's leader of wind energy. Supplies over 20% of the nations electricity needs.

Wind Power

- Wind farm = cluster of 20 to 100 + wind turbines.
- Wind plants use large blades to catch wind, turning rotors that produce electricity.
- Wind turbines begin to produce power at a wind speed of 10-12 miles per hour.
- Typical height of turbine = 130 ft – 328 ft
- Blades are 138 ft – 262 ft across

Advantages of Wind

- Produces no air pollution.
- Uses no water.
- No need to tear up land to extract the resource that produces wind power.
- Can use land for grazing cattle or growing crops.

Disadvantages of Wind

- Mechanical & Aerodynamic noise
- Increased bird deaths (estimated at 2 birds a year per turbine).
- Visual Impact
- Need back-up system

Solar

Solar Thermal Systems

Solar Stats

- 2004 – solar accounted for only 0.06% of the US primary energy source, and only 0.02% of US electricity generation.
- More attractive in developing countries – BP completed \$30 million dollar solar project to supply 400,000 people in 150 villages in Philippines and Indonesia.
- PV Cells sales are increasing in Japan at the rate of 63% per year.

Passive solar system

- Uses materials or absorptive structures
- Adobe and thick stone - Absorbs heat during the day and gradually releases it at night.
- Greenhouse
- No moving parts

Active solar system

- Use sun's energy to convert into heat.
- Requires a pump and pipes.
- Example: Solar panels on a house to heat hot water.

Solar & Generating Electricity

- Central Receiver System
- Distributed Receiver System
- Solar Cells

Central Receiver System

- Transform radiant energy into electricity.
- Requires Power Tower and Heliostats (mirrors that track the sun and focus sunlight on a central heat collection tower).
- Expensive to build & operate.

Solar Thermal Plant or Distributed Receiver System

- Sunlight is collected on oil-filled pipes located in solar collectors.
- Requires a back-up system.

Solar Cells

- Cell is transparent wafer – semiconductor material.
- Sunlight energizes and causes electrons in conductor to flow creating current.
- Cells wired together.
- Expandable.

Hydrogen

Alternative Fuel Source

Hydrogen

- Odorless, colorless, non-toxic.
- When burned with O_2 , produces energy + H_2O .
- Takes energy to produce fuel.
