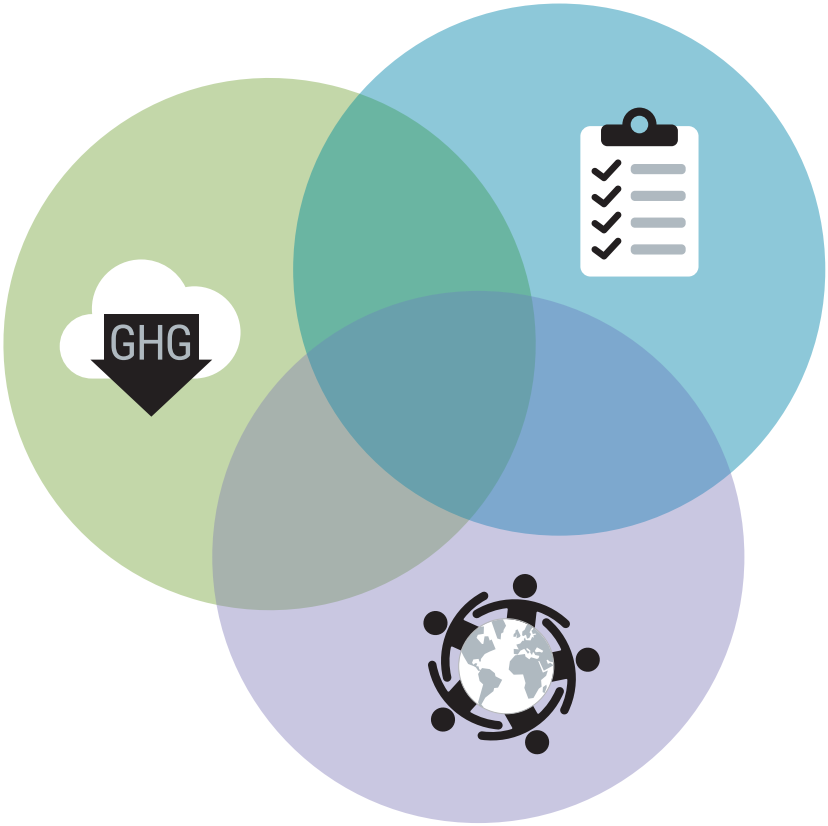
Joint Aircraft Emissions Technical & Community Task Force Report

KING COUNTY

2020

Strategic Climate Action Plan



King County

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Joint Aircraft Emissions Technical & Community Task Force Report

King County Aircraft Emissions Reduction Strategies

King County

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I. Introduction

Tackling aviation emissions presents a complex challenge for King County and other local governments, as technology and regulations limit swift action. The impact of emissions on frontline communities, coupled with a significant contribution to total planetary warming, requires urgent action with limited solutions available today. Initiated by Priority Action 1.2.3 in King County's 2020 Strategic Climate Action Plan, this report outlines key issues and recommendations from a Joint Aircraft Emission Technical and Community Task Force (Task Force), aiming to begin to address climate emissions and non-CO_2 warming around airport communities across King County.

A. Executive Summary

Aviation is an extremely difficult source of emissions and pollution to address, especially at the county level. King County and its regional partners are limited by technology and regulatory authority in taking major action on decarbonizing aviation emissions rapidly and effectively. Despite these limitations, emissions from aircraft disproportionately impact frontline communities and it is critical for King County and its partners to develop strategies for both emissions reductions and air quality improvements.

Developing a more concrete understanding of aviation emissions and available strategies for King County to adopt was included as a work item in the 2020 Strategic Climate Action Plan. The King County Council directed staff to form the Task Force, to update the methodology for determining baseline aviation emissions, and to recommend emissions reduction strategies. The Task Force is made up of broad representatives from climate action groups, technical experts, local airports and governments, and members of impacted communities. **Aviation emissions are responsible for 15 percent of King County's total emissions**, significantly larger than previous inventories, because they now more comprehensively track overall fuel consumption from flying and the additional warming effects that flying has on the atmosphere.

Not enough has been done to identify and implement strategies to reduce carbon and air pollution emissions from the aviation sector. As other sectors work to decarbonize in the coming years, the share of emissions from aviation is expected to grow as near- and medium-term emissions reductions are unlikely. Aside from a temporary decline in 2020 due to the COVID-19 pandemic, aviation emissions in King County have continued to rise due to increasing air travel and are expected to continue to grow in the years to come.

Despite these challenges, King County is the operator of a hub airport, King County International Airport (KCIA), and home to Seattle-Tacoma International Airport (SEA) – and along with partners can take some actionable steps to help spur the decarbonization of aircraft.

In the near term, the primary strategies the Task Force had broad agreement on center on prioritizing air quality improvements in communities near and around airports. Additionally, the Task Force reached broad agreement that KCIA should be working as quickly as possible to phase out leaded aviation gas, which can have harmful impacts on residents.

In the next several decades, policymakers should expect innovation in the aviation sector from new aircraft technologies. However, technologies such as battery electric or hydrogen fuel cells that work in on-ground transportation decarbonization, are too heavy for most commercial aircraft, are only in the primary stages of development, and are not expected to be broadly adopted in the near or medium term to meet climate goals. The next generation of aircraft is expected to be more fuel efficient, but total emissions are likely to remain the same or increase due to expected increases in air traffic.

The primary strategy for reducing emissions in federal and state level state climate action plans is through Sustainable Aviation Fuels. Sustainable Aviation Fuels (SAF), or alternative aviation fuels, refer to non-conventional aviation fuels such as biofuels (derived from a range of feedstocks including plant oils, used cooking oil, inedible fats, and municipal waste) or synthetic fuels that are blended with fossil fuels and used as a synthetic equivalent to jet fuel. Bio-based SAF's emit similar amounts of greenhouse gas emissions as conventional jet fuel during flying. However, lifecycle emissions can be lower because the carbon absorbed during the growth of the feedstocks offsets some of the carbon emitted when combusted. SAF's can be dropped into existing aircraft and do not require significant new infrastructure when mixed with conventional jet fuel.

However, there are significant concerns about SAFs feasibility and the extent to which they can reduce emissions. Whether or not the fuel reduces emissions varies considerably based on feedstock, many biofuels may raise other sustainability and equity concerns, and some feedstocks may have detrimental impacts on air pollution. SAFs also represent only 0.1 percent of current jet fuel consumption and whether or not enough low emissions fuel could be produced to meet global demand without unintended consequences remains to be seen.

Given these limitations, the primary recommendations where there was broad support from the Task Force are as follows.

Implementation: King County takes a leading role.

- Aggressively phase out leaded aviation gas at KCIA, addressing lead pollution.
- Plan for electric charging and hydrogen infrastructure at airports.
- Update net radiative forcing multiplier to fully account for warming effect of flying in future inventories.

Convene/Partner: King County needs external partners and collaboration to take action.

- Promote accurate emissions reporting methodologies.
- Study health effects of KCIA on surrounding communities.

Support/Advocate: King County's role is as a supporter or advocate for action.

- Advocate for alternative travel modes like rail and other ways to reduce demand for flying.
- Push for greater aircraft fuel efficiencies in federal aviation standards and from manufacturers.

A range of additional recommendations had support among some members of the Task Force, but either were identified as less of a priority given limited County resources or raised significant disagreement among other members of the Task Force.

B. Task Force and Purpose

King County government's vision is "a diverse and dynamic community with a healthy economy and environment where all people, businesses, and organizations have the opportunity to thrive." As part of this vision, King County developed a Strategic Climate Action Plan to outline the policies and investments necessary to reduce greenhouse gas (GHG) emissions countywide by half by 2030, lead with climate equity, and prepare for the impacts of climate change.

Community groups engaged in the development of the 2020 Strategic Climate Action Plan (SCAP) advocated and encouraged the plan to include aircraft emissions in the greenhouse gas reduction efforts and for a task force to address the challenges of decarbonizing aircraft emissions.

The 2020 SCAP directs King County to develop a Joint Aircraft Emission Technical and Community Task Force (Task Force). The Task Force, composed of community-based organizations, representatives of frontline communities, technical experts, and government agency staff, was directed to review and update King County's approach to aviation emission inventories and assess strategies to reduce greenhouse gas emissions from aircraft to protect residents, especially frontline communities, from harmful climate and air quality risks.[1]

The Task Force members include:

- Federal Way City Councilmember Susan Honda, King County Board of Health Member
- Dr. Laura Gibbons, 350 Seattle
- Velma Veloria, King County International Airport Community Coalition
- Anne Kroeker, Des Moines/Redondo Beach Community Member
- Debi Wagner, Burien Community Member
- Maria Batayola, Beacon Hill Council/Community Member
- Eric Miller, King County International Airport
- Brad Kramer, King County Public Health
- Mina Hashemi, King County Executive Staff
- Terry Sullivan, King County Executive Climate Office
- Erik Saganić, Puget Sound Clean Air Agency
- Dave Kaplan, Port of Seattle
- Dr. Tim Larson, University of Washington

The Task Force members met several times between November 2021 and November 2023 and took part in many conversations that shaped this report and its recommendations. While the report is a summary of the work, there was not unanimous agreement on every element of the work. Additional details on Task Force processes and input are included in an Appendix to this document.

1 King County 2020 Strategic Climate Action Plan. Priority Action GHG 1.2.3. https://your.kingcounty.gov/dnrp/climate/documents/scap-2020-approved/2020-king-county-strategic-climate-action-plan.pdf

The purpose of this report is to share the Task Force's findings including reviewing and recommending methodologies for accounting for the emissions inventories, evaluating emissions reductions technologies and policies, and recommending strategies and actions to reduce aviation emissions. The strategies the Task Force was directed to evaluate (included but were not limited to):

- Sustainable aviation fuels and technologies such as electric battery and hydrogen-powered planes;
- Pollution mitigation strategies and funding options;
- Travel policies for county workforce;
- State and federal carbon pricing that includes regulation of aviation sector GHG emissions, and
- Directing solid waste from County facilities to the Port of Seattle for conversion into sustainable jet fuel and other fuels.

C. Background

King County has a long history as a hub for aerospace innovation. With more than 400 aerospace companies and a workforce of 45,000 residents dedicated to the industry, aviation serves as a cornerstone of King County's economy.[2] While innovation and manufacturing in aviation are part of King County's economic identity, air travel at King County's airports is at odds with the County's climate goals with a challenging path to reach zero emissions. King County's Strategic Climate Action Plan (SCAP)[3] commits the County to reducing greenhouse gas emissions by 80 percent of 2007 levels by 2050 and major reductions emissions from aviation will be necessary to meet those goals.

While globally, aviation has been responsible for about 3.5 percent of anthropogenic climate change, in 2019, aviation fuels were responsible for 15 percent of King County's total emissions.[4] **Despite progress on policy solutions to reduce other sources of transportation and building emissions, the path to identify and implement strategies to reduce emissions in the aviation sector is less certain.**

Climate and Environmental Justice

Reducing King County's aviation emissions is critical for climate and environmental justice.[5] Frontline communities, while not a monolith, are communities that have experienced systematic social, environmental, racial, and economic inequities and these communities are more likely to live within 10 miles of King County's main airports.[6] Aviation emissions present a dual threat to all King County residents, but frontline communities are especially vulnerable to climate change and more directly experience air pollution caused by aviation emissions:

- **Warming Climate:** Aviation emissions exacerbate rising temperatures, and King County's frontline communities are already the most vulnerable to the impacts of climate change, including heatwaves, flooding, deteriorating air quality, and increased food costs. These challenges will only intensify as global temperatures continue to climb.
- **Harmful Air Quality:** Aviation emissions directly cause increased air pollution in frontline communities already exposed to high levels of pollution from road transportation and industry, including lead exposure from aviation gas. Overall, air pollution can cause shorter life spans and higher rates of adverse health outcomes, including asthma, cardiovascular, cancer, and respiratory illness.[7]

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2 King County Aerospace Alliance. https://kingcounty.gov/en/legacy/elected/executive/constantine/initiatives/aerospace-alliance

3 King County 2020 Strategic Climate Action Plan. https://your.kingcounty.gov/dnrp/climate/documents/scap-2020-approved/2020-king-county-strategic-climate-action-plan.pdf

4 King County Community Wide Geographic Greenhouse Gas Emissions. p. 30. https://your.kingcounty.gov/dnrp/climate/documents/2022/king-county-geographic-ghg-emissions-inventory-and-wedge-report-09-2022.pdf

5 This report focuses on climate emissions and air pollution but noise from aircraft also has proven harmful impacts on frontline communities.

6 Nearly three-quarters of people in King County who identify as Black/African American live in airport communities. Similarly, 74.8 percent of the county's Native Hawaiian and Pacific Islanders, 57.6 percent of the county's Hispanic/Latino, and nearly half of the county's Asian population call the areas within 10 miles of the airport home. See Community Health and Airport Operations Related Noise and Air Pollution. See https://apps.leg.wa.gov/ReportsToTheLegislature/Home/GetPDF?fileName=Community%20Health%20and%20Airport%20Operations%20Related%20Pollution%20Report_c7389ae6-f956-40ef-98a7-f85a4fab1c59.pdf

7 https://seatacnoise.info/community-health-and-airport-operations-related-pollution-report/

Aviation and air travel are important economic drivers and create good paying jobs for many residents, but air travel is a luxury for most Americans and only the wealthiest households travel by air frequently.[8] Hence, households in King County contributing to aviation emissions are not shouldering the same climate and air quality consequences as frontline communities. This is especially true for the wealthiest residents who travel on private jets which are five to 14 times more polluting than commercial planes per passenger.[9]

Role of King County: King County has a vested interest in decarbonizing aviation, but federal limitations on the ability of local jurisdictions to directly regulate the aviation industry require solutions focused on demonstrating leadership where the County has direct control and advocating with partners at the state and federal level to reduce aviation emissions.

King County is home to the Seattle-Tacoma International Airport (SEA), the eighth busiest commercial airport in the U.S. King County International Airport (KCIA), and three smaller airports are also located within King County: the Auburn and Renton Municipal Airports, and Crest Airpark in Kent. SEA is operated by the Port of Seattle and governed by elected Port Commissioners. King County can be an important partner in supporting and advocating for policies and programs to reduce the warming effects of aviation emissions at SEA Airport. And King County owns and operates KCIA in South King County, where the County can implement certain policies and programs to reduce emissions. KCIA serves cargo carriers, private aircraft owners, small commercial passenger airlines, corporate jets, helicopters, and some Boeing Company operations.[10]

Because of the regional history of innovation in aerospace, King County and Washington state will be important hubs for developing new technology that reduces emissions. And King County's involvement as a partner can be critical to spur innovation in decarbonizing aviation. King County also has a responsibility to develop proactive mitigation strategies to protect all residents, especially frontline communities, from the harmful impacts of aviation emissions through reduction strategies and by mitigating the impacts of air pollution caused by aviation fuels.

Difficulty of Decarbonizing Aviation Fuels: While much progress is on track to reduce other sources of greenhouse gas emissions in transportation, the plans for reducing aviation emissions are harder to execute and less certain. Aviation is one of the most difficult sectors to decarbonize because the alternatives to jet fuel are limited by energy density, weight constraints, safety, and infrastructure challenges, especially for longer distance flights.

8 King County Communitywide Consumption-based GHG Emissions Inventory. p. 14. https://your.kingcounty.gov/dnrp/climate/documents/2022/king-county-consumption-ghg-emissions-inventory-and-wedge-report-09-2022.pdf

9 Private jets: Can the super-rich supercharge zero-emissions aviation? 2021. https://www.transportenvironment.org/discover/private-jets-can-the-super-rich-supercharge-zero-emission-aviation/

10 King County International Airport-Boeing Field. https://kingcounty.gov/en/legacy/services/airport

II. Aircraft Emissions Today

A. Contribution of Aviation Emissions to Climate Change

Aviation emissions come from jet fuel or aviation gas burned to power aircraft. The primary greenhouse gas (GHG) emitted by aircraft is carbon dioxide (CO_2), but non-CO_2 emissions also affect the climate (including from nitrogen oxides (NO_x), sulfur oxides (SO_x), soot, and water vapor).[11] The overall contribution of aviation to warming comes from current and historical CO_2 emissions, which have a very long-term warming effect, as well as short-lived, non-CO_2 climate forcers. Although aviation is only responsible for 2.4 percent of global annual emissions of CO_2, because of the complex effects of non-CO2 emissions and their warming effect, the sector has contributed about 4 percent to observed human-induced global warming to date.[12]

B. Aviation Emissions Inventory in King County

Attributing aviation emissions to a specific geography is challenging because aviation fuel is mostly burned outside the County's boundaries. Previous inventories (prior to 2017) in King County only included the fuel used in the landing and takeoff of aircraft which is about 10 percent of the overall fuel used when flying. In the 2017 King County emissions inventory, commercial aviation emissions were determined to be 3.5 percent of King County's overall emissions (716,000 $MTCO_2e$).[13] This methodology did not comprehensively reflect the full warming effects associated with air travel due to County resident and business activities. Community members requested that King County broaden the definition and scope of the baseline inventory assumptions.

The Task Force was directed to review and select updated methodology for determining baseline aviation emissions. To better quantify the full magnitude of GHG emissions associated with air travel to and from King County, four separate approaches were used as part of this project to quantify the impact of this sector:

- A landing- and takeoff-only analysis, estimating only emissions that occur within King County.
- A passenger-based approach, looking at all aviation fuel sold in the Puget Sound region and attributable to King County residents or visitors.
- All fuels sold at airports located within King County.
- A consumption-based approach, estimating aviation emissions from King County residents that may occur anywhere in the world.

A summary of emissions for each methodology is included in Table 1 below.

11 Bergero, C. et al. (2023). Pathways to net-zero emissions from aviation. Nature Sustainability 6. Available at: https://doi.org/10.1038/s41893-022-01046-9.

12 For more on estimating the full warming effect of aviation, including short lived climate forcers, see Lee D S *et al* 2021 The contribution of global aviation to anthropogenic climate forcing for 2000–2018 *Atmos. Environ.* **244** 117834. And M Klöwer *et al* 2021 *Environ. Res. Lett.* **16** 104027.

13 GHG Emissions in King County: 2017 Inventory Update, Contribution Analysis and Wedge Analysis. p. 12, 29. https://your.kingcounty.gov/dnrp/climate/documents/201907-KingCounty-GHG-Emissions-Analysis.pdf

Table 1. County aviation sector GHG emissions for the 2019 calendar year.

Approach	Description	Per Capita ($MTCO_2e$)	Total ($MTCO_2e$)
Landing and takeoff only	Locally generated emissions associated with airplane takeoff and landing (incomplete, historic method recommended by local government GHG protocols, 10% of "all fuels" approach)	**0.3**	**678,000** (~2% of total King County geographic inventory)
Passenger based	Total attributable to King County residents, employees, and visitors (71% of "All Fuels"; remainder included in Snohomish, Pierce, and Kitsap County inventories; total included in geographic inventory)	**1.78**	**3,999,000** (total proposed for geographic "wedge analysis", ~15% of total geographic inventory)
All fuels	All fuels sold at SeaTac and KCIA/Boeing Field (no matter the user)	**3.0**	**6,783,000** (~25% of King County geographic inventory)
Consumption based	Personal air travel by King County residents (emissions occur worldwide; excludes some work travel; excludes travel associated with residents that live outside King County; uses lifecycle GHG coefficient)	**0.76**	**1,700,000** (included in consumption inventory and wedge analysis, ~4% of total)

The new inventory methodology is a 'passenger-based approach' that assesses all aviation fuel sold in the Puget Sound region associated with air travel due to County resident and business activities, though all approaches are reported on for transparency. The new methodology also adds a lifecycle emissions multiplier to account for high-altitude radiative forcing effects and life-cycle well-to-wheel emissions associated with jet fuel.[14] Using the new methodology, in 2019 aviation emissions accounted for 15 percent of King County's overall emissions or 3,999 million $MTCO_2e$ (Figure A).[15]

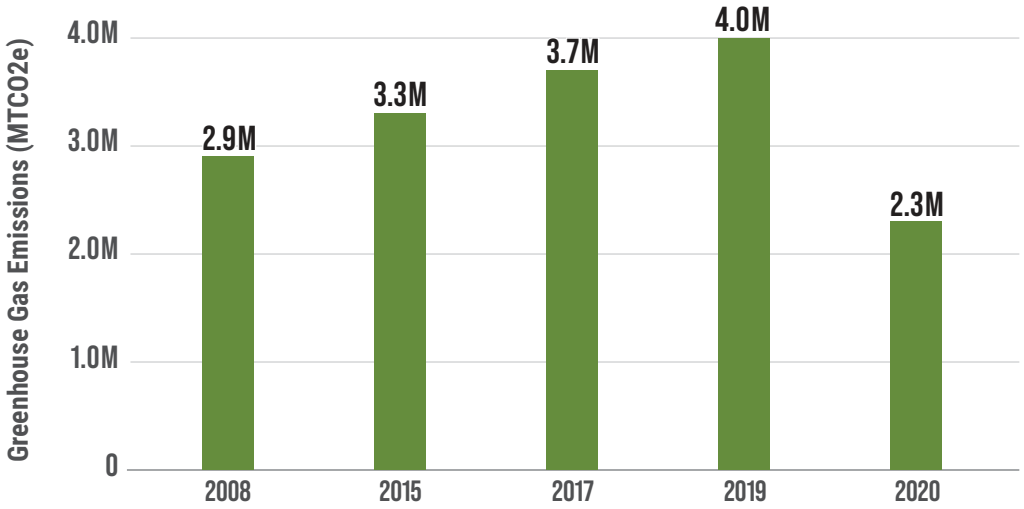
Note on emissions multiplier: The Task Force encouraged the use of the emissions multiplier to account for the full and unique warming effects of flying. UC Berkeley researchers provided the Puget Sound Regional Emissions Analysis project with a multiplier of 2.1. However, current research suggests a more accurate multiplier to capture the non-CO_2 warming effects of flying is around 3.0. The Task Force strongly recommended using the 3.0 as a multiplier in future inventories based on the current science, and this is included as a recommendation below.[16]

14 UC Berkeley researchers provided the Puget Sound Regional Emissions Analysis project with a multiplier of 2.1. However, current research suggests a more accurate multiplier to capture the non-CO2 warming effects of flying is around 3.0.

15 King County Community Wide Geographic Greenhouse Gas Emissions. p. 29-31. https://kingcounty.gov/en/legacy/elected/executive/constantine/initiatives/aerospace-alliance

16 See https://sustainable.stanford.edu/sites/g/files/sbiybj26701/files/media/file/s3-radiative-forcing-rfi-memo_public.pdf for more.

Figure A: Passenger-based aviation emissions trends using updated methodology



C. State, Federal, and Global Aviation Emissions Inventories

The new methodology for determining aviation emissions in King County is a more inclusive methodology, beyond state, federal, ICCT, and other local emissions inventory methods.

Washington State Aviation Emissions: In Washington State's 2019 greenhouse gas inventory, aviation CO_2 emissions account for approximately 6.2 percent of the state's overall greenhouse gas emissions. The methodology for aviation emissions in the Washington State Greenhouse Gas Emissions Inventory prepared by the Washington State Department of Ecology, determines greenhouse gas emissions based on a 'production-based emissions inventory' and determines emissions sources within the state's boundaries. The Department of Ecology's report acknowledges that this methodology may provide an incomplete picture of the state's carbon footprint as it does not account for warming due to radiative forcing and is calculated using the fuel consumption.[17]

Federal Aviation Emissions: Commercial aviation contributed 8.6 percent of the total US transportation sector's GHG emissions, and 2.5 percent of the nation's overall GHG emissions.[18] This approach does not appear to incorporate net radiative forcing.

Global Aircraft Emissions: Commercial aviation contributes to roughly 2.4 percent of total anthropogenic CO_2 emissions on an annual basis and that proportion is rising.[19] Accounting for all climate forcing effects and their net contribution, aviation has been responsible for about 3.5 to 4 percent of the drivers of climate change.[20]

17 Washington State Greenhouse Gas Emissions Inventory: 1990 to 2019. https://apps.ecology.wa.gov/publications/documents/2202054.pdf

18 U.S. Environmental Protection Agency (2023). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021. Available at: https://www.epa.gov/system/files/documents/2023-04/US-GHG-Inventory-2023-Main-Text.pdf

19 Intergovernmental Panel on Climate Change (2021). Climate Change 2022: Mitigate of Climate Change. Chapter 10: Transport. pp. 10-58. Available at https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Chapter_10.pdf

20 Lee, D.S. et al. (2020). The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018. Atmospheric Environment. Volume 244. Available at: https://doi.org/10.1016/j.atmosenv.2020.117834

D. Local Pollutants from Aviation and Health Impacts on Frontline Communities

Air pollutants and noise from aviation contribute to harmful health outcomes in residents that live near airports. The air pollutants from airport operations include particulate matter, ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur oxides (SOx), and other hazardous air pollutants. Lead exposure is also a concern around smaller airports because aviation gas contains lead and is used in small planes with piston engines. SEA Airport stopped using aviation gas in 2015. Jet fuel, the primary fuel for commercial jets, does not contain lead.[21]

While it is difficult to distinguish pollution from aviation versus other nearby sources, emissions from airplanes can have a harmful effect on air quality. A majority of Black/African American, Hispanic/Latino, and Native Hawaiian/Pacific Islander residents live within 10 miles of an airport and experience disproportionate health outcomes from airport, freeway, and industrial emissions.[22]

E. The Future of Aviation Emissions in the U.S. and King County

U.S. aviation emissions are expected to grow between now and 2050 without additional policy interventions (Figure B). Population and economic growth in King County have resulted in increasing aviation emissions over time as demonstrated in Figure A.

New aircraft that will be entering service in the coming years are expected to be more fuel efficient and are expected to reduce emissions by 11 percent by 2030. Each new generation of commercial aircraft can be 15 to 20 percent[23] more fuel efficient than the previous one. The FAA projects that new larger aircraft entering service around 2040 will have even greater fuel efficiency and is aiming for 30 percent efficiency in new aircraft emissions standards. However, according to the IPCC, "airframes performance has improved over the years with better wing design, but large incremental gains have become much harder as the technology has matured." [24]

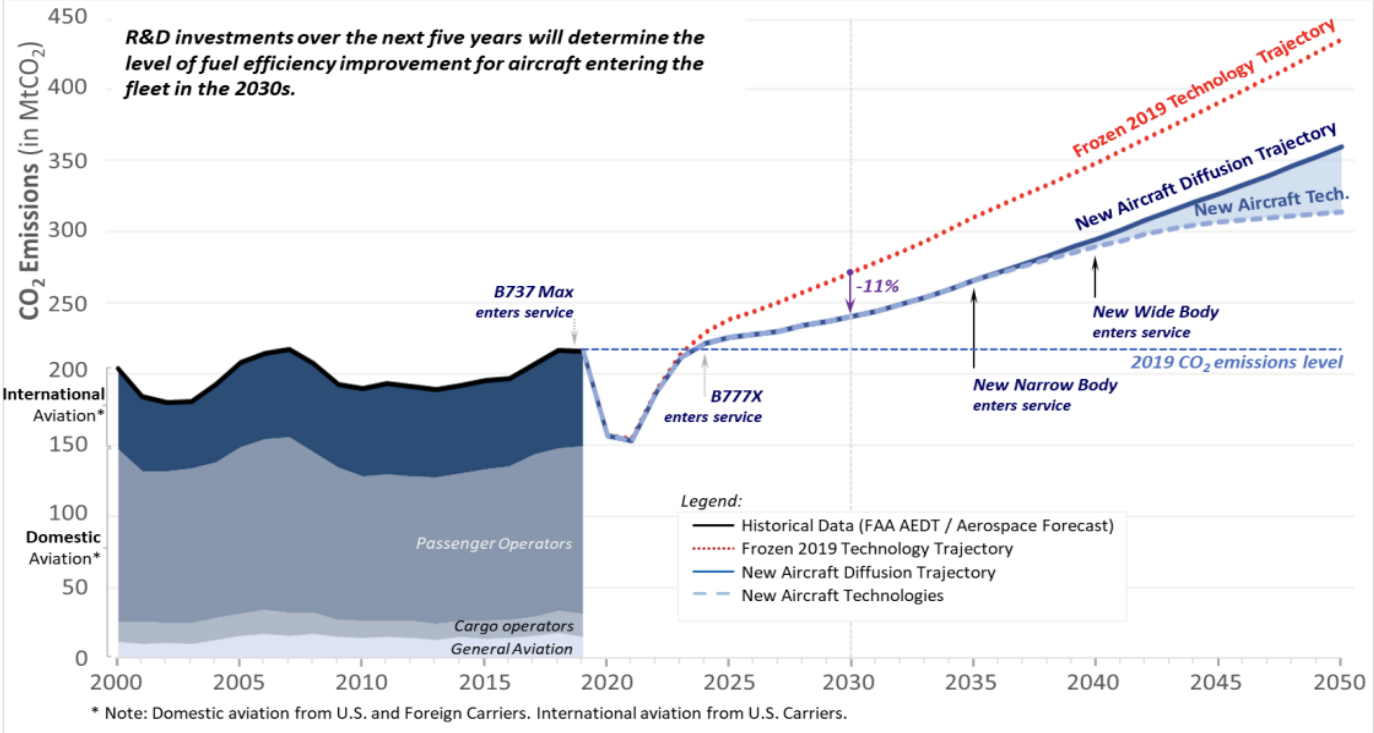
21 https://www.seattletimes.com/opinion/epa-knows-what-it-must-do-end-the-use-of-leaded-aviation-fuels/

22 Nearly three-quarters of people in King County who identify as Black/African American live in airport communities. Similarly, 74.8 percent of the county's Native Hawaiian and Pacific Islanders, 57.6 percent of the county's Hispanic/Latino, and nearly half of the county's Asian population call the areas within 10 miles of the airport home. See Community Health and Airport Operations Related Noise and Air Pollution.

23 International Air Transportation Association (2023). Net zero 2050: new aircraft technology. Available at: https://www.iata.org/en/iata-repository/pressroom/fact-sheets/fact-sheet-new-aircraft-technology/#:~:text=Each%20new%20generation%20of%20plane,better%20aerodynamics%2C%20and%20reduced%20weight.

24 IPCC

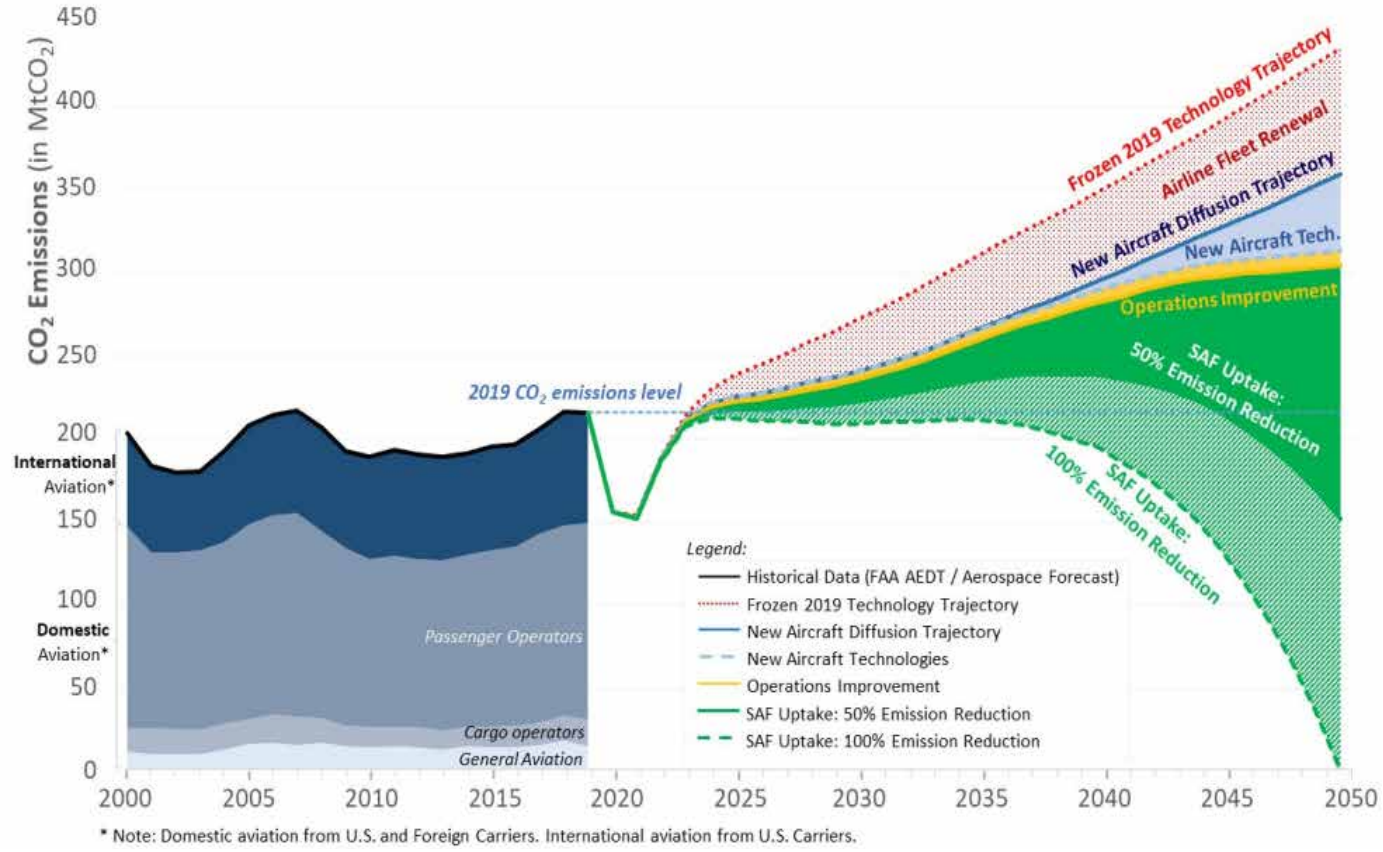
Figure B: Analysis of Future Domestic and International Aviation CO_2 Emissions: New Aircraft Development Scenario



The FAA developed the **U.S. Aviation Climate Action Plan** to address the contribution of U.S. aviation to climate change, in line with the national objective of reaching net zero by 2050.[25] The U.S. Aviation Climate Action Plan focuses primarily on the development and growth of Sustainable Aviation Fuels (see Figure C). According to the plan, the ability of the U.S. aviation sector to reach the ambitious targets "will depend on a number of factors including the sector's rate of growth, success in scaling up the production of SAF with significant life cycle emissions reductions, the introduction of new aircraft and engine technologies to reduce the amount of fuel required to move people and goods, and operational efficiency improvements." There are many challenges with the adoption and feasibility of SAF and the emissions reductions potential which are detailed in Section III of this report.

25 Federal Aviation Administration (2021). United States 2021 Aviation Climate Action Plan. Available at https://www.faa.gov/sites/faa.gov/files/2021-11/Aviation_Climate_Action_Plan.pdf

Figure C. Historical and Projected CO_2 Emissions from U.S. Aviation



The Future of King County's Aviation Emissions: Aviation emissions in King County are likely to rise in the coming years with the return to air travel and business activity following the COVID-19 related decline in emissions in 2020. For King County to reach the 2050 greenhouse gas reduction goals, King County will need to decarbonize aviation fuels by 95 percent and reduce aviation fuel use by 25 percent by 2050; additional local actions modeled in the recent Puget Sound Regional Emissions Analysis to achieve these targets from aviation emissions are outlined in Table 2. However, as outlined in this report, the technologies needed to decarbonize aviation fuels are still in early-stage development with little certainty they can meet growing demand for aviation by 2050.

Table 2. King County Emissions Reduction Targets[26]

Percent carbon emissions reductions from baseline year

Action needed	2030	2040	2050
Decarbonize aviation fuels (Percent reduction in fuel carbon intensity)	20%	55%	95%
Reduce air travel & increase efficiency (Percent% reduction in aviation fuel use)	20%	23%	25%

26 See King County's Geographic GHG Wedge Planning Tool and its assumptions for high-level modeling of aviation and other sectors. https://kingcounty.gov/en/legacy/services/environment/climate/actions-strategies/strategic-climate-action-plan/emissions-inventories#:~:text=King%20County%20Consumption%20GHG%20Emissions%20(2019),%25)%20are%20equally%20important%20sources.

III. Navigating the Path to Aviation Emissions Reduction

The pathways to reduce aviation emissions are harder to negotiate and the new technologies are less certain than decarbonizing other modes of transportation. But for King County to reach the emissions reductions goals defined in SCAP, much work must be done to develop clean aviation fuels and reduce aviation fuel use. While cleaner fuel, reductions in demand, and greater fuel efficiency will have major impacts on air quality, King County must also develop or expand on mitigation efforts to offset the impact of the air quality impacts that are especially harmful to frontline communities.

A. Challenges to Reducing Aviation Emissions in King County and Beyond

Federal jurisdictional limitations on King County enacting aviation mitigation or emission standards are not the only challenge for reducing aviation emissions. Achieving net-zero aviation in King County or anywhere by 2050 requires overcoming significant technological, logistical, behavioral, and economic challenges. The three central challenges in reducing aviation emissions are 1) technology and innovation, 2) transitioning infrastructure and regulatory systems, and 3) overcoming social and economic dependencies on air travel.

1. **Technology and Innovation:** Aviation operations have largely operated on the same technologies for the last century. While newer planes are more fuel efficient, aviation has exclusively operated on hydrocarbon fuels which are difficult to transition away from.
   - Aviation requires energy density and lightweight energy: Jet fuel has a high energy density where more energy is contained in smaller volumes, making it efficient for medium- and long-haul flights. The energy is also burned off and the weight is lost during the flight adding to the efficiency. Battery electric and hydrogen fuel-cell technologies thus far have lower energy densities that are promising for shorter flights but cannot fully replace jet fuel without technological advancements for long-haul trips. Battery technology has been an effective energy alternative to fossil fuels for ground transportation, but the weight-to-energy ratio remains a challenge for electric aviation.
   - Research and Development: Developing and scaling up alternative aviation technologies, such as electric, hydrogen-powered planes, or sustainable aviation fuels, requires significant research and development. In addition, there are many uncertainties that sustainable aviation fuels can be developed in large enough quantities to replace conventional jet fuel that can reach zero lifecycle emissions.
   - New technology is costly: There is a steep cost gap between new technology (alternative fuels or new aviation technologies) and the relatively lower cost of existing fuels.
2. **Transitioning Infrastructure and Regulatory Systems:** Emerging low- and zero-emissions aviation technologies offer hope, but as new technologies are developed, more time will pass before fleets are able to transition to new fuels or zero-emissions models. Advances in technology are critical within the next five years for more efficient aircraft to enter service in the 2040's.
   - Aircraft Service Lifecycle: Aircraft service life cycles span decades and recently delivered airplanes are expected to remain in service beyond 2040.
   - Infrastructure: The aviation industry has a vast infrastructure built around fossil fuels, from refineries to distribution networks. Transitioning to alternative fuels or electric propulsion requires extensive changes to and investments in infrastructure.

- Regulatory approvals: As new technology is developed, the regulatory process is complex and time consuming as it includes safety, certification, oversight, and mature standards and practices processes. While progress is being made in electric and hydrogen propulsion systems, these technologies have yet to be cleared by regulators, and it will take years of research, testing, and certification before they can be widely adopted.

3. **Social and Economic Dependencies on Air Travel:** A central policy challenge to decarbonization in aviation is that air travel plays an important role in the Puget Sound's economy and affecting personal behaviors and choices for travel will be difficult without reliable alternatives.
   - Economic Considerations: Commercial aviation is an important contributor to the economic vitality of the Puget Sound Region including from manufacturing, which creates a high number of family wage jobs. Businesses and tourism depend on aviation and are important economic engines that will be difficult and consequential to disrupt.
   - Lack of fast and convenient surface transportation options: Long distance, high speed zero-emissions transportation alternatives are not yet available, the US is behind major global leaders in developing high speed rail. Any high-speed rail options will take decades to fund, plan, and deliver. Increasing the frequency and reliability of existing Amtrak service is feasible with increased state and federal investment.
   - Consumer Preferences: Passengers are accustomed to the convenience and affordability of air travel. Shifting behaviors and travel choices will require feasible and reliable alternatives, along with better education for consumers on the impacts of flying.

B. Recent Federal and State Funding Initiatives

Since King County approved the Strategic Climate Action Plan in 2020, important funding initiatives at the state and federal level have been adopted that will support decarbonization efforts.

Federal Funding

At the federal level, the **Inflation Reduction Act**, passed by Congress in 2022, includes new grant and loan funding to advance sustainable aviation fuels and low emissions aviation technologies[27] to reduce emissions from aviation including:

- $46.5 million for 'Fueling Aviation's Sustainable Transition Technology' (FAST-Tech). According to the FAA, "FAST-Tech funds will accelerate aviation technology projects that reduce greenhouse gas emissions, improve aircraft fuel efficiency and increase the usage of sustainable aviation fuel. Eligible entities for the program are broad. They include airports, air carriers, universities, aviation and aerospace companies, state and local governments and nonprofit organizations."[28]
- $244.5 million for Fueling Aviation's Sustainable Transition through Sustainable Aviation Fuels (FAST-SAF). These grants "will focus on producing, transporting, and blending sustainable aviation fuel. These projects will build up regional SAF supply chains and increase SAF use."

Aviation manufacturers are also eligible to apply for the 'Advanced Technology Vehicle Manufacturing Loan Program' which is a $3 billion loan program for a variety of transportation manufacturing.

Among the incentives for renewable fuel production in the IRA, SAF's are eligible for a new set of tax credits. The provisions on SAF in the IRA include two phases. From 2023 to 2024, a new tax credit called the Biomass-based Diesel Blenders Tax Credit will start at $1.25 per gallon for fuels that reduce life cycle GHG emissions by 50 percent. An additional $0.01 is added to the tax credit for every percentage point over 50 percent that the fuel reduces life cycle GHG emissions up to a capped limit of $1.75 tax credit per gallon. Sustainable aviation fuel at a price of $44.09 per gallon

27 https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf

28 See https://www.faa.gov/newsroom/biden-harris-administration-announces-nearly-300-million-projects-reduce-carbon-pollution

($1,400 per ton) which produces 100 percent reduction in emissions is eligible for $1.75 tax credit per gallon purchased. To qualify for the tax credit, the blending must be done within the U.S. and the SAF must meet ASTM International standard D7566. During the second phase, from 2025 to 2027, SAF will be eligible for the Clean Fuel Production Credit program, which will provide incentives beyond the initial tax credit program, adjusted for inflation and other emissions factors.[29]

According to the FAA, a range of recent investments and other efforts will help move the U.S. closer to reducing emissions from aviation, including[30]:

- A $100 million investment to develop and implement airplane technologies that reduce fuel use, emissions, and noise;
- More than $130 million to university researchers to help improve our understanding of the impacts of aviation on the environment and develop cost-effective solutions to mitigate them;
- Deploying new software allowing airplanes to roll right to the runway and take off, which reduces fuel burn, emissions and taxi time, and
- Awarding $327 million to electrify airport gate equipment and vehicles.

In addition to direct incentives and grants to reduce emissions from aviation activities, the Inflation Reduction Act established multiple grant programs that could support efforts in community to improve air quality, track pollution, and build resilience in frontline communities. Among those include:

- Air Pollution Monitoring - $117.5 Million for community monitoring and expanding Tribal monitoring capacity.[31]
- Multipollutant Monitoring - $50 Million for state, local and Tribal air agencies to expand the national ambient air quality monitoring network with new multipollutant monitoring stations.
- Air Quality Sensors - $3 Million to support the purchase of air quality sensors for use in low-income and disadvantaged communities, including through grants and regional sensor loan programs.
- Environmental and Climate Justice Grants - $3 Billion to "advance environmental justice and support projects like community-led air pollution monitoring, prevention and remediation; mitigating climate and health risks from extreme heat and wildfires; climate resiliency and adaptation; and reducing indoor air pollution."[32]

29 Congressional Budget Office (2022). *Estimated Budgetary Effects of Public Law 117-169, to Provide for Reconciliation Pursuant to Title II of S. Con. Res. 14.*

30 More online at https://www.faa.gov/newsroom/biden-harris-administration-announces-nearly-300-million-projects-reduce-carbon-pollution

31 Puget Sound Clean Air Agency received nearly $500,000 in 2023 to "deploy an innovative air monitoring approach using a TREE (Trailer for Researching Environmental Equity) equipped with stationary instruments at a fixed location based on community input to explore their neighborhood air quality concerns. Community-led air monitoring activities will use portable hand-held sensors which can be cross-referenced to the instruments in the TREE and the approach will be a beacon for how government agencies and communities can share power, exchange information, and provide disadvantaged communities with flexible, responsive air quality resources." See https://www.epa.gov/arp/selections-arp-enhanced-air-quality-monitoring-competitive-grant for more.

32 https://www.epa.gov/inflation-reduction-act/advancing-environmental-justice

State Funding

Washington State has also taken important actions that will support the decarbonization of aviation emissions:

- **Climate Commitment Act (Cap-and-Invest):** The Washington Legislature passed the Climate Commitment Act in 2021, which created an economy-wide Cap-and-Invest auction for the state's largest polluters that began in early 2023. In its first year, the auction is generating more revenue than was initially anticipated.[33] Aviation fuels are exempt from participating in the Cap-and-Invest trading market. However, proceeds from the auction could be used to invest in aviation innovation, aviation fuel technologies, and supporting frontline communities that are overburdened by greenhouse gas emissions and air pollution.
- **Clean Fuels Standard:** The Washington Legislature also passed the Clean Fuels Standard in 2021 which the State Department of Ecology began implementing this year. The Clean Fuels Standard is designed to reduce the carbon intensity in transportation fuels by 20 percent below 2017 levels by 2034. The program assigns a carbon intensity score to transportation fuels, then fuel producers and importers receive credits for fuel that produces less greenhouse gas emissions than the requirement and receive deficits for emissions above the requirement. Emissions reductions can be achieved by improving the efficiencies in the fuel production process, by blending low-carbon biofuels into the fuel they sell, and by purchasing credits generated by low-carbon fuel providers. Aviation fuels are also exempt from the Clean Fuel Standard because of federal restrictions, but airlines can voluntarily opt into the program to receive tax credits and the program incentives the production of renewable fuels including sustainable aviation fuels.[34]
- **SB 5447 Sustainable Aviation Fuels Incentives:** This year, the Washington Legislature passed SB 5447, which allows Climate Commitment Act funds to be used as incentives to produce Sustainable Aviation Fuel.[35] The law creates a per gallon incentive that increases with greater emissions reductions, up to $2 per gallon.

C. Aviation Emissions Reduction Strategies

This section offers an overview of emerging strategies across the U.S., Washington, and King County for decarbonizing and mitigating aviation emissions along with recommendations and feasibility assessment of how King County could promote or support the policy strategies.

The three categories of strategies include 1) air pollution mitigation, 2) operational changes, and 3) new aircraft technologies and innovation.

Along with the Task Force recommendations, the strategies below include the 'King County Role' as defined in King County's Strategic Climate Action plan. The roles are as follows:

Implement

An action where King County has a lead role in carrying out the activity – may include cases where has direct control over an outcome and possesses or can acquire the necessary tools/ staffing to make progress on an action.

Convene

An action where King County needs external partners and collaborators to complete the action and King County is taking an active role in that work by convening partnerships for collective climate action.

Support/Advocate

An action where King County's primary role is supporter and/or advocate for the action. This includes actions that would need to be undertaken by other entities or where King County does not have control over the activities necessary to complete an action.

33 https://www.seattletimes.com/seattle-news/environment/was-carbon-pricing-program-nears-1-billion-in-revenue-far-outpacing-early-estimates/

34 https://www.seattletimes.com/seattle-news/environment/at-sea-tac-airport-where-emissions-are-rising-gov-inslee-pitches-clean-fuel-standard/

35 Washington State Legislature (2023). SB 5447-2023-24 Promoting the alternative jet fuel industry in Washington. Accessed in September 2023. Available at: https://app.leg.wa.gov/billsummary?BillNumber=5447&Year=2023&Initiative=false

Air Pollution Mitigation and Reduction

The Task Force recognized that most of the solutions to decarbonize and reduce air pollution from aircraft are mid- and long- term efforts. In the near term, there are more immediate needs to mitigate the impact of air pollution within one, five, and 10 miles of KCIA and SeaTac Airport, as well as in communities under flight paths.

Other air pollution mitigation measures are being considered and implemented as part of the Strategic Climate Action Plan and should be coordinated on the implementation.

- **Carbon Capture:** Implementing carbon capture and storage (CCS) technologies at airports or in collaboration with adjacent facilities to capture and store carbon dioxide emissions from aviation and ground operations.
- **Tree Planting:** Engaging in reforestation and afforestation initiatives around airports to absorb carbon dioxide, enhance local air quality, and provide noise mitigation.[36]
- **Building HVAC:** Ensuring schools, community centers, homes, and businesses have access to effective and well-maintained HVAC systems.

Regardless of the approach, the best and most effective emissions mitigation solutions can and should come from community-based solutions. The Port of Seattle developed the "ACE Fund"[37] and King County could explore developing a similar program either in partnership with the Port of Seattle or as a model for similar programming around KCIA. This approach would be an important step forward to mitigating emissions for frontline communities.

Lead in Aviation Gas: A significant air quality concern for communities around KCIA is lead in aviation gas. Aviation Gas is used for older piston-engine aircraft operating at KCIA (Table 3) and contains lead; it is the largest source of lead pollution[38] in Washington state and disproportionately impacts frontline communities that live around airports that continue to use aviation gas. SeaTac Airport stopped using aviation gas in 2015. The FAA's Eliminate Aviation Gasoline Lead Emissions (EAGLE) aims to eliminate leaded aviation fuels in piston-engine aircraft safely by the end of 2030. KCIA has committed to following the EAGLE program to ensure that the any fuel being provided at the airport meets the FAA EAGLE standards.

Table 3: Annual jet fuel and aviation gas usage from SEA/SeaTac and Boeing Field

Year	Airport	Annual fuel consumption (gallons)	Percent of annual consumption of fuel (SeaTac + Boeing)
Jet Fuel			
2019	SeaTac	667,574,189	97%
2019	Boeing Field	22,250,000	3%
2020	SeaTac	385,312,040	96%
2020	Boeing Field	16,550,000	4%
Aviation Gas (SeaTac stopped using aviation gas in 2015)			
2019	Boeing Field	297,000	100%
2020	Boeing Field	241,000	100%

36 Restrictions on use of revenue for off-airport projects and requirements to protect airspace and must prevent hazards need to be taken into consideration when exploring funding options and project ideas.

37 https://www.portseattle.org/page/airport-community-ecology-ace-fund

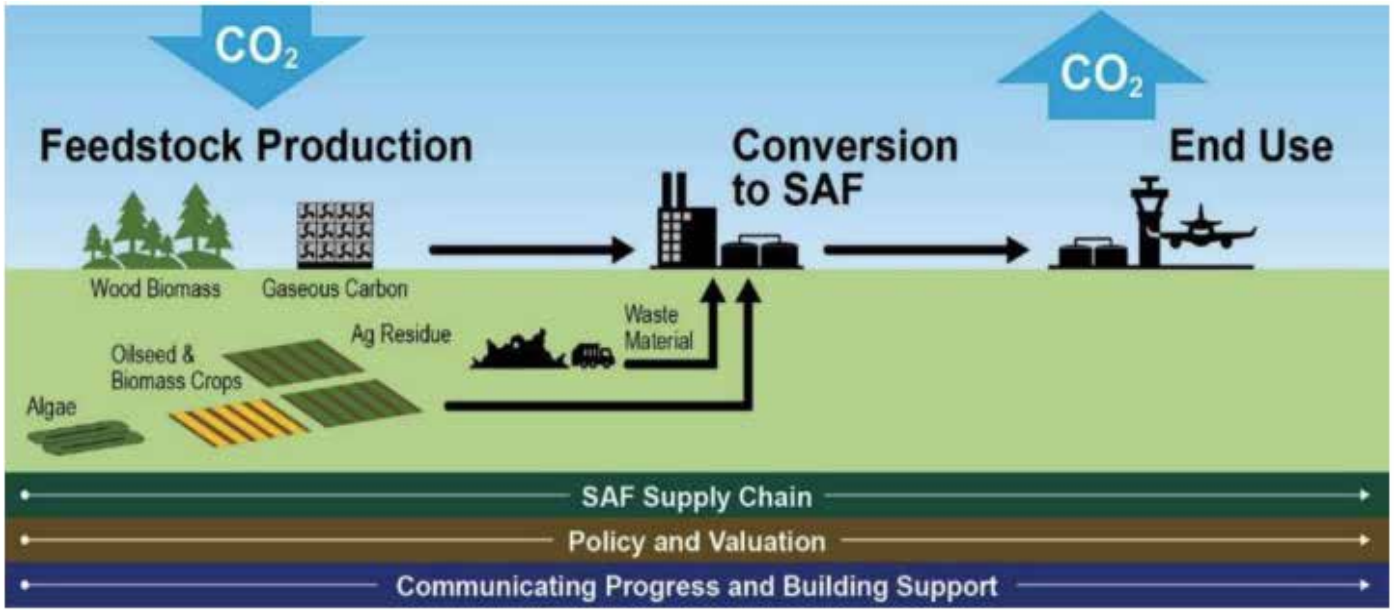
38 https://www.kuow.org/stories/where-leaded-gas-still-flies-in-the-united-states

New Aircraft Technologies and Innovation

Many of the new aircraft technologies that are reviewed in this section are in early research and development stages and will likely provide few direct implementation opportunities for King County. The largest area of disagreement and discussion from the Task Force overall was about Sustainable Aviation Fuels. Community members and climate organizations on the Task Force caution that SAF are likely to have adverse land use and equity impacts (especially when biofuels are used), that SAF do not have a clear pathway to scaling to meet growing demand, and that the emissions reductions from SAF are uncertain. Overall, the Task Force did not reach consensus around these recommendations and framing of approaches to reach emissions reductions.

Sustainable Aviation Fuels: Sustainable Aviation Fuel (SAF) is an alternative to conventional aviation fuel, due to its reduced greenhouse gas emissions throughout its lifecycle compared to fossil fuels. According to the IPCC, depending on the feedstock source, the lifecycle emissions from bio-based SAFs have been *estimated* "to achieve life cycle emissions reductions ranging between approximately 2 percent and 70 percent under a wide range of scenarios."[39] SAF's are hydrocarbon fuels and emit CO_2 when combusted, but CO_2 is absorbed in the growth cycle of sustainable feedstocks (fats, oils, greases, biomass such as algae and municipal solid waste, or agriculture and forest residue). However, according to the IEA, SAF's currently account for less than 0.1 percent of all aviation fuels consumed and "planned production capacities will provide just 1-2 percent of jet fuel demand by 2027."[40]

Figure D: Graphic representation of the SAF[41]



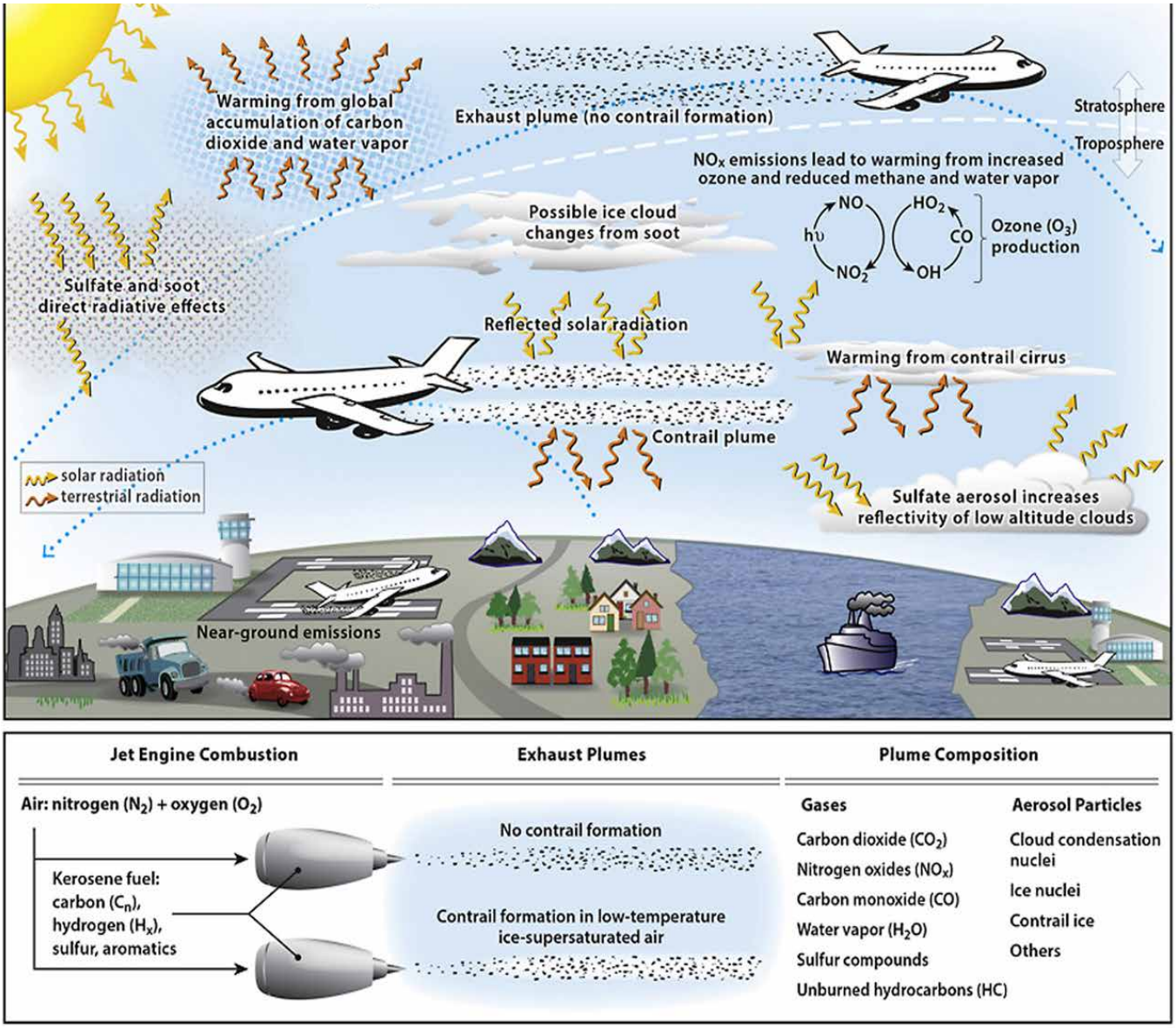
SAF's are easily used alternatives to jet fuel because they are a "drop-in" fuel and can be pumped into aircraft fuel tanks without expensive retrofitting to aircraft or significant infrastructure changes at airports. Because SAF's are drop-in fuels, the production of the fuel will need to capture CO_2 in the feedstock production process (shown in figure D) to offset the CO_2 burned and non-CO_2 impacts of climate forcing factors (radiative forcing shown in figure E). Non-CO_2 radiative forcing factors include emissions in the form of oxides of nitrogen (NOx), soot particles, oxidized sulfur compounds, and water vapor.

39 IPCC AR6 WGIII. Chapter 10. Transport. p. 10-61. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Chapter_10.pdf

40 https://www.iea.org/energy-system/transport/aviation

41 https://www.energy.gov/sites/default/files/2022-09/beto-saf-gc-roadmap-report-sept-2022.pdf

Figure E: Climate Forcings From Global Aviation Emissions and Cloudiness[42]



Current regulations only permit commercial aircraft to use a 50/50 mix of SAF and regular kerosene but aircraft have been successfully tested using 100 percent SAF.[43] While SAF's are not a clear solution for reducing air pollution, some research demonstrates that sustainable aviation fuel can reduce particulate matter pollution by 30 to 70 percent, but there is no statistically significant reduction in NO_x or other hazardous pollutants.[44]

SAF's are the primary emissions reduction strategy outlined in the U.S. Climate Action Plan (see Figure E) but there are legitimate feasibility and climate concerns around the emission reduction potential of SAF, including availability and cost, true lifecycle GHG reductions, and operational and safety challenges.[45] SAFs are currently significantly more expensive than conventional jet fuel due to a limited supply chain. Some progress has been made on the supply of SAF's in Washington and SkyNRG recently announced its intention to build a SAF facility in Washington state and the

42 https://csl.noaa.gov/news/2020/287_0903.html#:~:text=Global%20aviation%20operations%20contribute%20to,cloudiness%20due%20to%20contrail%20formation.

43 In November 2023, the first transatlantic flight using 100 percent SAF was completed by Virgin Atlantic using a Boeing 787. The flight used waste cooking oils and animal fat, plus a small portion coming from corn waste used to produce animal feed. Virgin Atlantic says that the SAF alone will cut the flight's emissions by 70 percent. See: https://www.theguardian.com/business/2023/nov/28/transatlantic-flight-sustainable-jet-fuel-virgin-atlantic-saf

44 Puget Sound Clean Air Agency, and STATE OF THE INDUSTRY REPORT ON AIR QUALITY EMISSIONS FROM SUSTAINABLE ALTERNATIVE JET FUELS. Prepared for: ACRP 02-80 Transportation Research Board of The National Academies). https://onlinepubs.trb.org/onlinepubs/acrp/acrp_wod_41.pdf

45 https://www.faa.gov/sites/faa.gov/files/2021-11/Aviation_Climate_Action_Plan.pdf

expectation that it will be operational by 2029.[46] There is also not enough certainty about feedstock availability, which has the potential to be difficult to source, and there is research and evidence that there is not enough feedstock available to source SAF's in large quantities. Recent research and studies detail the limitations of SAF feedstock and SAF as an overall solution for reducing aviation emissions without reducing air travel.[47]

Many environmental advocates and community members, including the Sierra Club, 350 Seattle, and members of this Task Force, are concerned about the prioritization of SAF's in aviation decarbonization strategies and also point to the challenge of accounting for actual lifecycle greenhouse gas reductions and the operational and safety barriers to ensure the product is safe to use on aircraft in the region. The production process of SAF's, especially if the feedstock source is from municipal solid waste, could also present additional air quality and health risks to communities who live around the biofuel conversion facilities.[48]

SAF's will also compete with other industries and non-aviation biofuel producers for feedstock for their own uses to produce products along with the implications for growing crops for SAF instead of growing food. According to the International Council on Clean Transportation, "even if all the world's grassland was converted to energy cropping, only around 15 percent of world energy requirements in 2050 could be replaced with biomass. **All of this would be needed to displace total jet fuel demand in 2050."**[49]

Locally, Washington state has taken some steps to begin to address the cost and supply chain for sustainable aviation fuels through the Climate Commitment Act, Clean Fuels Standard, and SB 5447 by providing incentives for the development of SAF's. In 2018, the Port of Seattle[50] established a timetable to transition to sustainable aviation fuels. The Port's SAF goals include:

- By 2028, 10 percent of jet fuel available at SEA will be produced locally from sustainable sources.
- 2035, 25 percent of jet fuel available at SEA will be produced locally from sustainable sources.
- By 2050, the maximum blend currently approved for jet fuel produced locally from sustainable sources e.g. 50 percent from sustainable sources is the maximum blend currently approved for HEFA-based SAF.

King County Solid Waste Conversion to Sustainable Aviation Fuel: The King County Solid Waste Division (KCSWD) provides garbage transfer and disposal for approximately two million residents and business employees, serving most cities and the large unincorporated area of King County. The Cedar Hills Regional Landfill, operated by KCSWD, the lone landfill for the service area near Maple Valley receives more than 800,000 tons of solid waste a year and is the site of a methane gas-to-energy facility.

In 2022, the Port of Seattle and King County jointly commissioned a study to explore the feasibility of converting Municipal Solid Waste (MSW) and other waste into renewable liquid fuels, including Sustainable Aviation Fuel (SAF), and the study is due in a time frame consistent with this Task Force's work. The study will assess costs, financing, MSW supply, and the potential site at locations across the state, and is expected to conclude by the end of 2023. The report will determine if the waste going to Cedar Hills landfill can support a renewable fuel facility and will evaluate sorting, equipment, and transportation logistics. This study was designed to align with previous research, including the 2019 King County Comprehensive Solid Waste Management Plan and the 2020 study identifying MSW as a viable SAF feedstock. In 2016, the Port of Seattle also identified a cost-effective location for a biofuel blending facility in the region, capable of supporting SAF production and aviation fuel needs.

Some Task Force members shared their concern about how safely municipal waste could be converted to aviation fuels, given that some will include plastics and that there are known hazards to living near refineries that burn plastic.[51]

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46 https://www.seattletimes.com/business/boeing-aerospace/new-800m-sustainable-aviation-fuel-plant-planned-for-washington-state/

47 See the International Council on Clean Transportation's *ASSESSING THE SUSTAINABILITY IMPLICATIONS OF ALTERNATIVE AVIATION FUELS* working paper (Assessing the sustainability implications of alternative aviation fuels - International Council on Clean Transportation (theicct.org)) and Net-zero aviation: Time for a new business model? - ScienceDirect

48 https://www.theguardian.com/environment/2023/feb/23/climate-friendly-us-program-plastics-fuel-cancer?CMP=share_btn_link

49 Decarbonizing aviation through low-carbon fuels will be beyond difficult - International Council on Clean Transportation (theicct.org)

50 https://www.portseattle.org/news/port-will-be-first-us-transition-sustainable-aviation-fuels

51 See https://www.theguardian.com/environment/2023/feb/23/climate-friendly-us-program-plastics-fuel-cancer?CMP=share_btn_link for more

Development of Next Generation Zero-Emission Aircraft Technologies

Electric aircraft, which have no direct emissions, are in the very early stages of research and development, but have the potential for lower operational and maintenance costs, and decreased noise pollution.[52] However, as noted above, weight and energy density barriers currently limit the range and potential emissions reduction potential of electric aircraft. The long-term potential of electric aircraft will depend on advances in technology, clean sources of electricity, and infrastructure needed to support charging at regional airports.

Manufacturers are researching and developing fully electric and hybrid-electric aircraft, but battery weight will be a challenge for developing zero-emissions aircraft especially for traveling long distances. Last year, Eviation, a Washington State-based company, tested the first all-electric airplane which took flight for eight minutes.[53] Eviation's flight was an exciting milestone and set ambitious goals to accommodate commercial and cargo flights that can travel distances between 150 and 250 miles. Significant work needs to be done to develop batteries that can accommodate commercial and cargo flights at these distances. Any new aircraft technology will also need to be approved and certified by the FAA, which is a lengthy process.

Hydrogen aircraft: Hydrogen powered aircraft are also in early stages of research and development and could be promising longer term alternatives to aviation fuel to help achieve net zero goals. It can be used in two ways: through fuel-cell technologies, where hydrogen is converted to electricity to power electric aircraft, and by burning hydrogen in purpose-built gas turbine engines. Hydrogen offers a high energy density, emitting no CO_2 and reducing NOx emissions by up to 90 percent, which can significantly cut greenhouse gas emissions. Estimates suggest that hydrogen-powered engines have the potential to reduce the climate impact during flight by 50 percent to 75 percent. Fuel-cell propulsion shows even greater promise, potentially reducing climate impact by 75 percent to 90 percent.

Several aircraft manufacturers are researching hydrogen-powered aircraft for medium- and long-range flights. Airbus joined a hydrogen infrastructure investment fund, and partnerships including Universal Hydrogen and magniX are working on converting aircraft to electric propulsion systems powered by fuel cells.

Burning hydrogen itself produces water vapor, but hydrogen is not necessarily "net zero" because its environmental impact depends on how it is produced. "Green hydrogen" produced using renewable energy is emissions-free and considered "net zero," while "blue hydrogen" produced from natural gas with carbon capture and storage may have associated emissions. Incentives in the Inflation Reduction Act and efforts in Washington State are in the works to develop green hydrogen facilities. This fall, the U.S. Department of Energy selected the Pacific Northwest as a clean hydrogen hub and is eligible for up to $1 billion in federal funding.[54]

Aircraft Fuel Efficiency: Newer models of aircraft are more fuel efficient. For example, the new Boeing 777x is 10 percent more fuel efficient than previous models due to new engine and aerodynamic technology. The U.S. Climate Action Plan's baseline emissions projections already expect an 11 percent reduction in GHG emissions by 2030 due to the newer and more efficient aircraft models beginning service (Figure B). In the long term, the US Government is working with manufacturers to achieve a 30percent emissions improvement to today's 'best-in-class' vehicles for aircraft that will begin service in 2040. While newer technology will slightly improve emissions and air quality, emissions will continue to rise over time due to an expected growth in air traffic despite the efficiencies and are not enough to reach federal and King County emissions reductions goals.

52 https://www.iea.org/energy-system/transport/aviation

53 https://www.seattletimes.com/business/boeing-aerospace/first-u-s-all-electric-airplane-takes-flight-at-moses-lake/?utm_source=marketingcloud&utm_medium=email&utm_campaign=BNA_092722155449+First+U.S.+electric+plane+takes+flight_9_27_2022&utm_term=

54 https://www.commerce.wa.gov/news/us-dept-of-energy-selects-pacific-northwest-for-regional-clean-hydrogen-hub/

Operational Changes

GHG Reduction Travel Policies for County Workforce: The King County Council, in the SCAP, requested more information on travel policies that could result in emissions reductions for the King County workforce. Current travel procedures at King County indicate all County employees are required to select flights based on the lowest logical fare (with reasonable connections and total travel time) and to determine the most suitable and economical mode of transportation to and from the airport. The travel policies do not consider the GHG emission aspect of these travels, nor impose any specific modal preference on the King County workforce.

New fees or taxes: Carbon pricing is a mechanism to internalize the price of pollution and greenhouse gas emissions, the mechanism itself is a tool to incentivize the development of technologies and decarbonization strategies and the revenue from the pricing is invested in efforts to decarbonize. As noted earlier, Washington state began a carbon pricing program (Cap-and-Invest) but aviation is exempt from these programs as is applying deficits to aviation in Washington's new Clean Fuel Standard program.

Some European countries have adopted aviation specific taxes or fees detailed in Table 4.

Table 4. Airports with Emission Mitigation

Country	City	Fee or Tax
Denmark	Kastrup/ Copenhagen	In 2009, it was agreed that airlines and Copenhagen Airports would introduce an emissions-based charge. The charge is based on the aircraft's landing/ take-off (LTO) cycle.[55] In June 2022, Denmark voted for a new corporate carbon tax that includes airlines. Companies subject to the EU ETS will pay one fee, while companies not subject to the EU ETS will pay another fee. Copenhagen plans to become the world's first carbon-neutral capital city by 2025 with the Copenhagen airport and transportation to and from the airport becoming emission-free by 2030.
Germany	Cologne, Dusseldorf, Frankfurt, Hamburg, Munich	In 2008, three airports in Germany (Frankfurt, Munich, and Cologne) started charging for emissions. Additional airports started implementation in Hamburg and Dusseldorf in 2010 and 2011. The emission-based fee is per landing and per take-off. The value is calculated by the type of aircraft and engine.
Norway	All	Norway participates in the EU ETS, cap-and-trade system. In 1999, Norway introduced a CO_2 tax on domestic aviation and in 2007, an NO_x tax was introduced.
Sweden	Jonkoping,Kalmar, Karlstad, Kiruna, Goteborg, Luleå, Malmo, Stockholm, Sundsvall-Härnösand, Umea, Visby	Sweden has had a carbon emissions tax since 1991 but adopted an aviation tax in November 2017. The tax went into effect in April 2018 and charges airlines a tax on flights originating from Sweden. The tax rate depends on the passenger's destination and only applies to larger aircraft with more than 10 seats. The tax is paid per passenger on both domestic and international flights.
Switzerland	Basel, Bern, Geneva, Lugano, Zurich	Switzerland first implemented emission surcharges in 1997 at Zurich Airport. Other airports (Geneva, Bern, Basel, and Lugano) in Switzerland followed suit, and legislation was enacted to allow airports to impose emission-related charges. Emission surcharges are applied for landing based on engine classification.[56] The emission charge is based on the absolute emission characteristic of the engine as described in the Federal Office of Civil Aviation (OFAC/FOCA) Directive "Aircraft Engine Emission Charges in Switzerland."

55 The Boeing Company (n.d.). Airports with Noise and Emissions Restrictions. Accessed in April 2022. Available at: https://www.boeing.com/commercial/noise/list.page

56 EuroAirport (2023). *Règlementation des Redevances Aériennes et d'Usage d'Installations: Tariff Regulation.* Available at: https://www.euroairport.com/sites/default/files/2022-11/EuroAirport%20Brochure_tarifaire%202023%20homologu%C3%A9e_0.pdf

Table 4. Airports with Emission Mitigation *continued*

Country	City	Fee or Tax
United Kingdom	London Heathrow, London Luton	As part of London Heathrow's Net Zero plan, landing charges include a new financial incentive in 2022 for 0.5% SAF. The incentive will increase in subsequent years. In 2018, Heathrow announced that landing fees would be waived for the first commercial flight operated by a zero emissions aircraft. At London Luton, there is a NOx emission charge for aircraft operators departing Luton and is calculated using the engine type of the aircraft and number of passengers or weight.

Mode Shift to Rail and Demand Management: Replacing short and medium flights with high-speed rail is an approach some European countries have adopted to reduce emissions from aviation. France was the first country to ban 'any flight between two cities that can be replaced by a train ride of less than 2.5 hours'.[57] The rule doesn't apply to connecting flights and ultimately cut three routes that account for about 5,000 flights, cutting emissions by about 55,000 tons of CO_2 annually.

Two routes that are near enough to King County to mode shift from flying are Seattle/Portland and Seattle/Vancouver. Current surface transportation options to travel these routes are Amtrak, private bus service (Greyhound and FlixBus), and by personal car. Travel times vary depending on traffic and time of day, and emissions levels vary depending on mode.

Washington state, in partnership with Oregon and British Columbia, has commissioned studies and formed an early governance framework for building high speed rail to connect Vancouver, Seattle, and Portland. High-speed-rail has the potential to provide better connectivity and, if powered by clean energy sources, a zero-emissions transportation option that can replace short-haul air travel.

The High-Speed-Rail Project, The Cascadia Ultra-High-Speed Ground Transportation Project, would take decades to plan, fund, and construct, but the vision for the project is to operate a train in about an hour between the three cities. In the nearer term, Improving the frequency and reliability of existing passenger rail service, Amtrak Cascades, between these destinations can improve the travel experience in the nearer term.

Table 5. Existing Vehicle Travel Time By Mode in the Pacific Northwest Corridor

Route	Mode	Distance (miles)	Travel Time (hours)*
Seattle-Vancouver	Air	119	0:55
	Cascadia UHSGT	<200	<1:00
	Amtrak Cascades	157	4:30
	Automobile	141	2:41
	Bus	141	4:08
Portland-Seattle	Air	130	0:50
	Cascadia UHSGT	<200	<1:00
	Amtrak Cascades	177	3:40
	Automobile	173	3:14
	Bus	173	3:35

* Excludes time required for security at departure airport

57 https://www.nytimes.com/2023/05/24/world/europe/france-short-haul-flights-emissions.html#:~:text=The%20ban%20on%20short%20domestic,2030%2C%20compared%20with%201990%20levels

While air travel has faster transit times in Table 5, passengers do need to arrive at least an hour ahead of the departure time to navigate security and departure/arrival point transportation options. For the purposes of this report, we do not have data on non-connection airplane trips on this corridor, but it is likely that HSR and Amtrak Cascades are alternatives for driving rather than traveling by plane based on cost and convenience.

Other countries are realizing that they need to focus on "demand management" of aviation to meet their climate goals, which includes some of the European efforts noted above. A report by the Chatham House in the United Kingdom found that "UK demand in terms of passenger-kilometres flown in 2030 would need to be 36 percent lower than in 2019 to stay within the sector's fair share of global carbon budgets, with demand returning to 2019 levels by 2050, once supply-side decarbonization has caught up."[58] They determined this could be achieved if people who took more than one round-trip flight in a year reduced that by one trip and took no more than four per year.

Task Force – Given concerns around SAFs and the limitations of new electric and hydrogen technologies, many members of the Task Force, including climate organizations and community members, see demand reduction strategies as the only feasible path to meeting the County's climate goals.

Operational Improvements: The U.S. Aviation Climate Action plan accounts for modest emissions reductions in the near- and long-term coming from operational improvements that can reduce greenhouse gas and air pollution. Some modest emissions reductions and safety for travelers can be made through improved air traffic control systems, which are operated by the FAA. Some operational investments could be made by the FAA in taxiing and on-ground operations to reduce emissions.

58 https://www.chathamhouse.org/2023/11/net-zero-and-role-aviation-industry

IV. Aviation Emissions Reductions Policy Alternatives for King County

In November 2023, Task Force members met to discuss a draft of this report and a slate of policy alternatives provided by County staff. Task Force members provided input, feedback, and ranked potential policy recommendations. Not all Task Force members support all of the recommendations below, but recommendations are sorted in each section to show where most or all of the Task Force members indicated support (Broad Task Force Support), where only some members indicated support for the recommendation but they were deprioritized relative to other recommendations (Some Task Force Support), and where an action was considered but there was significant disagreement or low interest in moving forward the recommendation (Considered but Not Recommended).

IMPLEMENT

An action where King County has a lead role in carrying out the activity may include cases where the County has direct control over an outcome and possesses or could acquire the necessary tools/staffing to make progress on an action.

Broad Task Force Support

1. **Aggressively phase out leaded aviation gas at KCIA.** Lead from aviation gas is the largest source of lead pollution in Washington, which disproportionately impacts frontline communities. KCIA should work with the FAA's EAGLE program to phase out leaded aviation gas and adopt unleaded alternatives and develop a clear plan to phase out its use.
2. **Promote and implement indoor air quality improvements and pollution mitigation in communities.** This could include but not limited to retrofit interventions that pay for improving indoor air quality in the most impacted areas likes homes, schools, and day cares; implementing natural pollution mitigation solutions in airport adjacent communities where allowed by FAA, and similar interventions. And build on efforts to educate and engage communities on health impacts of pollution and mitigation strategies.
3. **Plan for electric charging and hydrogen infrastructure at airports.** County leaders and KCIA should stay engaged with the latest technologies and innovations to develop and determine feasibility, cost, and budget needs to build out the electricity and hydrogen fuel-cell infrastructure needs to accommodate future zero-emissions aviation technology once technologies are approved by regulators.
4. **Update net radiative forcing multiplier in future inventories.** King County should update future emissions inventories with a multiplier of 3.0 based on the best available science - or another multiplier if additional research advances the current science.

Some Task Force Support but Not Prioritized

5. **Develop a low emissions County travel policy.** King County's current travel procedures require employees to select flights based on the lowest logical fare (with reasonable connections and travel time). The Task Force recommends that the County adopt a similar travel policy requiring employees to consider low greenhouse-gas emissions options for these travels and prioritize non-air travel options for work travel.
6. **Hire a Climate Equity Program Manager for KCIA.** This person would engage with community members, participate in KCIA planning processes, and SCAP alignment and implementation, and explore emission reductions, climate preparedness, green workforce, and community benefits opportunities.

Considered but Not Recommended

7. **Explore incentives for next generation of emissions reduction strategies for KCIA operations.** King County is home to a history of aviation innovation and much research and manufacturing for next generation zero-emissions aviation is happening in King County. King County should explore incentives or partnerships with innovators in partnership with KCIA operations.
8. **Explore options to develop a Community Airport Pollution Fund**: Identify sources of funding to develop a grant program for community-based air quality mitigation improvements within one, five, and 10 miles of airports and for communities in flight paths.
9. **Establish goal and timeline for transition to Sustainable Aviation Fuels at KCIA.** The Port of Seattle has developed timelines to transition to sustainable aviation fuels. King County International Airport should explore establishing similar goals and timeframes for SAF uptake that includes strategies to support the transition and adoption of these goals.

CONVENE/ PARTNER

An action where King County needs external partners and collaborators to complete the action and King County is taking an active role in that work by convening partnerships for collective climate action.

Broad Task Force Support

1. **Promote accurate aircraft GHG reporting methodologies.** The State of Washington's own aviation emissions inventories do not include the full warming effect of aviation emissions, but rather the fuel consumption. This Task Force worked to develop a more comprehensive inventory of aviation emissions and would partner with local and state governments to ensure aircraft emissions inventories incorporate a comprehensive approach to account for the full warming effect of aviation.
2. **Study of the health effects of KCIA on the surrounding communities.** Partner with King County Public Health and Puget Sound Clean Air to study the health impacts of KCIA on surrounding communities more comprehensively, including more and strategically placed air and noise monitors, up and down the corridors of KC flight paths, and around all aircraft usage. Support and seek efforts to systematically monitor air quality, including particulate matter. Support and advocate for research and monitoring of ultrafine particulate matter. This could also include engaging in community education to increase awareness of air and noise impacts from airport operations.

Some Task Force Support but Not Prioritized

3. **Continue to explore bringing a Sustainable Aviation Fuel biofuel conversion facility to King County.** King County should continue to collaborate with the Port of Seattle and other partners to establish a sustainable aviation fuel conversion facility within the county. The goal is to ensure verifiable lifecycle emissions reduction through this initiative.

Considered but Not Recommended

4. **Partner with universities and industry for emerging aviation technologies workforce development.** Partner with local governments, universities, and industry to promote equitable workforce opportunities in emerging aviation technologies.

SUPPORT/ADVOCATE

An action where King County's primary role is supporter and/or advocate for the action. This includes actions that would need to be undertaken by other entities or where King County does not have control over the activities necessary to complete an action.

Broad Task Force Support

1. **Advocate for greater aircraft fuel efficiencies in federal aviation standards and with manufacturers.** Advocate at the federal level to encourage federal regulators and manufacturers to improve efficiency standards for new technology development.
2. **Advocate for alternative travel modes such as rail.** Washington state, in partnership with British Columbia and Oregon, is in the early stages of planning for High-Speed Rail (HSR). King County should be a strong advocate for HSR and for improving frequency and reliability of the Amtrak Cascades service currently serving the Vancouver-Seattle-Portland corridor. And Identify opportunities to raise awareness to policy makers and the public of the impact of flying on climate and pollution and surrounding communities and options for alternative modes.

Some Task Force Support but Not Prioritized

3. **Advocate for strong SAF standards.** King County should advocate for programs and strategies to ensure SAF production is sustainable and verifying GHG lifecycle emissions reductions.
4. **Advocate for green hydrogen production.** Hydrogen has a promising role in future aviation technology and, while it can be produced using clean energy, it can also be produced using fossil fuels, which can have harmful impacts on air quality and emissions in communities where it is produced. King County should advocate and use tools to ensure any hydrogen development in King County and nationally is produced using clean energy.

Considered but Not Recommended

5. **Advocate for greater aircraft fuel efficiencies in federal aviation standards and with manufacturers.** Advocate at the federal level to encourage federal regulators and manufacturers to improve efficiency standards for new technology development.
6. **Advocate for federal legislation to apply surcharges on private jets.** U.S. senators introduced legislation to apply surcharges on private jets. King County should advocate to raise awareness of the legislation to hold top polluters accountable.

V. Conclusion

King County has a responsibility to address the climate and air quality impacts from aviation emissions, especially from the operations of the King County International Airport that it owns and operates. These emissions cause the most harm to frontline communities, those who contribute the least to the problem. While the County has some tools to reduce aviation emissions, they are not nearly enough or fast enough to alone tackle the stubbornly high emissions from aircraft.

In the immediate future, King County must focus on mitigating the harmful air quality impacts by investing in community mitigation programs and moving quickly to phase out dangerous lead in aviation gas. While there is not a clear path forward and much uncertainty over reaching zero-emissions, the aviation sector technologies and funding investments are changing rapidly. King County needs to stay engaged and proactive with partners in developing appropriate technologies and work to reduce air travel from employees and residents while fighting for better low- and zero-emissions alternatives.

VI. Appendix A – Summary of Task Force Processes

In late 2021, King County staff recruited technical experts, residents of airport adjacent communities , airport staff, representatives from climate action organizations, the Board of Health, and members of the King County government (from Public Health, KCIA, the Executive's Office, and the newly established Climate Office) to join the Joint Aircraft Emission Technical and Community Task Force (Task Force).

The Task Force met periodically from November 2021 through November 2023, held one-on-one meetings as needed with King County staff, and reviewed and provided input on methodologies and draft documents outside of Task Force meetings. The table below summarizes the main Task Force activities over that time.

Meetings and Engagement

Timing	Activity	Topics
November 2021	Task Force Meeting	• Kickoff and introductions • Review of Task Force orientation materials • Task Force Review and Input: Draft Aircraft Greenhouse Gas (GHG) Emissions Methodologies
December 2021	Review and Feedback	• Task Force members reviewed methodologies for aircraft emissions and submitted comments
March 2022	Task Force Meeting	• Reviewed draft emissions data • Reviewed proposed work to evaluate the effectiveness and feasibility of strategies to reduce aircraft emissions
September 2022	Task Force Meeting	• Reviewed draft emissions results and Q&A • Update on project to evaluate emissions reduction strategies
January 2023	Review and Feedback	• Reviewed and submitted comments on technical memos from consultants on sustainable aviation fuels and technologies, such as electric battery and hydrogen powered planes; pollution mitigation strategies, and funding options
January 2023	Task Force Meeting	• Reviewed and submitted comments on technical memos from consultants on sustainable aviation fuels and technologies such as electric battery and hydrogen powered planes; pollution mitigation strategies, and funding options
May 2023	Review and Feedback	• Reviewed feedback heard to date and a proposed report outline
May 2023	1:1 Check-In's	• Discussed proposed report outline and collected input on approach, scope, and structure
October 2023	Review and Feedback	• Reviewed and submitted comments on draft report and initial brainstorm of recommendations
November 2023	Task Force Meeting	• Met to further review and discuss draft report content and recommendations

Inventory Methodology

In late 2021 and early 2022, the Task Force reviewed an initial proposed set of approaches to updating the way King County accounts for aircraft emissions and weighed in on the approach. The Task Force feedback centered around the following:

- Stressed the need for a multiplier to account for the additional warming effects of high-altitude radiative forcing. And asked for a higher multiplier be used based on a recent literature review.
- Agreement that the aircraft landing/takeoff operations approach to accounting for GHG emissions is appropriate for criteria and toxic emissions, but not for CO2 or the additional warming effects of radiative forcing.
- Provide more information on the life cycle emissions multiplier of 2-to-1 that accounts for high-altitude radiative forcing effects.
- Clarification on the consumption-based GHG emissions methodology, including where work travel was or was not included and why.
- More detail on the distribution of aviation emissions (e.g. understanding business travel vs personal and more data on wealthier residents and disproportionate contributions to emissions).

As a result, changes made to King County's geographic and consumption-based inventories for 2019 and 2020 based on Task Force input include:

- Added information for the lifecycle emissions multiplier which is included to account for high-altitude radiative forcing effects (+90 percent) and life-cycle well-to-wheel emissions associated with jet fuel (+20 percent). Added narrative of uncertainties with this lifecycle emissions factor.
- Clarified that the "King County Aviation Sector GHG Emissions (2019 calendar year)" approach includes all employee/business travel for the "Passenger based" and "all fuels" approaches.
- Added additional Lifecycle GHG Emissions estimates for all approaches explored in report to increase transparency – this includes an "all fuels" total estimate paired with a lifecycle emissions coefficient.
- Added trend information showing large increase in aviation sector emissions over last decade with modest drop in 2020 associated with the pandemic.
- Clarified throughout the inventory report what the consumption-based methodology is and why it's a parallel, complementary estimate that is used for the whole community, but portrays emissions in quite a different way.

Task Force members requested additional information that was beyond the scope of the PSREA project and for additional changes to be made to the methodology moving forward. This included:

- More detail on the distribution of aviation emissions (e.g. understanding business travel vs personal and more data on wealthier residents and disproportionate contributions to emissions)
- On the emissions multiplier used for radiative forcing: to use a higher and more up to date multiplier (3.0 versus 2.1).

Draft Report and Recommendations

From September 2022 through November 2023, the Task Force met three times as a group and also in 1-on-1 meetings with County staff to: review early content on emissions reduction strategies, to discuss the layout and structure of the final report, and to discuss the final draft report and recommendations.

November 2023 Draft Report

Written comments on the final draft report submitted prior to the Task Force meeting included:

- 350 Seattle and some community representatives strongly disagreed with suggestions that SAF represented anything other than a trivial solution to aviation emissions. They indicated that there is no way to produce biofuels in any significant quantity, we don't have the feedstock, and the emissions and health impacts are unclear. Plus, there are new hazards from, for example, burning municipal waste that contains plastic. Any potential small benefits of SAF are completely outweighed by the continual increases in air travel.
- Similarly, they indicated that demand management is the only solution in the short- and medium-term, and part of that should be that the aviation industry bears the costs of decreasing its damage, reflected in ticket prices if need be.
- A few Task Force members indicated that aviation growth be more directly discussed in the report and that any improvements from fuel sourcing or technologies will be quickly outpaced by growth.
- The Task Force was charged with addressing emission due to GHGs. Two members suggested avoiding overstating how inclusive the report is in addressing air pollution, given the complex nature of those topics.

During the November 2023 Task Force meeting, members also provided additional feedback on the report contents. The first part of the conversation focused on Sustainable Aviation Fuels (SAF). A few Task Force members had concerns about recommending an emissions reduction approach that relied on SAF, citing expensive supply chains, competition with food crops, and lack of evidence that it could be deployed at a scale large enough to keep up with the projected growth of aviation.

One Task Force member stressed that the report should address how to reduce the projected growth of aviation traffic, including travel from County employees, and state directly that the goal of reducing emissions by 95 percent by 2050 is unrealistic without reducing air traffic, regardless of improved technologies or fuel sources.

Two Task Force members agreed they would like the report to include more baseline data and more convincing data on what emissions reductions were feasible. One recommended using clear comparisons of aviation industry vs. other industries in public-facing information to really drive home the need for emissions reductions. One recommended organizing the report as a narrative stating what the problem is, what was studied, what the recommendations are, and why. They felt that the organization of the report obscured the work that was done and made it hard to evaluate.

The Task Force member who recommended establishing a successor Aircraft Emissions Community Advisory Group and dedicate appropriate staffing to the effort said that the Task Force was a good start, and that much work, in partnership between government and community, still needed to be done to address the needs of frontline communities.

Recommendations Review and Discussion

Written comments on the potential recommendations submitted prior to the Task Force meeting included:

- Recommendations focused on SAF should not be a priority but advocating for green hydrogen productions should along with mode shifting and demand management advocacy.
- Initiatives focused on phasing out leaded gas at KCIA and doing more work to study health outcomes in airport adjacent communities had support from many Task Force members.
- A few members indicated that incentives or anything that could subsidize flying using government revenue posed significant equity concerns and should not be pursued.
- Recommendations are long-term and general. Something in the near-term is needed and not highlighted in the report and specifically called out public health as a top concern, potential collaborator, and motivation for action. They expressed interest in educational efforts, additional research, and more attention the air and noise pollution not comprehensively addressed in this report focused on GHG emissions.

During the Task Force discussion on recommendations, draft recommendations were categorized by the role that King County would have in implementing them. King County could focus on advocacy as a way to reduce emissions, or focus on strategies that it could directly implement, or on strategies that rely on partnerships. There was a slight preference for strategies in which King County would take the lead in implementing among the Task Force members who responded, followed by strategies that require strong partnerships, and then by advocacy.

In a general overview of the recommendations, the Task Force members advocated for including measures of public health improvement. In discussing advocacy-focused draft recommendations, members rated advocating for greater fuel efficiencies highest, followed by mode shifting/demand reductions. Advocating for strong SAF standards was the third highest but elicited strong negative reactions from many members.

When asked "**What advocacy strategies to reduce aviation emissions should King County consider that are not included in the recommendations you reviewed?"** Task Force members responded:

- Advocating for more local control to allow for more emissions reduction rather than ceding it to the federal government.
- Strong targeted education on the emissions caused by flying.
- Education about the public health costs of flying.
- Education about the real cost of flying without public subsidies.

When considering implementation strategies for King County, Task Force members strongly preferred phasing out leaded aviation gas at KCIA as the highest priority, followed by interventions at airports to plan for future low/no carbon technologies like electric and hydrogen infrastructure and SAF.

When asked **"What implementation strategies to reduce aviation emissions should King County consider that are not included in the recommendations you reviewed?"** Task force members responded:

- We need a comprehensive health study of the effects of KCIA.
- We need to establish a health threshold for GHG emissions.
- Fees yes, incentives no. We should not subsidize flying.
- Incentive for non-air travel or connection needs – hubs to connect without travel, eg.
- Not sure where to mention this, but the 1 mile-5 mile-10 mile language leaves out Beacon Hill and other communities where aviation UFP and noise have been identified.
- Work with most traveled to airports from KCIA, to coordinate how to lower emissions with them.
- Engage airlines in the advocacy/education for GHG emissions.

Among partner-focused draft recommendations, Task Force members prioritized encouraging other local and state governments to adopt the new GHG inventory methodology. When asked, **"What partnership strategies to reduce aviation emissions should King County consider that are not included in the recommendations you reviewed?"** Task Force members responded:

- Partnering with other county airports to fly less between each.
- More focus on Public Health
- Partner with research groups to provide support and advocacy for effective interventions and mitigation of pollution
- Partnering with local businesses who use airport to fly less

One Task Force member suggested working with companies who are responsible for shipping to get them to move more freight by rail rather than by air.

In general, Task Force members said they would like:

- The report and emissions reduction efforts to focus on public health improvements
- The report and emissions reduction efforts to focus on improving health disparities in frontline communities.
- Clear and understandable data in the report, and recommendations that come from that data.
- The recommendations to include educational efforts to make clear the impact of aviation so people and decision makers make different choices.