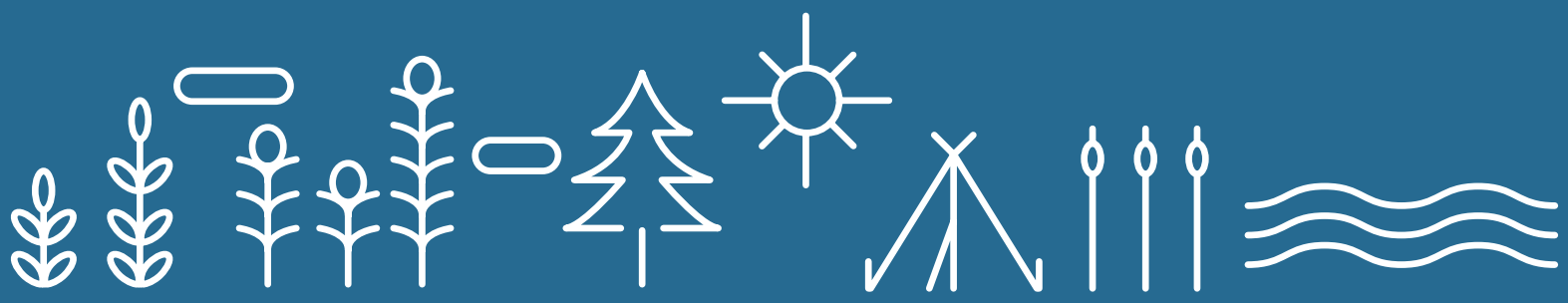
Canada's Bioeconomy Strategy

Leveraging our Strengths for a Sustainable Future



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Flax Field — Composites Innovation Centre

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

Foreword

The Canadian Bioeconomy Strategy was produced by Bioindustrial Innovation Canada in partnership with a writing team (McLaughlin Consultants, BioNB and Anne Waddell) and an advisory committee that has come together under the consortium of BioDesign (made up of representatives from BIOTECanada, FPInnovations and Forest Products Association of Canada). Together, the writing team and committee coordinated and hosted a series of national consultations across Canada to discuss key priorities with industry.

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Acknowledgments

Bioindustrial Innovation Canada (BIC) would like to acknowledge the contributions of our partners in organizing the Canadian industry consultation sessions in the winter of 2018 that laid the foundation for this work:

- Forest Products Association of Canada
- BIOTECanada
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- Bioscience Association Manitoba
- Manitoba Agriculture
- Ontario Agri-Food Technologies
- Ontario Federation of Agriculture
- Consortium de recherche et innovations en bioprocédés industriels au Québec
- Nova Scotia Innovation Hub

Sponsor
Agriculture and Agri-Food Canada

The Team is grateful to more than 400 participants, the majority of whom are hardworking business people and entrepreneurs, who contributed their ideas, experiences and valuable time to the conversations. Their insights, and the direct quotes that reflect these insights, are the foundation of this report and the framework for a Canadian Bioeconomy Strategy.

Report Design and Illustrations
Kathleen O'Donnell

The Approach

The foundation for Canada's Bioeconomy Strategy was launched with the Canadian Council of Forest Ministers' Forest Bioeconomy Framework for Canada (September 2017). Several other recent studies have offered recommendations that relate to the growth of the Canadian bioeconomy. These studies include:

- The Canadian Agri-Food Policy Institute report on Optimizing Growth in the Canadian Agri-Food Sector,
- The Report of the Advisory Council on Economic Growth (the Barton report), and
- Reports from Agriculture and Agri-Food Canada's (AAFC) Industrial Bioproducts Value Chain Roundtable (IBVCRT).

The Team used the recommendations from these studies as the "jumping off" point for the consultations. The studies show Canada as a global leader in the development of agriculture and forestry biomass feedstocks for the industrial bioeconomy. Additionally, the industry-led Economic Sector Strategy Tables, particularly those focused on Agri-Food, Clean Technology and Resources of the Future have also made recommendations directly related to the economic potential of Canada's resource-based sectors.

Treasury Board consultations on regulatory transformation in Budget 2018 including agri-food involved targeted regulatory reviews that will identify bottlenecks and other areas of regulation that can be improved.[1] The reviews will also explore ways to make regulations more agile, transparent and responsive. Stakeholder input was instrumental in developing recommendations that will help improve regulations for a national bioeconomy.

The consultations on the Bioeconomy Strategy revealed a clear path to fostering supply chain integration and the potential for increased adoption of feedstocks across a multitude of industries. The Team gathered input from industry, research organizations and stakeholders from across the bioeconomy value chain. The comments and observations concerning the challenges faced by Canadian firms in the bioeconomy underscore actions that can and should be taken to support the industry.

1 https://www.canada.ca/en/treasury-board-secretariat/corporate/transparency/acts-regulations/consultation-regulatory-modernization.html

Consultations

It was imperative that industry weigh in on the summary findings of the foundational reports and validate the key priority areas. Cross-country consultations were undertaken that engaged participants in the bioeconomy including producers, companies, academic institutions and other stakeholders. A total of 10 consultation sessions were hosted in 7 provinces with more than 400 participants. 146 companies and 62 industry associations participated in this process.

Industry validated the key priority areas and reinforced certain recommendations that were viewed as critical to the advancement of the industrial bioeconomy and the growth of their companies. These priorities from the foundational documents and consultations form the basis for Canada's Bioeconomy Strategy, its recommendations and action items.

> *"A public strategy is needed to clarify for all: 1) the goals that a Canadian bioeconomy is intended to meet; and 2) the path(s) that we are pursuing to attain these goals. Without this, we will not 'move the needle.' Other countries will capture the opportunities." — Survey Respondent*

The Strategy details the priority areas in which industry is recommending action.

These priorities were chosen because they are shared across the bioeconomy and were validated at both the in-person consultation sessions and through the industry survey. Throughout the document there are quotations from respondents and detailed case studies that illustrate the key priority areas.

The view from industry

Canada's Bioeconomy Strategy reflects the views expressed by the industry representatives who participated in consultations that were organized across the country.

Executive Summary

Canada's Bioeconomy Strategy serves as a call to action for Governments and industry to seize the opportunities of an industrial bioeconomy. Canada's competitive advantages for the bioeconomy include: access to biomass, global leadership in forestry and agriculture, sustainable resource management and a skilled workforce. Canada continues to rank first among the Organisation for Economic Co-operation and Development (OECD) countries in the proportion of college and university graduates[2] participating in the economy.

Canada has been much more than a nation of hewers of wood and drawers of water for a long time, yet the cliché lives on. It is a country rich with innovation in the resource economy. Biotechnology is an important enabler for many traditional sectors, opening new markets, promoting sustainability in resource management and advancing manufacturing technologies.

Canada's efforts to measure and account for natural capital are fragmented and lagging despite having 10% of the world's forests, 60% of the world's freshwater lakes and 25% of the world's wetlands. Without a decision-making framework or protocol that properly identifies and measures Canada's natural capital, the ability to properly value it and to strategically direct it, the real impact on the economy and industry will not be realized.

Agriculture and forestry use biotechnology to enhance their productivity, diversify their production and enhance their stewardship of Canada's natural resources. The chemical and manufacturing industries use biotechnology to enhance their performance and reduce the cost of their products, and to lessen their environmental footprint. Canada is home to a healthy and vibrant biotechnology ecosystem with industry clusters located in every province. In this context, the Canadian industrial bioeconomy is well-positioned to deliver very significant economic and social benefits to this country.

The Canadian agricultural sector has reliably developed and adopted productivity improvements and diversified production to ensure abundant food supply. The factors that now affect the production of food and energy, including demographics, climate change and resource constraints require more and faster innovation.

The global population is exploding. Society is looking to traditional industries like agriculture, forestry, energy and manufacturing to keep pace with the growing demand for food and energy while addressing the challenge of climate change.

Like the parts of Canada's industrial economy noted above, the bioeconomy must be supported by committed research and innovation policy, financing, and the development of skilled labour. Innovation clusters and ecosystems are important venues in which to develop the bioeconomy and facilitate relationships between actors along the full value chain.

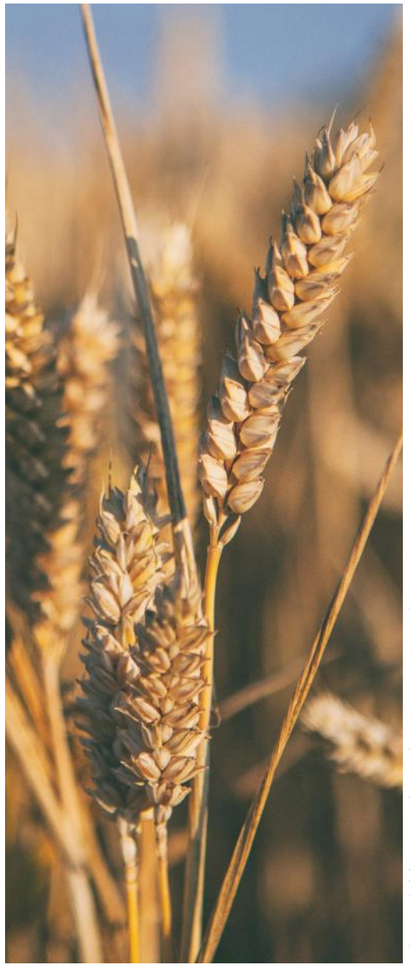
This Bioeconomy Strategy focuses on actions and results and is supported by industry.

2 https://www150.statcan.gc.ca/n1/en/daily-quotidien/171129/dq171129a-eng.pdf?st=Yg9_W6h- 2016 Census

The recommendations and accompanying implementation plans build on the work of the Advisory Council on Economic Growth (the Barton report) and the Canadian Council of Forest Ministers' Forest Bioeconomy Framework for Canada. The Bioeconomy Strategy does not duplicate these efforts but strives to distinguish the importance of the bioeconomy to these efforts in order to realize their full benefit. Case studies are available to illustrate, with concrete examples, current and future opportunities that the bioeconomy represents in Canada. The more than 400 participants that provided their input to this Report represent a strong voice for Canada's bioeconomy.

To seize the opportunities of Canada's bioeconomy the industry needs:

- A modern regulatory system that enables innovation, provides certainty to industry and enables the bioeconomy;
- To establish a biomass supply and good stewardship of agricultural and forestry lands;
- A business climate that supports the scaling up of Canadian companies in the bioeconomy and makes Canada a top country in which to invest; and
- A strong sustainable bioeconomy ecosystem with an emphasis on value chain creation, job training and skills development.



Wheat Field — BioIndustrial Innovation Canada

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

Introduction

The State of the Bioeconomy in Canada

Canada has the world's most abundant and sustainable biomass resources and is highly adept at generating value from them. These abundant natural resources have shaped the country from coast to coast. Historically, Canada's traditional industries — forestry, agriculture, fisheries, and mining — have been the economic drivers creating much of the fabric of Canadian business and culture.

In the 21st century, science and technology play an increasingly important role in maximizing the value and economic contribution of Canada's natural resources. By combining the advances in technology with Canada's traditional economic sectors, the underpinning of Canada's industrial bioeconomy can be seen. Canada has an opportunity to become a leading force in the global bioeconomy. Canada must protect and exploit the advantage of its natural resources to their greatest possible economic value to continue to build on its competitive advantage.

Canada's bioeconomy is comprised of several types of actors:

- Primary producers,
- Processors,
- Technology developers, and
- Production and manufacturing companies.

Producers and companies generate food, energy, fuels, chemicals, materials and industrial and consumer products. In 2015, these actors transformed over 21 million metric tonnes of raw biomass into bioproducts, of which 12.3 million metric tonnes were sourced from forestry and 8.8 million metric tonnes were sourced from agriculture, accounting for approximately $4.27 billion in revenues.[3] Traditional bioeconomy sectors (forestry and agriculture) represent more than 900 processing companies, employ 2 million people and generate sales of $300 billion/year.[4] This represents only a fraction of Canadian capabilities.

Companies and organizations in the bioeconomy in Canada have not yet realized their full potential. This realization will be achieved through the adoption of biotechnology and bioproducts by international value chains; more engagement with financial institutions; more agile regulation; and more partnerships between producers and industry that can collaborate to harness Canada's competitive advantages and grow anchor companies.

The challenges of climate change will identify producers and companies in the bioeconomy that belong to the next wave of adopters of automation and data exchange technologies in the fourth industrial revolution (Industry 4.0).

Canada has a window now to become one of the world's most successful modern bioeconomies. It is important that governments, financial institutions and large corporations hasten the pace of policies, regulation, financing and adoption if the promise of the bioeconomy as described in this Strategy and the reports of its precursors is to be fulfilled.

3 An Overview of the Canadian Agriculture and Agri-Food System, Agriculture and Agri-Food Canada (2017)

4 From Forest Products Association of Canada, http://www.fpac.ca/canadian-forestry-industry/forest-products/ and Canadian Agricultural Human Resource Council, http://www.cahrc-ccrha.ca/agriLMI.ca

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Harvesting Flax — BioIndustrial Innovation Canada

Progress to date
Canada has an exciting history and foundation of biotechnology innovation in agriculture and forestry. For example, the development of canola — an industry that generated one quarter of all farm cash receipts in 2017 and supported over 250,000 jobs[5], and the role of the Canadian Forestry Corps in the First World War.

The dedication of producers and companies that are part of the bioeconomy has grown out of this history. The recognition of the growing market for bio-based products that increases the use of agricultural, marine and forestry materials is the future. Several organizations contributed to the building of different aspects of the bioeconomy proposed in this Strategy. They include: hybrid chemistry clusters (Bioindustrial Innovation Canada); industrial biotechnology (BIOTECanada); agri-tech commercialization (BioEnterprise); the quality of biomass (Biomass Quality Network); and forest industry diversification and productivity (Centre for Research and Innovation into the Bio-Economy (CRIBE)). These are just a few of Canada's bioeconomy champions.

Alongside industry, the federal and provincial governments should champion the bioeconomy. The Industrial Bioproducts Value Chain Roundtable (formed in 2011), proposed recommendations respecting incentive programs, a policy and regulatory framework for the development of clusters, mandates for biofuels and the adoption of carbon pricing — with the intent of moving the bioeconomy forward.

Canadian policy and regulations have supported growth in the biofuels industry. The Clean Fuel Standard (CFS) Regulatory Design Paper was released by the federal government in 2018 and the design elements it sets out have been welcomed by industry.

Canada's Bioproducts Sector by the Numbers

- 208 firms employing 3,020 people
- $1.3 billion in revenues
- $433 million in exports
- $64.6 million invested in R & D
- 80 percent of firms are small and medium-sized enterprises (SMEs) and are seeking investors
- Active in biofuels, chemicals, plastics and composites, fibreboard, biocontrol agents and biocatalysts

Reference: Invest in Canada report on Canada's Bioproducts Sector: Winter 2014

5 https://www.canolacouncil.org/markets-stats/industry-overview/

Why Canada Needs a Bioeconomy Strategy

Canada's efforts to measure and account for natural capital are fragmented and lagging despite having 10% of the world's forests, 60% of the world's freshwater lakes, more agricultural land per capita than any other country and 25% of the world's wetlands. Without a decision-making framework or protocols to properly identify and the value of Canada's resources and the infrastructure and processing industries to fully employ all aspects of their production, i.e., residuals, the real impact on the economy and industry will not be realized.[6] Canada remains one of only 16 OECD countries without a bioeconomy strategy.[7]

The creation of bio-based chemicals from renewable resources in the production of advanced materials for the automotive industry has helped demonstrate a market opportunity while ensuring Canada lowers its dependence on depletable fossil-based resources. A number of international reports have pointed to the need for more biofuels and electricity in the transport sector if climate change targets are to be attained. Canfor Pulp's proposed biocrude project is underway through its joint venture with Licella Fibre Fuels of Australia. The joint venture will economically convert pulp biomass into a renewable biocrude. When the project proves to be economically successful on a larger scale, the biocrude oil can then be refined in a conventional refinery and easily be upgraded to gasoline, diesel, kerosene and fuel oil blend stocks.

Bio-based products are expected to make up 50% of consumer products by 2050.[8] Countries and anchor companies with the right policy framework and strategies, a desire to foster innovation, the ability to deploy technology with anchor companies having the capability to commercialize technology and product both domestically and internationally, will take market share and the accompanying job and economic growth.

> *"This key opportunity (and global differentiator) for Canada needs to be accelerated through government support to avoid being out-competed by other countries." — Survey Respondent*

Each of the Economic Sector Strategy Tables identified a lack of anchor companies in Canada. This deficit extends to a lack of decision-making and supplier development within the subsidiaries of multinational corporations in Canada. A strategic focus by all stakeholders in the industrial bioeconomy on value chain enhancement and the building of regional clusters will have many benefits for the growth of anchor companies in Canada. Despite the fact that there are very few anchor companies in the Canadian bioeconomy, supportive policy and a coordination of federal, provincial and municipal efforts can ensure anchor companies will develop and their spin-off benefits will be realized.

iStock.com

6 Financial Sector Primer, Natural Capital Lab (2017)

7 Meeting Policy Challenges for a Sustainable Bioeconomy, OECD 2018

8 Biomass and Bioenergy; Volume 96, January 2017, Pages 19-27

Forest Protection — Eh to Zed Photography

The market pull is evident
Companies like IKEA, Lego, Volvo and Michelin have made their KPIs and corporate sustainability goals public. For example: Michelin plans to reduce its industrial carbon footprint by 50% by 2050 and Lego launched a range of plant-based plastic toys in 2018.

Canada's Bioeconomy Strategy demonstrates that Canada is the place to help these companies achieve their goals.

References: *www.michelin.com/en/sustainable-development-mobility/environment/low-carbon-products/* and *www.lego.com/en-us/aboutus/news-room/2018/march/pfp*

An industry-led Bioeconomy Strategy will help Canadian governments and Canadian producers and companies in the bioeconomy to:

- Perform better in the later stages of development and commercialization of biotechnologies and bioproducts — where the majority of jobs and wealth are created;
- Respond to policies and a business environment that rewards sustainability, a low carbon footprint, and encourages the adoption of Canadian bioproducts through agile regulation;
- Address agriculture and forest management practices and mitigate climate change through innovation in resource stewardship;
- Realize growth through the diversification of the agricultural, manufacturing and forest economies; and
- Support the development of high performing bioeconomy clusters across Canada.

As the public becomes more aware the challenges of plastic waste and recycling, the bioeconomy remains fundamental to addressing these challenges. Concerns over the long-term effects of plastics in the environment have led to stronger calls for bio-based renewable materials. One such material is nanocrystalline cellulose (NCC). These tiny crystals are extracted from wood and processed into a powder or liquid suspension, which can be used to add strength, enhance lubrication and improve impermeability in everyday products.

A Global Opportunity
Countries innovate best around what they already do well. For Canada, the amount and availability of biomass is a unique advantage. Innovations in biotechnology support further development of economic drivers, in the form of new markets and enhanced global value chains. The industrial bioeconomy presents opportunities for vertical integration and year-round jobs in the agricultural sector leading to income stability and diversification of revenue sources.

The world's population is predicted to grow to almost 9 billion people by 2050. This means drastic global changes in human health, the environment, food security and economic fortunes.

As the pace of population growth and climate change has accelerated, biotechnology has been identified as a critical technology "whose domains of application are so wide and their role so crucial that the pattern of technological change in each country depends to a large extent on the national capabilities in mastering production/imitation/innovation in such crucial knowledge areas."[9]

9 Cimoli, Mario, Giovanni Dosi, Richard Nelson, and Joseph E. Stiglitz. 2009. "Institutions and Policies Shaping Industrial Development: An Introductory Note." In ***Industrial Policy and Development: The Political Economy of Capabilities Accumulation***, ed. Mario Cimoli, Giovanni Dosi, and Joseph E. Stiglitz. Oxford; Toronto: Oxford University Press, 19–38.

Biotechnology is undergoing a revolution with the introduction of techniques such as CRISPR and synthetic biology. The deployment of production employing gene technologies, micro-organisms, enzymes and fermentation, among other processes is transforming the production of materials and goods by traditional industries like agriculture, aquaculture, forestry, mining, energy and chemical manufacturing. The new products and applications perform better and are more environmentally sustainable than their traditional fossil-based counterparts.

Industry consultations for this Strategy showed that companies may encounter specific forms of market or system challenges associated with the development of bio-based technologies and/or products. These challenges include the greater degree of risk and higher level of uncertainty associated with the development of new technology platforms, the lack of standards for new and emerging technology platforms, as well as the proprietary technologies that are the domain of inter-firm competition.

These challenges mean that there is an even greater need for government to support the latter stages of the commercial development and adoption of bioproducts as well as various forms of networks, such as user-producer relationships, strategic alliances, R&D consortia and collaborative training and marketing schemes.

Domtar CelluForce is an example of how the forestry industry will contribute innovative products — beyond traditional forest products such as lumber and paper — to international value chains. CelluForce manufactures NCC from wood and operates the world's largest plant at Domtar's mill in Windsor, Quebec, producing 300 tonnes of NCC per year. NCC can be added as a layer in packaging films to improve food protection or used in lubricants to reduce wear in machinery and other moving parts. CelluForce NCC is used in a high-performance anti-fog solution for mirrors, dive masks, goggles and visors.

Domtar is creating markets for NCC, but even for a large successful company, the challenges described in this section are considerable and go beyond producing a performance enhancing, cost competitive and environmentally sustainable product. These products must be adopted and made part of international value chains.

Biotechnology can continue to revolutionize traditional industries and create new companies, but it will need support to:

- Attract investment to Canada's bioeconomy value chains;
- Align disparate industries and create synergies at a Pan-Canadian scale;
- Accelerate deployment and early adoption of disruptive technologies;
- Optimize innovation ecosystems and industry linkages; and
- Gain public awareness, understanding, interest and acceptance.

Introduction

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

Grain Bins at Parkland Farms, Sarnia, ON — BioIndustrial Innovation Canada

Industry Consultations

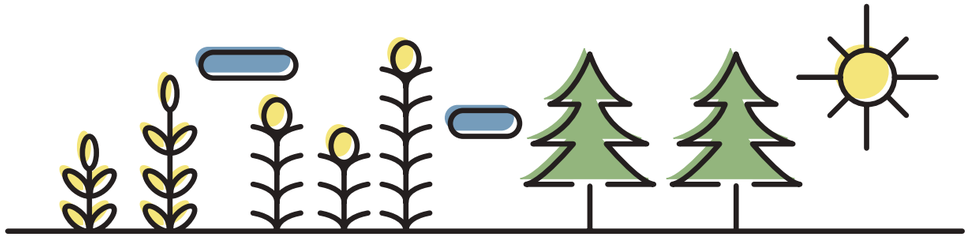
Total number of organizations representing industry in attendance

Halifax	8
Montreal	19
Montreal (forestry-focused)	25
Ottawa	11
Guelph	14
Sarnia	15
Winnipeg	13
Saskatoon	9
Calgary	22
Vancouver	18

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

DEFINITIONS OF THE KEY CONCEPTS

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future



Bioeconomy Definition

The European Commission provided this functional definition of the bioeconomy in October 2018:[10]

"The bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services.

"To be successful, the European bioeconomy needs to have sustainability and circularity at its heart. This will drive the renewal of our industries, the modernization of our primary production systems, the protection of the environment and will enhance biodiversity."

This Strategy will adopt this definition of the bioeconomy. but will rely on biotechnology as a competitive advantage. Europe is recognized as having the most stringent genetically modified organisms (GMO) regulations in the world. With Canada's history of biotechnology innovation, there is a competitive advantage to further streamline and adapt Canada's regulatory framework so that it supports a thriving bioeconomy.

To be competitive with other countries, the Canadian bioeconomy needs a supportive business environment that includes agile regulation, access to sustainable biomass supply and the ability to build strong anchor companies and value chains with strong ecosystem support.

> *"Government policy that sets new sustainability standards would go a long way towards supporting the emerging bioeconomy." — Survey Respondent*

The Canadian bioeconomy needs to have sustainability at its core. The representatives of the Canadian bioeconomy need to be working with other members of society towards circularity and the maximum valorization of resources including residuals and waste.

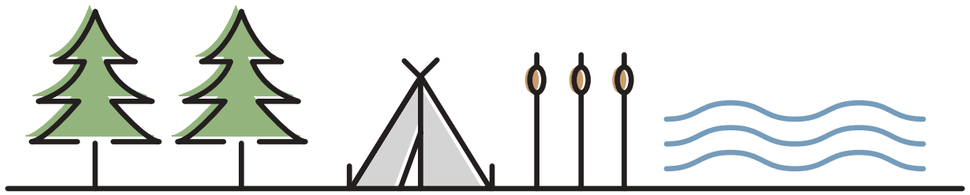
10 A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment, European Commission, 2018

Definitions of the Key Concepts

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

Industrial Biotechnology Definition

Industrial biotechnology is the replacement of traditional chemical processes with biological processes that are more sustainable. These biological processes can be incorporated into many production systems that produce energy, fuels, chemicals and materials. and they can bring significant performance and lower costs. With the adoption of these advancements, the world moves closer to a future with economic, environmental and social sustainability. Industrial biotechnology provides opportunities to innovate, grow and diversify markets. From new crops and improved agricultural practices to better performing materials and more sustainable consumer products, industrial biotechnology enables the development of other industry sectors and reduces dependence on fossil fuels and depletable resources.



Natural Capital

The Wealth Accounting and the Valuation of Ecosystem Services Project defines natural capital as follows:[11]

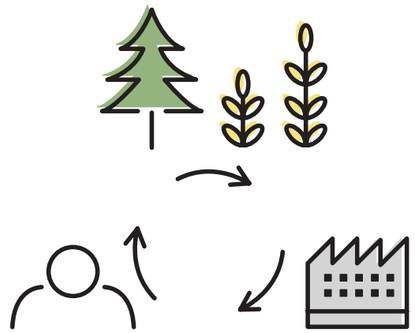
"Natural capital includes, first of all, the resources that are easily recognize and measure such as minerals and energy, forest timber, agricultural land, fisheries and water. It also includes ecosystems producing services that are often 'invisible' to most people such as air and water filtration, flood protection, carbon storage, pollination for crops, and habitat for fisheries and wildlife."

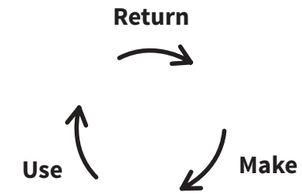
In Canada, Indigenous communities have a deep appreciation for natural capital and have been, in many places, its most committed stewards for generations.

Accounting for and protecting natural capital is crucial for sustained economic benefits. As the effects of climate change on natural capital become more obvious, many companies including those in the bioeconomy are seeking to understand how resource constraints and depletion will impact their businesses.

The tools and analysis that will help industry and society understand the costs of climate change — carbon pricing, cap-and-trade, life cycle analysis (LCA) and natural capital accounting — will be of considerable value in leading innovation in the bioeconomy and in other industry sectors.

11 https://www.wavespartnership.org/en/frequently-asked-questions-natural-capital-accounting-nca#1





The Circular Economy

The circular economy is a comprehensive framework for how materials and energy would flow in a fully sustainable, low-carbon economy.[12] It is estimated that the clean economy will be worth $26 trillion globally by 2030.[13] Canada has begun taking steps to support investors in clean technology, taking advantage of this once-in-a-generation economic opportunity and investing in emission-reducing technologies that lay the foundation of a Canada's bioeconomy.

In Europe, bioeconomy strategies are now being combined with circular economy strategies to more fully address the issues of climate change and resource consumption. This evolution is understandable in a society that is more densely populated and lacks the abundance of natural resources available in Canada.

Canadian discussions on the circular economy have emphasized climate change and clean growth. Both approaches focus on a low-carbon economy, economic growth, innovation and new technologies, but the circular economy responds to a broader set of factors including design, recycling and reuse. The circular economy looks for a deeper, systems-scale level of innovation for business.

A circular economy strategy holds the potential to address a more comprehensive set of environmental challenges but could also be more disruptive to the current model of the economy.[14] Key circular economy strategies include circular supply chains; recovery, reuse, and recycling of resources; product life extension; new business models (e.g., sharing platforms and service leases) for more efficient use of goods and capital assets; and deep technological innovations.[15]

An example of how circular economy strategies are being employed by Canada's bioeconomy companies can be found in the Case Studies section of this Strategy. The case study about biorefineries (pp. 58-59) describes how recovery and reuse of materials are important elements in Greenfield Global's manufacturing and packaging operations.

The bioeconomy is an important component of circular economy activities in Canada, especially where biotechnology can enable the transformation of biomass that would otherwise not be fully utilized into useful products. Canada's Bioeconomy Strategy is informed by the evolution and advancements in the circular economy.

12 Getting to a Circular Economy: A Primer for Canadian Policymakers. Smart Prosperity Institute, January 2018.

13 https://betakit.com/government-now-taking-applications-for-50-million-vcci-cleantech-stream/

14 Decoupling: Natural Resource Use and Environmental Impacts from Economic Growth, United Nations Environment Programme, International Resource Panel, 2011

15 Waste to Wealth: The Circular Economy Advantage, Lacy, P. and Rutqvist, J., Accenture Strategy, 2015

RECOMMENDATIONS AND ACTION PLANS IN FOUR KEY PRIORITY AREAS

1

Creating Agile Regulations and Government Policy

A government whose policies and processes are relevant to the current and future state of advanced biotechnologies and bioproducts will enable the bioeconomy in Canada to flourish.

2

Establishing Biomass Supply and Stewardship

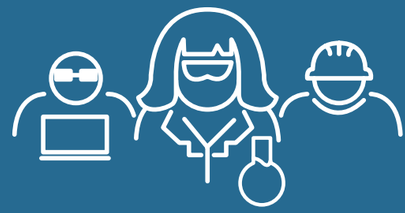
Agricultural and forest lands are crucial to the Canadian economy, culture and way of life. An evidence-based strategy is required to ensure exemplary stewardship of our nation's natural capital to the benefit of industry growth and a lower carbon economy.

3

Building Strong Companies and Value Chains

Addressing the needs of Canada's most promising and innovative businesses as they scale up to become world-leading anchor firms is crucial to the growth, success and attractiveness of Canada's bioeconomy.

4



Building Strong Sustainable Ecosystems

In order to develop high performing bioeconomy clusters across Canada, companies from across the value chain must come together to leverage opportunities to break into international and domestic markets.

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

Creating Agile Regulations and Government Policy

A government whose policies and processes are relevant to the current and future state of advanced biotechnologies and bioproducts will enable the bioeconomy in Canada to flourish.

1

Improving the Business Environment while Protecting Canadians

Canada has a strong regulatory framework that ensures the safety and quality of Canadian products. Companies in the bioeconomy identified the need for a more agile regulatory system to consider biotechnology and the resulting products.

The higher level of uncertainty associated with the development of new technology platforms, and the lack of standards for new and emerging platforms will challenge companies adopting biotechnology and producing bioproducts. Biotechnology challenges traditional notions of regulation because of the variety of intersecting stakeholders at the regulatory and production levels. Gaps in regulatory processes will emerge as novel products are brought forward in future years. These products are difficult to anticipate in any regulatory system, so they must be addressed as they emerge within the system. The Economic Sector Strategy Tables urged the establishment of, "a modern regulatory system that fosters innovation and adoption by focusing on outcomes, not prescriptions."[16]

Regulation should consider biotechnology as a technology and not simply a science since it is a complex and adaptive system. This suggests the need to consider social and political systems as a part of developing agile regulations. The consultations reinforced the importance of standards for bio-based technologies and products being recognized and supported by government to reflect sustainability impact, safety, quality, traceability and potential for economic impact. The recommendations in this key priority area exist because industry expressed the need for agility and speed in order for them to keep pace with the speed of commerce.

Regulating new innovations demands scientific, technical and business expertise and the consideration that these innovations often fall between traditional regulatory categories or face a more complex regulatory environment than traditional products. An industry advisory group for the bioeconomy could play an important role as an interface between new technology and regulation. The group's mandate would be to work with Government to review regulations, offer technical guidance and associated policies that affect the development of the bioeconomy and provide advice on reforms. 94.8% of survey respondents agreed with this multisector approach.

> *"I strongly support the set-up of an independent advisory group that includes industry and academia. It could provide guidance on need and relevance, technology trends as well as address barriers to development." — Survey Respondent*

The most recent federal economic statement called for agile regulations to support innovation and economic development, the need for Canadian regulations to be more supportive of innovation and commercialization opportunities were validated again by survey respondents (93.5% agreed). The consultation sessions also validated that the regulatory framework should become more supportive of the adoption of biotechnologies and associated bioproducts. Canadian bio-based industries would benefit from more agile and streamlined processes that allow for faster commercialization and adoption with a predictable pathway to commercialization that would foster investor confidence.

This Strategy calls for modernization of Canada's regulatory approach to new technologies with a particular focus on innovation, growth and competitiveness.

> *"Agile regulations and more rapid turn-around of certifications are important as these are often the road-blocks of commercial implementation. Addressing gaps of anchor companies in the supply chain is critical to foster growth throughout and have multiple companies in each stage." — Survey Respondent*

International Alignment on Regulatory Pathfinding

Barriers to commercialization exist domestically for Canadian-born technologies that do not exist in other jurisdictions. As an export-based economy, an understanding and alignment with regulatory requirements in partner markets is crucial to the successful development of Canadian-born biotechnologies. For example, Canada's Arctic Apple was approved for deregulation in the US by the US Department of Agriculture in before it was approved for sale in Canada by Health Canada.

A study of the performance of Canada's food regulatory system in the global marketplace[17] showed that there are substantial differences between Canada's regulatory system and those in a number of other countries. Canada's system is less accountable and more prone to delays than in many countries. The challenges exist in all three parts of the system – the legislation, regulation and administration processes.

16 Report from Canada's Economic Strategy Tables: Seizing Opportunities for Growth, Innovation, Science and Economic Development Canada, 2018

17 Food Regulatory Systems – Canada's Performance in the Global Marketplace. Prepared for Food & Consumers Products of Canada by the George Morris Centre. Fall 2008.

Composites Innovation Centre

Timelines for approval of innovative products and the use of health claims in Canada are much longer than those in the other jurisdictions.

From the study of Canada's food regulatory system came the following conclusion:

"Health Canada has discussed and consulted on the 'improvement' and 'modernization' of the regulatory system for years, through initiatives such as: Smart Regulation; Blueprint for Renewal: Transforming Canada's Approach to Regulating Health Products and Food; Blueprint for Renewal II: Modernizing Canada's Regulatory System for Health Products and Food; Towards a Regulatory Modernization Strategy for Food and Nutrition; and the newest Managing Health Claims for Foods in Canada: Towards a Modernized Framework. Although the consultations seem to move in the right direction there is little evidence of any significant results. It is time to step up the effort to reform the system."[18]

Industry survey respondents agreed, 93.5%, that collaboration and alignment between Canadian authorities and authorities in key trading partner nations on common reference methods and data requirements for the bioeconomy will make Canada more competitive in many domestic and global value chains.

> *"Continued investment in an agricultural sustainability framework and database to support compliance with international sustainability standards could be very helpful in providing market access, build trust in Canadian products, etc." — Survey Respondent*

Several activities would promote bio-based technologies and products in domestic and global value chains. These include joint scientific reviews to streamline standards, alignment of reference methods and requirements for claims (bio-based content, environmental sustainability, safety claims, etc.) and development of common bio-labelling initiatives. A program that supports the testing and certification required for bioproducts to enter a global value chain or meet customer purchase requirements is necessary.

> Case Study: *New Substance Notification and Biomanufacturing – Accelerating the Development of Biomanufacturing in Canada (Page 52)*
>
> Case Study: *Forest Management Certification System – How Standards Create Global Markets (Page 53)*
>
> Case Study: *Biofuels – An Essential Element in the Portfolio of Measures Needed for a Low Carbon Economy – The Importance of The Policy and Regulatory Environment (Page 54)*

18 Op. cit.

Recommendations and Action Plans in Four Key Priority Areas

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

Recommendations and Action Plan for Regulations

	Recommendation	*Action*
1	**Improve regulations for advanced biotechnologies and bioproducts while considering the context of a complex regulatory environment. (Make the regulations more intelligent.)**	Establish a permanent and independent panel of industry experts to advise regulators. The panel's mandate will be to work with regulators to review regulations and provide technical guidance on policies that affect the development of the bioeconomy and to provide advice on reforms.
2	**Improve the pathways to regulatory approval for advanced biotechnologies and bioproducts. (Make the path to commercialization more predictable.)**	Review Government mandates and update regulations and policies to include innovation and competitiveness as key criteria, including the Food and Drugs Act and Canadian Environmental Protection Act. Regulators and industry to review the state of all regulations, technical guidance and associated policies to ensure that they are necessary, appropriate and effective in achieving the intended objectives in the most cost-effective manner possible.
3	**Improve existing standards for advanced biotechnologies and bioproducts.**	Undertake a joint scientific review with key trading partners to develop improvements to standards, reference methods and requirements for claims. Define requirements for the verification of claims made about bio-based content, environmental sustainability, safety and toxicity, etc. already at play in Europe and the US that will support quicker up-take of new products in domestic and international value chains.
4	**Create new standards for advanced biotechnologies and bioproducts (they can help create industry innovate for biomaterials, bioplastics, animal feed, etc.).**	Develop bio-labelling initiatives. Establish standards for biomaterials, bio-plastics, or bio-ingredients (specialty) for animal feed. Develop and disseminate standards, methodologies, benchmarks, and evaluation criteria for the acquisition of sustainable technologies and products across government to help drive the adoption of bio-based technologies and products.

Laforge Bioenvironmental, Saint-André, NB
— Eh to Zed Photography

Policy and programming to support the growth of firms
New policy and program measures are needed to promote market uptake of bioproducts and to create a level playing field across bio-based products and conventional (fossil-based) alternatives. The Economic Sector Strategy Tables recognized that, "Government procurement can be used to accelerate adoption of Canadian innovation, drive solutions to big challenges and send powerful signals in the marketplace." [19]

The Economic Strategy Tables also recognized that, "We have to act now to ensure more Canadian firms have the opportunity to scale up and anchor clusters, build strong supply chains founded on Canadian innovation and ultimately become acquirers of companies themselves."

In 2017 the federal government provided $12 million over four years to establish a Clean Growth Hub to streamline client services, improve federal program coordination, enable tracking and reporting on clean technology results across government and connect stakeholders to international markets. The Hub is key to navigating federal support programs but more can be done to establish the market pull and value chains necessary to building the anchor firms Canada needs. The ability of firms to participate in global value chains depend on the nature of inter-firm linkages and their position in global production networks.

Models that provide services to connect large multinational enterprises (MNEs) and small and medium enterprises (SMEs) for the purposes of collaboration should be reviewed and implemented. In addition to business accelerator services offered by Global Affairs Canada, other models to be considered and adapted to Canada include:

- The Ellen MacArthur Foundation's CE100 Corporate
- Natural Step Canada's Sustainability Transition Lab Model
- Denmark's Vitus programme and Scale-Up Denmark
- The European Union's BioSTEP Programme

Many of the decision making and commercialization activities of multinationals are not located in Canada. The process of working with the customer at the top of a value chain for consumer products employing a bioproduct or technology can be daunting, complex and expensive. There are often many suppliers positioned between the Canadian entrepreneur and the customer. Requirements for testing and certification required for the adoption of bioproducts by firms such as IKEA, Unilever, P&G and others are complex, expensive and frequently require international travel.

For Canada to grow anchor companies, they must be supported beyond demonstration scale with support for commercial testing and certification and collaborative activities with decision makers at the top of the value chain.[20]

19 Report from Canada's Economic Strategy Tables: Seizing Opportunities for Growth, Innovation, Science and Economic Development Canada, 2018

20 Fostering Greater SME Participation in a Globally Integrated Economy. Discussion Paper, OECD SME Ministerial Conference 2018

Recommendations and Action Plans in Four Key Priority Areas

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

Recommendations and Action Plan for Policy Measures

	Recommendation	*Action*
5	**Improve matchmaking and program navigation support for developing anchor companies and existing SMEs in the bioeconomy.**	Realign the mandate of the Clean Growth Hub to improve support for anchor firms. Review, adapt and implement models that can connect MNEs and SMEs for the purposes of collaboration.
6	**Provide support to companies to build markets and enter global value chains.**	Increase support to (1) non-governmental business accelerators in support of these activities, (2) Global Affairs to support additional in-market partnerships, and (3) government procurement mandates to increase the procurement of early stage bio-based technologies. Support for testing and certification of bioproducts to be carried out at applied research institutions.

In summary, strengthening investment in a more responsive business environment and programs that will support the entry of Canadian firms into international value chains will lead to faster technology commercialization and adoption and put Canada in a leadership position.

Establishing Biomass Supply and Stewardship

2

Agricultural and forest lands are crucial to the Canadian economy, culture and way of life. An evidence-based strategy is required to ensure exemplary stewardship of our nation's natural capital to the benefit of industry growth and a lower carbon economy.

Sustainability as a Market Driver

A new era of sustainability is redefining global markets and the value chains that supply them. Canada's bioeconomy will be driven by a "Green Generation" where consumer demand for more sustainably-sourced products will push the market toward more validated sustainable biomass supply. Biomass industries will transform their resource management and development practices for production, conversion and management to meet customer and consumer demands and more fully utilize all aspects of feedstocks.

> Case Study: *Bioénergie La Tuque (BELT) – Recovering Harvest Residue (Page 56)*

Innovation in resource management and best practices will help to ensure the sustainability of natural resources in the face of the growing evidence of the effects of climate change. Sustainable resource management practices are currently in use in the forestry industry and 90% of survey respondents would like to see agriculture adopt more sustainable practices with 87% in agreement that smarter production and resource management practices across all resource sectors would lead to stronger biomass value chains.

Industry has recognized that to capitalize on the increased consumer expectations and demands for sustainability, improvements in resource management, production, supply logistics, product quality and traceability are needed. Technologies such as automated farm equipment, sensors and UAVs along with the digital data collected promise to revolutionize many businesses. The development, adoption of innovation, and integration of these Industry 4.0 technologies within traditional industries will support the transition to sustainability. The adoption of new technologies can enhance agricultural and forestry management practices making it easier for producers to access foreign markets and compete. New technologies often require up-front costs and infrastructure. Support is required to bring these technologies and processes to producers including the flexibility to trial, test and adopt them.

Achieving Efficient and Cost-Competitive Supply Chains through Digital Transformation

> Case Study: *Cellulosic Sugar Producers Cooperative (CSPC) and Comet Bio - A Biomass Supply Chain in Southwestern Ontario Leveraging Industry 4.0 (Page 57)*

In order to fully realize and encourage the adoption of innovation and integration of Industry 4.0 technologies, full participation in Canada's digital transformation is important. The 2019 federal Budget provided $1.7 billion beginning in 2019-20 to establish a Universal Broadband Fund that will "focus on extending 'backbone' infrastructure to underserved communities." Of that amount, the government intends to add money to the Connect to Innovate program that was announced in 2016 to secure a low-latency Low Earth Orbit (LEO) satellite capacity.

The use of LEO satellites to bring reliable internet to rural parts of Canada, and the development and adoption of this technology, can improve agricultural and forestry practices and bring significant benefits to these industries.

The Valorization of Biomass

Biomass inventories exist across Canada but they do not provide the information required by developers or the inventories are outdated, incomplete or difficult to access. 83.7% of survey respondents agreed that improvements to biomass mapping will increase knowledge about the quality, quantity and location of biomass across Canada. This will help build strong supply chains for the bioeconomy as described in Key Priority Area #3.

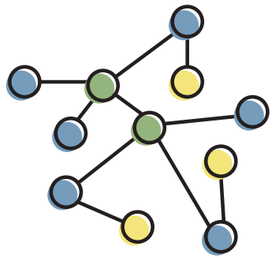
In order to reach its full potential, Canada will need to focus on the highest value uses of its abundant natural capital. In the future, determining the highest value use of natural capital will become paramount to managing the business of biomass. Producing more bio-based products requires a choice of what feedstocks can best be used, how logistics are employed and where intermediates can best be produced. Market demand and competing applications for biomass feedstocks are relevant considerations when evaluating projects.

The implementation of technologies and criteria to assess the quality and quantity of biomass and facilities to demonstrate scale will serve to validate production quantity and quality increasing opportunities for financing and the coordination of complex and fragmented production networks.

Recommendations and Action Plan for Establishing Biomass Supply and Stewardship

	Recommendation	*Action*
1	**Support the transformation of resource management and development practices for biomass, biomass conversion and residuals. Biotechnology methods are central to many of these innovations.**	Invest in science to better understand sustainability and appropriate stewardship of agriculture and forest lands. Develop better biomass sustainability management systems and best practices.
2	**Encourage the development, adoption and integration of innovative Industry 4.0 technologies within traditional bioresource industries.**	Review the policies and programs provincially and federally within line departments to ensure they encourage implementation of Industry 4.0 Action by government to advance Canada's leadership in adoption of reliable broadband internet throughout rural Canada.
3	**Increase knowledge of quality, quantity and location of biomass across Canada.**	Study biomass inventory activities taking place within government and pursue alignment with other similar initiatives and the needs of the end users for relevancy, accuracy and accessibility.
4	**Additional funding support to optimize efficient processing through research and development, and scaling of large demonstration/flagship biorefineries.**	Invest in research, development and scaling up activities to support large demonstration and flagship biorefineries.

BioIndustrial Innovation Canada



Building Strong Companies and Value Chains

3

Addressing the needs of Canada's most promising and innovative businesses as they scale up to become world-leading anchor firms is crucial to the growth, success and attractiveness of Canada's bioeconomy.

Building Anchor Companies

Anchor companies are an integral part of value chains and are required to establish market pull for early-stage technologies. Building anchor companies requires the integration of technologies with clear market demand. Anchor companies are larger, better managed, better financed and incorporate teams with established managerial and technical skills with links into international markets. The creation of more anchor companies will establish Canada as a top tier biotechnology innovation nation.

> Case Study: *Greenfield Global – Building Anchor Companies and Supporting the Development of Biorefineries (Page 58)*

> *"If the government has a stated intention to support new companies that have the potential to become anchor firms, plus a mechanism for new companies to demonstrate that they belong to that group, that would be a great start." — Survey Respondent*

> *"More government support funding at the growth stage that catalyzes co-investment with VC and private institutional funds." — Survey Respondent*

Anchor companies in the Canadian business environment face several barriers to growth. These include higher corporate taxes compared to the US, reasonable cost capital to support scale-up and commercialization, access to large customers and a regulatory environment that is frequently "out-of-sync" with Canada's major trading partners.

Recommendations and Action Plans in Four Key Priority Areas

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

The lack of anchor companies in Canada is cause for concern. The need for Canada to grow anchor companies and "Own the Podium" is a predominant theme in Economic Sector Strategy Table reports. The federal budget 2019 announced changes to the SR&ED program that will help anchor firms as they become profitable but a taxation gap will still exist between Canada and the US.

Attraction and support for anchor firms has been identified as a national priority by the Economic Strategy Tables and Canada's Superclusters. The interest in the Supercluster initiatives demonstrates that large companies need to be incentivized to adopt new technologies and support risk-taking behaviour when it comes to innovation. Additional programming support for pilot projects for the development of new products, practices, processes and technologies would help offset the barriers these firms face in the Canadian environment.

> *"Anchor firms need to see that there is a supportive innovation system in place and a concrete value chain that they are part of. EU BioStep program supports Living Labs for the Bioeconomy projects." — Survey Respondent*

Supporting Early Stage Technologies with Better Intelligence

Canadian governments provide an important suite of programs to assist companies through the Technology readiness levels (TRLs) 1 to 9.

The forces that shape value chains in the bioeconomy are rapidly evolving. With technological change creating new possibilities for products and materials, and increased demand from global markets for bio-based products, there is a unique need for companies in Canada's bioeconomy to be able to quickly validate their technologies and the infrastructure to achieve scale. Access to technology roadmaps that can provide an understanding of the state of development of a particular technology in regard to its scale-up and commercialization, the critical business challenges and intelligence on companies working in this sector would be invaluable. Access to technology roadmaps could serve a further purpose of accelerating partnerships and cross-sector collaboration.

Biomass inventories and relevant and accessible market intelligence are necessary to support due diligence and ensure that early-stage companies can quickly pivot. They would also increase the likelihood of success of the public support for scaling these technologies.

> *"Transparency is a critical element to promoting the collaboration necessary for Canada to compete in this highly competitive international sector — it will be critical that such inventories and roadmaps are seen to be completely objective, unbiased, reflective of reality and consistent with differentiating parameters for the Canadian resource, value chains and market opportunities." — Survey Respondent*

Composites Innovation Centre

Market Pull for Bio-based Technologies and Products
Large global brand owners play a significant role in creating market pull. Market pull by multinational companies and brand owners is a critical need for early stage companies to enable adoption by existing value chains. Significant resistance to change exists within the traditional value chains. Having strong supply chains and breakthrough technology is rarely sufficient to ensure commercial success for companies in the bioeconomy.

> Case Study: *Origin Materials and the NaturALL Bottle Alliance – Leveraging Market Pull to Build Value Chains (Page 60)*

Public procurement presents a significant opportunity for the bioeconomy to strengthen the market pull for bio-based products. Large government infrastructure projects could benefit from incorporating bio-based products, for example, UBC's Brock Commons tall wood building; or the Province of Prince Edward Island's infrastructure renewal project utilizing biomass-based heat at a number of its government buildings.

> *"Government procurement programs are very good for price discovery (just look at Alberta's renewable electricity program) and market development We need to develop these markets and prove out the business models and the government as a large buyer can do that." — Survey Respondent*

Government procurement and mandates for the use of bioplastics, second generation biofuels, biogas, lignocellulosic materials and biomaterials by the public and private sectors are activities that lead to commercial adoption. Government support for the development and dissemination of standards, methodologies, benchmarks and evaluation criteria for products of the bioeconomy also supports the development of the industry.

This Strategy recommends the use of LCA methodology for public procurement to help drive the adoption of bio-based technologies and products in Canada while creating domestic market pull.

> *"In the biogas world, we are currently seeing the value of long-term procurement contracts from gas utilities in getting projects built. Bankable contracts from credit worthy companies like utilities will allow companies to build out projects and grow." — Survey Respondent*

The development of standards and certifications that reflect an accounting of how much a product impacts the environment and the inputs and outputs throughout the life cycle of that product, including raw material extraction, material production, processing and assembly, are key to the adoption of Canadian technologies and products into global value chains and their support by consumers.

The implementation of the BioPreferred standards (as employed in the US) as part of Government of Canada's procurement policy would establish a common benchmark across North America and enhance the competitiveness of Canadian firms nationally and internationally. An umbrella brand like BioPreferred would increase visibility of bioproducts, contribute to increased market pull and develop a bioeconomy "culture."

Recommendations and Action Plans in Four Key Priority Areas

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

Composites Innovation Centre

Project Financing
Understanding and mitigating risk is critical to financing projects. Financial risks include supply chain risk, technology risk and market risk. Financial institutions use benchmarks and criteria to assess the financial risk of a project or an investment. The Equator Principles are a financial industry benchmark for determining, assessing and managing environmental and social risk in commercial projects.[21] The principles are widely used by banks and other financial institutions including Export Development Canada (EDC). The development of criteria and benchmarks to ensure the ability of capital markets to accurately quantify biomass feedstock risk would be a key to assessing credit worthiness, providing financing and reducing debt costs.

The US Department of Energy Bioenergy Technologies Office (BETO) is working with several Canadian firms to develop a standardized approach to evaluating the feedstock risk of bio-projects. Crown corporations such as the EDC and Farm Credit Canada (FCC) should be encouraged to review and consider adopting these criteria in the same way they have the Equator Principles. These instruments are important to providing access to reasonably cost capital for bio-based projects such as biorefineries, and to improving the availability of financing for biomass projects.

The Need for Business Support Services
Program and financial support for activities related to business management, mentorship and finance are key to building successful anchor firms. With over 150 accelerators and incubators in Canada providing business management and mentorship support, less than 10% are focused on supporting companies in the bioeconomy space. There is a dearth in the availability and accessibility of business knowledge and advice for companies in the bioeconomy.

Once companies have scaled up, they face different challenges making the leap to full production. Policies, programs and reasonable cost financing need to recognize the time, knowledge and resources that it takes to develop new markets and break into established value chains dominated by MNEs once a company reaches commercialization.

Government provides programs to support businesses to the point of becoming commercial, but business mentorship and executive talent is required beyond the point of scale-up if companies are to become anchor firms.

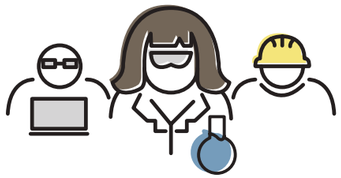
> Case Study: *Improving the Availability of Reasonable Cost Financing for Bioeconomy Projects – Green Bonds, the Equator Principles and the Development of New Canadian Standards for Biomass (Page 61)*
>
> Case Study: *BioAmber – A Cautionary Tale – Supporting Management Expertise from Scale-Up to Commercialization (Page 62)*

21 https://equator-principles.com/

Recommendations and Action Plan for Building Strong Companies and Value Chains

	Recommendation	*Action*
1	**Increase support for firms while they are commercializing new products, new practices, new processes and new technologies specifically in new markets or international value chains.**	Increase the amount of programming support in the form of risk capital for piloting, testing and demonstration projects. Increase and improve access to capital for resource sector projects. Ensure programs such as the Venture Capital Catalyst Initiative (VCCI) for Clean Technology recognizes industrial biotechnology as an important enabler of clean tech.
2	**Improve institutional understanding of value chains, critical business paths, valuation, credit-worthiness and risk for bio-products and biomaterials projects.**	Build and maintain technology roadmaps demonstrating critical business paths to advance biotechnologies and bioproducts in Canada and provide the support criteria for federal and provincial lending organizations. Participate in the development and adoption of criteria, protocols, and industry best-practices for the evaluation of biomass supply chain risks for the purpose of increasing capital available to these projects. Existing programming through financing firms like Business Development Bank of Canada (BDC) should integrate business services such as mentorship, knowledge transfer related to market intelligence to assist companies that are becoming commercial. Allow natural capital considerations as eligible costs for programs aimed at developing biotechnologies and bioproducts. Considering rating standards to provide bio-project developers and capital providers with guidance and best practices to better understand, quantify, and mitigate risks — and to rate the overall supply chain risk of bio-projects.

	Recommendation	*Action*
3	**Improve business intelligence resources for early stage companies and their investors.**	Develop market studies that demonstrate the value proposition of biomass transformation to funders and investors.
4	**Use Government of Canada procurement policy to promote the bioeconomy and contribute to market pull for the bioeconomy. Implement policy that supports the diffusion of bio-innovations through government procurement.**	Implement the USDA BioPreferred program in Canada.
5	**Improve institutional understanding of LCA methodology as it pertains to the sustainability goals of government.**	With public buyers, embed the necessary business skills, technical knowledge and procedural understanding to ensure that public procurement reflects the sustainability goals of government.



Building Strong Sustainable Ecosystems

4

In order to develop high performing bioeconomy clusters across Canada, companies from across the value chain must come together to leverage opportunities to break into international and domestic markets.

Canada's bioeconomy remains embryonic. Supply chains are still being developed, optimized and integrated. While some pioneering companies have successfully commercialized bio-based products, and small clusters have begun to appear, multiple companies partnered in the same value chain or utilizing similar supply chains rarely exist. High performing ecosystems support economic, environmental and social outcomes but they also require foundational support.

A strong sustainable innovation ecosystem needs to have an emphasis on value chain creation, job training and skills development, a multi-nodal and geographically-diverse group of clusters that build on regional strengths facilitating significant opportunities for commercial enterprises at the regional level, ensuring that a national competitive advantage is achieved.

For ecosystems to grow, regional governments and institutions need to understand and be prepared to address and financially support the skills needed by industry stakeholders. The bioeconomy sector is reliant on access to a pool of professional trades, scientists, engineers, computer scientists and business professionals. Unlike most other sectors of the economy, bioeconomy ecosystems flourish when they are surrounded and supported by institutions that can supply and support their needs.

> Case Study: *The Key to Establishing Clusters for the Bioeconomy – Characteristics of Success (Page 64)*

> Case Study: *Commercializing Biolubricant in Canada – The Critical Role of Innovative Ecosystems to Enable Companies to Succeed (Page 66)*

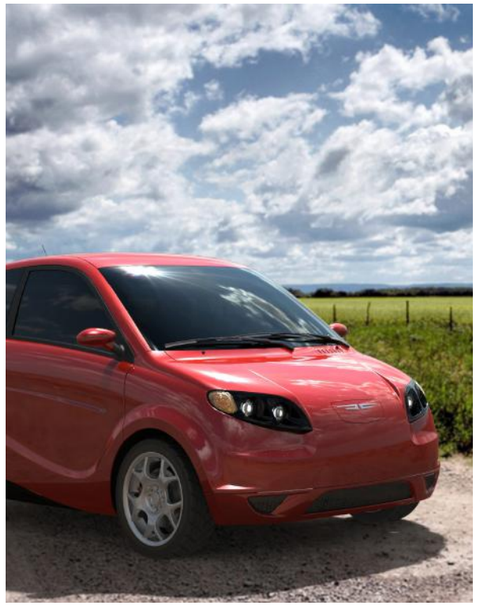
Access to innovation is fundamental to the establishment of strong sustainable ecosystems. Canadian companies such as EcoSynthetix, Greenfield Global and Woodbridge Foam are recognized for the commercial application of R&D expertise in important bioproduct verticals, including areas of bio-based materials and composites, cellulosic ethanol commercialization, platform chemicals and intermediates, fermentation technologies, nanocrystalline cellulose research, pyrolysis technologies and waste-to-energy technologies. These applications have benefitted from the significant talent and research capacity that exists in Canadian academic institutions.

The consultations underscored the need to ensure that support for this foundation remains a focus in the buildout of a strong sustainable bioeconomy ecosystem. Post-secondary institutions can play a critical role in providing talent and resources at lab and pilot scale for applied research.

In order to develop high performing bioeconomy clusters across Canada, there needs to be significant investments in infrastructure related to the development, modernization or adaptation of the agriculture and forestry sectors. Not-for-profit organizations maintaining networks with a track record of developing and attracting companies in the bioeconomy and collaboration should also be supported. Government can use such organizations to support due diligence, infrastructure buildouts and to enhance the knowledge of technologies and products that are part of the bioeconomy.

> *"We need regional business incubators & accelerators with a bioeconomy focus; pilot plant facilities to help de-risk new technologies; funding for business development for scaling and export market access; better regulatory that does not inhibit market uptake of new innovations."*
> *— Survey Respondent*

A bioeconomy strategy cannot be fully realized without acknowledging that Indigenous people have a special relationship with the land its resources as well as the recognition of Indigenous rights to the land and the resources that occupy it. It is imperative that a strong ecosystem encourages partnerships with Indigenous peoples by continuously engaging them on their vision for Canada's natural capital. Formal science and traditional knowledge can coexist and further co-create sustainable practices and renewable products, to the benefit of all communities involved.



Bio Car Rendering — Composites Innovation Centre

Recommendations and Action Plan for Building Strong Sustainable Ecosystems

	Recommendation	*Action*
1	**Support the full spectrum of talent needs including the need for reskilling, skills development, competency profiles and labour market needs of this emerging sector.**	Create a hub for skills and talent support. Provide support for programs offering on-the-job training and experiential learning opportunities. Support the required linkages between regional and national workforce development agencies to increase access to market information and data and ensure a thorough understanding of the sector's needs and support programs that will ensure those needs are being met.
2	**Support the development of the bioeconomy ecosystem.**	Conduct a gap analysis of bio clusters as compared to existing high-performing clusters. Based on the analysis, develop shared best practices and "common good" activities that support organizations can deliver to support commercialization. Increase programming support to existing agencies providing collaboration, networking and infrastructure support to assist with the build-out of Canada's high-performing clusters.
3	**Recognize Indigenous peoples in Canada as key players in resource-based projects.**	Explore opportunities to enhance the use of traditional Indigenous bioproducts Promote the development of more Indigenous businesses. Develop tools and practices and use traditional knowledge to balance traditional use of lands and resources with ways to participate in the bioeconomy

Recommendations and Action Plans in Four Key Priority Areas

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

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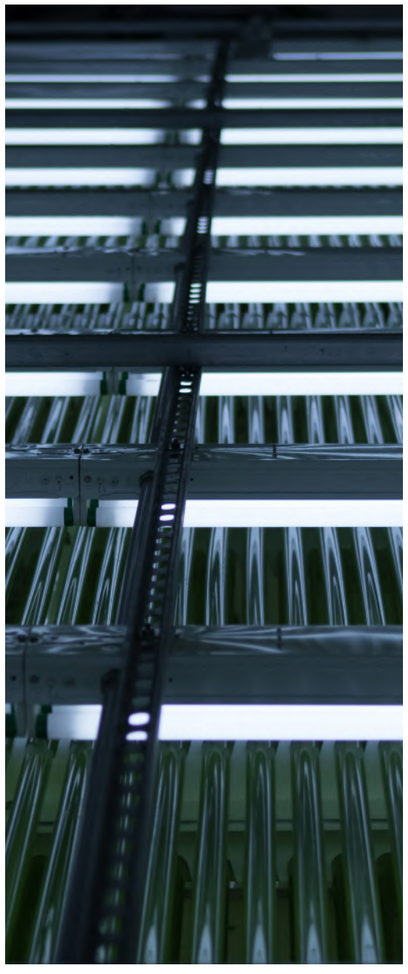

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Conclusion

A Shared Vision for Canada's Bioeconomy

The vision of Canada's Bioeconomy Strategy is to promote the highest valorization of Canadian biomass and residuals while promoting the objectives of a reduced carbon footprint and effective stewardship of natural capital for generations. The development of a vigorous bioeconomy is the platform that will help society address the challenges of plastics and continue the evolution of biorefineries that will reduce our dependence on fossil fuels. The benefits will be sustainable economic growth, particularly for rural economies, and the creation of new highly skilled jobs.

Industry from across the country has weighed in on key priorities and delivered recommendations and actions that they believe will serve the highest valorization of Canadian biomass.

For Canada's bioeconomy to succeed, there is a need:

- For a modernized regulatory system that enables innovation, provides certainty to industry and enables the bioeconomy;
- To establish exemplary stewardship of Canada's natural capital including agricultural and forestry;
- For a business climate that supports the scaling up of Canadian companies and makes Canada a leading nation in the bioeconomy and a country in which to invest; and
- To support a strong sustainable innovation ecosystem with an emphasis on value chain creation, job training and skills development.

A Shared Commitment

Stakeholders from government, academia and industry should align with the 'Recommendations and Action Plans in Four Key Priority Areas' and take action to deliver on these recommendations. The execution of this strategy will require continued coordination among all bioeconomy stakeholders to ensure its success.

Such efforts will require a shift in focus by leaders in government, industry and academia. This is the time to come together to build a common vision for a more economically diverse and sustainable future.

A thriving bioeconomy will ensure growth, access to new markets and jobs for our resource sectors as they continue to innovate and play key roles in the foundation of Canada's economy.

A Call to Action

The Strategy's authors and BioDesign committee members agree that Canada has valuable assets and significant new capacities to ensure the highest value development of Canada's natural capital to establish Canada's bioeconomy. All the stakeholders, as evidenced in this Strategy, remain committed to working together to realize the benefits described herein. The Strategy's authors challenge stakeholders to support their efforts by focusing on removing the barriers to industry success for Canada's bioeconomy. The Strategy's authors understand that the majority of the recommendations and actions will require alignment of departments and time to implement. They believe the following actions, if initiated immediately, will have a significant impact on the growth of Canada's bioeconomy:

1. Establish a permanent and independent panel of industry experts to advise regulators;
2. Undertake a joint scientific review with key trading partners to develop improvements to standards, reference methods and requirements for claims;
3. Increase government procurement mandates to increase the market uptake of bio-based technologies; and
4. Increase investment in:
   - Program scale-up support,
   - Programming support in the form of risk capital for bioeconomy projects, and
   - Programming support to existing agencies supporting high-performing bioeconomy clusters.

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Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

Flax — Composites Innovation Centre

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CASE STUDIES

Innovacorp Demonstration Centre, Brooklyn, NS — Eh to Zed Photography

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

New Substance Notification and Biomanufacturing

Accelerating the Development of Biomanufacturing in Canada

Canada is home to thriving biotechnology innovation with the goal of accelerating the development of biomanufacturing for the benefit of the Canadian economy. Building on this history of innovation and industriousness, Canada can continue to evolve as a global biotechnology leader. Canada can transition traditional industries into this bioeconomy while drawing on its strengths in agri-food and forestry, a world-class regulatory system, a highly skilled and educated workforce and its strong business economy that boasts the lowest business operating costs among G7 countries.

In Canada, the use of a new R&D microorganism in a contained manufacturing facility at a scale greater than 250 or 1,000 (depending on the classification of the organism) litres must be approved by Environment and Climate Control Canada in accordance with the Canadian Environmental Protection Act (CEPA) and the New Substance Notification Regulations (NSNR). There are no scale exemptions for commercial manufacturing in Canada. Canadian companies are involved in a globally competitive business of microorganism manufacturing with competitor manufacturers or affiliated facilities located in the US and elsewhere. In order to win challenging contracts, companies need to demonstrate the capacity to manufacture based on a very aggressive timeline and budget. CEPA and the NSNR are an important factor in the timeline for Canadian manufacture of the bioproducts.

Rationale

Improve and modernize the pathway to regulatory approval for advanced biotechnologies and bioproducts in contained facilities by making the path to commercialization more predictable and harmonized with other jurisdictions to maintain Canada's competitive advantage and attract global commercial biomanufacturing to Canada. The harmonization of environmental approaches, exemptions or licensing programs that would achieve the government's environmental goals while promoting ease of doing business in Canada would significantly improve the path to market for new biotechnologies.

Forest Management Certification System

How Standards Create Global Markets

Canada has three forest certification systems; the Canadian Standards Association, the Forest Stewardship Council (FSC) and the Sustainable Forestry Initiative (SFI). The 25-year-old certifications (all supported by industry) represent quality products and confirm to global markets that Canadian products are renewable and forestry practices are sustainable.

Forest products are renewable, which can constitute a tremendous environmental advantage over other materials and energy sources. However, forest products are only sustainable when they come from responsibly managed sources where forests are re-generated and ecosystem health is maintained. Forest certification is a key tool to demonstrate to consumers that the forest products they use come from well-managed forest.

Canada is considered a leader in forest certification and companies adopt these certifications to gain advantage in the global markets. As of 2016 end of year, 185 million hectares were certified to the three SFM certification programs in use in Canada. Just 11% of the world's forests are independently certified, and 37% of these certified lands are in Canada. This means customers are much more likely to find certified products from Canada that meet their specific needs.

Canada is the only country in the world whose national trade association (FPAC) makes third-party verified sustainable forest certification a condition of membership. The benchmarks demonstrate in practice the responsibilities of the operators for the changing nature of their environmental footprint including water management, species protection, and response to the recognition of indigenous rights.

As public and private sector organizations increasingly require evidence of environmentally responsible practices, certifications which address the concerns of customers and consumers particularly in European and Asian markets, gives forest owners and timber producers access to new markets and a stronger, more diverse customer base, creating higher revenues.

Rationale

The agriculture sector needs to follow a similar path with respect to the development and recognition of sustainable management practices based on solid science and will offer consumers the ability to choose products with enhanced sustainability profiles.

Biofuels

An Essential Element in the Portfolio of Measures Needed for a Low Carbon Economy – The Importance of the Policy and Regulatory Environment

Sustainable bioenergy is a key element in the portfolio of measures needed for a low carbon future particularly in the reduction of emissions from the transportation sector. Biofuels are a significant contributor to reducing emissions, due to their wide availability, low price point, and low carbon intensities; facts supported by independent analysis by third parties as well as Environment and Climate Change Canada.

The Canadian biofuels sector complements energy efficiency measures and electrification. Biofuels have an important role to play in aviation.

The role of policy and regulation in boosting the biofuels industry has been successful. The industry in Canada generates $3.5 billion worth of annual economic activity and has created more than 14,000 jobs. In 2018, according to Statistics Canada, Canada was estimated to have produced about 2 billion litres of ethanol and consume about 3.15 billion litres.

Biofuels production is driven by both federal and provincial mandates. The federal mandate requires that 5% of gasoline is blended with renewable fuel, and the provinces have implemented either equivalent or higher provincial mandates. The federal government has released the federal Clean Fuel Standard (CFS) Regulatory Design Paper, and the draft regulatory framework of the Output Based Pricing Standard (OBPS). These revisions have been welcomed by industry.

There are many examples of biofuel solutions that are ready for deployment. These technologies require:

- A stable predictable policy environment
- Clear targets
- Appropriate long-term remuneration
- Continued R&D and development to reduce costs and improve existing GHG performance
- Recognition of regional and sectoral differences including those related to opportunities, risks and governance
- Data and feedback into best practices and regulation

A favourable regulatory policy as described above will stimulate the development and deployment of new technologies including investment in new plants and the demonstration of reliable performance.

The positive evolution of biofuels and accompanying policy and agile regulation will continue to drive the contributions of the industry.

Case Studies

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

Many advanced biofuels are not yet cost competitive with petroleum fuels due, in part, to high capital and operating costs. High specification fuels such as aviation biofuels are more costly to produce than fossil jet fuel but offer the most significant route to decarbonization of the aviation industry. Procurement policy and incentives to ensure cost effective distribution systems will be needed to support the development of new aviation fuels. In the absence of sustained high oil prices, mechanisms that spread the additional cost of biofuel use among airlines, airports, governments and passengers may be needed for deployment and the price of addressing this source of emissions.

Progress in the biofuels sector is slower than necessary and there is a need to expand the deployment of existing technologies and develop the sustainable supply chains to support the industry.

Rationale
Canadian government policies and agile regulation are critical in the future development and deployment of biofuels which can significantly reduce greenhouse gas emissions and climate change while enabling economic development in Canada.

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Bioénergie La Tuque (BELT)

Recovering Harvest Residue

Bioénergie La Tuque (BELT) has a vision for 2023 to be able to respond to the challenges of recovering harvest residue on a large scale. One of the possible technology sectors that can make better use of this renewable resource is biorefining. BELT proposes a biorefinery plant that would have a production capacity of over 200 million (M) litres of biodiesel per year or the potential to move about 4.3% of the fossil diesel fuel consumption of Quebec for reductions in CO_2 of around 500 000 tonnes per year. The biomass required to supply such a facility would be 600 000 oven-dry metric tonnes (odt) per year (equivalent of 1.2 M green metric tonnes).

FPInnovations led a series of feasibility studies between April 2017 and September 2018 to measure the sustainable potential of the local forest to support such a massive bioenergy project. The studies confirmed the available biomass, proposed strategies for integrated operations, measured the CAPEX-OPEX of multiple operating scenarios, and included additional environmental considerations to confirm the sustainable biomass potential with research done alongside Laval University researchers.

The feasibility studies confirmed there is sufficient biomass availability that can be recovered sustainably in the regions surrounding La Tuque to support such a project. Multiple challenges need to be addressed and certain conditions need to be in place for all this volume to be readily available and delivered at an average supply cost of $4/GJ.

There is an important First Nation community located in the greater La Tuque, the Atikamekw Nation. The Atikamekw are involved on the Board of Directors of BELT and will be an important partner along the supply chain to build and secure the feedstock vital for the proposed biorefinery plant.

Rationale

"Integrated natural resource development" is key to sustainability and stewardship. By generating bioenergy from waste products and increasing energy efficiency, Canada's forest industry cuts its total energy use by 31% and reduced its greenhouse gas emissions by 49% between 2005 and 2015.

Cellulosic Sugar Producers Cooperative (CSPC) and Comet Bio

A Biomass Supply Chain in Southwestern Ontario Leveraging Industry 4.0

Bioindustrial Innovation Canada (BIC) supports agricultural organizations and companies to develop biomass supply chains to support industrial applications for bioenergy, biofuels, biochemicals and biomaterials.

In 2015, CSPC was formed to attract and invest in a cellulosic sugar mill with COMET Bio. The partnership has identified opportunities to satisfy producer and industry interests. Specifications were developed for land use, agricultural crop residue materials, biomass attributes, sustainability and value chain transfer of information from field to product.

CSPC is poised to leverage innovative technologies to efficiently aggregate biomass:

- Harvest equipment is equipped with GPS technology and yield monitoring to support the digitized maps.
- Optic sensors are deployed to measure soil parameters with limited need of soil sampling.
- Machine and machine operator tracking is accomplished through use of telemetry based on machine sensors and real time feedback to the operator.
- With the emerging use of satellite imagery, regional and individual field level assessments are possible that will enable grading of agronomic practices.
- Traceability of source is being tested based on bar code and RFID technologies. A blockchain technology can be considered to support the integrity of the data transfer.
- Information management flowing from field to plant is necessary to achieve economic goals and will need to rely on state-of-the-art telecommunication platforms capable of supporting simultaneous multi users uploading, sharing and retrieving data.

Rationale

Building strong and sustainable biomass supply chains must maximize productivity and ensure best practices are exercised. Precision agriculture leverage Industry 4.0 technologies and big data is critical to build world class competitiveness. This will require broadband area upgrades to support real time data exchanges.

CSPC Farm — BioIndustrial Innovation Canada

Greenfield Global

Building Anchor Companies and Supporting the Development of Biorefineries

Over the past 30 years, Greenfield Global has grown from a single plant in Tiverton, Ontario to become a global leader. It has manufacturing and packaging facilities in Canada, the US and soon in Ireland, reaching customers around the world. Greenfield's many endeavours are aimed at accelerating sustainable solutions for the health of the planet, while promoting economic growth, by responding to the needs of customers.

Greenfield produces corn-based ethanol at four distilleries, three in Ontario and one in Quebec. In addition to producing all formulations of alcohol and ethanol, fermentation CO_2 is bottled on site and sold to companies that make carbonated beverages and concrete, while corn oil and distillers' grains are sold to farms and feed mills for animal nutrition.

Specialty chemical manufacturing and packaging is done at three existing plants in Ontario, Kentucky and Connecticut, with a new plant to be built in the Republic of Ireland. It has two next-generation biofuel and renewable energy R&D centers, one each in Ontario & Quebec. Greenfield is in a unique partnership with the 270,000 residents near its Varennes, Quebec ethanol plant, operating a co-located anaerobic digestion facility, one of the largest in the province. Currently processing 40,000 tonnes per year of source separated organics, Greenfield recently announced the facility is set to double with the addition of more municipal customers. Importantly, Greenfield uses the resulting biomethane to reduce its natural gas consumption, thus reducing the carbon intensity of its fuel ethanol. Additionally, the digestate produced is sold as valuable fertilizer to the local corn farmers who supply the ethanol plant.

Greenfield's Engineering & Technology team has developed advanced anaerobic digestion technologies that will accelerate the conversion of organic waste into biomethane and biohydrogen to supply the growing Renewable Natural Gas market. Through other collaborations, Greenfield is working to commercialize the production of RNG from forestry residues.

In all of its enterprises, Greenfield embraces the notion that no product stream should be without a market. For example, both waste heat and carbon dioxide from its Chatham, Ontario ethanol plant is piped across the road to the neighbouring Truly Green, 90-acre greenhouse facility. The heat reduces natural gas consumption while the carbon dioxide increases tomato yields. This unique collaboration, and the co-located facilities in Varennes, Quebec are both excellent examples of valorizing co-products to their maximum profitability.

Rationale

This case study exemplifies three of the priorities for the bioeconomy including building anchor companies; valorizing co-products to their maximum use; and the importance of public policy in supporting commercialization. Anchor companies are created and strengthened through policy and funding support. For example, over a decade ago, federal and provincial governments mandated the use of ethanol in the national gasoline supply to both lower tailpipe emissions and reduce greenhouse gases. Recently, announced increasing mandates at the provincial level, coupled with the proposed federal Clean Fuel Standard, will only serve to spur on further use of biofuels. But it was the use of time limited, targeted government funding programs, whether through market sensitive support programs or specifically designed tax credits, that ensured that fuel ethanol is made in Canada, by Canadian companies, supporting Canadian farmers. Of note, in Ontario this has created a robust industry, including companies such as IGPC in Aylmer, Suncor in Sarnia, Kawartha Ethanol in Havelock and Greenfield Global in Tiverton, Chatham and Johnstown.

Case Studies

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

Origin Materials and the NaturALL Bottle Alliance

Leveraging Market Pull to Build Value Chains

The NaturALL Bottle Alliance is a consortium formed in 2017 by Danone, Nestlé Waters and Origin Materials to accelerate the development of innovative packaging solutions made with 100% sustainable and renewable resources. PepsiCo Inc. has recently joined the Alliance.

Origin Materials is a material technology company headquartered in California, with facilities and offices in Sarnia, Ontario, Canada. Their proprietary technology platform replaces petroleum with alternative cheap, renewable sources of carbon (e.g., pine and spruce, wood waste, waste paper, agricultural residue) to create building-block intermediates. Their vision is to industrialize a new material basis for the chemical industry—one built on technology that is not just sustainable, but restorative, powering the closed loop economy by recycling atmospheric CO2 into everyday things on an unprecedented scale.

Polyethylene terephthalate (PET), the material used in water bottles, polyester fibers and textiles and more, is estimated to be a $90 billion market. Although physically and chemically identical to petroleum-derived water bottles, bottles made from Origin materials meet consumer demands for sustainability by sequestering carbon and therefore are highly sought-after by consumer brand companies as a substitute for petroleum-based PET plastic. PepsiCo, Danone and Nestlé Waters have come together over Origin's technology and committed to Origin's product. The market pull exerted by the Alliance brand owners on the companies along the fossil-based PET value chain has been critical to Origin's market penetration.

After producing samples of sustainable PET in 2017, Origin Materials has made further progress toward its goal of bringing its breakthrough technology to commercial scale. It has notably selected a site in Sarnia, Ontario, and begun construction of its demonstration-scale plant which is expected to have the capacity to convert 15,000 tons of biomass when fully operational in 2020.

Rationale

The changes that need to occur need to be incorporated through the value chain, including market pull from large MNEs to support the adoption of renewable petroleum alternatives. In this case, Origin leveraged the existing infrastructure for the value chain by creating a drop-in chemical that required no additional capital expenditures to the existing supply chain and tapped into a large and growing market. Origin leveraged the current strategies of MNEs to reduce greenhouse gas emissions.

Improving the Availability of Reasonable Cost Financing for Bioeconomy Projects

Green Bonds, the Equator Principles and the Development of New Canadian Standards for Biomass

The development of the bioeconomy requires reasonable cost commercial financing that is knowledgeable about the technologies, products and infrastructure necessary to the development of this sector and this industry. Although financing has become more available for renewable energy, the commercial tools to finance biotechnologies and products that will address issues such as plastics (chemical plants will need to adopt new technologies) and improve agricultural and forestry productivity need further development.

Canada's largest ever green bond was issued by Canada Pension Plan Investment Board (CPPIB) (C$1.5 billion). It is the first ever green bond from a pension fund globally. Sub-national governments continued to drive issuance, with the Province of Ontario as Canada's largest issuer. Renewable energy and transportation dominated the use of proceeds, with cumulative allocations of 32% and 30% respectively.

The Equator Principles are a financial industry benchmark for determining, assessing and managing environmental and social risk in commercial projects. The principles enjoy widespread use by banks and other financial institutions including the Export Development Canada (EDC).

The US Department Energy (US DOE) recognized that a lack of a standardized approach to evaluating the feedstock risk of bio-projects means that debt and capital markets are unclear about how to rate biomass project risk. This can result in significant project financing barriers for bio-projects. The solution is to create an established protocol or set of standards that capital markets, credit agencies, commercial lenders, and insurance companies can utilize and rely upon to empirically price biomass feedstock risk.

The Bioenergy Technologies Office (BETO) funded a multi-year project to develop new US National Standards for Biomass Supply Chain Risk (BSCR). BSCR Standard development is carried out by Idaho National Laboratory and several other organizations including a Canadian firm. The US National BSCR Standards will provide bio-project developers and capital providers with guidance and best practices to better understand, quantify, and mitigate risks--and to provide financial criteria for the overall supply chain risk of projects.

The development and adoption of criteria applicable to the development of biomass projects from feedstock to market will significantly influence the amount of reasonable cost capital available to companies in the bioeconomy.

Rationale

Development and adoption of criteria for determining and managing financial risk particularly with the endorsement of Canadian financial institutions would significantly increase the ability of Canadian financial institutions to consider and rate risk associated with biomass projects including environmental risk, increasing the availability of capital to the bioeconomy.

BioAmber

A Cautionary Tale – Supporting Management Expertise from Scale-Up to Commercialization

The bankruptcy and subsequent sale of BioAmber's succinic acid plant in Sarnia, Ontario, that followed an investment of over $30 million in public funds and an operating history of less than two years, is testament to the vulnerability of anchor companies in the bioeconomy.

Companies face new challenges after they make the leap from scale-up to full production. Once a company has scaled its operations, more time and resources are needed to develop new markets, scale the business and break into established value chains dominated by MNEs. Many of the potential adopters of the processes and products of the bioeconomy do not have their decision making located in Canada, and the demands of large-scale commercialization challenge the resources of companies who have just reached that point.

Government provides programs to support businesses to scale and commercialize, but once a company begins to break into international value chains, further support is required, and this should include business advisory services. A company that has been preoccupied with building a plant, putting in place the necessary workforce, and fine tuning its operations may be surprised and challenged by the complexity of value chain adoption even if they have done their homework in identifying the markets and securing some customers.

Even if the technology demonstrates value for the customer, the rate of adoption and speed of commercialization – the time to market – may dramatically impact the financial/ business success of the technology. The speed of commercialization and time to market has been a particular challenge for the biotechnology industry.

In further developing commercial operations, management should be encouraged to allow a "challenge function" from business advisory services that would bring additional expertise to bear on the decision making in the company. These services should be ongoing. The challenge functions should include the growth plans of the organization, the functioning of management and the Board, and commercializing business, products or services.

Companies should perhaps be required to assume business advisory services as part of commercial financing, particularly those that have benefitted from public support.

Advisory services need to come from the Canadian marketplace. Developing a strong capability of relevant non-governmental Canadian business advisory services is important to ensuring that anchor companies develop strong roots and can withstand the challenges of testing, certifications,

Bankruptcy does not take into account public investment and if Canadians are to reap the benefits of the generous public support for new industries that will provide economic growth and support efforts to mitigate climate change and reduce dependence on fossil fuels, business advisory services to ensure the growth and longevity of anchor companies are key.

Case Studies

Canada's Bioeconomy Strategy Leveraging our Strengths for a Sustainable Future

Rationale
There are very few Canadian anchor companies particularly in the bioeconomy space. Building successful "anchor" companies requires more than financial support. Advisory services necessary to address market, human resources and cash management challenges in operating a newly commercial enterprise are key.

BioAmber, Sarnia, ON

The Key to Establishing Clusters for the Bioeconomy

Characteristics of Success

Start-ups, small and medium-sized enterprises (SMEs), and large corporations, look to multi-sector collaboration, open innovation, business services, and partnerships with researchers, post-secondary institutions, community leaders and other innovators to ensure the success and growth of their businesses.

Clusters make it easier for companies and potential customers to harness the strengths of local ecosystems and to collaborate.

The Sarnia-Lambton Hybrid Chemical Cluster grew out of efforts by the community to diversify the economic base after a decline in the traditional chemical sector. The not-for-profit organization Bioindustrial Innovation Canada (BIC) was created in 2008 to act as a business and cluster accelerator for the bio-based chemical industry. The formation of BIC initiated the Hybrid Chemical Cluster (HCC) in Sarnia-Lambton. The cluster includes all businesses and organizations involved in the petrochemical, natural gas, and biohybrid chemical industries. Sarnia-Lambton chose to accelerate this industry as Lambton County contains an abundance of fertile farm land, as well as knowledge and experience in producing both traditional and bio-based chemicals.

Saskatoon's Agriculture Biotechnology Cluster (Ag-Bio Cluster) is one of the country's oldest clusters. The cluster was initially agriculture based but later the aspect of biotechnology emerged with the development of the oilseed crop canola.

The Ag-Bio Cluster was conceptualized to accelerate Saskatoon as the hub for agriculture research. Innovation Place was built as a technology incubator to help develop early stage companies by providing facilities for research and development. Biotechnology was further supported by government organizations such as Agriculture and Agri-Food Canada and the National Research Council. The cluster initiative officially began in 1989 when the not-for-profit organization Ag-West Bio (AWB) was formed. AWB was developed to act as an accelerator for the agriculture biotechnology industry by attracting companies to the area and by providing small investments to help commercialization.

An analysis of these two enduring Canadian clusters[22] – Sarnia-Lambton Hybrid Chemical Cluster and Saskatoon's Agriculture Biotechnology Cluster – provide examples of best practices as to how to create successful clusters:

- Create a process with accountabilities/responsibilities that allows outsiders to see how the cluster works
- Connect/collaborate outside the cluster on areas such as universities and manufacturing
- Determine which types of collaboration would be of interested to the actors
- Determine ways to increase collaboration with all actors in the cluster
- Collaboration can happen between any cluster actor, but research collaborations are important for industry focused clusters
- Clusters can assist members by actively finding and forming these arrangements or by merely providing the space and opportunity for actors to form their own connections.
- Find ways to decrease bureaucracy for cluster participants
- Work with cluster actors to decrease barriers and create incentives for commercialization

22 Key Aspects of Developing A Cluster, Case Study of Sarnia-Lambton's Hybrid Chemistry Cluster and Saskatoon's Agriculture Biotechnology Cluster, Darian Budarick, 2017

Much like a business trying to sell a product, a cluster is trying to sell an area and industry. Promoting a cluster will help to attract companies and market to existing members. After 10-15 years of development, both clusters have a similar proportion of innovative companies. The key factors underpinning a cluster are: funding, networking, good management, business support, and the ability to get actors on board.

A cluster is not a guarantee of success. Globally, companies are grappling with an unprecedented rate of change. To remain at the forefront of competition, address key challenges and build a shared advantage, firms must partner in new ways – clusters offer these advantages.

Rationale

Clusters are a key ingredient to developing, scaling and commercializing biotechnology. Companies need to be supported and the actors that maintain the network must also be supported.

Commercializing Biolubricant in Canada

The Critical Role of Innovative Ecosystems to Enable Companies to Succeed

oilseed innovation partners
Building the Business of Oilseeds

Biolubricants are based on renewable feedstocks such as plant sugars or plant oils (i.e. high oleic canola oil, high oleic soybean oil, high oleic sunflower oil) or synthetic esters manufactured from renewable oils. Biolubricants rapidly degrade in the environment and exhibit very low toxicity (non-toxic to humans and many other species including those in aquatic habitats).

High oleic seed innovation has been mostly driven by the global seed companies working with university researchers and the National Research Council over the last three decades. The driver for the high oleic trait development was to replace the partially hydrogenated oils which contained trans-fats that were strongly linked to heart disease. These varieties offer much improved oxidative and heat stability, compared to conventional vegetable oils. These performance characteristics are required for lubricants to decrease degradation and polymerization which increases lubricant use life. This is a great example where the development of basic characteristics to satisfy one major market application (food processing and production) can be applied to another industry with different applications.

The global market for lubricants is forecasted to reach 44 million tonnes by 2020. To put that into perspective, global plant-based oil production in 2018 was estimated to be about 200 million tonnes.

Oilseed Innovation Partners (OIP) is a business accelerator supporting companies to commercialize plant-based oil products made from Canadian oilseeds. OIP is working with biolubricant companies such as Renewable Lubricants Inc, ELM, Smart Earth Lubricants and DM's Biobased Fluid Supply to develop market strategies, identify specific applications and engage with potential end use sectors and influencers to grow the market for non-toxic, biodegradable formulas for biolubricant products.

OIP is also working closely with academic partners to demonstrate the benefits of bio-based bar chain oils and 2 stroke engine oils to industry and young arborists. It leverages its relationship with influential associations such as International Society of Arborists, Ontario Commercial Arborists Association, Ontario Woodlot Association, Bruce Trail Conservancy and with conservation authorities and municipalities to prove these products in real world situations.

As part of this innovative ecosystem, The OIP is developing value for agriculture while supporting the environment and the economy through bioproduct commercialization using oilseeds. This includes developing new markets for crops that will help create jobs, build wealth and revenues while making a positive difference for the environment.

Rationale
All of the recommendations in this Strategy are linked by a single theme, "Increasing market pull." This case study offers an example of how business accelerators who are close to companies, relevant academic and R&D organizations, and industry associations can use these levers to help scale and de-risk innovative bioproducts.

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