**Why Wind Power Advantages and Drawbacks Must Be Taken Into Account**

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The control and use of wind power make for a clean and sustainable form of electricity generation. It does not produce global warming gases nor toxic pollutants. The wind is inexhaustible, abundant, and free, making it a perfect alternative to carbon and nuclear fuels. The use of wind power to produce electricity is growing at a fast pace all around the world. It is for this reason that a thorough analysis of its advantages and drawbacks must be taken into account each time a wind farm is developed. Although it has great potential and benefits, “wind power also impacts the environment as a whole” Union of Concerned Scientists. (2013, March 5) in ways that have to be observed and which can be mitigated.

To assess the benefits and drawbacks of wind power it has to be understood how electricity is generated from wind power. Wind power is the process by which wind is used to generate electricity. Wind is caused by the irregular heating of the atmosphere by the sun, the rotation of the earth, fluctuations in the earth's surface, vegetation, bodies of water, and mountains. The wind goes through the turbines that change the kinetic energy in the wind into mechanical power. A generator turns this mechanical power into electricity. The turbine starts generating electrical power with wind speed of six to nine miles per hour and shuts down if the wind is above fifty-five miles per hour to prevent damage to the equipment.

Wind turbines have two basic designs. Vertical axis and horizontal axis turbines. The vertical axis looks like an eggbeater and is best suited for residential applications. They perform better in places where turbines cannot be placed high enough for steady winds. Horizontal axis turbines look like an airplane propeller and are the most used in wind farms because they can produce more electricity. Experts indicate that wind power is capable of supplying more than twenty percent of the world’s electricity. Wind power has an enormous potential and big environmental and economic advantages over carbon energy production. Rural areas that have trouble attracting new industries are able to revitalize their economies by attracting the wind energy industry. Wind farm development generates millions in revenue from property tax and land lease payments. There is less tax-payer money spent in subsidies. Although wind power receives federal subsidies, it receives much less than conventional energy. According to Renewable Energy World magazine Ingram, E. (2020, March 2), “conventional energy receives three hundred billion dollars in subsidies per year, while renewable energy has received less than twenty billions of tax-payers' money in the last thirty years.” One big advantage of wind energy is that it has a free fuel source. Wind is free, it does not need to be mined. This also makes wind power price to be more stable because its fuel price is fixed and free. Per Ellsmoor (2019, June 15), the cost of electricity from wind power has dropped from almost forty cents in the 1980’s to almost two to five cents per Kilowatt/hour thus promoting a cost-effective energy production.

Daniels, L. (n.d.). Pros & Cons of Wind Energy indicates that another advantage of wind power is that it supports the agriculture since the turbines can be installed in the middle of the cropland without damage to production. Wind farms in flat areas on the most part take up more land than the ones located in the hills. The land in the farm can also be used for trails, highways, agriculture and livestock. At the same time, without the need for mining there is less destruction of land. Offshore wind farms take up more space because they require bigger turbines and blades. Some studies have found offshore farms act as artificial reefs and increase the fish population. Wind power also maintains lakes and streams clean. A nuclear power plant pollutes 600 times the amount of water to make the same amount of electricity with wind. Wind power does not pollute the air unlike coal and nuclear which produce emissions that cause acid rain and greenhouse gases.

Despite its vast potential, there are a variety of impacts associated with wind power generation that should be recognized and mitigated. Aesthetics is a disadvantage of wind power because wind turbines have a visual impact over the landscape. People have different reactions when seeing the turbines. To improve aesthetics the turbines can be arranged in a visually pleasing pattern or painted in neutral color. Sound and vibration are another problem since the wind turbines produce foreign noise to the area. With turbine development, the noise has been reduced considerably by the use of sound-absorbent material and minimizing blade surface imperfections. Another problem is the shadow flicker that is produced when the rotor blades turn during the day. This light alteration only affects the people living near the turbines. Depending on the area sensitivity, the turbine construction might affect plants and animals. The bird collisions are very rare since the rotor blades spin slowly at fifteen times per minute. For this reason, these impacts are not a threat to species population. One example are bats. Bats are more active when the wind speed is low. The environmental impacts of wind power are nominal compared to its advantages.

Almost everybody in the world knows that carbon energy sources are harming the environment. It is for this reason that energy production is transitioning to renewable energy. But renewable energy also has an impact on the environment. Some of the impacts are large land area requirements and warmer surface temperatures. Research has found that the move of the United States to solar and wind power would require five to twenty times more land area than previously expected. And if large wind farms are built, the continental United States average surface temperature would rise by 32.4 degrees Fahrenheit. "Wind beats coal by any environmental measure, but that doesn't mean that its impacts are negligible.” (Keith & Miller 2018, par. 17) We have to make broad studies of the advantages and disadvantages of the types of renewable energy to be used in certain areas. This knowledge will help us make a better choice in which technology to use that will cause the least damage to the environment.

Keith and & Miller (2018) modeled large wind farms electricity generating capacity and came to the conclusion that real life wind power generation had been overestimated. The interactions between turbines and the atmosphere was not accurately accounted for. In 2013 they researched the wind turbine blades and how the air behind them was slowed down. He describes this effect as a “wind shadow”. (Keith & Miller 2018, par. 20) To reduce the wind shadows the turbines have to be carefully spaced apart thus taking more land area. Power density is how power generation vs wind farm area is measured. When wind farms are larger than 10 kilometers the wind shadows have a big impact on power density by lowering it. This means that wind farms will need more land area to produce the proposed energy targets for wind power. With this large scale they would become an important figure in the climate system.

To estimate how large wind farms would impact the climate the model was established by Keith and Miller (2018). They used a standard weather forecasting model and then placed turbines over one third of the United States. This would simulate actual electricity demand in the United States. The model showed that this setting would rise by 32.4 degrees Fahrenheit the continental United States average surface temperature. The highest temperatures would happen at night with a rise up to 34.7 above average. This warming effect is caused by the turbines mixing the atmosphere above and below. Keith and Miller analyzed satellite studies of north Texas and compared them to their model observations and discovered similar increases in temperature. It is important to point out that Keith indicates "The direct climate impacts of wind power are instant, while the benefits of reduced emissions accumulate slowly. If your perspective is the next 10 years, wind power actually has--in some respects--more climate impact than coal or gas. If your perspective is the next thousand years, then wind power has enormously less climatic impact than coal or gas." (Keith & Miller 2018) This study is not a negative judgment on wind power. On the contrary, wind power has many beneficial factors and the study is just showing the world that other factors need to be taken into account when planning large scale wind farms.

One of the challenges of wind power is the intermittent nature of the wind. Even in the optimum locations for wind harvesting, there is no way to guarantee the wind will be providing enough energy to meet the demand for electricity at any given time. In order to ensure consistent and reliable electricity, wind energy needs to be able to be stored. According to Taylor, P. (2009, September 28), the wind itself cannot be stored, but there are a few ways to store wind energy. Wind farms generate make most of the electricity during the night, when the demand is at its lowest point. For this, the energy generated has to be stored to be used during the day. This is known as intermittent power source. There are companies working on the development of storage facilities to help the electric grid regulate wind power intermittent generation and the power supply demand. For example, Beacon Power has a storage device called a flywheel. Each flywheel weighs 2,500 lbs. and turns faster than the speed of sound. An array of hundreds of these is able to store 20 megawatts. When the wind power production is low, the flywheels can power 200 homes for one day. Another storage device in the making is a massive battery the size of a bus. These batteries are made of sodium-sulfur or lithium-ion. Other batteries are being assembled by racking smaller batteries together. With these innovations a buffer system can be put in place to store the energy needed to balance the wind powered electric grid.

Power Technology (2019, June 29) lists the world's ten largest wind farms by capacity and includes two which are offshore. From this list of ten, five of them are operated in the United States mostly in California and Texas. The biggest wind farm in the world is Jiu Quan Wind Power Base in China, also known as Gansu Wind Farm. When finished it will have a planned installed capacity of 20GW and 7,000 wind turbines. The wind farm will expand across the Shandong provinces of Gansu, Hebei, Inner Mongolia, Xinjiang, Jiangsu and the Jiu Quan, China. The fifth biggest windfarm in the world is the Shepherds Flat Wind Farm located in the United States. This wind farm covers 30 square miles of the eastern part of the state of Oregon and has 338 turbines. It generates enough electricity to power two hundred and thirty-five thousand households. The largest offshore and the sixth in the world is the London Array Offshore Wind Farm in the United Kingdom. Located off the south east coast of the United Kingdom. It is made up of 175 turbines that rise 87m above sea level and can power two-thirds of Kent area households.

In conclusion, wind power has enormous environmental benefits as it is a form of electricity generation that is sustainable and clean. Technology must move in this direction which is so beneficial for the environment and society. Unlike its fossil fuel counterparts, wind power does not produce greenhouse gases and is unlimited. Wind power supports the agriculture and rural areas are able to revitalize their economies. There is no need for mining so there is less destruction of land. Offshore wind farms act as artificial reefs and increase the fish population. Wind power also maintains lakes and streams clean. Despite its vast potential, there are a variety of impacts associated with wind power generation that should be recognized and mitigated. Aesthetics, sound and vibration, and shadow flicker are among some of the disadvantages. Large wind farms require large land areas. Research has found that such large wind farms warm the earth surface temperatures. If large wind farms are built, the continental United States average surface temperature would rise by 32.4 degrees Fahrenheit. Wind power advantages overwhelm its environmental and economic impacts. These impacts need to be studied and assessed to make a good choice when developing wind farms. By developing a wind farm from a robust and well assessed study the impacts will be mitigated.

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