A SOCIOTECHNICAL ANALYSIS OF BIOFUEL POLICY DEVELOPMENT

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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:

Despite only contributing to less than 5% of the world's population, the United States consumes up to 21% of the world's petroleum for transportation and other various uses (U.S Energy Information Administration, 2023). The transportation sector itself is dually responsible for 29% of the country's greenhouse gas emissions, making it a large target for improvement for the U.S. government and industry (US EPA, 2023). In the past two decades, there has been a significant push towards the large-scale production and implementation of biofuels as a partial solution. Biofuels are renewable fuel sources produced from renewable plant materials. Barack Obama, the president around the early stage of adoption, claimed that renewable energies like biofuels would be how America could achieve energy independence. He specifically stressed that the country would achieve this "not through short-term gimmicks, but through a real, long-term commitment to transform our energy sector" (Obama, 2008).

To regulate and implement these biofuels through this envisioned long-term plan, the U.S government established the Renewable Fuel Standard (RFS) as authorized by the 2005 Energy Policy Act and expanded under the Energy Independence and Security Act of 2007 (US EPA, 2015). The RFS requires minimum production volumes of renewable fuel each year to reduce the U.S. heavy reliance on petroleum-based transportation fuel (US EPA, 2015). Specifically, it required the ascending production and use of biofuels from 4 billion gallons in 2006 all the way up to 36 billion gallons in 2022 (*The Renewable Fuel Standard (RFS): An Overview,* 2023). It also required 16 billion gallons of cellulosic biofuels by 2022, such as those from agricultural waste such as corn stover, despite these biofuels not yet being commercialized (Breetz, 2020). Since 2014—with little surprise—the U.S. has consistently not met this renewable fuel goal (*The Renewable Fuel Standard (RFS): An Overview,* 2023). Despite this failure, an updated RFS

established in 2023 promotes up to an 8.2% increase by 2025 of current biofuel production volumes (*The Renewable Fuel Standard (RFS): An Overview,* 2023). This paper argues that in the original development of the RFS, strong proponents of biofuels were mobilized together to support an aggressive, market driven policy that overestimated the country's abilities to meet high mandates and misrepresented legitimate, biofuel-cautious perspectives.

This research begins with a literature review that details how U.S. energy policy has been historically developed through government leadership. It further provides a comprehensive summary of the specific unintended environmental and socioeconomic effects of biofuel energy policy implementation. This review sets context for the current issues associated with biofuel energy policy and its development, but this paper's analysis aims to find the true source of these problems.

To identify this problem source, this paper collects evidence from two relevant congressional hearings from the Senate Committee on Energy and Natural Resources about the RFS from two different stages of the policy's development. The evidence is analyzed using Pinch and Bjiker's Social Construction of Technology (SCOT) framework to parse together how social groups represented (or not represented) in these congressional conversations have influenced biofuels' trajectory. This trajectory is also analyzed through the collection of direct content pulled from the RFS proposal itself.

This research reveals how certain groups, such as state and federal levels of government, the petroleum industry, midwestern farming associations, climate researchers, and environmental groups have fought for varying levels of caution with biofuels in these Congressional conversations. Misrepresentation of environmental groups, certain state governments, and climate researchers at earlier conversations reflect misguided and overconfident goals addressed

in the first iteration of the RFS policy. These findings may demonstrate the fundamental issues with the U.S.'s process for developing biofuel energy policy, or possibly even for energy policy in general. This research may help improve the understanding of what makes biofuel policy development environmentally effective and sociotechnically just.

LITERATURE REVIEW

Since the energy crisis in the 1970s, the U.S. government has been a driving impetus for the trajectory of biofuels through its exhaustive policy standards and financial support. First, the Energy Policy Act of 2005 established the RFS that required the increased production and use of renewable fuel each year all the way until 2022 (Su et al., 2015). The EPA sets these RFS standards based on "the R&D and production of biofuels and assessments of production capability from industry" (Su et al., 2015, pg. 992). These R&D government grants have facilitated collaborations between agencies and labs such as the Department of Energy, Department of Agriculture, National Renewable Energy Laboratory, Oak Ridge National Laboratory, and RAND Corporation. (Usmani et al., 2023, pg. 8). The government places great importance on a systematical funding policy for biofuels, and its intricate involvement in this way is one of the essential reasons for why the U.S is leading in the world's bioenergy technology (Su et al., 2015

The historical process of developing federal U.S energy policy has also reflected a dominant model guided by energy efficiency and often politically conflicting market concerns. Since the energy crisis and climate change phenomenon's have made energy policy necessary, Congress has required the President to biannually submit to it a national energy plan (Tomain, 1990). This plan frequently reflects the tenets of democratic capitalism: "private ownership and production; competition; no overt central planning; wariness of monopoly; and government

support of each of the other elements." (Tomain, 1990, pg. 391). Despite a market-driven focus, the generalized mandates from policies such as the RFS nevertheless provide economic and political advantages to biofuel production. They do so by mobilizing several interest groups towards the cause, such as farmers, biofuel industry producers, environmentalists, and the larger energy security community (Holleman, 2012; Lawrence, 2010; Breetz, 2020). However, politics between these social groups is still one of the largest contributors to the trajectory of policy. Certain studies analyzing how the competing political views of individuals affect policy implementation reveal that "policy support and consumer decisions depend not only on [scientific] facts, but also on values" (Dietz et al., 2013, pg. 1).

The dramatic push and increase in U.S. biofuel production due to the RFS has consequently called into question the policy's unintended ecological effects. These effects in question relate to the true renewability, cleanliness, and water usage of biofuel production. Ideally, biofuels are sustainable and environmentally friendly because they offset the heavy reliance on CO_2 from finite fossil fuel reserves and create a new mechanism for CO_2 absorption through the growing of new biomass (Woodward, 1999). Yet, existing studies prove how the renewability of biofuels is dependent on the nonrenewable energy consumed in the biofuel life cycle process regulated through governmental and industrial regulations. Wider boundaries for these life cycle analysis assessments reveal poorer renewability of biofuel (Ji & Long, 2016). Mixed scholarly analyses also debate the true cleanliness of biofuel energy. Opponents prove that the competition between fossil fuels and biofuels will reduce the price of fossil fuels, thus increasing their use and exacerbating pollution (Ji & Long, 2016). In the U.S. as of late, fuel ethanol-powered cars possess a high ~118 L/km water consumption rate due to vigorous promotion of bioethanol development as well (Dominguez et al., 2009).

Other research scholars have also documented the unintended social and socioeconomic effects of biofuels directly linked with the nature of U.S. biofuel policy. Biofuel development provides job opportunities and improves farmers' income in the short term, but with the fragility of the biofuel market, this may be limited and unstable without proper governmental protection (Ji & Long, 2016). Researchers continually engage in the food versus fuel debate as well. Some argue that governmental mandates increase the competition between feedstocks and food production for land, water, and labor, while others claim that biofuel implementation will instead generate income and increase food accessibility (Ji & Long, 2016). Even with certain GHG reduction credits, biofuel implementation cost can also prove more expensive than that of fossil fuels (Duer & Christensen, 2010). Overall, researchers have determined that the economic benefit of biofuels depends on many external factors such as "the fluctuation of [the] energy market, extreme weather, variation in subsidy policy" (Ji & Long, 2016, pg. 47), technology available, and feedstock used (Ji & Long, 2016).

To fully analyze the development and implementation of the RFS policy and contextualize this analysis in society, this paper uses Pinch and Bjiker's (1984) social construction of technology (SCOT) framework. This framework establishes that the construction of society and technology are heavily intertwined. It claims that technology develops in a multidirectional model that is formed through the "alternation of variation and selection" (Pinch & Bijker, 1984, pg. 414), where different relevant social groups that "share the same set of meanings, attached to a specific artefact" (Pinch & Bijker, 1984, pg. 414) inherently influence the model. As the U.S. government remains the pivotal stakeholder addressed in this project, using this framework expansively offers answers into how biofuel production technology has been socially influenced by many competing internal governmental groups. It also provides

insight into many other group perspectives present and influential during RFS development. These other groups may include the petroleum industry, biomass feedstock growers, engine manufacturers, or environmentalists. This social group influence perspective might help postulate the true s*ource* of the ecological, environmental, and social unjustness with biofuels related to its policy development.

METHODS

This paper's primary method of research includes an analysis of relevant congressional hearings leading to the original RFS establishment in 2007. The congressional hearings chosen from the Sente Committee on Energy and Natural Resources are from two different points in RFS development. One is from the beginning talks of the RFS in 2001, (Renewable Fuels for Energy Security, 2001), and a final one dated right around RFS finalization in 2007 (Biofuels for Energy Security and Transportation Act of 2007, 2007). This method helped uncover the motivations behind the initial establishment of the RFS that may have led to certain unintended consequences outlined in the literature review. It was also an effective method for using Pinch and Bjikers' SCOT framework, for congressional hearings are rich sources for tracing social group perspectives and influences in the biofuel policy process.

This is supplemented with an analysis of the final Renewable Fuel Standard of 2007 policy itself. Content, purpose, organization, and rhetoric information was pulled directly from the RFS Environmental Protection Agency reports and proposals to support claims rooted from Congressional hearing evidence. Direct scrutiny of the policy itself provided a means for analyzing how biofuels were actually implemented when compared to skeleton conversations had in congressional hearings.

ANALYSIS

The early stage of RFS development was truly a time of peak energy crisis concerns that led to a destructively aggressive and market driven look at biofuel legitimacy. When looking at the grassroots of the policy development in the 2001 hearing, nearly all social groups were united through this focus. For example, a passionate representative of the Corn Grower's Association articulates his view of the energy crisis, comparing the U.S's high oil prices to the country's historical taxation "imposed from powers across the sea" (Renewable Fuels for Energy Security, 2001, pg. 5). A representative of the petroleum industry takes a slightly more practical, but still economically focused, view: "customer acceptance is the single most important factor in the success of a product, especially a transportation fuel" (Biofuels for Energy Security and Transportation Act of 2007, 2007, pg. 38). Nearly all parties within this 2001 hearing repeatedly focused on the notion that "these are times when prices for our commodities are at record lows and energy and other inputs are at record highs." (Renewable Fuels for Energy Security, 2001, pg. 8). To kickstart biofuel adoption and acceptance, the government and private biofuel proponents here seemed to have taken such a market driven stance, much like most energy policy developments have in the past. However, this stance shared by many represented social groups grew too large and influential for an effective, long term, forward-thinking solution for biofuel implementation that the government claimed this two-decade spanning policy to be.

Aggressive pushes from governmental state power with direct exposure to and experience with existing biofuel production in their Midwestern states also caused an overconfidence in the country's abilities to meet the RFS mandates. The 2001 hearing had ample representatives from Midwestern states, especially South Dakota, who was one of the leading producers of ethanol in 2001. A South Dakota senator stresses that the original proposed mandates leading up to the RFS

"are realistic targets…[and] I think we need to start with ambitious goals to utilize ethanol and biodiesel" (Renewable Fuels for Energy Security, 2001, pg. 3). The rest of the hearing presents testimonies from Midwestern coalitions, unions, and representatives from the agriculture sector that overwhelmingly support "an aggressive growth pattern for ethanol and biodiesel production and use in the United States" (Renewable Fuels for Energy Security, 2001, pg. 2). Because of the Midwest's crucial position as the largest existing and projected producers and suppliers of biofuel, this mobilization of many similar social groups towards an aggressive policy most likely contributed to an overly ambitious program.

Some may argue that it was perfectly reasonable for these midwestern states to have dominated these initial RFS conversations—for they were the most experienced with biofuels at the time. However, when analyzing the actual RFS proposal, the above claim about detrimental midwestern dominance still holds validity. The introduction section of the RFS is meant to provide the focus of the policy. This section overwhelmingly places emphasis on biofuels' favorable economics that will cause their production to "exceed the requirements" ("Regulation of Fuels and Fuel Additives: Renewable Fuel Standard Program", 2007, pg. 23902), the improved income potential for farmers, and a reduction of greenhouse gas emissions. These overarching goals nearly follow exactly what these midwestern states emphasized in the early conversations, especially the aspect expecting the U.S. to "exceed the requirements" ("Regulation of Fuels and Fuel Additives: Renewable Fuel Standard Program", 2007, pg. 23902). However, as history displays, the U.S. never came close to exceeding, let alone reaching, these biofuel mandates since 2014. This reveals how just one collective social group, if present and dominant in original conversations, can influence society's rapid adoption of a new energy technology.

Not only were midwestern perspectives dominant, but environmentally and ecologically cautious biofuel advocates were only extensively represented in later hearings much closer to final implementation. For example, in the 2007 hearing, a biofuel researcher raises his concerns for a more complex issue surrounding mandates and claims that "it really is not an adequate substitute for an explicit greenhouse gas performance standard and sustainable feedstock sourcing requirements" (Biofuels for Energy Security and Transportation Act of 2007, 2007, pg. 30). The director of a Climate center also calls attention to the RFS's lack of adequate safeguards and incentives to protect the "lands, forest, water, wildlife, public health, and climate" (Biofuels for Energy Security and Transportation Act of 2007, 2007, pg. 30). An environmental group further submitted their perspective for the record and urges the committee to "support…the performance standards that will ensure bioenergy meets its promise while avoiding collateral environmental damage" (Biofuels for Energy Security and Transportation Act of 2007, 2007, pg. 59). The environmental aspects of the final RFS proposal include information on the "impacts on emissions of regulated pollutants and greenhouse gases, air quality, [and] fossil fuel use" ("Regulation of Fuels and Fuel Additives: Renewable Fuel Standard Program", 2007, pg. 23904). This list of priorities does not adequately reflect the range of social group perspectives present in this important 2007 hearing, showing that they were most likely severely underrepresented in the original conversations about the policy. According to SCOT, their input outlined here may have better influenced the trajectory of the technology away from its environmental and ecological effects documented today.

Finally, socioeconomically concerned parties were also underrepresented in early RFS implementation conversations. Returning to the 2007 hearing, an Alaskan state government

senator brings a new viewpoint as a resident of a state with expensive means of obtaining fuel. She states:

"there are clear limits to the ability of Congress to manipulate markets, to pick 'winning' and 'losing' technologies, and this bill, mandating a 36-billion-gallon level of biofuels development within 15 years is clearly near my personal limit" (Biofuels for Energy Security and Transportation Act of 2007, 2007, pg. 3).

Previous conversations focused on biofuels' advantages of low commodity prices and increased economic security of farmers. This excerpt shows a possible lack of economic thoroughness and measures in initial talks, of which proved more influential in final policy enactments. A senator from another state, North Carolina, also articulates: "mandating arbitrary numbers for biofuel usage before economic and technological feasibility studies can be conducted…is unwise" (Biofuels for Energy Security and Transportation Act of 2007, 2007, pg. 4). This senator's reserves about economic and technological feasibility proves another perspective that was fundamentally missing, especially amidst the confident Midwest ethanol producers. A representative from the petroleum industry in this hearing further claims that **"**overestimates create unrealistic expectations, poor policy and wasted resources" (Biofuels for Energy Security and Transportation Act of 2007, 2007, pg 38). Not only are there governmental socioeconomic concerns, but industry also takes a cautious stance here and presents potential effects that should have been considered earlier. This is curiously also a contradictory perspective of a previous petroleum representative in the 2001 hearing. Again, SCOT provides a framework to explain and describe the importance of economically cautious social groups in the successful trajectory of biofuels long term.

CONCLUSION:

In conclusion, this research has dived deep into the specific conversations had, perspectives addressed, and social groups represented in the development process of the Renewable Fuel Standard of 2007. It offered a fresher approach to policy analysis, where SCOT helped pinpoint the source of direction for biofuel adoption and implementation in society. It provided context for how the matter-of-fact RFS mandates were inherently socially motivated. The research revealed how just small snippets into the congressional hearing process behind policy development can be representative of potentially why biofuels have had larger environmental and socioeconomic consequences than expected. It also can explain why the original mandates of the RFS soared higher than attainable. Traditional policy analysis often focuses on modelling and systematically choosing between policy alternatives—a quite technocratic approach. The research in this paper instead went deeper into understanding the behavioral and political dimensions of the energy policy political process often ignored in routine analysis. This alternate lens may provide the U.S. government with a more holistic, STS perspective for future energy policy enactment related to biofuels.

Future extensions of this project could include a more recent, sociotechnical re-analysis of biofuel mandates. It would be interesting to investigate the hearings surrounding the updated, 2023 Renewable Fuel Standard which adjusted original projected mandates to better reflect the country's realistic goals. At the time of this research, the 2023 congressional hearings surrounding the development of this policy were not publicly available. It would be intriguing to see if there were representatives present that were identified in this paper who swayed the downsizing of standards and established more forward-facing economic and environmental safeguards. As the timeline of these congressional conversations was a pivotal pillar of the

arguments in this paper, it would be fascinating to see if the claims established in this research remain true two decades later.

In all, this research provides an optimistic outlook on the future of energy policy if the government adopts a more sociotechnical outlook in policy development. This research proves the notable influence of congressional hearings on final policy, demonstrating that the U.S government has already established an effective means of addressing many social groups' concerns about alternative energy. In all, this project aimed to deepen the understanding of one of the most powerful stakeholders, the U.S. government, in energy policy formation and share a new approach for future policy analyses.

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