SUPPLYING SUSTAINABLE AVIATION FUEL TO DULLES INTERNATIONAL AIRPORT

THE FULCRUM BIOENERGY BANKRUPTCY: HOW UNCERTAIN CLIMATE UNDERTAKINGS CAN CAUSE MORE HARM THAN GOOD

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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

Global climate concerns are a pressing concern for the United States government. Sustainable aviation fuel (SAF), fuel sourced from renewable carbon sources, is one of several avenues the aviation sector can take to reduce environmental impact by reducing carbon emissions from fuel consumption. *The SAF Grand Challenge Roadmap* outlines a plan to achieve 3 billion gallons per year of domestic SAF by 2030 and 100% of projected aviation jet fuel use by 2050, 35 billion gallons (Department of Energy, 2022). Every state must determine how to source SAF within the state or import SAF from elsewhere to achieve netzero carbon emissions by 2050. Virginia must develop a supply chain from feedstock sources that take advantage of Virginia's resources to end use at its airports, firstly Dulles International Airport (IAD) because of its international mission.

I will be developing a supply chain for IAD that can offer a solution to reach national SAF goals in Virginia. Since SAF is a socially constructed technology, it is necessary to consider the actors that develop, proliferate, and use aviation fuel pathways and the physical, economic, and political problems and opportunities associated with alternative fuel pathways. I will draw on the STS framework of Social Construction of Technology to investigate how different social groups are developing and hindering the sustainable aviation fuel industry. Because getting Virginia ontrack with national SAF initiatives is socio-technical in nature, it requires attending to both technical and social aspects. In what follows, I set out two related research proposals: a technical project proposal for developing a pipeline for SAF from feedstocks in Virginia to IAD and an STS project proposal for examining how untargeted government subsidies, incomplete risk assessments, and disconnect between national aviation lobbyists and local environmentalists caused the collapse of Fulcrum's SAF facility in Gary, Indiana.

Technical Project Proposal

Virginia has no current understanding of the cost of gathering feedstock and developing a supply chain for SAF to Dulles International Airport despite a desire by several independent fronts to have SAF sourced in Virginia available at IAD. Using systems engineering to perform a robust price assessment and risk analysis of establishing a supply chain for SAF in Virginia can inform decision making, determine economically viable pathways, and provide a framework for targeted and tangible policy. There are two primary pathways to supply the fuel needs of the aviation industry. One is traditional Jet A, a highly-refined kerosene product derived primarily from petroleum (U.S. National Library of Medicine, 2017). Traditional Jet A is transported to IAD by pipeline (Aviation Pros, 2007). The second is SAF which is blended with Jet A and recertified as Jet A (U.S. Department of Energy). San Francisco International Airport (SFO) and Pittsburgh International Airport (PIT) are the leading airports in the move towards SAF. San Francisco uses SAF sourced from renewable waste products including used cooking oils and animal fat waste (Neste). Pittsburgh is building an on-site SAF conversion and storage facility, the first in the United States at an airport. Pittsburgh plans on using primarily ethanol from corn and other agricultural products (Budgen, 2024).

Traditional Jet A is not aligned with the SAF Roadmap's emissions goals and is the only option readily available at IAD. Shipping SAF from SFO and PIT's sources may prove inefficient given large distances and feedstock availability local to Virginia. Our technical solution offers a supply chain for SAF that will not be enacted unless proven economically viable or when new legislation makes the supply chain viable in the near and long term. The goal is to find a Virginia-centered solution. However, if importing SAF proves more affordable, that solution will be modeled further with a robust risk analysis. The pathway that has gained the most traction in previous research at the University of Virginia and among aviation stakeholders in Virginia is converting woody biomass, or waste from the logging industry, from Southwest Virginia into SAF (Davis et al., 2024). While the cost of producing SAF from woody biomass is not competitive with Jet A, woody biomass is a renewable source of carbon and plays into Virginia's strengths. The Bioeconomy Development Opportunity Zone Initiative has awarded Virginia's Tazewell County with a rating of 'A' denoting "high prospective viability of Feedstock Supply and Infrastructure and low expectations of default risk in the Zone" (Peranson, 2024).

Methods used to pursue our designed pathway will include event simulation, deterministic decision and linear statistical modeling, and the systems engineering process. The systems engineering process will be applied to this project through an exploration of the appropriate scope and central goals of the project, a SWOT (strengths, weaknesses, opportunities, and threats) analysis, and decision making based on marginal rates of substitution. Data will be collected from the Department of Transportation, Federal Aviation Administration, and several other key stakeholders and environmental agencies. The Freight and Fuel Transportation and Optimization Tool (FTOT) created by the DOT and the Ascent Model created by the Aviation Sustainability Center will be used for quantitative decision making.

STS Project Proposal

I am evaluating the failed start of Fulcrum BioEnergy's waste gasification plant in Gary, Indiana. This, along with the unprofitability of its facility in Reno, Nevada, caused the bankruptcy of Fulcrum BioEnergy. Fulcrum BioEnergy collapsed because of untargeted government subsidies, incomplete risk assessments, and disconnect between national aviation lobbyists and local environmentalists. There are several perspectives on why Fulcrum BioEnergy filed for bankruptcy, yet the perspectives fail to include or incorporate each other. The current authors fail to look at national trends for SAF facilities declaring bankruptcy despite hundreds of millions dollars invested alongside the qualities of Gary, Indiana that made it a poor candidate location.

Fulcrum BioEnergy declared bankruptcy on September 9, 2024 with liabilities between $100 and $500 million (Wallace 2024). Jenae Barnes, in a Capital B News article, labels the bankruptcy as “a rare environmental victory in a city often burdened by industrial pollution” (2024). Local environmentalist group Gary Advocates for Responsible Development (GARD) was quick to claim a hand in the collapse of what they considered to be a polluting and misguided bad actor in the community. A member of GARD, unimpressed with the claims of Fulcrum and worried about the impact of a facility that imported waste in her community, told Barnes, “We felt like they were liars. We felt like they weren’t transparent. We felt like they were polluters, and we felt it wouldn’t work. And in fact, all the things turned out to be true” (2024). Fulcrum experienced roadblocks in local governments due to pressure from stakeholders such as GARD, failing to meet construction requirements and to secure city owned property necessary to the facility even after securing the permit to begin construction in 2018 (Barnes, 2024).

Craig Bettenhausen, writing for Chemical and Engineering News, shared a different perspective for the failures in Reno, Nevada and Gary, Indiana. Bettenhausen lists upper-level mismanagement as one of the largest contributing factors to failures alongside a key financial backer from South Korea halting investment in 2023 (Bettenhausen, 2024). An anonymous employee at the Reno site reported the rush to begin production in 2022 caused severe manufacturing damage forcing them to shut down for months. Despite the collapse of Fulcrum, the anonymous employee at the Reno site held faith in the concept of converting municipal waste to fuel, saying “there were major tech issues, but we were constantly improving with time”

(Bettenhausen, 2024). The issues with these perspectives is that they are limited in scope, zooming in on specific stumbling blocks, that the larger picture of how SAF ventures are failing across the nation with the same key traits and key stakeholders is ignored. The roadblocks in the SAF field are caused by the national government setting unrealistic short term goals, business leaders rushing to produce when demand is nonexistent, and the disconnect between national climate lobbyists and local environmentalists. If advocates of SAF continue to view failures and large setbacks of this size in SAF as issues with a limited scope, specific and solvable issues without relation to a national context, setbacks of this kind will continue to occur.

The theory of Social Construction of Technology (SCOT) created by Trevor J. Pinch and Wiebe E. Bijker provides a valuable lens through which we can view the bankruptcy of Fulcrum Energy. SCOT outlines a multidirectional development of technology, pushed by social factors to develop in certain directions (1984). SCOT states the process of technological development is socially constructed as iterative designs are created to address the priorities and concerns of various social groups that have a stake in the technology's design. These designs often experience stabilization and closure as the degree of variation between design iterations decreases. SCOT provides an avenue for untested technologies such as SAF to gain ground if backed by individuals or groups with high levels of social influence, in this case the United States government. A key aspect of the SCOT model that fits this case is at the center of Pinch and Bijker's argument: "the 'successful' stages in development are not the only possible ones" (1984, p. 28). SCOT takes a decisively nonlinear approach to technology where individuals, groups, contexts, and social factors generate changes in technology or necessitate the creation of new technologies (Pinch & Bijker, 1984). This outlook matches the climate and political factors that necessitated a change in how aviation is fueled alongside its turbulent development and proliferation. Information to support this argument will come from news articles, interviews, the SCOT framework, publishings in the SAF field, and official legal documents.

Conclusion

Creating a supply chain for sustainable aviation fuel for Dulles International Airport and evaluating the larger context of bankruptcy of Fulcrum Energy will contribute to understanding how Virginia is able to address and contribute to the national SAF goals set out in the *SAF Grand Challenge Roadmap*. The technical project of building a robust supply chain and providing cost estimates are essential before any work is done in the state. Without developing a risk-averse supply chain, any future developments in Virginia SAF may result in outstanding losses, even with short and long term government subsidies, if the project never proves to be profitable. Additionally, confounding factors can cause a good-natured project to reduce carbon emissions to be viewed as an environmental plight, as was the case in Gary, Indiana. By applying SCOT to the bankruptcy of Fulcrum BioEnergy and the SAF industry, I will be able to determine how relevant social groups have interpretive flexibility in their view of SAF, its production, and its impact on local and global environments. This will allow my team to better understand the risk with specific relevant social groups when using specific technologies to establish an SAF supply chain in Virginia and point out key areas where education must take place. The STS and technical project are necessarily tied together in their collective effort to achieve the central goal of reaching national SAF goals in Virginia. This can only take place if there is a known cost, amount of risk, and relevant local social groups are convinced of the environmental benefit of bringing the SAF industry into their communities.

References

Aviation Pros. (2007, February 5). *Redefining Dulles (IAD)*. www.aviationpros.com/home/article/10380580/redefining-dulles-iad

Barnes, J. (2024, September 24). *Gary celebrates the end of waste-to-energy company Fulcrum BioEnergy*. Capital B Gary. https://gary.capitalbnews.org/gary-celebrates-the-end-of-waste-to-energy-company-fulcrum-bioenergy/

Bettenhausen, C. (2024, June 19). *Fulcrum bioenergy abandons trash-to-fuel plant in Nevada*. Chemical & Engineering News. https://cen.acs.org/energy/Fulcrum-BioEnergy-abandons-trashfuel-plant/102/web/2024/06

Budgen, E. (2024, June 18). *Pittsburgh International Airport leads the way on SAF production.* International Airport Review. https://www.internationalairportreview.com/news/223489/pittsburgh-airport-saf/

Davis, C. D., Sreekumar, S., Altman, R., Clarens, A. F., Lambert, J. H., & Colosi, L. M. (2024). Geospatially explicit technoeconomic assessment of Sustainable Aviation Fuel Production: A regional case study in Virginia. *Fuel Communications*, *19*, 100114. https://doi.org/10.1016/j.jfueco.2024.100114

Neste. (n.d.). *Products and innovation: Sustainable aviation fuel*. https://www.neste.com/en-us/products-and-innovation/sustainable-aviation/sustainable-aviation-fuel

Peranson, A. (2024, October 8). *Tazewell, Virginia - BDOZone*. BDOZone. https://bdozone.org/rating_award/tazewell-va/

Pinch, T. J., & Bijker, W. E. (1984). *The social construction of facts and artifacts: or how the sociology of science and the sociology of technology might benefit each other*. Social Studies of Science, 14(3), 399-441. https://doi.org/10.1177/030631284014003004

United States of America. Department of Energy, Department of Transportation, Department of Agriculture, Environmental Protection Agency. (2022, September). *SAF grand challenge roadmap: Flight plan for sustainable aviation fuel*.

U.S. Department of Energy. *Sustainable aviation fuel*. Alternative Fuels Data Center: Sustainable Aviation Fuel. https://afdc.energy.gov/fuels/sustainable-aviation-fuel

U.S. National Library of Medicine. (2017, March 4). *Chemical and physical information. Toxicological profile for JP-5, JP-8, and JET A Fuels*. https://www.ncbi.nlm.nih.gov/books/NBK592027/

Wallace, J. (2024, September 10). *Fulcrum bioenergy files for chapter 11 bankruptcy protection*. Waste Dive. https://www.wastedive.com/news/fulcrum-bioenergy-chapter-11-bankruptcy-nevada/726555/