Biodiesel Process Technology Transition: Brazil's Indigenous Population

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By

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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

In the next 20 years, biofuel production in Brazil is estimated to increase by over 200% (de Campos & Zuchetto, 2014). To support this increase, the land allotted for feedstock agriculture has been expanding rapidly. Specifically, over 25% of all the land expansions have targeted areas occupied by Brazil's indigenous communities (de Campos & Zuchetto, 2014). It is generally understood that the continuous agricultural expansion and the invasion of already owned lands is an unsustainable practice (Bastos Lima, 2012). However, most researchers assume due to the overwhelming power of the government, and their unwavering support of agriculturally based fuels, the current system is unlikely to change (Institute of Medicine, 2014). But this interpretation fails to consider how through forming relationships with other groups, the indigenous people may gain a voice, thus shifting the established power dynamics. As a result, we may not understand the role the indigenous people played in the changing processing technology, and how other unrepresented groups may disturb similar technological systems. In what follows, I will demonstrate that the existence of Brazil's commonplace biodiesel processing technology is threatened because the people in power, the government, have omitted the needs of the indigenous people. To support my argument, I will use the framework of Actor Network Theory (ANT). ANT claims that in a network, such as biodiesel technology network, power is based on the strength of the relationships between actors, and that changing relationships overtime can change the goals of the network (Cressman, 2009). My analysis will draw the viewpoints of Brazil's indigenous population, the government, and the international community to first establish how the indigenous population became isolated within the network, then how they formed relationships, which, finally, is causing a network shift.

Background

Transesterification is a chemical reaction between triglycerides and alcohol, such as methanol, to produce glycerol and fatty acid methyl esters. Fatty acid methyl esters are then separated from the glycerol by-product through separation process, this isolated product is what is sold as biodiesel. The transesterification reaction can occur either through a catalyzed process or a non-catalytic process, which occurs at temperatures and pressures above the reactant's critical points. While catalyzed processes, including acid and base catalysts, are operated at lower temperatures and pressures, and are therefore safer, they require high quality feedstocks such as soy, palm oil, or corn to prevent the contamination of the final biodiesel product. On the other hand, non-catalyzed reactions can occur with lower grade feedstocks, like waste cooking oil. However, the downside of these reactions are the higher operating costs and the tincomplete understanding of the process on a large industrial scale (Zeng et al., 2014).

Literature Review

Since the 1980's and the growth of the biodiesel industry, many scholars have researched the interactions between social groups that have contributed to the rise of a centralized technology within the biodiesel industry, acid and base catalyzed transesterification using agriculturally derived feedstocks. Despite their work, there is limited literature surrounding, not only the Brazilian biodiesel industry, but, specifically, the role indigenous peoples are playing in its trajectory.

For example, an analysis of a case study on the biofuel industry in Colombia, points towards direct government involvement in the propagated use of agricultural base feedstocks, which catalyzed transesterification processes require (Institute of Medicine, 2014). Government tax exemptions, loans, and farming courses strengthen the relationships between farmers, which

supply the necessary raw materials, thus fueling the existing industry. However, this case originates from Colombia, which has stricter regulations on land expansions than the neighboring Brazil. As a result, the research into the interrelationship between local indigenous people, the government, and land encroachment has yet to be fully considered.

A 2012 paper on the analysis on biofuel policies and their social implications in Brazil, India, and Indonesia does a better job in, not only, directly integrating Brazil, but also acknowledging the effects of indigenous people (Bastos Lima). Like Colombia, Lima mentions that Brazil also exercises economic incentives and regulatory mandates that encourage biofuel feedstock farming. However, Lima differs by continuing the discussion of the effect of these land grabs. He states, "[agricultural land expansion] has further tarnished the social profile of this sector [biofuels]." While this insight is beneficial, the analysis still lacks how this "tarnished" profile of the industry has the potential to disrupt or effect the existing standard processes.

In summary, there is past research regarding strong relationships between certain groups that have, thus far, provided a stable centralized method of biodiesel production. However, the lack of integration with previously neglected actors, the indigenous population, causes a failure to understand the fragility of the current technology. Therefore, through fully understanding the relationships between both the current powerful actors and the previously neglected actors, I aim to provide a more well-rounded view of the network, and more specifically, the potential change in the network due to the increased representation of the indigenous people.

Conceptual Framework

My analysis of the most predominant biodiesel production method in Brazil draws on the STS framework of ANT. This allows me to explain how the increased representation of a relevant social group, indigenous people, may threaten the stability of the currently established

technology. Initially developed by Bruno Latour in the 1980s, ANT focuses on the relationships between key human and non-human "actors" that are associated with each other around a specific problem or purpose, the "network" (Cressman, 2009). The interactions between the networks are able to transform the networks (Callon, 1987). Scientists and engineers and typically seen as the network builders, and therefore the overall network and the individual relationships are typically seen through their point of view. Through building the networks themselves, the engineers influence relationships that stabilize the existence of the current networks (Cressman, 2009).

Within a network, power does not exist within a single actor (Latour, 1996). This represents the idea of semiotics in ANT. Through increasing the relationships with other actors, relationships get strengthened, and the interconnections grow. This increased connectivity and allyship is what shifts the power balance within a network (Nickerson, 2024). Moreover, another key tenant of ANT, which is connected to the network's power dynamics, is translation (Callon, 1987). Translation is maintenance and formation of the networks themselves. Callon separates this into five steps: problematization, interessement, enrolment, mobilization, and the black box. Initially, the network is building around a unified problem, however through actor recruitment and assignment of roles, certain actors secure their status as network leaders. A key idea surrounding the recruitment of actors involves the potential coercion of others to align with the goals of the dominating actors (Callon, 1987).

In the analysis that follows, through drawing on ANT, I will first examine how the existing network has led to the isolation of an actor, leading to its development into a rogue actor. Next, I will highlight how this isolation has forged ties between the rogue actor, the indigenous people, and the consumers of biodiesel. Finally, I will analyze how this newly

developed relationship can shift the established power dynamics within the biodiesel industry and pose a threat to the longevity of the currently established network.

Analysis

Brazil's Indigenous People as a Rouge Actor

The encroachment on and representative isolation of Brazil's indigenous people by powerful actors, such as biofuel producers and the government, have propelled the widespread indigenous community to develop into a "rouge actor" within the Brazilian biofuel network. In Brazil, since the 1988 constitution guaranteeing "sufficient" territory to indigenous groups, government policies have been instituted that lessen the already small hold these groups have with their land. These policies include land demarcation and the concentration of property and the possession of land (Bessi & Navarro, 2014). The indigenous people have long been vocally opposed to these institutional changes. For example, Casé Angatu, an indigenous person from Tupinamba, stated in an interview:

> "There is currently a bill for a constitutional amendment, of the constitution of 1988, the Pec 215-A, which says that congress has the last word on the demarcation of our lands and we are radically opposed to this, because the congress is made up on individuals who have the firepower, the votes, and the money," (Bessi & Navarro, 2014).

Initially, Angatu's words plainly explain that her indigenous community, Tupinamba, and other indigenous groups at large are opposed to the changing governmental policies regarding land rights. However, as she continues, she highlights the reason *why* the government can change the policies. She references the "firepower, the votes, and the money," and how the government, not only holds power over the people, but they have the means to enforce the decisions that reinforce

their needs. Supporting the biofuel industry is precisely a need the Brazilian government desires to enforce.

In 2024, Brazil's President Inácio Lula da Silva introduced the National Program for Green Diesel. During his speech at the enaction ceremony he asserted, "Brazil will lead the world's largest energy revolution." (Planalto, 2024). This statement, specifically the desire to "lead", set the presidents sentiment throughout the rest of enaction day: a motivated and progress-driven country and leader. President Lula da Silva continued his directed goal, emphasizing the primary goal of Brazil is to focus on, "investments in agribusiness and the biofuels chain." This includes expanding mandated biofuel blends from 18% to 35% for bioethanol and 14% to 20% for biodiesel by 2030 (Planalto, 2024). This shows a 94% increase in bioethanol and a 42% increase in biodiesel, directly supporting the government's desire for biodiesel expansion. These metrics are important to consider when examining the effect on the indigenous people. Expanding the mandated biofuel blending requirements requires increased production of biofuels, which directly relies on increasing feedstock production. Particularly for bioethanol, which is set to nearly double by 2030, the required land expansion may interfere and threaten existing indigenous settlements. In her statement, Casé Angatu, declared the power and money of the government can infringe upon their rights and land. In President Lula's statement, through pushing for increased biodiesel blends, he expressed the government's desire to supply this funding.

The current biodiesel process network relies on expansion of agricultural land to supply its ever-growing demand for feedstocks such as soy and sugarcane. This system, as seen by the statements of Casé Angatu and President Lula, is further reinforced through government assistance towards the program, and through the support of agriculture and farmers, rather than

honoring its agreements with the indigenous tribes for land rights and demarcation. For example, in 2007, Brasil BioFuels (BBF) broke the agreements with the indigenous communities residing on the properties near their expanding palm oil plantations. BBF purchased the disputed land where the indigenous people were currently residing. One resident, Emídio Tembé, stated, "They bought the farms 'with closed gates', with the cattle inside. But it wasn't cattle, it was us." (Harari & Freitas, 2022). Instead of moving, the communities stayed. In response, the indigenous tribes reported that servicers to BBF beat, cursed, arrested, and shot the members of the indigenous camps (Harari & Freitas, 2022). The tribes fought back. "We lost people because we began to understand what it is to be quilombola, and we began to fight," stated on member of region. It is important to highlight the resistance and resolve the communities showed through fighting. While the BBF may have expected compliance, the members of the indigenous community did not respond to the threats of power and authority in the predicted manner. Through fighting back for their rights and their territories they began to disband the established relationship of agreement and compliance that they had with the biofuels industry and the government. By going against the norm and disrupting the existing interactions, the indigenous people have developed into a rouge actor within the catalyzed biodiesel process network. As a result, as a group they can forge and strengthen unexpected relationships, which shift the previously established network dynamics.

Indigenous People Strengthening Relationships

Through defying the established relationships within agriculturally based biodiesel process network, Brazil's indigenous people have formed unexpected ties with biodiesel communities and the general populous. The continued mistreatment and expansion onto indigenous lands in Brazil has led to outcry within Brazil and the international community at

large. In 2007, the Subsidiary Body on Scientific, Technical and Technological Advice met in Paris to discuss the concerns over expanding biofuels projects around the world (Global Justice Ecology Project, 2007). During this meeting representatives from nations, such as Norway, Germany, and Indonesia, met with indigenous people organizations. During their discussion of Brazil, a member of the Brazilian Landless Workers Movement highlighted concerns over Brazil's attempted blockage of a process to address the negative impacts of biofuels, "There is a clear strategy of the Brazilian government to block any consideration of the social and environmental impacts of agrofuels, as this may interfere with their commercial interests," (Global Justice Ecology Project, 2007). It is important to consider that the speaker chose to mention "social" and "environmental impacts" when referring to things that will interfere with the governments' "commercial interests." By referring to these subjects the speaker was attempting to appeal to pathos in order to garner the support of the United Nations (UN). The appeal to pathos was successful and garnered largescale support within the UN meeting. For example, following the meeting the UN released a report acknowledging the devastation with largescale farming for biofuels. Note that, not only an international meeting for the support of indigenous people affected by biofuels was held, but also that in response to Brazil's continued neglect of the indigenous people, a major international organization issued a statement of support. Furthermore, the countries that are concerned over the agricultural expansion are potential consumers of Brazilian biodiesel. This directly shows that despite the growing biofuel agriculture industry, people are standing behind the forgotten groups and attempting to make a change. Also, the groups are standing behind the indigenous peoples are able to impact the future of the biofuel market.

As I have begun to argue that the indigenous people have the potential to change the biodiesel processes from utilizing agricultural fresh feeds to more sustainable feedstocks, some may argue that the population of Brazil's indigenous people is too small to generate substantial relationships capable of dismantling decades old processes. However, this viewpoint fails to consider that the strength of an actor is not dependent on size, status, or the type of actor. The strength of an actor is based on the purpose they have within a network and how strong the connections are between different actors (Cressman, 2009). Through strengthening their relationships with other actors, the indigenous community can grow and secure their role as a leader within the system, even if they make up only a small percentage of the systems population.

An example of this widespread relationship formation can be seen when Jamie Camil, a Mexican actor known for hit shows like *Jane the Virgin*, took to Facebook in support of an open letter by Brazil's indigenous population about the expulsion from and deforestation of their lands (Camil, 2023). Camil quotes,

> "URGENT! In support of the Articulation of Indigenous Peoples of #Brazil, #APIB… We reinforce the cry of indigenous leaders from all over the Amazon Basin and beyond, and ask you to mobilize all the efforts within your power to prevent a historic injustice being committed by the House of Representatives against the indigenous peoples of Brazil." (Camil, 2023).

Camil links a petition to show support to the cause; 236,742 verified signers have pledged their support (Supporters of the Amazon, 2023). It is important to highlight that this post was written by a celebrity with a substantial social media following. In society, celebrities can act as role models for people and have a larger reach to the general population. Therefore, by them

expressing their support towards a cause, people are more likely to respond and follow suit. This can be seen by the hundreds of thousands of verified signers who supported the petition. Not every signer of the petition is directly affected by the cause or even resides in Brazil. However, because of the extension by celebrities, also who have no formal ties to the biodiesel industry, the indigenous people's problem was able to garner a wider net of supporters.

These prior examples show how Brazil's indigenous population have used their plight and their new status as a rouge actor to present a new problem within the biodiesel process network: the rights of people and their historic land. Through direct and indirect recruitment tactics, such as meeting with international organizations and writing open letters calling for support, the indigenous population is feeding on the sentiment of the outside world to build new connections. These connections with the outside world, including celebrities, the general populous, and international organizations, can be strengthened to shift power more into the hands of the indigenous people.

Transition of Power

The newfound relationship between Brazil's indigenous population, biodiesel consumers, and the international activists and population at large can shift the trajectory of the core biodiesel processing technology in Brazil. Within a network, power is not isolated to an individual network. Power is held within the relationships between actors. As new allies and adversaries form within a network, this has the potential to shift the power held by certain actors.

This shift has started within the Brazilian biodiesel process network. A report from the International Energy Agency (IEA) on biofuel policy in Brazil, India, and the United States explained the trajectory for the biofuel industry. Initially, IEA stated their goals for the future including, "More technology development and innovation efforts are needed to expand

sustainable feedstocks." They specifically included goals to, "Deploying technologies that can process different feedstocks such as agricultural and forest residues," (International Energy Agency, 2023). These words from the IEA express the desire to research and transition to second or third generation feedstocks using materials such as agricultural and forest residues. Using waste feedstock streams helps reduce the land demand associated with fresh feedstocks. Through expressing these specific biofuel related goals, it shows that the concerns of an international organization are analogous to those of the indigenous people: that continued agricultural expansion is not only unsustainable but also can be detrimentally impactful to indigenous people.

When considering how this connects with changes in Brazil, it is important to note that Brazil is an association country within the IEA. This means that Brazil has agreed to work with the IEA on matters regarding energy security and collaborate on analyses of national and international energy policy (International Energy Agency, 2024). In the same IEA report as previously mentioned, a section about Brazil states, "four cellulosic ethanol facilities under construction that plan to use agricultural residues to produce ethanol at commercial quantities." Cellulosic ethanol biofuel is a process that uses corn waste products, like husks, to create biofuel. This process uses second-generation feedstocks, thus reducing land demands that threaten indigenous people. The development of these plants shows a transition in the Brazilian biofuels industry, which is at odds with the previously stated desires of the Brazilian government. This change is likely due to the influence of the IEA, which has goals for sustainable biofuel development for member and association countries alike. While the desire to transition away from established agriculturally based biodiesel processes may not have been the direct desire of Brazil, as seen in the previous sections, the push of international organizations aligned with the indigenous people have been able to force a small change.

This can be explained because the biodiesel industry in Brazil had an existing network. This network consisted of actors, such as the government, farmers, biodiesel factory workers and owners, investors, international organizations, the international community, among other non-human actors. When the indigenous people began forming relationships with the international community and organizations, like the IEA, the existing relationships did not disappear. However, the goals of the groups began to change, and new allies formed. These new relationships could then be leveraged to change the power within the system. In this case, as the relationship between the international community and the indigenous people strengthened. Groups, like the IEA, could leveraged new goals onto the Brazilian government, an existing relationship. This continued shift in power supporting the goals of the indigenous people, as a result, has the potential to and has begun to dismantle the existing agriculturally based system.

Conclusion

In conclusion, because the indigenous people stood against the normative power dynamics, they were able to forge relationships with the unexpected group of the international community. As a result, these newfound relationships were leveraged to regain power against the government, which had formerly omitted their needs, causing a shift away from agriculturally based biodiesel to begin. Without considering the forming relationships between the indigenous people and the international community, not only would technological transition not be fully understood, but other potential points of failure could go overlooked. Finally, understanding how even small groups have the potential to cause change is important for engineers to remember when building new networks in the future, so the same vulnerabilities do not appear.

Word Count: 3,387 words

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