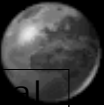


EGEE 102 – Energy Conservation  
And Environmental Protection



Energy and Environmental  
Consequences

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## Goals

- To gain familiarity with fossil fuel composition
- To understand basic combustion chemistry
- To know the quantitative implications of fossil fuel combustion
- To appreciate the health and environmental effects of products of combustion
- To gain basic understanding of the effects of primary and secondary pollutants



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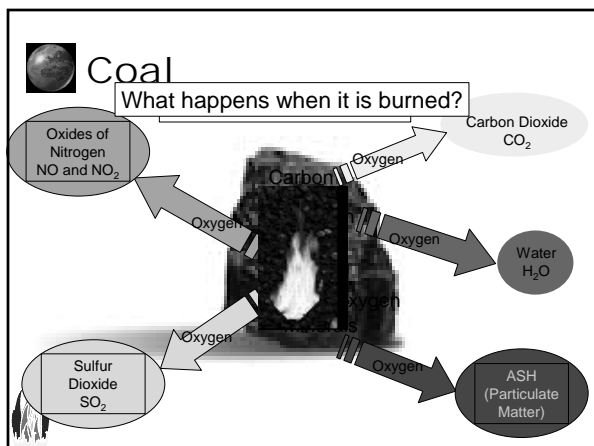
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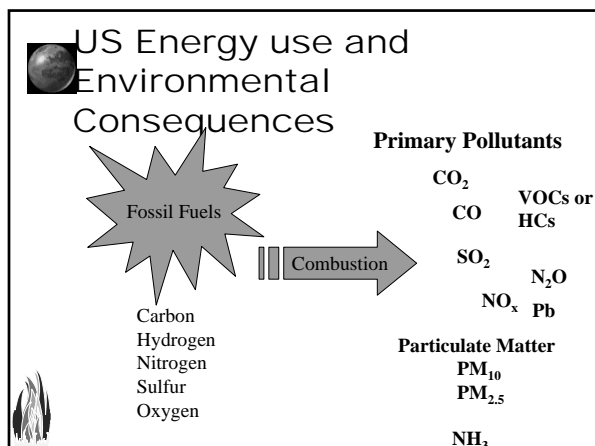
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### US Air Emissions, Mtons (1999)

Gas	Emissions
Carbon Dioxide	1,520
Carbon Monoxide	97.4
Lead	4.1
NO <sub>x</sub>	25.4
SO <sub>2</sub>	18.8
Particulate Matter	23.7

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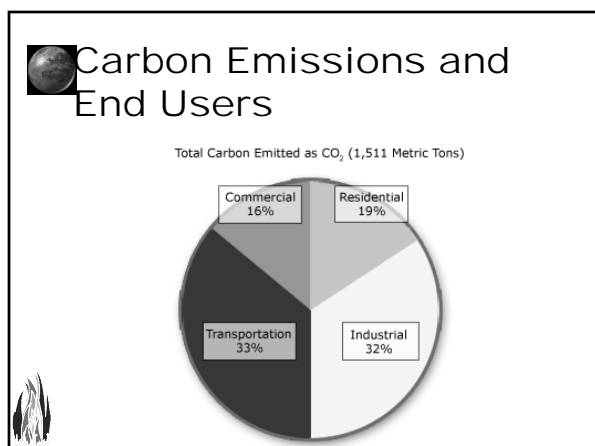
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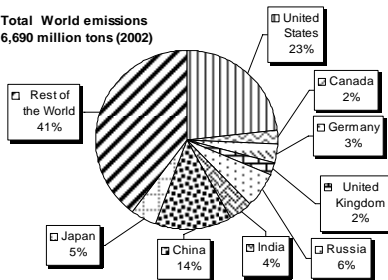
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## Global Carbon Emissions

Total World emissions  
6,690 million tons (2002)



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## Nitrogen Oxides (NO<sub>x</sub>)

- Short-term exposures (e.g., less than 3 hours) to low levels of NO<sub>2</sub> may lead to changes in airway responsiveness and lung function in individuals with preexisting respiratory illnesses. These exposures may also increase respiratory illnesses in children.
- Long-term exposures to NO<sub>2</sub> may lead to increased susceptibility to respiratory infection and may cause irreversible alterations in lung structure.



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## NO<sub>x</sub>- Effects

**NO<sub>x</sub> contributes to a wide range of environmental effects directly and when combined with other precursors in acid rain and ozone.**

- Increased nitrogen inputs to terrestrial and wetland systems can lead to changes in plant species composition and diversity.
- Direct nitrogen inputs to aquatic ecosystems such as those found in estuarine and coastal waters (e.g., Chesapeake Bay) can lead to eutrophication
- Nitrogen, alone or in acid rain, also can acidify soils and surface waters.



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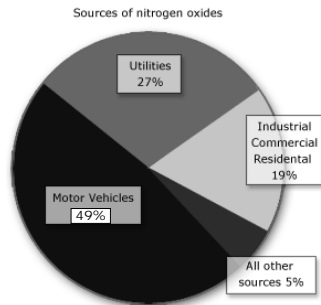
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## NOx Emissions



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## Carbon Monoxide

- **Product of incomplete combustion**
- **Reduces the flow of oxygen in the bloodstream**
- **Particularly dangerous to persons with heart disease.**
  - Visual impairment
  - Reduced work capacity
  - Reduced manual dexterity
  - Poor learning ability
  - Difficulty in performing complex tasks.



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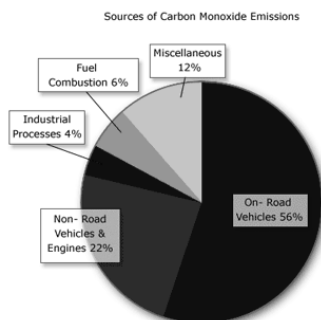
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## CO Emissions (60 million Tons, 2002)



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## Sulfur Dioxide

- **Short-term Exposure**
  - Adults and children with asthma who are active outdoors will experience temporary breathing impairment.
  - Individuals with asthma may experience breathing difficulties with moderate activity and may exhibit symptoms such as wheezing, chest tightness or shortness of breath.
- **Long-term exposure (along with high levels of PM)**
  - Aggravation of existing cardiovascular disease
  - Respiratory illness
  - Alterations in the lungs' defenses.
- **Together,  $\text{SO}_2$  and  $\text{NO}_x$  are the major precursors to acidic deposition (acid rain)**
- **major precursor to  $\text{PM}_{2.5}$ , which is a significant health concern**



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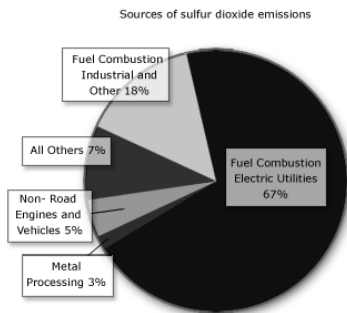
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## SO<sub>2</sub> Emissions



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## Lead

- **Exposure to lead occurs mainly through inhalation of air and ingestion of lead in food, water, soil, or dust. It accumulates in the blood, bones, and soft tissues and can adversely affect the kidneys, liver, nervous system, and other organs.**



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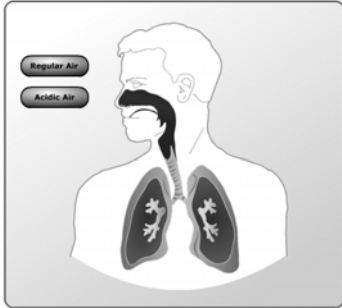
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## Lead Emissions



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## Particulate Matter

- **Health effects**
- **Visibility impairment**
- **Atmospheric deposition**
- **Aesthetic damage**



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## Particulate Matter

- **PM<sub>2.5</sub>** describes the “fine” particles that are less than or equal to 2.5  $\mu\text{m}$  (micro meter) in diameter.
- “Coarse fraction” particles are greater than 2.5  $\mu\text{m}$ , but less than or equal to 10  $\mu\text{m}$  in diameter.
- **PM<sub>10</sub>** refers to all particles less than or equal to 10  $\mu\text{m}$  in diameter (about one-seventh the diameter of a human hair). **PM** can be emitted directly or formed in the atmosphere.



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## Particulate Matter

- Primary
- Secondary



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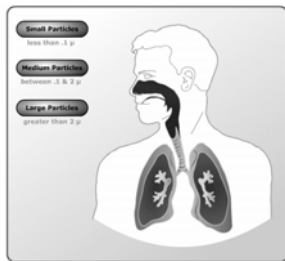
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## Effect of Particulates



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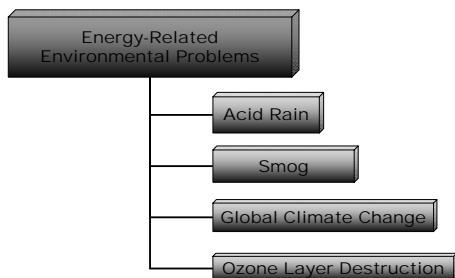
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## Secondary Pollutants



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