

I-BIOREF SOFTWARE

MODELING AND ANALYSIS FOR TECHNICAL, ECONOMIC, AND ENVIRONMENTAL ASSESSMENT OF BIOREFINERY PROCESSES

I-BIOREF brings together the power of process simulation and optimization to deliver a unique combination of biorefinery technology models and rapidly evaluate trade-offs that reflect the best biorefinery compromises for the production of bio-based products and commodities, from technical, economic, and environmental standpoints.

THE CHALLENGE FOR INDUSTRY

The transformation of the forest products sector is close to becoming a reality, as the emerging bioeconomy provides Canadian industries with promising opportunities to generate new revenue streams, by taking advantage of abundant, high-quality, and renewable forest resources. To establish biorefinery strategies, companies must determine which bio-based products are attractive and how to produce them efficiently, while minimizing technological, financial, and environmental risks. As a result, a number of key questions must be answered:

- Which products are the most interesting, given available biomass, existing infrastructure, and access to energy and water resources?
- What processes are available to produce these products, and which co-products could also be considered?
- How should one deal with complex and inter-connected technological, environmental, and economic issues, as well as operational constraints that compete and make trade-offs unavoidable?

THE I-BIOREF SOLUTION

Companies need a solution that enables them to model biorefinery processes and assess the technical feasibility, economic viability, and environmental footprint of the technology of their choice, prior to making any investment decision. Companies also require tools that enable them to benchmark their selected biorefinery option against other well-established options.

I-BIOREF is a flexible software with simulation capabilities that responds to these needs.

I-BIOREF incorporates graphical capabilities that make it possible to develop a detailed process flow diagram of biorefinery, integrated into an existing mill or a standalone biorefinery system. Each unit operation includes default values for process data and associated economic data.

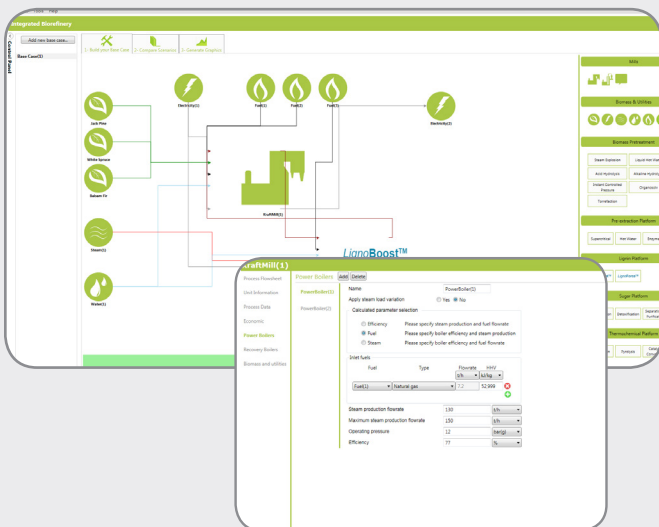
A Comprehensive Library of Process Models

I-BIOREF also incorporates pulp and paper process models and a comprehensive library of well-established biorefinery technologies – which can be combined or not –, allowing for the simulation of a wide range of plausible “what-if” scenarios.

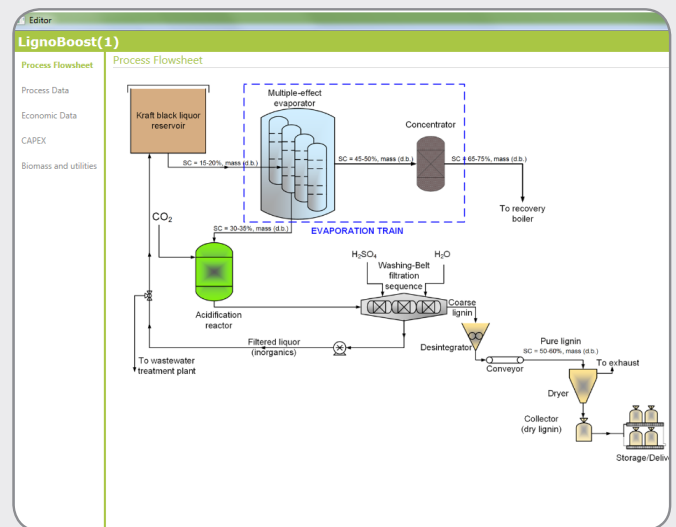
Models available in I-BIOREF include:

- **Pulp and paper processes**
Kraft; thermomechanical (TMP)
- **Biomass pretreatment processes**
Steam explosion; liquid hot water; acid hydrolysis; instant controlled pressure; organosolv; subcritical and supercritical fluids; ionic liquids; torrefaction
- **Pre-extraction processes**
Supercritical fluids (e.g. CO₂); hot water; enzymatic
- **Lignin recovery processes**
LignoBoost™; LignoForce™
- **Conversion processes of sugars from lignocellulosic biomasses**
Detoxification; fermentation; separation/purification
- **Thermochemical processes**
Gasification; pyrolysis; catalysis

Each model is supported by a detailed mass and energy balance and related key process characteristics, including electricity, steam, water, biomass, fuel, chemicals, and effluents. Process flow diagrams of the selected pulp and paper process and biorefinery technology are also provided to help visualize the main unit operations involved. An automatic control functionality of the consistency of data or specifications is incorporated to diagnose and communicate invalid data to the user, so that only valid data is used when creating process flow diagrams.



Process flow diagram of biorefinery technology, integrated into a kraft mill, with process and economic data input table



Process flow diagram of biorefinery technology

With I-BIOREF, the user builds a base case configuration of integrated or standalone biorefinery, and then creates a series of “what-if” scenarios that can be compared by using either results tables or a variety of graphs.

COMPREHENSIVE METRICS FOR EASY ASSESSMENT AND COMPARISON

I-BIOREF incorporates key metrics and information for the different scenarios evaluated. Technical information includes mass and energy balances, product specifications (e.g. purity, dryness), process performance (e.g. yield, productivity), and changes in revenue and operating costs of the mill, due to the integration of the biorefinery process.

I-BIOREF also calculates a range of economic metrics to support decision-makers in comparing and selecting viable biorefinery solutions. This includes conventional economic metrics (e.g. IRR, ROCE) as well as new ones (e.g. competitive access to biomass [CAB] – which reflects the ability to guarantee a supply of biomass over the long term, while providing competitive value to biomass producers – and resistance to market uncertainty [RTMU] – which corresponds to the biorefinery option’s sensitivity to fluctuations in market value, resulting from variations in the price of raw materials and energy).

Further, I-BIOREF evaluates environmental footprints, using life cycle assessment (LCA)-based criteria that include impacts on global warming, non-renewable energy, indirect land use, respiratory inorganics, respiratory organics, aquatic acidification, aquatic ecotoxicity, carcinogens, and water withdrawal.

The various results and metrics calculated in I-BIOREF for all scenarios can be presented side-by-side, in convenient and dynamic tables. I-BIOREF also has a graph wizard to create and edit 2D graphs (e.g. line, bar, and pie graphs) for easier comparison of different scenarios and to run sensitivity analyses of key parameters.

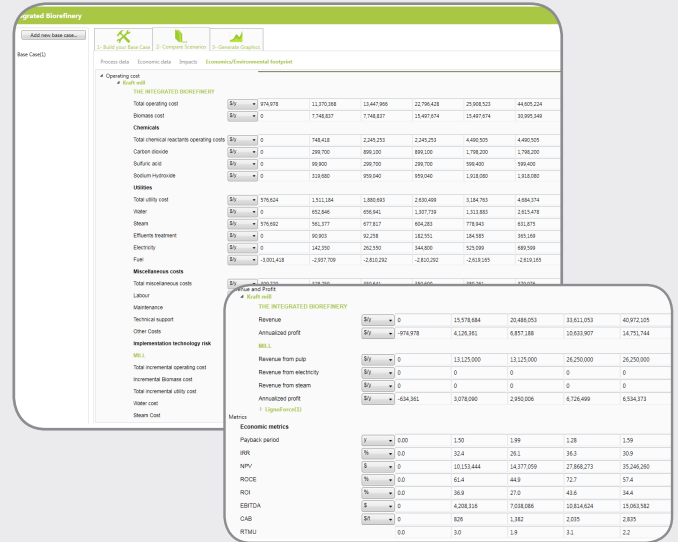
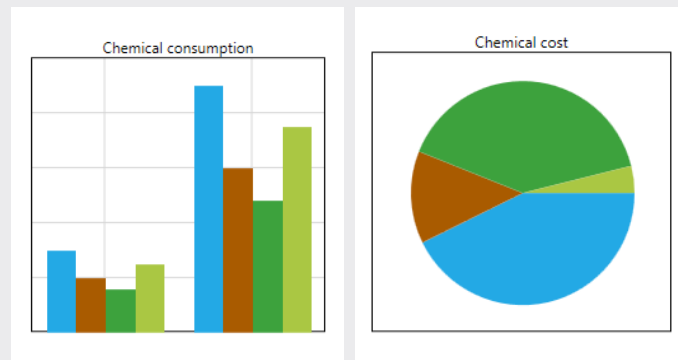
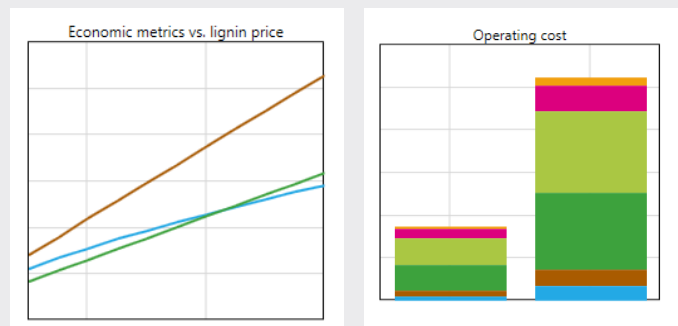


Table of results and metrics for each scenario evaluated



Chemical consumption and cost for four biorefinery scenarios



Economic metrics variations with key production and economic data

I-BIOREF KEY FEATURES

BENEFITS

Comprehensive Library of Pulp and Paper Mill Models	
Kraft processes	✓ Represents the existing mill, as it is currently operated ✓ Provides an overall understanding of the mill structure and operations ✓ Provides the opportunity to embed any model associated with the existing mill or a new one
Thermomechanical (TMP) processes	
Combined kraft and TMP processes	
Comprehensive Library of Biorefinery Models	
Includes over 15 biorefinery technologies	✓ Models a wide range of industrial biorefinery processes, including utilization of electricity, steam, water, biomass, fuel, and chemicals ✓ Quickly simulates a wide range of “what-if” scenarios for integrated or standalone biorefinery systems
Includes process data	
Includes flow sheet of selected biorefinery technologies	
Includes input unit prices	
Detailed Mass and Energy Balances	
Enables appropriate coverage of materials and energy entering and leaving a mill site, as well as the mill’s processes, systems or equipment	✓ Provides a structure for examining interactions between the different components of an operation ✓ Explores the relationship between energy use and the variables that may influence it, using data collected at appropriate intervals ✓ Evaluates how much energy is being used, wasted or lost, and where this occurs ✓ Examines chemical recovery and reuse opportunities
Systematically accounts for energy and chemical flows and transformations	
Multi-Criteria Decision-Making	
Technical performance metrics (e.g. yield, purity of the products)	✓ Instantly determines the economic impacts of process designs or scenario decisions ✓ Identifies revenue opportunities ✓ Instantly determines the environmental footprint of a biorefinery system
Includes 8 economic metrics	
Includes 17 LCA-based metrics	

For more information on I-BIOREF, please contact us: I-Bioref@canada.ca

CanmetENERGY’s Systems Analysis Software

To allow effective transfer to industry, CanmetENERGY is developing innovative software solutions that reflect the most recent advancements from our research activities.

COGEN, for maximizing revenues from cogeneration systems

INTEGRATION, for optimizing heat recovery in industrial facilities

EXPLORE, for improving process operation, using the power of advanced data analysis

I-BIOREF, for evaluating the economic viability and environmental impacts of biorefinery technologies

For more information, please visit our website or contact us: www.nrcan.gc.ca | 1-450-652-4621

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