# CE 213A
# Introduction to Environmental Science

## *L 7 :* Module A
## Conventional Energy Sources

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***Schedule : LEC: Tt. Thu 5:10 - 6:30; T108***

# Energy Sources

- **Primary Energy sources-**
  - Fossil fuels (oil, natural gas, coal)
  - Nuclear energy
  - Falling water, geothermal, solar
- **Secondary Energy sources-**
  - Sources derived from a primary source like…
    - Electricity
    - Gasoline
    - Alcohol fuels (gasohol)

# TYPES OF FOSSIL FUELS

1. Liquid Hydrocarbons- Petroleum (oil)
2. Coal
3. Natural Gas

Photo credit: California Energy Commission

# Problems with Fossil Fuels

- Non-renewable
  - At projected consumption rates, natural gas & petroleum will be depleted by the end of the 21st century
- Impurities are major source of pollution
  - **$SO_2$** travels on air currents & falls with precipitation as **acid rain**
  - **Mercury bio-accumulates & biomagnifies** thru ecosystems when it travels on air currents and fall as **particulate dust or with precipitation** elsewhere.
- Burning fossil fuels produces large amounts of $CO_2$, which contributes to **global warming**
- Makes us rely on other countries for our energy needs. Makes us vulnerable.

# 1. OIL

- Liquid mixture of hydrocarbons with S, O, N impurities
  - Impurities can create $SO_2$ and $NO_x$ air pollution
- Formed from remains of plankton, plants, animals in shallow seas millions of years ago.
- May be pumped up or may be under pressure
- Important producers: OPEC, Alaska, Siberia, Mexico

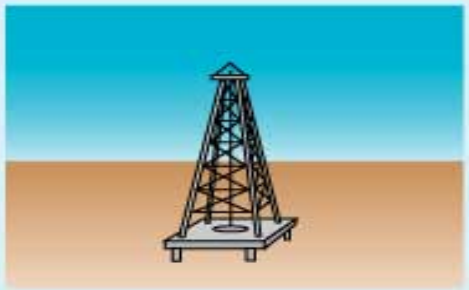
## Advantages

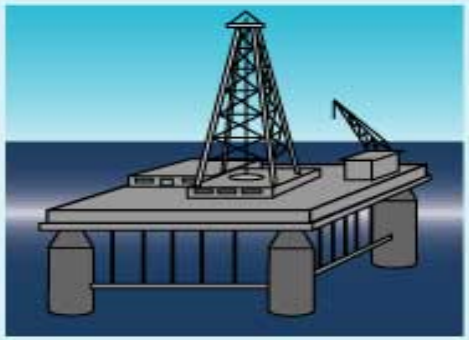
Ample supply for 35–84 years

Low cost (with huge subsidies)

High net energy yield

Easily transported within and between countries





## Disadvantages

Need to find substitute within 50 years

Artificially low price encourages waste and discourages search for alternatives

Air pollution when burned

Releases $CO_2$ when burned

Moderate water pollution





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# 2. NATURAL GAS

- Mixture
  - 50–90% Methane ($CH_4$)
  - Ethane ($C_2H_6$)
  - Propane ($C_3H_8$)
  - Butane ($C_4H_{10}$)
  - Hydrogen sulfide ($H_2S$)

## Advantages

Ample supplies (125–200 years)

High net energy yield

Low cost (with huge subsidies)

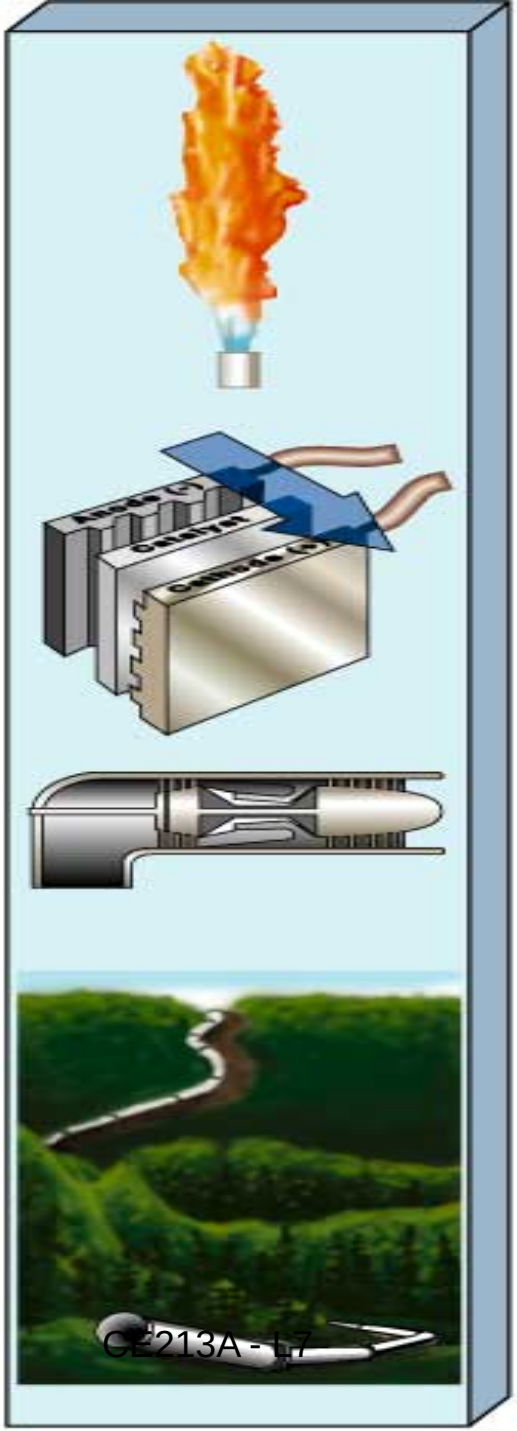
Less air pollution than other fossil fuels

Lower $CO_2$ emissions than other fossil fuels

Moderate environmental impact

Easily transported by pipeline

Good fuel for fuel cells and gas turbines



## Disadvantages

Releases $CO_2$ when burned

Leaks of methane (a greenhouse gas)

Shipped across ocean as highly explosive LNG

Sometimes burned off and wasted at wells because of low price





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# Natural Gas

- **Experts predict increased use of natural gas during this century**

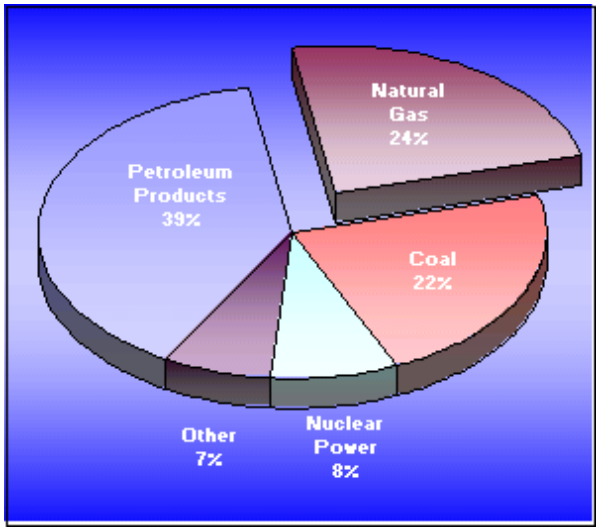
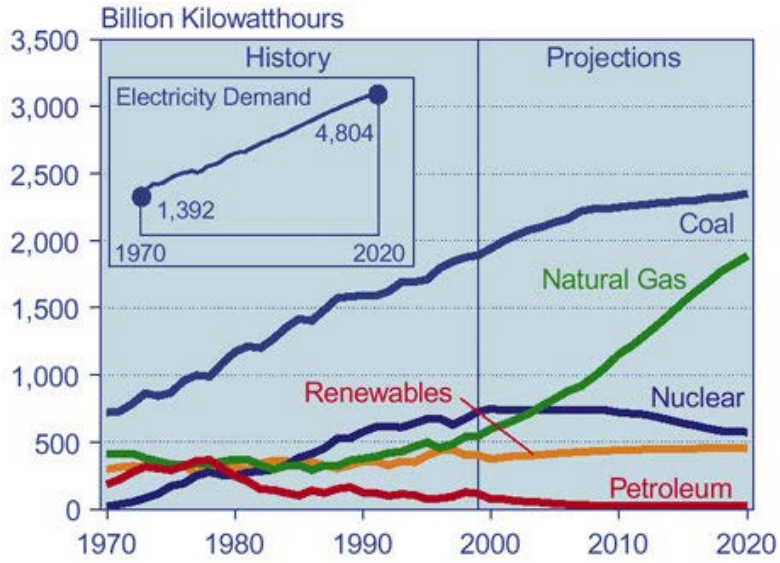



**Figure 26. Electricity Generation by Fuel, 1970-2020**




Sources: **History:** Energy Information Administration (EIA), Form EIA-860B, "Annual Electric Generator Report - Nonutility;" EIA, *Annual Energy Review 1999*, DOE/EIA-0384(99) (Washington, DC, July 2000); and Edison Electric Institute. **Projections:** EIA, *Annual Energy Outlook 2001*.

# 3. Coal

- Coal exists in many forms therefore a chemical formula cannot be written for it.

- Coalification: After plants died they underwent chemical decay to form a product known as peat
  - Over many years, thick peat layers formed.
  - Peat is converted to coal by geological events such as land subsidence which subject the peat to great pressures and temperatures.

# Advantages and Disadvantages

## Pros

- Most abundant fossil fuel
- 300 yrs. at current consumption rates
- High net energy yield

## Cons

- Dirtiest fuel, highest carbon dioxide
- Major environmental degradation
- Major threat to health



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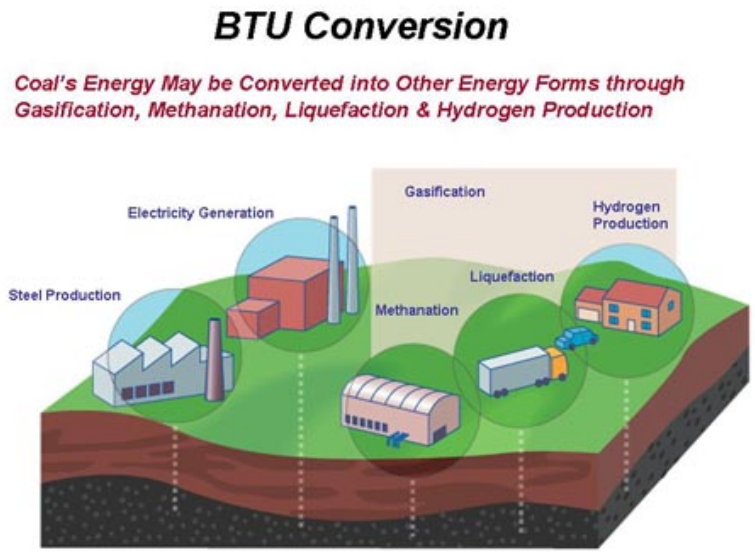
# Alternate Uses of Coal

- Coal **gasification** ® Synthetic natural gas (SNG) or Syngas (made up of CO and $H_2$)
- Coal **liquefaction** ® Liquid fuels (oil) ® gasoline
- Disadvantage
  - Costly
  - High environmental impact



# Sulfur in Coal

- When coal is burned, sulfur is released primarily as sulfur dioxide ($SO_2$ - serious pollutant)
  - Coal Cleaning - Methods of removing sulfur from coal include cleaning, solvent refining, gasification, and liquefaction
  - Two chief forms of sulfur
    - inorganic ($FeS_2$ or $CaSO_4$)
    - organic (Sulfur bound to Carbon)

# Effects on Ecosystems of acid rain from sulfur dioxide.

- Acid rain leaches metals (Al) out of soil, settles on fish gills, causing suffocation.
- Leaches out soil nutrients
- Kills eggs, larvae, fry (baby fish), and some adult fish
- Changes in pH can make some chemicals more toxic- kills trees or aquatic life
- Decreases health of plants- more susceptible to disease
- As animals die from pH changes, other more hardy animals will fill those new niches
- Upsets food web when sensitive species die.
- If regional climate changes due to cooling from sulfur pollution
  - Changes in crops
  - Changes in vegetation which leads to changes in fauna distribution
  - Changes in precipitation patterns

# Resources

- International Energy Agency
  - www.eia.gov
- **Ministry of Power**
- **Ministry of New and Renewable Energy**
  - *www.mnre.gov.in/*

The *Ministry* of New and Renewable *Energy* (MNRE) is the nodal *Ministry* of the Government of *India* for all matters relating to new and renewable *energy*.

- **Solar Energy Corporation of India Limited(SECI), A ...**
  - *www.seci.gov.in/*