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APPLICATION INFORMATION – SOLAR DECATHLON 2009

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Author Notes

This proposal follows a proposal we submitted last year. We are grateful for the $30,000 award out of the $100,000 initially requested for the project. We understand that there was some (justified) concern that the house built for the 2007 competition is not on the UIUC campus, and therefore does not contribute to the sustainability of the UIUC campus. Professor Emeritus Ty Newell is currently working on a plan to bring the 2007 house back to campus. Our understanding is that the Energy Biosciences Institute is arranging for the transportation from the Chicago Center for Green Technology. It was scheduled to return in November of 2008, but has been somewhat delayed due to transportation logistics. As for the house planned for the 2009 competition, we plan will to bring the house from the competition straight back to campus, and as such, the campus will realize the sustainability directly. In addition, architecture faculty is developing a continuing course to monitor, test and maintain the house after the competition.

The proposal below has some common material with the proposal from last year, but also updates the committee on the progress made so far for the 2009 competition.

Project Summary

The Solar Decathlon is a biannual international competition hosted by the Department of Energy and the US Green Building Council to design, build and present a 100% solar-powered house on the National Mall in Washington D.C. The University of Illinois has successfully completed an application to the 2009 competition and has been accepted to compete with 19 other universities. Over the last year, the project has developed dramatically and is approaching the time of initial construction. Dozens of students from across campus have been working together to design and research this home. Next semester, various departments from across campus will come together to construct this home on campus, learning valuable hands on experience while also building a sustainable building. Once complete, the home will travel to Washington D.C. for the competition and will then return to the University of Illinois to serve as a research facility and integrated learning experience. Together with the building research council, classes will test and monitor the home and visitors will learn about the possibilities of sustainable design.

The Illinois entry to the competition will consist of an interdisciplinary collaboration between three of our colleges; ACES, FAA, and Engineering (CoE). In addition, we expect involvement of students from Communications and Business. While successfully integrating all these different disciplines is difficult, it is feasible and extremely effective. The 2007 team consisted of over one hundred students and involved faculty members from at least six different academic apartments. We have continued this tradition, building on the success of the past and improving for the future.

Fig. A: Photograph of the 2007 UIUC house.

Fig B: Rendering of 2009 House – Cam Greenlee

Courtesy of Jim Tetro, Solar Decathlon

Project Goals

The University of Illinois entered the competition for the first time in 2007, placing 9th overall and earning 1st in two categories, market viability and thermal comfort. The house is currently on display at the Center for Green Technology in Chicago but will return to campus for monitoring, testing and display soon. Professor Emeritus Newell is currently in discussion with the city to arrange return transportation. In 2009, we hope to achieve an even better showing, effectively educating the public, both at the University of Illinois and nationally, that solar power and sustainable design is both feasible and attractive.

We will receive support from various faculty and a have created a consortium of well organized and committed students. Together, the team has extensively studied sustainable design, house detailing and final competition performance. In addition, we will focus on community and school outreach, developing public education about the sustainable opportunities for the future. The previous home, for example, has appeared in the Weather Channel, local television news, numerous newspapers, many different environmental websites, and is currently on display at the Chicago Center for Green Design. It was also a featured tour during the GreenBuild Expo in Chicago last fall. The 2009 Solar Decathlon expects to exceed this publicity and continue improving opportunities for education. Already, the home has appeared in multiple papers and the team's barn salvage effort in Rockford was filmed by the big ten network and local television channels. The competition itself in Washington D.C. draws over 100,000 visitors and receives national media coverage. We will retain this commitment to education and continue to pursue innovative ways to implement sustainable design in residential settings.

Education & Sustainability

The purpose of the Solar Decathlon competition is to inform and educate consumers about sustainable design alternatives and the attractiveness of solar as an energy source. In order to realize change, people must be educated in why and how to implement sustainable solutions. We will combine unique and innovative technologies within a passive solar design to create not only a self-sufficient, net zero energy home but potentially a plus energy carbon-neutral home. The project will be primarily carried out by students (with some faculty advising), involving as many participants as willing. By combining solar power with renewable, environmentally friendly materials and passive design, the 2009 University of Illinois Solar Decathlon team will be able to demonstrate the economic feasibility and importance of sustainability. Energy efficient building design is a significant contribution to the climate solution.

Longevity & Location

Based on more than just design, the project involves building a completely functional solar powered house that will remain in use after the competition, demonstrating its applicability for years to come. Both the 07 and 09 houses will return to campus where they will become a central part of Sustainable classes within the Schools of Architecture and Engineering. In collaboration with the building research council, the home will return to campus and students will study them continuously for their performance over time. The home will serve as a demonstration of sustainable practices, not only for the hundreds of students working on this house and the tens of thousands of visitors but also for many classes in the future. Both the Building Research Council and the School of Architecture have immediate plans for the houses once they return to the Illinois Campus. As part of a continuous monitoring project, students will study how the house performs over time and develop alternative options for exterior

cladding. The School of Engineering has also mentioned interest in using the house as a testing center for new technologies, however, no specific plans have been developed at this point. Possible locations for the house include the Building Research Council site, a location near the South Quad, and possibly integration with the School of Dance.

The team is in continuous communication with the University, the Research Park, and facilities and services for a potential construction site as well as placement for the completed dwelling. The team will continue working with facilities and services and will secure a location before construction begins in early 2009. Currently, the team has been using space in the Architecture Annex for mockups and basic testing.

Similar Projects

The first Solar Decathlon was held in 2002 and showcased 14 homes built by universities from around the world. Proving to be a complete success, drawing national interest and educating thousands of individual homeowners, the competition occurred again in 2005 and 2007. In total, there have been 52 homes constructed, each presenting possibilities in a unique and appealing way. The competition allows for direct comparison while still enabling unique and inspiring designs. For previous Solar Decathlon entries, visit: www.solardecathlon.com.

Budget & Fundraising

The SD07 team spent roughly $450,000 on construction and project management. It raised funds from many sources, including the $100,000 award from the DOE, $150,000 from the Illinois Clean Energy Community Foundation, $50,000 from the College of Engineering Design Council, and other cash or in-kind contributions from the UIUC campus and industry donors. The 2009 Solar Decathlon team expects to require slightly higher expenses and have summarized the anticipated needs in the following table:

Project Expense	Estimated Cost	Funding Source	Estimated Funding
Project Management	$120,000	DOE	$100,000
PV System	$100,000	ICECF	$200,000
Building Materials	$200,000	UIUC CoE Design Council	$30,000
Appliances, Interior Design, and Mechanicals	$50,000	Grainger CEME	$50,000
House Relocation	$50,000	UIUC Campus	$50,000
		Student Sustainability Committee	$80,000 (includes $30k already granted)
		Private Donor(s)	$50,000
Total	$520,000	Total	$560,000

We have estimated the expenses along five major categories. The first is project management. The SD09 team plans to use a dedicated staff member as project manager. The SD09 team will use faculty to advise the student participants, who are in turn responsible for the design and construction of the home. A sum of $120,000 is set aside to cover the project manager's salary, fringe, and overhead.

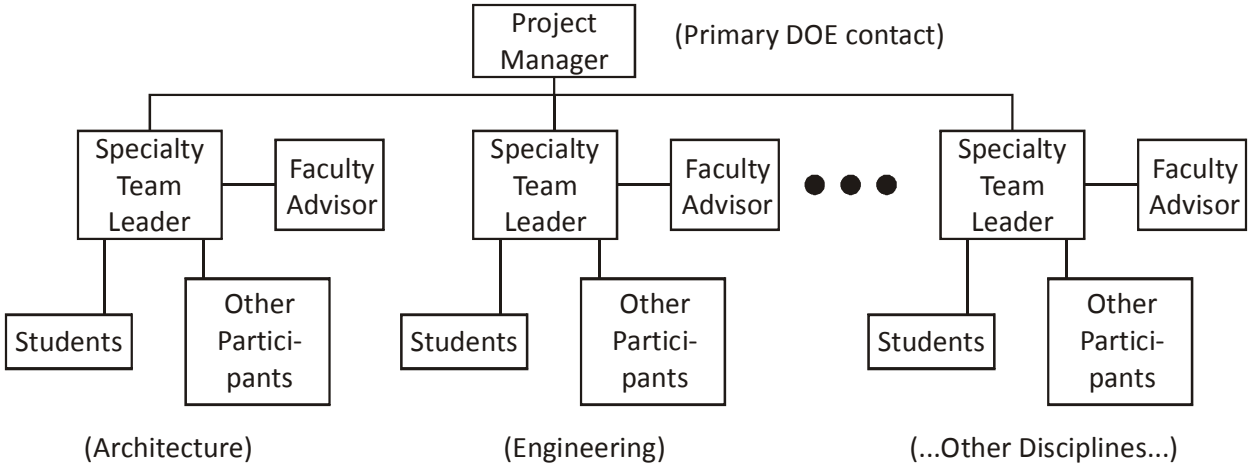

Fig. B: Project Organization Chart

The PV system for typical SD07 homes was around 8 kW or larger, peak DC rating. The UIUC SD07 house had a slightly smaller array, but as a conservative estimate we are budgeting for 10 kW at $10/W, or $100,000. This cost includes PV modules (or shingles, or other PV cell instantiation), protection, power electronics, wiring, any specialty contractor costs, and miscellaneous electrical fixtures.

The building materials will include all physical structures of the house except for the PV system and interior appliances, design, and mechanicals. Although $200,000 is a somewhat generous amount for an 800 sq. ft. home, the house must be designed for transport and will utilize the highest efficiency insulation, windows, and other building materials. The appliances, interior design, and mechanicals constitute an estimated $50,000 of the budget, however we expect to receive donations from numerous suppliers, distributors and sponsors to cover this expense.

Finally, we have included house relocation in our budget at an estimated $50,000, to cover transportation of the house to and from Washington D.C. The relocation budget will also include on-site costs for student housing, food, and transportation.

It is important to note that our funding sources total more than our estimated expenses. This is due to overhead within the University as well as the possibility of funding falling short of expectations. As we have found, many of our potential sources have opted to fund only a portion of the entire request. If fully funded by the Student Sustainability Committee, current expected capital is close to $490,000. This should put us in good shape for the upcoming expenses as construction begins in early 2009.

Funding Request

The Solar Decathlon 2009 would benefit greatly from continued funding by the Student Clean Energy Committee. Using students to design, build, transport, and present a 100% solar powered house requires a vast amount of coordination and capital. We request $50,000 to be used towards improving energy saving and sustainable features of the project, including sustainable practices and materials needed to successfully complete this home. Rather than rely on a single source for funding, the Solar Decathlon Team has been actively seeking numerous contributors. We desire to create the best possible product for the University of Illinois and believe that the investment is extremely worthwhile in promoting environmentally friendly possibilities, educating students and the public, a moving towards a sustainable future. The funds will help purchase items such as an automated system to monitor and control all aspects of the home. We will have an internet page so that people can see what is happening

with the house at any given minute. The home will also feature include extremely high quality windows, heat pumps, state of the art foam insulation, extremely efficient appliances, reclaimed wood, innovative lamboo structure, SunPower solar panels and other sustainable materials and techniques. This project will also help to establish U of I as a leading organization for environmental education in the future, attracting outside interest such as students or companies. Continued support will also allow the team to expand education and outreach, developing tours and public presentations.

Other Fundraising

The University of Illinois 2009 Solar Decathlon has identified a number of potential funding sources. In addition to the $100,000 offered by the DOE (which is to be used toward project management), we have identified several other sources of likely funding. The ICECF donated $150,000 (specifically for the PV system) for the SD07 competition, and we have recently received word that the team received $200,000 in funding for the solar panels and electrical systems. We have also received funding from the College of Engineering and the Student Sustainability Committee. The team will also petition the UIUC campus (provost's office). Finally, the team is exploring options with private donors and many companies may also donate cash, labor, or equipment.

Although the target fundraising mark ($560,000) is well below the budgets of some prior SD teams (up to $2,000,000), our emphasis will remain on creating a near-term marketable, buildable house, based on conventional materials and commercially available equipment. We believe this is in keeping with the DOE's 2015 goals.

Timeline

After officially receiving notification of acceptance into the 2009 competition in mid January, key faculty members began planning the project timeline. To begin, Professor Mike McCulley and Professor Mark Taylor of Architecture created a design class to study prior entries and initiate designs. With nearly 40 students involved with the class, potential ideas flourished and the class developed a unified home design. Since that date, the team has worked to refine the plan and detail many of the connections, structure, mechanical and electrical systems. Professors Chapman and Zhang have assembled teams from engineering disciplines. Simultaneously, students are being considered for the Team Leader positions, engineering students are drafting potential thesis projects, the team is pursuing funding, and website development is underway. The project timeline and tasks are outlined in the table on the next page. Compared to the SD07 effort, we will emphasize getting things done earlier to facilitate more testing.

Time Frame	Major Tasks
Spring 2008	Complete DOE contract execution Install project management Initial architectural design studio, candidate design concepts Team formation Fundraising – major sources secured Special course requests for coming academic year
Summer 2008	Settle on major design themes Settle on house transportation strategy Commence engineering tasks: code and major building impacts outlined Faculty and specialty team leaders retreat- define significant design parameters Design Development Drawings, Graphic Files, Preliminary Website, and Communications Plan due June 3
Fall 2008	Compliant Website due August 19 First semester of curriculum integration course sequence Detailed energy simulation of house Detailed engineering of PV and electrical system Candidate appliances, lighting, and mechanicals selected Financial analysis – cost per watt-hour Draft interior design Construction Documents, Graphics Files, Stamped Structural Drawings, and Project Manual due December 16
Spring 2009	Safety Plan and final Communications Plan due June 2 Second semester of curriculum integration course sequence Finalize construction documents Complete interior design Complete construction suitable for Engineering Open House event (March) Conduct initial tests of house against simulation; identify and correct errors in simulation or construction
Summer 2009	House testing and suitable modifications Prepare for inspections Furnish required reports and documents
Fall 2009	Continue house testing and evaluation of cost per watt-hour analysis Develop competition strategies based on weather, points per watt-hour, and competition scenarios Prepare and deliver house to competition (October)

Energy Impact

The Solar Decathlon house will be solar powered, utilizing an array of solar panels integrated into the design of the house. In addition the team is considering using, a solar hot water system of evacuated tube collectors. The home will be equipped with a solar array capable sufficient to meet energy demands for the home under normal living conditions. This energy production, combined with the highly efficient passive design of the house and extremely efficient appliances and construction will

result in the construction of a net-zero home, potentially plus energy home. While the primary function of this project is to educate students and the public about sustainable design, rather than to create an excess of energy or specifically save the university energy, it will not consume any additional electricity due to its existence.

We can estimate the energy savings based on the standard set by the Passive House Institute, which requires that the HVAC load be less than 15 kWh/m^2 per year, or about 1.67 kWh/ft^2 per year. A typical university building would use far more energy than this. Although exact numbers depend on many factors, we can safely estimate a typical building will use 8-10 kWh/ft^2/year. Therefore, an 800-ft^2 solar house will have net savings around 5600 kWh/year just in HVAC load. Based on the use of the home, the savings for the university could be realized almost immediately.

Based on our current design, we are expecting to use an array sized between 8 kW and 10 kW. An 8-kW array in central Illinois would yield about 10,000 kWh/year of electricity (according to the NREL PVWatts Calculator). Therefore, at a minimum the proposed project would result in energy improvements totaling about 16,000 kWh/year, when the PV system output and the efficiency savings are combined.
We are still deciding on our PV system design, but we believe it will be either 7360 watts or 9000 watts, in terms of peak, dc ratings. This will result in roughly 9500 kWh/yr or 11.7 kWh/yr in electricity (based on the PVWatts online simulation tool, we get 1300 kWh/yr for every 1 kW of PV power, in Illinois). Using the information provided in the Student Sustainability RFP, this would result in a savings of $529.92 or $648 depending on the final system installation. In addition, this will equate CO2 offset of 14,248 lbs or 17,424 lbs respectively.

Social Impact

The Solar Decathlon Project is an educational project designed to inform individuals of residential alternatives to standard construction. Creating a fully functional model home for people to walk through, touch and see establishes a lasting memory for all visitors about the practicality of environmentally friendly design. Even though all visitors will not decide to make their home net-zero, they may take away one or two key ideas. The 2009 team's focus on passive design will also spark the interest of many visitors. The Solar Decathlon house will influence many different people to take different actions towards a more sustainable future, creating a positive social impact.

Economic Impact

Designing, building, presenting and maintaining a self-contained solar powered house at the University of Illinois is an enormous task. The University of Illinois will maintain a focus on market viability and creating a house that an average American homeowner could build. Despite a large budget per sq.ft. of house, the U of I Solar Decathlon House remains an attractive investment due to the enormous educational benefit, social impact, long lifespan and sustainability. Given the analysis of energy impact, and assuming an electricity price of about $0.10/kWh, an 8-kW PV array would save about $1000/year in electricity. The HVAC savings would depend strongly on the type of HVAC system that is displaced, efficiency of this system, and the cost of the energy, but if about 5600 kWh/yr can be saved at an energy cost of $0.05/kWh, then the savings are approximately an additional $280/year.

Outreach and Education

The SD09 team is highly dedicated to the educational aspects of the project. Educational activities will be conducted within the university and to the general public throughout the project. As the public becomes more aware of sustainable design, providing educational opportunities to students in this area will become exceedingly attractive. The Solar Decathlon creates an opportunity for hundreds of students to spend considerable amounts of time thinking about and working to improve future practices.

The SD09 students will be able to integrate the project into several classes to provide many opportunities to the students, particularly those most dedicated, to receive credit for their efforts. By offering multiple classes, we will give students flexibility for integrating their efforts into their curricula.

We will aim to make the opportunities for student involvement as visible as possible, through faculty coordination, flyers, presentations, email distribution, and website development. In addition, we hope to construct the home in an area accessible to nearly everyone on campus and visible to many different individuals. Currently, the team expects to construct the home near the Architecture Annex off of the south quad. Because we will be creating a full size, functional house, we believe that visibility and interaction will be integral to our project's success. After the home is complete, it will become a central element in a sustainable, home monitoring class with the School of Architecture.

As in 2007, the Solar Decathlon creates numerous possibilities for media exposure, on both the local and national levels. Throughout different stages of the project, we will conduct community outreach events to present our progress to students and the public. Beginning with the Engineering Open House, the team will present the work completed by students at the University of Illinois while concurrently educating about potential environmentally friendly design possibilities. The team will make many presentations across campus and open the house to the public for tours near the end of construction. An open house event should draw the interest of local newspaper and television journalists as well as many residents of Champaign-Urbana. In October, the team will transport the house to Washington D.C. for competition on the National Mall where it should be toured by over 100,000 visitors and be featured on national media. The main mission of the 2009 Solar Decathlon Team will be to educate others about sustainable practices, helping improve our environmental outlook for the future. It will serve as a continuous training and educational facility regarding sustainable practice and zero energy solar design.

Furthermore, we recently received word that PBS is working with our partner Texas Instruments to develop a Discovery Channel special on the Solar Decathlon, featuring the Illinois team.

Conclusions

The 2009 Solar Decathlon is an exciting opportunity for the UIUC. The SD07 effort was very successful and enjoyed tremendous campus support. There were a number of exciting ideas that were simply not feasible in our first competition that we hope to implement in 2009. We look forward to the possibility of working with the UIUC Student Sustainability Committee and welcome any feedback about our proposal. If funded, this additional $50,000 will be used towards all our energy saving features of the project, and increasing student involvement. The focus will remain on creating an extremely energy efficient net-zero passive solar home, and educating students and the public about sustainable design opportunities. The home will serve as a model for students and visitors, both now and into the future, as to the possibilities of sustainable solar design.