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Sustainability: Wind

Increasingly in today’s world, the emphasis and use of “green” products and production methods is driving technological development. Humankind has finally recognized that the possibility of running out of exhaustible natural resources is a very real threat, and could occur within several generations if society is not careful. Pollution is rampant, in particular with all the cars on the modern roads, burning gasoline and spewing pollutants into the earth’s atmosphere. Scientists are starting to see signs of global warming because of all the pollution, consumers are seeing energy cost hikes, and nations and their leaders feel the tension amongst themselves as they compete to secure diminishing resources.

This is where the idea of sustainable energy comes in. Sustainable energy not only comes from renewable energy resources, but additionally does not pollute the earth, unlike burning fossil fuels. In short, sustainable energy provides the current generation with the energy we have become accustomed to living with, while at the same time ensuring future generations with the promise of having that same energy. Switching to sustainable energy is key to the survival of future generations.

There are several challenges that need to be addressed when producing sustainable energy that must be overcome in order to make the switch. The method through which we produce energy must be safe, first and foremost. Another huge obstacle is that sustainable energy sources are unpredictable and often unreliable in nature. For instance, how do you collect solar energy on a cloudy day? Or wind energy on a mild day? The design must be cheap too. If there is no benefit or profit to a company that would take part in producing sustainable energy, then no company will produce it. Or if a company produces sustainable energy for only small profits, the operation will not grow and we will remain dependent or exhaustible energy sources. Our SEDP projects therefore, must demonstrate primarily that sustainable energy is safe, reliable, and cheap.

All of our group’s research was done online, using the official websites of several wind power groups, such as The American Wind Energy Association’s website (http://www.awea.org) and renewable energy groups, such as The National Renewable Energy Laboratory (http://www.renewableenergyworld.com). Also online we found many resources and statistics provided by the U.S. Department of Energy, which was very useful for drawing conclusions about modern day wind power usage and trends.

From our research we reached several conclusions. First and foremost was that our design was going to involve a windmill in some form. An overwhelming majority of wind energy collectors are windmill shapes. These devices spin from the force of the wind, generating electricity. Since they are widely implemented and the most efficient design out there, that was decided to be the basic design of our project. Secondly, we learned that wind is an unreliable energy source compared to fossil fuels. Wind currents vary in strength depending on the weather. An idea we uncovered in our research was that wind collectors could be placed next to highways to collect the man-made wind of modern cars flying by on the highway. This concept came up constantly during our brain-storming process. The final key concept we uncovered was that the electricity produced by the wind collector did not necessarily have to attach to the power grid, but could rather be used to power a single object or function. In the past, this was the more popular use for a wind generator, to produce electricity for a single house. We decided to use this concept as well, as can be seen in our brainstorming sheet and final design, which produces electricity for a single purpose.

Our team was given the task of brainstorming five ideas each person. Being that our energy source was wind, many of us turned to wind turbines. The main differences between our ideas were how they were to be applied and how they would be used. There were turbines that were the stereotypical conventional ones while others were adapted to lamp shades and plastic bottles.

Some of the applications of conventional wind turbines consisted of: Turbines that soat over the road which would use the wind generated by cars passing under it; Wind turbine trike which has a turbine sit somewhere on the bike; Roof top turbines; vertical wind turbines; car-side wind turbines; streetlight wind turbines; wind turbines on airport runways; on-airplane turns; and turbines between buildings. Some of these options seemed somewhat realistic. For our purposes though, these were not applicable because we would not be able to make a scale model. Plus, it was pretty much just placing a wind turbine on a different location instead of on a wind turbine farm.

Now that those ideas that were impractical were sorted out, we tried to filter out the rest of the ideas that didn’t seem possible for us. Our top ideas consisted of the handheld wind charger, Wind Powered Light bulb, Wind Powered lamps (outdoors), and Magnetic levitation turbine. The handheld wind charger would be a personal, portable wind turbine that can power personal electronics. The main benefit would be that it was cheap and would be accessible for many people. The wind power lamps and the wind powered light bulb were pretty much the same thing-so we merged the ideas. It would basically have a wind-turbine like frame/lamp shade that would spin and act as a wind turbine which would generate enough energy to power the light bulb. This would be turned on during the light to conserve energy and would be placed in places such as a small garden or section of a sidewalk. The magnetic levitation turbine involved the turbine levitating off the ground using magnetic force-the lack of friction would increase efficiency. Instead, we combined something similar to the lampshade turbine and the magnetic levitation turbine. We had a plastic bottle cut in half and then placed so that it looked like the letter S from the top view. This would be centered on a stick and at the bottom of the stick would be a disk with eight magnets which would hover and spin over four coils of copper wire. When the magnets spun over the copper wire at a quick enough speed, it generated enough electricity to power a small light bulb.

At first, the group wanted to go with the lamp shade idea; but, we soon found out that it would be too difficult to make a practical model. So we scaled down the size of the light bulb and then built a turbine that would involve magnets spinning over coils of copper wire. When the magnets spin over a coil, it produces pulses of current. Every time the magnet passes over a coil, the coil becomes energized with electricity. Our particular device was to have four coils so that we could quadruple the amount of output, which allowed us to light up a small LED light bulb. Our model was just attached to a small LED light bulb to show that our device was generating electricity. If this were to be used in the real world, we would have to convert the alternating current into direct current. This would then allow us to store the energy/electricity in batteries so that we can use it at another time because wind speed varies and you can’t rely on a constant wind speed.

After the deciding on multiple solutions to creating a wind turbine it was the time to choose our final solution. There were many different ideas that were brought about and decided on by the group. Some had been combined others were thrown away entirely. The decisions for the group were mainly based around the constraints we were given and the criteria for the project itself along with other factors. It was not the hardest decision, but it was one that was time consuming as we wanted a simple idea that could be put to use and most importantly, had a chance to work.

The constraints in this project had a major influence on the final decision for the project. The first constraint was putting the project into one of the three design categories. The three categories were renewable energy systems, renewable energy solutions for the developing world, and finally consumer products and renewable energy. Renewable energy systems are large scale systems, renewable energy systems in the developing world are renewable energy systems that could be used in places with limited manufacturing resources, concluding with consumer products and renewable, which basically consists of a design that could be put on the market for sale. Another major constraint was the cap put on our spent currency, which was only twenty dollars. This, we believe was the biggest constraint put on the decision, because in the market today, some materials can become very costly and a whole project may become extremely difficult if it were not simple enough. Many of the possibilities that were thought of were immediately decided to cost too much and be much too complicated. The simplest idea on or list of solutions was a wind powered light that could be used along sidewalks or to light other small areas. The decision was made to this design under the category of consumer products and renewable energy. After some thought, we also decided this could be located in the category of

renewable energy sources for the developing world as it is a very simple design and could be used for lighting small areas and is relatively cheap, and large numbers could easily be created due to the simple design. When it came to cost, the design was still difficult to keep under cost so we used a business perspective to cut cost per model. For example we purchased approximately five hundred feet of wire but only used approximately one hundred and sixty five feet to make one single model. If the product were to say be on an assembly line, the extra wire would be used to create another two models, so we only accounted for the wire to create a single model towards our final cost of the product.

After the final plan was made to create a small wind turbine to provide power for a light source was made, a decision on the design was to be made. A wind turbine most people would think of is the typical turbine that looks similar to a fan with a horizontal axle that would use a system of gears to turn an armature to create electricity. The conclusion was made this design would be cost too much and take a simple idea and make it too complex. After researching different designs, the design of a wind turbine using scoops and a vertical axle to turn magnets over wire would be used to create an electrical current, which would then be directed to a small light was implemented. All of the products that were used were researched and price compared to be cost effective.

Ethical concerns were also reflected in the decision to create a turbine of this type. The main concern with wind turbines on a large scale (the fan type) is that they are aesthetically displeasing and result in the death of many birds. The type that was planned to be built, yes is still aesthetically displeasing, but has been studied and results in a much lower count of deaths in the bird population. A cost benefit analysis, a branch of utilitarianism, was used as well for the decision on what type of turbine would cost the least and provide the most benefit. On a small scale the generator causes virtually no real problems. It is green, only using wind to create electricity and the only hazards would potentially be an object on the ground that could be tripped over or another object the lawn mower may have to drive around. A benefit of the scoop design is that it is much sturdier than the fan design. This could prevent damaged from simple things such as being hit by something. Also being cost effective, would keep an engineer from having to be unethical by using faulty materials to create the product in the real world.

Sustainable energy is energy which is replenishable within a human lifetime and which causes no long-term damages to the environment. Being engineering students of a university devoted to improving sustainability, we are required to become attentive of current energy research efforts throughout the world and how they impact our future for both the environment and society. In order to begin our awareness towards sustainability, we are asked to develop a “Promotional Innovation” that shows our consciousness towards one renewable energy source and educate our fellow engineering students about it. Aside from just creating an innovation towards this specific renewable energy resource, we are restricted with a time of ten weeks and a budget of twenty dollars, just like modern engineers are restricted with today. To promote our awareness of sustainability, our group developed a simple wind turbine to light up an LED light to express the concept of electricity being powered by our renewable energy source, wind.

[](http://www.facebook.com/photo.php?pid=6006659&id=725112693)After going through the process of choosing what would make a cheap, functional wind turbine, we were able to begin gathering materials and start building. While having a twenty dollar budget, finding materials needed to create our design was not an easy route. We managed to buy enough supplies for $19.99. Our supplies consisted of one LED light, glue stick, wood, four washers, four magnets, 169 feet of copper wire, a water bottle, eye hook, and a screw. To support our wind turbine, we needed some sort of frame to either hold the design up or just keep it sturdy. We used a block of plywood that has dimensions of 14x25x2 cm as our base. In the center of the block of plywood, we screwed in a screw to secure a 30 cm round wooden dowel. In order to hold the water bottle up, we bought three square wooden dowels, each 30cm long and another that is 20 cm long. We placed the 30cm long dowels parallel to each other and 20 cm away, and glued the 20 cm long dowel across the top of each to connect them. Also, we glued supports to the bottom of each 30 cm dowel to keep it immovable to the base of the design. Next, we screwed the eye hook into the center of the 20 cm long dowel to hold another 30 cm dowel, shaved at the bottom to create a sharp end to maintain movement in the screw. After all of this was done, the frame was finally built. We chose these dimensions and the type of material for the frame used in order to fit a 21.5 cm tall and 8 cm wide (after adjusting) water bottle in between the dowels and remain durable enough to maintain the spinning of the water bottle, magnets, and washers. Before putting the shaven dowel through the water bottle, we had to adjust it; we cut the bottle in half. In order to keep both halves of the water bottle connected, we cut out semi-circles of cardboard that remain connected and hot glued them to both tops of each half of the water bottle, and both bottoms of each half. Therefore, the water bottle has gaps for the wind to push and create drag to spin. After gluing the cutouts of the cardboard to the water bottle, we then cut holes in the center of each of these cardboards, width being six mm, to fit tightly with the sharpened dowel. After doing all of this, we then slid the round dowel through the holes and made sure it was six cm away from the top of the sharpened end. After finishing the adjusting of the water bottle, we moved on to arranging the copper wires. Finding copper wire that was cheap and efficient was the hardest task for us to overcome. Luckily, we ended up finding some. In order to set up the wire to make it work and conduct electricity, we had to think of ways to fold it or circle it around a certain number of times. We made a jig out of cardboard to be able to wrap the wire around it. We needed four coils of wire, each being twenty meters long. Therefore, we wrapped each coil around 200 times, keeping each coil attached to one another. After doing this four times, we took each one off one by one and secured each by electrical tape. We used electrical tape to prevent the conductivity from stopping. When finished taping, we hot glued each coil down onto the base of the frame. We kept each coil going in a clockwise position, putting both ends of the wire to connect to the light bulb, creating a circuit. Next, we cut out a piece of cardboard, twelve cm in diameter, to hold four washers and four magnets. We glued the washers onto the cardboard, each being 90 degrees apart from another. After gluing these down, we placed the south pole (positive) onto the washers, facing the north pole (negative) of the magnet towards the coils. We cut a hole in the center of the cardboard, also with a six mm width, to snug the round wooden dowel in it. Finally, we slid the piece of cardboard, holding the washers and magnets, onto the wooden dowel. After doing so, we slid this dowel back into the eye hook and placed the sharp end in the screw. Before we began to test our design, we needed to make sure the magnets were three centimeters or less above the coils of wire, or else the electrons being pushed off would not produce any electricity. After making sure of this, we were able to being to test our prototype.

When one builds a prototype or a specific design, they want it to function properly the first test. Although they intend and expect for it to work on the first try, it is very slim for this to occur. Despite our design seeming to be anything less than functional, we did not expect for it to work on the first test. When using a blow dryer to produce our renewable energy resource, wind, it did not light up the LED light at first. We then waited longer, and it still was not producing electricity. After seeing our prototype not pass the first test, we thought of many different complications that may have arisen. First, maybe the blow dryer was not producing enough air towards the water bottle to spin it fast enough to create a greater magnetic field to produce electrons towards the coils of wire to light the bulb up. Secondly, there was a possibility that we put the wrong side of the magnet towards the washer, not giving off electrons to produce electricity throughout the copper wire as well. Another complication that we thought of was that the distance between the magnets and coils of wire being greater than three cm apart. Our last complication we came up with was the possibility of the ends of the wire not being correctly sanded or parts of the wire being broken or twisted. The first problem we decided to act upon was the switching of the magnets. We switched each magnet over, hoping the south pole would be facing the coils of wire. After doing so, we decided to test our prototype again. A few seconds later, the LED light was lighting up. Our prototype was successful after few tests and a minor change. Although we were successful, understanding the concept of how electricity was being produced to the LED is more important than getting it to work.

The function for our design is to light up an LED with a simple renewable energy source, wind. Our design succeeded in its goal as well. The reason for our design being successful is because of electromagnetism; magnets can create electricity, electricity can produce magnetic fields. In order for this to happen, the magnets used in our wind turbine must spin rapidly to create a flowing magnetic field to produce electrons onto the coils of wire to create a current of electricity, leading to the LED light. For the magnets to spin in the first place, we must have some sort of design of a wind turbine to catch the wind and force the magnets to spin with the turbine. Our turbine used to produce this electricity is a water bottle cut in half held by cardboard, which spins by a 30 cm round wooden dowel. Because the water bottle is cut in half and has pockets to catch air when gusted towards it, it performs the basis of drag. One side creates more drag in moving air than the other, causing the bottle to spin. Since the cardboard holding the washers and magnets is connected to the same dowel as the water bottle, it spins simultaneously with it. To produce electricity towards the LED light, the distance between the magnets and coils of wire must be less than three centimeters, or the flowing magnetic field and its electrons would not reach the copper wire properly and sufficiently. For the electricity to flow towards the coils of wire we placed the south side of the magnets towards the coils; electrons flow from this side (negative), whereas the positive side produces protons. In magnets, atoms are arranged so the electrons are not in balance. Electrons move from one end to the other to find this balance, creating the force of energy of a magnetic field. Magnets can be used to make electricity; a magnetic field can pull and push electrons to make them move. Since we used copper wire, copper has electrons that are loosely held, meaning they are easily pushed from their shells. For the coils of wire to also produce a sufficient amount of energy, each has a length of 20 meters long. Because of electromagnetism, our wind turbine is able to produce enough electricity to light up an LED light. Although we successfully achieved our goal and understand the concept of our wind turbine producing electricity, there were some feedback we had received from our fellow classmates to help improve our design.

Despite our prototype working, there is always room for improvement. After getting feedback from our fellow students, we began thinking of how we can go about changing our design. Some of the things suggested to our group were glue down wires so the wires do not hit the magnets, put a track on it to keep it spinning, use big propellers to spin it faster and create more energy, use a bigger light bulb, and more. After looking over the feedback, we took into account everything that was said and tried thinking of the most practical improvement without buying anything more, since we met our budget. The one improvement we decided to go about was to glue the wires down and retape them to prevent the coils from hitting the magnets. When finished with the improvements, we tested it for a few more times to make sure everything was functional. Our design lit up our LED light. Therefore, our design was finally finished. Aside from learning about sustainability and our renewable energy source, we all gained life skills from this ten week long project.

The most important things that we learned from this design included: teamwork, cost-efficiency, leadership (instead of management), reliability, communication, cooperation, flexibility, commitment, and problem-solving. While working on this project, we learned to all work together and to participate actively. The twenty-dollar budget also caused us to be cost-efficient with what we were spending (looking for the best deals, not necessarily the cheapest products). Another thing that took place was leadership, versus management; “you don’t manage people; you manage things. You lead people.” Leadership allows all of the members to have a say in the project, leading up to everyone reaching the common goal (creating a sustainable energy design project). Reliability also came into play when team members had tasks split up amongst each other in order to distribute the work evenly. This caused team members to rely on each other to get assigned tasks finished. Also, communication via e-mail and text helped to set up meetings, and to figure out how everyone was moving along in their processes; flexibility also came into this when team members had to rearrange schedules in order to meet up with everyone else and to correlate with everyone else’s schedule. Commitment to this project also played a huge factor; “a great leader's courage to fulfill his vision comes from passion, not position.” Finally, problem-solving took place whenever there was an obstacle overcome.

There really was no general role for each team member; assignments were distributed evenly among team members. Team members then met up and discussed each component, and gave feedback on everyone’s contribution. Therefore, each person did the same thing.

Working with a team was very enjoyable, especially since we were able to meet new people in our engineering class through this task; we all hang out after class now. From this project we learned that teamwork takes a lot of the qualities mentioned above.

If we had to redo this project all over again, I believe that we wouldn’t change a thing. We were able to finish the project in a timely manner, and our team really worked well together. Everyone’s opinion was heard, and everyone contributed equally to this assignment.

Overall, we believe that our group finished the task that was assigned 100%. Not only did we succeed as a team, but our SEDP prototype also worked. However, working together as a team was the most rewarding part of this project; the prototype working was just icing on top of the cake.