Future Prospects for USA Pulp and Paper Technology

Richard B. Phillips, PhD
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Main Points

1. USA very competitive with Rest of the World in Pulp and Paper
   – Both Cost and Profitability

2. Biggest issue for USA Paper and Board Industry is shrinking Demand
   – We are becoming more export oriented

3. World will face shortage of softwood fiber for paper
   – China’s growth in packaging will require more virgin softwood fiber
   – OCC supply will become tight
   – Growth of absorbent pulps will divert softwood pulp supply from paper
   – USA – Southeast well positioned to participate

4. What will be required for a new softwood mill to be built?
USA Competitive Costs

Softwood Logs
- NZ
- CHL
- CAN-BC
- USA
- SWE
- RUS-E
- CHI
- JAP

Hourly Labor
- NZ
- CHL
- CAN-BC
- USA
- SWE
- RUS-E
- CHI
- JAP

Softwood Chips
- NZ
- CHL
- CAN-BC
- USA
- SWE
- RUS-E
- CHI
- JAP

Transportation to Shanghai
- NZ
- CHL
- CAN-BC
- USA
- SWE
- RUS-E
- CHI
- JAP

Source: FisherSolve®
Softwood Market Pulp

USA Cash Cost Delivered to Shanghai very competitive with all except Russia

Total Cost and Cumulative Production

Canada biggest producer of softwood market pulp

USA minor player in paper pulp

Source: FisherSolve
Dominant in Fluff Pulp Market

Both Cost and Fiber Properties

Mfg. Cash Cost and Cumulative Production

Southeast USA owns the fluff pulp market

Source: FisherSolve™
Fluff Pulp Demand Growth to Continue

Mothers want their babies in disposable diapers

Source: RISI
USA Corporate Returns competitive with Latin America and superior to ROW

<table>
<thead>
<tr>
<th>Region</th>
<th>% EBITDA Margin 2011</th>
<th>% EBITDA Margin 2010</th>
<th>% Return on Capital Employed 2011</th>
<th>% Return on Capital Employed 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latin America</td>
<td>24.7</td>
<td>29.7</td>
<td>13.9</td>
<td>13.4</td>
</tr>
<tr>
<td>US</td>
<td>13.9</td>
<td>11.4</td>
<td>13.4</td>
<td>13.4</td>
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<tr>
<td>Europe</td>
<td>12.7</td>
<td>11.4</td>
<td>11.4</td>
<td>11.4</td>
</tr>
<tr>
<td>Emerging Asia &amp; Other</td>
<td>7.2</td>
<td>10.0</td>
<td>7.2</td>
<td>10.0</td>
</tr>
<tr>
<td>Japan</td>
<td>10.6</td>
<td>9.9</td>
<td>10.6</td>
<td>9.9</td>
</tr>
<tr>
<td>Canada</td>
<td>6.3</td>
<td>6.1</td>
<td>6.3</td>
<td>6.1</td>
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</table>

Biggest issue for USA is declining demand
Consumption of Paper and Board increasing in Asia
and stagnant to declining in the West

Asia account for ~ 50% of world Consumption

Source: RISI
Exports have not been a major factor for USA but they will be

Exports are 17% of Production

Source: RISI
Production of Paper and Board is Local …

Relatively good Regional Balance
... And will remain so in 2020

North America and Western Europe will become larger exporters
Purchased Softwood Pulp Must Grow

Softwood Pulp will likely be in significant shortfall

Shortage in Asia not balanced by Excess produced elsewhere
Asia currently imports 25 Million Tonnes of waste

*Current collection rate of ~50%*

Waste for Asia comes principally from North America and Western Europe.
Shortage grows to 35 Million Tonnes in 2020

If recovery rate grows to 64%

Waste availability from North America and Western Europe cannot grow because local consumption of P&B declines.
Main Points

- USA very competitive with Rest of the World in Pulp and Paper
  - Both Cost and Profitability
- Biggest issue for USA is shrinking Demand
  - We are becoming more export oriented
- World will face shortage of softwood fiber for paper
  - China’s growth in packaging will require more
  - OCC supply will become tight
  - Growth of absorbent pulps
- What will be required for new softwood pulp capacity to be built?
  - Economics do not favor construction of new softwood capacity
  - But prospects could change by incorporating biomaterials and bioenergy into scope of new mill
Abundant Softwood available in SE USA

- 30 Million Hectares
- 3.4 M3 / Ha / Year
- Annual Growth ~ 100 mm M3 per Year
- Annual Removals ~ 80 mm M3 per Year
- 90% of harvest takes place on 10% of the forest

<table>
<thead>
<tr>
<th>Timber Products</th>
<th>USA Domestic Demand 2007</th>
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</thead>
<tbody>
<tr>
<td>Saw logs</td>
<td>31,446,920</td>
</tr>
<tr>
<td>Veneer logs</td>
<td>4,721,578</td>
</tr>
<tr>
<td>Pulpwood</td>
<td>30,842,966</td>
</tr>
<tr>
<td>Composite products</td>
<td>4,133,231</td>
</tr>
<tr>
<td>Fuelwood</td>
<td>582,053</td>
</tr>
<tr>
<td>Posts, poles, and pilings</td>
<td>799,650</td>
</tr>
<tr>
<td>Miscellaneous products</td>
<td>703,356</td>
</tr>
</tbody>
</table>

All USA Forest Products Domestic Demand Falling Except wood pellets

Source: USDA FS RPA 2007
Modern Kraft Mill

1. Woodyard
   - Roundwood
   - Sawmill Chips

2. Pulp Mill
   - Kraft Cooking
   - Low Energy

3. Power Plant
   - High Pressure
   - 50% Excess Power
   - Black Liquor > 85%
   - Hog Fuel 15%

4. Chemical Plant
   - Turpentine
   - Tall Oil
   - Pulping / Bleaching Chemical Prep

5. Pulp Line
   - Pulp Drying
   - Pulp Bales for Shipment
## Characteristics of Modern Kraft Pulp Mill

<table>
<thead>
<tr>
<th>Greenfield Pulp Mill Investment</th>
<th>1,000,000 ADMt per Year</th>
<th>Southeastern USA</th>
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<tbody>
<tr>
<td>Woodyard</td>
<td>$119,826,634</td>
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</tr>
<tr>
<td>Pulp Mill</td>
<td>$312,398,638</td>
<td></td>
</tr>
<tr>
<td>Caustic Plant</td>
<td>$204,870,330</td>
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<tr>
<td>Evaporation</td>
<td>$139,684,316</td>
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<tr>
<td>Recovery Boiler</td>
<td>$377,829,924</td>
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<tr>
<td>Power Boiler</td>
<td>$102,787,517</td>
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<tr>
<td>Turbogenerators</td>
<td>$108,156,996</td>
<td></td>
</tr>
<tr>
<td>Machines</td>
<td>$433,187,011</td>
<td></td>
</tr>
<tr>
<td>Chlorine Dioxide Plant</td>
<td>$103,043,210</td>
<td></td>
</tr>
<tr>
<td>Infrastructure</td>
<td>$99,143,913</td>
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<tr>
<td><strong>TIC (USD 2016)</strong></td>
<td><strong>$2,000,928,488</strong></td>
<td></td>
</tr>
</tbody>
</table>
Net Present Value (10%) requires unrealistic price for Paper Pulp

Net Present Value at 10%

- $276,900,247
- $573,472,970
- $1,093,797,253

Price Escalation
- History
- 0.75% per Year
- 1.5% per Year
- 3% per Year

Analysis is based on southeast United States with the lowest softwood pulpwood price in the world

Source: Author
Kraft Pulp Mill integrated with Bioenergy and Biomaterials
NC State University

**Chemicals Extraction**

1. **Roundwood Receiving** → **Debarking** → **Chipping** → **Chip Pile**
2. **Chip Pile** → **Sawmill Chips** → **Chip Pile**
3. **Chip Pile** → **Chip Screens** → **Auto Hydrolysis** → **Enzyme Hydrolysis**
4. **Enzyme Hydrolysis** → **Ferment** → **Purify** → **Pelletizer** → **Bioproducts**
5. **Cellulose** → **Lignin** → **Chemicals / Materials**

**Kraft Pulp Mill integrated with Bioenergy and Biomaterials**
Integration of Kraft Pulp Mill with Bioenergy and Biomaterials

- **Roundwood Receiving**
  - **Debarking**
  - **Chipping**
  - **Chip Pile**
  - **Chip Screens**
  - **Pre-Cook**
  - **Kraft Cook**
  - **Collection**
  - **Bioenergy and Biomaterials**
  - **Bioethanol, Foams/Gels**
  - **Hemicellulose Extraction**
  - **Wood Chips**

**Chemicals Extraction**

**Pulp Wood**
Chemical and Energy Recovery

Kraft Pulp Mill integrated with Bioenergy and Biomaterials
Lignin Recovery

Kraft Pulp Mill integrated with Bioenergy and Biomaterials
Biomass Gasification

Pre-Cook → Kraft Cook → Pulp Washing → Lime Kiln → Caustic Plant

Biomass Gasifier

Evaporator Plant

Kraft Pulp Mill integrated with Bioenergy and Biomaterials
Chemrec Black Liquor gasification – biodiesel production
• Asia has become overly – dependent on cheap Recovered Paper that will become scarce and expensive in the future
• New softwood capacity will be needed to provide fiber to Asia
• Softwood capacity difficult to justify financially – bioenergy and biomaterials integration may make it work
• USA – Southeast a strong contender for a new mill
Questions?