Analyzing the Politics of Wind Farm 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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Background

Numerous self-reported mental and physical health problems are attributed to the constant hum of wind turbines in a nearby location. One example comes from Massachusetts, where a woman named Sue Hobart, "couldn't understand why she suddenly developed headaches, ringing in her ears, insomnia and dizziness to the point of falling 'flat on my face' in the driveway" (James, 2013). Reports like this bring attention to the potential risks and disadvantages caused by living adjacent to a wind turbine or wind farm. Currently, an average of 3000 wind turbines are installed in the United States of America each year, and the rate of installation is increasing proportionally to the size and power output of the turbines. Wind energy has become the primary method utilized for renewable energy generation in the US (Brower, 2020). The expansion in the wind energy market has provided the cleanest energy in the nation's history, but perhaps at the cost of local community members. Noise is one of the leading reasons for onshore wind opposition. The prolonged exposure to the turbine noise has been argued to negatively impact human health in addition to being a source of constant annoyance.

There are two main sources of noise produced by wind turbines: mechanical and aerodynamic. Mechanical noise is generated by contact between moving parts like gears and rotaries. Aerodynamic noise is caused primarily by wind blowing across the turbine blades, especially toward the tips, and this creates noise-producing vibrations in the blade. The mechanical noise is insignificant in comparison to the aerodynamic, so the noise discussed for the remainder of the paper will be referring to aerodynamic noise. A utility-scale wind turbine will produce sounds at over 100 decibels (dB) in typical conditions (Noise, 2020). For comparison purposes, this level of noise is about the same as a power lawn mower or a jackhammer (Noise, 2000). A utility-scale turbine is defined as a turbine that exceeds 100 kilowatts of power but are typically rated between 2-3 megawatts (MW) of power. This type of wind turbine, operating at full capacity, could power approximately 1500 homes.

Wind turbine noise and associated potential health effects are risks that locals incur after a wind farm is developed in their community. Other risks to landowners and community members include property value loss, damages from turbine malfunctions or fires, and visual disturbances to name a few. In order to appease or support local community members, energy companies will offer certain incentives for allowing the land for wind farm development and use. Energy companies themselves accrue risk through wind farm developments as well. These risks include natural disasters, turbine malfunctions, or other weather risks. Incidents occurring from risks to the energy company typically result in financial loss. This paper will examine the distribution of risks and benefits among stakeholders during the development and use of wind turbine farms in the United States.

Political Qualities of Wind Turbine Farm Installation

Utility scale wind turbines are typically over 100m in total height (blade length included). Wind farms vastly vary in number of turbines from as few as 5 to as many as 150 (Onshore, 2020). These statistics demonstrate the widespread impact that the installation of a wind turbine or farm can have on many neighboring communities. It also justifies looking further into the risks and benefits among stakeholders that accompany the installation of wind turbines.

In his paper *Do Artifacts have Politics*, Winner (2009) discusses two ways in which technologies possess political properties. The first concerns a creation or implementation of technology. Winner states that a technology that is designed or arranged in order to influence power or decision making in a community has political qualities. For example, in the 1800s, one factory owner in Chicago had pneumatic molding machines installed in factories replacing the skilled workers that were performing the same tasks as the machines before. At first glance, these machines were a way to reduce cost in the factory. However, the skilled workers that were displaced belonged to a local union in Chicago. Thus, introducing the technology into the factory had impacted the power distribution and increased the authority that the factory owner possessed. The effect of the technology on power and social relationships is key and will continually be discussed throughout this paper.

Winner's second argument asserts a technology that requires or is strongly compatible with certain power relationships can be considered inherently political. It is often difficult to foresee these types of social consequences of a technology. Historically, in the context of energy, renewable energy systems are thought to be more decentralizing and democratic, both politically and technically. In terms of solar energy, it is typically more appropriate to build arrays of panels close to the destinations for the power, rather than one enormous array of panels for the power to then be distributed much further away to different areas. With solar energy, high voltage transmission is very limited so power loss increases as the distance the power needs to travel increases. Since the solar arrays can more effectively be constructed closer to those who utilize them, they are decentralizing. Furthermore, because there are numerous smaller arrays to be managed in different areas, it would make sense that each area has some authority over their own array. This is the argument that solar energy is inherently a democratic technology. On the other hand, coal and nuclear power can be transmitted long distances with low power loss because it can be transmitted at higher voltages and low current. For nuclear power in particular, it also makes sense to reduce the dangers of radiation to one larger area. For these reasons, coal and nuclear power are considered centralizing and inherently an autocratic technology.

The large-scale wind turbine technologies themselves may prove to be an exception to the notion that renewable energy systems are more decentralizing and democratic. In her article, Ottinger (2013) explains that the benefits, in this case electrical power, are distributed mainly among a population unaffected by the noise, aesthetics, or optical effects from the wind farms. The analysis gets more complicated when taking in to account that energy companies will often provide incentives to local community members whose land they want to develop on or near to. Some of the benefits offered include property and income tax revenues from project owners for the local government, or income off of lease payments for those whose land they have built on. These are only the direct monetary benefits. Indirect benefits to communities include job production and stable energy costs (Wind, 2007). By supplying some of these incentives, energy companies attempt to balance the risks and benefits of their wind farm development and thus even out the social relationships between stakeholders (other than themselves). Lastly, it is important to note Winner claims that the political properties of technology are often used in defense of supporting or criticizing new technologies. This paper will not attempt to use any political properties of wind farms to support or oppose a course of action, but rather use Winner's ideas as a lens to look at the issue of wind turbine development in a novel way.

While noise from wind turbines is a very common complaint, advocates for wind energy would be the first to point out the controversy surrounding the adverse health effects caused by wind turbine noise. From three surveys conducted in Sweden and the Netherlands with residents exposed to between 40-45 dB of consistent turbine noise, between 25 and 30% reported the noises as just annoying. However, in two of the three studies, there was a statistically significant association between noise level and self-reported sleep disturbance (Bolin, Bluhm, Eriksson & Nilsson, 2011). The authors mentioned that a causal relationship between the noise and the reported sleep disturbance could not be established. In a book titled, *Wind Turbine Syndrome, A Report on a Natural Experiment,* Dr. Nina Pierpont asserts these symptoms and others can be attributed to low frequency noise and termed the disorder, Wind Turbine Syndrome (WTS). It is worth noting that Pierpont's work is in the midst of debate as there is still no concrete study showing the link between these reported symptoms and low frequency noise. Some critics cite her work as containing too small of a sample size and sample bias (Taylor & Klenk, 2019). It is evident that more research still needs to be completed in this area.

Case Context

The cases that will be closely examined in this paper include the Prairie Rose, Bearkat, and Desert wind farms. The selected cases each come from a state prioritizing a different level of government to hold the majority of authority over wind turbine siting decision-making (Khan, J., & Shields, L. 2020). First, the Prairie Rose wind farm is located in Rock County, Minnesota, which is a state prioritizing a dual authority approach to wind farm siting. It consists of 25,000 acres of development with a capacity of 200 MW (Work, 2021). The second case studied is a 22,000-acre project located in Perquimans and Pasquotank Counties of North Carolina. North Carolina favors state authority for power over turbine siting. The 208 MW capacity project was constructed to power data centers for Amazon (Amazon, 2017). The third and final case closely examined is the Bearkat project in Glasscock County, Texas, a state favoring local government decision-making on turbine placement. The Bearkat project is a two-stage project, the first stage included 30,000 acres of land, holding 104 wind turbines generating a maximum of 360 MW of energy (Lemolino, 2017). Each project yields benefits and risks to the county members near the wind farm, landowners, and the energy company(ies) sponsoring the project. Wind turbine noise is one risk factor involved after the farm is operational, however, this research will also incorporate factors from within the construction phase.

Research and Methods

I conducted research to answer the question: How does the installation of wind farms affect the distribution of risks, benefits, and authority among stakeholders in the United States? As wind energy technology is improving, and there is more pressure to utilize renewable energy, many energy companies are turning to wind energy to diversify and expand their energy portfolio. It is essential that the consequences of wind energy are well-defined and better understood for stakeholders.

In order to fully grasp and answer this question, I wanted to analyze in depth three different wind farm developments in the United States. I gathered data from policy documents, prior literature, news organizations, and energy companies. Policy documents contained necessary information regarding siting regulations for wind turbines and farms. These regulations vary within, and between states as the authority for creating these regulations is handled on state and/or local level. Wind farm developers have to consider regulations from all levels of government. I required prior literature in my research in order to demonstrate negative reported health effects of wind turbine noise and visual disturbances. The literature also supported the incentives offered to landowners and the community prior to development. I elicited public views and complaints from news reports on the wind farms. Finally, the energy companies responsible for the wind farms offer general details and statistics of the wind farms on their websites that benefitted this study.

To provide a more holistic answer to the research question, I wanted to include cases from states that varied in what level of government had prominent siting authority. Figure 1 displays the approach to authority by each state. The figure shows the primary regulatory power. I first compiled a list of wind farm sites in the United States and then selected a random wind farm in which to include in the study until I had one wind farm for each type of regulatory approach (local, hybrid, state). The three selected wind farms were the first stage of Bearkat in Texas, Prairie Rose in Minnesota, and Desert in North Carolina. The stakeholders included in the study were maintained in each case and consisted of the energy companies involved, communities, and landowners. Within this research, the term "community" refers to the local county(s) in which the wind farm was constructed. "Community members" describes the citizens who reside within said township(s). Although not an exhaustive list of stakeholders, the listed groups usually have the most direct involvement with wind farms through their lifetime. I then identified the benefits and risks to each stakeholder group. Finally, I performed case comparisons to describe the differences in risks and benefits between different instances of wind farm installations. Using Winner's framework of techno-politics, I can better evaluate how different instances of wind turbine and wind farm installations impact involved stakeholders by extrapolating how the power and decision-making authority was shifted by the wind farm development. This analysis could also yield potential correlation between the political qualities of the technology and the level of government primarily responsible for turbine siting authority.

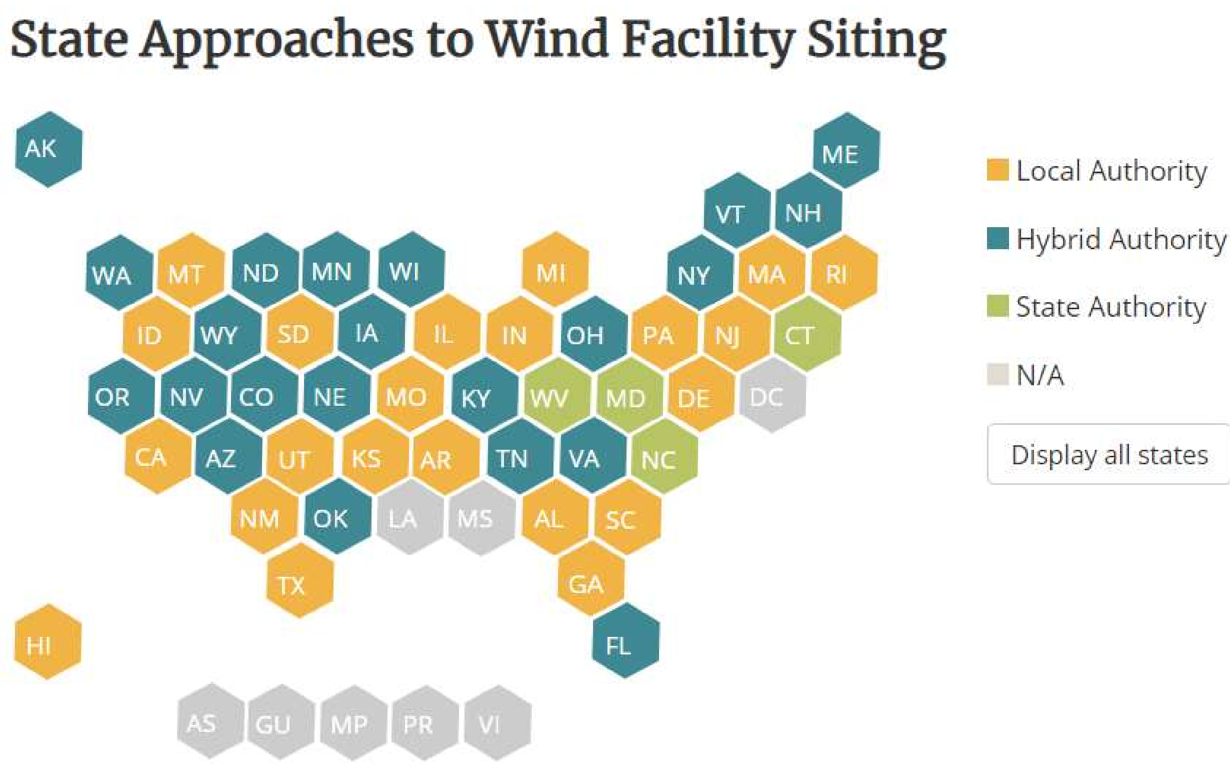

Figure 1. State approaches to wind facility siting (Khan, J., & Shields, L. 2020)

Findings

Landowners typically obtained annual lease payments for towers or power lines on their property, but lost the authority on the portion of land utilized by the energy company. Benefits to a community often included hundreds of temporary jobs, a handful of permanent jobs, and a temporary boom in the local economy. These economic advantages came at the cost of incurring the disturbances caused by the turbines. The case studies showed that the energy company making the initial investment will compensate landowners for land use, and in two of three cases, retained full authority over the wind farm. Each energy company gained tax credits through the wind energy Production Tax Credit (PTC) (Bowers, 2021). Furthermore, studied cases demonstrated more local authority in the siting process resulted in more capital and authority transferred to landowners and the community from the energy company(s). Across each case, the primary risks and benefits differed. The benefits were primarily economic, while the risks were either economic, weather related, or dependent on proximity to farm, see Table 1.

Table 1. Risks and benefits to each stakeholder group

Stakeholders	Benefits	Risks
Energy company(s)	Revenue from electricity generation	Large initial investment Natural disaster
Host county(s)	Temporary employment Permanent employment Temporary benefit to local economy	Visual disturbance Auditory disturbance Decreased property value
Landowners	Lease payments Royalties in electricity generation	Visual disturbance Auditory disturbance Decreased property value Loss of land

Geronimo Energy began the $350 million Prairie Rose Wind Farm project in 2012 and construction lasted just under 7 months. Since 2013, the wind farm has produced an average of 665 gigawatt hours (GWh) per year (U.S. Energy, 2021). Using the average commercial electricity cost in Minnesota of 7.7 cents per kilowatt hour (kWh), the wind farm has sold around $52 million worth of electricity per year. The most common types of disasters that could affect turbines in this area include tornados, floods, snow and ice. Benefits to the county's economy include 180 temporary jobs created as well as 12 permanent jobs and a short-term boom in the local economy of Rock County (Economic, 2020). Kyle Oldre, a Rock County Administrator, explained the additional tax revenue allowed "$4 million worth of road projects" in two years. A

$40k annual contribution from the money generated by the wind farm is also made to a community fund. The fund is managed by a board of directors consisting of township officials and landowners. The Rock County community as a whole gained authority over decision making process with the community fund. The group of landowners are projected to earn $22 million dollars over the 20-year contract in lease payments. The landowners, as part of the directorship overseeing the community fund, also gained decision making power via allocation authority of the fund. The threat of heavy snow and ice also poses another risk for landowners as ice chunks flying off of turbine blades is not uncommon.

In Texas, the Bearkat Wind Farm underwent its development in 2017 with an initial $270 million investment from Tri-Global-Energy (TGE) and Copenhagen Infrastructure Partners (CIP) (Franco, 2020). In the three year it has been operational, Bearkat Wind Farm has supplied an average of 721 GWh of electricity per year (U.S. Energy, 2021). Using the Texas commercial electricity rate of 7.9 cents per kWh, that is an average annual revenue of $57 million of electricity sales. Texas suffers from a larger threat of natural disasters than the other two cases. In February of 2021, Bearkat Wind Energy saw a loss of 177 MW of power for approximately 2 days and was a part of the power crisis that Texas endured during the winter. TGE employed its Work Force Plan which involves giving landowners a royalty in electricity generated by the wind farm for 50 years (Mettler, 2018). This replaces the conventional methodology of annual lease payments to landowners. Of the three cases examined in this study, this Work Force Plan resulted in the largest (projected) revenue for landowners over the lifecycle of the wind farm. Landowners assume a portion of TGE's risk with this agreement. As an example, the turbine failures in 2021 resulted in lost revenue for both the TGE and the landowners. Select landowners as well as investors were brought in to a management team with members of TGE for the created LLC of the wind farm (Mettler, 2018). TGE effectively relinquished a portion of authority over the wind farm to investors and landowners for their cooperation in the project. Glasscock county, where the wind farm is located, benefitted from the construction of the wind farm in through a temporary economic injection.

Lastly, Avangrid Renewables' Desert Wind Farm, also known as the Amazon Wind Farm, underwent an 18-month construction process in 2018 and 2019. This wind farm has a nameplate capacity of 208 MW and was built to power Amazon's data centers located in Virginia and the region (Amazon, 2017). In 2019 and 2020, the wind farm generated an average of 535 GWh of electricity per year (U.S. Energy, 2021). Since the electricity is primarily used for the Amazon data centers, at the average commercial rate of 8.5 cents per kWh, Amazon was able to save over $45 million dollars per year on electricity costs. The host counties of Perquimans and Pasquotank benefitted from the construction of the facility through roughly 500 temporary and 17 permanent employment opportunities to operate the wind farm. The two communities also receive over $500k in annual taxes from the energy production and a reported $18.5 million spent locally during the construction. In this case, the local communities are not guaranteed the energy that the wind farm provides as it supplies the data centers for Amazon Web Services. Approximately 60 landowners were involved in the land acquisition and now are the recipients of annual lease payments totaling $625k (Amazon, 2017). While compensated financially, landowners lose authority over a portion of their land they leased to Avangrid Renewables. John Winslow, a resident of Perquimans County, reported that the wind turbines are noisy, cast shadows, and are visible from many miles away. The Desert Wind Farm was the only wind project of the three cases studied in which a noise complaint could be found. Winslow also references the reported health of effects of turbines including headaches, dizziness, and sleep disruption.

Figure 2 compares the initial cost of the wind farm construction, including access roads and power stations, and the total revenue that the group of landowners for that development are projected to incur based on the agreement with the energy company. It is important to note that the landowner projected revenue for the Bearkat case was calculated based on the projected market value of electricity generated by the wind turbines over their "viable lifetime" (Lemolino, 2017). The exact royalties offered to landowners could not be found, however, the majority of royalties fall between 2% and 3%. The calculation was made based on a 2% royalty to landowners. Bearkat wind farm is located in Texas, which favors local siting authority. Desert wind farm is located in North Carolina, one of the few states favoring state siting authority. The trend in the chart displays an inverse correlation between initial investment and total landowner earnings.

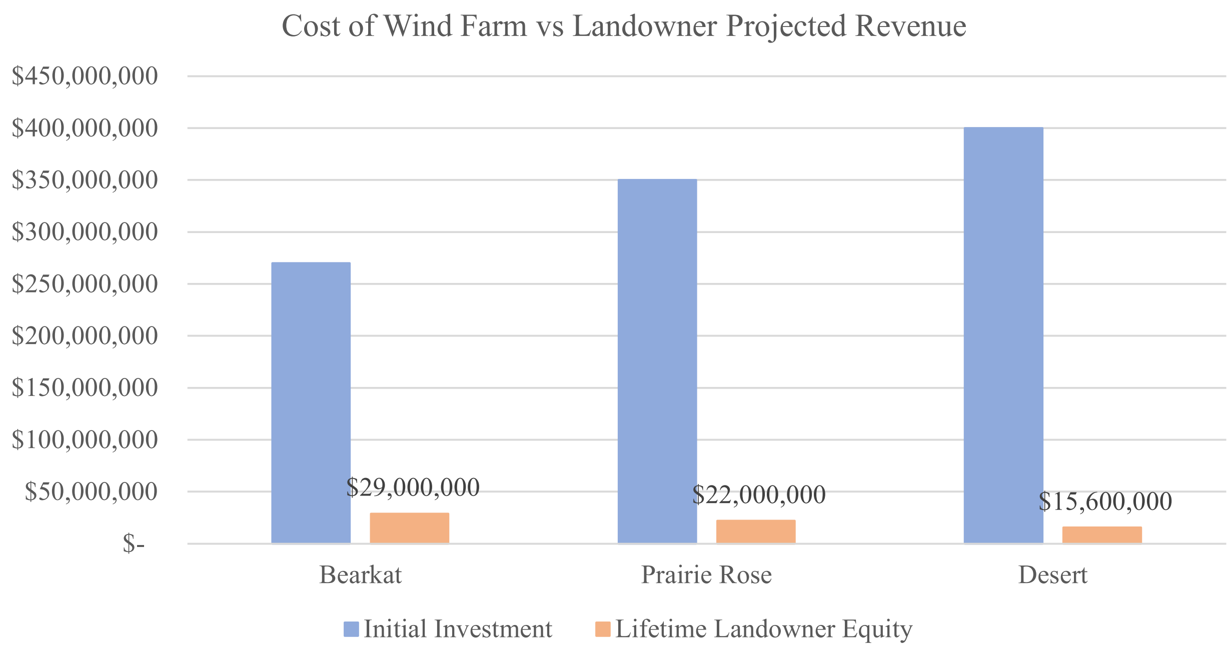

Figure 2. Cost of wind project vs expected earnings for landowners

Discussion

It is difficult to draw a general conclusion about the change in authority resulting from the development of a wind farm based on only a handful of case studies. However, from the three instances of wind farm development included in this research, it is typical for energy companies to gain authority by means of purchasing land from local landowners. Landowners were consistently compensated for the land, but lost control over both decision making for that parcel of land, as well as the restriction of land use based on the agreement with the energy company. Landowners are often restricted in what they are allowed to erect in the vicinity of the wind farm as to not obstruct natural air flow. Communities gained some decision-making power in two out of three instances. In the Bearkat case, a few Glasscock community members were part of the LLC created for the wind farm. In the Prairie Rose case, select Rock County members were appointed to board with control over the allocation of funds contributed by Geronimo energy.

Winner discusses technologies as possessing political qualities. The Desert Wind Farm is the only wind farm within this study which could be argued to be a more centralizing or autocratic technology. This is the exception to the notion that renewable energy systems are considered more democratic. The Desert Wind Farm generates electricity to be transmitted for use at the Amazon data centers in a different region. This follows Ottinger's argument that the benefits of the technology, electricity, are distributed to an area which is unaffected by the technology. The landowners do receive monetary compensation for the use of their land, but do not receive benefits from the wind farm technology in particular. The community members do not see the same type of benefits as uncovered in the other cases, but still are affected by the same auditory and visual disturbances. In contrast, the Prairie Rose and Bearkat wind farms would both be perceived as politically neutral in this sense. These wind farms generate electricity for use by the county and region in which they reside. Although members of Rock, Perquimans, and Pasquotank County still are at risk in terms of the ever-present noise and visual disturbances, they still receive the benefits of electricity, even at a lower cost, from these two wind farms. In the case of the Bearkat wind farm, local landowners and community members are part of a board overseeing the management of the wind farm. In Rock County, Minnesota, a board was devised to oversee a community fund contributed by the Prairie Rose Wind Farm. The shift in authoritative power is better balanced in these two scenarios. For these reasons, the Prairie Rose and Bearkat wind farms are instances of more decentralizing technologies in relation to the Desert Wind Farm.

As previously mentioned, a definite trend cannot be made through the examination of only three case studies. A limitation to the research is the amount that is able to be inferred with such a small sample size. Within these studies, it is very difficult to quantify the economic impact on the local community in the construction phase. Avangrid Renewables had an estimation for local spending during construction in a project document, however, I had no viable method for an estimation in the other two cases.

If I were to rework the study, I would include case studies in which wind farm project efforts were halted or ended based on community noncompliance. The pool of wind farms in which these were selected did not include those that were planned or began but never completed. It would be worth analyzing both successful and unsuccessful wind farm projects to determine the degree of differences in the distribution of risks, benefits, and authority. One other change I would employ is selecting a wind farm that was more local to my own area for the study. Although this would disqualify the randomness of the research, it would allow me to visit the wind farm for myself and I could perform a survey with local community members and landowners to get a different perspective on the project. A continuation of the research might include instances of unsuccessful wind farm development or surveys or interviews with members of each stakeholder group to share their experiences throughout the project planning and development phase. It would also be useful to research the correlation between the average distance between the landowner's home to nearest wind turbine and satisfaction with the development, by perhaps using a survey with a likert scale.

One impact this research has on my engineering career is the emphasizing the importance of community focused development. Just how in computer science, gathering user stories is crucial to developing an application that will actually benefit the end user, energy companies must consider the landowners' and community's needs prior to finalizing a plan for the wind farm. The unique underlying aspect of TGE's Work Force Plan was aligning the landowner's interests with their own by offering royalties on the profits from electricity generation. It discourages future issues with the landowner.

Conclusion

The goal of this research paper is to act as an informative piece of literature on the general changes that occur with risks, benefits, and authority throughout the development of a wind farm. During wind farm development, as seen with the case studies, the host community will often receive a temporary economic benefit during the construction phase of the project and a longer-term benefit through permanent jobs and the taxes paid by the developing energy company without incurring many of the same risks as landowners. For landowners, it is just a question of the required compensation in order to assume the risks of close proximity to wind turbines and relinquish some authority to energy companies by means of leasing land away. Understanding the inherent risks but also monetary benefits for landowners within these various cases could shift the opinions of landowners and community members on whether a wind farm is an attractive prospect in their area. Conversely, energy companies could take this research to modify both the locations of their wind turbines, and incentives offered to landowners in order to bring about a more unified goal of success for the wind farm and green energy as a whole.

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