

# Wood-based Energy: The United States Perspective

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# Presentation Outline

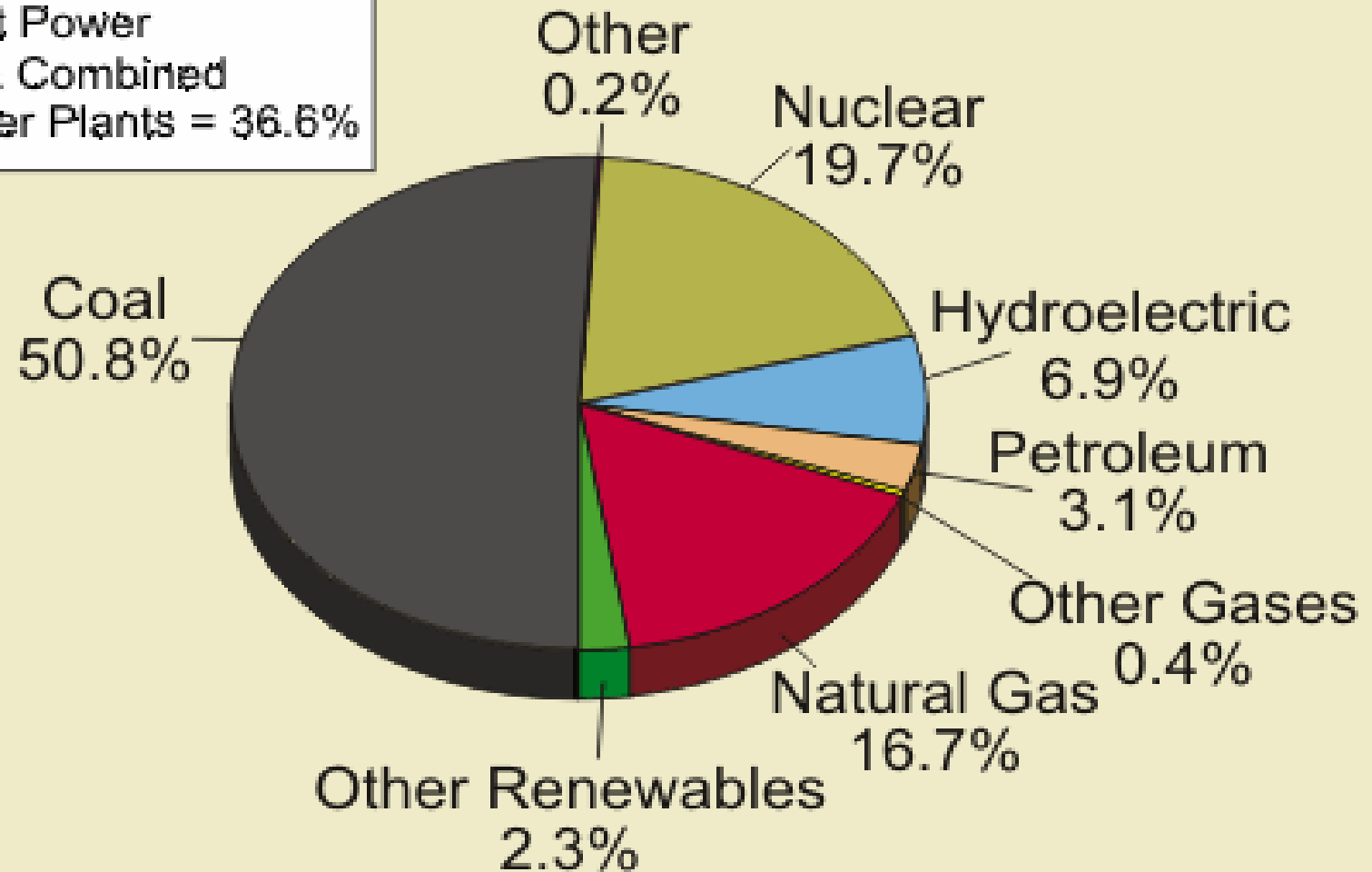
- Overview
- Wood Biomass
  - Types
  - Locations
  - Uses
- Facilities in the U.S.
- Wood Pellets
- Issues & Challenges
- Concluding Comments



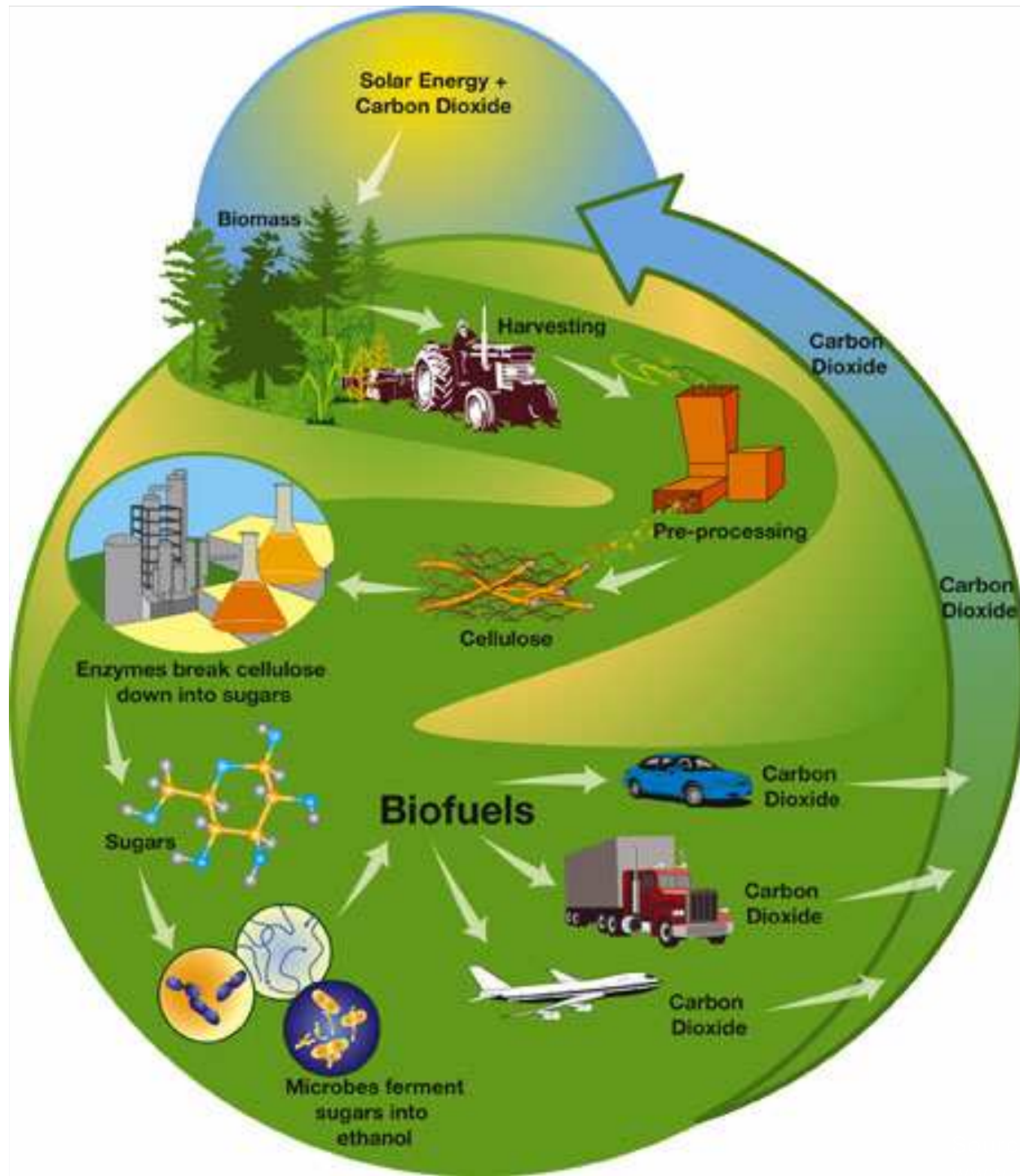
# U.S. Electric Power Industry Net Generation,

2003

Total = 3,883 Billion Kwh  
Electric Utility Plants = 63.4%  
Independent Power  
Producers & Combined  
Heat & Power Plants = 36.6%



Source: Energy Information Administration, Form EIA-906, "Power Plant Report" and EIA 920, "Combined Heat and Power Plant Report."



# Producing Electricity from Wood Using Gasification and Pyrolysis

Gasification and pyrolysis are similar processes.

Both require high temperatures and a oxygen-limited environment.

# Producing Electricity from Wood Using Gasification and Pyrolysis

## Gasification

Gasification converts biomass to combustible gases by heating it at high temperatures in an oxygen-limited environment. The resulting “synthesis” gases contain hydrogen and carbon monoxide.

Synthesis gases are mixed with oxygen and burned to heat water and produce steam to turn a turbine and create electricity.

Synthesis gases can also be used in gas turbines or converted into other fuels. Gasification of biomass removes pollutants such as ash and other particulates.

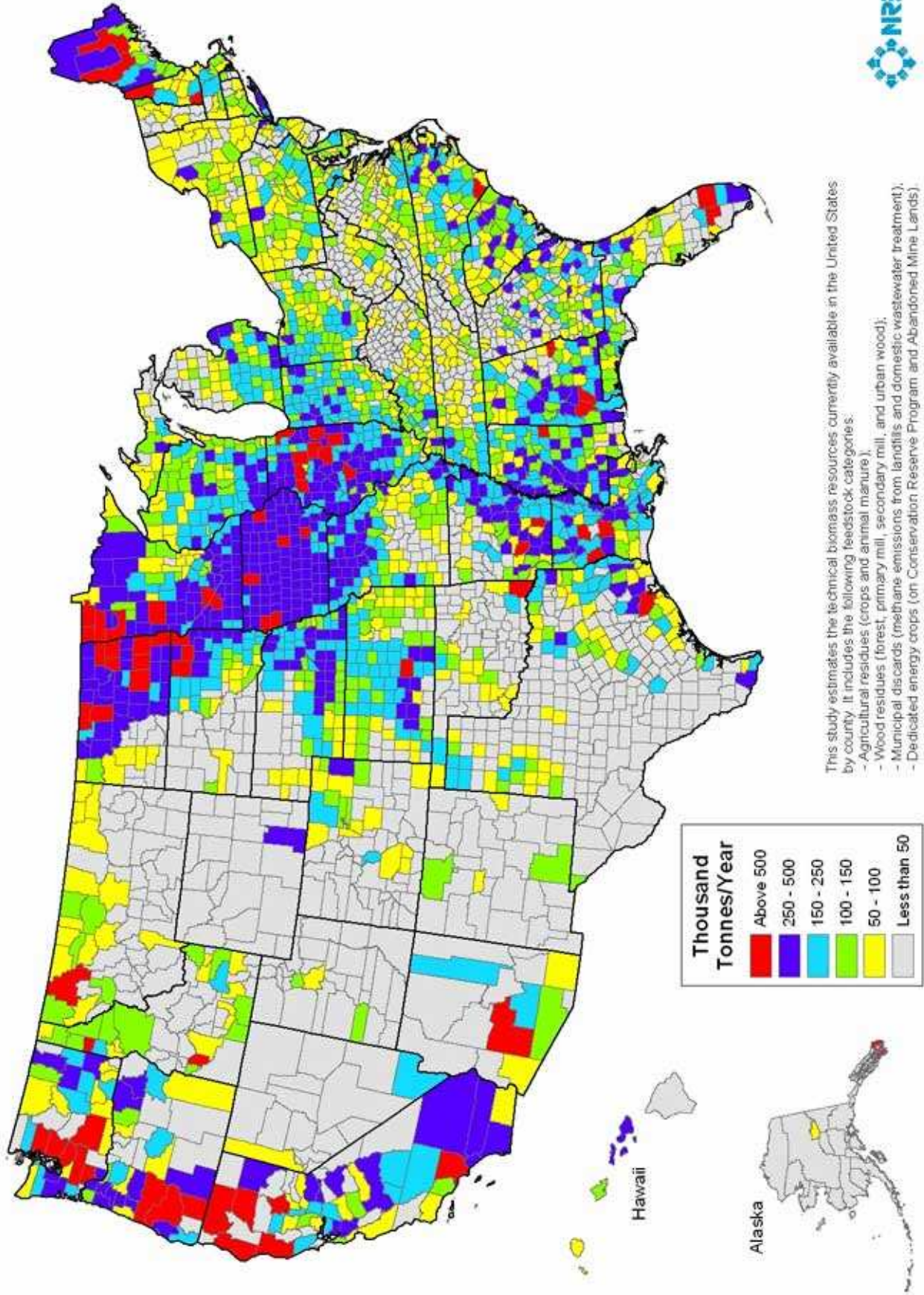
# Producing Electricity from Wood using Gasification and Pyrolysis

## Pyrolysis

Pyrolysis is used to convert biomass to a liquid. Heating biomass at extremely high temperatures (more than 1,000°F) in an environment with no oxygen produces vapors that can be condensed into a liquid called pyrolysis oil.

This oil, a renewable liquid fuel, can be stored and transported easily. It can be burned to create electricity or used to produce chemicals, plastics and other products.

# Biomass Resources Available in the United States



This study estimates the technical biomass resources currently available in the United States by county. It includes the following feedstock categories:

- Agricultural residues (crops and animal manure)
- Wood residues (forest, primary mill, secondary mill, and urban wood)
- Municipal discards (methane emissions from landfills and domestic wastewater treatment)
- Dedicated energy crops (on Conservation Reserve Program and Abandoned Mine Lands)

# Potential Biomass Resources in the U.S.

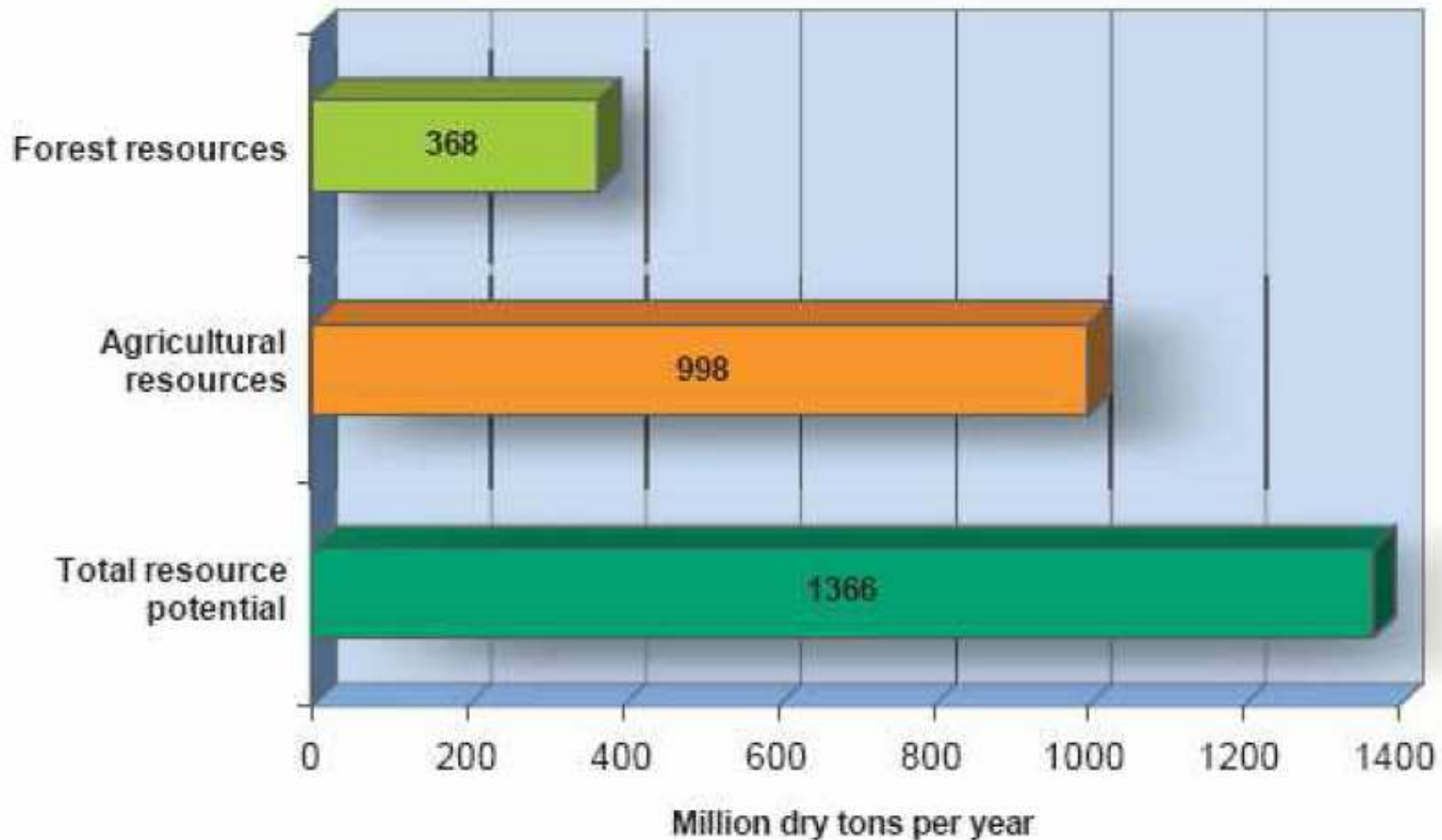


Figure 1: Annual biomass resource potential from forest and agricultural resources

## Definitions

- ◎ **Woody biomass** is defined as the by-product of management, restoration and hazardous fuel reduction treatments, including trees and woody plants (i.e., limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment).
- ◎ **Woody biomass utilization (WBU)** is defined as the harvest, sale, offer, trade, and/or use of woody biomass. This utilization results in the production of a full range of wood products, including timber, engineered lumber, paper and pulp, furniture and value-added commodities, as well as bio-energy and/or bio-based products such as plastics, ethanol and diesel.

# Wood-based Biomass Types

## Forest residues

Forest residues are logging residues and other removable material left after carrying out silviculture operations and site conversions. Logging residue comprises unused portions of trees, cut or killed by logging and left in the woods. Other removable materials are the unutilized volume of trees cut or killed during logging operations.



Source: USDA, Forest Service's Timber Product Output database, 2002

# Wood-based Biomass Types

## Primary mill residues

Primary mill residues include wood materials (coarse and fine) and bark generated at manufacturing plants (primary wood-using mills) when round wood products are processed into primary wood products, like slabs, edgings, trimmings, sawdust, veneer clippings and cores, and pulp screenings.



Source: USDA, Forest Service's Timber Product Output database, 2002.

# Wood-based Biomass Types

## Secondary mill residues

Secondary mill residues include wood scraps and sawdust from woodworking shops — furniture factories, wood container and pallet mills, and wholesale lumberyards.



Source: U.S. Census Bureau, 2002 County Business Patterns

# Wood-based Biomass Types

## Urban wood waste

Includes wood residues from wood chips and pallets, utility tree trimming and/or private tree companies, and construction and demolition sites.



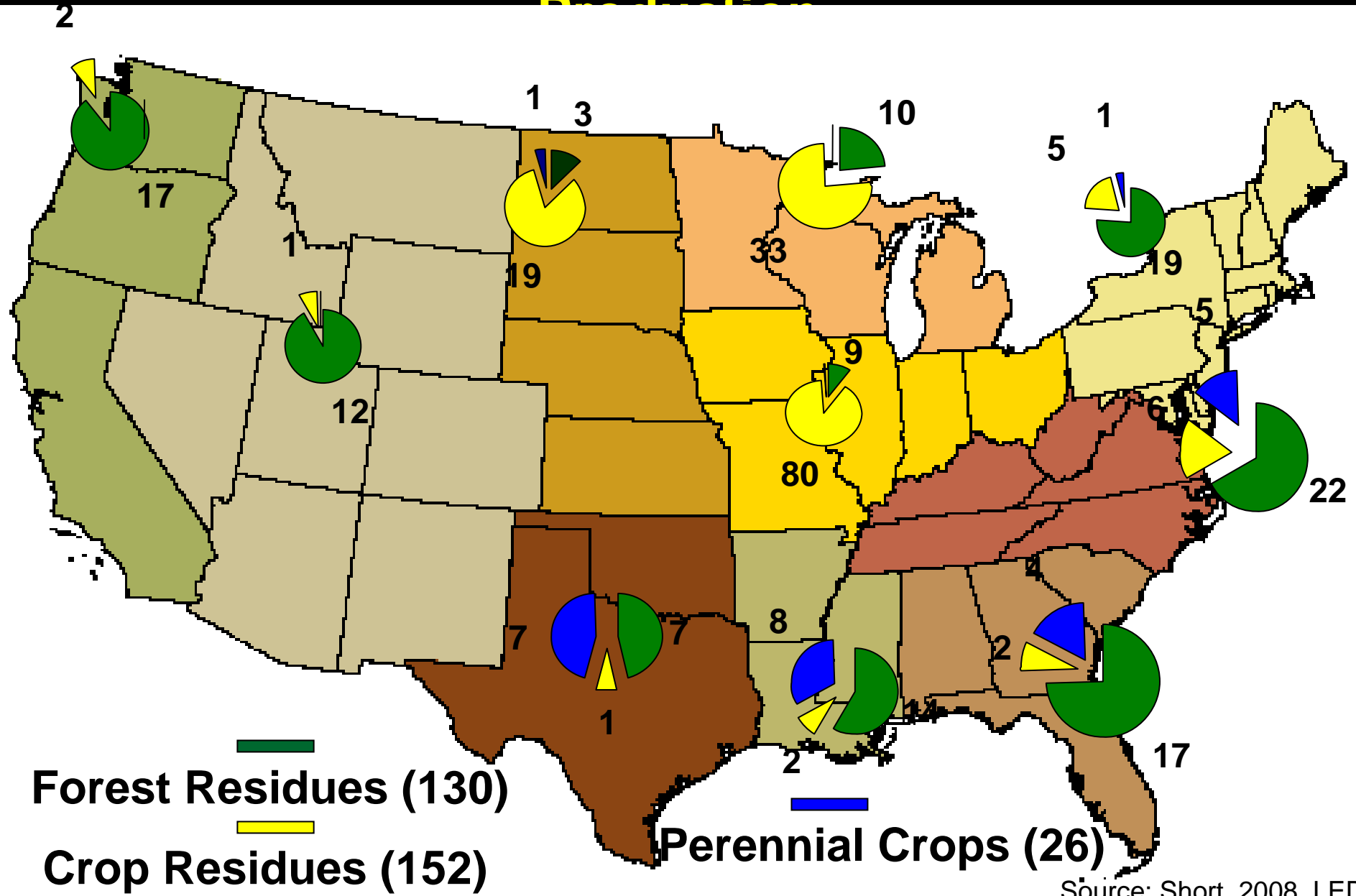
Source: U.S. Census Bureau, 2000 Population data, BioCycle Journal, State of Garbage in America, January 2004; County Business Patterns 2002.

# Forest Resource Analysis

The sustainable forest resource potential for energy is nearly 370 million dry tons annually



# Comparative Advantage in Feedstock Production

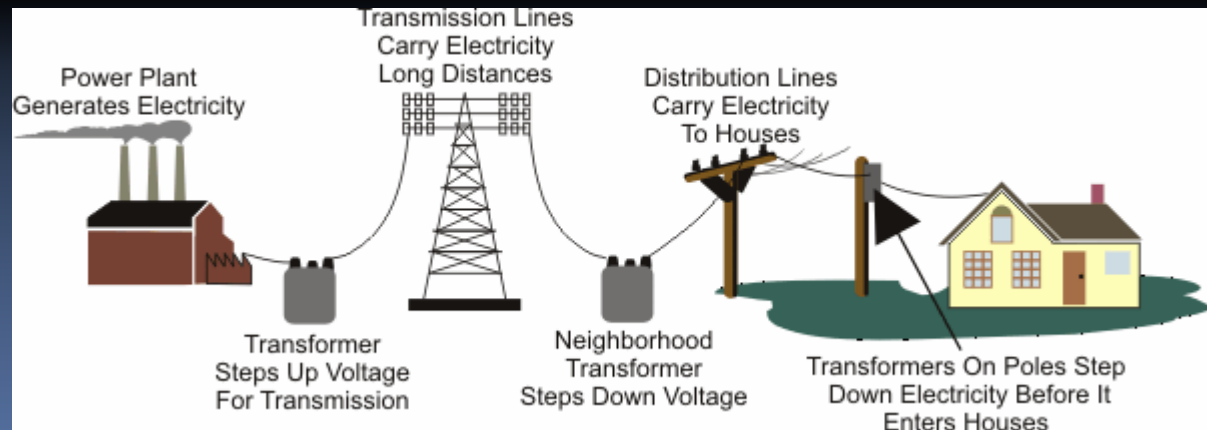


Source: Short, 2008. LED

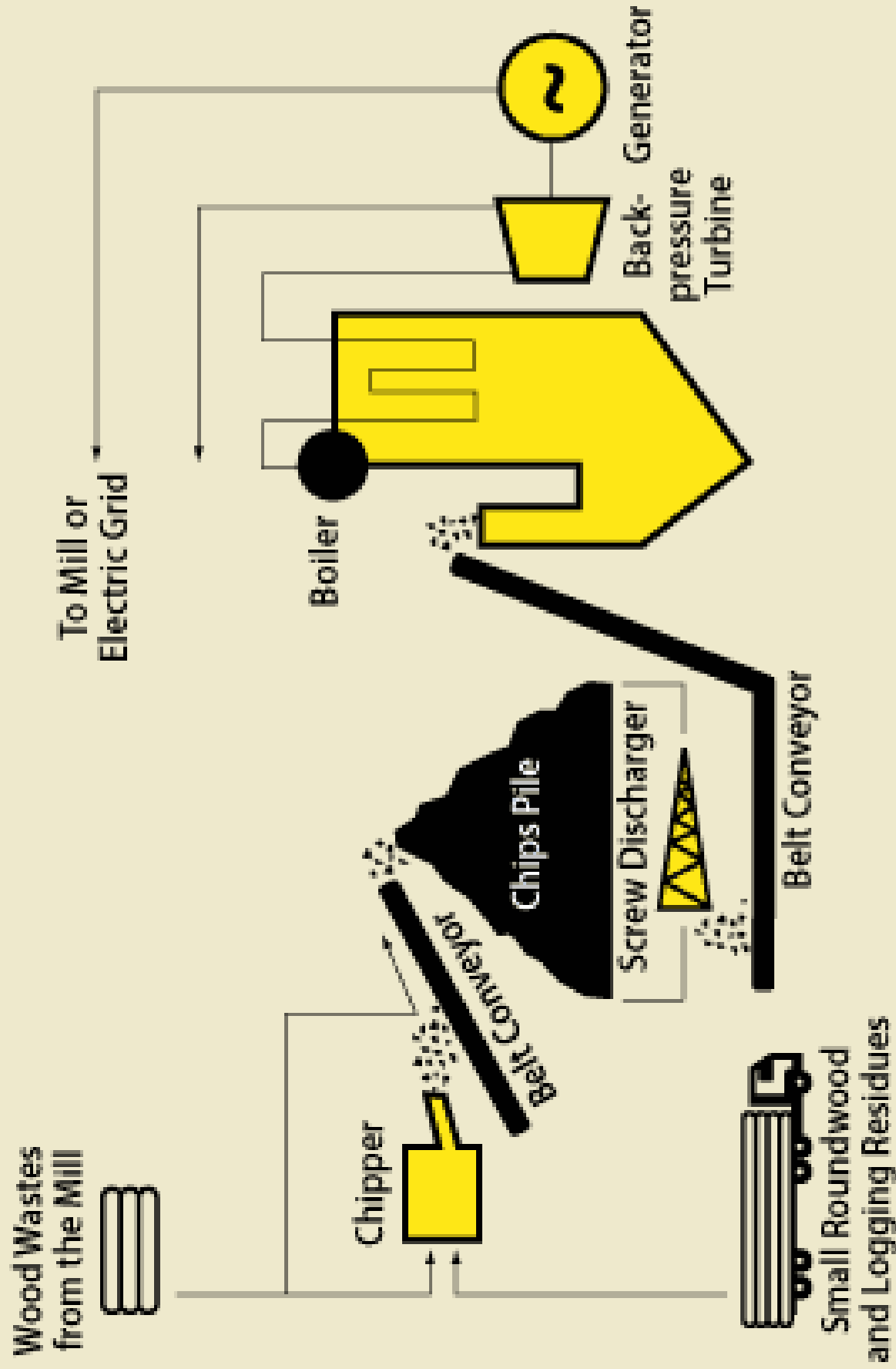
# Wood Energy in the U.S.

Wood is the most commonly used biomass fuel for heat and power in the U.S.

Local governments can encourage segregation of clean wood from other forms of municipal waste to help ensure its re-use for mulch, energy, and other markets. Using clean and segregated biomass materials for electricity generation recovers their energy value while avoiding landfill disposal.



# Electricity Production from Wood Firing



Source: Food and Agriculture Organization of the United Nations.

# Wood Potential for Electricity Generation

in the U.S.

## WBU Feedstock Potential (Millions of BDTs Annually)

- Electricity:
  - 8,500 Bone Dry Tons = One Megawatt/Hour for an entire Year of Electricity (1 MWY)
  - 368 Million BDT = 43,294 MW Years
  - One Megawatt = 1000 Households
  - 43,294 MWY = 43.3 Million Households

# **Wood Energy Facilities in the U.S.**

## Wood Energy Facilities in the U.S.

- There were 196 wood burning electricity plants in the United States as of January 2007, including 72 with 40 megawatt capacity or larger, according to the Department of Energy.
- The bulk of today's wood power comes from plants that mainly serve the onsite lumber or paper mills that supply their fuel.

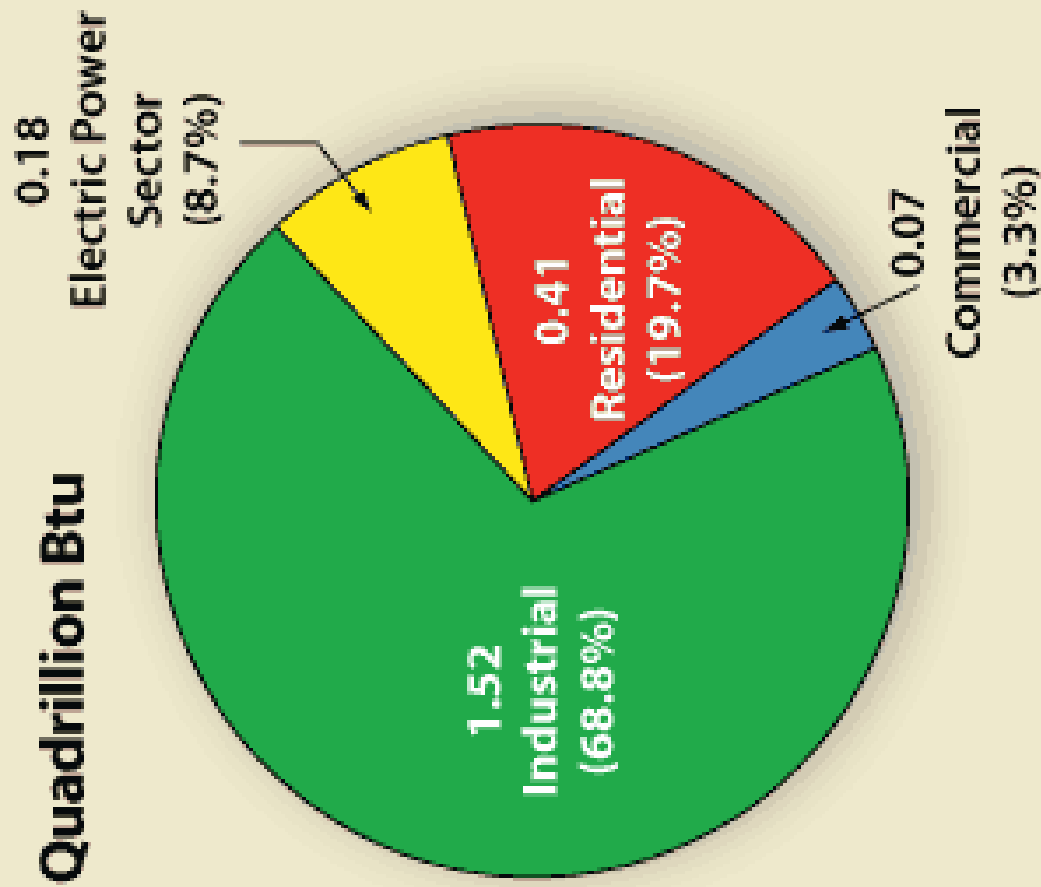
## Wood Energy Facilities in the U.S.

- Duke Energy Corp. and the French nuclear engineering company Areva announced plans to build up to 12 wood-electricity plants with roughly 50 megawatt capacity on the Eastern Seaboard in the next six years. (A one megawatt plant can supply up to 1,000 homes with power).
- At least another eight wood-burning electricity plants of 40 megawatt capacity or larger have been proposed around the country.

Source: *J. Lindsay*. Associated Press. October 9, 2008

# U.S. Wood Biomass Energy Consumption by Sector, 2006

In Quadrillion Btu



Source: U.S. Energy Information Administration.



More than 1,200 large (over 100,000 square feet) federal facilities that are within 50 miles of at least 10 sources of wood waste that could serve as a fuel supply for a biomass project.

There are more than 4,700 wood waste sources within 50 miles of these facilities. The map displays the wood waste sources that are within 50 miles of a large federal facility.

Source: Federal Energy Management Program. Fall 2003.



McNeil Generating Station, Burlington, Vermont, the country's only utility-owned and operated wood-fired power plant.



Truck unloading wood chips that will fuel the Tracy Biomass Plant, Tracy, California.



The Craven County Wood Energy Biomass plant, located near New Bern, North Carolina, is a 50 megawatt wood waste-fueled power plant. It consumes approximately 530,000 tons of wood waste each year.



This demonstration project converts wood energy to electrical power, and provides waste utilization and pollution alleviation. The 1 MW plant operates a reciprocating engine generator set on synthetic gas from a down-draft wood gasifier.



Biomass Boiler Facility - School in Darby , Montana

## Weyerhaeuser and Chevron Form Biofuels Joint Venture

- Oil company Chevron Corp and forest products maker Weyerhaeuser Co announced the launch of a joint venture to develop renewable fuels from nonfood sources *like wood*.
- The 50-50 joint venture, Catchlight Energy LLC, will research and develop technology for converting cellulose-based biomass into economical and low-carbon biofuels.
- The venture will focus on developing technology to transform *wood* and other cellulose sources into clean-burning fuels for cars and trucks.
- Ethanol from plant is produced from a variety of nonedible materials such as wood and sawdust.

## **Southeast United States**

- The southeastern United States has a vast amount of woody biomass.
- Prices for pulpwood are down and the pulp and paper industries are down. But the plants that provide those products also could be used for energy production.
- Woody biomass is a great potential for the South as a fuel source.

## Southeast United States

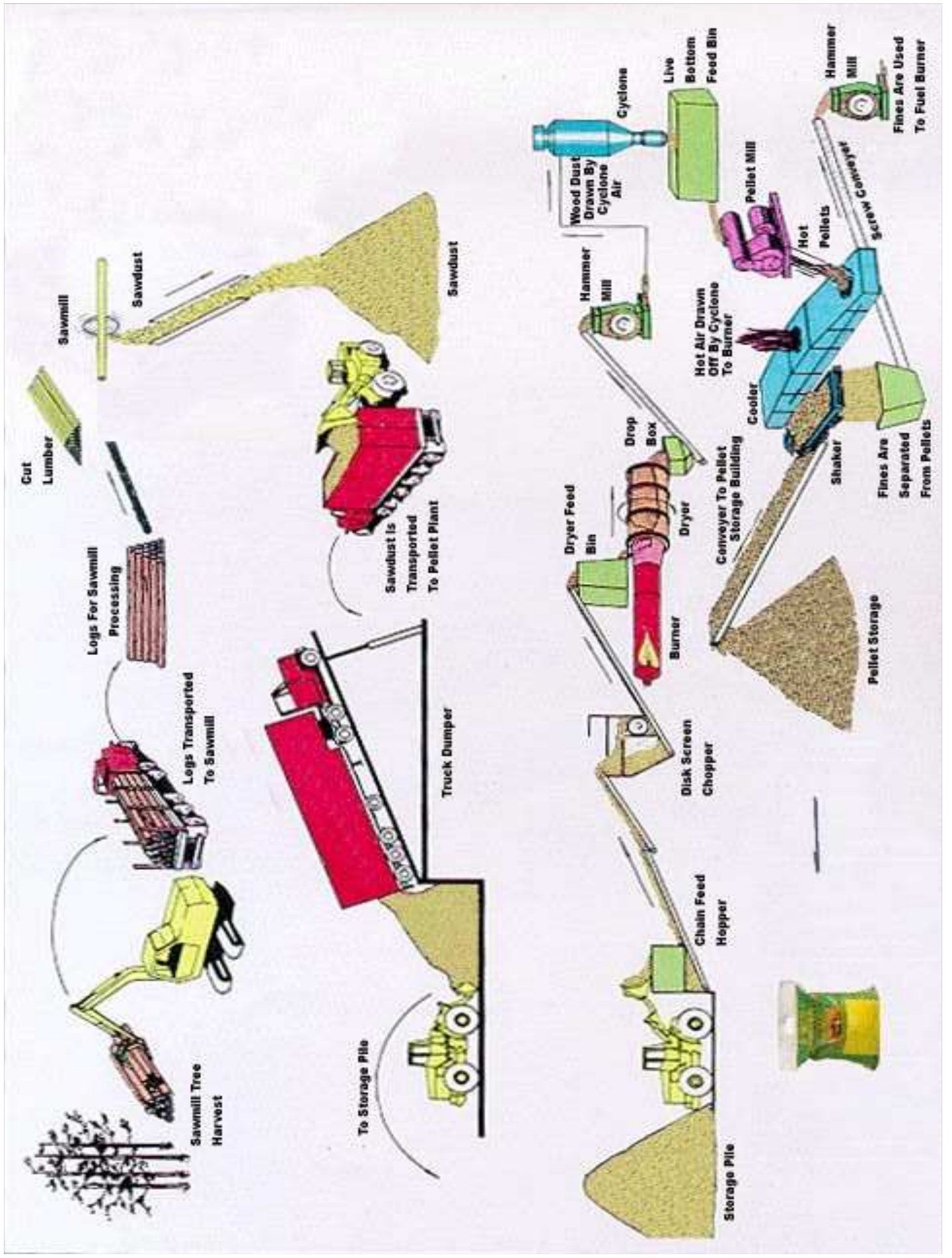
- Between 30 and 60 tons per acre of biomass are left on the ground following a typical timber harvest. This could be a valuable feedstock for a plant that produces energy.
- Marginal agricultural land that won't produce row crops profitably can grow a variety of grasses and woody plants – generally called woody biomass – for conversion into energy.

# Wood Pellets



## Wood Pellets


- Wood pellets were first engineered in the 1970s in response to an energy shortage in the U.S. and are generally manufactured from wood waste generated in saw mills, furniture manufacturing facilities, paper mills, etc. (Pellet Fuels Institute)
- High oil prices in early 2008 have nearly wiped out the inventory of wood pellets.
- Volatile oil prices prompted many users to increase the number of pellets they burned at the same time the number of new stoves were sold increased.



# Grades of Pellets

Pellet mills produce two grades of fuel – Premium and Standard. The only difference between the two is ash content. Standard grade fuel is usually up to 3% ash content, while premium grade is less than 1 percent. This difference is a result of the pellet contents.

member of



**Pellet Fuels Institute**  
www.pelletheat.org  
MANUFACTURER'S  
**GUARANTEED ANALYSIS**

<b>Grade:</b>	
<b>Material:</b>	
<b>Ash:</b>	
<b>Fines:</b>	
<b>Sodium:</b>	

Source: Pellet Fuels Institute

## Grades of Pellets

This difference is a result of the pellet contents. Standard pellets are derived from materials that produce more residual ash, such as tree bark or agricultural residues.

Premium pellets are usually produced from hardwood or softwood sawdust containing no tree bark. Premium pellets make up 95 percent of current pellet production and can be burned in all appliances.

Standard pellets should only be burned in appliances designed to burn the higher ash content pellets.

## Wood Pellets

- The last time there was a shortage, in 2005, supplies became tight mid-winter. This year, shortages started in August.
- The pellet industry can't react within a matter of months to meet the increased demand, but new manufacturers are expected to come on line next year.
- Dropping fuel oil prices also will ease the pressure.
- The public forgets about the alternatives when oil gets cheap.
- The driving force is price.
- The U.S. is a convenience-driven society.

Source: M. Ellen. Watertown Daily Times. October 25, 2008

## Wood Pellets

- The shortage has caused pellet prices to surge. Pellets sold out of a plant in upstate New York were at \$250 per ton, but the retail average is \$260 to \$300 per ton.
- A typical household using pellets for all of its heat might use four to six tons a year.
- Even though the escalated price of pellets is still less expensive than heating with fuel oil, there is a law of diminishing returns.

Source: M. Ellen. Watertown Daily Times. October 25, 2008

# Issues & Challenges

# 25x'25

- **25x'25 Vision:** By 2025, America's farms, forests and ranches will provide 25 percent of the total energy consumed in the United States.
- The measure expresses the sense of the Congress that "it is the goal of the United States that no later than January 1, 2025, the agricultural, forestry and working land of the United States should provide from renewable resources not less than 25 percent of the total energy consumed in the United States and continue to produce safe, abundant and affordable food, feed and fiber."

# Pulp & Paper Industry – A Driver for Bioenergy?

- Some suggest that the pulp and paper industry is uniquely positioned to immediately produce significant amounts of biofuels, bioenergy and bioproducts.
- With a mature, operating infrastructure capable of delivering double-digit billions of gallons of biofuels annually, generally without adding any new fiber processing capacity, many pulp and paper mills around the world are only a one-step investment away from becoming major renewable energy producers.
- Especially important, paper industry capacity that can be re-aligned and re-purposed toward bioenergy co-production would be 100% cellulosic feedstock based, with no agricultural attachments at all.

# Wood Energy Facility Subsidies

- Wood energy projects benefit from federal subsidies that developers say are essential. New mandates in many states to increase renewable power use has led to additional incentives.
- In Massachusetts, for instance, renewable energy must make up 15 percent of the state's electricity supply by 2020, compared with 3.5 percent now. To encourage growth, power plants get a market-based premium for producing renewable energy, currently about \$50 per megawatt hour.

## Issues & Challenges

- The Emerging Biomass Industry: Impact on Woodfiber Markets -- published by RISI, found that federal and state mandates, if fully implemented, would lead to over-harvesting of forests in the United States and are therefore unrealistic.
- Bioenergy projects will certainly boost the demand for woodfiber, but RISI does not see that demand reaching the levels implied by current policy goals.
- While there is clearly a lot of interest in wood-based bioenergy right now, growth for this new industry will be constrained by sustainable harvest levels as well as woodfiber prices.

## Issues & Challenges

- One of the issues facing the industry is that moving biomass more than 50 miles to a processing facility could take a major bite out of profits.
- It takes 12 cents per ton mile (or more) to move wood biomass around. Moving the procurement circle to 100 miles, adding 50 miles of freight costs, add \$6+ on a green weight basis to the cost of your biofuel.
- For a 1 million ton per year facility, that's at least \$6 million added to raw material costs.
- Increasing the distance also makes supplying a biomass plant less attractive to the timber producer.

Source: J. Kram. 2008. Biomass Magazine.

# Issues & Challenges

- Emerging biomass markets will significantly strengthen demand for wood fiber in the South, driving prices higher for forest products as the United States turns to alternative fuels for energy, according to a study released Monday by Forest2Market.
- The new demand will be fueled by wood-burning power companies that produce and sell electricity to public utilities, as well as an increasing amount of wood pellets that are exported to European energy markets.
- The development of new facilities that turn biomass into cellulosic ethanol for transportation fuel will also impact the forest products industry.

# Issues & Challenges

- As a result, demand for wood fiber from these emerging markets is expected to climb from 2 million tons in 2008 to at least 13.5 million tons in 2020, according to Forest2Market, a provider of pricing information and analysis for forest products.
- However, the estimate is conservative, and it could be adjusted higher as more companies announce plans to build biomass facilities.

## Issues & Challenges

- Wood has far less stored energy than fossil fuels and coal, so more must be gathered, trucked and burned to produce the same power. Higher transportation costs mean wood plants must gather their fuel nearby, limiting where plants can be located.
- The issue of carbon neutrality is also a point of contention. Opponents say the carbon given off when wood is burned isn't quickly offset by carbon absorbed when a tree grows. Susan Reid of the Conservation Law Foundation sees promise in wood, but warns increasing demand could push the limits of how much wood can be used before forests are damaged.

Source: *J. Lindsay*. Associated Press. October 9, 2008

# Issues & Challenges

- A new entrant into biomass processing might not be aware of the seasonality of wood harvesting.
- In Southern forests, there are periods during the spring when timber harvesting ceases due to wet conditions.
- In the West, harvesting often ceases in the winter due to snow.

**Economics**



**Alternatives**



**Market Demand**

**Environmental Issues**



## Conclusions/Discussion

- Development of the wood energy sector is growing in the U.S.
- Facility investors are opportunistic and are seeking competitive advantage.
- Demand for wood biomass inputs is expected to increase wood biomass/chip prices.
- Subsidies and other policy instruments create an uneven playing field.
- There are many issues and challenges that need to be taken into account in the wood energy arena.
- The wood energy industry trajectory is uncertain in light of current economic conditions and availability of capital in the U.S.

# Questions

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