

WWU SOLUTIONS

Campus Sustainability Planning Studio

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12 March 2012

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1.1 PROBLEM

Western Washington University has a Climate Action Plan which pushes the university to reach climate neutrality by 2050. In order to reach that goal, Western needs to find efficient sources of renewable energy to phase away from using natural gas to reduce greenhouse gases. The current water heating system for the Wade King Recreation Center is powered by natural gas and has a 25 percent energy loss, 15 percent is lost in the transition from natural gas to steam and 10 percent is lost travelling from the steam plant located near Red Square to the rec center. Annually, 274,733 pounds of carbon dioxide are emitted from burning natural gas to heat the swimming pool.

1.2 SOLUTION

By integrating a solar thermal system to heat the Wade King Recreation Center's hot water system, carbon emissions can be reduced. Western can use this pilot project to become a living laboratory for solar thermal energy; this is an opportunity to educate and influence WWU students, alumni and the community on the importance of sustainability. By investing in enough panels to produce near 100 percent solar thermal energy during the optimal months, April-November, the pool, spa and domestic hot water can reduce their carbon emissions by an estimated 72 percent. This investment includes a package of solar collectors, storage tank/solar heat exchanger, temperature controllers, expansion tank as well as installation, engineering, plumbing and permitting. This package, tailored for Pacific North West climate, has a ten year warranty and life expectancy of 20 years, the replacement cost is \$500 per collector.

1.3 FUNDING REQUIREMENTS

Based from an estimated 45 collectors needed to produce near 100 percent solar thermal energy for the pool during the optimal months, the commercial rate through a Bellingham solar thermal company, Western Solar, is \$157,500. Three funding options are; the Wade King Recreation Center, the Student Green Energy Fee Program and additional grants or incentives. For a payback period of eight years the rec center would invest \$41,600. After the payback period the rec center would save \$5,200 annually in natural gas costs. The remaining \$115,900 would be funded by the Student Green Energy Fee Program. Additional funds and incentives can potentially supplement the rec center and or green energy fee.

1.4 CASE STUDIES

[Colorado at Colorado Springs Recreation Center Solar Thermal Site](#)

Colorado at Colorado Springs used part of a 2.3 million dollar Energy Performance Bond to finance a solar thermal system of 68 evacuated tube collectors on their LEED certified recreation center. The collectors were estimated to heat two thirds of the pool water annually. However the collectors currently heat near 100 percent of the pool annually, and the system has now been tied to heat domestic hot water. This integration into the domestic hot water would have been more cost efficient if included in the initial installation. Colorado is a peer institute to Western Washington University and has a goal of reducing the universities greenhouse gas emissions 80 percent by 2050. The students on campus support these projects and introduced a student green fee of 5 dollars per quarter for the next 5 years to support solar power initiatives.

Everett Naval Station:

The Everett Naval Station recently partnered with Western Solar to install 120 flat plate solar thermal collectors to heat their 365,000 gallon swimming pool. The ratio of one collector to 3,041 gallons was used to determine the amount of collectors needed for Wade King Recreation Center's 138,000 gallon pool. The Btu output of 45 collectors is near the maximum Btu capacity of the Western's pool heat exchanger.

2.0 STATEMENT OF NEED

The Wade King Recreation Center will need an estimated 45 collectors to heat the swimming pool. This installation at the commercial rate provided by Western Solar is \$157,500. To be cost efficient, it will be best to apply the domestic hot water, spa and pool to the solar thermal system. This would be cost efficient because it is less expensive to install a solar thermal system to all hot water systems with the same permit, plumbing, engineering, and installation process versus treating each system separately. Additional collectors could be added in the future which would reduce more carbon dioxide emissions.

3.0 PROJECT DESCRIPTION

This pilot project proposes that the recreation centers swimming pool will use approximately 45 8X4 ft. Flat Plate Solar Thermal Collectors and a 700 gallon storage tank/solar heat exchanger. The system runs off a food grade nontoxic glycol closed loop which prevents freezing in winter months. A heat expansion tank used in the system prevents overheating during summer months; this expansion tank captures boiling glycol when in the gas phase, containing it until cooled back into a liquid. Automated temperature controls program the supply of solar thermal heat to the pool, which can either bypass or be supplemented by the steam heat exchanger.

3.1 METHODS

To determine if the recreation center would be a prime location to install solar thermal collectors, a tool called the Solar Pathfinder was used to collect data in two locations on the roof. The collected data included areas of available sun proving the rec center is an optimal location for solar collection. The pool heat exchanger has an estimated 90 gallon per minute flow rate, which is the maximum flow rate. All of the natural gas prices and CO2 emissions are based off this flow rate. For implementation of this project, the Wade King Recreation Center will need to give approval and following this approval; an application for the Student Green Energy Fee will be submitted. After funding is figured out, a solar company will be contracted to supply and potentially install the collectors. After the installation, once every six months the collectors will have to be hosed down to clear dust and every two to three years a solar technician will have to check the glycol levels.

3.2 STAFFING/ADMINISTRATION

Western Solar, Facilities Management, the Green Energy Fee, Wade King Recreation Center faculty and staff as well as Western's Faculty and Staff were key resources for developing this project.

- Brad Johnson, the Chairman of the WWU Physics department is sponsoring this project to apply for the Student Green Energy Fee.
- Facilities Management has provided information on the current heating system of the pool including flow rates, BTU's for the heat exchangers, steam and gas.
- Western Solar explained the solar thermal system, engineering and costs.
- Kathryn Freeman, the director of the Green Energy Fund Grant Program provided potential funding routes.
- Sandy Fugami, Facilities Management Mechanical Engineer, explained the mechanical engineering of the current system in regards to implementing a solar thermal system.

3.3 EVALUATION

This project is for the students, faculty and staff of Western as well as the general public. WWU's rec center has been used at least once by 91 percent of all students. This high visibility can provide an excellent educational tool for promoting sustainability through renewable energy, especially since the rec center is a starting point for campus tours. An informational kiosk in the lobby can showcase the solar system's functions and benefits. Multiple majors including energy, material science, economics, environmental studies and science can use this project as a learning site.

3.4 SUSTAINABILITY

Solar thermal energy can be used to create a living laboratory; “As we seek to change what is around us, we must seek to change what is within us also.”- Leith Sharp, “Green Campuses: the Road from Little Victories to Systematic Transformations” In order to change the unsustainable energy sources around Western, Western must first learn to change the energy sources within it. By harnessing heat from the sun, through this project, Western can take an important step to becoming a leader in reducing and hopefully eliminating anthropogenic negative impacts to earth. Natural gas has a nonrenewable supply, eventually this source can run out. By implementing solar thermal, long term energy security and resource conservation can be achieved.

4.0 BUDGET

With 45 8X4ft. flat plate collectors at the commercial price of \$3500 each, this project is estimated to cost \$157,500. For the Wade King Recreation Center to have an eight year payback they would invest \$41,600 and after eight years they will receive a savings of \$5,200 per year. The remaining \$115,900 will be supplied by the Student Green Energy Fee. Additional grants and incentives can supplement the rec center and or the green energy fee.

5.0 FUTURE WORKS

To calculate the exact number of panels needed, a panamatrix flow meter will be used to determine the correct flow rate of the pool, spa, and domestic heat exchangers. If the solar thermal system is installed to heat the entire hot water system at the rec center, additional solar collectors can be added to provide a greater percentage of annual solar collection. If this project proves successful it could be expanded to existing buildings on campus such as Carver Gym, dormitories and other buildings that use large amounts of hot water.

6.0 CONCLUSION

In conclusion this project will reduce carbon dioxide emitted from natural gas, as well as lower the amount of natural gas burned to heat water at the rec center. Investing in solar thermal will save the rec center money spent on annual utility bills. The returned savings from this project could be implemented towards other alternative energy projects at the recreation center that will educate and influence students about sustainability. The estimated 45 solar collectors will produce near 100 percent solar thermal energy for the pool during the optimal months

APPENDIX

1.0A ADDITIONAL CASE STUDIES

These following case studies helped us jump-start our research on solar thermal installations.

Case Study #1: Point Loma Nazarene University Solar Thermal Hot Water System

Point Loma Nazarene University is a small Christian Liberal Arts school with just 3,500 students. However small, PLNU is projected to save over \$1.6 million dollars in the next twenty years with a new Photovoltaic (PV) system and solar thermal hot water system. Granted this school is located in San Diego, California, installing a 54 kW solar water heating system, can heat up to 940 gallons of hot water a day and save the university \$5,000 annually in utility bills. PLNU is dedicated to implementing renewable energy throughout the university in a way in which it teaches the students about its sustainable choices through forums and sustainability classes. The heating system was financed by the students at PLNU by their contribution to the university's Green Fund of \$5 every semester, which raises \$25,000 a year for sustainability projects and the students chose to save the money for 2.5 years to buy the system outright without financing. This particular water system was used for the student dorms.

Case Study #2: Western Kentucky University Preston Pool Solar Thermal Project

Western Kentucky University is the fastest growing university in Kentucky with over 21,000 students and is still expected to grow in the coming years. As a result, WKU is looking for ways to reduce energy costs. The solar thermal project, which is part of an Energy Savings Performance Contract completed by Johnson Controls, will sustainably heat the Preston Center Pool for approximately ten months out of the year, and save the University around \$11,000 annually. The array will keep the pool heated at a constant 80-83 degrees Fahrenheit when in operation. The system consists of an eighty-eight panel solar thermal array that initially cost \$96,410 and will pay for itself in a little under 9 years.

Case Study #3: Solar Photovoltaic installation at James Madison University

JMU installed a 255 solar panel array on top of their ETEC building in 2003. The project cost 120,000 dollars, which was funded primarily through the university but also received a grant from the Virginia Alliance of Solar Energy. The current system provides approximately 10k watts of electricity to the building. While it does not power the entire building, the current system is set-up so that several dozen more panels can be added. The panels are set to last 20 years given proper maintenance. Other than being a source of electricity, it serves as an important teaching tool to students at the university.

2.0A INSIDER INTERVIEWS

From these contacts, we were able to collect valuable information relating to Western's current energy use and heating system and information to conduct a solar site assessment for the demonstration site.

Interviewer: Courtney Rondel

Interviewee: Josh Miller

Position: Project Manager at Western Solar

Contact: (360) 393-1288 josh@westernsolarinc.com

Josh will help us understand solar energy, through efficiency measures such as *solar flux* and *air mass data*. These measures will help us calculate the conversion efficiency of WWU's present recreation center heating system versus the potential solar heating system. Josh will also help the project by providing a solar site assessment, which will help us narrow down the best location on campus for solar thermal. The size and cost of this project is TBD, however if WWU were to implement solar thermal, at least one 75-gallon tank, (whether that be paired with evacuated tube collectors or flat plate collectors will be determined on the site assessment) will be purchased at a projected \$11k. Funding is still being calculated and therefore an estimate is currently unavailable. Currently, Josh and Western Solar are skeptical about being involved in this project since funding is not yet determined, as well as acceptance of the final result of this project. As a pilot project, Western Solar is weary about helping us build a design due to the chance that if we release an RFP, another firm could take their design and partner with WWU at a lower cost, stealing Western Solar's design and business. The biggest challenges we currently face are funding, conversion efficiency and projected installation. We know that solar thermal can work for Western, however we do not know if solar thermal is the best choice, given that future technology is still in the works. For example, a Hybrid Solar-Wind Forecasting system that Western is working on, would be much more efficient in our region since sunlight is sparse.

Interviewer: Chris Armstrong

Interviewee: Sandy Fugami

Position: Mechanical Engineer 3

Contact: (360) 650-2230

Sandy and I met to discuss the Facilities Improvement Measures (FIMs) that McKinstry had proposed. She didn't have any information on any solar thermal projects, but she did have some leads that will help us move ahead with the project. While we were discussing the FIMs she explained to me that the main reason why Facilities Management decided not to go with any solar thermal improvements is because of the long payback

period. They chose not to include any because the return on investment was more than 10 years.

We also talked about possible alternative places to put up a solar thermal display. The two most likely candidates as an alternative to the rec center that we thought of were the Campus Services building or at the Physical Plant because they are not connected to the steam heating system, they have their own boilers. While those two choices are good for a small system, they aren't highly visible. Both are a little out of the way and couldn't be used effectively as an educational tool.

Interviewer: Brian Maskal

Interviewee: Adam Leonard

Position: Associate director of Wade King Recreation Center

Contact: (360) 650-4972

Adam Leonard expressed his openness to a clean sustainable source of energy such as solar thermal being instituted in the recreation center. He was adamantly clear though that it would require a lot of research into cost and effectiveness to convince himself and Director Marie Saylor that this was the best thing for the recreation center. Also, we would need to thoroughly and clearly represent our data and findings to the director of the recreation facility in order to persuade them.

Interviewer: Stephen Harvey

Interviewee: Kevin Gilford

Position: Office of Sustainability Assistant Director of Colorado University at Colorado Springs

Contact: (719) 255-3089

The project has been a huge success at the Rec Center with the solar thermal system supplying "near 100%" of the energy to heat the pool water. There is excess heat that is dissipated and now engineers are looking to hook this extra heat into the shower/faucet system. There was never in depth analytical data analysis done with the cost benefits and electricity saved by the solar thermal system. Originally the system was expected to pay off two to three times within its 30+ year life, but now that payback times has decreased.

3.0A NATURAL GAS AND THE ENVIRONMENT

Fossil Fuel Emission Levels

- Pounds per Billion Btu of Energy Input Pollutant Natural Gas

Carbon Dioxide 117,000

Carbon Monoxide 40

Nitrogen Oxides 92

Sulfur Dioxide 1

Particulates 7

Mercury 0.000

*Source: EIA - Natural Gas Issues and Trends 1998. <http://naturalgas.org/environment/naturalgas.asp>