Support Electrification at Regional Airports to Preserve American Competitiveness & Improve Health Outcomes

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Summary

The Biden-Harris Administration, Congress, and state legislatures should adopt measures to reduce the substantial health and environmental impact of America's 5,000+ public airports while improving the competitiveness of American aviation. Aviation is our largest non-agricultural export industry, but we are losing our technological advantage to countries that have prioritized sustainable aviation technologies. Because our airports and aircraft use outdated technology, they disproportionately pollute the often-disadvantaged communities adjacent to them, causing health externalities while providing few benefits and job opportunities to local residents. Fixing this public health problem should start with the immediate phaseout of leaded aviation fuel, which is the largest source of lead emissions in the US. This should also be coupled with incentivizing advancements in sustainable aviation technology. The phaseout and innovation incentivization can be accomplished through regulatory agency mandates, new fees collected from combustion aircraft users, reprioritization of existing recurring federal funds for aviation, and allocation of additional funding—such as from the proposed national infrastructure plan—towards sustainable solutions. The focus of this funding should be comprehensive electrification of the entire aviation ecosystem, including airports, ground vehicles, support equipment, and aircraft. Electrification will remove the lead concern while also reducing other pollution and creating jobs. Funding for pollution mitigation and green job creation should be directed toward disadvantaged communities located near airports and US-based small businesses developing green aviation technologies. These actions must be taken immediately, lest our public health continue to suffer, and lest we jeopardize the future of the US aviation industry.

Challenge and Opportunity

Small aircraft are the largest source of environmental lead pollution in the US.[1] Blood lead levels are significantly elevated for children living within 0.6 mi (1,000m) of airports where leaded aviation fuel (avgas) is used.[2] An estimated 16 million Americans are at risk of elevated blood lead levels because they live near a regional airport, where the majority of flight operations are

[1] Rep. Technical Update: Reports on the Impact of Lead Emissions from Piston-Engine Aircraft on Air Quality Near U.S. Airports. EPA, 2020. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YG46.pdf.

[2] Miranda, Marie Lynn, Rebecca Anthopolos, and Douglas Hastings. "A Geospatial Analysis of the Effects of Aviation Gasoline on Childhood Blood Lead Levels." Environmental Health Perspectives 119, no. 10 (2011): 1513–16. https://doi.org/10.1289/ehp.100323.

undertaken by small piston engine aircraft burning leaded fuel.[3] Lead is a neurotoxin for which there is no safe level of exposure, as determined by both the Centers for Disease Control (CDC) and the Environmental Protection Agency (EPA).[4] However, the EPA has continued to permit over 2 grams of lead content per gallon of aviation gasoline, which is aerosolized into extremely dangerous microscopic particulate matter (PM) when burned in an aircraft piston engine.[5] When inhaled, small PM is capable of directly entering the bloodstream.[6] This lead exposure is especially dangerous for fetal development and for cognitive development in children. The science behind these effects is very well established because of decades of research into the effects of leaded automotive gasoline; this resulted in a complete ban of leaded gasoline in 1996, although aviation successfully lobbied for a special temporary exemption.[7]

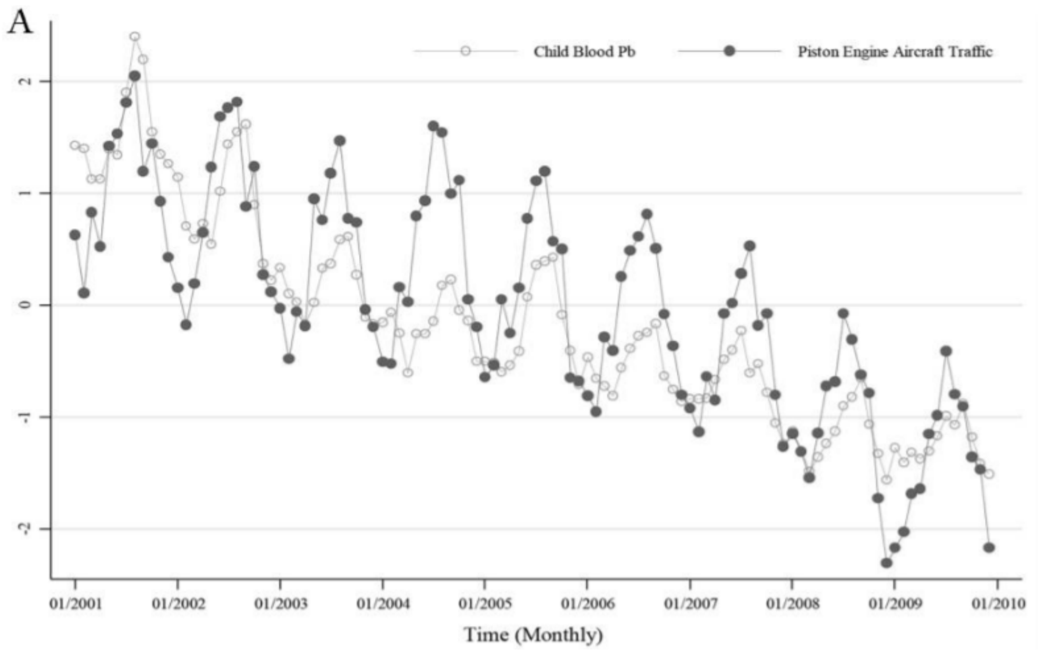

Figure 1: Monthly average child blood lead levels vs. sum of piston engine aircraft takeoffs and landings over time. This data was collected from over 1 million children living within 6.2 miles of 27 airports in Michigan with piston aircraft traffic. It is clear that blood lead levels rise and fall in concert with piston aircraft traffic.[8]

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[3] Zahran, Sammy, Terrence Iverson, Shawn P. McElmurry, and Stephan Weiler. "The Effect of Leaded Aviation Gasoline on Blood Lead in Children." Journal of the Association of Environmental and Resource Economists 4, no. 2 (2017): 575–610. https://doi.org/10.1086/691686.;

Miranda et al., 2011.

[4] EPA, 2020.;

"Blood Lead Levels in Children." CDC, April 5, 2021. https://www.cdc.gov/nceh/lead/prevention/blood-lead-levels.htm.

[5] "Issues Related to Lead in Avgas." AOPA Online: Issues related to Lead in Avgas. Aircraft Owners and Pilots Association, September 18, 2011. https://web.archive.org/web/20110918234831/http://www.aopa.org/whatsnew/regulatory/reglead.html.

[6] "How Does PM Affect Human Health?" EPA. Environmental Protection Agency, October 10, 2019. https://www3.epa.gov/region1/airquality/pm-human-health.html.

[7] "EPA Takes Final Step in Phaseout of Leaded Gasoline." EPA. Environmental Protection Agency, August 11, 2016. https://archive.epa.gov/epa/aboutepa/epa-takes-final-step-phaseout-leaded-gasoline.html.

[8] Zahran et al., 2017.

Although most attention has been focused on about 30 large hub airports in the US, lead pollution occurs primarily at smaller regional airports due to their reliance on piston-engine aircraft. There are over 10,000 airstrips and over 5,000 public airports in the US, or a public airport within a 16-minute drive of the average American. The nearly 200,000 leaded-fuel-burning aircraft operating from these airports are incapable of readily switching to unleaded fuel due to their outdated engine technology and the lack of availability of unleaded gasoline at most airports.[9]

Figure 2: How widespread is this problem? This is a map of regional airports where leaded avgas and other polluting fossil fuels are used.[10] There are over 5,000 public airports in the US — or one within a 16-minute drive of the average American.[11]

For both economic and technical reasons, a widespread, drop-in replacement for leaded aviation gasoline (avgas) has failed to emerge, despite the fact that leaded fuel was fully eliminated on our roads decades ago. Because of limited unleaded fuel supply, reduced power output, safety concerns, and pilot retraining needs, even engines theoretically capable of switching to unleaded fuel continue to use leaded fuel almost exclusively. However, simply switching to planes that use diesel or jet fuel is not the answer. Unlike cars, aircraft have no emissions control

[9] Antcliff, Kevin, et al. Rep. Regional Air Mobility. National Aeronautics and Space Administration, April 20, 2021. https://sacd.larc.nasa.gov//sacd/wp-content/uploads/sites/102/2021/04/2021-04-20-RAM.pdf.

[10] US Bureau of Transportation Statistics. "US General Aviation Airports." Koordinates. Accessed May 5, 2021. https://koordinates.com/layer/22869-us-general-aviation-airports/.

[11] NASA, 2021.

systems, and there is no existing way to install such systems. As a result, even aircraft that do not burn leaded fuel emit very high levels of PM and other forms of pollution detrimental to human health. For example, LAX alone produces nearly as much particulate pollution as all LA-area freeways combined, and LAX is just one of *39 airports* in the local air district.[12] **It is critical to American public health that any policies to phase out leaded avgas concurrently foster adoption of reduced-emission and reduced-fuel-burn technologies (such as electric propulsion), rather than encourage switching to fuel-hungry and high-pollution unleaded gasoline engines, diesel engines, turboprops, and jet engines.**

This is also critical to American economic health: European and Asian companies are beating the US at developing efficient unleaded-fuel engines and electric propulsion technology, winning market share in regions traditionally dominated by US-built light aircraft (e.g. where leaded fuel is unavailable or expensive). We need to invest in sustainable propulsion systems to maintain US competitiveness, and lack of supportive policy action has hampered technological advancement.

Zero funding, for example, has been allocated in the proposed American Jobs Plan to deal with dangerous aerosolized lead pollution from aviation, even though the plan dedicates $45B toward replacing lead pipes.[13] Combating aviation pollution, however, offers a significant opportunity to pursue electrification, with a wide variety of shovel-ready airport project locations. The US workforce can electrify airport infrastructure, ground vehicles, and aircraft domestically using existing and proposed federal funding as well as revenue from fees targeted at polluting aircraft. Shared charging infrastructure should be a special priority. Installing basic charging infrastructure at every one of the 5,000 public airports in the US — focusing first on the 500 most heavily-used airports located closest to populated areas and in disadvantaged communities — is a highly achievable near-term goal at moderate expense. For instance, **installing a 30-60 kW DC fast charger, which could charge small electric planes or ground vehicles, at the 500 highest-priority airports would cost less than $25M and could be completed in 2-3 years with sufficient federal backing.**[14]

Transitioning to biofuels or other so-called "sustainable" fuels can play a role, but should not be considered a substitute for fuel use reduction via electrification because their emissions can still be harmful. Both the biofuel supply chain and burning of biofuels, for example, emit a wide range of pollutants.[15] Even green hydrogen, currently a tiny fraction of the world's mostly fossil-fuel

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[12] Hudda, Neelakshi, Tim Gould, Kris Hartin, Timothy V. Larson, and Scott A. Fruin. "Emissions from an International Airport Increase Particle Number Concentrations 4-Fold at 10 Km Downwind." Environmental Science & Technology 48, no. 12 (2014): 6628–35. https://doi.org/10.1021/es5001566.

[13] "FACT SHEET: The American Jobs Plan." The White House. The United States Government, May 4, 2021. https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/.

[14] Smith, Margaret, and Jonathan Castellano. "Costs Associated With Non-Residential Electric Vehicle Supply Equipment." Prepared by New West Technologies, LLC for the U.S. Department of Energy Vehicle Technologies Office, 2015. https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf.

[15] "Analyzing Air Pollutant Emissions from the Biofuel Supply Chain." NREL.gov. Accessed May 30, 2021. https://www.nrel.gov/analysis/biofuels-emissions.html.

derived hydrogen supply, would still lead to emissions of water vapor. Water vapor is a powerful greenhouse gas when emitted at high altitude, and in some proposed implementations (such as direct hydrogen turbine combustion) hydrogen aircraft could also lead to significant high altitude nitrogen oxide pollution.[16]

Electrification also offers an opportunity to better integrate airports into both urban and rural transit networks, provide clean energy and charging services to local communities (e.g., charging buses overnight), and improve resilience to power outages by offering grid storage. Electrification infrastructure at airports could include, for example, solar panels and grid storage doubling as power backup systems at airports. This would serve not just airport power needs but also those of surrounding communities, especially in remote areas prone to outages. This power system resilience is especially critical in disaster situations, where airports often serve as hubs for emergency responders.

In the near term, electrifying aviation entails plugging planes into gate power instead of burning fuel, using electric power to taxi to the runway, and operating electric tugs and ground equipment. Electrifying aviation also means investing in R&D, scaleup, and adoption of electric trainer aircraft, hybrid electric short-range cargo and passenger planes, and eventually longer-range commercial planes. As batteries and electronics improve, larger and larger planes will become more and more electric over time. To facilitate these technological advances in electric aviation and maximize public benefit, federal funding should focus on promoting adoption of electrification on routes not currently serviced or readily serviceable by rail or other alternative rapid, sustainable forms of transportation.

[16] Hansen, Kathryn. "Water Vapor Confirmed as Major Player in Climate Change." NASA. National Aeronautics and Space Administration, November 17, 2008. https://www.nasa.gov/topics/earth/features/vapor_warming.html.

"Hydrogen Hype in the Air." Renewable Energy World, January 25, 2021. https://www.renewableenergyworld.com/hydrogen/hydrogen-hype-in-the-air/.

DAY ONE PROJECT

Plan of Action

Infrastructure Funding

(1) Reprioritize existing funding sources, such as the Federal Aviation Administration (FAA) Voluntary Airport Low Emissions Program (VALE) program,[17] to focus on sustainable infrastructure such as solar, storage, and chargers at both public airports and military airports. Supplement this funding by dedicating at least $10B of the proposed $25B of airport funding in the American Jobs Plan,[18] or $20B of the proposed $56B Republican counter-offer,[19] towards electrification across airports of all sizes. Initially prioritize:

a. The 500 most heavily-used airports located closest to populated areas and in disadvantaged communities,
b. Regional airports that have far fewer logistical barriers to infrastructure projects than congested hubs, and
c. Airports supporting routes not currently serviced or readily serviceable by rail.

R&D Funding

(2) Reprioritize existing federal research funding toward technologies aimed at reducing fuel burned by aircraft, such as significantly expanding current hybrid and electric aviation initiatives at the National Aeronautics and Space Administration (NASA), Department of Defense (DOD), Department of Transportation (DOT), and Department of Energy (DOE).[20] Additional funding paid for by fees on polluting aircraft should be added to these existing pools of research dollars (see "Plan of Action" items 4-6). To remain competitive with accelerating civil and defense aviation technology development overseas, the government should direct a minimum of $2B in annual federal funding to electric aviation R&D. Funding should prioritize the development of US-designed and manufactured electric and hybrid electric aircraft technologies, including both retrofit and new-build planes, ground equipment, and ground vehicles. At least 50% of funds should be dedicated to small businesses.

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[17] "Voluntary Airport Low Emissions Program (VALE)." Voluntary Airport Low Emissions Program (VALE) – Airports. Federal Aviation Administration, April 6, 2021. https://www.faa.gov/airports/environmental/vale/.

[18] American Jobs Plan, 2021.

[19] Garrison, Joey, Ledyard King, and Savannah Behrmann. "GOP Senators Pitch New $928 Billion Infrastructure Plan in Latest Offer to Biden." USA Today. Gannett Satellite Information Network, May 27, 2021. https://www.usatoday.com/story/news/politics/2021/05/27/joe-biden-infrastructure-plan-gop-senators-offer-new-counterproposal/7450437002/.

[20] Gipson, Lillian. "Electrified Powertrain Flight Demonstration." NASA. National Aeronautics and Space Administration, February 10, 2020. https://www.nasa.gov/aeroresearch/programs/iasp/epfd/.;

"Join the Air Race." Agility Prime. AFWERX, United States Air Force. Accessed May 5, 2021. https://agilityprime.com/.;

"Airport Zero Emissions Vehicle and Infrastructure Pilot Program." Airport Zero Emissions Vehicle and Infrastructure Pilot Program – Airports. Federal Aviation Administration, October 21, 2020. https://www.faa.gov/airports/environmental/zero_emissions_vehicles/.;

"Department of Energy Announces $33 Million in Funding for Carbon Neutral Hybrid Electric Aviation." Energy.gov. Department of Energy, August 16, 2020. https://www.energy.gov/articles/department-energy-announces-33-million-funding-carbon-neutral-hybrid-electric-aviation.

The US is currently the world leader in small aircraft production, but we are falling far behind Europe and Asia on electrifying fixed wing aircraft, funding development of new efficiency technologies, and implementing relevant policies. US companies have instead focused primarily on low-capacity "flying cars" for carrying high-net-worth individuals short distances over traffic.[21] The lack of funding and policy support for practical, high-impact innovation poses a significant threat to future US competitiveness and jobs, especially in the export market.

Regulations

(3) The EPA should issue its final endangerment finding banning leaded fuels,[22] and the Biden-Harris Administration should issue an executive order instructing the EPA and FAA to work together to eliminate lead pollution. This includes immediately implementing a 10-year phaseout mandate for the sale of leaded fuel, with use of leaded fuel banned after 2030 except for a limited number of historic aircraft. This phaseout timeline should be extended to 2040 in Alaska, due to the disproportionate impact on the greater than 80% of Alaskan communities reliant on small planes for year-round access. During the Obama Administration, an attempt was made to phase out leaded avgas, but it stalled largely because of the perceived impact on mobility in Alaska. It is critical to ensure that a phaseout plan recognizes Alaska's needs and funds sustainable solutions suitable for an arctic operating environment.

It is not enough to simply ban lead, because this may incentivize switching to other highly polluting technologies like dirty unleaded gasoline engines, diesel engines, and far less fuel-efficient turboprop or jet engines. Thus, **it is critical that a leaded fuel ban be accompanied by the immediate implementation of a fuel efficiency mandate for aircraft that are based in or that regularly fly to the US**. Inspired by the federal automotive Corporate Average Fuel Economy (CAFE) Standards program,[23] this efficiency mandate should utilize multiple aircraft size categories with targets based on maximum takeoff weight (e.g., <1,000 lb, 1,000-5,000 lb, 5,000-19,000 lb, 19,000-75,000 lb, 75,000-250,000 lb, and 250,000 lb+ categories). Efficiency targets should take into consideration typical missions and technical difficulty in reducing fuel burn for various types of aircraft. For instance, <19,000 lb aircraft are readily able to use hybrid electric propulsion — and, in some cases, pure electric propulsion — with existing technology and regulations. The largest aircraft flying long distance routes, on the other hand, will initially need to focus on smaller steps such as more efficient flight patterns, plugging into gate power/HVAC, electric taxi (either onboard or via tug), etc. until future technologies are developed; therefore, larger aircraft should have less aggressive targets (similar to less aggressive CAFE standards for

[21] Brown, Dalvin. "Possibility or Pipe Dream: How Close Are We to Seeing Flying Cars?" USA Today. Gannett Satellite Information Network, December 24, 2019. https://www.usatoday.com/story/tech/2019/11/04/flying-cars-uber-boeing-and-others-say-theyre-almost-ready/4069983002/.
[22] McCarthy, Gina. Letter to Deborah N. Behles and Marianne Engelman Lado. Washington, D.C., January 23, 2015. https://www.documentcloud.org/documents/20598031-ltr-response-av-ld-foe-psr-oaw-2015-1-23.
[23] "Corporate Average Fuel Economy (CAFE) Standards." U.S. Department of Transportation, August 11, 2014. https://www.transportation.gov/mission/sustainability/corporate-average-fuel-economy-cafe-standards.

larger vehicles). Technologies piloted in smaller electric aircraft will eventually make their way to larger aircraft, initially as high-power subsystems. Thus, these technologies are key early targets for federal funding and mandates. **The overall "CAFE" goal should be a 25% reduction in overall US aviation fossil fuel burned per passenger by 2030, and a 50% reduction by 2040.**

Taxes

The following programs offer pathways for making electrification programs financially sustainable beyond the initial infusions of funding for infrastructure transformation and R&D.

(4) Immediately implement a national $10 per flight hour use tax on all aircraft with 19 passenger seats or below. This should include an additional $2 per flight hour tax on leaded fuel burning aircraft and on any other aircraft burning more than 4 gallons of fuel per seat per flight hour. It is essential to avoid solely targeting leaded fuel piston aircraft, which would incentivize a switch to less fuel-efficient turboprop aircraft and business jets. 100% of tax revenues should be dedicated to the aviation industry and airports, and at least 50% of funds should go to small businesses. Tax revenues should be allocated toward:

1. The electrification of airports.
2. A "cash for clunkers" program to retire or retrofit polluting aircraft, with commercial and government operators receiving priority for funding. This funding should only be provided for US-manufactured or US-retrofit electrified aircraft.
3. Jobs training and career development for airport-adjacent communities.

This would not be an undue burden on air travelers, because the owners and users of small aircraft are generally affluent. The Aircraft Owners and Pilots Association reports that the net worth of its average member is over $1.6 million.[24] Aircraft operating in Alaska should be exempt from this tax until 2030. Revenue should exceed $260M/year based only on the base $10 fee, assuming pre-pandemic flight hour totals.[25]

(5) Immediately implement a $10 "Clean Skies Fee" per passenger for all international flights on planes with more than 19 passenger seats, excluding flights within North America, to be collected by air carriers from passengers at the time air transportation is purchased. The September 11 Security Fee offers a precedent for this type of fee.[26]

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[24] "Audience Demographics." AOPA. Aircraft Owners and Pilots Association, November 5, 2018. https://www.aopa.org/advertising.
[25] 2019 State of General Aviation. Aircraft Owners and Pilots Association, 2019. https://download.aopa.org/hr/Report_on_General_Aviation_Trends.pdf.

[26] Security Fees. Transportation Security Administration. Accessed April 25, 2021. https://www.tsa.gov/for-industry/security-fees.

An optional "Clean Skies Fund" contribution with suggested donations of $5, $10, $25, and $50 should also be offered at time of purchase for all flights on planes with more than 19 passenger seats—both domestic and international—to allow passengers an opportunity to further fund pollution-reducing technologies across the aviation ecosystem and to offset their personal environmental impact from flying. This fund is modeled after optional federal contributions such as the Presidential Election Campaign Fund.[27]

A portion of collected funds should be provided to airlines and travel booking services in order to implement and maintain this contribution mechanism, which must be prominently featured in the booking process. Carriers will remit the fees to federal programs promoting reduction in fuel use, airport electrification, and jobs training. At least 50% of funds should go to small businesses. Revenue should exceed $2.34B/year assuming pre-pandemic international flight passenger demand.[28]

(6) For planes with more than 19 passenger seats, implement a similar $0.25/mile per passenger fee on all domestic and North America region flights effective in 2030 to fund fuel burn reduction and airport electrification. At least 50% of funds should go to small businesses, and all funds should be dedicated to projects that directly benefit airports and aviation, as well as increasing accessibility to all Americans.

Jobs

The actions above should be immediately implemented in order to preserve the millions of US jobs in the aerospace industry. Aircraft are the largest non-agricultural US export product and one of the largest domestic manufacturing industries. As of 2018, the aerospace industry was directly responsible for over 2.4 million primarily high-paying US jobs, many of which are union jobs or in STEM fields.[29] Airlines directly employ nearly 500,000 Americans, and a wide variety of indirect jobs in travel agencies, airports, construction, and related industries are reliant on aviation.[30] Although we support expanded low-emissions rail transportation, continued modal shift away from aviation towards automobiles would be devastating to the airline industry and increase overall emissions.

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[27] "Public Funding of Presidential Elections." FEC.gov. Federal Election Commission. Accessed May 17, 2021. https://www.fec.gov/introduction-campaign-finance/understanding-ways-support-federal-candidates/presidential-elections/public-funding-presidential-elections/.
[28] 2018 Traffic Data for U.S Airlines and Foreign Airlines U.S. Flights. Bureau of Transportation Statistics, April 30, 2020. https://www.bts.dot.gov/newsroom/2018-traffic-data-us-airlines-and-foreign-airlines-us-flights.
[29] Rep. 2018 Facts & Figures: The U.S. Aerospace & Defense Industry. Aerospace Industries Association, 2018. https://www.aia-aerospace.org/wp-content/uploads/2018/07/2018_-Annual-Report_Web.pdf.

[30] November 2019 U.S. Passenger Airline Employment Data. Bureau of Transportation Statistics, January 21, 2020. https://www.bts.dot.gov/newsroom/november-2019-us-passenger-airline-employment-data.

The US currently leads the world in aviation manufacturing, but we are falling behind in electric aviation technology, including both airport-based ground vehicles and aircraft. **We are headed towards an inflection point that will determine the future of the US aviation industry.** Either US policy will promote adoption of more efficient technologies for aircraft as well as airport vehicles and equipment, thereby maintaining US world leadership in aviation, or the US will lose this market to other nations in Asia and Europe. **The only way to preserve aviation jobs is by investing in efficiency and by enacting smart policies that promote private investment in and adoption of cleaner technologies**.

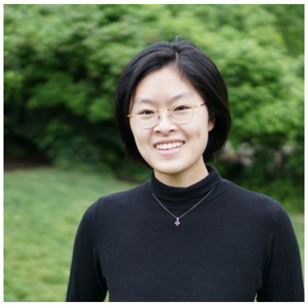
Not only can aviation jobs be preserved, but electrification of the aviation ecosystem will serve to create new green jobs related to air travel. This will include jobs in charging infrastructure installation, solar and storage construction, as well as related industries, which must be based locally and use US labor. Further, if the US leads in developing aviation electrification, there will be substantial export opportunities as other nations look to reduce aviation emissions and improve mobility. Potential clean aviation technology markets include countries such as Norway, which has committed to an electrified aircraft fleet by 2040 for all flights under 90 minutes duration, and Scotland, which has committed to a zero emissions airspace.[31] Numerous other countries are actively considering similar policies, creating a significant opportunity for US products.

Conclusion

Aviation emissions, especially lead, are a clear and present danger to the health of Americans and the global climate. Failing to develop and deploy more efficient technology represents an equal danger to US jobs and competitiveness. Thankfully, practical solutions exist today and even more are being developed to mitigate these dangers. To advance this mitigation, the Biden-Harris Administration and legislators should ensure that existing and new federal funding prioritizes holistic electrification of the aviation ecosystem, in addition to enacting legislation and regulations that ensure the success of this transition.

[31] Beedham, Matthew. "Norway Pushes to Electrify All Domestic Flights by 2040." TNW | Shift, April 27, 2021. https://thenextweb.com/news/norway-pushes-to-electrify-all-domestic-flights-by-2040.

Bol, David. "Scotland Could Become 'World's First Zero Emission Aviation Region'." The Herald Scotland, December 16, 2020. https://www.heraldscotland.com/news/18948484.scotland-become-worlds-first-zero-emission-aviation-region/.



About the Author

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