

2009 Solar Decathlon
Final Report
For
The Student Sustainability Committee
By
Team Illinois



(Photo by Charlie Simokaitis)

Project Contact*:

Mark Taylor, Assistant Professor
School of Architecture
117 Temple Hoyne Buell Hall
611 Lorado Taft Drive, Champaign, Illinois 61820
Ph: 217-244-8049; Email: mstaylor@illinois.edu

Dr. Xinlei Wang, Associate Professor
Department of Agricultural and Biological Engineering
332-C 1304 W Pennsylvania Ave
Urbana, IL 61801
Ph: 217-333-4446; Email: xwang2@illinois.edu

* This project was led by Dr. Patrick L. Chapman, former Associate Professor, ECE, University of Illinois

TABLE OF CONTENTS

I.	Overview of the Project	2
II.	Project Execution/Deployment.....	2
	Passive House Design	2
	Structure Engineering.....	2
	Mechanical Engineering	2
	Electrical Engineering	2
III.	Project Costs and Fundraising.....	3
IV.	Environmental, Social, and Economic Impact.....	4
V.	Educational Outreach and Public Engagement.....	5
	Results of Media-Outreach Activities	5
	Media Outreach Metrics.....	6
	National Mall	6
	Campus Temporary Building Site.....	7
	Evaluation of the Team's Web Site.....	7
VI.	Conclusions	8
VII.	Appreciation.....	8

I. Overview of the Project

The Solar Decathlon is a prestigious biennial competition sponsored by the U.S. Department of Energy (DOE) and the National Renewable Energy Laboratory (NREL). Only twenty teams of college and university students are selected from around the world in each competition. Each student team designs, builds and operates an energy efficient, solar-powered home for this competition. Teams are required to meet specific criteria, demonstrating their ability to design and build an innovative, entirely solar-powered, 900-square-foot home from scratch. Each house must produce enough electricity and hot water to perform all the functions of a home. The house were judged in ten specific areas of competition: *Architecture, Market Viability, Engineering, Communications, Comfort Zone, Hot Water, Appliances, Lighting, Net Metering and Home Entertainment*. The Solar Decathlon provides an exceptional opportunity for students across many disciplines including architecture, engineering, business, landscape and industrial design to interact with a team composed of members from many Colleges (ACES, Business, Engineering, FFA and Media). The Solar Decathlon is a highly publicized national event. The 10-day showcase of each team's design, on the national mall in Washington D.C., is a highly visible event that advocates public education and research advancement for solar energy, home systems efficiency, and green building design and construction. In the 2009 competition, there were over 300,000 people, including many congressmen, who toured and learned about the houses, and millions were exposed via internet, TV and radio. In addition to the great learning experiences for hundreds of students involved in this unique multi-disciplinary project, it is also a great opportunity to promote University of Illinois and highlight the achievements at Illinois in national media. The Illinois team won the 2nd place in the 2009 competition and was featured in many media including the Big Ten Network. In addition, the Illinois team earned top honors in three contests (Appliances, Hot Water, and Home Entertainment). Former Chancellor Herman wrote in his letter of congratulations to the team: *"Finishing in the top two among the very best in the nation and Europe is an achievement that has made the entire Illinois family proud. ... The creativity and hard work you each contributed to this effort shows how the interdisciplinary approach at Illinois can lead to amazing accomplishment."*



Figure 1. The Illinois team won the 2nd place in the 2009 Solar Decathlon Competition, National Mall, Washington DC

II. Project Execution/Deployment

The SD09 team involved more than a hundred students over two years, and faculty members from at least six different academic departments. The SD09 team developed a vernacular house that took advantage of locally reclaimed materials and was designed and met Passive House Standards. This house proved that it was possible to integrate new technology with traditional building methods and materials.

Passive House Design

The Gable Home was designed to meet Passive House standards, a rigorous performance evaluation that requires optimal performance and environmentally sensitive design. The house is highly insulated and incorporates advanced window design and installation technology. Such specifications reduce air infiltrations significantly and help the home act like a thermos, maintaining a comfortable, consistent indoor temperature. High-quality, energy-efficient window and door systems were required in order to meet Passive House standards and achieve certification. All windows and doors were generously donated by Optiwin. The window systems were designed to meet Passive House standards and have an approximate U value of 0.15 Btu/h·ft²·°F

Structure Engineering

The structural frame of Gable Home is made of 3/4" laminated bamboo framing elements. The laminated bamboo was generously donated by Lamboo Inc. Lamboo offers 10 times the strength of typical framing wood and in this application, the minimal thickness significantly reduced thermal bridging, which helped us achieve the energy efficiency required for Passive House certification.

Mechanical Engineering

The mechanical systems are located in a loft above the bathroom. From this location, the mechanical system supplies fresh, conditioned air into the spaces and returns exhaust air to the exterior of the building. The mechanical system is a compact HVAC system which combines a number of heating and cooling tasks for greater energy efficiency

Electrical Engineering

The solar photovoltaic (PV) power system is designed from both a power generation and an aesthetic standpoint. A minimal design would ensure that the PV system supplied all the energy needs of house, but with minimal upfront cost. The team preferred to blend the PV system into the building design without sacrifice of architectural objectives. The solar array is placed at nearly the optimal angle for solar harvest, fills the southern roof space, and provides far more than enough power to balance the building energy.

The house was completed on the University of Illinois campus and open to sponsors and the general public in September 2009 before transporting to the National Mall, Washington D.C. for 2009 Solar Decathlon. In fall 2009 the house was set in its final location south of the I Hotel

and Conference Center, 1902 S. 1st Street, Champaign, Illinois, where it has been used as an educational tool for classes in architecture and engineering.



Figure 2. 2009 Solar Decathlon Gable Home located in the south of the I Hotel and Conference Center, 1902 S. 1st Street, Champaign, Illinois

III. Project Costs and Fundraising

The Illinois team approached fundraising for the Solar Decathlon house with a holistic perspective, recognizing the need for large sponsors and donors but also focusing on small material donations and product providers throughout the process. We began the competition with an initial rough budget of \$650,000 including all purchases, student labor, management, transportation and competition expenditures.

With regard to contributions, the team initially received support from the DOE for \$100,000, and the Illinois Clean Energy Community Foundation for \$200,000. This provided us with substantial initial funding to begin design, manufacturing and purchasing. We then completed multiple grant applications and requests and obtained approximately \$55,000 from the Illinois Student Sustainability Committee, \$60,000 from the Grainger foundation and around \$80,000 in in-kind tuition and stipend support from various university departments. This included the ability to use facilities, work with professors and utilize graduate student's research. The remainder of our fundraising was contributions (cash or in-kind) from over 80 companies. From small donations covering only a single item to whole systems or support, we found numerous companies to be extremely generous with regard to their time, commitment, and donations. In total, we received over \$100,000 of in-kind contributions including a designer kitchen from

Valcucine, appliances, all interior furnishings from CB2, exterior clips for the solar panels, wood sheathing, flooring, structural members, lighting, insulation, windows, mechanical systems and marketing materials. The results of the fundraising efforts are shown in Table 1.

Table 1. Fundraising Results

Department of Energy	\$ 100,000.00
Illinois Clean Energy Community Foundation	\$ 200,000.00
Student Sustainability Committee	\$ 55,000.00
Internal Campus Support	\$ 140,000.00
Cash and In-kind Donations over 80 companies	\$ 100,000.00
Total	\$ 595,000.00

The total expenditure for the project is approximately \$657,000. The final large contribution that we believed that we had secured was approximately \$80,000 from the Chancellor's Office and the Office of Sustainability on campus but this fell through near the end of the competition, leaving a budget gap of approximately \$62,000 for the Illinois Solar Decathlon project, which was resolved with the contribution from the Department of Electrical & Computer Engineering, University Of Illinois.

IV. Environmental, Social, and Economic Impact

The University of Illinois Solar Decathlon team adhered to three basic tenets for the 2009 U.S. Department of Energy’s Solar Decathlon with a balance between sustainability and cost effectiveness:

- Compose an environmentally responsible design attitude that assesses the design resource’s impact, maintaining a holistic approach.
- Maintain an aesthetically pleasing and economically feasible design that is appealing, marketable and affordable to the public.
- Maintain the highest standards of energy efficiency with a synergism among the parts to optimize the whole. Conceptually, this stresses conservation more than production.

The Gable home was designed to meet Passive House standards set by the Passive House Institute US, a very well-insulated, virtually air-tight building that is primarily heated by passive solar gain and by internal gains from people, appliances, etc. It is constructed largely from recycled, reclaimed wood and engineered bamboo and is outfitted with a rooftop array of solar panels. The PV arrays are generating approximately 13,000 kWh electricity per year from sun without emission.

The environmental and social impact of this project includes education of participants and visitors on the benefits of energy efficiency, renewable energy and green building technologies; raising public awareness of these practices; encouraging research, development and marketability of solar energy technologies; fostering educational cooperation among students and institutions; promoting an integrated, “whole building design” approach to new

construction; and demonstrating the potential of zero-energy homes, which produce as much energy from renewable sources such as the sun and wind, as they consume.

V. Educational Outreach and Public Engagement

Results of Media-Outreach Activities

Media Outreach Instances in Chronological Order

News Bureau of the University of Illinois – Feb. 5, 2008
ABC7.com Green Content – Oct. 30, 2008
ECE Headline News – Feb. 6, 2009
Engineering at Illinois: News – Feb. 11, 2009
WILL AM580 News Headlines – June 15, 2009
WCIA – 3 News *Morning Show* – June 16, 2009
Champaign News Gazette – June 16, 2009 – FRONT PAGE
Daily Illini – June 17, 2009
Texas Instruments Press Release – June 18, 2009
ECE Headline News – Aug. 26, 2009
WICD ABC News Channel 15 – Sept. 10, 2009
Environmental Almanac Blog – Sept. 10, 2009
WILL AM580 Headlines – Sept. 11, 2009
Daily Illini – Sept 22, 2009
WCIA – Sept. 23, 2009
ECE Headline News – Oct. 6, 2009
CNET News – October 10, 2009
LA Times – Oct. 13, 2009
Chicago Tribune – Oct. 14, 2009
Eco Home - Oct. 15, 2009
Get Energy Smart Now – Oct. 15, 2009
Jetson Green – Oct. 15, 2009
ABC7.com Green Content – Oct. 16, 2009
Builder – Oct. 16, 2009
Huffington Post – Oct. 16, 2009
Inhabitat – Oct. 16, 2009
Reuters – Oct. 16, 2009
ABC Channel 7 Chicago – Oct. 16, 2009
News Bureau – University of Illinois – Oct. 16, 2009
Champaign News Gazette – Oct. 17, 2009
Washington City Paper – Oct. 20, 2009
AirTap Release – Oct. 22, 2009

The proceeding list describes a large portion of the media outreach activities achieved by the 2009 University of Illinois Solar Decathlon Team. Two large contributions not listed above are the BigTEN Network and Planet Green. They were not listed because their contributions have not yet manifest. The BigTEN is now under the process of editing video material accumulated

over the entirety of our project to debut as a documentary on the BigTEN network on April. Driverworks LLC is currently producing a promo for Planet Green that features our house in a new series called “Mind of the Designer.” Each of these media activities have enormous potential to reach a large populace.

Media Outreach Metrics

Listed below are data related to the metrics of various selected media groups as they pertain to the University of Illinois’ Solar Decathlon Project.

Chicago Tribune – Average 465,000 daily distributed copies

LA Times – Average 919,366 daily distributed copies [latimes.com]

Huffington Post – 4.5 millions unique viewers in September [comscore.com]

Champaign News Gazette – Average 98,735 daily distributed copies [powerreporting.com]

BigTEN Network – Available in over 70 million households

Planet Green – Available in over 50 million households [corporate.discovery.com]

The data represented above shows a small sampling of the magnitude of our communication efforts. On top of these media outreach activities, students have volunteered their time to reach out to the local Champaign/Urbana community through various events and organizations. For instance, the Engineering Open House, held by the University of Illinois annually, draws thousands of prospective engineering students to campus. Our team continues to set up desks and pass along fliers during each of these events to promote interest in the project. Students have also volunteered their time to set up exhibits at the local children’s museum to promote interest in the youngest populations. The exhibits were interactive, allowing children to see how solar panels create electricity to power small motors. These events, along with a series of Gable Home open houses reached a population that we estimated to be over 4,000 people.

National Mall

During the competition the liaison for the Gable Home kept exceedingly accurate counts of the amount of people who toured the house. Therefore, we accept the DOE’s estimates of on-site outreach. However, our tour strategy changed significantly after the first day, enough to be considered noteworthy here. During the first day of tours between 300 and 400 people toured the house. This, as we soon realized, was miniscule in comparison to some other teams. As a team we believed it was important to deliver a comprehensive and interesting tour of our house. To accommodate as many people as possible and provide a comprehensive tour, the team decided to condense our tour speeches, allowing more time for cumulative questions until the end of the tour. In doing so, the team toured over 1,200 people the second day of tours, a significant improvement from the first day. Our guests responded, “The amount of information was perfect. At no time was I overwhelmed.” This reinforced our strategy further. By holding detailed questions until the end of the tour, where we had a panel of students ready to answer, visitors were able to stay or go as they please. This, we believe, gave the greatest amount of satisfaction and exposure to a very diverse crowd.



Figure 3. Gable Home exhibition on the National Mall in Washington, DC

Campus Temporary Building Site

After construction was finished, the University of Illinois Team opened the house up to the public during a number of open house sessions, the largest of which was during the weekend of September 12-13th where the house was open to the public for 8 hours a day. During this open house the team practiced our tour delivery, making sure to take comments from the public. As a result, the team was able to formulate responses to questions we would have otherwise been unprepared for. The team also kept a guest book that documented people's thoughts about the house. There was an overwhelming positive response. In one case, a couple by the name of Mr. and Mrs. Jobbs had been coming by the house frequently on their bikes throughout the summer, checking up on our progress and making friends with many of the students on the team. In our guest book they wrote, "The team has done an excellent job. Our experience with this house has been impressive, not only with the actual building but with the students as well, who were always willing to stop and tell us about the work being done. We wish you the best of luck in D.C." In all, the team estimated that between 1,500 and 2,000 people physically walked through the house during tours in Champaign/Urbana.

Evaluation of the Team's Web Site

Like any area of the competition, our team website had strengths and weaknesses. The general perception of the website is that it was simple, easy to navigate, and offered numerous photographs which kept visitors up to date on the status of the project. On the other hand, those with particular skills related to home building, engineering or design, however, were not always able to find the level of detailed information they desired. We feel that although the website was not as perfect as it could have been, it did add to the success of the project.

Some interesting statistics regarding the website are listed below (from January 24, 2008 to December 7, 2009). For more information, please see the attached appendix, Google Analytics Report.

- Total number of visits: 31,614
- Absolute unique visitors: 21,172
- Total page views: 94,848

- Average time on site: 00:02:54

It is truly impressive how much international exposure the competition had. We had visits from 128 different countries. Solardecathlon.org was our leading traffic source, referring a total of 25.73% of our visits. It would be interesting to somehow include total unique visits in the competition communications score, as it would provide teams with an incentive to more rigorously advertise their site. The intent of course being that it may increase the exposure of the competition even more.

VI. Conclusions

It was a great learning experience for hundreds of students involved in this unique multi-disciplinary project. The students learned from the home and have been continually passing this knowledge along. It is also a great opportunity to promote the University of Illinois and highlight the achievements at Illinois in this international competition. Overall, the team has been pleased with the performance of the house during the 2009 Solar Decathlon competition. It was also very impressive with our overall media outreach and our ability to communicate with the public, both locally and nationally. Students were able to showcase the home to thousands of individuals in person and many students conducted countless interviews for the press. The public was able to learn a great deal about solar and sustainable construction opportunities. Gable Home, located south of the I Hotel and Conference Center, 1902 S. 1st Street, Champaign, Illinois, has been and will be made available to public groups interested to visit the home to learn about renewable energy systems and energy efficient building practices.

VII. Appreciation

The University of Illinois Solar Decathlon team appreciates the support the Student Sustainability Committee has given to the Gable Home project.