CRIBE | nextfor

Lignin

Request For Proposal (RFP)

Production of High-Performance Lignin Products in Ontario: A Roadmap

Introduction and background

CRIBE is an Ontario based non-profit organisation that works to support the development of next generation forest products through collaboration and project funding. Nextfor, an initiative of CRIBE, is an industry-led ecosystem of collaborations to create and accelerate new technologies and forest-based products in Ontario.

Lignin, a by-product of the kraft pulping process, is commonly burned to generate heat and power. However, there are opportunities to convert lignin into a variety of high-value, high-performance products, which can, in many cases, compete effectively with existing petroleum-based products.

CRIBE has supported the development of lignin processes and high-performance products, starting with commissioning a biorefinery roadmap from FPInnovations in 2009. Among other pathways, the roadmap outlined possible pathways to a lignin extraction plant in a typical Northern Ontario kraft mill producing of the order of 1000 air-dried metric tonnes (admt) per day of pulp. In 2011, in partnership with FPInnovations, the Canadian Forest Service and various Canadian forestry and engineering firms, CRIBE invested in the construction, installation and operation of a pilot lignin precipitation plant. This pilot was a component of the so-called Bio-Economy Technology Centre (BETC) on the site of Resolute Forest Products' Thunder Bay pulp mill. BETC is still in operation today.

The pilot plant was used to understand process operation and design, but also to provide tonne-scale samples to potential end-users. In 2016, the combined process design and market development work led to the construction of a LignoForce commercial demonstration plant in Alberta, with a capacity of 10,500 odt/y, initially supplying lignin for partial substitution in plywood-grade phenolic resins. The Thunder Bay pilot plant also served as a driver for a large-scale R&D program at Lakehead University, where a strong lignin centre of excellence has been developed and continues to thrive.

In parallel, Metso (now Valmet) developed the LignoBoost process based on fundamental research done in Sweden. LignoBoost plants have been installed in Plymouth, North Carolina (2013) and Sunila, Finland (2015). Total capacity of the two plants is 75,000 odt/y.

South American pulp and paper companies are actively developing their own lignin extraction capabilities. In particular Suzano, through its acquisition of Fibria, now owns the Canadian technology developer Lignol and its associated know-how. Separately, Valmet has sold at least one pilot lignin plant in South America.

The LignoForce and LignoBoost processes both extract lignin from black liquor via variations on the same chemical process, and function as add-ons to an existing kraft pulp mill. Separately there have been developments of hardwood-based hydrolysis pathways that do not make pulp; rather the wood input is converted to cellulose, hemicellulose and lignin streams, each one requiring its own market. Recent examples include plants built by Fibenol in Estonia, and by UPM at Leuna in Germany. These stand-alone plants do not need to be built next to a pulp mill, but benefit from availability of hardwood and access to common utilities found on pulp mill sites, such as heat, power, fresh water, effluent treatment, wood handling, etc.

Worldwide, three commercial kraft lignin plants were installed in the period 2013 to 2016. No new plants have been announced since then, implying that the three existing plants are not sold out. More recently, new hydrolysis plants have been announced, where lignin would be one of several co-products.

New product announcements and presentations at recent international conferences[1] have become more frequent in recent years, implying that the operators of existing plants are beginning to understand the process and product, and are developing the ability to tailor lignin to different customer needs. These include announcements by Finnish forestry companies Stora Enso (which operates the Sunila plant), West Fraser (operating in Hinton, AB), and UPM (which had an agreement to sell lignin made in the Plymouth mill). UPM and Fibenol are also pursuing new hydrolysis lignin product opportunities.

New products and new markets imply increased demand, perhaps sufficient to justify new plants, whether hydrolysis or kraft lignin, in the near future. A window of opportunity exists to put Ontario back at the forefront of lignin product development and commercialisation, leveraging existing knowhow at Lakehead University and the BETC pilot plant along with the results of past CRIBE investments.

The intent of this project is to provide a strategic, policy-level briefing note or roadmap showing the way towards the production and, ideally, the use of High-Performance Lignin from wood in an Ontario context. While the influence of policies is critical and should be acknowledged and addressed, the focus needs to be on technologies, business information such as capital or operating costs, potential markets and potential pricing, etc.

Project description: A Phase I roadmap

With interest growing in lignin worldwide, R&D providers, industries and governments in Ontario are well-placed to build on past work and move to the forefront of new developments. The desired outcome of this Phase I project is a policy-level briefing note describing next steps and necessary success factors leading to the installation of one or more lignin plants in Northern Ontario. Customer demand will obviously be a large part of this.

This briefing note will need to build on past work. There are several lignin marketing[2] and roadmap reports that could be useful background material. In particular, three road-mapping exercises[3] (available at https://nextfor.ca/resource/lignin-opportunity-roadmaps/) should be considered essential baseline and background material.

[1] Nordic Wood Biorefinery Conference, Helsinki, October 24-27, 2022; BioFor International, Montreal (online), February 6-9, 2023.
[2] Miller, J., "Lignin 2021" A Pivotal Year", Biobased Markets, 2021.
[3] "Resins and adhesives", 2020; "Thermoplastics and composites", 2020; "Polymers and Fine Chemicals", 2020.

Phase I Deliverables: Summary roadmap for decision makers

The primary deliverable will be a report outlining potential next steps in the context of the current state of the art, for a readership including Ontario government policymakers and industrial strategic planners.

This RFP is for Phase I of a potential multi-phase project. Specifically, CRIBE requires a strategic, techno-economic roadmap to identify production and market opportunities for lignin in an Ontario context, with specific focus on what it would take to get one or two lignin plants built in Northern Ontario in a 3-to-5-year timeframe. Report sections should cover the following items.

Section 1: Technology background

Given the significant differences between the products, two pathways need to be evaluated: kraft lignin extraction from a typical 1000 admt/d mill; and hydrolysis lignin based on excess hardwood available in Northern Ontario, or, hypothetically, hardwood freed up once a kraft lignin plant is built, thus allowing swing mills to move to more softwood:

- Scenario 1: Current state of kraft lignin at a 50,000 odt/y scale;
- Scenario 2: Current state of hydrolysis lignin at a feed rate of 250,000 odt/y birch and/or poplar.

Where appropriate, proponents should identify other lignin pathways or scenarios that might be a good fit in Ontario. For each scenario, the subheadings should include the following, among other topics:

- Current level of technology development and providers;
- Current applications and market development status (state of advancement, volumes, pricing, etc.), based on public information such as press releases or conference presentations;
- Probable capital and operating costs for the scales outlined above;
- Minimum or maximum viable scales if different from above;
- Impact on existing infrastructure and/or forest industry landscape:
    - Kraft mills: Sodium-sulfur balance, energy balance, black liquor calorific value, potential for added pulp production, etc;
    - Hydrolysis plants: use of bark, utilities requirements, etc.

Sources of information should include, among others, the following:

- Conversations with current and past recipients of CRIBE funding in this area;
- Conversations with equipment providers;
- New market studies;
- Recent press releases or conference proceedings;
- Proponent's own contacts and files;
- Any other relevant source.

A brief, high-level analysis of successful government/non-government incentives that have enabled biomaterial/lignin development in other jurisdictions is also required. This includes current US policies in the field of green technologies, EU programs such as the BBI JU initiative,

and other examples of relevant support in these or other jurisdictions. An outline of key drivers or success factors, such as government push or consumer pull, would be useful.

A record of past CRIBE investments in this area may be found on the CRIBE website, and should be reviewed to ensure the roadmap builds effectively on past work and avoids duplication of effort.

Section 2: Conclusions and recommendations

This section should provide a list of specific recommendations relevant to the Northern Ontario context:

- What technologies for lignin production make the most sense in Northern Ontario, given the existence of four pulp mills, a paper mill, and an abundance of underutilised hardwood?
- What markets for lignin products make the most sense, given the results of this technology scan and the unique transportation and industrial eco-systems in Northern Ontario?
- Summary of expected or potential capital investments required to develop a Northern Ontario lignin supply chain and anticipated benefits to Ontario forest products sector (competitiveness, utilization of species, etc.);
- Potential end-users for lignin, in Ontario and elsewhere;
- Discussion of potential operating costs and revenues.

Phase II: towards a future site-specific, investment-grade study

While not a part of this RFP, the Phase I report should be written in such a way as to support and guide an eventual Phase II project, should one be necessary. Phase II would lead to an investment-grade study funded jointly by an interested industrial partner.

Proponent skills and knowledge

CRIBE encourages applications from qualified proponents in the field. Recognising the mix of technology know-how, bio-product market knowledge and policy understanding that is required, proponents are encouraged to form consortia where applicable.

Timeline

In order to coordinate with government budget cycles, a final draft report must be delivered by Friday, August 18, 2023, with the final report delivered by Friday, September 1, 2023.

Monthly update meetings with a CRIBE-appointed project manager will be scheduled to review progress and drafts.

Submission Guidelines and Requirements

The following submission guidelines & requirements on the following two pages apply to this Request for Proposal:

1. Proposals are due **April 3, 2023**.
2. A proposal should be submitted electronically (PDF or DOC) that is no more than 20 pages. This must provide an overview of:

a) Methodology to address the requirements above,
b) description a staged approach to working with CRIBE and Project Manager
c) a proposed workplan and milestones,
d) project reporting and knowledge transfer.

3. Pricing should be included in this proposal, and should indicate both the overall fixed price for the project and a detailed breakdown of expected expenses based off proposed deliverables and draft workplan.
4. Background information to be included in the proposal:
   a) resumes of all key personnel performing the work.
   b) previous projects that are similar to this project
   c) references for each
5. Proposals must be signed by a representative that is authorized to commit bidder's company.
6. Proponents should be registered as a Nextfor user and submit a Vendor of Record form prior to submission of this proposal: https://nextfor.ca/opportunity/call-for-vendors-of-record/.

Project Partners

The Centre for Research & Innovation in the Bio-Economy, Nextfor Members, Tom Browne.

Contact and Submission

Please direct all inquiries and responses via email to:

Mike Barten
Nextfor Coordinator, Centre for Research & Innovation in the Bio-Economy

Email: rfp@cribe.ca

Refer to **"Production of High-Performance Lignin Products in Ontario RFP**" in the subject line.

Budget

CRIBE's targeted budget for this project is up to $75,000 plus applicable taxes.

Evaluation

CRIBE will rate proposals based on the following factors, in order of importance. CRIBE reserves the right to award to the bidder that represents the best value as determined solely by CRIBE at its discretion:

1. Cost
2. Responsiveness to the requirements set forth in this Request for Proposal
3. Relevant past performance/experience
4. Samples of work
5. Expertise/experience of bidder and bidder's staff.