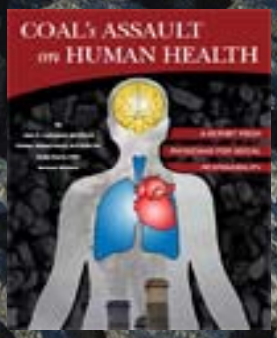
Coal's Assault on Human Health



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Coal: The Economy, Electricity, Political Power, and Health

- In 2007, the U.S. consumed 4,159,514 gigawatt-hours (GWh) of electricity, a 2.3-percent increase from 2006.
- 48.6% of U.S. electricity is produced by burning coal.
- Pollution from coal-fired power plants may cause as many as 49,000 deaths and 450,000 serious illnesses each year.
- "External Costs" of burning coal are about $62 billion per year
- The US has about 500 billion tons of proven coal reserves, a 250 year supply.
- Coal companies and electrical utilities are politically powerful with well funded lobbies.

Sources: Edison Electrical Institute,
Markandaya & Wilkinson, Lancet, 2007
National Research Council, 2009

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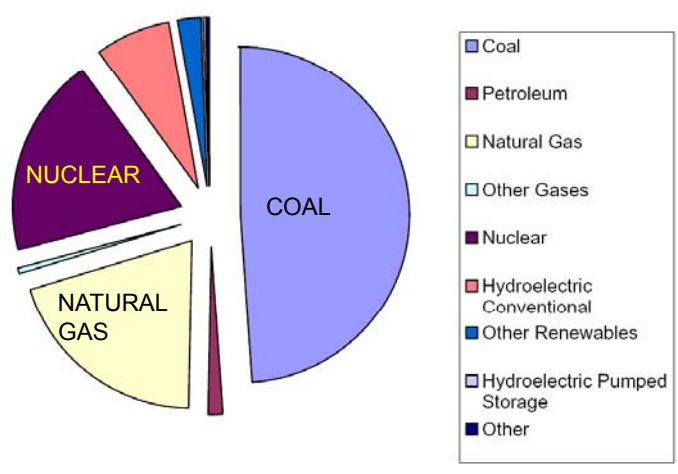
Power Plant Energy Sources, 2006
4,064,702,000 Megawatt Hours



Source: US Energy Information Agency

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Life Cycle of Coal

- Mining: a dangerous profession, leaching of elements, e.g. arsenic, affects water supply
- Transportation: substantial emissions by locomotives and watercraft
- Washing: slurry contains elements that affect health
- Combustion: the major problem
- Fly Ash: storage, escape of toxins into water supply, transportation

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Coal's Assault:

RESPIRATORY EFFECTS

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Pollutants Released by Burning Coal

- Over 60 pollutants have been identified in coal plant emissions
- SOx- Oxides of Sulfur: Affects children and adults with respiratory disease including asthma, contributes to PM formation
- NOx – Oxides of Nitrogen: Patients with respiratory diseases, contributes to secondary PM formation
- PM – Particulate Matter: classified by size and method of formation, contributes to respiratory, cardiovascular, and nervous system diseases (e.g., stroke, MI)
- Hg – Mercury: A naturally occurring element found in coal, bioaccumulates in food chain, especially fish, affects brain function
- CO_2 – Carbon Dioxide: a major greenhouse gas and contributor to global warming

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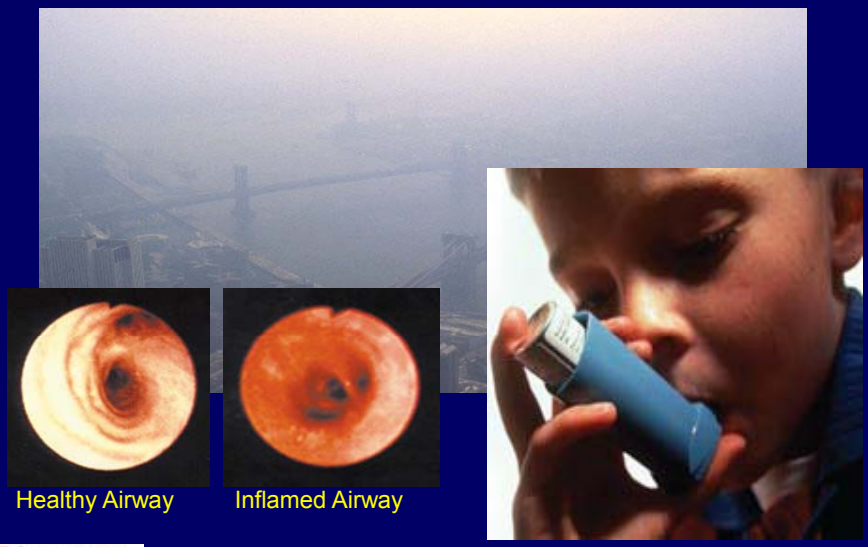
Coal Pollutants: Irritants



Healthy Airway

Inflamed Airway

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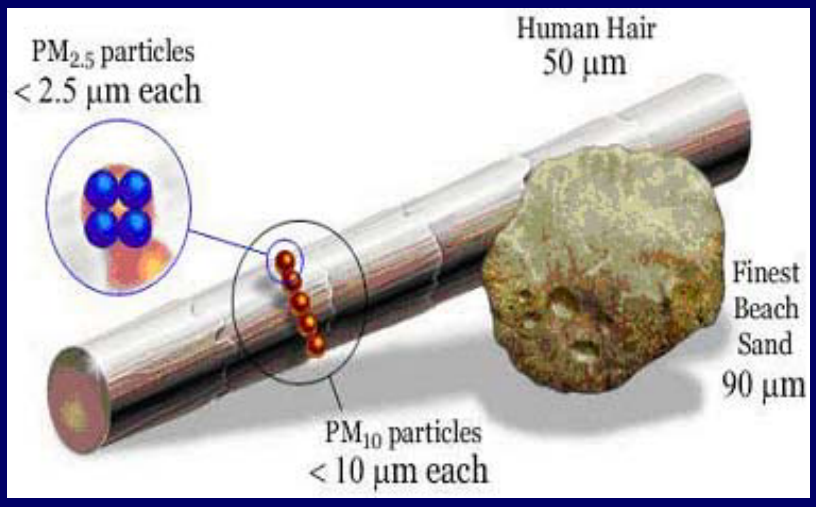
Size of Typical Particles



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Pollutants from Coal Combustion Linked to

- Asthma: especially acute exacerbations, may be triggered by inhalation of pulmonary irritants, including SOx and Ozone, children vulnerable
- Chronic Obstructive Pulmonary Disease: COPD, chronic bronchitis and emphysema
- Lung Cancer: linked to increases in PM concentration in ambient air

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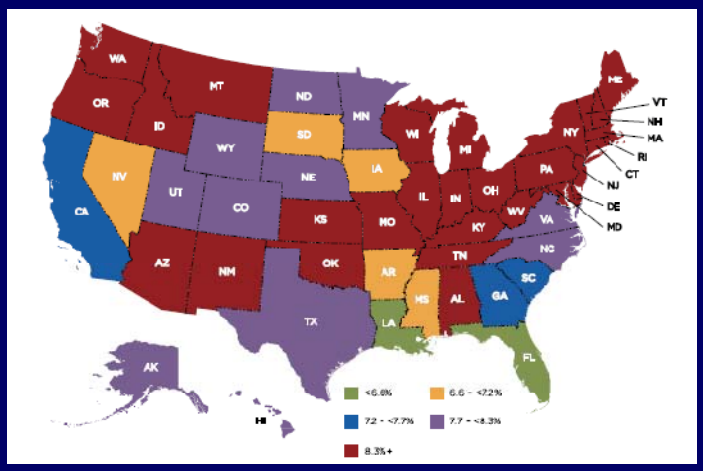
Effects on Respiratory System: Asthma Prevalence by State



Source: Centers

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Coal's Assault:

CARDIOVASCULAR EFFECTS

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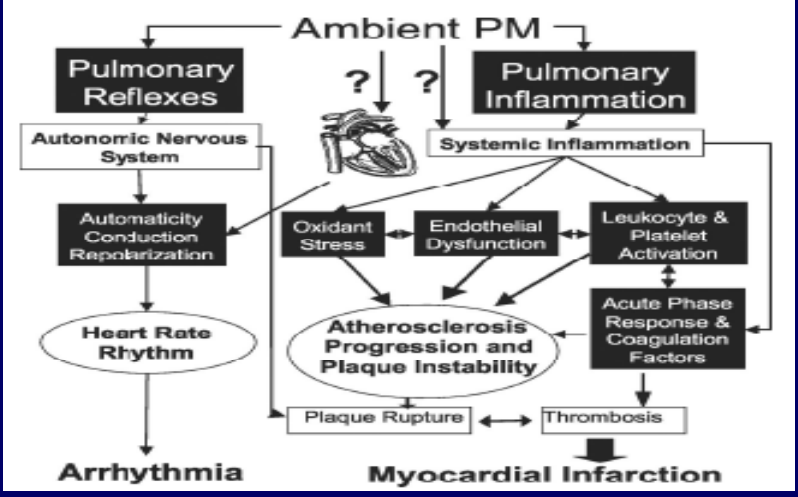
PM and Cardiovascular Disease



Source: Brook et al, Air Pollution and Cardiovascular Disease
Circulation 2004;109:2655-2671

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Cardiovascular Disease

Percent Change in Hospitalization Rate

Per 10 μgram/m^3 $PM_{2.5}$

Ischemic heart disease:	0.44
Heart rhythm disturbance:	0.57
Congestive Heart Failure:	1.28

Source: Domenici et al JAMA 2006

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Air Pollution and Stroke

- Korean Study: increased ischemic stroke risk with daily increases in suspended particulates and sulfur dioxide, one day lag nitrogen dioxide, and carbon monoxide, and 3 day lag for ozone
- Taiwan study: on warm days (≥ 20 C) positive association between PM_{10}, NO_2, SO_2, CO, and O_3 for cerebral hemorrhage and ischemic stroke admissions
- Women's Health Initiative: an increase of 10 μg/m^3 in the $PM_{2.5}$ concentration was associated with a 24% increase in the risk for a cardiovascular event and an increased risk for a cerebrovascular event
- Medicare study: 2.33 % increase in ischemic stroke in comparing quartiles of PM_{10}

Sources: Hong et al Stroke 2002, Tsai et al Stroke 2003.
Miller, et al, NEJM, 2007, Wellenius et al, Stroke, 2005

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Coal's Assault:

NEUROLOGIC EFFECTS

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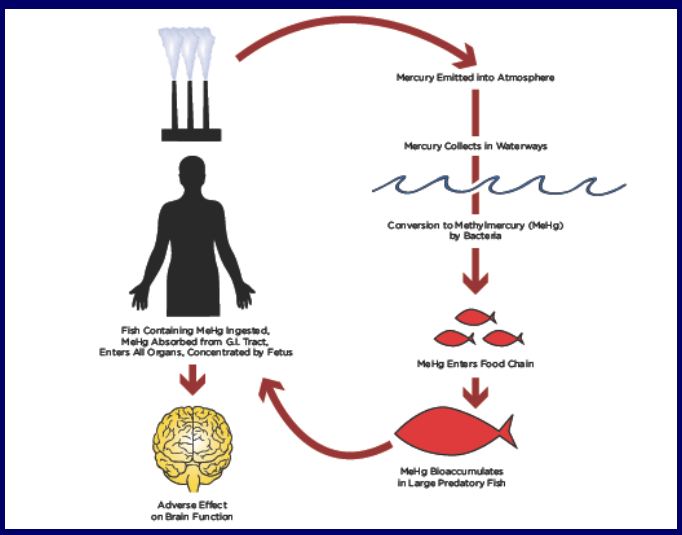
The Mercury Cycle



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Anthropogenic Mercury Sources

Source	Tons/year	%
Combustion	137.9	86.9
Utilities	52.0	32.8
Muni Incinerator	29.6	18.7
Industrial Boilers	28.4	17.9
Medwaste Incinerator	16.0	10.1
Other Manufacturing	15.8	10.0

Source: Mercury Study Report to Congress, EPA, 1997

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Mercury Health Effects

Predominantly nervous system, may also affect kidneys

- brain development *in utero* and after birth.
- paresthesias (peripheral neuropathy)
- incoordination (writing, speech, gait)
- impaired hearing
- mental disturbances

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Impact of Hg on Child Development

- Cord blood Hg levels 70% higher than maternal level
- 1999 – 2000 NHANES data indicate that 15.7% of women of childbearing age have Hg levels ≥ 3.5 μg/L.
- 630,000 children born annually in USA with cord blood Hg levels ≥ 5.8 μg/L

Sources: National Research Council, 2000; Stern & Smith EHP 2003
Mahaffey et al, EHP 2004

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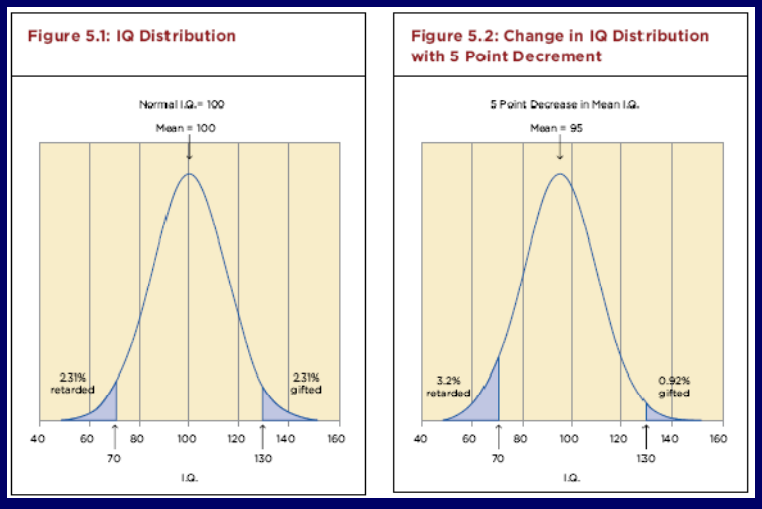

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Coal: Global Warming Culprit

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Global Warming and Health

- Flooding due to rising sea level
- Alterations in ability to grow food at different latitudes
- Increases in heat-related illness
- Increases in vector-borne illnesses (malaria, dengue, etc.)
- Increases in extreme weather events
- Reduced water quality and increased water-borne illnesses
- Reduced air quality and increased in pollution-related morbidity and mortality
- Ecosystem destruction and reduced biodiversity

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