Growing the green economy of the future

Ontario's potential for innovation in forest biomass products

A *Forest Biomass Action Plan* report

Ontario

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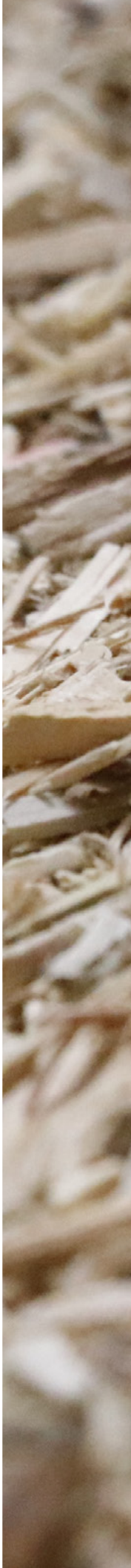


Introduction: **The bioeconomy and Ontario's green future**

Businesses and governments around the world are embracing circular economy principles and making commitments to achieve net-zero emissions. Fossil fuel products are being regulated and disincentivized. Consumers are rejecting unsustainable products in favour of renewable alternatives. Industry buyers are searching for ways to replace non-renewable inputs. Demand for new bio-based options is increasing, especially in categories like materials and chemicals. The global economy must move from fossil fuel dependence to a "bioeconomy" based on renewable resources. This shift will only accelerate with time.

Forest biomass is a remarkably adaptable raw material

Forest biomass innovation could be the solution to this challenge. Forest biomass is one of the most abundant and adaptable types of renewable raw materials. With the right technology, forest biomass can be transformed into everything from clothing to airplane fuel. Forest biomass products can directly replace many fossil fuel products, and forest biomass from Ontario's Crown (public) forests is sustainable. It will be a critical part of the future bioeconomy, and Ontario is well-positioned to seize this opportunity.

Through forest biomass, Ontario can bring home the benefits of this global shift.

What is the bioeconomy?

The bioeconomy is the economic segment that is powered by renewable resources from forests, agriculture, aquaculture, and more. The traditional bioeconomy is known for food, lumber, and natural fabrics. But new bioeconomy sectors are emerging. Today, the bioeconomy produces power, innovative materials, industrial chemicals, and more. As the global economy phases out fossil fuels, the bioeconomy must expand to meet new demands.

Forest biomass: the future, grown in Ontario

Over the last 25 years in Ontario, the forest industry has faced significant challenges. Today's forest industry harvests less than 50% of the sustainable limit. This is mostly due to shifts in markets for traditional paper products.

At the same time, new biomass processing methods, uses, and products are being discovered. Technological advances have created new ways to add value to forest biomass resources. There is increasing demand for biomass products in a wide variety of sectors. Growing a local bioeconomy manufacturing sector will unlock the full potential of Ontario's forest biomass.

Ontario is well-suited to becoming a bioeconomy hub where these innovations can grow and flourish. Ontario has forest industry capacity, an active manufacturing sector, a skilled workforce, and government funding for innovation. With these ingredients, and a collaborative vision for bioeconomy development, Ontario could become a global leader in the forest bioeconomy.

This green future is planted on the reputation of Ontario's sustainable forest management, cultivated by cutting-edge technology, and will bear fruit as the world moves toward renewable alternatives.

Bio-based products are expected to make up half of consumer products by 2050[1]

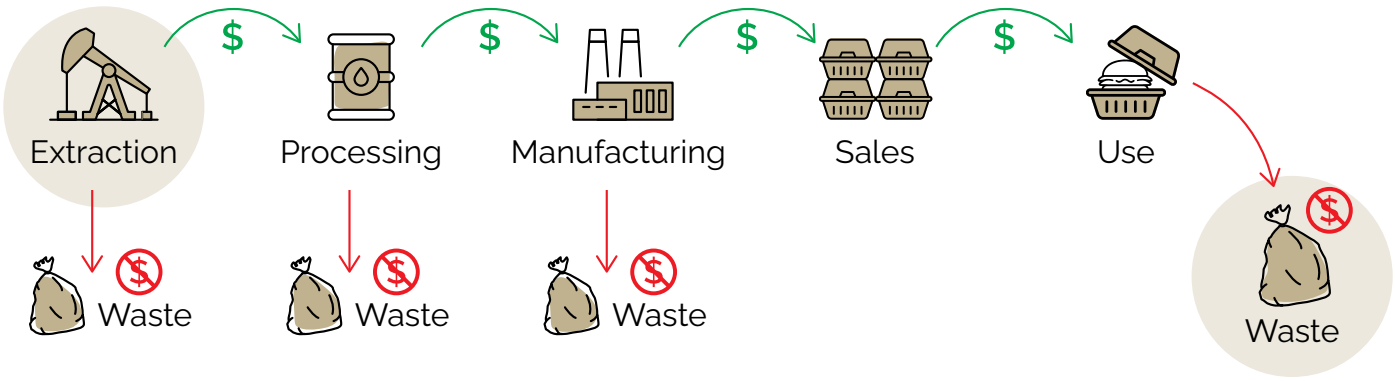
1. Brack, Duncan. (2018). Sustainable consumption and production of forest products. In *United Nations Forum on Forests.* https://www.un.org/esa/forests/wp-content/uploads/2018/04/UNFF13_BkgdStudy_ForestsSCP.pdf

Figure 1. **The bioeconomy, the circular economy, supply chains, and value chains**

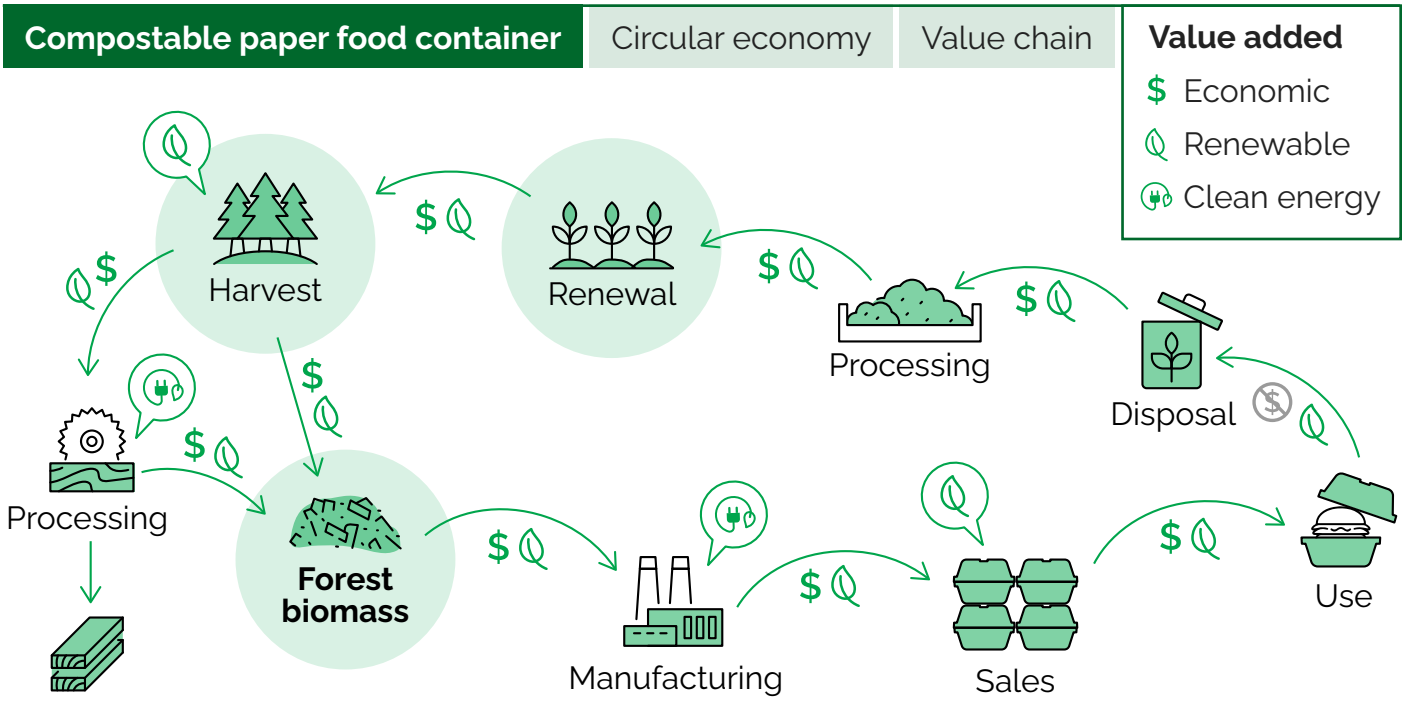
Our current economy is mostly a **linear economy**. Material moves in a straight line: it starts as raw resources, is turned into a product, is used for its purpose, and then becomes waste.

A **supply chain** refers to the steps involved in manufacturing and delivering a product. This chain connects the people who harvest the raw materials to those who use the final product.

Single-use plastic food container | Linear economy | Supply chain



Compostable paper food container | Circular economy | Value chain



In a **circular economy**, nothing becomes waste. The circular economy means finding new ways to repurpose material so nothing is thrown away.

Like a supply chain, a **value chain** includes sourcing material, production, sale, and use. However, where a supply chain focuses on the movement of material, a value chain focuses on creating **value for the consumer and society.**

What is forest biomass?

Forest biomass is a broad term that has multiple meanings depending on the intent of its use and the discipline or industry using it. In the most general sense, forest biomass refers to all biological material (living and dead) in forested landscapes.

Consistent with Ontario's sustainable forest management framework, this document focuses on two types of forest biomass that can be converted into bioproducts through new and existing industrial processes:

- **Forest biofibre:** Composed of forest resources (trees or above-ground tree parts) that are not normally used for conventional forest products, and that are made available from Ontario's provincial forests under an approved forest management plan, or sourced from private woodlots and other forested lands.
- **Mill by-products:** Composed of residues generated from forest product manufacturing (e.g., wood chips, bark, shavings, sawdust).

"There are multiple sources of clean energy in Canada… yet biomass is the only renewable source that can substitute the carbon from fossil fuels in chemicals, plastics and composites."

A Forest Bioeconomy Framework for Canada. Canadian Council of Forest Ministers.

What can forest biomass be used for?

Chemicals

Current uses

- Fertilizers and soil amendments
- Aromatic compounds
- Thickening agents
- Emulsifiers
- Binders
- Food additives
- Fragrances
- Flavouring
- Activated charcoal

Emerging uses

- Sugars and alcohols
- Green solvents and chemicals
- Resins, binders and adhesives
- Medicines and pharmaceuticals
- Paints and dyes
- Plastics and polymers
- Biocoal and bio-coke

Materials

Current uses

- Pulp and paper products
- Packaging
- Personal protective equipment
- Timber products
- Veneer
- Particleboard
- Rayon fibres
- Landscaping products

Emerging uses

- Mass timber products
- Composites
- Textiles
- Carbon fibre
- 3D printing
- Biochar and carbon
- Cellulose nanocrystals and nanofibrils
- Battery energy storage filaments

Energy

Current uses

- Pellet, wood chip, and cordwood heating
- Combined heat and power
- Drying and industrial processes
- Grid electricity

Emerging uses

- Renewable natural gas
- Modern wood heating
- Biodiesel and liquid biofuels
- Community and district energy systems
- Green hydrogen
- Jet fuel

Why forest biomass?

The forest industry of today provides important products, mostly lumber and paper. However, Ontario's forests could play a larger economic role in the province's success. With new technology, forest biomass can become a wide range of products that can be used as alternatives to petroleum products.

Technologies that process forest biomass can enhance efficient resource use, improving forest management, and contributing to a more resilient forest sector. By expanding markets for biomass products, communities that depend on forests will get new, stable jobs. Forest biomass can bring employment and prosperity to rural, remote, Northern, and Indigenous communities. And Ontario can bring the world better renewable products to replace fossil fuels.

New forest biomass products can benefit Ontario's economy, communities, and environment.

Forest biomass builds a resilient economy

- Stronger forest industry with diverse revenue streams
- New sustainable products and solutions
- New business and investment in Ontario's forested regions
- New markets and trade opportunities
- New and cost-competitive uses of wood
- Less waste in the forest industry
- Lower energy costs
- Provincial gross domestic product (GDP) growth

Forest biomass grows a sustainable future

- Less waste from mills goes to landfills
- Less fossil fuel use and lower greenhouse gas emissions
- New sustainable product options
- Less use of toxic fuels and chemicals
- Less wildfire risk in some areas

Forest biomass supports communities

- Local economic growth and prosperity
- Self-sufficient heat and power in Indigenous communities
- More Indigenous participation in the forest sector
- Energy security for remote communities
- Training opportunities
- Local business opportunities
- More community capacity and resilience
- More infrastructure investment
- Essential product manufacturing, such as surgical masks, respirators, and other personal protective equipment

Why Ontario?

Available forest resources

Forest industry capacity and experience

Globally recognized for sustainably managed forests

Diverse manufacturing sector

Large skilled workforce

Cutting-edge research institutions

Government funding and programs for forest biomass

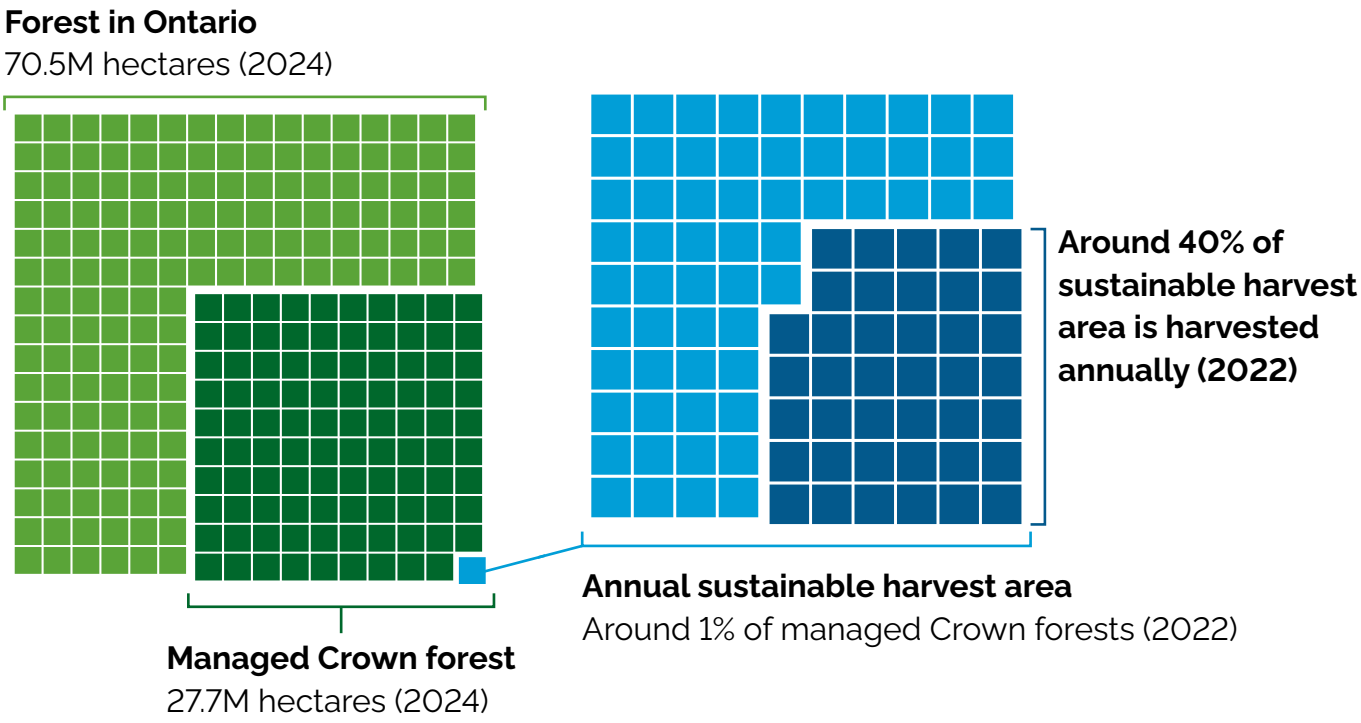
Ontario's underused forest resources

Sustainable harvest of Ontario Crown forests can yield 30M m^3 of forest resources every year. But since 2008, under 15M m^3 is being harvested yearly. In 2022, the total volume of wood harvested was under 13M m^3. Overall, less than 0.5% of managed Crown forest area is harvested yearly.

There is enormous potential for Ontario's forests to power a transition to a bioeconomy. This would boost the Ontario economy overall and provide new products that are increasing in demand around the world.

Figure 2. **Ontario's untapped forest biomass potential**

Room for growth In 2022, only 40% of available sustainable harvest area was used.[2]



Big economic impact With this fraction, the forest industry creates:

$22.8B
Revenue
2022

$7.9B
Exports
2023

$5.5B
GDP contribution
2023

45,800
Jobs in Ontario
2023[3]

2. Ministry of Natural Resources. (2024). *Ontario's Forest Facts.* https://public.tableau.com/views/OntariosForestFacts/AtaGlance?%3AshowVizHome=no
3. Direct employment

Paper demand has declined, impacting Ontario's entire forest industry

Lumber is the foundation of Ontario's forest industry, but a strong and sustainable forest sector depends on uses beyond lumber.

Sawmills create by-product material as they turn trees into lumber. This includes wood chips, bark, shavings, and sawdust. Without a use for mill by-products, sawmills have to pay to dispose of wood chips and sawdust. This potentially high-value material could end up unused.

In the past, pulp and paper were the main uses of forest biomass. Ontario pulp and paper mills depend on paper demand. Demand has been going down steadily, particularly for newsprint and printing paper. This drop is expected to continue. In recent years, Ontario's mills have struggled to stay profitable.

Three of the six remaining pulp and paper mills in the province closed between November 2023 and April 2024. Closures strain the entire supply chain and cause negative impacts across the forest sector.

Without pulp and paper mills buying forest biomass, sawmills have to seek other options. Alternatives may be limited, which can result in increased disposal costs and reduced income. The survival of these mills, and the viability of the entire supply chain, is now more precarious. The previous pulp and paper mill closures eliminated many jobs in communities with few other options, and more closures could come as a result of these downstream impacts on sawmills. This means an overall loss in forest sector capacity and resilience.

For new forest biomass technologies, the forest biomass supply chain in Ontario is a strength. Existing, efficient supply chains are a solid foundation for future investments. Starting new forest biomass projects will boost these supply chains. Innovation must be pursued in order to uplift the sector and ensure long-term stability.

The moment is right for a bioeconomy shift

Ontario can grow a resilient forest industry and support the global shift away from fossil fuels. Ontario can even become a leader in forest bioeconomy innovation. The province's forest sector is at a turning point — and so is the global economy. Ontario's unique strengths and potential have opened a path. Taking this path offers the province a wealth of benefits.

Ontario: excellence in sustainable forest management

Ontario is globally recognized for its effective management of Crown forests

Ontario's public (Crown) forests are vast. They provide many economic, social and environmental benefits to the people of the province. Through sustainable management, Crown forests support a forest industry that creates in-demand products and provides good jobs. For Ontario's forest industry to stay strong and resilient, Crown forests must stay healthy, diverse, and productive.

The policy framework for Ontario's sustainable forest is built on the *Crown Forest Sustainability Act*. The *Crown Forest Sustainability Act* defines sustainability as long-term forest health. The *Act* requires that public (Crown) forests are managed to conserve ecological processes and biological diversity. This includes using forest practices that emulate natural disturbance, such as fire, while minimizing adverse effects on plants and animals, including species at risk, as well as water, soil, and air.

Ontario's sustainable forest policy framework ensures that Ontario's Crown forests are diverse and resilient. The adaptive management approach is based on the best available science. Adaptive management uses an ongoing cycle of planning, implementing, monitoring, and re-planning. Changes are based on performance, and new information is constantly added. This framework draws on both science and Traditional Ecological Knowledge to inform decisions. Long-term forest health takes collaboration. There is a significant role for Ontarians, Indigenous communities, and stakeholders in the forest management planning process.

The world seeks low-carbon alternatives to fossil fuels. For forest biomass to provide sustainable solutions, buyers expect sources to be sustainably managed. Ontario's leadership in sustainable forest management is a strong foundation to build a thriving forest bioeconomy.

Internationally recognized certification

The Ontario forest industry also participates in third-party forest certification. The forest certification systems in Ontario include the Forest Stewardship Council and the Sustainable Forestry Initiative. These systems are recognized around the world.

Over three-quarters of Ontario's managed forest area is certified by third-party sustainable forest management systems. That's more than 27M hectares. This is one of the highest rates of certification anywhere. In fact, Ontario contains 6% of all certified forests in the world.[4]

4. Invest Ontario. (2024, May 13). *Forestry*. https://www.investontario.ca/forestry.

Strategies supporting the development of Ontario's forest bioeconomy

Ontario's Forest Sector Strategy

Vision

Ontario's Forest Sector is a world leader in making and selling forest products from renewable, sustainable and responsibly managed forests.

Ontario is a preferred location for investing in commodity and innovative forest products and advanced manufacturing.

Four pillars

1. Promoting Stewardship & Sustainability
2. Putting More Wood to Work
3. Improving Ontario's Cost Competitiveness
4. Fostering Innovation, Markets & Talent

Key principles

- Leveraging Assets
- Strengthening Partnerships
- Ensuring Sustainability
- Fostering Innovation
- Growing Markets

Ontario's Forest Biomass Action Plan

Five objectives

1. Identify pathways to markets for forest biomass.
2. Support demand for forest bioenergy and bioproducts.
3. Improve the business and regulatory environments for the use of forest biomass.
4. Support holistic, culturally relevant pathways for Indigenous community involvement in forest biomass value chains to support reconciliation between Indigenous communities and the Crown.
5. Communicate, collaborate, and inform on forest biomass opportunities.

Ontario working to evolve the forest sector

Ontario's Forest Sector Strategy

In 2020, the Government of Ontario released Sustainable Growth: Ontario's Forest Sector Strategy. One element of the strategy was a commitment to developing the potential of forest biomass in Ontario..

Ontario's use of forest biomass

Other than pulp and paper, forest biomass in Ontario today is mostly used for energy (heat, power, and combined heat and power). Forest biomass can provide heat and power to processing plants or generate electricity for Ontario's power grid. Forest product operations have long integrated forest biomass as a source of bioenergy. This often leads to using forest biofibre and diverting mill by-products destined for landfill sites. Ontario companies also make wood pellets and wood chips for heating in homes, businesses, institutions, and industry.

Forest Biomass Action Plan

As part of the Forest Sector Strategy, Ontario made a plan to develop forest biomass potential: The 2022 Forest Biomass Action Plan. This highlights Ontario's forest biomass advantages, recognizes challenges and seeks to identify more uses for forest biomass. The Forest Biomass Action Plan is underway, and several actions have been completed. By driving growth in Ontario's forest bioeconomy, the Forest Biomass Action Plan plays a key role in the development of new markets for sawmill residues and other forms of underutilized forest biomass.

Forest Biomass Action Plan Research Summary

This report summarizes research undertaken as a part of the action items in the Forest Biomass Action Plan. This research supports the implementation of the plan to advance bioeconomy development in Ontario. The research included:

- Analysing forest biomass biorefinery types, their products, and potential market paths
- Predicting demand for forest biomass products over the coming decades
- Analysing the current economic impact of biomass in Ontario's forest industry
- Analysing the socioeconomic impact of current and future biomass projects in rural, Northern, and Indigenous Ontario communities, and gathering community perspectives

These research findings enable and empower the expansion of a forest bioeconomy in Ontario.

Forest biomass: Refining a raw material

What is a biorefinery?

Before it can be used, biomass must be converted into a new form: pulp, biochar, gas, oil, or others. A biorefinery is a facility that turns biomass into this new form using a biomass conversion technology. Some technologies are still experimental or in pilot projects; others are already working and successful. Many of these conversion technologies can make several different products with diverse uses. The following section gives an overview of the conversion technologies that are most important and relevant for Ontario.

What is wood fibre made of?

Cellulose: Organic fibers that make up about 40–45% of a tree. Cellulose is a polymer made of repeating glucose (sugar) molecules.

Hemi-cellulose: Organic fibres that bind cellulosic fibres together and that make up about 30% of a tree.

Lignin: A glue-like compound that forms tree structure by keeping cellulose and hemi-cellulose together. It makes up about 25–35% of a tree.

Extractives: All other material in wood fibre. This can include fats, terpenes, phenols and alkaloids.

Pulp biorefineries

Modern pulp mills, also called pulp biorefineries, can create raw materials for a variety of more advanced biochemicals and biomaterials. These include products from lignin and products made from cellulose-based fibres. Both groups of products can replace petroleum-based plastics, chemicals, and more.

Lignin can be used to make adhesives, polymers, polyols, resins, coatings, surfactants, and more.

Cellulose (and variations) can be used to make bioplastics, textiles, concrete, other building materials, and more.

Technologies used to make these products can be added to existing infrastructure through side streams. Or they could be designed as parts of new, modern pulp mills. To seize this opportunity, Ontario needs capital investment in these projects. It also needs to identify markets for these biomaterials and biochemicals.

Investing in pulp biorefineries would bolster the existing pulp and paper supply chain, improve processing efficiency, and create opportunities for new high-value forest biomass products.

Advanced biorefineries (non-pulp)

Advanced biorefineries use fractionation processes instead of pulping. Fractionation means breaking down into fractions. There are many types of fractionation: pyrolysis, gasification, solvent-based, and more. Many products of advanced biorefineries are similar to those from pulp biorefineries, but they offer advantages in quality and purity.

Higher-quality lignin can be turned into more advanced chemicals and materials.

Sugars made from cellulose and hemi-cellulose by fractionation can become fuel, bioplastics, or other advanced chemicals.

Advanced biorefineries can be standalone facilities, whereas pulp biorefineries rely on pulping operations.

Like pulp biorefineries, starting up advanced biorefineries needs significant capital investment. But advanced biorefineries also require more research and development to reach market readiness. Advanced biorefineries represent a long-term opportunity to explore product diversification and value-added markets for forest biomass.

Forest biomass biorefinery types

Biorefinery	Description
Kraft pulp (sulfate)	The most common biorefinery type is the kraft pulp process. It is used around the world, and in the majority of Ontario biorefineries.
Dissolving pulp (sulfite)	Dissolving pulp mills create a pulp often used for fine paper or clothing. It can also be turned into methylcellulose, an additive in many products from toothpaste to baked goods.
Pulp mill side streams	New ways of processing biomass can be built inside of a traditional pulp mill to use unwanted by-products. Oils, chemicals, and raw material for bioplastics are just a few of the products that can be made.
Pyrolysis	This process uses heat and a low-oxygen environment. It breaks biomass down into three parts: biochar, a coal-like solid substance; a gas called syngas; and oil. Each of these products can be used in many ways.
Hydrothermal liquefaction (HTL)	This process can use wet biomass and convert it into an energy-dense heavy oil. Often called "biocrude," this can be used as a substitute for petroleum crude oil in oil refineries.
Gasification	This process uses heat and a low-oxygen environment to turn biomass into syngas. This can be refined into products such as renewable natural gas (RNG), hydrogen, or sustainable aviation fuel (SAF).
New and innovative biorefineries	New biorefinery technologies are being researched and developed around the world. Many of these technologies could create higher-value products. Forest biomass can produce industrial materials and chemicals that are otherwise difficult to make in a sustainable way.

Evaluating biorefinery technologies

Each biorefinery technology can make many products with many uses. The most promising products and markets for each type of biorefinery are shown in the table on the following page. Each product and market is rated by its level of commercial readiness.

Even an established biorefinery type, like a pulp mill, could make new and innovative products. However, they must find the markets that want these products and find a way to deliver them. One experimental process that many biorefineries are exploring is producing bio-based chemicals. These can replace industrial chemicals made from fossil fuels or become raw material for plastic.

New product pathway: from concept to market success

1. **Research and development:** A product concept exists, but it needs proof or detailed research to support it.
2. **Proof of concept:** Laboratory testing and early market research show what's possible.
3. **Demonstration or pilot project:** A small-scale test of a new technology or production process.
4. **Early market stage:** The product is on the market but only in limited amounts.
5. **Commercial maturity:** Widely used with stable demand.

Biorefinery type	Product	Use or market	Readiness for market
Kraft pulp (sulfate)	Pulp	Paper	Commercial maturity
Dissolving pulp (sulfite)	Pulp	Rayon	Commercial maturity
	Pulp	Methylcellulose	Commercial maturity
Pulp mill side streams	Turpentine	Paint, chemicals	Commercial maturity
	Chemicals	Bioplastics	Varies
Pyrolysis	Biochar	Steel (coal substitute for production)	Early market stage
	Biochar	Agriculture (soil amendment)	Commercial maturity
	RNG	Natural gas	Early market stage
	Oil	Oil refinery	Early market stage
	Chemicals	Adhesive, soap	Early market stage
HTL	Biocrude	Oil refinery	Early market stage
Gasification	Syngas	SAF	Pilot projects
New and innovative biorefineries	Chemicals	Industrial chemistry	Varies
	Chemicals	Bioplastics	Varies

The value of forest biomass

What is the financial impact of forest biomass today?

To understand the value that forest biomass brings to the forest sector today, researchers conducted a broad economic survey and analysis. They tried to trace the economic impact of forest biomass from individual facilities to the entire forest sector.

The focus was on two materials: mill by-products and forest biofibre. The survey covered Ontario forest industry activities from 2019 to 2021 and included harvesters, producers, and consumers.

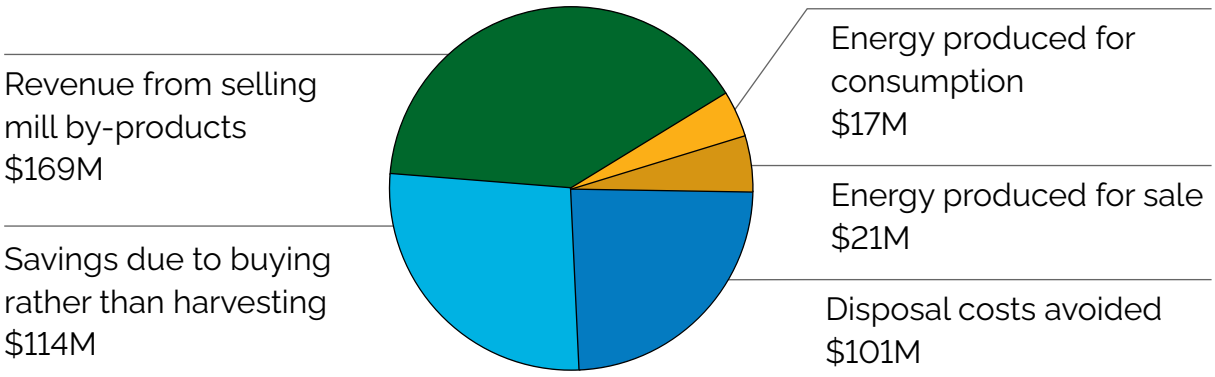
The total financial contribution of forest biomass is the total of:

- Income from the sale of mill by-products (producing mill)
- Savings on disposal cost for unused biomass (producing mill)
- Savings from buying mill by-products instead of harvesting (consuming mill)
- Income from selling biomass energy as electricity (both)
- Savings from using biomass energy at the mill (both)

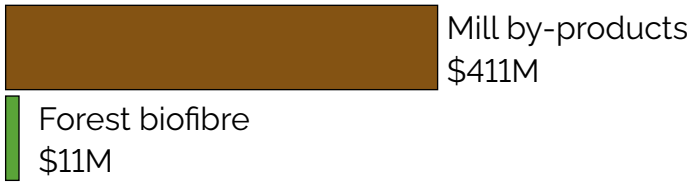
Figure 3. **Financial contribution analysis of Ontario's forest biomass**

Total financial contribution $422M CAD

By revenue source (average, 2019–2021)



By product type (average, 2019–2021)



Future markets for forest biomass

Estimating Ontario forest bioproducts market demand, today to 2050

There are many opportunities to use forest biomass today. New markets and products are developing rapidly. Over the next several decades, more opportunities will emerge.

Researchers used a combination of data gathering, market analysis, and surveys to provide a glimpse at a possible future bioeconomy. The table below predicts market demand for a wide variety of conversion technologies, products and uses. Predictions are broken down into two periods: today to 2030 and 2030 to 2050. These estimates were determined between 2023 and 2024, so they may not reflect current conditions.

Estimating market demand to 2050

The biomass product predictions are divided based on their predicted success in 2050: high, medium, and low.

These are long-term ratings only. The likelihood of short-term success could differ. Some products rated with a high likelihood of success in 2050 are only pilot projects today. One product rated with a low likelihood of success in 2050 — wood pellets for heat — is successful today. It is rated low for the future because any long-term prospects depend on more support from targeted programs.

Chance of success in 2050: high

Product	Details	Today to 2035	2050 market demand	2050 wood needed
Biochar for steel production (pyrolysis)	Biochar made from forest biomass can replace fossil fuels (coal and coke) in blast furnaces	At or close to commercial readiness; strong demand from the steel industry	925,000 t	3.3M bdt
RNG or hydrogen derived from syngas for energy (pyrolysis)	Replacing fossil fuels in heating and electricity; 2050 demand is uncertain and depends on larger economic trends	At or close to commercial readiness	50 PJ	2.8M bdt
Biochar for agriculture (pyrolysis)	Biochar can be added to soil to improve soil quality and reduce fertilizer use	At or close to commercial readiness	1.5M t	3.75M bdt
Lignin for asphalt (pulping)	Demand is based on replacing half of the bitumen in asphalt with lignin from wood pulp	Pilot projects	25,000 t (bitumen)	25,000 bdt

t (tonne) – 1000 kilograms.

bdt (bone-dry tonnes) – Forest biomass weight can vary greatly based on moisture levels, so it is weighed after it has been dried in a kiln to 0% moisture content.

PJ (petajoules) – A measurement of energy.One petajoule is the amount of energy in about 170,600 barrels of crude oil. This is about how much energy it takes to run Montreal's Metro system for one year.[5]

5. University of Waterloo. (n.d.). *Primary energy production.* Canadian Index of Wellbeing. https://uwaterloo.ca/canadian-index-wellbeing/what-we-do/domains-and-indicators/primary-energy-production-terajoules

Chance of success in 2050: medium

Product	Details	Today to 2035	2050 market demand	2050 wood needed
Composites to replace plastics	Demand estimate is very uncertain	Pilot projects	0.3% of world markets	472,000 bdt
Sustainable aviation fuel (SAF)	Assumes that SAF demand increases and other biofuels can't meet demand	Pilot projects	500M L	1.7M bdt
Biochar for metal production other than steel	By-product of RNG production	Pilot projects	About 200,000 t of biochar	800,000 bdt
Pyrolysis oil for industrial heat	Lower end of potential demand; already in use outside of Ontario	At commercial readiness	>300M L	More than 500,000 bdt
Pyrolysis oil and biocrude for refinery feedstock	Assumes replacing 5% of refinery input, with a 75% reduction in refinery activity by 2050	Early market stage	250M L	611,000 bdt
Marine fuel	Estimate is 13% of market	Pilot projects	123M L	300,000 bdt
Bio-based foam and plastic resins for packaging foam	Assumes a 5% annual market growth	Pilot projects	125,000 t	125,000 bdt

Chance of success in 2050: medium

Product	Details	Today to 2035	2050 market demand	2050 wood needed
Bio-based polyurethane for automotive industry	Assumes replacing 25% of fossil fuel input for polyurethane production	At commercial readiness; existing companies expanding	90,000 t	120,000 bdt
Graphite	Assumes 50% market share for bio-based anodes, 30% of Canadian production from Ontario	Pilot projects	85,000 t	800,000 bdt

Chance of success in 2050: low

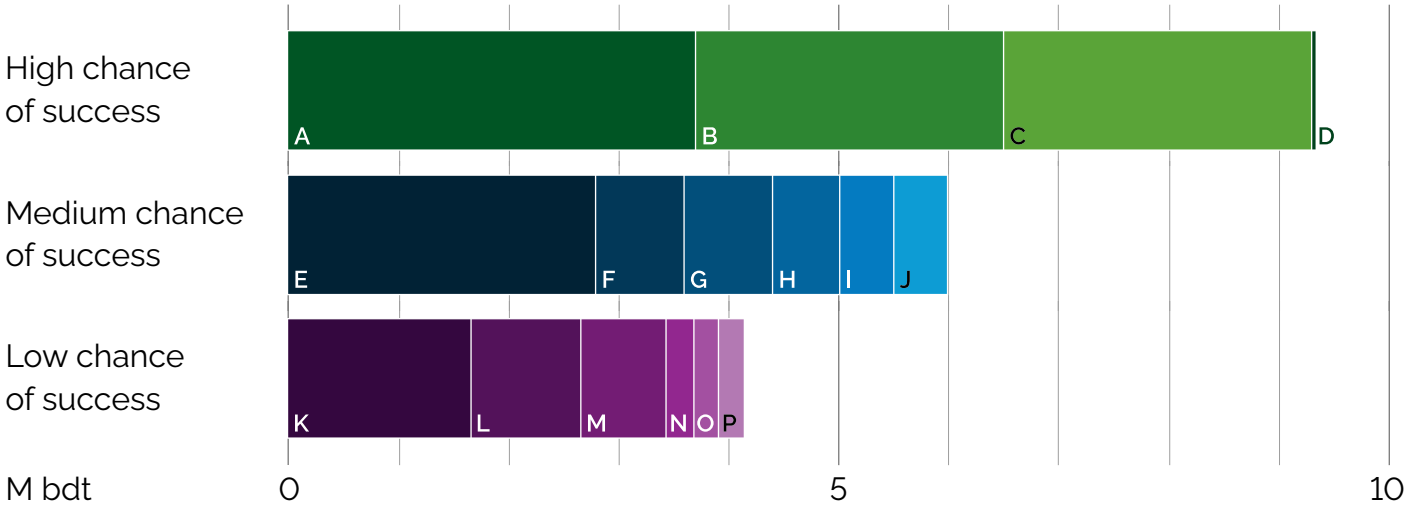
Product	Details	Today to 2035	2050 market demand	2050 wood needed
Bioliquids for chemical manufacturing	To replace natural gas liquids; assumes 10% of 2050 Ontario market	Unknown; more research needed	11,400 barrels per day	1.66M bdt
Bioplastics	Expansion of demonstration plant	At commercial readiness	Potential for one facility	1M bdt
Wood pellets/ chips for heat in rural settings	Replacing fossil fuels in residential, commercial, and institutional heating	At commercial readiness (Long-term opportunity is limited unless supported by targeted programs)	13 PJ	777,000 bdt
Bioenergy with carbon capture and storage (BECCS)	Based on facility in Williams Lake, BC, which generates power for 50,000 homes	Pilot projects	One 50 MW facility	220,000 bdt
Biorefinery for renewable glycols and lignin	Based on facility in Leuna, Germany	At commercial readiness; exploration with international partners	Potential for one facility	220,000 bdt
Textiles	Based on facility in Lenzing, Austria; pulp and paper sector is exploring production of textile-grade fibre	At commercial readiness	Potential for one textile plant	250,000 bdt

MW (megawatt)

Figure 4. **Estimated forest biomass harvest demand in 2050**

This chart estimates the raw biomass feedstock needs of each product. The data is based on predictions of 2050 market demand. The chart shows how much raw biomass each product would consume per year if it succeeds as predicted. The products are sorted by chance of success.

These are estimates only. The projections do not line up exactly with today's biomass supply and demand relationships. In addition, by-products like mill residue and harvest residue can be used for some of these technologies, but not all.



High

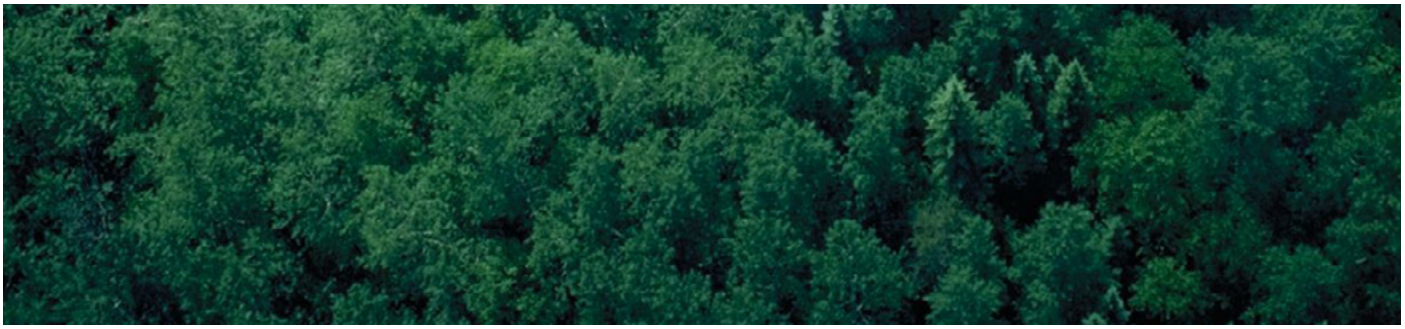
- A Biochar for agriculture
- B Biochar for steel production
- C RNG
- D Lignin for asphalt

Medium

- E Sustainable aviation fuel
- F Biochar for other metals
- G Graphite
- H Biocrude
- I Pyrolysis oil for heat
- J Composites

Low

- K Bioliquids (chemicals)
- L para-Xylene
- M Wood pellets
- N Textiles
- O Other biorefineries
- P BECCS (carbon capture)



Biorefinery investment costs

Pyrolysis plants and biocrude plants are the least expensive to start up ($50M–$200M). They often target lower-priced, higher-volume products and markets. Biochar for steel production or biocrude to replace crude oil are two possible pathways. There are opportunities to use lower-value types of forest biomass in these supply chains. This means lower costs for the plant and less waste for the forest sector.

Biocrude and pyrolysis oil can be used as a "drop-in" product at Ontario's existing fossil fuel refineries. These facilities can make their products more sustainable by replacing a percentage of their fossil fuel feedstock with biomass products.

In contrast to pyrolysis or biocrude plants, advanced biorefinery plants might need $1B or more in startup costs. However, many of these biorefineries can make higher-value products and target untapped markets. New innovative processes can make industrial materials and chemicals that are in high demand. These products are difficult to make in any other way and command high prices.

Replacing fossil fuels requires a multi-part strategy

Biomass can make products that meet environmental standards and help the world move to a circular economy. But the fossil fuel value chain is efficient, high volume, and relatively low cost. That makes cost competitiveness a challenge, and it means that new biorefineries may struggle to find the right market. Supporting the established biomass sector in the short term will strengthen supply chains and expand investment in the sector. This will enable more advanced biorefinery projects to become established in the long term.

Forest biomass projects and local community impacts

Innovative projects are already underway in several rural, Northern, and Indigenous communities across Ontario. More projects are planned or starting up. These projects create jobs in communities with few other options. Economic and social impact data helps determine how these communities are affected.

Ontario's northern, rural and Indigenous communities need sustainable and stable local economic opportunities. Forest bioeconomy projects can bring new employment that fits local needs and values. The FBAP names three broad types of benefits to using forest biomass. The second of these three, "supporting communities and livelihoods," brings benefits like:

- More local jobs
- Training and local business opportunities
- Indigenous community self-sufficiency
- Infrastructure investments

Local bioeconomy development can help alleviate poverty and make communities more self-sufficient and resilient. Programs need to be built with these goals in mind.

Bioeconomy strategies can involve a technology focus by prioritizing high-tech biorefineries, large private companies, and cutting-edge R&D. Local economic growth and technological advancements can coexist and complement each other. The right policies and funding could build a forest biomass value chain that spans all of these needs and benefits. Ontario's biomass industry could make cutting-edge products for global markets and provide benefits to northern, rural, and Indigenous communities at the same time.

Indigenous perspectives

Indigenous communities are leaders in several biomass projects and key partners in others. The forest bioeconomy gives Indigenous communities important pathways for economic development and energy self-sufficiency. It also offers greater influence over the use of forest resources in their territories. Indigenous communities have the potential to take a leading role in developing Ontario's forest bioeconomy.

Biomass projects have inspired praise and pride from community members and have provided jobs in communities that need them. They also contribute to community well-being, reduce reliance on fossil fuels, and use forest resources in a sustainable way. These communities have reported that representatives from other Indigenous communities are very interested in learning more about bioenergy opportunities.

Case study: **Bioheat is a winning strategy for this First Nation**

Wiikwemkoong Unceded Territory

As part of a program to reduce fossil fuel use, Wikwemikong Development Commission undertook an initiative to build bioheat infrastructure. They installed pellet stoves, biomass boilers, wood pellet furnaces, and wood pellet storage silos. These new bioheat appliances replaced old fossil fuel (heating oil) appliances or inefficient wood stoves. Bioheat is now used in large-scale municipal buildings such as the schools and church, as well as residential apartment buildings with up to 33 units.

Interviewers heard from community members hired to install appliances or deliver wood pellets, as well as appliance users. People were happy with the lower heating costs, quality of heat, and sustainability of the system.

Elders highlighted that using sustainable biomass harvest reinforces respect for the land. Youth were excited about an app that lets users track an appliance. There was interest in career options to support these appliances.

Several community members now have WETT (Wood Energy Technology Transfer) certification, which allows them to help with installing appliances. This certification also lets them troubleshoot existing appliances. Users don't have to wait for repair people from further away, which is a major benefit.

The next step for Wikwemikong Development Commission is to look at building a local wood pellet supply. They are proposing a wood pellet plant in Nairn Centre, next to an existing sawmill. Currently, long-distance transport drives up the price of wood pellets. A local wood pellet plant will mean lower costs for users. This project would employ 40 people in the plant and 100 in the forest.

Wiikwemkoong has hosted several other Indigenous community representatives who are interested in bioheat options for their communities.

What do communities want?

They want to know more

The concept of the "bioeconomy" is new to many communities, even those who are familiar with the forest industry. They see that it has economic, social, and environmental benefits. The potential is interesting, and they want help to understand it better. They want to know how the bioeconomy can work for them and their communities.

They want to educate others

In general, Northern Ontario communities feel their story is not well understood across the province. These communities seek to educate the broader public about the forest sector and the benefits it brings.

They want customizable solutions

Each community is unique. Programs to expand the bioeconomy will need to be flexible and customizable. Communities want the freedom to develop their own path.

People care about their communities

It is clear that the social benefits, not just economic growth, make the bioeconomy appealing to community members. These communities want to build thriving, resilient, and sustainable local economies. Many people are motivated to come together and take an active role in shaping local opportunities. (See "Local business owners collaborate on a bioeconomy pivot," next page.)

Case study: **Local business owners collaborate on a bioeconomy pivot**

Renfrew County

With the recent closures of Ontario pulp and paper mills, the local market for pulpwood in Renfrew County has dropped severely. In recent years, under half of the annual allowable sustainable harvest has been logged.

The same problem affected the Renfrew area in the 1990s. Pulp and paper mills were closing down. The region's seven sawmills were losing their buyers. They were all family-owned businesses, so they came together to build a solution. The owners decided they would all invest to build a medium-density fibreboard (MDF) plant.

The mills were responsible for a major part of the investment, but they also partnered with MacMillan Bloedel, a B.C.-based forestry company. The plan was a success. The new project became known locally as the "McBlo" MDF plant. The plant has changed ownership but is still operating today as Roseburg MDF.

Now, the Renfrew area is seeing a repeat of the 1990s downturn. The current sawmill owners are looking to repeat McBlo's success. They're ready to invest and are looking into what kind of biomass plant would fit with their needs. The "McBlo" model may be repeated very soon.

Cultivating future success

Collaboration

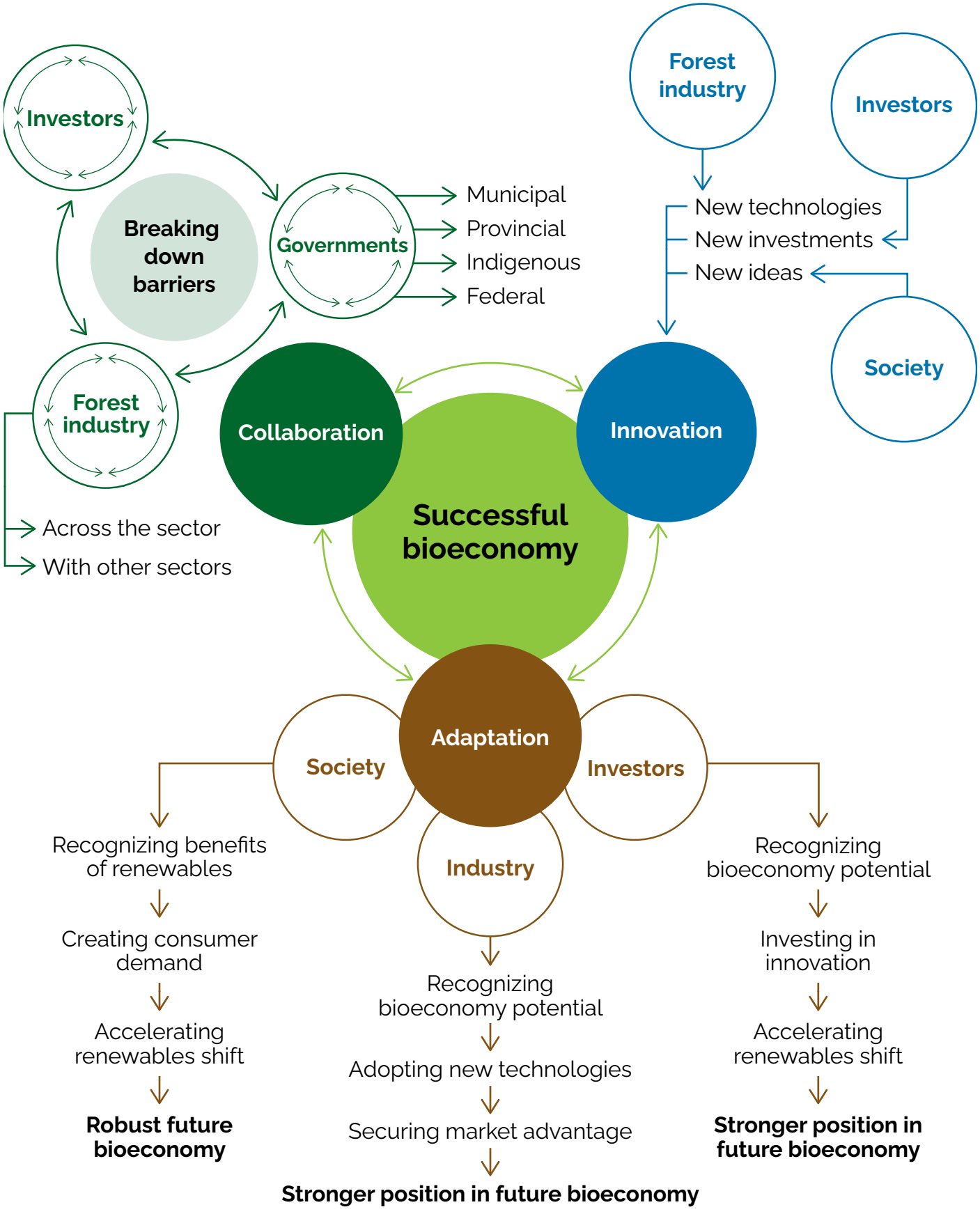
For a new technology to move from idea to pilot project, and from pilot project to mass production, the conditions around it need to be right. Many people need to come together. A new technology needs investment, favourable policies, skilled workers, the right materials, and market demand. Then, it can fulfill its potential.

Key industry stakeholders

These important groups will be at the forefront, building Ontario's future in the bioproducts sector over the next decades:

- The current group of specialized biomass producers and users in Ontario
- New biomass users that have already committed to building facilities in Ontario
- Biomass users from outside of the province that want to partner with Ontario companies
- Other Ontario industries that see opportunities to replace products made of fossil fuels (in auto parts, agriculture, heavy industry, and more)

Figure 5. **Key components of a successful bioeconomy**



Ontario's potential for global bioeconomy leadership

Shifts in global forest biomass sourcing

Ontario's size means wood must travel long distances, which increases cost. At first glance, this can make Ontario seem like a less attractive forest biomass source. However, wood is getting harder to access in many other places around the world. The cost of harvesting and transportation will keep rising in these areas.

An emerging bioproducts industry

Ontario companies are already active in the bioproducts sector. They produce biofuels, biochar, and biochemicals that can become plastic. Several universities and colleges are focusing on research or training for the bioproducts sector.

Innovation networks

The province established the Centre for Research and Innovation in the Bio-Economy (CRIBE) in 2019. This centre supports the creation of new jobs and businesses in the forest bioeconomy. CRIBE then established Nextfor, an industry-led group of collaborators across various sectors. Nextfor's goal is to bring innovators together to collaborate on developing Ontario's forest-based bioeconomy.

A green outlook

Global trends will create opportunities for Ontario's forest biomass. European renewable energy policies have been the main driver of forest bioenergy markets in Canada and Ontario in the last two decades. International demand for alternatives to fossil fuels continues to grow — whether used for energy, materials, or chemicals. International climate change policy will likely keep driving local bioeconomy growth.

Ontario proactively addressing sector challenges

Ongoing work under the Forest Biomass Action Plan is helping to promote the use of forest biomass to secure jobs, enhance forest sector sustainability and support economic development. A 2015 survey[6] asked 190 Canadian businesses in the bioproducts industry what challenges they faced. Lack of financing was the most common response — 30% said it is a major challenge. Regulatory approval costs and delays were the second most common response (over 20%).

With the Forest Sector Strategy and the Forest Biomass Action Plan, Ontario has taken action to address project financing as well as regulatory burden. The Forest Sector Strategy makes a commitment to "Improving Ontario's Cost Competitiveness," and in the Forest Biomass Action Plan, the province commits to "Improve the business and regulatory environments for the use of forest biomass."

Funding the bioeconomy shift

Ontario's Forest Biomass Program supports initiatives that maintain and increase the long-term use of wood in the province, commercialize new uses for forest biomass, and facilitate Indigenous-led projects and participation in forest biomass sectors. The program focuses on initiatives that work with underused species and forest biomass.

The Forest Sector Investment and Innovation Program provides funding for strategic opportunities to improve the forest sector. It intends to improve productivity and innovation, make the sector more competitive, support new market access, and strengthen regional economies.

6. Rancourt, Y., C. Neumeyer, N. Zou. (2017). *Results of the Bioproducts Production and Development Survey 2015.* Statistics Canada. https://www150.statcan.gc.ca/n1/pub/18-001-x/18-001-x2017001-eng.htm

Conclusion: **Growing a bioeconomy in Ontario**

Ontario has the right combination of resources and opportunities to grow a strong and flourishing forest biomass sector. It has sustainably managed forests to provide the raw material. It has the forest industry capacity and experience to build a foundation. It has a diverse manufacturing base to make new products and a skilled workforce to fill new jobs. Through the implementation of the Forest Sector Strategy and the Forest Biomass Action Plan, Ontario is working to create a robust, prosperous, and sustainable forest bioeconomy. The future is a bioeconomy, and Ontario is ready.

Ontario