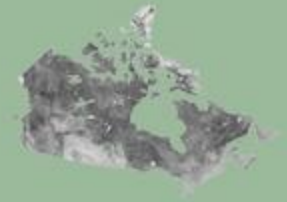


# R&D Activities & Initiatives for Biorefinery Development in Canada



IEA Bioenergy

Task 42 Biorefining

IEA Task 42 – Progress Meeting – May 15<sup>th</sup>, 2017

Eric Soucy

Natural Resources Canada - CanmetENERGY



Natural Resources  
Canada

Ressources naturelles  
Canada

Canada

# A Forest Bioeconomy Framework for Canada

## *Overview of Key Elements*



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Canadian Council  
of Forest  
Ministers



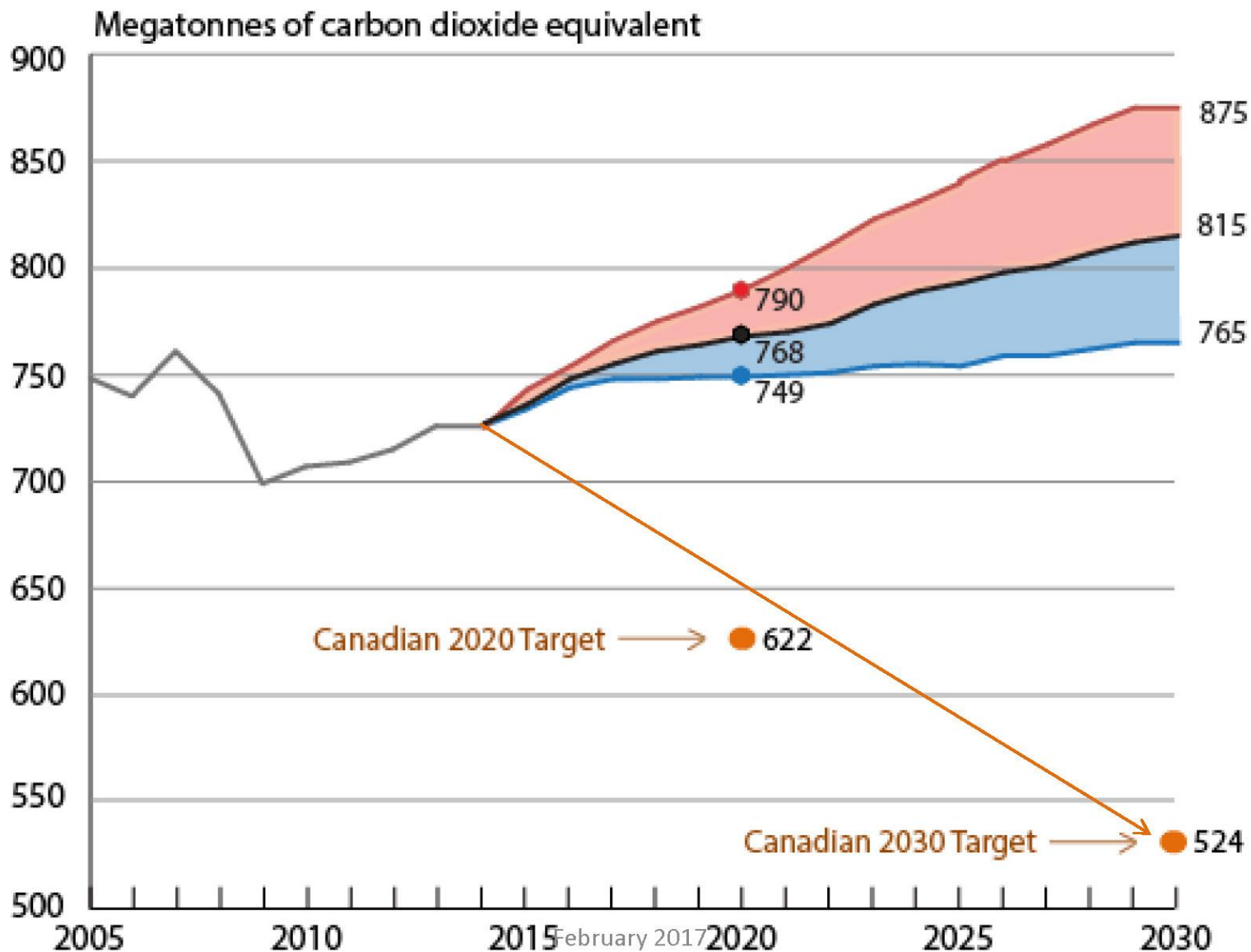
Conseil canadien  
des ministres  
des forêts

# Canadian Council of Forest Ministers

- Since 1985, the CCFM has brought together federal, provincial, and territorial forest ministers to:
  - *Promote cooperation* between governments
  - *Develop* and maintain a scientific information base
  - *Demonstrate* international leadership
  - *Share* information on issues impacting on the forest sector
  
- In June 2016, the CCFM released the ***Innovation Action Plan (2016-2020)***
  - Committed to developing a Forest Bioeconomy Framework for Canada
  - Three Pillars: *Collaboration, Engagement and Mobilization*
  - Currently in the Engagement stage
  
- Canada is the current CCFM chair



# Canada's Climate Change Commitments





# Canada has unique bio-based advantages



- Canada has one of the largest biomass resources in the world (agriculture, forest, marine)
- World-class forest sector innovation system based on strong collaboration

*And has...*



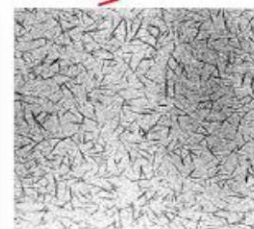
An abundance of  
skilled labour



Mature forestry  
fibre supply  
infrastructure  
and secure  
property rights



Emerging clusters  
that draw upon  
existing  
infrastructure



A **technology**  
**advantage** in  
several areas (eg.  
cellulose  
nanomaterials, agri-  
breeding and  
agronomics)



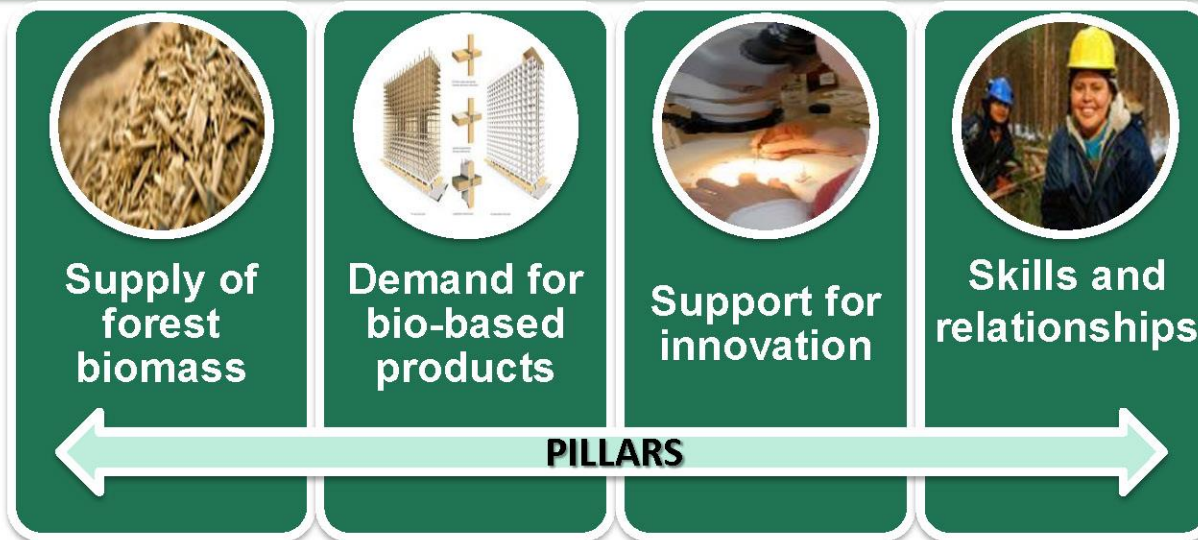
Strong and broad-  
reaching S&T and  
academic network



# Key Elements of the Framework

**Vision:** Canada is a recognized global leader in the forest bioeconomy

**Guiding Principle:** The bioeconomy is based on the principle of efficiency; forest resources should be managed in a sustainable manner adding maximum value, including by reusing materials to preserve natural capital stocks, and respecting the services and cultural value they provide to support the well-being of Canadians



**Long term outcome:** A robust forest bioeconomy in Canada would be identified by the accessibility of sustainable bio-based raw materials sourced from healthy forests available for high added-value processing supplied through a well-functioning market enabled by an effective innovation system and supported by a trained, competent labour force, founded on respectful relationships



# Policy Action Areas

Efficient standards and an effective regulatory regime for new bio-based products

Innovative financial mechanisms including tax measures to de-risk commercialization

Collaborative research and development along the innovation continuum

Public sector procurement to promote clean tech and supply chain sustainability

Outreach to attract investment and increase demand for Canadian bioproducts

Accessible comprehensive investment-grade data on the bioeconomy

Workforce training and strong partnerships with Indigenous communities



# Recent Canadian Biorefinery Initiatives



**2017**  
February 13-17  
Sheraton Centre  
Montreal, QC, Canada

The International Conference for the forest-based Bioeconomy



## BIOFOR's 3 main focus areas



### MARKET DEVELOPMENT

Within the MARKET section, targeted presentations and panels will set the table for a comprehensive overview of the current market potential and deployment of the forest bioeconomy. Notorious private and public companies will provide pertinent examples to show the current projects and initiatives underway. While Government representatives and policy organizations will describe the funding accessible to support innovation networks and clusters and depict tangible impacts on the industry and its players.

[Link to page](#)



### PROCESS ADVANCEMENTS

The Process Clusters Segment of BIOFOR will look at several process advancements that are catalysts in the deployment of the forest bioeconomy locally and around the world. The latest progress in biorefinery start-ups, pulp and paper mills that are being transformed in bioproduct sites, projects that are developed in different parts of the world, companies that are diversifying their product portfolio and more. The Process Segment will also feature some of the latest advancements in biomaterials, with presentations providing an in-depth overview of the different discoveries and opportunities in biomaterials production.

[Link to page](#)



### NEW TECHNOLOGY

BIOFOR Technology Segment will present a variety of technical and R&D presentations designed to continue finding new avenues and possibilities for the transformation of the forest products industry. Researchers, PhDs, consultants, governmental experts and engineers will present their latest work and will provide a unique opportunity to hear the latest developments and breakthroughs in transformational technologies. Time to open your mind, think outside the box and get inspired!

[Link to page](#)

## Keynotes at BIOFOR International



**Glenn Mason**  
Assistant Deputy Minister  
Natural Resources  
Canada



**Jean Hamel**  
Vice President  
Pulp, Paper & Bioproducts  
FPInnovations



**Gurminder Minhas**  
Managing Director  
Performance  
Biofilaments



**Peter Axegård, Ph.D.**  
Vice President,  
Bioeconomy Strategy,  
Inventia/  
RISE Bioeconomy



**Michael Rushton**  
Vice President,  
Chief Operating Officer  
Fibra Innovations Inc.



**Balázs Tolnai**  
General Manager  
Technology  
Kruger Inc.



**David Boulard**  
Executive Vice President  
Ensyn Corporation



**Daniel Archambault**  
Executive Vice President  
Kruger Inc.



**Marco Lucisano**  
Vice President  
Director, Business Area  
Papermaking & Packaging  
Inventia AB/  
RISE Bioeconomy



**Trevor Stuthridge**  
Executive Vice President  
FPInnovations



**Murray McLaughlin**  
Advisor  
Bioindustrial Innovations  
Canada



**Warren Mabee**  
Canada Research  
Chair in Renewable  
Energy Development  
Queen's University



**John Kettle**  
Vice President  
Sales and Business Dev.  
VTT Technical Research  
Centre Ltd



# Recent Canadian Biorefinery Initiatives (cont'd)

**CANADIAN BIOMASS** Like 659 Fol

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## Sawmills in Quebec and Ontario generating oversupply of wood chips

May 01, 2017  
Written by Wood Resources International LLC



May 1, 2017 - Sawmills in Eastern Canada have been running at record high levels in 2016, with production reaching levels almost 10 per cent higher than in 2015 and almost 40 per cent higher than five years ago. This has been very good news to the forest industry, with sawmills running at 97 per cent operating rates in late 2016, according to the WWPA. However, there are also worrisome developments regarding the large volumes of residual chips that are being generated and where the chips can be sold.

The pulp sector has been the key consumer of residuals in the past, but with a shrinking pulp industry in both Ontario and Quebec, there are concerns that sawmills in the region might be forced to limit production levels because it may be difficult to sell off the large volumes of chips that are being produced.

Despite the oversupply of residues in Quebec, wood chip prices have not changed much over the past few years in Canadian dollar terms. Most contract prices for residues are set on an annual basis and after four years of practically unchanged prices, they fell almost five percent in the 1Q/17. It is likely that prices will decline in the future but this will not necessarily solve the problem with access to chips in the province. Either new production capacity needs to be added (e.g. wood pulp, pellets, composite panels or bio-based products), or sawmills will have to find other outlets for their chips outside the province. Alternatively, sawmills might have to reduce production levels in the future.

Although the latter alternative would be less desirable for both the domestic forest industry and for lumber consumers in the U.S. to which much of the lumber is exported, it could still be a reality later this

## Government of Canada Invests in Renewable Natural Gas

### News Release

From [Natural Resources Canada](#)

March 15, 2017

Ottawa

Natural Resources Canada

Investing in the production of renewable natural gas (RNG) from forest industry residue can diversify Canada's energy mix, reduce greenhouse gas emissions, improve industrial efficiency and create new economic opportunities for Canadian companies and good middle-class jobs that benefit rural communities.

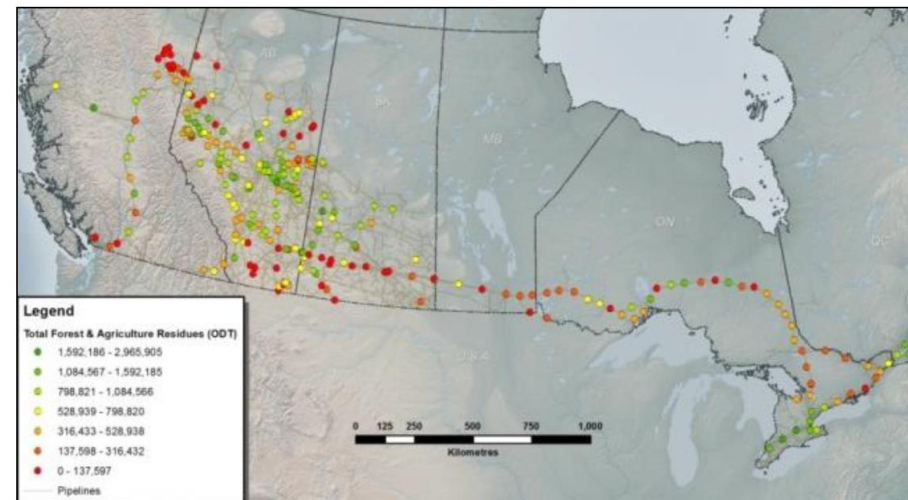
Canada's Minister of Natural Resources, the Honourable Jim Carr, today announced an \$800,000 investment in G4 Insights Inc. for the development of technology to convert forestry waste into RNG that can be distributed through existing natural gas pipelines in Canada.

G4 Insights is partnering with the Canadian Gas Association members Enbridge Gas Distribution, FortisBC, Gaz Metro, Union Gas, utility host ATCO, the Natural Gas Innovation Fund, Alberta Innovates, and FPInnovations, who are contributing a combined \$1.35 million towards this project.

Renewable natural gas produced from sustainably managed forest residue can emit up to 85 per cent less greenhouse gas emissions than traditional fossil fuels. Forest residue, which includes all parts of the tree, can be converted into solid, liquid or gaseous biofuels such as RNG that can then be burned for energy or used as fuel substitutes for transportation or industrial processes.

G4 Insights will build a RNG demonstration plant and test it under operational conditions with a range of biomass types to generate relevant technical operating and economic data. The optimal site location has been chosen in Edmonton, Alberta to support all-season operation in outdoor conditions.

Today's announcement reaffirms the Government of Canada's commitment to preserving our natural environment and resources for future generations — to put in place real actions that will work toward Canada's climate goals.



# Recent Canadian Biorefinery Initiatives (cont'd)

## Enerkem biofuels facility meets operational milestones

April 11, 2017  
Written by Enerkem Inc.



April 11, 2017 - Enerkem Inc. announced today that its first [full-scale commercial facility](#), located in Edmonton, has met all operational milestones set by its senior lender Integrated Asset Management (IAM).

"The Enerkem Alberta Biofuels facility in Edmonton is fully operational in accordance with very rigorous production criteria", said Vincent Chornet, President and Chief Executive Officer of Enerkem. "This third-party validation comes in at the right time as we are expanding our footprint in North America and Europe. Our disruptive solution sets a new standard in waste management, biofuels and chemicals, thus accelerating the transition toward a circular economy where waste becomes a resource to make everyday products."

"We have been impressed with Enerkem's discipline and commitment throughout the process of ramping-up the world's first commercial operation of its kind", said Greg Dimmer, Managing Director IAM Private Debt Group. "As Enerkem's senior lender we look forward to expanding our partnership through future financing opportunities as the company continues to expand its market outreach."

Enerkem's technology turns household waste into 99.9 per cent pure liquid chemicals and biofuels.

## Municipal solid waste to biomethanol



Natural Resources  
Canada

Ressources naturelles  
Canada

## Forge Hydrocarbons to build biodiesel plant in Sombra



March 21, 2017  
Written by Maria Church



Photo source: [igniteedmonton.com](#)

12 years ago by David Bressler, director of the Biorefining Conversions Network in the University of Alberta's Faculty of Agricultural, Life and Environmental Sciences.

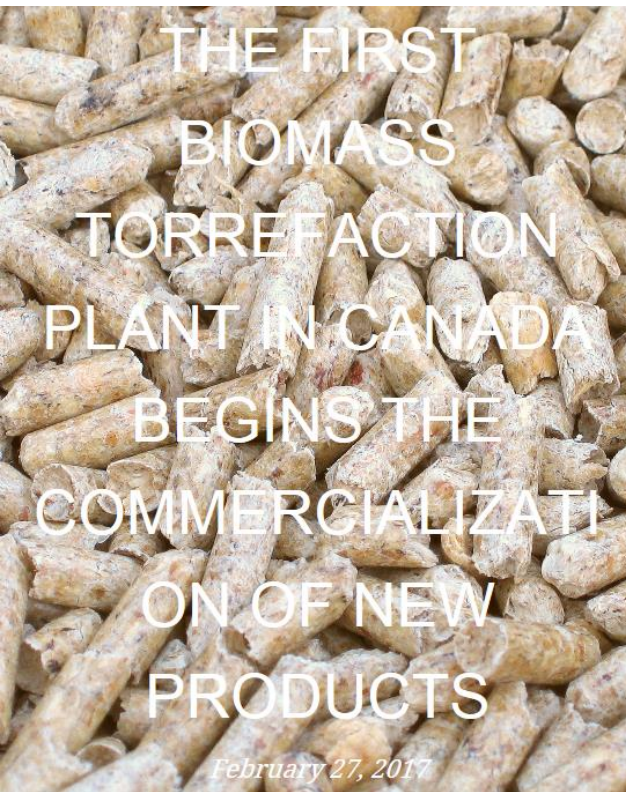
March 21, 2017 - Edmonton's Forge Hydrocarbons will begin construction of a \$25-million biodiesel manufacturing plant at a BIOX Corporation site near Sombra, Ont., as early as this fall.

The startup company received a \$4.2-million grant from Sustainable Development Technology Canada last year to help build the plant.

Forge's pilot plant in Edmonton converts low-value fats and oils into hydrocarbon, a process that was invented

A U of A news article reports that once the manufacturing plant is built it will produce renewable liquid hydrocarbons at a capacity of 19 million litres annually. Read the full article [here](#).

# Recent Canadian Biorefinery Initiatives (cont'd)



Airex Energy officially inaugurated its biomass torrefaction plant, located in the La Prade industrial park in Bécancour, Quebec. The industrial size demonstration plant, which required around 10 million dollars in public and private investments for its design, construction, and start-up, showcases the latest biomass torrefaction technology, called CarbonFX™. This unique, revolutionary technology, designed by Airex Energy, significantly reduces greenhouse gas emissions for many industries still using coal or coal by-products.

Airex Energy's torrefaction process **transforms biomass residues into biocoal pellets**, a clean and renewable fuel that can replace coal and oil. Biocoal's unique properties allows it to easily disintegrate, so it can be ground up and combined with bituminous coal in thermal power stations producing electricity, without major changes to existing systems for handling, storing, and grinding coal.





# Recent Canadian Biorefinery Initiatives (cont'd)

## BELT partners with Neste on biodiesel project



January 18, 2017

Written by [Maria Church](#)



Photo source: [neste.com](#)

Jan. 18, 2017 - Bioenergy La Tuque (BELT) has partnered with Finnish renewable fuels company Neste Corporation to study the feasibility of producing renewable diesel from forest harvest residues in La Tuque, Que.

Finnish and Canadian delegates made the partnership announcement in Montreal yesterday. The agreement focuses on the project's techno-economic feasibility and will assess the biomass availability at a

competitive cost, identify technology bottlenecks in process lines, and validate the acceptable level of techno-economic risk.

"We believe that forest harvest residues can play a significant role in the future in producing renewable products, and therefore, we are very excited about this cooperation," Lars Peter Lindfors, SVP of Technologies for Neste, said in a news release. "We expect to see the Canadian and Quebec legislations on advanced renewable fuels developing further in the next two years, as we see it as a prerequisite for any future investments."

The La Tuque project aims at the production of renewable diesel from the conversion of forest harvest residues. With the support of FPInnovations, the project aims to serve as a reference and flagship project so that, based on the knowledge, technologies, and competencies developed in the course of the studies co-financed by the provincial and federal governments, and industry partners, a similar project can be duplicated elsewhere in Canada.

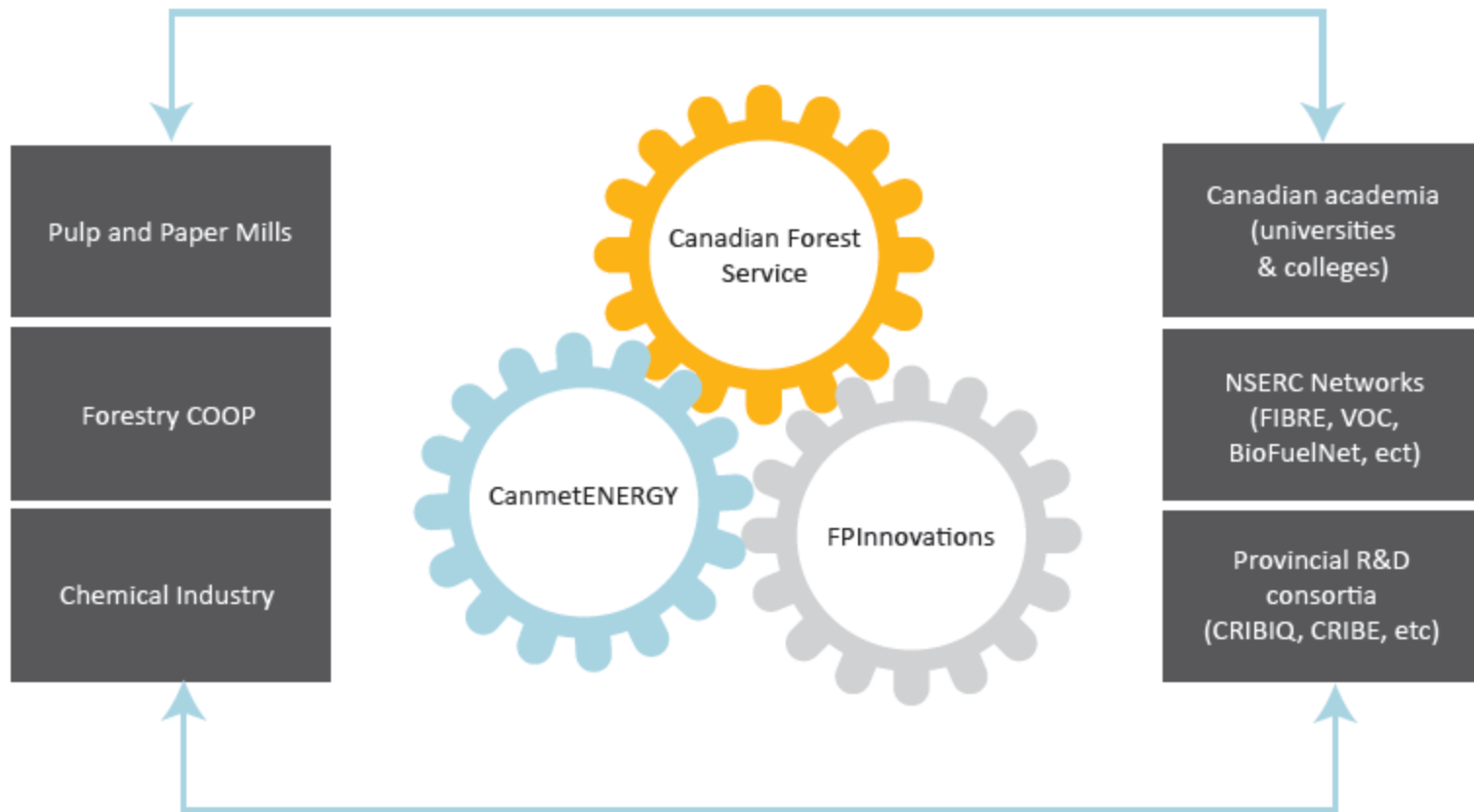


Natural Resources  
Canada

Ressources naturelles  
Canada

# R&D Biorefinery Hub Creation

Coordination across a wider range of biorefinery-based  
R&D and innovation in Canada



# The I-BIOREF Software



## Key Features

- **I-BIOREF** supports decision-makers in selecting viable biorefinery solutions
- **I-BIOREF** evaluates the benefits of integrating commercially available biorefinery processes
- **I-BIOREF** provides several criteria to assess the biorefinery project from different perspectives
- **I-BIOREF** performs sensitivity analysis to evaluate the impacts on resources utilization

## Metrics

- **6 economic metrics (PBP, IRR, NPV, ROCE, ROI, EBIDTA)**
- **2 competitiveness metrics (CAB, RTMU)**
  - Competitive access to biomass
  - Resistance to market uncertainties
- **17 LCA-based metrics**
  - Mid-point impact category (carcinogens, respiratory inorganics, land occupation, etc.)
  - Damage category (climate change, human health, ecosystem quality, etc.)

## Process and Technology Models

- **Pulp and paper processes:** Kraft and TMP
- **Biomass pretreatment processes:**
  - Steam explosion; Liquid hot water; Acid hydrolysis; Alkaline hydrolysis; Instant controlled pressure; Organosolv; Torrefaction
- **Pre-extraction processes**
  - Near-supercritical fluids (e. g. H<sub>2</sub>O-CO<sub>2</sub>); Hot water; Enzymatic
- **Lignin recovery processes:** LignoBoost™, LignoForce™, SLRP™
- **Sugar streams conversion processes:**
  - Detoxification; Fermentation; Separation / Purification
- **Thermochemical processes:**
  - Gasification; Pyrolysis; Catalysis



# Case study: Integration of a Biorefinery Technology in a Canadian Softwood Kraft Pulp Mill



Hinton case - Ottawa - Integrated Biorefinery

File Edit Options Window Help

**Integrated Biorefinery**

Add new base case...

Base Case(1)

1- Build your Base Case 2- Compare Scenarios 3- Generate Graphics

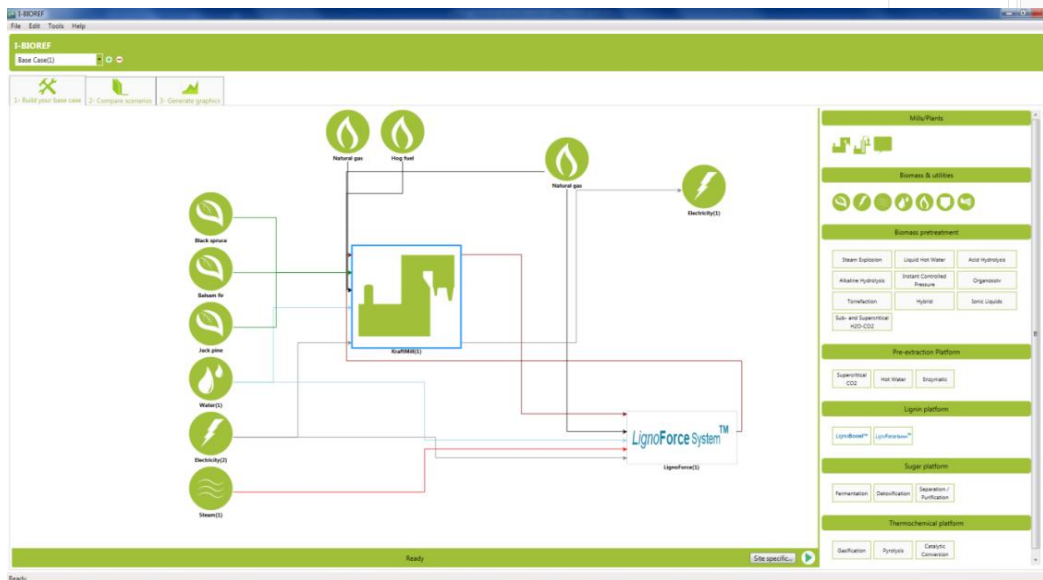
Process data Economic data Impacts **Economic/Environmental footprint**

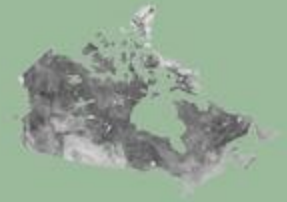
Base Case(1) Scenario(1) Scenario(2)

Operating cost Kraft mill

**THE INTEGRATED BIOREFINERY**

	Base Case(1)	Scenario(1)	Scenario(2)
<b>Total operating cost</b>	\$/yr 974,978	11,370,368	13,447,670
<b>Biomass cost</b>	\$/yr 0	7,748,837	7,748,837
<b>Chemicals</b>			
<b>Total chemical reactants operating costs</b>	\$/yr 0	748,418	2,245,253
Carbon dioxide	\$/yr 0	299,700	899,100
Sulfuric acid	\$/yr 0	99,900	299,700
Sodium Hydroxide	\$/yr 0	319,680	959,040
<b>Utilities</b>			
<b>Total utility cost</b>	\$/yr 576,624	1,511,184	1,880,693
Water	\$/yr 0	652,846	656,941
Steam	\$/yr 576,692	561,377	677,817
Effluents treatment	\$/yr 0	90,903	92,258
Electricity	\$/yr 0	142,350	262,550
Fuel	\$/yr -3,001,418	-2,937,709	-2,810,292
<b>Miscellaneous costs</b>			
<b>Total miscellaneous costs</b>	\$/yr 309,720	328,259	350,371
Labour	\$/yr 0	279,720	279,720
Maintenance	\$/yr 0	18,539	40,651
Technical support	\$/yr 0	30,000	30,000
Other Costs	\$/yr 0	0	0
<b>Implementation technology risk</b>	\$/yr 88,634	1,223,670	1,222,515
<b>MLL</b>			
<b>Total incremental operating cost</b>	\$/yr 634,361	10,046,910	10,174,994
<b>Incremental Biomass cost</b>	\$/yr 0	7,748,837	7,748,837
<b>Total incremental utility cost</b>	\$/yr 576,692	1,384,717	1,501,157





# Thank you for your time and attention!

**For further information, please contact:**

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Industry Program, CanmetENERGY – Varennes

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Website: <http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca>



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