CENTENNIAL SOLAR PANEL SYSTEM

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The Initiative for Sustainability and Energy at Northwestern

Engineers for a Sustainable World
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Project Description
The Centennial Solar Panel System (CSPS), a 17 kW solar photovoltaic array at Northwestern University, is a partner project between Engineers for a Sustainable World (ESW) and the Northwestern Sustainability Fund (NSF), in collaboration with NU Facilities Management (FM). Spearheaded, fundraised, and publicized by students, CSPS achieves its goals as Northwestern’s first onsite renewable energy generation system, and as an inspirational and educational display for student sustainability. Since its completion in April 2011, CSPS has proven its capability to produce the expected 20,000 kWh annually of electricity for the Ford Engineering Design Center. Additionally, it has motivated class projects and spurred development of student-staff collaborative sustainability efforts.

Engineers for a Sustainable World (ESW) empowers students to take on leadership roles in applying the principles of sustainability to their present and future work through action-based engineering projects and the education of ourselves and our community on sustainability. CSPS is a subset of ESW’s Clean Energy Plan (CEP), which aims to set Northwestern on a path towards sustainable energy consumption, through developing a clean energy plan and leading renewable energy generation installation projects. CEP is planning to undertake more renewable energy systems based on the skills developed during CSPS.

The Northwestern Sustainability Fund (NSF) is a student managed revolving source of capital to invest in sustainability projects that have both an environmental impact and cost savings. The NSF empowers members of the Northwestern community to take ownership of their university's environmental standing by implementing infrastructure improvement. The organization began in the fall of 2008 and in addition to CSPS has also completed a retrofit of the faucets of Northwestern University's student center. This project made the faucets both low-flow and automatic shutoff and is projected to conserve approximately 100,000 gallons of water per year and payback in less than five years.

Implementation
In the spring of 2009, the project was conceived by Phil Dzeidzic and RC Yu, the two student project managers of ESW GRIN (GReen It Now), which conducts energy audits on campus. At the time they were completing their first audit, of the GREEN House Dormitory. Looking to augment their audit with solar panels, the students explored adding photovoltaic panels to the GREEN House. Due to technical concerns, they moved the project to the Ford Motor Company Engineering Design Center, which had easy access to the mechanical room and a flat roof for the panels. After the decision was made to install the solar panels on the roof of Ford, an initial cost estimate was made with a solar installation company.

In the fall of 2009, the project team continued to gather support from other student groups and began its fundraising campaign. Despite an initial rejection from the Illinois Clean Energy Community Foundation (ICECF), the team managed to gather full approval and financial support from the McCormick School of Engineering, and academic departments in October of 2009. After a brief period of review of the technical feasibility and budget costs for such a project, Facilities Management provided their endorsement of the project. The team began making presentations to classes at this time. By the end of October, the team submitted an application to the Illinois Department of Commerce and Economic Opportunity (DCEO).

After being rejected by DCEO in January 2010, the team took a step back to evaluate the project. Faced with rejection from DCEO and still determined to install solar panels at NU, the team began revamping the project in preparation for the spring ICECF application. The first step of the process was coining the name, the “Centennial Solar Panel System” in honor of the engineering school’s centennial celebration during the 2009-2010 school year. More important than solidifying a name, the team developed their new method of proposal writing, focused on aligning the project goals with the goals of the recipient organization. With this format, the team set out on process of developing a strategy based around the four goals listed at the beginning of this report.
In preparation for the ICECF grant proposal, ESW also brought the Northwestern Sustainability Fund on board to provide funding and develop the project relationship with FM. Having worked with FM in the past, NSF was able to leverage their connections to raise additional funds and solidify the ICECF application. In Spring 2010, the team was awarded a grant from the Illinois Clean Energy Community Foundation (ICECF) for about 60% of the project budget. FM issued a Request for Proposals to engineering firms in June, 2010 for design services associated with the installation. Based on the firm’s experience, the University chose Elara Engineering.

In the fall of 2010, CSPS became the flagship project of ESW’s new Clean Energy Plan project. The student project managers worked alongside FM for the next few months implementing the design and construction, in addition to gathering in-kind support and preparing publicity. While FM focused on finishing the construction of the system by the grant deadlines, the student leaders worked with the University staff and faculty to prepare an opening event celebrating NU’s commitment to sustainability, attended by project sponsors, student and faculty environmental leaders, and administration. For that event, the students coordinated the production of a promotional video used throughout Northwestern’s news sources (the video is available here). Since the opening, the team has been working to develop the web-based monitoring capabilities and expand education and outreach.

In February 2011, the design was finalized and submitted to the City of Evanston for a permit. Divane Bros Electric was chosen in a bid process to construct the system based upon their work history. The installation of the panels was complete in time for ribbon cutting ceremony on April 21 and was turned on the following week for testing. CSPS is rated at 16.875 KW. The array’s major components are 75 225-Watt Canadian Solar CS6P Panels, 45 Enphase D380 Micro-Inverters and 15 30-foot sections of SolarDock racking system at 35° angle, facing due south.

The project team elected to utilize multiple Enphase D380 micro-inverters, located at the panels, rather than a single inverter located inside the building. This decision was based on economics, redundancy, and safety. The micro-inverters inherently offer a greater level of redundancy in the system, in that a failure of a single inverter would not take the entire array off-line. All trouble shooting on the system is aided greatly by the micro-inverter monitoring system, which provides panel-level production information on the system and does not require working with and measuring high DC voltages across the array.

Accomplished Goals of CSPS

Generate clean energy at Northwestern – The system is rated at 17 kW and is expected to generate 20,000 kWh per year. Peak production during testing reached approximately 14.9KW according to the Enphase monitoring system. We believe this peak – approximately 89% of the panel rating – is due to a combination of the rack angle, the panel efficiencies, and the efficiency of the inverter system. CSPS is expected to offset 15 tons of CO₂ equivalence per year in electricity purchase reduction. Interestingly, as Northwestern is in the state of Illinois, CSPS is expected to offset the generation of 2 lbs of high level nuclear waste as well over the next 20 years. The CSPS team is currently working with the Information Technology Institute at Northwestern University to develop an advanced web based monitoring system.

Demonstrate NU’s commitment to sustainability – With the accomplishment of this project, NU has expanded its sustainability efforts. ESW Clean Energy Plan is developing its next projects in sustainability and energy on campus. Through the course of the project there have been about a dozen news reports about CSPS, including a promotional video and story by the university relations staff that was highlighted on the main Northwestern homepage for more than a week. Reports have been included in the newspaper, magazine, and TV networks run by students. The overall participation from various groups throughout the university and the reception given to CSPS goes to show that Northwestern is moving towards sustainability.
For FM and ESW, CSPS has become a model and example of how to install more renewable energy on campus, developing many key relationships and skills. It has also helped identify topics that NU needs to improve in its future systems, such as communications between students and facilities management and funding systems for large student-based facilities projects.

Perhaps the most remarkable and unique development in sustainability at Northwestern that CSPS has contributed to is the high level of student involvement. For the student participation in the project, the CSPS team has applied to two awards from the Association for the Advancement of Sustainability in Higher Education (AASHE). ESW’s Clean Energy Plan has adopted many of the practices of CSPS to develop further projects that are student spearheaded to develop campus sustainability.

**Facilitate teaching and research about sustainability and energy at Northwestern** – The CSPS set the metric of integrating the solar panels and sustainability into four courses to quantify this goal. As of spring 2011, the team had worked with five courses and has plans to continue this integration into the future. The CSPS team presented lectures to three environmental policy courses and developed a homework problem for an engineering economics class. The largest educational assignment for CSPS was a design problem for a required freshman engineering class where one of the project managers worked with the professors and TAs to develop a scenario that integrated the programming and mechanical structures topics from the class. Overall, it is estimated that four to five hundred students learned about the project in the courses in which the CSPS team directly worked with the professors to develop material. Additionally, students have informed the CSPS team that they heard about the project being used as an example in a variety of classroom settings by professors not approached by the CSPS team.

The web based monitoring system will allow members of the community to track the progress of CSPS. It will offer interesting time related graphs of power production, pollutant offsets, energy equivalence. Additionally, students will be able to download the raw data to do research studies for classes. We are planning on implement additional sensors to track variables such as temperature and humidity to study their effect on production. The CSPS team is working to develop a class assignment around the data.

An additional education outcome comes from the next steps taken by the Clean Energy Plan team. In working towards the next installation, the team decided to develop a vertical axis wind turbine project. Since good financial and energy calculations cannot be determined without good wind speed data, the team is developing a one year anemometer research study on campus to develop the project.

**Act as an outreach and inspirational tool for the community** – CSPS has appeared in the Northwestern news on several occasions and has been discussed with students at Northwestern and neighboring k-12 schools. In the wake of CSPS’s completion, the team was contacted by many students throughout the university community to discuss their methods and the project. Many students in the journalism school used the opportunity to expand their knowledge of this increasing hot topic by doing major course stories on CSPS. A group of students even began developing a sustainability map of campus.

As the new project work of CEP is based off the work on CSPS, it is a clear descendent of this project, however not just in the sustainability sense. CEP is working to develop best practices protocol from many of the experiences of CSPS, from working with FM to how to approach the University for funding. Also, many less tangible skills, are being actively being passed from the older students who completed CSPS to younger students who could see the next installation through to completion. The CSPS team worked diligently to broadly publicize the project in the hopes that more students will move towards sustainability.
Acknowledgements

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- The Segal Design Institutes
- The Farley Center for Entrepreneurship and Innovation
- The Department of Engineering Sciences and Applied Math
- The Department of Earth and Planetary Sciences
- The Center for Student Involvement
- The Northwestern Institute for Sustainable Practices
- The Department of Environmental Policy & Culture
- The Northwestern Sustainability Fund
- Engineers for a Sustainable World
- An Anonymous Donation

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- Northwestern University Information Technology (NUIT)
- NU Cuisine (Sodexo)

Northwestern Employee Hours (Time donated to project):

- Northwestern University Facilities Management
- McCormick School of Engineering and Applied Sciences
- Initiative for Sustainability and Energy at Northwestern (ISEN)
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- McCormick Marketing Staff
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