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Getting to Zero:
The Frontier of Low-Energy Buildings

Zero-energy has become a buzzword of the green building movement, used in advertising slogans, conference presentations, and technical papers. Despite the excitement over the phrase, however, we lack a common understanding of just what zero-energy means. And despite proclaimed achievability, few if any buildings can demonstrate that they in fact use zero-energy as defined by most practitioners. In this article, we explore the concept of zero-energy: what it means, why it matters, and, most important, how to get there.

What Is Zero-Energy?

Zero-energy has been encapsulated by several definitions and assumptions. While sorting out the differences may seem unimportant, we found the results to be illuminating. The way in which zero-energy is defined affects the choices designers make to achieve the goal, and whether or not they can claim success.

How should zero-energy be defined?

Zero-energy can be defined in several distinct ways. Researchers at the National Renewable Energy Laboratory (NREL) have analyzed the policy and design implications of four common definitions:

- Zero-net-annual site energy
- Zero-net-annual source energy
- Zero-net-annual energy cost
- Zero-net-annual emissions

Photo: National Renewable Energy Laboratory

The home of Otto Van Geet, senior mechanical engineer in the Site Operations group at NREL, is located at 9,200 ft (2,800 m) in Clear Creek County, Colorado, and is not connected to the utility grid. A highly efficient building envelope combined with a 1 kW PV system, active solar water heating, and passive solar design limit the home's imported energy needs to a small amount of propane. A detailed report is online at www.nrel.gov/docs/fy04osti/32765.pdf.

Zero-net-annual site energy. Zero-annual site energy is perhaps the most intuitive definition of zero-energy. A building meeting this definition offsets any imported energy by exporting an equal amount of site-derived energy, measured over the course of one year. Electricity is the most common site-generated and exported energy source. With grid-connected buildings, electricity is drawn from the utility grid when the building's on-site generation is lower than its demand and electricity is exported to the grid when onsite generation exceeds demand. If the building's energy generation over the year *exceeds* its energy

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In This Issue

Quote of the month:

"Our nation can rebound from the shame of our hapless response to Katrina by demonstrating to the world a commitment to sustainable development."

Alex Wilson, executive editor

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Editorial & Subscription Office
122 Birge St., Suite 30, Brattleboro, VT 05301
802-257-7300 · 802-257-7304 (fax)
ebn@BuildingGreen.com · www.BuildingGreen.com

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From the Editors

A Bold Plan for New Orleans

It is easy to see what led to the catastrophe Hurricane Katrina wrought on New Orleans: a city of a half-million people at an average elevation of six feet (2 m) below sea level; wetlands that have been disappearing for decades for lack of replacement silt from the Mississippi River's annual flooding; a city that has been sinking as its silt soils compress; levees that are designed to withstand only Category 3 hurricanes in an age when global climate change appears to be spawning more catastrophic storms; and years of inadequate funding to maintain even the existing Category-3-rated levees that were built to protect the Crescent City.

In the aftermath of the devastating late-August storm, as rescue teams search for survivors and carry out the grim task of recovering the dead, discussion is well underway about what to do next in heavily damaged New Orleans—and nearby cities including Gulfport and Biloxi, Mississippi. New Orleans is the first large American city to be devastated by a catastrophic event since a mammoth earthquake and subsequent fires destroyed much of San Francisco in 1906, leaving three-quarters of its population homeless, and before that the Great Chicago Fire in 1871 destroyed a third of that city. From the San Francisco earthquake we learned to build structures that were more earthquake-resistant, and we instituted seismic building codes. From Chicago's fire we learned to replace wood-frame structures with masonry and steel, and we instituted rigorous fire codes. What will Katrina teach us?

In many respects, New Orleans should not be rebuilt in its present location—a lowland bowl situated between a lake and a river channel where this largest of America's rivers forms its delta. There are very good reasons for accepting the reality that the combination of subsiding land, rising sea levels, and the effect of shipping channels in funneling storm surges into New Orleans makes long-term survival of the city either very doubtful or highly expensive. Serious consideration should be given to the idea of relocating the city to stable land, either somewhat inland from the coast or farther from the delta where it can be better protected. But there's almost no chance of that happening. New Orleans will be rebuilt where it is. Our nation has learned a lot in its 200-plus years, but we're neither that smart nor that bold.

See Y'all in Atlanta!

BuildingGreen, Inc., will be participating actively in the U.S. Green Building Council's Greenbuild Expo and Conference in Atlanta this November. Both Nadav Malin and Alex Wilson will be presenting conference sessions, and Nadav will be part of a special preconference workshop on environmentally preferable products. Also, BuildingGreen will follow tradition by announcing the 2005 Top-10 Green Product Awards, recognizing the most exciting products added to the *GreenSpec Directory* during the past year.

- **Preconference Workshop:** *Peeling Back the Ecolabel*
  Monday, November 7, 1:00 – 4:00
- **Session:** *Shifting Our Collective Mindset: Deep Questions of Stewardship*
  Friday, November 11, 10:30 – 12:00
- **Session:** *The Future of Green Building: Report from the Press*
  Friday, November 11, 10:30 – 12:00

Please join us at Greenbuild for these activities, and stop by booth **905** to say hello!

So what can be done in rebuilding New Orleans to make it a better, more sustainable place? A great deal. The opportunities are exceeded only by the creativity that exists in the sustainable design community today. We have an opportunity with New Orleans to put into practice—in a far-reaching and highly visible manner—a vision infused by the collective wisdom of the green building movement. If common sense, intelligence, and forethought can prevail in the ensuing debates about the future of this great city, we will end up with a model that can be emulated around the world. Our nation can rebound from the shame of our hapless response to Katrina by demonstrating to the world a commitment to sustainable development.

In this spirit, we offer the following ten-point plan for moving this dialog ahead. These suggestions are directed specifically at New Orleans, though many of the ideas apply as well to other coastal areas damaged by Hurricane Katrina.

1. Institute a *Sustainable New Orleans* planning task force. This task force should be comprised of 20 to 30 of the best minds in sustainable development, urban planning, and green building, along with at least an equal number of community leaders of New Orleans and the surrounding region. Participation and buy-in by residents is critical to the long-term success of any sustainability initiative in a city or region, and that seems particularly the case in New Orleans, where too many have been disenfranchised for too long. This planning process should generate neighborhood, community, city, and regional plans that address such issues as housing, employment, government, transit, open space, healthcare, education, water, sewer, energy, and telecommunications. This task force should be funded at a level that will permit these outside visionaries and local participants to take leave of many of their other responsibilities for an intensive six- to twelve-month period, and the initiative should be enriched with the best support staff of computer modelers, ecologists, geologists, building scientists, and engineers that money can buy. This task force should be established as quickly as possible.

2. Pursue coastal and floodplain restoration as the number-one priority in rebuilding New Orleans. As has been widely reported, it doesn't make economic sense to invest in rebuilding New Orleans without also addressing the underlying hydrologic problems that will continue to threaten this area. Sediment deposition needs to be restored in the Mississippi River Delta, both to replenish wetlands in the delta that are being lost to erosion and to counteract the subsidence of land that is occurring in the region. We need to harness nature's restorative powers to support human efforts to create a habitable coastal zone—rather than continuing to work in opposition to the forces of nature.

Photo: NASA Landsat Project Science Office and USGS National Center for EROS

This satellite photo, taken in 2001, shows shipping canals carved through the marshes and mudflats of the Mississippi River Delta and sediment carried into the Gulf of Mexico.

3. Immediately establish *Sustainable New Orleans* enterprise-zone businesses to salvage and warehouse building materials from the destruction of New Orleans. The materials so salvaged should be cleaned and used in the rebuilding of the city. These businesses should be cooperatively owned by the people of New Orleans and should provide employment to those in the city who most need it—in the process, establishing models for the sorts of businesses that can ultimately build a vibrant, strong economy for New Orleans. Such start-up businesses can empower residents and help them emerge from the cycle of poverty and hardship that have for too long afflicted the city. Organized deconstruction of the tens of thousands or hundreds of thousands of buildings that are deemed unlivable should be undertaken. Temporary housing, food, and infrastructure will be needed to support this enterprise; the housing can start as tent barracks if necessary. If we can provide mobile living quarters and infrastructure for 150,000 ground troops in Iraq 8,000 miles (13,000 km) away, we should be able to do the same in Louisiana, an hour's flight from Atlanta.

4. Rebuild a levee system around the city that the water engineers of Holland will envy. The levees should incorporate redundancy and be designed to fully withstand a Category 5 hurricane and a storm surge exceeding that predicted by the most extreme computer models. Where possible, the levee system should be integrated into a perimeter park for the city that combines protective functions with recreational amenities that will help New Orleans lure its dispersed residents back to the city and attract the new companies and employment that the city so desperately needs to sustain itself in the long term.

5. Create *Sustainable New Orleans* overlay zoning for the city to ensure that the goals of sustainability, safety, and urban vitality will be followed in the city's redevelopment. This zoning code should emerge from the comprehensive planning process outlined in the first recommendation. It should provide for mixed uses (retail, commercial, and residential) in urban cores, public transportation, bicycle and pedestrian pathways, high levels of energy efficiency,

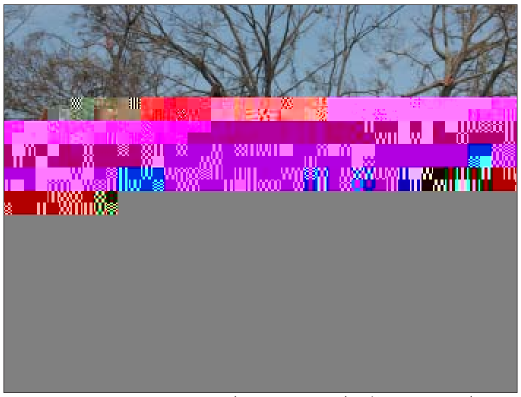


Photo: Gene Dailey/American Red Cross

Some of the debris left behind by Hurricane Katrina can be reused in the rebuilding efforts.

reliance on natural cooling strategies and solar power systems in buildings that can maintain comfort and provide critical electricity during power outages, and durable building systems based on a platform of building science. While there is an urgency to move ahead with the rebuilding of New Orleans, doing it right—in a way that will maintain and strengthen the character of the city—is paramount. The end result should not be a gentrified New Orleans, but a better, more sustainable version of the old New Orleans—a city that supports all segments of its society while protecting its environment and ensuring its long-term future.

6. Retain and restore those buildings that can be salvaged. Due to damage from contaminated water, extensive measures will be required to deal with mold. Gut-rehab will be required for many of the estimated 80% of the city's 200,000 homes that have been damaged and, of course, many homes will not be salvageable. Building codes should address resistance to non-catastrophic flood damage—for example, the most flood-prone lower floors of houses should have no paper-faced drywall, no ductwork, no air handlers, no wall-to-wall carpeting, and no electrical service boxes. Retaining the character of New Orleans, which is defined in part by its vernacular architecture and its diversity, should be a high priority.

7. Mandate or incentivize green building. Along with ensuring that certain minimum practices are followed in the rebuilding of New Orleans, the city, state, and federal government, as well as insurance companies and banks, should require, or offer incentives to encourage the implementation of, more comprehensive green building practices. Tax credits, zero-interest loans, density bonuses, grants to support the greenest redevelopment efforts, and other incentives should be offered to the people and businesses of New Orleans to support this greener vision of the city. Affordable housing should be built at least to the Enterprise Foundation Green Communities standards. Public buildings should be required to achieve LEED® Gold standards. The U.S. Green Building Council should encourage green construction by waiving or discounting the registration and certification fees for all private building projects going through LEED certification—discussions about doing this are already underway.

8. Work with ecologists and fisheries biologists to create more sustainable fisheries for the Gulf Coast. The Louisiana coast produces more seafood than any U.S. location outside of Alaska; as elsewhere, these fisheries are in decline. The terrible pollution that resulted from Katrina's floodwaters will doubtless further damage these fisheries—and likely extend the Gulf of Mexico's dead zone, which currently covers about 7,000 square miles (18,000 km^2)—an area about the size of New Jersey. This issue must be addressed if the culture of New Orleans is to survive.

9. Clean up the new brownfields of New Orleans. Pollutant-laden sediment and all manner of toxins will greet the city once it is drained of its floodwater. The most ecologically responsible means should be used to detoxify New Orleans, and an ongoing testing program should be implemented to ensure that New Orleans's water is safe to drink, its playgrounds are safe to play on, and its seafood is safe to eat. Indeed, this is an opportunity to put into practice, on a large scale, such leading-edge practices as bioremediation, phytoremediation, and ecological restoration.

10. Work with industry to clean up the factories along the Gulf Coast. There need not be a *Cancer Alley* along the Gulf Coast, but it will take a concerted effort by industry, environmentalists, and regulators—and a lot of money—to bring about the necessary change. In creating a sustainable economy and ensuring that residents can live healthy lives, however, this blight simply has to be addressed. Let's learn from the toxic sludge and silt left by Katrina and create industrial processes that will not leave a toxic legacy for our children and grandchildren. The long-term plan for industry along the Gulf Coast should address both a reduction of toxics and opportunities for synergies in material and resource flows—concepts of *industrial ecology*.

These are not easy tasks. Most involve hard, concerted effort and huge financial outlays. But these measures—and others that would doubtless emerge through the process laid out here—are critically important if New Orleans and the surrounding environs are to emerge from the devastation of Hurricane Katrina in better shape than before. New Orleans can emerge as a model for sustainable development, charting a course that other cities around the country and world can follow. Let's not look back at the rebuilding of New Orleans as a lost opportunity; let's work together for a future that the city—and all of America—can be proud of.

– Alex Wilson

Thanks to David Orr, Richard Haut, Kevin Settlemyre, Bruce Wheaton, Dan Williams, and members of the EBN *Editorial Advisory Board for their review and helpful comments on this editorial.*

What's Happening

FloorScore IAQ Testing Program Launched

The Resilient Floor Covering Institute (RFCI) now has its own green label for flooring products that meet low indoor emission standards. The FloorScore™ label can be found on vinyl and linoleum flooring from a half-dozen manufacturers, and the list is likely to grow. "We started with this program four years ago," says Bill Freeman, a consultant to RFCI. "We have been testing a lot of products. Changes were made to make sure that products would meet the requirements of the California standards," Freeman reports.

The world of testing emissions from products has been polarized in recent years. On one side, Air Quality Sciences, Inc., in Atlanta, tests for the Greenguard Environmental Institute and the Carpet and Rug Institute. On the other side, Berkeley Analytical Associates in Richmond, California, tests for California's Section 01350 Specification and its related programs, including the Collaborative for High Performance Schools (CHPS). The carpet industry's new Green Label Plus program bridges this gap to some extent, relying mostly on Air Quality Sciences' protocols and services but on California's performance thresholds (see *EBN* Vol. 13, No. 7). The FloorScore program falls squarely on the California side, relying on the 01350-based protocols and thresholds from the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers" (CA/DHS/EHLB/R-174). Although Air Quality Sciences and another lab have been officially approved for FloorScore testing, to date Berkeley Analytical has done nearly all testing for FloorScore.

Unlike the carpet program, in which the trade association controls the label, FloorScore certification is handled by an independent third party, Scientific Certification Systems, Inc. (SCS). In accordance with its SCS-EC-10-2004 Indoor Air Quality Performance standard, SCS performs site visits to verify raw material inputs and certifies products based on test results from the laboratories.

Flooring manufacturers seem to be looking to FloorScore as an alternative to Greenguard (see *EBN* Vol. 12, No. 10). The costs of participating in Greenguard and FloorScore are similar, according to Diane Martel, vice president of marketing at Tarkett Commercial, but "we're getting more value for costs through FloorScore." "It does follow California 01350, the strictest of the air quality policies at this point," Martel adds. Several Tarkett products are Greenguard-certified, but the company won't maintain those certifications now that its products all carry the FloorScore label, according to Martel.

Although the program was developed by RFCI, participation in FloorScore is not restricted to RFCI members. "The FloorScore program is available to all manufacturers of hard-surface flooring and hard-surface flooring adhesives and sundries," says Freeman. The list of certified products is available on both the RFCI and SCS websites. *– NM*

For more information:

Douglas Wiegand, Managing Director
Resilient Floor Covering Institute
Rockville, Maryland
301-340-8580
www.rfci.com

Jeff Stephens
Communications Director
Scientific Certification Systems
Emeryville, California
510-452-8003
jstephens@scscertified.com
www.scscertified.com

The Veneto and Etrusco lines of linoleum flooring from Tarkett, Inc., are among those recently certified under the new FloorScore indoor emissions program. Photo: Tarkett, Inc.

Newsbriefs

Illinois Adopts RPS—In July 2005 the Illinois Commerce Commission adopted Governor Rod Blagojevich's sustainable energy plan, including a renewable portfolio standard (RPS) requiring the state's electric utilities to meet 2% of their electricity needs with renewable sources by the end of 2006. The requirement will increase by 1% each year until it reaches 8% in 2012. An efficiency component of the plan requires utilities to create new programs that will reduce growth in electricity demand 10% by 2007 and 25% by 2015. Nineteen states and the District of Columbia have now adopted renewable portfolio standards.

Texas Strengthens RPS—Texas was among the first states to adopt a renewable portfolio standard (RPS), calling in 1999 for 2,000 megawatts (MW) of new renewable energy generation by 2009. Announcing that the state is on track to meet that target by the end of 2005, Texas Governor Rick Perry signed Senate Bill 20, strengthening the RPS, in August 2005. According to the new requirements, Texas will generate 5,880 MW of renewable energy by 2015, representing about 5% of demand. The legislation also sets a goal of reaching 10,000 MW by 2025. For details, see www.dsireusa.org.

Oregon Expands Solar Energy Tax Credits—Oregon Governor Ted Kulongoski signed a bill in September 2005 that expands tax credits for solar energy systems. The bill, which takes effect November 4 and expires in 2016, allows for tax credits of $3.00 per watt of installed solar electric output capacity. The credit is capped at half the cost of the installed system, up to $6,000. Additionally, the Energy Trust of Oregon, Inc., offers up to $10,000 for homeowners and $35,000 for businesses investing in photovoltaic systems. The Oregon State Legislature is online at www.leg.state.or.us (search for Senate Bill 31). The Energy Trust is at www.energytrust.org.

New York Passes Two Solar Energy Bills—New York Governor George Pataki signed two bills in August 2005 designed to encourage the use of solar energy. The first (S.4962-a) exempts the sale and installation of solar energy systems from state sales and compensating-use taxes and gives municipalities the option of extending the exemption to city taxes. The second bill (S.5252) expands the existing personal income tax credit for solar-electric generating equipment to include systems used for water heating and space heating or cooling. The credit is capped at 25% of the installed cost of the system, up to $5,000.

"Lights in the city are a fatal attraction for night-migrating birds," says E.J. McAdams, executive director of NYC Audubon. Photo: Charles Hofer/NYC Audubon

NYC Launches Lights Out NY—The New York City Department of Parks and Recreation—together with the New York Department of Buildings, NYC Audubon, the Real Estate Board of New York, and BOMA New York—has launched *Lights Out NY*, a voluntary program designed to reduce the number of migrating birds killed by flying into city windows at night. *Lights Out NY* encourages owners of tall buildings (40 stories or more) to turn off decorative lights on the upper stories from midnight until daylight through the end of October and asks tenants on upper floors to turn off lights or draw their blinds during the same time period. It also encourages owners of shorter buildings with extensive glass exteriors, especially those along the Hudson and East Rivers, to darken their buildings during that period. NYC Audubon estimates that 10,000 migratory birds, disoriented by lights, crash into New York City buildings during each fall and spring migratory season. Details about *Lights Out NY* are online at www.nycaudubon.org. For more information on bird collisions with buildings, see *EBN* Vol. 14, No. 8.

Million Solar Roofs Bill Dies—California's Million Solar Roofs bill, which would have led to the addition of 3,000 megawatts of solar panels on one million roofs, including half of all new homes, died in assembly in September 2005. The bill would have made California the world's third largest solar energy producer, behind Japan and Germany. After passing the Senate by a bipartisan vote of 30-5, the bill was slowed by the Assembly Appropriations Committee, which added three amendments in response to labor-union lobbying. The bill failed to receive a floor vote. "The derailment of one of the most popular and commonsense bills of the year is the new poster child for shortsighted partisan politics," said Bernadette Del Chiaro of the nonprofit Environment California. Aids to Governor Schwarzenegger say he will ask the State Public Utilities Commission to establish parts of the derailed program, but the Commission lacks the authority to implement the entire plan.

Dane County Habitat Homes Earn Green Built Home Certification—Green Built Home™, a voluntary green building program of the Wisconsin Environmental Initiative, in partnership with the Madison Area

Builders Association, has been partnering with Habitat for Humanity of Dane County to certify all new Habitat homes as Green Built Homes. For 2005, all new Habitat homes will earn at least 112 points in the Green Built Home rating system, far exceeding the 60 points required for basic certification. The homes also comply with ENERGY STAR® standards. "Green building saves homeowners money in the long term through reduced energy and maintenance costs and does not have to increase up-front costs," says Nathan Engstrom, Green Built Home program director. For more on greening affordable housing, see *EBN* Vol. 14, No. 3.

Keen Joins Stantec—Green engineering firm Keen Engineering has signed a letter of intent to join the professional design and consulting firm Stantec. "Joining Stantec will accelerate our vision of being a top-tier integrated building design firm promoting sustainable development," says Keen president and CEO Kevin Hydes. According to Stantec president and CEO Tony Franceschini, "When Keen's 163 LEED® accredited professionals are combined with our existing capabilities in building systems as well as architecture, interior design, and other related services, Stantec will have one of the largest sustainable design teams in North America with over 280 LEED accredited professionals." The transaction is expected to close in October 2005. Details are at www.keen.ca and www.stantec.com.

Genzyme Achieves Platinum—Genzyme Center, the world headquarters of the biotechnology company Genzyme Corporation, achieved 52 points in the U.S. Green Building Council's LEED® for New Construction Rating System, earning a Platinum rating. Located in Cambridge, Massachusetts, the 344,000 ft^2 (32,000 m^2) building was designed by Behnisch, Behnisch & Partner with Next Phase Studios and House Robertson Architects. A full project description is included in the *BuildingGreen Suite*, at www.buildinggreen.com/hpb/.

Photo: Anton Grassl

The Genzyme Corporation's world headquarters building in Cambridge, Massachusetts, has earned a Platinum LEED rating from the U.S. Green Building Council.

All Potlatch Forestland Achieves FSC Certification—As of September 1, 2005, all of Potlatch Corporation's 1.5 million acres (600,00 ha) of forestland, located in Idaho, Arkansas, Oregon, and Minnesota, has earned certification according to Forest Stewardship Council (FSC) standards. The certification of 319,000 acres (130,000 ha) in Minnesota, along with chain-of-custody certification of a Potlatch sawmill in Bemidji, Minnesota, completed the company's forestland certification quest, which began with 667,000 acres in Idaho in 2004. For more information on Potlatch and FSC certification, see *EBN* Vol. 12, No. 4; Vol. 13, No. 5; and Vol. 14, No. 6. The company is online at www.potlatchcorp.com.

AQS Tests Emissions from Material Installations—Air Quality Sciences, Inc., has developed a series of techniques to test product *assemblies*, as opposed to individual products, in controlled environmental chambers. Examples of these assemblies include paint and wallboard; carpet, adhesive, and subfloor; and laminate, adhesive, and particleboard. "Sometimes emissions may be reduced," notes AQS, "and yet, in some situations, new chemicals can be released resulting from interactions among the products." Several state and federal agencies require emissions data on assemblies, and certification programs including Greenguard and Blue Angel certify installation packages. Details are at www.aqs.com.

ASTM Publishes Sustainability Guide—ASTM International has published the *Standard Guide for the General Principles of Sustainability Relative to Building* (E2432). "It is expected that the Guide will be referenced and used by federal, state, and local governments, architects, and others seeking to solidify and/or justify the tripartite—environmental, economic, and social—approach to building siting, design, operations, maintenance, and end-of-life issues," according to Alison Kinn Bennet, chair of the task group that developed the standard. The six-page standard can be downloaded for $33.00 or ordered in hardcopy for $36.00 at www.astm.org.

DOE Compares Energy Simulation Programs—The U.S. Department of Energy, together with the University of Strathclyde in Glasgow, Scotland, and the University of Wisconsin in Madison, has released a report titled *Contrasting the Capabilities of Building Energy Performance Simulation Programs*. The report discusses 20 energy-modeling computer programs: BLAST, BSim, DeST, DOE-2.1E, ECOTECT, Ener-Win, Energy Express, Energy-10, EnergyPlus, eQUEST, ESP-r, HAP, HEED, IDA ICE, IES <VE>, PowerDomus, SUNREL, Tas, TRACE, and TRNSYS. Drawing from information provided by the program developers, the report compares the programs' handling of a range of parameters, including daylighting, renewable energy systems, and climate data availability. The report is online at www.energytoolsdirectory.gov.

Awards & Competitions

ASLA Announces 2005 Medal and Professional Award Winners

The American Society of Landscape Architects (ASLA) has awarded ***Jane Silverstein Ries***, FASLA, the ASLA Medal, the highest honor the organization bestows upon individuals, "for her lifetime achievements and contributions to the profession, the welfare of the public, and the environment." Ries began her 56-year career in 1933 as the first female landscape architect in Colorado. Within six months she started her own firm. ASLA describes Ries as "an early advocate of sustainable design, aesthetic green spaces, and raising the standards of urban life."

ASLA also announced the winners of its 2005 Professional Awards. Several winners in various categories incorporate green strategies or grace prominent green projects. Two Award of Excellence winners, described below, were designed with notable consideration of environmental responsibility. For more information on these and other winners, visit www.asla.org. Both the ASLA Medal and the Professional Awards will be formally presented on October 10, 2005, at ASLA's annual meeting in Fort Lauderdale, Florida.

Photo: Tom Fox, SWA Group

All excavation around existing trees in Houston's Hermann Park was performed by hand to protect the delicate roots.

- ***The Heart of the Park at Hermann Park in Houston***, Texas, submitted by master plan consultant Olin Partnership, Ltd., was given an Award of Excellence for General Design. The 18.5-acre (7.5 ha) site required $9.5 million and 12 years to complete. A passive biofiltration system on the 80' x 740' (24 x 226 m) reflecting pool eliminates the need for electricity and chemicals. The team used porous or semiporous decomposed granite for most hard surfaces, allowing stormwater infiltration. Equipment traffic near tree roots was limited during construction. Contractors performed all excavations within drip lines of trees by hand and wrapped each root with moisture-preserving insulation. Local materials and native plants were used to enhance the park's continuity, longevity, and environmental responsibility. More information is online at www.hermannpark.org.

- ***The Noisette Community of North Charleston***, South Carolina, submitted by BNIM Architects and Burt Hill Kosar Rittleman Associates, was given an Award of Excellence for Analysis and Planning. A 3,000-acre (1,200 ha) project at the historic center of North Charleston, Noisette is considered the leading sustainable redevelopment of an urban environment in the U.S. The master plan, developed through a five-year, collaborative process, calls for creating a mixed-use land-use pattern, restoring natural systems, restoring connections within the community, using neighborhoods as catalysts for change, and creating a new community on a portion of the former Charleston Naval Base, among other goals. Master planning team leaders Harry Gordon, FAIA, and Bob Berkebile, FAIA, and Noisette Company CEO John Knott Jr. are all *EBN* Advisory Board members. For more on Noisette, see *EBN* Vol. 10, No. 5 or visit www.noisettesc.com.

Award Brief

USGBC Wins Turner Prize— The U.S. Green Building Council (USGBC) has been awarded the fourth annual Henry C. Turner Prize for Innovation in Construction Technology. Named after the founder of Turner Construction Company, a corporate sponsor of USGBC's LEED® Rating System, the Turner Prize each year recognizes an invention, an innovative methodology, or exceptional leadership by an individual or team of individuals in construction technology. USGBC was recognized for its promotion of green design and building generally and, specifically, for the development of LEED. "Five years ago, when USGBC staff and volunteers created LEED, we never could have imagined the market transformation that would follow," says Rick Fedrizzi, USGBC president, CEO, and founding chair. USGBC will formally accept the Turner Prize, and its $25,000 cash award, at an October 24, 2005, reception at the National Building Museum in Washington, D.C.

Then & Now: 1995-2005

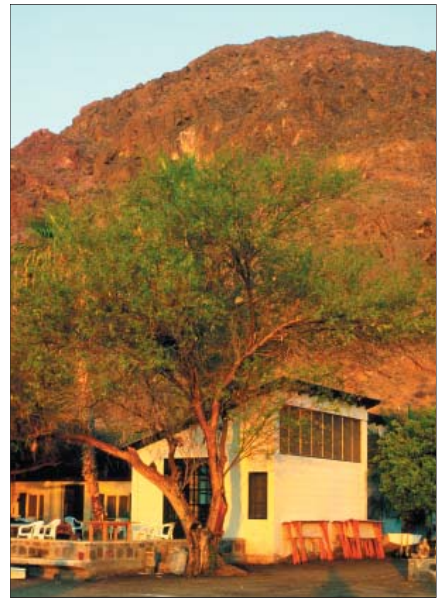
NOLS Mexico Branch Ten Years Later

The mission of the National Outdoor Leadership School (NOLS) is "to be the leading source and teacher of wilderness skills and leadership that serve people and the environment." When Taylor Galyean set out to design a set of structures for the NOLS Mexico Branch on Baja California, his goal was to embody that mission in the facility. We first wrote about Galyean's designs—his thesis for a master's degree in architecture from the Massachusetts Institute of Technology—a decade ago, in *EBN* Vol. 4, No. 5. At that time, most of his plans were still on paper. Having written in 1995 that "full implementation of the plan is expected to take about ten years," we decided to check in with NOLS and Galyean to find out where, and if, things stand.

"When you go on a NOLS trip or course, it's easy to be minimum impact, because you carry everything out with you," Galyean told *EBN* this year. "It took some twisting of our thoughts to reinterpret what that means for a permanent environment." Following the completion of Galyean's thesis, he and his wife, Marilyn Feldmeier, collaborated on the project as Feldmeier Galyean Design. With the goal of low-impact development in mind, the team designed the structures around "basic, simple components." They designed to foster a permeability between indoors and out. "We did everything we could to encourage natural ventilation," Galyean explains, and all of the designs include extensive daylighting. The Branch is entirely off-grid, with electricity supplied by an onsite photovoltaic array. Propane supplies heat for cooking, and a generator provides additional electricity on occasion. For the construction process, minimizing the project's impact meant using local materials, building techniques, and labor.

The 1995 article included three drawings. One was a design for a water tower that would double as a climbing wall. Although the design is ready, the structure has not been built—yet. "We've been waiting for the other water tower to collapse," explains Galyean. "Everyone thinks this thing's never going to make it, that it's going to fall down next year. But they've been saying that for ten years." A design for counselor housing also remains unbuilt. A drawing of a reinforced-concrete post-and-beam wall structure with various options for infill, however, did pan out. "The design has been wonderful in terms of work flow and usage of the facility," says David Lee, director of the NOLS Mexico program, noting that the only problem has been some corrosion of the concrete due to salt leaching from the soil. "We would love to bring Taylor back," Lee says, though no new structures are planned for at least the coming two years.

The base camp was designed to minimize use of energy and water. An open-air shower, shown here, is controlled by a foot pedal, and greywater from the shower drains directly to trees and other vegetation. Photo: Taylor Galyean



All of the buildings at the NOLS Mexico Branch, including the library, shown here, were designed to maximize daylighting and natural ventilation. Photo: Taylor Galyean

Galyean and Feldmeier continue to practice together. In addition, the two enjoy working with Galyean's father's company, the TAG Studio, which specializes in the design of luxury spas, resorts, and pool facilities. Galyean says his early work with NOLS continues to influence his practice. "The way I tie this together in my own mind—and I don't know if this is post-rationalization or not—is in the intersection between the landscape and the built environment, which was a huge part of the NOLS Mexico project," he says. "I always try to push everything for the health of the individual and the health of the environment. If people can come away from my work with a better understanding of the beauty of a place, and better health for that place and for themselves, then I've accomplished something." *– JB*

For more information:

Taylor Galyean
Feldmeier Galyean Design
New Orleans, Louisiana
504-891-3502, 815-550-8560 (fax)
taylor@studiofg.com

David Lee, NOLS Mexico Director
david_lee@faculty.nols.edu
www.nols.edu

Product News & Reviews

Ice Bear: Thermal Energy Storage for Smaller Buildings

Ice-based thermal energy storage systems have long been attractive to utility companies as a way to reduce peak loads on the electric power grid, and to commercial building owners as a way to save money. But the technology has been slow to catch on and generally limited to large buildings that use chillers. The Ice Bear™, introduced commercially in January 2005 by Ice Energy, LLC, may speed the adoption of thermal energy storage by extending the application to smaller buildings.

First, some background. Thermal energy storage (TES) is a relatively simple cooling technology through which cooling capacity is generated at night using off-peak electricity to chill water or make ice; then that chilled water or ice is used during the daytime to cool a building. TES systems shift the primarily electricity use for cooling to off-peak hours. This can be a huge money-saver for a company that pays demand charges or has time-of-day billing rates. In most commercial buildings, cooling is the largest energy load, and nearly all of the cooling demand occurs during daytime hours, when electricity demand is highest (see left graph in Figure). Shifting the electricity demand for cooling to nighttime hours reduces the daytime peak demand, saving money (graph on right). The steady load of cooling the ice or water also typically allows downsizing of the chiller.

Along with saving the end-user money and benefiting utility companies through peak-shaving, TES systems offer environmental benefits. Air pollution is reduced because utility peaking power plants, which are often the dirtiest (such as diesel-powered generators), do not need to be used as often. Also, *smog production* from power plant emissions is reduced because more emissions are shifted to nighttime hours when sunlight is not present to convert nitrous oxides into smog.

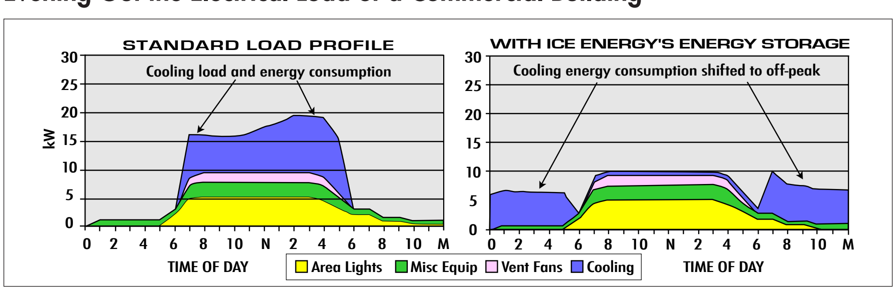
Until 2005, ice-based TES systems were limited to large buildings that rely on chillers for cooling. CALMAC Manufacturing Corporation and several other companies have long offered such systems. In January 2005, Ice Energy began shipping production units of its Ice Bear 50, the first ice-TES system designed to replace unitary, refrigerant-based air conditioners, thus making off-peak ice storage an option for commercial buildings in the 2,000 to 50,000 ft^2 (185 to 4,600 m^2) range and for larger homes. "Ours is the only [TES] system designed to work with refrigerant-based cooling," says Ice Energy's president, Greg Tropsa.

Here's how the Ice Bear 50 works: A standard, off-the-shelf, 5-ton (60,000 Btu) air-conditioning condensing unit operates during the nighttime hours to freeze about 500 gallons (1,900 l) of tap water in a separate energy storage module. The double-walled energy storage module is about 5 feet (1.5 m) on a side, made of rotationally molded, cross-linked high-density polyethylene (HDPE), and insulated to about R-18 (RSI-3.2). At night, the condenser operates continuously to freeze this water into a solid block of ice. During the daytime, when cooling is called for, a small, 100-watt pump circulates refrigerant through coils in the energy storage module to a standard 7.5-ton (90,000 Btu) evaporator coil and blower unit inside the building to provide the cooling. "Our product allows you to decouple electricity use for cooling during the daytime," Tropsa told *EBN*. Multiple units can be installed in larger buildings to increase the cooling capacity.

The Ice Bear provides up to a 95% reduction in cooling-related peak demand. While most ice-based TES systems achieve the peak-load reduction at the expense of efficiency—because the water has to be chilled to a lower temperature—Ice Energy claims that its system can actually achieve higher efficiency. Part of this gain in efficiency is achieved because the air-conditioner condenser (the component that freezes the ice) operates more efficiently at cooler nighttime temperatures, and part of the efficiency gain is achieved because the condenser operates continuously while making ice, rather than cycling on and off. Ice Energy claims that savings can be as great as 35% in climates with large diurnal temperature swings, such as America's western high desert.

The Ice Bear technology has actually been around for a while. In the 1990s Powell Energy Products developed and began field-testing this system, but the development efforts faltered when both the inventor and another key founder passed away. In 2003 several entrepreneurs, including

Evening Out the Electrical Load of a Commercial Building



A 95% reduction in peak electricity consumption is achieved by shifting cooling load to off-peak periods.

Source: Ice Energy, LLC

Ice Energy's Ice Bear energy storage system can reduce a building's cooling-related peak demand charges by 95%. Photo: Ice Energy, LLC

Tropsa and CEO Frank Ramirez, became convinced that the product had great potential, acquired the patents, and formed Ice Energy, LLC. After improving the technology, the company began field-testing units in November 2003, according to Tropsa, and began selling production models in January 2005. By September 2005 the company had installed 50 Ice Bear systems, including 30 production units.

With its Ice Bear 50 the company is focusing on retail facilities—typically buildings with one or two floors and between 2,000 and 50,000 ft^2 (185 to 4,600 m^2) that use packaged rooftop air-conditioning systems or split systems. Tropsa refers to this as the "Starbucks to Wal-Mart" market. The company is currently field-testing a smaller model, Ice Bear 30, which is optimized for production housing. This residential unit will generally make economic sense only in locations where the utility company offers time-of-day billing or off-peak electric rates.

Chuck Reynolds, facility manager for the City of Victorville, California, installed an Ice Bear 50 unit in late July 2005 to serve the city council chambers in their city hall building. While he hasn't yet seen energy performance data, he is very satisfied with the performance. Even with August temperatures in this high-desert climate reaching 115°F (46°C), the system had no trouble maintaining comfort. He hopes to install eight to ten additional units in other buildings the city manages. "The city would like to set an example of how we can save energy," he told *EBN*. *– AW*

For more information:

Ice Energy, LLC
Windsor, Colorado
970-545-3630
www.ice-energy.com

CALMAC Manufacturing Corporation
Englewood, New Jersey
201-569-0420
www.calmac.com

Cold-Climate Heat Pump Temporarily Chilled

Nyle Special Products, LLC, has suspended production of the Cold-Climate Heat Pump™ (CCHP) amid skirmishing between the manufacturer, its former general manager, and the developer of the technology. Duane Hallowell resigned as general manager of Nyle in February to form Hallowell International, LLC, which acquired the manufacturing rights to a group of patents held by engineer David Shaw for technology that he developed. Those patents were initially licensed to Nyle for use in the CCHP, but that agreement was terminated earlier this year by Shaw, who had a per-unit-produced compensation contract.

Nyle, which shut down CCHP production shortly after it began in order to perform additional R&D to increase efficiency and reliability, has sold approximately 250 units. The company plans to recommence production before the end of 2005, claiming that the technology it's actually using is defined under an earlier patent held by another individual. Nyle owns the Cold-Climate Heat Pump name. Meanwhile, Hallowell received a $200,000 loan-and-lease package last month from the Maine Department of Economic and Community Development to help establish the new venture, but product is not expected to be available from the startup sooner than the first quarter of 2007.

Charlie Stephens, policy analyst at the Oregon Department of Energy, is eager for the dust to settle. "I've been working with all of these people for a while," he told *EBN*, "and I'm in favor of anybody who can be successful in bringing this technology to the market."

EBN reviewed the CCHP in Vol. 13, No. 7 and subsequently named it a BuildingGreen Top-10 Green Product for 2004 (see *EBN* Vol. 13, No. 12). *– MP*

For more information:

Nyle Special Products, LLC
Bangor, Maine
207-942-2865
www.nyletherm.com

Hallowell International, LLC
207-990-5600

Product Brief

Johnson Controls Acquires York— Johnson Controls, Inc., an industry leader in control systems for heating, cooling, and ventilation equipment, and York International Corporation, a leading manufacturer of heating and cooling equipment, announced in August 2005 that Johnson Controls would acquire York. "The transaction will enable us to become a single source of integrated products and services that building owners want in order to optimize comfort and energy efficiency," says John Barth, chairman and CEO of Johnson Controls, noting that "bringing together our two organizations will also create the largest building services force in the world, strongly positioning us to capture an increased share of the fragmented $130 billion global services market for commercial buildings." For details, see www.johnsoncontrols.com.

Getting to Zero: The Frontier of Low-Energy Buildings *(from page 1)*

consumption, the building is a *net energy producer* or a *net energy exporter.*

For most zero-site-energy projects, imported energy is in the form of electricity or natural gas, and energy produced onsite is in the form of electricity from photovoltaics or wind turbines. By some interpretations, buildings with their own woodlots or farms with their own sources of methane can claim those energy sources as onsite production, but NREL's researchers take a stricter approach, limiting allowable onsite generation to energy produced within the building's footprint.

Buildings that are not connected to the utility grid but instead produce and store their own power may meet this definition. In practice, however, nearly all such buildings import at least a small amount of propane or other fossil fuel, and, without a grid connection, they have no practical way of exporting energy to offset that imported fuel.

Zero-net-annual source energy. This definition is based on energy used offsite to generate and transport the energy that is used at the building. On average in the U.S. it takes just over three units of fuel for a power plant to deliver each unit of electricity and about 1.1 units of fuel to deliver each unit of natural gas. To calculate a building's total source energy, both imported and exported energy are multiplied by the appropriate source-energy factor, so one unit of exported electricity can offset about three units of imported natural gas. While the site-energy-based definition favors the use of electricity as a purchased fuel, because it can be used for cooling or heating at efficiencies greater than 100% using chillers or heat pumps, the source-energy definition tends to favor the use of fossil fuels.

Strictly speaking, by this definition any fossil-fuel power plant that generates electricity with an efficiency better than the national average could be called an energy producer. For this and other reasons, the zero-source-energy definition should ideally be calculated on the basis of actual source energy used rather than national averages. The amount of source energy varies tremendously by region, season, and even time of day as the load profile on the utility grid changes to meet fluctuating demand.

Zero-net-annual energy cost. As electric utilities are increasingly being required to purchase excess energy generated by end-users through net-metering agreements, the possibility of a zero-energy-cost building emerges. In a zero-energy-cost building, the amount of money the utility pays the building owner for the energy that building exports to the grid equals the amount it charges the owner for the energy the building imports from the grid.

This definition uses market valuation to account for the relative value of various fuels. Natural gas costs less per unit of energy than electricity, so a building could export less energy in the form of electricity to offset the purchase of a certain amount of gas. The amount of electricity that has to be generated onsite and exported to offset imported electricity depends entirely on the relationship between the purchase price and the price at which the power is sold to the grid.

The purchase price of energy includes charges for distribution, taxes, and metering, as well as for the energy itself, so, even if the purchase price and selling price per unit of energy are equal, it may be necessary to export more energy than is purchased to cover those additional costs. Some net-metering agreements do not provide payment for exported electricity beyond the building's consumption—making it impossible to recover demand charges and fixed charges or to profit from the sale of onsite electricity generation. These prices reflect the cost of maintaining the infrastructure, which the building uses to export electricity even when it is producing more than it consumes. On the other hand, in some cases a premium is available to the building owner for the sale of renewably generated energy, as it can be used by a reseller to meet renewable portfolio standard requirements or otherwise sold as part of a green power mix. A building's success in meeting this definition is typically easy to verify, as utility bills regularly chart its performance.

Zero-net-annual emissions. A zero-emissions building offsets emissions equivalent to the amount emitted through the source energy that powers the building. This calculation is often limited to greenhouse gas emissions, which contribute to climate change; in this case, a zero-emissions building can be called *climate neutral.*

This definition can be achieved either through onsite electricity production, as a zero-source-energy building, or through the purchase of renewable energy credits (RECs, or green tags) supporting the generation of offsite renewable energy (see *EBN* Vol. 11, No. 5). Even the most inefficient building can achieve climate neutrality through the purchase of enough RECs—but there are other reasons, including cost savings, local air pollution reductions, and persistence of the benefits, why it makes sense to optimize a building's efficiency first. This definition is unique in that it holds each building directly accountable for its contribution to climate change.

How has zero-energy been defined already?

A few organizations have adopted different definitions of zero-energy, which have ranged from vague to misleading. The Net-Zero-Energy

Home Coalition, a multi-stakeholder group in Canada consisting of corporations and nonprofit organizations, defines a zero-energy home this way:

"A net-zero-energy home at a minimum supplies to the grid an annual output of electricity that is equal to the amount of power purchased from the grid. In many cases the entire energy consumption (heating, cooling, and electrical) of a net-zero-energy home can be provided by renewable energy sources."

In its Zero-Energy Homes program, launched in 2002, the U.S. Department of Energy (DOE) includes homes that use half as much energy as comparable, minimally code-compliant homes, according to project manager Lew Pratsch. "A Zero-Energy Home (ZEH) combines state-of-the-art, energy-efficient construction and appliances with commercially available renewable energy systems such as solar water heating and solar electricity," says a flyer promoting the program. "This combination can result in net-zero-energy consumption from the utility provider. Zero-Energy Homes are connected to the utility grid but can be designed and constructed to produce as much energy as they consume annually." The flyer goes on to describe two "ZEHs" expected to use at least 90% less energy than homes built to code. "We know most homebuyers will not buy a true zero-energy home that produces all the energy it needs over the course of a year," Pratsch told *EBN*, but he notes that "when a homeowner can see their energy bill cut in half, or more, that gets their attention."

More recently DOE has defined a zero-energy building as "a residential or commercial building with greatly reduced needs for energy through efficiency gains, with the balance of energy needs supplied by renewable technologies."

The American Council for an Energy-Efficient Economy has created a forum in which others may contribute to this debate. The theme of its 2006 conference, set for August 13 through 18 in Pacific Grove, California, is "Less is More: En Route to Zero-Energy Buildings." Paper abstracts must be received by October 21, 2005, to be considered for the conference. For more information on submitting an abstract or attending the conference, visit www.aceee.org.

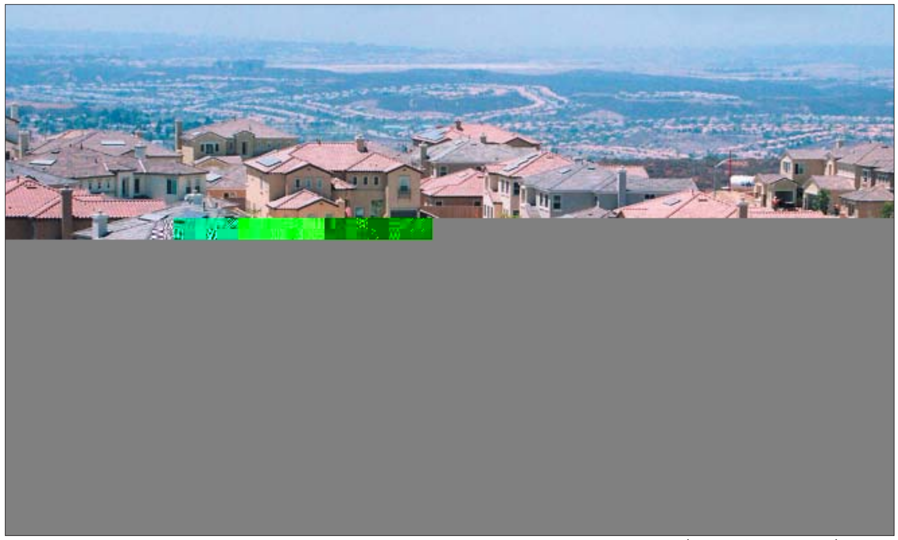


Photo: NAHB Research Center

The homes in this San Diego community, opened in 2001 by developer Shea Homes San Diego, are part of DOE's Zero-Energy Homes program. They were designed to use up to 38% less energy than homes built in minimal compliance with California's Title 24 standards.

What's missing from these definitions?

While these definitions of zero-energy tell a lot about the energy performance of a building, they leave a few blind spots.

Transportation impacts. These definitions measure energy used only within the building itself, ignoring the building's effect on transportation. A building located within walking distance of other amenities or along public transportation routes can be reached with minimal transportation energy. The same building located in the suburbs, on the other hand, might require residents, employees, or visitors to drive personal vehicles to reach it. Several studies have shown that the amount of energy used for transportation to and from a building can easily exceed the amount of energy used in the building.

Factoring in transportation sometimes introduces tricky tradeoffs. For example, running a separate freezer in a home clearly increases the home's energy use. But if that freezer reduces the need for driving to the supermarket, it may actually save energy overall. Thus, measures of climate impacts that include travel generally measure an individual's energy footprint more accurately than measures that consider the energy use of a just a home or business.

Variations in the utility grid. Emissions and resource depletion from energy use are not uniform and constant but vary by location, season, and time of day. Utility companies often fire up inefficient, more polluting generators to meet demand when power usage is high, and have more power than they can sell during the night. As a result, many utilities offer pricing structures with a higher rate for energy used at peak times, during the day, than at times of low demand, during the night. Mechanical systems that use inexpensive nighttime energy to chill water or make ice for use during the day moderate this demand (see page 10 for a review of an ice-based thermal energy storage system), but they sometimes use more energy to do so. Only the zero-energy-cost definition accounts for the benefits of load shifting, and only when on-peak energy costs more than off-peak energy.

Why is it Important to Get to Zero?

The many-headed monster of climate change is the preeminent reason to reduce energy use. "Energy consumption is the dominant environmental issue for the next century," says Gregory Kats, principal of Capital E, based in Washington, D.C., and chair of the LEED™ Energy & Atmosphere technical advisory group. Powering buildings accounts for 39% of America's carbon dioxide emissions, which in turn account for 24% of global emissions. Dramatically increasing the efficiency of our buildings is essential if we hope to stabilize Earth's climate.

At the same time, we face the looming end of the fossil fuel age and, likely, a consequential resource crisis. Whatever we can do now to decrease our dependence on energy, and especially on fossil fuels, will ease the transition to a renewable economy. Supporting cutting-edge technologies while they are still in their infancy enhances their chances of widespread adoption. "From a larger societal perspective, you want to encourage new technology which is still on a steep cost curve," says Kats. Reducing energy demand also reduces the price of energy for the entire market. "Supporting efficiency has cumulative market-wide impacts in price reduction at the same order of magnitude as in individual buildings," he argues.

Reducing energy use also has regional benefits. Producing electricity from fossil fuels creates air pollution, and communities downwind from these plants, too often representing minority and low-income people, suffer consequences ranging from asthma to mercury poisoning. And nuclear power introduces the risk of radiation to surrounding communities. "You want to reduce power generation in areas of highest population density," says Kats. If a building in New York doesn't reduce its need for imported energy but instead chooses to offset its usage with RECs, Kats explains, it is most likely contributing to the development of a wind farm in a sparsely populated area such as South Dakota. That action is great for limiting climate change, but it does nothing to reduce smog-generating pollutants or nuclear risk in the population centers.

Buildings that produce much of their own energy onsite can serve as safe havens following natural disasters or terrorist events. "Schools are ideal for providing backup," says Kats, noting that they are widely distributed, easy to locate, and spacious. "Federal programs should provide renewables and ride-through capability at schools, a distributed network of places where people can have basic services provided." Some of the strategies that improve a building's efficiency, such as natural ventilation and daylighting, also greatly increase its ability to function during power outages.

The above arguments support the need for energy efficiency across the board—not necessarily for zero-energy buildings. A move toward zero-energy buildings is needed to keep pace with the ever-growing number of buildings while still reducing energy use measured across the buildings sector, according to NREL's Paul Torcellini, Ph.D., P.E. "The number and floor area of buildings in this country continue to go up," says Torcellini. "Unless we can get to zero-energy buildings, how do you turn the ship around?"

With this need in mind, DOE's Building Technologies program has defined this goal: "To create technologies and design approaches that enable net-zero-energy buildings at low incremental cost by 2025." To achieve this goal, industry leaders must implement advanced technologies and design approaches today. In doing so, they accomplish several goals:

- Proving that zero-energy is possible (at least for certain building types in certain situations);
- Trying out various technologies and design approaches and gaining the experience to implement the most successful approaches more widely;
- Driving down the cost of specialized equipment and making it more readily available in the marketplace because increasing demand for these technologies introduces economies of scale; and
- Providing a model for the future and inspiring those who are trying to make *zero-energy* business as usual.

What Does it Take to Get to Zero?

Getting to zero, except by purchasing renewable energy credits, is difficult. It requires superior efficiency and a significant investment in onsite renewable energy generation. Getting to zero is difficult for a variety of reasons. The most obvious is upfront cost, which may be inherent to the goal but is also affected by project team capabilities and technological challenges. Other factors, such as building type, climate, and occupant inclinations, also play a pivotal role. "You have to start pushing and doing a lot of things simultaneously. It's expensive and it's complicated," says Peter Rumsey, P.E., president of Rumsey Engineers, Inc., in Oakland, California. Marc Rosenbaum, P.E., principal of Energysmiths in Meriden, New Hampshire, agrees: "My message is that it *is* possible and it *is* hard."

Building type and climate

Achieving zero-energy is possible in some, but not all, building types, according to several engineers *EBN* spoke with. "How the building is used has more effect on its load than anything," says Ron Perkins, principal of Supersymmetry USA. "For visitor centers and educational buildings, it's a reasonable goal to be a net-zero-energy consumer." Most warehouses are also candidates for zero-energy status, according to Torcellini. "Offices have some of the biggest savings potential, but getting to zero is tough because of the remaining energy needs—especially plug loads and ventilation requirements," he notes.

Building types that have higher internal loads may have to abandon the goal of achieving zero-site-energy in favor of zero-emissions. In other words, they may be unable to produce enough energy within the building footprint (or even onsite) to offset their annual use, but they can still purchase renewable energy credits, representing offsite renewable energy generation, to offset their energy use. Even the most energy-intensive buildings, however, can reduce energy use far below conventional practice. "You can do 30% reduction by not changing anything except equipment selection," says Perkins. "You can do 50 to 60% reduction fairly easily." The challenge, he says, is in the current profit model by which buildings are designed and constructed, not in the technologies.

In addition to a building's function, the climate in which it is situated has a large impact on the feasibility of getting to zero-energy. In benign climates, such as coastal California, relatively little energy is needed to provide for occupant comfort, compared to the cold areas of the Upper Midwest and Northeast or the hot, humid South. Those mild climates allow designers to use ambient conditions to provide comfort much of the year, while using onsite generation to meet demand for energy uses such as lighting and plug loads. Other climates have different challenges. Hot, dry climates, for example, may require a lot of cooling, but they are also typically blessed with large diurnal temperature swings, which opens up opportunities for cooling with nighttime venting or various forms of thermal storage.

Rendering: The Kubala Washatko Architects, Inc.

The Aldo Leopold Foundation's 13,000 ft² (1,200 m²) Aldo Leopold Legacy Center, a four-building complex, is planned for the site near Baraboo, Wisconsin, where Leopold died while fighting a grass fire in 1948.

Project team commitment and capacity

The pursuit of a zero-energy building in today's design and construction market is not for the faint-of-heart. It demands the commitment, the determination, and the knowledge to challenge conventional solutions and business-as-usual every step of the way. That commitment begins with the owner or client. Perkins, who has worked with several progressive owners, including Oberlin College and the Aldo Leopold Foundation, told *EBN*, "The owners have to impress their will on the designers." According to Rumsey, "You have to get owners to take the risk, and then get the contractors to roll along with it."

A zero-energy project is best approached through design from the ground up, rather than starting with the image of conventional building and looking for improvements. "First, inventory what the local resources are," says Perkins, noting that this includes resources ranging from wind and the sun as energy sources, to aquifers and the ground as temperature sinks, to gravity instead of pumps. "It's common that they go ignored in the design process," he says.

Not just the owner but the entire design team has to be committed to the goal of zero-energy in order to make that goal a possibility. Even when they claim to be pursuing low-energy designs, "architects are not paying a lot of attention to the things that drive the loads," complains Rosenbaum. Describing the problem as the "momentum mentality," Rumsey says, "It's actually hard to do something different, not from the technological perspective, but more from the process perspective. I can come up with lots of good ideas to save energy, but a lot of times they just mess everybody up." Perkins has also struggled with the design process: "Every time you try to interject an alternative to the beaten path, it always comes back that it is too expensive," he told *EBN*. "Then you have to do the research and find out if it *is* too expensive, and, if it is, why. That eats up time," he says, "but it's a necessary part of doing a green building."

Kats adds that difficulties during the design process extend beyond the capacity of the people involved to the capacity of our design tools. "The models we have are not very accurate. If you have inaccurate models and you want to be safe, you're going to build in safety margins that are fairly large," he says. He believes, however, that safety margins are dropping as design professionals gain experience with green buildings and gain confidence in energy-efficient systems working as designed. The development of more sophisticated, and more accurate, simulation tools should diminish this obstacle.

Next comes construction. "Can you get it designed," asks Rosenbaum, "and can you get it built? In general, the knowledge isn't out there to do either." Perkins stresses the importance of ensuring that everyone involved in the construction understands the project goals. "The local infrastructure of contractors and craftsmen has an impact on the projects. They have to buy in to make it work."

Photo: Rob Wellington Quigley Architects

The 13,200 ft^2 (1,230 m^2) Leslie Shao-Ming Sun Field Station at Stanford University's Jasper Ridge Biological Preserve uses daylighting, natural ventilation, solar hot water panels, and photovoltaic panels to limit its need for imported energy. Real-time energy monitoring data is online at http://jr-solar.stanford.edu/.

Technological opportunities and challenges

The low cost of energy over the past century has led to a situation in which most mechanical and electrical devices are optimized for low first cost rather than for efficiency or low operating cost. In addition to the obvious inefficiencies, such as fans that draw full power regardless of the amount of air they're moving, or heat exchangers that don't transfer as much heat as they could because they're too small, nearly every piece of equipment also has hidden loads that use extra energy because no one ever thought to design them otherwise. For example, hydraulic elevators have electric heaters to keep the hydraulic fluid warm.

Even renewable energy systems are often guilty of sucking up extra energy on the sly. Inverters and transformers that process direct-current electricity from photovoltaic (PV) panels and convert it to 120-volt alternating current for use in a building continuously consume energy, even when the panels themselves are not producing any. "When the PV panels aren't producing any energy, the transformer is still taking energy off the grid and turning it into waste heat," Philippe Cohen, Ph.D., administrative director of Stanford University's Jasper Ridge Biological Preserve, says of the Leslie Shao-Ming Sun Field Station (see description in BuildingGreen's Case Studies Database). Isolating that transformer when the system is not generating electricity will save 5 or 6 kWh each day, he estimates, enough to make the Station a zero-site-energy building.

Conservation vs. generation

"It's a lot cheaper to save energy than to generate it," says Rumsey, adding that "you can go really far before you get to a point where efficiency is more expensive than something like renewable energy or cogeneration." Even if it isn't feasible to install the energy generation equipment to make a building into a zero-net-energy user, designing it to use no more energy than could be generated within the building's footprint is a useful target, suggests Torcellini.

The amount of energy that a building can generate onsite is limited if only solar power is available, unless the collection area extends beyond the building itself. Today's commercially available PV panels have a peak output of roughly 11 w/ft^2 (110 w/m^2). In most U.S. locations, a properly oriented panel will generate about one kilowatt-hour (kWh) per year for each watt of peak output, or 11 kWh/ft^2 of collector. A very efficient commercial office building would do well to use less than 11 kWh/ft^2 per year (110 kWh/m^2/year)—to meet that load entirely with PVs on an annual basis requires as much surface area in properly oriented PV panels as there is floor area in the building. In a survey of six carefully monitored, relatively efficient buildings, NREL researchers determined that the one-story buildings could achieve true zero-site-energy status by using their available roof area for PVs, while the two-story buildings could not.

If the solar collection area is not limited to the building's roof area, more buildings can achieve the goal of zero-energy use. A PV parking-lot canopy now under construction at Oberlin College in Ohio, should nearly triple the amount of energy produced onsite, which should catapult Oberlin's Adam Joseph Lewis Center into energy-producer status. With PVs costing roughly \$50/ft^2 (\$500/m^2), however, even if the space is ample, the budget may not be.

Wind power can also be a good option for onsite generation. With a local source of wind power, even a high-rise building could be net-zero, says Perkins. "That's probably the only way you can do it," he says. "There's not enough surface area to do it with PV." Using about 5 kWh/ft^2 per year (50 kWh/m^2/year), the Woods Hole Research Center is an extremely efficient building, according to Rosenbaum (see description in BuildingGreen's Case Studies Database). About one-third of its energy need is currently supplied by PVs, and the organization plans to add a large wind turbine to provide the rest. "In a coastal location you can combine solar and wind to make a net-zero-energy building," says Rosenbaum.

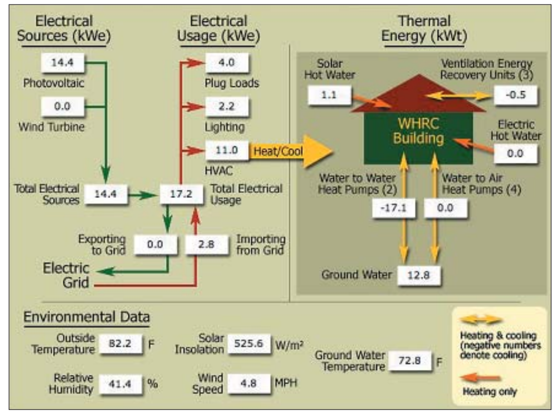
The occupant factor

"The technology part is fairly straightforward," says Perkins, "but the people part is challenging." Regardless of a building's designed efficiency, occupant interest and commitment drive energy use. Even in cohousing communities, which usually have a high level of environmental awareness, "you can see 3-to-1 variations in the amount of energy people use," says Rosenbaum. Before agreeing to work on a zero-energy house, Rosenbaum screens his clients carefully to understand whether they can be depended on to operate the house efficiently. For committed clients, he tends to recommend an all-electric home powered by photovoltaics, with a heat pump providing heat and hot water to limit the complexity of the systems. If the client is less conscientious, however, he employs solar hot water because it can provide larger quantities of hot water at a reasonable cost.

Even with significant financial and technical support, creating a zero-energy home for occupants who are not committed to saving energy may be not be possible today. A July 2004 article in *Energy Design Update* describes monitoring results from six homes built to be zero-energy under DOE's Building America program. Only one of the six managed to produce as much electricity as it used, and none came close to achieving true net zero, by any definition.

Getting occupants the information they need to make informed decisions can have a large effect on a building's energy performance. The first step is making sure that occupants understand why conserving energy is important. "The occupants have to be brought in," says Perkins. "If you don't make that connection, you can't achieve the potential of the building." Once the will is in place, basic information about how to operate the building is critical. "The trick is to use good sensors in the background and have a human interface that is reasonable," says Perkins. At the naturally ventilated Aldo Leopold Legacy Center in Baraboo, Wisconsin, still in design, "we finally boiled it down to one little light," he says. "When it's on, it means you need to close up shop and let the automated system take over. When it's off, you can use the fans and the windows."

Real Time Building Energy Flow



The 19,200 ft² (1,780 m²) Gilman Ordway Building at the Woods Hole Research Center in Falmouth, Massachusetts, generates much of its energy needs through onsite photovoltaic panels; an onsite wind generator is planned. The Center publishes real-time energy monitoring data on its website, at http://www.whrc.org/building/education/EngFlw2.asp.

Monitoring

Detailed information from energy monitors can help facility managers identify and address unanticipated energy demand. "The monitoring needs to be in place and so useful that they'll keep using it," says Perkins. At the Sun Field Station, Cohen discovered that high temperatures were diminishing the performance of the PV panels and that the inverters were exacerbating the resulting loss of power. He was able to offset the problem by adding 8% more panels, which led to a 30% increase in available power. "We could not have figured that out if we had not been collecting data," he says.

Sometimes sophisticated monitoring systems tell you more than you want to know. The Sun Field Station's system told Cohen that the building was using 8 to 10% more electricity than was measured by Pacific Gas and Electric Company's meter. "Some loads turn on and off so fast," Cohen explains. "Our system is monitoring for loads ten times a second. And the PG&E meter measures something like every 10 or 15 seconds. It's at least an order of magnitude slower." "If we hadn't collected the data, we would be operating under the assumption that we had made it to zero-energy," he says, adding: "I'm as proud of our monitoring as I am of our efficiency."

Monitoring total energy usage is rarely enough to really understand the energy flows in a building, however—especially if the building has systems that generate electricity. Over the past few years NREL researchers have undertaken detailed studies of the energy flows at six small commercial and institutional buildings, and each study has provided interesting lessons. Of the six, only one, the Lewis Center at Oberlin College, aspires to be a zero-energy building (see *EBN* Vol. 11, No. 7). And that building will now achieve that status by expanding its PV array from the roof of the building onto a parking lot canopy. Detailed technical reports describing the monitoring and performance of these buildings are available online:

- Adam Joseph Lewis Center for Environmental Studies, Oberlin College, Oberlin, Ohio: www.nrel.gov/docs/fy05osti/33180.pdf
- Zion National Park Visitor Center Complex, Zion National Park, Utah: www.nrel.gov/docs/fy05osti/34607.pdf
- BigHorn Home Improvement Center, Silverthorne, Colorado: www.nrel.gov/docs/fy05osti/34930.pdf
- NREL Thermal Test Facility, NREL, Golden, Colorado: www.nrel.gov/docs/fy05osti/34832.pdf
- Cambria Office Building, Ebensburg, Pennsylvania: www.nrel.gov/docs/fy05osti/34931.pdf
- Chesapeake Bay Foundation Building, Annapolis, Maryland: www.nrel.gov/docs/fy05osti/34830.pdf

All six of these projects are also profiled in BuildingGreen's Case Studies Database.

Upfront cost

Many of the challenges described above, whether they involve extra time and effort during design or an investment in additional equipment, have cost implications for a project. Given the cost of PV and windpower equipment, in almost every case it makes sense to invest heavily in good design solutions to reduce energy usage as far as possible, before meeting the remaining demand with onsite generation. At both the state and federal level, incentive programs are available to reduce the cost of some onsite generation equipment and even some energy conservation measures. But no one will claim that a zero-energy building is achievable today at no additional cost.

In some cases, there are tradeoffs between measures that reduce energy usage over a year and those that reduce peak building loads and peak electricity demand. For example, natural ventilation may reduce energy use during parts of the year, but there are very few climates in the U.S. in which it is helpful during the most extreme hot or cold seasons. From a cost point of view, reducing peak loads is critical because those loads determine the size of the mechanical equipment and electrical systems—minimizing peak loads can lead directly to cost savings in that equipment. In nonresidential buildings, peak electricity demand is reflected on the utility bill, so there are cost considerations there as well. Thus, the benefits of zero-energy may have to be weighed against the cost and societal benefits of reduced peak demand.

Final Thoughts

Both true zero-energy buildings and those that just give it a good shot are pioneers in the green building world. The reality is that most of the building design and construction industry today is challenged to achieve energy savings on the order of 30% beyond code, and many projects that should be performing that well according to their energy simulations are falling short. By pushing the envelope in front of their peers, zero-energy projects drive technological improvements, build capabilities in the industry, and diffuse the resistance to moderate levels of savings.

As these initiatives become more common, it will become all the more critical to sort out the meaning of the various definitions, to eliminate confusion about what is meant by a "zero-energy building." A lot of creative thinking remains to be done, beyond the concept of zero-energy itself, about how to provide the comfort and services that people expect with the least adverse impact on natural resources and natural systems. Opportunities may even arise to enhance natural systems while serving human needs. "A lot of people are thinking beyond to the next steps," says Rumsey. "There's so much improvement that can be made, and everybody is eager to get on board. They just don't quite know how."

– Nadav Malin and Jessica Boehland

From the Library

Design for Life

The Architecture of Sim Van der Ryn

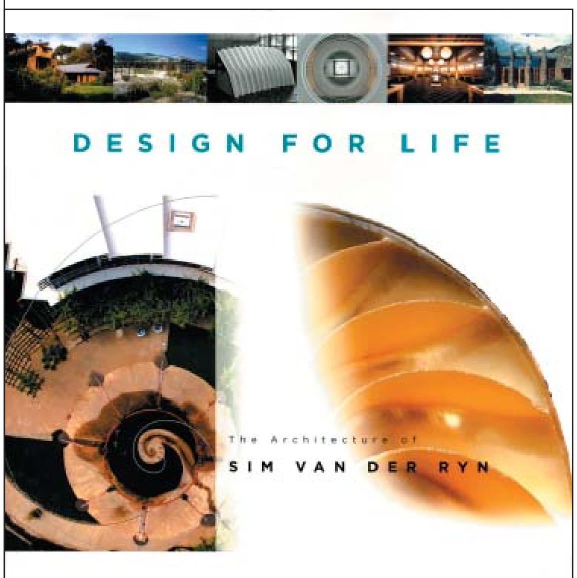
by Sim Van der Ryn. Published by Gibbs Smith, Salt Lake City, Utah. Hardcover, 2005, 182 pages, $39.95.

No history of today's green building movement can be complete without including the momentous role of Sim Van der Ryn. In this beautiful, coffee-table-style book, Van der Ryn showcases and explains his architecture, provides a personal account of his amazing career, and describes the philosophy behind his approach.

Having instigated so many pivotal initiatives, Van der Ryn is in a unique position to describe how they occurred and the underlying connections among them. His book *Dorms at Berkeley*, for example, was seminal in the evolution of post-occupancy evaluation (POE) of buildings. And he was among the founders of the storied Farralones Institute (now the Occidental Arts and Ecology Center), where Peter Calthorpe (now better known for his pedestrian-friendly urban designs) built and tested a cluster of solar residences. Each of these chapters from Van der Ryn's career is covered in two or three well-illustrated pages and provides just a glimpse into an episode that could make up an entire book.

Constantly pushing the limits, nearly

all of Van der Ryn's endeavors have been controversial on some level. While there is a sense of "setting the record straight" in these accounts (other participants would no doubt describe them differently), he doesn't shrink from describing his own weaknesses and learning experiences. Indeed, co-learning—whether with students at U.C. Berkeley, with colleagues, or with clients—is a key part of his approach to design and to life.



In the book's final chapter, Van der Ryn switches from the role of storyteller to that of cultural historian, anthropologist, and philosopher. These ideas don't flow as easily as his stories, but they are rich and provocative nonetheless. He lays out a view of human evolution, culminating in a vision of a cultural shift from our current materialistic, dualistic worldview to an integral and ecological consciousness. He describes ecological design, based on an understanding of natural flows and principles, as the architectural manifestation of this emerging cultural shift. In doing so, he continues the trajectory of his amazing career from the past on into the future. With this book, Van der Ryn has created yet another valuable element in his legacy to the sustainable design movement. *– NM*

Specifying LEED Requirements

Lessons Learned from Masterspec

from Architectural Computer Services, Inc. (ARCOM, producers of The American Institute of Architects' *Masterspec*®), www.arcomnet.com, 800-424-5080. Softcover book and CD-ROM, 2004, 250 pages, $240.

As anyone who has tried knows all too well, incorporating all the requirements for a LEED® project into the construction documents is no small task. Designers and spec-writers who've worked on LEED projects in the past can draw from those previous specifications and save a lot of time, but the first time through is always a challenge.

The American Institute of Architects' *Masterspec*® is a widely used master specification system, with specification language that aims to include all commonly needed requirements. Designers using *Masterspec* edit the master system for their projects by deleting requirements that don't apply and selecting or inserting the appropriate parameters for other requirements.

Recognizing the specification demands of the LEED Rating System, the writers of *Masterspec* have been proactive in including LEED-related requirements in the master specifications as the sections are revised. In all, nearly 100 sections now contain specific LEED language. They have also drafted whole new sections: one on LEED requirements in general, another on construction waste management, and a third on commissioning.

All of these materials are compiled in ARCOM's new resource, *Specifying LEED Requirements*. This book and its accompanying CD-ROM include all the LEED-related materials that *Masterspec* subscribers receive, including guidance documents, sample paragraphs to insert into the relevant sections, and lists for use in coordinating requirements across sections and with construction drawings. It even provides a large matrix indicating which specification sections are affected by each LEED credit.

Providing this level of guidance in a comprehensive manner is a mammoth undertaking, and these documents do a reasonable—but far from perfect—job. Among the most valuable function they serve is to translate the requirements of various reference standards, such as Green Seal's GS-11 standard for paints and coatings, into specific requirements governing the selection of paints. Sections that have not yet been updated for LEED, such as those covering windows (which could feature certified wood or recycled content) and structural steel (an important category for recycled content), are missing from this resource. There are also many LEED credits, such as those relating to energy efficiency, renewable energy systems, indoor air quality, thermal comfort, and daylighting, that cannot be addressed in terms of specification requirements until the relevant systems have been designed.

Given the ongoing changes to LEED, *Specifying LEED Requirements* could become dated quickly. It remains to be seen how aggressively this material will be updated and expanded to address other LEED rating systems, such as LEED for Commercial Interiors. Recent public comment drafts of LEED-NC 2.2 contain enough changes that these specifications will need significant revisions to apply to that document once it is formally adopted.

In spite of these concerns, for anyone developing a set of specifications with LEED-NC version 2.0 or 2.1 requirements for the first time, this book is worth its weight in gold. It lays out many of the requirements clearly and will save lots of time and effort. It will prove helpful even for sections that it hasn't addressed, because the model it sets forth is relatively easy to replicate. *– NM*

Calendar

OCTOBER

6-7 • 2005 Integrated Design Integrated Development Conference, Crawford Notch, NH. *Sponsor:* New Hampshire Chapter of The American Institute of Architects. *Information:* 603-357-2863; office@aianh.org; www.aianh.org.

6-9 • Solar Power 2005, Washington, DC. *Sponsor:* Solar Electric Power Association. *Information:* 202-857-0898; htaylor@solarelectricpower.org; www.solarpowerconference.com.

7-10 • ASLA Annual Meeting & Expo, Fort Lauderdale, FL. *Sponsor:* American Society of Landscape Architects. *Info:* 202-898-2444; www.asla.org.

11-12 • 5th Annual Empire Energy and Environmental Expo, Saratoga Springs, NY. *Sponsor:* Environmental Business Association of New York State, Inc. *Info:* 518-432-6400; www.eba-nys.org.

13 • Building Green: 2005 AIA Delaware Statewide Design Convention, Wilmington, DE. *Sponsor:* Delaware Chapter of The American Institute of Architects. *Information:* 302-654-9817; pwilson@dbia.org; www.aiadelaware.org.

17-19 • Buildings Executive Summit: Best Practices in Sustainability, La Jolla, CA. *Sponsor:* Stamats Business Media Live Events. *Info:* 952-224-8540; jhendel@sbmlive.com; www.buildings.com.

18-19 • Green Retrofit Strategies Summit, Toronto, ON, Canada. *Sponsor:* Strategy Institute. *Information:* 416-944-9200; ono@strategyinstitute.com; www.strategyinstitute.com.

19 • Sustainability and Energy Efficiency Leadership Conference, Oconomowoc, WI. *Sponsor:* Wisconsin Green Building Alliance. *Info:* 414-224-9422; connielindholm@wgba.org; www.wgba.org.

20 • Green Materials Showcase 2005, San Francisco, CA. *Sponsor:* Architects/Designers/Planners for Social Responsibility. *Information:* 510-558-1075; info@gms2005.org; www.gms2005.org.

26-28 • Excellence in Building 2005, Colorado Springs, CO. *Sponsor:* Energy & Environmental Building Association. *Info:* 952-881-1098; www.eeba.org.

NOVEMBER

6-8 • Building Materials Reuse and Recycling: Decon '05 Conference, Atlanta, GA. *Sponsor:* Building Materials Reuse Association. *Information:* 814-571-8659; guy_brad@yahoo.com; www.decon05.com.

8-10 • 2005 Design-Build Expo, Las Vegas, NV. *Sponsor:* Design-Build Institute of America. *Info:* 202-454-7535; pwilson@dbia.org; www.designbuildexpo.com.

9-11 • Greenbuild International Conference & Expo 2005, Atlanta, GA. *Sponsor:* U.S. Green Building Council. *Information:* info@usgbc.org; www.greenbuildexpo.org.

10-11 • Advanced Facilities Engineering Conference 2005 (AFEC), Denver, CO. *Sponsor:* USGBC, Colorado Chapter. *Info:* 303-771-2000; fax: 303-843-6232; lcramer@expomasters.com; www.afec.biz.

DECEMBER

13-16 • Ecobuild Federal, Washington, DC. *Sponsor:* Sustainable Buildings Industry Council. *Information:* 800-996-3863; www.ecobuildamerica.com.

FEBRUARY 2006

8-9 • Green Construction 2006, San Jose, CA. *Sponsor:* Construction Events. *Info:* 925-218-2225; www.greenconstruction2006.com.

MARCH

7-9 • Building Energy 2006 and Trade Show, Boston, MA. *Sponsor:* Northeast Sustainable Energy Association. *Information:* 413-774-6051; buildingenergy@nesea.org; www.nesea.org.

APRIL

19-20 • CleanMed 2006, Seattle, WA. *Sponsor:* CleanMed. *Info:* 617-524-6018; www.cleanmed.org.

MAY

10-12 • 4th Annual Greening Rooftops for Sustainable Communities Conference, Boston, MA. *Sponsor:* Green Roofs for Healthy Cities. *Information:* 416-971-4494; www.greenroofs.net.

22-26 • 2006 ACI Home Performance Conference, Austin, TX. *Sponsor:* Affordable Comfort, Inc. *Information:* 724-627-5200; lindawig@affordablecomfort.org; www.affordablecomfort.org.

More complete information and additional listings are online at www.BuildingGreen.com.

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