**Renewably Energy**

**Reading**
- Today: Ch 14 (348-363)
- Wed: Geomedicine chapter on Montgomery website

**Current Use of Renewable Energy**

Total = 97.551 Quadrillion Btu

- Natural Gas 26%
- Coal 23%
- Renewable Energy 8%
- Petroleum 29%
- Nuclear 6%
- Electric Power 6%

**US Energy Consumption 2002**

from U.S. Energy Information Administration

**Renewable Use in Wisconsin**

1970-2002

(Fillions of Btu)

- Petroleum, Coal, Natural Gas, Nuclear, Electric Imports, Renewable

**Hydroelectric Power**

Approximately 45% of US renewable energy sources in 2003 accounted for approx. 3% of total energy, 7% of electricity

[Map showing hydroelectric power generation in the U.S.]
Hydroelectric Power (cont.)

**Advantages:**
- Cost
- Proven technology
- No CO₂ emissions
- Renewable

Hydroelectric Power (cont.)

Disadvantages:
- Environmental impacts
- Conflicting demands for flood control and power
- Variable over time

Estimates of “undeveloped” potential in US total approximately 30,000 MW compared to 98,000 MW of current capacity.

Ocean Energy

**Wave Energy**
- 2-3 million MW worldwide potential

**Tidal Power**
- Largest operating system 240 MW in France
- Environmental impacts on estuaries
Ocean Energy (cont.)

Ocean Thermal Energy Conversion – developing technology
Some estimate worldwide potential at 10 billion MW

Geothermal Energy

Worldwide production of about 8,200 MW electricity (red dots)
11,000 MW thermal equivalent for direct heating (blue dots)

Geothermal Energy (cont.)

Electricity from Steam

Existing US Electricity Generation from Geothermal Resources
California - 2,500 MW
Nevada - 200 MW
Utah - 40 MW
Hawaii - 30 MW

The Geysers, CA

Geothermal Energy (cont.)

Heat pumps for heating or cooling – over 35,000 pumps sold in US in 2002

Direct use for space heating
Wind Energy

Fastest growing renewable worldwide. US has over 6,300 MW

Wind Energy (cont.)

Classic Windmill  Modern high efficiency horizontal axis turbines
Vertical turbines for new applications

Wisconsin Wind Energy

5 existing wind farms in WI with total capacity of over 52 MW

MADISON, WIS. – Mar. 25, 2004 – Officials at Wisconsin Power and Light Company (WP&L), a wholly-owned subsidiary of Alliant Energy Corporation (NYSE: LNT), announced today they will proceed with plans to increase the amount of wind power in their balanced portfolio of resources by adding 100 megawatts (MW) of wind generation in Wisconsin in 2005.
Solar Energy - Heat

Passive Heating

Active Heating

Solar Energy - Electricity

Photovoltaic materials and the photoelectric effect

Solar Energy – PV modules

Crystalline modules

Thin film laminates

Solar Energy – PV system

Control Electronics

Battery (optional)

DC to AC Inverter

AC Load
A solar roof in Madison

Equipment for grid connection without batteries

Total cost -$16,000
Annual output 1700 kWh

Biopower

Combustion of Plant Material

Landfill Gas

Biodiesel

Hydrogen Fuel Cells

Sources of Hydrogen

Hydrocarbons

Uses fossil fuel or biomass
Generates CO₂

Water

Electrolysis: Splitting water with electricity to produce hydrogen and oxygen.

Requires energy inputs