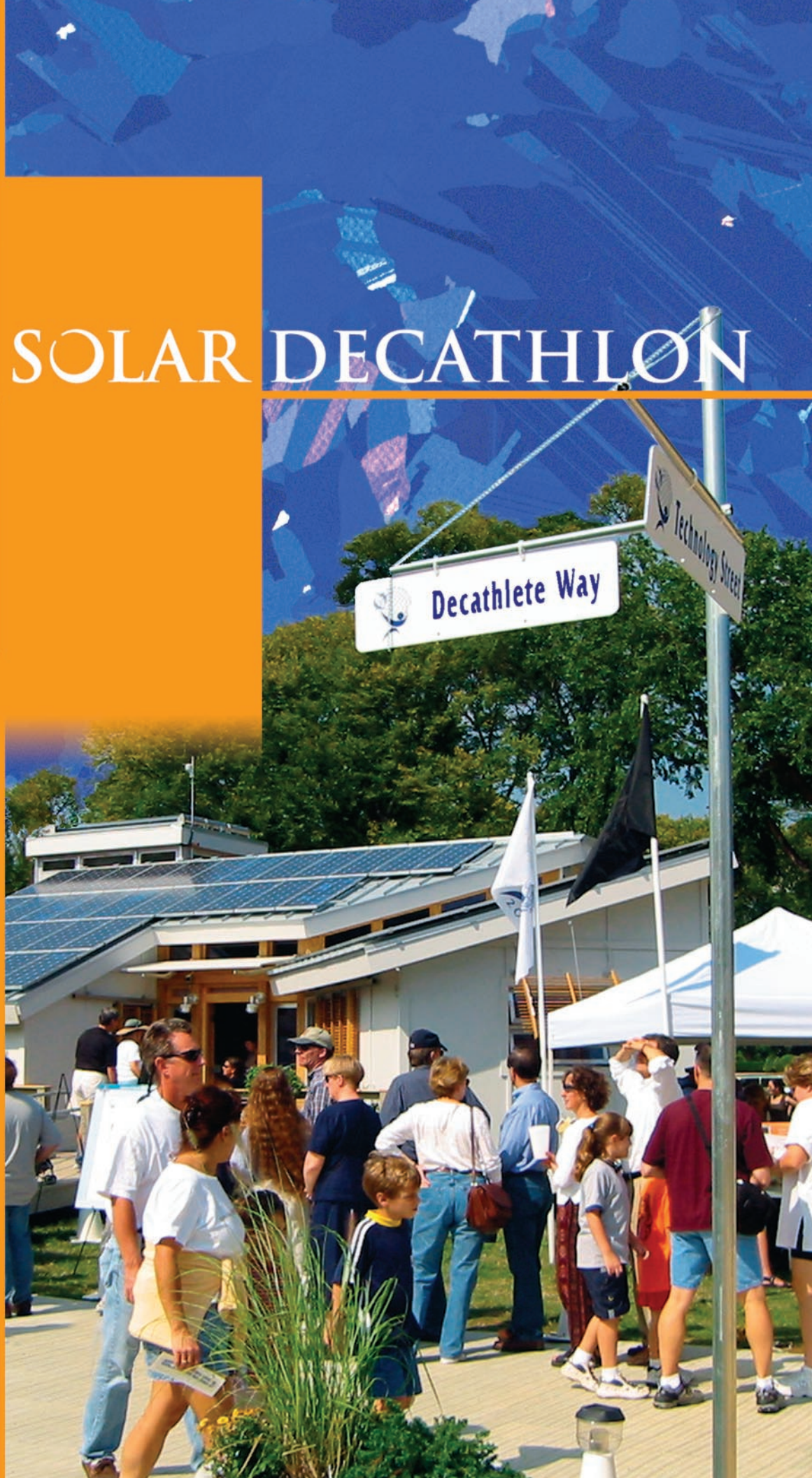
SOLAR DECATHLON

2005



U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Photo Credits

This page (clockwise from top): The University of Colorado 2002 Solar Decathlon winning house, NREL/PIX12166. 2005 Solar Decathlon teams constructing their houses for this year's event: University of Colorado/PIX14139; University of Michigan/PIX14140; University of Texas at Austin/PIX14143; New York Institute of Technology/PIX14141

Cover: All photos are from the 2002 Solar Decathlon (left, from top): NREL/PIX11796, 11892, 11762; large image: NREL/PIX12996

Secretary of Energy, Samuel Bodman, gives a hand in the construction of the National Renewable Energy Laboratory 2005 Habitat for Humanity house in Wheatridge, Colorado. This highly efficient, solar-powered house will generate as much energy as it consumes. *Credits: NREL/PIX14017 (above); NREL/PIX11977 (upper right)*

Message from the Secretary of Energy

Welcome to Washington, D.C., and the Solar Decathlon, the only competition that brings together architecture, design, and technology to demonstrate ways that Americans can produce and use energy more efficiently in their homes.

Increasing America's energy efficiency is an important part of President Bush's national energy strategy. During the past two years, the teams participating in this competition have worked hard to design, finance, construct, and operate the most energy-efficient solar-powered homes that can be imagined … now their work will be put to the test.

Ten contests ranging from indoor climate control to architectural aesthetics to powering and driving an electric car await these teams. The technologies they have developed will be tested and tried, with victory going to the team that performs the best overall.

Whether you are here as a competitor, a team supporter, or a visitor, I hope you will take time to see each team's accomplishments, as well as the many cutting-edge technologies that are available for use in your home today.

Again, welcome, and enjoy the competition.

Samuel W. Bodman
Secretary

Competition Program

Contents

Welcome to the Solar Decathlon

For ten days in October 2005, a "solar village" springs up on the National Mall in Washington, D.C., complete with houses powered solely by the sun and students who are making their marks on the future. Eighteen teams of students from colleges and universities from the United States (including Puerto Rico), Canada, and Spain are here to compete. They have spent the past two years learning about the latest solar energy and energy efficiency technologies—and applying that knowledge to designing and building their own "high-performance" houses.

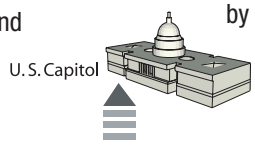
The students built the houses on their home campuses and have transported them to the competition site. Ten contests challenge their ability to produce electricity and hot water from solar panels to perform all the functions of home—from turning on the lights to cooking, washing clothes and dishes, powering home electronics, and maintaining a comfortable temperature. The architectural style and livability of the homes are paramount.

Like Olympic decathletes, the "Solar Decathletes" draw on all of their strengths. They take special Solar Decathlon-related classes, developed by faculty and included in their school curricula. Future engineers work with future architects to create energy-efficient homes that are also beautiful. They strive to innovate, using high-tech materials and design elements in ingenious ways. Along the way, they learn how to raise funds and communicate about team activities.

See the Houses, Meet the Students

The public is an important part of this event. We encourage you to meet the students and tour their houses. The Solar Decathlon is a valuable educational opportunity, but it is also an intriguing competition. Formulating and executing a sound strategy is critically important. During house tours, you may want to ask the students about their overall strategy or a specific aspect of the competition that you find particularly interesting. You will find that there are many (in this case, 18) different solutions to the design challenges.

The Solar Decathletes have learned to think in new ways about energy and how it impacts our everyday lives. In a quest to stretch every last watt of electricity generated by the solar panels on their roofs, they understand that energy is a precious commodity. They are here to share this knowledge with the world.



The National Mall in our nation's capital is the site of the 2005 Solar Decathlon.

Things to See and Do

Tour the Team Houses

October 7–11 and October 13–16, 2005
11:00 a.m.–4:00 p.m., Weekdays
9:00 a.m.–6:00 p.m., Weekends

The Solar Decathlon teams are here to compete. They're also here to share with you what they have learned. Team houses are living demonstrations of the latest in energy efficiency and renewable energy designs and products, and the best in home design.

On October 12, all houses are closed for competition purposes, but workshops are offered, and educational exhibits are open. Please note that during some public tour hours, some of the team houses are closed for competition purposes.

Visit the Educational Exhibits

October 7–16, 2005
11:00 a.m.– 4:00 p.m., Weekdays
9:00 a.m.– 6:00 p.m., Weekends

Energy Today

Located in the main tent at the west (Washington Monument) end of the solar village, this exhibit provides an overview of energy sources and uses in the United States today and options for the future.

Anatomy of a House

Located between the University of Maryland (120) and Florida International University (116) houses, this exhibit provides tips on saving energy for homeowners and includes several interactive features. The exhibit also includes a grid-connected solar electric ("PV") system. Unlike typical houses, none of the team houses are connected to the utility grid. The grid-connected PV exhibit demonstrates how a PV system would be set up for an average home.

Powered by Renewables

The entire Solar Decathlon is powered by renewable energy during the event —the team houses and all of the tents and trailers you see. Visit the exhibit northwest of the main tent to see the PV systems, biodiesel generator, hydrogen fuel cell, and wind turbine powering the village.

Credit: NREL/PIX11870

Tour the Product Expo

October 7–9, 2005
Sixty solar-related companies are exhibiting their products and services at Solar Power 2005 in the Hyatt Regency Capitol Hill, 400 New Jersey Ave. NW, Washington, D.C.

Attend a Workshop

A variety of workshops will be held throughout the competition. So whatever your interest and expertise level, there is likely to be a session that suits your needs. And, as is true of the entire event, all workshops are free.

For Building Industry Professionals

Friday, October 7, 2005

10:00 a.m., *The Energy Star Products*, presented by the U.S. Department of Energy (DOE)

11:00 a.m., *Solar Power and New Homes,* presented by BP

12:00 p.m., *An Overview of NAHB's Model Green Home Building Guidelines*, presented by the National Association of Homebuilders

1:00 p.m., *Emerging Power Technologies*, presented by Sprint Nextel

2:00 p.m., *Current Building America Designs*, Part I, presented by DOE

3:00 p.m., *Current Building America Designs*, Part II, presented by DOE

For Consumers

October 8–16 (except October 14), 2005
Presented by DOE

Solar Energy for the Homeowner
Weekends: 10:30 a.m. and 1:30 p.m.
Weekdays: 11:00 a.m.

Energy Efficiency for the Homeowner
Weekends: 12:00 p.m. and 3:00 p.m.
Weekdays: 12:30 p.m.

Credit: NREL/PIX11777

Credit: NREL/PIX11891

October 10–14
Presented by the U.S. Department of Housing and Urban Development
3:30 p.m., each day

Monday, October 10
Building Sustainably and Finding a Sustainable Builder

Tuesday, October 11
Renovating Green and the Five-Year Green Plan

Wednesday, October 12
Six Simple Ways to Improve your Next Home

Thursday, October 13
Innovation 101: What to Know when Talking to a Builder or Remodeler about Building Sustainably

Friday, October 14
Where Homebuilding is Headed

Additional Workshops

Monday, October 10, 2005
2:00 p.m., *Emerging Power Technologies,* presented by Sprint Nextel

Tuesday, October 11
2:00 p.m., *Earth to Architecture–Ecological Literacy in Architectural Education,* presented by the American Institute of Architects

Thursday, October 13
2:00 p.m., *Solar Power Trends and Residential Applications,* presented by BP

Let the Competition Begin

Just like the well-known Olympic decathlon, the Solar Decathlon consists of ten contests. But the Solar Decathlon centers on all of the ways in which we use energy in our daily lives—at work, at home, and at play.

To compete, the teams must design and build energy-efficient homes that are powered exclusively by the sun. The homes must be attractive and easy to live in. They must maintain a comfortable temperature, provide attractive and adequate lighting, power household appliances for cooking and cleaning, power home electronics, and provide hot water. These houses must also power an electric vehicle to meet household transportation needs.

The Ten Contests

Some contests are scored by measuring performance, such as meeting certain lighting-level or temperature requirements. Others require the successful completion of tasks. Some contests are scored by judges who are experts in architecture, engineering, and other appropriate fields. The subjective judging evaluates things that measurements cannot, such as aesthetics and comfort. Some contests are scored by a combination of these methods.

Architecture *(200 points)*

Teams are required to design and build attractive, high-performance houses that integrate solar and energy efficiency technologies seamlessly into home design. Scoring well in Architecture is crucial; teams can earn up to 200 points, twice the number of points available in the other contests. A jury of esteemed architects tour the team homes to judge the Architecture contest.

Dwelling *(100 points)*

Experts from the residential buildings industry award points for this contest based on their evaluations of the "livability" and "buildability" of the homes. They assess whether the houses are designed well for everyday living, simple to maintain, and attractive to potential home buyers. They also evaluate flexibility of design and construction, the construction methods used, and marketability of the houses. The Dwelling judges tour the team houses to make their assessments.

Documentation *(100 points)*

The Documentation contest awards points based on how well teams analyze their designs for energy performance and how thoroughly they document the design process. Teams must document all stages of the Solar Decathlon project. A panel of engineers evaluates the building energy analyses performed by the teams in the early stages of design. A panel of architects specializing in project management and documentation evaluate the teams' final "as-built" drawings.

Communications *(100 points)*

The Communications contest challenges teams to communicate their experiences to a wide audience through Web sites and public tours. Points are awarded based on success in delivering clear and consistent messages and images that represent the vision, process, and results of each team's project. To judge this contest, a panel of Web site development experts evaluate the team Web sites remotely, while a panel of public relations experts experience student-led tours of each home.

Comfort Zone *(100 points)*

The Solar Decathlon teams design their houses to remain a steady, uniform, comfortable temperature and humidity throughout. Full points for this contest are awarded for maintaining narrow temperature (72°F/22.2°C – 76°F/24.4°C) and relative humidity (40% – 55%) ranges inside the houses. A panel of engineers with expertise in building heating, cooling, and ventilation also tours the homes to make comprehensive assessments of thermal comfort and indoor air quality and to award points based on those assessments.

Appliances *(100 points)*

To earn points, student teams must maintain certain temperature ranges in their refrigerators (34°F/1.11°C to 40°F/4.44°C) and freezers (-20°F/-28.9°C to 5°F/-1.5°C). During the competition, they must wash and dry 12 towels for 2 days; cook and serve meals to contest officials for 4 days; clean dishes using a dishwasher for 4 days; and operate a TV/video player for up to 6 hours and a computer for up to 8 hours for 5 days. Points are awarded for this contest through measurements and task completion.

Hot Water *(100 points)*

Teams score points in the Hot Water contest by successfully completing the "shower tests." They aim to deliver 15 gallons of hot water (110°F/43.3°C) in 10 minutes or less. A panel of engineering judges also tours each home to make a comprehensive assessment of the hot water systems and awards points based on those assessments.

Lighting *(100 points)*

To win this contest, teams must meet specific lighting-level requirements in each room of their house. Contest officials measure lighting levels to ensure teams maintain typical lighting levels during the day and at night. Ideally, lighting design incorporates ambient and task lighting, electric and natural "daylighting" for energy efficiency and occupant comfort. A panel of lighting design experts tours the homes to subjectively evaluate overall lighting design—aesthetics, innovation, and annual performance.

Energy Balance *(100 points)*

The Energy Balance contest requires teams to use only the energy generated by the solar electric systems (also called photovoltaic or "PV" systems) on their houses during the competition to provide all of the electricity for the contests. Teams earn full points if the energy supplied to the batteries is at least as much as the energy removed from the batteries.

Getting Around *(100 points)*

In the Getting Around contest, student teams use electricity generated by their solar electric systems on their houses to charge their street-legal, commercially available electric vehicles. Points are awarded based on how many miles each team completes.

Photo credits: NREL/PIX11844, PIX11830, PIX11873

Competition Schedule

By the time the teams arrive on the National Mall, some contest activities have already been completed. The Documentation contest is complete, and the Web site judges began their evaluations on September 29. But the bulk of contest activities occur while the village is open. To accommodate contest activities such as judging and taking measurements, some of the houses will be closed some of the time during public hours.

Friday, October 7

- Lighting: Lighting-level measurements begin.

Saturday and Sunday, October 8–9

- Architecture, Dwelling, and Communications: Architecture Jury, Dwelling and House Tours panels of judges tour team houses
- Lighting: Lighting-level measurements continue.

Monday, October 10

- Comfort Zone: Temperature and humidity measurements begin
- Appliances: Refrigerator and freezer temperature measurements begin, computer and TV/video monitor operation, cooking task, dishwashing
- Hot Water: Shower tests
- Lighting: Lighting-level measurements continue, Lighting panel of judges tours team houses
- Energy Balance: measurements of energy into and out of battery system begin
- Getting Around: teams drive for mileage credit
- Results of Architecture and Dwelling contests announced.

Tuesday, October 11

- Comfort Zone: Temperature and humidity measurements continue
- Appliances: Refrigerator and freezer temperature measurements continue, computer and TV/video monitor operation, cooking, dishwashing, clothes washing and drying tasks
- Hot Water: Shower tests
- Lighting: Lighting-level measurements continue, lighting panel of judges tours team houses
- Energy Balance: measurements of energy into and out of battery system continues
- Getting Around: teams drive for mileage credit
- Results of Communications contest announced.

Wednesday, October 12 (Team houses closed)

- Comfort Zone: Temperature and humidity measurements continue. The houses will be closed so that measurements can be taken for one "typical" heating and cooling day—that is with about four people living in the houses rather than hundreds of visitors.
- Appliances: Refrigerator and freezer temperature measurements continue, computer and TV/video monitor operation, cooking, dishwashing
- Hot Water: Shower tests
- Lighting: Lighting-level measurements continue
- Energy Balance: measurements of energy into and out of battery system continues
- Getting Around: teams drive for mileage credit
- Results of Lighting contest announced.

Thursday, October 13

- Comfort Zone: Temperature and humidity measurements continue, Engineering panel of judges tours team homes to evaluate comprehensive thermal comfort and indoor environmental quality
- Appliances: Refrigerator and freezer temperature measurements continue, computer and TV/video monitor operation, cooking, dishwashing, clothes washing and drying tasks
- Hot Water: Shower tests, Engineering panel of judges tours team homes to evaluate hot water systems
- Lighting: Lighting-level measurements continue
- Energy Balance: measurements of energy into and out of battery system continues
- Getting Around: teams drive for mileage credit
- Results of Documentation contest announced.

Friday, October 14

- Comfort Zone: Temperature and humidity measurements end, Engineering panel of judges tours team homes to evaluate comprehensive thermal comfort and indoor environmental quality
- Appliances: Refrigerator and freezer temperature measurements end, computer and TV/video monitor operation
- Hot Water: Shower test, Engineering panel of judges tours team homes to evaluate hot water systems
- Lighting: Lighting-level measurements end
- Energy Balance: measurements of energy into and out of battery system end
- Getting Around: teams drive for mileage credit
- Results of Engineering judging panel evaluations—Comfort Zone and Hot Water contests—announced.
- 2:00 p.m.: Winner of 2005 Solar Decathlon announced.

And the winner is…

After an intense competition in 2002, an ecstatic—and relieved—University of Colorado team took home the victory. This year's competition promises to be equally exciting, with the overall Solar Decathlon winner announced at 2:00 p.m., Friday, October 14.

Credit: NREL/PIX11907

Who's Who at the Solar Decathlon

At the top of the Solar Decathlon "Who's Who" list are the students, whose talent, energy, and commitment are second to none. In the following pages, you will hear—and learn—from the students in their own words. On this page, we would like to recognize the Solar Decathlon judges and organizers.

Members of the Architecture Jury compare notes on the merits of this home at the 2002 Solar Decathlon.
Credit: NREL/PIX11766

Jury and Judging Panels

We value the contribution of our distinguished group of jurors and judges, all of whom are leaders in their fields. For biographical and contact information on these individuals, please refer to the Solar Decathlon Web site (www.solardecathlon.org).

Architecture Jury

Steve Badanes
Jersey Devil design/build

Ed Mazria
Mazria Odems Dzurec

Sarah Susanka
Susanka Studios

Ken Wilson
Envision Design

Dwelling Panel of Judges

Dennis Askins
Karim Rashid Design

Eric Borsting
ConSol

Steve Easley
Building Media, Inc.

Sam Grawe
Dwell Magazine

Katherine Salant
Author and nationally syndicated columnist

Architectural Documentation Panel of Judges

Phil Bernstein
Autodesk, Inc.

Kathryn Prigmore
HDR Architecture & Engineering

Grant Simpson
RTKL Associates, Inc.

Energy Analysis Panel of Judges

Doug Balcomb and Mike Deru
National Renewable Energy Laboratory

Pete Jacobs
Architectural Energy Corporation

Russ Taylor
Steven Winter Associates

Norm Weaver
Interweaver Consulting

Web Site Panel of Judges

Ethan Goldman
BuildingGreen

Kim Master
What's Working

Alan Wickstrom
BuildingOnline, Inc.

House Tours Panel of Judges

Ben Finzel
Fleishman-Hillard, Inc.

Jaime Van Mourik
National Building Museum

Craig Savage
Building Media, Inc.

Engineering Panel of Judges

Steven Emmerich
National Institute of Standards and Technology

John Mitchell
Wisconsin Solar Energy Laboratory

Terry Townsend
Townsend Engineering, Inc.; President-elect of ASHRAE

Lighting Panel of Judges

Howard Brandston
Brandston Partnership, Inc.

Sandra Stashik
Grenald Waldron Associates

Gary Steffy
Gary Steffy Lighting Design, Inc.

Organizers

Director
Richard King, *U.S. Department of Energy*

Project Manager
Cécile Warner, *National Renewable Energy Laboratory*

Rules and Regulations Committee
Pamela Gray-Hann, Linda Floyd, Sheila Hayter, Ruby Nahan, Charles Newcomb, Byron Stafford, Robi Robichaud, John Thornton, and Mike Wassmer
National Renewable Energy Laboratory

Dan Eberle
Formula Sun

Ed Hancock and Greg Barker
Mountain Energy Partnership

Susan Piedmont-Palladino
Washington Alexandria Architectural Consortium

About the Technologies

Some of the concepts and technologies used in the Solar Decathlon houses are tried and true, while others have seldom—or never—been tried. Learn more about these old and new ideas below.

Energy Efficiency

Why is energy efficiency important? Because it's much cheaper to save energy than to make it. An excellent place to start making a home more energy efficient is with good insulation, keeping out unwanted heat and cold.

R-Value and U-Value — R-value is a standard rating for heat transfer resistance. The higher the value, the better the insulation. U-value is the opposite, a measure of heat transfer, so the lower values are better. U-values are generally used for rating windows.

Structural Insulated Panels (SIPs) — These are prefabricated panels typically made of foam insulation sandwiched between sheets of oriented strand board or other building material. SIPs, which are used in many Solar Decathlon houses, offer superior insulation (typically R-4 per inch) and ease of construction.

Compact Fluorescent Lamps (CFLs) — These energy-efficient lamps use less electricity to provide lighting levels comparable to conventional (incandescent) lamps. Reduced electricity consumption (less wasted heat) also means that cooling loads are decreased during the summer months, thus reducing the electricity consumed by air conditioners. CFLs work in standard incandescent fixtures.

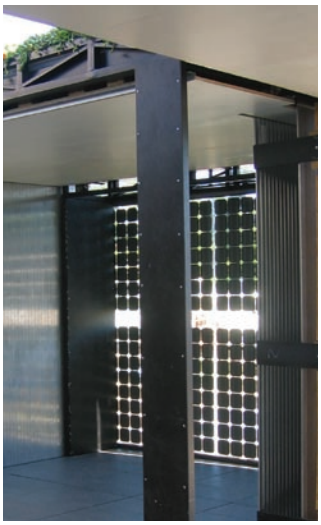
Low-Emissivity Windows — Low-emissivity (low-e) coatings for windows, invented and commercialized in the 1980s, have revolutionized window technology. Thin, transparent coatings of silver or tin oxide permit visible light to pass through, but also reflect infrared heat radiation back into the room. This reduces heat loss through the windows in winter. Low-e windows are available for different climate zones and a variety of applications.

Heating, Ventilating, and Air-Conditioning (HVAC)

Energy Recovery Ventilators (ERVs) — Effectively sealing or tightening a home against air leakage is one of the most cost-effective ways to increase energy efficiency. But to insure good indoor air quality, "exchanging" about one-third of the air in the house with outside air per hour is generally recommended. One way to maintain energy efficiency while providing fresh air is to use ERVs, which use heat exchangers (like little radiators) to transfer heat from the outgoing air to the incoming air, or vice versa, as needed.

Passive Solar Energy and Daylighting

Considerable amounts of solar energy can be captured for desired heating (while avoiding unwanted heating) without active mechanical systems, simply by properly siting and designing a home. South-facing windows, for example, can let in a lot of heat from winter sun, while large overhangs keep out that solar heat in the summer when the sun is higher in the sky and the heat is not desired. Similarly, proper window and skylight placement can provide appropriate light for home activities, reducing the amount of electric lighting that is needed. All of the Decathlon homes incorporate these design principles to some extent.



Active Solar Energy

Photovoltaics (PV) or Solar Electricity — PV systems are semiconductor devices that generate electricity by absorbing light energy, triggering electrical current flow from an electron-rich material to an electron-deficient one. Most of the Decathlon homes use crystalline-silicon PV modules, the most common type, but other types of PV cells include thin films of various compositions. With building-integrated photovoltaics (BIPV), traditional building components are replaced with PV materials. BIPV is used for vertical facades, roofing systems, and shading structures such as awnings. The cost of such a system is offset by the cost of traditional materials that would have been used to finish the building.

Solar Thermal Collectors — Solar thermal collectors use solar energy to heat water or a transfer fluid such as antifreeze flowing through a "collector" designed to capture sunlight. The heated water is then usually stored for use as domestic hot water, but several Decathlon homes also use it for space heating. Most of the Decathlon homes use better-insulated (but higher cost) evacuated-tube collectors for higher efficiency.

Energy Storage

Phase-Change Materials — It takes energy to change a solid to a liquid or a liquid to a gas (for example, melting ice or boiling water). Conversely, there is energy embodied in the liquid or gas, as it gives up heat energy when it liquefies or solidifies. While melting and freezing ice is not a very effective heat storage system, certain other materials with higher melting points can store heat (or cold) effectively. In the case of water and space heating in some Decathlon homes, excess hot water or exhaust air is routed through the phase-change material, cooling the water or air and melting the material. When heat is needed, cool water or intake air is run through the phase-change material, absorbing heat from the solidifying material. Several teams are using this technology.

Photo credits: Energy Efficiency, University of Texas at Austin/ PIX14144; HVAC, NREL/PIX11495; Passive Solar Energy and Daylighting, NREL/PIX12172; Active Solar Energy, Universidad Politécnica de Madrid/PIX14142

101 California Polytechnic State University

Sailing in Sunny California

Simple. Fundamental. Elegant. This is the mantra of the California Polytechnic State University (Cal Poly) Solar Decathlon team.

"We want the inhabitants to interact with the house."

—Cal Poly architecture student Jon Gambill

The 2,394 miles that separate the university from the National Mall in Washington, D.C., is, literally, the groundwork for this philosophy. The greatest land distance any team will travel to the competition, along with the desire to fit everything in one truck, led to what the students fondly call the "one truck solution."

While the constraints of the competition deliberately require all teams to minimize, Cal Poly students decided to take the simplicity concept as far as they could. You will not see a lot of high-tech gadgets on this house, nor is the building elaborate in form. Not only will this help ensure it will fit on one truck, but it fits well with their dedication to passive architectural design strategy, which relies as little as possible on the mechanical. "Ours is an architectural strategy for performance and comfort that encourages the use of the building itself," says Sandy Stannard, a faculty adviser on the team. Like most of the houses in the competition, this house is designed to optimize solar gain in winter and minimize unwanted heat gains in summer. But while some schools chose to automate their homes as much as possible, Cal Poly took the opposite approach.

"We want the user to interact with the house," says architecture student and Project Manager Jon Gambill. This means making a house that is "switch-rich"—plenty of operable windows, shading devices, and user-friendly controls—and relies less on mechanical equipment for heating, cooling, and lighting. The students say this will allow people to "sail" the house, adjusting the "trim" according to conditions of sun, wind, and temperature.

"We support the idea of people controlling their environment," says Stannard. "It puts you more in tune with your surroundings. We see this project as a potential prototype that could be altered to respond to a variety of climatic conditions."

Giving a nod to the California climate where the house is likely to end up, the Cal Poly house includes a large south side opening that adjoins a substantial deck. "One of the pleasures of living in our part of California is being able to dine outside year round," explains engineering student Robert Johnson.

The house is made from a combination of durable and environmentally sensitive materials, and includes three distinctive sets of exterior material palettes: one each for the mechanical, living, and cooking areas.

"We took a strategic approach to designing the home and its systems," says Johnson. The strategy included some design tradeoffs, including paying less attention to the "Getting Around" contest than some of the other contests, partly as a reflection of the students' philosophy. "We focused our energy on supporting the house functions first," Johnson says. "Our team approach supports a less car-oriented lifestyle, so we will drive as far as we can—and then we will bike." ♦

Team Web site: www.solardecathlon.calpoly.edu
Team contact: Professor Rob Peña, rpena@calpoly.edu

102 Rhode Island School of Design

Loft-Like and Very Cool

After Ryan Hammerschmidt presented his team's Solar Decathlon design to a Rhode Island community group, one woman in the audience told him, "Well, it's very impressive, but it's kind of a 'young design.'" Indeed, the Rhode Island School of Design (RISD) Decathlon entry seeks to move beyond the traditional. Intended as an urban dwelling that will work well as a row house, the team says it elicits adjectives such as "loft-like," "pure," "free-space," and "transformative," or just "very cool."

The RISD team also sought new directions for energy use and function. They emphasized efficiency, seeking to dramatically reduce the number of PV panels needed. They designed the bedroom to convert to a home office. A Murphy bed on one wall is matched by a "Murphy office" on another. The convertible theme carries over to the living room side of the house. A large window wall can slide away to open the living area up to merge with the balcony deck, creating a "sidewalk café" to enjoy in nice weather.

Architecture student Christina Zancani Tabena describes the house as having "high-tech and low-tech sides." The high-tech north side has the convertible home-office/bedroom, the solar panels—which still manage to face south—and the utility systems. The low-tech south side has the living area topped by a roof garden to keep the house cool and in touch with nature. In addition to doing research and design for the house, Zancani Tabena led the fundraising. "While that was sometimes an unfortunate distraction, it was also great seeing that all the students got involved with it," she says.

Key energy management features of the house are a louvered metallic skin to keep unwanted heat out and use of phase-change material to store heat and cold. The house is designed to operate on radiant heating and cooling from piped water, with no boiler or chiller. The vertical aluminum louvers, backed with extruded polystyrene insulation, rotate to track the sun. Architecture student Renee Moldovansky thinks the louvers give the house a "chameleon look." She was one of the main players in the conceptual design, but says "most exciting for me was bringing a team together for the actual construction."

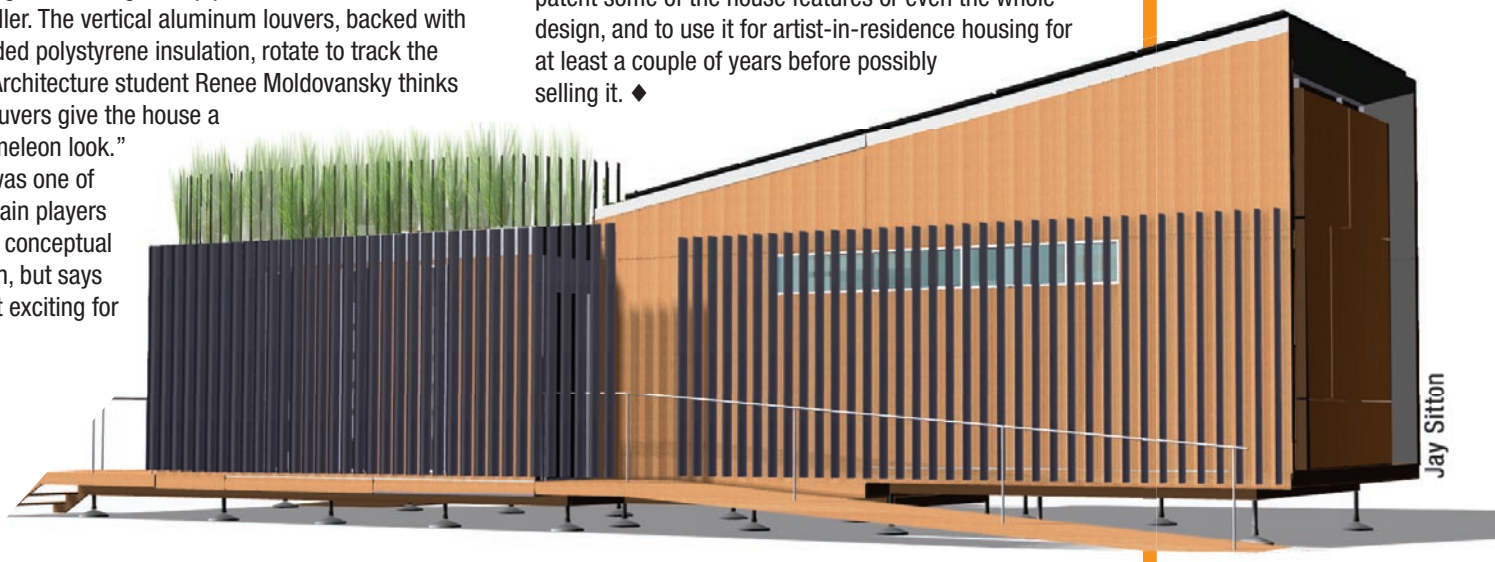
The phase-change material is used in separate heat and cold sinks—masses that absorb or release heat as available or needed—in containers under the house. The team is using a saline material cast into bricks, which is already available commercially in Europe. Hammerschmidt, a grad student and project manager for the RISD house, says that using it and the solar-tracking louvers cost much less than extra PV panels would, and that he was "impressed how mechanically simple better energy efficiency systems are."

Rhode Island School of Design is a stand-alone school, without associated engineering or other non-design departments. Faculty advisor Professor Jonathan Knowles says, "The Rhode Island community really came through for us, with an engineering firm helping with heating and cooling, and students at nearby Brown University designing a system that uses most water in the house twice."

And design school talents contributed in other ways, from logo design to costumes for the Decathlon event to specially designed task lamps. The team expects to patent some of the house features or even the whole design, and to use it for artist-in-residence housing for at least a couple of years before possibly selling it. ♦

"I am very excited about going out and using these materials and systems in designing full-sized commercial houses."

—RISD graduate student Ryan Hammerschmidt



Jay Sitton

Team Web site: http://solar.risd.edu
Team contact: Professor Jonathan Knowles, bkad@earthlink.net

103 Canadian Solar Decathlon

Concordia University and Université de Montréal

Smart House for a Cold Climate

In chilly Montreal, the appearance of the sun in winter is a welcome sight for more than one reason. "We hope to use weather prediction and smart controls as much as possible to effectively control the home," says Mark Pasini, Canadian Decathlon team project manager.

"We wanted the house to be high tech, but not have it be noticeable. If somebody walks into the house, it won't feel like a test pod."

— Concordia student Mark Pasini

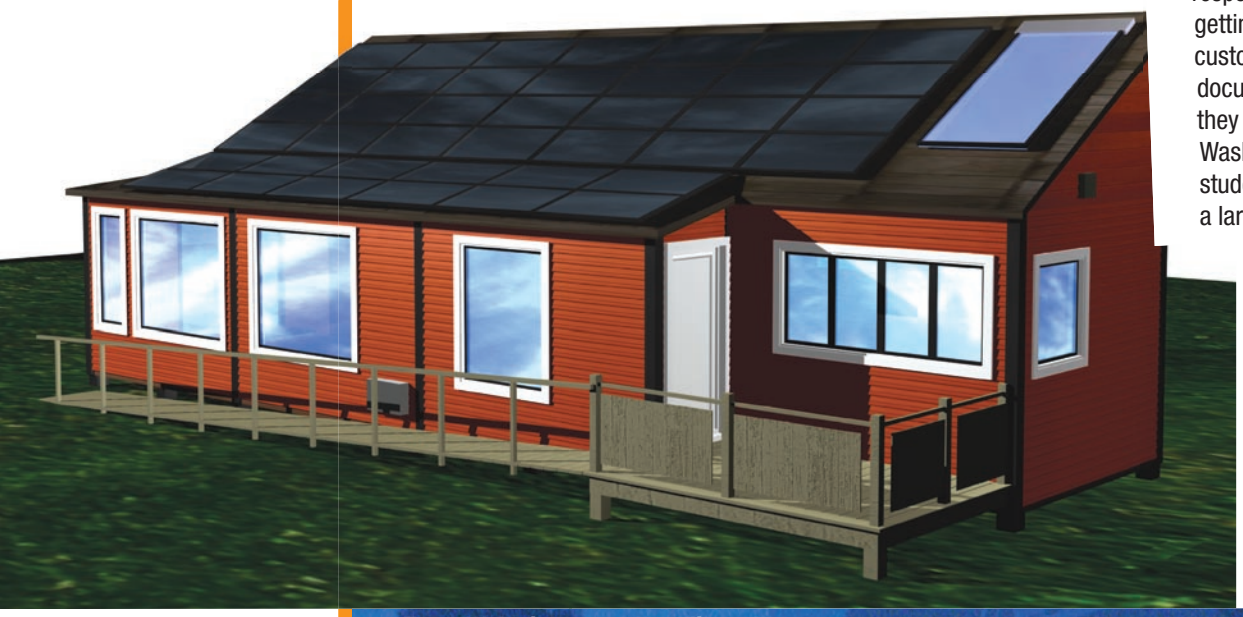
The Canadian Solar Decathlon team, made up of building, electrical, civil, and mechanical engineering students from Concordia University and industrial and architectural design students from L'Université de Montréal, set out to design a high-tech house in which most of the technology is invisible, seamlessly integrated through a special home automation system. The automation system monitors the home's temperature and links to controls throughout the house. For example, controls open or close window blinds according to the amount of heat the system deems necessary to help maintain a preset temperature.

To help with designing the automation system and other aspects of the house, team members designed their own software to simulate the thermal behavior of the house. The software combines all the unique components of the house including the automated blinds and the thermal storage. Phase-change materials and a wall of water placed adjacent to window glass serve as thermal storage and perpetuate the house's invisible technology design approach.

The solar panels are also intended to be an unobtrusive, if not nearly invisible, technological feature. "People may not even realize they are solar panels," says Pasini. Whereas some PV systems are almost a double roofing system, the Canadian team's PV panel is basically an energy-generating roofing material. Warm air from the house's solar panels, which would normally simply dissipate, will find a use in the clothes dryer, one of the biggest electrical loads in a house. Most of the systems in the house are Canadian, Pasini proudly points out.

Tight walls, lots of thermal storage, and plenty of foam insulation are important ingredients in this home built for a harsh, northern climate. But the students also boldly designed their house with large windows on the south-facing facade. Of course, the windows are triple glazed for the cold climate.

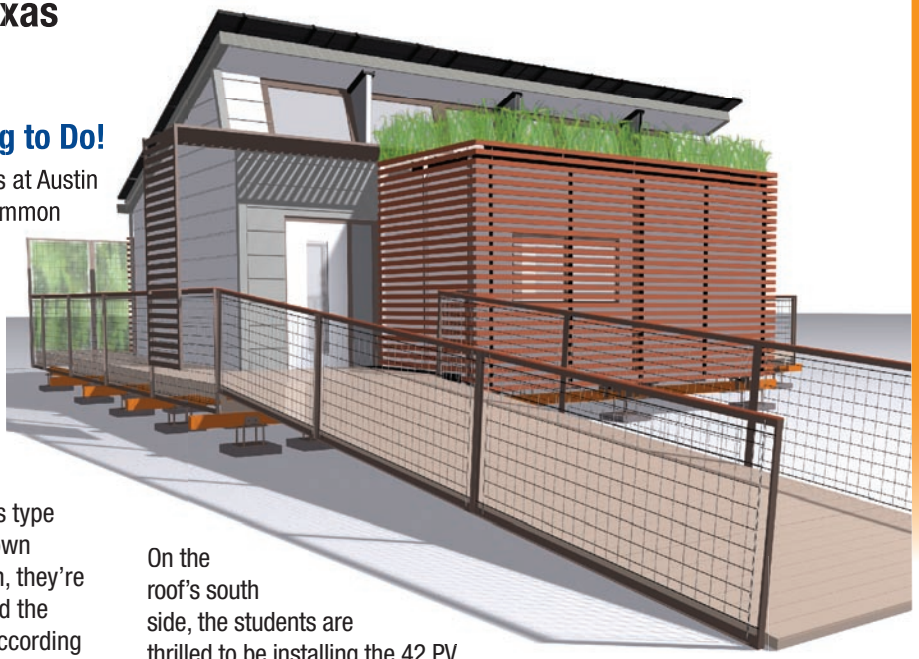
In addition to design requirements tailored to a colder climate, the Canadians have other unusual responsibilities. The first is getting their house through U.S. customs, which requires extensive documentation of the materials they bring to the competition in Washington, D.C. And, finally, the students are proud to represent a larger constituency than most teams. Says Robert Moussa, student and leader of the electrical/PV team, "We are the only team from Canada, and so we feel we are representing a whole nation." ♦



Team Web site: www.canadiansolar.org
Team contact: Professor Andreas K. Athienitis, athiena@alcor.concordia.ca

104 University of Texas at Austin

Sustainable Design: It's the Thing to Do!



Talk to any member of The University of Texas at Austin (UT Austin) team, and you'll quickly hear a common theme: the importance of public education about sustainable design, solar power, and energy efficiency. From their earliest conversations, the team members resolved to use the Solar Decathlon to work toward a broader vision—a new type of residential housing industry in which homeowners *produce*, not just *consume* energy.

Education, the team members feel, drives this type of social change. So while they further their own educations by participating in the competition, they're also actively educating the community beyond the campus, including the local schoolchildren. According to student Rachel Carson, "We feel that the children of our community are just as important as the adults. Kids love this stuff; they seem more willing to embrace the concepts, seeing sustainable design *as the thing to do*." And the team is reaching out to ALL community members—big and small—by attending meetings and conferences to talk about their home and the possibilities and practicalities on which it is built.

The team's "SolarD SNAP House" consists of prefabricated modules that "snap" together for ease of transportation and quick assembly on the National Mall. In a play on words that also demonstrates how they feel about their design, the team refers to the project as the "**S**uper **N**ifty **A**ction **P**ackage." Graduate architecture student Rea Koukiou says "the modular design worked itself into every detail, from the foundation, to the walls, to our innovative strategy for roof assembly." Project Manager and student Lauren Derrington adds "sliding became as important as snapping," with strategically located sliding doors and windows opening up the living spaces throughout the house and to the outdoors.

The students are especially pleased with their materials choices, which blend natural beauty with cutting-edge technology. Reclaimed redwood forms an exterior rain screen. The metallic matte finish of recyclable zinc cladding blends aesthetics with functionality. The students chose local mesquite wood for the floors and volcanic stone for interior tiles. The walls are structurally insulated panels with an expanded polystyrene foam core, finished with a high-performing translucent ecoresin.

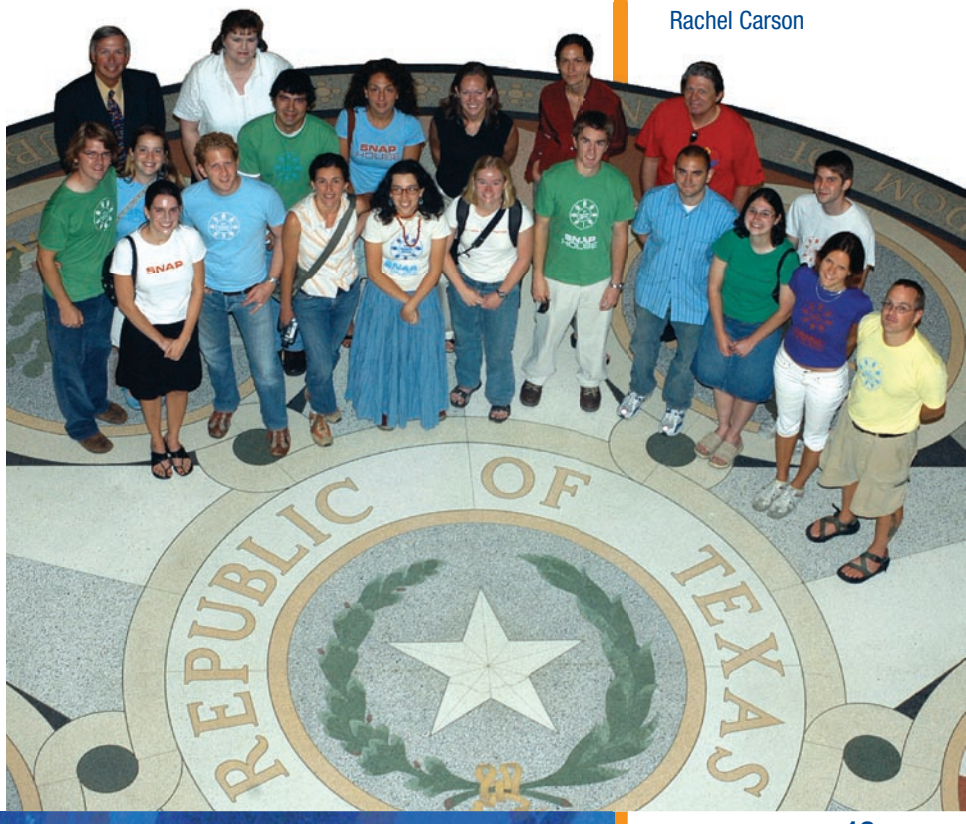
A "green roof" on the home's north side—planted with native Texas grasses—adds aesthetic appeal and provides extra insulation. According to student Sunshine Mathon, "It doesn't look like a lawn up there because the grasses have some height and blow in the wind, evocative of the Texas grasslands themselves."

On the roof's south side, the students are thrilled to be installing the 42 PV panels they won in BP Solar's separate design competition for the teams. BP, also a sponsor of the larger competition, awarded a free set of its BP 4175 panels—valued at approximately $40,000—to UT Austin, the team that BP representatives felt had most successfully integrated the PV panels into the home's design.

And the team's focus on education and outreach is paying off, too. In addition to local TV coverage and articles in the *Austin Chronicle* and regional trade journals, the students have their very own Senate resolution. On May 18, 2005, the students visited the Texas capitol, where they were honored by the passage of a resolution, introduced and sponsored by Senator Judith Zaffirini. ♦

"Our highest goal in this competition is to educate people about the many benefits of sustainable design … and to let them know that today, solar power is more affordable and easier to install, use, and maintain than ever."

—UT Austin student Rachel Carson



Team Web site: www.ar.utexas.edu/utsolard
Team contact: Professor Michael Garrison, mgarrison@mail.utexas.edu

105 Washington State University

So Many Ways to Be Green

The Washington State University students knew that, as the only team from the northwestern United States, they had a unique opportunity in the 2005 Solar Decathlon to showcase a number of local products and technologies. Student and team fundraising leader Andrea Read says, "We wanted to keep our house true to the green that people associate with our area." She adds that knowing their products would be featured in a national competition proved to be a huge selling point for sponsors and helped the team to raise funds and secure in-kind donations.

"Before this competition, nobody knew where Pullman, Washington, was … our participation has put Washington State University on the map. But more importantly for me personally, I've found this to be the most profound teaching experience of my life."

—Washington State University faculty advisor Mat Taylor

The Northwest is indeed famed and admired for the greenery of its scenery. But the political climate of Washington State exemplifies yet another way to be green. To support the creation of a statewide market for renewable energy that would also bring more high-tech manufacturing to the state, the state legislature passed SBs 5101 and 5111 last spring. Many consider these bills, which garnered overwhelming nonpartisan support, to be the most progressive and aggressive solar legislation ever enacted in this country.

Drawing inspiration from all these ways to be green, the students began their design conversations. According to architecture student Brad Frey, "We wanted our house to be affordable, to have wide appeal, and to exemplify sustainability along with architectural beauty. Although we're using innovative materials, anybody can get their hands on these same materials." The team decided to emphasize space planning, use function to create beauty, and select their building materials carefully.

And so the shipping container in which the house traveled to the National Mall actually becomes the core of the house, while also providing easy access to the electrical, mechanical, and water systems. The team's HVAC lead, student Marc Griffin, notes that "the container is the heart of the building, from which all the systems radiate outward."

The students are using a new type of structural insulated panel (SIP) for their structure. Griffin explains that their building system, designed by an architect in Spokane, Washington, is the inverse of a traditional SIP, in that the interior is a corrugated steel frame and the polystyrene is on the exterior. "This allowed us to run our electrical and plumbing systems through the walls without compromising the structural integrity of the panels."

The team is particularly excited about its fully integrated heating and cooling system. According to Griffin, "We're using a marine system from Glacier Bay, which makes refrigerators for high-end yachts that are so efficient that they only need to run 4% of the day. As a result, we were able to configure our heating and cooling system to allow the fridge compressor to run the house's air-conditioning for most of the day."

A goal important to the students was their determination that the house would live on in the Northwest after the competition. Working with representatives of the university's Northwest Solar Center and local solar expert and team advocate Mike Nelson, the students formed a partnership with Seattle City Light, the city's municipal electric utility. After the competition, the house will make its permanent home in northeastern Seattle's Warren G. Magnuson Park, where it will be open to the public as an educational and training facility in which new solar technologies can be tested and system performance monitored throughout the year. ♦

Team Web site: www.arch.wsu.edu/solardec
Team contact: Professor Matthew Taylor, solarguy@arch.wsu.edu

106 University of Colorado, Denver and Boulder

It's the Natural Place to Be, No Matter Where You Are

The materials used in the University of Colorado's home read like a health food restaurant menu. Soy, corn, sunflower, canola, coconut—these are just some of the natural "ingredients" in many components and furnishings (and even tableware) featured in this unique modular home.

Using natural materials was one of the team's five major design goals, along with innovation, energy efficiency, modularity, and accessibility. The result is a sustainable, attractive solar home built almost entirely of recycled and natural materials—one that can go almost anywhere to complement almost any lifestyle.

The Colorado team is especially eager to unveil the innovative, biobased structural insulated panels—BIO-SIPs—used for the walls. Julee Herdt, one of the team's faculty advisors, developed it with the help of researchers at the U.S. Department of Agriculture Forest Products Laboratory in Wisconsin. It meets all building code requirements and is patented for use in future products. "This product is a little like a giant ice cream sandwich," Herdt says. BIO-SIPs merge two commercially available green products: strong but lightweight Sonoboard, made of recycled cellulose materials by Sonoco Company, and BioBase 501, a lightweight foam insulation made by Biobased Systems of soybean oil.

The BIO-SIPs and high-performance window glazings both contribute to the home's energy efficiency. So does the integrated radiant solar thermal system used for space and water heating. "We wanted a nonintrusive, ductless heating and cooling system, and this really fits the bill," says Kendra Tupper, student leader of the engineering team.

The team also carefully selected the home's rooftop PV system and building-integrated PV awnings, which provide shade as well as electricity. "Our rooftop PV system is made of 32 SunPower 200-watt panels; they're around 16%–17% efficient," says Jeff Lyng, student project manager. After the Solar Decathlon, the home will be set up again and connected to a utility as part of the university's education and outreach activities.

The use of natural materials extends to the fuel used to transport the home to and from Washington, D.C. That fuel is B100 (i.e., pure) biodiesel, which is often made of used vegetable oil. Lightweight building materials and furnishings should also reduce transportation costs. Built on a single mobile home chassis, the home was designed for low-cost construction at the competition site.

Colorado's core team consists of about 20 engineering and architecture students. But many others contributed, too, in special projects and brainstorming sessions. The 2005 team wanted to build a home that would compare favorably with the university's 2002 Solar Decathlon entry, which took top honors.

"Our 2002 goal was to create an energy-efficient solar home that would fit right into an American suburb, so it was a little bit conventional," says faculty advisor Michael Brandemuehl. "In 2005, students are using more innovative materials and solar technologies to create a modular home for the future."

This natural home has inspired the Colorado team to prepare meals featuring some of the same ingredients as the ones used to build the home, though not in the same form, of course. "Come on over for some soy and kelp stir-fry!" they joke. ♦

"The Colorado team has created an environmentally conscious solar mobile home that is accommodating to changing lifestyles and energy needs."

—Colorado student Jeff Lyng

Team Web site: http://solar.colorado.edu
Team contact: Professor Julee Herdt, groundup@ecoisp.com

107 Universidad de Puerto Rico

Mi Casa Es Su Casa

When it comes to welcoming visitors to the Solar Decathlon, students of the University of Puerto Rico team want people to know that "my house is your house." Their house is open and inviting by design—it's all part of capturing the warmth and hospitality of island life. You'll see this in the style of the house, from the horizontal design elements, to the shallow roof pitch, to the luminaries used for lighting.

"The house expands—it looks bigger than it is," says student Robert Roche. A goal was to have a big comfortable area for living. By locating the terrace next to the living room, the whole space opens up. "The house represents a lot of our culture. One of the points of the house being beautiful is to represent who we are," he adds.

"We think the architectural style of the house represents us: it shows the Caribbean ideal of how to live."

—Puerto Rico student Robert Roche

The team also wanted to use as many conventional materials as they could—to make the house "buildable" and something the consumer can use today. There are a lot of new materials and systems on the market, but they can be expensive; so, wherever possible, the team worked with items at hand. "We chose the best appliances, selected for saving energy and reducing the heat that appliances produce. We modified the dryer to use hot water heat to dry the clothes instead of electricity," says team member Irwing Vargas.

Javier Cuadrado, mechanical engineering student, points out that this modification required more solar collectors, a larger storage tank, and higher-temperature water, "but the savings in electricity will be worth it."

The Puerto Rico team faces a challenge shared only by the team from Madrid—the need to ship their house across the ocean. The house will be transported by freight ship from the port of San Juan, Puerto Rico, to the port of Baltimore, Maryland. The modular design of the house allows transporting it in standard shipping containers.

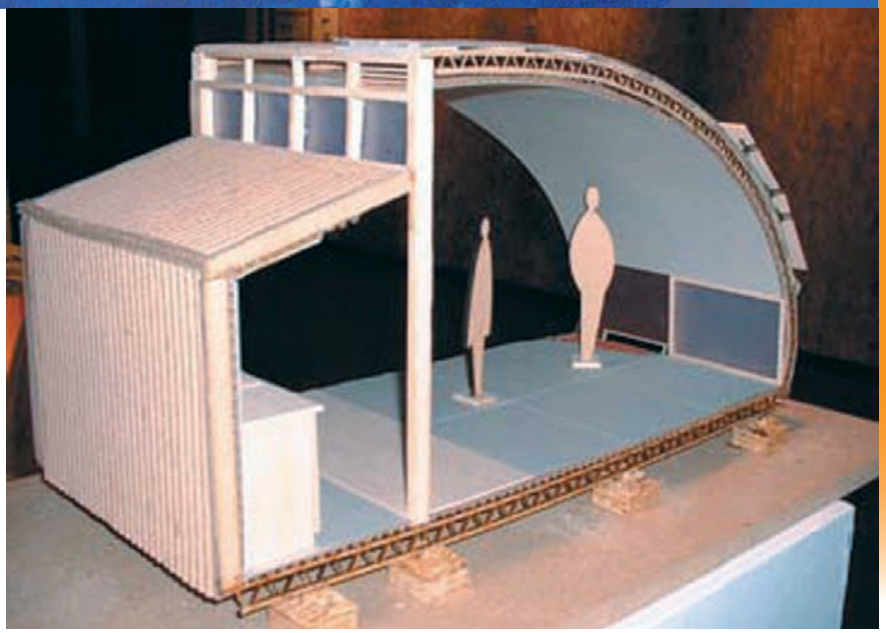
All indications are that the students of the Puerto Rico team are up to this challenge—and many more. They see their Solar Decathlon experience as a continuum of learning and growing, from their first meeting in the fall of 2003, to coursework focusing on rigorous design and building-specific requirements, to fundraising, and to actually building the house. A team member describes the experience as a melting pot of four or five different departments. "You don't see that anywhere else at the university," says Cuadrado. "This is knowledge you don't get in the classroom. I've learned about dealing with companies and public relations. The confidence grows."

Student William Santiago seconds that notion. "In the classroom, I can learn about electrical engineering, but with this, we had to open our minds to other defining concepts. We had to learn about how to interact and get to a common goal."

How well they met that goal is for others to judge, but the achievement and the competing is a reward in itself. "There's a great spirit here. I feel that we are heading for our future—and it's the very near future," says Roche. ♦

Team Web site: http://solar.uprm.edu
Team contact: Dr. Gerson Beauchamp, gerson@ece.uprm.edu

108 University of Michigan



MiSo*: Modular Solar, Mass Produced and Marketed

At the 2005 Solar Decathlon, MiSo* isn't a type of soup … it's short for the Michigan Solar House Project. The University of Michigan students hope their house, designed to be mass produced to generate less waste and reduce costs, will serve as a prototype for a more energy-conscious and energy-efficient way of living in America.

To give the house broad appeal to consumers and allow it to be mass marketed down the road, while also following the competition's stringent rules, the students began by addressing current domestic trends and talking about *domesticity*—how average homeowners interact with their living spaces. They didn't want visitors to think, "That's an amazing project, but I wouldn't want to live there." According to Project Manager and student John Beeson, "We wanted to make a prototype that's almost immediately an heirloom, so that through form, materiality, and workmanship, we've created a building that will last for 100 years. It's a very different way of thinking about any product in our society, particularly a house."

The home's modular construction allows consumers to add more living space or to tailor the house to their specific needs. Each house module breaks down to a street-legal size so it can be towed behind a standard-size truck. For the competition, the house includes a kitchen, living room, bedroom, and bathroom. Inspired by monocoque designs from the aircraft and automobile industries (in which the external skin of an object supports some or most of the load on the structure), the team chose aluminum for the shell of the house. Beeson notes that "Aluminum is not an energy-efficient material to produce, but it doesn't lose any of its value when recycled." That was important to the team, he adds, because they considered the life cycles of all their building materials. As a prototype for production home building, the form of the house allows future models to be universally shipped by rail, truck, boat, or air, and to be quickly assembled in large segments on site.

To capture and use the sun's energy, the house has a number of systems: purely passive solar from the ample windows; a "solar chimney" that supplies heat and active insulation; a 6-kilowatt photovoltaic system of Sanyo HIP190 panels arranged in six rows along an innovative curved roof; solar thermal panels linked to a radiantly heated floor; and an energy recovery ventilator (ERV) system. The solar chimney allows the sun to heat air in glass spaces at the base of the south wall. The hot air then rises along the curve of the roof and is either released into the house in the winter or outside in the summer. Either way, the layer of air functions as insulation to keep the house cool or warm. Batteries in the floor store excess energy, and the base of each module is a trailer for easy transportation.

Judging from the excitement the project has generated on campus and within the local community, the MiSo* concept appears to have caught on. Along with numerous donations from private individuals and foundations, especially the Kresge Foundation and Binda Foundation, the team has received in-kind contributions from corporations such as 3M, Sanyo, Fisher Paykel, Sterling, and Dexter Axle. ♦

"In some ways we're challenging the American style of living. For example, do you really have to leave your house behind when you move?"

—Michigan student Megan Johnson

Team Web site: www.umich.edu/~miso
Team contact: Jonas Hauptman, jonasiam@umich.edu

109 University of Missouri-Rolla and Rolla Technical Institute

Prairie Solar

"Our way of expanding solar is making it more visually acceptable," says University of Missouri-Rolla student Allison Arnn. Above all else, the Solar Decathlon team from the University of Missouri-Rolla and Rolla Technical Institute wanted to build a house in which any traditional Midwesterner might feel at home.

"It appeals to everyone," team architect and student Adam Tiehes elaborates. "We really believe that's an important thing, especially in our area where people might shy away from something more modern."

One way the house avoids a "solar house" look is that the northern roof has the same pitch as the southern roof. The ideal pitch at Missouri's latitude for solar, according to Project Manager and student Joel Lamson, is 54 degrees. Missouri-Rolla's roof pitch is 27 degrees—basically half of what would be ideal. The team felt it more important for the house to blend in with traditional designs than to have an ideal pitch for solar. The students ran computer simulations to ensure that the architecturally desired pitch would meet the energy needs of the house.

Although the roofline may be more traditional than some solar houses in the competition, one reason the house may be pleasing to the untrained eye is a bit unusual. Everything in the house is designed around a mathematical sequence known as the Fibonacci Sequence, or the Golden Ratio. This sequence can be found in most shapes and patterns in nature, from pinecones to seashells.

"Since the Fibonacci sequence is so evident in nature, it seemed especially appropriate for this competition, where we are relying on the sun and nature," Tiehes explains.

The students toyed with the idea of a shell shape for their house, but ever true to their goal of building within a traditional look, they decided to incorporate the sequence in more subtle ways. "While it may not be blatant, it's everywhere you look," says Arnn, who cites the curved kitchen island as an obvious example of the design.

As the team worked toward a more subtle incorporation of the numerical sequence, they looked to Frank Lloyd Wright, who also designed many of his houses using the sequence. "Frank Lloyd Wright's houses protruded out into nature," Tiehes says. "There are 28 windows and two doors in the [Decathlon] house to bring nature in. Our trim in really basic shapes and all natural colors, and our built-ins, all play off his designs."

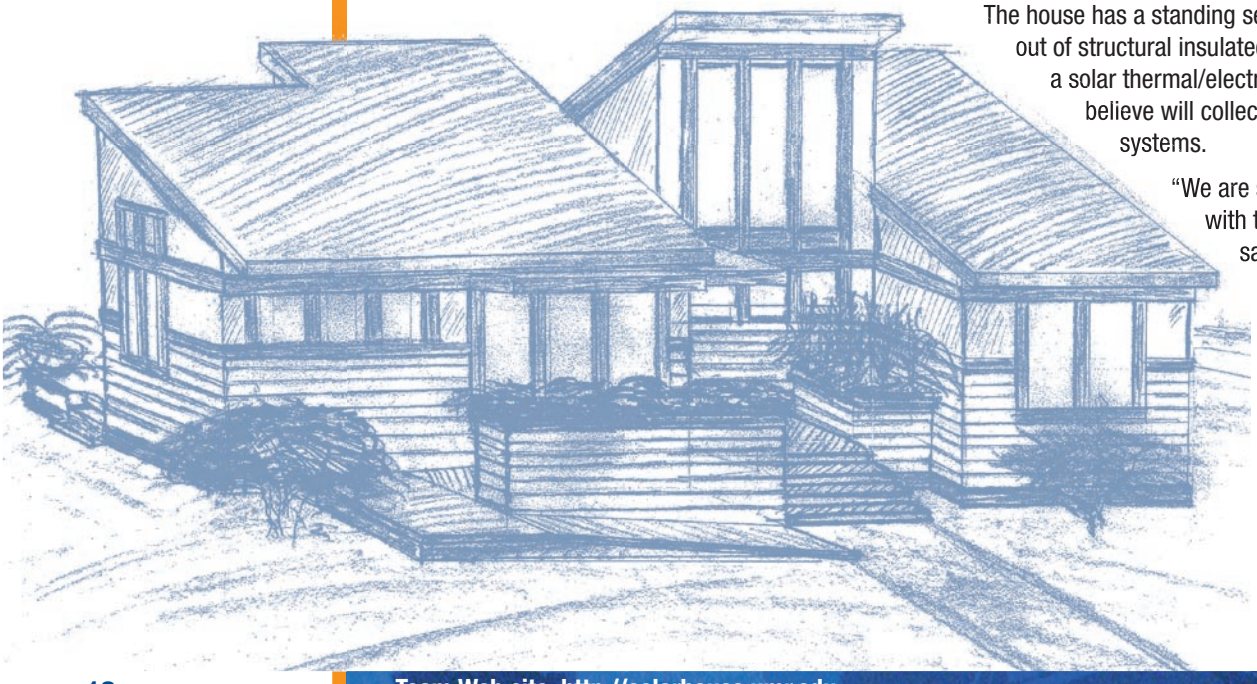
The house has a standing seam copper roof, is made out of structural insulated panels, and incorporates a solar thermal/electric panel system they believe will collect more power than separate systems.

"We are simply not going to show up with the biggest array," Lamson says, proudly.

Arnn clarifies the team's position on solar panels: "This competition is about doing things efficiently. We think you should take the time and make the effort to do all the math and come up with the optimum amount." ♦

"It's easy to build the strongest bridge in the world. The challenge is building a bridge that's strong enough. We're trying to create 'enough of an array.'"

—Missouri-Rolla student Allison Arnn, on the team's solar array.



Team Web site: http://solarhouse.umr.edu
Team contact: Jeff Birt, birtj@umr.edu

111 Cornell University

Wheel of Comfort

"We were not going to design just for the competition," says architecture graduate student Ben Uyeda. "Because we wanted the home to be a sound investment for the buyer, we made it modular so that homeowners could add to it as needed and as they could afford it." An overarching goal for the Cornell Solar Decathlon team was to create a home, or set of home designs actually, that could be mass-produced.

"We designed alternate versions, such as one for the cold winters back here in Ithaca, but made sure each complied with HUD guidelines for manufactured housing," points out architecture student Stephanie Horowitz. The team's goal was to create an affordable house that could sell for $50,000 to $100,000.

The Cornell house features a custom-designed energy recovery ventilator (ERV). ERVs are very effective at reducing the additional energy load for ventilation. To maintain healthy indoor air quality, adequate ventilation is necessary. The problem with good ventilation, however, is that it takes a lot of energy to heat cold, winter air or to cool and dehumidify hot, humid summer air.

The key component of Cornell's ERV is a rotary wheel composed of silica gel—the same material used in the little packets found inside food and other packaging. In summer, for example, the silica gel absorbs humidity from the fresh air intake before it reaches the air handler. It is then wheeled around to be regenerated, transferring the humidity to the exhaust along with extracted heat. This preconditioning can dramatically reduce the energy consumption of the heating and cooling system.

Control systems are another technical highlight of the Cornell entry, with systems designed to make it "very much a smart house," says Uyeda. Everything will be controlled automatically, but can also be adjusted by the occupants, with a manual-override touch screen. Heating and cooling beyond that provided by the ERV is by forced air from an electric heat pump. Power for the heat pump and home electrical needs comes from a set of crystalline-silicon PV panels.

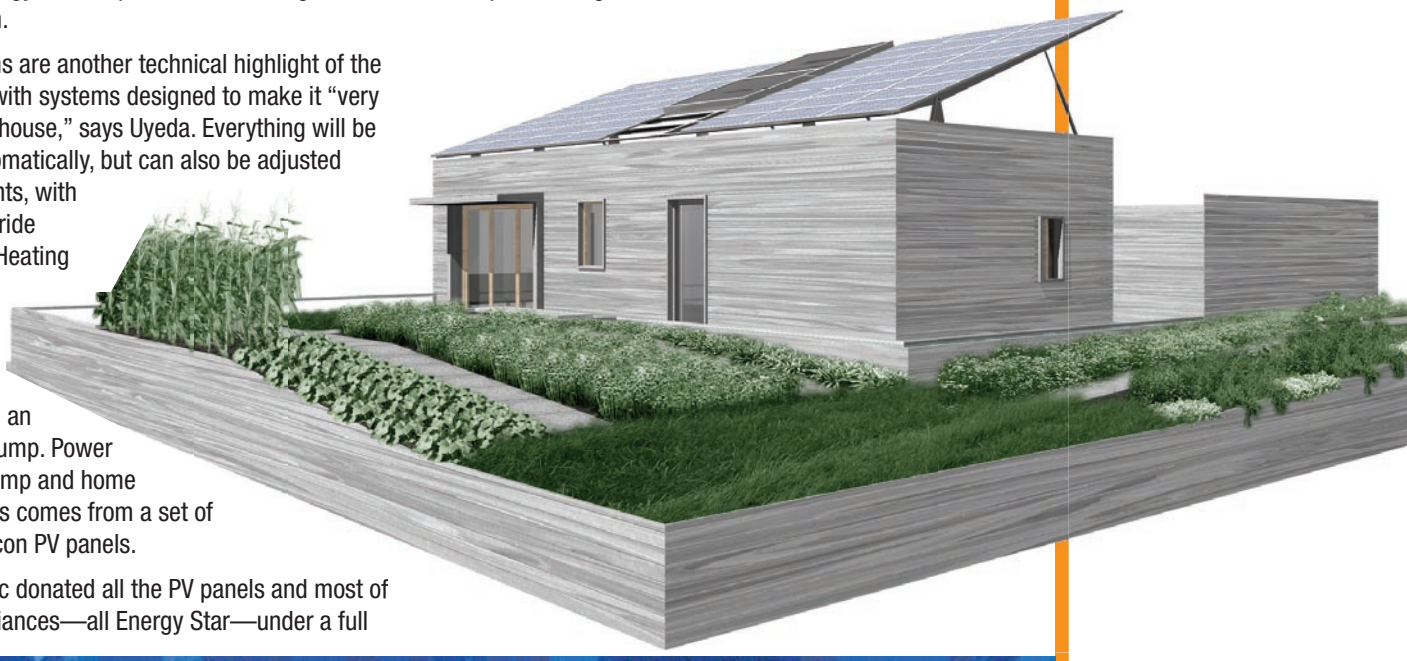
General Electric donated all the PV panels and most of the home appliances—all Energy Star—under a full sponsorship arrangement for the Cornell Decathlon home. Several other manufacturers with university affiliations also donated materials or other in-kind services for the project. Horowitz says the students did all the fundraising and that "Working together with students from different disciplines was particularly rewarding. We all learned from the constraints and building blocks of the other disciplines."

What impresses faculty advisor Zellman Warhaft the most is the interdisciplinary and student-led aspect of the project. "The whole philosophy was driven by students. The social interaction was fascinating and will be a great legacy for future students," he says.

Another feature of the house is the strong tie between the interior and the exterior. The living room connects to the patio through an accordion-folding door of 9-foot-tall (2.75-meters-tall) glass panels, which creates a great feeling of connection open or closed, but also provides an excellent thermal seal when closed. Finally, not only does the Cornell home use grey water from the shower for exterior watering—the team even brought modular trays of soil and plants for transplanting when the competition begins. ♦

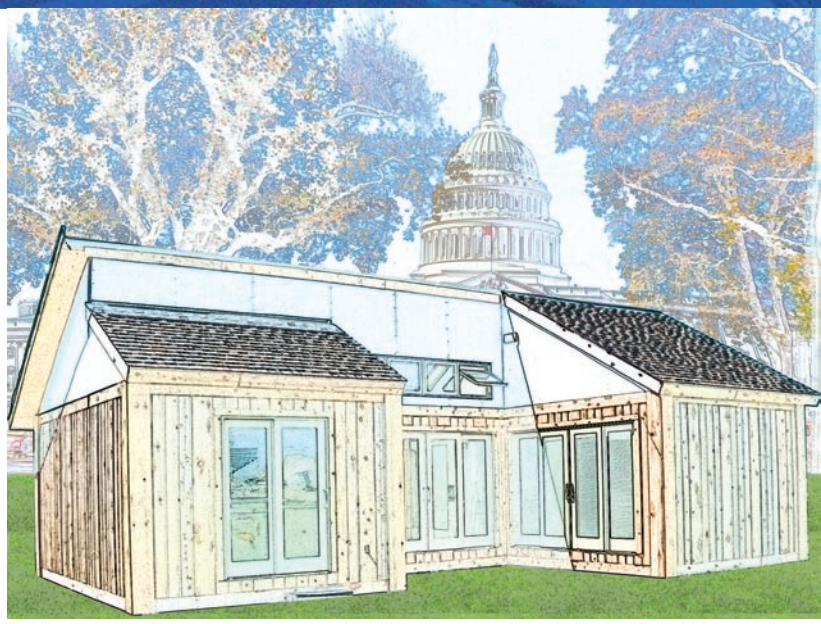
"It's not so much what we designed as how we got there. The multifaceted process of attacking and solving problems was a tremendous learning experience."

—Cornell graduate student Tim Fu



Team Web site: http://cusd.cornell.edu
Team contact: Professor Zellman Warhaft, zw16@cornell.edu

112 Crowder College



The Arts & Crafts House, Solar Style

The Crowder College Solar Decathlon team members think that their design philosophies would make Gustav Stickley proud. Stickley, a well-known American craftsman from the early 1900s, is considered the father of the American Arts & Crafts Movement, an architectural style built on the same principles that today we call *sustainable design*. Because many of the historically important structures in Neosho, Missouri—home to Crowder College—are built in the Arts & Crafts style, the students have adopted many of the principles pioneered by Stickley and later expanded on by Frank Lloyd Wright.

"We point out that our solar system costs about the same as a new SUV. That brings home the fact that you can choose to spend your money in ways that better the planet."

—Crowder student Dave Mathews

From the outset, the team thought carefully about how to blend these principles with the challenges presented by the Solar Decathlon. With design exercises ranging from drawing circles representing the home spaces on a blackboard to imagining themselves hosting a dinner party, they worked to configure the home for a comfortable, open flow. The students settled on a modified bungalow design constructed of "pods" that detach and fold down for easy transportation and construction. They describe the shape of their house as the letter U, but with one leg shorter than the other.

The courtyard on the home's north side is accessible from the home's interior, which the team feels has particular aesthetic appeal. Although north-facing glass presented a major challenge to the structure's energy efficiency, the students believe they have found ways to avoid compromising energy efficiency by using reproducible and flexible design strategies, and installing features such as high-efficiency Pella windows with internal reflective blinds that help keep heat inside during winter.

The home's broad south module permits optimum roof orientation and surface area for the hybrid PV/solar thermal system of high-efficiency, heat-tolerant Sanyo HIT 190 modules. The HIT (**H**eterojunction with **I**ntrinsic **T**hin Layer) modules consist of a thin single crystal silicon wafer surrounded by ultra-thin amorphous silicon layers. Dave Mathews says that these modules can maintain higher voltages at higher temperatures and adds that the team designed the home's roof around the dimensions of the panel itself. In terms of electricity, the students also plan to "walk the talk" by using the trailer that Crowder students built for the 2002 Decathlon competition—which houses an on-board battery system run off a PV panel—to power their tools during assembly on the National Mall.

For their flooring, trim, and cabinetry, the students are using hardwood from the Pioneer Forest in the heart of the Missouri Ozarks. Pioneer is the only forest in the state certified for responsible and renewable forest management by the Forest Stewardship Council. The same family has managed Pioneer Forest for more than 50 years, using a conservative harvesting technique called "single-tree selection." The technique most closely mimics natural forest processes, maintaining a diverse, "multi-aged" forest (a forest with three or more age classes).

In summing up her Solar Decathlon experience, Project Manager and student Liz Flores says "I wasn't at all familiar with solar technologies when I came to Crowder. But this technology makes a lot of sense, and it's been fun and interesting working through the process with a diverse mixture of traditional and nontraditional students. Now I'm staying around an extra semester so I can finish the project."

And Crowder College just may have pioneered a whole new Solar Decathlon tradition. After working together on the project, Liz and fellow team member Anthony Flores were married in January 2005. ♦

Team Web site: www.crowder.edu/solar/2005
Team contact: Professor Art D. Boyt, aboyt@crowder.edu

113 University of Massachusetts Dartmouth

Big-Hearted Effort

The University of Massachusetts Dartmouth may be the smallest of the five Massachusetts state universities, but its Solar Decathlon entry proves that its students have hearts as big as any school could boast. The overarching objective and guiding force for the project was to build it as a Habitat for Humanity house. When the Decathlon is over, the house will be moved from the National Mall to the northeast area of Washington, D.C., where it will be permanently installed as a Habitat-provided house.

Sixteen members of the UMass Dartmouth team jumpstarted the process more than a year ago with a spring-break trip that defied the usual fun-in-the-sun stereotype. On that trip to Loudon County, Tennessee, they helped an Oak Ridge National Laboratory team build its fourth high-efficiency, PV-powered home as a donation to Habitat. Next year, the UMass Dartmouth team and the local Habitat chapter it spawned will join with another chapter to build a Habitat house in Plymouth, Massachusetts.

The UMass Dartmouth home uses a computerized control system to draw heat and cooling from phase-change materials. The materials, which are made from blocks of cloth, are in containers under the front windows. The home was deliberately designed, however, to use off-the-shelf components as much as possible and deemphasize cutting-edge technology. "We tried to make the home as comfortable, normal looking, and acceptable for the D.C. location as possible," says Tom Celona, student project leader.

The home uses a combination of forced-air heat exchange, passing intake air by the phase-change material, and radiant-floor piping heated by one of two rooftop evacuated-tube solar thermal collectors. The other collector provides domestic hot water. Lighting is a combination of compact fluorescents and passive lighting, including light "tubes" to bring light down from the roof. All appliances were donated by Whirlpool, an ongoing sponsor of Habitat for Humanity. "They are Energy Star, but we worked with Whirlpool to pick as 'ordinary' ones as we could," says electrical engineering student Kenny Ventura.

The team also enjoyed extensive support from the local South Coast Massachusetts community. Clearwater Architects donated the design work (the Decathlon team is mostly engineering students) and New Genesis Construction led the actual construction. Teachers at a local vocational technology school provided electrical, plumbing, and heating, ventilation and air-conditioning advice.

The UMass Dartmouth team considered one of its biggest challenges to be transporting the house to the competition. They designed the house in three pieces, each of which could avoid "oversized load" designation. Two are being put together on the Mall for the Decathlon. The third will add a second bedroom for the permanent house in northeast Washington. "Building this house for Habitat for Humanity and using renewable energy is really great," says biology student Sri Reddy. "I can't imagine anything giving a better feeling of making a difference to society."

Grad student Shunde Lin talks about the tremendous excitement the project generates. "Everyone talks about global warming and using alternative energy, and this project gives us a chance to actually do something about it," she says.

Faculty advisor Gerald Lemay voices high praise for the team members as people as well as students. Thinking back to that road trip to Tennessee, he says, "I would travel with them anywhere." ♦

"We thought of the home almost as a living being; we harvested building 'nutrients,' such as the old siding from a remodeling job, from the community wherever we could."

—UMass Dartmouth student Tom Celona

Team Web site: www.umassd.edu/solar
Team contact: Professor Gerald Lemay, glemay@umassd.edu

114 Pittsburgh Synergy

Carnegie Mellon, University of Pittsburgh, and The Art Institute of Pittsburgh

Reaching for the Sun—and the Future

The Pittsburgh Decathlon Team calls itself Synergy, because it is a joint effort of Carnegie Mellon, the University of Pittsburgh, and The Art Institute of Pittsburgh. The multiple contributions go well beyond the formal partnership, however. For example, a group of ten students from the Technical University of Darmstadt in Germany came to Pittsburgh at a critical point in planning the house. They joined the team in reviewing the various design options and helped choose the direction to go. The Germans later hosted ten members of the Pittsburgh team for a tour of "green" building projects in Europe.

Closer to home, the team took advantage of Pittsburgh's workingman town spirit and worked closely with several labor unions. Ironworkers, carpenters, cement finishers, operating engineers, and others all volunteered time to guide the team in constructing the house. Union apprentices said it helped them to learn how architects think.

"We have tried to push the envelope to show that solar technology can be attractive and fun, to have a home we can be proud of."

—Carnegie Mellon student Jeremy Forsythe

The Pittsburgh Decathlon home literally reaches out to the sun with north and south walls tilting 12 degrees to the south. It also reaches out in terms of materials and mechanical systems. "We wanted the house to be an educational tool, to be a step between current practice and future concept," says Carnegie Mellon architecture student Kevin Wei. For instance, that tilted north wall is made of sheets of polycarbonate, a strong, insulating, translucent plastic, with embedded glass beads. The two-story "service" space it encloses contains all the home's mechanical systems and the bedroom.

To let in natural light and winter sun, the south wall enclosing the "great room" living and office space is all glass, with manually operated shades. The east and west walls are solid insulated panels clad with wood to keep out rain, cold, and unwanted summer sun. The concrete floor of the great room stores heat from both the sun and in-floor radiant heat pipes in the winter and keeps cool in the summer.

The home's reach to the future continues with use of environmentally sustainable materials and LED lighting throughout, as well as with its heating and cooling system. The home design devotes relatively more of its available solar input to water heating than PV, and then uses the solar hot water for domestic hot water, radiant heating, and even for cooling! Absorption chilling is a refrigeration technology that uses heat instead of mechanical compression.

The process of turning design into structure impressed all of the team members. "I barely knew what a hammer was when we started," says Carnegie Mellon architecture student Xiaoxian Huay. "To walk through spaces that we designed—and built ourselves—is pretty amazing."

While looking to the future, the Pittsburgh team also considered some nearer-term practicalities. "In designing the house, we kept the need for easy construction at the Decathlon very much in mind, trying to make it sort of 'plug and play,'" says Carnegie Mellon architecture student Diane Loviglio. "We are also looking forward to bringing it back to Pittsburgh, where it will become home for our environmental education center."

The home's translucent north wall works great for video projections, so don't be surprised to see information about the house displayed on its side. ♦

Team Web site: www.pittsburghsynergy.org
Team contact: Professor Stephen Lee, stevelee@andrew.cmu.edu

115 Virginia Polytechnic Institute and State University

A Soaring New Solar Home Comes Rollin' Down the Highway

Sometimes when you try to solve a transportation problem, you end up refining an exciting new mobile home design. That's what happened to the Virginia Tech team as the design of their 2005 Solar Decathlon home evolved. First, students and faculty selected a winning design from among 50 original entries. Then, they refined it further so they could assemble the home quickly on the National Mall.

Faculty advisor Joe Wheeler says, "We wanted to be able to transport our home to Washington intact so we could spend the five days in D.C. fine-tuning and testing it, rather than reconstructing the building." The result is a unique synthesis of manufactured housing principles and innovative transportation solutions.

The Virginia Tech home on wheels is 15 feet high. It is constructed as a double-drop lowboy trailer with a detachable, gooseneck assembly; this connects it to the tractor for the road trip. It also has a detachable bogey—a set of axles for the tire assembly. "The structure has supporting trusses on either side used during transportation that will eventually fold down and become supports for the outside deck," says student Brian Atwood.

The home's south, east, and west walls are constructed of two panels of very thin translucent polycarbonate material, each filled with aerogel insulation. These translucent walls can be modified during the day by using one or two motorized MechoShades to deploy either an absorptive or reflective shade. This allows the temperature in the wall cavity to be adjusted during the day and provides visual privacy at night.

Movable dampers in the walls allow fresh air inside the wall cavity to be brought into the building or to be exhausted outside. The walls are meant to be as attractive as they are functional. "At night, LED lights on the bottom of the polycarbonate walls illuminate the entire surface," Atwood says.

The 3-foot-wide north wall is made of ThermalSteel structural insulated panels; it houses the electrical and mechanical systems and the kitchen appliances. Clerestories between the walls and the roof allow daylight to illuminate the interior. Faculty advisor Bob Schubert says, "The three polycarbonate walls and the roof form a 'tunable' enclosure system that can be adjusted daily for a particular location or used to adapt to many different climate zones."

The roof is another unique feature. Designed to curve upward in a kind of gesture toward the sun, it is structured like a folded plate with a stressed skin. "We wanted the roof to float over the volume of the house," says student Brett Moss. Atwood adds, "Drawing that fancy curve was a lot easier than actually building it."

"The underside of the roof is extremely important," Moss says. "It's made of a stretched fabric material that reflects daylight from the clerestories down into the house during the day. And at night, it reflects and distributes indirect light from dimmable fluorescent fixtures at the top of the walls."

This soaring solar home, filled with light and color, is sure to delight visitors both during and after the 2005 competition. It is designed to be easy to tour and can serve as a demonstration and "celebration" of solar technologies. After the competition, the home will be displayed in different locations throughout the state. It can also be driven to area high schools for educational purposes, and may be featured in an online continuing education course for architects. ♦

"The main objective of this design is to celebrate solar energy."

—Virginia Tech student Brian Atwood

Team Web site http://vtsolar.arch.vt.edu
Team contact: Professor Robert Schubert, silver@vt.edu

116 Florida International University

Blurring the Boundaries

The Florida Decathlon team's solar house, at first, appears to be a U-shaped house. But look a little deeper, listen a little more carefully to the designers, and the house may appear as though it is a square-shaped house. If this sounds a bit Zen, wait until you hear why the house is named "Engawa."

Engawa is a Japanese term that describes space that is both inside and outside. It is the courtyard or entryway space that takes Florida's house from U to square. The walls separating the interior of the house from the courtyard are glass, so it can be difficult to tell where one space begins or ends. Double-swing glass doors can literally extend the interior space as the courtyard and the living room become one big room. "The interior walls can be changed in any way," says student Robert Perez, project architect. "It's not in a fixed state. The house promotes interactivity."

"Now the outside may come inside and the inside may and does go outside. They are of each other."

—Frank Lloyd Wright

Somewhat unusual for an energy-efficient house, the Florida house is about one-third glass. While the design is appealing to the architecture students on the team, it's the kind of thing that gives an engineering student fits. In the usual wrangling between form and function, the students accepted the challenge to both keep the glass and keep the heat out. Operable windows and the use of blinds are a return to the historical ways of heating and cooling, according to student Diane Marshall, the team's outreach and communications director.

Some of the glass is in the form of PV-integrated windows, which the team will also use as a projection surface. "Usually the house is open and airy, but you can make it dark, if, say you want to project a movie on to the PV window," says Perez.

Marshall says the Engawa philosophy of removing boundaries extends beyond the design and into the team's interactions with each other and with the community. The Florida team reflects the diversity of Miami. Students are from different ethnic, cultural, and religious backgrounds and range from first-year students to Ph.D. candidates. Team members come from four disciplines: architecture, engineering, journalism and mass communications, and creative writing. "People in different fields see things differently. This is what makes the house strong, because we did come to a consensus," says Marshall.

The Florida team has successfully forged relationships with local government, receiving a cash contribution from Miami Dade County via Commissioner Katy Sorenson. Also, the team involved Miami Dade schools through a summer camp for high school kids to attend Solar Decathlon-related classes.

The Florida team's community outreach efforts have been somewhat in competition with local fundraising efforts for families and businesses that sustained hurricane damage from the four hurricanes that swept through Florida last year. The construction industry is experiencing a boon as a result of the hurricane damage, as well, which may have benefited the Decathlon house, which has received generous in-kind contributions from builders. As one might expect, all materials in the Florida house are hurricane compliant. ♦

Team Web site: http://htd.fiu.edu/fiusolar
Team contact: Professor Yong X. Tao, Ph.D, taoy@fiu.edu

117 Universidad Politécnica de Madrid

A House for All People

Inclusion seems to be the main theme of the entry for the Universidad Politécnica de Madrid. It starts with the team, nearly 40 students from many different academic departments, all of whom will make the trip to Washington, D.C., for the Decathlon. The design effort began with an ideas competition, and elements of the top four designs were all incorporated into the house.

The inclusion theme continues with accessibility for the home occupants. Although the Madrid home has its share of high technology, the primary design objectives were to make it attractive and comfortable, so that it would appeal to anyone. You shouldn't have to be in love with gadgets to enjoy this flexible Mediterranean-style home with a great interior-exterior connection. Many of the controls are designed to work automatically. "Designing those controls, understanding when the various space conditioning and lighting systems should operate, and connecting sensors to them to allow them to operate automatically, was the most exciting part of the project," says engineering student Álvaro Gutiérrez.

"Ownership" of the project was also inclusive. Although all the team members are Madrid Polytech students, all of Europe seems to have adopted the team. Advance construction of the home in Madrid was widely covered by the media, including more than 40 newspaper stories, 4 hours of radio interviews, and 15 television appearances. The house was the most visited exhibit at the Real Estate Fair of Madrid in May. It was also the centerpiece of a course for 20 students from universities throughout Europe during the summer. "Being the only European entry to the Solar Decathlon is quite an honor," says faculty advisor and telecommunications engineering professor Estefanía Caamaño-Martin.

The most distinctive feature of the Madrid Decathlon home is its versatility. A set of moveable walls allows it to be divided into three (bedroom/office, dining room/kitchen, living room) or five spaces, or to be totally open. The living room also moves to create an internal patio: this purely Spanish courtyard configuration enhances ventilation and also makes a very enjoyable living space. "We call the house the 'magic box,'" says architecture student Sofía Melero.

When unfolded in the inside, the moveable walls also add efficient insulation. "Effective use of insulation materials is a key feature of the home," says architecture student María J. Uzquiano. They have a special window system on the south wall to capture winter sun—and add to the home's feel of interior/exterior connection. The east and west walls have attractive clay tile exteriors to hold in heat in the winter and keep it out in the summer. The north wall has all of the home's batteries, inverters, water tanks, and other technical equipment.

The home uses phase-change gel materials under the floor to preheat or precool intake air. Four different kinds of frameless solar modules (some student-designed) provide both electricity and architectural functionality and attractiveness to the house design. Rainwater is captured for watering the green roof plants. Water for domestic use is heated by an evacuated tube collector. And, as the shower and washing machine water drains, heat is captured and used to preheat incoming hot water.

Although fully constructed in Europe, the home had to be disassembled and packaged in eight containers for transport by ship to Washington, D.C., for the Decathlon—but a large and capable team is here to reassemble it. ♦

"The idea for us was to build a house that was efficient and automatic, but more importantly to integrate the technology in a way that is attractive and comfortable."

—Madrid student José Miguel Gómez Osuna

Team Web site: www.solardecathlon.upm.es
Team contact: Professor Estefanía Caamaño-Martin, estefan@ies-def.upm.es

119 New York Institute of Technology

Illustration by Michael Viggiano (design), Richard Merlau (art), and Jeff Weiner (photography).

The Complete Package

We've all seen it happen. You give a child a fantastic gift and later find the kid playing gleefully with the packing box. In a similar vein, student decathletes from the New York Institute of Technology (NYIT) became intrigued with the idea of packages—and the possibilities therein. Such was their interest that they eventually decided to use a shipping container as an integral part of their Solar Decathlon house, named "Green Machine/Blue Space."

"Green Machine/Blue Space" describes the two main house structures, which are joined by an enclosed sunspace. The Green Machine structure (the shipping container) contains most of the home's mechanical systems, as well as the kitchen, bathroom, and a roof garden for growing food and collecting rainwater. The Blue Space houses areas for sleeping, relaxing, and working.

"We view this house as extraordinary. We're going to demonstrate that a home's power system can achieve sustainability and comfort, leading the way toward a cleaner environment, energy independence, and better living."

—NYIT student David Schieren

Both beauty and functionality were on the minds of these student designers. "When design responds to the necessities of life, beauty is inevitable," says architecture student Heather Korb. Early in the process, they conducted a design charrette with four student design teams. One design was chosen, but they also carefully drew on the best elements from each of the teams.

"Our design philosophy is to live in harmony with the Earth," says Korb. That's why the soybean insulation, wheat straw building panels, and recycled rainwater are important.

And then there's the hydrogen power system. "From the beginning of this project, we decided to do something very special using a hydrogen fuel cell for energy storage," says energy management student David Schieren. Electricity from a roof-mounted PV system is used to separate water into hydrogen and oxygen through electrolysis; the hydrogen is collected and stored and later used to power a fuel cell. The fuel cell recombines hydrogen with oxygen to produce a household supply of electricity. This system replaces the batteries that are commonly used with stand-alone PV systems to store excess energy. The electric system is very dynamic and allows the monitoring of numerous household circuits. During the competition, this will allow the NYIT team to carefully direct power to the places where it can best be used.

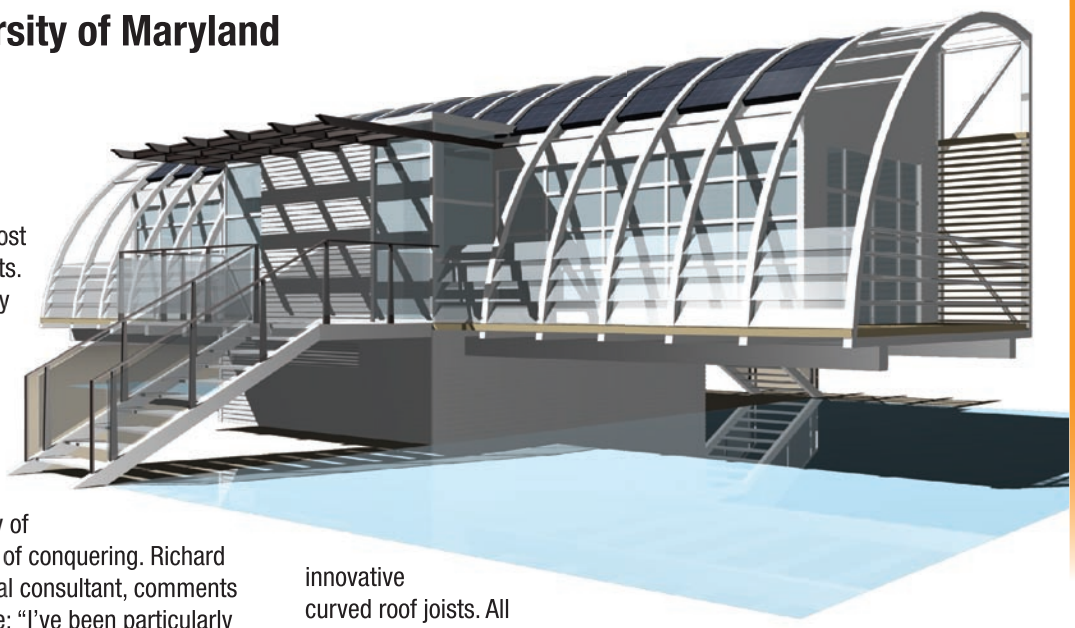
These NYIT students took on the role of trailblazers, knowing there would be many challenges involved in this untested approach. They consulted with a number of organizations and individuals, from utility companies to electrolyzer manufacturers, to their local fire marshal. But the students feel the goal is worth the effort and the risk. "We're taking energy from the sun to produce hydrogen from water, and turning that hydrogen back into water to produce electricity. It's a clean, renewable, and elegant cycle. We're doing something special—we've internalized this and it shows," says Schieren.

This desire to do something innovative carried over to the interior of the house, where a relaxing living environment is the goal. "We've created 'micro-climates' of comfort inside the house," says interior design student Mary Merges. There is lighting, heat, and special furniture for individual areas that eliminates the need to involve the entire house.

Seemingly, this team has thought of everything. Visitors will be offered a handheld computer, which will provide a content-rich, multimedia animation presentation describing particular features of the house. "We are trying to deliver a total educational experience to the competition visitor," says communication arts student Lawrence Yu. ♦

Web site: http://iris.nyit.edu/solardecathlon
Team contact: Professor Michele Bertomen, mcb@brooklynarchitects.com

120 University of Maryland



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Teamwork Rises to the Occasion

Learning how to make the most of diverse interests and talents. Delving into cross-disciplinary issues that they'll face in the workplace. Finding ways to keep people motivated on a demanding project spanning more than 2 years … these are but a few of the challenges that the University of Maryland students are proud of conquering. Richard Magnani, the team's structural consultant, comments on their drive and persistence: "I've been particularly impressed with the resourcefulness of these young people. They started out with a project they had no idea how to do, and they're finding the resources, manpower, and money to make it happen."

This team—composed of engineering, architecture, business, landscape architecture, art, and journalism students—emphasized student leadership from the very beginning when they developed and ratified a team constitution to serve as a framework for the project's membership and structure. Next, they held a design competition and studio within the university's School of Architecture, Preservation, and Planning, in which students evaluated a number of draft designs and arrived at a specific architectural character for their house. Maryland student Najahyia Chinchilla sums up their design approach: "To us, sustainability is not a product to be added onto a house, but a way of living. Since childhood, we've all been aware of recycling and other ways to reduce our impact on the planet." She adds that watching a concept transform into a design and then into a material object has been very gratifying.

Student Luming Lee, the architect of the winning design, originally envisioned a house "floating" over a field of water, describing it as "anchored to the earth, yet touching it lightly." To marry that vision with the practicality of transporting the house to the National Mall, the students chose to rest the house on a field of stone. Through their iterative design process, they arrived at a final design with "very clean and simple" lines.

The home's PV system, made up of 51 charcoal-gray, 175-watt, BP Solar 4175B panels, adds to its aesthetic appeal. Student Tom Serra says "We really believe in this technology and made a statement—that the panels are beautiful in their own right—by integrating the panels into the home's design, not hiding them." The roof also incorporates innovative curved roof joists. All walls except the south wall, which is mostly windows, are stick frame construction with an innovative, environmentally sensitive blow-fill insulation.

Inside, a radiant heating system gently warms the concrete floors, which also generate passive heat by absorbing the sunlight streaming through the home's large windows. To ensure comfort in the tight building envelope the competition requires, the team is using an energy recovery ventilator (ERV) in combination with a small central cooling unit. ERVs exchange stale interior air for fresh outdoor air while preserving temperature and humidity levels. Serra points out a related team challenge: "finding a cooling unit that was small enough; most air-conditioning units are sized for larger homes."

And in keeping with their determination to meet all challenges, six team members had to get creative when they arrived in Orlando for the January 2005 International Builder's Show. Finding that a reservations mix-up had left only one hotel room available, these students simply made it work— by "managing" their stay as just another team project. ♦

It's been really exciting to watch the team rise to every occasion and accomplish all that needs to get done on a project of this enormous scope. We'll never again be part of a project quite like this, and when we're done with the competition, we feel we'll be able to handle pretty much anything.

—Maryland student Rob Murray

Team Web site: http://solarhouse.umd.edu/page.php?id=65
Team contact: Dr. Kaye L. Brubaker, klbrubak@eng.umd.edu

U.S. Department of Energy
Energy Efficiency and Renewable Energy

The U.S. Department of Energy Office of Energy Efficiency and Renewable Energy (EERE), working in partnership with industry and academia, consists of 11 research, development, and deployment programs. Supported by six regional field offices and one national laboratory—the National Renewable Energy Laboratory in Golden, Colorado—EERE partners with industry and academia, sponsoring technological innovation in the fields of energy efficiency and renewable energy.

EERE supports two distinct branches of research and development—both of which are represented in the office's name.

The first branch includes renewable energy sources: solar, hydrogen, wind, biomass, and geothermal. Developing America's abundant renewable energy resources will decrease our dependence on foreign fuel and strengthen our national security. Another important benefit is that renewable energy technologies produce fewer greenhouse gas emissions and have less impact on the environment. The Solar Decathlon itself is a testament to DOE's ongoing efforts to make solar power a larger part of America's energy portfolio.

The second branch of EERE includes technologies that make buildings, transportation, and appliances more energy efficient, and make power transmission more reliable. Many examples of these are on display here at the Solar Decathlon and incorporated into the homes constructed by the student teams. By using less energy, American families save on their utility bills without sacrificing comfort.

The work of EERE also includes weatherizing the homes of American families in need, supplementing state energy programs, and promoting energy efficiency in federal government facilities and installations.

The Department of Energy mission lies at the cutting edge of science and social responsibility. By creating beneficial energy technologies and making use of "free" energy sources such as wind and sun and the Earth's own warmth, we can provide less expensive, more reliable, and more abundant energy for every family in the United States.

Welcome to the Solar Decathlon. Tour the homes, enjoy your visit, ask questions … and think energy! ♦

The DOE Building America/ Building Science Consortium approach to zero energy homes is based on this premise: A home that consumes no more energy that its renewable energy systems can produce must excel in all aspects of home performance.
Credit: Building Science Corporation/PIX13543

The 21st Century Performance home is in Livermore, California. Built by Centex and The Davis Energy Group, in partnership with DOE, the home combines state-of-the-art, energy-efficient construction with solar hot water and solar-electric systems to significantly reduce the amount of energy required from the local utility.
Credit: The Stone Group/PIX12245

For competition purposes, the Solar Decathlon homes are small, but larger homes, and even luxury homes, can be energy efficient, solar powered, and based on Earth-friendly materials. New homes in Pardee Home's Santa Barbara Community in San Diego, California, are highly energy efficient and may be purchased with a PV trellis, which uses the sun's energy to provide some of the home's electricity needs. *Credit: Pardee Homes/PIX12253*

National Renewable Energy Laboratory

The U.S. Department of Energy National Renewable Energy Laboratory (NREL) welcomes the Solar Decathletes who have come from around the country and around the world to participate in this unique and important competition.

NREL is honored to be a sponsor of the 2005 Solar Decathlon. It's a natural role for us—we're DOE's primary laboratory for renewable energy and energy efficiency research and development.

Our laboratory in Golden, Colorado, is home to the National Center for Photovoltaics, where world-class scientists explore new methods and materials for turning sunlight into electricity. Researchers in the NREL Center for Buildings and Thermal Systems likewise have forged a leadership role in energy-efficient building design.

NREL works to nurture a wide range of technologies that benefit America's economy, national security, and environment. Our research portfolio extends beyond solar and building design, into wind power, biomass power, biofuels, geothermal energy, hydrogen, fuel cells, distributed power, advanced vehicle design, and basic energy science.

Research into renewable energy has never been more critical than it is right now. Resources such as sunlight, wind, and biomass can be put to work producing electricity and fuels with little—if any—pollution. The United States imports about 60% of its petroleum, so there is a pressing need to find alternatives to help offset imported oil.

Since our Laboratory got its start as the Solar Energy Research Institute in 1977, we have successfully developed materials and technologies that have been instrumental in reducing the cost of solar electricity by more than 80%. In the buildings arena, NREL has developed software that helps architects design cost-effective, energy-efficient structures and technologies such as "smart" windows that darken in bright sunlight to help keep buildings cool.

By combining energy efficiency with renewable energy technologies, we are working with the nation's homebuilders to advance the concept of "net zero energy buildings"—structures that produce as much energy as they use on an annual basis.

The Solar Decathlon is a training ground for the architects and engineers who will help the nation shape its energy and architectural future. We at NREL join with our fellow Solar Decathlon sponsors in wishing these student teams continued success—throughout the competition they face now, and in meeting the exciting challenges that await them tomorrow.

NREL is a U.S. Department of Energy laboratory managed by Midwest Research Institute of Kansas City, Missouri, and Battelle of Columbus, Ohio. ♦

Young students learn about solar energy at NREL.
Credit: NREL/PIX06305

NREL researchers use state-of-the-art laboratories and outdoor test beds to measure the performance and reliability of solar-electric systems.
Credit: NREL/PIX10751

Visitors of all ages can take a self-guided tour through the interactive exhibit hall at NREL's Visitors Center (foreground) and learn about energy from the sun, wind, biomass, and other sources of renewable energy. The Solar Energy Research Facility is shown in the distance. *Credit: NREL/PIX12598*

The American Institute of Architects

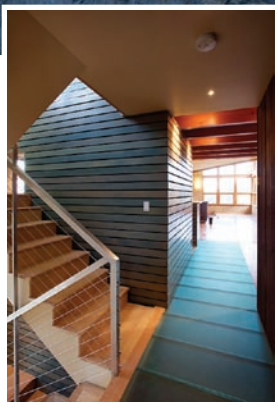
The American Institute of Architects (AIA), with more than 75,000 members across the nation and globe, is the voice of the architectural profession. We are dedicated to advancing the value of architectural services and to collaborating with others to improve the quality of the built environment. The AIA, started in 1857, will soon celebrate its 150th anniversary, a testament to our longstanding commitment to serve the public good through the profession. With more than 30 Knowledge Communities—professional interest areas among the members—the AIA is working to strengthen the level of understanding among both professionals and the public at large regarding a wide range of issues critical to the environment. Included among these important areas of focus are those of energy and sustainability.

The AIA has for many years worked actively with the U.S. Department of Energy (DOE) on a range of important energy-related research and programs. A Memorandum of Understanding between the two organizations, developed a few years ago, exemplifies this intention for strong collaboration. The Solar Decathlon, now in its second iteration, stands out as an excellent program demonstrating the critical connection between energy conservation and building design. In particular, the "house" as a building type provides a powerful means for exploring innovative design features, sustainable strategies, and new technologies toward increasing energy savings and efficiency for homeowners. We of the AIA are very proud to be a sponsor of this innovative event linking schools of architecture to members of the architectural profession through the leadership of DOE.

Shown on this page are some recipients of the 2005 AIA Committee on the Environment Green Project Awards, which recognize projects that address significant environmental challenges with designs that integrate architecture, technology, and natural systems. ♦

Austin Resource Center for the Homeless, Austin, Texas
Designed by LZT Architects

This meeting place and support center helps people transition out of homelessness through its many programs. There's preferred parking for carpools, storage space for bicycles, and a fueling station for an electric car. A 13,000-gallon rainwater collection system supplements the building's water supply. A solar hot water system preheats water for the showers, and a PV array supplements electricity usage.
Credit: Thomas McConnell Photography



Eastern Sierra Residence, Gardnerville, Nevada
Designed by Arkin Tilt Architects

Working with the slope, orientation, and dramatic views of a building site in the Sierra Nevada Mountains, the design team structured the house around a courtyard oasis shaded by a PV array. Solar hot water panels located at the edge of the terrace feed a heating system and provide domestic hot water. A variety of natural and durable materials harmonize with the landscape.
Credit: Edward Caldwell Photography

Pittsburgh Glass Center, Pittsburgh, Pennsylvania
Designed by Davis Gardner Gannon Pope Architecture/Bruce Lindsey

This building uses daylighting and extensive natural ventilation, as air-conditioning is prohibitively expensive and prohibitive for a glassmaking environment. Heat from the glassmaking equipment is recovered. Thermal mass inside the building moderates temperature swings.
Credit: Ed Masseray/DGGP Architecture

National Association of Home Builders

The National Association of Home Builders (NAHB) is an enthusiastic supporter of the innovative, environmentally friendly ideals and building technologies promoted through the Solar Decathlon. We are also pleased to be the sponsor of the program's Energy Efficiency Award, an award that rates the most energy-efficient home using the Home Energy Rating System (HERS) as its metric. Builders throughout the country use HERS to show compliance with above-code energy efficiency programs such as Energy Star.

NAHB has promoted energy-efficient building techniques for years; in fact, when energy prices soared in the late 1970s, we were the first organization to step forward and introduce voluntary energy guidelines for new residential construction. Over the next decade, the energy efficiency of new housing about doubled.

NAHB took those efforts a step further in January by introducing voluntary Model Green Home Building Guidelines. Our guidelines are designed to help mainstream builders incorporate environmental practices into every phase of the home-building process, while still placing a premium on affordability. These guidelines encourage many of the building techniques you'll see in the Solar Decathlon houses on the National Mall.

Although energy efficiency is a key component of our guidelines, there is also an emphasis on careful lot planning and design, using building resources effectively, conserving water, promoting healthy indoor air quality, and educating new homeowners on how to best use the green features of their new house.

Our members—all 220,000 of them—will construct about 80% of the more than 1.84 million homes projected to be built in the United States this year. We are committed to advancing energy-efficient building techniques and are excited about our involvement in the 2005 Solar Decathlon. ♦

This home features an attractive solar trellis next to the rear courtyard oasis. Built by Pardee Homes of San Diego, California, the home was a 2005 EnergyValue Housing Award gold winner in the Production Home, Moderate Climate category. All homes in this subdivision are highly efficient and have 2.4-kW PV systems. *Credit: NAHB Research Center*

A Built Green home in Denver, Colorado. Built Green Colorado has perhaps the largest participation of builders of any green builder program in the country. *Credit: Built Green Colorado/PIX09551*

With this home, McStain Neighborhoods of Loveland, Colorado, became a 2005 EnergyValue Housing Award gold winner in the Custom Home, Cold Climate category. Judges were impressed with McStain's use of a solar-assisted space and water heating system and the overall marketability of the home. *Credit: NAHB Research Center*

BP

BP is proud again to be a major sponsor of the Solar Decathlon. The Solar Decathlon offers BP an outstanding opportunity to provide support for some of the finest academic teams exploring today's and tomorrow's practical application of solar power.

Sponsorship of the Decathlon is consistent with BP's commitment to making solar power a more affordable and accessible part of everyday life. With solar electricity increasingly used by home and business owners to reduce electric bills, the solutions reached by the students often contain many economical options for the marketplace today.

BP is one of the world's leading energy companies and a global leader in the development of renewable fuels, including solar electricity. In addition to being one of the largest manufacturers of solar modules, BP is the world's largest private sector consumer of solar power, using solar energy in our facilities and offshore platforms. In remote areas such as the Philippines, BP Solar is bringing solar power to more than 400,000 residents in 150 remote villages. Throughout Europe and the Americas, BP Solar offers a clean energy option to supplement or replace utility power.

At the 2002 Solar Decathlon, BP provided the PV power system for the exhibit structure shown here ("below" the U.S. Capitol).
Credit: BP

Credit: BP

Credit: BP

These activities, together with the Decathlon, exemplify the values that drive BP—innovation, high-quality performance, a progressive and better way of doing things, and a commitment to environmental and community leadership. We invest in science, education, and technology to help achieve a sustainable future and brighter tomorrow.

BP and The Home Depot were both among the sponsors of the first Solar Decathlon in 2002. Through a partnership with The Home Depot in more than 200 stores in California, New Jersey, and New York, BP Solar Home Solutions® are now available to enable a wide range of customers to obtain complete solar home power systems.

As in 2002, BP Solar again is offering university teams discounted solar materials and technological advice. This year BP Solar is holding a special contest for the students to design a home with an integrated roof for new home construction. ♦

DIY Network

DIY Network first recognized the Solar Decathlon in 2002, the event's inaugural year. DIY producers joined the Department of Energy and the Solar Decathlon students on the National Mall in Washington, D.C., and produced a one-hour television special highlighting the event. Network television crews documented all phases of the competition and captured the students' enthusiasm and ingenuity as they set out to design, build, and operate solar-powered homes.

DIY, which stands for do it yourself, is proud to return to the Mall as a 2005 Solar Decathlon sponsor and will produce a new one-hour special dedicated to the second Solar Decathlon competition. The program will debut on the network in the fall of 2005 and will showcase the teams and the solar solutions they come up with for more energy-efficient living.

DIY's companion Web site, DIYnetwork.com, will feature video from this year's event and an online voting component where site visitors can choose their favorite team design. The team with the most votes will be awarded the DIYnetwork.com Voter's Choice Award. Other awards DIY will present at the Solar Decathlon victory reception are DIY's Best Built Home Award and DIY's Best Designed Kitchen.

Part of DIY's mission is to inspire and educate homeowners looking for today's cutting-edge solutions for better homes. The Solar Decathlon is a perfect event to share with DIY viewers because it shows firsthand how renewable energy and energy efficiency technologies can be applied to an average home.

In addition to the existing one-hour special that airs regularly on the network (titled *Solar Decathlon*), DIY airs such programs as *Home IQ*, *Home Energy Savings*, and *Solar Solutions*, further educating homeowners about energy conservation and efficiency at home. *Solar Solutions* was produced as a result of DIY's involvement with the 2002 Solar Decathlon and contains solar technology and design ideas from the event and basic solar projects available to homeowners.

DIY focuses on a broad range of programming categories, including home building and home improvement; autos and boats; crafts; gardening; hobbies; living; and woodworking. The network's programs and experts answer the most sought-after do-it-yourself questions, and offer creative projects and solutions to homeowners. ♦

As this series of photos shows, DIY Network crews documented the students assembling their houses on the National Mall during the 2002 Solar Decathlon. The footage was used in a one-hour television special. This year, DIY will again produce a television special and will also make video from the event available on DIYnetwork.com. *Credit: Photos ®2003, DIY network*

Sprint Nextel

Sprint Nextel Corporation is honored and excited to be a part of the 2005 Solar Decathlon. Innovation is a defining characteristic of our products, solutions, and service. The innovation demonstrated by participants of the Solar Decathlon taps into another important goal of ours—preserving the environment. From researching renewable power to recycling old cell phones, Sprint Nextel demonstrates its commitment to the environment everyday.

In our daily business activities, we actively pursue the use of renewable power technologies to better serve our customers. Telecommunications facilities rely heavily on commercial power to run their networks. However, overhead utility lines and outdoor substations are subject to both human and natural forces (e.g., tornadoes, lightning), which can shut down telecommunications. For this reason, back-up power sources are needed. The most commonly used forms of back-up power, such as lead-acid batteries and diesel generators, have drawbacks—noise, leakage, or polluting exhaust.

By donating your old wireless phone to Sprint Project Connect, you can help students around the world. All proceeds from resale of the phones are channeled to education programs and other worthy causes. *Credit: Sprint Nextel Corporation*

Sprint Nextel has researched several alternative power technologies that provide many benefits to the environment, including significantly reduced noise levels and pollutants. One of these technologies, fuel cells, for example, release no pollutants. Their only exhaust is drinkable water, which is endorsed by the U.S. Environmental Protection Agency.

Sprint Nextel is not only interested in these alternative power technologies for the environmental quality they bring, but because these technologies can be combined with others to increase the level of network reliability. As the industry continues its trend toward wireless applications, uninterrupted telecom service will take on more and more importance. Our goal is to provide the best quality network through cleaner, more efficient technology.

Sprint Project Connect

Did you know that you can help the environment and our Earth by donating your old wireless phone to Sprint Project Connect? There are about 55 million unused wireless phones sitting idle in peoples' homes. Instead of letting these phones pollute our landfills, donate them and make a difference! Many phones donated through Sprint Project Connect will be resold and provide value to those in need. Older, obsolete models are recycled in an environmentally sound manner.

A portion of the net proceeds (from resale) generated through Sprint Project Connect donations benefit education programs supported through the Sprint Foundation. The remaining funds support the Wireless Foundation, a nonprofit association that puts wireless technology to work addressing the challenges of society. *Sprint receives no portion of the money raised, and donations may be tax deductible*. Phones are accepted at Sprint Store locations nationwide. ♦

Thanks to So Many

The Solar Decathlon would not be possible without the generous support of so many people. We are grateful to the sponsors listed in the preceding pages—and to those listed below. We also acknowledge the volunteers, technical experts, and in-kind contributors whose support is vital to making the Solar Decathlon an enriching experience for the students and spectators alike.

The Home Depot

www.homedepot.com

The Home Depot, which also supported the 2002 Solar Decathlon, provided generous gift cards to each of the 16 teams and to the overall event. This was of particular value to the teams, because they could pick and choose what they needed at their local Home Depot stores.

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)

www.ashrae.org

ASHRAE generously hosted a student reception to recognize and honor the hard work performed by all the student teams.

The National Fire Protection Agency (NFPA)

www.nfpa.org

NFPA donated 25 copies of the *National Electric Code Handbook CD-ROM, 2002 Edition,* for use by the students and organizers.

Maui Solar Energy Software Corporation

www.mauisolarsoftware.com

Maui Solar gave substantial discounts on 25 copies of the *Solar Design Studio Suite*.

International Code Council

www.iccsafe.org

ICC generously discounted 25 copies of the *2003 International Codes-The Complete Collection-Version 2.0*.

Home Power

www.homepower.com

Home Power magazine provided free advertising space and is contributing a feature article about the event.

U.S. Department of Agriculture, Beltsville Agricultural Research Center (BARC)

www.ba.ars.usda.gov/research

BARC donated and delivered B100 (100% biodiesel) to the National Mall to run a biodiesel generator that's used when the sun is not shining.

Andersen Windows

www.andersenwindows.com

Andersen contributed windows for the "Anatomy of a House" exhibit.

Insulspan

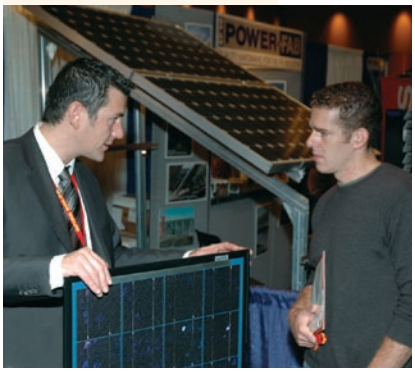
www.insulspan.com

Insulpan contributed structural insulated panels for the "Anatomy of a House" exhibit.

Three Steps to Powering Your Own Home or Business with Solar Energy

Solar Power 2005 is sponsored by the Solar Electric Power Association and the Solar Energy Industries Association.

- Step 1: Tour the Solar Decathlon homes to learn about solar energy technologies.
- Step 2: Visit the Solar Power Expo at the Hyatt Regency Capitol Hill to talk with representatives of companies that manufacture, distribute, and install solar energy systems.
- Step 3: Go online to the Solar Decathlon Web site (www.solardecathlon.org) and click on the Product Directory to find detailed information about the products used in each of the team homes.



Credit: Solar Electric Power Association

Solar Power 2005 Expo

What: Sixty companies exhibiting solar products and services. Admission is free!

When: Friday, October 7, 11:00 a.m.–5:30 p.m.
Saturday, October 8, 10:00 a.m.–5:00 p.m.
Sunday, October 9, 10:00 a.m.–5:00 p.m.

Where: Hyatt Regency Capitol Hill
400 New Jersey Ave., NW
Washington, D.C.

How: Take the free shuttle or a 20-minute walk (visit the Solar Decathlon information tent for a map or to catch the shuttle).

Product Directory

What: A directory of the products used by each team in the Solar Decathlon, including solar, appliances, windows, lighting, and many other product categories. The information in the directory can be sorted by team, product category, manufacturer, and keyword.

When: Available any time, including after the Solar Decathlon ends.

Where: www.solardecathlon.org (click on Product Directory)

For More Information

DOE Office of Energy Efficiency and Renewable Energy (EERE)
Information about all renewable and energy efficiency technologies.
www.eere.energy.gov

EERE Information Center
Answers questions on EERE products, services, and 11 technology programs.
www.eere.energy.gov/informationcenter

DOE Solar Energy Technologies Program
Covers photovoltaics, solar heating and lighting, and concentrating solar power.
www.eere.energy.gov/solar

DOE Building Technologies Program
Covers high-performance buildings and other solar building technologies.
www.eere.energy.gov/buildings

Consumer Energy Information
A consumer-oriented guide to energy efficiency and renewable energy, including the popular Energy Savers booklet.
www.eere.energy.gov/consumerinfo

Energy Star
Contains home-improvement tips and a locator map for purchasing Energy-Star labeled products.
www.energystar.gov

Efficient Windows
A primer on windows and a guide to selecting energy-efficient windows for specific regions.
www.efficientwindows.org

Photovoltaics
An introduction to photovoltaics, also called PV or solar electricity, with a section for consumers.
www.eere.energy.gov/solar/photovoltaics.html

Database of State Incentives for Renewable Energy (DSIRE)
Includes a guide to state, local, utility, and selected federal incentives that promote renewable energy.
www.dsireusa.org

State Energy Alternatives
Contains state-specific information, including incentives for renewable energy technologies.
www.eere.energy.gov/state_energy

For daily updates and photos, feature stories, general information, and competition results, visit the Solar Decathlon Web site at www.solardecathlon.org

Visit Our Sponsors on the Web

U.S. Department of Energy
www.energy.gov

National Renewable Energy Laboratory
www.nrel.gov

American Institute of Architects
www.aia.org

National Association of Home Builders
www.nahb.org

BP
www.bp.com or www.bpsolar.com

DIY Network
www.DIYnetwork.com

Sprint Nextel
www.sprint.com

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