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Canada

ENHANCING TECHNO-ECONOMIC AND CARBON INTENSITY CONSISTENCY IN BIO-SAF PRODUCTION ACROSS BIOMASS SOURCES: A PATH TO GLOBAL STANDARDIZATION

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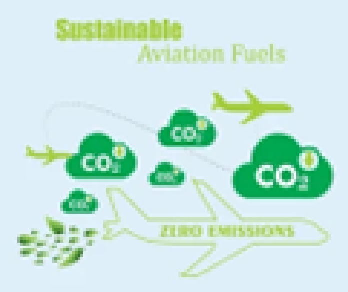
OUTLINE

1. Why is a harmonization framework needed Bio-SAF assessment? What are the critical challenges of the harmonization framework development?
2. Role of international collaboration networks
3. Canada – Brazil collaboration : Harmonization challenges and selected comparison metrics
4. Canada – Brazil : Key outcomes and takeaway messages



MI INTEGRATED BIOREFINERIES MISSION

WHY A HARMONIZATION FRAMEWORK IS NEEDED FOR BIO-SAF ASSESSMENT?

- Inconsistencies in metrics and methodologies:
  - Current techno-economic, sustainability, and carbon intensity (CI) **assessments vary significantly across studies and regions/countries**, hinder cross-border comparison and policy alignment.
  - **Differences in biomass feedstocks** and production technologies necessitate harmonized assessment frameworks for fair evaluation.
- Global nature of aviation:
  - Airlines and fuel producers operate **across jurisdictions**, requiring universally accepted benchmarks for Bio-SAF to align with industry and regulatory standards.
- Facilitation of policy alignment:
  - A harmonized framework **supports consistent policy development, promotes market growth,** and **facilitates global certification systems**, such as ICAO’s CORSIA, by providing unified assessment frameworks.
- Enhanced credibility:
  - **Standardized methods improve the credibility of Bio-SAF assessments**, building trust among stakeholders, including regulators, investors, and consumers.

CRITICAL CHALLENGES IN HARMONIZATION FRAMEWORK DEVELOPMENT

- Feedstock variability:
  - Biomass sources (e.g., agricultural waste, forest residues) differ in chemical composition and availability, complicating carbon intensity (CI) comparisons.
- Jurisdictional variability:
  - Differences in policy instruments, energy mixes, subsidies, and carbon accounting standards and biomass availability complicate harmonization and create market inconsistencies.
- Data gaps:
  - Limited availability of high-quality, comparable data across regions.
- Policy misalignment:
  - Lack of consistency in carbon accounting and life-cycle assessment (LCA) standards.
- Economic barriers:
  - Diverging costs of production and subsidy mechanisms hinder equitable adoption.
  - Lack of standardization increases uncertainty for airlines and producers, delaying Bio-SAF adoption.

ROLE OF INTERNATIONAL COLLABORATION NETWORKS

- Knowledge sharing:
  - Facilitate the **exchange of best practices, data, and methodologies** across borders.
  - **Co-develop** and implement a harmonized framework for Bio-SAF production.
- Stakeholder engagement:
  - **Unite** academia, industry, governments, and international organizations (e.g., **Mission Innovation**, IEA Bioenergy, IATA, etc).
  - **Support multi-stakeholder studies** to address knowledge gaps and refine methodologies.
- Harmonized policy frameworks:
  - **Coordinate policy alignment and advocate for policy convergence** to reduce trade barriers and foster market integration.
  - Advance Bio-SAF assessment for a **continuous refinement** to address evolving needs and challenges.
- Technology development:
  - Support the **global deployment of advanced SAF production technologies** by streamlining R&D efforts.
  - Continuously refine the framework using feedback and evolving technologies.

ADDRESSING THE HARMONIZATION CHALLENGE

- SAF production capacity
- Cradle-to-grave LCA boundaries
- Biomass residues used

Sugarcane straw (🇧🇷), forest residues (🇨🇦)

Only residues recovery and transportation included

Set common system boundaries

Align LCA methodologies and assumptions

Align TEA methodologies and assumptions

- Similar assumptions for product characterization (e.g., SAF price) and project implementation (e.g., construction period, process ramp-up, discount rate)
- Harmonized LCA databases and impact estimation methodologies
- Location-specific parameters considered for supply chain, specific capital and operating costs (e.g., utilities price, labor, taxes)

SELECTED COMPARISON METRICS

% Thermal efficiency

Biorefinery efficiency: energy of biorefinery products per energy input in the biorefinery

Energy Return on Investment (EROI)

Energy efficiency: renewable energy output per energy used in the life cycle*

$ Minimum Selling Price (MSP)

Economic feasibility considering capital and operating costs, as well as the role of co-products

Carbon intensity (CI)

GHG emissions on a cradle-to-grave basis

GHG Abatement cost

Combines economic and environmental aspects

* **Note:** The EROI metric is expressed through two variants:

(1) Energy efficieny, considering both renewable and non-renewable energy inputs in the lifecycle; and
(2) Energy transition, considering only non-renewable energy inputs.

HARMONIZED KEY PARAMETERS OF SAF BIOREFINERIES: CANADA – BRAZIL (1/2)

- Targeted SAF production capacity: **2,000 barrel/day of SAF.**
- Product properties:
  - Carbon intensity fossil jet fuel: **89 g CO_{2eq}/MJ.**
  - SAF: **LHV = 43.54 MJ/kg; Density = 735 kg/m^3; Energy density = 34.5 MJ/L.**
  - Naphtha: **LHV = 44.94 MJ/kg; Density = 690 kg/m^3.**
- **Jet fuel price in 2019** using IATA report and **actualized to 2023** using yearly average values **(0.55 US$/L)**.
- **No incentive and no premium** on product pricing for the base case scenario.
- CAPEX calculations:
  - **2023 Chemical Engineering Plant Cost Index (CEPCI) value**: 797.9.
  - **Contingency costs**: 10% of fixed capital investment (FCI).
  - Other CAPEX components such as installation factors are country-specific.

OUTCOMES OF CANADIAN SCENARIOS IMPLEMENTATION

% Thermal efficiency

60% - 66%

Energy Return on Investment (EROI)

Energy efficiency: **0.55 – 0.60**

Energy transition: **4.4 – 16**

$ Minimum Selling Price (MSP)

1.3 – 1.6 USD/L

About 2.5 times higher than fossil kerosene

Carbon intensity (CI)

2.0 – 2.5 g CO_2eq/MJ

About 98% reduction in GHG emissions

GHG Abatement cost

270 – 330 USD/t CO_2eq

Preliminary results vary with SAF capacity and underlying assumptions

KEY TAKE-AWAY MESSAGES

- Significance of Bio-SAF production location:
  - **Proximity to Biomass Sources:** The availability and diversity of biomass feedstocks significantly influence the feasibility of a biorefinery.
  - **Regional Variability:** Countries or regions with abundant, varied biomass sources are better positioned for sustainable aviation fuels production.
- Impact of biomass properties and logistics:
  - **Process Efficiency:** Variations in the chemical composition of biomass (e.g., lignin, cellulose, hemicellulose content) and its ultimate analysis (e.g., C, H, N, O, S and ash contents) affect conversion efficiencies and biomass-to-SAF yields.
  - **Carbon Footprint:** Transportation distance and methods influence the overall carbon intensity, with shorter, localized supply chains offering environmental advantages.
  - **Economic Viability:** Feedstock cost, transportation logistics, and operational expenses determine the profitability of biorefineries.

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THANK YOU!

QUESTIONS?