Biomass feedstock opportunities from a Kraft pulp mill

Discussion at DOE Biomass R&D Q3 TAC meeting
New Bern, NC

September 18, 2019

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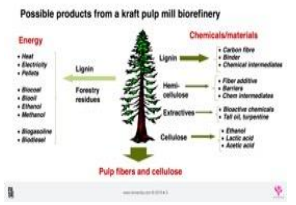
Overview of Domtar

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

SUSTAINABLE FIBER TECHNOLOGY AND WORLD CLASS WOOD FIBER CONVERTING ASSETS

	**Communication papers**	Business, commercial print and publishing papers
	**Pulp**	Manufacturer of paper grade, fluff and specialty market pulps
	**Specialty papers**	Leading manufacturer of premium, technical and specialty packaging papers
	**Personal care**	Marketer and producer of a broad line of absorbent hygiene products
	**NEW BioMaterials**	Lignin, extractives, cellulosic sugars, hydrocarbon fuels, advanced fibers

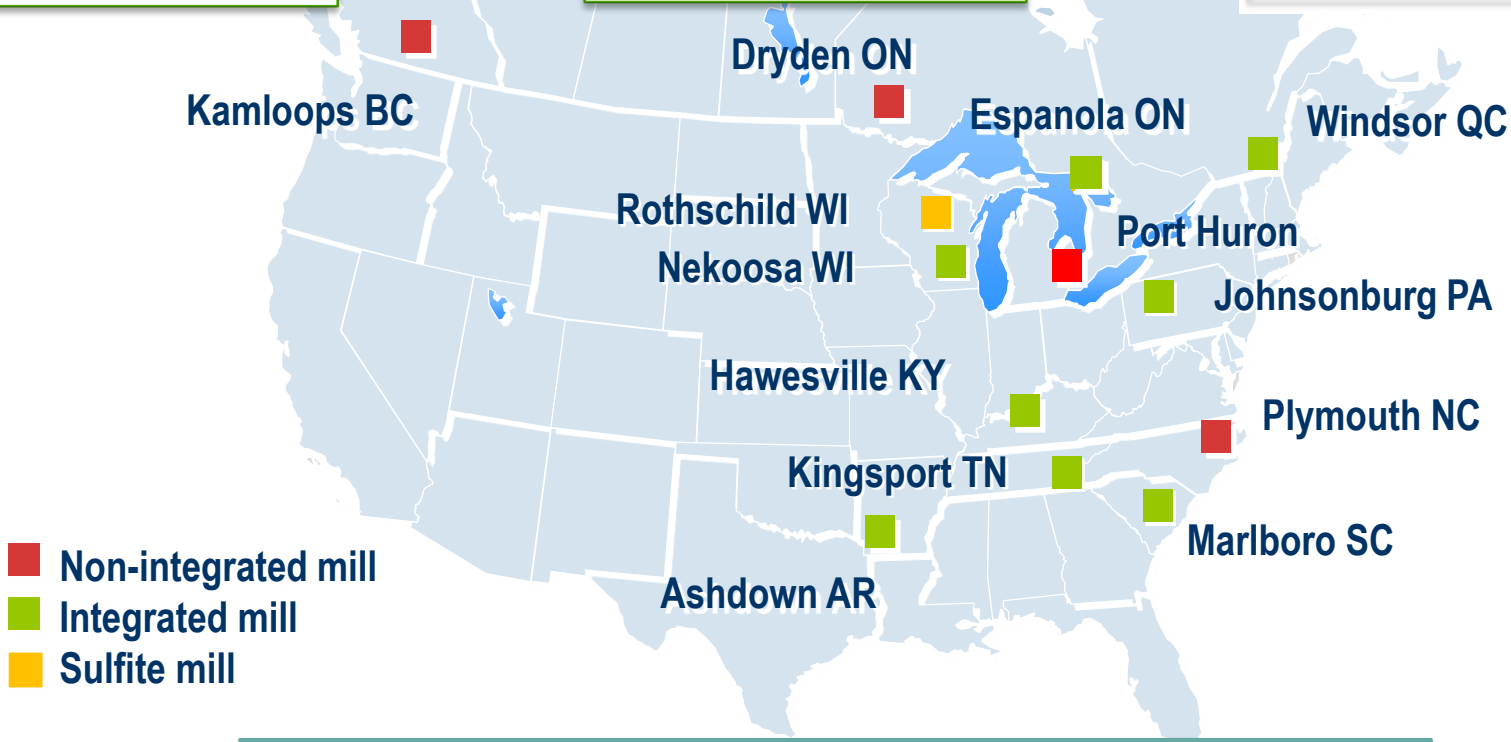
We design, manufacture, market and distribute a wide variety of fiber-based products

DOMTAR'S PULP AND PAPER OPERATIONS
13 MAJOR SITES IN NORTH AMERICA

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

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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

5 platforms

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 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.

Lignin Manufacturing

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

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

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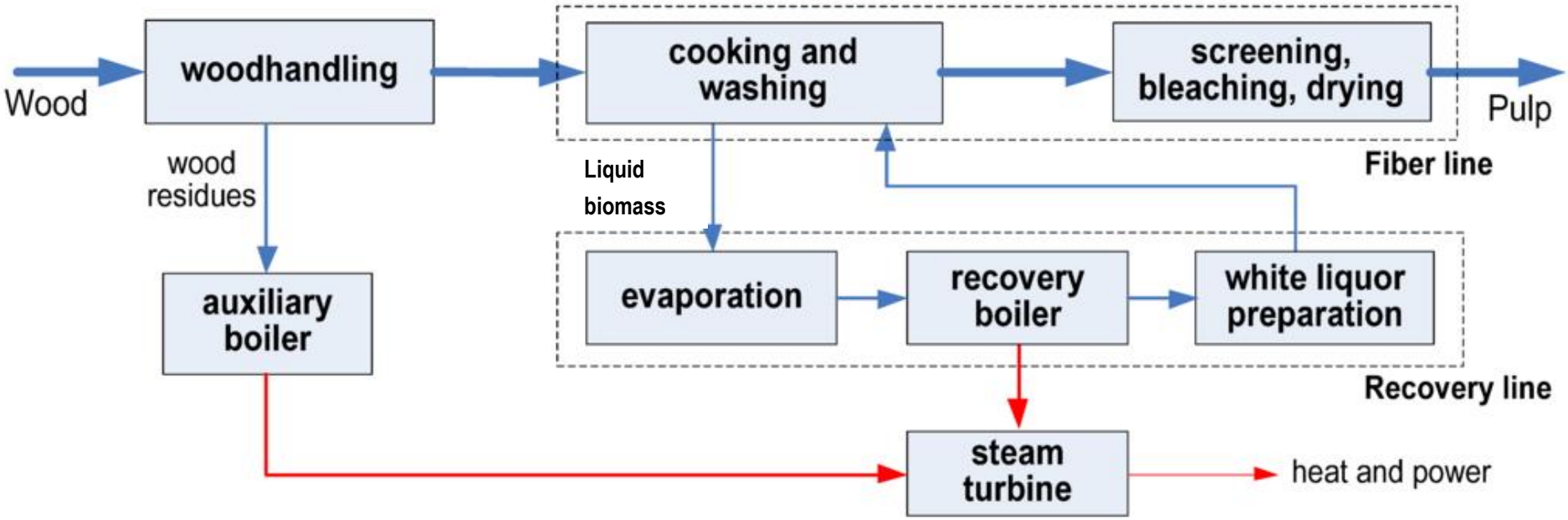
Biomass feedstock opportunities from a Kraft pulp mill

OVERVIEW OF THE KRAFT PULPING PROCESS



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

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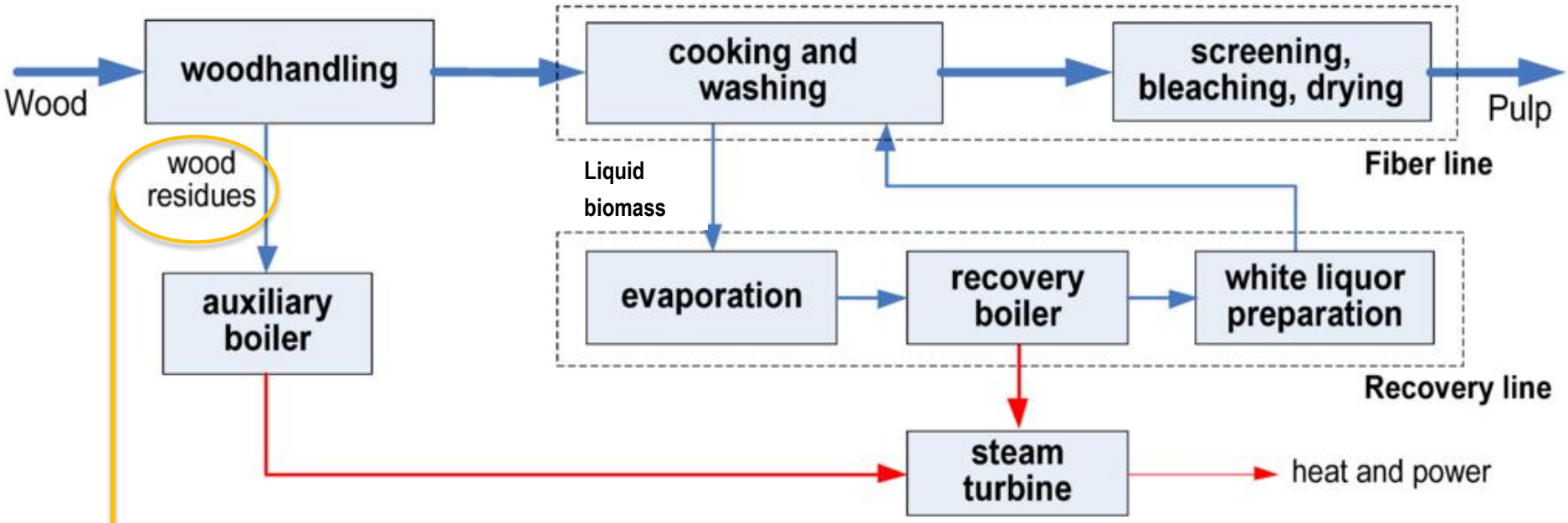
POTENTIAL BIOMASS FEEDSTOCK SOURCES



- 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

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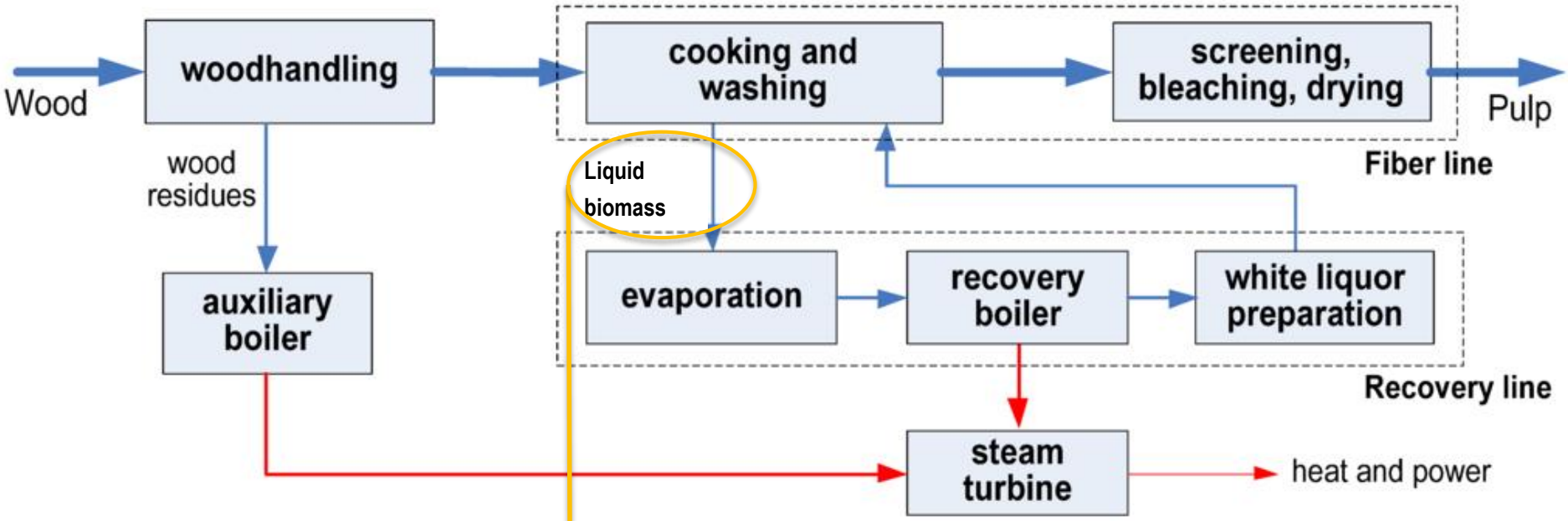
POTENTIAL BIOMASS FEEDSTOCK SOURCES



Domtar 2018

7 million BDMT BLS

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

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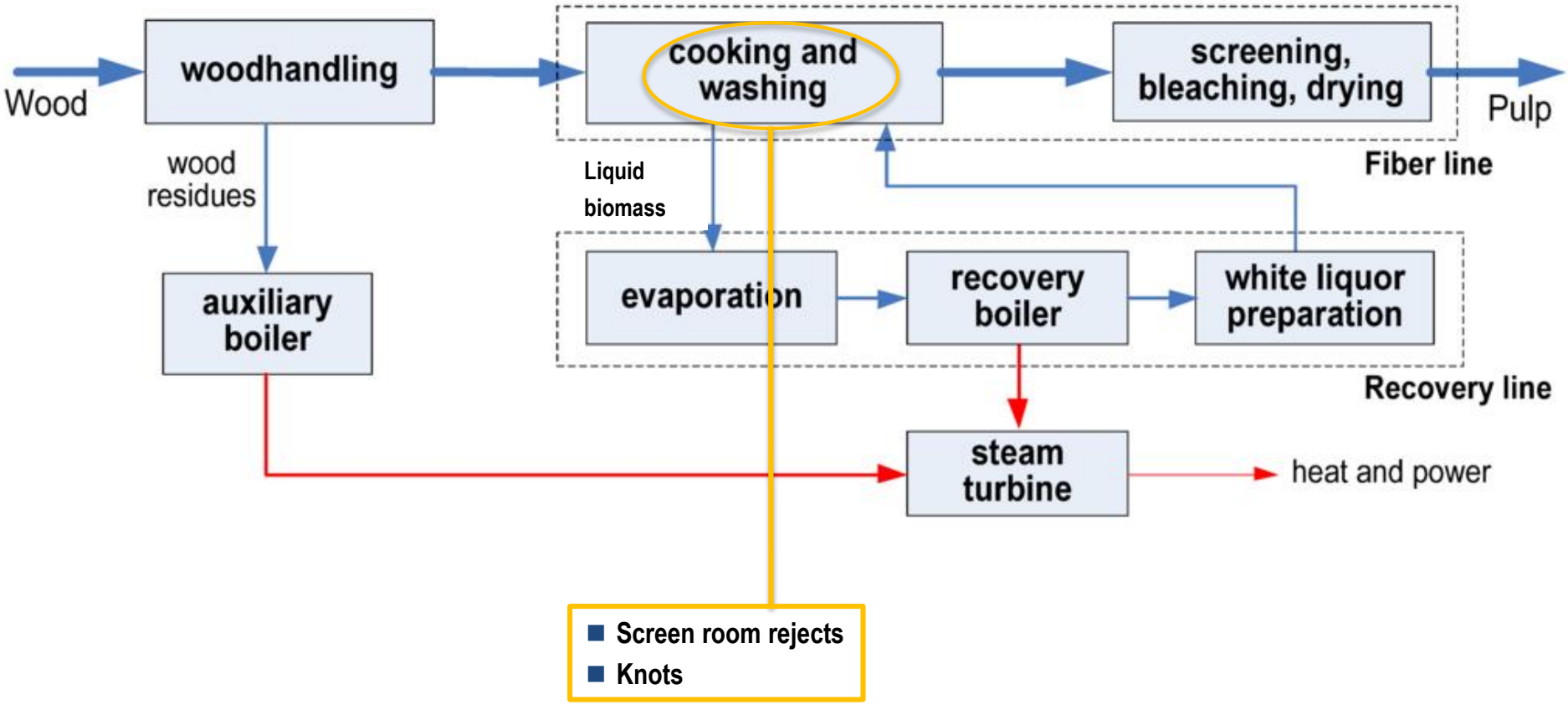
POTENTIAL BIOMASS FEEDSTOCK SOURCES



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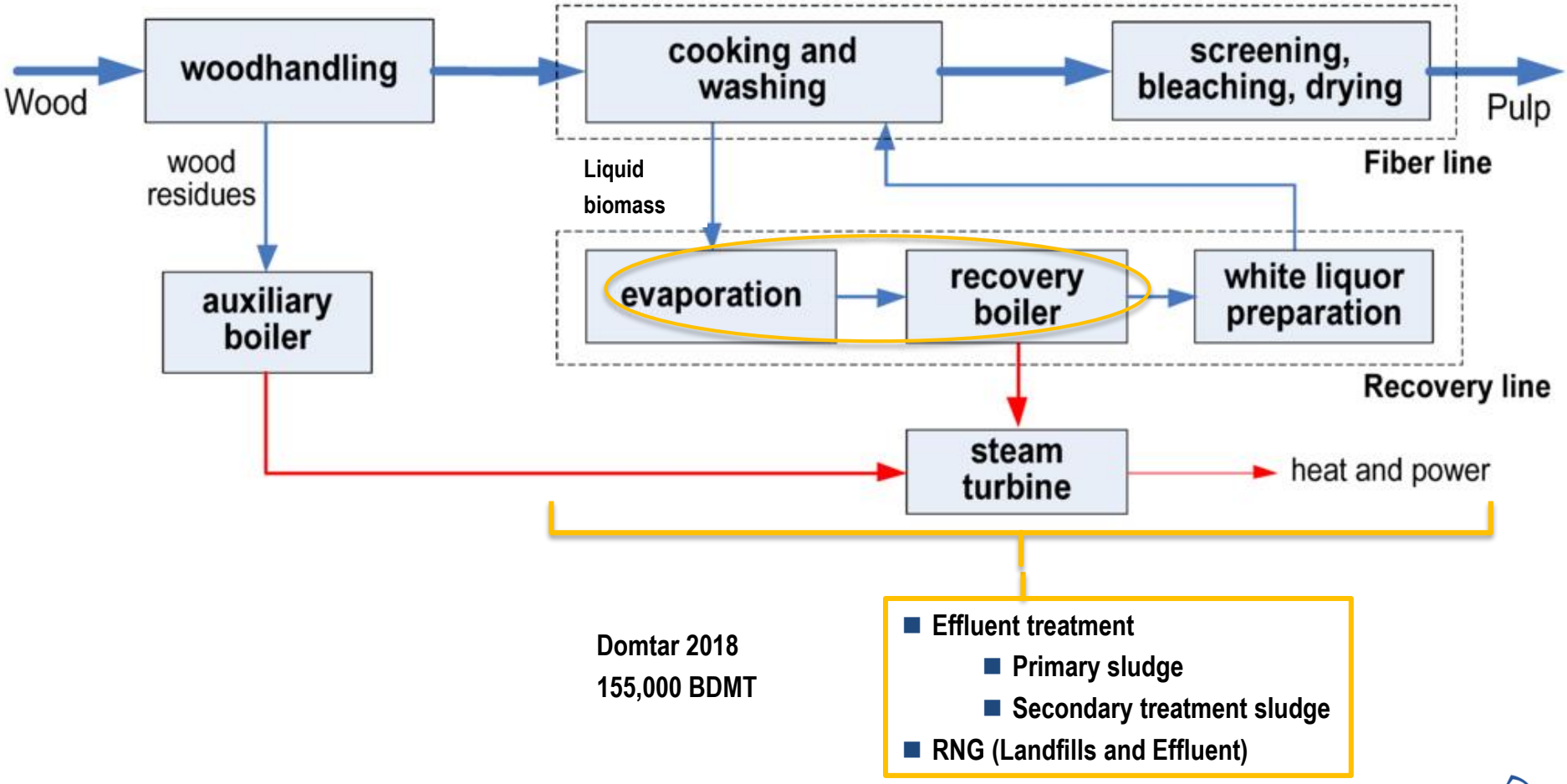
POTENTIAL BIOMASS FEEDSTOCK SOURCES



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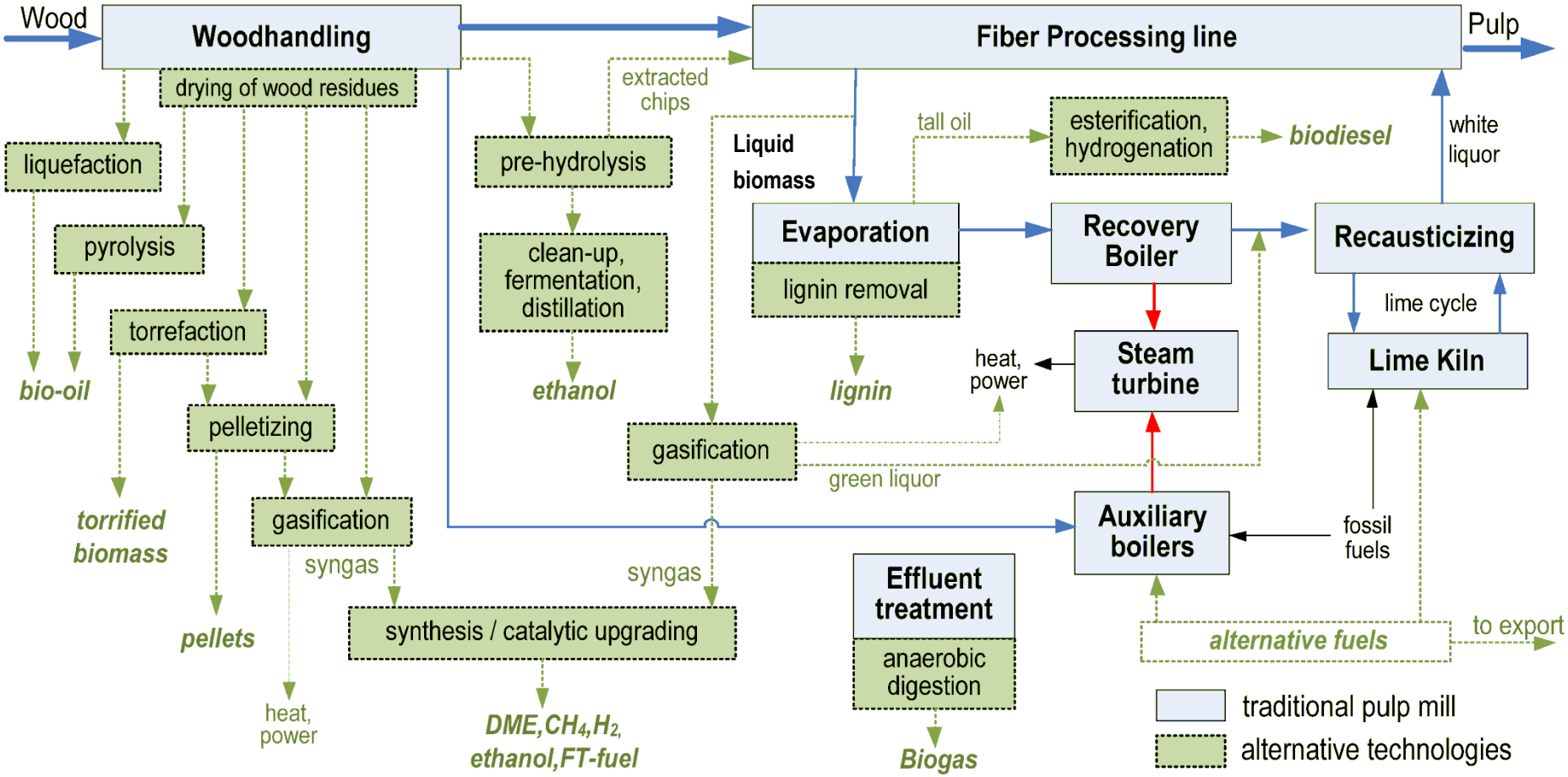
ALTERNATIVE BIOFUEL PROD'N TECHNOLOGIES



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

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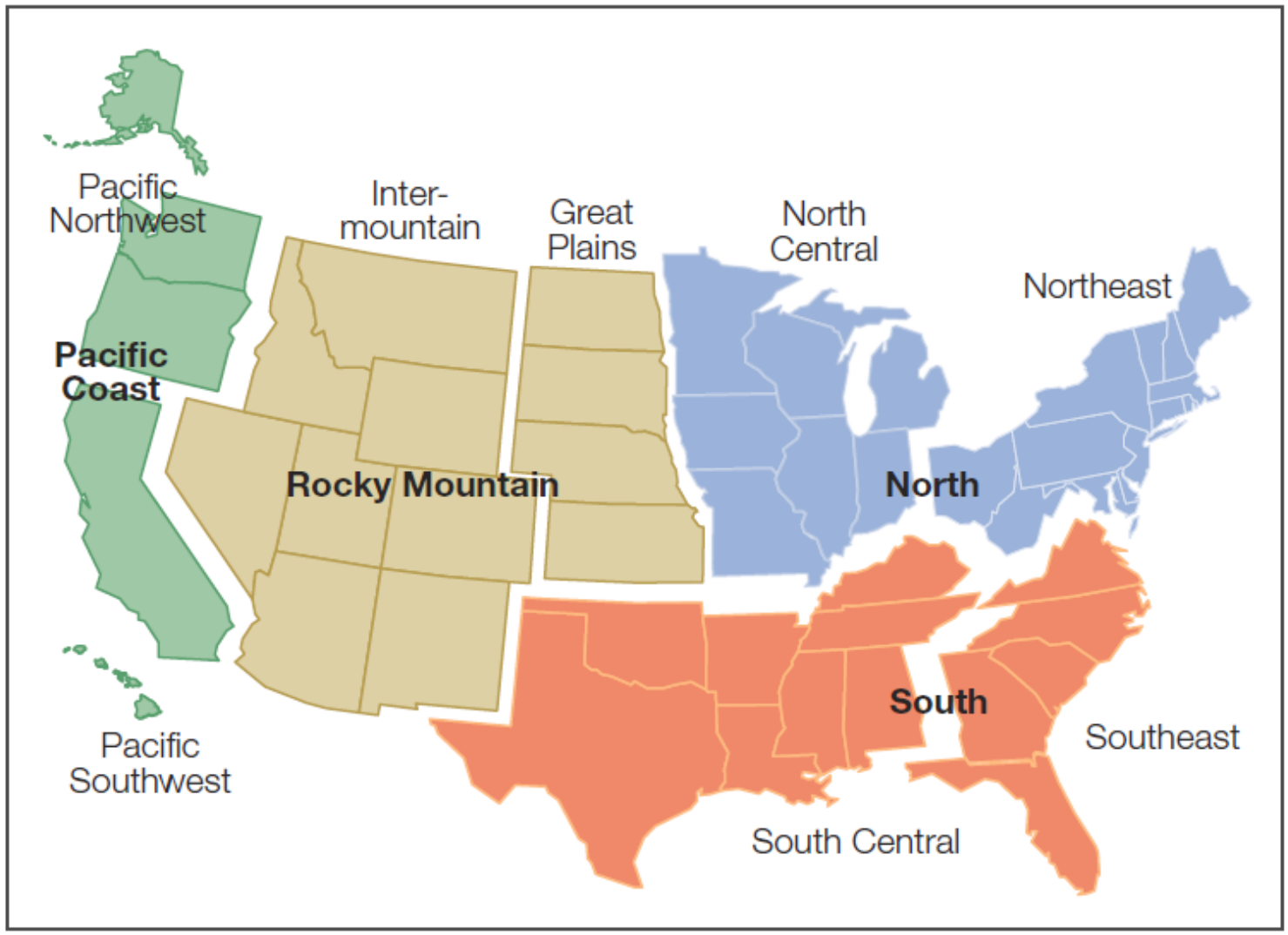
RENEWABLE FUELS FROM A KRAFT MILL

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



From Oswalt, et al. 2019. Forest Resources of the United States, 2017: a technical document supporting the Forest Service 2020 RPA Assessment. Gen. Tech. Rep. WO-97.

South	8,016	8,673	9,148	10,521
Rocky Mtn	2,602	3,014	2,854	3,093
Pacific Coast	4,870	5,277	5,268	5,226
United States	22,036	24,421	25,706	28,122

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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.

Potential Feedstock	Pulp and Paper	Wood Products	Combined
	All numbers in Billion BTU Higher Heating Value (HHV)		
Liquid biomass (black liquor solids)	1,029,846		1,029,846
Woody manufacturing residuals	299,753	256,375	556,129
WWTP residuals	10,231		10,231
Forest harvesting residues	31,265	35,279	66,543
Other biomass residues	11,146	16,766	27,912
Total Biomass	1,382,241	308,421	1,690,661

Source: NCASI from 2016 industry inventory data

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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**
  - 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**
  - 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**
  - 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

THE FIBER *of* Domtar

AGILE | CARING | INNOVATIVE

Domtar