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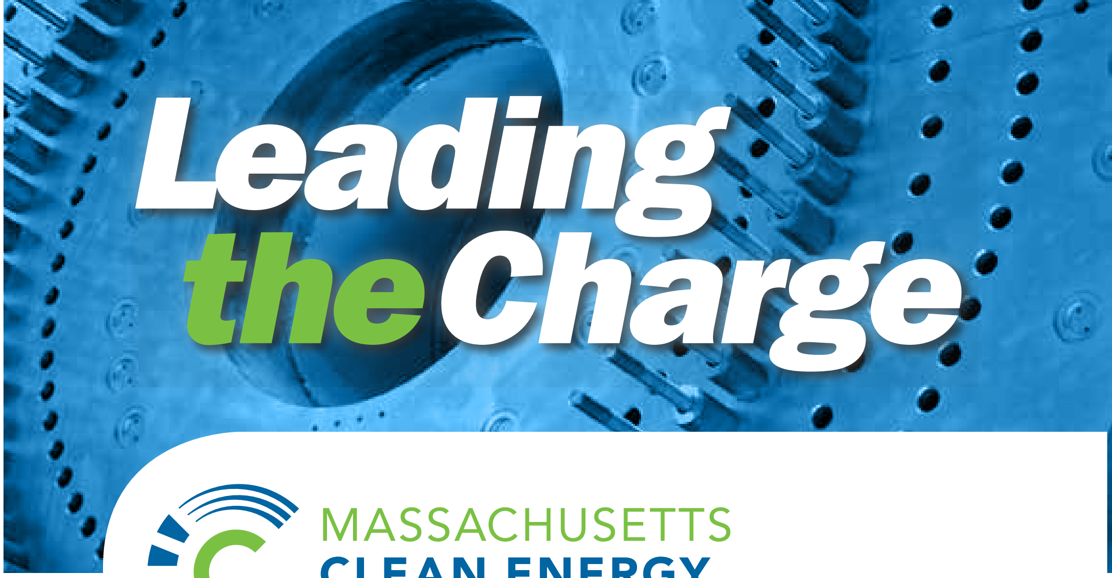
BUILDINGENERGY

THE MAGAZINE OF THE NORTHEAST SUSTAINABLE ENERGY ASSOCIATION

New territory: the Living Building Challenge

BuildingEnergy 2014 Conference Preview Issue




ENERGY SAVINGS
PRODUCTIVITY

Vol. 32, No. 1 | spring 2014

BUILDINGENERGY





On the cover

Smith College's Bechtel Environmental Classroom, in Whately, MA. When it receives certification, as anticipated, it will be one of just a handful of buildings in the world to meet the rigors of the Living Building Challenge. Bruce Coldham of Coldham and Hartman Architects tells the story starting on page 16.

About NESEA and *BuildingEnergy Magazine*

The Northeast Sustainable Energy Association (NESEA) is the region's leading organization of professionals working in sustainable energy, whole systems thinking, and clean technology. We advance the adoption of sustainable energy practices in the built environment through this magazine (distributed to NESEA members), our annual BuildingEnergy conference and trade show, professional workshops, our annual Green Buildings Open House, and more. A *BuildingEnergy* subscription is $55/year, which includes NESEA membership.

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Peer-to-Peer Learning for the Triple Bottom Line

It's been a busy fall and early winter at NESEA. In addition to gearing up for BuildingEnergy14, we've been working to launch a number of new initiatives, including BuildingEnergy Bottom Lines (BEBL). Of all the programs we've launched during my four years here, Bottom Lines is the one I've gotten most excited about—for both personal and professional reasons.

You can read much more about the Bottom Lines program and what inspired it on page 9, in an article by longtime NESEA members John Abrams, Paul Eldrenkamp, and Jamie Wolf. But in essence, BEBL is a response to two important questions: Are we being good ancestors? Are we being responsible stewards in our businesses? It is intended to help NESEA members who own their own businesses to maximize their triple bottom line: people, planet, and profit.

Bottom Lines takes the model for peer-to-peer learning that NESEA uses so effectively and applies it to business practices. Think BuildingEnergy, BuildingEnergy Pro Tours, and BE Local: they help us learn from each other what works—and more important, what doesn't—in terms of insulation, solar installations, or ventilation. BEBL will be the same, except it's for strategic planning, finance, HR practices, and so on. It's a truly compelling idea.

As with all NESEA programs, Bottom Lines works through networks. Within each network will be 10 noncompeting companies and one facilitator who will shepherd the discussion and provide good, sound business feedback. Each group will meet at least twice a year for a full day to take an in-depth look at one of the members' businesses and to more briefly review the metrics of the other participants.

> I believe that BuildingEnergy Bottom Lines is critical to our ability to scale the adoption of sustainable energy practices in the built environment.

So why am I so excited about Bottom Lines?

First, on a macro level, I believe this program is critical to our ability to scale the adoption of sustainable energy practices in the built environment. As practitioners, we may know everything there is to know about optimizing the building envelope and mechanical systems. We may know everything there is to know about siting a building for renewables, and about installing renewables to optimize their production. But if we are lousy at marketing, unable to sell sustainability, durability, and increased comfort to our clients, unable to determine which jobs are profitable and why, and unable to hire and retain the best talent in the industry, there's no hope we'll transform the built environment within our lifetimes.

Second, on a micro level, this program is the equivalent of my personal sustainability MBA. A month or two ago, while I was headed to a Bottom Lines

continued on page 51

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Mistakes Are Inevitable . . . But Let's Not Repeat Them

In the fields of building science and renewables, mistakes are inevitable. Especially when dealing with buildings as complex systems within an even more complex system—the environment. However, it's hard to understand why so many of our peers make the same mistakes over and over and over again. Why this resistance to change? We have the information we need to avoid at least some of the mistakes that have proven so costly to our fellow citizens and the environment.

Most recently, we have all heard the talk of rebuilding "bigger and better" after superstorm Sandy. This in spite of evidence that both the frequency and intensity of storms is increasing—which should make us at least consider whether it might be better not to rebuild in some areas. If we must rebuild, can't we at least learn from our mistakes and do it better? And then there's Boston's waterfront Innovation District. Apparently, in spite of its vulnerability, many of the new buildings slated for construction are designed with basement mechanical rooms.

What is it going to take to change the way we (re)build and site our buildings? What is it going to take for us to begin building for resilience?

> In Boston's waterfront Innovation District, many of the planned buildings are apparently designed with basement mechanical rooms.

On a more positive note, this past October I attended two very interesting and inspiring events. First was a forum in Boston called "Building a Resilient City: Preparing Our Buildings for Climate Change," sponsored by A Better City, where several projects designed for resilience were profiled. A week later, I went to a session at NESEA's BuildingEnergy NYC conference led by a member of the New York City Buildings Resiliency Task Force. Alex Wilson of the Resilient Design Institute, who spoke at the Boston forum, is doing great work in this area; he's made both the Boston and the NYC reports available on his website (www.resilientdesign.org).

While these recently published reports are an excellent resource, it will be years before any of this information is enshrined in the building codes. And unlike NESEA members and conference attendees (who can attend workshops like Kim Erslev's resilience-savvy "Beyond the Envelope: Right Building, Wrong Site"; see page 24), the vast majority of builders and developers will continue to build the worst buildings allowed by law. That is, they'll be "built to code."

This makes the work of organizations like NESEA even more important, as they continue to play a critical role in educating professionals to stop making the same mistakes over and over again. NESEA is doing this through, among other things, workshops and sessions at our BuildingEnergy conferences, peer-reviewed technical articles in this magazine, and BuildingEnergy Pro Tours that allow practitioners to learn directly from case studies presented by their peers.

continued on page 51

BuildingEnergy Bottom Lines: Whole Business Networking

A new NESEA initiative turns our peer-learning model to building better businesses

By John Abrams, Paul Eldrenkamp, and Jamie Wolf

Building Energy Bottom Lines (BEBL) is a new NESEA initiative that will help us use our businesses to create the world we wish for—make better lives for our families and our employees, enhance our communities, respond to the urgency of climate change, and achieve financial stability.

It will consist of regional peer-group networks of businesses dedicated to high-performance building, including architecture, engineering, building, design/build, energy efficiency, and renewable energy businesses. But the focus here is not building. It's the triple bottom line: people, planet, and profit.

If, like the three of us, you have great aspirations for your business that become overwhelmed by mundane daily realities, BEBL may be your ticket to a journey of discovery. Think of it as backpacking to a better business: it's strenuous, invigorating, scenic . . . and fun too!

The triple bottom line meets BE365

BEBL is designed to help us build stronger organizations through triple-bottom-line (TBL) practice.

TBL practice is a fundamentally different kind of commerce that is growing exponentially in the world of American small business. Whole business, you might call it. And peer-group networks are proven to enhance business performance. BEBL combines these two ideas, plus NESEA's model of peer-to-peer learning.

Within the various NESEA programs, we gain technical knowledge from our fellow practitioners. Willingness to share successes along with lessons learned from mistakes is a cherished NESEA core value. This value has cultivated a community that is truly a learning organization for developing broad-based mastery of technical skills. But we perceive a need

The Triple Bottom Line

BuildingEnergy Bottom Lines is designed to help us build stronger businesses through triple-bottom-line practice, a way of thinking and operating that assigns equal weight to people, planet, and profit.

People: social change and justice, employee well-being, governance, ownership, community involvement, philanthropy, legacy, and service

Planet: building-performance standards, resilience, company carbon footprints, and environmental restoration

Profit: financial success and stability, growth, capitalization, sales and marketing, investment

At BE14 "BE Bottom Lines" (Tuesday workshop), with John Abrams, Paul Eldrenkamp, and Jamie Wolf. For details, go to nesea.org/buildingenergy.

and a strong desire among the NESEA community to master complementary *business skills* as well.

This effort is part of NESEA's growing focus on BE365—that is, on making the level of learning and networking that happens at the annual BuildingEnergy conference a year-round phenomenon. We believe we are not changing the construction industry quickly enough to face the challenges ahead. We need to ramp up. We need to build capacity and new leadership potential. After hearing details of the vision at a recent BEBL planning session, longtime NESEA stalwart Bill Stillinger said, "This is something NESEA should have been doing for a long, long time."

What's under your hood?

Over the years, the three of us have benefitted from networks in which companies drilled into each others' businesses as a way to improve financial performance. As Paul says of one such group, "Before that I had no context, no idea what other people were really doing. If I had not joined that peer review group, I would not be where I am today." And Jamie: "We all must solve the same problems, but we solve them in different ways. I learned what's under the hoods of other companies; that helped me with mine."

Meanwhile, since 2007, John had been teaching a two-day class at Yestermorrow Design/Build School called "The Art of Small Business." In 2012 Jamie and Paul attended that class, and in 2013 Jamie returned. We decided we could expand what was happening there—companies coming together to share information about how to do better business that's better for the world—to a larger audience, and with more continuity. We agreed that the regional peer-group network model was the right one. We presented the idea to the 2013 class and asked for their reactions. They were enthusiastic.

And so BuildingEnergy Bottom Lines was born. The three of us are designing the program in association with NESEA Executive Director Jennifer Marrapese and Yestermorrow Executive Director Kate Stephenson.

How BEBL will work

To begin, we will establish three networks, each consisting of 10 to 12 geographically diverse (primarily New England) businesses. These businesses may range in size from no employees to 100 or more. Prerequisites for membership will include alignment with BEBL goals and commitment to engaged participation.

We have already identified a number of committed companies. At BE14, we will offer two half-day introductory workshops to collect more participants. In April, we will convene a two-day launch gathering at Yestermorrow in Vermont. If the program oversubscribes, we will form additional networks as our capacities permit—we need to be certain we can deliver a quality experience to everyone.

The networks will meet several times a year for two-day sessions at individual members' places of business, and they will communicate online year-round.

Initially, the three of us will be the facilitators—one of us for each network. The groups will agree on useful metrics and share performance data and experiences. We will learn from each other. We will swap stories. We will trade the marginalia in books we have learned from. We will examine documents that we have developed to help our business operations build capacity.

How to participate in BEBL
First, you must attend one of the introductory half-day BE Bottom Lines workshops on Tuesday, March 4, at the BuildingEnergy14 conference in Boston. To register for one, go to nesea.org/buildingenergy, where you'll also find more information about BEBL.

Most important, we will share the inner workings of our businesses—open them wide to scrutiny from our peers, who will help us to expand our capabilities and sharpen our skills.

Member businesses will pay a significant fee. We do not want cost to be a barrier, but it is important that everyone have skin in the game and that the program be profitable for NESEA and partner organizations. If your ability to pay the fee does not grow over time, we'll be surprised, because we're quite sure there will be great value to all participants.

As Paul says, "There are two kinds of small businesses in the NESEA community: those that I have learned a tremendous amount from and those that I will learn a tremendous amount from when I get the chance."

BuildingEnergy Bottom Lines will be that chance.

Jamie Wolf of Wolfworks operates Wolfworks in Avon, CT (homesthatfit.com). John Abrams is cofounder and CEO of South Mountain Company in West Tisbury, MA (www.southmountain.com). Both are former NESEA board members. Paul Eldrenkamp, a current board member, is founder and owner of Byggmeister in Newton, MA (www.byggmeister.com), and serves on Massachusetts Governor Deval Patrick's Zero Net Energy Building Task Force.

So You Think You Know How Insulation Works

On thermal radiation, natural convection, conduction, and the billions of fiber interactions that keep buildings warm

By Marcus V. A. Bianchi

Insulation is applied to building enclosures for many reasons: to provide comfort, to comply with building codes, to control surface temperatures, to reduce energy use, operating costs, and pollution, and to save distribution and heating plant costs. It is perceived as a product that building professionals are very familiar with. So I suspect that the title of this article sounds preposterous to some readers. If I got your attention enough to make you read on, good. The purpose here is to both revisit some of the concepts that most professionals know well and introduce others that are less familiar. How does insulation actually work? How does it reduce heat transfer?

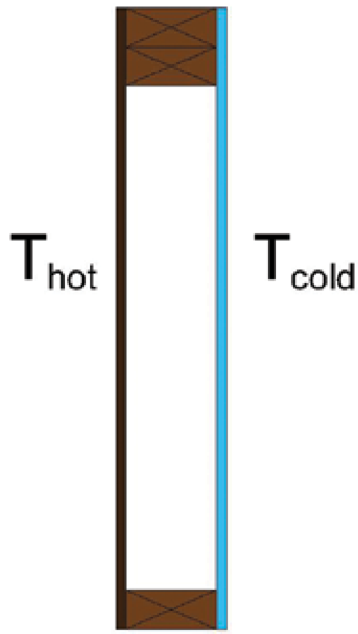


Figure 1. An uninsulated wall cavity separating a hot from a cold environment. It's not really empty; it contains air.

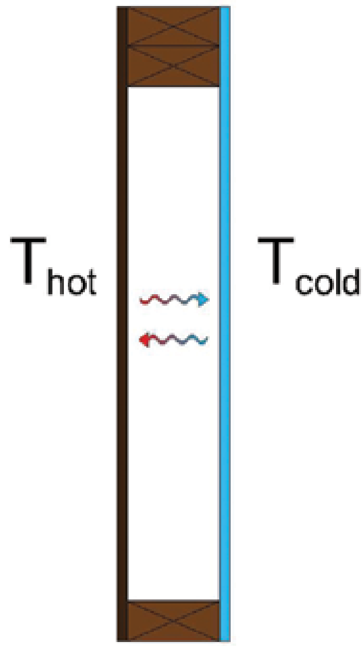


Figure 2. Heat is exchanged between the internal surfaces by thermal radiation, with a net effect that energy is lost from hot side to cold side.

Consider an uninsulated wall cavity

Let's first consider an uninsulated building cavity. It could be an attic, a wall cavity, or a floor cavity. But to simplify our discussion, let's consider a wall cavity, as shown in **figure 1**. Like every surface that is at an absolute temperature above zero, the internal surfaces of the cavity emit radiation. Heat is exchanged between the internal surfaces by thermal radiation in the infrared part of the spectrum, with a net effect that energy is lost from the hot side to the cold side, as shown in **figure 2**. The intensity of the thermal radiation depends on the absolute temperatures of the surfaces of the cavity and their emissivities (the relative power of their surfaces to emit heat by radiation). The temperatures are determined by the comfort temperature in the indoor environment and the outdoor weather. Emissivities are generally high for kraft paper, wood, and drywall, all around 0.9.

Note too that the uninsulated cavity is not really empty; it contains air. The air is virtually transparent to infrared radiation, so it has no effect on the *amount* of heat that leaves one surface and reaches the other. But that is not the end of the story. The air is free to move around within the cavity, even if the cavity is perfectly sealed. In the presence of a temperature difference between the two sides, the air near the hot side warms up, while the air near the cold side cools down. Warm air is less dense than cool air. This difference in density generates a recirculation, shown in **figure 3**, that *increases the efficiency of the heat transfer* between the hot and the cold surfaces. The intensity of this natural convection depends on the surface temperatures and the geometry and orientation of the building cavity.

The overall effect of a temperature difference on an uninsulated cavity is a combination of thermal radiation and natural convection, as shown in **figure 4**. This leads to a significant heat transfer between the hot and the cold surfaces. Thermal radiation dominates, contributing, depending on the temperatures, about 75 percent of the heat exchange. But natural convection, contributing the remaining 25 percent, is quite significant. To maintain the temperature difference between indoors and out, energy will have to be spent to either heat or cool the indoors. difference between the two surfaces. If the temperature difference vanishes, no heat transfer takes place. However, while foam sheathing may be part of the solution, cost considerations sometimes preclude it.

Let's consider the situation where fibers are introduced to the cavity, in the form of either a batt or loose fill. How does the insulation work? The fibers play two major roles in significantly reducing the heat exchange between the hot and cold surfaces: the fibers absorb and scatter thermal radiation, and they reduce the air permeability inside the cavity.

When I discuss how insulation works with practitioners, we usually talk about the creation of small air pockets inside the cavity. It is a way to say that the permeability of the cavity is so small that no airflow takes place. While this is great, it is the smaller part of the puzzle, since thermal radiation is the dominant mode of heat transfer in the cavity. Yes, the natural convection piece is very important, and fibers do reduce it by making it difficult for the air to flow. But the main reason insulation works well is that it significantly reduces the thermal radiation exchange between the two surfaces, as shown in **figure 5**.

In the presence of the fibers, radiation takes place not between the two surfaces, but rather between each surface and the fibers, and between the fibers themselves. The interaction between an incoming beam of radiation and a long, cylindrical fiber determines how thermal radiation propagates within the insulation. The complex mathematics involved in describing the phenomenon are beyond the scope of

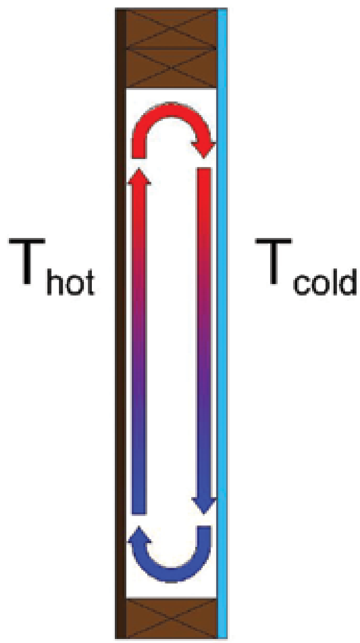


Figure 3. Warm air is less dense than cool air. This difference generates a natural convection that increases the efficiency of the heat transfer.

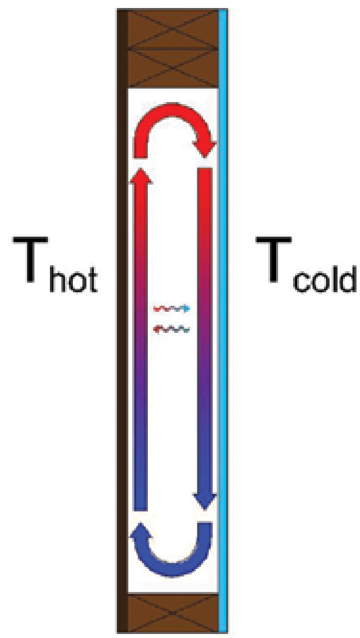


Figure 4. The effect of a temperature difference is a combination of thermal radiation and natural convection, which leads to heat transfer.

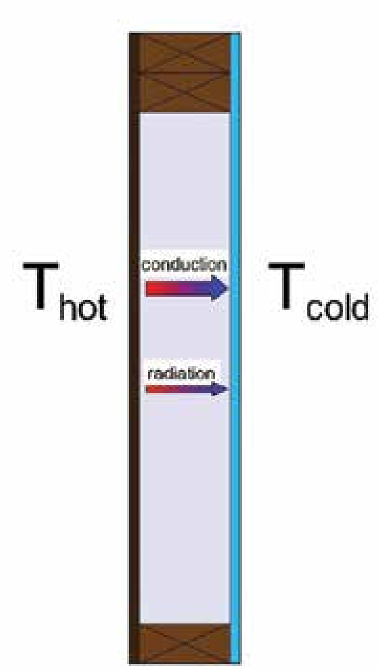


Figure 5. Fibrous insulation absorbs and scatters thermal radiation and reduces air permeability, reducing heat transfer.

Now add insulation

We add insulation to the cavity to reduce the heat exchange between the two surfaces. Reflective, foam, and fibrous insulation are among the types to consider. If one applies, for example, a reflective insulation to the cavity surfaces, it reduces the emissivity of one or both surfaces, thus reducing the thermal radiation between them. However, it does not reduce the natural convection exchange, which is still unacceptably high for a building enclosure. Alternatively, a layer of foam on the outside of the cavity will significantly reduce the temperature

At BE14 "The Science Behind the Insulation: Ignore at Your Peril," with Marcus Bianchi and Achilles Karagiozis, both of Owens Corning. For details, go to nesea.org/buildingenergy.

this article; it suffices to state that in each interaction between the radiation beam and the fiber, absorption and scattering take place. The effect of billions of fiber interactions like this is to reduce the intensity of the infrared radiation exchange from hot surface to cold surface.

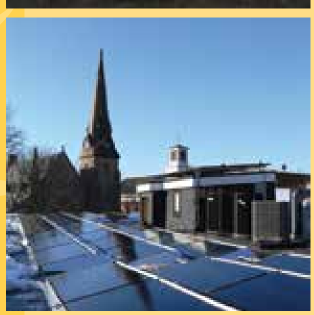
> The main reason insulation works well is that it significantly reduces the thermal radiation exchange between two surfaces.

The overall effect of adding fibers, then, is to significantly reduce thermal radiation and eliminate natural convection. The air, which no longer moves, can still conduct heat, but conduction is a lot less effective than natural convection in transferring heat from a hot region to a cold one. While heat transfer continues to take place in the insulated cavity, it is generally reduced by more than 90 percent. Conduction is responsible for approximately 75 percent of the heat transfer (depending on the temperatures considered), while radiation in the infrared spectrum is responsible for the remaining 25 percent.

In sum, insulation reduces the heat exchange between indoors and out, thus providing comfort—and reducing energy use, pollution, greenhouse gas production, and capital investments in power plants.

Marcus V. A. Bianchi, PhD, PE, is building science program lead with Owens Corning. Previously, he was a senior research engineer at the National Renewable Energy Laboratory, where he conducted research on deep energy retrofits. His research experience includes topics related to thermal sciences, such as building envelope thermal management, fault detection and diagnostics of HVAC equipment, materials processing, and bioengineering. Marcus received his PhD in mechanical engineering (heat transfer) from Purdue University and is a licensed professional engineer in the state of Colorado.

Peer reviewer *William B. Rose is senior research architect at the Prairie Research Institute, part of the University of Illinois at Urbana-Champaign. His research is in building performance, particularly the heat and moisture performance of building envelopes. His current research, with the US Department of Housing and Urban Development, concerns concentrations of common air compounds in weatherized and mechanically ventilated homes. He was recently named an ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) Fellow.*



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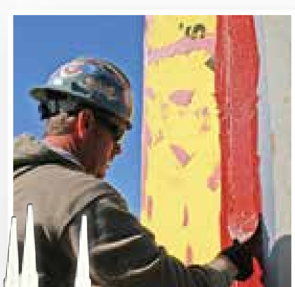

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Smith College Steps Up to the Living Building Challenge

A Northeast building is set to become one of the first in the world to meet the industry's most rigorous sustainability standard. Was it worth it?

By Bruce Coldham

The Living Building Challenge is the very highest bar of environmental performance. A considerable step above LEED Platinum, it essentially requires, among other things, that all energy, water, and nutrient flows be managed within the building and site boundaries. There are no points to tally, just 20 fundamental "Imperatives" (see sidebar, page 18). These Imperatives, rather than being mere improvements upon business as usual, are reverse-engineered from an understanding of the carrying capacity of the biosphere. All are validated by measurements during a full year of occupancy.

Worldwide, there are only about 160 LBC projects registered as in the works, and only four have been completed and earned full certification. So it is noteworthy to find four registered Living Building Challenge (LBC) projects in western Massachusetts. One of them is the Smith College Bechtel Environmental Classroom, in Whately, MA, which my firm, Coldham & Hartman Architects, completed in June 2012. With its 12-month occupancy period complete, it is on the verge of certification. How did we do it, what was the process like, and was it worth it?

The project team met the LBC's rigorous siting requirements by siting the building on what was once a farmer's boulder field, with the parking 1,000 feet away along an abandoned county road.

All photos by Ethan Drinker Photography

An ideal Living Building candidate

Smith College needed a building to support its environmentally themed classes and workshops—covering such diverse topics as earth sciences, botany, poetry, and dance. It was to be a 2,300-square-foot multi-use classroom and research building sited 10 miles north of Smith's main campus, at its 240-acre Archibald MacLeish Field Station. A large, flexible space would accommodate groups of up to 50 but also as small as 10 for either sedentary seminars or active dance or workshop construction activity. This primary space was to be supported by a smaller, laboratory-like classroom space for the science-oriented field study programs. Supplemental requirements included display space, toilet accommodations, a kitchenette, secure storage, and office space for the station manager.

> Rather than trying to predict behavior, our energy consumption projection was intended to regulate it by creating annual energy-use budgets.

The request for proposals to select the designer described what seemed like an ideal Living Building candidate:

At BE14 "Understanding the Living Building Challenge" (Tuesday workshop). For details, go to nesea.org/buildingenergy.

a small, manageable project for a long-established institutional client committed to sustainability, requesting a "world-class" environmentally high-performing building. We saw an opportunity and proposed that the college consider a response to the Living Building Challenge.

Salvaged cypress siding and locally and regionally harvested FSC lumber and glulams met the requirements of the LBC's "Materials" petal.

"Limits to Growth": rigorous siting

Four of the 20 LBC Imperatives relate to siting, and the first and by far the most demanding is "Limits to Growth." It requires that buildings be situated on previously developed locations, not "greenfields." But there is an exception for projects like ours whose primary purpose is environmental education and interpretation, and that can demonstrate that the site's ecological systems are not disturbed. By siting the building on what was once a farmer's boulder field, subsequently clear-cut and revegetated with invasive species, and by siting the parking 1,000 feet away along an abandoned (but previously established) county road, we were able to satisfy this rigorous imperative.

With a clear indication of likely acceptability for the siting, the design team proceeded to develop strategic responses to the core requirements of the LBC: zero net water, zero net energy, and benign materials sourcing.

Water: a closed-loop system

Achieving net zero water means designing a "closed loop system that accounts for downstream ecosystem impacts." The Northeast has an established practice of satisfying extramunicipal water supply using wells rather than roof catchment. Even so, our first instinct was to serve our modest load with captured rainwater. This arose from the recognition that this part of the world is endowed with extremely even precipitation—3½ to 4 inches each month of the year. But catchment is slow during winter (when the water comes in solid form), so it is still necessary to collect and hold a supply of four months or more.

Eventually we concluded that a concrete cistern was not the most elegant means of containment. Using the ground for storage is better because it is less material-intensive, and the storage medium retains the water at a higher quality. It also takes less energy to achieve acceptable water quality. This led to our exploration of what a "closed-loop system" means, and whether a well would be

LBC Hot Spot: Western MA

Four western Mass. institutions are responding to the Living Building Challenge. They represent a striking concentration of registered LBC projects.

Bechtel Environmental Classroom, Smith College
Whately
Completed June 2012
Certification anticipated 2014

Kellogg House, Williams College
Williamstown
Under construction

Campus Portal, Hampshire College
Amherst
In schematic design

Hitchcock Center for the Environment
Amherst (Hampshire College campus)
In schematic design

The Living Building Challenge, at a Glance

The Living Building Challenge (LBC) calls for buildings at all scales to "operate as cleanly, beautifully, and efficiently as nature's architecture," as the International Living Future Institute, the program's administrator, puts it.

Net zero energy, waste, and water are just the beginning. The Challenge comprises seven performance areas, or "Petals," which in turn are subdivided into 20 "Imperatives," each of which focuses on a specific sphere of influence. It is meant to be applied to almost any project type, be it a building, infrastructure, a landscape, or a community development. Certification is based on actual performance, as measured for at least 12 consecutive months.

One goal of the LBC is to challenge regulatory structures, which typically impede innovation. For example, public health regulations may inhibit on-site water catchment systems—and thus make achieving net zero water a challenge. The Coldham & Hartman team's exploration of water options pointed to a new route through the state regulatory maze. Ultimately, they didn't take it, but the LBC project team at Williams College did, and now it exists as an option for the next team.

Site Petal
1. Limits to Growth
2. Urban Agriculture
3. Habitat Exchange
4. Car-Free Living

Water Petal
5. Net Zero Water
6. Ecological Water Flow

Energy Petal
7. Net Zero

Health Petal
8. Civilized Environment
9. Healthy Air
10. Biophilia

Materials Petal
11. Red List
12. Embodied Carbon Footprint
13. Responsible Industry
14. Appropriate Sourcing
15. Conservation and Reuse

Equity Petal
16. Human Scale and Humane Places
17. Democracy and Social Justice
18. Rights to Nature

Beauty
19. Beauty and Spirit
20. Inspiration and Education

To learn more, go to www.living-future.org.

—Laura MacKay

LIVING BUILDING CHALLENGE

acceptable to the International Living Future Institute (ILFI), the LBC's parent organization. However, in the process of exploration we opened the possibility of a route through the state's regulatory maze to permit such a system under the reservoir provision of the existing statute—using a cistern instead of a lake, and roof catchment instead of acres of forested land. This route has subsequently been fully developed by another registered LBC project team (at Williams College; see the sidebar)

> The premium was in the time of the design team rather than the dollars of the building materials.

as a permissible option for potable water supply.

Even with composting toilets eliminating the need for flushing water, the state regulatory agencies projected a water flow of 360 gallons per day (gpd). The design team, however, projected a daily consumption of 48 gpd. Over the first year of occupancy, daily use was measured at only 5 gpd. That spread is indicative of the gulf between conventional wisdom and what a thoughtfully designed building operated with a conservation mindset can achieve.

With the composting toilets eliminating the blackwater flow, we considered in-building planter beds to treat remaining graywater flow—as we had done for the Wampanoag building on Martha's Vineyard in the early 1990s (see *Solar Today*, Jan/Feb 1995). But the building was not well suited to this type of system because of the inconsistent usage pattern: a four- to five-week midwinter student hiatus, and a similar decrease in activity over the summer. We considered an upper soil horizon root-zone leaching field, but that would have imposed an energy penalty for a pump and dosing chamber, which did not seem worthwhile given the

SMITH BECHTEL

PRODUCTION   Annual PV Production from 9.6 kW (projected)   12,000

CONSUMPTION			
	kWh/year	kWh/day	Comments/Assumptions
Annual Heating Energy	3,500	10	From in-house spreadsheet modelling
Hot Water	281	1	Tankless water heater- instantaneous electric — 200 gallons/mon.; 50F delta T; no stand-by losses SEE WORKSHEET
Ventilation	526	1	2 ERV @ 150 cfm at medium speed— 300 cfm @ 0.4 w/cfm; 120 Watts running for estimated 4,380 hours.
Lighting	1,104	3	2300 watts installed; assumes 50% for 2 hours (night) 25% for 6 hours (day) — 300 days
Plug loads	3,000	8	10 kwh per day — 300 days
Well pump	50	0	1,500 gallons per month; 6 gallons per minute; 250 minutes of 1kW (1/2 hp) well pump
Misc and Contingency 15% total	1,269	3	
Vehicles			NOT INCLUDED
TOTAL	9,730		
TOTAL no heat	4,961	14	

The projected energy-use budget derived in part from what we could achieve through design, and in part from what we anticipated could be achieved through a conservation mentality. Ultimately, the actual annual energy use was, at 8,892 kWh (13.2 kBtu/sf/yr), less than our projection.

slim nutrient return. So we elected to discharge effluent to a septic tank and from there to a leach field in a location with suitably porous soils. Graywater percolates into the soil and down into the water table, making for a "complete cycle." Even with over a year of occupancy, the 2,000-gallon septic tank is not yet full, and the leach field trenches are as pristine as the day they were buried.

Energy: the usual net zero strategy

The strategic thinking behind achieving the zero net energy Imperative was less intense. We live in the NESEA world and are accustomed to calculating energy flows into and out of our buildings as we design them, and public policy in most of the Northeast is fiscally supportive of distributed (i.e. decentralized) generation. So achieving a low-load building powered by a modest PV array was a clear and obvious strategy—and one that we had succeeded with before.

We began with an energy-use budget derived in part from what we could achieve through design, and in part from what we anticipated could be achieved through a conservation mentality. We use an internally generated spreadsheet to do this (see chart above). The assumptions upon which the chart's use estimates are based (noted in the comments column) basically reflect experience the design team has gained by paying attention to buildings that we have brought into being or taken an interest in over the years. The goal of this tabulation was to establish both the size of the PV system we should install and the fractional energy-use budgets for each major load component. With the production component established, we then designed with these load-component budgets in the front of our minds.

It is worth noting that we did not spend much time refining this rather crude projection of annual consumption. Consumption is ultimately more a function of behavior; rather than trying to predict behavior, this consumption projection is intended to regulate it by creating annual energy-use budgets in these categories. Using an Alteron dashboard to track energy use, we would be able to identify any behavioral aberration quickly and provide timely feedback. Ultimately, the actual annual energy use was, at 8,892 kWh (13.2 kBtu/sf/yr), less than our projection.

The mix of system components that made the most sense for this building was a pair of single-port air-source Mitsubishi FE 12 and 18 heat pumps with single wall-mounted indoor cassettes (one in each major space). Then we designed the envelope to be so tight and so thermally resilient that convective distribution of conditioned air to the smaller adjacent spaces was sufficient to maintain comfort. (Tested at 0.7 ACH50; 12-inch double-stud, dense-packed cellulose-insulated walls;16-inch cellulose-insulated roof.)

> The Challenge spreads its load among the owner/developer, the design team, the constructors, and even the users.

For ventilation we followed a similar path: two Zehnder ComfoAir 550 units, each serving one of the larger spaces. We balanced these with the continuous-exhaust ventilation associated with the composting toilets, controlling them using CO_2 sensing demand control devices. The intermittent use and the low water temperatures (mostly hand and specimen washing) were unsuited to a storage water heater, where standby losses from the required 140-degree F storage temperature would have been a considerable fraction of the total water-heating tally. So we decided on a Hubble instantaneous electric water heater with the temperature set at 110 degrees.

Photovoltaic panels were the obvious choice for a power source. Like most sites, this one was not rich in other alternatives, and the sun shone brightly. Typically we would expect to size and orient a portion of the roof plane to yield a sufficient solar harvest. But here, we were hard against a protected wetland tree line to the west, so we pole-mounted two 4.8 kW Sunpower arrays; fortunately the site was large enough to allow this. Freed from the need to dedicate a large roof to solar collection, we ran a cross-gable with a large south-facing clerestory window to provide copious and controllable daylighting to the major space.

"Appropriate Sourcing": arduous

The materials sourcing Imperatives are demanding. Particularly arduous is the "Red List," which precludes 15 chemical groups and natural elements from being construction material constituents, which requires formal declarations of constituent ingredients from all manufacturers.

The "Appropriate Sourcing" Imperative establishes a 1,000-kilometer radius from within which materials must be sourced. This has different implications for projects in the Northeast than elsewhere. For smaller wood-framed building, it is not possible to satisfactorily source LVL (laminated veneer lumber) or PSL (parallel strand lumber) products within the 1,000-kilometer limit. That leaves glulam beams as the most reasonable primary structural option, with solid flanged I-joists from manufacturers in Quebec as the secondary framing option. Exasperation mounts when sourcing preservative-treated material. Although there is a wonderful new Red List–compliant product from Arch Chemicals (EraWood) that treats for nonground contact using a combination of benign carbon-based ingredients, it requires southern yellow pine. And whereas southern yellow pine can be sourced just within the radius, the "Responsible Industry" Imperative (requiring responsible resource extraction—essentially an FSC certification) creates problems for projects with small-volume orders. In this case, putting the treatment process together with the sourcing restriction and the FSC requirement was like a rock-paper-scissors exercise. The LBC has provisions for reconciling these tensions. They come in the form of temporary "exemptions" and what they call "scale jumping"—which made achievement of the standards just possible.

Vetting materials produced by large, national corporations is uniformly challenging. The best strategy is to minimize the materials palette—to do more with less. (This was Bucky Fuller's dictum, but he did not have the LBC in mind.) Fewer products equals less hassle. That is especially true with lighting. We designed for a mix of recessed LED lighting and soffit-valanced indirect linear fluorescent fixtures (Phillips low-mercury T8 lamps—another current exemption). The recessed LEDs are mercury-free and very flexible—dimmable, tolerant of wet areas, and tolerant of cold. We designed sufficient dropped-ceiling planes to enable a comprehensive lighting solution without having to push recessed fixtures into the thermal envelope.

The flexible primary space, one side of which is shown here, accommodates seminars and dancing alike. A smaller, laboratory-like classroom suits science-oriented field study programs.

A premium in time, not materials

When, during the designer selection interview, the college asked us what the premium would be to build a Living Building, we referenced the Living Building Challenge Financial Study and determined that a "university classroom" building in "the Boston region" would be 16 to 21 percent more expensive. To account for our standard practices (12-inch walls, triple glazing, etc.), we suggested targeting the low end of that range.

Ultimately, we estimated the premium to be only around 8 percent. And we found it to be in the time of the design team rather than the dollars of the building materials. The time probably would have been reduced if we had been able to engage a construction manager earlier. The conventional bid process took design-team time at a critical juncture, and it delayed the arrival of the construction team, reducing their important role in the materials vetting process—a role that would have both given greater clarity to our options and avoided revisions to materials choices during the submittal process.

A challenge worth accepting?

So is "the Challenge" worth accepting? Why not just do one's best without regard to an essentially arbitrary set of targets and requirements, especially when mandatory targets can lead to suboptimal design decisions?

For such clients as liberal arts colleges and environmental education and advocacy organizations, the LBC

With the building site hard against a protected wetland tree line to the west, the project team pole-mounted two 4.8 kW Sunpower arrays, seen here beyond the entry porch.

The Team

Architecture
Coldham & Hartman Architects, Amherst, MA

Civil
Berkshire Design Group, Northampton, MA

Landscape
Dodson Flinker Associates, Ashfield, MA

Structural
Ryan S. Hellwig, PE, Northampton, MA

Interior design
Lorin Starr Interiors, Amherst, MA

Building performance
South Mountain Company (Marc Rosenbaum, PE)

Mechanical
Kohler & Lewis, Keene, NH

Electrical
Sager Associates, Stoughton, MA

Contractor
Scapes Builders, Deerfield, MA

has a great and growing brand value. But that value is hard to quantify, which is disconcerting when design teams are preparing to add considerably to the scope of their commissions and petitioning for commensurate increases in fees. For adequately compensated design teams, the LBC pushes all involved harder than we would push ourselves. Once the stakeholders and design team decide that the underlying values and aspirations are worthy, then yes, "the Challenge" is well worth accepting.

> The LBC pushes all involved harder than we would push ourselves.

At a societal level, to embrace the LBC is to support an effective force for positive change. While LEED aims for change by lifting the broad base of industry up by degrees (a good and critical starting point), the Living Building Challenge aims at deep philosophical change, pulling at the top, directing change to industry and regulatory environments not by brokering broad consensus, but by excellent example. The LBC empowers the design team to creatively achieve these performance standards (Imperatives) as best it can. The Challenge spreads its load among the owner/developer, the design team, the constructors, and even—and this is particularly important—the users. All parties have an integral role in striving for, and eventually achieving, the Challenge. This collaborative approach helps make really high-performing, low-impact, and even *restorative* buildings a reality.

Bruce Coldham, FAIA, is a founder and principal at Coldham & Hartman Architects, based in Amherst, MA. Active in NESEA since 1984 (or thereabouts), he spent three years as chair of the board of directors and is a three-time chair of the BuildingEnergy conference. In February 2010, he was elected to the American Institute of Architects College of Fellows. His architecture degree is from the University of Melbourne.

Peer reviewer *Jason Forney is a senior associate with Bruner/Cott Architects & Planners in Cambridge, MA. He is currently working on the Campus Portal Building at Hampshire College in Amherst, MA, which is being designed to achieve "Living" status under the Living Building Challenge. He is a graduate of North Carolina State University with degrees in both environmental design and architecture.*

Beyond the Envelope: Right Building, Wrong Site

The geography and ecology of a site can make or break your project

By Kim Erslev

Every building and its infrastructure affect a site's ecology and the health and resilience of its natural and human communities. As global climate change progresses and ecosystems evolve, site and contextual conditions beyond the building envelope will become more and more important for green building projects.

A building site potentially provides a host of ecosystem services: stormwater storage and infiltration, carbon sequestration, cleansing of polluted air and water, nutrient recycling, food production, and the support of human connection and well-being. We should always strive to protect existing ecosystem services and design every project to be resilient and ecologically sound.

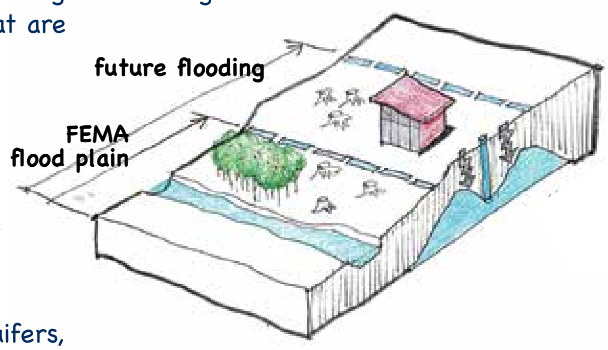
While careful development can increase community and ecological resilience, some sites are better preserved for their ecosystem benefits. When do we conserve a site and choose another, more appropriate site to develop?

Every green building project should start with a comprehensive analysis of the site's natural and cultural factors, current and potential ecosystem services, location within its watershed, and role as a positive, resilient component within its community context. This article offers a few examples. Only through such analysis can you understand the opportunities and constraints of the site, and whether it is wrong or right for your project—that is, whether the finished product will meet the needs of your clients, the wildlife, the water, the air, and the soil biota.

WATER

Wrong Site

Global climate change will increase sea levels and the frequency and intensity of storms, raising flood and groundwater levels. Avoid sites that are near current FEMA flood plains or are predicted to face flooding. Avoid low-elevation coastal properties or barrier beaches.



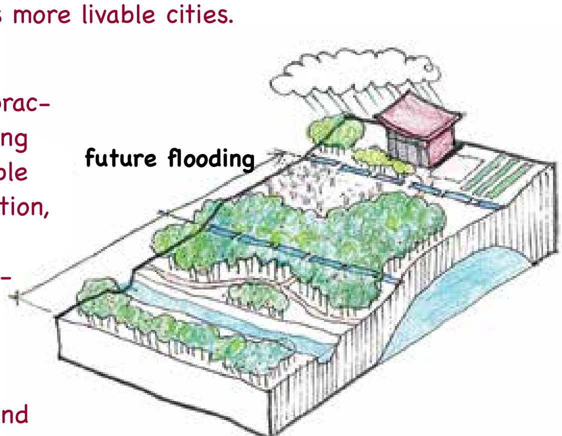
Wells draw down aquifers, and development pollutes underground potable water resources.

Know where your site is in relation to its watershed to track the upstream impacts of impervious development, forest clearing, and polluted runoff.

Better Site

Green infrastructure—porous paving, green roofs, planted areas—cools hot urban areas, increases biodiversity, cleans, stores, and infiltrates storm water, and creates more livable cities.

Employ net zero water practices: rainwater harvesting for potable and nonpotable uses, graywater reclamation, and onsite wastewater treatment, including composting toilets.



Locate structures outside flood-prone areas and protect the quality of deep aquifers.

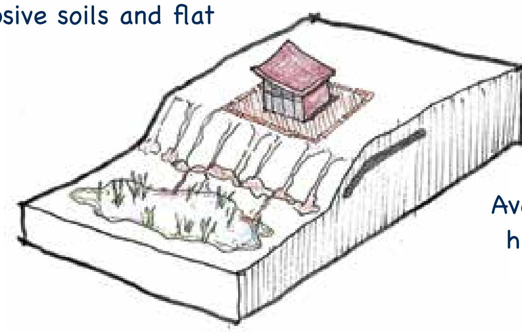
Protect clean water resources by planting stream edges to slow, clean, and infiltrate runoff.

SOILS/TOPOGRAPHY

Wrong Site

Avoid development on steep erosive soils and flat wetland soils.

Avoid excessively draining soils near sources of pollution or in areas that need irrigation.



Avoid human contact with contaminated soils.

Avoid soils with a perched or seasonal high water table, which could lead to water damage of buildings.

Better Site

Plant contaminated soils to stabilize, encapsulate, and/or phyto-remediate.

Protect wetlands and all wet soils from development to preserve their ecosystem functions.

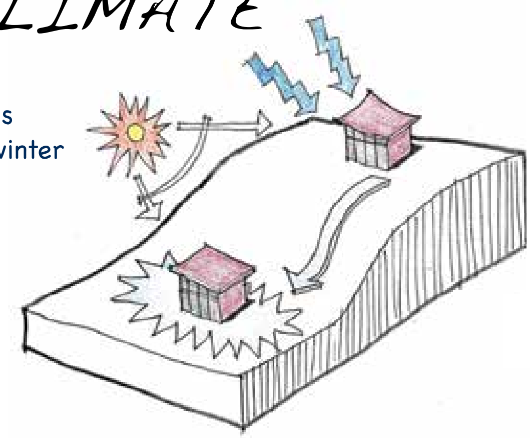
Stabilize erosive soils with plant root systems.

Use soil building techniques to create fertility for food crops or healthy vegetation.

MICROCLIMATE

Wrong Site

The top of a slope is vulnerable to cold winter winds.

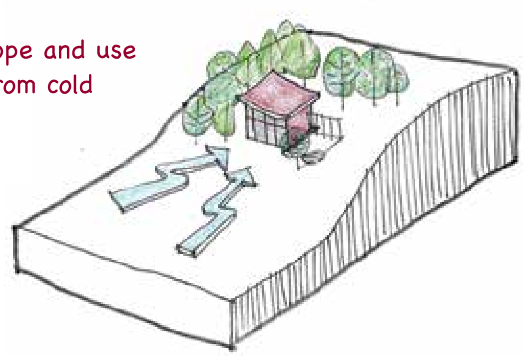


In summer, hot afternoon sun can create uncomfortable outdoor microclimates and increase cooling loads.

Avoid the bottom of a slope, where cold winter air settles in frost pockets.

Better Site

Locate buildings mid-slope and use vegetation to protect from cold northwest winds.



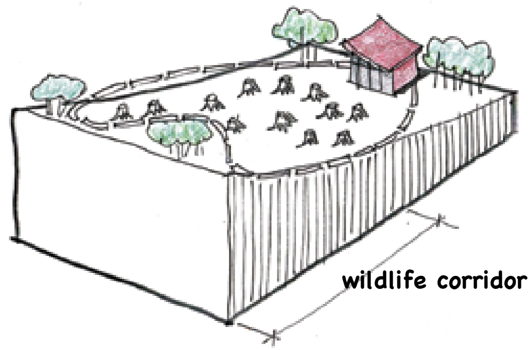
Locate for full sun in the winter.

Create easily accessible outdoor spaces that are south- or east-facing (in the Northeast US) and can be cooled with shade and summer breezes.

SOLAR ASPECT/ WILDLIFE

Wrong Site

Evaluate the impact of extensive clearing to maintain solar gain, which can affect storm water runoff, soil erosion, wildlife health, and carbon sequestration.

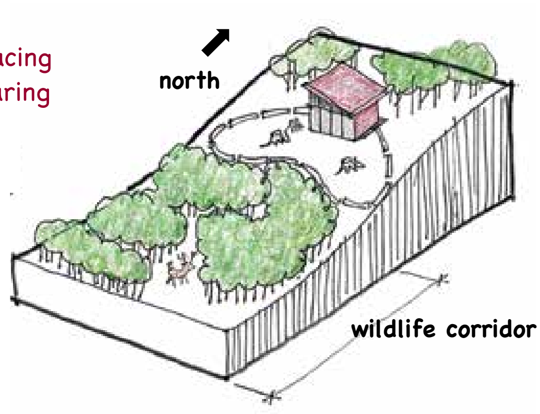


Avoid building on a north-facing slope, which increases the clearing needed.

Better Site

Developing on a south-facing slope decreases the clearing needed for solar gain.

Protect wildlife health and species diversity.



Support pollinator habitat for food production.

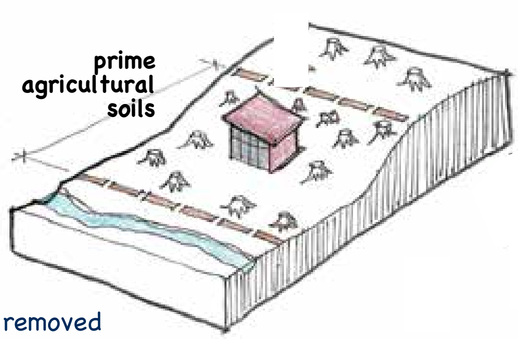
Minimize impact to wildlife corridors to allow for migrating animals.

PLANTS/ FOOD

Wrong Site

Avoid conventional development that results in extensive clearing and soil compaction.

Evaluate the ecosystem services provided by trees and vegetation slated to be removed before construction.



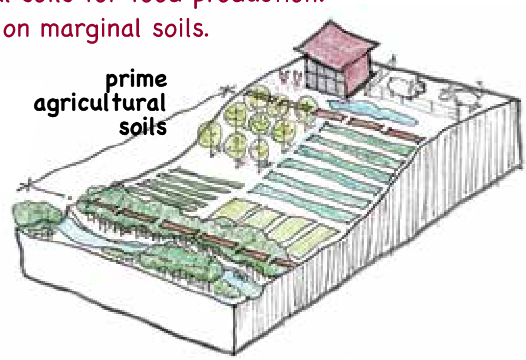
Ten 24-inch-thick red oaks . . .

- take up 10,000 gallons of storm water/year
- decrease soil erosion by slowing rain with foliage
- save 2,000 kw/year in cooling and wind protection
- absorb air and water pollution
- release oxygen through photosynthesis
- lower air temperatures with evapotranspiration
- sequester 10,000 lbs carbon/year

Better Site

Preserve prime agricultural soils for food production. Site buildings and pasture on marginal soils.

Plant stream corridors to slow and infiltrate runoff.



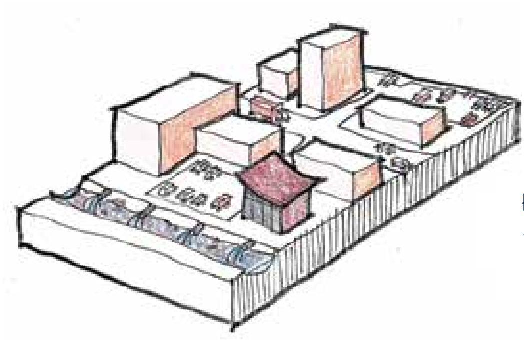
Stabilize slopes with terraced farms and orchards.

The current food system consumes a third of the total energy used in the United States. Supporting local food production as part of any building project decreases energy use and creates greater community resilience.

CONTEXT

Wrong Site

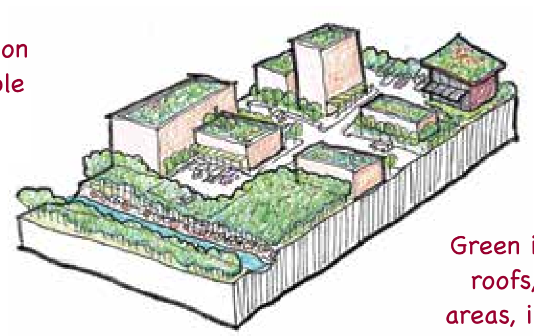
Urban sites with large impervious development increase flooding, and ground water levels rise.



Polluted storm water is dumped untreated from storm drains into local water bodies.

Better Site

Increasing public transportation and creating walkable, bikeable urban areas decreases the need for cars and parking areas and allows more room for green open spaces.



Green infrastructure—porous paving, green roofs, and planted areas—cools hot urban areas, increases biodiversity, cleans, stores, and infiltrates storm water, and creates more livable cities.

Porous parking lots can hold and infiltrate storm water.

Kim Erslev is both a practicing architect and a landscape architect. Her firm, Salmon Falls Ecological Design, is based in Shelburne Falls, MA. Since 2006, she has been on the faculty at Conway School of Landscape Design. Her current design practice focuses on superinsulated passive solar homes, ecological landscapes, and cohousing communities.

***Peer reviewer** Dillon Sussman, a sustainability coach and landscape designer, is the principal of Ground Truth Design and also a planning and design associate at Joel Russell Associates, where he works on innovative zoning and planning projects. He holds an MA in landscape planning and design from the Conway School of Landscape Design.*

At BE14 "Right Building, Wrong Site: How the Geography and Ecology of a Site Can Make or Break a Great Project" (Tuesday workshop), with Kim Erslev. For details, go to nesea.org/buildingenergy.

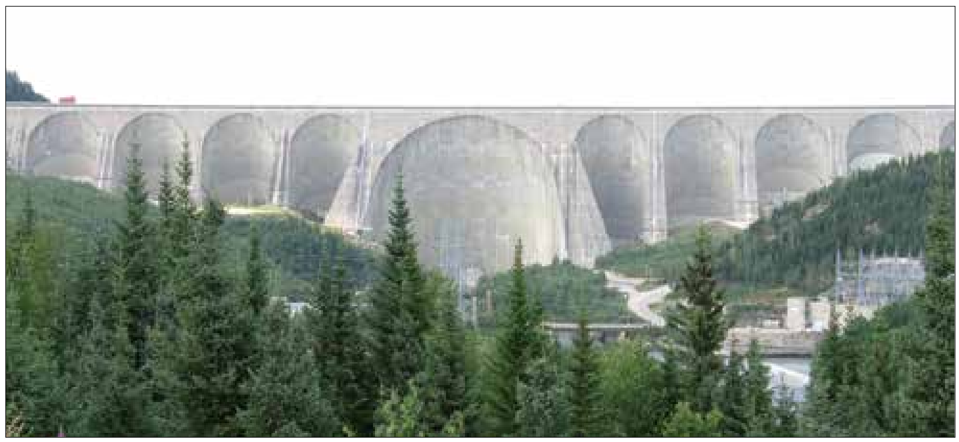
The Uses and Abuses of the Renewable Portfolio Standard

History shows that conventional power overcame market barriers only with help. Now it's the turn of budding renewables

By Joel Gordes

A majority of US states mandate that certain amounts of renewable energy be part of the electric mix. The goal of these mandates, known as renewable portfolio standards, is to help immature renewables become competitive. Yet here in the Northeast in particular, there is a battle between already mature, cheap Canadian hydro and more local sources that need market assistance.

The renewable portfolio standard (RPS) was never intended to support already mature technologies like large hydropower—which have already enjoyed a number of subsidies over the years. In some states, though, it's being misused in this way to create a less expensive path to meeting overall energy goals. Other states, driven by political extremists who oppose the RPS for creating new mandates, may repeal it or significantly alter it in ways that undermine its purpose.



The renewable portfolio standard was never intended to support already mature technologies like large hydropower. Yet here in the Northeast, local sources that need market assistance are competing with cheap Canadian hydro. This Hydro-Quebec dam north of Quebec, inaugurated in 1968, is the largest multiple-arch-and-buttress dam in the world.

Photo by Claude Bouchecl via Wikimedia Commons

Economies of scale, circa 1898

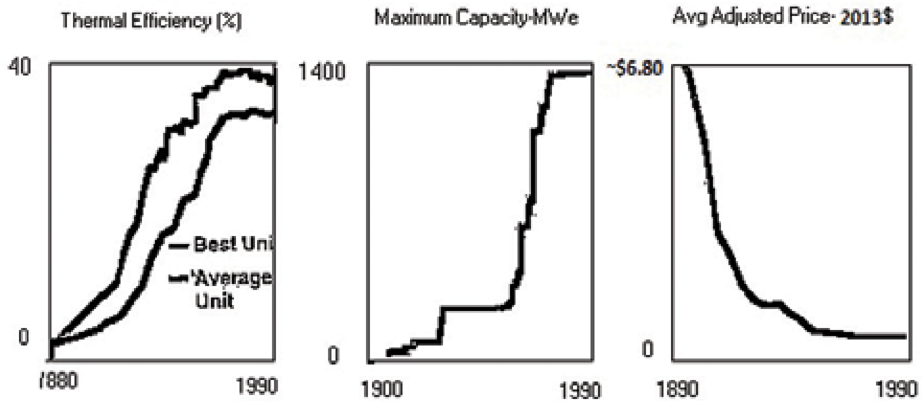
To better understand the intended role of the RPS in advancing renewable energy, it is necessary to know how conventional power advanced to where it is today: by breaking down "market barriers." And so it will be with renewables. This is best explained by a look at how generation has changed since Edison set up his first commercial generator in 1882, on Pearl Street in lower Manhattan.

Edison had a dynamo generator whose DC power could travel only about a half mile. Utility monopolies did not yet exist. The set of three graphs on page 30 shows that initial efficiencies were very low in early power plants. This was due to very small generators (in MWe), which produced power at very high prices per kilowatt-hour: an astounding ~\$6.80/kWh in today's dollars.[1]

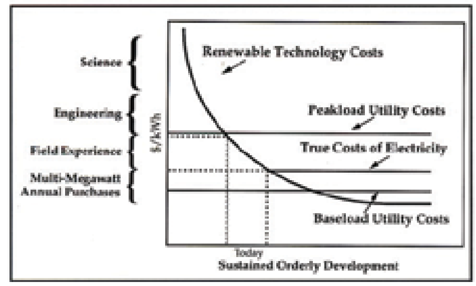
George Westinghouse and Nicola Tesla, Edison's competitors, knew that if they built larger AC generators with better economies of scale, they would have much higher efficiencies and could drastically lower the price of electricity. Another innovator, Samuel Insull—who had worked for Edison—also recognized this need. But the financial community was reluctant to bankroll the building of these new, larger steam turbine generators without some guarantee that the power company would be able to repay the loans.

To overcome this early market barrier to electricity use, Insull in 1898 began an effort to make a grand bargain with the states: the electric companies would be allowed to become monopolies in return for being regulated and having certain obligations. While monopolies were seen by some as contrary to free market principles, the rail monopolies had set a precedent. By 1907, New York, Massachusetts, and Wisconsin had set up commissions to regulate the electric companies. Other states followed.[2]

1. Hirsch, Prof. Richard F., *Technology and Transformation in the American Electric Utility Industry* (Cambridge University Press, 1989). NOTE: Prof. Hirsh showed this as \$3.20/kWh in 1986 dollars, but this paper's author has updated this to 2013 dollars, corrected for inflation.
2. Op cit. Hirsh. p. 22.



These graphs contrast the efficiencies of early and modern power plants. In Edison's day, efficiencies were low due to very small generators. Around 1898, to overcome market reluctance, states began allowing electric companies to become regulated monopolies. It worked. They built larger plants, and the economies of scale increased efficiency and lowered prices.



Reducing the price of renewable energy: This 1992 chart shows the various stages that contribute to the "sustained orderly development" of a renewable electric technology by steadily increasing procurement of resources over time, in a predictable manner (relative widths of brackets are hypothetical). Its prediction was very close to what has taken place, and still is taking place, with regards to prices.

As shown in the graphs, this subsidy[3] by monopoly worked. Over time, the larger plants' economies of scale led to a drastic increase in efficiency, which lowered the cost of power, making it affordable for many more people. This was a valuable lesson on when the free market works—and when it does not.

Sustained orderly development

Fast-forward nearly a hundred years after Edison, when a number of renewable energy technologies emerged but suffered from similar market barriers—as had their fossil fuel and nuclear predecessors.

"Sustained orderly development" describes a strategy for removing market barriers (see the graph at top right). It entails moving renewable energy sources toward cost-effectiveness with increased production and steady procurement, thus lowering their prices and eventually matching the cost of conventionally generated power.[4] Rather than forming monopolies—a rather drastic incentive mechanism—it employs mass production to lower cost in a market-oriented way.

In 1995, Dr. Donald W. Aitken of the Union of Concerned Scientists and Nancy Rader of the American Wind Energy Association developed the RPS policy and entered it for the first time in the California electric utility

Rather than forming monopolies—a rather drastic incentive mechanism—"sustained orderly development" employs mass production to lower cost in a market-oriented way.

restructuring proceedings before the Public Utilities Commission. It was one of several tools developed to implement the sustained orderly development path described above. It has since been widely adopted.

The prediction in the graph above, which appeared in a 1992 *Solar Age* article by Dr. Aitken[5], is very close to what has taken place, and still is taking place, with regards to prices. In that article, Dr. Aitken made important points relevant to today's RPS controversies:

> Thus the "push" from regulators and legislators is still warranted, along with a supportive understanding and participation by consumer and ratepayer advocacy groups, just to give the renewable technologies a fair chance against the major financial and institutional barriers they face. But unless actual market forces are harnessed in a way that can support the sustained orderly development of the solar electric technologies, no amount of governmental incentives will do the job. *Sustained orderly development does not imply that orders should be placed for unworthy technologies, nor that they should not also stand on their own correctly defined economic merits.* [emphasis original]

That last sentence may be construed as saying that certain technologies are unworthy of the aid provided by subsidies, but even those that are worthy eventually need to stand on their own merits

continued on page 51

3. Defined in this instance as "Financial assistance given by one person or government to another" (www.thefreedictionary.com/subsidy).
4. Aitken, Dr. Donald W. "Sustained Orderly Development." *Solar Age*, May/June 1992, p. 21.
5. Op cit. Aitken, p. 22.

Rethinking the Grid

Today's electrical grid is outdated, brittle and profoundly inefficient. We need a clear vision for the energy delivery systems of the future

By Fred Unger and Rob Meyers

Energy is the lifeblood of a modern economy. But few of us understand the complex systems that deliver the vast supply of electricity and fuels that our region depends on. The graphic on the facing page, from Lawrence Livermore National Laboratory, provides a great summary of our nation's energy profile. Anyone concerned about the environment, resource depletion, or economic efficiency should take a deeper look at the sector with our nation's largest energy use and most energy waste: electricity generation.

As you can see, in 2012, 40 percent (38.1 quads of the total 95.1 quads) of the primary energy used in the United States went into electricity generation. Of that, two-thirds (25.7 quads) was "rejected energy," lost as waste heat in generation or line losses associated with transmission and distribution.

In addition to inefficiencies and environmental concerns related to electricity generation and transmission, our aging electrical distribution system presents reliability and economic concerns that need to be understood from a whole systems perspective before they can be addressed effectively.

Further challenges are developing due to the electricity sector's growing overdependence on natural gas. Demand for gas is rising, but the natural-gas pipeline capacity into New England is extremely limited. With coal and nuclear generators being closed, natural-gas-fired plants supply an increasing portion of our electricity. Natural gas also supplies heat and hot water to many buildings in the Northeast, and gas is a primary fuel for industry.

Historically, natural gas prices have been volatile. Many people view natural gas as a bridge fuel to a future powered by renewables. But until substantial new electricity transmission or gas pipeline capacity is developed, along with significant increases in distributed generation (i.e. decentralized, as in solar panels on individual roofs), we remain vulnerable to gas-supply disruption and price shocks. As demand for natural gas and electricity grows for new uses such as transportation, we can expect further price swings. And until we transition to distributed clean energy generation, switching the transportation fleet to electricity only increases pressure on natural gas and electricity supplies while doing little to address the environmental challenges and inefficiencies of our transportation sector.

> The grid of the future will be bidirectional, flexible, and designed to encourage on-site generation and storage.

These challenges represent a huge opportunity to improve the resiliency, long-term stability, environmental impacts, and overall economic value of the ways we power and use our electrical grid.

Today's delivery system

Our electricity delivery system has evolved over more than a century into a very complex regional infrastructure with an even more complex regulatory framework. Today, the limits of that system are becoming apparent. It's challenging to obtain permits or rights-of-way to construct new power plants and transmission lines. The centralized, unidirectional nature of the system leaves it exposed to disruption from storms, equipment failure, or terrorist attack. Transmission and distribution capacity isn't keeping up with demand. Information flows are monopolized by utilities and system operators in a way that discourages the innovation that is needed to provide the best value to ratepayers.

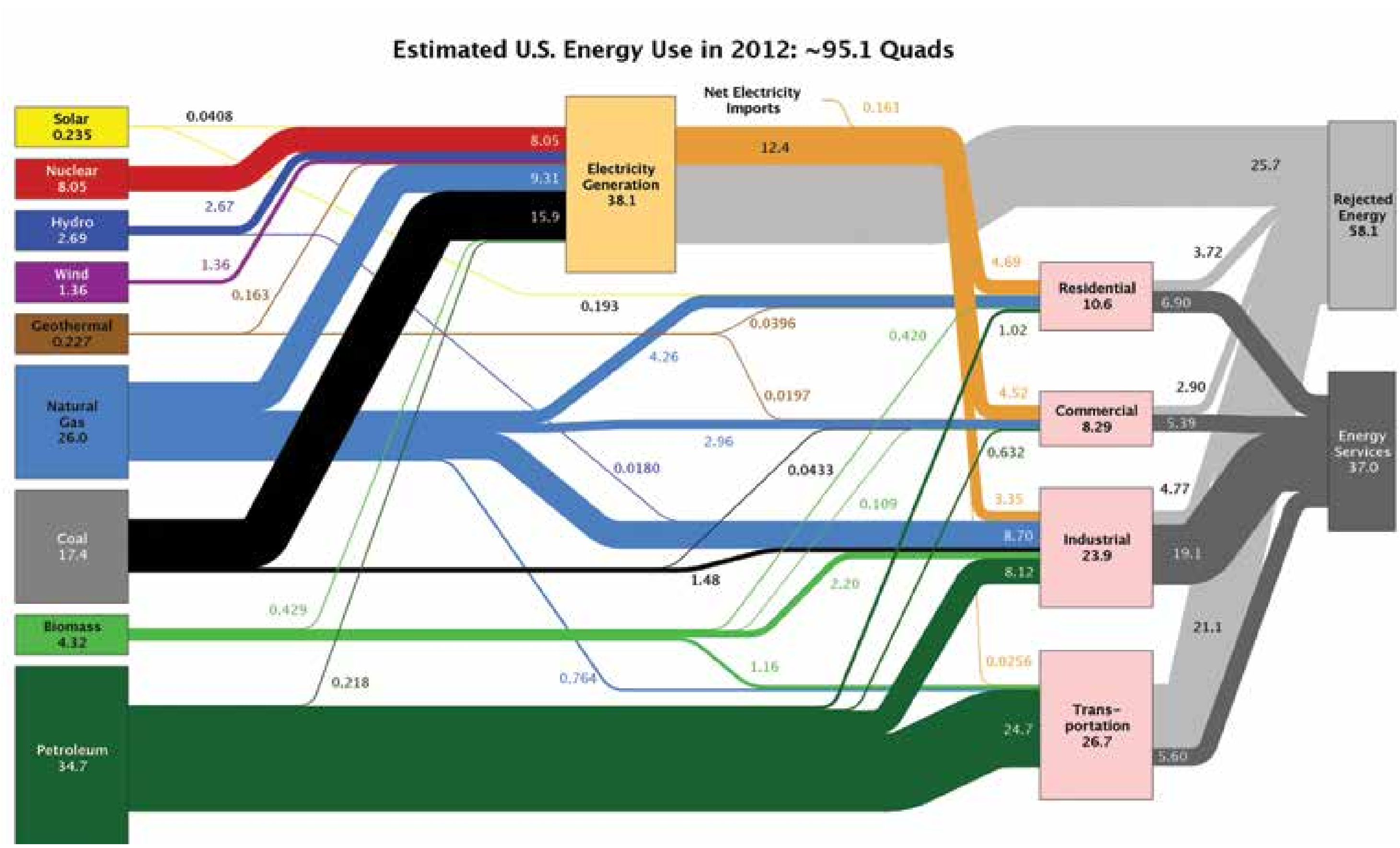
On-site generation can address many of these challenges. But today, on-site generators are restrained by and dependent on the grid, in part due to outdated utility interconnection requirements. Few projects have associated storage capacity, so their energy off-takers depend on the grid when the wind is not blowing or the sun is not shining. Due to Institute of Electrical and Electronics Engineers (IEEE) "anti-islanding" standards meant to address safety concerns, almost all of the distributed solar and wind electric systems installed in North America use grid-tied inverters that won't operate at all when the grid goes down. Many other types of distributed generation facilities face similar constraints. Recently, IEEE, grid operators, and utilities are starting to recognize that these requirements actually make the grid more subject to failures and that smart inverters and distributed storage would help solve many of the challenges the grid faces today. In Europe, more flexible regulations address safety concerns while allowing distributed generators to operate independently of the grid during power outages and also help prevent them.

The grid of the future

It is important to have a clear vision for the energy delivery systems of the future. Our goal should be to develop equitable, affordable, resilient, and environmentally sustainable energy systems that provide a foundation for economic prosperity.

We are confident that the grid of the future will be bidirectional, flexible, and designed to encourage on-site generation. It will match generation with loads and reduce transmission and standby generator losses through the use of smart grid information systems. It will utilize multidirectional open-access information and communication technology to maximize competitive market forces, thereby driving efficiency, load management, peak load shaving (reducing demand during periods of peak use), and dispatchable (on-demand) distributed generation. It will be interactive, encouraging user conservation, power-use scheduling, and other changes in consumer energy use based on clear market signals. It will support widely distributed electricity storage that will provide back-up power and consumer rate arbitrage, while also providing on-demand grid support services that will make the grid more reliable than it is today.

This redesigned grid will enable new opportunities and services in technology, finance, contracting, and



This shows US energy use for 2012 in quads, or quadrillion BTUs (one quad equals the energy value in approximately 172 million barrels of oil). The boxes on the left represent the total energy in the fuels and energy resources used in our economy. The pathways in the middle show how each of those resources is utilized, and at what scale. The pink boxes represent energy consumption by sector. The yellow box and pathways show how the electricity sector converts fuel to electricity, and how it is used. The dark gray pathways and box at the far right show the energy actually providing services like light, heat, or mobility. The lighter gray pathways and box show how we waste over 61 percent of primary energy inputs. So, for example, petroleum provided 34.7 quads of energy in 2012, with the lion's share (24.7 quads) going to transportation, where most of it was wasted. *Graph courtesy of the US Department of Energy and Lawrence Livermore National Laboratory.* https://flowcharts.llnl.gov/content/energy/energy_archive/energy_flow_2012/2012new2012newUSEnergy.png

At BE14 Renewables and the Grid, a track chaired by Fred Unger and Rob Meyers. For details, go to nesea.org/buildingenergy.

other critical areas of innovation. With thousands of independent interconnected generators, storage solutions, and microgrids, it will be far more resilient. It will capture input energy efficiently through combined heat and power and similar solutions, significantly reducing fuel needs relative to energy demands. It will be safer and more environmentally sound, increasingly powered by renewable-energy generators.

Entrenched regulated systems resist change

There are other, quite different, visions for how the energy distribution systems and energy markets of the future should be organized. Competing visions are being sorted out in legislatures and utility commissions around the nation, in regional grid operators' market committees, and in such agencies as the Federal Energy Regulatory Commission (FERC).

Unfortunately, rather than embracing the future, many utility companies are fighting to maintain the status quo. Steve Pullins of Green Energy Corp., a builder of commercial-scale microgrids, estimates that 24,000 US commercial and industrial sites are ripe for large-scale microgrid conversions that could leave them semiautonomous or fully independent of the utility system. Comparing utility resistance to that of US car makers' resistance to early federal fuel mileage standards, Pullins suggests, "When those rules came out, Toyota went out and hired 1,000 engineers to figure out how to meet them. GM went out and hired 1,000 lobbyists to figure out how to beat them. There is some of that going on."[1]

> In 2012, 40 percent of the primary energy used in the United States went into electricity generation. Of that, two-thirds was lost as waste heat in generation or line losses associated with transmission and distribution.

As the incumbent energy systems become more strained and expensive, increasingly low-cost distributed energy generation and storage solutions are combining to transform the utility business paradigm. A recent article from Greentech Media opened with this: "Utilities are in a 'death spiral,' trapped in a 'vicious cycle,' and are exploring 'profound transitions' to fight for their continued survival."[2]

A clean energy future is inevitable

As we write this, FERC reports that almost three quarters of the 699 MW of new generation brought online in October 2013 was solar. Most of the rest was either wind or biomass.[3] And that was just utility-scale projects—FERC doesn't even count small- to medium-scale solar projects.

In a debate hosted by the Economist website last fall ("Can Solar Energy Save the World"[4]), Richard Swanson, founder of SunPower

1. Wells, Ken, and Mark Chediak, "EBay, Ellison Embrace s to Peril of Utilities." *Bloomberg News*, Oct 20, 2013. http://www.bloomberg.com/news/2013-10-17/ebay-to-ellison-embrace-microgrids-in-threat-to-utilities.html
2. St. John, Jeff, "How New Regulatory Models Could Help Utilities Thrive and Survive." *Greentech Media*, October 28, 2013. http://www.greentechmedia.com/articles/read/how-new-regulatory-models-could-help-utilities-thrive-and-survive
3. "FERC: Almost All New US Electricity Generation Coming from Solar." Renewable Energy World.com, November 23, 2013. http://www.renewableenergyworld.com/rea/news/article/2013/11/ferc-almost-all-new-u-s-electricity-generation-coming-from-solar
4. Carr, Geoff, Richard M. Swanson, and Benny Peiser, "Can Solar Energy Save the World?" *The Economist*, October and November 2013. http://www.economist.com/debate/debates/overview/263
5. Binz, R., R. Sedano, D. Furey, and D. Mullen (2012), "Practicing Risk-Aware Electricity Regulation." A Ceres report. http://www.ceres.org/resources/reports/practicing-risk-aware-electricity-regulation

Corporation, made clear that it doesn't matter whether the world needs saving. As costs and benefits to end users improve relative to other energy sources, solar energy is already disrupting traditional utility business models. "Let's look at the German feed-in tariff more closely," Swanson suggests in the rebuttal portion of that debate:

> In 2013 residences and small businesses pay a levy of 5.27 euro cents/kWh out of an average residential rate of about 29 euro cents/kWh (18 percent). Of this levy, less than half (2.29 euro cents/kWh) comes from the cost of renewable energy. The remainder includes some social costs, plus a curious "industry privilege" charge of 1.26 euro cents/kWh. This compensates conventional generators because renewable energy has driven down the market cost of conventional power sources. Interestingly, a study from Green Budget Germany finds that the conventional power industry is subsidized by the German federal budget to the tune of 10.2 euro cents/kWh. From this perspective, solar is subsidizing fossil and nuclear power.

German gas and coal plants need such heavy subsidies because grid operators haven't transitioned their operations fast enough to keep up with the changing supply mix their customers are building. US electricity distribution systems aren't ready for the future either. Ron Binz, President Obama's recently attempted nominee to head FERC, declared, "The US electric utility industry has entered what may be the most uncertain, complex and risky period in its history. . . . These challenges call for new utility business models and new regulatory paradigms."[5] Change is gradually happening, but not nearly fast enough. Utility regulators face hard decisions. As argued in these pages recently, to work effectively, electricity market systems need to acknowledge the real costs to the grid and to our society of all types of generators.* It is equally important to acknowledge and pay for the very real benefits that distributed generators provide for ratepayers.

Sensible public policies will accelerate and bridge the transition to robust, resilient, and affordable energy delivery systems of the future, while keeping current utility systems functional and reliable. Those transition policies include continued net metering until regulators devise better mechanisms for fully compensating distributed generators for the benefits they provide. New policies like time-varying retail rates will support load-coincident generators like solar, while encouraging the more robust conservation and load-management measures that smart grid technologies enable. Policies favoring procurement based on least short-term costs need to be replaced with least life-cycle cost procurement measures that protect ratepayers against volatility.

> It doesn't matter whether the world needs saving. As costs and benefits to end users improve relative to other energy sources, solar energy is already disrupting traditional utility business models.

Major regulatory and policy changes are needed

We cannot continue to lose 27 percent of the primary energy our nation uses to the inefficiencies of our outdated electricity delivery system, as we do today. As existing power plants age and head toward decommissioning, new realities are emerging that will shift the utility system to an open, participatory model, with distributed generation, distributed storage, and microgrids first supplementing and eventually replacing many of the generators we now depend on.

There are critically important roles for electricity distribution utilities to play in the future, but they are in many ways very different from the roles utilities play today. The utility trade press is full of articles about the opportunities that the grid of the future offers. Utilities should be embracing those opportunities and hiring the engineers who can make the transition happen. If they don't, they will find their most profitable customers disconnecting from the grid, and legislators questioning the privileges they currently enjoy in their monopoly franchises.

Fred Unger manages project development for a subsidiary of Boston Community Capital that owns and operates 79 commercial-scale solar systems, with more in development. He has served on the NESEA board and chaired the 2003 BuildingEnergy conference.

Rob Meyers is the energy services general manager at South Mountain Company. He is a NESEA board member and has been active in BE conference planning for the last three years.

Peer reviewers *Thanks go to Rhone Resch, president and CEO Solar Energy Industries Association; Janet Gail Besser, VP of policy and government affairs, New England Clean Energy Council; and Seth Handy, principal, Handy Law Group. The views expressed are those of the authors alone.*

* Unger, Fred, "The Real Costs and Benefits of Solar Electricity." *BuildingEnergy Magazine*, spring 2013. http://issuu.com/nesea/docs/be_magspring13_final (page 32)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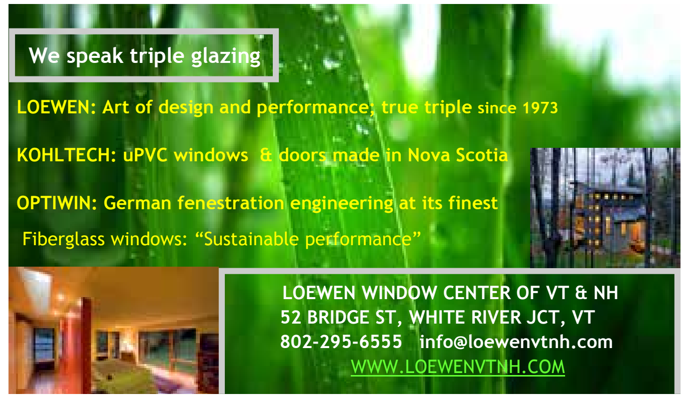
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Materials Matter

We're consuming three billion tons of building materials every year, and they're toxic to the planet and to us

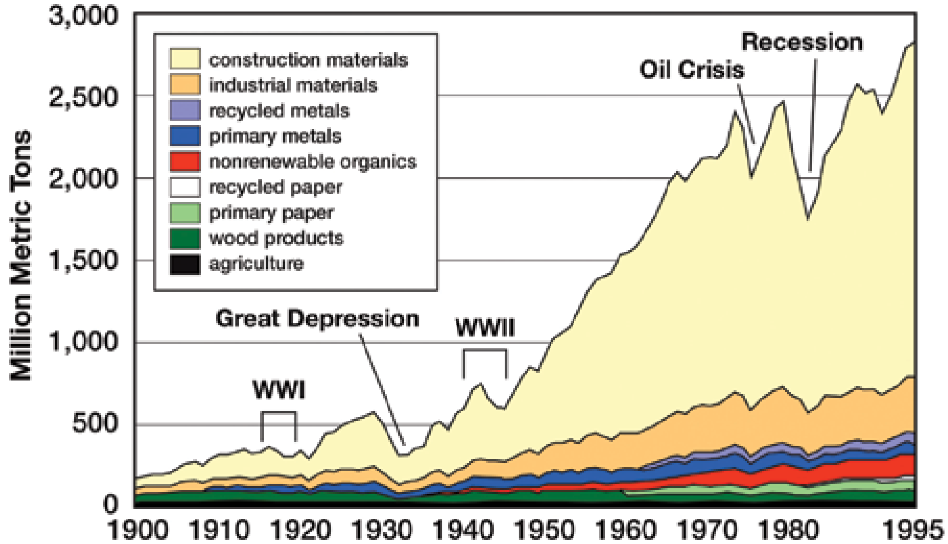
By Jean Carroon

In the last 50 years, humans have consumed more resources than in all previous history. The 3 billion tons of building materials created globally every year accounts for 40 percent of this consumption. As we strive for a resilient and sustainable world, these building materials matter, because making, using, and disposing of them affects both the health of our planet and our personal health.

> In the United States, extraction, production, delivery, and disposal of building materials accounts for 65 percent of electricity consumption and 35 percent of total greenhouse gas emissions.

More greenhouse gases

Every product has an environmental impact. That's why we bring our own bags to the grocery store and have refillable water bottles. In the United States, extraction, production, delivery, and disposal of building materials accounts for 65 percent of electricity consumption and 35 percent of total greenhouse gas emissions. With the US creating 17 percent of all greenhouse gas in the world, second only to China,



Raw material consumption in the United States increased fivefold between 1900 and 1995, as this 2009 EPA graph shows. Worldwide, we have consumed more materials in the last 50 years than in all previous human history.

Graph from "Sustainable Materials Management: The Road Ahead," US Environmental Protection Agency, June 2009

this means that our building materials alone are contributing about 6 metric tons of greenhouse gas per year, per citizen. This is roughly equivalent to the *total* annual contribution of an average Chinese citizen. What happens when the rest of the world matches the United States in building material consumption?

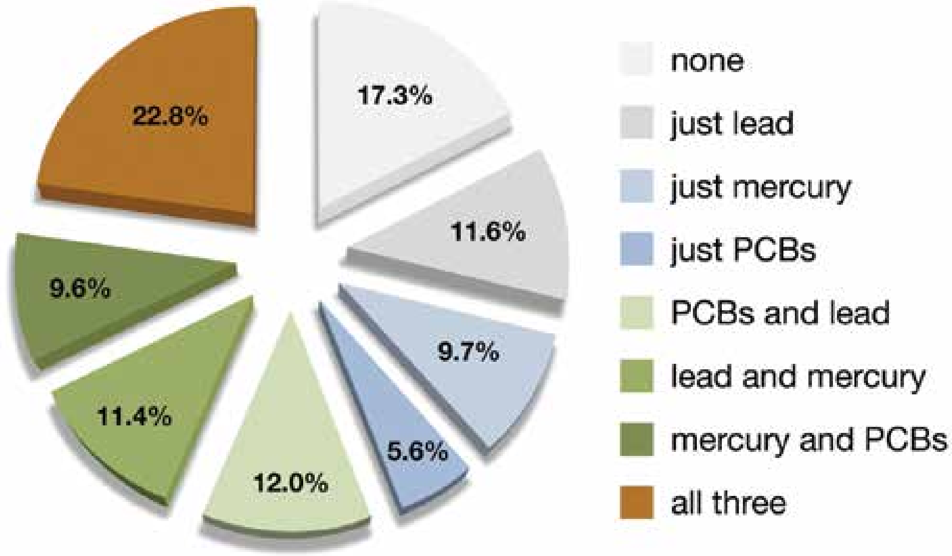
Toxins are trending up

Building materials, both new and old, are known to include many substances toxic to humans, such as lead, formaldehyde, asbestos, chlorinated solvents, petroleum distillates, toluene, xylene, and PCBs. And the list is steadily expanding. Isolating even a few examples of the impact reveals alarming trends.

A recent Brown University analysis of thousands of US women of childbearing age found that more than half had median or higher blood levels of at least two of three pollutants—lead, mercury, and PCBs—that could harm fetal brain development (turn the page for a pie chart).

The US Centers for Disease Control and Prevention has concluded that nearly 100 percent of us have brominated flame retardants in our bodies. Flame retardants are applied to fabrics, carpets, building insulation,

At BE14 Materials: Design for a Healthy World (Track 10), with chairs Jean Carroon of Goody Clancy and Marc Rosenbaum of South Mountain Company. For details, go to nesea.org/buildingenergy.



The body burden of multiple pollutants. A recent Brown University analysis of thousands of US women of childbearing age found that most had median or higher blood levels of at least two of three pollutants that could harm fetal brain development; 22.8 percent had raised levels all three pollutants in their blood.

Courtesy of Brown University

and electrical cables, among other things. Over the last 30 years, the level of flame-retardant chemicals in our bodies has increased by a factor of 100, essentially doubling every 5 years. These chemicals are linked to DNA mutation, thyroid disruption, memory and learning problems, delayed mental and physical development, lower IQ, advanced puberty, and reduced fertility.

We're responsible for change

Initiatives concerning the impact of building materials on the environment and on us are slowly gaining traction. The US Green Building Council is addressing material impacts with a new LEED pilot credit (NC V4, MRpc63). LEEDuser.com describes the credit as the next step in the evolution of LEED, actively engaging life cycle assessment in material decision making for buildings and quantifying environmental benefit for materials decisions. Architecture 2030's "2030 Challenge for Products," launched in 2011, asks the global building community to reduce the carbon-equivalent footprint of materials by 50 percent before 2030 using Environmental Product Declarations (EPDs) as the primary tool. EPDs are flanked by the Health Product Declaration, launched in 2012 and initiated by the Healthy Building Network and BuildingGreen to increase transparency about product ingredients. In 2013, the International Living Future Institute created a program called Declare to provide a database of building products with at least 99 percent of their ingredients fully disclosed.

The first step to a solution is awareness of the problem. Materials matter, and so the building community has tremendous potential to change the world for the better—and tremendous responsibility to do so.

Preservation architect, author, educator, and environmental activist Jean Carroon, FAIA, LEED AP, is a principal at the Boston-based firm Goody Clancy. A pioneer in applying sustainable-design technologies to historic buildings, in 2012 she recieved the Harley J. McKee Award, the highest honor bestowed by the Association for Preservation Technology International. Her portfolio includes four National Preservation Honor Awards. She is the author of Sustainable Preservation: Greening Existing Buildings *(2010, John Wiley & Sons).*

BuildingGreen's Top 10 Products for 2014

This year's most innovative building solutions focus on simplicity and quality

By Alex Wilson and Brent Ehrlich

BuildingGreen's Top 10 Awards go to the most innovative green building products from among the hundreds reviewed by BuildingGreen editors over the previous 12 months. The diverse products we're recognizing this year, our 12th, emphasize how a focus on simplicity and quality contribute to sustainable and resilient design goals. They include a commercial composting system, dimension stone that utilizes quarry waste, and an engineered-wood product sourced partly from trees killed by the mountain pine beetle. Inverters that take solar energy off the grid are also on the list.

The LEED rating systems continue to be a big driver of innovative green products. This year's launch of the newest rating system, LEED v4, marks an even stronger focus on safe materials and product transparency. Building Green's *GreenSpec,* a directory of green products, is organized by LEED credits, as well as by building category and the MasterFormat standard. *GreenSpec* is available online as part of the subscription-based BuildingGreen Suite.

Other BuildingGreen resources include *Environmental Building News* and LEEDuser.com, a resource for teams pursuing LEED certification. For information on BuildingGreen resources, visit www.buildinggreen.com.

At BE14 "Spec This, Not That," with Tristan Roberts of BuildingGreen. Also, some products featured in this article will be highlighted on the trade show floor. For details, go to nesea.org/buildingenergy.

CrossLam is a cross-laminated timber (CLT) structural panel that can be used for floors, walls, and roofing. CLT is made from less desirable wood, including wood taken from forests killed by mountain pine beetles, but higher-quality wood can be used if it is going to be exposed to view.

Earth Measure

Coldspring and Jason F. McLennan

CSI 04 42 00:
Exterior Stone Cladding

What makes it green?

- Durable or low-maintenance
- Provides connection to nature

This dimension stone product takes waste from stone manufacturing and cuts it into patterns that mimic the natural world. The Fibonacci series is based on spirals found in seashells and other natural elements; the Linear series is closest to standard dimension stone; the MUD series looks similar to drying mud; and the Reptile series mimics the look of reptile skin. Earth Measure can be used for pavers, flooring, walls, and more, so it can transition from exterior to interior and horizontal to vertical applications. Architects and designers work with Coldspring to select an appropriate pattern, and the team creates a CAD diagram that can be proofed. Once cut, the stone is packaged and delivered to the site, laid out in a manner that simplifies installation. Coldspring can supply or consult on any of the necessary mounting systems. Stone can be provided from regional quarries depending on project location. *www.coldspringusa.com*

CrossLam Cross Laminated Timber

Structurlam Products

CSI 06 11 13: Engineered Wood Framing Products

What makes it green?
• Low-emitting

LEED credit relevance:
• MR Credit 7: Certified Wood
• IEQ Credit 4.3: Low-Emitting Materials—Flooring Systems
• IEQ Credit 4.4: Low-Emitting Materials—Composite Wood and Agrifiber Products

CrossLam is a cross-laminated timber (CLT) structural panel made by gluing layers of softwood boards one on top of the next at right angles to each other. The resulting panels are light and dimensionally stable in all directions. They can be used for floors, walls, and roofing. CLT is made from less desirable wood, including wood taken from forests killed by mountain pine beetles, but higher-quality wood can be used if it is going to be exposed to view, and FSC-certified wood is available. CLT comes in panels up to 40 feet long, 10 feet wide, and 12 inches thick and uses formaldehyde-free Purebond polyurethane adhesive. *www.structurlam.com*

ComfortBoard Mineral Wool Board Insulation

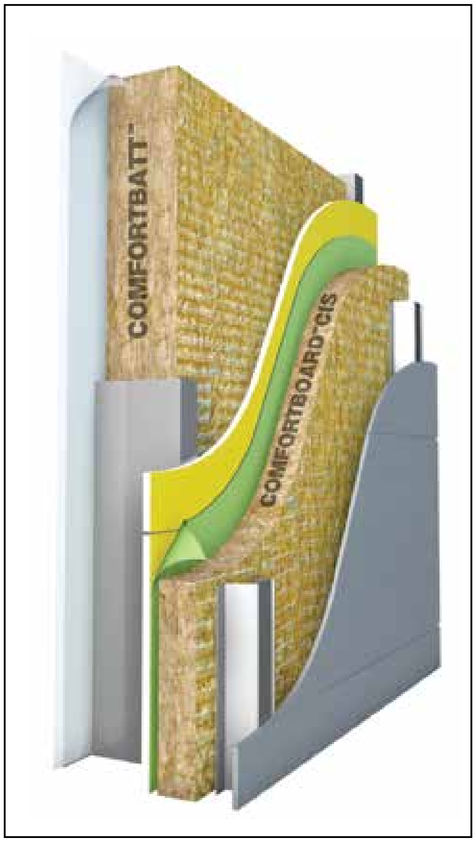
Roxul Inc.

CSI 07 21 13: Board Insulation

What makes it green?
• Reduces heating and cooling loads
• Avoids hazardous ingredients
• Preconsumer recycled content

LEED-NC v2009 credit relevance:
• EA Prerequisite 2: Minimum Energy Performance: Design & Construction
• EA Credit 1: Optimize Energy Performance: Design & Construction
• MR Credit 4: Recycled Content

Roxul manufactures rigid and semi-rigid mineral wool board insulation for both commercial and residential applications. ComfortBoard, designed for applications over exterior sheathing, is produced in the Ontario plant with a minimum 75 percent preconsumer recycled content, primarily iron ore slag. The residential version, ComfortBoard IS, has a density of 8.0 pcf, while the commercial product, ComfortBoard CIS, has a density of 11 pcf. At these densities, ComfortBoard is rigid enough to be used as exterior insulation, and it provides an affordable alternative to foam-plastic insulation materials. ComfortBoard also provides very good sound control and excellent fire resistance without flame retardants. It can be used in rainscreen details, and it retains thermal resistance when damp. The R-value ranges from 4.0 to 4.2 per inch. These products are produced with a urea-extended phenol formaldehyde binder, although heat processing during production drives off most of the formaldehyde, resulting in extremely low emissions.
www.roxul.com



An affordable alternative to foam-plastic insulations, ComfortBoard insulation has a minimum 75 percent preconsumer recycled content.

The ERC 50 Modernization Façade is a modular retrofit system that can be installed with minimal disturbance to a building's occupants.

ERC 50 Modernization Facade

Schüco

CSI 08 44 00: Curtain Wall and Glazed Assemblies

What makes it green?
• Reduces heating and cooling loads
• Information transparency
• Reduces construction impacts

LEED credit relevance:
• EA Prerequisite 2: Minimum Energy Efficiency Performance

• EA Credit 1: Optimize Energy Performance
• EA Credit 2: On-site Renewable Energy

The ERC 50 Modernization Facade from Schüco is a retrofit facade system that can be installed on older, inefficient commercial buildings to improve energy efficiency, occupant comfort, and aesthetics. It incorporates an aluminum load-bearing framework, Schüco's high-performance windows, exterior insulation, and cladding into a system that can be installed with minimal disturbance to building occupants. The ERC 50 is modular and uses EPDM gaskets rather than caulk, so it is relatively easy to replace damaged components. Schüco's building-integrated photovoltaic panels can also be used in this system.
www.schueco.us

PoE Access Control Locks

Assa Abloy Group, brands Corbin Russwin and Sargent

CSI 08 71 00:
Door Hardware

What makes it green?
• Increases resilience
• Energy-conserving equipment

LEED-NC v2009 credit relevance:
• EA Prerequisite 2: Minimum Energy Efficiency Performance

Assa Abloy offers power-over-Ethernet (PoE) electronic access-control locks, including the Sargent Profile Series v.S1, the Sargent Passport 1000 P1, and the Corbin Russwin Access 700 PIP1. Ethernet data cables carry low-voltage electricity to power the lock and also transmit data to and from the devices using a facility's already existing wired and wireless local area network (LAN). Each PoE door typically uses about one watt in standby mode, saving more than 150 kWh per year compared to a traditionally wired system. Ethernet power loads are low enough that a modest uninterruptable power supply (UPS) may be able to maintain electronic-access functionality in the case of a power outage.
www.sargentlock.com

Kinetex Textile Composite Flooring

J+J Flooring Group

CSI 09 68 13:
Tile Carpeting

What makes it green?
• Low-emitting
• Postconsumer recycled content
• Preconsumer recycled content
• Reduces operational pollution or waste

LEED-NC v2009 credit relevance:
• MR Credit 4: Recycled Content
• IEQ Credit 4.3: Low-Emitting Materials—Flooring Systems

This soft surface floor covering is intended for use in place of hard surfaces such as vinyl composite tiles in medium- to high-traffic commercial applications. The 24- by 24-inch semirigid tiles are 0.20 inches thick, compared to 0.25 to 0.60 for standard carpet tiles.

Kintex textile composite flooring is made from 60 percent recycled content—50 percent postconsumer PET sourced primarily from water and soda bottles.

The Earth Flow composting system uses a motorized traveling auger to aerate the compost. It's designed for use on college and corporate campuses and at resorts.

They are engineered with a wear layer made from solution-dyed PET that resists staining or bleaching and is woven for abrasion resistance and durability. Kinetex is made from 60 percent recycled content (50 percent postconsumer PET sourced primarily from water and soda bottles) and, unlike carpet, can be ground and processed into new backing in one step, without costly material separation and sorting or loss of performance. Note that Kinetex is treated with perfluorinated compounds to resist dirt and improve its lifespan; these chemicals persist in the environment and may have long-term environmental impacts.
www.jj-kinetex.com

Earth Flow Composting System

Green Mountain Technologies

CSI 11 82 29:
Composting Equipment

What makes it green?
• Reduces operational pollution or waste

LEED-EBOM v2009 credit relevance:
• MR Credit 6: Solid Waste Management—Waste Stream Audit

Earth Flow is a medium-size, in-vessel composting system with a motorized traveling auger to aerate the compost and a biofilter and fan to minimize odors. With walls insulated to R-18 and a greenhouse top, the vessel is sealed against pests and leakage. Designed for use on college and corporate campuses and at resorts, these units can accept 300 to 3,000 pounds of organic waste per day. Depending on size (from 10 to 40 feet in length), the system may consume 5 to 10 kWh per day, according to the company. A unique biofiltration system using wood chips can be part of the planted landscaping for some projects, and this system can be hooked directly to a commercial pulper system for greater convenience. Compost is harvested every two to three weeks and should be cured before spreading directly on beds or fields.
www.compostingtechnology.com

CO2-Refrigerant Heat Pumps

Mayekawa USA MYCOM

CSI 23 81 44: Heat Pumps

What makes it green?
• Avoids hazardous ingredients
• Energy-conserving equipment

LEED-NC v2009 credit relevance:
• EA Prerequisite 2: Minimum Energy Performance: Design & Construction
• EA Credit 1: Optimize Energy Performance: Design & Construction

Mayekawa manufactures three commercial heat pumps that use carbon dioxide as the refrigerant, rather than industry-standard HFCs. The EcoCute model is a water-to-water heat pump that provides both water heating (up to 194 degrees F) and cooling from any water source, including waste heat or solar-preheated water, with a COP of up to 8.0. This makes it feasible as an alternative to fossil-fuel-fired boilers. The Unimo air-to-water heat-pump water heater produces similar output temperatures using the outdoor air as the heat source, while the Sirocco water-to-air heat pump also offers high-temperature water heating. All Mayekawa heat pumps have 25 kW reciprocating compressors. Key markets include hotels, food processing, pasteurization, and thermal energy storage. The economics for EcoCute and Sirocco products will be most attractive where both heating and cooling loads exist and long run times are feasible. *www.mayekawa.com*

Sunny Boy 3000TL-US, 4000TL-US, and 5000TL-US Inverters

SMA America

CSI 26 37 00: Alternative Energy Balance of Systems Components

What makes it green?
• Renewable energy equipment
• Increases resilience

SMA's revolutionary new line of transformerless inverters enables daytime power in the event of a grid outage, without battery storage.

LEED-NC v2009 credit relevance:
• EA Credit 2: On-Site Renewable Energy

Most grid-connected inverters used for solar-electric systems cannot provide any power during power outages, even when the sun is shining. These revolutionary transformerless inverters from SMA America provide daytime power in the event of a grid outage. Without requiring battery storage, they can switch from interactive operation to providing off-grid energy to a dedicated power outlet. Provided the sun is shining, they can deliver 1,500 watts (12.5 amps at 120 volts) with a maximum efficiency of 97 percent. While they may not provide enough power for major household loads, these inverters can provide critical cell phone and laptop computer charging and other emergency needs. *www.sma-america.com*

Vivid MR16 LED

Soraa

CSI 26 51 16: LED Replacement Lamps

What makes it green?
• Energy-conserving equipment
• Avoids hazardous ingredients
• Improves light quality

LEED-NC v2009 credit relevance:
• MR Credit 7: Certified Wood
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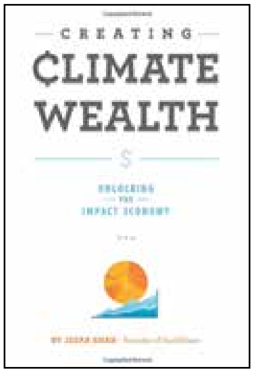
Soraa Vivid MR-16 LED luminaires are ideal where light quality is critical, such as in art galleries or retail displays. Unlike other LEDs that use gallium nitride (GaN) crystals grown on a sapphire or silicon carbide base, Soraa uses GaN grown on a GaN base, so the crystals have far fewer imperfections. While less efficacious than some LEDs, Soraa MR-16s produce higher intensity, "full spectrum" light that can rival that of halogen bulbs, while operating at much lower temperatures. The color rendering index (CRI) is as high as 95. Available in 14-, 25-, and 36-degree beam angles. *www.soraa.com*

Alex Wilson is president of the Resilient Design Institute, a nonprofit organization focused on resilience and adaptation to climate change. He is also founder of

The Vivid MR16 LED produces higher-intensity, "full spectrum" light that rivals that of halogen bulbs, but at much lower temperatures.

BuildingGreen Inc. in Brattleboro, VT, and executive editor of Environmental Building News. *He is an instructor with Boston Architectural College's Sustainable Design Institute. A widely published writer, he is author of* Your Green Home *(New Society, 2006) and coauthor of* Consumer Guide to Home Energy Savings *(ACEEE, 1990, 2007) and* Green Development: Integrating Ecology and Real Estate *(John Wiley & Sons, 1998). Alex served on the national board of the U.S. Green Building Council from 2000 through 2005 and received the organization's 2008 Leadership Award for Education. In 2010, he received the second annual Hanley Award for Vision and Leadership in Sustainable Housing.*

Brent Ehrlich conducts research and writes product- and category-level descriptions for BuildingGreen's GreenSpec *product directory. He also contributes product reviews and feature articles for* Environmental Building News *and is a contributing editor to McGraw-Hill's* GreenSource *magazine.*



Creating Climate Wealth

Jigar Shah
Icosa, 2013

By Laura Richardson

Jigar Shah is not yet a household name, but I know he will be. Because *Creating Climate Wealth: Unlocking the Impact Economy* is not about a tree-hugger economy. It's about *the* economy.

More than 10 years ago, the clean-energy entrepreneur realized that people want solar to power their buildings but do not want to pay up front for the system, installation, or maintenance. And that changing the business model from one of acquisition to one of services provided could dramatically open up the market. And that through a rigorous business model whereby conventional finance houses would invest, solar could move beyond the hobbyist market to wide-scale implementation—distributed, i.e. decentralized, electricity generation—becoming the new norm.

He linked those realizations to Excel spreadsheets and a solid business plan, and then sold the concept to finance giants and big-box retailers seeking to stabilize their energy costs and green their images. He came up with the PPA (power purchase agreement) model and founded SunEdison, now the largest owner of installed photovoltaics in the world.

With *Creating Climate Wealth*, Shah is not going to win a Pulitzer Prize for literature. However, he should win a MacArthur "genius grant" and maybe even a Nobel Prize in economics. The PPA model has been adopted by other PV installation companies, although none have been able to scale up the way SunEdison has. This model has evolved and morphed to finance thermal, transportation, and agriculture projects.

Shah hammers on the need for rigorous due diligence with mainstream investors and on the idea that paying higher interest rates for access to unlimited supply is a better long-term business decision than working with "impact investors." Impact investors have limited funds and, because of their interest in multiple metrics for success (number of jobs, emissions, and locally sourced products, as well as repayment of investments), create space for a sloppier business plan. Shah's point is that those metrics will be achieved if the business succeeds.

> Shah encourages us to discover disruptive business models that focus on what consumers really want.

He covers myriad related topics, many quite superficially and wonkily. That's okay, though, because with a little imagination, he encourages us to discover similar disruptive business models that focus on what consumers really want—clean, local energy, comfortable and cost-effective buildings, safe and inexpensive transportation, fresh and nutritious food—without the hassle or personal investment of owning everything.

His point is solid. There is so much opportunity to make a lot of money.

At BE14 "Rethinking the Architecture of the Grid: Visions for 2030" (see page 32 for a related article), with Jigar Shah and other speakers. For details, go to nesea.org/buildingenergy.

Shah lays out for his reader a vision of how trillions of dollars—money already floating in the economy, supporting Business as Usual, hurting us more than helping us—can launch an "impact economy." He talks about the scale needed to avert climate disaster and the obvious opportunities that are ready for development.

The book also highlights Shah's work as the first CEO of the Carbon War Room, founded by Richard Branson and Virgin Unite. During the three-year stint, he launched an initiative to find climate change solutions and connect those opportunities to the people who can realize them. He shares with us his story of teenage passion for solar and his journey to becoming one of the planet's most important innovators.

I bought a dozen copies of *Creating Climate Wealth*. I want to share Jigar Shah's vision and story with friends and colleagues, particularly the "nontraditional" stakeholders who will be a bigger part of the solution once they realize they too can make money *and* make good choices.

Laura Richardson is executive director of the Jordan Institute (www.jordaninstitute.org). She has coordinated nine stimulus-funded energy programs for the New Hampshire Office of Energy and Planning, led the StayWarmNH program, flipped a deep-energy-retrofit house in Woodsville, NH, cofounded the New Hampshire Sustainable Energy Association, and since 2001 has lived off-grid in a superinsulated, PV-powered, passive-solar and biomass-heated home.

From the executive director
from page 5

strategy session, I shared with NESEA member Kate Stephenson (executive director of Yestermorrow) that I would love to go back to school for an MBA. But I really wanted a practical, hands-on program that would help me be more effective with change management and with measuring the impact of NESEA's programs with respect to our mission.

Suddenly, a lightbulb went off. I too could participate in Bottom Lines as a member of the peer network. I too could benefit from the wisdom of a multidisciplinary group of peers, each with their own strengths and lists of mistakes to avoid. So I plan to use Bottom Lines to strengthen NESEA, to tend to our triple bottom line: our commitment to our people, our impact on the planet, and our profitability. And I expect to strengthen my leadership skills in the process.

Does this model resonate with you? If so, the next opportunity to get involved and to learn more will be March 4, at a BE Bottom Lines workshop at the BuildingEnergy conference in Boston. The first peer network will kick off in April of 2014. I hope you'll join us for both!

Jennifer J. Marrapese
Executive Director
jmarrapese@nesea.org

From the chair
from page 7

At BE14, March 4 to 6 in Boston, the Resilient Cities track includes presentations by Alex Wilson, Jim Newman (Linnean Solutions, Boston, MA) and Sarah Slaughter (Built Environment Coalition), coauthors of the report "Building Resilience in Boston." It will be the go-to place for learning more about bringing resilience thinking into our own practices.

There are so many mistakes to be made with respect to building. Let's do our best to ensure that, at a minimum, our mistakes will be new ones.

Caitriona Cooke
Chair, NESEA Board of Directors
caitriona.cooke@csgrp.com

The Uses and Abuses of the Renewable Portfolio Standard
from page 30

economically. Most renewable energy advocates look forward eagerly to the day when their technologies no longer need an RPS to provide "a fair chance against major financial and institutional barriers." That day is near, relative to when Aitken was writing. Wind electric-energy generation is already less expensive than new coal-powered electricity generation. Meanwhile, by all measures, large hydro seems to fall into the "unworthy" category.

In sum—as I recently confirmed in personal correspondence with Dr. Aitken[6]—inclusion of mature technologies in the electric mix is a bastardization of the RPS.

Joel Gordes is an independent energy consultant. His energy career spans nearly four decades. He has extensive experience in energy efficiency and has designed or aided in the design of over 200 passive solar homes. A strong advocate for energy and environmental security for greater resiliency, he has been involved in policy to further those aims. A resident of West Hartford, CT, he served as vice-chairman of the Connecticut legislature's Energy and Public Utilities Committee from 1987 to 1991. In 1990 he was a principal coauthor of the state's first global warming bill.

6. Facts on the RPS development and intent verified by Donald W. Aitken, PhD, on 10/18/2013.

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