# Understanding Woody Biomass

*Woody Biomass Utilization Workshop*

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# What is Woody Biomass?

*Portions of woody plants or residues from woody plants that accumulate to levels that pose a hazard or disposal problem or woody plants specifically grown for biomass markets*.

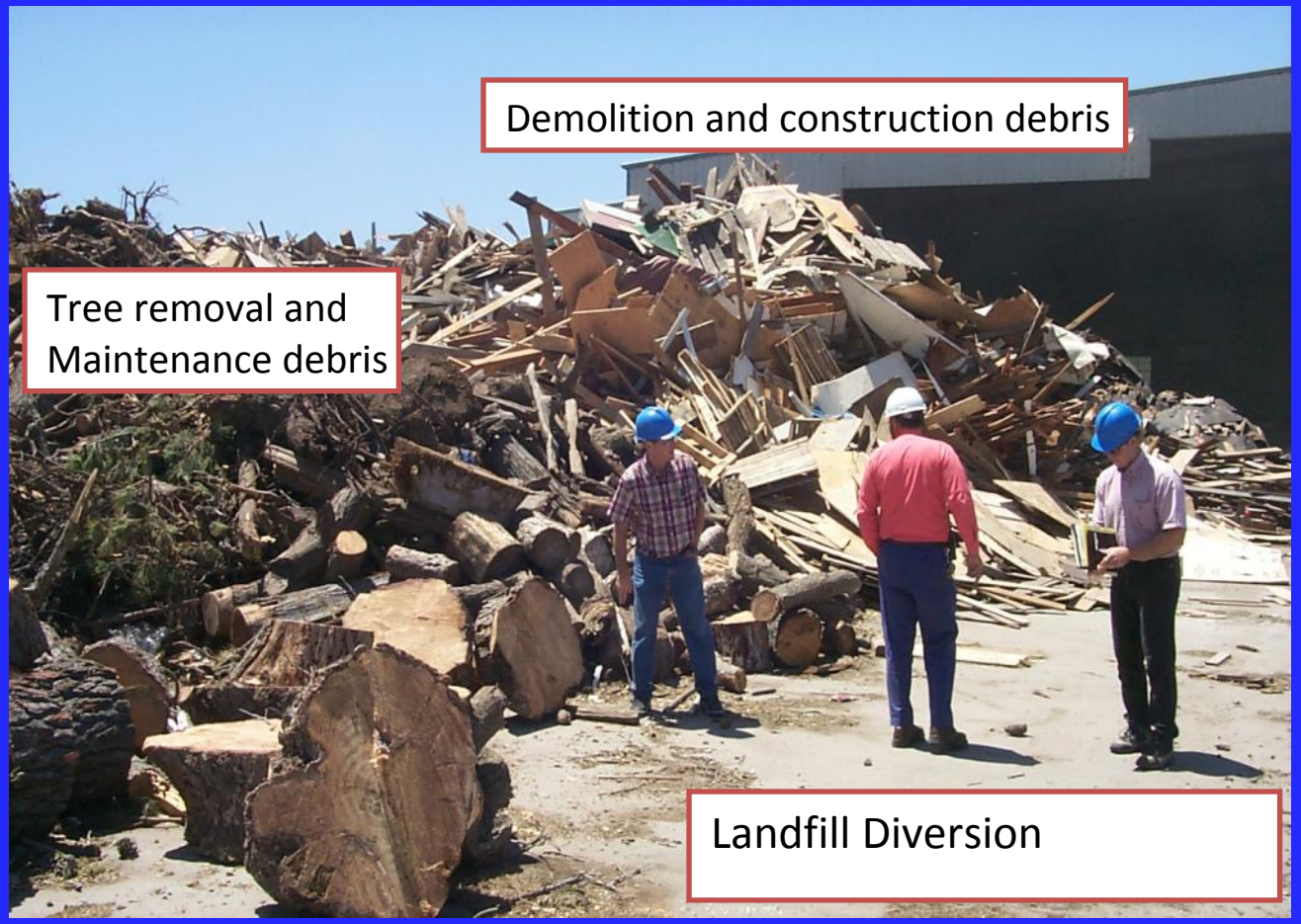
- Low quality natural resource
- Low value natural resource

Woody Biomass Comes from Many Sources!

# Woody Biomass Sources

Sawmill Residue

# Woody Biomass Sources



# Woody Biomass Sources


Logging Residue and Slash

# Woody Biomass Sources

# Woody Biomass Sources

Fuel Reduction Thinning

# Woody Biomass Sources

Dead Trees (disease or fire)

# Woody Biomass Sources

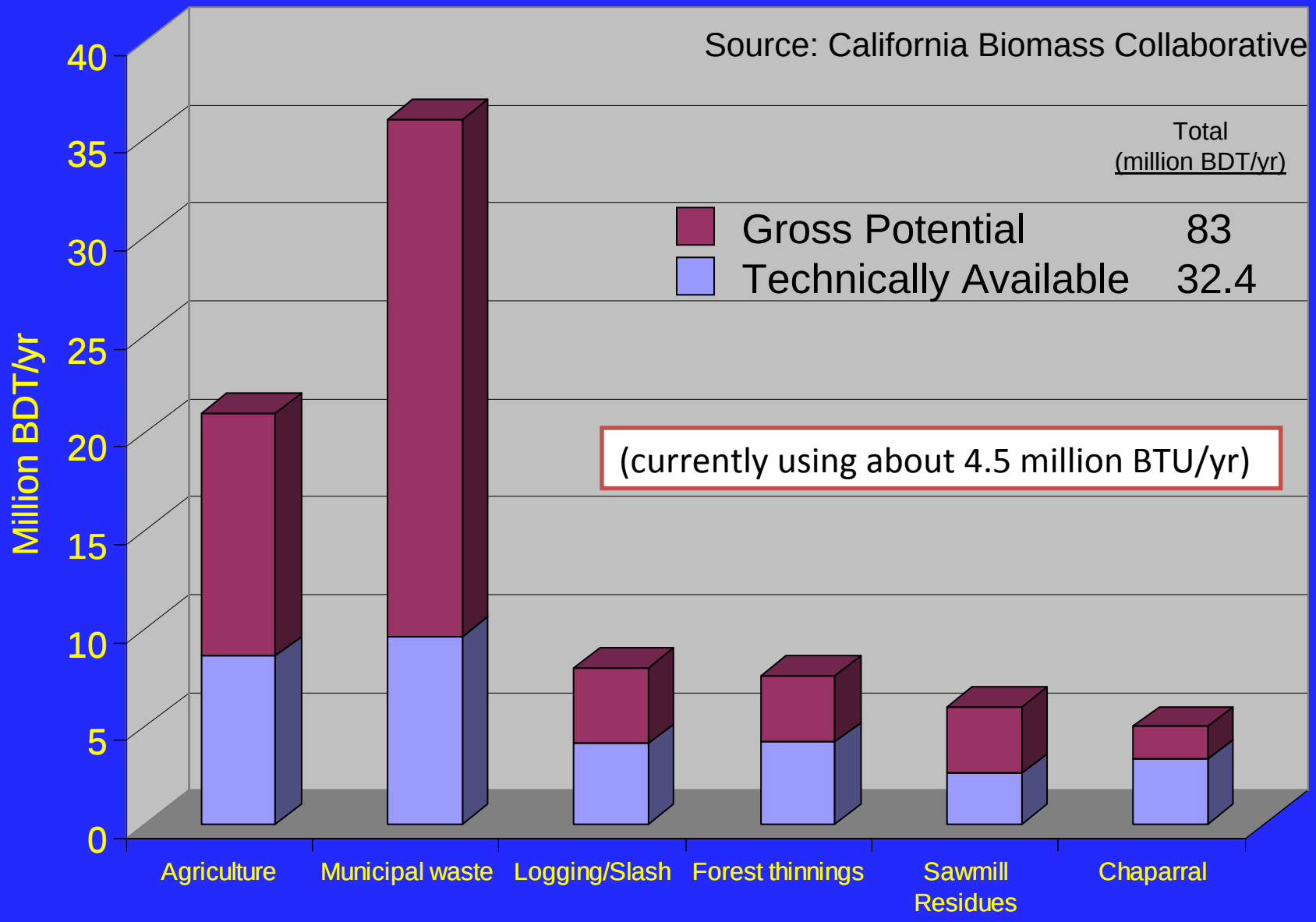
Woody Biomass

- Sawmill Residue
- Landfill Diversion
- Logging Residue
- Dedicated Forest
- Fuel Reduction Thinning
- Dead Trees

Other Biomass

- Agricultural Residues
- Chaparral

# Estimated California Biomass Potential in 2007



# Woody Biomass as a Resource

- Low Value Raw Material
  - Mixed species
  - Low quality wood (defects, abnormal wood, etc.)
  - Often includes bark and dirt
- Carbon Storage / Carbon Neutral
- Renewable Resource for Energy
- Using it can Reduce Wildfire Hazard
- Low Cost ???

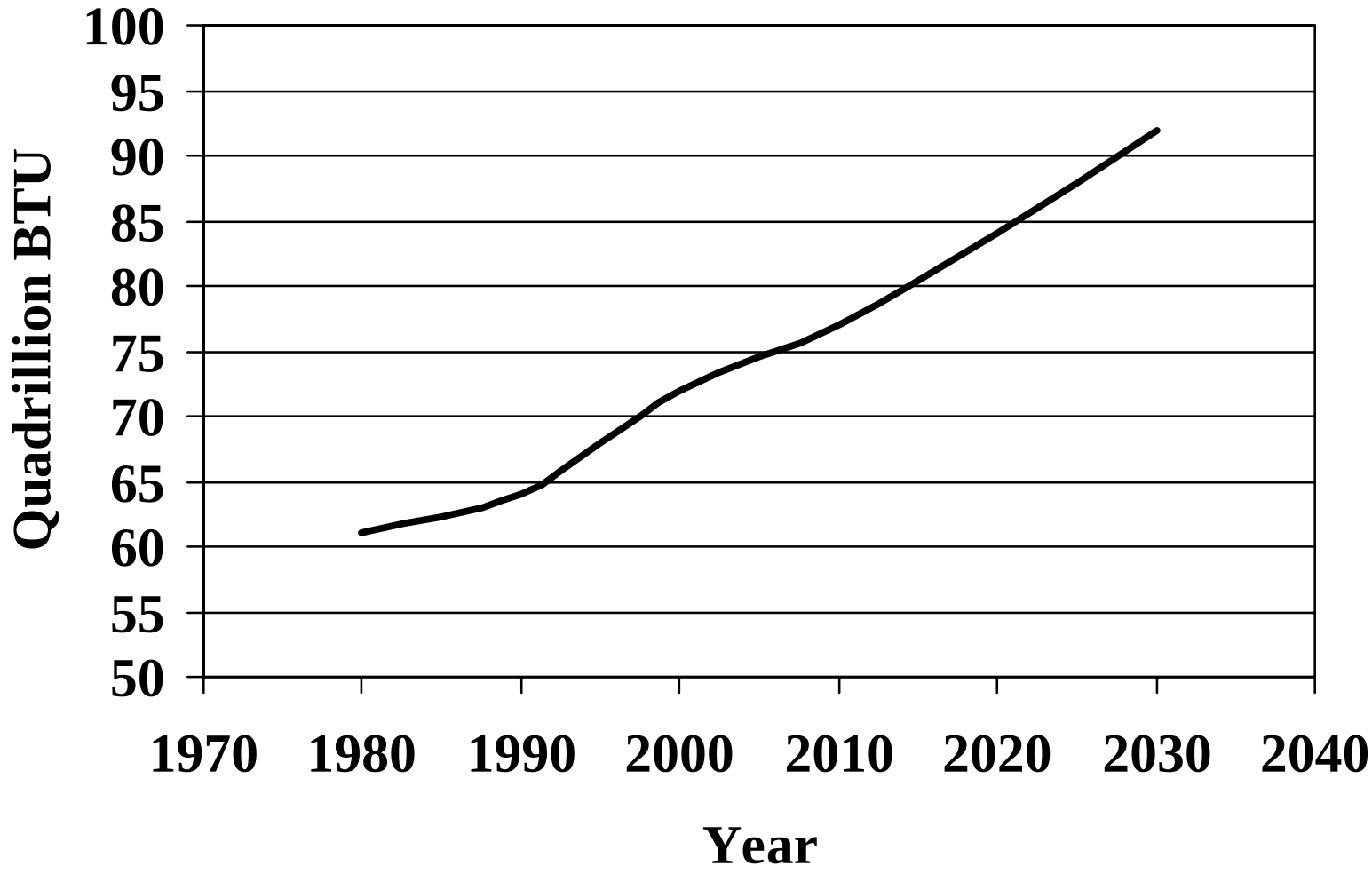
# Trees are Natures Answer to the Energy Crisis

- Solar Collector
- Consume CO2
- Energy Storage (Battery)
- Provides:
  - Heat
  - Electricity
  - Transportation Fuels

# Potential Uses and Competition

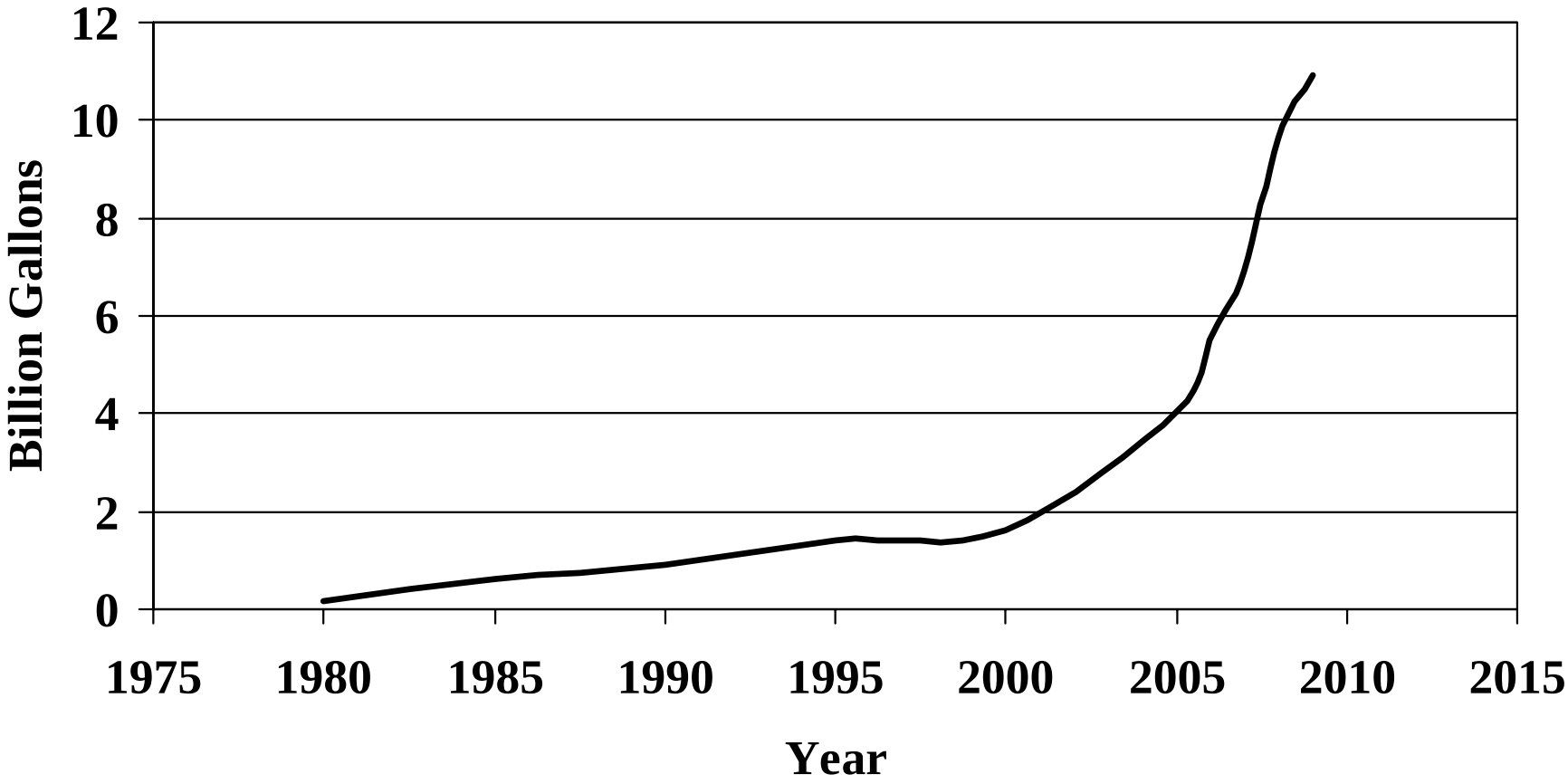
- Energy feedstock (heat and electricity)
- Landscape materials & soil amendments
- Extra steps in feedstock preparation elevate woody biomass to a higher value resource
  - Fiber resource – pulp or composites (particleboard, wood-plastic lumber, etc.)
  - Bio-refinery – organic chemicals including biofuels

# US Energy Demand




Source: Energy Information Administration: Annual Energy Outlook 2007

# US Renewable Fuel Demand




Source: Renewable Fuels Association 2010

Global Carbon Cycle (billion metric tons)

+ 3.2 Billion tons per year to atmosphere

88

90

119

120

6.3

Oceans

Vegetation and Soils

Caused by human activit

# Biochemical Potential

| | Softwoods | Hardwoods |
|---|---|---|
| Cellulose | 40-44 % | 43-47 % |
| Hemicellulose | 25-29 | 25-35 |
| Lignin | 25-31 | 16-24 |
| Extractives | 1-5 | 2-8 |
| Ash | < 1 | < 1 |

# Organic Chemicals from Biomass

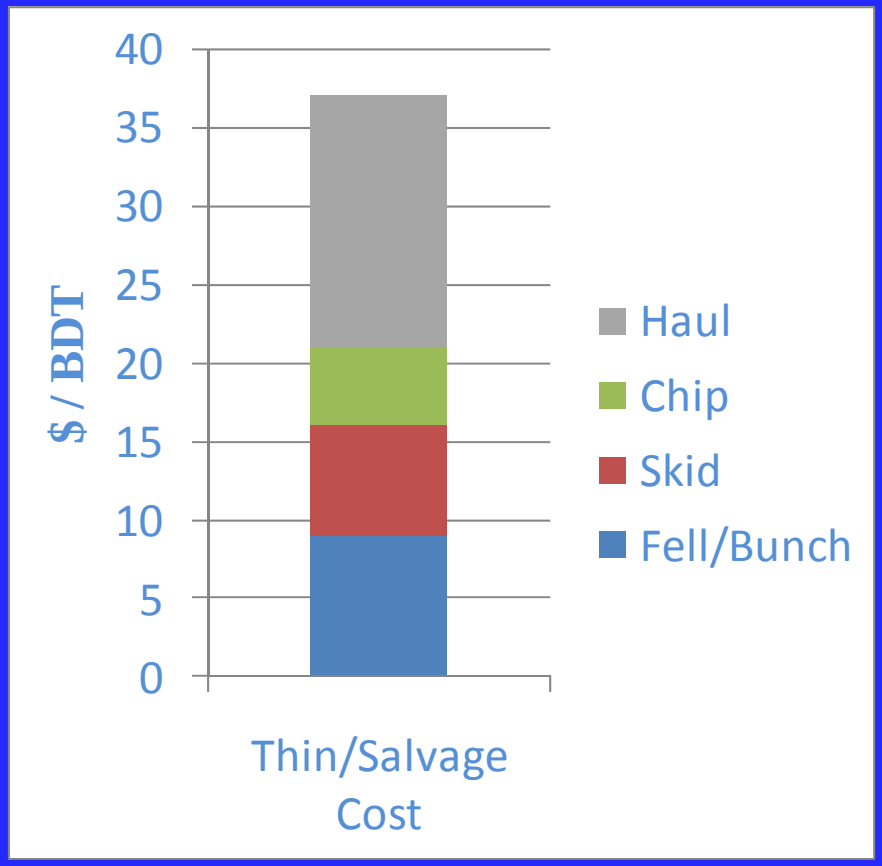
*Many Valuable Chemicals can be Made from Wood*

- Pharmaceuticals -- Extraction
- Fragrances -- Extraction
- Charcoal, phenolic oils, -- Pyrolysis
- Alcohols - Thermochemical, Hydrolysis/Fermentation
- Bio-Gases (low BTU, high CO) -- Gasification
- Levulinic and Lactic acid ("building blocks") –
  - Hydrolysis/Conversion

# So What's the Problem?

- Resource Availability
- Feedstock Quality and Cost
- Processing Cost
- Feedstock Competition
  - Competing uses for woody biomass
  - Competing feedstocks for energy products

# Example of Costs of Forest Thinning or Salvage Operations with a 50 Mile Haul




Value of biomass delivered to a powerplant ranges from about
$20 - $40 per BDT

## Competing Cellulosic Feedstocks

| | Cellulose | Hemi-Cellulose | Energy Cont ent (BTU/lb) | Yield (tons/acre) | Bulk Den. (kg/m$^3$) | Million BTU/m$^3$ | Conversn ratio |
|---|---|---|---|---|---|---|---|
| Switch-grass | 45% | 45% | 7,000 | 20 | 108 | 1.7 | |
| Miscanthus | 45 | 24 | 7,700 | 60 | 80 | 1.4 | 5 |
| Corn Stover | 35 | 25 | 7,300 | | | | < 1-1.2 |
| Bagasse | 40 | 22 | 7,500 | | 60 | 1 | |
| Wood | 42 | 25 | 8,000 | 10 | 450 | 8 | 2 – 5 |
| Coal | | | 10,000 | | 800 | 17.6 | |

transportation costs and energy conversion ratio are impt.

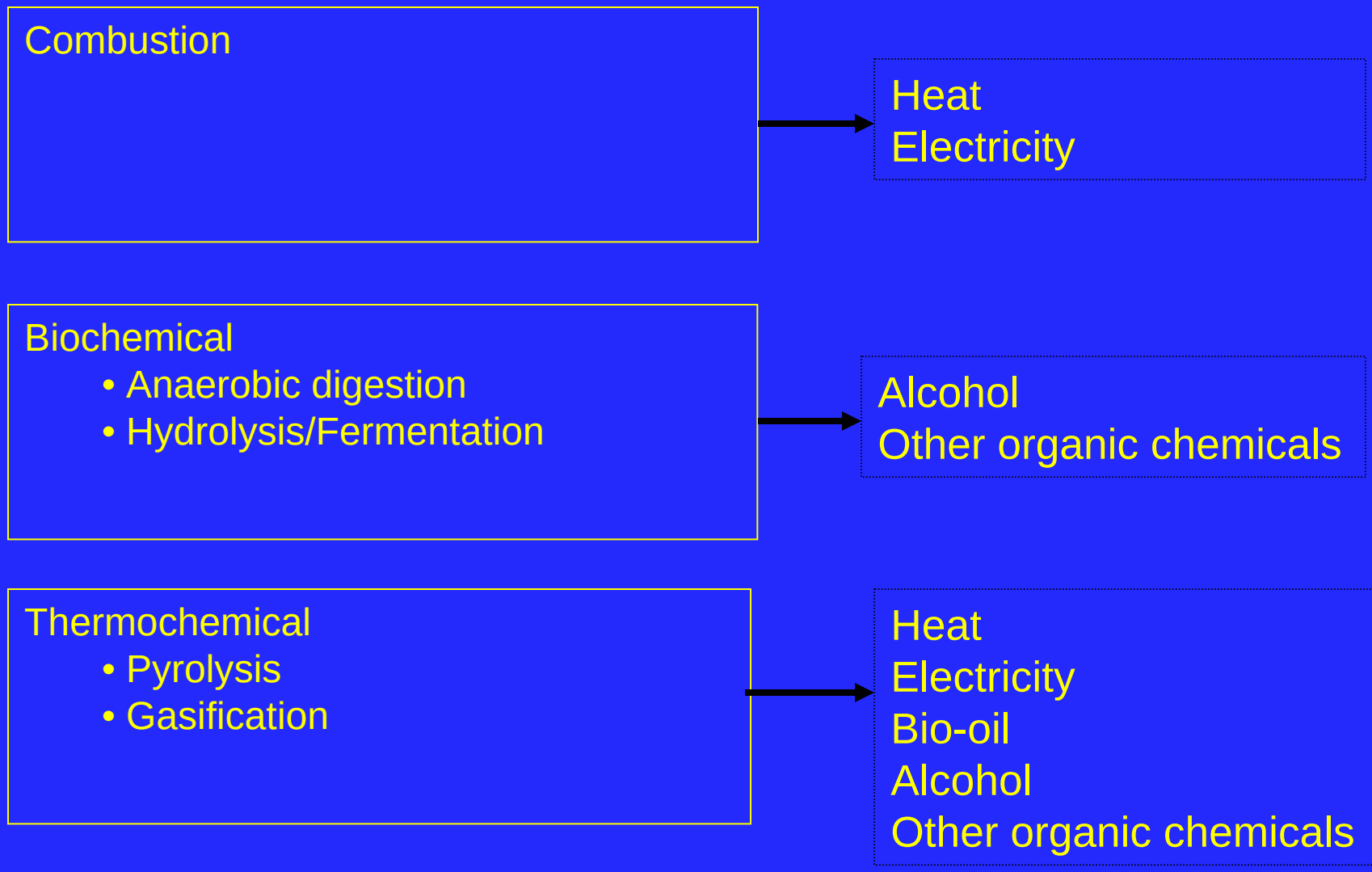
# Example of Competing Uses

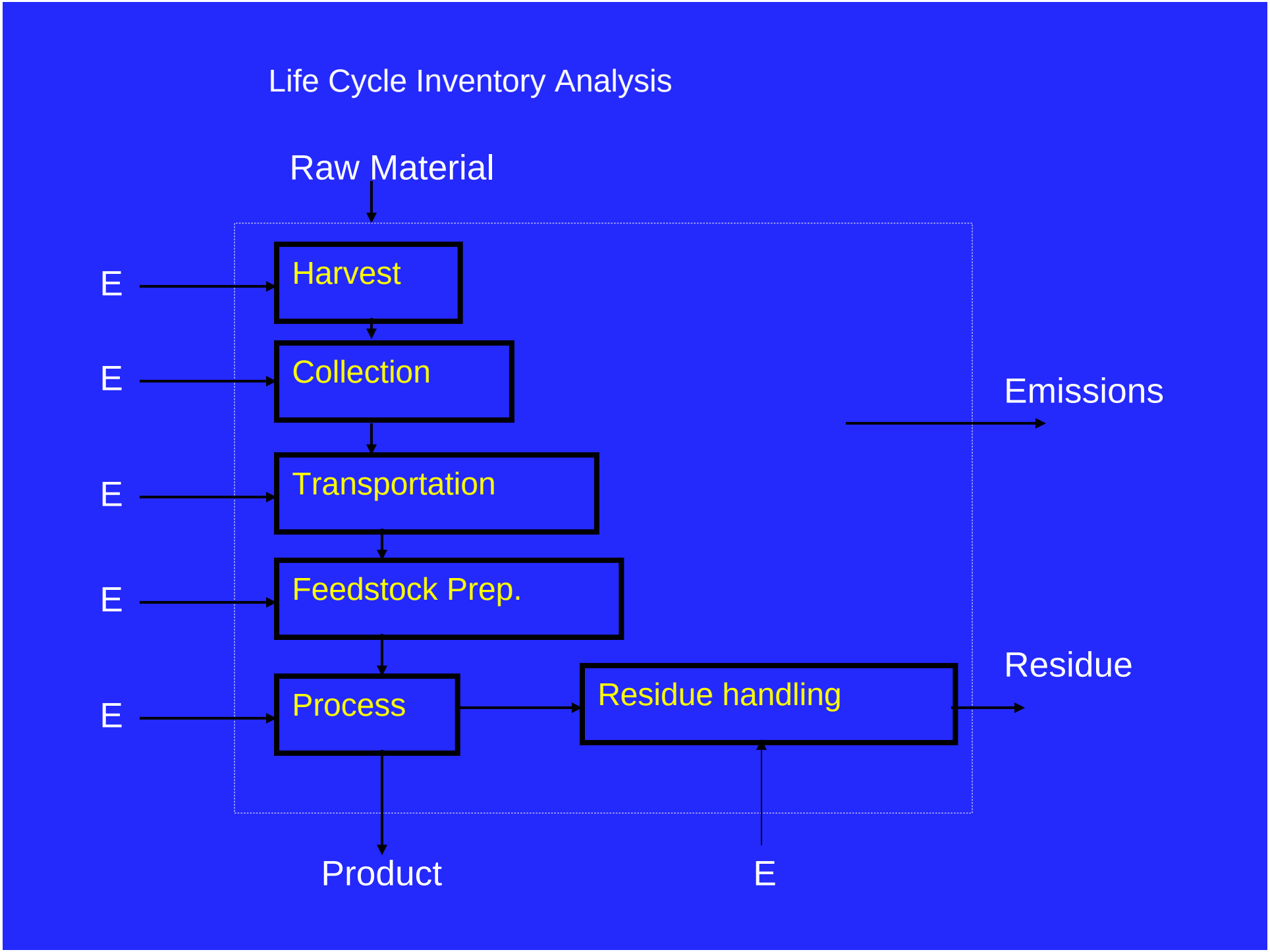

The Co-generation plant produces 8 MW of electricity and steam to operate the lumber dry kilns. The sawmill residues are more valuable for soil amendments than fuel for the boiler. The sawmill purchases lower value fuel in the biomass market.

# Define Terms

- Weight and Volume Measures
- Moisture Content
- Particle size
- Manufacturing terms
  - Co-generation
  - Combined heat and power
  - Pyrolysis
  - Gasification

# Conversion Pathways




Life Cycle Inventory Analysis
Raw Material
E
Harvest
E
Collection
Emissions
E
Transportation
E
Feedstock Prep.
E
Process
Residue handling
Residue
Product
E

# Encouraging Biomass Utilization

1. Reduce handling and processing costs
2. Improve conventional technology
3. Improve conversion efficiency
4. Develop new processes
5. Develop new products
6. Develop new markets
7. Educate public to benefits of utilization

# A Wood Scientist's Opinion

*Trees for the most part grow without intensive cultivation and are more adaptable to environmental changes than most plants. They consume $CO_2$ and produce wood – a basic building block for many products.*

*The importance of woody biomass as a raw material will increase dramatically through the 21$^{st}$ century becoming the raw material of choice for many carbon-based materials.*