

# Bioenergy retrofits in pulp and paper sector

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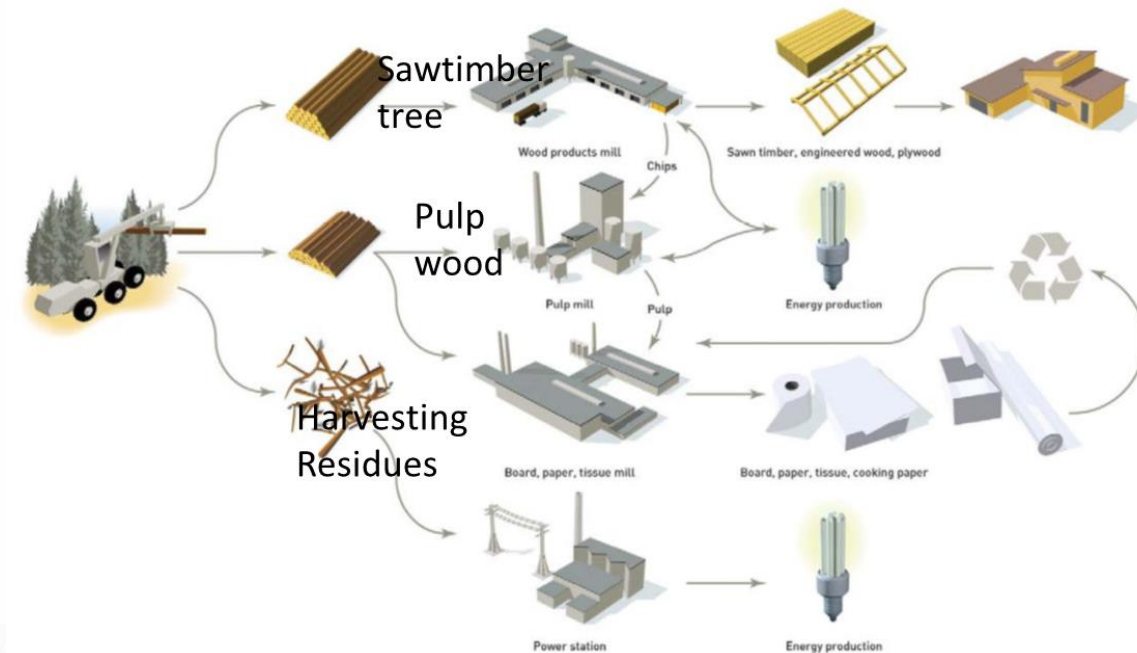


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# Why to retrofit pulp and paper industry with bioenergy?

- Pulp and paper industry plants often both need and produce large amount of heat and power
  - in some type of mills for example (Kraft Pulp Mills) only small amount or even no fossil fuel at all is needed and more bioenergy is produced than what is consumed
  - In other mills processing recycled paper significant amount of external fossil fuel is needed
- Because huge volumes of wood is used bioenergy retrofitting can have a big impact either through production of additional bioenergy, bioproducts, biofuels or substitution of fossil fuels
  - At mills using wood as raw material we can produce a large amount of bioenergy and biofuels both from by-products of the collection chain of pulp wood from the forest and from the pulp mills by-products!



Source: Metsä Group (2014)

- Drivers for retrofitting pulp mills to produce bioenergy and biofuels:
  - At many mills a lot of bioenergy is already produced today, and mill's increased energy efficiency means possibility to produce more additional product for example bioenergy, biofuels or bioproducts
  - Global trend of reducing print paper demand requires pulp mills to find also other valuable products besides paper and cardboard.
  - Climate mitigation and targets for advanced biofuels in EU
  - Use of by-products from industry or harvesting is more sustainable than use of slowly growing forest biomass for fuel or energy production.
- Barriers for retrofitting
  - Not all mills can use or have access to biomass residues
  - Some streams such as black liquor contains pulping chemicals that have to be separated and returned back to the mill
  - A significant amount of process heat and power is needed in the processes and most part of produced bioenergy is used for this purpose

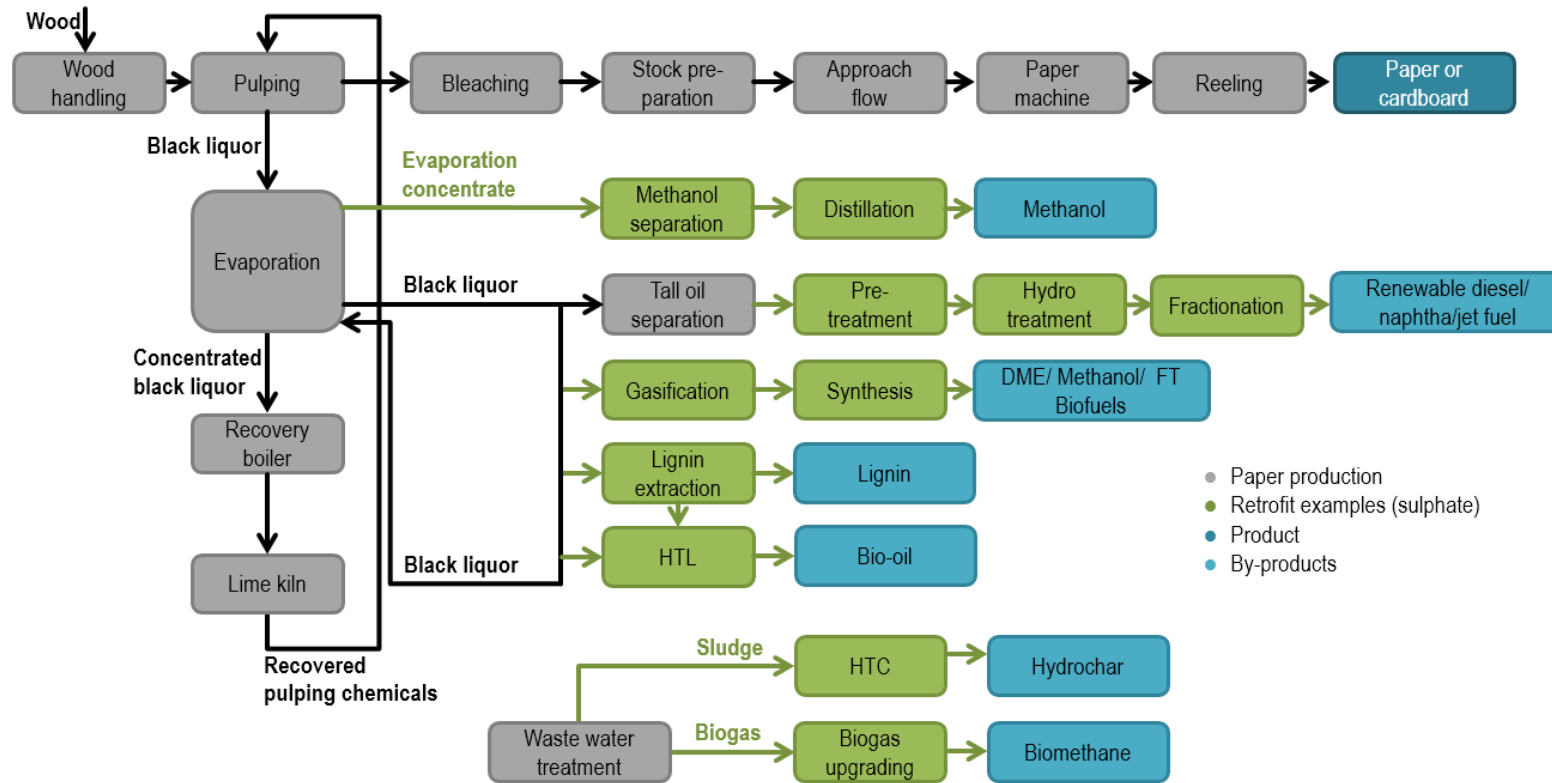


- Mechanical pulping, mechanical grinding of fibres
  - Limited possibilities for bioenergy retrofits
- Semi-chemical pulping, chemical "pre-treatment" before mechanical treatment
  - Some bioenergy retrofit possibilities from the liquids
- Chemical pulping
  - Sulphate (i.e. Kraft) pulp mills (NaOH and Na<sub>2</sub>S as cooking chemicals)
    - Available streams for retrofits: black liquor, waste water treatment sludge, bark, tall oil from softwood pulping, evaporator condensate (methanol) and turpentine
  - Sulphite pulp mills (sulphite salts, e.g. magnesium bisulphite)
    - Available streams for retrofits: residual sugars in brown liquor, bark



Source: Knowpulp (2019)

# Bioenergy retrofits for Kraft Pulp Mills

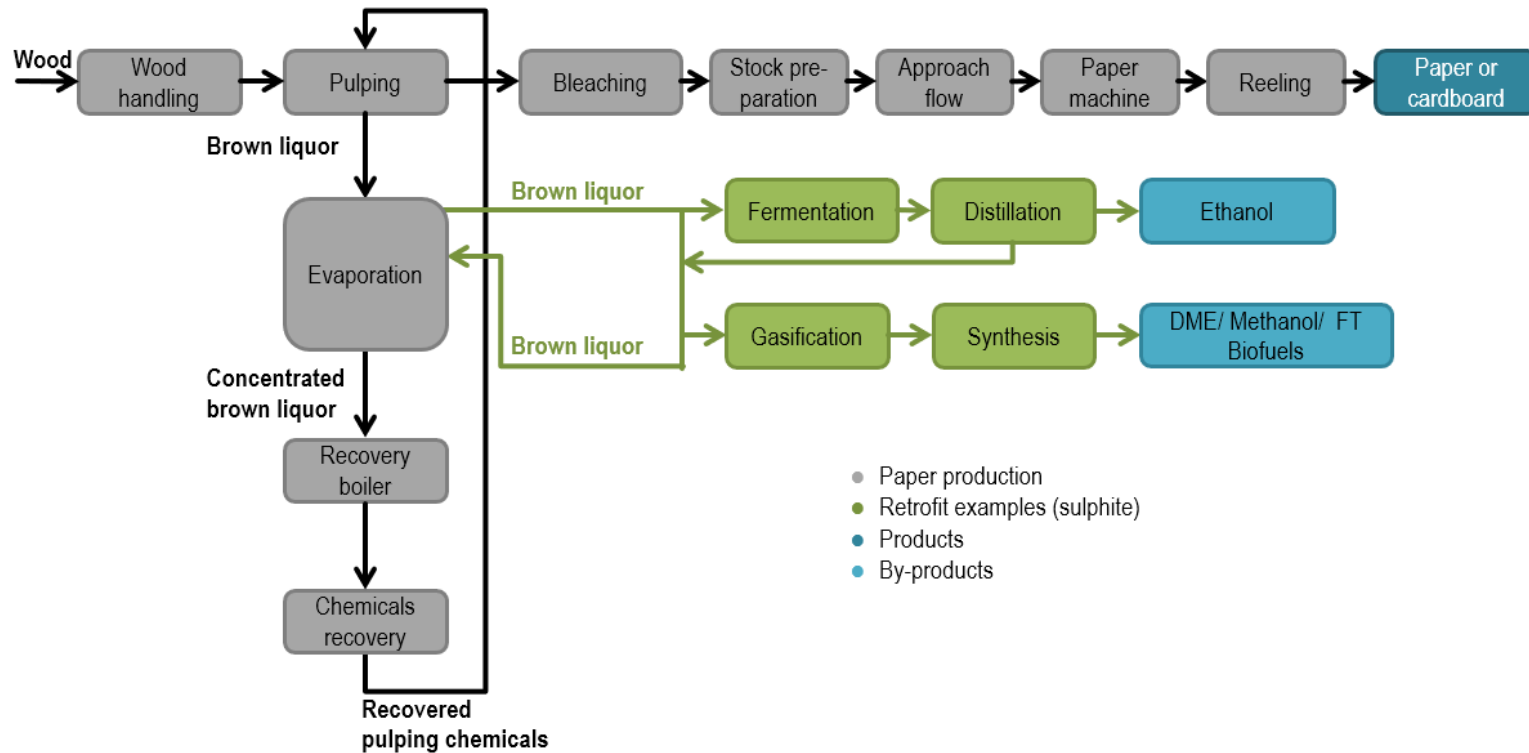


- In the sulphate/Kraft Pulp Mill, lignin and part of hemicelluloses end up in the black liquor which is combusted generating in many cases excess bioenergy
- Typically only in the lime kiln fossil fuels, such as natural gas, are needed and it can be replaced with biogas, synthesis gas from bark gasification, wood powder, lignin etc.
- There are several possibilities for additional biofuel production from black liquor, lignin extracted from black liquor, bark, sludge from waste water treatment, crude tall oil or methanol separated from the evaporation

# Kraft Pulp Mills Retrofits Status

- The retrofit options have different technical readiness levels – some alternatives are already commercial whereas some are still in the demonstration or pilot phase
- The following technologies are commercial:
  - biogas production from mill wastewater treatment applied for example at Äänekoski Bioproduct Mill in Finland
  - gasification of bark to replace fossil fuel in the lime kiln (in Joutseno and Äänekoski in Finland)
  - lignin extraction from black liquor (for example Lignoboost process in Kotka in Finland by Stora Enso or Domtar in USA)
  - biofuel production from crude tall oil applied for example by UPM in Lappeenranta and SunPine in Piteå in Sweden
- Under Demonstration
  - Biocoal production from mill's wastewater treatment sludge (C-Green in Heinola in Finland)
  - Transportation fuel production from lignin (Renfuel, Suncarbon)
  - methanol production from black liquor evaporation condensate (Södra in Mönsterås), gasification of black liquor and production of Dimethyl Ether (DME) (Chemrec nowadays Luleå Technical University)
- In Piloting HTL of black liquor BL2F EU project (<https://www.bl2f.eu/>)

# Bioenergy retrofits for Sulphite Pulp Mills



- In the sulphite pulp mills, lignin is typically obtained as a product (lignosulphonates) and therefore less bioenergy is produced compared to sulphate mills and external fossil fuels might be needed
- Part of the hemicellulose sugars is often hydrolyses into sugars that can be used for bioethanol or biogas production
- Brown liquor can also be gasified and bark can be used for bioenergy or for biofuel production

# Retrofit status for Sulphite Pulp mills

- The sugars in brown liquor has been utilized in several commercial plants already in the past.
  - An example of biogas production is AustroCel in Hallein in Austria,
    - retrofit to ethanol is studied as a case study in this project.
    - ethanol at Borregaard plant in Sarpsborg in Norway
- Brown liquor gasification has been studied as an option



- Retrofitting Bioenergy to Pulp Mills is interesting due to large volumes, even smaller sidestreams utilisation can result in significant amount of new bioenergy, bioproduct and biofuels.
- The retrofit options available for pulp mills depend mainly on the pulping process chemical semi-chemical or mechanical and type of process (sulphate or sulphite) and whether fossil fuels are used at the mill
  - It makes naturally sense to substitute first the fossil fuel and only after that produce additional biofuels or bioproducts
  - Some Retrofits options are already commercial whereas some other are under demonstration
- In addition to existing retrofit option in todays mills, new processes producing or example textile pulp production or microcrystalline cellulose leads to new opportunities for utilising hydrolysate side streams from cellulose hydrolysis etc.

# Thank you for listening !

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