

**Wednesday, February 27**

### Better Fuel Efficiency

- New goals in fuel economy: double fuel efficiency for cars and light trucks by 2025. Heavy truck efficiency will likely follow.
- 2011 use of transportation fuel (gas plus diesel) accounts for 28% of all energy related to carbon dioxide emission in U.S.
- Doubling fuel efficiency reduces greenhouse gas emissions from U.S. by about 14%.
- 14 major auto manufacturers signed the agreement.
- Achieved mostly by reducing vehicle weight with more use of carbon fiber and aluminum.
- According to Amory Lovins, Energy Analyst, in the near future, cars will routinely achieve 100 mpg. This will largely be due to cars being built from carbon fiber and therefore weighing much less.
  - BMW carbon fiber prototype: shell, frame, engine block from carbon fiber
  - propylene, the building block, made from algae

### Biofuels?

- Corn and palm oil create large greenhouse emissions when land use, direct and indirect, is considered.
- Waste cellulose and non-food crops on marginal soils have significant potential.
- In Indonesia, deforestation of the rain forests is occurring at a rapid rate for palm plantations, which produce palm oil.
- Microalgae can be farmed for biofuel and many products now made from petroleum, e.g., carbon fiber.
  - Does not require agricultural land, suitable for urban "brown fields."
  - Can produce as much biofuel as Iowa corn on 1/7 the land.

### Biodigesters: Producing Usable Energy and Clean Water

- Can break down human and animal waste
- Produce methane for cooking fuel or for running and electrical generator
- Exit water meets TMDL standards
- Carbon credits can be sold
- Inexpensive to build, easy to operate
- Suitable for low income rural development
- Cost of all US materials: \$300
- Can be scaled up
- In a subdivision, a biodigester could
  - treat all waste water without the need to increase wastewater treatment plants
  - return clean water to streams or groundwater, maybe with constructed wetland

- produce electricity
- produce marketable carbon credits

**\*\*\*The information on exam 2 ends here (even though there will be more lectures before the exam).**

**\*\*\*There will be an exam review on Tuesday, March 5 at 5:30 in the classroom.**

**\*\*\*The exam is Wednesday, March 6.**

## AIR ISSUES: AIR POLLUTION

### Composition of Earth's Atmosphere

- Nitrogen: 78%
- Oxygen: 21%
- Argon: 0.9%
- Carbon Dioxide: 0.035%
  - This extremely small amount has an incredibly big effect.

### Natural Air Pollutants: Gases

- volatile organic compounds (VOC) = methane, decaying organic matter, "after rain smell"
- sources include:
  - ruminants (cows, sheep, goats, deer - any animal that grazes and produces methane in their stomachs)
  - fungi
  - insects
  - anything else that is decaying

### Natural Air Pollutants: Particulates

- volcanic eruptive material
- wildfires

### Anthropogenic Air Pollutants

- mostly from combustion of fossil fuels
  - particulate matter
  - ozone
  - carbon monoxide
  - nitrogen oxides
  - sulfur dioxide
  - lead

### Particulate Pollution

- Particle pollution = microscopic solids and liquid droplets suspended in air. Composed of acids (nitrates, sulfates), organic chemicals, metals, soil or dust particles, and allergens (fragments of pollen or mold spores)
- Fine particles (found in smoke and haze) - 2.5 micrometers in diameter or less; and “coarse particles” (such as those found in wind-blown dust), which have diameters between 2.5 and 10 micrometers.
- Particle size - health problem potential
  - less than 10 micrometers in diameter - penetrate lungs, into bloodstream (emitted from power plants, industries, and automobiles)
  - larger particles (from wind-blown dust) can irritate eyes, nose, and throat

### Smog: Historical Event: Donora, PA

- Smog would be around past dawn.
- Ever-thickening smog turned lethal and killed about 20 people.
- Cold layer of air had trapped poisonous gases and dust in the air.
- Factories still operated.
- Let the public know that industrial pollution could kill.
- Led to the Clean Air Act.

### Inversion-Prone Locations

- Basins surrounded by mountains
- Examples:
  - Los Angeles
  - Mexico City
  - Mumbai, India
  - Santiago, Chile
  - Sao Paulo, Brazil
  - Tehran, Iran

### Photochemical Smog Inversions

- In normal circumstances (no smog inversions), warm air is below cool air, which is below cooler air. The pollution can rise to the top, to the cooler air.
- In an inversion, cool air is at the bottom, a warm inversion layer is above that, and another cool layer is above that. The warm air in the middle traps the pollution in the lower cool air.

### Ozone Pollution

- VOCs + NO<sub>x</sub> + Sunlight = Ozone (O<sub>3</sub>)
- NO<sub>x</sub> = nitrogen oxides (there are many forms)