

## Overview

*The Engineer's aesthetic, and Architecture, are two things that march together and follow one from the other.... The Engineer, inspired by the law of economy and governed by mathematical calculation, puts us in accord with universal law. He achieves harmony. The Architect, by his arrangement of forms, realizes an order, which is a pure creation of his spirit...it is then that we experience the sense of beauty. —Le Corbusier*

The Solar Decathlon is an intercollegiate and interdisciplinary design and construction competition that takes up a persistent and age-old question: How do we integrate architecture and technology with a dwelling? In other words, what makes a good house?

More than 2,000 years ago, the Roman architect Vitruvius claimed that all buildings should possess the qualities of “firmness, commodity, and delight.” Centuries later, architects and engineers of the Industrial Revolution were inspired and challenged by the new technologies and building tasks their age presented. In the early twentieth century, the influential Swiss Modernist architect, Le Corbusier, wrote in *Towards a New Architecture*, “Let us state the problem. Let us shut our eyes to what exists. A house: a shelter against heat, cold, rain, thieves, and the inquisitive. A receptacle for light and sun. A certain number of cells appropriate to cooking, work, and personal life.”

The sources of energy that powered the Industrial Age have revealed their limitations and their consequences, as contemporary living demands more and more energy for “commodity and delight” as well as “cooking, work, and personal life.” Architecture and engineering students of today, then, face both an old and a new problem: to satisfy an age-old curiosity about dwelling while solving the relatively new problem of post-industrial energy and its consequences. The Solar Decathlon challenges engineering and architecture students to design and construct a fully self-sufficient solar-powered house. Or, to paraphrase and gather inspiration from Le Corbusier’s words: a sun-machine for living in.

Like the athletic decathlon, the Solar Decathlon will test proficiency in a wide range of skills. Unlike its athletic counterpart, however, the Solar Decathlon is a team event, in which the diversity of abilities comes from the composition of the team rather than a single individual. Architecture and engineering students will work with students from other disciplines such as marketing, communications, graphic design, analysis, and computer science to do the troubleshooting, communicating, dreaming, and building this challenging project requires.

The second Solar Decathlon will take place on the National Mall in Washington, D.C., in the fall of 2005. For approximately three weeks, the Solar Decathlon organizers and teams will assemble and inhabit a “Solar Village” in view of the Nation’s capitol. When the village is fully assembled, teams will compete against each other during a week of 10 decathlon contests. The team with the highest point total at the end of the week will be the winner. Additional awards will be presented in several other categories. The village also will be open to the public and media, who will be invited to tour the teams’ homes and the educational exhibits provided by the organizers and sponsors.

The 10 contests are based on three guiding principles for the competition:

- The teams must supply the energy requirements necessary to live and work using only the sunlight shining on their entry—the global solar radiation incident on the house, specifically—during the contests.
- The houses will exemplify good design principles that will increase the public’s awareness of the aesthetic and energy benefits of solar and energy efficiency design strategies and technologies, which in turn will increase the use of these design principles and technologies.
- The work of the teams, organizers, and sponsors will stimulate accelerated research and development of renewable energy, particularly in the area of building applications.

The following set of priorities determines what the 10 contests should encompass.

- **Energy Production:** Each team’s house must be able to supply all of the energy needed for its occupants to survive and prosper in today’s society. Within their comfortable and well-lit houses, the teams will perform domestic tasks that require the operation of appliances and electronics, and they will transport themselves around town in an electric vehicle—all of this with energy from only the solar electric and solar thermal systems integrated into their houses. The competition will quantify each team’s energy production and productive output.
- **Energy Efficiency:** Efficiency reduces consumption and enables more work to be accomplished with a given amount of energy. Because the amount of sunlight that strikes the surface of a house is limited, end-use efficiency will be a key strategy to success.
- **Design:** Since the time of Vitruvius, design has been an essential part of deciding what makes “a good house.” Good design improves structural integrity (“firmness”), function and comfort (“commodity”), and aesthetic appeal (“delight”). Whether a house is a “good house” may be qualified by the architect who designs it, the engineer who optimizes its performance, the builder who constructs it, and the occupant who lives and works in it. Good design becomes more challenging as the building industry strives to integrate existing ideas and technologies with an increasing array of new ideas and technologies, many of which are just being introduced. Design is a critical part of the Solar Decathlon, emphasizing overall dwelling livability and structural and systems aesthetics and integration, especially integration of the dwelling with its energy systems.
- **Project Documentation:** Good design is as much a process as it is the result evidenced in the finished house. The competition requires teams to demonstrate their design processes by providing documentation such as energy performance analyses, drawings, and design narratives at the schematic design, design development, and “as-built” phases of their projects.

- **Communications:** Effective communications save time and improve our safety and quality of life by supplying the important information we use to make critical decisions. Variety, content, and design are essential to drawing an audience to a message. Getting a clear message about delightful design, energy efficiency, and solar energy to the public audience will be an important consideration in this competition.
- **Heating and Air Conditioning:** As Le Corbusier stated, a house must be a comfortable space in which to live, protected from wind and rain, from winter's snow, and summer's heat. For good health, the conditioned space must also minimize indoor pollutants. To succeed, the teams' houses must provide interior comfort and good environmental quality while meeting the energy requirements of the competition.
- **Appliances and Electronics:** Household appliances and electronics have improved our quality of life since the dawning of the industrial age. They use energy to save the physical energy and time of a household's inhabitants, and they provide entertainment and access to global communications. The demand for appliances and electronics grows greater every day, even as the consequences of supplying the energy they require becomes ever more apparent. The Solar Decathlon will challenge students to meet the energy demands of domestic and working life while competing to solve the problem of the consequences of energy use in the post-industrial age.
- **Hot Water:** Hot running water is considered a necessity. Energy- and water-saving strategies and technologies are readily available. The competition challenges the teams to demonstrate these options while meeting average hot water requirements for domestic activities.
- **Lighting:** Lighting improves our safety, productivity, and quality of life. Beyond its purely practical application, lighting also has the power to please the inhabitants of the "receptacle for light" that Le Corbusier described. The Solar Decathlon requires teams to design lighting solutions that are energy-efficient and abundant, as well as pleasing to the houses' inhabitants.
- **Transportation:** Mechanized transportation gives us greater freedom, saves time, and improves productivity. The competition will reward teams that can plan their use of transportation the most efficiently and that use their houses' energy systems to provide the energy to meet their transportation needs.

## Team Selection

The Solar Decathlon is an international competition open to all accredited colleges, universities, and other post-secondary educational institutions. Entrants are selected through a proposal process. All proposals are reviewed, scored, and ranked. Depending on the quantity and quality of submissions, a limited number of teams from all entries are selected for entry.

For the 2005 Solar Decathlon, the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) issued a Request for Proposals in February 2003. Proposals were due in April 2003. After reviewing, scoring, and ranking the proposals, a team of reviewers from DOE and NREL selected the following teams to compete in 2005:

- California Polytechnic State University, San Luis Obispo
- Carnegie Mellon, University of Pittsburgh, and the Art Institute of Pittsburgh
- Concordia University
- Cornell University
- Crowder College
- Florida International University
- New York Institute of Technology
- Rhode Island School of Design
- Universidad Politécnica de Madrid
- University of Colorado at Denver and Boulder
- University of Maryland
- University of Massachusetts Dartmouth
- University of Michigan
- University of Missouri—Rolla and the Rolla Technical Institute
- University of Puerto Rico, Mayagüez
- University of Southern California
- University of Texas at Austin
- Virginia Polytechnic Institute and State University
- Washington State University

Representatives from each of the teams attended a kick-off workshop in Washington, D.C., in September 2003. The workshop included information sessions about the competition and presentations from experts in the fields of architecture, building energy efficiency, fund raising, and communications.

## The 10 Contests

The Solar Decathlon organizers have selected the following 10 contests for the 2005 competition. The teams can earn up to 100 points for each contest except Architecture, for which they can earn up to 200 points. Of the 1100 total points possible, 480 points are awarded based on objective performance measurements or task completion, and 620 points are awarded through subjective evaluations by a variety of appropriately selected experts. For details about scoring: [Contests](#).

### ***Contest 1: Architecture***

To be architecturally sound, a home's design must not only satisfy human comfort needs, it must also be well organized and visually pleasing both inside and out. The Architecture contest is designed to demonstrate that solar-powered, energy-efficient homes can be designed to meet enduring architectural standards. Although the technologies in these competition houses are relatively new, the classic architectural standards of "firmness, commodity, and delight" remain the criteria for a successful building. A jury of architects will judge each entry on the overall aesthetics and the successful design and integration of the solar, energy-efficiency, and other technical features of the house. The jury will evaluate the houses early in the week of contests and will not be influenced by the objectively measured performances of the houses. For more details about: [Contest 1: Architecture](#).

### ***Contest 2: Dwelling***

An important objective of the Solar Decathlon is to prove that solar and energy-efficient design and technologies are market ready and belong in the world's diverse neighborhoods today. The Dwelling contest begins, in a sense, where the Architecture contest ends: after the design and construction of the houses are complete and living in them begins. Experts from the building industry (e.g., builders, marketing and design professionals) and representative homeowners will comprise the judging panel for this contest. Judging will take place early in the week of contests and will not be influenced by the objectively measured technical performance of the houses. For more details about: [Contest 2: Dwelling](#).

### ***Contest 3: Documentation***

Good design emerges from a process of exploring and evaluating alternatives through drawings, physical and computer-based models, and analyses. The Documentation contest evaluates the production of an imaginative and thorough set of documents from the schematic design, design development, construction, and "as-built" phases of the Solar Decathlon project. Analyses in the schematic design phase will focus primarily on energy performance. Documents illustrating the construction of the building are required at the design development, construction, and as-built phases. A panel of experts in building energy simulation will judge the energy analyses, and a panel of engineers and the architectural jury will evaluate the as-built drawings. Some evaluations for this contest will take place as the teams' projects develop before fall 2005. The evaluations that occur in fall 2005 will take place early in the week of the contests and will not be influenced by the objectively measured technical performance of the houses. For more details about: [Contest 3: Documentation](#).

### ***Contest 4: Communications***

The Solar Decathlon is a competition and a public event. The Communications contest challenges teams to communicate their experiences in this project to a general audience. Through Web sites and public tours, the teams will share the knowledge they have acquired. Their experiences and their houses will serve as living demonstrations of the viability of solar energy and energy efficiency technologies in the home. Panels of judges with expertise in communications and public relations will award points based on subjective evaluations of the teams' Web sites, house tours, and overall "branding effectiveness" (the ability to deliver clear and consistent messages and images that represent the teams' missions, visions, goals, and results). For more details about: [Contest 4: Communications](#).

### ***Contest 5: Comfort Zone***

Well-designed houses provide interior comfort and indoor environmental and air quality through heating, cooling, and humidity controls and ventilation. For this contest the teams will be evaluated objectively on their ability to maintain temperature and relative humidity within prescribed set points. A panel of heating, ventilating, and air conditioning experts will award points for the quality of thermal comfort and good indoor environmental and air quality based on subjective evaluations of each house. For more details about: [Contest 5: Comfort Zone](#).

### ***Contest 6: Appliances***

A house is not a home without kitchen appliances, laundry facilities, and electronics such as personal computers and TV/video players. This contest requires the teams to demonstrate that their houses can provide the necessary energy to effectively operate appliances and electronics. The teams will store food in their refrigerators and freezers, cook a set number of meals, wash dishes, and do laundry during the week of contests. The teams will also be required to operate their personal computers and TV/video players a set number of hours each day. All points for this contest will be awarded based on task completion and objective performance evaluations of the required appliances and electronics. For more details about: [Contest 6: Appliances](#).

### ***Contest 7: Hot Water***

This contest demonstrates that the teams' houses can provide all of the energy necessary to heat water for domestic uses. Teams will receive points for performing tests that simulate the average time and temperature requirements for two showers each day of the contest week. Twice per day, teams will have to deliver 15 gallons (56.8 liters) of hot water [at least 110°F (43.3°C)] in no more than 10 minutes. A panel of engineers will also award points based on subjective evaluations of the overall design of the teams' hot water systems. For more details about: [Contest 7: Hot Water](#).

### ***Contest 8: Lighting***

Sunlight, moonlight, and electric light all contribute to the livability and environment of a dwelling, inside and out. Lighting systems should be designed to minimize energy use by maximizing the contribution of daylighting and by using controls to minimize the use of electric illumination. This contest evaluates the quantity and quality of the lighting in the houses both day and night. Points will be awarded on a team's ability to provide lighting levels within prescribed set points. These lighting levels will be measured objectively. A panel of lighting designers will award points on the basis of subjective evaluations of the teams' lighting system designs. For more details about: [Contest 8: Lighting](#).

### ***Contest 9: Energy Balance***

This contest demonstrates that the sun can supply the energy necessary for all the daily energy demands of a small household and home-based business. The object is to begin and end the contests with the same amount of energy stored in the electrical storage system to demonstrate that the system functions sustainably. Points will be awarded based on each team's ability to use their solar electric systems to produce as much electrical energy as they require during the contest week. For more details about: [Contest 9: Energy Balance](#).

### ***Contest 10: Getting Around***

Because the amount of energy households use to meet their personal transportation needs is so significant, this contest is designed to demonstrate that a house itself can be used to provide that energy. The contest evaluates how much "extra" energy the houses can generate to provide transportation for the teams in street-legal, commercially available electric vehicles, which will be provided by the organizers. Teams will be required to log miles each day of the contest week as they "run errands" just the way we do in our everyday lives. All points for this contest will be awarded based on objective evaluation—the more miles the teams drive, the more points they get. For more details about: [Contest 10: Getting Around](#).

#### **Summary of Revisions**

November 2, 2004

- Minor editorial changes.