

Importance of Forestry Biomass-Based Research and Business to the Prosperity of Thunder Bay and Northwestern Ontario

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Thunder Bay at a Crossroads

Thunder Bay and Northwestern Ontario stand at a pivotal moment in their economic and social development. Historically, the region thrived as a center of forestry, pulp, and paper production. However, global market pressures, mill closures, and the decline of commodity pulp exports have threatened the economic vitality of the region. At the same time, new opportunities have emerged: the next-generation bioeconomy — using renewable forest biomass to produce clean energy, sustainable fuels, advanced functional materials (catalysts, battery components, etc.), and green value-added chemicals [1].

This article argues that investment in forestry biomass-based research and business development is essential to the community prosperity of Thunder Bay and Northwestern Ontario. By aligning with Lakehead University's research strengths, regional industries, and Canada's sustainability agenda, Thunder Bay can become a national leader in the forest-based bioeconomy.

The Boreal Forest as a Strategic Resource

Northwestern Ontario is home to vast boreal forest resources, one of the largest continuous forests in the world. The boreal forests are not only ecologically significant but also an economic backbone of the region. These forests is a strategic resource due to their immense environmental and global climate significance. It functions as one of the world's largest carbon sinks, storing vast amounts of carbon in its trees, soils, and peatlands, which helps mitigate climate change. Specifically, unlike fossil resources, biomass is renewable and carbon-neutral when managed responsibly. It also regulates water cycles, supports biodiversity by providing habitats for numerous plant and animal species, and enhances ecological resilience. These environmental functions contribute to global stability, making the boreal forest a vital component in international climate strategies and sustainability initiatives.

Economically and socially, the boreal forest supports industries such as forestry, mineral extraction, and ecotourism, and potentially bioenergy, providing thousands of jobs and contributing substantially to national economies, particularly in developed countries like the US [2] and Europe [3]. Forest biomass is increasingly valued for its role in the developing bioeconomy, producing sustainable materials such as biofuels, bioplastics, and nanocellulose in countries like China [4] and India [5]. Additionally, the forest holds cultural and livelihood significance for Indigenous communities, reinforcing its socio-cultural importance. As a renewable natural capital with geopolitical influence, the boreal forest is critical for long-term national security, economic development, and community well-being, solidifying its role as a strategic global resource. In future, sustainable forest management could ensure a steady supply of biomass for energy, biochemicals, and innovative bioproducts, while also providing carbon sequestration services critical to Canada's climate targets [6]. Utilized properly, the boreal forest can

certainly play a central role in our transition to a circular bioeconomy that combines prosperity with environmental stewardship.

Building a Sustainable Bioeconomy

A future generation sustainable circular bioeconomy goes far beyond pulp and paper. Forestry biomass can be processed into advanced fuels, hydrogen, bioplastics, nanocellulose, and bio-based chemicals that support industries ranging from transportation to construction.

At Lakehead University, the Biorefining Research Institute (BRI), established in 2008, is the oldest biorefining research institute and has become one of the leading academic institutions in sustainable biomaterial and biomass conversion process development in Canada. By mobilizing the expertise, experience, and passion of an enthusiastic, multidisciplinary research team to benefit the forest and agriculture industries, BRI is recognized as a center of excellence. At BRI, Dr. Pedram Fatehi is pioneering breakthrough research in lignin chemistry, converting this abundant and underutilized biopolymer into a diverse portfolio of high-value materials [7]. Dr. Kang Kang is advancing innovative thermochemical and catalytic processing technologies, including pyrolysis, hydrothermal carbonization, gasification, and catalytic upgrading, to convert biomass and waste feedstocks into clean energy solutions, sustainable fuels, and high-performance biocarbon materials for environmental remediation [8, 9]. Dr. Sudip K. Rakshit has been at the forefront of biorefinery research, advancing a holistic approach to sustainable development. His work emphasizes integrated sustainability assessments, including techno-economic analysis (TEA) and life cycle assessment (LCA), within the broader framework of the circular economy [10]. These advanced conversion pathways create value from materials once considered waste and reduce dependence on fossil resources. Examples of bioeconomy applications span multiple high-impact sectors:

- **Clean energy:** Biomass-derived hydrogen and syngas (a mixture of hydrogen, carbon monoxide, and minor gases) are increasingly used for heating, electricity generation, and transportation fuels.
- **Biochar:** Widely utilized as a soil amendment and slow-release fertilizer, biochar also serves as a catalyst support, a carbon capture medium, a reducing agent in mineral processing, and an efficient adsorbent for water purification.
- **Advanced functional materials:** Biomass-derived carbon-based composites are employed in energy storage systems and lightweight construction materials. At the same time, carbon dots are used for sensing metal ions and chemical pollutants, as well as for drug delivery applications.
- **Green chemicals:** Lignin-derived aromatic compounds, bioplastics, and specialty resins represent sustainable alternatives to petrochemical-based products.

Collectively, these innovations are transforming sectors such as forestry from traditional resource-based industries into modern, diversified engines of economic growth.

Cross-Sectoral Impact in Northwestern Ontario

A growing portfolio of biomass-related initiatives in Northwestern Ontario illustrates that this transition is already underway. Companies such as BioPower Sustainable Energy Corporation and GN Bio Energy are developing pellet manufacturing and biomass facility management services, generating employment in operations, logistics, engineering, equipment maintenance, and supply chain coordination. The Ontario Power Generation (OPG) Atikokan Generating Station, the largest 100% biomass-fueled power plant in North America, represents a CAD \$200 million investment that sustains long-term technical, maintenance, and transportation roles while securing regional energy independence. Collaborative efforts such as the FPInnovations–Resolute Forest Products bio-refinery demonstrate how research-driven innovation can convert wood into lignin and cellulosic sugar products, creating high-value chemical markets and attracting public-private funding (CAD \$23 million). Utilities like Synergy North are transforming landfill methane into renewable electricity, highlighting circular bioeconomy practices and supporting green job diversification. Emerging ventures such as Viridity Hydrogen Inc. position Thunder Bay as a future hub for green hydrogen production, while projects like Wataynikaneyap Power emphasize Indigenous-led renewable energy development, strengthening economic sovereignty in remote communities. Finally, regional accelerators such as CRIBE foster commercialization and entrepreneurial growth in forest-based innovation, supported by provincial investments. As a summary, the projects listed in **Table A1 (Appendix)** illustrate a growing innovation ecosystem that brings new capital, supports skilled employment, stimulates industrial diversification, and reinforces Thunder Bay’s role as a gateway to a resilient, biomass-powered economy.

The future circular bioeconomy has implications well beyond conventional forestry. For example, Thermochemical biomass research connects directly to other regional industries:

Mining and Mineral Processing: Biomass-based carbon materials can aid in critical mineral recovery (e.g., lithium, nickel), vital for battery supply chains [11].

Construction: Biocarbon composites and biochar-infused concrete reduce emissions while improving durability [12].

Water Pollution Remediation: Biomass-derived adsorbents can clean industrial wastewater, reducing pollution from local mining and pulp facilities [13].

Power Supply for Remote and Indigenous Communities: Mobile biomass-to-energy systems provide reliable, renewable power for communities historically dependent on expensive diesel fuel [8].

This integration strengthens the economic resilience of Thunder Bay while reducing environmental impacts across multiple sectors.

Modernizing Legacy Industries

To advance a smooth, sustainable transition, it is important to understand that Kraft pulp mills are already the closest operating model to practical modern biorefineries. Beyond producing pulp, they generate multiple renewable co-products, such as tall oil, turpentine, lignin, methanol, and bio-based process energy, that supply downstream chemical production, biofuels, and advanced materials. In this sense, Kraft mills serve as “anchor mills”: they provide the industrial platform, infrastructure, heat and power systems, and consistent feedstock processing capacity needed to foster secondary industries and stimulate broader regional bioeconomy growth.

Rather than focusing on re-opening specific legacy mills, which in most cases are no longer viable in their previous configurations, a more strategic approach would be to support the development of new or significantly modernized anchor Kraft pulp mills in Thunder Bay and across Northwestern Ontario. Notably, the strong regional hardwood resource base presents an opportunity to produce high-value bioproducts while also enabling future development of Softwood Kraft pulp capacity, a sector where demand remains steady and innovation in low-carbon fibers and packaging continues to expand.

In the short term, investment should prioritize establishing or upgrading Kraft pulp and paper facilities equipped with modern environmental controls, energy efficiency systems, and flexible feedstock utilization. In the long term, these facilities can be incrementally upgraded into fully integrated biorefineries, diversifying into fuels, green chemicals, advanced lignin-derived materials, and sustainable packaging solutions (illustrated in **Figure 1**).

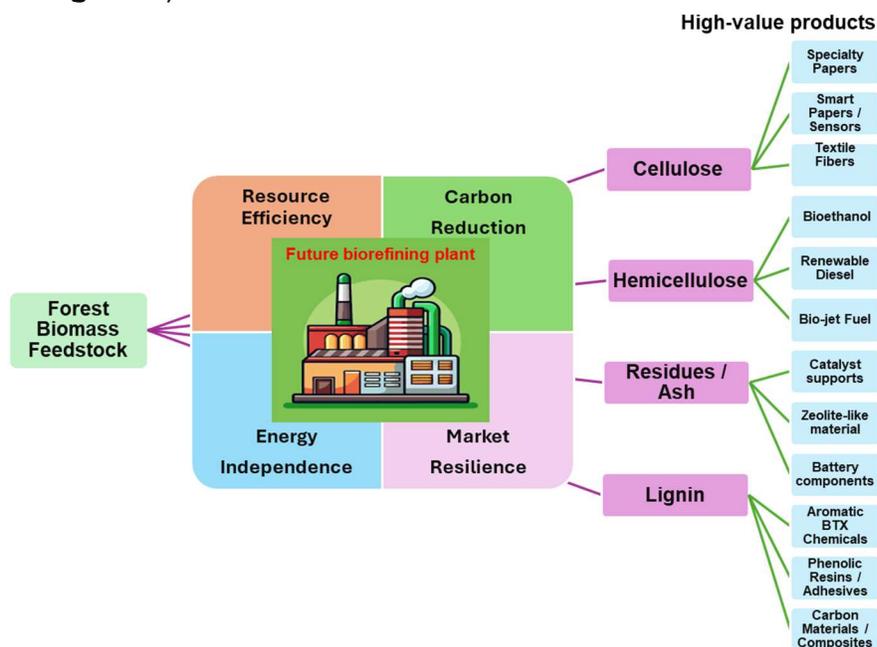


Figure 1: Concept of a futuristic integrated biorefining plant and its potential products.

As shown in **Figure 1**, through process optimization and tailored fractionation and conversion of biomass components, the following products can be derived from a future integrated biorefining plant:

Specialty papers: Engineered papers with tailored properties—such as high strength, water resistance, or biodegradability—are used in advanced recyclable packaging, medical products, filtration membranes, and security documents. These value-added grades command significantly higher market prices than conventional paper.

Dissolving pulp for textiles: High-purity cellulose extracted from wood can be converted into dissolving pulp, which is used to produce textile fibers such as viscose, lyocell, and modal [14]. These bio-based fibers serve as sustainable alternatives to fossil-based synthetic fibers like polyester.

Lignin-derived platform chemicals: Lignin, traditionally burned for process heat, can be isolated and upgraded into high-value bio-based chemicals, including aromatic monomers, adhesives, phenolic resins, dispersants, and carbon materials [15]. These compounds can replace petrochemical-derived counterparts in coatings, composites, and performance materials.

Paper-based electronics and sensors: Conductive coatings and functional nanomaterials can be integrated into cellulose substrates to create flexible, lightweight, and biodegradable electronic circuits, printed sensors, and smart packaging solutions for health monitoring, environmental detection, and supply chain tracking [16].

Renewable fuels: Hemicellulosic sugars and process residues can be converted into bioethanol, renewable diesel, syngas, or bio-jet fuel [17], providing low-carbon fuels for transport and industrial applications. Integration of fuel production enhances mill energy self-sufficiency and revenue diversification.

This phased approach strengthens regional competitiveness, aligns capital investment with market readiness, and positions ports and transportation infrastructure for future scaling into advanced bioproduct export hubs. The final form of the integrated bioeconomy hubs would generate skilled employment, restore industrial capacity, and demonstrate how legacy infrastructure can evolve into sustainable, future-oriented enterprises. It is also worth mentioning that modernized pulp and paper mills can provide important exhibition and education bases for the next generation of Canadian workers. Overall, sustainable development does not mean “stopping development”; rather, it requires a balanced approach that meets current economic and societal needs while preserving environmental integrity and resources for future generations. The visiting/internship experience in these mills, regardless of schooling children or coming to Canada as immigrants, will be a precious experience on their journey of understanding “sustainability”.

Lakehead University as a Catalyst for the Bioeconomy

Lakehead University is the cornerstone of Northwestern Ontario’s transition to a sustainable bioeconomy. Through the BRI and interdisciplinary, interdepartmental collaboration, Lakehead advances applied research in biomass valorization, clean fuels, and environmental remediation (**Table A2, Appendix**). Therefore, keeping the research and innovation hub of Lakehead University should be an important governmental strategy and it is well-aligned directly with Lakehead’s 2025–2030

Strategic Plan (<https://www.lakeheadu.ca/about/presidents-office/strategic-plans-initiatives>), particularly:

Sustainable economic and community development: propelling regional transformation through innovation and entrepreneurship.

Advancing our societal impact: positioning Lakehead as a leader in sustainability, climate leadership, and Indigenous education.

Expanding student opportunity: training a skilled bioeconomy workforce in Northern Ontario.

It is important to emphasize that R&D activities at Lakehead University should not be viewed as a means to generate “quick fortune.” Instead, they ought to be regarded as a high-risk, high-reward investment—one that contributes meaningfully to long-term innovation, societal advancement, and institutional leadership in research excellence. Comparing the information listed in **Tables A1 and A2**, it is clear that most of the bioeconomies’ commercialized products are still direct competitors with their “better” fossil-based products (e.g., pellets vs. coal). Therefore, to further increase the value of next-generation bio-products. Forward-looking research effort supported by local investment is a must. By educating local students, engaging Indigenous learners, and partnering with regional businesses, investing in Lakehead R&D can ensure that prosperity is rooted in the community, preventing the outmigration of talent to Southern Ontario and other parts of Canada.

Policy and Investment Alignment

Thunder Bay’s bioeconomy potential resonates with broader policy frameworks. The federal government’s Clean Fuel Standard, carbon reduction commitments, and investment in critical minerals and clean tech all intersect with biomass-based innovation. Ontario’s focus on forestry sector modernization aligns with this opportunity, particularly through the leadership of Hon. Kevin Holland, Associate Minister of Forestry and Forest Products. Moreover, it is worth mentioning that the Ontario Forest Biomass Program supports the expansion and modernization of the province’s forest bioeconomy by increasing the use of underutilized wood and forest biomass. Through four streams focused on Indigenous partnerships, pathway exploration, innovative bioproduct development, and sector modernization, the program encourages new business opportunities, investment, and sustainable economic growth (<https://www.ontario.ca/page/forest-biomass-program>).

At the national level, Mark Carney’s plan for building a stronger Canada emphasizes green growth, financial stability, and sustainable jobs (<https://liberal.ca/cstrong/build/>). A thriving Northwestern Ontario bioeconomy fits directly within this vision, ensuring that prosperity is inclusive, low-carbon, and regionally balanced [2]. Importantly, Indigenous communities across Northwestern Ontario hold rights, knowledge, and experience that are essential for developing a

sustainable forestry future; therefore, close collaboration with them when developing major projects would be critical.

Conclusion

Thunder Bay's future lies not in abandoning its forestry roots, but in redefining them for the 21st century. The boreal forest represents a renewable strategic asset that, if managed wisely, can drive long-term prosperity. By funding cutting-edge research at Lakehead University, investing in innovative biomass enterprises, and modernizing legacy industries, the region is well-positioned to emerge as a Canadian leader in the sustainable bioeconomy. This transition will stimulate the creation of skilled employment opportunities in forestry, engineering, and green technology, while fostering stronger partnerships with Indigenous and local communities. It will also align with Canada's broader climate and economic resilience objectives, positioning the region as a key contributor to national sustainability goals.

In this evolution, Lakehead University will continue to serve as a critical anchor institution for knowledge, innovation, and regional development. With strategic vision and sustained investment, Thunder Bay can transform from a traditional forestry town into a national hub of sustainable prosperity, driven by biomass innovation and future-focused thinking.

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Appendix

Table A1: Forest Biomass and Biorefining Relevant Projects/Activities in and around Thunder Bay

Company/ Initiative	Overview	Primary Biomass Resource	Main Product	Capacity	Investment Details	References
BioPower Sustainable Energy Corporation	Manufacturer of commercial wood pellets. Acquired Atikokan pellet plant in 2018.	Sourced wood from Northern Ontario forests	Commercial wood pellets	110,000 mt/year	Not specified	https://bpse.ca/company/
GN Bio Energy	Project management and technical services for biomass facilities.	Forest biomass	Wood pellet with a recycled carbon binder (Canadian patent)	Not specified	Two pellet production facilities and one co-generation facility.	https://www.gnbioenergy.ca/services/
Ontario Power Generation (OPG)	Operating Atikokan Generating Station, largest 100% biomass-fueled power plant in North America, started operation 2014.	2 mt of wood pellets (biocoal)	Electricity	180 MW in-service generating capacity (June 30, 2025)	\$200 million conversion from coal to biomass.	https://www.opg.com/power-generation/our-power/biomass/

Company/ Initiative	Overview	Primary Biomass Resource	Main Product	Capacity	Investment Details	References
FPIInnovations & Resolute Forest Products	Canadian research organizations with operations across North America.	Thermomechanical pulp (TMP) to extract valuable bio-based chemicals	Lignin and cellulosic sugars as alternatives to petro-derived chemicals	The bio-refinery pilot plant has the capacity to process 100 metric tons of biomass annually.	Total investment CAD \$23 million. Funding sources include: (1) Ontario Government: \$4.5 million (2) Resolute Forest Products: \$3.5 million (3) Natural Resources Canada: Through its Clean Growth Program	1. https://web.fpinnovations.ca/ 2. https://news.ontario.ca/en/bulletin/41463/ontario-supporting-forestry-innovation
Synergy North	Municipally owned by Thunder Bay and Kenora, engaged in renewable energy projects.	Methane from Thunder Bay's landfill	Renewable electricity (3.2 MW), enough to power ~2,000 homes.	3.2 MW; converts ~263 million cubic feet of methane annually.	Developed on leased city landfill land; specific financial details not publicly disclosed.	https://www.thunderbay.ca/en/city-services/landfill.aspx
Viridity Hydrogen Inc.	Canadian company focusing on producing green hydrogen from hardwood forest biomass.	Hardwood forest biomass sourced from the region	Green hydrogen	Not specified	Not specified	http://www.viridityhydrogen.ca/

Company/ Initiative	Overview	Primary Biomass Resource	Main Product	Capacity	Investment Details	References
Wataynikane yap Power	First Nation-led company working to replace diesel power with renewable energy in remote communities.	Biomass (wood pellets)	Renewable electricity from biomass.	Not specified	Not specified	Northwestern Energy Sector Labour Demand Report, March 2022
CRIBE (Centre for Research and Innovation in the Bio-Economy)	Thunder Bay-based non-profit organization that accelerates forest-based innovation and commercialization.	Underutilized wood and mill byproducts	Forest-based, low-carbon solutions such as biochar, biocarbon, and lignin-based materials.	Not specified	Ontario government: \$5 million	https://cribe.ca/?utm_source=chatgpt.com

Table A2: Forest Biorefining Researchers and Activities at Lakehead University

Name	Rank	Institute/Department	Research area	Recent works	Recent Publication	Ongoing projects
Dr. Pedram Fatehi	Director & Professor; CRC (Tier II); Industrial Research Chair	BRI/Chemical Engineering	Lignin modification & hemicellulose valorization; cellulose-based nanomaterials; colloid & interface science	Lignin-derived functional polymers, lignin nanoparticle materials, dispersants, and flocculants	https://doi.org/10.1016/j.fuel.2025.136451	Lignocellulosic feedstock valorization; lignin nanoparticle aerogels; lignin-based functional materials
Dr. Sudip K. Rakshit	Canada research Chair in Bioenergy and Biorefining Processes (Tier I); Professor	BRI/Chemical Engineering	LCA, TEA, and biological Biorefining processes	Production of biofuels: Techno-economic analysis	https://doi.org/10.1016/j.indcrop.2023.117620	Biocatalysts, bioethanol from residues, and circular bioeconomy (LCA and TEA studies)
Dr. Kang Kang	Associate Professor	BRI/Chemical Engineering	Biomass thermochemical conversion processes; biochar and related functional materials; Catalysis	Biomass gasification, pyrolysis, hydrothermal processes, and biochar/bio-carbon materials	https://doi.org/10.1002/cjce.70061	Bio-carbon nano sensors for pollutant sensing; Biochar-based adsorbent for critical mineral recycling and water decontamination; hydrogen production from catalytic biomass conversion
Dr. Seyedrahman Djafaripetroudy	Bio-refining Research Chair in Lignocellulosic Materials Development; Assistant Professor	BRI/Natural Resources Management	Lignocellulosic materials development; cellulose nanotechnology; eco-friendly Superabsorbent polymers	Conversion biomass to functional materials (seaweed based nanocomposite)	https://doi.org/10.1007/s13399-024-06413-4	Synthesizing bio-inspired nanomaterials from seaweed in different qualities

Dr. Baoqiang Liao	Professor	BRI/ Chemical Engineering	Lignocellulosic materials-based membranes; water & wastewater purification; Membrane bioreactors, particle science and technology	Biofilm photo bioreactor, Heterogeneous catalyst for pollutant removal and adsorbents for process water recovery	https://doi.org/10.1016/j.bej.2025.109932	Membrane Photo bioreactor (EK-MPBR) for Municipal Wastewater Treatment
Dr. Mathew Leitch	Chair, HBScF; Professor	BRI/Faculty of Natural Resources Management	Wood quality; value-added forest products; biomass for energy and heating systems	Wood property mapping; development of value-added wood composites and laminates	https://doi.org/10.1007/s00226-019-01101-3	Wood product development and testing
Dr. Ebrahim Rezaei	Associate Professor	BRI/Chemical Engineering	Catalytic total oxidation of organic pollutants in gas/liquid phase; heterogeneous catalysis; catalytic biomass conversion; modelling, simulation, and optimization of chemical process	Modelling and optimization of catalytic conversion processes; CO ₂ /CH ₄ reforming research	https://doi.org/10.1016/j.jece.2025.119661	Catalytic reforming of CO ₂ into syngas and the treatment of industrial air pollutants using catalytic ozonation
Dr. Lionel Catalan	Professor	Chemical Engineering	Process simulation & optimization; pulp and paper process engineering; pyrolysis modelling	Chemical process design, with emphasis on CO ₂ utilization	https://doi.org/10.1016/j.ijhydene.2024.03.286	Simulation/modelling for thermochemical biomass conversion processes

Dr. Wensheng Qin	Professor	Biotechnology/Biology	Biotechnology for enzymes, biofuels, bioproducts, and bioremediation.	Microbial Engineering, Cellulase Production	https://doi.org/10.1016/j.algal.2025.104264	Microbial engineering for lignocellulosic biomass conversion
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