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Decision Support Tools for Bioeconomy Transformation Strategies: Introduction of Natural Resources Canada' I-BIOREF Software Platform

IEA Bioenergy – In collaboration with the Canadian Institute of Forestry

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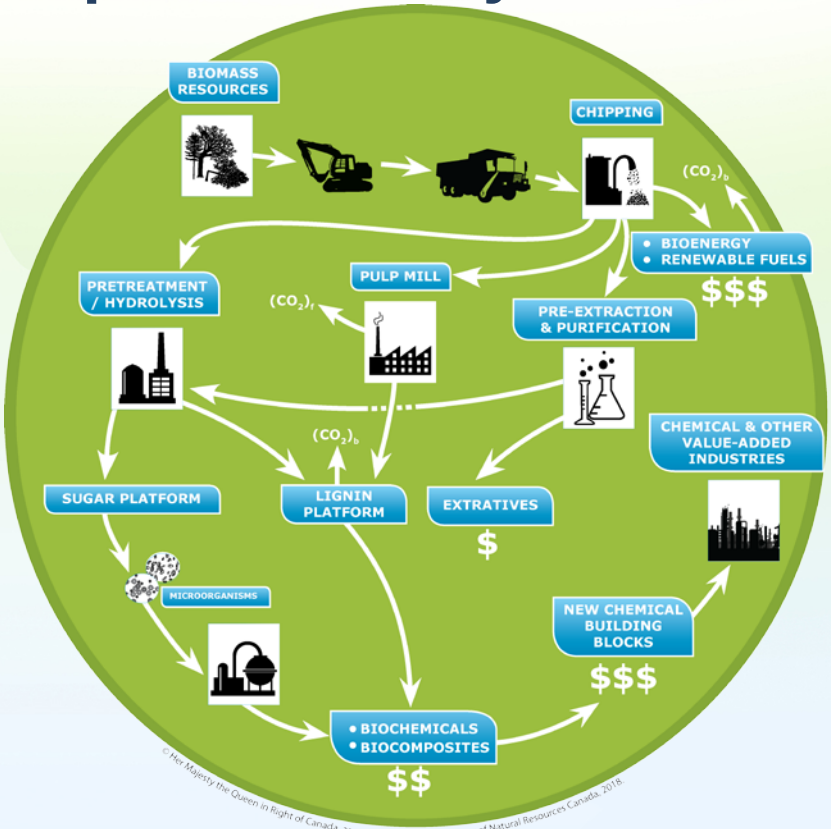
Biorefinery: From a Concept to a Reality

- **Forest biomass** has been used to supply useful services in the form of materials and energy since ancient times and the **forest industry of today** has developed into a **complex industry**
- Biorefinery is an integrated industrial « **biocomplex** » utilizing **all biomass assortments** to produce **multiple bioproducts** *(i.e. biochemicals, biomaterials, bioenergy and renewable crudes and drop-in fuels)* *[Our definition]*
- Biorefineries should be seen in the light of a number of driving forces induced by the challenges to:
  - **Mitigate climate change** by reducing fossil CO_2 emission;
  - **Reduce the dependence** on fossil sources such as petroleum;
  - **Adjust to changes in the markets** for raw materials and traditional products



Transition Toward a Growing Bioeconomy: Critical Questions

- How to **sustainably convert renewable forest-based resources** into value-added products by using multiple biorefinery options and **leveraging** the established efficient biomass supply chain of host mills?
- The **robustness** of new biorefinery pathways will depend on their **ability to survive under uncertain future conditions**:
  - Access to biomass, biomass/feedstock prices, performance characteristics of novel processes (e.g. yields, efficiencies, integration constraints existing or new facilities, etc.);
  - Energy prices, bioproduct prices and their market volatility over the plant lifetime;
  - New policy measures (e.g. new standards, cross-jurisdictional platforms, reviewed regulatory processes, certification of new entrants in the forest sector, etc.)
- As biorefineries will mostly be integrated into existing facilities, further questions will arise:
  - What are the **benefits of integrating** a biorefinery technology into an existing mill and what are potential **direct technical impacts**?
  - Under what scenarios does the biorefinery project become economically and environmentally viable?

➔ Due to all above complexities, a **Decision Support System**, driven by a systematic and multidimensional approach, is required

Decision Support Systems

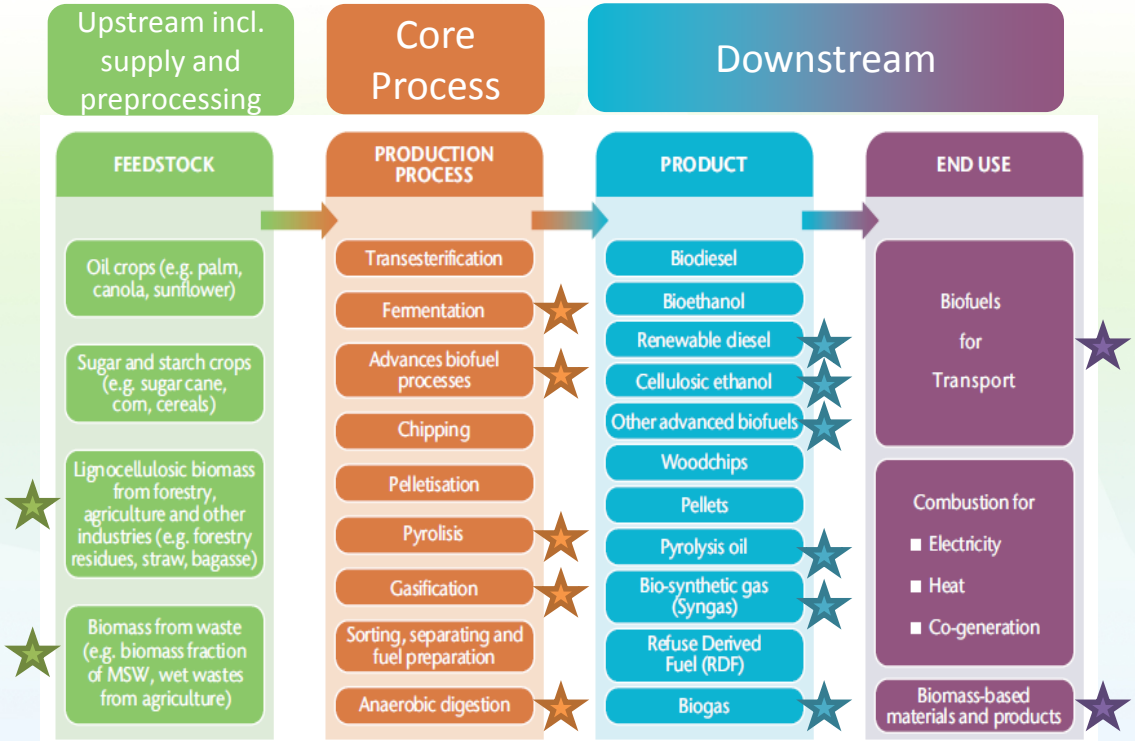
- Problematic:
  - **Decision-making is not a straightforward process**, as complex problems involve numerous options or alternatives as well as an array of **predefined criteria**, that differ in nature and can include **technical, economic, environmental, market, social, policy, and supply chain- related aspects**.
- Purpose:
  - Decision support tools usually provide computational support for **implementing multi-criteria decision analysis** as well as interpreting the results through numerical or visual graphic aids
- Drawback:
  - **Lack of customized tools for different needs**, specifically for the continuously evolving fields of industry including forest biorefining.
- Limitations:
  - Several general-purpose decision support tools provide guidance on how to perform analysis, their **correct use still falls under the responsibility of the decision-maker** who might not necessarily be aware of their limitations and flexibilities

Decision Support Systems in the Biorefinery Context

- There are currently no off-the-shelf tool that can readily be applied in the context of forest biorefinery implementation projects.
- Decision-making on biorefining technologies to be implemented should take into consideration **internal factors** (e.g., **uncertainties** due to biomass type and chemical composition, costs, production yield, and profitability) as well as **external factors** (e.g. technology availability, policy changes, and competitive products).
- Technical performance, economic viability, detailed life-cycle assessment-based environmental footprint, and supply chain have to be simultaneously taken into account and evaluated.
- A **Decision System Tool** for fruitful decision-making must be able to provide decision metrics based on the use of mass and energy balances, for the calculation of technical, economic, and environmental impacts and evaluation criteria.

➔ NRCan developed **I-BIOREF software platform**, a tool that represents a consistent approach needed for **prefeasibility studies and screening out non-viable alternatives**

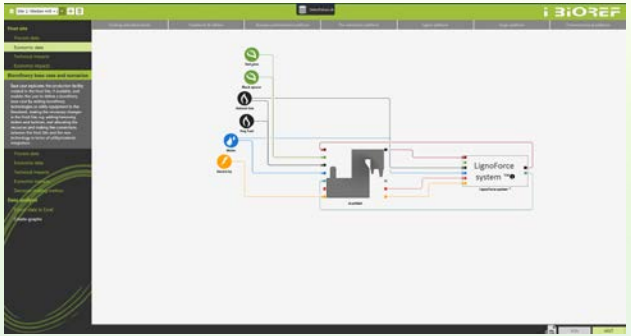
Biorefinery: Various Bioenergy Pathways



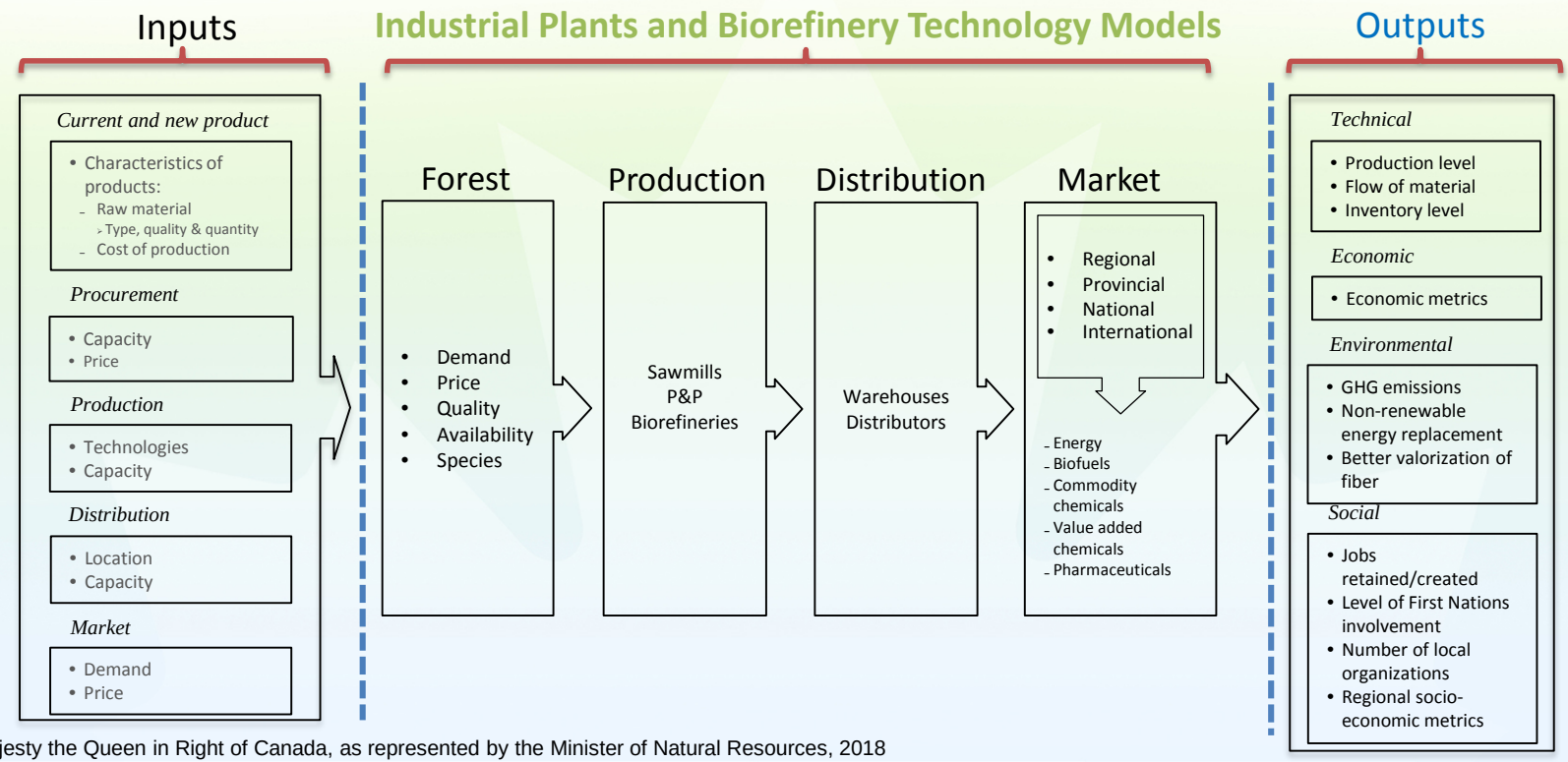
Source: IEA and FAO, 2017, *How2Guide for Bioenergy*, www.iea.org/publications/freepublications/publication/How2GuideforBioenergyRoadmapDevelopmentandImplementation.pdf.

I-BIOREF Software Platform: Version 2.0

- **I-BIOREF** supports decision-makers in selecting viable **biorefinery solutions** and evaluates the benefits of implementing commercially available biorefinery processes.
- **I-BIOREF:**
  - *is a project design tool creating the biorefinery projects step-by-step, and quantifies its technical, economic and environmental impacts.*
  - *enables creating multiple scenarios and provides metrics to be used for multi-criteria decision making.*
  - *has a flexible architecture so that new technologies can be easily incorporated, regardless of its complexity.*
- **I-BIOREF:**
  - *includes detailed feedstock database composed of hardwood species, softwood species, purpose grown-crops, and agricultural residues. It allows customizing a feedstock and its intrinsic chemical composition*
  - *has an automatic control to reconcile, diagnose, and communicate inconsistent data or specifications to the user.*
  - *computes case-specific performance indicators to assess technical risks when integrating any biorefinery technology model.*



I-BIOREF Software Platform: Our Approach



I-BIOREF Software Platform: Demonstration

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