

Fuels, Fiber and Energy

***An Opportunity for the Forested
Southeastern States***

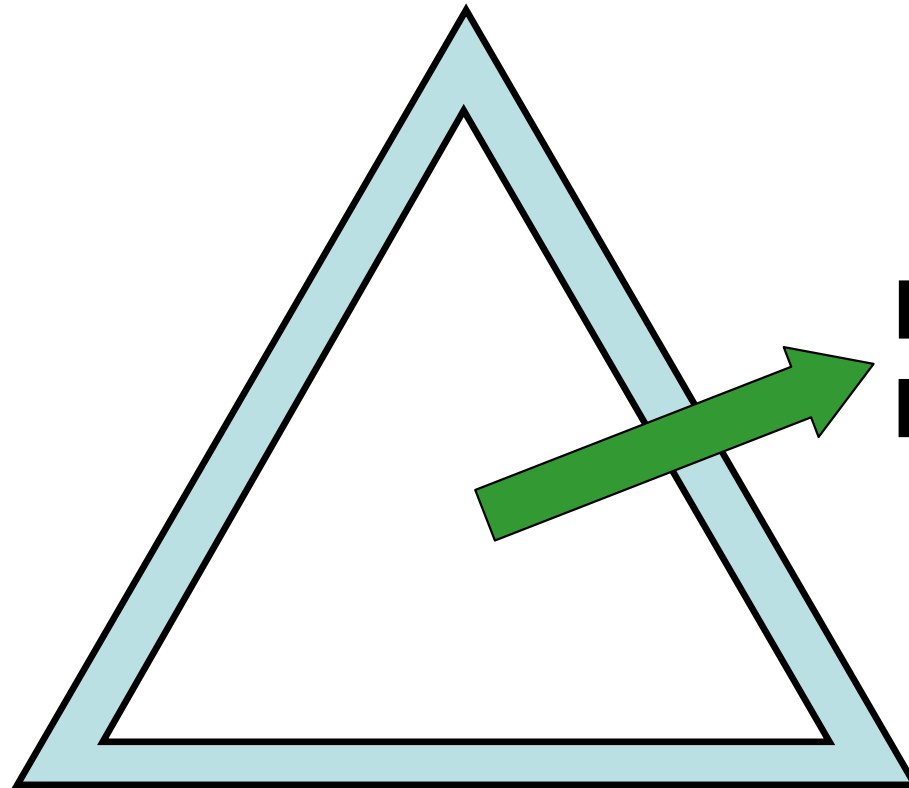
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Integrated Concept

Energy Industry



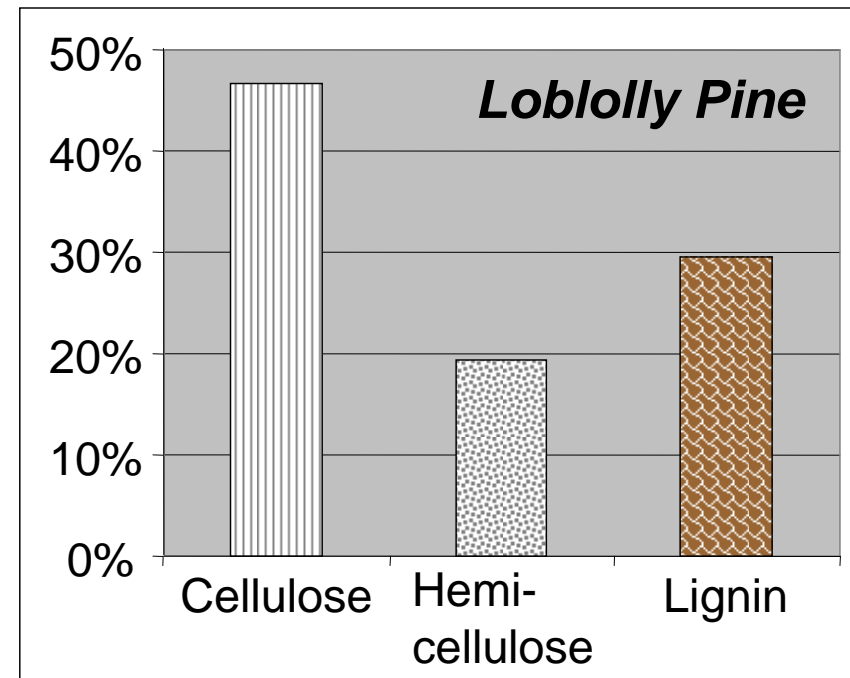
**Liquid fuels
Power**

Forest Industry

Agriculture Industry

Biomass in the southeastern U.S. is predominantly wood

- Georgia's forest biomass: 39 million tons/yr
 - Available today
 - Sustainable
- Energy content
 - 686 TJ/yr
 - 22 GW_{th}
 - Could yield 5.2 billion gallons of fuel-grade ethanol per year
- Similar in other SE states



Woody Biomass: Georgia's Energy Resource

	Georgia ^a	USA ^b
Unmerchantable timber	34%	35%
Harvesting residues Available	14%	13%
Urban waste	0.2%	13%
Mill residues	21%	19%
Black liquor Under-utilized	31%	20%
Amount available, million t/yr	39	368

^a Source: Biomass Wood Resource Assessment on a County-by-County Basis for the State of Georgia. Report to the Georgia Forestry Commission and the Southern States Energy Board by General*Bioenergy, Inc., Florence, AL (Nov, 2005).

^b Perlack et al., Biomass as Feedstock for a Bioproducts and Bioenergy Industry: The Technical Feasibility of a Billion-Ton Annual Supply. ORNL, (2005).

Availability of un- or underutilized woody biomass in Georgia and the U.S.

Source	Biomass, million dry tonne/yr		Ethanol product, million gal/yr	
	Georgia	U.S.	Georgia	U.S.
Umerchantable timber	13.3	77.3	1,110	6,468
Harvesting residues	5.3	47.8	445	4,004
Fuel wood		51.5	0	4,312
Urban waste	0.1	47.8	7	4,004
Subtotal	18.7	224.4	1562	18,788
Mill residues & sludge	8.4	69.9	700	5,852
Black liquor	12.1	73.6	1,010	6,160
Total	39.1	368.0	3,272	30,802

Contributions of Partner Industries

The Forest Products Industry

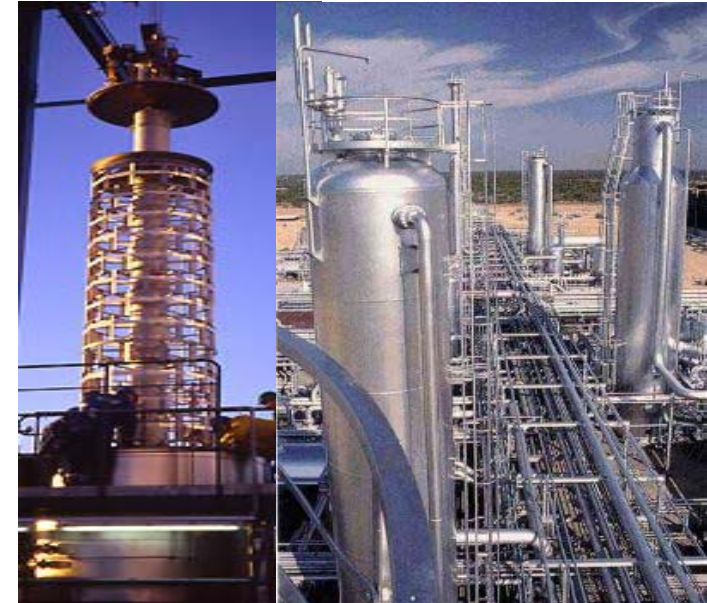
- Wood harvesting expertise
- Wood handling and comminution expertise
- A ***non-seasonal*** feedstock supply

The Agriculture Industry

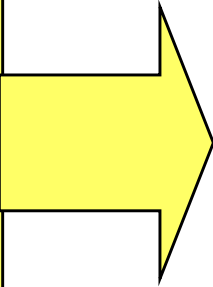
- Lignocellulosic crop and residue production
- Biomass harvesting and handling expertise
- A ***seasonal*** feedstock supply
- Bioprocessing expertise (ethanol, etc.)

The Energy Industry

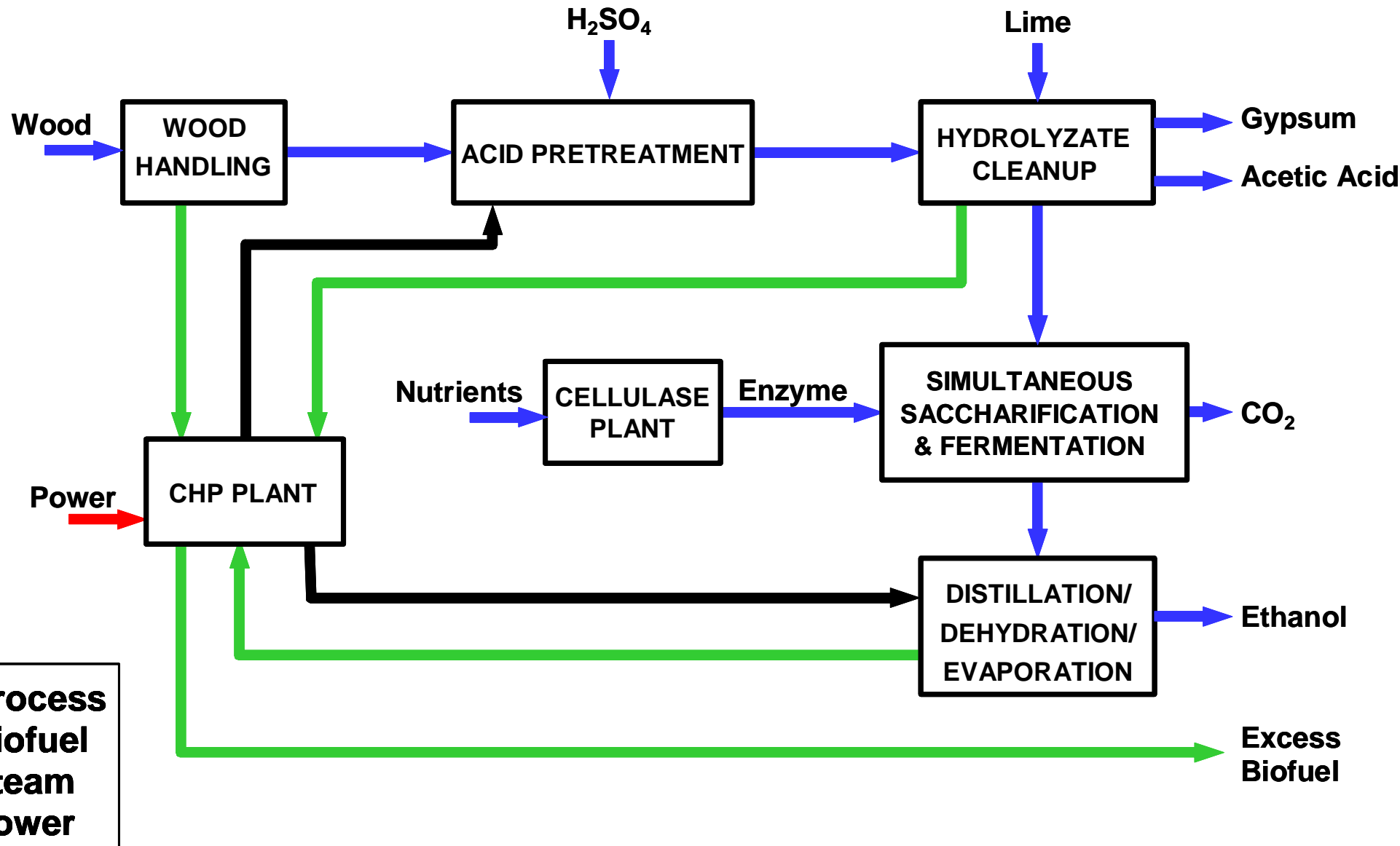
- Thermochemical route to liquid fuels:
processing, conditioning, conversion
- Blending & distribution



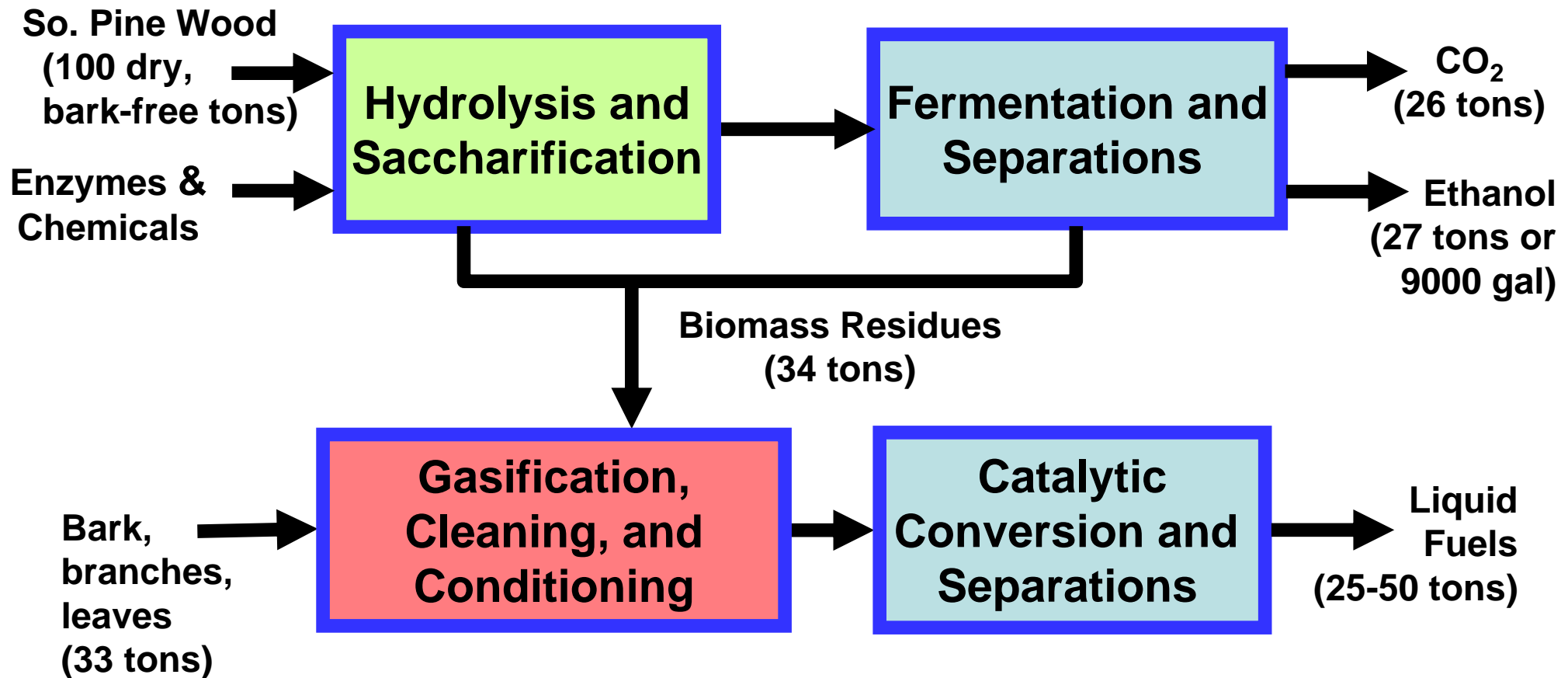
Chemical constituents of Loblolly Pine

Cellulose	43.6%		Ethanol and/or Fiber
Hemicelluloses			
Mannan	10.8%		
Galactan	2.2%		
Xylan	6.6%		
Arabinan	1.6%		
Acetal	1.1%		
Uronic anhydride	3.7%		
Lignin	26.8%		
Extractives	3.2%		
Ash	0.4%		
Total	100.0%		

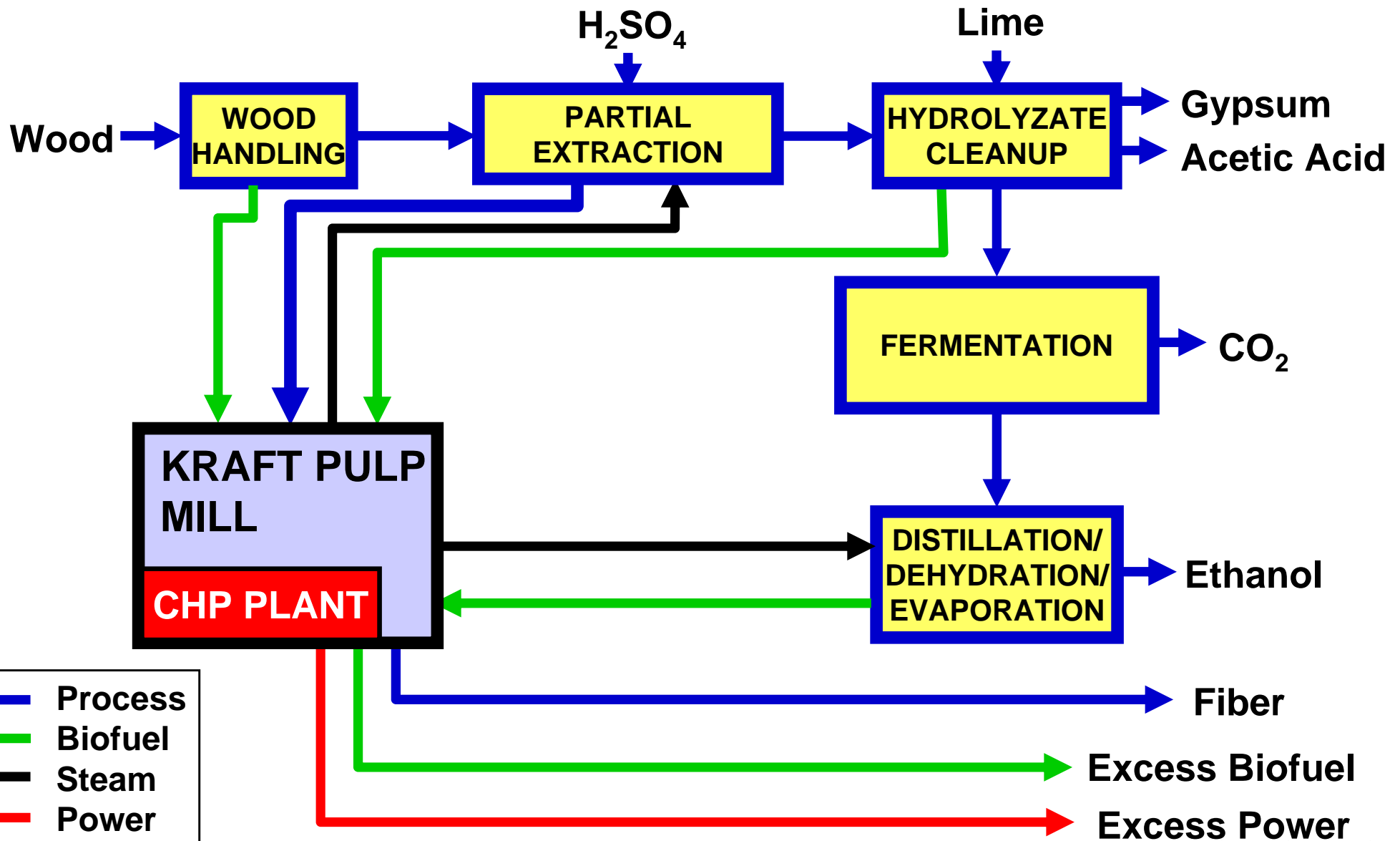
Ethanol from Loblolly Pine Carbohydrates

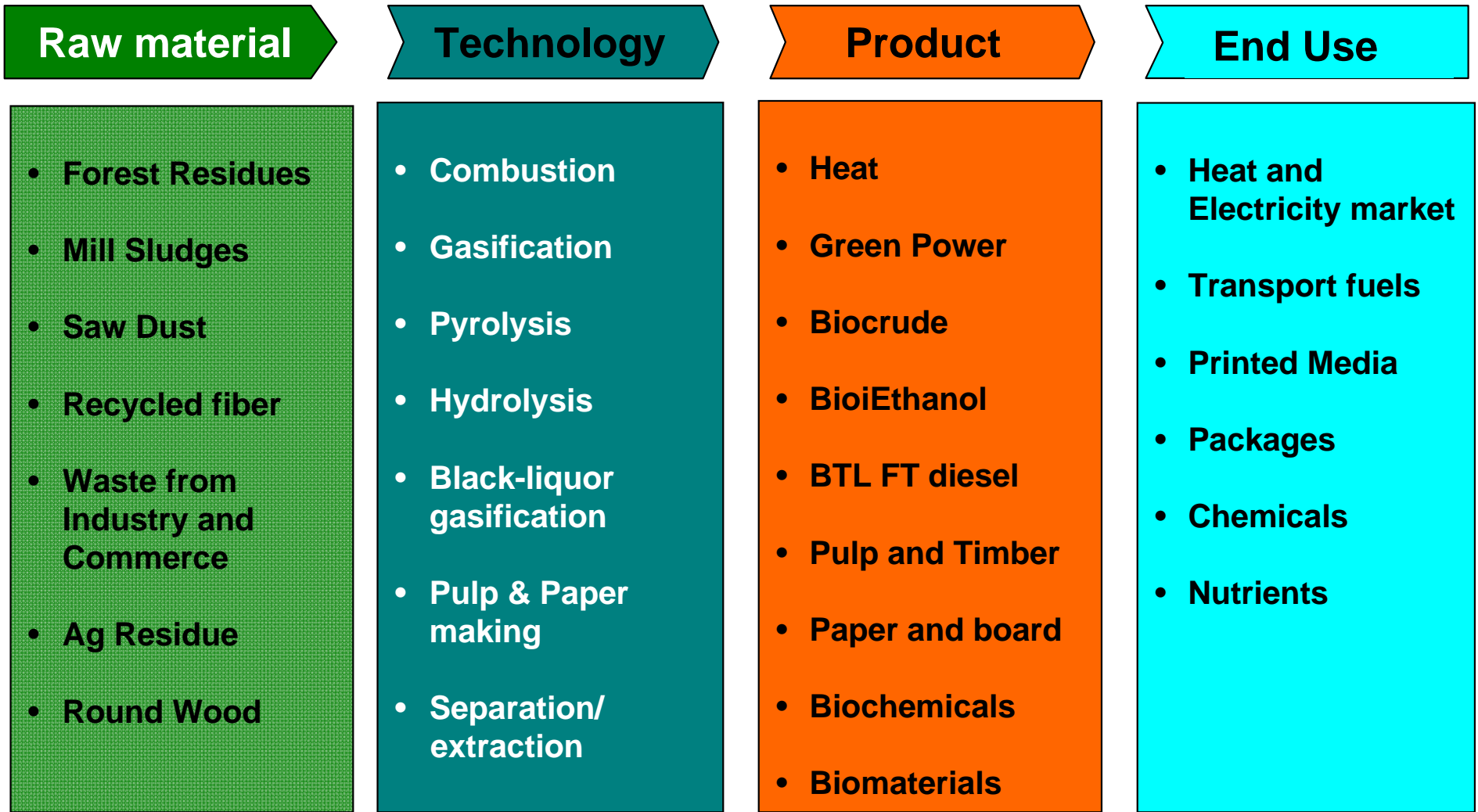


Integrated Fuels and Fiber Production



Ethanol + Fiber from Loblolly Pine Carbohydrates





Process integration and value chain optimization

Conclusions

- Ethanol can be produced competitively from loblolly pine
- Co-production of ethanol and fiber may be competitive
- Competitiveness will increase as extraction and fermentation technologies for wood carbohydrates improve