The Idea of an Essay

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Blowing in the Wind

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"Blowing in the Wind," by Ethan Law

Instructor's Note

Ethan Law's essay "Blowing in the Wind," describes the process by which wind turbines harness wind to create renewable energy. According to William Zinsser, renowned writer and teacher of writing, a person who can describe how something works can write anything. In this informative paper, Ethan clearly articulates the process by which wind turbines harness the wind to create energy. Even though Ethan is writing about a scientific topic, he clearly communicates his ideas to non-scientists with clear organization, analogies, and the human connection he makes with his readers. Analyze how the use of clear organization, analogies, and a human connection allows Ethan to communicate effectively with the essay's readers.

Writer's Biography

Ethan Law is a freshman Computer Engineering major from Virginia. He always enjoyed writing as a simple diversion, but was challenged to broaden his genres and refine his style while studying at Cedarville. He enjoys rooting for the Duke Blue Devils, participating in athletics, and spending his free time outdoors.

Blowing in the Wind

On a typical day in Cedarville, the casual observer will notice the hourly plight of students like me as we plod to class, desperately fighting the wind. Perhaps that observer will join me in my amused attention to young women who swat and claw at their hair to keep it out of their faces. Or perhaps the observer and I could witness a defenseless walker get blown off balance and into another person. I feel sympathy for those who attempt biking and longboarding, and especially for those unfortunate few who, on a rainy day, lose their umbrellas to the mayhem.

I, like many students, wonder if there exists a profitable use to this unusual windiness. Long ago, the medieval Persians contemplated the same thing and invented the windmill (Musgrove 15-6). Today, wind turbines meet one of society's greatest needs, electricity, by harnessing the free resource of wind. In a wind turbine, rotary motion from the blades travels through a driveshaft into a gearbox and then into a generator, which powers the controls and produces electricity.

The power generating process begins with rotating turbine blades. Power companies build wind farms in areas with strong, consistent wind to rotate the turbines. Dr. Pramod Jain uses his experience as president of Innovative Wind Energy to explain turbine generators in his book, *Wind Energy Engineering.* Engineers like Jain have designed the blades to produce maximum efficiency with minimum production costs. Engineers have developed many different types of blades, but the most common is a twisted, airfoil design. Because the blades have a twisted shape, they face forward and look wide in the center, but face laterally and look narrow near the ends. This creates greater efficiency because of the aerodynamics taking place as the tips of the blades move faster than the middle. Most blades also have an airfoil design, like the wing of an airplane. Just like an airplane receives lift from the air passing over its wings, a windmill rotates when air passing over its blades provides the blades with a lifting force. Many blades also have tips that can turn to prevent the blades from rotating, slowing them down much like landing flaps stop an airplane (43-5). Airfoil-style rotor blades only begin the process, however, and they must somehow connect to the electricity-generating components.

The rotor blades connect to a central hub, which turns a driveshaft inside the nacelle. The nacelle is the encasement on top of the wind tower that houses all the electricity-generating parts (Jain 173). According to engineering professionals Dr. Robert Gasch and Jochen Twele in their book *Wind and Solar Power Systems*, the hub acts as a central point for the blades to connect. Hubs typically exhibit simplicity, but some varieties feature flapping or teetering, which allow the blades to bend in the wind. This keeps the blades from breaking or rocking when the wind intensifies. The hub connects to the driveshaft, which rests on a series of low-friction bearings and supports (59-63). These bearings operate much like those in the wheels of a Cedarville student's longboard. In a longboard, bearings allow the wheels to turn freely, just like they do for a driveshaft. The driveshaft transfers the rotating motion of the blades into the gearbox, which sits in the nacelle.

Gearboxes transform the slow, powerful rotation of the blades into a much quicker rotation needed for the generator. A gearbox transfers the speed of the rotors into an appropriate speed for the generator. For example, a gear ratio of 1:7 means that for every time the rotor blades complete a revolution, the generator on the other side of the gearbox turns seven times. The gearbox does this by a series of gears linked together and fine-tuned for maximum efficiency. The types of gears vary from round spur gears to triangular bevel gears. The most common type, a planetary gear, has several spur gears inside of one stationary ring. Some applications even use belts or chains to change the low-speed rotation of the driveshaft into a quicker rotation for the generator. A lubrication system must keep the box oiled to prevent the gears from overheating and destroying the system. Because of the complexity of a gearbox, unreliability and inefficiency often stem from a poorly-designed or under-maintained gear system in a wind turbine. For this reason, some turbines use other methods to bypass using a gearbox, but typically only in small wind projects (Gasch and Twele 77-9). After increasing the speed of the rotation, the gearbox passes the rotary motion to the generator through a coupling mechanism.

The generator produces the electricity in a wind turbine. A generator consists of two parts, a rotor and a stator. The rotor is a magnet that rotates inside the surrounding stator. Because of a physical property called Faraday's Law of Induction, a magnet can induce a current in a wire. If the magnetic field cuts across a coil of wire, like it would in a rotating generator, then the wire obtains Alternating Current (Jain 198-203). The rate at which the generator produces this current depends on the speed of the rotation. Unfortunately, the wind doesn't always blow the same speed, especially in places like Cedarville. Generators compensate for this by allowing different numbers of wire coils to turn on depending on the speed of the wind. Once the generator starts pumping the electric current, it travels away from the generator to either the wind turbine's control mechanisms or to the power grid.

The small portion of the current that stays in the turbine regulates and controls many aspects of the electricity-producing process. Dr. Mukund Patel, who has engineered for several of the largest firms in the world and gained recognition from NASA for his work, writes about some of these control systems in *Wind and Solar Power Systems*. He explains that the main control systems include a stall controller, a yaw drive, a computer, and numerous sensors. The sensors measure wind speed, temperature, current flow, and other critical values and send them to the computer. The computer decides what systems need to be activated and when. It also sends collected data to a control center so operators can make manual adjustments if necessary. The yaw drive turns the direction that the windmill is facing by driving a gear along a small track that goes around the inside of turbine's tower. The stall controller, according to Patel, starts up the turbine when the wind reaches eight to fifteen miles per hour and shuts it off around fifty to seventy to prevent overheating or damage (61). These stall controllers sit in the hub and slow down the turbine by tweaking the direction the rotors point. This creates an aerodynamic disturbance that "stalls" the turbine. Many wind turbines also implement disc brakes on the driveshaft or hub to help stall a turbine that is turning too fast. All of these controls help ensure that the windmill generates electricity properly.

The final step requires transporting generated electricity to where it belongs. Since wind farms often lie far out in the countryside, high-voltage power lines take the electricity to the urban centers that demand it. Power electronics ensure that the current alternates at the proper frequency. They can also siphon any current needed either to run the wind farm or to charge turbine batteries (Jain 242). AC electricity coming from the generator passes through a series of transformers that raise its voltage so it can survive the long trip to the city.

Thus the nemesis of Cedarville students produces a necessary commodity. In fact, some engineers surveyed Cedarville for a potential wind farm, but found the wind to be too inconsistent (Schumacher). Other Midwestern areas, however, are investing in wind power. The whole world is keeping its eyes open to the possibilities of renewable energy, as described by Peter Musgrove in his book, *Wind Power*. Musgrove led the movement for the implementation of wind farms in Great Britain. He suggests wind power as a viable renewable energy source for a world facing an impending energy crisis. Constant advances in technology are making renewable energy sources comparable with coal and oil in price and practicality (209-225). So I face my daily fate with joy, knowing that the wind in my face is powering someone’s home today, and maybe mine one day, too.