Evaluating the Social Factors that Impact the Implementation of Wind Turbines in the U.S.

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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

Since the environmental movement kicked off in the late 1960s, the public push for stricter legislation against pollution has driven the explosive growth of the renewable energy sector. More specifically, the development of technology has allowed the electricity sourced from wind energy to reach 7.3% of total domestic electricity generation, equivalent to 300 billion kilowatts-hours, in 2019 (Energy Information Administration [EIA], 2020). Moreover, it is important to understand the sociotechnical factors that influence the development of wind energy to best outline and support its expansion.

Although the rise of wind energy has shocked the industry with a forecasted 17% growth in 2020, the contribution of this sustainable energy continues to represent a small minority of the energy generation in the U.S. (EIA, 2020). As past and current pollution continues to contribute to climate change, it is imperative to devise strategies that reduce the carbon footprint without sacrificing quality of life. The public acknowledges the importance of this issue with an overwhelming majority of 77% of those surveyed favoring the development of renewable energy sources (Funk, 2019). Public support alone, however, cannot alter the infrastructure of the energy sector nor erase the societal links to fossil fuels. The purpose of this STS research is to better understand these social influences and their impact on American wind energy, improving the ability of the public and policymakers to implement these systems successfully.

STS Framework

Using the Social Construction of Technology (SCOT) framework, the circumstances surrounding the development of wind energy can be analyzed through the lens of the stakeholders. Based on the concept that human actions and biases influence the success or application of a technology, this framework offers a unique perspective that enables a more

complete evaluation of important social factors. The most influential players in the development of wind technology are categorized into three groups: consumers, government, and corporations. Since the energy sector sits at the core of American industry and daily life, the sociotechnical analysis of these deep-rooted, social interactions is necessary to fully understand and subsequently improve wind energy implementation. Furthermore, the SCOT framework will help unravel the complexity of the issue through inspection of the historical context, the environmental reputation of wind energy, and the consequential policy and infrastructure of the electricity grid.

Aside from relevant social groups, the key facets of this framework are the concepts of interpretative flexibility and stabilization. Interpretative flexibility expresses that a technology can represent varying ideals across social groups, where biases influence the overall positive, negative, or neutral perception of a device. Through the analysis of the different reactions by specific subsets of a community, the gradual approval of wind turbines can be more thoroughly understood. As the relevant social groups coalesce around a single design, this point represents the stabilization of the technology and its role in society. The point of stabilization illustrates the fundamental function of the technology and the principal characteristics that render it acceptable by the public. Both concepts are necessary to paint a clear picture of wind turbines and the various influences that contribute to its capacity for acceptance.

Background

Widespread utilization of wind energy in America dates back to the mid-1800s, where traditional windmills were established to grind grain and pump water on farms as settlers migrated west (O'Connor & Cleveland, 2014). However, the simultaneous discovery of anthracite coal and its revitalization of iron manufacturing led to further technological

developments that boosted industrialization along the eastern seaboard. With this cheap, abundant fuel, the development of machinery grew to promote the expansion of transportation through the steam engine and domination of railroads (Chandler, 1972). While coal had cemented itself as the backbone of American industry, the invention of electricity and the first coal-fired, centralized power plant in 1882 ensured its authority over the early factory economy. Furthermore, the development of AC power stations combined with the extensive transportation networks eventually eliminated the necessity of windmills through rural electrification programs in the 1930's (Tuttle et al., 2016).

The transition from coal to oil occurred post-World War II during the automotive boom with major companies like Ford using the assembly line to cut costs (O'Connor & Cleveland, 2014). Newly attainable prices drove the automobile to become a stamp of the upper middle class. Consequently, the suburban infrastructure evolved to rely heavily on cars and unfettered access to plentiful, cheap oil. Shortly thereafter, the 1973 OPEC oil crisis pushed the country to reconsider its dependence on fossil fuels, forcing the public and government alike to focus on the diminishing supply of domestic reserves (Resilience, 2019). This international event coincided with the environmental movement that expanded throughout the 1970s, pushing legislation that would establish protections against pollution. As a result, the various complexities of wind power generation and other sustainable technologies currently stand at the forefront of modern society.

Analysis of Wind Turbine Development: Stakeholders & Interpretative Flexibility

The following discussion considers the three primary stakeholder groups: public consumers, the federal government and its officials, and corporations in the energy sector. Using the SCOT framework, the analysis draws on the background to explore the various interactions

of these stakeholders with society and their consequential impact on wind power expansion. It further applies the tenet of interpretative flexibility based on those observations. The various ways that these stakeholders view wind turbines provides a more complete perspective of the social challenges that hinder propagation and advancement.

Public Consumer Influence

A variety of factors have shaped the current role of wind technology and its function in the American energy industry. Although its slow expansion in the utility sector can be attributed to both political and corporate machinations, the lack of such barriers to its residential adoption implies other obstacles. The physical challenges such as noise and size of wind turbines offer a potential answer, yet approximately twenty percent of the American population lives in rural areas (WINDExchange, 2020). More than twenty million homes sit on over an acre of property, where the increasing cost and necessity of electricity suggest wind energy as a cost-effective alternative (Office of Energy Efficiency & Renewable Energy, 2020). Nonetheless, the decision remains a complex balance between economic, technical, and social factors.

Rural residents disproportionately influence the growth and success of residential wind energy due to the technical challenges that limit wind power within urban areas. Often scattered, tight-knit communities, this stakeholder group remains subject to the social guidelines fortified by the unyielding grip of family ties and history. Consequently, the historical context of industrialization paired with economic dependence on the industry due to the lower income level of rural areas offer a unique perspective. According to interpretative flexibility, the positive impacts that the exploitation of coal had on the overall quality of life distorted public reception to favor it over other alternatives. It fueled the economy, driving the advertisement of consumer products that only persuaded workers to spend their little dispensable income under the false

pretense that it would increase their social status (Corbett, 2014). This exploitation of the burgeoning capacity of electricity combined with the vulnerability of the workforce ultimately led crippling economic and environmental repercussions. The menial tasks of the labor stole away the last remnants of valuable skills that left a portion of the population dependent on the power plants (Corbett, 2014).

These historical economic circumstances laid the foundation of social construction of the wind power in the United States. Wind turbines were subsequently forgotten in the transition, where they remained untouched by most due to both practical and cultural barriers. They were a symbol of rejection to public dependence on the industry, which bore its own repercussions as a deviation from the traditional way of life in these insular communities. The technology also remained a substantial monetary risk, where an upfront cost of at least five thousand dollars makes the venture too great a sacrifice. As an expensive, obstructive, and foreign technology, wind turbines were an unpredictable option compared to the reliable energy that fueled the country to become an international superpower.

Additionally, the secluded and individual nature of rural pockets across the United States introduces another factor that impedes wind energy expansion. Ruled by local laws rather than worry about federal programs beyond their reach, these stakeholders are especially susceptible to the age-old fear of the unknown. Aside from the technology itself, the variety of schemes from specific concepts like a Renewable Energy Certificate (REC) to the broad idea of green pricing are intimidating to navigate for anyone with little time or experience (Office of Energy Efficiency and Renewable Energy, 2020). In accordance with the framework, these regulations combined with lack of access establish wind turbines as a prospect too complex and out of reach. The isolation of rural residents within their locality makes it even more difficult for them to seek

information, whether it be about permits or recommendations. Overall, these factors characterize wind turbines as an arduous if not menacing task, and these issues must be addressed to achieve any further development.

Political Influence

The elevated position of wind energy in the tense arena of politics owes itself to the OPEC crisis that sparked alongside the environmental revolution in the 1970s. With government policies and programs like Project Independence, the U.S. government poured money into renewable energy research and development with advancements in wind turbine technology led by NASA (Resilience, 2019). The circumstances of the time combined with the outpour of funds served to rebrand wind energy via interpretative flexibility as a means of economic security for corporate entities that benefited from the boom of electricity. Additionally, the threat of foreign power associated wind turbines with the proud ideals of nationalism and independence in the eyes of the general public. Fundamental to the individualism deep-rooted in American identity, the resurgence of these principles in connection to wind energy redirected the spotlight back onto wind power.

Moreover, the acclaimed professor Bill Heronemus established the fundamentals of modern wind turbines and its importance to the environmental movement (Stoddard, 2002). His congressional debate on energy policy centered the environmentalism movement around renewable technologies, while his research and design of the Wind Furnace at the University of Massachusetts-Amherst demonstrated a solution (Stoddard, 2002). As a tangible instrument of power generation, the environmental movement latched onto wind turbines as a remedy to the environmental damage caused by American industry. This social construction of technology molded wind turbines into a weapon for politicians and activists to gain public sentiments and

push associated agendas. Given that a majority acknowledge the necessity of alternate energy resources, the heroic reputation of the technology established by the environmentalism campaign continues to influence its development today.

The overall positive opinion of a government that favors these efforts towards preservation and sustainability further supports the reputation shift of wind turbines. For example, the presidential campaign that ultimately led President Biden to win the election by popular vote as well as the Electoral College emphasized environmental policy (Chinni, 2020). Following his executive orders to undo the aggressive deregulation associated with President Trump's outspoken support of fossil fuel, Biden has maintained a higher approval rating of 54% despite the pandemic (Chinni, 2020). The media has lauded over the early accomplishments of the newly elected executive, marketing renewable technology such as wind turbines as the upstanding savior in the controversy.

Nonetheless, the policies that garner public support contain some obstacles in addition to their advantages. As the primary motivation to employ renewable energy, the federal tax credits for investment (ITC) or production (PTC) in addition to others incentivize companies to finance its development (Center for Sustainable Systems, 2020). The idea originally linked wind energy with the positive ideas of prosperity and opportunity, associating the risky venture with an entrepreneurial spirit inbred in American culture to exploit interpretative flexibility. The large financial burden carried by the companies, however, restricts their capability to stimulate expansion since they are only effective given that value can already be derived in terms of tax equity (Bhattacharyya, 2020). Subject to the volatile nature of the market, the lack of refundability casts wind turbines in doubt as a futile endeavor due to the inevitability of an economic downturn.

Similarly, Renewable Portfolio Standards (RPS) are essential in the reconstruction of the electrical grid to accommodate renewable sources through mandates that require a certain percentage of electricity be generated from a specific technology (National Renewable Energy Laboratory [NREL], 2020). It possesses its own challenges given that some utilities do not have adequate transmission capacity nor do the ratepayers have the means to afford it (NREL, 2020). Net metering attempts to remedy the issue by allowing consumer generated electricity to be accessed at any time rather than immediately, but the customers must foot the upfront cost (Murtha, 2016). Moreover, the stakeholder group must maintain a delicate balance, otherwise it may disenfranchise some to the benefits of wind power.

Corporate Influence

Following the footsteps of the government, the corporate world aims to capitalize on the politically charged role of wind power regardless of their current position in the controversy. As the bureaucratic watchdog with regard to economic stability and public safety, the government stands as a powerful arena of influence that can either aid or hinder the goals of a corporation. With this in mind, the biggest U.S. clean energy companies formed an alliance with the top wind power trade group to support the Biden campaign (Eckhouse, 2020). The lobbyist organization formation acts as a critical strike to rally supporters and reignite commitment to the cause, forcing wind energy to the forefront of the conflict. It is similar to the original movement in the 1970s, where wind turbines are offered as a weapon against the reign of the opposing political party. Moreover, the economic downturn has left the field with a deficit that threatens their profitability margin, where an alliance with the new government could prove a fortunate remedy. The political promises of a two trillion-dollar plan to eliminate carbon emissions by 2035 offer them an unforeseen opportunity for exponential growth (Eckhouse, 2020).

On the other hand, the companies at the forefront of fossil fuel production hold a pivotal position in the expansion of wind energy. Rather than outwardly oppose the rise of renewable technology, most major companies take a much more subtle approach. These businesses recognize the modern social reconstruction of wind turbines, taking advantage of its unique role at the center of both policy and media coverage. As a primary member of the fossil fuel lobby group, BP maintains a 2200 MW wind capacity in the United States spread across nine wind farms (British Petroleum [BP], 2020). Competitors maintain this strategy, where Chevron has focused on carbon capture in Australia and local oil and gas company Equinor has taken on the largest offshore wind project to date (Todd, 2019). The substantial fossil fuel lobbying budget of $104 million in 2019 reveals their strategy, where they aim to maintain control yet prepare for the inevitable to prevent any financial losses (Eckhouse, 2020). Through the lens of interpretative flexibility, wind power serves as a mere tool for these corporations to maintain their public image and reap the benefits of legislation.

The utility sector remains shielded from scrutiny unlike its large fossil fuel counterparts, where the complex nature of the electricity grid has more influence on the implementation of wind power generation. Since the utility industry structure as a wholesale market requires a reliable source of energy, the intermittent nature of wind power generation discolors it as burdensome to corporations. The unpredictability and ineffective forecasting techniques further support these interpretations since the utility systems are responsible for the subsequent reconfiguration of the power dispatch to meet grid requirements (Tuttle et al., 2016). These obstacles combined with the demanding expectations of politicians to reduce carbon emissions illustrate potential pitfalls that must be addressed to fully integrate wind turbines into grid structure.

While sizable lobbyist contributions threaten to subvert corporate actions, the net impact on wind energy remains positive. Presently, corporations aside from clean energy groups view wind turbines and investment in the technology as a means to an end. The companies compete with each other for government contracts, taking advantage of the financial benefit for themselves whilst pouring desperately needed money and expertise into the sector. Regardless, the investment of corporate giants bolsters the appraising, hopeful narrative that stimulates the acceptance of wind energy among the public. With the widespread marketing of well-known companies, it stands to reassure citizens of the message that wind turbines are the path forward in the energy industry despite corporate attempts to delay that future.

Stabilization & Closure

Since its widespread implementation in the early 21st century, the energy industry has changed little despite the introduction of wind turbines. While wind turbines were initially regarded as insignificant contraptions located on farms, the technology has been revitalized as a leading contributor in the battle against climate change. The public opinion corroborates a positive shift in reputation, where 85% of those surveyed in 2016 were in support of wind power expansion (Funk, 2019). This general satisfaction with the technology combined with technical and infrastructure limitations demonstrate a temporary stabilization of wind turbines as a worthwhile, secondary energy source that continues to grow.

However, the future position of wind turbines within American society remains uncertain. There are multiple paths towards renewable energy, where solar energy has been continually favored by research and development. Although solar panels are limited in the electricity output and cost, wind turbines face many more difficulties given the unpredictability of weather and lack of urban applications (ElementalGreen, 2020). The photovoltaic process

used in solar panels has been a proven method since the 1800s, and the narrow focus of problem-solving makes it more palpable to investors. This development threatens the role of wind power in the American energy sector, where continuous and substantial progress could encourage the abandonment of wind power again.

On the other hand, the ongoing race for a solution to the increasing demand for electricity with limited carbon emissions offers wind power an opportunity. The executive order initiated by President Biden to double federal offshore wind energy production by 2030 echoes this sentiment (Felcyn, 2020). This renewed effort into development offers potential for the technology to expand its role in society with easy access to approximately 53% of the United States population settled along the coast (Felcyn, 2020). Looking to Europe, the wind turbine has the means to evolve into a more prominent source of power and stabilize itself as the backbone to the American energy sector. Moreover, the social, political, economic, and technical factors are left to determine whether its future point of closure situates itself higher or lower than its current position.

Conclusion

Given the global mission to rectify climate change, energy sources that are sustainable and carbon neutral are paramount to the preservation of the modern American lifestyle. By examining the historical context and stakeholders that shape American energy industry through the lens of SCOT, the mechanisms that promote and limit the development of wind energy can be identified and subsequently applied to nourish growth of the sector in the United States. This greater understanding will direct research to optimize wind turbine design and implementation whilst accounting for the social impacts of the technology and the challenges to its acceptance by both industry and the public.

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