Essentials of Energy
4-7-05

History
Technologies
Units
Resources

History of energy use
- Human
- Animal
- Simple machines amplify animal power
  - Lever-inclined plane: pyramid
  - Wheel
- Fire/ wood: cook, fire pottery, metallurgy
- More sophisticated technologies:
  - Windmills
  - Water wheels

19th century
- Steam (factories, pumps, engines[railroad] and space heat in buildings)---
  ------------→ now generate electricity via coal, heat buildings
- Direct water------------→ hydropower
- Transformed into

	19th century	20th century
Manufacturing	Steam, direct water, wind	Electricity
Transportation	Animal, steam, water, wind	Internal/external combustion
Space/building heat	Open fire (wood), steam (coal, wood)	Steam (gas), electricity, forced air (direct burn)
Communication	Transportation+electricity (telegraph)	Electricity plus some transportation (mail)
Lighting	Candles, kerosene, whale oil, gas, fireplace	Electricity
Cooking	Wood	Electricity, gas

Today's dominant technologies
- Internal combustion engine
  - Diesel
  - Gasoline (Otto)
- Electricity
  - Steam/Coal: 50%+
  - Gas Turbine 20%
  - Hydro >10%

Nuclear 20%
(Note: NO OIL)

Almost all require heat: the burning of something, mainly fossil fuels

Exceptions: hydropower, nuclear—but nuclear is still heat

All of our main energy technologies have serious environmental consequences:

Air pollution: health problems, acid rain, etc.
CO2 production: climate change
Waste disposal: health hazards
River alterations: ecosystem disruption, downstream users affected

Can they be controlled? Must they be replaced? Can they be replaced?

Examples and equivalencies of electricity generation technologies:

Bonneville Dam= Columbia Generating Station (formerly WNP2)= Centralia Coal Plant= about 1,000 mw capacity= power for Seattle= 8,760,000,000 kwh in a year

Units

Joules--→Kwh→ BTUs

British thermal unit
n. (*Abbr.* BTU or Btu)

1. The quantity of heat required to raise the temperature of one pound of water from 60° to 61°F at a constant pressure of one atmosphere.
2. The quantity of heat equal to $^{1}/_{180}$ of the heat required to raise the temperature of one pound of water from 32° to 212°F at a constant pressure of one atmosphere.

British thermal unit, abbr. Btu, unit for measuring heat quantity in the customary system of English units of measurement, equal to the amount of heat required to raise the temperature of one pound of water at its maximum density [which occurs at a temperature of 39.1 degrees Fahrenheit (°F)] by 1°F. The Btu may also be defined for the temperature difference between 59°F and 60°F. One Btu is approximately equivalent to the following: 251.9 calories; 778.26 foot-pounds; 1055 joules; 107.5 kilogram-meters; 0.0002928 kilowatt-hours. A pound (0.454 kilogram) of good coal when burned should yield 14,000 to 15,000 Btu; a pound of gasoline or other fuel oil, approximately 19,000 Btu.
(from http://www.answers.com/)

watt (W)

the SI unit of power. Power is the rate at which work is done, or (equivalently) the rate at which energy is expended. One watt is equal to a power rate of one joule of work per second of time. This unit is used both in mechanics and in electricity, so it links the mechanical and electrical units to one another. In mechanical terms, one watt equals about 0.001 341 02 horsepower (hp) or 0.737 562 foot-pound per second (lbf/s). In electrical terms, one watt is the power produced by a current of one ampere flowing through an electric potential of one volt. The name of the unit honors James Watt (1736-1819), the British engineer who built the first practical steam engines.

joule (J)

the SI unit of work or energy, defined to be the work done by a force of one newton acting to move an object through a distance of one meter in the direction in which the force is applied. Equivalently, since kinetic energy is one half the mass times the square of the velocity, one joule is the kinetic energy of a mass of two kilograms moving at a velocity of 1 m/s. This is the same as 10^7 ergs in the CGS system, or approximately 0.737 562 foot-pound in the traditional English system. In other energy units, one joule equals about 9.478 170 x 10^{-4} Btu, 0.238 846 (small) calories, or 2.777 778 x 10^{-4} watt hour. The joule is named for the British physicist James Prescott Joule (1818-1889), who demonstrated the equivalence of mechanical and thermal energy in a famous experiment in 1843. Although Joule pronounced his name "jowl", the unit is usually pronounced "jool" or "jew'l".

newton (N)

the SI unit of force. A force of one newton will accelerate a mass of one kilogram at the rate of one meter per second per second. The corresponding unit in the CGS system is the dyne; there are 10^5 dynes in one newton. In traditional English terms, one newton is about 0.224 809 pounds of force (lbf) or 7.233 01 poundals. The newton is also equal to about 0.101 972 kilograms of force (kgf) or kiloponds (kp). The newton is named for Isaac Newton (1642-1727), the British mathematician, physicist, and natural philosopher. He was the first person to understand clearly the relationship between force (F), mass (m), and acceleration (a) expressed by the formula $F = ma$.

(above from http://www.unc.edu/~rowlett/units/index.html)

work over time=energy

Capacity vs. energy

Wind: energy = 1/3 capacity (capacity factor of .33) over the course of a year, the wind will blow only enough to produce 1/3 of the electricity it

would have produced if it blew constantly at the greatest volume and speed to produce the rated capacity of electricity
Hydro: same principle; if max water went through the dam year round lots more power than is actually the case. Depending on demand, season, environmental constraints, precipitation, etc. Great for emergencies: can be increased very rapidly if needed.

Coal: can operate close to capacity all the time: just keep feeding in coal

Schools of thought regarding resources:
- Cornucopian, technological optimists
- Pessimists, limitationists,
- Environmentalists: environment, not resources set limits.

<u>Class logistics:</u>

What to read in the 5th Power Plan

Go to www.nwcouncil.org

Click on 5th Power Plan

Read: Executive Summary, skim "Final Overview" and Chapter 1, read Chapter 3: Conservation. You don't have to read every word—the point is to understand how conservation is conceptualized, quantified and implemented.

Paper #1: Due April 28
- Final instructions next week. For now: 2 pages on what you have learned so far:
  - What
  - Why it is important to you

Final Project: Due June 2.
- Final instructions next week. For now:
  - Energy policy recommendation: how to increase a resource you think is more desirable or decrease a resource that is less desirable (without doing undue damage to economy).
    - Explain technology
    - Explain policy: tax break, subsidy, regulation, program, etc.
    - Politics: who favors/opposes; what would be needed to get it passed—who has to pass and implement it?