American Science and Technology

A Foundation for Future Energy

Chemicals and Low Cost Sugar from Lignocellulosic Materials

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Company Profile

- American Science and Technology (AST), founded in 2003, provides common sense scientific, technological, and manufacturing solutions to its potential customers.

- AST is a full service scientific and engineering company specialized in research development, deployment, and commercialization of Advanced Technologies and Products

- Our major strength is our working relations with various domestic universities and research institutions,

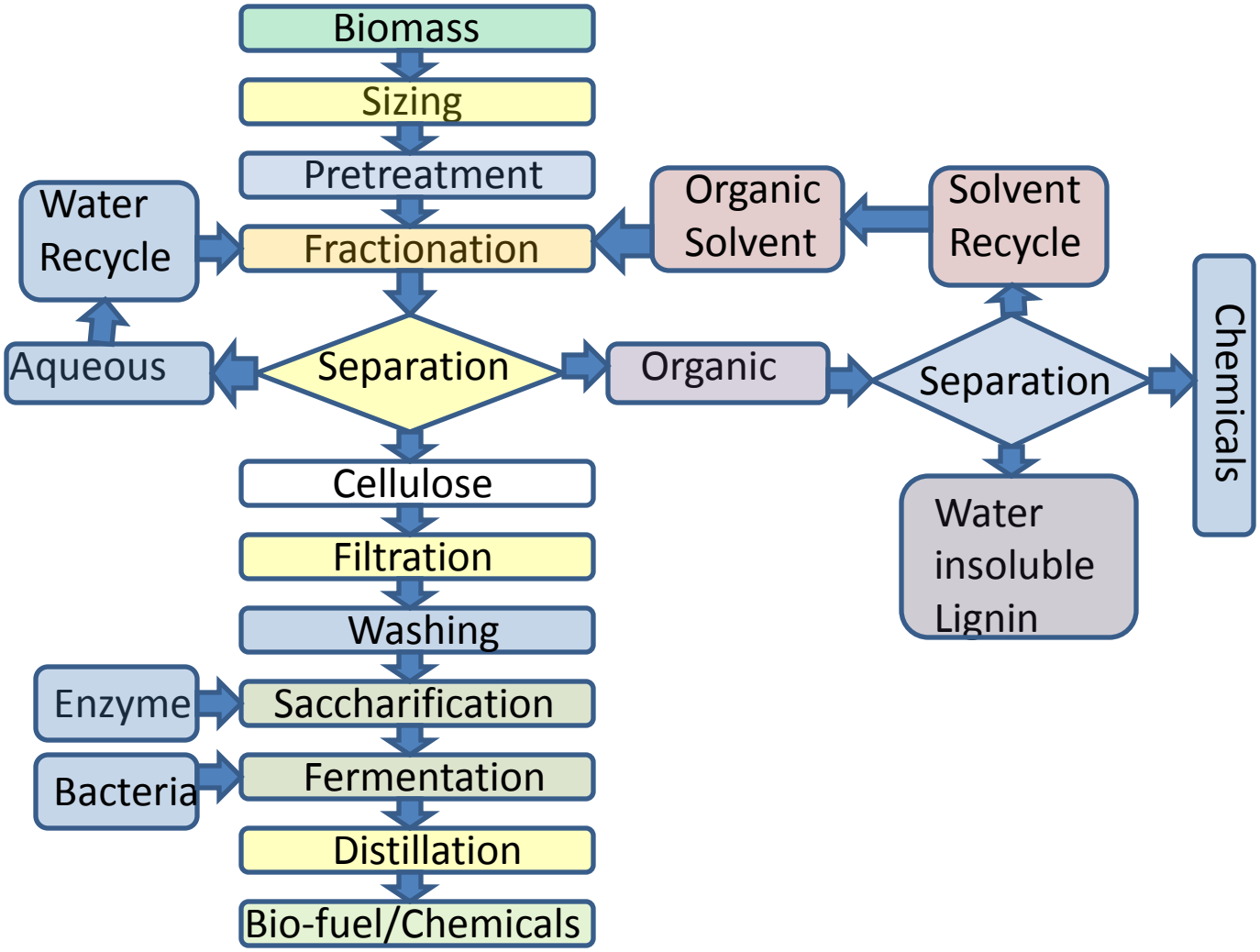
- AST's headquarter is in Chicago IL, manufacturing facilities are located in Wausau WI, and R&D labs in Charleston WV, and Brookings SD.


AST Bio- Refinery Manufacturing, Wausau, WI


AST Charleston WV

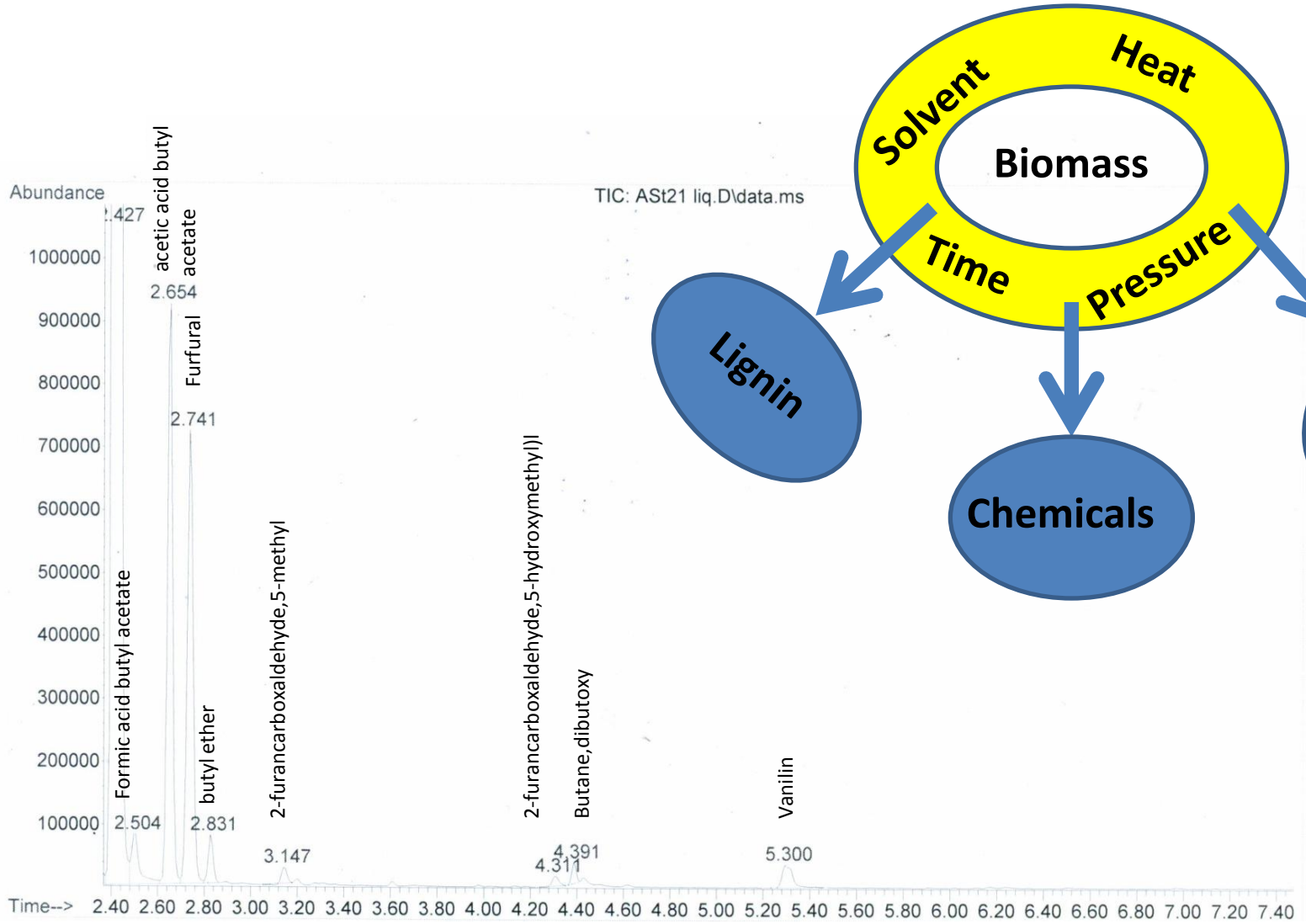

AST Brookings, SD

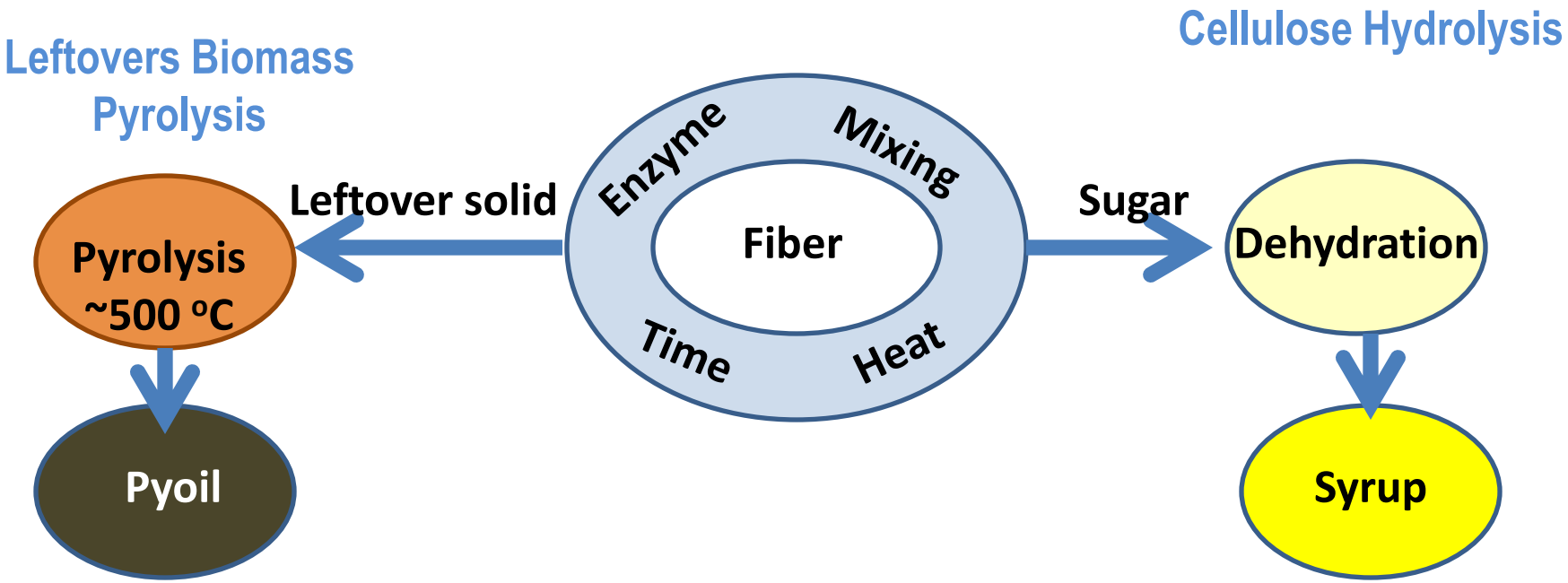
Our Biomass Conversion Processes



Process Flow Diagram, Organosolv Based Cellulosic Bio-Fuel

Typical GC results shows some of our Core Products





Typical Zero Leftover policy

AST's Pilot bio-Refinery uses Patented Process For Biomass Conversion

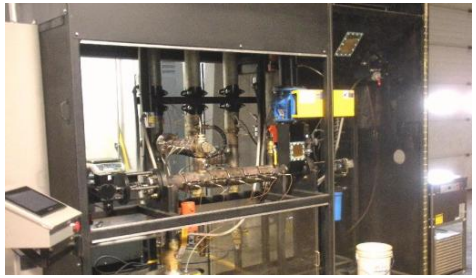
Our Pilot Equipment include following:

Wood Chip Digester

Hydrolysis

Fermenter

Fast pyrolysis



Product Separation systems and Various recovery systems

AST's complete Integrated Bio Refinery Pilot Plant

Pretreatment

Fiber

Sugar

Biofuels & Chemicals

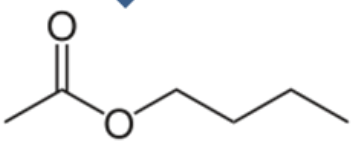
Upgraded Bio Oil

High quality lignin

Chemicals Solvent

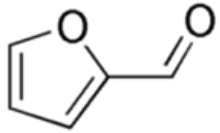
Our Core Products

Biomass



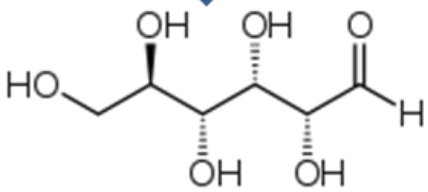
Butyl acetate

- synthetic fruit flavoring

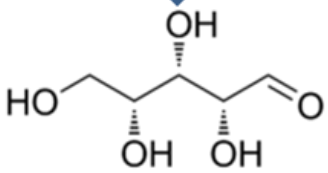


Furfural

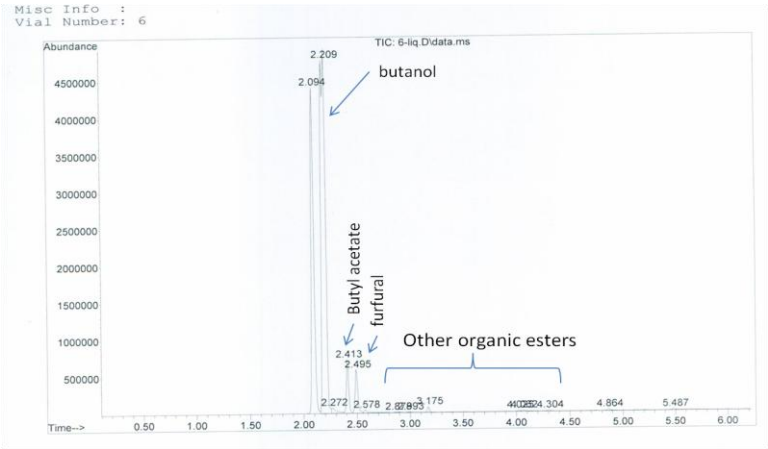
- chemical intermediate
- solvent

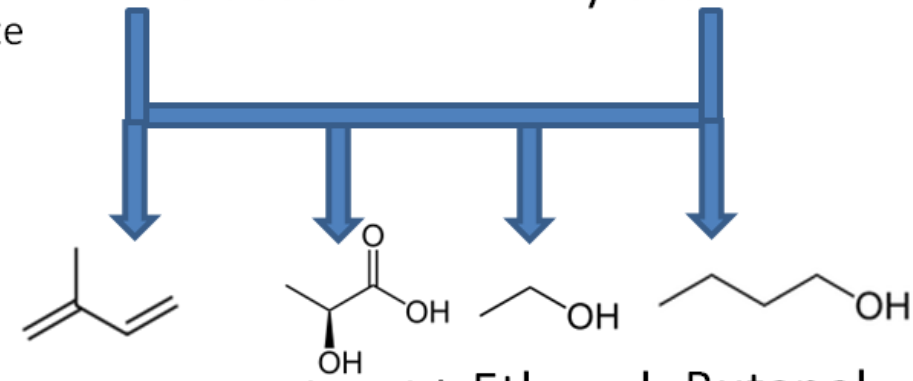


Glucose



Xylose





Isoprene

- Synthetic rubber

Lactic acid

- Polymer
- Biodegradable plastic

Ethanol

- Fuel

Butanol

- Fuel

Table 4: Annual operating costs for producing 119.1 million kg/year of ethanol 262.6 million lbs million gallons			
Raw Materials	US$/year		
Corn	$31,024,000.00		
Denaturant	$1,038,000.00		
Enzymes	$2,016,000.00		
Yeast	$477,000.00		
Other	$496,000.00		
Utilities			
Electricity	$1,063,000.00		
Steam	$5,054,000.00		
Natural gas	$3,222,000.00		
Cooling water	$922,000.00		
Labor & Supplies			
Plant operations	$1,037,000.00		
Maintenance	$1,315,000.00		
Insurance & Admin	$722,000.00		
Depreciation	$4,664,000.00		
Subtotal	$53,050,000.00		
Coproduct credit	-$11,742,000.00		
Net annua production cost	$41,308,000.00		

Source: Jason R. Kwiatkowski ∗, Andrew J. McAloon, Frank Taylor, David B. Johnston

Table 4: Annual operating costs for producing 119.1 million kg/year of ethanol 262.6 million lbs million gallons			
Raw Materials	US$/year	% of cost	US$/lb
Corn	$31,024,000.00	58.48%	$0.1181
Denaturant	$1,038,000.00	1.96%	$0.0040
Enzymes	$2,016,000.00	3.80%	$0.0077
Yeast	$477,000.00	0.90%	$0.0018
Other	$496,000.00	0.93%	$0.0019
Utilities			
Electricity	$1,063,000.00	2.00%	$0.0040
Steam	$5,054,000.00	9.53%	$0.0192
Natural gas	$3,222,000.00	6.07%	$0.0123
Cooling water	$922,000.00	1.74%	$0.0035
Labor & Supplies			
Plant operations	$1,037,000.00	1.95%	$0.0039
Maintenance	$1,315,000.00	2.48%	$0.0050
Insurance & Admin	$722,000.00	1.36%	$0.0027
Depreciation	$4,664,000.00	8.79%	$0.0178
Subtotal	$53,050,000.00		$0.2020
Coproduct credit	-$11,742,000.00		-$0.0447
Net annua production cost	$41,308,000.00		$0.1573

Corn verses cellulosic biomass			
Raw Materials	**Fiber US $/lb**		**Corn US$/lb**
Corn			$0.1181
Denaturant			$0.0040
Enzymes			$0.0077
Yeast			$0.0018
Other			$0.0019
Utilities			
Electricity			$0.0040
Steam			$0.0192
Natural gas			$0.0123
Cooling water			$0.0035
Labor & Supplies			
Plant operations			$0.0039
Maintenance			$0.0050
Insurance & Admin			$0.0027
Depreciation			$0.0178
Subtotal			$0.2020
Coproduct credit			-$0.0447
Net annua production cost			$0.1573

Corn verses cellulosic biomass			
Raw Materials	**Fiber US $/lb**		**Corn US$/lb**
Fiber / Corn	$0.2000		$0.1181
Denaturant	$0.0040		$0.0040
Enzymes	$0.0500		$0.0077
Yeast	$0.0018		$0.0018
Other	$0.0019		$0.0019
Utilities			
Electricity	$0.0040		$0.0040
Steam	$0.0192		$0.0192
Natural gas	$0.0123		$0.0123
Cooling water	$0.0035		$0.0035
Labor & Supplies			
Plant operations	$0.0039		$0.0039
Maintenance	$0.0050		$0.0050
Insurance & Admin	$0.0027		$0.0027
Depreciation	$0.0178		$0.0178
Subtotal	$0.3262		$0.2020
Coproduct credit			-$0.0447
Net annua production cost			$0.1573

Input / Output Prices	Usage	Market Price		
Input	Kg/DT W	$/Ton	Costs	Balance
Dry Wood Chips	1000	$100.00	$100.00	
Water (recycled)				
Acid	17.5	$100.00	$1.75	
Solvent (recycled)				
Total Input				$101.75
operational costs ($0.07/Lb)				$140.00
Total Costs				$241.75
Output excluding recycled materials				
Typical Fiber Production				
Using Organosolv Process				
typical Lignin extracted 20%	200	$100.00	$20.00	
Typical fibeer extracted 40%	400	$555.00	$222.00	
Total Organic Layer				$242.00
Net Profit per Ton of dry wood				$0.25

Input / Output Prices	Usage	Market Price		
Input	Kg/DT W	$/Ton	Costs	Balance
Dry Wood Chips	1000	$100.00	$100.00	
Water (recycled)				
Acid	17.5	$100.00	$1.75	
Solvent (recycled)				
Total Input				$101.75
operational costs ($0.07/Lb)				$140.00
Total Costs				$241.75
Output excluding recycled materials				
Typical process generate solvents / other chemicals and loses solvent with fiber and lignin				
solvent is recycled, extra chemicals, fiber, and lignin are extracted for sale				
Net gain on organic materials total input solvent minus total output solvent				
Typically 15% gain on organic chemicals	150			
typical Lignin extracted 20%	200	$200.00	$40.00	
Typical fibeer extracted 40%	400	$200.00	$80.00	
Pyoil 50% of left over	125			
Total Organic Layer				
Net Profit per Ton of dry wood				

Input / Output Prices	Usage	Market Price		
Input	Kg/DT W	$/Ton	Costs	Balance
Dry Wood Chips	1000	$100.00	$100.00	
Water (recycled)				
Acid	17.5	$100.00	$1.75	
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Total Input				$101.75
operational costs ($0.07/Lb)				$140.00
Total Costs				$241.75
Output excluding recycled materials				
Typical process generate solvents / other chemicals and loses solvent with fiber and lignin				
solvent is recycled, extra chemicals, fiber, and lignin are extracted for sale				
Net gain on organic materials total input solvent minus total output solvent				
Typically 15% gain on organic chemicals	150	$800.00	$120.00	
typical Lignin extracted 20%	200	$200.00	$40.00	
Typical fibeer extracted 40%	400	$200.00	$80.00	
Pyoil 60% of left overs	125	$200.00	$25.00	
Total Organic Layer				$265.00
Net Profit per Ton of dry wood				$23.25

Conclusion

With Zero Waste fractionation of lignocellulosic materials can become profitable.

With proper arrangement, fractionation process can produces high value products such as:

- **Butyl acetate:**
- **Furfural:**
- **Levunilic acid:**
- **Levunilic acid butyl ester**
- **Fiber**
- **Water insoluble Lignin**
- **vanillin**

With Subsidies fiber from lignocellulosic materials can compete with corn and cane

Without subsidies , the C6 sugar is too expensive for bio fuel and should be converted to other higher value chemicals such as:

- **isoprene,**
- **lactic acid,**
- **etc..**

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