Strengthening Aviation Policy for Emissions Accountability

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https://doi.org/10.38126/JSPG270111

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Keywords: aviation; emissions; climate change; aviation policy

Executive Summary: The aviation industry is responsible for 3-5% of the global greenhouse gas emissions, and airports are directly responsible for air quality issues relating to ground operations and infrastructure. While other industries utilize corporate sustainability reports (CSR) and sustainability reporting to measure their progress to decrease emissions and be more sustainable, this type of reporting falls short in aviation. Current voluntary and mandatory environmental monitoring programs, including the Airport Carbon Accreditation (ACA) Program and the Airport Environmental Review Process, help monitor current airport emissions. These are similar to programs like the Airplane Fuel Efficiency certification, which promotes more sustainable practices in airports and airplane manufacturers. However, these programs are only a small step towards the greater expansion required to help reduce emissions. To address this issue, a potential policy recommendation is to mandate airports to enter the Airport Carbon Accreditation Program at a Level 1 status and achieve Level 2 accreditation within 3 years, Level 3 within 5 years, and Level 3+ within 10 years. Another policy recommendation is that if an airport does not reach higher than a Level 2 status within 3 years, it must implement a minimum of two alternative options: the integration of Hybrid Renewable Energy Systems, taxi-out emissions reduction, or the adoption of Continuous Descent Operations. These policy recommendations offer a detailed and adaptable plan to reduce aviation emissions, ultimately mitigating climate change, protecting public health, and ensuring the long-term sustainability of the aviation industry.

I. Introduction

i. Issue

The aviation industry is responsible for negatively impacting air quality, including 3-5% of the global carbon emissions, which is expected to increase by 10-15% by 2050 (Monsalud et al. 2015). Airplanes are responsible for the majority of this pollution, but airports, as host locations to airplanes, directly affect air quality. Like other industries, airports have adopted emissions reporting strategies in the context of climate change, but the reporting strategies and commitment to sustainability fall short by not reaching established Sustainable Development Goals (SDGs), which are 17 sustainability goals placed under an urgent call for action by all developed and underdeveloped countries in global partnership (Jia et al. 2024).

SDGs and CSRs have two general approaches. One approach is more ethics-based, focusing on humanitarian efforts, whereas the other is more managerial, utilizing CSRs as a business strategy (Karagiannis et al. 2019). Differences in reporting strategies reflect the varying goals between individual airports, but commitment to sustainable development should not change within the industry (Karagiannis et al. 2019). Though very different in nature, they fall under the same "umbrella" term of sustainability reporting. A global study of 150

airports (Jia et al. 2024) showed that less than a quarter were highly engaged with sustainability reporting practices. The European airports in this study showed greater alignment with SDGs thanks to the governments having more defined regulations and financial incentives, like readily available financial capital specifically for funding upgrades to airports that enhance sustainability.

The driving forces for airports to reduce their carbon emissions in the United States are primarily social and economic. In 2000, the aviation industry and Congress identified a need for increased environmental management practices aimed at reducing emissions and conserving resources. The Federal Aviation Administration (FAA) responded to that request with initiatives to streamline environmental reviews and updates to environmental policies. While these efforts aimed to expedite environmental reviews, the process remains slow, and there is a lack of comprehensive studies evaluating the effectiveness of recent reforms relating to emissions reporting from aviation (Putnam 2009). Because there are currently no significant government incentives for US airports to address sustainability issues, there are also no substantial consequences for inaction (Monsalud et al. 2015). Required environmental guidelines for the aviation industry, including airports, by the FAA are federal laws, regulations, and the NEPA (National Environmental Policy Act), which requires federal agencies to assess the environmental effects of their proposed actions. These regulations include NAAQS (National Ambient Air Quality Standards); however, airports not meeting air quality standards are not penalized, yet are mandated to implement emission reduction strategies. For example, Title V of the Clean Air Act (CAA) requires an operating permit if more than 100 tons of a regulated air pollutant are emitted per year.

ii. Background

Aircraft engines are designed to operate on hydrocarbon fuels, the combustion of which releases harmful greenhouse gases and pollutants, impacting public health and ultimately contributing to climate change (Brasseur 2016). Aviation operations and financing are also affected by those environmental changes. For example, storms of increased intensity raise expenses due to infrastructure damage and faster deterioration of jet engines. Increased precipitation can cause flooding damage to runways and infrastructure, reducing flight capacity and increasing flight delays and cancellations. Deviation from typical wind direction and altered weather patterns can disrupt runway use, reduce take-off and landing efficiency, and alter departure criteria, leading to financial complications and personal disruptions. Due to the interconnectedness of airports, delays and cancellations at one airport can lead to ripple effects across multiple business and economic sectors (ICAO 2020). Given that airports are critical infrastructure to the economy, by proactively lowering their greenhouse gas emissions, they can safeguard their own future industry.

Quantifying and calculating the consequences of airport operations is critical. The Air Pollution Emission Experiments and Policy Analysis (APEEP) model draws on existing data and analyses of environmental and human health impacts to estimate the marginal cost of airport emissions, referring to these quantified harms as “damages”. An APEEP assessment of 70 airports in 2013 revealed $1.9 billion in damages, with individual airport contributions ranging from $720,000 to $190 million each in damages. The extent of damage varies significantly by airport location, aircraft technology, and airport activity levels. In general, larger airports with heavier passenger traffic and more ground operations account for the greatest costs. (Nahlik et al. 2016). By assigning a marginal cost to emissions, calculated damages transform abstract environmental harm into actionable economic signals.

II. Current policies

The ACA Program is a globally recognized initiative designed to assess, certify, and support airports in reducing carbon emissions. Established by Airports Council International (ACI) Europe in 2009, the program has over 400 certified airports worldwide. It is the only institutionally endorsed, airport-specific carbon management standard that provides a structured, multi-level framework aligned with international climate goals, including the Paris Agreement (Sena et al. 2024). *Table 1* demonstrates how airports at different stages of their carbon reduction journey participate and progressively enhance their environmental performance.

Tiers	Policy
Level 1	Requires airports to calculate and document their carbon footprint by measuring CO_2 emissions from sources they directly control, such as energy use in airport buildings and ground operations. This data must be independently verified to ensure accuracy.
Level 2	After establishing a baseline, airports must implement measures to actively reduce their emissions. This includes improving energy efficiency, investing in renewable energy, upgrading to low-emission ground vehicles, etc.
Level 3	Airports go beyond internal efforts and engage third parties such as airlines, ground handlers, and airport tenants to collaboratively reduce emissions. Including reducing aircraft taxiing times, promoting the use of sustainable aviation fuels, encouraging public transport, etc.
Level 3+	Airports at this level continue to reduce emissions but also begin to offset any remaining CO_2 output from their direct operations through verified high-quality carbon credits. This enables them to achieve carbon neutrality for emissions under their direct control.
Level 4	Airports must develop long-term carbon reduction strategies to achieve absolute emissions reductions, which aligns with the Paris Agreement standards and directs third-party contributors towards emissions reduction.
Level 4+	Airports must push to offset any remaining residual emissions while ensuring all feasible emissions reductions have been implemented. The goal is to move toward a net-zero operational model while continuing to invest in sustainability initiatives.
Level 5	An airport has successfully achieved and maintained net zero carbon emissions for Scope 1 and 2 while also addressing Scope 3 emissions (indirect emissions from external sources like passenger and airline activities).

Table 1*:* The ACA Program's seven-tiered certification system (Sena et al. 2024; Airport Carbon Accreditation 2025a)

The FAA has introduced many new certification requirements to enhance sustainable initiatives, including fuel efficiency for specific subsonic jet and propeller-driven airplanes. These regulations align the United States regulations with the International Civil Aviation Organization (ICAO) standards for CO_2 emissions. The rules require that airplanes meet certain fuel efficiency metrics to limit carbon emissions in support of the CAA. These certification requirements for aircraft manufacturers take effect for new airplane certifications being issued for aircraft manufactured after January 1, 2028. Fuel efficiency is assessed using a metric known as the Fuel Efficiency Metric (FEM), which combines the airplane's Specific Air Range (SAR) and Reference Geometric Factor (RGF), both important for determining how much fuel an airplane consumes relative to the distance it can travel. To comply, manufacturers must show that their aircraft meet the required fuel efficiency limits to be certified. (FAA 2024).

The new certification requirements offer significant environmental and economic advantages. Meeting the new certification requirements offers advantages such as aircraft that consume less fuel and emit less CO_2, decreasing aviation's carbon footprint. Furthermore, the FAA's rule aligns with the US Aviation Climate Action Plan and the CAA, which aims to achieve net-zero greenhouse gas emissions from the US aviation sector by 2050. By reducing fuel consumption, these efforts lead to a diminished

overall environmental impact from aviation, helping to decrease air pollution. From an economic standpoint, airlines will save resources by using less fuel, which accounts for a substantial portion of their operating costs. Improving fuel efficiency also enhances operational productivity within the aviation industry, improving flight affordability. Additionally, the certification process fosters innovation in aircraft design and engine technology, resulting in more efficient and sustainable solutions for the future of aviation (FAA 2024).

i. Pitfalls of current emissions reduction propositions

The aviation industry contributes 3.5% of global CO_2 emissions per year. This percentage is only projected to grow over the next 10 years as the aviation industry grows and the demand for long-haul flights increases (Monsalud et al. 2015). Since the industry is already large and growing, creating appropriate and size-accurate expectations and regulations is complex and will continue to be so in the future (SkootEco 2025). Sustainable aviation strategies already face hurdles when dealing with the industry's size, but unrealistic expectations for sustainable aviation deter airports from specific approaches. A majority of sustainable aviation strategies rely on airport redesign, better Air Traffic Control (ATC) technology, and/or Sustainable Aviation Fuels (SAFs).

Airport redesigns to include more direct routes from the hangar to the tarmac, additional ATC towers, and parking adjustments to terminal routes are not feasible for most airports. Redesigns are impractical because of the high cost and because most airports are in geographical areas that limit their ability to establish direct flight routes. Airports are also limited by the local environmental features in which they are built, like the coastline bordering the Boston-Logan International Airport in Massachusetts.

Geographical challenges occur when current ATC technology is applied to create the most optimal flight pathway. Certain programs do exist that create these optimized flight patterns, so mandating these systems, as well as the advanced technology that houses the programs, is one possible approach to overcome the shortcomings of most current ATC technology. This is mostly obstructed by a lack of funding and failure to coordinate improvements across complex socio-technical systems (Spinardi 2014). It is necessary to upgrade existing infrastructure in an ever-changing field like ATC to meet the increasing demands of increasing air traffic, but it is essential to consider what solutions are reasonably achievable and currently available (Xue, D., et al. 2025). Many attempts have been made at ATC automation that have been "largely unsuccessful" due to "unrealistic specifications and human difficulties…" (Spinardi 2014). Additional factors like airspace complexity, aircraft technical performance, and different regional ATC systems can complicate the implementation of Continuous Decent Operations (CDOs), another emissions reduction strategy that focuses on optimizing flight pathways, in complex environments (Xue et al. 2025).

Sustainable Aviation Fuels/Sustainable Aviation Operations (SAF/SFOs) are relatively new to the scene of sustainable aviation. The International Air Transport Association defines SAFs as those that reduce CO_2 emissions by up to 80% compared to conventional jet fuel (International Air Transport Association 2025). SAFs can be produced from non-petroleum-based renewable feedstocks, including portions of municipal solid waste, wood-based biomass, and fats/greases/oils (AFDC 2025). Despite their environmental benefits, SAFs remain more expensive to generate than traditional jet fuel, which raises SAFs' market prices and plane ticket prices, discouraging widespread adoption. The limited demand for SAFS then slows its production, keeping availability low. Unlike traditional jet fuel, SAFs currently lack a federal tax plan, making them very expensive for airlines to use, further limiting the use of SAFs. (Mohd Hasan Wong et al. 2024).

III. Policy proposal

Despite progress being made on certain emission-reducing air travel initiatives, implementing small-scale changes will not have the impact that larger-scale mandates would. Implementing a national standard for emissions reporting and reduction strategies is the most effective way to ensure the proper steps are being taken to reduce carbon emissions at and around airports. Policy Option 1 would be the most impactful approach for reducing carbon emissions and mandating emissions reporting, but recognising that national mandates across airports are difficult

to implement, there is a second, more adaptable policy that would also reduce CO_2 emissions around airports and increase emission reporting on a different scale.

i. Policy option 1: Require that airports join the Airport Carbon Accreditation Program with at least a Level 1 status, with level increases within established timeframes.

Registering airports for the program begins with an independent verification of the airport's carbon footprint in accordance with ISO14064 by a program administrator at Environmental Minds, which manages all claims relating to carbon emissions. With the evidence of carbon emissions submitted by the airport, an accreditation confirmation is issued (Airport Carbon Accreditation 2025).

Our recommendation is for US airports to adopt the ACA at the level they are given, following the initial assessment, with additional level increases in a mandated time. A Level 1 status would allow for a standardized emissions report, which currently does not exist under the FAA. Currently, without a standard emissions report timeline, it can take years for airports to publish their emissions data.

This approach would allow for more comprehensive emissions tracking, but also mandate that airports publish their emissions data within a year. Most airports would achieve a Level 1 certification (calculate and document carbon footprint by measuring CO_2 emissions from sources they directly control, with independent verification) as an initial certification, so reaching Level 2 (all Level 1 requirements, determining emissions sources within the operational boundary of the airport company, calculating annual carbon emissions, and compiling a carbon footprint report, and provide evidence of effective carbon management by showing quantified emissions reductions) certification would be feasible within 3 years (Table 1).

The suggested policy would include a clause that airports must reach Level 2 in 3 years, Level 3 in 5 years, and Level 3+ in 10 years. Most airports do publish their emissions data already, meaning that they would most likely achieve a Level 1 status upon entering the Airport Accreditation Program, which is why a Level 2 status is highly attainable within 3 years, but without the most recent data from most US airports being available to the public, there is not a way to know which airports would fall under each Level (Airport Carbon Accreditation 2025). A Level 3+ or above would be the most ideal situation for carbon emission reduction and management, but with the current emissions standards, the scenario is highly optimistic since most airports do not have the facilities in place to immediately achieve this level. By allowing the 3, 5, and 10-year grace periods, airports will have the time needed to optimize strategies, plan and develop new infrastructure, and collect the necessary data to join and implement at least a Level 2 program.

Currently, published data is difficult to come by for the average amount of time it takes for an airport to "level up" in status, since reporting of the levels is highly dependent on the airport's size and annual number of flights. For instance, a small, suburban county airport could calculate annual carbon emissions and show quantified emission reductions in a far shorter period than an international airport. However, based on case studies published on the ACA's website, the time frames in this proposal are representative of the current ACA airport goals.

A report through the ACA on the Québec City Jean Lesage International Airport, a member of the ACA since December 2017, stated that its goal was to reach a Level 3 accreditation by 2020 and a Level 3+ by 2022 (Airport Carbon Accreditation 2025). As of April 2025, it has a Level 3 accreditation, meaning that the time between a Level 3 and 3+ accreditation should be longer for the policy proposal, much like in the report published by the ACA for the Sir Seewoosagur Ramgoolam (SSR) International Airport. The report from SSR states that their goal is to achieve carbon neutrality "within the next 10 years" (Airport Carbon Accreditation 2025). SSR joined the ACA in July of 2017 as a Level 1 airport, and as of April 2025, it has a Level 2 accreditation, which puts it two levels away from its neutrality goal (Level 3+), with two years to spare in the 10-year plan (Airport Carbon Accreditation 2025).

As for an independent airport report, not done through the ACA, the Allegheny County Airport Authority (ACAA) Carbon Commitment/Policy Statement published a 25-year plan for its ACA goals. The ACAA covers the Pittsburgh International Airport and the Allegheny County Airport. The

report states that the Pittsburgh International Airport entered the ACA at a Level 1 accreditation in 2021, advanced to Level 2 with its 2023 application, and aims to reach a Level 4 accreditation by 2030 and a Level 5 by "no later than 2050" (Airport Carbon Accreditation 2025).

Based on these case studies and seeing realistic timelines of these airports, reaching a Level 2 accreditation in 3 years, Level 3 in 5 years, and Level 3+ in 10 years is the most feasible recommendation for this policy proposal.

ii. Policy option 2: Require airports to join the ACA Program at a Level 1 status without level increases, but with the implementation of a minimum of two of the alternative emissions reduction strategies.

Most US airports will enter the ACA at a Level 1 accreditation, but they may not have the facilities, funding, or staff necessary to make "leveling up" feasible. This is why an alternative proposal would be that if an airport does not reach higher than Level 2 status within 3 years, it must implement at least two of the alternative strategies listed below.

Integrated Hybrid Renewable Energy Systems (HRES)

Hybrid Renewable Energy Systems combine two or more renewable energy sources to improve efficiency, reduce intermediacy, and enhance overall system reliability by ensuring a consistent energy flow when one system underperforms. By adopting these technologies, airports can reduce emissions, optimize energy use, and contribute to sustainable aviation infrastructure (Baxter 2023). Airports can enhance overall efficiency and reduce land-based fuel consumption through numerous actions, such as installing LED lighting, variable-speed drive pumps, high-efficiency variable-speed chillers, and optimizing air conditioners, further mitigating the environmental impact (Baxter 2021).

A study done at Sydney Airport, Sydney, Australia, stated that over the study period, where HRES and the ACA were implemented, the yearly emissions intensity per enplaned passenger exhibited a "consistent downward trend" (Baxter 2021). During this period (2013-2019), the airport was able to decrease its total annual carbon emissions (tCO2e) from 90,716 tCO2e to 83,620 tCO2e, which is a 7.82% decrease in tCO2e (Baxter 2021).

Adopt an "element-by-element" approach to taxi-out operations

The taxi-out phase at airports, where aircraft move from the apron to the runway, contributes heavily to near-hanger emissions (Postorino 2018). During this phase, the aircraft is moving on the surface under its own power prior to takeoff, and thrust is increased for the purpose of takeoff (Uri et al. 2018). It is during this phase that the aircraft burns anywhere from 5-10% of its fuel (Postorino 2018). The process of getting engines up to speed and then increasing thrust burns jet fuel closer to the ground, where carbon emissions accumulate more than at higher altitudes due to higher air density.

Testing alternative scenarios, including having towbarless tractors tow aircraft to the runway so the engines do not sit at full speed for longer than necessary on the ground, and single-engine taxi-out procedures where only one engine is at full speed for the taxi-out phase, showed reductions of around 70% in CO_2 emissions compared to the traditional taxi-out method. Using a hybrid approach, utilizing both the towbarless tractor and the single-engine taxi-out, there was a 71.26% reduction in the annual tons of CO2 emissions when looking at Aircraft-related taxi-out emissions (Postorino 2018). These alternatives cut fuel consumption and offer cost savings without causing takeoff or landing delays (Postorino 2018).

Adopt Continuous Descent Operations (CDOs)

A Continuous Decent Operation is an alternative method of landing approach where an arriving aircraft "descends from an optimal position with minimum thrust and avoids level flight," like in the traditional, staggered descent operation. This technique allows the aircraft to stay as high as possible for as long as possible, decreasing the amount of carbon accumulation at the ground level (SKYbrary Aviation Safety 2025).

CDOs can significantly reduce fuel consumption, emissions, and operational costs, presenting a CO_2 reduction strategy that does not focus on limited resources, like SAFs. Implementing CDOs can cut fuel consumption by 21.5% per flight and lead to substantial CO_2 and pollutant reductions. The long-term benefits include a potential CO_2 reduction of 67.6 Mt in China from 2025 to 2050. This approach also provides economic advantages for

airlines and improves air quality around airports, benefiting public health (Xue et al. 2025).

CDOs are difficult to implement at a national level since larger airports rely on the staggered descent technique to reduce congestion on the tarmac. This approach to landing also relies on highly efficient ATC technology, which, as discussed previously, is not an option for all airports.

IV. Policy implementation

In the US, the Legislative and Executive branches are mostly responsible for the creation and implementation of policy. The executive authority tasked with handling aviation concerns is the FAA, meaning that it can issue new regulatory guidelines. In February 2024, the FAA issued new rules with a minimum emission threshold for commercial airplanes manufactured after 2028 (FAA 2024). This is an example of the type of power available within the FAA, a part of the executive branch, to make rule changes to implement a more sustainable aviation future.

Federal rules and guidelines tend to fluctuate more than laws due to changing administrations and Supreme Court rulings. Clearly written laws force the executive and judicial branches to officially uphold the intent of the legislature and create a more concrete mandate that can last several administrations. In addition, Congress controls the budget, giving it significant influence over the funding for environmental enforcement. In reality, both the executive administration and the legal framework created by laws end up being important factors in that regard. The legal enforcement of the ACA depends on using policy tools that are the most feasible. As elaborated on previously, there are logistical, technological, and geographical difficulties when implementing models like the ACA into law, but there are also social and political challenges. That being said, incorporating the ACA into law rather than just an executive policy is preferable because enforcement measures from governing bodies will have stronger effects.

Another important legal distinction is the difference between state and federal laws. While the federal government has more power over national airports through the FAA, the states still have significant power to make environmental standards. States, therefore, can make laws that apply to aviation in their jurisdiction that are stricter than federal standards. Oftentimes, state laws can force national companies to comply because the laws apply to anyone doing business in those regions. For example, the Climate Corporate Data Accountability Act (SB253) is a California law requiring that US Corporations earning more than $1 billion must annually publicly disclose their greenhouse gas (GHG) emissions. Reports include scope 1: direct GHG emissions from company-owned sources, scope 2: indirect emissions from purchased electricity, and scope 3: all other indirect emissions from across a company's supply chain (SB 2023). Therefore, once the Climate Corporate Data Accountability Act is implemented in 2026, airports in that threshold must publicly disclose their scopes 1, 2, and 3 GHG emission levels. That particular law leverages the fact that most high-profit businesses operate in California. If the ACA were embedded at the state level and modeled after the Climate Corporate Data Accountability Act, aviation companies would be encouraged to report full emissions. This enforcement style can be useful when the federal government is opposed to implementing comprehensive but vital regulations, especially in a dynamic field like aviation.

V. Conclusion

The aviation industry contributes to 3-5% of global carbon emissions, impacting air quality, damaging public and environmental health, and ultimately driving climate change. To protect long-term viability, airports must play a role in reducing the aviation industry's contribution to climate change. While policies like the ACA and organizations like the FAA provide a baseline for reduction strategies, the economic, technical, and regulatory challenges still hinder the broad application of sustainable practices.

By implementing a staged approach to the ACA and suggesting an alternative policy with more adaptability, this policy approach allows airports to take the time they need to address specific challenges they face when enacting and adapting towards sustainability. Also, by following an already established program instead of attempting to build a nationwide airport sustainability plan from the ground up, US airports will have examples to follow for sustainability suggestions and a timeline

framework. This program will not only emphasize emissions reduction within the aviation industry but will also help compile the data necessary for effective emissions reporting and further implementation of sustainable practices in aviation.

On a broader scale, the need for transparency and quick turnaround time for emissions reporting is essential. Knowing what scale emission reduction plans need to happen, but also knowing which of the strategies that are currently in place are most effective, is necessary for the future of keeping aviation sustainable. As sustainable practices advance worldwide, the US state or federal legislation must hold the aviation industry accountable for its carbon emissions.

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Nate Trost is a 2025 graduate from the University of Pittsburgh with a Bachelor's degree in Environmental Studies. He has extensive field experience in environmental consulting and sustainability. He interned at the Pittsburgh International Airport (Allegheny County Airport Authority) in the summer of 2024. Inspiration for this paper was partially from this internship experience. He has interests in environmental conservation and sustainability. He currently works as an environmental consultant.

Elena Mertens is a 2025 graduate from the University of Pittsburgh with a B.S. in Environmental Science. She is interested in the intersection between environmental health and public health, and has previously done research on understanding groundwater quality trends in environmental justice communities in Appalachia. In addition to this, she has volunteer experience with urban farms to help provide fresh and organic produce in areas considered food deserts. Whether on a large scale or locally, Elena is passionate about advancing climate and public health solutions.

Leyden van der Bent is a third-year student at the University of Pittsburgh, pursuing a major in Environmental Studies and a double minor in Chinese and Business. She volunteered in Zimbabwe on the Safari Stables Project, gaining field experience in animal and habitat conservation work. She engaged in volunteer work with the local community through outreach and educational initiatives. She has interests in sustainability and conservation.

Alice Arndorfer With an Associates in IT Programming and pursuit of a Bachelor's Degree in Environmental Studies, I take special interest in where technology meets environmental issues. I have a passion for conducting analysis and solving environmental problems for our society and the workplace. I went to the University of Pittsburgh to pursue this passion because, in my eyes, sustainability is the most urgent issue for society to solve. I hope to see a future where people can feel at ease about the longevity of mankind's abundance and where everyone can have the opportunity to experience it.

Acknowledgements
We would like to thank the Geology and Environmental Science Department at the University of Pittsburgh and the Environmental Law and Policy course (GEOL 1312) for the opportunity to write this paper and all of the guidance we have received. A special thanks to Dr. Patrick Shirey for allowing us to take this idea and make it into the proposal it has become. We would also like to acknowledge all of our peers, inside and outside of the GES Department, who aided in editing this paper.