Sustainable Aviation Fuel (SAF) Opportunities Study

An ICF Report for Vancouver Airport (YVR)

May 2025

Disclaimer

The Sustainable Aviation Fuel (SAF) Opportunities Assessment is focused on identifying opportunities for SAF development and deployment in British Columbia. It does not make recommendations on provincial policies such as the Low Carbon Fuel Standard or the carbon tax. Any references to these policies are included only to provide context on how existing policy frameworks interact with SAF competitiveness in the jet fuel market and the economic impact to the aviation sector.

Executive Summary

British Columbia (B.C.) has established itself as a leader in transportation decarbonization, implementing a sophisticated framework to reduce fuel emissions and drive the transition to cleaner energy sources. Through initiatives like the Low Carbon Fuel Standard (LCFS) and the Initiative Agreements, B.C. has created one of the most progressive regulatory environments in North America for low-carbon fuels.

Vancouver International Airport (YVR) is a diverse global hub that serves the community and the economy that supports it. Reducing the impact on the climate is a focus of YVR's 2025 Strategic Plan with commitments to reaching net zero by 2030 for airport operations and to support the aviation industry in achieving net zero by 2050.

Through the obligation to reduce the carbon intensity of jet fuel, including a volumetric requirement for Low Carbon Jet Fuel (in this report referred to as Sustainable Aviation Fuel (SAF)), B.C. has set a clear precedent for decarbonizing aviation. Building on this, developing SAF production capacity in province presents a significant opportunity to further enhance the economic, environmental, and societal benefits.

This report evaluates B.C.'s feedstock potential, analyzes the production costs of various SAF pathways, and examines the policies to efficiently increase SAF adoption in the province.

Summary of Key Findings

Sustainable Aviation Fuel Opportunity in B.C.

Sustainable aviation fuel (SAF) is a key method to decarbonize aviation. As a drop-in fuel, it can be used to reduce the life-cycle emissions for existing aircraft and airports, and the aircraft added to the global fleet over the coming years. In addition to environmental gains, a SAF industry in British Columbia (B.C.) brings economic benefits to the province, enhances energy security and reduces some exposure to global market volatility.

B.C. is uniquely positioned to become a national leader in SAF production and uplift. The province has a strong track record in climate and clean energy leadership, supported by progressive sustainability policies, a low-carbon electricity grid, and an active clean-tech sector. Vancouver International Airport (YVR), Canada's second-largest airport in terms of total passengers, is widely recognized for its climate ambition and innovation. The recently announced Low Carbon Jet Fuel (LCJF) Incentive Program, funded by the B.C. government, exemplifies the shared commitment of both the province and the airport to decarbonizing aviation. It positions YVR as an ideal early adopter and demonstration site for SAF integration.

The province also benefits from existing SAF and biofuel producers like Parkland's Burnaby refinery and Tidewater Renewables. Some facilities have announced plans to expand production, supported by B.C.'s diverse feedstock potential and strategic infrastructure. A key infrastructure advancement includes one of North America's busiest port networks, which facilitates feedstock logistics, equipment imports, and potential SAF exports to international markets. With the right policy framework, B.C. could anchor a thriving SAF ecosystem that supports jobs, attracts investment, and accelerates the decarbonization of aviation in the province, in Canada and beyond.

Domestic feedstock potential in B.C.

B.C. has a diverse range of feedstocks with varying availability, cost, and technology readiness, offering strong potential to support a domestic SAF industry. The most immediate potential lies in Hydrotreated Esters and Fatty Acids (HEFA) production, leveraging an established supply chain of waste and virgin fats and oils. Canola presents the best opportunity for local SAF production due to its availability and the lower carbon intensity assigned by the LCFS lifecycle assessment model compared to its carbon intensity in other jurisdictions like California, offering a unique advantage.

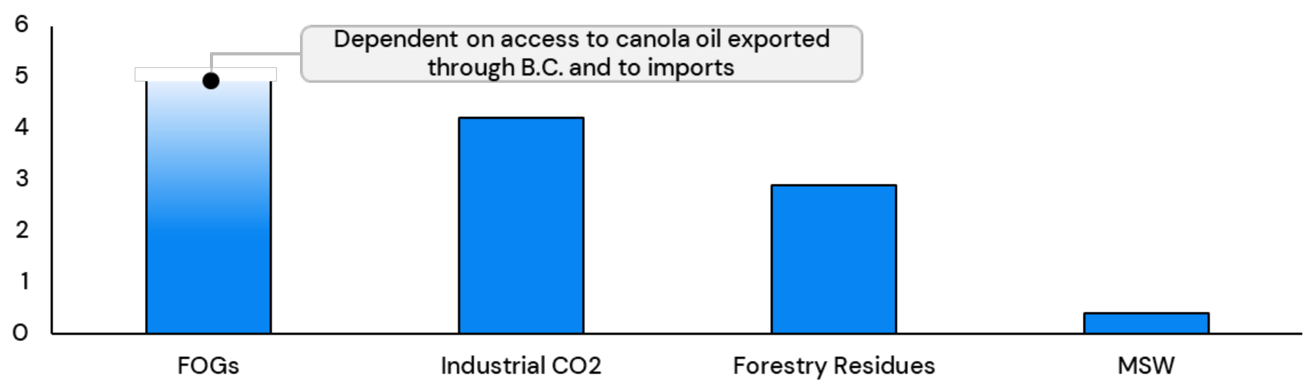
Forestry residues represent the largest volume feedstock, but strong competition from existing markets and their geographical distribution create challenges for economical collection. However, wood pellets offer a possible alternative to improve the efficiency of collection. It is important to note that the quantity of forestry residues is closely linked to the health of B.C.'s lumber industry, a decrease in this industry will result in reduced availability of forestry residues.

Municipal solid waste (MSW) presents a mid-to-long-term opportunity, with up to 0.39 Mt of biogenic waste available for SAF production, though commercialization of gasification remains slow.

Lastly, industrial biogenic carbon dioxide (CO_2) from waste-to-energy facilities and pulp mills could support power-to-liquid SAF pathways, though high production costs and technology risks remain a barrier.

A feedstock assessment identified FOGs, industrial CO2, and forestry residues as the most available resources available for SAF production in B.C.

Domestic feedstock availability, Million tonnes



Source: ICF Analysis

The readiness of SAF production pathways dictates how soon commercial volumes can be realized in British Columbia. HEFA is the most mature technology, with the Tidewater Renewables facility capable of producing 170 million litres of SAF annually. Co-processing fats oils and greases (FOGs) in existing refineries offers another near-term opportunity, with the Parkland refinery aiming to produce 435 million litres per year (7000 barrels per day) of renewable fuels including SAF by 2028.

Alcohol-to-Jet (AtJ) is the next most commercially ready pathway, but B.C. currently lacks domestic ethanol production. Future opportunities may emerge through gas fermentation at pulp mills or biomass facilities, however, details on yields and economics remain limited.

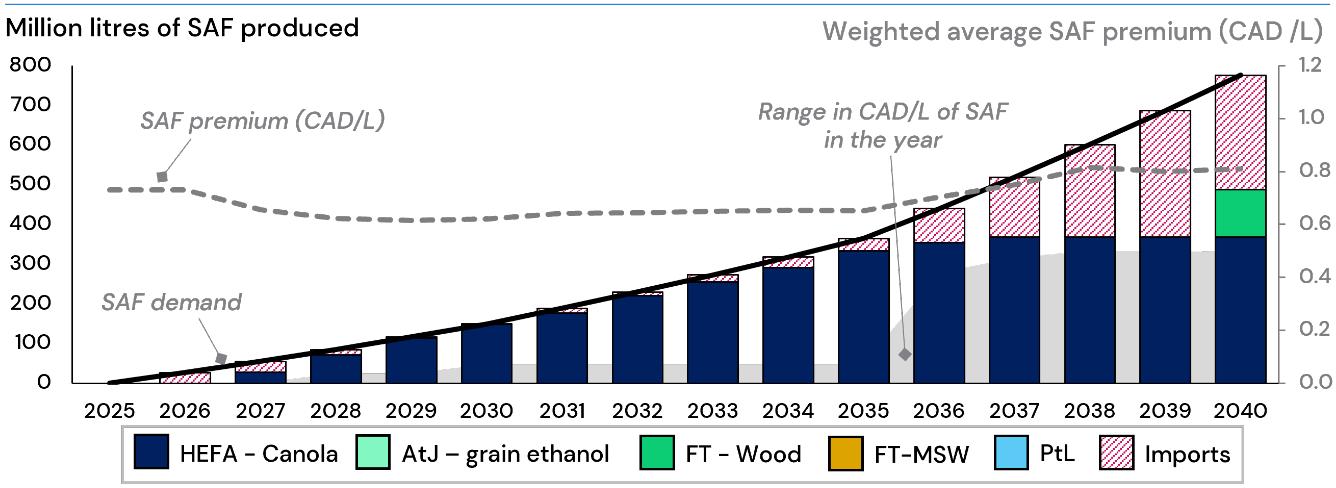
Gasification with Fischer-Tropsch (FT) offers potential particularly for processing diverse biomass feedstocks, though variability in feedstock quality and preprocessing requirements poses challenges. This complexity is highlighted by recent setbacks in projects using this technology. As a high capital expenditure (CAPEX) pathway with long construction timelines, its economic viability could improve by leveraging densified intermediates like wood pellets or bio-oils and co-processing FT liquids at refineries.

Impact of SAF deployment in B.C.

A baseline scenario was developed to assess the impacts of SAF deployment in B.C. by reflecting a future where current market conditions persist. Using forecasted commodity prices, feedstock availability, and jet fuel demand data from Vancouver International Airport, it provides a realistic reference point for evaluating production costs, market dynamics, and policy needs.

The analysis shows that HEFA remains the most cost-effective SAF option in the near term, with imports supplementing supply. However, a slight increase in HEFA feedstock prices results in imports becoming cheaper. HEFA feedstock limitations are evident by 2035, leading to greater reliance on imports. SAF remains approximately $0.70-0.80 CAD/L more expensive than Jet-A1 throughout the period. As HEFA SAF alone cannot meet demand post 2034, the range in the cost of SAF widens due to the growing contribution of the imports and FT SAF produced from forestry residues, which cost more than HEFA SAF. The baseline expectations are sensitive to the potential cost of imports, with small reductions to import cost resulting in fuel sourcing rapidly switching to imports over the construction of domestic production facilities.

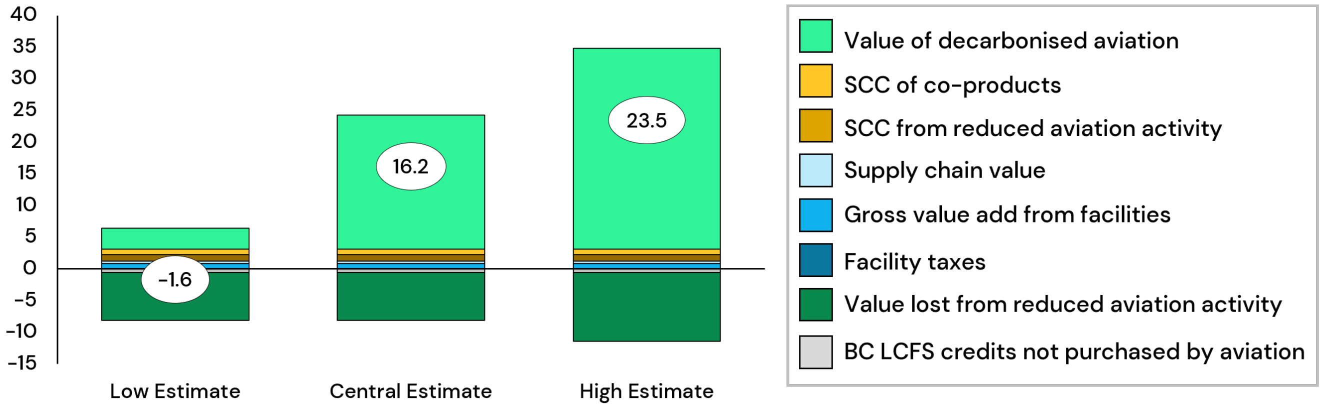
HEFA SAF meets demand until 2035, after which imports meet the additional demand until FT SAF from woody biomass becomes the next least-cost pathway



The economic impact of SAF deployment in B.C. was assessed by evaluating its effects on aviation, the broader economy, and society via the social cost of carbon (SCC). Given the challenges in quantifying the value of decarbonized aviation, three valuation approaches were used. The results demonstrate that SAF delivers a net economic benefit to B.C.

In the central and high estimate SAF adoption drives positive NPV by ensuring the aviation industry can continue to operate in a net zero economy

Net Present Value of benefits and costs, *Baseline*, CAD Billion, Discount rate of 2%



Scenario Analysis

A scenario analysis was performed to illustrate the sensitivity of SAF production costs to key inputs. By comparing them, the analysis highlights the potential SAF cost range and informs targeted policy recommendations.

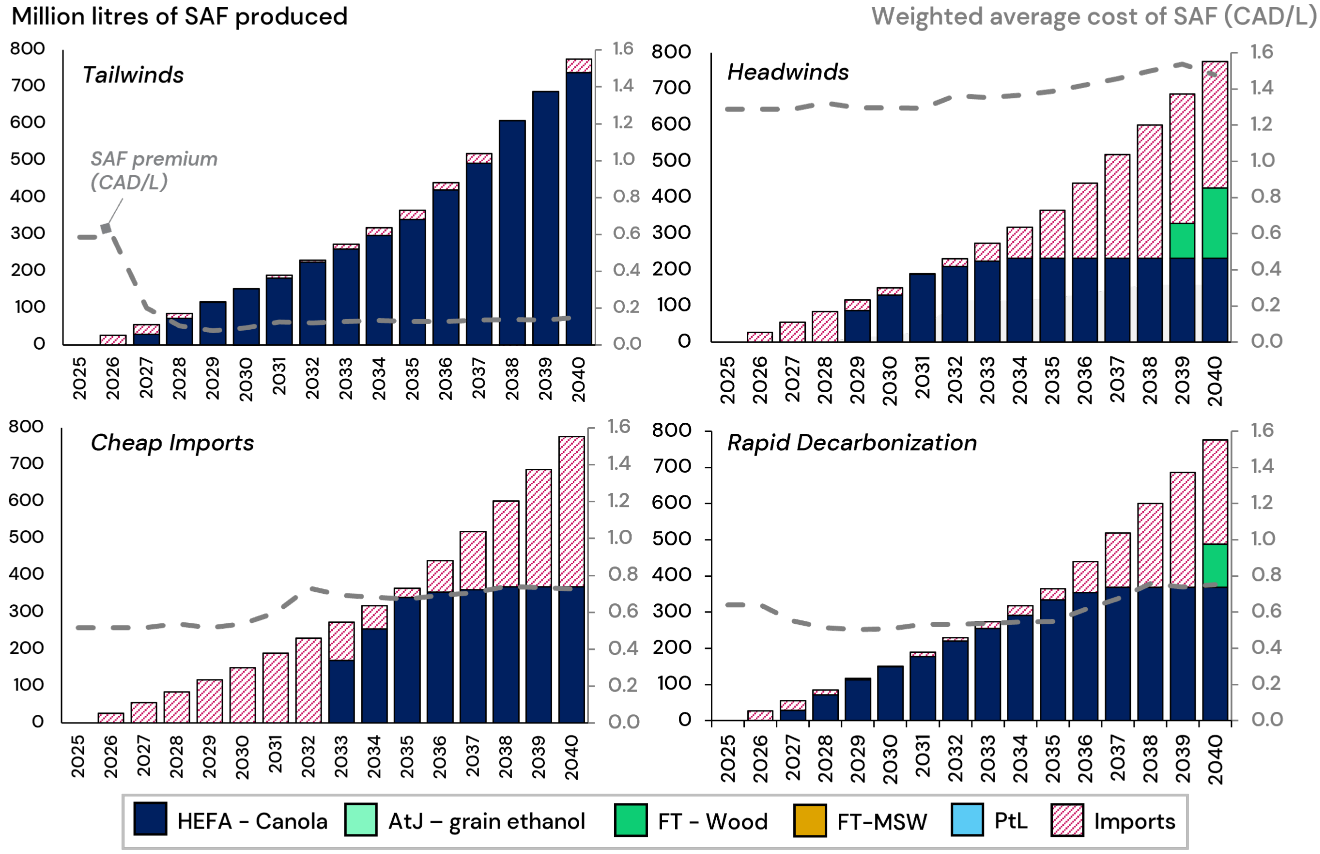
In the *Headwinds* scenario, which acts as a worst-case comparator, higher feedstock and commodity costs make domestic HEFA production less competitive, leading to an early reliance on imports. The Headwinds scenario also tests a market with lower HEFA feedstock availability than in the Baseline. Imported SAF remains the least-cost option until the late 2030s, when FT SAF from forestry residues becomes price competitive.

In the *Tailwinds* scenario, a best-case comparator, greater HEFA feedstock availability supports up to 730 ML of SAF per year, delaying the need for alternative pathways until 2039. Despite AtJ SAF from ethanol having the second-lowest production cost after HEFA, no facilities are constructed as HEFA production is sufficient to meet demand due primarily to the considerable levels of HEFA feedstock available.

The *Rapid Decarbonization* scenario, where the price of B.C. LCFS credits increase due to aggressive B.C. LCFS targets (jet fuel carbon intensity reduction schedule increases to 30% by 2040) results in the same SAF deployment as the *Baseline* but with a slightly lower weighted average cost of SAF. Higher LCFS credit prices reduce the SAF premium, but a more aggressive fossil CI reduction target limits the number of credits generated, leading to only a marginal overall impact.

In the *Cheap Imports* scenario, lower imported SAF prices make domestic HEFA uncompetitive until 2033, resulting in a heavy reliance on imports. FT SAF does not become cost-competitive within the timeframe, reinforcing dependence on foreign supply.

Reliance on imported SAF is primarily influenced by feedstock availability, feedstock costs, and the price of imports



Analysis of Supportive Measures

The current policy framework in B.C. relies on a combination of mechanisms to decarbonize aviation. The B.C. Low Carbon Fuel Standard (LCFS) sets a progressively decreasing carbon intensity (CI) requirement for transportation fuels, including jet fuel, incentivizing the supply of low-carbon alternatives. Under the LCFS, jet fuel suppliers can comply by supplying lower-carbon fuels such as sustainable aviation fuel (SAF) or by purchasing credits from parties that have over-complied. In addition, B.C. has introduced a volumetric requirement that mandates a minimum percentage of jet fuel be SAF, increasing to 3% by 2030.

Initiative Agreements (a credit-generating mechanism under the LCFS) and federal policies further support SAF production by providing financial incentives, regulatory frameworks, and market-based mechanisms. Initiative Agreements offer targeted credit-based support to accelerate low-carbon fuel supply, while federal policies create broader regulatory certainty and investment opportunities, helping to scale industry growth and drive emissions reductions

The scale-up of SAF faces three challenges in B.C.:

1. The LCFS is designed to enable flexible, cost-effective decarbonization by allowing obligated fuel suppliers to meet carbon intensity (CI) targets through a mix of low-carbon fuel supply across sectors and credit purchases. However, because SAF remains significantly more expensive than other low-carbon fuels, and other decarbonization methods, many obligated suppliers may prioritize lower-cost

compliance options, such as credit purchases or increasing renewable diesel procurement, rather than blending SAF. Even when the volumetric obligation begins, the remaining CI obligation may still be met through these other compliance options. While this approach reduces system-wide costs, the associated compliance costs may be passed through to airlines, raising fuel prices and ultimately ticket costs for passengers, without guaranteeing emissions reductions within the aviation sector itself.

2. There is unequal competition from SAF producers in other countries that receive greater support or cheaper input prices, meaning that obligated parties are likely to source imported SAF rather than domestic SAF, similar to how fossil jet fuel is predominantly imported today, resulting in lost opportunities for domestic job creation, innovation, and energy security.
3. While B.C. has considerable feedstocks to scale SAF production, some of the SAF technologies to exploit these cannot yet compete in an open market with existing technologies that are less risky, but also less scalable. Recognizing the greater potential for some feedstocks (and their associated refining technologies) would build the foundations necessary for the industry to scale over the coming years.

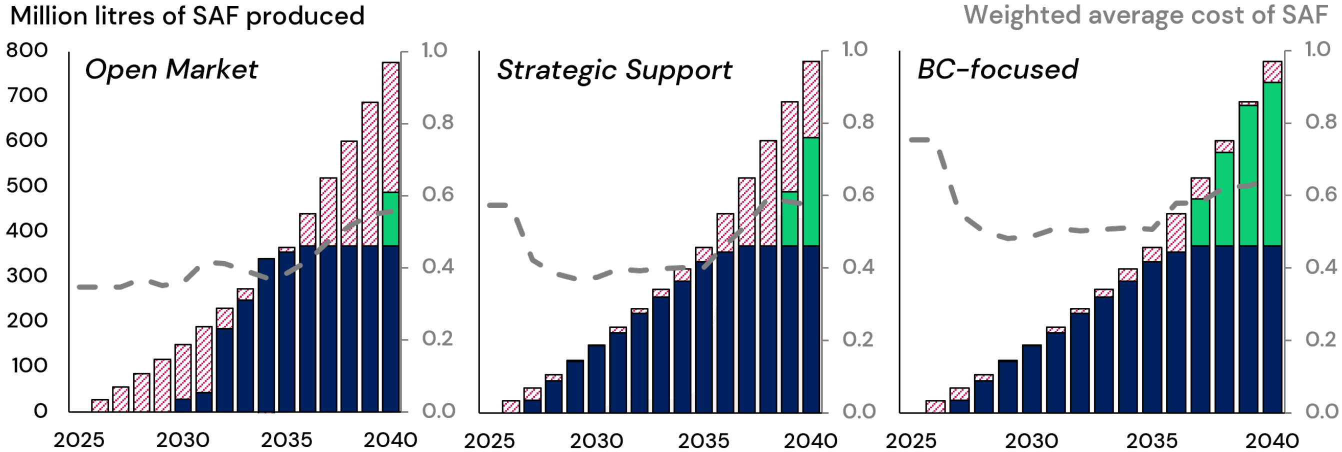
To fully unlock the potential for a domestic SAF industry, additional targeted policy support is required. ICF evaluated three distinct policy frameworks, each with an equivalent budget, to assess their impact on SAF deployment, cost competitiveness, and economic outcomes in British Columbia. Each framework represents a different approach to balancing market accessibility, domestic production incentives, and overall investment support.

- **Open Market:** Blenders tax credit of \$0.30 CAD/L for SAF with a carbon intensity less than 44.4 gCO2e/MJ, scaling linearly to \$0.40 CAD/L for SAF with a 100% emissions reduction.

- **Strategic Support:** Producer's tax credit of \$0.20 CAD/L for SAF with a carbon intensity less than 44.4 gCO2e/MJ, with an additional \$0.10 CAD/L for SAF made from scalable feedstocks (non-virgin oils, UCO or tallow) and an off-taker incentive of \$0.10 CAD/L for SAF with a carbon intensity less than 44.4 gCO2e/MJ, scaling linearly to \$0.20 CAD/L for SAF with a 100% emissions reduction.

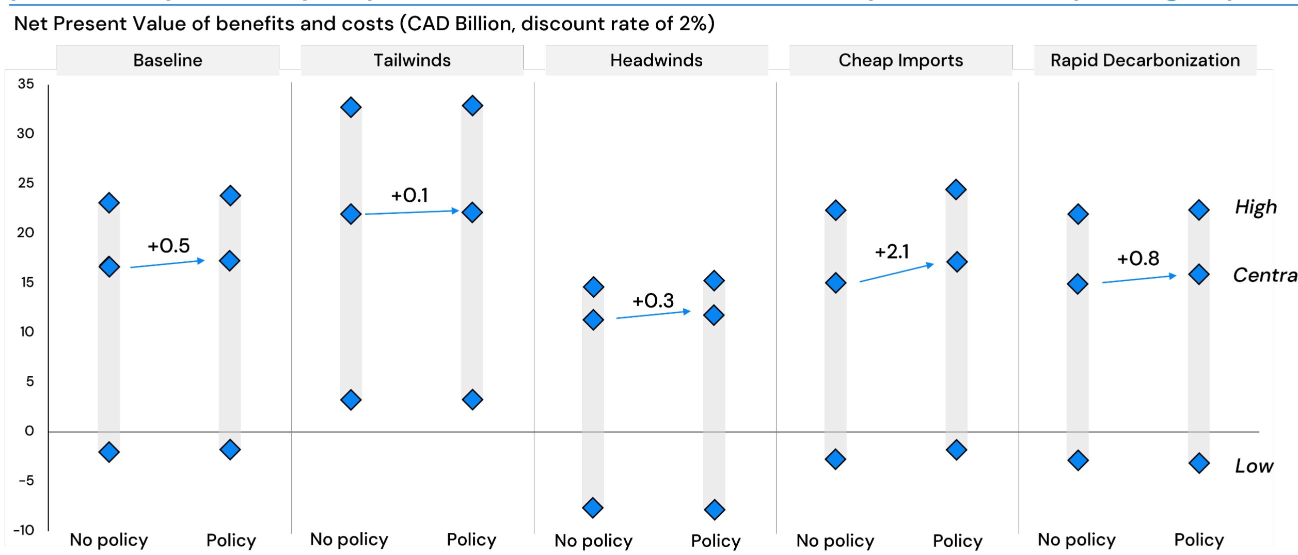
- **BC-focused:** Producer's tax credit of \$0.20 CAD/L for SAF with a carbon intensity less than 44.4 gCO2e/MJ, with an additional \$0.10 CAD/L for SAF made from scalable feedstocks (non-virgin oils, UCO or tallow) and a capital grant for SAF production facilities of \$100 million CAD or up to 15% project value.

All policy mechanisms lower the cost of SAF to varying degrees. The Open Market mechanism has the biggest impact on cost however it leads to high levels of imports



The *Strategic Support* policy framework offers the best compromise between lowering the cost of SAF, promoting domestic production, and incentivizing scalable feedstocks. To evaluate its effectiveness under different market conditions, this framework was tested against the scenarios defined previously. By analyzing these sensitivities, the assessment confirms that the *Strategic Support* policy framework consistently increases the NPV of SAF deployment across all scenarios, demonstrating its effectiveness in enhancing economic viability and long-term investment confidence in B.C. Notably, in all scenarios, domestic HEFA production is cheaper than imported SAF even when available at lower prices.

The Strategic Support policy framework leads to an increase in NPV across all scenarios, particularly in Cheap Imports, where it leads to domestic production replacing imports



Conclusions

- The analysis establishes that B.C. has considerable potential for a domestic SAF industry. One of the advantages that British Columbia enjoys is its feedstock availability. Canola oil from other parts of Canada can support modest HEFA production while ample volumes of woody biomass from B.C.'s lumber industry and MSW resources from local landfills could provide feedstock or next generation pathways. These feedstock volumes could support a significant SAF industry.

- British Columbia has also developed a policy environment supportive of SAF. The Vancouver Airport's Low Carbon Jet Fuel Incentive Program, and the British Columbia Low Carbon Fuel Standard provide financial support for SAF procurement. Indeed, a number of SAF producers already exist in British Columbia like the Parkland Burnaby refinery and Tidewater Renewables.

- The future success of a B.C. SAF industry depends on the right mix of further policy support, feedstock availability, and technology de-risking. HEFA SAF represents the most immediate opportunity given its maturity and existing infrastructure, but long-term scalability will require diversification into pathways that can access solid feedstocks, such as woody biomass, agricultural and municipal wastes, and green hydrogen.

- While imported SAF still moves the Province toward decarbonization, by focusing policy support on production within B.C, British Columbia can reduce its reliance on imports and avoid exposing B.C. to supply chain risks and ensure the economic advantages accrue to the province. By implementing targeted incentives, B.C. can develop a robust SAF market that enhances energy security, reduces carbon emissions, and stimulates economic growth.

- The Strategic Support policy framework emerges as the most effective approach to balancing affordability, scalability, and economic impact. It combines a producer credit with support for offtakers. Modulating the production support to reward more scalable pathways would send a strong demand signal for minimal costs. This approach ensures that domestic SAF remains competitive against imports while also fostering investment in advanced SAF technologies.

- By securing long-term policy certainty, B.C. can create a stable and attractive market for SAF producers, enabling sustained industry growth.

- The future of SAF in B.C. will be shaped by market conditions, regulatory developments, and the ability to scale up production efficiently. Near-term strategies should focus on maximizing HEFA production and co-processing opportunities while laying the groundwork for next-generation SAF pathways.

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