



The New Face of the Canadian Forest Industry

The Emerging Bio-revolution

The Bio-pathways Project

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Forest Products
Association of Canada
fpac.ca

FPIInnovations 



About Bio-pathways

The Future Bio-pathways Project is a comprehensive investigation of the opportunities to produce a wide range of bio-products from wood fibre. The first phase of the study, released in February 2010, examined the economic, social and environmental benefits of integrating these new bio-technologies within the traditional forest products industry and it considered how this approach will boost employment and strengthen Canada's economy and rural communities. The project was led by the Forest Products Association of Canada (FPAC), with FPInnovations, Natural Resources Canada and scores of economic and scientific experts.

The second phase of the Bio-pathways project, released in 2011, examined the market potential of emerging bio-energy, bio-chemical and bio-products, and it explored new approaches to managing value and building partnerships in this critical area.

Key findings of the Bio-pathways project:

- Numerous viable options exist to convert forest biomass to bio-energy, bio-chemicals and bio-material.
- These options are best achieved by integrating their production with the traditional forest industry.
- Producing these products at forest industry facilities improves the economic results for the bio-products and forest industry facilities. It increases the job potential by up to five times versus stand-alone bio-energy plants and is environmentally beneficial.
- Markets already exist and are dynamically growing for this broad range of innovative bio-products that can be produced by extracting maximum value out of the wood fibre from every tree. These new markets will reach an estimated \$200 billion by 2015.
- Canada's forest sector is already producing a range of bio-products, but it is not maximizing their contribution to the industry's bottom line.
- Integrating new bio-technologies into existing production will ensure a vibrant future and a Canadian advantage for the sector.

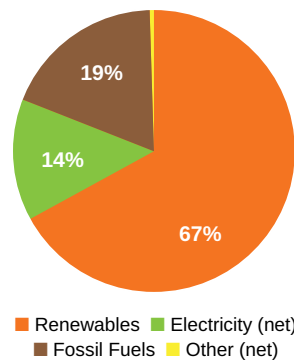
THE BIO-FUTURE FOR CANADA'S FOREST INDUSTRY: IT'S ALREADY BEGUN

The Bio-pathways project is a blueprint for an exciting future for Canada's forest products industry—a blueprint that would see the industry lead the world in innovation and give Canada an advantage in world markets. It's a future defined by new prospects for growth as the Canadian forest sector moves from an established, process-driven commodity industry to a nimble and "green" industry serving wider markets and driven by opportunities emerging in the 21st century bio-age.

Canada's forest products industry is already starting to extract more value from wood fibre. Yesterday's waste stream is fast becoming tomorrow's revenue stream. The Bio-pathways study identifies a potential global market opportunity of around \$200 billion.

This exciting transformation is already taking hold in the Canadian forest products industry.

Pulp & Paper Energy Shares, 2009

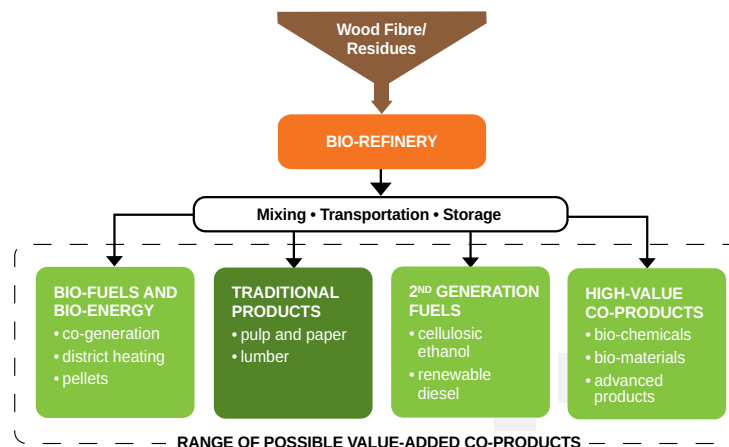


ADDING VALUE

The Bio-pathways project makes the case for integrating current operations with new add-on processes that create bio-energy, bio-chemicals and bio-materials that add value and jobs. Imagine a conventional forest industry operation. You would see piles of timber or wood chips waiting to be processed, a building housing a sawmill or pulp mill and stacks of processed wood or pulp waiting to be shipped.

In the near future, some of these traditional operations might include bio-refineries that produce renewable fuels, plastics and chemicals for the pharmaceutical and food industries while also generating electricity that can be added to the wider grid and used in people's homes. The site would produce little, if any, waste while generating higher income.

This vision is becoming reality faster than most Canadians realize. For example, FPInnovations, Canada's leading forest sector innovation centre and research and development institute, is already working with industry partners to verify and optimize the gasification of biomass at mills.



FOOD ADDITIVES, BULLETPROOF VESTS AND AIRPLANE WINGS

Products such as food additives, bulletproof vests and airplane wings may not come to mind when you think of a tree. Yet they're some of the existing and future products that are making up the dynamic new face of the forest sector in Canada.

Clothing: forest fashions

Wood can be processed to produce fibres with qualities suitable for textiles such as rayon. These traditional fibres could be combined with new technologies to compete with traditional synthetic textile fibres.

Market opportunity: Forest product textiles could take the pressure off the rapidly shrinking global cotton supply.



Aerospace: forests are taking off

Nanocrystalline cellulose composites being produced from wood fibres could be used in the aerospace industry to replace heavier more expensive non-renewable materials.

Market opportunity: Lighter materials mean lower fuel costs and fewer emissions for airplanes.



Bio-plastics: Biodegradable forest products

Bio-plastic is derived from renewable biomass unlike traditional plastic, which is made from petroleum. Renewable and biodegradable bio-plastic can directly replace or be blended with traditional plastics.

Market opportunity: The market demand for bio-plastics continues to grow. Overall, customer needs for plastic will double in the next decade.

Tires: forests are on the move

Lignin, the organic substance that holds together the individual fibres of wood, is being considered as a replacement for carbon black, a petroleum product used to manufacture rubber needed for products such as car tires.

Market opportunity: Substituting petroleum with lignin means greener tire products.



Bio-oil: forest power

Subjecting wood products to high pressure and temperature can produce renewable bio-oil in seconds.

Market opportunity: This petroleum substitute turns a forest waste stream into a revenue stream.



Bio-active paper and packaging: smart forest products

Emerging technology is pointing to new uses for paper: paper towels could indicate contamination on kitchen counters; strips of paper could remove pathogens from water and confirm the water is safe to drink; medical masks could actively remove viruses; and intelligent packaging could change colour to indicate freshness.

Market opportunity: Bio-active paper and packaging adds value and improves health.



Bio-pharmaceuticals: forest medicines

Bio-active compounds in plants could lead to new and economically viable pharmaceuticals and other bio-products. Already, paclitaxel, a bio-active compound originally isolated from the bark of western yew, is a proven anti-tumour agent.

Market opportunity: New drugs could help heal more people.

Bio-buildings: reaching for the sky

Wood has been used for centuries in buildings but new products and construction techniques are pushing wood construction into the sky. New developments include the possibility of 10-storey (or higher) wood buildings.

Market opportunity: One to three billion board feet could be used in non-residential construction each year.

INVESTING FOR GROWTH

Canada's forest products industry is already moving down the road of the bio-revolution. The industry has world-class environmental credentials, the expertise to thrive and the road map to combine traditional operations with leading-edge, value-added products. This adds up to a diversified revenue stream and attractive investment opportunities.

Being part of the 21st century Canadian forest products industry gives investors the best of many worlds — an essential commodity with a global customer base, as well as innovative bio-technology products poised to revolutionize vast sectors of the global economy. And these “green” products sourced from a well-managed renewable resource can also form a Canadian advantage in the rapidly evolving global marketplace.

The last decade saw brutal economic realities drive cost-cutting and efficiencies throughout the forestry supply chain. Today, the industry has a well-deserved reputation as a proven leader in process-driven improvements focused relentlessly on the bottom line. Consider that more than 600,000 Canadians are directly or indirectly employed by the forest products industry. Exports from the sector are worth \$23.6 billion, which translates into a trade surplus of \$14.4 billion — second only to the oil and gas industry.¹

But Canada's forest products industry is not content to maintain the status quo. A profound shift is underway. Industry will continue to optimize its core business, but it will also maximize shareholder value by allocating

“This study identifies a global market opportunity of \$200 billion. For example, the potential for bio-chemicals is \$62 billion.”

wood fibre to production processes with the highest possible profit and value added. For individual plants and mills, it means operations can channel production from basic materials to bio-products depending on market realities in the emerging bio-economy.

This chart highlights dynamic growth in emerging markets compared to little or no growth in the conventional forest products sector.

GROSS MARKET OPPORTUNITIES

| Products | Annual Growth Rate (%) 2009-2015 (approximate) | Global Market Potential 2015 (US\$ billion) |
|-----------------------------------|--|---|
| Green chemicals | 5.3 | 62.3 |
| Alcohols | 5.3 | 62.0 |
| Bio-plastic and plastic resins | 23.7 | 3.6 |
| Platform chemicals | 12.6 | 4.0 |
| Wood fibre composites | 10.0 | 35.0 |
| Glass fibre market | 6.3* | 8.4 |
| Carbon fibre | 9.5 | 18.6 |
| Canadian forest products industry | neg. to O-2 | 50.0 |

References:

Markets and Markets. 2009. Global Renewable Chemicals Market. The Freedonia Group. 2009. World Bioplastics. Industry Study 2548. Lucintel. 2009. Global Glass fibre Market 2010-2015: Supply, Demand and Opportunity Analysis. Acme Market Intelligence. 2010. World Carbon fibre Composite Market. * CAGR for 2010-2015

Source: Natural Resources Canada (NRCAN) and Industry Canada (IC)

This phase of the Bio-pathway project assessed global markets for these new emerging products. The potential market sizes are staggering. Countries and companies with the right policy frame, the desire to foster innovation and the ability to deploy the resulting technology will be poised to grab market share in these areas and experience growth rates far above those being generated by the traditional forest product sector. This is where the action is!

¹ All data is for the year 2009 unless otherwise indicated and is the most up-to-date annual information available from Statistics Canada.

THE EVOLVING BIO-AGE

Just as the industrial age gave way to the information age, the bio-age is being heralded as the next revolution to transform the globe economically, environmentally and socially. Canada's forest sector is poised to thrive economically in this new bio-age while building on its reputation as a world leader in greening its operations and reducing its environmental footprint.

Producing bio-energy, bio-chemicals and bio-materials from our vast forests — which are renewable and part of nature's cycle — will mean replacing materials now made from rapidly depleting fossil fuels. This can be a tremendous competitive advantage for Canada in the emerging bio-age.

A report from the Organisation for Economic Co-operation and Development supports this view. OECD research points to a long-term increase in the cost of fossil fuels as supplies

dwindle. It predicts that the expected increase in demand for energy combined with restrictions on the production of greenhouse gases will further stimulate the growing market for biomass from forests.²

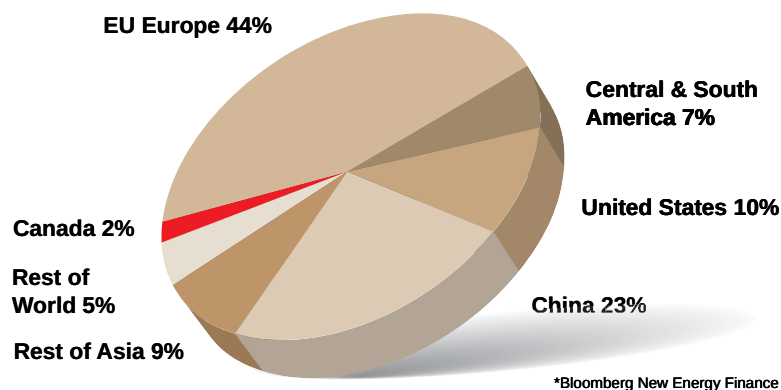
Countries around the world are not waiting to exploit the new markets being ushered in by the bio-age. Already, Canada's competitors are moving quickly to establish themselves as leaders and are heavily investing in their forest sectors in a quest to combat climate change, deliver energy security, and provide greener products to the marketplace.

The Bio-economy will contribute 10—14 new drugs per year by 2015, and it will be responsible for 10 percent of chemical production by 2030.

-The Bio-economy to 2030: designing a policy agenda, OECD

Between 2005 and 2009, the European Union, the United States and China accounted for over three-quarters of all investment in biomass-derived energy. Canada was responsible for just 2 percent — a sign of the huge untapped potential of the Canadian market in the developing bio-age.

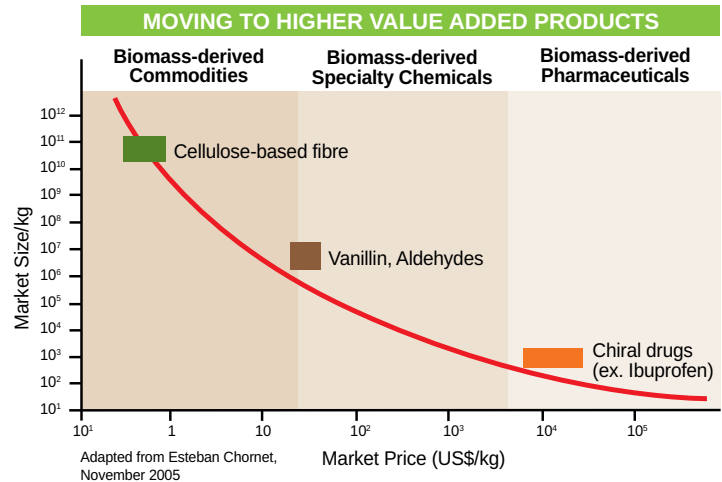
GLOBAL BIOMASS ENERGY INVESTMENTS (2005–2009)*



²The Bio-economy to 2030: designing a policy agenda, Organisation for Economic Co-operation and Development, 2009.

BIO-PATHWAYS — LESSONS LEARNED

The Bio-pathways project shows that markets will continue to exist for traditional forest products such as wood and pulp. Meanwhile, the new technologies will have smaller niche markets but generate a much higher price. Integrated plants could produce up to five times as many jobs as a stand-alone bio-energy plants. Combining the old and the new is the way forward for the next-generation forest industry.



This graph shows how big volumes of biomass-derived commodities will generate lower prices, while lower volumes of bio-chemicals and bio-pharmaceuticals will generate higher prices.

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Bio-energy findings

Combined heat and power production, also called cogeneration, is the simultaneous production of electric power and heat or steam from the same fuel source. The heat or steam that would otherwise be wasted can be used for industrial purposes or for heating or cooling.

Canada's forest industry already uses cogeneration. The Bio-pathways findings suggest this is a good first step on the road to integrating traditional mill operations with bio-energy production. The project also showed that producing more heat and power — and even transportation fuels — is economically viable in bio-refineries where other high-value byproducts are also made. Synthetic hydrocarbons, such as bio-oil, were also shown to be economically viable.

However, producing bio-energy on a commercially viable scale depends on the availability of biomass and creation of domestic markets.



Bio-chemical findings

Bio-pathways identified opportunities for developing new cellulose-based products that can be converted into bio-chemicals and used in novel ways such as making bulletproof vests. Older, smaller-scale pulp mills can be converted to produce a range of bio-chemicals to serve niche markets.

Producing bio-chemicals over the long term will continue to depend on integrated mill operations. Combining the extraction of lignin and hemi-cellulose with the operations of traditional pulp mills can add revenue. Lignin and hemi-cellulose can be used to produce new high-priced chemicals for niche markets. Hemi-cellulose has a number of bio-chemical applications, such as additives for jet fuel.



Bio-material findings

The demand is growing for forest products based on attributes over and above price. The industry must respond by finding innovative solutions to increase the quality and variety of speciality wood-based products. More focus should be placed on applying advanced and innovative technology to reduce production costs and improve methods of manufacturing. Opportunities identified in the Bio-pathways study include engineered wood, pre-fabricated wood construction, ultra-low density insulation and packaging, and repair and renovation systems.

Along with product innovation, there should be business model innovations and a concerted move to offer building systems to existing markets and to new markets that are developing in Europe and Asia. Non-residential construction warrants special attention.

There are already many small-market applications for bio-products — for example, replacing glass or other fibres in fibre-reinforced composites. The development of these products should be customer driven.

THE WAY FORWARD

The Canadian forest sector is ready and willing to play a central role in Canada's economy as a dynamic contributor to the new bio-age while maintaining its reputation as a model producer of traditional forest products. The industry is already exploring opportunities and investing in these new opportunities. But industry can't deliver on the promise by itself. Canadians need to collectively embrace a vision in which the country can be a world leader and build a true Canadian advantage in the new bio-economy.

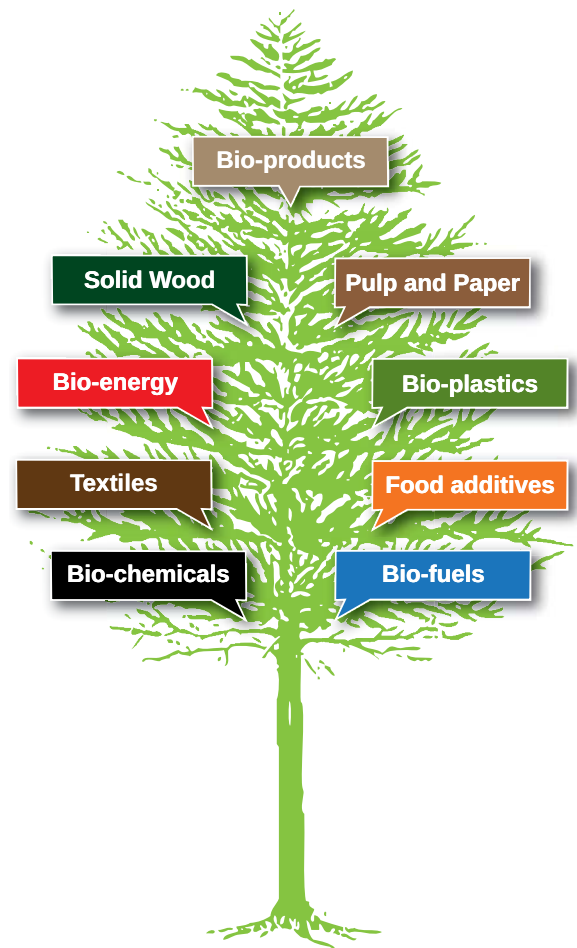
The right policies to compete and win

Other countries are already ahead of Canada on the policy front. The U.S., Europe and China are retooling their policies and making the necessary short-term investments to secure technology expertise, create employment, attract investments and capture fast-growing markets for bio-products. Globalization is also allowing for a more specialized range of forest products. Here too, innovation is crucial to being competitive.

Industry needs policies that focus on closing the innovation gap, creating domestic market potential and encouraging first adoption of the most promising technologies. Canada's policy framework must also support better infrastructure to facilitate the transportation and transmission of green electricity.

Shared risks, shared rewards

Success in the bio-age will come from coordinated investment linked to a vision of what governments want to achieve with their innovative and environmental agendas. The government of Canada has already invested in the transformation of the forest products industry. But more must be done so that the industry can produce long-term plans and share risks and rewards in a more vibrant, green, knowledge-intensive economy.



Partnering for progress

Industry must seek out new partnerships with innovative companies outside the forest sector and build networks to bring bio-technologies to market more quickly. Potential partners include the oil and gas, chemical, auto, aerospace and agricultural sectors as well as academia. Government policies should facilitate these partnerships by removing roadblocks based on dated 20th century economic models.



Learn more

To find out more about the Bio-pathways II project and how Canada's forest industry is moving up the forestry value chain: www.fpac.ca/bio-pathways.

FPAC would like to thank the dozens of researchers, academics and provincial and federal government representatives who collaborated on this project, in particular the staff of FPIInnovations, Natural Resources Canada, the NSERC Value Chain Optimization Network and Professor Sten Nilsson, Special Advisor to FPAC. It would have been impossible to complete this work without access to the data, skills and project leadership provided by such excellent collaborators.

Forest Products Association of Canada

The Forest Products Association of Canada (FPAC) provides a voice for Canada's wood, pulp and paper producers nationally and internationally in government, trade and environmental affairs. The \$54-billion-a-year forest products industry represents almost 2 percent of Canada's GDP and is one of Canada's largest employers, operating in hundreds of communities and providing hundreds of thousands of direct and indirect jobs across the country. All member companies are part of the landmark Canadian Boreal Forest Agreement.

To learn more about FPAC and its members, please visit fpac.ca

About FPIInnovations

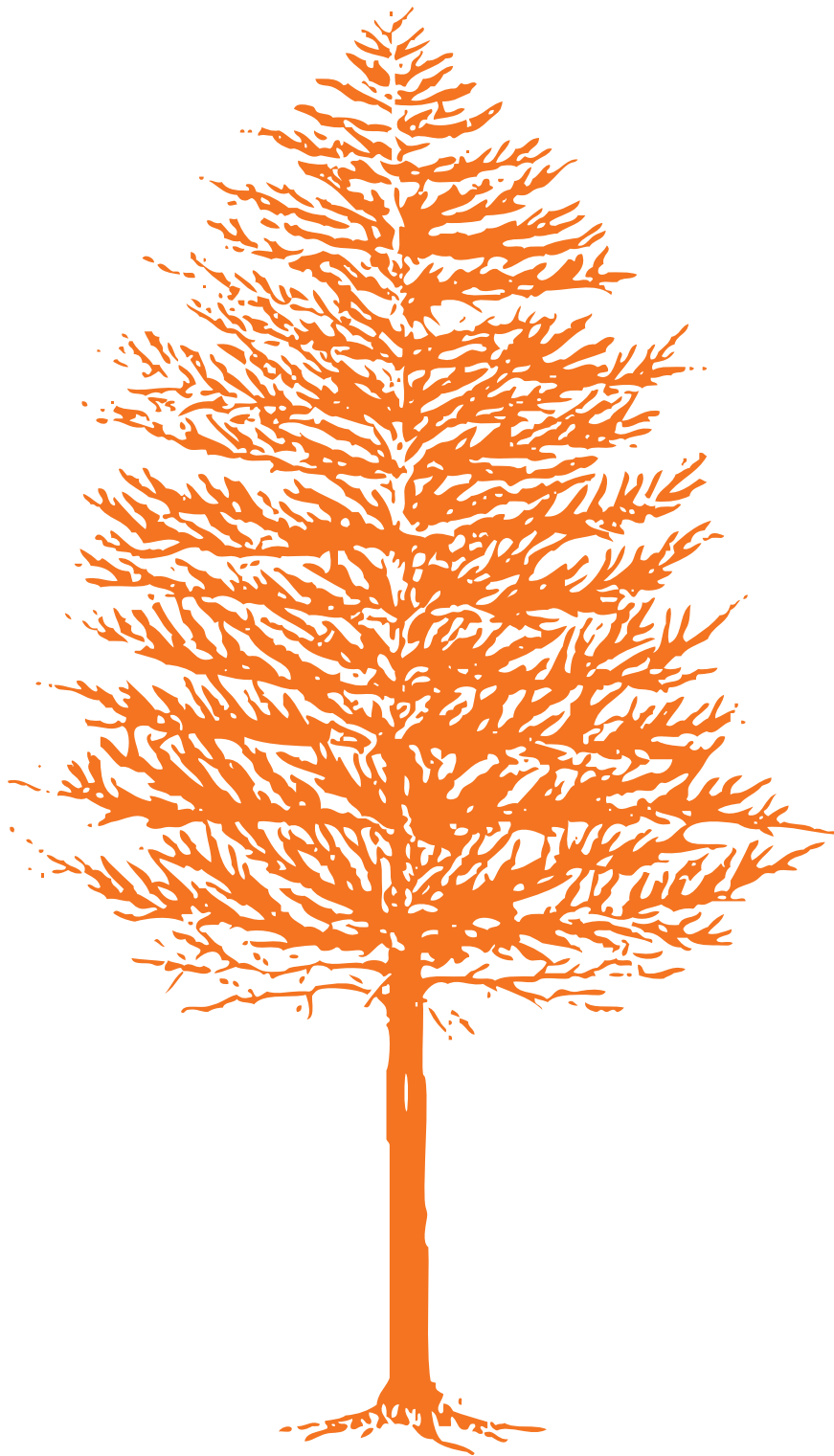
FPIInnovations is Canada's leading forest sector innovation and R&D centre which performs research, technical services and technology transfer activities relating to wood harvesting, wood products, pulp and paper, nanotechnology, bio-energy and chemical production. FPIInnovations' staff numbers approximately 550. Its research laboratories are located in Québec City, Montréal and Vancouver, and it has technology transfer offices across Canada.

To learn more about FPIInnovations and its members, please visit fpinnovations.ca



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