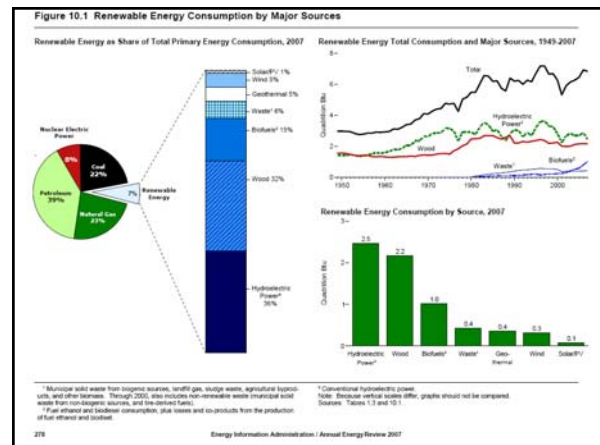
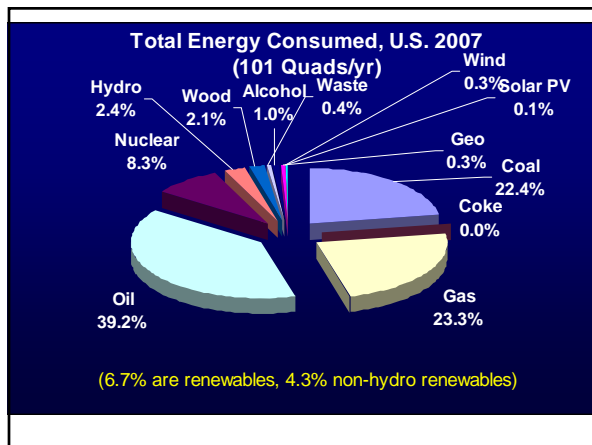
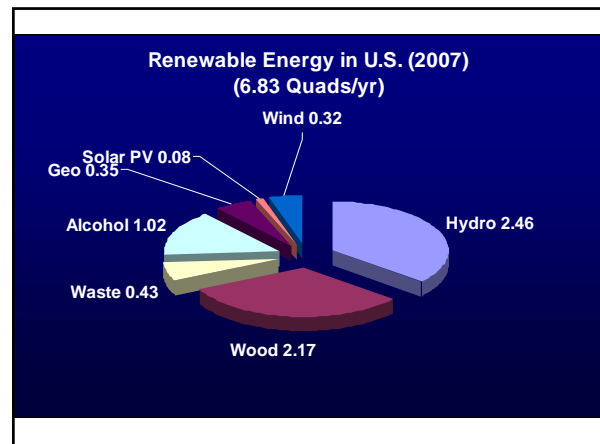


Class 15

Biomass



Biomass Feedstocks

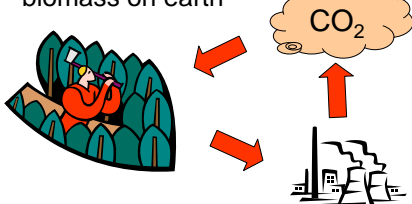
- Residues
 - Forest
 - Mill
 - Agricultural
- Urban wood wastes
- Dedicated energy crops
- Landfill gas
- Industrial residues
 - Black liquor
 - Animal manures
- Municipal solid waste
- Tires
- Railroad ties
- Utility poles

General Characteristics of Biomass

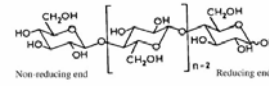
- Lower heating value than coal or oil
 - 15-19 GJ/tonne vs. 20-30 for coal, 42-45 for oil
- High moisture content
 - Air dried to 15-20% (Utah coal-5%, Wyo-28%)
- High oxygen content
 - (Cellulose, Hemicellulose & Lignin) – better ignition
- Low bulk density
 - ~100-150 kg/m³ vs. 700-850 kg/m³ for coal
 - Makes transportation uneconomical
- Low ash (but perhaps high alkali) (0.5 to 5%)
- Low sulfur (<0.1%)

Why Is Biomass Considered CO₂ Neutral?

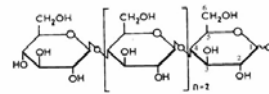
- Releases CO₂ when burned
- Grows by taking CO₂ from atmosphere
- No net increase or decrease in amount of biomass on earth



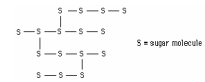
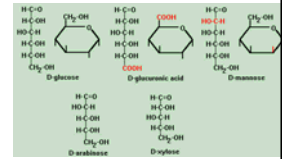
Chemical Structures



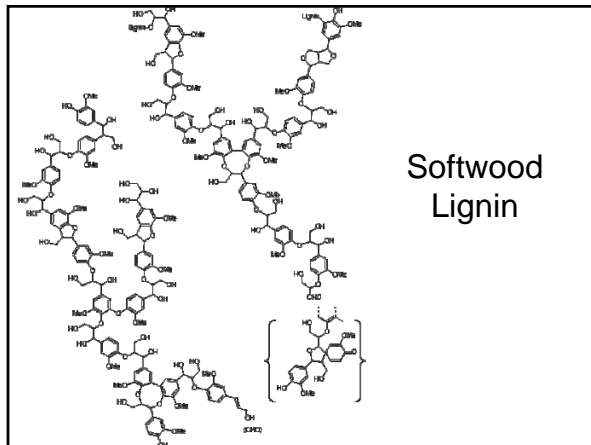
Sometimes shown as



Cellulose



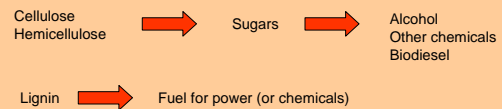
Hemicellulose



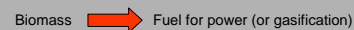
Softwood Lignin

Terminology

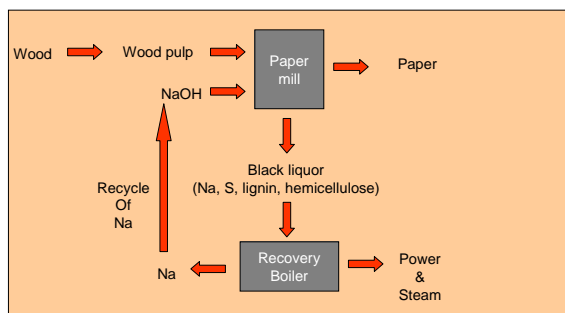
• Sugar platform



• Thermochemical platform



Black Liquor (5th largest source of power)



Potential Improvements in Black Liquor Recovery

Requirements:

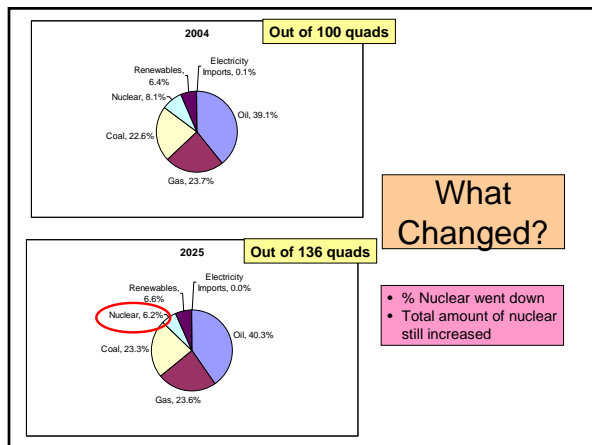
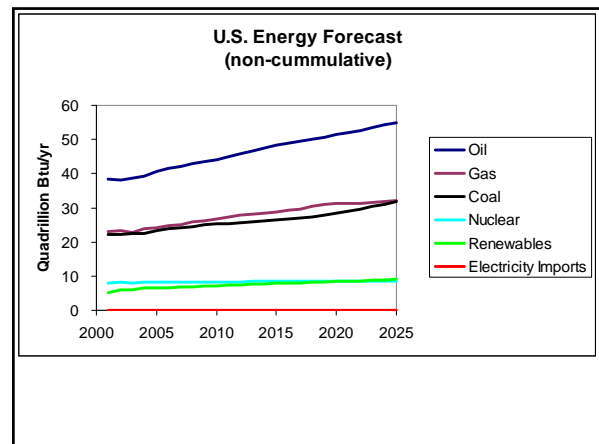
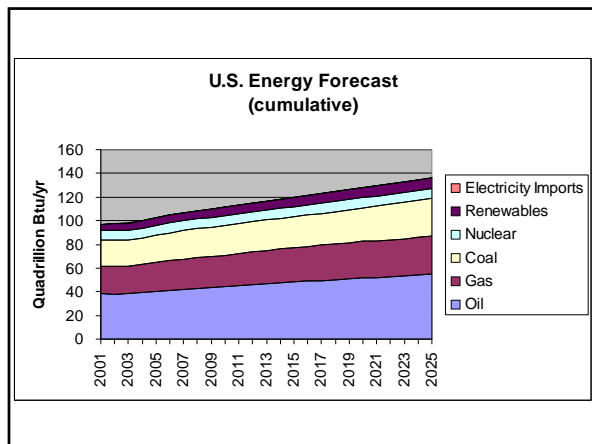
- Recover Na
- Recover energy

Research Ideas:

- Use recovery gasifier instead of boiler
- Output is CO & H₂
- Fischer-Tropsch Catalysis
- Product is liquid fuel (diesel or gasoline)

Driving Force:

- Large quantities of black liquor already being recovered!



Biofuels

- B20
 - Diesel with 20% bio-derived fuel
- E85
 - 85% ethanol, 15% gasoline
 - Special engines needed
- E10
 - 10% ethanol, 90% gasoline
 - Any engine

What Will E10 Do To My Car?

- Lower emissions
 - NO_x
 - CO
- Less knock (higher octane rating)
- Lower gas mileage
 - As much as 30%
- May clog fuel filter with continued use

Bottom line: Huge corn subsidy is not going away