Is Wind Energy a Better Option for the University of Richmond?

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Abstract

The purpose of this assignment is to answer the question of: Is Wind Energy the Better Option for the University of Richmond? This question is more than simply if wind power will supply the campus the greatest amount of energy, but also looks at the educational, social, environmental and political benefits that would also be associated with it. In order to understand the feasibility of wind power on the University of Richmond campus, I looked at factors such as: energy production from wind turbines, past wind patterns in Richmond, VA, impacts to the environment. This is only one part of a larger project that will explain the potential for using other sources of renewable energies such as hydropower, natural gas, and nuclear power. The overall goal of this paper is not to make a decision for the audience, but rather provide them with the information for the audience to decide which source of renewable energy they think is best.

Background

Introduction

Wind energy has existed since thousands of years ago, generated from windmills located on farms. The first wind turbine was introduced in Cleveland, Ohio, in 1888, to provide energy during the first World War (Kaldellis et. al, 2011). However, it was not until 1950 when wind energy started to develop and have the potential to be a sufficient source of energy (Leithead, 2007). Wind energy is generated from the rotation of turbines due to strong winds. The turbines are connected to a generator which will produce energy. However, the amount of energy that a wind turbine is able to generate is directly related to the size of the turbines themselves. Therefore, the size of wind

turbines has gradually increased to supply the growing levels of energy consumption. With the increase in sizes of the turbines, and the advancement of technology, wind power has become more efficient. Currently the average sized household would require a 1.5 kW wind turbine with wind speeds of 14mph in order to generate enough energy for daily activities such as heat water and power the lights (Energy, 2019). However, for installation purposes, wind turbines are required at least 150m of space away from, and 9m above, the nearest obstacle.

The University of Richmond has set a goal of becoming carbon neutral by the year 2050. The university is also striving to accomplish additional goals such as reducing 30% of its overall carbon emissions. The university consumes 40.7 million kwh of energy per year, which would require 2 million trees in order to offset the related emissions (University of Richmond, 2019). In order to offset their carbon emissions, the University of Richmond has implemented solar energy to the campus in 2016. These panels are able to generate 247,000 kWh of electricity per year, able to offset 364,000 lbs. of carbon dioxide annually.

Theoretical Framework

This project is whether or not wind energy is a better alternative for solar energy. My research will use the ecological systems theory, environmental justice theory, and stakeholder analysis to look at whether wind energy is the best alternative.

Using ecological systems theory, I looked at how human interactions will impact the relationships between the individual and the wider community. Implementing wind power into a community would affect the individual in many different ways. The

impacts of wind power are dependent on whether the individual is installing the wind turbines or if the individual is simply benefitting from the newly produced wind energy. This leads into the microsystem, where the individual's actions impacted those around them (Evans et al., 2014). For example, the microsystem looked at how the energy generated from the wind farms would impact the community as a whole. I looked at how the power gets segmented to provide energy for different areas such as schools and homes. I then looked at the impacts of wind energy on the mesosystem. Here I saw the various interactions between the agents in the microsystem. Analyzing the interactions between agents, the exosystem showed the externalities that are associated with implementing wind power. Afterwards the macrosystem, where people's different cultural views get looked at. Finally, the chronosystem, where results of implementing wind power over time would be located (Ellen et al., 1979).

I looked at the environmental justice side of implementing wind energy. Environmental justice is discrimination in the siting and permitting of industrial and waste facilities, which has forced minorities and the poor to experience disproportionate environmental benefits and burdens (Milner et al., 1999). Here I saw how introducing solar and wind power negatively impacted the communities in the area. I looked at how wind energy impacts communities, especially low-income communities and those of color. This is because these populations are the most impacted by large scale decisions, such as the implementation of a new energy source (Principles, 2017). These populations are also the ones with the least voice to enact change. When looking at how implementing wind energy into the community would affect those populations, I saw how land would be acquired for implementing the big project. How the land would

impact these communities, such as, would it impact the people, would it cause a NIMBY mentality, or would it cause home prices to increase?

Research

Wind Potential

In order to see whether or not wind technology would be a feasible option for supplying the University of Richmond with sufficient energy to complete their daily tasks, I looked at a couple of factors. As stated above, the amount of wind energy that a turbine can generate is dependent upon its size and the strength of the wind within the area. Between the two, the dependent variable is the wind speed in the area, therefore, I looked past wind speeds in Richmond, Virginia throughout the last 10 years. Looking at the charts, the overall wind speeds in the area have fluctuated throughout the years, but is currently at a high of 14mph. This shows us that, not only is wind energy in Richmond, VA strong enough to produce sufficient energy at the University of Richmond, but also wind strength is increasing so the overall amount of wind energy that the wind turbines are able to produce will also increase as well.

Based on the Total Electric Power Industry Summary Statistics, 2019 and 2018, wind energy was shown as the highest non-hydro powered renewable energy source in the US (Tyra, 2019). In 2015, wind energy totaled 4.7% of 2015 U.S. electricity generation (figure 1).

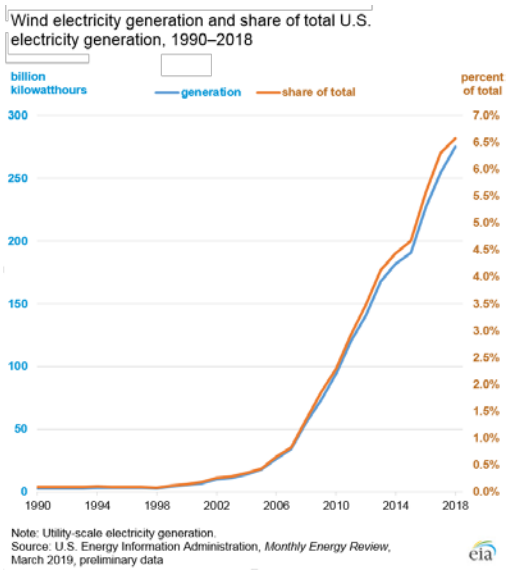

Figure 1: Wind energy supplies the US

The majority of current wind energy projects are onshore, and while wind technology is currently being developed, the technology for onshore wind has almost reached its potential. There is now a stronger push to move wind power to go offshore. This is because, offshore winds are stronger and have less turbulence away which result in increased efficiency and greater power production (Coyle et al., 2014). Wind is created from the difference in temperatures on the Earth's surface. This is stronger by the water due to the water's heating capacity because when the Sun's rays are warming up the land, the Earth's surface temperature is increasing, but the water temperature is not changing. Winds are even stronger at night because after the sun sets, the air temperature rapidly drops, creating a larger difference between the temperatures on the Earth's surface (Randel, 1987). Currently large scale energy companies, such as Dominion Energy, have already taken advantage of this renewable source of energy. Dominion Energy currently has two ongoing onshore with projects in Indiana and West Virginia, and plans on bringing their projects offshore. In West Virginia, Dominion

Energy's wind farm is able to produce power for 66,000 homes with only 12 miles worth of wind turbines (West Virginia, 2019). Dominion Energy is beginning a partnership with offshore wind company Orsted to create an offshore wind farm in Virginia (Coastal Virginia, 2019). This shows how Virginia has wind potential to generate sufficient energy for the greater community.

However, wind energy is not guaranteed, because at moments when the wind strengths are low, or none existent there will need to be another means to provide the required level of energy. Due to its uncertainty and high amount of construction costs, wind energy is considered both unreliable and uneconomical at times (Chapman et al., 2017). Other sources of energy, such as non-renewable sources, are cheaper and have more guaranteed benefits than wind energy. Therefore, if wind energy were to be implemented into the University of Richmond, there would be a need for nonrenewable sources, such as coal and gas, to supplement the rest of energy demand (Destouni et al., 2013). However, like all sources of energy, wind energy also has an impact on the environment.

Impacts

Environmental Impacts

Our global economy has increased by 3.3% every year for the last 30 years, with a similar increase to the energy demand of 3.6% every year (Saidur et al. 2011). In order to fulfill this change in demand, various forms of both renewable and nonrenewable energy sources have been implemented. The issue related here is that each type of energy source has its own impact on the overall environment, and with a

focus also on choosing the least impactful form of energy, people are looking towards wind power.

When deciding which form of renewable energy to choose from, people are looking at each form of energy's carbon footprint. Wind energy was seen to have the second lowest carbon footprint after hydro power (figure 2).

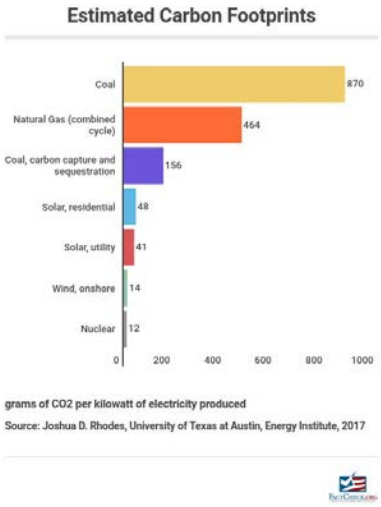

Figure 2: Wind energy has the second

Looking at the life cycle of wind energy, wind energy emits greenhouse gases only during the mining of the material for turbines, transporting of the materials, the construction of the actual turbines, and the decommissioning of the turbines. Unlike other forms of energy, wind energy does not produce amounts of greenhouse gases. In addition to the lack of greenhouse gas emissions, wind turbines do not require as much land as other forms of energy might require. This is because wind turbines can be attached to already created structures. However, if the turbines are on the ground, usual activities, such as farm animal grazing, can still continue because the turbines are so

high up that it would not affect the farm life below; thus, creating a positive externality as well by benefitting the overall rural economy (Varun et al., 2009). Garrett Gross, a scientist from UMKC in Kansas City, Missouri, claims that “The impact made on the environment is very little when compared to what is gained” This is partially due to the fact that wind turbines will have a net benefit, in regards to their environmental impacts, in 5-8 months (Haapala et. al, 2014).

Wind turbines also pose a threat to the wildlife and overall ecosystem. This threat is outlined mainly for bats and birds, such as seagulls, swallows, and swifts. These migratory birds risk flying into either the rotating blades, or the wind turbines itself. Looking at a study about bird mortality, about 328,000 birds are killed by wind turbines every year, however, when scientists compared this number to the amount of birds that are also killed from other forms of energy such as electricity lines, it was the same (Kellett, 1990). Wind energy is also thought to disrupt the behavior of these birds through noise pollution. Research showed that although wind turbines posed a threat to the wildlife in the area, the impacts on the wildlife was not a defining factor for opposition. In order for wildlife to be a factor for opposition, there must also be another reason for opposition such as aesthetics threat framing, economic threat framing, and proximity to a protected area (Giordono et al., 2018).

Social/Economic Impacts

The implementation of wind energy also has implications on the social and economic side of the community. Currently, with a focus on being more sustainable in mind, a carbon tax has been applied to various forms of energy to limit the overall

greenhouse gas emissions associated with them. This newfound focus has led to a push towards adopting more renewable sources of energy, one of which is wind energy. With systems, such as the tradable permit system, in place, there has been an economic incentive to push for adopting more renewable sources of energy. According to the Global Climate Network (GCN), the implementation of renewable sources of energy would also lead to the creation of millions of jobs (Senior, 2009). With the wind turbines only needing to be constructed and installed, with a maintenance plan in place, wind energy is a reliable job creator for both skilled and unskilled workers (Wei et al., 2010).

Health Impacts

Wind turbines also have an impact on the community. Wind turbines, when placed in a quiet area, can generate noise pollution when the propellers are being turned. Another impact that the turbines can have on the community is creating a shadow flicker. This is when the rotating turbines periodically block out the sunrays to people living in nearby buildings. Studies showed that homes located within 200m - 300m of the turbine, the most sensitive areas to the impacts of shadow flicker, had increased chances of having sensory related disorders such as epilepsy (Kellett, 1990). However, studies showed that if the turbines were moved farther away, the impacts on the nearby communities would be reduced.

Discussion

Educational Opportunities

Over 100 schools in 30 states have installed wind generators. This not only provides energy security and lower energy bills, but it also teaches the students and the local community about the benefits of renewable energy. When schools integrate wind energy into their day-to-day activities, they can change the curriculum so that students can learn about wind energy and the parts that go into generating it. Wind turbines at educational institutions are more small-scale which act as a supplement to its overall energy consumption. This allows for a steady integration of wind energy into the lives of those benefiting from it. It can also disprove misconceptions that people might have of wind energy, whether it will devalue the property, or cause negative health implications.

Implementing wind energy into the University of Richmond could open many doors in bringing both positive publicity as well as more educational opportunities for students and community members alike. If small scale turbines were inconspicuously placed on certain buildings around campus, such as the dining hall, the gym, Gottwald, and the business school, then the generators could exist without being in plain sight, which would remove the potential for devaluing the property. The University conducts frequent tour groups for local students, prospective students, and accepted students. When these students witness the University implementing wind energy into their way of life, they have the opportunity to learn more about renewable sources of energies. Dan Nagengast, a facilitator of the Winds for Schools project, says that “Young people really do get that we’re in a transition period away from fossil fuels. They understand the need, and they’re going to understand the technology.” Our generation is currently experiencing a shift towards making more sustainable options to offset the environmental damages that are contributing to climate change. However, the reason

that not more is done is due to either a lack of, or a misuse of information. Therefore, introducing wind energy, and other systems of renewable energies, to the students will provide them a chance to ask questions so that they may learn about how the technology works and impacts the greater society.

Having renewable sources of energy available for students to learn from will allow them the opportunity to make a final decision for themselves. When presenting the information about different forms of energy, whether it be wind, or solar, the intent of this project is to allow the audience to decide which form of renewable energy is the best for them.

Conclusion

In conclusion, I believe that wind energy has not been developed enough to make an impact in supplying the University of Richmond with sufficient energy. This is because of various factors such as wind speed, available technology, and potential locations. Looking at the current wind speeds, as well as the trend of wind speed over the last 10 years, Richmond, Virginia has only met the bare minimum requirements to generate enough wind energy for the average household. In addition to that, the available technology for harnessing wind energy is not at the point where we can guarantee continuous energy for moments when wind speed is either low or nonexistent. In order for wind to be more of a reliable source of energy, there needs to be development in storing wind energy. Finally, for the University of Richmond campus, there is not available space to set up the wind turbines without debilitating the aesthetic

that has already been established. With these factors in mind, I do not believe that wind technology is at the point to be able to supply the entire with energy.

Wind energy can, however, be a good educational component to introduce into the university. Wind technology is currently being developed, and if the University would to adopt wind energy onto its campus, then the University would be able to be a leading component in improving the various methods of renewable energy sources. With the various tour groups that the university hosts every year, adopting wind energy would allow the university to express their green initiative to prospective, accepted, and incoming students. The implementation of wind energy might not be a good alternative to an energy source, but can be a good supplement, as well as a good educational factor on campus.

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Citations

Ball, J. (2012). Tough Love for Renewable Energy: Making Wind and Solar Power Affordable. Foreign Affairs, 91(3), 122-133. Retrieved from http://www.jstor.org/stable/23217972

Chapman, S., & Crichton, F. (2017). The history and growth of windfarms, and early objections. In Wind Turbine Syndrome: A Communicated Disease (pp. 1-32). AUSTRALIA: Sydney University Press. Retrieved from http://www.jstor.org/stable/j.ctt1zrvhrt.7

Coastal virginia offshore wind | dominion energy | dominion energy. (n.d.). Retrieved May 1, 2019, from https://www.dominionenergy.com/company/making-energy/renewable-generation/wind/coastal-virginia-offshore-wind

Coyle, E., Basu, B., Blackledge, J., & Grimson, W. (2014). Harnessing Nature: Wind, Hydro, Wave, Tidal, and Geothermal Energy. In COYLE E. & SIMMONS R. (Eds.), Understanding the Global Energy Crisis (pp. 91-124). West Lafayette, Indiana: Purdue University Press. Retrieved from http://www.jstor.org/stable/j.ctt6wq56p.9

Destouni, G., & Frank, H. (2010). Renewable Energy. Ambio, 39, 18-21. Retrieved from http://www.jstor.org/stable/40801586

Dussias, A. (2013). Room for a (sacred) view? American Indian Tribes confront visual desecration caused by wind energy projects. American Indian Law Review, 38(2), 333-420..

Ellen, R., & Burnham, P. (1979). Social and Ecological Systems. Current Anthropology, 20(1), 117-118.

Evans, C., Smokowski, P., & Cotter, K. (2014). Individual Characteristics, Microsystem Factors, and Proximal Relationship Processes Associated with Ethnic Identity in Rural Youth. Journal of the Society for Social Work and Research, 5(1), 45-77. doi:10.1086/675848

Giordono, L. S., Boudet, H. S., Karmazina, A., Taylor, C. L., & Steel, B. S. (2018). Opposition “overblown”? Community response to wind energy siting in the Western United States. Energy Research & Social Science, 43, 119–131. https://doi.org/10.1016/j.erss.2018.05.016

Installing and maintaining a small wind electric system. (n.d.). Retrieved April 27, 2019, from Energy.gov website: https://www.energy.gov/energysaver/installing-and-maintaining-small-wind-electric-system

Kaldellis, J. K., & Zafirakis, D. (2011). The wind energy (R)evolution: A short review of a long history. Renewable Energy, 36(7), 1887–1901. https://doi.org/10.1016/j.renene.2011.01.002

Kellett, J. (1990). The Environmental Impact of Wind Energy Developments. The Town Planning Review, 61(2), 139-155. Retrieved from http://www.jstor.org/stable/40112888

Leistritz, F., & Coon, R. (2009). SOCIOECONOMIC IMPACTS OF DEVELOPING WIND ENERGY IN THE GREAT PLAINS. Great Plains Research, 19(1), 3-12.

Leithead, W. (2007). Wind Energy. Philosophical Transactions: Mathematical, Physical and Engineering Sciences, 365(1853), 957-970. Retrieved from http://www.jstor.org/stable/25190482

Milner, J., & Turner, J. (1999). Environmental Justice. Natural Resources & Environment, 13(3), 478-502. Retrieved from http://www.jstor.org/stable/40923860

Principles of Environmental Justice. (2017). Race, Poverty & the Environment, 21(2), 82-83. Retrieved from http://www.jstor.org/stable/44687765

Randel, W. J. (1987). The evaluation of winds from geopotential height data in the stratosphere. Journal of the Atmospheric Sciences, 44(20), 3097–3120. https://doi.org/10.1175/1520-0469(1987)044<3097:TEOWFG>2.0.CO;2

Saidur, R., Rahim, N. A., Islam, M. R., & Solangi, K. H. (2011). Environmental impact of wind energy. Renewable and Sustainable Energy Reviews, 15(5), 2423–2430. https://doi.org/10.1016/j.rser.2011.02.024

Senior, K. (2009). Renewable Energy Generation Creates Jobs. Frontiers in Ecology and the Environment, 7(9), 459-459. Retrieved from http://www.jstor.org/stable/25595213

Van Kooten, G., Johnston, C., & Wong, L. (2013). Wind versus Nuclear Options for Generating Electricity in a Carbon-Constrained World: Strategizing in an Energy-Rich Economy. American Journal of Agricultural Economics, 95(2), 505-511. Retrieved from http://www.jstor.org/stable/23358424

Varun, Prakash, R., & Bhat, I. K. (2009). Energy, economics and environmental impacts of renewable energy systems. Renewable and Sustainable Energy Reviews, 13(9), 2716–2721. https://doi.org/10.1016/j.rser.2009.05.007

University of Richmond. (2019). Energy at UR infosheet (Report No. 10-26). Richmond, VA: Office of Sustainability

Wei, M., Patadia, S., & Kammen, D. M. (2010). Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US? Energy Policy, 38(2), 919–931. https://doi.org/10.1016/j.enpol.2009.10.044

West virginia and indiana wind generation projects | dominion energy. (n.d.). Retrieved May 1, 2019, from https://www.dominionenergy.com/company/making-energy/renewable-generation/wind/west-virginia-and-indiana-wind-projects