The Case for Solar Energy Now and in the Future

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Abstract:

The Student Government Association (SGA) Environmental Affairs committee has recommended that SGA spend the Sustainability Fund on the development of a solar array within campus housing. The committee suggests that the environmental and health externalities associated with our campus' reliance on coal fired electricity are unnecessarily deadly, and the university, including campus housing, should consider alternative options to the status quo. This report suggests that solar electricity generation is not only viable for the state of Wisconsin, and this region specifically, but it is economically feasible to invest in this renewable energy source. This report has taken into account the concerns of housing and incorporates those concerns into the newest solar array proposal. Ultimately, the Environmental Affairs committee encourages campus housing to approve this revised solar energy project to produce a better environment, healthier residents, and cleaner energy.

I. Introduction

Located near the eastern shore of the bay of Green Bay, the University of Wisconsin-Green Bay (UWGB) has been a part of the greater Green Bay area since 1965 and continues to serve the community today. The original founding of UWGB focused on the connections between the natural environment and higher education. The Student Government Association (SGA) wishes to make good on this founding principle. SGA represents the student body at large, over 6,500 students, and serves as a voice on University policies and projects. SGA works to address concerns the student body may have whether it is regarding campus policies or those at the local, state, or federal level.

SGA has developed a host of committees in order to address these policy areas. The SGA Environmental Affairs Committee at the University of Wisconsin-Green Bay is committed to reducing the University's environmental impacts. It is the goal of the committee to see that affects to the natural environment are considered in all matters taken up by the University and those students serving on the committee seek to ensure that the importance of conservation and the environment remain a part of a UWGB education (Environmental Affairs Committee 2012a). More recently the Environmental Affairs Committee has been given the authority to manage the UWGB Sustainability Fund, and direct those funds to further the university's mission to reduce its environmental impact.

The Environmental Affairs committee has taken this position very seriously and has developed bylaws to manage why, how, and what types of projects should qualify for this funding including measurability, visibility, cost effectiveness, and student involvement in achieving outcomes (Environmental Affairs Committee 2012a). Furthermore, the committee has researched rather substantially the various current and ongoing sustainable initiatives on campus

and areas that are lacking or could use improvement (Environmental Affairs Committee 2012a). Out of this research, the Environmental Affairs committee selected to pursue a renewable energy project, more specifically solar energy, for a host of reasons that we will outline below. This discussion will provide an explanation for why the status quo is not sufficient, why residence life was selected, why solar energy is a viable and cost effective energy source for this region, and why this particular solar project should be approved.

II. Why Solar Energy: What is the Problem?

The Environmental Affairs committee has spent the great part of the past six months reviewing the potential projects SGA could fund to increase the sustainability of this campus. Ultimately, the committee has promoted the idea to install a solar panel array within the University's residence halls for a host of reasons.

The committee has determined that residence life through a host of awareness programs and appliance replacements have done a good job of increasing the energy efficiency of the residence halls. As a result, this solar panel installation represents a logical step to further reduce greenhouse gas emissions, and reduce the overall utility bill. Additionally, this installation will represent a highly visible installation of a "residential" solar array project, providing students and the overall community an educational display of what renewable energy projects are cost effective and practical for residential developments. The cost savings connected with this project will be monitored and could be used to produce additional environmentally sustainable projects on campus. Finally, while fitting into the overall mission of the University and of Residence Life, this installation could fold into the overall development of a sustainable living learning center sometime in the future.

Where does our current electricity come from?

However, these are all laudable goals and justifications for conducting this project, but the difficult question remains, why should campus housing be thinking about renewable energy when current electricity rates are so low? In order to address this issue, it is relevant to begin with a discussion of campus' current energy consumption. The University purchases electricity through Wisconsin Public Service and this electricity is theoretically derived from a mix of sources with approximately 67% coming from coal, 21% from nuclear, and about 6% from hydroelectric power, among a host of others (WPS 2012). However, it is more realistic to assume that a vast majority of our energy typically comes from the coal fired Pulliam Power Plant located at the mouth of the Fox River (EPA 2011a; Sourcewatch 2011).

The Pulliam Power Plant has a particularly poor history when it comes to environmental and citizen stewardship (Sierra Club 2005). In 2006 the Sierra Club and Clean Wisconsin sued WPS regarding their management of the Pulliam Plant and their failure to comply with the Clean Air Act (CAA) requirements to reduce pollutant levels (Sierra Club 2005). Coal fired power plants in general release a multitude of CAA and Clean Water Act (CWA) pollutants that have been determined by the Environmental Protection Agency (EPA) to be harmful to human health and welfare. These pollutants include Mercury, Lead, Particulate Matter, Arsenic, and Sulfuric acids among others (EPA 2011a). The burning of coal increases mortality, hospital admissions, and instances of sudden infant death syndrome.

Prior to this lawsuit and the following settlement, the Pulliam Plant was ranked 7th in the nation in regards to sulfur dioxide emissions, which is linked to acid rain and smog, and was nationally ranked as the 16th dirtiest power plant in the U.S. (Environmental Integrity Project 2007; Sierra Club 2005). As a part of the settlement, the plant was required to add new pollution

controls to this facility, and they were required to invest in cleaner energy projects around Brown County, WPS developed their foundation for this purpose (Sourcewatch 2011).

Despite these efforts the Pulliam Plant still emits 33,000 lbs of sulfur compounds, 1,192 lbs of lead, 140 lbs of Mercury, and 872,104 lbs of particulate matter (PM) into the atmosphere (WDNR 2010; EPA 2011a). These emissions contribute to Brown County's ranking in the Dirtiest 20% of counties in the entire United States for total environmental releases, cancer risk, noncancer risk, air releases of recognized carcinogens, and air releases of recognized reproductive intoxicants (Scorecard 2011). Additionally, the American Lung Association gives Green Bay an F for particulate matter, or soot, pollution (American Lung Association 2011). Thus, it is clear that the Pulliam Power Plant has a history of cutting corners with environmental and safety regulations in order to increase profits for WPS and/or keep energy costs artificially low for consumers that contributes to Brown County's poor air quality.

What consequences does this have on our campus community?

So, it is obvious that the Pulliam Plant produces pollution, but what is the true cost of this pollution and what are the ramifications for our residents, faculty, and staff for accepting this energy? Here it is necessary to discuss the variables which are not included in the utility bill, both environmental and healthcare externalities that are directly associated with coal electricity generation. For example, the Pulliam Power Plant emits a series of hazardous air pollutants that are stringently regulated under the National Ambient Air Quality Standards of the Clean Air Act, including Lead and Particulate Matter (EPA 2011a).

Heavy Metals

Beginning with the heavy metals and more specifically lead, of which the Pulliam Plant emits over 1,100 lbs per year (EPA 2011a). Lead negatively affects all bodily organs, including

the brain, and there is no real "safe" amount of exposure to lead (EPA 2011b). Lead, typically, enters the body through inhalation or ingestion, and it is particularly worrisome because it can accumulate in the environment in soils and sediments (EPA 2011b). Ecosystems near point sources experience significant losses in biodiversity as well as decreased growth and reproductive rates in existing animals and plant life (EPA 2011b).

Mercury is another heavy metal that can cause impaired speech, hearing, walking, muscle weakness and many other deficiencies (EPA 2012). Developing fetuses have an increased chance of being born with severe disabilities when exposed to mercury (EPA 2012). Half of all mercury pollution comes from power plants (EPA 2011c). Furthermore, 1/70th of a teaspoon is enough mercury to contaminate an entire 25,000 acre lake. The Pulliam Plant emits 140 lbs of toxic mercury per year (EPA 2011a). The EPA has recently published new regulations to reduce the mercury emissions from power plants by as much as 90 percent as these facilities have failed to reduce their emissions even though pollution control technology was readily available (EPA 2011c). Therefore, the federal government is taking a proactive approach to reduce mercury emissions suggesting the severity of mercury exposure to human health. To put this into perspective the Pulliam Plant emits 140 lbs of which the EPA suggests 120 of those pounds place humans at an unacceptable risk.

Both lead and mercury pollute the water and gets into the flesh of aquatic animals. Thus, the metals have made it into the food chain. When one animal eats another with lead or mercury, the predator then inherits the contamination (Mader 1996). As a predator eats more contaminated food sources, the amount of lead and mercury within that animal is compounded with the contamination that is already within the body. Therefore, the higher the species is on the food chain, the more lead and mercury contamination within that species. This is what is called

bioaccumulation. The bioaccumulation of mercury and other pollutants, such as PCB's, make it dangerous to eat high level predators such as tuna or Pike (Mader 1996).

Particulate Matter

Particulate matter is one of the leading causes of illness and mortality in relation to coal fired power plants (NAACP 2011). Particulate matter is a collection of particles that include heavy metals, sulfur dioxide, which causes coughing wheezing and nasal inflammation, and nitrogen oxides, which increase the risk of respiratory disease in children (NAACP 2011). The people most affected by particulates are the elderly, children, and people with respiratory problems. These fine particles cause lung and heart problems that lead to asthma and heart attacks. It is estimated that nearly 24,000 people die each year because of U.S. power plants (CATF 2010). Likewise, about 38,000 people suffer from non-fatal heart attacks caused by the pollution from power plants (CATF 2010).

Figure 2. Power Plant Mortality Per 100,000 Adults

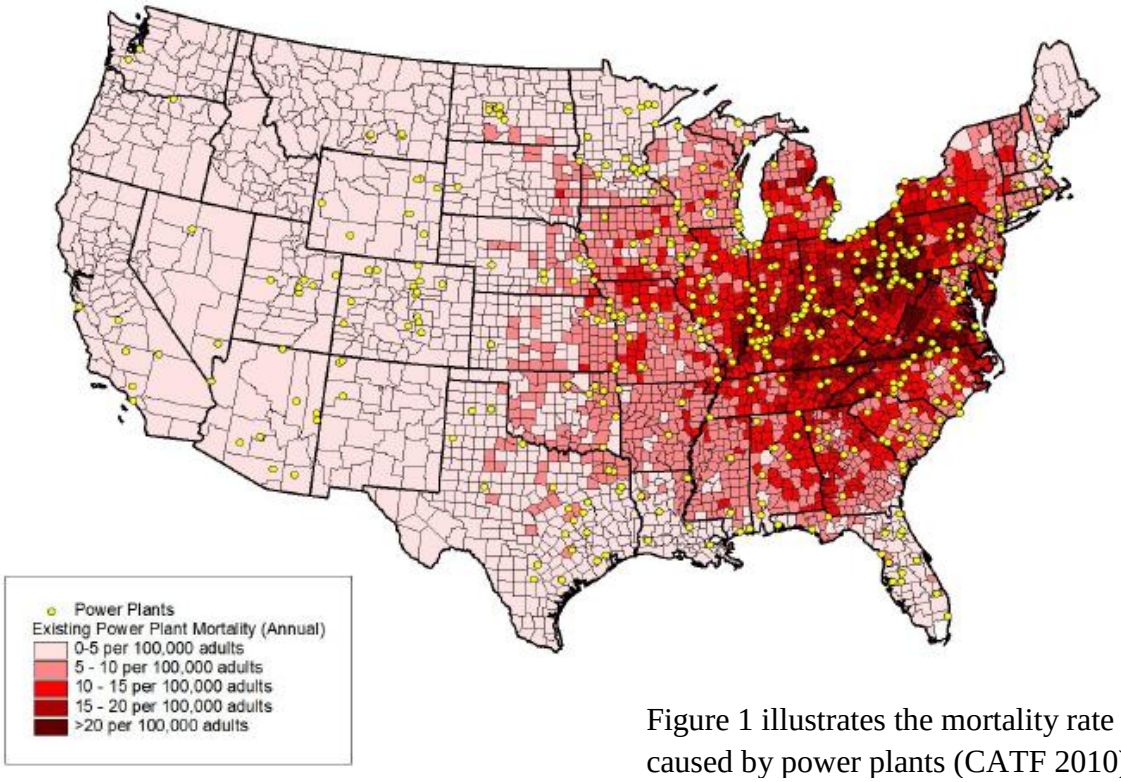

Figure 1 illustrates the mortality rate directly caused by power plants (CATF 2010).

People who live near the power plant feel the effects of particle pollution more than those who do not. The neighborhoods that are close to power plants tend to have lower property value therefore people with low income tend to live there (NAACP 2011). This brings up the question of environmental justice. People with lower incomes are limited in areas where they can live because of the prices of owning or even renting in areas. Because of this, lower income families must live in areas that may not be safe to live.

What is the Problem?

Collectively these pollutants cause a myriad of health and environmental effects, and the Annals of the New York Academy of Sciences estimated total external costs to the American public from the production and combustion of coal range from $175 billion to $523bn (9.42

¢/kWh to 26.89 ¢/kWh) with the best estimate at $345bn (17.84¢/kWh) (CATF 2010). In order to more adequately reflect what students are actually paying for this energy, Residence Life would have to more than double their current rates.

As a result, it is clear that the emissions from the Pulliam Plant, affects a person's health and people are more at risk of more serious conditions when living downwind of these types of facilities. Unfortunately our University is downwind from this facility, because the predominant winds in this region blow in a South West direction, transporting pollutants from the Pulliam Plant across the bay to UW-Green Bay and its housing, where residents are subject to enhanced risks from these pollutants (Wisconsin State Climatology Office 2011). To add on to this, most students living on campus would be considered low income persons (De Vise 2012). This is because, paying for college puts immense pressure on young adults financially, and many live on campus due to its affordability. However, prospective residents are unaware of the hidden dangers in the air that is perpetuated in part by our campus' reliance on coal (De Vise 2012).

Furthermore, with the high costs of healthcare, not many can afford treatment or early detection methods for some of the potential health conditions associated with poor air quality. In fact, according to the Clean Air Task Force, the Pulliam Power Plant cost citizens of Brown County $84,827,000 in 2010 due to the dangerous toxins released into the environment (CATF 2010). This number is derived from a cost analysis that compiles the monetary cost of premature deaths, heart attacks, asthma attacks and other conditions that are a direct result from the plant (CATF 2010).

Why should UWGB Housing Care?

Thus, the university should take a proactive approach to combat our addiction to this dirty fuel. More specifically, Residence Life should be particularly concerned, because the first

point of Residence Life's mission is to "provide *safe*, affordable, conveniently-located, and well-maintained housing for students" (UWGB 2012). As a result, Residence Life should not hide behind the cheap price tag of this energy source, and should instead consider what monetary impact this is really going to have on current and future residents. The environmental impacts are hazardous enough to warrant switching from this dirty source, couple this with these horrendous health risks and it is almost inconceivable to continue willingly purchasing this energy, and not disclosing the potential health risks that students are subjected to.

III. Is Solar Electricity Really Viable in Wisconsin?

However, is solar power really a viable alternative for Wisconsin? In order to address this point it is relevant to discuss how solar electricity is produced and how it is applied in this particular setting. First, ultraviolet rays from the sun cause electrons to flow throughout the panel causing a direct current of electricity (Focus on Energy 2012). The inverter in the solar panel then converts this direct current to an alternating current of electricity. This electricity is preferred because it is compatible with the utility grid (Focus on Energy 2012). The solar panel then takes the alternating current and sends it to the breaker panel (Focus on energy 2012). Any energy not used by the building goes on to the utility grid. The meter measures the excess of energy and delivers it to the grid (Focus on Energy 2012).

With this understanding of how the system operates, is it viable in Wisconsin? Does the state have an adequate climate, or more primitively, is it sunny enough here? To answer this question it is important to understand what truly impacts the production of solar energy. Focus on Energy (2012) suggests that a number of factors impact production including size and orientation of the solar panels (Focus on Energy 2012). However, Focus on Energy (2012) suggests that for each kilowatt (kW) of unshaded and stationary solar electric module, the system

will generate about 1,200 kilowatt-hours (kWh) of electricity per year in Wisconsin. In Green Bay, more specifically the energy potential is 402 watt hours/feet squared/day (DOE 2012). To put this into prospective, Germany, which has a solar potential much lower than Wisconsin, see figure 1-2, and in fact is more comparable to that of Alaska, is the number one producer of solar energy in the world producing 13,000MW of energy (Bayley 2008; NREL 2008). Therefore, if Germany can produce such a large amount of energy from solar, and they have poorer conditions than Wisconsin, it is simply inaccurate to suggest that solar energy cannot work in Wisconsin.

Figure 1-2 World Solar Energy Potential in Hours

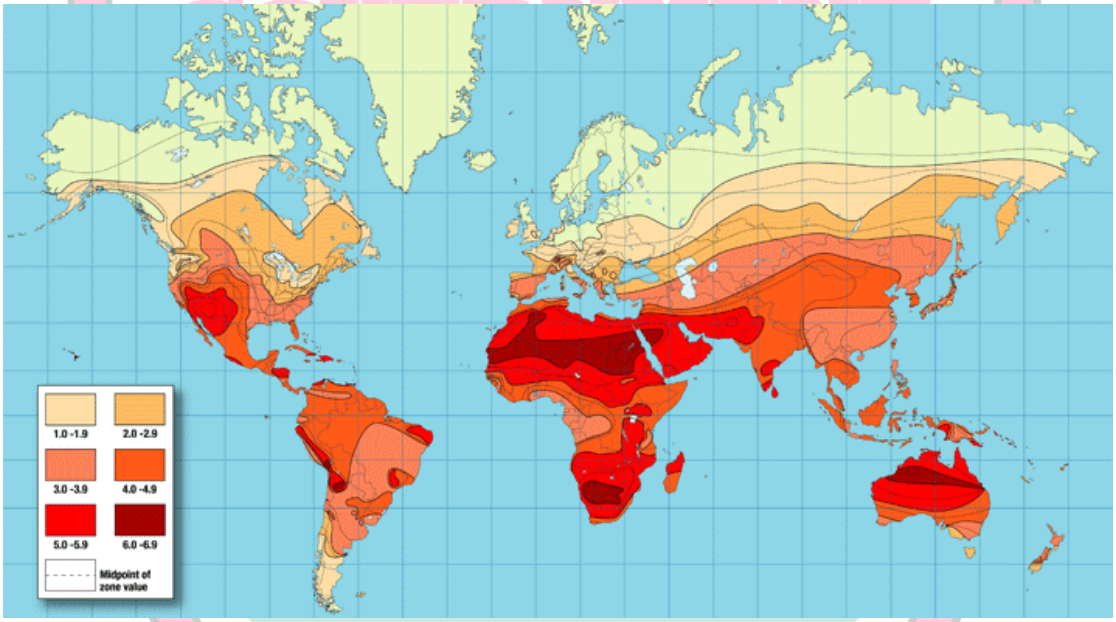

Figure 1-2 illustrates the amount of solar energy in hours received each day, during the worst month of the year (Chen 2011).

But is this particular system the best choice?

Not all solar technologies are created equal, and it is relevant to discuss the effectiveness and cost efficiency of the system as outlined in the accompanying site assessment. The housing board brought up a host of issues with the previous site assessment and solar installation that encouraged the committee to revisit the specifications of this project. The committee determined

that although the dual axis tracker system was more efficient in producing energy the overall maintenance, liability, and aesthetic concerns were unknown or unresolved (Environmental Affairs Committee 2012b). Thus, the committee has asked Ken Statz, the previous site assessor, to revisit the system selection and provide a more appropriate installation for this site. Therefore, Ken Statz has produced two potential roof mounted systems that both illustrate the increased funding that we have at this juncture to develop this project, and accommodate our previous concerns.

As a result, the attached spreadsheets include the information pertaining to 2 stationary roof mounted systems. This new roof mounted system will remove virtually all maintenance costs associated with the previous system, through the removal of the costly moving parts. These moving parts that allowed the previous system to track the sun are the cause for the maintenance requirements of the system. Additionally, the new roof mounted system will alleviate the liability concern that could be associated with a ground mounted system, either through students climbing on the panels or damaging the panels. Finally, by placing the panels on the top of the roof, they can still provide the building electricity without potentially blocking the view of residents. Finally, once the project goes out to bid we can begin to collect warranty information from the providers of the equipment to validate the assertions of the site assessor that these warranties last the lifetime of the project, or at least to the point of cost recovery.

It is now relevant to discuss the efficiency of these solar panels and if the numbers in the site assessment report are indeed accurate. To provide some context for this discussion, Lake Michigan Wind and Sun, a company located in Sturgeon Bay, Wisconsin has been tracking its solar electricity output for over a year and half (Lake Michigan Wind and Sun 2011). This business has been tracking the output of three different brands of 1.3 kw solar arrays. With some

variation, the different brands are relatively consistent with each other producing on average 160 kWh per month, or in total approximately 5,800 kWh over all of last year (SMA Solar Tech AG 201w). These three systems added together produce about 25% more electricity than is planned for our comparable 3.92 kw system. This makes sense because these solar installations are dual tracking systems which are more efficient than stationary systems (personal communication). Nevertheless, this example shows that our system should have no trouble producing the amount of energy that is outlined in the assessment in this region. Also, this example proves that it is also possible to track energy production monthly and to use that information to monitor energy production. This information can then be used to educate students and the public of how much energy is needed for day to day activities and illustrate the campus' commitment to reducing our reliance on dirty coal to fuel those actions.

IV. Conclusion

True this project does not end our reliance on fossil fuel, nor does it make a substantial impact on our environmental footprint. However, as this report illustrates we need to understand the sheer magnitude of the dangers and costs of coal that we willingly accept every day due to its convenience. Therefore, it is imprudent of us to simply disregard this project because it may send the wrong message that we are not completely sustainable. We need to stop using coal and any project big or small directed at this goal that provides a payback should be given a hard look. Furthermore, with the continuation of the sustainability fund for the foreseeable future, barring any unforeseen circumstances, the Student Government Association will continue to look at ways to reduce our impact on the environment. With much of that impact arising from our energy use, coal remains the elephant in the room when it comes to our efforts to become more sustainable. Thus, this project represents a necessary first step to a more sustainable future, and

provides a jumping off point to foster more renewable energy projects on campus that are both efficient and cost effective. Furthermore, this project fits nicely into the overall mission of Residence Life and illustrates both housing and the university's commitment to not only the environment, but the overall health of its students. Therefore, this committee, Student Government, and the whole student body urge the housing board to approve this project and improve the environment.

References

American Lung Association. (2011). *State of the Air Wisconsin.* Retrieved from American Lung Association Website at: http://www.stateoftheair.org/2011/states/wisconsin/brown-55009.html.

Bayley C. (2008). *Germany's sunny Revolution*. Retrieved from BBC website at: http://news.bbc.co.uk/2/hi/business/7181866.stm.

CATF. (2010). *The Toll From Coal An Updated Assessment of Death and Diesase from America's Dirties Energy Source*. Retrieved from CATF website at: http://www.catf.us/resources/publications/files/The_Toll_from_Coal.pdf.

Chen C. J. (2011). *The Physics of Solar* (1). New Jersey: John Wiley & Sons Inc.

De Vise, D. (2012). population of needy college students is exploding. In *The Washington Post*. Retrieved from The Washington Post website at: http://www.washingtonpost.com/blogs/college-inc/post/population-of-needy-college-students-is-exploding/2012/01/11/gIQARRaLrP_blog.html

Department of Energy (2012). *Solar Energy Potential*. Retrieved from DOE website at: http://www.doe.gov/maps/solar-energy-potential.

Environmental Affairs Committee (2012a). *Environmental Affairs*. Retrieved from UWGB Student Government Environmental Affairs Committee website at: http://www.uwgb.edu/studgov/committees/ea/index.asp.

Environmental Affairs Committee (2012b). *Meeting Minutes February 13th 2012*. Retrieved from UWGB Student Government Environmental Affairs Committee at: http://www.uwgb.edu/studgov/committees/ea/pdfs/minutes/MeetingMinutesFeb132012.pdf.

Environmental Integrity Project. (2007). *Dirty Kilowatts America's Most Polluting Power Plants.* Retrieved from Environmental Integrity Project website at: http://www.dirtykilowatts.org/Dirty_Kilowatts2007.pdf.

Environmental Protection Agency. (2011a). *TRI Explorer Releases: Facility Report*. Retrieved from EPA website at: http://iaspub.epa.gov/triexplorer/release_fac?p_view=COFA&trilib=TRIQ1&sort=_VIEW_&sort_fmt=1&state=55&county=55009&chemical=All+chemicals&industry=ALL&year=2010&tab_rpt=1&fld=RELLBY&fld=TSFDSP.

Environmental Protection Agency. (2011b). *Lead in Air*. Retrieved from EPA website at: http://www.epa.gov/air/lead/health.html.

Environmental Protection Agency (2011c). Cleaner Power Plants. Retrieved from EPA website at: http://www.epa.gov/mats/powerplants.html.

Environmental Protection Agency. (2012). *Mercury Health Effects*. Retrieved from EPA website at: http://www.epa.gov/mercury/effects.htm.

Lake Michigan Wind and Sun (2011). *Links.* Retrieved from: http://www.solar-flairs.net/drupal/node/8.

Mader, S. (1996). *Biology* (5) WCB. Retrieved from http://www.marietta.edu/~biol/102/2bioma95.html.

NAACP (2011). *Coal blooded: putting profits before people in Wisconsin*. Retrieved from http://naacp.3cdn.net/70e39b3822cda99733_1gm6bzlue.pdf.

National Renewable Energy Lab (2008). *Photovoltais Solar Resource: United States and Germany.* Retrievd from DOE website at: www.doe.gov

Scorecard. (2011). *Environmental Release Report: Brown County, WI*. Retrieved from Scorecard Website at: http://scorecard.goodguide.com/env-releases/county.tcl?fips_county_code=55009#major_chemical_releases.

Sierra Club. (2005). *Fox Valley Sierra Group Pulliam Power Plant*. Retrieved from Sierra Club website at: http://wisconsin.sierraclub.org/foxvalley/Pulliam.html.

Sourewatch. (2011). *Pulliam Power Plant*. Retrieved from sourcewatch website at: http://www.sourcewatch.org/index.php?title=Pulliam_Power_Plant.

SMA Solar Technology AG (2012). *LMWS PV Comparison*. Retrieved from: http://www.sunnyportal.com/Templates/PublicPageOverview.aspx?page=5c2e2b83-c7ad-485a-8708-85675636c711&plant=7e021a4e-d44a-4345-abdd-0a8d9888bc1f&splang=en-US.

UWGB. (2012). *Housing and Residence Life: Our Community Development Philosophy*. Retrieved from Housing and Residence Life website at: http://www.uwgb.edu/housing/community/.

WDNR. (2012). *Facility Information for JP Pulliam Plant*. Retrieved from WDNR website at: http://dnr.wi.gov/cias/am/amexternal/AM_PermitTracking.aspx?id=3001288.

Wisconsin State Climatology Office. (2003). *Monthly Winds at Green Bay*. Retrieved from WSCO website at: http://www.aos.wisc.edu/~sco/clim-history/stations/grb/gbywind.html.

WPS. (2012). *Average Fuel Mix Comparisons*. Retrieved from WPS website at: http://www.wisconsinpublicservice.com/home/choice_fuelmix.aspx.