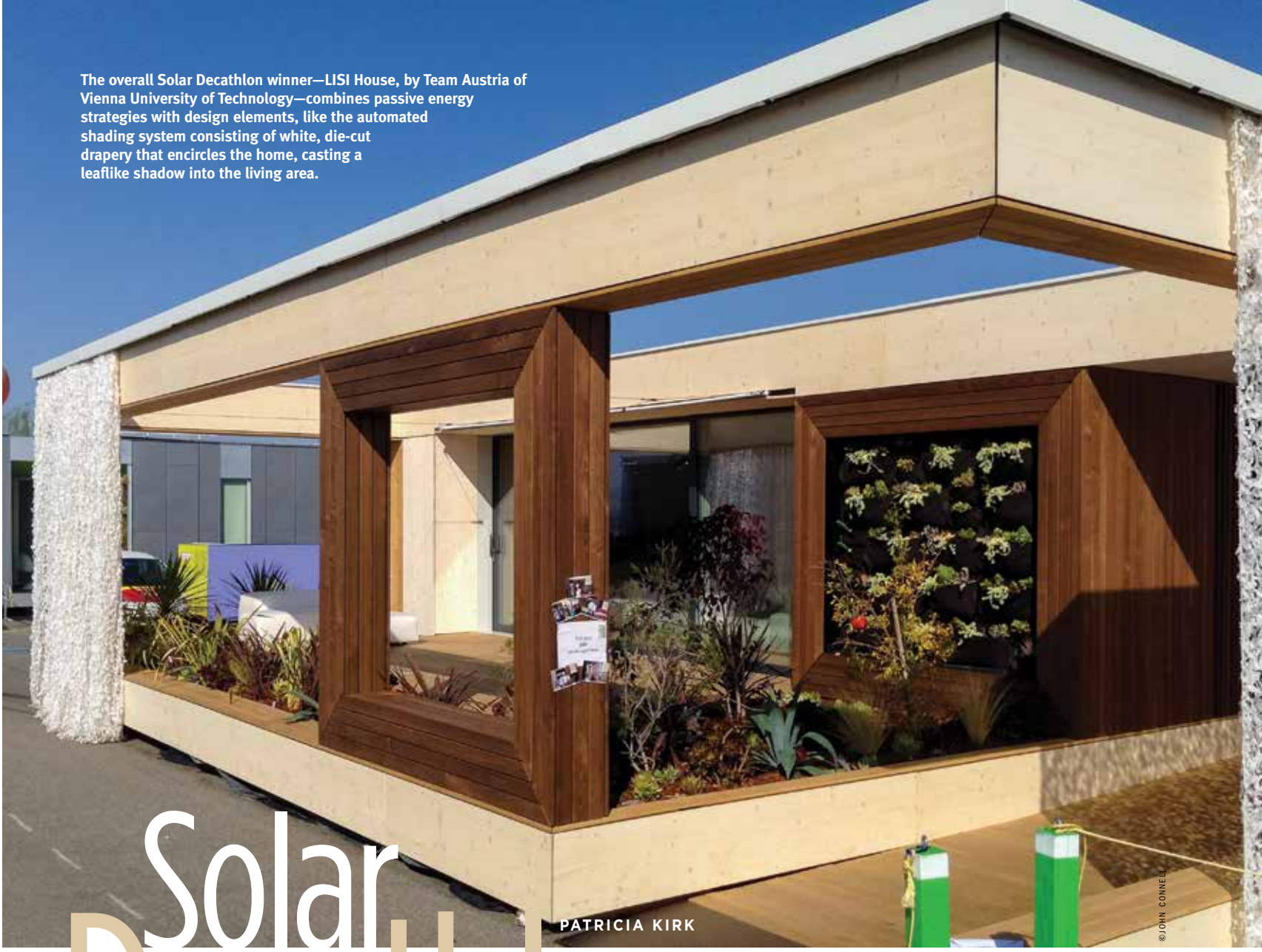


The overall Solar Decathlon winner—LISI House, by Team Austria of Vienna University of Technology—combines passive energy strategies with design elements, like the automated shading system consisting of white, die-cut drapery that encircles the home, casting a leaflike shadow into the living area.

Solar Decathlon 2013

University-led teams create a cutting-edge solar village in Orange County, California.

PATRICIA KIRK

When international teams of university students recently constructed a solar village, their creations predictably revealed innovative approaches to designing extremely high-performance homes. But the dwellings that the teams crafted also reflect and support the lifestyle, values—and financial means—of their generation Y creators.

The U.S. Department of Energy Solar Decathlon was held October 3 to 13 at Orange County Great Park in Irvine, California—the first time the biennial event was held outside the nation's capital—and attracted nearly 64,000 visitors, according to an estimate by the city of Irvine. The Solar Decathlon franchise is expanding, with a version having been held in Datong, China, in August 2013, and Solar Decathlon Europe

scheduled for June 27 through July 14, 2014, in Versailles, France.

The competition includes ten juried or measured contests, with up to 100 points awarded for each category. The categories include architecture, market appeal, engineering, communications, affordability, comfort zone, hot water, appliances, home entertainment, and energy balance. The Solar Decathlon overall winner is the project that accumulates the highest score across the ten contests.

Phyllis Alzamora, executive director of ULI's Orange County–Inland Empire District Council, said the event was a "wonderful learning laboratory" for sustainable solutions.

The teams applied a holistic methodology to achieve cutting-edge, sustainable designs that integrate energy solutions with attractive design elements to create flexible, functional living spaces that support a relaxed, informal, healthy lifestyle.

Jacob Atella, senior director of sustainability for KB Home, a Los Angeles–based homebuilder, noted that "every one [of the projects] celebrates the indoor-outdoor connection." The floor plans are flexible, adjustable, and open, maximizing use of space by combining kitchen, dining room, and living room into one large, open living area, he noted. Living areas open onto large outdoor spaces, connecting occupants with nature and expanding living space to accommodate entertaining. Atella is vice chair of the ULI Orange County–Inland Empire Sustainable Communities Initiative Council.

Top left: The University of West Virginia team created a living wall and greenhouse on the sunny side of PEAK that collects heat from the sun and releases it into the living area when the interior greenhouse doors are opened.

Top right: Third-place decathlon winner—AIR House, by the Czech Technical University team—has a passive solar canopy consisting of wood slats that cover the entire building and southern-facing wall and help eliminate the need for air conditioning.

Above: Team Texas, a collaboration of the University of Texas at El Paso and El Paso Community College, designed the ADAPT house for environmentally conscious urban dwellers. It has adaptable flex spaces and a modular structure ideal for placement in an existing urban neighborhood.

Right: DALE, a collaboration of the Southern California Institute of Architecture and California Institute of Technology, can triple its size at the push of a button.

The interior of LISI (Living Inspired by Sustainable Innovation) House by Team Austria of Vienna University of Technology—this year's overall winner—measures only about 700 square feet (65 sq m), but it lives larger with an open floor plan and plenty of storage integrated into walls. The interior wood floors continue outside, creating decks on both sides of the house to expand the living area. During the summer, double-paned, floor-to-ceiling glass doors can disappear into walls, fusing the interior living area with the outdoors.

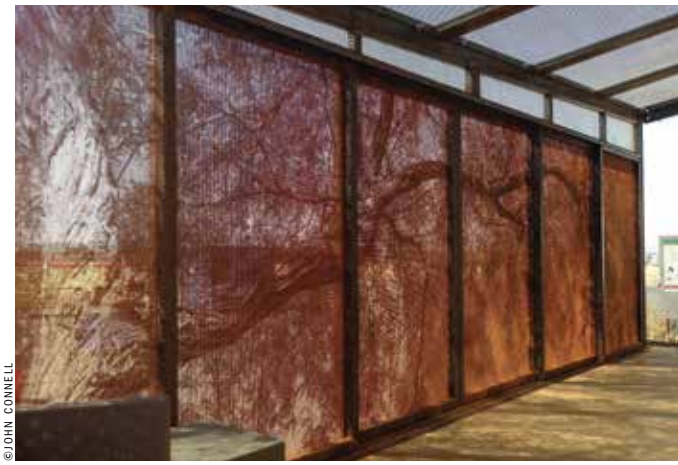
To achieve the goal of creating homes that produce as much energy as they use, the 19 multidisciplinary university-led teams from four nations—the United States, Canada, Austria, and the Czech Republic—collaborated to design residences that use a mix of passive and active energy solutions to achieve net-zero energy efficiency—consuming no more, and preferably less, energy than they produce.

Passive energy solutions are of great interest to Judi Schweitzer, principal and chief sustainability adviser at Schweitzer+Associates, a sustainable real estate consultancy based in Lake Forest, California. After touring the exhibits, she noted, "These kinds of solutions tap into nature's income"—taking advantage of what the climate offers. "Builders have known for years how to use passive strategies to improve energy efficiency, but for some reason there seems to be resistance in the marketplace to apply them to capture natural capital," Schweitzer said.

The fluxHome design by the University of Southern California (USC), for example, takes advantage of southern California's climate, said USC team member Evyn Larson, with openings situated to capture passive ventilation from the southwestern breeze. "The skylight acts as a solar chimney, allowing hot air to rise out of the house," she said, noting that the skylight's optical shade senses weather conditions, opening when it's hot and closing when it rains.

Team Capitol D.C., a collaboration of the Catholic University of America, George Washington University, and American University, used Flexinol wire louvers to shade windows on the southern exposure of its HARVEST HOME entry to prevent solar heat gain. Flexinol wire contracts when heated by outdoor ambient air, causing the louvers to close.

Atella cited the DALE (Dynamic Augmented Living Environment) entry, a collaboration of the Southern California Institute of Architecture and California Institute of Technology, as a project that pushes the envelope in terms of flexibility. The project consists of two modular sections mounted on rails. At the push of a button, the two modular sections slide apart to create an outdoor living space—tripling the size of the living area from 600 to 1,800 square feet (56



Above: DesertSol, by the University of Nevada at Las Vegas team, used a variety of passive energy strategies, including this metal solar screen, which was rusted to match the home's weathered facade. It doubles as an artwork, embedded with the shadow of a mesquite tree.

Above: The fluxHome, by the University of Southern California team, positions windows and doors to catch southern California's southwest breeze. A large, centrally placed skylight acts as a solar chimney.

Left: The Middlebury College team created a shaded walkway using photovoltaic panels at Insite House, instead of putting them on the roof. Because Middlebury lacks graduate engineering and architecture schools, this team—a collection of students from 25 disciplines—obtained information to build this house from the internet.

to 167 sq m). Thirty-two photovoltaic (PV) panels slide overhead to provide shade.

This project also has interior walls that can be moved back and forth to increase the size of bedrooms or the living room, depending on which space is in use. Another example of adjustable design elements is displayed in the UrbanEden entry by the University of North Carolina at Charlotte, in which the entertainment center transforms into a Murphy bed.

Schweitzer said she was especially impressed by passive energy solutions that also are used as design elements. Middlebury College, for instance, created a walkway shaded by the InSite house's solar panels, instead of using the panels as part of a traditional rooftop array.

The University of Nevada at Las Vegas created a digitally fabricated, retractable solar screen to shield the hottest side of the DesertSol house—the competition's second-place winner—in summer and capture the sun's warmth in winter. The metal solar screen, which was rusted to match the home's weathered facade, is imbedded with the muted outline of a mesquite tree to create a work of art.

Schweitzer also said the greenhouse built into the University of West Virginia's PEAK (Preserving Energy with Appalachian Knowledge) house is a "brilliant" passive energy design element for the Appalachian mountain region's climate. A living wall and greenhouse located on the sunny side of the house collect heat from the sun and release it into the living area when the interior greenhouse doors open.

She also praised the passive solar design in Team Austria's LISI House, which includes an automated shading system consisting of white drapery, die-cut with a design inspired by military camouflage fabric, that casts a leaf-like shadow into the living area. This curtain wraps around the perimeter of the building like a cocoon, shading the structure and lending it an elegant appearance. The curtain opens and closes with the push of a button to let in the sun's warmth in winter and provide shade in summer, and offers privacy for occupants.

While the building's technology is essential to the home's capacity to produce a surplus of energy, Gregor Pils, the project manager for Team Austria, pointed out that the LISI House design provides "understatement of the technology, with PV hidden on the roof, so it's not the first thing you see."

Team Austria also created a multifunctional subfloor system at the LISI House that regulates indoor climate using water and air, and these elements employ active cubic capacity to hold heat or cold. Pils explained that two high-efficiency, air-water heat pumps supply the system with cold and hot water for heating and cooling, as well as provide hot water for domestic use. The ventilation system in the floor heats and cools the living area. Cold water is pumped into pipes in the floor and as air flows past them it cools the room. In addition, the energy-recovery ventilation unit acts as a heat and humidity exchanger between exhaust and fresh air, keeping living spaces comfortable and healthy.

Atella noted that this type of system is superior because it gradually changes room temperature and maintains a constant level of comfort, rather than the intermittent warming or cooling inherent in conventional systems, which create hot and cold spots.

Czech Technical University's AIR (affordable, innovative, recyclable) House—which placed third in the competition—features a passive solar canopy that shades the structure while producing energy. Project structural engineer Pavel Nechanický noted that the solar canopy consists of wood slats that cover the building and the southern-facing wall, helping to eliminate the need for air conditioning. Cross-laminated wall panels used in the living area hold thermal balance, and a radiant chilled ceiling system regulates humidity and stabilizes indoor comfort, he said.

Atella suggested that the prefabricated CORE in Stanford University's Start.Home is a "takeaway" with potential application for KB Home. The prefabricated CORE module, which includes a kitchen counter and appliances, a bathroom, a laundry room, and a mechanical room with integrated electrical and plumbing systems, can be transported easily and plugged into the main section of this modular structure. The mechanical room is a compact, energy-efficient distribution center that facilitates control and maintenance. CORE's systems were built on a plug-and-play concept and can be easily updated by replacing the outdated module, he noted.

Atella is also interested in intelligent home systems, which control lights, mechanical functions, and other home functions. Team Ontario—a collaboration of Queen's University, Carleton University, and Algonquin College—created a sophisticated intelligent home system for its ECHO house, which won the engineering contest. Using real-time data

Decathlon Champs

The overall winner of this year's competition is the Living Inspired by Sustainable Innovation (LISI) House by Team Austria of Vienna University of Technology.

DesertSol House, the University of Nevada at Las Vegas team's entry, took second place, and AIR (affordable, innovative, recyclable) House, by the Czech Technical University team, came in third.

Contest winners in each of the ten categories are as follows:

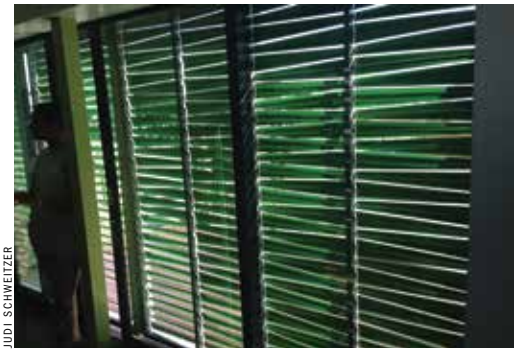
- **Architecture, AIR House, Czech Technical University;**
- **Market appeal, DesertSol House, Las Vegas;**
- **Engineering, ECHO House, Team Ontario: Queen's College, Carleton University, and Algonquin College;**
- **Communications, LISI (Living Inspired by Sustainable Innovation) House, Team Austria: Vienna University of Technology;**
- **Affordability, Start.House, Stanford University;**
- **Comfort zone, Radiant House, Santa Clara University;**
- **Hot water, Ecohabit House, Stevens Institute of Technology;**
- **Appliances, fluxHome, University of Southern California;**
- **Home entertainment, Radiant House, Santa Clara;**
- **Energy balance, DALE (Dynamic Augmented Living Environment), SCI-Arc/CalTech: Southern California Institute of Architecture and California Institute of Technology.**

generated by a roof-mounted weather station, the system detects changes in climate and automatically adjusts lighting, windows, blinds, and heating or cooling systems to maintain interior comfort and safety. The system can also be controlled remotely with a tablet app.

HARVEST HOME and UrbanEden offer innovative garden concepts. The HARVEST HOME team created a pop-up vegetable garden using milk crates. Noting that this house is being donated to the Wounded Warrior Program in San Diego, project manager Robert Blabolil said the milk-crate concept is part of the home's universal design, allowing the disabled veteran who will occupy the house to move plants around or take them into the kitchen for harvesting.

UrbanEden features vertical "wallgardens" of removable planters. The living room garden panel has sweet-smelling florals to create an inviting space, while the kitchen panel features vegetables and herbs. Outside the bedroom, thick ever-

JUDI SCHWEITZER



JUDI SCHWEITZER

Above: Team Austria's LISI entry brings the outdoors inside with the living area's wood floor extending to create decks and gardens on two sides of the home.

Left: A passive energy solution used in Team Capitol D.C.'s HARVEST HOME, these Flexinol wire louvers contract automatically when heated by outdoor ambient air, causing the louvers to close.

green vegetation ensures privacy year-round. The gardens' vertical configuration uses an efficient, water-conserving drip irrigation system; each planter box has holes in the bottom to allow water to drain from the top module all the way to the bottom plant.

Several homes also used sensory design elements to evoke a positive emotional response. Designed for a veteran with post-traumatic stress disorder (PTSD) or a traumatic brain injury (TBI), HARVEST HOME uses its garden, colors, and other sensory strategies to create a tranquil atmosphere that calms the body, mind, and spirit, explained Blabolil.

ECHO also has a sensory feature: a band of light-emitting diode (LED) lighting, which circles the perimeter of home's main living area about a foot below the ceiling and changes colors, effectively changing the color of the walls at the push of a button.

In addition, projects reduced their carbon footprints by using recycled and renewable materials. For example, LISI House is 96 percent wood and is constructed of locally available timber products. "We used everything from the tree," said Pils, noting that the organic insulation is 49 percent timber material, and even the tree bark was used to construct kitchen chairs.

HARVEST HOME comprises 80 percent reclaimed and recycled materials, according to Kyle Noell, the project's sponsorship and construction manager, who noted that the 100-year-old wood floor was reclaimed from a deconstructed church in Ohio, and the wood studs came from a deconstructed building in Washington, D.C.

The UrbanEden team used precast geopolymer cement concrete as the primary building material. Compared with conventional concrete, this material provides a 90 percent reduction in the carbon footprint of a building and creates a barrier to city noise.

Designing for the Masses

Ranging in size from about 600 to 1,000 square feet (56 to 93 sq m), projects recognize the growing market for housing that meets the needs of the nation's two largest groups of homebuyers: generation Y (also referred to as the echo boomers, or millennials) and baby boomers. Some of the homes have only one bedroom, while others add a small multipurpose room that could be used as an office, a guest room, or a child's bedroom.

Pils said the LISI design is ideal for a retirement cottage or a second home in the countryside. Noting that empty nesters account for 20 percent of the Czech Republic's population, Nechanický said the 700-square-foot (65 sq m) AIR House, which is estimated to cost about US$300,000, targets this group. Santa Clara University's Radiant House and SHADE, by a collaboration of Arizona State University and University of New Mexico, also target retiring baby boomers.

Other projects target young gen-Y professionals. ECHO, with an estimated price of just $257,584, targets the average young, professional Canadian couple, which earns about $80,000 on average per year. ECHO

can evolve with the family, providing a small extra room that could be used as an office or a bedroom for one or two children.

Team Texas, a collaboration of the University of Texas and El Paso Community College, designed its ADAPT home for young urban singles, couples, and other environmentally conscientious homebuyers. This project features adaptable flex spaces and a modular structure ideal for placement near an urban environment or in an existing neighborhood.

Missouri University of Science and Technology's Chameleon House is aimed at tech-savvy and budget-conscious young professionals interested in reducing their carbon footprint. The house has a modern aesthetic to engage recent college graduates and supports both a quiet working atmosphere as well as social gatherings.

Special Needs

A few projects are geared toward people with special needs. Team Capitol D.C.'s universally designed HARVEST HOME features Americans with Disabilities Act universal design requirements for physical accessibility.

Designed for easy transport and quick construction by semiskilled laborers, Borealis, the University of Calgary's entry, offers workers in Alberta's northern territory an alternative to crowded work camps. Also designed for rapid assembly, Phoenix House by the Kentucky/Indiana team, a collaboration of the University of Louisville, Ball State University, and the University of Kentucky, is designed for middle-class families displaced by tornadoes or other natural disasters.

Schweitzer commended the U.S. Department of Energy and the National Renewable Energy Laboratory for sponsoring this event. "Every one of these projects is a winner," she said, noting the thoughtful creativity and diversity of ideas in projects designed to meet various challenges presented by different demographics, climates, and geographical regions. **UL**

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