Barriers to Implementing Sustainable Aviation Fuel (SAF) in Massachusetts

Neil Rasmussen
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Institute for Policy Studies
INEQUALITY.ORG
AN INSTITUTE FOR POLICY STUDIES PROJECT

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OTHER RELATED REPORTS

Sustainable Alternatives to Jet Fuels: Promising Solution or Industry Hype? by Chuck Collins, Omar Ocampo, Kalena Thomhave and Jiaqin Wu. May 2024.

Hanscom High Flyers: Private Jet Excess Doesn't Justify Airport Expansion by Chuck Collins, Omar Ocampo, Kalena Thomhave and Jiaqin Wu. October 2023.

High Flyers 2023: How Ultra-Rich Private Jet Travel Costs the Rest of Us and Burns Up the Planet by Chuck Collins, Omar Ocampo and Kalena Thomhave. May 2023.

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KEY FINDINGS

Re: Massachusetts and Greenhouse Gas emissions (GHG)

- Massachusetts has ambitious plans to reduce GHG emissions while aviation emissions continue to grow. As the Commonwealth reduces GHG emissions in many sectors, aviation emissions continue to rise. For example, we found:
    - "The CO_2 emissions from jet fuel consumed in the Commonwealth today are 5.9 megatons per year and growing, while the City of Boston's emissions today (all sources except aviation) are 6.0 megatons per year and falling. The technical options to address aviation emissions by 2050 are limited…"
    - "Proposals to continue studying SAF are logical. Supporting basic research aimed at improving the efficiency of SAF production is prudent. However, proposals to drive production or consumption of SAF through economic policy or subsidies do not make financial sense, as **SAF currently and for the foreseeable future increases GHG emissions."**
    - "While subsidies can be enacted at the state level, the subsidy required to drive the wholesale conversion to SAF would be unfundable."
- SAF solutions will not be available at scale on a timetable that will have any significant benefit to the 2050 Massachusetts GHG plan.

Re: Massachusetts and E-fuels:

- The possibility of e-fuel technologies is not realistic because the huge diversion of clean energy to e-fuel production will increase GHG emissions and be prohibitively expensive.
    - "CO_2 emissions are five times lower if we direct new clean electricity to the grid to displace natural gas, instead of using it to create e-fuel SAF." Put another way, "a switch by Massachusetts to e-fuel based on grid electricity would save 5.9 MT of fossil jet emissions but add 21 MT of grid emissions, for a net increase of 15.1MT of CO_2 per year."
    - "To displace current fossil jet fuel use with e-fuel in Massachusetts would require annual subsidies of $2.9 billion to $16.5 billion. This is 2 to 12 times the entire annual Massachusetts Transportation budget of $1.37 billion."
    - "The magnitude of electrical power required to produce e-fuel to meet Massachusetts aviation requirements is much more than the Commonwealth generates today."

- "Until the utility grid is completely decarbonized, every kWh of clean electricity generated must be applied toward the maximum reduction in CO_2, and not toward the inefficient production of e-fuel."

Re: Sustainable Aviation Fuels (SAFs) in general:

- "The most severe and unsolved problem with SAF is that its use ***increases*** CO_2 emissions."

- Any of the SAF production scenarios would require massive taxpayer subsidies.

- In relation to biogenic fuel options, our report confirms the assertion of the MA SAF Workgroup that land use for crop-based fuels would compromise food security and lead to resulting deforestation with attending reductions in CO_2 sequestration. Inexplicably, the Workgroup Recommendations fail to exclude proposed subsidies for this pathway.

- Technical options to reduce aviation emissions by 2050 are limited: electric aircraft will only address a fraction of short-haul flights.

INTRODUCTION

Sustainable Aviation Fuel (SAF), promoted as a low-carbon aviation solution, is the subject of numerous technical reports. Massachusetts is one of the few states considering policies that encourage SAF. This report reviews the policy recommendations from a recent report[1] by several Massachusetts state agencies that formed an ad-hoc Workgroup on SAF.[2]

Massachusetts is a state with ambitious plans to reduce greenhouse gas emissions, where aviation emissions will continue to grow and become a significant fraction of remaining emissions in the coming decades. For reference, the CO_2 emissions from jet fuel consumed in the Commonwealth

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[1] MA SAF Working Group, "Recommendations to the Governor on Accelerating the Adoption of Sustainable Aviation Fuels in Massachusetts and New England," May 2025. https://www.massport.com/sites/default/files/2025-07/MA-State-SAF-Workgroup-Report.pdf

[2] John Chesto, Massport pushing to make the state a hub for sustainable aviation fuels, The Boston Globe, June 5, 2025. https://www.bostonglobe.com/2025/06/05/business/massport-sustainable-aviation-fuels/

today are 5.9 megatons per year and growing,[3,4] while the City of Boston's emissions today (excluding aviation) are 6.0 megatons per year and falling.[5] The technical options to address aviation emissions by 2050 are limited: electric aircraft are expected only to address a small part of short-haul flight activity; hydrogen and other fuels requiring new types of aircraft engines are unlikely to have a significant impact; and improvements in aircraft efficiency of only a few percent are anticipated.[6]

Recently, various reports and the popular press have suggested that Sustainable Aviation Fuels are a way to reduce aviation emissions. The report of the ad-hoc Sustainable Aviation Fuels (SAF) Workgroup states that such fuels "have the potential to dramatically reduce lifecycle aviation emissions to near zero by 2050." It offers recommendations about SAF, including further research on its emission reduction potential, the prospects for the local industry, and the use of subsidies to encourage early adoption.[7] Similar reports, often promoted by aviation interests, imply that proposals to reduce aviation emissions through SAF are necessary to ease concerns about future aviation emissions growth. The aviation industry has described the potential of SAF as: "maintaining our license to grow; perhaps maintaining our license to exist!"[8]

A recent environmental submission regarding the expansion of private luxury jet activity in Massachusetts, relying in part on expected future use of SAF, stated that the project will be "…in line with the Commonwealth's decarbonization goals."[9] However, this massive expansion of private jet operations is expected to generate an *increase* of 134,000 to 161,000 Tons of Greenhouse gases (GHG) per year, while the Commonwealth's GHG reduction plan requires a decrease in emissions.[10] Aviation growth cannot be reconciled with the Massachusetts plan that requires emission reductions, unless low-emission fuels are available now. Yet all recent

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[3] Massachusetts 11,768 thousand barrels or 1.5 megatons Jet Fuel, US Energy Information Administration, State Profiles and Energy Estimates, Table F2. Converted to CO_2 at 3.16 kg CO_2 per kg jet fuel; adjusted for U.S. embodied carbon at 0.69 kg CO_2 per kg of jet fuel, per Jing, "Understanding variability in petroleum jet fuel life cycle GHG emissions to inform aviation decarbonization," Nature Communications, June 2022, Fig 2

[4] This report will refer to the contributions of CO_2; GHG emissions, or CO_2e, from aircraft are nearly 2X higher

[5] City of Boston Climate Action Plan, 2019 Update, p 23-24

[6] US 2021 Aviation Climate Action Plan, p 6-9

[7] SAF Workgroup Recommendations to the Governor on Accelerating the Adoption of Sustainable Aviation Fuels in Massachusetts and New England, May 2025

[8] "CAAFI Perspectives on SAF Status and Commercialization Acceleration," Commercial Aviation Alternative Fuels Initiative, presentation Nov 19, 2019

[9] L.G. Hanscom Field North Airfield Development Draft Environmental Impact Report, EEA 16654, March 2024, p 1-3

[10] Project GHG creation per: Analysis of the Greenhouse Gas Emissions Impact of Proposed Expansion of Hangar Capacity at Hanscom Field. Industrial Economics, Inc. April 4, 2024, p2 Note: the project proponent denies responsibility for emissions of jets in flight, and only estimates emissions of jets while at the airport or during takeoff and landing

discussions regarding SAF are hypothetical and notably devoid of any commitment or timetable regarding the implementation of SAF.

This paper reviews the best available science to determine the *feasibility, energy requirements, affordability*, and *timetable* regarding SAF. The findings here indicate that hypothetical future use of SAF should not serve as a green light for expanding aviation: SAF solutions provide minimal or negative GHG reduction; they will not be available on a timetable that will contribute to the 2050 Massachusetts GHG plan, and in any scenario, they would require massive public subsidies. These critical drawbacks are explained in the following sections.

THE THREE TYPES OF SAF HAVE DIFFERENT IMPACTS AND CHALLENGES

The International Civil Aviation Authority has determined that, even with a major global SAF development program with policy support, aviation emissions will rise by 2050.[11] Nevertheless, the ad-hoc SAF Workgroup report and public statements by Massport take the conflicting view that SAF will reduce aviation emissions well before 2050; however, these statements are aspirational and provide no technical references that support this assumption.[12] This report, in contrast, considers the numerous academic and industry studies that have examined the economics, energy use, and land use of various forms of SAF. The SAF Workgroup report does not appear to correctly comprehend the results of those studies, which clearly indicate that it is not advisable to develop GHG reduction plans that assume the existence of SAF by 2050. The reasons are:

- The SAF Workgroup Report suggests that SAF based on waste cooking oil or wood scrap be considered; however, the data shows this is not a feasible high-volume solution due to extremely limited source material with competing uses.
- The SAF Workgroup Report correctly states that crop-based SAF is not feasible due to competition with food crops and poor GHG reduction potential; however, the report fails to exclude promotion or subsidy of SAF of this type in its concluding Recommendations, which is the only type scalable in the following decades.
- The SAF Workgroup Report suggests that Synthetic SAF (e-fuel) is an effective solution; however, e-fuel is not a realistic solution for Massachusetts because: A) the diversion of clean energy to e-fuel production will actually ***increase*** GHG emissions, and B) the cost is so high that subsidies of between $2 to 6 billion per year for the foreseeable future would

[11] Scenario 2, Report on the Feasibility of Long-Term Aspirational Goal for International Civil Aviation Emissions Reductions, ICAO, March, 2022, p4

[12] The SAF Workgroup report relies on the US 2021 Aviation Climate Action Plan, p 6, which suggests a desired goal for annual SAF use until 2050, but that report provides no technical justifications of feasibility or cost.

be needed to incent a full conversion to e-fuel (or a carbon tax of between $200 to $1,070 per ton).

None of the three known types of SAF described above —waste-based, crop-based, or e-fuel — has the potential to reduce aviation emissions significantly. It is important to note that *SAF has the same GHG emissions as fossil jet fuel when burned*. The proposed benefit of SAF is that its *production* absorbs CO_2, which partially offsets the emissions when later burned; this is a benefit that varies greatly depending on many factors. Each of the three types of SAF is examined.

WASTE-BASED SAF IS NOT FEASIBLE

Waste cooking oil and animal fats can be converted to SAF via the proven HEFA process. Today, this is the most efficient method for producing SAF. Of the 36 projects globally that have made any SAF, all but one rely on this process.[13] However, the available feedstock volumes are minuscule when compared with SAF requirements. To put this into perspective, the global demand for liquid fuel is approximately 4,500 Megatons, while the global supply of waste cooking oil is around 15 Megatons.[14] Although the USA has not yet produced significant amounts of SAF based on waste cooking oil, domestic waste oil supplies are already fully utilized, and the USA is currently importing to meet current requirements for other uses, such as biodiesel and animal feed.

Another form of waste considered for SAF feedstock is residual wood scrap. This requires a more complex conversion process, which is currently theoretical. The availability of this feedstock is also insignificant when compared with SAF requirements. Today, wood scrap is often burned in power plants to generate electricity. To illustrate the inadequacy of the supply, the 2.6 GW Drax electrical power plant in the UK, which burns wood scrap imported from the USA, has cut down whole forests in the US when faced with insufficient wood scrap supply.

The SAF Workgroup Report says, on page 19, "Feedstock options that may be advantageous for Massachusetts and the New England region include municipal waste, waste oils, and wood waste residues…" This contradicts the findings of multiple studies, such as those presented in Figure 3 of the Report itself, which consistently show that the supply of these materials is insignificant compared to demand and therefore can have no meaningful impact.[15] This approach is a technological dead end for SAF, and it would be irrational to invest in it through subsidies or other forms of funding.

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[13] Plucinska, Joanna, "The Airline Industry's Dirty Secret: Clean Jet Fuel Failures," Reuters, Aug 11, 2025

[14] Waste cooking oil and fats can be (and are) used to make all types of sustainable fuels, not only jet fuel, and are also currently used for animal feeds and other purposes.

[15] Wood waste for SAF is restricted by limited feedstock. Wood waste is first converted to ethanol in a bioreactor and then to SAF through an "alcohol to jet" process. This process requires considerable energy and only results in a CO_2 reduction of around 50%.

Today, mandates for blending small amounts of SAF into fossil jet fuel, combined with incentives, are driving the production of small-volume SAF, based on waste cooking oil and animal fats, which cannot be a high-volume solution. Nevertheless, this is the dominant source of SAF today, and any attempt to subsidize SAF today is incentivizing this ineffective solution. While SAF produced from "waste" seems an appealing concept, the process provides limited GHG benefit, is much more costly than fossil jet fuel, and cannot scale. To be realistic, Commonwealth policy should specifically exclude all current forms of waste-based SAF.

CROP-BASED SAF IS NOT FEASIBLE

The use of crops as a feedstock for SAF has been deemed impractical by many analyses. The first problem is that the GHG emissions of this type of SAF are only slightly better than fossil jet fuel, and vary considerably based on the crop used and the soil conditions. Therefore, this approach cannot reach carbon neutrality.

The more serious issue is that the land use requirement for crop-based SAF for global aviation has been calculated to represent a significant fraction of the world's arable cropland, displacing food crops and forests. When forests are displaced to make room for SAF crops, the loss of forest CO_2 sequestration results in a GHG *increase* on the order of 2-4 Tons per acre per year, which is much greater than the expected savings of 0.37 Tons CO_2 per acre per year from SAF.[16,17] Consequently, replacing forests with SAF crops will result in *increased* CO_2 emissions; *the displacement of forest and cropland is the primary reason that the European Re-Fuel Aviation program specifically prohibits the use of crop-based SAF*. The current standards for measuring GHG effects of crop-based SAF grossly underestimate the actual emissions, because land use changes are excluded.[18]

The SAF Workgroup report appears to recognize this problem by excluding crop-based SAF from the advantageous feedstocks (p. 19) and stating the need for "polices that support sustainable aviation fuels that do not compromise food security…"; however, the report's recommendations for advancing SAF via investment and subsidy inexplicably fail to exclude crop-based SAF. *This is critical*. Regardless of the intentions of the SAF Working Group, crop-based biofuels are the only SAF feedstock that can scale in the coming decades, whether the state subsidizes them or not. Reliance on these feedstocks for SAF will seriously harm the climate, food supplies, and the environment.

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[16] Bernal, Global Carbon Dioxide Removal Rates from Forest Landscape Restoration Activities, Carbon Balance and Management, Springer Nature, 11/20,2018, Table 1

[17] Based on approx. 50% GHG reduction per SAF Workgroup report, Figure 3, combined with 0.23 SAF tons per acre per Smith, Alternative Land Use Impacts of the Sustainable Aviation Fuel Grand Challenge, American Enterprise Institute, April 2024. Adjusted by 3.16 Tons of CO_2 per ton of jet fuel

[18] H.R.1, Sec 70521,(1),iv "Exclusion of Indirect Land Use Changes," as enacted, July 2025

USING GRID POWER TO PRODUCE E-FUEL SAF WILL INCREASE CO_2 EMISSIONS

The SAF Workgroup Report concurs that replacing forests with SAF crops is counterproductive from an emissions standpoint. This leads to the conclusion that jet fuel volume requirements with significant CO_2 reduction can only be met with *synthetic* SAF or e-fuel, also known as Power-to-Fuel. The aviation industry generally shares this view: according to Lufthansa CEO Carsten Spohr, reducing emissions through sustainable fuels “cannot be done with bio-based fuel, it can only be done using e-fuels.”[19]

The creation of e-fuel as a substitute for jet fuel requires a considerable amount of electrical power. If current grid power is used, *the production of e-fuel will greatly increase CO_2 emissions.*

To see why this is true, consider the energy requirements of e-fuel. Three major components comprise the known process for creating e-fuel, all of which require electricity: first, to capture CO_2, second, for hydrogen electrolysis, and third, for the Fischer-Tropsch process. The most optimistic estimate of the overall energy efficiency of this process is 35%, corresponding to 0.03 kg of e-fuel produced for each kWh of energy used[20]. E-fuel releases 3.16 kg of CO_2 per kg when burned, offset by the same amount captured during the manufacturing process, making the e-fuel use theoretically carbon neutral.[21] In principle, converting from fossil fuel to e-fuel saves all the carbon that would otherwise be generated by burning fossil jet fuel. However, the energy required to produce e-fuel will produce GHG emissions, canceling out these gains.

Producing the Commonwealth’s e-fuel requirement would require monumental amounts of electricity. Massachusetts currently uses 1.5 million tons of jet fuel per year[22], which, if manufactured as e-fuel, would require approximately 52 terawatt-hours per year.[23] To put this in perspective, this is the amount generated by 32 GW of Solar PV or ***ten*** nuclear power plants the size of the retired Pilgrim Nuclear Plant.[24] It is also more than ***double*** the electric power generation in Massachusetts today.[25]

[19] Sentner, Irie, “The airline CEO pessimistic about alternative fuels” Politico, 6/21/2023

[20] Rohas, Sustainable Aviation Fuel (SAF) Production Through Power to Liquid, Energy Conversion and Management 292, 2023, Elsevier, Table 4

[21] There is additional embodied carbon in the e-fuel due to embedded carbon in the production equipment that prevents true carbon neutrality, which will be ignored for this discussion. Therefore, the actual emissions due to e-fuel will be higher than presented.

[22] The numeric analysis in this report is limited to Massachusetts, whereas the Workgroup Report considered all of New England.

[23] 1.5 M Tons/year of Jet fuel at 43 MJ/kg contains 18 TWh/year of energy. Divided by the efficiency of the e-fuel process gives an input requirement of 52 TWh/year

[24] Pilgrim Station provided 670 MW of rated power with a 0.9 capacity factor

[25] According to the EIA, In 2023, the Commonwealth consumed 50 TWh but only produced 20 TWh

Supplying the e-fuel power requirement from the *current* grid is counterproductive, emitting many times the carbon saved, and all studies show why. ISO New England estimates that 0.4 kg of CO_2 is emitted for every kWh of grid energy used.[26] The emissions associated with the grid electricity needed to supply Massachusetts with jet e-fuel can be calculated at 21 MT/year.[27] However, the emissions avoided by replacing all of Massachusetts' fossil jet fuel with e-fuel are only 5.9 MT/year. *Therefore, a switch by Massachusetts to e-fuel based on grid electricity would save 5.9 MT of fossil jet emissions but add 21 MT of grid emissions, for a net* ***increase*** *of 15.1MT of CO_2 per year.*

This is an acknowledged drawback; consequently, all e-fuel proposals assume that new clean energy sources, such as solar, would be built and *dedicated* to e-fuel production. However, the use of dedicated clean energy also has carbon problems.

DEDICATING CLEAN POWER TO PRODUCE E-FUEL SAF WILL ALSO INCREASE CO_2 EMISSIONS

The use of dedicated clean power for e-fuel production, if viewed in isolation, is theoretically expected to result in aviation emissions savings. However, clean power has competing decarbonization uses that have important GHG implications.

When we create new clean energy plants using wind, solar, or nuclear sources, we have a choice: we can either apply them to displace fossil fuel-based electrical generation or produce e-fuel. The figure below shows that 52 TWh of clean solar energy used to produce e-fuel to meet current jet fuel demand would reduce Massachusetts' GHG by 4.0 megatons per year.[28] However, if that same amount of energy were *instead* directed toward displacing fossil fuel electric generation, it would reduce GHG emissions by a much larger 19.4 megatons per year.

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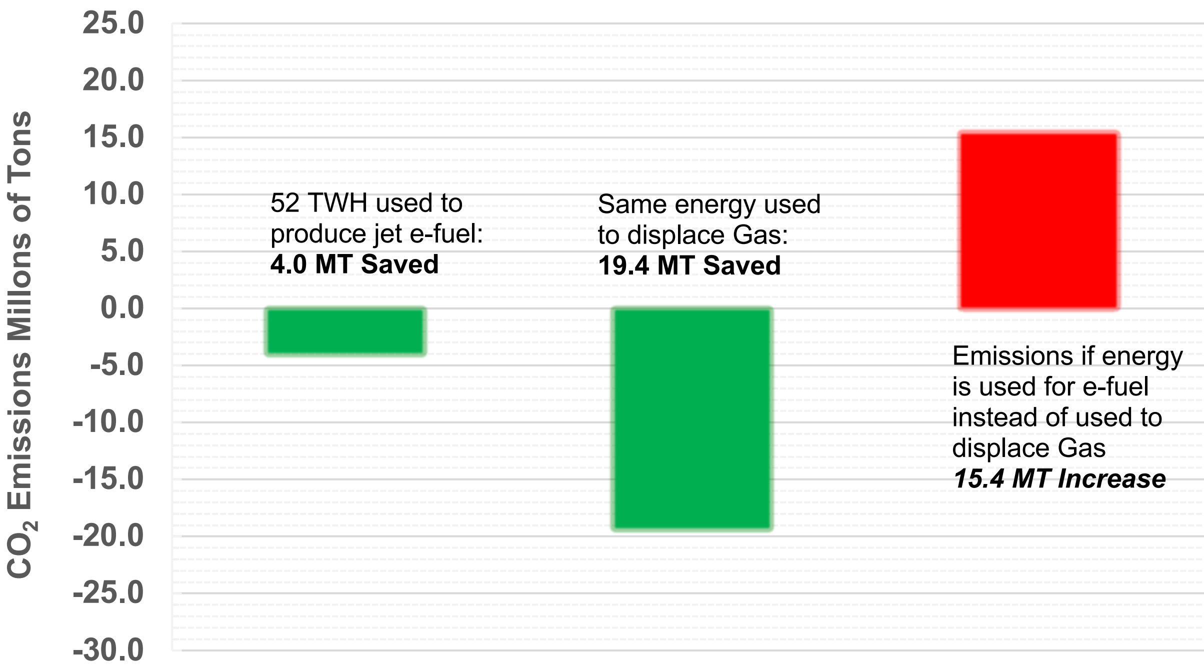
[26] 2023 ISO New England Electric Generator Air Emissions Report, ISO New England, p. 11

[27] 51 TWh/year x .41 kg CO_2/kWh is 21MT of CO_2 per year

[28] The 5.9 MT/year savings gained by using e-fuel instead of fossil jet fuel (discussed earlier) are reduced by 1.8 MT/year of embedded carbon in the required e-fuel solar installation, 52TWh at 0.036 kg/kWh, per Gan, "Greenhouse Gas Emissions Embodied in the US Solar PV Supply Chain", Environmental Research Letters, IOP Science, 9/21/2023

Figure 1: Massachusetts CO_2 emissions changes resulting from alternative applications of clean energy



Should we use clean electricity to displace fossil fuel electricity or to produce e-fuel? If our goal is to reduce CO_2 emissions, the answer is clear. CO_2 reductions are five times larger when clean electricity displaces fossil fuel power generation, rather than producing e-fuel. The SAF Workgroup Report fails to acknowledge this critical problem.

The figure shows that meeting today's jet fuel demand by using electricity to produce e-fuel (instead of using it to displace fossil electricity) *increases overall CO_2 emissions by 15.4 megatons per year*. By comparison, the entire Commonwealth (minus aviation) has CO_2 emissions of 70 megatons.[29]

> ***CO_2 emissions are five times lower if we direct new clean electricity to the grid to displace natural gas, instead of using it to create e-fuel SAF.***

The reason for this is that creating SAF from electricity is quite inefficient; it is much more effective to use clean electricity to directly reduce fossil fuel grid emissions than to offset jet emissions inefficiently.

[29] Massachusetts Clean Energy and Climate Plan for 2050, P29

E-FUEL CANNOT BE CONSIDERED A PRACTICAL GHG SOLUTION UNTIL SEVERAL CONSIDERATIONS CHANGE

The above discussion shows that today, it makes no sense at all to use clean electricity to make SAF. This situation will not change until the grid is decarbonized, which is not likely to happen by 2050, and may not occur before 2100. Then why is e-fuel being considered at all? Two future scenarios could make e-fuel an effective means of reducing CO_2 emissions. Each will be addressed in turn.

The first scenario is that fossil electricity may be effectively eliminated in the future. If this occurs, additional clean electricity can no longer displace fossil sources, and its use for producing e-fuel becomes a more attractive means of reducing CO_2 emissions. As long as any fossil electricity remains, using new clean energy to make e-fuel instead of displacing fossil generation would be an error because it results in significantly more GHG. There is no realistic path for electrical decarbonization in Massachusetts or the nation before 2050, and many believe that 2100 is unlikely. However, in practice, the intermittency of many carbon-free sources may result in periodic surpluses of clean power as sources like wind and solar increase on the grid. This may create temporary situations where surplus clean power cannot otherwise be utilized, and its temporary application in the creation of SAF would have emissions benefits. However, designing SAF refineries to operate intermittently only in times of surplus clean energy is a poor use of capital, greatly increasing the levelized cost of the resulting e-fuel, and therefore cannot be considered realistic. As we develop new clean electrical generation, we must apply it where it results in the highest CO_2 reduction, such as electric cars, heat-pumps, cement production, displacing gas generation, etc. These applications, and many others, provide MUCH larger CO_2 reduction per kWh than SAF production. *This is because the basic science of SAF production is so inefficient.* The current GHG penalty of using clean energy for e-fuel instead of for more effective GHG reduction applications will remain well past 2050.

The second scenario that might increase the viability of e-fuel is that the energy efficiency of the e-fuel manufacturing process might improve over time. The current overall energy efficiency estimates for future e-fuel manufacturing, ranging from 25% to 39%, are based on optimistic estimates that have yet to be achieved in volume production. Many studies predict incremental improvements over time. Unfortunately, there are significant warning signs that improvements are not forthcoming. First, the federal government is reducing clean energy investments, and second, key process equipment, such as electrolysis and air capture systems, is currently increasing in cost and failing to meet performance expectations. For example, the most advanced direct air capture systems currently generate more CO_2 emissions than they capture.[30] Even with incremental efficiency improvements, from a carbon reduction perspective it will still be four times better to use clean electricity to displace fossil fuel generation than to use it for e-fuel. There is hope that a new miracle technology will be developed, which might dramatically improve e-fuel

[30] Alexandersson, B, "Climeworks' Capture Fails to Cover its Own Emissions" Heimildin, May 15, 2025

production efficiency. The Commonwealth should encourage further basic research that may change the outlook for e-fuels. However, e-fuel production is a well-understood chemical process governed by physics, and it is imprudent to develop policy based on speculative future technology breakthroughs.

E-FUEL SUBSIDIES WILL NOT PROVIDE EMISSIONS BENEFITS

The use of clean energy to produce e-fuel is counterproductive because it has a negative emissions benefit for the foreseeable future. Subsidizing the use of e-fuel will result in *increased* emissions. Even if e-fuel were to provide an emissions benefit, its production cost is significantly higher than that of fossil jet fuel. The only ways to drive e-fuel use are:

- Mandating the use of e-fuel
- Sufficient carbon pricing of fossil jet fuel
- Sufficient subsidies for e-fuel

The projected production cost for e-fuel has been extensively studied and is currently estimated to range between $4.50 and $13.00 per gallon in 2050[31,32], as compared with the current production cost of fossil jet fuel, which is $2.50 per gallon.[33] The required subsidy to achieve parity with fossil jet fuel is therefore between $2.00 and $10.50 per gallon. By comparison, the current federal subsidy for e-fuel is capped at $1.00 and is set to expire in 2029.[34]

Alternatively, cost parity could be achieved by a carbon price of $200 to $1,070 per ton of CO_2 applied to fossil jet fuel.[35] Environmental groups suggest the Social Cost of Carbon is around $190 per ton. However, the current RGGI auction price is only around $18 per ton, and the Trump administration has just announced that the Social Cost of Carbon will be zero for new impact assessments. It appears impractical to enact a sufficient carbon price that would drive a conversion to e-fuel, particularly if future e-fuel costs approach the top of the expected range (as it certainly will in the early decades).

Mandates or carbon pricing at the national level could drive e-fuel adoption, but are unworkable at the state level, as they would result in interstate market distortions and legal challenges. The only practical option at the state level is an e-fuel subsidy. To displace current fossil jet fuel use

[31] D'Adamo, "Environmental Implications and Levelized Cost Analysis of E-fuel Production", Elsevier Environmental Research, Vol 246, Jan 2024

[32] The $6.35 cost quoted in the Workgroup Report is slightly below the middle of this range.

[33] Based on a rate of $800/ton, per "The Role of E-fuels in Decarbonizing Transport, International Energy Agency, 2024, p47

[34] H.R.1, Section 70521, (d) and (g)3b, as enacted, July 2025

[35] The required subsidy range expressed in $/kg divided by 3.16 kg CO_2 per kg of fuel

with e-fuel in Massachusetts would require annual subsidies of $2.9 billion to $16.5 billion.[36] This is 2 to 12 times the entire annual Massachusetts Transportation budget of $1.37 billion.

If the purpose is to drive jet fuel to net-zero, then subsidies that are not intended to drive a wholesale conversion to e-fuels, but rather to create a small market for e-fuel to be blended into fossil jet fuel, are counterproductive. However, this is the stated goal of the SAF Workgroup Report. It has already been shown that such use will increase CO_2 emissions. Furthermore, a small SAF market is unlikely to be served by e-fuel, but rather by SAF derived from crops or waste cooking oil, which are dead-end technologies because they cannot ultimately meet the needs of the larger market.

CONCLUSION

Carbon pricing and/or mandates for SAF use can drive a conversion to SAF, but these approaches require national action and cannot be effective at the state level, except to encourage the blending of small amounts of SAF into fossil jet fuel. While subsidies can be enacted at the state level, the subsidy required to drive the wholesale conversion to SAF would be unfundable.

The most severe and unsolved problem with SAF is that its use ***increases*** CO_2 emissions. The SAF Workgroup report does not comprehend this issue. Until the utility grid is completely decarbonized, every kWh of clean electricity generated must be applied toward the maximum reduction in CO_2, and not toward the inefficient production of e-fuel. This is not a minor issue: the GHG benefit of displacing fossil electricity in Massachusetts is approximately five times greater than any benefit gained by creating SAF.

The magnitude of electrical power required to produce e-fuel to meet Massachusetts aviation requirements *is much more than the Commonwealth generates today*. Such a dramatic growth in generation to support e-fuels cannot be realistic when there is already an unmet need to provide new generation for other sectors with higher GHG reduction potential, such as automobiles and building heat pumps.

Even if a future technological miracle allowed SAF to reduce GHG, the public costs necessary to subsidize its widespread use would be huge. The required subsidies, ranging from $2.9 to $16.5 billion per year, are unworkable in the state budget; this amount of funding could be deployed on alternative investments that would provide a much greater GHG reduction.

Proposals to continue studying SAF are logical. Supporting basic research aimed at improving the efficiency of SAF production is prudent. However, proposals to drive production or consumption

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[36] The subsidy rate per gallon multiplied by 490 million Gallons/year (equivalent to 1.5 MT/y)

of SAF through economic policy or subsidies do not make financial sense, as SAF currently and for the foreseeable future increases GHG emissions.[37]

The two best ways to decrease CO_2 emissions from aviation today are:

1. Ensure that inefficient modes of aviation are avoided. The Commonwealth should implement policies and infrastructure to transition short-hop local flights using small aircraft, like Cape Air, to electric aircraft as soon as possible. The Commonwealth should also reduce the use of private luxury jets, which produce the highest CO_2 emissions per passenger mile. Subsidies for these aircraft should be eliminated.[38]
2. Replace short flights with high-speed rail or other electric ground transportation. A significant portion of Massachusetts's jet fuel is used for flights to the Northeast Corridor. The Commonwealth, working with other corridor states, should prioritize the development of true high-speed rail through legislation, eminent domain, and other methods. This presents the Commonwealth's greatest opportunity to cut aviation-related GHG emissions by 2050.

SAF clearly cannot significantly reduce Massachusetts aviation emissions before 2050. Justifying aviation expansion today based on a hypothetical future availability of SAF is not aligned with any plan to reduce GHG emissions. "This is first and foremost about justifying never-ending growth [of aviation] and pretending that you can do that without heating the planet more and more - which you cannot do," said Almuth Ernsting, from the advocacy group Biofuelwatch.[39]

Aviation emissions can only be reduced this century by flying less—particularly eliminating wasteful or inefficient trips—and by investing in low-emission ground transportation. Relying on speculative, expensive SAF far in the distant future is a dangerous excuse to avoid confronting jet aviation's greenhouse gas problem now.

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[37] Waste cooking oil and animal fats may provide a slight GHG reduction, but these sources cannot scale to meet SAF requirements.

[38] For example, Mass. Chapter 177 of the Acts of 2001, providing for sales tax exemption for aircraft, aircraft parts, and aircraft storage; federal preemption of local jet fuel tax; accelerated depreciation for private aircraft; exemption from local property tax and permitting if on Massport property, ability to declare jet as a business loss to cancel other taxes, use of business jet for personal use is undervalued in reporting of personal income, subsidy of infrastructure by FAA AIP funds paid by commercial passengers, etc.

[39] Plucinska, Joanna, "The Airline Industry's Dirty Secret: Clean Jet Fuel Failures," Reuters, Aug 11, 2025