SAF are today the primary alternative to fossil aviation fuels for powering commercial aircraft [1]. The use of SAF will reduce CO2 emissions and help aviation reach carbon neutrality goals.

Moreover, SAF deployment reduces the gap between new and previous technology aircraft regarding CO2 emissions. Additional SAF can help previous technology aircraft level up with the new and more fuel-efficient aircraft – at a cost.

Annual cost of SAF to offset CO2 emissions between new and previous technology aircraft is estimated at:
~$1 million for single-aisle aircraft
>$2 million for twin-aisle aircraft.

MATCHING CO_2 EMISSIONS

New technology aircraft consume less fuel and produce fewer emissions than the previous technology. However, previous technology may level up and become as green as the newer technology by using additional SAF* to offset the CO_2 emissions resulting from the extra fuel consumption. For a CEO to match a NEO's emissions, the CEO would have to use the SAF quantity the NEO uses and, further, an additional amount of SAF to offset the emissions from the extra fuel consumption of the CEO compared to NEO. For this comparison, we select the latest generation CEO aircraft and compare it with the same vintage NEO to isolate the benefits from the new engine technology. In reality, airlines introduce new technology aircraft in their fleets to replace 10-15 years older aircraft. In this case, the gap between the new and previous technologies increases beyond the results observed in this paper.

SAF cost for single-aisle aircraft – A320CEO vs A320NEO

For an A320CEO to level up with an A320NEO's CO_2 emissions, under certain assumptions (Figure 1), an A320CEO would need to reduce the emissions from the additional ~350k gallons of jet A-1 fuel per year. SAF† blend rates of 0%, 1%, 5%, and 10% for the A320NEO translate into matching blend rates of 14.4%, 15.3%, 18.8%, and 23.2% for the A320CEO. For example, an A320CEO requires 14.4% SAF to equate an A320NEO with 0% SAF. The resulting additional annual costs for the A320CEO are summarised in Table 1.

SAF cost for twin-aisle aircraft – A330CEO vs A330NEO

For an A330CEO to level up with an A330NEO's CO_2 emissions, under certain assumptions (Figure 2), the A330CEO needs to reduce the emissions from ~800k gallons of jet A-1 fuel per year. SAF blend rates of 0%, 1%, 5%, and 10% for the A330NEO translate into matching blend rates of 11.8%, 12.7%, 16.3%, and 20.8% for the A330CEO. For example, an A330CEO requires 11.8% SAF to equate an A330NEO with 0% SAF. Additional costs for the A330CEO are displayed in Table 1.

Table 1 Estimated volumes and costs of SAF required for emissions equivalence‡

(a)	**A320NEO** SAF blend %	0%	1%	5%	10%
(b)	A320CEO blend % required to equal A320NEO emissions	14.4%	15.3%	18.8%	23.2%
	Total annual cost of (b)	$0.99m	$1.05m	$1.30m	$1.60m
	Average cost per passenger / ~2hr flight	$4.00	$4.25	$5.23	$6.46
(c)	**A330NEO** SAF blend %	0%	1%	5%	10%
(d)	A330CEO blend % required to equal A330NEO emissions	11.8%	12.7%	16.3%	20.8%
	Total annual cost of (d)	$2.29m	$2.47m	$3.17m	$4.05m
	Average cost per passenger / ~7hr flight	$12.37	$13.32	$17.13	$21.89

Conclusion

The cost of bringing the previous technology to the same level of emission reductions as the new technology is high. The annual cost is $1 million for A320CEO and $2.29 million for A330CEO. Arguably, when such costs are distributed to passengers, the overall cost of SAF may be considered affordable for low SAF blend rates on specific passenger segments.

* CO_2 emissions reductions from biofuels use come from feedstock production and fuel conversion, not from fuel combustion. Biofuels are designed to have very similar properties to fossil fuel, burn the same way, and cause a similar amount of CO_2 (3.16 kg of CO_2 per kg of jet fuel).
† SAF is assumed to produce approximately 80% fewer CO_2 emissions than conventional jet fuel on a lifecycle basis (i.e., at all stages of production, distribution, and usage).
‡ Assuming fuel prices of SAF ~ 4.00 $/gallon and Jet A-1 ~ 1.75 $/gallon for all simulations

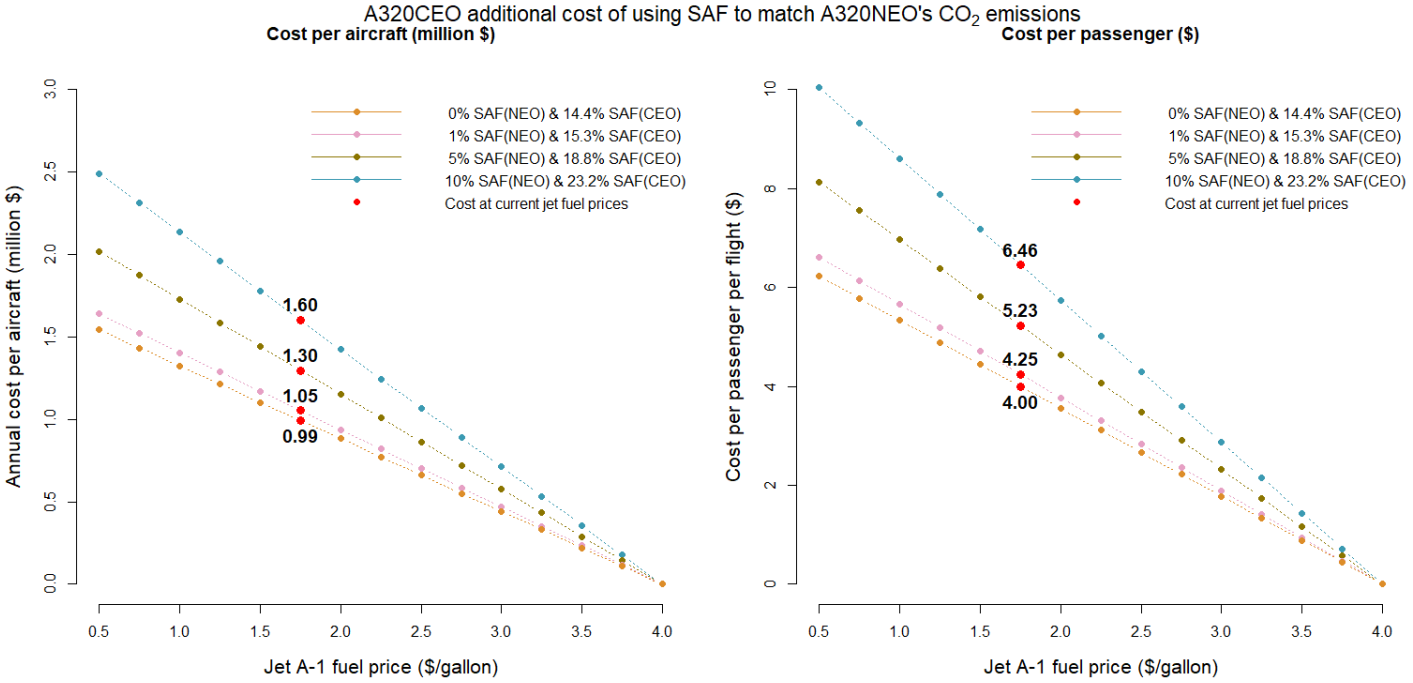

Figure 1. Simulation results: the additional cost for an A320CEO to match the emission reduction in an A320NEO, which uses no SAF, 1%, 5%, and 10% SAF. The A320CEO must use SAF in all scenarios to level up with the A320NEO's emissions reduction. The additional baseline cost for the A320CEO is ~$1 million per aircraft or ~$4 per passenger per flight. Both the CEO and NEO are assumed to have a full economy seating capacity with 80% load factors and an average utilisation rate of 9 flight hours per day or equivalently an average of 4.5 flight cycles per day, each cycle consisting of a two-hour flight.

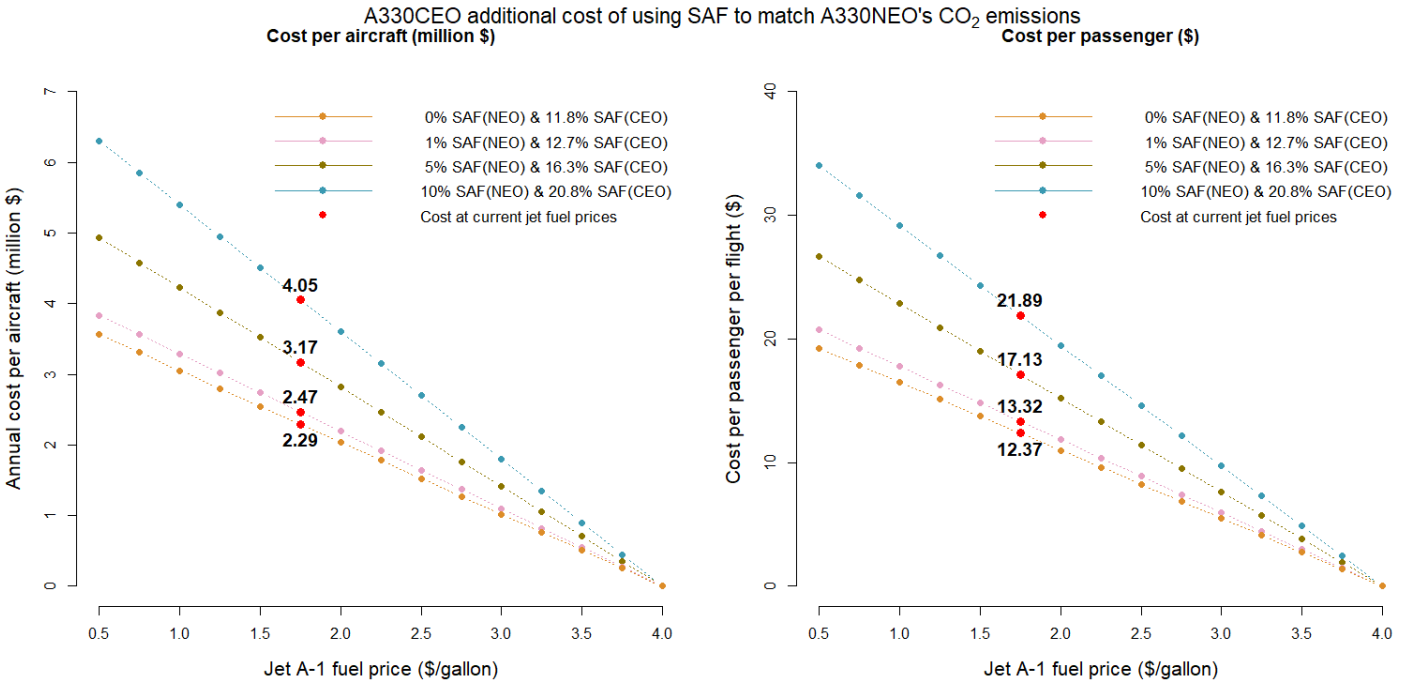

Figure 2. Simulation results: the additional cost for an A330CEO to match the emission reduction in an A330NEO, which uses no SAF, 1%, 5%, and 10% SAF. The A330CEO must use SAF in all scenarios to level up with the A330NEO's emissions reduction. The additional baseline cost for the A330CEO is ~$2.3 million per aircraft or ~$12.37 per passenger per flight. The CEO and NEO are assumed to have a two-class configuration of 317 seats — 287 economy and 30 business class layout. Both aircraft types assume 80% load factors and a utilisation rate of 14 flight hours per day — the equivalent of flying every day of the year a return flight between Dublin and New York.

REFERENCES

[1] FPG Amentum (2021). *The Ascent of SAF*. https://www.fpg-amentum.aero/research/the-ascent-of-saf.pdf

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