Growth through Degrowth: A Critique of Aviation Emissions

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Aviation is well known to be a significant contributor to global emissions. As a result, many efforts have been made to develop and introduce technological fixes, such as electric propulsion, sustainable fuel, or more robust design. However, these innovations face challenges, but above all, the nature of these solutions require additional investments and resources to be poured into the industry. While this may prove productive, what if we were to approach solving emissions through conservation. The degrowth movement is an economic theory that suggests that such focus on growth at all costs is not only inefficient, but damaging. There are a limited number of resources on Earth, and degrowth theory suggests that this needs to be taken into account when working to solve problems. For example, while the United States and other developed nations benefit from a growing sustainability sector, this is in part because much labor and manufacturing is shipped off to underdeveloped nations, who face the consequences through excessive pollution and overconsumption of natural resources. In general, the degrowth movement asks us to consider who our consumption helps and who it hurts, both now and in the future. Through this lens, the movement calls into question if the price of developing new technologies to solve the conceptually straightforward problem of aviation emissions is worth the cost of its resource consumption. Perhaps the existing approaches to aviation sustainability have been misguided. *What does the degrowth movement say about current efforts towards sustainable aviation?* The consequences of this question could mean the difference between meaningful investments and misappropriated funds. It could mean the difference between lasting results and temporary fixes. It could mean the difference between a thriving aviation industry, or being gutted for failing to meet climate goals.

Background

Many countries, including the United States, have created initiatives to achieve zero carbon emissions. Additionally, as more and more travellers continue to fly, emissions are only set to increase. Researchers have been looking into different solutions to achieve these goals, such as alternative fuels, more efficient design, and electric propulsion. However, the readiness of each technology differs greatly, as does the effectiveness (or how much carbon is actually reduced). The parties in consideration are flight passengers, airlines, and the governments that support them. Certain solutions, such as cutting down on the number of flights overall, are viable (airlines receive large subsidies from the government to maintain operation which could be shrunk to instead spend on mass transit systems like high speed railways), but would face resistance in implementation. Other solutions, such as alternative fuels, are widely anticipated, but face long lead times for development and implementation.

Governments both local and national play a crucial role in aviation, both in its development and operation. In 2021, to keep the market afloat during pandemic times, the US government poured $14 billion into the domestic airline industry (Shepardson & Rucinski, 2021), bringing the total award amount to $59 billion across three payments in 2021 (U.S. Department of the Treasury, 2025). Likewise, in 2017, the FAA set an estimate of costs for developments at airports nationwide during the 2019 - 2023 to be $22 billion (U.S. Government Accountability Office, 2020). This economic push likely influences interest towards technological solutions, as companies are eager to turn a profit on investments in technologies.

Existing Efforts Towards Solutions

As a whole, the transport of both freight and passengers accounts for 28% of greenhouse gas (GHG) emissions in 2023 (Hohne et al., 2023). In 2016, the United States drafted its strategy to cut 80% of 2005-level GHG emissions by 2050. However, critics point out that in the area of transportation, the strategy banks on carbon capture technology to compensate for a majority petroleum-based industry instead of implementing low or zero carbon technology to cut emissions to begin with. Provided, in 2016, the renewable energy scene, especially in regards to electric vehicles, was not as robust as it is today. However, the strategy reads like treating symptoms rather than the cause of emissions. It is perhaps this thinking that has led to the current fossil fuel reliance in aviation, believing that all concerns can be alleviated by spending its way towards carbon capture technology.

According to Bardon and Massol (2025), Sustainable Aviation Fuels (SAFs) are a promising fuel technology due to their natural abundance. SAFs can be made from plants and animal waste, similar to biofuels, which means they have less of an environmental impact in production/harvesting (Crownhart, 2023). However, because the technology is novel, processing and development of these fuels is costly. Moreover, SAFs do not burn as efficiently as standard fossil fuels, meaning a plane would need to carry more fuel to go as far. A final nail in the coffin comes from the fact that in order to be considered an “SAF,” US regulation requires that a fuel must cut 50% of GHG emissions compared to standard fuels. This is quite restrictive, and eliminates many options. Considering this, airlines have “little to no incentives to transition to SAF spontaneously,” which suggests that under a free market framework, airlines would prefer to continue operating under the status quo of cheap fossil fuels instead of investing in an SAF that is both more expensive and less efficient. In fact, Bardon and Massol call on the government to use policy to “allocate decarbonization resources fairly among sectors” as well as suggesting that because of airlines’ preference to continue to pollute without restrictions, the government should do more to market SAFs as an alternative.

Another prominent technology is electric aviation, much anticipated but also much critiqued. According to Rane et al. (2023), a discussion for electric aircraft must involve charging infrastructure. This basic necessity for EVs faces 3 major challenges: natural, human, and technological. To start, industry experience from electric automobiles can largely be carried over to flight. Specifically, this means that the electric supply chain from grid to plane is expected to be similar to what is already done for electric cars, except for the fact that the power demand will be larger. A technology expected to be implemented is large-scale battery energy storage systems (BESS) which, as their namesake suggests, can store a lot of energy at a time to reduce peak demand from the grid. To make a long problem short, BESS are susceptible to natural damage, and its chemical/electrical nature requires additional resources to ensure safety. BESS is also at risk of human hazards like overcharging/undercharging systems or malicious cyberattacks. The final hazard comes in technological form, which is to say that electricity, especially the high voltage system needed to charge such a big system, is innately dangerous. Physical damage accumulated from the prior natural or human hazards can only increase this risk. Considering these hazards, studies have been done to assess what the future of aircraft electrification could look like.

In its current state, models suggest that unless sustainable alternative fuels (SAFs) are widely implemented in the aviation sector (generally 100% utilization), a reduction in passenger demand is the most effective way to lessen GHG emissions such as by shifting away from longer-distance air travel and increased availability of commuter rail (Schwab et al., 2021). This is in part because freight transport is harder to decarbonize than passenger transport. This is for a variety of reasons, most notably because the growth of commerce and shipping far exceeds the growth of the travelling population and is harder to manage, so the latter must compensate for the former. However, similar to how the EV market was not considered in the 2016 plan, current models cannot account for electric aviation technology that may or may not be coming in the near future.

Methods

As uncovered through prior research, solutions to aviation emissions largely fall into three categories: alternative fuels (like SAFs), improvements to aircraft (like switching to electric propulsion), or by decreasing demand for flight. The aim of this paper is not to uncover new and innovative technologies, nor is it to determine which technology is the best, but to evaluate these approaches through the context of degrowth. This means that although this paper does encompass every single approach to aviation emissions, by categorizing them into three general categories, it is as cumulative as it needs to be to apply degrowth standards. Instead, it aims to be authoritative by cultivating an understanding for what it means to be degrowth-worthy, why it is important, and how this applies to aviation.

In order to accomplish this, Google Scholar was used to find scholarly sources to provide a background on the degrowth movement. What it means and where it comes from. Then, evidence of its application was collected from a variety of sources. The strategy was to use a basic search engine (Google) to track significant areas where the degrowth movement was applied to technological or business industries. These sources were mainly news articles. The topics covered within the articles were then explored in depth using some of the myriad of databases accessible to me through the university library. This yielded more scientific journals and research studies. Arguments and counterarguments were then synthesized and compared. To relate all of this back to aviation, research was done to compare the different industries the degrowth movement had been applied to with aviation, analyzing the differences as well as how the different solutions in each sector can be feasibly applied to aviation.

Again, this strategy does not aim to be comprehensive, as that would yield an impossibly long paper, but instead aims to be efficient. By targeting news articles, I guarantee I am covering newsworthy topics of interest to the general public. Going in depth with databases means I can both educate myself on a deeper level and uncover what experts say. Finally, because this strategy uses other industries, the additional step needs to be taken for how the degrowth movement applied in other sectors can apply to solving aviation emissions.

Degrowth: What it is and Where it Comes From

Writings challenging sustainability in modern capitalism surfaced in the 1980s (Demaria et al., 2013). The degrowth movement, as it was coined, gained momentum in Europe in the early 2000s, where it was used in France in 2001, Italy in 2004, and Spain in 2006, as a call for a more equitable environment by protesting for car-free cities and anti-advertising. The International Conferences on Economic Degrowth for Ecological Sustainability and Social Equity meets almost every year to discuss strategies and progress. Degrowth is radical in nature and critiques modern capitalism, primarily its tendency to sacrifice the future for the present. Unlike the popular concept of sustainable development, degrowth doesn't aim to be socially accepted, but instead exists as an alternative viewpoint to challenge the idea that sustainability can only be achieved through innovation and investment. A few key ideas surrounding degrowth are ecology (degrowth stresses that ecosystems have value in and of themselves, not simply as a resource), anti-utilitarianism (humans have become economic agents and have grown out of touch with individual cultures), meaning of life (the Easterlin Paradox, which details the uncorrelation between higher incomes and life satisfaction, suggests that more meaning in life is not found through work and pay), bioeconomics (industry creates waste out of natural resources, degrading the quality of the natural world), democracy, and justice. In this way, degrowth theory promotes environmental consciousness, but also the sense of priority for individual cultures. Degrowth asserts that by maintaining current corporate-centric economic models, local communities are overshadowed, causing the individuals within them to lose touch on what it means to be human and what it means to be a global citizen. These concepts shape how degrowth evaluates technology through viability and conviviality criteria.

Degrowth helps to provide an alternative assessment of sustainability, one that challenges pre-existing notions. However, it is important to recognize the limits of degrowth. Namely, degrowth is primarily a political discussion that aims to criticize, and does not provide a framework for divestment. It is by design incompatible with modern capitalism. It systematically rules out conventional forms of innovation. In regards to aviation emissions, degrowth theory suggests that researchers approach the topic from a misguided perspective, and that prominent technologies like electric propulsion and SAFs are illegitimate solutions for sustainability, instead opting to cut away from a historic industry. Degrowth works best when people act for the betterment of the world.

Degrowth Criteria

Climate engineering is a field dedicated to how the climate can intentionally be altered (Muraca & Neuber, 2018). In an age where climate change is a popular challenge, climate engineering provides technologies to combat this. Although one would assume that such tools would inherently be sustainable due to their climate-change-fighting nature, a critical review from the degrowth framework reveals that the sourcing and implementation of these technologies carry a higher toll than expected. Namely, degrowth theory discusses **viability** and **conviviality**. The principle of viability says that a technology must not require constant resource inputs from non-renewable stocks or require constant maintenance and must function through its lifetime without harming the environment or disrupting ecological systems. Essentially, the technology must be able to sustain itself on a small cache of renewable resources without much human input. It is a viable solution to a problem without additional investment in technology or human resources. A key question to consider is: Can it self-sustain? Conviviality takes this a step further by instructing that technologies must be "decentralized [unilaterally manageable by local communities], democratically controlled, reversible [its effects can be undone], subordinated to the values and ends commonly negotiated [serves the needs and wants of a consensus], and is accessible in terms of knowledge and affordability." Conviviality literally means friendliness. In this case, conviviality means a solution is friendly to the existing communities it is addressed to. This means it is well integrated and accepted within the community without being parasitic, or draining community resources. Note how the afore-mentioned ecological and human justice principles are encompassed within the two criteria.

Consider sulfate aerosol injection, brought up by Muraca & Neuber as a technological solution to climate change. Sulfate aerosol injection is the practice of releasing sulfate particles into the air, which mimic volcanic eruptions, blocking out sunlight and indirectly cooling the environment. The technology is "organic" in that it mimics natural processes found in nature (biomimicry), but to be applied at a large scale on a regular basis would require regular sulfur contributions from fossil fuel industries, which would require regular resource consumption. Additionally, the sulfur in the air has toxic effects on the environment as it falls, such as ocean acidification or acid rain. Implementing the technology would also require expertise, and the resulting particle distribution could unaccountably cause unequal benefit. This fails the viability and conviviality standards and are thus incompatible with degrowth.

Instead, a viable and convivial technological solution could look like reducing energy usage in hotspot communities by introducing auto-dimming lights in frequently unoccupied spaces (bathrooms, closets, etc.) in a home. This would be viable since reducing energy required doesn't directly utilize additional resources from the community, and the technology of auto-dimming lights is easily installed without excessive maintenance or fossil fuels. It would also be convivial because a homeowner is able to control where the technology is able to be installed, and auto-dimming technology is easily removable if the homeowner decides it's not a good fit. Moreover, auto-dimming technology is not prohibitively expensive to install and easy to operate without specialized skills.

In terms of Aviation Emissions

The viability and conviviality criteria must be adjusted when it comes to aviation. The industry is heavily regulated and inherently requires specialization. In addition, government presence cannot be ignored in this industry. As previously mentioned, local, state, and federal governments are responsible for awarding grants and shaping policy. Although there is a bit of decentralization in local governments, a government in its inception is centralized in nature. It is an entity of consolidated power. This means that no single technology can shift aviation to a decentralized system nor can it remove human maintenance altogether. Barring that standard, we can apply the rest of the standards onto the afore-mentioned emissions technologies.

Regarding alternative fuels, although its namesake promotes its sustainability, SAF's quality is questionable in the context of degrowth. SAFs can come from a wide array of sources. Some are sourced from waste products, like excess algae or oil. These meet viability requirements, but others sourced from crops like corn would detract from food production and would require additional investment. This brings a whole host of unintended consequences, such as deforestation for more farmland, decrease in biodiversity. SAFs are also shaky on conviviality, because many companies are developing them as an economic product, which would place control firmly in the hands of these private entities, out of pure democratic control. This may be fair according to capitalist principles, but it is not convivial. SAFs pollute the air as well, but since the overall carbon impact is much lesser than conventional fuels, and we have recognized that no technology will be perfectly degrowth-worthy, I am willing to give this a pass. Nevertheless, SAFs' status is largely implausible as a degrowth solution to aviation emissions. Additionally, Bardon & Massol's implication that SAFs are not a solution readily accepted by the market means additional resources need to be expended to be successfully implemented.

Regarding aircraft improvements, such as through electric propulsion, the main idea behind aircraft improvements is to make them more efficient. In the case of switching to electric, it would make them 100% fuel efficient. By definition, these technologies *are* materially conservative. Although novel technologies tend to require high maintenance at inception, after the technology matures, we can infer that it will be less needy. Adopting a sociotechnical imaginary viewpoint, it's reasonable to infer that aircraft improvements *could* pass viability criteria, but not without caveats. Depending on the robustness of the adaptation, additional infrastructure may need to be constructed and maintained. In the case of electric aircraft, the BESS system, as discussed earlier, presents a potential hazard. Viability of this system is highly dependent on its robustness. If it is easily susceptible to damage from natural or human factors, it would require constant maintenance and expenditure, which would decrease its viability. Let us also not forget that a 100% viable electric system requires the energy grid to be 100% renewable, and in its current state it is not. If an aircraft's innovation is too novel, such as electric aircraft, it may require exotic materials like lithium or cobalt, of which cannot be sustainably sourced. Regardless, already recognizing that aviation is not a decentralized industry, aircraft improvements would not pass conviviality criteria. Obtaining exotic materials could put stress on the environment, which is irreversible and violates the fundamental value of ecology. One could argue that aircraft improvements address negotiated needs, as the improvements would only seek to meet consumer needs and wants, but aircraft improvements may fail accessibility criteria of conviviality. Most innovations are so transformative that they require specialized knowledge. Take for example the Boeing 737 MAX, which was Boeing's attempt to increase efficiency on its 737 platform. It completely redesigned the engines, shifting piloting dynamics and requiring specialized training to fly effectively (Gates & Baker, 2019). Electric aircraft would also shift flight dynamics, as electric propulsion systems do not behave similarly to conventional aviation engines. This makes aircraft improvements generally unsustainable in accordance with degrowth. The exception is with upgrades that are minor and do not change flight characteristics, in which case the improvement is insufficient to meet climate goals.

Regarding decreasing aviation demand altogether, the concept is consistent with degrowth principles by literally "de-growing" the aviation industry. Since decreasing demand actively works to lessen resource consumption and decentralizes travel demand from the heavily regulated airline industry, decreasing demand passes the viability test easily. Strategies for decreasing aviation demand include investing in other forms of transportation, like high speed rail and metro infrastructure, which can be locally controlled. This is to say that decreasing demand opens the door for more democratic, convivial forms of mid to long range transportation. In addition, decreasing demand is conceptually reversible (though in practice it may be hard to regain lost consumers). Decreasing demand thus largely passes degrowth standards and is a favored solution. However, as mentioned prior, millions of dollars of public (and private) funding are spent on finding solutions to aviation emissions. The nature of industry is to aim for economic growth, to turn a profit on investments. We can anticipate that affected parties will *not* be interested in a solution that aims to decrease its money-making capabilities.

Nevertheless, the systematic analysis is displayed in Table 1.

Table 1

Degrowth Analysis of Aviation Emission Solutions

Emission Solution	Viability Test	Conviviality Test	Degrowth Accepted?
SAFs	**Plausible**: SAFs require biomaterials for synthesis, but if sourced from raw crops, SAFs could place additional strain on agricultural systems.	**Implausible**: Development of SAFs would place control of a lucrative fuel in the hands of select companies, violating democratic concepts of degrowth.	**No:** SAFs could be harmful to ecology, and would likely violate democratic ideals.
Electric Propulsion	**Plausible, but not likely**: Highly dependent on the robustness of the system. A perfect technology would not need maintenance, but adjustments to infrastructure could potentially require excessive resources and maintenance. Additionally, switching to electric requires a sustainable energy grid.	**Implausible**: Altering aviation systems so drastically would require specialized knowledge to operate, limiting accessibility and democratic control and negotiability.	**No**: Electric propulsion sustainability is highly dependent on the nature of the system, but realistically it asks too much to be sustainable for degrowth, counteracting its nature to downsize.
Decreasing Demand	**Plausible**: The strategy aims to actively reduce the size of the industry, *decreasing* existing resource and maintenance requirements.	**Plausible**: Though not without its economic challenges, decreasing demand is reversible, and frees up resources to contribute to local transportation sectors.	**Yes**: Decreasing demand is consistent with degrowth concepts, promoting individuality in transportation choice and reducing the ecological strain of aviation.

To summarize, in examining the technological solutions of SAFs and electric propulsion, degrowth theory reveals that although they are innovative, they overlook the role of local communities. Developing SAFs replaces an environmental issue with a social one by turning aviation emissions into economic gain for a select few companies that produce the anticipated alternative fuel. What's more, sourcing SAFs could lead to additional strain on environmental/agricultural industries, diverting important land and food crops towards industry instead of people or ecology. Electric propulsion is not much better. Although it's comparatively more maintenance-friendly, its implementation requires adjustments to infrastructure that pose the same socioeconomic risks that SAFs do. The exotic materials in many electric technologies also harm the environment in their retrieval. Instead, a highlight of degrowth theory is lessening demand for air travel to begin with. By "de-growing" the airline industry, less resources are consumed and less emissions are made with substantially less risk to the environment and community.

Conclusion

Although many prominent technological solutions exist for combating aviation emissions, one has to wonder if the best solution is not technological, but social. Through degrowth theory, which exists to promote ecology and human well-being through critiquing modern industry, examining SAFs and electric propulsion degrowth theory reveals that the resources required to develop and maintain these are not sustainable at all. In particular, the viability and conviviality criteria highlight missteps in things like bioeconomics and accessibility. Instead, a more productive strategy would be to divert resources to massaging the social narrative of travel to promote local transportation (bus systems, regional rail, etc.). If a technological solution must be made, degrowth theory suggests it isn't where the limelight shines, as little economic gain would inherently be made by "de-growing" an industry. So, degrowth has highlighted the imperfections of current aviation emissions approaches. Extensions to this research could be made by attempting to resolve these issues while still maintaining effective emissions culling. Additionally, investigations should be made towards poor return-on-investment solutions. After all, R&D investments in degrowth solutions will likely fail to yield revenue, but revenue isn't the point. Stopping climate change is. Although degrowth isn't perfect, perhaps lacking in practicality, it provides an alternative mindset for bettering our environment and community.

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