Thesis Project Portfolio

Systems Analysis and Negotiation of Strategic Partnerships in the Supply of Biofuels to Commercial Aviation

(Technical Report)

Marathon Martinez Biofuel Refinery Fire: Why an Impatient Transition from Fossil Fuels to Biofuels Won't Work

(STS Research Paper)

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Technical Project Abstract

Industrial supplies of energy and fuels need coordinated efforts of stakeholders to address complex challenges related to resources, finances, infrastructure, regulations, innovations, behaviors, etc. Advanced aviation biofuels, in particular, involve negotiations and tradeoffs among subsystem owners and operators, regulators, government agencies, and transportation providers. This paper utilizes a case study on biofuel distribution to Dulles International Airport to address three primary components of a systems engineering-based supply chain analysis: (i) stakeholder mapping, (ii) scenario evaluations, and (iii) resilience analysis. This paper builds upon the power-interest matrix to develop an Engagement, Financing, and Time Horizon Analysis (EFHA) matrix to support systems engineering and stakeholder negotiations for energy and fuel supply chains. EFHA identifies several key problem dimensions: coordination among diverse stakeholders, resource allocation and policy considerations, and time horizons for action. In evaluating various supply chain scenarios, the Freight and Fuel Transportation Optimization Tool (FTOT) from the U.S. Department of Transportation was utilized to assess network infrastructure, sensitivity constraints regarding feedstock and pricing assumptions, and capacity impacts of different transportation options, all in the scope of biofuel distribution. In evaluating enterprise resilience, the paper employs comprehensive systems criteria, system components, and emergent conditions to understand disruptions and scenarios that most matter to a biofuel supply chain at airports.

STS Project Abstract

The 2023 fire at the Marathon Martinez biofuel refinery highlights the inherent dangers in an impatient transition from fossil fuels to biofuels, revealing systemic vulnerabilities

worsened by corporate, economic, and political pressures. Utilizing Actor-Network Theory (ANT) as a framework, this paper identifies three interconnected causes for the incident: chronic understaffing and inadequate employee training, workforce disruptions from the COVID-19 pandemic, and political policy and goals for accelerated biofuel production. The conversion of the Martinez refinery from crude oil to biofuels coincided with pandemic-induced layoffs that eroded essential institutional knowledge and safety readiness, setting the stage for operational failures. Federal and state policies, notably the Federal Aviation Administration's aggressive biofuel production targets and California's Low Carbon Fuel Standard, imposed aggressive demands on the industry without sufficient infrastructure, regulatory oversight, or workforce preparation. Investigations by the U.S. Chemical Safety and Hazard Investigation Board and Cal/OSHA documented specific safety oversights, highlighting systemic issues in corporate oversight and emergency preparedness. This research stresses that the Marathon Martinez fire was not merely the result of isolated human errors or equipment malfunctions but stemmed from deeper structural and regulatory misalignments. To prevent future incidents, it advocates for comprehensive regulatory frameworks tailored specifically to biofuel operations, enhanced workforce training programs, and balanced policy approaches that prioritize safety and sustainability alongside production targets. This case exemplifies the risks of a rapid energy transition that neglects critical human, technical, and institutional factors necessary for safe and sustainable industry practices.

Project Relationship

The two projects are deeply interconnected through their shared emphasis on supply chain coordination as a foundational element for a successful transition to biofuels and bio-aviation fuels. *Marathon Martinez Biofuel Refinery Fire: Why an Impatient Transition from*

Fossil Fuels to Biofuels Won't Work analyzes the 2023 Marathon Martinez refinery fire using Actor-Network Theory (ANT), revealing how poorly coordinated supply chain and workforce dynamics, exacerbated by post-COVID disruptions and political pressure, can lead to catastrophic outcomes. *Systems Analysis and Negotiation of Strategic Partnerships in the Supply of Biofuels to Commercial Aviation*, centered on the distribution of aviation biofuels to Washington Dulles International Airport, uses systems engineering tools like stakeholder mapping and scenario-based resilience analysis to proactively plan for those same kinds of disruptions. Together, these projects highlight both the consequences of neglecting coordination and the benefits of structuring it effectively from the start.

The Martinez refinery case shows what can happen when supply chain actors, corporations, government regulators, and frontline workers fail to align around operational safety and training timelines. Here, the push to meet aggressive federal and state biofuel mandates outpaced the facility's ability to adapt its infrastructure, retrain its workforce, and maintain safety standards. The breakdown in supply chain readiness exposed a key lesson: no matter how ambitious the sustainability goals, they cannot be met without foundational coordination among all participants in the production and distribution network. The Dulles airport case study represents a forward-looking effort to build that very coordination. It lays the groundwork for a scalable, resilient supply chain by identifying key stakeholders, assessing feedstock availability, evaluating logistical pathways, and modeling disruption scenarios. Where the Martinez case reveals the dangers of reactive policy compliance, the Dulles project demonstrates a proactive approach to stakeholder alignment and systems thinking.

Importantly, these projects do not exist in isolation; they inform and reinforce each other. The failures documented in the Marathon case can directly influence the stakeholder negotiations

and risk assessments in the Dulles project, helping prevent the same vulnerabilities from reappearing in aviation biofuel infrastructure. Conversely, the systems engineering strategies developed in the Dulles study could serve as a model for refinery retrofits or future fuel hubs, illustrating how to build safety, flexibility, and stakeholder buy-in into the supply chain from day one. Both projects represent essential early steps in building a viable biofuel economy. One exposes the stakes of misalignment and the other offers a path forward. Together, they emphasize that coordinated supply chain planning is necessary for a sustainable and safe energy transition and not just beneficial.