Alternative Energy Proposal for the University of Kansas

From April 30th to May 4th of 2007, scientists from the International Panel for Climate Change (IPCC) met in Bangkok, Thailand to discuss global warming from a policy perspective. The results of their report on May 4th were quite conclusive. As long as current energy trends remained in place, increases in greenhouse gases including CO_2, would continue. In correlation with the rise in greenhouse gases, there would most likely be a rise in global average temperature. The report released on May 4th was one aimed at policymakers and gave suggestions on the best techniques for the mitigation of greenhouse gases. In their report, one of the first things listed under "Key mitigation technologies and practices currently commercially available" was switching from coal to renewable sources of heat and power.[1] This included technologies such as hydropower, solar, wind, geothermal, and bio-energy. Another practice they pressed for was more efficiency in the building and energy sectors with increased efficiency in use and design. By using alternative sources of power and conservation practices, we could have cleaner power that we needed less of and the goal of reversing greenhouse gases would be more attainable.

On Monday, April 2 the Supreme Court ruled in a 5 to 4 decision, that by failing to regulate certain greenhouse gases such as CO_2, that scientists believe cause global warming, the Environmental Protection Act was in violation of the Clean Air Act. Justice John Paul Stevens wrote, "EPA has offered no reasoned explanation for its refusal to decide whether greenhouse gases cause or contribute to climate change."[2] With this decision, it seems more than reasonable that there will soon be some sort of limit and or taxation on carbon in the energy sector. This

[1] http://www.ipcc.ch/SPM040507.pdf
[2] http://www.washingtonpost.com/wp-dyn/content/article/2007/04/02/AR2007040200487.html?nav=hcmodule

could signal the beginning of consciousness about the affects of CO_2 on global warming at least on a regulatory level, and the end of cheap coal as we know it.

How does this affect us at the University level? As an institution of higher learning the University of Kansas and other universities around the country, in the past, have been pioneers for many different problems and issues facing our country and the globe. From women's and minorities' rights to cutting edge research in science and society, universities have long been at the forefront of social and scientific progress. As we take our baby steps in the 21^{st} century, it is apparent that one of the greatest growing pains that our species will face is how do we deal with global warming and climate change. Do we turn a blind eye until it is too late? Or do we meet the problem head on? Since universities are social institutions, it behooves them to not just look after their own problems, but open their eyes to the problems of all of society. In this manner, by instituting some manner of energy policy that incorporates social responsibility towards global warming through the use of alternative energy, even if only on a small scale, the University of Kansas can start to make the right steps in the global fight against greenhouse gases.

As evidenced by the International Panel on Climate Change and the Supreme Court of the United States, two key trends for energy are emerging. First, dirty electricity will not remain cheap much longer. The externalities of pollutants and the costs they bring to society will soon be incorporated their costs to consumers. Second, global awareness of the problem is beginning to put pressure on governments to make an active change in the status quo because people are worried. This makes alternative energy sources such as wind and solar that much more attractive. The interest in these energy applications will do two things. It will drive technological innovation. Wind and Solar like every other energy sector application that is given sufficient attention from the government and scientific community will improve in both efficiency and output. Secondly, as these products become more widespread and their novelty fades, their price will decrease. Due to this, the University of Kansas needs to begin addressing the idea of adding alternative energy to its energy supply. In our analysis we will address a few aspects of alternative energy at the University of Kansas. First, we will address where the University of Kansas presently gets its energy. We also address what the environmental ramifications of the current usage are to the community and region. Next we will do a case study of Wescoe Hall and how this can be supplemented alternatively. Finally, we will give alternatives that were considered but not feasible for Wescoe Hall.

Hazards of Coal Powered Electricity

The University of Kansas currently receives 85% of its electricity through Westar Energy. The remaining 15% of electricity is produced through a distribution system that is owned and operated by Kansas University. This distribution center is located on the KU West Campus.[3]

Over a 7-year period, from 1998 through 2004, KU has used an average of 110,620 MWh of electricity per fiscal year.[1] By strategically implementing the use of photovoltaic cells on the roofs of several on campus buildings, the university would first free itself from the rising costs of electric utilities, and second, add to and improve the current energy conservations measures already in place in some of the buildings, and third, spare the community, and essentially the world, of the harmful residual effects associated with coal fired power plants.[4]

Highly industrialized areas create pollution hotspots. People who live near coal- fired power plants experience many negative health effects. However, these harmful emissions aren't

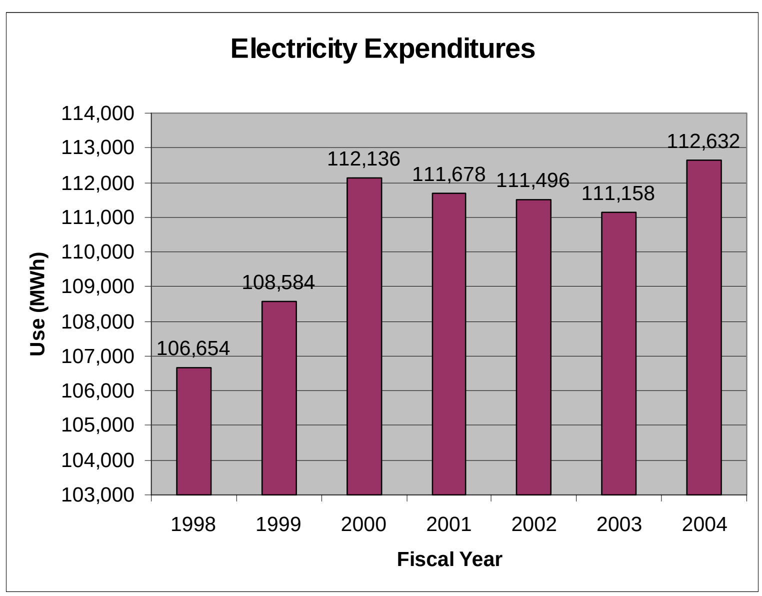
[3] www2.ku.edu/~kufo/utilities
[4] Steven A. Scannell, AIA, CCS Assistant Director, Consultant Services

limited to doing damage to urban and industrialized areas. Rural areas, once thought to be free from urban pollution, are now experiencing significant reductions in air quality and visibility.

Air pollution can travel thousands of miles through long-range transport systems that result in high concentrations of pollutants at higher latitude areas. These pollutants fall to the ground, enter the food chain, and wreak havoc throughout the ecosystem.

Air- borne pollutants emitted from coal-fired power plants include carbon dioxide, sulfur dioxide, nitrogen oxides, volatile organic compounds, and other toxic elements. These pollutants have many negative effects on the environment and human health. Carbon dioxide is the main controllable component that contributes to global climate change, and many volatile organic compounds oxidize to become CO2. Sulfur dioxide is a corrosive compound that causes harm to the environment, primarily when it reacts with water in the atmosphere and forms acid precipitation. Nitrogen oxides attribute to smog, soot and acid precipitation. Human exposure to nitrogen oxides often results in asthma and other serious respiratory ailments. Coal-fired plants contribute approximately 20% of the total nitrogen oxides in the U.S.[5]

Though the EPA has been somewhat successful in regulating the release of sulfur dioxide from power plants, the concentration of nitrogen oxides has risen 20% over the last 30 years.[6] These toxic elements accumulate in aquatic systems, primarily fish populations, and raise numerous health concerns.

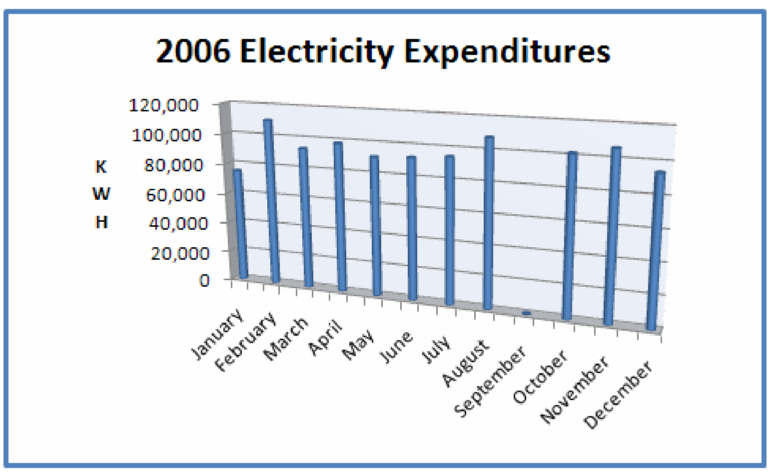


5 www.environmentaldefense.org
6 www.epa.com

One of these toxic elements, mercury, is a harmful neurotoxin that attacks and disrupts the nervous system of those who are most vulnerable, including children, the elderly and pregnant women.[7] To some degree, all of these pollutants increase the risk of serious health problems. Bronchitis, emphysema, heart attacks, lung cancer, and even decreased life expectancy are present in areas of high exposure from coal fired plants.

Photovoltaic Electricity: Is It Feasible for KU?

Photovoltaic, or as it is commonly known as, solar power is a means of producing electricity by utilizing the energy beamed to the Earth everyday by the sun. The process is actually a chemical reaction; as the sun's rays interact with silicon, there is a reaction in which electrons are freed. These free electrons are then collected and direct current (DC) electricity is the end result.[8] The smallest individual portion of the photovoltaic system is the solar cell. Multiple cells are then wired together to form a module which then can be wired together to form an array. Once the array is converting sunlight into DC power, an inverter is needed to convert that electricity to alternating current (AC) which is the standard that this country uses to power our homes and businesses. This also makes the power compatible with the electric grid which allows for the possibility

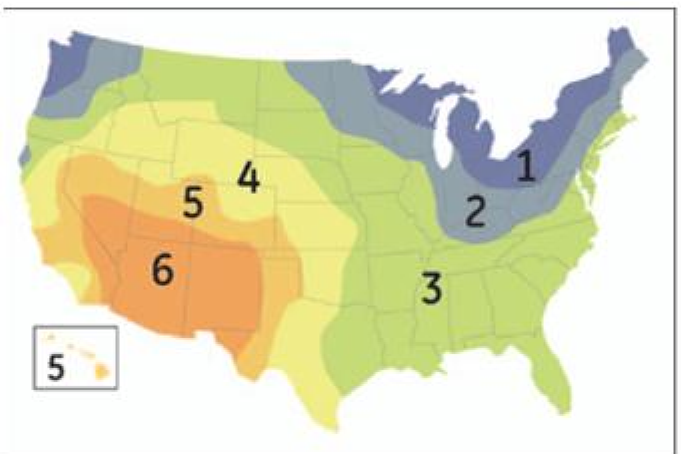


[7] William P. Cunningham, Mary Ann. 2005. *Principles of Environmental Science: Inquiry and Applications.*

[8] *Buying a Photovoltaic Solar Electric System, A Consumer Guide, 2003 Edition, pg 8* California Energy Commission

of selling back excess electricity to the local power plant thus incurring a credit which can be used when drawing power back from the grid on days of low production and/or night hours. For those that cannot sell back excess power, or who do not wish to purchase any "dirty" power can instead purchase a number of batteries to store any excess power made to be used at a later date.

The building on the University of Kansas campus that is the focus of this feasibility project is Wescoe Hall. During the year of 2006, Wescoe used approximately 1.2 million kWh of electricity which cost over $63,000.[9] This is a large amount of electricity being used but it is neither the highest nor the lowest consuming building on campus. One nice feature that Wescoe has is its large, flat roof that has a usable area of nearly 60,000 square feet. An extremely large system of around 500kW would need between 30-40,000 square feet. That 500kW system would produce peak electricity about 5 hours a day since we are in the AC Production Range of zone 4. That equates to 500*5 = 2500kWh a day. Multiply that by 30 days and you would be producing about 75,000kWh per month during the summer months when the solar angle is higher and more direct. Each kilowatt of unobstructed, stationary solar panels would, on average, generate 1,200-2,000kWh a year, depending on solar zone.[10] In addition to the energy being produced, solar tiles from a company called PowerGuard actually help to reduce cooling



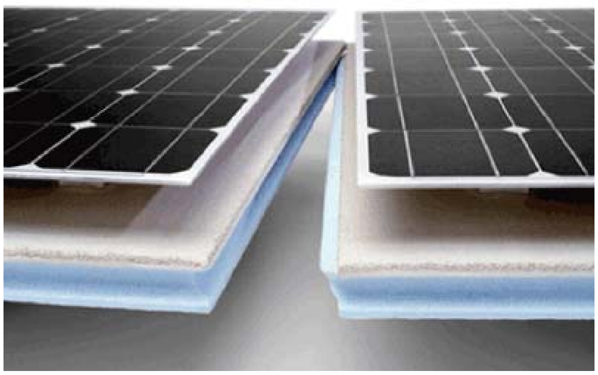
1 kW (DC) GE Energy Solar System

Zone Average Monthly kWh (AC) Production Range	Zone Average Monthly kWh (AC) Production Range
1. 80-90	4. 115-125
2. 90-100	5. 125-135
3. 105-115	6. 135-145

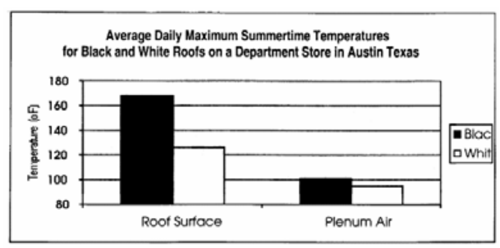
Approximate Required Roof Space [ft2] 100

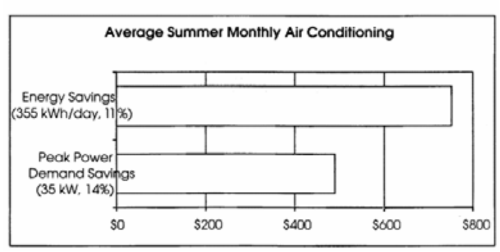
[9] Yearly totals obtained from Cindy Strecker, Energy Manager, Facilities Operations, KU
[10] *Renewable Energy: The Benefits and Costs of Large Commercial Solar Electricity Systems.* 2006

and heating costs throughout the year. Their tiles protect the roof from UV and thermal cycling that the roof usually absorbs and transfers throughout the house. The tiles sit on a pad of insulation that adds another R-10 factor to the roof's overall insulation capabilities.[11] To simplify, imagine the roof in the unobstructed summer sun. It literally bakes as it soaks in the heat from the sun reaching approximately 170^{o}F.[12] Instead, place a layer of these solar tiles over the roof and now the tiles are absorbing the sunlight and keep it from reaching the roof itself lowering the roof's ambient temperature to about 120^{o}F. In 1999 and 2000, the EPA and Department of Energy cosponsored an experiment on roof absorption and its effect on total air conditioner use in a 100,000ft^2 building. By simply reducing the roofs absorption, they were able to save $7,200 a year and used 35kW less per summer day. This temperature reduction and financial savings is a side benefit to be had while the system is producing clean electricity.



These tiles are also rated to withstand winds up to 140 mph, lightweight at less than 6lbs/ft^2, are fire Class B resistant, highly efficient by producing 1.25kWp per 100ft^2 output *and* comes with a 25 year warranty on solar power output. The tiles are excellent quality and offer a great opportunity to become self sufficient in energy production. A





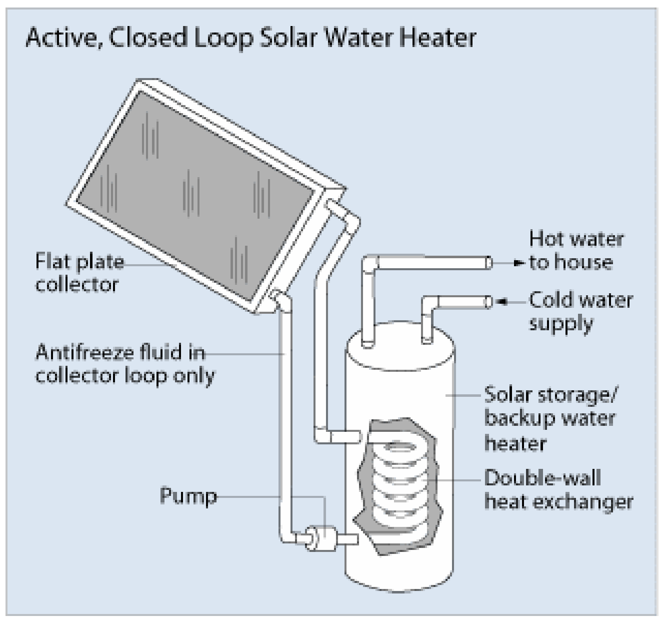
11 PowerGuard Solar Electric Roof Tiles - http://www.powerlight.com/products/powerguard_features.php
12 Roof Temperatures in Simulated Attics – U.S. Forest Service FPL-RP-543

500kW system would cost about $2.5 million which is probably, and understandably, the largest hurdle in pursuing a solar power system. The initial investment is very large. The end result would be positive though, because after 19 years of not paying an electric bill, the system will have totally paid for itself. That is using a very conservative energy cost increase of 3.78% inflation. More than likely, with regulation and climate change remediation, coal powered electricity generation would cost much more. This cost would naturally be passed on to the consumer meaning that the yearly bills could easily double or triple. If this were to happen, the break-even point on purchasing a solar system could be theoretically cut to 6 or 7 years! This 174% return on investment would equal about $1.7 million after 25 years and that is for only one building. This would cut Wescoe's dependence on "dirty" energy by at least three-fourths. This clean power would equal to removing 12,300 tons of CO_2 from the atmosphere. An easier way of comprehending that is that this system would equate to not driving 24,600,000 miles! That is a massive amount of CO_2 kept out of the atmosphere, not to mention the other pollutants like mercury, sulfur dioxide and nitrogen oxides. Many of the smaller buildings on campus could be powered by a much smaller system that only costs around $200,000. Or the university could choose to gradually work its way up on Wescoe by purchasing a "small" 50kW system a year. By purchasing in small steps, the smaller system would break-even sooner as the university increases from 20% to 40%, etc.

Unfortunately, many of the savings and incentives given by the federal and state governments to purchase a solar system are tax related which means that KU, which is tax-exempt, would not benefit from the incentives. This is a let-down but there are other means of gaining some funds. One such proposal comes from Zephyr Energy and was approved by the students at KU. It involves the university purchasing Green Tags from Bonneville

Environmental Foundation which offsets our carbon usage. BEF would then reinvest a portion of the money spent on Green Tags for a dedicated solar power system on campus. Perhaps other businesses in Lawrence or alumni would agree to contribute to a fund for converting the campus to solar power. If the university becomes serious about this proposal, a committee could be formed to secure funds for the project.

Another way the university can use solar power to save money would be to install a solar water heating system. They can be used in any climate and use only sunlight to heat the water. There are two types of solar water heating systems, passive and active. The active systems use circulating pumps and controls which must use energy to be run. In Kansas where freezing occurs during the winter (and in spring thanks to climate change), an indirect circulation system "pumps a non-freezing heat transfer fluid through the collectors and heat exchanger."[13] This heats the water that then goes into the building. On average, a typical water heating bill would drop from 50%-80%. To determine the annual operating cost of a solar water heating system, you would have to know the solar energy factor (SEF) and what type of auxiliary tank is used. You then plug that into this formula to determine the cost. $365 \times 41{,}045/SEF \times$ Fuel Cost (Btu) = estimated annual cost of operation. Solar water heating systems would be



[13] U.S. Department of Energy. *A Consumer's Guide to Energy Efficiency and Renewable Energy.* *http://www.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=12850*

another means of utilizing the sun to reduce our dependence on dirty electricity and to become more self-sufficient.

Difficulties with Wind Power

Although wind power is seen as eco-friendly, it does have its many downsides. On the environmental side, wind power is noisy, land-intensive, materials-intensive (concrete and steel in particular), a visual blight, and a hazard to birds. These problems have a definite impact when choosing a site for wind power development. A place such as our KU campus is the exact opposite of what would be presumed to be an ideal location. Although located on a hill, which would help with wind speeds, the noise of the turbines would disrupt students, and the amount of space that would be needed is just not feasible. These are just some of the setbacks that we have encountered when assessing KU for alternative energy sources, such as wind power.

"Relative prices tell us that wind power is scarcer than its primary fossil-fuel competitor for electricity generation-natural gas, used in modern, state of the art facilities (known in the industry as combined-cycle plants). That is because wind power's high upfront costs and erratic opportunity to convert wind to electricity (referred to as a low capacity factor in the trade) more than cancel out the fact that there is no energy cost for naturally blowing wind. And current price estimates do not account for implicit costs, which would add approximately 1cent per kWh to its price."[14] The amount of money needed up front is substantial. This is not something that students or the state are willing to pay. Plus peak demand for electricity and peak wind speeds do not always coincide making banking the energy also costly. Wind power is also competing with advancing technologies, so who is to say that in five years something cheaper, more environmentally friendly will not come along.

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[14] http://www.mensetmanus.net/windpower/cato/probwind.shtml

A distinct air-emission problem of wind capacity is created when a new project is built where there is surplus electricity-generating capacity. Because wind farms require hundreds of tons of energy-intensive materials, virtually all of the air emissions associated with the gas or electricity used to make the materials (such as cement or steel) must be counted against the "saved" air emissions once the farm comes on line and displaces fossil-fuel-generated output. Wind farms also fail the land-use test compared with fossil fuel alternatives. A wind farm requires as much as 85 times more space than a conventional gas-fired power plant. Birds are also the victims of wind power. Studies done in California have shown that wind turbines kill at least 500 threatened or endangered birds a year. A campus full of bird carcasses is not something that environmental studies majors want to see. Another drawback is the high maintenance that the turbines need on a constant basis. The University would need to hire a crew of experienced technical specialists to maintain the massive turbines. The bottom line is that wind power is not feasible for the KU campus. To harness the environment for power we should look elsewhere. The use of photovoltaic cells that can turn sunlight into energy looks to be the most efficient way to harness such energy.

Conclusions

In conclusion, solar power is probably the best way for the University of Kansas to generate its own renewable, clean energy. With all the pros detailed above, the only main con would be its price tag. It is not cheap to get into solar power but with help from grants, donations and government loans, it is possible. Solar water heating is also another feasible way for the university to produce its own energy and save money in the process. The most important thing to remember is that these options are an investment in our future. The only better solution would be for Westar to build a wind farm that could power the entire city with clean, renewable energy!

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