Biomass feedstock opportunities from a Kraft pulp mill
Discussion at DOE Biomass R&D Q3 TAC meeting
New Bern, NC

September 18, 2019
DOMTAR IS:

- North America’s largest producer of printing and writing papers
- Serving global markets in over 50 countries
- One of North America’s largest generators of renewable power with around 740 megawatts of installed capacity (World class experts on Combined Heat and Power)
- The largest offering of environmentally preferable paper products, EcoChoice, in North America
- Transforming and will continue to be a major player in the future forest-fiber based industry
- A supporter of our local communities
- Collaborator with the World Wildlife Fund and the Rainforest Alliance
- Experienced environmental leadership
<p>| | |</p>
<table>
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<tr>
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<tbody>
<tr>
<td>Communication papers</td>
<td>Business, commercial print and publishing papers</td>
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<tr>
<td>Pulp</td>
<td>Manufacturer of paper grade, fluff and specialty market pulps</td>
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<td>Specialty papers</td>
<td>Leading manufacturer of premium, technical and specialty packaging papers</td>
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<td>Personal care</td>
<td>Marketer and producer of a broad line of absorbent hygiene products</td>
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<tr>
<td><strong>NEW BioMaterials</strong></td>
<td>Lignin, extractives, cellulosic sugars, hydrocarbon fuels, advanced fibers</td>
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*We design, manufacture, market and distribute a wide variety of fiber-based products*
DOMTAR’S PULP AND PAPER OPERATIONS
13 MAJOR SITES IN NORTH AMERICA

Kamloops BC
Dryden ON
Espanola ON
Windsor QC
Plymouth NC
Hawesville KY
Ashdown AR
Kingsport TN

Non-integrated mill
Integrated mill
Sulfite mill

25 million green tons/yr of biomass (17 MM of wood chips)
Over 4.4 million tons/yr of pulp
Over 3.4 million tons/yr of uncoated freesheet paper

+ Personal Care facilities located in the U.S. and Europe
DOMTAR’S BIOMATERIALS PROGRAM
Projects & Products Organized Across Five (5) Platforms

- **Biomaterials Business Unit:** Its main objective is to reduce Domtar’s exposure to paper market decline by creating high growth, high value businesses via leveraging Domtar’s assets

1. **Advanced Fibers and Fiber Derivatives**
   - Specialty Pulps
   - Fiber Reinforced Materials
   - Nano-Crystalline Cellulose (thru Celluforce)

2. **Extractives and Volatiles**
   - Turpentine and its derivatives
   - Soap and its derivatives
   - Tannin and its derivatives

3. **Lignin and Lignin Derivatives**
   - Lignin precipitation
   - Lignin into thermoplastic blends and products
   - Other Lignin based specialty chemicals & materials

4. **Hydrocarbons and Biofuels**
   - Biomass boilers, pyrolysis, gasification

5. **Cellulosic sugars**
   - Fermentation products, organic acids, biopolymers, etc.

**Diverse multi-product, multi-project portfolio approach to develop new forest based bioproducts**
COMMERCIAL BIOMATERIALS PROJECTS
PUBLICLY FUNDED AND PUBLICLY ANNOUNCED BIOREFINERY INITIATIVES

- **Lignin Manufacturing**
  - Manufactures Kraft Lignin (Lignoboost technology)
  - Use lignin as a platform for new products
  - With support from USDA-NIFA BRDI program

- **Lignin Valorization (lignin-thermoplastic)**
  - Valorizes lignin into value-added products (dried lignin pellets, lignin-thermoplastic compound pellets, blown film, cast sheet film)
  - With support from NRCan (IFIT Program) and CRIBE

- **Advanced Fiber (SEPF) Manufacturing**
  - High strength SWK fibers
  - Market and applications development
  - With support from NRCan (IFIT program)

- **Advanced Fiber (NCC) Manufacturing**
  - Manufactures Nano-Crystalline Cellulose
  - Market and applications development
  - In partnership with FP Innovations, Suzano, Schlumberger and IQ
  - With support from NRCAN and Quebec Government.

- **Evaluation of Biofuels Manufacturing**
  - With support from NRCan (EIP Program)
OVERVIEW SUMMARY – BIOMATERIALS ACTIVITIES

- We are active in the field of exploring and manufacturing various BioMaterials

- Domtar is using a financially successful manufacturing system as a platform to generate new bioproducts to maximize synergies between the current and future business

- We favor collaborative projects, and these are just a few of several biomaterial projects that Domtar is currently working on

- We are investigating the efficient manufacturing of biofuels from woody biomass and hope to ultimately position our mills to produce new bioeconomy products that help to further a low-carbon economy. Some end-use examples for these technologies include:
  - Advanced fibers
  - Biofuels (such as ethanol or biodiesel)
  - Replacements for plastic car parts
  - Feed for animals and aquaculture
  - Biochemicals

- We remain committed to on-going collaboration and partnerships with universities and research and technology organizations
Biomass feedstock opportunities from a Kraft pulp mill
OVERVIEW OF THE KRAFT PULPING PROCESS

Source: Alternative Technologies for Biofuels Production in Kraft Pulp Mills—Potential and Prospects
POTENTIAL BIOMASS FEEDSTOCK SOURCES

- Thinning's
- Forest residue
- Bark
- Chip screening rejects

Domtar 2018
Purchased: 1 million BDMT
Self-generated: 0.5 million BDMT

Construction and demolition debris

Source: Alternative Technologies for Biofuels Production in Kraft Pulp Mills—Potential and Prospects
POTENTIAL BIOMASS FEEDSTOCK SOURCES

Liquid biomass

- Crude Sulphate Soap (CSS)
- Crude Tall Oil (CTO)
- Lignin
- Aromatics

Source: Alternative Technologies for Biofuels Production in Kraft Pulp Mills—Potential and Prospects

Domtar 2018

7 million BDMT BLS
POTENTIAL BIOMASS FEEDSTOCK SOURCES

- Screen room rejects
- Knots

Source: Alternative Technologies for Biofuels Production in Kraft Pulp Mills—Potential and Prospects
POTENTIAL BIOMASS FEEDSTOCK SOURCES

- Effluent treatment
- Primary sludge
- Secondary treatment sludge
- RNG (Landfills and Effluent)

Source: Alternative Technologies for Biofuels Production in Kraft Pulp Mills—Potential and Prospects
ALTERNATIVE BIOFUEL PROD’N TECHNOLOGIES

Source: Alternative Technologies for Biofuels Production in Kraft Pulp Mills—Potential and Prospects
RENEWABLE FUELS FROM A KRAFT MILL

Potential for a Kraft Pulp to produce alternative biofuels:

- Technologies available are:
  - Biomass as a solid fuel
  - Biomass liquefaction
  - Biomass gasification
  - Lignin extraction
  - Production of biodiesel from soap and tall oil (typically already collected)
  - Ethanol production from woody biomass (hemi-cellulose, rejects or cellulose)
  - RNG’s (biogas collection at landfills or effluent treatment)
- The feasibility of these processes depends on many factors such as:
  - Local energy policies and economics (prices of pulp, wood, biofuels or electricity)
  - Wood species
  - Availability of capital for commercialization
  - Scale of production, process maturity, end-use requirements and effects that the integration would cause on existing mills and their pulp
ABOVE GROUND BIOMASS INVENTORY
US Forest Service Regions for Resources Planning Act (RPA) Assessment and Forest Inventory and Analysis (FIA) Program

<table>
<thead>
<tr>
<th>Region</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
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<tbody>
<tr>
<td>South</td>
<td>8,016</td>
<td>8,673</td>
<td>9,148</td>
<td>10,521</td>
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<tr>
<td>Rocky Mtn</td>
<td>2,602</td>
<td>3,014</td>
<td>2,854</td>
<td>3,093</td>
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<tr>
<td>Pacific Coast</td>
<td>4,870</td>
<td>5,277</td>
<td>5,268</td>
<td>5,226</td>
</tr>
<tr>
<td>United States</td>
<td>22,036</td>
<td>24,421</td>
<td>25,706</td>
<td>28,122</td>
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AVAILABLE RENEWABLE FUEL FEEDSTOCKS FROM THE US FOREST PRODUCTS INDUSTRY

These biomass materials are currently being burned for energy and potentially some streams could be diverted for renewable fuel feedstocks.

<table>
<thead>
<tr>
<th>Potential Feedstock</th>
<th>Pulp and Paper</th>
<th>Wood Products</th>
<th>Combined</th>
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<tbody>
<tr>
<td><strong>All numbers in Billion BTU Higher Heating Value (HHV)</strong></td>
<td></td>
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<tr>
<td>Liquid biomass (black liquor solids)</td>
<td>1,029,846</td>
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<td>1,029,846</td>
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<tr>
<td>Woody manufacturing residuals</td>
<td>299,753</td>
<td>256,375</td>
<td>556,129</td>
</tr>
<tr>
<td>WWTP residuals</td>
<td>10,231</td>
<td></td>
<td>10,231</td>
</tr>
<tr>
<td>Forest harvesting residues</td>
<td>31,265</td>
<td>35,279</td>
<td>66,543</td>
</tr>
<tr>
<td>Other biomass residues</td>
<td>11,146</td>
<td>16,766</td>
<td>27,912</td>
</tr>
<tr>
<td>Total Biomass</td>
<td>1,382,241</td>
<td>308,421</td>
<td>1,690,661</td>
</tr>
</tbody>
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Source: NCASI from 2016 industry inventory data
RFS – OPPORTUNITIES AND ISSUES/CONCERNS

Potential Opportunities

• The pulp & paper industry has potential capabilities in the area of bio-fuel production
• The pulp & paper industry can help the government achieve its RFS goals
• Must incentivize the industry to get involved in the production of advanced biofuels

Key areas of concern

• **Carbon neutrality of biomass**
  o Designation of biomass, including all biomass feedstocks is absolutely essential to the successful evolution of alternate energy sources

• **We must work carefully to ensure the sustainability of the forest resource**
  o Care is needed to ensure that the forest resource is managed in all phases of its lifecycle in a responsible and sustainable manner

• **Maintaining focus on driving the highest value from each component of a wood chip**
  o We need to drive the highest and best use, both in terms of economic value added and job creation/preservation, from every wood chip that is processed