

## Resources of the lithosphere

Introduction, significance, examples and extraction processes

## Resource types

- Recall that resources break broadly down into two categories:
  - Renewable resources: either unlimited or able to be replenished within a human lifespan (30-70 years). Examples: trees, animals, wind energy, etc.
  - Nonrenewable resources: not able to be replenished OR replacement time so long that this it might as well be non-existent. Examples: fossil fuels, most minerals, metals.
- Ideally, we would focus on using renewable resources, but this is not always possible



## What are lithosphere resources?

- Any resource or commodity collected, mined, or extracted from the Earth
- Typically found in soils and rocks and can be the soils and rocks themselves
- Almost all are nonrenewable
- Many require expensive or environmentally harmful extraction processes



## Importance of lithosphere resources

- Usually harder to extract than biosphere resources
- Tend to be more multi-purposed and ubiquitous than renewable commodities
- Most materials and goods, especially in the developed world, have at least some lithosphere resource component



## Importance of lithosphere resources

- Almost anything you can think of!
  - Metals
  - Building materials
  - Plastics
  - Electronics
  - Glass



## Metals

- Costly and environmentally degrading extraction
- VERY important for communication, infrastructure, construction, defense, etc.



### Building Materials

- Concrete—conglomerate of rock fragments, cement (crushed rock and a binder like burnt lime or gypsum), and water
- Bricks are fired clay, essentially hydrated and baked dirt



### Plastics

- Usually synthetic and derived from fossil fuels (more to come), though some are organic



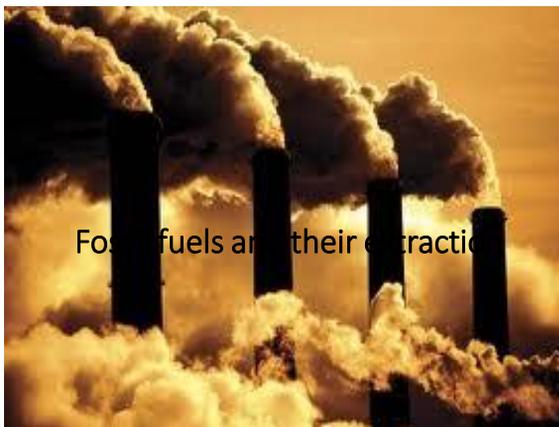
### Electronics

- All electronics contain important lithosphere interior components:
  - Old vacuum tubes made of glass with wire circuitry
  - Modern electronics are primarily plastics with metal circuitry and elemental components—copper, aluminum, silicon, gold, silver sulfide, gallium, germanium, etc.



### Glass

- Amorphous solid typically made from silicates (heated and melted sands)
- Important in buildings, everyday commodities, communication, etc.



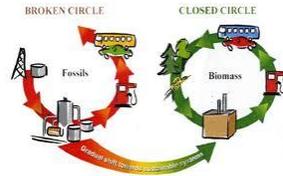
### What are fossil fuels?

- Fossilized biological material that died millions of years ago
- Nonrenewable resource
- Are typically (especially in modern times) mined or drilled for
- Energy released by burning the fuel and breaking C-C bonds



### Problems with fossil fuels

- Both extraction and consumption are dirty, energy expensive processes
- World dependencies, especially in MEDC's, focuses on **nonrenewable** fossil fuels
- Pollution
- Relied upon in economic sectors that might make them harder to replace (transportation)



### Fossil fuel consumption

- Energy consumption certainly not universal or evenly distributed
- United States has the highest consumption of fossil fuels, with per capita energy consumption of 355 GJ per person.
  - This equals roughly the energy in 2,840 GALLONS of gasoline
- Energy consumption tends to follow the theory of demographic transition:
  - More developed = more technology = more fuel consumption per capita

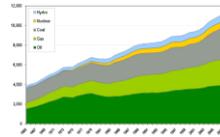
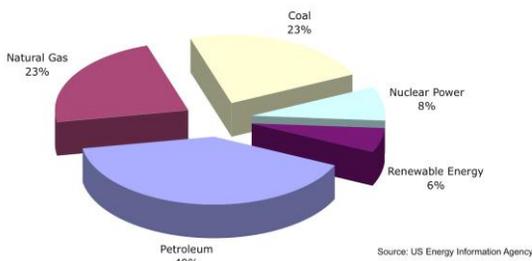


Figure 1: 86% of US Energy Consumption Is Fossil Fuels



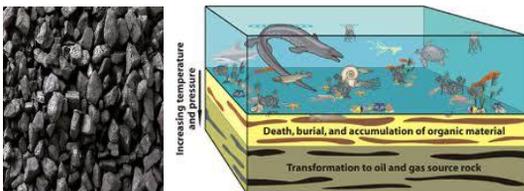
### Why fossil fuels?

- Often most efficient for the job they are set to do
  - Gasoline is compact, ignites quickly, and has a lot of energy— good for cars
  - Coal is easy to transport and contains lots of energy in solid form— good for electric plants.
- Up until relatively recently, they were comparatively easy to extract
- Value of fuel far exceeds manufacturing costs
- Seek out the most efficient source for whatever job you're doing
  - Example: electricity

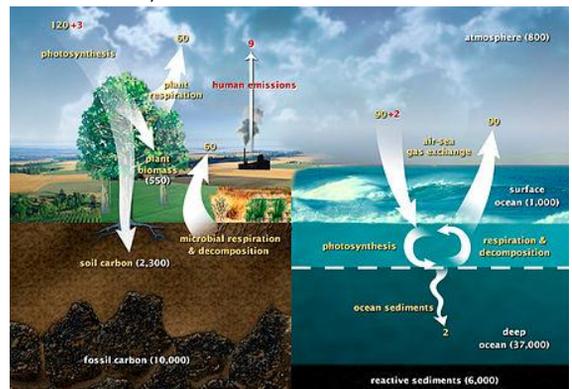


### Creation of fossil fuels

- Originally organic matter (dead stuff)
- Heat, pressure, LONG amounts of time!
- Requires that decomposers like bacteria don't break down all of the initial biomass (doesn't re-enter food chain like usual)

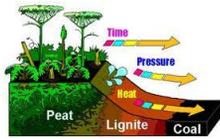


### The carbon cycle



coal

- Solid fuel primarily from plants
- 280-360 million years old
- Four tiers of aged coal:
  - Lignite
  - Sub-bituminous
  - Bituminous
  - Anthracite
- "Peat" is a precursor often extracted from bogs.
- Coal is relatively cheap, until it becomes expensive to extract.



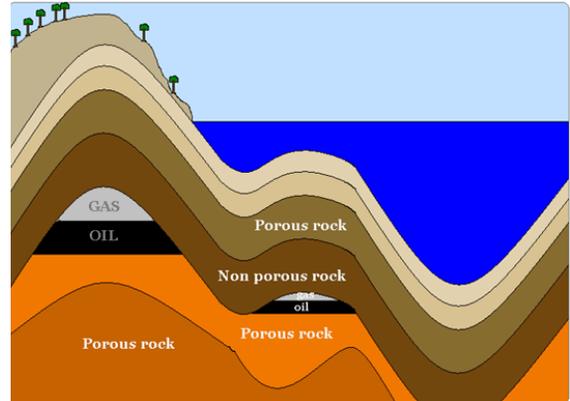
Advantages and Disadvantages of coal

- Advantages:
  - Comparatively cheap to extract
  - Easy to transport via surface infrastructure
  - Little processing to burning: all countries can use it
- Disadvantages:
  - Chemical impurities cause atmospheric pollution (sulfur, lead, mercury, arsenic, etc.)
  - Remnants of ash difficult to dispose



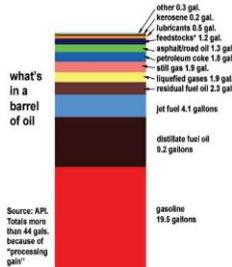
petroleum

- Fluid fossil fuel found in underground reservoirs
- Remains of ocean-dwelling plankton
- 50-150 million years old
- Collects between barriers in porous and nonporous rock
- Collects with natural gas (some burns off naturally)



Crude oil

- Liquid petroleum pulled straight from the Earth
- Refined into various materials: tar, kerosene, gasoline, diesel, asphalt
- ~150 oil refiners in the USA, biggest are capable of handling 80 million liters of petroleum a day
- Top producing countries by volume, in order: Saudi Arabia, Russia, USA, Iran, China, Canada.
  - Creates varied and COMPLEX political interactions



Advantages and Disadvantages of Petroleum

- Advantages:
  - Liquid, so convenient for transport and use
  - Ideal for mobile combustion engines
  - Produces only about 85% the CO2 emissions of coal
- Disadvantages:
  - Poisonous trace components like coal
  - Oil drilling seeps oil into the environment in small and catastrophic quantities (spills)
  - Drilling destroys habitats, fragile ecosystems, and kills organisms



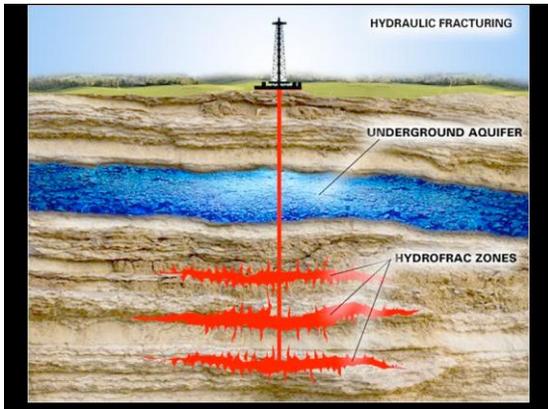
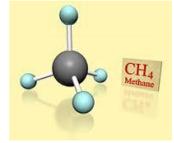
## Natural gas

- Gaseous fossil fuel
- 80-95% Methane, 5-20% ethane, propane, and butane
- Generally extracted concurrently with petroleum
- Used for electricity generation and industrial processes
- Can be liquefied as a fuel (like propane in grills)



## Advantages and Disadvantages of Natural Gas

- Advantages:
  - Extensive pipelines make it available to about half of the homes in the US
  - Fewer impurities and emits virtually no particulates of SO<sub>2</sub> in combustion
  - Emits only 60% of the CO<sub>2</sub> of Coal
- Disadvantages:
  - Natural gas itself can be a greenhouse gas if leaked
  - Mining for natural gas on its own (called "Fracking") is secretive and potentially very dangerous to the environment, especially for groundwater contamination



## Other fossil fuels: Oil sands

- Viscous sands mixed with **bitumen**
- Bitumen is degraded petroleum, called tar or pitch close to the surface
- Mining is much more energy-intensive and can be more degrading to the environment
- Heavy water use in extraction



## Other fossil fuels: Liquefied coal

- When coal is converted to liquid via... CTL (coal to liquid) technology
- Heavily researched in China and USA due to large coal reserves
- Comparatively expensive
- Many of the same drawbacks of oil sands PLUS coal mining is dirty AND CTL is dirty as well



## The Hubbert curve

- Though energy efficiency has increased, our overall consumption has as well, meaning we use more, faster
- Hubbert Curve: predicted by geophysicist M. King Hubbert, predicts when we will reach peak oil production and when oil will run out
  - Used both upper and lower estimates, but didn't influence when we would run out of oil
  - Peak oil: extraction and use begin to decline.
  - Hubbert's predictions say we've already hit peak oil, but regardless, oil will run out within a relatively narrow margin of time

