

# Comparative assessment of technologies to produce sustainable aviation fuels from lignocellulosic biomass



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## Introduction

Aviation contributes around 2.5% of global greenhouse gas (GHG) emissions due to its dependence on fossil-based jet fuel. Sustainable Aviation Fuels (SAF) have emerged as a promising alternative, and Colombia has strong potential for using lignocellulosic biomass as for example sugarcane bagasse in SAF production. This study compares three technological pathways: Alcohol to Jet (AtJ), Synthesized Iso Paraffins (SIP), and Fischer Tropsch (FT), integrating green hydrogen as raw material to identify the most sustainable option for the Colombian context.

The processes were simulated using Aspen Plus V15.0. The assessment included technical, economic, and environmental indicators. The technical analysis considered product yield (PY), conversion efficiency (CE), and energy consumption (SEC). The economic pre-feasibility study was conducted using estimates of CapEx and OpEx, as well as financial indicators (NPV). Finally, the environmental analysis was carried out using the ISO 14040 methodology and SimaPro software V.8.3, employing a cradle-to-gate approach.

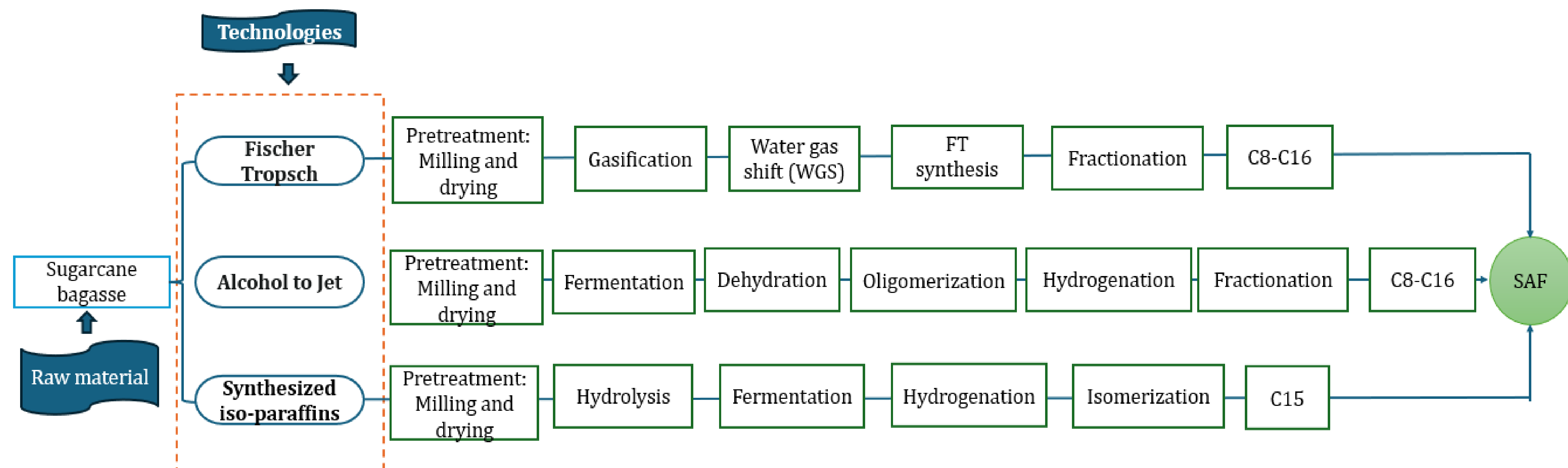


Figure 1: Technological pathways for the production of sustainable aviation fuel (SAF) from sugarcane bagasse.

## Results & Discussion

Table 1: Technical results of the SAF pathways.

Process	PY	CE	PMI	SEC (GJ/Ton)
AtJ	0.05	0.03	25.21	53.25
SIP	0.06	0.04	23.34	49.88
FT	0.04	0.04	23.31	12.57

The SIP technology achieved the highest SAF yield and exhibited lower raw material consumption per unit of product. In contrast, the Fischer Tropsch process had the lowest specific energy consumption among the technologies evaluated.

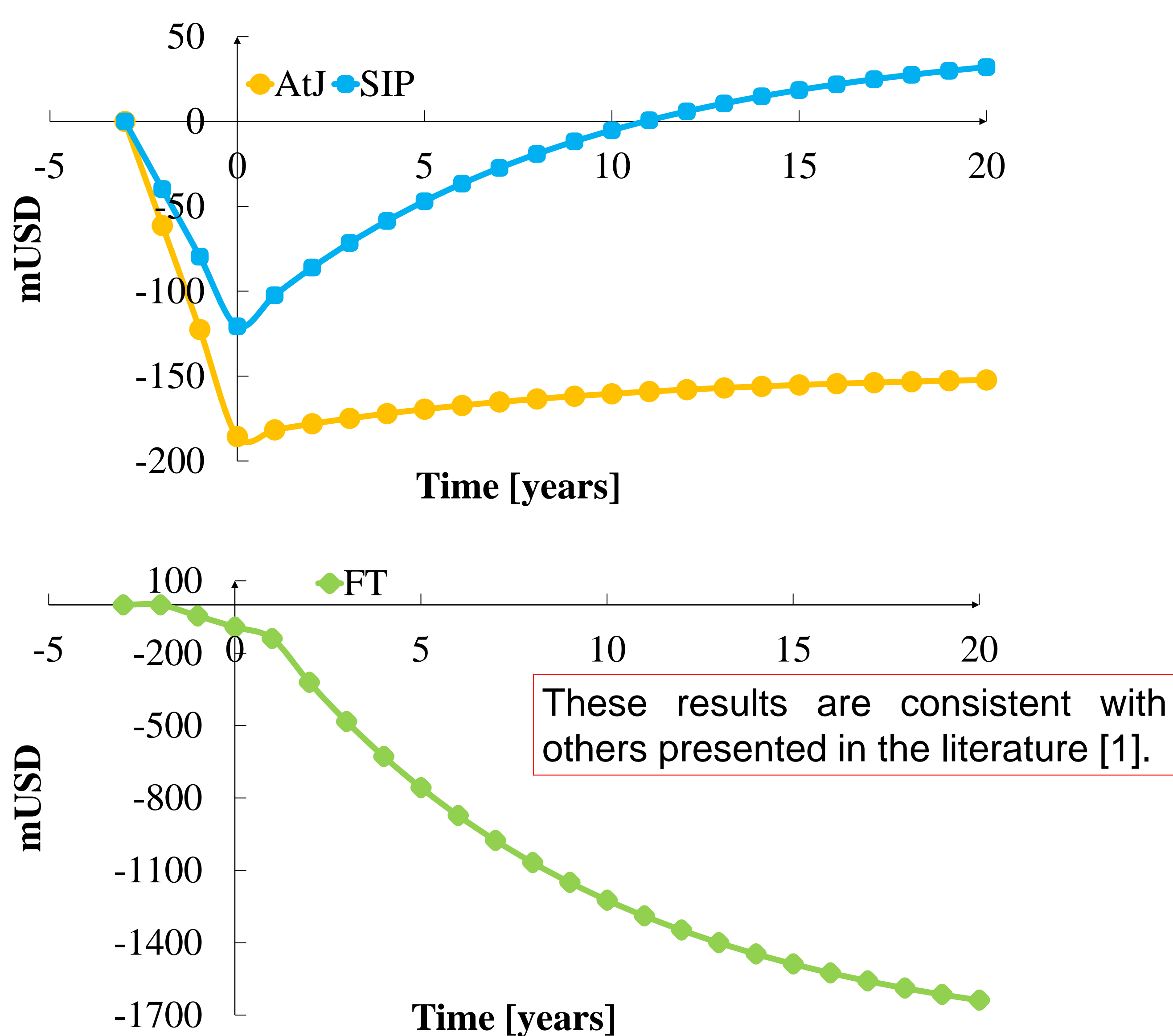


Figure 2: NPV Projections for the AtJ, SIP, and FT Routes.

The NPV projections reveal significant differences in the profitability of the routes evaluated. SIP showed the most favorable economic performance, while FT showed the least favorable. The OpEx analysis indicated that the FT route is dominated by utility consumption, particularly electricity, due to the high energy demand of the compression systems involved in the process.

SIP demonstrated the best economic performance and the highest product yields, indicating a more efficient use of biomass. Meanwhile, the Fischer-Tropsch (FT) route stood out for its lower energy consumption and better relative environmental performance, coming closer to international sustainability criteria for SAF. Overall, the results show that SIP is the most competitive option for producing SAF from sugarcane bagasse in Colombia. However, a very concerning conclusion in agreement with other authors in the literature is the fact these non-conventional jet fuels are not really sustainable to be called as SAF.

## Conclusions

## References

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All routes evaluated had GHG emissions exceeding the sustainability threshold established by CORSIA (80.1 g CO<sub>2</sub> eq/MJ) for sustainable aviation fuels [2]. Nevertheless, the Fischer-Tropsch route had the lowest climate impact among the technologies analyzed, coming closest to the reference value compared to AtJ and SIP.

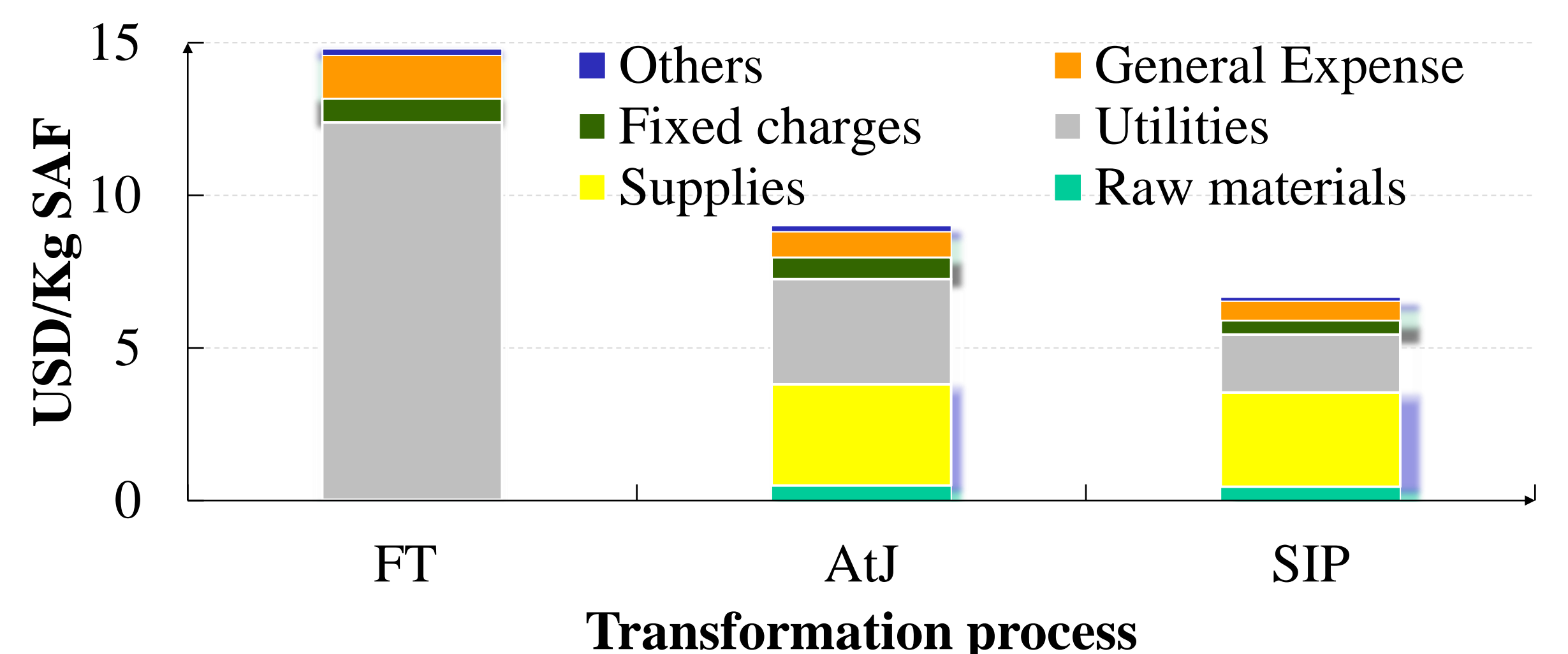


Figure 3: Breakdown of Operating Expenses (OpEx).

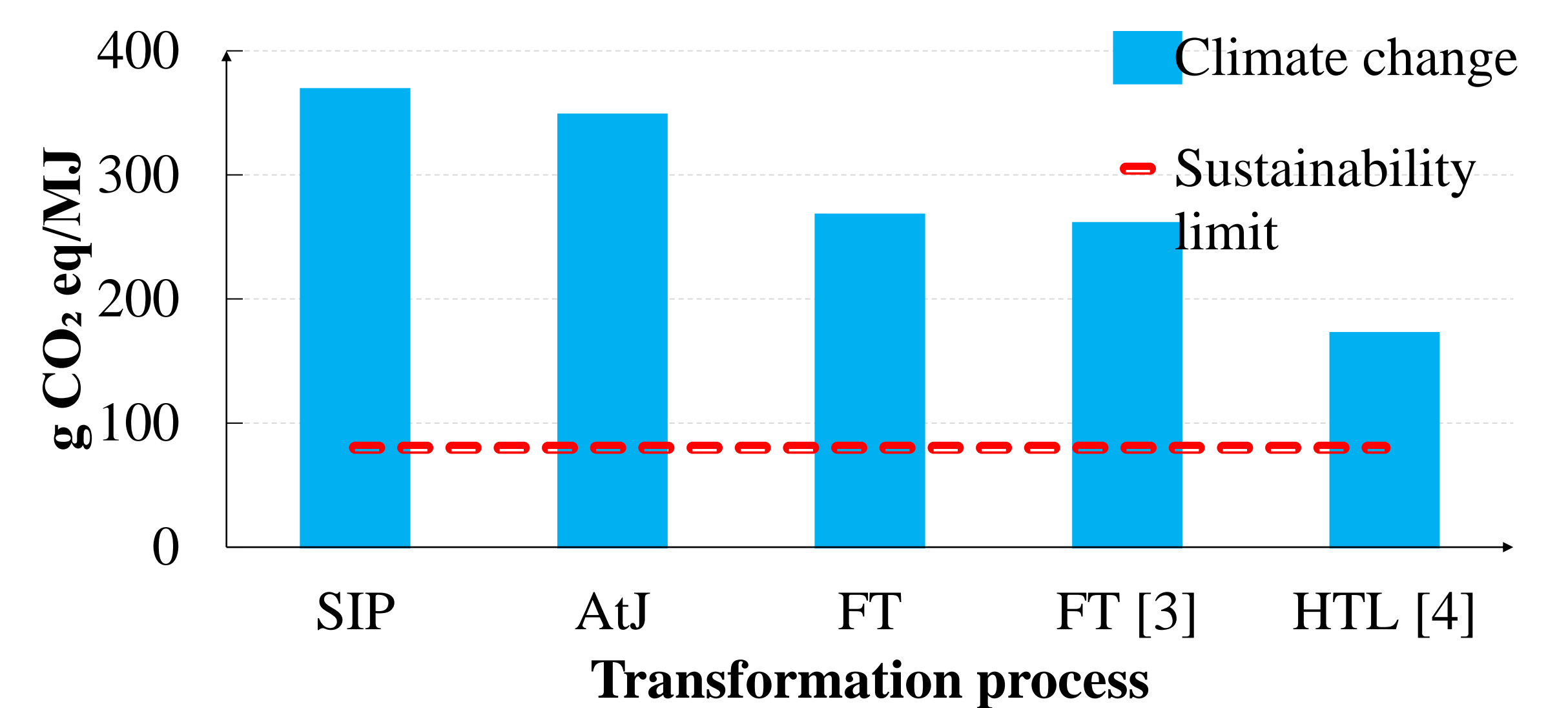


Figure 4: Climate change potential and sustainability limits.

A comparison with studies reported in the literature shows that the results obtained for FT are consistent with those from other biomass-based SAF production processes. Additionally, FT had a lower impact in terms of fossil fuel depletion, while AtJ and SIP performed better on indicators related to human toxicity and water depletion.

Table 2: Environmental impact indicators

Indicator	AtJ	SIP	FT
Human toxicity (g 1,4-DB eq/MJ)	44.29	52.47	6.65
Water depletion (L/MJ)	69.72	68.16	168.63
Fossil depletion (g oil eq/MJ)	89.96	105.75	4.28