

DEPARTMENT OF ENERGY

US DEPARTMENT OF ENERGY SOLAR DECATHLON

Research Performance FINAL Report

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Submission Date: 03/14/2017

DUNS #029031796

Recipient Organization:

Report Period: April 15, 2014 – April 15, 2016

FINAL Report



Signature

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ACCOMPLISHMENTS

This material is based upon work supported by the Department of Energy under Award DE-EE0006563

1. ACCOMPLISHMENTS: Mandatory

a. What are the major goals of the project?

- i. **Our primary objective is to design and build a 600-1000sf home that produces more energy than it consumes and to showcase this home at the 2015 Solar Decathlon in Irvine, CA. Further objectives are to educate consumers and home builders, alike (including K-12 students – the industry’s future consumers), inspire a shift towards the adoption of net-zero energy solutions in residential building, and to be a leader in the transformation of the California residential marketplace to a net-zero standard. Our specific mission statement for this project is as follows:**

Solar NEST strives to discover the future of sustainable, energy-efficient housing and deliver these innovations to home buyers at an affordable price. To make substantial improvements to conventional building methods with regard to aesthetics, performance, and affordability. Through our efforts, we aspire to bridge the gap between ‘what is’ and ‘what is possible’ by providing unique, elegant simplicity.

ii. Budget Period 1 – Objectives:

1. **Achieve 80% design documents, i.e. all design information required to build the structure is complete**
2. **Fundraising substantially complete, i.e. donations in the form of cash and/or materials and labor required for the project are received or committed such that successful completion of the project may be reasonably expected.**
3. **Achieve substantial regional awareness of the project, i.e. robust online and physical community presence has been established.**
4. **Design incorporates price-point and cost parameters for the house for local market conditions**
5. **Successful incorporation of Solar Decathlon project into curriculum across multiple disciplines**
6. **Timely submission of all DOE required deliverables**

iii. Budget Period 2 – Objectives:

1. **Achieve 100% design documents, i.e. all design information required to build the structure is complete**
2. **Computer animated walk-through and renderings, full Building Information Model (BIM), including coordination with**

constructability and staging the building for transport in modular sections.

3. **Project Health and Safety Plan complete – construction stages and public tours**
4. **Finalize project costs – construction, structure transport, housing for team during competition, and final destination on university campus**
5. **Public exhibit materials, audiovisual, and tour information to be completed.**
6. **OSHA 30-hour safety training conducted by the project Co-Principal Investigator (authorized OSHA instructor). Key student team personnel will receive this training at no cost, as a service from the university and this Professor.**
7. **Construction activities completed with time for testing and startup prior to competition**
8. **Testing confirms net-zero functionality of the home**
9. **Successfully transport and reconstruct dwelling at competition site**
10. **Win competition**
11. **Successfully deconstruct dwelling and transport back to Sacramento**
12. **Complete approval process with CSUS facilities for engineering and final destination of the solar home, including utility tie-ins**
13. **Complete all final project documentation requirements**
14. **Timely submission of all DOE required deliverables**

b. What was accomplished under these goals?

i. For this reporting period describe:

1. major activities;

- a. **Work with university facilities management planning department to determine several options for final location of solar nest home.**
- b. **Obtained approval from campus president to re-locate solar nest home from storage site to permanent location in the campus arboretum**
- c. **Work with facilities management for logistics in relocation, utility ties-ins, permanent concrete foundation design, campus master plan, end use agreement, and costs for the work.**
- d. **Work with campus development office to determine fundraising plans for securing funding to move the home.**

2. specific objectives;

- a. **Campus administration has approved plan to move forward with relocating home to a more permanent location in the campus arboretum at the north side of campus (as of 07/13/16). No utilities are available, but plans are to turn this into an off-the-grid home, with future applied research to develop supporting facilities.**

3. significant results, including major findings, developments, or conclusions (both positive and negative); and
 - a. **We reached 100% completion on this 20-month duration project, and finished 10th overall....a significant milestone.**
 - b. **Our team successfully competed in the 2015 Solar Decathlon competition in Irvine, CA and placed 10th overall**
 - c. **As of Feb 16, 2017 – foundation plans and calculations are completed, and we are awaiting funding to construct foundation and move home late spring 2017.**
 4. key outcomes or other achievements. Include a discussion of stated goals not met. As the project progresses, the emphasis in reporting in this section should shift from reporting activities to reporting accomplishments.
 - a. **See comments above**
- c. What opportunities for training and professional development has the project provided?
- i. **Student groups continued to work alongside faculty with industry professionals and gaining experience in green building and energy-efficient design, and the full construction of a residential home. The students have had the opportunity to not only work with industry professionals, but to go to their offices and observe and learn on ways to come up with new innovations.**
 - ii. **The Association of Energy Engineers (AEE) provided workshops in August 2014 and guidance to our students in developing energy models for our project. This group continues to provide assistance as needed in our development, and has offered to assist with in-kind material/equipment procurement and fundraising efforts through their extensive network of energy professionals**
 - iii. **The co-principal investigator has provided training and guidance to students for the structural engineering design and constructability of this project. This training will continue until the project is complete.**
 - iv. **The co-principal investigator is an authorized OSHA instructor and has provided 10-hour OSHA training to several of the solar decathlon team students. Key personnel received the final 20-hours of training to reach the 30-hour OSHA requirement for DOE.**
 - v. **The North State Building Industry Association continues to provide networking opportunities to our team through their members and monthly events, most of which have led to sponsors, design assist, and industry relations.**
 - vi. **The International Brotherhood of Electrical Workers (IBEW) and National Electrical Contractors Association (NECA) provided training for students in the installation of roof mounted photovoltaic (PV) panels, including electrical training for connections and functionality of the entire home.**
- d. How have the results been disseminated to communities of interest?
- i. **A Community Lecture Series on this project was presented on September 24, 2015 to the campus and local Sacramento community, in a large**

- ballroom on campus. The lecture was conducted by the principle investors for this project.
- ii. Reflect Home Launch Party for all our supporters, donors, and campus on September 18, 2015. Attendees were able to tour the home, meet our student team, and learn about our solar efficient systems.
 - iii. The university provided a large building site centrally located on campus for the construction of our project. This location was key to increasing the visibility to other students, faculty, administrators, and the public.
 - iv. The final design, including 3-D digital modeling and a physical scaled model (3-D printing), has been formally presented to the following communities of interest:
 1. Sacramento Municipal Utility District (SMUD): SMUD's in-house architect provided feedback on schematic designs that led to our final product, and the Community Solar group at SMUD has been involved for the past several months in our selection of solar system designs. SMUD has also formally committed to \$50,000 for in-kind materials donations and additional funding in cash is going through the approval process.
 2. International Delegation of Energy Professionals – as stated above, we hosted an event to showcase our solar home to 25 professionals from 20 countries. This event was advertised across campus, well attended by students and university administration (president, provost, and dean), and an article followup with short video was published on our university website and our Facebook page.
 3. Kaufmann and Broad (KB) Homes – Grand Opening event for their latest net zero production home design, located in El Dorado Hills, CA. This new home had 14 energy efficient features, called the Double ZeroHouse 3.0. We were able to publicly present our solar decathlon project to this group, received a donation from KB homes, toured the Zero House 3.0, and exchanged contact information for sharing ideas with the companies that provided the 14 energy efficient features of this home.
 4. North State Building Industry Association (BIA): The co-principal Investigator has met with the North State BIA president several times to present our work on the solar decathlon. He has attended BIA events to network with local homebuilders. The team presented to the BIA board of directors at their January 2015 meeting, with the intent to provide exposure of the project, student involvement, what the results of this competition can do for the production homebuilding industry, and to secure sponsorships. This meeting was well received, resulting in many new sponsorships and partnerships.
 5. North State Building Industry Association "Idea District": An event that took place on February 10, 2015 to allow our team to network with building industry professionals. Our students were able to showcase various components of our project in a social setting on campus. The objective of this event was to have our student team

present our concepts for the home and to get feedback from a production home builder's perspective.

6. **Association of Energy Engineers (AEE)**: Our team has formally presented to the AEE group at monthly meetings, and their members have provided energy model lectures to our team. This group has promised to continue to inform their members of our progress, in order that they can provide feedback at the various stages of the design and construction.
 7. **Wall Raising Ceremony – May 8**: This brought local media attention to our project, as the provost spoke and we erected our first wood framed wall. The local newspaper wrote an article, and followed up a few times during construction. Two local news stations aired our project as one of their community stories, and we were highlighted on a very popular morning show “Good Day Sacramento.”
 8. **Sacramento Municipal Utility District (SMUD)**: Their marketing team has been video taping various stages of our project and interviewing our students and faculty. They are producing a segment for distribution publicly in early October 2015 to promote their support of our team and of the competition.
- e. What do you plan to do during the next reporting period to accomplish the goals?
- i. **Reporting Period are over.**

PRODUCTS

2. PRODUCTS: Optional/ Mandatory

NO Inventions were produced under this project, so no invention certificate is required. All documents produced as outlined below are public and provided to the Solar Decathlon 2015 staff for the competition. All systems used in the building construction and functions are readily available off-the-shelf items from building supply stores.

- a. What has the project produced?
 - i. **100% Design Documents were completed on February 15, 2015 and submitted to DOE as one of the major milestone deliverables.**
 - ii. **All deliverables have been completed and submitted to DOE in a timely manner to-date.**
 - iii. **Marketing - Website has gone live, we have established a Social Media presence (facebook and Twitter), and the university has written an article and produced a short video with our team about the project.**
 - iv. **As stated above, we have hosted several events with professionals in the engineering and construction field during the last three reporting periods. We have additional events scheduled as we increase our visibility and secure sponsorships.**
 - v. **The completed home was produced, which is the major objective of this 20-month competition. This includes all funding and material donations.**
- b. Publications, conference papers, and presentations:
 - i. **The co-principle Investigator presented the project to colleagues at the 2015 Associated Schools of Construction Region 7 Conference on February 5, 2015.**
 - ii. **Both co-Principle Investigators presented an abstract reviewed by their peers in December 2014. This abstract was approved in January 2015, and a poster session was presented to colleagues from around the world at the 2015 Associated Schools of Construction International Conference at Texas A&M in College Station, TX on April 24, 2015.**
 - iii. **Community lecture series on this project on Sept 24, 2015 on campus. Lecture by the co-principle investigators for this project.**
- c. Journal publications.
 - i. **Nothing to Report**
- d. Books or other non-periodical, one-time publications.
 - i. **Nothing to Report**
- e. Other publications, conference papers and presentations. Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication as noted above.
 - i. Website(s) or other Internet site(s)
 - 1. **Website: <https://www.SolarNest.org>**
 - 2. **Facebook: <https://www.facebook.com/solarnest>**

- 3. Twitter: <https://twitter.com/sacstatesolar>**
 - ii. Technologies or techniques
 - 1. Passive energy design, naturally ventilate space through upper operable windows**
 - 2. Advanced 2x6 framing techniques**
 - 3. Solar thermal water heater – DELETED from scope Aug 2015**
 - 4. Architectural PV systems – skylights and railing**
 - 5. Daikin Split HVAC System**
 - 6. Big Ass Fans, low energy efficient fans**
 - 7. NEST Learning Thermostat – fully integrated, network connected home experience with SMART appliances (dishwasher, washing machine, dryer, and refrigerator).**
 - 8. Rain water collection system integrated into a water feature on the home.**
 - 9. Thermo-sensors installed throughout the wall and roof assemblies to collect real-time data on energy loss/gain for various assemblies techniques.**
 - iii. Inventions, patent applications, and/or licenses
 - 1. Nothing to Report**
- f. Other products
 - 1. Nothing to Report**